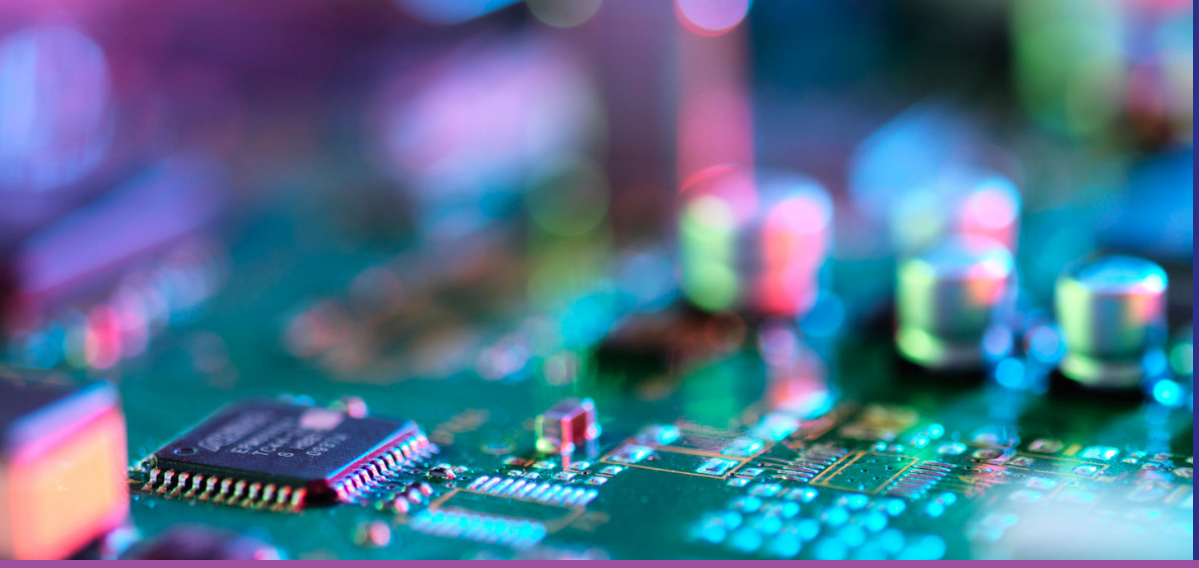

Impact Capital for Development

# The role of broadband in the digital economy

In a digital economy, broadband networks lay the groundwork for fostering inclusion in the digital economy by providing Internet access to billions of people all over the world.

The brief seeks to identify specific attributes of broadband networks that can help policymakers and regulators build a digital economy that includes — and serves — everyone.

The brief, written in close collaboration with Macmillan Keck.

BRIEF

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## Summary

Broadband networks offer high-speed Internet access. Access may be fixed, mobile or nomadic, connecting users via wired or wireless access networks overlaying an invisible fibre backbone. Over-the-top services and apps deliver valuable services and experience for users. Broadband access and adoption have a positive economic impact. Yet, of the 3.8 billion people who remain unconnected to mobile Internet, only 450 million people lived in areas without mobile broadband coverage and 3.4 billion with coverage were not using it in 2020.[1]

Most countries promote competition, but there is no consensus on state ownership. Supply-side markets can be optimized with pro-competitive market rules and spectrum policy, an efficient mix of rivalry and sharing, fit-for-purpose infrastructure sharing models, universal service programs, and reinforced network effects. Regulatory supervision plays an essential role in supply-side competition, requiring regulatory independence, competence, and capacity. Sector regulators can cultivate competition through tailored market interventions. Policymakers can increase broadband adoption rates by addressing demand-side challenges such as digital literacy, affordability, and consumer utility.

## Considerations while reading this brief

1. Which challenges related to access to broadband technology in a digital economy are most prominent in your market, both 1) in general and 2) for historically underserved groups such as women and low-income people?

2. Do broadband policy and regulations in your country address:
   - **Digitization:** The application of broadband regulation to the digital economy?
   - **Inclusivity:** The specific challenges faced by women, low-income people, and/or other underserved groups in accessing broadband?

3. Which entities are responsible for regulation of provision of and access to broadband? Are responsibilities clear, and are mechanisms in place to avoid regulatory arbitrage? If not, how could this be improved?

## Broadband's characteristics and impact

### *High-speed Internet access*

**Broadband** is synonymous with high-speed Internet access. While the International Telecommunication Union (ITU) defined broadband as 256 Kbps in 2003,[2] by 2021, mobile broadband speeds averaged 40 Mbps in high-income countries, 13 Mbps in lower-income and middle-income countries, and below 10 Mbps in sub-Saharan Africa.[3] The **Internet** is a global, public network of networks carrying voice, text, audio, images, video and other information using the Internet protocol suite (TCP/IP) to enable interconnection and interoperability.[5] Its value is driven by strong **network effects**, whereby existing users benefit from adding more users with whom they can communicate.[6] Since release of the **World Wide Web (WWW)** content management system in 1991,[7] the Internet has become the world's universal data network.

### *Last-mile access networks*

Broadband is delivered ultimately to a customer over an **access network**, i.e., the last-mile link to a customer. The access may be provided through a wired or wireless connection,[8] in the latter case reaching the customer through radio waves. A network may be fixed, mobile or nomadic.

**Fixed access**, i.e., wired, enables connection at one location, such as an office or home,[10] and allows particularly high speeds.[11]

**Mobile access** enables connection and movement without disconnection within a wide coverage area. Each network comprises an array of radio base stations or **BTS**, i.e., antenna and associated equipment, spread over its coverage area. The coverage area is divided into **cells**, which can hand off the customer device from one to the other, thus permitting mobility (also referred to as a **cellular network**). A mobile operator can add new cells or increase existing cell capacity to handle increases in traffic.[12] Mobile broadband access has become near-ubiquitous – 94% of the global population had mobile broadband coverage by 2021.[13] Mobile access is by far the dominant means of delivering broadband in low-income and middle-income countries (by 2020, mobile access enabled 87% of all broadband connections in such countries).[14] Four generations of mobile access networks are currently used, from 2G to 5G, supporting increasingly high Internet speeds as the generations have developed.[15] Satellite phones offer remote coverage, but only at 9.6 kbps, limiting their use to emergency response.[16]

**Nomadic access** enables connection at multiple **hotspots**, typically using Wi-Fi, but does not offer connectivity while moving between hotspots.[17] Most **smartphones**[18] contain mobile and **Wi-Fi** radios, enabling connections to either network type.[19] To reduce network congestion, mobile operators off-load data traffic to Wi-Fi networks when available. Wi-Fi is expected to serve 59% of worldwide mobile broadband traffic by 2022.[20] Some developing countries are promoting the mobile-to-Wi-Fi trend. Since 2018, Rwanda has required all public and private institutions to offer free Wi-Fi for visitors.[21]

Terrestrial wireless fixed access networks today often use the same technology as mobile networks, such as 4G or 5G.[22] Satellite fixed and nomadic access networks have seen renewed interest,[23] and investors are backing the potential of low-earth-orbit

(LEO) satellites to bring broadband to remote areas that cannot be economically served by terrestrial networks.[24]

### *Backbone networks*

Broadband's backbone comprises a web of domestic and international fibre links. These are vital inputs to broadband access and are largely invisible to end users.[25] Network **backhaul links** carry traffic from mobile network base stations to the core network and haul traffic across long distances between urban centres and to international links. In mobile networks, backhaul links are steadily shifting from microwave to fibre because fibre enables higher access speeds and reductions in congestion.[26]

A large volume of developing country Internet traffic is carried as **IP transit**,[27] via international links, to and from **Internet exchange points (IXPs)** in higher-income countries.[28] Though satellite still connects many locations, by 2015, 99% of transoceanic IP transit traffic was carried over submarine cables.[29] Four major OTT providers – Amazon, Meta (formerly Facebook), Google and Microsoft, which accounted for 55% of global IP transit traffic in 2018 – are investing extensively in submarine cable systems and distributed data centres.[30]

### *Impact of broadband access and adoption*

Broadband encompasses and permits diverse functionalities, infrastructures, and technologies.[31] Increased broadband access and adoption in developing countries boosts economic growth through gains in productivity, innovation, and efficiency.[32] A 2018 study of 63 countries with GDP per capita less than USD 12,000 found a 10% increase in mobile broadband penetration yielded a 2% increase in GDP.[33] A 2020 study found that an increase from 2010 to 2015 in 3G mobile broadband access and use in Nigeria improved household welfare, especially in rural areas, lifting some 2.5 million people out of extreme poverty.[34]

Most applications (**apps**), services, and content are provided over-the-top (**OTT**) of the Internet, which operates as a general-purpose data pipe, as opposed to being provided by the telecom network operator.[35] These enrich the broadband user's experience, drive demand,[36] and improve economic and social welfare.[37] OTT services include connectivity apps, social media apps, content sources, search engines and commerce apps. OTT services are supplied by numerous firms, usually separately from network access, and sometimes free-of-charge to the end user. Many OTT apps exhibit strong user network effects.[38]

Social media apps have become a major driver of developing country broadband adoption, sometimes through partnership with network providers such as through special pricing for using certain apps. In September 2021, Facebook (now Meta) had over 2.9 billion monthly active users worldwide,[39] of which the vast majority accessed their accounts exclusively from mobile devices.[40] Social media use is increasing at a similar pace as Internet use in many developing countries.[41]

## Supply-side broadband market development

Effective broadband policy provides leadership, sets stakeholder expectations, and defines the state's role in supply-side market evolution. Policymakers have three main sets of implementation tools:

- control over state supplies to the market, such as radio spectrum and wholly or partly state-owned operators;
- regulation of competition and efficient use of infrastructure; and
- fiscal levies and expenditures, such as universal service funding.[42]

The Broadband Commission for Sustainable Development (**Broadband Commission**), set up in 2010 by the ITU and the United Nations Educational, Scientific and Cultural Organization (UNESCO), promotes broadband policy on the global agenda and encourages governments to adopt national plans.[43] By 2020, 174 countries had national broadband plans.[44] Policymakers devising or updating broadband plans should consider in particular the roles that radio spectrum, state-owned enterprises, and competition play in supply-side broadband development.[45]

### *Radio spectrum management and use*

Radio spectrum is a vital input to wireless broadband technology. The transmission of signals by specific technologies depends on certain frequency bands of radio spectrum. The availability of particular radio frequencies thus directly affects market entry, market growth, innovation, and service quality.[46] In some cases, the more radio spectrum an operator can use, the less densely it needs to build out its mobile network transmitters. Depending on the technology, there are limits to how many different systems can use the same radio frequencies, particularly because multiple users could cause interference in the signals. This may result in competing demands for the limited amounts of spectrum in the various relevant frequency bands. As a result, radio spectrum is a **scarce public resource**, and spectrum policy and management are critical to broadband goals. Permission to use radio spectrum is controlled by sovereign nations[48] and coordinated by the ITU and various regional organizations. Attracting investment requires a robust and effective compliance and enforcement regime.[50]

Spectrum **allocations** for types of uses (e.g., mobile broadband, police, coastguard, etc.)[51] determine the amount of spectrum available for mobile broadband. These determine the scope and scale of mobile broadband markets. Given that spectrum is a scarce resource, the telecom or radio spectrum regulator typically determines who may use which bands. It does so by making **assignments** or **authorizations** of specific frequencies to specific entities (or sometimes classes of entities)[52] and determining who may enter the market.

