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Digital economy and structural change

Digital infrastructure

Bottlenecks hamper Europe's progress

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During the last few years, the expansion of digital infrastructure in the EU has been carried out more slowly and less comprehensively than politically intended. The EU's objective of ensuring fast broadband coverage (more than 30 megabits per second) for all Europeans by 2020 seems out of reach. In 2017, only 79% of all households had access to such connections (up from 55.8% in 2013). Germany, too, has regularly missed its broadband connection goals in the past.

There are economic and regulatory reasons for the insufficient progress with digital infrastructure improvements. One reason is that providers continue to focus on copper infrastructure instead of optical fibre networks. In addition, competition is lacking. Moreover, (state) financing bottlenecks, particularly in rural areas, and low demand for fast internet connections have delayed investment.

Inadequate digital infrastructure will weigh on companies' chances to enter and develop digital markets and applications. In particular, it puts them at a disadvantage versus US competitors, but increasingly also versus Chinese players. European companies may be attacked, overtaken or squeezed out of the market even in sectors where they are currently well positioned (robotics and automation, industry 4.0, networked mobility etc.).

The European Commission estimates that more than EUR 500 bn will need to be invested by 2025 to achieve the goal of a "gigabit society". State subsidies will continue to be necessary in rural areas; however, the government should support gigabit-enabled technologies only. In urban areas, market solutions are possible. Demand for fast internet connections will steadily rise in the coming years, even though some customer groups will probably be content with slower connections for now. In addition, policymakers need to make sure that spending on broadband infrastructure does not deplete funds needed for state support in other core digital areas (e.g. for venture financing for tech start-ups).

As the data volume will continue to rise, it will be necessary to improve the digital infrastructure further and even accelerate the process. In this context, governments should think about how to define optimal assisted areas to achieve economies of scale. Moreover, co-operations may make sense as well, from co-ordinating earthworks to jointly using the same network. It will be the task of the regulatory authorities to make sure that such co-operations do not reduce competition. From a market-economy point of view, we are sceptical about subsidising demand for fast internet access.

Several hurdles will need to be overcome on the way towards the gigabit society. In all probability, updated copper lines, which are, however, not gigabit-enabled, will remain in place for some years to come and compete with (new) fibre networks. In addition, the availability of state funding will continue to limit the extension of broadband coverage to rural areas; more money from the public coffers would certainly be helpful. Finally a simple reason why infrastructure improvements are delayed: available construction capacities are too low.

Digital in Europe: Risk of further fall-back in core areas

US digital ecosystems are leaders in many digital markets

Europe and European companies are clearly lagging behind their US competitors in the race for a leading position in many digital markets. In fact, US digital ecosystems seem to have such a large lead that European companies simply cannot keep up. Competition with Chinese companies is hampered and distorted by the fact that China tends to close off its domestic digital markets from foreign players and to protect domestic companies. Moreover, Chinese companies are trying to take over their global competitors in robotics and automation (and other sectors) and can rely on their government's support in these efforts. At the same time, it is almost impossible for foreign competitors to take over a Chinese company. China's "Made in China 2025" strategy aims to improve the country's competitiveness and innovativeness in a number of key technologies and to arrive at a global leading position in the long run.

Various risks for European companies

Europe is faced with three major risks in the area of digital transformation. First, European companies are at risk of falling even further behind in those core areas of technological change where they have almost lost contact with their US and Chinese competitors already. This applies in particular to platform economics and digital ecosystems. Second, the US and China in particular seem to be engaged in a neck-and-neck race in the area of Artificial Intelligence (AI); currently, they are vying for the best starting position. And third, European companies may be attacked, overtaken or squeezed out of the market even in sectors where they are currently in a good or leading position, such as robotics and automation, industry 4.0, networked mobility, smart energy networks etc.[1]

Digital infrastructure is a necessary condition for the development for digital markets and applications

Whether and to what extent these risks actually materialise will depend on several factors, such as companies' innovativeness and their willingness to invest and take risks, government (support) initiatives and the regulatory framework at both the national and the international level. Nevertheless, digital infrastructure (fixed and wireless networks, antennas, data centres etc.) is a necessary but not sufficient condition for the further development of the European digital economy and industry and for Europe's international competitiveness.

High-performance infrastructure is key for digital applications

If the infrastructure is insufficient or not available everywhere, European and German companies' chances of success will be seriously diminished. A nation-wide broadband network (optical fibre and 5G) which offers high transmission rates and volumes, reliability and short delays is regarded as a precondition for establishing sustainable connectivity and real-time communication between physical and virtual "things". Digital infrastructure is thus indispensable for progress in core areas of digital transformation, such as the Internet of Things ("IoT"), industry 4.0, networked mobility or cloud services. It permits the automatic and decentralised exchange of information between machines, appliances and sensors ("machine to machine" or "M2M"), which is, in turn, the basis for a virtual network to control largely autonomous production and maintenance processes in "smart factories" in the near future. It also enables real-time communication between vehicles (car2car) and vehicles and infrastructure appliances (car2X), which are necessary for automated driving. And it paves the way for a broad range of time-sensitive and data-intensive

[1] See Körner, Kevin et al. (2018). Digital economics: How AI and robotics are changing our work and our lives. Deutsche Bank Research. EU Monitor. Frankfurt am Main.

applications, from medicine to smart energy supply, professional or leisure virtual reality applications or the development of "smart cities".

German companies criticize the digital infrastructure environment

In a recent survey by the German Economic Institute (Institut der deutschen Wirtschaft), 28% of the participants said that deficiencies in the communications network significantly impaired their business activities. 44% said they experienced minor impairments. Back in 2013, the percentages were 15% and 39%, respectively. If we add up the two percentages, we find that, of all types of infrastructure, companies are most displeased with the IT infrastructure, even before traffic infrastructure.[2]

A deficient digital infrastructure will also reduce households' opportunities to benefit from the digital transformation, particularly in rural areas (home office work, digital administration, health care and education services). Overall, a high-performing, nationwide digital infrastructure should be one of modern society's usual amenities, such as a working and efficient transport infrastructure or reliable power and water supply.

Improvement of digital infrastructure: Numerous ambitious goals set by the EU ...

"Digital Agenda for Europe": EU-wide broadband coverage has to be improved

In the last few years, policymakers have, in fact, set themselves quite ambitious goals to improve the digital infrastructure in the EU and in Germany. Let us look at a number of past plans which help to understand the political ambitions. Back in 2010, the "Digital Agenda for Europe"[3] already formulated targets for broadband access[4] in the EU; this agenda was updated in 2012. The three targets were

— to bring basic broadband (up to 30 Megabits per second (Mbit/s) to all Europeans by 2013

— to provide all Europeans with fast broadband (over 30 Mbit/s) by 2020

— and to ensure take-up by 50% or more of European households to ultra-fast broadband (over 100 Mbit/s) by 2020.

Ambitious goals until 2025

In 2016, the European Commission updated and extended its digital infrastructure goals:[5]

— By 2025, all major socio-economic drivers (such as schools, transport hubs, the main providers of public services or highly digitalised companies) should have access to connectivity of at least 1 gigabit/second.

— Moreover, all urban areas and all major terrestrial transport paths should have uninterrupted 5G coverage[6] by 2025.

— And finally, all European households should have access to internet connectivity of at least 100 Mbit/s, which is upgradable to gigabit speed.

[2] See German Economic Institute (2018). Infrastructure Deficiencies in Germany. iwd 15/2018. Cologne.
[3] See European Commission (2010). Europe 2020. A strategy for smart, sustainable and inclusive growth. Brussels.
[4] The term "broadband" usually does not have a specific technical meaning but is used to refer to any infrastructure or technology for high-speed internet access that is faster than traditional dial-up access.
[5] See European Commission (2016). Connectivity for a Competitive Digital Single Market – Towards a European Gigabit Society. Brussels.
[6] "5G" is used to describe the fifth generation of mobile communication networks.

... and the German government

In German politics the definition of goals for the digital infrastructure expansion have a long tradition

In Germany, too, policymakers have set themselves numerous goals for the improvement of digital infrastructure during the past decade.[7] The coalition agreement of 2009 was still quite vague on the subject, saying only that a nationwide infrastructure for fast internet connectivity should be quickly installed. Four years later, in 2013, the new coalition agreement was more concrete. It said that basic broadband coverage (at least 50 Mbit/s) should be installed nationwide by 2018. This goal was confirmed at the beginning of 2017, when the government and the "Network Alliance for a Digital Germany"[8] agreed upon the "Gigabit Initiative for Germany". Beyond installing a 50Mbit/s network, the Network Alliance defined additional targets in order to make Germany one of the leading nations in terms of digital infrastructure.[9]

— By 2019, poorly served business parks are to be provided exclusively with fibre connections.

