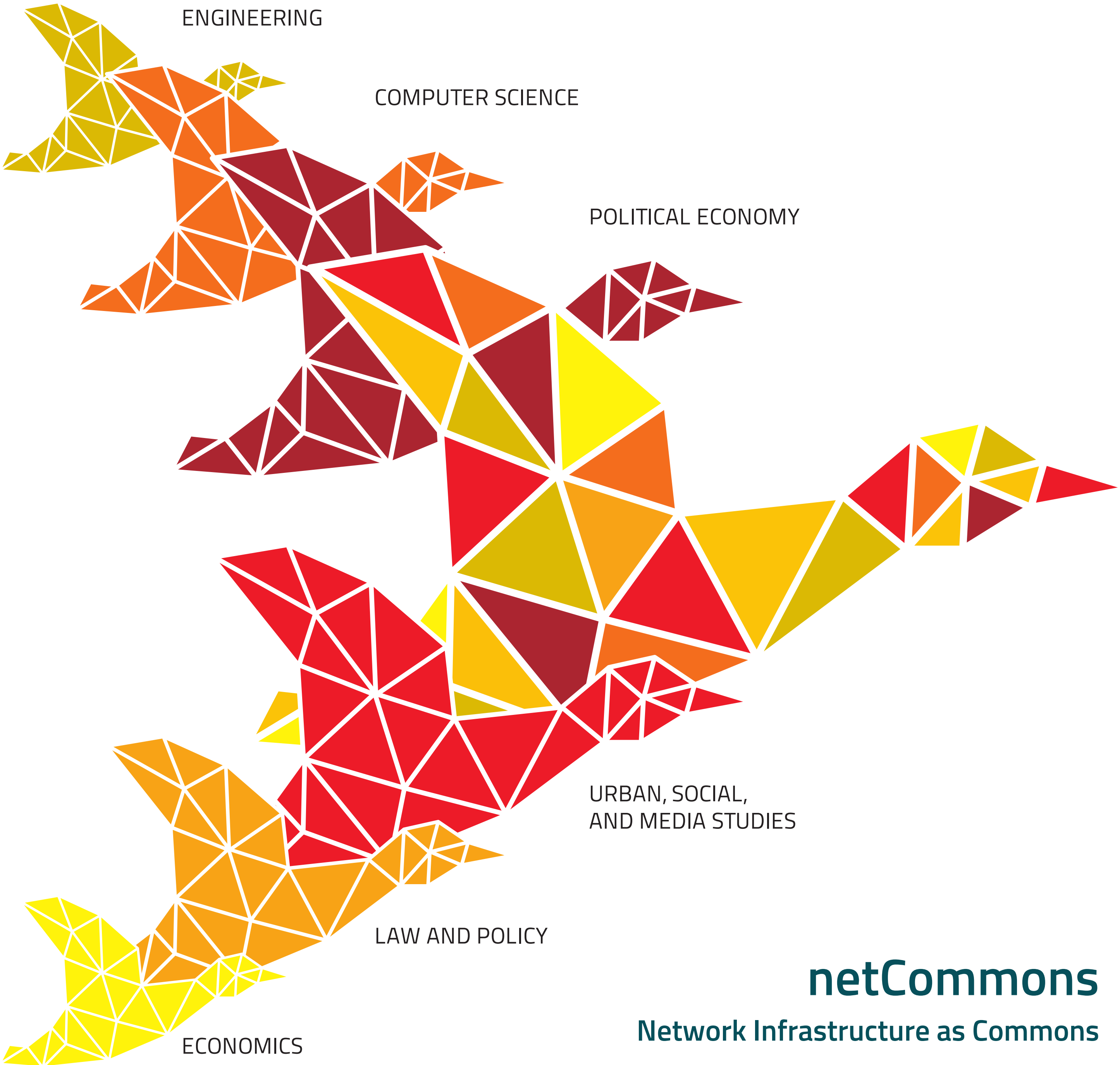


netCommons

Network Infrastructure as Commons

Dissemination Report: Summary of Dissemination Actions and Adoption of netCommons Solutions During the Third Year

Deliverable Number D6.3
Version 2.0
May 14, 2019

Co-Funded by the Horizon 2020 programme of the European Union
Grant Number 688768

netCommons.eu

Project Acronym:	netCommons
Project Full Title:	Network Infrastructure as Commons.
Call:	H2020-ICT-2015
Topic:	ICT-10-2015
Type of Action:	RIA
Grant Number:	688768
Project URL:	http://netcommons.eu

Editor:	Ileana Apostol, NetHood Renato Lo Cigno, UniTN
Deliverable nature:	Report (R)
Dissemination level:	Public (PU)
Contractual Delivery Date:	December 31, 2018
Actual Delivery Date	May 14, 2019
Number of pages:	371
Keywords:	community networks, dissemination
Authors:	Ileana Apostol, NetHood Renato Lo Cigno, UniTN Panayotis Antoniadis, NetHood Leonardo Maccari, UniTN Leandro Navarro, UPC Merkouris Karaliopoulos, AUEB Melanie Dulong de Rosnay, CNRS Maria Michalis, UoW

History of Revisions

Rev.	Date	Author	Description
v0.1	20/09/2018	Ileana Apostol	Outline
v0.2	27/10/2018	Panayotis Antoniadis	First draft of events
v0.3	10/12/2018	Panayotis Antoniadis	Impact and local stakeholders
v0.4	15/12/2018	Leandro Navarro	UPC input
v0.5	15/12/2018	Merkouris Karaliopoulos	AUEB input
v0.6	15/12/2018	Maria Michalis	UoW input
v0.7	15/12/2018	Melanie Dulong de Rosnay	CNRS input
v0.8	24/12/2018	Ileana Apostol	Various edits
v0.9	5/01/2019	Leandro Navarro	Collaboration with industry
v1.0	12/01/2019	Renato Lo Cigno	Full editing
v1.1	18/01/2019	Leonardo Maccari	Internet presence and ninux appreciatin
v1.2	28/01/2019	Renato Lo Cigno	Final proofreading

v2.0	14/01/2019	Panayotis Antoniadis and Renato Lo Cigno	Amendment on request of the EC, chapter 7 has been added as well as Appendix B reporting a vast collection of the material used in the dissemination activities in the third year an also in 2016 and 2017. This activity and additions also required extensive checks and additions to the original document

Executive summary

This deliverable summarizes the dissemination activities of the netCommons Consortium and their overall impact during the third and last year of the project, as well as outlining the impact that some actions had and possibly will have in the near and far future.

The structure of the deliverable is based on the type of activity, with an initial overall description and final conclusions. Chapter 1 summarizes the dissemination work documented in this deliverable, giving an overall picture of the strategies adopted and the overall effort both on the inner (communities) and outer (policy makers, society) loop as described in the Description of Action (DoA); Chapter 2 lists and presents one by one the events organized or attended by netCommons researchers; Chapter 3 discusses the activities devoted to improve and support Community Networks (CNs) advocacy initiatives; Chapter 4 is devoted to the meetings and support with local communities in general and CNs in particular; Chapter 5 presents the other dissemination activities that cannot be easily categorized as well as some industrial liaisons that we were able to establish, even if the project in itself did not initially consider this possibility; Chapter 6 discusses the overall positive impact generated for CNs by netCommons, attempting an objective analysis as far as possible; Chapter 7, added in Version 2.0 of the document, summarizes the impact of the project in form of tables presenting activities, actions, their impact and the means to reach these goals; Chapter 8 lists all the scientific publications and interventions of netCommons during the third year of activity classified by publication type; Chapter 9 draws some final considerations on the success of dissemination and impact of netCommons, and provides evidence for its potential impact beyond the end of the project. The Appendices collects appreciation documents to netCommons activity, as well as material used in the dissemination of results.

netCommons dissemination has been in general very successful, both from a quantitative point of view, with participation in many events, presentations at conferences, scientific papers and so on, and from a qualitative point of view, with publications in top venues and interventions at the EU and UN levels whose final outcome has been the recognition of Community Networks as key elements of an healthy Internet ecosystem, and legal provisions in the European Electronic Communication Code specifically designed for them.

The interaction with Community Networks has also been successful and fruitful, in an exchange process that enabled netCommons to root its research on solid ground, and empowered Communities with a renewed sense of purpose and importance, strengthened by the recognition they got on the legal and socio-economic dimension and by the consciousness of using and building a still evolving, novel, and challenging technological and engineering platform and infrastructure.

Extending the document to its Version 2.0 it became even more evident how vast and trans-disciplinary netCommons action has been. Beyond the fundamental research activity, the actions of the consortium partners and their involvement with Community Networks, policy makers, local activists and administrations has lead to a *'corpus'* of material, influence, and actions whose impact on Community Networks, but in general on the movement for a more democratic and socially sustainable Internet architecture keeps growing after the end of the project, and will continue to grow for several years to come.

Contents

List of Figures

List of Acronyms

APC	Association for Progressive Communications
AWMN	Athens Wireless Metropolitan Network
B4RN	Broadband for the Rural North
BEREC	Body of European Regulators for Electronic Communications
BREKO	German Broadband Association
CITEL	Inter-American Telecommunication Commission
CN	Community Network
CNSIG	Community Networks Special Interest Group
DC3	Dynamic Coalition on Community Connectivity
DoA	Description of Action
EECC	European Electronic Communications Code
EETT	Hellenic National Telecommunications and Posts Commission, National Regulator
ENISA	European Union Agency for Network and Information Security
EP	European Parliament
FOSS	Free Open Source Software
GAIA	Global Access to the Internet for All
GISWATCH	Global Information Society Watch
IAMCR	International Association for Media and Communication Research
IETF	Internet Engineering Task Force
IGF	Internet Governance Forum
IMCO	Internal Market and Consumer Protection
IRTF	Internet Research Task Force
ISOC	Internet Society
ISP	Internet Service Provider
ITRE	Industry, Research and Energy
LACNIC	Latin American and Caribbean Internet Addresses Registry
LIBE	Civil Liberties, Justice and Home Affairs
MEP	Member of the European Parliament
NGO	Non-Governmental Organisation
NGO	non-profit organisation
NPO	Non-Profit Organization
OAS	Organization of American States
SAC	Social impAct Committee
UNESCO	United Nations Educational, Scientific and Cultural Organization
WALC	Workshop for Latin America and the Caribbean

1. Overview of the activities

The third and final year of the netCommons project was marked by several important contributions to the struggle of Community Networks to get legitimized and recognized as a viable means for communities to connect themselves and own their networking infrastructures, to gain access to the Internet or to reduce the digital divide by providing customized services and applications.

- In January 2018 netCommons has initiated an exchange with United Nations Educational, Scientific and Cultural Organization (UNESCO). This positive interaction was followed by a netCommons contribution during the consultation process that finally led to the inclusion of Community Networks in the Internet Universality Indicators document. This is definitely a very important achievement with a major and lasting impact for the future of Community Networks that have been formally included into a UN-supported document.
- Next, netCommons has become an even more active contributor in the CN community, playing a key role in all relevant bodies like Internet Governance Forum (IGF)'s Dynamic Coalition on Community Connectivity (DC3) (netCommons partners contributed five chapters in the latest DC3 book, the "CN Manual"), Internet Society (ISOC)'s Community Networks Special Interest Group (CNSIG) and ISOC-CH[1] (NetHood is leading the social impact working group in both ISOC bodies), Association for Progressive Communications (APC) (UPC and UniTn contributed key chapters in the latest Global Information Society Watch (GISWATCH) book on "Community Networks"), and Battle of the Mesh (UniTn run the core testbed experimentation and NetHood organized a novel encounter –for this community– with local urban activists).
- netCommons has been guiding the advocacy effort by CNs to reach policy makers and politicians, through open letters, the telecommons mailing list and policy briefs, developed by CNRS and UniTn, which maintain a close collaboration with key organizations like the La Quadrature du Net.
- Later, netCommons has been invited to represent the CN case in the EU parliament following its own workshop, a strong evidence of a lasting impact in the EU policy ecosystem, achieved rarely by such short-lived EU projects.
- On the inner loop, two high impact gatherings were organized at the birth places of Sarantaporo.gr and guifi.net where key actors were present and thus had the unique chance to engage in fruitful exchanges with the local community. This gave the opportunity to bring to the table local stakeholders difficult to reach until now, like the Greek regulator and Athens municipality.
- Midway between the inner loop and the outer loop we can place the high popularity of the netCommons twitter channel ($\sim$ 10 k impressions monthly), the increasing number of invitations to participate in international high-impact events, and the public praise by bodies like ISOC and the Commons Network are very telling measures of impact.
- netCommons Deliverable 4.5 "Best Practices Guide for Community Networks" will be published, with minor modifications, as a book by APC and supported by ISOC. Several scientific (or technical) results have been re-compiled and published in friendly formats like the policy brief[2]. The participatory design methodology developed in Task 3.1 has been summarized in a booklet[3]. All this and much more give us confidence that the impact of the netCommons work will continue beyond the duration of the project.

[1] The Swiss subsidiary of ISOC https://www.isoc.ch/commitees-bodies/sac

[2] See https://www.netcommons.eu/?q=content/netcommons-guidelines-telecom-policy-makers

[3] The current draft is at https://www.netcommons.eu/sites/default/files/pd-methodology-booklet-v0.6.pdf; later versions will be available at http://nethood.org/studio

- The software and applications developed in WP3, but also the monitoring tools developed in WP2, are receiving attention from the communities that are considering their adoption for different uses, thus also the engineering and computer science research and innovation in netCommons is leaving a significant mark in the world of Community Networks.
- Finally the third year has marked a record of more than 50 scientific publications and contributions. Some of them are being translated in different languages (e.g., Greek, German, Spanish, French, Portuguese) adding to the multi-dimensional impact of netCommons in many relevant fields for the sustainability and development of the CN model.

1.1. Internet Presence

netCommons web site in 2018 served 1,988,870 requests for 34,527 visitors (excluding robots) with an average of 94 visitors per day (with a 34% increase with respect to 2017). Fig. 1.1 reports the time graph of number of objects served (blu line, left hand axis) and the unique daily visitors (red line, right hand axis) for the reported period. More details on the website statistics, together with detailed impact of publications and other dissemination indicators are included, at the end of the project, in the dedicated management deliverable D7.5 "Report on the publications and data download, use, and citation".

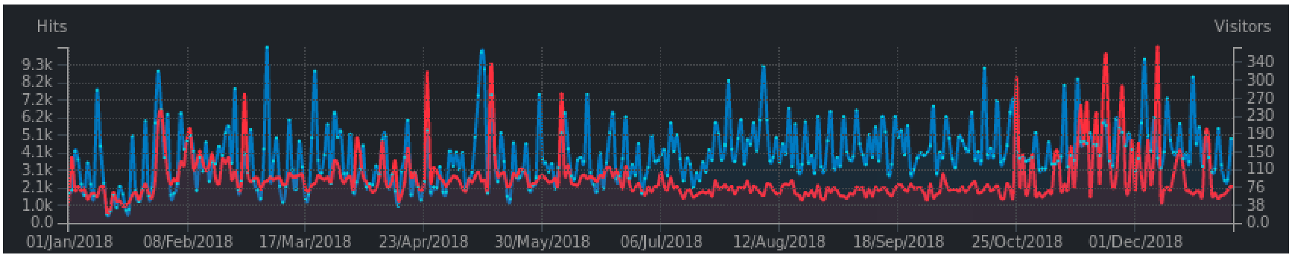


Figure 1.1: The access statistics of www.netcommons.eu for 2018.

2. Events

netCommons has organized numerous events and participated in well established events organized regularly by other stakeholders, being them communities, large scientific societies or other recognized actors. As done in the previous dissemination deliverables we divide events in categories: we first report on the events organized or co-organized by netCommons in Sec. 2.1, then on those where we participated in Sec. 2.2. These two Sections refer to general multi-cultural events. Sec. 2.3 is dedicated to specialist scientific venues where netCommons partners participated. Next, Sec. 2.4, Sec. 2.5 and Sec. 2.6 summarize on general public talks and other community building activities.

2.1. Organized events

2.1.1. What strategy for Alternative Internets?

Type: Workshop

Date: January 29, 2018

Place: Paris, France

URL: http://www.iscc.cnrs.fr/spip.php?article2420

Dissemination Level: International

Actors: Academia, civil society, activist, policy makers, CAPS community

Audience: 60

Organizers Melanie Dulong de Rosnay (CNRS) and Francesca Musiani (CNRS)

Description (from the conference material): netCommons in collaboration with NextLeap, another EU-funded research project working on alternative networks and encryption, co-organized a discussion on alternative Internet infrastructures, at the Institut de recherche et d'innovation, Salle Triangle, Beaubourg Center, Paris.

Many groups across the world are trying to build technical infrastructures, be they telecom networks, access provision services or hosting and other online services, that foster decentralization and defend human rights. In that respect, they build "alternative Internets" that embody spaces of autonomy and resistance to hegemonic players in the digital realm. In this workshop, we invited activists and researchers to discuss the state of play, reflect on the success and failures of the "alternet movement" and lay out strategies that can help it grow and flourish in the coming years.

Summary: The main questions raised during this workshop was regarding the decentralization of the Internet and how to develop strategies from several perspectives (technical, economic model, policy).

Input interventions were provided by Ramon Roca (guifi.net), Tristan Nitot (cozy cloud), Félix Tréguer (CNRS), Oriane Piquer-Louis (FFDN), Pierre-Yves Grosset (Framasoft), Alison Powell (LSE).

A animated discussion followed on the main challenges for alternatives to survive and become more mainstream. The overall agreement was that we have to continue trying. Things change in a way you cannot anticipate and thus it is important to propose new possibilities.

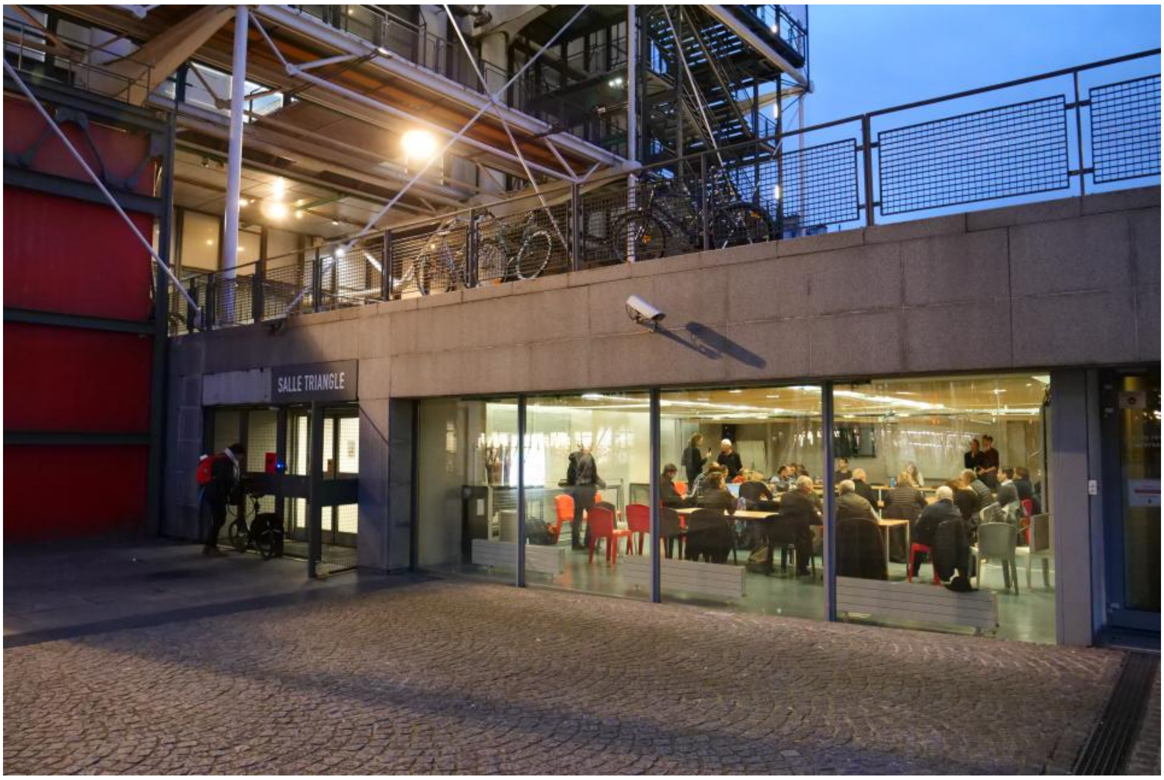


Figure 2.1: The venue of netCommons workshop "What strategy for Alternative Internets?" at Center Pompidou, Paris

2.1.2. netCommons at UNESCO

Type: Workshop

Date: January 30, 2018

Place: Paris, France

URL: https://netcommons.eu/?q=news/netcommons-unesco

Dissemination Level: International

Actors: Academia, civil society, activist, policy makers

Audience: 25

Organizers Maria Michalis and Melanie Dulong de Rosnay

Description (from the conference material): The netCommons project, together with members of its advisory board visited on January 30, 2018, the offices of UNESCO in Paris for a discussion on the potential impact of Community Networks for several Internet Universality Indicators.

Summary: Leonardo Maccari, Maria Michalis and Melanie Dulong de Rosnay did three presentations to the UNESCO staff with focus on the technical feasibility and social impact of CNs, the perception of CNs from interested people and the impact of the legal system on CN respectively. All three themes produced an informed discussion with the UNESCO working group on the Internet Universality Indicators which was extremely fruitful to enlarge the interest on CNs to a wider community, and to improve the indicators. The netCommons project was asked to participate at the consultation on the indicators, and to produce a formal feedback.

Notes: Eventually, the final version of the UNESCO's Internet Universality Indicators contains at p. 39 an indicator explicitly mentioning Community Networks "**C.6 Are communities able to establish their own**

Figure 2.2: The netCommons team at UNESCO headquarters, Paris

networks to provide Internet access?".
Slides reported in Appendix B.1.1.

2.1.3. Towards an Alternative Internet in the Age of Cambridge Analytica and Fake News

Type: Workshop

Date: May 15, 2018

Place: London, UK

URL: https://netcommons.eu/?q=content/towards-alternative-internet-age-cambridge-analytica-and-fake-news%C2%A0

Dissemination Level: International

Actors: Academia, civil society, activist, policy makers, CNs

Audience: 30

Organizers Dimitris Boucas (UoW) and Maria Michalis (UoW)

Description: As part of the netCommons project, UoW organized a one-day policy workshop in London in May 15, 2018 that brought together a range of stakeholders for discussing what kind of Internet is desirable; whether the digital commons pose viable models for the organisation of the Internet infrastructure, software, platforms and content; and what policies and measures are needed for strengthening the commons as alternatives to Internet monopolies, surveillance, privacy violations, and targeted ads.

The workshop brought together twenty stakeholder representatives from the world of policy making, community networks and civil society. They included participants from community network organisations such as Balancing Act, B4RN, Community Broadband Network, Free2Air, guifi.net, Independent Networks Cooperative Association (INCA), Sarantaporo.gr, Senza Fili Senza Confini, and Wansdyke as well as representatives from organisations such as Association for Progressive Communications, Commons Network, Information Society S.A., Ofcom, the Dutch Pirate Party, and UNHCR. In addition to the organizers, Virginie Aubrée (UniTN) and Melanie Dulong de Rosnay (CNRS) participated on behalf of netCommons.

Summary: The summary of the event has been published on netCommons web site as specific event, and developed in detail in Deliverable 4.4.

Notes: There was a very positive post by the Network Commons project[1], which gained significant attention on twitter[2].

Figure 2.3: netCommons Alternative Internet workshop in London

2.1.4. Encounters in the hybrid city

Type: Roundtable

Date: March 31, May 13, May 25, 2018

Places: Heraklion, Greece; Berlin, Germany; Zurich, Switzerland

URL: https://netcommons.eu/?q=content/encounters-hybrid-city

Dissemination Level: International

Actors: Academia, civil society, activist

Audience: 10; 40; 20

Organizers Panayotis Antoniadis and Ileana Apostol

Description: The netCommons project collaborates with the MAZI project in organizing a series of gatherings, or encounters, that bring together people from the digital and urban rights movements in an informal and playful way. There is no other agenda but to raise awareness between digital and urban activists on each other's challenges, tactics, and lessons learned. The format varies depending on the context and the available resources and time.

[1] http://www.commonsnetwork.org/news/commonsnetworkinlondon/
[2] https://twitter.com/commonsnetwork/status/1026456858607996928

Summary: The summary of the three encounters is included in detail in Deliverable D5.5 [2], and especially for the one in Berlin, held in the framework of the Battle of the Mesh, there is a dedicated blog entry in netCommons web site. The slides used by Ileana Apostol in Zurich are reported in Appendix B.2.

Figure 2.4: Encounter in the hybrid space in Berlin

2.1.5. Sarantaporo Conference

Type: Conference

Date: July 7-8, 2018

Place: Sarantaporo area, Greece

URL: https://netcommons.eu/?q=content/sarantaporo-conference-building-community-community-networks

Dissemination Level: International

Actors: Academia, civil society

Audience: 20

Organizers Panayotis Antoniadis

Description: On July 7-9th researchers, practitioners, and key actors in the development of Community Networks around the world will visit one of the success stories of this movement in Greece, the Sarantaporo.gr Community Network. The event includes a 2-day guided visit in the Sarantaporo area and a public event in Athens, with local stakeholders, organized by the netCommons project and the Sarantaporo.gr Non-Profit Organization.

Organizing gatherings and workshops where the real action takes place is important for both parties involved.

The local community feels recognition and empowerment, and realizes the importance of their endeavor at a global scale.

The people working on the global technical, social, economic, and political challenges that these networks face get the opportunity to progress their agenda in an environment that is full of information on how things work on the ground, but also full of inspiration and motivation being in contact with the people's particular stories related to their CN.

The Sarantaporo.gr CN being located close to the highest and most popular Greek mountain, the mount Olympos, offers also a great opportunity for informal discussions and socialization in nature, a collaboration experience that can prove much more productive than 'air conditioned rooms and power point presentations,' both in the short and in the long term.

Figure 2.5: Workshop at the Sarantaporo village with local residents and netCommons guests, including a live streaming session with NYC Mesh

Summary: This conference managed to bring to the remote Sarantaporo.gr area key actors in the CN worlg community like Jane Coffin (ISOC) and Steve Song (VillageTelco), but also the netCommons advisors like Ramon Roca (founder Guifi.net) and Adam Burns (founder Free2Air).

The netCommons consortium and their distinguished guests were hosted by the members of the Sarantaporo.gr network and engaged in numerous formal and informal interactions, with highlight the public live stream, the "CN encounter #1" with the NYCMesh Community Network, more specifically with its core members Brian Hall and Joly MacFie, in New York City.[3].

[3]A tweet by Jane Coffin, ISOC, documenting the encounter: https://twitter.com/jane_coffin/status/1015639201453207552 and more photos are available at https://netcommons.eu/?q=content/sarantaporo-conference-building-community-community-networks

Notes: This event was very well received by all parties involved and generated significant praise online[4]. It served both giving the local community a strong sense of global participation, extremely important for isolated communities, and raised additional attention by global bodies like ISOC on the work of netCommons.

At the end of the conference and before the participants head to Athens for the ImpactHub symposium, see Sec. 2.1.6, an interesting improvised workshop was carried out for the preparation of the different presentations and the overall “strategy” of the group given the opportunity created by the presence of high profile guests from the Greek regulator and the city of Athens in the same panel.

A lot of interesting important points were raised like a metaphor with forests by Steve Song explaining that we are not trying to insert a new giant tree into the forest/market but looking for space for new small trees to grow, to create a healthy ecosystem. And you need small operators for that.

Ramon Roca also stressed that it is dangerous to ask for “pilots” because CNs might end up always constrained to such pilots. We need true fair competition to create alternatives.

2.1.6. ImpactHub symposium

Figure 2.6: ImpactHub workshop in Athens with special guests the Greek Regulator and the Chief Digital Officer of the City of Athens

Type: Symposium

Date: July 9, 2018

Place: ImpactHub, Athens

URL: https://netcommons.eu/?q=content/new-eu-telecommunications-code-greece-and-its-effect-community-networks

Dissemination Level: International

Actors: Academia, civil society, policy makers, local authorities, regulators, general public

Audience: 50

Organizers: Panayotis Antoniadis

Description: After the 2-day visit and conference of the Sarantaporo.gr CN, this public panel in Athens, organized by netCommons, brought together international experts and local stakeholders to build a better un-

[4]E.g., https://twitter.com/jane_coffin/status/1017016892668743680

derstanding of the key role of small providers and community networks, and their needs, how the new EU telecommunications code might affect them, and which precautionary actions can be taken today.

We will present to the Greek public the Community Network model and the worldwide movement aiming to support it, and the current legal and regulatory situation in Greece as an EU member state, through a series of 5 min statements of special guests from abroad and local stakeholders.

We will then open the discussion to explore how community networks like Sarantaporo.gr can be supported and replicated.

Summary: The presence of netCommons guests in Greece, made it possible to have in this event in Athens key stakeholders difficult to reach until then: Vassiliki Gogou, President's Office, Hellenic National Telecommunications and Posts Commission, National Regulator (EETT). Konstantinos Champidis, Chief Digital Officer, City of Athens, and Prodromos Tsiavos, Member of the board of the Greek Free Open Source Software (FOSS), responsible for Policy Recommendations, Open Content and Intellectual Property

After a roundtable of introductory presentations, a very interesting discussion developed which highlight the expression of interest for a pilot project in the city of Athens, the development of first ideas on how the regulator can help CNs catch up with the upcoming regulations through dedicated seminars, and the creation of dedicated educational processes on community networking through the Greek FOSS. The slides used at the event by most presenters are reported in Appendix B.3.d

2.1.7. Global Access for All (GAIA) WG

Type: Workshop

Date: November 6; Jul 17; March 22, 2018

Places: Bangkok, Thailand (IETF 103); Montréal (IETF 102), Canada; London, UK (IETF 101).

URL: https://irtf.org/gaia

Dissemination Level: International

Actors: All actors, mainly the technical community, standards and research.

Audience: 40 (IETF 103), 60 (IETF 102), 60 (IETF 101)

Organizers: Leandro Navarro (UPC) and Jane Coffin (ISOC)

Description (from the conference material): The Global Access to the Internet for All (GAIA) Research Group is an Internet Research Task Force (IRTF) initiative that aims to create increased visibility and interest among the wider community on the challenges and opportunities in enabling global Internet access, in terms of technology as well as the social and economic drivers for its adoption; to create a shared vision among practitioners, researchers, corporations, non governmental and governmental organisations on the challenges and opportunities; to articulate and foster collaboration among them to address the diverse Internet access and architectural challenges (including security, privacy, censorship and energy efficiency); to document and share deployment experiences and research results to the wider community through scholarly publications, white papers, presentations, workshops, Informational and Experimental RFCs; to document the costs of existing Internet Access, the breakdown of those costs (energy, manpower, licenses, bandwidth, infrastructure, transit, peering), and outline a path to achieve a 10x reduction in Internet Access costs especially in geographies and populations with low penetration. to develop a longer term perspective on the impact of GAIA research group findings on the standardisation efforts at the Internet Engineering Task Force (IETF). This could include recommendations to protocol designers and architects.

Summary: The summary of the activities are reported in the IETF repository for all editions[5].

The slides used by Leandro Navarro are reported in Appendix B.4 and Appendix B.5.

[5] https://datatracker.ietf.org/group/gaia/meetings/

2.1.8. Community Networks course in Latin America and the Caribbean

Figure 2.7: An image of the participants in the course in Latin America and the Caribbean

Type: An intensive, one week course, on community networks in Spanish, as part of the Workshop for Latin America and the Caribbean (WALC) 2018 (Track 7) of training activities coordinated by Fundación EsLaRed.

Dates: 26-30 November 2018

Place: Santo Domingo, Dominican Republic

URL: http://eslared.net/walc2018/?page_id=1172&lang=en_US

Actors: General Public and Students

Audience: 15

Organizers: Leandro Navarro from UPC, Erick Huerta from RedesAC/Rhizomatica (Mexico), Roger Baig from the guifi.net Foundation, Roger Pueyo and Emmanouil Dimogerontakis from UPC and netCommons.

Sponsors: EsLaRed foundation, Internet Society, Inter-American Telecommunications Commission (CITEL), American States Organization (OEA), netCommons.

Description: This workshop trains participants, through a combination of theoretical and practical elements, in the tools and techniques for planning, designing, deploying, operating and maintaining community networks, with an emphasis on the use of low-cost solutions suitable for rural and urban areas.

The course targets people interested in making a first immersion in community networks and citizen-based telecommunications networks, they can have diverse profiles with previous training or experience (organizational, social, networking, economic) that can provide and enrich the exchange of views and activities in the course group.

Summary: The course was organized over 5 days with the following content:

Day 1: Concepts, models and cases of community networks and operators.
Day 2: Activity models, experiments to familiarize yourself with various access and transport technologies.
Day 3: Network planning, design, deployment and operation, development of individual cases I.
Day 4: Regulation, feasibility and impact, development of individual cases II.
Day 5: General summary, development of individual cases III, presentation of results (cases and implementation plans).

The slides, activities and diverse materials are available from Leandro Navarro web site, and a copy of the main presentations is reported in Appendix B.9

2.1.9. netCommons Booksprint

Figure 2.8: Writing intensely during the netCommons booksprint

Figure 2.9: Group photo after the visit of guifi.net at EU's Ombudsman

Type: A full immersion week to prepare the material for a book

Date: October 21-25, 2018

Places: Seminari de Vic, Catalonia

URL: N/A

Dissemination Level: Internal (the Booksprint); Global the resulting book

Actors: netCommons partners, Advisory Board members, and

Audience: 12 booksprint participants and around 10 guifi.net community members

Organizers Local organization: Ramon Roca, Meritxell Vilaró, Clara Cusó (guifi.net); Scientific organization: Melanie Dulong de Rosnay (CNRS) and Félix Tréguer (CNRS)

Description: Creating the basic content of a book in 5 days with approx. 12 experts:

- A book with social and technical guidelines to structure the practice of the CNs;
- In a nice-to-read, useful style for enthusiasts with basic knowledge which want to know how to create, develop and maintain free networks;
- Comprehensively covering recommendations in legal, policy, governance and economic models, with hints for the technical start-up.

Summary: The netCommons booksprint was organized as a small event taking place in guifi.net's birthplace the Seminari de Vic, in Catalonia.

In addition to the collective writing process we had the opportunity to visit important locations in the history of guifi.net and talk with key actors. netCommons also participated in the submission of a complaint to EU's Ombudsman one day after the end of the booksprint. The presence of netCommons partners and advisory board was used as evidence for the wider potential impact of addressing the complaint for all CNs in Europe.

Notes: The outcome of the booksprint is the netCommons deliverable 4.5 "Best Practices Guide for CNs." However, there has been an agreement to proceed to a proper book publication by APC supported by ISOC in 2019.

netCommons produced a video report documenting the guifi.net's visit to EC Ombudsman in Barcelona.

2.2. Participation in high-impact international events

2.2.1. Battle of the mesh, Berlin

Type: International Conference

Date: May 7-13, 2018

Place: Berlin, Germany

URL: https://wireless-meshup.org/doku.php

Dissemination Level: International

Actors: Activists, Academia

Audience: 100

Participants Leonardo Maccari, Luca Baldesi, Virginie Aubrée, Panayotis Antoniadis

Description (from the conference material): The Wireless Battle Mesh v11 (#WBMv11) and the Wireless Community Weekend 2018 (#FFWCW18) will be meshed up and co-located in Berlin from May 07 to May 13, 2018. Since it is the 15th anniversary of the WCW, friends and fellows from across the globe celebrate together wireless mesh network technologies and ideas of community networking.

You can expect to meet with tech experts in mesh technologies, policy discussions, talks, hands on workshops, late night hacking sessions, measurement campaigns and an ongoing barbeque at the riverside. If you are a mesh networking enthusiast, community activist, or simply have an interest in WiFi or dynamic routing protocols, you can't miss this event!

Summary: This core event for the CN Community included many netCommons contributions, including the implementation of the main activity (the set-up of the testbed and comparisons by Leonardo Maccari and Luca Baldesi, which was a key step for the development of PeerStreamer-ng, and it is better detailed in D3.5 [3]), the coordination of a panel on the CNSIG by Panayotis Antoniadis, the invitation to a call for action by Virginie Aubrée, and the organization of a "hybrid encounter" between the battle of the mesh participants and urban activists from Berlin, by Panayotis Antoniadis and Ileana Apostol.

The slides used by Leonardo Maccari to present the netCommons project are reported in Appendix B.7.

2.2.2. Internet Engineering Task Force (IETF) 101

Type: International Forum

Date: March 17-23, 2018

Place: London, UK

URLs:

- Plenary talk: https://www.internetsociety.org/blog/2018/03/connect-everyone-internet-ietf-101-technical-plenary/
- General details of the event: https://www.ietf.org/how/meetings/101/
- Blog article about the talk: https://netcommons.eu/?q=content/internet-everyone-everyone
- Slides: https://datatracker.ietf.org/meeting/101/materials/slides-101-ietf-sessb-go-local-community-networks-leandro-navarro-00
- Video Recording: https://www.youtube.com/watch?v=zRF6Trtk290&feature=youtu.be

Dissemination Level: International

Actors: Industry, Developers, Civil society, technical community, standardization groups

Audience: 2026

Participants: Leandro Navarro

Figure 2.10: Leandro Navarro keynote at the IETF 101 Plenary

Description: IETF Meetings are very large conventions where the future standards of the Internet are discussed. This year, thanks also to netCommons activities, one of the Technical Plenary Sessions of the IETF was organized by GAIA IRTF WG and dedicated to "The Future of Internet Access", or how community networks, spectrum regulation and satellite links can enable the remaining 50% of the global population in developing their own network infrastructures.

Before the keynote we had a private lunch meeting with the Internet Architecture Board (IAB) where we discussed about the obstacles for an open and public Internet.

Summary: How do we connect everyone, everywhere, to the Internet? What role do "community networks" play in helping connect more people? How can we best use wireless spectrum and what are the issues with that? How can satellites fit into the picture? And what is the state of satellite technology? And what about the role of "space lasers"?

These were the questions that the panel at the Technical Plenary at IETF 101 in London tried to answer. The panel was moderated by Jane Coffin and included these speakers: Leandro Navarro Moldes, Steve Song, and Jonathan Brewer.

The session began with Leandro Navarro outlining how half the world is still not connected to the Internet and is not able to benefit from all the opportunities. He explored the reasons why, the challenges with business models, and the opportunities to improve the situation. He spoke about the different types of community networks and the need for small providers to cooperate and collaborate to be most effective.

Next Steve Song opened with the provocative question –do we care more about connecting refrigerators than poor people? He went on to talk about the impact of fiber optic connections in Africa– and then explained both the opportunities and challenges of using radio spectrum for communication. Steve discussed the economics and politics of spectrum allocation and finished looking at some of the upcoming next generation technologies. A key message: access diversity is critical!

Finally, Jonathan Brewer provided a view on satellite options for Internet access. He outlined typical orbits and latencies; spoke about different architectures and common deployment scenarios; and explained different satellite spectrum bands and then pros and cons. We learned about "rain fade" and other terms. He also offered three newer commercial ventures as examples of the exciting activities in the space sector.

After the panelists spoke, Jane opened the floor to questions. Attendees asked about the diversity of options, the need to include more people and regions, and more. It was an educational session that offered many ideas for how to connect the rest of the world, and self-provision is an opportunity for citizens and small providers to cooperate to be effective in developing local networking infrastructures that provide regional coverage and services. As netCommons has shown, community networks have demonstrated to be effective for helping in local socio-economic development, developing local connectivity, enabling the growth of local business, and supporting local resilience. Community networks need diversity, standards, interoperability, commodity components, ways for incremental upgrading of the networks, and decentralised management, investment and governance. The IETF community can contribute to create this environment.

We firmly believe that connectivity for the next 50% of the global population will develop bottom-up. The research in netCommons and the discussions and work of the IRTF GAIA WG contribute to understand and achieve this.

The slides used by Leandro Navarro are reported in Appendix B.8.

2.2.3. "Community Networks: How the Unconnected Connect Themselves" at WSIS 2018

Type: Thematic Workshop in International Forum

Date: March 19, 2018

Place: Geneva, Switzerland

URL: https://www.itu.int/net4/wsis/forum/2018/Pages/Agenda/Session/143

Dissemination Level: International

Actors: Academia, Policy Makers, Activists

Audience: 50

Participants Panayotis Antoniadis

Description (from the conference material): Half of the world's population does not have access to the internet. Limitations on existing business models to provide affordable services in low-income areas, combined with innovations in low-cost communication technology, have resulted in new possibilities for the development of affordable, locally owned and managed networks, commonly known as Community Networks.

Community Networks don't just provide affordable access; they have broader development implications. In the first part of this workshop, representatives from 5 different Community Networks worldwide will present their infrastructure and approaches to show the links between their work and the Sustainable Development Goals. Presentations will focus on the progress made by each of the initiatives during the last year, as progress is taking place in the field constantly.

In the second part of the workshop a panel discussion will take place among the presenters to discuss what lies ahead, including opportunities and challenges they face to expand their infrastructure.

Summary: The description of several Community Networks, including guifi.net and sarantaporp.gr were given highlighting their of Community Networks in connectivity spread

The full report is available at https://dig.watch/sessions/community-networks-how-unconnected-connect-themselves

2.2.4. Session on Sustainability and Governance Training for Community network operators, in the Third Summit on Community Networks in Africa

Type: International Forum

Date: September 2-7, 2018

Place: Wild Lubanzi Trail Lodge, Eastern Cape, South Africa

Organizers: ISOC, APC, Zenzeleni.

URL: https://www.internetsociety.org/events/summit-community-networks-africa/2018/agenda/

Dissemination Level: International (mainly in Africa)

Actors: Community networks, civil society, technical community, international organizations.

Audience: 90

Participants: Carlos Rey Moreno and Sol Luca de Tena from Zenzeleni, Leandro Navarro (remotely) prepared and run the session.

Description (from the conference material): On day 2 of the event, netCommons contributed to prepare a session on"Sustainability and Governance Training for Community network operators." This session aimed to give a clear idea of the various elements that play into the sustainability of CNs; business (governance, finance), legal, social. Understanding planning aspects, opportunities, start up and business operation and business purpose, documentation (lessons learned and evidence building), reporting, unique value proposition and constraints.

Summary: The session offered practical tools and examples towards understanding the phases of planning, start up, operation and growth, building a business canvas/plan in groups. The session is based on the WP1 results on organizational models using the business model canvas as a template for the description of how communities relate and provide value to its local environment.

It was very helpful as a way to structure and highlight critical aspects to consider in the different initiatives, and be able to compare and complete each high level section of the canvas.

2.2.5. Internet Governance Forum (IGF) 2018

Type: International Forum

Date: November 12-14, 2018

Figure 2.11: The CN summmit was attended by many community networks projects, realities, and interested parties.

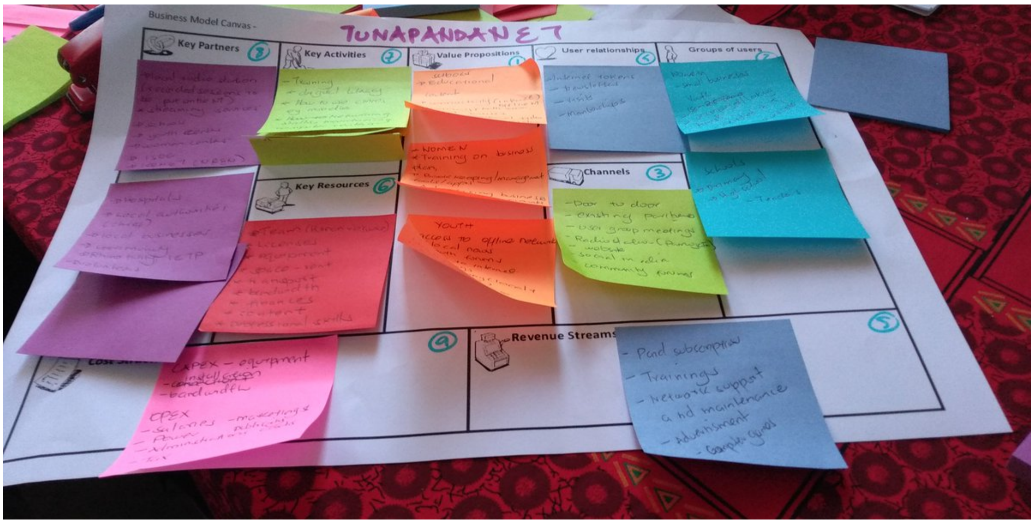


Figure 2.12: One of the canvas model developed during the CN summmit.

Place: Paris, France

URL: https://www.intgovforum.org/multilingual/content/igf-2018-0

Dissemination Level: International

Actors: Academia, Policy Makers, Activists, Regulators

Audience: 3000 at the forum, 30-100 in the netCommons sessions

Participants Leandro Navarro (UPC), Virginie Aubrée (UniTN), Melanie Dulong de Rosnay (CNRS), Félix Tréguer (CNRS), Panayotis Antoniadis (NetHood)

Description: netCommons contributed to two main sessions during the IGF2018:

- **IGF 2018 DC Community Connectivity: When The Unconnected Build Connectivity (DC3)**[6] The Dynamic Coalition on Community Connectivity (DC3) provides a common platform involving all interested stakeholders in a cooperative analysis of the community network model, exploring how such networks may be used to sustainably expand Internet connectivity while empowering Internet users.

  The DC3 session 2018 has been organised through email interactions on the DC3 mailing-list as well as through a face-to-face meeting, held at RightsCon 2018.

  Session panelists presented their contributions to "The Community Network Manual: How to Build the Internet Yourself," which is the official 2018 outcome of DC3 and is a joint publication of the ITU, FGV and ISOC. Furthermore, the session will stimulate discussion with stakeholders that are developing community network-related initiatives and that could become DC3 partners.

- **IGF 2018 WS #279 Scaling community networks: exploring blockchain and efficient investment strategies**[7]

  The goal of the session is to bring together multiple stakeholders from the Community Networks movement, including collaborators from academia and funding agencies, to discuss the future of community networks through the integration of new technologies –particularly Blockchain– and the development of effective investment strategies for scaling-up.

  The establishment of Community Networks has emerged as a concrete alternative to address the challenge of connecting the unconnected. In recent years, a range of CNs worldwide have consolidated and demonstrated not only the viability of CNs from a infrastructure standpoint, but also from community management perspective through the establishment of sustainable business models.

netCommons also had significant contribution to the GISWatch 2018 book on Community Networks and the DC3 "The Community Network Manual: How to Build the Internet Yourself," which were launched during IGF 2018[8].

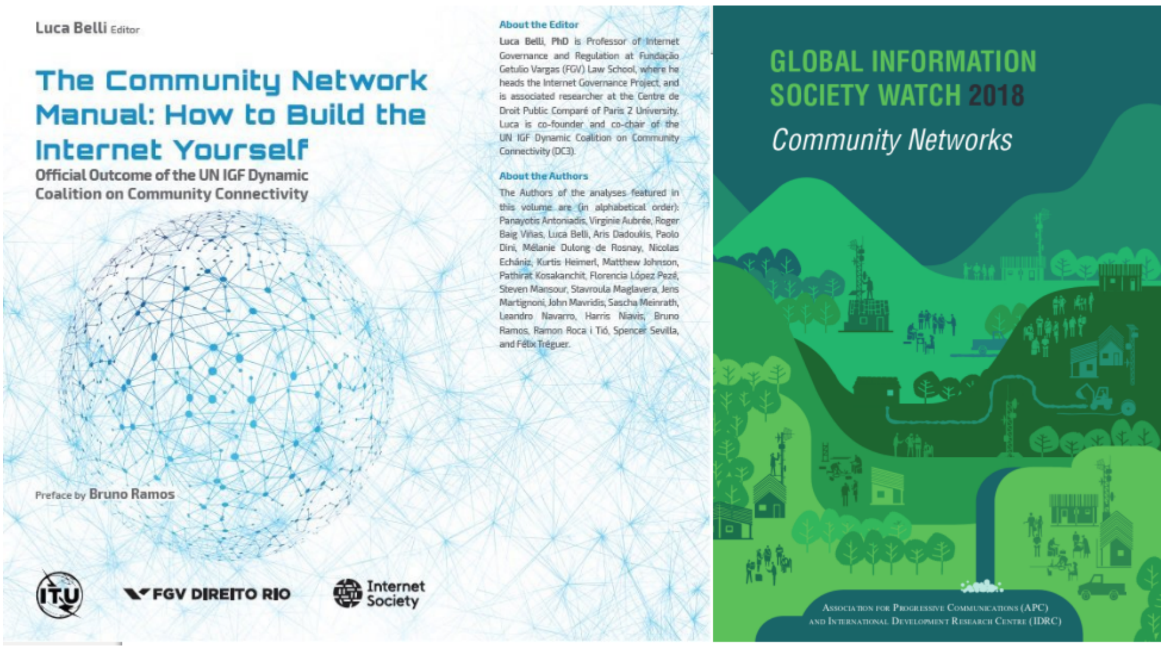


Figure 2.13: Two books on CNs with significant netCommons contributions launched at IGF2018

[6]https://www.intgovforum.org/multilingual/content/igf-2018-dc-community-connectivity-when-the-unconnected-build-connectivity-dc3

[7]https://www.intgovforum.org/multilingual/content/igf-2018-ws-279-scaling-community-networks-exploring-blockchain-and-efficient-investment

[8]https://www.intgovforum.org/multilingual/content/igf-2018-apc-giswatch-launch

Summary: Community Networks had a significant presence in IGF 2018, one of the most important global events on Internet Governance and beyond. And netCommons contributed significantly in three of the most important sessions around this topic. In addition, among many private meetings with key actors present in the conference, Félix Tréguer and Mélanie Dulong de Rosnay had a meeting with Jane Coffin (ISOC) and Carlos Rey-Moreno (APC) to organize the publication in 2019 of the netCommons book deriving from Deliverable 4.5 (see Sec. 2.1.9).

Notes: A blog post including the draft talk by Panayotis Antoniadis at WS #279 is available at https://netcommons.eu/?q=content/blockchain-and-community-networks-friends-or-foes

Figure 2.14: Full house at the IGF 2018 DC Community Connectivity Session

2.3. Scientific conferences and workshops

2.3.1. 14th IFIP/IEEE Conference on Wireless On-demand Network Systems and Services (WONS)

Type: Conference

Date: 6-8 February 2018

Place: Isola 2000, France

URL: http://2018.wons-conference.org/

Presented paper: Lorenzo Ghiro, Leonardo Maccari, and Renato Lo Cigno "*Proof of networking: Can BlockChains Boost the Next Generation of Distributed Networks?*"

Dissemination Level: International

Actors: Academia and industry

Audience: Around 50 people

Participants Renato Lo Cigno

Description (from the conference web site): Wireless on-demand network systems and services have become pivotal in shaping our future networked world. Starting as a niche application over Wi-Fi, they can now be found in mainstream technologies like Bluetooth LE, LTE Direct and Wireless LANs, and have become the cornerstone of upcoming networking paradigms including mesh and sensor networks, the Internet of Things, cloud networks, vehicular networks, disruption tolerant and opportunistic networks, underwater and intra-body networks.

The challenges of this exciting research field are numerous. Examples include how to make smart use of these novel technologies when multiple technologies or a mix of permanent services and on-demand networking opportunities are available to a network node, how to provide robust services in highly dynamic environments, how to efficiently employ and operate heavily resource-constrained devices, and how to develop robust and lightweight algorithms for self-organization and adaptation. Finally, there are many application-specific challenges.

WONS, now in its fourteenth edition, is a high quality forum to address these challenges. WONS aims to provide a global platform for rich interactions between experts in their fields, discussing innovative contributions in a stimulating environment.

Summary: Renato Lo Cigno presented the mentioned paper, a short, vision paper where the role of blockchains in distributed networking is seen from a very different perspective: instead of using an external blockchain to achieve consensus for networking, the implicit consensus required to run the network is used to build a management system exploiting blockchains. The idea raised attention, and the following discussions, both in-session and informal gave ideas for further research work and possible practical impacts.

2.3.2. IEEE International Conference on Computer Communications (Infocom)

Type: Conference

Date: April 15-19, 2018

Place: Honolulu, HI, USA

URL: http://infocom2018.ieee-infocom.org/

Presented paper: Leonardo Maccari, Lorenzo Ghiro, Alessio Guerrieri, Alberto Montresor, and Renato Lo Cigno, "*On the Distributed Computation of Load Centrality and its Application to DV Routing*"

Dissemination Level: International

Actors: Academia and industry

Audience: Around 800 people

Participants Leonardo Maccari

Description: IEEE Infocom is one of the top conferences on Computer Communications, by far the one with the largest audience. The acceptance rate is below 20%. If covers all fields in networking, thus papers presented get a very wide audience.

Summary: The presentation got several questions from the audience, showing interest. Centrality-based routing, a research mainly supported by netCommons, is getting attention to improve resilience and failure recovery in Wireless Mesh Networks, hence in Community Networks too, and may find its way into IETF standards in the future.

2.3.3. 15th Italian Networking Workshop (INW)

Type: Workshop

Date: 15-17 January 2018

Place: Courmayeur, Italy

URL: https://inw2018.polito.it/

Presented papers: Lorenzo Ghiro, Leonardo Maccari, and Renato Lo Cigno "*Proof of networking: Can BlockChains Boost the Next Generation of Distributed Networks?*"; Leonardo Maccari, Lorenzo Ghiro, Alessio

Guerrieri, Alberto Montresor, and Renato Lo Cigno, "*On the Distributed Computation of Load Centrality and its Application to DV Routing*"

Dissemination Level: National

Actors: Academia and industry

Audience: Around 50 people

Participants Leonardo Maccari, Renato Lo Cigno, Luca Baldesi, Lorenzo Ghiro

Description (summarised from the conference web site): This annual workshop provides a forum to present recent and original work in various areas of telecommunication networks. It is mainly intended for researchers working in Italian Universities. International speakers and attendees are most welcome and in fact growing in number in the last few years. The main purposes of the Italian Networking Workshop are to present the latest research results, obtaining immediate feedback from the research community in a rather informal but thorough way, fostering discussions about scientific topics, as well as interaction with Professors and researchers from other universities. The workshop is quite informal. Contributions are not published nor copyrighted, and participants are encouraged to submit the work presented here to the most appropriate international venues.

Summary: Leonardo Maccari presented the paper published at WONS, while Lorenzo Ghiro presented the work published at Infocom. In both cases the paper sparkled discussion and further feedback were collected by the researchers present to the conference. Slides handout reported in Appendix B.10.

2.3.4. Conference on Digital reality legal issues, The Law Institute, University of Iceland, Reykjavik

Type: Conference

Date: June 13, 2018

Place: Reykjavik, Iceland

URL: https://www.hi.is/vidburdir/stafraenn_veruleiki_lagaleg_alitaefni

Dissemination Level: National

Actors: Academia

Audience: 50

Participants Melanie Dulong de Rosnay

Description (from the conference material): Conference on Digital reality legal issues, The Law Institute, University of Iceland, Reykjavik

Summary: Melanie Dulong gave a talk on Community Networking as Commons, raising awareness on CNs in a country without CNs and on commons in an assembly of lawyers not familiar with the concept. Slides available in Appendix B.11.

2.3.5. European Conference on Networks and Communications (EuCNC)

Type: Conference

Date: June 18-21, 2018

Place: Ljubljana, Slovenia

URL: https://www.eucnc.eu/2018/www.eucnc.eu/

Presented papers and contribution:

1. Leonardo Maccari, Merkouris Karaliopoulos, Iordanis Koutsopoulos, Leandro Navarro, Félix Freitag, Renato Lo Cigno, "*5G and the Internet of EveryOne: Motivation, Enablers, and Research Agenda*"
2. Aris Pilichos, Merkouris Karaliopoulos, Iordanis Koutsopoulos "*From Community Networks to Community Data: The AppLea Farming Mobile App*," Poster presentation

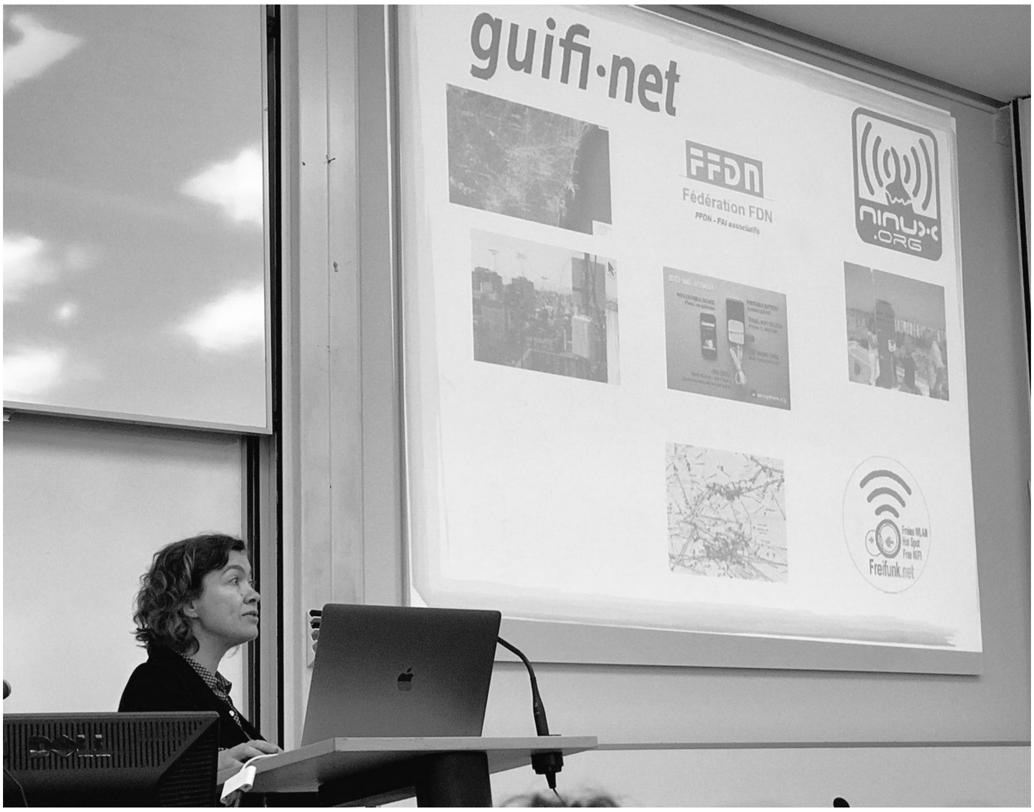


Figure 2.15: Melanie Dulong de Rosnay presenting results of netCommons at the University of Reykjavik in June 2018

3. Leandro Navarro, Leonardo Maccari, Renato Lo Cigno, Merkouris Karaliopoulos, Iordanis Koutsopoulos, "*Wireless Community networks and 5G: the 7 Billion challenge*," half-day tutorial, description and slides available in Appendix B.12.1 and Appendix B.12.2
4. Renato Lo Cigno, "*Wireless 2035: New Technologies or New Architectures?*," Invited speech at the "thinking outside the box session," slides available in Appendix B.12.3

Dissemination Level: International

Actors: Academia and industry, EU officers

Audience: About 300 people

Participants Renato Lo Cigno, Merkouris Karaliopoulos, Aris Pilichos, Iordanis Koutsopoulos

Description (from the conference web site): EuCNC 2018 is the 27th edition of a successful series of a conference in the field of telecommunications, sponsored by the European Commission. The conference focuses on various aspects of 5G communications systems and networks, including cloud and virtualisation solutions, management technologies, and vertical application areas. It targets to bring together researchers from all over the world to present the latest research results, and it is one of the main venues for demonstrating the results of research projects, especially from successive European R&D programmes co-financed by the European Commission.

Summary: EuCNC 2018 key focus was on 5G technology, where most of the project present in the demo parts were showcasing their results. netCommons presence, with its focus on organization rather than technology, alternative views on future communications and wireless usage has been an interesting seed for discussion.

On the first day Renato Lo Cigno and Merkouris Karaliopoulos gave the tutorial "*Wireless Community networks and 5G: the 7 Billion challenge*." Unfortunately being the first day of the conference, and probably also due to

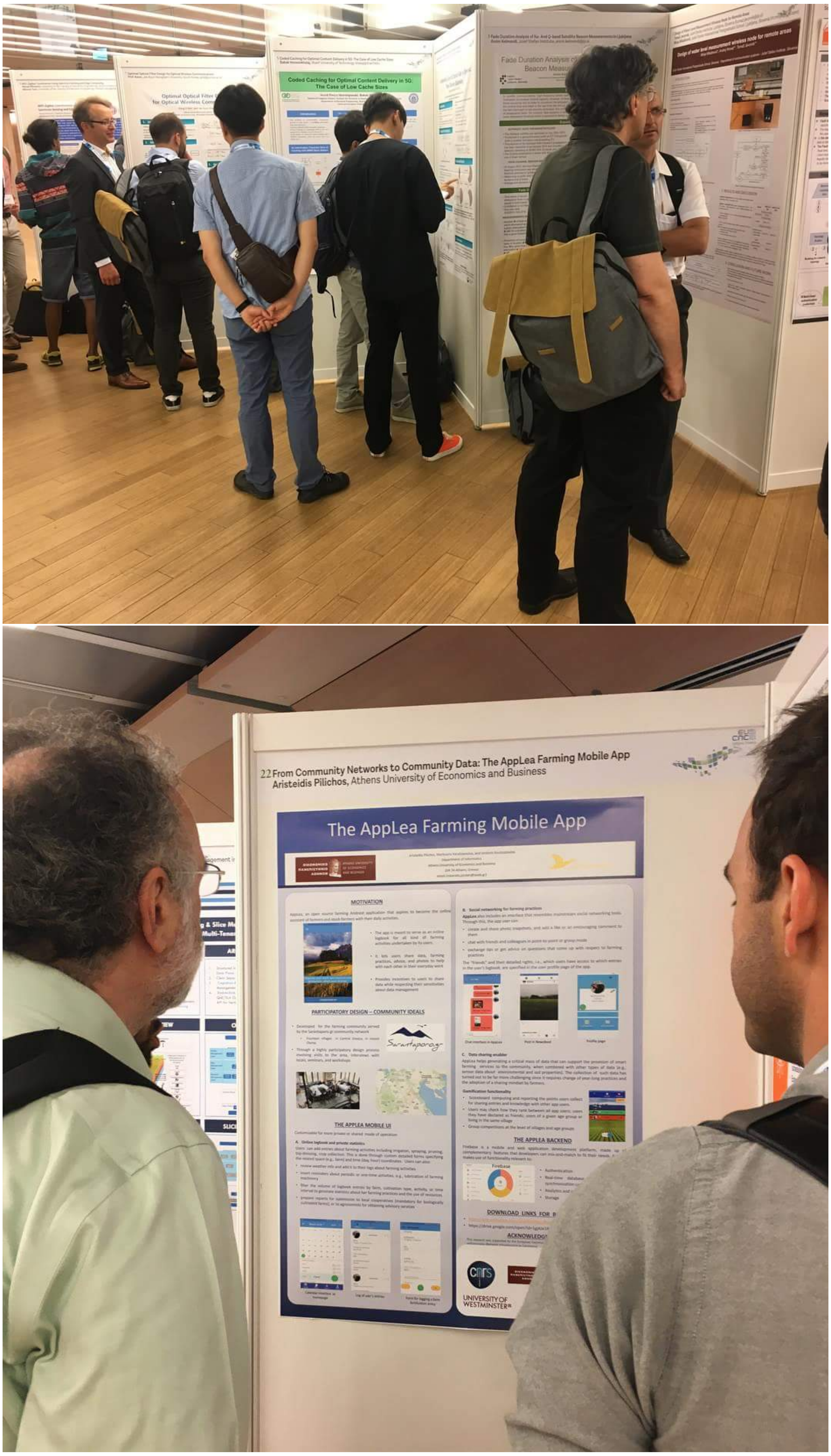


Figure 2.16: View of the poster session and the AppLea poster presented in the poster session at EuCNC '18 conference.

the non-mainstream topic related to EuCNC 2018, the attendance was low; however the few attendants were interested and participated in the presentation and discussion.

In the following days Renato Lo Cigno presented the paper "*5G and the Internet of EveryOne: Motivation, Enablers, and Research Agenda*," which outlines the open questions that relate to the global implementation 5G vision and presents possible answers to them, as anticipated and pursued within the netCommons project. Aris Pilichos presented the poster "*From Community Networks to Community Data: The AppLea Farming Mobile App*," summarizing the work on the AppLea mobile app, which is carried out by AUEB in the context of netCommons WP3, and that raised keen attention for its diverse approach to sharing data and economy, while still spinning orund smartphones, which are obviously mainstream in 5G vision.

Finally, at the 'out of the box thinking' session the speech "*Wireless 2035: New Technologies or New Architectures?*," given by Renato Lo Cigno raised high attention and received very good appraisal, being the only one in the session to present an architectural view of possible wireless communications in the future and to challenge the "technology first" (so no really new, ground-breaking ideas, but just traced furrow innovation) perspective dominating at the conference.

2.4. Local events

2.4.1. MERGE-it

Type: Community Meeting

Date: March 24, 2018

Place: Torino, Italy

URL: https://merge-it.net/

Dissemination Level: National

Actors: Community Networks and more Open-* Italian groups (Open source/data/knowldege. . .)

Audience: About 30 stability present in the CN track, with hundreds in the whole event roaming from a track to another.

Participants Leonardo Maccari

Description: The goal of the event was to gather together all the entities/realities that operate in Italy in the context of open culture and digital rights. It was the first one of its kind and it put together similar projects that never "merged" before, like community networks, Wikimedia Foundation, open data associations and many more.

There was a dedicated track on community networks organized by ninux, and also other communities around Italy, in which several themes were discussed.

Summary: Leonardo Maccari made a presentation on the state of progress and on the results achieved so far by the netCommons project. Slides reported in Appendix B.13. It was also an occasion to physically meet with people from remote ninux islands (like the island in Cosenza, South Italy, approx 900km from Trento) and involve them in the experimentation with the PeerStreamer-ng platform which we describe in D3.5 **??**. This meeting replaced the ninuxday (the a-periodic meeting of the ninux community) for 2018.

2.4.2. General Assembly of the FDN Federation

Type: Assembly

Date: May 5, 2018 to May 8, 2018

Place: Saverdun, France

URL: https://www.ffdn.org/fr/article/tag/ag

Figure 2.17: The audience in the ninux track of MERGE-it.

Dissemination Level: National

Actors: Existing Community Networks

Audience: 70

Participants Félix Tréguer, Virginie Aubrée

Description (from the conference material): Yearly Meeting of the French Federation of Community Networks

Summary: The "law and policy" team of the netCommons research team is just back from a three-day field trip in Southern France with French Community Networks.

Regarding governance, one key focus this year was on inclusion, with the goal of making FFDN's member organizations more welcoming for women, non-whites and disabled persons. As underlined in another report we released last year on governance, this has been long-running concern at FFDN and this year, participants decided to launch a new working group to tackle these structural challenges. Another focus of the discussions on governance was how to fund the growing joint actions taking place within the federation, and how to build financial solidarity between member organizations.One challenge in this regard is to account for the diversity of financial situations among them while preserving local autonomy and equal representation at the federal level.Finally, we have seen a growing willingness on the part of many participants to start focusing again on growing existing organizations and seeding new ones across France. Founded in 2011, FFDN indeed underwent a fast-paced growth at the beginning and then capped at about 30 member organizations. But time now seems ripe to expand the initiative. A working group has been set up to start developing a new strategy to that effect.

On the technical front, the three-day event was extremely fruitful as well. On the first day, a small team worked on sharing the castle's WiFi network with a circus troop established down the hill and deprived of any Internet access. To that end, the castle's own WiFi network –connected to an ADSL access in a nearby village through a radio link– was expanded thanks to a new antenna installed on the castle's roof. Other workshops focused on starting new development efforts of the "Internet Cube," a device allowing for self-hosting functionalities (thanks to the Yunohost operating system) and channeling Internet traffic to a CN's VPN services. We also took part in a demonstration on fiber optic soldering.

Finally (and most importantly for us), we has many fruitful interactions on the legal front. We gave an update of our work on legal guidelines on data retention obligations and data protection. Several participants gave us very positive feedbacks on our guide on legal aspects of open access points (based on French law), and in particular the fact that the guide was already helping local public authorities and libraries resist pressure to implement illegal surveillance measures and better protect the rights of Internet users. We also discussed the findings of our recent report on how to develop advocacy capacities to influence regulation in the interest of CNs.

Figure 2.18: The old castle were FFDN's 2018 General Assembly took place

2.4.3. General Assembly of the guifi.net community (SAX 2018)

Type: Assembly, community meeting

Date: June 2-3, 2018

Place: Benasque valley, Spain

URL: https://sax2018.ribaguifi.com/

Dissemination Level: National

Actors: Different stakeholders involved in guifi.net

Audience: 50 on-site + 200 remote

Participants Roger Baig (on-site), Leandro Navarro (remote)

Description (from the conference material): Yearly Meeting of the guifi.net community network

Summary: A discussion about economic sustainability and ways to implement it. Inspired by business and organizational models developed in netCommons, extended to collect organizational and economic models in different local community networks that are part of guifi.net. Different local groups explained their own local ways to organize and crowdsource economic contributions, voluntary and professional work to expand and maintain the network. Data was collected in forms and the differences were discussed.

Figure 2.19: The session on economic sustainability of guifi.net

2.4.4. Sarantaporo training workshop

Type: Community workshop

Date: March 11, 2018

Place: Flambouro village, Sarantaporo area

URL: N/A

Dissemination Level: National

Actors: Sarantaporo.gr CN community

Audience: 30

Participants Panayotis Antoniadis, Alexandros Papageorgiou, Merkouris Karaliopoulos, Aris Pilihos

Description (from the conference material): Sarantaporo organized a training workshop at Flambouro village with the support of ISOC's "beyond the net" fund and netCommons contributed also and organized a side-event, a participatory design workshop at Flambouro village, documented briefly in Deliverable 3.6 (p.18-22).

Summary: The workshop was very successful in that it managed to engaged a wider range of actors than the previous ones, most importantly many women, and it was a step forward in the appropriation of the Sarantaporo.gr CN by the local community[9].

Slides and representation of other material used in Appendix B.14.

Notes: A short video report from this workshop was produced and presented at WSIS conference (see Sec. 2.2.3).

[9]See also a related blog post by Vassilis Chrysos: https://blog.apnic.net/2018/04/20/empowering-local-communities-to-build-maintain-and-expand-their-community-network/

Figure 2.20: Training workshop at the Flambouro village

2.5. Public presentations

2.5.1. Economic landscape under the new Telecommunications Code

Type: EU parliament workshop

Date: May 23, 2018

Place: Brussels, Belgium

URL: https://www.greens-efa.eu/en/article/event/economic-landscape-under-the-new-telecommunications-code/

Dissemination Level: European

Actors: Policy makers, regulators

Audience: 50

Participants Maria Michalis (UoW) and Panayotis Antoniadis (NetHood)

Description (from the conference material): Competition has been the driver for investment and better services for Europeans under the current legislative framework. The new framework looks towards future deployments and aims to continue a competition based model with added incentives for investment, putting in place a co-investment system for the current and future big market players. Small commercial players and the community networks are the seeds of innovation and have the potential for growth either through better offers or disruptive technologies that cover traditional and previously unexplored markets. For them, it is important to create a framework that provides incentives for competition, investment and does not block their way to operate.

A growth model based solely on incentives is a transitory one, reliant on the lifecycle of the incentives, while a competition based model is sustainable and capable of delivering the best results for consumers. And the

Figure 2.21: EU Parliament workshop “Economic landscape under the new Telecommunications Code”

positive impact on consumers should be the ultimate goal of legislation. In that regard, the event is offering a platform for debate on the obligations for providers, especially small and community networks, the benefits of a clear framework and the potential changes in the relation between the providers and the consumers.

Co-organisers: MEPs Julia Reda, Max Andersson, Jan Philipp Albrecht

Summary: Maria Michalis and Panayotis Antoniadis together with Ramon Roca remarked, at this important policy venue the importance of supporting CNs for the health of the global communication market in Europe. Further information on this event is reported in Sec. 3.2.3.

Notes: The full video recording of the workshop is available a the event’s web site. The slides used in this event are reported in Appendix B.15.

2.5.2. Human Rights and present / future ICT

Type: Workshop

Date: September 11, 2018

Place: Zurich, Switzerland

URL: https://www.isoc.ch/archives/3396

Dissemination Level: Local

Actors: Academia, Policy Makers, Industry

Audience: 30

Organizer ISOC-CH

Participants Panayotis Antoniadis

Description (from the conference material):

Building on the first two events of the Values of Internet Technologies (VIT) series, this third workshop will explore Human Rights and how they relate to the digital sphere. We will delve into the impact of Internet protocol design on Human Rights and look at the protocols existing today. Finally we will discuss the potential of technology for protecting Human Rights and changes needed to strengthen this role.

Summary: A parallel workshop organized by ISOC-CH members in Zurich and Geneva, which gathered a quite diverse set of people interested on the discussion of new technologies from a human rights perspective.

Notes: The slides of Panayotis Antoniadis' presentation are available at http://nethood.org/slides/antoniadis_ISOC-CH.pdf

2.5.3. University of Natural Resources and Life Sciences (BOKU), Vienna

Type: Invited seminar in workshop

Date: June 28, 2018

Place: Vienna, Austria

URL: http://short.boku.ac.at/q33z5q

Dissemination Level: Local

Actors: Academia, Policy Makers

Audience: 40

Participants Melanie Dulong de Rosnay

Description: This was the last lecture of the summer term of the LTS LunchTimeSeries on Law, Technology and Society at the Institute of Law, University of Natural Resources and Life Sciences (Universität für Bodenkultur). These are formal seminars given at the Institute of Law open to all members of the University.

Summary: The computing model of peer-to-peer, a type of architecture in which actions are distributed, can be a source of inspiration for a law of the commons. Both movements, as alternatives to the market and state, question the Western concept of individual agency. By attributing rights and responsibilities to collective persons, the commons movement can take inspiration from environmental law and the law applied to artificial intelligence, both of which have succeeded in surpassing the notion of individual person.

It was attended by legal academics and by former PhD and master students of the programme, including an assistant to an MEP working on telecommunications reform. Many questions were raised on the role of law and policy to sustain alternative networks.

Notes: The full report of the lecture is available at the LTS web site. The Slides are reported in Appendix B.16.

2.5.4. AFTER: Futuri Digitali

Type: Invited speech in workshop (in Italian)

Date: October 19, 2018

Place: Reggio Emilia, Italy

URL: https://www.afterfestival.it/programma

Dissemination Level: Local

Actors: General Public, Local Authorities, Local Stakeholders

Audience: 50

Participants Renato Lo Cigno

Description: A local event sponsored by Reggio Emilia Municipality discussing experiences of bottom-up networking in the aftermath of the deploiment of a "municipal network" in Coviolo a small segregated hamlet in the municipality of Reggio Emilia.

Summary: Several interventions spanned from the role played by the local Internet Service Provider (ISP) Lepida that is fully controlled by 'Regione Emilia Romagna' and has the role of providing digital services to all local public sector (municipalities, provinces, region, etc.), plus schools and support for marginal areas, to the guifi.net experience, the global visions brought by netCommons and Jan Droege, BCO support network director.

The slides are reported in Appendix B.17.

2.5.5. Persona Non-Data Festival at Gaîté Lyrique

Type: Invited panel at festival

Date: December 2, 2018

Place: Paris, France

URL: https://gaite-lyrique.net/en/event/cultivons-des-reseaux-et-elevons-des-chatons

Dissemination Level: International

Actors: General public, activists, civil society, CNs

Audience: 60

Participants Panayotis Antoniadis

Description: A panel session on technological sovereignty at the "Persona Non Data" festival at the prestigious Gaîté Lyrique, moderated by Claire Richard, author of the "Petit ouvrage d'autonomie technologique (éditions 369)", with Panayotis Antoniadis (NetHood), Benjamin Cadon (Labomedia), Clara Cuso (Guifi.net) and Spideralex (Tactical Tech).

Summary: It was a very interesting panel offering diverse perspectives on technological sovereignty with special focus on Community Networks.

One of the highlights was the presence in the audience of the president of Franciliens.fr (member of FFDN) who intervened to give a short overview of the situation in France, and also engaged in discussions with the panelists after the event.

Figure 2.22: Persona Non-Data Festival at Gaîté Lyrique

2.6. CN Oriented Workshops

2.6.1. 3rd Community Network Summit

As part of the ongoing collaboration with Zenzeleni, APC and ISOC, we co-organized a business model canvas design exercise, based on the results of WP1 ([4, 5, 6]) for community networks, with the participants of the 3rd Community Network Summit in South Africa. See Sec. 2.2.4 for details.

2.6.2. CNSIG council assembly

After the IGF 2018, the CNSIG council gathered for the first time after its inauguration (in IGF 2017) and discussed about the current activities of the member CNs and future plans for common action. Special focus given on the development of a strategy for "local content", of special interest for netCommons.

The minutes of the discussion are available at http://nicolasacco.diveni.re/~gio/asciipad/CNSIG_CouncilMeeting20181115Paris/.

2.7. Other

2.7.1. Meeting with MP of the Iceland Parliament

Type: Meeting

Date: June 13, 2018

Place: Reykjavik, Iceland

URL: https://www.hi.is/vidburdir/stafraenn_veruleiki_lagaleg_alitaefni

Dissemination Level: National

Actors: Academia, Local Authorities, Policy Makers

Audience: 5

Participants Melanie Dulong de Rosnay

Description: Private, close meeting with a member of the Iceland Parliament

Summary:

Melanie Dulong de Rosneay, together with 4 other legal academics participating to a conference, met with Björn Leví Gunnarson, a member of the Althingi, the Iceland Parliament, working on technology questions and a member of the Pirate Party.

The country has no CN, despite not being well covered by national commercial ISPs in the rural areas (sometimes visitors roaming between several national ISPs have a better connectivity in the countryside than nationals who are bound with one provider).

The meeting approached topics related to the regulation on telecoms and the development of commons-based alternatives. In particular, the MP had just been working on a bill promoting FabLabs.

Figure 2.23: Mélanie Dulong de Rosneay at the Icelandic Parliament with other meeting participants

3. Advocacy

The work of netCommons on advocacy deserves a separate chapter because of the importance of the topic in times of critical changes of the regulatory and policy European framework, but also because of the significant successes achieved during the 3 years of the project. Obviously this activity overlaps with the participation to the various events described in Chapter 2.

In the following we summarize this work, focusing on the activities during the last year, covered by this deliverable.

3.1. UNESCO's Internet Universality Indicators

The netCommons project managed to successfully intervene in another policy initiative, this time at the international level. netCommons participants from CNRS and the University of Westminster had been invited to contribute to UNESCO's work on Internet Universality Indicators, presented at the International Association for Media and Communication Research (IAMCR) conferences, notably at a panel in Leicester, UK in 2016. They also participated in a panel in Cartagena, Colombia in 2017. On both occasions, CNRS and University of Westminster made the point about the potential of CNs to contribute to Unesco's indicators, raising UNESCO's awareness on the necessity to include Community Networks in their work on Internet Universality Indicators.

Building on these contacts with UNESCO, netCommons was invited to organise a presentation on aspects of the project at the UNESCO headquarters in Paris with a view to provide an input to their Internet Universality Indicators project.

More specifically, the netCommons project, together with members of its Advisory Board, visited the offices of UNESCO on January 30, 2018, as reported in our web site news . netCommons researchers presented the key ideas of CNs to UNESCO staff, most of whom came from the Division Freedom of Expression and Media Development. In particular, Leonardo Maccari, Maria Michalis and Melanie Dulong de Rosnay gave three short overviews focusing on the technical feasibility and social impact of CNs, the EU telecommunications policy framework and perceptions of CNs by interested people, and the impact of the legal system on CN respectively.

All three themes produced an informed discussion with the UNESCO working group on the Internet Universality Indicators, which was extremely fruitful to enlarge the interest on CNs to a wider community, and to improve the indicators and make them inclusive of CNs specific needs, building upon a set of previous documents (Open letter, note to policy-makers) netCommons had previously produced. Following that presentation, the netCommons project was asked to participate in the consultation on the indicators, and to produce a formal written submission. Indeed, in May 2018, netCommons submitted a formal response to UNESCO consultation[1]. We worked on targeted suggestions, modifications and additions to the Indicators.

In June 2018, UNESCO released the second draft of Internet Universality Indicators. This version[2] includes a new indicator under Theme C: Open Markets that explicitly mentioned CNs: **C.6 Are communities able to establish their own networks to provide Internet access? Legal framework for establishment of community networks.**

In November 2018, UNESCO released the final version of the Internet Universality Indicators and the above indicator for CNs has been retained[3].

[1] See https://en.unesco.org/sites/default/files/ui_c2_en_sub075.pdf

[2] See https://en.unesco.org/sites/default/files/unesco_internet_universality_indicators_second_version.pdf

[3] See http://unesdoc.unesco.org/images/0026/002658/265830e.pdf

This is a significant achievement with a potential impact for the whole CN movement worldwide. The Indicators will be used by UNESCO and other international bodies as the base criteria to evaluate national policies regarding Internet connectivity and their impact on human rights. It is thanks to netCommons that CNs are now recognized at the UN-level as useful and effective instruments to reduce the digital divide and are now part of the Internet Universality Indicators (whereby their legal support is one component of Internet Universality support by governments).

3.2. EU parliament workshops

During the project, netCommons organised a workshop on the European Electronic Communications Code (EECC) at the EU parliament, Sec. 3.2.1, which was very successful as it led to netCommons partners (and advisory board) being invited in follow-up workshops in the EU parliament, bringing CNs to the policy and regulation table. More specifically, one legal workshop regarding data retention obligations, Sec. 3.2.2, and another economic about co-investment, Sec. 3.2.3.

3.2.1. EU Parliament workshop of 2017 on Community Networking and telecom policy

netCommons co-organised with Commons Network a workshop on Community Networks at the European Parliament on October 17th, 2017. It focused on Telecom regulation and takes place during the negotiations of the European Electronic Communications Code (EECC).

This workshop brought for the first time key actors from the CN movement to the policy table. The event, entitled 'Community Networks and Telecom regulation', was divided in two parts.

The first one aimed to assess the role of Community Networks, especially in light of EU broadband policy. Several members of the project explained how community concretely works. Especially, they pointed out how CN activity can promote social inclusion (Leandro Navarro) digital literacy (Leonardo Maccari) and, in the end, fundamental rights.

The second one, focused on identifying legal hurdles to the development of community networks. We stressed issues based on experience of CNs about liability (by Arthur Messaud), but also on access to optical fibers and global interconnection points (by Ramon Roca).

For each part of these panels, an Member of the European Parliament (MEP) was a discussant. We could therefore confront CNs' needs with the ongoing draft of the EECC, so that this major regulation would take into account their peculiar position and concerns.

The impact of our advocacy work on this regulation was described in Deliverable 4.3. The specific timeline and program of this event is described on the netCommons website[4]

Finally, videos recording all interventions and discussions are available at the netCommons youtube channel.

3.2.2. EU Parliament meeting on data retention and coalition-building for the #STOPdataRetention campaign

As one of the main evolution of the legal framework for CNs was data retentions obligations – which forces Internet access providers and host providers to maintain logs regarding the online activities of their users for a duration of up to two years, raising significant privacy issues –, netCommons participated in a European Parliament strategy meeting on "The Future of Data Retention and Targeted Criminal Investigations" on 12 April 2018, as reported on the netCommons blog. Virginie Aubree (UniTN) participated in a panel with very diverse speakers (more than thirty persons) including representatives from non-profit organisations (NGOs)

[4]See https://netcommons.eu/?q=content/eu-parliament-workshop-community-networks-and-telecom-regulation and netCommons Deliverable 6.2.

defending digital rights (60%), members of the European Parliament (20%, such as Julia Reda), academics (11%) and members of National Regulation Authorities (3%).

The official purpose of the meeting was to share experience and legal information about data retention national laws –in light of European requirements in terms of fundamental rights– in order for MEPs and civil society at large to coordinate.

The meeting was divided in two parts. The first one focused on data retention per se, and the second one broadened the debate on digital Privacy and Copyright concerns.

First, it is worth noting that the timing as well as the purpose of this meeting was very appropriate to advertise the advocacy strategy devised by netCommons. Especially, we were able to share the project of a litigation campaign on this issue – the #STOPdataRetention campaign (see below Sec. 3.6) – that we were actively supporting in partnership with French digital rights advocacy groups and CNs, and invited participants from other EU countries to join.

Second, Virginie Aubree shared legal information from netCommons research, especially concerning data retention and its application to Community Networks (a topic emphasized in Deliverable 4.3 due to the prominent legal context). Sharing national litigation experience (about Germany and France especially) was really helpful since natives were there to present their policy context and share legal references.

Third, as they are directly part of the process of retention, CNs had specific ethical and technical concerns about data retention, as expressed in the last open letter (described below, as part of the STOPdataRetention campaign). Expressing the shared values of CNs regarding online Privacy was important to point out. Virginie Aubree also presented the current practice of data retention by Community networks, as described in Deliverable 4.2, and highlighted their peculiar perspective about the legal framework. It was interesting and very encouraging to see that most people actually knew Community Networks, their existence as well as their benefit for society.

Now that CNs have finally found a common voice, and are acknowledge by policy-makers, we wanted to help them to extend their advocacy capabilities by joining forces with other allies (such as NGOs and academics).

The meeting was held private, no public invitation was issued, but we could document it on the netCommons website[5].

3.2.3. EU Parliament workshop of May 2018 on communication policy

On May 23, 2018, three MEPs, namely Julia Reda (one of the hosts of the netCommons organized workshop described in Sec. 3.2.1), Jan Philipp Albrecht and Max Andersonn, organised an event at the European Parliament titled “Economic Landscape under the New Telecommunications Code: How will the New Co-investment Rules and New Obligations Affect Small Providers in the EU.” The whole workshop was recorded and made available online, and it was reported by the University of Westminster News. See also the news entry at the netCommons web site.

Two netCommons partners Maria Michalis (UoW) and Panayotis Antoniadis (NetHood), together with Ramon Roca (guifi.net) member of our advisory board participated in a panel with speakers including representatives from the European Commission (DG CNET), the German Broadband Association (BREKO) –alternative fixed line providers, the Body of European Regulators for Electronic Communications (BEREC), the EU European Union Agency for Network and Information Security (ENISA) (represented by Evangelos Ouzounis, Head of Secure Infrastructure & Services), the small French provider Leonix, and the trade body DigitalEurope.

In terms of content, Maria Michalis and Ramon Roca joined their voices in the first panel to make three important statements:

- The vital contribution that small and community providers can make to strengthen communication markets’ diversity and the establishment of high-capacity networks, a contribution that goes beyond “filling

[5] https://netcommons.eu/?q=content/data-retention-and-telecommunication-providers-new-eu-parliament-meeting

the gaps;"

- CNs have for years been relying on co-investment;
- It is crucial that CNs have a seat at the policy table, and important that they are mentioned in the legislation as possible participants in co-investment schemes as this would increase the legitimacy of the CN model.

In the second panel, Panayotis Antoniadis, stressed the importance of language and proposed the analogy between organic agriculture and CNs (the organic Internet) as the right mental frame that this discussion should be placed.

Interestingly, it was through Evangelos Ouzounis that the Greek Telecoms Regulator EETT was subsequently contacted and agreed to participate in the netCommons workshop at Impact Hub Athens (see Sec. 2.1.6), an indication of the successful impact that this EU workshop had for a specific CN (Sarantaporo.gr).

3.3. "Fibre to the Home" (FTTH) advocacy and litigation to open up the fibre market for CNs

Throughout the last year of the project netCommons fostered initiatives taken by CNs to improve their legal framework, as well as their ability to cope with their obligations. As such, we offered a support in their litigation actions to open the fibre market, presented in this section, help them in the drafting of national practices guides (Sec. 3.4), amending the EECC (Sec. 3.5), and fighting blanket data retention models (Sec. 3.6).

Being able to interconnect to the Internet, but also to provide Internet access through fibre is fundamental for CNs to become sustainable and to grow beyond certain limits. In some countries (UK with Broadband for the Rural North (B4RN), in Spain with the success of guifi.net) this is already possible, though with different degrees of accessibility and legal contexts. In others, like France and Italy, this is extremely difficult to say the least. In France there are discriminatory prices and strong entry barriers.

Inspired by CNs from other countries, and in particular by the guifi.net example they came to know through netCommons, the French federation of community network (FFDN) decided to develop a dedicated advocacy action concerning fibre. It is a specific group of ten people within FFDN, mostly engineers but also one lawyer and one person with a human sciences background. netCommons researchers supported this group from the very beginning (June 2017) participating in all the workshops of the group to provide legal and policy expertise. Those workshops took place during a whole weekend every 2-3 months to advance the project. netCommons support included legal information gathered thanks to the deliverables (D4.1, D4.2, D4.3 and D1.5) as well as general knowledge concerning proceedings before courts. We also shared our experience about advocacy projects, helping the design of a structured advocacy action composed of the following three items.

- An open letter sent to the french historical telecom operator (Orange) and the competent national regulation authority (ARCEP)[6]. The purpose is to raise the awareness on this topic and to open a dialogue with the ARCEP.
- A website and interactive map called 'the Barometer FTTH' (in French) clearly pointing out which areas are covered by a public network initiative –*Réseaux fibre optique d'Initiative Publiqu (RIP)* in French– and the conditions of access to active offers (if any) for CNs. The tool rate each land in France according to their accessibility for small operators. This part of the project took a lot of energy and patience for FFDN because collecting information was though and often other operators were clearly reluctant to provide it, even though they have the obligation to do it. netCommons support to the group was key to provide a legal analysis of terms and conditions of contracts and to determine whether offers were reasonable and correct according to their legal obligations.
- Finally, together with the group, we worked to identify illegalities in these various public-private partnerships and we are considering possible litigation strategies to remedy them.

[6] See, in French, https://www.ffdn.org/fr/article/2018-10-21/lettre-ouverte-sebastien-soriano-et-stephane-richard

In November 2018, FFDN presented the whole project (in French) in Toulouse within the framework of a large public festival with over 1500 participants. We expect this advocacy project to have a great impact on the French fibre market by enhancing competition.

3.4. French practical guides for Community Networks

As part of the WP4, studying the legal framework of the Community Network and actors interacting with them, netCommons produced short legal practice guides, trying to find synergies with ongoing projects within the communities we're in touch with.

- In the framework of collaboration with FFDN, we published, in January 2018, a guide targeted at french CNs and other organisations offering open access to the Internet via WiFi hotspots[7]. These guidelines were presented to librarians on Monday January 29, 2018 at the 'Bibliothèques des langues orientales', in Paris. They have also been featured in various press outlets related to libaries or local authorities, and are apparently helping people within their organisations to promote open WiFi networks, without privacy-invasive authentication schemes. This short guide is integrated into an FFDN long-term project started years ago to promote open WiFi networks, and actively maintained, so that the netCommons resources are bound to a project that will survive beyond the research project maximizing its impact.
- After the publication of this first guide, we expanded the project and worked with a working group of FFDN to move towars general legal guidelines regarding the creation and operation of grassroots Internet service proividers. The netCommons legal team drafted these guidelines in cooperation with FFDN and La Quadrature du Net. We have now reached a final draft. FFDN members are currently reviewing the draft before we can move to publication. It may takes a few weeks, but, this way, we will make sure they are accessible to them and cover everything they need in terms of common legal issues.

  This practical guide, written in French and based on French law, is divided in three parts:

  1. Protecting Privacy: This part focuses on data protection laws and measures that should be taken by CNs to protect Privacy. It describes the framework of collection, processing and retention of data and future access by competent authority.
  2. Managing content:This part describes what blocking measures are weighting on Internet service providers and CNs.
  3. Accessing to infrastructure: This last part presents the rules framing the management of different infrastructure such as open network, Tor relay and VPN services.

  For each category, the guide offers concrete advice on how to respect the legal framework, thereby facilitating the work of emerging CNs or those expanding their operation, offering clear insight on how to deal with the legal framework to expand their infrastructure and run in a way that maximize the protection of users' fundamental rights.
- This work was also key in helping us draft the Template terms of use for Community Networks, annexed to Deliverable 4.5 and which will be part of a book of guidelines to be released in the coming months. The terms of use, written in English, offer clear legal guidelines on the reciprocal legal obligations of CNs and their users.