Some frequency bands and technologies, such as for Wi-Fi, involve low-power, short-range signals that allow multiple users to use them without significant threat of interference. As a result, these can be designated for **licence-exempt uses**, i.e., requiring no permission to use the relevant frequency band. The choices around licence-exempt frequencies define the scope of shared public use.[53]

Reassessments of existing allocations and reassignment of spectrum can accommodate evolving technology, needs, and uses,[54] such as the migration from analog to digital television broadcasting. This has freed up significant blocks of spectrum for repurposing to support the introduction of 4G and 5G networks.[55]

Approaches to spectrum licensing and pricing vary and have significant impact on market structure, competition, fiscal revenues, and consumer prices.[56] A competitive approach, used when spectrum is scarce (as explained above), assigns spectrum through an **auction** to the highest bidder and/or through a **beauty contest** based on qualitative factors.[57] A first-come-first-served or direct assignment approach, more often used when spectrum is not scarce, allows market entry or expansion by making more spectrum available as and when needed.[58] Except for auctions, spectrum fees are set by **administrative pricing**, i.e., prices set by the spectrum regulator rather than the market using a variety of calculation methods.[59]

### *The legacy and continuing role of state-owned enterprises*

Where many countries' telecommunications sectors had typically been operated by state-owned enterprises (**SOEs**), early telecom liberalisation efforts focused on privatisation.[60] By 2002, incumbents in 113 countries were fully or partially owned by entities other than the State, new entrants that were not owned by the State had been licensed in another 49 countries, and full SOEs generated only 2% of global sector revenue.[61] A 2002 study of 86 developing countries found that privatising SOEs and introducing competition improved sector performance.[62] That said, the impact of privatisation varies.[63]

Developing country governments often struggle to manage SOEs due to inefficiency, fiscal risks, and corruption.[64] Competition (discussed next) is weakened if SOEs have preferential access to spectrum or rights-of-way, are exempt from competition law or fiscal levies, or face lighter enforcement efforts than private-sector rivals.[65] SOEs can also be weakened if burdened by civil service and public procurement rules or political pressure to undertake special projects.[66]

There can be a policy case for SOEs,[67] and SOEs have persisted in some broadband markets.[68] Indeed, State participation in public-private partnerships (**PPPs**) has gained popularity to finance particular types of new infrastructure,[69] but the case for SOEs in competitive markets is often not compelling.[70] Other potentially positive roles for the State are discussed further below in relation to infrastructure sharing models.

## Competition as a driver of broadband development

### *The introduction of competition in broadband*

After enshrining telegraph and telephone monopolies for much of the 20th Century,[71] most countries now rely on competition to stimulate broadband development.[72] Competition has been embraced as the most efficient means to discipline economic markets and increase consumer welfare.[73] In theory, competition puts pressure on firms to be efficient, innovative, and customer-focused, leading to lower prices, better coverage, higher capacity, and more service choices. The alternative – controlling behaviour through regulation (e.g., requiring minimum broadband speeds or coverage, or limiting prices) – is largely considered a second-best solution that is useful only if competition is ineffective.[74]

By 2010, 93% of countries had introduced Internet access competition and 92% had introduced 3G competition.[75] From 2001 to 2011, competition in 165 mobile markets resulted in 26.5% higher user penetration,

leading the Broadband Commission to recommend extending competition to international gateways and fibre backbones.[76]

### *Concentrated nature of supply-side broadband markets*

Broadband networks require large technological investments, including large **fixed costs**, i.e., costs that do not vary with the usage of the network. They have **economies of scale**, meaning that because the fixed costs are spread out over the customers, the extra (what economists call "marginal") cost of supplying each additional user declines as the number of users increases. And if network capacity is sufficient, it does not cost more to carry two calls or two megabits of data rather than one. Broadband networks also feature **economies of scope**, meaning that the cost of using the network for multiple purposes is less than it would be to build and operate a network for each purpose separately. So instead of having a network that can only carry voice calls (like an old telephone network) or television channels (like an old cable TV network), broadband networks can be used for calls, internet access, television channels, music and video streaming, and a near-infinite array of other uses.

Together with network effects (mentioned above), economies of scale and scope create **structural barriers to entry** into the market. The very nature of broadband network economics makes it difficult for new competitors to succeed in building networks, attracting customers, and competing. Such barriers lead to **highly concentrated markets**, i.e., where there is a small number of broadband providers, and in the case of fixed broadband, often only one.[77] These economics of broadband make policy-led efforts to strengthen competition and attract investment in networks and services particularly challenging.[78]

### *Regulating for competition*

When broadband policy seeks to rely on market forces, regulators must adopt and enforce pro-competitive market rules to ensure fair play and a level playing field.[79] Public service licensing and other market entry authorisations are critical to ensuring contestable markets.[80] Regulation needs to avoid erecting artificial entry barriers while implementing policy goals.[81] Regulators may regulate certain non-price behaviour of all firms to ensure an orderly and functioning marketplace[82] – as well as to empower and protect consumers[83] – on topics such as interconnection, telephone numbering, SIM registration, quality of service, customer care, cybersecurity, privacy and data protection, and consumer dispute resolution.

Enforcing market rules intended to strengthen competition requires proactive supervision, investigation, and remedies. Regulators may have to decide difficult cases. For example, some non-cooperative behaviour (such as not offering to share facilities) could be a sign of healthy competition, while other non-cooperative behaviour (such as denial of an important input to a competitor that needs those facilities to compete) could prevent competition, depending on the circumstances.[84] Conversely, cooperative behaviour, such as network sharing, could also be pro- or anti-competitive.[85] Sharing would eliminate competition in the development of the network, yet may make it possible for a service provider to use a network without which it would not have been able to provide a competing service.

Periodic market assessments may be employed to discern if a provider has market dominance or significant market power that enables it to unilaterally increase prices and profits.[86] Many telecom laws empower sector regulators to impose regulatory obligations on such firms.[87] Typically, wholesale remedies that require the dominant firm to make its facilities or wholesale services available to service providers that can compete with it in retail markets are considered more effective than regulation of the dominant firm's retail services.[88] For instance, rather than regulating the prices a dominant firm charges consumers, requiring the dominant firm to permit rivals to use parts of its network so that they can compete with it in retail services at least introduces some competitive pressure in the market. Regulatory remedies involving passive infrastructure such as towers and dark fibre are often more practical and beneficial than those involving active services such as wholesale capacity (see next section for a discussion of optimisation of infrastructure sharing).[89]

As discussed in this briefing note, competition is a key tool for advancing broadband development. National competition authorities also often have jurisdiction over telecom competition matters. Appropriate exercise of the concurrent jurisdiction conferred on sector regulators and national competition authorities requires cooperation and coordination to ensure well-functioning and competitive telecom markets.

## Optimising competition and infrastructure sharing

A key question that broadband policy makers and regulators face is how to foster the optimal level of competition. Eventually, competition yields diminishing returns in driving rollout and quality of networks and services and imposing discipline on costs, and consolidating resources through infrastructure sharing would be more effective. Understanding market structure options and pitfalls is vital for effective policy interventions.[90]

### *Facilities- and services-based competition*

Competition involves rivalry among providers. Providers may compete up and down the full value chain with each operating its own network facilities, i.e., **facilities-based competition**. However, economies of scale and scope (discussed above) may make it more efficient to have fewer networks. One way to address this tension is to allow for or require some sharing of infrastructure, particularly infrastructure that is costly to duplicate, while seeking competition in the provision of services, i.e., **services-based competition**. A key question in broadband policy is how much sharing and consolidation among providers to aim for or allow in the underlying infrastructure.

Past telecom sector liberalisation experience offers lessons. Policymakers introducing mobile competition in the 1990s focused on spectrum licensing and facilities-based competition, not infrastructure sharing.[91] Both last mile and backhaul links were wireless in emerging markets, while backhaul in developed markets used either wireless or leased copper lines.[92] The end-to-end configuration of 2G networks thus allowed operators to scale-up fixed costs as penetration and use grew, enabling multiple operators to achieve economies of scale in the same coverage area.[93]

This facilities-based competition improved **dynamic efficiency** by driving operators to expand coverage and upgrade networks. Across 200 countries from 2001 to 2014, facilities-based competition using 1G, 2G or 3G technologies achieved wider mobile coverage more quickly.[94] Facilities-based competition also improved **static efficiency**, pushing prices to their lowest sustainable levels.[95] In the United States, the price per minute of mobile voice calls declined steadily from USD 0.44 in 1993 to USD 0.05 in 2011.[96]

In contrast, infrastructure sharing was a centrepiece of opening wired telephone access markets to competitive entry.[97] Fixed costs of wired infrastructure were **sunk costs**, i.e., they had been fully incurred and could not be recovered. This advantage over new entrants operated as a **moat**, i.e., a protective barrier to entry in the market against new entrants seeking to build networks and compete with the incumbent. This established or embedded incumbents' **natural monopoly** characteristics,[98] as their average costs would be inherently lower than those of new entrants.[99]

Therefore, policymakers seeking to use competition to improve market performance required incumbents to share infrastructure with new entrants. This was typically a one-way obligation applying only to the incumbents and not new entrants, i.e., it was **asymmetric regulation**. One approach required them to share **essential facilities** that could not be viably replicated, such as access to the **local loop**, i.e., the last-mile connection to the customer.[100] New entrants combined these wholesale inputs with their own facilities to compete with incumbents. Another approach introduced service-based competition, where rivals shared most infrastructure, forcing incumbents to offer end-to-end wholesale services that rivals could resell.[101] Both approaches required rate regulation of wholesale inputs, improving static efficiency through price reductions, but reducing dynamic efficiency by suppressing investment incentives for facilities owners and access seekers.[102] Efforts to address these disincentives largely failed.[103]

