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5G and the notion of network ideology, or: the limitations of sociotechnical imaginaries

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Abstract

Transnational communication networks are produced in contestation between and among multinational corporations and nation-states. In the study of the governance of communication networks governance in science and technology studies traditionally the emphasis has been on sociotechnical imaginaries (Jasanoff and Kim 2015) which encapsulate joint futures that produce institutional configurations and the discursive roles in the power tussle between various stakeholders. I argue that next to the studying of power *over* infrastructures and their governance through sociotechnical imaginaries, there is an increasing need to study how power is distributed and control is exercised *through* the shaping of the technological materiality of infrastructures, as is happening for instance in the process of standardization. To describe the workings of the distribution of power and the exercising of control *through* networks, governance, and standardization, I expand the concept of network ideologies (Bory 2020) to show how several network ideologies are at play in the shaping of 5G networks. I base my analysis on the quantitative and qualitative analysis of standard-setting processes through document analysis of mailinglist conversation, standards, and policy documents, as well as through the parallel operation of experimental 5G networks. The analysis shows that sociotechnical imaginaries are insufficient to show the political process of the distribution of power and opportunities for control through the production of transnational communication infrastructures. The notion of network ideologies might provide a basis to study the merging of internet and telecommunication infrastructures, their standard-setting, and their governance.

Introduction

To analyze the development, standardization, and deployment of 5G technologies I contribute to the concept of 'network ideology' (Bory 2020). For the analysis of policies, infrastructures, and institutions, many scholars in science and technology studies have relied on the concept of sociotechnical imaginaries (Jasanoff and Kim 2015). While sociotechnical imaginaries are very successful in explaining collaborations between diverse groups with distinct interests, expertises, and backgrounds through a joint vision of the future, the concept of network ideology can help analyze and explain the intentional ordering of infrastructures as means of power and control. Where sociotechnical imaginaries have allowed for the translation of political ideologies into material infrastructures (Steger 2009), network ideologies allow for the translation of particular modes of infrastructural control into standards and implementations. The notion of network ideology helps explain how power is exerted *through* technological standards and *by* transnational communication networks, whereas political ideologies help explain how power is exerted *over* transnational communication networks. This contribution helps further the debate on the turn to infrastructure in Internet governance (Musiani et al. 2016; DeNardis 2020).

5G standards make use of the availability of processors for routers with increased speeds and more memory for lower costs to leverage technical computing paradigms such as *Software Defined Networking*, *Network Function Virtualization*, and *Edge Computing.* The paradigms locate service provision inside of computing networks and thus increasing the influence and control that can be exerted through these networks. In governance bodies and standards development organizations such as the 3rd Generation Project Partnership (3GPP) and the International Telecommunications Union (ITU), this has led to the request for minimal networking requirements by a wide range of actors, ranging from law enforcement agencies to car manufacturers and Internet of Things equipment providers. Whereas in the Internet standards development this could lead to the development of a consensus through productive contestation (ten Oever 2018), in the case of 5G nearly all requirements seem to be addressed in the standards. I argue this can be attributed to an underlying network ideology that locates control over end-user devices inside the network, with network operators and aligned service providers.

I will first provide an overview of the methods I used to operationalize this research, after which I will provide a brief overview of the literature on sociotechnical imaginaries, the governance of communication networks, standardization, and power and the role of various stakeholders. After that, I will provide an analysis of the standardization and development of 5G and its projected functionality, its sociotechnical imaginary, and provide an overview of how the techno-material properties of 5G are being shaped through various network ideologies. Finally, I will provide some reflections on the impact this might have on the studies of transnational communication networks.

Methods

For this paper, I engaged in code ethnography of open source 5G implementations through the parallel deployment of experimental telecommunications networks in an act of transgressive infrastructuring (Wagenknecht and Korn 2016). Next to that, I engaged in statistical, discourse, and network analysis of 5G standards and mailinglist conversations and participant observation in the main standards body that is responsible for the development of 5G, the Third Generation Protocol Partnership (3GPP). Finally, I engaged in quasi-structured interviews with engineers that develop and deploy telecommunication standards. The combination of these methods allows me to gain insights into the workings of 5G infrastructure production and the motives, interests, and approaches of the engaged stakeholders.

