The Norwegian Mobile Telephony and Internet Markets

Harald Øverby and Jan A. Audestad

Abstract Norway has been a pioneer in the development and adoption of the Internet and mobile telephony technologies. Already from an early stage, Norway was involved in research, development, and testing of initiatives such as the ARPANET project and the Nordic Mobile Telephone (NMT) system. Today, access to the Internet and mobile technologies—including smartphones—is globally widespread. The major objective of this chapter is to describe how the market for the Internet and mobile telephony in Norway has evolved since its inception in the 1970s until today. The historical and current market structure of telecommunications is discussed. Moreover, the chapter investigates the role and significance of mobile virtual network operators (MVNOs). Finally, the chapter examines the regulations imposed by the Norwegian Communications Authority (Nkom) on dominant stakeholders in the Norwegian telecom market.

1 Introduction

The Internet and mobile telecommunications are the two chief enabling technologies underpinning the digital economy. The early version of Internet—put into operation in 1969—evolved from the ARPANET project initiated in 1966 [1]. Advanced Internet protocols were developed in the 1970s. Throughout the 1980s, the Internet was mainly used by the military, research organizations, and universities. However, following the commercialization of the World Wide Web (WWW) in 1993, the Internet was quickly adopted by the public. Today, more than 50% of the world's population has access to the Internet, and almost 100% of the Norwegians has access to the Internet [2].

The first-generation (1G) automatic cellular mobile telecommunications network was launched in the Nordic countries in 1981. It was replaced by the

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second-generation (2G) mobile network (GSM) in 1991, supporting fully digital transmission of voice and data. Data rates were significantly improved with the third-generation (3G) mobile network (UMTS) launched in 2001. Today, many countries have fully deployed the fourth-generation (4G) mobile network (LTE) and are currently in a transition phase to the 5G mobile network.

Norway has been a pioneer in the development and adoption of these technologies. Today, close to 100% of the population in Norway has access to the Internet, mobile telephony, and mobile broadband. Moreover, the Internet is accessed mostly using wireless terminals, such as laptops and smartphones.

This chapter investigates the evolution of the Internet and mobile telephony access in Norway. New market actors, such as virtual operators, are discussed along with historical and current regulations.

The rest of the chapter is organized as follows: Sects. 2 and 3 present a brief overview of Internet technology and cellular mobile technology evolution, respectively. Section 4 presents the adoption of Internet access and mobile telephony in Norway from a historical point of view. Section 5 discusses the telecommunications market structures, including the de-monopolization of this market that took place in 1998. Section 6 presents how the de-monopolization has opened for two new market actors: the resellers and the virtual network operators (VNOs). The regulation of the telecommunications markets is discussed in Sect. 7. Finally, Sect. 8 concludes the chapter.

2 Internet Technology Evolution

The major goal of the ARPANET project was to build and demonstrate a data communication network based on packet switching. It was also the first communication network to implement the TCP/IP protocols—later to become the key protocols of the Internet. The ARPANET project was funded by the US Department of Defense and launched in 1966. Packet switching was a novel technology at that time, challenging the established circuit switching technique used in telephone networks. The two key advantages of packet switching over circuit switching were efficient resource sharing and resilience against node and link failures [3]. Some scientists and engineers doubted packet switching could be implemented due to its complexity.

In 1969, the ARPANET project built an experimental packet switched network connecting a few computer sites. In subsequent years, the ARPANET was refined and expanded to the network shown in Fig. 1. The first international connection in the ARPANET was to Norway via a satellite link in 1973.

Why Norway was the first country outside the USA to be interconnected to ARPANET may seem strange. The reason was the Cold War and the need for monitoring test activities with nuclear weapons, in particular, in the USSR. A seismic array was built in Norway for this purpose, and data from possible test activities was sent to the USA. One and a half years later, ARPANET terminals were

