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Executive Summary

This deliverable conducts a pilot study in order to examine the perceptions of and attitudes towards sustainability of community networks (CNs) held by key actors involved in their creation. It does so by employing the conceptual framework of sustainability developed by Fuchs (D2.1). Indeed, this deliverable should be seen as building on and complementing D2.1, in that it examines the multiple aspects of sustainability in community networks through empirical research.

We examined seven cases of community networks located in the EU, notably in the UK and Greece: Consume.net in East London; Free2Air in East London; Digcoop in East London; B4RN in Lancaster; Kinmuck in Aberdeenshire; I4free network in Trizonia, near Nafpaktos, Greece; and the Sarantaporo network in northern Greece. These community networks were selected using purposive sampling. They represent a reasonable diversity of community networks: some in urban locations, some in rural areas whilst others in quite remote places; some quite small in size, others bigger; some more successful than others; a couple wound down or yet to take off.

For all the cases examined, we relied on semi-structured interviews. For analytical purposes, these were organised on the basis of three broad aspects of sustainability: economic, political, and cultural.

The deliverable discusses the seven selected community networks separately and proceeds to identify some common themes and challenges. Key themes around *economic sustainability* concerned funding and resourcing, the size of the community, and time. Main questions around *political sustainability* touched on organisational and legal issues, and open structures. Finally, core issues around *cultural sustainability* related to the sense of belonging, community identity and spirit and communitarian practices. The narratives provided by our interviewees suggest that their perceptions of sustainability cannot be straightforwardly anchored on a single aspect but, rather, that all three broad dimensions of sustainability examined (economic, political, cultural) are inextricably linked whilst some themes are hard to classify.

We conclude with some thoughts about the contemporary relevance and the future of community networks, as well as a checklist and an evaluation form that communities can use to assess the sustainability aspects of their (planned) network. Given the sustainability challenges that community networks face as well as the evolving technological and market circumstances since many of them started, the logical question which comes to mind is whether community networks should be understood as a response to specific contexts which have now eclipsed and as such these networks are expected to fade away gradually; or, rather, whether there are continuing and perhaps even new reasons behind the conception, launch and development of community networks. These are some of the core questions that the netCommons project as a whole attempts to address. At this stage, we suggest that there still are valid reasons for running community networks, notably the lack of (adequate) Internet access; arguments around open structures, better privacy, autonomy and control; and issues related to experimentation, playfulness and knowledge transfer.

Broader implications of this deliverable for further work in the netCommons project have to do with the challenges related to economic sustainability, the incentives for those involved in them, the need for community building, as well as potential policy and legal issues.

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1 Introduction

The Internet has been conceived as a distributed, decentralized and self-organized network. However, there is a trend for it being transformed to a highly centralized system dominated by the services offered by big private commercial corporations such as Google, Facebook, and Yahoo!, and monitored by intelligence agencies such as the National Security Agency in the USA and the Government Communications Headquarters in Britain (McChesney and Bellamy 2011, Mosco 2009). This trend has important implications for both civil liberties, as it affects privacy, security, freedom of expression, and for economic freedoms, as it creates concentration, walled gardens and unbalanced terms of use.

Various research and activist projects worldwide try to avoid dependencies on such corporations and offer proposals for an alternative Internet, one that would rely on distributed architectures throughout the range from infrastructures to services. Examples include community wireless networks, peer-to-peer applications, and distributed online social networks.

"**Community networks"** is a general term used to denote (mainly) grassroots initiatives to organize in network form for the purposes of communication between the users and/or access to the wider Internet. For analytical purposes, they can be seen as comprising different dimensions:

Technologically, the initiatives are extending the reach of a larger network provider, or providing an alternative network. They are often wireless community network using 802.11a/b/g/n Wi-Fi networking protocols, but other forms of connectivity include Ethernet or satellite links and sometimes optical backbones. Often networks use a combination of technologies to provide coverage to their subscribers. For example, they use either wireless connections between groups of subscribers and then connect homes, offices and shared properties with wired local infrastructures, or wired connections to a number of locations and then wireless access points to provide localised wireless network clouds (Gaved 2011).

Economically, in the ideal scenario, community networks provide freedom of access for all, distribution of costs (for equipment, human resources and other) and not-for-profit operation. However, different economic rationales can be identified in different cases. Bina and Giaglis (2004) differentiate between ad hoc community networks and commercial networks on the basis of their community, as opposed to commercial, business model and identify that in the former cases the motivation is to provide a community service rather than profit making.

Politically, community networks are often governed by horizontal governance and decision-making structures. Most of these networks are grassroots but they vary in size and organizational model and may be organized as social enterprises or similar entities. They are often driven by a social agenda to build stronger community links (Sandvig 2003).

Culturally, community networks intend to address community needs and, to this end, engage in

community building, and provide support and mutual engagement. As a result of this, they are, often, informed by a strong participatory culture and community identity. Community networks exemplify the notion of 'community informatics', which is understood as the application of ICTs to enable community processes and the achievement of computer objectives (Gurstein 2007).

The above dimensions define either an ideal type and suggest a range of possible community networks with philosophies that approximate this ideal type or, at the other end of the spectrum, just provide resources for community use, but are not guided either by the principle of shared ownership or by that of non-profit operation. Indeed, the literature differentiates between common property and common pool resources. The former incorporates the right of a community to own, use and control a resource (Benkler 2006). The latter simply provides common access but not ownership; the common pool resources can be owned (therefore managed and controlled) by local, municipal or central governments, by communal groups, or by private enterprises and access to the resources may be provided on for-profit basis (Hess and Ostrom 2003, Hess and Ostrom 2011).

An extra dimension that can perhaps be added is whether a community network is an urban or a rural initiative. Whilst the first attempts at building community networks in urban areas where normally there is the presence of other access networks, rural networks are normally characterised by being the only access network available (or any case by far the best connectivity option), thus they become prominent features of a rural community, as connectivity differentials between urban centres and remote rural regions remains pronounced. Urban and rural community networks are thus comparable, but not identical: they are both driven by lack of adequate infrastructure, but in rural areas this normally coincides also with low absolute demand and high connectivity prices (Gaved 2011).

1.1 Community Networks and Sustainability

A core issue regarding community networks is the extent to which they can be sustainable over time. The idea of sustainability applied to this context comes with a theoretical baggage from environmental studies, and has been subsequently enriched by perspectives from political economy and sociology.

Often the effects of sustainability are primarily apparent in specific instances of technical enhancements of economic efficiency. These effects are taken as better utilising the resources that are available and consequently generating social welfare benefits. However, the economic and social aspects of sustainability are often conflictual. Quite frequently, what is a goal from the point of view of economic efficiency might function against social welfare and vice versa.

In neoliberal thinking, economic sustainability is often taken to include efficiency as well as value creation, profit or competitive advantage over time. Social sustainability, however, is a more subtle notion. According to the framework put forward by Anand and Sen, social sustainability comprises

the following dimensions regarding life in a social community (Anand and Sen 1994):

Equity - the community provides equitable opportunities and outcomes for all its members, particularly the poorest and most vulnerable ones;

Diversity - the community promotes and encourages diversity;

Interconnectedness and social cohesion - the community provides processes, systems and structures that promote connectedness within and outside the community at the formal, informal and institutional level;

Quality of life - the community ensures that basic needs are met and fosters a good quality of life for all members at the individual, group and community level (e.g. health, housing, education, employment, safety);

Democracy and governance - the community provides democratic processes and open and accountable governance structures;

Maturity - the individual accepts the responsibility of consistent growth and improvement through broader social attributes (e.g. communication styles, behavioural patterns, indirect education and philosophical explorations).

This is just one framework of social sustainability, but it clearly necessitates also a notion of economic sustainability that moves beyond profitability. As social sustainability implies the welfare of the community, as just noted, ensuring the continuation of this welfare in the future (implied in the sustainability idea) requires resources. The availability of them cannot be governed by the notion of profitability (for the simple reason that these resources will need to be in existence even if they are not profitable) (Stiglitz, Sen, and Fitoussi 2009).

Not much has been written on the sustainability of community networks, nor is the notion of sustainability defined in any formal sense. Gaved summarises certain sustainability issues from his studies of community networks in the UK. He links it with the extent to which services of good quality at a reasonable price can be provided, as well as with the issue of financial support and funding. Yet for others, the role of community networks is limited to experimentation and innovation, or provision of services not available from commercial providers at least at the initial stage, without necessarily a concern for the long-term future (Gaved 2011).

Still, there is literature which has identified and addressed the various challenges facing community networks. A major challenge is that of involving communities in the project. As Powell has shown, community network projects ‘create new potential for local community engagement, but they also have a tendency to reinforce geek-publics more than community-publics’ (Powell 2008, p.1). This is a challenge to the potential and effectiveness of community networks for community involvement and promotion of democracy, and a salient issue for our research.

1.2 Aims of the Research

Our aim is to systematise the challenges surrounding community networks by using the language of sustainability. More specifically, in order to understand the multiplicity of sustainability issues involved in such networks, we draw on the perceptions of sustainability of key actors involved in such networks.

In doing so, and to resolve the ambiguities surrounding sustainability as a notion, we use the conceptual framework of sustainability developed by (Fuchs 2010b) in the context of an 'information society for all'. This framework moves beyond the antagonism of economic and social sustainability present in other approaches and promotes the elements of participation and co-operation as prerequisites of economic *a n d* social sustainability. Self-managed ownership, advancement of public goods and distributive justice are considered key features, while 'ecological preservation, human-centred technology, socio-economic equity, political freedom, and cultural wisdom are identified' as additional core elements (Fuchs 2010b, 43). This framework has been further elaborated in deliverable D2.1 and has informed the choice of the semi-structured interview questions (see Appendix 1).

The present deliverable puts the framework of sustainability into practice and uses it as a conceptual tool for collecting relevant data drawing directly upon the lived experience of central actors with pivotal involvement in the selected community networks. At the same time, the deliverable uses the framework as a starting point: the intention is not to test the framework but to use it to arrive at the sustainability issues and the meaning attached to them by the aforementioned actors. The research, therefore, is more of an exploratory, rather than explanatory, nature in that it allows potential non-anticipated views on sustainability as well as not-predicted issues to emerge in the course of the data collection. The overarching aim is to understand how sustainable community networks are whilst enriching the notion of sustainability itself. The next section explains in more detail the methodological choices of the researchers.

1.3 Methodology

The research aims are best served by qualitative, as opposed to quantitative, research methods. These methods better highlight our need to bring out the perspectives of the people interviewed, while they place adequate emphasis on context and process (Gray 2014).

The broader methodological framework adopted is one of a multiple case study. A case study is seen as a suitable method when a contemporary phenomenon is studied in its context, and the boundaries between phenomenon and context are not very clear (Yin 2008). As our purpose is to understand the degree and forms of sustainability of contemporary community networks, the object of study (a community network) is inescapably embedded in its context (a particular community or local

context).

1.3.1 Sampling

Our initial decision was to examine cases of community networks in the UK and Greece. The first reason for selecting the two countries was a practical one, namely that we are both Greek natives residing in the UK; this meant easy access in both physical and linguistic terms, something that is considered an asset for qualitative interviewing. Furthermore,we were interested in the specific telecommunications contexts of the two countries. On the one hand, the UK, where market liberalisation and regulatory reform has been the key development since the 1980s, resulting in what looks like an oligopoly of telecommunication providers in DSL and fibre broadband (where a private BT dominates), cable (mainly Virgin) and satellite, but where remote areas, e.g. in Scotland, are not included in government policy for broadband roll-out. On the other hand, Greece, where again a traditional public monopoly has been converted into an oligopoly defined by the ex-national telecommunications operator OTE (now owned by Deutsche Telekom) and a few other players (e.g. WIND) using the OTE infrastructure for broadband, but also leaving great parts of rural areas in particular uncovered or with very slow Internet access. An additional element has been the explosion of mobile telephony in both countries and the increasing reliance of the population, notably the young, on smartphones for their communication needs.

Lastly, we were interested in the broader socio-economic conditions in the two countries, which though presenting different degrees of development, have pursued economic policies based on austerity measures since 2010 with common outcomes of poverty (sometimes extreme) in certain segments of the population. We anticipated possible interactions between this socio-economic background and the propensity to build and use alternative community networks, as demand for them might be larger but contribution of resources to building and maintaining them might be problematic.

Community networks are neither in abundance nor widely visible. For the reasons mentioned above we tried to include cases of community networks in both urban and rural settings in the UK and Greece. The selection of cases was formulated in tandem with our growing awareness of cases of community networks in the two countries.

We let our research question, namely the perceptions on sustainability of key actors involved in community networks, guide our selection of respondents: in most cases we interviewed the main actor behind the establishment of the community network, or the main network administrator. We thus relied on purposive sampling, i.e. a strategic sampling method which seeks to strike a good correspondence with the research questions (Bryman 2012). Participation in community network meetings (e.g., the May 2016 Battle of Mesh event in Porto) and informal gatherings in the UK and Greece have provided contacts with key community network actors.

The final sample of community networks selected (with certain identified key interviewees) are the following:

- Consume.net in East London (James Stevens)
- Free2Air in East London (Adam Burns)
- Digcoop in East London (Mark Gaved)
- B4RN in Lancaster (Chris Conder)
- Kinmuck in Aberdeenshire (key actor in local technical company)
- I4free network in Trizonia, near Nafpaktos, Greece (key actor TR)
- The Athens Wireless Metropolitan Network (key actor NS)
- The Sarantaporo network in northern Greece (George Klissiaris and Rossie Simeonova)

Most interviewees have been willing that their name be mentioned in this deliverable text and other outputs produced from this research. Two of them preferred to stay anonymous, as indicated in the above list. Informed consent has been asked of and provided by all interviewees before the interviews, providing to them information as to the purposes of the research and the ways in which the data produced will be used. The consent provided conformed to the wish of the respondent to be named or not and to the ethical standards identified in deliverable D7.1. The relevant consent form templates have been included in Appendix 2. The signed consent forms of all the interviewees have been archived at the University of Westminster repository for the project and under the responsibility of Prof Christian Fuchs. The original transcripts of the interviews, where the interviewees are either named or anonymised according to their preference, have been kept separate from this deliverable; they are archived at the University of Westminster and available upon reasonable and justified request. In all cases, personal data of the interviewees (telephone number, email and similar) have been kept private and used only by the researchers for the purpose of communication with them.

1.3.2 Semi-structured interviews

The nature of the study has demanded expert knowledge about how the examined networks operate and are organised, as well as a broader understanding of the use of these networks in the existing communities. In light of this, expert interviews has been seen as an appropriate research tool.

