Chapter 3

ACCESS AND CONNECTIVITY

KEY FINDINGS

- The COVID-19 pandemic has fuelled more demand for high-quality connectivity. In some cases, operators have experienced a 60% jump in Internet traffic.
- For the first time, the share of fibre in all fixed broadband subscriptions in OECD countries rose to 27% by June 2019, up from 12% eight years earlier. In nine OECD countries, high-speed fibre makes up at least half of fixed Internet connections. Overall, fixed broadband networks more and more take on the 'heavy lifting' of the increasing demands on wireless networks.
- Mobile broadband subscriptions increased in the OECD from 32 subscriptions per 100 inhabitants in 2009 to almost 113 subscriptions per 100 inhabitants by June 2019. The average mobile data usage per subscription in the OECD has quadrupled since 2014, reaching 4.6 GB in 2018. Machine-to-machine embedded mobile cellular subscriptions grew by over 21% in 2017-18. Prices for high-usage plans of mobile broadband services decreased by 59% over 2013-19. Several operators have announced the "shutting down" of legacy wireless networks (e.g. 2G/3G wireless networks).
- Many countries in the OECD moved towards high-capacity fixed networks (Gigabit networks), and the next generation of wireless networks, i.e. 5G. As of June 2020, 22 OECD countries offered 5G commercial services in selected locations. Gigabit networks and 5G are likely to become the underlying connectivity behind the Internet of Things (IoT) and artificial intelligence.
- Many OECD countries have published 5G national strategies. COVID-19 has further shown it will be essential to deploy more fibre deeper into networks and to gradually phase out xDSL technologies to allow for more symmetrical speeds.
- Convergence, and the pervasiveness of bundled communication services, has largely driven market consolidation in recent years. Many proposed mergers and acquisitions have been both horizontal and vertical, increasing the complexity of analysis. Key regulatory trends include data-driven regulation, promotion of the IoT, IPv6 and developments in the area of network neutrality. New regulatory trends are emerging focusing on the role of terminal devices and their effects on open Internet access.

Introduction

This chapter analyses recent trends in communication markets, broadband networks and the Internet of Things (IoT), which provide the foundation of connectivity within digital environments. It then discusses recent changes in communication policies and regulatory frameworks, the potential regulatory implications of the evolution of broadband networks, as well as developments in convergence with the associated effects on market structures.

Economies, governments and societies across the globe are going digital. Reliable connectivity is essential for the digital transformation and facilitates interactions between people, organisations and machines. Communication subscriptions providing such connectivity have continued to grow rapidly in recent years and bundled communication offers are becoming increasingly pervasive. The COVID-19 health emergency further fuelled demand for broadband communication services. Some operators have experienced as much as a 60% Internet traffic growth compared to before the crisis.

Fixed broadband networks increasingly take on the "heavy lifting" of the growing demands on wireless networks, as cellular Internet Protocol (IP) traffic is being offloaded into fixed networks through Wi-Fi. For the first time, the share of fibre in all fixed broadband subscriptions in OECD countries rose to 27% by June 2019, up from 12% eight years earlier. This allows for high-bandwidth online activities, such as video streaming services, multiple screens services and home-connected devices. In nine OECD countries, high-speed fibre makes up at least half of fixed Internet connections.

Mobile broadband subscriptions increased in OECD countries from 32 subscriptions per 100 inhabitants in 2009 to almost 113 subscriptions per 100 inhabitants by June 2019. The average mobile data usage per subscription in the OECD has quadrupled since 2014, reaching 4.6 GB in 2018. Machine-to-machine

(M2M) embedded mobile cellular subscriptions grew by over 21% in 2017-18. Prices for mobile broadband services have seen a strong decrease over 2013-19, namely in high-usage plans (i.e. 900 calls and 2 GB of data basket), with a price reduction of 59%.

As more people and things go on line, many OECD countries have witnessed an increasing trend towards high-capacity fixed networks (Gigabit networks), and the next generation of wireless networks, i.e. 5G. As of June 2020, 5G commercial services were available in selected locations of 22 OECD countries.

Gigabit networks and 5G are likely to become the underlying connectivity behind the IoT and artificial intelligence (AI). In particular, the use of connected devices in critical contexts, including in health, energy or in transport sectors, may require time-sensitive upload or download of data. This underscores the need for ultra-reliable, low-latency networks (OECD, 2018[1]). Networks will also need to become more flexible, and in this sense, 5G may allow the same network to cater to objects with diverse quality features (OECD, 2019[2]).

Regulatory measures and policies that promote access to high-speed broadband networks at affordable prices are crucial given the role of these networks for a successful and inclusive digital transformation (OECD, 2019[3]). Key issues include trends in convergence, the evolution of fixed and mobile networks, and the increased need for different stakeholders in government and industry (i.e. connectivity providers and industrial players) to work closely together. These, among other issues, are raising new challenges for policy makers in the area of communication infrastructures and services.

OECD countries committed to enhancing access to high-quality and affordable communication infrastructure and services at the Cancún Ministerial Meeting in 2016 (OECD, 2016[4]). Over the subsequent three years (i.e. 2017-20), countries worked on policies and regulation to extend access and promote deployment of the next generations of fixed and wireless networks. Those include policies to reduce broadband deployment costs, streamline rights of way, ensure efficient spectrum management and promote connectivity to backhaul and backbone facilities. Many OECD countries have also published 5G national strategies. The COVID-19 health emergency has further shown it will be essential to deploy more fibre deeper into networks and to gradually phase out xDSL technologies to allow for more symmetrical speeds.

The analysis of market structures and their effects on delivering efficient and inclusive communication services has been an additional key policy and regulatory issue. Convergence, and the pervasiveness of bundled communication services, has been a driver for market consolidation in recent years.

Many proposed mergers and acquisitions have been both horizontal and vertical, increasing the complexity of analysis. Overall, scrutiny over these mergers in OECD countries has increased. Many countries have recurred to behavioural and structural measures when approving them to safeguard competition.

Data-driven regulation is an emerging trend in the OECD to complement traditional regulatory tools. It relies on the power of disclosing information to steer communication markets in the right direction.

Further regulatory trends include the promotion of the IoT, IPv6 and developments in the area of network neutrality. Several OECD countries have adopted policies and regulatory measures aiming to harness the IoT. These include extraterritorial use of numbers and solutions to facilitate provider switching to avoid lock-in. Discussions are ongoing regarding the use of embedded SIMs.

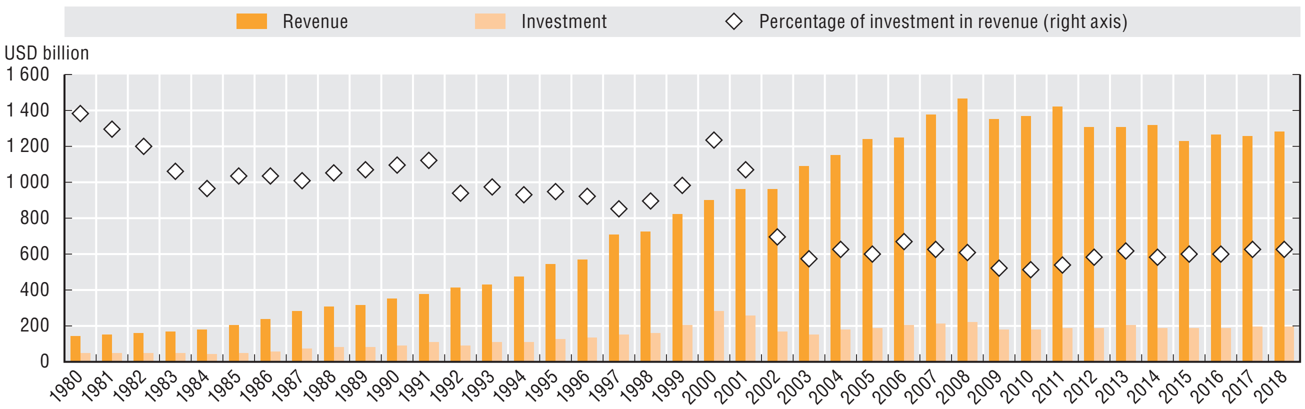
In the area of network neutrality, in particular within the debate of zero rating, governments in the OECD area are taking a number of different approaches. Some are implementing network neutrality rules and reviewing them. Furthermore, new regulatory trends are emerging on the role of terminal devices and their effects on open Internet access.

Trends in access and connectivity

Communication revenues in the OECD area reached their peak in 2008, amounting to USD 1 472 billion. Since then, with several fluctuations inherent to the economic cycle, revenues have remained relatively high. In the past decade, revenues have averaged USD 1 330 billion, stabilising at USD 1 287 billion in 2018 (Figure 3.1). Turkey, Ireland, Canada and Mexico had the highest growth rates in revenues in the last two years – an increase of more than 8% for the period. For Canada, this revenue growth was partly because more people bought offers with higher broadband speeds (CRTC, 2019[5]).

Investments in OECD countries have been relatively stable in the past ten years, reaching a level of USD 202 billion in 2018 (Figure 3.1). The share of investment relative to revenues has been stable at around 15% for the last 15 years. The latter compares to higher shares of 28% and 30% in the early 1990s and 1980s, respectively. These higher shares were mostly driven by the lower revenues in the telecommunication industry at that time. Revenues started to increase sharply in 2000, which coincides with the rapid increase in mobile telephony subscriptions in OECD countries.

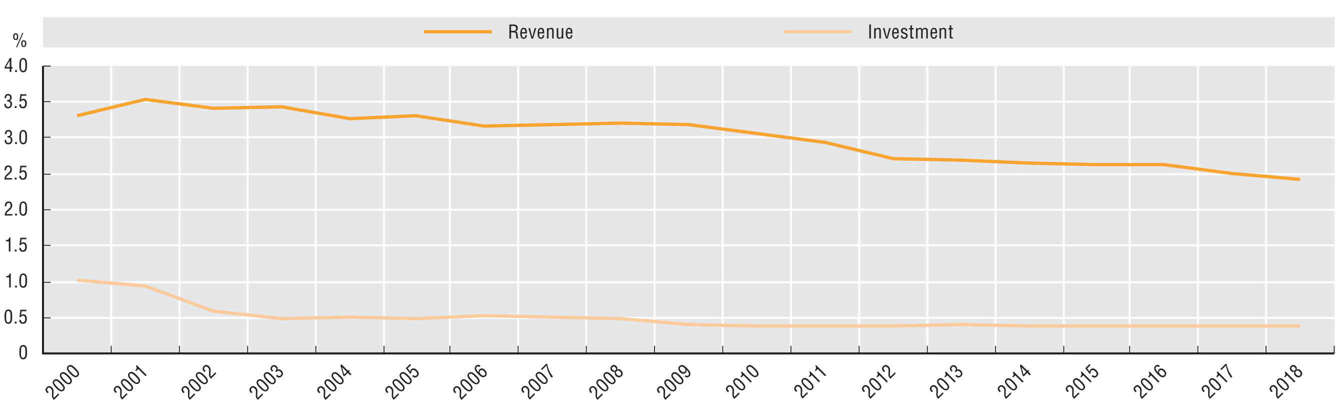
Figure 3.1. Telecommunication sector revenue and investment in the OECD area, 1980-2018



Source: OECD (2020[6]), *OECD Telecommunication and Internet Statistics* (database), *http://dx.doi.org/10.1787/tel_int-data-en* (accessed on 10 May 2020).
StatLink https://doi.org/10.1787/888934191198

Over the ten years between 2008 and 2018, telecommunication sector revenue in the OECD area averaged around 2.8% of gross domestic product (GDP). From 2016 to 2018, the overall growth of sector revenue, expressed as a share of GDP, was slightly negative in the OECD area. A declining trend can be observed from 2008 onwards, with sector revenues dropping from 3.2% to 2.4% of GDP at the end of 2018. On the other hand, investment expressed as a share of GDP has remained relatively stable, declining slightly from 0.5% to 0.38% during the same period (Figure 3.2).

Figure 3.2. Telecommunication sector revenue and investment as a percentage of GDP in the OECD area, 2000-18



Source: OECD (2020[6]), *OECD Telecommunication and Internet Statistics* (database), *http://dx.doi.org/10.1787/tel_int-data-en* (accessed on 10 May 2020).
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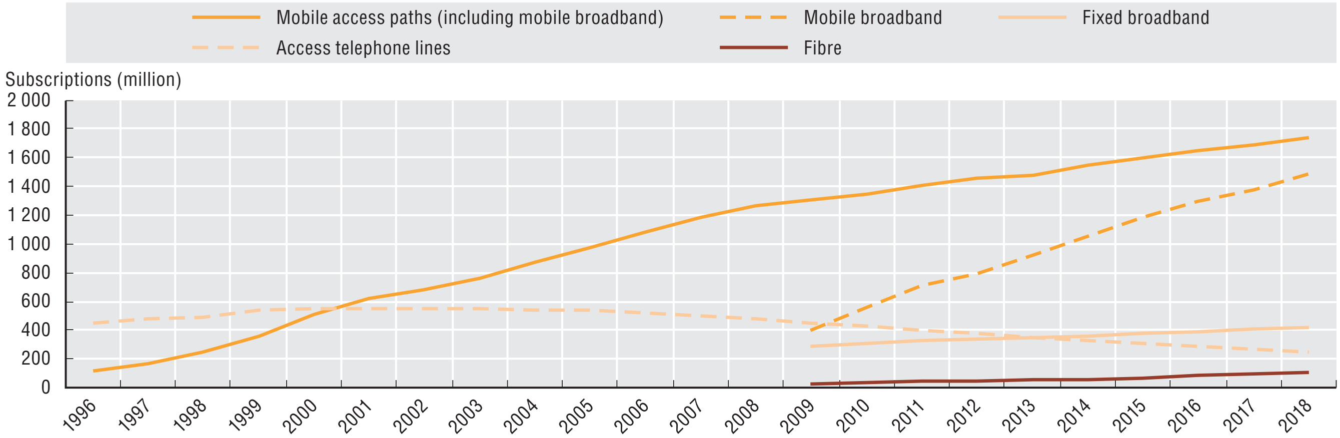
Communication operators' revenue and investment data may not always capture the full diversity of investments in the communication market given the emergence of new players. As highlighted in previous OECD work (OECD, 2019[7]), non-traditional communication providers have also made important investments. For instance, Google invested USD 30 billion in infrastructure, including submarine fibre cables and data centres (OECD, 2019[7]). These and similar data are not included. These new players are not considered traditional communication operators and do not typically report to communication regulators.

In recent years, the number of telecommunication subscriptions, measured by access paths,[1] continues to grow apace. Fixed voice telephony lines, which continue their longer-term decline, are the exception. These fixed lines are increasingly replaced by fixed broadband (Figure 3.3).

Fixed broadband bundles typically include a fixed broadband Internet connection, fixed phone services (over IP) and TV services. This partially explains the decline of pure fixed lines. Fixed broadband connections have developed as the main access path for fixed voice services. Fibre subscriptions continue to rise, and will soon equal the number of standard fixed telephone lines.

Figure 3.3. Trends in communications access paths in the OECD area, 1986-2018



Sources: OECD (2020[6]), *OECD Telecommunication and Internet Statistics* (database), *http://dx.doi.org/10.1787/tel_int-data-en* (accessed on 10 May 2020); OECD (2020[8]), *Broadband Portal* (database), *www.oecd.org/sti/broadband/oecdbroadbandportal.htm* (accessed on 14 March 2020).

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An increasing share of mobile cellular phone subscriptions are for mobile broadband, which went from 31% to almost 85% over 2009-18. Key drivers behind this trend are the widespread adoption of smartphones, higher mobile broadband speeds inherent to the evolution of wireless networks and more commercial offers with unlimited data packages. Improved mobile network connectivity has paved the way for new applications and digital tools. These, in turn, have increased demand for high-quality networks.