— By end-2020, the foundations for nationwide 5G rollout are to be laid.

— By the end of 2025, a "converged gigabit-ready infrastructure" is to be established in Germany.

Long-term target gigabit society

The term "gigabit society" is also used in the most recent coalition agreement. It is somewhat vague and sometimes used as political waffle. In terms of infrastructure, it means that a gigabit-ready network is to be established nationwide by 2025. For that purpose, a fibre network is to be installed. At the moment, copper phone lines are still the main means of internet access in Germany.[10] The coalition agreement also says that mobile coverage is to be improved in order to make Germany a leading market for 5G.[11]

[7] Other EU countries have, in fact, adopted similar goals. However, the national goals are not necessarily the same as the EU targets; sometimes they are much more detailed.
[8] An alliance of "telecommunications and network companies that are willing to make investments and are innovative", which was established in 2014 by then minister Alexander Dobrindt.
[9] Network Alliance for a Digital Germany (2017). Gigabit Initiative for Germany.
[10] Cable networks usually established for TV broadcasters (coaxial cables, HFC networks) can also be used for fast internet access. In fact, c. 70% of the German households can access the internet via a HFC network. The ratio is much lower in business parks. Meanwhile, the political focus has shifted towards optical fibre networks. For a detailed overview of the different technologies see Fraunhofer Institute for Open Communication Systems (2016). Netzinfrastrukturen für die Gigabitgesellschaft. Berlin.
[11] For an overview of further measures and projects in the area of digitalisation see: Federal Government (2017). Legislative report on the Digital Agenda 2014-2017. Berlin.

Considerable investment necessary across Europe

More than EUR 500 billion will have to be invested in digital infrastructure in the EU

Upgrading the digital infrastructure is an expensive endeavour. While the estimates of the actual funding requirements differ depending on the time horizon and the size of the planned investments, they often come to a three-figure billion amount. The European Commission believes that EUR 515 bn will need to be invested over ten years to achieve the targets for 2025.[15] In 2017, the Federal Ministry of Transport and Digital Infrastructure claimed that investments worth EUR 100 bn would be necessary to reach the German targets for 2025.

Mobile communications summit in Germany and the path towards 5G 1

In July 2018, the so-called mobile communications summit took place in Berlin. Mobile network providers committed themselves to extend 4G (fourth-generation mobile standard) coverage to 99% of all German households by the end of 2020. The term "4G" is often used synonymously with "LTE" (long term evolution) or "LTE Advanced". The aim is to close existing gaps in the network ("dead zones"). The providers plan to cooperate, with each of them providing the necessary infrastructure to a poorly served region and then allowing the other providers to use it as well.

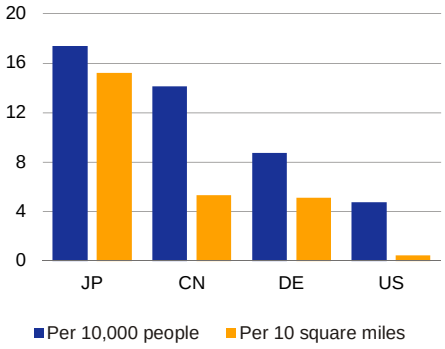
Policymakers and network operators said in a joint declaration that they wanted to make Germany a leading market for 5G. The fifth generation of mobile communications and network technology is thought to be a key precondition for the establishment of the gigabit society and a core element of a modern digital infrastructure. The future 5G infrastructure will not rely exclusively on a mobile network, but integrate other networks (optical fibre, copper, LTE). Compared to its predecessors, 5G allows significantly higher download and upload speeds (c. 100 times quicker), is therefore gigabit-ready and has short response times (latency). 5G is therefore key for time-critical applications, where several mobile participants/appliances communicate simultaneously (e.g. autonomous driving, Internet of Things etc).

According to the Federal Ministry of Transport and Digital Infrastructure and Fraunhofer Institute for Open Communication Systems, commercial 5G services will be available from (end-) 2020. Larger urban agglomerations and key transport routes are to be completely covered by 5G by 2025. Nationwide 5G coverage is unlikely in the short to medium term. This will be a significant disadvantage for SMEs in rural areas.[12] The Federal Network Agency is preparing an auction of 5G frequencies. According to the network providers, the government's main aim in the auction should not be to achieve the highest possible revenues, as the money paid for the frequencies would not be available to install the necessary infrastructure. While this argument is quite understandable from the providers' vantage point, 5G frequencies are nevertheless in short supply and valuable, which means that a certain price is justified. The declaration agreed upon at the mobile communications summit enables the government to set a later date for payment or to allow payment in instalments if the providers make binding commitments to establish the necessary infrastructure. More details about the procedure will be released during the coming months.

In an international comparison, Europe lags behind in terms of 5G deployment, particularly in comparison to Asia or North America. Japan, South Korea and the US are among the leaders. US companies plan to deploy a 5G network in a few pilot cities during the remainder of the year. However, it is the Chinese which are currently the frontrunners in the area of 5G infrastructure. According to the current five-year plan, the Chinese government intends to invest an aggregate EUR 400 bn in the technology by 2020. A Deloitte research study finds that, since 2015, China has overtaken the US in terms of investment in 5G (by more than USD 20 bn) and in terms of the number of mobile phone towers. The number of network cells per inhabitant is three times higher than in the US.[13] Mobile networks are another area where international competition and mistrust are becoming increasingly evident. For example, as of this summer, US authorities may no longer use appliances by Chinese producers and 5G frontrunners Huawei or ZTE for security reasons. Australia has excluded Huawei and ZTE from any participation in the deployment of its 5G network because the companies are perceived to be too close to the Chinese government. And in Europe, too, awareness of security risks in the area of digital infrastructure has increased – just look at the EC's proposal for an EU Cybersecurity Act.[14] At the same time, the European Investment Bank (EIB) has granted loans with an aggregate volume of EUR 750 m to Scandinavian telecommunications companies Nokia and Ericsson. The money is to be used for the development of 5G technology and strengthening the competitive position of European companies at the international level.

China's massive push to build its 5G infrastructrure 2

Number of wireless sites



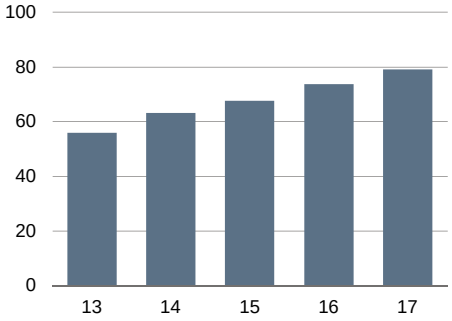
Source: Deloitte

[12] See VCI et al. (2018). Auction of 5G licenses must benefit the entire industry. Joint press information from VCI, VDA, VDMA and ZVEI. Berlin, Frankfurt.
[13] See Deloitte (2018). 5G: The chance to lead for a decade.
[14] See European Council (2018). EU to create a common cybersecurity certification framework and beef up its agency – Council agrees its position. Brussels.
[15] See European Commission (2016). Commission Staff Working Document SWD (2016) 300 final. Brussels.

Digital infrastructure: Bottlenecks hamper Europe's progress

Broadband coverage in the EU has improved 3

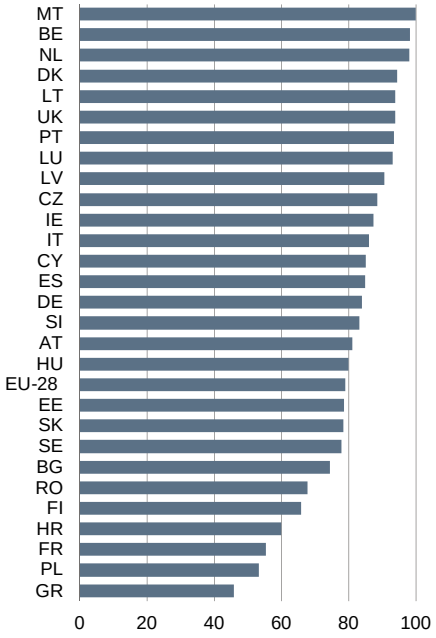
Share of households with broadband connectivity of more than 30 Mbit/s, %



Source: EU Commission

Broadband coverage in the EU: Some countries lagging behind 4

Share of households with broadband connectivity of more than 30 Mbit/s, 2017, %



Source: EU Commission

In principle, private-sector companies are responsible for both the provision of the necessary digital infrastructure and the provision of telecommunications and internet services in the EU. Nevertheless, the government may subsidise infrastructure works, for example in rural areas, where the small number of potential customers or a low population density render the necessary investments unprofitable. Opinions differ within the EU as to the download and upload speed up to which state support should be permitted (30Mbit/s or more).[16] Still, putting the threshold at 30Mbit/s will not allow rural areas to join the gigabit society.

