The stabilization of mobile communications infrastructure in post-modern society

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Introduction

It is a fact – nowadays mobile communications are deeply embedded in our life. International Telecommunication Union (ITU) says in one of its reports “The year 2002 marked an historic turning point in the history of telephony, for it was the year when mobile subscribers overtook fixed-line subscribers worldwide”\(^1\) Since the first commercial system for mobile telephony was launched in Japan in 1979, in front of our eyes an entire new infrastructure has been established. During these years, society changed as well. As Charles Jenks writes “If we date the beginning of post-modern movements in 1960s, then we might imagine that the paradigm as a whole is starting to dominate … by year 2000”\(^2\). Were the development of mobile communication infrastructure and the raise of post-modernity coincidently happening at the same time, or were they tangled together in a web of mutual influences? How come, that the mobile phone became a symbolic device for our post-modern culture? This paper tries to provide some answers to such questions. But first, we have to clarify our main concepts.

Definitions

Post-modernity and modernity

There is no single, formal definition of post-modernity. After all, the pluralistic and relativistic character of the post-modernity itself makes such definition almost impossible. So the most used way to describe post-modernity (and post-modern society) is to compare it with modernity. But before making this comparison, it is important to look first at another distinction – (post)modernity vs. (post)modernism. According to Klages, there are two general approaches towards defining modernism. “Modernism”, according to her, “generally refers to the broad aesthetic movements of the twentieth century; ‘modernity’ refers to a set of philosophical, political, and ethical ideas which provide the basis for the aesthetic aspect of modernism… modernity is older [and broader as concept] than modernism”. In a similar distinction, “definition, of post-modernity comes more from history and sociology than from literature or art history. This approach defines post-modernity as the name of an entire social formation, or set of social/historical attitudes; more precisely, this approach contrasts post-modernity with modernity, rather than postmodernism with modernism.”\(^3\)

Although this terminological convention is not universally accepted (many authors use the term “postmodernism” in a broad sense, close to our definition of “post-modernity”), we will use in this paper the terms modernity and post-modernity in order to emphasize that we analyze the social formations of modern and post-modern societies and not only the aesthetical movements of modernism and postmodernism.

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\(^1\) Valerie Feldmann - “Mobile overtakes fixed: Implications for policy and regulations”, ITU 2003
\(^2\) Charles Jenks – “What is Post-Modernism?”
\(^3\) Mary Klages – “Post-modernism”
Reason and homogeneity can be seen as symbols of modernity. Based on the ideals of European Enlightenment, modernity assumes that reality is knowable through (scientific) rationalization. Modern culture is related to industrial capitalism and it reflects mass-production and the industrial design of artifacts. It was important for modern designers to create durable and functional artifacts - “Forms follows functions” as Verbeek has put in his book4. Modern engineers and managers embrace standardizations and uniformity and they focus on efficiency. Modern firms valued highly educated engineers specialized in certain domain. They are tightly integrated in organizations with hierarchical structure. “This hierarchy became a source of power, continued growth, and permanence” [Hughes]5. A hierarchy also represents order. Klages explains, following Lyotard, that “totality, stability and order are maintained in modern societies through the means of "grand narratives" or "master narratives," A grand narrative can be seen as a kind of meta-theory, or meta-ideology, that is, a fundamental story that explains the belief systems and theories that exist in the society” [Klages 2003]. As result of this, only one representation of the reality is possible and reason alone can help us to reach the truth. If there are several representations (e.g. several grand narratives) only one can be the real and true and others are untrue. Pluralism is in general not acceptable.

One of the main characteristics of post-modernity, according to Lyotard, is rejection of grand narratives. Linked to post-industrial, consumer society, post-modernity is pluralistic and relativistic. There can be different interpretations of the reality, e.g. different grand narratives, which are true at the same time – especially in different cultural contexts. But furthermore, there is no need of a grand narrative at all – it is not necessary to have a total, hierarchical system of beliefs. Reality can be accepted as fragmented and sometimes contradictory. This is reflected in what Kockelkoren calls “decomposition of self”6 – participating in different social network and in different roles and switching them freely. In this context, personal autonomy and choice become more central.

Another defining characteristic of post-modernity, according to Lyotard, is its interconnection with information technologies. The development of IT, he argues, changes our perception of knowledge – knowledge is something that can be digitalized and processed by a computer. Furthermore, the role of knowledge changes – in modernity it is an end in itself, in post-modernity it is a means to achieve practical goals. In other words, knowledge becomes more pragmatic. Pragmatism in a broad sense is often seen as important characteristic of post-modernity. As Lyotard writes (quoted by Boyne and Rattansi) “social development in postmodern epoch… will be a pragmatic matter of inventing new rules, whose validity will reside in their effectiveness rather than in their compatibility with some legitimizing discourse”

Many post-modernists reject modernist design and culture. They strive to prove that post-modernist culture is something radically new. Artifacts are not anymore only function but they have meaning and show personal life style – so “form follows fun”. Post-modern management and governance also differ from modern one. According to Hughes, for example, post-modern organizations are with horizontal, network and

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4 Peter-Paul Verbeek- “What things do”
5 Thomas Hughes- “Rescuing Promethesus”
6 Petran Kockelkoren – “Technology: Art, Fairground and Theatre
project based governance. In post-modern society changes in development of technology are fast and interdependent, so post-modern engineers and managers embrace interdisciplinary approach and value more generalists. Today, previous experience is of less importance because problems that arise in research and development projects are often unprecedented. Furthermore, concerns of various interest groups (like environmentalists, for example) are of big interest for the designers and engineers.

On the other hand, some authors see post-modernity as continuation and further development of the modernity, rather than as its rejection. They claim that although the above mentioned changes do exist, they are not radically new, not universal and they don’t amount to total rejection of modernity. As Harvey says “I also conclude that there is much more continuity than difference between broad history of modernity and post-modernity” [Harvey]7

What is Infrastructure?