### *The limits of mobile broadband facilities-based competition*

Meanwhile, as mobile broadband has been deployed, the sustainable level of network rivalry in many countries has plateaued and begun to decline due to two evolving cost factors. First, customers use increasing volumes of data for a variety of business and personal purposes. The growing volumes of data on the radio access network require more spectrum, towers, and radios; this trend, which will increase significantly with the introduction of 5G, increases per-customer costs. Second, replacing microwave backhaul with fibre that can handle larger traffic volumes has increased costs and rendered them less scalable. At the same time, telecom operators' revenues per customer have remained flat due to competitive pressure from OTT providers in voice and text services (e.g., people calling and texting over WhatsApp using the operator's data connection instead of its voice and SMS services).[104]

These trends have led to consolidation in many markets. Among 30 European Economic Area states, the number of countries with 4 or more mobile network operators declined from 17 in 2012 to 12 in 2017.[105] The United States went from 4 to 3 mobile network operators in April 2020.[106] India had 15 2G operators in 1999, but only

eight 3G or 4G operators in 2019.[107] Similar consolidation has occurred in West Africa,[108] where active national mobile network operators have declined from 6 to 3 in Côte d'Ivoire,[109] 6 to 4 in Ghana,[110] and 5 to 2 in Liberia.[111]

### *Passive and active infrastructure sharing*

Underscoring the need for more infrastructure sharing in all broadband markets, the Broadband Commission,[112] ITU, and World Bank[113] recommend blanket policies to promote sharing of **passive infrastructure**, i.e., facilities that do not include the electronics, such as rights-of-way, towers, ducts, dark fibre, equipment rooms, and power supplies. At the same time, greater caution is required when it comes to sharing of **active infrastructure**, i.e., the electronics such as antennas, transmission equipment, and software.[114] Such sharing involves complex transactions and can undermine the incentives to compete that lead to greater investment in networks and lower prices for consumers. Therefore, policymakers may wish to take a case-by-case approach to permitting or requiring active infrastructure sharing.

## Infrastructure sharing models

Broadband infrastructure sharing requires fit-for-purpose institutions designed around the sharing model and role of the State, taking into account the type of infrastructure.

Sharing models include (1) **asymmetric**, where an operator with market power provides access to rivals; (2) **wholesale**, where an upstream party provides access to downstream operators; and (3) **cooperative**, where a multi-operator-owned entity provides access to members.[115]

States may choose to:

- permit voluntary sharing that might otherwise have been prohibited, e.g., on grounds that it reduces facilities-based competition;
- induce operators to share;
- participate in the investment alongside operators sharing in it; or
- compel operators to share when they might otherwise have chosen not to do so.

This section examines infrastructure sharing models for different types of infrastructure through these four roles of the State.

### *Voluntary sharing arrangements*

Sharing towers, the primary last-mile broadband infrastructure in emerging markets, can reduce costs and mitigate health or environmental concerns.[116] Some operators share towers asymmetrically on an ad hoc basis, but most sharing occurs through wholesale tower companies (TowerCos), formed either by independent investors[117] or structural separation within operator-led groups.[118] TowerCos manage half of the global tower inventory outside China.[119] By 2020, 30% of emerging markets had two or more TowerCos and another 30% had one.[120] Early evidence suggests that TowerCo market entry helps drive down retail prices.[121] Policymakers can stimulate further market entry by removing entry barriers while maintaining regulatory oversight to prevent potential abuse of dominance.[122]

Similarly, because fibre is now a preferred middle-mile and last-mile wired solution, sharing benefits operators by reducing costs. Wholesale fibre companies (which are sometimes referred to as **FibreCos**, **Infracos**, or **Netcos**) have entered many emerging

markets to offer dark fibre or transport over intercity, metro, and access infrastructure. These include utilities (often state-owned) seeking to commercialize excess capacity on internal networks, such as Lesotho Electricity Company;[123] spinoffs of incumbent operators, such as Malawi's Open Connect Limited (which was separated from the privatised fixed-line incumbent)[124] or MTN Global Connect (which is being separated from MTN Group's mobile business);[125] and standalone new entrants, such as South Africa's Dark Fibre Africa[126] and CSquared, which operates in Ghana, Liberia, and Uganda.[127] In Africa alone, as of 2019, over 250,000 km of new fibre must be deployed to achieve universal mobile broadband.[128] Policymakers can attract further entry and investment by ensuring open licensing and equal access to state-owned rights of way, poles, and ducts.[129]

Voluntary infrastructure sharing is common for **submarine cables**, i.e., cables laid on the seabed between land-based stations to carry telecom traffic across ocean and sea, which are the principal first mile in most emerging markets. Some 426 submarine cables connect nearly all coastal countries worldwide,[130] including 37 of 38 coastal African countries[131] and 12 Pacific island territories (with plans to connect the remaining seven).[132] Most submarine cables are owned by groups of operators under a cooperative model, but some function as wholesalers or internal OTT networks.[133] Operators with submarine cable capacity typically **self-provision**, i.e., use the capacity for their own purposes, and offer **wholesale service**, i.e., provide services to other operators. Pricing depends on the competitive landscape, but regulators can counter anticompetitive behaviour. In 2010, Fiji's regulator found landing station owner FINTEL had significant market power, introduced rate regulation, and afforded local operators rights to purchase capacity directly from cable owner Southern Cross.[134]

Voluntary sharing of active r**adio access networks (RANs)**, i.e., the part of the telecom system that connects customer devices to the network through radio connection to the base station, has also become common. Such sharing first gained a foothold mainly in developed economies during 3G and 4G deployments. Facing costly radio spectrum pricing, smaller operators struggling in crowded markets embraced sharing as an alternative to merger or exit, with regulators closely scrutinizing and conditioning the arrangements to address competition concerns.[135] As costs of technology upgrades increase, interest in 5G RAN-sharing, such as the shared 5G network to be deployed by mobile operators M1 and StarHub in Singapore,[136] has increased as a means to improve business cases.[137]

However, in many markets, operators tend not to share even if it might be more efficient to do so. For example, Africa and the Middle East together had only 10 active network sharing agreements out of 98 worldwide by 2017.[138] It is unlikely that simply permitting RAN-sharing will suffice to foster its development in many markets where the necessary business culture or trust is lacking. Developing country governments may have to induce or compel sharing (or participate alongside operator investors) in order to introduce RAN sharing.[139]

Some higher-income markets, such as Europe and the United States, have experienced rapid growth of voluntary partnerships between mobile operators and mobile virtual network operators (**MVNOs**).

MVNOs offer mobile telecommunications services to customers using the mobile networks of MNOs with which they have agreed upon wholesale arrangements. Typically, MVNOs serve niche market segments (e.g., particular population groups). This benefits MNOs by increasing penetration through service differentiation to such niche market segments and using network capacity that might otherwise have gone unused, hence leading to voluntary arrangements.[140] By 2019, about 1,500 MVNOs served 337 million customers (4% of all mobile customers worldwide).[141] MVNOs have entered some developing markets, with one in Fiji[142] and nearly 20 in South Africa,[143] but they have not entered other countries such as Nigeria,[144] which does not permit MVNO market entry.

### *State-induced sharing arrangements*

Some countries have sought to induce additional infrastructure sharing through asymmetric, cooperative, or wholesale models by introducing regulatory or financial incentives. In the 2018 European Electronic Communications Code,[145] the EU adopted regulatory incentives, encouraging rivals to co-invest in shared fibre or make commercial offers to rivals by relieving those who do from asymmetric regulatory obligations to provide access.[146] New Zealand provided financial incentives to develop fibre access networks. Its Ultra-Fast Broadband Initiative involved paying a one-time government subsidy to the bidder in each region proposing the lowest amount of subsidy it requires to receive for it to build a network and establish a fully independent wholesale provider (often referred to as a **reverse auction**).[147] Malawi employed an **anchor tenant** purchase in 2015. This involved using connectivity procurement by the Government to provide sufficient scale and certainty of funding to induce new private investment in wholesale IP transit that could also be made available to private sector operators.[148] Some countries, such as Malaysia, have used spectrum licensing to incentivize mobile operators to make wholesale offers for MVNOs,[149] while others have extracted commitments to host MVNOs when approving mergers between mobile operators.[150]

### *State equity participation in wholesale PPPs or SOEs*

Some countries have instead set up PPPs by investing directly alongside private partners in the equity of wholesale or cooperative operators. In 2013, Rwanda established a combined 4G/LTE and fibre wholesale operator in partnership with KT Corp of South Korea.[151] Nine West African governments have since 2011 partnered with local operators to introduce cooperatives as submarine cable system landing parties, including Benin,[152] Burkina Faso (via terrestrial route),[153] The Gambia,[154] Guinea,[155] Guinea-Bissau (pending),[156] Liberia,[157] Mauritania,[158] São Tomé & Príncipe,[159] and Sierra Leone.[160]

Other countries have retained or re-established fully state-owned enterprises to serve as wholesale infrastructure and service providers. Broadband Infraco was established by the South African Government in 2007 as a state-owned wholesale FibreCo, acquiring existing fibre assets from state-owned national railway Transnet and electric utility Eskom. Broadband Infraco subsequently has invested in additional fibre assets, is mandated to reach unserved or under-served areas, and encourages infrastructure sharing to avoid duplication of fibre network roll-outs.[161] Botswana Fiber Networks (BoFiNet) was established by the Botswana

Government in 2012 as a state-owned wholesale provider. It acquired state-owned Botswana Telecom's existing domestic fibre infrastructure and capacity in two submarine cables, and it is mandated to drive connectivity and economic growth.[162]

### *State-compelled asymmetric sharing arrangements*

By 2019, at least 110 countries had embraced asymmetric access regulation. Such regulations covered a broad range of sharable facilities,[163] often limited to passive infrastructure and sometimes only to owners with market power.[164] Ghana's 2008 telecom law requires every licensed operator, without regard to market power, to share passive infrastructure with any requesting operator.[165] Some countries compel mobile operators with market power to make wholesale offers to MVNOs, although Canada[166] and South Africa[167] have recently considered and rejected such moves based on findings that retail markets were competitive and no wholesale remedy was necessary. Many countries also compel public utilities and authorities to share land, poles, ducts, and fibre with operators, as this typically has no adverse investment impact.[168] Informed policymakers and regulators exercise caution to ensure that compelled asymmetric access between rivals does not undermine investment.[169]

