9 Complementary Networks Meet Complementary Currencies: Guifi.net Meets Sardex.net

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Abstract

Reading in parallel the description of community networks and community currencies reveals many similarities and differences between these two models of self-organisation around networking infrastructures and monetary systems, respectively. This chapter brings together experts from both domains in an effort to share knowledge and experience, using as case studies two emblematic projects, Catalonia's success story on community networks, Guifi.net, and Sardinia's success story on community currencies, Sardex.net. The long-term objective is to build a better common understanding of the individual models but most importantly the stimulation of synergies and collaborations of researchers and activists from both sides.

Acknowledgement

9.1 Introduction

Community (wireless) networks (CNs) are communications networks built out of the individual contributions in time, money, hardware, and software by the community members. The most typical image behind the construction of such a network is the mounting of antennas on rooftops, which create wireless links that can cover from small to large areas. Successful community networks like guifi.net and Freifunk.net include in their collective

infrastructure also fibre cables, and more. The resulting networking infrastructure is a *commons* that can offer access to the Internet in so called "market-failure areas", such as rural regions, where commercial Internet Service Providers (ISPs) do not have a benefit to invest. The newly created common networking infrastructure can be also used as a basis to provide a wide variety of local services, hosted and sometimes only reachable inside the geographic area covered by the network. The latter has been always considered as one of the big advantages of CNs but until now it has not delivered its promises.

Indeed, the Internet could in principle support also local online interactions. The promotion of local interactions would represent a substantial change of the current situation, which is rarely analysed critically by Internet users. Indeed users do not seem to consider the potential problems of using online platforms based in a foreign jurisdiction, very far from the local area served; owned by multinational corporations completely disconnected from local institutions, whose main concern is the extraction of (local) value for a limited number of external investors; and if sensitive private information is gathered, processed for vaguely communicated purposes and shared with unspecified "third parties" for the exclusive profit of platforms' shareholders (Belli et al., 2017).

Is it possible to build more ethical platforms that support local development instead of being based on an extractive model, while still operating on a global scale? Should we focus instead on local solutions that are in principle more "complementary" than "alternative" to the Internet and may consider scaling up at a later stage? In this latter case, should network infrastructure be clearly treated as a community resource by the services offered on top of it? Can we act just as a *homo civicus* would do, sensitive to the collective implications and local effects of our individual choices, or are we always going to behave like a *homo economicus*, purely driven to the cheapest option at any cost?

Interestingly, advocates of community currencies (CCs) face different but in some sense analogous challenges to the ones faced by CNs. For example, community or complementary, or regional, or alternative, or social currencies are also subject to the "why?"

question. As the global Internet can support local communications, similarly the globally established national currencies like the US-Dollar or the Euro (also called fiat money) are perfectly capable of supporting the functionality of a local community currency, *i.e.,* the exchange of goods and services in localities. Moreover, they do so avoiding the limitations and the increased risk of failures introduced by an extra currency limited to a specific geographic location.

As in the case of communication networks, most people do not feel empowered or even allowed to operate their own local economy. "Is it legal?" is often the next question when one starts debating the pros and cons of a community currency. The answer is that, depending on the scale, a local currency can be more or less easily designed to be perfectly legal and compliant with, for example, tax regulations. Nevertheless, for this to happen it requires the mobilisation and cooperation of many different actors and a broader awareness of how the economy works and why local currencies play an important role from the perspectives of sustainability, resilience, social learning, self-determination, and more.

The same holds for CNs, which similarly to CCs are not well understood by the wider public and face various social, political, economic, legal, regulatory, and educational challenges. They also have to compete with global institutions with tremendous power and require a level of social cohesion and local collaboration that is more and more difficult to take for granted, while the solutions they offer may be complex to implement and prone to failures. In some countries, furthermore, communications regulation can make it difficult on legal grounds to establish a separate and independent communications infrastructure.

Both types of community initiatives share similar long-term objectives: to close digital (for CNs) and economic (for CCs) divides, which often depend on and influence each other; to offer easier access to information and services; to promote local social and economic development and employment; and to strengthen local identity and culture.

However, not all CNs and not all CCs are the same. Most importantly, there are different levels of "complementarity" in

relation to the global system, the Internet and the global economy, respectively, for which such platforms provide an alternative local solution. For example, the most well-known CNs – both in rural and urban areas – are mainly perceived by outsiders as free or cheap gateways to the Internet, while failing to understand the significant differences between them on how such access is achieved. In addition, when they do support *local* interactions besides providing Internet access, this is often between those who contribute in the construction of the network, the "node owners" typically tech enthusiasts and hackers. Some CNs have successfully engaged the local community in a more inclusive way, as is the case of the Redhook[189] WiFi initiative in Brooklyn (Baldwin, 2011) or Quintanalibre in Argentina (Belli, 2017), but their overall impact is still rather limited. As will be further discussed below, guifi.net[190] is a special case that distinguishes completely between the network infrastructure and the services provided on top, including the Internet connectivity.

At the same time, the CC ecosystem is filled with numerous important design variables that generate a very complex design space. There are solutions putting small and medium-sized enterprises (SMEs) at their centre like WIR[191] in Switzerland and Sardex.net[192] in Italy, others that have expanded this idea towards customers, like RES[193], established in Belgium and now expanding to Catalonia. Others aim to support the regional economy and sustainability as the English transition currencies Totnes Pound[194] and Bristol Pound[195] or the German Regiogeld Chiemgauer[196]. There are also examples of currencies with social and environmental motivations like Torekes[197] in Gent, Belgium or Spice Credits[198] in

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189 See <https://redhookwifi.org>.

190 See <http://guifi.net>.

191 See <http://wir.ch>.

192 See <http://sardex.net>.

193 See <https://www.res.be>.

194 See <https://www.totnespound.org>.

195 See <http://www.bristolpound.org/>.

196 See <https://www.chiemgauer.info>.

197 See <http://www.torekes.be>.

198 See <http://www.wearetempo.org/>. (Spice changed its name in Oct. 2018 and is now called Tempo Time Credits)

England and there are many hundreds of time banks[199] and LET-Systems[200] worldwide.