Overall, the impact of these guides is to facilitate the appropriation by CN practitioners of the complex regulatory environment they evolve in, thereby improving compliance with the legal framework, improving their ability to debate various choices in dealing with the law as well as increasing their knowledge and ressources to engage in advocacy so to change telecom policy when needs be, and finally to improve the protection of the human rights of their users.

[7] https://www.netcommons.eu/?q=content/french-pratical-guide-cns-and-organisations-providing-open-access-internet

3.5. Amending the European Code of Electronic Communications

In parallel with the EU parliament workshops discussed in Sec. 3.2, and synergistic with the effort to have CNs recognized by UNESCO as discussed in Sec. 3.1, netCommons has pursued a strategy to transpose the research on the legal and policy needs of CNs into actual legislation, in part by collaborating with digital advocacy groups like La Quadrature du Net. This was a success, since EU law now provides for special provisions regarding Community Networks, paving the way for policy change that will enable their development.

As already reported in D6.2 [7], in March 2017, more than 30 European CNs and 35 supporting organizations wrote an open letter to EU telecom policy makers[8]. The letter came at a particular, strategic moment of the EU policy-making process. The EU Parliament was then initiating the legislative process on several proposals reforming the legal framework for telecom regulation, culminating with the adoption of the new EECC. The goal of the action was to get recognition from EU lawmakers of the specific, fundamental role of Community Networks for the health of the telecommunication market as well as human rights in Europe, and to call on them to modify the policy framework to sustain the development of Community Networks. Following the open letter, netCommons and La Quadrature du Net created a mailing list allowing the 65 organisations who had signed the open letter to coordinate on future policy developments.

To influence the policy-making process, the advocacy group coordinated by netCommons and La Quadrature du Net suggested amendments favorable to CNs, and then analysed the various amendments tabled on the text by the three competent European Parliament (EP) committees (Industry, Research and Energy (ITRE), Civil Liberties, Justice and Home Affairs (LIBE), and Internal Market and Consumer Protection (IMCO). We prepared voting list for each of these committees where we assessed the amendments in accordance with the interests of CNs, giving negative opinions on those which would hamper the development, and positive ones to the favourable amendments:

- To the ITRE: https://wiki.laquadrature.net/Paquet_Telecom_2017/amendements_ITRE
- To the LIBE: https://wiki.laquadrature.net/Paquet_Telecom_2017/amendements_LIBE
- to the IMCO: https://wiki.laquadrature.net/Paquet_Telecom_2017/amendements_IMCO

To prepare for the crucial committees' votes, netCommons' legal and policy team also wrote a detailed brief sent to Members of the EU Parliament to explain how some of the key amendments that we identified would impact CNs, based on some of our fieldwork (and thereby giving an on-the-ground analysis of how the said amendments would impact CNs[9].

After a crucial committee vote in September 2017 on which netCommons and its allies commented, the EU Parliament directly entered into negotiations with Member States with the goal of reaching an agreement on a final text. A netCommons workshop organized on the premises of the EU Parliament on October 17th, 2017 ensured that key MEPs taking part in these negotiations understood the potential of CNs and the urgency to lay the ground for a recognition of these initiatives by EU policy-makers.

The trilogue process took almost a year, concluding in June 2018. The final agreement brings significant improvements to the regulatory framework, echoing some of the crucial demands formulated by CNs in the open letter. These are analyzed in a policy brief released in November 2018, presented at the Internet Governance Forum in Paris on November 12th [8]. The brief is meant to facilitate the work of CNs as they engage with local, national and European policy-makers[10]

These improvements can be summarized in the following items.

- The new EU telecom framework lifts administrative burdens for Community Networks.

[8] https://netcommons.eu/?q=news/open-letter-eu-policy-makers-community-networks

[9] The brief is reported as attachment to the relative blog post on netCommons web site: https://netcommons.eu/?q=content/notes-european-electronic-communications-code-decisive-votes-european-parliament

[10] See https://www.netcommons.eu/?q=content/netcommons-guidelines-telecom-policy-makers & https://www.netcommons.eu/?q=content/enabling-telecommons-guidelines-policy-makers

- Regulators are asked to invite Community Networks to the policy table. Article 3.3.e) agreed upon in the latest negotiations posits that National Regulatory Authorities (NRA), national governments and EU policy-makers should "take due account of the variety of conditions relating to infrastructure, competition, end-user and consumers circumstances that exist in the various geographic areas within a Member State, including local infrastructure managed by individuals on a not-for-profit basis." This language covers most, if not all, of CN models and suggests that regulators should actively mobilize the knowledge of Community Networks in the development of telecom policy.
- Regulators will still be able to safeguard competition on FTTH networks. The notion of "regulatory holidays" favored by incumbent operators and the EU Commission has been significantly delimited, and NRAs will have the tool they need to ensure that private networks rolled out by large players remain open to smaller players, including CNs, on reasonable financial and technical terms.
- Unlicensed access to spectrum is encouraged by new provisions. This is key for wireless Community Networks who have difficulties to operate in urban areas where WiFi bands are getting increasingly saturated, but more generally to build resilient and affordable long distance wireless networks.
- Policy-makers and telecom providers are banned from hindering the right to share one's Internet connection. This is key for CNs like Freifunk which rely on the ability of subscribers to traditional telecom operators to share their connections with people in their vicinity.

The policy brief is featured in a blog post to be published on the Media & Policy Blog of the London School of Economics [9].

3.6. Strategic litigation against data retention: the #STOPDataRetention campaign

A second fundamental advocacy work conducted in cooperation with la Quadrature du Net has been the support of an international litigation and advocacy campaign against blanket data retention.

The initiative stems from a litigation group in France, named "the Exegetes," which works closely with French CNs of the Federation FDN and NGOs defending digital rights, in particular La Quadrature du Net. These organisations had made a first call for a joint action in November 2017. netCommons, in line with the spirit of supporting existing communities rather than building new ones, joined this effort to support the abrogation of illegal national data retention laws, a demand formulated in theOpen Letter of March 2017 , also presented during the workshop with Members of the European Parliament organised in October 2017 (see Sec. 3.2.1). Virgnie Aubrée therefore joined a group of a half-dozen people working on this campaign.

The #STOPdataRetention campaign started from an observation: a wide part of Member States' legislation on data retention does not comply with EU law requirements regarding fundamental rights. Indeed, since EU Court of Justice's decisions, Digital Rights Ireland in 2014 and all the more since Tele2 in 2016, it is clearly stated that general and indiscriminate collection of data is precluded. However, most of member States did not take action to repeal or adapt their legislation after the first ruling of the CJEU, nor after the second one. Confronting this collective inertia, this action intended to join forces and coordinate at the European level, by coordinating individual actions (as an alternative to regular national and isolated litigation).

- First, we set up a campaign website whereby a Community Network, an organisation, or an individual could use a template document we had prepared to lodge an individual complaint with the European Commission against their national provisions regarding data retention in breach of EU law.
- Second, we drafted a joint open letter explaining our strategy, highlight the coordinated aspect of the action and express our common concerns regarding blanket data retention in terms of human rights.

We played a key role in these two tasks, and also co-drafted the the press-release to be published on CNs and NGOs' websites, and several members of netCommons helped translate the complaint and open letter in Spanish and Italian. We participated strongly in the coordination work by relying on advocacy capacity built in the past months, for instance through the telecommons mailing list.

3.7. Universal Deployment Model

The guifi.net Foundation, in its struggle to fairly access optical fibres, proposed a universal deployment model that can be applied at many different levels, from municipalities, to whole countries and super-national coverage too. In this model, new deployments by a private requester are allowed as long they provide enough resources that simultaneously allow for three uses:

- private for the requester,
- internal service for the public administration, and
- shared use on a commons base.

The principle, albeit developed initially for a municipality, can be extended to apply to any other regional or even international infrastructure deployed in non-private land; the proportion of resources for each uses should be carefully adjusted to meet a correct economic balance[11]. The effect of this model is the deployment of private infrastructures generate a direct return as infrastructure for shared use, and shared, commons based use can contribute to deliver universal connectivity, which should be in the charter of all public administrations.

netCommons (Roger Baig and Leandro Navarro from UPC) has collaborated with the guifi.net Foundation in the revision and generalisation of the document[12], now in version 30 in the Catalan version, with a draft version in English[13] including material in English.

The issue is simple: to allow and regulate the deployment of private networking infrastructures (such as private cables, towers) over public areas, that literally or conceptually belong to everyone, in a way that generates a return to everyone, which preserves and directly contributes to universal connectivity. That return is in the form of paths of appropriate cost, or not cost at all in specific cases. This way any investment in connectivity infrastructure for private lucrative benefit, always results in an added value infrastructure for everyone. Instead of an "abstract" monetary tax return for private deployments, land and submarine cables should generate a mandatory return in terms of a portion of infrastructure sharing. In general terms, this return will be as open-access fiber managed collectively, as a commons. Many stakeholders may be interested in it, allowing scaling up of commons initiatives, as it is well known (from the engineering community) that optical fibres provide a communication infrastructure much more reliable that wireless communications and with virtually unlimited capacity.

We extend the concept of universal deployment defined for the municipal scope, to the state level, and multi-state in the case of undersea cables. The proposal builds on the universality of participation in the Internet from the recent UNESCO Universality Indicators (Sec. 3.1).

The goal is to define the principle of mandatory infrastructure sharing for private deployments on public space and commons infrastructure. This principle is related to the recommendations of the ITU[14] on the benefits of infrastructure sharing, the related work by APC on the topic to "maximize access and minimize the resources needed for communication infrastructure, making it much less costly and faster to deploy"[15], and the EU directive on cost reduction in the deployment of high-speed broadband networks[16]. In the recent IRTF GAIA[17] working group, as part of the IETF 102 (see Sec. 2.1.7), we introduced the generalised universal deployment

[11] We are well aware that this model is indeed not entirely new, and that in many places in Europe and in the world there are similar schemes enforced by local (sometimes national) administrations; however, none of these schemes devised comprises all the three categories, in general leaving out the commons concept. The point is to scale these un-coordinated initiatives into a structured framework that can be used to reduce the digital divide.

[12] See https://www.netcommons.eu/?q=content/universal-deployment-model for a public note about this effort.

[13] Ramon Roca, Lluís Dalmau and Roger Baig from the guifi.net Foundation have created and coordinated the development of this document that can be found at https://fundacio.guifi.net/en_US/page/documentos

[14] Trends in Telecommunication Reform 2008: Six Degrees of Sharing, at http://www.itu.int/ITU-D/treg/publications/trends08.html

[15] Infrastructure Sharing for Supporting Better Broadband and Universal Access, at https://www.apc.org/en/infrastructuresharing

[16] Digital Single Market: EU rules to reduce cost of high-speed broadband deployment, at https://ec.europa.eu/digital-single-market/en/cost-reduction-measures

[17] Global Access to the Internet for All Research Group (GAIA), at https://irtf.org/gaia

proposal[18] These concepts have been published, both as an article in the PoliTICs journal in Brazilian portuguese [10] and as a public report in English [11].

3.8. RED Directive

The Radio Equipment Directive (RED, 2014/53/EU) is a potential obstacle to the diffusion of open source radios and community networks. In 2017 an expert group was set-up by the commission to discuss on the potential implications of the RED directive[19]. The Freifunk CN, one of the largest and most active in Europe informally participates to the group, and submits documents for its attention. Among them, a set of case-studies were collected to be discussed in the WG. Leonardo Maccari helped shaping a case-study for the case of CNs, which was published by Freifunk [20], presented in two official occasions and sent to the commission.

[18]The slides at IETF 102 are a joint effort that we continue to elaborate with other activists and researchers.

[19]See http://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetail&groupID=3413.

[20]See https://freifunk.net/blog/2017/12/das-problem-mit-der-eu-funkrichtlinie/ for the Freifunk publication (in German) and https://pad.freifunk.net/p/freifunk_casestudy_radiolockdown for an English translation.

4. Local actors and stakeholders

Since Community Networks are by definition local projects projects, often grassroots, the relationships between CNs and local actors is critical for their growth and sustainability. netCommons has contributed significantly in initiating, establishing, nurturing, and advancing such relationships in the different countries where netCommons partners are based, and beyond.

In the following we report on activities carried out during the third year of the project, spanning from the collaboration with local CNs in Europe, all the way to support in developing areas as Latin America and Africa.

4.1. Iberian peninsula

The activity in this geographical area is centered on the guifi.net community network (see Sec. 6.3 for the direct collaboration with guifi.net), with interventions, in several of the different localities where guifi.net is present or active, on municipalities, regional authorities, local interest groups, and other administrative or economic entities relevant for the CN activity.

Members of the guifi.net community in different locations expressed interest, co-designed and deployed Cloudy as a way to run local services, in most if not all cases, to run network management related services or applications. Interestingly, the locations are quite widespread and diverse, such as Madrid around the Medialab Prado [1], a rural area in the Ribargorza[2] area of the Pyrenees, or several participants spread across the urban area of Barcelona.

Diverse authorities have shown interest and given support to CN related initiatives, such as several municipalities interested in the development of networking infrastructures (the Universal Deployment Model presented in Sec. 3.7 was born out of these activities).

A long-term collaboration has emerged in relationship to local participation and commons-based models driven by the city council of Barcelona, specifically with the department for Social Economy, Local Development and Consumption. Many of these are part of Barcola[3], a city-wide working group of social and public actors around that topic. We have established an ongoing contact with the regional government of Catalonia (The ICT Centre). We have participated in the yearly event of the Solidarity Economy Fair (FESC) organized by the The Solidarity Economy Network (XES), through the stands of the guifi.net community and participated in diverse talks and round tables around commons models and specifically community networks and clouds.

As part of the Concurrency and Distributed Systems Spanish network, UPC has disseminated and established collaborations with other universities (research groups) in the area interested in supporting local initiatives promoting universal connectivity, community clouds, and related research on the topic at national level[4]. UPC has also continued joint research[5] with INESC-ID on project related activities as part of the Erasmus Mundus Joint Doctorate in Distributed Computing.

[1]Medialab Prado: A citizens' laboratory supported by the city council of Madrid, that serves as a place of encounter for the production of open cultural and digital projectshttps://www.medialab-prado.es/en

[2]Ribaguifi: A cooperative offering community connectivity to several villages in that county: https://www.ribaguifi.com/

[3]Barcola: Collaborative Economy and Commons Based Peer Production in Barcelona: http://wiki.p2pfoundation.net/BarCola

[4]For instance, the XXV Workshop on Concurrency and Distributed Systems: https://www.dsi.uclm.es/retics/jcsd2018/

[5]3 joint PhD projects during the lifetime of netCommons

4.2. Italy

Various activities have been carried on with Italian CNs and other entities based in Italy. WP3 had a continuous interaction with the ninux Italian CN, as reported in Sec. 6.4. We participated to activities organized by ninux (like the MERGE-it meeting Sec. 2.4.1), internal meetings in the ninux island of Florence (almost weekly), and maintained constant contacts with several more ninux islands. This produced a virtuous feedback loop with the community, that participated to the experimentation with PeerStreamer-ng, it sparkled ideas that led to project proposals and joint activities. Among these activities the most relevant are the following.

- The participation of two ninux communities in the use of PeerStreamer-ng (see D3.5 [3]).
- The participation of ninux Florence in the experimentation of the Participatory Design Methodology (see D3.6 [12]).
- One project proposal submitted to RIPE (already mentioned in D2.7 [13], submitted in 2017). It was unfortunately not successful, but opened the way to further activities in 2018, such as the Google summer of code which Leonardo Maccari supervised on the Turnantenna project, which is now in the process of becoming a start-up (see D3.5 for the technical part, while Appendix A.1 reports the letter sent by the project leader to netCommons).
- support to the ninux Calabria island on the re-organization of their statute which was reported in D4.5 [14], but whose impact is further stressed by the appreciation letter from ninux Calabria reported in Appendix A.2.

Furthermore, netCommons team in Italy has maintained relations with some local administrations in Trentino, but most notably in Emilia Romagna, which lead to the invitation to the event described in Sec. 2.5.4.

4.3. Greece

As documented in previous deliverables, the Greek landscape is rather challenging for approaching and engaging local actors. We report on the direct interaction with Sarantaporo.gr in Sec. 6.2.

One of the reasons is that the most prominent CN, Athens Wireless Metropolitan Network (AWMN), has been traditionally placing itself "outside" the Internet. So, it has not engaged in legal and policy battles, like for example Freifunk or guifi.net, and legal and policy issues related to CNs have not bothered significantly the local authorities until recently.

However, at the last plenary meeting of netCommons a significant success was realized to this respect, and more specifically a workshop titled "The new EU telecommunications code in Greece and its effect on community networks," organized at Impact Hub Athens and reported in detail in Sec. 2.1.6.

In this workshop three key actors were present together in the same panel: Vassiliki Gogou, President's Office, EETT (Hellenic National Telecommunications and Posts Commission, National Regulator), Konstantinos Champidis, Chief Digital Officer, City of Athens, and Prodromos Tsiavos, Member of the board of GFOSS, responsible for Policy Recommendations, Open Content and Intellectual Property.

Having these three key actors in the same room with key people from the CN community like Jane Coffin, Director, Development Strategy, Internet Society (ISOC), and Steve Song, Village Telco, together with the netCommons partners and advisory board was already a success.

The discussion after the initial presentations was very interesting and various expressions of interest for future collaborations were expressed. Time will show how fast these will materialize, but the first seed has been placed.

Figure 4.1: The poster presented at the Swiss Inter- Trans-disciplinary Day 2018 [1], describing the concept and vision of the space L200.

4.4. Switzerland

In Switzerland, during the last year of netCommons, there have been developments in two fronts.

First, the initial contacts with various cooperative housing projects, resulted to an interesting "encounter" of local actors with the researchers and activists from the CAPS project MAZI (see D5.5 [2]), which led to additional interactions.

The most promising development to this end, is the participation of NetHood in a nation-wide working group on Internet access sharing for new cooperative housing projects, opening a new important area for CNs recognition, which is the appropriate networking infrastructure building and management in large (and small) housing projects, starting from cooperative housing, but possibly expanding to other forms of housing projects.

Second, the new space, L200, co-founded by NetHood in the context of the Task 5.5 has already engaged a wide variety of actors[6], including the ISOC-CH chapter whose latest event was organized at L200[7] by Panayotis

[6] See http://langstrasse200.ch/pub/projekte & http://langstrasse200.ch/pub/digital/

[7] Announcement and agenda at https://www.isoc.ch/events/how-can-digitalization-mitigate-current-challenges-of-humanity-listen-

Antoniadis. Panayotis Antoniadis has also been elected member of the board and leader of the Social impAct Committee (SAC)[8].

The fact that a real urban space in a very central location in Zurich is used as a hub for various actors outside the project, many of them in non-technological areas (housing, food, economy, ...), L200 has already engaged over 70 members in the first 8 months of operation, provides good evidence that the concept of the "right to the hybrid city" presented and described in D5.5 is rising attention and interest, and it has materialized in something very concrete (the L200 space) and promising for the future.

4.5. Latin America and the Caribbean

As part of the preparation of the WALC course on "Community Networks course in Latin America and the Caribbean" (See Sec. 2.1.8), we had exchange of ideas with Rhizomatica and RedesAC, organizations supporting several CNs in the south of Mexico, Colombia and Brazil. As part of the WALC 2018 training on community network, we spent part of the course (2 full-time days) applying the content of the course into the design of three CN projects in the region (Panama, Mexico and Dominican Republic). Several national governments and universities in the region have shown interest in community networks, including public infrastructure operators and telecom regulatory agencies such as those from Costa Rica, Dominican Republic, Mexico (with participants from these agencies involved in the course) and supported by the Inter-American Telecommunication Commission (CITEL) of the the Organization of American States (OAS). The experience was perceived as very successful by everyone involved, and the plan is to repeat it in future editions of WALC.

4.6. Africa

Training in the series of community network summits in Africa, that started first in Kenia 2017, and continued this year in the Zenzeleni community in South Africa with the support of Internet Society in the region and globally, see Sec. 2.6.1, where a training and workshop about business model canvas for community networks as reported in D1.3 and D.14 [5, 6] was held. Several African governments have considered and even supported the model, such as the South African government with an explicit award and recognition to the Zenzeleni CN, and several African CNs have developed the model, and adopted it in successive local training.

from-zurich

[8] See https://www.isoc.ch/commitees-bodies/sac of ISOC-CH focused on building awareness and stimulate learning on the processes and internal workings of the Internet

5. Other dissemination activities and achievements

5.1. Videos

During 2018 netCommons produced two short "video reports" from two interesting events organized by the Sarantaporo.gr NPO and guifi foundation. It also released the videos from all talks during the EU parliament workshop.

5.2. Miscellaneous written pieces

5.2.1. Press

- F. Tréguer, 2018, Directive sur le droit d'auteur: l'affrontement factice des deux têtes du capitalisme informationnel[1].
- "Hyperlocal radio and do-it-yourself networks bring information closer to home" is the title of an article by Rex Merrifield published on Horizon The EU Research & Innovation Magazine, Jan. 10, 2019, discussing community communication and networking, including material on netCommons deriving from a couple of interviews with Renato Lo Cigno

5.2.2. Blog posts

F. Tréguer, 2018, EU telecom reform paves way for policies tailored for community networks, LSE Media Policy Project blog post[2].

5.3. Translations

The article "How to build a more organic internet (and stand up to corporations)" by Panayotis Antoniadis was translated in Greek by MediaLibre.[3] and the book chapter "The Organic Internet: Building Communications Networks from the Grassroots"[4], is being translated in Spanish in collaboration with Altermundi, [5], and in French and Italian in collaboration with C.I.R.C.E. [6]

5.4. Collaboration with industry and start-ups

The results of wireless community networks, such as the Barcelona mesh in guifi.net (QMPSU), combined with the results in the netCommons project, has brought interest from industry. The huge amount of underserved

[1] Available at https://www.lemonde.fr/idees/article/2018/09/09/directive-sur-le-droit-d-auteur-l-affrontement-factice-des-deux-tetes-du-capitalisme-informationnel_5352566_3232.html
[2] http://blogs.lse.ac.uk/mediapolicyproject/2018/11/27/eu-telecom-reform-paves-way-for-policies-tailored-for-community-networks/
[3] https://medialibre.net/2018/05/24/pos-na-oikodomisoyme-ena-pio-organiko-diadiktyo-kai-na-antitachthoyme-stis-megales-etaireies/
[4] https://link.springer.com/chapter/10.1007/978-3-319-66592-4_13
[5] http://altermundi.net
[6] http://circex.org

and unconnected, in the range of billions, has brought industrial interest both from established and emerging initiatives. After initial interactions with several prospective industrial groups, UPC reached an agreement for research under the framework of the Ammbr Research Labs (ARL)[7]. For that, several preparatory meetings and many weekly conference calls were held. An industrial partnership was signed between UPC and ARL, from February 2018 until the end of 2018, to do applied research on several topics and develop a prototype and pilot sites to build wireless mesh networks that include blockchain-based automated economic compensation systems that allow self-provision of a crowdsourced client Internet access over a set of access-points, a mesh network and Internet gateways. The collaboration has allowed to customize Cloudy and develop several components for that purpose.

The collaboration between UniTN and ninux helped the creation of a Florence-based start-up on a concept named Turnantenna. The Turnantenna (better described in D3.5 [3], Chapter 3) comes from the effort of two people in ninux that were supported and sustained by UniTN through netCommons in two ways: directly, mentoring the initial design of the Turnantenna software and providing material to build the prototype; indirectly, providing the documentation that strengthened the idea that a CN can become a sustainable social enterprise.

The collaboration with the ninux helped the creation of a Florence-based start-up on a concept named Turnantenna. The Turnantenna (better described in D3.5) comes from the effort of two people in ninux that were supported and sustained by netCommons in two ways: directly, mentoring the initial design of the Turnantenna software and providing material to build the prototype; indirectly, providing the documentation that strengthened the idea that a CN can become a sustainable social enterprise.

5.5. Teaching and Courses

Leonardo Maccari held a Ph.D course at the university of Trento named: “Connecting the Unconnected: Mixing Graph Analysis, Large-Scale Mesh Networks and Blockchains for Universal Internet Access”. The course deals with the technologies and the open research issues related to the growth and expansion of CNs.

Renato Lo Cigno and Leonardo Maccari introduced, in Academic Years 2017/18 and 2018/19 roughly 16 hours dedicated to Community Networks and Wireless Mesh Networks in the course Wireless Mesh and Vehicular Networks offered at the Master (Laurea Magistrale) in Computer Science of the University of Trento.

Felix Freitag and Leandro Navarro introduced, in Academic Years 2016/17 and 2017/18 roughly 6 hours dedicated to community networks, routing in mesh networks and community clouds in the course Decentralized Systems offered at the Master in Computer Science of the Technical University of Catalonia (UPC).

[7] A company part of the AmmbrTech group: http://ammbrtech.com/.

6. Impact on the Community Networks Movement

6.1. Overall impact

All of the dissemination work of netCommons, as analyzed in the previous sections, had a significant impact on and for the CN movement as a whole.

The inclusion of Community Networks in the Internet Universality Indicators, the three workshops in the EU parliament, the numerous publications in scientific venues and popular press, the organization of events, and the production of different types of guidelines and methodologies, have all contributed to the collective knowledge and the amplification of the voice of CNs around the world.

In addition, netCommons has worked very closely with some European and non European CNs, with additional explicit impact, as summarized in this chapter.

6.2. Sarantaporo.gr CN

Sarantaporo.gr has been a very important case study for the netCommons project, and also one of its success stories in terms of direct impact.

As, documented in netCommons D3.1 [15] (p. 47) when the netCommons project started the overall impression was that, with a few exceptions, many people from the local community "hold a position of distrust." More specifically,

> "*despite long and persistent efforts to mobilize local inhabitants from Sarantaporo village to actively participate to the community network, the prevalent mentality has been one of "committal", in the sense that people expected from some actor (prominently the municipality) to provide them with the whole service. In large part the majority failed to see the community side of the project. The Sarantaporo.gr team repeatedly tried to inform the local population, but the "battle" was really tough: a strong mentality of resignation and self centeredness became the fertile land for rumors, such as "they are from some political party," or "they receive tons of money from various funds". Combined with a lack of permanent local presence from the Non-Profit Organizations (NPOs) members (no member of the NPO is currently a permanent inhabitant in the village) and perhaps lack of communication skills, this led to multiple misunderstandings and even a certain negative disposition towards the team and its work by influential members of the local community. The only way to resume dialogue with the local community passed, unfortunately, through the decision of the NPO team to temporarily disconnect the local access network. Eventually this fact motivated some members of the local community to get more actively involved. Currently the NPO team is collaborating with these people to set the operation of the local network to a more participatory course. This incident highlights the necessity to have local opinion leaders on board the project from a very early stage and to profoundly understand their motives. If one earns their support, it is expected to have a strong local ally to one's cause.*"

Almost three years afterwards, Sarantaporo.gr has renewed and expanded both its backbone and access networks, with support of complementary funding from ISOC[1], started a knowledge transfer in collaboration with P2PLab supported by Fund Action[2], was invited to participate in related panels in IGF 2017 & 2018, and IETF

[1] See https://www.internetsociety.org/beyond-the-net/grants/2017/sarantaporogr-community-network/ and http://www.sarantaporo.gr/node/405

[2] See http://www.sarantaporo.gr/node/408

101, had a dedicated documentary on national TV[3], but most importantly has successfully engaged the local community in a long-term learning and engagement process with a brand new economic model and around 50 node owners (among which 13 women) active in the corresponding telegram group[4].

Of course, netCommons has not been the only actor that contributed to this impressive progress of this small Community Network in rural Greece. But there have been several important interventions by netCommons partners that have definitely played a role. More specifically:

Community engagement and trust building: This was primarily achieved through coordinating a series of local events with external visitors that attracted publicity and made locals appreciate more the effort put in the CN.

- The participatory design workshop on November 26, 2016[5] increased the interest and trust of the influential farmer community (e.g., as evidence immediately after the workshop 2 nodes were installed in farms) and set the scene for a new phase in the relationships between the local community and the Sarantaporo.gr NPO.
- The interview, in Greek, by the national television ERT3 called "Antidrastirio," broadcasted on May 25th and May 29th[6], contributed to the decision by the same program to dedicate a full episode on Sarantaporo a few months later[7]. The presence of the national TV in this abandoned rural area, was yet another important push for the Sarantaporo.gr NPO and the realization of the importance of the Sarantaporo.gr CN.
- The presentation of Sarantaporo.gr CN as a success story in the EU parliament at the European Commons Assembly, November 16, 2016[8], and the CAPS workshop in Rome (D6.2 [7], p. 28), and the very popular article on "The Conversation"[9] with over 13600 readers, increased the overall awareness of this case study in key people and organizations like the Commons Network, the P2P foundation, and more.
- The organization of a knowledge transfer session in the context of a training program at the Sarantaporo village (D3.3, p.23), including the invitation of Nicolas Pace from Altermundi and Vasilis Niaros by P2PLab, also invited in the first participatory design workshop, but this time with an extra guest from the Ioannina municipality, contributed to the increase of trust toward the Sarantaporo.gr NPO by the local community. It also initiated the collaboration between Sarantaporo.gr NPO and P2PLab that led to the knowledge transfer funded project by FundAction[10].
- The international conference with distinguished guests like Jane Coffin and Steve Song, combined with the workshop at ImpactHub Athens with key local stakeholders (see Sec. 2.1.5 and Sec. 2.1.6), have put a strong basis for even more fruitful international and national collaborations in the future. E.g., the fact that members of the Sarantaporo.gr NPO met for the first time with the Greek Telecom regulator can lead to developments of significant impact for this and other CNs in Greece.
- The production of a video report from Sarantaporo, presented in the WSIS conference (see Sec. 2.2.3) created quite some impact in the DC3 mailing list with a lot of praise, generating even more attention toward the Sarantaporo.gr CN.
- The contribution by Alexandros Papageorgiou (NetHood) to the GISWatch report on Sarantaporo.gr CN[11] helped to highlight the community perspective in the description of this case study in such a

[3] See https://webtv.ert.gr/ert3/antidrastirio/05mar2018-antidrastirio-kinotiko-asyrmato-diktyo-sarantaporo-gr/
[4] See https://www.youtube.com/watch?v=FDanOsKu2js
[5] See https://netcommons.eu/?q=content/agricultural-sector-ict-innovations-and-commons-towards-building-synergies
[6] See http://webtv.ert.gr/ert3/25me2017-antidrastirio-kina-ke-kinoniki-allilengya-ikonomia
[7] See https://webtv.ert.gr/ert3/antidrastirio/05mar2018-antidrastirio-kinotiko-asyrmato-diktyo-sarantaporo-gr/
[8] See https://www.youtube.com/watch?v=XEWDstHb8Bg, at 1h2m17s
[9] See https://theconversation.com/diy-networking-the-path-to-a-more-democratic-internet-67216
[10] See http://www.sarantaporo.gr/node/408 and http://www.sarantaporo.gr/node/413.
[11] See https://www.giswatch.org/en/country-report/infrastructure/greece

prestigious publication with large diffusion and significant potential impact.

Funding resources: The presentation of P. Antoniadis on Sarantaporo.gr CN in the GAIA workshop in Cambridge[12], initiated the contact with ISOC. The contact was developed further and Sarantaporo.gr, with the help of Nethood, bid and won a grant that helped them renew their network.

Training: The training session at Pythio village organized by netCommons on March 4, 2017 (D3.3, p.15), with the use of the real map and toys for representing the different parts of the networks as suggested by the participatory design methodology (see D3.1 and D3.3 [15, 16]), was identified by members of the Sarantaporo.gr NPO team members as a milestone for the engagement of people in the practical aspects of the network maintenance.

Software: Part of the netCommons heritage is the Android mobile app AppLea, an online assistant for logging and analyzing the farming activities and sharing data about them. The long-term impact of the app remains to be seen, however, it has already had an impact on the local community through the participatory way it was designed and developed. The overall participatory design process led by NetHood and software development process led by AUEB (see D3.2, D3.4 and D3.5 [17, 18, 3]) evolved with several additional participatory design sessions in the villages, the set up of a beta testing team out of local members, regular interactions through a dedicated telegram group, generating further interest in the CN and strengthening its importance for the local community.

Organizational model: The AUEB team has had a series of discussions with Sarantaporo.gr about the possible legal hypostasis of the team, which is currently a non-profit civil partnership. The two options that Sarantaporo.gr has been iterating on are a) setting up a small ISP entity, under the expectation that small ISP entities will not be subject to the mandatory prerequisites normal ISP are; b) launching a cooperative for sharing the Internet connectivity, in conjunction with an entity that will maintain the CN. Both options have a mix of positive and negative aspects.

Economic model: In 2017, Sarantaporo.gr changed its subscription model towards a model that the AUEB team has called ”collective subscriptions”. The dynamics of this model have been analyzed in a research paper by the AUEB team [19]. Moreover, AUEB has forwarded to Sarantaporo.gr information about the economic models of two of the most successful CN funding models worldwide, those of guifi.net and B4RN.

6.3. The guifi.net CN

The intense collaboration with guifi.net has produced very significant results with mutual influence, where netCommons has contributed to elaborate, consolidate, disseminate, or measure impact on several result areas. Proximity with the UPC group, with frequent meetings on a daily, weekly and near monthly basis with several members of the community and employees of the guifi.net Foundation help to build this relationship[13]. The main interactions and result areas are the following:

Organizational models: As a result of WP1, there has been an evolution towards the consolidation of the sustainability and organizational models applied to guifi.net as a whole and specific groups. A workshop as held on organizational models of different local groups as part of the guifi.net assembly, see Sec. 2.4.3, where several groups (around 6) drafted a canvas and table description of their local organization, that lead to a debate and exchange of different ways to handle common issues. Definition of a guifi.net-based commons model for community cloud services, as reflected by the [20] journal paper.

[12] See http://dsg.ac.upc.edu/gaia-cn-ws and https://netcommons.eu/?q=content/gaia-community-networks-sustainability-regulation-workshop

[13] One Foundation employee is doing an industrial doctorate at UPC since 2016, one former Foundation employee and still member of the community has started his PhD at UPC in 2018, several other community members collaborate with research and other activities with UPC, and several UPC staff are guifi.net volunteers.

Software: Maintenance of the Cloudy distribution that incorporates several guifi.net services, and therefore facilitates the deployment of several legacy and current services.

Sustainability: Elaboration of the sustainability model of guifi.net and lessons learned (DC3) [21].

Policy: Elaboration of a revised version of the Universal Deployment Model as a template for municipal ordinances, and generalization of the model, as presented in the GAIA WG, see Sec. 2.1.7, and reported in a journal by invitation from the editor of the Brazilian poliTICs journal [10] in Brazilian and open-access in English [11].

Economic: Elaboration of the economic model of guifi.net (report), specifically the economic compensation system, and exploration of scalable models using blockchain models.

Dissemination: Participation and publications in different international events such as the Internet Governance Forum 2018, see Sec. 2.2.5, the Global Information Society Watch (GISWATCH) 2018 report about guifi.net [22], or the “Community Networks course in Latin America and the Caribbean”, see Sec. 2.1.8, different guifi.net related presentations in the GAIA IRTF.org working group such as mentioned before about the universal deployment model (see Sec. 2.1.7 and Sec. 3.7).

6.4. ninux

Ninux was included in the project in several ways, and this process of involvement, discussion and feedback produced impact on the community under several aspects. We actively participated and helped to organize two ninux meetings (in Florence and in Bologna), plus one open meeting (the MERGE-it) with several other communities in Italy. We followed the work of one community (the one in Florence) with almost weekly participation to the meetings of the community. We also maintained tight relationships with the community in Rome and Cosenza. The three main areas in which we had a measurable impact are.

Organizational models: In the course of the project we studied and we interacted with ninux in order to outline the shortcomings of the model that the community adopted so-far. We verified that ninux was using a model that was hiding some critical points of failure behind the definition of “distributed network”. We provided some metrics and software libraries to quantify this phenomenon, and we provided to the OpenWISP community the necessary software to visualize such metrics. One of ninux community (Cosenza, Calabria) started a process of re-work of their internal governance, inspired by the analysis we provided (see Appendix A.2). The community is now growing with a more balanced and sustainable model than before.

Software: We involved ninux Florence and Cosenza in the experimentation with both the participatory software design methodology and the testing and adoption of the PeerStreamer software. On the one side, the methodology received interest and inspired the development of software in ninux. For instance, the Turnantenna project by Marco Musumeci, thanks to the guidelines included in the methodology, opened up from a one-man hobby to a team-work that produced a new cooperative start-up. The letter in Appendix A.1 mentions the participation to an Italian seed program, and it was received before its results were available. **At the time of writing this deliverable we know that the start-up was financed with a monetary prize plus 6 months training for all the components of the group**.

PeerStreamer produced a renewed interest in internal services and it was used to broadcast public events. It is now a instrument that people in ninux can keep using and experimenting with.

Legal aspects: In Y2, as reported in D4.2 [23], we helped clarify the legal aspects of community networks in Italy, as well as in other European countries. This served as an encouragement for ninux communities. This activity continued in Y3 with a less formal structure, giving specific feedback (normally via jitsi or skype calls) in order to improve the clarify legal provisions for ninux in the Italian system.

Improved Narrative and presentation: we produced documentation and diffused information that made the case of Community Networks clear to the public and to stakeholders. We contributed to extend the idea of CNs from hacker experiments to solid initiatives with a social background that helped to develop a cooperation with other actors. We mention the cooperation of ninux with ARCI (the largest non-profit, non-ecclesiastic organization in Italy) documented in D2.7 [13], as well as the fact that ninux was asked to participate to the future experimentation with the AMMBR hardware, as soon as this will be available[14].

6.5. Other CNs globally

Several CN initiatives in Africa such as Tunapanda or Zenzeleni have been influenced by the results of netCommons that build on previous direct collaborations with UPC. In the last years and particularly in 2018 the results on organizational and sustainability models have been explored and partially adopted by these CN, as part of an invited and jointly organized session on the recent "Third Summit on Community Networks in Africa" (see Sec. 2.2.4).

The WALC course in December 2018 about community networks for Latin America and the Caribbean is another example of influence in the region, combining the results of netCommons with the reputation and experience of guifi.net and the common language and cultural links with the team at UPC. The most direct outcome has been the direct interaction and exchange of ideas, models, results, with the Mexican CNs supported by Rhizomatica and RedesAC, that brought one of the directors (Erick Huerta) as part of the instructors team, together with members of UPC and guifi.net. We expect that the presence of multiple stakeholders including governments, public network providers, telecom regulators, community members, regional authorities such as Latin American and Caribbean Internet Addresses Registry (LACNIC), Inter-American Telecommunication Commission (CITEL), and Internet Society will help develop a more favorable environment for emerging CN in the region (see Sec. 2.1.8).

[14] Note the presence of the ninux logo in AMMBR.com, which points to an entry in the ninux blog that explains the availability of the community to participate to the experimentation, together with the ethical constraints the community poses.

7. Summarizing the Overall Impact

Before closing the deliverable, we briefly summarize in form of easy-to-browse tables the multifaceted impact netCommons has made, and is still making, on Community Networks. We distinguish between three main target groups of this impact: the policy-making and regulating bodies, the CNs themselves, and the broader research and academic community.

This chapter is not intended as a standalone description but rather as a directory, with pointers to other places in this document, or other documents, for more details on the individual activities that made netCommons so visible and impactful. Only the actions that already had a measurable and visible outcome are reported here, which does not mean that other activities and actions were less important or will not have relevant outcomes in the future.

We are trying to be as objective and honest as possible, highlighting results already achieved and the positive impact that netCommons research already had. Sometimes we also hint to impact that we earnestly think will happen, and also to impact that will most probably happen, but it is indeed impossible to collect without a global (and very expensive) action that goes well beyond our possibilities and capabilities. This consideration refer specifically to change in EU legislation and the inclusion of the concept of Community Networks in global organizations like ISOC and UNESCO. These specific results, albeit hoped and looked for by the consortium, were obtained also thanks to a favorable timing and the interaction with many activists and advocacy groups, and their long-term consequences are so complex and articulated we cannot claim, now, what the global impact will be.

7.1. Policy and Public Administrations

We split the summary tables between those at a global level and those at a local level, in line with the structure of our workflow as described in the Grant Agreement. Some activities, e.g., those with industries, may pertain both to the global and local level, thus their classification is somewhat arbitrary.

Actions at the Global Level

Action	Impact Type	Achievement Means and Results
Advocacy for the update of the EU Electronic Communications Code	Policy change	Engagement with policy makers. Revision of the EECC and proposal of changes to tens of clauses, many of them accepted. EU Electronic Communications Code now acknowledges that it is important that policy changes take into account “the variety of conditions relating to infrastructure, [. . .] including local infrastructure managed by natural persons on a not-for-profit basis” (Article 3). The impact of these changes will extend for decades; it is possible that the entire telco industry in some countries may be affected (positively) by these changes

UNESCO Internet Universality Indicators	Policy change	UNESCO revised its Internet Universality Indicators in such a way that indicator C.6 now focuses on community networks. Indicator asks: "Are communities able to establish their own networks to provide Internet access?" Direct engagement with UNESCO through events and a written submission, the change may look minimal, but acknowledges the existence of CNs and their role for the universal access to the Internet.
IRTF WG Chair	Shape research agenda and Internet standards	Through chairing the IETF GAIA WG and actively contributing to its meetings and lists, we have ensured that the requests and objectives of community networks and underserved communities have been part of the technical agenda of Internet standards. Reported in Sec. 2.1.7
GISWATCH book	Produce documentation for policy-makers	Contribution to key publications on CNs like the GISWATCH book from APC to describe and report about community networking experiences globally. Reported in sections Chapter 6
Partnerships	Collaboration with industry	Collaboration agreements and technology transfer with industry and start-ups. Reported in Sec. 5.4
Advocacy against unfavorable provisions of RED	Policy change	The RED (Radio Equipment Directive, 2014/53/EU) was (and still is) an obstacle to the expansion of CNs. We supported the working group that is discussing how to limit the impact on open source and CNs, and helped drafting a brief published by the Freifunk CN (reported in Sec. 3.8)

Actions at the Local Level

Action	Impact Type	Achievement Means and Results
Barcelona city expert group	Shape municipal research agenda	Participation in the Barcola working group of the department for Social Economy, Local Development and Consumption, city of Barcelona. Reported in Sec. 4.1
Spain: definition of research challenges	Shape national research agenda	Definition and coordination of systems research on networking, connectivity, community clouds, decentralized systems, distributed ledger technologies and applications across national research groups funded by the Spanish government. Reported in Sec. 4.1
Athens, Greece. Policy-making workshop	Enable CN access to policy making	Set up the link between CNs and policy-makers.Bringing together the Greek Regulator, the City Digital Officer of the City of Athens and key actors of the CN movement in an open public discussion. Reported in Sec. 2.1.6, and slides available at Appendix B.3
Zurich, CH. Dedicated urban spaces	Help communities access to policy-making	The L200 space in Zurich is designed in a way to bring together a diverse set of local actors including neighbourhood organizations, the municipality, different activist groups (urban, digital, sustainability) and more. See http://langstrasse200.ch/events/

7.2. Community Networks

Interactions and Impact on Community Networks

Community Network	Impact Type	Achievement Means
ninux	Legal and liability issues	Consultation on the legal aspects of the Picopeering agreement. Ninux Cosenza reshaped their internal agreement based on the legal work netCommons did in WP4. This impact was reported in Sec. 6.4, D4.2 [23] and the letter in Appendix A.2
ninux	Open source software	The research realized in WP2 led to new metrics and open source code that is now included in an official branch of the OpenWISP2 open source platform. The software and impact (with a letter from the maintainer of OpenWISP) was reported in D2.7 [13]
ninux	Open source software	The research realized in WP3 led to new services in the ninux network. A group of members started to use the PeerStreamer open source project developed in netCommons. This was documented in D3.5 [3], and reported also in the letter in Appendix A.2
ninux	Organization and technology support	Through the collaboration with netCommons the Florence ninux island was able to organize live meetings, collaborations and developments. This is reported in several deliverables: D3.6 [12] reports how using the participatory methodology ninux organized new activities, a letter in D2.7 [13] documents the effort to improve the internal organization, Appendix A.1 shows how with the collaboration of netCommons a start-up was born from a member of Ninux Florence
guifi.net	Governance and sustainability	Contribution to formalisation of cost sharing and universal deployment model. Reported in [11] and [10], presented in IETF 103 GAIA WG Sec. 2.1.7
guifi.net	Community clouds	Software development to support local network and community services, governance and sustainability model of community cloud infrastructure and services. Reported in Sec. 6.3 and D3.2 [17], D3.4 [18] and D3.5 [3]
Sarantaporo.gr	Open source software	The community of Sarantaporo adopted the AppLea software for the monitoring of farming activity, developed by WP3. This is documented in D3.5 [3]
Sarantaporo.gr	Community training	Regular visits at the Sarantaporo area followed by training seminars, participatory design workshops, and interactions with global actors D3.1 [15] and D3.3 [16]
Sarantaporo.gr	Complementary funding sources	Public presentations of the Sarantaporo.gr case study in international fora of high-impact, organization of workshops including key actors as guests
Sarantaporo.gr	Networking opportunities	Invitation of Sarantaporo.gr members in a wide variety of events, both local and international, providing many opportunities for contacts with peers and important actors

Tunapanda, Zenzeleni, Taknet	Definition of internal and external organizational model	Development or contribution to define the "business" model canvas and the organizational model canvas. Reported in Sec. 6.5 and D1.2 [4], D1.3 [5], and D1.4 [6]

7.3. Academia

We summarize here the scientific production and update the citation table presented in D7.5 [24] that highlights the quick and deep impact that netCommons research is having on the academic community. As a project netCommons already has an **h-index of 10** (up from 9 in early January), and a total number of **313 citations** (up from 218 in early January) to papers bearing thanks to it. In the table summarizing citations the line in red marks the project h-index so far. In early January the number of cited papers were 42 and now they are 43. A simple extrapolation from average citation trends puts the overall citations to netCommons supported papers between 2000 and 4000 in five years from now, and twice as much or more in ten years. Additional information and statistics on netCommons academic impact can be found in D7.5 [24].

Summary of scientific papers, talks, seminars, and other activities

Publication type or Action	Year	Quantity and description
Book Chapters	2016	**4 articles.** In the first year these were mainly position papers presenting the project ideas. See [25].
	2017	**1 article.** The article has also been translated in German. See [7].
	2018	**10 articles.** Published in various high impact books and collections. See Chapter 8.
Journal Papers	2016	**8 articles.** Also journal papers in the first year were mainly focused in presenting the ideas of the project and the key findings on the applicability of commons theory to CNs. See [25].
	2017	**8 articles.** These articles spans from engineering to law and social sciences. See [7].
	2018	**9 articles.** Most in English and one in Portuguese. Accepted in top-tier journals; most notable are *IEEE/ACM Transactions on Networking*, and *Ad-Hoc Networks* flagship journals in the area of networking of IEEE Communication and Computer Societies and ACM SIGCOM, and Elsevier respectively. See Chapter 8.
Conference with Proceedings	2016	**8 articles.** Conference papers were instead devoted, in the first year, to present the first scientific works of the project to obtain feedback in the presentation discussion. See [25].
	2017	**9 articles.** All in top conferences, most of them supported by IFIP or IEEE[7].
	2018	**11 articles.** All in top conferences, most of them supported by IFIP, IEEE, ACM or the EC directly. See Chapter 8.
Presentations, Talks and Others	2016	One working paper and one demo were also produced. See [25].

	2017	Three PhD theses were discussed during this year in UPC related to netCommons, and three presentations were given in different venues. In particular Félix Treéguer received the 2017 Emerging Scholar Best Paper Award of the CP&T (Communication Policy & Technology) section of the IAMCR (international association for media and communications research. See [7].
	2018	**7 venues.** netCommons researchers have been invited to give speeches or present research or in general to disseminate project-related results in seven different venues. See Chapter 8
Work in Progress		**12 additional** scientific works stemming from netCommons research and bearing acknowledgment to it are under review, submitted (some of them, on journals, are at the second review round), or in preparation.

Citations to netCommons academic publications at the beginning of May 2019

cit #.	Publication Title
36	First learn then earn: optimizing mobile crowdsensing campaigns through data-driven user profiling
22	Making Community Networks Economically Sustainable: The Guifi.net Experience
18	Practical Service Placement Approach for Microservices Architecture
15	Cloudy in guifi.net: Establishing and sustaining a community cloud as open commons
14	Sustainability and community networks
14	Local networks for local interactions: Four reasons why and a way forward
14	Community Networks: Legal Issues, Possible Solutions and A Way Forward in the European Context
11	On the Computation of Centrality Metrics for Network Security in Mesh Networks
11	Community Networks and Sustainability: a Survey of Perceptions, Practices, and Proposed Solutions
10	Incentivizing social media users for mobile crowdsourcing
10	Alt. vs. ctrl.: Editorial notes for the JoPP issue on alternative Internets
9	A Commons-oriented Framework for Community Networks
9	Efficient Collaboration between Government, Citizens and Enterprises in Commons Telecommunication Infrastructures
9	Mobile Crowdsensing Incentives Under Participation Uncertainty
9	Towards Network-Aware Service Placement in Community Network Micro-Clouds
8	Client-Side Routing-Agnostic Gateway Selection for heterogeneous Wireless Mesh Networks
8	Wireless Community Networks: Towards a Public Policy for the Network Commons?
8	A Lightweight Service Placement Approach for Community Network Micro-Clouds
6	The Organic Internet: Building Communications Networks from the Grassroots
6	On the Use of Eigenvector Centrality for Cooperative Streaming
5	Sustainability and Participation in the Digital Commons
5	Bandwidth-aware Service Placement in Community Network Clouds
5	Optimized P2P Streaming for Wireless distributed Networks
4	Community Sharing of Spare Network Capacity
4	Optimized Cooperative Streaming in Wireless Mesh Networks
4	Gossip-based Service Monitoring Platform for Wireless Edge Cloud Computing
4	On the Distributed Computation of Load Centrality and Its Application to DV Routing
4	Where have all the MPRs gone? On the optimal selection of Multi-Point Relays
4	Information Technology and Sustainability in the Information Society

3	Peer to party: Occupy the law
3	Coordinated detection of forwarding faults in Wireless Community Networks
3	A dynamic and autonomous channel selection strategy for interference avoidance in 802.11
3	On the Technical and Social Structure of Community Networks
3	Enabling Individually Entrusted Routing Security for Open and Decentralized Community Networks
2	Proof of Networking: Can Blockchains Boost the Next Generation of Distributed Networks?
2	Design Trade-offs of Crowdsourced Web Access in Community Networks
2	Alternative Internet Networks: History and Legacy of a Crazy Idea
2	Cooperation in Open, Decentralized, and Heterogeneous Computer Networks
2	On the Feasibility of Collision Detection in Full-Duplex 802.11 Radio
1	Blockchain for Economically Sustainable Wireless Mesh Networks
1	5G and the Internet of EveryOne: Motivation, Enablers, and Research Agenda
1	Improving Routing Convergence With Centrality: Theory and Implementation of Pop-Routing

7.4. Additional evidence of impact

Impact assessment beyond simple metrics as citations or attendance to events is challenging[1], since the effect of a certain action or result can be direct or indirect and can become manifest only at timescales and with modes that are impossible to track. This is especially true for societal impact: Who can ever claim that the birth (or death) of a specific Community Network is merit (or fault) of netCommons?

As a group of researchers, whose work is continuously subject to evaluation about its impact, we will never boast results that cannot be properly claimed, but we have collected a set of impact metrics based on a simple definition of impact: the generation of a positive concrete action by someone external to the project actors.

In this simple definition, "generation" means that there is a visible causality between the contribution and the external action. And of course, the more independent and remote from the project is the external actor, the more demanding the corresponding action in terms of resources, and the more the impact of the external action itself, the more the impact of the original action. The letters of appreciation in Appendix A are in this line of thought.

In the following table we list a wide variety of such "objective" evidence of impact and summarize the performance of netCommons according to these metrics, trying to highlight a quantitative impact when possible and highlighting the effort and/or investment required by the external actor to engage with a certain contribution, and the potential reach of the action. To exemplify, a "view" of an article or engagement with a "tweet" is considered a lower effort and a smaller reach than a documentary on a national TV channel, because of the human resources required but also because of the "reputation risk" that such a big media organization faces for every choice made, and reach because of the very large number of people potentially reached.

We do not consider anymore scientific and academic contributions, because the summary presented in Sec. 7.3 shows that our research is having a deep and durable impact on the community, with a very large number of actual citations. Browsing all the publishers sites to count the number of downloads (and discounting the fact that several publishers do not provide this information and that, being all papers in Open Access, it is simply impossible to track how many people viewed them) would simply add an extremely high number, whose impact "quality" is however impossible to state, differently from an actual citation.

To give an idea, the paper "Improving Routing Convergence With Centrality: Theory and Implementation of Pop-Routing" was downloaded (and presumably read) by 159 people directly from the IEEE Xplore library (which requires a pricey subscription to download papers), while it was cited only 1 time so far. With the number of citations received by netCommons papers and some, more or less credible, multiplicative factor

[1] See for example,http://ia4si.eu/

given by the Open Access policy, it would not be difficult to claim that netCommons academic work was downloaded and read 150 000 or 200 000 times, but to what avail?

The table below tries instead to describe, and quantify when possible, impacts and achievements that cannot have a direct, quantifiable impact as citations, but that have required the engagement of someone or some community/association.

Impact of the Action

Impact metric	Quantified Impact	Qualitative aspects
Reach out	Over 200000 tweet impressions (peak of 21K on May 2018, and an average of 8K / month) and over 17000 readers of the two online articles on The Conversation Global for which there are available statistics	Many of netCommons achievements (like the newspaper articles and national TV programs) are difficult to quantify in terms of reach-out
Appreciation of online content	An estimated amount of 2000 retweets, 200 mentions, and 5000 likes. Various translations of netCommons articles with external resources; Regular appearance of netCommons contributions in APC's newsletter; Integration of netCommons code in bigger projects (WISP)	Some of the appreciation actions have very strong qualitative characteristics like the tweets by Jane Coffin, strategy director of ISOC, referenced in Sec. 2.1.5
Level and quality of participation in netCommons events	All netCommons events reached the target level of audience ranging from 10-20 people for small workshops (8), to around 50-60 for specialized public events (3), up to 100 for wider audience public events (2)	All of the main netCommons events included distinguished guests and speakers, both from abroad and key local stakeholders
Participation of netCommons in high-impact events	netCommons researchers gave talks and participated in panels of more than xx high-impact events (with levels of participation between 100-5000 and high exposure in the corresponding communities)	Arguably, netCommons was present in most major events related explicitly or implicitly to CNs, ranging from small but very central like the battle of the mesh to very big and more generic like the IGF
Invited talks in public events with travel expenses covered by external resources	After the end of the project, invitation of NetHood in high impact event "Biennale du Design", St-Etienne in a panel on "Infrastructures as a Commons: the local data centre, guarantor of urban commons" together with Guifi and FFDN[2] and invitation of CNRS to the international symposium "The limits to growth of the smart city: spaces and energies of digital infrastructures"[3], from which a book chapter will be co-authored by CNRS (Felix Treguer) and NetHood (Panayotis Antoniadis and Ileana Apostol)	The fact that netCommons researchers are invited to talk in important events after the end of the project without own funding is an indication of the long-term impact of the project

Collaboration with or support by large organizations	netCommons collaborated closely with the most significant organizations in its area of research and action, including ISOC, APC, LQDN,	Publishing of the netCommons book by APC with the support of ISOC is a strong evidence about the impact that the overall work of netCommons had in the field of CNs
Contact opportunities	Facilitated more than 6 CNs to participate in more than 10 events (3 of which in the European Parliament)	Contacts can have a very significant impact in the long-term which is very difficult to measure. For example, bringing P2PLab to Sarantaporo area led a few months later to a small grant for replicating the model in Tzoumerka region
Complementary funding and follow-up projects	netCommons was involved in two grants for Sarantaporo.gr during the duration of the projection (see Sec. 6.2) and also an ERC Grant Heteropolitics[4] which made one of its case study Sarantaporo and collaborated closely with netCommons. Also, one grant application was successful after its end, a collaboration between Altermundi and NetHood based on the netCommons participatory design methodology[5]	Funding is an important impact factor because it has the power to put together more resources that can then generate more and more impact
Career development	4 PhDs on netCommons topics were defended during the duration of the project and one Post-doc (Felix Treguer) on related topics started after its end; NetHood's project L200 whose initiation was supported by netCommons has become the core activity for NetHood's future plans	Engaging young people and organizations to frame their career around the work carried out inside the project is an indication of long-term impact since the knowledge generated will feed future activities and other projects
Representing CN-related organizations	Leandro Navarro co-charing GAIA and representing APC; Leonardo Maccari representing ninux; Felix Treguer representing the Quadrature du Net; Panayotis Antoniadis voted as board member of ISOC-CH and acted as representative of ISOC-CH at the ISOC European Chapters Meeting presented the CN model	Note that some of these representations (like the one of ISOC-CH) happened toward the end of the netCommons project as a direct outcome of its activities
Advocacy engagement	More than 30 European CNs and 35 supporting organizations signed netCommons open letters and many high profile organizations like EDRI supported publicly the cause and forwarded the letters to their audiences	The vast majority of EU CNs and organizations defending digital rights joined the netCommons advocacy efforts, a strong sign of credibility and professionalism of this work

Being part of important collections	The DC3 books, and especially the 2018 one is dominated by netCommons contributions	Being included in milestone publications that are expected to become main references in the CN bibliography is a clear evidence of impact
Printed and online press	Three articles in local newspapers (Italy, Greece, France) and two online articles in The Conversation Global	Some of the newspapers are of very high visibility and reputation like ”Le Monde”
National TV documentaries and Radio Interviews	Two national TV channels featured netCommons: The Greek National TV ERT3 with a 20min interview of Panayotis Antoniadis on CNs, and after the end of the project, in May 2019, the Swiss National TV SRF1 with a 1.5 min coverage of NetHood's new space L200[6]; Renato Lo Cigno was interviewed by RAI 1 on February 2016	National TV and Radio shows are not only very high reach-out capacity but serve also as very credible references for future publications, advocacy and educational projects, and more

As a final note, notice that many of these impact metrics are extremely difficult to predict and include as KPIs and sometimes one of such unpredictable successes are a much more tangible measure of impact than standard quantitative indicators. Indeed, a single appearance in a National TV program can have such a cascading effect that can not be measured, because people inspired by the TV program to build or do something will most probably not even remember the program itself, let alone mention the research project that was supporting the person interviewed on TV.

[2]https://www.biennale-design.com/saint-etienne/2019/fr/programmation/?event=manufacture-de-la-ville-606
[3]https://gtvilleenergiehome.files.wordpress.com/2019/05/programme-colloque-56juin.pdf
[4]http://heteropolitics.net
[5]See http://nethood.org/elrepoio/
[6]See https://www.srf.ch/sendungen/unterhaltungssendungen/schoene-neue-stadt-die-langstrasse-im-wandel, episode (2/2), 00:16:30 - 00:18:00

8. List of Publications (2018)

We list here the scientific and position manuscripts published in 2018 together with those submitted but not yet accepted or published.

Book Chapters

1) Roger Baig-Viñas, Leandro Navarro, and Ramon Roca-i-Tió. “Multiple Dimensions of Community Network Scalability”. In Belli et al. [26], pages 133–158. ISBN 9788595970298. URL http://bibliotecadigital.fgv.br/dspace/handle/10438/25696

   A detailed report that combines the lessons learned in guifi.net with the experience in netCommons. We analyse the overall strategies and tackle scalability from what we consider the four main dimensions of CNs: social, legal, economic, and technological dimensions. We utilise the experience and lessons learned from guifi.net and other CNs to illustrate the discussion and the ways to achieve scalability in CNs.

2) Félix Tréguer. “Federating Community Networks: A case study from France”. In Belli et al. [26], pages 159–176. ISBN 9788595970298. URL http://bibliotecadigital.fgv.br/dspace/handle/10438/25696

   This chapter posits that, despite some difficulties, FFDN represents an interesting precedent for other national and regional CN environments willing to foster collective cohesion. We start by offering a brief history of the CN movement in France up to the creation of Fédération FDN in 2011, before surveying the federation’s main organisation features and accomplishments. Although communities in other states have explored other forms of coordination, this process of federation provides an interesting model for ensuring the coordination of various CNs with different models, and for establishing solidarity and f ostering resiliency in the face of the many challenges entailed buy the maintenance and defence of CNs.

3) Virginie Aubrée and Mélanie Dulong de Rosnay. “Fostering sustainability of Community Networks: Guidelines to Respect the European Legal Framework”. In Luca Belli, editor, *The community network manual: how to build the Internet yourself*, pages 177–188. FGV Direito Rio Edition, 2018

   This chapter proposes guidelines to help Community Networks (CNs) to cope with the applicable European legal framework and mitigate legal risks while protecting users’ rights and enforcing core values such as privacy. It covers three main topics that are key to the activity of CNs: civil liability, data protection, data retention and provides concrete recommendations on the legal choices to be made, as well as suggestions for CN governance choices.

4) Panayotis Antoniadis, Jens Martignoni, Leandro Navarro, and Paolo Dini. “Complementary Networks Meet Complementary Currencies: Guifi.net Meets Sardex.net”. In Belli et al. [26], pages 189–222. ISBN 9788595970298. URL http://bibliotecadigital.fgv.br/dspace/handle/10438/25696

   A comparison between different aspects of community networks and community currencies. The long-term objective is to build a better common understanding of the individual models but most importantly the stimulation of synergies and collaborations of researchers and activists from both sides.

5) Panayotis Antoniadis and Jens Martignoni. “What Could Blockchain do for Community Networks”. In Luca Belli, editor, *The community network manual: how to build the Internet yourself*, pages 223–248. FGV Direito Rio Edition, 2018

   This Chapter builds on previous work establishing an analogy between Community Networks (CN’s) and Community Currencies (CC’s), highlighting the variety of possible models that exist in both domains.

We advance this work by exploring two different ways through which an alternative currency model can support an existing Community Network. Although blockchain could be the underlying implementation solution for any alternative currency, we discuss separately recent blockchain solutions.

6) Steve Song, Carlos Rey-Moreno, Anriette Esterhuysen, Mike Jensen, and Leandro Navarro. "Introduction: The rise and fall and rise of community networks". volume 1. Association for Progressive Communications, November 2018. ISBN 978-92-95113-06-0. URL https://www.giswatch.org/community-networks

   An introduction to the GISWATCH book and the overall role and opportunities of community networks.

7) Leandro Navarro, Leonardo Maccari, and Renato Lo Cigno. "At the limits of the internet: Technology options for community networks". volume 1. Association for Progressive Communications, November 2018. ISBN 978-92-95113-06-0. URL https://www.giswatch.org/community-networks

   An overall description of the technological elements and choices for community networks in the recent years, and implications in these infrastructures.

8) Roger Baig, Leandro Navarro, Ramon Roca, and Felix Freitag. "Catalonia, guifi.net: scaling up a community network". volume 1. Association for Progressive Communications, November 2018. ISBN 978-92-95113-06-0. URL https://www.giswatch.org/community-networks

   A description of the situation in Catalonia with respect to the expansion and challenges of cooperative network infrastructures, and the case of the guifi.net community network.

9) Leandro Navarro. "Network infrastructures: The commons model for local participation, governance and sustainability". Association for Progressive Communications, Feb. 2018. URL https://www.apc.org/en/pubs/network-infrastructures-commons-model-local-participation-governance-and-sustainability

   An issue paper by APC about network infrastructure commons models in the context of community networks.

10) Panayotis Antoniadis. "The Organic Internet as a Resilient Practice". In Kim Trogal, Irena Bauman, Ranald Lawrence, and Doina Petrescu, editors, *Architecture and Resilience: Interdisciplinary Dialogues*. Routledge, 2018. ISBN 978-1-138-06581-9. URL https://www.routledge.com/Architecture-and-Resilience-A-Series-of-Interdisciplinary-Dialogues/Trogal-Bauman-Lawrence-Petrescu/p/book/9781138065819

   Popular internet platforms that currently mediate our everyday communications become more and more efficient in managing vast amounts of information, rendering their users more and more addicted and dependent on them. Alternative, more organic options like community networks do exist and they can empower citizens to build their own local networks from the bottom up, from the grassroots. Since digital communications are today necessary for supporting a wide variety of participatory processes, especially in cities, such resilient practices in the digital domain can have a strong effect on other domains of local action, as well. This chapter aims to make clear that digital tools are not neutral facilitators and they are subject themselves of the "right to resilience".

Journal Papers

11) Leonardo Maccari. "Detecting and Mitigating Points of Failure in Community Networks: a Graph-based Approach". *Accepted for publication on IEEE Transactions on Computational Social Systems*, 2019

   Wireless Community Networks are generally unplanned and non-layered, and the community tries to mirror the same approach in its governance, avoiding unnecessary management structures and relying on selforganization and spontaneous interactions. This paper analyses ninux.org, the largest community network in Italy, and one of the eldest in Europe. The goal of the paper is to understand if the spontaneous growth of the network and the community leads to a technically robust network and a socially robust community, or it hides the presence of (potentially interdependent) points of failure. We will show that, in spite of the original motivations of the ninux community, the network is fragile under several aspects, and we suggest ways to improve it. The paper is one of the main results from T2.4.

12) Mennan Selimi, L Cerdà-Alabern, Felix Freitag, L Veiga, Arjuna Sathiaseelan, and J Crowcroft. "A Lightweight Service Placement Approach for Community Network Micro-Clouds". *Journal of Grid Computing*, 2018. ISSN 1570-7873. doi: https://doi.org/10.1007/s10723-018-9437-3

This article describes service deployment models that allow locality and capacity of local cloud services, ensuring performance and resilience. The separation from resource allocation from service provision by this platform service is key.

13) Roger Baig, Felix Freitag, and Leandro Navarro. "Cloudy in guifi.net: Establishing and sustaining a community cloud as open commons". *Future Generation Computer Systems*, 87:868–887, Oct. 2018. doi: 10.1016/j.future.2017.12.017

In this paper, we explore the feasibility and sustainability of community clouds as open commons: open user-driven clouds formed by community-managed computing resources. We propose organising the infrastructure as a service (IaaS) and platform as a service (PaaS) cloud service layers as common-pool resources (CPR) for enabling a sustainable cloud service provision. On this basis, we outline a governance framework for community clouds, and we have developed Cloudy, a cloud software stack that comprises a set of tools and components to build and operate community cloud services. Cloudy is tailored to the needs of the guifi.net community network, but it can be adopted by other communities. We have validated the feasibility of community clouds in a deployment in guifi.net of some 60 devices running Cloudy for over two years. To gain insight into the capacity of end-user services to generate enough value and utility to sustain the whole cloud ecosystem, we developed a file storage application and tested it with a group of 10 guifi.net users. The experimental results and the experience from the action research confirm the feasibility and potential sustainability of the community cloud as an open commons.

14) Ester López and Leandro Navarro. "Coordinated detection of forwarding faults in Wireless Community Networks". *Journal of Network and Computer Applications*, 109:66–77, 2018

In this paper we present KDet, a decentralized protocol for the detection of forwarding faults by establishing overlapping logical boundaries that monitor the behavior of the routers within them. KDet has been designed with Wireless Community Networks (WCN) in mind. WCN have three intrinsic characteristics that make forwarding faults more likely: inexpensive equipment, non-expert administration and openness. These characteristics hinder the robustness of network connectivity. KDet is designed to be collusion resistant, ensuring that compromised routers cannot cover for others to avoid detection. Another important characteristic of KDet is that it does not rely on path information: monitoring nodes do not have to know the complete path a packet follows, just the previous and next hop. As a result, KDet can be deployed as an independent daemon without imposing any change in the network, and it will bring improved network robustness.

15) Panagiota Micholia, Merkouris Karaliopoulos, Iordanis Koutsopoulos, Leandro Navarro, Roger Baig, Dimitris Boucas, Maria Michalis, and Panayiotis Antoniadis. "Community Networks and Sustainability: a Survey of Perceptions, Practices, and Proposed Solutions". *IEEE Communications Surveys & Tutorials*, 20, March 2018. doi: 10.1109/COMST.2018.2817686

In this paper we approach sustainability in community networks as a broad term with an economical, political, and cultural context.

16) Axel Neumann, Leandro Navarro, and Llorenç Cerdá-Alabern. "Enabling Individually Entrusted Routing Security for Open and Decentralized Community Networks". *Ad Hoc Networks*, 79:20–42, Oct. 2018. doi: 10.1016/j.adhoc.2018.06.014

Existing community networks are vulnerable to various attacks and are seriously challenged by the obligation to find consensus on the trustability of participants within an increasing user size and diversity.

We propose a practical and novel solution enabling a secured but decentralized trust management. This work presents the design and analysis of securely-entrusted multi-topology routing (SEMTOR), a set of routing-protocol mechanisms that enable the cryptographically secured negotiation and establishment of concurrent and individually trusted routing topologies for infrastructure-less networks without relying on any central management. SEMTOR extends BMX6, one of the most popular mesh routing protocols in wireless mesh based community networks.

17) Leonardo Maccari, Mirko Maischberger, and Renato Lo Cigno. "Where have all the MPRs gone? On the optimal selection of Multi-Point Relays". *Ad Hoc Networks, Elsevier*, 77:69–83, Aug. 2018. ISSN 1570-8705. doi: https://doi.org/10.1016/j.adhoc.2018.04.012. URL http://www.sciencedirect.com/science/article/pii/S1570870518301537

OLSR is a widespread routing protocol in wireless mesh networks: static, mobile, ad-hoc, and even sensor networks. The selection of MPR that form a signaling backbone is at the heart of the protocol and it is a crucial process to reduce the signaling overhead. Since the protocol proposal and specification, the original heuristic for MPR selection has been largely studied showing it has good local properties; however, this does not give insight about the properties of the global set of MPRs. Here lays the contribution of this paper: First we define the problem of the minimization of the global MPR set (the union of all the MPR sets) as a centralized integer linear programming problem, which is NP-hard. We are able to solve it for networks of practical size, up to 150 nodes. Second, we define a bound that we call the "distributed optimum," which we show to be a lower bound for distributed MPR selection algorithms, still requiring considerable power to be computed. Finally, we set-up an experimental performance evaluation methodology and we show that a heuristic that we recently proposed performs very close to the distributed optimum, and always outperforms the original heuristic.

18) Leonardo Maccari and Renato Lo Cigno. "Improving Routing Convergence With Centrality: Theory and Implementation of Pop-Routing". *IEEE/ACM Transactions on Networking*, 26(5):2216–2229, Oct. 2018. ISSN 1063-6692. doi: 10.1109/TNET.2018.2865886. URL https://ieeexplore.ieee.org/document/8457534

One of the key features of a routing protocol is its ability to recover from link or node failures, recomputing routes efficiently without creating temporary loops. Indeed, in real conditions, there is always a trade-off between the overhead due to the periodic generation of control messages and route convergence time. This paper formalizes the problem of the choice of timers for control message generation as an optimization problem that minimizes the route convergence time, constrained to a constant signaling overhead. The solution requires the knowledge of nodes' centrality in the topology and can be obtained with a computational complexity low enough to allow on-line computation of the timers. Results on both synthetic and real topologies show a significant decrease of the transient duration with the consequent performance gain in terms of reduced number of unreachable destinations and routing loops. Our proposal is general and it can be applied to enhance any link-state routing protocol, albeit it is more suited for wireless networks. As a concrete example, we present the extension of OLSRv2 with our proposal, named Pop-Routing, and discuss its performance and the stability of centrality metrics in three large-scale real wireless mesh networks. This exhaustive analysis on traces of the topology evolution of real networks for one entire week shows that pop-routing outperforms the non-enhanced protocol in every situation, even when it runs with sub-optimal timers due to centrality computation on stale information.

19) Ramon Roca, Lluís Dalmau, Roger Baig, and Leandro Navarro. "Modelo de implantação de Rede Universal para Conectividade Universal". *poliTICs*, 2(28), 2018. ISSN 1984-8803. URL https://politics.org.br/edicoes/modelo-de-implanta%C3%A7%C3%A3o-de-rede-universal-para-conectividade-universal

There is interest in the deployment of cable and other networking infrastructure for private use in public land, but the lack of clear guidelines to regulate deployment in public land can block authorization decisions, which can be controversial due to the consequences of the private ownership and use of a private infrastructure in public space. The guifi.net Foundation proposed a universal deployment model for municipalities, where new deployments by a private requester are allowed as long it provides paths that simultaneously allow for three uses: self-service for the city council, private for the requester, and shared or common use for everyone else. The principle can be extended to apply to any other regional or even international infrastructure deployed in non-private land, although the proportion of resources for each uses can be adjusted. The effect of this model is that the deployment of private infrastructures generate a direct return as infrastructure for shared use by everyone can contribute to deliver universal connectivity.

In Brazilian Portuguese, English version [11]:

Conference with Proceedings

20) Leonardo Maccari, Merkouris Karaliopoulos, Iordanis Koutsopoulos, Leandro Navarro, Fèlix Freitag, and Renato Lo Cigno. “5G and the Internet of EveryOne: Motivation, Enablers, and Research Agenda”. In *IEEE European Conference on Networks and Communications (EuCNC)*, pages 429–433, June 18–21 2018. doi: https://doi.org/10.1109/EuCNC.2018.8443200. URL https://ieeexplore.ieee.org/document/8443200

As mobile broadband subscriptions grow twice as fast as the fixed ones and the Internet of Things comes forth, the 5G vision of the Internet of Everything (people, devices, and things), becomes a substantial and credible part of the near future. In this paper, we argue that the 5G vision is still missing a fundamental concept to realize its societal promise: the Internet of EveryOne (IoEO), i.e., means and principles to overcome the concerns that the current 5G perspective raises for the digital divide and the network neutrality principle. We discuss open-source software and hardware, Community Networks, mobile edge computing and blockchains as enablers of the IoEO and highlight open research challenges with respect to them. The ultimate objective of our paper is to stimulate research with a short-term, lasting impact also on that 50% (or more!) of population that will not enjoy 5G anytime soon. Internet of EveryOne, community networks, 5G, mobile edge computing, network neutrality, community cloud computing.

21) Leonardo Maccari, Lorenzo Ghiro, Alessio Guerrieri, Alberto Montresor, and Renato Lo Cigno. “On the Distributed Computation of Load Centrality and Its Application to DV Routing”. In *37th Annual IEEE International Conference on Computer Communications (INFOCOM)*, pages 2582–2590, Honolulu, HI, USA, Apr. 16-19 2018. ISBN 978-1-5386-4128-6. doi: https://doi.org/10.1109/INFOCOM.2018.8486345. URL https://ieeexplore.ieee.org/document/8486345

Centrality metrics are a key instrument for graph analysis and play a central role in many problems related to networking such as service placement, robustness analysis and network optimization. Betweenness centrality is one of the most popular and well-studied metric. While distributed algorithms to compute this metric exist, they are either approximated or limited to certain topologies (directed acyclic graphs or trees). Exact distributed algorithms for betweenness centrality are computationally complex, because its calculation requires the knowledge of all possible shortest paths within the graph. In this paper we consider *load centrality*, a metric that usually converges to betweenness, and we present the first distributed and exact algorithm to compute it. We prove its convergence, we estimate its complexity and we show it is directly applicable–with minimal modifications–to any distance-vector routing protocol based on Bellman-Ford. We finally implement it on top of the Babel routing protocol and we show that, exploiting centrality, we can significantly reduce Babel’s convergence time upon node failure without increasing signalling overhead.

Our contribution is relevant in the realm of wireless distributed networks, but the algorithm can be adopted in any distributed system where it is not possible, or computationally impractical, to reconstruct the whole network graph at each node and compute betweenness centrality with the classical approach based on Dijkstra’s algorithm.

22) Lorenzo Ghiro, Leonardo Maccari, and Renato Lo Cigno. “Proof of Networking: Can Blockchains Boost the Next Generation of Distributed Networks?”. In *14th IFIP/IEEE Annual Conf. on Wireless*

On-demand Network Systems and Services (WONS), pages 29–32, Isola 2000, France, Jan. 2018. ISBN 978-3-903176-02-7. URL http://dl.ifip.org/db/conf/wons/wons2018/index.html

The recent explosion of interest in blockchains led to a plethora of proposals for their application, including attempts to decentralize some centralized network functions. At the same time, real "distributed wireless networks" are emerging. Community networks, for instance, are large mesh networks made of hundreds of nodes built by communities primarily to solve digital divide, and they are thriving. The challenges these networks face are not only technological: they deal with creating incentives to participate, with the business model they may adopt, and with their internal governance. Very few models have been proposed to apply blockchains to bottom-up distributed networks: we instead expose how they can solve many problems which so far hindered the diffusion of such networks. Maybe we can push this further: a network is, in essence, a system in which all nodes find a rough consensus on the best paths to connect a node with another. Can we use this consensus method to run a distributed ledger and a cryptocurrency within the network itself, rather than simply applying to networks the effects of a blockchain defined in a separate system? This paper introduces this concept, named "Proof of Networking", and discusses its potential avails.

23) A. M. Khan, F. Freitag, V. Vlassov, and P.H. Ha. "Demo abstract: Towards IoT service deployments on edge community network microclouds". In *IEEE INFOCOM 2018 - IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS)*, pages 1–2, Apr. 2018. doi: 10.1109/INFCOMW.2018.8406840

Internet of Things (IoT) services for personal devices and smart homes provided by commercial solutions are typically proprietary and closed. These services provide little control to the end users, for instance to take ownership of their data and enabling services, which hinders these solutions' wider acceptance. In this demo paper, we argue for an approach to deploy professional IoT services on user-controlled infrastructure at the network edge. The users would benefit from the ability to choose the most suitable service from different IoT service offerings, like the one which satisfies their privacy requirements, and third-party service providers could offer more tailored IoT services at customer premises. We conduct the demonstration on microclouds, which have been built with the *Cloudy* platform in the Guifi.net community network. The demonstration is conducted from the perspective of end users, who wish to deploy professional IoT data management and analytics services in volunteer microclouds.

24) Felix Freitag. "On the Collaborative Governance of Decentralized Edge Microclouds with Blockchain-based Distributed Ledgers". In *BCT4MAS 2018 - 1st International Workshop on Block Chain Technologies 4 Multi-Agent Systems (BCT4MAS) at WI 2018*, Dec. 2018

Today's commercial model for edge computing services consists in lightweight devices at the network edge connected through the Internet to remote cloud data centers. Microclouds are an alternative vision of edge computing, where the cloud infrastructure runs at the network edge leveraging decentralized resource contributions of a community. But current attempts to build such microclouds lack a collaborative governance system to operate successfully. In this paper we discuss the opportunity to implement with blockchain technologies key services to enable the decentralized collaborative governance of microclouds. A multi-agent approach could further contribute to improve the efficiency in the decision making in the collaborative governance service.

25) Khulan Batbayar, Emmanouil Dimogerontakis, Roc Meseguer, Leandro Navarro, Esunly Medina, and Rodrigo M. Santos. "The RIMO Gateway Selection Approach for Mesh Networks: Towards a Global Internet Access for All". *MDPI Proceedings*, 2(19), 2018. ISSN 2504-3900. doi: 10.3390/proceedings2191258. URL http://www.mdpi.com/2504-3900/2/19/1258

Community wireless mesh networks have emerged as cooperative initiatives to provide Internet Access in areas where traditional ISP costs are not affordable for the population. It is common in wireless mesh networks sharing several capacity limited Internet gateways to provide Internet access. As routing does not handle capacity planning, end-users have to select gateways in such a way that the overall capacity of all gateways could be used effectively. An efficient gateway selection should minimize the processing logic and measurements over the mesh network. Selecting a high performance gateway can also ensure that the overall network load is balanced. This paper presents RIMO, a standalone best-effort algorithm for client nodes to select their preferred gateway without interacting with other client nodes. RIMO-based selection matches the gateway performance of the reference brute-force and omniscient algorithms for 60% of the test duration while reducing the gateway performance measurement cost from a factor of n to 2. With a reduced overhead and high efficiency, the RIMO algorithm automates the aggregation of multiple Internet gateways in wireless mesh networks, which results in robust last mile Internet connectivity to people in vulnerable situation.

26) K. Batbayar, R. Meseguer, L. Navarro, R. Sadre, and E. Dimogerontakis. "Collaborative informed gateway selection in large-scale and heterogeneous networks". In *IFIP/IEEE International Symposium on Integrated Network Management (IM)*, Apr. 2019. URL N/A

In wireless community access networks, clients tend to reach the Internet through multiple gateway nodes instead of a single default gateway. The mapping of gateways to clients should take into account the perception of network performance from each client node. Network conditions and traffic load can fluctuate and make repeated client-gateway measurements necessary. However, frequent measurements would result in a high communication overhead as well as high processing overhead in gateways and clients. We propose a lightweight client-side gateway selection algorithm by crowd-sourcing monitoring information from neighbor clients, without requiring explicit topology information or a detailed view of the network, while providing an accurate selection as compared to an ideal omniscient approach. Our collaborative gateway selection algorithm achieves good end-to-end performance, such as low latency perceived at client nodes, and fair distribution of the measurements over the gateway nodes. The number of performance measurements triggered by clients is reduced drastically, from n down to 2 measurements per node in each period. An experimental evaluation of our approach shows more than 80% precise estimation of the gateway performance in the majority of the considered cases. We propose two variants of the gateway selection algorithm, collaborative-best, and collaborative-fair, which yield near-optimal gateway selection while utilizing partial information.

27) Merkouris Karaliopoulos and Iordanis Koutsopoulos. "Mobile App User Choice Engineering Using Behavioral Science Models". In *Proc. 19th IEEE International Workshop on Signal Processing Advances in Wireless Communications (SPAWC), 2018*, pages 1–5, June 2018

When interacting with mobile apps, users need to take decisions and make certain choices out of a set of alternative ones offered by the app. We introduce optimization problems through which we engineer the choices presented to users so that they are nudged towards decisions that lead to better outcomes for them and for the app platform. User decision-making rules are modeled by using principles from behavioral science and machine learning. Such instances arise in (i) mobile crowdsensing campaigns, where tasks are assigned to users through the app, and the goal is to optimize the quality of fulfilled tasks; (ii) smart-energy apps, where energy-saving recommendations are issued through the app, and the goal is to optimize energy savings; (iii) mobile advertising, where ads or offers are projected to the user, and the aim is to optimize revenue through user response to ads. Each user is modeled as a vector of feature values for a set of features. In an important class of decision-making models in behavioral science, the lexicographic fast-and-frugal-tree (FFT) heuristics, user decision emerges through a ranking of features that in turn gives rise to a decision tree. Having the incentive as a controllable feature that guides the user decision process, we study and characterize the complexity of the problem of allocating choices and incentives to users out of a limited budget. Numerical results indicate important performance gains when the incentive allocation policy adapts to user lexicographic choices.

28) Iordanis Koutsopoulos. "Incentive allocation to sequential decision-making sensors in Mobile Crowdsensing". In *IEEE International Conference on Pervasive Intelligence and Computing (PICom)*, pages 1–5, Aug. 2018. doi: 10.1109/DASC/PiCom/DataCom/CyberSciTec.2018.00-18. URL http://cyber-science.org/2018/picom/

In this work in progress, we consider incentive allocation to a set of measurement sensors in the context of mobile crowdsensing. The novelty stems from considering a new model perspective for each sensor, that of a rational sequential decision-maker. At each time slot, each sensor observes the time-varying cost it undergoes for submitting measurements and the advertised reward for submitting measurements to the platform. Its decision policy at each time slot is whether to become active and submit measurements or stay inactive. The sensor decision problem is shown to be described as an optimal stopping one, and the sensor policy that maximizes its expected net benefit over a time horizon is shown to be of threshold nature at each time slot, where the threshold is non-increasing with the elapsed time. With the derived optimal policies for sensors, we next seek to determine the optimal price per time slot paid by the platform to each sensor so as to maximize the expected total quality of collected measurements, subject to a budget constraint. Finally, we introduce the problem of centralized sensor activation in a dynamically varying system so as to maximize the longterm average utility stemming from the quality of collected data. The characterization of distributed sensor equilibrium policies and the assessment of their impact on the global performance metric compared to the optimal centralized policy, are outlined as important directions that warrant further investigation.

29) Iordanis Koutsopoulos. “The impact of Social-network diffusion on wireless edge resource allocation”. In *International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM) 2018*, pages 1–3, June 2018. doi: 10.1109/WoWMoM.2018.8449791

Content providers (CPs) increasingly deploy network infrastructures that oftentimes reach up to the wireless network edge, i.e. base stations or small cells. Hence, they are interested in optimizing resource allocation and relevant performance metrics for that infrastructure. On the other hand, mobile apps featuring streaming content (e.g. video, music) come with social-networking and content-sharing capabilities among users. These need to be taken into account in resource allocation since they decisively shape content demand. In this work, we introduce mathematical optimization problems about resource allocation at the wireless network edge, which obtain interesting twists when social-network diffusion is considered. Specifically, we consider, (i) the problem of content caching and user targeting through the recommender system of the app, with the goal to maximize the social diffusion effect of cached content, and (ii) the problem of user targeting through the mobile app recommender system, so that the available wireless bandwidth is utilized as efficiently as possible.

30) Luca Baledesi, Leonardo Maccari, and Renato Lo Cigno. “On the Properties of Infective Flooding in Low-Duty-Cycle Networks”. In *15th IFIP/IEEE Annual Conf. on Wireless On-demand Network Systems and Services (WONS)*, Jan. 2019. URL http://2019.wons-conference.org/

Broadcasting information in a network is an important function in networking applications. In some networks, as wireless sensor networks or some ad-hoc networks it is so essential as to dominate the performance of the entire system. Exploiting some recent results based on the computation of the eigenvector centrality of nodes in the network graph and classical dynamic diffusion models on graphs, this paper derives a novel theoretical framework for efficient information broadcasting in mesh networks with low duty-cycling without the need to build a distribution tree. The model provides lower and upper stochastic bounds with high probability. We show that the lower bound is very close to the theoretical optimum and that a preliminary implementation provides results that are very close to the lower bound on classical graph models.

Conference Presentations

31) Renato Lo Cigno. Wireless 2035: New Technologies or New Architectures? “IEEE European Conference on Networks and Communications (EuCNC) – Invited Speech”, June 18–21 2018

Wireless technologies in the past 40 year have evolved and changed as fast as any other ICT sector, maybe more. Links' speed has grown 6 orders of magnitude or more; spectrum efficiency has increased too, and all transmission-related technologies followed a similar trend. The network architecture instead as changed only marginally (compared transmission technologies!), and we are stuck with WiFi-like, one-hop access and GSM-like cellular networks, with 5G promising the final solution (just like UMTS before . . .), but indeed introducing marginal modifications presented as revolutions because they are based on SDN/NFV paradigm. What shall we research and invest on in the next 15 years? How can we expect transmission technologies to change? Can we imagine a different architecture empowering all people to have proper an appropriate access to mobile technologies and, at the same time wireless networks supporting advanced and sophisticated Cyber-Physical Systems that require by nature reliable, low-latency and also large capacity mobile communications, like autonomous and cooperative driving? This short talk tries to focus what is needed and how we can achieve it, underlying what is instead useless overhead.

32) Ileana Apostol, Panayotis Antoniadis, and Thomas Raoseta. "The right to the hybrid city: central space as a commons", 2018. URL http://www.transdisciplinarity.ch/td-net/Veranstaltungen/ITD-CH-2018/Posters.html. Poster paper presented at the Swiss Inter- Transdisciplinarity Day 2018 with theme "Inter- and Transdisciplarity in a Digital World"

Fifty years after Henri Lefebvre published on 'the right to the city', we propose to discuss the concept under the current digital and physical spatial condition. Today urban spaces shall be conceived as hybrid, physical and digital, due to the advance of ICTs and their impact on almost every aspect of social life; a key question arises, how the different rights to the hybrid urban space can be claimed by citizens. NetHood, a transdisciplinary association undertaking research and learning within the hybrid spatial conditions, focuses on the right to centrality and to difference, for which the city of Zurich brings particular challenges and opportunities. For example, because of high value real estate and due to a long experience with democratic urban practices. In context a promising project was initiated recently: the co-creation of a neighbourhood space in a key location of the city center, by the name L200, conceived as a hybrid urban node run collectively; as a commons managed by the L200 association of neighbourhood small shops, initiatives and non-profit organizations; at the crossings of manifold urban networks such as those of paths and spaces for public life, of communication and information, of trade, exchange and networking, etc. The idea is to use digital technology both as an enabler of such a complex and demanding collaborative project and as a proof of concept on how our rights to the digital space can be exercised in creative and democratic ways toward better coordination, organization, information sharing, deliberation as well as social learning in the long term. In this sense, L200 is developed as an urban living lab for hybrid tools that can help small neighbourhood shops to create economies of scale in a distributed and decentralized way, or allow a diverse group of organiza.ons and individuals to share the space and its street windows efficiently over time. It will also become a pilot project for DIY networking tools, like the MAZI toolkit, which can facilitate the creation of digital spaces that are collectively owned and are literally attached to the physical ones, in our case the L200 space, a feature that allows for many playful and creative ways to build collective identity and memory in a participatory way. We document in this work the transdisciplinary process of producing hybrid space through various actions including petitions and claims for favourable action, applied projects in the neighbourhood, and recent shifts toward formulating guidelines based on the experience built at L200. The project describes a potential blueprint for creating hybrid infrastructure, and in the near future urban policies may be devised to bring such grassroots initiatives to reality at the city scale.

The poster is available at http://nethood.org/publications/nethood_L200_netCommons_MAZI_ITD_Poster_final.pdf

Others / Miscellanea

33) Leandro Navarro. "Network infrastructures: The commons model for local participation, governance and sustainability". Association for Progressive Communications, Feb. 2018. URL https://www.apc.org/en/pubs/network-infrastructures-commons-model-local-participation-governance-and-sustainability

This is an issue paper published by the Association for Progressive Communications in February to clarify the concept of the commons model as it applies to network infrastructures. Network infrastructures provide connectivity, a critical resource for our digital lives, and are therefore key for social inclusion and public participation. There are many technical, economic and operational ways to provide internet connectivity. In this paper we describe a model to develop network infrastructure as common property, governed under the principles of common-pool resources.

The model is based on the principles of cooperation instead of competition – because universal connectivity can only be achieved if everyone has the right to create their own connectivity. There are many examples of how communities have succeeded in organising to achieve this. The result is local community network infrastructures that are open, sustainable and adapted to local conditions, which can produce abundant connectivity and support local socioeconomic development, everywhere and for everyone.

34) Merkouris Karaliopoulos, Iordanis Koutsopoulos, Leonardo Maccari, Renato Lo Cigno, and Leandro Navarro. "Wireless Community networks and 5G: the 7-Billion-user challenge". IEEE European Conference on Networks and Communications (EuCNC) – Tutorial, June 18–21 2018

As the 5G vision gets unfolded and the requirements of its ambitious key performance indicators are better understood, it also becomes clearer that there will not be a single realization path for this vision. Large parts of the worldwide population, including those living in rural areas of developed countries and those in developing regions will probably not be served by ultra- dense networks and super-fast radio links. This tutorial aims to delineate the role that community networks emerging out of citizens' grassroots activities could play in the realization of the 5G vision.

