WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD

Industry Agenda

# Expanding Participation and Boosting Growth: The Infrastructure Needs of the Digital Economy

Prepared in collaboration with The Boston Consulting Group

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# Contents



# Preface

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**Background**

The potential of digital technologies to improve national economic developments, productivity of businesses across all industries, and increase quality of life for human beings is significant. However, the challenges of ensuring a successful deployment of future digital infrastructure are just as substantial.

In May 2013, the World Economic Forum convened a cross-industry initiative to determine how digital infrastructure could keep pace with the fast-growing demand for digital services. The conclusions of the initiative were published in the 2014 report: *Delivering Digital Infrastructure: Advancing the Internet Economy*. Building upon this work, the Forum's "Digital Infrastructure and Applications 2020+" initiative further investigated the greatest challenges facing the information and communications technology environment in the next five to ten years, in both developed and developing markets, and made recommendations on how best to overcome these challenges.

More specifically, the initiative examined the exact issues of providing infrastructure and applications to people all over the world – including the 4.5 billion people, mostly in emerging markets, who remain unconnected. It leveraged the unique multi-stakeholder approach of the World Economic Forum to bring together all relevant stakeholders, including communications services providers, digital services and applications companies, equipment and device manufacturers as well as policy makers, to identify and propose policies and other recommendations for overcoming these challenges. Throughout the work, participants jointly assessed digital infrastructure adequacy and, in particular, identified best practices to overcome the impediments – technological, financial and political – to the policies and investments necessary for a successful deployment of future digital infrastructure.

The conclusions and recommendations of this report are integrated into the Forum's Global Challenge "the Future of the Internet", a multi-stakeholder initiative that integrates various efforts to help understand and manage the social, economic and political consequences of digital technology. This report examines the steps necessary for digital infrastructure to keep up with the demand for digital services and facilitate the growth and development of a vibrant global digital economy in both the medium and long term. Other recent Forum reports in this series include *Partnering for Cyber Resilience: Towards the Quantification of Cyber Threats, Data-Driven Development Pathways for Progress and Industrial Internet of Things: Unleashing the Potential of Connected Products and Services.*

The report was prepared in collaboration with the Boston Consulting Group. I would like to thank them, as well as the Steering Committee and Working Group members, and the more than 50 industry partners who were involved in shaping the findings and recommendations of this report. I am confident that the recommendations will help accelerate the deployment of a key enabler for improving the state of the world: future digital infrastructure.

# Executive Summary

The internet already plays an indispensable role in the everyday life of billions of people. Yet, the surface is only being scratched. The potential to bring new and more advantages to individuals around the world, and to provide benefits for billions more as they gain access, has few limits. While many benefits could have their biggest impact in emerging markets, these are unfortunately the countries where internet penetration and use often lag.

This report builds on the broad recommendations of the World Economic Forum's 2014 report, *Delivering Digital Infrastructure: Advancing the Internet Economy*, which explored serious obstructions to the continued growth of the digital economy over the next three to five years. This current report looks further into the future and seeks to identify the most important challenges facing the development of a healthy digital infrastructure for 2020 and beyond. It examines the particular difficulties of bringing connectivity's economic and social benefits to emerging markets, which in 2014 were home to 96% of all people who were not internet users.

**Emerging markets face two broad issues in providing affordable internet access: building network capacity and expanding network coverage.**

- A critical and urgent need exists for more licensed and unlicensed spectrum to be released and allocated to mobile usage. This should be done on a planned basis with sufficient notice to network operators. The primary goal for policy-makers and regulators should be to maximize the use, rather than the short-term value, of this precious asset.
- Too many areas of too many countries lack internet connectivity, and many of these areas are not economically viable for private companies to serve using traditional business models. Connectivity's economics are determined by a variety of factors (e.g. site security and the availability of electricity), with only some related to technology. Countries need to make smart choices and trade-offs.
- The first step is for governments to determine the specifics of their broadband access aspirations. The second is for each government to establish a country-specific operating and funding approach – one that is technology-agnostic, provides incentives for investment and allows for experimentation. Countries can learn from the different models being used to connect these economically unviable regions.

**Encouraging broader internet usage, particularly in emerging markets, is critical to bringing more people online.**

- Many developed countries have a 30-50% difference between the number of people reached by digital networks and the number actually online. This gap jumps to 55-75%, and up to 90% in some cases, in emerging markets.
- Research shows three main reasons for not adopting the internet: a perceived lack of need (mostly because of a lack of local-language content), followed by a lack of skills and, as a distant third, affordability.
- Local content in local languages is vital for attracting local users and serving local needs. Governments also can help drive digital engagement with their own online services.
- Network operators, content providers and others can accelerate internet adoption, especially the use of the mobile internet in emerging markets, by clearly conveying the value of internet use and simplifying the pricing of access.

**The changing nature of consumer and business usage in both developed and emerging markets, as well as the rise of the Internet of Things (IoT), raise new infrastructure issues.**

- The fast-increasing volume of digital traffic, as well as the growing need for providing low latency and handling far more uploads, pose new challenges for network infrastructure. The need for increased capacity is a critical issue in emerging markets, where the lack of fibre networks is a serious constraint, but it also affects the "last mile" almost everywhere. Security and privacy are major concerns as well, and are being analysed and addressed by other Forum initiatives.
- The technologies exist to help resolve several of these issues, but some are hampered by out-of-date policies, legislation and regulations. Legacy regulation needs to be rationalized, and experimentation is required with new commercial pricing models that can fund network investments without harming competition. Despite differing interests, network operators and content providers can find a mutually beneficial path that maintains the commercial nature of Internet Protocol interconnection contracts with no unfair discrimination. In addition, regulatory

barriers to adoption of low-cost and capacity-increasing technologies such as small cells need to be removed.

– The addition of 30-50 billion or more connected devices over the next five years represents an enormous opportunity for economic expansion and growth, but also a big infrastructure challenge. Serving the needs of expanding IoT traffic presents some unique spectrum requirements and the need for standardized and secure communication protocols. Policy-makers and regulators should consider the allocation of new types of spectrum for different IoT needs, while industry participants must accelerate discussions and actions around a standardization roadmap for IoT communication protocols.

**As more of the world's population migrates to urban centres, the development of "smart cities" requires planning for and deploying information and communications technology (ICT) infrastructure.**

– Over the next 15 years, more than 1 billion people will move to cities, and some 360 new cities with populations of 500,000 or more will be created. Almost 80% of these new cities will be in developing markets.

– Tools ranging from those that perform basic monitoring to advanced systems that enable predictive, analytics-based applications can all have a significant impact on citizens' well-being and the efficiency of their daily lives. Many of the ICT-based systems, apps and services that can address urban needs such as energy, transport, water and waste, social services, and building management and services already exist.

– Many cities lack a comprehensive vision for building ICT infrastructure or for constructively using the massive data that they generate every day. The business cases for many ICT investments are complex, and it is difficult to finance large investments that have payback periods of many years, even a decade or more.

– The best solution is likely a combination of various elements with clear roles for public- and private-sector players.

**As digital technologies become more pervasive, the need grows to unlock consumer and industry value by removing frictions that prevent users from transporting and accessing their data (particularly personal data and digital identities), while continuing to respect user privacy and data security.**

– Consumers have started to compile digital assets that are tied to their online lives and distributed across multiple sites, apps and sectors. These data include, among other things, government records, healthcare files, financial information and basic identity content.

– This digital dependence creates new questions about consumers' ability to easily access and use their data, while at the same time raising privacy and security concerns related to use of their data by others.

– The interplay among consumer benefits, privacy and security risks as well as industry impact needs more time and experience before it can be accurately assessed. But it's not too soon to recognize that, left unaddressed, unwarranted limitations on seamless or universal use of data could become a serious barrier both to people's ability to get basic things done as well as to overall digital growth and economic activity.

– Multistakeholder dialogue on near- and long-term initiatives is required to reduce sources of friction in the transportation, use and accessing of data, thereby unshackling consumers' digital lives. Common technical, policy and legal frameworks may need to be developed for high-priority data and the most important ways they are used.

# 1. Introduction

If "what's past is prologue," as Shakespeare observed in *The Tempest*, then the first few decades of the digital age point to an evermore potent future.

The internet already plays an indispensable role in the everyday life of billions of people. Almost 3 billion connected consumers and businesses search, shop, socialize, transact and interact every day using personal computers (PCs) and, increasingly, mobile devices.[1] The digital economy, which contributed $2.3 trillion to the G20's GDP in 2010 and an estimated $4 trillion in 2016, is growing at 10% a year – significantly faster than the overall G20 economy. The growth is even higher in developing economies, at 15-25% annually. Not only is the digital economy an increasingly important source of jobs, but digital technologies are also enabling far-reaching social and political changes.[2]

Yet the surface is only being scratched. The potential to bring new and more advantages to individuals around the world, and to benefit billions of additional people as they gain access to the internet, has few limits. More than 1 billion new users will be added by 2020 as internet penetration expands, connection speeds improve and device prices fall.[3] The digital economy's contribution to GDP in the G20 will reach $6.6 trillion a year, or 7.1% of the total.[4] Moreover, these figures do not reflect the potential impact of the Internet of Things (IoT), which could involve 30-50 billion additional connected devices by 2020, helping to manage everything from home heating systems to automotive vehicles and jet aircraft. Cisco estimates the cumulative value of this fast-rising market at $19 trillion in a few years' time.[5]

The internet's impact extends far beyond GDP. All kinds of economic activity, including business-to-business e-commerce, online advertising, consumer-to-consumer e-commerce and other consumer economic activity, are not well captured in GDP figures. The internet has a huge impact on productivity, giving businesses access to new markets, customers and suppliers. It enables new business models and saves endless amounts of time and energy for countless individuals every day. There are broader social impacts as well. Digital technologies are already transforming essential social services, such as education and healthcare, and how people interact with their governments. In addition, the potential for massive improvements in universal utilitarian services, such as transportation and energy and power delivery, is clear.

Many of these benefits could have their biggest impact in emerging markets; unfortunately, these are the countries in which internet penetration and use often lag. Although several studies have shown a positive correlation between internet penetration and GDP growth, countries need to build critical scale first in order to take advantage of this.[6] Studies by the World Economic Forum on network readiness[7] and The Boston Consulting Group (BCG) on "e-intensity"[8], the latter a combination of internet enablement, engagement and expenditure, show emerging markets trailing developed countries on key measures of internet infrastructure and use.

As technological advances and their applications race forward, they create new needs to be addressed and fresh issues to be resolved in all markets. The digital economy depends on adequate infrastructure to carry all that traffic and process all that data. Infrastructure requires investors, who want the ability to foresee a return. Benefits accrue unevenly for reasons of geography, economics, policy and opportunity. In many geographies and population segments, the business case does not work, despite substantial societal returns. The resulting gaps must be addressed.

The Forum's 2014 report, *Delivering Digital Infrastructure: Advancing the Internet Economy*, explored serious obstructions to the digital economy's continued growth over the next three to five years, with an emphasis on the developed markets of the United States and Europe. These impediments include lagging adoption of long-term evolution (LTE) technology, spectrum scarcity, the need to modernize policy and regulation, and disputes over IP (Internet Protocol) interconnection agreements, which are already constraining digital activity and interaction. For each one, it suggested solutions or avenues to find solutions, and argued that policy-makers, industry participants and other stakeholders need to work collectively to do three things:[9]

- Commit to actions that promote the digital economy's long-term growth
- Remove impediments to expanding digital infrastructure
- Modernize policies to encourage investment and innovation throughout the internet system

This report builds on these broad recommendations and looks further into the future. It draws on interviews with more than 50 industry participants and observers (including experts from network operators, hardware manufacturers, content companies, application providers, academics and equity research firms). It also reflects the expertise of the Forum's 38-person working group and a steering committee comprised of representatives from more than eight leading companies. It seeks to identify the most important challenges facing the development of a healthy digital infrastructure for 2020 and beyond, in both developed and developing markets. The following content is explored in the report:

**Chapter 2.** Providing affordable internet access in emerging markets, especially in rural areas

**Chapter 3.** Encouraging broader internet usage, particularly in emerging markets

**Chapter 4.** Addressing the infrastructure issues raised by the changing nature of consumer and business usage and the rise of the IoT

**Chapter 5.** Furthering the development of "smart cities" connected by information and communications technology (ICT), as more of the world's population migrates to urban centres

**Chapter 6.** Unlocking consumer and industry value by removing frictions that prevent users from transporting and accessing their data (particularly personal data and digital identities), while continuing to respect user privacy and data security.

These are huge opportunities to further economic growth, human productivity and the quality of life for billions of people. Equally, in each of these areas, lack of attention, investment and innovation, in addition to misguided or inappropriate regulation, could seriously undermine the digital economy's development. The following chapters examine each area in depth, including recommendations for both industry and governments on steps to take, beginning immediately, to ensure they minimize roadblocks and delays and realize the potential of digital technologies.

# 2. Improving the Economics of Infrastructure: Deployment in Emerging Markets

Few would argue against making increased internet penetration and use in emerging markets a priority. As pointed out in *Delivering Digital Infrastructure: Advancing the Internet Economy*, both a strong social argument and an equally compelling economic rationale underpin the objective of bringing more people online in developing countries. Research has shown that each additional 10 percentage points of internet penetration adds 1.2 percentage points to per capita GDP growth in developing markets, and each additional 10 percentage points of broadband penetration adds 1.4 percentage points to per capita GDP growth.[10] Separate BCG research reveals that connected consumers in developing countries are more frequent and active users of online government services than those in developed nations, and that they are particularly heavy users of services with a significant impact on life and livelihood, such as healthcare and education. Developing 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. Many are young, and want to use the internet to improve their opportunities for education and employment – to give them life chances they would not have otherwise.[11]

With these positive developments, emerging markets face two broad issues: network capacity and the need to expand network coverage (and, as explored in the following chapter, use):

**Network capacity:** Most of the next billion consumers coming online will be using mobile devices as their only means of access. In many places, the existing infrastructure's ability to handle the increased traffic will be strained. Some projections show the volume of emerging- market mobile traffic increasing 13-fold by 2018; others see traffic volume soaring much higher.[12] Sound spectrum policy would be one big step forward to help clear both financial and physical hurdles – and, if managed wisely, help keep down the cost of expanding access.

**Expanding coverage:** About 4.5 billion people are unconnected, and in 2014, 96% of non-users lived in emerging markets, many of those in rural areas.[13] The economic barriers to connecting these people are unquestionably high; they include big capital expenditures, high operating costs and low average revenues per user (ARPUs), as well as the need for investments in ancillary areas such as site security and electricity. A combination of approaches and the efforts of multiple stakeholders will be required to reach them.

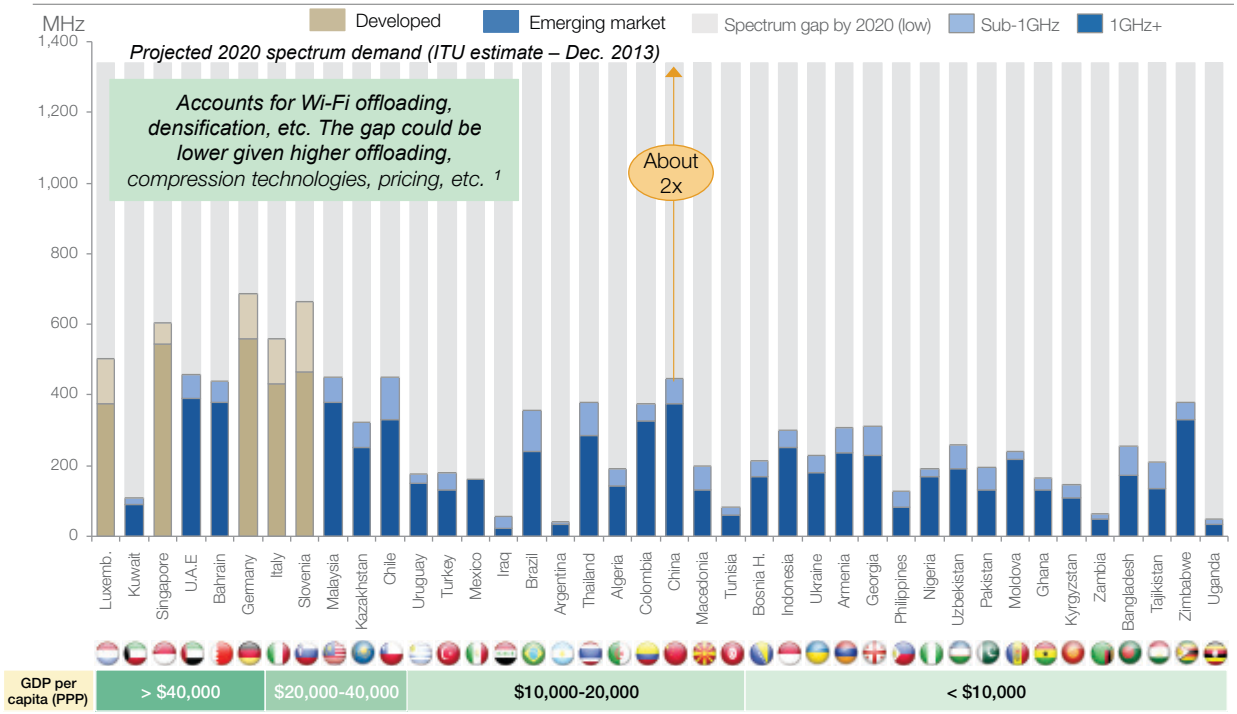
This chapter examines these two challenges in depth.