In the following sections, we develop a parallel introduction of CNs and CCs as collaborative "commoning"[201] activities, around six key characteristics:

1. The "commons" resource (characteristics, properties)

2. Community building (bootstrapping, membership, vision)

3. Managing the commons (participation, accounting, rules, decision-making)

4. Boundaries and complementarity (interactions with the global system)

5. Growth model (distributed vs. centralized architecture)

6. Computer-support tools (proprietary vs. free software)

Reading in parallel the description of CNS and CCs will already reveal many similarities and differences. However, the goal of this paper is not only to highlight those similarities but engage in a discussion with the stakeholders in a wide range of community-based initiatives that will allow to learn from each other's successes and failures. Such exercise may also lead to collaborations on the production of more holistic models of local ownership and governance of these core common resources, networking and financial infrastructures.

For this, we have chosen to focus on two success stories, and somehow special cases: the guifi.net CN and the Sardex.net CC. We discuss their particular interpretation of complementarity, how they managed to scale, and the key compromises that they had to make on the way. This analysis leads us to understand better the concept of "complementarity" in the case of CNs, inspired by the importance that this has played since the financial crisis in the case of CCs, and vice versa.

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199 The term time bank refers to a reciprocity-based work exchange system in which hours are the currency.

200 LETS: Local Exchange and Trading System

201 See <http://wiki.p2pfoundation.net/Commoning> for a definition of the term.

This analogy and knowledge sharing exercise between these two different domains of collective action will also hint to possible integrated models of both complementary networks and currencies in specific geographic areas. For example, an appropriately designed complementary scheme can place a CN into a broader local economy. This would enable, on the one hand, the provision of incentives for investments in infrastructure and effort for deployment and maintenance of the network and, on the other hand, the inclusion in the community of people and companies that do not have ICT expertise, but can bring other resources and competence.

9.2 Two success stories: the guifi.net Community Network and the Sardex.net Community Currency

CNs are communication networks built by citizens and organisations who pool their resources and coordinate their efforts to develop a local networking infrastructure (Baig, 2015). The infrastructure is built, via a collaborative process, by individuals who, typically, install some kind of network equipment at home or at a participant organisation. They deploy an antenna on their roof, or a cable or optic fibre, and connect with others in an urban or rural area over short or long distances.

The resulting network infrastructure can then be used for internal communication between those that have access to the network or for delivering local content, such as live video, or providing services, such as symmetric access to the global Internet. This is possible when an "Internet source", an Internet gateway, is made available inside the network infrastructure. They are sometimes referred to as wireless community networks (WCN) when built fully with wireless technologies (point-to-point, access points, or mesh topologies, with WiFi or GSM links).

Our selected example of a successful community network is guifi.net, a citizen project in Catalonia with over 34,000 nodes branded as "a network infrastructure as commons"[202], on top of which a wide variety of entities take advantage of

202 See also the EU Horizon2020 project (2016-2018) netCommons: <http://netcommons.eu>.

the local connectivity to offer a variety of services, including Internet access for clients and servers. Many people use the network infrastructure for the good-quality connectivity that it provides. One of its most important strengths is that connectivity is managed cooperatively, while at the same time the core infrastructure is managed purely as a commons. These are some of the reasons why the CN received the European Commission's 2015 European Broadband award on "Innovative models of financing, business and investment"[203].

In the case of currencies, differences between community currencies that are not national currencies (legal tender or fiat money) have led to different designations:

- *Alternative* is maybe the broadest term, indicating all non-official currencies but also a competitive stance with respect to the dominant national currencies.

- *Community*, or *social*, highlights democratic and social goals, and tendency to foster the benefits of society, emphasising self-help and caring and often focusing on social projects and services that are not part of the mainstream market.

- *Complementary* indicates a more cooperative relation towards national currencies, complementing them where they do not succeed, while remaining compatible with them (e.g. by paying taxes on the payments and deposits in CCs).

- *Regional* or *local* are often used to stress the limited geographical area where CCs apply.

In this chapter we use the fairly generic term "community currencies", since this is also used for the case of networks, and the term "complementary" for the special category of community currencies, like Sardex.net, that we want to draw attention to.

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203 European Broadband Award 2015: <https://ec.europa.eu/digital-single-market/en/news/five-projects-got-first-ever-european-broadband-award>.
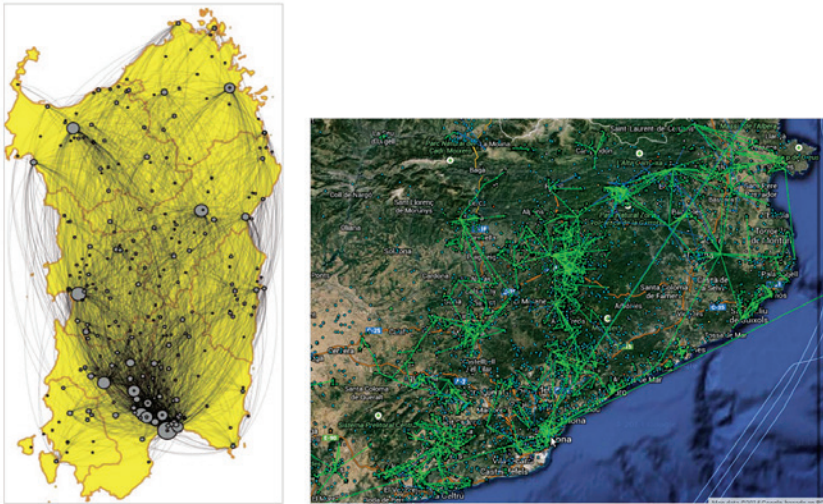
Figure 9.1. Comparison: economic transactions using Sardex.net in Sardinia, Italy (reproduced from Iosifides *et al.* 2015) and guifi.net network graph sector around Barcelona, Spain.

