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Expanding the Internet Commons :
The Subversive Potential of Wireless Community Networks

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"Freedom is fostered when the means of communication are dispersed, decentralized, and easily available, as are printing presses and microcomputers. Central control is more likely when the means of communication are concentrated, monopolized, and scarce, as are great networks," wrote professor Ithiel de Sola Pool (1984), an American political scientist and legal analyst of communications technologies. Beyond highlighting historical and technical trends in technology, Sola Pool also understood that there was nothing deterministic about how technologies evolve. While control over printing presses and microcomputers can, as it turns out, be highly centralized, the deployment and management of telecommunication networks can, eventually, undergo a process of decentralization. The outcome ultimately depends on political, technical, economic, institutional and legal arrangements shaping both the development of communications tools and their use.

Often, when it comes to politics – and Internet policy is obviously no exception – the antagonism between freedom and control essentially comes down to the trade-off between centralization or decentralization. In the past year, the ongoing controversy regarding the massive surveillance undertaken by the US National Security Agency (NSA) and its allied organizations has encouraged a growing number of technology activists to deploy decentralized and free software[3] alternatives to the centralized online services known to collaborate with the NSA.

This trend can be likened to what happened repeatedly in the history of the Internet. The rise of the personal computer and the widespread adoption of the Internet network came out of a need to democratize computing technologies by taking them out of the hands of technocracy – decentralizing both the use of computers and the control of communication technologies. Later, in the 80's, the free software movement emerged as an attempt to alleviate the threat that proprietary software vendors created on the ecosystem of innovation. Likewise, in the early 2000's, the control exerted by a few large media conglomerates on the circulation of copyrighted works sparked a counter-reaction on the part of activists, lawyers and librarians to establish an alternative, more

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[3]Free software, software libre, or libre software, is computer software that is distributed along with its source code, and is released under a software license that guarantee users the freedom to run the software for any purpose as well as to study, adapt/modify, and distribute the original software and the adapted/changed versions. Free software is often developed collaboratively by volunteer computer programmers (Wikipedia).

participative and democratic regulatory framework through the creation of the "Creative Commons"licenses to encourage the dissemination and facilitate the reuse of digital works.[4]

The history of communication technologies is populated with conflicts between centralization and decentralization.[5] While many of these technologies started as a decentralized structure, all have progressively evolved into concentrated clusters of power as a result of industrialization and the reaffirmation of state sovereignty, following a schumpeterian process of "creative-destruction" (Wu, 2010). However, as the examples above suggest , when the oppressive potential of centralized technologies becomes clear and when the needs of citizens turn out to be systematically overlooked, decentralized initiatives may emerge as an attempt to disrupt the dominant hegemony – a process that the philosopher Andrew Feenberg calls "subversive rationalization" (Feenberg, 1995).

In this paper, we aim to shed light on an ongoing – though often neglected – phenomenon of decentralization in telecommunications networks: the revival of local, grassroots community networks.[6] As opposed to more larger and centralized network infrastructures owned and managed by powerful third parties (such as the state or large, highly capitalized Internet Service Providers, or ISPs), grassroots community networks are deployed *by* the community and *for* the community. Rather than being driven by profits, they focus on the actual needs of the needs of its participants. They also experiment with novel models of distributed governance relying on cooperation and sharing among a community of peers, and that are reminiscent of commons-based peer production schemes (Benkler, 2006).

In our study, we focus on "Wireless Community Networks" (WCN), i.e those community networks providing connectivity through radio technologies, and Wi-Fi especially.[7] While many of community networks do not rely on radio technologies, those who do exhibit particular features that contrast more strongly from the dominant paradigm found in traditional ISPs. In particular, to the extent that they rely solely and exclusively on the airwaves (or "spectrum commons"), WCN are to some extent more independent from incumbent ISPs than landline community networks who

[4]Creative Commons (CC) is a non-profit organization headquartered in Mountain View, California, United States, devoted to expanding the range of creative works available for others to build upon legally and to share. The organization has released several copyright-licenses known as Creative Commons licenses free of charge to the public. These licenses allow creators to communicate which rights they reserve, and which rights they waive for the benefit of recipients or other creators (Wikipedia).

[5]Historical precedents in the telecom sector exist. For instance, at the turn of the twentieth century, the United States witnessed intense citizen mobilizations over the deployment and ownership of the telephone infrastructure. At the time, the Bell telephone company was a monopoly that only served rich individuals living in large East-Coast cities (Wu, 2010:46). Thus, as Paul Starr writes, "instead of waiting for either the government or a corporation to provide telephone service to them, millions of ordinary people created their own telephone networks. Rather than having their needs defined for them, they define those needs for themselves", displaying "a wide distribution of self-organizing capacity at the local level" and an "autonomous development on the periphery of power" (Starr, 2004:203). Small independent telephone companies as well as farmers cooperatives and city governments strived to "build a widely distributed national communication system through a kind of creative resistance to centralized power" (Starr, 2004:229), sometimes even anticipating the uses of radio by using telephone lines to locally broadcast live music performances or news reports. Soon, however, they were to be absorbed by a predatory corporation, AT&T, which had just gone on an eventually successful quest to become a private telecom monopoly sanctioned by the state.

[6]The last-mile or last kilometer is a phrase used by the telecommunications, cable television and Internet industries to refer to the final leg of the telecommunications networks delivering communications connectivity to retail customers, the part that actually reaches the customer. Examples are the copper wire subscriber lines connecting telephones to the local telephone exchange, coaxial cable service drops carrying cable television signals from utility poles to subscribers' homes, and cell towers linking local cell phones to the cellular network. The word "mile" is used metaphorically; the length of the last-mile link may be more or less than a mile. (Wikipedia).

[7]Wi-Fi is a technology that allows an electronic device to exchange data or connect to the internet wirelessly using 2.4 GHz UHF and 5 GHz SHF radio waves. The Wi-Fi Alliance defines Wi-Fi as any "wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards" (Wikipedia).

necessarily have to enter into a contractual relationship with the owners of the "last-mile" landline network infrastructure.[8]

We also take a somewhat narrow geographical and jurisdictional scope, focusing on European community networks (though we also illustrate our developments with examples from other regions). Since the early days of the Internet, Europe has been a fertile ground for the development of community networks, and many (though not all) of the groups we surveyed are based in Europe. Given our goal to contextualize WCN in the history of telecom policy, we have used the telecom regulatory framework of the European Union (EU) as a background picture on which to situate WCN and from which to draw various legal and policy analysis.

The paper begins by sketching out a short history of telecom policy in Europe, showing how the process of privatization of telecommunication infrastructures initiated in the 1990's led Internet access provision to move rapidly from a niche market populated with competing services providers to a highly concentrated sector prone to corporate regulatory capture. The first section underlines the mixed results of European telecom policy and analyzes the prejudicial consequences of centralization from a political perspective, as incumbent ISPs or network gatekeepers tend to foster their commercial interests by exerting greater control over users' communications. Based on our fieldwork and qualitative interviews, the paper then moves on to describing WCN, presenting the main characteristics of these grassroots attempts at bringing about a "subversive rationalization" of the last-mile network infrastructure. This second section outlines the motivations underlying the deployment of WCN, together with their technical features and innovative, commons-based models of governance, which all strongly contrast with the dominant, commercial model for Internet access provision. Finally, the third section assesses the impact of WCN on telecom regulation and the new power dynamics it entails, with regard to both the private sector and the public sector. The paper concludes that current telecom regulation significantly overlooks the contribution of community networks to fostering political and socio-economic objectives associated with broadband policy and proposes a number of policy recommendations to overcome this gap.

1. A short history of the Internet access market in Europe

1.1 The Internet and the decentralization of power in communications networks

Since its early days, the Internet has followed a trend of emancipation. As early as the immediate post-World War II years, key American scientists envisioned how computers, originally built for military and technocratic command-and-control applications, could be used by individuals as communications devices (Licklider & Taylor, 1968). In the sixties and seventies, the use of computers as a tool for emancipation went a step further when the counter-cultural youth began using these machines against the ruling technocracy to decentralize power, bring it down to the local level, and allow for the emergence of free and autonomous communities (Kirk, 2002, Turner, 2006).

Already throughout the 1970s and 1980s, engineers and early hackers were experimenting with and exploring the potential of these new machines. But it is only in the following years, as personal computing boomed and the computer networks spread, that efforts from civil society to democratize the use of these revolutionary technologies went viral. Non-Governmental Organizations (NGOs) and activist groups started developing their own computer networks to coordinate and share

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information (Willetts, 2010), the first online communities settled on cyberspace, and the creation of the World Wide Web in 1989 finally opened the door to widespread Internet use.

Time was ripe for the launch of countless initiatives bringing social movements, activists and general citizens into this new world of global, seamless and instantaneous communications. Stefania Milan, a social researcher working on media activism, describes the mid-1990's as an era of "renaissance" for what she calls "emancipatory communication practices". Echoing the pirate radio movement of the late 1970's and 1980's, the Internet sparked a political movement of tech activists whose aim was "to bypass the politics of enclosure and control enacted by states and corporations" on the public sphere. They wanted to achieve a "structural reform at the grassroots level through the creation of autonomous spaces of communication. By emancipating other social actors from commercial communication services, they aimed to empower them to articulate, voice and convey their own messages without filters" (Milan, 2013:10). In the early days of the Internet, these groups implemented secure e-mailing and free hosting services, as well as innovative web-publishing tools. They sought to dis-intermediate the public sphere and to promote unhindered information flows as a guarantee for political autonomy – a philosophy that has been described as "informational liberalism" (Loveluck, 2012). They also assimilated the Internet's original ethos and governance model: a network of equal peers communicating freely on a decentralized, end-to-end architecture, exerting bottom-up control on the tools used for communicating, in particular through free software (Coleman, 2005).

At the infrastructure level, this bottom-up governance was achieved through the deployment of the first grassroots Internet access providers, as tech activists organized to make use of the incumbent telephone carriers' network in order to provide access to the Internet. For instance, in France, a small group of Internet hobbyists set up the "French Data Network" (FDN) as early as 1992. Though it was among the most active groups, this grassroots community network was only one of several small companies or nonprofit entities working to grant access to the Internet to a specific community. FDN members paid a fee of about 120 francs (around €18) a month plus the cost of telephony to call into the FDN modem, which in turn connected them to the global Internet network. To carry its traffic to global network, FDN contracted one of France Telecom's business offers which had been developed to provide bandwidth to a variety of closed computer networks, such as the Minitel for instance. FDN was thus able to acquire large batches of IP addresses[9] and to obtain an uplink to the Internet at the speed of 32 kilobits per seconds with one of the few "transit operators".[10] As opposed to many mainstream ISPs that operated in a "walled-garden" (such as AOL or CompuServe, for instance), FDN provided a real Internet access providing users with their own IP addresses, configurable email services. It also ran a file-sharing server from which members could download free software to manage their modem and configure their connection. The FDN community contributed to that software by writing bits of code, and translated English technical documentation and tutorials to make them more accessible to a French audience. Although (unlike FDN) most of them vanished when the commercial ISP market boomed in the late 1990's, similar endeavors had also been developed in other European countries.

Tech activists and community networks often resented the corporate world. They saw the Internet as an unowned public space, and, as many early Internet users, they shared the "assumption that commercialism and an honest, democratic public sphere do not mix" (McChesney, 2013:102). While the Internet could, of course, be used to trade goods and services, many believed that because it would lower barriers to entry and foster both competition and innovation, this open network would ultimately foster free and transparent markets populated with small firms and individuals

[9] An Internet Protocol address (IP address) is a numerical label assigned to each device (e.g., computer, printer) participating in a computer network that uses the Internet Protocol for communication. An IP address serves two principal functions: host or network interface identification and location addressing (Wikipedia).

[10] "Transit ISPs" are private telecom companies who own or rent backbones and operate on the business-to-business market to provide Internet upstream to other organizations (in particular to small ISPs, who unlike traditional mass market ISPs do not own backbones, as well as hosting companies and other businesses).

competing or cooperating with each other, without the oligopolistic and rent-seeking behaviors that typified the old, industrial corporate economy.