Works In Press

35) Melanie Dulong de Rosnay. "Regard sur le droit et les communs : un droit pair-à-pair". In Danièle Bourcier, Jacques Chevallier, Gilles Hériard Dubreuil, Sylvain Lavelle, and Emmanuel Picavet, editors, *Dynamiques du Commun. État, Marché et Société*. Publications de la Sorbonne, 2020. in press

Dans ce chapitre, je postule que le modèle informatique du pair-à-pair, un type d'architecture dans lequel les actions sont distribuées, constitue une source d'inspiration pour le droit des communs, qui adopte également la décentralisation en tant que principe de design. Ces deux mouvements constituent des alternatives au marché et à l'Etat d'inspiration libérale, et contribuent à renouveler les fondements du système juridique occidental. Ce dernier a en effet été conçu pour s'appliquer à des personnes, physiques ou morales, en tant qu'entités individuelles, alors que les communs et les architectures distribuées conceptualisent l'agentivité et la responsabilité de collectifs humains ou agents artificiels aux membres non identifiés et fluctuants. Du faisceau de droits d'Elinor Ostrom aux licences Creative Commons, le droit des communs réussit à fragmenter le droit de propriété en un ensemble d'attributs, entre un ensemble de personnes non définies. Afin de préserver les communs et développer un droit adapté à ces formes, il est nécessaire de transformer la culture politique, économique, et juridique issue du paradigme libéral, afin de reconnaître des droits et des responsabilités à des personnes collectives. Le mouvement des communs peut s'inspirer du droit de l'environnement et du droit appliqué à l'intelligence artificielle qui ont tout deux réussi à dépasser la notion de personne individuelle. Ce chapitre reprend des portions d'un article en anglais par l'auteure : Mélanie Dulong de Rosnay, 2016. "Peer to party: Occupy the law", First Monday, Volume 21, Number 12. [1]

[1] http://journals.uic.edu/ojs/index.php/fm/article/view/7117/5658

36) Félix Tréguer and Dominique Trudel. "From Internet Access Provision to Political Advocacy: The History of the French Data Network". *Histoire et informatique*. in press

Based on interviews conducted with founding members and leaders of the French Data Network (FDN) (Benjamin Bayart, Laurent Chemla, Jean-Philippe Nicaise, and Christian Paulus), this paper chronicles the history of FDN, from the early concern with Internet access and education to a broad conception of Internet rights, as exemplified by the creation of a mirror site of Wikileaks (2011) or by providing VPN access to political dissidents during the Arab Spring (2012). In doing so, this paper simultaneously contributes to the development of a French national history of computer networks, to the ongoing diversification of the historiography of digital rights activism (that has long been dominated by Anglo-Saxon perspectives, see Jordan & Taylor, 2004; Levy, 2001; Postigo, 2012), as well as to future comparative works. In the French context, state and public actors were central in the development of early networks such as Cyclades, RENATER, and Minitel. While these actors already received scholarly attention (see Schafer, 2012; Schafer & Tuy, 2013), very little consideration has been given to the political action of civil society actors and in their role in the co-shaping of computer networks, their politics, and their users

37) Félix Tréguer, Dominique Trudel, and Melanie Dulong de Rosnay. "Learning from the History of Alternative Networks". *Journal of Alternative and Community Networks*. in press

This article explores the legal, economic, and governance challenges to the sustainability of contemporary alternative Community Networks by drawing lessons and parallels from eight historical precedents. Building on academic literature related to alternative and community media, the article lays out an encompassing definition of alternative networks (or "alternets"), and develops a multidisciplinary approach to comparative history. After briefly presenting eight case studies (three independent telephone networks of the late 19th century, three Free Radios of the 1950s, 1960s, and 1970s, two Community Networks providing Internet access in the 1990s), the paper then draws from these case studies to identify key recurring challenges that can inform present-day initiatives, namely: the articulation of local community with global connectivity, the development of political advocacy capacities aimed at influencing the law and technology, the creation of appropriate resources aimed at resisting co-optation, and the need to build collective cohesion and mechanisms to handle disagreements.

Works Under Review

38) Leonardo Maccari, Gabriele Gemmi, Renato Lo Cigno, Merkouris Karaliopoulos, and Leandro Navarro. "Assistive Growth: Towards Scalable Community Networks Topologies". *Submitted to Ad Hoc Networks*

The growth of Community Networks is mostly unplanned, depending on the one hand on the willingness of people to participate, and on the other hand on the feasibility of the wireless links connecting the home of the potential participant to the infrastructure. Exploiting open source resources, such as Open Street Map and LIDAR-based data on building altitudes, this paper presents a methodology to stochastically forecast the growth of a Community Network given the area where the community starts building it. This base methodology, implemented into an automated tool, takes into account the technical and economic feasibility of adding nodes to the network, as well as guaranteed limits on the per-node performance of the network in saturation. The methodology is coupled with simple economic incentive schemes to explore if proper incentives mechanisms can influence (and improve) the growth of the network in four different scenarios: Urban, Suburban, Intermediate, and Rural areas. Results in all four scenarios highlight the characteristics of the topology that spontaneously emerge from the natural growth of the network, and the advantages that properly crafted incentives bring to this process, improving the size, the performance, and the resilience of the network emerging from this spontaneous process.

This paper is based on several results produced in netCommons, like the network characterization done in WP1 and the incentives and graph analysis produced in WP2.

39) Mennan Selimi, Adisorn Lertsinsrubtavee, Arjuna Sathiaseelan, Llorenc Cerdà-Alabern, and Leandro

Navarro. “PiCasso: Enabling Information-Centric Multi-tenancy at the Network’s Edge”, Jan. 2019. URL https://www.journals.elsevier.com/computer-networks

In the context of edge computing, in thispaper, we propose to leverage lightweight virtualisation, Information-Centric Networking (ICN), and service deployment algorithms to overcome these limitations. The proposal is implemented by the PiCasso system, that utilises in-network caching and name based routing of ICN to optimise, combined with our HANET (HArdware and NETwork Resources) service deployment heuristic, to optimise the forwarding path of service delivery. We analyse the data collected from Guifi.net, the biggest CMN worldwide, to develop a smart heuristic for the service deployment. Through a real deployment in Guifi.net, we show that HANET improves the response time up to 53% and 29% for stateless and stateful services respectively. PiCasso achieves 43% traffic reduction on service delivery in our real deployment, compared to the traditional host-centric communication. The overall effect of our ICN platform is that most content and service delivery requests can be satisfied very close to the client device, many times just one hop away, decoupling QoS from intra-network traffic and origin server load.

40) Aniruddh Rao Kabbinale, Emmanouil Dimogerontakis, Mennan Selimi, Anwaar Ali, Leandro Navarro, and Arjuna Sathiaseelan. “Blockchain for Economically Sustainable Wireless Mesh Networks”. *Under review in Concurrency and Computation: Practice and Experience*, 2018. URL https://onlinelibrary.wiley.com/journal/15320634

Decentralization, in the form mesh networking and blockchain, two promising technologies, is coming to the telecommunications industry. Mesh networking allows wider low cost Internet access while blockchain enables complete transparency and accountability for investments and revenue or other forms of economic compensations from sharing of network traffic, content and services. Crowdsourcing network coverage combined with crowdfunding costs can create sustainable yet decentralized Internet access infrastructures, where every participant can invest in resources, and pay and be paid for usage. While mesh networks and mesh routing protocols enable self-organized networks that expand organically, cryptocurrencies and smart contracts enable the economic coordination among network providers and consumers. We explore and evaluate two existing blockchain software stacks, Hyperledger Fabric (HLF) and Ethereum geth with Proof of Authority (PoA), deployed in a real city-wide production mesh network, and in a centralized laboratory network. We quantify the performance, bottlenecks and identify the current limitations and opportunities for improvement to serve the needs of wireless mesh networks.

41) Merkouris Karaliopoulos and Iordanis Koutsopoulos. Collective subscriptions: towards sustainable funding of community network infrastructures, 2019. URL http://www.wi-opt.org/

Community networks (CNs) are initiatives led by communities of people, who collectively contribute time, effort and resources to their purpose. Over the last two decades, they have proven their capacity to provide affordable connectivity in areas outside the coverage of commercial operators, but also strengthen local community bonds. Nowadays, the realization of ambitious broadband connectivity agendas, the desire to bring online another billion of people in developing countries, but also concerns about concentration in the telecom market, motivate a more integral role of CNs in the global networking infrastructure. Prerequisites for this role are funding models that ensure their sustainable operation. In our paper, we study collective subscriptions, a novel subscription model that CNs experiment with for self-funding their activities. With collective subscriptions, a fixed subscription fee is charged per CN node and shared between all individuals or households subscribing to those nodes. We analyze this subscription scheme in two scenarios. First, we formulate the problem of subscription revenue maximization when the assignment of users to subscriptions is centrally coordinated, e.g., by the CN operator (CNO). We show that the problem has a non-trivial objective function and we identify special instances admitting more trivial solutions. Then, we consider the game that emerges as the CN operator announces the node subscription fee and CN users respond strategically by joining (or not) a collective subscription. We prove the existence of equilibrium states in pure strategies, we propose ways to compute them, and analyze their efficiency. Our evaluation of the scheme against both real and synthetic data shows that it achieves both higher subscription revenue and increased community inclusion when compared to the default fixed price individual subscription scheme. On a practical note, our analysis helps the CN operators understand and optimally use this funding tool for sustainably operating the CN and engaging the community into the CN activities.

42) Merkouris Karaliopoulos and Iordanis Koutsopoulos. "Infrastructure and service provider games in crowdsourced networks", 2019. URL https://www.sigmobile.org/mobihoc/2019/

Ambitious plans for ubiquitous broadband connectivity call for huge investments in network infrastructures. Sharing the deployment costs of these infrastructures increasingly appears to be inevitable, but its exact form and the involvement of different actors may vary across the world. Our paper analyzes the role that crowdsourced network infrastructures such as Community Networks (CNs) could undertake in realizing these ambitious visions and coping with their financing needs. Key to this role are open business models fostering synergies of CNs with commercial Internet Service Providers (SPs). In such synergies, the SPs make their pricing policies commensurate with the investment of the community, in order to fuel the CN growth and generate a market for their services. At the same time, they compete with each other for customer shares in this market. We formulate the leader-follower game that emerges out of the strategic interactions of the actors and compute numerically its equilibrium states under a broad range of scenarios, built out of real data. In all cases, our results point to mutual profits for all actors, turning such synergies to win-win strategies.

43) Leandro Navarro, Ignacio Castro, Arjuna Sathiaseelan, Emmanouil Dimogerontakis, Mennan Selimi, Felix Freitag, and Roger Baig. "Blockchain models for universal connectivity". *Under review in Telecommunications Policy Journal*, -(-), 2018. ISSN 1084-8045. URL https://www.journals.elsevier.com/journal-of-network-and-computer-applications

Universal connectivity is still a dream for half of the global population, despite being used to provide crucial services and enable participation in societies around the world. Decentralised infrastructures create an opportunity for local entrepreneurship, mainly in underserved areas, where connectivity can expand incrementally and be sustainable through service fees obtained from the demand and consumption of services that compensate the cost of the services provided by network devices that mesh with each other. While the data flow is supported by routing decisions, the economic flows can be supported by the use of blockchain transactions, combined with networking devices such as wireless mesh or fibre networks that offer Internet access to clients using Wi-Fi, TVWS or cellular access points, combined with Internet backhaul links. We discuss the characteristics of different service models, the technological opportunities of combining blockchain with mesh networks, the options for pricing and investment models, validated in our case studies, laboratory and field experiments. We find that blockchain and mesh networking technologies enable decentralised models to bootstrap and scale-up crowdsourced networking services that aim to be socially and economically sustainable.

44) Melanie Dulong de Rosnay, Félix Tréguer, and Panayotis Antoniadis. "Commonswashing by information technologies and online platforms, the semantic appropriation of the commons". Submitted to the International Association on the Study of the Commons (IASC) 2019 conference

Enclosure of the commons by private actors is an old phenomenon. With information technologies and digital commons, we noticed a tendency to coopt or claim elements of language of openness and the ethics of sharing to designate for-profit endeavours. Our paper proposes to inscribe these trends within larger policy trends, while building on examples from internet connectivity and Community Networks. We argue that such appropriations lead to new forms of "enclosure" of common resources, as private actors come to dominate the governance structures for the commons-based production of a good or the provision of a service, thereby perverting some of the key features and values of commons-based production (for instance through financialization and quantitative management approaches).

Works Under Submission

45) Félix Tréguer and Melanie Dulong de Rosnay. “The Political Defence of the Commons: The Case of Community Networks”. To be submitted to a journal on communications and policy

This article analyses experiences of political advocacy which have been led by Community Networks activists in Germany, France and Spain to support the sustainability of these bottom initiatives aimed at building community-owned telecom infrastructures. By identifying advocacy methods that illustrate the diversity of action repertoires used by various Community Networks across Europe, the case studies point to the potential to democratise policy-making in the telecom sector, an area that are prone to regulatory capture by special interests. Examples of advocacy tactics used by Community Networks also offer a set of reproducible tactics that are often available to very small actors without dedicated advocacy staff nor budget. They speak to the inventiveness of these grassroots initiatives, and serve to illustrate both the potential and pitfalls of political advocacy for small-scale social movements working for the political defence of the Commons.

46) Melanie Dulong de Rosnay. “Community Networks: From Top-Down Citizen Science to Bottom-Up Citizen Policy Makerspaces”. To be submitted to a Science and Technology Studies journal

The article studies the impact of the decentralization ofcertain aspects of citizen science projects, the production of knowledge, including science and policy. Community wireless networks (CNs) constitute local, commons-based alternatives to commercial internet service providers, formed by routers and devices in people’s houses interconnected according to specific topologies. I use them as an example to test and push the boundaries of the definition of citizen science centralized around a professional researcher, and consider decentralized peer production as a meansmodel of production of scientific knowledge by citizens. This article is exploring CNs as a case study of both citizen science and peer production, leading to the improvement of scientific knowledge in several disciplines, includingthe participation to public policy, through the co-production of a techno-legal agenda evidencedby underlying scientificknowledge.

47) Stefano Crabu, Melanie Dulong de Rosnay, and Paolo Magaudda. “Socio-technical governance of Community networks as co-produced commons. A comparative research”. To be submitted to a Communication Science journal

This article aims to foster analysis and debate on the co-production and governance of emerging distributed infrastructures for digital communication, generally defined as Community Network. CNs are ‘distributed’ local communication infrastructures, often based on a commons paradigm, as they are usually built, self-managed and owned by collectives of people (Smith, et al., 2017), including hackers, geeks, engineering students, political activists and lay people. In these last few years several CNs have been built in many European cities or regions to strengthen the neutral access to digital communication networks (Franquesa and Navarro, 2017) and to cope with specific needs, such as fight the digital divide. These communication infrastructures are conceived by their developers as a political alternative to the global, business-oriented governance of the Internet (Chenou 2014). Thus, CNs represent a peculiar type of commons, distinctively characterised by the need to collectively cooperate in building, maintaining and governing material and technical infrastructures for digital communication. This type of commons is achieved thanks to the creative adaptation of technologies of communication operated by collectives of activists and concerned group of engaged citizens, which share a techno-political strategy to cope with critical issues, and political concerns about the pervasiveness of neoliberal digital sharing economy (Martin 2016). Drawing from a conceptual framework relying on the governance of the commons (among many others Ostrom, Frischmann), the article has the purpose to disclose the multimodal forms of governing CNs, by showing how the shaping and everyday organizing of digital commons resides on situated “commoning” practices (Esteva, 2014) concerning a collective competence in managing both technical, political and legal issue at stake in contrasting the hegemonic and mainstream infrastructures for digital communication. With this general aim in mind, the article presents the main results of a qualitative comparative study about two wireless community network (CN), one developed in France and the other in Italy. We provide a comparative understanding of the different governance rules, e.g. organizational principles and every day practices adopted in managing such communities, and then we demonstrate how the governance principles of CNs are the emerging outcome of the entanglement between local policy, technical and legal (or policy?) elements. In this way, we highlight that governing CNs require to enact bottom-up, within specific local settings, different knowledges (i.e. political, technical) and technologies, rather than to implement abstract or normative principles. Furthermore, by adopting a comparative approach we are able to better define different kind of governance models of CNs operating in the Europe, informing possible factors of success and risk.

48) Virginie Aubrée and Melanie Dulong de Rosnay. "The Aftermath of Digital Rights Ireland and Tele2 ECJ cases: a diversity of data retention national practices". To be submitted to a Law and tech journal

In 2018, Data retention obligations – the collection and storage of metadata communication by telecom operator for future access by police authority – is at a crossroad in the legal field with the entry into force of General Data Protection Regulation, the implementation process of the Directive 2016/680 and the current negotiation of the ePrivacy Regulation. Beyond the pure legal debate, Data retention is a key point in the technological discourse of mass surveillance policy schemes, raising (serious) democratic issues about State domination in a digital era. In both a practical and ethical point of view, Community Networks – alternative local telecom operators managing their networks as commons – are all the more involved in this issue as they promote a high standard of Privacy of their users. Thus, as a survey conducted by netCommons in 2017 pointed out, 60% of the CNs respondents do not retain any data to comply with national law as these go against their core values of providing Internet access and services. Some regular telecom operators seem to follow the same path of refusal to retain, which does not appear unreasonable regarding the current legal framework. Since Digital Rights Ireland case law and all the more since Tele2, national laws implementing the previous data retention directive are very likely to be inconsistent with EU law and the Charter of Fundamental Rights. Many authors offered a throughout analysis of EU law as well as national frameworks, but also cross-analysis and even comparative material beyond EU. Joining numerous calls from legal doctrine for harmonization at a EU level, this paper aims to complete and update this overview of national frameworks – with an emphasis on France, Italy, Germany, Greece and Spain. Through this scope, this study intends to decipher different socio-legal and cultural approach of Data retention throughout Europe and how they could match or clash in the current negotiation of the ePrivacy Regulation. To fully understand the diversity of Member States' reactions to this European framework (Par. III), a technical (Par. I) and legal (Par. II) introduction should be provided beforehand.

49) Ileana Apostol, Panayotis Antoniadis, and Thomas Raoseta. "The right to the hybrid city: Central space as a commons". To be submitted at an Urban Studies journal

This paper presents three aspects of an ongoing attempt to bridge the struggles for the right to the Internet with those for the right to the city. The term 'the right to the city' was coined by Henri Lefebvre (1996), following his active involvement in the 1968 street unrest in France, in order to denominate a ubiquitous 'cry' for the democratization of urban space. Through adapt Lefebvre's formulation to the current hybrid spatial condition, and bring into the discourse a set of fundamental rights within this ongoing struggle, which are relevant for both physical and digital space. The narrative of this paper presents a tangible manifestation of previous theoretical approach on the 'right to the hybrid city' [69], noting that in both processes of spatial design and in the design of digital technology is critical to create collective awareness of the implications, benefits and threats of the hybrid condition of space. On the one hand, there is a historic take on the provision of infrastructures and services as public goods. Stories of development of network infrastructures have great potential to bring to light useful analogies, capable to provide insights on the role of regulation for keeping a power balance between the different actors. On the other hand, there is an action approach in the form of organizing a series of 'encounters' in various locations, between digital and urban researchers and activists, and at the same time, the ongoing process of building an association that runs a very central space in Zurich with exceptional visibility. This space, called L200 from its address Langstrasse 200, is shaped as a hybrid urban node and a living lab for co-creating tools that empower citizens to claim their rights to the hybrid city.

50) Panayotis Antoniadis, Ileana Apostol, and Alexandros Papageorgiou. Reflection-in-action in participatory design. To be submitted at C&T Conference, 3-7 June 2019, Vienna

This is an account of NetHood's recent exploration of a methodology for participatory practices, which is capable to include many voices and to mediate conflicting interests, and is also flexible to accommodate different working habits and various disciplinary cultures. The methodology is meant to facilitate the engagement of people in design processes, in particular in the design of community networks. Thus this paper elaborates on the process to devise some of its main characteristics, including researcher's reflections while working on this task, which are critical to note in the spirit of Donald Schön's reflection-in-action. Although the methodology is still work in progress, we present here some methodological guidelines that are inspired by musical composition processes, building on a concrete case study of the Sarantaporo community network in Greece.

9. Conclusions

The dissemination activity of netCommons in the third year of the project has been huge, reaching wide and large in (almost) all possible directions and touching all levels of the inner and outer loop as designed in the DoA. The impact of the work is already extremely relevant, and we think it will still increase in the months and years to come.

It is difficult, among all the activities presented, to select one that we deem more important than the others, or that we can claim is the one with the highest impact. Surely the interventions at the EU Parliament level and with UNESCO must be cited for the global relevance they have: Community Networks are now recognized as important infrastructures to spread the Internet global accessibility, and their principles are included and protected by the European Electronic Communications Code (EECC). Still at the level of global visibility and outer loop, the presence in ISOC and IETF, as well as the publications with APC, are extremely visible and bring netCommons contributions to the widest possible dissemination level. We also have very high expectations from the book that will be published by APC based on D4.5 [71], the outcome of the booksprint writing residence organized at the birthplace of guifi.net, in Seminari de Vic, Catalonia, where the first guifi.net node was installed: a location with high symbolic value for the entire Community Networks movement.

At the other extreme, meaning the inner loop, the interaction with CNs in Spain, France, Italy, Greece and to some extent also Germany, UK and many spots around the globe, especially in South America and Africa, has been very fruitful giving these CNs practical support and the feeling that they are not pariah of the Internet, but part of a vast movement whose goal is to reduce the digital divide and to influence the future development of the Internet toward a more democratic and sustainable structure.

Finally, it is worth mentioning that netCommons, albeit investing an enormous effort in the interaction with communities and in advocacy and public dissemination activity, has produced, in the third year alone, more than 50 scientific papers, tutorial, presentations that appeared (or will appear in the near future) in leading journals and conferences covering all the disciplines involved in netCommons, from law to engineering, from sociology to computer science and political economy. Regarding this specific aspect, and also including results from years one and two, more will be reported in Deliverable 7.5, the "Report on the publications and data download, use, and citation."

Version 2.0 of this Deliverable, extended a few months after the end of the project during the assessment phase of the project, contains a more comprehensive and 'detached' (because of the time elapsed from the end of the project) evaluation of the achievements of netCommons and the impact its activities are having on the stakeholders, from the academic community to the policy makers, to CNs themselves. This revised evaluation highlighted how the project is impacting positively the entire movement for a more sustainable and democratic Internet, and how the work done in netCommons has laid foundations for subsequent actions in research, civil society, and community-based networking and information processing.

Bibliography

[1] Ileana Apostol, Panayotis Antoniadis, and Thomas Raoseta. “The right to the hybrid city: central space as a commons”, 2018. URL http://www.transdisciplinarity.ch/td-net/Veranstaltungen/ITD-CH-2018/Posters.html. Poster paper presented at the Swiss Inter- Transdisciplinarity Day 2018 with theme ”Inter- and Transdisciplarity in a Digital World”.

[2] Panayotis Antoniadis, Ileana Apostol, and Alexandros Papageorgiou. Community Networks and the Right to the City. **netCommons Deliverable D5.5**, Nov. 2018. URL https://netcommons.eu/?q=content/community-networks-and-right-city.

[3] Leonardo Maccari, Luca Baldesi, Renato Lo Cigno, Felix Freitag, Leandro Navarro, Merkouris Karaliopoulos, and Aris Pilichos. Report on the Results of the Socio-Technological Experimentation of Open Source Software. **netCommons Deliverable D3.5**, Jan. 2019. URL https://netcommons.eu/?q=content/report-results-socio-technological-experimentation-open-source-software.

[4] Leandro Navarro, Roger Baig, Felix Freitag, Emmanouil Dimogerontakis, Felix Treguer, Melanie Dulong de Rosnay, Leonardo Maccari, Panagiota Micholia, and Panayotis Antoniadis. Report on the Existing CNs and their Organization (v2). **netCommons Deliverable D1.2**, Sept. 2016. URL https://netcommons.eu/?q=content/report-existing-cns-and-their-organization-v2.

[5] Stefano Crabu, Leandro Navarro, Melanie Dulong de Rosnay, David Franquesa, and Felix Tréguer. Report on the Governance Instruments and their Application to CNs (v1). **netCommons Deliverable D1.3**, June 2017. URL https://netcommons.eu/?q=content/report-governance-instruments-and-their-application-cns-v1.

[6] Leandro Navarro, Roger Baig, and Felix Freitag. Report on the Governance Instruments ant their Application to CNs (v2). **netCommons Deliverable D1.4**, Dec. 2017. URL https://netcommons.eu/?q=content/report-governance-instruments-and-their-application-cns-v2.

[7] Panayotis Antoniadis, Leonardo Maccari, and Leandro Navarro. Dissemination Report: Summary of Dissemination Actions and Adoption of netCommons Solutions During the Second Year. **netCommons Deliverable D6.2**, Aug. 2018. URL https://netcommons.eu/?q=content/dissemination-report-summary-dissemination-actions-and-adoption-netcommons-solutions-durin-0.

[8] Félix Tréguer. “EU telecom reform paves way for policies tailored for community networks”, November 2018. URL http://blogs.lse.ac.uk/mediapolicyproject/2018/11/27/eu-telecom-reform-paves-way-for-policies-tailored-for-community-networks/.

[9] Félix Tréguer. “enabling the Telecommons: Guidelines for Policy-Makers”. Technical report, netCommons, November 2018. URL https://www.netcommons.eu/sites/default/files/telecommons-policy-guidelines.pdf.

[10] Ramon Roca, Lluís Dalmau, Roger Baig, and Leandro Navarro. “Modelo de implantação de Rede Universal para Conectividade Universal”. *poliTICs*, 2(28), 2018. ISSN 1984-8803. URL https://politics.org.br/edicoes/modelo-de-implanta%C3%A7%C3%A3o-de-rede-universal-para-conectividade-universal.

[11] Ramon Roca, Lluís Dalmau, Roger Baig, and Leandro Navarro. “Universal network deployment model for universal connectivity”. Public access in arxiv, 2018. URL https://arxiv.org/abs/1812.11525.

[12] Alexandros Papageorgiou, Panayotis Antoniadis, Merkouris Karaliopoulos, George Klissiaris, Vassilis Chryssos, Leonardo Maccari, Renato Lo Cigno, Felix Freitag, and Lea ndro Navarro. Deployment experiences with a Multi-Disciplinary approach. **netCommons Deliverable D3.5**, Oct. 2018. URL https://www.netcommons.eu/sites/default/files/d3.6_v1.0.pdf.

[13] Leonardo Maccari and Renato Lo Cigno. Monitoring CNs: Report on Experimentations on CNs. **netCommons Deliverable D2.7**, Dec. 2017. URL https://www.netcommons.eu/?q=content/monitoring-cns-report-experimentations-cns-v2.

[14] Virginie Aubree, Mélanie Giovanella, Federica and Dulong de Rosnay, Arthur Messaud, and Félix Tréguer. European Legal Framework for CNs (v3). **netCommons Deliverable D4.3, version 1.0**, Aug. 2018. URL https://www.netcommons.eu/?q=content/european-legal-framework-cns-v3.

[15] Panayotis Antoniadis, Ileana Apostol, Panagiota Micholia, George Klissiaris, Vassilis Chryssos, and Merkouris Karaliopoulos. Multi-Disciplinary Methodology for Applications Design for CNs, including Design Guidelines and Adoption Facilitation (v1). **netCommons Deliverable D3.1**, Jan. 2017. URL https://netcommons.eu/?q=content/multi-disciplinary-methodology-applications-design-cns-including-design-guidelines-and.

[16] Panayotis Antoniadis, Ileana Apostol, Alexandros Papageorgiou, Merkouris Karaliopoulos, George Klissiaris, and Vassilis Chryssos. Multi-Disciplinary Methodology for Applications Design for CNs, including Design Guidelines and Adoption Facilitation (v2). **netCommons Deliverable D3.3**, Apr. 2018. URL http://netcommons.eu/?q=content/multi-disciplinary-methodology-applications-design-cns-including-design-guidelines-and.

[17] Nicolò Facchi, Felix Freitag, Leonardo Maccari, Panagiota Micholia, and Francesco Zanini. Release of All Open Source Software for all Applications (v1). **netCommons Deliverable D3.2**, Dec. 2016. URL https://netcommons.eu/?q=content/release-new-open-source-software-all-applications-v1.

[18] Leonardo Maccari, Luca Baldesi, Nicolò Facchi, Renato Lo Cigno, Felix Freitag, Leandro Navarro, Roc Messeguer, Merkouris Karaliopoulos, Panagiota Micholia, and Aris Pilichos. Release of All Open Source Software for all Applications (v2). **netCommons Deliverable D3.4**, Mar. 2018. URL https://netcommons.eu/?q=content/release-new-open-source-software-all-applications-v2.

[19] Merkouris Karaliopoulos and Iordanis Koutsopoulos. Collective subscriptions: towards sustainable funding of community network infrastructures, 2019. URL http://www.wi-opt.org/.

[20] Roger Baig, Felix Freitag, and Leandro Navarro. "Cloudy in guifi.net: Establishing and sustaining a community cloud as open commons". *Future Generation Computer Systems*, 87:868–887, Oct. 2018. doi: 10.1016/j.future.2017.12.017.

[21] Roger Baig-Viñas, Leandro Navarro, and Ramon Roca-i-Tió. "Multiple Dimensions of Community Network Scalability". In Belli et al. [26], pages 133–158. ISBN 9788595970298. URL http://bibliotecadigital.fgv.br/dspace/handle/10438/25696.

[22] Roger Baig, Leandro Navarro, Ramon Roca, and Felix Freitag. "Catalonia, guifi.net: scaling up a community network". volume 1. Association for Progressive Communications, November 2018. ISBN 978-92-95113-06-0. URL https://www.giswatch.org/community-networks.

[23] Mélanie Giovanella, Federica and Dulong de Rosnay, Arthur Messaud, and Félix Tréguer. European Legal Framework for CNs (v2). **netCommons Deliverable D4.2, version 1.0**, Jan. 2018. URL https://www.netcommons.eu/?q=content/european-legal-framework-cns-v2.

[24] Leonardo Maccari, Roberta Guidolin, and Renato Lo Cigno. Report on the publications and data download, use, and citation. **netCommons Deliverable D7.5**, Mar. 2019. URL https://netcommons.eu/?q=content/report-publications-and-data-download-use-and-citation.

[25] Panayotis Antoniadis, Jens Martignoni, Leonardo Maccari, Renato Lo Cigno, Federica Giovanella, Leandro Navarro, Roger Freitag, Felix Baig, Félix Tréguer, Mélanie Dulong de Rosnay, Dimitris Boucas, Maria Michalis, Christian Fuchs, Panagiota Micholia, and Merkouris Karaliopoulos. Dissemination Report: Summary of Dissemination Actions and Adoption of netCommons Solutions During the First Year. **netCommons Deliverable D6.1**, Feb. 2017. URL https://netcommons.eu/?q=content/dissemination-report-summary-dissemination-actions-and-adoption-netcommons-solutions-during.

[26] Luca Belli, Bruno de Souza Ramos, Panayotis Antoniadis, Virginie Aubrée, Roger Baig Viñas, Aris

Dadoukis, Paolo Dini, Mélanie Dulong de Rosnay, Nicolas Echániz, Kurtis Heimerl, Matthew Johnson, Pathirat Kosakanchit, Florencia López Pezé, Steven Mansour, Stavroula Maglavera, Jens Martignoni, John Mavridis, Sascha Meinrath, Leandro Navarro, Harris Niavis, Ramon Roca i Tió, Spencer Sevilla, and Félix Tréguer. *"The community network manual: how to build the Internet yourself"*. FGV Direito Rio, Nov 2018. ISBN 9788595970298. URL http://bibliotecadigital.fgv.br/dspace/handle/10438/25696.

[27] Félix Tréguer. "Federating Community Networks: A case study from France". In Belli et al. [26], pages 159–176. ISBN 9788595970298. URL http://bibliotecadigital.fgv.br/dspace/handle/10438/25696.

[28] Virginie Aubrée and Mélanie Dulong de Rosnay. "Fostering sustainability of Community Networks: Guidelines to Respect the European Legal Framework". In Luca Belli, editor, *The community network manual: how to build the Internet yourself*, pages 177–188. FGV Direito Rio Edition, 2018.

[29] Panayotis Antoniadis, Jens Martignoni, Leandro Navarro, and Paolo Dini. "Complementary Networks Meet Complementary Currencies: Guifi.net Meets Sardex.net". In Belli et al. [26], pages 189–222. ISBN 9788595970298. URL http://bibliotecadigital.fgv.br/dspace/handle/10438/25696.

[30] Panayotis Antoniadis and Jens Martignoni. "What Could Blockchain do for Community Networks". In Luca Belli, editor, *The community network manual: how to build the Internet yourself*, pages 223–248. FGV Direito Rio Edition, 2018.

[31] Steve Song, Carlos Rey-Moreno, Anriette Esterhuysen, Mike Jensen, and Leandro Navarro. "Introduction: The rise and fall and rise of community networks". volume 1. Association for Progressive Communications, November 2018. ISBN 978-92-95113-06-0. URL https://www.giswatch.org/community-networks.

[32] Leandro Navarro, Leonardo Maccari, and Renato Lo Cigno. "At the limits of the internet: Technology options for community networks". volume 1. Association for Progressive Communications, November 2018. ISBN 978-92-95113-06-0. URL https://www.giswatch.org/community-networks.

[33] Leandro Navarro. "Network infrastructures: The commons model for local participation, governance and sustainability". Association for Progressive Communications, Feb. 2018. URL https://www.apc.org/en/pubs/network-infrastructures-commons-model-local-participation-governance-and-sustainability.

[34] Panayotis Antoniadis. "The Organic Internet as a Resilient Practice". In Kim Trogal, Irena Bauman, Ranald Lawrence, and Doina Petrescu, editors, *Architecture and Resilience: Interdisciplinary Dialogues*. Routledge, 2018. ISBN 978-1-138-06581-9. URL https://www.routledge.com/Architecture-and-Resilience-A-Series-of-Interdisciplinary-Dialogues/Trogal-Bauman-Lawrence-Petrescu/p/book/9781138065819.

[35] Leonardo Maccari. "Detecting and Mitigating Points of Failure in Community Networks: a Graph-based Approach". *Accepted for publication on IEEE Transactions on Computational Social Systems*, 2019.

[36] Mennan Selimi, L Cerdà-Alabern, Felix Freitag, L Veiga, Arjuna Sathiaseelan, and J Crowcroft. "A Lightweight Service Placement Approach for Community Network Micro-Clouds". *Journal of Grid Computing*, 2018. ISSN 1570-7873. doi: https://doi.org/10.1007/s10723-018-9437-3.

[37] Ester López and Leandro Navarro. "Coordinated detection of forwarding faults in Wireless Community Networks". *Journal of Network and Computer Applications*, 109:66–77, 2018.

[38] Panagiota Micholia, Merkouris Karaliopoulos, Iordanis Koutsopoulos, Leandro Navarro, Roger Baig, Dimitris Boucas, Maria Michalis, and Panayiotis Antoniadis. "Community Networks and Sustainability: a Survey of Perceptions, Practices, and Proposed Solutions". *IEEE Communications Surveys & Tutorials*, 20, March 2018. doi: 10.1109/COMST.2018.2817686.

[39] Axel Neumann, Leandro Navarro, and Llorenç Cerdá-Alabern. "Enabling Individually Entrusted Routing Security for Open and Decentralized Community Networks". *Ad Hoc Networks*, 79:20–42, Oct. 2018. doi: 10.1016/j.adhoc.2018.06.014.

[40] Leonardo Maccari, Mirko Maischberger, and Renato Lo Cigno. "Where have all the MPRs gone? On the optimal selection of Multi-Point Relays". *Ad Hoc Networks, Elsevier*, 77:69–83, Aug. 2018. ISSN 1570-

8705. doi: https://doi.org/10.1016/j.adhoc.2018.04.012. URL http://www.sciencedirect.com/science/article/pii/S1570870518301537.

[41] Leonardo Maccari and Renato Lo Cigno. "Improving Routing Convergence With Centrality: Theory and Implementation of Pop-Routing". *IEEE/ACM Transactions on Networking*, 26(5):2216–2229, Oct. 2018. ISSN 1063-6692. doi: 10.1109/TNET.2018.2865886. URL https://ieeexplore.ieee.org/document/8457534.

[42] Leonardo Maccari, Merkouris Karaliopoulos, Iordanis Koutsopoulos, Leandro Navarro, Fèlix Freitag, and Renato Lo Cigno. "5G and the Internet of EveryOne: Motivation, Enablers, and Research Agenda". In *IEEE European Conference on Networks and Communications (EuCNC)*, pages 429–433, June 18–21 2018. doi: https://doi.org/10.1109/EuCNC.2018.8443200. URL https://ieeexplore.ieee.org/document/8443200.

[43] Leonardo Maccari, Lorenzo Ghiro, Alessio Guerrieri, Alberto Montresor, and Renato Lo Cigno. "On the Distributed Computation of Load Centrality and Its Application to DV Routing". In *37th Annual IEEE International Conference on Computer Communications (INFOCOM)*, pages 2582–2590, Honolulu, HI, USA, Apr. 16-19 2018. ISBN 978-1-5386-4128-6. doi: https://doi.org/10.1109/INFOCOM.2018.8486345. URL https://ieeexplore.ieee.org/document/8486345.

[44] Lorenzo Ghiro, Leonardo Maccari, and Renato Lo Cigno. "Proof of Networking: Can Blockchains Boost the Next Generation of Distributed Networks?". In *14th IFIP/IEEE Annual Conf. on Wireless On-demand Network Systems and Services (WONS)*, pages 29–32, Isola 2000, France, Jan. 2018. ISBN 978-3-903176-02-7. URL http://dl.ifip.org/db/conf/wons/wons2018/index.html.

[45] A. M. Khan, F. Freitag, V. Vlassov, and P.H. Ha. "Demo abstract: Towards IoT service deployments on edge community network microclouds". In *IEEE INFOCOM 2018 - IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS)*, pages 1–2, Apr. 2018. doi: 10.1109/INFCOMW.2018.8406840.

[46] Felix Freitag. "On the Collaborative Governance of Decentralized Edge Microclouds with Blockchain-based Distributed Ledgers". In *BCT4MAS 2018 - 1st International Workshop on Block Chain Technologies 4 Multi-Agent Systems (BCT4MAS) at WI 2018*, Dec. 2018.

[47] Khulan Batbayar, Emmanouil Dimogerontakis, Roc Meseguer, Leandro Navarro, Esunly Medina, and Rodrigo M. Santos. "The RIMO Gateway Selection Approach for Mesh Networks: Towards a Global Internet Access for All". *MDPI Proceedings*, 2(19), 2018. ISSN 2504-3900. doi: 10.3390/proceedings2191258. URL http://www.mdpi.com/2504-3900/2/19/1258.

[48] K. Batbayar, R. Meseguer, L. Navarro, R. Sadre, and E. Dimogerontakis. "Collaborative informed gateway selection in large-scale and heterogeneous networks". In *IFIP/IEEE International Symposium on Integrated Network Management (IM)*, Apr. 2019. URL N/A.

[49] Merkouris Karaliopoulos and Iordanis Koutsopoulos. "Mobile App User Choice Engineering Using Behavioral Science Models". In *Proc. 19th IEEE International Workshop on Signal Processing Advances in Wireless Communications (SPAWC), 2018*, pages 1–5, June 2018.

[50] Iordanis Koutsopoulos. "Incentive allocation to sequential decision-making sensors in Mobile Crowdsensing". In *IEEE International Conference on Pervasive Intelligence and Computing (PICom)*, pages 1–5, Aug. 2018. doi: 10.1109/DASC/PiCom/DataCom/CyberSciTec.2018.00-18. URL http://cyber-science.org/2018/picom/.

[51] Iordanis Koutsopoulos. "The impact of Social-network diffusion on wireless edge resource allocation". In *International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM) 2018*, pages 1–3, June 2018. doi: 10.1109/WoWMoM.2018.8449791.

[52] Luca Baledesi, Leonardo Maccari, and Renato Lo Cigno. "On the Properties of Infective Flooding in Low-Duty-Cycle Networks". In *15th IFIP/IEEE Annual Conf. on Wireless On-demand Network Systems and Services (WONS)*, Jan. 2019. URL http://2019.wons-conference.org/.

[53] Renato Lo Cigno. Wireless 2035: New Technologies or New Architectures? "IEEE European Conference on Networks and Communications (EuCNC) – Invited Speech", June 18–21 2018.

[54] Merkouris Karaliopoulos, Iordanis Koutsopoulos, Leonardo Maccari, Renato Lo Cigno, and Leandro Navarro. "Wireless Community networks and 5G: the 7-Billion-user challenge". IEEE European Conference on Networks and Communications (EuCNC) – Tutorial, June 18–21 2018.

[55] Melanie Dulong de Rosnay. "Regard sur le droit et les communs : un droit pair-à-pair". In Danièle Bourcier, Jacques Chevallier, Gilles Hériard Dubreuil, Sylvain Lavelle, and Emmanuel Picavet, editors, *Dynamiques du Commun. État, Marché et Société*. Publications de la Sorbonne, 2020. in press.

[56] Félix Tréguer and Dominique Trudel. "From Internet Access Provision to Political Advocacy: The History of the French Data Network". *Histoire et informatique*. in press.

[57] Félix Tréguer, Dominique Trudel, and Melanie Dulong de Rosnay. "Learning from the History of Alternative Networks". *Journal of Alternative and Community Networks*. in press.

[58] Leonardo Maccari, Gabriele Gemmi, Renato Lo Cigno, Merkouris Karaliopoulos, and Leandro Navarro. "Assistive Growth: Towards Scalable Community Networks Topologies". *Submitted to Ad Hoc Networks*.

[59] Mennan Selimi, Adisorn Lertsinsrubtavee, Arjuna Sathiaseelan, Llorenc Cerdà-Alabern, and Leandro Navarro. "PiCasso: Enabling Information-Centric Multi-tenancy at the Network's Edge", Jan. 2019. URL https://www.journals.elsevier.com/computer-networks.

[60] Aniruddh Rao Kabbinale, Emmanouil Dimogerontakis, Mennan Selimi, Anwaar Ali, Leandro Navarro, and Arjuna Sathiaseelan. "Blockchain for Economically Sustainable Wireless Mesh Networks". *Under review in Concurrency and Computation: Practice and Experience*, 2018. URL https://onlinelibrary.wiley.com/journal/15320634.

[61] Merkouris Karaliopoulos and Iordanis Koutsopoulos. "Infrastructure and service provider games in crowdsourced networks", 2019. URL https://www.sigmobile.org/mobihoc/2019/.

[62] Leandro Navarro, Ignacio Castro, Arjuna Sathiaseelan, Emmanouil Dimogerontakis, Mennan Selimi, Felix Freitag, and Roger Baig. "Blockchain models for universal connectivity". *Under review in Telecommunications Policy Journal*, -(-), 2018. ISSN 1084-8045. URL https://www.journals.elsevier.com/journal-of-network-and-computer-applications.

[63] Melanie Dulong de Rosnay, Félix Tréguer, and Panayotis Antoniadis. "Commonswashing by information technologies and online platforms, the semantic appropriation of the commons". Submitted to the International Association on the Study of the Commons (IASC) 2019 conference.

[64] Félix Tréguer and Melanie Dulong de Rosnay. "The Political Defence of the Commons: The Case of Community Networks". To be submitted to a journal on communications and policy.

[65] Melanie Dulong de Rosnay. "Community Networks: From Top-Down Citizen Science to Bottom-Up Citizen Policy Makerspaces". To be submitted to a Science and Technology Studies journal.

[66] Stefano Crabu, Melanie Dulong de Rosnay, and Paolo Magaudda. "Socio-technical governance of Community networks as co-produced commons. A comparative research". To be submitted to a Communication Science journal.

[67] Virginie Aubrée and Melanie Dulong de Rosnay. "The Aftermath of Digital Rights Ireland and Tele2 ECJ cases: a diversity of data retention national practices". To be submitted to a Law and tech journal.

[68] Ileana Apostol, Panayotis Antoniadis, and Thomas Raoseta. "The right to the hybrid city: Central space as a commons". To be submitted at an Urban Studies journal.

[69] Panayotis Antoniadis and Ileana Apostol. The Right(s) to the Hybrid City and the Role of DIY Networking. *The Journal of Community Informatics*, 10(3), 2014.

[70] Panayotis Antoniadis, Ileana Apostol, and Alexandros Papageorgiou. Reflection-in-action in participatory design. To be submitted at C&T Conference, 3-7 June 2019, Vienna.

[71] Panayotis Antoniadis, Ileana Apostol, Virginie Aubrée, Adam Burns, Maria Michalis, Juergen Neumann, Ramon Roca, and Félix Tréguer. Best Practices Guide for Community Networks. **netCommons Deliverable D4.5, version 1.0**, Jan. 2019. URL https://www.netcommons.eu/?q=content/best-practices-guide-cns.

[72] Mélanie Dulong de Rosnay, Federica Giovanella, Arthur Messaud, and Félix Tréguer. European Legal Framework for CNs. **netCommons Deliverable D4.1 (v1)**, Dec. 2016. URL http://netcommons.eu/?q=content/european-legal-framework-cns-v1.

[73] Dominique Trudel and Félix Tréguer. Alternative Communication Technologies Throughout History. **netCommons Deliverable D5.1**, Dec. 2016. URL http://netcommons.eu/?q=content/alternative-communication-technologies-throughout-history.

[74] Dimitris Boucas, Christian Fuchs, Maria Michalis, Virginie Aubree, and Félix Tréguer. netCommons Political and Ethical guidelines for an Alternative Internet. **netCommons Deliverable D4.4**, Dec. 2018. URL https://netcommons.eu/?q=content/political-and-ethical-guidelines-alternative-internet.

[75] Christian Fuchs, Maria Michalis, and Dimitris Boucas. The Multiple Aspects of Politics of Sustainability in Community Networks: Definitions, Challenges, and Countermeasures (v1). **netCommons Deliverable D2.1**, June 2016. URL https://netcommons.eu/?q=content/multiple-aspects-politics-and-sustainability-cns-definitions-challenges-and-countermeasures.

A. Letters of Appreciation

We report here the letters and statement of appreciation we received from ninux members after some of the “non institutional” activities we carried out with them. These are mostly the interactions that served to bootstrap, or to foster, or simply to revive activities and initiatives that CNs were nurturing since some time, but did not find the resources to start.

A.1. Marco Musumeci on the Turnantenna Project

I'm Marco Musumeci and I'm a mechanical engineering student of Florence University. Around September 2017 a friend of mine introduced me to the Ninux community. During the first meeting I attended, I was struck by the passion of this people to the technology and by their commitment to the community. I was discovering a Wireless Community Network (WCN) district: Ninux. Since that first meeting I started keeping in touch with that community.

One day Salvatore Moretti, a Ninux fellow, talked to me about the Turnantenna, a project that was born in the community. Then I decided that I would have liked to contribute with my mechanical skills; so I started working on that. Turnantenna is a motor device that is able to point a ninux device by remote, without need of human intervention. It has a mechanical part (the engines and the mechanical rods) and a software part (the driver and the interface).

Leonardo Maccari, introduced me to the *Participatory Design Methodology* from the netCommons project. It seemed to be an interesting approach. In particular I liked the idea behind the method: to merge together social interaction with innovative projects development; so we decided to use it to schedule our work for the Turnantenna. Then we started programming new activities in different branches, for instance *how to improve other Ninux islands engagement to the project, how to collect and exploit technical skills*, and *how to make the hard work visible to the outer people*. All concepts derived following the methodology.

Working as a community, the project moved on and the Turnantenna gradually came to life. As scheduled, after the first minimum viable prototype production we presented the idea during the national Ninux meeting in November 2017 in order to collect improvement and suggestions for further developments. We gathered a lot of informations so I started working on a next-generation prototype.

This was the right time to present it to the people from other communities. We scheduled a series of talks in different events: the Turnantenna was presented, together with most important open source projects in Italy, during the Merge-it conference in Turin (March 2018); it was shown to a world wide WCN audience during the Battle of the mesh in Berlin (June 2018). Following the methodology we also tried to gather sources of funding, and as a consequence, Turnantenna was selected for being a Google Summer of Code project during the last summer, and the mechanical study I did became my bachelor degree thesis.

In fall 2018 I proposed the Turnantenna for the Maker Fair in Rome, the largest exhibition of innovators, makers and technology passionates in Italy, and the European version of the US-based Maker Fair. The turnantenna was selected as an innovative project, and I was invited to the Maker Faire in Rome, where I also won a *blue ribbon* award as “maker of merit” (October 2018). Several weeks later, I discovered that our project was also cited in the EngineeringNet magazine.

During these events the Turnantenna was a success, and I’m in touch with many people that want to know how it will grow. That’s why I decided to keep working on the project. Right in these weeks, I’m trying to team-up with other people to upgrade my project from a personal project to a start-up. We have created a good base team and now we are among the seven finalists of an open selection that will provide initial funding to the best three.

In this phase, Leonardo has also directed me to more results of the netCommons project, in particular the deliverables concerning the legal aspects of community networks. This material helps me to strengthen my start-up project, which deals with how to access Internet access using community networks, reducing the costs of maintaining a network using Turnantenna. The results contain a lot of useful information to make my proposal legally strong and also many links to European initiatives that justify my proposal also from a commercial point of view.

In conclusion, in my experience as a member of Ninux Florence, the netCommons project has been instrumental in guiding my choices, and therefore my contribution to the Ninux network.

24/12/2018

Marco Musumeci

A.2. ninux Calabria community on the interaction with netCommons

My name is Stefano De Carlo and I am a member of Ninux Cosenza, as well as secretary of Hacklab Cosenza, an association deeply rooted in the territory that for many years promotes the use of free technologies.

I came into contact with the netCommons project thanks to Leonardo Maccari, who actively participated in our community and I was deeply impressed by the results of the project. Firstly, we appreciated the results of the analyzes produced on the Ninux network which showed how the growth of the Rome network was driven by an unsustainable model. We decided that in order to avoid a similar development of our network in Cosenza, we would have had to change both the technological and the organizational approach. In this second aspect, the netCommons project has provided us with solid foundations concerning the governance and legal aspects, and thanks to the dialogue with the netCommons experts we decided to change the "picopeering agreement", which is the basic set of rules that keep our community together. Now our network is in a growth phase and we expect that with the change in approach that we have had, this growth is sustainable.
The results produced by netCommons have influenced our path very positively.

Answers to the questionnaire:

1) Were you, or someone in your community, involved in the development or use of open source software realized in the netCommons project? Please briefly describe your experience.

In the last period we have also adopted one of the software produced by netCommons, the Open Source PeerStreamer-ng program. We were positively impressed by the first tests we carried out with its public instance and decided to install PeerStreamer-ng in three instances in our network.

2) What is the added value that such software brought to your community?

PeerStreamer-ng solves an evident problem that afflicts the other streaming platforms, which is the centralization due to the use of a single server, and the relative overload due to the use of multiple video streams.

3) Are you planning to keep using the netCommons software after the end of the project?

Our experience with PeerStreamer-ng has been positive, it is used for videoconferencing among the users of the network and we have appreciated its performance and simplicity.

We plan to continue using it and to increase the number of nodes in our network in the next year.

4) Where you involved in the use of the participatory methodology developed in the netCommons project? If yes, was it useful to the co-creation and use of applications in your community network? if not briefly describe why.

No, we were not involved in development activities recently, so we did not use the mentioned methodology.

Overall, I want to show my full support for the results obtained by netCommons. The project has been extremely useful for us, it has helped us to change our path, and I think that its successes (both from a technological point of view, but also form a legal one) are useful for the whole movement of community networks.

Cosenza, 27/12/2018

B. Dissemination Material Divided by Event

This appendix collects selected slides and additional material used in dissemination events, namely public speeches, keynotes, panels, training sessions, and similar events. Slides used to present scientific papers are not included as the papers themselves, all available in Open Access, and the same holds for slides decks used more or less the same in more than one events.

All the material reported here and additional one can be obtained for proper re-use under the relative Creative Commons Licence either by contacting the authors or writing to info@netcommons.eu or netcommons@unitn.it.

B.1. netCommons at UNESCO
Reference event Sec. 2.1.2

B.1.1. Presentation by Melanie Dulong de Rosnay

The Influence of Legislation for Bottom-Up Networking

netCommons

Melanie Dulong de Rosnay
melanie.dulong@cnrs.fr
UNESCO, 30 January 2018

For the footer 1/10

The netCommons project

- The legal framework of CNs
  - Liability for infringement by other users
  - Access to spectrum
  - Privacy and data retention
  - Telecommunications law
  - Balanced terms of use
  - Governance and decision-making above these
- Advocacy efforts
  - Open letter to the EU
  - Notes to the Members of the European Parliament
  - Workshop at the European Parliament

Melanie Dulong de Rosnay UNESCO 2/10

Internet Universality indicators Rights

- B6 Freedom of Expression: Are low-cost online services available which enable citizens and civil society organisations to make use of the Internet to express their views
  - CNs as enablers of alternative services in addition to connectivity: streaming, self-hosting, local broadcasting, digital communications tools (VPN, IM, wiki)
- E2 Privacy: Is the protection of personal data guaranteed in law and enforced in practice, with respect to governments, businesses and other organisations, including rights of access to information held and to redress
  - Data sovereignty, the right not to be data mined
  - Balanced terms of use

Melanie Dulong de Rosnay UNESCO 3/10

Internet Universality indicators Openness

- A3 Regulatory framework: Are there restrictions on which organisations or individuals can establish Internet, or Internet-enabled, services?
  - Does the law allow to re-use of existent hardware with new open-source software? This is related to e-waste also and a key point to deploy CNs
  - Does the law make it possible to legally set-up a CN? does the law encourages bottom-up associations to provide connectivity?
- C2 Rates and licences for spectrum: Are licensing and allocation of critical resources (including spectrum, domain names and IP-addresses) flexible, technology- and service-neutral, non-restrictive and non-discriminatory?
  - CNs need unlicensed spectrum. Is it available enough? Is it efficiently used or it is taken over by commercial entities? What about TV-white spaces, which would boost the growth of bottom-up networks?
- E4 Data: Are provisions concerning the location and duration of data retention consistent with international standards of data protection and supportive of effective access?
  - Data retention best practices

Melanie Dulong de Rosnay UNESCO 4/10

Internet Universality indicators Accessibility to all

- B.1 Are broadband networks geographically available throughout the country?
  - Alternative or complement to the market.
  - Bottom-up technological independence vs GringoNet & digital colonialism
- C.2 Is the cost of broadband access and use affordable to all sections of the population?
  - Free or cheaper
  - Value and possible fee retained locally, benefit sharing with the local community
- D.1 Are there significant differences in broadband access between urban and rural areas?
  - Address market failure
- D.2 Is there a gender digital divide in Internet access and use and, if so, is this gender divide growing, stable or diminishing? Also older people
  - Powell 2007
- Capabilities: F.3 What proportion of the population and the workforce is skilled in the use of ICTs?
  - Skills: technical, legal, socio-economic, governance, political advocacy

Melanie Dulong de Rosnay UNESCO 5/10

Internet Universality indicators Multistakeholder participation

- A1 Does the government encourage participation by other stakeholders in national governance through the Internet?
  - The right not to be excluded from telecom discussions
- B.1 Are there active associations of Internet professionals, consumers and other stakeholder communities?
  - FFDN structuration & advocacy

Melanie Dulong de Rosnay UNESCO 6/10

Open letter to the EC policy-maker

• Lifting unnecessary regulatory and financial burdens
- Registration fees, administrative charges

• Getting rid of third-party liability when sharing Internet Access
- open wifi, right to share internet connection

• Expanding the spectrum commons & unlicensed Wi-Fi bands incl. white spaces in lower frequencies
- new technical standards that use the so-called ISM frequency band (like LTE-U) that hamper the reliability of Wi-Fi communications

• Updating open-access rules in telecom infrastructures
- Networks built with taxpayers money should also be treated as a commons and, as such, remain free from corporate capture
- extremely costly for small access providers to interconnect
- community networks often cannot have access to the private local infrastructures of incumbent players
- in many European markets, the deployment of optical fiber networks is (re)creating monopolistic conditions on local loops through pricing schemes which preclude small actors from accessing these private networks

Melanie Dulong de Rosnay UNESCO 7/10

Open letter to the EC policy-maker (2)

• Protecting free software and user freedom in radio equipment
- community networks usually need to replace the software included by the manufacturer in radio hardware with free and open source software especially designed to suit their needs, a collective process that improves security and encourages the recycling of hardware, among other benefits
- incentive for manufacturers to lock down their devices and prevent third-party modifications of the hardware
- provide a general exception for all free software installed on radio devices by end-users and operators (the latter being liable if their software lead to violations of the regulatory framework), so that users' rights are safeguarded

• Abrogating blanket data retention obligations
- Community networks strive to safeguard human rights in communication networks, and in particular the right to privacy and the confidentiality of communication
- ensure that only targeted and limited retention obligations can be imposed on hosting and access providers

Melanie Dulong de Rosnay UNESCO 8/10

Open letter to the EC policy-maker (3)

• Bringing direct and targeted public support
- small grants, crowd-funding and subsidies
- giving them access to public infrastructures (for instance, the roof of a public building to install an antenna)
- support their research on radio transmission, routing methods, software or encryption
- CNs have pioneered various models for the provision of free public access points
- meet the same policy-objectives at a fraction of the cost that would be charged by mainstream telecom operators

• Opening the policy-making process to CNs
- ask regulators to pay more attention to our activities when drafting regulation
- take an integral part in technical and legal debates over broadband policy in which traditional, commercial ISPs are over-represented, and represent the public interest

Melanie Dulong de Rosnay UNESCO 9/10

From Recommendations to the (EC) policy-maker to CN-based enablers for digital divide reduction

- Enhance data protection while complying with data retention
- Foster the development of wireless community networks
- Promote a shared and unlicensed spectrum
- Create the appropriate conditions for small ISPs
- Address oligopolistic situations
- Lobbying to contribute to the discussion on the Telecom Package
- Convey stakes for CNs in less technical terms

Making Regulation Work for Community Networks
=
Existence threatened by inadequate legislations designed for commercial, large-scale ISP
+
Support sustainable commons
in telecom infrastructures and in policy-making in general

Melanie Dulong de Rosnay UNESCO 10/10

B.1.2. Presentation by Leonardo Maccari

Technical Reasons for Community Networks

UNIVERSITY OF TRENTO
Department of Information Engineering and Computer Science

netCommons

Leonardo Maccari, leonardo.maccari@unitn.it

Paris, 29/1/2018

Co-Funded by the Horizon 2020 programme of the European Union, Grant Number 688768

CNs: two Themes

1 - Digital Divide
They lower the cost of the infrastructure and make it possible to operate in digital divide areas

2 - Bottom-up Networks
They offer a new and revolutionary networking model compared to traditional Telco model.

CNs Vs Digital Divide

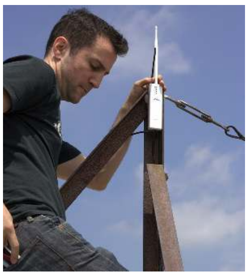
- One of the obstacles for Internet diffusion is the cost of the infrastructure.
- CNs offer a low-cost alternative to other network models, with minimal initial investment and "organic" growth.
- A CN generally start as a wireless mesh network, what does it mean?

Mesh Networks

- A mesh network is a distributed wireless network.
- Each node of the network receives, generates and also routes traffic

Mesh Nodes

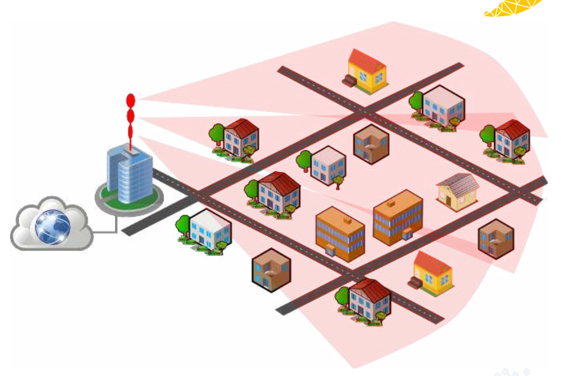
- The market offers devices for less than 60€ that can be easily mounted outdoor, and allow to bootstrap a network with a very small investment



Scaling up Networks

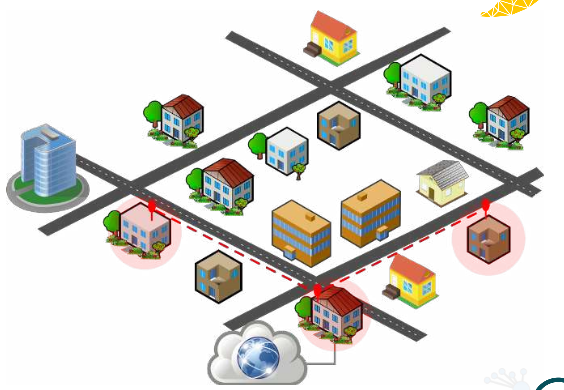
- As networks grow, things get technically more complex, but large networks are still viable and affordable.
- We have studied networks made with this principle that scale to hundreds of nodes, and cover large areas (i.e. the city of Vienna)

Classical WISP



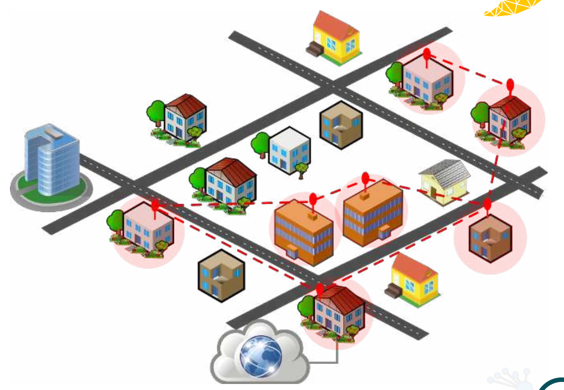
Leonardo Maccari leonardo.maccari@unitn.it netCommons@UNESCO 7/25

Mesh Model



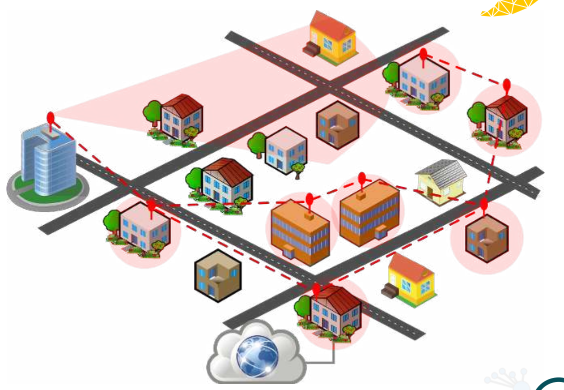
Leonardo Maccari leonardo.maccari@unitn.it netCommons@UNESCO 8/25

Mesh Model



Leonardo Maccari leonardo.maccari@unitn.it netCommons@UNESCO 9/25

Mesh Model



Leonardo Maccari leonardo.maccari@unitn.it netCommons@UNESCO 10/25

Bottom-up Technology

- The network grows with the community
- To reduce the cost, voluntary participation is a **need**
- People pool their resources to build their own network
  - Roofs
  - Technical skills
  - Energy . . .
  - . . . in order to keep the price of the infrastructure low

Leonardo Maccari leonardo.maccari@unitn.it netCommons@UNESCO 11/25

Take Away:

- Affordable technology, no need for large CAPEX, easy to bootstrap
- Scales up to hundreds, which makes it possible for the community to gather momentum and become "serious"
- Based on cooperative organization
- Makes it possible to set-up networks in areas of "market failure"

Leonardo Maccari leonardo.maccari@unitn.it netCommons@UNESCO 12/25

From Internet Users to *Community Networkers*

- As the network does not come in exchange of a fee, but as a peer production effort, people do not only passively use it.
- They own it.
- As such, they need to self-educate on networking principles, they have to set-up policies, governance, and take collective decisions.
- These decisions are generally different from the decision that an ISP takes, regarding neutrality, openness, and transparency.

CNs do not only tackle digital divide: they propose a new model for Internet development

Leonardo Maccari leonardo.maccari@unitn.it *netCommons@UNESCO* 13/25

Wireless Technology Driven?

- A CN must be a Mesh Network? **NO**
- Mesh networks are a superb instrument to bundle demand, and build a critical mass of people interested in connectivity.
- They also offer a strong techo-social metaphor to express the concept of a CN
- But they are not always usable (they need density and Line of Sight) and they scale up to a certain size
- The same concept of cooperative organization can be used with another technology.

Leonardo Maccari leonardo.maccari@unitn.it *netCommons@UNESCO* 14/25

Wired CNs

- There are CNs that rely on wired connections
- Deploying fiber may cost tens of thousands of Euros per km (CAPEX and OPEX)
- How does a community-based approach faces this challenge?
- We have working models proposing a mixed for-profit/not-for-profit approach.

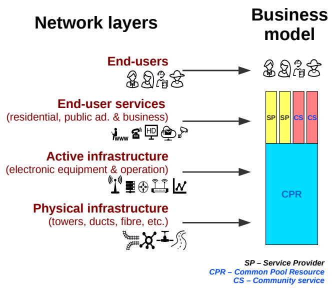
Leonardo Maccari leonardo.maccari@unitn.it *netCommons@UNESCO* 15/25

Guifi.net

- In Guifi, the passive and active infrastructure is treated as a Common Pool Resource (i.e. by the community)
- For-profit activities are allowed to use it, but they are asked for a fee
- This fee can be monetary, or can be made of verified investments in expanding the network, with a compensation system
- Internet access is one of the many potential applications the network supports.

Leonardo Maccari leonardo.maccari@unitn.it *netCommons@UNESCO* 16/25

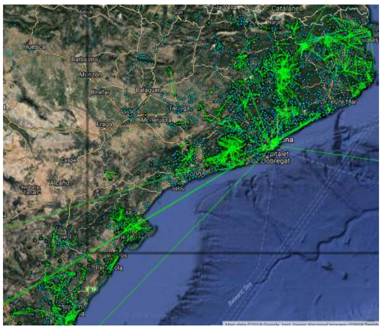
The Guifi.net Model



Key Theme: Sharing Vs Vertical Integration

Leonardo Maccari leonardo.maccari@unitn.it *netCommons@UNESCO* 17/25

The Guifi.net Network



Guifi.net is so far the largest CNs known, with about 35.000 nodes

Leonardo Maccari leonardo.maccari@unitn.it *netCommons@UNESCO* 18/25

Feedback and Recommendation

How could the presence of CNs impact the Internet Universality Indicators?

- Rights: C.2 Does the government block or filter access to the Internet or to specific online services, applications or websites, and on what grounds is this exercised?
- Openness: A.3 Are there restrictions on which organisations or individuals can establish Internet, or Internet- enabled, services?

Leonardo Maccari leonardo.maccari@unitn.it *netCommons@UNESCO* 19/25

Feedback and Recommendation

How could the presence of CNs impact the Internet Universality Indicators?

- D.2 Do arrangements for intellectual property protection balance the interests of copyright holders and information users in ways that promote innovation and creativity?
- D.1 Are there significant differences in broadband access between urban and rural areas?
- F.3: What proportion of the population and the workforce is skilled in the use of ICTs?

Leonardo Maccari leonardo.maccari@unitn.it *netCommons@UNESCO* 20/25

Feedback and Recommendation

How could the presence of CNs impact the Internet Universality Indicators?

- Are universal access/service arrangements in place which seek to reduce the cost of access for poor and marginalised groups within the population? Evidence that universality policies and arrangements address affordability in law and practice
- F.1 Do school and higher educational curricula include training in ICTs and Internet, focused on effective and safe use, and are these curricula implemented in practice? F.2 Are media and information literacy programmes (including digital aspects) provided for adults by government or other stakeholders, and used by citizens?

Leonardo Maccari leonardo.maccari@unitn.it *netCommons@UNESCO* 21/25

Can we add CN-specific Indicators?

- CNs need unlicensed spectrum. Is it available enough? Is it efficiently used or it is taken over by commercial entities? what about TV-white spaces, which would boost the growth of bottom-up networks?
- Does the law allow to re-use of existent hardware with new open-source software? This is related to e-waste also and a key point for CNs
- Does the law make it possible to legally set-up a CN?

Leonardo Maccari leonardo.maccari@unitn.it *netCommons@UNESCO* 22/25

Additional comments

- "Broadband": incorrect term from analog & radio signals $\mapsto$ "high speed" digital networks
- Enabling infrastructures: Internet exchanges, open-access networks, community networks, municipal networks
- Functional separation (ITU) of service provision: physical, active net, end-user
- Barriers for entry & provision of connectivity: use + sharing of public & private infrastructures, rights of way, access to spectrum
- Diversity & choice of models: public, private, large and small (barriers)

Leonardo Maccari leonardo.maccari@unitn.it *netCommons@UNESCO* 23/25

Self-reliant societies

- R Human rights: the rule of rights (e.g. UDHR) and the rule of law (local authority). Precise indicators (*consistency, evidence*) and performance (cases, incidents) assessed by independent third-parties (agencies, CSO). [A2, A3, B1-8]
- R.B4: liability of access providers
- R.B6: low-cost? $\mapsto$ non-profit/cooperative service providers
- R.E5: Any limitations
- O.A3: Incentives & barriers
- O.B3: facilitate $\mapsto$ consider: incentives & barriers
- O.B+: available: public right of way, landmarks & spectrum
- O.C1: incentives & barriers
- O.C4: incentives & barriers (municipal, CNs)
- O.C6: Cooperative (commons) infrastructures: IX, OAN, CNs (cost reduction, sharing)

Leonardo Maccari leonardo.maccari@unitn.it *netCommons@UNESCO* 24/25

Self-reliant societies

- A.A5: *public access* (free? not-for profit?): self-provision: affordable, cost oriented, CNs, centers of public life
- A.B1: open access networks
- A.B2: *comms/broadband* ↦ residential, personal
- A.C2: *broadband* ↦ residential (high-speed)
- A.F3: Indicator: existence of CNs (capability to self-provide)
- X.C2: *management of e-waste* ↦ environmental and social impact of devices and electronics: circular economy, efficiency (manufacturing,use, reuse, repair, recycle)
- X.E+: Legal and ethical rights: impacts on labor, environmental

Leonardo Maccari leonardo.maccari@unitn.it *netCommons@UNESCO* 25/25

B.1.3. Presentation by Maria Michalis

Community Networks and Society: Perceptions and Reality

Dr. Maria Michalis
M.Michalis@westminster.ac.uk
University of Westminster
London

netCommons@Unesco 30 January 2018 1/15

Outline

- Context
  - Liberalization process: promises and pitfalls
- Community Networks
  - Where do they fit in the picture?
  - Benefits
  - Future & potential of alternatives
  - Internet users' concerns & perceptions about standard Internet
- Key takeaways – relevance to IU indicators

Maria Michalis netCommons@Unesco 2/15

Liberalization of Telecomm markets (1/2)

- Since mid-1980s
- Emphasis on competition
  - –Dismantling inefficient State monopolies
  - –Improve corporate efficiency
- Investment through private funding and access to capital markets
- 'Retreat' of the State

Maria Michalis netCommons@Unesco 3/15

Liberalization of Telecomm markets (2/2)

- Liberalization hasn't met the original expectations fully
  - Monopolies/ oligopolies persist in many (most?) markets
  - Race to broadband: Main market players are asking for *less regulation* and *market consolidation* in order to invest in broadband
  - Areas underserved or not served at all
  - Consumer prices?

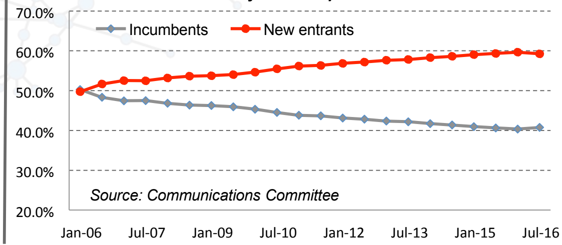
Maria Michalis netCommons@Unesco 4/15

Competition in the fixed broadband market: new entrant operators are continuously gaining market share, but incumbents still control 41 % of subscriptions.

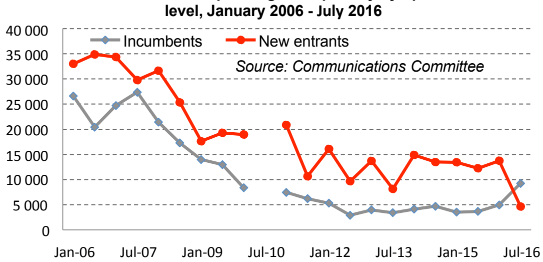
Incumbent operators are market leaders in almost all Member States, although their market share is decreasing gradually. During the last 10 years, new entrant operators have consistently posted higher net gains then the incumbents in each year, although a reverse in this trend has been observed over the last six months. Overall, market share of incumbents in the EU has decreased by 10 percentage points since 2006.*

* Break in series in July 2010 due to modification of historical data.

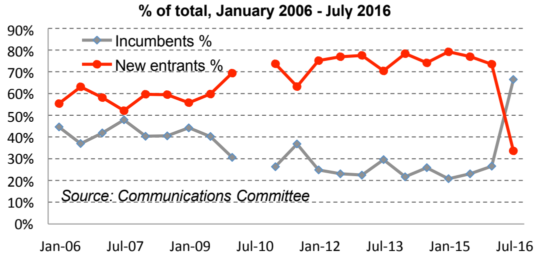
Fixed broadband subscriptions - operator market shares at EU level, January 2006 - July 2016



Fixed broadband subscriptions growth per day by operator at EU level, January 2006 - July 2016



Fixed broadband subscriptions growth per day by operator at EU level % of total, January 2006 - July 2016



Where do CNs fit into this picture?

CNs and the Heineken effect

"Refreshes the parts that other beers cannot reach"

Maria Michalis netCommons@Unesco 7/15

Community networks

- Have been around for about 20 years
- Often seen as simply 'filling in the gaps' (Heineken)
  - Defending the human right to connectivity
- But much more than that (Heineken +)
- They typically offer an 'alternative', e.g.
  - Topology & architecture
  - Ownership
  - Business model
  - Values
  - Social inclusion

Maria Michalis netCommons@Unesco 8/15

The continuing importance of CNs

- Some valid reasons for CNs
  - Need: Lack of (adequate) Internet access
    e.g. Migrant and refugee settlements
  - Open structures
  - Better privacy and control of user data
  - Experimentation, playfulness and knowledge transfer
  - Greater (non-economic) societal benefits
- Main challenges
  - Changing market and technological conditions
  - Resources

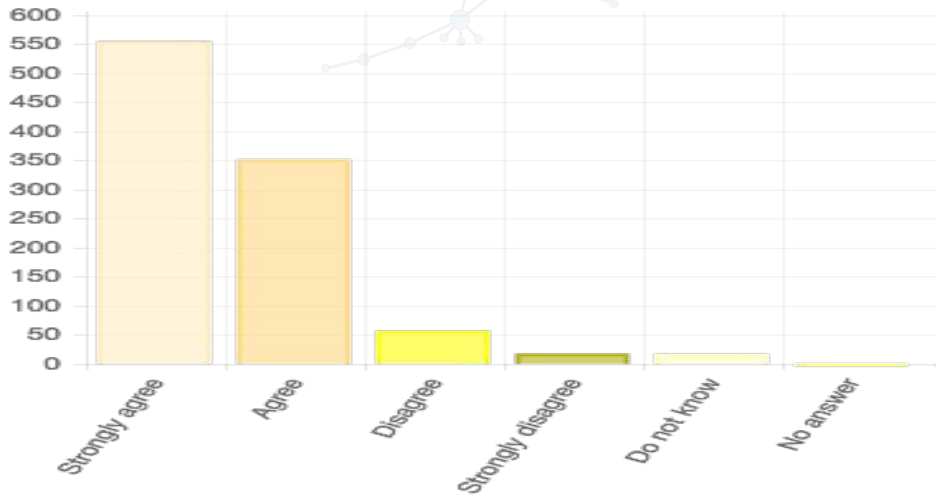
Maria Michalis netCommons@Unesco 9/15

Online survey: Users' concerns about the Internet and potential for alternatives

- As part of the netCommons project: online survey on users'
  - concerns about Internet use and
  - perceptions about potential of alternative Internet provision
- 1000 Respondents (competent Internet users)
  - academic/research staff, students, IT product/services professionals or administrative/clerical staff at Universities or research institutes

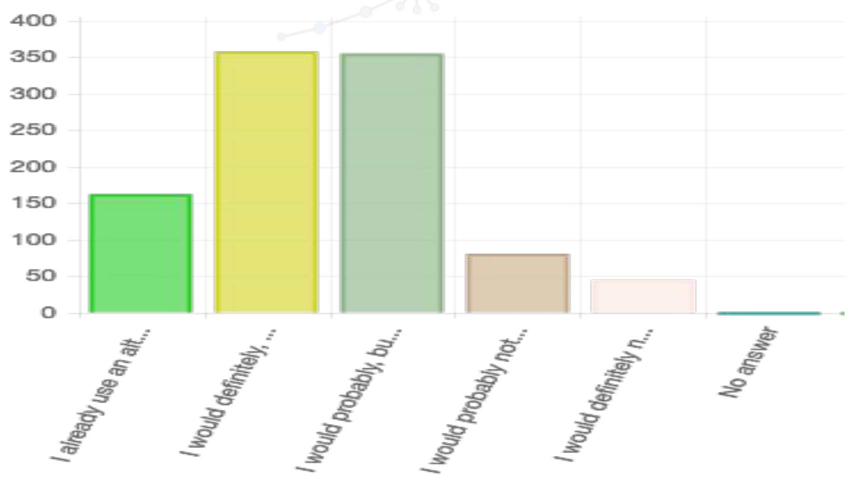
Maria Michalis netCommons@Unesco 10/15

Please consider the following statement: Users do not have control over how personal information is collected and used by online companies.



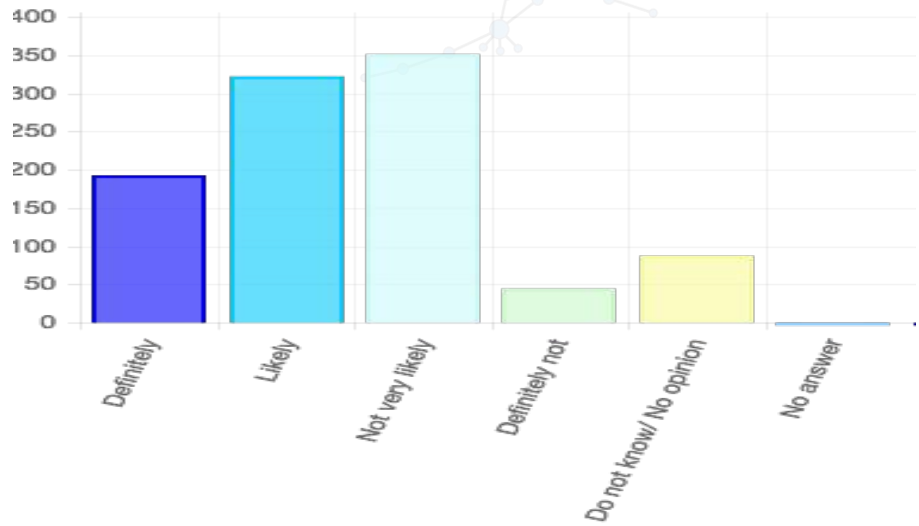
Maria Michalis netCommons@Unesco 11/15

Would you consider using alternative platforms instead of Facebook, Twitter, YouTube, or Google to avoid such monopoly effects as these seem to have at the moment?



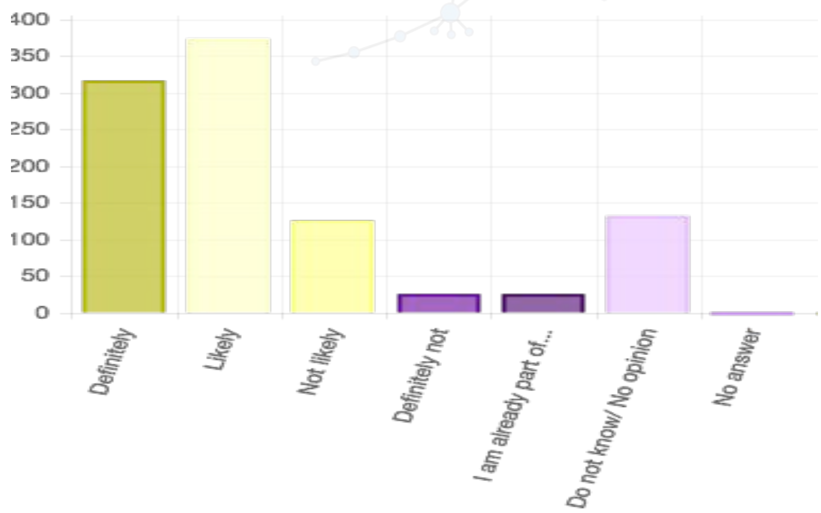
Maria Michalis netCommons@Unesco 12/15

Do you think there is potential for local community networks to overcome your concerns about the Internet identified in this survey?

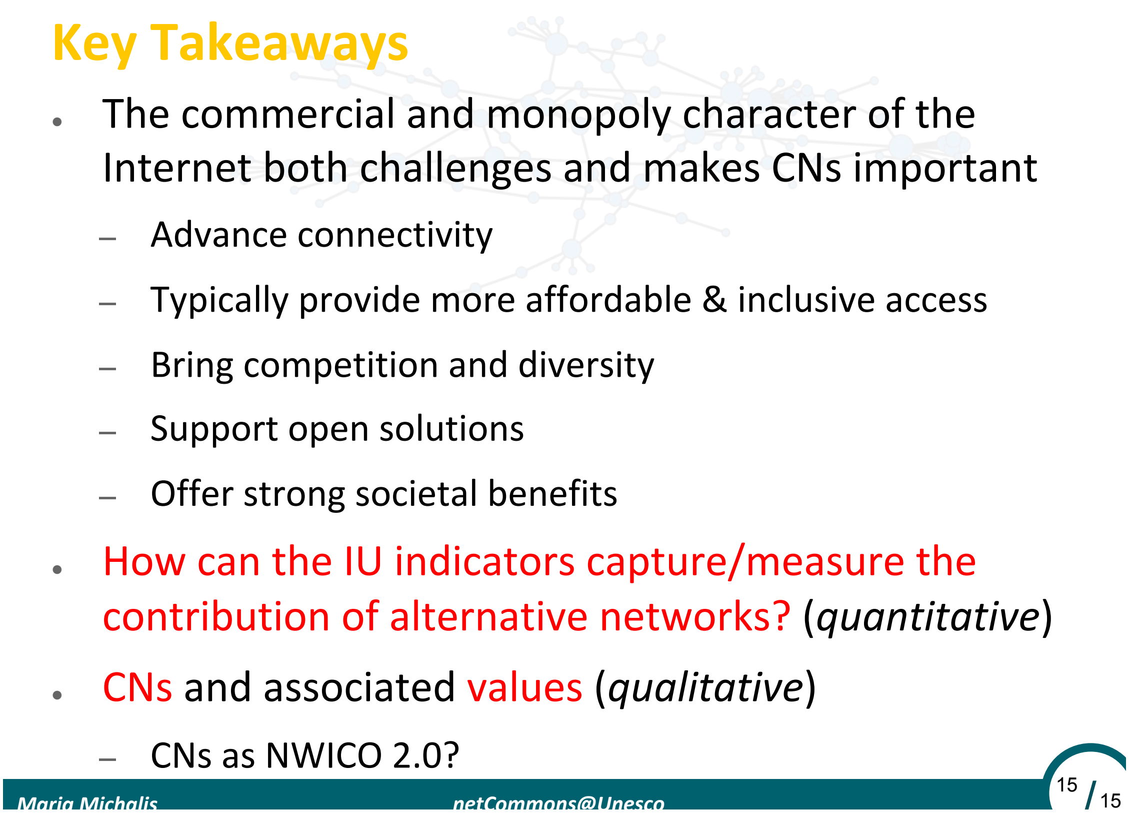


Maria Michalis netCommons@Unesco 13 / 15

Would you consider using such a community network instead of, or in addition to, your current Internet provision?



Maria Michalis netCommons@Unesco 14 / 15


Key Takeaways
The commercial and monopoly character of the Internet both challenges and makes CNs important
Advance connectivity
Typically provide more affordable & inclusive access
Bring competition and diversity
Support open solutions
Offer strong societal benefits
How can the IU indicators capture/measure the contribution of alternative networks? (quantitative)
CNs and associated values (qualitative)
CNs as NWICO 2.0?
Maria Michalis
netCommons@Unesco
15 / 15

B.2. The right to the hybrid city
Reference event Sec. 2.1.4
Introductory talk by Ileana Apostol at the Zurich encounter

netCommons

Alternative Internets and the Right to the City

Ileana Apostol
Zurich * May 25, 2018
NetHood

Hybridity of Space

netCommons

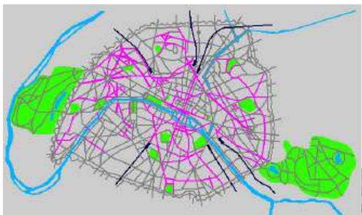
netCommons

"Remembering the modernisms of the nineteenth century can give us the vision and courage to create the modernisms of the twenty-first." Marshall Berman

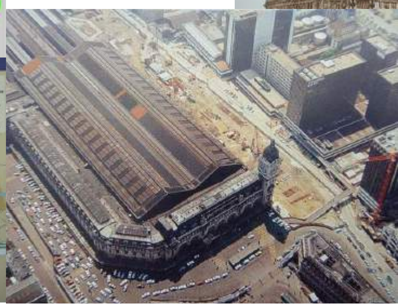
Stories of Railways

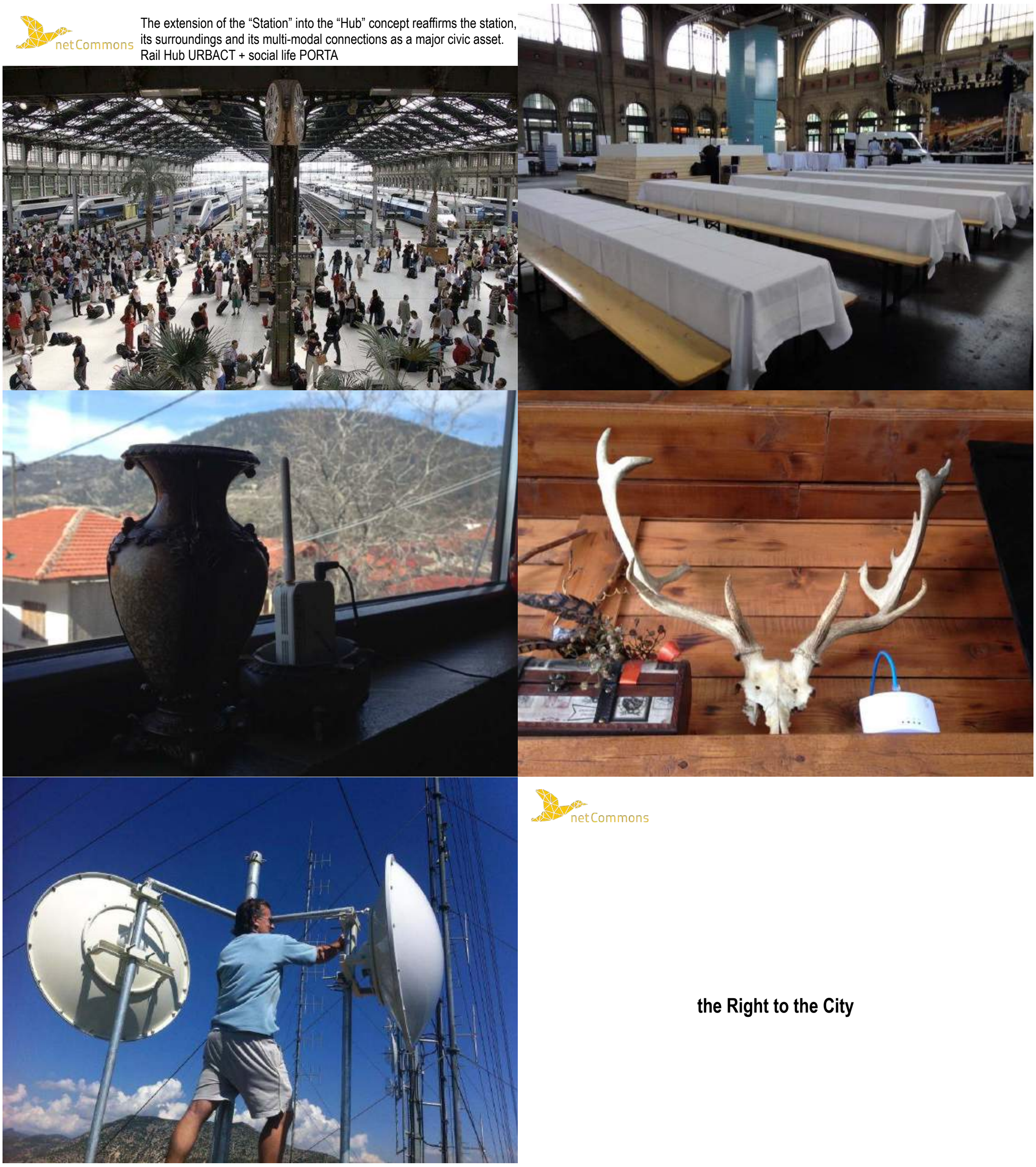
netCommons

Railways - territory



netCommons




The extension of the "Station" into the "Hub" concept reaffirms the station, its surroundings and its multi-modal connections as a major civic asset.
Rail Hub URBACT + social life PORTA
the Right to the City

netCommons

"The coercive laws of competition also force the continuous implementation of new technologies and organizational forms, since these enable capitalists to out-compete those using inferior methods.