## The Urgent Need for More Mobile Spectrum

While projections of mobile traffic growth in emerging markets vary widely, more spectrum urgently needs to be released and allocated to mobile usage. These allocations should include licensed and unlicensed spectrum bands, and a mix of low- and mid-to-high-frequency spectrum, to accommodate both network coverage and capacity needs. Releases should be organized and scheduled, with sufficient notice to industry participants so they can plan accordingly. Spectrum is a scarce resource, with compelling economics for allocating more for mobile use. Yet, according to data compiled by the International Telecommunication Union (ITU) at the end of 2013, many emerging markets had released one-third or less of the spectrum that will be required to meet mobile demands in 2020.[14] Some countries will need up to 10 times more spectrum than is now available. (Figure 1).

**Figure 1:** Significant Gap in Current and Required Spectrum by 2020

Gap significantly higher for emerging markets




Note: Current spectrum holding for each country represents a lower end of the scale; auctions may not be reflected. 1. Based on recent report entitled "Overestimating Wireless Demand: Policy and Investment Implications of Upward Bias in Mobile Data Forecasts" by Aalok Mehta and J. Armand Musey.
Source: GSMA, ITU.

The many difficulties that surround spectrum allocation and use were discussed in detail in the 2014 report. The problem is complex and multifaceted, although many countries, especially emerging markets, face similar issues (Figure 2). These include the following:

– *Many nations allocate multiple bands exclusively for military and analogue TV purposes*. Not necessarily (or fully) needed, these valuable bands go largely unused.

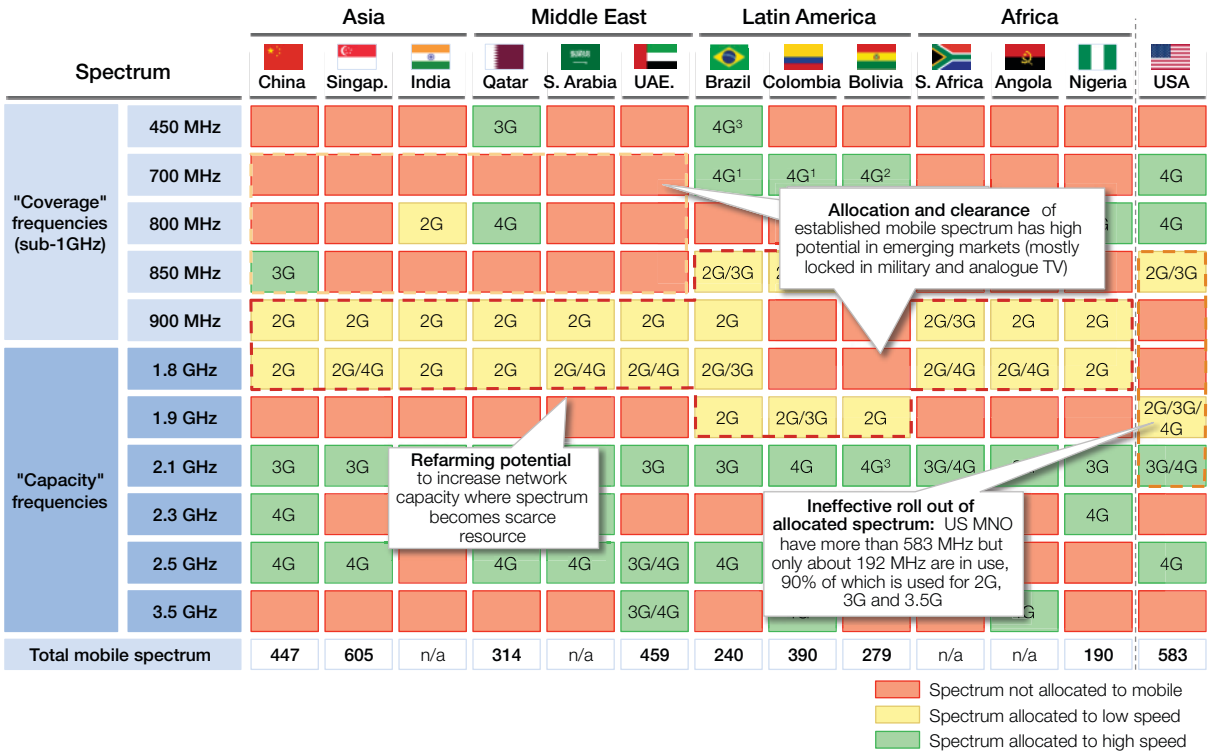
– *Few functioning secondary markets exist in countries other than the United States*. Operators thus may not be able to optimize their holdings through sales, acquisitions or trades with other spectrum holders. This limitation has very real costs in technology and complexity.

– *Too many technology licences are not technology neutral.* Licences often dictate that Second Generation (2G) must be deployed in a particular band, which prevents "refarming" these bands for more advanced and efficient 3G or LTE use. Lack of harmonization at the regional and international levels – meaning, for example, that different operators' 3G or 4G networks operate on different bands of spectrum in different countries or in different regions of the same country – leads to further inefficiency. Unnecessary complexity results from 4G networks that can potentially operate on more than 40 different spectrum bands around the world, which also means device manufacturers are unable to take advantage of economies of scale. They must manufacture region-specific devices and handset and network equipment that support multiple bands, for example. This increases prices and impedes far-reaching service.

– *Spectrum is released and allocated in a fragmented manner.* A comparison of Indonesia and India, both emerging markets, shows how low spectrum availability and high fragmentation can significantly slow mobile penetration (Figure 3). Too many players with low spectrum holdings can undermine operator profitability and the ability to roll out networks nationwide.

– *High auction prices, overbearing licence fees and restrictions, and uncertain terms create uncertainty and potential disincentives to invest.* When they do release new spectrum, too many governments regard it as an asset whose full value to the seller should be immediately realized. Because licence terms can be long, mobile operators are forced to bid or risk being shut out of the market. Empirical evidence shows that high auction prices can result in successful bidders lacking the resources to make the capital investments necessary to put their newly acquired purchases to use (Figure 4). As a result, many operators have yet to build out infrastructure for spectrum they have licensed, turning a scarce resource into a wasted one. In addition, licenses can be overly restrictive, and their terms with respect to duration and renewal are often not clearly spelled out.

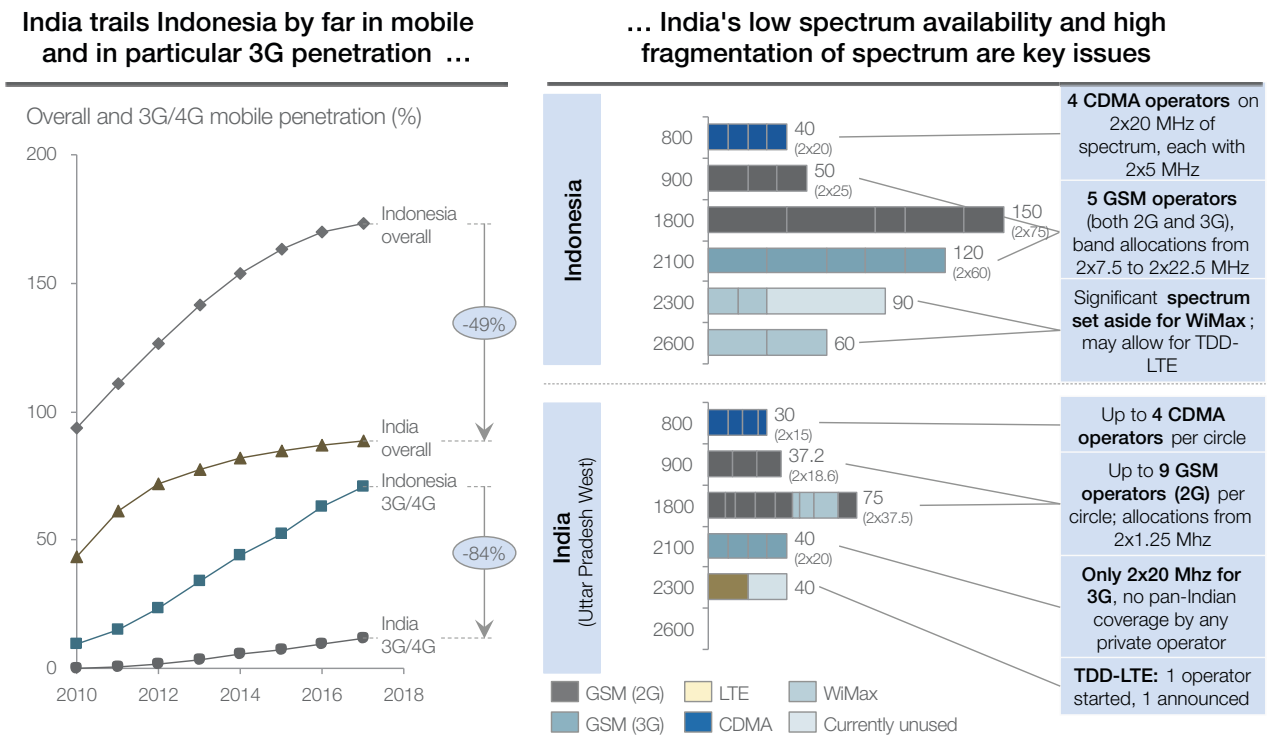
**Figure 2:** Current Spectrum Snapshot: Potential for Higher Allocation and Utilization across Countries




1. Announced to be auctioned. 2. Partial coverage only (i.e. large cities). 3. Allocated to mobile but not deployed.
Note: 2.6 GHz included in 2.5 GHz; 1.7 GHz included in 2.1 GHz; For some countries, total spectrum varies strongly by region or is n/a.
Source: GSM Arena; BCG analysis.

**Figure 3:** High Spectrum Fragmentation Limits Ability of Operators to Roll Out at Scale

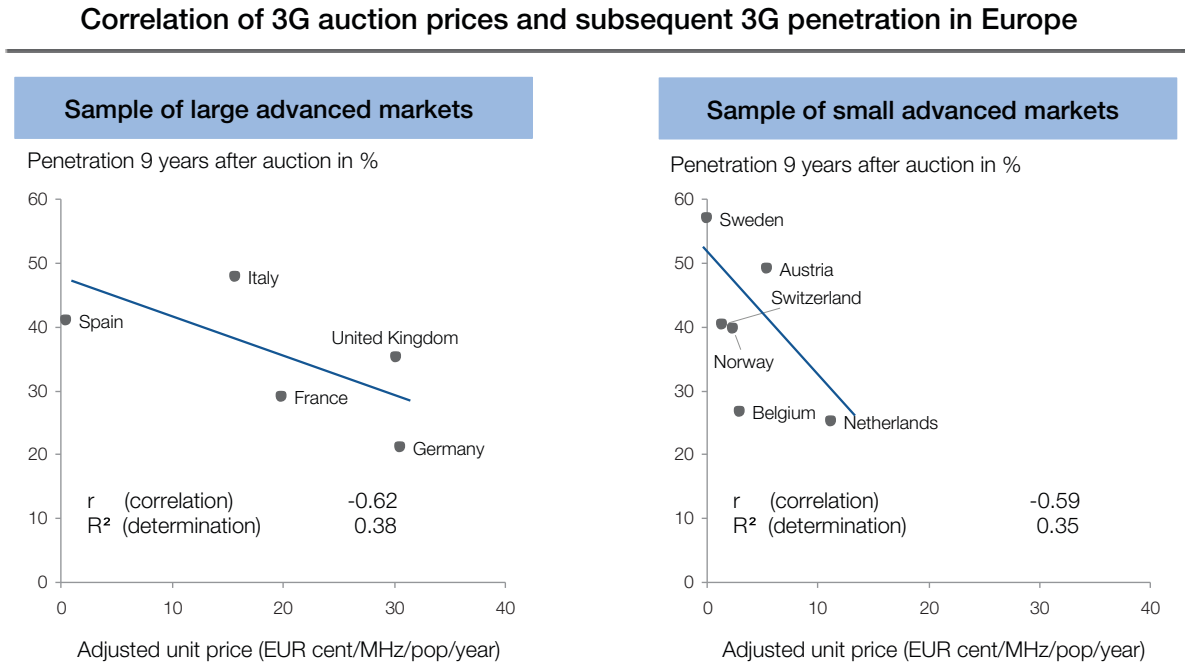
Fragmentation in terms of competition and spectrum lots




Note: TDD = Time Division Duplex.
Source: Ovum, EIU, Telecom Regulation Authority of India (TRAI), Indonesian Ministry of Communications and IT, press search, BCG analysis.

**Figure 4:** Empirical Indication that Higher Auction Prices Lead to Lower Penetration

Reserve prices preferably reflect market value and government's strategic vision




Note: TDD frequencies not included since little value for 3G.
Source: NRAs, Analysys Mason, 2012; BCG analysis.

The primary goal for policy-makers and regulators should be to maximize the use of spectrum, rather than its short-term value. Their countries will be the immediate beneficiaries. Research by BCG in 2012 showed that the socio-economic benefits of allocating the 700 MHz band to mobile services in the Asia-Pacific region could be worth almost $1 trillion in cumulative additional GDP between 2014 and 2020, as well as $215 billion in additional tax revenue and 2.7 million new jobs. On the other hand, a one-year delay in allocating the 700 MHz band could result in a loss of incremental GDP growth of $40 billion in the first year, and an indirect loss of $70 billion in the three subsequent years, as well as 200,000-500,000 fewer jobs created. The negative impact of a two-year delay would be even greater.[15]

In addition, the more harmonized the spectrum that mobile operators have available, the more economically viable the overall solution to furthering internet access will be. The more certainty that policy-makers and regulators can bring to the process of when and how spectrum will be released, the better that operators and equipment vendors can plan, which will have an added impact on cost-effectiveness. The need for revamping spectrum policy is urgent because of the long lead times involved in spectrum planning, allocation, mobile network design, financing and construction.

The goal of every country's spectrum policy should be the abundant supply and flexible use of this valuable resource. Emerging-market governments should consider undertaking the following actions:

– *Accelerate the fair, market-based allocation of mobile spectrum within their countries.* They should also ensure regional and cross-border band harmonization.

– *Optimize spectrum allocation policy for long-term value.* This may mean foregoing high near-term auction proceeds in favour of schemes that create revenues over time, based on the value generated by usage. Governments should avoid spectrum-band fragmentation among too many players and require licensees to commit up front to network roll-out schedules, future investments and rural coverage targets. Network roll-out schedules in particular could be enforced through "use it or lose it or share it" provisions for winning bidders in spectrum auctions, thereby preventing speculative investment in mobile spectrum licences. (A prerequisite for the effectiveness of such provisions, however, is a well-functioning secondary market for spectrum.) Governments should make coverage obligations band-neutral and award spectrum packages as opposed to single bands, which provides cost and network quality benefits for countries and limits risks in availability, capacity and coverage gaps for operators.