Depending on the population density and settlement structure, public-private co-operations are in many cases the best option to provide the necessary digital infrastructure. The EU has created several programmes and funds to finance the past and future upgrading of the digital infrastructure network.[17] The latest draft of the financial framework for the years 2021–2027 earmarks EUR 3 bn for spending under the Connecting Europe facility. This means that digital infrastructure spending is set to increase in comparison to the current budget (see also p. 19).

According to its coalition agreement, the German federal government intends to invest EUR 12 bn in digital infrastructure during the current legislative period. A large share of this amount is to come from the revenues of the upcoming auctioning of UMTS and 5G licences. However, it is not clear just how high the revenues from these auctions will be. In terms of reliability, it would be better to put aside funds in the public budget or in the medium-term financial planning for this purpose. In addition, authorities at lower administrative levels, for example local authorities, will also need to advance money for the improvement of the digital infrastructure if the necessary investments are unlikely to pay off for private-sector investors. Highly indebted municipalities in particular will find this difficult, as they have to use much of their funds for obligatory spending.

Progress lags behind the targets

During the last few years, the goals for digital infrastructure improvements in the EU were clearly missed. Nevertheless, there has been some progress. According to the most recent report on broadband coverage in the EU, which is prepared annually for the EU Commission, the target of providing basic broadband coverage has been (largely) reached.[18] In 2017, 99.6% of all EU households had access to some type of broadband connection. Fixed broadband services reached 97.4% of EU households. This ratio amounts to "only" 92.4% on average in rural areas. Estonia, Poland, Romania and Slovakia were the only EU countries where less than 90% of households had access to fixed broadband services in 2017. 96% of EU connections offered download or upload speed of more than 2 Mbit/s.

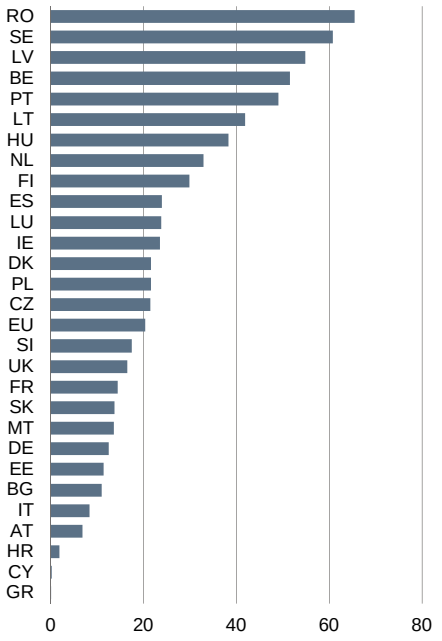
However, the target of providing all EU citizens with broadband connectivity of more than 30 Mbit/s by 2020 will probably be missed. In 2017, only 79% of all EU households had access to such connections (up from 55.8% in 2013). Moreover, there are still considerable differences between the individual EU countries. In France and Poland, for example, the share of households with internet connectivity of more than 30 Mbit/s was still below 60% last year. Despite their progress in the last few years, these countries are very unlikely to

[16] See European Court of Auditors (2018). Broadband in the EU Member States: despite progress, not all the Europe 2020 targets will be met. Luxembourg. The Court of Auditors' report focuses on five EU member states, namely Germany, Ireland, Italy, Poland and Hungary.
[17] For an overview see the Report of the European Court of Auditors mentioned in footnote 14.
[18] See IHS Markit and Point Topic (2018). Broadband Coverage in Europe 2017. A study prepared for the European Commission. Luxembourg. These figures deviate slightly from those given, for example, in the report of the European Court of Auditors quoted above.

Digital infrastructure: Bottlenecks hamper Europe's progress

Share of ultra-fast broadband connections relatively small 5

Share of fixed broadband connections over 100 Mbit/s in total connections*, 2017, %

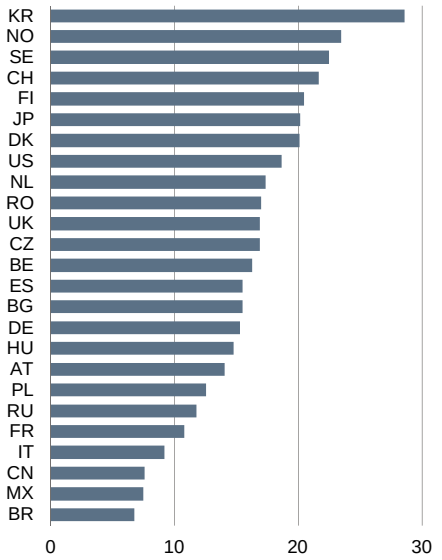


* Based on actual fixed broadband subscriptions of private households

Source: EU Commission

Fast internet connections in Korea 6

Average connection speed of actually used internet connections, Mbit/s



Source: Akamai

reach the target of (almost) 100% by 2020. In contrast, Malta (99.9%), Belgium (98.4%) or the Netherlands (98.2%) have almost reached the goal of nationwide broadband coverage.

Broadband coverage significantly exceeds actual take-up

The third target of the EU Commission, namely having at least 50% of all EU households actually use an ultra-fast broadband connection by 2020, will probably be missed as well. Just as with the other two targets, there has been some progress in this regard. According to the European Commission, only 6.7% of all fixed broadband connections provided ultra-fast access by mid-2014. By mid-2017, this share had risen to 20%.[19]

Again, there are massive discrepancies between the individual EU countries. While the share of ultra-fast internet connections amounted to more than 60% in Romania or Sweden in 2017, it was below 10% in Italy and Austria. And in Greece and Cyprus, the official number was even 0%.

Moreover, people do not automatically use fast internet access, even if it is available. Demand for high-speed broadband services depends on numerous factors, including the income, age and use by consumers and the price for the internet access. Of course, demand for high-speed internet influences, in turn, the pace with which the digital infrastructure is improved.

Germany misses its broadband targets ...

During the last few years, Germany regularly missed its policy goals for the improvement of its digital infrastructure – or changed them as soon as it became evident that the targets were out of reach. One example is the (meanwhile abolished) goal of achieving nationwide coverage of at least 50 Mbit/s by 2018. According to the latest activity report for telecommunications by the Federal Network Agency, "only" 77% of all German households had access to such a connection by mid-2017. Just like in the EU as a whole, there is a significant gap between cities and rural areas: while more than 90% of all urban households can access a broadband connection with more than 50 Mbit/s, the ratio drops to c. 36% in rural areas.[20]

... and is only average in terms of digital

By mid-2017, 65% of German households had access to an ultra-fast internet connection (more than 100 Mbit/s). In this regard, Germany exceeded the EU average. However, the actual take-up rate paints a different picture. Only 40% of German households had subscribed to an internet connection of more than 30 Mbit/s in 2017. 13% avail themselves of more than 100 Mbit/s. In the EU as a

[19] Another 24% of EU connections offered download speed of 30–100 Mbit/s. This suggests that 56% of EU households used internet connections with less than 30 Mbit/s, even though the coverage ratio amounted to 79%.

