WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD

Industry Agenda

Delivering Digital Infrastructure

Advancing the Internet Economy

Prepared in Collaboration with The Boston Consulting Group

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Preface

In May 2013, the World Economic Forum convened a cross-industry initiative to examine the ability of digital infrastructure to keep pace with the fast-rising demand being put on it, with a focus on developed markets. The assembled steering committee and working group include communications service providers, content companies, software companies and hardware manufacturers active in the United States, Europe, Latin America, Africa and Asia. For 12 months, they have jointly assessed digital infrastructure adequacy and, in particular, the impediments – technological, financial and political – to the investments necessary to maintain and improve the telecommunications networks and digital ecosystem that constitute the internet.

This report is part of the World Economic Forum's series on the Hyperconnected World, a cross-industry, umbrella platform that connects the dots across industry projects to understand and manage social, economic and political consequences of digital technology. The report, which was prepared in collaboration with The Boston Consulting Group, discusses the steps necessary to keep digital infrastructure improving at a rate that will enable it to facilitate the growth and development of a vibrant global digital economy in the near and medium term. Other reports by the World Economic Forum in this series include *Risk and Responsibility in a Hyperconnected World, Rethinking Personal Data* and *Global Information Technology Report 2014*.

Executive Summary

The internet is fast becoming the essential infrastructure of the 21st century. It is as revolutionary in its way to how people live, work, play and interact as previous revolutions in transportation, energy and telephony have been in theirs. For billions of people already, and for billions more to come, life without digital interaction and the services it enables is all but unthinkable.

But suppose the unthinkable were to happen. Imagine that the infrastructure fails. Think of a bridge with a fractured support. Or a pipeline slowed to a trickle. Or an electrical grid that functions only intermittently. Such infrastructure-related realities are all too frequent occurrences – and they represent big daily headaches and economic impediments for the people who must contend with them.

The costly and complex infrastructure that carries the traffic that makes digital services possible is hardly immune to similar headaches and impediments. In its own highly interconnected way, the internet can be as fragile as a bridge or roadway exposed to the elements. It is subject to breakdowns; it needs investment and maintenance; it has limitations in reach, penetration and capacity that require innovations to overcome. Perhaps most important, it needs the continuing collaboration of its own ecosystem of participants – companies, governments, users and other parties – to keep things moving.

This report examines the present threats to digital infrastructure and suggests approaches and actions for addressing them before they affect the flow of information and services that serve the digital economy. Each chapter addresses a technological, commercial, policy or regional challenge that is of particular significance.

Chapter 1. Introduction: The Digital Infrastructure Imperative
The potential of the digital economy can only be realized if digital infrastructure keeps pace.

- Significant impediments constrain the continued development of digital infrastructure. Without corrective action, the drag they impose will get worse.
- Communications service providers (CSPs), digital service and content providers, hardware and software manufacturers, industry groups, and governments all play critical roles.
- Effecting change is the collective responsibility of all the participants in the digital ecosystem.

Chapter 2. Growth Driver: Developing Digital Services
Countries need energetic digital service sectors. They are drivers of social and economic development, job creators, talent magnets and the exports of the future.

- Robust digital service sectors depend on a complex ecosystem that includes adequate infrastructure and an investment-friendly business environment.
- Governments can play a key role in catalysing digital development by creating the right environment.
- Governments also need to know when to step aside and let markets flourish.

Chapter 3. Spectrum: Invisible Infrastructure
The availability of mobile spectrum is one of the biggest, and most complex, infrastructure constraints.

- Unless changes are made, inefficiencies in allocation, utilization and harmonization of spectrum will only get worse as demand increases for mobile services.
- Governments must release additional spectrum – licensed and unlicensed – for private mobile use, as well as take steps to encourage spectral efficiency. New approaches to encourage harmonization are required.
- Establishment of secondary markets and pursuit of alternative deployment models are necessary to meet the fast-growing demand for mobile data.

Chapter 4. Staying Interconnected
Resolving internet protocol (IP) interconnection disputes is required to ensure digital traffic continues to flow efficiently.

- The rapid rise in streaming video, combined with conflicting views over who should build and pay for internet infrastructure, has led to IP interconnection disputes in recent years.
- Because these arrangements dictate how traffic is exchanged among networks, it is in everyone's interest to resolve disputes rapidly.
- Despite differing interests, CSPs and content providers can find a mutually beneficial path that maintains the commercial nature of IP interconnection contracts with no unfair discrimination.

Chapter 5. How Regulatory Policy Can Keep Up
Policy and regulation must be modernized to deal with 21st century realities and issues.

- Today's critical issues span a much more complex, interconnected value chain; policies must take into account the impact on investment and innovation across multiple industries.
- Given the rapid pace of change, policy-makers should pursue forward-looking, light-touch approaches to regulation.

Chapter 6. The Challenge for Europe: Crafting a Digital Renaissance
Europe's digital health requires attention; without infrastructure investment, it is

difficult to see the EU capitalizing fully on the benefits of the internet economy.

- Europe has gone from digital leader to laggard in less than a decade.
- Current industry economics constrain investment in telecommunications infrastructure; consumers pay less for connectivity than in some other countries, but they are missing out on advanced services.
- Policy-makers should improve the investment environment for infrastructure by allowing targeted consolidation; operators must also adapt their business models to grow digital services.
- A true single digital market, in which data and services can flow across borders, is required to build a robust digital service sector in Europe.

Chapter 7. Encouraging Infrastructure Investment and Innovation in the US
New sources of competition and technology will help the US to remain a world leader.

- While consumer and business internet use is robust in the United States, there is debate over whether the current market is driving infrastructure innovation.
- US policy-makers should encourage the innovations taking place in local markets to heighten competition and investment, especially in "the last mile".
- Policy-makers should also encourage investments in next generation technologies to accelerate the transition to high-capacity IP networks.

Chapter 8. Emerging Markets: Big Challenges, Big Opportunities
Digital technologies can have an outsized impact in emerging markets, but they face big challenges in getting established, many of them infrastructure-related.

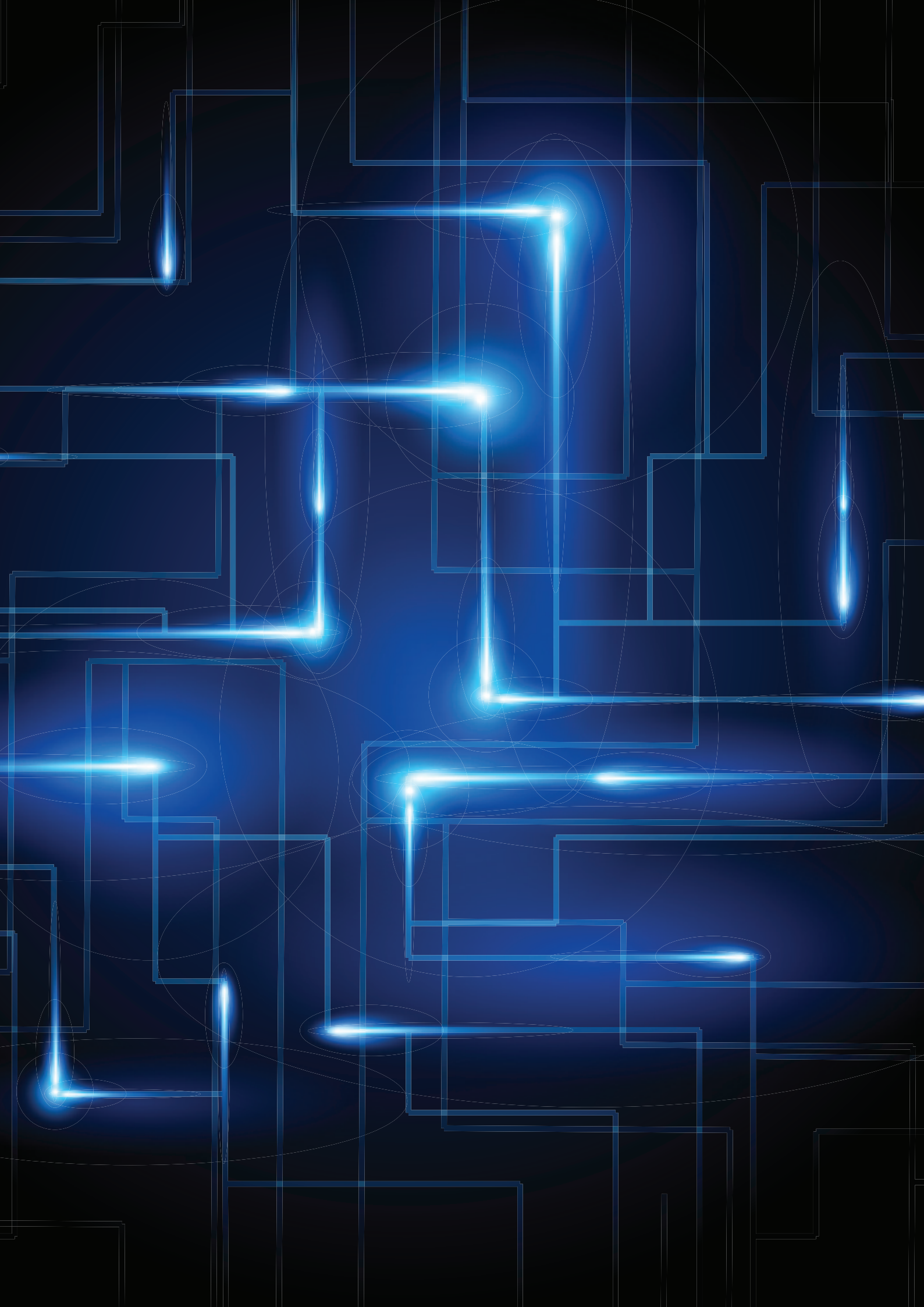
- Lack of existing infrastructure allows operators to adopt and implement the new technologies that suit their markets' current situation and projected requirements.
- Public-private partnerships can encourage efficient and expedient infrastructure deployment in emerging markets.
- The development of local digital service markets can be big steps towards addressing local problems.
- Bridging the digital divide may require non-traditional, innovative approaches, especially in funding and market access mechanisms.

Chapter 9. Towards a Robust Digital Infrastructure
Effectively delivering digital infrastructure and realizing the promise of the digital economy rests on three pillars:

1. Commitment to actions that promote the long-term growth of the digital economy
2. Removal of impediments to the expansion of digital infrastructure
3. Modernization of policies and regulations to encourage investment and innovation throughout the internet ecosystem.
(See Figure 1.)

Figure 1: Summary Recommendations for Delivering Digital Infrastructure

Commitment to actions that promote the long-term growth of the digital economy	i Governments, businesses and other stakeholders should commit to long-term actions that promote growth of digital services and the digital economy. ii Establish international guidelines that enable the flow of data and services while recognizing privacy and security concerns. iii Open doors (or keep them open) to international digital service businesses while promoting and supporting local initiatives.
Removal of impediments to the expansion of digital infrastructure	iv Encourage technological and business model experimentation in infrastructure by removing barriers to innovation and encouraging local experimentation. v Encourage stakeholders to pursue cooperative business models to achieve greater utilization of infrastructure and grow demand for digital services. vi Experiment with innovative funding and market-access mechanisms to promote market-based infrastructure investments in emerging markets.
Modernization of policies and regulations to encourage investment and innovation throughout the internet ecosystem	vii Modernize policies and regulations to be light-touch in approach and supportive of innovation and investment across the entire ICT value chain. viii Allow targeted consolidation of mobile operators to encourage service-level innovation in markets where fragmentation limits investments. ix Release more spectrum for private-sector mobile use and adapt allocation and utilization policies to encourage greater efficiency in its use.



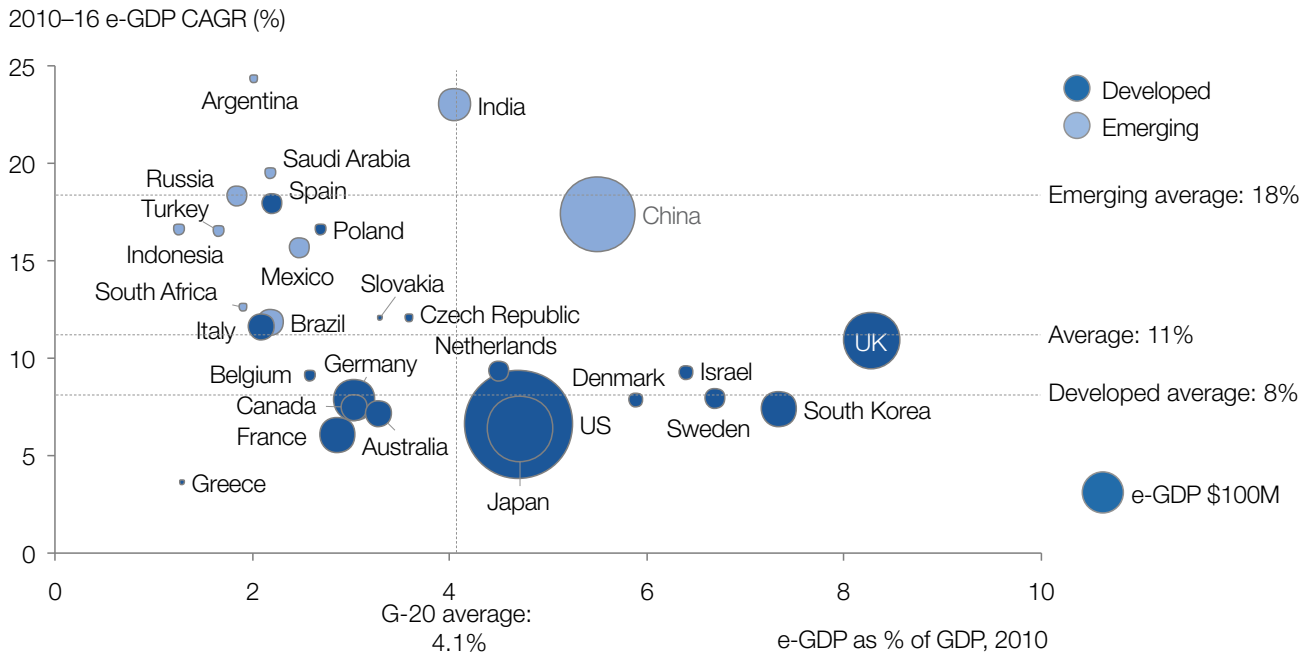
1. Introduction: The Digital Infrastructure Imperative

It has taken less than two decades for the commercial internet to go from innovation to indispensable, from fun to fundamental. About 2.5 billion people are connected to the internet today, a third of the world's population; there are projected to be about 4 billion users by 2020, or more than half the global population.[1] Continuous access to information, commerce, communication, friends and entertainment – among myriad other things – has become a daily fact of life for billions and will soon become a reality for billions more. As the internet makes its full weight felt in more high-impact areas such as healthcare, education and government services, access to digital services will only become more essential for everyone in the years to come.

Big expectations are riding on the continued expansion of the digital economy. Internet-based economic activity is expected to reach $4.2 trillion in the G-20 nations by 2016, or more than 5% of GDP, and this does not include a whole universe of pursuits not captured in GDP figures. The digital economy is growing at more than 10% a year, significantly faster than the economy as a whole. In emerging markets, the internet economy is growing at 12-25% per year, and it is having a far-reaching social and political, as well as economic, impact.[2] (See Figure 2.) Around the world, it is an increasingly important source of growth and, frequently, jobs.

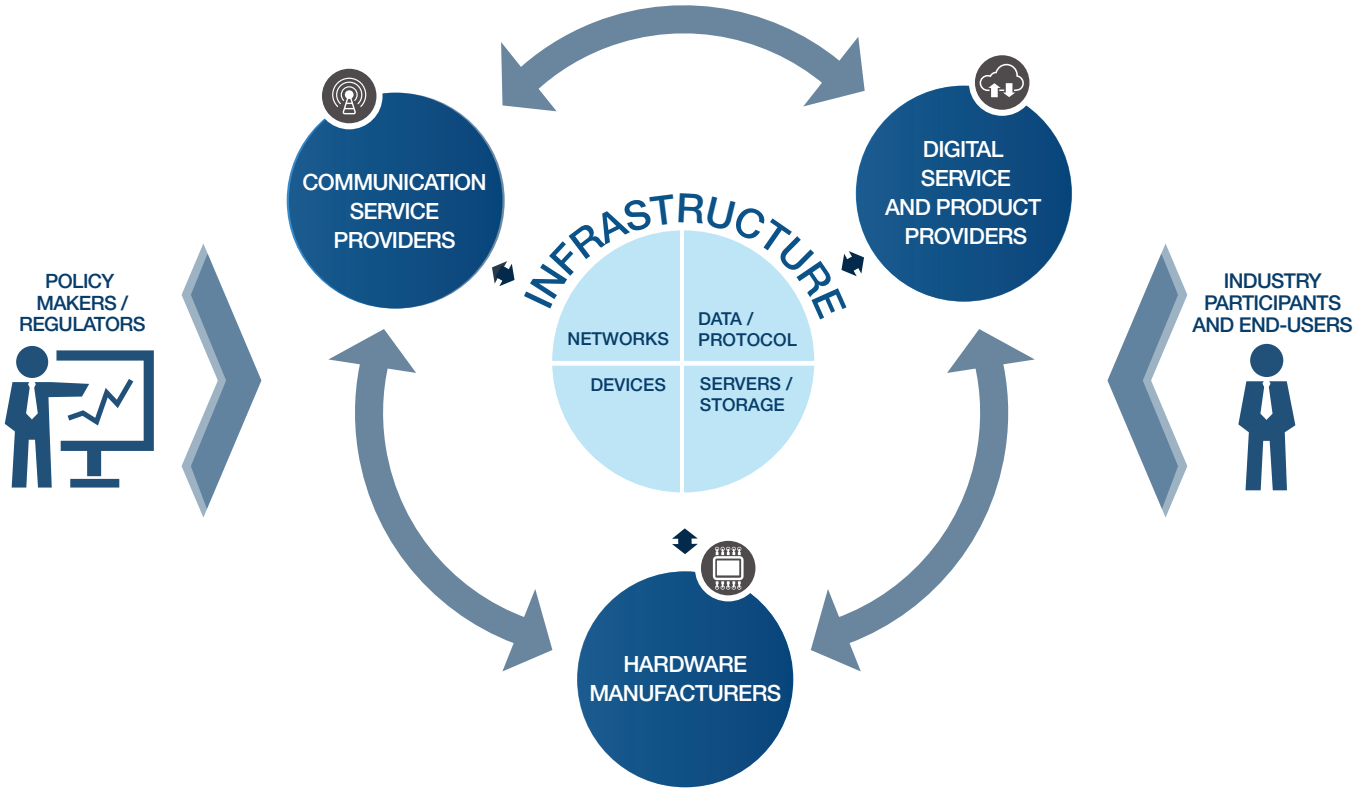
Such is the impact of digital services and the digital economy that they sometimes seem to be riding a wave of their own momentum. This is not the case. Multiple parties have invested trillions of dollars (and euros and pounds and renminbi, among other currencies) in capital and operating expenditures and research and development to construct and maintain the infrastructure that supports the digital ecosystem that makes the digital economy possible. These parties include communications service providers, or CSPs (fixed line and wireless telecommunications companies, cable companies, and bandwidth providers), digital service and content providers (content, media and IT service companies), and hardware and software manufacturers (infrastructure equipment, device, software and component manufacturers).