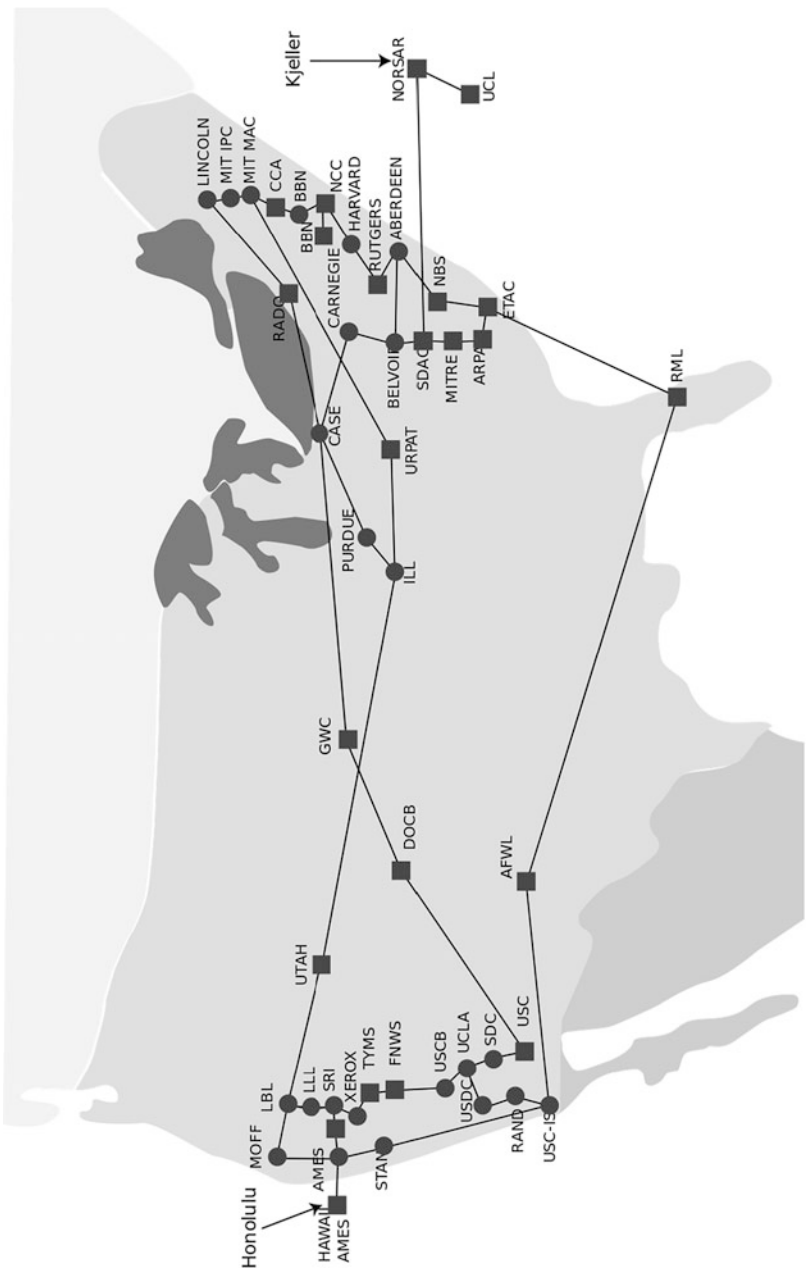


Fig. 1 The ARPANET in 1974. Note that the first node outside the USA was at Kjeller in Norway. The figure is adapted from [4]

established by the Norwegian Defence Research Establishment (FFI) and the Telecommunications Research Establishment (TRE) as the first non-military terminal outside the USA. These terminals were also connected to the American network over satellite links. This brought Norway to the forefront of early packet data research, soon also involving research groups at the University of Oslo.

ARPANET was the predecessor of the Internet in which the key technologies in the current Internet were developed and tested. This includes packet switching, protocol layering, and the TCP/IP protocol suite [1]. Many of the early services of the Internet, such as e-mail and file transfers, were also first developed and tested on the ARPANET. The ARPANET was decommissioned and replaced by NSFNET in 1990 and became the first part of the current Internet.

The early Internet was mainly used at universities and research establishments. The network was hardly known outside these circles until the World Wide Web (WWW) was commercialized and taken into use by several telecommunications carriers in 1993, thereby becoming available to the public. The WWW technology had been invented by Tim Berners-Lee at CERN already in 1989. However—since it was not invented by the telecommunications industry—it took a long time until they discovered the potential the new technology would have for the data communication market, a market the carriers had strived to build up for more than a decade without succeeding.

3 Cellular Mobile Technology Evolution

The development of public cellular mobile technologies started in the 1970s. As of 2021, five generations of mobile systems have been developed and deployed, illustrated in Fig. 2. Observe that there are approximately 10 years between each generation of mobile technology—this denotes the approximate time needed to research, specify, standardize, and develop the technology. Even though 5G technology has been launched and is currently in deployment (2021), the development of the sixth-generation mobile technology has already begun. Each generation of mobile technology builds on the previous generations, and both enhance existing functionalities and add new functionality. For instance, the fifth-generation mobile technology adds functionality to support the evolving Internet of Things (IoT) devices.

Altogether, five generations of mobile systems have been developed:

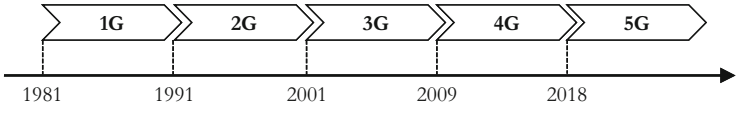


Fig. 2 Overview of the generations of mobile technologies and their year of release

- *First generation (from 1981):* This includes the NMT (Nordic countries), TACS (UK), Radiocom 2000 (France), and C-Netz (Germany) offering only analogue telephony. These systems supported primitive roaming capabilities, though the more advanced methods used in NMT became the basis for the more sophisticated roaming capabilities of GSM.
- *Second generation (1991):* 2G (GSM) offering digital telephony, data communication at speeds up to 10 kilobits per second (kbps), and short message service (SMS) over signaling channels. GSM was designed for automatic international roaming and non-disruptive handover when the mobile terminal moves from the coverage area of one base station to the coverage area of a neighboring base station during conversation.
- *Third generation (2001):* 3G (UMTS) is a dual system offering packet radio services at a data rate of 128 kbps (initially) for Internet services and narrowband GSM services for telephony and SMS. The architecture consists of two separate network architectures for data and telephony but using the same radio interface based on spread spectrum technologies. 3G is an extension of both the Internet and the telephone network.
- *Fourth generation (2009):* 4G (LTE—Long-Term Evolution) is an extension of the Internet offering only packet radio services including voice over IP (VoIP), narrowband data, broadband data, and streaming services over a dynamic mix of narrowband and wideband data channels. Interconnection with the fixed telephone network is via conversion units at the interface between the telephone network and the 4G network.
- *Fifth generation (2018):* 5G is based on 4G but offers new features such as very high data rates, edge computing (cloud computing close to the mobile user, e.g., in the base station, to reduce latency), network slicing (allowing independent providers to operate simultaneously over the same infrastructure offering complex services to the same user), and connection of millions of remote sensors and other devices. 5G will be one of the basic technologies of the Internet of Things.