Similarly to guifi.net, Sardex.net is a very successful complementary currency in Sardinia, Italy, founded in 2009 (Littera *et al*., 2017; Posnett, 2015). Figure 1 depicts two popular graphs of the two networks. The graphs might look similar, but in reality, they represent two different communication layers. The Sardex.net graph corresponds to the actual transactions between members of the Sardex.net network that are limited only by demand-supply relationships. The guifi.net graph corresponds to the communications network, the network infrastructure itself, which is limited by the geography and equipment costs, and thus results in a more structured network with "highways" and "low traffic roads". However, like in Sardex.net, the guifi.net network allows the implementation of a wide variety of services that could mediate interactions between any set of nodes.[204]

Sardex.net has managed to offer a local currency system that is operated by local actors, offering credit without interest to local businesses, and promoting the local economy while at the same

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[204] Every participating business could be seen as "node" in a CC that is connected through buying and selling to other "nodes".

time remaining compatible with the global economy. That is done by setting one Sardex equal to one Euro but not allowing convertibility between the two. Mixed payments, however, are allowed, e.g. an article offered at a price of 100€ by a participant might be paid with 50€ plus 50 Sardex by the buyer.

Sardex is in fact a commercial credit circuit which gives a credit-limit to the member businesses that is a fraction of their estimated ability to produce (and sell) goods and services. This credit can be used to buy from others and should be repaid by selling to others. Most important here is "the absence of interest on all balances" (Dini and Kioupkiolis, 2014, p.9). Even if there is no direct exchange between Sardex and Euro, every transaction in Sardex is subject to VAT tax in Euros, as the business keeper books it as if it were an income in Euros.

The success of Sardex.net is impressive: after only seven years of existence, around 3.800 businesses representing more than 2% of all enterprises in Sardinia are participating to the initiative. The accumulated transaction volume, until June 2017, exceeded already more than 212 Million Euro (in 2015, the volume was 51m and, in 2016, 67m). Like guifi.net, Sardex.net was awarded several prices, including the 2013/14 European Business Award.

It is interesting also to note how both these systems started in small villages out of a pressing need (the lack of Internet connectivity in the case of guifi.net and the lack of credit from banks in the case of Sardex.net[205]) and were founded by small teams of highly motivated and trusted people. Those individuals keep, until today, the decision-making power while trusting that their actions are toward the common good.

The strong regional identity is another common characteristic of the environments (Catalonia and Sardinia) where these two systems managed to develop further than the majority of their counterparts. Is this the most important requirement for success or perhaps a small extra driving force that could be replaced by clever design choices derived from the lessons learned from these pioneering systems?

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205 In times of crisis, weak economies experience a lack of the medium of exchange, which in the case of SMEs is experienced as a lack of credit from banks.

Finally, another key reason behind our choice of guifi.net and Sardex.net as the leading examples of the two domains of local action, which we wish to study in comparison, is their innovative models of governance and sustainability; and especially the way they have positioned themselves in relation to the dominant players, not as potential replacements but as complementary solutions.

9.3 Six common characteristics of CNs and CCs, in comparison

9.3.1 Common resource

9.3.1.1 CNs

The collection of antennas, cables, hardware (i.e., routers, servers), and services, sometimes including Internet connectivity form an infrastructure that serves as a common-pool resource (i.e. common property) for those that have contributed individual resources. Thus, unlike traditional ISPs, the ownership and management of the infrastructure are collective and cooperative: since they are distributed amongst the members of the community, they constitute in essence a framework for "commons" governance (Ostrom, 1990). CNs are characterised by being open, free, and neutral.[206] They are open because everyone has the right to know how they are built. They are free (as in freedom) because the network access is driven by the non-discriminatory principle; thus they are universal. In addition, they are neutral because any technical solution available may be used to extend the network; and because the network can be used to transmit data of any kind by any participant, including for commercial purposes (Baig *et al.*, 2015).

CNs generally feature three types of resources: *individual* or peer-contributed such as routers in a small mesh network or individual content servers that can self-organise in a purely decentralised manner; *group* or local resources to be crowdfunded, contributed and managed by a regional group, such as local backbone capacity and maintenance of local services (*e.g.* software and services such

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206 See Declaration on Community Connectivity <https://www.intgovforum.org/multilingual/index.php?q=filedepot_download/4391/1316>.

as telephony, conferencing, media, Internet); and *global* resources to be contributed and managed by the community at large (*e.g.* node database, public website, Internet interconnection, traffic exchange). While the first is typically based on contributing your own device and on emergent behaviour, the other two types of resources rely on coordination mechanisms that require more abstract contributions and the aggregation of money and effort to crowdfund these resources.

In the case of guifi.net all above resources are present and managed collectively as a commons as described in Section 3.3 below.

9.3.1.2 CCs

The currency itself can be considered as a common pool resource[207], and be conceived like a network through which participants can compare, exchange or store economic values. In the same way that a CN, as a commons, is not just a passive set of routers and links, in the case of currency the governance framework that ensures the fair operation of the currency and the corresponding market are a commons. Finally, the stability of the network is based on trust which is another common resource deeply connected with the behaviour and trust relationships among the participating humans.

Typically, community currencies are organised as legal entities (*e.g.*, associations, cooperatives, non-profit organisations or for-profit companies). Many currencies run on centralised ICT infrastructures and platforms like Cyclos[208], CES[209], etc. In some cases, paper notes are used alone or alongside with electronic money. However, the costs associated with the maintenance of this infrastructure have to be covered. This is done through voluntary work, membership fees, and demurrage fees or, in the case of professional currencies, by transaction costs, fixed fees, or even a taxing system. The

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207 A good explanation is given by Graham Barnes (2014, p.1): "From one particular point of view – that of money as private property – the idea that money could be treated as a Common Pool Resource (CPR) seems patently absurd. [...] But going forward money is either a reward for past work, or (when issued through the device of credit) an advance secured in expectation of future work. From this viewpoint we can see money as an aspirational commons – a Common Pool Resource backed by our collective efforts, that with the right governance regime could be managed equitably and to mutual benefit."

208 See <http://cyclos.org>.

209 See <http://community-currency.info/>.

currency survives as long as its operational costs are covered, as it is well operated by the management, and is regularly used by the members of the community.

In the case of Sardex.net, unlike guifi.net, the core infrastructure is centrally managed by the Sardex S.p.A. (Inc.) company, but the mutual credit network itself and most importantly the trust relationships built around it (Littera *et al*., 2017), are certainly a commons built step-by-step through the individual contributions of all participants.