Figure 2: Digital Economy Growing at Over 10% per Year across G-20 Countries and Select Other Countries



Sources: EIU, Ovum, Gartner, Euromonitor, OECD, BCG analysis

Figure 3: Many Stakeholders Play a Role in Digital Infrastructure



Governments also play big parts. Three of the most prominent roles are as policy-makers, regulators and the owners and dispensers of spectrum for mobile networks. Non-governmental organizations (NGOs), industry associations, standards bodies, multistakeholder associations such as the World Wide Web Consortium (W3C), the Internet Corporation for Assigned Names and Numbers (ICANN) and the International Telecommunication Union (ITU), a UN agency, are key players, too. Together, all of these participants are responsible for the fixed and mobile networks, exchange points, datacentres, devices and network equipment, and platforms and protocols that make the internet work. (See Figure 3.)

As more people and businesses come online, and more companies invent more ways to serve their needs – cloud services, machine-to-machine communications (M2M), and the Internet of Things are all new and fast-growing phenomena, for example – the volume of digital traffic will continue to grow exponentially. Can the infrastructure that society now counts on (mostly without thinking about it) to carry all this traffic keep up? A corollary question: who is responsible for making sure that it does?

Infrastructure does not get built without foresight, planning, investment and innovation. Even though CSPs by themselves currently invest more than $300 billion a year in infrastructure-related capital expenditure[3], serious impediments are already constraining digital activity and interaction. Without new approaches, the constraints will not be relieved and could intensify. In Europe, for example, lagging adoption of long-term evolution (LTE) technology limits the speed and functions of consumers' mobile devices. Spectrum scarcity – exacerbated by inefficient allocation and utilization – constrains mobile network capacity worldwide. Disputes over IP interconnection agreements – the deals that dictate how traffic is passed among internet infrastructure providers – could slow the online flow of data. In emerging markets and many rural regions, basic issues of access and cost remain high hurdles. These and other problems threaten to undermine the continued rapid growth of the digital economy.

Numerous issues complicate decision-making and cloud prospects for necessary upgrades and improvements. At the same time, all along the digital value chain, there are tremendous opportunities for businesses to provide better customer experiences, increase demand, improve productivity and save costs. Digital service delivery has the potential to revolutionize fields with huge social and economic impact such as healthcare and education. The degree and nature of the challenge vary by region, but the need for improved infrastructure to accommodate fast-growing digital growth is global.

This report examines the interaction between the digital economy and the infrastructure that supports it. It identifies the main problems and issues undermining investment and innovation in infrastructure today and suggests solutions or avenues to finding solutions. A key underlying premise is that CSPs and content providers face a mutually dependent future. Digital services depend on infrastructure for delivery, and without digital services, infrastructure providers have little for their infrastructure to do.

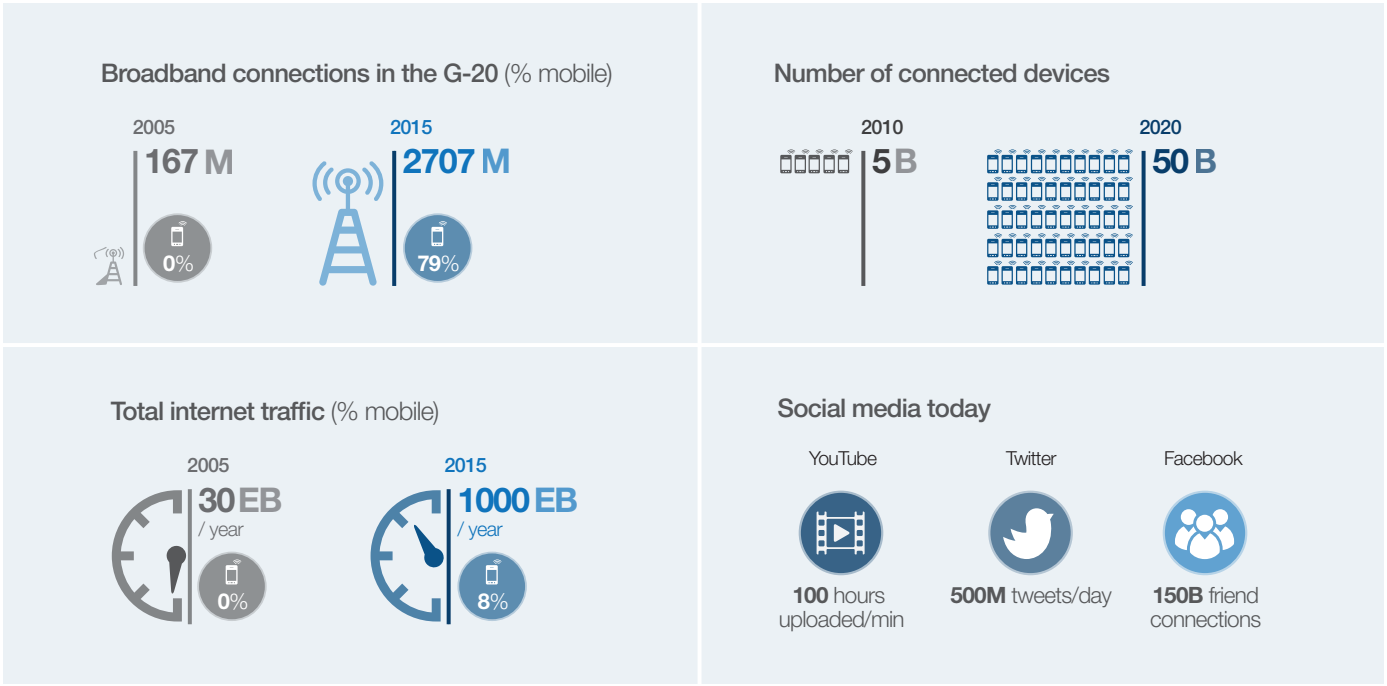
Policy-makers, industry participants and other stakeholders need to work collectively to do three things:

1. Commit to actions that promote the long-term growth of the digital economy
2. Remove impediments to the expansion of digital infrastructure
3. Modernize policies to encourage investment and innovation throughout the internet ecosystem

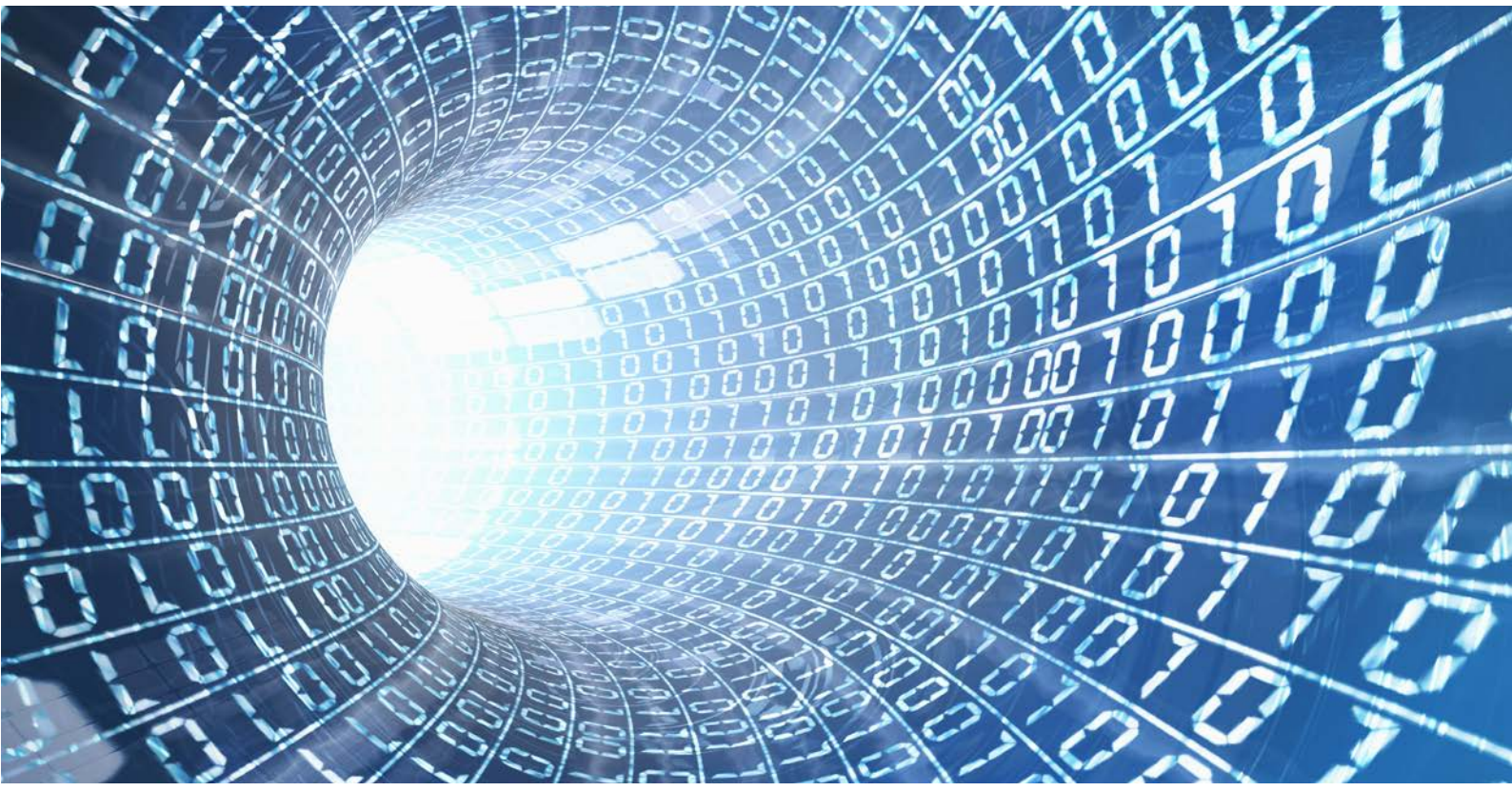
This report explores each pillar and provides more detailed recommendations at the end. (See Figure 4.)

Digital services depend on infrastructure for delivery, and without digital services, infrastructure providers have little for their infrastructure to do.

Figure 4: Demands on Digital Infrastructure Exploding



Sources: EIU, Cisco, Ovum, Company press releases, BCG analysis

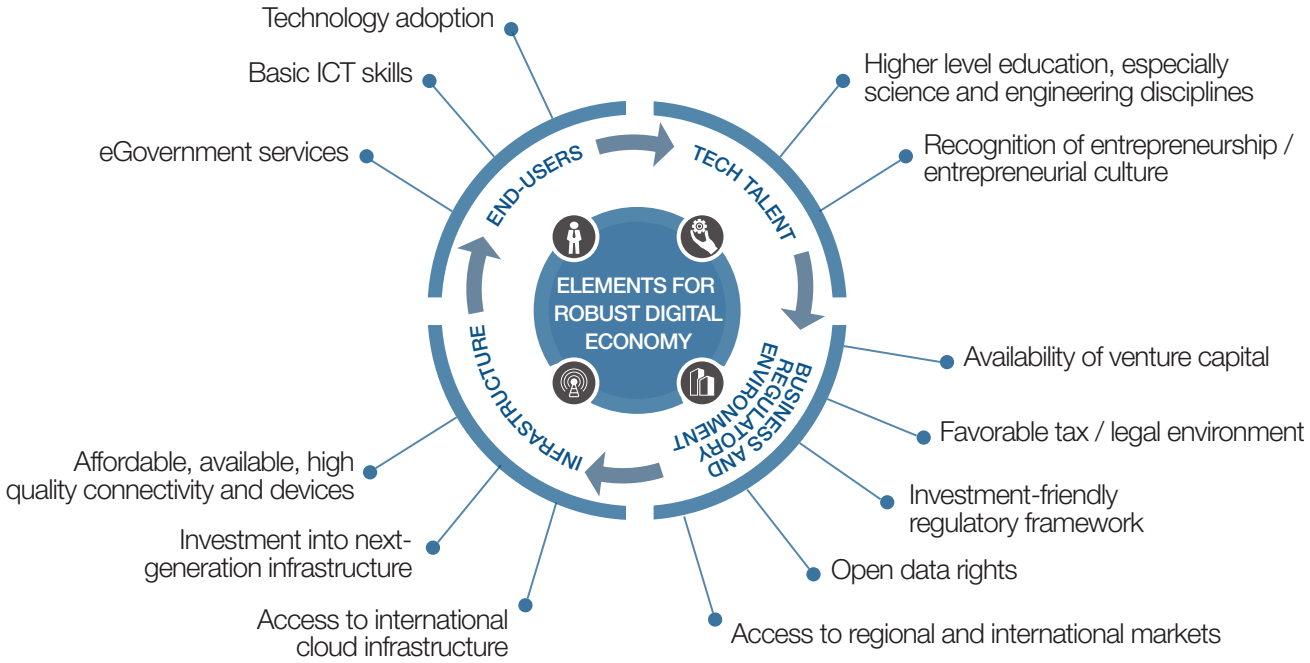


2. Growth Driver: Developing Digital Services

In the digital era, connectivity counts. It is impossible to imagine the country, sector, industry or area of endeavour that cannot benefit from digital services. The services enabled by digital technology are economic growth drivers, job creators, talent magnets and big sources of exports. The internet has created entirely new fields of commerce (the term "app developer" did not exist a few years ago), and its impact extends deeply into traditional industries, enabling new capabilities, products and services. The quality, speed and extent of connectivity will be increasingly important factors in business and economic decisions in the future, including where companies decide to expand or locate new facilities.

Digital service sectors have evolved along many different paths, but they have certain key attributes in common: adequate digital infrastructure, technology-literate end-users, technology talent with entrepreneurial spirit, and a friendly business environment. (See Figure 5.)

Figure 5: Many Elements Required for a Healthy Digital Service Sector



Sources: BCG analysis

Governments Can Lead – Up to a Point

In a number of countries, but by no means all, governments have played a key role in getting the digital ball rolling with strategies, policy initiatives, investment incentives and even funding. South Korea saw the potential of information and communications technologies (ICT) – many then still in their youth – during the South-East Asian economic crisis of the late 1990s and the public and private sectors combined to turn the country into an economic powerhouse. Sweden was the first country in Europe to develop a broadband policy with the principle that everyone should have access. The government provided IT training to 75,000 teachers and funded IT training for small businesses and the unemployed. It led a public-private partnership to develop Stockholm's Kista Science City, home to more than 1,000 information and communications technology companies with some 25,000 employees and Europe's largest ICT cluster.[4] In these instances, as well as others, the governments also knew when to step aside and let the private sector maintain the momentum.

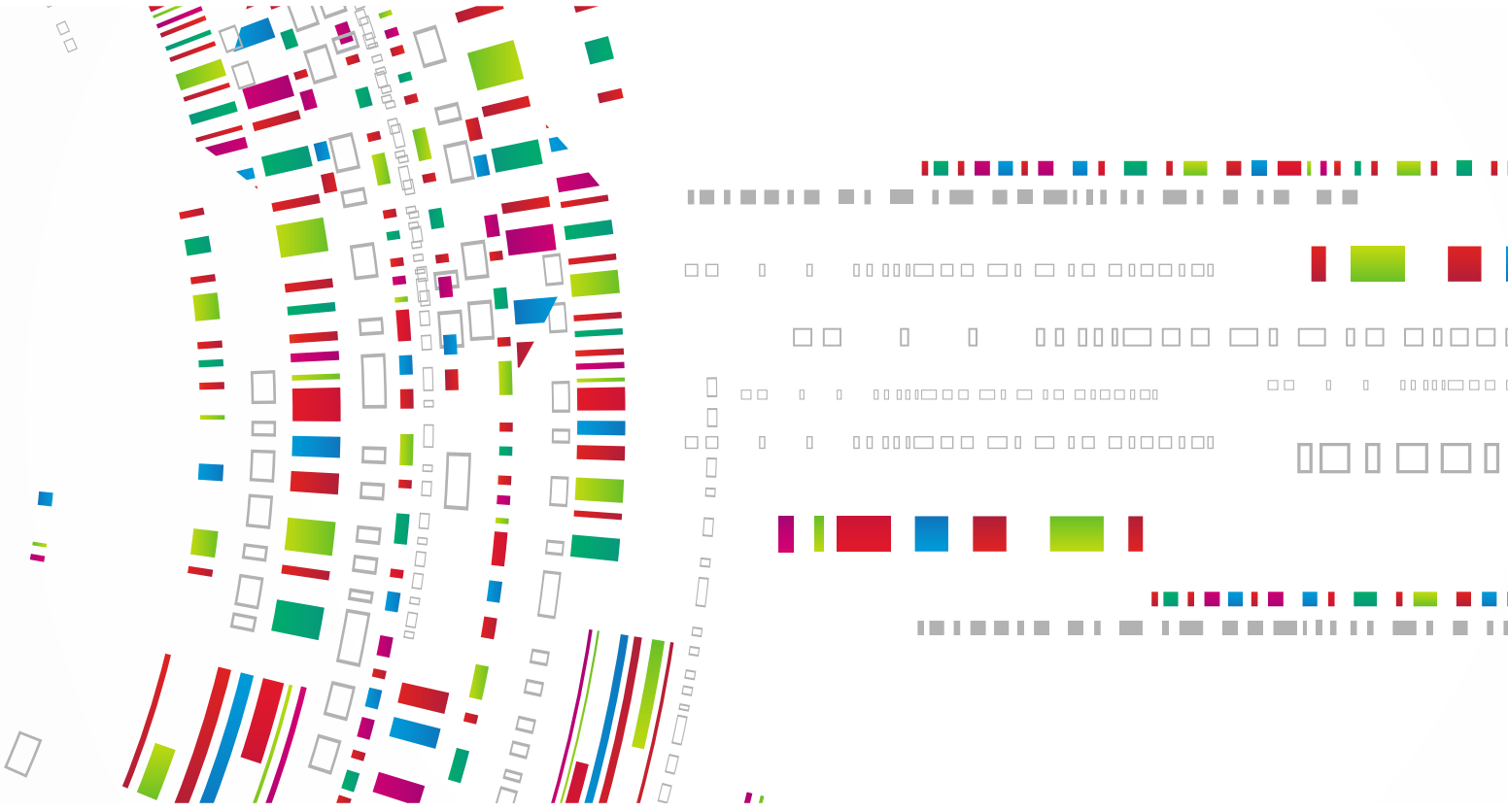
California's Silicon Valley is perhaps the leading example of a thriving digital service economy that grew almost entirely out of successive waves of private sector innovation and investment, albeit with major assistance from a leading educational institution (Stanford University) and the nearby presence of the US military. Countries as varied as China, Israel and Kenya have built energetic digital service industries with their own mixes of private and public sector involvement.