### *Universal service frameworks and programs*

In 2021, 450 million people – 93% of whom lived in low- and middle-income countries – had no mobile broadband coverage[170] and were beyond the viable reach of any fibre access network.[171] Satellite/Wi-Fi access offers the potential to close 10-20% of this coverage gap with fixed or nomadic broadband,[172] but mobile broadband remains the most cost-effective solution to reach the remaining 80-90%.[173]

Policymakers in market-based economies have four main options to close the coverage gap. The first is to foster more infrastructure sharing to improve viability.[174] The second is to impose minimum coverage obligations under service or spectrum licenses.[175] This forces operators to cross-subsidize rural service internally from their urban profits and is thus limited by overall network profitability.[176] It may also reduce the government's radio spectrum revenue[177] and typically cannot achieve universal coverage.[178] The third option is for the government to procure services for public-sector connectivity needs (for schools, health facilities, and other remote sites) in unserved areas to stimulate coverage expansion.[179]

The fourth option establishes universal access subsidies to reach areas remaining after exhausting the first three options.[180] Contributions may come from levies on telecom revenue, fiscal appropriations, international donor grants, or other sources.[181] Held in a universal service fund, deposits are disbursed to operators selected to extend coverage in designated areas. Contracts can be awarded through reverse auctions or other mechanisms. As in Pakistan, the successful operator may be required to provide wholesale open access to the subsidized facilities.[182] Economic challenges faced by remote and dispersed countries, such as small island developing states, require proportionately larger external subsidies.[183]

### *Politics and regulation*

As discussed above, regulatory frameworks can play an important role in optimising broadband policy. Telecom regulation, once limited to managing spectrum[184] and monopolies,[185] now requires strong institutions and an evolving focus on fostering and strengthening competition.[186] This is all the more important given the continued role of SOEs in the sector alongside and often in competition with privately-owned entities.

Sector regulators in liberalized markets are typically entrusted with expansive duties and powers that are vital to performing their functions.[187] Because regulatory independence typically leads to more objective, reasoned, competitively neutral, and predictable decisions, a majority of countries have separated telecom regulator structures, financing, and decision-making from ministries and SOEs (increasing from 14 in 1990 to 153 in 2018).[188] In reality, regulators in many countries often attempt to align to the political will of a country's government. This can lead them to be influenced by political pressure to protect an SOE incumbent that may be an important employer or provider of revenue through its control over fibre or the international gateway. Regulators may also find that they are circumvented by actions of governments that may issue orders or new licenses without lawful powers or respecting requisite procedure.

The pressures on regulatory authorities make it particularly important to establish the institutional framework and regulatory processes in primary legislation. A sector law typically sets out the framework governing the regulator's composition, selection, decision-making, powers, funding, and accountability.[189] The legal framework may establish principles and procedures to ensure stability, long-term orientation, transparency, consultation, evidence-based and non-discriminatory decisions, judicial oversight, and dispute resolution.[190] It may also authorize regulators to acquire sufficient competence and capacity through authority to hire qualified staff and source external services.[191]

## Demand-side broadband policy

In 2020, some 3.4 billion people in areas with mobile broadband coverage did not use the Internet.[192] Responding to the usage gap, the Broadband Commission and policymakers in many countries have stepped up their focus on demand-side measures in consumer markets, where penetration levels are impacted by skills, affordability, and consumer utility.

Lack of digital and literacy skills is the predominant broadband adoption barrier.[193] Many developing countries and regions, such as Kenya[194] and the Pacific Islands,[195] increasingly recognise the need for educational, training, and certification measures to provide their populations with the requisite skills to participate in the digital ecosystem.

Affordability of broadband devices and services is the next most important adoption barrier.[196] In 2019, the average cost of entry-level smartphones in developing countries was 34% of GDP/capita, an unattainable investment for many consumers.[197] Airtel, Orange, Safaricom, and Vodacom offer smartphone financing to facilitate broadband adoption in some African markets.[198] Tax burdens on consumers contribute to the

affordability gap.[199] Some countries impose higher levies on broadband than other goods and services.[200] In 2017, Guinea levied taxes equivalent to 61% of mobile operators' market revenue, of which over half was sector-specific.[201]

Limited utility to consumers also suppresses adoption in some developing countries. For example, some globally popular OTT apps have limited localization of content and language in some countries.[202] OTT providers, particularly in Asia, are now increasingly localizing their applications and content.[203] Some governments are also adding content. In 2015, Rwanda established Irembo,[204] an online e-government platform that operates in English, French, and Kinyarwanda over the Internet (as well as on 2G USSD channels) and through support agents. Irembo aims to make citizen-government transactions easier, faster, and less costly.[205]

## Additional resources

### *Resources for further reading*

- Digital Regulation Platform (ITU and World Bank)
- OECD (Organisation for Economic Co-operation and Development) broadband
- European Union broadband

### *Organizations*

- Broadband Commission
- ITU

## Notes

[1]https://www.gsma.com/newsroom/press-release/over-half-worlds-population-now-using-mobile-internet/

[2]In 2003, the International Telecommunications Union (ITU) defined broadband as 256 kbps or more. ITU, Birth of Broadband, ITU Internet Reports, Executive Summary §2 (Sep 2003) [ITU Birth of Broadband Report]. Available at https://www.itu.int/osg/spu/publications/sales/birthofbroadband/exec_summary.html.

[3]See GSMA, The State of Mobile Internet Connectivity 2021 at 44 (2021). Available at https://www.gsma.com/r/wp-content/uploads/2021/09/The-State-of-Mobile-Internet-Connectivity-Report-2021.pdf. Broadband speeds vary based on the technology deployed which may be affected by radio spectrum available. Average broadband speeds may depend on the coverage of different technologies across a country.

[4]The other leading public telecommunications network is the public telephone network (public switched telephone network or PSTN), which routes communications with telephone numbers and carries voice and data using protocols and standards developed by the International Telecommunications Union and others to enable interconnection and interoperability. See, e.g., US Code of Federal Regulations, Tit. 47, Chap. 1, §20.3 (definition of "public switched network"). Available at https://www.govinfo.gov/content/pkg/CFR-1996-title47-vol2/pdf/CFR-1996-title47-vol2-sec20-3.pdf .Many end users also connect to high-speed private networks, such as cable television networks and satellite television networks that provide subscription programming, or closed user groups and enterprise networks. Such services often use the same infrastructure as Internet access, strengthening the broadband investment case, but lack network effects.

[5]See Network Working Group, TCP/IP Tutorial, Request for Comments (Jan 1991). Available at https://datatracker.ietf.org/doc/html/rfc1180.

[6]See, e.g., Corporate Finance Institute, Network Effect: Existing users benefit from addition of more users (2021). Available at https://corporatefinanceinstitute.com/resources/knowledge/economics/what-is-network-effect/.

[7]The World Wide Web uses uniform resource identifiers (URIs) to identify, link and route information resources accessible over the Internet. See World Wide Web Consortium, Architecture of the World Wide Web, Volume One, W3C Recommendation, §2 (15 Dec 2004). Available at https://www.w3.org/TR/webarch/.

[8]See, e.g., ITU Radiocommunication Bureau, 1 Fixed Wireless Access: Handbook on Land Mobile (including Wireless Access) 5 & Figure 1 (2nd ed. 2001). Available at https://www.itu.int/dms_pub/itu-r/opb/hdb/R-HDB-25-2001-OAS-PDF-E.pdf.

[9]See ITU, Radiocommunication Study Groups 8 (Working Party 8A) and 9 (Working Party 9B), Vocabulary of Terms for Wireless Access, Recommendation ITU-R F.1399 §4.1 (1999). Available at https://www.itu.int/dms_pubrec/itu-r/rec/f/R-REC-F.1399-0-199905-S!!PDF-E.pdf.

[10]Wired last-mile networks link to the customer premises over a physical medium. Common infrastructures include twisted copper pairs (telephone lines retrofitted with asymmetric digital subscriber line (ADSL) technology), coaxial cable (cable television plant retrofitted with cable modem technology), and fibre-to-the-premises (FTTP) (deployed where legacy infrastructure is unavailable or inadequate). Electric power lines also have the potential to be retrofitted to carry communications, but this technology failed to achieve sufficient traction to be commercially available and supported by major equipment vendors. But see R. Knutson, "AT&T to Test Broadband over Power Lines," Wall Street Journal (20 Sep 2016). Available at http://www.wsj.com/articles/at-t-to-test-broadband-over-power-lines-1474411386.

[11]The current maximum download speeds are about 35 Mbps for ADSL, 500 Mbps for cable modem and 1 Gbps or more for FTTP. See Tyler Cooper, "DSL vs Cable vs Fiber: Comparing Internet Options," BroadbandNow (updated 5 Aug 2021). Available at https://broadbandnow.com/guides/dsl-vs-cable-vs-fiber.

[12]See, e.g., Richard N. Clarke, "Expanding mobile wireless capacity: The challenges presented by technology and economics," 38 TELECOMMUNICATIONS POLICY 693 (Sep 2014). Available at https://www.sciencedirect.com/science/article/pii/S0308596113001900.

[13]GSMA, The State of Mobile Internet Connectivity Report 2021 at 6 (2021). Available at https://www.gsma.com/r/wp-content/uploads/2021/09/The-State-of-Mobile-Internet-Connectivity-Report-2021.pdf.

[14]GSMA Intelligence, The State of Mobile Internet Connectivity Report 2020 at 5 (Sep 2020). Available at https://www.gsma.com/r/wp-content/uploads/2020/09/GSMA-State-of-Mobile-Internet-Connectivity-Report-2020.pdf.

[15]Second generation (2G) networks support voice, text messages (SMS) and Internet access at 114 kbps (GPRS) or 384 kbps (EDGE). Third generation (3G) networks and HSDPA upgrades (known as 3.5G or 3.75G) also support multimedia messaging (MMS) and Internet speeds up to 3.1-14 Mbps. Fourth generation (4G), or long-term evolution (LTE), networks support speeds up to 300 Mbps. Fifth generation (5G) networks support speeds up to 10 Gbps. Satellite phones offer remote coverage, but only at 9.6 kbps, limiting their use to emergency response. See ETSI, Technologies > Mobile (2021). Available at https://www.etsi.org/technologies/mobile/2g. See also, Andrea Saravia, "What's the Difference Between Internet Speeds?" Ufinet News (30 Sep 2020). Available at https://www.ufinet.com/whats-the-difference-between-internet-speeds/.

[16]See, e.g., Kristin Cooke, "Your Guide to the Best Portable Internet Options," SatelliteInternet.com (28 May 2021). Available at https://www.satelliteinternet.com/resources/mobile-satellite-internet/.