There are more formal definitions of “infrastructure” than of “post-modernity”. Wikipedia, for example, defines infrastructure as “the set of interconnected structural elements that provide the framework for supporting the entire structure” The American Heritage Dictionary define the term as “underlying base or foundation, especially for organizations or a system”, or “the basic facilities, services, and installations needed for functioning of the community or society, such as transportation and communication systems, water and power lines, and public institutions including schools, post offices and prisons” In a 1983 report, the Congressional Budget Office (CBO) defined infrastructure as facilities “like highways, public transit systems, wastewater treatment works, water resources, air traffic control, airports, and municipal water supply”. The CBO also noted that the concept of infrastructure could be “applied broadly to include such social facilities as schools, hospitals, and prisons, and it often includes industrial capacity, as well.”8

US President’s Commission on Critical Infrastructure Protection also has a definition: ”by infrastructure ….we mean a network of independent, mostly privately owned, man made systems and processes that function collaboratively and synergistically to produce a continues flow of essential goods and services ” [Edwards 2003]9

These definitions are in general similar, but they emphasize different characteristics of infrastructures. First of all, each infrastructure is based on interconnected technical systems. Second, infrastructures include flow of something - like oil and gas, water, energy, money, or data. Third, infrastructures provide services which are essential for the society. That’s why Edwards defines infrastructure simply as “infrastructures are those systems without which contemporary societies cannot function” [Edwards 2003]. Forth, the infrastructures have to be extendable.

Although in everyday language infrastructure is often used as synonym of hardware, it is true that all infrastructures are sociotechnical by definition. The infrastructure is

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7 David Harvey – “The Condition of Post-modernity”, p.116
Based on interconnected hardware, but it includes also social organizations, socially communicated knowledge and wide reliance upon and acceptance by the users.

Infrastructures are socio-technical not just because they are a combination of technology and social organizations around the technology. They have impact on society and on technology that goes beyond this simple combination. Misa describes this impact as creative – “technology… in the infrastructure of daily life, is socially constructing”.

Infrastructure is that gives sense of stability for the user. It is an artificial environment that creates possibilities for us to have at our homes clean water from the tap, heating installations that can be regulated, electricity, etc. So “we can live, work and play on agenda we designed” [Edwards2003]. Infrastructure ensures that things work and will continue to work without our participation. Infrastructure is that reproduces the features of the natural environment that people find useful and eliminates others that are dangerous and useless. So building infrastructures means to imbed those features of the nature that are comfortable and convenient for the people and to create sense of stability. Part of this sense of stability is the perception that infrastructure is something reliable and ever working so we almost don’t thing about it except in the cases when it breaks down. In this sense an infrastructure is an invisible background and a back-box. The sense of stability is so fundamental for our society, that without it the society can’t function at all.

But infrastructures become black-boxed only when they stabilize. Their socially constructing effect is even clearer, when they are just introduced. Let’s take as example the distribution of electricity in Ivory Coast, described by Akrich. Until recently the land there was “public property” and it was distributed by the elders in the village to villagers, depending on their needs. The distribution was non-permanent, villagers could move from one piece of land to another. When the government decided to bring electricity to the villages, it required permanent land ownership. Only villagers who owned land could get electricity. In this case the state asked villagers to pre-inscribe (in Latour’s terminology) to private property ownership. In this way a new society with new rules was created. It became compulsory for every one to have own land so that to be able to use this new service-electricity delivery. For this it is necessary to know enough of the infrastructure of delivery electricity and to be aware that it is necessary to pay bills and taxes.

We can distinguish two important social aspects of the infrastructure from this example. First is about knowledge. To be part of given society means, in part, to have fluency in its infrastructure. As Edwards notes, we learn about infrastructure naturally and unnoticeably just as we learn our native language.

The second aspect is about social structures and order. Infrastructure creates both possibilities and constrains of our behavior. It is possible, for example, to speak with someone on the other end of the earth but only if s/he has subscribed to the telecommunication infrastructure. Like in the example of Ivory Coast, people can have electricity only if they are subscribed to the electrical infrastructure and they are owners of land. Infrastructures are based on webs of bureaucracy - institutional groups.

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10 Madeleine Akrich – “The De-scripting of Technological Objects”
that collect taxes and probably explain to people why they need to pay at all, technical
groups that maintain the hardware, governmental regulating agencies, etc.
Infrastructures are also based on sets of rules, by which all related actors play, so the
concept of infrastructure presupposes control, regularity and order.

**Post-modern infrastructure – contradiction in terms?**
From our analysis of infrastructures it may seem that infrastructures construct a
typical modern society. Indeed, as Edwards points out, “control, regularity, order,
system, techno-culture” are symbols of infrastructures but also basic to modernity.
The sense of stability is also something that naturally makes infrastructure to be
modern.

But contrary to what technological determinism may claim, the connection between
infrastructures and society is not so straight and one-directional. The process of
stabilization of an infrastructure is dependent on the society, its culture, economics
and demands. It is a process of co-construction, in which “technology is both
constraining and constrained” and technology itself adapts to the society.

This notion of mutual constraints and adaptation is what makes studying the
infrastructures in post-modern society interesting. If post-modernity as philosophy
and culture is a rejection of modernity and has fragmentation and relativism in its
core, does it mean, that it is “anti-infrastructural” by definition? Is it becoming much
more difficult for a new infrastructure to stabilize in post-modern time and will even
existing infrastructures start to fracture? If not, how can we explain this
“contradiction”? Are infrastructures themselves changing, reflecting the post-modern
values in society? To what extend infrastructures influence these values? Is the
process of co-shaping between infrastructures and post-modern society similar to the
modern times, or fundamentally different?

In the rest of this paper, we will try to analyze these questions by taking as a case
study the stabilization of mobile communications infrastructure.

**Theoretical framework - three levels of analysis**
Edwards analyses infrastructure on tree levels- micro, meso and macro. He argues
that a micro-scale approach produces different view about the role of infrastructure in
modernity than a macro-scale approach.

*Meso-scale* approach is concerned with organizations, corporations, standard setting
bodies and long term periods like decades or more. He writes that there is well
defined path of development of big technological systems. First, inventors of the
technical system create technological possibilities. Then system builders try to create
order and regularity in the complexity crated by technology and “unorganized set of
inventions” [Edwards 2003] System builders have to play the role of nexus between
technical inventors and the society. They have to understand not only how the systems
have to be built but also what may seem attractive for the society. Only then can be
expected commercial success.