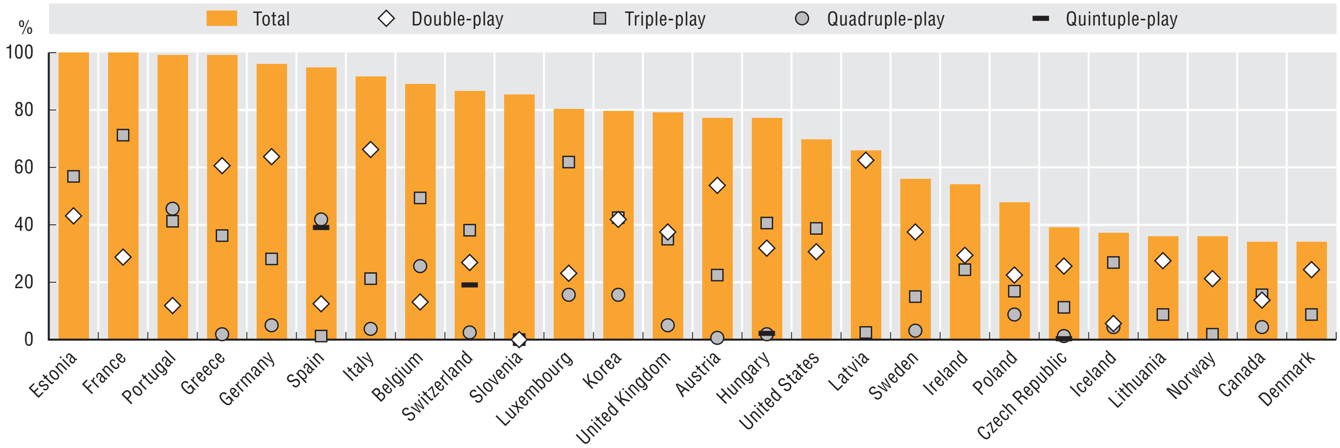
Mobile connections are growing at an even faster pace than fixed broadband connections. However, increased expansion of fixed networks with sufficient capacity to support all types of access technologies remains important. In particular, the core infrastructure of both fixed and mobile networks will continue to be complementary (OECD, 2019[2]). For example, globally, 54% of mobile data traffic was offloaded to Wi-Fi fixed networks in 2017 (Cisco, 2018[9]).

The complementarity of core fixed and mobile communication infrastructure reflects two trends. First, network densification inherent to 5G deployments requiring to install small cells closer to users to increase network speeds and capacity. These cells will need backhaul connectivity. Second, data traffic will continue to grow exponentially driven by the increase use of IoT and AI applications.

As convergence blurs the contours of previously distinct sectors (e.g. communication and broadcasting sectors), bundled communication services offers are becoming increasingly pervasive in the OECD area. In 2018, they represented the overwhelming majority of fixed broadband offers in many OECD countries. For instance, bundles accounted for more than 90% of fixed broadband subscriptions in Estonia, France, Portugal, Greece, Germany, Spain and Italy (Figure 3.4).

Figure 3.4. Bundled communication services subscriptions, 2018

Percentage of fixed broadband subscriptions that are bundled communication services



Source: OECD (2020[8]), *Broadband Portal* (database), *www.oecd.org/sti/broadband/oecdbroadbandportal.htm* (accessed on 14 March 2020).

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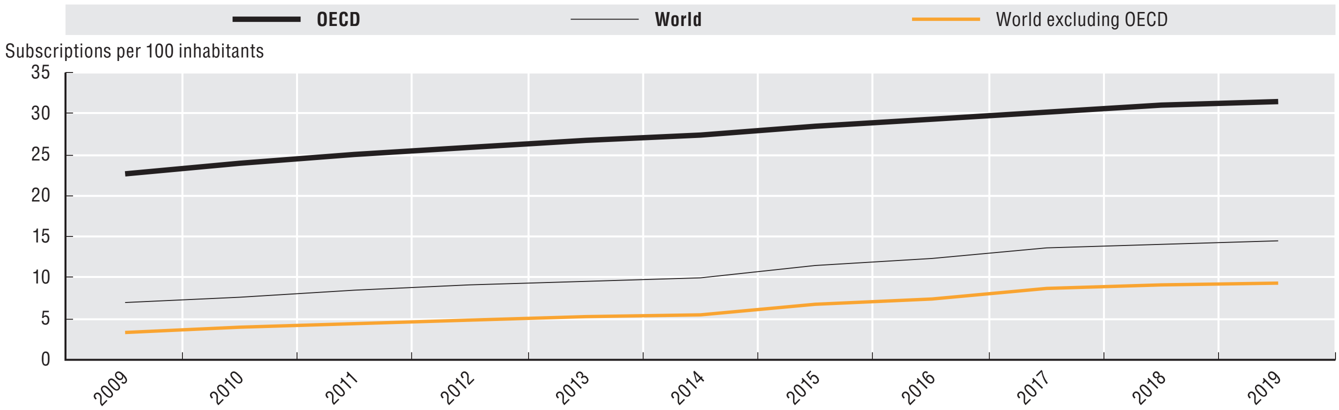
A steady increase of fixed broadband penetration with the gap narrowing among different OECD countries

Fixed broadband penetration has experienced a steady growth in the 2009-19 period (Figure 3.5). Over the past nine years, fixed broadband subscriptions have grown by one-third, representing an average compound annual growth rate of 3.7%. In June 2019, OECD countries had a higher level of fixed broadband penetration (31.6 subscribers per 100 inhabitants) than the world's average (14.5 per 100). However, both groups are following the same growth path.

Figure 3.5. Fixed broadband evolution, OECD area and world, 2009-19



Note: For 2019, data refer to Q2.

Sources: OECD (2020[8]), *Broadband Portal* (database), *www.oecd.org/sti/broadband/oecdbroadbandportal.htm* (accessed on 14 March 2020); ITU (2019[10]), *World Telecommunication/ICT Indicators* (database), *www.itu.int/pub/D-IND-WTID.OL* (accessed on 10 May 2020).

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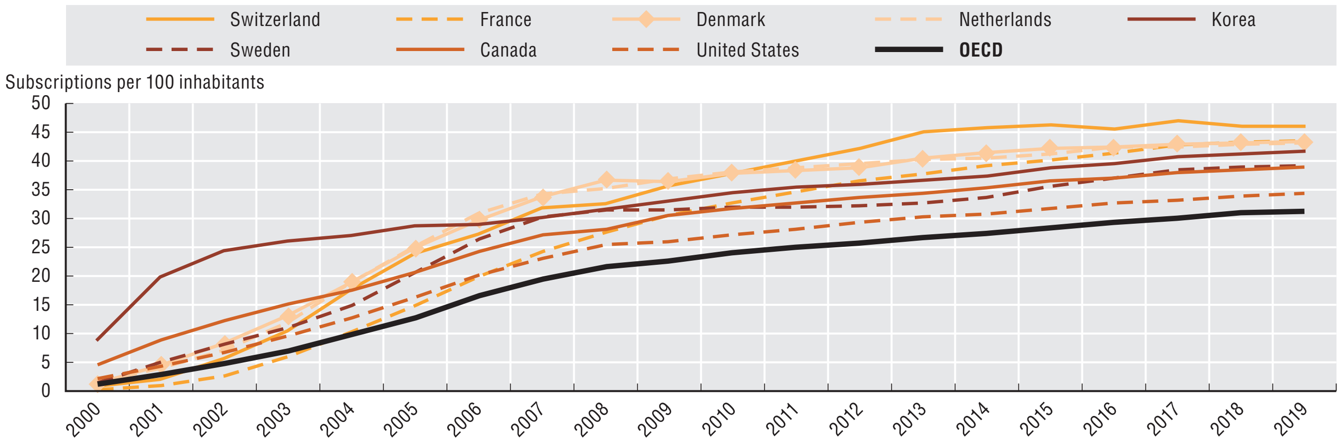
Some historic leaders in the OECD in terms of fixed broadband penetration are Canada, Denmark, France, the Netherlands, Sweden, Switzerland and the United States. In the early 2000s, Korea was far ahead of other OECD countries. It had a fixed broadband penetration of more than 20 subscriptions per 100 inhabitants in 2001. Korea achieved this rate when residential broadband was still at an early stage of development in other OECD countries. The gap among OECD countries has narrowed in the past two decades, however. Switzerland, Denmark, France and the Netherlands were leading in terms of fixed broadband penetration in June 2019 (Figure 3.6).

Figure 3.6. Fixed broadband penetration, historical leading OECD countries, 2000-19



Notes: For 2019, data refer to Q2. Data for Switzerland and United States are preliminary.

Source: OECD (2020[8]), *Broadband Portal* (database), *www.oecd.org/sti/broadband/oecdbroadbandportal.htm* (accessed on 14 March 2020).

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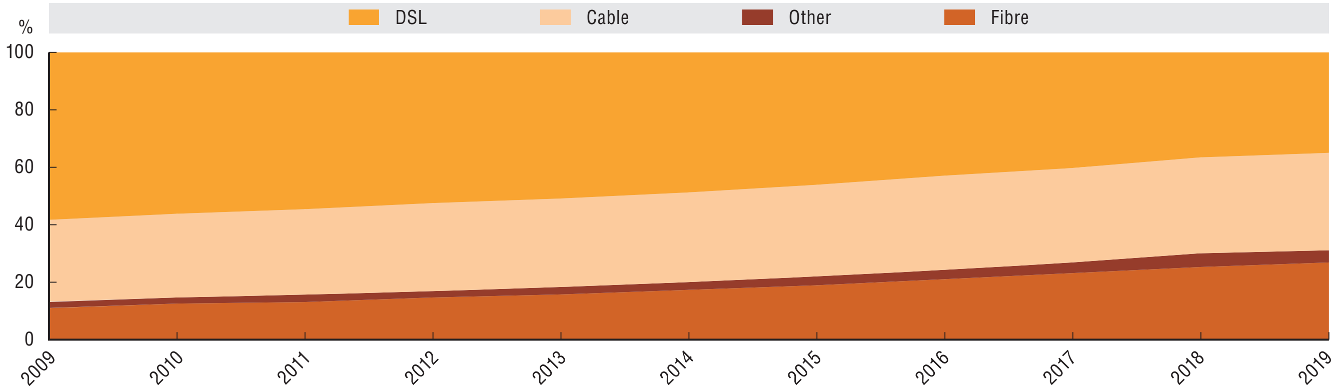
Fibre now makes up over one-quarter of fixed broadband connections in the OECD

The share of high-speed fibre in fixed broadband connections in OECD countries rose to 27% by June 2019, up from 12% eight years before. This upward trend drove the overall increase in broadband subscriptions. DSL subscriptions in total fixed broadband decreased notably (-23%) in the 2009-19 period. The decline was offset in large part by the growth in fibre (16%), as well as cable, although to a smaller extent (5%) (Figure 3.7).

Nevertheless, these numbers mask significant differences among OECD countries. For example, in Korea and Japan the percentage of fibre in total fixed broadband connections was 81.7% and 79% in 2019, respectively. Conversely, this share was below 5% in some countries, for example Germany, Austria, United Kingdom, Israel, Belgium and Greece (Figure 3.8).

The importance of deploying fibre deeper into networks goes beyond the requirements of fixed broadband. It is also key for mobile networks. For example, 5G networks rely on a strong fibre backhaul infrastructure to face the growth of data traffic driven by the digital transformation.

Figure 3.7. Evolution of fixed broadband technologies, 2009-19



Notes: DSL = digital subscriber line. Fibre subscriptions data include fibre-to-the-home, fibre-to-the-premises and fibre-to-the-basement, and exclude fibre-to-the-cabinet and fibre-to-the-node. For 2019, data refer to Q2.

Source: OECD (2020[8]), *Broadband Portal* (database), *www.oecd.org/sti/broadband/oecdbroadbandportal.htm* (accessed on 14 March 2020).

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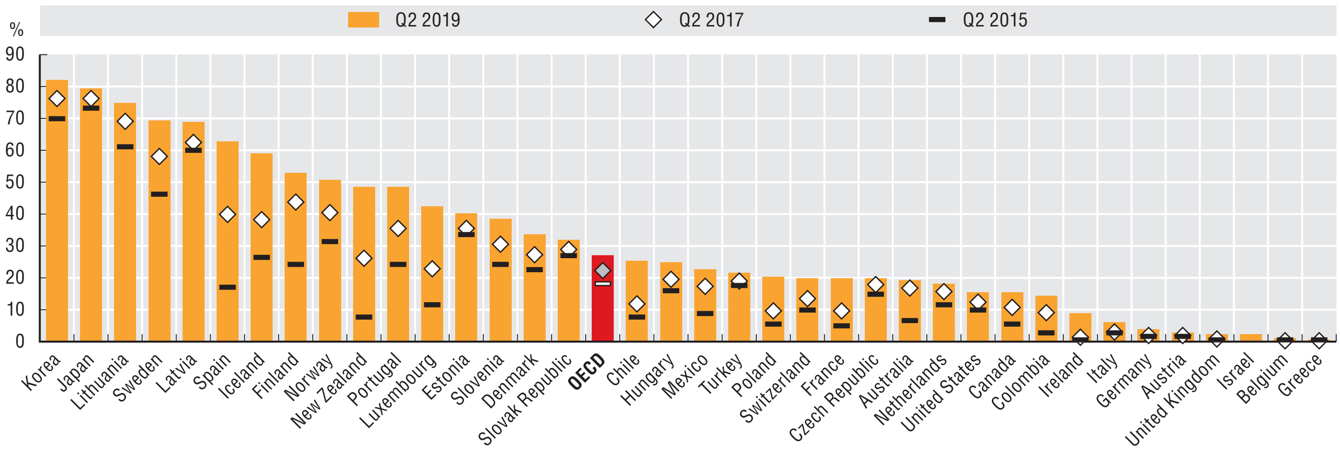
Figure 3.8. Fibre broadband connections, June 2019

As a percentage of total fixed broadband subscriptions



Notes: Fibre subscriptions data include fibre-to-the-home, fibre-to-the-premises and fibre-to-the-building and exclude fibre-to-the-cabinet and fibre-to-the-node. In Australia, a new entity using a different methodology is collecting data reported for December 2018 and onwards. Figures reported from December 2018 comprise a series break and are incomparable with previous data for any broadband measures Australia reports to the OECD. The OECD definition of fibre differs from fibre classifications commonly used in Australian reporting. These figures treat connections known in Australia as fibre-to-the-node and fibre-to-the-curb as DSL connections, while fibre-to-the-premises and fibre-to-the-basement are treated as fibre connections. Data on technology type prior to Q2-2016 should be treated as indicative until further notice. Data for Israel are OECD estimates. Data for Switzerland and United States are preliminary.

Source: OECD (2020[8]), *Broadband Portal* (database), *www.oecd.org/sti/broadband/oecdbroadbandportal.htm* (accessed on 14 March 2020).

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Higher speeds as fibre is deployed deeper into broadband networks

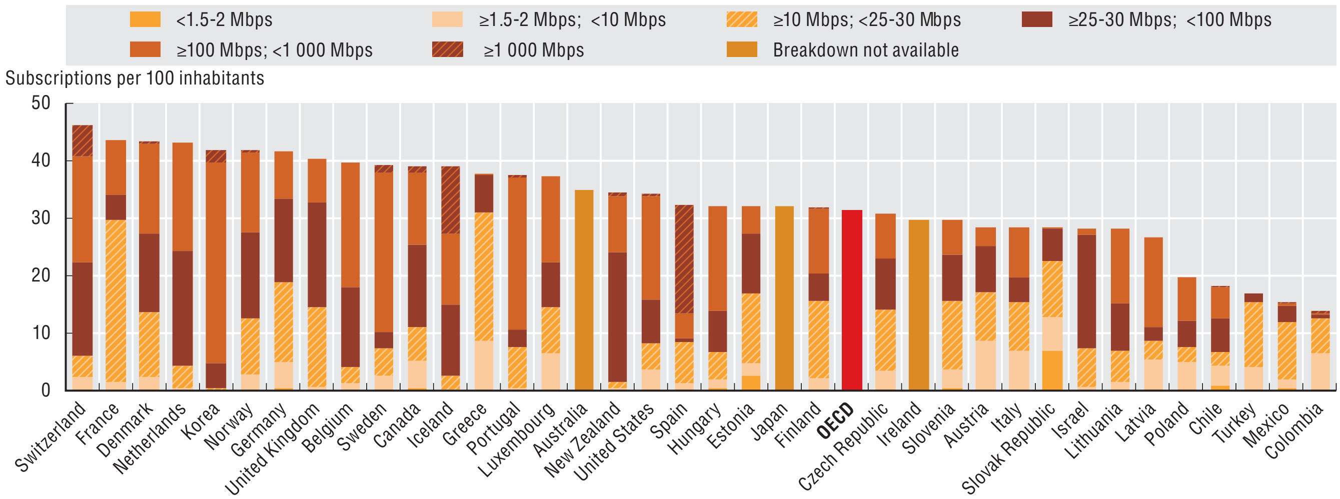
The growing share of fibre in fixed broadband[2] allows for much higher speeds for high-bandwidth online activities such as video streaming services, multiple screens services and home-connected devices. The average fixed broadband download speed has continued to grow in recent years. For example, according to data from the Ookla Speedtest Global Index, download speeds in the OECD area have increased from 24.1 Mbps to 40.9 Mbps between April 2014 and July 2019 (Ookla, 2019[11]).[3]

The share of broadband subscriptions, relative to broadband penetration, in higher speed tier categories (advertised data as provided by countries) is becoming increasingly common in OECD countries (Figure 3.9). A large number of countries had a significant share of their fixed broadband subscriptions with speeds above 100 Mbps in 2018. Nine countries had more than half of their subscriptions above 100 Mbps (e.g. Korea, Sweden, Spain, Portugal, Iceland, Latvia, Hungary, Belgium, United States and Switzerland). The OECD average was situated at 37% (Figure 3.10).