The subversiveness of tech activists is also reflected by their rejection of law. As legislators began transposing traditional legal principles regulating the public sphere into the Internet, the cyber-libertarian ethos prominent in many of these communities made them extremely reluctant to state regulation (Barlow, 1996). Regulation by nation-states was perceived to be a direct threat to freedom of expression and privacy, and civil society mobilizations in both the United states and Europe partly succeeded in convincing policy-makers and judges to restrain in excessively regulating the Internet[11]. Though it would soon once again clash with governmental and corporate interests, the idea of a free communication space for people to organize with or against established powers, challenge the hegemony of political, media and business elites, engaging in practices of "insurgent citizenship" in the public sphere (Tréguer, 2013) had already taken root.

1.2 Network centralization: the corporate capture of telecom infrastructures

Although it has been very influential in the evolution of the Internet, the spirit of emancipation has since been heavily contested. By the early 2000s, not only had it become clear that states have indeed the means to enforce social control online, it also became obvious that rather than crushing down multinational corporations, the Internet could actually become their new battlefield. Along with the growing concentration and increasingly oligopolistic outlook of the online service sector – with giants such as Apple, Microsoft or Google, which all rank among the five largest global corporations in terms of market valuation – the telecom market as gone through a rapid process of expansion, diversification, and concentration, as more and more regulatory failures resulted in the corporate capture of telecom infrastructures.

In the mid-1990's, the Internet access market boomed in Europe, partly because incumbent network operators had to open up the infrastructure rolled-out by state monopolies – and hence built with taxpayers' money – to small and innovative ISPs. In a context of rapid privatization, regulation promoted facility-based competition[12] and new companies began laying down their own network infrastructure. This, along with the explosion of mobile telephony and the democratization of Internet access, made liberalization look like a success story: innovation in telecom services was dynamic and fast-paced, prices were low, and the overall number of subscribers surged.

Today, the EU regulatory framework is often praised when compared to the situation in the US, where local Internet access markets are generally under a duopoly. Regulatory policies have, indeed, ensured some level of competition in European markets. However, they have been unable to prevent the growing concentration of power in the telecommunications sector, where abuses of dominant positions by incumbent network operators have been fairly common. Since the early 2000's, the European Commission's antitrust division has issued fines up to €10 millions to a variety of incumbents accused of dragging their feet and keeping their prices high in granting competitors access to their legacy networks, in spite of the "open access" provisions provided by EU law.[13]

[11] From the mid 1990's on, various debates took place around intermediary liability in both the U.S (around the Communications Decency Act especially), in Europe, which eventually led to a rather protective legal framework granting liability exemptions to technical intermediaries (hosting providers and ISPs).

[12] Facility-based competition, or infrastructure-based competition, refers to the regulatory focus on creating competition between telecom firms that each have their own distinct network infrastructure for delivering end-user services, such as Internet access provision.

[13] In 2013, the Commission sanctioned Telekomunikacja Polska (TP) in Poland. The incumbent operator had unlawfully refused to grant alternative operators access to its wholesale products for more than four years. In July 2007, the Commission stepped in to increase competition in the Spanish telecoms market by fining the Spanish incumbent telecoms operator Telefónica €11.8 million for "a very serious abuse" of its dominant position, imposing unfair prices during five years to competitors and forcing them to make losses if they wanted to match Telefónica's retail prices. In

Sanctions and remedies have typically come years after such anti-competitive practices started, allowing incumbents to reinforce their dominant positions and crush competitors in the meantime. Several cartel cases have also shed light on oligopolistic trends that helped incumbent operators maintain high levels of market shares.[14]

Overall, in the EU, policy targets in terms of broadband penetration and quality of service remain a distant reality: a third of European households still have no Internet access (32%) and, in a country such as Greece, penetration of broadband access is as low a 55%. A fifth of EU citizens with no Internet access say they are deterred by the sheer cost of it (EU Commission, 2013):the cheapest available broadband offer can be as high as €46.20 in Cyprus, €38.70 in Spain or €31.40 in Ireland (EU Commission, 2014a). Meanwhile, users are not provided with the service they paid for: on average, they only get 75% of the broadband speed they signed up for; 63% when they get it through ADSL rather than cable or fiber lines (SamKnows, 2013) – a situation that is usually much worse in rural areas.

Such mitigated results – which have to be seen in the wider context of telecom policies – beg the question of the unholy alliance between big telecom companies and the state. In the US, the issue of regulatory capture in the media and telecom sectors was most notably addressed by Ronald Coase in his 1959 article on the Federal Communications Commission (Coase, 1959). At the time, Coase criticized the FCC's licensing procedures on spectrum allocation for being inefficient and giving too much leeway for the state to pick and choose licensees. Instead, Coase advocated for property rights and market pricing mechanisms as better alternatives for determining spectrum allocation. First in the US and then in Europe, his criticism eventually sparked a wave regulatory reforms based on proprietary incentives. They gave way, among other things, to the auction frenzy which began in the 1990's and still lasts to this day (an issue we will return to later in this paper).

But, as it was to be expected, increased privatization failed to eliminate harmful corporate influence on policy-making. To the contrary – and even though neo-liberal economists might argue that this is due to there being still "too much" regulation – corporate regulatory capture remains a fundamental feature of regulatory economics in general, and of telecom policy in particular (Laffont & Tirole, 1991, 2001; Levine, 1990).

At its most extreme, regulatory capture takes the form of outright corruption. Bribery is indeed relatively widespread in the telecom sector.[15] In the past couple of years, cases or allegations involving politicians and companies in the telecom sector have surfaced in France[16], Austria[17], Poland[18], Ireland[19] or Portugal[20]. In the Arab world, in Africa, Latin America or Asia, there are also

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2003, the Commission also imposed a fine on France Telecom's Wanadoo for abuse of a dominant position. For other examples, see: http://ec.europa.eu/competition/sectors/telecommunications/broadband_en.html

[14]There are recent examples of cartel cases: in January 2013, the EU Commission fined incumbents Telefónica and Portugal Telecom for their cross-border market sharing agreement not to compete with each other in their respective countries. A few months later, the Commission opened formal investigations over dominant European ISPs (at least Orange, Deutsche Telekom and Telefónica) for potential abuses their dominant position in the broadband market (these companies are suspected of creating artificial scarcity of Internet bandwidth at the interconnection level, resulting in congestions, interruptions and delays of traffic flows, to gain leverage in commercial negotiations over so-called peering agreements – where traffic is exchanged between online content providers such as YouTube and ISPs).

[15] A recent EU report on corruption shows that businesses find corruption to be most prevalent in the construction and telecom sectors (EU Commission, 2014b).

[16]French Polynesia – Gaston Flosse, convicted a second time of corruption, wants the appeal trial to be heard away from Tahiti. (2013, July 25). *Against corruption in telecoms*. Retrieved May 11, 2014, from http://anti-corruption-telecoms.blogspot.fr/2013/07/french-polynesia-gaston-flosse.html

[17]Prodhan, G. (2013, July 18). Trial over Telekom Austria payments to rightist party starts. *Reuters*. Retrieved from http://www.reuters.com/article/2013/07/18/telekomaustria-corruption-trial-idUSL6N0FO10K20130718

[18]Ex-president of Kulczyk Holding arrested for corruption. (2012, June 13). *Warsaw Business Journal*. Retrieved May 11, 2014, from http://www.wbj.pl/article-59485-ex-president-of-kulczyk-holding-arrested-for-corruption.html?typ=ise

[19]Mansfield, I. (2012, July 18). Irish High Court to Hear Corruption Allegations Over a 1995 GSM License Award. *cellular-news*. Retrieved May 11, 2014, from http://www.cellular-news.com/story/Regulatory/55450.php

several cases of corruption, involving European companies such as Orange/France Telecom, TeliaSonera, Siemens or Alacatel-Lucent (Sutherland, 2012).

Apart form its illegal manifestations, regulatory capture generally takes more subtle forms, namely a bias on the part of regulators in government or national regulatory authorities (NRAs) leading to lenient regulations, undue subsidies, or decisions illegitimately favoring the regulated firms. Such bias often stems from the mutual acquaintances or even friendships built over time by attending the same universities,meeting regularly to discuss the regulatory issues in which firms have a stake, but also as a result of individuals shifting back and forth from government to industry to work as an executive or lobbyist – a phenomenon known as the "revolving door".[21] Bias is also due to the fact that governments often retain golden shares in their former monopolies, as communications networks remain a strategic asset, a purveyor of taxes and employment, and can also be a non-negligible source of revenues.[22] All of this leads to what a French minister euphemistically defined as "friendly pressure" on business leaders in the telecom sector (Reuters, 2014, April 9th)[23], but it might also lead to political interferences in the functioning of the National Regulatory Authority (NRA), which researchers have found to undermine investment by introducing instability and uncertainty in the regulatory framework (Cambini & Rondi, 2011).

All the while, grassroots and non-profit networks, who provide flexible and cheap Internet access to small communities in spite of the hostile regulatory framework, have remained well below the radar of policy-makers. Especially in the past couple of years, the narrow priority of many policy-makers has been to move towards greater consolidation in the telecom sector so as to facilitate the advent of powerful pan-European operators, as incumbent firms have been calling for competition regulators to further ease oversight on mergers.[24] The economic downturn may help explain such cry wolf: with lower revenues in recent years, after governments opted to sell for colossal sums 3G and 4G licenses, and with the pressure to invest in faster networks, shareholders have seen their shares plunged in the past couple of years.[25] Now, as one banker puts it, "this is an industry that investors turn to for cash flow, but at the same time it is being milked by governments in next generation auctions as well as facing the need to spend more on infrastructure for the future"[26]. In these rough times, incumbents argue, reduced competition and economies of scale would help them boost revenues and maintain their reputation with investors. As investment has declined by approximately 2 percent a year over the last five years, they see no other way to

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[20] Anacom favoured Portugal Telecom in DTT. (2012, October 31). *Telecompaper*. Retrieved May 11, 2014, from http://www.telecompaper.com/news/anacom-favoured-portugal-telecom-in-dtt-thesis–905308

[21] For instance, the current CEO of Orange, Stéphane Richard, is the former chief of staff of then French Minister of the Economy Christine Lagarde (now managing director of the International Monetary Fund). In Spain, incumbent operator Telefónica hired several former high-raking public officials as consultants, such the former Minister of the Economy, Rodriguo Rato, also head of the IMF from 2004 to 2007, who has also incidentally been hauled into court for his mismanagement in the banking sector. Day, P. (2012, July 4). Former IMF-chief Rodrigo Rato faces court probe. *Reuters*. Madrid. Retrieved from http://www.reuters.com/article/2012/07/04/us-bankia-rato-idUSBRE8630MU20120704

[22] In the past years, the French government, for instance, has usually drawn around €1bn annually from its 26% share in France Telecom/Orange.

[23] French government says will pursue telecom market consolidation. Reuters. Retrieved from http://www.reuters.com/article/2014/04/09/us-france-telecomunications-government-idUSBREA3824T20140409

[24] Based on the studies commissioned to consultancies such and Standards & Poor or the Boston Consulting Group, incumbent operators across Europe argue that a maximum of three telecom giants should compete against each other in European markets. See Schechner, S. (2014, March 11). Europe's Telecom Companies Push to Merge. *Wall Street Journal*. Retrieved from http://online.wsj.com/news/articles/SB10001424052702303795904579433113580321016

[25] The telecom sector is an industry that usually boasts high dividend payouts for shareholders, with a dividend yield of around §7% (up to 8 to 11% for companies such as France Telecom, Deutsche Telekom or Portugal Telecom). Dividends even peaked in 2011 with €22bn paid, after "boom years" of very high profits, though even then big operators were reluctant to keep up with the investment pace recommended by the EU Commission (Guarascio, 2014).

[26] Thomas, D. (2013, November 17). Telecoms dividends set for further fall. *Financial Times*. Retrieved from http://www.ft.com/intl/cms/s/0/258ad6a0-4e19-11e3-8fa5-00144feabdc0.html

increase annual revenues than to "substantially reduce" any pro-competition regulation (BCG, 2013).