4 Internet and Mobile Telephony Access Adoption

Figure 3 shows the percentage of the population in the age span from 9 to 79 years having access to the Internet for Norway and the world. Observe that Norway adopted the Internet exceptionally quickly in the years 1998–2008. The Norwegian market for Internet access became saturated in 2012 when 95% of the population had access to the Internet. In 2020, about 98% of the population has access to the Internet in Norway.

Figure 4 shows the number of cellular mobile subscriptions per 100 inhabitants. Observe that the Norwegian market became saturated in 2008. In comparison, the world market passed the world's population in 2019, even though there still exist countries in which mobile cellular subscriptions are not widely adopted. The obvious reasons are that, in the developed world, some people have more than one

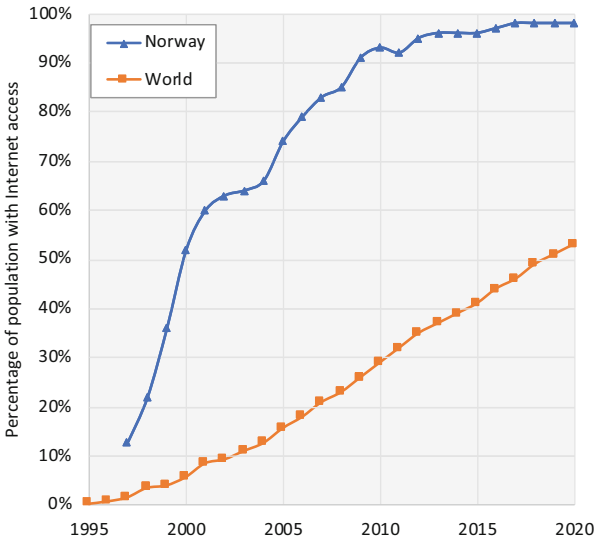


Fig. 3 The Norwegian and world Internet access. Data is collected from [2, 5, 6]

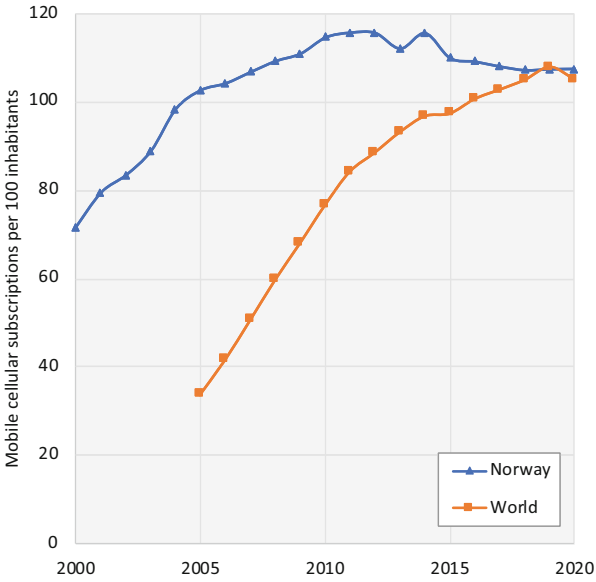


Fig. 4 The Norwegian and world mobile cellular subscriptions per 100 inhabitants. Data is collected from [2]

subscription—e.g., one for private and one for work—and that mobile phones are used in autonomous communications equipment in machines and infrastructures. However, access to mobile cellular (voice) technology is more widespread than access to the Internet. Norway is a pioneer in the adoption of the latest generations of mobile technology, including 4G and 5G (see Fig. 5).

The number of fixed telephone subscriptions in Norway has declined since the early 2000s. Today, there are less than seven fixed telephone subscriptions per

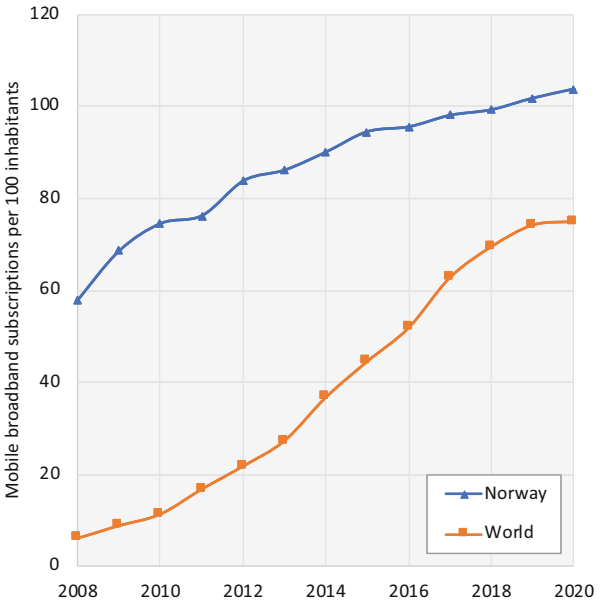


Fig. 5 The Norwegian and world mobile broadband subscriptions per 100 inhabitants. Data is collected from [2]