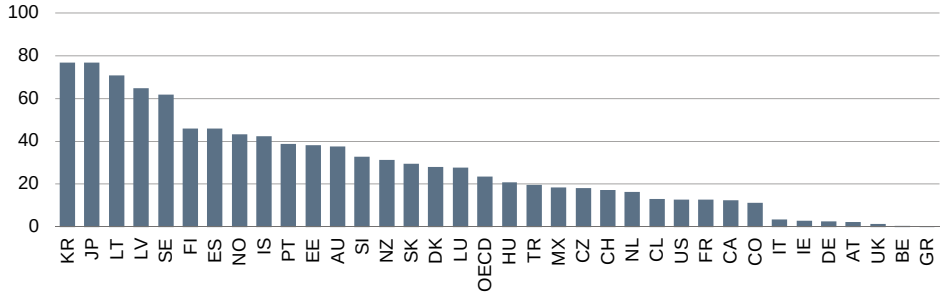
[20] See Federal Network Agency (2017). Activity report for telecommunications 2016/2017. Bonn.

whole, 44% of households actually subscribe to more than 30 Mbit/s, of which 20% use a connection of than 100 Mbit/s.[21]

Other international statistics confirm Germany's need to catch up in terms of digital infrastructure. According to the OECD, only 2% of internet subscriptions in Germany used a pure optical fibre network by end-2017.[22] The OECD average was 23.3%. South Korea and Japan are at the top, with almost 78% of only optical fibre connections each, followed by the EU countries Lithuania, Latvia and Sweden. The IT company Akamai regularly publishes international comparisons of the average download and upload speed of regularly used internet connections. While Germany, at 15.3 Mbit/s, was above the global average of 7.2 Mbit/s at the beginning of 2017, it was "only" average in an OECD comparison. South Korea is in the lead (28.6 Mbit/s), ahead of Norway (23.5) and Sweden (22.5). The US achieve 18.7 Mbit/s.[23]

Pure fibre connections are an exception in many countries 7

Share of fibre connections in total broadband subscriptions, 2017, %



* FTTH and FTTB respectively. Based on actual subscriptions

Source: OECD

Digital Economy and Society Index: Northern Europe at the top

With regard to digitalisation, Germany is (only) average in a European comparison and is far away from the desired position in the "global top group". A look at the Digital Economy and Society Index (DESI) confirms this assessment. The index is released annually by the European Commission and focuses on five key areas: connectivity, human capital, use of internet services, integration of digital technology and digital public services. In turn, each of these areas is broken down into several sub-categories.[24]

Germany ranked 14th in 2018. Denmark, Sweden, Finland and the Netherlands form the top group and have a considerable lead over the other EU member states. Italy, Bulgaria, Greece and Romania are at the bottom of the ranking. Connectivity, which is the main subject of this report, focuses on indicators such

[21] For additional data concerning broadband coverage in Germany see TÜV Rheinland (2017). End-2017 Report on the Broadband Atlas commissioned by the Federal Ministry of Transport and Digital Infrastructure. Berlin.

[22] The terms "Fibre to the House" (FTTH) or "Fibre to the Building" (FTTB) are used if the apartment or building are actually connected to the optical fibre network. "Fibre to the Curb" (FTTC) means that the optical fibre network ends at the curb and does not enter the building.

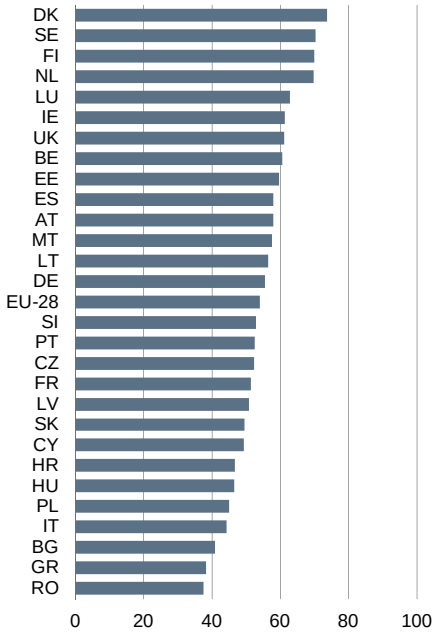
[23] See Akamai (2017). State of the Internet. Q1 2017 Report. This statistic divides the average data volume per country and second by the number of active IP addresses, not by the number of connections. As a result, the average will decline if a country is home to a big number of large companies which use many active IP addresses. See Weiss, Harald (2018). GroKo: Digitalisierung bleibt Stiefkind. VDI Nachrichten of 16 March 2018. Nevertheless, the statistic is a useful indicator to gauge the capacity of the national networks.

[24] See, for example, European Commission (2018). Digital Economy and Society Index (DESI) 2018. Questions and Answers. Brussels.

Digital infrastructure: Bottlenecks hamper Europe's progress

Northern European countries leading, Germany somewhere in the middle 8

DESI, total index*, 2018



* Composite index based on the following criteria: connectivity, human capital, use of internet services, integration of digital technology, digital public services

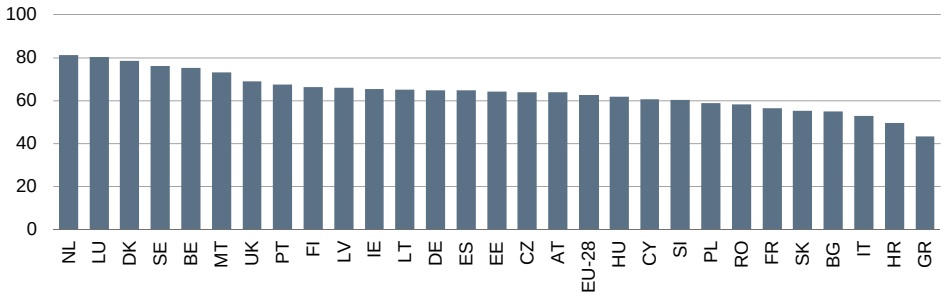
Source: EU Commission

as the capacity of broadband connections, the actual take-up of fast or ultra-fast broadband services and the price of broadband services. In terms of connectivity, Germany ranks 13th of all EU countries. The Netherlands, Luxembourg and Denmark are at the top of the list, Italy, Croatia and Greece at the bottom.

A look at the overall DESI shows that all countries have made progress in the last few years. On average, the DESI rose from 41.5 pp in 2014 to almost 54 pp today. Still, there are significant differences between the EU countries. In 2014, the best-ranking country (Denmark, just like today), had a lead of more than 35 pp over the worst-ranking country (Romania, also like today). Between 2014 and 2018, the gap only narrowed by 1 pp. The gap between the most advanced countries and the laggards is unlikely to be eliminated in the foreseeable future, as also the leaders will continue to upgrade their digital infrastructure in the coming years.

The Netherlands in the lead regarding digital infrastructure 9

DESI, key area connectivity*, 2018



* Composite index based on the following criteria: fixed broadband, mobile broadband, fast and ultrafast broadband (speed), prices

Source: EU Commission

Numerous reasons for infrastructure deficiencies

Academic literature lists a quite impressive number of reasons why the policy goals for upgrading the EU's digital infrastructure have not or not completely been reached in the last few years. Roughly speaking, these reasons fall into two categories: economic and policy/regulatory reasons. However, the boundaries between the two categories are not clear, and it depends on the country which reasons are the most important.

The European Court of Auditors report mentioned above gives several reasons why the countries examined in detail failed to reach their goals. The policy and regulatory reasons include delays during the planning procedure for broadband infrastructure upgrades. These delays shorten the time available to actually implement the plans. The Court of Auditors also explains that obtaining co-financing for infrastructure measures from the European Regional Development Fund was made more difficult by deficiencies of the required national and regional broadband plans drawn up by the beneficiary countries.

Promoting copper networks instead of switching towards fibre technologies

In addition, the pace and the technological details of any infrastructure upgrades depended on the existing economic, regulatory and technological framework conditions. The Court of Auditors takes Germany as an example. The incumbent chose to upgrade the existing copper lines to extend broadband coverage instead of installing a new optical fibre optic network. Policymakers have accepted this decision. The so-called vectoring technology allows to increase the speed of copper cables to 60–100 Mbit/s; in the long run, even more than 100 Mbit/s may be possible.

German focus on copper cables under criticism

Vectoring not gigabit-ready

Vectoring (or other methods to improve the capacities of the existing copper cables) is considerably cheaper than laying new infrastructure, such as optical fibre or coaxial cables.[25] That is why it makes sense for the incumbent to opt for this strategy. However, the Court of Auditors points out (as do others) that the transmission speed declines as the number of users increases and that vectoring is only a short-term solution, as it is impossible to achieve the significantly higher transmission speed needed for a gigabit society. In short, Germany will miss its goal of creating a nationwide gigabit network by 2025 if it continues to rely mainly on vectoring.

Competition problems regarding retail customer access

In addition to these two capacity-related deficiencies, vectoring has another disadvantage. Physical access to the last mile, i.e. the actual connection for the end user, is limited to one single provider. This will restrict competition, unless the regulator intervenes. That is one of the reasons why municipal and business associations criticise the incumbent's vectoring measures.[26] Ultimately, the competition issue was addressed by introducing the "virtually unbundled local access product" (VULA) in Germany. The European Commission and the Federal Network Agency participated in the development of this solution. Under the VULA, the incumbent is obliged to allow its competitors (against a fee) similar (virtual) access to the end user as the competitor would have enjoyed if it had physical access to the copper line.[27] Nevertheless, the European Court of Auditors reports that competitors often decide to build their own fibre networks, which offer greater capacities. We will return to these competition aspects later on.