After chaotic and diffuse stage of invention, there follows the critical point when
standards are set. Competition becomes organized around “stable system concept”.
Competition between standards leads to a situation where the winner wins everything.
Nonstandard devices have to find a way to connect to standard network, otherwise
they die out. Setting up a uniform standard creates conditions for monopoly, where competitions are unacceptable. In fact, most infrastructures have been seen as “natural monopolies” for quite a long time – electricity, phone, water and sewerage, etc. Only recently governments decided to remove their monopoly protection and tried to create a free market environment with competition. The conclusion of Edwards is that socio-technical institutions follow a well defined pattern of development visible on historical scale- innovation, system design, standardization (monopoly), and deregulation. He claims that analyses on the meso-scale position infrastructures as modern organizations. In our analysis at meso-level we will focus in particular on whether mobile communications infrastructure followed a similar development path as described by Edwards.

Analyses on the micro-scale can give us different lesson. Approaches like SCOT or ANT from science and technology studies can help to understand the role of the users in design and usage of technology. Sometimes a user uses devices in a completely different way than designers intended. In this way users turns out to be co-designers. For example, fixed telephone was meant to be a business device, but it was used also extensively by women to socialize. Technology marketed as “for business” was used for non-business purposes. Only after decades of spontaneous user-driven usage of telephone for sociability telecoms perceived this as an opportunity rather than as “waste of the system’s value” [Edwards 2003]. A micro-scale analysis of telephone does not present this technology only as modern (hierarchical, organizing and functional). Users invented new usage of telephone suitable for their goals which could be pre-modern like sociability.

In our micro level analysis we will look at the way of use of mobile phone and how its script evolved and will try to identify post-modern values and goals in this usage.

On the macro-scale analyzes explanations are “functional and systemic” [Misa, quoted in Edwards 2003]. On long historic scale infrastructures die but if we look not at a particular infrastructure but on the function that it fulfills, we will see development rather than disappearance. In other words, new infrastructures compliment or replace old infrastructures because they perform their functions better and they better satisfy the needs of the society. For example, telegraph once complimented postal services. Both infrastructures had the function to enable remote communication; but the telegraph was fast and postal services were cheap. Later telephone replaced telegraph, because telephone allowed instant feedback, could carry more information than the telegraph and was no more expensive. Now e-mail replaces most private postal letters, etc. At macro level, Edwards sees infrastructures as “socio-technical solutions to large [social] problems” [Edwards2003]. He gives as example the mass-production (as core characteristic of industrial capitalism), which creates problem with overproduction of goods and thus creates a need for finding new markets. Transport and communication infrastructures of 19th century (railroads, telegraph, and telephone) can be seen as solutions of this problem or need. The macro-level analysis, claims Edwards, requires a time scale of “many decades or entire centuries” and “[analysis of] entire political economies or social systems”. This last point raises the question if macro-level analysis (in Edwards sense) can be performed already on the subject of mobile infrastructure and postmodernism. To what degree post-modernity can be seen as a new social system is clearly a matter of discussion. It is also not clear whether mobile communications are complimenting or
replacing fixed telephony\textsuperscript{11}. Furthermore, we certainly don’t have yet the time frame of “many decades” in which to analyze either post-modernity or mobile communications.

There are very relevant questions for macro level analysis of mobile communications and post-modernity - like if post-modernity is associated with new large social problems, if mobile communication is a solution to principally new problems or an improvement of existing functions, if the way of solving large problems via infrastructures has changed in post-modern society, etc. But because of the reasons mentioned above and in order to keep the scope of this paper reasonable, I will not include the macro level in my further analysis.

Following the meso and micro levels of analysis introduced by Edwards, we will try to show that infrastructures (as hardware and organization) are essential for both modern and post-modern society; but some characteristics of postmodern infrastructures are different than in modern infrastructures.

**Meso level analysis**

As mentioned before, Edwards sees a pattern of development of all infrastructures, which consists of innovation, system design, standardization (monopoly), and deregulation.

For example railroad and telephone infrastructures started as decentralized and competitive\textsuperscript{12}. Before 1850 railroads have been mostly local and fragmented. During and after 1850s, railroads grew rapidly both in US and some short tracks have been linked together to provide longer distance railroads. By the American Civil War several major companies begun to construct uniform railroads in the US. Between 1860 and 1890 railroads become nation-wide, characterized with standardizations of the gauge and complex administration. As the Big Business, the major railroads companies started to organize themselves in modern organizational structures to cope with expansive operations and internal complexity. They discovered the advantage of cooperation in otherwise severe competitive environment.

Telephone services also started as local. Mainly because of limited telephone transmission capabilities in late 1870s and early 1880s, the telephone companies had to confine themselves only to local services\textsuperscript{13}.

So both infrastructures in US follow the pattern proposed by Edwards. They started as local or regional, unlinked technological systems open for free competition. Later they started to become centralized and nation-wide during the Civil War and afterwards. Growth, centralization and introduction of uniform standards led to monopolization [Edwards2003].

\textsuperscript{11} NOTE: One report of International Telecommunication Union suggests that in the developed world mobile and fixed telephony are complimentary, while in the developing countries the mobile infrastructure replaces the (underdeveloped) fixed one.

\textsuperscript{12} Amy Friedlander – “Emerging Infrastructure : The Growth of Railroads”,

\textsuperscript{13} Amy Friedlander - “ Natural Monopoly and Universal Service: Telephones and Telegraphs in the U.S. Communications Infrastructure, 1837-1940”
What is different in the development of the mobile infrastructure is that it was from the very beginning nation-wide instead of local and the competition is between parallel national telephone infrastructures not between local service operators. Mobile infrastructure follows Edward’s pattern of development but without monopolizations and deregulations phases. At the time when mobile communications became widespread, most mobile telecoms were not owned by the states and they didn’t hold a national monopoly. Instead, they were market orientated, interlinked on the international level, cooperating and competing at the same time.

As Kersbergen and Waarden argue, in our post-modern time the phase of concentrations and monopoly has been replaced by a looser form of co-operation between distinct firms in networks. In order to operate properly big firms try to concentrate on their “core competency” and to outsource all other activities. The spin-offs firms, as well as other small and medium firms, also need of knowledge and innovation. These firms in many cases can be competing but also can co-operate between each other. This way “dense, complex and more or less stable networks of suppliers, customers and cooperating competitors” are formed. So, in the postmodern society there is clear tendency to use network, alliance based governance and mobile communication infrastructure is not an exception. Open technical standards, incorporating the vision of both technical developers and entrepreneurs, are another characteristic of the postmodern infrastructure.