9.3.2 Community building

9.3.2.1 CNs

CNs are typically constructed either out of social or economic need (in most cases due to limited or no access to the Internet) or out of political reasons related to sovereignty, independence, network neutrality,[210] affordable Internet access for all, and more. Being fully inclusive to their natural community, the fundamental principles revolve around i) the openness of access to the infrastructure (usage), and ii) the openness of participation (construction, operation, governance) in the development of the infrastructure and its community.

Nevertheless, there are often misunderstandings since the word "community" could have a different meaning depending on the situation. A "community" could refer to a community of like-minded people connected through their own "overlay" network in a big city. It could refer to the wider community of any people enjoying the services of a local network, as for example a rural village. It could generally refer to services organised by public administrations.

Antoniadis (2016) analyses in detail the differences between the first two interpretations of the term community in "community networks", which together with the two basic services offered (local vs. Internet connectivity) form a two-dimensional matrix, which could be used to characterise a specific CN. The netCommons

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210 For further information on the concept, see <http://www.networkneutrality.info/>.

project's report (Navarro *et al.*, 2016) provides a descriptive and comparative analysis of the organisation and governance of several CNs.

Guifi.net is an example of a network that cannot be easily classified and thus provide a single point in a two-dimensional matrix for the whole network. Indeed, guifi.net is a big federated social community with multiple local network infrastructures, including rural networks offering connectivity to certain small to medium communities, or urban CNs such as in several neighbourhoods in Barcelona**.**

Therefore, different types of communities operate at different layers of this complex social arrangement, from the local "traditional" communities of rural areas, to the overall guifi.net social community coming together at the annual meeting and assembly, to the international community of policy makers, researchers, activists, and other key actors, like the DC3[211], GAIA[212], and battle of the mesh community[213].

However, the guifi.net social community has succeeded in reducing the dependence of the network operation and sustainability of local or regional network infrastructures, from the strong face-to-face ties between like-minded individual volunteers. Opportunities to develop professional services, have become a way towards local economic sustainability, but also have become attractive not only to those that share the same values of self-determination, but also to those who just wish to have access to affordable Internet access of high quality in exchange of a service fee.

9.3.2.2 CCs

Similarly to CNs, most CCs are built and maintained by groups of like-minded people. Those "core" groups need to promote the currency, motivate participants and foster engagement. Time-exchange or LETS-groups[214] for example gather in regular meetings to facilitate the exchange of services and goods. Larger systems organise

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211 See <https://www.comconnectivity.org/>.

212 See <https://irtf.org/gaia>.

213 See <http://battlemesh.org/>.

214 See <http://www.lets-linkup.com/>.

market events or even big regional fairs as the WIR-Messe[215]. Online marketplaces and maybe forums or discussion groups are also essential for most currencies.

The effectively realised transactions are the most important success metric for the majority of all CCs. For this support by brokering could be crucial, but is not often used. Nevertheless, US or British time banks use professional brokers and Sardex.net, and its off-springs in Italy, have been very successful by following such a strategy. Part of the success of the Sardex brokers stems from the fact that they are employees of Sardex S.p.A. (Inc.) and do not receive a commission on successful matches. This improves the perception of the quality of service offered and fosters trust between the circuit members and the central credit clearing company.

Another approach is used by the German Chiemgauer Regiogeld, which introduces all sorts of local cultural and sports clubs by sponsoring them through exchange and demurrage fees. The members of Chiemgauer decide, by declaration, which of these clubs should get their turnaround-benefit.

Sardex.net is also very active in community building events at different scales, with most prominent the annual Mitzas conference[216]. However, as in the case of guifi.net, the motivations for the participation in the network go beyond the community spirit and shared values, and include the access to high-quality brokering services, interest-free loans, and a robust local economy with many concrete benefits for local SMEs.

9.3.3 Managing the commons

9.3.3.1 CNs

One of the key challenges of CNs and in general peer-to-peer systems is the fair sharing of the available resources, efforts and costs, and the existence of the appropriate incentives for participation and investments required to sustain the infrastructure. In the case of "locally-driven" communities, this may

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215 See <http://www.wmzag.ch/>.

216 See <https://www.sardex.net/mitzas-intelligenza-connettiva/>.

not be a big issue since most participants have strong motivations for participation and there is a significant level of contributions, without the need of incentives, as additional common costs such servers, backbone, maintenance are negligible and can be easily assumed by some members. However, when Internet connectivity is one of the main services offered there are non-negligible common costs that need to be taken into consideration. In this case, there are different approaches.

On the one hand, there is the "free Internet for all" approach of highly decentralised systems like Freifunk.net and WLANSlovenja, which depend mostly on voluntary contributions of their members to offer Internet connectivity to all that have access to the network, without exceptions. On the other hand, there are more structured approaches like the French FFDN, which operates as a network of "ethical" ISPs, offering good quality and non-discriminatory connectivity, at lower prices compared to commercial ISPs.

Between these two instances, there are various alternative options in terms of ownership, management and contribution of the common resources, including Internet connectivity. Guifi.net has developed a unique model, in which the network infrastructure is treated as a separate commons from the services on top of it, and Internet access is just one of them. A *compensation* scheme is being implemented to create an economic balance between consumption and contribution of connectivity that works for both voluntary and commercial services (Baig *et al.*, 2016).

The result is a diverse offer of fee-based and free-of-charge Internet connectivity provided by volunteer or professional ISPs reachable through guifi.net. The same model applies to any other service. For instance telephony (via Voice over IP) is offered as free or fee-based by diverse voluntary or professional providers.

Among other governance instruments (Crabu *et al.*, 2017), the guifi.net licence (Network Commons Licence[217]) establishes the participation framework. It sets the freedoms and boundaries of the commons (Baig, 2015).

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[217] The FONN licence can be accessed at <http://guifi.net/en/FONNC>.

Any guifi.net participant must subscribe to the community licence. The licence preamble has four freedoms, comparable to libre software licences:

1. You have the freedom to use the network for any purpose as long as you do not harm the operation of the network itself, the rights of other users, or the principles of neutrality that allow contents and services to flow without deliberate interference.

2. You have the right to understand the network and its components, and to share knowledge of its mechanisms and principles.

3. You have the right to offer services and content to the network on your own terms.

4. You have the right to join the network, and the obligation to extend this set of rights to anyone according to these same terms.