As mentioned above, this research combines explanatory and exploratory elements, in that whilst it has used a conceptual framework (on sustainability) as a starting point, it has remained open towards qualifying and enriching this framework. Semi-structured interviews has been considered the best data collection method for our purposes, as it both accommodates a set of broad, pre-determined (but not rigid) questions, while it also retains a dynamic element of activating questions in a different order. Thus, semi-structured interviews can highlight diverse and often unexpected aspects according to the interests, knowledge of each interviewee and her/his potential contribution to the community network initiative (Silverman 2014, Robson 2011). Still, the choice to conduct semi-structured interviews has ensured that the responses sought for will be ‘standardised’ at least

as far as the basic topics are concerned. This has helped extract many different views on a basic set of questions, while leaving open the possibility of other questions to emerge in the process of interviewing (Gray 2014).

As mentioned, we have deployed the conceptual framework by Christian Fuchs, described in detail in D2.1. This has been operationalised into the semi-structured interview guide presented in Appendix 1). The operationalisation was the result of a brainstorming process involving the members of the University of Westminster team. In this process, and in accordance with the conceptual framework, we identified categories of questions to include in the interview guide, namely questions on perceptions of sustainability in general, as well as more specific aspects of sustainability that touched upon the economy, the politics and the culture of each community network. Economic aspects have included resources and their management, as well as issues of access. Political aspects have involved ownership, governance and data management in each community network. Cultural dimensions have addressed questions of identity and cohesion in the communities of the community network. We have also included legal and policy topics and have generated relevant questions.

Following that, we made the interview guide available to all members of the netCommons project for improvements and contributions and we incorporated the comments received. Most of these had to do with technical aspects of the networks.

Thus, the conceptual framework has guided the interview question categories, we have retained throughout the flexibility to activate the interview guide according to the interview setting and to engage in conversation to ideally elicit the perceptions and in-depth experience of some of those at the heart of the community networks studied, namely the interviewees-actors.

Our intention has been to follow the practice of qualitative researchers, who are guided by an inventory of issues to be covered but, as the interview proceeds, ask follow-up questions or raise additional issues, which are be incorporated in the study findings. The open-ended nature of the interview has engaged us in an iterative process of refinement, as we progressed, whereby lines of thought provided by earlier interviewees have been adopted and presented during later interviews (Bryman 2012).

The iterative process has also let theoretical issues to emerge, not necessarily by generating a new theory (as mentioned, we already have a theoretical departing point), but rather grounding this theory to reality and enrich it through reality, as presented by the subjective viewpoints of the respondents themselves.The interviews have ultimately been of conversational style, where rapport needs to be developed so as to maximize non-biased contribution of data by the interviewees (Silverman 2014).

2 Description of the Cases

Using the semi-structured interview guide developed through the operationalisation process we have carried out the interviews, either in person or on skype, recorded them (adhering to the ethical standards included in the consent forms) and transcribed them. We have subsequently engaged in qualitative analysis of the data, identifying the dominant themes, keeping track of similarities and differences in the accounts of the interviewees, and referring back to the conceptual framework and the interview guide itself.

In the process, we have presented each community network case by describing the origins and character behind the establishment of the community network, and by presenting its economic, political and cultural aspects, as understood and communicated by our interviewee in each case, relating these perceptions to the overarching issue of sustainability. We have respected differences, but have kept the overall categories of origins, economy, politics, and culture for reasons of consistency in analysis and presentation of the cases. We have also decided not to focus on technical aspects of the networks, as these are most covered in other deliverables, but also due to the fact that we have not had consistent technical data for all the community networks examined.

In sections 2.1-2.8 we provide the description of each case through a narrative based on the information provided by the key actor-interviewee, whether anonymised or not. Each narrative has been communicated back to the relevant interviewee to check for possible inaccuracies or misrepresentations of the data they provided in the interview. Following thus the practice of 'member checking' (Bryman 2012, Gray 2014) we have attempted to minimise researcher bias. All interviewees have provided their agreement that the data presented are both accurate and reflect their intention.

2.1 Consume.net

2.1.1 Origins and Character

Consume.net is considered an emblematic organisation for community networks, as it has developed a philosophy around wireless community network organization.

Its seeds have originated in the early activities of James Stevens and Julian Priest who were active in network technology since the beginning of the 1990s. James Stevens started web design boutique Obsolete in London Bridge, where he was originally engaged with a number of artists and musicians. He experimented with network technology of the time to provide shared network resources. Obsolete owned a fibre connection and they distributed access to others around the building with wires in the period 1995-1997. When Obsolete dissolved these resources became

responsibility of Lateral.net. Backspace continued to use the connection until end of 1999 when everyone in the building was forced out.

Subsequently, Stevens was involved in Backspace, established in 1996, a purely social creative space where subscribers could construct and publish their web material, and which could also be used for video distribution and live streaming also. Backspace provided an environment for training, whilst it further enhanced involvement with other communities and local networks through to 2000. This early hub of artists and technologists (about 100 people around 1999) further pushed experimentation with network technologies. Using a commercial ISP supply internet gateway over fibre, Stevens and his colleagues needed (in 1998) to extend fibre communication across buildings; at that point they realised that passing a fibre/wire was not permitted by the existing legal framework and that an expensive license was required. As a result, they added a wireless link between buildings in Clink street SE1 and built expertise on network peering and relevant technological and legal issues, which led to the philosophy for Consume.

> "*We had uncovered a ridiculous state of affairs of monopolistic construction of legislation and business protecting certain interests, mainly BT; there were a lot of stakeholder interests to be protected, including those of government officials. There was all this anti-competitive legislation to protect business interests. We allowed this problem to shape our activities from that point on*." (James Stevens, interview, 30 September 2016).

Consume.net, which followed, was a group of enthusiasts and engineers intent on exploring a network 'strategy' written by James Stevens and Julian Priest in spring 2000. They built the first national mapping system to demonstrate the extent of interest and activity. Several very busy mailing lists were set up to accommodate the varied discussion. It was a community of geeks, whose energy dissipated into regional projects by 2004.

At a later stage, in 2001, a mesh wireless network developed, which included Deckspace in Greenwich, and a number of organisation in Deptford, including Creekside discovery Centre and APT (artist in perpetuity trust), as well as Stevens's home; all were connected through radio links set up on roofs. Subsequently, the social enterprise Boundless was initiated (2004-2007) in response to a local feasibility study which Consume co-ordinated that was funded by Lewisham council. The most recent community network set up by Stevens is the OWN open wireless network (2008 onwards). It is a group of individuals at home or at work with commitment to share broadband internet access via a set of off-the-shelf wireless routers.

2.1.2 Economy

The provision of the necessary economic resources, at the early stages of Consume was by the key actors and administrators involved in the network, notably James Stevens and Julian Priest themselves.

Obtaining income from the community of users was not considered, while suggestions of formalisation of Consume from the wider group of administrators and technologists involved was resisted. One the one hand, they wanted to avoid the risk that funding by an organization might compromise their objectives according to the business or political interests of the funders, or might result in possible legal challenges. On the other hand, they identified the need for some funding, but it was not clear how to bring these issues together.

In early and later initiatives of Consume members, the necessary resources involved equipment, including routers, antennae and various other components of telecommunications infrastructure. Upgrade and maintenance needs were evident and were very costly. Time investment was also a central pillar in sustainability. The existence and expansion of the network involved a great degree of personal involvement by a very small number of central actors. This was most certainly the case for the Boundless coop phase 2004-2007 and with OWN from 2008 onwards. Some support was received from Boundless but it turned out to be minimal.

> "*We need communication resources…quality access to internet gateways at reasonable costs so that resources can be shared and development and utilisations can flourish. Cooperating to cover financial overheads and sharing the workload are vital. We needed more time for ourselves and to push on with the vital experiments to best illustrate the extended uses of these community network beyond the basic task of routing to the commercial Internet… i.e. local services for local people and for those visiting*" (James Stevens, interview, 30 September 2016).

Working with people with limited and varied incomes, Stevens claims, has made it hard to imagine how to hold attention and faith of those peers once money is introduced to the equation other than for capital costs. "Our arrangement with collaborators is that they own everything and we support their use and integration. If they want to buy from us we will make a modest surcharge to cover our costs. However we don't charge otherwise for any services related to network infrastructure" (James Stevens, interview, 30 September 2016).

Not asking for payment means that people cannot be rewarded for their hard work, something that "is desirable but fraught with interpersonal anxiety". Still, users "should be able to offer personal reward in terms of cake and beer for work done. A gift economy can be sustained better than cash. The rule is collaboration, not service delivery… that's the hard unforgiving road" (James Stevens, interview, 30 September 2016).

2.1.3 Politics

> "*Consume was a network as much as a recipe of how to build wireless community networks. Our objective was always to bypass the BT exchange, the commercial infrastructure and connect, say, two buildings directly. We were at the time restricted by the speed of the modem. But when we realised that we could connect with radio at much faster speed it became clear to us that bypassing the commercial route was possible. We communicated this*

> *idea with Julian Priest and other friends got excited and involved. The exciting proposition was that the expansion of the network was dependent on the willingness of users to connect and create new nodes. This was an extremely powerful idea and prospect"* (James Stevens, interview, 30 September 2016).

The philosophy of Consume was that a wireless community network could be built by linking individual nodes, owned and maintained locally, in a decentralised topology. The nodes were configured using ad-hoc mesh network routing protocols in a way that they would link up with other nodes and carry data regardless where it came and where it went. Some of those nodes were gateways to the Internet, and in this way Internet access was available to everybody else on the wireless network. The underlying idea was that of a self-organised node: there existed a website where node owners could enter their node and some additional information, all of which resulted in a map. In parallel, one could encounter an early concept of net neutrality, as far as indiscriminate traffic was concerned.

A core idea in Consume is one of decentralised ownership: "T*he peers own the network…we direct the dialogue and introduce objectives in collaboration with one another. Very few if any rules… proximity, persistence and pleasure*". This was coupled with openness: "*Speaking in public is the default, connecting the networks has to be done in the knowledge that it's a public space. We run an open wireless network. so no passwords for access but encrypted tunnels between network nodes and internet gateways. If this is a concern or messages need security then it's the responsibility of each individual to guard against intrusion and practice effective methods. Those who wish to communicate in secret will always find a way of achieving this goal. Once through the gateway we have no control anyway*" (James Stevens, interview, 30 September 2016).

In terms of decision-making, technological decisions, e.g. routing protocols or standards, were taken by small core team, notably James Stevens and Julian Priest. Key members of Consume were also active in promoting an alternative political agenda. "*At the same time we were trying to get involved in policy discussions about the possibilities of having community networks; some of this was transferred through John Wilson, who established a Welsh part of Consume, as high as the Welsh Assembly*" (James Stevens, interview, 30 September 2016).

They also had an increasing media presence and meetings with the radio authorities, which Stevens recalls:

> "*In a 2000 meeting with them we announced our intention, namely to short-circuit the commercial loop. They had not anticipated that somebody would come and make such suggestions within the legal framework. Our ambition was to short-circuit the whole of UK's telecomm economy! We were unbridled in our ambition to be disruptive"* (James Stevens, interview, 30 September 2016).

These attempts involved intensive and persistent, though not always effective, activism:

> "*Some of our earliest work in 2002 was to campaign that the 'not by way of business' clause*

> *be retained in the wording of the 'light licensing' legislation for 2.4GHz. BT lobbied government on the basis that without license to trade in the frequency would hold back Britain's digital economy. Later we campaigned with a lot of industry people for access to the UHF frequencies at the analogue TV turn off – the digital dividend was instead auctioned to commercial interests! Ratification of 5GHz use took place during the transition of the then Radio Authority to Ofcom and sanctioned further exploitation of public bands for business purposes. The effect has been to push community networks out of the picture in most situations…the cash has almost all gone to the mobile telecom industry in the UK and elsewhere; I mean, our cash has left the local economies rather than being recirculated locally*" (James Stevens, interview, 30 September 2016).

2.1.4 Culture

Consume was driven by a strong culture of experimentation and learning-by-doing. "*We had to put up the equipment properly; we had to make all the antennae installations work… without any guidelines. We always had to buy and try new stuff*" (James Stevens, interview, 30 September 2016).

When the network moved in the Deptford area, a more formal organisational structure established, which made practices less experimental. Numerous meeting were taking place, both decision-making and educational ones (workshops for installation), but not many people were involved. The growth of the network was also facilitated through mailing lists.

> "*The Boundless co-op brought members of the local community together in meetings to discuss and agree upon principals for starting a social enterprise to expand on the Consume objectives for locally owned and operated community wireless network. It was based in Deptford and we ran weekly workshops in an incubator space in central Deptford. It grew to 40 network nodes running Locustworld AODV meshing system…the hardware was nearly all recycled PC hardware – this being a prime preoccupation at the time*" (James Stevens, interview, 30 September 2016).

For Stevens, this was the beginning of a recognisable community net. However, many people got involved in the Deptford community network because they thought they could get 'free' internet. They did not understand that 'free' would mean 'open'. And that they would need to take on responsibility for installation and maintenance i.e. learn much more about the technological overhead.

> "*Our most recent community network (since 2008) is OWN open wireless network. It is a group of individuals at home or at work with commitment to share broadband internet access via a set of off-the-shelf wireless routers. We took this path rather than to continue along the fully DIY home-built router endeavour (Guifi and Freifunk) to allow those we hoped would adopt and collaborate the option of doing so more independently of us as key advocates. The Open mesh firm (http://open-mesh.com) supplied supplied equipment direct to users*" (James Stevens, interview, 30 September 2016).

Stevens was paying for the service to an Internet provider, he was the gateway; the idea was to wet the appetite of the other members for a service of their own. In case the network was not sustainable, which was often the case because of technological reasons or lack of adequate skills, the users were prepared to pay to keep it running (i.e. get a better connection). They wanted to buy their own connection, and thus improve the viability of the network for others.

Financially, there was reluctance to spend money not knowing what is going to happen. There clearly was a need for understanding of what the benefit of it all might be:

> "*It's always hard to lead on technological initiatives, mitigate local rivalries and convince people to spend their own cash. But that's the only way these projects have any sort of chance to get started, sustain and propagate*" (James Stevens, interview, 30 September 2016).

In the early days, as there was no broadband, users were motivated as they could have a very fast link for email or file transfer between them, though they had to face the bottleneck of the Internet via modems which was still very slow. But gradually the problem of persuading people to participate in the first place became larger. Later technological developments affected the sustainability of community networks:

> "*Where people could switch to DSL, they did. And as technology progressed to the emergence of mobile phone/ smartphone the landscape of wireless community networks was transformed completely as needs have changed and can be probably met in better ways, with better quality of service, stronger signal, and more applications. Technological developments contributed to make the 'free connection' element difficult to argue. They could not see the benefit, they could not see why the self-provision of networking was better rather than paying monthly*" (James Stevens, interview, 30 September 2016).

In the light of the above, the most important aspect of sustainability "*has to be identify shared goals for your collaboration and remain adaptive and interested in the opinions and ideas of those about you. Remain positive despite the inevitable difficulties and detractors*". However, "*we invest in internet ideals but cannot escape the reality and responsibility associated with participating in the longer term. So tactics and techniques need to be explored, tested and practiced publicly*". Sustainability is crucially dependent on social networks and relationships: "*One cannot rely on people on the other end to do everything*". At the same time, not many people think along the lines "*there'll be a social benefit even if there's no financial return*" (James Stevens, interview, 30 September 2016).

