Chapter 6

Mobile Internet

The Politics of Code and Networks

Lela Mosemghvdlishvili

Introduction

The term mobile internet refers to accessing the internet through (cellular) mobile devices and represents the convergence of mobile telephony, internet services, and personal computing. Whereas iMode (mobile internet and data services) was introduced in Japan as long ago as 1999 and became widely used (Barnes & Huff, 2003; Daliot-Bul, 2007), the release of the iPhone is commonly regarded as the decisive moment in popularizing mobile internet and smartphones in the West (Goggin, 2009; West & Mace, 2010; Campbell & La Pastina, 2010).

The convergence of mobile phones into programmable hand-held computers has reshaped the ICT industry and created a lucrative mobile internet business that spans the telecommunications, handset manufacturer, and software sectors. Goggin (2012, p.742) rightly points out that mobile media nowadays represents 'a new, exciting, but troubling set of developments.' Mobile technologies are indeed exciting, as they symbolize a new cultural platform and one of the most personal technologies available today. However, their development is also troubling, because critical issues such as net neutrality, access to the internet, and control over and the commodification of user data are extended to the mobile domain and require timely evaluation. Exploring the development of the mobile internet is crucial for understanding the ubiquitous internet. Indeed, it is not only that increasingly more users access the web through mobile devices, but industry standards, structures, and practices are also changing, with implications for society at large.

In this chapter, I aim to pinpoint the most discernible patterns of how the mobile internet is shaped. My focus is on the initial phase of design and development, rather than the end-users' appropriation of mobile devices. By drawing on the 'Critical Theory of Technology' (Feenberg, 1999, 2002, 2010; for a critique, see Vaek, 2006), I attempt to transcend the instrumental account of market analysis and evaluate the development of the mobile internet in the light of democratic rationalization (Feenberg, 2010). Democratic rationalization refers to the need to expand democratic procedures to the process of technological design and development by subjecting technological decision-making to social control, public participation, and conscious orientations towards politically legitimated human values, rather than profit-driven interests.

The remainder of the chapter unfolds in the following order: I first introduce the theoretical perspective and analytical tools (technical code, democratic rationality) that inform my analysis of the development process of the mobile internet. I then discuss three instances of how the interests of the decisive groups, namely mobile network carriers, handset manufacturers, and operating system owners, shape mobile networks.

Technical Codes of Capitalism and Democratic Rationalization

Let me start with problematizing the 'standard image on technology' (Bijker, 2001, p. 26) in society and stressing that, regardless of academic work (especially in the tradition of social studies of technology), technological determinism is still the common view in political, corporate, and media discourses about the relationship between technology and society (Feenberg, 2010, pp. 8–9). As Feenberg highlights, technologically determinist stances share two basic premises. First, technological progress is believed to follow a unilinear course, namely a fixed, irreversible path, which means that even though political, cultural, and other factors may influence the pace of technological change, they cannot alter the general path. This premise does not bear close scrutiny, as there are a number of possible development paths available for the same technological artifact, and which of them will become standardized is the outcome of social processes (see, for example, the development of the bicycle in Pinch & Bijker, 1984). Second, determinism affirms that society must adapt to the imperatives of technological change (Feenberg, 1999, pp. 77–78; 2002, pp. 137–144; 2010, pp. 8–9). Conceiving technology in such terms depoliticizes its development and withdraws it from public deliberation.

Despite tremendous dependency on technology in almost every aspect of our social lives, mere women and men, as Feenberg writes (2002), are removed from the decision-making process of technological development and in principle have no say in deciding what type of technology will structure their lives at home, on the street, at airport check points, in their pockets, or in the workplace. In fact, citizens are left with the so-called consumer 'veto power' with respect to whether to adopt an artifact or not (Cockburn, as cited in Williams & Edge, 1996, p. 878). The situation is not very different when it comes to information and communication technologies, which, as Williams (1997) maintains, are predominantly shaped by the commercial strategies of the supply side-actors in order to create and maximize their market share.

