

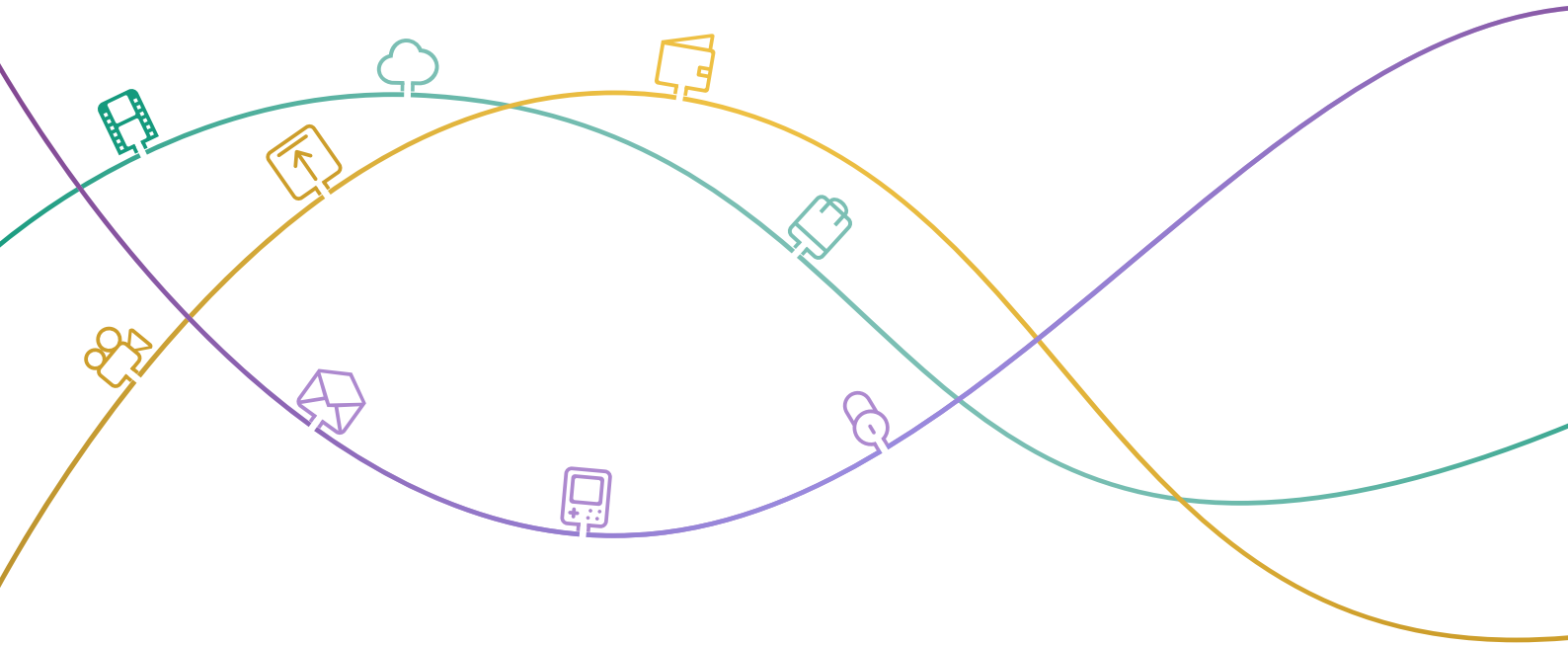


# GLOBAL CONNECTIVITY INDEX 2015

## Benchmarking Digital Economy Transformation



BUILDING A BETTER CONNECTED WORLD



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# EXECUTIVE SUMMARY

The economy of all countries is transforming into a digital economy whether they like it or not. The rapid proliferation of cloud computing, Big Data and analytics, and mobility combined with many significant technology changes have created an ICT environment that has enabled the Internet of Things (IoT) to rise and become one of the key disruptive forces in our economic lifetimes.

The most important necessity for IoT — connectivity — will become so ubiquitous and widespread that by 2025 the number of IoT devices installed, connected, and autonomously managed will reach 100 billion.

