5 Unleashing the potential of digital services in rural communities

While providing digital services has the potential of overcoming distance barriers, the availability and scope of education and health care digital services is directly affected by lower quality broadband connections in low-density areas. This chapter examines how current digital provision of education and health services can address the challenges of rural areas, while assessing technological and digital barriers to this provision such as the broadband connectivity gaps or the need for digital skills. The chapter also illustrates the advantages and drawbacks of current and emerging broadband technologies. Finally, the chapter sheds light on several strategies deployed by OECD governments in order to improve rural connectivity and expand broadband to low-density rural areas.

Introduction

The cost of service provision in physical facilities increases with the degree of remoteness and sparsity. Lower density means higher transportation costs, loss of economies of scope and economies of scale, and greater difficulty in attracting and retaining professionals (e.g. health care professionals). Population ageing and decline in rural areas will accentuate these factors, as populations become sparser and less mobile. In this context, new technological advances have opened the door to providing quality services in new forms and substituting physical forms of delivery with virtual ones. Digital provision allows decoupling service provision from specific locations, greatly improving access to services such as education or health care.

The digital provision of services is a fast-moving field. For example, early models of telemedicine where one could access health practitioners over the phone have now been complemented by videotelephony, advanced diagnostic methods and in-home care support and monitoring. Advanced imaging and health informatics have ballooned as have the application of these approaches. Looking ahead, technological innovations including artificial intelligence and the Internet of Things (IoT) promise a vast array of new capabilities with potentially transformative impacts for the economy and society (OECD, 2018[1]) while demanding ever-faster connections.

The availability and affordability of fast, reliable connectivity – and the equitable distribution of that connectivity across the terrain – is a key consideration for improving the provision of services, not just to enable digital tools for the delivery of public services but as a fundamental underpinning of national economic and social well-being going forward. Moreover, the uptake of emerging technologies requires professional training, reskilling and capacity building at local levels. Besides investments in physical infrastructure, there is a need for resources to integrate these systems into standard service delivery models and to ensure that the potential of digital technologies is fully exploited.

This chapter reviews current service provision efforts using digital tools across OECD member countries. Specifically, it looks at how governments are using the digital provision of education and health services as one way to meet the challenges associated with low-density terrain while discussing technological and other barriers (e.g. skills gaps) to this provision and mitigation strategies for these. Given the vital role of connectivity in the delivery of these services, the chapter also reviews the specific challenges that impede connectivity in rural places and offers a review of current and emerging broadband technologies, to better understand the advantages and drawbacks of each one, as well as how these technological constraints need to be factored into digital service design. Finally, it looks at a range of strategies deployed by OECD governments in an effort to improve rural connectivity, to examine how each of these works and identify some particularly effective approaches.

Digital provision of education and healthcare

Three conditions must be met in the transition to digital services including telehealth and distance learning: access to the Internet, the right technology and the skills needed to use it. The possibility to offer educational and health services digitally has been available for quite some time. Today's digital tools offer myriad capabilities, including rich interactive experiences and high-definition multi-channel video communication, but these capabilities demand connections that are thousands of times faster than in the early days of digital services. The COVID-19 restrictions to mobility brought to light not only the huge potential of distance learning and telemedicine for addressing provision gaps but also the broadband connectivity gaps rural and remote areas face. This section reviews the current state of distance learning and telehealth, including recent developments following COVID-19 restrictions.

Unlocking funding, skills and connectivity barriers to distance learning in rural schools

As early as 1960, the United States (US) government was funding the development of the PLATO system, which became the world's first e-learning system that sought to scale up the supply of mathematicians and engineers at the dawn of the space age (see Box 5.1). Since then, several initiatives have been put forward to support technology-enhanced learning in rural schools:

- The Chilean "Enlaces" programme for teachers' information and communication technology (ICT) skills and ICT use in the classroom has a dedicated component tailored to support technology-enhanced learning for rural schools. Given the potentially higher cost of training rural teachers, the programme provides training in a more concentrated form at certain times of the year (OECD, 2019, p. 58[2]). Through the programme, rural schools in Chile could also access digital teaching materials and benefit from improved technological infrastructure. For more than 2 000 schools with limited Internet access, offline digital resources were provided through a complementary programme (Santiago et al., 2017, p. 132[3]).
- In Ontario (Canada), the 2016 budget explicitly committed to fostering equitable and affordable access to high-speed broadband Internet in schools to support distance learning as well as the delivery of well-being and mental health services. E-learning resources allowed students to engage in blended learning or even take courses fully online, for example through a digital library of materials related to the curriculum as well as a virtual learning environment (Ontario Ministry of Education, 2017[4]). More recently, Ontario has launched a Broadband Modernisation Programme (2020-21) that aims to modernise distance learning opportunities and support access for students to the virtual learning environment wherever educational resources are available.
- In Quebec (Canada), the project Networked Schools (*L'École en réseau*) allows students and teachers in small and remote schools to learn and collaborate via ICT tools such as video-conferencing, enabling the formation of learning communities and augmenting pedagogical approaches (CEFRIO, 2011[5]).
- In Spain, the ProFuturo initiative, an educational programme launched by the Telefónica Foundation and "la Caixa" in disadvantaged areas, is based on five pillars: teacher training, provision of digital platforms and equipment, technical and pedagogical support, community awareness and monitoring evaluation. After the emergence of the COVID-19 pandemic, ProFuturo designed resources for teachers (a digital learning platform with 160 courses and 2 800 hours of free training in different languages), students (1 600 additional hours of content in language, mathematics, science, technology and life skills to continue learning from home) and institutions (opening student content to organisations with common objectives). ProFuturo currently works in 38 countries and has 450 000 teachers and 11.5 million beneficiaries.

Box 5.1. PLATO, the first e-learning tool

The PLATO (Programmed Logic for Automated Teaching Operations) system, developed at the University of Illinois (University of Illinois[6]), was a mainframe/terminal-based e-learning tool that delivered automated classes in a variety of subjects to students from kindergarten through to university. From the 1960s through to the arrival of the personal computer (PC) in the 1980s, PLATO was used to educate tens of thousands of students across the US and internationally. These tools have always relied on connectivity; PLATO's terminals communicated with their mainframe using a connection that transferred 1 200 bits per second (Britannica[7]), enough to enable teaching materials that used simple graphics and text.

Source: University of Illinois (n.d.[6]), *PLATO – Illinois Distributed Museum*, https://distributedmuseum.illinois.edu/exhibit/plato/ (accessed on 11 August 2020); Britannica (n.d.[7]), *PLATO, Computer-based eEucation System*, https://www.britannica.com/topic/PLATO-education-system (accessed on 11 August 2020).

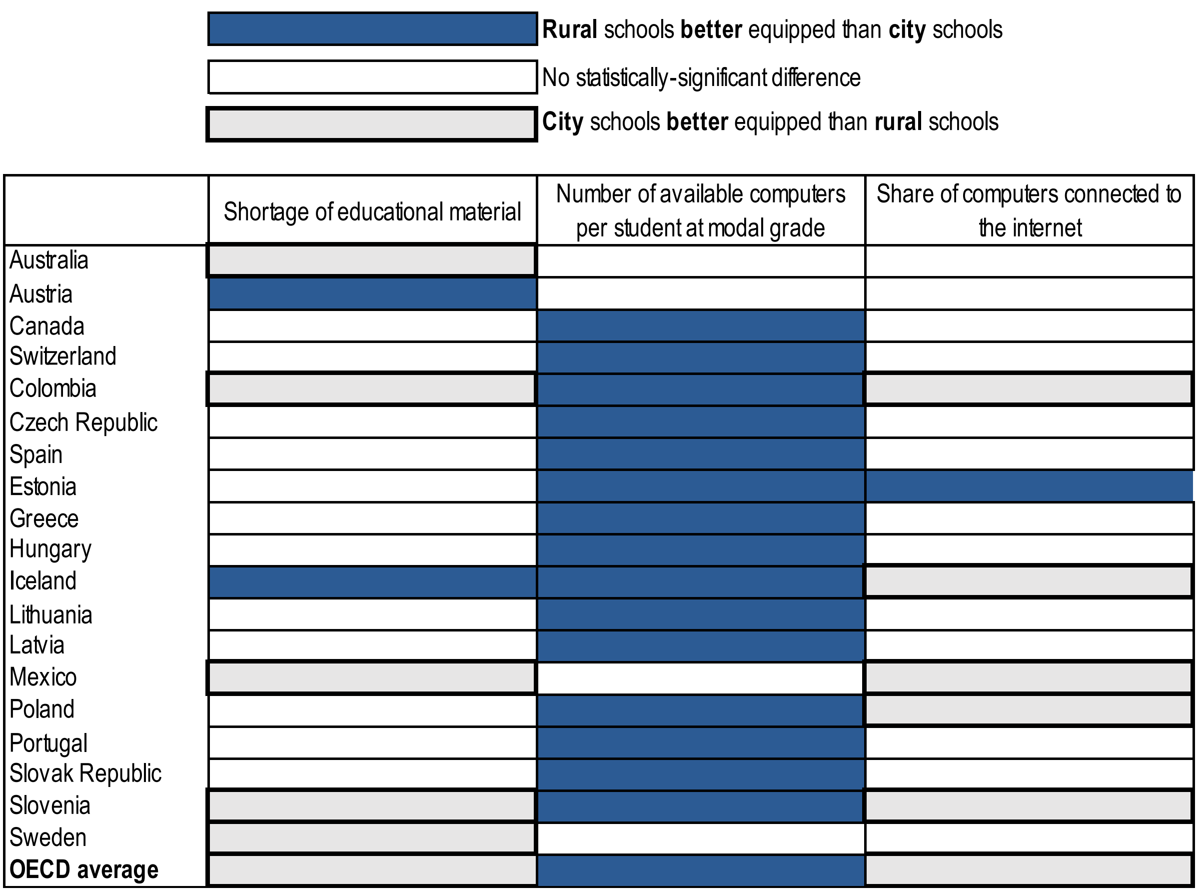
Resources, skills and connectivity gaps limit the potential of distance learning

Digital technologies can be a key lever for enabling quality distance learning but are limited by rural-urban gaps in ICT resources in schools and beyond (Trendov, Varas and Zeng, 2019[8]). For instance, rural schools tend to have, on average, more computers per students than city schools but they are less frequently connected to the Internet across OECD countries (Figure 5.1).

Local capacity in effectively scheduling and delivering distance courses to support all students is key to distance learning, beyond immediate Internet connectivity issues (OECD, 2018, p. 162[9]).

Figure 5.1. The rural-urban gap in schools' material resources

Based on school principals' 2018 reports.



Note: Shortage of educational material is measured by an index based on school principals reports about the extent to which their school's capacity to provide instruction is hindered ("not at all", "very little", "to some extent", "a lot") by a shortage or inadequacy of physical infrastructure, such as school buildings, heating and cooling systems, and instructional space; and educational material, such as textbooks, laboratory equipment, instructional material and computers. No statistically significant differences in any category in Chile, Denmark, Finland, France, Ireland, Israel, Italy, Norway, New Zealand, the United Kingdom (UK) and the US.

Source: OECD (2018[10]), *PISA 2018 Database*, https://www.oecd.org/pisa/data/2018database/ (accessed on 15 May 2020); adapted from Echazarra, A. and T. Radinger (2019[11]), "Learning in rural schools: Insights from PISA, TALIS and the literature", https://doi.org/10.1787/8b1a5cb9-en (accessed on 6 August 2019).

Distance learning requires the development of several new digital skills in students, including managing and operating software, communicating and researching with ICT, and being mindful of changing and complex intellectual property and security protocols. While some countries like Australia have developed specific frameworks, promote digital skills beyond the classroom and track progress in skill development, in many countries, the development of digital skills in schools has relied primarily on ICT or computational science classes (see Box 5.2 for more on the framework for digital competency of Australia).

Box 5.2. The Australian Curriculum, Assessment and Reporting Authority (ACARA)

At the school level, an example of a framework for digital competency is the one put forward by the ACARA. Students who develop an ICT capability are students who “learn to use ICT effectively and appropriately to access, create and communicate information and ideas, solve problems and work collaboratively in all learning areas at school and their lives beyond school” (ACARA, 2015[12]).

For ACARA, ICT capability development is organised around several dimensions: managing and operating ICT (e.g. managing data, selecting and using software), communicating with ICT, creating with ICT (e.g. using ICT to generate ideas or manage digital solutions for issues arising in learning activities), investigating with ICT (e.g. finding and analysing information, verifying sources and reliability of digital data), and applying social and ethical protocols and practices when using ICT (e.g. recognising intellectual property, applying personal security protocols).

Students’ proficiency is assessed in all these dimensions and across all school years since the development of ICT capability is considered as a learning continuum. At the same time, ICT capability supports student learning in all subjects covered by the curriculum, for instance by using digital tools to create artwork, looking for and critically analysing online information about historical events or investigating mathematical concepts using multimodal technologies. A digital technologies learning area is also part of the curriculum, focusing specifically on “understanding the characteristics of data, digital systems, audiences, procedures and computational thinking” (ACARA, 2015[12]).

The framework developed by ACARA is an example of a progressive move from developing digital skills as part of stand-alone ICT classes, to a more comprehensive approach fostering digital skills in other learning areas.