Although the EU Commission anti-trust chief has so far been averse to these calls,[27] the commissioner in charge of telecom policy, Neelie Kroes, has been much more receptive and has even put forward a legislative package to facilitate pan-European consolidation.[28] Of course, national governments have also been keen on supporting their national champions' pro-consolidation strategy, in the hope of doubling on auction revenues while cashing in more dividends as shareholders in the years to come. But more often than not, industrial policy conflicts with other public interest goals, such as social and political rights: lowering competitive pressure could prove risky from a public policy standpoint, leading to price inflation on the ISP market and running counter to the goal of bringing affordable Internet access to all citizens. Most importantly, however, an ever more concentrated Internet access market risks significantly undermining citizen autonomy.

1.3 The erosion of autonomy in the feudal Internet

The shortfalls of telecom regulation and the growing centralization in the sector highlights a more general problem with the evolution of the Internet's political economy. Indeed, there is a direct relationship of one's communication environment and one's political autonomy, that is the ability for an individual to make choices and determine the course of her life free of external manipulative forces (Christman, 2011). As Yochai Benkler explains in his seminal book, *The Wealth of Networks*, autonomy is adversely affected by concentration and increased top-down control over communications resources:

> "All of the components of decision making prior to action, and those actions that are themselves communicative moves or require communication as a precondition to efficacy, are constituted by the information and communications environment we, as agents, occupy. Conditions that cause failures at any of these junctures, which place bottlenecks, failures of communication, or provide opportunities for manipulation by a gatekeeper in the information environment, create threats to the democratic autonomy of individuals in that environment. The shape of the information environment, and the distribution of power within it to control information flows to and from individuals, are, as we have seen, the contingent product of a combination of technology, economic behavior, social patterns, and institutional structure or law" (2006:159).

In a context of growing Internet use, and following the widespread deployment of such a global network, centralized services come with many advantages for users, such as ubiquitous access to data and applications, easy-to use designs and features, delegated security maintenance, etc. But these advantages come at a price, which is not always apparent to users.

Indeed, centralization in Internet architectures has given Internet actors much more power than they used to have in its early days, thereby undermining the very democratic values that the Internet was to foster. For online services – a.k.a. the "cloud" – as well as the devices we use to access these

[27] The EU commissioner for competition, Joaquin Alumnia, stated his views on the concentration in the telecom sector in March 2014: "The industry says it needs to consolidate to invest in the next-generation networks. However, allowing fewer, larger players in individual EU countries would just reinforce market power at that level." Guarascio, F. (2014, March 10). Telecoms merger reforms in doubt. *EurActiv.* Retrieved April 9, 2014, from http://www.euractiv.com/infosociety/call-softer-rules-telecoms-merge-news-534007

[28] Thomson, A. (2013, October 8). Kroes Sees Potential for Telecom Consolidation With New Rule. *Bloomberg*. Retrieved April 9, 2014, from http://www.bloomberg.com/news/2013-10-08/kroes-sees-potential-for-telecom-consolidation-with-rule-changes.html

services, many scholars have already warned against the fast-paced process of centralization currently taking place under the influence of profit-seeking corporations (Zittrain, 2008; Zhang & al., 2010; McChesney, 2013). These devices are becoming less and less generative as the ecosystem shifts away from general-purpose personal computers to laptops, tablets, smart-phones and other "tethered" terminals whose sole function is to access preselected online applications provided by a handful of service providers. The machines we use to go online are sometimes unable of interacting with anything but the central server to which they are tethered (Giurgiu & al., 2009). As a result of this trend, one of the founding principles of the Internet – the end-to-end principle – is being gradually jeopardized, as most of the network intelligence is moving away from the end-points towards the core of the network, at the level of service providers.

A similar trend is happening at the infrastructure level as well, as much of the network infrastructure is nowadays owned and controlled by a few centralized ISPs. Historically, the Internet networks have been regarded as a neutral pipe or "mere conduit". In line with the end-to-end principle, the role of network operators was merely to provide efficient data delivery in accordance with the "network neutrality" principle, i.e. via the homogeneous delivery of all data packet, without altering or discriminating one type of traffic over others. Today, however, the principle of network neutrality (sometimes summed up by the motto inspired by constitutional law that "all bits are created equal") is being progressively undermined by incumbent ISPs.

Not only have telecom operators gained the technical ability to manipulate Internet communications, they also have the economic and regulatory incentives to do so. The development of so-called "deep packet inspection" (DPI) and other similar technologies allow them to monitor data streams as they flow through their routers, so as to determine their nature and potentially block, throttle, prioritize or alter users' communications based on a range of factors (i.e. protocol used, website accessed, or the very content of the messages being carried).

As for incentives, they stem from both economic and regulatory pressures. From an economic standpoint, traffic inspection and management can be used to find new revenue streams. Telecom operators have, for a while, been tempted to use DPI for monetizing their subscribers' "eyeballs", collaborating with tech companies providing analytical tools to establish user profiles based on their browsing habits and serve them with targeted advertising (Asghari & al., 2013). While these experiments have remained limited due to public outcry, other discriminatory pricing or discriminatory traffic management practices are becoming commonplace. For instance, particularly in mobile Internet access offers, many operators impose data-caps on their users but exempt their own online services or those of commercial partners, often Internet giants such as Google or Facebook.[29] Some ISPs are also known to have blocked or throttled the use of voice-over-IP tools such as Skype on their 3G networks to protect revenues from voice telephony, or the use of file-sharing peer-to-peer protocols as a way to mitigate network congestion and delay bandwidth investments (BEREC, 2012). In other instances, ISPs have also even been suspected to throttle encrypted data streams or prevent their users from using privacy-enhancing tools such as the TOR network or Virtual Private Networks, in particular in connection to wireless access (LQDN, 2012).

On the political front, despite civil society mobilizations calling for protecting freedom of communication and the confidentiality of online communications (Musiani & al, 2013), policy-makers have thus far been reluctant to enshrine Net neutrality into law. To date, only the Netherlands and Slovenia have enacted Net neutrality legislation in Europe. At the EU level, and in most member states, regulators have instead been shielding operators from normative non-

[29] In a study conducted in 2012, European NRAs underlined "some examples of special treatment for over-the-top traffic reported by fixed operators are prioritisation of certain kind of traffic or applications at peak times (such as HTTP, DNS, VoIP, gaming, instant messaging, etc.), and assigning lower priority to applications such as file downloading, P2P, etc. In mobile networks, it is worth to mention some cases of applications or websites which are excluded from the monthly data cap (HTTP traffic, customer care portals or applications such as Facebook)" (BEREC, 2012). These trends have only amplified in the last two years.

discrimination rules. Weeks before the 2014 European elections, and after an important campaign by civil society organizations, the EU Parliament endorsed strong Net neutrality rules at the EU level , but it remains to be seen whether these will be able to pass the national governments' muster.[30]

ISPs also have regulatory incentives to interfere with users' autonomy, in particular when they are pressured by public officials to censor online content. In the mid-1990s, "self-regulation" was seen by many as a way to escape heavy state regulation and instead promote a decentralized, polycentric legal architecture more in tune with a transnational network where traditional sovereignty was thought to be unfit (Johnson & Post, 1997). This vision led to a relatively light-touch approach to content regulation on the Internet, which somewhat echoed the libertarian discourse of the time (Mueller, 2010:191). Yet, to many policy-makers, self-regulation was, in fact, a means to delegate law-enforcement to online intermediaries – be they hosting platforms or ISPs – in an attempt to reassert their sovereign power over the Internet (Goldsmith & Wu, 2006). Like in many other countries, Internet censorship thus progressively became widespread in European democracies, as public authorities and civil society organizations partnered with ISPs to establish extra-judicial enforcement schemes to censor certain categories of online content, and especially that related to child abuse (Villeneuve, 2009). The big operators' readiness to respond to injunctions by policy-makers allowed for the establishment of a culture of "privatized enforcement", with private actors arbitrarily determining the limits to freedom of expression and implementing them as they see fit. While there is generally little transparency regarding the websites and content blocked by ISPs, the risk of accidentally filtering or censoring legitimate material is technically inevitable and, in practice, fairly common (Bradwell & al., 2012). Today, anecdotal evidence of legitimate content being blocked by the ISPs' filtering technologies abounds, ranging from activist websites to sexual education portals, or even Wikipedia.[31] According to the Brussels-based digital rights NGO EDRi, such a growing recourse to networks intermediaries for regulating online content leads to a "general abandonment of the traditional concept of the rule of law and the role of the judiciary – resulting in the 'death by a thousand cuts' of traditional policing and judicial transparency" (McNamee, 2011).

Another example of how telecom operators might undermine users autonomy is through their collaboration with intelligence agencies for surveillance purposes – privacy being a core component of autonomy (Bernal, 2014). In the post-2001 geopolitical context, and as evidenced by the ongoing revelations on the practices of the NSA in the US, states are now engaging in massive and generalized surveillance of Internet communications (often beyond the realm of the law) by establishing private-public partnerships with telecom operators. Intelligence agencies in European countries, such as the UK, France and perhaps many others, have teamed up with big network operators for intercepting traffic flows at the backbone level (Deibert, 2013; Ball et al, 2013; Follorou, 2013).

German philosopher Jürgen Habermas (1991) describes the 19th century in emerging European democracies as a "golden age" for the public sphere: the latter was both diverse and autonomous, free from commercial interests and independent of government power-holders. He writes about how mass media in the twentieth century progressively led to the "refeudalization" of the public sphere,

[30] Scott, M., & Kanter, J. (2014, April 3). EU Lawmakers Approve Tough "Net neutrality" Rules. *The New York Times*. Retrieved from http://www.nytimes.com/2014/04/04/business/international/eu-lawmakers-approve-tough-net-neutrality-rules.html

[31] In the UK for instance, the whole Wikipedia site was blocked for several days in 2008 after the page related to a rock band and which included a cover album depicting a naked young girl was added to the blacklist managed by a private organization, the Internet Watch Foundation. British mobile operators have also implemented a blocking system to ensure that minors buying prepaid Internet subscription do not have access to pornographic material. Activist websites such as that of the TOR project, which builds tools for anonymizing online communications, or La Quadrature du Net, which advocates against extra-judicial online censorship, have been blocked for several months along with dozens of other perfectly legal websites as a consequence.

with the dominance of media conglomerates, manipulative commercial culture as well as influential agenda-setters in state apparatuses. Today, the 1990s' utopian and deterministic discourses about the inherently progressive and democratic nature of the Internet have, for the most part, been relegated to history, as states and corporations found ways for dominating cyberspace and reshaped it in accordance with their own interests. On the Internet too, we have seen a fast-paced process of feudalization of what was supposed to be a decentralized, citizen-centric and subversive public sphere. Yet, while it is now on the defensive, this fundamental idea has not yet vanished. The erosion of autonomy in cyberspace is providing new incentives for citizens to counteract, as a community striving to control the tools used for communicating on the Internet. This is illustrated, in particular, by the recent deployment of grassroots, wireless community ISPs who try to independently manage the wires and antennas that connect people to the global Internet.

2. Governing the last-mile as a commons: the revival of community networks

The trend towards centralization, combined with economic incentives and regulations encouraging surveillance and control has led to the revival of more decentralized, citizen-centric network architectures. In the remainder of this section, we will focus specifically on the deployment of Wireless Community Networks (WCN) as a possible alternative to the growing centralization of power and control over the Internet's physical network and describe the characteristics of decentralized and per-to-peer governance structures adopted by describe these grassroots organizations.

2.1 The rise of Wireless Community Networks in Europe

WCN represent a means for civil society to re-gain control over the infrastructure of communication and acquire the technical know-how necessary to communicate freely without being dependent upon any third-party operator or large corporation.