Advertised broadband speeds may differ from actual speeds experienced by users. Regulatory authorities across OECD countries have increasingly examined this issue. Internationally comparable data on "actual" broadband speeds are not easy to collect. Many countries have national speed statistics, but use different methodologies. As a result, the OECD often relies on external sources such as Ookla, M-Lab, Steam or Akamai for broadband speed measurement to obtain comparable national average or peak speeds. OECD (2019[7]) reviews different approaches of broadband speed measurement.

It is worth noting the features of the different tools used for measuring download speeds when drawing conclusions from these data. M-Lab and Ookla compile results from speed tests by users who actively measure their actual speed to access the Internet.[4] Steam data are a further way to consider download speeds across countries. They reflect the speeds of one of the most IP-intensive applications: online games. According to M-Lab data, the average fixed broadband download speed in OECD countries was 26.8 Mbps in July 2019. Using Ookla data as a reference, the average download speed was 78.3 Mbps, whereas the OECD average calculated using Steam data was 36.1 Mbps (Figure 3.11). Leading OECD countries in 2019 in terms of fixed broadband download speeds, using Steam data as a reference, include Korea (106.5 Mbps), Japan (69.6 Mbps) and Sweden (68 Mbps).

Figure 3.9. Fixed broadband subscriptions per 100 inhabitants, by speed tiers, June 2019



Notes: Mbps = Megabits per second. In Australia, a new entity is using a different methodology to collect data reported from December 2018 onwards. Figures reported from December 2018 comprise a series break and are incomparable with previous data for any broadband measures Australia reports to the OECD. Data for Israel are OECD estimates. Data for Switzerland and United States are preliminary.

Source: OECD (2020[8]), *Broadband Portal* (database), *www.oecd.org/sti/broadband/oecdbroadbandportal.htm* (accessed on 14 March 2020).

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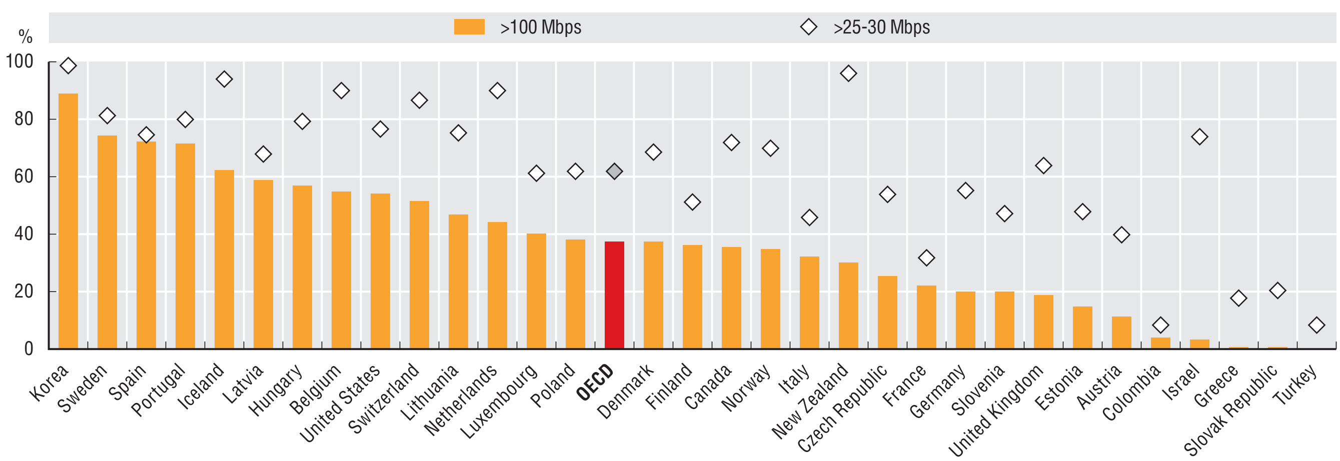
Figure 3.10. Fixed broadband subscriptions with contracted speed faster than 25/30 Mbps and 100 Mbps, 2018



Note: Mbps = Megabits per second.

Source: OECD (2020[8]), *Broadband Portal* (database), *www.oecd.org/sti/broadband/oecdbroadbandportal.htm* (accessed on 14 March 2020).

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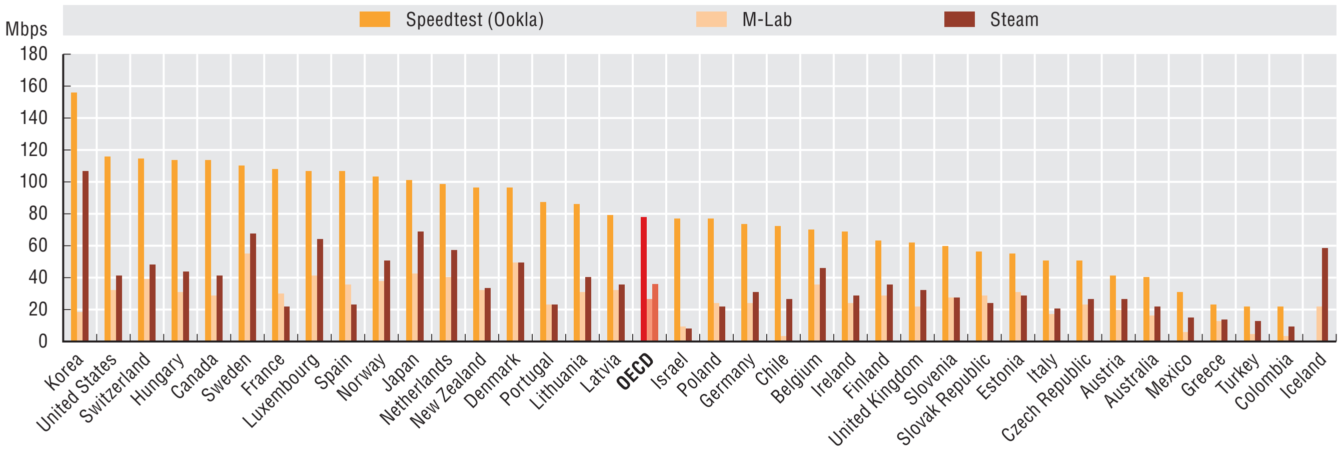
Mobile broadband continues to be a strong driver of growth in broadband subscriptions

Growth in mobile broadband subscriptions has been impressive for the last nine years across OECD countries and partner economies.

The total number of subscriptions in the OECD area grew by 278% or 16% per annum (Figure 3.12). The second quarter of 2019 had a slightly lower growth rate despite more than 100 subscriptions per 100 inhabitants. The sector seems to be still growing apace and will not reach maturity yet for many years.

Figure 3.11. Average experienced download speed of fixed broadband connections, July 2019



Notes: Mbps = Megabits per second. Speedtest (Ookla) data are for July 2019; M-Lab (Worldwide Broadband Speed League) speeds were measured from 9 May 2018 to 8 May 2019; and Steam data are for July 2019.

Sources: Ookla (2019[11]), "Speedtest Global Index", *www.speedtest.net/global-index*; M-Lab (2019[12]), "Worldwide Broadband Speed League", *www.cable.co.uk/broadband/speed/worldwide-speed-league*; Steam (2019[13]) "Steam Global Traffic Map", *https://store.steampowered.com/stats/content.*

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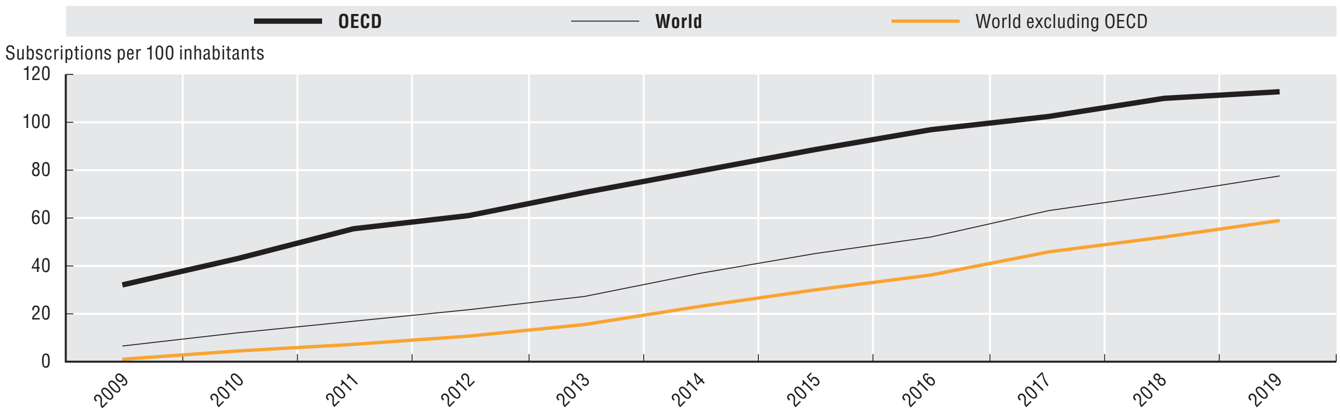
Figure 3.12. Mobile broadband evolution, OECD area and world, 2009-19



Notes: For 2019, data refer to Q2. World data for 2019 are estimates.

Sources: OECD (2020[8]), *Broadband Portal* (database), *www.oecd.org/sti/broadband/oecdbroadbandportal.htm* (accessed on 14 March 2020); ITU (2019[10]), *World Telecommunication/ICT Indicators* (database), *www.itu.int/pub/D-IND-WTID.OL* (accessed on 10 May 2020).

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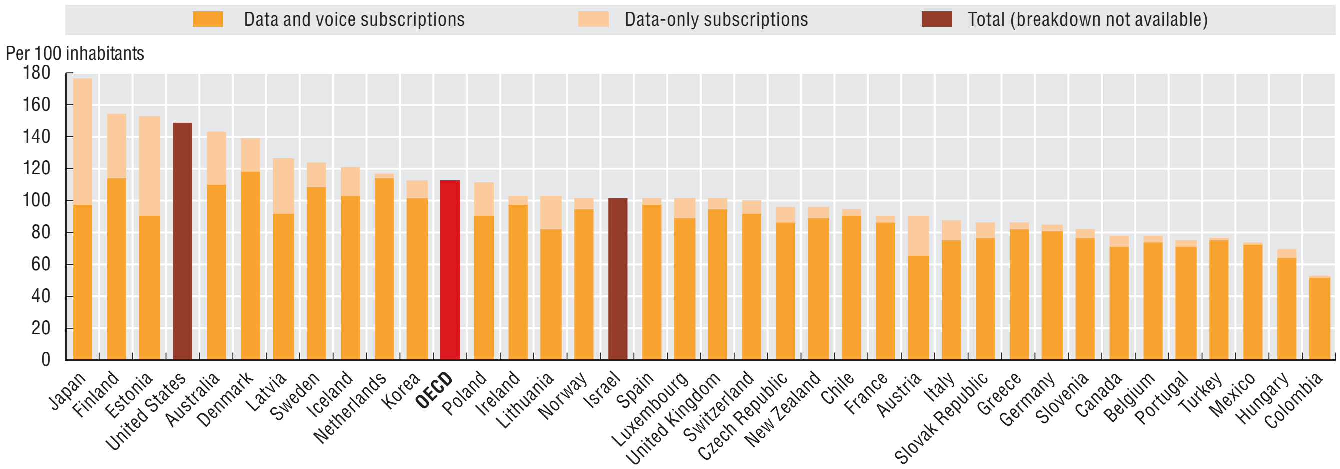
In OECD partner economies, the annual growth rate in mobile broadband penetration is higher. It will likely remain high for a long time; mobile broadband fills a connectivity gap due to relatively low levels of fixed broadband infrastructure. In the OECD, the leaders are Japan, Finland, Estonia, United States and Australia with a mobile broadband subscription rate of more than 140 per 100 inhabitants (Figure 3.13).

Mobile data usage has reached over 15 GB per subscription a month in the leading OECD country

The high growth in mobile broadband subscriptions is led by an ever-growing demand for mobile data used for services and apps, which are becoming essential for everyday life. In OECD countries, the growth in average mobile data traffic through cellular networks has been exponential, passing from 1.1 GB used per mobile broadband subscription per month in 2014 to 4.6 GB in 2018 (for available countries) (Figure 3.14). Leading countries in 2018 were Finland, Austria, Latvia and Lithuania.

Figure 3.13. Mobile broadband subscriptions per 100 inhabitants, June 2019

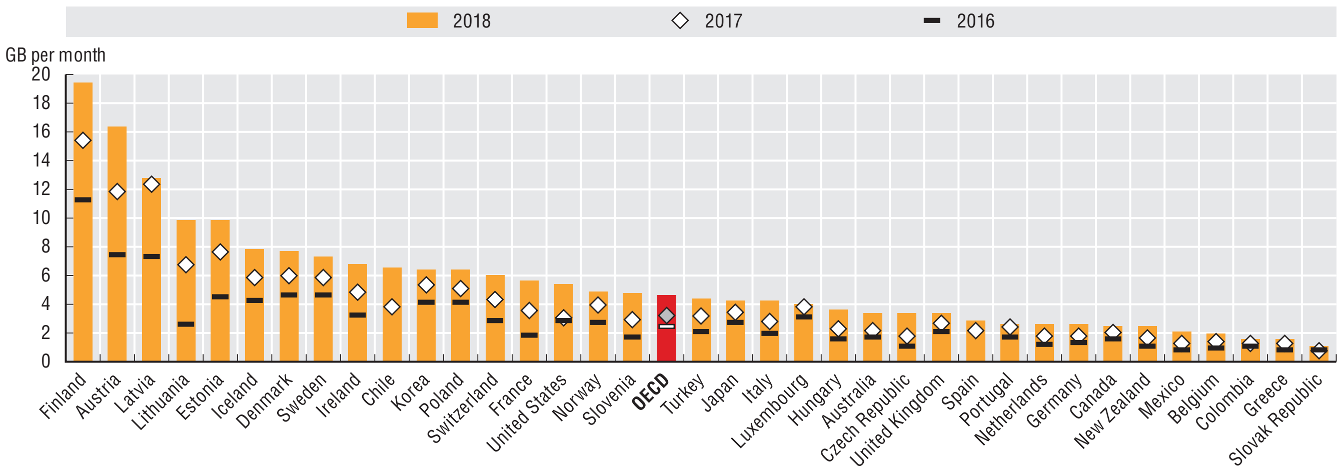


Notes: In Australia, a new entity using a different methodology is collecting data reported for December 2018 and onwards. Figures reported from December 2018 comprise a series break and are incomparable with previous data for any broadband measures Australia reports to the OECD. Data for Israel are OECD estimates. Data for Switzerland and United States are preliminary. StatLink contains more data.

Source: OECD (2020[8]), *Broadband Portal* (database), *www.oecd.org/sti/broadband/oecdbroadbandportal.htm* (accessed on 14 March 2020).

StatLink https://doi.org/10.1787/888934191426

Figure 3.14. Mobile data usage per mobile broadband subscription, 2018



Notes: GB = gigabyte. A new entity using a different methodology is collecting data reported for December 2018 and onwards. Figures reported from December 2018 comprise a series break and are incomparable with previous data for any broadband measures Australia reports to the OECD. Data for Canada and Switzerland are preliminary.

Source: OECD (2020[8]), *Broadband Portal* (database), *www.oecd.org/sti/broadband/oecdbroadbandportal.htm* (accessed on 14 March 2020).

StatLink https://doi.org/10.1787/888934191445

The growing demand for mobile data can be exemplified with the remarkable success of the Finnish company Elisa, the first company in the country to offer unlimited data plans back in 2007. All of Elisa's mobile plans come with unlimited data for the home markets (Elisa, 2017[14]). They are differentiated by speed with tiers ranging from 1 Mbps up to 300 Mbps. As a consequence of these offers, the data volume handled by Elisa has grown more than 700% over five years. Meanwhile, the number of mobile subscriptions has remained constant between 2013 and 2017 (roughly 4.7 million). Its share of non-voice revenues in mobile communications rose from 44% to nearly 66% of revenues during the five years between 2013 and 2017. This growth highlights the role of data service and the increase of data-voice substitution (OECD, 2019[7]).