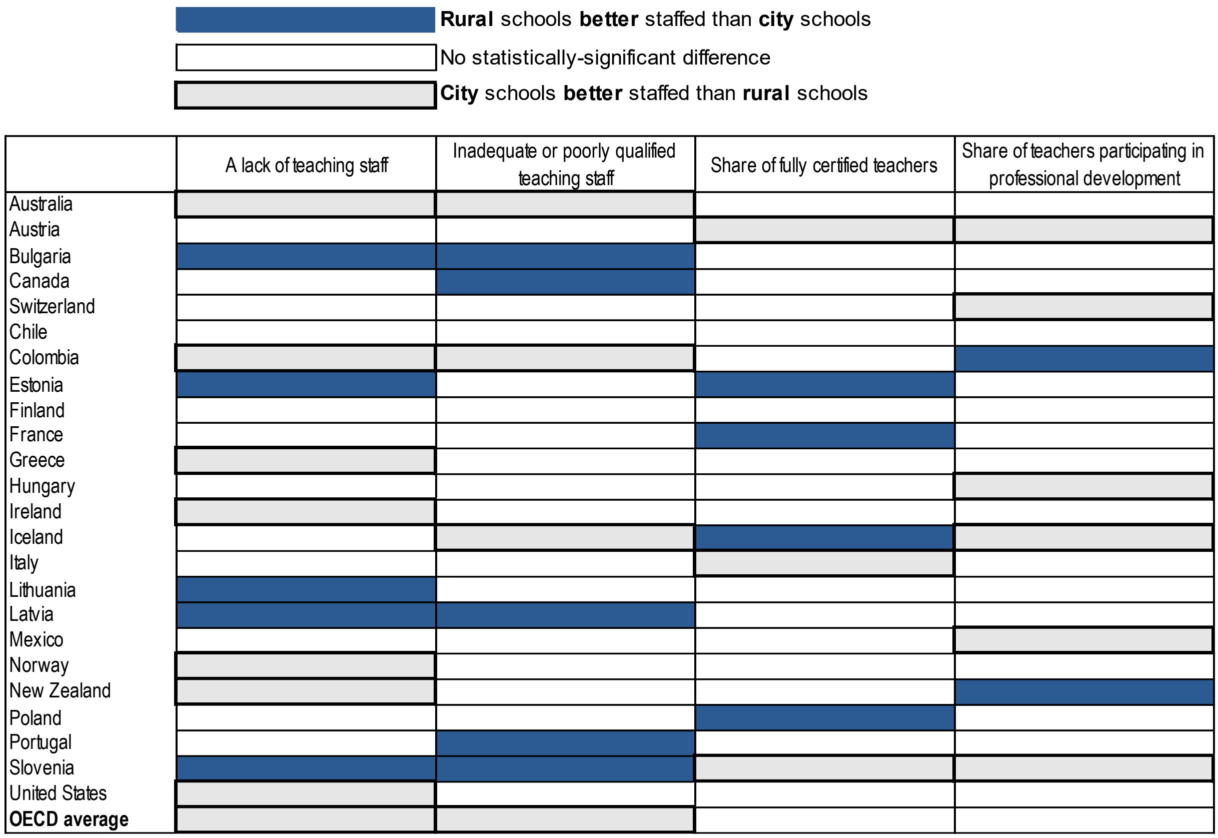
Source: ACARA (2015[12]), *Information and Communication Technology (ICT) Capability*, https://www.australiancurriculum.edu.au/f-10-curriculum/general-capabilities/information-and-communication-technology-ict-capability/ (accessed on 15 May 2020).

Beyond students’ digital skills, the adoption of distance learning will also require a dramatic increase in ICT training for teachers in rural areas. As Chapter 2 showed, rural areas in most countries in Europe considerably fall behind in the share of individuals living in rural areas with basic or above digital skills compared to individuals living in cities. The need for training in the use of ICT for teaching was recognised as the second most important need identified by teachers in OECD countries even before the COVID-19 pandemic (OECD, 2020[13]). This context calls for policy efforts to help integrate the specific needs of rural teachers into technological products and services.

Digital tools can support the delivery of much-needed ICT training for teachers in rural areas. According to the latest OECD Education Review, only 36% of lower secondary teachers report participating in online courses or seminars, less than half the share participating in courses or seminars in person. The case of Korea, where over 90% of teachers report undertaking online professional development, shows that there is great room for improvement in the digital provision of ICT training for teachers (OECD, 2020[13]). Closing ICT skills gaps among teachers in rural areas requires special attention to their professional development. Data from PISA 2018 on teaching staff gaps between rural and urban schools show that city schools have significantly higher shares of teachers participating in professional development compared to rural schools in six countries (Figure 5.2).

Figure 5.2. The rural-urban gap in teaching staff

Based on school principals' 2018 reports



Note: No statistically significant differences in any category in the Czech Republic, Denmark, Israel, Spain, Sweden and the UK.
Source: OECD (2018[10]), *PISA 2018 Database*, https://www.oecd.org/pisa/data/2018database/ (accessed on 15 May 2020); adapted from Echazarra, A. and T. Radinger (2019[11]), "Learning in rural schools: Insights from PISA, TALIS and the literature", https://doi.org/10.1787/8b1a5cb9-en (accessed on 6 August 2019).

The limitations of distance learning due to connectivity problems may affect not only students in rural and remote areas but also rural schools, as the case of Spain illustrates: estimates of the Association of Secondary School Principals in Madrid show that 90% of schools do not have a sufficient high-speed Wifi network to ensure multiple connections in classrooms and quality interaction with students confined to their homes. The cost of installing such a network in a school in Madrid has been estimated at around EUR 10 000 (Lucas, 2020[14]). These issues and the cost of fixing them extend to rural areas with limited broadband connectivity.

The COVID-19 pandemic stressed the need to overcome barriers to distance learning in rural areas

The COVID-19 pandemic took almost 1.6 billion children out of school in more than 190 countries worldwide, which affected over 94% of the world's student population (UN, 2020[15]). The risks of exclusion and dropping out of school exploded as the resources needed to learn properly from home, such as online courses, video classes and electronic textbooks, are insufficient for many pupils. The distribution of Internet access and its quality, access to equipment (tablets, laptops) and the existence and use of online distance learning platforms determines who benefits and who suffers from switching education to distance learning.

The switch to distance learning following COVID-19 restrictions came even as resources in schools were deemed insufficient, especially in disadvantaged households. Before the crisis, a quarter of school principals on average in OECD countries indicated that they did not have sufficient digital technology for teaching. In the UK, almost a third of disadvantaged students reported not having adequate resources and a suitable environment to study from home while schools were closed. Pupils spent an average of only 2.5 hours a day on school activities during the pandemic and 71% of them received a maximum of just 1 online lesson a day (Green, 2020[16]).

Even in countries with a strong technology base, distance learning was little exploited during COVID-19 restrictions because technology is not necessarily perceived as an educational tool. For instance, Japanese schools were not as keen to embrace distance learning during COVID-19 restrictions compared to what their technology availability would suggest. This was due to low use of computers at school, low skills of students (e.g. eighth graders are able to input only 17.4 characters per minute), lack of instructions from education councils, lack of initiative by local schools and cultural reasons such as the importance of looking in the eyes of ones' interlocutor (Daisuke, 2020[17]).

The COVID-19 restrictions will likely have a disproportionate impact on the performance and cognitive skills of the low-income pupils and likely widen already large territorial gaps. As a recent study reports, primary school students in the Netherlands made little or no progress from home during the eight-week school closure (Engzell, Frey and Verhagen, 2020[18]). Students from less-educated homes bore the brunt in terms of skill losses, with 55% larger losses for students with parents in the lower educational categories. In the UK, socio-economic skills gap could grow by 30% as a result of the COVID-19 pandemic, partly because working-class children are less likely than middle-class children to be helped at home by their parents (Cullinane and Montacute, 2020[19]),. This decline in human capital brings negative consequences on long-term economic opportunities: a learning loss of 0.2 standard deviations (1 SD = 100 PISA scores) can translate into a decrease of 2.6% in future income and a decrease in 0.86% in the probability of finding a job (Maldonado and De Witte, 2020[20]).

Other studies carried out following the closure of schools showed more positive results. In November 2020, an evaluation by the French Ministry of Education of the performance of more than 810 000 sixth grade students (Ministère de l'Éducation, 2020[21]) showed no difference in performance for student tested in September 2020 versus those tested in 2019. Beyond immediate performance, school closures could carry other consequences such as curbing of educational aspirations and disengagement from schooling, which could affect student outcomes for the long term.

The radical switch to distance learning during COVID-19 restrictions also required new ICT skills for teachers. Since the emergence of the crisis, the ability of teachers to use new technologies and to manage distance learning has likely improved because of increased exposure. Several OECD countries succeeded in rapidly training teachers who had difficulties with new technologies, including South Korea, where the government launched a digital platform where teachers could train their colleagues on a voluntary basis (Gouëdard, Pont and Viennet, 2020[22]). The COVID-19 pandemic will also likely encourage the integration of technology in pedagogical methodologies and distance learning, which however will require a territorial approach in order to reach rural communities.

Governments have also put in place measures to financially support schools and ensure the proper functioning of online education during the COVID-19 pandemic. Italy undertook measures in March 2020 to better equip schools with digital platforms and tools to guarantee distance learning, to lend digital devices to less well-off students and to train teachers to use digital tools. The UK put in place a school support plan in April 2020 to help schools meet additional costs, including opening schools during school holidays for priority students, providing free school meals for eligible children and cleaning schools following suspected or confirmed cases of coronavirus. In the US, the CARES Act Elementary and Secondary School Emergency Relief Fund from March 2020 provided support to schools in the districts most affected by the virus. Australia launched in May 2020 the Higher Education Relief Package to reduce the costs of online courses and loan fees for Australian students for a period of six months.

Box 5.3. Education responses to the COVID-19 pandemic: OECD recommendations

As “learning is never a place, but an activity”,[1] the COVID-19 pandemic crisis offers an unprecedented opportunity to stimulate innovation within education and accelerate the implementation of e-learning in education systems. The OECD paper “Education responses to COVID-19: Implementing a way forward” (Gouëdard, Pont and Viennet, 2020[22]) has drawn up a series of recommendations to effectively implement an education policy response during the next steps of the COVID-19 pandemic. The main elements of the four recommendations are as follows:

1. Identify key contextual factors relevant to the crisis: by assessing the resources necessary for a transition to distance or hybrid learning approaches; by broadening the co-operation between schools and potential partners such as existing institutions or national pedagogical centres; and by considering health, welfare and assessment policies in the education response.
2. Consider stakeholders as the main drivers of change: by co-constructing the education response with key stakeholders such as unions or parent associations to ensure broad policy support; by focusing responsibilities of different stakeholders such as school principals or local education authorities on supporting education delivery; by building on existing tools to support communication between stakeholders within school communities and across the system; and by adapting existing feedback loops such as surveys or other data collection to gather information on teaching and learning progress, challenges and solutions.
3. Design an educational policy informed by the educational impact of the crisis to respond to school needs: by developing a vision guiding the policy response that acknowledges the crisis and its implications; by choosing the adequate modes of education delivery based on the assessment of resources and stakeholders’ feedback; by providing just in time professional development for teachers and parents to support learners in their instructional approach; and by empowering schools in the delivery of learning, building on the experience of the COVID-19 crisis to transform schools.
4. Shape a clear and coherent implementation strategy: by bringing together the different relevant dimensions, including the national education vision, the available resources or the updated assessment methods; by establishing a communication strategy that can reach different audiences; and by developing monitoring approaches to understand progress and avoid potential pitfalls.

Source: Gouëdard, P., B. Pont and R. Viennet (2020[22]), “Education responses to COVID-19: Implementing a way forward”, https://doi.org/10.1787/8e95f977-en.

Unleashing the potential of telemedicine to increase access to quality health care in rural areas

Telemedicine encompasses a wide range of technology-assisted health activities and no single definition exists. Some of the more common uses of telemedicine include telemonitoring, store and forward, and interactive telemedicine. Telemonitoring is the use of mobile devices and platforms to conduct routine medical tests, communicate the results to health care workers in real-time, and potentially launch pre-programmed automated responses. For example, a patient with congestive heart failure may use a device to record vital signs that are communicated remotely to a health provider who can advise patients if action is needed. Store and forward is similar to telemonitoring but is used for clinical data that are less time-sensitive and for which a delay between transmission and response is acceptable. For example, store and forward is used widely in dermatology. Finally, interactive or real-time telemedicine involves direct and synchronous communication between providers and patients. This can include between a doctor and a patient as part of a teleconsultation or between medical professionals (Oliveira Hashiguchi, 2020[23]).

The greatest potential benefit of telemedicine to rural populations is greater and timelier access to health care and specialists. A 2015 study estimated that a typical visit to a doctor takes 2 hours on average: 37 minutes are spent travelling, 84 minutes are spent at the clinic and only 20 minutes are spent on face-to-face physician time (Ray et al., 2015[24]). These times are likely much longer in rural and remote areas where distances are longer and medical professionals scarce. Teleconsultations can reduce travel and waiting times to nearly zero, resulting in significant time gains for patients and health workers. Moreover, as specialised clinics/services in rural areas are often sparse, going to a local primary health facility to have a telemedicine appointment can be time-saving for both patients and specialists. Teleconsultations can also help alleviate disparities in the geographic distribution of health workers. Doctors, including specialists who are not located in areas with low doctor density, can still provide medical care to those living in these zones.

Evidence of effectiveness of telemedicine

Like any medical intervention, the impact of telemedicine depends on the population served, the programme funding, the benefits provided and the goals of the service (Hauck, Smith and Goddard, 2004[25]). The flexibility of telemedicine that makes it adaptable to nearly any situation also makes it hard to determine a generalisable measure of effectiveness. The evaluation of the economic utility of telemedicine is also particularly difficult across settings and evidence is inconclusive. In some cases, telemedicine has been shown to increase access and effectiveness, while lowering costs. Studies of teleconsultations found that they were associated with increased access due to reduced waiting times and reduced travel (Caffery, Farjian and Smith, 2016[26]; Masino et al., 2010[27]). Patients in the Canadian Ontario Telemedicine Network avoided travelling 270 million km in 2017 and the network saved CAD 71.9 million in travel grants (Ontario Telemedicine Network, 2018[28]).