Literature Review

Sociotechnical imaginaries

The concept of sociotechnical imaginaries - the combination of visions, symbols, and futures that exist in groups and society that guide the co-creation of knowledge, technology, policies, and institutions - as developed by Jasanoff and Kim (2015), has become a central notion in science and technology studies. It helps to explain processes of co-production of technology among heterogeneous groups with distinct interests, knowledges, and practices (Jasanoff 2004). It sheds a light on the processes of technology production, and the role of institutions in this, but particularly centering the role of communities, sense-making, and world-building in the production of technology. The notion of sociotechnical imaginaries furthered the work of infrastructure studies (Star and Ruhleder 1994; Star 1999; Lampland and Star 2008; Bowker et al. 2010), a field that theorizes and uncovers how power and control is an inherent part of the production, maintenance, and usage of infrastructures.

Jasanoff and Kim write that sociotechnical imaginaries are ‘collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology’ (2015, 6). But if one looks closely at processes through which infrastructures are produced, these visions often turn out to be ‘[m]yths [that] are important for what they reveal (including a genuine desire for community and democracy) and for what they conceal (including the growing concentration of communication power in a handful of transnational media businesses)' (Mosco 2005, 19).

Sociotechnical imaginaries are commonly found and used within the analysis of communication infrastructures, starting with the telegraph, but similarly with the radio, telephone, television, mobile telephony, and the Internet. Whereas the technological sublime is a feature of sociotechnical infrastructures that depict them as an inherent part of a solution to social problems (Marx 1956; Nye 1996), sociotechnical imaginaries help describe how the sublime is leveraged to produce and implement an infrastructure by building social, political, legal, and economic support. Examples of this are the electronic superhighway metaphor – which helped garner political, economic, and popular support for the Internet (Abbate 1999). However, as Julie Cohen highlight, the electronic superhighway metaphor has been replaced with the image of the cloud. While this might seem innocuous, the imaginary of the electronic superhighway implied that there are rules and regulations that the internet should be bound to in a way that the cloud does not (Cohen 2019). A cloud is ephemeral and cannot really be caught, and therefore escapes regulation. Cohen describes this as 'deep capture strategies are concerned not only with results in particular cases but also with crafting and reinforcing master narratives that become deeply internalized, and they do not target only regulators but also cultural influencers, public intellectuals, and academic thought leaders.' (Cohen 2019, 105).

Could it be that sociotechnical imaginaries play an extensive role in 'how technologies are marketed, used, made sense of, and integrated into people's lives' (Sturken, Thomas, and Ball-Rokeach 2004, 3), but a rather limited role in the *material production* of technologies, for instance through standardization? If true, the production of technologies and the gathering of support for their acceptance and integration would occur simultaneous but not in parallel, meaning that sociotechnical imaginaries serve to legitimize a particular infrastructure, technology, or governance regime (ten Oever 2021c) whereas the material production of the infrastructure, technology or governance regime happens through other means (ten Oever 2021b). I will argue that the material production of communication infrastructures is led by network ideologies (Bory 2020) that get translated into infrastructural norms (ten Oever 2021b).

Infrastructure, Standards, and Power

Standardization is a point of convergence in the process of contestation about the shaping of the material technologies that underpin infrastructures. If 'changes to the globalising world are being written, not in the language of law and diplomacy, but rather in the language of infrastructure' (Easterling 2014, 11), then standards are the grammar of this language. Within science and technology studies and connected fields, excellent scholars have studied standards and their relation to power (Lampland and Star 2008; Abbate 1999; DeNardis 2009; Rogers and Eden 2017). They have shown how power and standards are entangled and interrelated but have not provided a theory for how it is exercised.