Many market observers believe that the fact that the incumbent has focused for a long time on upgrading the existing copper network instead of investing in optical fibre technology is the main reason why Germany is so slow in extending broadband coverage.[28]

Competitive framework conditions have an impact on investment behaviour

Non-discriminatory access to network is not always guaranteed

The competitive framework conditions give rise to criticism of the incumbent, and not just in Germany. Competitors, business associations, political parties and research institutes have repeatedly voiced their concerns and are continuing to do so. They point out that non-discriminatory access to the incumbent's network is not possible and that, depending on the customer structure, it does not make sense to deploy a second network in addition to the already existing one. For example, the European Court of Auditors reported that the Irish incumbent's competitors complained about the lack of and the prices for network access. In Germany, the Court noted complaints about the regulation of vectoring technology (including VULA), which might have a negative impact on the services which competitors can offer.

The Association of German Chambers of Commerce and Industry (DIHK) has also listed certain aspects of competition policy which have hampered the improvement of digital infrastructure in the past. In 2016, DIHK pointed out that a private-sector competitor was unlikely to deploy a (new) network if the existing

[25] Below, we will only deal with optical fibre technology as an alternative to copper cables, as optical fibre is what policymakers are focusing on. Still, cable networks can successfully compete with fibre networks (see also footnote 10).
[26] See for example VATM et al (2015). Verbände lehnen Vectoring-Monopol der Telekom ab. Joint press release of the Association of German Cities, Deutscher Landkreistag, BREKO, BUGLAS, VATM, VKU of 10 December 2015.
[27] See Federal Network Agency (2017). Bundesnetzagentur specifies final details for vectoring in proximity areas. Press release of 31 July 2017, Bonn.
[28] See Lobo, Sascha (2018). Warum ist das Internet in Deutschland so langsam? Spiegel Online. 6 June 2018.

copper line network benefited from regulatory decisions.[29] DIHK wrote that the deployment of an optical fibre network would not take place (quickly enough) because the political target, i.e. a download speed of 50 Mbit/s, could be realised by upgrading the existing copper network. Overall, DIHK claims, the incentives to establish a fibre network are inadequate.

Governmental influence on grid operators under critique

Several political parties have also criticised the competitive framework conditions for the digital infrastructure. The Greens recently claimed that, while the incumbent had won numerous tenders under the federal support programme for broadband coverage[30], it had received contractual reassurances that it could take up to three years before actually providing the required coverage.[31] The FDP criticizes in general that, by holding shares in the incumbent, the federal government is influencing the incumbent. This, the party says, results in conflicts of interest because the government is the co-owner of a company which it needs to regulate, for example concerning network access issues. The FDP is therefore calling for a full privatisation of the incumbent.[32]

And finally, competition aspects are relevant to customers as well. For example, the European Court of Auditors reports that German customers find it difficult to change their provider. Moreover, it points out that, according to tests, only a small share of customers actually received the data transfer rate as stated in their subscription contract.

Tight public funds and lack of profitability delay infrastructure upgrades

Infrastructure grants are essential in rural areas, but public budgets are limited

A lack of profitability and insufficient availability of funds (which is, to some extent, the consequence of this lack of profitability) are two major reasons why the improvement of the digital infrastructure takes so much time. This is true across Europe and applies to rural areas in particular. According to the European Investment Bank (EIB), 50% of the expenditure which would be necessary to reach the broadband targets for 2020 would have to be spent in rural areas – where, however, only 20% of the population live. As a rule, private-sector companies only invest in (potentially) profitable ventures. If a project is not profitable, the public sector will need to subsidise investments in digital infrastructure in order to achieve the policy targets. In fact, the government is often the most important investor in rural areas.[33] Still, the public sector's resources are limited, and governments alone cannot finance the investments needed to reach the infrastructure goals for 2025. In any case, the medium-term financial planning for the EU as a whole and its member states does not foresee such investments.

EU support programmes are not well targeted

And the absolute amount of available funds from public and private sources is not the only factor which stands in the way of a fast improvement in the digital infrastructure. The implementation of the programmes does not run smoothly either. For example, the European Court of Auditors criticised the use of funds for a large project supported by the European Fund for Strategic Investments (EFSI), which had provided a total of EUR 500 m. Most of the money had been

[29] DIHK (2016). DIHK opinion on the draft of the National Reform Programme 2016 of the federal government. Berlin.
[30] According to the Federal Ministry of Transport and Digital Infrastructure, this programme aims to promote high-speed broadband networks (50 Mbit/s) in poorly served regions. It shall provide support to local authorities and district governments and enable them to close gaps in the existing broadband coverage. As a rule, the federal government provides 50% of the eligible expenditure. It is possible and, indeed, desirable to combine funds from this programme with funds from other support programmes.
[31] See Alliance 90/The Greens (2018). Breitbandausbau ist ein Trauerspiel. Online article published on 12 June 2018. The European Court of Auditors also points out that providers can retroactively decide not to go through with their broadband network plans for a given area.
[32] See FDP (2017). A new way of thinking. Election manifesto for the Bundestag elections 2017, Berlin.
[33] See European Court of Auditors (2017). Broadband in the EU. Audit brief.

used for projects in commercially viable areas instead of under-served areas. In addition, the project could have been financed with an EIB loan and not via EFSI. The Court also describes a case in Germany, where the incumbent had connected profitable premises to the network in an area which had been declared as a "market failure area" before, even though public investments were planned or had even started. This "cherry picking" increased the costs of having the less profitable premises within the area connected to the network. This example shows that the shape and definition of assisted areas plays a significant role for the pace and the costs of extending broadband coverage.[34]

In Germany only a small volume of the overall development funds has been retrieved yet

In Germany, the federal government's reply to a small interpellation by the Greens shows that only a minuscule share of the funds earmarked for the Federal Programme for Funding the Roll-Out of Broadband had actually been paid out by the end of May 2018 (EUR 3.2 m out of a total of EUR 3.5 bn).[35] The Greens wrote that the technical documentation obligations and Europe-wide tenders exceeded the capacities of smaller municipalities in particular. Moreover, building capacities were lacking, even though this was not primarily an issue for policymakers.

Demand for ultra-fast internet (still) too low

Private households' demand for high-speed internet is still restrained

There are not only supply-side, but also demand-side reasons for the slow progress with broadband deployment. As the figures quoted in this report show, there is a discrepancy between the availability of broadband connections and the actual demand for ultra-fast internet. And this is true across Europe. If customers were more interested in fast internet access and willing to pay for it, the digital infrastructure upgrade would be a more attractive investment for private-sector companies.[36] It seems that many households are quite content with slower, but cheaper internet access. And this is likely to remain the case for the foreseeable future. Households' reluctance to pay for faster internet connections may be due to the fact that the number of attractive digital applications is still too small. To some extent, this is a chicken-and-egg problem. Demand will not increase as long as there are no attractive digital services, and if demand remains low, it does not make sense to upgrade the infrastructure. At the same time, data-intensive digital applications can be offered (and used) only if the network capacities are adequate. Still, both supply and demand will certainly rise in the coming years. Household demand will increase simply because the number of people who are less interested in the internet will steadily decline over the coming years.

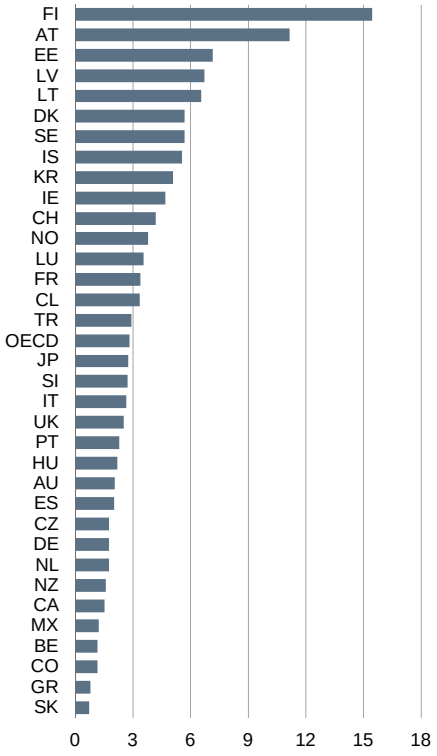
Interestingly, demand for digital services differs strongly between the OECD countries, as a look at the OECD data for annual data volumes per mobile broadband connection shows. Finland (more than 15 GB in 2017) has a large lead over Austria (11.2 GB), which ranks second. The OECD average is 2.8 GB, with Germany only coming in at 1.8 GB. There are several reasons for these discrepancies, for example different mentalities. Mobile payment by smartphone applications is much more popular in northern than in southern European countries. Low population density, for example in Scandinavia, may also be a factor which promotes mobile data applications.