All across Europe, and beyond, there is currently a large number of grassroots community networks seeking to provide a decentralized alternative and more commons-based approach to the current Internet infrastructure . While most of them are very limited in scope – and are therefore not widely heard of –, the most popular ones enjoy more than dozens of thousands of users. For our study, we focused on a handful of groups, and in particular FreiFunk (Germany), Wlan Slovenija (Slovenia), Guifi.net (Spain) and Tetaneutral.net in Toulouse (France) – the latter is also a member of the FFDN, a federation of French grassroots networks initially spearheaded by the landline community network FDN. Other European WCN include Ninux (Italy), Funfeuer (Austria), the Athens Wireless Metropolitan Network (Greece), Djurslands.net (Denmark) and Czfree.net (Czech Republic). Several of these initiatives are currently collaborating to promote the deployment and long-term sustainability of community networks. For instance, the recently-launched "DIY ISP initiative"[32] seeks to create a forum for like-minded tech activists engaged in community networks to share ideas as well as technical and legal knowledge. They want to show that "building an ISP from scratch is entirely within the range of motivated individuals."

The common characteristic of all of these networks is that they are community-driven: they are deployed *by* the community *for* the community. Yet, the values and underlying justifications for their deployment might be difficult to delineate, since they can be fueled by a variety of motivations: from the need to support undeserved areas lacking broadband connectivity to the will to provide a more diversified (and often cheaper) means to access the Internet; from the aspiration to preserve network neutrality and civil liberties online to an eagerness to counteract the growing concentration of power in the hands of a few large ISPs; from the desire to learn and experiment with telecommunication technologies, to the satisfaction of being part of a collective of like-minded individuals.

[32] See http://diyisp.org

Most of the Europe-based groups we have interviewed for this study are driven by a combination of these motivations, but the two prime drivers are usually the lack of quality and affordable Internet access and the ideological challenge to successfully roll-out and maintain a citizen-owned telecom infrastructure.

Tetaneutral.net is a wireless community network founded in 2011 and run by a non-profit organization based in Toulouse (France's fifth largest city) whose starting goal was to provide Internet access rivaling commercial ADSL offers that, in certain parts of the city, were limited to 512K. Its coverage soon expanded to half a dozen rural areas in the surroundings of Toulouse that previously did not have access to a decent broadband connection. After 3 years of existence, Tetaneutral.net now counts almost 500 members who contribute with a small fee to the organization, 300 of which are subscribers who also pay about €20 a month (depending on their financial situation).

Similarly, Guifi.net is a community network that began in 2004 in a rural community in Central Catalonia (120 kilometers outside of Barcelona) where DSL connection provided by the incumbent carrier Telefónica was both expensive and unreliable. While it is possible to deploy ad-hoc routers within the network, most of the nodes are either clients or final nodes that do not provide routing capabilities for other nodes. Like Tetaneutral.net, Guifi.net's infrastructure is managed as a "commons": it is legally owned and commercially run by a non-profit foundation (on behalf of its users). Guifi.net also enjoys long-term partnerships with local governments and city councils for the construction of a large-scale sustainable WCN. Several municipalities contribute resources to Guifi.net's network (i.e. by installing antennas on street lamps or rooftops) and share their Internet connection. Guifi.net rapidly spread and currently provides connectivity to over 45000 users, across various Spanish regions.

As opposed to the traditional, tree-like topography where network administration is centralized and routing follows a predetermined route, certain community networks have chosen to implement a more decentralized network architecture based on "mesh" networking technologies. "Community Mesh Networks" (CMN) are a subcategory of WCN which adopt a radically distributed network topography, whereby every device can simultaneously be both a client and a relay node for other users (Akyildiz & al., 2005; Zhang & al., 2007). Mesh networks interconnect users' devices (routers, computers, mobile phones and other terminals) via WiFi directly to one another without following a predetermined hierarchical, tree-like topography, depending on the relay nodes located within the range of the WiFi signal at any given moment.

Freifunk and Wlan Slovenija are two community networks that operate through a mesh network topography. Interestingly, their deployment did not stem from a technical necessity, but rather than an ideological drive: deploying a mesh network infrastructure was a sensible and well-informed choice aimed at maximizing individual autonomy through a decentralized peer-to-peer communication network.

However, like in other peer-to-peer architectures,[33] while the political values attached to decentralization might have driven the launch of this initiatives, such motives are not in and of themselves sufficient for the network to scale up beyond a restrained community of highly engaged individuals with strong ideological values. To grow, these community networks must also provide a service that is considered at least as good and preferably better than that of mainstream ISPs. In

[33] Most users' choice are not determined by decentralization as such, but only by the competitive advantage that decentralization might provide. The success of P2P file-sharing was not actually due to the oppressive reaction of the MPAA (the trade association representing Hollywood majors) against copyright infringement, but rather to the ability for people to download files (for free) that they could not get otherwise. Yet, the popularity of these networks dropped as Apple came into play with the a centralized alternative, the iTunes store, providing a better experience that users were actually willing to pay for. Similarly, while many people cheer at Bitcoin for its decentralized architecture, its recent growth in popularity is not directly related to decentralization but rather to the new opportunity it offers (in terms of financial speculation, experimentation and lower transaction costs) over the traditional financial system.

Ljubljana, for instance, where cheap fiber connections were already available to many households, there was no immediate practical need to build an alternative network, and the ideological drive to participate in a Do-It-Yourself network or the desire to experiment with mesh networking technologies did not scale to more than a few tech-savvy individuals. The rapid growth of Wlan Slovenija – which started in 2009 and now counts almost a thousand nodes – is due to the fact that the network actually turned out to be very useful to its users. Indeed, by sharing their Internet connection with the community, and by encouraging others to do the same, participants could get free Internet access from potentially anywhere in the city. As the network grew, Wlan Slovenija gained both recognition and even more traction. To be sure, some new users were ideologically appealed by the project, while others joined because they could not afford commercial Internet access. But the critical mass attained by the community mainly resulted from its competitive advantage over mainstream ISPs.

2.2 Technological features: greater flexibility, resiliency, autonomy

At the technical level, the main benefits of WCN come from their flexibility and resiliency, and the fact that they are designed to foster user autonomy.

a) Network flexibility and resiliency: Given the considerable investments required to set up an independent network infrastructure, and given the costs of purchasing wholesale access to last-mile landline networks from commercial operators, many grassroots community networks have decided to operate via wireless technologies, setting up network of peers sharing radio signals. Most of their network infrastructure consists of wireless radio equipment: Wi-Fi routers and antennas strategically distributed at different locations so as to maximize coverage. As a result, they can often provide a service of better quality than that which is generally available from commercial alternatives.[34]

With regard to mesh networks because of their low-cost and flexible infrastructure taking advantage of users' terminal equipments, they have historically been deployed in areas with little or no pre-existing network infrastructure, mostly in Africa[35] But mesh networks have also been deployed in countries where proper telecommunication infrastructures exist, but are simply not affordable for lower-income households. For example, in the American city of Detroit, where a mesh network is currently being deployed, the inhabitants could not afford to pay for an Internet connection.[36] The mesh network – which relies on the Commotion open source software kit – builds upon pre-existing resources in terms of both hardware and social capital to deploy and maintain a community network with almost no upfront investments. In a European context, CMN are even

[34]For instance, in Toulouse, in contrast to commercial alternatives, whose speeds are less than 1Mbps in some parts of town, Tetaneutral.net brings symetric 30Mbps connections (to be shared between several users). Its network topography follows a tree-like structure, with some members hosting both client and access point antennas, relaying radio signals to other clients of the network. Most of Tetaneutral.net's infrastructure relies on wireless radio connectivity, which allows for a highly flexible network. Unlicensed Wi-Fi spectrum also makes up for cheap network connections: each antennas – emitter or receiver – costs around €60, whereas the home Wi-Fi routers range around €15 (these are paid for by the organization). Nodes are able to maximize the bandwidth to be shared between different users on the same branch by using up to three radio channels within the Wi-Fi frequency range; however, Tetaneutral.net also features five landline fiber-optic accesses in several parts of the city to offload Wi-Fi traffic. Radio also allows for a more flexible network: Tetaneutral.net is able to extend its network "on demand" in a couple of hours, for instance to bring Internet connectivity to moving protests and demonstrations taking place in the city.

[35]Mesh networks have been experimented in Africa,, where a large portion of the territory is beyond the reach of the established network of communication, mesh networking technologies are used to provide basic connectivity to undeserved areas that would otherwise be unreachable. See e.g. Mesh Potato in Kenya and South Africa (http://villagetelco.org/mesh-potato/), Feem in Cameroon (http://www.tryfeem.com/), and the One Laptop Per Child initiative of the Massachusetts Institute of Technology (http://one.laptop.org/).

[36]This project is coordinated by the Allied Media Project, in collaboration with the Open Technology Initiative (OTI) of the New America Foundation] purports to provide free Internet access to the poorest neighborhoods of Detroit, where many of the inhabitants could not afford to pay for an Internet connection.

known to provide better service than commercial alternatives, especially when used with high speed landline infrastructure. For instance, Guifi.net, which began as a Do-It-Yourself wireless network intended to provide local radio connectivity to undeserved areas devoid of decent broadband Internet access, is now expanding its infrastructure by rolling out physical fiber optic cables so as to beef up the speeds delivered to the rural areas in Catalonia, and which so far had not been considered sufficiently profitable by incumbent ISPs.

In terms of flexibility, the main technical advantage of mesh networks are their dynamic routing protocols, which define the rules for transmitting and circulating packets throughout the network: as the network evolves – with new relay nodes appearing, others disappearing, and some merely changing their location –, it automatically reconfigures itself according to the availability and proximity of bandwidth, storage, and routing protocol.[37]

This is feature allows them to grow organically with minimal coordination and give mesh networks maximum resiliency: with mesh topology, there is theoretically no sensitive points (or single points of failure) to jeopardize the functioning of the local network. In practice, mesh networks are very resistant to network failure or interference since they constantly reconfigure themselves by establishing ad-hoc connections between any device at range. Even if a particular node is down, dynamic connections between nodes enable packets to travel through multiple routes, relayed from one node to another until the final destination is reached. Hence, to the extent that the network is dense enough and that many users operate as relay nodes, the only way to shut down the mesh network is to shut down every single one of them.

This ease of deployment and resiliency explains why a variety of mesh networks have been deployed in areas affected by natural disasters and impoverished communities where the basic communication infrastructure has been severely damaged or degraded. For instance, in the face of the damages caused to Haiti's communication infrastructure by the 2010 earthquake, the Serval project was launched in Australia with the objective to create a disaster-proof wireless network that relies exclusively on the connectivity of mobile devices. Similarly, in the US, the Red Hook wireless network, which had formerly been deployed as a precautionary measure in Brooklyn (NY), has been extremely useful in the midst of recovery from Hurricane Sandy: thanks to mesh network technologies, rescue teams and local inhabitants could quickly recreate a communication system in spite of the damages incurred by the conventional infrastructure of communication.

Yet, despite these advantageous features, the deployment of CMN is not devoid of problems. Common issues range from the lack of infrastructure, to excessive packet loss resulting from transmission errors and slow bandwidth rate. These difficulties (many of which might eventually be overcome with the progressive refinement of mesh networking technologies) explain why some communities prefer to achieve similar goals by deploying self-managed communications networks through to a more manageable and more centralized network structure, such as the one deployed by Tetaneutral.net, with its tree-like topology.

b) User autonomy: Another distinctive feature of WCN – both mesh and non-mesh – relates to the commitment of grassroots community networks to promote users' communicational autonomy and fundamental rights to communication and privacy. As opposed to commercial ISPs blocking certain ports and censoring websites or content, community networks ardently protects Net neutrality. Their commitment to fostering human rights is also reflected by the light-touch approach to logging users' communications and sometimes their refusal to abide to legally mandated data-

[37] To date, many mesh networks that have been deployed relyon one of two so-called "dynamic routing" protocols: OLSR (a proactive link-state routing protocol allowing users to compute next hop destinations for all nodes in the network using shortest hop forwarding paths) deployed within the Commotion toolkit and currently adopted by the majority of CMN, such as RedHook; and B.A.T.M.A.N. (Better Approach To Mobile Adhoc Networking) specifically developed by the Freifunk community in order to reduce the overhead in network communication by eliminating the need to spread information concerning network changes to every node in the network. Other dynamic routing protocols exist, such as Babel or BMX.

retention requirements imposed on traditional ISPs. What is more, in several countries, small community networks are usually not bound by censorship orders issued by courts against illegal online content. In France for instance, the state has to compensate ISPs financially for the cost incurred for blocking websites. As a result, prosecutors make the choice of focusing on the few large commercial ISPs with the biggest market share.