[17]See Techopedia, Dictionary > Networking > Nomadic Wireless (last updated 6 Mar 2013). Available at https://www.techopedia.com/definition/2961/nomadic-wireless.

[18]See ITU Expert Group on Household Indicators, Background Document 3, Proposal for a Definition of a Smartphone (2017). Available at https://www.itu.int/en/ITU-D/Statistics/Documents/events/egh2017/EGH%202017%20background%20document%203%20-%20Definition%20of%20smartphone.pdf.

[19]See, e.g., Jon Martindale, "What is Wi-Fi?" Digital Trends (28 Mar 2021). Available at https://www.digitaltrends.com/computing/what-is-wi-fi/.

[20]See, e.g., Cisco, Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2017–2022, White Paper (Feb 2019). Available at https://s3.amazonaws.com/media.mediapost.com/uploads/CiscoForecast.pdf. Wi-Fi served 70% of Dutch smartphone connections in 2016. Based on an Opensignal analysis of 12.3 billion measurements taken by 822,556 end users in 95 countries during an 84-day period in 2016 found high levels of mobile Wi-Fi connections both in countries where mobile broadband is ubiquitous and in countries where it is more limited. See Opensignal, Global State of Mobile Networks, Report (Aug 2016). Available at https://www.opensignal.com/reports/2016/08/global-state-of-the-mobile-network.

[21]See Rwanda Utilities Regulatory Authority, Guideline on Minimum Bandwidth for Broadband Internet Connectivity in Rwanda, Guideline No. 01/GL/UAS-ICS/RURA/018 §2.1 at 6 (7 Jun 2018). Available at https://www.risa.rw/fileadmin/user_upload/Others%20documents/Guideline_on_minimum_Bandwidth_for_Broadband_Internet_Connectivity_in_Rwanda.pdf

[22]See, e.g., Telefonaktiebolaget LM Ericsson, Fixed Wireless Access > 4G and 5G fixed wireless access unlocks a world of opportunity (2021). Available at https://www.ericsson.com/en/fixed-wireless-access. Legacy CDMA technologies are still used in some countries. See ITU Radiocommunication Bureau, 1 Fixed Wireless Access: Handbook on Land Mobile (including Wireless Access), supra, at 99. Legacy WIMAX technologies are also still used in some countries. See, e.g., ITU, "How low cost wireless broadband networks are connecting 'last-mile' communities in Djibouti," ITU News (21 May 2019) (discussing WiMAX use in Djibouti). Available at https://www.itu.int/en/myitu/News/2020/05/18/12/59/How-low-cost-wireless-broadband-networks-are-connecting-last-mile-communities-in-Djibouti.

[23]See, e.g., Kathryn Martin, "WRC-19: Driving the growth of satellite broadband," ITU New Magazine (No. 5, 2019). Available at https://www.itu.int/en/itunews/Documents/2019/2019-05/2019_ITUNews05-en.pdf.

[24]See, e.g., Amy Borrett, "Satellite broadband is the future of the $1trn space economy," TechMonitor (updated 2 Mar 2021). Available at https://techmonitor.ai/techonology/cloud/satellite-broadband-future-1trn-space-economy.

[25]See ITU & World Bank, "Emerging technologies > The evolving Internet value chain," Digital Regulation Platform (31 Aug 2020). Available at https://digitalregulation.org/the-evolving-internet-value-chain/.

[26]See Telefonaktiebolaget LM Ericsson, Ericsson Microwave Outlook 6 (Oct 2020). Available at https://www.ericsson.com/4a811d/assets/local/reports-papers/microwave-outlook/2020/2020-ericsson-microwave-outlook-report-digital.pdf.

[27]See United Nations Conference on Trade and Development, Digital Economy Report 2019 – Value Creation and Capture: Implications for Developing Countries 12 (4 Sep 2019). Available at https://unctad.org/system/files/official-document/der2019_en.pdf.

[28]See, e.g., Internet Society, OECD & UNESCO, The Relationship between Local Content, Internet Development and Access Prices at 31-32 (2011). Available at https://www.oecd.org/sti/ieconomy/50305352.pdf. Internet traffic is exchanged at such IXPs on the basis of settlement-free peering whereby the operators do not pay one another for the exchange of traffic. See Jon Hjembo, "Understanding Peering," TeleGeography Blog (22 Nov 2019). Available at https://blog.telegeography.com/settlement-free-paid-peering-definition.

[29]Douglas Main, "Undersea Cables Transport 99 Percent of International Data," Newsweek (2 Apr 2015). Available at https://www.newsweek.com/undersea-cables-transport-99-percent-international-communications-319072.

[30]See TeleGeography, The State of the Network 3, 5, 7 & 14 (2020 ed.). Available at https://www2.telegeography.com/hubfs/assets/Ebooks/state-of-the-network-2020.pdf.

[31]Convergence has blurred distinctions among telephone, cable television and Internet services, which some providers now compete to offer as a triple-play bundle. See, e.g., OECD, Triple and Quadruple Play Bundles of Communication Services, OECD Science, Technology and Industry Policy Paper No. 23 (Apr 2015). Available at https://www.oecd-ilibrary.org/docserver/5js04dp2q1jc-en.

[32]Raul Katz, ITU, Impact of broadband on the economy: research to date and policy issues at 4 & 17 (Apr 2012). Available at http://www.itu.int/ITU-D/treg/broadband/ITU-BB-Reports_Impact-of-Broadband-on-the-Economy.pdf.

[33]Raul Katz & Fernando Callorda, The economic contribution of broadband, digitization and ICT regulation at 14 (ITU 2018). Available at https://www.itu.int/en/ITU-D/Regulatory-Market/Documents/FINAL_1d_18-00513_Broadband-and-Digital-Transformation-E.pdf.

[34]Kalvin Bahia, Pau Castells, Genaro Cruz, Takaaki Masaki, Xavier Pedrós, Tobias Pfutze, Carlos Rodríguez-Castelán & Hernan Winkler, The Welfare Effects of Mobile Broadband Internet: Evidence from Nigeria, World Bank Policy Research Working Paper 9230 (May 2020). Available at https://documents1.worldbank.org/curated/en/626011588705072099/pdf/The-Welfare-Effects-of-Mobile-Broadband-Internet-Evidence-from-Nigeria.pdf.

[35]See, e.g., Working Party on Communication Infrastructures and Services Policy, OECD, "The Development of Fixed Broadband Networks" at 30 (8 Jan 2015). Available at https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DSTI/ICCP/CISP(2013)8/FINAL&docLanguage=En.

[36]See, e.g., World Bank, Digital Dividends: World Development Report 2016 at 205 & 207-8 (2016). Available at https://documents1.worldbank.org/curated/en/896971468194972881/pdf/102725-PUB-Replacement-PUBLIC.pdf.

[37]See, generally, OECD, Economic and Social Benefits of Internet Openness, 2016 Ministerial Meeting on the Digital Economy, Background Report, OECD Digital Economy Paper No. 257 (2016). Available at https://www.oecd-ilibrary.org/docserver/5jlwqf2r97g5-enpdf?expires=1629890206&id=id&accname=guest&checksum=0C5B8B6905EE5078CAB10DB17EFA71BF.

[38]See, e.g., ITU & World Bank, "Competition and economics > Explanation of externalities on digital platforms," Digital Regulation Platform (28 Aug 2020). Available at https://digitalregulation.org/explanation-of-externalities-on-digital-platforms/.

[39]See CR Newswire, Facebook Reports Third Quarter 2021 Results. Available at https://www.prnewswire.com/news-releases/facebook-reports-third-quarter-2021-results-301407881.html.

[40]H. Tankovska, "Countries with the most Facebook users 2021," Statistica (9 Feb 2021). Available at https://www.statista.com/statistics/268136/top-15-countries-based-on-number-of-facebook-users/.

[41]Internet use among adults in 19 emerging and developing economies increased from 42% in 2013/14 to 64% in 2017/18, while social media use among adults increased from 34% to 53%. See Pew Resarch Center, Social Media Use Continues to Rise in Developing Countries but Plateaus Across Developed Ones, supra.

[42]See, generally, Tim Kelly & Carlo Maria Rossotto, eds., Broadband Strategies Handbook (World Bank, 2012). Available at https://ddtoolkits.worldbankgroup.org/sites/default/files/2018-10/Broadband%20Strategies%20Handbook_0.pdf.

[43]The Commission comprises recognized senior leaders from industry, government, international organizations and academia. See ITU & UNESCO, The State of Broadband 2020: Tackling digital inequalities at xii (Sep 2020) [2020 Broadband Commission Report]. Available at https://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-BROADBAND.21-2020-PDF-E.pdf.

[44]2020 Broadband Commission Report, supra, at 13.

[45]See Broadband Strategies Handbook, supra, at 52-59.

[46]See, e.g., ITU Radiocommunication Bureau, Handbook on National Spectrum Management §1.2 at 4-5 (2015 ed.). Available at https://www.itu.int/dms_pub/itu-r/opb/hdb/R-HDB-21-2015-PDF-E.pdf.

[47]See ITU & World Bank, Digital Regulation Handbook, supra, at 112.

[48]See, generally, ITU, Guidance on the regulatory framework for national spectrum management, Report ITU-R SM.2093-3 §2.1.1 at 16 (Jun 2018). Available at https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-SM.2093-3-2019-PDF-E.pdf.

[49]See Ryszard Struzak, Introduction to International Radio Regulations (2003). Available at https://www.osti.gov/etdeweb/servlets/purl/20945052.

[50]See, e.g., GSMA, Spectrum Licensing, GSMA Public Policy Position at 3 & 5 (Mar 2013). Available at https://www.gsma.com/spectrum/wp-content/uploads/2013/04/GSMA-Policy-Position-on-Spectrum-Licensing.pdf.

[51]The ITU provides member countries with guidance in developing and updating their frequency allocation tables. See, e.g., ITU, Spectrum Management System for Developing Countries Version 3: Frequency Allocation Table (SMS4DC training seminar Oct 2010). Available at http://www.itu.int/ITU-D/asp/CMS/Events/2010/SMS4DC/SMS4DC2_AllocationsV2.pdf.

[52]See, e.g., GSMA, Introducing Spectrum Management at 14 (Feb 2017). Available at https://www.gsma.com/spectrum/wp-content/uploads/2017/04/Introducing-Spectrum-Management.pdf.

[53]See ITU Radiocommunication Bureau, Handbook on National Spectrum Management, supra, at 74.

[54]See ITU Radiocommunication Bureau, Handbook on National Spectrum Management, supra, §2.11.4 at 66.