Why did these characteristics appear? Because they were success factor in early development and spread of the infrastructure. I will show in this section how the existence of open standards, lack of monopoly, and network based governance helped better spreading of the mobile telephony in the early stages of its existence and how the dominant post-modern culture played important role in this process.

Mobile telephony first became wide-spread and accepted as transparent and reliable service (i.e. as an infrastructure by our definition) when the first-generation (1G) standards were created and 1G networks were developed. The 1G mobile telephony uses a cell-based, analog architecture for voice communication only. Second generation standards (like GSM) are digital, but still focused mainly on voice transmission. The 3G standards and networks are high-speed digital networks for both data and voice transfer.

We will look into examples that trace the development of 1G infrastructure in US, Japan, Nordic countries, UK and Germany. They are from “Achieving high momentum in the evolution of wireless infrastructures: the battle over the 1G solution” by Kalle Lyytinena, Vladislav V. Fomin

In the United States the liberation of the telecommunication market happened at the same time as the development of the 1G mobile communications. The development of the mobile telephony started first by AT&T. AT&T was a hierarchical organization and monopolistic provider of telecommunications in US in the late 1960s. With liberation of the market other potential providers of mobile telephony emerged, which created difficulties and administrative delays in obtaining frequencies for mobile

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14 Kersbergen and Waarden, “Shifts in governance: Problems of legitimacy and accountability”, p.43
15 For good overview of mobile telephony generations see Wikipedia - http://en.wikipedia.org/wiki/1G
communications. AT&T received permission for creating Chicago pilot mobile telephony system in 1977 but FCC (Federal Communications Commission) did not license it for commercial use until 1983. The system, which later became the basis for the AMPS standard, was mainly created by Bell Labs (AT&T subsidiary) and was driven by the vision of American system builders (engineers) with little influence from entrepreneurs and other stakeholders. This, together with the fact that the standard was not conceived as open standard from the beginning, created institutional problems when moving the system to commercial use. As a result the 1G mobile services in US were delayed and since the beginning they were somewhat outdated. Consequently AMPS standard has been revised several times to cope with initial weaknesses. Later FCC demanded opening of AMPS standard and actual development of its latest stages has been outsourced to spin-off R&D firms. Despite its weaknesses and its delay due to institutional constrains, the AMPS standard first introduced the concept of a portable terminal and changed the perception of mobile communication as car-based service only.

Japan had the first world commercial wireless service in 1979. It was offered by Nippon Telegraph and Telephone (NTT), which was set up in 1956 as a governmental corporation that had monopoly in telecommunication business. Due to the growing interest in the emerging cellular concept, NTT developed their own wireless analog system in 1970. The technical solution was similar to the AT&T Chicago trial system. The service was meant to be offered to the upper class businessmen and high state officials. So the system had limited capacity because it was believed that there will be no widespread interest in it. There was a high subscription fee in order to prevent this service from mass use. The equipment was manufactured by Japanese companies, closely related to NTT. With the liberation of the market in mid 80s NTT changed into a publicly traded company, although the biggest share was owned still by the state. At the same time competing cellular companies were licensed in each of the nine national markets. Two of them used NTT standard and the other seven used TACS standard – derivative form US AMPS standard. The NTT system was expanded with introduction of other competing companies but the prices and capacities remained problematic, which created some difficulties with start of development of the next generation mobile service 2G. The success of the system was moderate and penetration rate was considerably less in comparison with US. One important difference with US was, that in US the AMPS standard was made open before a commercial system was actually in place, while in Japan there was a commercial system running before the standard was made public and competition was allowed – so both the standard and the system had to be changed later.

The first generation of mobile telephony services in the Nordic countries was organized by the four PTTs (Post, telegraph and telephone administrations). At end of 1960’s, all of the Nordic countries had their own operational car-based mobile environments that were incompatible. They decided to create one new joint infrastructure instead of trying to link the existing incompatible systems. In 1970 Nordic PTTs established a joint committee (called NMT) to look at regional collaboration on radio telephony services. The committee was independent from any national PTT or device manufacturer. The PTTs were not in direct competition and that allowed for a completely new organization and control of the development process and also for knowledge sharing into common design. The developers of mobile services had enough time to work in peace and create robust solution for the
technical part. The committee established pragmatic goals - common design, efficient use of common frequency, large subscriber base and low cost of the terminals. But the NMT group itself had no experience in manufacturing or in research and development. They had to overcome these weaknesses by outsourcing some part of the research to the separate R&D firms and establishing good relationships with several universities and research institutes. Because of lack of experience in manufacturing, the committee decided to create open technical standards. So if one manufacturing firm said that something is difficult to be done then other manufacturers were able to take the opportunity – thus a competition between manufacturers was created and Nordic companies were not given any special preference. The intentions and comments of the manufacturers were eventually incorporated in the design but no one single firm was in control of the design. During the process the NTT group became a nexus and tried to make easier the reconciliation of clashing visions of the technologists and entrepreneurs. The result was the NMT standard. It introduced many new services that were of great importance for the future wireless infrastructure - universal roaming, charging schemes similar to the fixed phone calls, quality of the calls similar to the quality of the normal phone calls. The NMT-450 MHz standard was launched in 1981. In 1983 NMT group started planning for update of the NMT-450 in the 900 MHz band and the service began in 1986. Open standard, market driven services, reasonable pricing and big subscriber base led to largest penetration rates amongst 1G wireless system. Except AMPS/TACS family (in its later stages), NMT was the only other truly open standard.

While Nordic PTTs sought to increase the competition between manufacturers and at the same time they kept the monopoly of the respective PTT as service provider, UK tried to increase the competition between telecom operators. Since the introduction of mobile telephony in UK there were two licensed operators - Cellnet and Vodafone. Both of them began service in 1985. Although they started 4 years after the Nordic countries, UK was most competitive market in telecommunications in the beginning of 90s. UK did not have big domestic player in the telecommunication industry at that time, so they were much behind USA, Japan and the Nordic countries in R&D of telecommunications. Thus, British regulators decided to adopt a modified version of American AMPS standard in 900Mhz band and started service immediately after that. The standard was called TACS. The goal of the regulators was to achieve fast diffusion of the service and to achieve “economy of scale”. This was possible because of choosing of an existing (proven) standard and the large open market. Relative early start of the services, intensive competition, improved services, low cost of terminals and phone calls led to relatively good success of wireless service based on TACS system.