User autonomy and self-reliance is maximal when WCN are apprehended not just as part of the wider Internet but as autonomous local networks (or Intranets), allowing users to share information with other users connected to the same community network. In this regard, to the extent that they do not require centralized administration to operate, mesh networks' flexible topography make them especially fit for deploying flexible and autonomous peer-to-peer radio networks. In the town of Sayada in Tunisia, an experimental mesh network has recently been deployed to operate locally, separate from the open Internet. The aim is to provide residents with an improved communication infrastructure, enabling them to freely and more securely communicate with each other, without having to rely on any third party ISPs.[38] Local mesh networks also enable users to escape from the ubiquitous and pervasive surveillance that is occurring on the global Internet, as a result of privacy-intrusive practices undertaken by traditional online operators. In particular, given the lack of a central authority regulating access to the network, it is in theory more difficult for anyone to assess the real identity of users connected to these networks.

That being said, the resistance of mesh networks to surveillance and repression has its limits should not be over-hyped, as it is sometimes the case in media reports. "Devices operating in any wireless network – including mesh networks – use a radio transmitter that can always be located by triangulation," notes a member of Freifunk. Besides, even with highly distributed networks, traffic can always be monitored. As professor Edward Felten writes, "as soon as an adversary connects to your network, or your network links up to the Internet, you're dealing with the same security and privacy problems you would have had with an ordinary connection" (Felten, 2014). Thus, in spite of their benefits, in no way can local community networks replace proper encryption techniques. Their primary advantage in times of crisis is the fact that they provide community with the means to communicate independently from the central command of governments and traditional operators. They enable citizen to organize (politically or otherwise) even in the eventuality that the established powers activate the so-called "kill-switch" and shut down communications networks in a given area (Hasan & al.), as occurred in Egypt and Libya during the 2011 Arab spring,[39] and as has been considered elsewhere.[40]

2.3 Governing Internet networks as a commons

WCN constitute, essentially, a political choice: by establishing a mix of social and relational ties between participants involved in the provision of the network infrastructure, they promote a more democratic and cooperative political system, with a more symmetrical and participatory governance structure (Bauwens, 2005).

[38]The Sayada community network, Mesh Sayada, is a collaboratively designed and built wireless network. The town of Sayada is located on the Tunisian coast, 140 kilometers from Tunis. The network serves as a platform for locally-hosted content, such as Wikipedia and Open Street Maps, and is expected to expand to include locally created content. For more details, see http://commotionwireless.net/blog/2014/04/18/case-study-mesh-sayada/

[39]The Commotion Wireless project of the New America Foundation was originally motivated by the need to provide a secure and reliable platform to prevent authoritarian governments from controlling or blocking dissident or activist communications (King, 2011) Likewise, the Open Mesh Project was initiated after the Egyptian Mubarak government's attempt at shutting off the Internet in the whole country, with the goal of providing open and free communications to every citizen in the world, regardless of national boundaries, by developing the best open source technologies, while simultaneously partnering with existing technologies, to create a private,& citizen-owned communications infrastructure.

[40]For a commentary on the "kill-swtich" debate in the US, see Ackerman (2011).

In the Internet history, such participatory, consensus-driven governance model has only been applied to a limited number of layers of the Internet (Lessig, 1999). Early on, it had been the founding ethos of Internet governance and soon became a norm for the development of Internet protocols and standards (e.g. IETF for Internet networking standards; W3C for web standards) where decision-making is decentralized – or, in the words of David C. Clark: "We reject kings, presidents and voting. We believe in rough consensus and running code"[41] At the application and content layers, commons-based governance can also be found in the context of the Free Software and Creative Commons movements, with projects such as Linux and Wikipedia. The revival of community networks has shown that the model of open governance characteristic of many "common pool resources" (Ostrom, 1990) can also be applied to the physical, last-mile infrastructure of the network, with important consequences on the following key features:

a) Transparency: Transparency is key to open governance. In terms of accounting, whether it relates to expenses or equipment costs, fees or other revenue streams, all items are typically publicly made available to anyone. .[42] On a more technical front, many tree-like WCN also make the logical interface for administrating the network available to all those members who wish to access it, whereas in the context of mesh networks, the community is in charge of maintaining a public database of active relay nodes.

b) Inclusiveness: in the context of many WCN, it is for the community itself to decide the manner in which the network should effectively be designed and managed. This goal is achieved via flat organizations and a peer-to-peer approach to decision-making, based on deliberation and consensus. While most of the communication is done via mailing lists, many WCN try to organize weekly or monthly meetings where all willing participants and the most active volunteers can get together to socialize and discuss important management issues. "Day-to-day decisions are often proposed and debated on mailing lists and social networks, while most important decisions are usually presented and discussed in meetings," says one member of Guifi.net.

Yet, as it is often the case in other Internet governance fora, community networks tend to favor the most active members. Some define themselves as a "do-ocracy":

> "We are organized in a non-hierarchical community where common decisions are made consensually through constructive debate and arguments, but where in the case of equivalent arguments, we favor arguments of those who are more actively participating in the network," writes a member of the Slovenian network Wlan Slovenija. Yet, "the most active members should pay attention to not overuse this favoring carelessly because, in every case, at a technical level, the network requires at a complete consensus, because the dissatisfied can in any moment decide not to participate anymore. That way, the whole network would be at loss."

Thus, as with Internet standard-setting bodies and free software projects, the governance of grassroots community networks ultimately mandates consensus to alleviate the risk of "forking".[43] The network's technical properties and, in particular, the possibility for dissatisfied users to leave

[41] Dave Clark, IETF Credo (1992), available at http://www.vtac.org/Tutorials/ietf_hx.html.

[42] Tetaneutral.net, for instance, sends out monthly emails to its mailing-list describing the current number of fee-paying members, subscribers and associated revenues, recent investment in equipment as well as changes in the network infrastructure. These e-mails are publicly available through the "transparency" section of the organization's website. For an example of such an e-mail, see Tetaneutral.net's financial state of play for March 2014: http://lists.tetalab.org/pipermail/Tetaneutral.net/2014-March/002128.html

[43] In software engineering, a project fork happens when developers take a copy of source code from one software package and start independent development on it, creating a distinct piece of software. The term often implies not merely a development branch, but a split in the developer community, a form of schism (Wikipedia).

the original network and create a new one reinforce the group's commitment to consensus-driven governance.

c) Social goals: Most WCN are committed to serving the wider community they belong to. As outlined before, many provide connectivity to places that traditional, commercial ISPs neglect. These are often undeserved areas or poor neighborhoods, whether in rural or urban settings.

To take into account the socio-economic situation of some of their members, several of the organizations we surveyed give preferential subscription fees to unemployed people and students, and some even consider their subscriber's fee a "suggested donation".Often, WCN even configure their networks to provide Internet access to cultural centers, public parks, squats, or even schools and city halls. For instance, in Toulouse, Tetaneutral.net has been working with a clinic specialized in providing healthcare to homeless people, many of which are "illegal" immigrants, so that they could video-chat with their families back in their home countries[44].

d) Education: For community networks, users' lack of technical skills is sometimes one of the most challenging problems, and can lead projects to fail (Albert, 2013). Educating users to the use of technical tools and network management is therefore an important task for community networks to thrive and meet their goal of creating inclusive and citizen-centric networks. In the US, this objective is sought, for instance, by the Digital Stewards program, a technology training designed by the OTI. The program aims to impart to community members the basic knowledge and skills required to design and deploy a communications network, such as wireless mesh networks. More generally, in all the WCN we have interviewed, active and skilled volunteers are in charge of training new-comers and neophytes, helping them for instance to set up and manage their routers and Wi-Fi antennas.

In addition to sharing knowledge about how the Internet and community network function, WCN also encourage users to adopt a more pro-active approach to securing network connectivity and their online communications. Accordingly, community networks often promote the use of free software, decentralized online services and end-to-end encryption techniques. "We are educating users how they can protect themselves on our and any other network," says one of our interviewees. Surveillance is also an important concern: "We are teaching people that even through they do not have to give their identity to log into our mesh network, they are not anonymous toward the authorities or other entities due to hardware and software profiles of their devices and other metadata", explains another participant.

e) Incentives for participation: The flip-side to a commons-based governance for WCN, however, is that they only subsists insofar as there is someone willing to contribute to the network As opposed to software, which, once produced, remains operational and available to all, WCN cannot operate without a constant provision of bandwidth resources to sustain the infrastructure and to pass traffic on to relay nodes across the network. Members, therefore, have an incentive to provide resources to the network and to work together to address any network failure that might occur (say, a displaced radio antenna) so as to maximize the benefits they can derive from it, both individually and collectively. In Detroit, for instance, the longer term vision is to have the community more directly engaged in the governance of the network, through direct participation in the installations and maintenance of Wi-Fi routers and antennas for public use.

While free riding cannot be completely avoided, WCN have to provide enough incentives for the community to contribute a sufficient amount of resources so as to ensure the long-term sustainability of the network. This is especially true in the context of mesh networks: given that

[44] The clinic gives its patients free Internet access, but used to rely on the commercial subscription of the hospital to which it is attached. That 40Mbps connection was being shared between hundreds of staffs and patients, thus forcing the hospital's technology officer to restrict Internet communications: along with other bandwidth-intensive protocols or applications, online video-conferencing was blocked. By working with Tetaneutral.net, the clinic was able to easily set up an independent broadband wireless Internet access and lift traffic restrictions.

they use a dynamic routing method where relay nodes and routes are not predetermined, the efficiency of the network depends on the number of users who accept at any given moment to operate as relay nodes. This way, although specific routing protocols might allow for the establishment of supernodes (which have priority over the other nodes by virtue of their greater bandwidth, for instance), all users can potentially contribute to increasing the network bandwidth.

A number of WMN are experimenting with innovative mechanisms to incentivize participation and to encourage users contributions to the network. For instance, Guifi.net elaborated the idea of deploying a "CommunityCoin" – a cryptocurrency based on Bitcoin's block-chain technology whose objective is to reward the contribution of community members so as encourage and facilitate the assessment of internal community participation. While these coins do not have any real monetary value, they can be spent by community members to purchase a variety of goods or services from other community members. Here, again, the political goal of encouraging the establishment of strong and cohesive communities capable of self-organizing in order to fulfill their own needs by their own means is reinforced by technical necessities.

As we have seen in this overview of European community networks, grassroots organizations are a citizen response to the growing centralization and corporate enclosure of network infrastructures operated by commercial ISPs. Given the motivations underlying these initiatives, as well as the technical and governance features they implement, WCN have the potential of shifting the power dynamics in the telecom sector, by addressing many of the concerns raised by the growing concentration of power in last-miles networks, and potentially at the backbone level as well.

3. Community networks and new power dynamics in telecom infrastructures

If telecom policy sets the goal of promoting individual and collective autonomy, what is to be done is the face of growing concentration threats? According to Benkler, law should respond by "implementing policies that predictably diversify the set of options that all individuals are able to see as open to them" (2006:152). In the field of communications, this is precisely what community networks can achieve, and the reason why they might subvert the political economy of Internet access.

3.1 The interplay between WCN and telecom operators

From a political standpoint, following the typology of social movements drawn by Stefania Milan in her analysis of "emancipatory communication practices", we can infer three ways by which community networks can act to counteract existing power dynamics in the telecom sector.

One way is to address the issue from within the political system, as *insiders*, formally interacting with the power holders in order to make them support the deployment of community networks. Another solution is to fight the problem as *outsiders*, pressuring both regulators and incumbents from outside the political system, by means of protests, demonstrations and other campaigning tactics aimed at voicing dissent against the practices of commercial ISPs and against the lack of appropriate regulation for community networks.