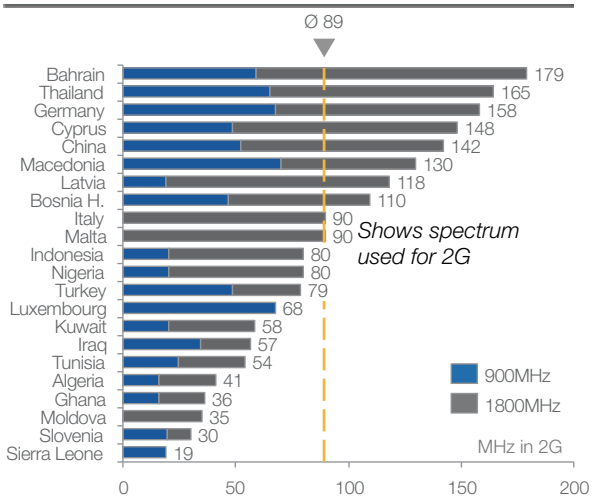
– *Facilitate refarming, along with providing clarity on licence renewal, and lift technology restrictions to help develop a transition plan for legacy services and devices.* Refarming bands that are now allocated exclusively to 2G, especially in the 900-MHz and 1800-MHz ranges, has huge potential for improving spectral efficiency in multiple markets, especially emerging ones, from China to Indonesia to Thailand to Turkey. Experience in developed markets such as Denmark, France and Sweden shows that the refarming process can take three to four years, and a clear roadmap is needed to guide all participants (Figure 5).

– *Encourage research, development and the potential deployment of innovative solutions for using spectrum efficiently.* This especially applies to geographically or economically challenging markets that existing business models cannot serve. For example, unused spectrum – on the basis of time, geography or both – could be shared through authorized shared access, licensed shared access or unlicensed use (also known as licence-exempt). Such approaches have helped to promote and support higher spectrum use in both developed and developing markets. Careful consideration should be taken not to disrupt existing licences on which business models have been built. Authorized shared access of licensed spectrum should be based on voluntary commercial contracts.

**Figure 5:** 2G Refarming Has High Potential to Unlock Valuable Spectrum

Clear roadmap and government policy support needed to make the transition

### 2G refarming has high potential especially in 900/1800 MHz band...

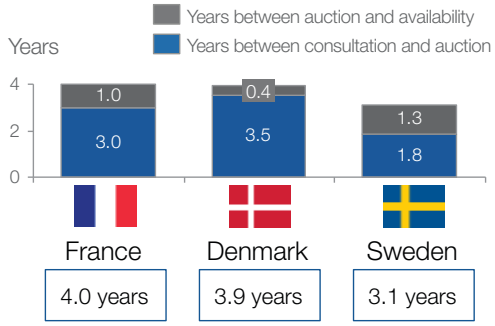



**Refarming increases spectral efficiency**

- Possible data transmission per MHz increases among generations (2G → 3G → 4G)
- Spectral efficiency for LTE can be 23x that of EDGE

### ...however, experience shows the need for a clear roadmap to enable transition

**1 3-4 years preparation for refarming**




**2 Need for clarity on licence renewal and removing technology obligations**

- Mobile network operators (MNOs) often forced to wait for licence end due to technology obligations

**3 Roadmap for transition of legacy devices**

- Policy roadmap to enable transition of 2G applications and devices

Note: Spectral efficiency measure for LTE carrier >10 MHz. SE data represents DL cell SE bps/Hz under normal conditions. EDGE = Enhanced Data rates for GSM Evolution.
Source: BCG Analysis, GSMA, Huawei.

# Expanding Connectivity: Defining the Challenge

In the context of network infrastructure, the terms "rural," "developing" or "emerging" are very broad. They encompass markets and geographies with quite different population densities, economies and technology needs. Each country, and each region within a country, faces its own challenges, and each demands customized solutions, business models and degrees of government involvement. Connecting hard-to-reach homes in some areas can be profitable or at least break-even, based on existing technologies and market structures. Other areas will need help from stakeholders such as non-governmental organizations (NGOs) and private companies, as well as the ability to develop innovative solutions to challenges falling outside the normal laws of supply and demand (Figure 6).

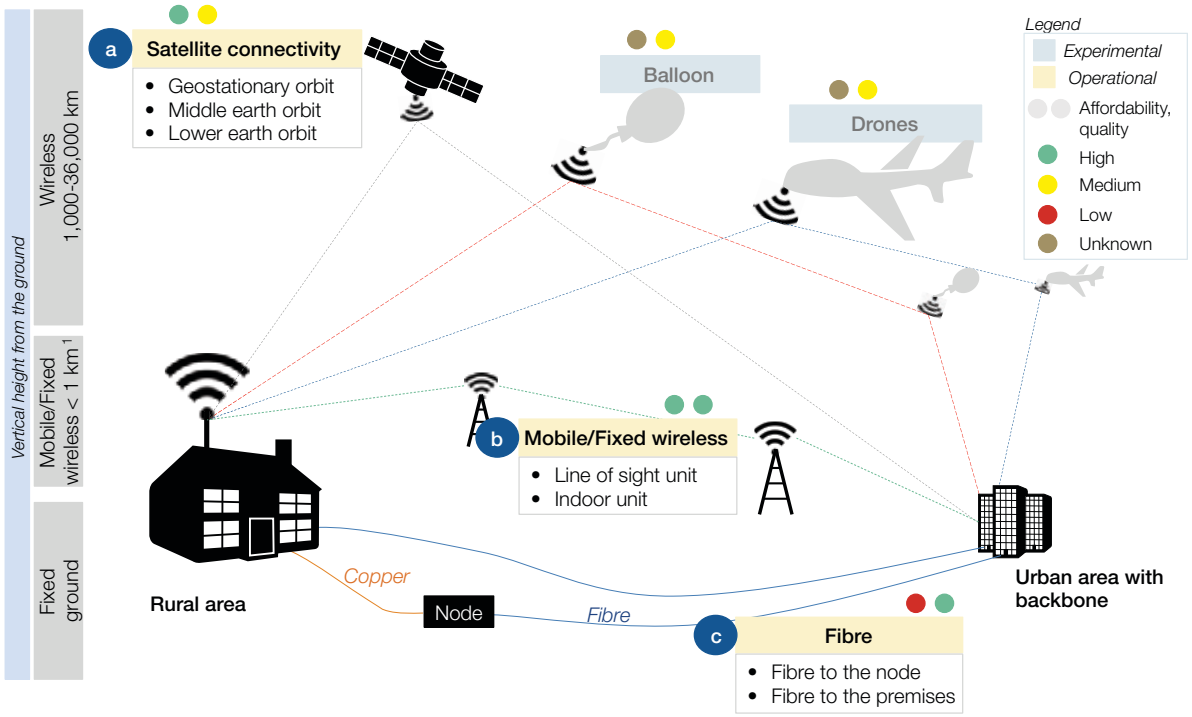
Only some of the various factors that determine connectivity's economics are related to technology. Population density, topography and distance from fibre connection points are all huge contributors to cost and revenue calculations. The often-used urban-rural distinction is a crude basis for comparison. Guatemala, China, the Czech Republic and Indonesia, for example, all have similar population densities (125-145 people per square kilometre), but their economics of internet infrastructure differ enormously, owing to size, geography, topography, distances from the nearest fibre connection points, and consumer purchasing power, among other factors. Within many larger countries, conditions vary widely. Consider the distinctions between the Amazon River basin and the Brazilian highlands, the topographical diversity of an archipelago such as Indonesia, or the proximity to undersea fibre-optic cables for people living on the coast of Kenya or Nigeria, compared with those in villages 200-300 kilometres inland.

Both capital and operating costs fall along a continuum rather than on either side of an urban-rural divide. Still, an analysis of a typical rural region compared with an urban counterpart (with data taken from Brazil) illustrates the degree of the challenge. While multiple network operators can be profitable in an urban environment thanks to density, relatively high internet penetration and attractive ARPUs, the cost of building and operating the rural network, even on a single-operator basis, are generally too high for the operator to make money. The problem worsens in a two-network scenario, although network sharing can reduce the gap by almost 50% (Figure 7).

Countries need to make choices and trade-offs. While providing everyone with high-speed, high-capacity broadband connectivity everywhere is an admirable goal, the more pressing need is to provide basic access to more people in emerging markets, with plenty of room for progress. Research by Ericsson and others has shown that gaining access to low broadband speeds has a positive impact on household incomes – for the so-called BIC countries (Brazil, India and China), on the order of 0.5 megabits per second (Mbps), and up to 4 Mbps for a similar impact for nations of the Organisation for Economic Co-operation and Development (OECD). The

economic benefit in the BIC countries increases as speeds rise to 4 Mbps, but after that, the incremental impact on household income, at least for now, is minimal. (The comparable levelling of benefits in OECD nations comes after 8 Mbps is reached.)[16] However, markets evolve, and some companies are experimenting with new, more data-intensive services and offerings that could change these dynamics.

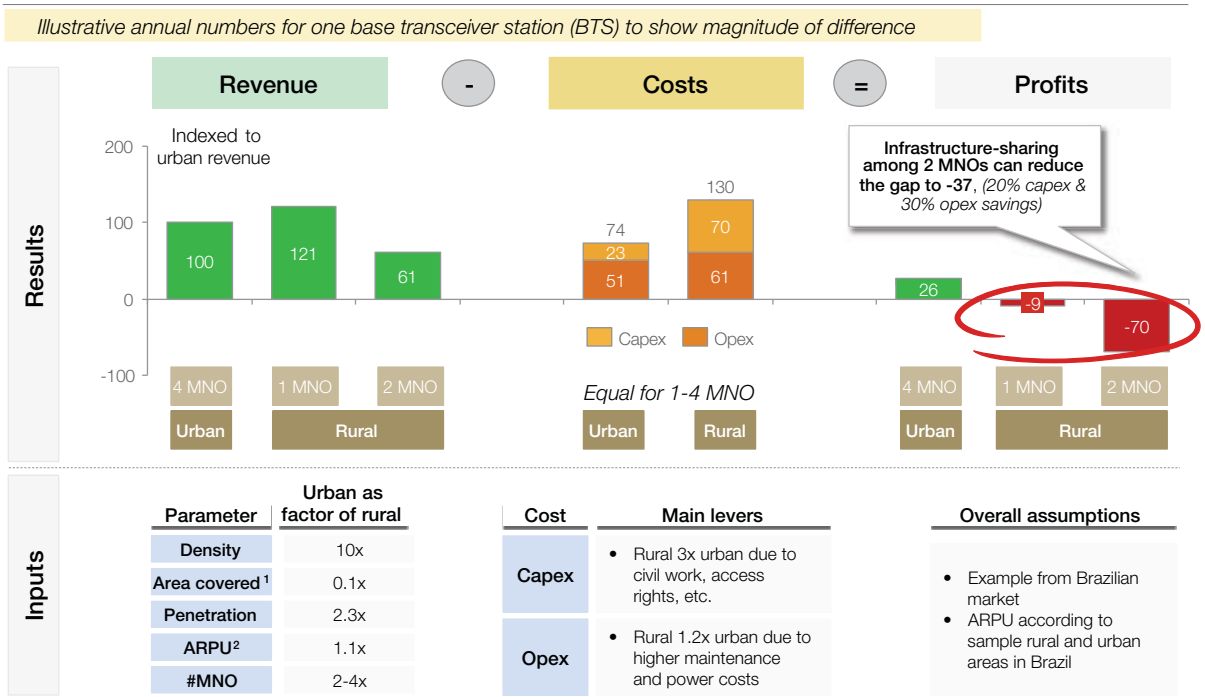
**Figure 6:** Choosing the Right Technology: Critical from a Cost, Service-Quality and Risk Perspective




Note: Affordability represents cost to consumer for different technologies. Variations within each technology are not captured on this chart. 1. Represents the typical installation height.
Source: BCG Analysis, Filiago, Google, Facebook.

**Figure 7:** Current Economics to Build Rural Connectivity Often Unattractive for MNOs

Illustrative economics using data from Brazil




1. ZTE study for BTS area coverage in rural and urban areas. 2. BCG analysis based on ARPU in Brazilian market. 3. GSMA intelligence for developing markets.
Note: Capex = Capital expenditures; Opex = Operating expenditures.
Source: BCG Analysis.

In the process, governments need to undertake two steps:

1. *Define their broadband-access aspirations:* These include how people will go online (fixed, mobile, or nomadic access); the target speed and capacity of the network in each region of the country; and the costs involved with various technologies, especially in economically challenged regions.

2. *Determine a country-specific approach – one that is both technology agnostic and allows for experimentation:* The optimal technology depends on local conditions, with a combination of mobile and fixed wireless generally the most cost-effective approach for rural areas, and satellite typically the best bet for truly remote areas. Experiments by various companies involving balloons, drones and other approaches are in their early days, and some have big goals and deep resources behind them. Other innovations will be developed. Governments should allow for new approaches with flexible spectrum policies and avoid locking themselves into a technology-specific model that could be overpriced and outdated in a few years' time.

## Multiple Models at Work

A number of emerging markets are experimenting with several funding and operating models. The right choice for each country depends on multiple factors, which are covered at the end of this chapter.

**Infrastructure sharing:** As already noted, sharing network infrastructure can reduce the profitability gap in economically unviable regions by as much as 50%. The GSMA has recommended network sharing to reduce the cost of rolling out infrastructure, and that regulating authorities should take a positive stance on network sharing arrangements, encouraging operators to engage in such agreements.[17]

Various approaches and levels of sharing are at work, and each has its own potential for cost saving. From the least to the most involved, these approaches include site sharing, mast and backhaul sharing, rural area network sharing (operators share their entire infrastructure up to the point where it connects to the core network) and core network sharing. In some instances, two or more operators pool assets and create a joint venture that handles the infrastructure and equipment, and leases their use to the venture partners.

Examples of network sharing can be found in multiple countries. Tower sharing is common in India, for instance, where operator-owned companies – including Indus Towers, which itself is a joint venture between Bharti, Vodafone and Aditya Birla Telecom – own and manage more than 80% of mobile towers. In some countries such as Bangladesh, which has a number of passive network sharing agreements, network sharing has been mandated. In others, it is encouraged by government authorities who include infrastructure sharing as one of the evaluation criteria in public auctions. These nations also offer legal incentives and simplified civil work procedures for sharing arrangements.[18]

**Government subsidies for rural roll-outs:** Under this model, governments provide subsidies to private companies to encourage building out infrastructure in hard-to-reach areas. Subsidies are often used to provide backhaul connectivity in remote regions while operators compete on the "last mile" – the connection to consumers' homes and to places of business (The funding for this kind of initiative still often comes from network operators through taxes, high auction prices or other means.) Governments can also provide indirect fiscal benefits, such as tax incentives in connection with tower sites, income generated in remote regions and reduced import tariffs on network equipment.

The history to date is mixed. The GSMA has estimated that more than one-third of 64 national funds established to provide universal service had yet to spend any of their contributions, and very few of the funds appeared to disburse all the monies collected. At the time, more than $11 billion remained undisbursed. The UK government provided funds to private entities to cover black spots (areas with no coverage), including £150 million in public funds to install infrastructure for 60,000 premises, although the roll-out has been slower than expected. India charges operators a levy of 5% on revenue to fund infrastructure buildout, among other purposes, with the plan that the government provides the basic infrastructure, such as towers and electricity, and mobile network operators (MNOs) operate their equipment on top. However, since the country's Universal Service Obligation Fund is not

committed upfront to specific projects, and projects are often blocked for other reasons, the programme has been limited in its effectiveness, with about 60% of the monies not utilized.[19]

**Rural wholesale network:** Under this approach, the government funds, either partially or fully, a single wholesale network for uneconomic hard-to-reach areas. The network is then provided without any discrimination to mobile operators, allowing for competition at the retail level. The history of nationwide single wholesale networks (SWN), however, has not been positive. In general, governments have repeatedly demonstrated that they are not good network operators, and SWN models have significant potential to hamper innovation if not actual coverage. In a recent report, the GSMA discusses in detail how geographically restricted wholesale networks for underserved areas could work with the right regulations that prevent distortive competitive effects (e.g. network quality and upgrade targets, wholesale access pricing).