In the early 1980s Deuche Bundespost was European’s biggest PTT with a lot of resources for research and development in telecommunications. The whole technical design and manufacturing of the mobile service was outsourced to Siemens. With the liberalization of the market in 1989 this business was transferred to another company - DBP Telecom. Monopolization of some of the services was removed including wireless communications, so some new services were able to emerge on the German market during the introduction of the 2G services in early 1990s. Innovation process started in 1979. At that time wireless services had been started in USA and Japan and it was expected to start in Nordic countries. Germany was focused on the technological design and expected that this will provide future
possibilities for exporting their system, so they decided to postpone the introduction of the wireless services. The design was meant to be national technology solution so it was closed and it was not allowed that other manufacturers, except Siemens, sell their solutions to the operators. Siemens developed a technically sophisticated solution (C-Net) but the system went to the market relatively late and it was expensive. The technical design of C-Net system was result of engineering’s ambitions rather that driven from market demands. The service concept was similar to Japanese early concepts which had been developed 10 years earlier. The success of C-net was very limited. The service was expensive and attracted very limited number of subscribers.

The success of the 1G mobile communications, measured as penetration rate (percentage of subscribers) was biggest in Nordic countries, followed by US and UK. The service in Japan (based on NTT standard) and in Germany (C-Net) wasn’t successful.

The success can partly be linked to the absence of monopoly – in UK and in US already at the start of commercial services there were several competing service providers in the same markets. Although in the Nordic countries each PTT has a national monopoly as service provider, the market for mobile phones and other technical components of the infrastructure was liberalized. Globalization also played a role in creation of mobile communication infrastructure – not only by making international networks, but also by allowing international competition and collaboration between manufactures and by international public trading of telecom shares, which decreased control of national states over the infrastructure.

Another important success factor in the 3 successful cases is that they were based on open standards and open exchange of knowledge. System builders did not try to control all knowledge created during the development of infrastructure. Instead, they were the nexus between all organizations and institutions that participated in the development of the infrastructure. All of them created together the necessary knowledge and the knowledge ownership was distributed amongst the participants. The situation in early modernity was different. Then the system builder was trying to control and possess all necessary knowledge for system development. This was the case with, for example, Edison’s electrical system. “The system, the community and the style of the inventions was essentially Edisonian”16. At that time this was necessary for the success of the system, because ownership of knowledge provided a competitive advantage. But nowadays the knowledge necessary to create an infrastructure is much more complex, multidisciplinary and expensive to create – as result of development of science and technology. So it becomes impossible for a single party to create and hold all this knowledge. Pre-competitive cooperation for research and development between separate firms is one popular solution to this problem. Pre-competitive cooperation means that companies in one branch, which usually compete between themselves, make joint investments in research and development and benefit together from its results. This cooperation usually happens with regards to long-term and/or fundamental R&D and it often involves universities and governmental organizations. Public funding, for example through EC (European Commission) programs, is obtained in many cases17. We may see pre-competitive

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16 Thomas Hughes – “Edison and Electric light”, p.44,
17 Pedro Nueno and Jan Oosterveld, “Managing technology alliances”
cooperation as a post-modern phenomenon – it involves network-based, decentralized post-modern governance, it is cooperation with concrete pragmatic goals between otherwise competing firms and it involves together partners from different spheres. So in this case we may say that technological and scientific developments help promote (through the development of large technical systems) certain post-modern characteristics in society.

Yet another characteristic of successful early mobile communication infrastructures is its service-orientation. The infrastructure is designed as service to the users (North Europe, UK, US), not just as technical system (Germany). The design is pluralistic, reflecting demands from various stakeholders – users, entrepreneurs, regulators, engineers.

But why these factors were important for the early success of mobile communication infrastructure? We can explain this, if we look at the evolutionary model of technological development, which is suitable at meso-level analysis [Rammert 1997]. The evolutionary model draws a parallel between the stabilization of technologies and the Darwinian model of development of natural species. The essence of the evolutionary model is that technological innovations happen more-or-less randomly (like mutations in the natural species), but only these innovation that fit to the environment survive (like only species that are the fit to the living conditions survive). The “selection environment” for the technical innovations consists of various components. These components include “scientific knowledge, engineering practices and beliefs, production processes, consumption patterns, institutions [and their rules and regulations], infrastructures and social values.” A stable combination of these factors is called a “technological regime”. A variation of the evolutionary model, so called “quasi-evolutionary model” accepts also that the process of creating innovations and the process of selection are not completely independent. On one hand, existing technological regime influences the thinking of innovators and the R&D funding thus influencing the innovations themselves. On the other hand, when innovations stabilize, they influence parts of the selection environment (for example consumption patterns or social values) and in extreme cases may even lead to change of the entire technological regime. These mutual links, though, don’t make the innovation process determined by the technological regime. As we saw, quite different systems for mobile communications have emerged (although not all did stabilize) in more-or-less similar selection environment.

In the case of mobile infrastructure creation we can then see that the selection environment has already changed compared with the time of fixed phone infrastructure stabilization, for example. There were changes in terms of institutional context and rules and regulations. The markets were liberalized and internationalized and states supported actively technological innovations. The perception of infrastructure also changed – consumers expected from an infrastructure more services and less obligations than before. The paradigm of (remote) communication also changed – people expected more instant and more involving communications. These changes in selection environment facilitated stabilization of innovations like NMT and AMPS/TACS. But the changes in selection environment were reflection of

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19 Rene Kemp et al., “Regime shift to sustainability through processes of niche formation”,

deeper post-modern social and cultural changes. Internationalization of markets (and the relevant rules and regulations) reflects the decline of the national state and rise of overall globalization. Changes of communication paradigm are part of the compression of time and space. Pluralism, importance of individual choice and pragmatism lead to the demand of service-oriented, less restricting infrastructure, etc.