The positive impact a Better Connected World can have on any country, socially and economically, is evident and correlates well with the dynamics around supply, demand, experience, and potential of connectivity. In fact, by measuring, analyzing, combining, and forecasting multiple connectivity dynamics, not only can a country's current status of economic health be determined in relation to others, but it can also be predicted. This can be done by calculating a Global Connectivity Index (GCI). Key insights from the index shows that:

- The GCI index has a strong correlation with GDP. Countries with higher GCI scores have higher GDP per Capita. The results of the GCI model shows that ICT technology has become a new production factor which drives the economic transformation of a country (for example, Singapore's Smart Nation strategy seeks to circumvent the limitations of natural resources, and leads to the development of "Digital Fuel").
- Construction of ICT infrastructure is critical for a country's competitiveness. A 20% increase in ICT investment will grow GDP of a country by 1%. The three key foundations of forming the digital

economy ecosystem are: Network infrastructure; IT infrastructure; and Digitalization infrastructure.

- Mature countries lead the GCI with the United States, Sweden, Singapore, and Switzerland at the top. Chile, China, and United Arab Emirates (UAE) lead the pack for developing countries.
- A country's GCI performance can be categorized into three clusters — Leaders, Followers, and Beginners. Leaders are mainly mature economies, Followers are mainly developing economies; however, four mature countries of Spain, Italy, Czech Republic, and Portugal have fallen into the Follower cluster. Beginners are developing economies that are far behind other countries.
- GCI Leaders have better Supply of connectivity, but more importantly they have invested to drive better adoption in Demand and improved usage in Experience. Experience has become a key factor for ICT development. Followers and Beginners are mainly focused on developing Supply at this stage.
- Developing countries or Followers performed better in building the supply of connectivity in 3G coverage and mobile adoption, but lag behind the mature countries in building up their datacenter capabilities (core). Datacenter investment by developed countries is three times that of developing countries. Datacenter investment is the major catalyst of cloud proliferation as "the edge does not exist without the core."
- Developing economies lag behind the mature economies by two folds in supplying, adopting, and using the transformation technologies of Broadband, Cloud, IoT, Big Data, and Datacenter. These five technologies interactively promote



each other, laying a solid foundation for ICT development of a country.

- In the next 10 years, developing countries like China, Indonesia, Brazil, among others, will enjoy faster digital transformation than mature economies due to their high ICT spending growth, large ICT technology workforce, and data consuming population. However they will need to look into developing their GCI components to take advantage of this.
- The GCI can be used to help understand at what stage a country is in, how it compares with its peers, and how close it is to breaking out of its stage into a more advanced stage or the risk it has in falling behind. The findings from the GCI can help governments and business leaders navigate the daunting march toward a digitally transformed economy. Here are six focus areas for governments:
- Lead the way to be more assertive in pushing for development and not just rely mainly on market forces that may not be sufficient or have different priorities.
- Invest in core areas of ICT first —without a robust infrastructure/foundation, anything built atop of it risks falling prey to low usage due to poor experience.
- Invest in IoT and Big Data. Every connection introduces new sources of data, and decisions will need to be made on that data.
- Invest in people. There are no shortcuts in transforming into a digital economy, especially when it comes to the IoT and Big Data.

- Focus on improving experience to sustain demand. There are plenty of other ways to improve experience, but ubiquitous broadband, real-time interactions, and speedy downloads are guaranteed to compel more use and more innovative solutions and applications.
- Plan, be deliberate, do not delay, and stay on course. Our surveys on the intent of business leaders and governments to invest in ICT across all the horizontal attributes were some of the least differentiated across the tiers of countries. In other words, intentions are always high, but unfortunately, intentions are a huge step away from actually doing. Our advice is to engage in strategic planning and prioritization around improving your GCI.

We hope our efforts will mobilize countries and industries to find ways to build a modern, competitive digital economy together, to benefit the lives of more people in more places.

Together, let's Build a Better Connected World.



# THE UNSTOPPABLE FUTURE

The digital transformation of our world is an unstoppable phenomena. The way we live, do things, run a country, conduct our business, and earn a living is being transformed by digital technology. Countries and communities that do not embrace this trend risk being left behind. In fact countries are under tremendous pressure to ride the digital transformation wave to accelerate social and economic development and improve their competitiveness. In other words, countries are in a race to develop their digital economy.



A digital economy is an economy in which its participants (governments, businesses, and consumers) are adapting to disruptive changes in their business models, ecosystems, and individual lives by leveraging digital technologies (e.g. connectivity, applications, storage, and compute), to create new business models, products, and services that blend the digital and physical seamlessly resulting in new business and customer experiences and behaviors; and improved operational efficiencies, organizational performance, and customer accessibility.

A Digital Economy can also be reflected by 4 aspects, namely ICT Spending, ICT Skills, eGovernment, and eCommerce. ICT spending builds the platforms upon which the digital economy runs. ICT Skills makes it possible for communities in the country to partake in the digital economy. eGovernment is representative of the way public services and other services are delivered to the communities and eCommerce enables the communities to monetize their digital assets.