**Private investment:** Some countries have had success allowing private companies to take the lead with the necessary investments, while finding a way to make the economics work. China Mobile has made capital expenditures of $12 billion to construct 500,000 new mobile base transceiver stations to expand 4G coverage. These provide free mobile broadband in rural areas in the short term to drive longer-term customer growth and stimulate data demand. They have resulted in 7 million new 3G users and 2 million new 4G users in a month.[20] Malaysia has pursued a public-private partnership for rural connectivity and awareness, in which Telecom Malaysia (TM) funds about 80% of the costs and the government covers the rest and the government covers the rest, partly through Universal Service Provision. TM is charged with building high-speed broadband connectivity to government offices and universities, and with promoting the initiative to drive awareness and adoption. The programme tripled broadband penetration in three years to 67%, and Malaysia can claim one of the world's fastest and lowest-cost high-speed broadband deployment programmes.[21]

**Other innovative approaches:** These include rural coverage obligations, "dig once" policies that share the cost for backhaul infrastructure with civil projects such as road or power-line construction, microwave-based backhaul in regions where fibre deployment is too expensive, and commitment of government demand across departments to a single rural operator to improve economics.

## Choosing the Right Model

Governments need to assess the different rural buildout models and make choices based on their country's situation (or situations). The right solutions will likely vary depending on population geography, population density and the current state of social and economic development. Countries with large rural areas, low population densities and low GDPs will probably need to consider publicly funded basic infrastructure programmes. Those with more urban centres may be able to spring ahead technologically, going straight to more advanced infrastructure, such as 4G connectivity. Countries further up the economic-development curve may be in a position to encourage private infrastructure investment and design programmes to demonstrate the internet's value and thereby encourage adoption (Figure 8).

In the areas hardest to reach, government involvement may well be necessary because private players need encouragement to address these regions, owing to their unfavourable economics. While government intervention can change this dynamic, the goal should always be intervention at the level causing the least market distortion and underpinning the greatest possibility of coverage and innovation.

**01:** Paul E. Jacobs, Executive Chairman, Qualcomm, USA
**02:** Jeroen Tas, Chief Executive Officer, Healthcare Informatics, Solutions and Services, Royal Philips, Netherlands; Carlos López Blanco, Global Head, Public and Regulatory Affairs, Telefonica, Spain; Serpil Timuray, Regional Chief Executive Officer, Africa, Middle East and Asia-Pacific and Member of the Executive Committee, Vodafone Group, United Kingdom; Ulf Ewaldsson, Senior Vice-President and Chief Technology Officer, Ericsson, Sweden; Diego Molano Vega, Minister of Information Technologies and Communications of Colombia

**Figure 8:** Approach to Building Rural Infrastructure Differs Based on the Country's Degree of Urbanization and Wealth

| Wealth \ Environment | Rural | Urban |
|---|---|---|
| Moderate GDP per capita ($5,000-15,000) | **Potential priorities**<br>— Encourage private infrastructure investment<br>— Prove value of internet to encourage adoption<br><br>**Example case studies**<br>— Malaysia | **Potential priorities**<br>— Invest in enabling infrastructure (internet exchange points, fibre-optics)<br>— Engage SMEs in digital economy<br>— Expand digital employment<br><br>**Example case studies**<br>— China: Balance of mobile/fixed infrastructure investment |
| Low GDP per capita (<$5,000) | **Potential priorities**<br>— Publicly fund basic infrastructure access<br>— Reduce connectivity costs<br>— Provide remote e-government, e-health and e-education services<br><br>**Example case studies**<br>— Oman | **Potential priorities**<br>— Leapfrog infrastructure (4G)<br>— Spur local app ecosystems to drive demand<br>— Encourage enabling applications like identity, payments<br><br>**Example case studies**<br>— Philippines |

Source: BCG Analysis

# 3. Stimulating Consumer Demand

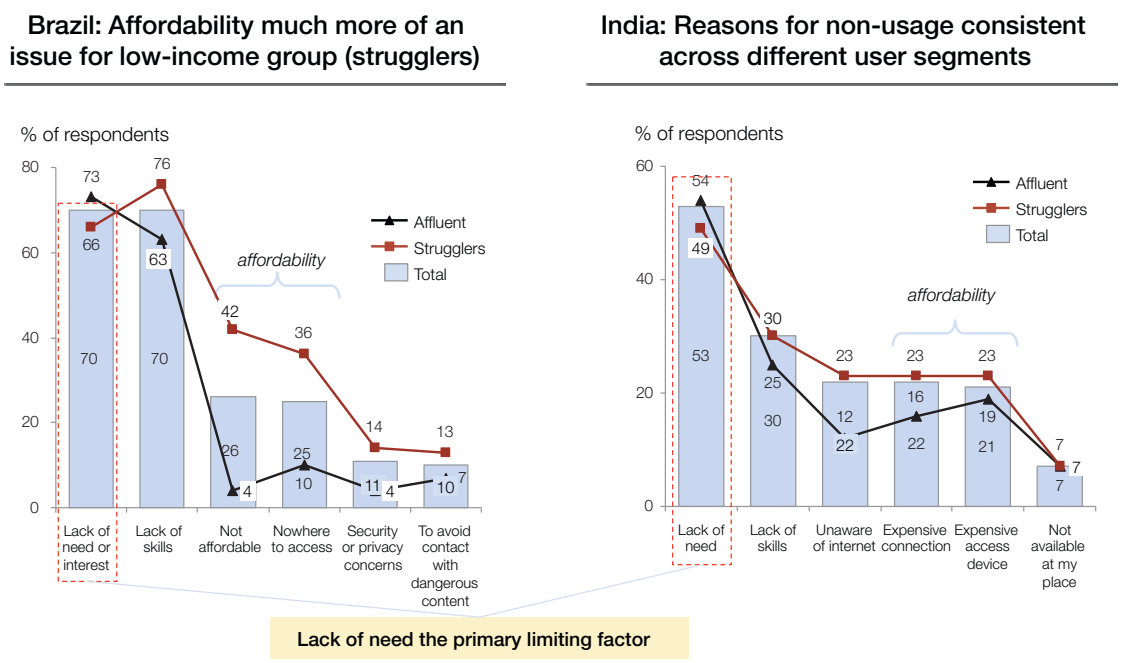
”You can lead a horse to water, but you can’t make it drink.” This old saying holds true as well for digital infrastructure: the internet can be delivered to the consumer’s front door or fingertips, but that doesn’t mean it will be used. The gap between coverage and penetration is 30-50% in many developed countries, and this difference jumps to 55-75% in emerging markets. The gap is 63% in Brazil and 73% in Argentina. Adoption lags especially among women and certain disadvantaged groups, such as people in remote areas or those lacking basic skills.[22]

BCG research shows three main reasons for not adopting the internet: a perceived lack of need resulting largely from lack of local-language content, followed by a lack of skills in certain markets and the question of affordability (the last, perhaps surprisingly, a distant third). Constraints are present at many levels – the lack of locally produced content is a widespread problem, and low literacy rates (own-language, English and digital) are a major hurdle. More than a billion people in developing countries cannot read or write. BCG research has shown that in Brazil and India, the perceived lack of need to use the web and lack of skills are equally big impediments for both affluent and poorer consumers in using the internet, and that both of these reasons far outrank cost (Figure 9). Another factor is simple unawareness: many people consider their phones as just phones – for making calls and, in some places, for SMS-based services. They do not realize that an interesting, useful and potentially valuable world of data is waiting to be explored. In addition, the cost of devices and access of course remains high in many markets (Figure 10).

Billions of consumers have discovered the internet on their own; however, many in emerging markets need help. Government and private companies alike will reap big benefits from efforts that bring more people online. Good models to follow exist in four key areas: furthering local content development, building digital literacy, simplifying access and use, and reducing the cost of devices and access.

**Figure 9:** Lack of Need: The Primary Limiting Factor for Not Using the Internet

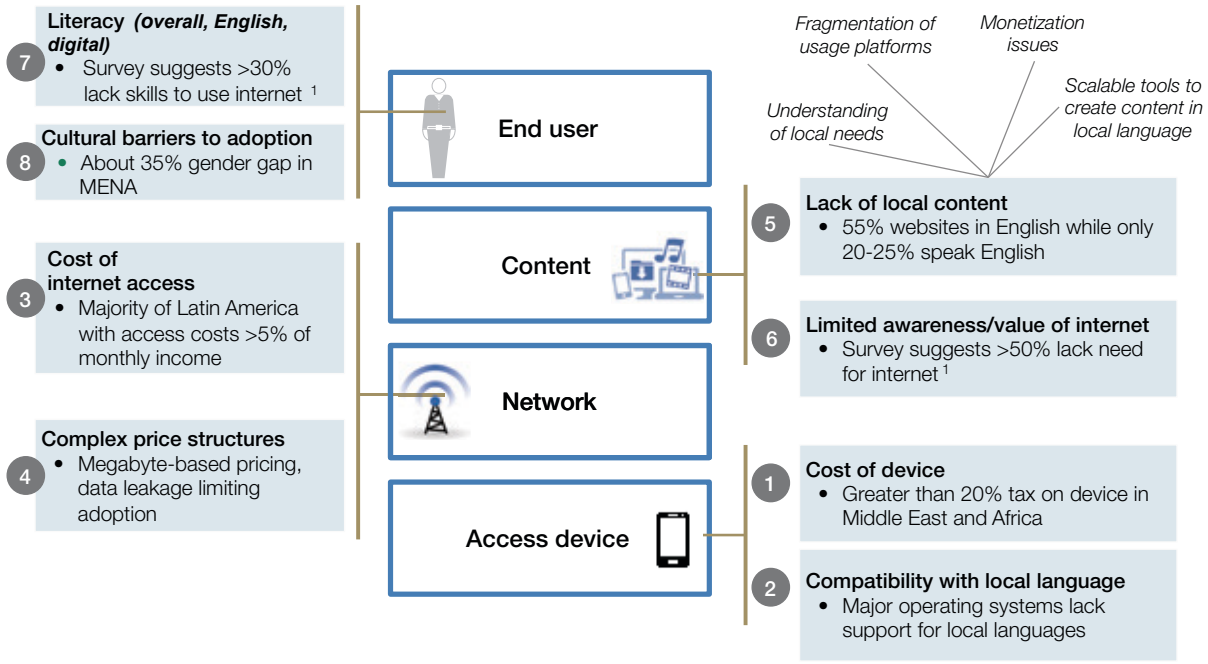
Skills and affordability are other big drivers, varying by income and education level




Source: BCG CCI India and Brazil studies 2014, BCG analysis


**01:** Anne Bouverot, Director-General and Member of the Board, GSMA, United Kingdom

**Figure 10:** Multiple Challenges Limit Consumer Adoption of the Internet




1. Based on BCG CCI Study for India 2014
Note: Gender gap is defined as difference in percentage of men and women with online access (weighted by their numbers).
MENA = Middle East and North Africa.

## Developing Local Content

Local digital systems are vital for building digital literacy, attracting local users and serving local needs. Digital services can be a big step towards addressing local problems and boosting competition in an increasingly international and worldwide digital services market. Today, for example, 55% of all websites use English, while the percentage of English speakers globally is estimated at 20-25%, and for most of these people English is a second or third language.[23] Local content providers face many hurdles, including lack of scalable tools to create content in local languages; fragmentation of usage platforms (multiple operating systems, devices and network speeds, for example); difficulty in monetizing content for providers and network operators; and lack of sufficient understanding among service providers of local needs.

One of the oldest and best examples of content stimulating use is the M-Pesa system in Kenya, where two-thirds of Kenyans use mobile-money technology.[24] Innovative applications such as Eko and Bandhan are bringing financial services to the unbanked in India. Among many other examples is Mxit, a South Africa-based mobile-messaging platform, which claims to be Africa's biggest social network, with 7 million monthly active users and over 65 million registered users.[25] The Chinese market has its own unique dynamics, but 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.

SingTel, a private Singaporean company, has a multifaceted and sophisticated programme to develop a local-content system. The company supports local content and app development, and funds digital initiatives with venture capital across Asia. SingTel offers its own content to users including HungryGoWhere, a successful restaurant review portal, and the fashion portal Clozette. The company's Accelerator Challenge gives developers application programme interface (API) access to "anonymized" SingTel data, and handles such administrative functions as in-app payment. SingTel also makes venture-capital investments, funding 16 companies in Asia to date through its Innov8 initiative. In addition, it offers cloud-based services, such as software and a platform in partnership with other companies.

Governments can help drive digital engagement with their own online services. BCG research in 12 countries in 2014 found that 94% of internet users have accessed at least one government service in the last two years, and an average of 32% use online government services more than once a week. Users in developing countries access more services online, access them more frequently and place greater importance on online service delivery. BCG found that people in developing countries are heavy users of services that have a significant impact on life and livelihood, such as those related to healthcare and education.[26]

Governments in many developing countries have done a more complete job of bringing full-service capabilities online than their developed-country counterparts. Most can go even further to help make the internet part of everyday life by moving more critical services online and providing full transactional capability. Some countries are moving aggressively in this direction, but in many nations full digital interaction has yet to be developed. The Government of Botswana, for example, has launched a National Broadband Plan with the aim that all appropriate government information and over 300 services will be available through a single government portal by 2016.[27]

## Building Digital Literacy

Three layers of literacy affect people's ability to become active online. First, basic literacy is essential. English language literacy, as the second layer, is important because of the amount of online content in English. And third, digital literacy involves both being able to use mobile devices and developing the awareness of the internet's value for people's daily lives.

While bringing government services online helps build digital literacy, governments can take other steps. Developing countries such as Thailand, Chile and Peru have established programmes to connect schools and build digital literacy. The Government of Colombia has educated 19,000 public officials and contractors in digital services and provided 82,000 computers for children at educational sites. Digital citizenship is growing fast, with some 300,000 participants in 2013 and 700,000 expected by the end of 2014.[28]

The private sector also plays a role in helping to overcome the literacy challenge. Current experiments include KrishiPustak, a social networking system for low-literate farmers, and CGNet Swara, a voice-based news and information portal serving a rural region of India and accessible for free via mobile phone.[29]

## Simplifying Access and Use

While the internet is getting smarter, many unconnected consumers remain largely unaware of its myriad benefits. In addition to making content more relevant, simplifying pricing and better demonstrating how the internet can improve everyday life are also needed.

Network operators, content providers and others can do a lot to further internet usage, especially of the mobile internet in emerging markets, with better, locally based marketing. Mobile marketing campaigns that attempt to move users from voice to voice-and-data plans often stumble over consumers' lack of knowledge of what they can do with the megabytes they are encouraged to buy.

One mobile operator in India has bridged the knowledge gap and shown substantial success building mobile data usage, increasing the operator's revenues at twice the market's rate. The company had invested heavily in 3G spectrum, but consumer uptake was low. The operator revolutionized pricing by offering 3G "data packs" that starkly contrasted their price/value benefits with those of traditional "pay as you go" 2G plans. At the same time, it changed its marketing from emphasizing Mbps to focusing on uses. The data packs were organized around access to information on popular pastimes such as sports and movies, as well as social networking and video apps including Facebook and YouTube.


**01:** Bradford L. Smith, Executive Vice-President and General Counsel, Microsoft Corporation, USA

Network operators and content providers can also help address barriers to adoption by reaching out in their marketing and other efforts directly to women and other underserved groups. In many countries, women have less access to technology than men. For example, only about 9% of women in Sub-Saharan Africa have access to the internet, according to a study by Dalberg, a strategic advisory firm, and women's access to the internet trails that of men by 40%.[30] At the same time, BCG research has shown that when women do get opportunities, they make the most of them: small businesses founded by women are among the most technically advanced, innovative and successful.[31]

## Reducing the Cost of Devices and Access

The two main contributors to cost are devices and access. Smartphone shipments are expected to grow from 1 billion in 2014 to 1.6 billion in 2017, of which 780 million will be in emerging markets. As a result, the average penetration rate in developing countries will double to 46%. Still, device cost is a big issue for billions of consumers.