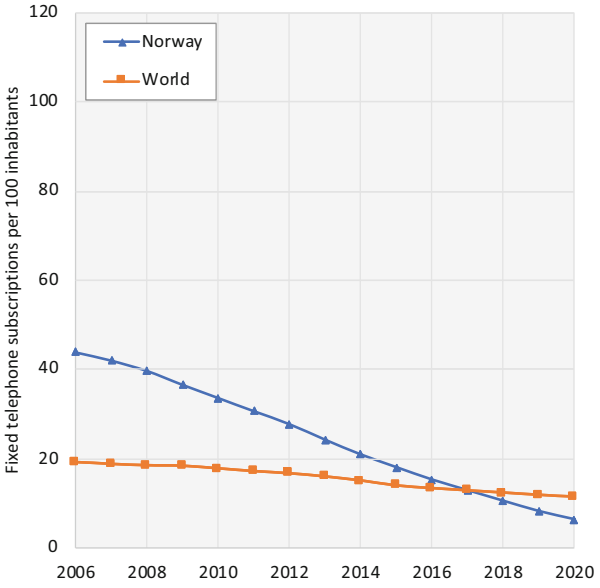


Fig. 6 The Norwegian and world fixed telephone subscriptions per 100 inhabitants. Data is collected from [2]

100 inhabitants as shown in Fig. 6. This shows that mobile technologies have been replacing the fixed telephone service for quite a while. The same trend can also be observed on a global scale.

5 Telecommunications Market Structures

The telecommunications industry has undergone an evolution in market structure from monopoly to competition market as illustrated in Fig. 7. This process is referred to as the *de-monopolization* of the telecommunications market. Other often used terms are *market deregulation* and *market liberalization*. The evolution in Europe took place in three steps [7]:

1. The market for retail sales of user equipment was opened for competition during the period 1985–1987 (Sect. 5.1).
2. Competition was introduced for mobile network operation, first in the UK (1982) and about 10 years later in other European countries (1991) (Sect. 5.2).
3. Full competition on all aspects of telephone network operation in Europe was introduced in 1998 (Sect. 5.3).

Note that this is the evolution of the telecommunications industry and not the Internet service industry. The industry producing Internet-based services has always been open for a global competition. This competition has produced a few digital monopolies, such as Facebook, Apple, and Google, and governments are now attempting to regulate these monopolies to foster more competition and innovation on the Internet.

Traditionally, most telecommunications operators in Europe were state-owned monopolies. In Norway, Televerket (Norwegian Telecommunications Administration) had this monopoly position until 1998 when all aspects of telecommunications were de-monopolized. The evolution toward de-monopolization took place simultaneously in EU and associated European countries (the EEA). Since the evolution in Norway followed the same evolution as the rest of Europe, the general evolution in Europe is presented next.

The argument in favor of monopolies was that it would be more expensive for the users if there were more than one telephone operator in the region because of the large investments in telecommunications infrastructures required. Moreover, the

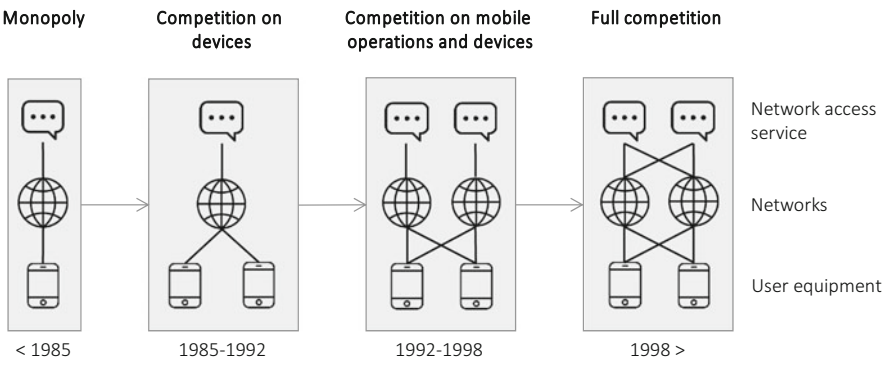


Fig. 7 Evolution of the telecommunications business [7]

technology used prior to the 1980s (electromechanical telephone exchanges interconnected by coaxial cables and radio relays) had an economic lifetime of several decades, often as much as 50 years. Therefore, it was deemed inefficient to allow several telecommunications carriers to build their own communication networks delivering the same set of services. Telecommunications was then regarded as a natural monopoly.

The state monopoly owned the network, offered the few services supported by the network, and sold or rented out telephones, local switchboards, data modems, and other terminal equipment. Consumers usually had one choice concerning network provider, telecommunications service, and type of user equipment. The governments also decided the charges the subscribers had to pay for subscriptions and use of the services.

During the late 1980s, it was questioned whether it would be better to open up for full competition in telecommunications considering the rapid evolution of digital networks and digital switching, the growing need for computer communications, and advances in mobile network technologies. This came at the same time as the internationalization of the industry started in general. Many companies expanded to become international corporations with factories in several countries. This evolution also triggered the governments to consider opening national monopolies for full competition to enhance innovation and making services and industrial products cheaper for the consumers. De-monopolization and the belief in free markets became the *zeitgeist* of the late 1980s. However, the process to transform the monopolistic telephone operators into competitive businesses in a competitive market took a long time because new competition laws and market legislation had first to be put in place and enough time had to be allowed for the monopolies to reconfigure their business models to face a situation where they had to fight for market size and revenues.

5.1 De-monopolization of User Equipment

In the early 1980s, the first public data networks were put into operation, and the first automatic mobile networks were up and running. The number of different types of user equipment had exploded, and the monopolies were too bureaucratic and too inexpert to handle this profusion of new equipment. Responding to this, starting from about 1985, the authorities opened the sale of user equipment for free competition; however, the equipment had to be approved by the telecom operator or a separate regulatory authority before the new device could be connected to the network to ensure that the equipment met international and national performance standards.