Moving to a digital economy is a transformative process that happens over time as each participant

or community within any given economy embraces digital change. One of the key elements to this process is connectivity.

Connectivity links the computing devices, sensors, and effectors at the edge to the compute and storage facilities usually housed in a datacenter at the core. We use the term connectivity here in a broader sense to mean an entire connectivity system upon which the transformation into a digital economy is enabled. This includes the edge devices, the network connectivity infrastructure, the datacenter core, and the transformation enablers as represented by cloud services, Big Data analytics and IoT.

The future is replete with the benefits and conveniences that come along with digital transformation. People's imagination is the real limitation as connectivity and all the technologies associated with it surround us and touch us to cater to our personal preferences and to direct our every step.

**MOVING TO A DIGITAL ECONOMY IS A TRANSFORMATIVE PROCESS THAT HAPPENS OVER TIME AS EACH PARTICIPANT OR COMMUNITY WITHIN ANY GIVEN ECONOMY EMBRACES DIGITAL CHANGE. ONE OF THE KEY ELEMENTS TO THIS PROCESS IS CONNECTIVITY.**



# IMAGINE THE WORLD IN 2025 AND BEYOND

The increasing availability of always-on connectivity and real-time services made possible through affordable ubiquitous broadband is transforming the way we live. Passive input from post processing of data is shifting to proactive and predictive data analytics designed to complement, or even digitally drive our physical lives. What impacts the way we experience each and every day is moving outside of traditional spheres of influence and into new and exciting realms of inspiration. The future will deliver expected as well as unexpected innovation that will tightly integrate digital information and services with our lives, impacting not only individuals, but also businesses, governments, societies, and countries. Consider the potential of a connected world over the next 10 years:

- A majority of automobiles will have a driverless mode and accelerate a next-generation service known as transportation as a service (TaaS) solution. Autonomous vehicles displace 2nd and 3rd car ownerships, thereby helping to decrease congestion by over 10% in served cities.
- Increasingly, business will be done “at the edge” of the network, which will drive the launch of new business services, new cloud-based data sources and repositories, new cloud-based systems of engagement, and the need to access more geographic regions. Providing actionable results or decisions based on predictions will be the result of active cognition and analytics-based automation that happens real time. The majority of Big Data and analytics (BDA) applications and services will be cloud-based, moving compute closer to the point of data capture or creation, and thereby decreasing latency and improving experience. Analytics will have moved from correlation to prediction, which permeates customer experiences in wellness, product maintenance, retail, and media.

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**WE NO LONGER  
SURF THE  
INTERNET...  
THE INTERNET  
SURFS US....  
AND WE ALLOW  
IT TO!**

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- City governments will provide a completely connected and customized experience on the street. Connected infrastructure — parking spots, streetlights, trash bins, and park benches will all supply ubiquitous connectivity as well as information to citizens, tourists, businesses, as well as city departments. Connected citizens and other assets, like police vehicles or public buses, also serve as part of the city information infrastructure capturing, disseminating, and using information daily.
  - » A **tourist** walking down the street receives personalized information via a wearable device that offers the coupons for nearby stores along with crowdsourced store ratings, optimal routes to get from one tourist destination to the next using all forms of transport — from networked public bicycles to shared cars to public buses, alerts for events of interest based on personal preferences, and using a smartphone or other device to access historical information, video spots, and 3D tours of historical buildings or locations.



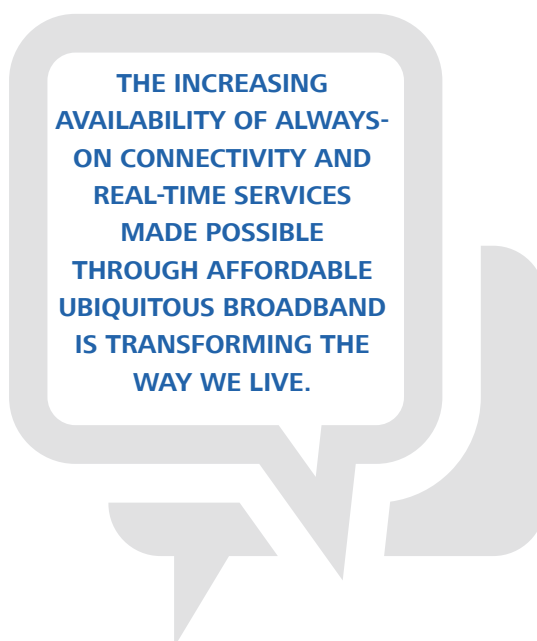
» A **connected citizen** sends and receives information that allows them to manage their daily life more efficiently and communicate quickly and directly with the city when issues arise. Analysis and integration of real-time weather, events, traffic patterns, accidents, and personal schedules along with variable pricing of tolls and fares, direct commuters to the most efficient route to work each day, taking into account not just time and cost but CO2 emissions. Mobile apps available via a variety of devices allow citizens to receive alerts for trash collections, snow removals as well as for online payments. Citizens can provide information to the city on crimes, property damage, or needed repairs working in concert with city departments in the running of city itself.