**Cost of devices:** Device manufacturers and operating system companies, including some new players such as Xiaomi and Mozilla, are making progress. While phones priced below $100 made up only about 20% of smartphone shipments in 2013, today a large and growing range of companies are making affordable phones, including global manufacturers (Samsung, HTC), local players (Xiaomi, Micromax) and new entrants (Mozilla/Intex). Smartphones are priced at $55-60 in Indonesia and around $40 in Myanmar. In India, a potentially massive market, Intex Technologies has launched a $33 Firefox smartphone (the same price as a feature phone), and Google has introduced Android One, a set of high-quality, affordable phones from different manufacturers, all priced around $100. Both companies plan to roll out these low-priced new phones across Asia shortly.

Nevertheless, above-average mobile-sector taxes (on both services and handsets) in many emerging countries remain a barrier to adoption. In more than 35 emerging economies in Eastern Europe, Asia-Pacific, Latin America, the Middle East and Africa, taxes as a proportion of the total cost of mobile ownership (TCMO) are higher than the 18% global average. In Turkey, they are almost 50%, and close to 40% in Gabon, among numerous other examples. Governments may argue that they need the revenue, but they are making the situation worse for themselves, their economies and their consumers. GSMA estimates that each percentage-point reduction in mobile sector taxes could increase mobile device penetration by about 0.6 percentage points.[32]

As demonstrated by Kenya, lowering or eliminating taxes can stimulate a market. Prior to 2009, the government charged value added tax (VAT) and other levies on mobile phones that aggregated 21% of TCMO, which was several percentage points higher than the global average. The government exempted mobile phones from VAT for two years beginning in June 2009 with the expectation that lower handset costs would lead to increased mobile penetration, thereby stimulating the mobile market with more subscribers and more revenues for MNOs. It expected to make up lost VAT revenue with 33% more taxes and fees from MNOs doing more business. Indeed, handset sales doubled in the next two years and penetration jumped by 20 percentage points to 70%.[33]

**Cost of access:** The cost of fixed-line access in some emerging markets can be high relative to inhabitants' low incomes, and well above the affordability threshold set by the United Nations of 5% of per capita GDP. A report by the ITU and the United Nations Educational, Scientific and Cultural Organization found that while the number of developing countries with broadband costs at less than 5% of average income increased from 48 in 2012 to 56 in 2013, fixed broadband services remained

expensive for many, accounting for 32% of average monthly incomes in developing countries (compared with just 1.5% in developed nations). The cost of mobile access is considerably lower, and often below the UN threshold, but it is still an impediment for many consumers.[34]

Multiple private-sector organizations, including companies and not-for-profit NGOs, are experimenting with ways to bring access costs down. In Koforidua, Ghana, Spectra Wireless recently launched djungleEd, a low-cost internet access service accessible from any Wi-Fi-enabled device, with data packages priced as low as GHS 2 (Ghana cedi) per day, or about $0.60, for 24 hours of access. Targeted to university students, djungle combines Wi-Fi with longer-range communications over unused television frequencies ("TV white space"), increasing spectrum efficiency and lowering costs. Governments should support such innovations through a light-touch regulatory approach and flexible spectrum policy.

In addition, governments and private companies can work together to further internet access and use. In 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 all of the country's 18 provinces. Similarly, Pan-African operator Airtel recently partnered with Wikimedia to provide its subscribers with free access to Wikipedia. By delivering this sort of on-ramp to the internet, companies can help new users understand the web's relevance to improving their lives.

Various industry bodies are also working to make access more affordable. These include internet.org, a global partnership dedicated to making affordable internet access available, and the Alliance for an Affordable Internet, which brings together organizations, private companies and government bodies to create policy and regulatory solutions that drive down costs. Both the private and public sectors should actively engage in and support such initiatives.

Figure 11 shows the various ways that different emerging markets are addressing the consumer demand issue.

**Figure 11:** Case Studies and Best Practices at Play to Address Impediments to Access and Usage

| | Dimension | Country | Best practices |
|---|---|---|---|
| 1 | Cost of device | Kenya | • Taxes accounted for 25% of TCMO [1] in 2006 – reduced to 21% by 2011<br>• Mobile handset sales increased 4x from 2009 to 2011 – penetration from 50-70% |
| 2 | Device compatibility with local language | India | • Handset initiatives that support multiple local languages (e.g., Android One launched in India) |
| 3 | Cost of internet access | Brazil | • MNO collaboration on network infrastructure-sharing to lower costs (2013) |
| 4 | Complexity of pricing | India | • Transitioned from megabyte-based pricing to value-based pricing (e.g. video for a nominal cost) |
| 5 | Lack of local content | Saudi Arabia | • Robust set of e-government services related to health, education, taxation, etc., to drive digital engagement |
| 6 | Limited awareness/value of internet | India | • Targeted marketing approach adopted by MNO based on segmentation and interest tagging for each segment |
| 7 | Literacy | Colombia | • Full-blown ICT initiative along the dimensions of user engagement, fibre infrastructure, app ecosystem and access to service to build know-how |
| 8 | Cultural barriers to adoption | Iraq | • 70% fewer women internet users compared to men [2]<br>• 2x increase in women customer base for Asiacell by solving barriers to adoption (e.g. reluctance to visit/call male only shops or customer centres) |

1. TCMO: Total Cost of Mobile Ownership. 2. Based on survey by Ooredoo.

# 4. Rethinking Network Infrastructure in the Face of Evolving Needs

The fast-rising volume of mobile traffic is creating infrastructure challenges in both developed and developing markets. The 2014 report examined near-term challenges of the former, including the need for more spectrum, modernized policy and regulation, and an effective means of resolving IP interconnection disputes. It also discussed the spectrum implications of rapid mobile growth in emerging markets. And, separate World Economic Forum initiatives are addressing critical issues such as internet governance, cybersecurity and privacy that are central to the network of the future in both developing and developed markets.

Two longer-term trends that will impose their own rapidly evolving demands on existing infrastructure are the shifting usage patterns of consumers and businesses, and the rise of the IoT. By 2018, almost three-quarters of all internet traffic is expected to consist of bandwidth-hungry video. Peer-to-peer traffic, or data that is transferred between or among users without using an intermediate server, will make up 6% of all internet traffic. A billion new users and faster network speeds will increase volume on the internet's backbone.[35] The addition of 30-50 billion connected devices (depending on the estimate used), many of which have very different purposes and constraints than PCs, smartphones and tablets, will add volume and complexity, and lead to a growing need for security and reliability. In many markets, these revolutionary shifts are likely to place their own strains on infrastructure's ability to handle the growth (Figure 12).

## Shifting Consumer and Business Traffic Patterns

By 2018, traffic volume is expected to rise 2.6 times on fixed networks, 11 times on mobile networks and up to 1,000 times in densely populated areas.[36] These growth levels create stress on both the internet's backbone and in the last mile. Industry experts generally agree that the backbone will be able to handle the increasing demand in developed markets but, as already seen, this is not the case in emerging countries, where the lack of long-haul fibre networks is a serious constraint and where new investments are needed. As mobile traffic grows quickly, the capacity of last-mile wireless infrastructure is a concern in all markets. Meanwhile, projections show capital expenditures by network operators flattening as traffic volumes grow, raising questions about whether investments are keeping up with demand (Figure 13).

Needs are evolving as well. High volumes of video traffic strain bandwidth, but this is only one measure of network performance. For many important future applications, such as high-speed securities trading, Voice over Internet Protocol phone service and the security of connected homes, network latency could be a future constraint. Latency – the amount of time it takes data to travel between its source and destination, measured in milliseconds (ms) – is a bigger potential issue for wireless connections than the fixed-line internet. To date, latency of 40-100 ms has been considered adequate for most users, but many future applications require latency of less than 40 ms. Wireless networks in the United States, for example, tend to have latency rates higher than 100 ms, except for LTE networks, but even LTE rates are generally higher than 50 ms.[37] It is claimed that future 5G connections will aim for latency of less than 10 ms, but it is unclear when, and in what form, 5G will become a market reality.[38]

Upload speeds are another emerging factor. The internet's short history has been mainly about consumers and businesses downloading content from servers maintained by content providers

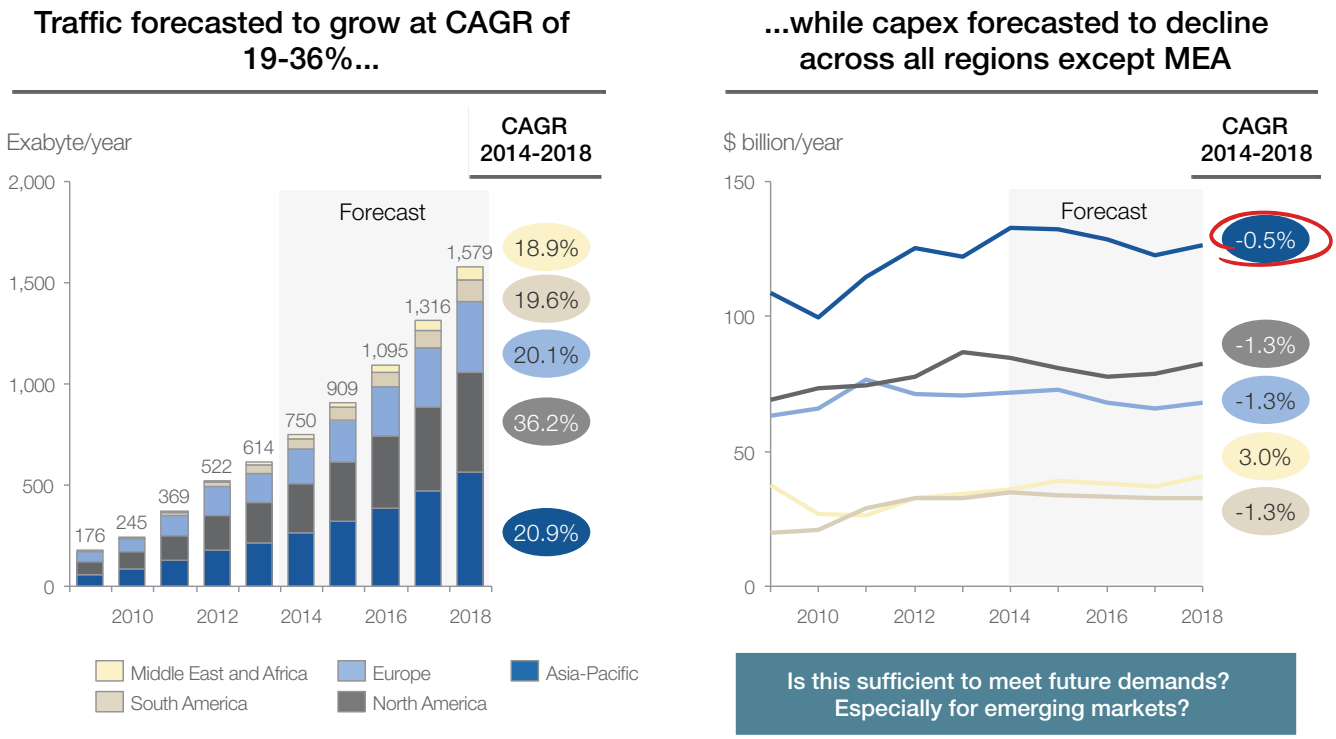
**Figure 12:** Solutions to Increased Consumer and Business Traffic Needs

| | Solution | Description | Demand addressed | Regulatory/Industry support needed |
|---|---|---|---|---|
| Spectrum | **Spectrum allocation** | More spectrum needed to increase capacity | ■ ■ | • *Governments should release more (un)licensed spectrum, revise allocation (secondary markets), allow refarming, spectrum sharing* |
| | **Small cells** *(low-cost technology)* | Roll-out of small cells to address coverage and capacity needs | ■ ■ ■ | • Facilitate rent and backhaul cost reduction<br>• Simplify indoor small cell installation regulation<br>- Closer to Wi-Fi than BTS |
| New business models | **Innovative consumer pricing** | New consumer pricing approaches to improve ARPU, i.e. pricing uploads, speed/bandwidth, latency, etc. | ■ | • Allow alternative value based consumer pricing models that help reduce the investment gap |
| | **IP interconnection agreements** | Market-driven, transparent IP traffic agreements to avoid congestion of the network | ■ ■ | • *Allow experimentation with new IP pricing models. All parties should commit to avoiding anticompetitive actions and unreasonable discrimination against different kinds of traffic* |
| Technology solutions | **Traffic compression** | Compression by default can reduce traffic up to 10x among nodes | ■ | • Stakeholders should apply compression by default and design protocols accordingly |
| | **Network optimization** | Adoption of SDN/NFV, etc., can increase network functionality and lead to capex/opex benefits for operators | ■ ■ ■ | • *Reassess legacy regulatory requirements like PSTN investments in light of modern technologies and market structures – modernization of policies and regulations to encourage investment and innovation* |

■ Capacity ■ Latency ■ Inc. in upload *Italicized information – addressed last year*

Note: SDN/NFV = software designed networks/network function virtualization; PSTN = public switched telephone network.

**Figure 13:** Capex Projected to Remain Stable with Traffic Growing at over 20% CAGR across Regions




Note: Capex projections include both fixed and mobile. CAGR = Compound annual growth rate.
Source: Ovum Service Provider Revenue and Capex Forecast, 2014; BCG analysis

and their content delivery networks (CDNs). Network operators have configured their networks to reflect this reality. Changes are occurring quickly, however, as consumers and businesses take advantage of a growing number of cloud-based services that offer video sharing, real-time video monitoring, data storage, data processing, software and other services. While upload-download ratios have yet to be affected (owing primarily to the growing volume of data-intensive video downloads), the shift towards uploading greater volumes of data can create strains.

Reconfiguring a network to support more uploads is easier for fixed-line than for mobile operators, although it comes with a cost: the finite capacity of the "pipe" means that download speeds could suffer as upload volumes increase. For wireless communications service providers (CSPs), the impact varies depending on the type of network involved. For some, regulatory changes and costly hardware modifications are necessary to alter upload capabilities. Others face no critical regulatory, technological or cost barriers. All operators will need to address rising upload volumes in the coming years.

## New Network Investments Required

The general consensus is that significant investments in fixed and mobile networks are needed to support the network requirements in coming years, and new operating models must help to fund these outlays. The technologies exist to help resolve several of these issues, but they are hampered by out-of-date policies and regulations that have not kept pace with technological advances and changing network needs. A number of recommendations were made in the 2014 report regarding spectrum and IP interconnection that are still relevant to addressing rising demand.

New business models and technologies can address many issues, but they can also run into regulatory hurdles, one of which is simple uncertainty over the direction of future regulation. The policy and regulatory environment also needs to provide the flexibility and vision for companies to experiment with new models and approaches. Today's linear network models don't reflect the expanding diversity of demand caused by new and different types of traffic, and the issues this diversity creates in multiple areas, including cost, speed, volume and latency. Furthering deployment of low-cost, capacity-increasing technologies such as small cells (see in this section) and advancing other new technologies can also have a significant impact.

Government policies can encourage network investments in the following areas:

*New business models:* The internet needs to continue to embrace market-driven innovation in business models, including transparent and non-discriminatory IP traffic agreements to avoid congestion; experimentation with new IP interconnection and consumer pricing models; and rethinking pricing for the growing volume of uploaded traffic. (Some of these issues were discussed at length in the 2014 report.) Governments can help with policies that encourage network investments, such as by continuing to allow experimentation with alternative consumer pricing models, including value-based pricing derived from factors such as usage, speed, bandwidth, latency and time of day (lower charges for non-peak traffic, for example). While sponsored data plans raise concerns and controversies

related to net neutrality, these plans may improve ARPUs for network operators. Governments can also encourage experimentation with new IP interconnection pricing models for sharing network investment. At the same time, all parties should commit to avoiding anti-competitive actions and unreasonable discrimination against different kinds of traffic. In addition, governments can reduce administrative barriers to accelerate rapid deployment of internet exchanges, which should be accessible to everyone on a fair and non-discriminatory basis.