A survey of OECD country experts found that the vast majority thought that telemedicine can be beneficial (Oliveira Hashiguchi, 2020[23]). The most commonly cited benefits were increased access, quality of care and cost-effectiveness (Table 5.1). Regarding cost-effectiveness, it should be stressed that telemedicine should not be seen as a way to scale down massively health services in rural areas, as many of them still require face-to-face interaction.

A systematic review of the effectiveness of telemedicine found that nearly 90% of international studies concluded that telemedicine interventions were at least as effective as face-to-face interventions (Oliveira Hashiguchi, 2020[23]). Specific benefits included glycaemic control in diabetic patients, fewer hospitalisations for patients with chronic heart failure, effective pain management and effective management of health risk factors including exercise and nutrition.

Table 5.1. Impacts of telemedicine highlighted by experts

Impacts of telemedicine highlighted by experts*	Number of country experts agreeing
More cost-effective care	**9**
Improved quality of care	**7**
Improved access and reduced inequality in supply	**6**
Increased knowledge sharing and learning	**5**
More patient-centred care and health literacy	4
Savings in patients' time and avoided travel costs	4
Avoided hospitalisations and emergency care	3
Fewer unnecessary transfers and avoided subsidised travel	3
Better models of care for chronic diseases	3
Improved timeliness of care	3
Increased continuity of care	2
Higher volume of consultations	2
Reduced provider travel time	2
Improved care co-ordination	2
More equitable access to rural and aboriginal communities	2

Note: *Number of reporting countries = 13.
Source: Oliveira Hashiguchi, T. (2020[23]), "Bringing healthcare to the patient: An overview of the use of telemedicine in OECD countries", https://dx.doi.org/10.1787/8e56ede7-en.

Like effectiveness, the cost-effectiveness of telemedicine is difficult to generalise across settings and purposes. For example, cost-effectiveness analyses often take a health systems perspective, missing important cost categories for rural areas such as the cost of patient travel. These cost-effectiveness analyses also rarely take into account any cost savings to patients or patient families from reductions in health utilisation and avoided hospital visits due to more effective home care. Despite these limitations, current cost analyses point to positive cost impacts. In a review of 19 systematic reviews and/or meta-analyses on cost-effectiveness, 13 concluded that telemedicine interventions were either cost-effective or had the potential to be cost-effective (Table 5.1) (Oliveira Hashiguchi, 2020[23]).

More telemedicine uptake in rural areas requires a change in culture, more funding and sounder legislation

Despite the possible benefits, the use of telemedicine in OECD countries is still not at its full potential. This is in part due to a significant number of barriers to its use such as technological hurdles as well as inequalities in digital literacy. An OECD working paper from before the COVID-19 pandemic summarises the main barriers cited by experts on telemedicine in OECD countries (Oliveira Hashiguchi, 2020[23]). Amongst the most cited are legislations and technology management, including payment methods, the culture of integrating these new technologies and governance issues (Table 5.2). The resistance of health professionals that deal with poorly designed digital solutions and digital transitions that are not mindful of their needs and workloads represents an additional barrier to telemedicine. Especially in the case of health professionals working in rural areas, more training and support in terms of time and resources to undergo the needed digital transition are critical.

Table 5.2. Barrier and enablers of telemedicine use highlighted by experts

Barrier and enablers of telemedicine use highlighted by experts*	Enablers	Barriers
Single coherent governance, management, funding strategy	**5**	**7**
Culture of change and adoption of new technologies	**4**	**8**
Specific legislation on telemedicine (e.g. on liability)	**4**	**6**
Suitable qualification/accreditation/training of staff	**4**	**5**
Evidence of better quality of care and patient benefit	4	0
Interoperability and ICT infrastructure	2	6
Privacy and security legislation, information governance	2	4
Ease of use for providers and patients	2	1
Applications meet an existing need and emerge naturally	2	0
Clarity on division on tasks and responsibilities	2	0
Connectivity, access of broadband and coverage in rural areas	1	5
Professional organisations' view on remote care	1	2
Appropriate clinical and continuity of care models	1	2
Digital health literacy of patients	1	1
Recognition as a priority among competing priorities	1	1
Clear reimbursement mechanisms	0	9
Medical licensure	0	2
Evidence of cost-effectiveness or cost-benefit	0	2
Co-ordination of participating health professionals' schedules	0	2

Note: *Number of reporting countries = 13.
Source: Oliveira Hashiguchi, T. (2020[23]), "Bringing healthcare to the patient: An overview of the use of telemedicine in OECD countries", https://dx.doi.org/10.1787/8e56ede7-en.

Before COVID-19, telemedicine remained largely unregulated across OECD countries, with some countries even maintaining legal restrictions. Across OECD countries that use telemedicine, 12 have no national legislation, policy or strategy regarding telemedicine and 11 have no medical jurisdiction, liability or reimbursement for e-health services (Oliveira Hashiguchi, 2020[23]). In some countries, telemedicine depends on sub-level national authorities, as in the case of Spain where the autonomous communities are in charge of telemedicine services. While countries such as Austria, Slovenia and Sweden have integrated telemedicine into broader health laws due to the lack of specific national legislation (Oliveira Hashiguchi, 2020[23]), others maintain significant legal restrictions. In Hungary, certain services such as a major therapeutic change or the doctor's final diagnosis cannot be treated remotely. In Japan, telemedicine use requires an initial face-to-face appointment where the physician deems it appropriate and safe for the patient. In some states of the US such as Georgia or Texas, follow-up medical appointments preceded by an initial remote contact must be face-to-face (Thomas and Capistrant, 2017[29]).

The complexity of telemedicine makes the attribution of its management and regulation difficult and uncertain, requiring the production of specific guidelines for rural and remote areas. Medical councils or colleges have published national telemedicine guidelines, including Canadian medical colleges and the Medical Board of Australia. Examples of guidelines incorporating a territorial lens include the Rural & Remote Medicine Telehealth Guidelines produced by the Australian College. In Mexico, the *Centro Nacional de Excelencia Tecnológica en Salud* (CENETEC) has included rural areas in a Telehealth Service Catalogue with tools to make communication more consistent across providers.

The lack of clear regulation for larger data and information privacy and security issues also impedes the development of telemedicine. Telemedicine services have increased the circulation of sensitive personal information protected by medical secrecy among health institutions, such as those relating to mental illness or cases of abuse. A governance framework including technical, legal and political mechanisms is needed to counter risks to individual privacy (OECD, 2015[30]).

Besides regulation, funding levels and fragmentation remain a key barrier to telemedicine services, especially those in primary care that are key to rural areas. In 2016, out of a total budget of USD 588 billion in the US, Medicare spent only USD 28.7 million on telemedicine services (Flannery and Jarrin, 2018[31]). The multiplicity of funding sources also represents a current challenge in many countries. In Norway, primary care is financed by municipalities and hospitals from central budgets. In Australia, primary care is funded by Medicare while hospitals are funded simultaneously by the states, the federal government and non-governmental organisations.[2] Due to this split in funding, in both countries, among others such as Germany, telemedicine would require several sources of funding, which limits the implementation of telemedicine services.

The lack of a clear publicly funding policy and reimbursement mechanisms also severely limits the use of telemedicine. In France, until recent COVID-19 restrictions, reimbursements for teleconsultations with a physician are made if the patient previously had a physical appointment with the same physician within the previous 12 months. In Poland, only a few telemedicine services such as cardiac rehabilitation are reimbursed. In the Czech Republic or Ireland, telemedicine services are generally not covered by health insurance and are at the patient’s expense (Oliveira Hashiguchi, 2020[23]).

Regulation and funding barriers are compounded by skill and digital gaps in rural areas. Digital barriers include technological illiteracy and lack of training, poorly designed interfaces, lack of user feedback, poor correspondence between the services offered and the specific needs of patients and healthcare staff, and cultural preferences to prefer face-to-face appointments. In fact, patients living in rural and remote areas without adequate broadband access who could benefit the most from telemedicine have the most difficulty accessing and using it (Oliveira Hashiguchi, 2020[23]). Although telemedicine requires trained and qualified staff in order to optimise the provision of services, about one-third of health workers in OECD countries report lacking sufficient knowledge and skills to use digital solutions. Countries such as Australia, Canada, Germany and the US have implemented policies to improve clinical informatics skills and digital literacy among health workers. However, giving existing skill gaps, increasing skill levels and attracting digital technology professionals requires place-based strategies such as the dedicated institutes and increased course offer in universities in rural regions.

COVID-19 has uncovered the potential and limitations of telemedicine for rural areas

The ongoing COVID-19 pandemic has had a profound impact on the use and visibility of digital health technologies. Telehealth has been used to monitor the health and well-being of people who have been diagnosed with COVID-19, including both patients with less severe cases who are able to stay at home and the more critical cases who need to be hospitalised. Examples come from Israel and Korea where patients use wearables and communication technologies to remotely monitor patients with COVID-19 at home (OECD, 2020[32]).

Using teleconsultations has also been important to follow quarantine orders and avoid coming into contact with others for potential COVID carriers. Notably, barriers have been eliminated or relaxed in order to allow for additional use of telemedicine during this period. England, France, Germany, Japan and the US have relaxed regulatory barriers to encourage the use of teleconsultation (OECD, 2020[32]). In France for instance, patients are authorised to consult remotely with any doctor that uses telemedicine regardless of any previous contact and receive complete reimbursement of teleconsults. In Germany, a temporary provision was introduced to allow physicians to issue or renew prescriptions, referrals or sick notes digitally or by phone, and to offer video consultations. In the aftermath of the pandemic, policymakers should ensure that these tools are made available to all primary healthcare teams, patients and communities.

In most remote rural areas, the conditions of care have nevertheless worsened with the COVID-19 pandemic. Geographically isolated hospitals are poorly equipped to care for severe COVID-19 patients. The lack of care for other serious pathologies due to the pandemic is greater in these areas, which means that people no longer go to hospitals, even for emergencies. This situation, aggravated by the lack of access to broadband and technologies, has increased the feeling of anxiety and worsened issues of chronic pain of patients in rural and remote areas in the US (Stone, 2020[33]).

The pressing need for access in rural areas during COVID-19 restrictions calls for faster implementation of suitable regulations with a territorial approach. In France, the *Ségur de la santé*, a consultation of healthcare system stakeholders in May-July 2020, strongly supported the "development of telehealth in all territories". The agreement promises to extend the COVID-19 emergency provisions by relaxing physical consult preconditions for teleconsultation with specialists.[3] Although the consequent unleashing of access to specialists would greatly increase access for patients in rural and remote areas, the extension of this measure has been called into question in September 2020 because it would break existing territoriality principles in provision.[4] Current negotiations between private health professionals and the National Health Insurance Fund (CNAM in France) intent to enhance the role of community medicine and facilitate the use of telemedicine (Millet, 2020[34]).

Service provision in low-density rural areas and the digital gap

Maximising the potential of digital service provision in rural areas requires first and foremost appropriate broadband connectivity. Since the 2000s, broadband services have flourished, from 82 million fixed-line subscribers across the OECD in 2003 to over 431 million in 2019. There is now, on average, one fixed broadband subscription for every three people (OECD, 2019[35]). This expansion has included rural areas, with broadband service now available to the great majority of rural residents in almost all OECD member states except Chile, Colombia, Greece, Mexico, Portugal and Turkey, where 40% or more of households do not have Internet (OECD, 2018[36]) (Figure 5.3) (see Box 5.4 for a historical overview of broadband policies in rural areas). In Europe, research conducted on behalf of the European Commission (EC) has found that fixed-line broadband is now available to 96.7% of all households in the EU27+UK (IHS Markit and Point Topic, 2019[37]), including 87.4% of rural households, with satellite connectivity available to the remainder.

Box 5.4. A short history of broadband policies in rural areas

In the early days of the telephone in North America, private telephone companies showed little interest in connecting rural communities, the business case for investment simply was not strong enough, so they focused their network development activities on cities. In Canada and the US, rural residents responded by establishing independent mutual co-operatives and publicly owned telephone companies at the municipal and state/provincial levels to build the networks that private enterprise would not. By 1912, there were over 3 000 independent rural telephone systems in the US (NTCA[38]), while in Canada, the three Prairie Provinces (Alberta, Manitoba, Saskatchewan) had purchased the assets of the incumbent provider to create provincially owned telephone monopolies mandated to expand coverage. The early results were positive, with farmers in Manitoba, for example, paying only around half for their telephone service what it cost to provide it (Winseck, 1995[39]), thanks to the provincial government's recognition that connectivity was a key factor in driving economic development. Elsewhere, state ownership was typically the starting point, with the major telephone companies of Europe, Australia, Korea and other OECD members typically beginning life as divisions of their respective national postal services.

A century later, the challenges of connectivity in low-density regions remain, though there are some additional considerations today. Where traditional telephony was a stable technology, characterised by incremental innovation that built on existing network assets, modern digital connectivity is evolving at a more rapid pace and features more disruptive change. For network builders, these distinctions necessitate ongoing investment, with the risk that existing assets might be rendered irrelevant by emerging technologies such as new wireless or satellite-based technology. At the same time, rural regions across the OECD today face ageing and stalled or shrinking populations, further eroding the business case for private investment.