In a capitalist society, what dictated the development path of technologies over the generations was the pursuit of efficiency and deeply ideological practices on restricting opportunities to participate in decision-making (Feenberg, 2010). To illustrate this, the operational rationality of capitalism presupposes the separation of workers from the means of production. This highly subjective, material, and historical aspect of a private-capitalist's enterprise became a formal structural element and the basis of what is considered to be rational in economic activities themselves. Likewise, the concept of efficiency became an unquestioned ideological justification for certain types of strategic decision. However, the problem lies in how efficiency is conceived. From an environmentalist perspective, efficiency would entail quite different measures than under capitalism, where profit is the most important element. It is through such justifications that an assembly line is a progressive form of technology that has increased the profits of company owners. The fact that this happened at the expense of de-skilling workers is of less importance, because the primary measure of efficiency does not account for the participation of workers. As a consequence, a subjective interest becomes the very structure under which choices about which technologies to develop are legitimated.

One of the most important contributions of the Critical Theory of Technology (CTT) is its critique of the very structure and processes within which technological decision-making takes place. Moreover, its

framework, which classifies activities as permitted or forbidden, is a type of 'regime of truth' that brings the construction and interpretation of technologies into line with the requirements of the capitalist system. An analytical tool that I will draw on is technical code, which aims to capture such formal biases of technologies. As Feenberg defines it (2010, p. 68–69), a technical code is a rule under which technologies are realized in the social context, and serves as a criterion to select between alternative feasible technological designs. Crucially so, technical codes are always biased to some extent with respect to the values of dominant actors, and reflect the unequal distribution of social power (an understanding of a particular profit-measured efficiency is a good illustration of formally biased values in a capitalist society). However, subordinated groups may yet challenge the technical code and thereby influence the development of technologies.1

Accordingly, CTT rejects the neutrality of technology and enables commentators to uncover formal (ideological) biases. It is committed to subjecting the development of technology to democratic rationalization, which suggests a different rationalization based on responsibility for human and natural contexts and the democratic values of equality and participation, and not merely economic efficiency (with a narrow understanding of maximizing profits).

The agenda of democratizing technologies in the context of new information and communication technologies is primarily the struggle over the structure of communicative networks and practices. In what follows, I discuss three contested areas: the ownership of networks, power over setting technology standards, and gate-keeping power in permitting code production for mobiles. The three selected areas illustrate the operational rationality under which decisions regarding the architecture of mobile internet are negotiated; and at large define a 'terrain of possibilities' of how this complex technological assemblage will be developed. By highlighting the technical codes that over-determine the process, I aim to reveal broader ideological biases that, to a large extent, channel the development of the mobile internet.

Mobile Network Carriers and Net Neutrality

In this section, I illustrate the growing role of mobile network owners in altering the operational principle of the internet, namely net neutrality, on the example of recent changes in the US and EU.

The transformation of a mobile phone into an access device for the internet has brought about the long predicted convergence of the media and computing and telecommunications services, albeit with major implications for the future of the internet. These industries were hitherto considered to be distinct (Zuckerman, 2010; Goggin, 2011) in terms of their architecture, concentration of power, and organization of labour. Formerly, the government-owned telecommunication sector was traditionally centralized and monopolistic, but a massive deregulation process resulted in the establishment of regional and global network carriers. Ironically, deregulation, which was justified on the grounds of creating more competition and allowing new entrants to join the telecommunication sector, did not lead to a fundamentally different market structure (Wilson, 1992); historically dominant carriers still enjoy the privilege of providing mobile services as part of their integrated businesses (Goggin, 2011) under rebranded corporate identities. To illustrate this, in the US, the offspring of the American Telephone and

Telegraph Company, Verizon Wireless and AT&T Mobility, together captured 70% of the market share (90% of mobile subscribers are tied to only four corporations; Statista. n.d.).

Mobile network carriers have access to cell phone subscribers' huge base, and retain strategic power with matters like investment, control, commissioning, and the closure of network infrastructure. Respectively, their role in channeling the development of the mobile internet has become decisive. The conflict of interest is critically seen in relation to net neutrality, which is an essential principle of the internet as a decentralized (and non-discriminatory) network (Cooper, 2004; Wu, 2003; Lessig, 2001), where no one single authority has the power to discriminate in terms of content and information flows (see also: Meinrath & Pickard, 2006; Barratt & Shade, 2007). The following two examples illustrate the conflict between the profit interests of large telecom companies and the democratic potential of having a non-discriminatory internet.