It's the Environment

Governments can play a big role in creating environments that facilitate digital exchange. Attitude is important. The UN as well as a number of countries have declared internet access to be a fundamental right of all citizens, and Finland and Spain have mandated connection speeds of at least 1 megabit per second for everyone. Fibre-optic broadband projects have led to higher than average penetration in such countries as Slovakia and Estonia, where fibre as a percentage of total broadband exceeds 30%, compared with an OECD average of less than 14%.[5]

Policies matter, too. Governments can make it easy and attractive for digital service providers to operate within and across their borders. They can promote the free flow of information and services across those borders. They can recognize that the competition for investment and talent is global, and that digital infrastructure and the business friendliness of a country are critical attributes for attracting both. Many have a lot of catching up to do in this regard. Countries vary widely in their ability to attract venture capital, with most lagging the leaders by a substantial margin. Engineers are in high demand: they make up approximately 80% of the expense structure for start-ups and are a critical resource for larger companies seeking to grow.[6] Developing strong tech communities – often by first attracting international digital service players – creates a virtuous circle, furthering the attraction, development, and retention of talent. The fact that more than 50% of Silicon Valley start-ups had first-generation immigrants on the founding teams illustrates the importance of immigration-friendly environments.[7] Reforming immigration rules to attract and retain foreign-born technical talent are signals that a country is open for digital business.

Many factors, such as workforce ICT skills, trade barriers, access to capital and the strength of intellectual property protection, hold back successful online business operations. Countries with well-developed markets for international



trade and a domestic business environment that fosters innovation and creativity have a big advantage. Equally, lack of ICT literacy and access to and affordability of financial services impede consumers' interaction with the digital economy. These are areas in which education, trade and consumer policies and programmes can help.

Governments should recognize that there are things they should not do. Tariffs, taxes and technology controls slow things down. So do excessive or intrusive regulations. If a country limits access to cloud computing and data, wherever those resources happen to be based, it is a big obstruction for start-ups. It is equally important to avoid protectionist solutions, such as mandated national traffic routing or "country clouds", that lack scale, push the potential fracturing of the internet, and put users at a disadvantage to peers and competitors elsewhere.

Data security and privacy are two high-profile areas countries need to get right. Consumers value privacy, but studies also show they are happy to trade personal information for expanded services and convenience if they are satisfied with the privacy controls. Better aligning tax laws, copyright protections and data protection rules improve the environment for digital services.

Setting an Example

Three areas in which governments can lead by example and promote digital services demand are education and training, healthcare, and bringing public services online. Today's challenge is not whether to use the internet in education; it is how to do so effectively. Emerging countries such as Chile, Colombia and Peru have established programmes to connect schools and build digital literacy.[8] Schools and school districts need to reorganize their instructional models, using digital technology to raise the productivity of teaching staff and improve educational outcomes through high-quality, individualized instruction at a more affordable cost.

Digital innovation has the potential to unlock similar value in healthcare. It can expand access to health services and improve their quality; it can equip patients with the tools to manage their own health and wellness; and it can lend new energy to public health initiatives. There is only so much that innovators, providers and patients can do on their own, however. To unlock the full benefits of digital innovation, policy-makers must remove healthcare industry barriers to faster adoption and encourage experimentation and development. Denmark, for example, has set out a National Strategy for Digitalisation of the Danish Healthcare Sector 2013-2017, with a goal of increasing the "focus on ensuring full deployment and use of existing ICT solutions".[9]

In emerging and developed markets alike, putting government services online can encourage internet use and digital development. Interactions with private companies in developed markets are raising citizens' expectations for how all organizations should perform. In all countries, the next step is to move to digital services as the default standard – or to go even further and follow the Danish government's aspiration to phase out paper-based interaction for government services entirely.

Digital services are still in their youth. Governments that want to secure a piece of the action for their economies should play to their countries' strengths and established capabilities. Not every country can be home to Silicon Valley. Smart policy-makers will use the internet to extend their nations' inherent economic advantages.

01: Toomas Hendrik Ilves, President of Estonia, highlighting key elements of Estonia's ICT policy and Carlos López Blanco, Global Head, Public and Corporate Affairs, Telefonica, Spain, at the World Economic Forum Annual Meeting 2014.

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3. Spectrum: Invisible Infrastructure

Across all geographies, one of the biggest digital infrastructure constraints in the coming years will be the availability, allocation and use of mobile spectrum – the bands of radio waves over which data and voice communications (as well as other over-the-air media) travel. This constraint is also one of the most complex.

Spectrum, by definition, is a limited resource. The amount currently released is far less than that required to support the expected growth in mobile data traffic, which increased 80% to 1.5 exabytes a month by the end of 2013, according to Cisco[10], and is expected to soar by a factor of 1,000 in the next 10 to 15 years.[11] Technology has helped overcome similar constraints in the past, and it will no doubt continue to do so, but governments and operators also need to do more to alleviate issues of availability, allocation and harmonization that constrain the ability of various participants in the mobile ecosystem to invest in infrastructure and deliver services.

Availability, Allocation and Utilization

Governments are releasing and redirecting additional spectrum for mobile use; they need to hasten these efforts. Many are planning to do so. A significant amount of spectrum is not fully utilized: valuable bands in the 600-700 MHz range are currently inefficiently employed by television broadcasters, for example. Many bands reserved for government and military use are not being used all the time. In some cases, operators are not fully using their spectrum holdings.

While they have the clear goals of providing value and delivering spectrum to the entities that will use it most efficiently, spectrum auctions do not always function as intended. The priorities of ministries responsible for finance and ICT can conflict. Some auctions have become exorbitantly expensive both because spectrum is scarce and because some governments, with a short-term focus, covet the cash that they raise. Companies nonetheless feel bound to participate, lest they lose access to resources they need, but in some instances successful spectrum purchasers find that they lack the capital to build out the infrastructure necessary to put the spectrum they have purchased to use. Governments that focus too narrowly on budget goals may also lose out on larger opportunities to stimulate economic growth through the release of licensed and unlicensed spectrum.

Over the long run, approximately 25% of all "capital investments" by network operators are dedicated to acquiring spectrum, a level that can limit funds available for investments in new infrastructure.[12] Moreover, high-spectrum costs have an impact on operations. CSPs cannot always buy the bands that would be most efficient given their current holdings. Fragmented holdings lead to greater complexity in operations and increase costs for equipment (both network and handset) manufacturers.

Meeting the spectrum needs of large and small players by imposing restrictions and incentives can be a tricky balancing act for most governments. Large companies tend to need more spectrum owing to their bigger subscriber bases; their experience and customer bases also help them use spectrum more efficiently. Smaller, sometimes disruptive, CSPs can be the source of new business models and other innovations. Reserving spectrum (or too much spectrum) for entrants without experience can reduce overall availability and may cause spectrum prices and network costs to increase for the larger companies, impairing their ability to serve customers economically. Impeding new entrants (through price or otherwise) from acquiring the spectrum they need to get into the market may limit competition in the long term.

Other issues plague the efficient allocation and use of spectrum. Unlike in the US, there are few functioning secondary markets in Europe, the Middle East and Africa, which means operators may not be able to optimize their holdings through sales, acquisitions or trades with other spectrum holders. This limitation has very real technology and complexity costs.

Ideally, spectrum licenses should be technology neutral; however, some are technology specific. For example, they dictate that 2G must be used in a particular band, rather than more advanced – and more efficient – 3G or LTE. Other licenses cover bands that are too narrow to be useful or carry timeframes that are too short to justify further investment. Spectrum is often released in small blocks – in some extreme cases as low as 1 MHz bands – which provides limited flexibility and raises costs for operators. At the same time, some operators have yet to build out infrastructure for spectrum they have acquired, turning a scarce resource into a wasted one.

(Lack of) Harmonization

Lack of harmonization at regional and international levels – meaning, for example, that the same operator's 3G or 4G network operates on different bands of spectrum in different countries or in different regions of the same country – leads to further inefficiency. Currently, for example, 4G networks operate on more than 40 spectrum bands around the world.[13] Devices such as smartphones must be designed to work across multiple bands of spectrum, instead of just a few, which is expensive and requires more battery

power and antennae complexity. Certain devices are incompatible with particular operators' networks. Because handset makers focus on the most popular bands (often the bands serving larger markets), smaller operators or operators in some markets may not have access to the most recent devices. New technologies, such as multiband chipsets, are addressing some of these challenges, but lack of spectrum harmonization still imposes inefficiencies and adds costs. Research by The Boston Consulting Group for the GSMA found that countries in the Asia-Pacific region can unlock up to $1 trillion in GDP growth by 2020 through the harmonized adoption of the 700 MHz spectrum band for mobile services.[14]

Harmonization is a huge challenge because each country has released and allocated spectrum according to its own needs and timing imperatives, and the state of mobile infrastructure development varies widely. No country wants to wait for others to catch up or let others determine the development of its market. Setting out recommendations and procedures to achieve better harmonization at the regional and international level is the goal of the ITU World Radio Conference, which next meets in 2015. There is urgency to this issue. The slow pace of spectrum harmonization processes must be accelerated, or countries that tire of waiting for new processes and procedures will act on their own, further fragmenting an already disjointed system.

Structural Adjustments Are Needed

Many of the problems with spectrum allocation require the efforts of both companies and governments to solve. Governments need to focus on making additional spectrum available while encouraging its efficient use. Companies must make the most of the technology and tools at hand to maximize the capacity of current and future allocations.

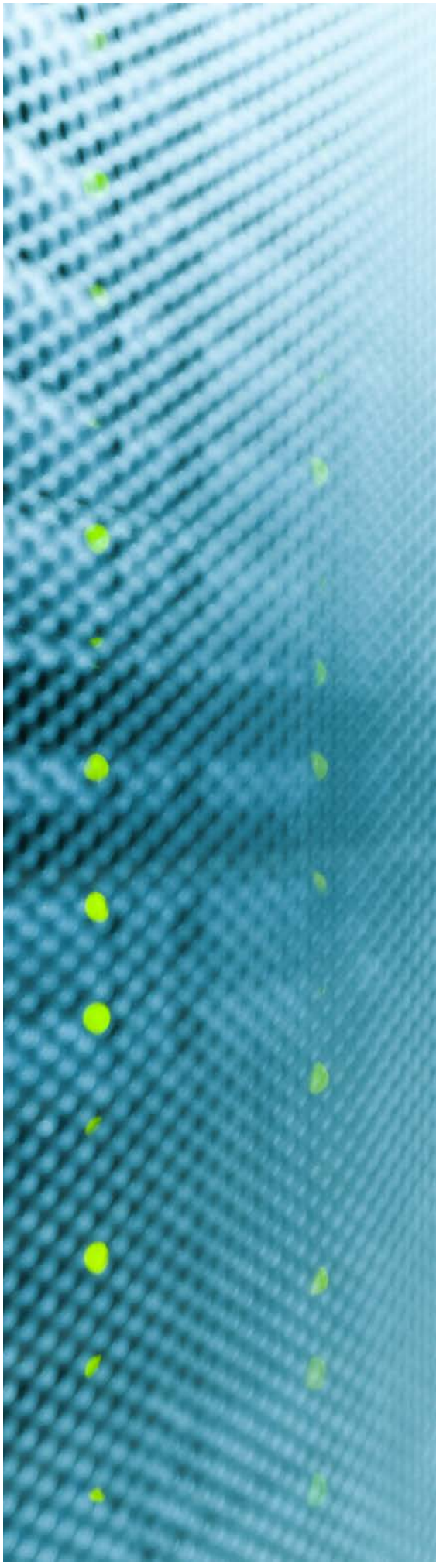
Since spectrum is the life-blood of wireless networks, the most important step governments can take is releasing more spectrum for mobile use. This includes traditional licensed spectrum, the top priority for operators in connection with delivering ubiquitous and predictable quality of service, as well as spectrum for new sharing models, including both licensed and unlicensed shared access.

Governments should consider refining auction processes for licensed spectrum. Among the ideas receiving consideration are auctions geared to longer-term value, which charge fees over time based on the value generated by usage, rather than set-level upfront payments. Goals include attracting a wide range of bidders – regardless of size – and ensuring that purchasers efficiently utilize the spectrum they buy. As the range of bidders expands, the importance of including build-out requirements in purchase agreements also increases.

Improving the efficient utilization of spectrum allocations can be pursued through additional methods. Governments can minimize the underutilization of a scarce asset and let operators know that they cannot sit on unused spectrum, by ordering appropriate build-out requirements for licensed spectrum and authorizing the claw-back of designated bands if these obligations are not met. Governments can also support the development of secondary markets so that operators have additional opportunities, beyond one-time auctions, to match spectrum acquisitions with their needs.

Other, more technically oriented spectrum management innovations can not only improve use of existing bands, but also enable more rapid incorporation of technological advances that provide efficiency benefits. Regulators should release larger contiguous bands of spectrum that provide operators more flexibility and greater throughput, though new technologies may be reducing this need. When band assignments are directly tied to specific technologies, such as 2G or 3G, utilization can wane as the market shifts to newer and more efficient technologies, such as LTE. Regulators can refarm such bands, and in the process, give licensees future flexibility to deploy their choice of new technologies, subject to effective oversight to ensure compatibility with neighbouring allocations.

Several spectrum-sharing models offer the potential to increase utilization through approaches that complement long-term, exclusive-use licenses. Licensed Shared Access and Authorized Shared Access seek to make broader use of dedicated spectrum that is currently used only at certain times or in particular locations (such as for testing of military equipment, or ship-to-shore radar). These approaches increase efficiency



by allowing commercial users to share access on a designated basis, which helps provide the reliability and predictability that operators desire. Unlicensed dynamic shared access models can also work through specific technical rules.

Unlicensed spectrum also has an important role to play. The best-known unlicensed technology is Wi-Fi, which is now available on billions of devices, and has emerged as an important resource for operators to offload burgeoning data traffic. This will only increase with LTE Advanced technology, which can involve aggregating unlicensed and licensed spectrum in the same network with the same wireless technology. This helps operators augment the capacity of their networks by using the unlicensed spectrum more efficiently while providing a tight interworking between the licensed and unlicensed bands.

As the Internet of Things and M2M services evolve, an ever-broader variety of spectrum needs will need to be filled. New M2M services, such as smart electricity metering, may initially have needs more akin to low bitrate 2G services. However, as M2M communications become smarter – think self-driving cars – more advanced 3G or LTE spectrum may be required. Although operators can likely leverage 2G networks for M2M now, in the long run, as services become more intelligent, they may find it difficult to justify maintaining these networks and using valuable spectrum to support such low bitrate use. Operators should be allowed to recognize the specific needs of these services – and how these needs will evolve – and use spectrum to serve them in an efficient manner.

Unlicensed spectrum will also play an important role in the future of M2M. Today, many sensors and M2M services already communicate through Wi-Fi, Bluetooth, radio frequency identification (RFID) and other unlicensed technologies. Satisfying these diverse needs will require balanced policies that provide not only more licensed and unlicensed spectrum allocations, but also more flexibility for shared access to underutilized spectrum.

Improving Efficiency

Operators also need to invest in strategies that maximize the efficiency of their current holdings and the capacity of their networks. Initiatives such as those described above are key. So are incentives for users to move up to more efficient 3G and 4G networks (the majority of the world's wireless customers, more than 4 billion connections, are still on 2G networks) and to build denser networks with smaller cell deployment models that can handle higher traffic.

Smaller cells will represent a vital, complementary tool for improving efficiency, especially in densely populated areas. While traditional cellular deployment, which relies on relatively few high-powered radios usually mounted on cell towers, has been cost effective, the growing number of users and exploding amount of data are pushing the limits of capacity. By contrast, small cells can be placed almost anywhere – on buildings, streetlamps and bus stops, for example. They can handle a much higher volume of traffic and are adding much-needed density to cellular networks, bringing connections closer to end-users and blurring the distinctions between wired and wireless networks. Mobile networks in Tokyo have already moved towards a small cell approach, with stations spaced every 100-200 meters.[15] This is approximately five times the density of a typical urban market.[16] One potential model even involves the deployment of open-access small cells in existing premises, such as homes and offices, simultaneously freeing up macro network capacity for other users and increasing network capacity inside buildings, where most wireless broadband data is consumed.

Small cells are a key component of the more heterogeneous network environments – combining macro cells, Wi-Fi and small cells – that are expected to evolve in the near to medium term. Governments can encourage new wireless facilities deployment by quickening permitting and other approval processes.

As a final point, application developers can take spectrum use into account in the technical specifications of their innovations, reducing the spectrum stress that growing volumes of content place on mobile networks. Facebook founder Mark Zuckerberg has advocated making applications more efficient as a means of expanding internet access, particularly in emerging markets, by reducing data delivery costs.

4. Staying Interconnected

IP interconnection agreements are the lubricating oil of internet infrastructure. These are the commercial arrangements that dictate how traffic is passed among the thousands of networks that make up the internet. As the sheer volume of digital traffic has soared in recent years, driven in large part by video, these agreements have come under increasing pressure for renegotiation and oversight by public authorities in a number of countries. Other sources of expanding data will only add to this pressure. Everyone has an interest in their continued smooth operation, because everyone benefits from the continuing efficient flow of data.

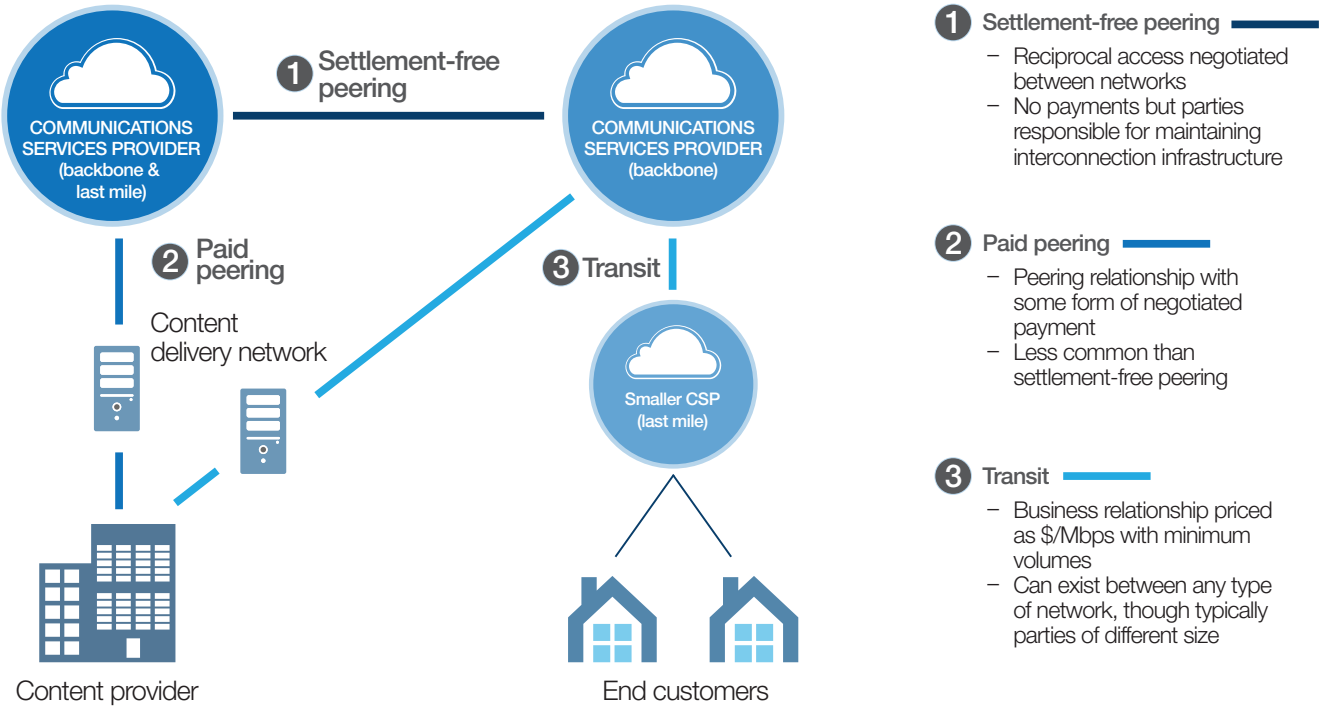
Net neutrality and IP interconnection agreements are related but distinct issues. Both concern how traffic is managed across networks, but at different points. The debate over net neutrality affects the so-called "last mile" – the connection between the internet and the end-user. (See the sidebar, "IP Interconnection and Net Neutrality".)