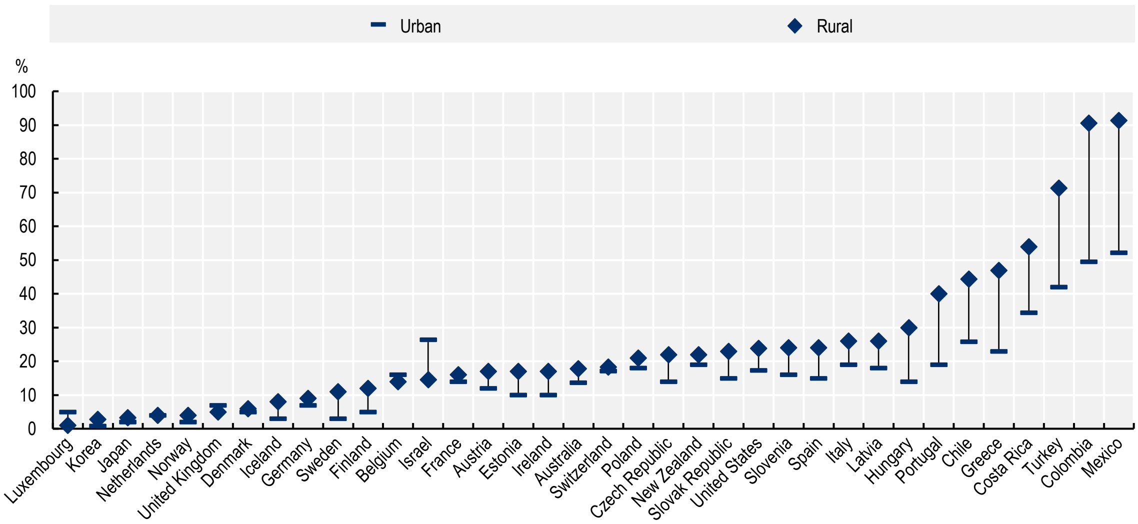
In 2004, the OECD urged governments to be patient before subsidising rural and remote connectivity (OECD, 2004[40]). At the time the organisation noted that rapid progress was already being made by the private sector and that an array of then-new technologies, such as fixed wireless Internet service providers (WISPs), were challenging the traditional relationship between cost and distance. Competition from new entrants using these technologies was prompting incumbent telecom networks to invest in upgrading their infrastructure or else risk losing their customers. The report concluded that "while there may be a place for government funding under some circumstances, the market should be given time to work".

Indeed, the organisation's research over the past two decades has shown that the liberalisation of the communication sector with the goal of fostering greater competition has brought many benefits in terms of increasing the affordability, availability and quality of communication services. Promoting competition enables users to benefit from greater choice from network service providers and spurs innovation in communication markets. It increases investment, lowers prices and drives up the overall quality and speed of broadband offers, including to underserved populations. Gaps, however, remain, particularly in low density and remote regions, where market mechanisms alone have not yet satisfactorily delivered the high quality connectivity demanded by modern services. Active intervention by governments, particularly in these areas, continues to play an important role (OECD, forthcoming[41]).

Source: Winseck, D. (1995[39]), "A social history of Canadian telecommunications", http://dx.doi.org/10.22230/cjc.1995v20n2a863; OECD (2004[40]), Document of the OECD "Working Party on Telecommunication and Information Services Policies", OECD, Paris; OECD (forthcoming[41]), "Bridging connectivity divides", OECD Going Digital Toolkit Policy Note, OECD, Paris.

Figure 5.3. Households without Internet by urban/rural location

Share of households reporting not using the Internet, 2017 or earliest year available



Note: For European countries, data on Internet uptake by "households living in densely populated area" was used for the "urban" category and on "households living in a sparsely populated area" was used for the "rural" category, and correspond to 2016, with exception to Iceland (2014); while data on "households living in an intermediate urbanised area" was disregarded. International Telecommunication Union (ITU) data was used for non-European countries and corresponds to 2014-15, and national household surveys were used for Chile (2015), New Zealand (2012), Turkey (2013) and the US (2015).
Source: (OECD, 2018[36]), "Bridging the rural digital divide", OECD Digital Economy Papers, No. 265, OECD Publishing, Paris, https://doi.org/10.1787/852bd3b9-en (accessed on 12 August 2020).

StatLink https://doi.org/10.1787/888934226747

Mobile broadband subscriptions have grown rapidly since 2010. They now account for 77% of all the broadband access pathways across OECD countries, with 1 subscription for every citizen and even 3 subscriptions for every 2 inhabitants in Finland and Japan (OECD, 2019[35]). As of 2018, mobile broadband based on 4G (LTE) technology was available to 98.9% of all households, including 96.1% of rural households, in the EU27+UK (IHS Markit and Point Topic, 2019[37]). Mobile broadband is typically used for smartphones, the contracts for which generally include voice calls and monthly data usage caps. Around 90% (December 2019) of OECD mobile subscriptions include voice calls, meaning they are likely used in conjunction with a telephone. Relatively low data usage rates for mobile subscriptions (5.8 gigabyte [Gb] per month, on average, across the OECD in 2019; (OECD, 2020[42])) suggest this connectivity is lightly used by many at the moment. For context, streaming 1 hour of 4K high-definition video over Netflix consumes around 7 Gb of data. Use cases for service delivery, for example, remote consultations between doctors and patients, could consume large amounts of data (to support two-way high-definition video), so the role that data usage limitations might play is something policymakers may need to consider when designing service offerings.

While data consumption patterns suggest mobile broadband is not widely used for data-intensive applications (like Netflix) at the moment, with sufficient tower capacity it can be used that way. There is some evidence of that happening, notably in Finland. Finland's mobile data usage is much higher than average (23.5 Gb per month in 2019) and includes a higher proportion of data-only contracts. Relative to other OECD countries, Finland has a very high level of mobile broadband subscriptions and a relatively low level of fast fixed broadband connection availability in rural areas, with around 8% of rural Finnish households having access to a fixed broadband connection of 30 Mbps or more in 2017.

Box 5.5. Broadband terminology

A discussion of broadband provision involves the use of several terms that are important to understanding the issues and technologies. Here is a brief overview of the key terms:

- **Download speed** – The rate data moves from the Internet to the user's device. Higher is better.
- **Upload speed** – The rate data moves from the user's device to the Internet. Higher is better.
- **Mbps/Gbps and Gigabits** – These are measures of speed. Mbps = Millions of bits (digital ones and zeroes) per second. Gbps and Gigabit both refer to speeds in the range of billions of bits per second or 1 000 Mbps and higher.
- **Latency** – Latency is the time delay between when a user requests data and when they begin to receive it (for example, requesting to visit a website). Lower is better.

Multiple factors affect latency but a critical one for broadband provision in rural areas is the distance between the user and their Internet provider. Among present-day connectivity technologies, geosynchronous satellite-based services typically suffer the highest latency because the distance from the user to the satellite is large. A connection with a high latency might feel slow to a user, even if the download speed is high.

- **Symmetric/Asymmetric** – Describes the relationship between upload and download speed. Symmetric means the flow of data moves at the same speed in both directions. Asymmetric means the rate of data flow in each direction differs. In most cases, an asymmetric broadband connection means that the download speed is faster than the upload speed.
- **Data cap** – Some Internet providers impose limits on their subscribers, capping the maximum amount of data they may use in a given period (typically per month). These limits usually apply to mobile and satellite-based technologies. Whether users face data caps or not is an important consideration when designing digital services since they will affect usage patterns irrespective of speed, latency and other factors.
- **FTTH** – Fibre to The Home – meaning a fibre optic connection that stretches directly to the point of use. This is currently the gold standard in wired Internet service provision. It is also sometimes referred to as Fibre to the Premises (FTTP), to be sufficiently general to capture business users as well as residential users.

How close a fibre connection gets to the point of use varies and several similar terms exist for different situations, these include Fibre to the Node (FTTN) and Fibre to the Curb (FTTC). These refer to situations where the fibre connection gets close to the point of use but does not stretch all the way. FTTN and FTTC connections typically get to within a few hundred metres of the point of use. The remaining stretch between where the fibre ends and the user's location is usually filled by a pre-existing network technology such as a twisted-pair telephone line or a coaxial cable TV connection.

- **DSL/ADSL/VDSL** – Digital Subscriber Line – the technology used for broadband connectivity over traditional twisted-pair telephone network wiring. ADSL refers to an asymmetric version that offers faster download speeds than upload speeds and which is the most common residential form of DSL broadband. VDSL, or very-high-speed DSL, is an advanced version of ADSL.
- **DOCSIS** – Data Over Cable Service Interface Specification – the standard for broadband connectivity over traditional coaxial cable TV wiring. The standard has continually evolved over time, with its latest iteration considered a next-generation technology given the speeds it is able to support.

Barriers to higher broadband connectivity in rural areas

Whether fixed (wired, fixed wireless and satellite) or mobile, the business of providing connectivity involves an upfront cost to build the necessary infrastructure followed by revenue potential over time from the customers who make use of that infrastructure. Variables include the type of infrastructure deployed and the amount of it required, with higher costs for the latest/fastest connection technologies and with greater physical distances respectively. With fewer potential customers per kilometre of wiring, or per radio tower, rural regions encounter a distance penalty. Consequently, achieving connectivity investment in low-density regions has always been a challenge, one that predates digital technology. Across 26 OECD countries, just 64% of rural households had access to fixed broadband with a minimum speed of 30 Mbps in 2018 (2019 for the United States and Canada), compared to 87% of households in all areas (OECD, 2020[43]).

The rollout of broadband differs from traditional telephone connectivity in that the technology is rapidly improving and several competing approaches – whether through wires or wireless, satellite or other solution – exist to achieve the same ultimate objective of connecting people. This creates both new opportunities and also some additional risks for investors and policymakers. While in the past it was possible, given enough time, to achieve universal, equitable access to telephones across the national terrain, broadband is a moving target and the rapid pace of change means the quality of the connection available continues to vary significantly in ways that leave people and firms in rural regions disadvantaged.

While policies that promote competition and private investment, as well as independent and evidence-based regulation, have been tremendously effective in extending broadband coverage in OECD member countries (OECD, forthcoming[41]), there remain some areas, typically low-density rural and remote areas, that are underserved. Today, low-density rural and remote areas across the OECD remain more likely to encounter:

- **Lower speeds and older technologies** – Network operators face a never-ending investment cycle, with each new technology being deployed first in the densely populated urban areas where the high upfront cost is most easily recouped. The latest fixed and wireless broadband technologies, Fibre to the Home/Premises (FTTH/ FTTP) and 5G respectively, are currently being rolled out in cities, while older, slower technologies (e.g. DSL) remain dominant in low-density rural regions (OECD, 2019[44]).
- **Fewer options and less value** – Market competition has spurred investment and helped lower prices for consumers but the level of competition is not consistent across the terrain. New entrants tend to focus on urban areas, providing residents in these areas with higher levels of competition, earlier access to the newest technologies and better value for money. The available performance varies widely between technologies, (e.g. from 1 Mbps to over 1 000 Mbps) but pricing tends to be much less elastic and since rural areas are where the maximum available speed is lowest, rural dwellers are therefore disproportionately paying more per Mbps than their urban counterparts. In June 2019, 98% of urban Americans had access to 3 or more broadband providers, while for rural dwellers the proportion was 79% (FCC, 2019[45]). In 2018, the average lowest-cost monthly bundle for a 12-30 Mbps package of Internet, telephony and television across the EU27+UK was EUR 40.12 while the same package with 100+ Mbps access, cost EUR 53.22: 32% more money for at least 333% more bandwidth (Empirica, 2019[46]). Another important factor is the distinction between advertised speed and the speed actually experienced by users. Distance from the exchange being one of the factors determining the speed experienced by the user at the point of use, rural dwellers may be more likely to see shortfalls in the speed they experience compared to the maximum advertised speed of the connection they pay for.
- **Other limitations** – When comparing connectivity offerings, the commonly used metric is the maximum download speed though this is but one of a range of factors. Download speed is critical for content consumption (e.g. streaming Netflix) but it does not capture the full picture and not all broadband technologies are equal.

- **Data caps** – Fixed satellite Internet services and mobile broadband contracts commonly include caps on the total amount of data a subscriber may use each month, or will otherwise restrict consumption, for example by offering the full-speed connection only for an allocated amount of "priority data", with a lower speed for any usage beyond that.
- **Latency** – Another limitation of satellite-based Internet services is latency times. Latency is the period between requesting information and beginning to receive it. Given the distances involved for signals to reach satellites in geosynchronous orbit, this technology can feel slow even though the download speed may be comparable with other technologies. For example, if someone using a high-latency connection is participating in a video chat, it is likely they would have to pause between sentences or else the participants would end up speaking over each other.
- **Speed asymmetry** – Connection speed asymmetry may be an issue in some circumstances. The most common fixed connection technologies in rural areas, DSL and satellite, both typically offer asymmetric connections, prioritising download speed over upload speed. This makes sense for content consumers but, for those creating and transmitting data, uses that include businesses and public services, it may restrict usability. For example, in a two-way video-call between a student and teacher, a high download speed would permit a smooth, high-definition inbound video stream, while the lower upload speed might deliver only a low-resolution, laggy stream in the other direction. Speed asymmetry is common in several broadband technologies, which makes sense given that content consumption is the common use-case for consumers. While symmetric DSL lines are available, these can cost more and are usually marketed towards businesses not households – an important consideration if digital services are intended to be delivered to the home.