2.2 Free2Air

2.2.1 Origins and Character

Free2Air offers an alternative network to commercial Internet provision. A small number of actors, such as artists of AmbientTV.net, Mute magazine and a number of other individuals and groups developed the project of building a wireless backbone for the East End. A central figure is Adam Burns, whose background is in the IT industry, specialising in IT security.

It is part of a broader Free2Air group (an incorporated legal company), which involved a collective of wireless networking enthusiasts spread across the world, including the USA, Australia and Germany. There were interesting links between Berlin and London, in the sense that a lot of people from London met in Berlin in meetings that involved a lot of early standards on the later Freifunk network. This movement included some American people and the idea was for wireless community networks to discuss ways to link with each other and share stories in terms of different environments and demographics. Adam Burns has relocated to Berlin, but the network still exists, albeit in a more fragmented form.

The architecture of the network is based on wired islands connected by a wireless backbone; a wireless connection to each building and then Ethernet wired connections to individual users in the building. It deploys 802.11b/g wireless networking equipment, which presents certain reach limitations, as it has a maximum range and is line-of-sight. Apparently, the necessary geographical proximity has also functioned as a cohesive factor on the membership of the network initiative. Many of the users are in the same social milieu, related to the creative industries and have relevant businesses. The outcome has been an active intranet, with users hosting servers and adding their own content (Gaved 2011).

2.2.2 Economy

Economic resources were provided in essence by a small group of 3-5 people (including Burns himself) and then there were also people providing singular services in the area. All started working together, assisting each other through sharing expertise in technical network routing, planning and other tasks.

The economic model of the community network was based on offering free connectivity and local services to most of the users, but at the same time encouraging users (e.g. a local Internet café) to become subscribers and provide a contribution, which, however, was more of the nature of “pay what you can”. The estimate is that there were round 30-50 subscribers on that basis and this provided some resources to the network. In addition, certain people in the community offered to share own resources, such as their large-scale photo printer or other services.

In that way, most of the time Free2air varied between making a small loss and recovering its costs.

However, for Burns “*the economic side is not necessarily the most important aspect of*

sustainability; it is the social aspects that matters most". The presence of a significant social element provided "*13-14 years of operational stability*" and most importantly "*a great degree of satisfaction having an experimental laboratory and people willing to explore and extend it*" (Adam Burns, interview, 10 November 2016).

The outcome has been an active intranet, with users hosting servers and adding their own content (Gaved 2011).

2.2.3 Politics

Adam Burns sees Free2Air as very much a political project and an attempt to put into practice ideas about control and ownership of personal communication, as well as the possibilities of strengthening local community through technology.

> "*There were a number of purposes behind the start of this network. My first motivation was play and exploration with the technology. Having had a background in early ISPs, I was interested in this as a direct communication technology. This brings me to my second motivation, which was a very political one. This was along the lines of de-mediating your communication and take back control and understand your own communication needs.*" (Adam Burns, interview, 10 November 2016).

Burns's political activity has included participation in debates on governance, legal and policy issues related to the idea of the commons, alternative organisation and autonomy of communication. In 2004 he co-authored a paper, called *Network Commons*, which outlined that community wireless on Wi-Fi was only one section of what was needed to take back creative and managerial control of personal and community communications. Exploration of these ideas has been carried out through cross-fertilisation and collaboration with the activities of other networks, such as Consume, as well as with individuals such as Armin Medosch, a member of Free2Air active in writing about and practising community networks (Medosch 2015).

An organisational idea behind the network was active ownership of resources. Active network management of resources was encouraged. More specifically, there were links that enabled anybody to see the actual network use by other users in real time. This proved quite successful in the sense that users could email each other and notify a user that might be over-using bandwidth. Open source management tools, such as the ntop project (http://www.ntop.org) were utilised and available in a web page.

It should be stressed that this monitoring of bandwidth usage was done only by the users of the network and was not accessible to the Internet. When it comes to data privacy, users gradually understood the value of encryption through transfer of local knowledge between artists and other users on the issue of encryption and managing visibility. For example, it was understood that information sent unencrypted would be visible on the Internet. There was identifiable information coming through the network central nodes, of course, but it was transient and not stored on any central computer.

Ownership of resources was important because it helped people understand the nature of trust in community networks. The Picopeering agreement was a relevant document, co-authored by Burns, which standardised expectations about interaction between peers in community networks. It involved the idea that owners of network nodes would be willing to allow free exchange of data and free transit through their network or node and that they would not interfere with the content passing through. (http://picopeer.net).

2.2.4 Culture

Connectivity was just one issue. Free2air was also an attempt to re-introduce the social aspects of neighbourhood communication.

> "*There was a considerable amount of social fabric there. There was an interesting mix of people in the community. There seemed to be a convergence of interests between a reasonable number of technically adept people, but it also seemed to capture the interests of a lot of artists, primarily because there was a number of artists' studios in the area, who, due to the industrial buildings and the landscape of the East End at the time could not get Internet access. They would use the network to promote their professional activities. This mixture of technologists and artists, including radio artists, Internet TV, performance artists etc. would push experimentation and discovery of new uses of technology.*" (Adam Burns, interview, 10 November 2016).

There was also a large number of end users' who used the network as a local community-run ISP. These tended to be less technically competent and needed some degree of support depending on their knowledge level. This was provided by local experts for each wired island (Gaved 2011).

There was a collaborative culture of creative ideas as to what could be possible using this technology. An example was an interesting experiment of a temporary FM radio, which a community wireless network linked to a user centre that was acting as a studio. It was a collaboration between radio enthusiasts who established the FM station with a temporary license, and technology enthusiasts who were interested in expanding the link between the studio and the FM radio transmitter. There was a lot of interest in being a radio DJ in the studio. Other examples included live streaming video of artists and generally all sorts of mixed media art. It was quite a dense urban area bringing together people interested in technology and those interested in the creative arts.

This culture of collaboration and experimentation was articulated with the use of the technology. A multimedia server allowed streaming audio and video. There were services, such as VoIP running over the network, and the idea was that more localised services would enable users to communicate outside of the Internet (e.g. not using Messenger for communication). There was a lot of experimentation going on to extend this communication network in interesting ways.

For Burns, "*sustainability was about maintaining the social elements.*" Public events were

organised to promote involvement. People were encouraged to meet at local workshops on antenna-building, on wireless networks, or on how to recycle computer devices and reuse them. Users were also involved in carrying out surveys to expand the network.

> "*At some point we persuaded a rector to install an antenna in his church spire. This was interesting if you compare it to the fact that other churches bore the masts of major telecomm operators.*" (Adam Burns, interview, 10 November 2016).

Clearly, people involvement was essential for sustainability. The network needed human attention and care. Having said that, it was evident that some of the people had to put much more effort than others.

2.3 Digcoop

2.3.1 Origins and Character

Digcoop was a community network in Hackney, East London. It had a ten-year active life: it became established in 2001 but in 2011 it wound down to a very small operation. The network connected around 40-50 people (29 properties) living in a housing cooperative that spread over two parallel streets in the area.

2.3.2 Economy

Digcoop was a network to connect together people living in a housing cooperative. There was a group of people who used to squat illegally in approximately 30 properties in two parallel streets in Hackney, in East London. The Council wished to get everybody out. In response, the occupants developed a regeneration plan and formed a housing cooperative to manage it. Mark Gaved moved in at the time the housing cooperative was being established. There was a lot of vitality and interest in community processes.

The community network was originally conceived in direct response to the formation of the cooperative. It was envisaged that such a network would service the internal communication needs of the community as well as support the work of the housing association.

At the time, he was working as a researcher in a Higher Education Institution. He had an interest in networks. There was a requirement in the housing cooperative to put in what was called 'sweat equity' which meant that to help finance the housing cooperative project, the members had to agree to put in certain amount of hours working. He had come across some projects in other areas (e.g. Manchester) about people overcoming lack of access to the Internet by building their own community networks. Since he was interested in networking, he made a proposal to the housing cooperative that they built their own network and suggested that he would lead this initiative.

At the time (2001), it was expensive to get unlimited Internet broadband access in many places in

London. Hence, he proposed that that would be a useful utility for them. A community network could be cheaper and thus more affordable to the members of the housing cooperative. Most of its members were "*single people and couples aged between 25 and 45, with some small children*" and many of the occupants were in self-employment and using computers for their work, thus the idea of sharing the cost of Internet access appealed to them (Gaved, 2011, p. 195-196).

Mark Gaved also suggested that, in addition to the cost advantage, there might be more benefits if the community itself was to provide and run their own networking facilities. He had been thinking of the benefits he had seen that Universities had from their own networks (and prior examples of community networks such as the Manchester example); and these reflected some of the emerging concerns developing in the housing cooperative about their own information sharing needs. . In particular, there was an interest, first, in not simply accessing the Internet (this was a dominant concern in 2001) but, second and importantly, in how they might share resources as a community (information, and awareness of physical resources). Finally, there was a concern to find mechanisms to reduce the bureaucratic overheads of running the housing cooperative. The idea, therefore, of a shared resource which would allow decision-making, managerial tasks to be allocated, voting and these kinds of process activities within the housing cooperative was quite appealing as well as more socially focussed community activities like sharing music, asking for a babysitter, requesting the loan of a tool. In short, there was already a relatively small community (around 40-50 members) with strong ties and they could identify tangible community benefits from having own-provision of their networking infrastructure. The three main benefits were affordable Internet access, sharing of resources, and services tailored to the community needs.

However, initial ambitions and hopes was one thing; what actually happened was another. The community network had a ten-year active life. It started operation in 2001 but it pretty well wound down into a very small operation in 2011. We shall now discuss these initial ambitions and associated benefits.

In 2001, there was interest in Internet connectivity at reasonable speed. The discussion was framed in terms of Internet access, provision and affordability. At the time, the alternative was a telephone connection where consumers would be charged for how many minutes they were on. In other words, the alternative was a slow and expensive dial-up connection. Indicatively, the first connection Digcoop got was costing around 250 GBP per month for 512 Kbit/s. In sharp contrast, today a domestic connection for maybe 10 Gbit/s can cost around 10 GBP a month. For a group of people who were low income the idea of individually gaining relatively fast access to the Internet to use for both business and pleasure was very appealing. The 'Culture' section below discusses the characteristics of the community in more detail.

In terms of resourcing the community network initiative, there was a core group of 3 people who developed the necessary technical knowledge and who effectively took on the job themselves. They proposed it to the housing cooperative that they would run the network, and the general proposal was that they would manage the initial technical implementation without drawing on housing

cooperative financial resources. Once successfully demonstrated, it was proposed the service would be run voluntarily (as a contribution to the community, 'sweat equity') and basic costs would be achieved through a low price subscription model. This small group of people was trusted by the community and were visible within the housing cooperative as the leaders of that service. There was an interesting debate about what kind of service they were offering (see in the 'Culture' Section below). Suffice here to say that informally it was communicated that the network was a community contribution that people could use and that they would do their best to maintain it as a voluntary group but, it was clarified, there had to be no expectations. Service requests for help were addressed through voluntary support help.

Moving to the resourcing of the network, the initial resourcing was through equipment they had gathered themselves through their contacts (they managed to get old computers and donations of equipment) and some they had purchased using their own money to start things going such as cables and tools. The resourcing of the network shows the environmental sustainability side of community networks whereby they re-use as far as possible existing networking equipment. Recycling was partly an approach taken out of financial necessity in this case, but also the members of the housing community had a strong philosophical alignment with the culture of environmental sustainability (e.g. the refurbishment of the houses was undertaken with this in mind) so reuse and refurbishment was a cultural norm that the community network team also adhered to.

The network was conceived and built in 2001 and it was a completely wired network (it later became partly wireless). Wired networks were what the core team knew and that was what they decided to do. Moreover, in 2001 wireless equipment was more expensive and less commonplace. As equipment became more accessible, and their understanding became better, they wanted to move in part to wireless for very practical reasons: they could run wireless across gardens and across streets including one piece of land that they did not own themselves. More specifically, the initial bridging between two blocks of properties was via a wire that ran over land the group did not own: while the tenants of the properties in the middle did not mind this wire, the group were aware of the legal and physical vulnerability of this important connection. They were very keen to avoid any potential legal or neighbourhood issues by using wireless as much as they could. With the introduction of wireless elements, they ended up with three islands of wired networks (in housing blocks) which were wirelessly connected to each other.

It is clear from the discussion here that an element which affects sustainability is relevant technical knowledge. The core technological team of the initiative had to struggle to find enough time to put in the network and at times they felt they did not posses the necessary knowledge to develop certain services. For instance, it would have been great if they could run a music sharing system but none of them knew how to do it and none had the time to learn to do it. In the words of Mark Gaved:

> "*We did what we could and people had to understand we would do what we could.*" (Mark Gaved, interview, 18 November 2016)

To improve their knowledge, the core team relied on the goodwill and support of other community

network organisations and individuals who were generous with sharing their time and knowledge (e.g. Free2Air, Consume etc.).

Getting an ADSL connection was straightforward and easy. They decided to purchase a business connection from British Telecom, the incumbent provider. As a community network in a large city, the telecom provider already provided backhaul to the area. The physical construction of the network was unproblematic and they got many community volunteers.

The resourcing model was linked directly to the community network's operational and funding model. The latter model referred to **volunteers** doing the work whilst the basic cost which they could not get around (the Internet connection) was paid through a subscription model.

Digcoop encountered the usual challenges of volunteer-run organisations. In other words, many of the sustainability issues that community networks face are not unique to community networks but rather they are part and parcel of community-based initiatives in general. The main challenge concerned insufficient volunteer availability and enthusiasm. With the completion of the physical construction of the network, the initial excitement started to subside and there was a challenge of keeping people engaged. It was relatively easy to find people to help with particular one-off tasks like running new wires or new systems but Digcoop struggled with the day-to-day tasks.

It is worth noting here that the pool for volunteers was small. This suggests that the size of the community might play a role in the sustainability of the network. The housing cooperative was a closed community with about 40-50 people. The cooperative was relatively stable in terms of the population. We believe that Gaved's suggestion that there might be an optimal size of neighbourhood for a successful grassroots managed community intranet is relevant more broadly to community network initiatives: a community might be "*too large to generate a sense of community and participation, [and] it may be also true that too small a community will struggle to support a [community network].*" (Gaved 2011, 329).

There was a core of people (three "technology champions" and a further administrative person) who were running Digcoop. They always needed more people than they had. They were aware that they would benefit from having more people working, participating, and carrying out some of the tasks, and they did their best to engage enthusiasm at individual level.

It follows then that the sustainability risk from people moving away from the community is higher in these circumstances, especially if those people are part of the core team responsible for the network. This happened, and led to a struggle to keep the service running.

Added to the small pool of volunteers were the demands on people's time. The time resource is finite. In the case of Digcoop it might be argued that the demands on people's time were more onerous given that the community network was built in response to the needs of a housing cooperative where the members of the community were expected to volunteer for other jobs too such as building maintenance or the administration of the cooperative. Digcoop was in some degree in competition with the other roles and activities people had to undertake within the cooperative.