The Short History of IP Interconnection Agreements

IP Interconnection refers to the commercial agreements among network providers that exchange the traffic transmitted across the internet. There are three principal types of agreements:

1. Settlement-free peering, in which two network providers agree to accept from each other, free of charge, traffic that terminates on each party's network. The basis for this exchange is that each operator receives mutual value, so each pays to maintain the infrastructure necessary to support traffic levels on its own network. With the vast amount of traffic that is exchanged every day, settlement-free peering simplifies these transactions and provides for efficient traffic routing.
2. Paid-peering agreements, under which one network (or, more recently, a network operated by a content provider) pays another to terminate traffic on its network. These are much less common than settlement-free peering agreements.
3. Transit agreements, under which a party pays a network provider to accept traffic that is destined to or from another network anywhere on the internet. (See Figure 6.)

Figure 6: Illustration of Common IP Interconnection Agreements



Note: Simple depiction of typical IP Interconnection agreements; many other variations can and do exist
Source: BCG analysis

All three types of IP interconnection agreements are wholesale arrangements, usually struck between network operators; they do not involve consumers. In the past, they did not directly involve content providers either, but the lines are blurring. In February 2014, Netflix struck an IP interconnection agreement with US cable operator Comcast, under which Netflix will load its streaming video content directly onto Comcast's network.[17] In addition, some large cloud providers have effectively become private network providers because they operate their own networks and negotiate IP interconnection agreements with other networks for their own traffic to and from their data centres.

IP interconnection agreements have evolved on a global basis since their inception. To date, most of the traffic travelling among network providers has been exchanged without charge in settlement-free peering agreements.[18] Until recently, most of the peering traffic ratios have remained within relatively narrow (and similar) bands that reflected reciprocal traffic levels, 1:5, for example, or 5:1. In recent years, however, disputes have arisen among CSPs as the volume of content carried has soared, and some peering ratios have become lopsided, such as 1:10 or 1:20, because of the rapid growth in content providers' services and the associated traffic (predominantly video, but likely to include more games and other media in the future). In the US today, Netflix and YouTube together account for more than half of all downstream fixed broadband traffic.[19] Some CSPs, often those on the receiving end of lopsided handoff ratios, have maintained that the traffic imbalances no longer represent mutual value and have sought to negotiate paid peering arrangements. Their interconnection partners have balked, arguing that each CSP should be compensated by its own end-customer base, and there is no difference in actual cost resulting from the direction in which traffic is carried.

Three Interconnection Issues

As part of this project, the World Economic Forum's working group on digital infrastructure has facilitated many cross-industry discussions on the increasing contentions surrounding IP interconnection agreements. Three basic issues are at stake.


01

01: Manuel Kohnstamm, Senior Vice-President and Chief Policy Officer, Liberty Global, Netherlands, leads a breakout discussion on IP Interconnection at the World Economic Forum Annual Meeting 2014.

The first is **whether IP Interconnection should continue to be based on commercial agreements or directly regulated**. CSPs and others argue that these agreements should continue to be commercial in nature, governed by competition laws. Content providers agree on commerciality, but some are concerned over how CSPs are able to control traffic over the last mile, the only path through which the content provider can deliver traffic to end-users. As content providers see it, CSPs should be required to provide high-capacity connections, since they are compensated by their end-user customers. If CSPs do not adequately maintain their networks on their own, regulators may be required to step in. Most CSPs see only fair business practice in asking content providers to pay for upgraded capacity connections when they send a disproportionate volume of traffic in the direction of the CSP.

The second issue is **whether content companies should help fund network infrastructure upgrades**. A number of CSPs say that two-sided commercial models, in which both end-users and content providers compensate the CSP, are required to respond to the infrastructure-related costs of traffic growth and new usage patterns. They contend that if end-customers alone are required to cover these increasing costs, some could be priced out of high-speed internet access. In addition, in their view, the two-sided model imposes an important incentive on content providers to efficiently deliver content across access networks.

Some content providers disagree. In their opinion, CSPs already benefit greatly from the growth in internet traffic as more and better content attracts more customers and leads existing customers to upgrade their broadband connections to plans with higher capacities and prices. Making wholesale carriers or content providers pay to support CSPs' infrastructure requirements – in addition to their own infrastructure costs – detracts from these companies' research and development and capital expenditure programmes and could also cause them to pass on the interconnection charges to consumers. Some also argue that paid peering will lead to consumers losing access to some non-commercial content (such as free education and non-profit content) from providers who cannot afford to pay interconnection charges. Both sides have expressed willingness to further explore new business models that make efficient use of the network and promote the development of new digital services.

A third key question is **whether different quality of service tiers will lead to better delivery of content, especially high bandwidth and quality-sensitive content, such as real-time video**. As the internet has evolved, the content it carries has become more varied. Most content used to be similar in volume and urgency. Today, transmissions can include anything from basic emails to feature-length movies to high-urgency medical images. Many CSPs argue that different users put different demands on the network and that CSPs need

flexibility to determine how to transmit data, and at what cost, to manage their networks most efficiently. Establishing different quality of service tiers – one for high-quality delivery, another for "best-effort" delivery (equivalent to how most traffic travels today) – is one proposed solution. Content providers fear that a multi-tiered internet will lead CSPs to favour their own high quality of service infrastructures and potentially underinvest in the upkeep and operation of other service tiers. They point to situations where they claim that CSPs are degrading best-effort quality by failing to augment interconnection capacity. CSPs maintain that high-quality delivery would not negatively affect best-effort quality since they cannot afford to risk losing customers to other CSPs because of poor quality.

Finding Common Ground – On an Uncertain Playing Field

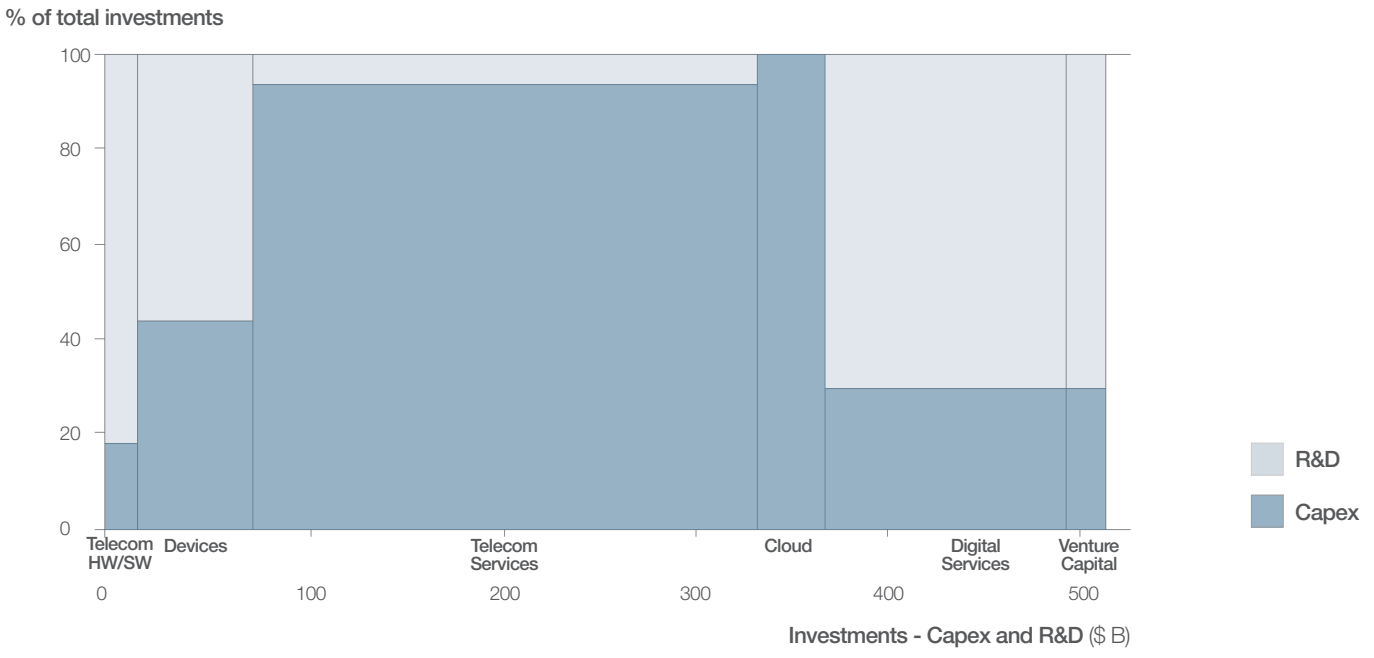
Because of the central importance of IP interconnection agreements to the functioning of the internet, the disagreements over how they operate require attention. They also need a resolution that the disputing parties can call fair and that does not impede the internet's dynamic growth. A good place to start may be a set of basic insights that can help address these issues through establishing common ground and understanding on the nature of issues under dispute.

The first is the need for common metrics that can provide a fair and accurate assessment of the size of a particular dispute. Although traffic ratios have been used as a core metric for measuring equivalent value in some IP Interconnection exchanges, some parties argue that these ratios may no longer serve this function effectively. They point to other, more pertinent, in their view, means of measurement. Measuring bit-miles (the average number of gigabytes carried multiplied by the number of miles the data travel) has been suggested as an alternative, most notably by wholesale providers; other options include the total transmission costs borne by each network and the value exchanged at interconnection points. No industry consensus has yet emerged on this need, and players on all sides need to continue to work towards an agreement.

Second, while it is customary to think of infrastructure investment primarily in terms of wires and cables, in reality ICT "investment" is much more broad-based. While telecommunications players build the vast majority of network infrastructure, other players invest large sums in vast data centres and cloud infrastructure. There is also a broader universe of companies that invest in creating the digital products – hardware, software and devices, for example – and the services that run on them. Still other companies ensure that the services are effectively delivered and charged for. The total amount of worldwide investment made in "the network" on the one hand and "everything else" on the other is roughly equal.[20] (See Figure 7.)

Third, differentiating between services that require less or more bandwidth does not constitute discrimination. Varying service tiers may be one of the most useful ways to ensure adequate quality of service for all kinds of traffic as traffic volumes expand. Quality of service differentiation also can open development of new business models, such as multilateral agreements among network operators and content providers for the provision of managed or specialized services. Implementing agreements based on tiered quality of service, however, will require reassurances to some that tiered systems will not be used to avoid or sidestep investment in infrastructure to support lower quality service tiers.

Figure 7: Total Investment in All Other Areas of ICT Value Chain Similar to Telco Capex



Note: Basic methodology leverages market research to estimate market sizes and public company financials to estimate Capex and R&D; assumes capital investments and R&D are both investments in ICT value chain

Source: Telecoms equipment (Gartner), telecoms SW (IDC), devices (IDC), cloud (public company financials), telecoms services (IDC), digital services (BCG), venture capital (OECD); Thomson Reuters Datastream, BCG analysis

While consumers are not party to IP interconnection agreements, most network participants would agree that it should be easier for consumers to access and understand basic information on the speed and performance of networks, hosting services and digital services. The level of transparency needs to be appropriately calibrated for the intended audience, with the goals of consumers being able to use simple tools to see (to the extent they wish to) where content is coming from, how it is travelling and, in the event of a problem, where – and under whose supervision – it occurred.

A Path Forward?

Despite the uncertainty, discussions on these issues among industry participants have established several important areas of agreement, and these provide a direction for resolving many IP Interconnection issues. The areas of agreement include:

– IP interconnection should remain commercial in nature, as a means for the industry and its participants to keep pace with the pace of change. All parties should commit to avoiding anti-competitive actions and unreasonable discrimination against different kinds of traffic. Industry participants should work to resolve their own disputes; if they are successful the debate over the involvement of regulators is rendered moot.

– Agreements should allow experimentation with new pricing models, again with the condition that the same rules must apply to all players. This experimentation may generate models under which CSPs charge content providers – provided that all parties, including CSPs' own content operations, face similar types of pricing that do not amount to unreasonable or anti-competitive practices.

– Building private and expedited dispute resolution mechanisms, such as arbitration provisions, into agreements may speed up resolutions when disputes arise. In this type of commercial environment, disputes are inevitable. They become particularly problematic when they reach the point where consumers are affected. Private arbitration can be written into contracts – assuming both parties agree – as a means to expedite the resolution of these agreements and limit impact on consumers. When the issues under dispute transcend a particular agreement (or arbitration is not provided for), the relevant authorities may need to be called on to help reach resolution.

– Appropriate transparency on network and digital service performance is needed, including last-mile performance even though this is not a direct IP interconnection issue. Forming a voluntary cross-industry body to develop the specific metrics and approaches to measurement that can provide a complete (and unbiased) picture is recommended. A multistakeholder approach, involving a range of participants with clearly differing points of view, has a better chance than either a unilateral approach or a regulated one to agree on a simple set of metrics that adequately captures performance levels of services across the internet.

Sidebar: IP Interconnection and Net Neutrality

IP interconnection agreements affect how traffic is routed among the internet's wholesale networks, and net neutrality rules apply specifically to the last-mile connection to the end-user's home or place of business. Definitions of net neutrality are (often hotly) debated, but the essential principle is that all consumer traffic must be treated equally, subject to reasonable network management and network security principles, with potential exceptions for specialized services. What should constitute a specialized service - examples could include medical imaging, video conferencing or even streaming video - is still up for debate. The basic tenets of net neutrality include no blocking or throttling of traffic; appropriate transparency (principally for consumers, but also for content providers) in how traffic is managed within networks; and no unreasonable or anti-competitive discrimination among different kinds of traffic from different sources.

The underlying principle of net neutrality, in the eyes of its advocates, is that neither a CSP nor a government nor anyone else should be able to block or discriminate unreasonably – by price, availability, or otherwise – against any content carried over the internet.

Net neutrality has become a hot political and judicial issue. The European Commission has included a net neutrality guarantee in its "Connected Continent: Building a Telecoms Single Market" package of legislative proposals which passed an important milestone in the European Parliament in April. In January 2014, a US appeals court partially struck down the Federal Communications Commission's (FCC) 2010 Open Internet Order, which had established net neutrality regulations for CSPs. The FCC has announced that it will issue new rules to "ensure that the internet remains open and fair".[21] Comcast, the largest US cable provider that would become even larger with its proposed acquisition of Time Warner Cable, has already declared that it will continue to abide by the FCC's long-standing net neutrality principles until 2018, regardless of the court's remand of the specific regulations in the Open Internet Order. Some observers expect little impact; others see a major shift in the internet's basic business model. The latter predict that bundling various kinds of content for delivery over the last mile, according to an array of pricing models offered by both CSPs and content providers, could become the new normal.

In theory, the court's decision, and the FCC's new rules, should have no effect on IP interconnection agreements. Inevitably, perhaps, some issues blur the lines between the two concepts. Quality of service plans are one example. Sponsored data plans are another. Proponents of net neutrality view such plans as open doors for the unequal treatment of traffic and a threat to smaller, innovative start-ups that play an essential role in the internet ecosystem. Those on the other side argue that these plans are not only pro-competitive, they are pro-consumer in that they facilitate the desired content getting into the hands of the end-user who wants it in an economical and technically efficient manner.

5. How Regulatory Policy Can Keep Up

"Fast-paced regulatory change" is not a phrase one hears often – or wishes to. We all expect, rightly, that regulation will be well thought out, unrushed and promulgated with care. This presents a conundrum in the internet age: the sort of deliberate approach that has characterized telecommunications regulation for most of its history is ill-suited to the speed of digital disruption and the marketplace developments it spawns. Policy and regulation need to evolve with changing nature of the industry; the question is, how do they keep up?

A good first step is recognizing the nature of today's challenge. The communications industry has changed substantially in the last three decades. The break-up of the AT&T monopoly in the US was set in motion only in 1982. Social media barely existed a decade ago. Mobile has gone from nascent to nearly everywhere in a few years. During much of this time, the primary regulatory issue has been the shift from state-owned and monopolistic service to private sector competitive markets and a substantially less regulated industry.

Today's critical issues span a much more complex, interconnected value chain and could not be more different: the protection and use of personal data, the fractured allocation of mobile spectrum, and the growing convergence between telecommunications (fixed, mobile, cable) and media and digital service industries. CSPs are looking to expand into digital services while digital service players are experimenting with connectivity. New business models such as M2M and the Internet of Things involve companies and consumers in many sectors of the economy. Establishing rules for an increasingly fragmented marketplace, especially without unduly restricting some participants, is a much tougher challenge than overseeing a monopolistic industry.

It is also becoming increasingly clear that, in certain areas, policies need to cross national borders and be developed or harmonized at the international level (digital services and their underlying data benefit from the freedom to flow internationally, for example), while other areas will benefit more from local experimentation. International bodies such as ICANN and ITU can play a role. Greater clarity is required to give confidence to industry participants and investors.

Today's markets need something other than new regulations – markets and their participants will benefit from entirely rethought regulatory frameworks that

Figure 8: Policy-Makers Must Rethink Scope, Approach and Level of Engagement

	Historical perspective	Future perspective
Scope	Telecom-specific policies and regulations to ensure competition	Policies that recognize impact across entire ICT value chain
	Technology-specific market definitions	Converged fixed/mobile/cable definitions
Approach	Heavy regulatory approach	Lightened approach and non-regulatory tools (e.g. transparency, self-regulation)
	Primarily ex-ante intervention to avoid harm	More ex-post to encourage experimentation (where competitive)
	Regulations established by government authorities	Collaboration with industry and other organizations
Level of engagement	Policies and regulations established by national bodies and in select cases institutions (e.g. ITU)	Policies and regulations established at appropriate level (e.g. international where harmonization required, local where experimentation needed)

Source: BCG analysis

establish structures and approaches rooted in 21st century realities. It will help policy-makers in developing these frameworks if they think in terms of three dynamics: scope, approach and level of engagement. They should also bear in mind that the internet gives all marketplace participants – most notably consumers – much greater choice and transparency than they ever had before. Information truly is power; consumers are in their strongest position ever to make choices and protect their own interests. (See Figure 8.)