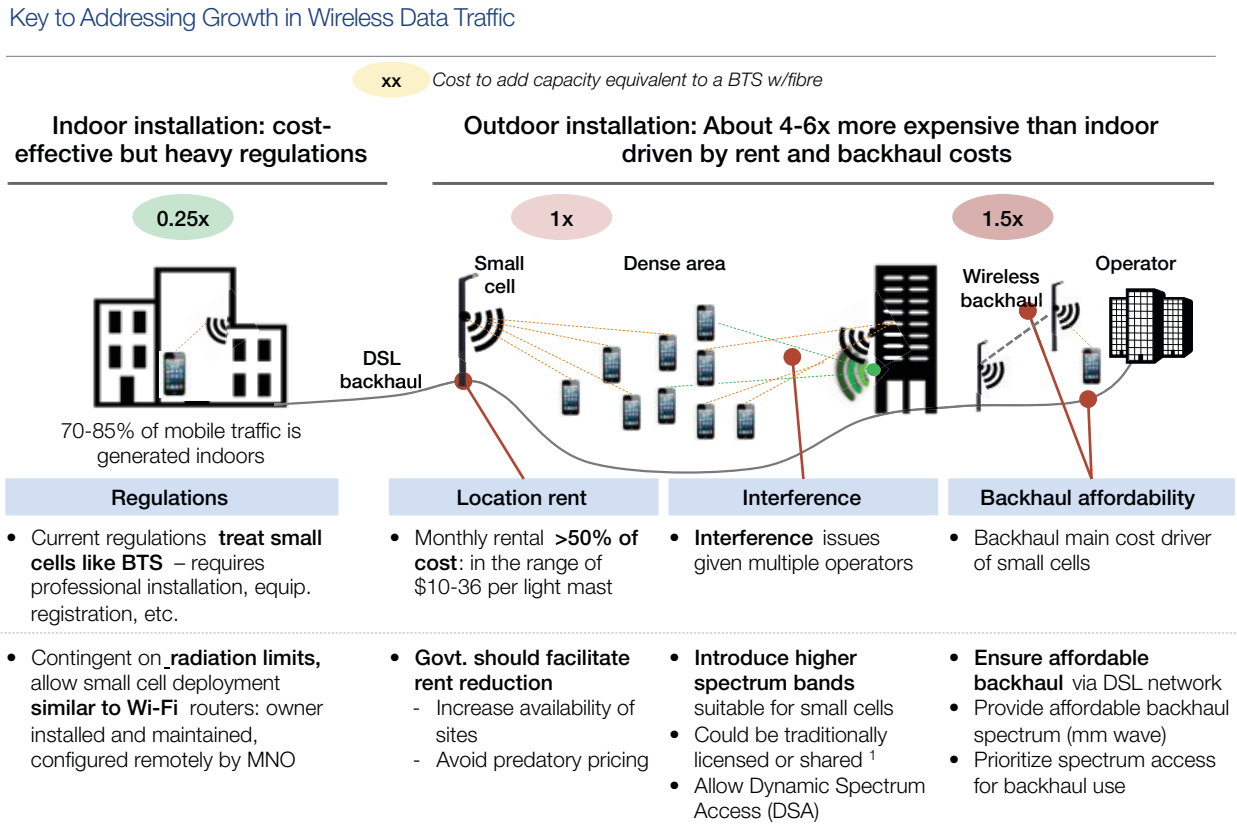
*Small cells:* As already noted, more spectrum is important to meeting wireless data growth in both developed and developing markets. In addition, clearing the way for widespread adoption of small cells is one critical approach to address some of the most severe coverage- and capacity-related problems, which often occur in densely populated urban areas.

As observed in last year's report, small cells represent a vital, complementary tool for improving efficiency. Traditional cellular deployment has relied on relatively few high-powered radios, usually mounted on cell towers. By contrast, small cells can be placed almost anywhere, such as on buildings, street lights or at bus stops. In large numbers, 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, for instance, have already moved towards a small-cell approach, with stations spaced every 100-200 metres. This is approximately five times the density of a typical urban market.[39]

Two big barriers hinder greater small-cell deployment: current regulatory constraints and cost. Small cells are installed using two main modes. One is installing them indoors (where 70-85% of mobile data traffic is generated[40]), which is highly cost-effective – an indoor small cell can cost one-quarter of a traditional base station of equal capacity. But in certain countries, regulations lag reality and impose hard-to-overcome constraints. Current technology enables what are effectively "plug-and-play" small cells that are similar to Wi-Fi routers; they can be easily and cheaply installed by home- or business-owners, and maintained and configured remotely by a mobile network operator. Current regulations in some countries, however, treat small-cell stations like any base transceiver station, requiring professional installation and equipment registration, among other stipulations. While issues remain, such as those involving potential exposure to radiation, governments can promote small-cell deployment by updating regulatory regimes on issues such as ownership restrictions, installation and operation, and registration.

Compared with indoor deployment, outdoor small-cell installation is four to six times more expensive[41] owing to rent and backhaul costs, which involve connecting the small cell to the backbone network. (Interference issues also exist in areas with multiple small cells or multiple mobile operators.) Relevant government authorities can help with outdoor deployment by taking steps to help reduce these costs, such as increasing antenna-site availability, following standard building codes for installation, introducing higher-spectrum bands suitable for small-cell use and providing affordable spectrum for backhaul use (Figure 14).

**Figure 14:** Regulatory Support Required to Ensure Low Cost of Small-Cell Roll-out




1. Authorized shared access. 2. Dynamic spectrum access.
Note: DSL = digital subscriber line.
Source: BCG Analysis, Inter Digital "Street Light Small Cells". Cost estimates based on BCG experience

*New technologies:* Other technology-based solutions can address traffic constraints, especially for traffic moving from the edge of the internet to its core. Currently, several third-party vendors can compress data, cutting traffic volume by 50-90% without noticeably affecting user experience. Content and application providers could adopt such compression protocols as default standards. Enhanced network design, using technologies such as software designed networks (SDN) and network function virtualization, can improve network quality and flexibility while bringing cost and revenue benefits for operators.

SDN, for example, enables improved capacity utilization, automation of network provisioning, faster deployment of new services and shorter network-equipment innovation cycles, which lead to both increased revenues and lower capital and operating expenses for CSPs.

In many jurisdictions, however, deployment of such advanced network technologies is slowed by legacy regulatory requirements, such as those governing public switched telephone network (PSTN) investments, as well as the lack of modern policies and regulations to encourage investment and innovation. Removing out-of-date requirements and introducing more flexible and light-touch regulatory regimes would help simplify network design and installation, and speed the application of new technologies.

# The Impact of the Internet of Things

The addition of 30-50 billion or more connected devices over the next five years, in industries ranging from manufacturing to energy and utilities to transportation, represents an enormous opportunity for economic expansion and growth. The potential market is huge. But as more machines come online and interact with each other, they will have a strong impact on the internet and how it functions. More data and many more individual communications will be on the network, with many of the latter travelling short distances around the edge rather than from a device on the edge to a server at the core.

### New devices, changing needs

Many of the newly connected devices comprising the IoT will be designed as small in size, low in weight, power-thrifty and, above all, inexpensive to manufacture and install. While it remains to be seen what memory and processing power will ultimately be available in some devices, many are expected to be significantly constrained in power, memory and processing capacity, which presages big changes for the network.[42] More data will be uploaded to the cloud to allow for anytime, anywhere access and to enable applications to combine data from multiple sources in more useful ways.

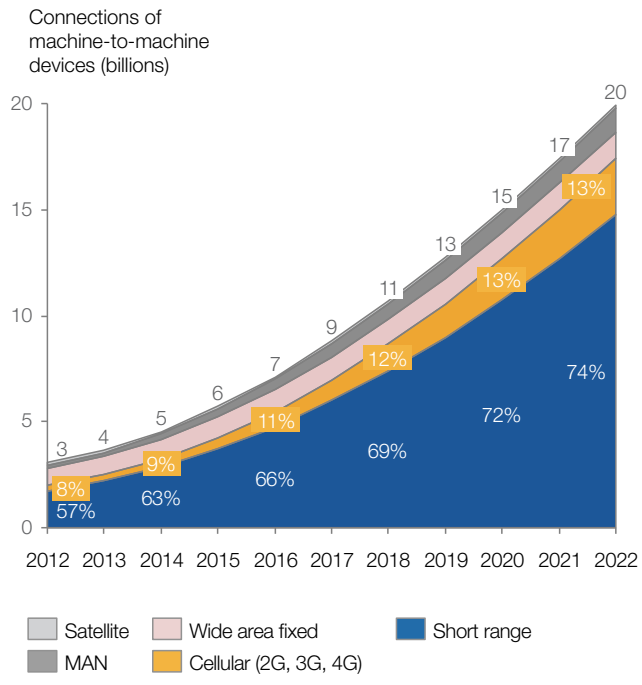
Security becomes a significant issue given the sensitivity and frequent urgency of data handled in IoT applications, such as smart grids, health monitoring, autonomous cars and smart buildings. Devices with multiple constraints need to do the following: authenticate users by restricting access to IoT devices that have been granted permission; transmit securely by applying secure data-transfer standards such as constrained application protocol; and ensure anonymity (where appropriate) and privacy by protecting sensitive data from being recorded by intermediate network nodes and providing sender intractability where needed.

Some of this data will be mission-critical – a medical image from a CT scanner, for example, travelling to a hospital; or information about a performance problem on a smart electrical grid. New devices with evolving functions will have very different needs from smartphones and tablets. Data security and network reliability become even bigger concerns; a serious risk of fragmented or uncoordinated approaches exists, resulting in potential breakdowns in security and even in the basic ability to communicate.

### IoT spectrum needs

The sheer number of IoT-connected devices, as well as their particular requirements (for example, about 75% are expected to operate on short-range connections [Figure 15]), will create a host of infrastructure challenges. While most IoT applications can run on existing spectrum, some specialized ones will generate new spectrum demands. The 802.15.4 standard, for instance, is gaining momentum for home automation. Bluetooth low-energy technology (which like "classic" Bluetooth utilizes the 2.4 GHz unlicensed band) is also popular and widely supported on mobile phones and tablets.

**Figure 15:** About 75% of Connections in 2020+ Expected to Be on Short-Range Wireless




Source: Machina Research 2014, "The need for low cost, high reach, wide area connectivity for the Internet of Things", Altair, 2013

Many applications would benefit from using low- and high-frequency bands. The sub-1-GHz spectrum can provide wide-area coverage for applications with power constraints, such as health monitors and sensors. High-frequency spectrum (5 GHz and above) is well suited to data-intensive, short-distance applications such as in-room video distribution and cloud uploads.

Certain mission-critical IoT applications need high-quality service capabilities and could require prioritized or licensed access to spectrum. Other applications with less stringent needs may be able to share spectrum or use unlicensed bands. Policy-makers and regulators should consider allocating new types of spectrum for different IoT needs, both licensed and unlicensed, depending on usage scenarios and cost-benefit trade-offs.

Use of spectrum frequencies in all ranges should be permitted for experiments to advance innovation within IoT, while continuing to protect the rights of existing licence holders and avoiding interference with licensed bands. In all markets, greater regulatory flexibility is needed to try new models for IoT purposes, including dynamic spectrum access approaches such as repurposing unused analogue TV spectrum, or the authorized shared-access approach for specified spectrum bands. In the United Kingdom, for example, Ofcom has piloted a flood warning system uti lizing a relatively dense network of water-level sensors that transmit their readings over TV white-space spectrum.[43] In Singapore, Power Automation, a joint venture between Singapore Power and Siemens, envisions using TV white space for electricity grid management. In both countries, regulators recently approved unlicensed use of these bands based on these and other experiments.

LTE Advanced and 5G have the potential to address multiple IoT needs. For 5G, a current need is to define research and development, standards and a roll-out roadmap. The overriding need for the IoT is that all types of devices must be able to connect to the cloud using the best means available to them (Figure 16).

### Standards and protocols

To function effectively and securely, the IoT requires standards and protocols, much like those that enable interaction among PCs, smartphones, tablets and other devices using the internet. Because of the power, memory and processing constraints of IoT devices, however, these protocols also need to use less capacity in all kinds of areas. The significant, additional challenge is that they need to be "light" and secure, much like a scaled-down equivalent of internet protocols.

Efforts to develop standards for the IoT are currently fragmented. Picture a crowded convention hall in which attendees stop listening to the speaker and start talking among themselves at varying volumes and distances, and in their different languages. With no protocols to govern the debate – or if different groups around the hall develop their own set of rules without regard to what others are doing – chaos eventually results. This is the state of play in the IoT today, with at least seven different organizations and consortia each developing and promoting its own set of standards for IoT communications and interaction. New, universally accepted and globally relevant standards are required to support next-generation IoT security and interoperability. Industry participants need to accelerate discussions and ultimately actions around a standardization roadmap for IoT communication protocols.

**Figure 16:** Key Recommendations to Address IoT Network Requirements

| | Solution | Description | Demand addressed | Regulatory support needed |
|---|---|---|---|---|
| Spectrum | **Allocate new spectrum types** | • Sub-1GHz unlicensed spectrum<br>• High frequency spectrum<br>• Experimental spectrum | ■ | • Drive allocation of new types of licensed and unlicensed spectrum for different IoT needs |
| Spectrum | **Low-cost alternative ways of using spectrum** | • Dynamic spectrum access<br>- Unused analogue TV spectrum<br>- ASA/LSA/PA [1] /Unlicensed | ■ | • Allow regulatory flexibility to adopt different spectrum usage approaches<br>- TV white space<br>- Authorized shared use/access |
| Spectrum | **Advanced spectrum technologies like LTE A or 5G** | • Potential to solve for new requirements<br>- Multi-spectrum operability<br>- Capacity, security and availability | ■ ■ ■ | • Define R&D, standardization and roll-out roadmap for new spectrum tech<br>• Reduce burdens of spectrum usage for experiments to drive innovation |
| Standard and Protocols | **Common open standards for IoT communication** | • Scaled down equivalent of internet protocols for the IoT world<br>• Standardization among multiple competing platforms | ■ ■ | • Strengthen/accelerate the standardization roadmap for IoT communication protocols<br>• Ensure standards are globally relevant and interoperable |

■ Security and Availability ■ Protocols and Standards ■ Spectrum needs

1. Authorized shared access/Licensed shared access/Priority access.

# 5. Bringing Smart Cities to Life

Of all the use cases for digital technology, few have higher potential to drive major investments with large, widespread economic and social impact than the development of the smart city. But, for all the excitement over the potential, the reality to date is far more anecdotal than universal. While plenty of programmes are under way to reduce energy use, lower carbon emissions, improve public transport and tap citizen creativity, among other goals, few cities have any comprehensive vision for building the ICT infrastructure needed, or for constructively using the massive amount of data they generate daily to make the urban environment more sustainable and improve the quality of life for its residents.

This needs to change. The percentage of the world's population living in urban areas crossed the 50% mark in 2007 and will increase to 60% by 2030. More than 1 billion people will move to cities, and some 360 new cities with populations of 500,000 or more will be created over the next 15 years. (There are currently more than 1,000 cities with at least 500,000 residents). Almost 80% of the new cities will be in developing markets, led by China, India and Nigeria. Ten of the most populous emerging-market countries will account for 70% of all cities.[44]

All of these new urban centres face big economic, social and environmental challenges. Traffic and transportation are major issues throughout the developed and developing world. Water supply needs scalable solutions along with monitoring and management. Significant challenges can include delivering utilities such as electricity and alternative sources of energy, and providing basic services of sanitation, refuse collection, and repair and maintenance of roads, bridges and walkways. Existing cities are grappling with many of the same concerns. Today's physical infrastructure is already hitting its limits in many places.

Smart cities are clearly a big part of the answer. For old and new cities alike, the critical question is: how can "smart" be brought to life?