In addition to voluntary work, a second element relating to resourcing was **subscriptions.** The network worked on a very simple subscription basis. Subscriptions paid for the Internet connection (basic cost) with a small excess which would give the community network team a small reserve to enable the purchase of equipment as and when it needed replacing or upgrading. They were fully aware that one of the prime motivations for most people becoming interested in the network was affordable Internet access and this informed the level of the subscription.

They did a very simple calculation of how much it would cost them for a monthly connection to the Internet (ADSL connection) and that allowed them to divide that by the number of people there were in the housing community and come up with a figure that they felt on reflection would be an acceptable figure. That figure was 6 GBP a month.

Besides voluntary work and subscriptions, a third element concerning resourcing was the gradual opportunity to grow to neighbours who were friends. The expansion of the network to people in the area outside the housing cooperative happened as they started to get enquiries from people who were not part of the cooperative but wished to join the network because they saw it as of value, financially cheap and also providing a quality service. That development raised technical and theoretical questions around what could those people access because until that point everybody who had been members/ subscribers to the network and had been using the services were within the housing cooperative so they could share all documents and they could have an open intranet. With the expansion of the service to users outside the housing cooperative, they had to consider what it would mean for people who could connect through them, could take part in social conversations in the intranet and share social resources, but should not have access to the housing cooperative business and organisational documents that were held on the intranet. So that required some organisation of the documents (‘what services could be seen by what people’).

The people outside the housing cooperative would pay the same subscription price. Where possible the group encouraged people to do direct debit into the bank account or they would go around and knock on doors to collect the money. It was a small enough community; they could manage to do that individually. This funding and operational model worked in the long run. The network would break even. The operational model, and in particular the small overhead, allowed them to gradually built a small reserve which they subsequently used to purchase antennas and other equipment when they moved to wireless.

However, external sustainability factors can affect a community network (the 'Culture' section below discusses some main internal community sustainability factors). The most prominent of these external factors concern broader technological and market changes. In the case of Digcoop, an important external sustainability challenge was the change in the pricing model of the Internet. In 2001, when Digcoop started, an ADSL connection was over 200 GBP and subscribers had to pay 5.00 GBP per month. By around 2010, the price differential had reduced. Gradually the price from commercial providers would get lower and that was a competition factor that threatened the sustainability of the community network.

2.3.3 Politics

The organisational aspects of this community network were very informal. Out of the 40-50 people living in the housing cooperative, there was a core group of three people leading the community network initiative. It was very much a self-policed process. The core group would make the decisions and would do the core maintenance, and there were some other people who took an active role in maintenance. At various points during the building and construction phases of the network other people would come in (e.g. for running cables along roofs and at height, the group was able to call on housing cooperative members who were experienced in building trades and were competent at working at height installing services). Finally, the group had a reporting role to the housing cooperative group itself.

The 'Culture' section below explains the different levels of engagement. In the rest of this section, we shall discuss some issues that relate to the provision of services and traffic management.

Once the network was put into operation and the community had Internet connectivity, the discussion quickly moved to services. There were debates about different services which might be set up and might be used. Also, they had to carry out some mediation of traffic control, and go through a sort of process deciding how to manage requirements on the network. The challenge they had to start with was that 2-3 people were using shared music Internet services which nearly killed the network. They had to respond to that to ensure quality of service equitably to all people in the community, using both social and technical responses.

The core team took the diplomatic and technical approach and asked the community members to consider their responsibilities. At the same time, they also recognised the lack of technical expertise and that the music sharing use of a few members was not necessarily malevolent action. They had to come up with a process for warning repeat offenders, and they engaged in bandwidth monitoring and network load management.

Bandwidth monitoring and network load management were not straightforward. Initially the core team did not have any data on traffic but were helped by another community network to set up and run suitable services. When the Digcoop service started, there were no intranet services so no data were held within the system; it was just shared Internet access. As time went on, the group started to host intranet servers and holding some data. Because everybody was a member of the housing cooperative they all had rights to the archives of the association so there was no issue about data storing and in fact there was a request (one of the positive service requests) about sharing cooperative data and knowledge (what had happened in meetings, what decisions were being made about future building projects etc.) and this became a challenge when they had members of the network who were not members of the housing cooperative. They had to think about data access and ensuring that there were private "housing cooperative members-only" areas.

In terms of personal data storage there were chat spaces within the community network to which everybody had access. They did not go as far as offering a document repository of private data for

users (this was initially explored and preliminary services set up, e.g. to enable local sharing of music files to overcome the bandwidth issue that had become a problem, but with network management, this became less of an issue and, apart from this specific case, no great demand was identified). The only documents that were being stored were housing cooperative documents and shared chat spaces/ forums. In the words of Mark Gaved:

> "*People wanted to share and they wanted to just share within the community in a trusted space.*" (Interview, 18 November 2016)

It is worth noting here that the network was put into operation 15 years ago (in 2001) and at that time there was less awareness of data security issues.

2.3.4 Culture

The initiative was a spin-off of the formation of the housing cooperative whose aim was to redevelop the properties occupied and thus regenerate the area. The network was originally confined to the members of the housing cooperative (40-50 people). The small number of members made the internal links among them quite strong. Community ethos and spirit were well established and it was relatively easy to build on them to form the community network. In turn, as is the case with other community networks examined here, the very process of planning and building and later the use of the community network served to strengthen community ties further.

There was a strong community identity too. It was a relatively small group of people who had already identified as a community. It was an elective community and the majority of people had already been living as a community voluntarily in the properties which were illegally occupied. They worked very hard together to find funding to be able to take ownership of their own properties and refurbish them. There was therefore a strong community spirit together with a lot of energy and enthusiasm around community-based actions and community-sharing. That group of people self-identified as a community and self-identified in a communitarian approach to living and operating.

It is worth noting here that the cohesion of the community can impact upon a community network. In the case of Digcoop there were some internal tensions. On the one hand, there were those in the core network team who wanted "the housing association to adopt the intranet as its primary means of communication" and, on the other hand. there were reservations from some representatives of the housing cooperative. (Gaved 2011, 326-327).

There were a variety of reasons why people were interested in having Internet access. To begin with, in this small and tightly-knit community, there was an interest in how a digital system could help share physical resources (e.g. babysitting, calls to action "I'm going on holiday – can somebody lent me a tent?", a noticeboard which would allow people to post messages to request help with resources etc.). These were the kinds of things people were interested in, in particular a local network which would allow them to extend what they were capable of doing. They were generally younger people in the community who had been living in quite uncertain conditions so the

idea of portability about resources (a sharing culture) was something they were already in tune with. Moreover, people were fed up with the level of bureaucracy that was required to continue to run a housing cooperative and were curious as to whether a networked set of tools would lighten the load and make life easier (e.g. advance notification of meetings, being able to vote on decisions without having to attend, being able to catch up with what had happened, being able to use a document repository to find about what had happened etc.).

Second, in addition to the internal needs of the housing cooperative, there were other reasons why people were interested in having Internet access. These included, for instance, personal needs such as study, personal communication or work.

Third, there was interest in people using Internet access for external purposes. This actually became a technical issue in terms of offering reliability and maintaining quality of service as well as an identity issue ("what was the purpose of community network?"). Two examples are worth mentioning here.

The first example concerns the discussion which arose when community members had to relocate while the houses were being refurbished during the regeneration process and some other members moved away to another town and there was interest to explore whether an Internet connection would allow them to access the intranet and be able to still be a virtual member of the physical community. Those who moved out were self-identified and identified by the people still living in the community as being part of the "family", part of the community so there was a real interest for both sides in letting people know what was happening socially and culturally, in enabling those people to still participate. One of the aims of the community network then was to help engage community members in participation.

As a second example, some people were studying online and planned to hand in online assessments to their University. They needed to make sure that their assignments got in in order that they met the set deadline and there was a big debate about whether people could rely on the community network to do this. In short, using Internet access for external purposes led to a discussion about what they were actually offering. There was a big debate about what they were, the identity and purpose of the community network: were they a community resource that had to be treated as a voluntary organisation with the associated limitations or were they perceived as a service which had to match commercial Internet provision in terms of reliability and quality of service?

The core network team ended up having to make a statement along the following lines "*you must recognise that that is a voluntary service and we'll do our best to provide a good service but do not rely on us for your work.*" They found themselves being an enthusiastic community organisation which had to start moving into considering legal language or certain clarification of their offering.

Turning now to engagement, there were various levels of community engagement. The community understood that physical effort was required to build the initial wired network and they got a lot of support. The members of the community were very practical; they were people who squatted and

were used to practical hands-on work. They were very happy to be guided by the core team and carry out jobs such as running connections from house to house.

Upon the completion of the network, they had a volunteer in each one of the three blocks of housing who would take on a local responsibility for maintaining their own Internet router that serviced their block and do the front line help.

The community network was seen as a service that was about providing foremost Internet connectivity. Requests for help and support would be around not having connectivity. There was an informal sharing of responding to calls. The network run a self-diagnostic system enabling people to self-diagnose connectivity to the Internet and the intranet on the basis of just a traffic light system, thus when people phoned them up they would get a sense of what the problem was in the network.

In terms of service provision, there were many enthusiastic ideas at the beginning. They implemented some but not many were taken up. The services provided were community-centred such as forums, shared conversation spaces, and a repository for community related documents.

The discussion in this section indicates that the purpose of the network can be another factor which might affect sustainability. This refers to issues of perception (how the network is perceived by the community members) and the service it provides. There was a lot of excitement and ideas originally to develop and run services on the intranet. For instance, the core team, having consulted the community members, proposed a number of services to allow social sharing. They did that about a year before Facebook started so one would expect that the context was favourable to such an initiative. In the end, though, there was no interest. Reflecting the experience of other community networks in Britain, they found that although at the beginning they started with a relatively large number of intranet services, these were effectively reduced to about three. Digcoop came to be seen mostly as providing Internet connectivity rather than much added-value in terms of specific services for the housing cooperative that could encourage engagement, interaction and participation in the life of the community. Lack of clarity with regard to the community network's purpose (simple internet connectivity or community-specific services too?) stretches further the limited human and time resources available as the core team tries to respond to differing purposes.

When the core team of Digcoop suggested the development of a social sharing space on the intranet, it seems that the idea came too early. Timing is therefore another factor. Some of the ideas the core team had planned seemed alien to the community people. About a year after they proposed it, Facebook launched and within 2-3 years it became massive. Other social spaces were starting too. Suddenly, there were alternative services that people could move to. The level of awareness and knowledge on the part of Internet users is now greater. If they were to start now, the kind of conversations they would have with the local community would be very different. For instance, they would not need to introduce the idea about what an online social space. Fifteen years ago, people were happy in this closed community to trust them and go with their decisions. Mark Gaved thought that now people might ask much more difficult questions about data management or security, for example. They tried their best to think about them then but there is more awareness of these issues

now.

2.4 B4RN

2.4.1 Origins and Character

Broadband for the Rural North Ltd ('B4RN') is a pioneering community network and one of the most successful ones in Britain with over 2300 subscribers. It is located in Lancashire. It started in December 2011 by a local volunteer group under the strong leadership of a networking expert, Barry Forde. Unlike the other community initiatives examined here, B4RN is a fibre network. B4RN is a registered community benefit society, which means that "it can never be bought by a commercial operator and its profits can only be distributed to the community" (B4RN 2016a).

The following material is based on the interview with one of the founding members, Chris Conder, and the information available on the B4RN website. Chris Conder was previously involved in another community project, where they built a wireless mesh network. She learnt how communities work. Building on this experience, she later got in touch with Barry Forde and started working on the project that became known as B4RN.

2.4.2 Economy

The community Chris Conder was based in had access to the Internet but "it was very bad". They got together with other villagers to try and find an alternative feed. That was all they were after at the time, they were not after fibre. However, whatever they did, they could not get one. The main benefit of this exercise was that all villagers worked together.

They subsequently got in touch with a "genius network man", Barry Forde, who had the contacts and the knowledge of how to build a proper network. He came up with this master plan of getting a node in each village and then each village could run its own Wi-Fi network off it, if it wanted to, or lay fibre in it, if it wanted it. It was all optional. Thus the original plan was to get the fibre feed to the communities.

In terms of human resources, the project benefited from the large pool of mixed relevant skills, expertise and knowledge that was available. They put together a management team to form the basis of the group and they called it B4RN. They launched an information campaign and approached the various communities in the area in December 2011 where they explained the plan.

In short, B4RN was born out of desperation due to the lack of or minimal and below standard Internet connectivity. In the words of our interviewee:

> "*It was built because we cannot get [broadband Internet] any other way. We have given up believing the false promises of the government and the telcos in this country because they keep promising us we are going to get broadband, and where I live you still cannot get*

> *broadband. You cannot get decent satellite because of the hills and the weather. We met with two people yesterday who totally rely on satellite and they were both saying that they were paying for 20Mbit/s, but it is very rare to get 1 or 2 Mbit/s because most of the time, especially if it's foggy, the mist comes down quite low, the villages are quite high up, so there is a lot of cloud; and when it rains it doesn't work, and the children cannot do their homework (a lot of the primary school homework is now done on tablets – they don't have exercise books). In some areas you can get 4G but only very intermittently. One person said that in the first three weeks he had it, his bill was over 500 GBP because of the data charges. So 3G, 4G or 5G isn't economic especially for a family or a business even if you can get it. Most of the areas don't even have 2G. Sometimes they can get dial-up but they cannot get broadband.*" (Chris Conder, interview, 25 November 2016).

Take-up of B4RN averages around 65% of all properties in the communities they pass (B4RN, website, http://b4rn.org.uk/about-us/). They can never claim full take-up but the important point is that the duct passes from every single property because they believe that one day they will want broadband and they will become B4RN subscribers so they are planning for the future.

Not only do these communities get fibre-based Internet connectivity, they get it at a fraction of the price they would get it from a commercial provider even if that option existed. B4RN makes economic sense.

Our interviewee explained that originally they explored the possibility of getting a feed from BT but that was economically impossible. As an example, to get fibre to her farm, it would cost 340,000 GBP and 2,000 GBP a month for the connection she has now. But, in any case, commercial providers are not interested in offering such high-speed Internet access; they prefer to continue reusing as much as possible the old copper-based lines or, more recently, they might consider rolling out fibre to the cabinet but that might be a plausible option for some big villages only and even then the final connection to the home will not be based on fibre. Our interviewee continued saying that she now has a 1GB symmetrical connection; the connection fee was 150 GBP and she pays 30 GBP per month. It is the same like any other villager who gets on the network, no matter where they live.

The network is totally funded by the community. Everything that makes their network work (e.g. switches, battery back-ups) is paid for by the B4RN shareholders and each community accepted this funding model. As B4RN is non-proft, commercial speculation is not part of their agenda, so they only extend the network where there is demand and need. Each new area that invites B4RN in needs to raise the investment to cover the work and materials required for the area's installation.