Scope

In the digital age, policy-makers need to think in broad terms, taking multiple overlapping sectors into account. A debate should take place in multiple markets, for example, over whether telecom-specific regulation is still necessary, beneficial or sufficient. The ICT value chain is both much expanded and more intertwined – investments and innovations in one segment are quickly felt in many others. Moreover, because the internet accounts for a large and growing share of market activity in so many sectors of the broader economy, ICT policy-makers should strive to eliminate distortions between ICT and other industries.

None of this should mean more regulation or regulations that apply more broadly. Rather, the internet affects a wide range of industries and commerce. Regulations that shape, alter or constrain online commerce – new rules on data use, for example, or attempts to regulate automotive telematics or communications among machines – have ramifications for companies and consumers that extend well beyond the internet itself. A new mindset is required, as are periodic reality checks on the effects of new or altered rules. As industries and ways of doing business evolve, it will be necessary from time to time to remove outdated regulations that result in discrimination between industries. There may also be value in experimenting with non-regulatory means of encouraging online behaviours, using rating systems or the principles of open data, for example, with issues such as data use by operators and data services companies.

Approach

Many regulatory regimes have been predominantly ex-ante in approach – they have set down rules in anticipation of marketplace developments. In the fast-changing digital era, however, it is hard to apply foresight with prescience in an environment that gives birth to entire new industries seemingly overnight. Could anyone have anticipated the privacy and data security issues spawned by social networks even a decade ago, for example? Policy-makers should look for opportunities to establish ex-post regulatory approaches where there is sufficient competition and vehicles exist or can be established for the speedy resolution of disputes.

For such social-policy challenges in particular, governments need to devolve and evolve. They should create regulatory systems that can be adaptive, enacting laws based on principles – for example, that consumers have a right to keep certain personal data private – and giving authority to third parties to apply those principles to changing market conditions.[22] For issues such as privacy and copyright, this can be accomplished through formal and informal judicial processes. For issues such as technology or content standards, industry bodies can take the lead, often with government as a partner.

Governments also need to experiment with different approaches, selecting the ones that appear to work, and giving them room to grow in impact. Many countries with fast-growing internet economies have tried out such policies as light-handed regulation or targeted tax incentives, then stepped aside and let the resulting innovations flourish. They have pursued industrial policies that seeks to mimic the rapid innovation cycles of internet-based business models. Equally, governments should set out guide rails – signalling types of policy that they will not pursue or areas where they intend to rely primarily on industry or third-party oversight.

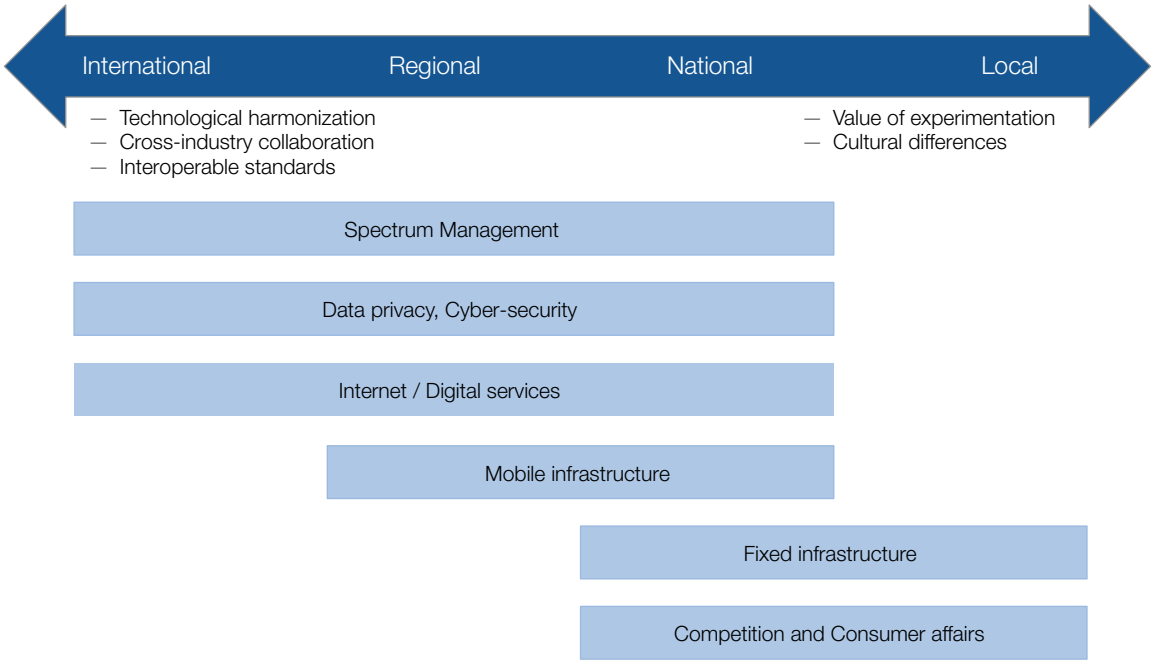
Level of Engagement

As observed with respect to the regulation of spectrum, lack of harmonization or interoperability at the regional and international level in certain areas can lead to inefficiency and add complexity and cost for companies and consumers. There is a trade-off to be assessed: international policy can lead to better coordination and efficiency, but often at the expense of experimentation and speed. Policy-makers need to identify the appropriate geographical level, or reach, for various policies and regulations. Harmonization in spectrum is required at a regional and international level. Policy for fixed infrastructure - for example regarding municipal operators - should be examined locally to encourage innovation. In markets such as the EU, better coordination in such areas as mobile infrastructure and digital services will further investment and innovation as well as the goals of the EU's single digital market. (See Figure 9.)

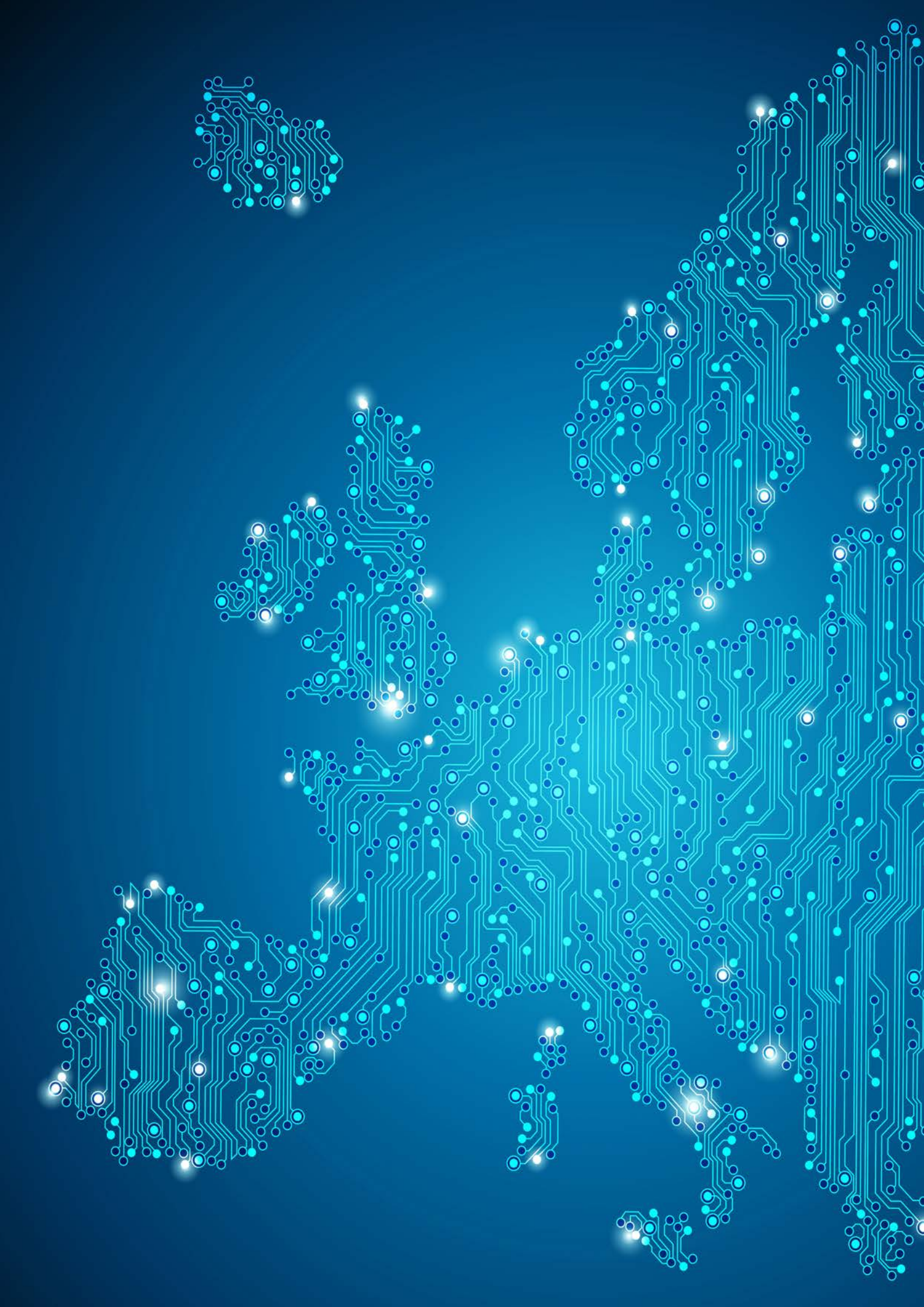
Policy-makers need to stay mindful of the potential for fragmentation at multiple levels in how, and by what rules, the internet is governed. Networks are means of bringing people, businesses and ideas together. Policies that promote separation or isolation run counter to the internet's overriding strength. "Forward-looking" and "light-touch" should be policy-making watchwords in the digital age.

"Forward-looking" and "light-touch" should be policy-making watchwords in the digital age.

Figure 9: Policies Should Be Established at Appropriate Level



Source: BCG analysis



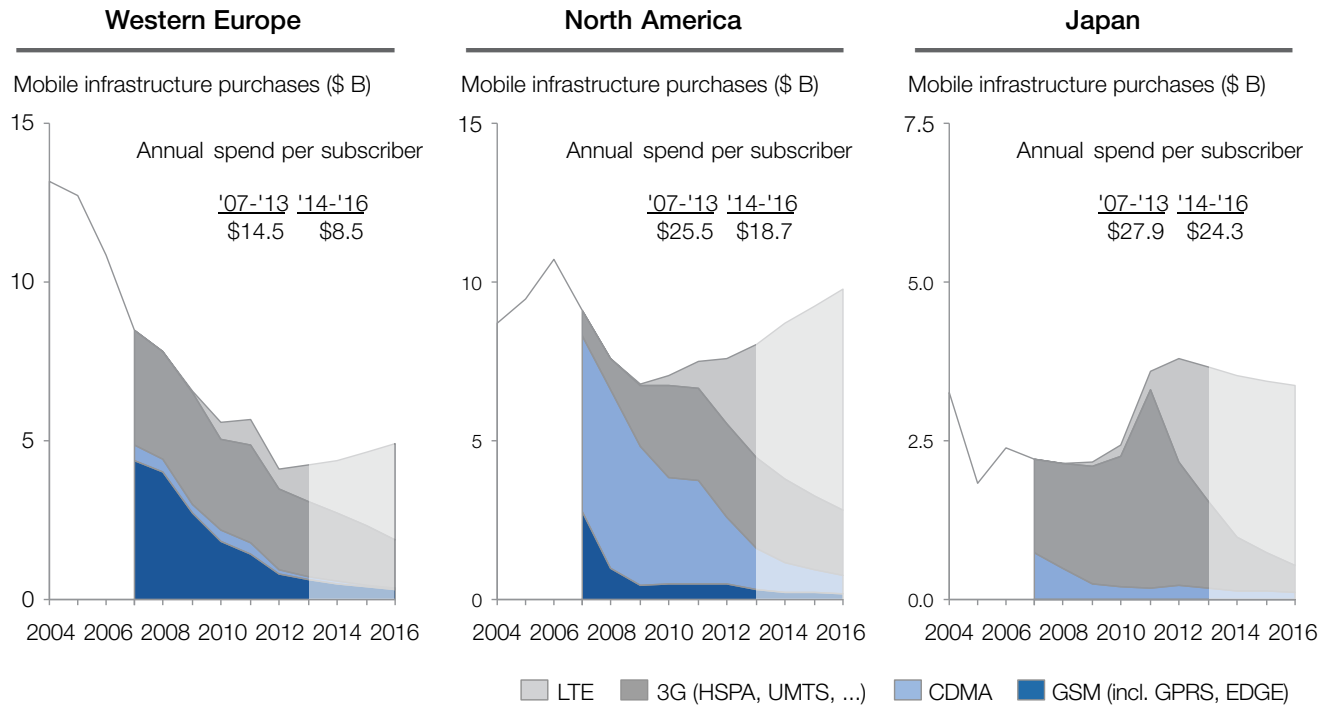
6. The Challenge for Europe: Crafting a Digital Renaissance

There is widespread recognition that the EU's digital health needs attention. Unfortunately, much of the discussion tends to focus on treating the symptoms – removing roaming charges, for example – rather than addressing the root causes of the EU's digital malaise. Europe has gone from digital leader to laggard in less than a decade. It has fallen behind in ultra-fast mobile and fixed-internet connectivity as well as in developing and manufacturing the technologies that run today's systems and equipment. European consumers may pay less for digital connectivity, but they are missing out on many of the advanced services and experiences that are available on next-generation networks elsewhere. Moreover, perhaps partly as a result of the economic crisis, much of Europe seems to have adopted a form of old-world anxiety over digital technology. The European Commission's Digital Agenda and proposed digital single market are far from being realized. Few expect the next Google, Alibaba or Facebook to emerge from the EU.

Europe is hardly homogenous, of course, and different countries are in very different stages of digital development. The UK's internet economy represents close to 10% of GDP, led by a strong e-commerce sector. Denmark and Estonia have nurtured vibrant online sectors, including e-government capabilities that are among the world's most sophisticated. In Sweden, consumers have driven digital-economy growth to almost 8% of GDP, and the country has built a significant competitive advantage in digital services and platforms. But, truth be told, most of Europe's economies lag.[23]

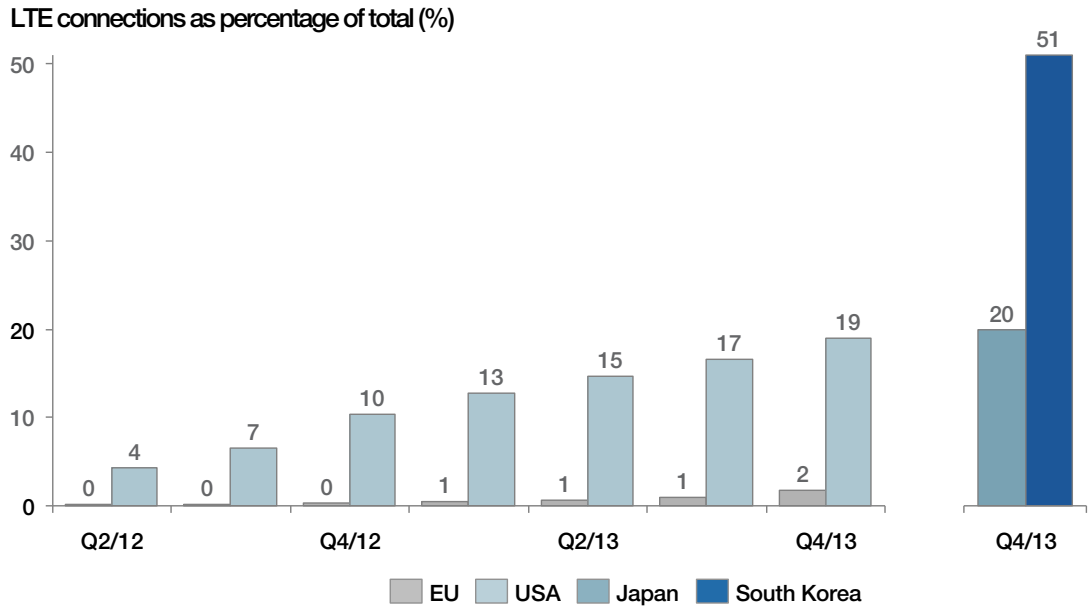
Europe's digital health requires many things, but without infrastructure investment, it is difficult to see rapid digital growth taking off. By 2014, investments in mobile infrastructure equipment will have fallen 67% since 2004, as current levels of investment in LTE technologies have not matched the heavy spending on 3G networks.[24] (See Figure 10.) In fact, European spending, on a per-subscriber basis, is half that of the United States and of Japan. No surprise, then, that LTE accounted for only about 2% of mobile connections in Europe at year-end 2013, compared with approximately 20% in the US and 50% in South Korea and the sidebar, "LTE Leadership in South Korea".[25,26] (See Figure 11.)

Figure 10: Investment in Mobile Infrastructure Equipment Has Dropped Significantly in Western Europe



Note: Includes investments into base station and core infrastructure equipment; actuals until 2012, forecasts thereafter
Source: Gartner, IE Market Research, BCG analysis

Figure 11: European Operators Have Fallen Behind in LTE



Source: GSMA, Ericsson, BCG analysis

The depth of the challenge is compounded by its complexity. Infrastructure spending has multiple constraints in Europe, including the ability of telecom operators to monetize mobile data use and generate sufficient returns. The inefficient and fragmented system of spectrum allocation undermines the delivery of high-quality mobile communications, not to mention the growth of mobile connectivity generally. Much of the continent is trapped in a downward "less for less spiral" with EU operators struggling both to justify investments in next generation LTE infrastructure and to convince consumers to upgrade to LTE data plans. Despite many operators subsidizing smartphones to encourage LTE, in many countries between 25% and 40% of smartphone users do not purchase data plans from their carriers.[27]

The development of a vibrant digital-services sector, including widespread entrepreneurial start-up activity, lags for a variety of reasons, among them labour law inflexibility, high taxes and bureaucratic red tape. In the World Economic Forum's most recent ranking of red tape, or the burden of government regulation, the UK ranked 45th and Germany 56th, and five European countries placed between 125th and 146th, in the survey of 148 nations.[28] Only one of the top 25 internet companies by market capitalization is based in Europe.[29] Venture capital investments in Europe represent 0.03% of GDP, compared with 0.17% of GDP in the US and 0.36% in Israel.[30]

This lack of competitive vigour constitutes a barrier to adopting digital services, attracting international investment and creating jobs. Among other factors, simple attitudes towards technology and entrepreneurship need to change. Fear of disrupting existing paradigms needs to be replaced by the sense of opportunity that such creative destruction represents.