Yet, most of the community networks we surveyed do not properly qualify as what social movement scholars define as "insiders" (although they sometimes do interact with policy-makers), and much less as outsiders. Mostly, they fall within the third category – what Milan identifies as "*beyonders*". They acknowledge that law and regulation will always be late compared to practice and private ordering, and purport to influence the networked ecosystem by remaining beyond the political system. This objective is achieved by building self-organized, decentralized and citizen-owned communications networks and setting up alternative socio-political and technical arrangements as a substitute for the traditional top-down power dynamics typical of of traditional institutions. As one member of Guifi.net puts it, "our community can show that we can do things in

another way, more participative, ethical and transparent, without the extortion of big companies nor the corruption of politicians and opaque public administrations." In this sense, these networks are "prefigurative realities" that challenge the status quo and ultimately contribute to a new political order (Milan, 2013:126-138). Accordingly, these networks built "for the people, by the people" fundamentally embody a form of political action.

WCN can also be regarded as a distributed counter-power to traditional telecom operators since they have the potential of being a source of competition to mainstream commercial ISPs. As we have seen, WCN often provide better services than commercial alternatives. What is more, they adhere to specific ethical commitments and governance structures. As opposed to commercial providers, which often go counter to the interests of consumers, engage in anti-competitive behaviors and are sometimes prohibitive to the poorest households, WCN promote open and democratic values, such as Net neutrality and consumer protection, aim for social inclusion and thrive to protect civil liberties. While they do not directly wage competition against traditional ISP, these nonprofit, community networks serve to increase diversity in the market for Internet access – thereby opening up the range of options available to citizens. This, in turn, affects the operations of commercial ISPs. In Berlin, for instance, Freifunk's popularity actually brought incumbent telecom operators to update their service agreements enabling subscribers to share their DSL connection to contribute bandwidth to the network. In this sense, WCN constitute a form of grassroots, bottom-up regulation of established players that simply emerges from there being a viable (and more attractive) alternative to the dominant, commercial system.

WCN also exemplify the process of disintermediation, that is characteristic of many other social arrangements brought about by the advent of the Internet network. They show that people dissatisfied with commercial offerings can actually get together and cooperate to create independent grassroots network infrastructures, or simply join those which already exist. From locally-grown food to locally-grown network, community networks form part of a wider movement focused on empowering local communities to directly produce and manage the resources that matters the most to them.

At this point in time, however, WCN cannot totally emancipate from intermediaries. Although they can be completely autonomous when they operate as closed local networks, they eventually need to connect with the global Internet network. Uplink Internet access is achieved by linking the local network to one or several "Internet gateways" in charge of routing the traffic from and to global backbones.[45] Here, potential bottlenecks resurface.

To obtain such an uplink to the Internet, community networks currently choose from a number of strategies. The first is to use upstream through traditional mainstream last-mile ISPs. Some WCN, like Freifunk in Berlin, prefers not to build any formal relationship with third party ISPs, and simply rely on the goodwill of community members (who are also subscribers of commercial ISPs) to share their commercial Internet connection so as to provide bandwidth and connectivity to the rest of the network.[46] The same is true for Wlan Slovenija.

When relying exclusively on the uplink connections of mainstream ISPs to provide a gateway to the Internet is not possible, or perhaps simply not reliable enough, WCN must establish a commercial relationship with transit ISPs. The transit market is generally much more competitive than the mainstream last-mile Internet access markets. Lesser concentration creates a more diverse ecosystem where multinational firms, such as Cogent or Level 3, compete with smaller, local companies. Some of these smaller telecom companies grew out of tech activist circles as community networks, and are keen to offer support (to the extent that it is commercially viable). Diversity therefore drives both competition and cooperation, and allows grassroots community

[45] An Internet gateway is all that is required to connect a particular network to an existing Internet connection. The gateway router will share bandwidth with other devices on the network from that connection. Multiple gateways can be deployed on the same network to provide additional bandwidth, as does for instance Tetaneutral.net.

[46] One other group we interviewed reported contracting a commercial fiber connection at one of their member's house, using this landline connection to create 8km-long radio link up to a small village, bringing high-speed Internet access to a half-dozen households who previously only had access to slow (512K) and expensive commercial offers. But the ISP terms and conditions did not permit such use of the infrastructure, as contractual restrictions precluded subscribers from sharing their connection with multiple users. If that commercial ISP was able to spot that the connection is being shared in violation of its terms and conditions, the connection of the whole village could be shut down.

networks to escape the risk of abusive behaviors on the part of incumbent operators. In New York, the RedHook initiative is getting support from both medium-sized ISPs (such as Brooklyn Fiber) and a number of even smaller ones established in the area. This is also true of Tetaneutral.net, who recently entered into a contractual arrangement with uplink provider Cogent to access backbone infrastructure. Meanwhile, the group's former transit provider is a local telecom company who offered to lease part of their brand new data-center to various nonprofit tech groups at a preferential price, allowing Tetaneutral.net to interconnect its servers and routers with Cogent's nearby facilities and benefit from first-rate bandwidth capacity.

That being said, one cannot rule out the possibility of a transit operator exerting control over, and even disconnecting, a community network. An anecdote actually illustrates the point: In 2009, the US Chamber of Commerce sought to silence a parody website created by "artivist" group the "Yes Men". To do so, they sent a take-down notice to the Yes Men's hosting service's upstream service provider Hurricane Electric, which, as a response, immediately disconnected the Yes Men hosting provider May First / People Link – a 400-member-strong organization committed to protecting freedom of expression. Hurricane Electric's actions temporarily took offline hundreds of "innocent bystander" websites also hosted by May First / People Link (Mintcheva, 2009). This anecdote shows that even when upstream providers do not have immediate economic incentive to engage in extra-judicial access restrictions, they remain nevertheless a potential bottleneck which can be pushed, through legal pressure, to censor their clients – be they a hosting provider or a small community networks seeking an uplink connection to the global Internet.

To the extent that in some markets (in both urban and rural areas) a few large telecom operators retain the ability to filter, censor, monitor, discriminate online communications, or simply refuse to interconnect, the need for uplink leads to the emergence of new bottlenecks that replicate the problems that community networks aimed to address in the first place.[47] To meet the challenge, some activists have begun to organize: the goal is for community networks to collectively acquire more independence and more bargaining power in the various markets in which they operate, and promote their philosophy in the face of the conflicting value systems of commercial telecom operators who might engage in predatory practices. Indeed, if a given grassroots community network strongly believes in the principles of freedom, openness and individual autonomy, how can it ensures that these principles are being endorsed by the network with which it interconnects to pass on Internet traffic? Or, in other words, how can a free (free as in "free" speech) network remain such when it starts reaching beyond the local community that initiated it?

Such are the tough questions being addressed by the Free Network Foundation (FNF) – a nonprofit organization created to support "free networks"[48] – defined as any network that equitably grants the following freedoms to all: "Freedom to communicate for any purpose, without discrimination, interference, or interception; freedom to grow, improve, communicate across, and connect to the whole network; freedom to study, use, remix, and share any network communication mechanisms, in their most reusable forms." In conjunction with this definition and labelization effort, the FNF seeks to create a license for interconnections agreements replicating the "share-alike" provision characteristic of many copyleft licenses and free software licenses.[49] Building on previous reflexions, such as the Pico Peering Agreement[50] or the Commons for Open Free &

[47] Following up on footnote 3: in the 1910's, it is because they lacked their own long distance networks for interconnecting and had to rely on AT&T's that American grassroots telephone networks eventually had to sell out and withered (Wu, 2010:53).

[48] See: http://thefnf.org

[49] See e.g. the GNU General Public License of the free software Foundation, or the Creative Commons licenses featuring the Share-Alike clause).

[50] A similar endeavor had already been undertaken back in 2004, with the drafting of the Pico Peering Agreement (PPA) – a template agreement laying down the minimum baseline for peering agreements and data exchange among free networks. In contrast to standard peering agreements, contracted between parties in charge of a specific network infrastructure, the PPA was designed to be contracted by individual network nodes, rather than the network itself. The

Neutral Network (OFNN)[51] elaborated by Guifi.net, the idea is to transpose this concept to the realm of network "peering agreements",[52] through the establishment of a "peer-alike" provision that would favor free networks over non-free networks. By offering free transit only in exchange of reciprocal values, such a provision could act either as an incentive for non-free networks to convert into free networks, or (at least) as a way for community networks to build bargaining power and better defend themselves from predatory behaviors. This way, community networks could eventually provide a new model for interconnection, one that blurs the distinction between the backbone and the last-mile and federates networks in a decentralized manner, extending in every direction and potentially spawning over whole countries and even across borders. A first experiment of this kind was carried on in 2012, when community networks FunkFeuer from Austria, NEDWirelles from Croatia, and Wlan Slovenija established a wireless backbone spanning across geographical borders to create a direct link between them. As the number of mesh networks deployed over the world grow, the potential for establishing a global and independent network infrastructure that abides to the founding principles of the Internet network will also increase.

3.2. How regulation favors commercial players and creates hurdles for WCN

Despite their potential in fostering public interest goals in telecom policy, regulators have so far failed to support the efforts of community networks. More often than not, public policy actually puts important hurdles on their way.

The most striking example of such hurdles relates is that several community networks have been precluded from using public broadband networks funded with taxpayers money. In France for instance, many local governments invested in rolling-out fiber networks in both urban and rural areas. These networks built and managed by a private company contracted by the public authority, a company which then lease access to traditional access providers. ISPs then sell Internet access offers to subscribers. Yet, the fee charged to access the network is designed for big commercial ISPs, and is often much too prohibitive for nonprofit community networks.[53]

Another other major problem of current telecom policies for WCN is the issue of spectrum management. Here, again, regulatory capture by commercial interests leads to regulatory choices that systematically overlook the potential of more flexible and citizen-centric policies. The recent allocations the so-called "digital dividend" (i.e. the frequencies left vacant by the switch from analog to digital television) is a textbook case. In France for instance, it was proposed to use part of the spectrum dividend to create new digital TV channels and develop mobile television as well as digital radio (neither of these two technologies has taken off thus far). The remaining half of these "golden frequencies" of the lower UHF bands (sought-after for their long-range propagation) was then auctioned off to telecom operators for their 4G mobile Internet access offers (the lucrative

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goal, ultimately, was to build a common space of information transit, where packets can freely transit from one node to another without any discrimination or interference. Although the initiative never really took off, the PPA is nonetheless relevant to the extent that it constitutes the first attempt at establishing the notion of "network commons" by delineating the principles of free data transit and the nature of "freedom" in "free networks."See http://picopeer.net.

[51]Since its conception, Guifi.net has been built around a particular peering-agreement which is designed to preserve the freedom, openness and neutrality of overall the network. All conflicts in the network are resolved according this interconnection agreement. For more details, see: http://guifi.net/en/CommonsXOLN

[52]In computer networking, peering is a voluntary interconnection of administratively separate Internet networks for the purpose of exchanging traffic between the users of each network. The pure definition of peering is settlement-free, "bill-and-keep," or "sender keeps all," meaning that neither party pays the other in association with the exchange of traffic; instead, each derives and retains revenue from its own customers (Wikipedia).

[53]Several French community ISPs have been unable to afford such fees, and are being denied access on a preferential basis. In at least one reported case, the network operator even refused to communicate the its price listing. In a neighboring country, a community ISPs similarly underlined "the lack of collaboration with public administrations" in securing access to landline infrastructure.

license auctioning took place between October 2011 and January 2012 and brought €3,5bn to the French state). Similar policies have been devised in other European countries.

In the process, one option has, however, never been considered: extending "unlicensed" access to some of these frequencies – that is,effectively turning them into a commons open for all to use. Long thought to be unreasonable because of the risk of radio interferences, opening up the spectrum to multiple, non-coordinated radio users has actually been experimented on a worldwide basis more than a decade ago for the Wi-Fi frequencies. Needless to say, it has proved to be a very wise policy choice. At the time, those frequencies were referred to as "junk bands", because few actually thought they could have valuable applications. Now, experts predicts that Wi-Fi will power 55% of Internet traffic by 2017 (Cisco, 2013). It is widely recognized as a flexible and very efficient technology, enabling large-scale innovation, allowing laptops, mobile phones, tablets, game consoles, cameras, e-book readers and countless other devices to connect seamlessly to the Internet. As our case-studies have shown, it also plays a key role in fostering the development of citizen-centric last-mile networks. Even exclusive licensees in the telecom sector providing Internet access over 3G and 4G increasingly resort to Wi-Fi's open spectrum to offload their Internet traffic (Juniper Research, 2013).