[55]See, e.g., World Bank, Support for Digital Switchover in Developing Countries: Opportunities, Challenges and Recommendations for Enabling Digital Dividend, Project Final Report §1.1 at 1 (May 2020). Available at https://documents1.worldbank.org/curated/en/157061592987137957/pdf/Support-for-Digital-Switchover-in-Developing-Countries-Opportunities-Challenges-and-Recommendations-for-Enabling-Digital-Dividend-Project-Final-Report.pdf.

[56]See ITU Telecommunication Development Sector, Guidelines for the review of spectrum pricing methodologies and the preparation of spectrum fee schedules at 4-8 (ITU 2016). Available at https://www.itu.int/en/ITU-D/Spectrum-Broadcasting/Documents/Publications/Guidelines_SpectrumFees_Final_E.pdf.

[57]See ITU Telecommunication Development Sector, Guidelines for the review of spectrum pricing methodologies and the preparation of spectrum fee schedules, supra, at 6.

[58]See ITU Telecommunication Development Sector, Guidelines for the review of spectrum pricing methodologies and the preparation of spectrum fee schedules, supra, at 6.

[59]See ITU Telecommunication Development Sector, Guidelines for the review of spectrum pricing methodologies and the preparation of spectrum fee schedules, supra, at 9-13.

[60]See, generally, ITU, World Telecommunication Development Report 2002: Reinventing Telecoms at 4 (Mar 2002). Available at https://www.itu.int/ITU-D/ict/publications/wtdr_02/material/WTDR02-Sum_E.pdf.

[61]See ITU, World Telecommunication Development Report 2002: Reinventing Telecoms, supra, at 4-5 & Fig. 1. In 1999, just three years earlier, 8.5% of 188 national markets had been fully privatized, 35.6% had been partly privatized and 55.9% remained fully state-owned. See Tim Kelly, Process and impact of commercialisation/privatisation: Worldwide trends at slide 4 (ITU, 20 May 1999). Available at https://www.itu.int/ITU-D/ict/papers/1999/Malta/TK%20private%20May99.pdf.

[62]See Carsten Fink, Aaditya Mattoo & Randeep Rathindran, An Assessment of Telecommunications
Reform in Developing Countries, Policy Research Working Paper (World Bank, Oct 2002). Available at https://openknowledge.worldbank.org/bitstream/handle/10986/19209/multi0page.pdf?sequence=1&isAllowed=y.

[63]For example, in a 2011 study of privatizations in 108 countries from 1985 to 2007, outcomes were strongly positive in OECD and resource-scarce African coastal countries, weakly positive in Latin American and Caribbean countries, and strongly negative in resource-rich African countries and resource-scarce African landlocked countries. See F. Gasmi, A. Maingard, P. Noumba & L. Recuero Virto, Empirical evidence on the impact of privatization of fixed-line operators on telecommunications performance – Comparing OECD, Latin American, and African countries (Feb 2011). Available at http://publications.ut-capitole.fr/18415/1/medias/doc/wp/2011/gasmi_privatization_final_2011.pdf.

[64]See IMF, "State-Owned Enterprises: The Other Government," Fiscal Monitor: Policies to Support People during the COVID-19 Pandemic, supra, at 47.

[65]See OECD Secretariat, Competition Law and State-Owned Enterprises, DAF/COMP/GF(2018)10 12-14 at 6-7 (OECD 30 Nov 2018). Available at https://one.oecd.org/document/DAF/COMP/GF(2018)10/en/pdf.

[66]See OECD Secretariat, Competition Law and State-Owned Enterprises, DAF/COMP/GF(2018)10, supra, 11 at 6.

67 See, e.g., IMF, "State-Owned Enterprises: The Other Government," Fiscal Monitor: Policies to Support People during the COVID-19 Pandemic at 47 & 64 (Apr 2020). Available at https://www.elibrary.imf.org/view/books/089/28929-9781513537511-en/ch03.xml.

[68]For example, both Malaysia and Thailand have retained SOEs that continue to operate in their broadband markets. However, while Malaysia has reserved a special role for SOE Telekom Malaysia in its fixed broadband strategy, Thailand has allowed private operators to compete directly with its SOEs in fixed broadband markets. See Pornchai Wisuttisak & Nasarudin Bin Abdul Rahman, Regulatory Frameworks for Reforms of State-Owned Enterprises in Thailand and Malaysia, ADB Institute Working Paper Series No. 1122 §3.1.1 at 6 & §3.2.1 at 9 (Apr 2020). Available at https://www.adb.org/sites/default/files/publication/602081/adbi-wp1122.pdf.

[69]See, e.g., Morten Falch & Anders Henten, "Public private partnerships as a tool for stimulating investments in broadband," 34 TELECOMMUNICATIONS POLICY 496 (2010). Available at https://www.researchgate.net/publication/223348686_Public_private_partnerships_as_a_tool_for_stimulating_investments_in_broadband.

[70]See, generally, Hans Christiansen, Balancing Commercial and Non-Commercial Priorities of State-Owned Enterprises, OECD Corporate Governance Working Paper No. 6 (OECD, 2013). Available at https://www.oecd.org/corporate/OECDCorporateGovernanceWorkingPaper6.pdf.

[71]The early 20th Century saw the Bell Telephone Company (founded by Alexander Graham Bell), through its patents, establish telephone companies in Europe as well as the United States. However, some European countries established telephone lines through their state-owned telegraph businesses and prohibited private firms from entering the market. See, generally, Scott Wallsten, Ringing in the 20th Century: The Effects of State Monopolies, Private Ownership, and Operating Licenses on Telecommunications in Europe, 1892-1914 (World Bank, Oct 2001). Available at https://documents1.worldbank.org/curated/en/484801468766467490/pdf/multi0page.pdf. In the heyday of voice communications, wired copper telephone networks had come to be treated by most governments as supply-side natural monopolies due to increasing economies of scale at all output levels. The copper networks were largely operated through each state's post, telegraph and telephone (PTT) department, with AT&T in the United States being the primary exception. The advent of wireless cellular telephone technology in the mid-1980s enabled the sector's first wide-scale introduction of facilities-based competition among mobile networks in the 1990s. This was extended to wired networks as telephone and cable television companies began competing to provide Internet access. Competition was introduced more recently in some smaller and developing countries.

[72]See, e.g., World Bank Group, Broadband Strategies Toolkit §2.2.4.1 (2013). See, e.g., infoDev, ICT Regulation Toolkit §1.4.3 (2011) [ICT Regulation Toolkit]. Available at https://documents1.worldbank.org/curated/en/390451468780890888/pdf/multi0page.pdf.

[73]See, e.g., Paul Crampton, Striking the Right Balance between Competition and Regulation: The Key Is Learning from Our Mistakes (OECD 2002). Available at https://www.oecd.org/regreform/2503205.pdf.

[74]See, e.g., ICT Regulation Toolkit, supra, §1.4.1.

[75]ITU, Trends in Telecommunication Reform, Report (31 Mar 2011). Available at https://www.itu.int/net/itunews/issues/2011/03/04.aspx.

[76]Broadband Commission for Digital Development, The State of Broadband 2013: Universalizing Broadband, Report §7.1 at 78 (ITU & UNESCO, Sep 2013). Available at https://www.broadbandcommission.org/Documents/bb-annualreport2013.pdf.

[77]See, e.g., Corporate Finance Institute, "Barriers to Entry" (2021). Available at https://corporatefinanceinstitute.com/resources/knowledge/economics/barriers-to-entry/. Similar problems cause barriers to exit by investors. These arise when a provider is performing poorly. It has made its investments and they cannot be used for much else, i.e., they are sunk costs. Investor efforts to recover sunk costs also create barriers to exit, often leading to a war of attrition among poorly performing firms that precludes entry by more efficient firms. This may be particularly so if failing firms hold spectrum resources that are scarce in that there are more firms seeking to use radio spectrum bands than are available for use. See, e.g., OECD Secretariat, Barriers to Exit – Background Note (2019). Available at https://one.oecd.org/document/DAF/COMP(2019)15/en/pdf.

[78]See ITU, Birth of Broadband Report, supra, §5.

[79]See ITU & World Bank, Digital Regulation Handbook, supra, at 3; and ITU, Trends in Telecommunication Reform Special Edition – 4th Generation Regulation: Driving Digital Communications Ahead at 22 & 37, Box 2.4 (2014). Available at https://www.itu.int/dms_pub/itu-d/opb/pref/D-PREF-TTR.15-2014-PDF-E.pdf.

[80]See ITU & World Bank, Digital Regulation Handbook, supra, at 17-18.

[81]See ITU & World Bank, Digital Regulation Handbook, supra, at 23.

[82]See, e.g., Office of Fair Trading, Government in markets: Why competition matters – a guide for policy makers (2009). Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/284451/OFT1113.pdf

[83]See, e.g., Working Party on Communications Infrastructure and Services Policy, Committee for Information, Computer and Communications Policy and Committee on Consumer Policy, OECD, Enhancing Competition in telecommunications: protecting and empowering consumers, Ministerial Background Report (OECD, 2008). Available at https://www.oecd.org/sti/consumer/40679279.pdf.

[84]See, e.g., Paul G. Scott, "Unilateral Refusals to Supply and the Essential Facilities Doctrine under New Zealand's Competition Law," 49 VICTORIA UNIVERSITY OF WELLINGTON LAW REVIEW 371 (2018). Available at http://www.nzlii.org/nz/journals/VUWLawRw/2018/17.pdf.

[85]See, e.g., European Commission, "Antitrust: Commission sends Statement of Objections to O2 CZ, CETIN and T-Mobile CZ for their network sharing agreement," Press Release (7 Aug 2019). Available at https://ec.europa.eu/commission/presscorner/detail/en/IP_19_5110.

[86]See, e.g., ICN Advocacy Working Group, Market Studies Good Practice Handbook (International Competition Network, 2016). Available at https://www.internationalcompetitionnetwork.org/wp-content/uploads/2018/09/AWG_MktStudiesHandbook.pdf.

[87]See ITU & World Bank, Digital Regulation Handbook, supra, at 34-35.

[88]See, e.g., Ofcom, Wholesale Broadband Access Market Review 2018, Final Statement (non-confidential version, 31 Jul 2018). Available at https://www.ofcom.org.uk/__data/assets/pdf_file/0030/116994/statement-wba-review.pdf. See also Iratxe Gurpegui & Przemyslaw Kordasiewicz, "Solving problems at the sources: why telecommunications regulation should focus on wholesale, not on retail, markets," Competition Policy Newsletter at 49 (Spring 20017). Available at https://ec.europa.eu/competition/publications/cpn/2007_1_49.pdf.