With the deployment of 5G networks in the OECD area, mobile data traffic is increasing and the nature of the traffic is changing. For one operator in Korea (LGU+), services such as Augmented Reality and Virtual Reality (VR) accounted for 20% of mobile traffic by May 2019 (Waring, 2019[15]). Likewise, the Korean operator, SKT, reported that by the end of February 2020, new 5G subscribers used 7 times more VR services, 3.6 times more video streaming services and 2.7 times more gaming applications compared to 4G subscribers. The monthly data usage per user who switched devices from 4G to 5G in SKT's network increased from 14.5 GB (LTE) to 28.5 GB (5G) from December 2019 to February 2020 (Waring, 2020[16]).

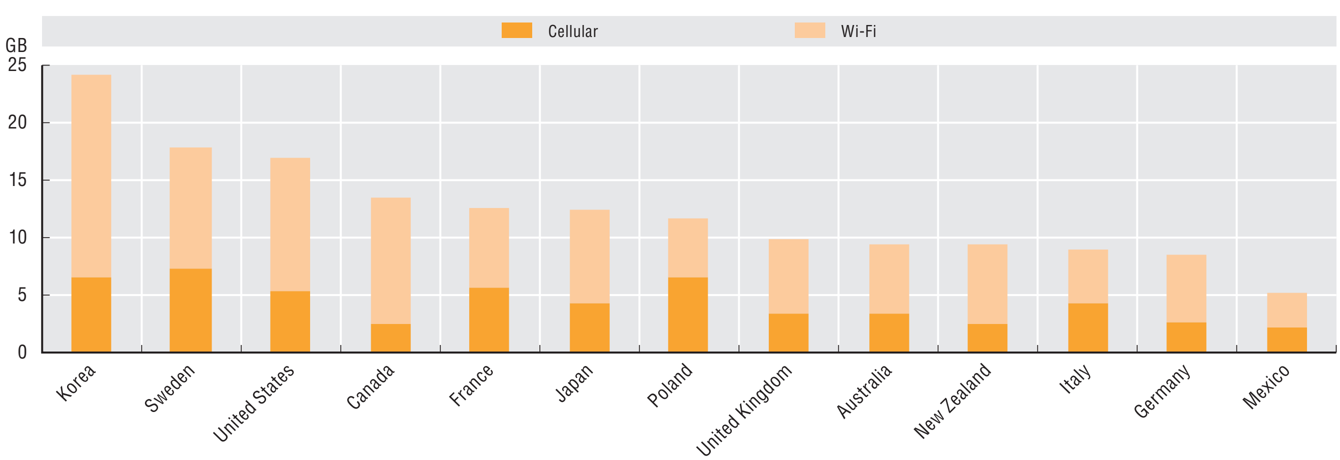
The increasing need to offload cellular IP traffic highlights complementarities of fixed and wireless networks

Fixed networks can effectively be used to take on the "heavy lifting" of the increasing demands on wireless networks, especially where radio spectrum is a scarce resource (OECD, 2019[2]). In particular, cellular IP traffic can be offloaded into fixed networks through Wi-Fi. The Cisco Mobile Visual Networking Index (VNI) provides information for 13 OECD countries[5] on the percentage of smartphone data traffic offloaded through fixed networks using Wi-Fi. In addition, the OECD Broadband Portal statistics provides information on the amount of mobile traffic generated per mobile broadband subscription through cellular networks (Figure 3.14).

One way to see the total amount of IP traffic used by smartphones is to combine both sets of data. In so doing, one can estimate the total amount of traffic in terms of gigabytes generated by mobile devices. This represents the sum of the traffic offloaded through Wi-Fi plus the traffic transmitted through cellular networks. Using this approach, at the end of 2017, Korea had the largest amount of total data usage per smartphone device, followed by Sweden (Figure 3.15). The same year, 73% of total mobile traffic in Korea was downloaded to Wi-Fi, whereas this amounted to 59% in Sweden (Cisco, 2018[9]).

Figure 3.15. Total data per mobile broadband user per month, 2018

Mobile traffic disaggregated by the Wi-Fi offloaded traffic and cellular network traffic



Notes: GB = gigabyte. Offloaded Wi-Fi traffic has been calculated using the CiscoVNI percentage of smartphone offloaded traffic. Mobile data traffic corresponds to 2018, while Cisco VNI data correspond to the end of 2017.

Source: OECD calculations based on OECD (2020[8]), *Broadband Portal* (database), *www.oecd.org/sti/broadband/oecdbroadbandportal.htm* (accessed on 14 March 2020) and Cisco (2018[9]), "Cisco VNI Global Fixed and Mobile Internet Forecasts", *www.cisco.com/c/en/us/solutions/service-provider/visual-networking-index-vni/index.html* (accessed on 14 February 2020).

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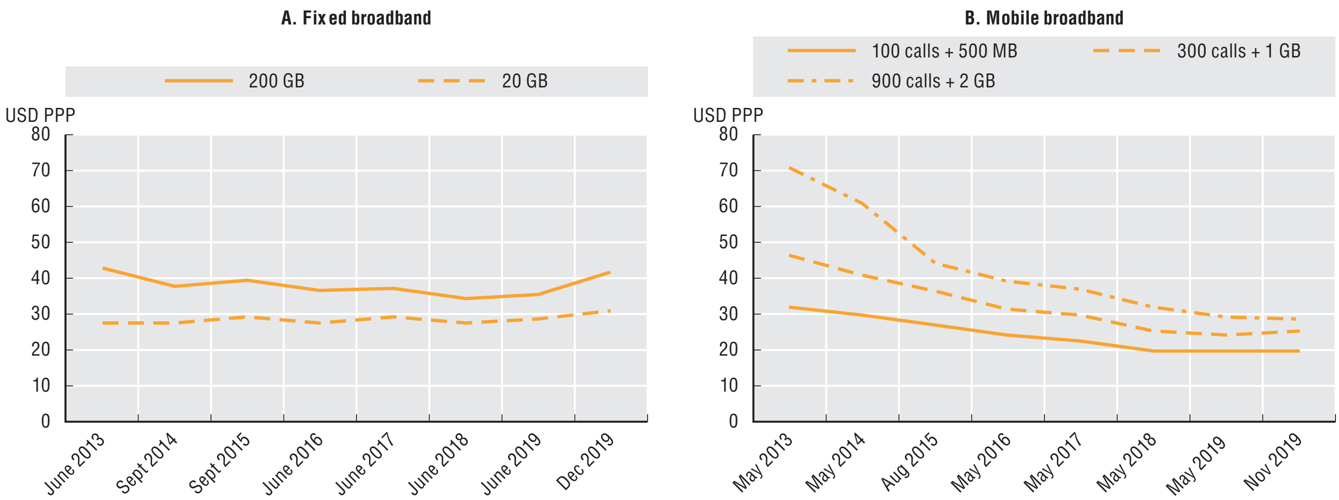
Affordability: OECD trends in fixed and mobile broadband prices

Access to communication services need to be affordable for the digital transformation to be inclusive. The OECD telecommunication baskets provide good insights on how average OECD prices for both fixed and mobile broadband plans have evolved for the last five years.

OECD countries have observed a sharp decline in mobile broadband prices, which reflects greater competition in this market. This is especially true of high-usage plans, including 900 calls and 2 GB of data, with a 59% reduction in prices from May 2013 to November 2019 (Figure 3.16B). The two other mobile broadband baskets also witnessed important prices drops: -46% for the medium usage basket (i.e. 300 calls and 1 GB of data) and -39% for the low-usage plans (i.e. 100 calls and 500 MB of data).

Concerning fixed broadband baskets, the price decreases have been less steep or null, compared to mobile broadband usage baskets (Figure 3.16A). The price of the high-usage fixed broadband basket (i.e. 200 GB) shows a slight decrease of 3% over the June 2013 to December 2019 period. Meanwhile, the low-usage basket shows a price increase of 13% in the same period.

Figure 3.16. OECD trends in fixed and mobile broadband prices, 2013-19



Note: GB = gigabyte; MB = megabyte; PPP = purchasing power parity.

Source: OECD calculations based on Teligen/Strategy Analytics (2020[17]), "Teligen tariff & benchmarking market data using the OECD methodology", *https://www.strategyanalytics.com/access-services/service-providers/tariffs---mobile-and-fixed/* (accessed on 14 March 2020).

StatLink https://doi.org/10.1787/888934191483

The development of the Internet of Things in OECD countries

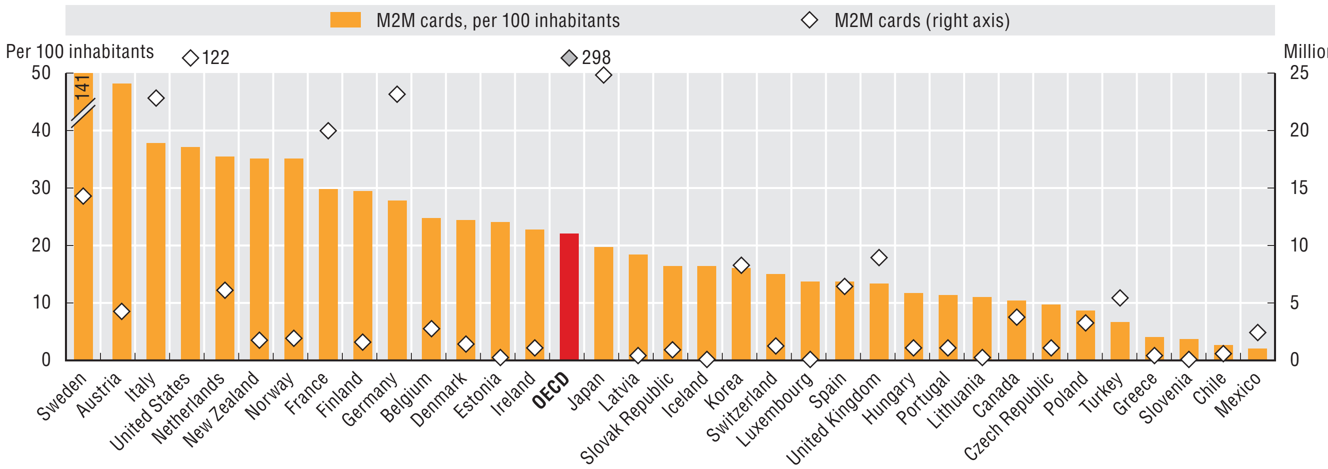
The OECD began measuring M2M, a subset of the IoT, in 2012. Since that date, M2M/mobile broadband subscriptions per 100 inhabitants in the OECD area grew from 4.3% to 22% in June 2019. The most recent data on M2M communications show Sweden as the leading country in terms of the number of M2M SIM cards in use per 100 inhabitants (with 140.6 M2M SIM cards per 100 inhabitants). Sweden is followed by Austria, Italy, United States, the Netherlands and New Zealand (Figure 3.17). Sweden provides such a high number of M2M SIM cards because most (61%) of these cards are used in other countries by one Swedish operator (PTS, 2020[18]). Overall, M2M/embedded mobile cellular subscriptions grew by over 30% in one year (the Q2 2018-Q2 2019 period) in countries where data were available.

To date, the OECD has gathered data on the number of M2M connections on cellular wireless networks. However, platform-agnostic IP IoT devices increasingly create new challenges for policy makers seeking to measure the number of such devices and their implications for communication networks. Following the Cancún Ministerial mandate on the Digital Economy (2016), recent OECD work has provided a comprehensive overview on how to tackle the measurement of the IoT (OECD, 2018[1]).

OECD countries have agreed on a working definition of IoT. They have also proposed a framework (taxonomy) for measurement, which includes subcategories of the IoT according to demand placed on networks. The OECD overarching IoT definition is below:

> *The Internet of Things includes all devices and objects whose state can be altered via the Internet, with or without the active involvement of individuals. While connected objects may require the involvement of devices considered part of the "traditional Internet", this definition excludes laptops, tablets and smartphones already accounted for in current OECD broadband metrics. (OECD, 2018[1])*

Figure 3.17. M2M/embedded mobile cellular subscriptions, June 2019



Notes: M2M = machine to machine. For Switzerland, data are preliminary. For United States, data are OECD estimates.

Source: OECD (2020[8]), *Broadband Portal* (database), *www.oecd.org/sti/broadband/oecdbroadbandportal.htm* (accessed on 14 March 2020).

StatLink https://doi.org/10.1787/888934191502

The OECD taxonomy for the IoT includes subcategories based on the diversity of network needs. Namely, it includes critical IoT applications (e.g. automated vehicles or applications for remote surgery), and massive and disperse M2M (e.g. sensors used for smart agriculture or smart cities, among others) (OECD, 2018[1]).

Some IoT applications, such as connected and fully automated vehicles, may have strong implications for network infrastructure. Therefore, their measurement may be a priority to track developments. While "connected cars" have been common for several years in OECD countries, the trend in the level of automation of vehicles may pose significant network infrastructure challenges in the near future (OECD, 2018[1]). For example, Intel estimated in 2016 that one fully automated vehicle would produce 4 000 GB of data per day (Krzanich, 2016[19]). Compared to the OECD average mobile data usage of 2018, this would be equivalent to the data usage of 26 000 mobile subscribers per day.

New developments in IoT applications may help fill gaps in connectivity. There is a gap between the new forms of cellular wireless connectivity for IoT devices and smart home devices relying on short-range technologies such as Bluetooth and Wi-Fi connections. In response, Amazon Sidewalk aims at providing a low-cost and low-bandwidth connectivity that extends the range of sensors around the home (Amazon, 27 September 2019[20]).

An inclusive digital transformation: The need for higher speeds and high-quality broadband in rural areas

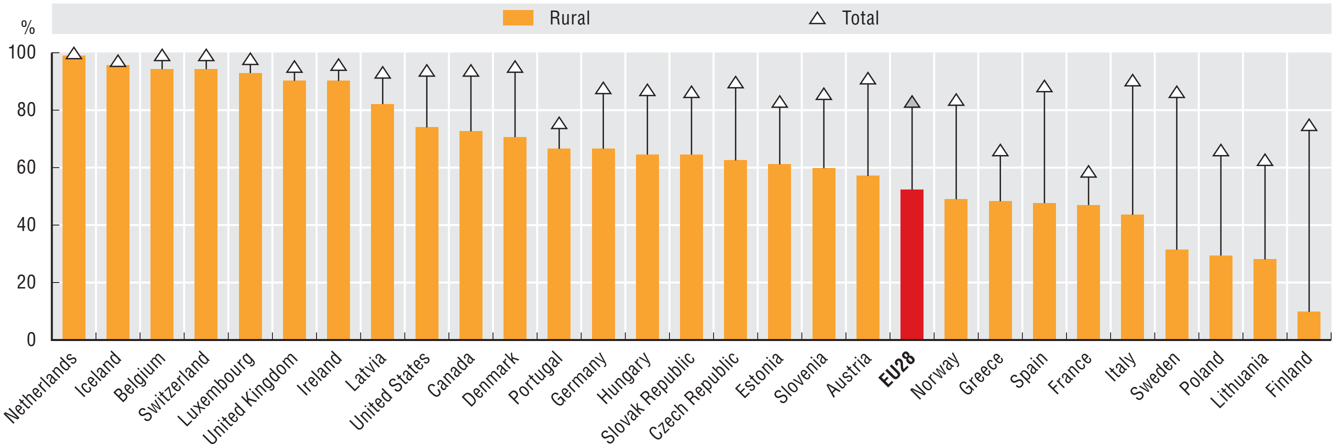
While overall speeds have been uniformly increasing, important disparities still exist between urban and rural areas in terms of the quality of connections.

There are persistent gaps between rural and urban households across the OECD in terms of the availability of fixed broadband services with a minimum speed of 30 Mbps. In 2018, only 52% of rural households in Europe had access to fixed broadband with this speed compared to 83% of households in other areas. For Canada, the difference is 72% of availability in rural areas, against 94% in total. In 2018, in the United States, 74% of rural areas have access to this minimum speed against 93.5% in total.[6] Meanwhile, just 9.3% of Finnish rural households had access to fixed broadband with a minimum speed of 30 Mbps (Figure 3.18). However, household surveys show that 90% of rural Finnish households had broadband access (OECD, 2019[3]). The difference can be explained by the importance of mobile technologies such as 4G for broadband coverage in rural Finland.

The availability of advanced mobile services, such as LTE, has been improving across the OECD. For the European Union, coverage of rural LTE reached 96% households by 2018. Rural LTE coverage for Canada and the United States amounted to 96.5% and 99%, respectively, in the same year (Figure 3.19).