Aside from science and technology studies, the studying of telecommunication standards and standard-setting largely takes place within the fields of history of technology, economics, and law. The debate within this literature foreground the workings of network externalities (Katz and Shapiro 1985; Ankney and Hidding 2005), patents (Baron, Blind, and Pohlmann 2011; Bekkers et al. 2012), standard essential patents,(Pohlmann, Neuhäusler, and Blind 2016; Baron and Pohlmann 2018), and path dependencies (Barnes, Gartland, and Stack 2004; Shin, Kim, and Hwang 2015) in standard setting. These studies focus on how actors in standard-setting behave (Teubner, Henkel, and Bekkers 2021), and what makes standards succeed, and what makes them fail (Cargill 2011). These studies provide a tremendously useful insight into the motivations and behavior of actors in standard-setting but provide relatively little insight into the societal impact and participation outside of the industry. Some scholars argue that standards are not just a public good, but that standard-setting is essentially the work of a global social movement (Yates and Murphy 2019). Other strains of research have investigated how users can be integrated into standard-setting processes (Jakobs, Procter, and Williams 1996; Jakobs 2000), how user interests can be prioritized in standards-setting (Nottingham 2020), and how end-user rights advocates sought to participate in standard-setting processes (Morris and Davidson 2003; Castka and Balzarova 2008; Balzarova and Castka 2012, 29000; Cath 2021). However, the conclusion of most of these researchers is that there is little to no place for users or civil society in modern standards-setting if is not in the direct interest of the industry stakeholders (ten Oever 2021b). Whereas matters of the societal implication of standardization and infrastructures have been a core part of standardization literature (Yates and Murphy 2019), telecommunications, and internet standardization discussions (Braman 2011; 2012), these matters of public interest are *intentionally* not structurally considered in standardization (Carr 2015; Harcourt, Christou, and Simpson 2020).

The media scholar Alexander Galloway mainstreamed the idea that the founding principle of the Internet is not freedom but control. He argued that control was exercised in this distributed architecture was exercised through protocols (Galloway 2006). Especially in a world where geopolitical tensions are rising and policymaking in global governance bodies is grinding to a halt, telecommunications infrastructure and its standardization form a welcome alternative. Especially since the standard-setting of transnational information networks has been cast as de-politicized through a veneer of open consensus-based standard-setting (Russell 2014), but practically this translates into a limited role of the state and civil society (Carr 2015), and a predominant role of transnational corporations. This practically makes internet governance and transnational communication standard-setting an exercise in bottom-up industry self-regulation (Sowell 2012).

For the corporations involved in designing, standardizing, and maintaining transnational communication networks and the services that run over them, extracting data from end-users and exercising control over data streams is what the network is optimized for (Easterling 2014; Cohen 2019; Powell 2021). The internet architecture is continuously shaped in the contention between parties that are interested in control over these data streams. An example of this is the deployment of encryption in the latest Internet transport protocol QUIC, which is used by content providers to ensure that network operators have access to as little data and metadata as possible. This reinforces the position of consolidated content providers, such as that of the developer of this protocol, Google (ten Oever 2021c).

The Return of the State?

The Internet governance scholar Jeanette Hofmann (Hofmann 2005) differentiates three phases of internet governance. A first phase of technical coordination, a second phase of self-regulation, and a third phase in which the state reasserts itself in internet governance. I want to contend with this view because the state has never been structurally gone from the governance of transnational communication networks. It was the telegraph network that changed the British empire from a colonial power to an imperial power (Cowhey 1990) by integrating an immense geographical space through the speed of near-instant communication. Equally, one of the most influential (and most-funded) predecessors of the internet, the ARPANET, was developed by the United State government in response to the launch of the Sputnik satellite by the Soviet Union (Abbate 1999).

The influencing of standard-setting by the introduction of vulnerabilities in the Internet architecture by the United States National Security Agency, disclosed by Edward Snowden, is merely one example of continued engagement by states in Internet standardization (Rogers and Eden 2017). The book edited by Haggart et al (2021) highlights the return of the state in international policymaking, and the book edited by Musiani et al (2016) shows the turn of the state to internet infrastructure for governance and policy goals. While there has been significant attention to the political economy of the production of transnational communication networks (Powers and

Jablonski 2015; Hong 2017; Winseck 2017; 2019; Zajácz 2019; Cohen 2019), the production and reconfiguration of institutional arrangement for these networks (Drake 2000; Mueller 2002; 2010; Cath 2021), and the economic drivers and interests in ICT standard-setting (Pohlmann 2014; Shin, Kim, and Hwang 2015; Ermoshina and Musiani 2019; Baron and Kanevskaia 2021) there is a gap in the literature where it comes to the inscription of particular network ideologies (Bory 2020) in communication architectures through standard-setting, or as Julie Cohen calls it: 'the exercise of network-and-standard-based governance authority' (2019).