Importantly, the guifi.net licence is written to be enforceable under the Spanish legislation. Legal certainty is essential to stimulate participation and investment that, in turn, is at the base of any economic activity. The licence has been developed as part of a long-lasting participatory deliberation process over several years, with contributions from many community members, reaching a consensus, revised and approved in several versions by the Foundation's Board.

9.3.3.2 CCs

In addition to the basic accounting functionality that is inherent in every currency, sustainable CCs need to take measures against failures. In many systems, members that fail to pay back their negative credit could be difficult to handle because the legal situation is often based on weak membership agreements. On the contrary, members that have too much positive credit and do not spend it, and therefore block the flow, might become serious obstacles. Another important point is the guard of the boundaries as mentioned later. For instance, in a non-convertible currency like WIR it is forbidden to exchange WIR-francs into Swiss francs but still some businesses do that and, in such circumstances, the management has to take measures to punish rule breakers (*in extremis* by exclusion).

An important decision-making process to this end, and especially when there is no exchange between the local and the national

currency, is the "credit lines" offered to different members of a community currency. This is a very complex risk assessment process that requires intuition and good knowledge of the community on behalf of the currency managers and a high-level of trust by the community toward the management.

In Sardex.net, credit lines are a fraction of turnover (about 2% on average). Any (*multilateral*) debt created by the company must be recovered within one year by selling back to the circuit its 'spare capacity' in terms of products and services, which represent the 'backing' of the currency. Since the backing (about 10% of turnover) is much larger than the credit lines, the financial model is the opposite of a speculation bubble and very stable. In addition, Sardex is very active in helping to avoid irrecoverable debt situations through a very effective brokering and sales service,[218] which strives to maintain a healthy local economy for instance with sector-specific interventions if a weak link in a supply chain is detected, while at all times seeking to extend the circuit to all product and service sectors.

9.3.4 Boundaries and complementarity

9.3.4.1 CNs

The fundamental principles of open and non-discriminatory access, and open participation, in the life of a CN are integrated with instruments such as the community licence, the management tools, and the specific collaboration agreements with professionals and third parties. These instruments prevent exclusion and regulate open and fair usage of the resource, clearly defining the boundaries, the 'bundle of rights' (Schlager, 2015).

When discussing the design and deployment of local services offered by a community network, a very challenging question arises: What does local actually mean? What are the borders inside which a local service is made available? Moreover, how are they related to the complementary Internet services?

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218 The sales persons are called "Community Trade Advisors" or CTAs. They are not employees and receive a commission on successful onboarding instances. The Brokers provide a post-sale customer service, they are employees, and do not receive a commission on successful brokering events.

Today, most CNs advocate for the development and hosting of local services inside the CN. That provides very cost-effective service hosting facilities (community data centres) allowing dual-sided services that can be reached from inside the CN (an intranet) or from the Internet (using a single or double local and global IP address).

In guifi.net cheaper and safer local connectivity is used for local traffic (e.g. IoT applications, local videoconferencing), whereas Internet services are reached through global Internet connectivity as each participant can be attached to both networks. The costs of both are defined and governed separately, one being the local network infrastructure commons, and the other being the Internet access commons. In each one, the overall costs are shared among all participants, again, as a commons.

9.3.4.2 CCs

Perhaps the most important decision while designing a complementary currency is whether and how local currency can be exchanged to the predominant national currency. In other words, how the boundaries of the currency are defined and managed. Schroeder (2016) recognised this feature as crucial and links the extent to which a new currency is competing or complementing national currency to the long-term success of that currency in being socially just. Blanc distinguishes four dimensions – commensurability, convertibility, co-use, and coincidence – to determine the relation between different currencies (Blanc, 2009:6). Currency design and rule setting can determine these features and the resulting boundaries, but these will be also influenced by the actual use of the currency.

For example, allowing the seamless exchange of a CC to the national one facilitates the participation of people since there is no fear for lost income in case the local currency is abandoned. However, this can reduce significantly the impact of the currency in the local economy and the overall economic behaviour that it promotes since it does not pose strong incentives to avoid economic exchanges with external actors (Sartori and Dini, 2016; Motta *et al.*, 2017). In other words, because the CC is only valid for a small spectrum of purposes compared to the national currency it is much more likely to exchange CC into national instead of national into CC.

This leads to a very limited or decreasing liquidity, making the CC even more unattractive. For this, many schemes implement a "penalty" for such an exchange while others do not allow it at all. The compliance with the national tax regulations is also a very crucial aspect since it is necessary for a community currency to adapt to the existing legal framework especially if it wishes to extend its reach to traditional markets and increase its scale.

In Sardex, transactions below 1000 EUR are paid in Sardex, while transaction above 1000 EUR can be partly paid in EUR. Most importantly, for every transaction VAT is paid on the whole amount in EUR. As we discuss in more detail in the following section, although this feature might be considered a "weakness" of Sardex, it is actually one of the reasons that allows Sardex to grow at a significant scale and make feasible an alternative interest-free economy here and now.

9.3.5 Growth model

9.3.5.1 CNs

There are different ways to approach the concept of "growth". A first one may entail a specific network under a certain administration, growing bigger and bigger, scaling up with more and more nodes connected, as it includes more users (higher density) in the same area, or more space (wider coverage). A second one may focus on a specific set of technology, rules, and branding, in other words a certain "model" being replicated in different places, as part of a single federation (under a single governance) or as a new disjoint community.

When these two forms of growth are combined it is not always easy to identify the borders of a single "autonomous system". However, we can always assess the growth of a certain network by considering two important characteristics: how easy it is for a new participant to join the network (for scaling up) and how easy it is to create a new network of the same type from scratch (for replication or federation). Note also that scaling is usually non-linear: *e.g.* in infrastructure mode, a supernode[219] (not trivial

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219 The term supernode refers to a central node of the network.

to install) can allocate tens of end-user nodes (relatively easy to install); on the other hand, in the ad hoc mode mesh clouds at some point saturate, such that going beyond the point of saturation is not easy.

As community networks grow and become a significant or even a critical infrastructure for local or regional connectivity, they also serve more purposes, from experimentation to sustainable or even critical infrastructures. That brings specialization, professionalization, institutionalization, and therefore strong service expectations, and regulatory and governmental pressure.