Driven by market forces, broadband provision in lower-density areas has improved and will continue to do so thanks to innovation in connectivity technologies. However, the same market forces that have delivered improvements in the past decade will also likely ensure that geographical inequities remain. These inequities may even widen, at least initially, with the arrival of next-generation connectivity. The next section reviews current and emerging technologies and their implications for lower-density areas, particularly on service delivery.

Technology options to boost provision in low-density rural and remote areas

Several wired, wireless, fixed and mobile technologies are used to deliver broadband connectivity but none offers a perfectly cost-effective solution for low-density and remote areas. Some are already widespread (e.g. DSL) while some technologies are in the process of being rolled out in low-density regions (e.g. VDSL, Cable DOCSIS 4.0, Fibre, 5G, LEO). Among the emerging technologies, some require new networks to be built (e.g. Fibre, 5G, LEO) while others are designed to make use of existing network infrastructure (e.g. VDSL, Cable DOCSIS 4.0). New technologies tend to be more "future-proofed", with headroom to grow in the years ahead, while others aim to squeeze performance from legacy infrastructure that is nearing the end of its useful life. Older technologies are more common outside cities and the relatively higher cost of installation and lower level of competition that exists in these areas means that when network upgrades do happen, they are more likely to leverage legacy infrastructure. Table 5.3 provides an overview of current and emerging technologies.

Table 5.3. General overview of current broadband technologies in OECD countries

	Maximum download/ upload speed (Mbps)	Latency (milliseconds)	Range (km)	Notes
Currently available in low-density regions				
DSL (F)	24/3	Medium	5	• Runs on the traditional telephone network (twisted-pair copper wiring) • The most widely available fixed broadband technology in rural areas in European Union (EU) countries • Speed declines with distance from street-cabinet
Cable (DOCSIS 1.0-3.0) (F)	1 000/200	Low (varies)	100	• Runs on existing coaxial cable television networks • Less widely available than DSL in low-density and remote regions • Bandwidth is shared with other users on the line, so speed may decrease and latency may increase at peak times
Geosynchronous satellite (F)	50/10	Very High	N/A	• Uses geosynchronous orbit satellites to provide universal coverage across all parts of a national terrain • High latency and other limitations restrict its appeal to only those areas that lack alternatives • More information: Lee González Fanfalone et al. (2017[47])
4G/LTE (M)	100/50	Medium	3-6	• Widely available and increasingly affordable but with limited tower capacity • While peak speeds can reach 100 Mbps, this is only possible under perfect conditions. Real-world connectivity is much slower, typically <20Mbps
Emerging				
VDSL (F)	300/100	Low	1	• A more advanced DSL, it continues to use traditional telephone wiring • Has short range, with speed declining rapidly with distance from the base
Cable (DOCSIS 4.0) (F)	10 000/6 000	Low	100	• Fast with good range but only feasible where existing cable TV networks exist
HAPS/LEO satellite/ broadband balloons	50-1 000/10+	Medium	N/A	• HAPS: High-altitude pseudo-satellite LEO = Low earth orbit • These technologies are premised on addressing the latency issue of traditional geosynchronous satellites by bringing the satellite (or pseudo-satellite aircraft, or high-altitude balloons) closer to the earth
Fibre (F)	10 000+/10 000+	Very Low	60	• Fibre is the leading next-generation fixed technology, offering symmetric connectivity with very low latency and huge potential for future growth • The technology is expensive because it requires building an entirely new network, replacing existing twisted pair

	Maximum download/ upload speed (Mbps)	Latency (milliseconds)	Range (km)	Notes
				and coaxial cable networks
5G (M)	30-10 000/30-10 000	Very Low	0.5 – 6	• 5G is highly scalable, with extremely-fast, fibre-like connectivity available over short ranges, while over longer distances it will deliver more moderate improvements on 4G speeds

Note: F = Fixed, M = Mobile.
Source: OECD elaboration based on multiple sources, primarily EC (2018[48]), "Comparison of wired and wireless broadband technologies", https://ec.europa.eu/information_society/newsroom/image/document/2018-17/comparison_of_broadband_technologies_table_75B12AE2-FC37-D44B-C75B5885D383A0FE_51503.pdf (accessed on 13 August 2020).

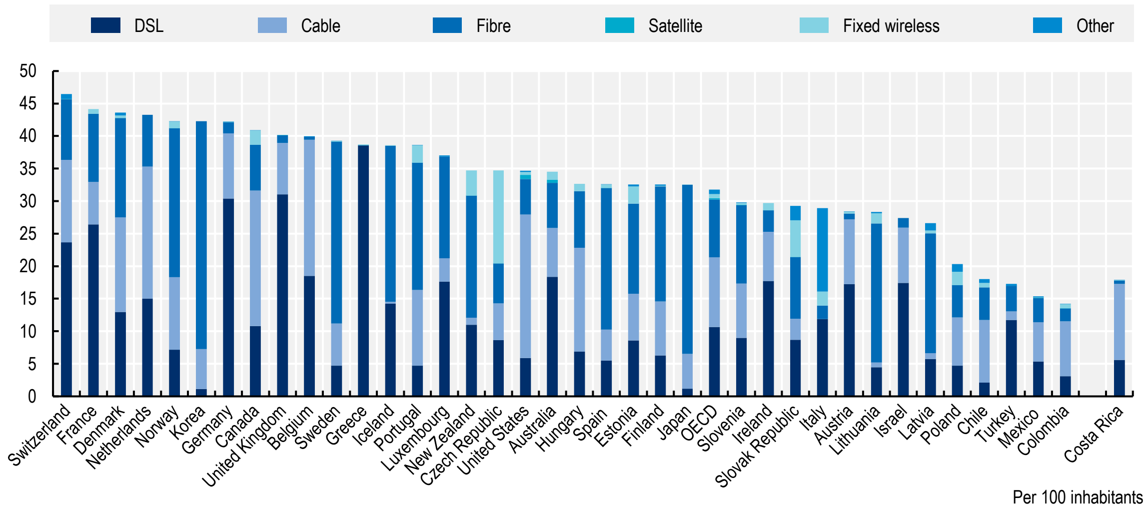
Among the technologies still emerging in low-density and remote regions, VDSL and Cable's DOCSIS 4.0 are advanced forms of connectivity yet they are transitory, a bridge between current and future technologies designed to squeeze performance from networks built long ago. In many cases, networks offering these technologies are already busy upgrading their network backbone and will replace the last mile to people's homes and places of business as a final step in the renewal of their networks. These transitory technologies are not without trade-offs: VDSL's range is short and its speed declines rapidly the further the user is from the line's point of origin. This is because interference along the unshielded copper wiring increases with its length. Cable Internet uses a shielded coaxial network, so interference is less of an issue, however cable bandwidth is shared between all the users connected to the same line, so speed may decline at peak times and latency may increase.

Both traditional telephone companies and cable companies are replacing their older networks with fibre, a true next-generation technology that offers symmetric connectivity, extremely low latency and which can achieve unparalleled speeds. However, there is evidence that some countries where legacy networks were poorly developed are leapfrogging ahead in their fibre rollout. In 2019, fibre represented an average of just 28% of all fixed broadband subscriptions in OECD countries (Figure 5.4), while in China, this number tops 70%. China and Russia currently have around twice as many fibre subscriptions per 100 inhabitants as Canada and the US, 2 countries where fibre penetration remains low (with 5.5 and 7.0 fibre subscriptions per 100 inhabitants respectively) (OECD, 2019[35]), yet also 2 countries with well-developed legacy networks for both telephone and cable TV and above-average broadband coverage generally.

Market forces may encourage network operators to focus on deriving value from their legacy assets while avoiding the large investments necessary to put fibre in the ground but this is likely a medium-term solution at best, especially for those networks based on traditional twisted-pair telephone wiring, one that may ultimately impede future development. With regard to spatial distribution, fibre is more concentrated in cities. For example, in Europe, twice as many urban households than rural households had access to fibre in 2018 (approximately 30% vs. approximately 15% respectively) across the EU27+UK (IHS Markit and Point Topic, 2019[37]) (see Box 5.6 for an explanation on rural area definitions).

Figure 5.4. Fixed broadband subscriptions, by technology

Subscriptions per 100 inhabitants, December 2019



Note: Australia: Data reported for December 2018 and onwards is being collected by a new entity using a different methodology. 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 substantially 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 Switzerland and the US are preliminary.
Canada: Fixed wireless includes satellite.
France: Cable data include VDSL2 and fixed 4G solutions
Italy: Terrestrial fixed wireless data includes WiMax lines; other includes vDSL services.
Source: OECD (2020[42]), *Broadband Portal (database)*, https://www.oecd.org/sti/broadband/broadband-statistics/ (accessed on 15 May 2020).

StatLink https://doi.org/10.1787/888934226766

Box 5.6. Rural definitions used on broadband statistics

This chapter makes several references to urban and rural households and populations. A limitation on the comparability across countries and reports is that rurality is defined in different ways by different organisations. This section uses OECD definitions developed by the Directorate for Science, Technology and Innovation. In addition, it references two other sources:

- **FCC definition (United States data)**

  References to the availability of broadband in the US are sourced from the Federal Communications Commission (FCC) (FCC, 2019[45]). The FCC’s urban-rural definition is derived from the US Census Bureau, which defines urban in two ways:

  - Urbanised Areas (UAs) of 50 000 or more people.
  - Urban Clusters (UCs) of at least 2 500 and less than 50 000 people.

  The US Census Bureau considers rural all locations not considered urban (Ratcliffe, 2016[49]).

- **EU27+UK households**

  References to the availability of broadband to households in the EU27+UK are sourced from an EC report *Study on Broadband Coverage in Europe 2018*. This report was prepared for the EC by IHS Markit Ltd. and Point Topic (2019[37]). Rural in this data is defined as follows: "the research team uses a methodology first developed by Point Topic in 2012, which defines rural areas using the Corine land cover database, and creates a database of population and land type in every square kilometre across Europe. Households in square kilometres with a population of less than 100 are classified as rural. This granular approach based on population density identifies the truly rural areas likely to be unserved or underserved by broadband operators. According to an updated estimation of the rural population in individual NUTS 3 regions, approximately 15% of households in the study countries were rural in 2017. Combining this information with updated population and household data from Eurostat, the EU statistical office, allowed the research team to create new estimates for the numbers of rural households across each market and NUTS 3 area".

Source: IHS Markit and Point Topic (2019[37]), "Digital single market fixed broadband prices in Europe 2018", http://dx.doi.org/10.2759/94991; FCC (2019[45]), *Area Comparison - Fixed Broadband Deployment Data*, https://broadbandmap.fcc.gov/#/area-comparison?version=jun2019&tech=acfosw&speed=25_3&searchtype=county (accessed on 12 August 2020); Ratcliffe, M. (2016), *Defining Rural at the U.S. Census Bureau*, http://dx.doi.org/10.13140/RG.2.2.16410.64969 (accessed on 10 May 2020).

Fibre also plays a key role in the future of mobile connectivity, so much that, going forward, mobile and fixed networks are expected to converge. With previous generation mobile technology, the cellular towers could connect to each other and the wider world (known as backhaul) through copper cabling (e.g. using DSL-based technology), wirelessly (e.g. using microwave antennae) or with fibre. However, the demands of next-generation 5G mobile technology are such that fibre connectivity is expected to be necessary at the towers to support the high-speed, low-latency connectivity the technology is capable of. The need for fibre at the towers may slow the deployment of 5G to rural areas where such fixed networks are scarce.

Another issue that may prove problematic for the delivery of 5G in rural areas is the technology's wireless range. In order to deliver gigabit+ transfer speeds, this technology can make use of very short wavelengths but these waves only travel a short distance, meaning 5G cells must be smaller than previous generation technologies in order to deliver the promised speed increases. Whereas a 4G tower might reliably cover a radius of approximately 5 km, a 5G tower may only provide its maximum potential speed within a few hundred metres. While 5G technology can still be deployed in larger cells, at distances similar to those covered by a 4G tower, a 5G tower may only deliver moderately faster speeds, not the quantum leap its proponents highlight. This limitation, coupled with the need to connect the towers to fibre represent significant challenges to bringing true next-generation connectivity to rural and remote areas, and the level of investment needed to provide equitable access may be higher than that of earlier technologies. If successful, new low Earth Orbit (LEO) satellite technology may become part of the solution (Box 5.7).

Box 5.7. Satellite technology to connect rural areas

LEO satellites may offer a new solution to rural connectivity (Lee González Fanfalone et al., 2017[47]). This technology has the potential to provide both fixed connectivity directly to rural and remote households and to serve as the backhaul for terrestrial 5G towers (negating the need for fibre). This would mean a mobile network operator could build a 5G tower in a remote area to serve that community, with the data flowing to the outside world via satellite. Existing geostationary satellites suffer from high latency due to their altitude, some 35 000 km above the earth. These satellites remain above the same fixed point on the earth's surface, such that only one satellite is needed to cover a whole country or group of several countries like the EU. LEO satellites address the latency issue by orbiting much closer, at around 500 km, but this means they are constantly moving in relation to the planet. The same satellite that provides connectivity in Canada might, a short while later, provide connectivity in Russia or Sweden. A constellation of several hundred of these satellites is therefore needed to blanket the planet with continuous coverage. There is currently much private-sector interest in this technology, with major names like SpaceX investing heavily to develop it, though the business model remains in question (McKinsey, 2020[50]) given the high cost of building and launching so many satellites. Due to the inherently global nature of the technology, global co-ordination for its development and deployment (for example to deal with regulatory issues like foreign ownership of connectivity providers) may be helpful. As of November 2020, SpaceX has launched 955 of their Starlink Internet service satellites with beta testing of the technology now underway in parts of Canada and the US.