The number of independent retailers of various types of user equipment grew rapidly, in particular, for sales of ordinary telephones and mobile phones. An important offspring of the deregulation was that the telecommunications operators no longer owned the telephone apparatus, the data modem, or the local switchboard at the user premises as they did before sale of user equipment was opened up for

competition. This equipment was regarded as a technical extension of the network and, as such, an integral part of the network. After the deregulation, the operator's responsibility and ownership of equipment ended at the network interface device (NID) on the wall of the house; this technology is often referred to as "wire-to-the-wall" and, in the optical age, "fiber-to-the-premises." The manufacturers could now build the data modem into, for example, computers, fax machines, and copying machines. This simplified the use of data communications but had little impact on the number of users of data communications until the Internet was incorporated in the portfolio of the telecommunications operators in the mid-1990s.

The first regulatory authorities were established during this period to ensure fair competition and to avoid that the telecommunications monopolies misused their market power to hinder other retailers to establish their independent businesses. The predecessor of the regulatory in Norway (Nkom) was established in 1987. The regulatory authorities also issued licenses for sale of equipment and followed up that the retailers had access to enough technical expertise for installation and maintenance of equipment.

5.2 De-monopolization of Mobile Network Operations

In 1981, the Nordic Mobile Telephone (NMT) had just been put into operation in the Nordic countries. NMT was the first cellular system offering automatic roaming and undisruptive handover of calls when the mobile terminal moved into a new cell. Already in 1982, NMT was about to become the preferred common European land mobile system. British Telecom participated together with the Norwegian Telecommunications Research Establishment (now Telenor Research) preparing the NMT for implementation in the UK. France declared that they also would choose NMT if the UK did so. Germany had decided to build their own system (C-Netz) but promised to build an "NMT highway" through the country to interconnect "NMT countries."

In 1982, Prime Minister Margaret Thatcher and her government decided that there should be full competition on mobile communications in the UK with two independent operators. This implied that the UK had to choose a system other than NMT; otherwise, one of the competitors would have too big advantage. Europe was then left with four incompatible automatic land mobile systems: NMT in Norway, Finland, Sweden, Denmark, Iceland, Spain, the Netherlands, and Switzerland; TACS in the UK and Ireland; C-Netz in Germany; and Radiocom 2000 in France.

This was, in fact, the major incentive for the Netherlands to suggest in 1982 that Europe should develop a new pan-European digital mobile system—the Global System for Mobile Communications (GSM). GSM was originally an abbreviation for the name of the group developing the technology—Groupe Spécial Mobile. In 1992, the GSM system was put into operation, and EU and EFTA decided that each country should have at least two competing land mobile networks. GSM was an ideal place where the de-monopolization of telecommunications could start. In

Norway, this resulted in two operators: NetCom (now Telia Norway) and one subsidiary of Televerket (now Telenor Mobil). Both operators commenced operation in 1992.

GSM was a completely new network where all operators had to build the network infrastructure from scratch. The new infrastructure consists of base stations, telephone exchanges supporting entirely new functions, and entirely new databases for subscription handling and location management. The only advantage the telephone monopolies had was transmission lines that could be used to interconnect the new devices, thereby reducing the need for investments in basic infrastructure; however, by simple regulatory requirements, all mobile operators in the region had equal opportunities to lease such lines from the monopoly operator for the same price as a subsidiary of the monopoly operator.

Televerket, and all other European telecommunications operators, continued as monopolies offering fixed telephone services. Hence, from 1992 onward, consumers could choose between at least two providers of mobile telecommunications services in Europe, while fixed telephone services and data communication were still restricted to the offers of the monopoly operator.

A mobile operator established in one country could now also establish subsidiaries in other countries, thereby increasing the market of potential subscribers and, as a result, enhancing its business prospects and boosting its financial value. Several mobile telecommunications companies then rapidly developed into large international conglomerates.

5.3 De-monopolization of All Telecommunications Operations

In 1998, the EU opened all aspects of telecommunications for full competition. The process toward full deregulation had started already in 1987 by the Green Paper on the Development of the Common Market for Telecommunications Services and Equipment. The earlier monopole operator was referred to as the *incumbent operator*.

Note that in 1998, fixed telephone services were still regarded as the most important business in the telecommunications industry despite that mobile phone and data services were growing rapidly. More than 20% of the Norwegian population owned a mobile phone at that time.

Mobile communications had already been de-monopolized as described above, and the Internet had existed for several years as an independent network not owned by anyone. In 1998, Internet had just started to be included in the business portfolio of the telecommunications operators in Europe but was still regarded as a rather minor addition to their portfolio. Almost unrecognizably, the Internet had started to replace the X.25 data network as carrier for data communication services, in particular in Norway, where Telenor sponsored communication lines for

interconnecting universities and research establishments with high-speed Internet connections. Telenor Research was in the forefront of this evolution.

While the network operators could levy differentiated charges on the services offered by the telephone network (local calls, long distance calls, international calls, calls to value added services, and so on), it turned out that this was not possible for Internet services. The revenue basis of the telecommunications industry was about to change.

Both the Internet and the mobile phone have altered the business landscape of telecommunications entirely. Now, about 20 years after de-monopolization, the fixed telephone service is about to be replaced by cellular mobile networks, and the telephone service, fixed or mobile, is itself soon incorporated as one out of numerous data services on the Internet using voice over IP technology. By the end of 2020, only about 7% of the population in Norway had a subscription for fixed telephony. The number of subscriptions is still decreasing by about 13% per year. The fixed telephone service in Norway will disappear entirely in 2024. The service has been replaced by telephony over mobile networks and VoIP over broadband cable networks.