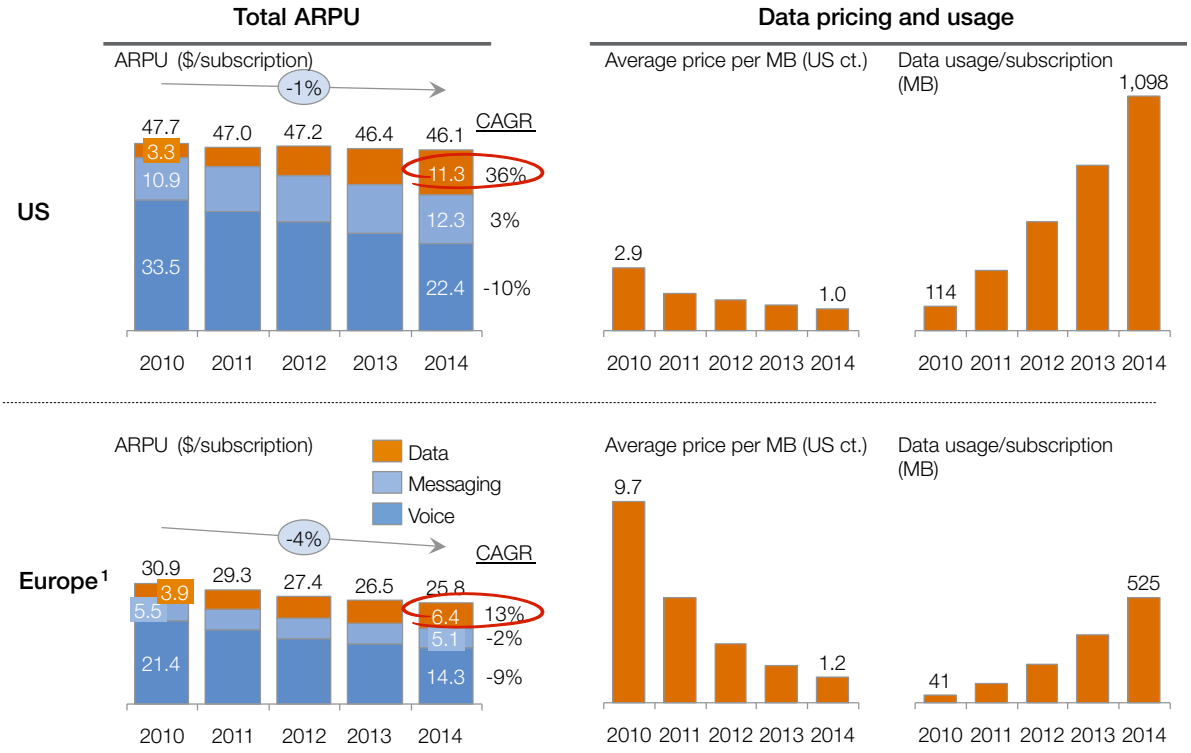
Europe needs to take steps in four areas to transform its approach and achieve the EU's Digital Agenda for Europe. These include addressing the market environment, refining industry models, adjusting the regulatory framework, and taking affirmative steps to promote development of a more energetic digital economy.

Market Environment

European policies and regulations have long pushed for low-cost mobile access plans – and they have largely succeeded. Europeans often pay less per subscription for digital connectivity than consumers elsewhere. But low cost comes at a cost – significant impediments in some cases to the ability of telecom companies to make necessary investments in improving quality and service. As a result, European consumers and businesses often experience slower, less reliable connections, leading to less use, less value for consumers, and lower economic growth. They often pay more than others on a per-megabyte of data basis. (See Figure 12.)

There are exceptions, of course. In the Nordic countries, mobile broadband penetration is quite high (including both 3G and LTE). Sweden's mobile broadband penetration of 85% is one of the highest in the world, and other Nordic nations are in the 75% to 80% range, roughly in line with the US and well above the Western Europe average of about 67%.[31] Sweden was the first country to launch LTE in 2009, and it currently has the world's fastest LTE network.[32] LTE penetration (around 10% for the Nordic nations[33]) is well above that of most of Europe, but still trails the US, Japan and South Korea by substantial margins. Despite this penetration lag, data use and pricing is very healthy. The average customer in Sweden and Finland uses more data than customers in the US – twice as much in the case of Sweden.[34] Swedish and Finnish customers also pay about half as much per megabyte (or less) as consumers in the US.[35]

Figure 12: European Operators Have Had Difficulty Monetizing Mobile Data



1. EU-15 plus Switzerland and Norway
Note: Actuals until 2012, forecasts thereafter
Source: Ovum, Ericsson, BCG analysis

Europe also needs to allow more consolidation among operators, especially in mobile. There are 100 operators in Europe, compared to five in the US and three in China. US providers have an average of about 84 million subscribers each; the average in large European countries is between 15 million and 30 million.[36] Allowing operators to exit unprofitable markets can also help drive necessary consolidation.

Price is one critical component of competition, but only one. European policy-makers need to adopt a broader view that extends beyond price to include quantity and quality of service over time as key determinants of consumer welfare.

Industry Models

Data consumption in Europe lags other markets. Data per megabyte in Europe is priced 20% higher than in the US, and consumption is less than half the US rate. European data revenues are growing about one third as quickly.[37] (See Figure 12.)

CSPs need to adapt a new mindset towards data. The experience of markets such as the US and Sweden suggests that lower per-megabyte prices may encourage consumers to consume more data to satisfy their hunger for digital communication, potentially leading to higher overall revenue per user. Adopting new mobile data pricing plans that encourage data use, for example through linear pricing (plans that price data consumption in a fair, roughly linear manner – 4GBs cost no more than twice as much as 2GBs, for example), elimination of throttling, easy plan upgrades and family plans, can generate new sources of revenue. As Sweden's Spotify and TeliaSonera have shown, partnerships between operators and digital service players also can lead to new demand for data – and new sources of revenue for both.

In recent months, several operators have started to pursue "packaged offerings" or "quadruple plays" that combine voice and fixed broadband offerings in addition to fixed voice and TV. For example, Liberty Global recently announced plans to roll out a pan-European MVNO service. Vodafone has agreed to acquire Spanish cable operator Ono with a similar idea in mind. These strategies have the potential to reduce costs for operators and prices for consumers, as well as impact competitive dynamics. In Portugal, the partial deregulation of fibre access, combined with a concerted approach to drive a quadruple-play package, has led to the resurgence of Portugal Telecom (PT). According to Bernstein Research, consumers are more willing to adopt such bundles from fixed-line incumbents. PT has priced its package to gain wireless share and reduce churn, both fixed and mobile. The company has reported revenue increases of about 10% and customer cost savings of almost 20%.[38]

Regulatory Framework

As discussed in Chapter 5, Europe needs to rethink its regulatory frameworks, in particular the scope, approach and level of engagement of regulatory initiatives. Other big economies – the United States and China, for example – enjoy healthy and growing telecom and digital-services sectors as well as thriving entrepreneurship, resulting in widespread job creation. One reason is

that these are true single digital markets: data and services flow freely within the market. They also have single bodies overseeing spectrum management, consolidated telecommunications industries (the US has experienced multiple waves of telecommunications consolidation since the break-up of the AT&T monopoly in 1985) that are lightly regulated by international standards, and they share a willingness to invest in infrastructure. The extent to which Europe can follow suit and form its own single digital market is central to the future of European competitiveness and wealth creation.

Towards a Digital Single Market?

A committee of the European Parliament, for example, has observed, "gaps and differences in EU member states' laws governing online trading or inconsistent enforcement of rules, as well as inadequate digital infrastructure, are preventing EU firms and citizens from reaping the full benefits of the digital single market and causing the EU to fall behind the global competition."[39] Without a market where digital goods and services can travel freely across borders – just as physical goods already do – Europe will never achieve its full potential for a digital economy. A single digital market (and one that is allowed to flourish without undue regulatory intervention) would also encourage greater entrepreneurship in digital services, as the opportunity size and potential for scale for European start-ups would be greatly enhanced.

Other major economies have already achieved conditions conducive to infrastructure investment and rapid growth in digital services, both for consumers and for businesses. The companies that are driving the development of a worldwide digital economy – from Alibaba to Facebook, and Google to Tencent – are one result. Unless it transforms its approach, Europe gives its companies little chance to compete with such leaders. A new European Commission will take the reins this autumn. It has the opportunity to drive the Digital Agenda and vision of a digital single market forward and "enable Europe's citizens and businesses to get the most out of digital technologies".[40]

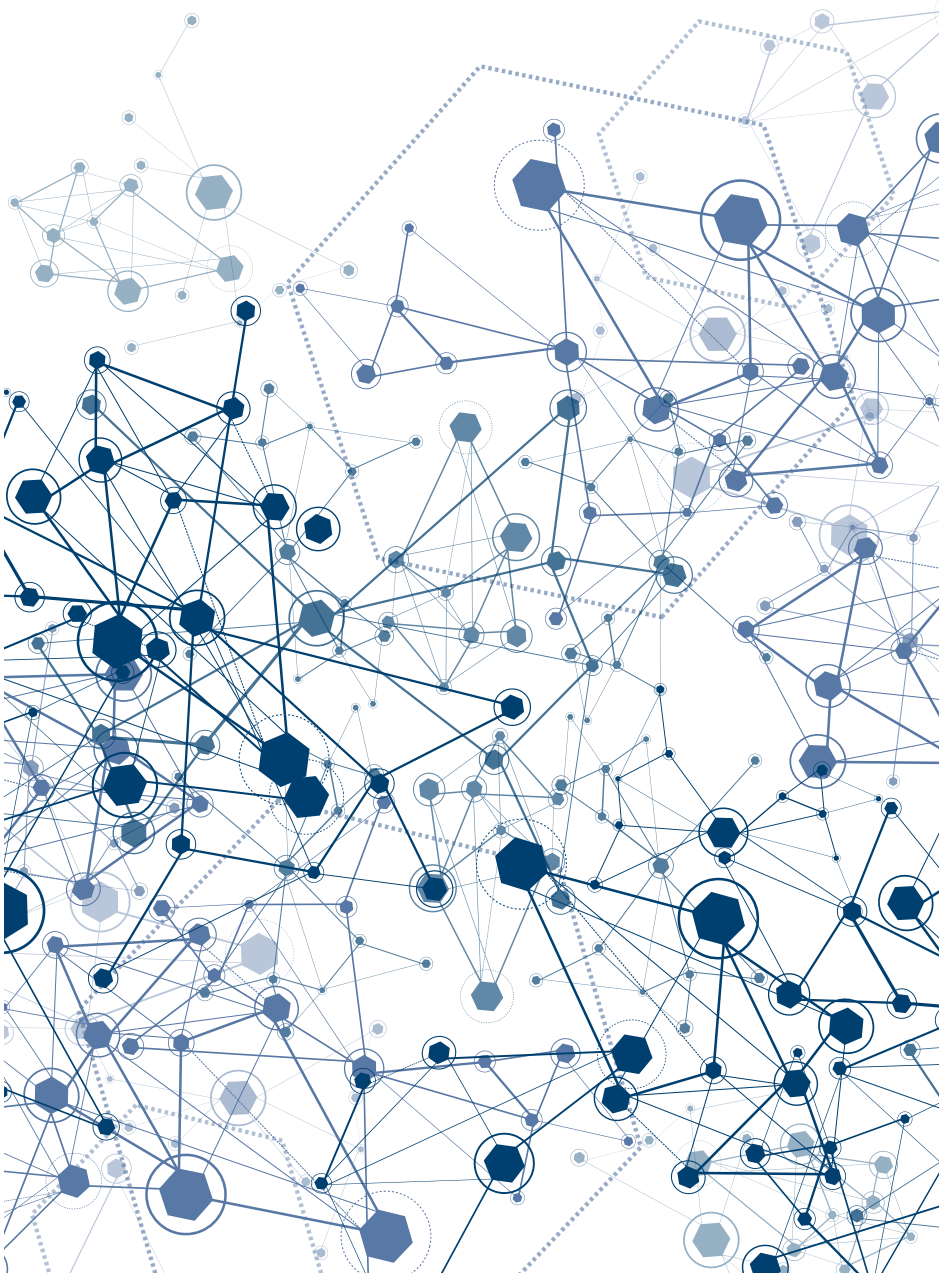
Sidebar: LTE Leadership in South Korea

While next generation wireless technologies have struggled to gain a foothold in Europe, other countries are moving ahead. South Korea, for example, has seen far faster adoption of LTE technology than any other country in the world. Its first LTE network was launched in 2011; already more than half of all mobile connections are on LTE.

The impact on revenue has been significant. LTE users generate average revenues per unit (ARPUs) that are almost 1.5 times higher than non-LTE users. Three major carriers are starting to see ARPUs increase after years of decline.

This growth has not come without cost. To facilitate LTE rollout, carriers increased capital expenditures by two to five percentage points of revenue, funding both network equipment deployment and LTE handset subsidies.

South Korean carriers are already starting to roll out LTE Advanced networks. Current networks support speeds of up to 150 Mbps, but this is expected to reach at least 300 Mbps later this year.[41]



7. Encouraging Infrastructure Investment and Innovation in the US

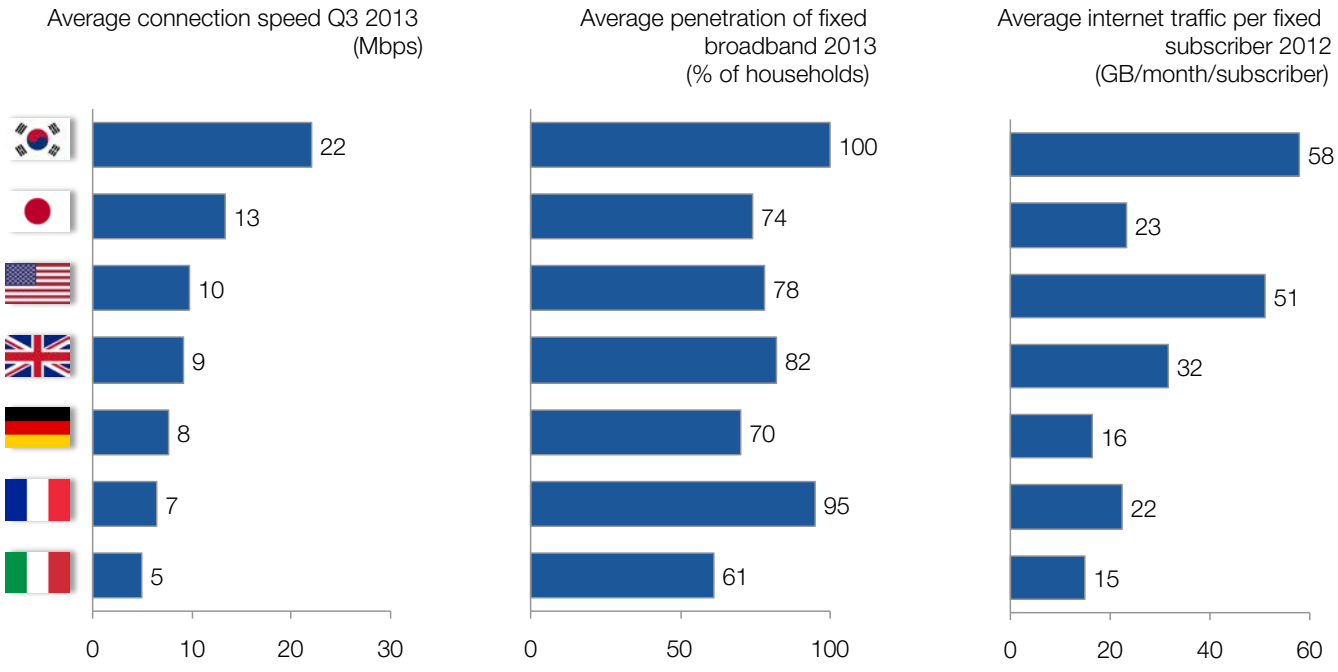
Broadband infrastructure in the US has evolved along its own path, owing in large part to the size of the country and consumers' enthusiastic embrace of cable TV in the decades immediately preceding the advent of the internet. CSPs in Europe typically "compete" through a services-based competition model over "unbundled local loops" – wires owned by one operator and leased to others – which reduces total infrastructure costs (especially for new entrants) but relies on centralized price setting and a high degree of permanent regulatory involvement. Other markets, such as Australia and Singapore, have nationalized broadband networks run by governments. The US developed along a path of infrastructure-based competition. Cable provided a second line into almost every US home, a line well suited to digital traffic. Competition now takes place among operators, cable companies and to some extent satellite providers. More recently, mobile broadband providers and, in some communities, new fibre entrants such as electric utilities, have joined the battle, especially over the last-mile connections that serve places of business and homes.

How Deep, How Fast, How Costly?

Despite robust consumer and business internet use, some observers have voiced concern that the penetration and speed of US broadband infrastructure are not what they should or could be. They point out that although the US leads many markets in terms of the health of its digital infrastructure, it trails such digital leaders as Japan and South Korea, and it has a discernible urban-rural divide. These observers argue that the infrastructure-based competition model is inferior to a service-based competition model, and that if cable broadband becomes a more pervasive technology, there may be less incentive, theoretically at least, for CSPs (and others) to invest and innovate. The concern is not so much that smaller countries will supplant the US as a leader in digital services, but that the rapid pace of innovation and advancement that has characterized the US digital economy for years will slow as market leaders face falling competitive pressure.