The success of Wi-Fi has proven Coase's defense of a market-based approach as the sole alternative to exclusive licensing to be overly simplistic. Against the backdrop of traditional economic theory, open spectrum policies has shown that commons-based approach to many-to-many communication infrastructure can actually work in practice. Through packet switching, best-effort delivery, as well as innovative radio transmission and bandwidth managements techniques, Wi-Fi has successfully verified Ostrom's claim that users themselves can create and enforce rules that mitigate the over-exploitation of the commons, confirming the point that orthodox economists usually overlook the practical failures of privatization and government regulation (Ostrom, 1990). In many regards, though property-based allocations of spectrum and exclusive licensing still have the upper half, it has often come short of fostering public interest goals, by creating a very significant underutilization of public resource.[54] Moreover, not only does the regulatory focus on exclusive licensing create an enormous opportunity cost by favoring established players over innovative new-entrants (such as community networks), it has even been argued by human rights NGOs that it may actually breach the international law on freedom of expression (Article 19, 2005).

Meanwhile, despite the successes of Wi-Fi, unlicensed access to spectrum remains marginal, and WCN's spectrum needs are largely ignored by regulators[55] – which is all the more worrying

[54]First, exclusive licensing have led to anti-competitive behaviors by spectrum owners, or favored certain technologies over potentially more promising ones. For example, several countries grant exclusive licenses to established commercial players providing Internet access through WiMAX or satellite, and even subsidize them. Second, such schemes have proved to encourage underutilization of the resource in the name of avoiding congestion, thus creating artificial scarcity of frequency bands. Many spectrum owners, be they the military or commercial operators (again, satellite or WiMAX come to mind) own important portions of spectrum but do not actually make full use of it, thus crowding out other technologies and potential uses of social value. TV and radio broadcasters also leave significant gaps between their respective channels (these so-called "white spaces") acting as buffers to avoid interference – thereby leaving many frequencies unused in the valuable UHF bands. Combined together, these phenomena bring underutilization to stunning levels: a recent study conducted for the EU Commission finds that, in Paris, the average spectrum use is as low as 7,7% of the 400MHz-3GHz bands, while the average spectrum utilization rate in Europe is under 10%.(Forge & al., 2012).

[55]These groups are increasingly becoming victims of the rapid growth of Wi-Fi traffic in the 5GHz bands. Guifi and Freifunk, for instance, report having a hard-time maintaining the quality of their network because of the saturation of these frequency bands. In some instances, they theoretically would be allowed to use the other portion of spectrum open to unlicensed uses in the 2,4 GHz band; yet, this constitutes a niche market for manufacturers of radio transmitters, and the gear necessary to deploy wireless networks in these bands is costly and community networks generally cannot afford the price . Another issue for WCN is linked to the topography of their environment: Wi-Fi bands have some important technical limitations, in particular in terms of propagation, and signals are easily blocked by buildings or trees. WCN are thus faced with the choice of either renouncing to create a new radio link in a given location, or push the emission power levels beyond the legal limits to overcome these obstacles.

considering that these are more and more victims of the rapid growth of Wi-Fi traffic. Guifi.net and Freifunk, for instance, report having a hard-time maintaining the quality of their network because of the saturation of the 5GHz frequency bands.[56] Another issue for WCN is linked to the topography of their environment: Wi-Fi bands have some important technical limitations, in particular in terms of propagation, and signals are easily blocked by buildings or trees. WCN are thus faced with the choice of either renouncing to create a new radio link in a given location, or push the emission power levels beyond the legal limits to overcome these obstacles.

3.3. Towards a public policy for the network commons

Much can be done at the regulatory level not only to lift the technical, legal and policy hurdles that community networks run into, but also to actively support them. Several elements presented in the course of this paper – from regulatory capture to the impressive results achieved by these small nonprofit citizen groups – show that this is both an urgent and sound policy move. Considering the increasingly concentrated outlook of telecom markets across Europe, a policy overhaul focused on community networks can indeed help create effective counter-powers to the dominance of commercial operators in the communications infrastructure. Various policy considerations follow from our fieldwork.

First, there is a range of regulations which make WCN's work and very existence significantly and often unnecessarily difficult. In a country such as Belgium for instance, the registration fee that telecom operators must pay to the NRA is relatively high, whereas in France, Spain or Germany, it is free – which may explain why the movement is much more dynamic in these countries. It is, therefore, all the more important that registration processes be harmonized at the EU level, and, in particular, that they remain free for nonprofit networks.

Second, several laws seek to prevent the sharing of Internet connections amongst several users by making people responsible (and potentially liable) for all communications made through their Wi-Fi connection. This is the case in France, for instance, where the 2009 three-strikes copyright law against peer-to-peer file-sharing also introduced a tort for improperly securing one's Internet connection against unlawful activity on the part of a third party. As a result, many community networks who would like to establish open Wi-Fi networks in public spaces, such as parks and streets, refrain from doing so out of legal insecurity. In our view, even though connection sharing might sometimes make law enforcement more difficult by allowing many unrelated users to share the same IP address, this drawback is more than compensated by the benefits brought about by the deployment of open wireless networks.

Third, it is not just Internet wireless access points that can be shared, but also the intangible infrastructure on which radio signals travel. As we have seen, unlicensed spectrum is a key asset for community networks to set up affordable and flexible last-mile infrastructure, but it is currently very limited. In the US, the FCC has initiated promising policies in that field.[57] But for the moment, the EU has shied away from similar moves. In 2012, the EU adopted its first Radio Spectrum Policy Programme (RSPP). During the legislative process, the EU Parliament voted in favor of ambitious amendments aimed at opening more spectrum to unlicensed uses.[58] Even if some of these

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[57] For the past years, through several regulatory moves, the FCC has been opening UHF "white spaces" to unlicensed uses. It has also started expanding the so-called "Unlicensed National Information Infrastructure" by adding 195MHz of spectrum in the 5GHz band and increase the permissible power for radio transmitters in these bands. See Farivar, C. (2014, March 31). More Wi-Fi is better: FCC expands use of 5GHz spectrum. *Ars Technica*. Retrieved May 11, 2014, from http://arstechnica.com/information-technology/2014/03/more-wi-fi-is-better-fcc-expands-use-of-5-GHz-spectrum/

[58] La Quadrature du Net. (2011, May 11). EU Parliament Adopts Open Wireless Communications Policy. *LaQuadrature.net*. Retrieved May 12, 2014, from http://www.laquadrature.net/en/eu-parliament-adopts-open-wireless-communications-policy

amendments were later scrapped by national governments, the final text still calls for member states and the European Commission to "assess" the "need for and feasibility of extending the allocations of unlicensed spectrum" in the Wi-Fi bands, while also voicing tepid support for mesh networks by stressing their potential to foster access to the global Internet.[59] As EU lawmakers were working on the RSPP, a study commissioned by the EU Commission also called for a new 100 MHz of license-exempt bands as well as for higher power output limits in rural areas to reduce the cost of broadband Internet access deployment.[60] Since then, however, EU work on unlicensed spectrum and on flexible authorization schemes which would be more accessible to community networks has stalled. In a communication released in September 2012, the EU Commission failed to announce any concrete action to expand unlicensed use of the spectrum (European Commission, 2012). A the national level too, there is unfortunately no policy change in sight.

Fourth, networks built with taxpayers money could also be treated as a commons, and as such should remain free from corporate capture. Regulators should ensure that nonprofit community networks can access publicly-funded and subsidized physical infrastructures without unnecessary financial or administrative hurdles. Accordingly, they should review existing policies and current practices in this field, providing transparent information to map publicly-funded networks, and mandate rules to allow community networks to use these on a preferential basis.[61]

Of course, countless other policy initiatives can help support grassroots networks, such as small grants and subsidies to help these groups buy servers and radio equipment, communicate around their initiative, but also support their research on radio transmission, routing methods, softwares or encryption (Shaffer, 2013). Like Guifi.net, the most successful of these groups suggest that even little governmental support – either local or national – can make a big difference in their ability to successfully accomplish the ambitious objectives they set for themselves.

But all of these policies point to an overarching issue, namely the need to democratize telecom policy and establish procedures that can institutionalize "subversive rationalization" in this field. In many countries, such as Spain or Italy, even though city councils may occasionally actively support these organizations to the extent that they provide better Internet access to their citizens, regional governments and national regulators have so far largely neglected them. An Italian group, Ninux, feels that "the government simply does not understand who or what we are." At the EU level, where much of telecom regulation applicable in Europe is ultimately crafted, community networks are virtually absent of policy debates.

[59] The RSPP states for instance that "wireless access systems, including radio local area networks, may outgrow their current allocations on an unlicensed basis. The need for and feasibility of extending the allocations of unlicensed spectrum for wireless access systems, including radio local area networks, at 2,4 GHz and 5 GHz, should be assessed in relation to the inventory of existing uses of, and emerging needs for, spectrum (...)." On mesh networks, it adds that "member states shall, in cooperation with the Commission (...) take full account of (...) the shared and unlicensed use of spectrum to provide the basis for wireless mesh networks, which can play a key role in bridging the digital divide." Decision No 243/2012/EU of the European Parliament and of the Council of 14 March 2012 establishing a multiannual radio spectrum policy programme, available at: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32012D0243

[60] For giving unlicensed access to another 100MHz of spectrum bands, the report suggested that half of these should be in the 1 GHz bands and the other one at 1,4 GHz. To avoid underutilization, the report also calls on policy-makers to suspend exclusive use of specific channels whenever the use of that spectrum is consistently below a level justifying any form of exclusivity. In France, where WiMAX roll-out has been so slow that the NRA eventually notified the corresponding licensees that they were in breach of their obligations, such a measure could lead to many more channels being opened up for shared or even unlicensed use, for instance to community networks.

[61] On very-fast broadband roll-out, our interviewees also pointed to the need to reorient both public and private investments in fiber-optic last-mile networks where they are most needed, that is in rural communities where decent broadband is crucially lacking, rather than in already well-connected urban areas where there is usually less demand for higher speeds. They also called on regulators to better coordinate so that any public work being carried to roll-out fiber-optic cables that can then be used to expand and improve Internet access.

Given the revival of community networks in the past years, it is not enough for regulatory authorities to treat citizens as mere consumers by occasionally inviting consumer organizations at the table. Regulators and policy-makers need to recognize that the Internet architecture is a contested site, and that citizen groups across Europe and beyond are showing that for the provision of Internet access, commons-based forms of governance are not only possible but that they also represent effective and viable alternatives to the most powerful telecom operators. Their participants have both the expertise and legitimacy to take an integral part in technical and legal debates over broadband policy in which traditional, commercial ISPs are over-represented. They can bring informed and dissenting views to these debates, and eventually help alleviate regulatory capture. In the very few instances where regulators reached out in good faith to community networks, it led to significant achievements. On one occasion, Wlan Slovenija was invited to actively contribute to a policy debate on a piece of telecom legislation, which translated in the adoption of a Net neutrality provision in Slovenian law in late 2012.

But democratizing telecom policy is not the sole responsibility of institutional actors. If regulators are not ready to listen, community networks must organize politically and pressure them to do so. In Germany, Freifunk's members claim that it might be paying off: "Recently, we have been doing a lot of policy work on the level of the municipality, the districts and the local regulatory bodies," reports one member "and we are having some success." For instance, the group has been allowed to conduct a limited experiment in Berlin in the so-called "white space" (white spaces refer to the frequencies in the UHF band left unused by TV and radio broadcasters). Radio signals in the lower UHF bands can go through walls and other similar obstacles, allowing for long distance radio links – potentially across several dozen kilometers – without the need to have the receiver antenna in sight, as it is the case for traditional Wi-Fi bands. The goal, explains that Freifunk member, is therefore "to show that we can build inexpensive mesh nodes operating in white space bands with off-the-shelf equipment and demonstrate that the power of mesh multiplies once we are able to use radio frequencies with greater propagation than Wi-Fi."