9.3.5.2 CCs

The scaling or the number of users and transactions are of course also crucial for any currency to become stable and sustainable. Usually, this depends on the type of currency and its goals. A time bank can be very successful and stable with 200 active members, whereas a regional currency needs maybe around 200 businesses and 1000 users to be stable. These numbers stem from empirical evidence around many examples, both failed and successful (see Martignoni and Gmür, 2012), but there yet is little scientific research to produce more accurate numbers or a deeper understanding of the success factors.

In practice, the majority of CCs fail to scale more than a few hundred active members and therefore rarely manage to engage a wider part of the local economic actors. There are some exceptions, however, like the Swiss WIR with around 45,000 business members representing around 8% of all Swiss SMEs. For social purposes, a small number of participants might be sufficient to sustain a small-scale currency scheme. However, for the economic part, without a sufficient number of transactions, a currency becomes literally useless and therefore people will reject it or step out.

One possible way out of the too-small-to-succeed-trap is the nesting of small currencies in networks of inter-trade and interchange (Martignoni, 2015). One such successful example is the South African but worldwide operating Community Exchange System (CES), which allows and supports trade between different member currencies using conversion rates and an integrated clearing

centre. "CES users can also trade with CES users of exchanges hosted on other servers, as well as with users of exchanges hosted on servers belonging to other trading systems altogether."[220] The entire system has an actual total of 844 registered CCs operated on three main servers in South Africa and Australia.[221]

Another way to address the problem of scale is to build tools and knowledge for supporting the creation of new systems. Growing to a sustainable size and replicating a success to other regions is, for example, the strategy followed successfully by Sardex.net (Littera *et al.*, 2017). Then interconnecting the different regions running compatible currency systems would depend on the specificities of the environment and the potential balance between the different economic activities in the different regions. Another factor for scaling is the work of the brokers, already described above.

9.3.6 Computer-support tools

9.3.6.1 CNs

There are different types of shared tools required to operate a CN. It goes from shared knowledge (catalogues, documentation, best practices), shared artefacts (hardware developments like Mesh Potato[222], software distributions like OpenWRT[223], routing protocols like BMX6[224], coordination services like node databases) that can be used to develop and implement specific community procedures. More specifically, communities have knowledge repositories for sharing useful information and experience across a given community. This shared knowledge promotes collective efficiencies, saving time for participants and reducing the complexity of the collective effort (e.g. what hardware, software, installations are known to work well, best practices).

Second, certain routing solutions require the replacement of the proprietary software of routers (also called "flashing") with

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220 According to <https://www.community-exchange.org>.

221 Idem.

222 See <https://villagetelco.org/mesh-potato/>.

223 See <https://openwrt.org/>.

224 See <https://bmx6.net/projects/bmx6>.

free, libre, and open source (FLOSS) software, which among other benefits offers advanced security solutions, maintained by an ideally global community and tailored by local teams. This may also provide the means to keep operational devices that are no longer supported by their manufacturers with positive economic and ecological impact. And most importantly it protects consumers from lock-in and non-transparent policies by big corporations: for instance, the qmp.cat firmware in mesh areas of guifi.net, or the Freifunk Firmware.

There are also different management tools being developed by the involved communities. Examples are node databases, monitoring systems, address allocation services, crowdfunding tools, and decision-support systems. These allow the implementation of specific community procedures in a cost-effective manner that facilitates the governance of the community and the quick resolution of conflicts, without imposing additional burden on specific participants.

Finally, there is a wide variety of FLOSS software applications that can be easily hosted on one's own server and which could be in principle used for providing local services and a more "intimate" digital space for the members of a CN, but also people, not necessarily members, that have access to the network through access points in public spaces. Until recently, there were not many such easily customizable applications having a level of quality and usability comparable with commercial products, with only few exceptions, such as Wordpress[225]. Today more and more applications reach a state of maturity, like Etherpad[226], NextCloud[227], Limesurvey[228], and more. Containerised services like Docker[229], or application servers like Cloudy[230], make it also easier to "self-host" them.

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225 See <https://wordpress.com/>.

226 See <http://etherpad.org>.

227 See <https://nextcloud.com/>.

228 See <https://limesurvey.org/>.

229 See <https://www.docker.com/>.

230 See <https://cloudy.community/>.

9.3.6.2 CCs

To operate a CC, in most cases a special software is used. There are many proprietary solutions but also some open source developments, which have proven to be successful. Two main products are *Cyclos*, a universal solution developed by the STRO foundation[231] in the Netherlands which in the meantime has developed also a "closed" source banking system-branch with the option of a "social licence" for non-profit organizations and small scale projects. Another solution, *Hamlet232*, is developed by Community Forge Association Geneva, and is mostly used by time banks and LETS. The above-mentioned CES does have a proprietary software framework closely related to the Community Forge solution[233].

In recent times, more and more initiatives are considering building CC based on blockchain technology. There is even a specially designed social digital currency Freecoin developed by the EU Horizon2020 CAPS-Project D-CENT (Decentralized Citizens ENgagement Technologies) which provides a solution for operating distributed CC (D-CENT, 2015). This is a necessary step because the standard crypto currencies like Bitcoin do not support community building. Instead, they are designed to replace the critical trust-building process through social and other interactions with cryptographic algorithms and machine-intelligence.

Sardex's operation is based on the Cyclos software, which was actually improved through the experience with Sardex, which today explores in parallel innovative blockchain technologies as well (INTERLACE, 2017).

9.3.7 Summary

The following table provides a brief high-level mapping of key characteristics of community networks and community currencies as collaborative "commoning" activities:

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231 See <https://www.cyclos.org>.