Analysis

International Mobile Telephony Standards in the International Telecommunications Union

The invention of the first two generations of mobile networks led to competing uninteroperable standards, namely GSM, produced by the European Groupe de Travail Spécial pour les Service Mobiles and the standard Code Division Multiple Access developed by the North-American Qualcomm. Both these standards gained popularity outside of the respective origin geography, and thus standardization in a body that covered more than Europe or the United States was needed. This role was taken up in part by the International Telecommunication Union (ITU), which developed the requirements needed for what would become the third generation of mobile networks, 3G for short. These requirements were summarized in the International Mobile Telecommunications 2000 standard, or IMT-2000.

Based on the requirements of the ITU, manufacturers engage in the production of technology and technology specifications that live up to the requirements. Once this is done, the ITU assesses whether these technologies deliver on their promises, and subsequently, these technologies and specifications become part of the standard. This is what happened with technologies for 3G (under the ITU IMT-2000 standard), 4G (under the ITU IMT Advanced standard), and this is what is expected to happen for 5G (under the ITU IMT-2020 standard). However, this has not happened yet.

Preceding 3G there was strong competition between various implementations of standards, but the industry consortium that encapsulated telecommunications standards organizations from Japan, the United States, China, Europe, India, and Korea is now producing practically all standards for mobile telephony. This consortium is called the 3rd Generation Partnership Project (3GPP). Qualcomm sought to establish the 3rd Generation Partnership Project 2 (3GPP2), but this has only been able to produce standards that have been recognized by the ITU for 3G (namely the CDMA2000 standard). There is one other body that produced specifications that live up to the ITU standards, and this is the Institute for Electrical and Electronic Engineers (IEEE), but their WiMAX standards mostly focus on long-distance WiFi connections that are not produced for mobile phones.

5G's sociotechnical imaginary

In the information, marketing, and communication material on 5G provided by the 3GPP and those engaged in the standardization of 5G three main points are communicated every time: 5G will provide (1) higher bandwidths at (2) lower latency for (3) more devices. In other words, 5G networks will be faster, better, bigger, and more. But at the same time, 5G is positioned as the logical successor to 4G networks, which will be produced by the same (or similar) phone and equipment manufacturers and the networks will be operated by familiar telecommunications providers.

In the sociotechnical imaginary of 5G there is an inherent friction between the claims it makes: is it an evolution or a revolution? Will it simply be like 4G, but a tad bit better, or will it power smart cities, create 'new immersive experiences' ? There answer to this question might be simpler than one would expect: we do not know yet, because 5G has not yet been standardized or implemented. And the candidate standard for 5G, as it is currently being developed in the 3GPP, is by no means uniform or monolithic. The 5G is a complex combination of standards (some of which have not been finalized yet) that can be implemented in modular manners, resulting in heterogeneous networks with varying functionalities.

5G can be implemented to power smart cities, or 5G implementations could be run by private actors in 'Industrial Internet of Things'-settings to network production lines and factories with high timing precision and control systems (Rendón Schneir et al. 2018). But these things do not come without cost. To deliver on the high bandwidth and low latency promises of 5G, the use of higher frequencies than currently are allocated to private mobile communication networks are needed, namely in the mid-band (3.4 - 4.5 GHz) and high-band (24GHz and up) frequencies. A consequence of the use of these frequencies is that signals will travel less far and have a limited penetration rate through for instance walls, trees, and will suffer more from interference from other signals. To establish coverage for this network new and more antenna's will need to be deployed, leading to an increase in devices and energy consumption, as well as usage of spectrum by large telecommunication providers. This

5G network ideologies

The rise of a sensor network and the end of end-to-end

The development of 5G networks heralds a significant change in the topology of communication architectures. The rise of the Internet model was characterized by the introduction of a dumb network with smart edges (Abbate 1999; Zittrain 2008; Clark 2018) in which it was the sole role of the network was to route data, and for connections to be initiated by the end-nodes, where processes and innovation would take place (Internet Architecture Board 1996). The introduction of this model was a direct response to the preceding telecommunications model in which the end-nodes were dumb (think of a phone with a rotary dial) and the network was (relatively) smart. Or at least smart enough to limit the smartness of the end-nodes (Russell 2014).