In the US on January 14, 2014, the Court of Appeals for the D.C. Circuit ruled in favor of Verizon (the largest mobile network in the US) and struck down the Federal Communication Commission's (FCC) Open Internet Order, which prohibited Internet Service Providers (ISPs) from blocking and discriminating against content. This means that network providers are able to engage in business deals with content providers, charge consumers differently for accessing various content (e.g., blogs and YouTube), and discriminate in terms of content by artificially slowing down traffic (Levy, 2014). Granting the power of gate-keeper to network owners is being actively contested and represents one of the crucial ongoing struggles. Indeed, two weeks after the court's decision, more than a million users signed a petition urging the FCC to intervene (Tropper, 2014) and safeguard freedom of expression on the internet.

The situation in the US is not exceptional; the same struggle is also evident in the eastern hemisphere, where the EU Commission has been promoting a new proposal to reform the EU telecom market since September 2013. The interests of leading European telecom companies are strongly represented in the proposed reforms. Indeed, activist groups were struck by the similarities between the reform proposal and the recommendations issued by the Economics and Technologies for Inter-Carrier Services consortium. This consortium was led by Alcatel-Lucent and was comprised of the dominant telecom operators such as BT, Orange, and Deutsche Telekom. During the negotiation stage, to which the so-called 'CEO-roundtable' representatives of the interested large private enterprises were invited, small ISPs as well as advocacy groups were excluded (La Quadrature du Net, 2013, July 9; Mangalousi & Mosemghvdlishvili, 2014).

These struggles over net neutrality are currently taking place on the regulatory level, and its outcome is critical to the future design of the internet. However, in the following section, my focus is on how technology standards are set by industry players, removed from public or political deliberation, and how intellectual property rights are used as tools to enable companies to profit from enclosed technological paths.

‘Smartphone Patent Wars and Standardization

In this section, I review the state of patents in relation to mobile technologies and networks, and demonstrate the process of how patents are used to secure the market share of well-known companies by establishing standards. I also explain the surge in patent litigation in relation to smartphones.

It is possible to connect a mobile device to the internet by way of various access technologies, the two predominant ones of which are so-called mobile broadband (3G, 4G) and wireless broadband (Wi-Fi). Although both Wi-Fi and 3G enable internet access, they differ in terms of their service, industry, architectural origins, and even philosophies. In an insightful comparison of Wi-Fi and 3G technologies as two (albeit different in their possibilities) development paths for accessing the mobile web, Lehr and McKnight (2003, p. 353) point out that ‘3G offers a vertically integrated, top–down, service-provider approach to delivering wireless Internet access; while Wi-Fi offers (at least potentially) an end-user-centric, decentralized approach to service provisioning.’ Moreover, the deployment costs of 3G (and 4G) are considerably higher than for Wi-Fi (or WiMAX, a successor technology of Wi-Fi). Nevertheless, 3G is still the favored option for mobile network providers due to its top-down and centralized architecture.

However, to use 3G, both mobile network providers as well as mobile device manufacturers need to comply with a set of essential standards, including the Third Generation Partnership Projects (3GPP and 3GPP2). These standards are set2 within the industry by private companies that together hold a substantial share of the market (Lemley, 2002). In the case of 3G, the corporate members of these partnerships have identified up to 8,000 patents that they declared to be essential for 3G standards, 90% of which are owned by 13 companies. The following four entities account for 30% of these patents: Qualcomm, Ericsson, Nokia, and Motorola. Despite being declared as essential, a study revealed that only 21% were actually vital for 3G technologies (Goodman & Mayers, 2005).

As a consequence, a salient outcome is that companies that manufacture equipment or offer services for third generation cellular systems pay royalties for 80% of the patented technologies, which are too narrowly defined as being essential by patent owners (Goodman & Mayers, 2005). Even though the companies that own patents for standards are required to license them on fair, reasonable, and non-discriminatory terms, in reality royalties ‘tend to be higher than the benchmark level’ defined by law, and in the case of 3G phones amount to an increase of 30% of the total price of each phone (Lemley & Shapiro, 2007, p. 23).