Box 1: How is the B4RN network funded?

> ***Shares***
>
> Every community's core investment is made up of shares, the value of which can be ring-fenced for supporting the build-out in their area. The shares are an investment, not only do they support the project in that community, but they have tax advantages and will pay a good return.
>
> • Minimum shareholding £100 / maximum £100,000.
>
> • All shareholders are members of B4RN. One member one vote.
>
> • Shares must be held for a minimum of 3 years.
>
> • Individual investors can claim 30% tax relief (HMRC Enterprise Investment Scheme).
>
> • After year 3, interest of 5% can be paid out or reinvested.
>
> • Some shareholders choose to invest £1,500 and claim free connection worth £150.
>
> • Shares can only ever be sold back to B4RN at £1 each.
>
> ***Loans***
>
> B4RN also currently accept a limited number of 5 and 10 year loans from the community, paying 5% interest."

(Source: (B4RN 2016c)

B4RN operates a subscription model. They charge a one-off 150 GBP connection fee. After that, their prices differentiate between different customers as follows:

Box 2: The most popular B4RN subscription packages

> "***Households***
> £150 connection
> £30/month service
>
> ***Non Domestic Users***
> • Micro businesses (1-5 site staff) and small schools (1-15 staff)*
> £150 connection
> £30/month service [But in the future small schools will have free service.]
> • Small businesses (6-15 site staff)*
> £150 connection
> £60/month service
> • Medium businesses (over 15 site staff)*
> £150 connection
> £150/month service
> *Holiday cottages, caravan sites, larger businesses and schools, hotels, churches etc. all have special pricing plans that take into account their special circumstances."

Source: reproduced from (B4RN 2016b)

Nobody was ever refused because they were poor and could not afford B4RN. In fact, many people do not have shares. If people cannot afford it, they can still get a connection. B4RN have to lay a duct to every house they go past. If the household think they can build it up themselves, then they will tell them how to do it. If they cannot do it themselves (for instance, they are too old), somebody else will do it for them. Nobody gets left out if they want it. But if they do not want it or they do not want B4RN on their land, then they will leave it ready for when they do.

Before a village is accepted, they have to raise enough money to do the whole village. The most cost-expensive community they brought connection to had to raise 350,000 GBP and that would cover everything they needed to provide to every house. If they can raise half of the funds required, B4RN can make a start. They do not need all the money upfront but they have to be sure they will get it.

As noted, B4RN is successful and has around 2300 subscribers. Initially, they had to raise money from people who often did not know what they were talking about. Now it is quite easier. They are non-profit and will expand where communities want them. There is interest and sometimes they have to say "no" to communities. B4RN says "*we will help you but even if you were to raise the money tomorrow, it won't happen straight away*" (Chris Conder, interview, 25 November 2016). They want to grow at a reasonable pace. They are committed to looking after what they have and do not want to get too big too quickly.

In sum, B4RN, an all fibre network, was built because they had no alternative. They saw it as

crucial for the sustainability of their communities where small businesses play an important role. They wish to have a good local economy, keep these businesses going in the rural areas where they are, so that their children can find employment and stay in the communities rather than go to the cities for a better future. It is, therefore, vital that small local rural businesses survive.

Their thinking is that because the farmers, the landowners, the people have all contributed financially to B4RN that is another reason for it to be sustainable: it belongs to them, they built it, they will tell their children and their grandchildren that they built it, so it will belong to their children and grandchildren, and they will all look after it. Thus, it becomes sustainable.

> "*If wires break down the road, if you own those wires, you know your grandfathers built them, you will report it and get it fixed right away. This wouldn't happen if you had BT wires breaking down. And if you're driving away and you see a pole, you are not going to damage it or hurt it in any way because it is your pole. Not that we use poles but you get the drift.*" (Chris Conder, interview, 25 November 2016).

"Ownership" seems to matter to these communities. It is a big advantage to this type of alternative network and can make it more sustainable.

The network has good technical support. They have both in-house support and external support as a back-up if needed. The network is sustainable from the point of view of good technical support.

In terms of external changes that might affect sustainability, it is worth noting the reaction from commercial operators.

> "*Every village B4RN has gone through, BT comes and builds a cabinet that should have been there 40 years ago and it's obsolete and next to it they put a fibre cabinet and nobody takes the service [they are using public money to do this]. They are trying to cherry pick the big customers from these communities.*" (Chris Conder, interview, 25 November 2016).

2.4.3 Politics

As mentioned, B4RN is a community benefit society which "*can never be bought by a commercial operator and its profits can only be distributed to the community*." (B4RN website, http://b4rn.org.uk/about-us/)

The management decisions were all made in the early days. Each person on the management committee was literally representing his or her own community. They had people with different but complementary backgrounds (e.g. engineering, accounting, legal, medical for health and safety). So they had expertise on most of the decisions they needed to make and they knew what they had to do.

B4RN now employs 14 members of staff and relies on "hundreds of volunteers" (B4RN 2016a). They only managed to take on staff two years ago, in 2014. The staff they have now make the decisions for them. Their staff does not change but is stable. Most of them are young people; there

are also older staff who have worked as volunteers and then been take on. If it is something controversial, it will go up to the shareholders but there is nothing controversial. They have rules and regulations. The staff and the main volunteers will meet every Monday morning and they will make decisions about what is happening during the week and what goes on and any problems they might have.

B4RN can never be sold unless another community or cooperative buys them. They could not, for instance, sell it to BT.

> "*B4RN belongs to the people and it'll always have to belong to the people. So even if the people were to say "go on sell it and we'll share the money out" we still couldn't. Everything has been set, how it's got to be, decided and it's not decisions that we've all made lightly, you put in a lot thought and worry into making them, to make this company as safe as it possibly can be.*" (Chris Conder, interview, 25 November 2016)

2.4.4 Culture

A very strong community spirit and commitment characterise the areas where B4RN operates.

Similar to other community networks, there are different kinds of involvement in the project. There are hundreds of volunteers who do their own little bit and every contribution is valuable. For instance, as Chris Conder observed:

> "*the contribution of the ladies who come out when you pass their house and offer you scones they've just baked is just as great as somebody digging the hole in the field*" (Chirs Conder, interview, 25 November 2015) .

Interestingly, the network is built by people who are "either bald or their hair is white". There are very few volunteer young people building the network. It is built by the retired people in their 50s, 70s, 80s and even 90s. They might not have got the physical strength of the young but they are the ones who have the work ethic, the common sense, and the experience. The younger people are at work and lead busier lives, so it is the older community members who mostly do the digging. In the words of our interviewee:

> "*There are so many jobs. It is not rocket science. It is easy. Anybody who shows willingness and enthusiasm can contribute. Older people will do it because they want to do it. Younger people take a job there because they might be unemployed. You do need youth. They aren't as good as some of them older ones but they have more stamina. They're worth putting in the extra effort into training. And they cannot do as much volunteer as older people can do because they need to earn some money. If you get a youngster working and really loving the work, then you have him or her for 30 to 40 years. They are the ones you want.*" (Chris Conder, interview, 25 November 2016)

Significantly for a community project, it is the older people in particular who know how to deal

with other people in the community and can often act as catalysts in resolving any initial resistance. Community members trust their neighbours who they have known for years and they stand a much better chance of getting them engaged in the initiative, more than a community outsider no matter how expert he/she might be. This is how the network expands and reaches the next farm or the next village. It is up to each community to manage itself. Each community has what they call a "community champion" who are volunteers and do not get paid. B4RN does not interfere. B4RN tells people how to do it and they will draw a map. The map might change in response to the local knowledge that a specific community possesses and accommodate what the locals say is best.

90% of the community are completely enthralled and overjoyed with the network and think it is wonderful. Proof to this is the fact that they have no churn. A few will complain about the mess or Wi-Fi in their house (even though it has nothing to do with B4RN).

In short, similar to other community networks, the communities where B4RN operates are all very strong. Community involvement and commitment are central. B4RN helps rejuvenate and sustain local communities by, for instance, creating and supporting jobs, community spirit, cohesion, and bringing the people together.

2.4.5 Policy

B4RN has some experience with trying to access local and national funding but got disappointed and stopped even trying ever since. Originally, B4RN applied for rural development funding and got 750,000 GBP allocated to them but then when the superfast Digital Britain project started and the Broadband Delivery UK office (BDUK) was set up, they took that money off them to give to their county project. The funds went into a pot for the whole of Lancashire and the community initiative could not have it. Still, they carried on with their plan and decided to finance it themselves because they believed in it and thought that it was good and was going to be sustainable.

Our interviewee was also critical of the recent policy announcement regarding funding for rural broadband. She thinks that the way it is set up, it is impossible for communities to get any funds (for instance, there will be tenders) and so they are not even going to try. They believe it is more sustainable to rely on own funds.

A final interesting point that relates to regulatory issues is that in 2015 the national regulator Ofcom granted B4RN "code powers", which make them more independent. Instead of Councils holding them up for months on end and causing them trouble, they can say to Councils what they are going to do and expect to be trusted. "*Code powers allow operators to benefit from certain exemptions under Town and Country Planning legislation and also entitles them to carry out street works under the New Road and Street Works Act 1991 without needing to apply for a licence to do so*" (Ofcom [UK] 2004)

In short, B4RN have not faced any serious policy or regulatory issues. They try as much as possible to stay independent (not least in terms of funding) as they believe that this strengthens the

sustainability of the network.

2.5 Kinmuck

2.5.1 Origins and Character

Caleycom is a social enterprise established in 2010 to provide fast broadband and ultimately next generation broadband to Kinmuck, Aberdeenshire and the surrounding area. There is no acceptable broadband coverage at the time and it is unlikely to be included in the recent government roll-out plan. The owner of the enterprise provided the broadband service investing significant personal effort and having good financial support through Leader EU funds from Aberdeen City council, as well as National Lottery funding. The users could select between three subscription packages, ranging from £30 to £90. The technology was provided by a licensed radio link from a disused ex-telecoms tower in Aberdeen; it was relayed in the area by using old telegraph poles and farm buildings.

Due to other professional obligations and the increasing demands of the network the owner of Caleycom subsequently decided to hand over the service (October 2013) to a local technical company specialising in CCTV, security and telecoms systems.

2.5.2 Economy

Our interviewee, a central actor in the aforementioned technical company, identified serious problems of sustainability in the network:

> "*Originally Caleycom had their own engineer, but when the engineer left, he started receiving support from a company called Safenet, which was proving quite a financial burden. At the same time, the equipment installed, which was very good quality, did not seem to stand up to it. We took over in September and in November the thing literally fell apart. There was serious grief technically. We then put in Ubiquiti radio equipment and turned the infrastructure into wireless*" (interview, 17 November 2016).

One of the reasons why a radio server was used was that they wanted to run this as a commercial enterprise, whilst being able to offer less well-off people a tailored package for as much as they can afford. With the radio server they could tailor the package in terms of speed and amount of data. There are two packages, silver and gold (30Mbit/s and unrestricted data and 12 Mbit/s and 120 Gbit/s data respectively).

The original radio equipment investment was about 24,000-25,000 GBP. As the network has expanded, further investment is needed to connect parts in a bigger whole. Human resources come from the technical company:

> "*Our staff members (24 people) are paid full-time to deal with faults and installations. We*

> *provide enterprise-level service. When there is a fault or breakdown, unlike social enterprises, we are on the case within a day*" (interview, 17 November 2016).

The company's interest in the first instance is to provide access to remote places at reasonable cost:

> "*Our market really are the villages. There are some areas that have fibre. However, outside those areas there is not and there will never be. You can go 4G there, but you pay £1 per Gb. We charge one fifth of that. As soon as we get enquiries from different areas, we just expand into them*" (interview, 2016).

Despite operating a commercial business model, the company does serve the community needs:

> "*There are communities outside Aberdeen which have been fighting for years to have some form of broadband and they still have nothing. We put a repeater in locally and local companies came on to it. Our main target are local businesses which we can charge. If they were to put in their own fibre, they would be paying over a thousand pounds a month and excess construction charges of many thousands to get it in there in the first place. We put 100 Mb, which would have cost us £29000, but we do this on a radio link which is far more viable*" (interview, 17 November 2016).

In this way, local businesses find a solution to their connectivity problem. Their clients are roughly 40% commercials and 60% domestics. However, there are a lot of small limited companies of 1 or 2 people in the area who are classified under domestics. Conveniently, commercial utilisation of the band is mainly during the day and domestic utilisation during the night.

For our interviewee, a commercial character is necessary to provide a good service to the community.

> "*People do not want to have grief every day. The owner of Caleycom could not walk down the road without having someone complaining about something which was not working"* (interview, 17 November 2016).

Sustainability, then, is linked with the feasibility of providing a good and consistent service:

> "*The community network to me is more like a feral cat. Feral cats live seven years and then the whole breed dies out. The same happens to community-backed networks. They do not have enough engineers capable of doing this; they may have one or access to one. If that person moves, the whole thing falls apart. And that is what happens a lot of time. I have seen two such systems locally that have fallen over due to lack of support. That is why we did it commercially; we are giving a service which is as good as BT*" (interview, 17 November 2016).

Competitive threats from the big companies are always a possibility.

> "*It is always possible that someone comes along and invests 30-40,000 GBP. There was a village in Angus we were aiming to serve and within two weeks BT came and put fibre there.*

> *That is why we are mainly concentrating on people living in areas which will never ever get fibre because they are at least 7 or 8 km away. At such distances you are lucky if you see between 1.5 to 2 Mbit/s. We are offering them 12 Mbit/s now and I can wind it up to 30"* (interview, 17 November 2016).

2.5.3 Politics

Data protection issues have not been identified as a problem in the network. There have been no complaints on that front.

Different stakeholders in the community seem to be coming together to discuss issues of connectivity and network services:

> "*We are speaking to the Aberdeenshire City Council that are quite forward-thinking and keen to have a network set up with like-minded people, where we will put a little bit into and get a lot out of it. They want to set up a community intranet where they can utilise traffic signals, they want to use if for medical records so that people can get access to their records without having to go through their GPs, they want to have an integrated package. We could provide the infrastructure in the project*" (interview, 17 November 2016)

However, such prospects are still very far ahead.

2.6 i4free

2.6.1 Origins and Character

i4free is a network in an area about 30km from the city of Nafpaktos in Greece. It has been developed almost single-handedly by the non-Greek engineer TR, who has lived in Greece for about 30 years and who came to the Trizonia island area about 10 years ago. He quickly realised that there were only two Internet connections on the island, one in the marina and one in a taverna by the port.

Since vessels came regularly to the marina, there was demand for Internet access:

> "*This made me think that I could turn the two connections into two nodes of the same network by writing the appropriate mesh protocol that would enable them to communicate. Through my links with Muenster University in Germany, I drew on the Batman protocol, so the protocol we use here is the Batman advanced. We use Linux operating system. Each access point has one router, which is compatible with many other routers. The Linux we adjust to be compatible with many different routers both old and new"* (TR, interview 2 August 2016).