To go back to the typology of political action, these examples show that "insider" strategies, i.e. direct engagement with policy-makers, are worth pursuing. In a sign that community networks might increasingly be moving in this direction, many of them are working to form a more cohesive and powerful group to discuss legislative issues and advocate regulatory reforms, for instance within the DIY ISP initiative mentioned above. Of course, a potential problem for sustaining political engagement is the fact that community networks are often run by volunteers whose lack of time and resources may sometimes make it difficult form them to participate as actively as the full-time and well-resourced lobbyists of incumbent actors. But overtime, as the movement grows, it may be able sustain its engagement with public authorities, especially if the latter adapts and establish ad hoc contact channels and remote participation mechanisms.

Twenty years after the privatization of national networks in Europe, there is certainly a long way to go for telecom policy to balance the interests of all various stakeholders – including citizens – so as to live up to the social, economic and democratic stakes of Internet governance, of which it is a crucial part. In this process, community networks will undoubtedly have an important role to play. These burgeoning initiatives should invite policy-makers to break away from the narrow focus of past regulatory logics, overly driven by industrial economics and prone to regulatory capture. Bringing the impetus for reform, however, will undoubtedly require on the part of community networks and their allies in civil society to further organize for collective action and make these issues a visible part of the public debate, where they belong.

References

Ackerman, L. (2011, March 9). Internet "Kill Switch" Legislation: Can Obama Turn Off the Internet? *The BTLJ Bolt*. Retrieved May 16, 2012, from http://btlj.org/2011/03/09/internet-kill-switch-legislation-can-obama-turn-off-the-internet/

Akyildiz, I. F., Wang, X., & Wang, W. (2005). Wireless mesh networks: a survey. *Computer networks*, *47*(4), 445-487.

Albert, S. (2013). The Case of Chapleau Network: Why Community Wireless Networks Fail? In A.

Abdelaal (Ed.), *Social and Economic Effects of Community Wireless Networks and Infrastructures:* (pp. 178-194). IGI Global.

Article 19. (2005). The legitimacy of license requirements for the use of wireless communications devices. Retrieved April 16, 2014, from http://www.wsis-community.org/pg/file/read/1674/the-legitimacy-of-licence-requirements-for-the-use-of-wireless-communications-devices

Asghari, H., Eeten, V., Van Eaten, M., Bauer, J. M., & Mueller, M. (2013). Deep Packet Inspection: Effects of Regulation on Its Deployment by Internet Providers. Presented at the 41st Research Conference on Communication, Information and Internet Policy, Rochester, NY: Social Science Research Network. Retrieved from http://papers.ssrn.com/abstract=2242463

Ball, J., Harding, L., & Garside, J. (2013, August 2). BT and Vodafone among telecoms companies passing details to GCHQ. *The Guardian*. Retrieved from http://www.theguardian.com/business/2013/aug/02/telecoms-bt-vodafone-cables-gchq

Barlow, J. P. (1996, February 9). A Cyberspace Independence Declaration. Retrieved from https://w2.eff.org/Censorship/Internet_censorship_bills/barlow_0296.declaration

Bauwens, M. (2005). P2P and Human Evolution: Peer to peer as the premise of a new mode of civilization. *Ensaio, rascunho, 1*.

Benkler, Y. (2006). *The Wealth of Networks*. Yale University Press.

BEREC (Body of European Regulators for Electronic Communications), 2012, "*An assessment of IP-interconnection in the context of Net neutrality*", Draft report for public consultation

Bernal, P. (2014). *Internet privacy rights: rights to protect autonomy*. Cambridge University Press.

Boston Consulting Group. (2013). Reforming Europe's Telecoms Regulation to Enable the Digital Single Market. Retrieved from https://www.etno.eu/news/etno/2013/219

Bradwell, P., Craggs, G., Cappuccini, A., & Kamenova, J. (2012). *Mobile Internet censorship: what's happening and what we can do about it* (LSE Media Policy Project & Open Rights Group). London. Retrieved from https://www.openrightsgroup.org/ourwork/reports/mobile-internet-censorship:-whats-happening-and-what-we-can-do-about-it

Cambini, C., & Rondi, L. (2011). *Independence, Investment and Political Interference: Evidence from the European Union* (EU Working Papers). Florence School of Regulation, Robert Schuman Center for Advances Studies.

Christman, J. (2011). Autonomy in moral and political philosophy..*Stanford Encyclopedia of Philosophy online*.

Cisco. (2013, May 29). Cisco Visual Networking Index: Forecast and Methodology, 2012–2017. Retrieved May 10, 2014, from http://www.cisco.com/c/en/us/solutions/collateral/service-provider/ip-ngn-ip-next-generation-network/white_paper_c11-481360.html

Coase, R. H. (1959). The Federal Communications Commission. *Journal of Law and Economics*, *2*, 1–40.

Coleman, G. (2005). Indymedia's Independence: From Activist Media to Free Software. *Multitudes*, *21*(2), 41–48.

Deibert, R. J. (2013). *Black Code: Inside the Battle for Cyberspace*. Random House.

European Commission. (2012). *Communication on promoting the shared use of radio spectrum resources in the internal market*. Brussels.

European Commission. (2014a). *Broadband access in the EU: Situation at 1 July 2013*. Retrieved from ec.europa.eu//digital-agenda/en/news/broadband-access-eu-situation-1-july-2013

European Commission. (2014b). *EU Anti-Corruption Report* (No. COM(2014) 38). Brussels.

Feenberg, A. (1995). Subversive Rationalization: Technology, Power and Democracy. In A. Hannay & A. Feenberg (Eds.), *Technology and the politics of knowledge* (pp. 3–22). Indiana University Press.

Felten, E. (2014, April 22). Mesh Networks Won't Fix Internet Security. *Freedom to Tinker*. Retrieved May 6, 2014, from https://freedom-to-tinker.com/blog/felten/mesh-networks-wont-fix-internet-security/

Follorou, J. (2014, March 20). Espionnage : comment Orange et les services secrets coopèrent. *Le Monde.fr*. Retrieved from http://www.lemonde.fr/international/article/2014/03/20/dgse-orange-des-liaisons-incestueuses_4386264_3210.html

Giurgiu, I., Riva, O., Juric, D., Krivulev, I., & Alonso, G. (2009). Calling the cloud: enabling mobile phones as interfaces to cloud applications. In *Middleware 2009* (pp. 83-102). Springer Berlin Heidelberg.

Goldsmith, J., & Wu, T. (2006). *Who Controls the Internet?: Illusions of a Borderless World*. Oxford University Press, USA.

Habermas, J. (1991). *The Structural Transformation of the Public Sphere: An Inquiry Into a Category of Bourgeois Society*. MIT Press.

Hasan, S., Ben-David, Y., Fanti, G., Brewer, E., & Shenker, S. (2013). Building Dissent Networks: Towards Effective Countermeasures against Large-Scale Communications Blackouts. In 3rd USENIX Workshop on Free and Open Communications on the Internet. Washington DC. Retrieved from https://www.usenix.org/conference/foci13/workshop-program/presentation/hasan

Johnson, D. R., & Post, D. G. (1997). And How Shall the Net Be Governed?: A Meditation on the Relative Virtues of Decentralized, Emergent Law. In B. Kahin & J. H. Keller (Eds.), *Coordinating the Internet* (pp. 62–91). Cambridge, MA, USA: MIT Press.

Juniper Research. (2013, April 10). Mobile Data Offload & Onload Wi-Fi, Small Cell & Carrier-Grade Strategies 2013-2017. Retrieved May 10, 2014, from http://www.juniperresearch.com/reports/mobile_data_offload_&_onload

Kirk, A. (2002). “Machines of Loving Grace”: Alternative Technology, Environment and the Counterculture. In P. Braunstein & M. W. Doyle (Eds.), *Imagine Nation : The American Counterculture of the 1960s and ’70s* (pp. 353–378). New York: Routledge.

La Quadrature du Net. (2012). *Commentaires sur le projet de rapport de l’Arcep au Parlement et au Gouvernement sur la neutralité de l’Internet*. Retrieved from http://www.laquadrature.net/files/LQDN-20122106-Commentaires_Pr%C3%A9Rapport_Arcep_Neutralit%C3%A9.pdf

Laffont, J.-J., & Tirole, J. (1991). The Politics of Government Decision-Making: A Theory of Regulatory Capture. *The Quarterly Journal of Economics*, *106*(4), 1089–1127.

Laffont, J.-J., & Tirole, J. (2001). *Competition in Telecommunications*. MIT Press.

Lessig, L. (1999). Open Code and Open Society: Values of Internet Governance. *Chicago-Kent Law Review*, *74*(102).

Levine, M. E. (1990). *Regulatory capture, public interest, and the public agenda: toward a synthesis*. Yale School of Organization and Management.

Licklider, J. C. R., & Taylor, R. (1968). The Computer as a Communication Device. *Science and Technology*.

Loveluck, B. (2012). *Freedom Through Information: A Political Genealogy of Informational Liberalism and Self-Organization on the Internet*. PhD thesis. EHESS, Paris.

McChesney, R. W. (2013). *Digital Disconnect: How Capitalism is Turning the Internet Against Democracy*. The New Press.

McNamee, J. (2011). *The slide from self-regulation to corporate censorship*. Brussels: European Digital Rights.

Milan, S. (2013). *Social Movements and Their Technologies: Wiring Social Change*. Palgrave Macmillan.

Mintcheva, S. (2009, October 29). The Chamber of Commerce is not and should not be immune to political satire | National Coalition Against Censorship. *National Coalition Against Censorship*. Retrieved from http://ncac.org/blog/the-chamber-of-commerce-is-not-and-should-not-be-immune-to-political-satire/

Mueller, M. L. (2010). *Networks and States: The Global Politics of Internet Governance*. MIT Press.

Musiani, F., Schafer, V., & Le Crosnier, H. (2013). Net neutrality as an Internet Governance Issue: The Globalization of an American-Born Debate. *Revue Française D’études Américaines*, *n° 134*(4), 47–63.

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge university press.

Pool, I. de S. (1984). *Technologies of Freedom*. Belknap Press of Harvard University Press.

SamKnows. (2013). *SamKnows study on Internet speeds*. Retrieved from https://ec.europa.eu/digital-agenda/en/news/quality-broadband-services-eu-samknows-study-internet-speeds

Shaffer, G. (2013). Lessons Learned from Grassroots Wireless Networks in Europe. In A. Abdelaal (Ed.), *Social and Economic Effects of Community Wireless Networks and Infrastructures:* (pp. 236–254). IGI Global.

Starr, P. (2004). *The creation of the media: political origins of modern communications*. Basic Books.

Sutherland, E. (2012). Corruption in telecommunications: problems and remedies. *Info*, *14*(1), 4–19.

Tréguer, F. (2013). Insurgent Citizenship on the Internet: Pushing Back the Limits of the Public Sphere. In *Non-Compliance to the Rules and Disobedience Towards the Law.* International Congress of the Research Committee on Sociology of Law, Toulouse.

Turner, F. (2006). *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism*. University of Chicago Press.

Villeneuve, N. (2010). Barriers to Cooperation: An Analysis of the Origins of International Efforts to Protect Children Online. In R. Deibert, M. Haraszti, J. Palfrey, Zittrain, & R. Rohozinski (Eds.), *Access Controlled: The Shaping of Power, Rights, and Rule in Cyberspace*. MIT Press.

Willetts, P. (2010). NGOs networking and the creation of the Internet. In *Non-Governmental Organizations in World Politics: The Construction of Global Governance* (pp. 114–143). Taylor & Francis US.

Wu, T. (2010). *The Master Switch: The Rise and Fall of Information Empires*. Knopf.

Zhang, W., Wang, Z., Das, S. K., & Hassan, M. (2007). Security issues in wireless mesh networks. In *Wireless Mesh Networks* (pp. 309-330). Springer US.

Zhang, Q., Cheng, L., & Boutaba, R. (2010). Cloud computing: state-of-the-art and research challenges. *Journal of internet services and applications*, *1*(1), 7-18

Zittrain, J. (2008). *The Future of the Internet — And How to Stop It*. Yale University Press.