[34] See also Delhaes, Daniel (2018). Weniger Kontrolle, mehr Tempo. Handelsblatt, 11 June 2018, Düsseldorf.
[35] See Federal Ministry for Transport and Digital Infrastructure (2018). Reply of the federal government to a small interpellation by Bundestag members Margit Stumpp, Oliver Krischer, Matthias Gastel, other Bundestag members and the parliamentary group of Alliance 90/The Greens concerning the "use of funds under the Federal Programme for Funding the Roll-Out of Broadband". Berlin.
[36] See Federal Ministry of Finance (2018). Herausforderungen beim Ausbau der digitalen Infrastruktur. Monthly Report of the Federal Ministry of Finance, March 2018. Berlin.

Large differences in terms of mobile data usage

10

Mobile data usage per mobile broadband subscription, 2017, gigabit per month



Source: OECD

While these figures (only) refer to mobile data volumes, they indicate that insufficient demand for internet services is a more important hurdle for the digital infrastructure upgrade in Germany than in many other countries. This theory is also supported by the fact that German consumers are content with a lower broadband speed than the OECD average (see above).

Numerous measures against infrastructure bottlenecks

We have explained in detail why the digital infrastructure upgrade has been slower and less sweeping than planned, both at the EU and the German level. It makes sense to analyse the reasons why the targets were missed in order to avoid or at least mitigate future failures. Any measures taken to ensure quick and efficient broadband deployment will need to address both the economic and the policy/regulatory problems mentioned in this report. Before we take a look at individual measures, we will explain just why it is necessary to roll out a high-speed broadband network across Germany (and Europe as a whole).

Why a nationwide network?

As we have just explained (see above), a significant number of (household) customers will not be interested in gigabit-ready internet connections in the next few years, not even if they are available. This means that the existence of gigabit-enabled digital infrastructure is a necessary, but not a sufficient condition for the intended transformation into a gigabit society. Demand has to keep up as well.[37] Right now, many customers are not willing to pay for ultra-fast internet, and it is difficult to gauge when and if they will be ready to do so. This is a major risk for investors in optical fibre networks, and there may be (regional) resource misallocations. Nevertheless, a nationwide, high-capacity IT network is doubtlessly necessary to turn a gigabit society into reality. Without a nationwide network, companies in rural areas will be hampered in their efforts to use modern production and services systems. Digital technology will probably increase corporate productivity, and this makes sense both for individual companies and for the economy as a whole. Households (not just in rural areas) will have new options, for example in the area of work-life balance (better opportunities to work from home, digital public administration). Less commuting would be good for the environment and reduce traffic. Moreover, the widening gap between urban and rural areas might narrow again to some extent (just look at the lack of affordable living space in large cities and vacant homes in the country). Another key factor is that certain digital applications, such as autonomous driving, will require a nationwide digital infrastructure.

For many digital applications the nationwide coverage is important

Overall, the improvement of the existing digital infrastructure will result in positive externalities for the economy as a whole. This justifies state subsidies for regions where a purely private-sector investment is not commercially viable.[38] Due to the favourable overall externalities, it is probably not a problem if some regions are temporarily or even sustainably over-served with gigabit-enabled networks.

Developments of the digital infrastructure are associated with positive external effects

However, the authorities will need to make sure that spending on broadband deployment does not deplete funds needed for state support in other core digital areas, in particular (venture) financing for tech start-ups or the development and commercialisation of Artificial Intelligence or other key technologies. For example, there are no concrete funding plans for the German government's

Government expenditures for digital infrastructure investments compete against other types of subsidies

[37] In addition, the term "digital society" is largely meaningless unless there is a large number of digital services which are provided and which people actually use in business and social life.

[38] See Briglauer, Wolfgang and Ingo Vogelkamp (2018). Fördermodelle und Aspekte einer optimalen Migration zur Gigabitinfrastruktur – Breitbandziele, Fördermaßnahmen und Technologieneutralität. ifo Schnelldienst 7/2018. Munich.

ambitious plans to make the country a global leader in the area of Artificial Intelligence.[39] Discussions about urgency and priorities will be necessary in case of conflicts about the best use of scarce public funds. And action is highly necessary, seeing that the global race for technology leadership has begun.

Massive increase in data volumes

The digital infrastructure upgrade will need to include an increase in transmission capacities, as the data volume will certainly rise steadily over time. Utilisation of digital infrastructure will intensify considerably more quickly than that of transport or energy infrastructure. Numerous commercial, public and private-sector digital applications are still in their early stages of development. In addition, new services are steadily being developed. Data traffic during peak times is estimated to increase 18-fold between 2015 and 2025. And mobile data traffic will grow even more rapidly.[40] Data volumes will continue to rise after 2025. This means that the digital infrastructure will need to be improved further in the foreseeable future; in fact, it will be necessary to continue and even accelerate the process in line with the motto "after the investment is before the next investment". This will create major challenges for both private and public-sector investors.

As much market as possible – subsidies where necessary

Academic literature has made numerous suggestions for optimal ways to upgrade the digital infrastructure. However, one thing is necessary in any case: a clear policy goal. The European Commission and the federal government have adopted the term "gigabit society" to describe their goal. They plan to create an EU-wide (if possible) digital infrastructure (fixed and mobile networks) which allows gigabit transmission speed (and more) and short response times (latency).

Starting with this policy goal, we would like to call several economic principles to mind:

As of yet fibre networks and 5G are without alternatives

— Economists tend to think that market forces and competition should determine which technologies are used to reach a given goal. However, in the case of digital infrastructure this argument appears largely superfluous. Optical fibre networks (FTTH/B) or the new 5G standard for the mobile network are currently regarded as the only available technologies which can ensure that the targets are reached. Cable networks (HFC) are approaching their capacity limits.

Public subsidies only in unprofitable areas

— (Ordoliberal) economists will also give a standard answer to the question of whether the state should subsidise (digital) infrastructure improvements: If market forces (i.e. competing private-sector suppliers) are able and sufficient to realise the policy goals, state subsidies are unnecessary. If, however, it does not make economic sense for private-sector companies to upgrade the digital infrastructure (taking into account only primary effects), the government should provide financial support.[41] In practice, it is impossible to draw clear boundaries between these regions. The EU broadband state aid guidelines distinguish between white, grey and black

[39] See federal government (2018). Key points for a Federal Government Strategy on Artificial Intelligence. Berlin.
[40] See Fraunhofer Institute for Open Communication Systems (2016). Netzinfrastrukturen für die Gigabitgesellschaft. Berlin.
[41] This fundamental distinction can be found in numerous publications and is also supported by business associations. DIHK, for example, distinguishes between regions where investors compete with each other and regions where they do not. See DIHK (2017). Digitale Infrastruktur für die deutsche Wirtschaft.

areas.[42] The "whiter" an area, the more necessary it is for the government to support investment. In return, the EU guidelines set out that state subsidies are permitted only under certain conditions in "black areas".

— Just as with other network infrastructures, the deployment, operation and use of digital infrastructure require a certain degree of state regulation. Potential monopolies or technical or economic market entry barriers may limit competition in these sectors. Competitive aspects also play a role in the tender procedures for assisted areas or in cases where public-sector companies (such as local utilities, which are organised as private-law companies) compete with private-sector organisations for infrastructure networks. It is therefore important to make the regulatory framework as efficient and effective as possible.

Regulation to stimulate competition

The regulatory framework for the telecommunications sector should give incentives for investments and stimulate competition. Competition, in turn, helps to exploit potential opportunities for cost-cutting. Just how state regulation promotes competition depends on the individual market area. If an area is commercially viable, several providers may establish parallel networks. From a macro-economic vantage point, this solution may not be ideal if one single network is sufficient. However, if several parallel networks make economic sense for the providers, they guarantee a maximum degree of competition (unless a change of provider is made excessively difficult).

The regulation of the network access allows for competition

So-called "open access" regulation is a common practice in the EU to stimulate competition in the telecommunications sector. It is used if creating parallel infrastructure networks[43] does not make economic sense for providers (or does not take place for other reasons). Under an open access regulation, other providers can rent transmission capacities from the incumbent against a regulated price. The system was adopted at the EU level in 2000. However, hammering out the details of an open access regulation is quite difficult. If the incumbent is obliged to allow third parties easy and cheap access to the network, any incentives to invest in a better infrastructure dwindle away. At the same time, competition will suffer if access is made more difficult for alternative providers.[44] Strict caps on the network rent set by the regulatory authority ex ante may prove to be too inflexible, particularly with regard to investments in new optical fibre networks, which are subject to considerable uncertainties (for example concerning future demand). An ex-post regulation may be more suitable. In this case, the regulator trusts that contractual agreements can be found and acts only if competitors complain. In the end, regulatory authorities will continue to play an important role in the long run. They are needed to stimulate competition, for example if people want to change their providers, and to counteract any market failures (for example the abuse of a predominant position in a given region).[45]

[42] The EU Court of Auditors explains in the report quoted above: "In white areas no provider of broadband access services currently is operating and there is no such provider to be expected in the coming three years either. In grey areas there is one (infrastructure-based) provider already active, however, another network is unlikely to be developed in the next three years. In black areas there are or there will be in the next three years at least two basic broadband networks of different operators."