[…] far more than the individual liberty to access urban resources: it is **a right to change ourselves by changing the city**. It is, moreover, a common rather than an individual right since this transformation inevitably **depends upon the exercise of a collective power** to reshape the processes of urbanization. The freedom to make and remake our cities and ourselves is, I want to argue, one of the most precious yet most neglected of our human rights" (Harvey 2008, emphasis added)

netCommons

the Right to the Hybrid City

netCommons

- the right to **access** the core resources of the city;
- the right to be **represented**, to be part of the **collective identity**;
- the right to **participate** in important decisions regarding urban policies and design;
- the right to **ownership of the commons**, which refers to commonly held property, and use, stewardship and management in common of the available and produced resources (Antoniadis and Apostol 2014)

netCommons

the Partner State and Collective Actors

The state that 'enables autonomous social production', and that 'embraces win-win sustainable models for both civil society and market' (Kostakis & Bauwens 2014)

the Right to Difference

"a 'right' whose only justification lies in its **content**; it is thus diametrically opposed to the right of property, which is given validity by its **logical and legal form** as the basic code of relationship under the capitalist mode of production" (Lefebvre 1991)

Encounters in the Hybrid City

Hybrid Infrastructure for the Future

A Hybrid Neighborhood Node: Guidelines

- Integrating real needs
- Defining a vision in a world of possibility
- Seizing an opportunity
- Formulating a project
- Organizing a plan for action
- Defining a temporary use
- Establishing a living lab

B.3. ImpactHub workshop on “The new EU telecommunications code in Greece and its effect on community networks”

Reference event Sec. 2.1.6

Selected presentations

Presentation by Merkourios Karaliopoulos and Renato Lo Cigno

net Commons

Merkourios Karaliopoulos, Renato Lo Cigno,

ΟΙΚΟΝΟΜΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS

UNIVERSITY OF TRENTO Department of Information Engineering and Computer Science

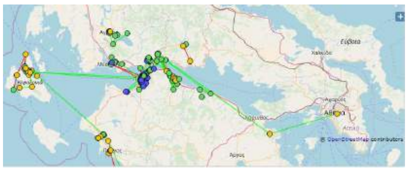
Impact Hub, Athens, 9/7/2018

Co-funded by the Horizon 2020 program of the European Union, Grant Number 688768

Athens 9/7/2018

1

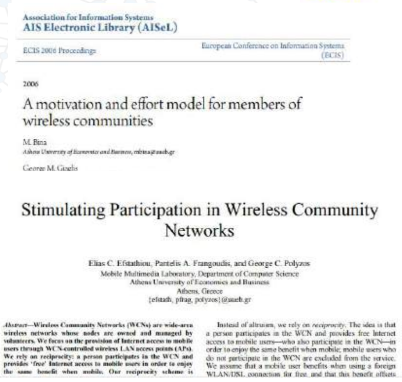
CNs in Greece : a 15-year long story



- set up both in urban and rural areas
- addressing mixes of needs
  - experimentation with technology and DIY, digital divide, autonomy and community ideals

2

CNs as sociotechnical systems and academic interest

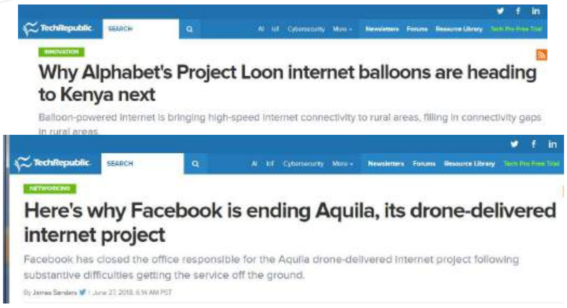


3

3 good reasons for CNs currently

1. Bridging the digital divide

- the "local" bottom-up approach to the problem
- ...as opposed to ambitious global top-down approaches to the problem

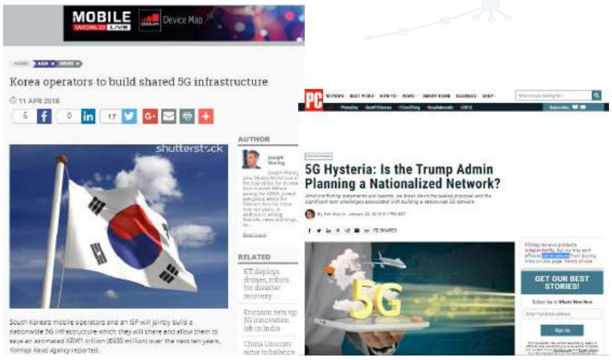


4

3 good reasons for CNs currently

2. Enabling broadband connectivity agendas: CNs as network infrastructure providers

- e.g., Broadband Europe 2020 and 2025 or 5G mobile systems

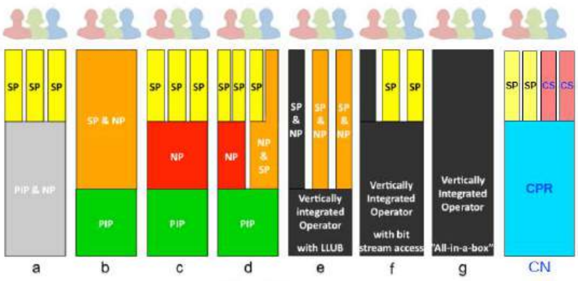


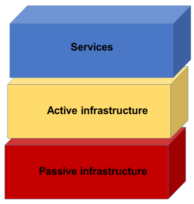
5

3 good reasons for CNs currently

3. Democratizing the market

- through fostering more open telecom network models against dominant trends for verticals

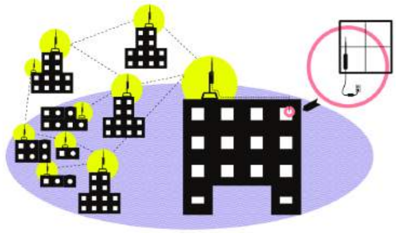




6

EC Ecosystem For Distributed Broadband

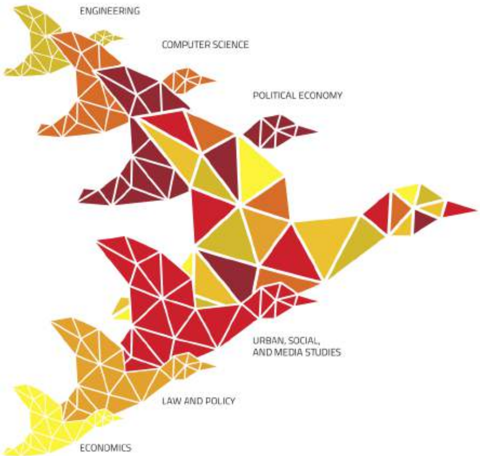
- An entire “movement” to find novel communication paradigms
  - A mosaic of initiatives
- CAPS (Cooperative Platforms for Social Sustainability)
  - Focus on bottom up networking (whatever it means)
  - netCommons is one of the most future-oriented projects here
- NGI (Next Generation Internet)
  - Technical Research but also novel architectures and organizational models



Athens 9/7/2018

5 61

netCommons project – netcommons.eu



UNIVERSITY OF TRENTO - Italy

UPC

cnrs

NetHood

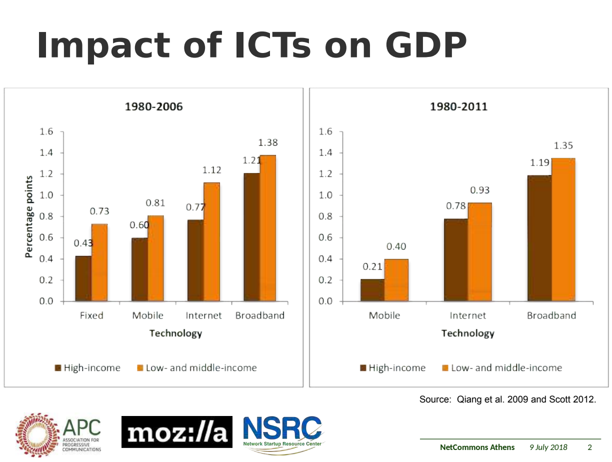
ΟΙΚΟΝΟΜΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS

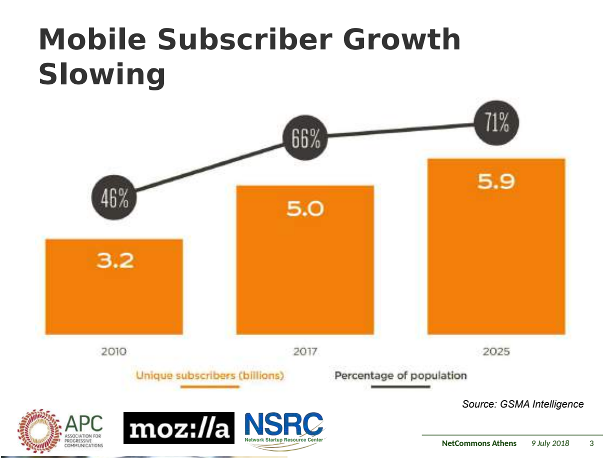
UNIVERSITY OF WESTMINSTER

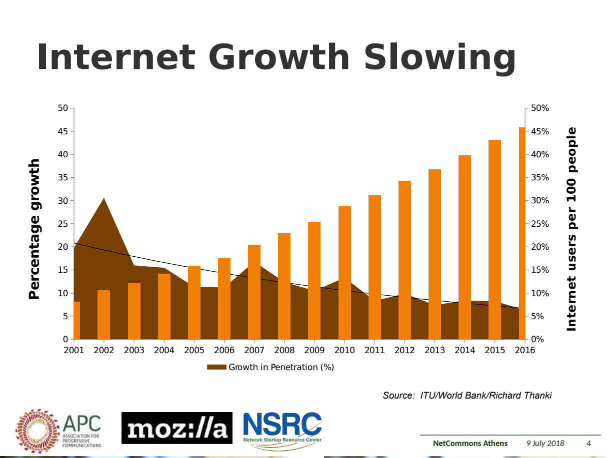
Athens 9/7/2018

5 61

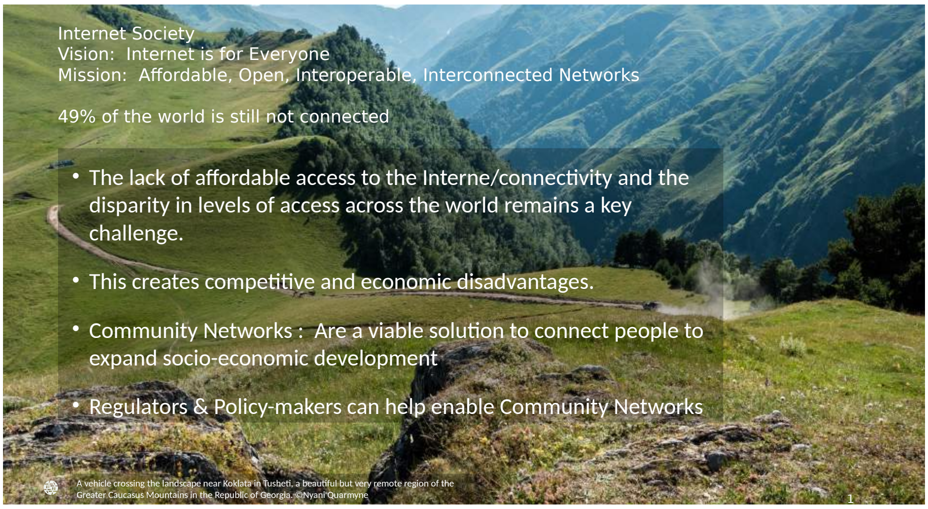
Presentation by Steven Song

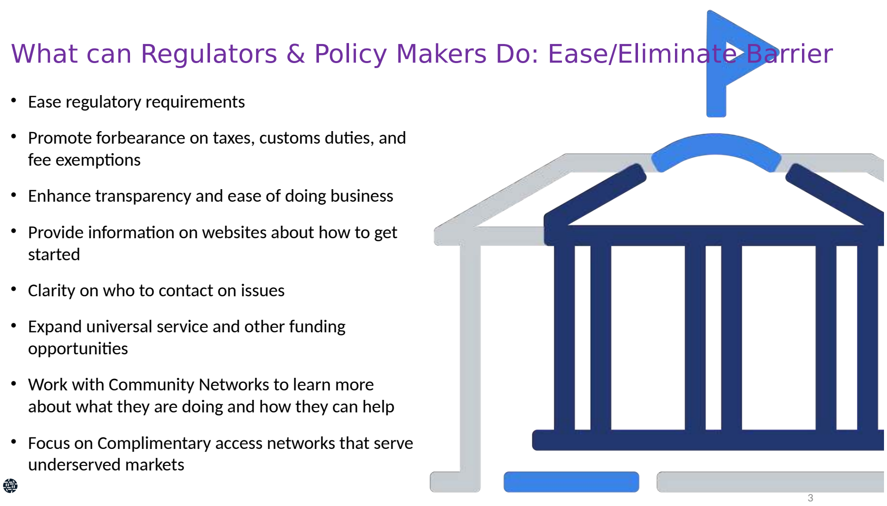






ISOC Presentation



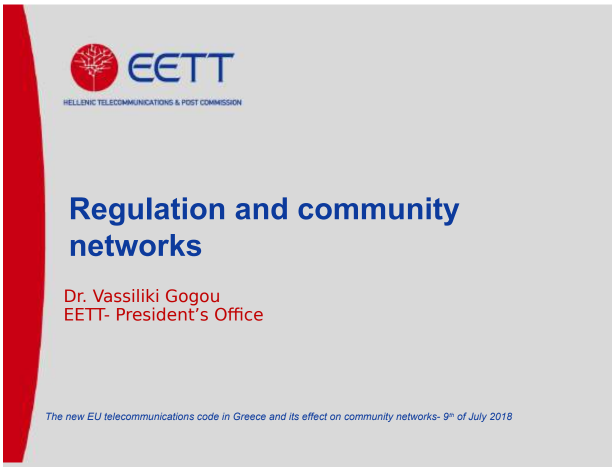


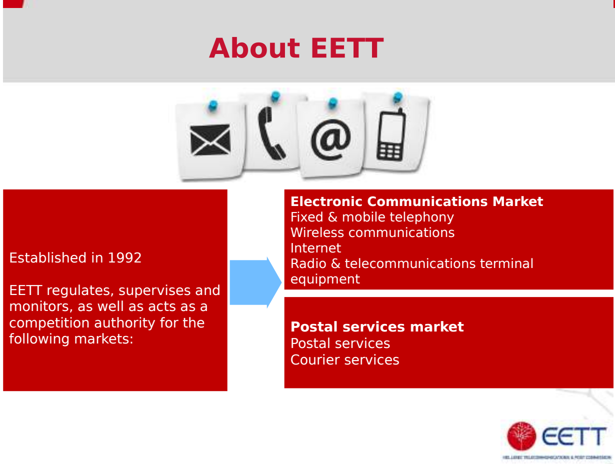
To make this happen, it is going to take partnerships!!

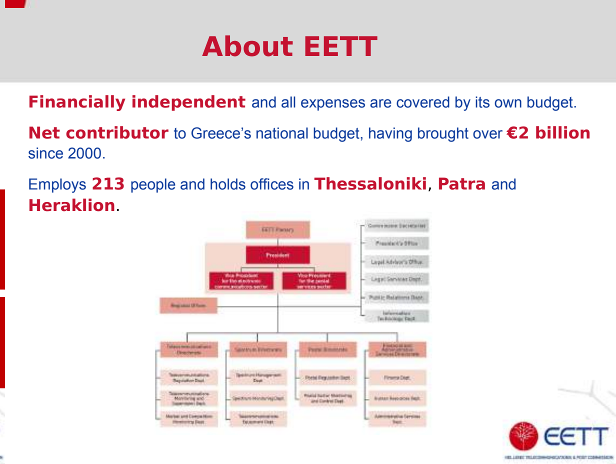
- Join with partners to bring the resources together to work with local communities.
- Build a global network of policymakers, businesses, regulators, governments, and other influencers to raise awareness about community networks and the alternative they offer to connect the most remote regions.
- Work to change old policies in areas such as licensing, universal service, spectrum to accommodate new connectivity.
- Advocate for new policies, processes, partnerships and ways of working.

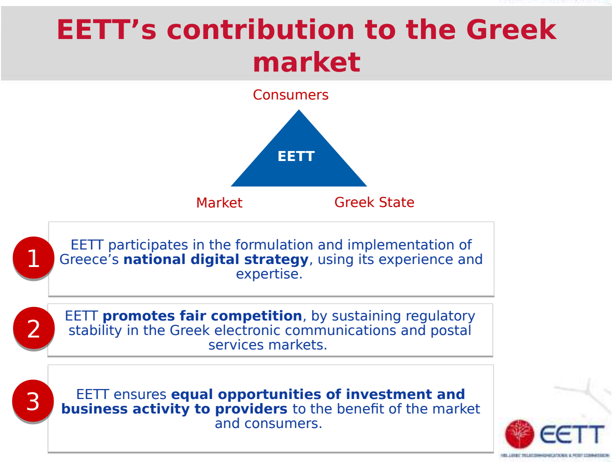
5

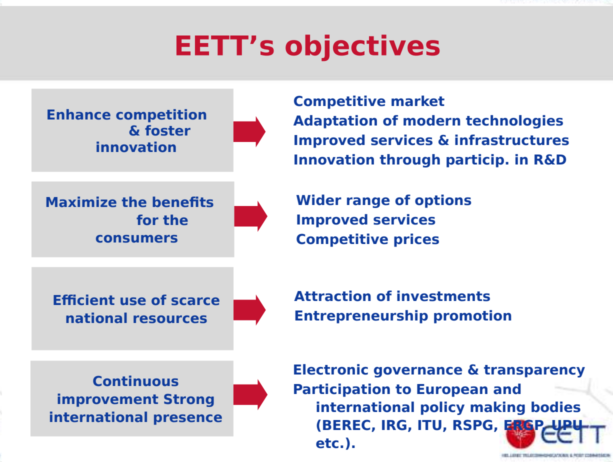
Presentation by Vassiliku Gogou

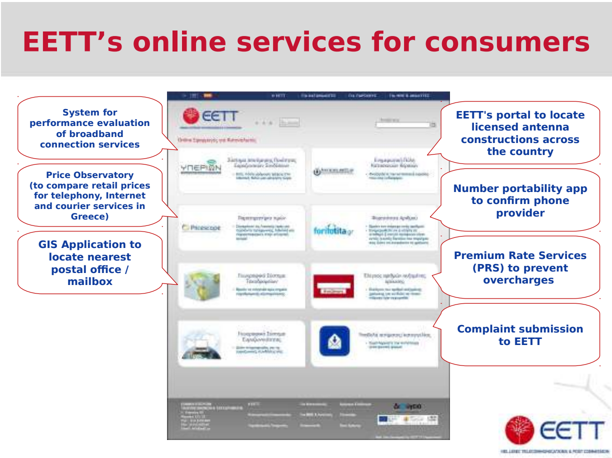




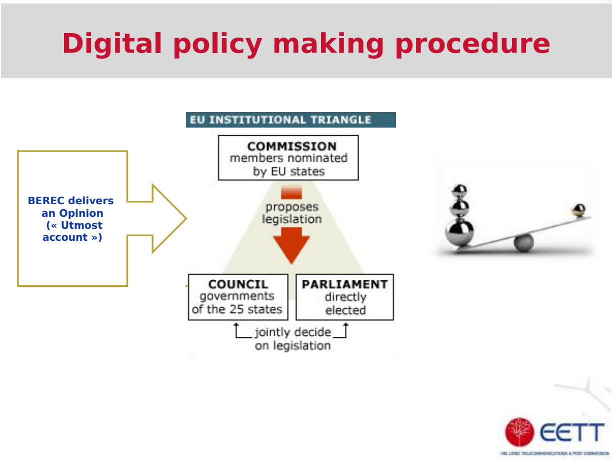


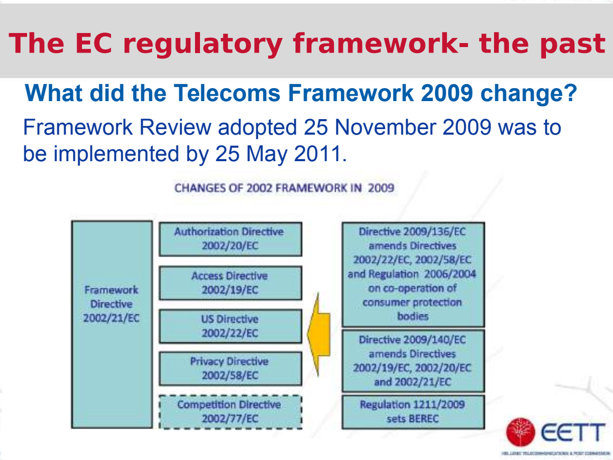


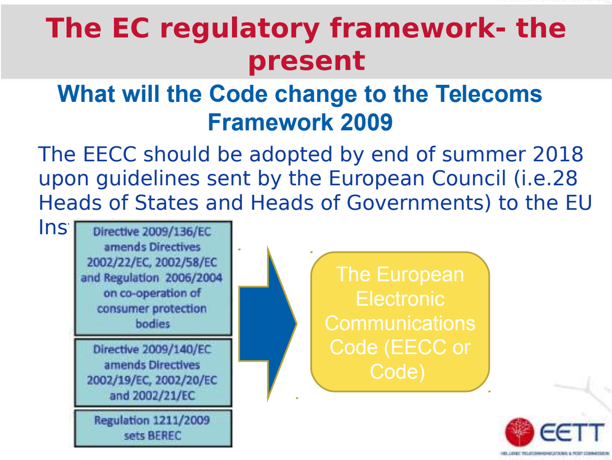



EETT's online services for consumers
System for performance evaluation of broadband connection services
Price Observatory (to compare retail prices for telephony, Internet and courier services in Greece)
GIS Application to locate nearest postal office / mailbox
EETT's portal to locate licensed antenna constructions across the country
Number portability app to confirm phone provider
Premium Rate Services (PRS) to prevent overcharges
Complaint submission to EETT
EETT


EETT online services for market providers
Electronic submission of license applications for antenna constructions
Preliminary control model for SMP bundled offers
Price Observatory (for providers to register retail prices for telephony, Internet and courier services in Greece)
Online submission of general requests/applications to EETT
Electronic management system for consumers' complaints
EETT


Digital policy making procedure
BEREC delivers an Opinion (« Utmost account »)
EU INSTITUTIONAL TRIANGLE
COMMISSION members nominated by EU states
proposes legislation
COUNCIL governments of the 25 states
PARLIAMENT directly elected
jointly decide on legislation
EETT


The EC regulatory framework- the past
What did the Telecoms Framework 2009 change?
Framework Review adopted 25 November 2009 was to be implemented by 25 May 2011.
CHANGES OF 2002 FRAMEWORK IN 2009
Framework Directive 2002/21/EC
Authorization Directive 2002/20/EC
Access Directive 2002/19/EC
US Directive 2002/22/EC
Privacy Directive 2002/58/EC
Competition Directive 2002/77/EC
Directive 2009/136/EC amends Directives 2002/22/EC, 2002/58/EC and Regulation 2006/2004 on co-operation of consumer protection bodies
Directive 2009/140/EC amends Directives 2002/19/EC, 2002/20/EC and 2002/21/EC
Regulation 1211/2009 sets BEREC
EETT


The EC regulatory framework- the present
What will the Code change to the Telecoms Framework 2009
The EECC should be adopted by end of summer 2018 upon guidelines sent by the European Council (i.e.28 Heads of States and Heads of Governments) to the EU Ins
Directive 2009/136/EC amends Directives 2002/22/EC, 2002/58/EC and Regulation 2006/2004 on co-operation of consumer protection bodies
Directive 2009/140/EC amends Directives 2002/19/EC, 2002/20/EC and 2002/21/EC
Regulation 1211/2009 sets BEREC
The European Electronic Communications Code (EECC or Code)
EETT


EECC Objectives
Simplification: get rid of overregulation (???)
Modernisation: adapt to new digital ecosystem, new competition lines, new players
New objectives completing the existing ones: investments and connectivity. What balance Existing vs. New ?
Ambitions: Convert the EU into a world digital leader boosting growth and jobs
Because digital transformation is on its way in any other continent
EETT

EECC (?) Community Networks

- EECC mainly addresses regulated entities **BUT**
  - ➔ **Universal service**
    - MS shall take measures to ensure **affordability** for low-income or special social needs consumers of adequate broadband internet access and voice communications at least at a fixed location
  - ➔ **End user rights – related to the scope**
    - NI-ICS and M2M service providers are excluded from **contract duration and termination**
    - The Code ensures greater **accessibility** for disabled end-users.

Infrastructures?

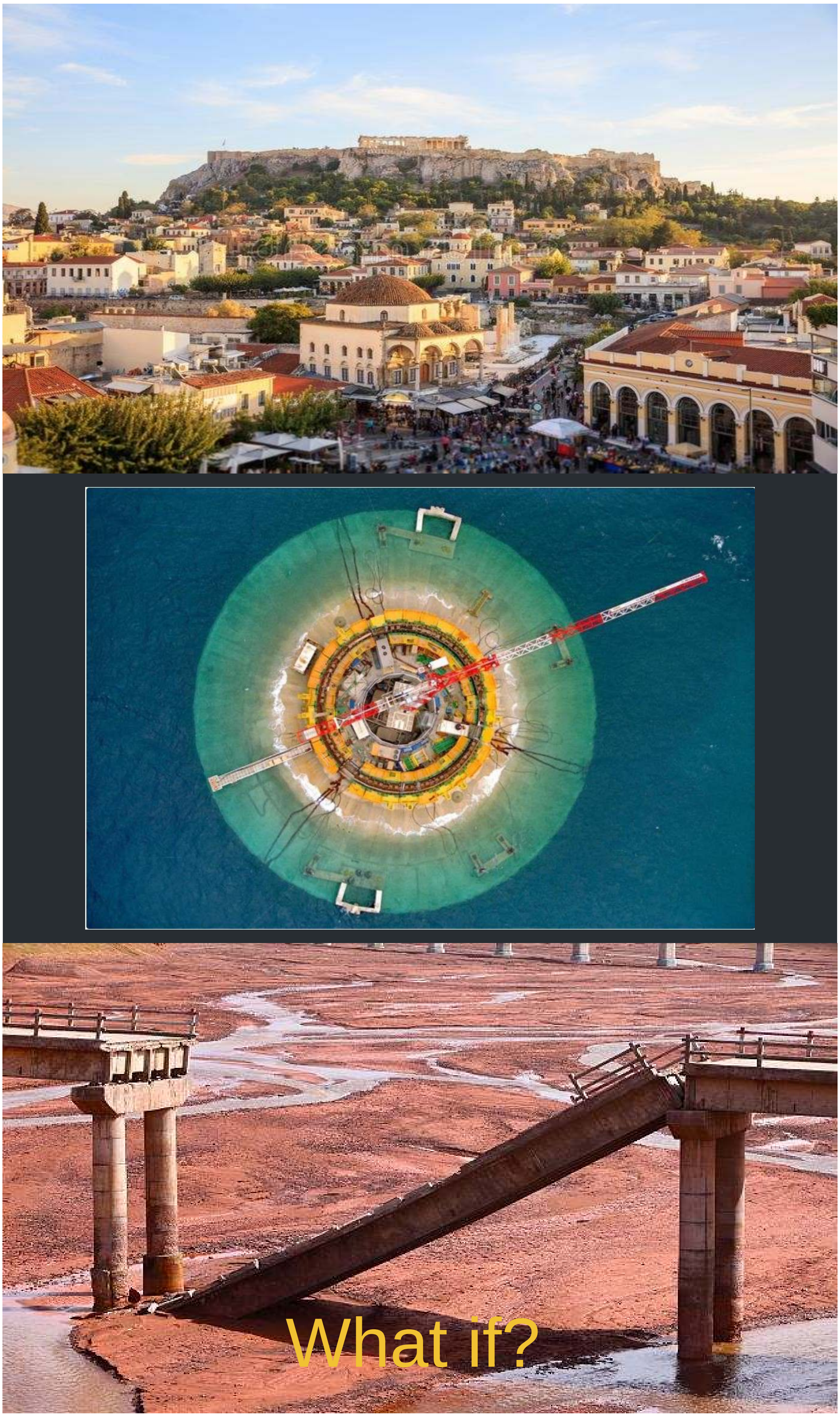
Notion about co-investment

Harmonization …sometimes centralization

Thank you for your attention!

Happy to discuss further…

Presentation by Konstantinos Champidis

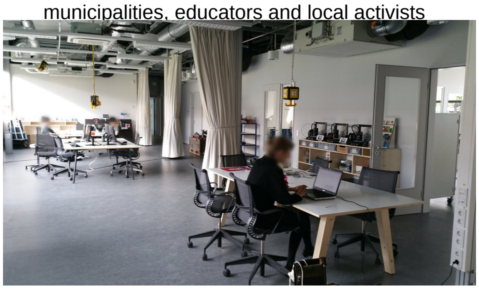

What if?


CITY OF ATHENS - IT COMPANY
Thank you
Konstantinos Champidis,
CHIEF DIGITAL OFFICER, City of Athens

Presentation by Prodromos Tsiavos

OpenLabs

A network of Labs for Open Technologies in local communities in cooperation with universities, municipalities, educators and local activists



Prodromos Tsiavos
Open Technologies Alliance - GFOSS
09 July 2018, Netcommons

GFOSS
Open Technologies Alliance

Established in 2008, in operation since 1996
members: 36 Hellenic Universities and Research Centers
non-profit organization with shareholders its members

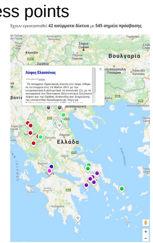
Objective:
Promote Open Technologies in collaboration with Universities, Schools, Municipalities

OpenWiFi Project

www.openwifi.ellak.gr

Open Wireless Access to Public Spaces by using Open Source tools and platforms and Open Mesh technology.

In collaboration with stakeholders and volunteers there have been implemented **42** wireless networks with **545** access points

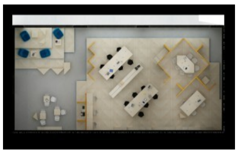


OpenLabs Idea

Open Technologies Lab (OpenLabs) is an attempt to organize, connect and develop a network of physical spaces and people.

Space/Infastructures: Open WiFi, Open Design, Open Hardware, Open Software

People: Local Stakeholders (Universities, Local Municipalities, Educational Communities, Open Technologies Communities, Activists)



OpenLabs Aim

- Implement innovative projects and initiatives involving local stakeholders and communities
- Design and Work exclusively using open hardware and open source tools
- Develop OERs (Open Educational Resources)
- Participatory Design of Procedures (aka diadikasies.gr)
- Open Access to knowledge and share of Good Practices

OpenLabs Design

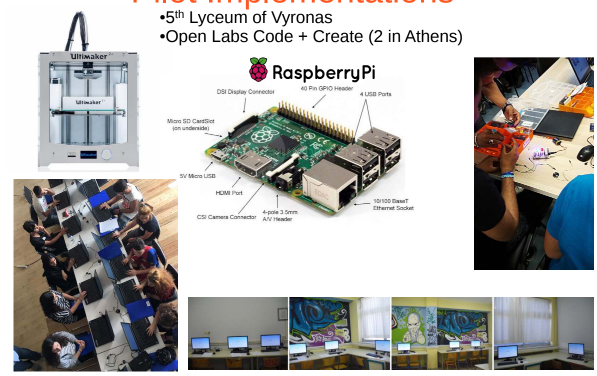
Open Lab

Open Lab
Εθνικού Μετσόβιου Πολυτεχνείου
ΕΕΛΛΑΚ
Οργανισμός Ανοιχτών Τεχνολογιών

Open Lab
Δήμου Αθηναίων
ΕΕΛΛΑΚ
Οργανισμός Ανοιχτών Τεχνολογιών

Pilot Implementations

- 5th Lyceum of Vyronas
- Open Labs Code + Create (2 in Athens)



THANK YOU!

More info available at:

https://opendesign.ellak.gr/2017/12/21/open-lab/

www.gfoss.eu

Presentation by Maria Michalis

The Electronic Communications Code and Greece: Its Effect on Community Networks

netCommons

Dr. Maria Michalis
M.Michalis@westminster.ac.uk
University of Westminster
London

netCommons 9 July 2018 1/5

Community networks

- Not new: have been around for about 20 years
  - Originally wireless – increasingly fibre
- But largely off the policy radar

Maria Michalis netCommons 2/5

Where do CNs fit into the picture?

- Often seen as simply ‘filling in the gaps.’ But much more
  - **Need**
  - **Connectivity +**
    - Greater (non-economic) societal benefits
    - Better respect of digital rights
    - Experimentation, playfulness and knowledge transfer

Maria Michalis netCommons 3/5

Lately, some recognition

- “Such projects [CNs] have generally been *very successful in driving the take-up* rate among the end users and in building *financially sustainable* cases.” (EC 2016b)
- Unesco Internet Universality Indicators (2nd draft 6/2018)
  - “C.6 Are communities able to establish their own networks to provide Internet access? Legal framework for establishment of CNs networks”

Maria Michalis netCommons 4/5

Take-away points

- Recognition of CNs is a welcome starting point but more needs to be done

- CNs bring multi-level diversity in the market
  - Sustainability

Maria Michalis netCommons 5/5

Thank you for your attention!

Questions & comments?

netCommons

netCommons /

B.4. IETF 102 Montréal, Canada, GAIA working group talk
Reference event Sec. 2.1.7
Network deployments for universal connectivity (Leandro Navarro)

Network deployments for universal connectivity

- Radical solutions to radical problems
- Universal deployment
- Private deployments on public space and commons infrastructure
- Mandatory infrastructure sharing
- From the experience of a proposed ordinance in Catalan municipalities

- Leandro Navarro, UPC, leandro.navarro@upc.edu

We know that ...

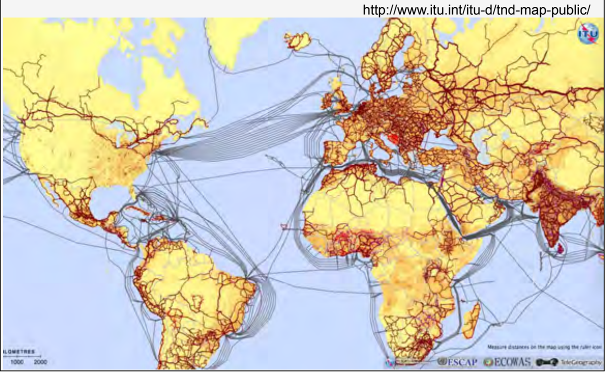
- Companies are regulated to provide "universal service": to "the market" and to everyone else *Makes sense*
- But companies say that they have not provided service in some rural and poor areas due to no ROI: *Okay*
- Regulators did not (or have a hard time) finding a way to justify making these rural areas a new market area and allowing new ideas/new networks? *Unacceptable*
- Clear market failure, or no market at all *Underserved*
- Need for further policy and regulation

Principles

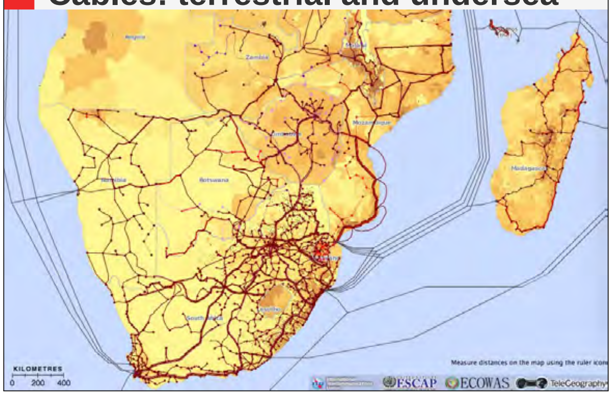
- Ether: a medium for the propagation of "connectivity"
- WiFi uses ISM open-access bands, a local "*ether*" also for long distance communication: point-to-point
- Fibre: shared *ether* across long distance.
- Service models for universal connectivity: home-made (self-provision) or restaurant (operator, ISP)
- Private infrastructures over public space, occupy public resources: air spectrum, land, sea
- *Belong to everyone, return to everyone.* ***"Open-access bands" for fibre?***

Cables: terrestrial and undersea

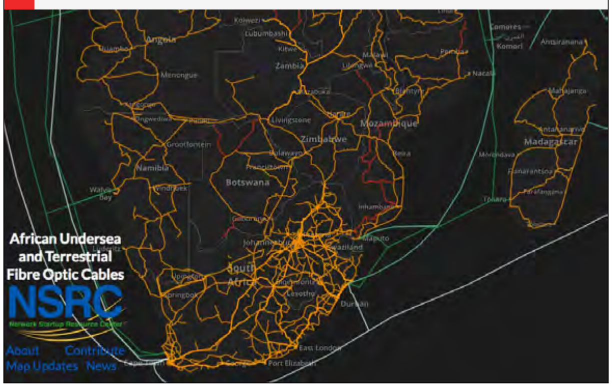
http://www.itu.int/itu-d/tnd-map-public/



Cables: terrestrial and undersea



Cables: terrestrial and undersea



netCommons

Universal Deployment Format

- An initiative of the guifi.net Foundation
- **Municipal ordinance** for the deployment of access networks to next-generation telecommunication services (ANNGTS) in **Universal** format
- In the global, European, Catalan, Spanish legal framework
- **Technological evolution**: “unlimited” capacity of fibre, distance is no major obstacle, still costly civil work
- **Economic transformation**: amplified social effect, new forms of sharing
- **Evolution of normative instruments**: transformation to competitive env, equal conditions, elimination of entry barriers, stimulating investment, best and most diverse range of telecom services to society

Sharing fibre cables in public space: Effects, incentives

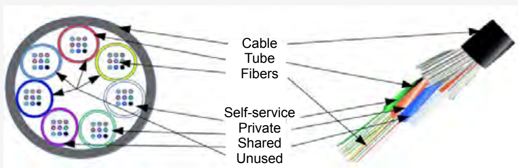
- Users are responsible for the cost of management and maintenance
- Exemption of maintenance costs for self-service of the city council
- Implementation of sharing or commons:
  - The **cost** of management and maintenance of the infrastructure affects the operators that use it **proportionately to the use** made by each, by applying criteria set for transparency, absence of conflicts of interest, and non-discrimination.
  - To comply with these conditions, the implementation of **sharing** of commons is done through an **entity** that is responsible for applying the **governance** of this shared use.

Uses

- a) Self-service for the city council.
  to provide public communications to smart public services or internal use
- b) Private.
  Done in a private manner by either an operator providing services to third parties (other operators or end users), or a private entity who is not an operator for self-service
- c) Shared or commons.
  Sharing between operators of the same infrastructure in an effective manner, through a governance scheme that ensures the absence of conflict of interest and that is always open to any skilled operator that wants to participate in conditions of transparency and equal conditions, thereby creating **a shared space** (also called commons, neutral, or open), where the costs of management and maintenance are proportionally compensated for by the operators who share the ANNGTS infrastructure and its use

Deployment in Universal format

- Deployment that simultaneously allows for the three uses described (self-service for the city council, private, and shared/common use)

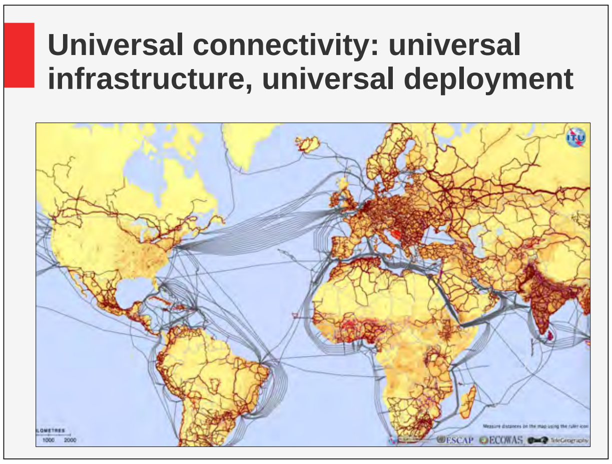


Minimal structural unit

- ... that can be allocated to a single use in the most practical way, while allowing the management of a single infrastructure for multiple different uses
- Examples:
  - In a cable with fibres grouped into tubes: the tube
  - In loose bare fibres (blown in micro tubes): the fibre
  - In multiple ducts and tri-tubes: the duct
  - In insulated ducts: the sub-duct
  - In the single fibre: wavelength
- *Development and adoption by municipalities in Catalonia (v28, v14 in English)*

Imagine universal deployment everywhere

- Expansion of private infra over public land create open-access *ether*: public, education, community, private use
- Occupying public space ⇒ return everyone min cost fibre
- **Regulation**: cost-reduction, **mandatory infra sharing in public space**, public-private-citizen collaboration → commons that benefits all
- From municipal land to regional, national, international land overseas and underseas
- Combined with universal service funds, community networks, Internet exchanges ...
- **Implementation**: mandatory (legal, regulation) or voluntary adoption (CSR) by private Internet companies, + oversight of practices by global organization


Universal connectivity: universal infrastructure, universal deployment

B.5. IETF 103 Bangkok, Thailand, GAIA working group talk
Reference event Sec. 2.1.7
New generation access (Leandro Navarro)

Network deployments for universal connectivity: **new generation access**

- New generation: New age, sharing similar ideas, problems, attitudes
  - Tension: right to participate, vs barriers and the queue of the unconnected
  - Decentralization: my WiFi AP, my community, vs their service
  - Technology gen: faster, cheaper?, simpler?
  - New forms?
  - Documenting as best current practices (BCP)
- Leandro Navarro, UPC, leandro.navarro@upc.edu

G: 1000 M, Generation

- We are 7.5 Giga-humans …
- Wireless tech generations:
  - 0.0002+ Gbps: (few Mbps) → 3G
  - 0.450 Gbps: IEEE 802.11n → WiFi 4
  - 0.1-1 Gbps: IMT-A LTE mobile 4G
  - 1 Gbps: IEEE 802.11ac → WiFi 5
  - 1-10 Gbps: 3GPP 5 → mobile 5G
  - 10 Gpbs: IEEE 802.11ad,ax → WiFi 6
  - 100 Gbps?: IEEE 802.11ay? → 7G

Generation terminology adopted by mobile and Wi-Fi Alliance

Mobility in IEEE 802.11: s: mesh, r: roaming, k: management, v: config

Radio tech: OFDMA, MIMO, smart antenna, femtocells, new radio

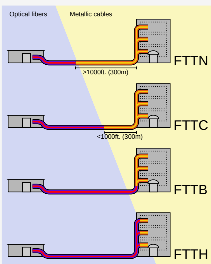
http://dsg.ac.upc.edu/qmpsu

3G, 4G, 5G community networks

Business/organizational models

- **Operator** model: centralized authority, uniform, corp
  - Fixed or mobile network operator: own or shared infra, licensed spectrum
- **Community** model: distributed, crowdsourced
  - Community networks: regional mesh or p2p, shared infra, unlicensed spectrum
  - Other: Eduroam, Govroam, FON (federated)
- **Home-made** model: decentralized, individual
  - DIY: My own coverage, single-multisite (links, mesh), my own infra, unlicensed spectrum
- **Under a socio-economic-legal-regulatory env**

Fibre access?



- Generations?
- Tech:
  - FTTX ...
  - 0.05..1..10.. Gbps
  - Sharing: mux
- Models: cost of deployment ...
- Planning, investment, sharing, incentives ...

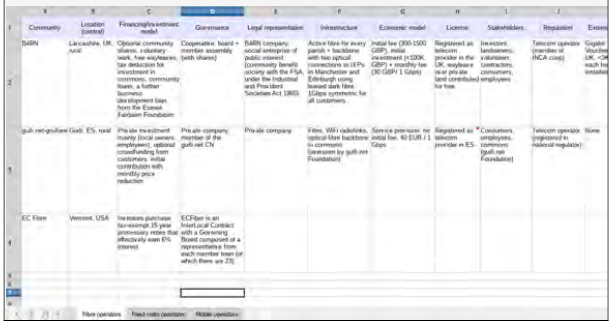
Alternative models

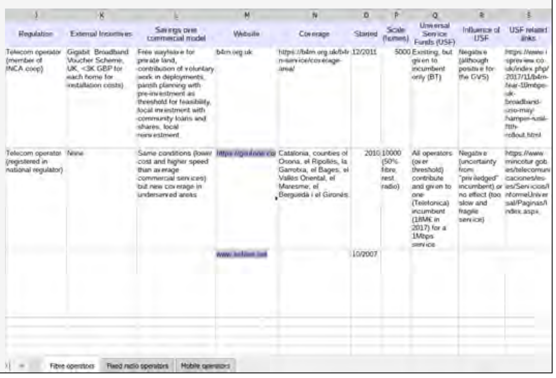
- Fibre operators:
  - B4RN: Lancashire UK – Rural fibre coop, 5000
  - Goufone–guifi.net: Catalonia ES – ...infra sharing
  - ECFibre: Vermont US
- Fixed radio operators:
  - Many CN around worldwide – Wi-Fi mesh
- Mobile operators:
  - Rhizomatica: Oaxaca MX – social licence 20 villages
- Many studies already … (e.g. netCommons.eu)

Columns

- Community
- Location (central)
- Financing/investment model
- Governance
- Legal representation
- Infrastructure
- Economic model
- License (Resources)
- Stakeholders
- Regulation
- External Incentives
- Savings over commercial model
- Website
- Coverage (area)
- Started (year)
- Scale (homes)
- Existence of Universal Service Funds (USF)
- Influence of USF
- USF related links

Documented towards a BCP





BCP on Alternative operators

https://en.wikipedia.org/wiki/Best_current_practice

- A Best Current Practice (BCP):
  - A de facto level of performance in engineering and information technology
  - More flexible than a standard, since techniques and tools are continually evolving
  - Carry the endorsement (tech approval) of the Internet Engineering Steering Group (IESG) or IRSG?
- Paired to RFC 7962:
  - *Alternative Network Deployments: Taxonomy, Characterization, Technologies, and Architectures*
  - Organize, summarize, reference practices +/-

Network deployments for universal connectivity: **new generation access**

- Document as best current practices (BCP)
  - Alternative … fibre, fixed radio, mobile operators
- Understand mechanisms and environmental factors for/against alternative networks → replication
- Makes sense?
- Leandro Navarro, UPC, leandro.navarro@upc.edu

B.6. Community Networks course in Latin America and the Caribbean (WALC): Track on community networks

Reference event Sec. 2.1.8

WALC 2018: Redes comunitarias (Leandro Navarro et al., in Spanish)

WALC 2018
Redes comunitarias

- Roger Baig,
  Fundació *guifi.**net***, roger.baig@guifi.net
- Emmanouil Dimogerontakis,
  UPC, edimoger@ac.upc.edu
- Erick Huerta,
  RedesComunica AC, redescomunica@gmail.com
- Leandro Navarro,
  UPC, leandro@ac.upc.edu
- Roger Pueyo,
  UPC + *guifi.**net***, rpueyo@ac.upc.edu

Roger Baig

- Trabajador de la Fundació *guifi.**net***
- Responsable de la participación en proyectos internacionales
- Estudiante de doctorado en la UPC, dirección Leandro Navarro
- Steering committee de la IEEE Connectivity Coalition

Emmanouil Dimogerontakis

- Investigador, UPC & AmmbrTech
- Doctorado por la UPC con Leandro Navarro, sobre Accesso a Internet en Redes Comunitarias
- Intereses:
  - Redes Comunitarias
  - Blockchain y Sostenibilidad

Erick Huerta

- Abogado, Universidad Iberoamericana, Mexico
- Master en Social Administration with a concentration in Community Development, University of Queensland, Australia
- PhD en Desarrollo Rural, Universidad Autonoma Metropolitana, Mexico
- Experto de la International Telecommunications Union
- Consejero de IFETEL, regulador de México

Leandro Navarro

- Profesor titular, UPC, Grupo de sistemas distribuidos
- Investigación en sistemas distribuidos
- Coordinador Doctorado Europeo Erasmus Mundus de Computación Distribuida
- Investigador proyecto netCommons.eu modelos de comunes
- Dirección convenio AmmbrTech blockchain
- IRTF.org co-chair WG GAIA: Global Access to the Internet for All

Roger Pueyo

- Estudiante de doctorado en la UPC, en el Grupo de Sistemas Distribuidos
- Investigador proyecto LightKone H2020
- Voluntario en *guifi.**net***
- Intereses:
  - Redes mesh
  - Redes comunitarias
  - Desmontar cosas

Esquema del curso

- Objetivo general:
  - Herramientas y técnicas para planificar, diseñar, desplegar, operar y mantener redes comunitarias,
  - con énfasis en la utilización de soluciones de bajo costo y adecuadas para zonas rurales y urbanas.
- Metodología:
  - Presentaciones, actividades en grupo, discusión, experimentación tecnológica, desarrollo y tutorización de casos en el contexto local de los alumnos.
  - Desarrollo de un proyecto de despliegue durante el curso.

Programa diario

- Día 1 (lu 26) - Conceptos, modelos y casos de redes y operadores comunitarios
- Día 2 (ma 27) - Modelos de actividad, experimentos para familiarizarse con diversas tecnologías de acceso y transporte
- Día 3 (mi 28) - Planificación, diseño, despliegue y operación de redes, desarrollo casos individuales I
- Día 4 (ju 29) - Regulación, viabilidad e impacto, desarrollo casos individuales II
- Día 5 (vi 30) - Resumen general, desarrollo casos individuales III, presentación de resultados (casos y planes de implementación)

Día 1: Conceptos, modelos, casos de redes y operadores comunitarios

1. Presentación e introducción general, de qué estamos hablando, de qué no estamos hablando, CN en el mundo (tabla) Leandro
2. Actividad: 1) conocer background de estudiantes 2) conocer intereses de los estudiantes a desarrollar durante la semana
3. Presentar el ejemplo para ilustrar los distintos aspectos por lo que pasa una red comunitaria, Rizhomatica. Erick
4. Actividad: identificar la CN más cercana a tu domicilio. Es activa? tamaño? Cómo está organizada? etc. Objetivo: mapa de CNs en LAC (a desarrollar durante la semana)

- 30 min conjuntos para hacer lista de CNs en LAC
- 30 min en grupos para trabajar
- 30 min exposición de resultados

Día 2: Modelos de actividad, experimentos con tecnologías de acceso y transporte

1. Arquitectura de Internet y protocolos, Mano
2. Laboratorio: Arquitectura de Internet y protocolos
3. Prácticas: última milla e interconexión, Roger Pueyo
4. Laboratorio: última milla e interconexión

Día 3: Planificación, diseño, despliegue y operación de redes, desarrollo casos I

1. Aspectos sociales, Leandro
2. Actividad aspectos sociales
3. guifi.net, Roger B
4. Actividad: definición proyectos a desarrollar días 4+5

Día 4: Regulación, viabilidad e impacto, desarrollo casos II

1. Aspectos legales: Naturaleza jurídica de cada modelo ¿Licencia no licencia? Autorregulación, Incidencia regulatoria, Erick
2. Económicos, Roger Baig
3. Desarrollo casos II
4. Desarrollo casos III

Día 5: Resumen, desarrollo casos, presentación de resultados

1. Desarrollo casos individuales IV
2. Presentaciones casos individuales: casos y planes de implementación
   - 1a hora: presentaciones breves sobre los aspectos particulares
   - 2a hora: discusión general de aspectos no tenidos en cuenta en 1a hora
3. Resumen clausura

Actividad: conocernos

- De dónde venimos? (quién y porqué estoy aquí)
  - Nombre, lugar/región, algo personal (afición), algo profesional (formación, intereses, actividad), porqué hago este curso
- A dónde vamos? (para qué)
  - Qué me gustaría tener claro o saber cómo hacer al final de este curso
- Alguien con intereses comunes y complementarios
- Presentarnos (mutuamente)

Día 1: Conceptos, modelos, casos de redes y operadores comunitarios

1. Presentación e introducción general, de qué estamos hablando, de qué no estamos hablando, CN en el mundo (tabla) Leandro
2. Actividad: 1) conocer background de estudiantes 2) conocer intereses de los estudiantes a desarrollar durante la semana
3. Presentar el ejemplo para ilustrar los distintos aspectos por lo que pasa una red comunitaria, Rizhomatica. Erick
4. Actividad: identificar la CN más cercana a tu domicilio.
   ¿Está activa? tamaño? Cómo está organizada? etc.
   Objetivo: mapa de CNs en LAC (a desarrollar durante la semana)

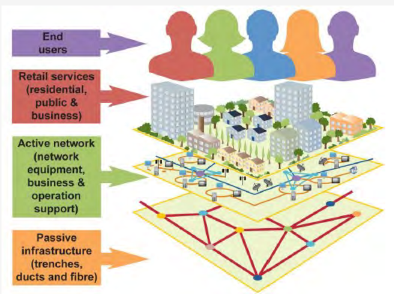
- 15 min conjuntos para hacer lista de CNs en LAC
- 30 min en grupos para trabajar
- 20 min exposición de resultados

Introducción

- Comunicaciones:
  - Un servicio de interés público de provisión privada, de monopolios estatales a empresas privadas …
  - "Servicio universal" pero la mitad de la población …
- ¿Cómo se ofrece?
- ¿Quién lo necesita?
- ¿Quién lo puede ofrecer y cómo?
- Diversidad …

26-30/11/2018 WALC 2018 CN 2 / 59

Capas de red de acceso y modelos de cadena de provisión

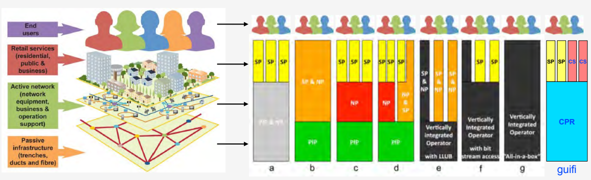


(Alcatel-Lucent)

Capas de red de acceso y modelos de cadena de provisión

Capas de red de acceso

Modelos de capas de provisión



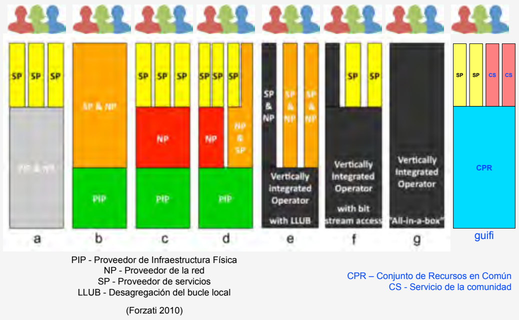
(Alcatel-Lucent)

PIP - Proveedor de Infraestructura Física
NP - Proveedor de la red
SP - Proveedor de servicios
LLUB - Desagregación del bucle local

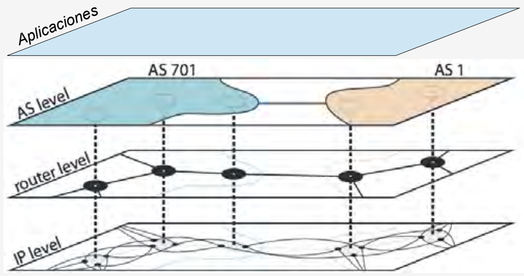
CPR - Recurso Común
CS - Servicio de la comunidad

(Forzati 2010)

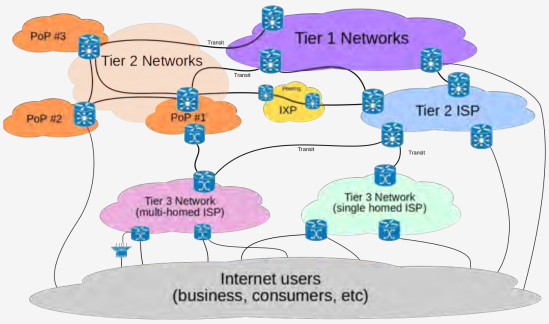
Capas de red de acceso y modelos de cadena de provisión



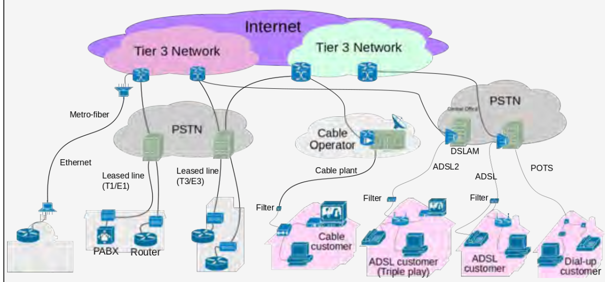
Niveles



Backbone – eXchanges – carriers



Access



Infraestructuras de red compartida

- Infraestructuras de red: producen conectividad
- Participantes: productores, consumidores, beneficiarios
- Minorista: a consumidores inviduales
- Mayorista: a otros proveedores (minoristas)

26-30/11/2018 WALC 2018 CN 9 / 59

Infraestructuras de red compartida – minorista

- Proveedor comercial – servicio minorista a cliente fijo o móbil …
- Proveedores de Servicios de Internet Inalámbricos (WISPs) - redes de Internet inalámbricas operadas comercialmente
- Proveedores inalámbricos compartidos (FON comercial o Eduroam académico) - compartir la conexión Wi-Fi
- Proveedor patrocinado – paga el proveedor (Free Basics)
- Cooperativas de servicios públicos rurales – ofrece un servicio público a sus miembros (electricidad + Internet, Ubuntu Power)
- Redes municipales – red proporcionada/gestionada por gobierno local, orientadas a costes, inversión o supervisión pública
- Redes comunitarias (CN) – redes IP construidas, propiedad y operadas por los ciudadanos de forma participativa y abierta ...

Infraestructuras de red compartida - mayorista

- Proveedores de red de “acceso abierto” mayoristas de fibra
- Puntos de intercambio de tráfico (IXP) – lugares de interconexión física que permiten a redes intercambiar tráfico (CABASE, IX.BR)
- Infraestructura Compartida – operador de telecom que utiliza infraestructura existente propiedad de los usuarios/comunidades para proporcionar conectividad de última milla en zonas rurales
  - *Redes municipales – red proporcionada o gestionada por gobierno local, orientadas a costes, inversión o supervisión pública*
  - *Redes comunitarias (CN) – redes IP construidas, propiedad y operadas por los ciudadanos de forma participativa y abierta ...*

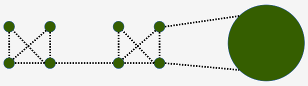
Redes comunitarias

Redes de comunicación construidas, poseídas, operadas y utilizadas por los ciudadanos de manera participativa y abierta.

- Crea oportunidades para interacciones de valor añadido:
  - Internet, llamadas, electricidad, asesoramiento, gobierno electrónico, dinero, educación, entretenimiento, banca, etc.
- Infraestructura orientada a costes frente a servicios de valor añadido (beneficio)
- Voluntarios vs. trabajos
- Impacto económico: beneficio, inversión, retorno, reinversión
- Impacto social, desarrollo
- Involucra a todos: personas, orgs privadas y públicas
- Cada comunidad es diferente!

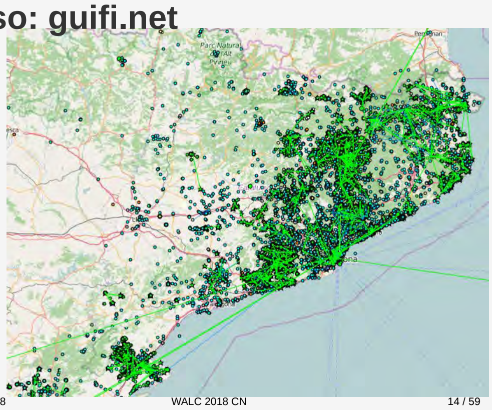
El valor y el coste de una red

- Población + opciones tecnológicas → coste de puesta en marcha + coste de mantenimiento de la red, coste unitario
- ¿Valor?



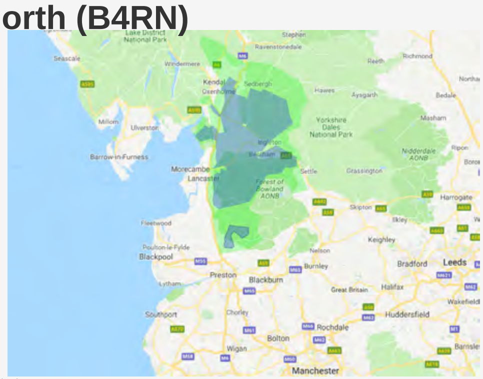
- Valor: número de usuarios conectados (n^2) [Ley de Metcalfe]
- Infraestructura de red, un recurso crítico para una comunidad, para nutrir y cuidar, un bien común

Caso: guifi.net



26-30/11/2018 WALC 2018 CN 14 / 59

Caso: Broadband for the rural north (B4RN)



26-30/11/2018 WALC 2018 CN 15 / 59

Caso: América

26-30/11/201

¿Qué es un recurso o bien común?

26-30/11/2018 WALC 2018 CN 17 / 59

La tradición de bienes (recursos) en común

- Agua, pastos, bosques .... críticos para supervivencia
- Sistema de recursos naturales o artificiales por agregación
- Evitar la "congestión" o la sobreexplotación
- Cantidad limitada de recursos que se pueden extraer
- Organización social para regular la participación y preservar el sistema de recursos

Regímenes de coordinación y decisión

- Público, Privado, Club, Común
- Exclusión, rivalidad
- **Bienes comunes**: autorregulación de una comunidad

	Excluible	No excluible
Rival	Bien privado: comida, ropa, coche	Bien común: Bosque, pesca
No rival	Club bueno: cine, parque privado	Bien público: TV abierta, aire, calle

Acceso al conjunto (recurso)

Formas de acceso:

- uso privado
- exclusivo (producto comercial, beneficio)
- (sin agregación)
- parcialmente compartido (acceso limitado)
- totalmente compartido (según la licencia, a coste ...)

Formas de participación

- **Acceso**: **contribución** a, **uso** de
- **Gestión**: coordinación, decisiones
- **Gobernanza**: definición del reglamento
- **Coordinación** entre los participantes: burocracias, mercados (precios), jerarquías (la "empresa", el "poder").

Gestión, gobernanza

- Propiedad común
- Regula la conservación, el mantenimiento y el consumo del recurso
- Acuerdos, licencias, estipulaciones:

  mecanismos de resolución de conflictos, reparto de costes, reglas de acceso, uso, contribución, estructuras de supervisión, decisión,...

Actividad 1: un ejemplo cercano

- Actividad: identificar algún ejemplo de algún recurso gestionado en común que resulte conocido (cualquier tipo).
- ¿Qué actividad realiza? ¿Tamaño? ¿Cómo está organizado? ¿Qué aporta? ¿A quién? etc.

Bienes comunes (redes)

- Los bienes comunes son recursos naturales o artificiales que se gestionan *de forma cooperativa*
- El modelo de gobernanza de propiedad común o de recursos comunes (CPR) es un modelo tradicional y reconocido para los *sistemas de recursos compartidos* Ostrom, E. (1990)
- La red comunitaria guifi.net es un ejemplo exitoso de una infraestructura digital, una red informática, gestionada como un *bien común abierto* (extensible)

26-30/11/2018 WALC 2018 CN 26 / 59

Bienes comunes (redes)

- Recurso común: un *recurso básico* que proporciona una cantidad limitada de unidades de *recurso extraíble*
- Recursos básico: infraestructura de red
  Recurso extraible: conectividad y tráfico (extraíble)
- Necesidad de gobernanza efectiva para mantener dirección y resolver la dificultad para manejar muchos actores y cambios en un sistema complejo (tragedia de los comunes)
- Dirección a largo plazo (sostenibilidad): seguir siendo productivo u operativo
- Objetivo a corto plazo (adaptabilidad): reaccionar y adaptarse al cambio.

Sostenibilidad (Ostrom)

1. *Límites claramente definidos*: acceso abierto, no discriminatorio y participación abierta → formas de organización que evitan la exclusión y regulan el uso abierto y justo de los recursos
2. *Normas para apropiación y provisión de recursos comunes que se adapten a las condiciones locales*: La congruencia entre la apropiación (uso de la red) y la provisión (expansión de la red) gestionada por herramientas comunes de gestión de la red que ayudan a evaluar el estado de la red, uso y cobro de costes
3. Mecanismos de *elección colectiva* que permiten a la mayoría de los que se apropian de los recursos *participar* en el proceso de toma de decisiones
4. *Vigilancia efectiva* por parte de monitores que son parte de, o responsables ante, los apropiadores

26-30/11/2018 WALC 2018 CN 29 / 59

Sostenibilidad (Ostrom)

5. *Sanciones graduales* para quien no respeten las reglas de la comunidad: su propio sistema de resolución de conflictos con métodos para penalizar participantes que perjudican
6. Mecanismos de *resolución de conflictos* que son baratos y de fácil acceso: su propia manera de resolver estos conflictos de forma barata, accesible, eficiente, eficaz y escalable
7. *Autodeterminación de la comunidad, reconocida* por las autoridades de alto nivel: su propia manera de validar y hacer cumplir sus normas y estructuras de acuerdo con los diferentes niveles de la legislación
8. En el caso de las CPR más grandes, la organización puede ser en forma de *múltiples capas de iniciativas anidadas*, con pequeñas CPR locales en la base

26-30/11/2018 WALC 2018 CN 30 / 59

El valor de las infraestructuras: mayor margen para valor añadido

- Los bienes públicos y los bienes no comerciales, como infraestructuras de red, generan *efectos positivos* que benefician a la sociedad al *crear oportunidades y facilitar* muchas otras actividades socioeconómicas
- Una infraestructura gestionada de forma cooperativa y sostenida deja un *mayor margen para actividades de valor añadido* que las infraestructuras de redes comerciales desarrolladas de forma competitiva

26-30/11/2018 WALC 2018 CN 32 / 59

El valor de las infraestructuras: la conectividad es no excluible

- Las infras de red se consideraban *bien de club privado* (excluible y virtualmente no rival), proporcionado por un ISP comercial a aquellos en las áreas de cobertura dispuestos a pagar la tarifa de servicio
- Las RC son una respuesta social a la conectividad como *derecho humano básico* => la infraestructura de red que conecta a las personas se vuelve no excluible
- Redes de conmutación de paquetes + planificación de capacidad para hacer frente a la demanda → buena calidad de servicio y evitar la congestión que degrada la eficacia de la red

El valor de las infraestructuras: la conectividad es rival

- Las infraestructuras de red reales (de producción) son rivales (*capacidad limitada*): el tráfico adicional tiene un coste y un impacto en el resto del tráfico
- Las redes suelen realizar ingeniería de tráfico para operar eficientemente (y gestionar la rivalidad)
- Los propietarios de las redes tienen que controlar las características y el volumen de tráfico para planificar la capacidad e invertir en su capacidad cuando la congestión empieza a degradar la calidad del servicio
- Los enlaces de Internet tienden a saturarse. Como hay varios usuarios, la congestión es habitual

Bienes comunes abiertos

- Expresamente abiertos a la participación de cualquier parte interesada que esté dispuesta a contribuir a su sostenibilidad a cambio de los beneficios que pueda extraer (redes, computación, almacenamiento y servicios).
- Los bienes comunes abiertos se (deben) amplían con nuevos participantes, ya que *deben aportar recursos* necesarios para ampliar la capacidad y la cobertura de la infraestructura.

26-30/11/2018 WALC 2018 CN 35 / 59

Gobernanza local eficaz

- Dos principios son fundamentales para las estructuras de gobierno inspiradas en la idea de un bien común:
  - **Acceso abierto y no discriminatorio**: El acceso es no discriminatorio porque la fijación de precios se determina mediante mecanismos transparentes, normalmente *orientados a los costos*. El acceso está abierto porque todo el mundo tiene derecho a unirse y utilizar la infraestructura según las normas de acceso.
  - **Participación abierta**: Toda persona tiene derecho a unirse a la comunidad para participar en la construcción, operación, provisión y gobierno de la infraestructura.

26-30/11/2018 WALC 2018 CN 36 / 59

El conjunto de derechos

- **Acceso**: El derecho a entrar y conectarse a la red (aportar recursos, conectarse)
- **Consumo**: El derecho a "extraer recursos" del sistema (obtener conectividad)
- **Gestión**: El derecho a regular el uso y hacer mejoras
- **Exclusión**: El derecho a determinar quién tendrá acceso y cómo se puede transferir este derecho
- **Alienación**: El derecho a vender una parte del recurso (por ejemplo, por parte de participantes profesionales que venden conectividad a sus clientes)

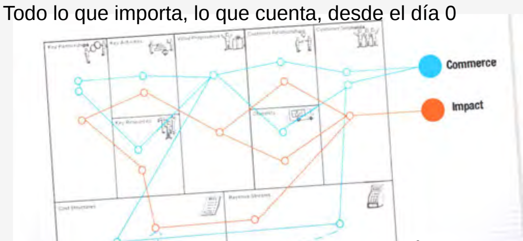
26-30/11/2018 WALC 2018 CN 37 / 59

Algunos ejemplos ...

26-30/11/2018 WALC 2018 CN 38 / 59

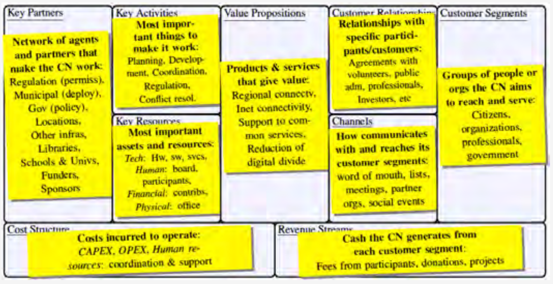
Un ejercicio de mapeo: el diagrama del modelo de negocio

- Todo lo que importa, lo que cuenta, desde el día 0

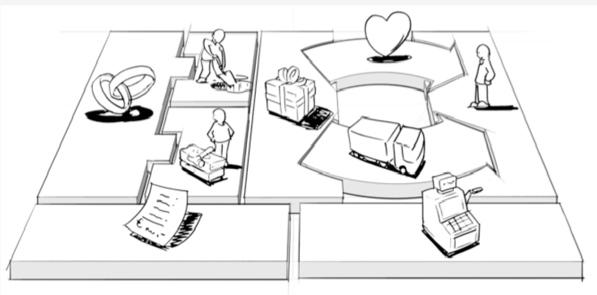


Un diagrama (canvas) sencillo, visual, en una página para diseñar, innovar y dialogar sobre modelos de negocio, impacto social y económico.

Vista desde el exterior: diagrama del modelo de negocio



Diagrama



Alianzas clave:

- La red de organizaciones circundantes (proveedores, autoridades, socios, simpatizantes) que permiten y hacen funcionar el recurso/infraestructura en común
- Ejemplos:
  - todos los niveles de gobierno, ayuntamientos y gobierno (política), organizaciones comunitarias, financiadores, otros ISP, organizaciones internacionales (ISOC, APC), bibliotecas, organizaciones comunitarias locales, instituciones locales, ubicaciones (torres, conductos), municipal (despliegue de permisos), regulación (permiso), redes de acceso abierto, otras infraestructuras, escuelas, proveedores de servicios, grupos de desarrollo de software, patrocinadores, proveedores de tecnología, organizaciones paraguas, organizaciones globales, universidades, instituciones públicas, organizaciones comunitarias locales, centros sociales autogestionados, okupas.

Actividades clave:

- Las cosas más importantes que hay que hacer para que los bienes comunes funcionen y aporten valor.
- Puede ser:
  - *Complementario: la* expansión u operación de la red atrae a más participantes y contribuye a la sostenibilidad de los bienes comunes.
  - *Oposición:* La participación y coordinación con otros en la infraestructura común puede basarse en la cooperación o la competencia,
- Preguntas para hacer sobre las actividades:
  - ¿Cuáles son las actividades clave que deben emprenderse para aportar valor económico o social a nuestros participantes/clientes?
  - ¿Cuáles son las actividades clave para entregar nuestra propuesta de valor de impacto?
  - ¿Qué actividades de oposición existen? ¿Cómo podemos abordarlas para que sean más equilibradas?

Actividades clave: ejemplos

- Contabilidad, facturación, gestión de flujo de caja, resolución de conflictos, construcción de redes locales, coordinación, despliegue de redes, desarrollo, experimentación, desarrollo de infraestructura, cooperación intercomunitaria, cabildeo, servicio de gestión por parte de la cooperativa local, planificación de pequeñas redes, planificación de redes, regulación, desarrollo de software, cumbre para el intercambio y la discusión, formación de formadores locales (ingenieros descalzos), pequeños miembros de coordinación, formación y experimentación, planificación de pequeñas empresas, desarrollo de software y servicios digitales, eventos públicos, promoción de la política de Internet y los derechos de Internet.

Recursos clave:

- Los activos, tangibles e intangibles, que hacen que un modelo de negocio funcione
- Qué impulsa un modelo económico o social y qué impulsa sus impactos:
  - La infraestructura común es un conjunto de recursos (sujeto a contribución y consumo)
- Ejemplos:
  - Organizativo: miembros, licencia (espectro, servicio)
  - Humano: junta directiva, voluntarios, personal de org paraguas, profesionales
  - Financieros: contribuciones de voluntarios
  - Tecnología: hardware (puntos de acceso wifi, celulares de la comunidad, routers, antenas, voip), software, servicios (servidor de mapas),
  - Físico: oficina, equipamiento, coche, localizaciones aportadas, derechos de paso, derecho de tejado.

Propuestas de valor:

- Los productos y servicios que crean valor para segmentos específicos de participantes - lo que hace que los participantes regresen a tu "empresa"
- Ejemplos:
  - Conectividad local, conectividad a Internet, DNS, libertad de expresión, gestión de redes, servicios de los miembros (Internet, llamadas), coordinación de la gestión y funcionamiento de la infraestructura de la red, experimentación e innovación de redes y programas informáticos, productos y servicios que aportan valor, conectividad regional, reducción de la brecha digital, apoyo a los servicios comunes, formación y apoyo, VPN, formas de gestionar y operar un operador móvil propio, desarrollo local de aplicaciones para las necesidades locales, prestación de servicios en cooperación, correo electrónico, alojamiento de servidores y contenidos, neutralidad en Internet, difusión del conocimiento.

Relación cliente/participante:

- Los tipos de relaciones que un dominio público establece con segmentos específicos de clientes/participantes
- Ejemplos:
  - asesoramiento, asesoramiento sobre el funcionamiento de la red, acuerdos con voluntarios, apoyo a la comunidad, seguimiento de las comunidades, membresía formal (voluntarios), membresía informal (voluntarios), instalación de una red de malla, instalación de estaciones base de radio, asesoramiento sobre operación y mantenimiento, integración voip, integración con PSIIs, inversores, apoyo mutuo, relaciones con participantes o clientes específicos, pequeños acuerdos con voluntarios, apoyo técnico, profesionales, participantes en tablas de compensación, administraciones públicas (gov)

Canales:

- Cómo se comunica una RC con sus segmentos de clientes/participantes y cómo llega a ellos para entregar su propuesta de valor
- Ejemplos:
  - Digital: foros, listas de correo, participación remota en el día de la comunidad, boca a boca, enlaces w/orgs, eventos sociales, web, mensajería instantánea (matrix, irc, jabber)
    Social: reuniones f2f, hacklabs, boca a boca, día de la comunidad, eventos sociales, asamblea general
  - Cómo se comunica y llega a sus segmentos de clientes: boca a boca, listas, reuniones, orgs de socios, eventos sociales, promotores locales, tiendas, escuelas, boca a boca, cobertura mediática, enlaces con orgs locales.
  - Enlaces con organizaciones gubernamentales, eventos públicos
  - Comunicación y documentación: desarrollo de canales de comunicación propios (instantáneos y listados, repositorio de documentos).

Segmentos de clientes/ participantes:

- Los diferentes grupos de personas u organizaciones a los que una iniciativa pretende llegar y servir (y convertirse en participantes, con plenos derechos, no puros consumidores)
- Ejemplos:
  - Ciudadanos, organizaciones, profesionales, municipios, gobierno
  - Ciudadanos interesados en redes alternativas y conectividad simétrica a Internet
  - Comunidades: rurales, indígenas marginados
  - Expertos (trabajo en red)
  - Deseables: ciudadanos, organizaciones, ciudadanos no expertos, público en general.
  - Miembros: expertos, ciudadanos, organizaciones sociales, público en general
  - Comunidades subatendidas, ingenieros descalzos

Estructura de costes:

- Los costes de los servicios,
  - el coste de producir un impacto,
  - los costes de la contribución a la infraestructura común, y
  - su compensación para alcanzar un equilibrio.
- Ejemplos:
  - CAPEX (costo inicial, capacidad) y OPEX (operacional, mantenimiento)
  - CAPEX: Estación de compra e instalación de 10.000 USD.
  - CAPEX: compra e instalación de equipos: nodos, servidores, routers, enlaces, conexión troncal.
  - OPEX: personal de operación 200 USD + llamadas VOIP + asistencia 1 USD/usuario +++
  - OPEX: servicios tales como el tráfico de Internet, el tráfico de red troncal, el tráfico, el mantenimiento de equipos, los recursos humanos, etc.
  - Recursos humanos: coordinación y apoyo, personal central y local, voluntarios.
  - Innovación y formación
  - Comunidad celular, antenas, licencia, enlace a internet, servicios VOIP
  - Financieros: costo de la oficina, inversión en infraestructura local, costos de operación.
  - Físico: oficina y su equipo
  - Costos de contribución a la infraestructura común, y compensación para alcanzar un equilibrio, costos de los servicios

Coste social y medioambiental: (opcional)

- Externalidades no incluidas en la estructura de costes.
- Puede incluirse en la sección de *costes.*

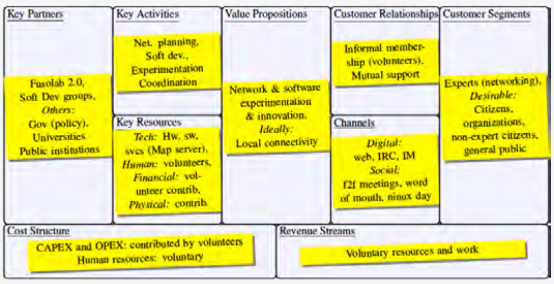
Flujos de ingresos:

- Lo que permite operar (intercambios, consumo, servicios) y generar el impacto.
- Ejemplos:
  - Efectivo que la CN genera de cada segmento de clientes: honorarios de los participantes, donaciones, proyectos
  - Remuneración de los participantes (profesionales y org)
  - Por comunidad: ingresos de algunos usuarios maduros
  - Por miembro/mes: 10 EUR miembro + 2 túneles de Internet
  - Donaciones y por proyecto: variable
  - por miembro/mes: 2 USD/miembro + llamadas entrantes
  - Por comunidad: ~2000 USD + 0.8 USD/usuario
  - Recursos y trabajo voluntario

Beneficios sociales y ambientales: (opcional)

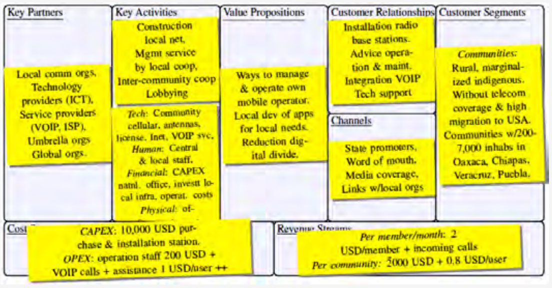
- Externalidades no incluidas en los flujos de ingresos.
- Puede incluirse en la sección de *ingresos.*

Ninux.org Italia

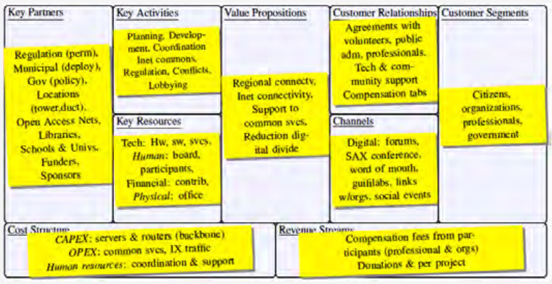


netCommons

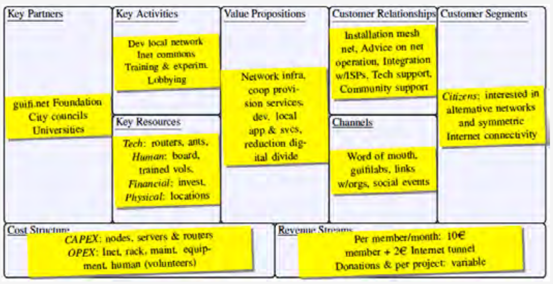
Rhizomatica México



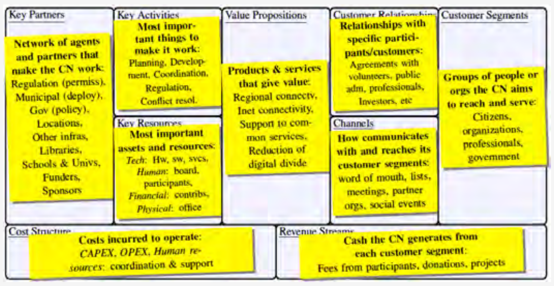
guifi.net, colectivo, federación



eXO.cat: guifi.net en Barcelona



¿Tu red?



En resumen

Actividad 2: tu turno

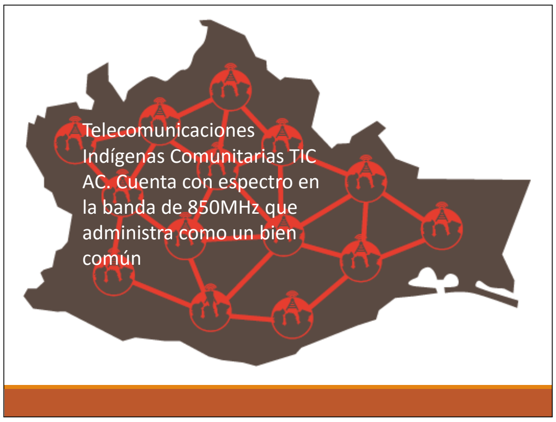
- El diagrama cambia con el tiempo
- Puede ser: ahora, en 6 meses, 1 año, 2-5 años
- Un panorama global

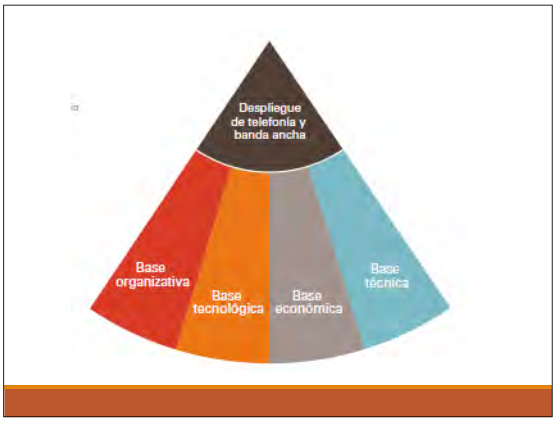
- La base de un modelo de negocio detallado
- Enlaces con lo demás: mapa de cobertura, opciones tecnológicas, presupuesto, plan de difusión,...

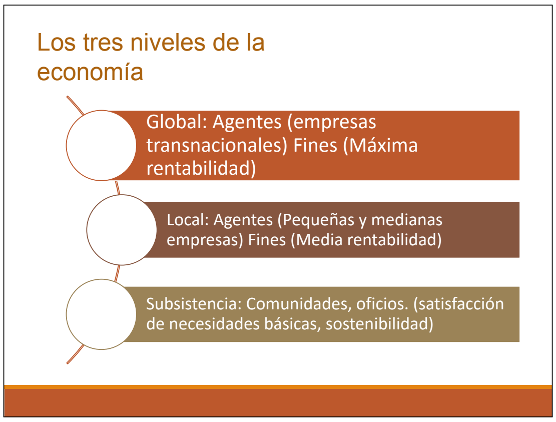
- El **plan de acción**: principales acciones para llevar a cabo el plan: visión, misión, objetivos, estrategias, plan de acción (VMOSA)
- Objetivo: mapa de CNs en LAC (durante la semana)

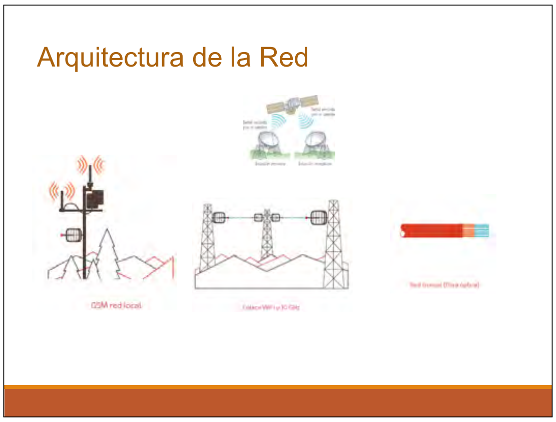
Resumen

- Modelos y estructura en capas de infrastructura de red
- Redes comunitarias: infraestructura en común, abierta y extensible
- Gobierno de comunes: sostenibilidad y adaptabilidad
- Nuestros modelos (actividad)
- Generación de infraestructura y conectividad a coste mínimo, más oportunidades de valor añadido
- Diagrama (canvas) de modelo de negocio
- Nuestro diagrama (actividad)
- También organización interna








Arquitectura de la Red
GSM red local

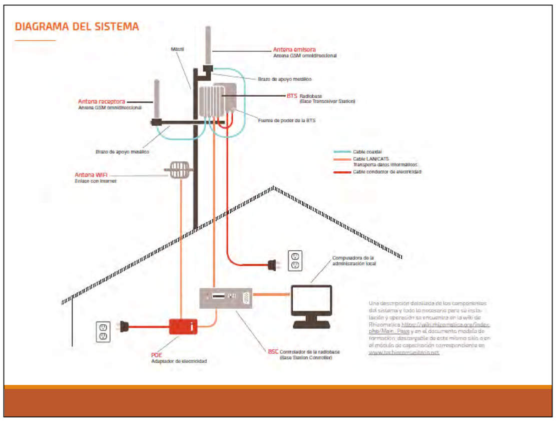
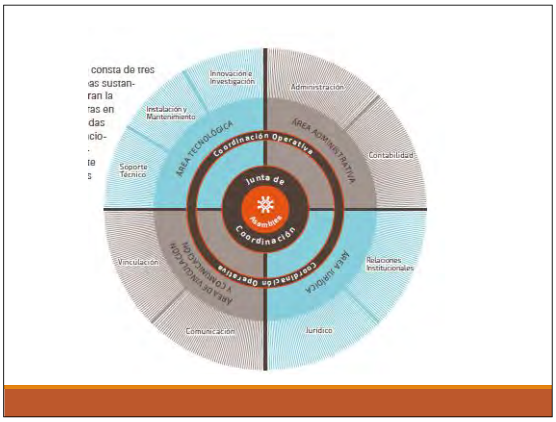
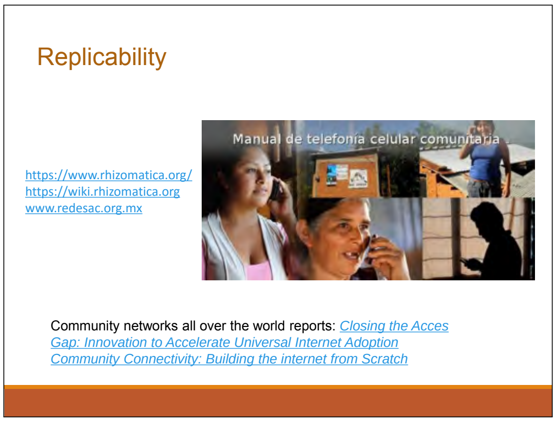
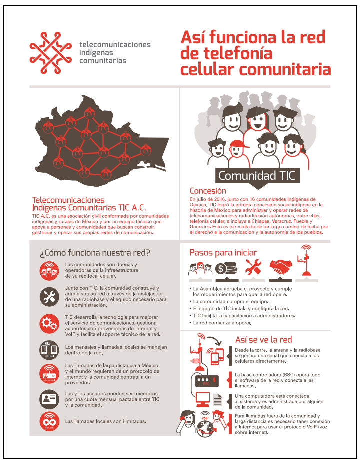


DIAGRAMA DEL SISTEMA


Administración
Contabilidad
Relaciones Institucionales
Jurídico
Comunicación
Vinculación
Soporte Técnico
Instalación y Mantenimiento
Innovación e Investigación


Replicability
https://www.rhizomatica.org/
https://wiki.rhizomatica.org
www.redesac.org.mx
Manual de telefonía celular comunitaria
Community networks all over the world reports: Closing the Acces Gap: Innovation to Accelerate Universal Internet Adoption
Community Connectivity: Building the internet from Scratch


telecomunicaciones indígenas comunitarias
Así funciona la red de telefonía celular comunitaria
Comunidad TIC
Telecomunicaciones Indígenas Comunitarias TIC A.C.
Concesión
¿Cómo funciona nuestra red?
Pasos para iniciar
Así se ve la red


WALC 2018
Redes comunitarias
• Roger Baig,
Fundación guifi.net, roger.baig@guifi.net
• Emmanouil Dimogerontakis,
UPC, edimoger@ac.upc.edu
• Erick Huerta,
RedesComunica AC,
redescomunica@gmail.com
• Leandro Navarro,
UPC, leandro@ac.upc.edu
• Roger Pueyo,
UPC + guifi.net, rpueyo@ac.upc.edu

Día 2: Modelos de actividad, experimentos con tecnologías de acceso y transporte

1. Arquitectura de Internet y protocolos
2. Redes de acceso y última milla
3. Laboratorio: última milla e interconexión
4. Laboratorio: Arquitectura de Internet y protocolos

Internet Architecture and Protocols

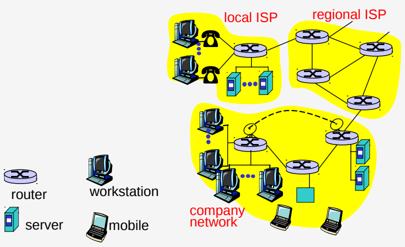
Objective

- Establish a common backgournd and vocabulary
- Learn from the design of the biggest network

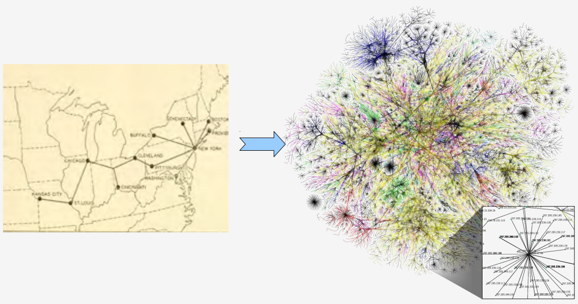
Contents

- Protocols and Design
  - Internetworking
  - Control de Congestion
- Structure of the Internet

The Internet



From telephone to Internet



History

The history of the Internet is the history of how to deal with failures

- 1960: Packets instead of circuits
- 1967: Connect computers at research sites across the US using telephone lines (ARPA)
- 1973-75: Developed TCP and IP (originally intertwined)
- 1978: Layering: TCP and IP split; TCP at end points, IP in the network
- 1991: “WorldWideWeb”
- Mid-1990s: Commercial ISPs
- 1998: Google, Akamai
- 2000s: P2P, Web2.0, Cloud ...

First steps to Networking

- From telephone circuit switching to packet switching
- From one circuit per connection to one packet per group of data (datagram)
- From analog to digital
- From connection-oriented to connectionless

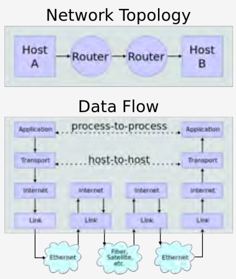
Internetworking

- Gateways connecting heterogeneous networks
- A computer is a part of the Internet if he implements the IP protocol:
  - IP Addressing
  - Implements Routing table and performs forwarding
  - Best effort
  - No global control: decentralized

Design Principle: “End-to-End”

- Maintain in the network only the necessary functionality
- Move the rest to the endpoints
- Design for flexibility, not for optimization

TCP/IP Protocols Architecture



Interent Routing (IP)

Internet Protocol service

- Task: delivering packets from source host to destination host solely based on the IP addresses in the packet headers.
- Packets encapsulate data, routed
- Connection-less datagram service (Vint Cerf, Bob Kahn, 1974)
- Two versions: IPv4, IPv6

Internet Protocol characteristics

- Characteristics: (dummy core)
  - No connection: Connectionless
  - No memory: Stateless
  - No guarantee: best effort
- Consequences:
  - Packets can be delivered out-of-order
  - Each packet can take a different path to the destination
  - No error detection or correction in payload
  - No congestion control (beyond “drop”)

Layer 3 - IPv4 datagram

Version	IHL	Differentiated Services	Total Length
Identification		Flags	Fragment Offset
Time to Live	Protocol	Header Checksum	
Source Address (32-bit IPv4 address)			
Destination Address (32-bit IPv4 address)			
Options			Padding
Data (contains layer 4 segment)			

- Version = 4
  If no options, IHL = 5
  Source and Destination are 32-bit IPv4 addresses
- Protocol = 6 means data portion contains a TCP segment. Protocol = 17 means UDP.

Purpose of an IP Address

- Identifies a machine’s connection to a network
- Physically moving a machine from one network to another requires changing the IP address
- **Unique**; assigned in a hierarchical fashion:
  - IANA (Internet Assigned Number Authority)
  - IANA to Regional Internet Registries (RIRs): AfriNIC, ARIN, RIPE, APNIC, LACNIC
  - RIR to ISPs and large organisations
  - ISP or company IT department to end users
- IPv4 uses unique 32-bit addresses
- IPv6 used similar concepts but 128-bit addresses

Basic Structure of an IPv4 Address

- 32 bit number (4 octet number): (e.g. 133.27.162.125)
- Decimal Representation:

133	27	162	125

- Binary Representation:

10000101	00011011	10100010	01111101

- Hexadecimal Representation:

85	1B	A2	7D

Addressing in Internetworks

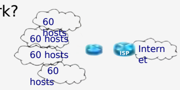
- The problem we have
  - More than one physical network
  - Different Locations
  - Larger number of hosts
  - Need a way of numbering them all
- We use a structured numbering system
  - Hosts that are connected to the same physical network have “similar” IP addresses
  - Often more then one level of structure; e.g. physical networks in the same organisation use “similar” IP addresses

Network part and Host part

- Remember IPv4 address is 32 bits
- Divide it into a "network part" and "host part"
  - "network part" of the address identifies which network in the internetwork (e.g. the Internet)
  - "host part" identifies host on that network
  - Hosts or routers connected to the same link-layer network will have IP addresses with the same network part, but different host part.
  - Host part contains enough bits to address all hosts on the subnet; e.g. 8 bits allows 256 addresses

Subnetting

- What if we want to divide the network?
-



Subnetting allows adding bits from the hostid to the netid (called subnetid bits).

Example: For the ISP the network prefix is 24 bits. For the internal router the network prefix is 26 bits. The 2 extra bits allows 4 "subnetworks".

A **mask** is used to identify the size of the netid+subnetid prefix.

Mask notations:

dotted, as 255.255.255.192

giving the mask length (number of bits) as 210.50.30.0/26

The need for Packet Forwarding

- Many small networks can be interconnected to make a larger internetwork
- A device on one network cannot send a packet directly to a device on another network
- The packet has to be forwarded from one network to another, through intermediate nodes, until it reaches its destination
- The intermediate nodes are called "routers"

Network Masks

- "Network Masks" help define which bits are used to describe the Network Part and which for the Host Part
- Different Representations:
  - decimal dot notation: 255.255.224.0
  - binary: 11111111 11111111 11100000 00000000
  - hexadecimal: 0xFFFFE000
  - number of network bits: /19
    - count the 1's in the binary representation
- Above examples all mean the same: 19 bits for the Network Part and 13 bits for the Host Part

Forwarding

An IP Router

- **A device with more than one link-layer interface**
- Different IP addresses (from different subnets) on different interfaces
- Receives packets on one interface, and forwards them (usually out of another interface) to get them one hop closer to their destination
- Maintains forwarding tables

IP Router - action for each packet

- Packet is received on one interface
- Checks whether the destination address is the router itself – if so, pass it to higher layers
- Decrement TTL (time to live), and discard packet if it reaches zero
- Look up the destination IP address in the forwarding table
- Destination could be on a **directly** attached link, or **indirect**, through another router

Forwarding vs. Routing

- **Forwarding**: the process of moving packets from input to output
  - The forwarding table
  - Information in the packet
- **Routing**: process by which the forwarding table is built and maintained
  - One or more routing protocols
  - Procedures (algorithms) to convert routing info to forwarding table.