2.6.2 Economy

TR's intention in establishing the i4free was to provide Internet access in an area where there is

almost none. There are young people in the villages who cannot have access. The signal does not quite reach their remote places or they cannot afford to have 3G or 4G mobile broadband. Nor can they rely on places such as local cafeterias to get to the Internet. In terms of fixed lines, the signal is inadequate, if not bad, and the telephone lines are very old and maintenance is insufficient. Through i4free there are tangible practical benefits for the community.

TR has clear experience of the costs involved in setting up a community network and maintaining it. He has so far paid about 8,000 Euros for the equipment, not to mention the countless hours of personal time invested.

TR has been active in meetings like the Battle of Mesh, the FOSSCOM and has provided training for a younger generation of technicians, certified by IEEE:

> "*A necessary condition for my network here to be sustainable is to find young people to continue keeping it. A critical mass of people willing to get involved is crucial. Otherwise, when I die the network will die with me… If community does not exist, any idea will die…Of course, the young generation needs to have incentives. One way to offer them, for instance, is to provide them skills with general applicability. For example, if we train young people in Linux and Bash, these are skills that they can use in other contexts, too. In every seminar I stress that: this is basic knowledge. My primary concern is to gather young people and make a community; this is the only way, it is the only thing that is alive"* (TR, interview 2 August 2016).

On the issue of providing local applications as an incentive for utilisation of the network he is rather reserved:

> "*Consumers could not be attracted through local applications because what they need they can find on the Internet. The only thing I would see as important for the consumer would be the so-called Internet of Things. For example, if you want to measure the flow of water through sensors and monitor the flow remotely. But again, you could put an application on the Internet doing this. Providing local applications does not make much sense; it is much easier to put applications on a cloud server than having them on a local server. I have a local server here but it costs much more than the 10 USD a month I would pay to rent a cloud server*" (TR, interview 2 August 2016).

2.6.3 Politics

TR is the network administrator himself. The servers of the network are kept in the UK, Germany and the USA. They keep the splash-pages, the pages of control, where a programme shows you the information collected from all the nodes every 10 minutes. Here the administrator can see all the nodes, including all the consumer nodes and the quality of the signal they have. With i4free (certain) user data can be controlled to stay inside the network (on a local server) and not go to the Internet (depending on the application used). Control of user data is one important attraction in

(potentially) using a local application from a user's point of view. However, no such applications are available yet, the network only provides Internet access.

TR believes that better connections with the local authority could help providing access to have a mast high up on the hill where there is electricity, and network coverage can be better. He would still have to cover the costs. However, the local authorities have never approached him, though he is well-known in the area.

2.6.4 Culture

TR's intention was two-fold: to build a network from scratch and to establish strong community links. He wanted to develop skills in network building and transfer knowledge and gradually form a community of people who could know how to build a community network.

The basic problem he identifies is to maintain interest in the i4free project and imbue it to the new generation, this way diffusing knowledge and innovation. He has been involved in running several seminars with numerous students, but has found that almost nobody is keen on maintaining relationships and engagement with network building.

> "*Young people are spoilt now; they are used to easy money. I see it in my seminars, where we discuss topics in a lively way. They are only interested in getting the certificate for the seminars. I followed up with an email asking them for their details and no one replied! I have invited young people to get together and form a community but no one showed interest. They do not seem to understand. I think it is a sign of the times. And we need to find 'tricks' to stimulate interest and form communities*" (TR, interview 2 August 2016).

> "I*mportant is to have the idea of community. But you have to start with something, even if there is no community there. A problem is that the community is often sceptical. Here they tell me: why are you doing this?*" (TR, interview 2 August 2016).

TR has had to find ways to engage users. Two years ago, in July-August 2014, there were about two thousand users using the i4free. He prepared a text and asked them to email him confirming that they used the network. No user responded. On one occasion and because one of the users had been complaining about the signal he was getting from his provider, TR suggested to them to buy a good router costing about 100 Euros so as to connect to his provider, but also to provide through this router access for i4free too (be an access point); in exchange, TR offered to install the modem and do the maintenance for him for free.

In a more general sense, there is a detectable degree of scepticism in the small local community in Trizonia. Through informal interviews with users who wanted to remain anonymous we have realised that people have a difficulty to understand why somebody would provide free Internet and what their motivation might be. They expect that there must be some secret gain to be received. Is the provision of free Wi-Fi linked with unidentified business activities of the administrator (e.g. provision of security in vessels in the marina)? And what happens to the user data, where is it stored

and where is it used?

A certain degree of 'noise' generated this way has had an impact on the sustainability of the network (from the point of view of willingness to use it and to provide access to it). Paradoxically, charging a small fee accompanied by publicity of the vision behind i4free the Wi-Fi, would probably help establish the network in the consciousness of the locals.

TR attaches a lot of importance in education and training:

> "*There are four or five ways of building a community network and you should know them if you are to build one. It involves different topologies and one needs certain technological knowledge of specifications regarding distance, speed and so on. I suggested that there should be a school organised in e.g. Thessaloniki, to train people in these matters. This is a long-term investment and goes beyond developing a certain application. It is about knowledge transfer*" (TR, interview 2 August 2016).

2.7 Sarantaporo.gr

2.7.1 Origins and Character

Sarantaporo.gr community network is located in the remote, isolated, mountainous region of Elassona municipality, in central Greece. The municipality has more than 50 villages, scattered around a mountainous relief, just opposite of the Olympus Mountain. Being remote and sparsely populated, many of these villages lack Internet connectivity, as telecommunication companies do not see profit opportunities investing in infrastructure.

To alleviate this shortcoming the Sarantaporo.gr core team designed and deployed wireless community networks in 14 villages in its area, starting from 2010 as a voluntary group until present as a legal entity. These villages are currently interconnected wirelessly under the same backbone network and with other community networks in Greece and Europe through VPN.

The Sarantaporo.gr community network was an afterbirth of several events' sequence. Initially, back in 2010 a globally dispersed group of people stemming from Sarantaporo village decided to establish an entity, which would provide various voluntary services to the local community. Many of these actors reside in Athens, including George Klissiaris and Rossie Simeonova. The primary aim was to create a website to serve as a communication channel for the creative exchange of views/ideas and to coordinate creative activities/actions, which would benefit the local community. Within the first 3 years, the group deployed community broadband infrastructure in the closest villages as well, serving almost 5000 locals and doubled the number of visitors during summertime and holidays.

In September 2013 the Sarantaporo.gr organization was founded in order to take the community network to the next level. It was then, when the team became larger with people from other places

of Greece, with diverse skills and a will to actively get involved in the project. It was also the year of successful application for an open call of CONFINE, an FP7 EU funded project, which allowed to expand the infrastructure with a backbone and federate the network with other community networks across Europe.

Today, at the end of 2016, Sarantaporo.gr counts 6 years of network operation and has managed to serve 200Mbit/s symmetrical connectivity, far better than one can find in Athens. Until now the community network has expanded to 14 villages out of almost 60 in the area. There is still ground to cover, people to connect and isolation of remote areas to be broken.

The team behind Sarantaporo are enthusiastic and ambitious:

> "*Currently, our scope is to make use of the network not only as an Internet provider, but also as a platform for socio-economic development in the area. We are working on creating various collaborations with academia, business and individuals on elaborating projects related to innovations in the agricultural sector*" (George Klissiaris, interview, 29 November 2016).

The mission of the team is to reduce the digital divide and provide equal access to the Internet and the opportunities of the digital economy and take advantage of the ICT in remote and rural areas of the Greek countryside, providing opportunities for development and prosperity of local communities.

2.7.2 Economy

In the case of Sarantaporo.gr,

> "*sustainability would mean to firstly have a sufficient number of local followers and supporters, who would share the same ideas and values and would understand the value of the model the community network promotes, the opportunities for local socio-economic development it gives and the potential benefits for the local community. The business model of the Sarantaporo.gr community network very much relies on people believing in the sharing idea*" (George Klissiaris, interview, 29 November 2016).

The core team of Sarantaporo.gr understands as sustainability the capacity to maintain adequate resources (human, tangible and intangible) and utilize them in order to achieve the set objectives. Sarantaporo.gr would be financially sustainable if it could be able to maintain the proper operation of the infrastructure by a) having full-time employees, who would support the community network in terms of technical support, education and coordination of local support groups; this point is essential, as the network users do not have any technical knowledge b) having full-time employees, who would be involved in R&D, search of financial resources and community building by creating lasting and sustainable partnerships with locals and third parties (individuals, business and institutional sectors).

2.7.3 Politics

The ownership of the community network is shared, whoever invests in equipment is its owner.

> "*The most important point is that no matter who the owner is, the equipment is utilised for the same purpose - to build a community infrastructure as commons. The governance of the community network, however, is kept centralised, mainly because of lack of technical expertise of the users. The majority of people living permanently in the area have primary or secondary education, which means the majority haven't got the background to deal with the community network issues and cope with its operation and maintenance. It also seems to be the easiest way to maintain, monitor and control the quality of service of the community network*" (George Klissiaris, interview, 29 November 2016).

In order to avoid conflicts between users and malfunction of the backbone network, its administration is responsibility of a small team (the technical team) and for the access network plug and play solutions are used (openmesh devices and firmware).

2.7.4 Culture

Sarantaporo.gr community network is a 'commons' infrastructure in the sense of:

- sharing the costs for infrastructure development, operation and maintenance,
- sharing property space for the installation of equipment,
- open network use - access to all (currently serving approximately 5.000 local inhabitants),
- active involvement of locals on a voluntary basis (local support groups of 4-5 people in 12 villages, totalling almost 60 people) to technically and financially support the endeavour.

The majority of locals appreciate the opportunity to have access to the Internet. However, most of them do not, cannot or do not care to see further than the Internet access. Furthermore, most of them do not conceive the potential of this tool to its fullest extent and how important and productive the utilisation of modern technologies in the agricultural sector (their main occupation) could be.

Users of the community network are mainly locals and visitors (mainly people stemming from the area, visiting periodically their relatives or premises). They include mostly children and young people, mainly pupils and students, some middle age people - mostly professional farmers and few of the older generation. New users join during local or national holidays, the biggest influx of visitors - 3 to 5 times per year and less during weekends. Periodically, there are informational days for the local community, but these do not seem to have been efficient in community building, so the team are planning social events for that purpose.

3 Discussion: Perceptions of Sustainability of Community Networks

In their study of community broadband initiatives, Wallace and Vincent identified several important factors that lie behind the success (or sustainability) of the broadband community initiatives they examined (Wallace and Vincent 2015):

- Leadership in the form of one or more community leaders, who are able to gain the respect of the community and to mobilise local networks. These community leaders were often social entrepreneurs and relied on subscriptions or external funding, e.g. national lottery or EU Leader programmes.
- The presence of human capital. Incomers into the community bring with them external social capital and new skills and expectations. Technological capital is also indispensable, as competent people are needed who know how to set up these systems networks and link them to existing infrastructure. Social capital for the mobilization of local resources to link the community broadband initiatives into different constituencies within the community is crucial.
- Pre-existing community capital is important, as it provides useful grounds for showcasing the technology. In most of the areas in Scotland and Northern England, people studied were poor and were closely connected with each other. It is essential to understand more of what the community is and what it involves. Of particular importance is that young people tend to leave these areas and this makes the sustainability of the network more difficult.
- Commitment of the community to engage in broadband deployment for serving own needs and community building. The presence of certain kinds of local business can be a contributing factor, in particular business – such as 'small creative industries' - that rely on broadband communication to reach people and business beyond their community. Similarly, demand can come from people working from home or wanting to run technology companies.
- Multiple stakeholders, e.g. civil society, council authorities, local businesses, all make the cases more sustainable. This is for many reasons, including finding easier ways around administrative procedures through council authorities. Economic resources are necessary, particular access to funding from councils, or other bodies (EU funds, national lottery etc.). Wallace observes that "The fact that this funding is generally short term, however, jeopardises the sustainability of at least some of these projects." In addition, the big telcos soon turn up when they realise that there is a market (which has been created by the community network). And they drive out in many cases the community broadband because they can provide better quality of signal, lower cost and better maintenance.

Most of these factors of success (or, in the language used here, sustainability) have been present in one form or another in the cases we have examined. Our own comparative research has revealed that sustainability is explicitly or implicitly understood by the key actors (mainly network administrators) as involving economic, political and cultural dimensions. Importantly, these understandings and perceptions of sustainability have also unraveled the main contradictions facing community networks (for a discussion of contradictions see also Fuchs 2017).

Economic sustainability was primarily based on the personal efforts of the key actors. Indeed in a number of cases (Consume, Free2Air, i4free) personal efforts by a small number of people or even a single individual were instrumental for the deployment and take off of the network. However, there is a range of models that diverse actors understand as sustainable. Our research found two different economic attitudes. On the one hand, for some actors, sustainability has to do with maintaining an alternative character and bypassing commercial interests, particularly those of the big providers (e.g. Consume, Free2Air, B4RN, i4free). On the other hand, sustainability is simply a matter of providing a good service, and this can be realised better through commercial arrangements, albeit with small commercial providers, rather than the big telcos (e.g. Kinmuck). The first economic attitude then sees community networks as grounded on commons, communitarian practices and not-profit initiatives whilst the second economic attitude is based on for-profit provision but by small- and medium-sized enterprises. The main economic contradiction underlying community networks appears to be one between community economy and commercial for-profit provision.

The need for resources suggests that the size of the community might play a role in the sustainability of the initiative, in the sense of providing a critical mass of users/members who can either provide subscriptions or contribute own resources. A valuable resource is time. Such initiatives depend by definition on volunteers who are prepared to give up their time and contribute to various aspects and stages of the process.

Access to funding is crucial too. Some communities tried to access local or national funding (in the case of B4RN, their bid was subsequently withdrawn and put into a larger regional pool), but the experience of the cases examined here suggests that financial sustainability requires a subscription model and the funding of the network from community-owned resources. It is not simply the case that some community networks examined here found potential access to local, national or European funds too difficult and demanding, often not tailored to such initiatives, uncertain, and too bureaucratic, but it is the belief that the funding of a community network from own-resources is more reliable and sustainable (e.g. B4RN), as it precludes dependence on external funding which might not materialise or, given that it has a fixed term, it might put at risk the subsequent development and maintenance of the network when it finishes. Internal funding from own resources, if possible, was preferred as being more reliable and sustainable

The provision of Internet connectivity by community networks is normally significantly cheaper and often better quality and faster than commercial alternatives, if they exist. Subscriptions then are relatively low and do not jeopardise affordability. It is important to note here that, in sharp contrast

to commercial for-profit provision, the non-profit character of community networks contributes to their sustainability in various ways. First, subscriptions are affordable. This creates a virtuous circle: the more affordable access to the community network is, the more users will join; the more users join, the larger the pool that contributes to the financing of the network helping therefore to maintain subscriptions affordable. Second, this non-profit funding model of community networks brings the community closer together and this in turn increases the commitment of the community to the network. Rather than (higher) network subscriptions creating profits which then go into benefiting primarily the shareholders of commercial for-profit providers, the link between financial (and other, for instance time) contributions by community members and the development of the community network is more direct and visible to the community in question. In short, the research presented here suggests that the non-profit character of community networks improves their economic sustainability and strengthens community ties and commitment to the initiative.