[43] This is usually the case for the "last mile", i.e. the actual connection to the end user. Alternative providers can often rely on their own backbone infrastructure (primary transmission lines). There is also a medium level ("middle mile") which connects the last mile with the backbone infrastructure.

[44] See also Girard Yann et al. (2018). Gigabit Access: Germany Lags behind in International Comparison but Demand Is Low. DIW Weekly Report no. 25/2018. Berlin.

[45] See Homann, Jochen (2018). Ausbau der digitalen Infrastruktur bis 2025: Welche Wege führen in die "Gigabit-Gesellschaft"? ifo Schnelldienst 7/2018. München.

Enabling competition in non-profitable areas

Suitable regulation can help to establish competition in the telecommunications sector even in regions which are not commercially viable. One of the most important tools is a tender procedure for assisted areas, which are allocated to the provider which can offer the desired service at the lowest cost. The open access regulation makes sure that competition does not end with the tender procedure. For example, state support for the infrastructure deployment may depend on the winner's allowing alternative providers access to the network once it is completed. In this way, open access helps to prevent (temporary) monopolies.

Gap funding model versus operator model

In practice, there are several types of public-sector support for infrastructure upgrades, for example the gap funding model or the operator model. Under the gap funding model, the government bridges the gap between the expected revenues accruing to the network provider and the costs for the implementation and operation of the network. The operator remains the owner of the network. Under a privately run municipal operator model, the municipal authorities remain direct or indirect owners of the network. However, they outsource the actual operation (in a tender procedure) to a private operator. This model has the practical advantage that it tends to result in the deployment of FTTH (and not FTTC) connections, which will improve transmission capacities on the last mile. The gap funding model will only support FTTC infrastructure (i.e. optical fibre networks which stop at the curb and do not go into the building). This means that any incentives for operators to undertake an FTTH upgrade are near zero. However, the operator model also results in higher economic risks and workloads for the local authorities.[46]

Competition between optical fibre and copper network to continue for now

Strengthening copper networks may reduce investment in optical fibre networks

If the government really wants to create a gigabit society, it should support only gigabit-capable technologies. In the fixed broadband sector this is an optical fibre network. Nevertheless, copper and optical fibre networks will continue to co-exist in the coming years, above all in those countries where the existing copper network is in a condition that allows vectoring upgrades. This is the case in Germany, where private-sector network operators regularly criticise the incumbent for upgrading its copper network exactly in those areas where a private competitor has just finished, started or planned to deploy an optical fibre network. With vectoring being used to "overlay" existing or new optical fibre networks, it becomes much more difficult for private operators to generate sufficient revenues to cover their investment expenses. After all, some customers in the relevant areas will opt for an upgraded copper connection, which offers lower transmission rates than a fibre connection, but is cheaper. The criticism indirectly targets the federal government, which is a co-owner of the incumbent and has so far tolerated this behaviour.[47]

Upgrading the copper network and the last mile makes sense for the incumbent, as this is a way to improve the incumbent's chances of hanging on to its customers (who might otherwise switch to the new optical fibre connections provider) at relatively low expenditure. However, from a regulatory vantage point the practice gives rise to a dilemma. On the one hand, upgraded copper networks run counter to the policy goal of a gigabit society, as vectoring simply will not be sufficient to establish a nationwide gigabit-capacity network. On the

[46] See WIK-Consult (2017). Ansätze zur Glasfaser-Erschließung unterversorgter Gebiete. A study for DIHK. Bad Honnef.

[47] See VATM (2018). "Deutschland kann sich das nicht länger leisten" – Telekom setzt weiterhin auf Überbau mit Vectoring statt auf Kooperation. Press release of 9 July 2018, Cologne. See also BREKO (2018). BREKO-Regulierungskonzept zur Beschleunigung des Glasfaserausbaus (FTTB/FTTH) in Deutschland. Bonn.

other hand, competition will intensify if customers can choose between copper-based access (after vectoring) and optical fibre access. Prohibiting vectoring would be tantamount to a massive regulatory intervention, which would be difficult to justify in terms of regulation and competition policy. Instead of prohibiting a technology which will prove inadequate in the medium to long term, the government should opt to support only investments in gigabit-enabled infrastructure.

New aid guideline by the German federal government: Technology upgrade and less red tape

Support only for gigabit-ready

The federal government's revised Funding Guidelines for Broadband Deployment were presented in July 2018 and address some of these points of criticism. They say that, in principle, subsidies will be granted only if all customers in the assisted area can reliably be provided with a transmission rate of 1 Gbit/s.[48] This is in line with the target set out in the current coalition agreement, which foresees that public money should be provided only for assisted areas where optical fibre technology is deployed. In addition, the Funding Guideline includes a "technology upgrade", which will allow local authorities which have so far gone for copper technology to switch to optical fibre by the end of the year. To this end, the federal government will step up the available funding.

Less bureaucracy – more subsidies

In addition, subsidies for optical fibre projects may be raised later on if the commercial viability of the project suffers from later, overlaying vectoring measures, which result in unexpected revenue losses that may endanger the project's financial soundness. This may increase providers' willingness to invest in optical fibre networks and prevent vectoring. However, rising costs are a disadvantage. Overall, the Funding Guidelines aim at favouring optical fibre technology without prohibiting copper lines completely.[49] This is an acceptable compromise.

The Funding Guidelines also aim at accelerating the broadband deployment by cutting red tape. If local authorities want to submit an application, they will only need to demonstrate the relevant region's eligibility for funding on the basis of a market survey. A value for money comparison to justify the funding model selected (gap funding model or operator model) will no longer be required. Moreover, the local authorities no longer need to present a detailed funding plan when submitting an application; a preliminary estimate of the funding needs is sufficient. And finally, the maximum amount of funding available per project is raised from EUR 15 m to EUR 30 m.

These measures should indeed help to accelerate broadband deployment. Smaller municipalities in particular were unable to meet the bureaucratic requirements in the past. However, more generous funding and less red tape may result in excessive support in some cases. Still, it is impossible to find the "golden mean" between the necessary attention to detail and rapid implementation in each and every case. Of course, the regulatory authority should take care to ensure that the digital infrastructure is indeed upgraded quickly after the funding is granted.

[48] See Federal Ministry for Transport and Digital Infrastructure (2018). Funding Guidelines for Broadband Deployment. Berlin.

[49] See Krempl, Stefan (2018). Upgrade auf Glasfaser. Das neue Breitbandförderprogramm des Bundes steht. c't 2018, issue 16. Hannover.

Exploit potential efficiencies – rely on cooperation

Academic literature usually recommends to be as efficient as possible in any efforts to upgrade the digital infrastructure. While this should be regular practice, it does not always work. However, exploiting efficiencies helps to achieve economies of scale and cut costs. These two goals often go together. Economies of scale can be achieved by creating optimal assisted areas. Larger assisted areas will improve the chance of getting private providers interested in deploying their own network and of reducing state subsidies due to the higher number of potential customers and degressive fixed expenditure. This may help to prevent private investment from being crowded out by state subsidies.[50]

Advantages from economy of scale can be realized throughout the whole value chain

Cooperation along the value chain can also result in economies of scale. Since a large share of total infrastructure expenditure will be used for earthworks, it makes sense to cooperate with other network operators (electricity, gas, water). Of course, this is easier in areas under development than in existing quarters. As this way of doing things is in the best interests of the individual network operators, additional state incentives appear superfluous. At the very least, it makes sense to put empty pipes into newly constructed buildings to allow for a later upgrading of digital infrastructure. Why not make this a legal requirement for newly constructed buildings? However, cooperation must not lead to less intensive competition. This shows once again why regulatory authorities will continue to play an important role.