232 See <http://communityforge.net/en/our-solutions>.

233 See <http://communityforge.net/>.

Characteristics	Community networks	Community currencies
The "commons" resource (characteristics, properties)	• Contributed resource: network routers, links, computers. • Extractable resource: connectivity and optional services (partially rivalrous).	• Contributed resource: available assets and services, market infrastructure. Extractable resource: the established "market" and network of trust, the currency itself as infrastructure for exchange.
Community building (bootstrapping, membership, vision)	• Membership: Any citizens and organisations in an area. • Bootstrapping: developing connectivity in an area. • Vision: infrastructure for connectivity and services for all.	• Membership: Any citizens and organisations in an area. • Bootstrapping: building a small but balanced economic circle between trusted entities. • Vision: Stable and resilient local economy for all, disincentives for accumulation.
Managing the commons (participation, accounting, rules, decision-making)	• Participation: accept licence, establish links to existing nodes. • Design variables: unit of account (bandwidth, throughput, delay), relative value of resources (hardware, maintenance, etc), voluntary and professional work. • Accounting: local compensation scheme (guifi.net). • Decision-making: consensus, conflict resolution.	• Participation: accept currency. • Design variables: credit limits, membership and transaction fees, transparency. • Accounting: centralized accounting system, currency notes, blockchain based solutions. • Decision-making: various mechanisms.

Characteristics	Community networks	Community currencies
Boundaries and complementarity (interactions with the global system)	• Service: local services vs. Internet access. • Membership: defined by community licence. • Compatibility: Compliance with telecom regulation (e.g., data retention).	• Service: local products and services. • Membership: acceptance of the currency, eligibility criteria (for mutual credit systems). Compatibility: Exchange with fiat currency, tax compliance.
Growth model (distributed vs. centralized architecture)	• Federation of small groups, peering, economic compensation, professionalization. • Replication of successful model. • Inclusion of different actors (SMEs, customers, public institutions, etc), professionalization.	• Nested structure of federated small groups, bound together by negotiated exchange rules and exchange rates. • Replication of successful model. • Inclusion of different actors (SMEs, customers, public institutions, etc), professionalization.
Computer-support tools (proprietary vs. free software)	• Building blocks to reduce complexity (planning nodes and links). • Participation (communication) and coordination tools (shared knowledge, node database, accounting).	• Accounting and Marketplace tools with integrated management abilities. • Communication and extraction of data for economic stirring processes.

In addition to this short summary of our comparison, note that a key concern in both CNs and CCs is that the more the system grows the more its internal workings become more layered and complex, and less visible. The main novelty of CNs compared to the commercial ISP services is that the nodes of the network belong to its users and they do not form a "black box" managed by external companies, in terms of technical functionality, economics and

governance. When there is additional "professional" infrastructure required, e.g., an access network in public spaces or fibre cables, this is also owned by individuals and/or local institutions, *e.g.*, municipalities, non-profit organisations, etc.

Bitcoin, based on blockchain technology, is an example of an effort to do something similar in the domain of currencies at a global level. At the local level, CCs are typically centralised systems from a technological point of view, at least. That means that, traditionally, there is a single server storing all interactions, while with blockchain, the interactions are stored in many if not all nodes – indeed for this reason the technology is called distributed ledger. However, despite the centralisation or not of the ICT infrastructure, all the members of the network need to install their own "node" in the system. This node needs to be equipped with all required infrastructure to exchange goods using a local currency (special receipts, card readers, hardware wallets, etc) and advertise this information (*e.g.*, through the use of the "we accept local currency" sticker on the store window).

Trust plays also a critical role in both domains of local action. Indeed, trust is one of the most important investments required to build the "nodes" of a local currency. First, all members of a community currency network need to fully trust those that run the underlying accounting infrastructure and/or the printing process. In addition to safeguarding the integrity of the accounting information, the management team needs to take complex decisions in relation to credit lines, and other thresholds required to guarantee a balanced economy. However, most importantly, everyone needs to trust the currency itself and its future survival. For this, the exchangeability with fiat currency plays a key role.

When a local currency is not exchangeable with fiat currency, the failure of the system is translated to loss of income. However, allowing for such exchanges reduces significantly the impact of the community currency in the local economy. Moreover, the threat of failure of fiat currencies, which recently became more likely due to the unsolved monetary problems and the big amounts of currencies distributed by quantitative easing of central banks, might reveal the important role of non-exchangeable CCs as an insurance, and therefore the increase of trust.

In CNs, trust plays also a very important role. First, there is the issue of integrity of the infrastructure, which has a direct impact in terms of net neutrality and privacy. Second, there is the long-term perspective and the expectations of the future sustainability of the network. However, one of the most important aspects of both CNs and CCs is their commonly-shared character, and how the more the system grows the more it becomes possible for all actors to benefit from the success of the network, triggering positive network effects. For this, trust is critical for the system to reach the required critical mass to have the envisaged impact.

9.4 Complementary networks meet complementary currencies

Both CNs and CCs are known with different names, sometimes with common adjectives such as "community", "alternative" or "local", and sometimes with more specialised terms like "mesh", "ad-hoc" or "wireless" for the case of networks and "regional", "sectoral" or "transition" for the case of currencies.

The term "complementary" is a term that is used widely in the case of CCs, pointing to a very important active mechanism of initiatives that allows them to operate "in parallel", both dependent and independent from the mainstream economy, as discussed above. Such currencies complement the predominant national currency and are able to compensate some of its disadvantages and weaknesses for a better functioning of the local economy. Similarly, community networks are complementary to other forms of development or governance of networking infrastructures, that may produce effective connectivity in dense and wealthy areas, but do not work in less developed and challenged areas.

Complementary models based on inclusive cooperative models that rely on local investment could provide alternatives to exclusive competitive models based on extracting profit. Therefore, we wish to motivate the readers to think about such networks more as "complementary" to the Internet rather than either, on the one extreme, as alternatives, or on the other extreme, as simple gateways to the Internet.

So, what could today's CNs learn from the Sardex.net experience and other complementary currencies? What would a "complementary network" look like?

Perhaps the most important lesson to be learned by systems like Sardex.net is the combination of compatibility with the "system" (*i.e.,* paying taxes and allowing mixed purchases) while at the same time being radical in the design of the "local" currency which operates completely isolated from the national currency (no exchange possible). It is exactly this compatibility with the global system that allows for significant innovation and radical approaches for core elements of local infrastructures, like for example the development of appropriate local applications, identity management, etc. at a significant scale.

The other important lesson from Sardex.net is that a local solution for a critical part of our everyday life (economic activities and communication) should not be constrained to its core functionality (*e.g.,* running the CC) but engage in additional educational, cultural, and social activities. For example, Sardex.net collaborates with an online TV channel, ejatv.com, organizes various social and educational events, including the Mitzas annual conference bringing together experts around the world with local stakeholders and citizens.