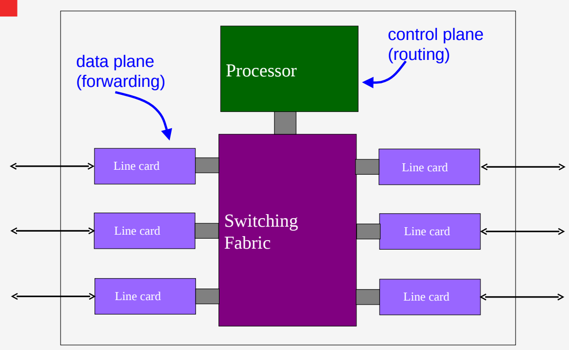
Forwarding is hop by hop

- Each router tries to get the packet one hop **closer** to the destination
- Each router makes an **independent** decision, based on its own forwarding table
- Different routers have **different** forwarding tables and make different decisions
  - If all is well, decisions will be consistent
- Routers talk routing protocols to each other, to help **update** routing and forwarding tables

Router Functions

- Determine optimum routing paths through a network
  - Lowest delay
  - Highest reliability
- Move packets through the network
  - Examines destination address in packet
  - Makes a decision on which port to forward the packet through
  - Decision is based on the Routing Table
- Interconnected Routers exchange routing tables in order to maintain a clear picture of the network
- In a large network, the routing table updates can consume a lot of bandwidth
  - a protocol for route updates is required

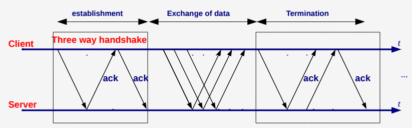
Data and Control Planes



Congegstion Control (TCP, UDP etc.)

Client-server: transport

- User Datagram Protocol (UDP)
  - Datagram service: unreliable, connectionless
- Transmission Control Protocol (TCP)
  - Pipe service: reliable (ack correct, lost nack'd and retransmitted), connection-oriented



Transport Protocols

- Logical communication between processes
  - Sender divides a message into segments
  - Receiver reassembles segments into message
- Transport services
  - (De)multiplexing packets
  - Detecting corrupted data
  - Optionally: reliable delivery, flow control, ...

36

User Datagram Protocol (UDP)

- Datagram messaging service
  - Demultiplexing: port numbers
  - Detecting corruption: checksum
- Lightweight communication between processes
  - Send and receive messages
  - Avoid overhead of ordered, reliable delivery
- Multimedia streaming, Simple query-response protocols (DNS, DHCP)

37

TCP Design Principles:

- Find saturation point (How?)
- Metrics to consider: Packet loss, Queue size, delays
- Follow an adaptive strategy Packet Preservation principle

Transmission Control Protocol (TCP)

- Stream-of-bytes service
  - Sends and receives a stream of bytes
- Reliable, in-order delivery
  - Corruption: checksums
  - Detect loss/reordering: sequence numbers
  - Reliable delivery: acknowledgments and retransmissions
- Connection oriented
  - Explicit set-up and tear-down of TCP connection
- Flow control
  - Prevent overflow of the receiver's buffer space
- Congestion control
  - Adapt to network congestion for the greater good

39

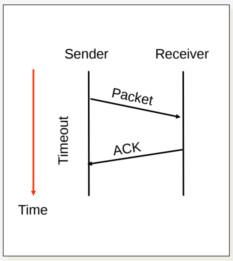
TCP Support for Reliable Delivery

- **Detect bit errors:** checksum
  - Used to detect corrupted data at the receiver
  - ...leading the receiver to drop the packet
- **Detect missing data:** sequence number
  - Used to detect a gap in the stream of bytes
  - ... and for putting the data back in order
- **Recover from lost data:** retransmission
  - Sender retransmits lost or corrupted data
  - Two main ways to detect lost packets

42

Automatic Repeat reQuest (ARQ)

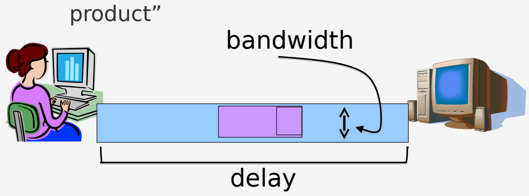
- ACK and timeouts
  - Receiver sends ACK when it receives packet
  - Sender waits for ACK and times out
- Simplest ARQ protocol
  - Stop and wait
  - Send a packet, stop and wait until ACK arrives



43

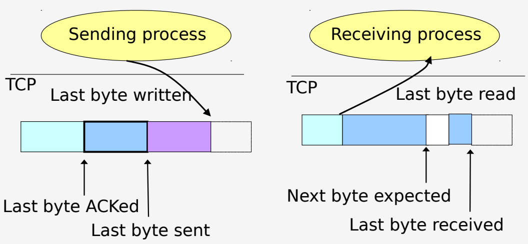
Motivation for Sliding Window

- Stop-and-wait is inefficient
  - Only one TCP segment is "in flight" at a time
  - Especially bad for high "delay-bandwidth product"

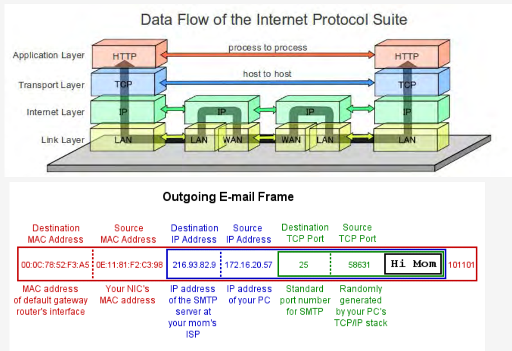


Sliding Window

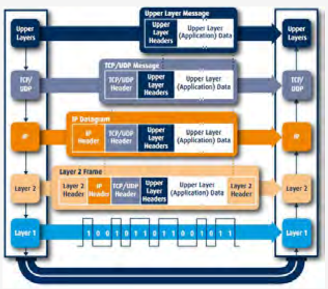
- Allow a larger amount of data "in flight"
  - Allow sender to get ahead of the receiver
  - … though not too far ahead



TCP/IP Stack Example



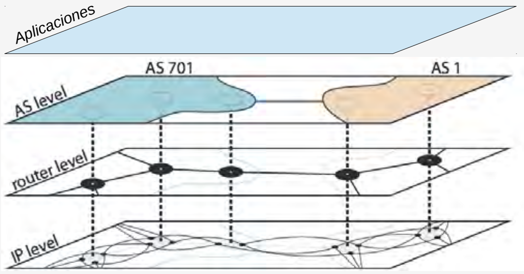
Encapsulation



- Gateway
- Proxy
- Router
- Switch
- Amplifier

Structure of the Internet

Niveles



About the Internet

- Internet's two-level topology
  - Autonomous Systems + connections between them
  - Routers + links between them
- AS-level topology
  - Autonomous System (AS) numbers
  - Business relationships between ASs
  - Tier-1 providers
- Routing:
  - Interior Gateway Protocols: RIP, OSPF, CISCO IGRP
  - Exterior (Among AS): BGPv4

Internet Routing Architecture

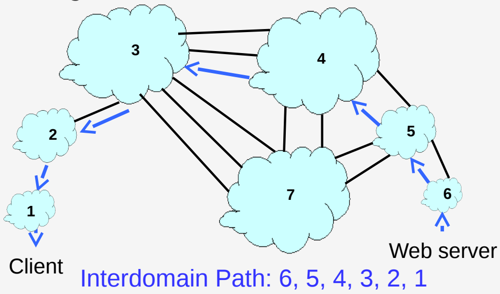
- Divided into Autonomous Systems
  - Distinct regions of administrative control
  - Routers/links managed by a single "institution"
  - IP prefixes w/ single routing policy
  - Service provider, company, university, …
- Hierarchy of Autonomous Systems
  - Tier-1 providers with nation/continental wide backbone
  - Medium-sized regional provider with smaller backbone
  - Small network run by a single company or university
- Interaction between Autonomous Systems
  - Internal topology is not shared between ASes
  - … but, neighboring ASes interact to coordinate routing

Tiers

- **Tier 1** An IP network that can reach every other network on the Internet solely via settlement-free peering (no upstream provider)
- **Tier 2** An ISP that peers with other networks, but which also purchases IP transit to reach some portion of the Internet.
- **Tier 3** Networks who solely purchase IP transit from other networks to reach the Internet.

AS Topology

- Node: Autonomous System
- Edge: Two ASes that connect to each other



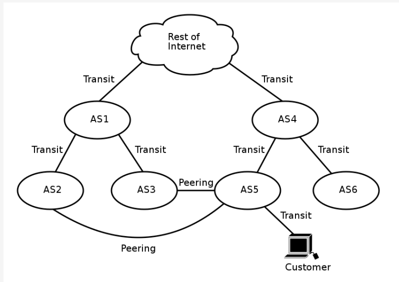
Business Relationships

- Neighboring ASes have business contracts
  - How much traffic to carry
  - Which destinations to reach
  - How much money to pay
- Common business relationships
  - Customer-provider
    - E.g., UPC is a customer of RedIris
    - E.g., XYZ is a customer of Cogent
  - Peer-peer
    - E.g., UPC is a peer of UB
    - E.g., Telefonica is a peer of RedIris

Peering Relationships

- **Transit** The ISP pays money (or settlement) to another network for Internet access (or transit).
- **Peer** Two networks exchange traffic between their users freely, and for mutual benefit.
- **Customer** A network pays another network money to be provided with Internet access.

Peering Relationships



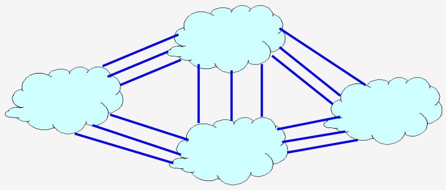
Internet Exchange Points (IXP)

- The physical infrastructure through which (ISPs) and (CDNs) exchange Internet traffic between their ASs
- Reduce ISP's traffic to transit providers → Reduce average per-bit delivery cost
- Increased number of paths →

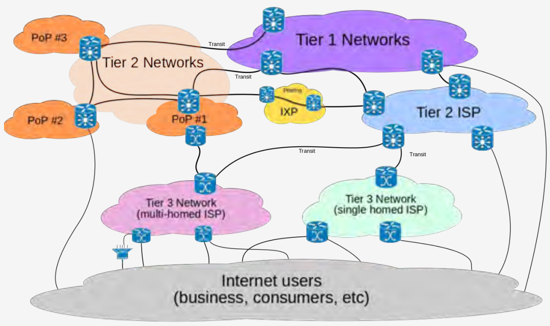
  improve routing efficiency and fault-tolerance

AS Structure: Tier-1 Providers

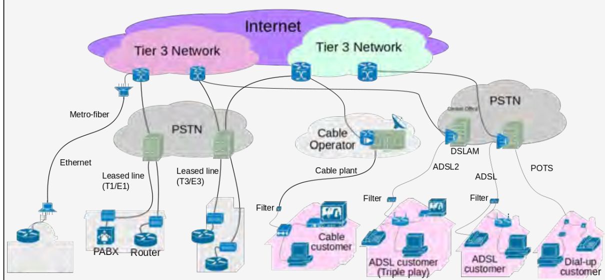
- Tier-1 provider
  - Has no upstream provider of its own
  - Typically has a national or international backbone
  - UUNET, Sprint, AT&T, Level 3, ...
- Top of the Internet hierarchy of 12-20 ASes
  - Full peer-peer connections between tier-1 providers



Backbone – eXchanges – carriers



Access



WALC18 – Track Redes Comunitarias

Redes de acceso:

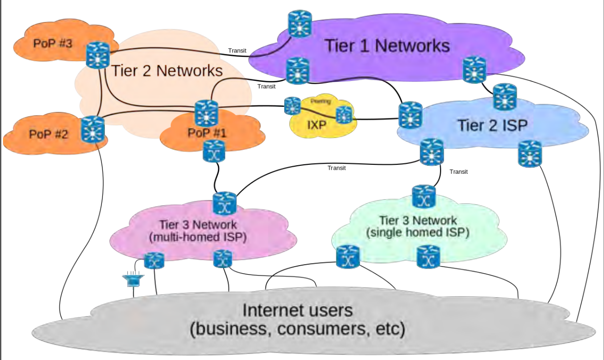
En la última milla. Una aproximación teórico-práctica para redes comunitarias. WiP.

Roger Pueyo Centelles – rpueyo@ac.upc.edu

Resumen

- Qué son las redes de acceso
- Tecnologías de redes de acceso
- Tecnología radio para redes de acceso en RRCC
  - WiFi
- Práctica 1: despliegue red WiFi comunitaria AP/sta
- Redes mesh inalámbricas comunitarias
- Práctica 2: despliegue red WiFi comunitaria mesh
- Tecnología cableada para redes de acceso en RRCC
  - Fibra óptica

2

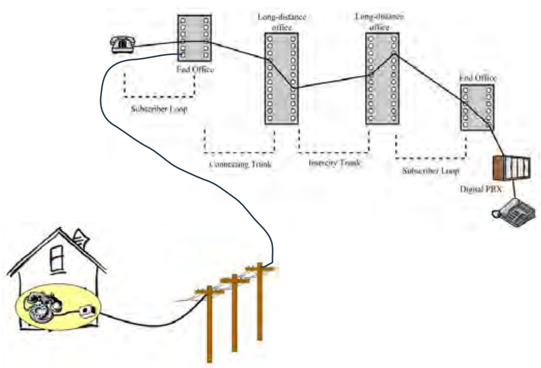


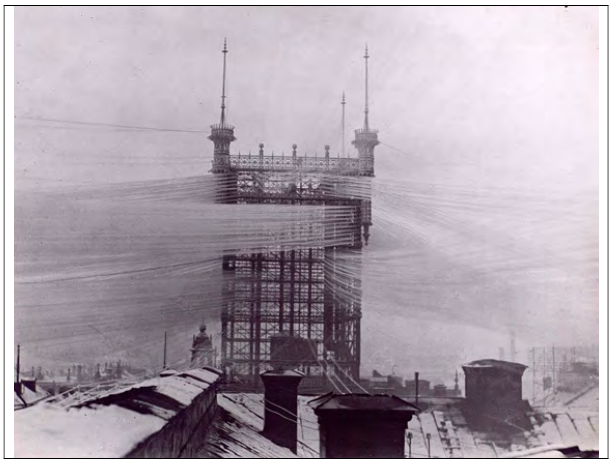
Qué son las redes de acceso

Una **red de acceso** es la parte de una red de telecomunicaciones que **conecta a los usuarios finales** con su proveedor de servicios.

Los inicios se encuentran en las redes de telefonía básica (RTB), en el cable de cobre que conecta a los abonados con la central.

4





netCommons

Tecnologías para RRAA (cableadas)

- RTB // PSTN // POTS (i.e., telefonía analógica)
  - Voz; Fax, datos
- RDSI // ISDN (Red Digital de Servicios Integrados)
  - Red digital de voz y datos. EU, DE.
- Circuitos y líneas dedicadas // Leased lines
  - T1, E1, ATM, et al.
- DSL
  - ADSL, VDSL, etc.
- Cable coaxial
  - TV
- Fibra óptica
  - FTTx

7

Tecnologías para RRAA (inalámbricas)

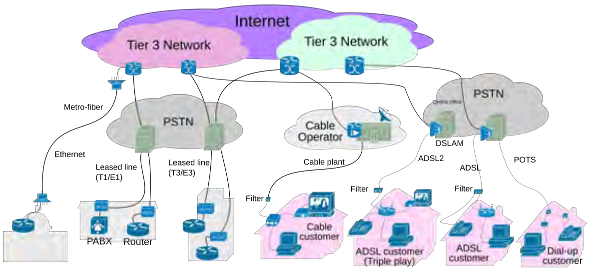
- Radioenlace [de bucle local]
  - μondas, WiMAX
- GSM, tecnología celular
  - GPRS, EDGE, 3G, UMTS, 4G, LTE, 5G, 6G
- Satélite
  - Cielo => Conexión
- TV white space
  - 
- … Wi Fi?

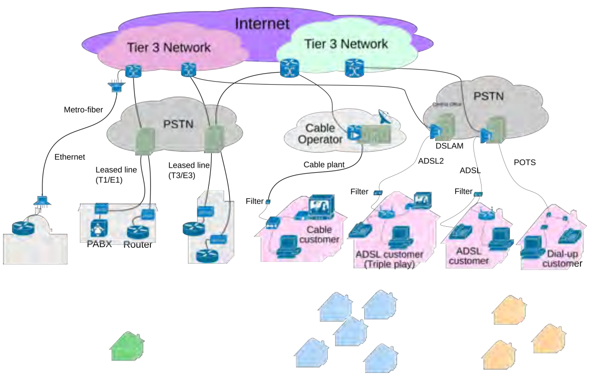
8

Velocidades de transmisión de datos

RTB	40 kbps		μO	10~100 Mbps
RDSI	64 kbps		GSM 3G GSM 4G	7~28 Mbps ≤ 1 Gbps
T1 E1	1544 kbps 2048 kbps		Satélite	~20 Mbps
ADSL VDSL	10~15 Mbps 30~50 Mbps		TVWS	10~40 Mbps
Coax	50~150 Mbps		WiFi	10~500 Mbps
Fibra	≥ 1 Gbps			

9





Construyendo red *desde* la última milla

- ¿A qué dan respuesta las redes comunitarias?
  - Usuarios que no están cubiertos por operadores incumbentes
  - Usuarios que no pueden acceder vía operadores incumbentes
  - Usuarios que no quieren acceder mediante operadores incumbentes

12

The Internet, but truly yours

- Construcción de la red desde abajo hacia arriba (*grassroots, bottom up*)
  - En contraposición al modelo ***top-down*** de los operadores incumbentes
- Desde una infraestructura oportunista hasta un operador Tier-2
- Copiando lo que funciona en Internet
  - IP, BGP, AS, fibra, etc.
- Innovando en modelos económicos, sociales, organizativos...

13

Tecnología radio para RRAA en RRCC

- ¿Porqué WiFi y no X, Y o Z?
  - Precio/prestaciones
  - Exención de licencia
  - Facilidad de despliegue
- Neutralidad tecnológica

14

Tecnología radio para RRAA en RRCC

- ¿Porqué WiFi y no X, Y o Z?
  - Precio/prestaciones
  - Exención de licencia
  - Facilidad de despliegue
- Neutralidad tecnológica

15

Breve historia de las *wireless LANs*

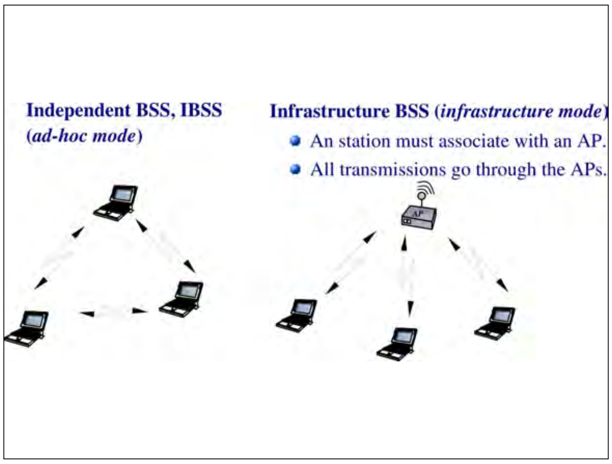
- 1971: Prof. Norman Abramson desarrolla ALOHAnet en la Universidad de Hawái
- 1990: varias compañías desarrollan soluciones WLAN propietarias
- 1996: ETSI aprueba HIPERLAN/1
- 1997: IEEE aprueba 802.11
- 90~00: Wi-Fi Alliance, expansión de 802.11
- 1999: 802.11a, 802.11b
- 2003: 802.11g
- 2009: 802.11n
- 2012: 802.11ad
- 2013: 802.11ac
- 2017: $15x10^9$ dispositivos WiFi fabricados, $9x10^9$ en uso

16

Conceptos básicos de operación en WiFi

- Basic Service Set (BSS)
  - Conjunto de dispositivos comunicándose entre ellos
  - Un identificador común (Service Set Identifier, SSID)
- Independent BSS
  - Modo "*ad hoc*"
- Infrastructure BSS
  - Modo "infraestructura", AP/sta
- 802.11s mesh
  - Modo "mesh"

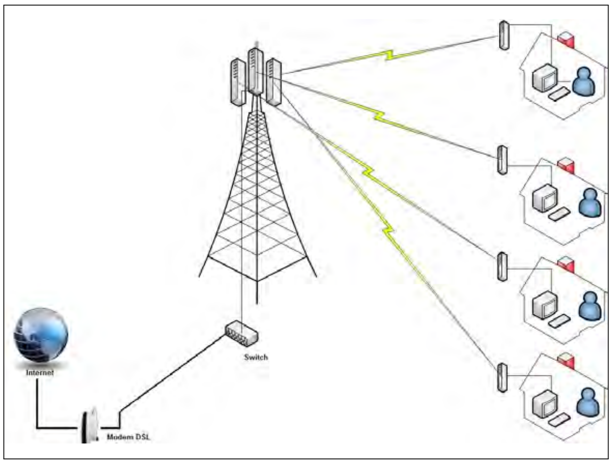
17



Usos de tecnología WiFi en RRCC

- Red de acceso
  - AP/Clientes
  - Mesh
- Red de transporte // troncal
  - P2P
- Mesh
  - AdHoc/802.11s + routing dinámico
- **(dentro de casa)**
  - AP/Clientes

19



Práctica 1: despliegue RRCC WiFi AP/sta

- Actividad: Construir el despliegue de RC WiFi más simple posible
- Metodología: Replicar arquitectura de la transparencia anterior
  - Compartir entre varios usuarios de una comunidad una conexión a Internet de forma oportunista
    - ¡Así empezó *guifi·net*!
- Material: dispositivos habitualmente usados en RRCC
  - Routers WiFi para exteriores (CPE) operando a 5 Ghz
  - 1 AP ubicado en el punto de donde se obtiene la conexión a Internet
  - Conexión ADSL // F.O. // SAT...
  - n clientes (estaciones) en ubicaciones remotas (casa, centro comunitario, etc.)
- Objetivo: conocer la magnitud de la tragedia
  - ¿Se nos ha escapado algo? 🤔

21

Práctica 1: despliegue RRCC WiFi AP/sta

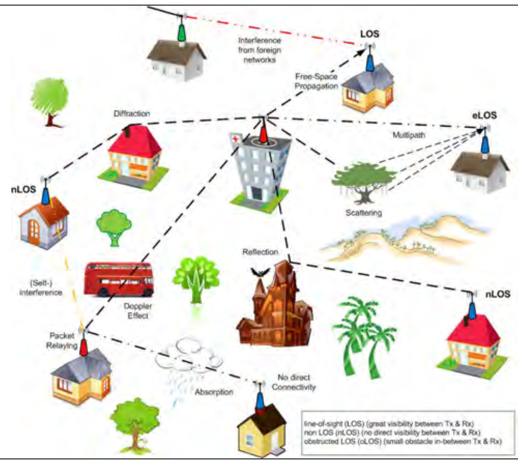
- Actividad: Construir el despliegue de RC WiFi más simple posible
- Metodología: Replicar arquitectura de la transparencia anterior
  - Compartir entre varios usuarios de una comunidad una conexión a Internet de forma oportunista
    - ¡Así empezó *guifi·net*!
- Material: dispositivos habitualmente usados en RRCC
  - Routers WiFi para exteriores (CPE) operando a 5 Ghz
  - 1 AP ubicado en el punto de donde se obtiene la conexión a Internet
  - Conexión ADSL // F.O. // SAT...
  - n clientes (estaciones) en ubicaciones remotas (casa, centro comunitario, etc.)
- Objetivo: conocer la magnitud de la tragedia
  - ¿Se nos ha escapado algo? 🤔

22

Más allá de la práctica 1

- Para saber más:
  - Track redes inalámbricas http://eslared.net/walc2018/?page_id=80&lang=es_ES
  - Track gestión y monitoreo de redes http://eslared.net/walc2018/?page_id=84&lang=es_ES
  - Track IPv6 http://eslared.net/walc2018/?page_id=82&lang=es_ES
  - Wireless Networking in the ~~Developing~~ World http://wndw.net/
  - Manuales, webinars, tutoriales WISP
    - Los fabricantes como Ubiquiti, MikroTik, etc. proporcionan materiales, cursos, formación...

23



¿Todo resuelto?

- La arquitectura AP/cliente funciona muy bien
  - Excepto cuando el cliente no puede conectar al AP
- La RC crece
  - Planificación del despliegue
  - Gestión de direcciones IP
  - Encaminamiento dinámico
  - *Single failure points*
- Las redes mesh rompen el modelo y automatizan muchas tareas
  - Todos AP y cliente a la vez
  - Red entre iguales
  - Enlazar con un nodo == estar dentro de la red

26

Redes mesh inalámbricas al rescate

qMp
quick mesh project

27

qMp – Quick Mesh Project

- Sistema operativo para routers WiFi
  - Facilitar los despliegues de MANETs
    - MANET: mesh ad hoc network ~~metropolitan area network~~
- Basado en OpenWRT
  - Distribución GNU/Linux para dispositivos WiFi embebidos
  - El SO abierto estándar de facto para redes [comunitarias]
- Usa el protocolo de enrutamiento dinámico BMX6
- Diseñado para redes mesh inalámbricas ad hoc

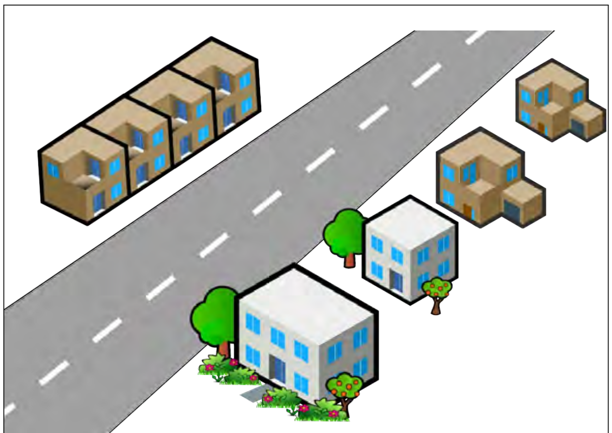
28

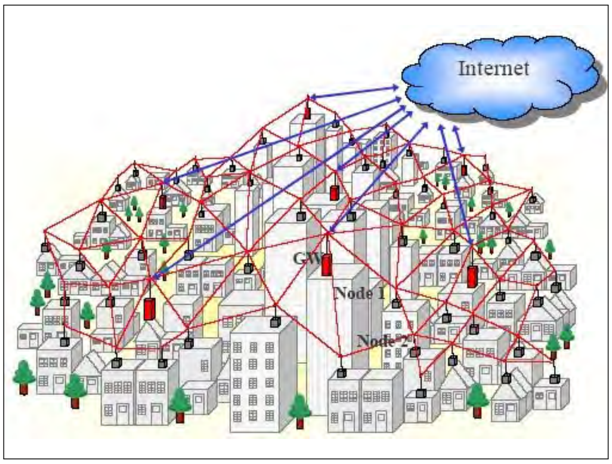
Características de qMp

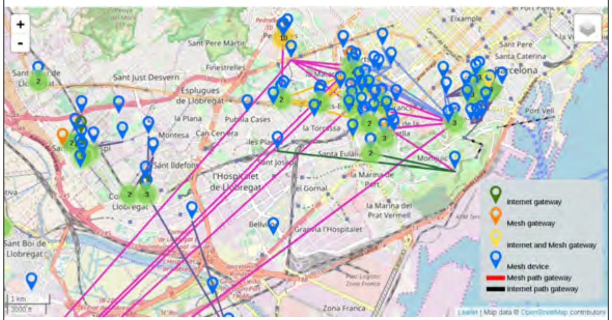
- Autoconfiguración automágica
  - Flasheo del dispositivo y listos
- IPv6 nativo
  - ¡Bienvenidos a 1998!
- IPv4 tunelado sobre IPv6
- Interfaz web de gestión y monitoreo
- Routing dinámic automágico con BMX6
- FLOSS

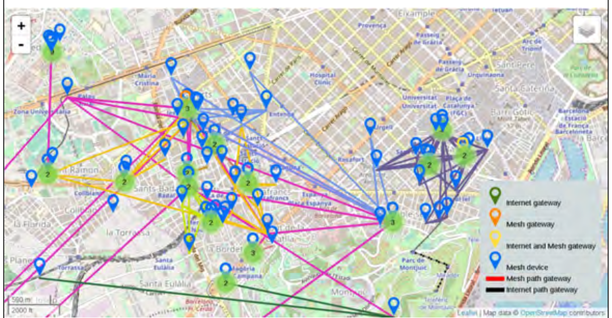
- Para dispositivos compatibles con OpenWrt
  - > 32 MB RAM, > 4MB flash

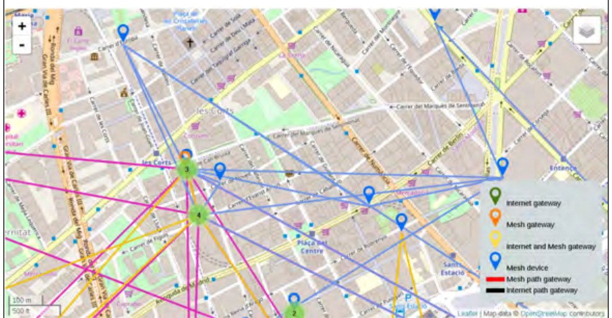
29

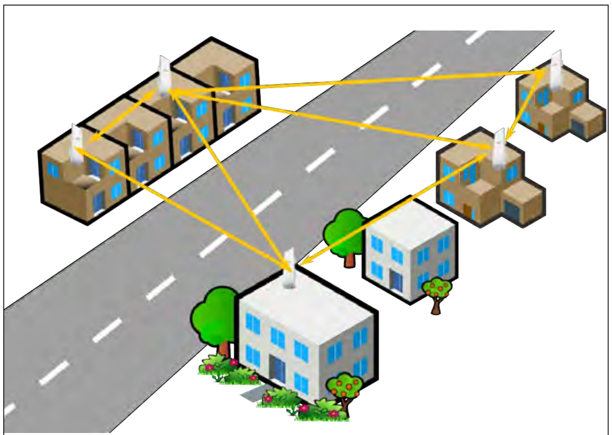












Práctica 2: despliegue RC WiFi mesh

- Actividad: Construir un despliegue de RC WiFi usando tecnología mesh
- Metodología: Replicar arquitectura de la transparencia anterior
  - Compartir entre varios usuarios de una comunidad una conexión a Internet de forma oportunista
    - ¡Así empezó ***guifisants·net***! http://sants.guifi.net
  - Usaremos el firmware qMp – Quick Mesh Project http://qmp.cat
  - Como estamos todos en un laboratorio, a pocos metros de distancia un nodo de otro, tendremos que complicar artificialmente el despliegue
  - Si da tiempo y conviene, pensaremos cómo gestionar el acceso de los usuarios finales
- Material: dispositivos habitualmente usados en RRCC
  - Routers WiFi para exteriores (CPE) operando a 5 Ghz
  - n+1 nodos mesh
  - Conexión ADSL // F.O. // SAT
  - n clientes (estaciones) en ubicaciones remotas (casa, centro comunitario, etc.)
- Objetivo: conocer la magnitud de la tragedia v2.0
  - ¿Se nos ha escapado algo?

36

Más allá de la práctica 2

- Para saber más:
  - qMp – https://qmp.cat
  - LibreMesh - https://libremesh.org
  - LibreRouter - https://www.librerouter.org
  - NYCmesh - https://www.nycmesh.net/blog/how/
  - Wireless Battle of the Mesh - https://www.battlemesh.org/

37

¿Todo resuelto?

- La arquitectura mesh funciona muy bien
  - Es muy flexible, pero a costa de un peor rendimiento
- Las redes grandes requieren planificación
  - Enlaces P2P «troncales»
- Escalabilidad
  - La red qMp en producción más grande tiene ~100 nodos
- Seguimos trabajando en ello
  - BMX7
    - Semtor
- Parte económica, social, organizativa

38

Economía de Redes comunitarias

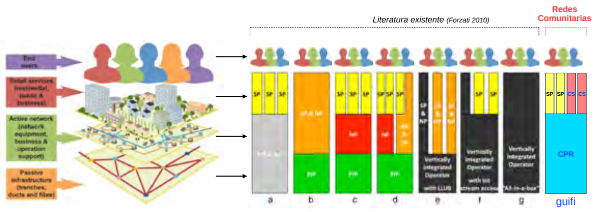
- Contexto: Modelos de negocio
- Dimensión temporal
- Dimensión geográfica
- Introducción a los costos
- Problema general y el subproblemas económicos
- Sistema de compensación de costes
- Ejemplos de aplicación

26-30/11/2018 WALC 2018 CN 1 / 24

Modelos de negocio I

Situación de CNs en el contexto general

Capas de red de acceso **Modelos de capas de provisión**



(Alcatel-Lucent)

PIP - Proveedor de Infraestructura Física
NP - Proveedor de la red
SP - Proveedor de servicios
LLUB - Desagregación del bucle local

CPR - Recurso Común
CS - Servicio de la comunidad

26-30/11/2018 WALC 2018 CN 2 / 24

Modelos de negocio II

Estamos hablando de...

- Gestión de activos de red en formato de procomún extensible
- ... donde todos los usuarios comparten, gestionan y mejoran la misma infraestructura según unas normas iguales para todos (no discriminación)
- … donde las empresas pueden ofrecer sus servicios en igualdad de condiciones

=> Las empresas compiten en servicios en un mercado realmente único, pero no en infraestructura

26-30/11/2018 WALC 2018 CN 3 / 24

Modelos de negocio III

Beneficios de la infraestructura como CPR

- Aumento de la eficiencia (i.e. incremento de prestaciones o más cobertura con la misma inversión)
  - Estimula la cooperación
  - Evita la duplicación de infraestructuras y esfuerzos
  - Facilita las economías de escala
- Maximiza la oferta
  - Coexistencia de DIY () y soluciones profesionales
  - Iguala las oportunidades empresariales
    - Baja las barreras de entrada
    - Mismo único mercado para todos
- Actividad empresarial
  - Comporta la dependencia de la infraestructura (para cumplir las SLAs)
    - Asegura la reinversión
- Fiel a los principios de CNs
  - Inclusión, solidaridad, redistribución de la riqueza, igualdad de oportunidades

26-30/11/2018 WALC 2018 CN 4 / 24

Modelos de negocio IV
Infraestructura como CPR vs como activo privativo

	CPR – Economía colaborativa	Activo privativo - “libre mercado”
Gestiona	Un recurso procomún	Bienes y usos privativos
Objetivo	Maximización del beneficio social (utilidad del recurso compartido)	Maximización de beneficios de los inversores
Estrategia	Maximización de la coordinación	Maximización del market-share (monopolio idealmente)
Gobernanza	Auto-gobierno, auto-regulación	Necesita de legislación y regulación externa
Inversiones	Colectivas, a largo término. O	Cortoplacistas y especulativas
Características	Orientado a costes, inclusivo, solidario, sostenible, redistributivo, solidario, de proximidad	Discrecional, extractivo, especulativo, fallos de mercado

26-30/11/2018 WALC 2018 CN 5 / 24

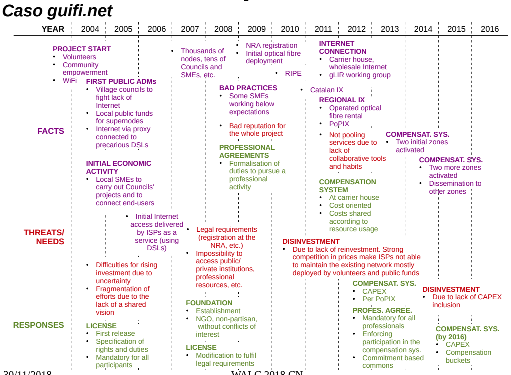
Dimensión temporal I
Objetivos por fases

	COMUNIDAD	INFRAESTRUCTURA	FINANCIACIÓN	EMPRESA
INICIO	* Conocimientos básicos * Principios fundamentales (incluyendo posibilidad negocio	* Despliegue mínimo completo operativo: casa - centro de connección – Internet * Servicios locales	* Beneficiarios (crowdfunding) * AAPPs locales * Orgs internacionales	* Puede haber empresas des el principio
ESTABILIZACIÓN	* Afianzar conocimientos * Entidad legal (L2)	* Despliegue mínimo→municipio * Legal: licencia	* Inversión empresas * Otros inversores	* Instaladores * Servicio acceso Inet
ESCALA	* Agregación * Participación regulación y legislación	* Réplica en muchos municipios * Red troncal * Backbone * NOC	* Créditos bancarios * Universal Service Funds	* Consolidación empresas * Empresas nuevas * Especialización * “franquicias”
RÉPLICA	* Más L2 y federación (L3)?	* Más NOCs (conectados directamente o no)	* Fondos estructurales * Sistematización del sistema creditício	* Consorcios?

Desarrollo incremental y iterativo por retos
Las soluciones tiene que escalar x10

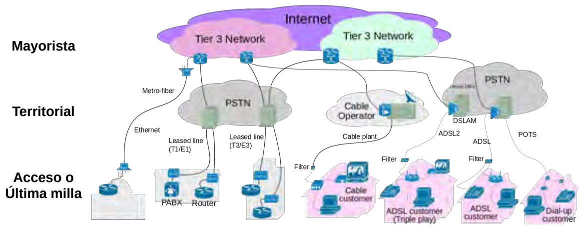
26-30/11/2018 WALC 2018 CN 6 / 24

Dimensión temporal II
Caso guifi.net



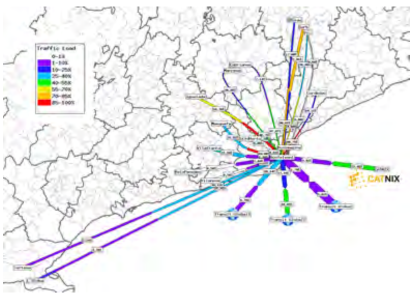
26-30/11/2018 WALC 2018 CN 7 / 24

Dimensión geográfica I
Tramos de red



26-30/11/2018 WALC 2018 CN 8 / 24

Dimensión geográfica II
Caso guifi.net – Territorial y mayorista (2015)



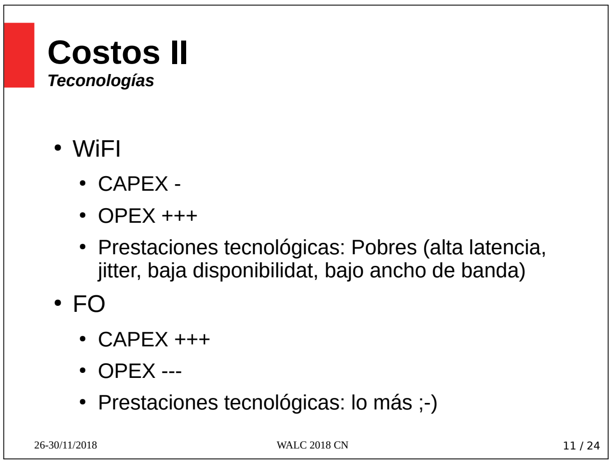
26-30/11/2018 WALC 2018 CN 9 / 24

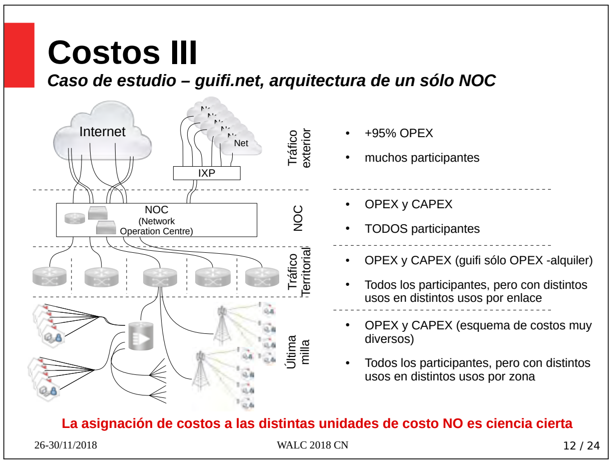
Costos I
Conceptos básicos

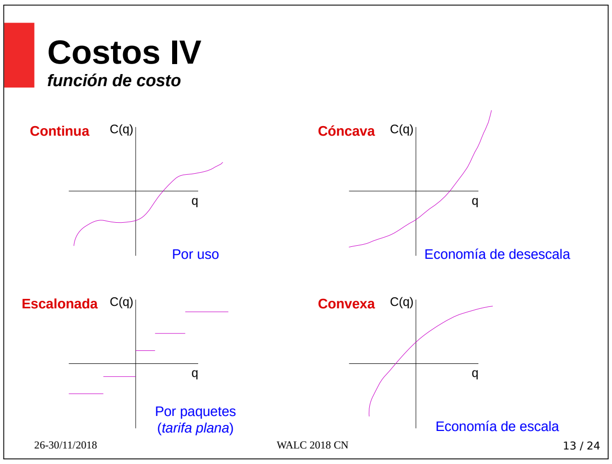
- CAPEX
  - Costos de capital → adquisición de activos
  - Financiables (diferibles en el tiempo)
  - Ej: Hardware, obra civil, altas servicios
- OPEX
  - Costos de operación → gastos corrientes
  - NO financiables
  - Ej: Mano de obra, servicios, alquileres

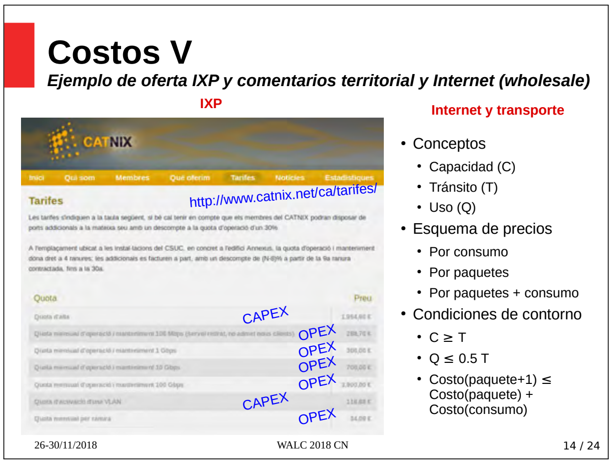
La clasificación NO es ciencia cierta en el 100% de los casos
(algunos costos pueden ser considerados CAPEX o OPEX)

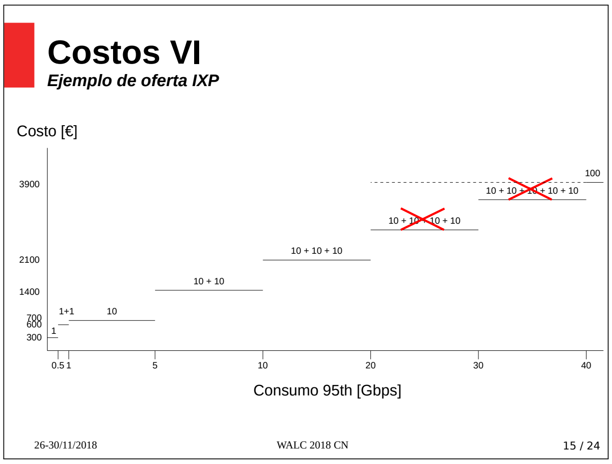
26-30/11/2018 WALC 2018 CN 10 / 24

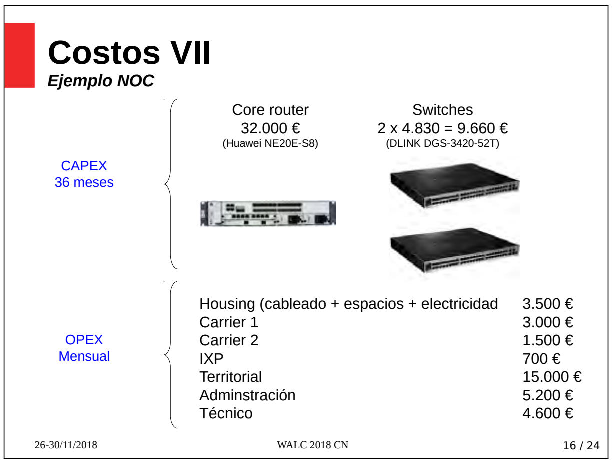

Costos II
Teconologías
• WiFI
• CAPEX -
• OPEX +++
• Prestaciones tecnológicas: Pobres (alta latencia, jitter, baja disponibilidat, bajo ancho de banda)
• FO
• CAPEX +++
• OPEX ---
• Prestaciones tecnológicas: lo más ;-)
26-30/11/2018
WALC 2018 CN
11 / 24


Costos III
Caso de estudio – guifi.net, arquitectura de un sólo NOC
Internet
Net
IXP
NOC
(Network
Operation Centre)
Tráfico exterior
NOC
Tráfico Territorial
Última milla
• +95% OPEX
• muchos participantes
• OPEX y CAPEX
• TODOS participantes
• OPEX y CAPEX (guifi sólo OPEX -alquiler)
• Todos los participantes, pero con distintos usos en distintos usos por enlace
• OPEX y CAPEX (esquema de costos muy diversos)
• Todos los participantes, pero con distintos usos en distintos usos por zona
La asignación de costos a las distintas unidades de costo NO es ciencia cierta
26-30/11/2018
WALC 2018 CN
12 / 24


Costos IV
función de costo
Continua
C(q)
q
Por uso
Cóncava
C(q)
q
Economía de desescala
Escalonada
C(q)
q
Por paquetes
(tarifa plana)
Convexa
C(q)
q
Economía de escala
26-30/11/2018
WALC 2018 CN
13 / 24


Costos V
Ejemplo de oferta IXP y comentarios territorial y Internet (wholesale)
IXP
CATNIX
Tarifes
http://www.catnix.net/ca/tarifes/
Quota
Preu
CAPEX
OPEX
OPEX
OPEX
OPEX
CAPEX
OPEX
Internet y transporte
• Conceptos
• Capacidad (C)
• Tránsito (T)
• Uso (Q)
• Esquema de precios
• Por consumo
• Por paquetes
• Por paquetes + consumo
• Condiciones de contorno
• C ≥ T
• Q ≤ 0.5 T
• Costo(paquete+1) ≤ Costo(paquete) + Costo(consumo)
26-30/11/2018
WALC 2018 CN
14 / 24

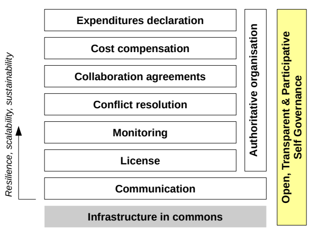

Costos VI
Ejemplo de oferta IXP
Costo [€]
3900
2100
1400
700
600
300
100
10 + 10 + 10 + 10 + 10
10 + 10 + 10 + 10
10 + 10 + 10
10 + 10
1+1
10
1
0.5 1
5
10
20
30
40
Consumo 95th [Gbps]
26-30/11/2018
WALC 2018 CN
15 / 24


Costos VII
Ejemplo NOC
CAPEX
36 meses
Core router
32.000 €
(Huawei NE20E-S8)
Switches
2 x 4.830 = 9.660 €
(DLINK DGS-3420-52T)
OPEX
Mensual
Housing (cableado + espacios + electricidad) 3.500 €
Carrier 1 3.000 €
Carrier 2 1.500 €
IXP 700 €
Territorial 15.000 €
Adminstración 5.200 €
Técnico 4.600 €
26-30/11/2018
WALC 2018 CN
16 / 24

Problema general

- Contexto: claros incentivos para la colaboración
  - Sociales
    - Aumento de la eficiencia de la inversión
    - Despliegues en zonas desatendidas
    - Redistribución de la riqueza
  - Económicos
    - Economías de escala
    - Acceso a servicios (y calidades) inalcanzables individualmente
    - Acceso a un mercado único
- Reto
  - Sistema para hacer posible la colaboración
    - Requerimientos: seguridad jurídica y respeto a los principios de CNs

Solución: gobernaza



26-30/11/2018 WALC 2018 CN 17 / 24

Subpoblemas económicos

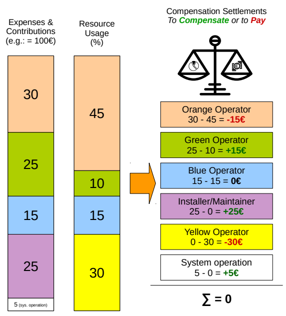
- Financieros
- Gestión de empresas
- ...
- Repartición de costos del CPR
  - El más específico
  - Uno de los que ha generado más interés

26-30/11/2018 WALC 2018 CN 18 / 24

Sist. de compensación de costos I

Fundamentos

- Reto: Repartir de manera justa los costos de provisión del CPR dado que hay distintos grados de apropiación
  - Observación: "justo" es un término subjetivo => no hay una única solución
- Enfoque de la solución
  - Contribución fija + contribución variable en función de la apropiación
  - Hay apropiadores que no tienen porqué participar
  - Reglas claras, conocidas y preestablecidas
  - Diseño participativo
- La solución
  - Genérica: pensamos que válida por cualquier CPR
  -

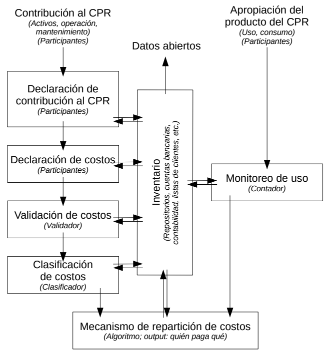


26-30/11/2018 WALC 2018 CN 19 / 24

Sist. compensación de costos II

Componentes

- Inventario
  - Lo que no está en el inventario no existe
  - Pieza central: sistema de datos para la comunicación entre todas las funcionalidades; todas extraen y aportan info
- Declaración de contribuciones / de costos
  - Autoservicio
- Validación de costos / Clasificación de costos / monitoreo de uso / mecanismo
  - Roles ejecutados por agentes legítimos



26-30/11/2018 WALC 2018 CN 20 / 24

Sist. compensación de costos II

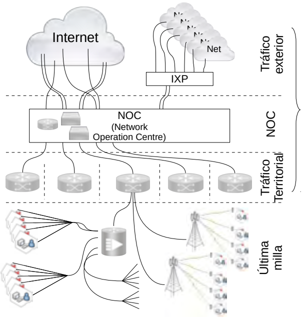
Mesas de compensación

- Cámaras de compensación
  - Regionales o temáticas
- Necesitan de agentes legítimos
  - Sin conflicto de interés
- Seguramente hay que
  - Es sano distinguir entre CAPEX y OPEX (pq tienen realidades muy distintas)
  - Es eficiente agrupar costos por unidades funcionales (no todos los participantes usan todo)
- Mesa de compensación: reunión periódica de los participantes donde
  - Se aprueban los cálculos del ciclo vencido
  - Se revisan las reglas de juego para los ciclos venideros
  - Se planifican inversiones y acciones futuras

26-30/11/2018 WALC 2018 CN 21 / 24

Sist. compensación de costos III

Caso de estudio – guifi.net, Mesas de compensación



- Cámara única (BCN-ZF)
- CAPEX y OPEX conjuntamente (a separar en el futuro)
- La Fundació se paga todas facturas a terceros
- Unidades funcionales
  - Comunes → reparto entre el número de participantes
  - NOC → reparto por tráfico de cada part.
  - Tráfico exterior → reparto por tráfico de cada part.
  - Tráfico territorial → reporte por trafico de cada circuito y part.
  - Espacios → reparto por Us' de cada CPD y part.

- Una cámara por PoPIX (punto de presencia territorial)
  - Cámara de CAPEX
  - Cámara de OPEX
- Contribuciones básicamente de agentes locales (beneficiarios, operadores, instaladores)

26-30/11/2018 WALC 2018 CN 22 / 24

Sist. compensación de costos III

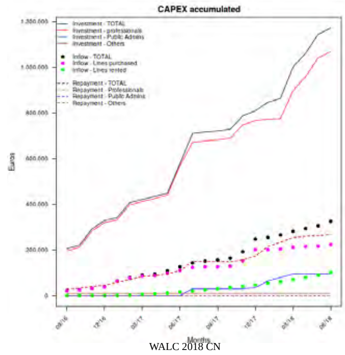
Caso de estudio – guifi.net, Mesa de compensación BCN-ZF

Participant	Quotes	Amort.	Espais	Territorial	Extern	SUMA	Tipus	Contribució	BALANÇ
1	162,00	0,00	0	451,18	201,30	814,48	A	0,00	814,48
2	162,00	17,34	50	66,48	30,63	326,45	A	0,00	326,45
3	162,00	0,00	200	1.439,26	1.242,82	3.044,08	A	0,00	3.044,08
4	162,00	0,00	25	2.565,33	2.468,14	5.220,48	A	0,00	5.220,48
5	162,00	0,00	0	871,46	402,61	1.436,06	A	0,00	1.436,06
6	162,00	0,00	0	0,00	459,50	621,50	A	0,00	621,50
7	162,00	0,00	0	28,49	13,13	203,62	A	0,00	203,62
8	162,00	0,00	0	208,92	96,28	467,20	A	0,00	467,20
9	162,00	0,00	0	123,46	56,89	342,34	A	0,00	342,34
10	162,00	215,62	25	1.142,23	494,50	2.039,36	A	0,00	2.039,36
11	162,00	1.832,18	970	8.380,33	5.401,46	16.745,98	A	0,00	16.745,98
12	162,00	0,00	0	92,95	78,77	333,72	A	0,00	333,72
13	162,00	0,00	50	28,49	13,13	253,62	A	0,00	253,62
14	162,00	10,10	0	50,25	2.748,22	2.970,57	A	0,00	2.970,57
15	162,00	0,00	0	55,34	26,26	243,60	B	0,00	243,60
16	162,00	0,01	25	335,04	20,13	542,18	A	0,00	542,18
17	162,00	18,56	0	44,50	0,88	225,93	A	0,00	225,93
18	162,00	0,00	200	28,49	33,13	423,62	A	0,00	423,62
19	162,00	0,00	400	1,90	0,88	564,77	A	0,00	564,77
20	162,00	180,37	50	884,39	437,61	1.714,38	A	0,00	1.714,38
21	162,00	66,51	0	189,44	161,92	579,87	A	0,00	579,87
22	162,00	1,03	915	2.402,80	570,00	4.050,83	A	0,00	4.050,83
23	162,00	253,53	0	1.278,02	582,03	2.275,57	A	0,00	2.275,57
24	162,00	0,00	25	55,93	3.873,96	4.116,89	A	0,00	4.116,89
TOTAL	3.888,00	2.595,26	2.935,00	20.724,66	19.414,16	49.557,08		0,00	49.557,08

26-30/11/2018 WALC 2018 CN 23 / 24

Sist. compensación de costos V

Caso guifi.net – Ejemplo de impacto CAPEX Garrotxa



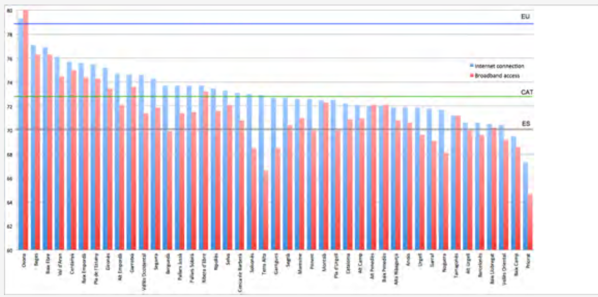
26-30/11/2018 WALC 2018 CN 24 / 24

Día 3: Planificación, diseño, despliegue y operación de redes

1. Planificación
2. Diseño
3. Despliegue
4. Operación
5. Actividad: "mapeo" de una zona, identificar escenario a 1-6-24 meses

- 10 min conjuntos para hacer lista de posibles lugares
- 30 min en grupos para trabajar
- 15 min exposición de resultados

Banda ancha + acceso Internet doméstica



Fuente: IDESCAT 2013

2 / 45

Planificación

- Mapeo:
  - Población, demanda, densidad: volumen y tipos
  - Aliados y competidores (para el despliegue)
  - Ingresos y gastos
  - Aspectos legales
  - Financiación inicial

Diseño

- Qué tecnologías usar?
  - Algunos Mbps (3G), 100 Mbps (4G), 1G (5G)
  - Radio (mesh, p2p), fibra (¿cómo?)
- Cobertura usuarios
  - Tipo de vivienda (cubierta para radio, suelo para fibra, distribución interna)
- Zonas: urbanas, distancia, visión
- Interconexión
  - Distancias, capacidad, redundancia
- Salida a Internet
  - Minorista (agregación), mayorista, IXP, carrier

Hacia la sociedad a gigabit

- Generaciones de radio:
  - 0.0002+ Gbps: (algunos Mbps) → 3G
  - 0.450 Gbps: IEEE 802.11n → Wi-Fi 4
  - 0.1-1 Gbps: IMT-A LTE celular 4G
  - 1 Gbps: IEEE 802.11ac → Wi-Fi 5
  - 1-10 Gbps: 3GPP 5 → celular 5G
  - 10 Gpbs: IEEE 802.11ad,ax → Wi-Fi 6
  - 100 Gbps?: IEEE 802.11ay? → 7G

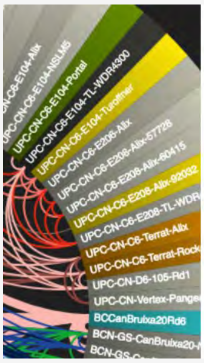
Terminología por generaciones de la Wi-Fi Alliance

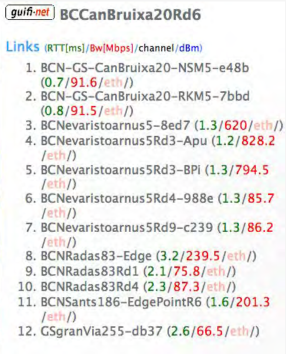
Mobilidad en IEEE 802.11:
s: mesh,
r: roaming,
k: gestión,
v: configuración

Tecnología radio:
OFDMA,
MIMO,
array antenas,
femtocells,
"nueva radio"

3G, 4G, 5G y redes comunitarias

http://dsg.ac.upc.edu/qmpsu




guifi·net BCCanBruixa20Rd6

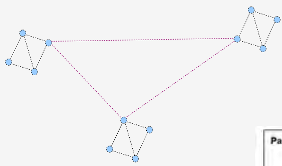
Links (RTT[ms]/Bw[Mbps]/channel/dBm)

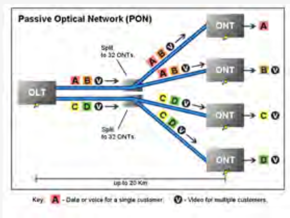
1. BCN-GS-CanBruixa20-NSM5-e48b (0.7/91.6/eth/)
2. BCN-GS-CanBruixa20-RKM5-7bbd (0.8/91.5/eth/)
3. BCNevaristoarnus5-8ed7 (1.3/620/eth/)
4. BCNevaristoarnus5Rd3-Apu (1.2/828.2/eth/)
5. BCNevaristoarnus5Rd3-BPi (1.3/794.5/eth/)
6. BCNevaristoarnus5Rd4-988e (1.3/85.7/eth/)
7. BCNevaristoarnus5Rd9-c239 (1.3/86.2/eth/)
8. BCNRadas83-Edge (3.2/239.5/eth/)
9. BCNRadas83Rd1 (2.1/75.8/eth/)
10. BCNRadas83Rd4 (2.3/87.3/eth/)
11. BCNSants186-EdgePointR6 (1.6/201.3/eth/)
12. GSgranVia255-db37 (2.6/66.5/eth/)

Factibilidad: tecnología

- Un nodo (router)
- Un nodo y un servicio (salida Internet, wikipedia o video local, punto de acceso)
- Dos nodos, un enlace (ruta estática)
- Tres o más nodos: una malla (routing)
- Reuniones comunitarias (periódicas) para compartir información y coordinación entre el equipo central

Combinación de tecnologías

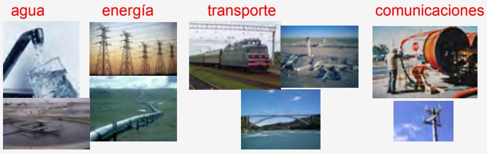




Grandes infraestructuras

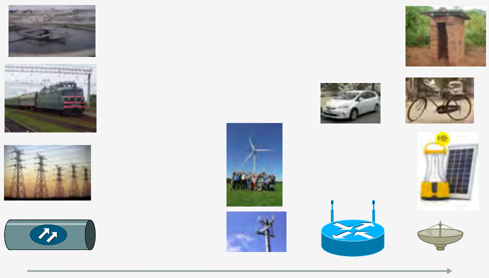
- Infraestructuras técnicas de soporte a la sociedad
  - Grandes
  - Construídas a lo largo de generaciones
  - No se reemplaza a menudo en su conjunto
  - Reacondicionamiento continuo de los componentes
  - Componentes interdependientes con interfaces bien definidas
  - Alto costo inicial

agua energía transporte comunicaciones



Fuente: H. Schulzrinne, 2014

Infraestructura: centralizada o no



centralized
more coordination

distributed
less coordination

Fuente: H. Schulzrinne, 2014

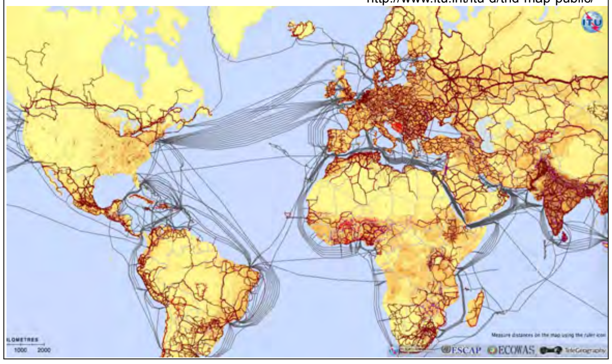
Coste fibra

30%

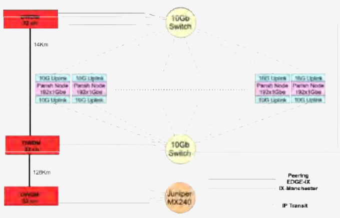
Fuente: H. Schulzrinne, 2014

Cables (fibra): terrestre + submarino

http://www.itu.int/itu-d/tnd-map-public/



B4RN red



Viabilidad: una organización

- Reunión de inicio (todos los interesados)
- Autoridad (junta) entre los miembros financiadores
- Licencia de operación
  Aspectos legales: registro de la asociación, operador, cuenta bancaria, etc.
- Licencia de participación (interno)
- Herramientas de comunicación
  Listas de correo, mensajería instantánea, web público, mapa, email contacto, lugar de reunión
- Modelo de inversión/contribución (crowdfunding)

Según inca.coop

Despliegue

- ¿Por dónde comenzar?
- Permiso:
  - Proveedor de servicios (registro)
  - Obligaciones (licencia)
  - Obstáculos ...
- Infraestructuras a reutilizar
- Compartición de costes (público, privado, operadores)
- Despliegue universal (inversión/paso privada, pública)
- Cobertura zona o “backbone”

Compartir entre participantes (común)

- Valor:
  - Voluntarios (su conexión, aprender)
  - Profesionales (ingresos) y clientes (precio)
  - Permisos de paso
  - Inversores (título de participación, retorno en conectividad o financiero)
- Complementariedad:
  - La expansión u operación de la red atrae a más participantes y contribuye a la sostenibilidad de lo común.
- Oposición (competición):
  - Cooperación o competencia: costes

Comunicación

- Contactos
- Formación
- Promoción
- Nuevos participantes
- Soporte

Operación

- ¿Quién puede operar la red?
- ¿Cómo mantener?
  - Si hay una tormenta, la electricidad, si falla, si hay congestión, …
- ¿Cuánto cuesta?
- ¿Quién se encarga?

Asociación (la red)

- Asociación sin ánimo de lucro:
  - Cuotas de uso (matenimiento)
  - Conexión a Internet, telefonía, ...
  - Acceso público ¿?
- Empresas sociales:
  - Empresas con objetivos principalmente sociales, cuyos excedentes se reinvierten principalmente con ese fin en la empresa o en la comunidad
- Empresas comerciales:
  - Expansión con inversores, riesgo/beneficio, excedentes para el promotor

Operadores privados en guifi.net

https://www.ecrowdinvest.com/detalles/goufone-2-muntanyola

Experiencia de asociación público-privada en inversión y despliegue de fibra rural

- Modelo de inversión: en la comarca de la Garrotxa con fibra (10 M€)
  - Incentivos: Prioridad en el momento de la conexión
  - Desgravación fiscal (deducción fiscal entre el 30 y el 75%)
  - Rendimiento de la inversión
- Modelo de ordenanza municipal:
  - Base para los acuerdos con los municipios, alineados con la directiva de la UE (EU/61/2014) para la reducción de costes y la transposición (RE/330/2016).
- Desarrollo de la plataforma para la gestión de la fibra

Actividad: elección, planificación de red comunitaria

- Actividad: elegir una zona de actuación ¿dónde?
- ¿Qué población tiene? características, número
- ¿Qué necesidades?
- ¿Infraestructuras existentes?
- Aliados, recursos, obstáculos a salvar (canvas)
- ¿Cómo empezar?
- Diseño: demanda, viabilidad, tecnologías, servicios, crecimiento (sostenibilidad, adaptabilidad)

Declaración de gastos y liquidación de compensaciones

La brecha entre lo urbano y lo rural

- Desarrollo: mercado global,
  mercado local, subsistencia!
- Eficiencias e ineficiencias en cada contexto
- Uniformidad de oferta, abuso posición y escala

Fuente: UIT

Sistema de facturación unificado + división de ingresos

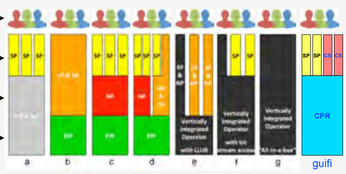
- Redes Comunitarias (CNs)
  - Los ciudadanos y las organizaciones ponen en común recursos y coordinan esfuerzos para construir infraestructuras de red.
  - Rasgos: abierto, libre, neutro
  - Ejemplos: FreiFunk (Alemania), FunkFeuer (Austria), wlan Eslovenia, B4RN (Reino Unido), etc.
- Desafío
  - Típicamente basado en esfuerzos voluntarios y contribuciones no reembolsables → ¿Cómo hacerlos **sostenibles** y **escalables**?
- Respuesta de Guifi.net
  - Permitir la **actividad profesional** y,
  - Desarrollar mecanismos para asegurar la **reinversión** de una fracción de los beneficios de la actividad profesional.
    - Acuerdo sobre actividades económicas y participación en el sistema de compensación
    - Liquidaciones de compensación
    - Separación de ingresos y contabilidad

Resultados

Capas de red de acceso

(Alcatel-Lucent)

Modelos de capas de provisión



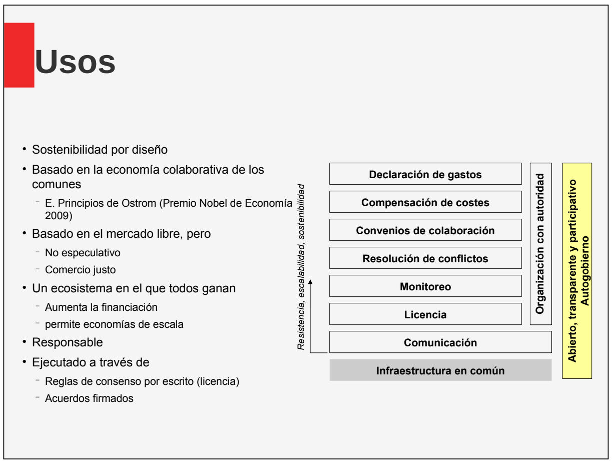
PIP - Proveedor de Infraestructura Física
NP - Proveedor de la red
SP - Proveedor de servicios
LLUB - Desagregación del bucle local

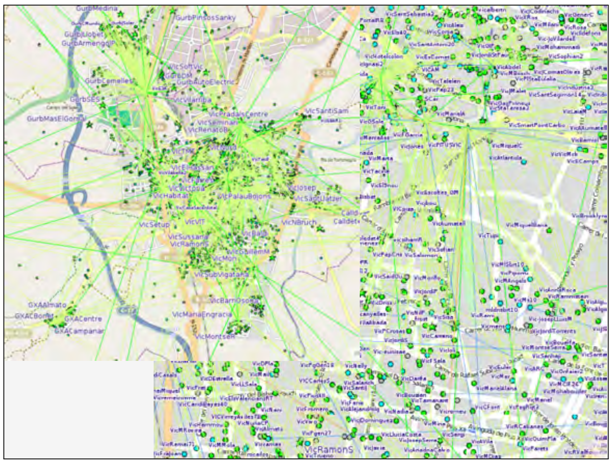
CPR - Recurso Común
CS - Servicio de la comunidad

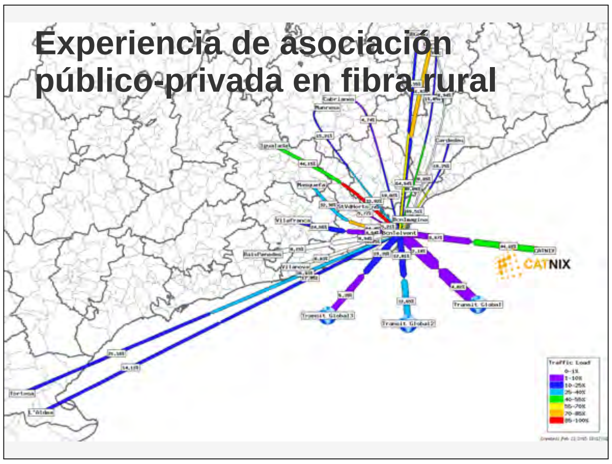
(Forzati 2010)

Compartir cables de fibra en el espacio público: efectos, incentivos

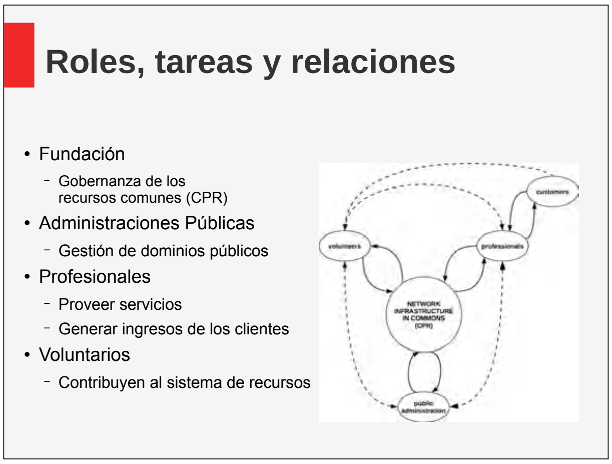
- La puesta en común de la infraestructura de red pasiva y activa produce conectividad de forma cooperativa
- Servicios de valor añadido proporcionados por la comunidad y los proveedores de servicios
- Riesgos de recursos comunes **Agotamiento**
- Problema identificado y bien abordado en otros campos
- E. Obras de Ostrom, etc.

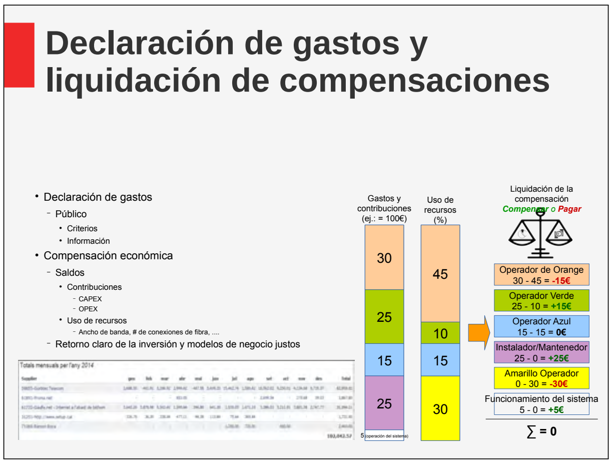

Usos
Sostenibilidad por diseño
Basado en la economía colaborativa de los comunes
E. Principios de Ostrom (Premio Nobel de Economía 2009)
Basado en el mercado libre, pero
No especulativo
Comercio justo
Un ecosistema en el que todos ganan
Aumenta la financiación
permite economías de escala
Responsable
Ejecutado a través de
Reglas de consenso por escrito (licencia)
Acuerdos firmados
Resistencia, escalabilidad, sostenibilidad
Declaración de gastos
Compensación de costes
Convenios de colaboración
Resolución de conflictos
Monitoreo
Licencia
Comunicación
Infraestructura en común
Organización con autoridad
Abierto, transparente y participativo
Autogobierno



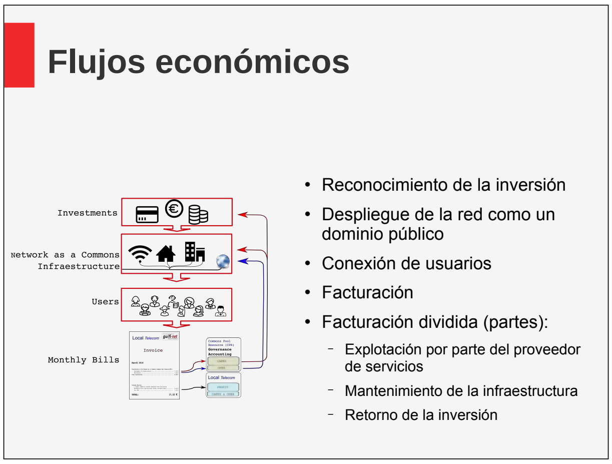

Experiencia de asociación público-privada en fibra rural
CATNIX

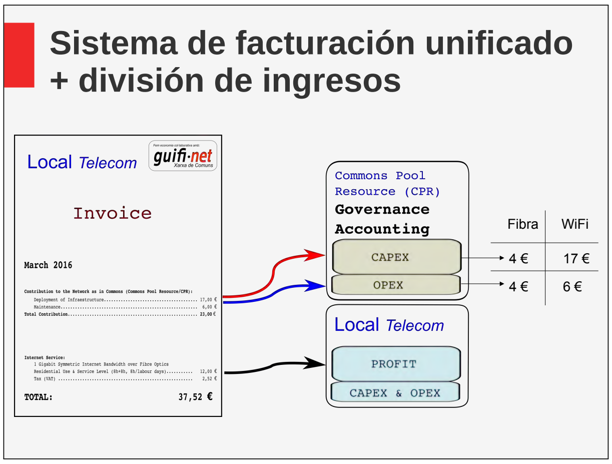

En resumen
Una economía colaborativa con....
guifi·net
La red como un bien común
Ciudadanos involucrados (voluntarios)
Gobiernos inteligentes
Pymes y organizaciones involucradas


Roles, tareas y relaciones
Fundación
Gobernanza de los recursos comunes (CPR)
Administraciones Públicas
Gestión de dominios públicos
Profesionales
Proveer servicios
Generar ingresos de los clientes
Voluntarios
Contribuyen al sistema de recursos
customers
volunteers
professionals
NETWORK INFRASTRUCTURE IN COMMONS (CPR)
public administration


Declaración de gastos y liquidación de compensaciones
Declaración de gastos
Público
Criterios
Información
Compensación económica
Saldos
Contribuciones
CAPEX
OPEX
Uso de recursos
Ancho de banda, # de conexiones de fibra, ...
Retorno claro de la inversión y modelos de negocio justos
Totals mensuals per l'any 2014
Gastos y contribuciones (ej.: = 100€)
Uso de recursos (%)
30
25
15
25
5 (operación del sistema)
45
10
15
30
Liquidación de la compensación
Compensar o Pagar
Operador de Orange
30 - 45 = -15€
Operador Verde
25 - 10 = +15€
Operador Azul
15 - 15 = 0€
Instalador/Mantenedor
25 - 0 = +25€
Amarillo Operador
0 - 30 = -30€
Funcionamiento del sistema
5 - 0 = +5€
∑ = 0


Participación e implementación de las liquidaciones de compensación: **tablas de compensación**
Tablas de compensación
• Establecer los criterios de compensación territorial
• Frecuencia mensual
Operadores/ Proveedores de servicios
• Derechos
• Voz y voto
• Recibir compensaciones
• Hacer propuestas
• Deberes
• Para liquidar compensaciones
• Para proporcionar los datos a calcular las compensaciones
Administración Pública Inversores
(opcional)
• Derechos
• Voz y voto
• Calidad de voto y veto sobre cuestiones relacionadas con los beneficios
o la administración de fondos públicos
• Hacer propuestas
• Deberes
• Cumplir con los criterios de no discriminación e igualdad
Fundación guifi·net
• Derechos
• Voz
• Calidad de voto y veto sobre cuestiones relacionadas con los recursos en común
• Deberes
• Hacer propuestas
• Buscar consenso
• Contabilidad
• Ejecutar compensaciones


Flujos económicos
Investments
Network as a Commons Infraestructure
Users
Monthly Bills
• Reconocimiento de la inversión
• Despliegue de la red como un dominio público
• Conexión de usuarios
• Facturación
• Facturación dividida (partes):
– Explotación por parte del proveedor de servicios
– Mantenimiento de la infraestructura
– Retorno de la inversión


Sistema de facturación unificado + división de ingresos
Local Telecom
guifi·net
Invoice
March 2016
TOTAL: 37,52 €
Commons Pool Resource (CPR)
Governance
Accounting
CAPEX
OPEX
Local Telecom
PROFIT
CAPEX & OPEX
Fibra
WiFi
4 €
17 €
4 €
6 €

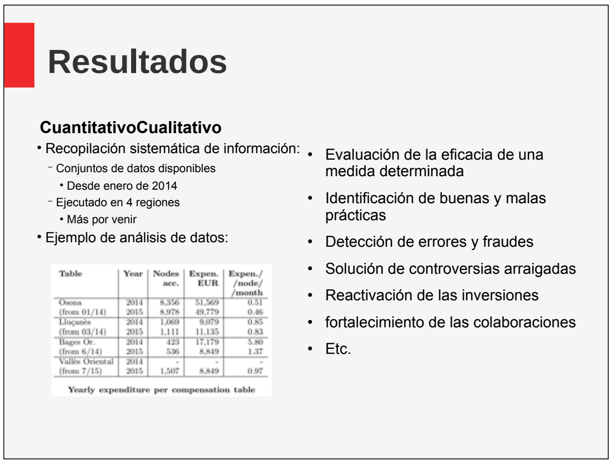

Resultados
CuantitativoCualitativo
• Recopilación sistemática de información:
– Conjuntos de datos disponibles
• Desde enero de 2014
– Ejecutado en 4 regiones
• Más por venir
• Ejemplo de análisis de datos:

Table	Year	Nodes acc.	Expen. EUR	Expen./ /node/ /month
Osona	2014	8,356	51,569	0.51
(from 01/14)	2015	8,978	49,779	0.46
Lluçanès	2014	1,069	9,079	0.85
(from 03/14)	2015	1,111	11,135	0.83
Bages Or.	2014	423	17,179	5.80
(from 6/14)	2015	536	8,849	1.37
Vallès Oriental	2014	-	-	-
(from 7/15)	2015	1,507	8,849	0.97

Yearly expenditure per compensation table
• Evaluación de la eficacia de una medida determinada
• Identificación de buenas y malas prácticas
• Detección de errores y fraudes
• Solución de controversias arraigadas
• Reactivación de las inversiones
• fortalecimiento de las colaboraciones
• Etc.


Formato de implementación universal
• Una iniciativa de la Fundación guifi.net
• **Ordenanza municipal** para el despliegue de redes de acceso a los servicios de telecomunicaciones de próxima generación (ANNGTS) en formato **universal**
• En el marco jurídico global, europeo, catalán y español
• Evolución tecnológica, Transformación económica, Evolución de los instrumentos normativos

Compartir cables de fibra en el espacio público: efectos, incentivos

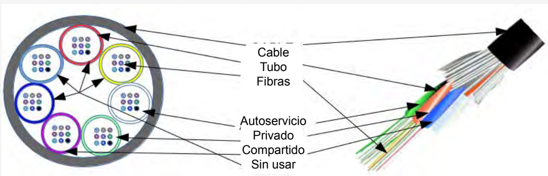
- Los usuarios son responsables de los costes de gestión y mantenimiento.
- Exención de los costes de mantenimiento para el autoservicio del ayuntamiento
- Implementación de la compartición o los bienes comunes:
  - El **coste de** gestión y mantenimiento de la infraestructura afecta a los operadores que la utilizan **proporcionalmente al uso que** cada uno hace de la misma, aplicando criterios de transparencia, ausencia de conflictos de intereses y no discriminación.
  - Para cumplir con estas condiciones, la implementación de la **compartición de los** bienes comunes se realiza a través de una **entidad** que es responsable de aplicar el **gobierno de** este uso compartido.

Usos

- a) Autoservicio para el ayuntamiento
  - Proporcionar comunicaciones públicas a servicios públicos inteligentes o de uso interno
- b) Privado
  - De manera privada por un operador que preste servicios a terceros (otros operadores o usuarios finales) o por una entidad privada que no sea un operador de autoservicio.
- c) Compartido entre otros operadores en común
  - Compartir entre operadores de la misma infraestructura de manera efectiva, a través de un esquema de gobernanza que garantice la ausencia de conflictos de intereses y que esté siempre abierto a cualquier operador cualificado que quiera participar en condiciones de transparencia e igualdad, creando así **un espacio compartido** (también llamado de comunes, neutral o abierto), en el que los costes de gestión y mantenimiento sean compensados proporcionalmente por los operadores que comparten la infraestructura ANNGTS y su uso.

Despliegue en formato Universal

- Despliegue que permite simultáneamente los tres usos descritos (autoservicio para el ayuntamiento, privado y uso compartido/común).

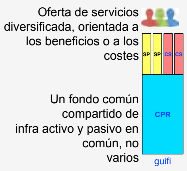


Formato de implementación universal

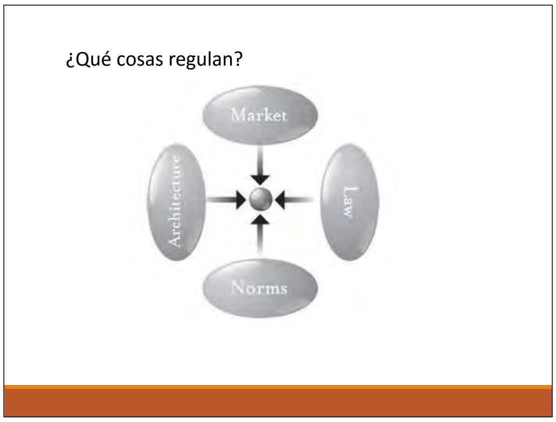
- Aumenta la eficiencia *(mejor rendimiento o mayor cobertura para la misma inversión)*
  - Estimula la cooperación
  - Evita la duplicación de infraestructura/esfuerzos
  - Facilita las economías de escala
- Maximiza la libertad de elección
  - Coexistencia de opciones de bricolaje y profesionales
  - Iguala las oportunidades de negocio
    - Reduce las barreras de entrada
    - Expande el mercado
- Actividad profesional
  - Implica dependencia de la infraestructura (para cumplir con los SLAs)
    - Reinversión necesaria
- Compatible con los principios de las CNs

En resumen

- Guifi.net ha desarrollado e implementado con éxito una solución para asegurar la **sostenibilidad** y **escalabilidad** más allá de los esfuerzos voluntarios y las contribuciones no reembolsables.
- Basado en
  - Permitir la **actividad profesional** y,
  - Desarrollo de herramientas que aseguren la **reinversión** de una fracción de los beneficios de esta actividad profesional.
- Respetuoso con los principios de CNs
- Aumenta la eficiencia
  - Estimula la cooperación
  - Evita la duplicación de infraestructura y esfuerzos
  - Facilita las economías de escala
- Maximiza la libertad de elección
  - Coexistencia de opciones de bricolaje y profesionales
  - Iguala las oportunidades de negocio
- Produce
  - Resultados cualitativos y cuantitativos



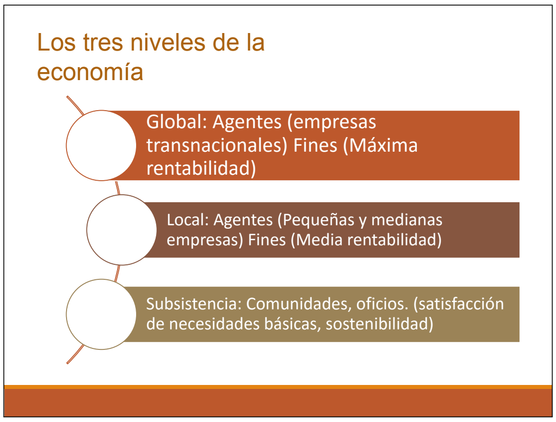

- Oiga ¿eso del Derecho es una invención?
... Sí
- Pues inventemos otro


¿Qué cosas regulan?
Market
Architecture
Law
Norms


Principios Básicos en Materia de Regulación de Telecomunicaciones
1. El espectro es escaso o abundante dependiendo del paradigma en que se base su regulación.
2. Existen tres niveles económicos cada uno con agentes específicos que persiguen fines distintos.


Espectro: Un lote o un derecho de tránsito
HOTEL

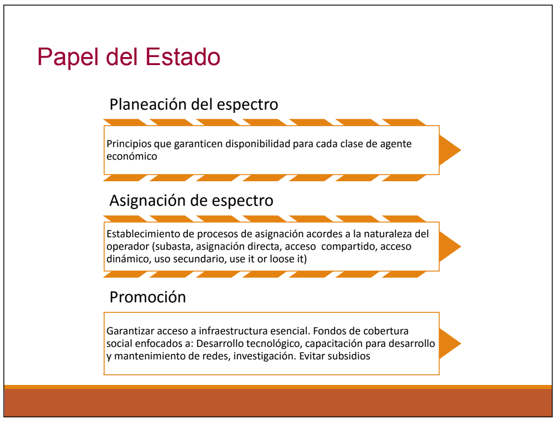

Regulación de espectro
• Espacio
• Tiempo
• Tipo de uso
La mayor combinación de estas variables determina una mayor eficiencia el aprovechamiento del espectro

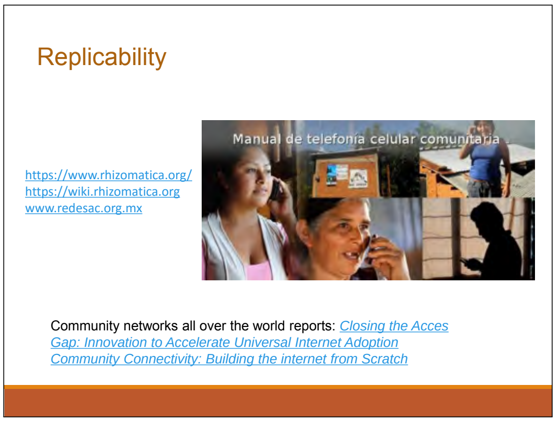

Los tres niveles de la economía
Global: Agentes (empresas transnacionales) Fines (Máxima rentabilidad)
Local: Agentes (Pequeñas y medianas empresas) Fines (Media rentabilidad)
Subsistencia: Comunidades, oficios. (satisfacción de necesidades básicas, sostenibilidad)


¿Qué le interesa a la Autoridad al otorgar una licencia?
Privado
Público
Económico
Técnico
Económico


Licencias ¿Cuándo, cómo?
Red privada espectro libre
No requiere licencia
Opera sin licencia
Red pública o espectro licenciado
Revisar organización y fines de la red
Licencia comercial o régimen especial social/rural
https://www.redesac.org.mx/regulacion


¿Cómo estructuro un solicitud?
Quién – Sujeto jurídico (Ej. pueblos indígenas, derecho al libre desarrollo de la presonalidad)
Qué va a hacer – Actividad esencial (derechos relacionados al acceso universal)
Para qué – Derechos aledaños (libertad de expresión, libre asociación, derechos culturales, derecho a la salud)
Con qué – Neutralidad tecnológica
https://docs.wixstatic.com/ugd/68af39_96b5e5248cc8447db5a9347b88c53db2.pdf
ejemplo


Papel del Estado
Planeación del espectro
Principios que garanticen disponibilidad para cada clase de agente económico
Asignación de espectro
Establecimiento de procesos de asignación acordes a la naturaleza del operador (subasta, asignación directa, acceso compartido, acceso dinámico, uso secundario, use it or loose it)
Promoción
Garantizar acceso a infraestructura esencial. Fondos de cobertura social enfocados a: Desarrollo tecnológico, capacitación para desarrollo y mantenimiento de redes, investigación. Evitar subsidios


Replicability
https://www.rhizomatica.org/
https://wiki.rhizomatica.org
www.redesac.org.mx
Manual de telefonía celular comunitaria
Community networks all over the world reports: Closing the Acces Gap: Innovation to Accelerate Universal Internet Adoption
Community Connectivity: Building the internet from Scratch

B.7. Battle of the Mesh 2018
Reference event Sec. 2.2.1
The netCommons project, (Leonardo Maccari)

THE NETCOMMONS PROJECT

2.5 YEARS AFTER THE BEGINNING OF NETCOMMONS, WHAT WE DID AND WHAT WE PLAN TO DO

UNIVERSITY OF TRENTO
Department of Information Engineering and Computer Science

netCommons

Leonardo Maccari, leonardo.maccari@unitn.it

Berlin, 10/5/2018

Co-Funded by the Horizon 2020 programme of the European Union, Grant Number 688768

Leonardo Maccari leonardo.maccari@unitn.it *the netcommons.eu project* 1/13

The netCommons Project

- H2020 Financed project (CAPS)
- 2016-2018
- 4 Universities
- 1 Research Center
- 1 not-for-profit association
- 6 countries

Leonardo Maccari leonardo.maccari@unitn.it *the netcommons.eu project* 2/13

Goals of netCommons

1. Help CNs with their challenges:
   - Governance
   - Sustainable growth
   - Internal services
2. Contribute to the development of Internet Science by expanding/generalizing results from the work on the community networks
3. . . . and, this way, strengthen the arguments in favor of community networks towards policymakers.

Leonardo Maccari leonardo.maccari@unitn.it *the netcommons.eu project* 3/13

netCommons

- 5 research Work Packages, each one devoted to a specific task.
- we have 12 Deliverables currently published.
- I will summarise the work we did and we plan to do.

Leonardo Maccari leonardo.maccari@unitn.it *the netcommons.eu project* 4/13

Work Package 1

Governing the CNs: Organizational Models for Sustainable Growth and Advocacy Capacity-Building

WP1 analyzes and clarifies the internal organizational model of different CNs. Organizational models influence both the socio-economic and management aspects of the network and the way relationships with external entities are implemented. The goal of this WP is to create a portfolio of organizational models that CNs can adopt to improve their internal governance, for a better and more democratic exploitation of their resources and to have a stronger impact on external society.

Leonardo Maccari leonardo.maccari@unitn.it *the netcommons.eu project* 5/13

Work Package 1: Themes

1. Documenting (some) existing networks around the world: D1.2
2. Documenting their governance, band and good practices: D1.4
3. Examples on How to build Advocacy Power: D1.5

Leonardo Maccari leonardo.maccari@unitn.it *the netcommons.eu project* 6/13

Work Package 2

Sustainable Growth in CNs: Socially, Economically and Technically Sustainable CNs

WP2 investigates the sustainability of CNs, it will identify its political and ethical values, the incentives to make CNs grow and the tools that CNs can use to monitor that the ethical values are kept intact with the growth of the network. It will clarify the political values of CNs, and the related aspects of sustainability for CNs.

Leonardo Maccari leonardo.maccari@unitn.it *the netcommons.eu project* 7/13

Work Package 2: Themes

- Defining sustainability for networks: D2.2
- Economic Sustainability and Community Currencies: D2.6
- Tools for monitoring the Distributed nature of a CN: D2.7
- Incentives for participating to CNs: D2.8

Leonardo Maccari leonardo.maccari@unitn.it *the netcommons.eu project* 8/13

Work Package 3

Enriching CNs: Applications, Technical Excellence, Local Fruition

WP3 is dedicated to open-source applications for CNs. This WP will build on existing open source projects for P2P cloud and streaming applications and use them as building blocks to develop applications that can exploit the potential of CNs for local communications in the fields of distributed cloud systems and P2P video streaming. We will also develop a participatory methodology to improve the self-production of applications by CN members, with special attention to CAPS, and applications for crowd* use of the technical and social resources of CNs.