The US does trail some countries in internet penetration and others in speed. US broadband penetration currently approaches 78% of the population, behind countries like Korea and France.[42] Cable currently has a 57% market share and continues to

Figure 13: Overview of Fixed Internet Performance by Country



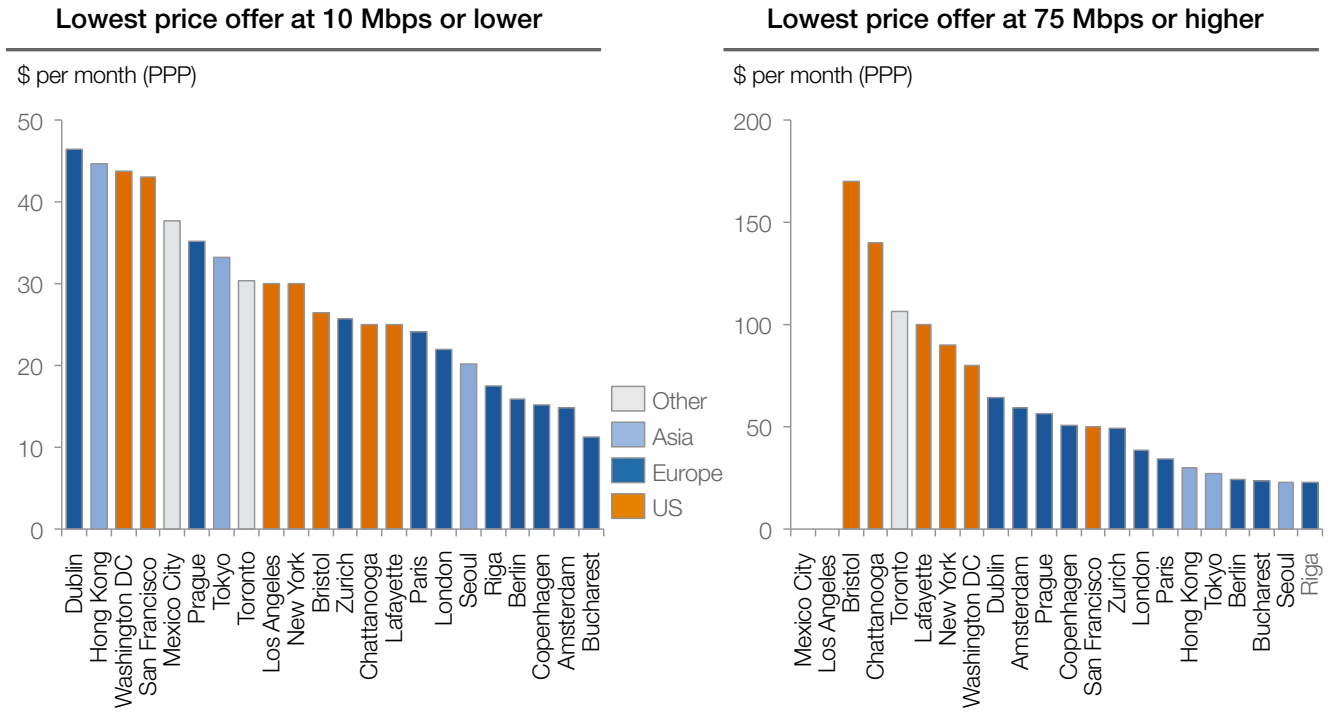
Source: : Akamai State of the Internet Report, Cisco VNI, EIU, OECD, US Telecom, BCG analysis

grow while its principal competition, fixed operator DSL service with its 34% share, has been on the decline. Fibre-to-the-household (FTTH) access, also principally a fixed operator-offered product in most markets, is growing faster than cable, but is subscribed to by only about 7 million homes, even though the infrastructure investment has been made to serve more than twice this number.[43]

Average peak (37.0 Mbps) and average mean (9.8 Mbps) connection speeds in the US rank high, but are slower than in some other markets.[44] Some global rankings place the US among the top 10 countries; others only among the top 30.[45] Akamai ranks the US seventh in terms of average connection speed and eighth in high-speed broadband (more than 10 Mbps) connectivity, behind both global leaders and several smaller markets in each instance. Speedtest.net ranks the US 34th in terms of average measured speed.[46, 47] (See Figure 13.)

Price criteria are complicated to compare, due to the wide variety of connection speeds and service packages offered by CSPs around the world, but there is some evidence that the US is more expensive than other markets, particularly for very high-speed broadband.[48] One reason is that the US is a geographically large and diffuse country with wide variations in population density. Some critics also argue that higher prices are evidence of the competitive model not providing adequate levels of competition in infrastructure. The extent to which broadband pricing in the US is a problem can be debated – on the one hand, higher prices might limit adoption (though adoption remains relatively high), while on the other, they can fund investments in next generation technologies. (See Figure 14.)

Figure 14: US Fixed Broadband Often More Expensive, Especially for Higher Speeds



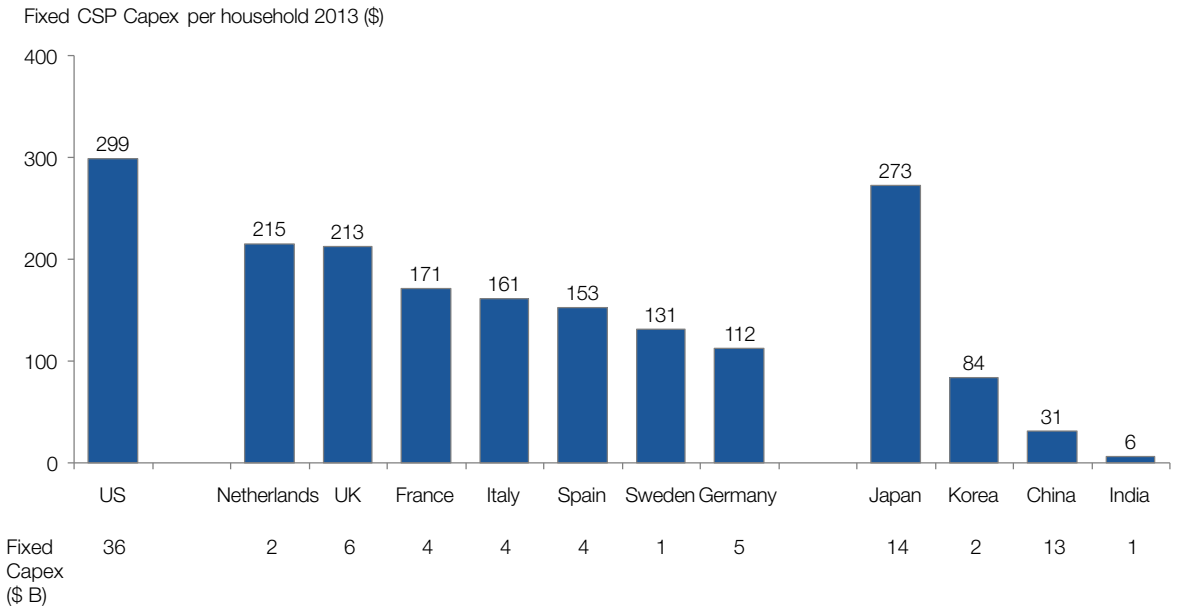
Note: Data shown is for internet-only offers; select cities did not have offers at 10Mbps – lowest price offer shown
Source: New America Foundation, BCG analysis

01: Padmasree Warrior, Chief Technology and Strategy Officer, Cisco, U.S.A., leads breakout discussion on infrastructure innovation at the World Economic Forum Annual Meeting 2014.

The argument advanced by many CSPs and others is that the competitive market is working just as it should and that the US remains a world leader in digital investment and innovation. Analysts in other countries, including the EU, point to the US market and regulatory environment for infrastructure investment as models for other nations to consider. Proponents of this view cite high levels of investment in US infrastructure, the competitive rates of penetration, performance and use of broadband, and the continuing growth of the world's leading digital service sector as evidence of the competitive market's success.[49] US operators spent $36 billion on fixed-line infrastructure in 2013, or $299 per household, according to Ovum – higher than any other major country worldwide. More than 60% of this investment was made by telecom operators.[50] (See Figure 15.)

There is a related debate among experts over how much digital speed is really required. One side believes that download speeds of 50 Mbps are more than adequate to support current and projected needs, including the advent of next-generation 4K HD video content. The other side argues that usage expands to fill the available bandwidth, that there will always be consumers and businesses that will make use of faster access (and are willing to pay for it), and that history demonstrates the impossibility of accurately projecting future needs. This debate will doubtless rage on, but proponents of the competitive market can agree that high penetration rates indicate that consumers find value in the quality of broadband access and are willing to pay for faster connections to more content, and better services.

Figure 15: US Fixed CSPs Have Higher Capex per Household



Note: Data represents total CSP Capex divided by total number of households subscribing to broadband; includes all fixed telecommunications spend – fixed telecoms and cable operators
Source: Ovum, EIU, BCG analysis

Travelling the Last Mile

There are few new sources of competition in the last mile in the US generally, but a small number of projects are producing more competitive access on a local basis. These undertakings are small (although some have big backers) and geographically dispersed, and the extent of their impact nationally remains to be seen.

One of the more publicized is in Chattanooga, Tennessee, where the publicly owned electricity supplier EPB has wired 56,000 residential and commercial customers with high-speed fibre-optic access.[51] Google has mounted well-publicized FTTH initiatives in Kansas City, Provo, Utah, and Austin, Texas, where it will go head-to-head with AT&T, among others. Both companies plan to offer Austin homeowners speeds of 1 gigabit per second in 2014, the same speed enjoyed in Chattanooga. Google currently charges Kansas City customers $70 a month for high-speed fibre service. Typical cable or DSL service in the US costs less – but not enormously less – for much lower speeds.[52] Google is considering expanding its fibre service to up to nine additional metropolitan areas.

High-speed FTTH access is underway in more than 25 North American municipalities ranging in size from Chicago (where selected neighbourhoods are being wired) to Orono, Maine.[53] Many of these undertakings are experiments or in the early stages, but a host of start-up "gigabit providers" – companies, government agencies and non-profit institutions – are pursuing various models. Like EPB in Chattanooga, many involve publicly owned municipal electricity authorities. Some are community-based, others have broader ambitions. One such undertaking is Gig.U, the University Community Next Generation Innovation Project, a collaborative effort that seeks to bring gigabit-speed internet connections to some 30 partner universities and their surrounding communities.

Other players are also active. Australia's Macquarie Capital, which has an extensive international track record in infrastructure investment, has entered the US digital market with an innovative partnership agreement with the Utah Telecommunications Open Infrastructure Agency to build out a fibre network connecting homes and businesses in 11 cities.[54]

This kind of local competition is still very much in the experimental stage, but to the extent that the consumer response is favourable – which so far it appears to be – more of such experiments are to be encouraged.

Beyond the last mile, the market also continues to attract investments by new players. In addition to the investments being made by CSPs, major digital service companies, such as Google, Amazon, Facebook and Microsoft, are busily assembling IP backbone networks for their own use. These private networks incorporate fibre-optic links leased from CSPs and interconnect with last-mile networks. They are spurred by the growing data transmission needs of their owners' cloud-based businesses and the desire of these companies to control their own data destinies. Their infrastructure programmes are global in scale. According to a report in the *Wall Street Journal* in December 2013, Google now controls an international fibre-optic network extending over 100,000 miles, more than twice the size of some operators' networks.[55]

As discussed in Chapter 4, the shifting IP interconnection playing field is likely to lead to more experimentation in speed and pricing models.

Two Priorities

Some policy advocates argue that the US needs to replace private sector-funded networks with a nationalized infrastructure that can serve all of its varied digital needs – including, importantly, future developments with unknown infrastructure impacts. The lack of consumer outcry over current circumstances, however, combined with current US political realities and the prospect of massive public expense, make such a change in course theoretical at best.

The most realistic path forward in the US is two-fold. First, policy-makers should encourage the innovations taking place in local markets to heighten competition and investment among infrastructure competitors in the last mile, including the involvement of new sources of capital such as infrastructure funds. While some experts question how much they need, US consumers like speed. Anecdotal evidence to date indicates that when a new player introduces faster service, or faster or better service at a lower price, others feel obliged to follow.

Consumers benefit from the removal of regulatory and other barriers to new infrastructure models. The US FCC estimates, for example, that permitting and accessing infrastructure in public rights of way (such as utility poles) amounts to 20% of the total deployment cost.[56] Communities should ensure that companies can get access to poles and other existing infrastructure in rights of way at reasonable prices, make available data about where existing infrastructure is, and provide for fast permitting processes. In addition, 19 US states currently restrict or prohibit municipalities from investing in digital infrastructure. Relaxation of such restrictions – especially in areas where limited high-speed infrastructure has been built or where competition is limited – removes a prohibitive barrier to investment. In general, these innovations can spark private innovation. However, it is also important to ensure that municipal investments do not lead to excessive distortion of competition that reduces the incentives of private operators to invest.

Second, policy-makers should encourage investments in next generation technologies, including high-capacity IP networks and other advances such as software-defined networking and network functions virtualization technologies. Deployment of new platforms depends in part on demonstrating to consumers and investors alike that the installation of new technologies and the retirement of legacy platforms will improve the customer experience and value. Part of this effort is a top-to-bottom review of current regulations, which were established to guide the 20th century public switched telephone networks, and an evaluation of what regulations are appropriate for the 21st century IP networks (including wired, wireless, cable and satellite). Such a review should also take into account the contemporary competitive environment for services on these new networks. The regulatory review process should recognize, however, that while the US is a single market, it is a highly varied one with significant local differences, and specific steps will need to vary by geography, with some level of flexibility required, particularly to account for the different needs in rural and urban environments.

8. Emerging Markets – Big Challenges, Big Opportunities

Emerging markets are an amalgamation of paradoxes. Some 4.5 billion people remain unconnected to the internet, but most of them live within areas covered by 2G or 3G mobile access.[57] Mobile broadband is the key to getting people online, but greater mobile penetration depends on handset costs falling at the same time as low ARPU figures discourage investment by mobile operators. The opportunities for potentially massive impact in such fundamentally important fields as education and healthcare need users to become sufficiently well-educated and skilled to demand greater access to the technology and its benefits.

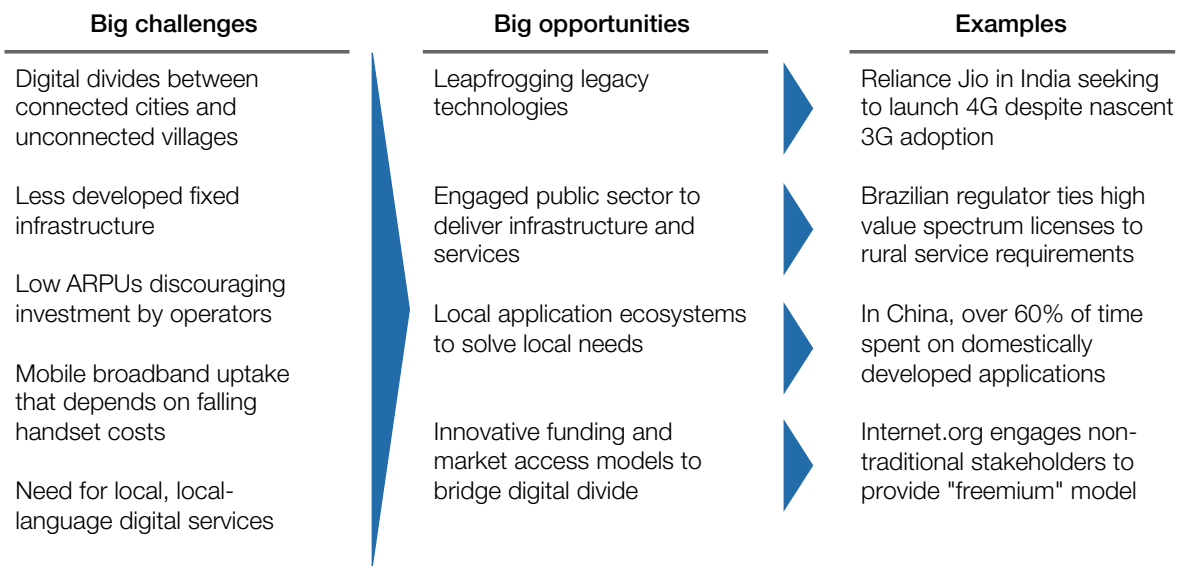
While there is a strong social argument for bringing more people in emerging countries online, there is an equally compelling economic one. Research has shown that each additional 10 percentage points of internet penetration adds 1.2 percentage points to per capita GDP growth in emerging markets, and each additional 10 percentage points of broadband penetration adds 1.38 percentage points of per capita GDP growth.[58] Separate research by The Boston Consulting Group shows that people in emerging countries are more frequent and active users of online government services than those in developed countries and they are particularly heavy users of services with a significant impact on life and livelihood, such as those related to healthcare and education. Emerging market consumers are embracing the web as much more than a purveyor of convenience; they are using it to improve their well-being, intellect and earning ability.[59]

While each market has its unique characteristics, multiple challenges are common factors, which are distinct from those facing the developed world. These include:

- Severe digital divides between more wealthy urban centres and rural districts
- Less developed fixed infrastructure, necessitating greater access through mobile networks
- Low ARPUs that discourage investment by mobile operators
- Mobile broadband uptake that depends on handset costs falling to affordable levels
- The need for local and local language digital services

The challenges are big, but emerging markets actually have the opportunity to adopt new and in many ways more versatile technology without having to support legacy infrastructures. They do not need to follow the path of the US and Europe; the lack of existing infrastructure allows operators to adopt and implement the technologies that suit their markets' current situation and projected requirements. Some of the ways in which emerging markets can accelerate development of their digital service sectors and digital economies include focusing on new technologies, especially those that can address infrastructure needs, such as mobile; pursuing public-private investment partnerships; encouraging the development of local services that use digital technology to address local needs; and developing innovative funding and market access mechanisms. (See Figure 16.)

Figure 16: Emerging Markets – Big Challenges, Big Opportunities



01: Manoj Kohli, Managing Director and Chief Executive Officer, International, Bharti Airtel Limited, India at the World Economic Forum Annual Meeting 2014.

Focus on New Technologies

The lack of broadband penetration in emerging countries – especially fixed, but also mobile – is well documented. This ought to represent an opportunity – many emerging markets are free to adopt new technologies, such as LTE and fibre, without the burden of managing legacy infrastructures. Progress has often been slow, however. India, for example, has struggled to develop digital infrastructure. Fixed broadband reaches less than 10% of households, and while mobile penetration has hovered around 75%, it is dominated by 2G networks; 3G and 4G penetration is less than 5%. There is also a strong urban-rural divide, with mobile penetration in urban areas topping 160% while in rural areas it does not reach 40%.[60] Indian mobile operators struggle with fierce competition, low consumer spending power and poor spectrum management.

The cost of smart devices remains an issue as well. Despite attempts by manufacturers to bring less expensive smartphones and tablets to market, prices for 3G and 4G handsets have remained too high to boost additional demand for data services in many emerging markets.

Despite such constraints, India is nonetheless an example of creativity and entrepreneurialism that makes the most of the mobile connectivity that is available. Competition among 2G operators has led to the creation of an ecosystem of value-added services built around the networks and less sophisticated feature phones that provide users with a wide array of services. Many Indians use their devices for entertainment and information, and are now starting to conduct basic financial activities such as bill payment. Matrimonial matchmaking and astrology sites are highly popular. Farmers use mobile phones to check commodity prices. In a country with more mobile-phone subscribers than individuals with bank accounts, "mobile money" has huge potential. The Boston Consulting Group has estimated that by 2015, $350 billion in payment and banking transactions could flow through mobile phones in India, compared with around $235 billion of total credit- and debit-card transactions today.[61]

The mobile pump is primed, and a gusher of activity can be expected to flood India when smartphones penetrate the market more widely. Some observers believe the major market shift may be imminent with the advent of pan-Indian 4G service offered by Reliance Jio. The unified voice and data services on a 20 MHz band may bring the speed and capacity increase needed to jumpstart the Indian mobile data market.