Of course, technical characteristics of the infrastructure also played a role. Because there is no physical connection between the end terminal and the base station, it is relatively easy to create parallel technical infrastructures (hardware systems), compared for example to electricity or fixed phone infrastructures. So this also helps to come to the idea for a liberalized market for mobile communications. Complexity of the infrastructure, together with the characteristics of contemporary science, demanded open, shared knowledge production and led to institutional development in this direction – for example European public funds for collaborative R&D.

Thus, the link between the innovation and selection environment works in two directions. We have seen how selection environment influenced the 1G mobile infrastructures. But their initial stabilization influenced the selection environment itself, by strengthening regulations about liberalization and globalization and further changing the paradigm of (mobile) communication. The changes were so significant, that the 2G mobile infrastructure, the first one which truly stabilized, was conceived from the beginning as decentralized, multi-national, based on open standards, service-oriented and certainly not only car-based. Furthermore, even existing infrastructures, like fixed phones, followed these trends later. So we see here how a technology is both shaped and shaping its social environment. Although this co-shaping has been already present in modern times, it is important to notice that it continues to be present also in post-modernity.

**Micro level analysis**

At micro level we have to analyze the actual use of the infrastructure by various social groups, the individual preferences of users, their impact on the design of the infrastructure and social changes that have been helped by the infrastructure. In some cases, we’ll make comparison between mobile telephony and land-based telephony to show the similarities and differences between them, seeing the land-based telephony (especially in 1970s) as an example of a modern infrastructure.

The development of mobile telephony has been established in the beginning of 1940s but real, mass popularity it has achieved in early 1990s. The explanation of this mobile phone revolution has been related to the changes in way communication happens through social networks.

Just like landline telephone, mobile telephone has been initially marketed mainly to business class people. And in the same way as with fixed telephone, sometimes unexpected by operators and designers, the mobile phone penetrated more and more spheres of our every day life. In fact, the initial design of mobile infrastructure was deliberately similar to the land-based telephony. For example, in Nordic countries the marketing of the new mobile infrastructure emphasized that charging schemes and quality of mobile phone calls were similar to those of fixed phone calls.
But what is different is that the world in which we live is extremely complex and there is need to participate in social networks that are not limited to our geographical position. We often need to keep social relationships from distance and mobile telephony answers these needs. Mobile telephony frees and un-bounds us from any specific location. This process can be seen as part of what Harvey describes as “compression of time and space” [Harvey 1989]. Space is not very big obstacle for communication anymore; people can communicate over big distances and still to be able to retain significant social relationship. For example, in UK parents give to their children mobile phone when they leave home to go to university. Mobile phone helps students to be tightly connected to the home and also to overcome the potentially traumatic experience of living in foreign environment20. Mobile communications also helps to fold the time. All processes in the society become faster and faster. There is no need to schedule the time for calling someone, because everyone is accessible even if s/he is not present at home or in the working office. Furthermore, if the moment is not convenient for a call, other less disturbing services exist, like SMS or voice mail. So we are able at least to transmit information at any time and from any place.

Harvey says that now society experiences another round of compression of time and space. The first round he sees in the early 1970s with the increased mobility and internationalization of the capital. The current round of “compression” he links directly to the contemporary communication technologies and post-modernity.

Ross finds that the post modernity is not in the fast speed of the processes in the society or in using of fast cars and aircrafts – this is all part of modernity. What makes mobile communications typically post-modern is the combination of mobility and permanence. The caller is mobile, while the person who is being called is "always there". To make someone to seem as if s/he is “always there” while s/he is actually traveling is a combination of ambivalences. “Being free from fixed location and being simultaneously locally reachable is one of prime criteria in distinguishing postmodern from modern”, claims Ross21.

This explains why mobile infrastructure stabilized in 1990s while technically it was available in 1940s. It stabilized when there was dramatic need for mobile, instant communication. And this demand came from the compression of time and space and from increased (simultaneous) combination of social roles, two phenomena typical for the postmodern era.22 In turn, mobile communications strengthened further these, and other, post-modern phenomena. But how did this actually happen? In order to answer this question, we will deploy the actor-network theory. Actor-network theory (ANT) explains technological developments by analyzing interactions in networks that contain humans and non-humans (artifacts). As Latour points out23, such networks can exist only when human and non-human actors behave in a certain way, so that they do remain connected. This means that each actor performs certain tasks itself, while delegating other tasks to other actors. This network-dependent behavior Latour calls a script or a scenario. According to Akrich [1992], designers put initial scripts in artifacts based on their ideas of who will be the users of these artifacts. These users are called projected users or virtual users. The actual users may invent new practices
and applications of the artifacts. This is one way in which users influence the design process and can change the script of the device – so the real script of an artifact is not always the script intended by designers. Creative use of artifacts is although not the only way in which differences between intended and actual scripts show up. For example an artifact may unintentionally discriminate against certain types of users, or it may have unpredicted side effects in some other parts of the socio-technical network.

Let’s start with the mobile phone as a device. The script which the designers put in the early mobile phones was to enable calling from any place and at any time. Such script is clear because the mobile phone is a portable device, which can be carried with you – thus it was (relatively!) small and light. Furthermore, a portable device can’t have a physical connection to its master station, so the only option is to use radio-waves. Thus, the script of the early phone was to be carried, to make calls and certainly to receive calls. The task of finding the recipient is delegated to the system. In return, mobile phone delegates to its user the tasks to charge it, carry it, keep it on (or not) and answer the calls (or not).

Since mobile phone invites you to use it and to carry it, and since we spend a lot of our time in public, the phone actually invites you to use it in public too. And here come some problems. The task of answering a call becomes problematic in several senses. First, you are not sure if it is your phone that rings. Second, since calls can come in every situation, the phone doesn’t help you to decide whether to take the call or not. Very early mobile phones had even no screen (as shown for example in Wikipedia24) and there was no way to see the number of the caller. Another problem of using mobile in public is that people around you hear what you say. So in general to maintain your privacy and to be available at the same time becomes more and more difficult. Several solutions of these problems were introduced with the development of mobile phones. Probably most important one was displaying the caller ID, so that you can see who is calling. Initially mainly for this purpose mobile phones got screens. In this way designers delegated the task “guess who is calling” from the receiver of the call (for whom the task is difficult and uncertain) to the infrastructure, for whom this task is in many cases easy and certain.25 What is important here is that the task can’t be delegated to any single component of the infrastructure, only to the infrastructure as a whole.