The relationship between standards and patents has received considerable attention in policy and innovation studies (Bekkers et al., 2002; Bekkers & West, 2009; Gallini & Scotchmer, 2002; see also Ibrus, 2014), and has raised critical issues regarding the implications of increasingly patented standards. For instance, Shapiro (2001, p. 114) in a review of the literature regarding the patent system, argues that: ‘our [US] current patent system is causing a potentially dangerous situation in several fields, including biotechnology, semiconductors, computer software, and e-commerce.’ The interests of patent holders, in contrast to the public interest, are problematized in research that explored the GSM standard-setting procedure (Bekkers et al., 2002). Using the example of Motorola, the study’s authors illustrate how patent ownership enabled the company to define the terms of the standardization

process and argue that: at the level of the public interest in standard setting, the increasingly sharp negotiations about essential IPRs are not necessarily a positive development.' Lemley (2002, p. 1900), who focuses specifically on the process of standard-setting in the ICT sector, also argues that when standards are owned by a few of the largest companies, instead of promoting competition, patent owners act: 'as a cartel with the power to reduce output by excluding certain kinds of products.'

Another area of the mobile internet where patents are used as powerful tools to secure market share rather than promote innovation is the issue of design. Since 2011, several expensive legal disputes over patent infringements between giants like Apple and Samsung (Parish, 2011, Edwards, 2013), Google and Oracle, and Microsoft and Motorola became the subject of media interest, and terms like 'patent wars' and 'smartphone wars' appeared not only in the blogosphere and Wikipedia, but in academic work as well (Paik & Zhu, 2013). The number of court cases has risen so rapidly that even the most modest visualizations of patent litigation between corporations appear to be bewildering. The following estimations capture the magnitude of patent turmoil when it comes to phone design; since 2010, some $20 billion has been spent on patent litigation in the mobile phone industry (Cohan, as quoted in Paik & Zoe, 2013). With respect to smartphones alone, there are 250,000 active patents, which means that in the US every sixth active patent is used in these devices (O'Connor, 2012).

The reason for such a dramatic increase in patent litigation is that mobile devices are cumulative innovations, meaning that they are built on previous discoveries. As Shapiro (2001) explains in the case of complex information and communication technologies, new products will inevitably infringe patents, creating the so-called danger of 'hold-ups' (when companies avoid manufacturing new products in order to avoid patent litigation). Secondly, patents in the smartphone sector (as illustrated with litigation between tech giants) are not used to promote innovation, but as a strategic business tool. For instance, companies that are often publicly perceived to be rivals engage in cross-licensing (Shapiro, 2001). This explains a rather counterintuitive situation whereby when an HTC smartphone, which runs Android (Google's OS), is sold, its competitor Apple collects between $6 and $8 for each device. Similarly, Microsoft benefits from each LG, Acer, and Samsung phone sold by as much as $5 per device (Koetsier, 2012).

What the two examples discussed above point to is the alarming situation when patents, unlike their original conception to incentivize innovation (Gallini & Scotchmer, 2002), are used as a business tool for market competition and as a source of profit outweighing social benefits (Bessen & Meurer, 2008; Bessen et al., 2011; Coriat and Orsi, 2002, Cockburn & MacGarvie, 2009).

Defining Functionalities: How Code is Written for Mobile Platforms

In this section, I review how code can be written for various mobile platforms, and how OS providers started to serve as gate-keepers. I also focus on the dominant platform, Google's Android,3 and its particular business model that, by providing Android for 'free,' gives access to its source of capital—user data.

The importance of reviewing code/software in the mobile domain is determined by its critical function in modern technologies. As code serves as both a structuring and mediating framework, it not only runs on

hardware and executes certain operations, but also defines the range of possibilities in terms of how a technological artifact can be used. Moreover, the importance of who is allowed to write code and under what conditions is a political question (Mosemghvdlishvili & Jansz, 2013; 2014).

Similar to the case of personal computing, in mobile devices there are likewise a number of locked-in platforms that are grouped around operating systems for which handset manufacturers build devices and programmers write apps. Currently, the most widely used platforms are Google's Android, Apple's iOS, RIM's Blackberry, and Microsoft's Windows Phone. Platforms differ in terms of being open or closed (i.e., the type of software licensing that is used), control over content (through a review process), programming language (platforms are tied to specific programming languages), and distribution (through which channels and under what conditions apps are allowed to be distributed, Mosemghvdlishvili & Jansz, 2013).

The distinction between proprietary (closed) and open platforms refers to the access to source code. When source code is not publicly shared, the platform is considered to be proprietary (e.g., Windows Mobile, iOS). In such cases, only prescriptive software is sold. However, when a source code is publicly shared to enable its use, repair, and modification, its platforms are regarded as open.