The deregulation process took several years because the telecommunications network was regarded as a public utility that was best served by the old state monopolies (the incumbents). Moreover, it was a long and difficult process to establish the rules and procedures for regulating the market so that new entrants had a fair chance to compete with the incumbents.

After 1998, anyone in the EEA could become a network operator, service provider, or retailer of user equipment. However, the stakeholders in this market were subject to some regulatory restrictions related to the competition between network operators—including virtual network operators—on price, performance, customer care, and quality of service. These regulations included mandatory cooperation between network operators to ensure full connectivity between users of competing networks at reasonable prices and quality of service and non-discrimination of application service providers accessing the network, in particular, preventing network operators from giving advantages to application service providers owned by themselves.

To understand the present situation, it is important to note that the deregulation of 1998 had to do with the telephone network only. The driving force for the de-monopolization was the political idea that a competitive market would be more efficient and offer lower prices than the monopoly. This conclusion may be true for fixed and mobile telephone operation, but the development of Internet services has shown that this is not always true. A concern for policy makers now is that free competition has led to the undesirable situation that several companies in the data or Internet business have had a tremendous increase in market value and revenues during the last few years. Some of these companies have also become ad hoc monopolies in their market segments (e.g., Google, Facebook, and Netflix) by acquisitions of competitors. These companies also benefit from strong network effects, thereby resulting in robust lock-in barriers for users. Moreover, several of these companies are true global companies. They can operate from anywhere in the

world, place their equipment in any country, offer services to anyone and anywhere, and relocate their equipment and headquarter at short notice to avoid interference from authorities. This makes these companies hard to regulate and control.

The deregulation of telecommunications has also generated a new form of competition in the global telecommunications industry. Until 1998, the old monopolies existed within a single country, but after 1998, these companies could also start operations in other countries. Making the situation even more complex, two new types of operators have arrived: resellers and virtual network operators.

6 Resellers and Virtual Network Operators

Resellers and virtual network operators (VNOs) are two stakeholders in the telecommunications market that are direct results of the de-monopolization of this business area. The resellers buy bulk traffic capacity and call time from telecommunications carriers and resell it to their customers with profit. Reselling is particularly popular in the mobile market. The reseller does not own any network infrastructure. In the mobile market, they may issue their own SIM. The profit is generated from discounts they obtain by buying large quantities of traffic capacity and by combining telecommunications services with other services or goods, e.g., service packaging, price profiles, and value-added services.

The reseller is the single point of contact for their customers independently of the operators from which the reseller buys traffic capacity. The resellers are in control of their own systems for customer care, billing, marketing, and sales, either owning these facilities themselves or outsourcing them to specialized providers of such services. The mobile market was opened for resellers in Europe in 1992, just after the first GSM network was put into operation. As of February 2020, there are 13 resellers in the Norwegian market, including Chilimobil and Atea [8].

The virtual network operators buy access to the network infrastructure of network operators (NOs) owning their own network. The most common VNOs are the mobile virtual network operator (MVNO). They deliver services to their customers using the radio network infrastructure of mobile network operators (MNOs) owning base stations and other mobile network infrastructure. Lyca Mobile is an example of an MVNO operating in the Norwegian market. The MVNO issues its own SIMs, operates its own Home Subscriber Server (HSS) for subscription and location management, and has at least one Internet gateway router and/or telephone gateway exchange for access to the network of the MNO. The configuration is shown in Fig. 8 for an MVNO offering 4G services. Data packets from the mobile terminal are then routed from the base station via the gateway router (GW) into the Internet, and data packets coming from the Internet are routed to the gateway router before they are routed into the network of the MNO and delivered to the mobile terminal over the base station.

What makes the MVNO different from a reseller is that the MVNO owns some network infrastructure, while the reseller does not. The actual MNO serving the

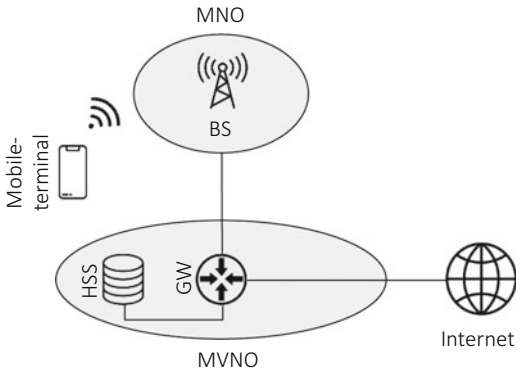


Fig. 8 Network with MVNO with access to network resources owned by an MNO

MVNO is not visible for the customers, and the MVNO has roaming agreements with other MNOs independently of the MNO serving the MVNO.

MVNOs are particularly interesting because there are so many of them. The first MVNO (Sense Communications) was established in Denmark in 1997 and in Norway and Sweden in 1999. In 2014, there were 943 MVNOs worldwide.

The number of MNOs in a region is limited by the amount of radio spectrum available, and the dominating mobile operators in EEA are obliged by EU directives to offer services to both resellers and MVNOs to enhance competitions in the mobile market. The effect of competition with MVNOs may not be obvious. Initially, there was strong resistance from mobile network operators (MNOs) to allow mobile virtual network operators (MVNOs) into their networks. They were afraid of increased competition without really appreciating the difference between market share and revenue share. The size and value of mobile operators are measured in terms of market shares and not in terms of revenue shares.