Specialized glass fibre providers …

Economies of scale may also be realised if several competitors use one and the same existing or new network instead of creating parallel structures. However, as we have shown in this report, they are not always willing to do so. Several market observers, for example WIK-Consult, argue that specialised optical fibre providers should focus only on implementing and operating fibre networks and marketing them to as many retail providers as possible in order to generate high network utilisation rates (wholesale-only business model). These specialist companies might generate cost advantages along the value chain, from obtaining the construction permit to the construction works as such and ultimately to the marketing phase, in comparison to investors which deploy only one single network (for example local authorities).

… could be attractive for institutional investors

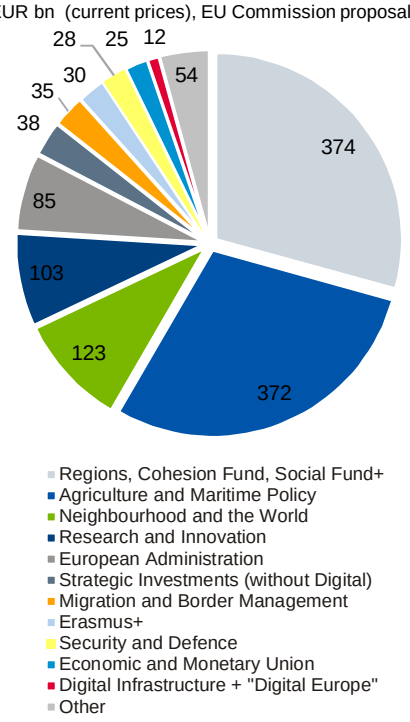
In addition, they might be attractive for institutional investors (pension funds, insurance companies), as they can offer a balanced risk return profile, not least in the current situation, where it is difficult for investors to find worthwhile investments. The involvement of such investors might help to mobilise funds and accelerate the infrastructure deployment, provided that the necessary capacities in the construction sector are available. This business model would require vertically integrated companies (which operate the network and provide services) to be split up. This may be a politically difficult issue.[51]

In this context, it makes sense – at least from an economic vantage point – to discuss the principle of network neutrality and its impact on digital infrastructure upgrades. This is a politically difficult issue. The principle of network neutrality guarantees that all data share the same transmission capacities on the internet and ensures that individual user groups are not discriminated against. Nevertheless, capacity utilisation might be increased if the principle was watered down for reasons of competitive policy. This might increase investment incentives for network operators.[52] In fact, operators of other infrastructure networks often differentiate their pricing by user types or prioritise certain

[50] See WIK-Consult (2017). Op. cit.
[51] In the report quoted above (op.cit.), WIK-Consult describes the experience Sweden and the Czech Republic have made with a wholesale-only model.
[52] See Baake, Pio and Slobodan Sudaric (2018). Net Neutrality: Prioritization Is Beneficial from an Economic Perspective. DIW Weekly Report no. 25/2018. Berlin.

EU budget 2021 to 2027: Focus remains on regional policy & agriculture 11

EUR bn (current prices), EU Commission proposal



Sources: EU Commission, Deutsche Bank Research

customer groups. In any case, network neutrality is certainly an issue which merits further research. For now, this is mainly a political issue.

More public funding – coordination of funding programmes

Another reason for the slow deployment of broadband infrastructure, particularly in rural areas, is that public funds are limited. Ultimately, the government will probably have to provide more money and raise its spending as data traffic increases. Paving the way towards a gigabit society is a question of political priorities, too. Estimates of public funding requirements for the coming years can be based on off-the-cuff calculations of upgrading expenditure and experience from completed projects. This will also illustrate the "typical" cost split between private operators and the government.

There are numerous national and EU funding programmes for digital infrastructure improvements. They should be better coordinated to facilitate their use for the relevant market participants.

The EC's proposals for the European financial framework for the next seven years (2021–2027) foresee considerably higher spending on the digital transformation (EUR 9.2 bn) and digital infrastructure (EUR 3 bn). Nevertheless, taken together, these two items amount only to 1% of the total budget, which has a size of EUR 1,279.4 bn.[53] The lion's share (almost 60%) will go to agriculture and regional and cohesion policy (despite significant cuts). Moreover, the amounts earmarked in the budget are only a fraction of the estimated aggregate investment required for digital transformation and infrastructure in Europe.[54] Obviously, most of the funding is expected to be provided by the individual EU member states or by the private sector. In addition, innovative, future-oriented budget items are often not yet supported by major stakeholders among the member states and thus run the risk of falling by the wayside in the upcoming EU budget discussions and negotiations. Just like at the national level, there is a risk that EU budget policy tends to protect existing interests and ensure transfer payments instead of pushing for future competitiveness and ensuring future prosperity.

Direct subsidies for private or commercial customers are hard to justify from a market-economy point of view

Stimulate and articulate demand – but how?

And finally, measures to speed up the deployment of broadband dig can focus on the demand side. From a market-economy point of view, we would argue against subsidies for households or companies which opt for ultra-fast optical fibre internet access. After all, the customers directly benefit from quick internet access. In addition, the advantages of having an optical fibre connection will rise over time as the number of digital applications increases. As a result, more and more customers should switch over to such a connection. If the government decides to subsidise end users at all, there are valid arguments for granting the subsidies for a limited period of time and for linking them to household income.

Interested customers could pay in advance

While there are good economic arguments against subsidies for the demand side, customers can, of course, make clear to network operators and investors that they would like to have fibre-based internet access and would be willing to pay for it. For example, companies in a business park which is currently poorly served or only served by copper lines might join forces and ask the network

[53] See European Commission (2018). EU Budget for the future. Brussels.

[54] According to estimates, more than EUR 500 bn will need to be invested in digital infrastructure by 2025. At the same time, the Connecting Europe facility earmarks only EUR 3 bn for this purpose for the years 2021–2027. The Commission itself calculates that annual investment requirements in Artificial Intelligence will amount to EUR 20 bn for the next decade. However, the budget proposal foresees only EUR 2.5 bn for AI projects for the years 2021 to 2027 – or EUR 350 m per year. This is equivalent to just 1.75% of the actual investment requirements.

More digital applications at the government level would stimulate demand

operator to install an optical fibre network. And there is nothing to stop them from offering funding for or participating in the operator's investment expenditure. This would improve the operator's planning security and willingness to invest in optical fibre technology instead of upgrading the copper network. From an economic vantage point, limited financial resources would be allocated more efficiently than if optical fibre networks were deployed "at random" in poorly served areas. The approach may make sense in areas where the government does not need to subsidise the digital infrastructure – i.e. the "black areas". Any financial participation by (commercial) end users would provide demand-side stimulus and contribute to a quicker extension of the optical fibre network.

Demand, in turn, might benefit if the government offered a larger number of digital applications (digital government, online education). This would, in any case, improve administrative efficiency. Moreover, if more people work from home, demand for optical fibre connections may increase. It might make sense to offer tax incentives for companies which allow their employees to work from home. In addition, there is an ecological benefit as commuting is reduced (which justifies tax incentives).

Conclusion and outlook

The EU and Germany have missed their ambitious goals for the upgrading of their digital infrastructure. And the way towards the gigabit society planned for 2025 is not free from economic and policy/regulatory hurdles either. For example, network upgrades in sparsely populated areas will often not be commercially viable for private operators. In these cases, state subsidies will be necessary. However, a lack of public funding will put a brake on nationwide broadband deployment. More public money will be needed, and state programmes should be better coordinated, particularly since the continued rise in data traffic will require additional digital infrastructure investments. In fact, further and higher infrastructure investments will be necessary in the future. It seems very likely that digital infrastructure and other core areas of the digital transformation which currently require significant public support (AI, start-up financing) will compete with each other for scarce public funds. Resolving this conflict will be a delicate political issue.

While it makes sense for incumbent network providers to upgrade their existing copper networks, doing so may turn out to be a hurdle for the deployment of gigabit-enabled optical fibre technology, as it will reduce potential demand for optical fibre connections. This will make it more difficult to generate enough revenues to finance the investment in such technologies. The government should therefore only support gigabit-enabled technologies.

Economies of scale and potential cost cutting should help to achieve a quick and efficient broadband deployment. One potential measure is to designing the assisted areas accordingly (i.e. make them bigger). Co-operations along the value chain may make sense as well, from coordinating earthworks to having several providers jointly use the same network. The parties involved should have a vested interest in such approaches. The regulatory authorities will need to make sure that such co-operations do not weigh on competition and to provide sufficient investment incentives for network operators at the same time.

Finding the optimal solution for this trade-off is anything but trivial. At the same time, subsidising demand for fast internet access may raise regulatory issues.

And finally, the lack of capacities in the construction sector is a major hurdle for further digital infrastructure upgrade. And this is a problem which even the best regulation of the telecommunications sector will not resolve in the short term.

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