Figure 3.18. Households with minimum 30 Mbps of fixed broadband coverage, 2018

As a percentage of all households in total and rural areas



Notes: For EU countries, rural areas are those with a population density less than 100 per square kilometre. For Canada, rural areas are those with a population density less than 400 per square kilometre. For the United States, rural areas are those with a population density less than 1 000 per square mile or 386 people per square kilometre. For EU countries, fixed broadband coverage of NGA technologies (VDSL, FTTP and DOCSIS 3.0) capable of delivering at least 30 Mbps download was used. For the United States, coverage of fixed terrestrial broadband capable of delivering 25 Mbps download and 3 Mbps upload services was used.

Sources: OECD calculations based on CRTC (2019[5]), *Communications Monitoring Report, 2019* (Canada); European Commission (2019[21]), *Study on Broadband Coverage in Europe 2018* (European Union) and FCC (2019[22]), *2019 Broadband Deployment Report* (United States).

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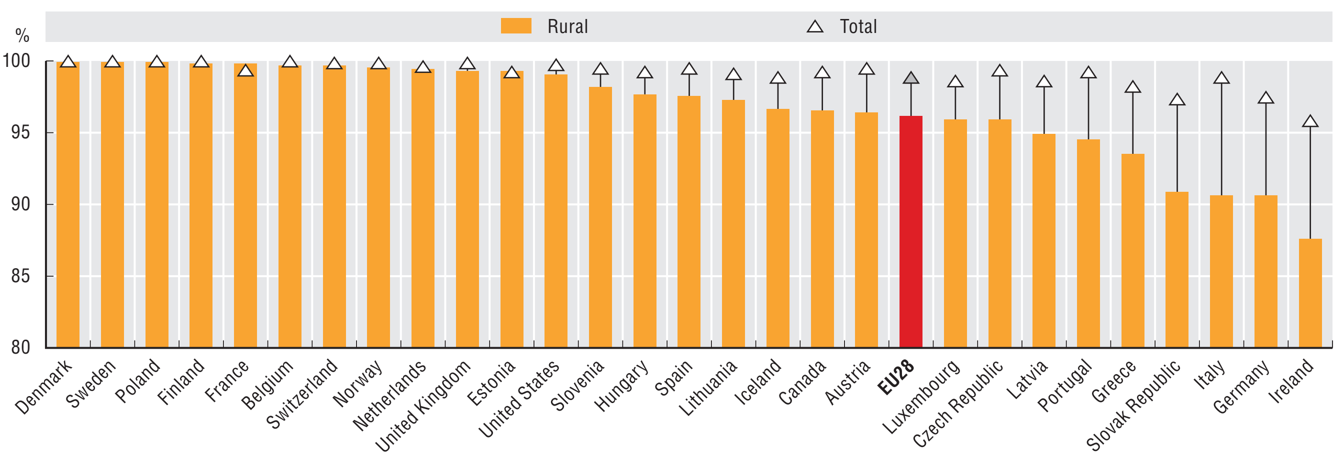
Figure 3.19. Households with LTE mobile coverage, 2018

As a percentage of all households in total and rural areas



Notes: For EU countries, rural areas are those with a population density less than 100 per square kilometre. For Canada, rural areas are those with a population density less than 400 per square kilometre. For the United States, rural areas are those with a population density less than 1 000 per square mile or 386 people per square kilometre.

Sources: OECD calculations based on CRTC (2019[5]), *Communications Monitoring Report*, 2019 (Canada), European Commission (2019[21]), *Study on Broadband Coverage in Europe 2018* (European Union) and FCC (2019[22]), *2019 Broadband Deployment Report* (United States).

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While the available data indicated important advances in connectivity in rural areas through mobile technologies, OECD countries look for additional metrics to complement their assessment. One metric could include measuring speed tiers for both fixed broadband and mobile broadband services. Regulators and policy makers still have valid concerns around the reliability of broadband connectivity over mobile networks, such as LTE, despite improved speed and connection quality.

The persistence of the rural-urban divide raises questions about inclusiveness and opportunities in the digital age. It highlights the importance of better metrics for quality broadband access and of continued investment and sharing of good practices for ensuring connectivity for all.

The next evolution of fixed and mobile networks

As more people and things go on line, continued investments in fixed and mobile broadband networks are required. These are needed to face the increasing demands in data stemming from the digital transformation. In particular, it is becoming increasingly critical to upgrade networks to “future proof” technologies, such as fibre, to support increases in speed and capacity across all next-generation technologies. In response, many OECD countries have witnessed an increasing trend towards high-capacity fixed networks (Gigabit networks) and the next generation of wireless networks, i.e. 5G. Policies and regulatory measures that seek to foster competition, promote investment and reduce obstacles to infrastructure deployment will be key for an inclusive and successful digital transformation. Potential synergies in deployment among providers will become increasingly important to drive deployment costs down.

The next generation of wireless networks, also known as 5G, refers to networks designed to support enhanced mobile broadband, massive machine type communications, as well as critical communications and applications (ultra-reliable and low-latency communications). The promise of 5G includes 200 times the current data transfer capacity with one-tenth of the latency of 4G networks. The combination of increased data transfer speeds and heightened processing power could enable many more simultaneous connections. Combined with lower latency, 5G networks have been heralded as necessary to support the deepening of digital transformation (OECD, 2019[2]).

The next generation of wireless networks, 5G, requires bringing smaller cells closer to connected devices through a process called “network densification”. Such cells will need to be connected to backhaul, underlining the need for more investment in next-generation network deployment (OECD, 2019[2]).

Infrastructure-sharing agreements among operators are likely to become common to mitigate the costs of 5G deployment. The nature of these agreements may change as they may possibly relate to deeper forms of network and spectrum sharing. Specifically, this would affect the active layer of networks compared to only passive infrastructure- sharing agreements. This may create new competition and regulatory challenges, forcing communication regulators to adapt to this development (OECD, 2019[2]). Some operators in OECD countries are leveraging on passive infrastructure, as well as active network sharing agreements to expand their coverage and speed up the deployment of 5G networks. Such countries include Belgium, Colombia, Italy, Spain and the United Kingdom.

In line with the trend towards upgrading networks, operators in several OECD markets have announced the “shutting down” of legacy wireless networks (e.g. 2G/3G wireless networks), and the transition to the next evolution of mobile networks. Several examples are highlighted below.

In June 2020, the Colombian Ministry of Information Technology and Communications (Ministerio de Tecnologías de la Información y las Comunicaciones, MinTIC) published a plan to transition to new mobile technologies in the country. This would include a tax reduction for 4G terminal devices. It would also provide incentives to connect rural areas where operators have coverage obligations that stemmed from the 700 MHz auction.

In Switzerland, Swisscom announced it would guarantee 2G networks until the end of 2020. After this date, it would use those allocated spectrum frequencies for 5G.

In June 2019, Vodafone announced it would start closing down 3G networks in the United Kingdom and in the Netherlands. The company is planning to use the spectrum frequencies for 4G and 5G. It also plans to migrate business users’ 3G equipment so it will be compatible with the next generation of networks. Vodafone plans to keep 2G operating as it is still important for many M2M devices, and the company has been focusing on its IoT business strategy in the past years.

In Europe, the European Commission issued a regulation in 2015 on new car models to be equipped with the “eCALL” emergency system. These often rely on 2G and 3G communication services. Shutting down legacy networks may thus raise issues for the emergency system (European Commission, 2015[23]).

With regards to fixed broadband, operators in several OECD countries have begun closing down copper networks and upgrading them to fibre:

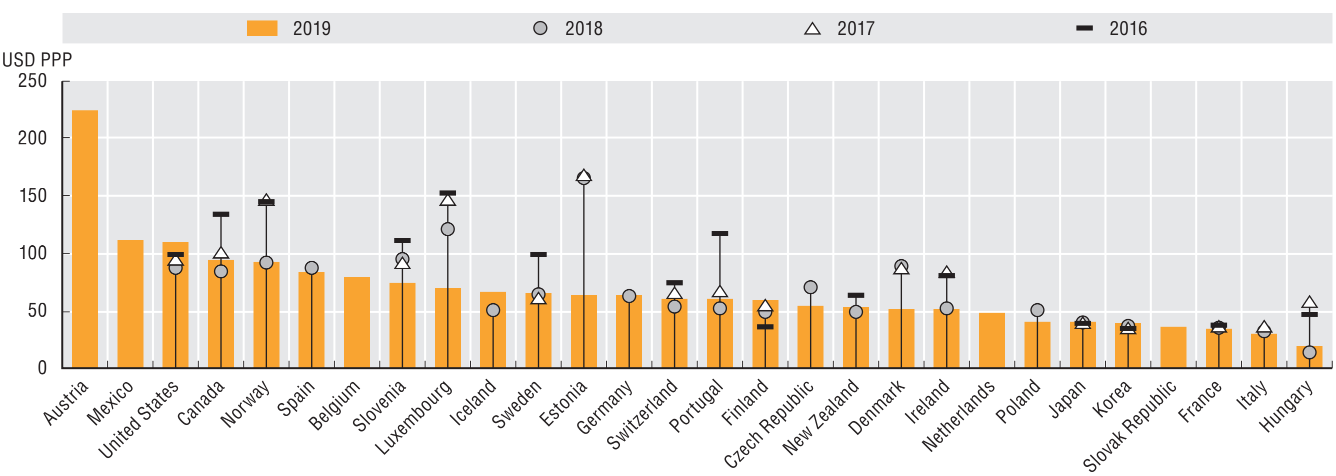
- In Japan, the operator NTT released a "PSTN Migration General Outlook" in 2010. It aims to shift its networks from PSTN to IP over 2020-25.
- In Portugal, the fixed incumbent operator told the regulator (ANACOM) it would initiate the phase-out of its copper network, as fibre deployment is increasingly reaching the geographical footprint of copper. The transition should take several years. Initially, it will focus on areas with fibre coverage and where no other operator accesses the incumbent's copper network.
- In Sweden, Telia is gradually transitioning its copper network and replacing it by fibre, fixed wireless services or wireless connectivity (Telia, 2020[24]).

The path towards Gigabit networks

While fibre is increasingly being deployed deeper into networks throughout the OECD, some countries and operators have started to extend coverage of Gigabit Internet commercial offers. A number of OECD countries offer fixed broadband subscriptions with advertised speeds above 1 Gbps (i.e. "Gigabit offers") to consumers and businesses (Figure 3.20). The least expensive countries in 2019 were Hungary (USD 20 PPP), Italy (USD 30 PPP) and France (USD 35.5 PPP).

Residential offers at 1 Gbps and low prices are most common where there is either strong infrastructure competition between operators or competition between retail providers using wholesale networks. In Singapore, for example, its structurally separated entity has given rise to commercial offers of two 1 Gbps fibre connections to a single household. Singapore has a national two-layer wholesale-only broadband network model (NetLink Trust). It provides dark fibre to ISPs like MyRepublic, which then provide the active electronics and manage services to their customers (OECD, 2019[7]). Such offers indicate that competition can drive markets to be more responsive to demands, which are constantly rising in this environment.

Figure 3.20. Baskets of fixed broadband offers for 1 Gbps, 2019



Note: PPP = purchasing power parity.

Source: OECD calculations based on Teligen/Strategy Analytics (2020[17]), "Teligen tariff & benchmarking market data using the OECD methodology", *https://www.strategyanalytics.com/access-services/service-providers/tariffs---mobile-and-fixed/* (accessed on 14 March 2020).

StatLink https://doi.org/10.1787/888934191559

The first 10 Gbps broadband commercial offers (advertised speed) for consumers have emerged in France, Korea, Japan, Sweden and Switzerland. Outside the OECD, Singapore was one of the first countries with 10 Gbps consumer offers (Table 3.1). By way of example, a 10 Gbps connection allows users to download the latest full 4K ultra HD movie (75 GB) in one minute, compared to almost two hours on a 100 Mbps connection (Wakefield, 2018[25]).

Table 3.1. 10 Gbps Internet cases in the OECD and Singapore

Country	Network	Offer	Date	Price per month	Technology	Link
France	Free	10 Gbps	December 2018	USD 67.6	..	*https://www.free.fr/freebox/freebox-delta*
Japan	NURO (So-Net)	10 Gbps	June 2015	USD 57.8	..	*https://www.nuro.jp/10g/*
	KDDI	10 Gbps	March 2018	USD 51.7	10G-EPON	*https://www.marketwatch.com/press-release/japan-nec-provides-10g-epon-system-supporting-kddis-au-hikari-home-10-giga-2018-03-26*
Korea	KT	10 Gbps	November 2018	USD 78	EPON	*https://www.telegeography.com/products/commsupdate/articles/2018/11/01/kt-launches-10gbps-capable-broadband-service/*
	SKB	10 Gbps	December 2018	USD 73	SK-GPON	*https://www.koreatimes.co.kr/www/tech/2018/05/133_248767.html*
Singapore	Singtel	10 Gbps	February 2016	USD 137.95	GPON	*https://www.singtel.com/about-Us/news-releases/singtel-to-ofer-fastest-residential-broadband-experience-in-singapore-*
Sweden	Bahnhof	10 Gbps	October 2018	USD 34.86	..	*https://www.bahnhof.se/press/press-releases/2018/10/17/varldspremiar-bahnhofs-10-gbit-s-router-for-hemanvandare-snabbast-pa-marknaden*
Switzerland	Salt (Iliad, Free)	10 Gbps	March 2018	USD 50.7	XGS-PON	*https://fiber.salt.ch/en/box-en/*
			Tests			
United Kingdom	Hyperoptic	Test	February 2018	x	x	*https://www.thinkbroadband.com/news/7948-hyperoptic-tests-10-gbps-connections-for-home*
France	SFR	Test	July 2018	x	x	*https://www.zdnet.fr/actualites/fibre-sfr-se-dirige-vers-le-10-gb-s-39871611.htm*

Notes: x = not applicable; .. = not available. Gbps = Gigabits per second. Exchange rate of 2017 to USD from OECD.stat, and currency exchange rate for USD/SGD=1.37. Original currencies are the following. France (Free): EUR 60; Japan (So-Net): JPY 6 480; Korea (KT and SKB): KRW 110 000; Singapore (Singtel): SGD 189; Sweden (Bahnhof) SEK 298; Switzerland (Salt): CHG 49.95. Prices for Korea and Japan (KDDI) are for a subscription with a three-year commitment period. Prices for NURO in Japan are for a two-year commitment.

Source: OECD, based on data from operators' websites.

OECD countries on the road to 5G at full speed

OECD countries are heading full speed towards 5G commercial deployments (Table 3.2). Recent developments such as the first 5G commercial offers in the OECD area testify to the rapid pace of 5G deployment. For example, by April 2020, 5G subscriptions in Korea had reached 6.34 million users. In December 2019, cellular base stations had increased 2.6 times since 5G commercial networks were launched on April 2019 in Korea (Ministry of Science and ICT, 2020[26]).

By June 2020, 5G commercial services were available in 22 OECD countries through 48 operators (Table 3.2). Of those countries offering 5G service plans, Korea and Switzerland planned to provide nationwide coverage (i.e. approximately reaching 90% of the population in 2019). Nevertheless, the coverage of 5G within the OECD area is constantly evolving as most operators are under network expansion.

Some 5G service providers are present in several OECD countries. For example, Vodafone, is present in 100 European cities across Germany, Ireland, Italy, the Netherlands, Spain and the United Kingdom (Vodafone, 2020[27]), emphasising 5G roaming capabilities (Bedford, 2019[28]). Vodafone has also deployed 5G networks in Australia and New Zealand. Some operators, such as Elisa in Finland and Vodafone in Spain, are offering price plans based on speed tiers instead of placing data usage caps. Nevertheless, it remains complex to compare 5G price plans across the OECD. Network rollout is in full expansion in most countries, and services available offer diverse coverage possibilities and roaming advantages.

In selected OECD countries, operators are offering 5G as an alternative to fixed broadband through fixed wireless access (FWA) solutions (e.g. Australia, Switzerland and the United States). For example, Optus in Australia offers FWA 5G to selected areas of the country. Meanwhile, in Switzerland, Sunrise offers to replace slow fixed broadband lines with Home FWA 5G. Similarly, in the United States, Verizon offers "5G Home" in a handful of cities (Optus, 2019[29]; Verizon, 2019[30]). Nevertheless, 5G deployments, in particular of this nature, will increasingly require high-capacity backhaul connectivity to be extended closer to the end user's premises.