Several other technologies have been proposed and trialled, including high-altitude pseudo-satellites (HAPS), such as the Airbus Zephyr solar-powered autonomous drone (Airbus, n.d.[51]), broadband balloons, such as those being developed by Loon, a division of Alphabet/Google (Loon[52]), and free-space optical communication systems (FSOs). FSOs transfer data with a beam of light, much like a fibre connection, except with an FSO there is no fibre; the light is beamed point-to-point through the air. These systems can theoretically achieve speeds and latency similar to fibre at a fraction of the installation cost, the major downside being that obstacles blocking the beam (e.g. precipitation and pollution) can slow or break the connection. An LED-based installation was built and operated successfully for many years in the Czech Republic beginning in 2001 (Twibright Labs, n.d.[53]) and a much more ambitious laser-based system is currently being deployed in Bengaluru, India (Wifi Dabba, n.d.[54]). All of these systems have different advantages and disadvantages and none is perfect. The best solution for any given location will depend on the circumstances of that location, indicating the need for a technologically agnostic, place-based approach, with the need to find solutions for rural and remote places becoming more urgent as fibre and 5G become more widespread in cities.

Source: Lee González Fanfalone, A. et al. (2017[47]), "The evolving role of satellite networks in rural and remote broadband access", https://doi.org/10.1787/7610090d-en (accessed on 2 October 2020); McKinsey (2020[50]), "Large LEO satellite constellations: Will it be different this time?", https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/large-leo-satellite-constellations-will-it-be-different-this-time# (accessed on 17 August 2020); Airbus (n.d.[51]), *Zephyr - UAV - Airbus*, https://www.airbus.com/defence/uav/zephyr.html#capabilities (accessed on 19 August 2020); Loon (n.d.[52]), *Connecting People Everywhere*, https://loon.com/ (accessed on 19 August 2020); Twilight Labs (n.d.[53]), *RONJA*, http://ronja.twibright.com/ (accessed on 19 August 2020); Wifi Dabba (n.d.[54]), *Homepage*, https://www.wifidabba.com/ (accessed on 19 August 2020).

As governments look at using digital tools to deliver public services to areas outside cities, a place-based approach will also be an important factor in service design, one that includes consideration for the locally prevailing connectivity technologies. For example, an educational service that includes a unidirectional video feed of the teacher, with students asking questions via text message, would likely work better for communities dependent on an asymmetric technology like ADSL, than one that requires significant bi-directional flows of data, such as a video conference between both the teacher and the students.

Services where bi-directional data flows are essential, such as a teleconsultation between a doctor and patient, may require that the government create locations outside cities equipped with a symmetric connection that residents can then visit to use the service since they are unlikely to have such connectivity at home. Looking ahead to more advanced applications like remote surgery, next-generation speeds with low latency and extremely high reliability will be needed to enable these. Other services that require low latency, such as real-time monitoring/response for health care purposes, are already being delivered in some areas. One example is in Sweden, where doctors are offering patients a wearable real-time, remote cardiac and respiratory monitoring device that leverages cloud computing to enable physicians to remotely detect murmurs and auscultate heart and lungs during their patient's daily life. Services like these may not work for areas dependent on traditional satellite connectivity or other high-latency technology, or that lack mobile coverage. Until these issues are addressed, these areas may be better suited to "store and forward" telehealth services. The US Veterans Administration currently delivers one such telehealth initiative. Through VA Telehealth, patients can have medical data such as their blood oxygen levels, pulse, blood sugar, heart and lung sounds, collected and monitored remotely, on a regular basis (e.g. a daily check of a patient's vitals), albeit not in real-time.

With so many technological options available, each with advantages and disadvantages, it is not obvious which to pursue, nor would it be wise to prescribe specific solutions since the constant innovation taking place means the best fit for any given part of the terrain is fluid. In light of this, many governments have today taken a technology-agnostic approach to promoting broadband, yet pure agnosticism may miss important distinctions. A 100 Mbps VDSL connection, from the policymakers' perspective, is not the equal of a 100 Mbps fibre connection, though the experience of using it might feel the same to a consumer since one is at the height of its potential while the other is only at the beginning. The next section examines several of the ways governments are working to expand broadband to low-density rural and remote areas to review how these challenges are being dealt with.

Current approaches to closing connectivity gaps

Governments across the OECD have recognised the important role of connectivity in driving future prosperity, cohesion and well-being. All member governments, with the exception of Japan, have identified specific goals for broadband availability. Japan has already achieved universal access to the connectivity of at least 30 Mbps and half of all Japanese households already have access to at least 100 Mbps, so it has chosen not to set additional goals (OECD, 2018[36]). For all other members though, targets have been set for broadband speeds and the continued expansion of its availability, along with timelines.

As discussed above, the technology continues to improve, as do the demands of connected applications and services, so the definition of what constitutes broadband continues to evolve. When the OECD first defined broadband in 2001, the minimum speed required to qualify was approximately 0.25 Mbps, a speed that would not meet anyone's idea of a fast connection today, insufficient to stream even the most basic video. Most OECD governments have targeted a download speed over 100x faster than that early definition, of at least 30 Mbps and in several cases 100 Mbps, to be achieved in most cases for all households by 2020. Where upload speeds are also targeted, asymmetry is embedded into the targets, with targeted speeds for uploads generally half or less those targeted for downloads, reflecting the ongoing reliance on older network technologies in most countries. In support of these targets and timelines, governments have taken a wide variety of approaches, to reduce regulatory barriers and improve competition, to facilitate demand aggregation models and in many cases to invest public funds. This section reviews several of these to examine potential lessons.

Supporting the business case through demand aggregation models

In some low-density communities, the deployment of broadband might make sense for a communications company if it could be confident in advance of building the network that it would secure sufficient subscribers to achieve an adequate return on the investment. Demand aggregation models are intended to help give investors this confidence, by essentially signing up customers in advance (OECD, forthcoming[41]). For example, a company may require that a certain percentage of households in a given community commit to using their broadband service for a certain period before they proceed with the deployment. In some countries, the risks for the private sector are further reduced when a local organisation (i.e. a municipality or co-operative organisation) handles the demand aggregation process, securing commitments from residents to subscribe to the service then contracting the private-sector operator to develop the network (OECD, forthcoming[41]). Thus, demand aggregation can be a tool that is used either directly by the private sector (likely in cases where the investment decision was on the margin) or in combination with other approaches described here.

Putting the community in control through locally owned co-operatives

In the early part of the last century, mutual and co-operative organisations at the local level played a key role in bringing electrical and telephone service to the rural US. In the 21st century, many of these same organisations are now working to do the same with broadband. Across the US, there are now more than 200 rural co-operatives building advanced broadband networks, many of them providing FTTH, in rural communities. Research has shown these networks typically provide connectivity that is cheaper than that of private-sector incumbents (Talbot, Hessekiel and Kehl, 2018[55]), with prices for an entry-level broadband connection (25Mbps) priced between 3% and 50% lower than the same service from a private provider in 23/27 surveyed communities where comparisons were possible. In many cases, the connectivity provided by rural co-operatives is also faster.

Dakota Carrier Network

One particularly successful example is in North Dakota. The state is highly rural and sparsely populated, with a density of just 4.1 persons per square kilometre. Out of the 50 states plus Puerto Rico and the District of Columbia, North Dakota ranks 49th in population density. Despite this, 70% of rural residents have access to gigabit-speed fibre connectivity (FCC, 2019[45]), a level that far exceeds the current average level of fibre provision in both rural (12%) and urban (24%) areas nationwide (as of June 2019). This was achieved in large part thanks to a consortium of small, independent rural companies and co-operatives that came together in 1996 to purchase the 68 rural exchanges of the incumbent telephone company, US West (now named Century Link). In doing so, these small organisations formed the Dakota Carrier Network (DCN), a state-wide umbrella organisation that covers 90% of the state's land area and 85% of its population (Sousa and Herman, 2012[56]). Federal support for their fibre-building efforts came from the Broadband Technology Opportunities Programme (BTOP), which provided USD 10.8 million for a project to construct 272 km of new fibre in the state, with backhaul speeds as fast as 1 Gbps to enable last-mile service. The project also enhanced e-health in the state by deploying a dedicated 10 Gbps healthcare network to over 200 hospitals, clinics and other healthcare providers to enable telemedicine, teleradiology, telepharmacy and electronic health information exchange (NTIA[57]).

B4RN

Broadband for the Rural North (B4RN) is a non-profit community benefit society that operates a broadband network dedicated to providing fibre to the home/premises in North West England. B4RN offers 1 Gbps symmetrical fibre broadband to every property in their coverage area. Subscribers are charged an initial GBP 150 installation cost then GBP 30 per month for their service. For a premium price of GBP 360 installation and GBP 150 per month, the organisation offers its subscribers 10 Gbps connectivity, leading B4RN to describe their offering as the world's fastest rural broadband connection. B4RN supports public services and community development in its region by offering free connections to religious institutions and discounted access to schools (B4RN[58]). Anyone who hosts one of their nodes on their land is given free service for life. Like the community organisations in Finland and Sweden, B4RN relies heavily on voluntary support from the community. It also raises money from investors and through crowd-sourced bond issues. When a new community on the edge of the existing coverage area wishes to be connected, B4RN asks them to raise investment and gain support from local volunteers and landowners. The government has provided indirect support by providing tax relief to investors via the Enterprise Investment Scheme and the organisation has also received support as a registered supplier of the government's Gigabit Broadband Voucher Scheme, discussed in more detail below.

Simplifying subsidies using vouchers for consumers and businesses

Several countries have established voucher programmes to assist consumers in getting connected. In some cases, these are to help low-income households pay the subscription fee, while in others they intend to encourage service providers to expand their networks and to encourage communities to work together on the issue. These vouchers are a relatively new form of subsidy programme, with the advantage that they permit recipients, rather than the government, to decide which provider and broadband technology are best suited to their needs. Vouchers may also be more accessible to smaller entrants like B4RN than a more traditional project or auction-based subsidy programmes since these typically require that the provider participate in a state-administered application and/or bidding process.

The UK Gigabit Broadband Voucher Scheme (GBVS) and the Scottish Broadband Voucher Scheme (SBVS) are examples. Under the GBVS, homes and businesses in rural areas of the UK are eligible for funding towards the cost of installing gigabit-capable broadband when part of a group scheme. Group projects are when two or more residents and/or small- and medium-sized enterprises (SMEs) get together to combine their vouchers towards the shared cost of installation. Single connections are not eligible for additional funding. Rural premises with broadband speeds of less than 100 Mbps can use vouchers worth GBP 1 500 per home and up to GBP 3 500 for each SME to support the cost of installing new fast and reliable connections. The voucher funding is transferred directly to the consumer's selected supplier on verified completion of the line installation. There are more than 450 registered suppliers, participating in the programme, including major national companies like BT, Virgin Media and TalkTalk, and also small co-operatives like B4RN.

The SBVS has been introduced as a supplement to the Scottish Government's main national broadband project, which is known as the Reaching 100% or R100 programme. Through R100, the government is investing GBP 579 million to install Fibre to the Node (FTTN) broadband nationwide. This network design is intended to fulfil a commitment to provide access to broadband of 30 Mbps to every home and business in Scotland. Despite the investment however, some homes and businesses in the most remote areas are expected to remain out of the scope of the programme, while for others, it will take several more years before the network upgrades are built in their area. The SBVS, therefore, provides 2 distinct levels of subsidy: a voucher worth up to GBP 5 000 to help deliver a permanent broadband connection to those properties which are out of the scope of the R100 plan; and a voucher worth up to GBP 400 to help deliver an interim connection to those properties for which R100 broadband is planned but not until 2022 or later. Properties in more difficult-to-reach locations may be eligible for an additional subsidy of GBP 250. Funding for both voucher programmes comes from the respective governments.

Project and auction-based subsidy programmes to drive change at scale

Several governments have used subsidies as a tool to encourage service providers to expand their networks into areas where they would not otherwise invest. As a relatively minor market intervention (as compared to public options and other interventions covered here), these programmes can quickly deliver connectivity upgrades. In most rural communities across the OECD, the incumbent provider and therefore a likely subsidy recipient, is a privately owned for-profit company; in many cases, it is the country's largest telecommunications corporation. The use of public funds to build what then becomes private assets can attract controversy. To address this, several governments have tied public subsidies to requirements for open access, such that incumbent providers must make their lines available to new entrants. However, the success of these efforts in creating competitive marketplaces may be somewhat tied to the technology used. If open access is applied to true next-generation technologies like fibre (FTTH), it may lead to competition that delivers continuous improvements well into the future. On the other hand, if it is applied to technology leveraging legacy infrastructure, like VDSL, then the business case for upgrading the legacy infrastructure may be further weakened.

Spain

In recent years, Spain has emerged as a connectivity leader in Europe, with the country's regulatory environment a key driver of private sector-led investment in fibre networks. Two regulatory measures have been key:

- Third-party network access obligations on the formerly state-owned incumbent, Telefónica, were capped at 30 Mbps, meaning that new entrants could use Telefónica's network to deliver connectivity at up to those speeds, with Telefónica obligated to sell them wholesale access at regulated pricing.
- Telefónica was obligated to permit new entrants to use their ducts to build their own networks.