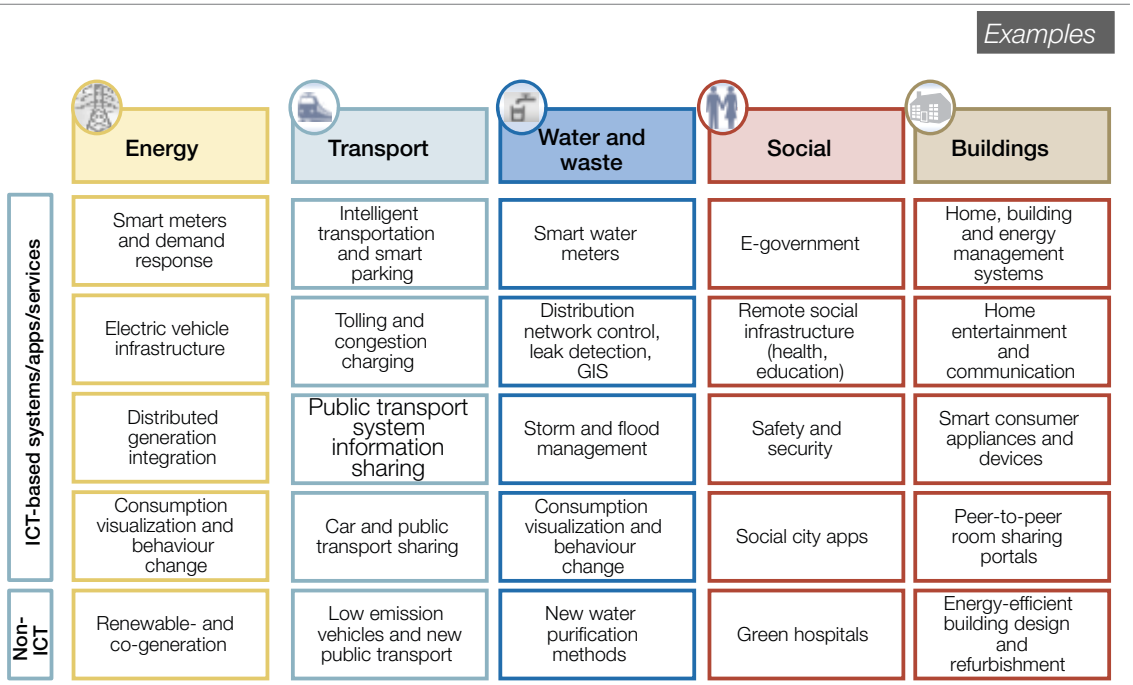
## Infrastructure for Smart Cities

Many of the ICT-based systems, apps and services that can address urban needs such as energy, transport, water and waste, social services, and building management and services already exist (Figure 17). Importantly, different levels of "smartness" exist; tools ranging from those that perform basic monitoring to advanced systems enabling predictive, analytics-based applications can all have a significant impact on improving citizens' well-being and the efficiency of daily life. Singapore, for example, uses sophisticated traffic control systems to maximize the efficiency of 164 kilometres of expressways and road tunnels. Rio de Janeiro uses an advanced weather-forecasting system and mathematical models that take in data such as topography and historical rainfall to predict heavy rains and possible flash floods at highly localized levels.[45]

Small steps can make a big difference, but even those require the ability to collect, transmit, collate and analyse massive amounts of machine-generated data. These activities depend on infrastructure to enable them individually and connect each one with the others. To be useful, sensors and actuators (remotely controllable devices such as controllable building thermostats) need digital networks that are secure, have available capacity and are inexpensive to use. Fast, large-scale data analytics for complex prediction models require access to high-powered computers running advanced applications. Secure data warehouses, most likely located in the cloud, must provide adequate access to real-time data that has been appropriately "anonymized" and can be used for predictive actions. Most importantly, all of these elements need to be connected so they can work in concert in a sort of digital virtuous circle (Figure 18).

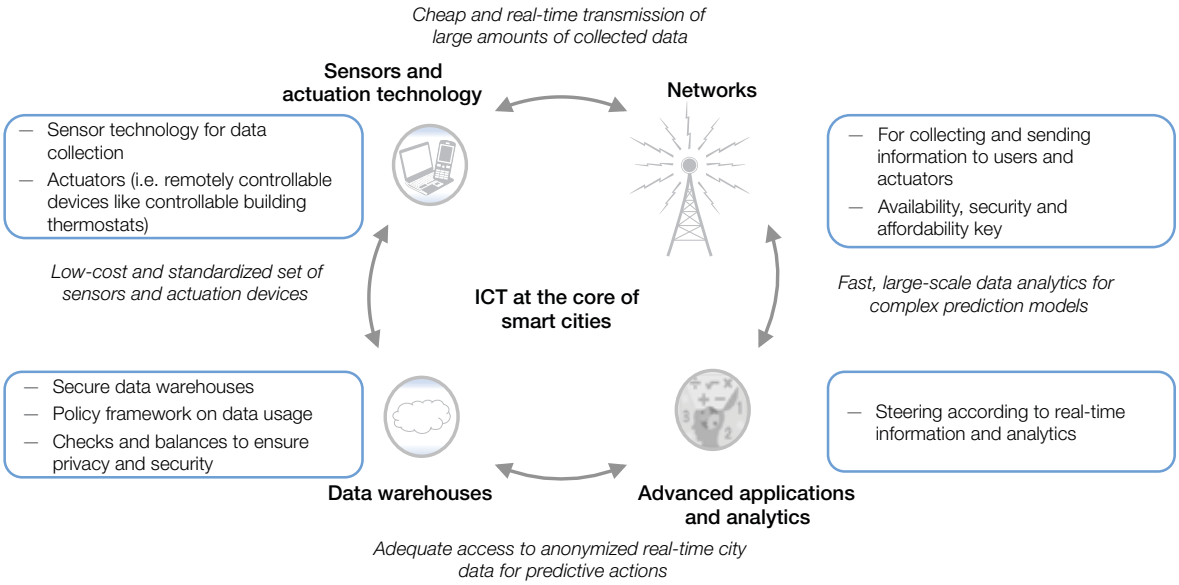
**Figure 17:** Smart-City Applications Can Help Cope with Scalability of Smart Cities

Examples from different verticals




Note: GIS = geographic information system.

**Figure 18:** Many Elements of ICT Infrastructure Needed for Smart Cities




**Individual building blocks often in place – need for government to play the coordinating role to bring it all together**

Source: BCG analysis

While the general needs are similar, the particular challenges of building and applying various elements of ICT infrastructure differ greatly in existing cities – with their older buildings, roads, physical infrastructure and systems – and cities of the future still to be designed and built. But both older and new cities share challenges of investment, operations and decision-making. The business cases for many ICT investments are complex, and it's difficult to finance large investments with payback periods that may extend out over many years, even a decade or more.

At an operating level, additional issues related to such factors include:

- Programme management – too many one-off initiatives and the lack of a coordinated approach
- Long procurement cycles – outpaced by rapidly advancing technology
- Legacy infrastructure – different cities, and different parts of the same city, all with existing infrastructure and their own needs and challenges
- Security – vulnerability to faults and cyberattacks
- Privacy – protecting citizens' personal data
- Standards – the current proliferation of standards for IoT devices
- Scale – the need to better leverage solutions globally

Each of these factors is complex in its own right; taken together, they present a daunting challenge to turning any city "smart".

## The Role of the Soul

The successful city of the future needs to have a "body, mind, and soul", as was noted at a regional conference. The "body" is the infrastructure, the "mind" the software and the "soul" the human element making it all work together – the vision, creativity, planning and coordination that individuals in the private and public sectors bring to the task. The big challenge is pulling it all together.

In a perfect world, the coordinating and enabling, through open data and other programmes, is an ideal role for government. In the real world, while many governments have poor track records in coordinating, overseeing and implementing large, complex projects, they also have access to much of the data that smart cities need, and they are well positioned to set priorities (based on public input) that can direct private-sector efforts. Private companies typically lack the incentive to take a holistic or long-term view; they excel at executing specific tasks or realizing projects.

As with bringing connectivity to hard-to-reach rural areas, the best solution may be a mixed one. Roles are defined according to which are best suited for either government engagement, public-private partnerships or the private sector. In general, government should set smart-city policies, while industry should focus on executing those policies and determining where to get the best returns on investment.

Under this approach, governments can help move smart cities forward in the following ways:

**Plan, coordinate and monitor** – This includes determining the targets for long-term investments in a city's digital architecture, for example traffic control, power and water usage, and emergency response, focusing efforts on applications that produce the biggest benefits, and pushing cross-department coordination within cities' own administrations to remove administrative barriers. Governments also must create environments where digital systems can flourish, by defining communication infrastructure standards with a cross-department approach, and helping to drive the public-private

partnerships needed in some areas to spur investment and get programmes off the ground. They can also provide the basis for assessing performance with measurable and trackable performance indicators and results-oriented benchmarks.

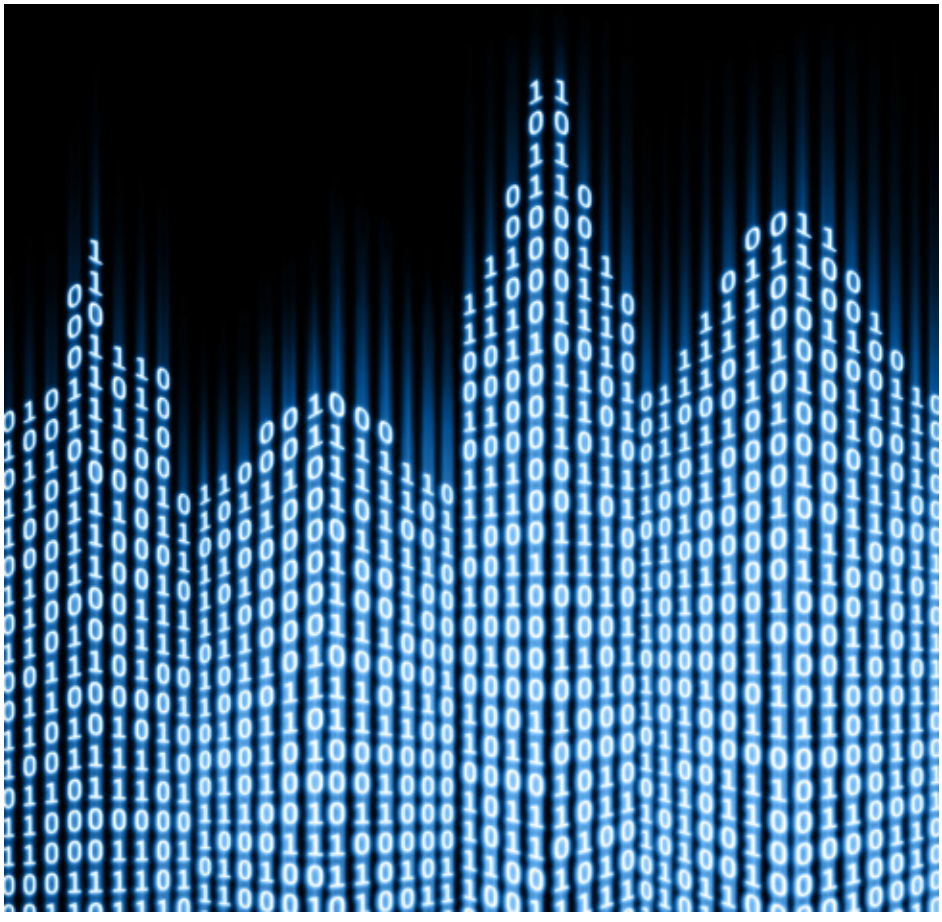
**Incentivize others** – Providing a suitable, flexible regulatory framework, applicable to ICT as well as other functions, helps ensure the necessary investment in infrastructure and the requisite coordination across government entities. A "digital building code" that requires digital upgrades and improvements to be part of all new construction and renovation projects, for example, helps ensure that cities are continually improving their digital infrastructure. Alternatively, if government does not set broad direction, such as establishing requirements for digital infrastructure in building codes, few incentives for private industry to build out digital capabilities may be available, and the efforts that are set in motion will likely lack coordination and focus.

**Enable data** – Governments have access to all kinds of data that, if released to the public, can spur creativity and innovation, effectively making cities smart from the bottom up. The city of Montreal unveiled a programme in January 2015 to get smart with five broad goals: improving urban mobility; enhancing resident services; creating living spaces, such as libraries, that can be used for citizen innovation; improving transparency, in part through broader data access; and boosting economic development. The city plans to release more data for public scrutiny and will encourage citizen participation in developing solutions to urban issues.[46]

Privacy and security concerns must be addressed, of course, putting governments in the role of "first movers of data". They ensure the governance structure and safeguards are in place, and then work with industry to determine how data can be collected, analysed and used to address specific issues. While many cities already employ data scientists, they lack an overall vision and plan for what data to collect and how it should be used. Singapore has appointed a data tsar to ensure protection of citizens' information. Industry often knows where the digital "pain points" are. Cooperation among local municipalities, infrastructure and telecommunications companies is essential to advance and manage smart cities.

**Enable people** – The value of open-source initiatives is well established, but citizen involvement in the "open sourcing" of ideas needs to be promoted and coordinated, as Montreal is seeking to do. Governments can pursue volunteer programmes similar to Volunteers in Service to America (VISTA) for the digital age that build city "labs", provide access to open data and invite volunteers to work remotely to build smart-city applications. New York City's BigApps competition, for example, offers cash prizes for teams that design innovative solutions to urban problems.

**Ensure scalability** – Coordinated government efforts are needed to ensure that smart-city applications can be scaled, to make sure these applications go beyond the lab and to share what is working in other municipalities. One approach is to apply the build-operate-transfer model often used in infrastructure projects; simple sharing of best practice is another. In the United States, the National League of Cities published a report in 2014 on what's working, called *City Open Data Policies: Learning by Doing*.[47]




**01:** Ken Hu, Deputy Chairman, Huawei Technologies, People's Republic of China

# 6. Accessing, Transporting and Using Digital Data: New Challenges and Complexities

As online usage rises, and as more applications for digital technologies are invented (more than 3 million apps are offered today by various vendors, including Apple's App Store and Google Play), the momentum for doing still more with digital and mobile devices continues to build. Further big changes are expected as wearables and other innovations gain popularity and the IoT picks up speed.

Many of these online activities are primarily for convenience or fun (e.g. online shopping, game playing); many more are far from frivolous. As already noted, people particularly in emerging markets are heavy users of digital government services that have a significant impact on life and livelihood. They are embracing the web to improve their well-being and ability to earn a living.

As a result of this digital activity, consumers have started to compile digital assets tied to their online lives and distributed across multiple sites, apps and sectors. This data includes government records, healthcare files, financial information and basic identity content, some of which could result in serious harm if it falls into the wrong hands. The data, and uses thereof, range from being relatively low in importance (e.g. simple demographic information) to critical (tax filings or healthcare records), especially if the data were compromised.