Table 3.2. Status of 5G commercial deployment in OECD countries

Country	Operator	Technology	Launch date	Coverage	Details
Australia	Telstra	Mobile; FWA	22 May 2019	46 cities	
	Optus	Mobile; FWA	28 November 2019	14 cities	
	Vodafone	Mobile	5 March 2020	8 cities by mid-2020	
Austria	Drei (Three) Austria	Mobile; FWA	19 June 2019	4 cities (Linz, Wörgl, Pörtschach and Vienna)	
	Magenta Telekom (T- Mobile Austria)	Mobile	26 March 2019	28 cities	
	A1 Telekom	Mobile	27 January 2020	129 municipalities	Download and upload speeds from 100 Mbps/50 Mbps to 500 Mbps/70 Mbps.
Belgium	Proximus	Mobile	2 April 2020	79 municipalities	
Canada	Bell	Mobile	11 June 2020	5 cities (Calgary, Edmonton, Montreal, Toronto and Vancouver)	
	Rogers	Mobile	15 January 2020	4 cities (Montreal, Ottawa, Toronto and Vancouver)	Using 2.5 GHz and 600 MHz spectrum; Rogers plans to start deploying with 3.5 GHz spectrum and dynamic spectrum sharing.
	Telus	Mobile	18 June 2020	5 cities (Calgary, Edmonton, Montreal, Toronto and Vancouver)	
Czech Republic	O2	Mobile	19 June 2020	2 cities (Prague and Kolin)	
Finland	Elisa	Mobile	1 July 2019	30 cities	
	DNA	Mobile; FWA (5G-Home)	3 June 2020	21 cities	In December 2019, DNA launched “Home 5G” (FWA).
	Telia	Mobile; FWA	9-October 2019	8 cities	In March 2019, Telia and Nokia introduced Nokia FastMile 5G gateway for 4G-5G Fixed Wireless Access (FWA).
Germany	Vodafone	Mobile	16 July 2019	96 cities	
	Telekom Deutschland	Mobile	18 July 2019	8 cities, 20 cities by end of 2020	
Hungary	Maygar Telekom	Mobile	19 April 2020	2 cities (Budapest and Zalaegerszeg)	
	Vodafone	Mobile	17 October 2019	2 cities (Budapest and Zalaegerszeg)	
Ireland	Vodafone	Mobile	13 August 2019	5 cities (Dublin, Cork, Limerick, Waterford and Galway)	
	Eir	Mobile	24 October 2019	19 cities and towns	
Italy	Vodafone	Mobile	6 June 2019	5 cities: Milan, Turin, Bologna, Rome and Naples (expects 45-50 cities to be covered by the end of 2020)	
	Telecom Italia (TIM)	Mobile	25 June 2019	8 cities (expects to cover 120 cities by 2021)	
Japan	NTT Docomo	Mobile	25 March 2020	35 cities and towns (expects 200 cities to have 5G service by March 2021)	Peak speeds of 3.4 Gbps to 4.1 Gbps in June 2020
	KDDI	Mobile	26 March 2020	15 prefectures (19 cities and townsas of in August 2020 , with 10 000 additional stations throughout all Japan’s major cities)	First unlimited 5G data plan in Japan.
	Softbank	Mobile	27 March 2020	12 cities and towns	New services, (5G LAB and VR SQUARE) deliver immersive viewing experience, and Augmented Reality experiences, respectively.
Korea	SKT	Mobile	3 April 2019	85 cities (93% of population in 2019)	Stand-alone (SA) 5G to be launched in 2021.
	KT	Mobile	3 April 2019	85 cities (93% of population in 2019)	
	LGU+	Mobile	3 April 2019	85 cities (93% of population in 2019)	
Latvia	Tele2	Mobile	22 January 2020	2 cities (Daugavpils and Jelgava)	Peak theoretical download speeds of over 1 Gbps.

Table 3.2. Status of 5G commercial deployment in OECD countries *(cont.)*

Country	Operator	Technology	Launch date	Coverage	Details
Netherlands	Vodafone Ziggo	Mobile	28 April 2020	50% of the Netherlands, or around 940 locations (expects to reach the entire country by July 2020)	
New Zealand	Vodafone	Mobile	10 December 2019	4 cities (Auckland, Wellington, Christchurch and Queenstown)	
Norway	Telenor	Mobile	13 March 2020	4 cities (Oslo, Bergen, Stavanger and Sandnes)	
	Telia	Mobile	12 May 2020	2 cities (Lillestrøm and parts of Groruddalen in Oslo; nationwide 5G network by the end of 2023)	
Poland	Plus	Mobile	12 May 2020	7 cities (plans to extend coverage to 3 million people by 2021)	
	T-Mobile	Mobile	9 June 2020	11 cities	
Spain[1]	Vodafone	Mobile	15 June 2019	22 cities	
Sweden	Tele2	Mobile	24 May 2020	3 cities (Stockholm, Gothenburg and Malmö)	Peak theoretical download speeds of over 1 Gbps.
	3-Sweden	Mobile	17 June 2020	5 cities (Malmö, Helsingborg, Lund, Västerås, Uppsala and Stockholm)	
	Telia	Mobile	25 May 2020	12 cities	
Switzerland	Sunrise	Mobile; (FWA)	1 April 2019	384 cities	Vodafone and Sunrise announced partnership on 23 January 2020 to leverage their combined 5G scale.
	Swisscom	Mobile	17 April 2019	90% population coverage in 2019	
United Kingdom	Vodafone	Mobile; (FWA)	3 July 2019	44 towns and cities	
	EE	Mobile; (FWA)	30 May 2019	80 towns and cities	
	Three	Mobile; (FWA)	14 February 2020 (1 August 2019)[2]	66 towns and cities	
	O2	Mobile	17 October 2019	60 towns and cities	
United States	Sprint	Mobile	1 May 2019	9 major cities (20 million people)	According to the company, 5G download speeds of 213 Mbps (i.e. five times faster than Sprint's average 4G speeds).
	Verizon Wireless	Mobile; (FWA)	3 Apr 2019	35 cities (plans to expand coverage to 60 cities by end of 2020)	Verizon is using millimetre wave (mmWave) spectrum for 5G. They plan to expand mmWave 5G services to a total of 60 cities during the course of 2020.
	T-Mobile	Mobile	6 December 2019	6 000 cities and towns	SA-5G launched in August 2020
	AT&T	Mobile	13 December 2019	335 cities (179 million people)	In June 2020, AT&T commenced dynamic spectrum sharing in parts of Texas.

1. At the time of writing only Vodafone was present in Spain. The other players (including Telefónica) planned to deploy after the 700 MHz spectrum auction to commence 5G deployments; however, the COVID-19 health emergency delayed the auction to June 2020.

2. Launch dates in parenthesis correspond to the date of launching the FWA service.

Notes: FWA = Fixed Wireless Access. Survey initially done on 11 October 2019 and updated on 30 June 2020.

Source: OECD, based on data from operators' websites, Ookla (2020[32]), "Ookla 5G Map: Tracking 5G rollouts around the world", *www.speedtest.net/ookla-5g-map* (accessed 30 June 2020) and GSMA (2020[33]), "5G Global Launches & Statistics", *www.gsma.com/futurenetworks/technology/understanding-5g/5g-innovation* (accessed on 30 June 2020).

Many operators in the OECD area are predominately relying on low and mid- range spectrum for initial 5G commercial network deployments (e.g. 700 MHz and 3.5 GHz frequency bands), some operators have started to deploy commercial networks making use of higher spectrum frequency bands (i.e. mmWave spectrum), which may necessitate the use of complementary solutions to resolve indoor network coverage.

While in its initial stages 5G is being deployed in OECD countries for enhanced mobile broadband applications, in a second stage is likely to be driven by applications across economic sectors, such as health, energy, mining, robotics, automotive, and so forth. Thus, 5G may represent a paradigm shift as the first standard conceived with the IoT world in mind, where different connected devices have diverse network requirements (OECD, 2019[2]). In particular, "network slicing" may be key for innovative IoT and AI business models. As one of the main features of 5G, network slicing offers the possibility of several customised virtual networks over one physical infrastructure. However, the transformational aspects of 5G are likely to commence after 2020, when "stand-alone" (SA) 5G networks start their deployment. It is believed that SA-5G networks will increasingly make use of network slicing, with productivity effects across all sectors in the economy.

Several OECD countries have concrete plans for SA-5G networks. In Korea, all three operators expected to launch SA-5G networks in 2021 with industrial applications. In the United States, T-Mobile expected to launch SA-5G networks by the end of 2020.

OECD partner economies also expect to launch SA-5G. For example, in Singapore, the Infocomm Media Development Authority (IMDA) announced in April 2020 that Singtel, together with StarHub and M1, will deploy a nationwide SA-5G network from January 2021 onwards. According to the Ministry for Communications and Information in Singapore a "secure and resilient 5G infrastructure" will be the backbone of its digital economy (IMDA, 2020[31]).

The COVID-19 crisis has placed unprecedented demand on communication networks

As mobility restrictions are enforced to contain the spread of COVID-19, increasingly the estimated 1.3 billion citizens of OECD countries are working and studying from home. Fora such as the G7 and G20 are co-ordinating critical international policy on line. Along the entire Internet value chain, the various players are experiencing as much as 60% more Internet traffic than before the outbreak. This includes fixed and mobile broadband operators, content and cloud providers, and Internet exchange points (IXPs), where Internet networks connect to exchange traffic. In this unprecedented situation, the resilience and capability of broadband networks has become even more critical.

Fixed and mobile operators are witnessing a surge in Internet traffic:

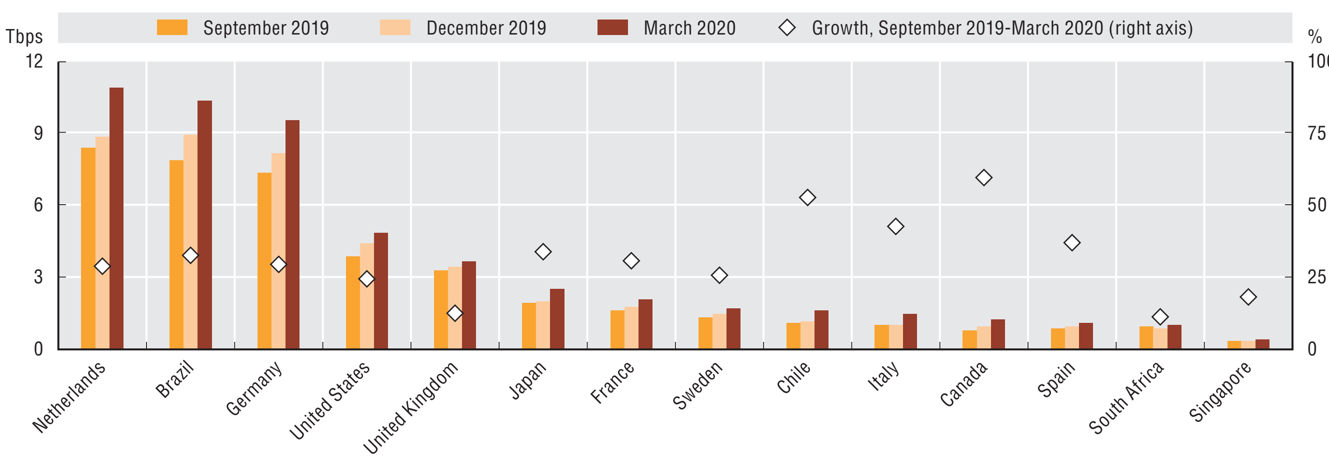
- In Canada, between 16 March and 27 April 2020, operators reported an increase of Internet traffic through fixed broadband connections of 48.7% and 69.2% for download and upload traffic, respectively (CWTA, 2020[34]).
- In Colombia, during the first two weeks of confinement (i.e. the last two weeks of March 2020), total Internet traffic increased by 37%; levels increased by 20% to 42% depending on the operator (CRC, 2020[35]).
- In France, Orange reports that its international infrastructure has been in high demand. Some 80% of traffic generated by Orange users in France went to the United States, where a good part of entertainment and content are located (Orange, 2020[36]).
- In Italy, Telecom Italia traffic has increased by 70% to 90% in the fixed network and by 30% in the mobile network.
- In Japan, NTT Communications reports an increase in data usage of 30% to 40%.
- In Korea, operators have reported traffic increases of 13%, reaching 45% to 60% of their deployed capacity (Woo-hyuan, 2020[37]).
- Telefónica reports nearly 40% more bandwidth in Spain, with mobile traffic growth of 50% in voice and 25% in data (Telefónica, 2020[38]).
- In the United Kingdom, BT reports a 35% to 60% increase in daytime weekday fixed broadband usage (BT, 2020[39]).
- In the United States, Verizon reported a 47% increase in use of collaboration tools and a 52% increase of virtual private network traffic (Verizon, 2020[40]). AT&T has seen mobile voice and Wi-Fi call minutes up by 33% and 75%, respectively, while consumer voice minutes were up by 64% on fixed lines: a reversal of previous trends. AT&T also reported its core network traffic was up by 23% (AT&T, 2020[41]).

The content and application industries report similar surges. Cisco Webex, the most prevalent cloud-based videoconferencing application, is peaking at 24-fold higher volume (Davidson, 26 March 2020[42]). Facebook experienced increases of 100% on voice calls and 50% on text messaging over its WhatsApp, Facebook Messenger and Instagram platforms, while group calls in Italy increased ten-fold (The New York Times, 2020[43]). Google similarly reports increased usage of its videoconferencing products and different usage patterns on YouTube, but indicates that peak traffic levels remain well within their capacity (Hölzle, 26 March 2020[44]). Due to higher demand, several application providers such as Netflix, Akamai and YouTube agreed to reduce video streaming qualities at peak times in Europe. Some have shifted default settings from high-definition to standard-definition globally (Netflix, 21 March 2020[45]; Leighton, 24 March 2020[46]).

The underlying Internet infrastructure is also facing unprecedented demands within OECD Europe. One critical element of this infrastructure are the crossroads of bulk traffic exchanges where multiple networks connect to exchange traffic (IXPs). IXPs reported record net increases of up to 60% in total bandwidth handled per country from December to March 2020 (Figure 3.21). The Netherlands experienced a net increase of 5.5% between September and December 2019, which can be considered a baseline prior to COVID-19. Between December 2019 and March 2020, bandwidth increased by 22.3%, more than four times that of the prior quarter. Germany experienced an increase from 11.2% to 16.5%. Italy, one of the most severely affected countries in Europe, handled 39.9% more bandwidth between December 2019 and March 2020, up from only 1.8% growth in the prior quarter.

In other regions, statistics also show similar trends in traffic increases in the first quarter of 2020. In Japan, the baseline growth of 5.9% increased to 26.2%, while Chile's bandwidth increased dramatically from 10.4% to 38.3%. The United States, Singapore, South Africa and Brazil all report similar trends.

Figure 3.21. Bandwidth produced at Internet exchange points, 2020



Notes: Tbps = Terabits per second. Data show the median IXP peak traffic aggregated by country in September 2019, December 2019 and March 2020, based on public sources. For Canada, data may not capture all Internet traffic as Canadian ISPs do not rely exclusively on public IXPs to exchange traffic, and often leverage on private direct exchange (transit) with content providers. StatLink contains more data.

Source: OECD calculations based on data from Packet Clearing House (2020[47]), "Internet Exchange Point Growth by Country", *www.pch.net/ixp/summary_growth_by_country* (accessed on 3 April 2020).

StatLink https://doi.org/10.1787/888934191578

To cope with significant traffic increases, network operators and governments across the globe are working to ensure that connectivity and communication services operate in a reliable, stable and secure manner. Fixed and mobile broadband operators, as well as content providers, have managed their networks successfully. To that end, they have accommodated changes in use patterns, responded to overall increased demand and avoided congestion that impacts working and studying from home. Meanwhile, they have supported critical services such as telemedicine and emergency response.

Developments in communication policy and regulation

Various regulatory frameworks have been adapted in the past three years

Over the past three years, policy makers and regulators have been adapting regulatory frameworks to spur competition, innovation and investment in communication markets. Several OECD countries are reviewing their regulatory frameworks, public policies and telecommunication laws. For example, in 2017, the Government of Canada announced its intention to review and modernise Canada's communication legislative framework. In February 2019, the Canadian Radio-television and Telecommunications Commission issued a notice to review the regulatory framework regarding mobile services. For OECD countries within the European Union (EU) area, the publication of the new European Electronic Communications Code (EECC) in December 2018 completed the overhaul of the European Telecommunication framework.[7] EU member states will have to transpose the EECC into national legislation by 21 December 2020. Therefore, many changes of telecommunication frameworks at a national level are expected to occur in the next couple of years.