Presence of the screen was a very important development. Since the script of the screen is to show information (initially only text), there was an opportunity to add textual messages to the service. What telecom operators didn’t realize initially, but many users did, was that SMS is not only cheap, but also helps easing the privacy problem. An SMS can be written and read without others overhearing it and it is much less disturbing to the recipient than a call. So the task to decide to call or not (which is always delegated to the user) is split in more tasks – to call, to send SMS or to do nothing. In this sense the system gives more flexibility and helps the user to reflect the

25 Note: Assuming that the calling user hasn’t kept his number private. For a discussion on this topic see DeCew - “In pursuit of Privacy: Law , Ethics and the Rise of Technology”, Cornell University Press 1997, ISBN 0-8014-3380-0
urgency of the matter. Actually the SMS service was a success that no one network operator expected. SMS quickly achieved mass popularity, especially amongst young people [Lacohée 2003]. Sending a text message from tiny keypad of a mobile is not as easy as making a call. But this difficulty is less of a problem for teenagers and young people (they are not so pressed for time). The prices of sending message are also very suitable for this group. They even created own m-etiquette, similar to the netiquette in Internet and they invented a specific alphabet around text messaging that makes the messages unreadable for the outsiders. This helps them to show belonging to certain informal group that has own sub-culture. Furthermore, such informal groups often organize themselves almost entirely by SMS. From racial clashes in Australia to improvised skating competitions in Brussels, all sorts of events are spontaneously organized via SMS. This service has further enabled pluralism in society – important characteristic of post modernity - by facilitating informal group formation. This is an example how inventive use of mobile phone by users makes them “designers”.

We may see mobile phone development as typical problem-solving loop in technology, where users’ problems and needs are helped with introducing new technical capabilities, which capabilities in turn enable new uses of the technology (invented either by designers, or by creative users), creating on the way new problems and needs.

As a result of this problem solving loop, the script of the mobile phone became inviting for private (individual) use in public. This invites people to combine multiple social roles at the same time and independently from the place – for example K. Gergen speaks about “people who are physically present but are absorbed by a technologically mediated world of elsewhere”. Combining multiple social roles and compression of space are typical post-modern characteristics, which are then strengthened by the mobile phone.

But the mobile phone is not a standalone device – it works only because it is part of an infrastructure. The other components of the infrastructure – technical systems, services, and maintenance and management organizations – also have heavy impact on the use and social role of the infrastructure. One component of the mobile communication infrastructure particularly linked to post modernity, is the pre-paid card. It involves a combination of technical capabilities (in the SIM card), service and management organizations (for example for sales and “filling” of prepaid cards). The result of it is that they make joining the infrastructure easier. Users are not obliged to have permanent address, own bank account or good credit rating in order to have their personal mobile phone. But it poses fewer demands to the users also in another sense. There is no need to know a lot for the infrastructure, for example how to pay your bills; even controlling the expenses of the user have been delegated to the system – when your credit if over, you are cut off. We may conclude here that allowing easy and more or less equal access to the infrastructure is a post-modern thing, since it enables more personal choice and decrease the importance of belonging to certain (pre-defined) social groups.

26 NOTE: Development of voice mail followed similar logic, but on the receiver side (the task of answering a call or not). You have more flexibility in answering calls when you know that the caller can always leave a message, which you can listen to at a more convenient moment.

27 Kennet Gergen, - “The challenge of absent presence”
Phone calls by using prepared cards are relatively expensive so the script of it to speak shortly and to be conscious of the call expenses (or type SMS instead of speaking). On the other hand, there are other paying schemata, which encourage heavier use of the mobile phone. In fact, there are so many different charging options that users are able to make a pragmatic choice, based on their own personal profile of mobile communication. This pragmatic and personalized usage of the infrastructure is often explained with the competition and openness of the telecommunication market nowadays. But competition and openness simply enable the market to respond better to the consumer demands – so we may conclude that the post-modern demand for pragmatism, equality and personalization was already there and mobile communication infrastructure was able to respond to it, because of its openness and de-centralization.

Speaking about personalization, we see another phenomenon – the mobile phone as a fashion tool. The mobile phone is not only communicator – it also shows personal style and identity. It is the first really individual device for communication and it is also an accessory, that shows who you are or you want to be. To facilitate individualization there are many ways to personalize the phone. Adjustable ringing tones (even per caller), replaceable front panels, enormous variety of phone models and combinations of functions – all this is in line with postmodern design. Things have not only a function, they have their own meaning and expression, or - as Verbeek has put it - the form follows fun. How did the mobile phone become such style-expressive device? One explanation is to say that when there is an item, which invites you to carry it almost always and to use it in public, it also invites you to show it off – so when you look for a mobile phone you also take its style into account. This might sound as natural statement, but we have to realize that it is natural only if we have already the post-modern wish to show our individuality. But there might be also another explanation. Since there is an easy-to-join infrastructure and public use of the phone is invited by its script, soon there are many users in public. This creates a new problem – “whose phone is ringing” (for example in the train, but also during a meeting)? The technical possibility to have different ringing tone comes to easy this problem – but it also gives the start of the personalization race. I don’t think we can say one explanation is better than the other – they are both true. The functional/technical and the cultural factors come together to make the mobile phone “a very postmodern phenomenon”, according to Ross.

So we can say that the mobile infrastructure is socially constructed, but also socially constructing, in a particularly post-modern way. As Townsend says “the mobile telephone arrived just at the time when it was needed to facilitate dramatic decentralization of communications channels required by new social systems in the postmodern age. In fact, the mobile phone is so well-designed for this task that it has been even called it a “postmodern form of communication”. Ross continues “mobile phones [are], in the centre of post modernity: here and now vs. independence of time and place, fragmentation of life with virtual totality, absolute individuality with

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28 NOTE: Personal computer and mobile phone can be described also as the most multi-functional, hybrid devices nowadays – mobile phone is combined with alarm clock, agenda, camera, games, Internet access, etc. Hybridization is a characteristic of post-modernity and we see how quickly the technical capabilities of the mobile phone (screen, keyboard and sound in a portable device) were quickly used to reflect the cultural tendency to hybridization.