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[91]See George Houpis & Tom Ovington, Oiling the gates to the new economy: competition and change in telecoms at 64 (Frontier Economics, Apr 2019). Available at https://www.frontier-economics.com/media/3260/oiling-the-gates-to-the-new-economy-telecoms.pdf.

[92]See Tzvika Naveh, "Mobile Backhaul: Fiber vs. Microwave - Case Study Analyzing Various Backhaul Technology Strategies," Ceragon White Paper at 1 (Oct 2009). Available at https://www.winncom.com/images/stories/Ceragon_Mobile_Backhaul_Fiber_Microwave_WP.pdf.

[93]See Working Party on Communication Infrastructures and Services Policy, OECD, "The Development of Fixed Broadband Networks," supra, at 11; see also George Houpis & Tom Ovington, Oiling the gates to the new economy: competition and change in telecoms, supra, at 72.

[94]Frontier Economics, Assessing the case for Single Wholesale Networks in mobile communications, Report prepared for GSMA at 3 (Sep 2014). Available at https://www.gsma.com/publicpolicy/wp-content/uploads/2014/09/Assessing_the_case_for_Single_Wholesale_Networks_in_mobile_communications.pdf.

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[96]US Federal Communications Commission, Annual Report and Analysis of Competitive Market Conditions with Respect to Mobile Wireless, Including Commercial Mobile Services, WT Docket No. 11-186 at 178, Table 38 (released 21 Mar 2013). Available at https://www.fcc.gov/document/16th-mobile-competition-report.

[97]George Houpis & Tom Ovington, Oiling the gates to the new economy: competition and change in telecoms, supra, at 72.

[98]See, https://stats.oecd.org/glossary/detail.asp?ID=3267

[99]See, e.g., Olivier Boylaud and Giuseppe Nicoletti, Regulation, Market Structure and Performance in Telecommunications, OECD Economic Studies No. 32, 2001/1 at 136 Note 1 (OECD 2001). Available at https://www.oecd.org/economy/outlook/2736298.pdf.

[100]See Working Party on Communication Infrastructures and Services Policy, OECD, "The Development of Fixed Broadband Networks," supra, at 11. For an example of compelled wholesale unbundled access, see the United States Telecommunications Act of 1996, codified as amended at 47 U.S.C. §251(c)(3). Available at https://www.law.cornell.edu/uscode/text/47/251.

[101]See, e.g., OECD and IDB, Broadband Policies for Latin America and the Caribbean: A Digital Economy Toolkit at 124 (2016). Available at https://www.oecd-ilibrary.org/docserver/9789264251823-en.f?expires=1631274070&id=id&accname=guest&checksum=49AF9B7AA139D4A5C5462CDBB0A9A44F. For an example of compelled wholesale offerings for resale, see the United States Telecommunications Act of 1996, codified as amended at 47 U.S.C. §251(c)(4). Available at https://www.law.cornell.edu/uscode/text/47/251.

[102]See, e.g., M. Grajek & L Röller, Regulation and Investment in Network Industries: Evidence from European Telecoms (15 Jun 2009), available at http://siteresources.worldbank.org/DEC/Resources/84797-1257266550602/GrajekM.pdf; W Briglauer, K. Gugler & A. Hashimusa, Facility-and Service-based Competition and Investment in Fixed Broadband Networks: Lessons from a Decade of Access Regulations in the European Union Member States (self-published 2014), available at https://www.wu.ac.at/fileadmin/wu/d/ri/regulation/Briglauer_Gugler_Haxhimusa_Oktober_2014.pdf; W. Briglauer et al., The impact of infrastructure and service-based competition on the deployment of next generation access networks: Recent evidence from the European member states, supra; T. Hazlett, Rivalrous Telecommunications Networks, supra, at 480 ("evidence from telecommunications markets supports the view that mandatory network sharing has effectively blocked the transition [to facilities-based competition] it was advanced to assist"); Vogelsang, supra, at 212-15.

[103]See M. Cave & I. Vogelsang, "How access pricing and entry interact," 27 TELECOMMUNICATIONS POLICY 717-27 (2003); M. Cave, "Encouraging infrastructure competition via the ladder of investment," 30 TELECOMMUNICATIONS POLICY 223-37 (2006); T. Hazlett, Rivalrous Telecommunications Networks With and Without Mandatory Sharing, FEDERAL COMMUNICATIONS LAW JOURNAL 58:3 at 477 (2013) ("evidence from telecommunications markets supports the view that mandatory network sharing has effectively blocked the transition [to facilities-based competition] it was advanced to assist"). Available at http://www.fclj.org/wp-content/uploads/2013/01/h-hazlet.pdf.

[104]See World Bank, Digital Dividends: World Development Report 2016, supra, at 207-8.

[105]See Belgian Institute for Postal Services and Telecommunications, Impact study of 26 June 2018 regarding a fourth mobile network operator on the Belgian mobile market, Fig. 32 at 59 (7 Dec 2018). Available at https://www.bipt.be/operators/publication/impact-study-of-26-june-2018-regarding-a-fourth-mobile-network-operator-on-the-belgian-mobile-market.

[106]See T-Mobile, "T-Mobile Completes Merger with Sprint to Create the New T-Mobile" (1 Apr 2020). Available at https://www.t-mobile.com/news/un-carrier/t-mobile-sprint-one-company. See also Arriana McLymore & Diane Bartz, "T-Mobile-Sprint merger wins approval from U.S. judge," Reuters (10 Feb 2020). Available at https://www.reuters.com/article/us-sprint-corp-m-a-t-mobile/t-mobile-sprint-merger-wins-approval-from-u-s-judge-idUSKBN2042MG.

[107]See Competition Commission of India, Market Study of the Telecom Sector in India: Key Findings and Observations at 2 (22 Jan 2021). Available at https://www.cci.gov.in/sites/default/files/whats_newdocument/Market-Study-on-the-Telecom-Sector-In-India.pdf

[108]See, generally, GSMA Intelligence, The Mobile Economy West Africa 2018 at 32 (2018). Available at https://data.gsmaintelligence.com/api-web/v2/research-file-download?id=30933401&file=The%20Mobile%20Economy%20West%20Africa%202018.pdf

[109]In 2013, Côte d'Ivoire had 6 active mobile operators (in declining order by market share): Orange, MTN, Moov, Comium, GreenN, and Café Mobil. See Autorité de Régulation des Télécommunications/TIC de Côte d'Ivoire, Rapport d'Activités 2013 Figures 1 & 2 at 20 (2014). Available at https://www.artci.ci/images/stories/pdf/rapport_activite/rapport_activites_artci_2013.pdf. Licenses had also been issued to Globacom and Warid Telecom. See "Globacom gets mobile licence in Côte d'Ivoire," Balancing Act (13 Nov 20019. Available at https://www.balancingact-africa.com/news/telecoms-en/14969/globacom-gets-mobile-licence-in-c%C3%B4te-divoire. But neither had yet launched service. In March 2016, the regulator withdrew the operating licenses of Café Mobile, Comium, GreenN and Warid Telecom for failure to pay USD 155 million in taxes. See "Ivory Coast withdraws four mobile licenses over back taxes," Reuters (25 Jun 2015). Available at https://www.reuters.com/article/ivorycoast-telecoms/corrected-ivory-coast-withdraws-four-mobile-licenses-over-back-taxes-idUKL8N0ZA4FJ20150625. See also "Cote d'Ivoire: Comium, Café Mobile and Warid stripped from licences, GreenN bets on 4G," ITC & Telecom (Ecofin Agency, 1 Apr 2016). Available at https://www.ecofinagency.com/telecom/0104-33995-cote-d-ivoire-comium-cafe-mobile-an-warid-stripped-from-licences-greenn-bets-on-4g. Meanwhile, Globacom never launched mobile service in the country. See "Ivory Coast: revoked telco licenses on offer," IT Web (12 Apr 2016). Available at https://itweb.africa/content/P3gQ2qGxxz3vnRD1. By the end of 2016, Orange, MTN and Moov were the only remaining operators in the country's mobile market. See Autorité de Régulation des Télécommunications/TIC de Côte d'Ivoire, Rapport d'Activités 2016 Tables 3 & 4 at 52 & Figures 14 & 15 at 95-96 (2017). Available at https://www.artci.ci/images/stories/pdf/rapport_activite/rapport_activites_artci_2016.pdf.

[110]In 2015, Ghana had 6 mobile operators (in declining order by market shares): MTN, Vodafone, Tigo, Airtel, Glo and Expresso. In 2018, Tigo and Airtel merged and Expresso exited, bringing the total to 4. See Ghana National Communications Authority, quarterly statistical bulletins from 2015 – present. Available at https://nca.org.gh/reports/#statistical-bulletins. In April 2021, the owners of Airtel-Tigo agreed to transfer to the Government of Ghana, for one US dollar plus assumption of about USD 25 million in debt, all of their shares in the loss-making "unsustainable . . . JV" as a "going concern." See Victor Oluwole, "Airtel finally exits Ghana, sells business to the Ghanaian government," Business Insider Africa (17 Apr 2021). Available at https://africa.businessinsider.com/local/markets/airtel-finally-exits-ghana-sells-business-to-the-ghanaian-government/8712dbx. Although Ghana technically has 4 licensed operators, the fate of AirtelTigo is now uncertain and Glo's market share has remained around 2% since 2016. See Ghana National Communications Authority, quarterly statistical bulletins from 2015 – present. Available at https://nca.org.gh/reports/#statistical-bulletins.