Together these rules provided incentives for Telefónica and others to install fibre, since at speeds above 30 Mbps they would not have to provide access to competitors, strengthening the business case for their investment by reducing the time needed for them to achieve positive returns. The result has been a rapid rollout of FTTH connectivity across the country, with fibre as a percentage of total fixed broadband connections growing from 35% in 2016 to 67% in 2019 ((OECD, 2020[42])). Telefónica claims that Spain now has more installed fibre than France, Germany, Italy and the UK combined (Telefónica, 2020[59]). The supportive regulatory environment is bolstered by subsidies outside of the cities. Backed by funding from the European Regional Development Fund, Spain has delivered two major programmes to subsidise connectivity investment in these areas:

- Next Generation Broadband Expansion Programme (NGBEP) – This programme is intended to support the investment effort of private operators, with the aim of extending the deployment of high-speed broadband networks (more than 100 Mbps) to the most rural areas. From 2013 to 2020, the programme held annual application windows for providers to propose projects through a competitive application process. Funding was a mixture of grants and repayable loans. Beneficiaries of the aid are obliged to offer wholesale access to the subsidised infrastructure for a minimum period of seven years from the date of entry into service. Funding over the 7 years totalled approximately EUR 540 million, around 80% of it in loans and 20% grants.
- The 300x100 Project – Following on from the NGBEP, this 300x100 project aims for even faster connections, targeting connectivity of at least 300 Mbps to 100% of premises nationwide. The project is distributing up to EUR 525 million to fund specific projects in rural areas.

United States

The US Department of Agriculture (USDA)'s ReConnect programme is a pilot initiative aimed at increasing broadband development in rural areas through the provision of federal grants, loans and combinations thereof. Eligible applicants include for-profit companies, non-profit entities, and state and local governments. Up to USD 600 million is being made available through the current allocation, approximately 50/50 grants and loans (USDA, 2019[60]). Applications will be assessed against criteria such as the rurality of the location, the number of farms, businesses, educational and medical facilities and the number of essential community facilities (e.g. emergency centres) that are included in the proposed service area. A minimum bandwidth of 10 Mbps download and 1 Mbps upload is required, though bonus points are available during assessment for connections that can sustain a symmetric 100 Mbps.

In 2019, the Federal Communications Commission (FCC) proposed to establish a USD 20.4 billion Rural Digital Opportunity Fund (RDOF) that will, through a series of reverse auctions, distribute funding to service providers with the aim of improving connectivity in rural areas. The programme is targeting over 6 million homes. The first auction is expected to take place in October 2020 and the criteria include consideration for both speed (upload and download) and latency.

In addition to these programmes, the US government has an American Broadband Initiative (ABI) that aims to increase the transparency and responsiveness of federal processes with regard to broadband and to better leverage federal assets in its provision. Among the objectives of the ABI is to increase co-ordination between the USDA and the FCC to ensure their respective programmes are complementary and not overlapping.

Canada

Given its size, challenging terrain and low population density, rural and remote broadband provision in Canada has been a key challenge for the government for many years. Several different federal programmes have provided subsidies to service providers in an effort to have them improve the connectivity in these areas (Table 5.4). The government of Canada currently targets making a minimum speed of 50/10 Mbps (download/upload) available to at least 90% of households and businesses.

Table 5.4. Major federal broadband programmes in Canada

Programme	Department responsible	Description
Connecting Canadians	ISED	Since 2015, the Connecting Canadians programme has helped households in rural and remote areas get access to high-speed Internet and participate in the digital economy. Connecting Canadians projects are expected to provide up to 350 000 households with improved connectivity. The programme ends in 2020.
Connect to Innovate	ISED	Launched in 2016, the Connect to Innovate programme is supporting over 220 different projects across Canada, which have the potential to impact 390 000 households. When completed, these projects will bring high-speed Internet access to approximately 975 rural and remote communities, including 190 Indigenous communities. Most projects are currently in the building phase and many are expected to be completed in 2020.
Universal Broadband Fund	ISED	The Universal Broadband Fund will provide up to CAD 1 billion over 10 years to support broadband projects across Canada. The fund is still in development and details of the funding mechanism have not yet been announced, however, it is intended to address the needs of rural and remote communities, and it is expected to launch in 2020.
CRTC Broadband Fund	CRTC	The CRTC is providing a CAD 750 million fund to support projects that will provide broadband Internet and mobile wireless services in eligible underserved areas of Canada.
CIB Broadband Funding	CIB	The Canada Infrastructure Bank plans to invest up to CAD 2 billion to accelerate connectivity in underserved communities by focusing on the development and execution of large, high impact projects. They will provide low-cost, flexible financing, in co-operation with Internet service providers and potentially other governments (e.g. provincial, municipal). Aims to connect more than 750 000 households, businesses and institutions.

Note: ISED = Innovation Science and Economic Development Canada; CRTC = Canadian Radio-television and Telecommunication Commission; CIB = Canada Infrastructure Bank.
Source: ISED (2020[61]), *Homepage*, http://www.ic.gc.ca/eic/site/icgc.nsf/eng/home (accessed on 15 May 2020); CRTC (2020[62]), *Homepage*, https://crtc.gc.ca/ (accessed on 15 May 2020); CIB (2020[63]), *Homepage*, https://cib-bic.ca/en/ (accessed on 15 May 2020).

In addition to these major programmes, specific funds are available for remote communities in the far north and Indigenous communities, through the rural and northern communities' stream of the Investing in Canada Plan and the First Nation Infrastructure Fund respectively. Connectivity in the Arctic region is particularly challenging, yet the importance of achieving it was recently highlighted in a report by the Arctic Council Taskforce on Improved Connectivity in the Arctic (Artic Council, 2019[64]). In addition to other issues highlighted in this report, the council report noted the importance of redundancy in the connection, especially for health clinics, schools and other services where network reliability is critical for these services to be delivered effectively.

Funding through all of these programmes is distributed on a project basis to selected applicants following a competitive process. Applicants are asked to provide detailed information such as the specific communities involved and the number of people/households impacted, the speeds that will be achieved and the technology used. ISED programmes are funded through general government revenue, while the CRTC's Broadband Fund is funded through a universal service contribution levied on telecommunication service providers. The Canada Infrastructure Bank makes use of federal funds but also seeks private investors.

Canada's major telecommunication companies are significant recipients of these subsidies: for example, Telus Communications received CAD 23.5 million from the Connecting Canadians programme (ISED[65]) and with the Connect to Innovate programme, 48% of the approved projects (106 of 219) have been with Bell Canada, which has received over CAD 50 million (ISED[66]) towards those efforts. Funds provided typically do not need to be repaid, nor does the government take equity in the provider.

Driving competition through the creation of publicly owned market entrants

Ensuring the adequate and equitable provision of connectivity is an issue that is often taken into public hands. While public monopolies are uncommon today in the communications sector, much more common is the establishment of public providers that compete with the private sector, this is particularly true at the local and regional levels.

SaskTel

SaskTel, first established in 1908 to provide telephone services, is a provincially owned company that today offers mobile and fixed broadband in one of Canada's most rural provinces, Saskatchewan. With the guiding principle that rural and remote residents should have access to quality, advanced services at rates reasonably comparable to urban residents, the company has built the most comprehensive network in the province, with better coverage in rural and remote areas than any private provider. This has included working with the federal government to provide fibre broadband to health centres and schools in Indigenous communities. The company competes in the market alongside Canada's major private providers (i.e. Bell, Rogers, Telus), offering a public option that helps to boost competition. In 2017, Canada's Competition Bureau found that the presence of strong regional players in the Prairie Provinces had led to substantially lower pricing for mobile subscriptions in this region of Canada, and that data usage by residents was also substantially higher (Competition Bureau Canada, 2017[67]). The company operates profitably, paying for its network development with its revenues as well as paying dividends to the provincial treasury.

Reykjavik Fibre Network

Another example is found in Iceland, where one of the world's highest rates of fibre connectivity has been achieved thanks in part to the municipally-owned Reykjavik Fibre Network (known locally as Gagnaveita Reykjavikur). The fibre network has been developed by Reykjavik Energy, a for-profit utility that is owned by the Icelandic capital's municipal government. The utility provides electricity, water and waste-water treatment services in addition to fibre connectivity. Though the network began in the capital city, it has since been expanded to neighbouring regions and is continuing to expand.

The network is based on a wholesale open-access model, with subscribers able to select between multiple providers for the services they receive. The construction of the municipally-owned network has not displaced the private sector; Iceland's major telecommunications company continues to own and built its own network in competition with the Reykjavik Fibre Network. To minimise the disruption associated with construction (trench digging, road closures, etc.), the private and public network builders signed a co-operation agreement in 2018 such that whenever one of them installs a new section of fibre, it will install two independent lines in the trench at the same time so that the ground need only be dug up once (Iceland

Competition Authority, 2018[68]). Combined, these 2 fibre networks now connect more than 120 000 Icelandic homes, 82% of all homes. As of April 2020, 65.9% of Icelandic households were making use of the connection, the highest proportion in Europe (Ljósleiðarinn, 2020[69]).

While the Reykjavik Fibre Network is being built by Reykjavik Energy on a commercial basis, in the most remote areas of the country, some national government subsidies have been made available to connect outlying premises. This funding, through the Iceland Connected to Light initiative, is provided to municipal governments to co-fund their network development activities. Iceland considers local government participation vital to bringing fibre networks to rural areas. Three project application rounds took place between 2016 and 2019, each distributing ISK 450 million with the objective of connecting up to 6 000 premises.

Sunet and municipal fibre in Finland and Sweden

Other examples have been considered in previous OECD documents, such as municipal fibre in Sweden (OECD, 2018[36]). Swedish municipalities began building their own fibre networks in the mid-1990s following the liberalisation of the telecommunication market. Within a few years, these networks grew to cover entire communities, serving homes and businesses and connecting cell towers. Similarly, to SaskTel, these networks have not displaced private operators; rather, they offer effective competition that exerts pressure on the private operators' prices and service levels.

In rural and remote areas, municipal community co-operatives have been formed to build these networks in Finland, Sweden and other countries. Sunet, a non-profit municipality-owned fibre network that connects 55 villages in rural western Finland, is an example of this concept. Sunet is an open-access network that is used by a variety of private-sector service providers to offer connectivity packages to consumers. Sunet however does not charge for this access, opting to bill consumers directly a fixed fee for the network's maintenance. This lowers the barrier to entry for service providers and encourages greater competition. These community projects are made possible through streamlined regulatory approvals at the local level (which reduces costs), voluntary work contributed by local residents and with funding support from the government. In the case of Sunet, a portion of this funding was in the form of a bank loan guaranteed by the local municipalities, coupled with a contribution from the national government (FTTH Council, 2013[70]).

Gaining expertise and sharing risk through public-private partnerships

While all the models examined include roles for public and private actors, those that follow bring these two together in more explicit partnerships aimed at sharing the investment cost and risk of broadband projects. While these examples are not explicitly aimed at rural areas, they may be applied in such settings.

Community Fibre Partnership

British broadband network operator Openreach offers a Community Fibre Partnership (CFP) initiative whereby communities can register their interest in improved connectivity and then work with the company to build a customised fibre solution to bring fibre broadband to the community's homes and businesses. These projects involve a cost-sharing contract between Openreach and the local community which sees the company paying part of the cost and the community paying the rest. Sources of funding for the public contribution at the local level can include the national government's GBVS. As of 2019/20, Openreach has signed 1 330 partnerships connecting 122 000 homes and businesses to fibre through this approach (Openreach[71]).

Westminster, Maryland

The town of Westminster, Maryland, with a population of approximately 18 000 inhabitants, is a community on the outskirts of Baltimore that has traditionally experience weak broadband connectivity. In 2010, the state of Maryland received a large award from the federal government to deploy a regional fibre network called the Inter-County Broadband Network (ICBN) that included infrastructure in Westminster. Seizing on the opportunity that the ICBN project offered, the town launched an initiative to improve its connectivity through a middle-mile fibre network (Hovis et al., 2014[72]).

With the ICBN project, the city saw an opportunity to expand the last mile of the network to serve residents but it was not well equipped to accomplish this, lacking a municipal organisation with the expertise necessary to tackle this technical challenge. Since Westminster did not have the resources or expertise to develop a municipal fibre network of its own, they decided to take an innovative approach based on a public-private partnership. Westminster would build, own and maintain a fibre network but it would look to a private-sector partner to light the fibre, deliver services and handle relationships with customer residents and businesses. This approach meant the city did not need to have any involvement in the network's operations. The city sought a partner via a request for proposals (RFP) and eventually selected Ting Internet, a Canadian company headquartered in Toronto (Hovis et al., 2014[72]).

Under the terms of the partnership, Westminster is building and financing the fibre network through a bond offering, while Ting leasing the fibre through a two-tier lease payment. Ting was also required to commit to building an open-access network by opening its operations to competitors through wholesale within two years so that other providers can then enter the market. The two-tiers on the lease payments include one based on the number of premises the fibre passes and another based on the number of subscribers Ting enrols. The model shares the risk between the town and Ting. While Westminster took on the bond to build the network, the payment structure with Ting requires that it pay the town a monthly fee for every premise the fibre passes, irrespective whether those premises are subscribers; thus Ting was financially obligated to the city even if it had no customers. This ensured that Ting would be motivated to sign up as many subscribers as possible. An additional mechanism built into the partnership deepened this risk-sharing. In any quarter where Ting's financial obligations to the town were less than Westminster's debt service costs, Ting was obligated to pay 50% of the shortfall, while, in quarters where the company's contributions were larger than the debt service, Ting would be reimbursed an equivalent amount (Hovis et al., 2014[72]).

National Broadband Ireland (NBI)

The government of Ireland has embarked on a major project to provide nationwide access to fibre connectivity. Two features of the NBI initiative are of particular interest:

- The new fibre network is being built with state support only in those areas of the country where the private sector would not invest (i.e. the government's intervention will not apply in the major urban areas where the private sector is providing connectivity).
- The network is being built using a public-private partnership (PPP) model, which reduces the government's costs and exposure to risk, but also means that the new network that is built will be privately owned, operated and maintained.