Leonardo Maccari leonardo.maccari@unitn.it *the netcommons.eu project* 9/13

Work Package 3: Themes

- Local applications for CNs: D3.4
- A methodology for participatory design of applications: D3.3

Leonardo Maccari leonardo.maccari@unitn.it *the netcommons.eu project* 10/13

Work Package 4

CNs as Commons

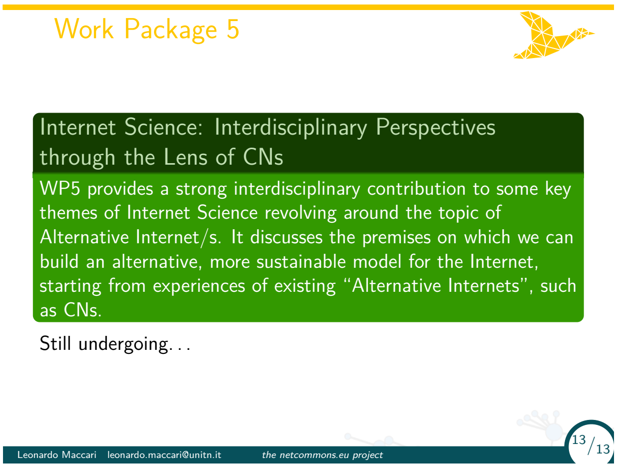
WP4 analyses CNs in relation to their surrounding socio-legal environment and produce general policy guidelines for the internal management of the CNs and for policy makers to preserve CNs as a commons. It raise awareness of the CNs managers and users on the legal constraints of their activity and produce recommendations for the policy-makers based on the CNs needs.

Leonardo Maccari leonardo.maccari@unitn.it *the netcommons.eu project* 11/13

Work Package 4: Themes

- Legal context for CNs: D4.2

Leonardo Maccari leonardo.maccari@unitn.it *the netcommons.eu project* 12/13


Work Package 5
Internet Science: Interdisciplinary Perspectives through the Lens of CNs
WP5 provides a strong interdisciplinary contribution to some key themes of Internet Science revolving around the topic of Alternative Internet/s. It discusses the premises on which we can build an alternative, more sustainable model for the Internet, starting from experiences of existing "Alternative Internets", such as CNs.
Still undergoing. . .
Leonardo Maccari leonardo.maccari@unitn.it
the netcommons.eu project
13/13

B.8. IETF 101 London, plenary talk
Reference event Sec. 2.2.2
"Go local: community networks" (Leandro Navarro)

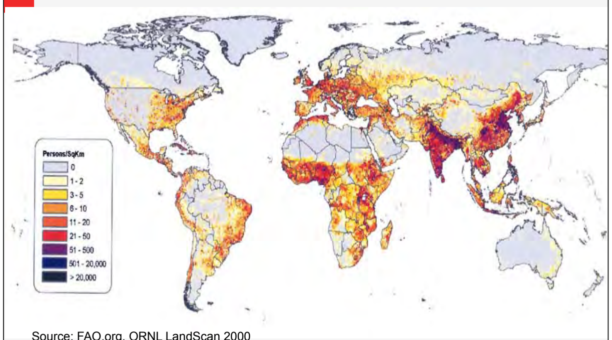
Go local: community networks

Leandro Navarro
Leandro.navarro@upc.edu
Barcelona

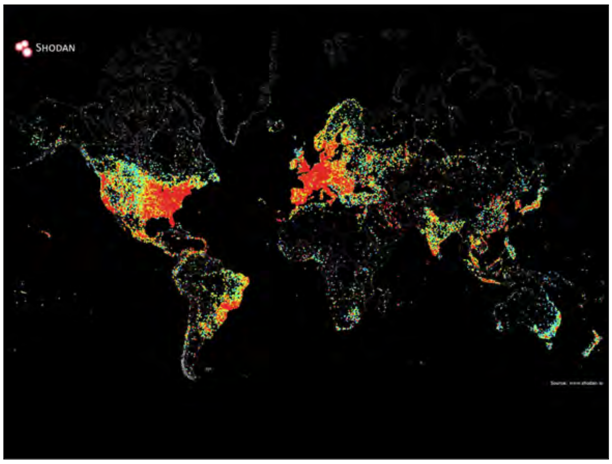
Supported by AmmbrTech, APC.org, Catalan gov, guifi.net, ISOC.org, netCommons.eu, Spanish gov

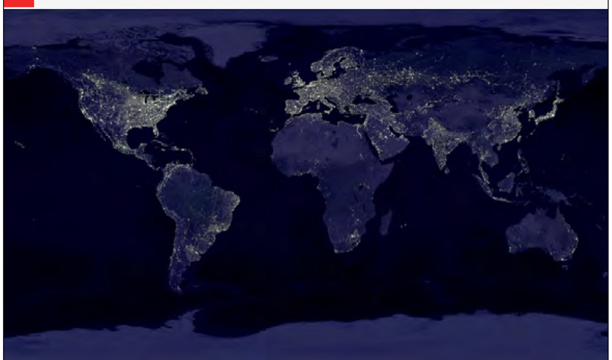
Internet is for everyone (RFC 3271) Vint Cerf 2002

- Everyone has the right to communicate, access to information
- *Article 19. Everyone has the right to freedom of opinion and expression; this right includes freedom to hold opinions without interference and to seek, receive and impart information and ideas through any media and regardless of frontiers.*
  (Universal Declaration of Human Rights)
- Not everyone has access, not everyone can provide it



Source: FAO.org, ORNL LandScan 2000





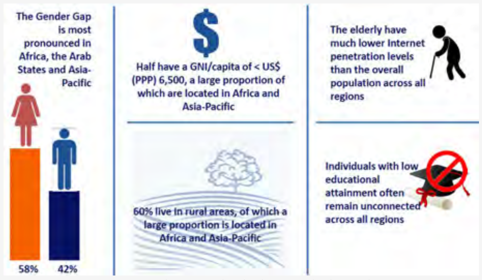
Connectivity in local communities

- Universal service (ECC)
  - Right to a functional internet connection … that is affordable and allows full engagement with the digital economy and society
- Urban: high population density and infrastructure
- Rural: not urban, not centres
- How to sustain connectivity and net services?
  - Business models & technology

Internet for everyone Distribution of offline population

Source: ITU.int, International Telecommunications Union 2017

Internet for everyone Offline population



Source: ITU.int, International Telecommunications Union 2017

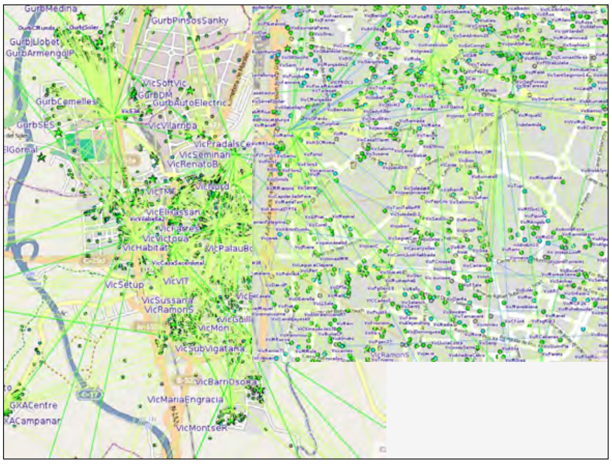
The challenge

- Not only availability (offer), but also a dramatic reduction of cost (affordability),
- Provision:
- *... (by & for) local or "extractive" economy?*
- Farms, fields, less or not profitable?
- Not only offering, but also local development: local provision = Self-provision

Community networks

Crowdsourced networks built by citizens, that contribute and coordinate their own network devices to create a shared network infrastructure

- What technology? *wireless, fibre* commodity, mixed (standards, interop)
- What governance? *of a shared infrastructure* (cooperative, open to anyone, local Internets)
- Decentralized investment, management by everyone: volunteers, professionals, ...
- *Openness (participation, operation, services)*

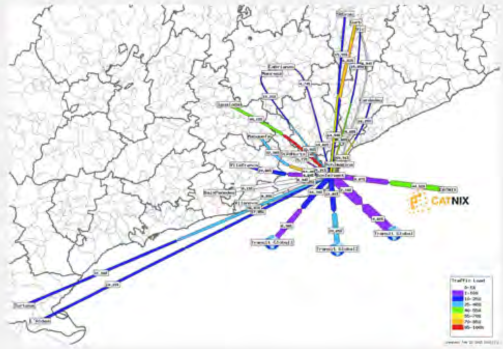


guifi.net: many communities

Self-service connectivity

- Connectivity (local+global) not everywhere
- Connectivity expensive to have (bring)
- Sometimes not feasible in commercial terms: the (licensed) "restaurant model" *(large operators)*
- Self-provided connectivity: the "homemade model" *(small operators, WiFi)*

Regional backbone & Internet



Governance

- Based on principles for governance of commons as common property (E. Ostrom)
- Aim: preserve local connectivity as a key resource for the community, avoid the "*tragedy of the commons*"
- Ensure right of access, participation, provision, benefits for all
- *All: individual citizens, professionals, private or public orgs …*

Business models

- Who does it?
  - One for all: a large operator (with license)
  - Wireless ISP (WISP): a local operator
  - Community networks: anyone in a community
- Differences in costs *(e.g. right of way, deployment, maintenance, local staff)* & ownership
- Technology comes bundled with business models: *Ethernet, ATM, GSM, 5G, WiFi, mesh, bitcoin …*
- Infrastructure sharing: + complex, - expensive: *Open Access Networks, Internet eXchanges*

Ingredients in Community nets

- Diverse, small Internets, experimentation:
  - Multiple AS, IPv6, routing protocols (BGP, OSPF, BMX6), unlicensed spectrum, diverse technology, (WiFi AP, WiFi P2P links, wireless mesh, fibre, anything …)
  - Infrastructure sharing: Regional IX, decentralized net management, backhaul sharing, virtualization => software & services
  - Decentralized economic model: compensation, incentives, blockchain, cryptocoins

Internet for everyone by everyone

- Need for an open Internet, self-provision
- Small providers, need to cooperate to be effective in regional coverage, services
- Community networks: Local development, local connectivity, local business, local resilience
- Diversity, standards, interop, commodity components, incremental upgrade, decentralised
- *Connectivity for the next 50% will develop bottom-up*
- *The topic of the IRTF GAIA WG*

B.9. Third Summit on Community Networks in Africa, session on sustainability and governance

Reference event Sec. 2.2.4

Community Networks, business and sustainability: all that matters, all that counts from day 0 (Leandro Navarro et al)

Community Networks, business and sustainability

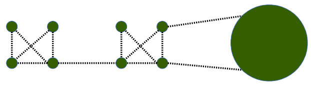
All that matters, all that counts from day 0

Sol Luca de Tena, Zenzeleni Networks
Leandro Navarro, UPC, netCommons.eu
Carlos Rey-Moreno, APC

1/29

The value and cost of a network

- Population + technology choices → startup cost + maintenance cost of the network, unit cost
- Value?



- Value: the number of connected users (n^2) [Metcalfe's law]
- Network infrastructure, a critical resource for a community, to nurture and care, a commons

2/29

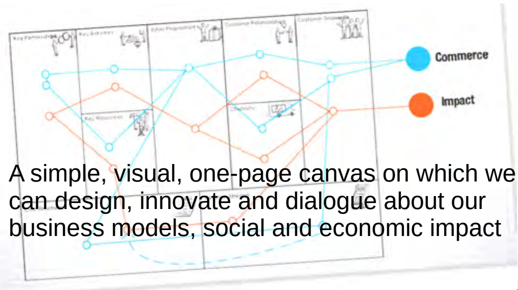
Community networks

- Communication networks built, owned, operated, & used by citizens in a participatory and open manner
- Creates opportunities for added-value interactions:
  calls, electricity, advice, e-government, money, education, entertainment, banking, etc.
- Cost-oriented infrastructure vs added-value services
- Volunteers vs jobs
- Economic impact: profit, investment, return, reinvest
- Social impact, development
- Involves everyone: people, private and public orgs
- Each community is different!

3/29

A mapping exercise: business model canvas

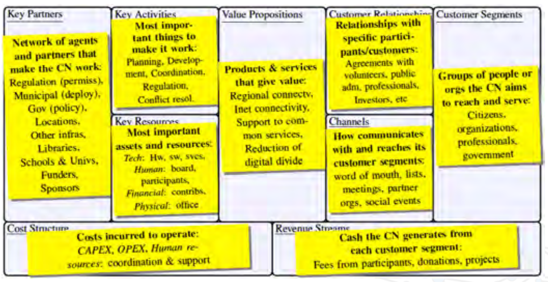
- All that matters, all that counts, since day 0



A simple, visual, one-page canvas on which we can design, innovate and dialogue about our business models, social and economic impact

4/29

Outside view: business model canvas



5/29

Key partnerships:

- The network of surrounding organizations (suppliers, authorities, partners, supporters) that enable and make the commons work
- Examples: (try to be specific for your case)
  all level govt, city councils & gov (policy), community orgs, funders, other ISP, international orgs (ISOC, APC), libraries, local community orgs, local institutions, locations (towers, ducts), municipal (permit deployment), regulation (permission), open access nets, other infrastructures, schools, service providers, software dev groups, sponsors, technology providers, umbrella orgs, global orgs., universities, public institutions, local community organizations, self-manned social centers, squats

6/29

Key activities:

- The most important things that need to be done to make the commons work and deliver value.
- Can be:
  - *Complementary:* expanding or operating the network brings more participants, and contributes to the sustainability of the commons.
  - *Opposing:* Participation and coordination with others in the commons infrastructure can be based on cooperation or competition,
- Questions to ask about activities:
  - What are the key activities to undertake that deliver economic or social value to our participants/customers?
  - What are the key activities to deliver our impact value proposition?
  - What oppositional activities are there? How we can address these so that they are more balanced?

7/29

Key activities: examples

Accounting, billing, cash flow management, conflict resolution, construction local network, coordination, network deployment, development, experimentation, infrastructure development, inter-community coop, lobbying, management service by local coop, small planning, network planning, regulation, software development, summit for exchange & discussion, training local trainers (barefoot engineers), small coordination members, training & experimentation, small planning, software & digital services dev., public events, promotion of internet policy & rights

8/29

Key Resources:

- The assets, tangible and intangible, that make your business model work.
- What drives your economic or social model, and what drives your impacts:
  - The infrastructure commons is a resource aggregate (subject to contribution and consumption).
- Examples:
  - Organizational: members, licence (spectrum, service)
  - Human: board, volunteers, staff from umbrella org, professionals
  - Financial: volunteer contributions
  - Tech: hardware (wifi access points, community cellular, routers, antennas, voip), software, services (map server),
  - Physical: office, equipment, car, contributed locations, rights of way, right of roof

9/29

Value propositions:

- The products and services that create value for specific participant segments – what keeps participants returning to your "enterprise".
- Examples:

  Local connectivity, internet connectivity, DNS, value freedom of expression, network management, services by members (internet, calls), coordination of management & operation of the network infrastructure, network & software experimentation & innovation, products & services that give value, regional connectivity, reduction of digital divide, support to common services, training & support, VPN, ways to manage & operate own mobile operator, local development of apps for local needs, cooperative provision of services, email, server and content hosting, internet neutrality, knowledge dissemination

10/29

Customer/participants relationships:

- The types of relationships a commons establishes with specific customer/participant segments.
- Examples:

  advice, advice on network operation, agreements with volunteers, community support, communities followup, formal membership (volunteers), informal membership (volunteers), installation of mesh network, installation of radio base stations, advice operation & maintenance, integration voip, integration w/ISPs, investors, mutual support, relationships with specific participants or customers, small agreements with volunteers, technical support, professionals, participants in compensation tables, public administrations (gov)

11/29

Channels:

- How an CN communicates with and reaches its customer/ participant segments to deliver its value proposition
- Examples:
  - Digital: forums, mailing lists, remote participation in community day, word of mouth, links w/orgs, social events, web, instant messaging (matrix, irc, jabber)
  - Social: f2f meetings, hacklabs, word of mouth, community day, social events, general assembly
  - How communicates with and reaches its customer segments: word of mouth, lists, meetings, partner orgs, social events, local promoters, shops, schools, word of mouth, media coverage, links w/local orgs
  - Links w/gov orgs, public events
  - Communication and documentation: development of own communication channels (instant and lists, document repository).

12/29

Customer Segments:

- The different groups of people or organizations an enterprise aims to reach and serve (and become participants, with full rights, not mere consumers).
- Examples:
  - Citizens, organizations, professionals, municipalities, government
  - Citizens interested in alternative networks and symmetric internet connectivity
  - Communities: rural, marginalized indigenous
  - Experts (networking)
  - Desirable: citizens, organizations, non-expert citizens, general public
  - Members: experts, citizens, social orgs, general public
  - Underserved communities, barefoot engineers

13/29

Cost structure:

- The costs of the services,
  - the cost in delivering an impact,
  - the costs in contributing to the infrastructure commons, and
  - its compensation to reach a balance.
- Examples:
  - CAPEX (initial cost, capacity) and OPEX (operational, maintenance)
  - CAPEX: 10, 000 USD purchase & installation station.
  - CAPEX: purchase & installation of equipment: nodes, servers, routers, links, backbone connection
  - OPEX: operation staff 200 USD + VOIP calls + assistance 1 USD/user ++
  - OPEX: services such as internet traffic, backbone traffic, IX traffic, maintenance of equipment, human
  - Human resources: coordination & support, central & local staff, volunteers
  - Innovation and training
  - Community cellular, antennas, license, internet link, VOIP services
  - Financial: cost of office, investment in local infrastructure, operational costs
  - Physical: office and its equipment
  - Costs in contributing to the infrastructure commons, and compensation to reach a balance, costs of services

14/29

Social and environmental cost: (optional)

- Externalities not included in the cost structure. Can be included in the *cost* section.

15/29

Revenue streams:

- What enables to operate (exchanges, consumption, services) and generate the impact.
- Examples:
  - Cash the CN generates from each customer segment: fees from participants, donations, projects
  - Compensation fees from participants (professional & orgs)
  - Per community: revenue from some mature users
  - Per member/month: 10 EUR member + 2 internet tunnel
  - Donations & per project: variable
  - per member/month: 2 USD/member + incoming calls
  - Per community: ~2000 USD + 0.8 USD/user
  - Voluntary resources and work

16/29

Social and environmental benefits: (optional)

- Externalities not included in the revenue streams.
  Can be included in the *revenue* section.

17/29

Your turn

- The canvas changes over time
- Can be: now, in 6 months, 1 year, 2-5 years
- A global picture

- The basis for your detailed business model
- Links to everything: coverage map, tech choices, budget, dissemination plan, …

- The **action plan**: main actions to deliver your plan
- … part of VMOSA: vision, mission, objectives, strategies, and action plans

18/29

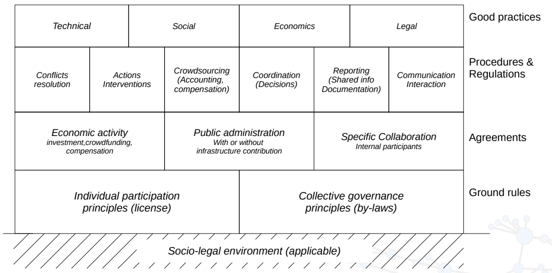
How we organize inside

- If the outside view ...
  - Shows an overview of how a CN interacts with its environment as, metaphorically, a living organism in a given locality
- **The inside view**
  - Provides an anatomy, the structure of body parts, and physiology, the functions and relationships of these

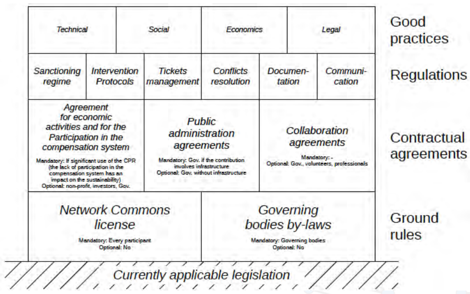
Categories

- Community Networks exist in a **socio-legal environment**: Defined by a set of practices and rules applicable in a locality, can facilitate or restrict: regulations and legislation regarding network infrastructures, spectrum, telecom operators, telecom services, legal entities
- **Ground rules**: formal or informal, define the commitments, rights and obligations, and therefore the limits:
  - individual participation principles, a concise individual participation license
  - collective governance principles, the by-laws of the community
- Additional or specific **agreements**: specific collaboration with large org, government, economic activity,
- **Procedures and regulations**: more or less formal or rigid as needed.
  - Communication and interaction, Reporting (information sharing, transparency), coordination (decision making), crowdsourcing (accounting and compensation of contributions in terms of human, material or economic resources), actions, interventions (installations, repairs, maintenance), conflict resolution
- Good/encouraged (+bad/discouraged) **practices**: to repeat or avoid
  - Legal, economic, social, technical

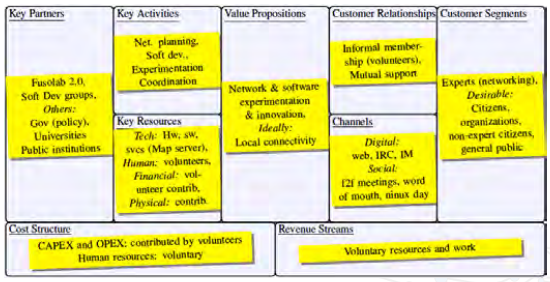
Inside view: internal organization, generic?

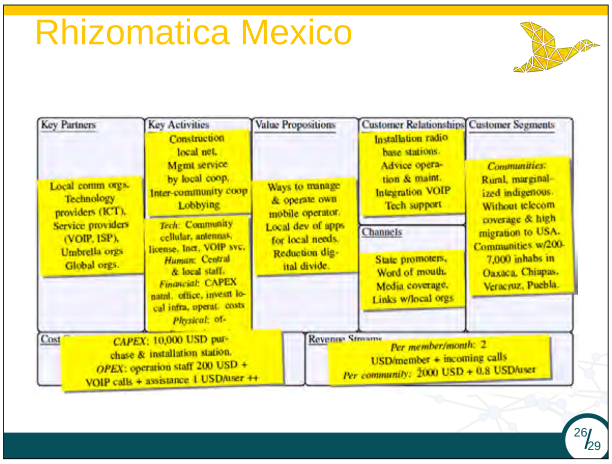


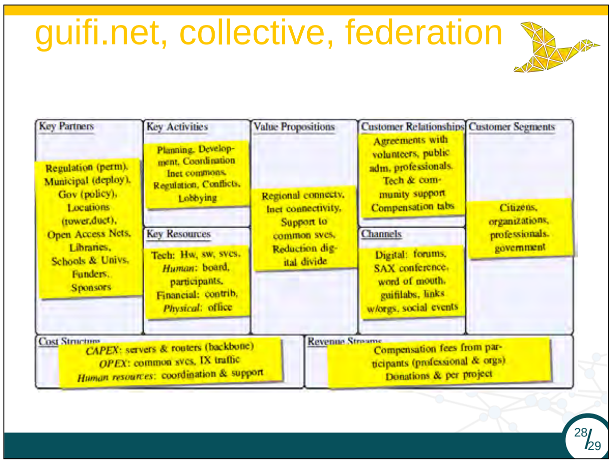
Inside view (guifi.net)

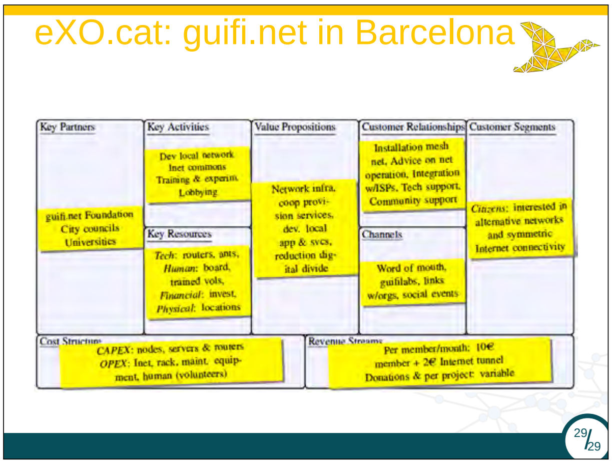


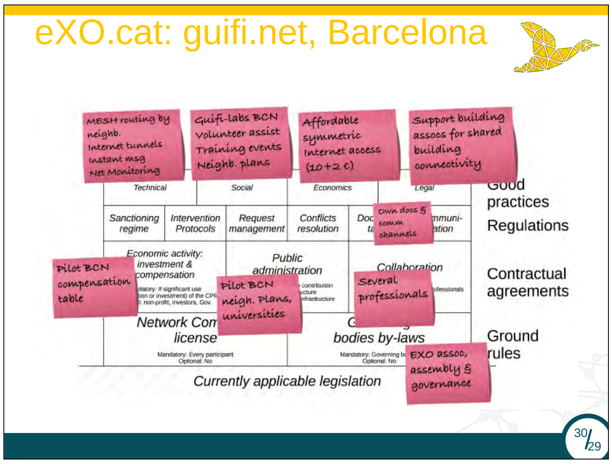
Ninux.org Italy

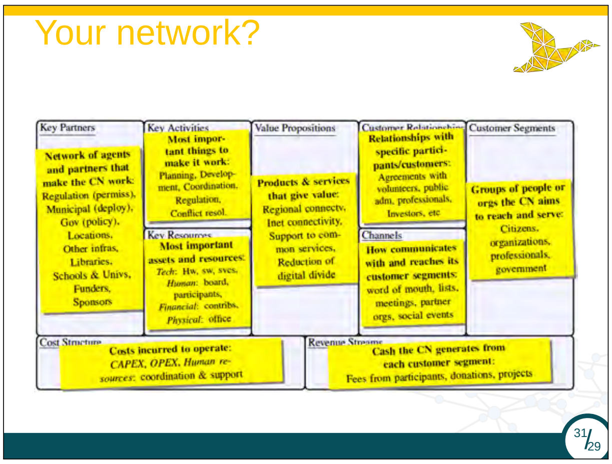



Rhizomatica Mexico
Key Partners
Key Activities
Value Propositions
Customer Relationships
Customer Segments
Channels
Cost
Revenue Streams
26/29


guifi.net, collective, federation
Key Partners
Key Activities
Value Propositions
Customer Relationships
Customer Segments
Key Resources
Channels
Cost Structure
Revenue Streams
28/29


eXO.cat: guifi.net in Barcelona
Key Partners
Key Activities
Value Propositions
Customer Relationships
Customer Segments
Key Resources
Channels
Cost Structure
Revenue Streams
29/29


eXO.cat: guifi.net, Barcelona
Good practices
Regulations
Contractual agreements
Ground rules
Currently applicable legislation
30/29


Your network?
Key Partners
Key Activities
Value Propositions
Customer Relationships
Customer Segments
Key Resources
Channels
Cost Structure
Revenue Streams
31/29

B.10. Italian Networking Workshop
Reference event Sec. 2.3.3
Proof of networking, can blockchain boost the next generation of distrbuted networks? (Leonardo Maccari)

PROOF OF NETWORKING

CAN BLOCKCHAINS BOOST THE NEXT GENERATION OF DISTRIBUTED NETWORKS?

UNIVERSITY OF TRENTO
Department of Information Engineering and Computer Science

netCommons

Lorenzo Ghiro
Leonardo Maccari
Renato Lo Cigno

Courmayeur, Jan 2018

Co-Funded by the Horizon 2020 programme of the European Union, Grant Number 688768

Leonardo Maccari leonardo.maccari@unitn.it *Proof of Networking: PoN* 1

The netCommons Project

UNIVERSITY OF TRENTO - Italy
UPC
cnrs
NetHood
ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS
UNIVERSITY OF WESTMINSTER

- H2020 Financed project (CAPS)
- 2016-2019
- 4 Universities
- 1 Research Center
- 1 not-for-profit association
- 6 countries

Leonardo Maccari leonardo.maccari@unitn.it *Proof of Networking: PoN* 2

Background for netCommons:

- ITU says that 3.9B people are not connected, mostly in developing countries
- Digital divide is still present in developed countries
- Digital Divide is diversifying: more people are connected, but less empowered
- Network Neutrality is threatened: suspended in EU for mobile applications, now under discussion in USA by Trump administration.
- Community networks are an answer to this state of things

Leonardo Maccari leonardo.maccari@unitn.it *Proof of Networking: PoN* 3

Community Networks

CNs are communication networks, based on a mixture of wireless and wired technology, created by a community with a bottom-up approach.

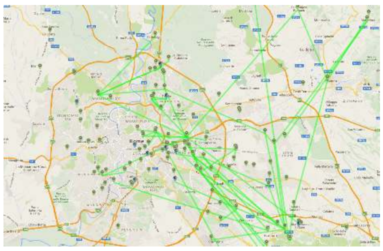
Leonardo Maccari leonardo.maccari@unitn.it *Proof of Networking: PoN* 4

Community Networks

- CNs promote a bottom-up, neutral, free to access network model
- Community Networkers want to retain the control on their network
- For this reason they adopt a not-for-profit approach with a decentralized and commons-like governance.

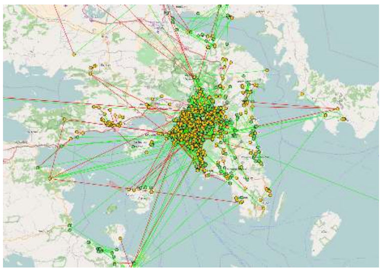
Leonardo Maccari leonardo.maccari@unitn.it *Proof of Networking: PoN* 5

Community Networks: ninux.org



Leonardo Maccari leonardo.maccari@unitn.it *Proof of Networking: PoN* 6

Community Networks: awmn.net



Leonardo Maccari leonardo.maccari@unitn.it *Proof of Networking: PoN* 7

Community Networks: guifi.net

Leonardo Maccari leonardo.maccari@unitn.it *Proof of Networking: PoN* 8

netCommons

The big question to answer are:

- are community networks the building block on which we can build a bottom-up Internet?
- can we envision a future in which connectivity is provided bottom-up, and scales?

netCommons' goal is to contribute to this vision with interdisciplinary research.

And here comes this idea, which at the current state is just an intuition. . .

Leonardo Maccari leonardo.maccari@unitn.it *Proof of Networking: PoN* 9

Lessons Learnt: How is a CN made?

- For a CN to start, a small community of motivated, tech-savvy people is needed
- These people will bootstrap a network for generally two reasons (or a mix of them):
  - lack of connectivity
  - idealistic attitude towards openness, network neutrality, privacy, self-sovereignty etc. . .

Leonardo Maccari leonardo.maccari@unitn.it *Proof of Networking: PoN* 10

Lessons Learnt: How is a CN made?

- The price of an outdoor city-wide 100-300 Mb/s link to 150€
- The mesh-network is often the building block of these experiences
- These building block can scale up to hundreds of nodes, with decent performance
- After that point you have to federate and generally wire.

Leonardo Maccari leonardo.maccari@unitn.it *Proof of Networking: PoN* 11

Lessons Learnt: How is a CN made?

- CNs generally operate in a market failure condition.
- Thus, they reduce deployment costs with the use of wireless, with the free access to private roofs, with the use of open source, with voluntary work. . .
- Voluntary work is key. The more you replace people engagement with money, the more the CN becomes an ISP, operating in a market failure zone. . .

Leonardo Maccari leonardo.maccari@unitn.it *Proof of Networking: PoN* 12

Anti-Patterns

Many community networks rise and fail, they can't scale. Two observed anti-patterns are[1]:

The *"Dumping"* Problem

- People don't see the value of a network. They see the value of an application, but not of the infrastructure.
- They accept to enter the network, then they stop maintaining it as long as it works for them.

[1] D1.3: Report on the Governance Instruments and their Application to CNs (v1), see `netcommons.eu`

Anti-Patterns

The *"Club of Techies"*

- A small group of techies set-up the initial core of the network.
- The network grows and it is successful.
- The techies are not interested in diversifying the community, they are interested in having the largest network they can
- After a certain scale, the voluntary effort needed to make the network function is too much, techies get discouraged and the network collapses.

Take-Away

- CN are in between a fully voluntary system and a production network.
- We need lightweight tools for these people to coordinate their community, and **incentives** for the networks to expand
- The more this is informal and P2P the better it is

Take-Away

- CN are in between a fully voluntary system and a production network.
- We need lightweight tools for these people to coordinate their community, and **incentives** for the networks to expand
- The more this is informal and P2P the better it is

Similar reasoning can be done for other distributed networks, like ad hoc networks.

Blockchains

- We know blockchains are successfully used for cryptocurrency and smart contracts,
- They have been proposed to solve a number of open problems in the Internet.
- What about distributed networks?

Blockchains in Networking Problems

- I. Castro, A. Panda, B. Raghavan, S. Shenker, and S. Gorinsky, "Route Bazaar: Automatic Interdomain Contract Negotiation," in *15th Workshop on Hot Topics in Operating Systems*, May 2015
- K. Christidis and M. Devetsikiotis, "Blockchains and Smart Contracts for the Internet of Things," *IEEE Access*, vol. 4, May 2016
- Emercoin (distributed DNS), Mysterium (decentralized VPN server) etc. . .

Two Applications: Althea Mesh

- Althea uses cryptocurrency to incentive *peering agreements* between nodes
- Node A that has Internet access will broadcast in beacons the expected quality, and its price per kilobyte
- Node B that needs Internet access will do a peering agreement with A using a micro-transaction before actually establishing a working link at the IP layer
- Node B may re-sell access to a third node C that does not have direct visibility of node A, and so on
- Althea uses the Babel routing protocol, and the Ethereum blockchain with Micropayment Channels. Code is available.

Two Applications: AMMBR

- The AMMBR blockchain instead is a dedicated immutable ledger to record pricing, metering, billing, payment, reconciliation, reporting and auditing
- In practice, the blockchain is used for peering but also to support the presence of services inside the network
- AMMBR uses a dedicated chip to replace PoW with the proof of Elapsed time (PoET)
- AMMBR did not release anything yet.

Apparently, Tokenization + mesh networks is a good idea

- Tokenization (Token Economy) is a term that is used by Psychologists to indicate a system in which you use tokens to reward positive behaviour.
- In several contexts it was shown that somehow quantifying the "value" of behaviours increases the participation to the system.
- But, the approaches we mentioned basically superimpose a currency (and thus a blockchain) to a distributed network.
- So the question is, can we embed blockchain in a network to obtain tokens and a positive network effect?

Can we embed a BlockChain in a network?

- Can we have a blockchain-based system that generates value, and trust, when the network grows?
- Can this value be distributed based on the role of nodes in the network?
- Can this value be exchanged directly on the network?
- Can this blockchain be used also to solve other problems that are generally solved with a centralized approach (i.e. address allocation, key exchange etc...)?

Sanity Check:

- Multiple parties that do not fully trust each other ✓
- Don't want trusted intermediaries ✓
- Transactions interact with each other ✓
- Transactions need validation ✓

Proof of Networking, Ideas

- At the end of the day, a blockchain is a distributed db based on consensus.
- We note that a network, to work, needs to reach consensus on at least a few things, such as, a network topology (i.e. as in a Link-State protocol)
- We may choose the node that produces the next block using some topological feature, for instance, the most central node (based on some centrality metric, with some randomization applied).

Proof of Networking, Ideas

What does the block contain?

- The whole topology, so every node can verify that the block was generated by a valid generator (simplifying, the most central)
- Topology can be annotated with whatever tag that nodes can locally agree upon (traffic exchanged)
- A Generation Transactions for new tokens, and their distribution to nodes (potentially based on centrality, again)
- Transactions of tokens between nodes, for whatever reason: Peering, access to services, etc. . .

Leonardo Maccari leonardo.maccari@unitn.it *Proof of Networking: PoN* 24

Proof of Networking Vs Anti-Patterns

- People will try to be more central → they will invest on their network node (against Dumping)
- A "marketplace" of services can be enabled, to let more people enter the network, not only geeks → against Club of Techies
- That tokens does not necessarily mean real money ($). Tokens could be internal to the community, and simply help letting the value of voluntary activities emerge (as in many pre-bitcoin alternative currency experiments).

Leonardo Maccari leonardo.maccari@unitn.it *Proof of Networking: PoN* 25

Of course you need. . .

- A cryptographically robust protocol
- A robust blockchain protocol
- A robust way to enforce conflict resolution (can I verify the quality of the network access that I am paying for?)
- . . .

Leonardo Maccari leonardo.maccari@unitn.it *Proof of Networking: PoN* 26

Conclusions

- We need to find instruments that make networks grow, without collapsing
- Incentives drive the growth of voluntary distributed networks
- Blockchains could be one such instrument, with a number of open issues and doubts

Questions?

Leonardo Maccari leonardo.maccari@unitn.it *Proof of Networking: PoN* 27

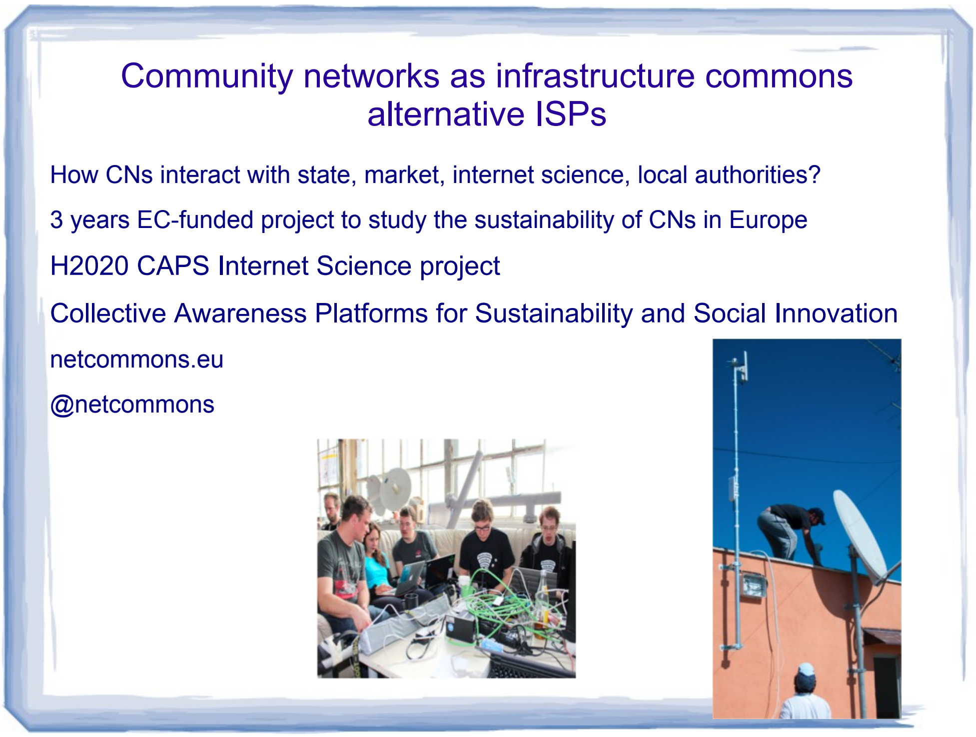
- I. Castro, A. Panda, B. Raghavan, S. Shenker, and S. Gorinsky, "Route Bazaar: Automatic Interdomain Contract Negotiation," in *15th Workshop on Hot Topics in Operating Systems*, May 2015.
- K. Christidis and M. Devetsikiotis, "Blockchains and Smart Contracts for the Internet of Things," *IEEE Access*, vol. 4, May 2016.

Leonardo Maccari leonardo.maccari@unitn.it *Proof of Networking: PoN* 27

B.11. Conference on Digital reality legal issues, The Law Institute, University of Iceland, Reykjavik

Reference event Sec. 2.3.4

Presentation by Melanie Dulong de Rosnay



Community Networks

Affordable internet access

free or cheaper subscription

+ Extra services in addition to connectivity

Sharing content,broadcast radio, video streaming, wiki, podcast...

Storage, VOIP, encryption, IM, IRC, videoconference, mail servers, VPN, self-hosting…

Bottom-up alternatives to ISPs

- Peer production
- Citizen science
- Do It Yourself, makerspace
- Alternative
- Autoproduction, autogestion, cooperatives
- Commons-based
- Sharing
- Collaboration & participation

Sources:
https://commonsblog.wordpress.com/2014/09/23/ schaft
http://chateauxrealtyparkcity.com/do-it-yourself-projects-should-you-or-shouldnt-you/

Alternative to commercial ISPs

- Independence
- Decentralised
- Avoid dependencies (single points of failures)
- Deconcentrated (avoid concentration of power)
- Respectful of users' rights
- Balanced terms of use
- No surveillance
- Bottom-up, self-organised, democratic
- Not commercial, non-profit, commons-based

"Not..." → Positive definition of what **is** alternative

Values

- Democratic governance
- Net neutrality, transparency
- Participation & local development, social integration
- Public private commons partnerships collaboration local communities, policy-maker and local authorities
- User rights & Terms of use

Data sovereignty

managing data as a commons

counter-projects for local communities

empower citizens

to govern their local infrastructure

to manage their own data and retain it

the right not to be data mined

not to be surveilled

or algorithmically profiled

in the context of “smart” cities

mitigate some of the excesses of big data and surveillance

data transiting through infrastructure controlled by commercial ISPs

can be monetised without permission

nor benefit sharing with local communities

and lead to exclusion

Data as Commons Managed in Complex Commons

Infrastructure commons because of their physical materiality (internet cables) and the need of open hardware (routers),

Natural commons because of their dependance on access to spectrum, an unusual natural resource,

Knowledge commons because of the technical and governance skills required to deploy and maintain a local CN

Inclusion … Perfection

Urban commons because of their local organisation, and value sharing on territories,

Digital commons because of their purpose, the communication of information, subjected to the same regulation and challenges, such as tort, copyright or privacy, than intangible informational commons

Governing a Commons Requires Skills

- Computer & network science: router, nodes,
- Communication and community-building:
  - f nd more nodes
  - write documentation
- Political and governance:
  - run a co-
  - manage decisio
- Socio-economics:
  - negotiate with partners
  - crowdfunding
- Legal: liability, privacy, terms of service
- Advocacy: telecom package reform, data retention

Techno-political citizen science & advocacy

- geek <---> hacker <---> activist
- a **techno-political community**

  (STS) material practise + civic participation

  - Teaching to researchers
  - CS, commons, IT law
- Existence threatened by inadequate legislations designed for commercial, large-scale ISP
- Support sustainable commons in telecom infrastructures and in policy-making in general

Implementation and inf luence

- The legal framework of CNs
  - Avoid liability for infringement by other users
  - Access to spectrum
  - Privacy and data retention
  - Telecommunications law
  - Balanced terms of use
  - Governance and decision-making above these
- Advocacy efforts
  - Open letter to the EU for the EECC
  - Notes to the Members of the European Parliament

12/17

Open letter to the EC policy-maker

• Lifting unnecessary regulatory and financial burdens
- Registration fees, administrative charges

• Getting rid of third-party liability when sharing Internet Access
- open wifi right to share internet connection

• Expanding the spectrum commons & unlicensed Wi-Fi bands incl. white spaces in lower frequencies

13/17

Open letter to the EC policy-maker (2)

• Protecting free software and user freedom in radio equipment
- community networks usually need to replace the software included by the manufacturer in radio hardware with free and open source software especially designed to suit their needs, a collective process that improves security and encourages the recycling of hardware, among other benefits
- incentive for manufacturers to lock down their devices and prevent third-party modifications of

14/17

Open letter to the EC policy-maker (3)

• Bringing direct and targeted public support
- small grants, crowd-funding and subsidies
- giving them access to public infrastructures (for instance, the roof of a public building to install an antenna)
- support their research on radio transmission, routing methods, software or encryption
- CNs have pioneered various models for the provision of free public access points
- meet the same policy-objectives at a fraction of the cost that would be charged by mainstream telecom operators

15/17

From Recommendations to the (EC) policy-maker to CN-based enablers for digital divide reduction

- Enhance data protection while complying with data retention
- Foster the development of wireless community networks
- Promote a shared and unlicensed spectrum
- Create the appropriate conditions for small ISPs
- Address oligopolistic situations
- Lobbying to contribute to the discussion on the Telecom Package
- Convey stakes for CNs in less technical terms

Again : Making Regulation Work for Community Networks requires advocacy for/against
=
Existence threatened by inadequate legislations designed for commercial, large-scale ISP

16/17

Next steps

- UNESCO Internet Universality Indicators

Theme C: Open markets that explicitly mentions CNs

C.6 Are communities able to establish their own networks to provide Internet access?

*Legal framework for establishment of community networks

- Abrogate blanket data retention

17/17

B.12. European Conference on Networks and Communications (EuCNC), Reference event Sec. 2.3.5

B.12.1. Tutorial description

TUTORIAL PROPOSAL FOR WCNC 2018

Title
Wireless Community networks and 5G: the 7Billion challenge

1. Type and Duration
Intended as a half-day tutorial.

2. Abstract

As the 5G vision gets unfolded and the requirements of its ambitious key performance indicators are better understood, it also becomes clearer that there will not be a single realization path for this vision. Large parts of the worldwide population, including those living in rural areas of developed countries and those in developing regions will probably not be served by ultra-dense networks and super-fast radio links. The tutorial aims to delineate the role that community networks emerging out of citizens' grassroots activities could play in the realization of the 5G vision. It summarizes state-of-the-art practices and experience with their use, and outlines technical research problems as well as outstanding challenges for their adoption. This way, it essentially lays out elements of a complementary research agenda that so far has not attracted the proper attention from the research community.

3. Objectives and Motivation

As main motivations for this tutorial stand:

- Rrecent advances in the field of community networks, both on the technological but also their strategic and organizational form
- The ongoing discussion and research effort on realizing the highly ambitious 5G vision in ways that will not further amplify the digital divide worldwide
- The equally ambitious EU agendas (EU2020 and EU2025) for broadband connectivity across Europe and the therein identified potential role of grassroots- and, more generally, locally-driven network infrastructures.

The tutorial objectives could be summarized along the following lines:

- Review recent advances and trends in the otherwise multifaceted area of Community Networks, both in terms of technologies but also strategies, as these emerge throughout the world
- Summarize the difficulties that stand on the way to delivering the 5G vision to several areas across the world and detail how Community Networking initiatives could contribute to coping with them
- Identify the research challenges that need to be tackled so that Community Networks can play an active role to this end
- Outline additional actions that need to be taken at policy-making and regulatory level to enable this role

4. Timeliness and intended audience

As described in the previous paragraph, the timing for this tutorial is particularly attractive for a number of reasons.
On the one hand, it is the time of paving paths to the sustainable realization of highly ambitious visions. Both the 5G vision, as summarized in its 10 Key Performance Indicators, and the EU goals for Broadband Connectivity in Europe over the next 5-10 years imply huge investments in network infrastructure. It is acknowledged that (a) there is no one-size-fits-all implementation strategy for realizing these agendas everywhere across Europe and worldwide; (b) the cost would need to be shared across multiple stakeholders; (c) grassroots networking activities are one way to involve local authorities and administration in the development and deployment of the required network infrastructures.

On the other hand, community networks have traversed a long way since their first years. Whereas some CNs have become obsolete due to the rise of commercial high speed broadband networks in the areas CNs operated, others have flourished, introducing faster transmission technologies and sustainable business models, and evolved into alternative telecommunication network models, which enable the separation of the network infrastructure owner and network service provision roles and promote their synergy with commercial (Internet) Service Providers. At the same time, technological advances such as block-chaining present new technological solutions to fundamental issues in highly distributed operation and accounting, further facilitating crowd-sourced approaches to the connectivity provision.

The proposed tutorial is intended for a broad audience including:

- Graduate students and researchers in the area of wireless networks and network economics
- Practitioners in the area of mobile cellular networks
- Members of community networking initiatives
- Interested relevant stakeholders such as Telecom operators, Mobile Virtual Network Operators (MVNOs) and Service Providers (SPs)

5. Detailed outline of the tutorial

The proposed tutorial is structured into three sessions, each one covering a particular theme. The three sessions (S1-S3) and their content are:

S1. 5G implementation paths and Community Networks: a review of the current state of affairs

This session first reviews the evolution of the 5G vision, dominant approaches to its implementation and concerns about them. It then proceeds to give an overview of the advances in CNs over the last 15 years both on the technological and organizational front. Finally, it describes how these networks could support/constitute sustainable paths towards the next generation of wireless connectivity in many areas around the globe.
The session includes:

- A discussion of the 5G vision, the dominant approaches proposed for its implementation, and main challenges faced by them
- A review of CNs across the globe: technologies, organizational models, financing
    - case studies : guifi.net, Sarantaporo.gr, others
- CNs as alternative paths to realizing network access visions

S2.Edge computing in CNs

Some of the research challenges in CNs are similar to what 5G networks face, in particular, distributing data processing and storage in the edges of the network in order to have smaller delays and reduce the load on the backhaul. The session will treat two research threads that try to tackle these issues with a P2P approach, relying on the openness of the network and without sacrificing Network Neutrality.

- Distributed cloud platforms in CNs and service placement
- P2P streaming in CNs

S3. Economic sustainability in CNs and incentives for participation

This session will focus on the ways CNs pursue their sustainability so far and new approaches that have recently emerged to this end involving synergies with commercial service providers. It will review game-theoretic tools that help analyze and optimize these sustainability models. The session covers:

- Infrastructure cost sharing and pricing issues in CNs
- Incentive mechanisms for different stakeholders in CNs
    - Use of blockchaining technologies – the case of AMMBR
- Synergistic models with commercial service providers

The estimated sessions' duration and the names of instructors in each session are summarized in the table below (refer to paragraph 8 for their brief bios)

Session	Instructor	Est. duration
S1	Dr. Leandro Navarro (Universitat Politècnica de Catalunya, Spain)	45 mins
S2	Dr. Leonardo Maccari (University of Trento, Italy)	45 mins
S3	Dr. Merkouris Karaliopoulos and Dr. Iordanis Koutsopoulos (Athens University of Economics and Business, Greece)	90 mins

Remarks

a) The assumption in the schedule is that the overall duration of the tutorial is 3hrs (2 parts of 1.5 hr each, 9-10.30, 10.45-12.15) with a 15-min break between them. Hence, the first two sessions will occupy the first part of the tutorial (9-10.30) and the third part will take place in the 2nd part, after the coffee break of 10.30.

b) All four instructors are collaborating in the content of the EU R&D project netCommons (https://www.netcommons.eu). Most of the tutorial's material is the outcome of their research collaboration in the context of this project.

6. Plan to solicit participation

Besides the conventional means to disseminate the tutorial (conference website, academic/research mailing lists), the tutorial will be actively advertised through all dissemination channels of the EU R&D *netCommons* project (http://www.netcommons.eu), as well as related dissemination channels of the CAPS (Collective Awareness Platforms), an EU research initiative involving more than 30 EU R&D projects, and the follow-up recently launched EU activity on Next Generation Internet (NGI).

Furthermore, the location of the conference particularly favors the participation in the tutorial since:

- One of the tutorial instructors, Dr. Leandro Navarro, is Associate Professor at the Department of Computer Architecture of Universitat Politècnica de Catalunya (UPC) in Barcelona. Hence, there will be further promotion of the material towards the academic community of UPC.
- Barcelona is the home city of one of the largest Community Networks in Europe, guifi.net, which has received several awards from EC and acknowledged as a success story in the field of community networks. Since the tutorial will also have an educational dimension for members of Community Networks, it is expected to attract interest from the large guifi.net community.

7. Required equipment

No particular equipment is required other than a computer projector and a screen. Any additional requirements that may arise will be notified to the organizers in due time.

8. Short biographies of the instructors

Dr. Merkouris Karaliopoulos (http://cgi.di.uoa.gr/~mkaralio/) is a Senior Research Associate at the Athens University of Economics and Business, in Greece. He obtained the Diploma in Electrical and Computer Engineering from the Aristotelian University of Thessaloniki, Greece, in 1998, and the Ph.D. degree in Electronic Engineering from the University of Surrey, UK, in 2004. He has been a Postdoctoral researcher at Computer Science Department of University of North Carolina at Chapel Hill (2005- 2006), and a Senior Researcher and Lecturer at the Department of Information Technology and Electrical Engineering, in ETH Zurich (2007-2010). Prior to joining AUEB, he was a Marie-Curie Fellow at the Department of Informatics and Telecommunications, University of Athens from 2010-2012 and a Researcher with the Center of Research and Technology Hellas (CERTH) from 2013-2015. His research interests lie in the broader area of wireless and mobile social networks, focusing, among others, on mobile crowdsensing and collective awareness platforms. He has worked in several EC collaborative R&D projects holding both research and technical coordination roles.

Dr. Iordanis Koutsopoulos (http://www.cs.aueb.gr/~jordan/) is an Associate Professor at the Department of Informatics of Athens University of Economics and Business (AUEB). He obtained the Diploma in Electrical and Computer Engineering from the National Technical University of Athens (NTUA) in 1997, and the M.Sc. and Ph.D. degrees in Electrical and Computer Engineering from University of Maryland, College Park in 1999 and 2002. He has been Assistant Professor at AUEB (2013-2016) and Assistant Professor (2010-2013), Lecturer (2005-2010) with University of Thessaly. During his sabbatical in 2012 he was visiting Research Scientist with Yahoo! Research Labs, Barcelona. During 2005 he held a visiting scientist position with University of Washington, Seattle, USA. He has held internship positions with Hughes Network Systems (HNS), Germantown, MD, Hughes Research Laboratories LLC, Malibu, CA, and Aperto Networks Inc., Milpitas, CA. He was awarded a European Research Council (ERC) H2020-ICT-09-2017 Research and Innovation Actions competition runner-up award (co-funded by Greece and the European Union) for the project "RECITAL: Resource Management for Self-coordinated Autonomic Wireless Networks", €690K (single investigator), for the period 2012-2015. For the period 2005-2007 he was awarded a Marie Curie International Reintegration Grant (IRG). He has been coordinator for the ERC-runner-up RECITAL project and the scientific coordinator for the EU R&D NET-REFOUND, NCRAVE, OPNEX, CONECT and STAMINA projects. His research interests are in the broader area of network control and optimization, with applications to wireless networks, social networks, smart grid control, sensor networks and cloud computing systems.

Dr. Leonardo Maccari (http://disi.unitn.it/maccari) is an Assistant Professor at the Department of Computer Science of the University of Trento, Italy. He received a Master from the Faculty of Computer Science Engineering from the University of Florence in November 2004 and a Ph.D. from the same institution in 2010. He has been involved in several research projects financed by the Italian Ministry of research (PROFILES Project), the EU FP6/7 programme (CRUISE NoE, NI2S3 Strep) the European Defense Department (ESSOR project) and private companies (Telecom Italia, Selex Communications, Siemens). He received a Marie Curie COFUND grant for the PAF-FPE project for the period 2011-2014. He is the Technical Coordinator of the netCommons H2020 project on behalf of the University of Trento. He is an IEEE member and co-authored about 40 publications in refereed conferences, journals and book chapters, he participated in the TPC of several conferences (IEEE Globecom, IEEE ICC, IFIP Networking among them). He has extensive experience in research and development of techniques for wireless mesh networks, and their direct application to real networks, he is also among the authors of three patents.

Dr. Leandro Navarro (http://people.ac.upc.edu/leandro/) is an Associate Professor at the Department of Computer Architecture of Universitat Politècnica de Catalunya (UPC) in Barcelona, Spain, which he joined in 1988, after receiving his graduate degree on Telecommunication Engineering from UPC and his Ph.D. from UPC in 1992. His research interests include the design of scalable and cooperative Internet services and applications. He coordinates the CNDS (Computer Networks and Distributed Systems) and the Erasmus Mundus Joint Doctorate in Distributed Computing. He has participated and managed the participation of UPC, in several EC funded projects such as Catnet (FET), Catnets, SORMA, Grid4All FP6 EU projects. He is member of the IRTF Global Access to the Internet for All (GAIA) WG and the IEEE Internet Inclusion initiative. He is vice-chair of the executive board of the Association for Progressive Communications (APC.org). He has coordinated the CONFINE FIRE IP project (2011-2015) that developed Community-Lab.net a European-wide tested for Community Networks.

B.12.2. Tutorial slides

Wireless Community Networks and 5G: The 7-Billion-User Challenge

netCommons

Merkouris Karaliopoulos, Iordanis Koutsopoulos, Renato Lo Cigno, Leonardo Maccari, Leandro Navarro

EUCNC, Ljubljana, 18/6/2018

Co-Funded by the Horizon 2020 programme of the European Union, Grant Number 688768

EUCNC 2018 Tutorial – Wireless Community Networks ... 1/129

Organization: Three Sections

- S1 – 5G Implementation Paths and Community Networks: A Review of Current State of Affairs (Renato Lo Cigno)
- S2 – Edge Computing in CNs (Renato Lo Cigno)
  - ⇒ ***Coffee Break***
- S3 – Economic Sustainability in CNs and Incentives for Participation (Merkouris Karaliopoulos)

EUCNC 2018 Tutorial – Wireless Community Networks ... 2/129

5G Implementation Paths and Community Networks: A Review of Current State of Affairs

netCommons

Merkouris Karaliopoulos, Iordanis Koutsopoulos, **Renato Lo Cigno**, Leonardo Maccari, Leandro Navarro

EUCNC, Ljubljana, 18/6/2018

Co-Funded by the Horizon 2020 programme of the European Union, Grant Number 688768

EUCNC 2018 Tutorial – Wireless Community Networks ... 3/129

Outline

Universal Connectivity
- Facts on Today Connectivity
- 5G Vision and Strategy

Community Networks
- CNs Essentials
- CNs Models & Examples

Technical challenges in CNs
- Networking challenges
- Blockchains in networks
- Some Proposals
- Proof of Networking

S1 - Summary

Distributed Applications
- Some Facts
- Example: Video Streaming

P2P Streaming
- P2P Operation
- Performance

Community Clouds
- Principles
- Comparison

S2 - Summary

References and Resources

EUCNC 2018 Tutorial – Wireless Community Networks ... 4/129

Outline

Universal Connectivity
- Facts on Today Connectivity
- 5G Vision and Strategy

Community Networks

Technical challenges in CNs

S1 - Summary

Distributed Applications

P2P Streaming

Community Clouds

S2 - Summary

References and Resources

EUCNC 2018 Tutorial – Wireless Community Networks ... 5/129

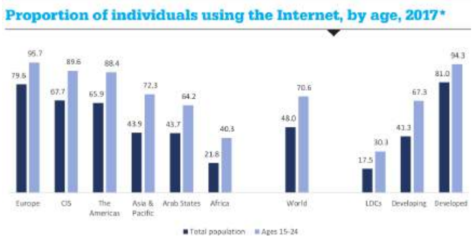
World Connectivity Indicators (WCI)

- Roughly 50% of the world population is disconnected[1]
- Most of them are concentrated in developing countries

[1] International Telecommunication Union (ITU), "ICT Facts and Figures 2017." [1] Figures in the following slides are reproduced from this official report

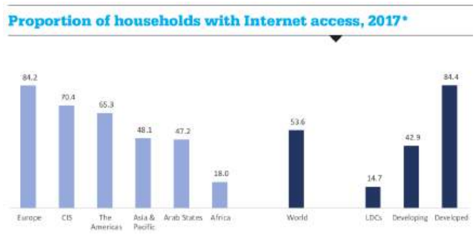
EUCNC 2018 Tutorial – Wireless Community Networks ... 6/129

WCI: Unconnected People



EUCNC 2018 Tutorial – Wireless Community Networks . . . 7/129

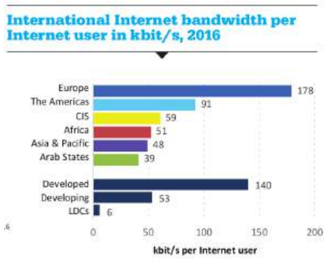
WCI: Unconnected Homes



EUCNC 2018 Tutorial – Wireless Community Networks . . . 8/129

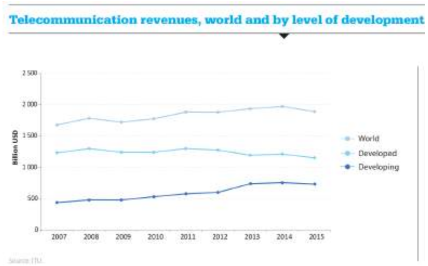
WCI: Insufficient Capacity

- Not only few connected people
- Also little bandwidth per connected person



EUCNC 2018 Tutorial – Wireless Community Networks . . . 9/129

WCI: Revenues are Stagnating



Apparently, we connected all those that could pay for it

EUCNC 2018 Tutorial – Wireless Community Networks . . . 10/129

Economy and Connectivity

- Being connected improves the economy of a society
- Getting Connected implies Economic growth. This was studied and shown in many cases
- But . . . is it true that getting higher speed implies Economic growth?
- This is debated[2] Apparently we know that passing from 0 up to 8 Mb/s brings economic benefit to society. After that speed the improvement is marginal

[2]International Telecommunication Union (ITU), "The impact of broadband on the economy: Research to date and policy issues," 2012 [2]

EUCNC 2018 Tutorial – Wireless Community Networks . . . 11/129

Two possible future steps

- We invest in technology that gives more bandwidth **and** a technology breakthrough that enables new services.
- This is operated only by licensed mobile operators.
  - **This is what 5G looks like**
- We invest in technology that fills the gap and brings more people on the Internet, and on the market
- This can be operated even by local startups
  - **This is (among other things) what a Community Network looks like**

Can we have both?

EUCNC 2018 Tutorial – Wireless Community Networks . . . 12/129

netCommons

5G Key Performance Indicators (KPIs)

5G is a vision for future wireless communications and a realization path to it. The ambition of the 5G vision is most clearly reflected in the KPIs that accompany it [3]

- 1,000-fold increase of the aggregate network capacity coupled with 10-fold decrease of the latency compared to 4G
- Provision of 100 Mbps access speed to 95% of the users
- Support for up to 10,000 connected devices per Base Station
- Strong reduction of the *per link* infrastructure cost in order to compensate for the higher density of users

Two Key Aspects

Extreme densification of points of access

Vertical integration of applications with networks

AP Densification

- One open problem in 5G is to find a cost-effective technology to sustain the aggregate throughput in the network
- Research is pushing mmWave wireless technologies in the (6-80 GHz band), but the technical challenges are forbidding, and LOS is in any case required
- Whatever the development for the wireless access and fronthaul, backhaul and backbone require huge deployments of new optical fiber, possibly getting close to a FTTC (Fiber-to-the Curb) scenario

AP Densification

- FTTC is scarcely present even in developed countries:
  - As of Sept. 2016 the average penetration of FTTC/FTTH over the 28 EU states is 9.4%, with large countries like Italy or Germany below 5% [4]
- To realize the vision of 5G, a major infrastructure investment is needed.
- EU estimates 56.6B € (just a linear interpolation of the costs for 2G, 3G, 4G), but it's probably an underestimation
- In urban areas of developed countries such investment is currently undergoing, though often subsidized, but it is unlikely that suburban and rural areas will experience similar investments in FTTH/FTTC or even just in high speed wireless access.

AP Densification: costs

- It is hard to find reliable numbers on the cost of fiber deployment in rural areas
- In the USA are in the order of 4,000-10,000$ per household when the number of users per linear mile of fiber ranges from 65 to 5, and skyrockets up to more than 25,000$ for less than 5 users per mile [5]
- The cost of deployment of fiber in rural areas in UK can reach 12,000£ [6]
- The largest portion of the cost is due to civil works (hard to compress)

The success of next generation wireless networks depends on . . . digging

Vertical integration of network and services

5G magical keywords are SDN/NFV and vertical integration. Let's analyze them

- Software Defined Networking means higher flexibility ad higher cost
  - The network can be reconfigured and evolved dynamically, but the hardware support is much more complex
  - Many functions can be embedded in the network, making it more sophisticated, but also more complex and less prone to accept novel idea and breakthroughs
- Network Function Virtualization empowers vertical integration
  - More and more functions are pushed in-network, breaking the golden rule of the Internet: Keep it Simple!

Vertical integration of network and services

5G magical keywords are SDN/NFV and vertical integration. Let's analyze them

- Vertical Integration means operators partners with service providers to let them access advanced in-network functionalities
  - Using "open APIs" the partner service providers control how data packets are processed in the network, and may place services directly into the 5G network
  - All these functions will be regulated by service level agreements [7].
- This is claimed to produce breakthrough in terms of bandwidth and most of all, in latency, and enable new applications (Tactile Internet, real-time Augmented reality etc.)

EUCNC 2018 Tutorial – Wireless Community Networks . . . 19/129

What about Network Neutrality and Innovation?

Vertical Integration stands add odds with Network Neutrality (NN) [8] and with any Innovation

- NN has been one of the enablers of Internet service explosion and success
- NN guarantees a low entry barrier for now services and grants competition
- Vertical Integration means that a novel service cannot be introduced unless a partnership with operators is found
- Partnership means that those who pay more get better service . . . draw your conclusions

EUCNC 2018 Tutorial – Wireless Community Networks . . . 20/129

5G: Takeaways

- 5G is not just a new generation of mobile access network
- It is imagined as an end-to-end system, which will change the way we access and use the Internet in order to open new scenarios, possibly changing the Internet itself
- It will increase the difference between the (well) connected and the others
- It will challenge the concept of network neutrality
- It will challenge the economic model and development of on-line systems

EUCNC 2018 Tutorial – Wireless Community Networks . . . 21/129

Outline

EUCNC 2018 Tutorial – Wireless Community Networks . . . 22/129

Community Networks: two Themes

1 - Digital Divide
They lower the cost of the infrastructure and make it possible to operate in digital divide areas

2 - Bottom-up Networks
They offer a new and revolutionary networking model compared to traditional telco model

EUCNC 2018 Tutorial – Wireless Community Networks . . . 23/129

CNs vs. Digital Divide

- One of the obstacles for Internet diffusion is the cost of the infrastructure, specially the CAPEX
- CNs offer a low-cost alternative to other network models, with minimal initial investment and "organic" growth
- A CN generally start as an initiative to bring connectivity to a new place, building a local network to share access to the Internet (and more)

EUCNC 2018 Tutorial – Wireless Community Networks . . . 24/129

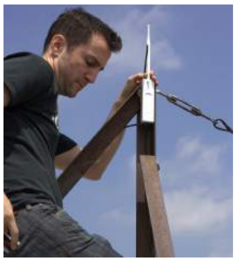
Mesh Networks

- A mesh network is a distributed wireless network
- Each node of the network receives, generates and also routes traffic
- Meshes can grow as new nodes connect
- The initial seed can be as small as two houses sharing internet access

EUCNC 2018 Tutorial – Wireless Community Networks . . . 25/129

Mesh Nodes

The market offers devices for less than 60€ that can be easily mounted outdoor, and allow to bootstrap a network with a very small investment



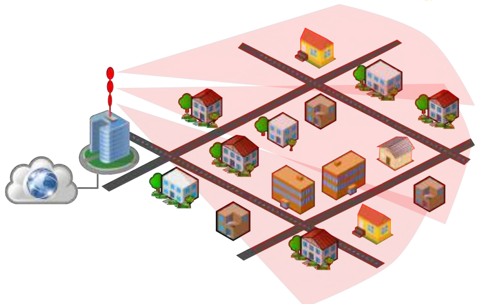
EUCNC 2018 Tutorial – Wireless Community Networks . . . 26/129

Scaling up Networks

- As networks grow, things get technically more complex, but large networks are still viable and affordable
- We have studied networks made with this principle that scale to hundreds of nodes, and cover large areas (e.g., the city of Vienna or Rome) [9, 10]

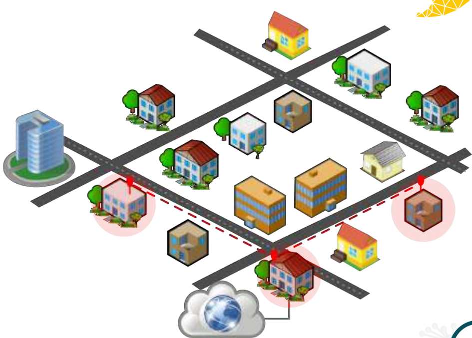
EUCNC 2018 Tutorial – Wireless Community Networks . . . 27/129

Classical WISP



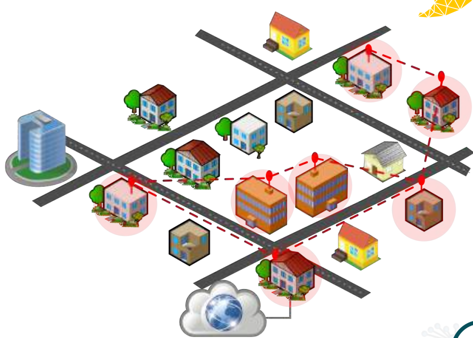
EUCNC 2018 Tutorial – Wireless Community Networks . . . 28/129

Mesh Model



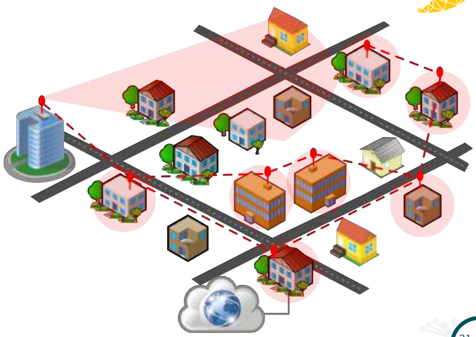
EUCNC 2018 Tutorial – Wireless Community Networks . . . 29/129

Mesh Model



EUCNC 2018 Tutorial – Wireless Community Networks . . . 30/129

Mesh Model



EUCNC 2018 Tutorial – Wireless Community Networks . . . 31/129

Bottom-up Cooperative Technology

- The network grows with the community, adding resources as more users connect.
- People pool their resources to build their own network:
  - Roofs
  - Technical skills
  - Energy
  - . . .
- Proper management and networking paradigms keep the price of the infrastructure low.
- Voluntary participation and some voluntary work is fundamental as in any non-profit business.
- Non-profit does not mean for-free, professionals can have a role and also make revenues (as in any cooperative business)

EUCNC 2018 Tutorial – Wireless Community Networks . . . 32/129

CNs: Take Away

- Affordable technology, no need for large CAPEX, easy to bootstrap
- Scales up to hundreds without a real management, which makes it possible for the community to gather momentum and become “serious” and have enough resources to define its charter
- Based on cooperative organization and a self-conscious use of global communications.
- Makes it possible to set-up networks in areas of “market failure”
- Makes it possible to set-up “alternative Internets” to reduce the phenomenon of “post-connection Digital Divide"

EUCNC 2018 Tutorial – Wireless Community Networks . . . 33/129

Wireless Technology Driven?

- A CN must be a Mesh Network? **NO**
- Mesh networks are a superb instrument to bundle demand, and build a critical mass of people interested in connectivity or alternative info-systems
- They also offer a strong techo-social metaphor to express the concept of a Community Networking
- But they are not a silver bullet (they need density and Line of Sight) and they scale up to a certain size
- The same concept of cooperative organization can be used with other technologies

EUCNC 2018 Tutorial – Wireless Community Networks . . . 34/129

Wired CNs

- There are CNs that rely on wired connections
- Deploying fiber may cost tens of thousands of Euros per km
- How does a community-based approach faces this challenge?
- The key point is a non-financial approach
- Cooperative local investment and property, local operation
- Involves local citizens, private and public orgs that can be investors and beneficiaries
- Deployment and operation creates local jobs (SMEs)

- There working models proposing a mixed for-profit/not-for-profit approach

EUCNC 2018 Tutorial – Wireless Community Networks . . . 35/129

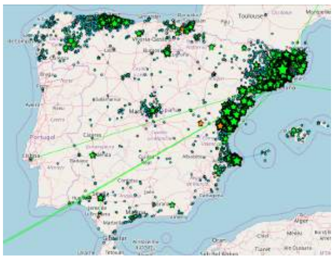
Typical structure

- Regional long distance links:
  - Fiber or point-to-point radio links (WiFi)
  - Community owned/leased (open-access dark/active fiber)
- Regional shorter distribution: one or several meshes interconnected
- Local Areas: each household connected in the mesh

A radically different topological model compared to traditional telco:
a Mesh of Meshes instead of a Tree of Stars

EUCNC 2018 Tutorial – Wireless Community Networks . . . 36/129

guifi.net: The Network



guifi.net is the largest CN known, with about 35.000 nodes [11].

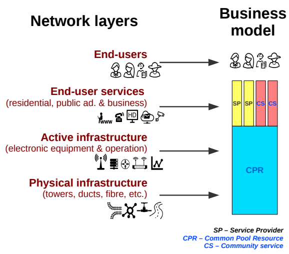
EUCNC 2018 Tutorial – Wireless Community Networks . . . 37/129

guifi.net: The Paradigm

- In Guifi, the passive and active infrastructure is treated as a Common Pool Resource (i.e., owned by the people and managed by the community)
- For-profit activities are allowed to use it, but they are asked for a fee.
- This fee can be monetary, or can be made of verified investments in expanding the network, with a compensation system.
- Internet access is only one of the many applications or content the network supports.

EUCNC 2018 Tutorial – Wireless Community Networks . . . 38/129

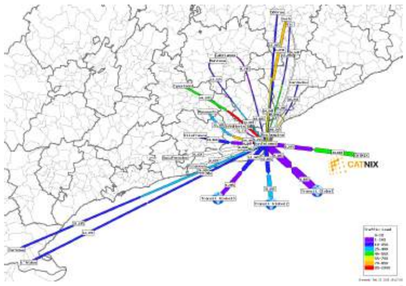
guifi.net: The Model



Key Theme: Sharing Vs Vertical Integration

EUCNC 2018 Tutorial – Wireless Community Networks . . . 39/129

guifi.net: Backhaul and Regional Fiber



EUCNC 2018 Tutorial – Wireless Community Networks . . . 40/129

guifi.net: Semi-rural with wireless supernodes

EUCNC 2018 Tutorial – Wireless Community Networks . . . 41/129

guifi.net: Urban meshes in Barcelona

EUCNC 2018 Tutorial – Wireless Community Networks . . . 42/129

Broadband for the Rural North (B4RN)

- Rural area near Lancaster (UK), started in 2011
- Community fiber, 1-10 Gbps, 30 £/month
- Stakeholders: investors, landowners, professionals, volunteers

EUCNC 2018 Tutorial – Wireless Community Networks ... 43/129

Broadband for the Rural North (B4RN)

- Community shares, investment, rights of way, voluntary work
- Deployments combine professionals with volunteers
- Replicated in 20+ other rural areas over Great Britain

EUCNC 2018 Tutorial – Wireless Community Networks ... 44/129

Rhizomatica (Mexico)

- Community GSM operator since 2009
- 20+ indigenous communities, Oaxaca
- Community spectrum license, noncommercial, Mexican regulator + ITU-D 19
- The community invests in base station (10 k$), a volunteer collects monthly fees + maintenance
- Voice calls (no data), remote via VoIP (local ISP)

EUCNC 2018 Tutorial – Wireless Community Networks ... 45/129

From Internet Users to *Community Networkers*

- As the network does not come in exchange of a fee, but as a peer production effort, people do not only passively use it
- They own it. It creates local benefits and local employment
- As such, they need to self-educate on networking principles, they have to set-up policies, governance, and take collective decisions
- These decisions are generally different from the decision that an ISP takes, regarding neutrality, openness, and transparency

CNs do not only tackle digital divide: They propose a new model for Internet Development

EUCNC 2018 Tutorial – Wireless Community Networks ... 46/129

The Commons: Common-Pool Resource

- Commons: resources belonging to or affecting the whole of a community (common property, critical need, no exclusion)
- Networking infrastructure ⇒ produces connectivity
- Networking infrastructure as a commons, governed as a common-pool resource (E. Ostrom)[12, 11].
- Sustainability:
  - 1 Clear defined boundaries
  - 2 Adaptability of the Rules
  - 3 Open Governance
  - 4 Self-Monitoring
  - 5 Sanctions for Violators
  - 6 Dispute Resolution
  - 7 Legal recognition
  - 8 Tiered Governance
  - + Economic model

EUCNC 2018 Tutorial – Wireless Community Networks ... 47/129

The Bundle of Rights in a Commons

- Right to access: obtain connectivity
- Right to participate: define, decide
- Right to produce connectivity: + provide services, content
- Public vs private space
- Costs, efficiency, effectiveness

Governance ensures the rights of all participants in equal terms, preserves the resource system (sustainability), ensures the viability of activities that rely on the commons

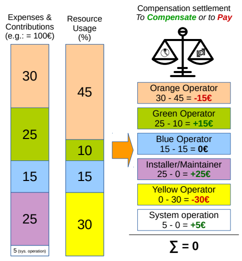
A commons network infrastructure ensures connectivity

Personal or professional activities/services can develop (both non-profit, for-profit) ⇒ socio-economic development

EUCNC 2018 Tutorial – Wireless Community Networks ... 48/129

Economic Compensation

- *Problem:* Cost sharing, coordination of contribution and consumption, to achieve overall sustainability.
- *Context:* In remote or less populated areas, the demand and its growth may not be enough for small communities and ISPs to pay for long distance links *individually*
- *Solution:* Cost sharing: Declaration of investment & consumption with periodic settlement (compensation tables)



EUCNC 2018 Tutorial – Wireless Community Networks . . . 49/129

Outline

Universal Connectivity

Community Networks

Technical challenges in CNs
- Networking challenges
- Blockchains in networks
- Some Proposals
- Proof of Networking

S1 - Summary

Distributed Applications

P2P Streaming

Community Clouds

S2 - Summary

References and Resources

EUCNC 2018 Tutorial – Wireless Community Networks . . . 50/129

Research Topics in CNs

- Mesh, bottom-up networks have 10 years or life, not 100
- Specific technologies have been sometimes discussed, but CNs use generic WiFi devices
- Spectrum management in unlicensed bands is challenging
- Mobility has never been tackled
- Access interacts with routing (no complex tunneling used), which still suffers from naive modeling
- Management requires different approaches
- Accounting is not only billing (pico-peering, trust building, . . .
- Applications . . . the "cloud" model clashes with meshes and in general with distributed systems
- Security and privacy have a different "flavor"

EUCNC 2018 Tutorial – Wireless Community Networks . . . 51/129

Networking challenges

- L2: Client access and roaming in APs: (Batman-adv)
- L3: Trust and security (Babel, BMX7)
- L3: BGP for large CNs
- Internet gateways selection:
  - Aggregate multiple gateways of limited capacity (sharing spare Internet access capacity)
- QoE: Monitoring and capacity planning and management [13]
- Sustainability: economic compensation of contribution and consumption of resources (decentralized: can blockchains help?).

EUCNC 2018 Tutorial – Wireless Community Networks . . . 52/129

L2/L3 mesh routing

- Typical mesh routing protocols:
  - L2: Batman-adv: proactive link-state; L2 ⇒ bridging, all nodes link local (LAN)
  - L3:
    - OLSR: Link-state
    - Babel: Distance-vector, reactive updates
    - BMX6: Distance-vector, periodic descriptive updates
- Classic challenges: overhead (protocol), scalability (size), adaptability and reactivity (changes)
- Specific challenges:
  - *Decentralized dynamics:* nodes may join/leave/move any time
  - *Accountable routers:* Identification, authentication
  - *Faulty/malicious routers:* integrity of protocol messages, trusted virtual topologies, tolerance to attack (false, manipulation, overload), audit/fault-detection/reputation of routers

EUCNC 2018 Tutorial – Wireless Community Networks . . . 53/129

Internet gateways: transit and content

- Multiple ways for Internet access:
  - One or several Internet gateways
  - L3 routers
  - L7 content proxies (web proxies, CDN surrogates, . . .)
  - L7 management devices (firewalls, logical partitioning, . . .)
  - Dedicated (what capacity?)
  - Non-dedicated (spare capacity left by primary user)
- The routing protocol selects default gateway for each router
- Best path = best performance? Not always

Ideally: aggregation of all gateway capacity
Reality: one gateway may be overload, others may be unused

EUCNC 2018 Tutorial – Wireless Community Networks . . . 54/129

QoE, planning & management

- In unplanned networks, capacity and demand may not match
- Routing just selects the "best" path, doesn't manage logistics or external capacity
- Transport handles (slow down), doesn't prevent congestion
- Crowdfunding + installing more capacity can help in mid term
- Classic tools: load balancing by routers and middleboxes ...
  - Alternative or multiple network paths in the mesh access net
  - Multiple content gateways: CDN surrogates or content servers
  - Balancing/aggregation of the capacity of network gateways

Lack of capacity planning results in need for capacity handling: end-users get better QoE, the network gets more balanced usage

EUCNC 2018 Tutorial – Wireless Community Networks ... 55/129

Blockchains and Cryptocurrency on Mesh Networks

CNs face the tragedy of the commons as people don't "see" the value of a network

- They see the value of an application, but not of the infrastructure
- So people accept to enter the network, then they stop maintaining it as long as it works for them
- Techies (mostly volunteers) set-up the initial core; the network grows and it is successful
- After a certain scale, the voluntary effort needed to make the network function is too much ... the network collapses

EUCNC 2018 Tutorial – Wireless Community Networks ... 56/129

Let's Make CNs Sustainable: Business Models

Model 1

- Let users pay a fee, and transform a CN into a profitable wireless ISP
- Generally a bad deal, as CNs grow in areas of *market failure* or target a different market model

CNs are sustainable because of the mix of voluntary and professional spirit that keep cost/prices down

Cooperation at cost vs. competition at profit ... [14]

EUCNC 2018 Tutorial – Wireless Community Networks ... 57/129

Let's Make CNs Sustainable: Business Models

Model 2

- The network is recognized as the enabler of a better economy/society
- Networking infrastructures developed cooperatively can create margin for sustainable/profitable value-added businesses on top (relying on basic & widespread connectivity)
- Paradigms and technical means to foster this observation must be found

EUCNC 2018 Tutorial – Wireless Community Networks ... 58/129

Can a Blockchain help?

- A Blockchain provides a distributed ledger (accounting), but needs a consensus mechanism
- What can we use of it?
  1. Blockchains can decentralize services that are still centralized in a network, and thus, reduce the effort needed to run the network
  2. We can create cryptocurrencies, and provide a tangible value for those that participate in the CN
- Before we go on, a sanity check...

EUCNC 2018 Tutorial – Wireless Community Networks ... 59/129

A Blockchain makes sense when:

- Multiple parties that do not fully trust each other ✓
- Don't want trusted intermediaries ✓
- Transactions interact with each other ✓
- Transactions need validation ✓

EUCNC 2018 Tutorial – Wireless Community Networks ... 60/129

What can we do with a Blockchain?

- Authentication and logging
- Certification Authority
- Traffic monitoring
- Multi-party peering balance
- Service publishing & control
- ...

EUCNC 2018 Tutorial – Wireless Community Networks ... 61/129

What can we do with a Cryptocurrency?

- Peering and service agreements
- Payment schemes
- Bring in a "monetary" incentive to build and maintain nodes
- "Traditional" cross-goods balance
- ...
- Why not with money?
  - Because micro-transactions are hard with real money
  - Because the community can decide the value of its internal currency
  - Because it can better match the charter and by-laws of the CN

EUCNC 2018 Tutorial – Wireless Community Networks ... 62/129

Examples: Althea Mesh[3]

- Althea is one of the few (only one?) open source software that uses crypto currencies to enable mesh networks
- Althea nodes do not mine blocks, they use an external blockchain (the Ethereum blockchain) with Micropayment Channels
- Neighbouring nodes, before creating a link, agree on a price per byte
- They pre-charge some credit with an empty transaction on the blockchain. While working, they perform frequent local transactions to pay for the exchanged traffic
- The local link-balance, frequently updated off-chain, is sync-ed with the blockchain from time to time

[3] https://altheamesh.com/

EUCNC 2018 Tutorial – Wireless Community Networks ... 63/129

Examples: AmmbrTech Mesh[4]

- AmmbrTech develops Hw+sw: mesh AP, routers, servers, wallet
- Local blockchain with smart contracts
- Local consensus based on PoET, PoV, PoA (no mining)
- Each router announce price metric
- Traffic consumption on both sides fed to oracle
- A smart contract holds credit (escrow) and determines payments or conflict (service dispute)
- Local balance periodically synced with global blockchain

[4] https://ammbrtech.com/

EUCNC 2018 Tutorial – Wireless Community Networks ... 64/129

Mesh + blockchain

- These examples reproduces the way the Internet works at small scale
- People receive a monetary incentive to deploy and maintain their nodes (access, forwarding, services, gateways)
- The more important their node is (more people connect to it), the more they could gain
- Decentralization: the network grows as devices are added, meshing with each other (crowdsourcing)
- Sustainability: Usage of the devices and the network create an economic return (of the investment + maintenance + margin)

EUCNC 2018 Tutorial – Wireless Community Networks ... 65/129

Open Issues

- Despite the efficient payment system, the proposed metering mechanism to verify the service-level and, consequently, authorize or deny payments, to be further studied and verified
- What is the best pricing scheme for such a mechanism?
- Cryptocurrency: global (e.g., Ethereum) or local?
  - In global currency, prices influenced by global value fluctuations, very volatile
  - A local currency instead?
  - How to generate, distribute and exchange it?

EUCNC 2018 Tutorial – Wireless Community Networks ... 66/129

Towards an in-network blockchain: Proof o Networking[5]

- Can we have a Blockchain embedded in the network?
- Not Proof of Work
- Alternatives?
  - Trusted hardware: Proof of Elapsed Time (PoET), Proof of Velocity (PoV)
  - Permissioned blockchains: Proof of Stake (PoS), Proof of Authority (PoA)
- If the technical problems are solved, we could have a distributed ledger on the mesh
- Smart contracts have to run on small servers in the mesh with storage capacity for state and blockchain data
- Identity and wallets need to be generated and stored safely

[5] L. Ghiro, L. Maccari, and R. Lo Cigno, "Proof of Networking: Can Blockchains Boost the Next Generation of Distributed Networks?" IFIP/IEEE WONS 2018, Isola 2000, France, Jan. 2018 [15]

EUCNC 2018 Tutorial – Wireless Community Networks . . . 67/129

Proof of Networking, Ideas

- At the end of the day, a blockchain is a distributed db based on consensus
- We note that a network, to work, needs to reach consensus on at least a few things, such as, a network topology (i.e. as in a Link-State protocol)
- We may choose the node that produces the next block using some topological feature, for instance, the most central node (based on some centrality metric, with some randomization applied)

EUCNC 2018 Tutorial – Wireless Community Networks . . . 68/129

Proof of Networking, Ideas

What does the block contain?

- The whole topology, so every node can verify that the block was generated by a valid generator (simplifying, the most central)
- Topology can be annotated with whatever tag that nodes can locally agree upon (traffic exchanged)
- A Generation Transactions for new tokens, and their distribution to nodes (potentially based on centrality, again)
- Transactions of tokens between nodes, for whatever reason: Peering, access to services, etc. . .

EUCNC 2018 Tutorial – Wireless Community Networks . . . 69/129

Of course you need. . .

- A cryptographically robust protocol
- A robust blockchain protocol
- A robust way to enforce conflict resolution (can I verify the quality of the network access that I am paying for?)
- . . .

EUCNC 2018 Tutorial – Wireless Community Networks . . . 70/129

Outline

Universal Connectivity

Community Networks

Technical challenges in CNs

S1 - Summary

Distributed Applications

P2P Streaming

Community Clouds

S2 - Summary

References and Resources

EUCNC 2018 Tutorial – Wireless Community Networks . . . 71/129

CN Networks & 5G: Conclusions

- The 7-Billion challenge has multiple facets
- 5G model and KPI answers more a commercial vision than a social good
- 5G may prove unsustainable also in developed countries, specially in market-failure areas
- Developing countries may not even benefit from it
- Community Networks roots in Commons theory (Nobel prize awarded)
- They provide a different development model and pose different technical challenges
- Interdisciplinary research is required
- Technical challenges exists . . . and are enticing

EUCNC 2018 Tutorial – Wireless Community Networks . . . 72/129

Edge Computing in CNs

netCommons

Merkouris Karaliopoulos, Iordanis Koutsopoulos, **Renato Lo Cigno**, Leonardo Maccari, Leandro Navarro

EUCNC, Ljubljana, 18/6/2018

Co-Funded by the Horizon 2020 programme of the European Union, Grant Number 688768

Outline

Facts: CN Capacity

- 802.11ac devices can reach 450 Mbit/s for less than 100 €, on links up to 15 km
- Initial 802.11ad PtP devices are out and reach 1Gb/s, below 1 km, for less than 500 €
- 802.11ax targets link speeds above 2 Gbit/s and max 11 Gbit/s . . . and it's coming
- A gateway equipped with 3 devices can nominally sustain 3 Gbit/s to the Internet, enough for hundreds of client devices
- This is orders of magnitude less than what 5G promises, but may be more than enough

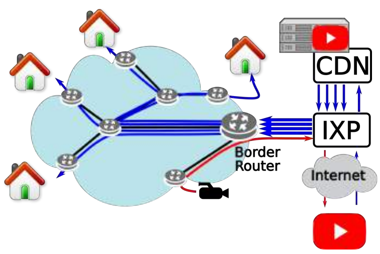
Facts: Application Design

- Applications today are designed to meet the data-analytics business model
- E-t-E client/server models are stressed, even with clouds and CDNs
- . . . these are the main reasons for in-network elaboration and Edge Computing
- A service in a CN needs not be based on the same business and technical principles as mainstream Internet ones, i.e., they can be distributed
- Similarly to what happens with 5G, we need to do in-network elaboration
- In-network elaboration may be different

Example Application: Video Streaming

- Today, the major video platforms use a single TCP connection for every delivered stream: Multiple Unicast Model
- In order to save resources & reduce latency, they use CDNs with content replicated close to end-users, but still in the backbone
- A single video stream generated from the network is sent to the CDN, then re-streamed once per client
- Specially for real-time streaming this is far from optimal
- Requires an enormous amount of resources, justified only by the data-analytics business model

VS: CDN model

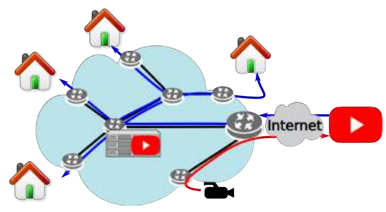


Edge Computing

- In order to save resources, but also to guarantee lower latencies, the Edge Computing model embodies the vertical integration we discussed before
- Service providers can place virtual servers directly inside the network: in some sense the CDN becomes in-network
- The in-network virtual server is integrated in a network slice (vertical integration) and can serve each user the content required with further cost reductions

EUCNC 2018 Tutorial – Wireless Community Networks . . . 79/129

VS: Edge Computing model



EUCNC 2018 Tutorial – Wireless Community Networks . . . 80/129

Edge Computing: Consequences

- The service provider sign deals with the operator assigning network slices and virtual servers
- Network slices need to be independent one-another (yet insisting on the same hardware . . .)
- Conflicts with network neutrality
- Creates dependencies between network functions and service functions . . . just like in old POTS/ISDN!!!

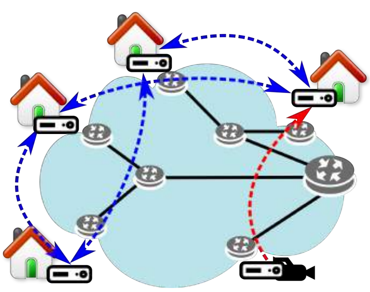
EUCNC 2018 Tutorial – Wireless Community Networks . . . 81/129

P2P Paradigm

- In a CN resources are evenly distributed (Mesh of Meshes, not Tree of Stars)
- There is not up-link down-link mismatch, but bandwidth toward the Internet may be scarce/costly
- . . .
- We can exploit P2P technologies
- The service becomes inherently distributed
- No need for centralized or decentralized servers
- Distributed and decentralized are not the same

EUCNC 2018 Tutorial – Wireless Community Networks . . . 82/129

VS: P2P model



EUCNC 2018 Tutorial – Wireless Community Networks . . . 83/129

Outline

Universal Connectivity

Community Networks

Technical challenges in CNs

S1 - Summary

Distributed Applications

P2P Streaming
- P2P Operation
- Performance

Community Clouds

S2 - Summary

References and Resources

EUCNC 2018 Tutorial – Wireless Community Networks . . . 84/129

P2P Model

- P2P protocols have been deeply studied starting from early 2000s
- Yet, they did not achieve mass distribution, if not in niche applications
- One reason for this is that a P2P protocol to achieve excellent performance needs to be network-aware: It needs to be optimized to the underlying network[6][16]
- . . . but operators are generally unwilling to share information about their networks

[6] S. Traverso, L. Abeni, R. Birke, C. Kiraly, E. Leonardi, R. Lo Cigno, and M. Mellia, "Neighborhood Filtering Strategies for Overlay Construction in P2P-TV Systems: Design and Experimental Comparison," IEEE/ACM Trans. on Networking, June 2015.