[111]In 2011, Liberia had 5 mobile operators (in declining order by market shares): Lonestar-MTN, Cellcom, Comium, Libercell and Libtelco. See Liberia Telecommunications Authority, 2011 Annual Report Table 3 at 9 (2012). Available at https://lta.gov.lr/wp-content/uploads/2017/03/LTA_Annual_Report_2011.pdf. Liberian authorities shut down Libercell in July 2012 for failure to pay USD 1.4 million in tax arrearages. See "Liberia's Libercell shut down," IT News Africa (31 Jul 2012). Available at https://www.itnewsafrica.com/2012/07/liberias-libercell-shut-down/. Ownership of Comium changed hands in 2012. See "Comium Liberia sold for USD18m, paper says," Comms Update (Telegeography, 31 Jul 2012). Available at https://www.commsupdate.com/articles/2012/07/31/comium-liberia-sold-for-usd18m-paper-says/. See also "Sierra Leone News: Government issues Ultimatum to close Comium" (Awoko Publications, 18 Jan 2014). Available at https://awokonewspaper.sl/sierra-leone-news-government-issues-ultimatum-to-close-comium/. Comium was rebranded by its new owners as Novafone in September 2013. See LinkedIn > Company > Novafone Inc (2021). Available at https://www.linkedin.com/company/novafone-inc-/. Meanwhile, Libtelco exited the market, shutting down its CDMA network in early 2016. See Liberia Telecommunications Authority, Public Consultation Document on the Definition of Relevant Telecommunications Markets at 2 (1 Jun 2016). Available at https://www.emansion.gov.lr/doc/CONSULTATION-DOCUMENT.pdf. Soon thereafter, France-based telecom conglomerate Orange acquired Cellcom in April 2016. See James Barton, "Orange completes rebrand of Cellcom Liberia to Orange Liberia," Developing Telecoms (8 May 2017). Available at https://developingtelecoms.com/business/operator-news/7085-orange-completes-rebrand-of-cellcom-liberia-to-orange-liberia.html. Still struggling in the market, Novafone was acquired by Lonestar-MTN later in 2016, after negotiations for a sale to state-owned Libtelco fell apart. See "On, off, on again: Novafone sale may go ahead after all," Comms Update (Telegeography, 16 May 2016). Available at https://www.commsupdate.com/articles/2016/05/16/on-off-on-again-novafone-sale-may-go-ahead-after-all/. See also "Novafone Goes to Court Over Denied Duty Free Privilege," Front Page Africa (25 Jul 2017). Available at https://frontpageafricaonline.com/business/novafone-goes-to-court-over-denied-duty-free-privilege/.

[112]Expert Group to the Broadband Commission, A New Deal: Investing in our common future Policy recommendations to close the broadband gap 10 (Broadband Commission Feb 2018). At www.broadbandcommission.org/Documents/reports/ExpertGroupReportFeb2018.pdf.

[113]See, e.g., ITU & World Bank, "Competition and economics > Infrastructure sharing," Digital Regulation Platform (15 Dec 2020). Available at https://digitalregulation.org/competition-and-economics/.

[114]See, e.g., Body of European Regulators for Electronic Communications, BEREC Report on infrastructure sharing (14 Jun 2018). Available at https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/8164-berec-report-on-infrastructure-sharing. See also Zoltán Pápai, Gergely Csorba, Péter Nagy & Aliz McLean, Competition policy questions in mobile network sharing (2018). Available at https://www.econstor.eu/bitstream/10419/184960/1/Papai-et-al.pdf.

[115]See, e.g., Jose Marino Garcia & Tim Kelly, The Economics and Policy Implications of Infrastructure Sharing and Mutualisation in Africa, supra, at 2. See also OECD, Restructuring Public Utilities for Competition 11-16 (2001). Available at http://www.oecd.org/daf/competition/sectors/19635977.pdf. For analysis of the relative merits of each model, see generally Malcolm Webb, "Accelerating Broadband Deployment through Network Sharing and Co-investment," GSR Discussion Paper §2.4 at 5-6 (ITU, 2015). Available at https://www.itu.int/en/ITU-D/Conferences/GSR/Documents/GSR2015/Discussion_papers_and_Presentations/Discussionpaper_networksharing.pdf.

[116]See, e.g., GSMA, Mobile Infrastructure Sharing Figure 5 at 16 (Sep 2012). Available at https://www.gsma.com/publicpolicy/wp-content/uploads/2012/09/Mobile-Infrastructure-sharing.pdf.

[117]See Georges V. Houngbonon, Carlo Maria Rossotto & Davide Strusani, "Enabling A Competitive Mobile Sector in Emerging Markets Through the Development of Tower Companies," EMCompass Note 104 at 2 (IFC, Jun 2021). Available at https://www.ifc.org/wps/wcm/connect/938e73d8-94cc-40b5-a5af-aa7c016c8f67/EMCompass_Note_104-web.pdf?MOD=AJPERES&CVID=nEqOjj8.

[118]See Kieron Founde, "Independent towercos inaugurate an era of infrastructure sharing," ITU News (2 Feb 2018). Available at https://news.itu.int/independent-towercos-infrastructure-sharing/.

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[120]See Georges V. Houngbonon et al., "Enabling A Competitive Mobile Sector in Emerging Markets Through the Development of Tower Companies," supra, at 1.

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[128]See Broadband Commission Working Group on Broadband for All, A "Digital Infrastructure Moonshot" for Africa: Connecting Africa Through Broadband – A strategy for doubling connectivity by 2021 and reaching universal access by 2030 at 64 (Oct 2019). Available at https://www.broadbandcommission.org/Documents/working-groups/DigitalMoonshotforAfrica_Report.pdf.

[129]See Broadband Commission Working Group on Broadband for All, A "Digital Infrastructure Moonshot" for Africa, supra, at 73 (licensing and rights of way) & Davide Strusani & Georges V. Houngbonon, "Accelerating Digital Connectivity Through Infrastructure Sharing," supra, at 2-3 (poles and ducts).

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[142]Inkk Mobile has operated as an MVNO in Fiji using Vodafone Fiji's mobile network since 2007. See Inkk Mobile > Home > About Us (2021). Available at https://inkk.com.fj/about-us/.

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[144]See Nigeria Communications Commission, Department of Licensing and Authorization, License Framework for the Establishment of Mobile Virtual Network Operators in Nigeria, First Draft Document (published 10 Dec 2020). Available at https://www.ncc.gov.ng/accessible/documents/941-draft-mvno-licence-framework/file.

[145]See European Electronic Communications Code, supra, preamble 198-201.

[146]W. Briglauer et al., Why Is Europe Lagging on Next Generation Access Networks? supra, at 10-11.

[147]See Murray Milner, "Ultra-fast Broadband: The New Zealand Experience, JOURNAL OF TELECOMMUNICATIONS AND THE DIGITAL ECONOMY (Jun 2020) Available at https://telsoc.org/sites/default/files/journal_article/248-article_text-2746-1-11-20200527.pdf

[148]See World Bank, Implementation Completion and Results Report on a Credit in the Amount of SDR 13.5 Million (US$ 20 Million Equivalent) to the Republic of Malawi et al., Report No: ICR00004013 at 9-10 (28 Jun 2018). Available at https://documents1.worldbank.org/curated/en/414221531333372143/pdf/ICR00004013-07062018.pdf.

[149]Malaysia originally introduced the MVNO hosting requirement as a condition for bidding on 3G licenses. More recently, the sector regulator has required mobile operators to publish reference offers and has reserved the right to impose hosting terms if MVNOs and mobile operators are unable to reach agreement. By 2018, 34 MVNOs had entered the Malaysian market. See Karen Woo, "Regulatory framework for MVNO," Regional Standardization Forum for Asia: Emerging Economic, Regulatory and Policy Trends in a Fast-Changing Digital World at Slide 4 (ITU, 27 Aug 2018). Available at https://www.itu.int/en/ITU-T/Workshops-and-Seminars/bsg/201806/Documents/Karen_Luan.pdf.

[150]For example, in its effort to obtain EU regulatory approval for the acquisition of Orange Austria, Hutchison promised wholesale access to its network for rivals, allotting up to 30 percent of its capacity for as many as 16 MVNOs within 10 years, with at least one MVNO arrangement required to be concluded prior to completion of the merger. See "Hutchison wins EU approval for Orange Austria deal," Reuters (12 Dec 2012). Available at https://www.reuters.com/article/us-orangeaustria-hutchison-eu/hutchison-wins-eu-approval-for-orange-austria-deal-idUSBRE8BB12220121212.

[151]See kt Rwanda Networks > About > Our History (2021). Available at https://www.ktrn.rw/about.

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[153]See World Bank, Burkina Faso Technical Annex on a Proposed Grant in the Amount of SDR 14.2 Million (US$23 Million Equivalent) to Burkina Faso as Part of SDR 56.8 Million (US$92 Million Equivalent) for the Second Series of the First Phase of the West Africa Regional Communications Infrastructure Program (WARCIP APL 1B), Report No: T7745-BF at 28-29 (25 May 2011). Available at https://documents1.worldbank.org/curated/en/232691468020336029/pdf/T77450PAD0Burk0isclosed0July1520110.pdf.

[154]See The Gambia Submarine Cable Company Ltd. > Services (2021). Available at http://gsc.gm/?page_id=429.

[155]Guinea established GUILAB SA as a cooperative of Government and eight network operators. See World Bank, Emergency Project Paper on a Proposed Grant in the Amount of SDR 2 Million (US$34 Million Equivalent) to the Republic of Guinea as Part of SDR 56.8 Million (US$92 Million Equivalent) for the Second Series of Projects under the First Phase of the West Africa Regional Communications Infrastructure Program (WARCIP APL1B), Report No: 62002-GN at 15-16 (25 May 2011). Available at https://documents1.worldbank.org/curated/en/868171468032398453/pdf/620020PAD0Guin0isclosed0July1520110.pdf.

[156]See World Bank, International Development Association Project Appraisal Document on a Proposed Credit in the Amount of SDR 25.8 Million (US$35 Million Equivalent) to the Republic of Guinea-Bissau for the West Africa Regional Communications Infrastructure Project, Report No: PAD1761 on at 9-10 (10 Mar 2017). Available at https://documents1.worldbank.org/curated/en/877611490105113713/pdf/Guinea-Bissau-WA-Regional-Communication-PAD-PAD1761-03152017.pdf.

[157]See World Bank, Implementation Completion and Results Report on an International Development Association Credit in the Amount of SDR 16.3 Million (US$ 25.6 Million) [for Liberia] and International Development Association Credit of SDR 19.8 Million (US$ 31 Million Equivalent) [for Sierra Leone], Report No: 00003971 at 10-11, 15 & 28 (30 Dec 2017). Available at https://documents1.worldbank.org/curated/en/661221514405908388/pdf/ICR-Main-Document-P116273-12302017.pdf.

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The UN Capital Development Fund makes public and private finance work for the poor in the world's 46 least developed countries (LDCs). UNCDF offers "last mile" finance models that unlock public and private resources, especially at the domestic level, to reduce poverty and support local economic development. UNCDF pursues innovative financing solutions through: (1) financial inclusion, which expands the opportunities for individuals, households, and small and medium-sized enterprises to participate in the local economy, while also providing differentiated products for women and men so they can climb out of poverty and manage their financial lives; (2) local development finance, which shows how fiscal decentralization, innovative municipal finance, and structured project finance can drive public and private funding that underpins local economic expansion, women's economic empowerment, climate adaptation, and sustainable development; and (3) a least developed countries investment platform that deploys a tailored set of financial instruments to a growing pipeline of impactful projects in the "missing middle."

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