All along the spectrum of criticality and type of use, the vision of the future is clearly a digital one, with increasingly more aspects of daily life tied to some form of digital asset (Figure 19). At a growing pace, consumers need to access and share data across networks, devices, operating systems and applications. At least three principal types of application can be highlighted:

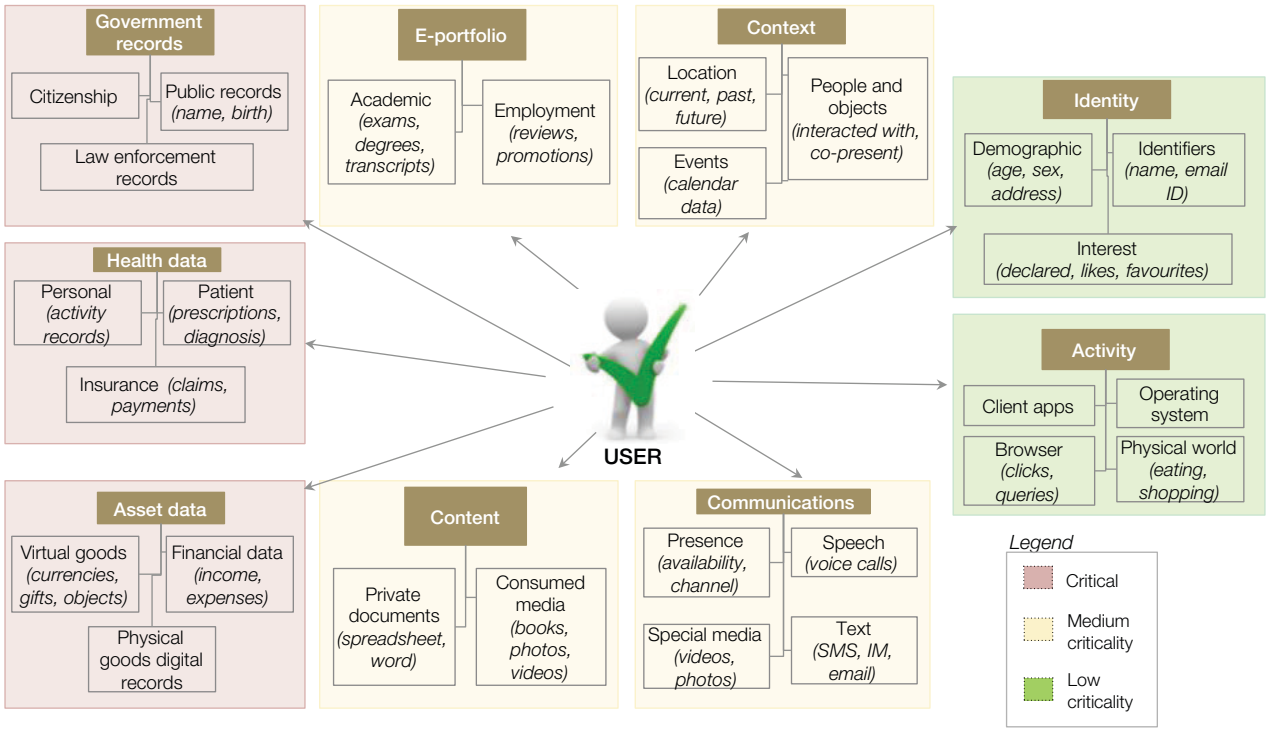
– **Data made available to multiple people with a common, authorized purpose** – Consider, for example, a patient with a medical condition visiting a hospital in one jurisdiction and being treated by a doctor in another, while that patient's primary physician resides in a third. Each provider may have a different data records system. And, while such patients benefit if all the healthcare providers have access to their health data, they also want assurance that access to medical records does not "leak" beyond authorized users.

– **Data used by individuals across different platforms** – A user, for example, wants to transfer content, originally downloaded to a tablet via a specific operating system (such as iOS), to a smartphone but using another system (such as Android or Windows).

– **A single user sign-on (the individual's digital identity) to coordinate services from multiple agencies** – In Estonia, a newborn is issued a temporary ID card number and registered online. The parents can then complete all the necessary formalities from home in a sequence of consecutive steps, such as registering the child for health insurance and applying for state social services, without visiting different public authorities.[48]

This digital dependence leads to new issues regarding consumers' ability to easily access and use their data

**Figure 19:** Consumers Are Tied to Many Digital Assets




Source: Kaliya "Identity Woman" Hamlin and Personal Data Ecosystem Consortium derived from a list of personal data types appearing in: Davis, Marc, Ron Martinez and Chris Kalaboukis,
"Rethinking Personal Information – Workshop Pre-read" Invention Arts and World Economic Forum, June 2010; Criticality is defined as impact to individual if data is compromised.

seamlessly, and at the same time raises privacy and security concerns about others using their data. An appropriately seamless digital experience not only makes lives easier, but also drives higher usage and therefore greater investment in digital infrastructure and applications. Reducing or eliminating the friction consumers encounter when moving digital assets from point A to point B also gives rise to a system of third-party services that further industry innovation.

It's probably too early to quantify the impact of easing constraints on universal personal data access and use. The interplay among consumer benefits, risks to privacy and security, and industry impact needs more time and experience before it can be accurately assessed. Not all digital activity is good activity; piracy and copyright infringement, for example, are serious problems, and some innovations can do substantial economic harm. The music industry's history has shown that disruption is one thing; illegally undermining existing business models (and destroying incentives for innovation) is another. Such activity can also pose risks to data security and online privacy. But it's not too soon to recognize that, left unaddressed, inappropriate limitations on seamless or universal use of data could constitute a serious barrier both to people's ability to get basic things done – move a bank account or access medical care, for example – and to overall digital growth and economic activity.

## The Constraints

Implementations of such initiatives are limited by complex and multifaceted constraints. Major questions of consumer privacy; the ownership, residency and traceability of data; data security and protection; and the rights and responsibilities of those using data are big issues in the digital age (they are all subjects of separate World Economic Forum initiatives examining these questions in detail). A general lack of agreement on digital asset ownership and usage rights exists, and few consistent rules or regulations, either government- or industry-led, define data use. In many instances (e.g. email accounts and media consumption), the ramifications of the interplay among consumer benefit, privacy and security risks, and industry impact are not yet evident and need more extensive evaluation. No less critical are the policy and technology questions surrounding how data is shared, transported or accessed by owners/users, and the organizations and institutions with which they interact.

One big concern is that data varies substantially by type and use, and few technical standards or operational and governance frameworks for gathering, storing and using data are in place. Integrating user data from multiple sources, such as multivendor and multimode networks, is difficult. A legal and regulatory framework is also required, as well as commonly agreed policies and technical specifications for data exchange between networks and

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**01:** Jean Philbert Nsengimana, Minister of Youth and Information Communication Technology of Rwanda

service providers. These should address issues such as proofing and vetting related to data transmission, receipt, acceptance and liability.

## For the Future

It's too early to frame specific recommendations. However, multistakeholder dialogue on near- and long-term initiatives is needed to eliminate unnecessary sources of friction in transporting, using and accessing data, thereby unshackling consumers' digital lives. Benefits may be generated from prioritizing different sectors or use cases, and focusing first on those that offer higher impact and higher-value benefits. These are based on an assessment of the security, privacy, IP infringement, business model disruption and level of complexity involved in each, as well as an evaluation of the pros and cons for individual stakeholders.

Some players are advancing solutions related to the three areas of application just described; their efforts should be monitored and evaluated for more widespread use. Several of these initiatives are government-led. In the early 2000s, the Estonian government began to provide all citizens with a single "e-ID" through which they could access multiple public- and private-sector services. The programme, which has focused on services with maximum user benefit and given users full transparency and control of their data, has been broadly adopted, covering over 2,000 services used by more than 900 organizations daily. It has resulted in time savings equivalent to 2% of Estonia's annual GDP.[49]

Users in France can access some 30 government services with a single user name and password. The Australian government offers simplified registration and authentication processes, with one user name and password that links existing accounts and connections to new services. Some 2 million Australians now have a myGov account. Singapore's SingPass programme provides a single online authentication system through which users can access 270 different services from 58 government agencies, using one identifier and password from one point of departure. SingPass' utilization rate is over 90%, with better than 80% user satisfaction.[50]

A huge potential exists in larger markets. A study from the United States suggests that storing healthcare records electronically (with user control) and enabling full information exchange and interoperability among providers, payers, public health departments and ancillary services (e.g. laboratories, pharmacies) could generate up to $78 billion a year in benefits.[51] Opinion research in the United Kingdom has shown that more than 60% of people are worried that the inability of providers to access vital information about patients' health could result in treatment delays or potentially life-threatening medical errors. Interoperability has now been mandated by the Department of Health as an essential requirement of future computing systems for general practitioners.[52]

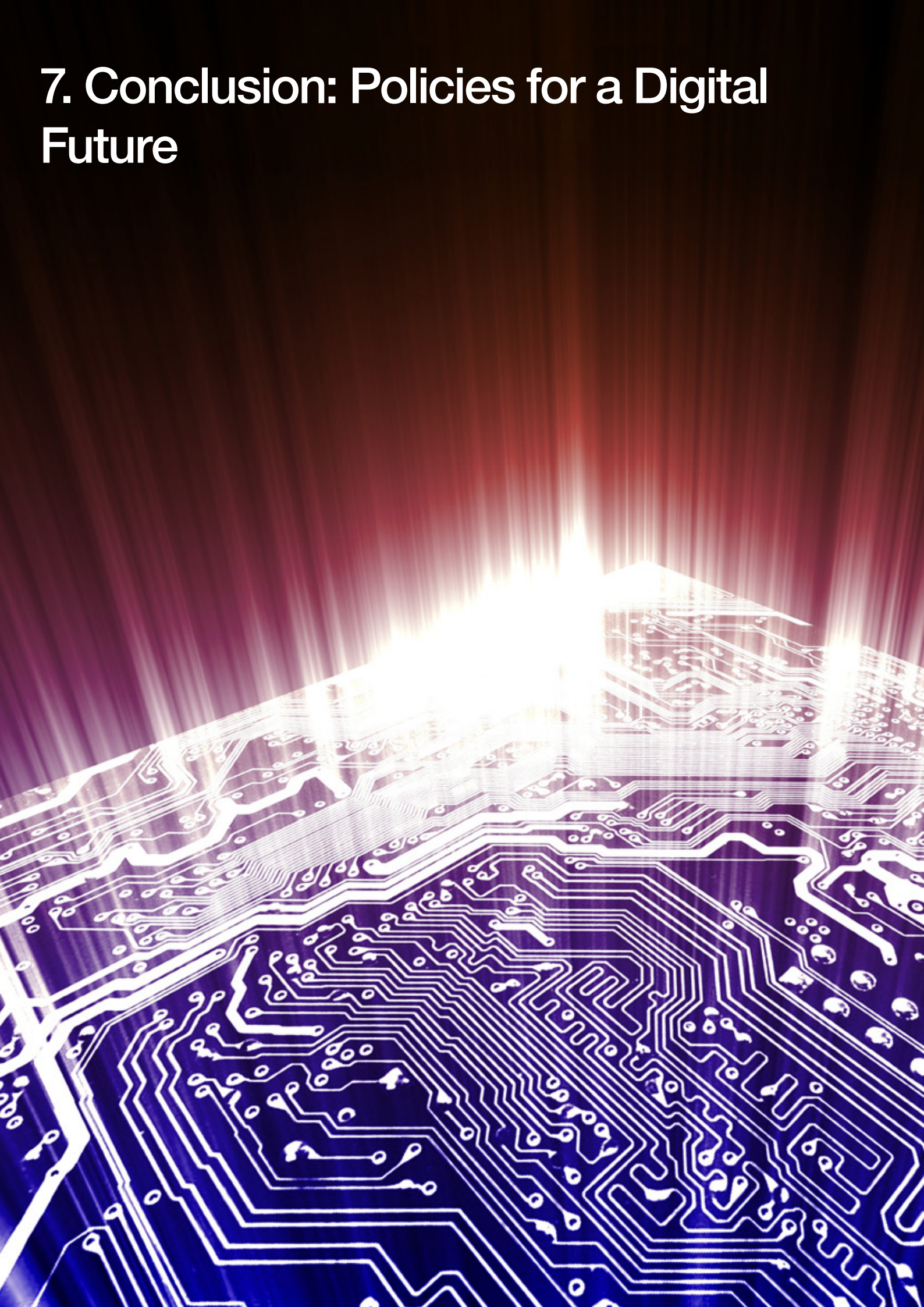
Industry players may want to pursue their own experiments to facilitate greater data portability and easier access and use, as they are likely to find self-regulation preferable to government-mandated change. Developing and adopting common minimum standards is a clear short-term step. The ISO/IEEE 11073 health informatics standards are one model; others include ISO/IEC standards for cloud computing, such as 17788 (adopted standard addressing overview and vocabulary) and 19941 (in-progress standard addressing interoperability and portability), as well as frameworks from the Open Identity Exchange. Banks in the United Kingdom are developing common code on financial data exchange (transmission, receipt and acceptance), albeit in response to a government mandate to help consumers with switching their current or checking accounts.[53]

Over the longer term, common technical, policy and legal frameworks may need to be developed for priority data and use cases. These include:

- Common standards for data description (metadata), storage and authenticated exchange of data across platforms
- Operational and governance frameworks for data exchange, including liability, identity proofing, and vetting related to the transmission, receipt and acceptance of data between systems
- Harmonized interpretation of privacy legislation involving issues such as data ownership and usage rights across jurisdictions, focusing on regulatory outcomes
- Global guidelines for enforcement based on country-specific laws

Given that many of these issues are complex, this is likely to be a multi-year discussion involving many players on multiple levels. The goal now is to put some important issues on the table and begin prioritizing so that they are in clear view, allowing public- and private-sector participants to consider how to advance the debate.

# 7. Conclusion: Policies for a Digital Future



While the market is generally the best mechanism for connecting consumers with technological and business innovations, help from the public sector can provide support at times and in certain places, provided the parameters of such assistance are clearly defined. For digital economies to take root and flourish in their countries, all participants have roles to play in the following areas:

### Developing Comprehensive Country-Level Digital Agendas

Working with private-sector leaders and industry associations, emerging-market governments especially should look to develop an overall digital agenda for their countries. The agenda should include near-term initiatives that encourage investment from the private sector, generate tangible societal benefits, and engage citizens and consumers. It should also focus on a 5-to-10-year vision that defines a nation's broadband penetration, including a roadmap to connect all citizens, a definition of different players' roles and an expectation of the market conditions required for success.

Among developed markets, multiple countries have used such programmes to drive and shape their digital development with high-impact results, among them Sweden, Denmark and South Korea. The vision should have specific criteria for hard-to-reach and economically challenged regions, and provide the criteria on which funding and operating models can be assessed. Any specific plans for infrastructure construction or deployment should be technology-agnostic, provide incentives for investment and allow for experimentation, without creating market distortions. These agendas also need to include measures for building digital demand and use, such as education and training that help consumers acquire the necessary skills leading to digital literacy.

### Promoting Investment

To further these agendas, countries need policies that encourage network investments by all stakeholders, but especially by private industry. These policies should allow for experimentation with new business models (including for consumer pricing) and further adoption of new technologies, such as small cells in urban areas and IoT-advancing technologies. Regulatory environments also need to evolve to ease and encourage investment.

### Increasing Mobile Spectrum

Few policy efforts have the potential for greater economic impact than optimizing mobile spectrum allocation policy for long-term value; accelerating fair, market-based allocation of spectrum; and enabling more efficient use through spectrum-sharing regimes. Allocating more licensed and unlicensed spectrum for mobile use helps countries achieve their digital agendas by making mobile access more affordable and attracting investment. The primary goal for policy-makers and regulators should be to maximize the use, rather than the short-term value, of this scarce and precious asset.

### Advancing Smart Cities

Governments can help to further develop smart cities by determining targets for long-term investment, creating environments where digital systems can flourish, and providing regulatory frameworks that help ensure the necessary infrastructure investment. They can take a leading role in planning, prioritizing, coordinating and monitoring the development of smart cities – and in identifying and removing barriers, especially administrative roadblocks. In addition, they can pursue cross-department coordination and provide funding support where needed, and also advance open data policies, coordinate citizen involvement in open-sourcing ideas, and help ensure that smart-city applications are scalable.

### Furthering Universal Usage

As digital use increases across sectors, a growing need may develop for national policies, technical standards and global guidelines that allow consumers to transport, access and use data in multiple settings and jurisdictions, without encountering significant barriers or compromising their privacy and security. The difficulties are complex, but the potential value – to consumers and industry alike – is astronomical. The vision should be based on an interoperable digital world in which the universal use of digital assets encounters the least possible amount of friction, consistent with appropriate safeguards for consumers.

Digital technology's most powerful attribute may be its ability to level the playing field – for everyone, everywhere. People who are poor or live in remote areas gain access to services that were previously available only to their wealthier or more urban neighbours. Small businesses have the same national and international reach as big companies. Everyone can use and enjoy information, services, media and culture.

There are few areas in which governments can have a bigger impact than helping to extend digital infrastructure and access throughout their countries. They need clear and ambitious long-term policies and goals, and should recognize the private sector's vital role in bringing new technologies and other innovations to market. Governments' approach to the marketplace should be light-handed, and they should seek to limit distortion of free-market innovation and investment.

Governments face a challenging journey with few established roadmaps to follow. Experimentation will be essential. And most of all, no country should fail to capitalize on the potential of digital technologies to bring substantial improvement to human productivity and the quality of life.

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