Currently, there is a crucial difference within open source software when it comes to copyright versus copyleft (aka free/libre software), as these are two ideologically distinct views on the mode of the production and distribution of software. When a license requires users who have used, modified or repaired a code to redistribute it under the same terms and conditions (hence enabling what was publicly shared to return to the public), we speak of copyleft. Whereas open source and copyleft initially represented one struggle against the enclosure of software production through copyright, since the late 1980s an important (ideologically motivated) split has occurred between open source and free/libre software (Berry, 2004, 2008; Elliott & Scacchi, 2008; de Laat, 2005; Sullivan, 2011). Correspondingly, a number or so-called permissive licenses were created, which even though they permit almost any use of the code, do not require it to be shared under the same terms, meaning that what was gained for free from the public domain can be enclosed and excluded from the public at large. This salient distinction is crucial in understanding how Google was able to capture more than 70% of the market share in five years, which will be revisited after a review of closed platforms (the example of Apple's iOS and Microsoft's Windows Mobile).

Because the success of an operating system is largely dependent on the number and quality of the application software, in the mobile sector proprietary platforms allow and even encourage third party developers to write software for their devices by releasing the software development kit (SDK). However, they retain control over the content through a mandatory app review process and exclusive distribution channels. To illustrate this, Apple allows apps to be distributed only via its exclusive channel, the App Store, whereas OS providers (including Google) charge fees to access their distribution channel, and also collect up to 30% from app sales (Mosemghvdlishvili & Jansz, 2013).

What emerged is the situation whereby mobile OS providers became important gate-keepers, retaining the power to review software not only for its technical compatibility with their platform, but also for

content. This is a very sensitive issue if one takes into account the fact that apps define the functionalities of smartphones, meaning that OS providers have the power to channel what social uses are allowed through these devices.

In contrast to the positions of iOS and Microsoft Windows discussed above, Google appears to be the most lenient when it comes to control over the content of apps. Indeed, even though it favors its own Google Play (formerly known as Android Marketplace), it still allows other distribution channels. There is no official (content related) review process, and developers have to themselves ensure that their app is compatible with Android. However, ironically, in May 2013, Google removed advertising blocking apps from the Google Play store, one of which was Adblock Plus. This is not surprising because, even though Google appears to be geek-friendly and brands its Android as the developer-friendly OS, it is an advertising company at heart and evokes its power over the platform as soon as it interferes with its profit interests.

What is interesting in the case of Google is its unique model and approach to open source. The company is not interested in the commodification of code (unlike Microsoft or Apple), but in capturing Android user data and selling it to advertisers. It should be noted that Google's operations are predominantly driven by advertising services; in 2011, for instance, from total revenues that were estimated in its annual report to be US$37,905 million, $36,531 came from advertising. Accordingly, by giving away its OS for free and making it selectively open source, Google is able to achieve a critical level of dominance in having access to vast user data (Spreeuwenberg & Poell, 2012; Goggin, 2012; Mager, 2012; Mosemghvdlishvili & Jansz, 2014) and control of a large mobile ecosystem.

To respond to Google's selective adoption of open source strategies, a 'Free Your Android' campaign was initiated by the Free Software Foundation's European branch in 2009 (for more information about FSF, see: Berry, 2008; Elliot & Scacchi, 2008). The foundation maintains that access to software determines who can participate in a digital society. The freedoms to use, study, share, and improve software enable there to be equal participation, and are therefore extremely important. Indeed, the libre software community has developed the Replicant OS (a completely libre Android distribution) and the F-Droid (an alternative to Google Play that enables browsing and the installation of free/libre apps on mobile devices; whether an app is proprietary or libre software is not visible in Google Play).

Whereas user participation in code production has been celebrated as an example of user-led innovation (Von Hippel, 2004) and an alternative to capitalist modes of production and distribution (Benkler, 2006 Söderberg, 2008), in the case of Android, it resembles what Sawhney (2009, p. 113) calls the corporate effort to 'harness open-source energy for their own benefit.' The problem is further exacerbated by the concentration of large sets of heterogeneous user data within a single company (Mager, 2012), which in the wake of recent revelations about the NSA poses serious concerns.