5G Edge Computing vs. CN P2P Model

- With Edge Computing, the operator forces the service provider to place services in the network
- Operators gain a huge control on service provider, and in exchange, they share information on the state of the network
- Large service providers in turn can force operators to bias the network performance to favor them
- In a CN the state of the network is generally known
- Nodes can export the whole topology, and the link quality (with some meaningful metric)
- P2P applications can be optimized based on the network condition

P2P on CNs for Video Streaming

- Imagine that every home router is equipped with an always-on media device
  - Can be a cheap device based on raspberry-pi or similar
  - Some more "central" nodes may have more performing devices
- There is a source of video in the network
  - Can be just a web-cam
  - Or a local live event professionally recorded
  - Or it can be a proxy for a video generated outside the network

Streaming Example

Let us formalize the problem:

- we describe the physical network (the *underlay*) with an undirected graph $U(H, L)$ with vertexes $h \in H$ called hosts and edges $l \in L$ called links
- On top of the underlay there is an *overlay* graph which represents the distribution of the video from the source to the all the destinations
- The *overlay* is modeled as a directed graph $O(P, E)$ with vertexes $p \in P$ called peers, and edges $e \in E$ called logical links
- Each logical link in O corresponds to a path (a series of links) in U.

Point-to-Multipoint: Metrics

- PtMP approach: the source generates one separate video stream per client, O is a star graph with the source at the center and clients at the edges
  - This is the 5G Edge Computing model: Once a video is injected to the Virtual Server, it is distributed PtMP to final users
- A link in U must sustain a load that is proportional to the number of virtual links that pass through it (we simplify the load of each stream as a unitary load)
- We call $\mathcal{H}(l)$ the number of logical links loading l
- The load produced by the overlay on the underlay is given by:

$$\mathcal{L} = \sum_{l \in L} \mathcal{H}(l)$$

Load Distribution

- The total load on the underlay is not the only important factor, another fundamental one is how evenly this load is distributed in the underlay links
- We use the Jain's fairness to quantify the fairness of the load distribution[7]
- If we call $L' = \{l \in L | \mathcal{H}(l) > 0\}$ the subset of L made of all the links with some load, then the overlay fairness is defined as:

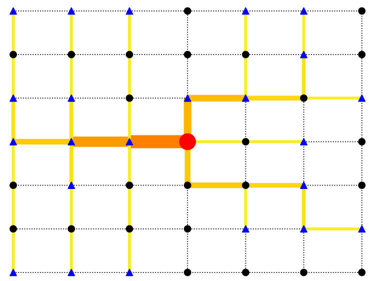
$$\mathcal{F} = \frac{(\sum_{l \in L'} \mathcal{H}(l))^2}{|L'| \sum_{l \in L'} \mathcal{H}(l)^2}$$

[7] Jain's fairness is maximal ($\mathcal{F} = 1$) if $\mathcal{H}(l)$ is constant for all l and approaches the minimum ($\mathcal{F} = \frac{1}{|L'|}$) if there is one link l_{max} for which $\mathcal{H}(l_{max}) >> \mathcal{H}(l)\ \forall\ l \neq l_{max}$

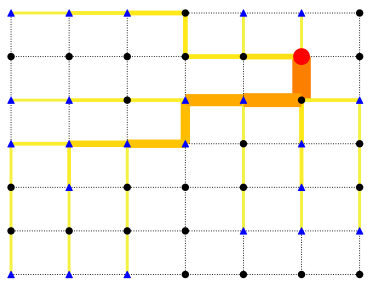
Example

- Let's consider a grid network with 7x7 nodes, $\simeq 50\%$ nodes participate in the stream (1 source, 23 receivers)
- The load and fairness depend on where we place the source
- We consider three different cases to show differences
- Keys of the following figures
  - Red circle: source
  - Blue Triangles: receivers
  - Link thickness proportional to load

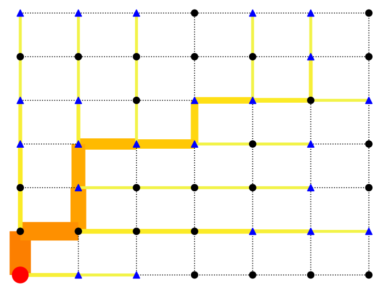
Best Case



Median Case



Worst Case



Numerical Results: Grid with PtMP

- Total Load (cost): $\mathcal{L}$
- Maximum Load: $\max(\mathcal{H}(l))$
- Fairness: $\mathcal{F}$

	Best	Median	Worst
$\mathcal{L}$	83.0	111.0	143.0
$\max(\mathcal{H}(l))$	12.0	18.0	21.0
$\mathcal{F}$	0.47	0.39	0.36

P2P Model

- A P2P approach uses some strategy to build an overlay: a directed graph that connects the peers.
- Once the overlay graph is formed the video source injects only **one** copy of the video, and the "clients" become "peers" and start to trade video "chunks".
- Every peer receives the whole video, and uploads it (split in chunks) to its neighbors.
- It is intuitive to understand that if the average degree of the *overlay* is d, every virtual link does not produce an unitary load on the underlay link, but it produces a load given by $\frac{1}{d}$.

P2P Model

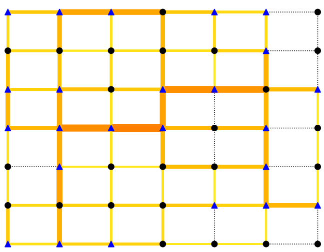
- To account for signaling redundancy needed for dynamic P2P management we add a 50% overhead (pessimistic assumption!)
- Consequently the load of each virtual link on the underlay link is given by $\frac{3}{2d}$, and the total load becomes:

$$\mathcal{L} = \sum_{l \in L} \mathcal{H}(l) \frac{3}{2d}$$

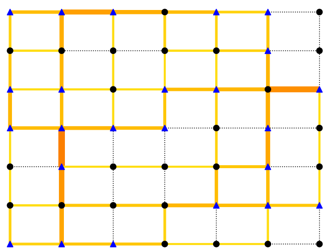
Overlay Building Strategy

- Given $U(H, L)$, and a set of peers that need to receive the video, how do we choose $O(P, E)$?
- . . . Or given a degree d for each peer that is the "optimum" in some sense, how do we choose the edges from one peer to another?
  - At random to maximize uniformity
  - Every peer choose the d closest peers
  - Every peer tries to minimize the load on central peers [17, 18, 19]
- Now we can even ignore which is the source: every Peer can be the source!!

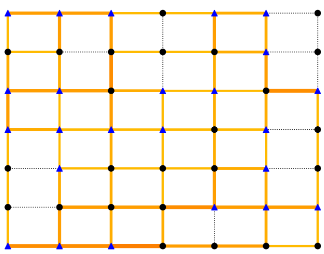
Random Placement



Closes Peers



Centrality-based



Numerical Results: P2P & Comparison

- Total Load (cost): $\mathcal{L}$
- Maximum Load: $\max(\mathcal{H}(l))$
- Fairness: $\mathcal{F}$

	Random	Distance	Centrality	**PtMP (Best)**
$\mathcal{L}$	168	103	87	**83**
$\max(\mathcal{H}(l))$	7.7	6	3	**12**
$\mathcal{F}$	0.65	0.63	0.79	**0.47**

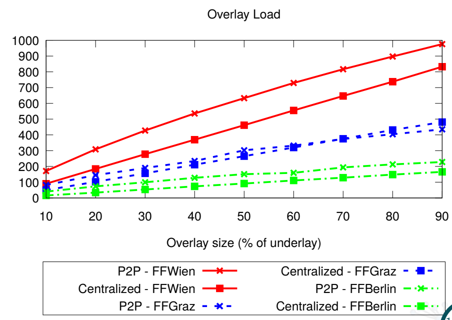
Even with 50% P2P overhead and optimal placement for PtMP, P2P performance is much better

A Real World Example

- We take the topologies of three operational networks: FFWien, FFGraz, FFBerlin made of respectively 341 (822), 143 (208), and 94 (261) nodes (edges).
- Topology is derived from the dump of the routing daemon, each node is a host in the network
- Given a certain percentage of nodes that are peers in the overlay, we run 30 random choices of peers, and compute the metrics for the graph
- We compare the best PtMP placement, with P2P distribution based on centrality overlay building

EUCNC 2018 Tutorial – Wireless Community Networks . . . 103/129

Total Load



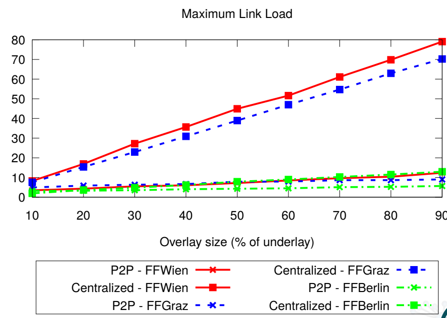
EUCNC 2018 Tutorial – Wireless Community Networks . . . 104/129

Total Load

- In all cases load grows linearly with overlay size (as expected)
- For smaller networks, the overall load is comparable
- For the largest network the overall load is higher: recall we are comparing against the best centralized case, in which the source has the smallest average distance to any other node

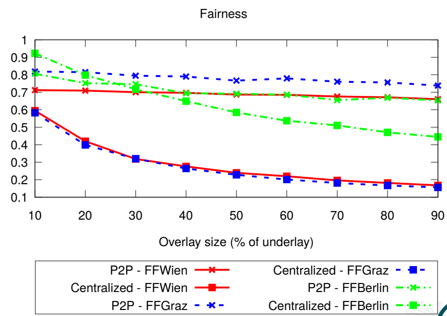
EUCNC 2018 Tutorial – Wireless Community Networks . . . 105/129

Max Link Load: P2P wins by far!



EUCNC 2018 Tutorial – Wireless Community Networks . . . 106/129

Fairness: PtMP decays as Overlay grows



EUCNC 2018 Tutorial – Wireless Community Networks . . . 107/129

Real World P2P Feasibility

- The P2P model relies on efficient software that runs in people house
- Is it a realistic scenario in operational networks?

YES:
Indeed, traditional PtMP solutions are extremely inefficient and require that the network is designed having them in mind, which leads to high initial deployment costs

EUCNC 2018 Tutorial – Wireless Community Networks . . . 108/129

Outline

P2P Streaming

Universal Connectivity

Community Networks

Technical challenges in CNs

S1 - Summary

Distributed Applications

Community Clouds
- Principles
- Comparison

S2 - Summary

References and Resources

EUCNC 2018 Tutorial – Wireless Community Networks . . . 109 / 129

Community Clouds (CCs)

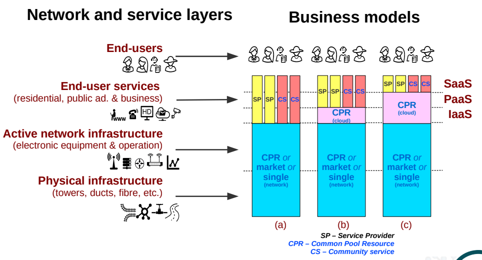
- CNs infrastructure is held in commons
- We discussed how a P2P paradigm can reduce costs and improve performance of video streaming
- Can we imagine other services that can either be adapted or benefit from this "commons" model?
- Community Clouds [20] embody the model of service "commoning" and are the archetype of any other application
- The model has been developed and guifi.net has its own community cloud[8] [21]

[8] https://cloudy.community/

EUCNC 2018 Tutorial – Wireless Community Networks . . . 110 / 129

CCs: business model

- Infrastructure (servers) and platform (discovery, monitoring) as commons



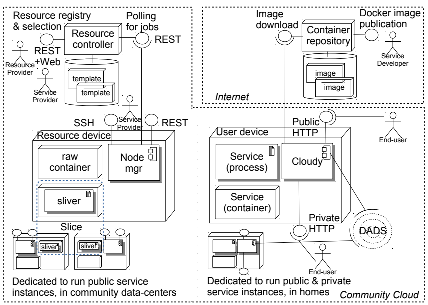
EUCNC 2018 Tutorial – Wireless Community Networks . . . 111 / 129

CCs: decentralized architecture

- Resources: computing, storage & networking in home servers virtualized as Linux and Docker containers
- Platform: Discovery service (DADS), based on Serf (gossip)
- Applications: CN specific + Docker-based services
- Can embed the P2P Streaming application described before

EUCNC 2018 Tutorial – Wireless Community Networks . . . 112 / 129

CCs: decentralized architecture



EUCNC 2018 Tutorial – Wireless Community Networks . . . 113 / 129

Community Clouds: Are they Possible?

- Existing: Open Source platform that the user can install in his home, on low-power devices, to create a shared application/storage overlay
- If coupled with information extracted from the network, applications can be optimized without the need of central control
- Guarantee by design better privacy and better information control by the legitimate (information) owner

EUCNC 2018 Tutorial – Wireless Community Networks . . . 114 / 129

CN + Community Clouds Vs 5G + Edge Computing

Pros of 5G + Edge Computing:

- Will give unprecedented speed and latency to connected mobile users
- Exploits SDN and NFV to achieve high network efficiency and low-latency via proximity to the user

Cons of 5G + Edge Computing

- Will connect only those already connected, and widen the digital divide (increased costs)
- Networks become programmable. They are not neutral anymore, and as of today there is no way of moving control from the operator to the end-user (albeit attempts exist [22])

EUCNC 2018 Tutorial – Wireless Community Networks . . . 115/129

CN + Community Clouds Vs 5G + Edge Computing

Pros of CN + Community Clouds:

- It has the potential to scale down the costs of orders of magnitude
- It gives control back to the communities

Cons of CN + Community Clouds:

- Distributed networks can hardly achieve the capacity of centralized infrastructure
- Distributed networks can hardly achieve the efficiency of centralized infrastructure

EUCNC 2018 Tutorial – Wireless Community Networks . . . 116/129

Outline

- Universal Connectivity
- Community Networks
- Technical challenges in CNs
- S1 - Summary
- Distributed Applications
- P2P Streaming
- Community Clouds
- S2 - Summary
- References and Resources

EUCNC 2018 Tutorial – Wireless Community Networks . . . 117/129

Services for CNs: Conclusions

- Services and applications for CNs are intrinsically more distributed than traditional Internet ones
- On a local scale P2P may finally get rid of its illicit flavor
  - Distributed video conferencing solves once and for all privacy concerns (for this application)
  - Blockchains may offer a handy tool to manage P2P
- We don't need super data-centers to create "clouds"
- Edge computing can be declined in favor of the user rather than the service provider
- Community Clouds are one example and can be the base for further services

EUCNC 2018 Tutorial – Wireless Community Networks . . . 118/129

Outline

- Universal Connectivity
- Community Networks
- Technical challenges in CNs
- S1 - Summary
- Distributed Applications
- P2P Streaming
- Community Clouds
- S2 - Summary
- References and Resources

EUCNC 2018 Tutorial – Wireless Community Networks . . . 119/129

On-line Resources and References (I)

- netCommons web site: `https://netcommons.eu`
  - Deliverables of the project
  - Open Source code for applications development
- Some notable and studied Community Networks
  - Guifi.net: `https://guifi.net/`
  - Freifunk.net: `https://freifunk.net/`
  - B4RN: `https://b4rn.org.uk/`
  - Rhizomatica: `https://www.rhizomatica.org/`

EUCNC 2018 Tutorial – Wireless Community Networks . . . 120/129

On-line Resources and References (II)

- Open source software
  - OpenWRT the Linux distribution for embedded devices used by many CNs: `https://openwrt.org/`
  - OpenWISP2, a network management software for wireless networks: `http://openwisp.io/`
  - The Cloudy platform for Community Clouds: `https://cloudy.community/`
  - The PeerStreamer P2P video streaming platform: `http://www.peerstreamer.org/`
- Some well known routing protocols used in CNs.
  - OLSRd: `http://www.olsr.org/`
  - Batman-Advanced: `https://www.open-mesh.org/`
  - BMX7: `https://github.com/bmx-routing/bmx7`
  - Babel: `https://www.irif.fr/~jch/software/babel/`

On-line Resources and References (III)

- Relevant Organizations involved:
  - IEEE: `https://internetinitiative.ieee.org/resources/inclusion-working-groups`
  - IRTF: `https://irtf.org/gaia`
  - Internet Society: `https://www.internetsociety.org/issues/community-networks/`
  - Association for Progressive Communications: `https://www.apc.org/en/topic/community-networks`

Bibliography I

International Telecommunication Union (ITU), "ICT Facts and Figures 2017."

——, "The impact of broadband on the economy: Research to date and policy issues," 2012.

J. G. Andrews, S. Buzzi, W. Choi, S. V. Hanly, A. Lozano, A. C. K. Soong, and J. C. Zhang, "What Will 5G Be?" *IEEE Journal on Selected Areas in Communications*, vol. 32, no. 6, pp. 1065–1082, June 2014.

R. Montagne, "FTTH/B Panorama Europe (EU39) at September 2016," in *FTTH Conference 2017*, Feb. 2017.

M. Zager, "Modeling the Cost of Rural Fiber Deployment," *Broadband Communities Magazine*, March/April 2011.

Bibliography II

Broadband StakeHolder Group, UK, "The costs of deploying fibre-based next-generation broadband infrastructure," Sept. 2008.

Next generation mobile networks (NGMN) Alliance, "5G White Paper," 2015.

Z. Frias and J. Pèrez Martínez, "5G networks: Will technology and policy collide?" *Telecommunications Policy*, Jul. 2017.

L. Maccari and R. Lo Cigno, "A week in the life of three large Wireless Community Networks," *Ad Hoc Networks*, vol. 24, Part B, pp. 175–190, Jan. 2015.

Bibliography III

L. Maccari, "An analysis of the ninux wireless community network," in *Proc. 9th IEEE Int'l Conf. on Wireless and Mobile Computing, Networking and Communications (WiMob)*, Oct 2013.

R. Baig, R. Roca, F. Freitag, and L. Navarro, "guifi.net, a crowdsourced network infrastructure held in common," *Computer Networks*, vol. 90, pp. 150–165, 2015.

E. Ostrom, *Governing the commons: the evolution of institutions for collective action.* Cambridge University Press, Nov. 1990.

Bibliography IV

E. Dimogerontakis, R. Meseguer, L. Navarro, S. F. Ochoa, and L. Veiga, "Community sharing of spare network capacity," in *IEEE International Conference on Networking, Sensing and Control (ICNSC)*, 05/2017 2017.

P. Micholia, M. Karaliopoulos, I. Koutsopoulos, L. Navarro, R. Baig, D. Boucas, M. Michalis, and P. Antoniadis, "Community networks and sustainability: a survey of perceptions, practices, and proposed solutions," *accepted for publication in IEEE Communications Surveys & Tutorials*, 2017.

Bibliography V

- L. Ghiro, L. Maccari, and R. Lo Cigno, "Proof of Networking: Can Blockchains Boost the Next Generation of Distributed Networks?" in *14th IFIP/IEEE Conf. on Wireless On-demand Network Systems and Services (WONS)*, Isola 2000, France, Jan. 2018.
- S. Traverso, L. Abeni, R. Birke, C. Kiraly, E. Leonardi, R. Lo Cigno, and M. Mellia, "Neighborhood Filtering Strategies for Overlay Construction in P2P-TV Systems: Design and Experimental Comparison," *IEEE/ACM Transactions on Networking*, vol. 23, no. 3, pp. 741–754, June 2015.

EUCNC 2018 Tutorial – Wireless Community Networks . . . 127/129

Bibliography VI

- L. Maccari, N. Facchi, L. Baldesi, and R. Lo Cigno, "Optimized p2p streaming for wireless distributed networks," *Accepted for Publication in the Elsevier Journal of Pervasive and Mobile Computing*, 2017.
- L. Baldesi, L. Maccari, and R. Lo Cigno, "Optimized Cooperative Streaming in Wireless Mesh Networks," in *IFIP Networking Conference (NETWORKING)*, Vienna, (Austria), April 2016.
- ——, "Improving P2P streaming in wireless community networks," *Computer Networks*, vol. 93, Part 2, pp. 389–403, 2015.
- A. Marinos and G. Briscoe, "Community cloud computing," in *IEEE International Conference on Cloud Computing*. Springer, 2009, pp. 472–484.

EUCNC 2018 Tutorial – Wireless Community Networks . . . 128/129

Bibliography VII

- R. Baig, F. Freitag, and L. Navarro, "Cloudy in guifi.net: Establishing and sustaining a community cloud as open commons," 01 2018.
- Y. Yiakoumis, S. Katti, and N. McKeown, "Neutral net neutrality," in *Proceedings of the 2016 ACM SIGCOMM Conference*, ser. SIGCOMM '16. New York, NY, USA: ACM, 2016, pp. 483–496.

EUCNC 2018 Tutorial – Wireless Community Networks . . . 129/129

B.12.3. “Thinking outside the box session," Renato Lo Cigno Presentation

Wireless 2035:
New Technologies or New Architectures?

Renato Lo Cigno

UNIVERSITY OF TRENTO
Department of Information Engineering and Computer Science

EUCNC SPS12, Ljubljana, 19/6/2018

netCommons

Co-Funded by the Horizon 2020 programme of the European Union, Grant Number 688768

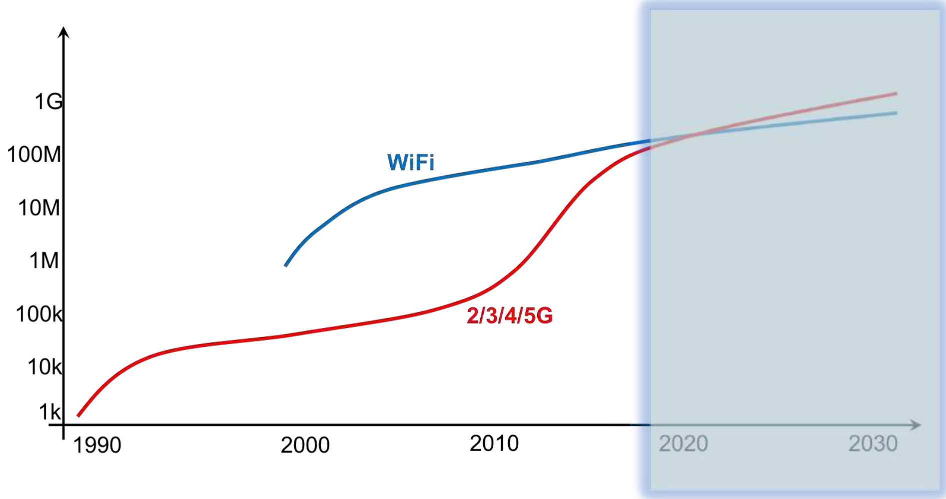
EUCNC 2018 – Wireless 2035: New Technologies or New Architectures? – renato.locigno@unitn.it 1/16

Outline

- Technological (PHY speed) Evolution
- Architectural Changes
- Some measures, “pictures”, and reasoning
- What May Change More Performance (User Experience, Cost, Privacy/Security) in 15 Years?

EUCNC 2018 – Wireless 2035: New Technologies or New Architectures? – renato.locigno@unitn.it 2/16

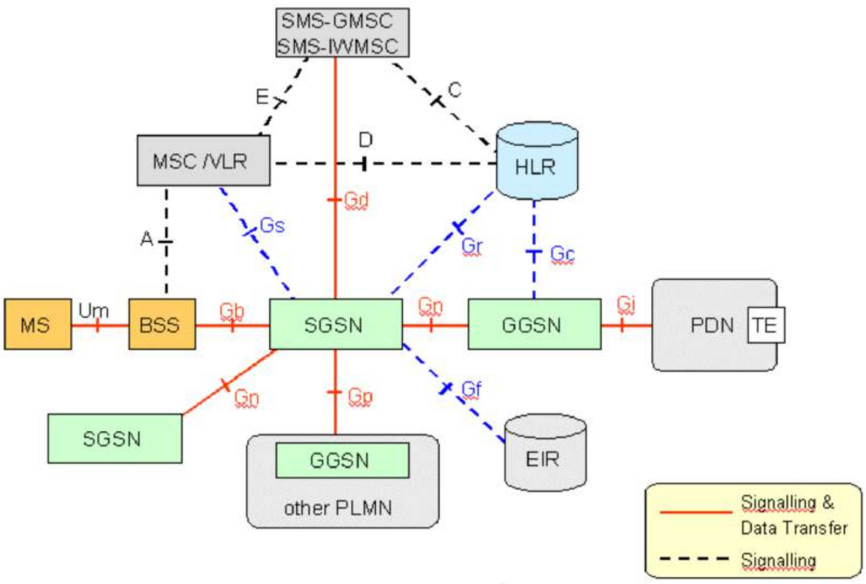
Tx Speed 1990–2030



EUCNC 2018 – Wireless 2035: New Technologies or New Architectures? – renato.locigno@unitn.it

3/16

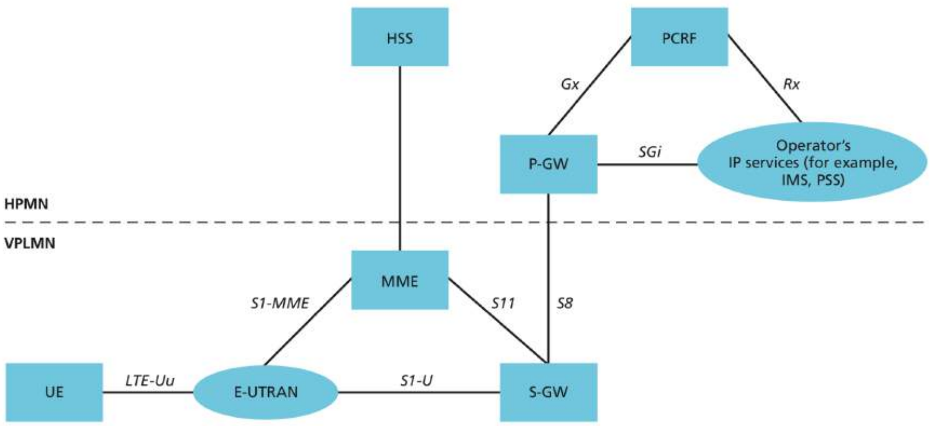
Logical Architecture: 2G



EUCNC 2018 – Wireless 2035: New Technologies or New Architectures? – renato.locigno@unitn.it

4/16

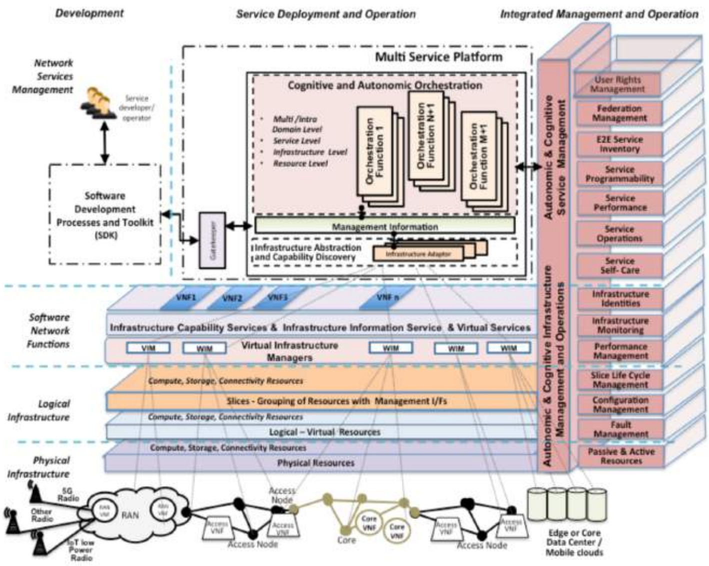
Logical Architecture: 4G



EUCNC 2018 – Wireless 2035: New Technologies or New Architectures? – renato.locigno@unitn.it

5/16

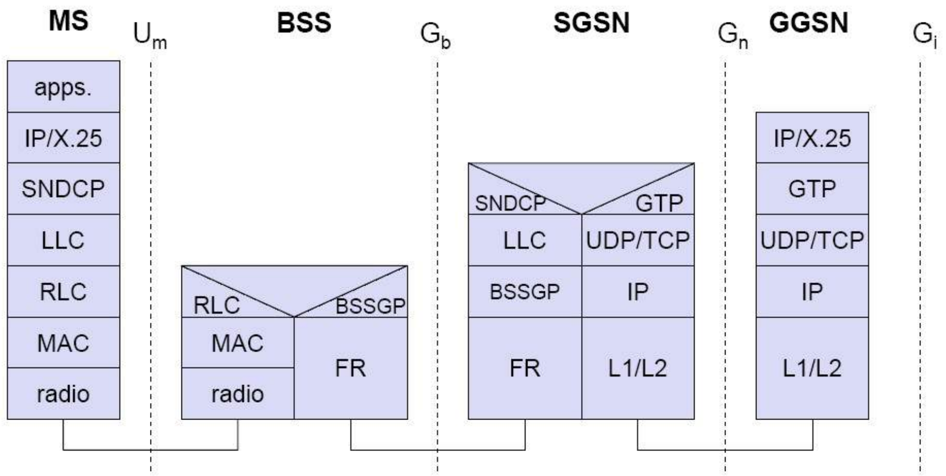
Logical Architecture: 5G



EUCNC 2018 – Wireless 2035: New Technologies or New Architectures? – renato.locigno@unitn.it

6/16

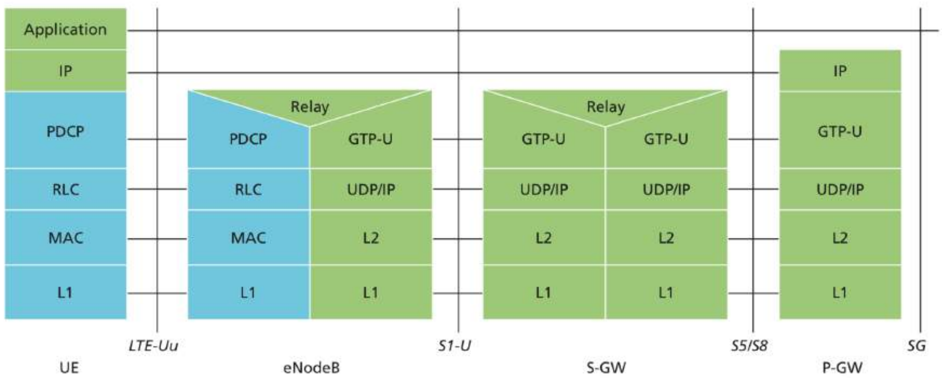
Protocol Architecture: 2G



EUCNC 2018 – Wireless 2035: New Technologies or New Architectures? – renato.locigno@unitn.it

7/16

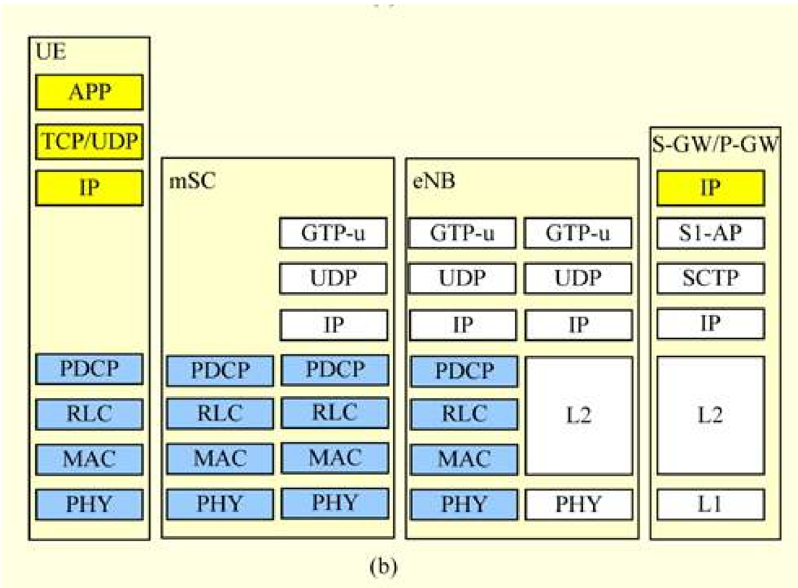
Protocol Architecture: 4G



EUCNC 2018 – Wireless 2035: New Technologies or New Architectures? – renato.locigno@unitn.it

8/16

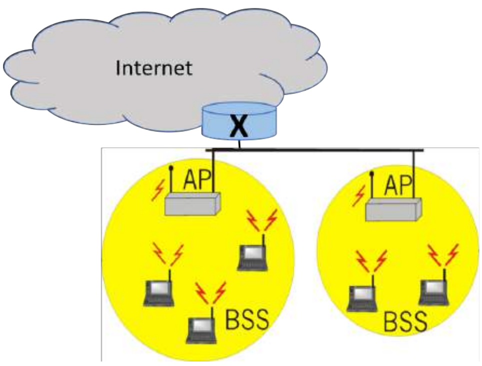
Protocol Architecture: 5G

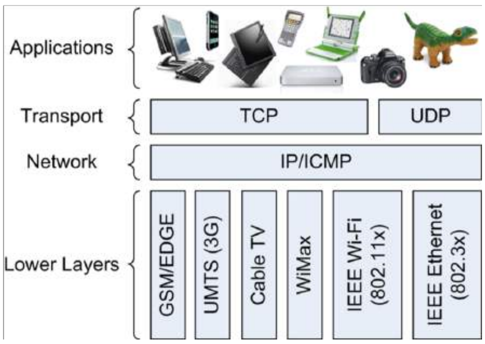


EUCNC 2018 – Wireless 2035: New Technologies or New Architectures? – renato.locigno@unitn.it

9/16

Logical & Protocol Architecture: WiFi





EUCNC 2018 – Wireless 2035: New Technologies or New Architectures? – renato.locigno@unitn.it

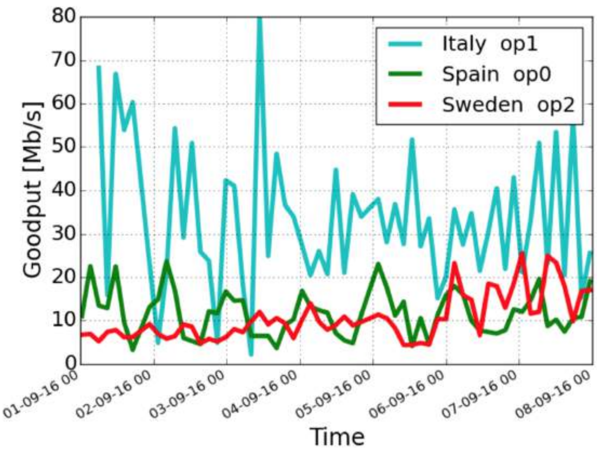
10/16

Some Reasoning

- How much speed do we need?
  - a High Quality Picture in a blink of an Eye
  - . . . 10 Mbytes in 100 ms . . . ⇒ 80 Mbit/s . . .
  - So what?

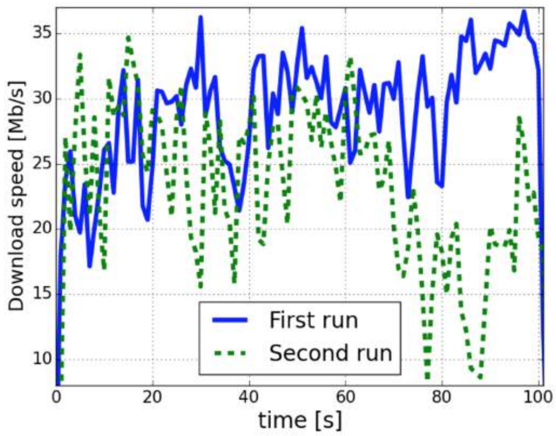
- How the current architectures support evolution and natural communications?
  - Pretty bad I would say
  - Why?
  - Can we do better?

Some Measures from EU Mobile Networks[1]



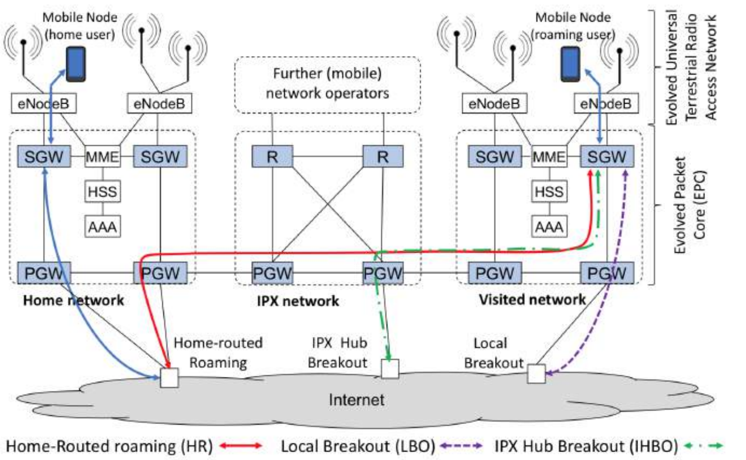
[1]Reproduced with permission from "Experimentation and Characterization of Mobile Broadband Networks" By Ali Safari Khatouni, PhD Dissertation, Politecnico di Torino, 2018, Supervisors: Proff. M. Mellia, and M. Ajmone Marsan

Some Measures from EU Mobile Networks[2]



[2]Reproduced with permission from "Experimentation and Characterization of Mobile Broadband Networks" By Ali Safari Khatouni, PhD Dissertation, Politecnico di Torino, 2018, Supervisors: Proff. M. Mellia, and M. Ajmone Marsan

Roaming: An Example of Madness[3]



[3]Reproduced with permission from "Experimentation and Characterization of Mobile Broadband Networks" By Ali Safari Khatouni, PhD Dissertation, Politecnico di Torino, 2018, Supervisors: Proff. M. Mellia, and M. Ajmone Marsan

Simplify and "humanize" the architecture

If we want ubiquitous, multi-purpose, cheap, socially sustainable wireless networks in 2035 we should start now to:

- Simplify architectures & think out-of-the-box for novel ones (no GPRS- WiFi-Like)
- Keep local what is local, think about natural communications and not client/server model (cloud is just a big server)
- Don't think in terms of one one-size-fits-it-all, let things be things and not people, let vehicles communicate between themselves an not with "the cloud"
- Don't mess up networks and applications, that's what killed ISDN/B-ISDN & made Internet successful
- Lobby, as researchers and civil society, so that rules & policies are done for society and not for business

EUCNC 2018 – Wireless 2035: New Technologies or New Architectures? – renato.locigno@unitn.it

15/16

Wireless 2035: New Technologies or New Architectures?

Renato Lo Cigno

?? Other Perspectives ??

!! Discussion !!

EUCNC SPS12, Ljubljana, 19/6/2018

EUCNC 2018 – Wireless 2035: New Technologies or New Architectures? – renato.locigno@unitn.it

16/16

B.13. Merge-it 2018
Reference event Sec. 2.4.1
The netCommons project, research end experimentation with CNs (Leonardo Maccari)

NETCOMMONS PROJECT
RESEARCH AND EXPERIMENTATION WITH CNS

UNIVERSITY OF TRENTO
Department of Information Engineering and Computer Science

netCommons

Leonardo Maccari, leonardo.maccari@unitn.it

Torino, 24/3/2018

Co-Funded by the Horizon 2020 programme of the European Union, Grant Number 688768

Leonardo Maccari leonardo.maccari@unitn.it netCommons 1/63

CNs: two Themes

1 - Digital Divide
They lower the cost of the infrastructure and make it possible to operate in digital divide areas

2 - Bottom-up Networks
They offer a new and revolutionary networking model compared to traditional Telco model.

Leonardo Maccari leonardo.maccari@unitn.it netCommons 2/63

CNs Vs Digital Divide

- One of the obstacles for Internet diffusion is the cost of the infrastructure.
- CNs offer a low-cost alternative to other network models, with minimal initial investment and "organic" growth.
- A CN generally start as a wireless mesh network, what does it mean?

Leonardo Maccari leonardo.maccari@unitn.it netCommons 3/63

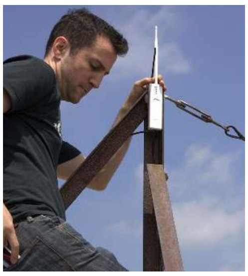
Mesh Networks

- A mesh network is a distributed wireless network.
- Each node of the network receives, generates and also routes traffic

Leonardo Maccari leonardo.maccari@unitn.it netCommons 4/63

Mesh Nodes

- The market offers devices for less than 60 Euro that can be easily mounted outdoor, and allow to bootstrap a network with a very small investment

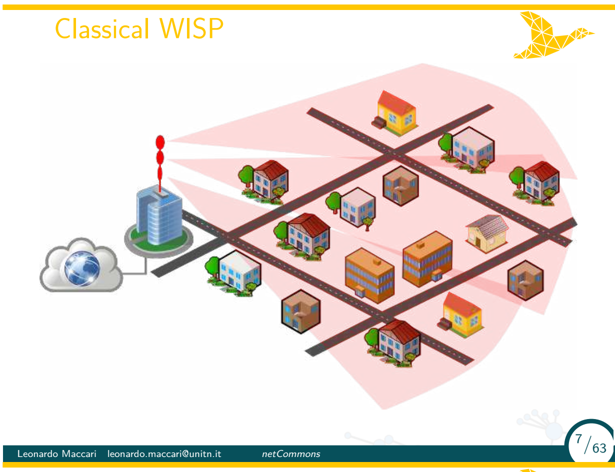


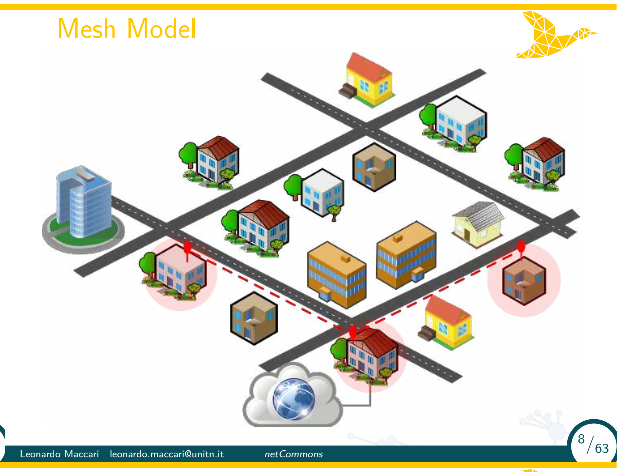
Leonardo Maccari leonardo.maccari@unitn.it netCommons 5/63

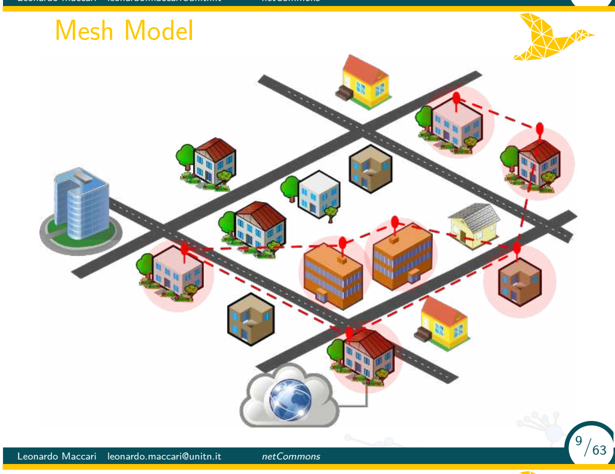
Scaling up Networks

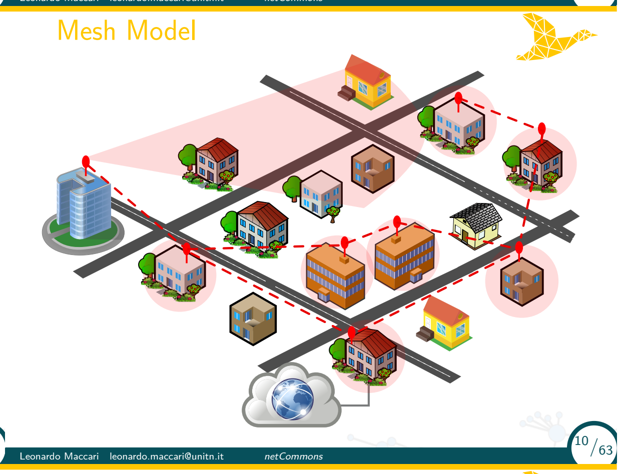
- As networks grow, things get technically more complex, but large networks are still viable and affordable.
- We have studied networks made with this principle that scale to hundreds of nodes, and cover large areas (i.e. the city of Vienna)

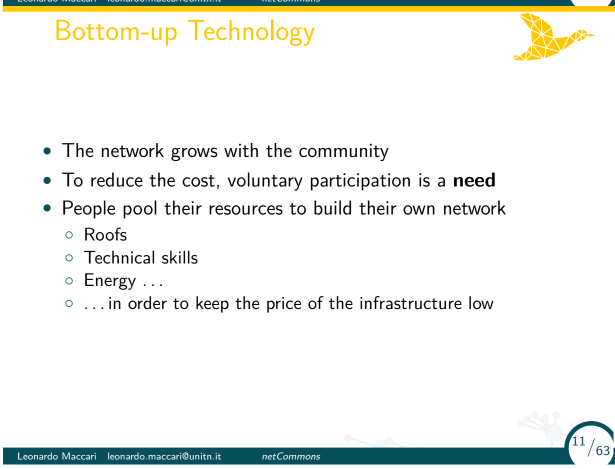
Leonardo Maccari leonardo.maccari@unitn.it netCommons 6/63

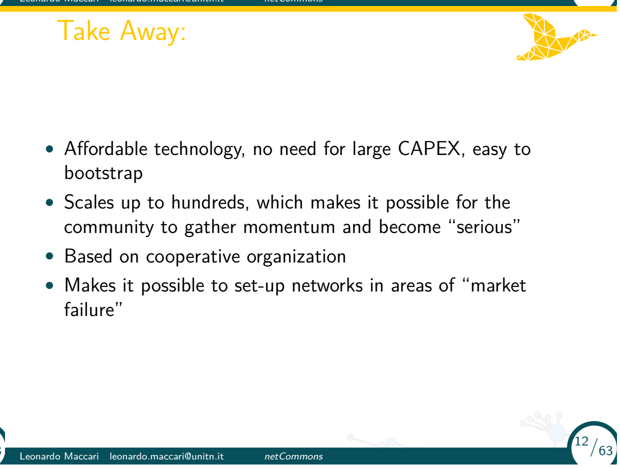

Classical WISP
Leonardo Maccari leonardo.maccari@unitn.it netCommons
7/63


Mesh Model
Leonardo Maccari leonardo.maccari@unitn.it netCommons
8/63


Mesh Model
Leonardo Maccari leonardo.maccari@unitn.it netCommons
9/63


Mesh Model
Leonardo Maccari leonardo.maccari@unitn.it netCommons
10/63


Bottom-up Technology
• The network grows with the community
• To reduce the cost, voluntary participation is a **need**
• People pool their resources to build their own network
◦ Roofs
◦ Technical skills
◦ Energy . . .
◦ . . . in order to keep the price of the infrastructure low
Leonardo Maccari leonardo.maccari@unitn.it netCommons
11/63


Take Away:
• Affordable technology, no need for large CAPEX, easy to bootstrap
• Scales up to hundreds, which makes it possible for the community to gather momentum and become "serious"
• Based on cooperative organization
• Makes it possible to set-up networks in areas of "market failure"
Leonardo Maccari leonardo.maccari@unitn.it netCommons
12/63

From Internet Users to *Community Networkers*

- As the network does not come in exchange of a fee, but as a peer production effort, people do not only passively use it.
- They own it.
- As such, they need to self-educate on networking principles, they have to set-up policies, governance, and take collective decisions.
- These decisions are generally different from the decision that an ISP takes, regarding neutrality, openness, and transparency.

CNs do not only tackle digital divide: they propose a new model for Internet development

Leonardo Maccari leonardo.maccari@unitn.it *netCommons* 13/63

Wireless Technology Driven?

- A CN must be a Wireless Mesh Network? **NO**
- Mesh networks are a superb instrument to bundle demand, and build a critical mass of people interested in connectivity.
- They also offer a strong techo-social metaphor to express the concept of a CN
- But they are not always usable (they need density and Line of Sight) and they scale up to a certain size
- The same concept of cooperative organization can be used with other technologies: fiber, cellular etc.

Leonardo Maccari leonardo.maccari@unitn.it *netCommons* 14/63

Wired CNs

- There are CNs that rely on wired connections
- Deploying fiber may cost tens of thousands of Euros per km (CAPEX and OPEX)
- How does a community-based approach faces this challenge?
- We have working models proposing a mixed for-profit/not-for-profit approach.

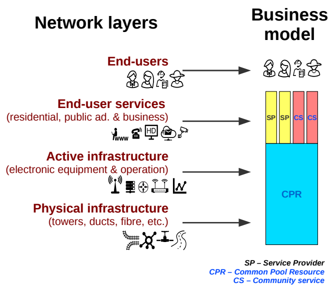
Leonardo Maccari leonardo.maccari@unitn.it *netCommons* 15/63

Guifi.net

- In Guifi, the passive and active infrastructure is treated as a Common Pool Resource (i.e. by the community)
- For-profit activities are allowed to use it, but they are asked for a fee
- This fee can be monetary, or can be made of verified investments in expanding the network, with a compensation system
- Internet access is one of the many potential applications the network supports.

Leonardo Maccari leonardo.maccari@unitn.it *netCommons* 16/63

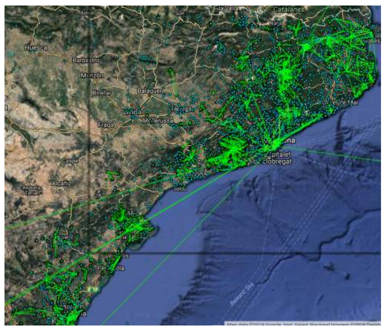
The Guifi.net Model



Key Theme: Sharing Vs Vertical Integration

Leonardo Maccari leonardo.maccari@unitn.it *netCommons* 17/63

The Guifi.net Network



Guifi.net is so far the largest CNs known, with about 35.000 nodes

Leonardo Maccari leonardo.maccari@unitn.it *netCommons* 18/63

Context: ninux.org

- The ninux CN is one of the eldest in Europe, it started in Rome in the early 2000s
- It is a fully distributed network, with several disconnected "islands" spread around Italy
- It is one of the most geek-friendly network, in which the community puts a strong focus on experimentation
- I will use ninux as an example of what CNs do to promote the idea and the instruments for a fairer Internet

Leonardo Maccari leonardo.maccari@unitn.it netCommons 19/63

ninux.org

1. ninux is a community of wireless hackers, that enjoys creating their own network
2. to be part of ninux you have to accept the Pico-Peering agreement, which basically states that:
   - you agree to give free transit to other people
   - you collaborate with others that want to peer with you
   - there is no guaranteed service level

Leonardo Maccari leonardo.maccari@unitn.it netCommons 20/63

We Disseminate the Internet

- Surprisingly enough we still need to disseminate about the importance and the impact of the Internet on society
- CNs are always involved in the realization of courses about Internet technologies and Internet basics
- They are most effective because they are carried out in tight partnerships with local bottom-up organizations

Leonardo Maccari leonardo.maccari@unitn.it netCommons 21/63

Internet Courses

Leonardo Maccari leonardo.maccari@unitn.it netCommons 22/63

We Develop the Internet

The Internet is not static, it is constantly "under development". CNs help shaping the Internet, and coordinate to do so. Countless efforts in open source developments and innovation exist:

- Protocols and platforms: OLSRd, Batman advanced, BMX... are examples of protocols designed/improved/implemented by the communities and today widely used outside the CN world
- This year both Freifunk and OpenWISP were recognized by Google as relevant organizations to be financed by the Google Summer of Code program.

Leonardo Maccari leonardo.maccari@unitn.it netCommons 23/63

2 - Develop the Internet: Tangible Results

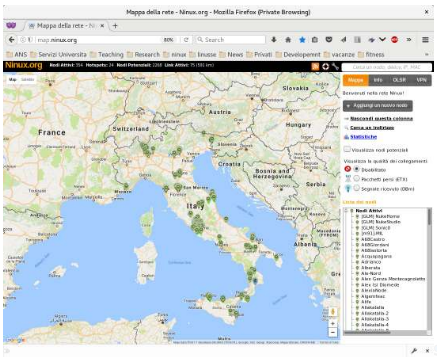
- From the European Battle Mesh experience, LibreRouter is now under development, the first low-cost open source router hardware
- The CONFINE FP7 research project: how 17 research institutions used CNs for real world experimentation
- Broadband innovation award: Guifi (2015) and HUBS (2016)

Leonardo Maccari leonardo.maccari@unitn.it netCommons 24/63

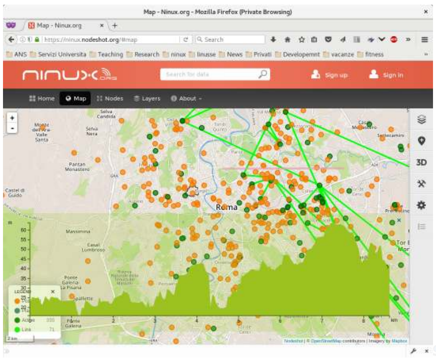
Case study: Story of OpenWISP2

- The ninux community, as all the other community, needs a tool to show the state of the network. Federico Capoano started developing NodeShot in 2011
- A new version of NodeShot was developed in 2013, with added features
- Federico was hired by an Italian PA, which develops OpenWISP, a tool to manage public Wi-Fi networks
- He decided to merge both things, in 2016 OpenWISP2 was born

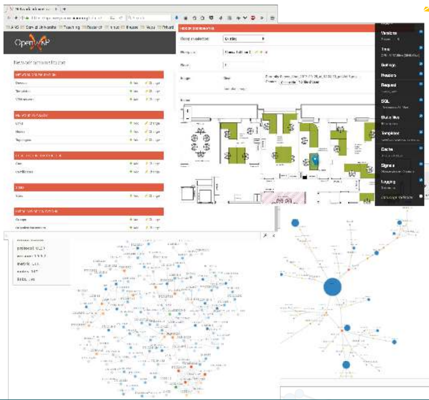
NodeShot



NodeShot2



OpenWISP2



We are the Interet

- There is a lot of attention on how Internet services and applications work, and their societal impacts
- Little interest instead is given to what there is under the hood. Internet as a communication infrastructure *just works*
- CNs instead unveil what are the societal consequences of the governance of the "physical" Internet (neutrality, just to name one theme)
- CNs engage people in modifying the Internet in a way they consider fair fair, equal and democratic
- CNs are drivers and initiators of awareness and advocacy initiatives

Dissemination/Advocacy Initiatives

The netCommons Project

- H2020 Financed project (CAPS)
- 2016-2019
- 4 Universities
- 1 Research Center
- 1 not-for-profit association
- 6 countries

netCommons Activities

- Legal research (are CNs really legal, can we do them?)
- Social Science (Are CNs more than just low-cost Internet?)
- Technical research (distributed applications, routing, technical analysis)

We do all this together with CNs.

Legal studies: In a nutshell

Simplifying to the extreme:

- If the network is fully distributed, and there is no legal entity beyond it (as in ninux), then there is individual third party liability: if someone does something wrong with your ADSL or node, you are to blame
- If the community becomes a legal entity, it may become an ISP: no third party liability, but problems with data retention.

Social Studies: In a nutshell

Simplifying to the extreme:

- CNs are much more than low-cost Internet
- In some cases, they don't even offer Internet connection
- In all cases, in order to cut-down costs, you have to cooperate.
- When people cooperate, the governance of the network is transparent, the choices made are close to the people need
  - Neutrality, Privacy, Openness are key values for Community Networks.
- CNs are like "organic food" for connectivity.

Technical Studies: In a nutshell

- We do Distributed Cloud platforms: Cloudy
- We do Distributed live video Streaming: PS-ng
- We do Network Monitoring Tools
- We do Routing protocol Enhancements: Pop-Routing
- We do Bottom-up applications for smart Farming

Community Clouds (CC)

Motivation: explore CC as commons (infrastructure & services)
Goal: experiment & develop CC to CNs: Cloudy[1]

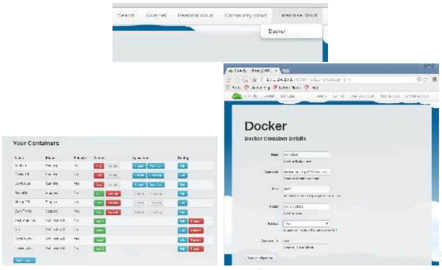
- A Debian GNU/Linux software distribution for CC participants that runs Infrastructure-Platform-Software-aaS on end-user devices. Open source, can be extended with distributed services.

[1] Cloudy started in the Clommunity research project (EC FP7-317879)

Cloudy services

Users can manage services & applications through a common web interface:

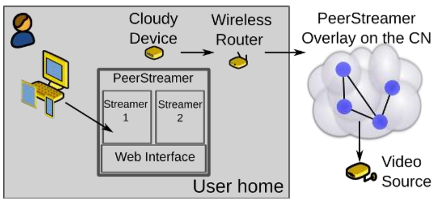
- Activate pre-installed, install additional
- For personal use or community use



Gossiping Services

- Cloudy uses a Gossiping protocol (Serf) to disseminate the information about services.
- Once you activate the service on your instance of cloudy, everyone else is notified that that service exists
- What service? anything dockerizable and web-controlles
  - Etherpad
  - Wordpress
  - OwnCloud
  - IPFS
  - P2P Video Streaming . . .

PS-ng, Vision:



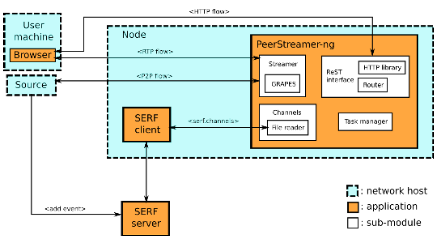
Workflow

- An user starts a streaming session in the network
- The Serf protocol gets notified, information is propagated
- Any other user running PS in Cloudy sees the new stream among the available ones from PS web page
- He/She chooses the stream and watch it on the browser

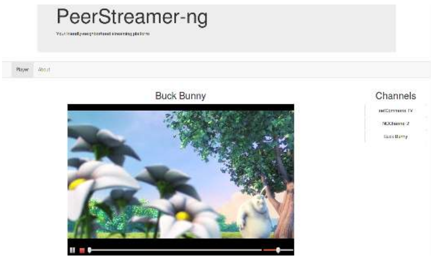
What is available:

- We wrote a client library for Serf, now we can notify Serf of new streams
- We created a Docker image for PeerStreamer-NG
- We created a web-based front-end for PS-ng, controlled via REST
- We created the necessary modules to wire everything together.

PS-ng, components



It works!



VLC problems...

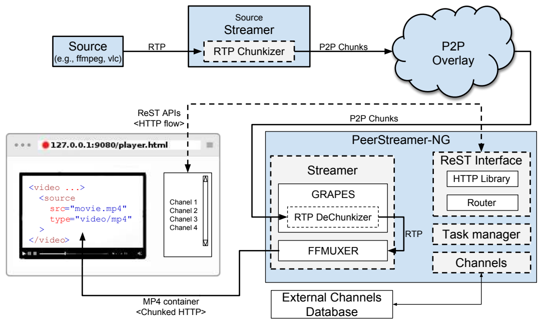
- We stream the video using the UDP-based RTP protocol, which is a better choice than any TCP based transport for live video
- RTP streaming is supported by HTML5, but no browsers currently implement it
- So far, the only way to have RTP on browser was with the VLC plugin. The plugin is widely used and works pretty well.
- In spring, for security reasons, browsers decided not to support plug-ins anymore (Firefox). Now it is cumbersome to enable a plugin in Firefox :-(
- Alternatives are:
  - use HTML5 VIDEO tag
  - use some live-streaming oriented protcol: WebRTC

HTML5 and WebRTC integration

To stream a non-live video using HTML5 you have to:

- reconstruct the video in a local file (or buffer)
- have it read from the web server
- have it served to the client in an HTML video tag.
- Pros:
  - All browsers support it
- Cons:
  - Too many caches: ← **several seconds delay**

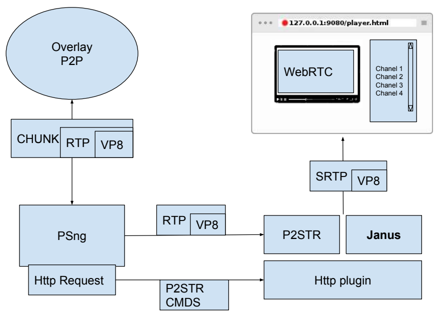
HTML5: implementation



WebRTC:

- WebRTC is a new protocol under standardization for live interactions
- Pros:
  - It is fast
  - It is made for bi-directional interactions (Jitsi uses it).
- Cons:
  - It is very complex
  - It is not yet supported by all platforms (no MS yet)
  - There is no library to support it, need a media gateway (Janus).
- We implemented it and it works well enough to support live video

WebRTC implementation



We Want You

Leonardo Maccari leonardo.maccari@unitn.it netCommons 49/63

Do you want to Experiment?

- Are you part of a community?
- Do you have a Raspberry Pi?
- Do you want to help us?
- . . . we need to talk.
- We want to test PS-ng in real communities, and we will dedicate this year to this task.

Leonardo Maccari leonardo.maccari@unitn.it netCommons 50/63

Metrics

We designed metrics for measuring the "pulse" of the CNs include:

- Centrality and robustness indices of the network topologies
- Distribution of ownership across the network nodes to prevent the centralization and the hegemony of a few people on the whole infrastructure;
- Participation level in the on-line social tools (mailing lists, forums etc.) to monitor the inclusiveness of the on-line participation;

Leonardo Maccari leonardo.maccari@unitn.it netCommons 51/63

In a few words:

Provide the tools to analyze CNs and verify to what extent we can consider them "distributed", both technically and socially

Leonardo Maccari leonardo.maccari@unitn.it netCommons 52/63

In a Nutshell

- All the robustness, centrality and hierarchy metrics that were studied so far on the network topology can be used to evaluate the state of the network.
- If mixed with the analysis of the social networking instruments (mailing lists, telegram chats, github interactions etc. . .) they can give a multi-layer overview of the state of the network and of the community.
- What is the best way of integrating them into CN monitoring tools?

Leonardo Maccari leonardo.maccari@unitn.it netCommons 53/63

ninux management interface

- Currently ninux uses 2 instruments to monitor the state of the network, and to add/remove nodes in the network:
  - http://map.ninux.org: the network visualizer used so-far, based on the home-brew 'nodeshot' interface
  - http://ninux.nodeshot.org: the new network visualizer based on the new, home-brew 'nodeshot2' interface
- both these tools will be dismissed in favour of a third one, based on an open format: NetJSON.

Leonardo Maccari leonardo.maccari@unitn.it netCommons 54/63

NetJSON

from netjson.org

> *"NetJSON is a data interchange format based on JSON designed to ease the development of software tools for computer networks. NetJSON defines several types of JSON objects and the manner in which they are combined to represent a network: configuration of devices, monitoring data, network topology and routing information."*

NetJSON is under development and it is described in an informational RFC.

NetJSON example

```
"type": "NetworkGraph",
"protocol": "olsr",
"version": "0.6.6",
"revision": "5031a799fcbe...",
"metric": "etx",
"router_id": "172.16.40.24",
"nodes": [
    {
        "id": "172.16.40.24",
        "label": "node—A",
        "local_addresses": [
            "10.0.0.1",
            "10.0.0.2"
        ],
        "properties": {
            "hostname": "node1.my.net"
        }
    },
    {
        "id": "172.16.40.60",
        "label": "node—B",
        "properties": {
            "hostname": "node2.my.net"
        }
    }
],
```

```
"links": [
    {
        "source": "172.16.40.24",
        "target": "172.16.40.60",
        "cost": 1.000,
        "cost_text": "1020  bit/s",
        "properties": {
            "lq": 1.000,
            "nlq": 0.497
        }
    }
]
```


NetJSON

The stated goal of NetJSON is :

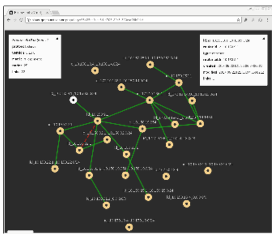
> *"[to] build an ecosystem of interoperable software tools that are able to work with the basic building blocks of layer2 and layer3 networks, enabling developers to build great networking applications faster."*

NetJSON

- The main reason NetJSON was designed is to overcome the current fragmentation of tools that various CNs use to describe/manage/visualize their networks
- Since there is no hope in merging the various (and different) tools used by all the communities, they started from a common description format.
- Several Routing Protocols daemons allow to export the network topology using NetJSON (olsrd, OONF, BMX...).
- Note that not only the network can be described with NetJSON, but also node configuration parameters.

netjsongraph.js

- Once the format is standardized, several applications can be based on it, such as netjsongraph.js, a Javascript library for network visualization[2].



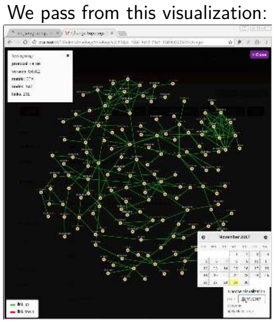
[2] http://ninux-graph.netjson.org/topology/643c4577-cef2-4b5e-b8a4-c29756b10748/

Developments Done

- Modified several components of OpenWISP to add the feature of multiple visualization of networks

Developments Done

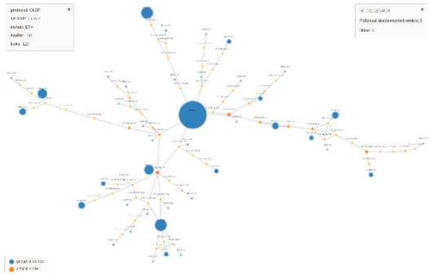
We pass from this visualization:



https://opendata.netcommons.eu/examples/dark.html

Developments Done

To this visualization:



https://opendata.netcommons.eu/examples/condensed-ninux.html

NETCOMMONS PROJECT

RESEARCH AND EXPERIMENTATION WITH CNS

UNIVERSITY OF TRENTO
Department of Information Engineering and Computer Science

netCommons

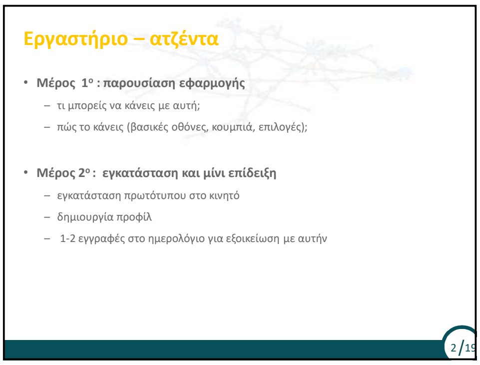
Leonardo Maccari, leonardo.maccari@unitn.it

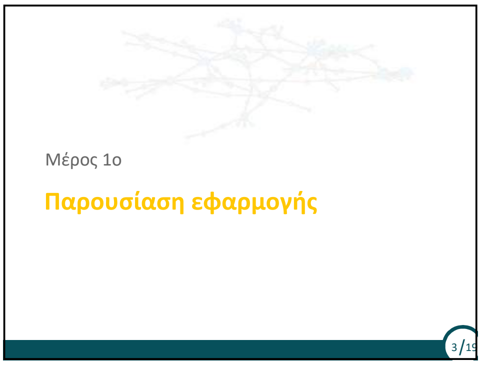
Torino, 24/3/2018

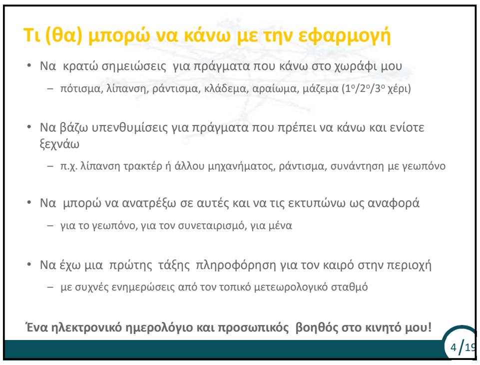
Co-Funded by the Horizon 2020 programme of the European Union, Grant Number 688768

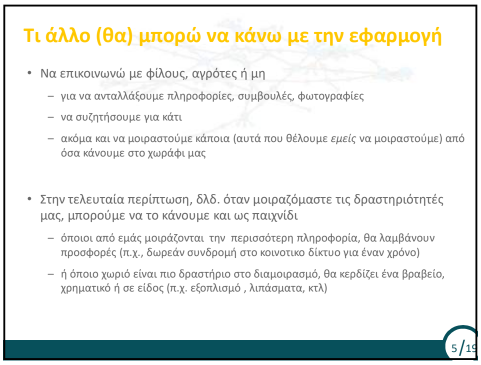
B.14. Sarantaporo training workshop, March 11, 2018
Reference event Sec. 2.4.4

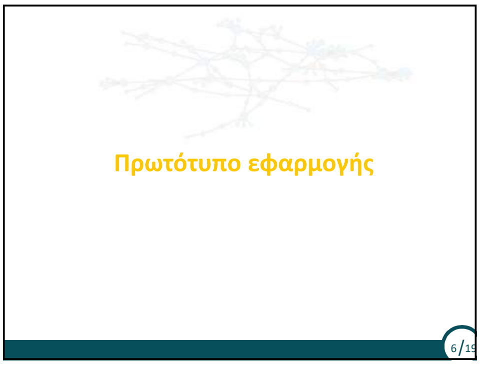
B.14.1. AppLea presentation in Flabouro (Merkourios Karaliopoulos), in Greeek



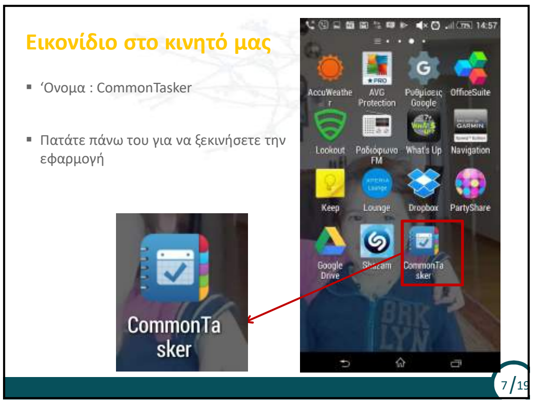


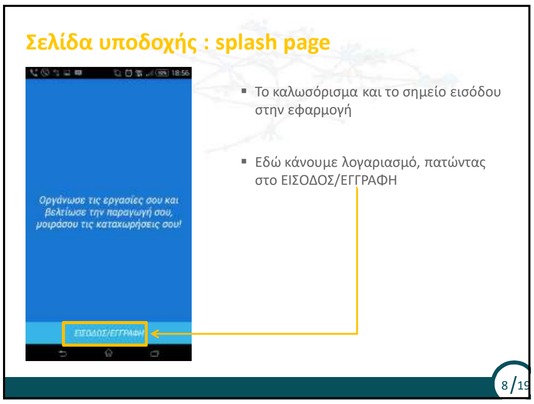


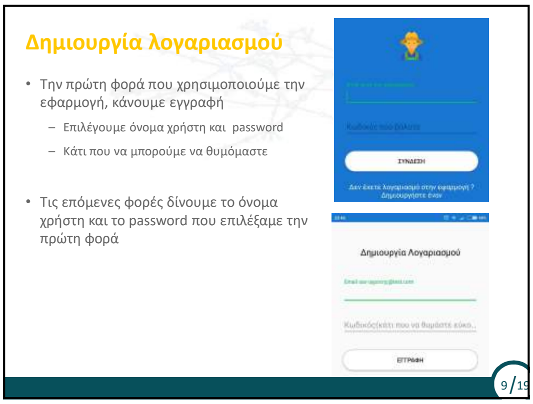


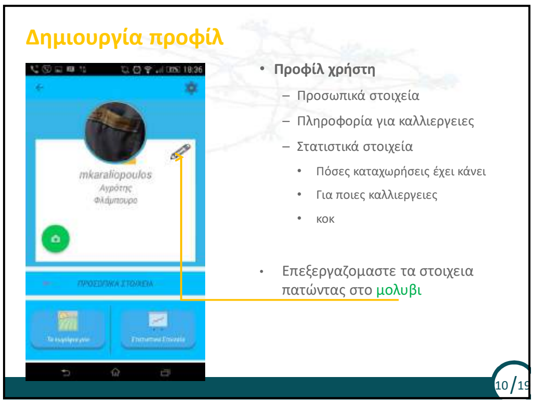


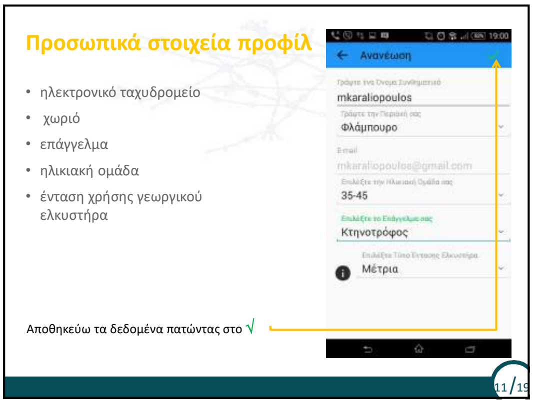
1

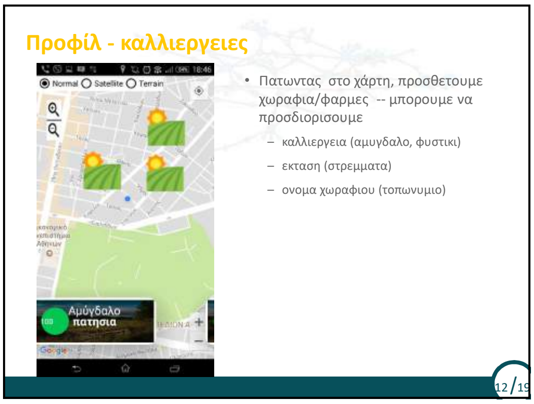






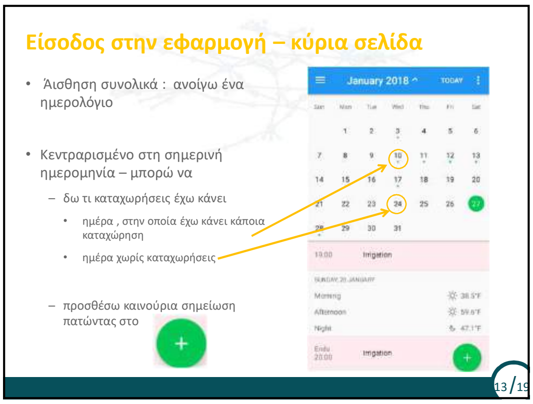


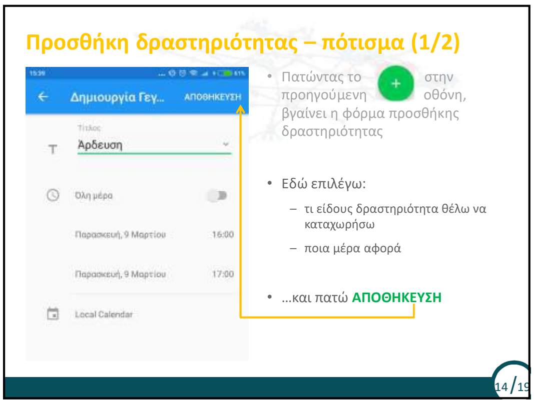


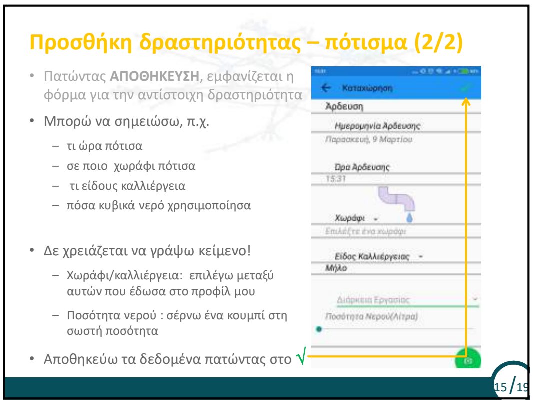


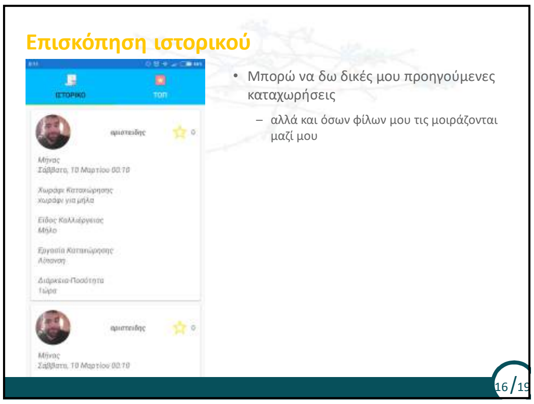
2

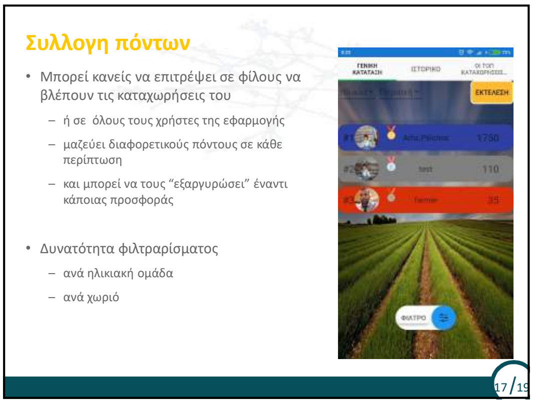
netCommons

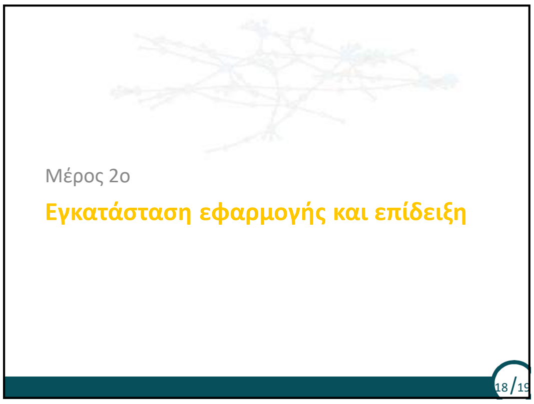

Είσοδος στην εφαρμογή – κύρια σελίδα
• Άισθηση συνολικά : ανοίγω ένα ημερολόγιο
• Κεντραρισμένο στη σημερινή ημερομηνία – μπορώ να
– δω τι καταχωρήσεις έχω κάνει
• ημέρα , στην οποία έχω κάνει κάποια καταχώρηση
• ημέρα χωρίς καταχωρήσεις
– προσθέσω καινούρια σημείωση πατώντας στο
January 2018
TODAY
Irrigation
13/19


Προσθήκη δραστηριότητας – πότισμα (1/2)
• Πατώντας το στην προηγούμενη οθόνη, βγαίνει η φόρμα προσθήκης δραστηριότητας
• Εδώ επιλέγω:
– τι είδους δραστηριότητα θέλω να καταχωρήσω
– ποια μέρα αφορά
• …και πατώ ΑΠΟΘΗΚΕΥΣΗ
Δημιουργία Γεγ...
ΑΠΟΘΗΚΕΥΣΗ
Άρδευση
Όλη μέρα
Παρασκευή, 9 Μαρτίου
16:00
17:00
Local Calendar
14/19

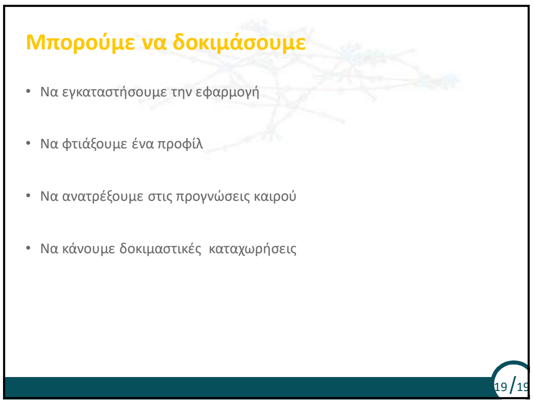

Προσθήκη δραστηριότητας – πότισμα (2/2)
• Πατώντας ΑΠΟΘΗΚΕΥΣΗ, εμφανίζεται η φόρμα για την αντίστοιχη δραστηριότητα
• Μπορώ να σημειώσω, π.χ.
– τι ώρα πότισα
– σε ποιο χωράφι πότισα
– τι είδους καλλιέργεια
– πόσα κυβικά νερό χρησιμοποίησα
• Δε χρειάζεται να γράψω κείμενο!
– Χωράφι/καλλιέργεια: επιλέγω μεταξύ αυτών που έδωσα στο προφίλ μου
– Ποσότητα νερού : σέρνω ένα κουμπί στη σωστή ποσότητα
• Αποθηκεύω τα δεδομένα πατώντας στο √
Καταχώρηση
Άρδευση
Ημερομηνία Άρδευσης
Ώρα Άρδευσης
Χωράφι
Είδος Καλλιέργειας
Μήλο
15/19


Επισκόπηση ιστορικού
• Μπορώ να δω δικές μου προηγούμενες καταχωρήσεις
– αλλά και όσων φίλων μου τις μοιράζονται μαζί μου
ΙΣΤΟΡΙΚΟ
16/19


Συλλογη πόντων
• Μπορεί κανείς να επιτρέψει σε φίλους να βλέπουν τις καταχωρήσεις του
– ή σε όλους τους χρήστες της εφαρμογής
– μαζεύει διαφορετικούς πόντους σε κάθε περίπτωση
– και μπορεί να τους "εξαργυρώσει" έναντι κάποιας προσφοράς
• Δυνατότητα φιλτραρίσματος
– ανά ηλικιακή ομάδα
– ανά χωριό
ΓΕΝΙΚΗ ΚΑΤΑΤΑΞΗ
ΙΣΤΟΡΙΚΟ
ΕΚΤΕΛΕΣΗ
ΦΙΛΤΡΟ
17/19


Μέρος 2ο
Εγκατάσταση εφαρμογής και επίδειξη
18/19

3


Μπορούμε να δοκιμάσουμε
• Να εγκαταστήσουμε την εφαρμογή
• Να φτιάξουμε ένα προφίλ
• Να ανατρέξουμε στις προγνώσεις καιρού
• Να κάνουμε δοκιμαστικές καταχωρήσεις
19/19

4

B.14.2. Training material: Toys representing the Sarantaporo.gr CN according to the netCommons methodology

Example of the application of the “Planning for real methodology” as described in netcommons participatory design methodology in the case of Sarantaporo.gr CN

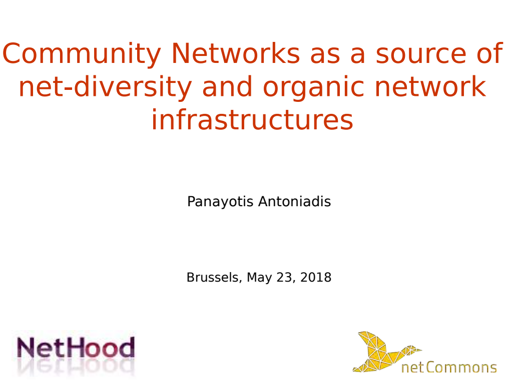
Details of the toys used to represent the Sarantaporo.gr CN on a real map of the area

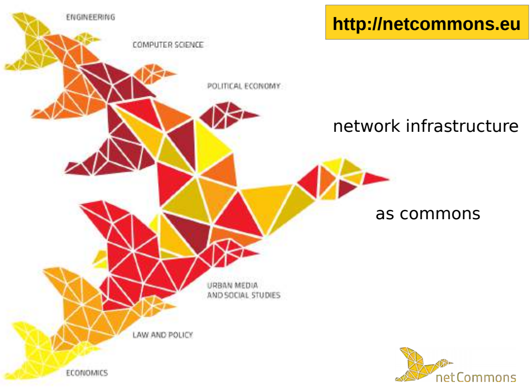

INTERNET

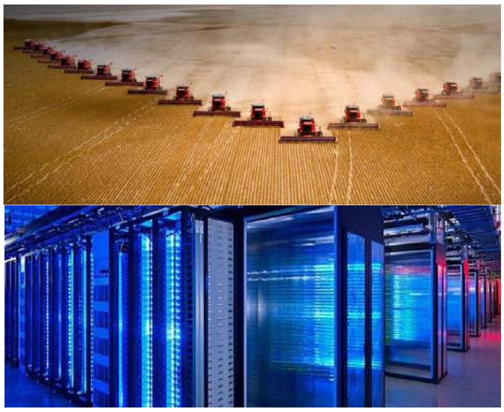
B.15. netCommons at the European Parliament, workshop on *"Economic landscape under the new Telecommunications Code"*
Reference event Sec. 2.5.1

B.15.1. Presentation by Panaiotis Antoniadis

The same set of slides was used for the events Sec. 2.5.2 andSec. 2.1.4



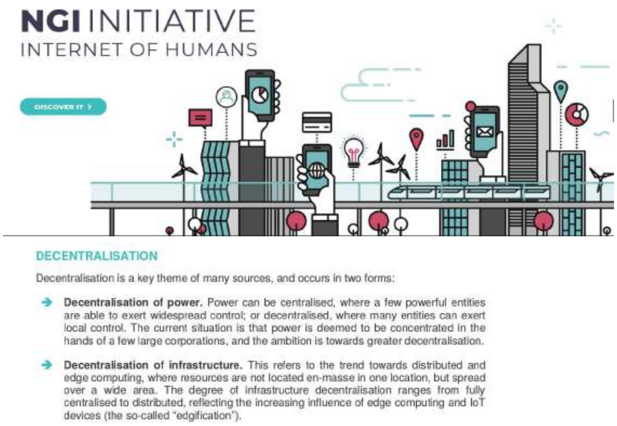





Is an **"organic" Internet** possible?


guifi·net
freifunk.net


Internet access
Local services
Introvert
Extrovert
FFDN
guifi·net
Sarantaporo.gr
RED HOOK WIFI
wlanslovenija
freifunk.net
AWMN
MAZI TOOLKIT
SUPERGLUE
ninux.org
occupy.here
PIRATEBOX


NGI INITIATIVE
INTERNET OF HUMANS
DISCOVER IT
DECENTRALISATION
Decentralisation is a key theme of many sources, and occurs in two forms:
Decentralisation of power. Power can be centralised, where a few powerful entities are able to exert widespread control; or decentralised, where many entities can exert local control. The current situation is that power is deemed to be concentrated in the hands of a few large corporations, and the ambition is towards greater decentralisation.
Decentralisation of infrastructure. This refers to the trend towards distributed and edge computing, where resources are not located en-masse in one location, but spread over a wide area. The degree of infrastructure decentralisation ranges from fully centralised to distributed, reflecting the increasing influence of edge computing and IoT devices (the so-called "edgification").


May 2018
Unleashing Community Networks: Innovative Licensing Approaches
Internet Society


Internet Society Community Networks SIG
About
Organizations
Organizations
ALTER MUNDI
altermundi.net
ata laya sur
COOLAB
Fantsuam Foundation
freifunk.net
GRAM MARG
guifi·net
NetHood
ninux.org
telecomunicaciones indígenas comunitarias
RHIZOMATICA
Sarantaporo.gr
Zenzeleni

Diversity is the source of life

Networking infrastructure:

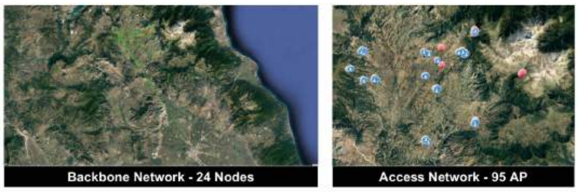
Backbone → access → servers → software

- **Net-Diversity**: allow alternatives of solutions at all levels
- **Design for tussle**: allow diversity of actors
- **Fair competition**: allow diversity of models

=> Beyond affordable Internet access

=> Creation of new institutions from the bottom-up

Sarantaporo.gr CN in numbers today



- 11 villages + 3 Farms + 1 Camp
- 24 backbone nodes
- 40 point-to-point connections

- 95 Access Points
- ~50 active local community members

Readings

Co-Designing Economies in Transition pp 235-272 | Cite as

The Organic Internet: Building Communications Networks from the Grassroots

Authors Authors and affiliations

Panayotis Antoniadis

https://rd.springer.com/chapter/10.1007/978-3-319-66592-4_13

THE CONVERSATION

How to build a more organic internet (and stand up to corporations)

https://theconversation.com/how-to-build-a-more-organic-internet-and-stand-up-to-corporations-70815

B.15.2. Presentation by Maria Michalis'

Electronic Communications Code – Co-investment: A view from Community Networks

Dr. Maria Michalis
M.Michalis@westminster.ac.uk
University of Westminster
London

netCommons@EP 23 May 2018 1/5

Outline

- Community Networks
  - What are they?
  - Where do they fit in the picture?
  - Benefits
  - Examples

Maria Michalis netCommons@EP 2/5

Community networks

- Not new: have been around for about 20 years
  - Originally wireless – increasingly fibre
- Bottom-up initiatives
- They typically offer an ‘alternative’ e.g.
  - Topology & architecture
  - Ownership
  - Business model
  - Social inclusion
- Often seen as simply ‘filling in the gaps.’ But much more

Maria Michalis netCommons@EP 3/5

The continuing importance of CNs

- Some valid reasons for CNs
  - Need: Lack of (adequate/ affordable) Internet access
  - Connectivity +
    - Greater (non-economic) societal benefits
    - Better respect of digital rights
    - Experimentation, playfulness and knowledge transfer
- Main challenges
  - Changing market and technological conditions
  - Resources
- Diversity in the market is good

Maria Michalis netCommons@EP 4/5

CN	Location	Start Year	Activity	Nodes	Networking technology	Internet	Description
AWMN	Greece	2002	active	300	wifi	Yes*	Built by network technicians, enthusiasts and radio amateurs. Contains native services without need for public Internet connectivity *i.e.*, games, libraries, network monitoring tools, DNS solutions, and experimental platforms.
B4RN	UK	2011	active	4000	fibre	Yes	Started by a local volunteer, who led the group as a networking expert. Aimed at bridging the digital divide. Based exclusively on fiber.
Consume	UK	2000	inactive	x	wifi	Yes	One of the first CNs to be conceived and deployed in Europe. The original motivation was to save Internet access fees for conducting business. It has epitomised the anti-commercial model of networking. Not active anymore.
FFDN	France, Belgium	2011	active	2500	wifi, DSL/fibre	Yes	An umbrella organization embracing 28 CNs operating across France. Adheres to values of collaboration, openness and support of human rights (freedom of expression, privacy).
Free2Air	UK	1999	inactive	x	wired, wifi	Yes	An alternative to the commercial Internet provision. Run by a small number of artists and a number of other individuals until 2015.
Freifunk	Germany	2002	active	40000	fibre, wifi	Yes	An open initiative that supports free computer networks in Germany. It attracted many artists, activists and tech enthusiasts from all over Europe.
Funkfeuer	Austria	2003	active	220	wireless	Yes	A free experimental wireless network across Austria, committed to the idea of DIY, built and currently maintained by a group of computer enthusiasts.
guifi.net	Global	2004	active	40000	fibre, wifi	Yes*	Started in Osona to serve remote rural areas that were not covered by conventional ISPs. Applies the principles of CPR management. Diverse communities around the world.
i4Free	Greece	2014	active*	2	wifi	Yes	The initiative of a German engineer and professor in an island of Greece with poor Internet connectivity.
Ninux	Italy	2003	active	172	wifi	No	Experimentation and hacking culture. Ninux operates as an experimental platform for decentralized protocols, policies and technologies.
Rhizomatica	Mexico	2009	active	N/A	wireless	Yes	Provides community mobile telephony services. Creates open-source technology and helps communities build their own networks. Initiated by a small group of people with knowledge of community organization and technology.
Sarantaporo.gr	Greece	2010	active	153	wireless	Yes	People with origins from the area of Sarantaporo wanted to create a website for their village when they realized that there was no network connection.
TakNET	Thailand	2012	active	20	wifi	Yes	Established as an academic project at the Asian Institute of Technology (AIT). Follows the goal of bridging the digital divide in Thailand villages. Composed of TakNET1, TakNET2 and TakNET3.
TFA	US	2004	active	21	wifi	Yes	The TFA project became true with the partnership of Rice University and Technology for All (TFA) organization. It is an urban wireless mesh network aiming to bridge the digital divide and provide Internet access in one low-income neighborhood in Houston.
Wireless Leiden	Netherlands	2002	active	120	wifi	Yes	Volunteer-based open, inexpensive, fast wireless network in Leiden and surrounding villages. Developed by a group of local residents. Provides Internet access and free local communication.
Zenzeleni.net	South Africa	2013	active	13	wifi	Yes, VoIP public phones	Initiated by researchers from the University of the Western Cape (UWC) in the rural under-developed area of Mankosi. Solar powered network. Operated as an umbrella co-operative enterprise and a telecoms provider.