29 J.P.Ross, “Postmodernity and Mobile Communications”
absolute communication, ..., proximity and distance, total availability (control) vs.
individual freedom.”

We can further confirm the socially constructing role of mobile infrastructure at
micro-level if we look at how other infrastructures developed in the last years.
Especially the fixed phone infrastructure resembles more and more the mobile
infrastructure – voice mail, caller ID, flexible subscription and payment schemas,
even SMS and the design of the terminals are GSM-like. We more often put a fixed
phone in each room – so we are used to the post-modern idea of having an individual
phone.

Finally, let’s come back to the comparison between mobile and fixed telephony and
analyze a similarity that was already mentioned. We said that initially both fixed and
mobile telephony were intended for business purposes and in both cases users re-
defined and extended the purpose of the infrastructure. We can look at this as a post-
modern feature, since individual users have found pragmatic way to bypass the order,
imposed by the infrastructure. Does this mean, that post-modernity was present
already in 1930’s, when housewives socialized by telephone? Or was it present in
1920’s, when American farmers were using their Ford cars also as static power
generators in the farm30? Is any creative use of technology sign of post-modernity? I
think that in regards to modern/post-modern distinction it is more important to see
how such creative use was accepted by the designers and system builders. After initial
period of silent tolerance, Ford tried to restrict such use of their cars by limiting the
warranty in this case – especially after Ford started producing mobile power
generators. Fixed phone operators largely ignored the “social” traffic or tried to limit
it by making longer calls more expensive. Only during 1970s this policy started to
change. On the other hand, mobile operators and mobile phone vendors actually
picked up the creative use, encouraged it and tried to capitalize on it. So we may say
that while creative use of technology has always been present (creativity is a human
feature in all societies), in the post-modern culture it influences the design of
technology – thus also design of infrastructures – stronger and faster than during the
modern times.

Conclusions and discussion
If we come back now to our initial question, is post-modernity anti-infrastructural, the
answer seems to be “no”. Not only a new infrastructure has developed and stabilized
in our post-modern times, but we have seen how it further helped shaping typical
post-modern characteristic of the society.

The need of the society to function in an artificial, controlled environment instead of
in the “raw” nature hasn’t changed – so infrastructures remain essential for the
society. They continue to provide stability and order. But the order is somewhat
different than in modern society. Post-modern infrastructures increasingly reflect and
reinforce individualization, pragmatism and hybridization. This trend is most clear
when we make a micro level analysis and focus on the usage of the infrastructure. We
may say that the usage of infrastructure changes fast and reflects the culture changes
in society. Infrastructures themselves change more slowly, but even small changes
have significant effects in society. The co-shaping of infrastructures and society

30 See Ronald Kline and Trevor Pinch, “The Social Construction of the Automobile in Rural US”
works in a similar way in modern and post-modern times. In particular, in post-modern society infrastructures play socially-constructing role as they do in modern society. This is further in line with Misa’s overall statement that “post-modernity is not more or less tangled with technology, than modernity”.

Analyzed at meso-level, infrastructures in post-modern times show a clear tendency towards network-based governance, establishment and use of open standards, and service-orientation. This is a result of the fact that system builders and infrastructure operators operate in a competitive environment (national and international) and the institutional framework in which they operate reflects the post-modern orientation towards de-centralization and pragmatism. Furthermore, the necessary knowledge for creating and operating an entire infrastructure is so much and so complex\(^\text{31}\), that cooperation between different parties is necessary to produce it. The answers to this need were the open standards and the “pre-competitive cooperation”. The more and more widespread concept of pre-competitive cooperation itself can be seen as typical post-modern example of pragmatism and acceptance of (seeming) contradictions. So also at meso-level we see the co-shaping between infrastructures and society.

Philosophically speaking, these similarities in the social role of infrastructures in modern and post-modern society may be seen as an evidence for the idea, that post-modernity is not a rejection of modernity, but as its further development. As Charles Jenkins wrote, “[post-modernity] is so continuously mixed, mongrel and dialectically involved with modernity”. David Harvey mentions further, that “there is much more continuity than difference between the broad history of modernity and the movement called post-modernity”. When we look at the roles and development of infrastructures in society, this conclusion seems well supported. On the other hand, if we look for example at nation building and social stratification, the differences between modernity and post modernity seem much more radical. Such differences are actually to be expected. When we look at any major social change, there are some areas and values which change dramatically and some where the changes are more gradual and continuity is present. While infrastructures and their social role changed dramatically during pre-modern to modern transition, their changes are more gradual during modern to post-modern transition.

Of course, this paper doesn’t describe all differences between modern and post-modern infrastructures. One interesting aspect for further study, for example, is the role of surveillance in contemporary infrastructures and its contradiction with the trend towards individualization and respect for privacy. “Modernity is in part constituted by surveillance practices and surveillance technologies”, says David Lyon. It looks like that this continues and even increases in post-modern world. Another aspect which deserves attention is whether our dependency as society on (technical) infrastructures actually increases, and if so, what impact this would have on society and culture.

\(^{31}\) NOTE: This is a result both from the technical complexity of contemporary artifacts and from the (post-modern) demand to create multifunctional, hybrid infrastructures.
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In this modern era, people are more likely to use mobile phones as the mean of communication rather than doing face-to-face communication. Recent research indicates that the majority of people in cosmopolitan cities are completely isolation because they are bordered in the virtual communication. In conclusion, there are negative effects of mobile phones that can interrupt humans' lives in social, medical and technical problems. Despite its drawbacks, mobile phones provide the flexibility in term of communication. As suggested above, the contribution of mobile phone to the society is enormous and people's dependence on it for communication is an irreversible trend, albeit it has a number of problems that should be well handled. Model Answer 9 The IEEE Communications Society & Information Theory Society Joint Paper Award. IEEE Marconi Prize Paper Award in Wireless Communications. Service Awards. This Feature Topic (FT) aims to address the intersection between mobile communications and railways. Therefore, we invite potential authors from both academia and industry to submit their papers on the subject of modern communication technologies for railways. In this FT, we would like to try to answer some (or all) of the following questions: will modern communication systems revolutionize railways? Select the "June 2019/Modern Railways: Communications Systems and Technologies" topic from the drop-down menu of Topic/Series titles.