This is important both because such a grassroots institution with a good reputation can engage more people in such activities and, on the other hand, the social interactions and knowledge shared during such events are extremely effective at building trust and transforming people from passive consumers and producers to active citizens and open-minded members of a vibrant local economy. However, all this additional activity requires a lot of time, in addition to the highly demanding management of a complementary currency. This is perhaps the main reason why guifi.net has experimented but not fully developed yet similar activities, until now.

However, guifi.net has also an important lesson to offer as complementarity is concerned. Although not used often as an explicit term, guifi.net advocates in favour of the complementarity of a network infrastructure as a whole, built as a commons, co-

existing with other solutions. As Roger Baig stressed in his presentation at a recent workshop in Barcelona[234], guifi.net wants "to be treated exactly as the other players in the market, not favourably." In other words, guifi.net offers an alternative that is complementary to the standard *de facto* way of doing networks, *i.e.* the traditional telcos.

It does not position itself against them, but claims that the commons-based model is fairer in terms of social justice, and economically more efficient. Moreover, the separation of the network infrastructure from the provided services on it is exactly an enabler of complementarity, in a sense a form of "vertical" complementarity, and this is an interesting aspect to be considered also in the case of currencies.

For example, vertical complementarity in the case of currencies would help distinguish the two layers of accounting and of social value and understand them better. That would especially help currency designers and managers take more accurate measures to tackle malfunctions. For instance, today one malfunction of the fiat currencies is their systemic support for growing inequality. In a "vertically" complementary CC, it will be easier to differentiate between its members that become "rich" through their increased contribution toward other members of the system, and those that become "rich" by speculating and exploiting systemic failures, or by the manipulation of rules. Diversity and complementarity of models, therefore, are two ways to contribute to sustainable and stable systems.

9.5 Opportunities for integration

After analysing the similarities and differences between CNs and CCs, a natural question arises: could they be combined to enhance each other's operation and sustainability?

Would a CC help the management of resources shared in a CN and, therefore, empower economic sustainability? At a first glance, the two models seem to be able to complement each other very

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234 See <https://netcommons.eu/?q=content/workshop-community-networking-infrastructures-barcelona>.

well. The network is somehow difficult to develop beyond its role as a carrier and connector. By using a CC, the value side and therefore more "meaning" to use and maintain the network could be developed. The currency on the other hand could gain from the pure technical and logical structure of a network to assure its accounting side but also provide a more attractive medium of communication for the local "market".

A CN could be itself the driver for a wider local economy, in which Internet connectivity could become one of the goods exchanged. For example, imagine guifi.net becoming member of one of the under-development CCs in Catalonia, the Mercado Ecosol[235], which is part of a wider network of cooperatives, XES[236], of which guifi.net could also become part. Then also members of guifi.net could be involved, maybe by a subset of the currency which would also fit in the special needs of these members.

If cleverly adopted, this collaboration could boost both sides. However, during such an integration one should be careful not to threaten one of the success factors of guifi.net: the clear distinction between network and content, and the clear focus on the network, leaving the participants to organise and populate it with the content they want. Currently, there are also more opportunities in the Barcelona region, because the municipal government plans to support social and solidarity economy with a new plan for the period of 2016-2019. In this plan, a so-called social currency has been introduced in a first pilot since 2017[237]. This might open a window of opportunity to a new kind of combination between CNs and CCs.

An interesting practical development along these lines would be to attempt the creation of a small-scale CN in Sardinia (like in Catalonia there are many underserved rural areas) and explore the feasibility of its participation in the existing Sardex mutual credit network.

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235 See <https://www.economiasolidaria.org/xes-catalunya/noticias/nace-el-ecosol-una-moneda-que-garantiza-un-consumo-responsable>.

236 XES - Xarxa d'Economia Solidària de Catalunya see <https://www.economiasolidaria.org/xes-xarxa-deconomia-solidaria-de-catalunya>.

237 See <http://www.euronews.com/2016/11/16/barcelona-set-to-introduce-local-currency>.

9.6 Conclusions

This chapter has attempted a somewhat stretched analogy between CNs and CCs, which is still an ongoing learning process for all parties. The main reason that motivated us to engage in such an intellectual experiment is that CNs and CCs are systems not well understood: neither by outsiders, nor by insiders. Even people active in these domains do not always see how guifi.net or Sardex.net are different from similar initiatives. In addition to a mere analogy for educational purposes, bringing closer together experts on CNs with those on CCs is also a first step toward interesting potential integrations between the two models.

However, the introduction of a complicated and not well-understood mechanism as a CC, or a CN, in an equally complicated domain of collective action, is subject to a number of challenges that need to be carefully addressed for the suggested integration to be successful.

First, the *duality between the global and the local*, between Internet access and local services, between the global and the local economy. For example, the fact that most people see CNs as ways to get affordable Internet access makes it difficult to promote the role of these networks as "catalysts" in a local economy, because the Internet resembles a commodity service and, if Internet access is the only service offered by a CN, it is difficult to imagine balanced loops, cycles in graph theory, for resource exchanges.

Second, the need of *quantification of voluntary activities.* The quantification of labour, that until now was meant to be voluntary, is one of the most common negative feedback from people introduced to CCs, like in the case of the district currency simulation game (Martignoni, 2017; Antoniadis *et al*., 2017). Such reactions exist also in the case of CNs and guifi.net makes a lot of effort to keep a balance between the professionals and volunteers that are part of the network.

Third, the huge success of Bitcoin and the *hype behind the blockchain* has attracted the interest of hackers and technical people on the idea of an alternative currency. However, the accounting infrastructure is only a small part of an alternative

economy and, for example, it is not concerned with the ways one can fulfil the requirement for balanced "cycles" as discussed above. Nonetheless, technologies like blockchain have a considerable potential and generate enthusiasm.

Despite the challenges, we believe that it is worth exploring further these models individually and in collaboration since every person has the right to participate in society and both infrastructures are enabling components for participation, interaction and coordination. Legacy models have proven their limits and the models explored in this paper are clearly complementary. Diversity and complementarity of models should therefore be explored as a way to contribute to expanding these universal rights.

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