The changing nature of communication markets, such as the increase in convergence, has driven significant modifications in the mandates and responsibilities of communication regulators in OECD countries. In Colombia, for example, the new ICT Modernisation Law created a converged regulator by merging the audio-visual broadcasting regulatory entity with the communications regulator.[8] In Finland, the Law on Electronic Communications was reformed in 2018, and merged the communication and transport regulator into one entity, Traficom. Germany is transposing provisions of the EECC into the German Telecommunications Act. In this way, the Federal Ministry for Economic Affairs and Energy and the Federal Ministry of Transport and Digital Infrastructure aim to create a modern regulatory framework. It will pave the way for an accelerated rollout of high-capacity networks, as well as creating a level playing field for communication and over-the-top providers.

Adapting the regulatory framework for closing down legacy networks

Several OECD countries have begun the transition of legacy networks and services, such as copper fixed networks, and are adapting regulatory frameworks to the evolving nature of networks. For example, in Italy, the regulator adopted measures for the migration from legacy copper network of the incumbent to a Next Generation Access (NGA) network.[9] In OECD countries within in the EU area, the EECC (Article 81) establishes that operators with significant market power should notify in a timely manner their plan to migrate from legacy infrastructure (including copper networks). Furthermore, the regulator should ensure this transition occurs in a timely and transparent manner (European Commission, 2018[48]). In Mexico, asymmetric regulation has been imposed to the "preponderant" economic agent in the communication sector (i.e. a similar notion to the player with significant market power). The regulation requires this agent to transition its legacy network to fibre, and to provide non-discriminatory access to wholesale services to rival operators. In the United Kingdom, the communication regulator, Ofcom, has noted the need for regulatory approaches that encourage investment in fibre-to-the-premises (FTTP) deployment, or what it calls "full-fibre broadband" (Ofcom, 2020[49]).

Data-driven regulation gains in importance through applications that monitor the quality of communication networks

OECD countries increasingly make use of data-driven regulation to complement traditional regulatory tools. Austria, France, Germany and Korea, for example, rely on the power of disclosing information to steer communication markets in the right direction. In particular, the transparency generated by data on network quality provides incentives for operators to "self-regulate" and invest in network improvements. These types of measures may become increasingly important with the next evolution of fixed and wireless networks.

Arcep, the communication regulator in France, is seeking to provide users with precise and personalised information. This could come from users (crowdsourcing) or be collected by the regulator from operators (Arcep, 2019[50]). Arcep's priority is to make data on coverage and quality of communication networks available to users. In this way, competition extends beyond prices to also include network quality. Since "crowd-sourced" quality measures of broadband depend on the user's connection at home, France moved to use more complex techniques in December 2018. Such techniques, such as application programming interfaces, will be implemented in operators' set-top boxes to measure the quality of networks more accurately.

In a similar fashion, the Korean government, through the National Information Society Agency (NIA), monitors the quality of broadband providers through "in the field" measurements, and renders the results publicly available. According to the NIA, the service quality evaluation has significantly contributed to broadband development, as operators increased network quality each publication of the results. Furthermore, it has helped increase competition by providing users with objective quality information on communication services. In this way, they can choose providers accordingly.

Austria and Germany provide two other examples of broadband quality measurements by regulatory authorities. The Austrian communication regulator, RTR, offers a certified measurement of fixed broadband quality. This allows consumers to make conclusive statements about the quality of the service and may be used to file complaints. The German communication regulator, the Bundesnetzagentur (BNetza), has operated a broadband measurement tool since October 2015. It enables users to measure the download and upload speeds of their fixed and mobile broadband connections.

Extending access through policies reducing the cost of broadband deployment

Besides reviewing the overall regulatory frameworks and telecommunication laws, OECD countries are further focusing on how to extend and improve access through policies to reduce broadband deployment costs. These include work on infrastructure sharing and co-investment provisions, as well as dig-once policies.

With the increasing need for high-quality networks, new partnerships and infrastructure-sharing agreements among operators will likely become common to reduce deployment costs. Many OECD countries have witnessed network sharing, either passive infrastructure or active mobile infrastructure such as antenna-, site-, radio access network- or even spectrum sharing. In addition, most encourage infrastructure sharing, provided it does not undermine competition. Passive infrastructure sharing has been common in such OECD countries as Australia, Colombia, France, Korea and Switzerland. There are also increasing examples within the OECD of active infrastructure sharing. Communication operators in the Czech Republic, Germany, France, Spain, Sweden and Switzerland, for example, have radio access network (RAN) sharing agreements. Meanwhile, operators in several OECD countries, for example Colombia and France, have national roaming agreements.

More and more OECD countries have adopted policies to reduce broadband deployment costs through co-investment or joint deployment of broadband networks. For example, in OECD countries within the EU zone, the EECC envisages incentives to foster co-investment because it provides for regulatory relief to operators entering into such agreements.[10]

A number of OECD countries have focused on "dig-once" policies. On the one hand, these aim to leverage non-broadband infrastructure projects (e.g. utilities, street light providers and highway/road construction). On the other, they seek to reduce the costs of broadband network deployment. For example, in January 2020, Colombia updated its regulation for passive infrastructure sharing (i.e. towers, poles, and ducts). This resulted in faster procedures for new agreements and estimated fee reductions of up to 74% (CRC, 2020[51]). Countries in the European Union transposed the European Union Broadband Cost Reduction Directive (2014/61/EU) into national legislation by January 2016. This includes provisions that allow communication network operators to access other utility networks. In Germany, the fifth action to amend the German Telecommunications Act, was enforced by the end of 2019. It contains additional provisions regarding transparency of mobile network coverage. It also has measures relating to co-ordination of civil works regarding the deployment of high-speed telecommunication infrastructure in areas of public funding. In Switzerland, through commercial agreements in the past decade, Swisscom has signed several contracts of co-operation with municipal utilities to deploy fibre-to-the-home networks on communal territories.

Facilitating the deployment of 5G networks is a key priority for OECD countries

The required "network densification" for 5G deployment may magnify the traditional challenges of operators or tower companies in securing rights of way (i.e. permissions to install towers or masts). As such, it will have important technical, regulatory and policy implications for all levels of government (where municipalities will play a key role), industry and the public (OECD, 2019[2]). Policies seeking to streamline rights of way, increase backhaul and backbone connectivity, and promote efficient spectrum management should ease the deployment of 5G networks. Several OECD countries have regrouped these policies in national 5G strategies.

Several OECD countries have been working to streamline rights of way to facilitate network densification. In the United States, the Federal Communications Commission (FCC) adopted the "Accelerating Wireless and Wireline Broadband Deployment by Removing Barriers to Infrastructure Investment" order on September 2018 (FCC, 2018[52]). The decision clarifies how much municipalities may reasonably charge for small cell deployment given the practicalities of 5G deployment and its importance to the United States. In offering guidelines for determining this value, the FCC cited the rules of 20 states that limit charges to USD 500 for use of an existing pole, USD 1 000 for installation of a new pole and recurring fees of USD 270 (OECD, 2019[2]). The United Kingdom reformed its Electronic Communications Code in 2017 as part of the Digital Economy Act 2017. These reforms, which came into force in December 2017, were intended to reduce the cost and make it easier for operators to deploy communication infrastructure. In Colombia, the regulation for passive infrastructure sharing was to be revised in 2021 to include installations that may be required for 5G deployment (e.g. small sites, post lamps, indoor installations, etc.).

Taking fibre backhaul closer to the end user is important for increasing speeds across all technologies, not only 5G. This is true whether the speed is for a business location or residential dwelling, and includes final connections using co-axial cable or copper. A growth in fibre backhaul availability should help support projected capacity demands, particularly demands raised by 5G networks (OECD, 2019[2]).

Several OECD countries have adopted policies to enhance backhaul and backbone connectivity. For example, Korea requires network operators to share fibre cables, including backhaul, but to maintain incentives to invest. In its "Future Telecoms Infrastructure Review", the United Kingdom sets out such measures as allowing "unrestricted access" to Openreach ducts and poles (i.e. BT's physical infrastructure company) for both residential and business broadband use, including for essential mobile infrastructure (DCMS, 2018[53]). The Irish communication regulator (ComReg), has mandated access to dark fibre on the operator with significant market power (SMP) in certain circumstances. In Sweden, the operator with SMP – Telia – must provide access to a backhaul connection between an operator's co-located equipment and a point no more than 50 km away. This would allow a so-called backhaul connection for transport to the operator's own network (PTS, 2015[54]).[11]

Promoting efficient spectrum management

In mobile markets, OECD countries continue to focus on efficient spectrum management to boost deployment of the next generation of wireless networks. Spectrum is the primary essential input for wireless communications. Therefore, its timely availability is of critical importance for the next generation of wireless networks (OECD, 2019[2]). Spectrum assignments for wireless networks have been prominent in in the OECD since 2016 (e.g. Austria, Canada, Chile, Denmark, Finland, France, Germany, Ireland, Italy, Latvia, Spain, Sweden, Switzerland, the United Kingdom and the United States). Spectrum auctions conducted in OECD countries follow, in general, the principle of technological neutrality. That said, many recent auctions have intended to encourage 5G deployments.

When designing spectrum auctions, policy makers need to strike a balance between several policy objectives. These include expanding network coverage and investment, assigning spectrum to the operator that will make the most efficient use of it (expressed by its willingness to pay), and promoting competition.

Spectrum assignment procedures (i.e. auctions or comparative selection processes) in OECD countries in the past three years have taken into account coverage obligations and/or included means to promote market competition (e.g. giving priority to new entrants, spectrum caps – generic or spectrum-specific – or commitment to host mobile virtual network operators [MVNOs]). For example, in France, Arcep has imposed obligations in spectrum auctions such as hosting MVNOs (i.e. 800 MHz auction) or spectrum caps (i.e. 700 MHz allocation). In the June 2019 auction for spectrum licences of the 2.1 GHz and 3.6 GHz bands, Germany included coverage obligations of 98% of all households per federal state with 100 Mbps by the end of 2022. It also included coverage of all transport ways (motorways, main roads, waterways, railways) by the end of 2022 or 2024 (BNetza, 2018[55]). In 2011, during the 800 MHz auction, Spain imposed commitments on operators to jointly cover 90% of the villages with fewer than 5 000 inhabitants at 30 Mbps. In 2018, it finalised regulations to this effect (Government of Spain, 2018[56]).

National strategies fostering 5G deployments

Many OECD countries have published strategies to promote 5G deployment in the last three years. For example, Australia published a 5G strategy in October 2017. It recognised the potential benefits of 5G to the country's economy, identifying actions to support the timely rollout. In Austria, the Broadband Strategy 2030 embedded a vision for 5G. Published in August 2019, Austria's Path to the Gigabit Society aims to realise a nationwide coverage with gigabit connections (both fixed and mobile) by 2030.[12] In Colombia, MinTIC published the 5G Plan in December 2019. It identifies policy challenges linked to 5G deployment and sets a strategy to foster its adoption. The Colombian communication regulator (Comisión de Regulación de Comunicaciones, CRC) followed this plan with a regulatory framework analysis to identify potential barriers to 5G deployment. Additionally, in June 2020, MinTIC granted five licences for 5G trials to establish case studies for the industry and foster a 5G ecosystem.

The European Union has several 5G initiatives, such as the 5G Action Plan and the 5G Infrastructure Public Private Partnership for 5G (European Commission, 2019[57]). In France, the government published its 5G national strategy in December 2017 (Ministère de l'économie et des finances, 2018[58]). Meanwhile, Arcep released a report to share its understanding of the issues and challenges to foster deployment of 5G networks (Arcep, 2018[59]). Germany established a Government 5G Strategy 5G-Strategie für Deutschland in July 2017 (Federal Government of Germany, 2018[60]). On 18 November 2019, the German government released the Mobilfunkstrategie (Mobile Radio Strategy) to improve 4G-network connectivity, while helping accelerate 5G deployment. In Korea, to maximise impact of early 5G commercialisation (April 2019), the government established a comprehensive 5G strategy named 5G+ on 8 April 2019 (Box 3.1). It aims to promote a "5G ecosystem" where 5G is the underlying infrastructure connecting advanced devices and innovative services.

Box 3.1. Korea's 5G+ strategy: To realise innovative growth

For Korea, 5G is a core infrastructure of the 4th Industrial Revolution, characterised by the ability to connect all objects in a network and transmit large volumes of data at high speeds and in real time (i.e. ultra-low latency). In addition, 5G can trigger a ripple effect in large investments and across upstream and downstream industries. The Korean government sees it as a driving force of Korea's new economic growth.

The 5G+ Strategy in Korea aims to create a holistic and safe 5G environment by integrating advanced devices and innovative services that connect all things to the 5G infrastructure. In particular, it plans to focus efforts on ten core industries[1] and five core services based on 5G networks (i.e. digital health care, immersive contents, smart factories, autonomous vehicles and smart cities). To this end, the government aims to support growth of the 5G market through its use in the public sector and to accelerate private-sector investment. At the same time, it expects the strategy will address institutional barriers to innovative convergent services.

The Korean action plan aims to i) secure early market dominance and improve quality of life with lead investment by the public sector; ii) create a testbed and pursue industrial advancement to attract private investment; iii) support adoption of 5G services and user protection through institutional improvements; iv) develop companies and talent that match the global standard; and v) promote globalisation of Korea's 5G technology and services by supporting their overseas expansion.

1. The industries included are wearable devices, Augmented Reality and Virtual Reality devices, next-generation smart phones, network equipment, edge computing, information security, 5G Vehicle-to-Everything communication (V2X) for self-driving cars, connected robots, drones and intelligent CCTV.

Source: MSIT (2019[61]), "5G+ strategy to realize innovative growth", *https://www.msit.go.kr/cms/english/pl/policies2/__icsFiles/afieldfile/2020/01/20/5G%20plus%20Strategy%20to%20Realize%20Innovative%20Growth.pdf*.

In Spain, the 5G National Plan aims to become the foundation to maximise the benefits from 5G for the telecommunication sector and more broadly for economic and social development. The plan is grounded on three main pillars: spectrum management; 5G trials and fostering research in 5G; and taking advantage of Spain's extensive fibre optic network coverage.

The United Kingdom aspires for 5G to cover most of the population by 2027. The Future Telecoms Infrastructure Review analysed the telecommunication market to understand incentives for investment in future infrastructure and assess whether the market could deliver the government's aims (DCMS, 2018[53]). The report suggested incentives to encourage 5G investment such as streamlining rights of way and obliging the installation of fixed fibre in new buildings.

In the United States, the FCC released a comprehensive strategy to "Facilitate America's Superiority in 5G Technology" ("5G FAST Plan"), and has acted to foster 5G deployment. The plan seeks to make more spectrum available to the market and to update infrastructure policy so as to reduce deployment costs and modernise regulation (FCC, 2018[62]).

Broadband targets and universal service provisions are used to promote an inclusive digital transformation in the OECD

Almost all OECD countries have established broadband access targets, and somewhat less commonly, usage targets. National targets differ in elements such as end-dates, speed and proportion of population or premises to be covered.

Within the OECD, Korea has the highest target in terms of download speeds: 10 Gbps to half of urban households (85 cities) by 2022. When considering both percentage of households, timeframe and speed contemplated, Luxembourg has the highest access target with a goal of offering 1 Gbps to all households by 2020. Sweden follows with the goal of connecting 98% of both households and businesses with 1 Gbps broadband by 2025. Meanwhile, Belgium aims to provide that speed to half of its households by 2020. Austria is targeting nationwide coverage of 1 Gbps broadband connections (i.e. both fixed and mobile) by 2030. In Canada, the government aims for 90% of Canadians to access 50 Mbps download speeds by 2021, with the remainder to be served over the subsequent decade (CRTC, 2016[63]). By 2020, the United States aims for broadband of 100 Mbps or more in 80% of households; Norway has the same goal for 90% of households.

A growing number of countries in the OECD have changed their legal frameworks to include broadband as part of their universal service framework. In 2018, Switzerland became the first country to include broadband in its universal service obligations, followed by Australia, Belgium, Canada, Finland, Spain and Sweden, among many others.. In Canada, a 2016 decision declared broadband Internet a basic service, which recognises broadband as part of its universal service framework (OECD, 2018[64]). Korea fixed broadband was designated as a universal service in January 2020. In Mexico, the constitutional reform of the telecommunication sector in 2013 included notions of universal service. It underscored the state should guarantee access to ICTs, including broadband services.