The rise of 5G fits in a model in which the network can service more devices than ever, but these devices are not the room-filling computing devices from the 1970s, nor the size of smartphones, but rather take the shape of video cameras, smartwatches, vibration sensors, and traffic lights. For the longest time, it was expected that at least one end of a connection between two end-hosts on a communication between was connected with an end-user. But this is less and less the case. This is a process that Galloway, Thacker, and Wark theorize as the excommunication of the user (2013). Where the term 'user' was already a rather one-dimensional understanding of a human in relation to computing networks (Satchell and Dourish 2009), in the network ideology of the Internet of Things (IoT), as popularized by IBM (Powell 2021) the user has less and less control over communication infrastructures. This results in humans being configured through their computational context through infrastructures in smart cities, instead of controlling these infrastructures themselves (Mosco 2019). The infrastructures are thus, in short, producing the user. The sensory feedback loop between sensors, users, servers, screens, and urban devices produces an image of a fully programmable infrastructure that is programmable, adjustable, and optimizable, except for the subject that is being optimized (Gurses and Van Hoboken 2017; Powell 2021). The excommunication of the user in 5G enabled networks reveals the optimization of communication networks for data extraction and the creation of a data proletariat.

The 'telecomification' of the Internet, or: back to the future

Since 4G all traffic in mobile networks is using the Internet Protocol (IP). This removed the theoretical and practical difference between Internet Service Providers (ISPs) and Mobile Network Operators (MNOs). Next to that, all across the world, independent ISPs have been acquired through mergers and acquisitions by the telecommunication industry, leading to the overall oligopolization of MNOs (Warf 2007; Genakos, Valletti, and Verboven 2018). This makes MNOs the main providers for wired internet connections to homes and businesses. In the near future this might mean that copper networks might not be replaced with fiber to the home (FTTH), devices in the home might directly be connected to 5G networks (Knieps and Stocker 2019). Where a home router provides an opportunity for users to deploy firewalls, manage, and administer traffic, and provide a certain level of anonymity among family members, direct connections to networks provided by MNOs will provide the network operator with a lot of information about individual users. Especially since with new antenna technology and lower latency, the location and position of devices can be monitored in far greater detail with 5G networks. This means that MNOs will have a lot of data and control over end-user connectivity. Add to this is the introduction of so-called embedded SIM-cards, or e-SIMs. Meaning that devices can remotely be connected to telecommunication networks through software-based programmable identifiers. This is transforming the cloud into a fog that makes it impossible to see whether, how, and to whom devices are connected. This transformation makes communication infrastructures omnipresent and invisible at the same time, practically blackboxing the foundation to information societies.

The 'internetification' of telecoms, or: the collapsing of the stack

The integration of the internet with telecommunication networks is working both ways. Whereas previous telecommunication networks generally were provided through an integrated stack that was offered by one provider, in 5G the network consists of many interoperable microservices. This microservice architecture makes it possible for parts of the network to be offered by different providers. This fits within the trend of financialization where MNOs are practically being hollowed out, and the running of the network is being outsourced to equipment providers (Hubert 2020). The presence of these microservices makes it also possible to place more content caching services in the network, a move that has been popularized by Content Distribution Networks (CDNs) (ten Oever 2021a). CDNs provide, such as Akamai, NetApp, and Cloudflare, provide for services that make content available closer to users by using content caches in edge networks. This decreases the amount of transit traffic because content gets distributed to regional or local caches, and from there gets requested by users near the cache. With the rise of 5G networks and the emergence of oligopolies at the edge of the network that has been described in the previous section, there is no cache that can be brought closer to users than through 5G networks. This means that not just the latency of the network is low but also the length of the path that the data needs to travel is very short. Which leads to very short response times. This is a popular approach to bringing traffic faster to users than competitors and thus moving around net neutrality legislation.

Facebook, the company that is known for its social media network, has funded the development of Magma, which describes itself as 'an open source platform for building carrier-grade networks'[1] by developing and providing both hardware[2] and software[3] for running 3GPP compliant 5G networks. Facebook subsequently also provides a hosted environment to manage mobile these mobile networks[4]. The cross-stack integration here seems clear, Facebook is seeking to stimulate a telecommunication market in areas whether there is no connection yet. By providing this connectivity, and backhaul through submarine cables that they are investing in as well, it will be

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1 https://www.magmacore.org/ accessed on October 30, 2021
2 https://freedomfi.com/ accessed on October 30, 2021
3 https://github.com/magma/magma accessed on October 30, 2021
4 https://freedomfi.com/ accessed on October 30, 2021

very easy to provide locally pre-cached services within networks that have been optimized to deliver Facebook content.