It is also worth stressing that many communities valued inclusiveness more than profitability. Some communities had ways to provide connection even to those who could not afford it (e.g. B4RN). Equally, fairness was another aspect that some pricing policies reflected as was the case of B4RN where there are different pricing schemes for residential users, small enterprises and bigger businesses, the latter two considered as heavier Internet users.

Culturally, sustainability is predominantly understood as a spirit of social cohesion and common identity or, at least, as a spirit of sharing common resources. Communitarian practices and philosophical concerns for the commons in general were often additional features of the communities in most of the cases examined (e.g. Digcoop, Consume, Free2Air). These features in turn resulted in strong practical efforts to re-use as much as possible existing networking and other equipment and in doing so contribute to environmental sustainability.

Commitment, solidarity and trust are also key ingredients and their absence is detrimental to this notion of sustainability: *"For me it is a matter of building community spirit. People who have Internet access because they can afford it do not care whether the others do not. Others are clearly sceptical, while others are interested in opportunities for quick and easy profit"* (TR, interview, 2 August 2016). The problem identified, namely free-riding in peer initiatives and their reliance on the efforts of the very few for the benefit of the many, is also a cultural contradiction at the heart of community networks.

The presence of a strong relatively closely-knit community is a necessary but not sufficient condition for the take-off and subsequent success of community network initiatives. In turn, through the process of setting up and running the network the community is brought closer together and in this sense community ties are further strengthened, whilst Internet connectivity brings the community closer to other parts of the society. In short, social cohesion is therefore enhanced.

Good community relations also matter. Knowing the people in the community well can help resolve any disagreements, conflicts and soften intransigence (e.g. B4RN). Conversely, mistrust in the community adversely impacts upon the sustainability of the network (e.g. i4free).

The community needs to have identified specific needs that the initiative will address. To start with, a basic need is Internet connectivity and possibly at a later stage specific community-services. Put differently, there has to be demand in the community.

The community also has to be resourceful. Various resources are essential and they include: a community leader who can bring the community behind the project, and technology leaders who will design the network. Added skills are desirable such as people with a good knowledge of accounts and law. The more people are trained and willing to take on leadership roles the better is it for the network. This can counter problems when some leaders have to move on and cannot commit anymore to the same degree.

Experimentation and knowledge has also played a central role in many of the cases we have examined. Very often the technology leader at least was is regular contact with other leaders in other communities with similar initiatives underway. Knowledge exchange and sharing of experiences can contribute to the sustainability of the network. Many actors attach great importance in involving the young generation and provide motivation to them to build skills and transfer them in building other community networks.

But while the presence of relevant, mostly technical, knowledge is an important precondition for the initiation of a community network initiative, the cases examined here were not confined to so-called geek-publics. Although some might have started as communities of geeks (e.g. Consume), all the networks studied for the present deliverable strived to reach out to the general public of non-geeks and non-techies. Still, the passing down of technical knowledge, the sharing of experiences and the support of other similar initiatives, as well as, finally, the acquisition of new technical knowledge and capabilities are all key elements for the sustainability of community networks. Thus, the cultural contradiction of community networks between geek publics and community public has not been encountered in this research.

Politically, the idea of empowerment, active ownership of resources and data, and control of one's own communication needs, often linked with the idea of bypassing dominant commercial providers, clearly evokes both libertarian and anti-capitalist dispositions. The importance of community networks is indisputable because they offer an open structure, whose management, operation, experimentation and lack of censorship are hugely important. The contradiction here then is one between the potentially more open and privacy-friendlier character of community networks, and the closed environment of commercial for-profit networks where surveillance practices are deeply entrenched features for commercial and political reasons. Awareness around privacy has increased in recent years, in particular following the Snowden revelations, and the open privacy-respecting alternative that community networks promise might well increase their attractiveness and contribute to their growth and expansion. The cases we examined have generally provided opportunities for user active involvement in managing their data and have kept user data storage and central control at a minimum. However, the contradiction between data control/privacy and data ownership by big corporations, such as Facebook, remains in the cases where community networks are used only for

free or low-cost Internet access for the purpose of deploying these large corporate platforms.

Organisational aspects are also a locus of cultural contradictions of community networks, as in some cases they can operate against sustainability. A suitable organisational form, addressing economic aspects but also being democratic and targeted towards serving community interests is thus perceived of as essential for sustainability.

Last, certain **legal aspects** are also seen as ingredients potentially threatening sustainability. The case of Sarantaporo, operating a non-profit community network, possibly faces legal challenges based on the Greek regulatory framework, which does not distinguish between the regulation of for-profit and non-profit network providers.

> "*A regulatory framework embracing community networks should be a two-tier framework : (a) recognising the legal status per se of the common pool resource [community network] as a common good and embedding high level rules as to its governance, and (b) recognise the rights of producers / users to contribute work and resources without imposing regulatory burdens. Access providers to the network should be able to cover expenses for the provision of scarce resources, such as access to the Internet or support.*" (George Klissiaris, interview, 29 November 2016).

Some of these issues echo the situation in the UK:

> "*There are still no legal issues with setting up a community network, but increasingly there is an anxiety that doing so will lead to an exposure of risk for those sharing internet gateways, setting up social enterprise and competing for resources and attention of publics. The Digital Economy Act, passed at end of the Labour government, was very disruptive in terms of perceptions of how more exposed we could be to claims of damages from copyright holders and police investigations of cyber crime...60% of the material exchanged over the internet is still peer-to-peer but it all goes via commercial intermediaries. The spectre of risk has taken the fun out of sharing for most people who prefer to outsource their media servicing tasks rather than face responsibilities of DIY.*" (James Stevens, interview, 30 September 2016).

Perceptions of sustainability of community networks are also influenced by current technological developments. When Digcoop started, for instance, there was limited access to the Internet. Closing the digital divide and promoting digital accessibility were very strong arguments at the time but these have lost their strength, even though the issues are still valid. Internet access has increased, its costs have generally fallen and the entry into the market by various commercial providers threatens the viability of community networks. Technological changes at the level of applications might make the choices of the community network obsolete. Our interviewees have expressed awareness that local applications do not make as much sense as it used to be the case. The proliferation of sophisticated applications on the Internet, and the lower cost of storing such applications on cloud, as opposed to local servers, create further tensions on community networks.

4 Conclusion

Our research has exposed the multiple aspects involved in the ways in which key actors understand sustainability in community networks. Using the framework outlined by Christian Fuchs in D2.1, we have engaged in qualitative research to understand these multiple views on sustainability based on the hands-on experience that these actors can contribute.

Based on the narratives of the interviewee as discussed in the previous section we have revisited the sustainability framework elaborated in D2.1. The aim in D2.2 has been to examine the perspectives on the sustainability of community networks of the key actors involved in certain network cases. The starting point was the framework developed and presented in Table 13 of D2.1 (pp. 77-79). This informed the semi-structured interview guide that we used to collect interview data. The data collection process largely verified the framework by confirming economy, politics and culture as co-constitutive dimensions of sustainability in community networks and perceived as such by the key actors. Importantly, the data collected can help also modify the starting framework in two ways: a) identifying dimensions that have been less dominant than others in these perceptions and b) enriching the initial framework with new dimensions emerging from the interview data. Based on the findings, as a first step we have enhanced the checklist of D2.1 keeping the big categories of 'nature', 'economy', 'politics', and 'culture' that comprise the framework whilst adding (highlighted in bold) the dimensions that have emerged from our interviews (Table 1 below). As a second step, we have selected all dimensions that have proved to be significant for our interviewees and have produced the evaluation form of sustainability of community networks (found in Appendix 3).

Table 1: Checklist for sustainability issues in community networks with input from fieldwork

Dimension	**(Un-)Sustainability issue**	**Sustainability questions**
Nature	Energy use	To which extent does the community network rely on relatively environmental-friendly energy sources (wind energy, solar power, tidal power, wave power, geothermal energy, biomass and waste energy)? To which extent does the network rely on suppliers of such energy forms? What is the share of the total energy consumed per year by the network that is based on relatively clean power sources?
Nature	e-waste	What is the average lifespan of different hardware types used in the community network? Can measures be taken for ensuring the long-term re-use and update of hardware? If hardware devices have to be replaced, is it possible to recycle the old ones? How? If hardware devices have to be trashed, is it possible to do so in

		a way that does not threaten humans and nature? How? If hardware devices have to be trashed, is it possible to do so in a way that avoids the creation of e-waste that is shipped to developing countries where it poses threats to e-waste workers, humans and nature? How? If old hardware devices that a network no longer uses are donated to other networks, can it be ensured that this does not result in a two-tier Internet access structure, in which poorer communities have slower Internet access than others?
Economy	Monopoly power and corporate concentration **Market and model of provision**	How strongly concentrated is the Internet access market in a specific region, country and the world? What share of users and financial resources (revenue, capital assets, profits) does the incumbent Internet service provider have in a specific region, country and the world? Does the operation of the community network help to challenge the financial and market power of dominant Internet service providers and to advance a plural economy? How? What are the dangers and what happens when a community network suddenly faces competition by a private for-profit Internet service provider? **To which extent is the community network supported by non-profit/ community-based network access and services provision?** **To which extent does the community network rely on a commercial provider? What is the nature of this provider (e.g. for-profit vs. social enterprise, or local vs. non-local)?** **To which extent does the model of network provision of the community network face competition from commercial for-profit telcos on the basis of quality of signal/provision, lower cost and/or better network maintenance?**
Economy	Survival and resources	Does the community network manage to survive economically, i.e. to afford the necessary hardware and labour-power necessary for running the network? How does it do that? What are its financial sources? **To which extent does the community network rely on internal funding sources?** **To which extent does the community network rely on external funding sources? How regular are they?** To which extent can the community network ensure that it has enough resources, supporters, workers, volunteers, and users? **To which extent are there people to provide the technological skills for running/maintenance/upgrade of the community**

		network? **To which extent are there people to provide skills in accounting or law?** **To which extent does the community network rely on a single individual or a small group of actors for providing the necessary resources (time, skills, money)?** Can the risk be avoided that the community network is a "secondary Internet" that is marginal, slower and less attractive than other services? How? What strategies can be used for avoiding marginalization and resource precarity? **Are there possibilities for the community network to obtain public or municipal funding or to co-operate with municipalities, public institutions or the state in providing access and services?**
Economy	Economic democracy	Is the community network collectively controlled by its members as a common good? How can the community network best ensure that it is a not-for-profit project? Are those who work professionally for the maintenance of the network fairly remunerated for their labour so that they can lead decent lives? To which extent does the network rely on community control, municipal control, or private control? What are potential dangers of collaboration with or inclusion of private for-profit companies? How can they be avoided?
Economy	Tragedy and comedy of the commons	Is the network large enough to attract significant numbers of users so that this community can have mutual benefits from network effects? How can possible congestion and slowdown of the network best be avoided if it is very popular?
Economy	Network wealth for all	To which extent does the community network provide gratis/cheap/affordable network and Internet access for all? **If subscriptions are used, to which extent are they affordable?** **To which extent are there different pricing schemes such as for residential users, small enterprises , bigger firms, and public institutions (e.g. schools)**?

	Needs	How can the community avoid or lower the digital divide? How can the community network help to avoid a two-tier Internet with slower Internet access for some and faster for others? How can the community network avoid the commodification of a) access (i.e. using access fees) and b) users (i.e. using advertisements) that bring about a) inequality of access and b the exploitation of users' digital labour? **What technological skills are required of the average user to benefit from the community network?** **To which extent are the community needs served by the community network?** **To which extent are the needs of diverse individuals (e.g. by gender, age, nationality) and groups in the community served by the community network?** **To which extent are the needs of local businesses served by the community network?**
Politics	Participation/**governance**	How is the community network governed? How does it decide on which rules, standards, licences, etc. are adopted? Does the community network allow and encourage the participation of community members in governance processes? How? Are there clear mechanisms for conflict resolution and for proceedings in the case of the violation of community rules?
Politics	Privacy-enhancement and protection from surveillance	How can a community network best be designed and governed so that the privacy of users is guaranteed, it is technically secure, and protects users from corporate and state surveillance? How can privacy-enhancing and privacy-friendly community networks best face the threat that in a culture of law-and-order politics and a surveillance society, in which governments believe that surveillance is a way of preventing crime and terrorism, they are outlawed? How can they best challenge the argument that they provide a safe harbour for the communication of criminals and terrorists? How does the community network deal with actual crime occurring in its network? How can it best minimise the occurrence of crime?

	Data ownership and control	**To which extent does the community network provide opportunities for active user involvement in the management of their data? What are the skills required and how are they provided?** **To which extent and for how long are user data kept in servers controlled centrally (e.g. by the network administrators)? How do you guarantee that data storage is done in line with data protection regulation and is privacy-friendly?**
Culture	Conviviality, learning and community engagement	To which extent does the community network provide mechanisms for learning, education, training, communication, conversations, community engagement, strong democracy, participation, co-operation, and well-being? In what ways? To which degree is the community network able to foster a culture of togetherness and conviviality that brings together people? In what ways? **To which extent are trust and solidarity present in the community and how are they manifested?**
Culture	Unity in diversity	To which degree is the community network a "geek public" that has an elitist, exclusionary culture or a "community public" that is based on a culture of unity in diversity? How can a culture of unity in diversity best be achieved?

Source: based on Table 13 of D2.1 and adapted to take into account the result of the field work (the adaptations are shown in bold)

One overarching conclusion is that the boundaries between the economic, political and cultural aspects of sustainability, as outlined by the above framework, are far from clear cut. The narratives provided by our interviewees suggest that their understanding cannot be straightforwardly anchored on just one of these aspects; indeed, the economics, politics and cultural dimensions of sustainability are blended in inextricable ways.

In this respect, the funding of community networks from community-owned resources (an economic issue) can bring a feeling of common ownership of and commitment to the network (a cultural issue) and can enable data autonomy and control (a political issue). Likewise, the reliance of the community on the key actor or actors for problem solving and maintenance (an economic issue) generates an issue of power concentration (a political issue), though not necessarily power that these single actors enjoy having. Conversely, the need for data control and ownership (a

political issue) is inextricably linked with the business model of the community network (an economic issue), as well as a community spirit (a cultural issue).

Further aspects, such as organisation or communication are also important for sustainability and are not easy to classify.