OECD countries are adapting to new developments in convergence and competition in communication markets

A key issue for policy makers and regulators has been the effects of market structures on delivery of efficient and inclusive communication services. Due to convergence, bundles of communication services have become more pervasive in the OECD area. These developments have been key drivers for market consolidation in recent years.

In approving mergers between mobile network operators, competition and regulatory authorities in OECD countries have imposed a number of conditions. These include divestment of spectrum or facilities (e.g. towers) to open possibilities for new mobile network operators (MNOs); allowing other operators on their networks through wholesale access obligations; and new innovative remedies to reduce consumer switching costs. In Italy, for example, the main remedy issued in 2017 for the Hutchison 3G/Wind merger in Italy allowed a new MNO entry by divesture of spectrum and a transitional roaming agreement.[13] As a result of these commitments, Italy experienced the entry of a challenger MNO in 2016. In 2019, the European Commission cleared the Vodafone–Liberty global merger subject to remedies. This included the company granting wholesale access to its cable network in Germany to its rival company, Telefónica Deutschland. In the United States, within the context of discussed merger remedies for the T-Mobile – Sprint merger of 2019, the Department of Justice may require the merged entity to support eSIMs[14] to reduce consumers' switching costs (Bohn, 2019[65]).

Several policies aim to ease market entry and reduce switching costs for the IoT

Previous OECD work has highlighted several policies to spur development of the IoT. Those include fostering interoperability; an efficient spectrum management; the extraterritorial use of numbers; and solutions to help consumers switch providers and avoid lock-in (OECD, 2018[1]). Several OECD reports have highlighted extraterritorial numbers as a way to increase competition (OECD, 2012[66]; OECD, 2015[67]). For example, Italy allowed the use of extraterritorial numbering resources for the IoT in 2016, creating a clear regulatory framework for SIMs used in connected vehicles.[15] For OECD countries in the European Union area, EU member states may allow the use of certain national numbering resources in an extraterritorial manner. This could include, in particular, certain non-geographic numbers (European Commission, 2018[48]), which could be the case of a new M2M range.

Several OECD countries have reviewed their net neutrality frameworks

Some countries have reviewed their legislative frameworks around network neutrality in the past years. The European Union published a report in April 2019 on the implementation of its Open Internet Access Rules (Regulation (EU) 2015/2120), which compared the current situation with the one in 2015. The report concluded "the Regulation's principles are appropriate and effective in protecting end-users' rights and promoting the Internet as an innovative engine" (European Commission, 2019[68]). The Body of European Regulators for Electronic Communications (BEREC) reviewed its guidelines on the implementation of European net neutrality rules by national regulators. BEREC held a public consultation on the guidelines between 10 October 2019 and 28 November 2019, and they were adopted in June 2020.

Some countries have been discussing whether 5G network "slicing" will be consistent with their "net neutrality" regulation. In 2016, BEREC had already recognised that network slicing in 5G networks may be used to deliver "specialised services" (BEREC, 2016[69]). In 2019, BEREC further clarified that the regulatory framework allows for 5G technologies, such as network slicing, Standardised 5G QoS Identifier (5QI) and Mobile Edge Computing. It stated that both tariffs with different quality of service (QoS) parameters (as long as they remain application-agnostic), as well as specialised services, were possible (BEREC, 2019[70]).

In Japan, a study group organised by the Ministry of Internal Affairs and Communications began discussing network neutrality in 2018. It produced a report in April 2019 (Box 3.2).

Box 3.2. Expert discussion on network neutrality in Japan

In October 2018, the Ministry of Internal Affairs and Communications in Japan set up a study group on network neutrality. The group discussed potential provisions to maintain the benefits of "the openness of the Internet". At the same, it considered the evolution of the Internet, including the growing number of mobile broadband subscriptions and the rapid increase in IP traffic.

The interim report in April 2019 highlights the rights of users (consumers and business). Namely, users are entitled to: i) use the Internet and access content and applications freely; ii) provide their content and applications freely to other users; iii) connect to the Internet freely through any device that complies with technical standards; and iv) use communication and platform services fairly at appropriate prices. The report highlights the need to continuously monitor network neutrality At the same time, co-regulatory approaches, including use of the revised Telecommunications Business Act, can ensure compliance with network neutrality principles. This includes the revised Telecommunications Business Act. In addition, it states that network neutrality is closely connected to safeguarding users' rights. It provides the direction of future approaches for issues such as "traffic management" and "zero rating".

Source: MIC (2019[71]), "Interim report on Study Group on Network Neutrality".

In Mexico, the Federal Telecommunications Institute opened the draft guidelines for traffic and network management for public consultation in December 2019, which ended on July 2020. Among several objectives, the guidelines seek to promote end-user freedom, provide legal certainty in terms of traffic management and foster innovation.

In the United States, the FCC enacted its 2017 Restoring Internet Freedom Order. Among other goals, the order classified broadband Internet access service as an information service, eliminated certain reporting requirements and authorised the Federal Trade Commission to oversee the privacy practices of ISPs.

The discussion of zero rating is embedded in the wider network neutrality debate. In the OECD area, governments are taking a number of different approaches towards zero rating. While some countries do not have specific zero-rating policies and regulation, others have network neutrality laws and regulation that cover zero-rating matters. Many countries with network neutrality regulation take a case-by-case approach in assessing offers in the market (OECD, 2019[72]).

Governments are seeking ways to foster IPv6 adoption

Policy makers can enable the IPv6 transition in three key ways. They can establish government promotion programmes to upgrade Internet services. They can adapt government purchasing. Finally, they can promote multi-stakeholder task forces to foster IPv6 deployment. IPv6 may also be important for the IoT for scalability, security (end-to-end encryption) and numbering reasons. For example, a “focal user” approach can play an important role in facilitating the transition to IPv6. Governments and large companies can sometimes play this role (OECD, 2018[73]).[16]

In 2017, *OECD Reviews of Digital Transformation: Going Digital in Sweden* recommended that the government could work as an enabler of the IPv6 transition by establishing government promotion programmes to adjust Internet services for which it has responsibility, adapting government purchasing and ensuring multi-stakeholder task forces to foster IPv6 deployment to foster IPv6 in the country (OECD, 2018[73]).

The government of Sweden implemented this recommendation in 2019 and provided the communication regulator, PTS, with funds to promote IPv6 deployment.

Connectivity and COVID-19: Keeping the Internet up and running in times of crisis

As the world weathers the COVID-19 crisis, connectivity is more essential than ever to ensure that economic activities can continue remotely. In addition, disparities in access to communication services among and within countries may accentuate the consequences of the crisis. Therefore, policies aiming to reduce digital divides is of paramount importance. In addition, regulation and policies that foster competition and investment in communication infrastructure become even more crucial. In the medium and long term, upgrading networks to the next evolution of fixed and wireless broadband will help ensure reliable and resilient connectivity for all.

The following good practices offer means for maintaining and supporting the networks as they evolve to meet both the surge and the changing nature of demand in network connectivity (Box 3.3).

Preventing logistical and supply-chain shortages. Network operators need to be able to order and receive new hardware and consumables to implement network upgrades and replace components that fail. If countries close borders, shortages or delays in the global supply chains could prevent network operators from repairing an outage or upgrading their capacity.

Maintaining access to key communication facilities. Data centres play a critical role, but most facilities are restricting access in response to the outbreak to prioritise scheduled maintenance by established customers. Governments should ensure that staff can access their equipment under controlled conditions in case of a critical need. In Sweden, for example, the national crisis co-ordination group for the communication sector stays in contact with the Swedish regulator (PTS) on datacentre access. While PTS cannot legally mandate datacentres to take specific actions, this is under review.

Box 3.3. COVID-19: Key recommendations for policy makers, regulators and/or network operators to meet both the surge and the changing nature of demand in network connectivity

Policy makers/regulators

- Ensure network operators and content providers have access to the equipment-supply chain and maintain controlled and prioritised access to datacentre facilities.
- Grant the engineering workforce of network operators and content providers the needed mobility to maintain functionality of the core and access networks and still be able to connect homes at customers' sites. Alleviating administrative burdens would also help operators to deploy networks rapidly.
- Release additional spectrum temporarily or approve temporary commercial spectrum transactions between providers that put unused spectrum into service to alleviate congestion in mobile networks.

Network operators

- Anticipate increased demand and prevent congestion by upgrading interconnection capacity with other providers, including for additional direct traffic exchange between networks (peering).
- Track key performance indicators of the Internet infrastructure such as the Domain Name System, particularly when they are provided externally.

Regulators

- Stimulate broadband providers to deploy more fibre deeper into the networks in the medium term and gradually phase out xDSL technologies, where possible.

Source: OECD (2020[79]), *Keeping the Internet up and running in times of crisis*, *https://www.oecd.org/coronavirus/policy-responses/keeping-the-internet-up-and-running-in-times-of-crisis-4017c4c9/*.

Monitoring the performance of key Internet infrastructure services. Essential Internet infrastructure services such as the Domain Name System (DNS) are seeing more use. Unimpeded access to the DNS is crucial given its performance is a prerequisite to reaching any service on the Internet. Some operators, particularly of country-code top-level domains, perform domain resolution for public health awareness websites and related online emergency services. Operators of DNS authoritative servers should therefore monitor the load to ensure service availability. Governments could also review the configuration and standards-compliance of their national top-level domains.

Improving direct interconnection. A lack of direct interconnection among networks negatively affects the overall Internet performance in a country, while increasing costs and risk, and diminishing quality. In some countries, large communication operators may refuse to interconnect domestically with other networks. This forces smaller networks to send domestic traffic over large distances to IXPs in other countries and back, leading to higher costs and lower quality. Two large Canadian operators, for instance, peer at IXPs within the United States. This forces 64% of Canadian domestic traffic to flow through the United States. Some Latin American countries, including Mexico and Colombia, exchange an important amount of traffic outside the countries. In general, a lack of domestic interconnection negatively affects overall Internet performance in a country and also increases costs and potential risks. In Italy, one of the most affected countries, Telecom Italia agreed to open peering at two exchange points to improve network experience between 6 April and 30 June 2020 (Telecom Italia, 2020[74]). In Costa Rica, the largest communication provider (Grupo ICE) joined the local Internet exchange on 30 March 2020 to improve network experience during the crisis (La Nación, 2020[75]). Network operators should anticipate increased demand and prevent congestion by upgrading their interconnection capacity with other providers, including adding more direct traffic exchange between networks (peering).

Placing unused spectrum into service on a temporary basis. Regulators and policy makers could consider making additional spectrum available on a temporary basis for mobile operators to add capacity to the over-the-air interface. In the United States, the FCC granted approval to AT&T, Verizon and T-Mobile to reach a commercial agreement with satellite TV provider Dish. The companies could thus borrow Dish's unused wireless spectrum to address congestion created by COVID-19 quarantines (Welch, 2020[76]). In addition, the FCC granted operators temporary access to spectrum in the 5.9 GHz band to meet increased rural broadband demand and granted use of spectrum for 60 days in the AWS-4 and AWS-3 band. In Ireland, the regulator ComReg approved plans to release extra radio spectrum in the 700 MHz and 2.6 GHz bands. This added capacity for mobile phone and data connectivity. It also issues temporary Electronic Communications Services licences on 22 April 2020 to three operators (ComReg, 2020[77]; ComReg, 2020[78]). Reducing administration burdens and streamlining rights of way for faster deployment of networks is another way to expand mobile connectivity.

Increasing network capacity by upgrading legacy infrastructure. Residential broadband operators might suffer from congestion due to the inherent asymmetrical capacity of xDSL technology and oversubscription. xDSL networks use telephone infrastructure that was primarily built for low-speed analogue voice service. Most xDSL broadband services have moderate download speeds but low upload speeds. This makes them poorly suited for services requiring higher upload speeds that are needed to support work its use from home for work or other activities. While transitioning from copper to fibre takes longer-term planning, broadband providers could be encouraged in the medium term to deploy fibre deeper into their networks to gradually phase out xDSL technology and replace it with FTTx technologies. Such investments would add resilience to help combat epidemics like COVID-19 and prepare for a post-crisis environment that is likely to require more connectivity and network capacity.

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Notes

1. Total communication access paths = total access telephone lines + total fixed broadband subscriptions + cellular mobile subscriptions.

2. The baseline definition of broadband is an Internet connection above 256 kbps given that many OECD countries have different broadband definitions. One important way to visualise the data is the use of speed tiers. For more information on the methodology used to define the fixed and mobile broadband penetration indicator, visit the site: "OECD Broadband Portal: Methodology" at *www.oecd.org/sti/broadband/broadband-methodology.htm*

3. According to M-Lab data, mean download speeds in the OECD area have increased from 18.4 Mbps in July 2017 to 26.8 Mbps in July 2019 (M-Lab, 2019[12]).

4. M-Lab enables visualisation of the results of the Network Diagnostic Tool (NDT) test, which measures the maximum amount of data that can be transferred from an M-Lab server to the user's device within a defined period of time ("download throughput"). Ookla employs a method for its speed tests that aims at "filling the pipe" of a testing user, to assess the capability of single computers to perform multiple downloads of one type or another simultaneously (OECD, 2013[80]).

   A number of factors can be considered when comparing speed measurement based on voluntary tests by broadband customers. First, although speed tests are valuable tools to inform consumers of actual performance of broadband services, consumers may show different degrees of willingness or incentives across different countries to perform those tests. Second, speed tests are more or less popular depending on country, so the available sample may be significantly larger or smaller (OECD, 2013[80]).

5. Cisco VNI Mobile Highlights 2017-18 includes information for the United States, Canada, Chile, Mexico, Poland, France, Germany, Italy, Spain, Sweden, United Kingdom, Japan, Korea, Australia and New Zealand (Cisco, 2018[9]).
6. For the United States, the speed threshold is 25 Mbps.
7. Directive (EU) 2018/1972.
8. ICT Modernisation Law of Colombia, Law 1978 of 2019: *www.funcionpublica.gov.co/eva/gestornormativo/norma.php?i=98210*.
9. Decision AGCOM no. 348/19/CONS. There are two conditions to be met before announcing the decommissioning of a given local exchange: i) the coverage to be reached and ii) the percentage of accesses already migrated to Next Generation Access (NGA) networks from the given local exchange. As regards the coverage, 100% of NGA coverage needs to be reached. To this end, fixed wireless networks are also included in the coverage, but only to a limited extent. Take up of NGA has to be at least 60% of activated accesses on the given local exchange, both by SMP operator and alternative operators.
10. In the context of the European Electronic Communications Code (EECC), examples of co-investment include co-ownership, long-term risk sharing through co-financing or purchase agreements "giving rise to specific rights of a structural character". Namely, the EECC establishes that an operator with Significant Market Power (SMP) will be able to propose commitments on offers for co-investment in new networks that consist of optical fibre elements up to the end-user premises or base station. In return for those commitments, an operator agrees to fulfil a number of criteria on access for co-investors and third parties. If the national regulatory authority makes these commitments binding, the operator with SMP would be exempted from *ex-ante* regulation.
11. PTS's decision on Market 3a in 2015 stated the following. The SMP-operator should primarily provide backhaul connection by providing access to fibre-based network infrastructure (dark fibre). As an alternative, the SMP-operator should provide backhaul connection by providing optical wavelength or digital connection capacity, depending on the request from the wholesale buying operator (PTS, 2015[54])
12. Austria's Broadband Strategy 2030 aligns with the European Commission's strategic objectives for 2025. However, it surpasses its targets and draws a path through 2030. Its overall objective is to realise a nationwide coverage with gigabit connection (fixed and mobile) by 2030. To turn the vision of nationwide availability of gigabit-capable connection by the end of 2030 into reality, the rollout must advance in individual phases:
    - phase 1: nationwide provision of ultrafast broadband connections (100 Mbit/s) by the end of 2020
    - phase 2: market launch of 5G in all state capitals by the end of 2020
    - phase 3: Austria as a 5G pilot country by the beginning of 2021
    - phase 4: availability of 5G services along main transport paths by the end of 2023
    - phase 5: availability of gigabit-capable connections nationwide by the end of 2025, including nationwide 5G coverage.
13. See the European Commission's press release "Commission approves Hutchison/VimpelCom joint venture in Italy, subject to conditions" at *https://ec.europa.eu/commission/presscorner/detail/en/IP_16_2932*.
14. eSIMs represent the next generation of SIM technology, replacing physical cards with software capable of remotely switching a device between operators. The technology allows one device to host multiple connectivity providers. It is designed for use across the whole spectrum of wireless devices, including smartphones and IoT modules.
15. See decision 639/16/CONS, n. 161/17/CIR and n. 110/19/CIR.
16. In a detailed analysis in Colombia, the CRC found the end-user's dimension was the main reason behind lack of adoption.


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