The United States vs China – an ironical geopolitical tussle for control.

In December 2018 Meng Wanzhou, the Chief Financial Officer (CFO) and daughter of the founder of Huawei was arrested in Vancouver, Canada, based on an extradition request by the United States. This heralded the intensification of a trade war between the United States and China, which culminated in the addition of Huawei equipment to a blacklist, designating the equipment a national security threat, making it impossible for critical infrastructure providers to use Huawei hardware in their network[5]. The United States subsequently went ahead and tried to convince other countries to follow suit (Rühlig and Björk 2020). NATO added fuel to the fire and published a paper titled 'Huawei, 5G, and China as a Security Threat' (Kaska, Beckvard, and Minárik 2019) that concluded that Huawei equipment *could* pose a security threat because of its ties with the Chinese Communist Party and its intelligence apparatus. Interestingly, the United States Department of Defense, NATO reports, nor any of the other countries that followed suit in the implementation of restrictive policies towards Huawei equipment, produced a *technical* reason for the exclusion of Huawei from their networks. The sole reason was that the dominance of Huawei could pose a risk for the market, produce vendor lock-in, and then make it easier for the Chinese government to introduce *backdoors.* This argumentation has been echoed by many international media, whereas there has been no clear indication that this might concretely happen, and if it would, it would probably be the instantaneous end of Huawei usage outside of China.

The allegations of the United States vis à vis Huawei and China are deeply ironical for several reasons. First, as elegantly shown by Yun Wen in 'The Huawei Model' (2020), the emergence of a Chinese telecommunications market is the product of high technology transfer and export tariffs for European and North-American telecommunications equipment. Years of excessive costs had crippled the expansion of Chinese telecommunication networks, leading to an interest by the Chinese state to develop an alternative. When China opened its telecommunications market for foreign investors, relatively low-tech parts were produced or the Chinese locations were used to assembly devices made out of more high-tech parts produced in other south Asian nations, for a while this was even called 'the Chinese disease' (Hong 2017). To simulate a local market and expertise, China adopted its own 3G standard, TD-SCDMA. To reassert itself as a stronger global player, China chose to de-link itself from the global telecommunication standard, to reconnect with stronger expertise at a later stage. At the same time, China became part of the WTO, and was stimulated to stop violating intellectual property and develop its own patent portfolios and engage in international standard-setting. And this is exactly what China and Chinese companies did, causing the second ironical twist in this story.

In standard-setting companies need to declare when they hold a patent over a technology that is being standardized. When a patent becomes part of the standard, the patent is called a Standard Essential Patent (SEP). This means that every time that standard is being implemented, the holder of the SEP should be paid a license fee (unless other arrangements are made, such as patent pools (Bekkers, Iversen, and Blind 2006) or cross-licensing (Shapiro 2000)). Because of the many new functionalities in 5G, there has been a sharp increase in patents in comparison to earlier generations of telecommunication networks (Baron, Blind, and Pohlmann 2011; Baron and Pohlmann 2018). The majority of these patents have been registered by Huawei, only to be followed by Samsung, ZTE, and LG. These four Chinese and Korean-owned companies make up the overwhelming majority of the totality of 5G patents (Pohlmann, Blind, and Heß 2020). Nokia and Ericsson take up the fights and sixth place, and only after that comes an American corporation, namely Qualcomm (ibidem). Meaning that in a relatively short period, Huawei has become at the forefront of telecommunication standardization, exactly as been told by leading

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[5] https://docs.fcc.gov/public/attachments/DA-21-309A1.pdf accessed on November 1, 2021

countries in the WTO. But when they beat these countries at their own game, it is exactly these countries that cry foul.

The third twist of irony is that not China, but the intelligence services of Great Britain and the United States have been perpetrators of mass surveillance by weakening the security of global communications networks (Rogers and Eden 2017). Furthermore, the United States has been accused time and again of seeking to de-state the governance of communications networks and use North American market parties to control the internet (Carr 2015), now other countries are responding by either establishing rules and regulations to curb that influence, or engage in competition through standard-setting, but both are cast as acts against 'the open internet', or even 'acts of repression'.