This process began in consultation with the private sector to determine which areas of the country would be connected on a purely commercial basis. The major incumbent provider, eir (Eircom Limited), a formerly state-owned telecommunications company, indicated which parts of the country they had already connected and which they planned to connect in the near term, and the remaining territory was deemed an intervention area, where state support would be needed. The intervention area is home to about 1.1 million people and 540 000 premises, in rural and remote areas of the country. Having determined the intervention area, the government then partnered with a private-sector investor through a PPP. NBI is a privately owned company that aims to deliver advanced connectivity to all premises in the intervention area, installing up to 146 000 km of new fibre. NBI's investment will be backed by state subsidies of up to EUR 3 billion (over the 25-year term of the agreement). Through the PPP, NBI will own the network and will generate income by selling wholesale access to service providers; however, NBI will also carry risk, as the government's support is capped so any cost overruns will be borne by the private investors (Department of Communications, Climate Action & Environment, 2019[73]).

With the construction of the new fibre network expected to take up to seven years, an additional feature of Ireland's broadband plan is the inclusion of interim measures for those areas where fibre installation is still some time away. Through the designation of 300 broadband connection points (BCPs), the government and NBI are working to bring connectivity to rural and remote regions more quickly – with temporary wireless connections to these facilities to be installed within the first 12 months. BCPs will be located in buildings such as community centres and sports clubs. These facilities will be provided with a wireless broadband connection (up to 150 Mbps) as a temporary measure until the fibre connectivity arrives in the community and will make access to that connectivity freely available to the public onsite. Some locations will also have additional facilities, such as hot-desking, and may be used as hubs to support local economic and social development initiatives, including digital service delivery. The intent is that these will form an important element of the local digital strategy developed by local authorities to increase adoption and usage of digital technologies by businesses and communities.

Rural hubs like Ireland's BCPs have been used with some success in other countries, including France and the UK, where they are similarly used not only to provide connectivity but to combine that with training and support to develop rural skillsets and foster the uptake of digital tools by local firms and residents (ENRD, 2017[74]).

The complex public wholesale monopoly

The final example demonstrates the creation of a publicly owned wholesale monopoly. The national telephone network in Australia began similarly to that of many other countries as a publicly owned entity within the national postal service. In common with a pattern seen in many countries, Telecom Australia, which became Telstra, was privatised in the 1990s and the market was opened to competition, though in the Australian case, Telstra retained a dominant position in the market. In 2009, the government identified the need to upgrade the country's network infrastructure as a priority and wanted to achieve that in a way that did not re-enforce the already dominant position of Telstra. Estimates at the time indicated that 700 000 households in rural and remote areas had no broadband coverage of any kind and there was a lack of incentive for continued investment. The government decided to use the federal capacity for low-cost borrowing to finance the development of a new national broadband network, one that would support further growth in capacity in the network as a whole as well as pursuing equitable connectivity for rural and remote areas in so far as was technologically possible.

The National Broadband Network (NBN) is one of the country's largest-ever public infrastructure project, funded with AUD 29.5 million of equity and AUD 19.5 billion in debt. Under this initiative, the government is progressively transforming the country's fixed connectivity infrastructure into a for-profit, publicly owned monopoly wholesaler. As a wholesaler, NBN does not sell services directly to the public, rather it sells access to its network to retailers such as Telstra, Optus and TPG telecom, as well as new entrants, on a level playing field basis, making it an open-access network. For those households that were already receiving services over Telstra's voice and ADSL-capable copper, they are notified when NBN has completed its upgrades to their home's connection and they are then transitioned from Telstra's copper to the NBN (they may have a choice of several different providers). Residents are given an 18-month transition period during which they must choose a new NBN-based provider, after which the old cabling is logically disconnected (Department of Infrastructure, Transport, Regional Development and Communications[75]).

The original plan called for 93% of all households and businesses to be connected with fibre to the home/premises, with the new NBN company replacing the old copper wires, but re-using the ducts and exchanges of Telstra for this purpose where possible (something they pay Telstra for permission to do). Of the remaining 7%, fixed wireless technology would be used for 4% and satellite service would be provided for the remaining 3% (Morrow, 2018[76]). The country launched two geosynchronous satellites named Sky Muster 1A and 1B in 2015 and 2016 to provide satellite coverage. These offer download speeds of 25 Mbps and 5 Mbps upload speeds, albeit with the same latency issues of other geosynchronous offerings. In 2013, the plan was significantly modified to reduce cost and speed up implementation by making use of existing telephone and cable TV wiring for the final section of wiring into people's homes and business premises. Completion of the initial network is expected in 2020 and is intended to deliver speeds of 25 Mbps to all premises, and at least 50 Mbps to 90% of fixed-line premises.

The initial construction cost of NBN has been financed by the government through AUD 29.5 billion in contributed equity and a further AUD 13.1 billion in loans as of 30 June 2019 (NBN Co., 2019[77]). These costs are expected to be repaid through the revenue the network generates in the years ahead. To foster greater equity and inclusion across the country, NBN charges the same wholesale rates to all service providers regardless of their size and it charges the same rates nationwide for each of its delivery technologies (fixed line, fixed wireless and satellite), including in rural and remote areas, where the infrastructure installation costs were said to be higher. While in many parts of the country NBN will be the only fixed-line operator, it does not have legislative monopoly protections and is subject to competition from fixed-line and wireless competitors. Companies including Telstra have indicated they intend to leverage the 5G networks they are building to compete with NBN in the future. This is, however, likely to happen only in the most densely populated urban areas rather than in low-density rural and remote areas.

Unlike Ireland's NBI, which focuses only on the underserved parts of the country, the Australian NBN set out to connect the whole country, including in its densely populated urban areas (which also suffered from underinvestment prior to the creation of the NBN). In the early phase of the rollout, NBN was instructed to deliver its network to areas that were "underserved". This decision has meant NBN delivered high-speed broadband to areas of the country that were most lacking first and has also meant that a uniform standard of broadband has been able to be delivered across the whole Australian continent. This ambitious project has proved very large and very complex.

COVID 19 responses

Across the OECD, response measures during the COVID-19 crisis have included efforts to close the digital divide and accelerate efforts to better connect rural and remote areas. These efforts took on new urgency during lockdown periods where populations came to rely more heavily than ever before on digital connectivity and services while states also sought to leverage technology to maintain delivery of public services such as health and education. Demand for broadband communication services has soared since the crisis began, with some operators experiencing as much as a 60% increase in Internet traffic (OECD, 2020[78]).

The United States' Coronavirus Aid, Relief and Economic Security (CARES) Act allocated an additional USD 100 million to the USDA's ReConnect programme along with USD 25 million for the department's distance learning and telemedicine programme. The FCC also received USD 200 million for a new COVID-19 Telehealth programme. In August 2020, a new bill before congress, the Accelerating Connected Care and Education Support Services on the Internet (ACCESS the Internet) Act, proposed an additional USD 400 million for the FCC's telehealth programme, after it quickly exhausted its original allocation. The programme provides immediate support to eligible healthcare providers responding to the COVID-19 pandemic by fully funding their telecommunications services, information services and devices necessary to provide critical connected care services. The new bill also proposes USD 100 million for the Department of Veterans Affairs to expand its connected health access for veterans in rural and underserved areas after the department reported a 1 000% increase in demand for this service during the pandemic. The bill also includes USD 1.3 billion for the Department of Education to boost distance learning.

In Korea, the government has announced plans to invest a total of KRW 1.3 trillion in the digital transformation of education infrastructure for all elementary, middle and high schools, universities and vocational training institutions by 2025. This includes plans to deploy high-speed Internet services in all classrooms of elementary, middle and high schools nationwide by 2022, the replacement of 200 000 old personal computers and laptops for teachers and the provision of 240 000 tablet PCs at 1 200 schools designated as Pioneers for Online Textbooks. The government will also establish an Integrated Platform for Online Education that can offer a variety of customised educational materials. Online education provided at universities and vocational training institutes is also being enhanced.

In Canada, part of the federal government's COVID-19 response has been to accelerate delivery of its existing rural and remote connectivity programmes, pushing the funding out more quickly than originally scheduled to connect more communities more quickly. At the subnational level, the Ontario government announced a CAD 315 million initiative to improve rural fixed and mobile broadband services, some of which may be co-invested in projects with the federal government. In an effort to tackle not just the accessibility but also the affordability aspect of getting connected, Ontario also announced a partnership with Apple and Rogers Telecommunications to provide low-income students with iPads and free mobile data plans so they could continue their education during school closures.

Conclusions

Digital services like distance learning and telemedicine have moved to the forefront of public discourse during the COVID-19 pandemic. The potential of these technologies to deliver services that are efficient, effective and resilient is increasingly recognised, as is the understanding that over time these tools will continue to evolve with the ever-increasing capability and transformative effects. Just as was the case with the PLATO system 60 years ago, connectivity is key. Without it, these technologies, with all of their promise, cannot function. Equitable access to connectivity across terrain is, therefore, a priority for national development and cohesion throughout the OECD, yet some disparities remain. In developing digital services, the connectivity available in the targeted rural areas is, therefore, a key consideration, with latency, symmetry, data caps and upload speed all important factors in addition to download speed. Awareness of digital tools and the skills necessary to use them among the local population may also be an issue in rural areas. The government can tackle both these challenges by providing facilities in rural locations with the necessary connectivity and then using those facilities to provide hands-on support to local residents and businesses to help them understand the potential of the new technology and make the most of it.

Some of the most successful initiatives to bring broadband to rural and remote places have been locally-led, driven by municipalities, small-scale co-operative organisations and, in many cases, with the help of volunteers. While major telecommunications companies are occasionally accused of neglecting rural areas, locally-led initiatives benefit from the commitment of the people who live there, who are likely more deeply invested in their community's success. Local control brings real benefits beyond emotional commitment. Planning permission, construction permits and other regulatory instruments necessary to dig trenches are typically within the responsibilities of local governments. These initiatives also benefit from voluntary labour and greater public support, which has been seen to both lower the cost of building the networks and lead to higher uptake of service once it is built.

Some rural areas have benefitted from the longstanding expertise of their local public or co-operative telephone company. These organisations stood ready to provide the necessary expertise that would permit them to build their own broadband networks without the involvement of major telecommunication companies. In areas where such expertise is not available at the local level, a PPP may offer an alternative approach to attain the necessary skills while reducing the community's risk. PPPs have also been leveraged for broadband development at the national level with the same risk-mitigating benefits.

Project- and auction-based subsidy initiatives enable central governments to quickly deliver a large number of connectivity upgrades in many low-density rural and remote places, though these may only offer a short-term solution. Without fixing the underlying market failures that brought about the lagging connectivity in the first place, any upgraded capacity may fall into obsolescence as technology continues its inexorable march, necessitating further rounds of subsidy in future years. In some areas, governments have sought to fix these underlying market problems. Voucher initiatives are a relatively recent form of subsidy which can deliver local control by letting users decide which provider to buy from and which technology to deploy, these may be simpler to administer for the government and also simpler to access for providers. The cost of connecting different places can vary in relation to terrain, remoteness and other factors however, an important consideration in relation to vouchers that offer a fixed amount of support.

In terms of technology, a nuanced agnosticism that prescribes no particular approach yet which leans towards those technologies with the greater potential for future growth may be helpful in driving necessary investment in places where incumbent providers are reliant on legacy networks.

Since national governments cannot force community groups to take the lead and since community-led initiatives alone might deliver wide geographical disparities in outcomes, an approach that combines national initiatives that prioritise access equity, with initiatives like voucher schemes that promote greater local control, offer an approach towards sustainable and inclusive connectivity.

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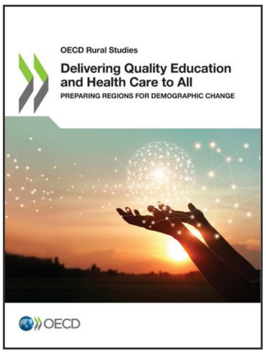
Notes

[1] Speech of Andreas Schleicher, OECD Director for Education and Skills, and Special Advisor on Education Policy to the Secretary-General, to the OECD Forum (https://www.oecd-forum.org/rooms/oecd-forum-virtual-event-schooling-in-times-of-covid-19).

[2] The Australian health system is a complex mix of programmes and services. It includes public and private hospitals, primary healthcare services and referred medical services. Founded on the principles of universal health coverage, free access to public hospital services and partially or completely subsidised access to medical services (through the Medical Benefits Schedule, MBS) and medications (through the Pharmaceutical Benefits Scheme, PBS), are available to all Australian residents and certain categories of visitors to Australia. More information can be found at https://www.health.gov.au/health-topics/medicare.

[3] The *Ségur de la santé* follows a decree of the French government published on 10 March 2020 which aims to relax the conditions of access to teleconsultation for the duration of the pandemic, such as prior knowledge of the doctor by the patient, which implies that the patient has had at least one face-to-face consultation with the doctor in the 12 months preceding the teleconsultation.

[4] A legal notice published on 3 September 2020 in the *Journal officiel de la République française* (Official Journal of the French Republic) questioned the government’s provisions on telemedicine during the pandemic. The notice aims to recover the requirement of prior knowledge of the teleconsultant and prevent telemedicine from leaving the co-ordinated care path (which consists of entrusting the attending physician with the co-ordination of care for the medical follow-up of patients). Link to the legal notice: www.legifrance.gouv.fr/jorf/id/JORFTEXT000042302716/.



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OECD