Four out of five internet users in sub-Saharan Africa go online using mobile phones, according to TNS, a market research firm. Mobile connections in Africa are projected to grow at an annual rate of 21% between 2012 and 2016. The government of Rwanda hopes to establish its country as a regional information- and communications-technology hub by 2020 and has embarked on building a fibre-optic network and an advanced data center.[62]

In other emerging markets, fibre-optic cables and new IP exchange points are the modern-day equivalent of providing landlocked countries with ocean port access. They open up an entire world (literally) of new trade routes and partners. Undersea fibre cables have brought high-speed access to both the east and west coasts of Africa in recent years, for example. Main One's cable system, which links West Africa with Europe, was the first submarine cable to bring open-access, broadband capacity to multiple countries in West Africa. Google's Project Loon is experimenting with high-altitude balloons to "connect people in rural and remote areas, help fill coverage gaps, and bring people back online after disasters".[63] In Kenya, Microsoft has partnered with the Ministry of Information and Communications and a local internet service provider to bring low-cost internet access and charging stations to rural communities that lack electricity, using a solar-powered wireless broadband network featuring TV White Space radios.

Public-Private Commitment

There is a greater role for governments to play in emerging markets, particularly as catalysts for essential infrastructure projects. Public-private partnerships are a time-tested method of getting big infrastructure projects off the ground, although it is important to ensure that the capabilities and experience of private market players are not lost and that public sector involvement does not lead to market distortions. Several emerging economies are using this tool to build out digital infrastructure and increase internet access.

Public and private sector players in Brazil have come together to develop and implement a plan for boosting digital penetration and use by building out infrastructure coverage and raising service quality. Smart policy has led to a well-functioning marketplace.

Competition is facilities-based with three or four major operators in each of the fixed, mobile, and pay-TV markets, with some overlap among them. Spectrum policy spurs competition among mobile operators and propagates mobile broadband coverage. LTE spectrum assignments through an auction process in 2012 linked ownership to comprehensive coverage obligations to ensure access is brought to rural or less desirable coverage areas. An auction of the 700 MHz band of spectrum is expected in 2014. It is hoped that the Brazilian government will make appropriate efforts to clear this band and encourage investments in new networks.

Brazil nonetheless has issues related to penetration and coverage. While mobile penetration in Brazil already exceeds 100%, it is mostly 2G coverage. The rollout of 4G networks begins this year. The Brazilian National Broadband Plan combines government spending on fibre networks with public-private partnerships to provide basic broadband access at a low cost. The first phase (2010-2013) has 30% of the population covered. The ultimate goal is 90% fixed-line coverage.

In Malaysia, the government launched Telekom high-speed broadband (HSBB) in 2009 with a subsidy of RM 2.4 billion (about $730 million) to "expand the communications network to ensure more equitable access to information and services", and to "bridge the digital divide". At the time, broadband penetration was only 22%. The broadband service based on HSBB offers special packages for low-income households in both urban and rural areas.

While the government contributed approximately 20% of the total capital, operational control remained in the hands of Telekom Malaysia. To ensure fair play and competition for all industry service providers, the government subsidy, issued under a public-private partnership agreement, committed Telecom Malaysia to open its network to its competitors. This competitive, open market will help to create multiple "innovation clusters". As of early 2013, broadband penetration in Malaysia had increased by a factor of three to 66%. The HSBB project is expected to increase national GDP by 0.6% and create 100,000 new jobs by 2018.[64]

Local Digital Services Can Address Local Issues

It is easier today to open a mobile bank account in Kenya than in Kansas. The development of local digital service markets can be a big step towards addressing local problems.

Like other emerging markets, Kenya is unconstrained by the legacies of infrastructure, regulations and inertia. Its success with mobile money – two-thirds of its citizens use the technology – shows how technology can be put to work addressing local needs. In many African countries, mobile phones are helping people run businesses, find jobs, pay their bills, transfer money, learn, share, bank, and connect with family and friends. Mxit, a South Africa-based mobile-messaging platform, claims to be Africa's biggest social network, with 7 million monthly active users and more than 65 million registered users.

Elsewhere on the continent, other new services are starting up. In June 2012, Angola's Education Ministry and mobile-network operator Unitel partnered with Huawei to launch E-net, a project designed to provide free internet access for selected groups of public and private secondary-school students across the country's 18 provinces. Similarly, pan-African operator Airtel recently partnered with Wikimedia to provide free access for its subscribers to Wikipedia. The government of Botswana has launched a National Broadband Plan with the aim that all appropriate government information and services (more than 300 services in all) will be available through a single government portal by 2016.[65]

Local app development is beginning to take hold in a few countries, where they provide important local language resources for local users. Chinese users already spend far more time on apps developed locally than those from other countries. Brazilian users are also spending considerable time using locally developed apps. Local digital ecosystems are vital developments for serving local needs and boosting competition in an increasingly international digital service market.[66] By maintaining a free and open internet, governments have a role to play in fostering future development of these ecosystems and enabling compelling app development within them. (See Figure 17.)

A Role for Innovative Funding and Market Access Mechanisms

The economics of many emerging economies make infrastructure (as well as other) investment tough. At the same time, a growing number of governments, companies and organizations recognize the benefits of expanding internet access as widely as possible. They also see that gaining access can have an outsized impact for people who live in particularly poor and remote areas.

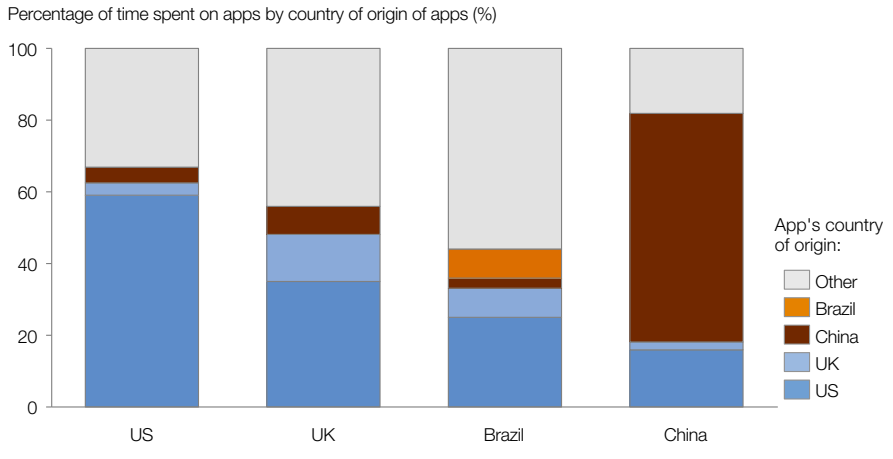
Bridging this divide may require non-traditional and innovative approaches. Internet.org is a partnership started by a group of major technology companies (the founding partners include Ericsson, Facebook, Mediatek, Nokia, Opera Software, Qualcomm and Samsung) with the goal of working with governments and NGOs to bring basic internet services to people who do not have them. Facebook founder Mark Zuckerberg describes it as "the on-ramp for the internet". The underlying philosophy is that demonstrating the internet's value for free will cause users to want to pay for more or better services down the road (which is not too far removed from how internet use evolved in the rest of the world).

Public-private partnerships, such as the one being pursued in Malaysia, have an important role to play. The M-Pesa money transfer system in Kenya is the result of collaboration and public and private sector organizations. The government of Rwanda and KT, the Korean telecommunications company, have developed a joint venture to roll out 4G LTE access to 95% of Rwandans.

There may be a productive role for funding and coordinating organizations that can help match players and provide seed capital to advance innovative ideas for expanding digital infrastructure and access as well as sharing costs and capabilities. Such programmes could involve non-traditional companies and explore the possibility of infrastructure-sharing among entities. It would be important to ensure that any non-traditional mechanisms focus on especially poor and hard-to-reach areas and do not impede traditional private investments.

The World Economic Forum's digital infrastructure initiative will be exploring issues related to emerging markets in more detail in the coming year.

Figure 17: "App Economy" Already Emerging in Brazil and China



Source: Flurry Analytics, GSMA, BCG analysis

9. Towards a Robust Digital Infrastructure

A large and complex ecosystem of companies and other entities compete, collaborate and cooperate to construct and maintain the interconnected network of networks that is the internet. The ecosystem works, and anyone can download a web page or video, or activate a mobile app, because of common standards and a shared understanding among participants of the benefits of a vibrant and growing economic system. With rapid growth, however, as well as big differences between where various players stand on the development path, individual interests inevitably diverge, and the shared understanding can start to fray. When companies lose the incentive to invest, for example, technological advancement slows. Essential processes such as spectrum allocation can be subverted. Governments can feel compelled to intervene in unproductive ways. Any of these actions can have an adverse impact that is felt throughout the ecosystem. Users and usage suffer. Services go un- or under-delivered. Growth slackens.

A clear understanding of goals and direction for the future can help overcome uncertainty and disagreement in the short term created by current challenges and emerging trends. Particular challenges and solutions differ around the world, but based on conversations with a wide range of players who will collectively determine how – and how well – the internet functions in the future, the understanding rests on three pillars:

1. Commitment to actions that promote the long-term growth of the digital economy
2. Removal of impediments to the expansion of digital infrastructure
3. Modernization of policies and regulations to encourage investment and innovation throughout the internet ecosystem

1. Commitment to actions that promote the long-term growth of the digital economy

It is much easier to grow in an expanding market than in a stagnant one – especially if that stagnation is brought on by unnecessary action (or inaction). All of the participants in the digital ecosystem have a shared interest in its continued growth. They can take the following steps:

i. *Governments, businesses, and other stakeholders should commit to long-term actions that promote growth of digital services and the digital economy.*

   All stakeholders can establish comprehensive, aspirational plans that lay out a path to broadband connectivity for all. Making expanded connectivity a reality requires a continuing commitment to investment and innovation by the private and public sectors – and an understanding of the importance of keeping digital traffic flowing. Governments in particular need to recognize the broader role that digital services can play in economic development and growth; the digital economy is much more than a potential source of tax revenues. Multistakeholder forums such as the April 2014 conference in Brazil on the Future of Internet Governance can help further this goal. Broadband targets and other digital goals need to be included in the UN's post-2015 agenda of Millennium Development Goals.

ii. *Establish international guidelines that enable the flow of data and services while recognizing privacy and security concerns.*

   This includes developing cybersecurity and privacy frameworks for data use that facilitate accountability and enforcement. Countries should also take steps towards establishing regional and international digital markets that remove barriers to cross-border trade and cooperation, enabling, for example, entrepreneurs to access international suppliers (such as cloud providers) and consumers to purchase products and services without regard to country of origin.

iii. *Open doors (or keep them open) to international digital service businesses while promoting and supporting local initiatives.*

   The most important thing public sector participants can do is create investment-friendly tax, legal and regulatory environments for digital services. They can also commit resources to fund basic and advanced technical education, and take steps to deliver government services digitally and provide open access to government data to spur innovation. Public and private sector players can serve as catalysts. Private companies, particularly infrastructure providers, can help make it easy for consumers to access and use digital services.

2. Removal of impediments to the expansion of digital infrastructure

Ensuring a basic level of well-functioning, reasonably-priced digital infrastructure for consumers and businesses is an essential goal. Facilitating delivery of faster, more capable infrastructure is the appropriate next step. Removing policy, regulatory and financial impediments to

the construction and improvement of robust digital infrastructure is critical to both.

Stakeholders should consider the following steps:

iv. *Encourage technological and business model experimentation in infrastructure by removing barriers to innovation and encouraging local experimentation.*

Policy-makers should seek to liberalize fixed broadband markets where adequate infrastructure-based competition exists, for example by allowing operators to set prices on fibre networks. They should allow experimentation with commercial IP interconnection agreements as long as they are fair and they benefit innovation and growth in the overall digital ecosystem. Restrictions on municipal and other local investments in high-speed broadband networks should be relaxed. Regulatory policy should permit new entrants and incumbents to use existing fixed infrastructure assets, such as utility poles and underground conduits, at fair prices.

v. *Encourage stakeholders to pursue cooperative business models to achieve greater utilization of infrastructure and grow demand for digital services.*

While competition will likely remain the dominant business model in most markets (as it should), companies in different segments – CSPs and content providers, for example – can also benefit from cooperating in areas that expand the digital pie by serving consumers better. Companies can pursue opportunities to reduce the overall investment burden by sharing infrastructure investments by mutual accord in areas such as equipment and spectrum.

vi. *Experiment with innovative funding and market-access mechanisms to promote market-based infrastructure investments in emerging markets.*

International as well as local efforts should focus on emerging markets and hard-to-reach areas where infrastructure needs are less likely to be addressed by commercial players. Governments, NGOs and businesses can experiment with funding and market-access mechanisms to promote market-based infrastructure investments in emerging markets. These explorations could be multi-party and could include shared infrastructure approaches based on commercial agreements that reduce the investment burden on individual participants.

3. Modernization of policies and regulations to encourage investment and innovation throughout the internet ecosystem

The policy-makers of the future must be able to tackle the challenges posed by the digital economy. They need to consider the impact of policies on the entire value chain, including telecommunications, digital services and media, and ensure that any regulations that are deemed necessary are applied with a light touch and restraint. Perhaps most importantly, policy-makers need to take into account how quickly technologies and the innovations they enable are evolving. Complicating matters is the fact that the internet is a global phenomenon, and many of the issues it gives rise to are also global in nature. These issues often require some form of global, coordinated solution. The following is recommended:

vii. *Modernize policies and regulations to be light-touch in approach and supportive of innovation and investment across the entire ICT value chain.*

Simple, transparent policies work best in fast-changing environments. Existing regulation should be reviewed for the possibility of reducing or eliminating rules that impede technological innovation and business model experimentation (for example, by relying on ex-post approaches where possible). Governments should avoid, or look for alternative approaches to, adding new regulations or expanding existing regulations to new sectors. In some instances, self-regulation can be a viable option in competitive markets. Governments should seek to develop policies that address issues at an appropriate geographic level (which, in some cases, will be international).

viii. *Allow targeted consolidation of mobile operators to encourage service-level innovation in markets where fragmentation limits investments.*

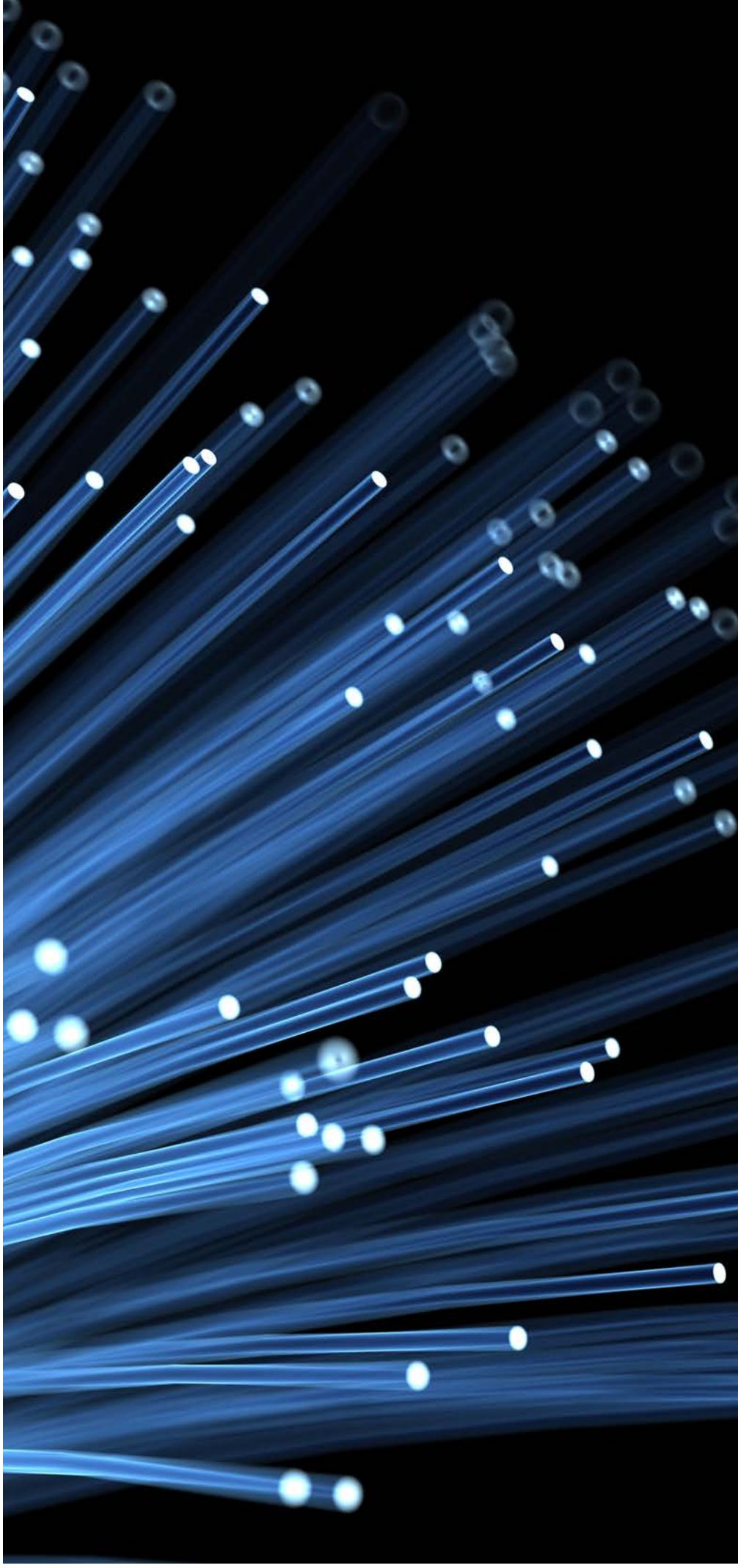
Policy-makers and competition authorities need to take a more comprehensive view of the mobile marketplace that includes both price-based competition and the benefits of improved infrastructure and services. To this end, competition authorities can take into account dynamic efficiencies (improvements in network quality and innovation, for example), as well as consumer prices, when conducting merger reviews. They can also include the impact of fixed/mobile convergence and growth of cable broadband when considering market definitions. They can allow for more consolidation in markets where competition is fragmented and take steps to facilitate swaps among operators that lead to efficient network footprints. They should allow sharing of infrastructure to encourage cost-effective coverage in lower-density areas.

ix. *Release more spectrum for private sector mobile use and adapt allocation and utilization policies to encourage greater efficiency in its use.*

Governments need to release additional spectrum for licensed and unlicensed use. They also should accelerate their approaches for spectrum harmonization to avoid unilateral band assignments by countries. Auction models can be modified to reduce the cost of spectrum, and secondary markets will enable spectrum owners to swap holdings to improve utilization and reduce costs. Governments at all levels can support experiments in alternative deployment models, such as small cells.

The digital economy will not stop or stand still. New technologies and services are already on (digital) drawing boards worldwide. The digital economy will continue to expand and generate growth. The only questions are where and how fast.

Lack of investment in infrastructure is an impediment, but barriers are never erected evenly. Some economies grow faster and more dynamically than others. Policy plays a role in determining which economies lead. Some companies and sectors are quicker to embrace technological and business model development, taking the risks that expand existing markets and create new ones. It is within the power of each of the digital ecosystem's participants – public and private sector alike – to reap their own benefits while furthering the global investment and innovation necessary for continued expansion.



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