The 3GPP has a long history of appealing to the discontent of governments over the usage of communication networks that they do not approve of. Testament to this is the 'lawful intercept'-working group, which has been active in the 3GPP nearly since its inception[6]. In this working group, technical requirements are determined for new technical standards how they should facilitate state surveillance. In 5G this means that Law Enforcement Agencies (LEA) have access to nearly every layer of the 5G stack (Access and Mobility Management Function, Session Management Function, User Plane Function, Control Plane Function, Unified Data Management, and the SMS Function) through a standardized API.

The concern of the United States about Huawei's success in the 3GPP and 5G industry in general, is that it seems to be losing its competitive edge. The protective measures instated by the United States, based on fact-free scaremongering, is typical behavior for a hegemon in decline. Europe used to have the competitive edge in telecommunications in times of the development of GSM (Hillebrand 2001), the United States had the competitive advantage with the development of the Internet (Abbate 1999), and clearly, it is now China that has the competitive advantage in the development of 5G (Dunajcsik and ten Oever 2021).

Discussion

Making sense of 5G through network ideologies

While discussing the architecture of telecommunications networks with standards engineers, it can be complex to discover architectural principles or visions that underpin the development of new telecommunication networks. During a 3GPP meeting, I asked a senior standards engineer for a large telecommunications provider: 'What is 5G optimized for?'. He looked at me and smiled when he said: '5G is not optimized for anything, it is optimized for everything.' He then continued: 'We will implement what we can to develop and explore new earning models.'. This characterizes the rapidly expanding size of the combined 5G standard. The total number of pages describing the 5G standards in the 3GPP is already exceeding that of 4G and the standardization of 5G is expected to continue for several more years. The deployment of 5G will likely lead to the deployment of heterogeneous networks that become more configurable for network operators, and others that have access to the programing interfaces of these networks. This fits with an overall network ideology of network control that departs from the end-to-end architecture of the internet which places control at the edges of the network. Whereas on the internet it was initially expected that all end-hosts were equal, current dynamics play out between consolidated content providers such as Google, Amazon, and Facebook on the one hand, and consolidated network operators on the other, such as Vodafone, China Telecom, MTN, and AT&T, that vie for the access to user data and subscriptions.

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[6] https://list.etsi.org/scripts/wa.exe?A0=3GPP_TSG_SA_WG3_LI accessed on October 31, 2021

Content providers, network operators, networking equipment providers, content distribution networks, and nation-states all have their particular interests where it comes to the development and implementation of communication networks. These parties all aim to control data streams while seeking to benefit at the same time from the network effects of an interconnected network. Continuously infrastructural norms are introduced that accommodate various networking ideologies. Within the standardization and governance of the internet, the accepted overlapping infrastructural norm was one of voluntary interconnection (ten Oever 2021b). But in the governance of telecommunication networks, asymmetrical end-to-end approaches have been common since the early 20th century (Zajácz 2019). Therefore, to understand contemporary issues and trends in internet governance, it should no longer be discussed in separation from telecommunication governance. The studying of the rise and decline of the telecommunications regime provides ample examples of the role and impact of regulation on a sector controlled in some geographies by a monopoly whereas in other countries it is controlled and regulated by states (Cowhey 1990; Drake 2000; Frieden 2002).

Another reason for no longer studying telecommunication governance and internet governance separate is the technical integration of both regimes through the IP layer, as well as the institutional ambitions of networking equipment providers and network operators to provide and standardize services outside of the lower layers of the traditional internet stack (see *figure 1*). Therefore a limited understanding of the internet governance regime, namely the idea that Internet governance consists of practices and institutions that produce the logical layer of the internet, is no longer sufficient. Because the networks underpinning the internet, as well as new devices that function as endpoints, and applications that are being run *inside* the network, are changing the nature of inter-connectivity on the internet.