If we apply the notion of democratic rationalization, as discussed in the theoretical perspective of this chapter, Google's selective open source strategies do not have an emancipatory or democratizing effect in terms of subjecting technological decision-making to social control and values (Mosemghvdlishvili & Jansz, 2014). Even though Google releases its source code, it does not involve developers directly in

writing the code, and retains the right to integrate the contributions of others. The company certainly opened itself up to the range of groups that are involved in shaping the mobile internet (by writing apps for mobile devices), albeit while maintaining strict control, thus resembling what Goggin (2012) described as 'guided democracy.' I challenge the use of democracy in the metaphor, because Google's practices of mass surveillance and data commodification (Fuchs, 2010; 2011; Mager, 2012) are not in accordance with the principles of democratic rationalization.

Conclusion

The internet as we know it is changing. Mobile devices and networks are becoming pervasively ever more important in accessing online space, largely redefining established practices. As I illustrated with the example of the struggle over net neutrality, the owners of mobile network carriers are emerging as a decisive group in shaping the internet. The implications of the increased gate-keeping powers of internet service providers (who will differentiate among content that flows through their wires) is worrying for the democratic promise of the internet. Will it lead to a situation whereby content creators (for instance, bloggers, artists, small communities) who are unable to engage in financial deals with carriers will be trapped in slow traffic? The outcome of the struggle between the profit interests of large carriers and the millions of users who have benefited from having equal access to online content is yet to be seen.

Whereas the debate over net neutrality is evidently political, the second scenario that I discussed appears to be more subtle. Uncovering the subjective interests of the powerful group (in the light of patent owners) is possible through the analytical tool of technical code. As seen in the example of patents in 3G technologies, the private interests of patent holders are neutralized in standards. Technical codes, as defined in the theoretical framework of the chapter, represent such an abstraction, when the interests and/or values of powerful groups become embedded in technological design. The technical codes of capitalism draw on the reification of intellectual property, and so discussing the current terrain of possibilities in which technologies developed is not possible without considering the peculiarities of treating the forms of knowledge and information as property. What is currently legally safeguarded as intellectual property (particularly in the forms of patents) was considered to be a range of privileges, more in the category of welfare and the common good, than property. Concrete legal and institutional changes led to the establishment of the 'new IP regime' (see, e.g., Bessen & Meurer, 2008; Coriat & Orsi, 2002), when patentability was expanded to include new forms of information and knowledge (research on the human genome, software, and the so-called business models). However, unlike material property (which is naturally scarce), forms of information and knowledge are not scarce, but are made scarce to enable their commodification (May, 2006; Kleiner, 2010; Bessen & Mayer, 2008). A salient outcome of this in relation to the development of technology is that patents are not only used to extract rent (Vercellone, 2008), but also grant power to private patent holders to channel the development of technology in accordance with maximizing profits and securing market share.

In relation to the patterns of how code is developed for mobile devices, I addressed the differences between open and closed platforms. As seen from the selective adoption of open source strategies, code development for iOS and Android does not differ much. Google is more permissive and its platform

is contingently open. The company, through the selective adoption of open source strategies (change of license, exclusion of developers from directly contributing to the development of Android, as well as use of its Android Compatibility Program), has redefined open source development in the mobile space. What has been argued as representing a challenge to the capitalist mode of labor organization is co-opted to fit Google's business model. Here, it is hard not to agree with Terranova's (2004) famous thesis that free labor has become structural to informational capitalism and its cultural economy. Yet, despite the widely practiced integration of open source development with business models of for-profit corporations, moments of rupture do occur, as seen in the efforts of free/libre software activists to re-politicize the development of code for mobiles.

My aim in this chapter was to consider the design and development phase of mobile technologies. I also wanted to reflect on the broader terrain of the possibilities within which decisions regarding the pace and direction of technological developments are negotiated. Moreover, I have both illustrated the prevalence of technical codes of capitalism that over-determine the process, and questioned the reification of intellectual property rights in relation to technological standards and code production.

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Notes

1 As an example, Feenberg (2010, pp. 100–104) discusses the case of French Minitel, which was hacked by users and transformed from a strictly informational utility into a communication medium.

2 There is also the possibility of de facto standardization, which is when certain products (e.g., Microsoft's operating system Windows) become widely accepted on the market, or standardization through government intervention, which sets the appropriate standard and compels all participants in the market to comply (e.g., the Federal Communications Commission; Lemley, 2002). (For a close analysis of internet standardization processes, see Ibrus, this volume).

3 Google's executives claimed that in 2012 some 1.3 million Android devices were activated and the total number of handsets that operated on this OS had surpassed 500 million (Shankland, 2012).