Given the sustainability challenges that community networks face and the changed technological and market environment since many of them started, the logical question that comes to mind is whether community networks belong to the past or whether there is a future for them. James Stevens has expressed it eloquently (interview, 30 September 2016):

> "*Local users were in the beginning intrigued and excited but have grown bored and disappointed as it failed to grow and 'succeed' lessons have been learned by everyone involved. Smart phone access over 3G and 4G have changed the whole idea of networks for most people... they barely switch to wifi when they get to work or home networks.*"

Most of our interviewees, however, believe that there are still valid reasons for running a community network despite changes in the external circumstances. Of course, there will always be communities that do not get Internet access such as rural areas, or informal settlements of refugees and migrants. But beyond need, arguments around open structures, better privacy, autonomy and control, as well as experimentation, playfulness and knowledge transfer, mean that community networks are still valid today.

In this light, the broader implications of this research for further work in the netCommons project have to do with the challenges and contradictions related to economic, cultural and political aspects of sustainability. It seems that the growth of community (including community identity, community spirit and communitarian practices) can potentially overcome such contradictions: it can provide the necessary economic resources in a non-profit model based on fair and inclusive subscriptions according to means; it can generate and maintain demand for connectivity, applications and local services; it can promote data ownership, autonomy and privacy. Whether the circumstances (technological, economic, political, cultural) for community growth exist or will be present in the future is an open question.

Appendix 1: Semi-structured Interview Guide

INTRODUCTORY QUESTIONS

In what ways is your network a Community Network? What are the purpose(s) of it and how are they served?

Can you tell me more about the origins and start of your community network?

How and why did you get involved in it?

What kind of hardware and software are you using for running the community network?

What kind of software do you use for running your hardware? Do you also use platforms that are specifically oriented on users of your community network? If so, which ones?

How did you decide on these technological choices?

SUSTAINABILITY

In this project we are interested in the sustainability of the Internet and community network.
What is your notion/understanding of sustainability?

How do you think sustainability relates to the Internet and community networks?

What in your opinion makes a community network sustainable or unsustainable

ECONOMY

Why did you feel the need to build an alternative network instead of using the mainstream Internet service providers?

Are there commercial ISPs in this area? How dominant are they in your region? What is their impact on your community network?

What kind of resources do you need or use to run your community network (in terms of finances, human resources, technology, or physical infrastructure)? Where do these come from? Have you faced problems in organising the money, technical staff & users, and technologies you need for running the community network? In what ways have they been or can be overcome?

How do you manage access to your community network? Why have you decided to organise in this way?
If the access is gratis: Why do you think gratis access is important? Have you faced problem by providing gratis access to your community network? [network congestion=lots of users => low bandwidth, problem of getting any money required for paying the infrastructure, employees, etc.]

If the access is commodified (users pay): Why do you think users should pay for access to your community network? Is there any risk of a digital divide in your community network? How do you think about the philosophy of 'free access for all' as a way for overcoming the digital divide**?**

POLITICS
[Ownership, governance and decision-making]
Who owns your community network? Why have you chosen this form of ownership?

How does the community network decide on the definition and use of certain licenses, standards, rules, technologies? How are conflicts/disagreements resolved? Have you experienced any problems in making decisions regarding the community network?

[Privacy and surveillance]
There have been many discussions about Internet surveillance post 9/11 and in the context of the so-called 'terrorist threat'. Some people argue that the Internet should be monitored to prevent crime, whilst others claim that such controls infringe on privacy. What do you think about this issue?
In what ways do issues of privacy and surveillance affect your community network? How do you deal with these issues? [data retention, storing of meta-data]

CULTURE
How do local people think and feel about your community network?

Who are the uses of your community network? Do they share a common identity? How often do new users join? Are there activities aiming at bringing users together?

What is the role of tech people running the community network compared to everyday users without technical expertise? Do they share common activities or do they form two separate groups? What has been your experience in this respect?

POLICY/ LEGAL

Did you face any legal problems in setting the community network up and now in running it?

Have you been involved in relevant policy debates and actions (national, European & international levels)?

How can policy help the introduction and development of community networks? Are there any specific policy/legal issues that need to be addressed in order to facilitate their introduction and running?

Appendix 2: Interview Consent Forms

The following informed consent form was provided to the interviewees who wished to remain anonymous:

Informed Consent Form

This interview/survey is part of the EU Horizon 2020 research project "netCommons: network infrastructure as commons": www.netcommons.eu.

Scholars from the five EU-based institutions involved in the netCommons project carry out the survey research. The study does not have any commercial purposes, the involved researchers do not have any monetary benefits by conducting the study and the results will be published in the form of a report and research papers based on the interview/survey. Furthermore, the collected data will be published in anonymous form as open data. The open data will not contain any personal identifiers, which is data that we are not interested to collect, do not ask for and do not publish.

We will not ask you to provide personally sensitive data in this interview/survey and all the answers provided will be used only in aggregate and anonymous form.

By signing this form, you confirm the following:

- *I agree to the digital recording of the interview/survey*
- *I agree that the answers I give are stored in digital form in a database in such a way that I am not personally identifiable (anonymous or pseudonymous form)*
- *I have been given the opportunity to ask questions about the project.*
- *I understand that my taking part is voluntary. I can withdraw from the study at any time during the interview/survey and I do not have to give any reasons for why I no longer want to take part.*
- *I understand my personal details such as my name, email, phone number and address will only be used by the researcher to contact me and not be revealed to people outside the project.*
- *I understand that my words may be quoted in publications, reports, web pages, and other research outputs in anonymous or pseudonymous form only (no name or other personal identifiable data will be mentioned).*

The person responsible for the treatment of the data used in this interview/survey is:

Prof. Christian Fuchs
University of Westminster

Email: c.fuchs@westminster.ac.uk

phone 44 20 7911 5000 ext 67380

If you have any questions, don't hesitate to contact him/her.

I agree to these terms and want to participate in the interview/survey.

Yes **No**

Signed: Date:

The following informed consent form was provided to the interviewees who wished to be named:

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● *I understand that my words may be quoted in publications, reports, web pages, and other research outputs under my name*

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I agree to these terms and want to participate in the interview/survey.

Yes **No**

Signed: Date:

The signed informed consent forms for all interviewees are stored at the UoW archives and are under the responsibility of Prof Christian Fuchs.

Appendix 3: Evaluation Form of the Sustainability of Community Networks

The purpose of the evaluation form below is to assist communities to assess various aspects of sustainability when considering the building, maintenance and subsequent development of community networks. The form is based on the analytical framework elaborated in D2.1 (summarised in Table 13 in D2.1) as enriched by the fieldwork presented in this deliverable (Table 1). The points derived from the fieldwork are shown in bold in the form below; the remaining points are taken from the analytical framework developed in D2.1.

This form is to be used by key actors involved in the building, running and development of community networks (rather than the users of the network), similar to those approached for the fieldwork of this deliverable. Indeed, the form builds on the main issues that the key actors involved in the community networks interviewed raised and as such certain aspects developed in the analytical framework in D2.1 are not included here simply because they did not figure highly or at all during the interviews conducted (for instance, aspects of the 'nature' broad dimension). Our aim in developing this evaluation form is to build on the experience of the case studies we examined. We are fully aware of the limitations of constructing the evaluation form on the basis of evidence provided by the seven case studies we selected and respondents to the evaluation form should bear this in mind.

For a fuller account of sustainability, those interested are encouraged to use the evaluation form together with the fuller picture of sustainability presented in Table 1 'Checklist for sustainability issues in community networks with input from fieldwork' in the Conclusion of this deliverable. In any case, the results of the evaluation form should be read as indicative, as opposed to definitive, of the sustainability potential of a community network initiative. The objective of the form is to generate discussion and thinking around the issues it raises with the ultimate aim to help the formulation of solutions which promote the success and sustainability of such community initiatives.

Evaluation Form of the Sustainability of Community Networks

ECONOMY
Market and model of provision
• **To which extent is the community network supported by non-profit/community-based network access and services provision?**
• **To which extent does the community network rely on a commercial provider? What is the nature of this provider (e.g. for-profit vs. social enterprise, or local vs. non-local)?**
• **To which extent does the model of network provision of the community network face competition from commercial for-profit telcos on the basis of quality of signal/provision, lower cost and/or better network maintenance?**
Resources
• To which extent does the community network manage to survive economically, i.e. to afford the necessary hardware and labour-power necessary for running the network?
• To which extent can the community network ensure that it has enough resources, supporters, workers, volunteers, and users?
• **To which extent does the community network rely on internal funding sources?**
• **To which extent does the community network rely on external funding sources? How regular are they?**
• **Are there possibilities for the community network to obtain public or municipal funding or to co-operate with municipalities, public institutions or the state in providing access and services?**
• **To which extent are there people to provide the technological skills for running/maintenance/upgrade of the community network?**
• **To which extent are there people to provide skills in accounting or law?**
• **To which extent does the community network rely on a single individual or a small group of actors for providing the necessary resources (time, skills, money)?**

• Can the risk be avoided that the community network becomes a “secondary Internet” that is marginal, slower and less attractive than other services? How? What strategies can be used for avoiding marginalization and resource precarity?
Economic democracy
• To which extent is the community network controlled by the community?
• Is the community network collectively controlled by its members as a common good? How can the community network best ensure that it is a not-for-profit project?
• To which extent is the community network controlled by the local/municipal authorities?
• To which extent is the community network controlled by private interests?
• Are those who work professionally for the maintenance of the network fairly remunerated for their labour?
• Is the network large enough to attract significant numbers of users so that this community can have mutual benefits from network effects?
• How can possible congestion and slowdown of the network best be avoided if it is very popular?
Network wealth for all
• To which extent does the community network provide gratis/cheap/affordable network and Internet access for all?
• **If subscriptions are used, are they affordable?**
• **To which extent are there different pricing schemes such as for residential users, small enterprises, bigger firms, and public institutions (e.g. schools)**?
• How can the community avoid or lower the digital divide?
• How can the community network help to avoid a two-tier Internet with slower Internet access for some and faster for others?
• How can the community network avoid the commodification of a) access (i.e. using access fees) and b) users (i.e. using advertisements) that bring about a) inequality of

access and b) the exploitation of users' digital labour?
• **What technological skills are required of the average user to benefit from the community network?**
Needs
• **To which extent are the community needs served by the community network?**
• **To which extent are the needs of diverse individuals (e.g. by gender, age, nationality) and groups in the community served by the community network?**
• **To which extent are the needs of local businesses served by the community network?**
POLITICS
Participation/governance
• How is the community network governed? How does it decide on which rules, standards, licences, etc. are adopted?
• To what extent does the community network allow and encourage the participation of community members in governance processes?
• To what extent are there in place mechanisms for conflict resolution and for proceedings in the case of the violation of community rules?
Data ownership and control
• To which extent does the community network enhance the protection of privacy of user data?
• **To which extent does the community network provide opportunities for active user involvement in the management of their data? What are the skills required and how are they provided?**
• **To which extent and for how long are user data kept in servers controlled centrally (e.g. by the network administrators)? How do you guarantee that data storage is done in line with data protection regulation and is privacy-friendly?**

CULTURE
Community spirit
• **How closely knit is the community? To which extent are trust and solidarity present and how are they manifested?**
• To which degree is the community network a “geek public” that has an elitist, exclusionary culture or a “community public” that is based on a culture of unity in diversity?
• To which extent does the community network provide mechanisms for learning, education, training, communication, conversations, community engagement, strong democracy, participation, co-operation, and well-being? In what ways?
• To which degree is the community network able to foster a culture of togetherness and conviviality that brings together people? In what ways?

Bibliography

Anand, Sudhir, and Amartya Sen. 1994. 'Sustainable Human Development: Concepts and Priorities, Office of Development Studies Discussion Paper, No. 1'. http://hdr.undp.org/sites/default/files/anand_sudhir_-_sustainable_human_development-_concepts_and_priorities.pdf.

B4RN. 2016a. 'B4RN [Broadband for Rural North, UK] Website'. Accessed December 6. http://b4rn.org.uk/about-us/).

———. 2016b. 'B4RN Charges'. Accessed December 6. http://b4rn.org.uk/b4rn-service/charges/.

———. 2016c. 'B4RN Investors'. Accessed December 6. http://b4rn.org.uk/b4rn-community/investors.

Benkler, Yochai. 2006. *The Wealth of Networks*. Yale University Press.

Bina, Maria, and George Giaglis. 2004. 'A Game Theoretical Approach to Community WLANs Research. Working Paper 2004-008.' Athens University of Economics and Business.

Bryman, Robert. 2012. *Social Research Methods*. Oxford: Oxford University Press.

Fuchs, Christian. 2010. 'Theoretical Foundations of Defining the Participatory, Co-Operative, Sustainable Information Society'. *Information, Communication & Society* 13 (1): 23–47.

———. 2017. 'Sustainability and Community Networks'. *Telematics and Informatics* 34 (2): 628–39. doi:10.1016/j.tele.2016.10.003.

Gaved, Mark. 2011. *An Investigation into Grassroots Initiated Networked Communities as a Means of Addressing the Digital Divide*. PhD Thesis. London: The Open University. http://oro.open.ac.uk/id/eprint/29696.

Gray, David E. 2014. *Doing Research in the Real World*. 3rd ed. London: Sage.

Gurstein, Michael. 2007. *What Is Community Informatics and Why Does It Matter?* Monza: Polimetrica.

Hess, Charlotte, and Elinor Ostrom. 2003. 'Ideas, Artifacts, and Facilities: Information as a Common-Pool Resource'. *Law and Contemporary Problems* 66 (1/2): 111–45.

———. 2011. *Understanding Knowledge as a Commons: From Theory to Practice*. MIT Press.

McChesney, Robert, and Foster Bellamy. 2011. 'The Internet's Unholy Marriage to Capitalism'. *Monthly Review* 62 (10). http://monthlyreview.org/2011/03/01/the-internets-unholy-marriage-to-capitalism/.

Medosch, Armin. 2015. *The Rise of the Network Commons*. http://www.thenextlayer.org/NetworkCommons.

Mosco, Vincent. 2009. *The Political Economy of Communication*. 2nd ed. London: Sage.

Ofcom [UK]. 2004. 'Ofcom Frequently Asked Questions'. https://www.ofcom.org.uk/phones-telecoms-and-internet/information-for-industry/policy/electronic-comm-code/faqs.

Robson, Colin. 2011. *Real World Research: A Resource for Users of Social Research Methods in Applied Settings*. 3rd ed. Chichester: Wiley.

Sandvig, Christian. 2003. 'Assessing Cooperative Action in 802.11 Networks. 31st Conference on Communication', 31st Conference on Communication, Information, and Internet Policy. Washington, D.C., . https://www.researchgate.net/publication/228539408_Assessing_cooperative_action_in_80211_networks.

Silverman, David. 2014. *Interpreting Qualitative Data*. 5th ed. London: Sage.

Stiglitz, Joseph, Amartya Sen, and Jean-Paul Fitoussi. 2009. *Report by the Commission on the Measurement of Economic Performance and Social Progress*. CMEPSP.

Wallace, Claire, and Kathryn Vincent. 2015. 'Six Factors for Success in Community Broadband Initiatives'. *Interactions* 23 (1): 36–39. doi:10.1145/2847208.
Yin, Robert. 2008. *Case Study Research: Design and Methods*. 4th ed. London: Sage.

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