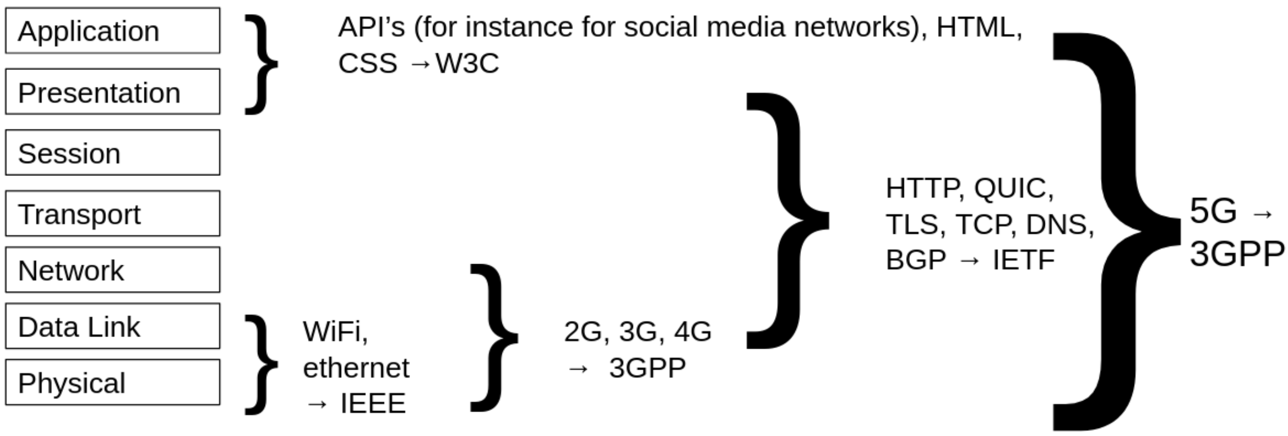

Figure 1: Standards bodies and technological stack as per the OSI model. Adapted from A. Andersdotter and ARTICLE19.

To better understand and conceptualize the governance and standardization of transnational communication networks, a new interdisciplinary understanding of them is needed. The tussle over control over data streams through the introduction of infrastructural norms by various actors should be understood as attempts to inscribe network ideologies into technological infrastructures. These network ideologies are more than mere reflections of the interests and values of stakeholder groups, they are the translations into material technology and technology policy of these values. Whereas sociotechnical imaginaries emphasize a joint vision of the future, network ideologies emphasize the technological translation of values, interests, and strategies. This contributes to the understanding of infrastructure as governance (DeNardis and Musiani 2016)

Conclusion

The tussle over the distribution of power over data streams between network operators, networking equipment providers, nation-states, and content providers plays out at an ever deeper infrastructural level and is deeply seated in a network ideology of control over users, their data, and the services and content they have access to. The production of new transnational communication infrastructures takes place outside of the confines of traditional internet governance bodies. Actors engaged in the standardization of 5G aim to reconfigure and transform the traditional end-to-end architecture of the Internet by excommunicating the user from control over data streams and providing network operators and content providers with an extensive programmable infrastructure. The programmable infrastructure, leveraged by concepts of network function virtualization, software-defined networking, network slicing, and beamforming antennas on small cells, provides a high density, low latency, high bandwidth, high capacity grid for data extraction and the shaping of urban spaces. The tussle over the shaping *over* the shaping on this infrastructure has led to geopolitical tussles between the United States and China. This has not been founded in technological materiality, but rather in the trauma of a hegemon in decline that is being beaten at its own game by a rising power.

The concept of network ideology helps to discern between the shiny produced visions of future technologies and that builds support and legitimizes the development and integration of infrastructures and the underlying tussle for power and control that take place in the material production of infrastructure in standardization and governance processes.

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Biography

Niels is a postdoctoral researcher with the ‘Making the hidden visible: Co-designing for public values in standards-making and governance’-project at the Media Studies department at the University of Amsterdam. Next to that, he is a research fellow with the Centre for Internet and

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Niels tries to understand how invisible infrastructures provide a socio-technical ordering to information societies and how this influences the distribution of wealth, power, and possibilities.

While writing his PhD 'Wired Norms: Inscription, resistance, and subversion in the governance of the Internet infrastructure', which was awarded with an honorary mention by the Association of Internet Researchers, Niels was affiliated with the DATACTIVE Research Group at the Media Studies and Political Science department at the University of Amsterdam. After that, he was a postdoctoral researcher at Texas A&M University. Before that Niels has worked as Head of Digital for ARTICLE19 where he designed, fund-raised, and set up the digital programme which covered the Internet Engineering Taskforce, the Internet Corporation for Assigned Names and Numbers, the Institute for Electric and Electronic Engineers, and the International Telecommunications Union. Before that Niels designed and implemented freedom of expression projects with Free Press Unlimited. He holds a cum laude MA in Philosophy from the University of Amsterdam.