Figure 9 shows the case of two competing network operators (MNO1 and MNO2) and an MVNO leasing infrastructure from MNO1. The MVNO pays a leasing fee to MNO1 for using its infrastructure.

The effect of the MVNO is illustrated by the following simple numerical example, illustrated in Fig. 10: Suppose that the market consists of 3 million subscribers and is equally shared between the two MNOs before the MVNO enters the market. The revenue per user is 1000 money units. Then the revenue for each of the two MNOs will be 1.5 billion money units initially.

At some time after the MVNO entered the market, the two MNOs and the MVNO have 1 million subscribers each generating 1000 money units each; that is, MNO1 and MNO2 have both lost 0.5 million subscribers to the MVNO. Supposing next that the rent the MVNO must pay for using the network of MNO1 is 500 money units per subscriber, then the revenues of MNO1 will be 1 billion from own subscribers plus 0.50 billion from the MVNO; that is, the revenues of MNO1 are 1.5 billion money units. The revenues of MNO2 are 1 billion money units.

Compared to the situation that existed before the MVNO entered the market, the revenues of MNO1 have stayed the same, while the revenues of MNO2 have become

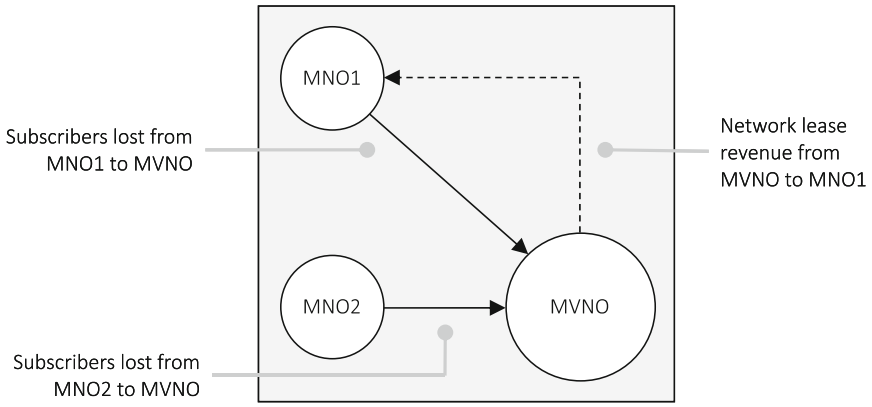
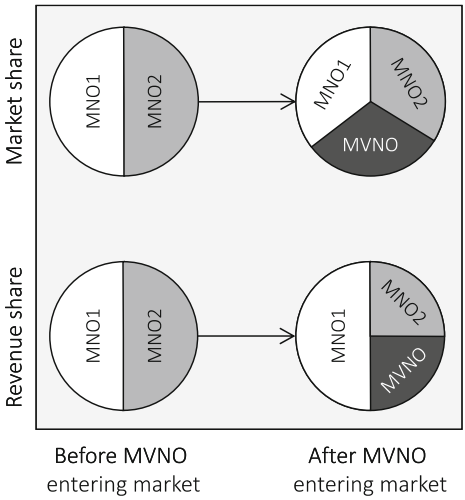


Fig. 9 Competing network operators

Fig. 10 Market shares and revenues for mobile network operators (MNOs) 1 and 2 and mobile virtual network operator (MVNO)



0.5 billion money units smaller. This simple example shows that even if the MVNO is winning many customers from MNO1, housing the MVNO may still be a good business for MNO1 since a large proportion of the revenues of the MVNO is fed back to MNO1 in the form of network leases. Some of these revenues are revenues lost by MNO2 to the MVNO. The result is that MNO2 always loses both market share and revenues.

7 Regulation on the Norwegian Telecommunications Market

The Norwegian Communications Authority (Nkom) is responsible for regulating the Norwegian telecommunications market. Nkom is a member of the Body of European Regulators for Electronic Communications (BEREC), which fosters regulation of digital markets in Europe. Nkom enforces the Electronic Communication Act. The most important task is to ensure fair competition in the mobile market. The purpose of regulating mobile and other telecommunications markets is [9]:

- To avoid market failure such as formation of monopolies
- To foster fair competition
- To secure that the users have correct and adequate information about the market
- To ensure affordable access to the ICT infrastructure, thereby satisfying collective needs of the public
- To protect individuals against unethical business conduct and abuse of personal data
- To promote professional and ethical conduct of market participants
- To stimulate peer-based service innovation and development of new technologies

The regulations apply to fixed and mobile network operators, user access providers, Internet service providers (in particular net neutrality), application service providers, and content providers. The mobile access market is, by far, the most complex market to regulate. In contrast, the regulation of the Internet is mainly to ensure that net neutrality is fulfilled. In Norway, the telecommunications market is regulated by the Norwegian Communications Authority (Nkom).

When Europe opened for full competition of mobile communication in 1992, one of the first companies in each European country to establish itself as a mobile network operator (MNO) was the operator owning the entire telecommunications infrastructure of that country—also called the *incumbent*. Televerket (now Telenor) was the incumbent in Norway. The incumbent had thus an enormous initial market power. To reduce the market power of the incumbent as MNO and allow fair competition, the authorities required that:

1. The MNO had to be commercially separated from the other business areas of the incumbent, including prohibition of cross-subsidizing
2. The conditions for connecting the mobile network to the fixed network infrastructure of the incumbent and lease of infrastructure components (e.g., to interconnect base stations and exchanges) had to be the same for all MNOs, including the incumbent's own MNO

The MNO must have access to exclusive slots in the radio-frequency spectrum. One of the important tasks of Nkom is to allocate and supervise the use of the radio spectrum in Norway. The amount of spectrum allocated for mobile communications is scarce, and there is room for only a few MNOs in the same region. Fair competition for frequency resources is achieved by dividing the spectrum into

slots and then auctioning each slot to existing or new operators. This allows only a few MNOs in each country. To increase competition, the market is also opened up for resellers and mobile virtual network operators (MVNOs) as described above. One task of Nkom is to supervise that MVNOs and resellers meet fair competition in the mobile market.