Maria Michalis netCommons@EP 5/5

Thank you for your attention!

Questions & comments?

netCommons

netCommons@EP /

B.16. University of Natural Resources and Life Sciences (BOKU), Vienna
Reference event Sec. 2.5.3
Presentation by Melanie Dulong de Rosnay

Peer-to-peer law and the commons

netCommons

Melanie Dulong de Rosnay
@melanieddr

French National Centre for Scientific Research (CNRS)
Institute of Communication Sciences (CNRS - Paris Sorbonne – UPMC)

LTS Lunch Time Series on Law, Technology and Society
Institute of Law, University of Natural Resources and Life Sciences
Vienna, 28-06-2018

Law, technology and society

- Relationships between law and technology
- Impact on rights and usages
- Policy recommendations
- Internet & society
- Copyright, licensing, commons, creative, digital, public domain, open data, open science, PSI
- Other types of commons: infrastructure

The myth of the golem

- An uncontrollable creature
- Applying the orders of the master who designed it
- Can turn out to be dangerous
- Even for their masters...

Encoding rules into binary, uncontrollable creatures

- DRMs: books, streaming
- drones
- 3D printing
- algorithmic governance
- internet of things
- “smart” cities or homes

Same risks of encoding rules
Into technical norms of a data-driven society

applying the orders

of the master

who designed it

a powerful person or an hegemonic company

can become invisible

master can decide to deactivate it once a week for Sabbath

Blind enforcement

automate decisions

without distinguishing legitimate from illegitimate usages

greater dangers

impossibility to access and remix culture and science

3D print drugs, dangerous, life-saving, patented?

Different modes of relationship between law and technology

1. Digital golems

tech tries to dominate law

developed by right holders

to protect their interests

without accountability

nor control by society

domination of corporations

lobbying tech-clueless governments

towards stronger protection of their interests

regardless of massive infringement of our personal freedoms

2. Cyberlaw & Lex electronica

Regulation of code &

Regulation by code embedding legal values

Instead of blind domination

Attempt of cooperation between legal & tech orders

3. Peer-to-Peer Law

a hybrid model of regulation

integrating the two sorts of code

Similarly to
techno-legal rights information expressing users' rights

The law could infect code,

carrying its values,

but code could also infect the law and export its design features

Alternative thinking in the law

Define collective and distributed forms of ownership, responsibility or liability

- as examples of integration of p2p
- as a design principle for the law

Collective rights

Cooperatives, social center law (Finchett-Maddock, 2015), anarcho-communism, autogestion

Multitude, complexity, risk

Buen vivir, pachamama, traditional knowledge and folklore, res communis, biodiversity

Sources of inspiration & metaphores to conceptualise collective persons, distributed rights and duties

t

Applying the model of distributed architectures to the law itself

p2p computing
principe & design

distributed &
federated
architecture vs
centralised

= subsidiarity

Community networks
p2p, DIY, mesh & alternative internets

“Mesh networks are an especially resilient tool because there's no easy way for a government to shut them down. They can't just block cell reception or a site address. Mesh networks are like Voldemort after he split his soul into horcruxes (only not evil).

Destroying one part won't kill it unless you destroy each point of access; someone would have to turn off Bluetooth on every phone using FireChat to completely break the connection. This hard-to-break connection isn't super important for casual chats, but during tense political showdowns, it could be a lifeline."

http://www.npr.org/blogs/alltechconsidered/2014

How does the law deal with p2p tort

Traditional application of law to tech disrupting the law

Actions and files fragmentation

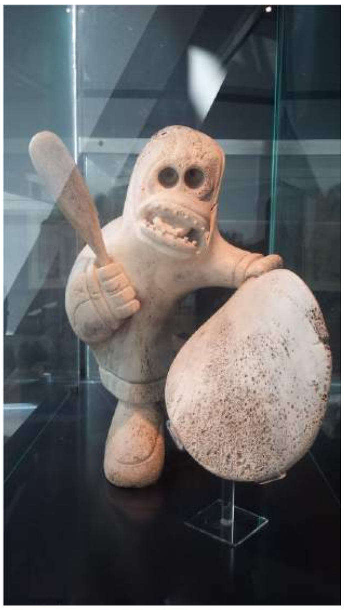
+ local encryption

Challenge liability, control, ownership and responsibility

Harder to al/locate responsibility on one agent

Chilling effect of cybercriminality regulation

- Three strikes
- Monitoring
- Outlaw the tech?



NetCommons: network infrastructure as a commons

- H2020 CAPS project: Collective Awareness Platforms for Sustainability and Social Innovation
- Possibility to have a bottom-up, democratic, commons-based organisation
- Neutrality, transparency, participation
- Local communities
- Skills: technical, legal, socio-economic, governance, political lobbying
- Solutions for policy-maker and local authorities
- Inform Internet Science: peer production, sustainability, participation, socio-economic opportunities

a transdisciplinary methodology

to study and support the development
of local network internet infrastructures
as commons
for resiliency, sustainability
democracy, privacy
self-determination, and social integration.

Alternative?

- Independent
- Decentralised
- Avoid dependencies (single points of failures)
- Deconcentrated (avoid concentration of power)
- Respectful of users' rights
- Balanced terms of use
- No surveillance
- Bottom-up, self-organised, democratic
- Not commercial, non-profit, commons-based

“Not...” → Positive definition of what **is** alternative

Global complex commons

Infrastructure commons because of their physical materiality (internet cables) and the need of open hardware (routers),

Natural commons because of their dependance on access to spectrum, an unusual natural resource,

Knowledge commons because of the technical and governance skills required to deploy and maintain a local CN,

Urban commons because of their local organisation, and value sharing on territories,

Digital commons because of their purpose, the communication of information, subjected to the same regulation and challenges, such as tort, copyright or privacy, than intangible informational commons

Decentralised networks

Mélanie Dulong de Rosnay, Francesca Musiani, 2016, "Towards a (De)centralization-Based Typology of Peer Production", TripleC: communication, capitalism & critique, vol. 14, no 1, p. 189-207.

	Ownership	Technology	Governance	Rights	Value
Centralised	Company Major platforms	Central server controlled by platform owner	Top-down decision-making by platform owner	Exclusive rights/liability assigned to platform owner	Concentrated in hands of platform owner
Decentralised	Cooperative non-profit Informal unstructured collaboration	Several user-controlled computers/ nodes linked in a peer-to-peer network	Participative democracy Autonomy of peers	Terms of contribution leaving some rights/liability to contributors	Redistributed within community and/or society at large

Comparative table of main EU CNs

Community	Scale	Commons-based governance	Legal representation	Infrastructure	Economic model	Licensing model
Guifi	4 zones in Africa, 16 in America, 2 in Asia, 14 in Europe (Countries), 21 provinces in Spain, and for instance 41 counties in Catalonia	Mixed (decentralized at local level but strong commons-based governance at level of Guifi foundation). Related groups organising software, Internet connectivity, contents as commons	Yes (telecom regulation, agreements with external orgs, tax, clearance of compensations, research, development)	Decentralized optical fibre and WiFi networks, acts as regional IX (private transit providers, mechanism to share and access transit capacity)	Subscriptions, crowd-funding, economic compensation system (importance of professionals)	Community License (FONN), agreements with external orgs, and compensation agreements
FFDN	28 local organizations/1 500 subscribers	Decentralized (importance of core volunteers)	Yes (both local and national) + litigation	Decentralized (WiFi) / Centralized (leased ADSL)	Membership fees, subscriptions, donations	Bylaws, internal rules (réglement intérieur), charter of good practices and common commitments
Freifunk	304 local groups	Very decentralized	No (but litigation strategy nevertheless)	Very decentralized (free contribution of WiFi access points) + centralized last-mile?	Volunteer contribution by citizens and professionals	Informal agreement
Ninux	350 nodes	Decentralized (importance of core volunteers)	No recognised legal entity	Decentralized in theory (WiFi), but bottleneck at supernode level	Volunteer contributions	Pico-peering agreement

analyse CNs in relation to their surrounding socio-legal environment

produce general policy guidelines to feed advocacy

- for the internal management of the CNs
- and for policy makers to preserve CNs as a commons

raise awareness of the CNs managers and users

on the legal constraints of their activity

produce recommendations for the policymakers based on CNs needs

Produce analysis of current legal situation of European CNs.

Produce Legal recommendations.

Produce Political-economy and ethical guidelines.

Produce overall guidelines for CNs.

Mc Fadden EJC Case

likely to influence the fate and to shape

the organisational design

of Community Networks in Europe?

Can CNs continue to offer

open WiFi access points

- whether it is core to their functioning like Freifunk

- or only one of the services their offer (like Tetaneutral and others)

- and one of the way by which the technical architectures they develop supports political values of communicational autonomy, Net neutrality (the network is just a pipe, liability rests on users) privacy and confidentiality of communications

Consider structural changes?

The donation policy, the fee or absence thereof, as the decision refers to the commercial status of providers,

The legal status (network operator, intermediate service provider) and the existence of a legal representative, or the absence thereof in the case of very decentralised CNs,

Possible warranties and disclaimers contained in the service Terms of Use,

The technological decentralised architecture, impacting and impacted by possible password, data retention and registration obligations.

Liability issues

- For the end user: facilitating? Negligence?
- For the CN
  - Not necessarily an entity
  - Not necessarily a budget or financial assets
  - ToU & disclaimer of liability: valid?
    - BE NICE!
      - And we try to be nice too...

Mélanie Dulong de Rosnay, 2015, "Peer-to-Peer as a Design Principle for Law: Distribute the Law", Journal of Peer Production, 6.

2001 E-commerce Directive

Access providers are not liable

Access providers normally rely on contractual clauses through which they **forbid their customers to share the connection**; in so doing they limit their responsibility. If the user/node opens her connection to the network she breaches the contract.

As for the gateway node, since it has a public IP address assigned by its access provider, the **owner of the node would be identifiable and could be sued for damages directly** from the victim of the wrongdoing.

However, it should not be taken for granted that **a user could be considered liable for another person's conduct**.

National law

Italian framework for tort law would not allow to place liability on the gateway node for the activity of another user, since **no general clauses exist on third-party liability**

France & Hadopi / Open Wi-Fi: duty of care vs **negligent conduct**

German doctrine of “**Störerhaftung**” applied to open wireless networks

“liability of the interferer”

strict liability, but limited to injunctions, limited to measures that aim at stopping the infringing activity or at preventing it for the future

Background of the case

2010 Bundesgerichthof case

“Sommer unseres Lebens”

considered a **private owner**

of an unprotected Wi-Fi network

to be **liable** for copyright infringement

committed by an unidentified person

The owner of the network should have protected it with safety measures to prevent the misuse of third parties...

The case of commercial open wireless networks

In a case involving the owner of a holiday apartment, the same court considered the owner **not liable as he had instructed** his guests not to use the Wi-Fi network for illicit actions

In another case, the district court of Hamburg applied the **liability limitation** of the Tele Media Act to the wireless network operated by the owner of a hotel

The case of unknown users

In a case involving an Internet café, the Regional Court of Hamburg held that the owner was **liable since he had not blocked the ports** that were used by unknown clients to share copyrighted files

In 2014 the district court of Berlin-Charlottenburg decided on a lawsuit involving **Freifunk**, the main German CN. The Court ruled out the liability of the operator of the Freifunk Wi-Fi hotspot under the doctrine of Störerhaftung.

the Court stated that **imposing the owner to block certain ports or DNS or to instruct all the users would place on the owner an excessive burden**

Mc Fadden vs Sony

Tobias Mc Fadden **owns a shop** where he sells and leases lighting and sound systems. Within his shop, Mr Mc Fadden runs a wireless local area network (WLAN) free of charge; access to the network was **intentionally open to anyone and not protected by a password**, to allow customers to use it and to draw passers-by's attention

Sony counterclaimed asking for damages compensation on the ground of direct liability for copyright infringement.

The company also **asked an injunction, meaning: an order from the judge to stop Mc Fadden**'s allegedly infringing activities.

The position of the Munich Court

The Munich court considered plausible that the violation of Sony's rights was not committed by Mr Mc Fadden, but by another party.

At the same time, the German court was also incline to consider Tobias Mc Fadden liable under the **Störerhaftung** doctrine.

However, the Court was **not sure whether the exemption provided by article 12, Dir. 2000/31 was or not applicable** to Mr Mc Fadden; as if it was, the he could not be considered liable at all.

The questions asked by the Munich Court to the ECJ

1) Can a free WLAN operator **be qualified as “provider** of information society services” and enjoy the liability limitations introduced by art. 12, Dir. 2000/31 applicable to a WLAN operator?

2) **What measures** should a provider adopt to avoid liability for third party’s intellectual property rights infringement?

What is a provider of information society services?

Recital 18 of Dir. 2000/31 specifies that information society services **must be an economic activity**.

However, this does not mean that the “remuneration” has to come from clients or customers

What measures should a provider implement to avoid liability for infringement?

terminate the account,

password-protect the access to the network,

examine all communications passing through the network.

Monitoring, termination, and password protection **clash with fundamental rights**

- To conduct a business
- Copyright
- Freedom of information
- Privacy

examination of all communications passing through the network

The CJUE easily stated that such a measure would be in contrast

with art. 15 of Dir. 2000/31 on certain legal aspects of information society services

that excludes the imposition

on service providers

of a general obligation to monitor

termination of the account

this solution would cause serious infringement

to the **freedom to conduct a business**, although in the case at issue this is only a secondary activity for Mr Mc Fadden

hence it would not allow to strike a fair balance amongst the various rights the password protection of the Internet connection

ECJ: such measure could instead strike a fair balance, given that, although it **would affect both freedom to conduct a business and users' freedom of information**, it would limit both rights only marginally.

In particular, it **would not affect deeply the freedom of information of the recipient**, as such connection would be **only one in many ways to access the Internet**

...

Possible impact for CNs

Applicability of the liability limitation:

how to distinguish ancillary and commercial activity

in the absence of a remuneration

… while the case was pending before the Court of Justice the German legislator amended the law on media and communications and extended the liability exemptions for access providers to providers that offer Wi-Fi connection...

Risks and drawbacks of injunctions requiring to apply password-protection

as identified by Advocate General Szpunar...

the obligation to make Wi-Fi secure would actually **undermine the business** model of those offering Internet connection as an additional service to the main ones offered

disproportionate to people that offer an Internet connection as extra-activity to their principal one

The applicability of the decision will depend of the **scope of national definitions** of intermediaries and economic operators

As CJEU's decisions refer to "**economic operators**", the Mc Fadden judgement applies surely to those who provide an Internet connection as main activity, as well as to those providing it as an ancillary activity to their main economic one

Is there a choice?

Would it for a CN – or for a gateway node - be better to qualify as a provider

and to be submitted to liability exemption

but also to its counterparts, including possible injunction?

//

Or in the contrary, would CNs be better off

(and would this be an option at all)

if they do not quality as intermediaries and economic operators?

→ non-profit but at the same time non-ancillary nature of their activity

→ each individual node an intermediary in the technical sense

but not in the economic sense

Here come STS:
The impact on the structural design of CNs

What could CNs modify in their features in order to avoid the negative consequence?

Can the decision affect the shaping and the sustainability of ecology of

CNs as alternative, peer to peer, commons-based solution to provide a service?

Which dimensions would be likely to be affected?

Should CNs take preemptive measures to avoid negative consequences

or would a modification of the design be so disruptive that it would signify the end of open CNs?

Design features

- Fee, absence of a fee, subscriptions at different levels for different categories of members, depending of their involvement in the CN

Would in-kind contribution

(as manager of a node, as rooftop care-taker, as community officer reaching out to new audiences, as drafter of user documentation)

be assimilated to a professional role?

- Governance decisions: board, nodes, noone?

modifications to the other dimensions of the CN: the fee policy, the legal structuration, the technical design, or Terms of Use, when they exist, and whether CN could or should amend their promises or exclusion of service (is 'be nice' enough?)

Technical decisions

- Cost to implement a password protection

They may be too expensive or too difficult to implement, and compliance may signify the death of the CNs, if too many individual nodes choose to close, jeopardising the technical viability of the local network

- Distribution of the network

many nodes are actually owned by a single person, who is also the one that manages and keeps the network running. These are called critical nodes and reflect a more general trend on the re-centralisation of the web. If a node opened to the Internet is also a critical node for the functioning of the entire CN, the imposition of an injunction or the request for damages to the owner might hamper not only the functioning of the node, but the functioning of the entire CN.

One step backwards: Western laws vs Commons

Designed to regulate individuals

Can successful regulatory practices

mitigate legal challenges of CNs?

Can CNs get inspiration from environmental commons experiences and transpose existing legal hacks?

Examples of laws for the commons

CNs as commons

Identify legal principles supporting and sustaining CNs

Existence threatened by inadequate internet and telecommunication legislations

Designed for commercial, large-scale Internet Service Providers

CNs as global commons

Alternative

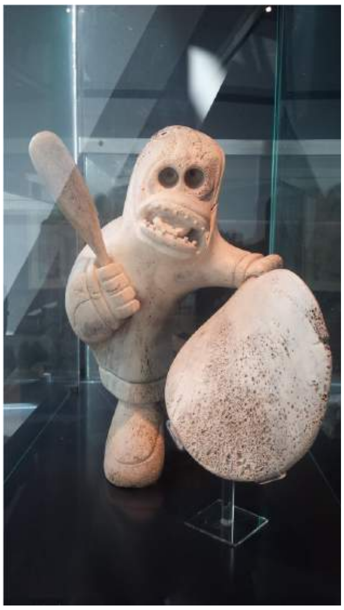
DIY

Citizen

Rights Enabling

How do CNs deal with tort law

- Change IP address
- Use IP addresses from other countries
- Anonymisation, encryption
- Terms of use shielding
- Absence of legal status
- Coshaping
- Funding and governance model
- Impact on qualification as a provider protected by intermediary liability limitation
- Password



Towards a 3rd way: Laws for the Commons

Can legal hacks, or effective regulatory principles be designed, or transposed from other types of commons and communities than the ones they were originally designed for?

Can precedents of successful legislations for the commons, mostly in the field of the environmental commons, be imported to better manage digital commons?

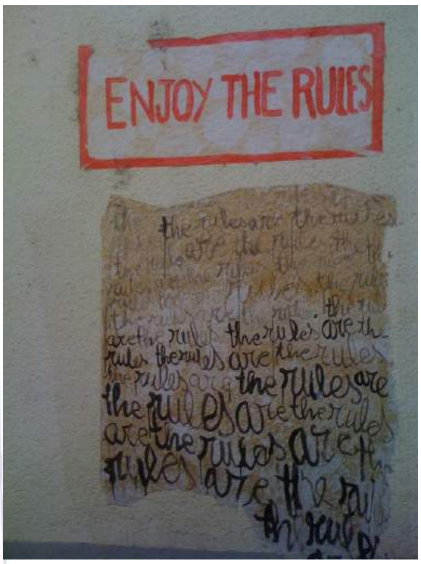
Need to adapt laws which have not been designed to support the commons, and which are being challenged by the commons

Possibility to conceptualise and develop generic legal principles which would work to support very different types of commons, and could be adapted to protect specific artefacts, local contexts and legal frameworks

Applying the model of distributed architectures to the law itself

The law could infect code, carrying its values, but code could also infect the law and export its design features

Instead of trying to apply the law to p2p...



How about applying p2p to the law?

To try to transform it

Apply architectural design principles based on decentralisation

- To influence legal thinking
- Towards the distribution of the law

(Dulong de Rosnay, *Journal of Peer Production*, 2015)

How to challenge western, liberal, legalist categorisation designed around individualism

Instead of coming up with a regime of limited responsibility for intermediaries or whatever individually identifiable entity

Towards the recognition of collectives of users as subjects of rights?

Communities of user peers

- Non-stabilised, evolving, or non formalized groups
- Local communities
- Online communities
- Theoretical break from envisioning the individual person as unique point of reference

Network theory
Law and artificial intelligence

- Need for a systemic way
- Epistemological transformation of the model where law assign rights to responsible individuals
- How other rights and duties may be assigned to collectives
- Rights of non-humans electronic agents (Teubner, 2006)
  - 'attribute contractual act to this socio-technical ensemble'
  - To make it the 'well-acquainted juridical person'
- Intentionality of software agents? (Sartor, 2009), AI & copyright (Guadamuz, 2017)
- It can work: collective insurances & commons-based mutualisation

Agency of collectives

- Problem is lack of decisional autonomy
- Concepts of actants and hybrids (Latour, 2004):

'In hybrids, the participating individual or collective actors are not acting for themselves but are acting for the hybrid as an emerging unit, the association between human and non-humans'.

So are user communities hybrids?

If they don't know what they are carrying

there is no a common will or common action

so they do not form an association?

Joint collective action

- The 'we' of a cyber-community can be found in the Declaration of Independence of the Cyberspace (Barlow, 1996)
- not, however, as an aggregation of individuals
- but rather as a whole, as a collective that acts jointly' Lindahl (2013)
- 'we, each' and 'we, together' Margaret Gilbert 1996
- “pool of wills” condition of the plural subject
- **Does group intention (e.g. user generated wifi) leads to collective and/or distributed responsibility?**
- Fragmented contribution to the network will help a political dissident, a cybercriminal, a privacy-concerned individual or someone downloading music? **No way of knowing**

Legal hacks

The commoners' bundle of rights allowing to conceptualise property fragmentation into components,

The movement on water held as commons in Italy hacking privatisation,

Free software and Creative Commons licensing hacking copyright,

Collective groups of unidentified and future peers are addressed in environmental law legal hacks to property

fragment rights on the land

to purchase the right to build

to limit possible usages of a piece of land only to preserve it unbuilt for future generations.

Voluntary servitudes

Community land trusts

Conservation covenants

designed to protect the environment, where a land owner transfers a fragment of her rights to the state or a non-profit intermediary for purposes of biological conservation.

p2p law as an experiment

how property and liability

two core legal institutions attached to individual persons

react and can be transformed

(like chemical elements)

when applied a peer to peer, distributed design

evolutionary approach of hacking the law, seen as a regulatory system

(Dulong de Rosnay, *First Monday*, 2016)

Ontological differences

- p2p disrupts the law
- legal reasoning is accustomed to operate on subjects which are characterized by and uniquely attached to some spatio-temporal existence
- ontological difference between the nature of distributed technology and positivist legal thinking
- also reflected in the gap between
    - capitalism, relying on identified entities (firms, workers) and
    - commons-based peer production, organized around non-fixed and uneven contributions

Capital vs the Commons

the law is traditionally much more protective of the interests of capital (Capra and Mattei, 2015)

with its identified owners

than of the commons

with a crowd of distributed peers, and the future generations which may contribute to and benefit from it

applying peer to peer to the theory of law:

potential to reduce inequalities caused by the extreme

concentration of capital and political power?

Distributed property

- The bundle of rights (Commons, Ostrom)
- Usus, fructus, abusus
- Land law (harvest, gleaning, pasture, grazing)

rights of access to the common resource

removal (eg of wood from a forest)

management (of rights to remove)

exclusion (deciding who will have access rights)

alienation (right to sell or transfer other rights)

Anti-enclosure hacks

- Copyfraud and copyleft for IP & PD
- Allocate rights to collectives, or to future persons in environmental law

Voluntary servitudes, community land trusts, and conservation covenants or easements

Ecocide

hold liable a company which could potentially damage the environment and harm future generations, by preventing them from exercising any rights to a piece of land, before pollution takes place

Harder to conceptualise

ideological construction of property

as an individual freedom

has done a lot of harm

used only to support extractive capitalist ideological hegemony

making it difficult to imagine other more generative purposes

such as the transmission of rights to the next generations, to a fuzzy group of unknown peers

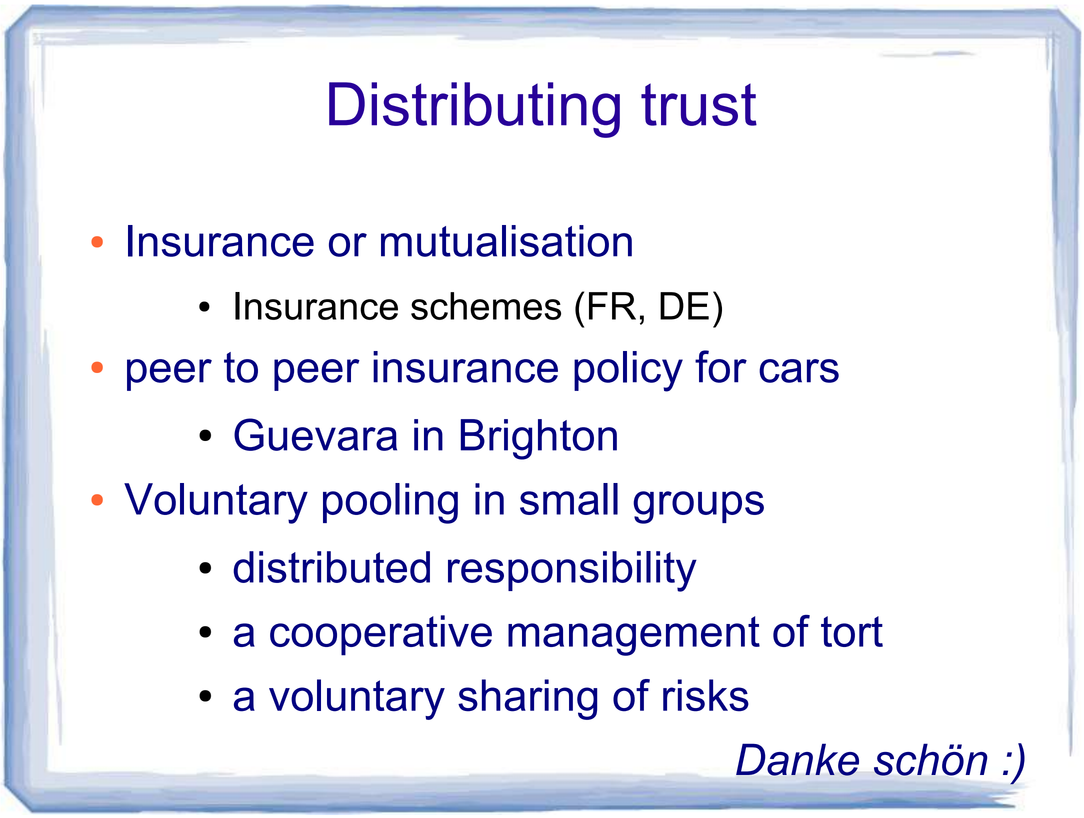
Distributing liability?

is it possible or desirable

to allocate socio-legal responsibilities or liability directly to collectives constituted of peers

rather than identified individuals?

- Distributed policing by users (Wikipedia duty of care and repair)
- Local management: Commons Ostrom Institutional Design Principle #4 & #5 monitoring and graduated sanctions
- But this responsibility is social, not legal
- Crowdsourced infringement monitoring: unlikely, or leading to discrimination


Distributing trust
Insurance or mutualisation
Insurance schemes (FR, DE)
peer to peer insurance policy for cars
Guevara in Brighton
Voluntary pooling in small groups
distributed responsibility
a cooperative management of tort
a voluntary sharing of risks
Danke schön :)

B.17. AFTER: Futuri Digitali, Reggio Emilia, Italy
Reference event Sec. 2.5.4
Invited Speech by Renato Lo Cigno (in Italian)

08/05/19

Architettura, Coinvolgimento, Successo

Renato Lo Cigno

DISI – Università degli Studi di Trento
http://disi.unitn.it/locigno

Advanced Networking Research Group
http://ans.disi.unitn.it

netCommons Project
http://netcommons.eu

After - Futuri Digitali - Reggio Emilia - Coviolo Calling - 19 ottobre 2018 Renato Lo Cigno 1

netCommons

- Network Infrastructure as a Commons
- Progetto H2020 (Grant Number 688768) centrato sulle reti comunitarie
- Moltissimi documenti e studi disponibili liberamente:
  https://netcommons.eu/?q=content/deliverables-page/
- Uno per tutti
  "Report on the Governance Instruments and their Application to CNs "

After - Futuri Digitali - Reggio Emilia - Coviolo Calling - 19 ottobre 2018 Renato Lo Cigno 2

1

08/05/19

Cos'è una Community Network?

- "La mia" ... naturalmente!
- 1000 diversi modelli di
  - Finanziamento
  - Sviluppo
  - Sostenibilità
    - Economica
    - Sociale
  - Gestione
  - Interconnessione
    - Con Internet
    - Con altre "comunità"

After - Futuri Digitali - Reggio Emilia - Coviolo Calling - 19 ottobre 2018 Renato Lo Cigno 3

Accesso o Servizi?

After - Futuri Digitali - Reggio Emilia - Coviolo Calling - 19 ottobre 2018 Renato Lo Cigno 4

2

08/05/19

Accesso o Servizi?

After - Futuri Digitali - Reggio Emilia - Coviolo Calling - 19 ottobre 2018 Renato Lo Cigno 5

Volontariato e Supporto

- Contenimento dei costi
- Risposta ai guasti e malfunzionamenti
- Economia locale
  - Importante soprattutto per aree marginali
- La rete come patrimonio comune (e inalienabile)
- Attenzione alle normative ...

After - Futuri Digitali - Reggio Emilia - Coviolo Calling - 19 ottobre 2018 Renato Lo Cigno 6

3

08/05/19

Quale Successo?

- La maggior parte delle reti di accesso create per ridurre il digital divide sparisce quando arrivano operatori commerciali
- È un fallimento??

After - Futuri Digitali - Reggio Emilia - Coviolo Calling - 19 ottobre 2018 Renato Lo Cigno 7

Conoscenza e Educazione

- Digital divide (almeno in Europa) è principalmente di tipo culturale non economico
- Partecipare a una rete comunitaria aiuta (implica?) migliorare le conoscenza su cos'è Internet
- Conoscenze tecniche, legali, socio-economiche

After - Futuri Digitali - Reggio Emilia - Coviolo Calling - 19 ottobre 2018 Renato Lo Cigno 8

4

08/05/19


Organizzatori
Partner
Media partner
Sponsor
netCommons
Grazie!
After - Futuri Digitali - Reggio Emilia - Coviolo Calling - 19 ottobre 2018
Renato Lo Cigno
9

5

B.18. International Conference on Sustainable Connectivity – Fund. Getulio Vargas Faculty of Law – Rio de Janeiro, Brasil, April 2016

Reference Deliverables: D6.1 [25], D4.1 [72]

Community Networks: Legal Issues and Possible Policy Actions (Federica Giovanella)

UNIVERSITÀ DEGLI STUDI DI TRENTO
Facoltà di Giurisprudenza

netCommons

Community Networks: Legal Issues and Possible Policy Actions

FGV Direito Rio de Janeiro
Centro de Tecnologia e Sociedade
April 29, 2016

Federica Giovanella

netCommons

Funded by the EU Framework Programme for Research and Innovation **Horizon 2020**.

Lasting **3 years** and involving **5 universities/research centres** and a **non-profit organisation**, with experts in engineering, computer science, economics, law, political science, urban, media, and social studies.

Proposing a **transdisciplinary methodology** to promote and support network infrastructures as commons, with emphasis on their **sustainability**.

netcommons.eu 2

About Community Networks

- **Bottom-up approach**: users are peers and create a **network** with hardware **distribution**
- Some CNs have only **wireless connections**, some rely on mixed connections (wired and wireless)
- Some are associations/foundations or even professional ISPs; some **do not have a legal status**
- Some are **self-organized** and **self-governed**; have no written rules or contracts, except for the PicoPeering Agreement; others rely on a **licence**, such as the FONN Compact
- (Might be) opened to the **Internet** through so called «**gateway nodes**»
- **No** pre-assigned **Internet Protocol** addresses (except for gateway-nodes) and use of anonymizing software to obtain a high level of anonimity

netcommons.eu 3

Legal Issues in CNs: Civil Liability

Three different situations:

1. **User's liability** (for her own conducts or for others' ones, when acting as «gateway») **or shared-liability of many users**
2. **ISPs' liability** (for wrongful conducts carried out through the «gateway»)
3. **CN's liability (?)** (for wrongful conducts taking place within the CN)

netcommons.eu 4

Legal Issues in CNs: Civil Liability

There seems to be an «**enforcement failure**»:

- Users are not idenfiable, except for the gateway
- The majority of CNs do not have legal personality and cannot be sued
- Specific statutes very often shield ISPs from liability; ISPs also rely on 'terms and conditions'

netcommons.eu 5

Legal Issues in CNs: Civil Liability

BUT: studies in computer engineering (Maccari, 2014) demonstrate that the actual structure of some CNs is not as distributed as it should be:

- Some «critical nodes» route the majority of the traffic
- Such nodes are owned by few people
- The owners of these nodes are also the people most involved in the CN's organisation

netcommons.eu 6

Legal Issues in CNs: Civil Liability

Implications for tort law enforcement:

It is easy to detect the so called «critical node»

It is easy to find out the owner of the critical node

It is easy to sue the owner of that node, negatively affecting the entire CN

netcommons.eu 7

Legal Issues in CNs: Civil Liability

Suggestions for CNs on how to **avoid** such **negative effects**:

- Limit the number of critical nodes
- Diversify the ownership of the nodes
- Make sure that people in charge of the CN's organisation do not own critical nodes
- Consider tools for the internal governance of the network (for instance: the Compact for a Free, Open & Neutral Network of guifi.net)

netcommons.eu 8

Legal Issues in CNs: Civil Liability

The FONN Compact is basically a license introducing

"the **freedom to use** the network for any purpose as long as you **don't harm** the operation of the **network** itself, the **rights** of **other users**, or the principles of **neutrality** that allow contents and services to flow without deliberate interference"

netcommons.eu 9

Legal Issues in CNs: Civil Liability

As well as...

"the right to understand the network and its components, and to **share knowledge** of its mechanisms and principles"

"the right to join the network, and the obligation to **extend this set of rights** to anyone according **to these same terms**"

netcommons.eu 10

Policy Considerations

What could policy-makers do? They should:

- Encourage the adoption of codes of conducts or other forms of internal regulation.
- Not impair CNs' development.
  - on the contrary: «Radio Equipment Dir. 2014/53/EU»
- Consider ad-hoc statutes or exceptions allowing the prosperity of CNs.
  - e.g.: mandatory contractual clauses for ISPs imposing them to allow users to share their connection

netcommons.eu 11

Thank you!

netCommons.eu

lawtech.jus.unitn.it

federica.giovanella@unitn.it

netcommons.eu 12

References

Crabu, S., **Giovanella, F.**, **Maccari, L.**, **Magaudda, P.**, 2015, A Transdisciplinary Gaze on Wireless Community Networks, 6 Tecnoscienza - Italian Journal of Science & Technology Studies 2, 113

Crabu, S., **Giovanella, F.**, **Maccari, L.**, **Magaudda, P.**, 2016, Hackivism, Infrastructures and Legal Frameworks in Community Networks: the Italian Case of Ninux.org, Journal of Peer Production, Special issue on Alternative Internets

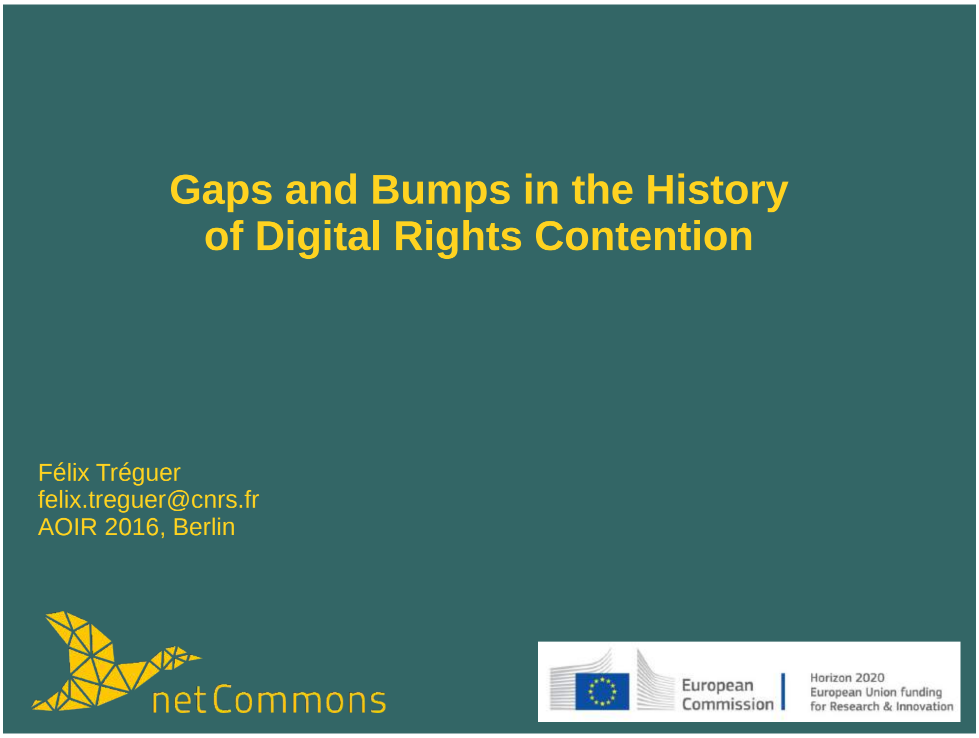
Dulong de Rosnay, M., 2015, Peer-to-Peer as a Design Principle for Law: Distribute the Law, Journal of Peer Production, Special issue on Peer Production, Disruption and the Law

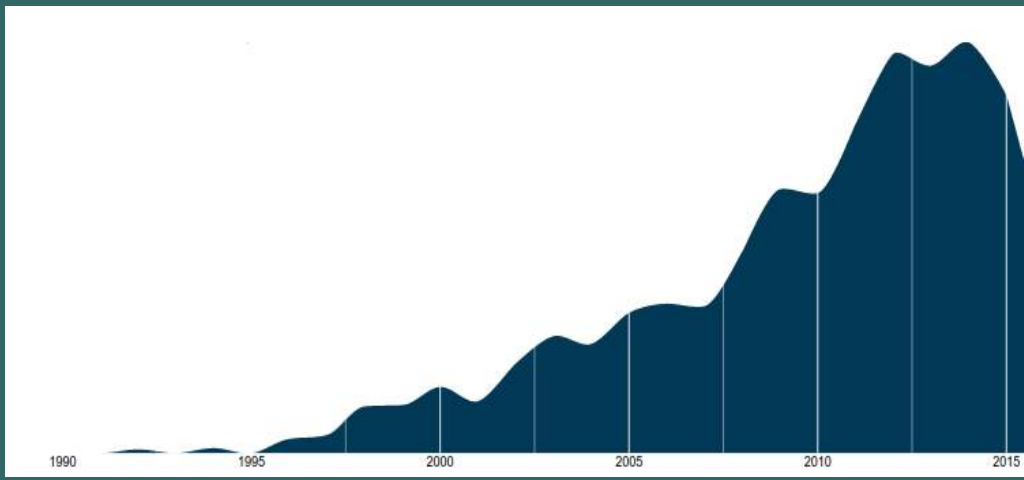
Giovanella, F., 2015, Liability Issues in Wireless Community Networks, 6 Journal of European Tort Law 1 (2015), 49

Maccari, L., 2014, Decentralized, multi-hop networks: Are They really different from the Internet?, Dagstuhl Seminar November 16–21, 2014

netcommons.eu 13

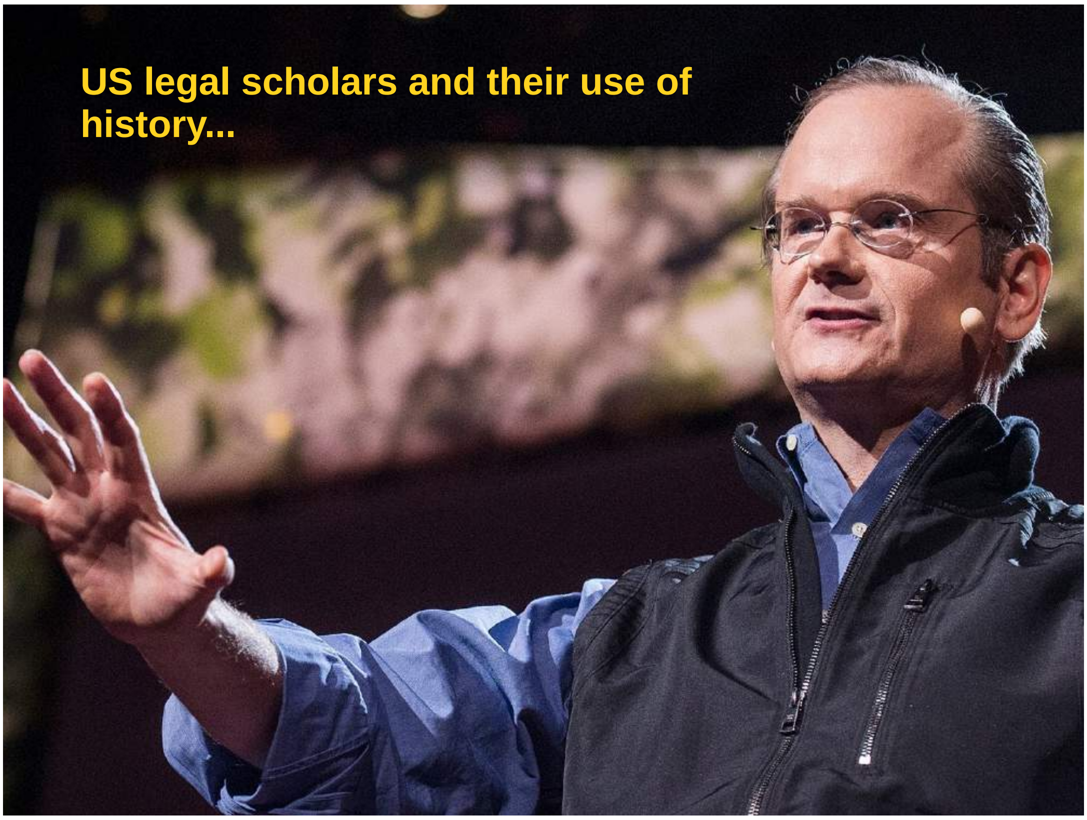
B.19. Association of Internet Researchers Annual Conference, Berlin, Oct. 2016
Reference Deliverables: D6.1 [25], D5.1 [73]
Presentation by Félix Tréguer





Volume of academic papers per year dealing with digital rights contention between 1993 and 2015.

IANAH ("I am not a historian")


US legal scholars and their use of
history...


US history of technology and technologists


WELCOME TO
US history of revolutionaries and computer heroes
HACKERS

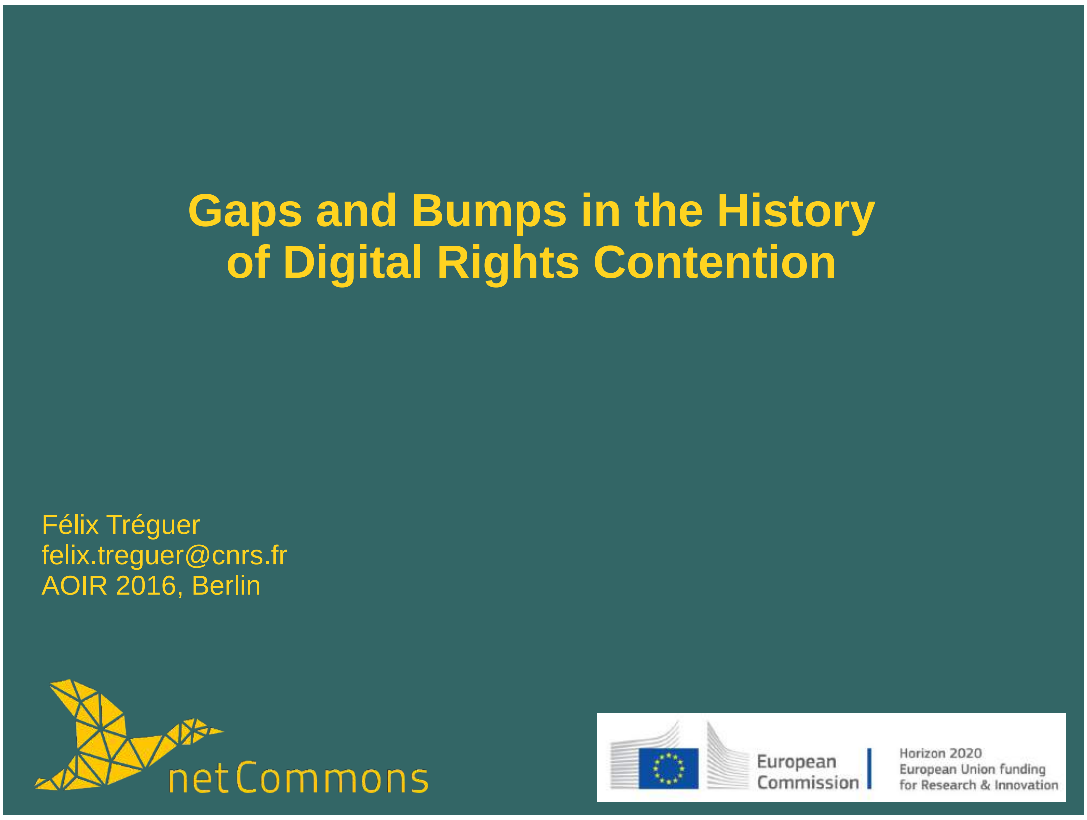

History of the appropriation of the Internet by social movements
independent media center
imc
independent media cent
Features Archive
Peace and Justice events
Struggle for Global Justice Continues in Seattle


Cultural and economic history of the Internet and of its competing scenarios
COMMUNITY
MEMORY

Bumps

Gaps

Why these gaps?


Gaps and Bumps in the History
of Digital Rights Contention
Félix Tréguer
felix.treguer@cnrs.fr
AOIR 2016, Berlin
netCommons
European
Commission
Horizon 2020
European Union funding
for Research & Innovation

B.20. netCommons Ethics and Policy Workshop, London, May 15, 2017
Reference Deliverables: D6.2 [7] and D4.4 [74]

B.20.1. netCommons Policy Workshop Alternative Internet Survey (Maria Michalis)

netCommons Policy Workshop
Alternative Internet Survey

netCommons

Dr. Dimitris Boucas & Dr. Maria Michalis
D.Boucas@westminster.ac.uk
M.Michalis@westminster.ac.uk
University of Westminster
London

netCommons 15 May 2018 1/31

Outline

- ➢ netCommons project
- ➢ Alternative Internet Survey
  - Aims & brief description
  - Results
    - ✓ Concerns
    - ✓ Alternatives
- ➢ Key takeaways

netCommons Policy Workshop 2/31

The netCommons project

- netCommons: Network Infrastructure as Commons http://netcommons.eu
- EU Horizon 2020 project, 3-year project
- Study, support and further promote community-based networking and communication services that can offer a complement, or even an alternative, to the global Internet's current dominant model
- *Partners*: Uni of Trento (I), The Polytechnic University of Catalonia (E), the National Center for Scientific Research (FR), the University of Westminster (UK), the Athens University of Economics and Business (GR), and the non-profit organization Nethood (CH)

netCommons Policy Workshop

3/31

The story so far

- Operational / technical
- Legal
- Advocacy
- Dissemination & publicity
- Political economy/ social/ organisational
  - Alternative Internet Survey

netCommons Policy Workshop

4/31

Alternative Internet Survey

- **1000 respondents**
- **Section A:** aims of the survey and consent form
- **Section B:** internet usage and digital skills
- **Section C:** concerns of Internet users, e.g.
  - surveillance, data protection and privacy
  - digital labour, advertising and consumer culture
  - digital monopolies
  - internet governance and electronic democracy
- **Section D:** two questions on the possibility of alternative internet, directly relevant with community networks
- **Section E:** demographics (age, education/background, profession, area, community participation)

Total Questions: 48 (10 open)

netCommons Policy Workshop 5/31

Section C: Concerns - Privacy

netCommons Policy Workshop 6/31

Privacy & data control

- Strong concerns about:
  - handful of commercial companies that rely on harvesting personal data using extensive tracking and profiling practices
  - use of data for commercial but also political benefit
  - lack of alternatives and the inability to use a service unless one surrenders personal data
- In response…

Steps taken (from given list of options)

- changed the default privacy settings, though "Over-riding / altering existing settings is very frustrating." (63.6%)
- installed ad-block software (61.2%)
- paid more attention to the terms of use and privacy policies of online series and ISPs (43.6%)
- blocked certain applications on social media, e.g., Facebook birthday calendar (43.6%)
- reduced the frequency of usage of online services they have concerns about (30.4%)
- stopped using the online service(s) they have concerns about (27.2%)
- used a service that anonymises or encrypts online data or identity (26.3%)
- taken other steps (19.8%)
- stopped using open Wi-Fi (19.3%)
- not taken any steps (13.6%)
- reduced their use of the Internet to the minimum (4.8%)

Section C: Concerns - Monopolies

Monopolies of information provision

- Questions on Facebook and Google reveal concerns about:
  - ad-driven business model which relies on personal data
  - increasing market power and intrusiveness
  - potentially severe adverse effects for citizenship, democracy and the public sphere,
  - doubts about whether one can stop using these platforms totally.

Facebook as privacy violator

- “exposing private information”
- “invading privacy”
- “intrusive”
- “non-transparent”

netCommons Policy Workshop

11/31

Facebook as information provider

- “single information source”
- “decision-maker of terms of access to information”
- “propaganda”
- “spreading toxic silicon valley ideology”
- “spreading fake news”
- “negative campaigning tool”
- “trivia information provider”
- “micro-targeting users with political messages”

netCommons Policy Workshop

12/31

Facebook as monopoly (power)

- “monopoly company”
- “holding too much (data) power”
- “abusive of power”
- “danger to democracy”
- “political/social influence”
- “shaping/limiting expressive choices’
- “alienating”
- “global imperialism”

netCommons Policy Workshop

13 / 31

Facebook as commercial

- “corporate infrastructure/ company”
- “using data for advertising/commercial purposes/ profit”

netCommons Policy Workshop

14 / 31

Section C: Concerns – Internet Governance and Electronic Democracy

Open Q on subscriptions to news content

- Main contradiction
  - funding of (quality and credible) journalism and content generally
  - potential for exclusion and implications for democracy and plurality
- Alternatives
  - market structure and organizational models
    e.g., new news ventures and non-profit news provision, including community, media; and various funding methods such as state subsidies and public service media, micro-payments, donations, crowdfunding etc.
  - behavioural interventions
    e.g., regulation for free and independent press.

Section D:
Community networks as an Alternative

netCommons Policy Workshop

17 / 31

Identified advantages of CNs

- Affordable internet connection
- Closing the digital divide between places and within places
- Democratic participation and involvement in the running of the network
- Gaining control over one's data, privacy and digital infrastructure
- Promotion of public goods
- Promotion of digital rights
- Gaining technical expertise
- Enhancing social cohesion and strengthening community ties

netCommons Policy Workshop

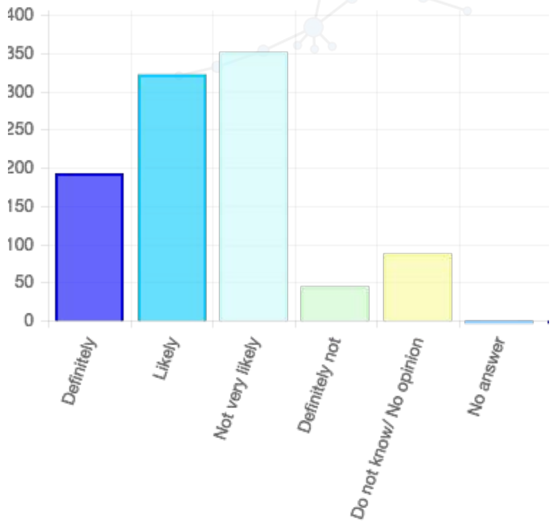
18 / 31

Challenges CNs face

- Funding
- Resources, e.g. expertise and time
- Fundamental prerequisites for a CN initiative, e.g. community and scale needed
- Motivation
- Opposition from established commercial players, dominant commercial model of telecoms/Internet provision, regulation is not addressing CNs' needs

netCommons Policy Workshop 19 / 31

Do you think there is potential for local community networks to overcome your concerns about the Internet identified in this survey?



netCommons Policy Workshop 20 / 31

Meanings of 'alternative'

- increasing market competition in infrastructure, platforms, operating systems and applications
- non-commercial arrangements in infrastructure and content
- decentralized power and infrastructure
- more flexibility
- less surveillance and more control of personal data
- the reduction of the degree of the appropriation and alienation of mental and social work
- the democratic control of infrastructure and services (alternatives to corporate/state control)
- the transformation of existing services into public utilities

netCommons Policy Workshop 21/31

CNs as alternatives? (1/2)

Are CNs still relevant?

- Yes (technological): CNs are taking momentum, not dwindling
- Yes (social): Mainstream internet is becoming more and more a place of control and manipulation, not of freedom and innovation
- Yes (legal): Legislation is still lagging behind and is dominated by lobbies

netCommons Policy Workshop 22/31

CNs as alternatives? (2/2)

- Distinction between

  Infrastructure - services/ content/ applications/ platforms

- Are CNs about connectivity or connectivity+ ?

- Dimension of CNs
  - Local and/or global?

netCommons Policy Workshop 23/31

B.20.2. Political Economy of the Internet: Ethical and Policy Questions (Christian Fuchs)

Political Economy of the Internet: Ethical and Policy Questions

Prof. Christian Fuchs
@fuchschristian, fuchs.uti.at

Political Economy of the Internet

3 current key political economic issues affecting the Internet's political economy:

1. Fake news

2. Surveillance and privacy violations

3. Monopolies

=> 1) Fake news

Political Economy of the Internet

Cambridge Analytica paid Global Science Research (GSR) for conducting fake online personality tests in order to obtain personal Facebook data of almost 90 million users (first assumed to be 50 mn); used for targeting political ads

Political Economy of the Internet

* Cambridge Analytica is a story about how the combination **of digital capitalism/neoliberal politics/far-right ideology** that threatens democracy

* Far-right extremism fosters the use of dubious and manipulative information and communication strategies in politics. **Far-right ideologues** will do everything necessary to win elections.

* **Social media corporations** turn data into profit, are supported by governments => lax regulation of data processing and privacy protection

* Tolerating manipulative and democracy-threatening ads makes money, => **Facebook** did not do anything against Cambridge Analytica/GLS data breach

Political Economy of the Internet

* Lax data protection regulation

* Algorithms control **ads**, not humans; social media corporation have no interest in human control because that costs money and means less profits

What can be done?

- Human control, replace algorithms by humans, fact-checking
- Extension of political ad ban to targeted and behavioural online ads
- Public service Internet, slow news instead of fake news
- Strengthening of the power of information commissioners

Political Economy of the Internet

2) Surveillance and privacy violations

Rise of “Big Data” stands in a broad political economy context:

* Economy – The commodification and privatisation of almost everything, including **data and communication(s)**

* Politics – **Surveillance-industrial complex**

* **Surveillance ideology**: **Culture of control**, fear-mongering, scapegoating, suspicion, competition and individualisation

Collection, storage, control, analysis of “big data”
=> economic and political control and targeting of individuals, targeting as consumers, targeting as potential terrorists and criminals

Political Economy of the Internet

User data is in the surveillance-industrial complex first externalised and **made public or semi-public on the Internet** in order to enable users' communication processes,

then **privatised as private property by Internet platforms** in order to accumulate capital,

and finally **particularised by secret services** who bring massive amounts of data under their control that is made accessible and analysed worldwide with the help of profit-making security companies.

The NSA has subcontracted and outsourced surveillance tasks to around 2000 private security companies
=> Surveillance is not just a threat to privacy! It is big business!

Political Economy of the Internet

3) Monopolies

Infrastructure monopolies, platform monopolies, content monopolies

The Herfindahl-Hirschman-Index is a measure of market concentration. It is calculated the following way:

$$HHI_j = \sum_{i=1}^{f} S_{ij}^{2}$$

f = number of firms participating in an industry,
S_{ij} = each firm *i*'s market share in the industry *j*.
HHI < 1000: low market concentration,
1000 < HHI < 1800: moderate market concentration,
HHI > 1800: high market concentration

Country	Share	HHI >
Luxembourg	69%	4761
Cyprus	64%	4096
Austria	58%	3364
Denmark	58%	3364
Estonia	58%	3364
Latvia	58%	3364
Croatia	53%	2809
Lithuania	51%	2601
Malta	49%	2401
Portugal	48%	2304
Italy	48%	2304
Spain	45%	2025
Belgium	44%	1936
Hungary	44%	1936
Greece	43%	1849
Germany	42%	1764
Netherlands	41%	1681
France	39%	1521
Sweden	39%	1521
Ireland	37%	1369
Slovenia	35%	1225
Slovakia	34%	1156
UK	32%	1024
Poland	32%	1024
Czech Republic	29%	841
Romania	27%	729
Bulgaria	23%	529
Average in EU	44%	HHI > 2106

Market share of the incumbent in fixed line broadband subscriptions and minimum level of the Herfindahl-Hirschman-Index, data for 2015, data source: European Commission 2015

Political Economy of the Internet

Platforms and Software

Google is estimated to have controlled 55.2% of global online advertising revenue in 2016, and Facebook 12.3%

Table: Calculation of the search engine concentration index

Rank	Company	Search engine(s)	Country	Share (a):	a^2
1	Google	Google	USA	70.85%	5019.7
2	Microsoft	Bing	USA	11.61%	134.8
3	Baidu	Baidu	China	8.14%	66.3
4	Yahoo	Yahoo	USA	7.48%	56.0
5	IAC	Ask, Excite	USA	0.25%	0.1
6	AOL Inc.	AOL	USA	0.13%	0.0
		Other		1.54%	
				HHI:	> 5276.8

Table: Calculation of the social network concentration index, data source: www.statista.com, accessed on January 2, 2017

Rank	Company	Number of accounts (in millions)	Platform(s)	Country	Proportion a	a^2
1	Facebook	3890	Facebook, WhatsApp, FB Messenger, Instagram	USA	42.9%	1842.3
2	Tencent	2190	QQ, WeChat, Qzone	China	24.2%	583.9
3	Yahoo!	555	Tumblr	USA	6.1%	37.5
4	Microsoft	400	Skype, LinkedIn	USA	4.4%	19.5
5	Twitter	320	Twitter	USA	3.5%	12.5
6	Baidu	300	Baidu	China	3.3%	11.0
7	Rakuten	249	Viber	Japan	2.7%	7.5
8	Sina	222	Sina Weibo	China	2.4%	6.0
9	Naver	215	LINE	South Korea	2.4%	5.6
10	Snap Inc.	200	Snapchat	USA	2.2%	4.9
11	Yy	122	yy	China	1.3%	1.8
12	Mail.ru Group	100	Vkontakte	Russia	1.1%	1.2
13	Pinterest	100	Pinterest	USA	1.1%	1.2
14	BlackBerry	100	BBM	Canada	1.1%	1.2
15	Telegram Messenger LLP	100	Telegram		1.1%	1.2
	Total:	9,063			HHI:	2536.1

Political Economy of the Internet

Market share of operating systems

https://netmarketshare.com/operating-system-market-share.aspx
Time period: May 2017-April 2018

Desktop/Laptop OS	Market share	
Windows	88.59%	7848.2
Mac OS	8.69%	75.5
Linux	2.29%	5.2
Chrome OS	0.31%	0.1
BSD	0.01%	0.0
		HHI = 7929.0

Mobile OS	Market share	
Android (Google)	69.75%	7848.2
iOS (Apple)	28.86%	75.5
		HHI > 5698.0

Political Economy of the Internet

Content: Attention economy

Table: The most watched YouTube videos of all time

#	Title	Type	Owner	Access
1.	Luis Fonsi – Despacito	Music	Universal	4.90 bn
2.	Wiz Khalifa – See You Again	Music	Warner Music	3.44 bn
3.	Ed Sheeran – Shape Of You	Music	Warner Music	3.34 bn
4.	Psy – Gangnam Style	Music	YG Entertainment, Universal	3.12 bn
5.	Mark Ronson – Uptown Funk	Music	Sony	2.98 bn
6.	Masha and the Bear: Recipe for Disaster	TV-series	Animaccord	2.91 bn
7	Justin Bieber – Sorry	Music	Universal	2.89 bn
8.	Maroon 5 – Sugar	Music	Universal	2.53 bn
9.	Taylor Swift – Shake It Off	Music	Universal	2.52 bn
10.	Enrique Iglesias – Bailando	Music	Universal	2.48 bn

Political Economy of the Internet

Table: The World's Most Profitable Transnational Information Corporations, 2015. Data source: Forbes (2015)

	Forbes rank	Company	Industry	Profits 2015 (billion US$)
1	40	Vodafone	Telecommunications	77.4
2	12	Apple	Computer hardware	44.5
3	18	Samsung Electronics	Semiconductors	21.9
4	25	Microsoft	Software and programming	20.7
5	20	China Mobile	Telecommunications	17.7
6	39	Google	Computer services	13.7
7	44	IBM	Computer services	12.0
8	67	Intel	Semiconductors	11.7
9	88	Oracle	Software and programming	10.8
10	22	Verizon	Telecommunications	9.6
				Total: 240.0

Political Economy of the Internet

The combined profits of the world's 10 largest transnational information corporations (US$240.0 billion) are larger than the combined GDP of the world's 16 least developed countries (US$229.2 billion) and larger than the combined GDP of the world's 54 smallest economies.

Vodafone was, in 2015, the world's most profitable transnational information corporation. Its profits amounted to US$77.4 billion. Vodafone's profits were larger than the individual economic performance of 114 of the world's countries (World Bank Data, GDP at market prices in current U.S. dollars for 2015), including populous countries such as Ethiopia (100 million inhabitants), the Democratic Republic of Congo (75 million), Tanzania (52 million), Kenya (45 million), and Uganda (38 million).

Political Economy of the Internet

=> Ethical and policy questions:

What kind of Internet do we want? How should the Internet look like?

Are commons at the level of infrastructure, platforms/software and content viable alternatives?

How can the infrastructure commons, platform/software commons and content commons best be strengthened and advanced?

What policies do we need in order to strengthen alternatives to Internet monopolies, surveillance, fake news, etc.?

B.21. 2017 European Sociological Association Conference, Athens, 2017
Reference Deliverables: D6.2 [7], D2.1 [75], D4.4 [74]
Sustainability of Community Networks in the UK and Greece (Maria Michalis)

SUSTAINABILITY OF COMMUNITY NETWORKS IN THE UK AND GREECE: EVIDENCE FROM KEY ACTORS

Dimitris Boucas and Maria Michalis
University of Westminster, UK

netCommons

The netCommons EU project (netcommon.eu)

- Nature of the existing Internet: top-down, commercial, dominated by large platforms, limited control of user data
- The netCommons project aspires to study, support and further promote community-based networking and communication services that can offer a complement, or even a *sustainable* alternative, to the global Internet's current dominant model.
- netCommons is a multi-disciplinary project involving teams based in different EU universities and dealing with social, political, legal and technical aspects of *Community Networks* (CNs)

netCommons

Community networks: Definitions and rationale

- Networks (historical or present) built and managed by citizens or local/community organisations in a non-profit way –often extending the reach of a large telecomms provider
- Grassroots and bottom up
- Efforts and resources provided by the local/community people
- To provide alternatives to commercial Internet provision
  - Address digital divide and provide connectivity either free or at reasonable cost
  - Provide local applications/services as opposed to corporate global ones
  - Provide more autonomy/better control of user data
- Often inspired by the philosophy of the Commons and the democratisation of the telecomms market and the Internet
- Promoting openness and participation for all

netCommons

Sustainability in Community Networks

- Drawing on conceptual framework by Fuchs (2010) and Fuchs (2017)
- Using three main aspects of sustainability
- Economic sustainability
  - Resources (equipment, labour, time)
  - Funding (private/public, subscriptions)
  - Community needs
- Political sustainability
  - Participation/ Organisation
  - Ownership and control of data
- Socio-cultural sustainability
  - Community Identity, spirit, commitment
  - Sharing ethos, trust

netCommons

Multiple case study: 7 cases in UK and Greece

- Consume.net in East London
- Free2Air in East London
- Digcoop in East London
- Broadband for the Rural North (B4RN) in Lancaster
- Kinmuck in Aberdeenshire
- i4free network in Trizonia, near Nafpaktos, Greece
- The Sarantaporo network in Northern Greece

Method and Outputs

- Semi-structured interviews with key actors
- Aim: to understand how sustainable CNs are from the perspective of key actors
- Output: Evaluation Form of Sustainability of CNs

Sustainability in Community Networks

- Perceptions of key actors largely verify the conceptual framework by Fuchs (2017) – but also enrich it
- Economic sustainability
  - Personal efforts/ resources of key actors are seen as crucial
  - Funding a key factor for success for some
  - Community needs that cannot be served otherwise – and inclusiveness
  - Size of community is considered important (network effects)
- Political sustainability
  - Participation/ Organisation
  - Ownership and control of data
- Socio-cultural sustainability
  - Identity, spirit, commitment
  - Sharing ethos
  - Trust

Community Networks: Can they be sustainable?

- Challenges
  - Changing market and technological conditions (Mobile telecomms, sophisticated applications, cheap cloud storage)
  - Legal restrictions
- Some valid reasons for CNs
  - Lack of (adequate) Internet access
  - Open structures, anonymous connectivity
  - Better privacy and control of user data (within limits)
  - Experimentation, playfulness and knowledge transfer
- Our argument is that the non-profit character of CNs can improve their economic sustainability and strengthen community ties
- Community and community cohesion is crucial

Online survey: User concerns about the Internet

- As part of the netCommons project, we are conducting an online survey to examine users' concerns about Internet use and at the same time explore the potential of alternative Internet provision.
- Such concerns will provide useful input to policy makers and regulators who hold significant responsibilities over the telecommunications and Internet landscape.
- We are looking in particular for respondents (Internet users) who are academic/research staff, students, IT product/services professionals or administrative/clerical staff at Universities or research institutes.
- We would be grateful if you could take about 20 minutes to complete the survey.
- **Survey link:** **https://d52netcommons.limequery.com/357528?lang=en**

netCommons

Thank you for your attention

netCommons

B.22. IAMCR Conference: "Transforming Culture, Politics & Communication: New Media, New Territories, new discourses," July 2017

Reference Deliverable: D6.2 [7], D4.4 [74]

B.22.1. Presentation by Maria Michalis

Outline

- Two liberalisation phases (policy changes):
  - Mid-1980s till early 2000s – focus on competition
  - Early 2000s to present – focus on innovation
- Municipal/ community broadband networks
- Advantages/ challenges/ remarks

M. Michalis - University of Westminster

/

1st phase: the market can deliver

- Mid-1980s till early 2000s
- Abolishing monopolies
- Gradual introduction of liberalisation
- Emphasis on competition (Hayek)
  - Dismantling inefficient State monopolies
  - Improve corporate efficiency
  - Big market base
- Investment through private funding and access to capital markets
- 'Retreat' of the State

M. Michalis - University of Westminster

/

2nd phase: the market fails to deliver

- Early 2000s to present
- Rethinking of policy
  - Technological convergence
  - Commercialisation of the Internet
  - Continuing widening growth, productivity & competitiveness gap (esp. with USA)
  - Policy of 1st phase hadn't delivered
- Internet reaches high political level, e.g.
  - Lisbon 2000; DAE 2010 – EU 2020
- = Broadband Internet is the answer

M. Michalis - University of Westminster

2nd phase (cont'd)

- Some form of public funding, and public intervention more generally, '*is now seen as necessary and appropriate*' (Cave & Martin)
- From Hayekian to Schumpeterian thinking
  - precondition for innovation (NGAs) is not competition but rather the right incentives to economic agents
  - inter-firm competition is not a prerequisite but actually large, even monopolistic, companies stand a better chance to promote innovation

M. Michalis - University of Westminster

2nd phase (cont'd)

- For instance, ETNO's arguments:
  - 'Old rules' (remnant of 1st phase) need to be abolished: network access obligations, price regulation (esp. cost-orientation), and network neutrality rules
  - Solution:
    - Regulatory holidays
    - Market consolidation
    - Policy makers pressured to allow these in the name of innovation

M. Michalis - University of Westminster

/

Municipal networks

- Growing explicit recognition of Muni nets
  - *ETNO*: 'local/regional fibre deployment by … municipalities is leading to increasingly competitive and heterogeneous market structures in high-speed broadband access, also with the potential to significantly distort competition in competitive areas'
  - OECD
  - EU
  - Evidence from an increasing number of EU and non-EU countries

M. Michalis - University of Westminster

/

Community networks

- OECD and EU define them narrowly on the basis of their funding
  - *OECD*: gap funding (public financial support likely)
  - *EU*: one of four investment models
    - Investment is the private initiative of citizens
- Gap filling
  - Commercially unattractive areas
  - Minor part of the overall broadband market
  - Access (not backhaul) networks

  Q*:* Beyond gaps? Principles & values? Can they respect fundamental rights more and promote cohesion?

M. Michalis - University of Westminster

CNs - State Aid

- If public funding is involved, it might constitute State aid and might be unlawful
- Some encouraging provisions but have yet to be tested legally
  - '*The roll-out of a broadband network for non-commercial purposes might not constitute State aid'*

  But
  - '*State aid may be used to obtain a more desirable, equitable market outcome*'
  - 'However, if State aid … were to be used in areas where market operators *would normally choose to invest* [or have already], this could significantly undermine the incentives of commercial investors to invest '
- Q: economic sustainability of CNs?

M. Michalis - University of Westminster

Remarks

- Muni/Community Nets seen as the exception
- Way forward:
  - Beyond gap-filling scenario
  - Public/ Community partnership?
  (observe State Aid rules)
  - Public/ Community/ Private partnership?
  (More likely to be accepted but potential benefits diluted?)
- Challenge: technological and market conditions
- Likely reasons for CNs:
  - Need: Gap-filling
  - Open structures
  - Better privacy
  - Autonomy and control
  - Experimentation, playfulness and knowledge transfer
  - Greater (non-economic) societal benefits

M. Michalis - University of Westminster

/

B.22.2. Presentation by Félix Tréguer

Alternative Internet Networks

History and Legacy of a "Crazy Idea"

Félix Tréguer, felix.treguer@cnrs.fr

IAMCR2017, Cartagena

netCommons

For the footer

1/18

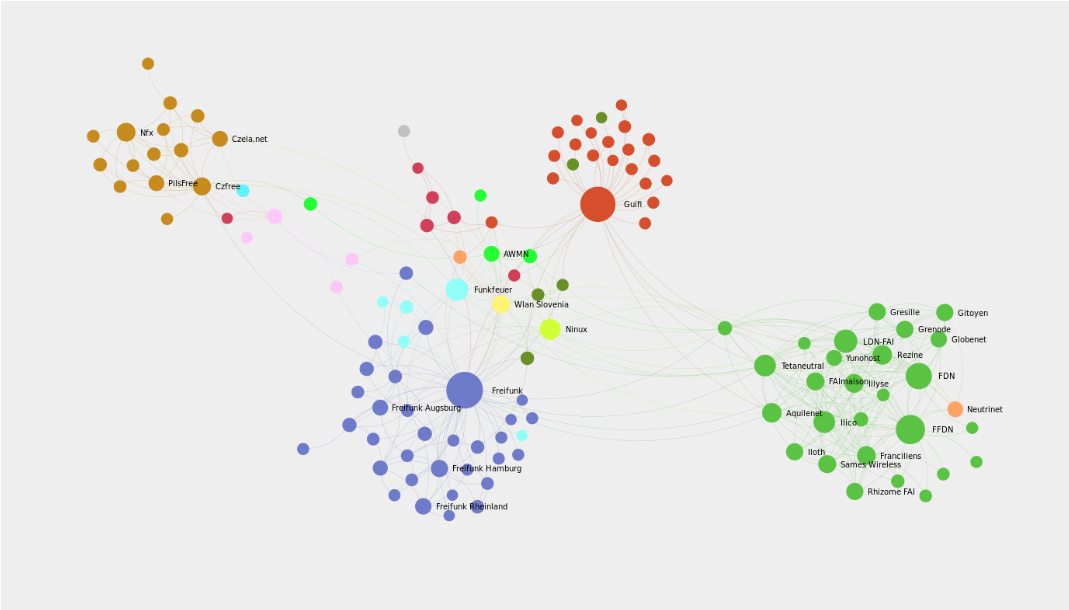
Community Networks: Expanding the Internet Commons

- Commons-based management of Internet connectivity
- act as a site of solidarity, education and experimentation in relation to digital technology, computer security, etc.
- a strategic locus for reinterpreting both ends of traditional "mediactivism" (Cardon & Granjon, 2010): expressivist critique / counter-hegemonic critique.

Author

For the footer

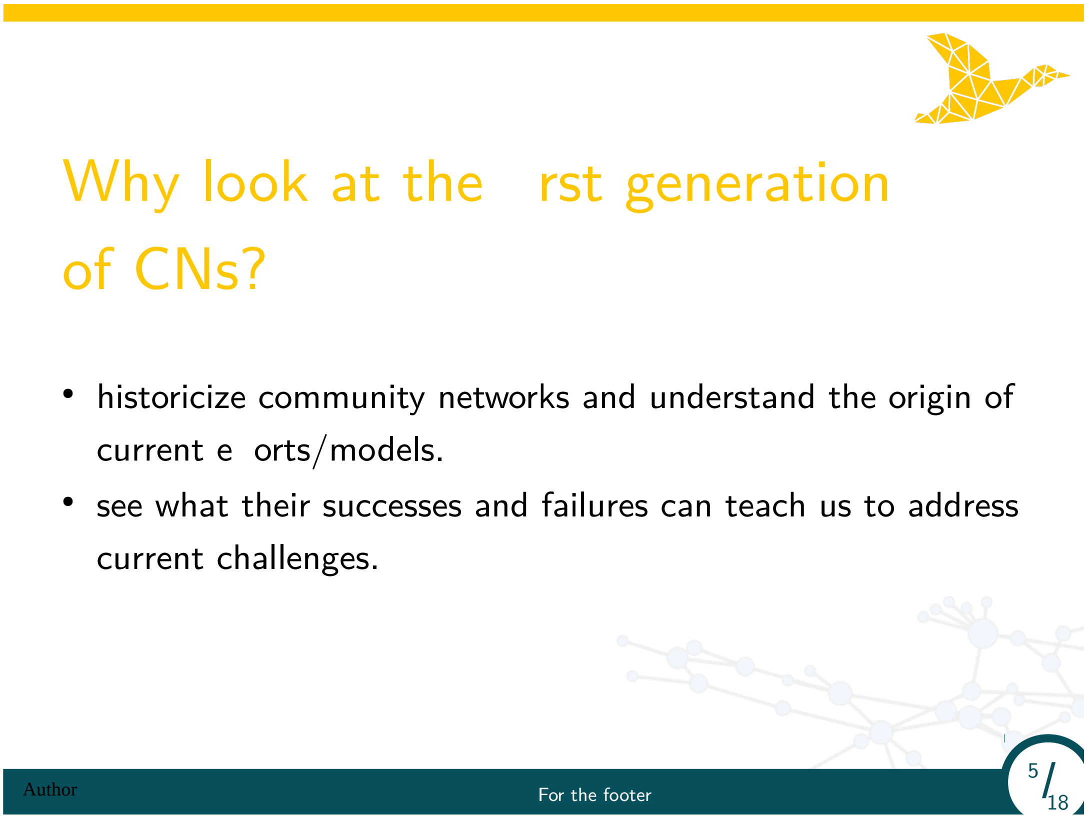
2/18



Author For the footer 3/18

Community	Scale	Commons-based governance	Legal representation	Infrastructure	Economic model	Licensing model
Guifi	21 provinces in Spain, and for instance 41 counties in Catalonia, other countries: Africa 4, America 16, Asia 2, Europe 14	Mixed (decentralized at local level but strong commons-based gov. at level of Guifi.net foundation). Related groups around software, Internet connectivity, contents as commons	Yes (local and national: telecom regulation, agreements with external orgs, tax, clearance of compensations, research, development)	Decentralized optical fibre and WiFi networks, acts as regional IX (private transit providers, mechanism to share and access transit capacity)	Subscriptions, crowd-funding, economic compensation system (importance of professionals)	Community License (FONN), agreements with external orgs, and compensation agreements
FFDN	28 local organizations/1500 subscribers	Decentralized (importance of core volunteers)	Yes (both local and national) + litigation	Decentralized (WiFi) / Centralized (leased ADSL)	Membership fees, subscriptions, donations	Bylaws, internal rules (réglement intérieur), charter of good practices and common commitments
Freifunk	304 local groups	Very decentralized	No (but litigation strategy nevertheless)	Very decentralized (free contribution of WiFi access points)	Volunteer contribution by citizens and professionals	Informal agreement
Ninux	350 nodes	Decentralized (importance of core volunteers)	No recognised legal entity	Decentralized in theory (WiFi), but bottleneck at supernode level	Volunteer contributions	Pico-peering agreement
Sarantaporo	153 nodes	Organization-centered (local support groups, open meetings, participatory design).	Yes (Non-Profit Organization)	Decentralized (WiFi) / Centralized bandwidth provider.	Volunteer contributions, individual donations, collective donations, subscriptions, collaboration with companies.	Informal agreement.

Author For the footer 4/18


Why look at the rst generation of CNs?
• historicize community networks and understand the origin of current e orts/models.
• see what their successes and failures can teach us to address current challenges.
Author
For the footer
5/18


Methodology
• Literature review (limited)
• Interviews
• Digital archives and news coverage
Author
For the footer
6/18

French Data Network (FDN)

- Founded in 1992 in France by a group of computer engineers
- Lease access to landline networks from incumbents
- Bylaws French “association” (non-pro t)
- Members pay a at-rate monthly subscription fee

Author For the footer 7/18

Consume.net

- Founded in 1999 by two designers from London's alternative scene
- WiFi bands to hack the political economy of networks
- No bylaws (voluntary cooperation)
- Free donations in equipment, connectivity and bandwidth

Author For the footer 8/18

Diversity in motivations & ideologies

- FDN founded by privileged men coming from top schools. Initial need is to mutualize cost of Internet connection (politicization comes afterwards).
- Consume emerges from a hacklab, i.e. counter-cultural scene. Incumbents immediately identi ed as an adversary. Thanks to WiFi, Consume is "a techno-social system from the very start" (Medosch, 2014).

Author For the footer 9/18

Author For the footer 10/18

Di erences in techno-legal governance

- FDN leases landline infrastructure (source of weakness)/ at-rate subscription fees
- Consume uses WiFi for building cheap wireless and local network / voluntary donations

Author For the footer 11/18

Author For the footer 12/18

Networking costs and the issue of scale

- FDN: nation-wide e ort to bring scattered geeks to global networks at a reasonable cost / be its own ISP.
- Consume framing local networks as a shared resource of a local community (“right to the city”), with global connectivity framed as a plus (when it is vital in practice). Model of a federation of local CNs emerges from that idea

Author For the footer 13/18

Regulation and the issue of advocacy

- FDN did not truly develop capacities from political advocacy (although it gained expertise in telecom regulation, started responding to consultations, would later become a key stakeholder in French Net neutrality debate). Link to the digital right scene but little e ect for its own regulatory needs.
- Consume proved very good at pitching their idea politically (media coverage). They successfully teamed up with an existing pressure group to oppose BT's attempt to ban free WiFi over the public realm

Author For the footer 14/18

Enduring Legacies

- FDN sparked growing interest around 2011 and mounted a federation aimed at spreading the model (now 28 CNs across the country)
- The Consume experiment ended after 3 years. It was a “proof-of-concept” for local wireless networks that provided the inspiration for Europe's most successful CNs to date

Author For the footer 15/18

Conclusion 1

- Consume was an adversarial, a catch-eye experiment but maybe too loosely organized. It “burned out” after a few years
- FDN was less salient, slow to get to politics, more like an old-style non-pro t, but proved to be more resilient

=> two extremes pointing to middle ground?

Author For the footer 16/18

Conclusion 2

- CNs are heavily dependent on techno-legal regulation - need for organizing to in uence regulatory developments
- importance of alliance with advocacy groups to help them develop policy and legal expertise and the resources to mobilize them

Author For the footer 17/18

Alternative Internet Networks

History and Legacy of a "Crazy Idea"

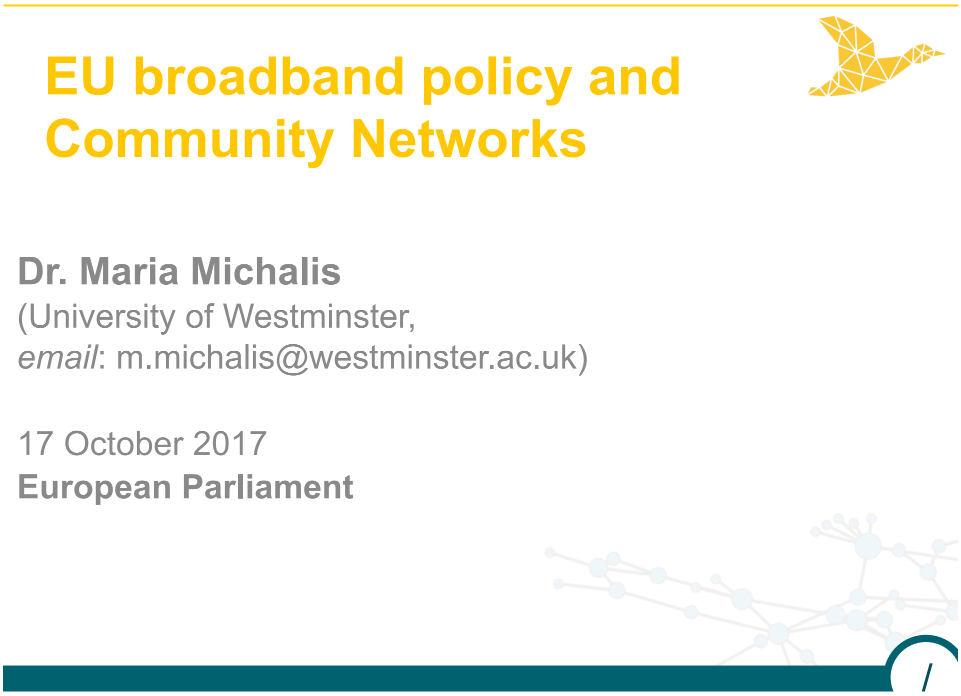
Félix Tréguer, felix.treguer@cnrs.fr

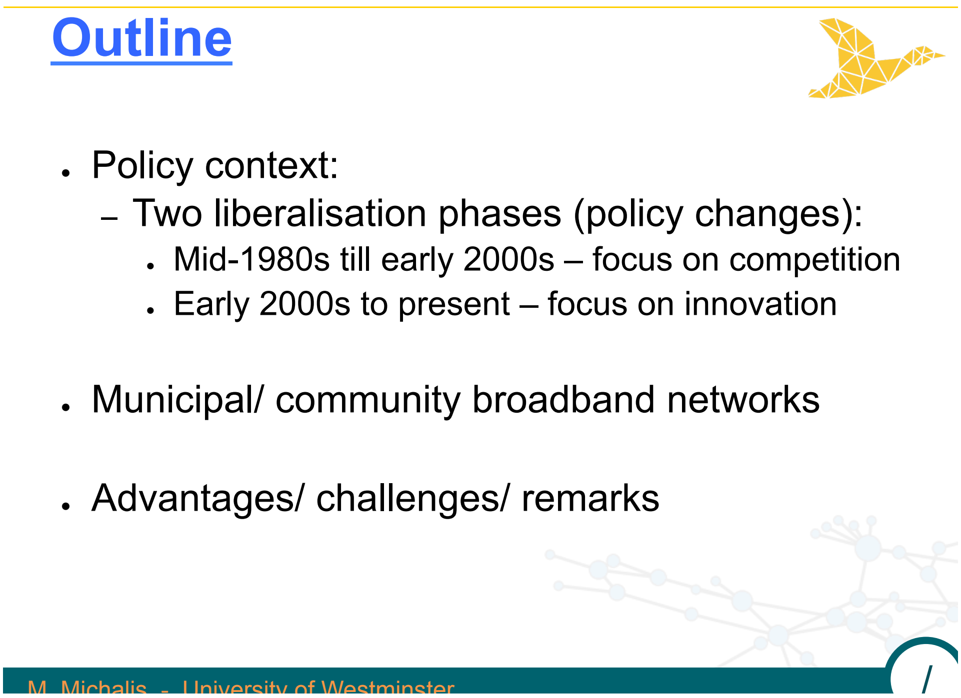
IAMCR2017, Cartagena

netCommons

For the footer 18/18

B.23. EU broadband policy and Community Networks
Reference Deliverable: D6.2 [7]
Intervention ad the EU Parliament, October 2017, presentation by Maria Michalis





1st phase: the market can deliver

- Mid-1980s till early 2000s
- Abolishing monopolies
- Gradual introduction of liberalisation
- Emphasis on competition (Hayek)
  - Dismantling inefficient State monopolies
  - Improve corporate efficiency
  - Big market base
- Investment through private funding and access to capital markets
- 'Retreat' of the State

M. Michalis - University of Westminster

2nd phase: the market fails to deliver

- Early 2000s to present
- Rethinking of policy
  - Technological convergence
  - Commercialisation of the Internet
  - Continuing widening growth, productivity & competitiveness gap (esp. with the USA)
  - Policy of 1st phase hadn't delivered
- Internet reaches high political level, e.g.
  - Lisbon 2000; DAE 2010; Broadband 2020 and 2025 agendas; Connectivity for a European Gigabit Society
- = Broadband Internet is the answer

M. Michalis - University of Westminster

2nd phase (cont'd)

- Some form of public funding, and public intervention more generally, '*is now seen as necessary and appropriate*' (Cave & Martin)
- From Hayekian to Schumpeterian thinking
  - precondition for **innovation** (NGAs) is not competition but rather the right incentives to economic agents
  - inter-firm competition is not a prerequisite but actually large, even monopolistic, companies stand a better chance to promote innovation

M. Michalis - University of Westminster /

2nd phase (cont'd)

- For instance, ETNO's arguments:
  - 'Old rules' (remnant of 1st phase) need to be abolished: network access obligations, price regulation (esp. cost-orientation), and network neutrality rules
  - Solution:
    - Regulatory holidays
    - Market consolidation
    - Policy makers pressured to allow these in the name of innovation

M. Michalis - University of Westminster /

Municipal networks

- Growing explicit recognition of Muni nets
  - *ETNO*: 'local/regional fibre deployment by … municipalities is leading to increasingly competitive and heterogeneous market structures in high-speed broadband access, also with the potential to significantly distort competition in competitive areas'
  - OECD
  - EU
  - Evidence from an increasing number of EU and non-EU countries

M. Michalis - University of Westminster

/

Community networks

- OECD and EU define them narrowly on the basis of their funding
  - *OECD*: gap funding (public financial support likely)
  - *EU*: one of four investment models
    - Investment is the private initiative of citizens
- Gap filling
  - Commercially unattractive areas
  - Minor part of the overall broadband market
  - Access (not backhaul) networks

  Q: Beyond gaps? Principles & values? Can they respect fundamental rights more and promote cohesion?

M. Michalis - University of Westminster

/

CNs - State Aid

- If public funding is involved, it might constitute State aid and might be unlawful
- Some encouraging provisions but have yet to be tested legally
  - '*The roll-out of a broadband network for non-commercial purposes might not constitute State aid'*

  But
  - '*State aid may be used to obtain a more desirable, equitable market outcome*'
  - 'However, if State aid … were to be used in areas where market operators *would normally choose to invest* [or have already], this could significantly undermine the incentives of commercial investors to invest '
- Q: economic sustainability of CNs?

M. Michalis - University of Westminster

/

Remarks (1/2)

- Muni/Community Nets seen as the exception
- Way forward:
  - Beyond gap-filling scenario
  - Public/ Community partnership?

  (observe State Aid rules)
  - Public/ Community/ Private partnership?

  (More likely to be accepted but potential benefits diluted?)
- Challenge: technological and market conditions

M. Michalis - University of Westminster

/

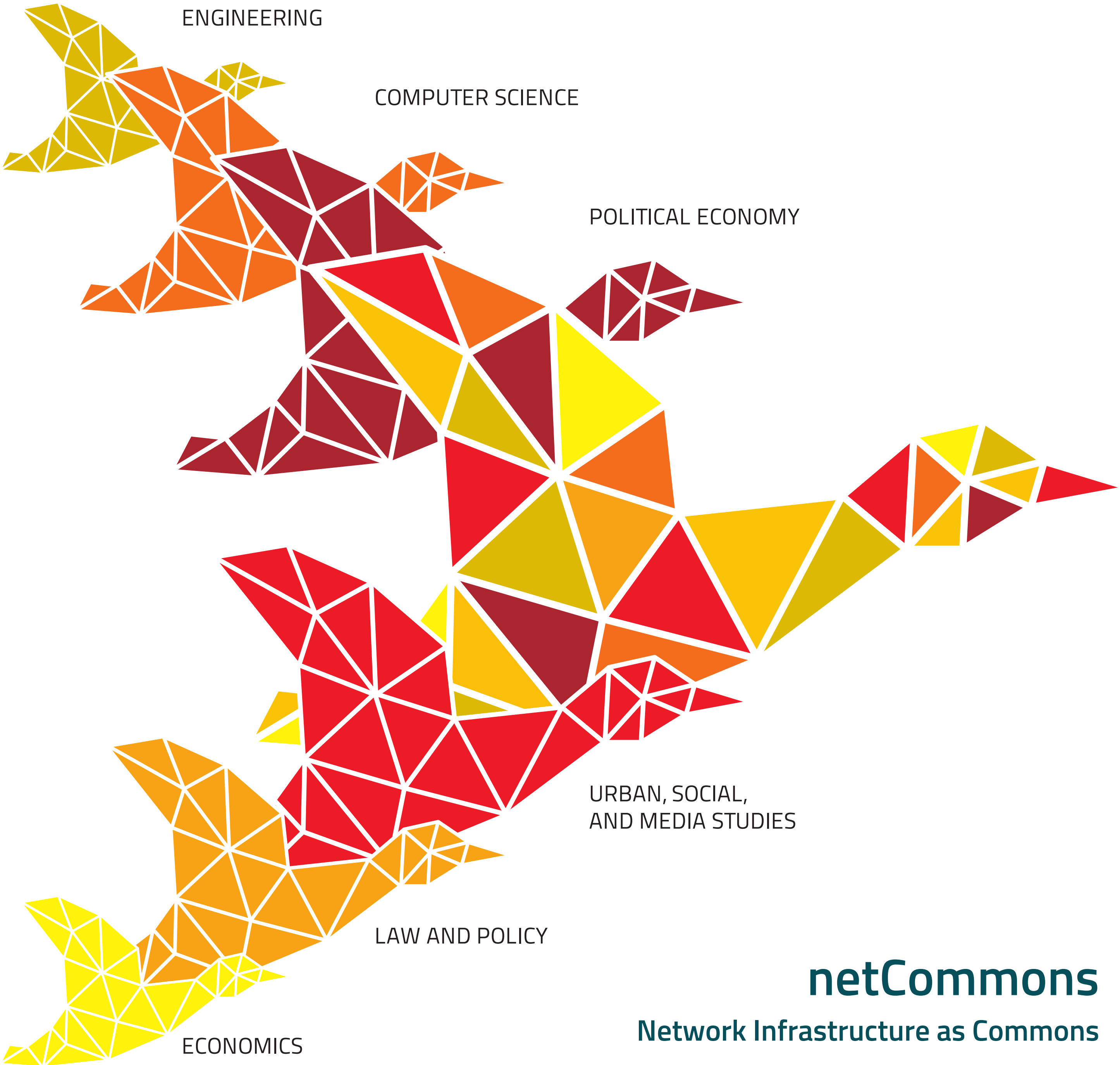
Remarks (2/2)

- Likely reasons for CNs:
  - Need: Gap-filling
  - Open structures
  - Better privacy
  - Autonomy and control
  - Experimentation, playfulness and knowledge transfer
  - Greater (non-economic) societal benefits

/

Thank you !

/



netCommons

Network Infrastructure as Commons

Dissemination Report: Summary of Dissemination Actions and Adoption of netCommons Solutions During the Third Year

Deliverable Number D6.3
Version 2.0
May 14, 2019

Co-Funded by the Horizon 2020 programme of the European Union
Grant Number 688768

netCommons.eu