Hence, the mobile market is an oligopoly with just a few MNOs in each country. Some MNOs, including the incumbent, may have market power big enough to take actions that alter competition or establish new market rules. These are referred to as *dominating MNOs*. The main objective of market regulation is then to hinder that dominating MNOs misuse their market power to push competitors out of the market, to hinder new entrants to enter the market, or to unduly exploit the customers by overcharging. In Norway, there are 2 dominating operators and 15 small ones, mostly resellers and MVNOs. The dominating MNOs are Telenor Mobil and Telia Norway with market shares (2020) 49% and 37%, respectively.

Sections 7.1–7.6 provide a list of competition problems that may arise in the mobile market and must be mitigated by market regulations (based on the Annual Report of Nkom, 2020).

7.1 Denial of Interconnection

MNOs are value networks. The value proposition of the value network is to support mediation services within the same user group or between different user groups (multisided markets). MNOs benefit from interconnecting with other national or international MNOs and fixed networks to make their network of relationships between users as big as possible. Full interconnectivity in the international telephone network is also governed by rules set up by the International Telecommunications Union and universally endorsed by the member countries. These requirements apply to both fixed and mobile telephone networks.

However, an MNO with dominating market power may squeeze new entrants out of the market by denying them interconnection or call termination. This means that users of the new entrant cannot call users of the MNO, thereby reducing the value perceived by the users of new entrant dramatically. This conduct is also referred to as *denial of traffic termination*. One of the responsibilities of the Nkom is to supervise that such actions do not take place.

7.2 Excessive Pricing

The terminating MNO is in a kind of monopoly situation since this is the only network in which a particular call can end up (i.e., where the called user lives or are temporarily located). This allows the terminating network to decide the price for connecting the called user, a price the calling network (and the user) must accept. If

the price claim is not accepted, the call is rejected by the terminating MNO. The terminating MNO may then be tempted to levy excessive charges. To avoid such behavior, the regulator may set a price cap for call termination, making the prices more predictable for the user. However, lower bilateral termination prices may be negotiated between MNOs to support roaming users.

In Norway (and in the EEA), excessive pricing is avoided by the price cap method; that is, the termination price of all MNOs in the EEA region must be equal to or lower than the price cap set by the national regulator. Outside the EEA, there are several countries in which the termination price is not regulated and can be set independently by the termination MNO.

7.3 Cross-Subsidizing

Cross-subsidizing means to charge excessive prices for one service (the subsidizing service) and to use the additional earnings to reduce the charges for another service (the subsidized service). The major source for cross-subsidizing in the telecommunications market is high termination charges. These earnings may be used to subsidize another service and thereby obtain competitive advantages for that service.

Cross-subsidizing may, to a large extent, be avoided by price-cap regulation of call termination charges as explained above. Cross-subsidizing between fixed and mobile network operation is avoided by requiring that the subsidiaries offering fixed and mobile services are commercially separated.

7.4 Price Discrimination

The terminating MNO may charge lower termination charges for calls from MNOs belonging to the same group (e.g., a subsidiary in another country) and from other MNOs with which the terminating MNO has particular agreements (e.g., bilateral roaming agreements). Such practice may upset competition and should be avoided by regulations.

Price discrimination may also be used for cross-subsidizing by charging low termination charges from own subsidiaries and higher charges from other MNOs.

7.5 Lock-In of Customers

Customers may be locked in by contractually binding the customer for a period of time and to enforce economic penalties if the customer leaves the provider before the end of the contractual period. This may be done by offering cheap mobile phones and services to customers who accepts the contract and mobile phones for market

price for those who do not. This is standard competition behavior and is not subject to regulation. Another method is SIM lock where the mobile phone will not accept a SIM from a competing MNO until the lock has been removed. The regulator may set an upper limit for the duration of the SIM lock period or not allow SIM lock at all. In Norway, the operator may apply SIM lock for up to 12 months as part of the subscription.

7.6 Non-price Discrimination

There are also several factors other than price that may twist competition in an undesirable direction. Examples are:

- Dragging out interconnection negotiations, thereby slowing down the market growth of the competitor.
- Deliver insufficient interconnection specifications, also slowing down competition or making interconnection more expensive for the competitor.
- Deliver stripped down functionality, thereby disallowing the competitor access to some interconnection services.
- Reduced quality of technical interfaces (e.g., throttled data rate, slow connection establishment, long latency, and so on).
- Unwarranted requirements (e.g., liabilities in case of network failures).
- Negotiating the interface between MVNOs and MNOs is particularly complicated because it includes both commercial and technical aspects that are much knottier than the interconnection of ordinary MNOs.

8 Conclusions

The Internet and mobile telephony are two enabling technologies for the digital economy. Norway has been a pioneer in the development and adoption of these technologies. This chapter has examined the historical evolution of these technologies and how they impact digital markets. In particular, the transition from national monopolies to competition markets in the telecommunications sector had profound impacts on consumer prices, quality, innovation, and technology development. To ensure fair competition, national regulations are needed.

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