» **City workers**, like police officers, will be connected to each other, their operations centers, and other departments. In public safety, for example, the connected officer will be the norm — a connected officer whose vest contains sensors to collect biometric data, environmental data, location and other pertinent data will also have sensorized guns and holsters that automatically let the command center know when weapons have been drawn or shots fired and under what conditions. Wearable devices allow for officers to see 3D images of structures as well as information on residents and potential bad actors.

» **Businesses** and citizens do business with the city on-demand using mobile devices or street kiosks to videoconference with city departments and to file permits and licenses and schedule inspections. The city proactively helps small business owners and citizens navigate processes.

and visitors. Cities will be a part of shared clouds in which data can be centralized and shared in various forms to different departments, operations centers, and other levels of government, which will enable greater coordination, especially in times of emergencies or during big events.

- By 2025, the number of people over the age of 65 will increase from nearly 600 million to 800 million, or approximately 10% of the total worldwide population according to the World Health Organization. Coupled with longevity is an increasing prevalence of chronic conditions; diseases that were once fatal a generation ago can now be treated with life-saving surgeries and/or drugs. The increased demand for healthcare services will place an additional burden on an already stressed healthcare system. Shortages of healthcare workers in both developed and emerging countries will continue to worsen in the next 10 years. These demographic trends combined with positive technology trends, such as the consumerization of technology, greater adoption of mobile devices, better access to broadband connectivity, telepresence, and increasingly smaller sensor technology, will promote the use of connected health technologies to provide healthcare more efficiently to the masses in a more



All of this makes it easier for the city to serve and protect its citizens, support businesses to get up and running quickly, collect fees and revenues, gather key information to help city operations, and engage in proactive, positive ways with its businesses, citizens,



In the next 10 years, health monitoring sensors will become even smaller and cheaper and collect multiple biometric data to create a full 360-degree view of the consumer's health status. Sensors could be woven into the fabric of consumers' clothes or applied directly to the consumer's skin in the form of a patch or temporary (and prescribed) tattoo, to collect and send data with little to no effort on the part of the consumer. Greater adoption of standards and open applications will improve the flow of data into electronic health records (EHRs) and other clinical information systems, thus enabling better decision at the point of care. The use of connected monitoring devices makes virtual care via video visits possible. Instead of traveling great distances and waiting for hours to be seen, consumers can either schedule an appointment with their physician or be seen on demand by the next available physician. Vital signs can be transmitted directly from the consumer's monitoring device ensuring the veracity of the data. Images and videos can also be sent to aid the clinician in making a diagnosis. Reliable bandwidth and telepresence enhances the immersive experience for consumers and clinicians. Similarly, these technologies can be used by seniors (and their adult children or caregivers) to promote aging in place. In addition to sensors worn by consumers, sensors would be placed in the home to monitor activities of daily living such as preparing meals, taking medicine at the appropriate time, and moving about the house. By 2025, 85% of healthcare organizations will invest in consumer-facing mobile applications, wearables, remote health monitoring, and virtual care to control spiraling healthcare costs and to address access to healthcare services issues brought on by increased demand for services and clinician shortages.

Fast forward further to a time when diagnosis of ailments can be completed in minutes by medical robots that can cull data from connected devices within the home and on the person. Medication (matched to the patient's DNA) will be prescribed and delivered (or 3D-printed) to a home or a local pharmacy. This type of future is enabled through connectivity.

As each year passes by, millions of devices are integrated with sensors and silicon to enable connectivity to an infrastructure that ultimately delivers ubiquitous broadband. This connectivity, which is essential, is only the beginning of a universal

quest to connect anything to everything and anyone to everyone, but in a smart and deliberate way in which real value is perceived, personal privacy is protected, businesses thrive, and economies are transformed.



# THE FUTURE AND IMPACT OF IOT ON DIGITAL ECONOMIES



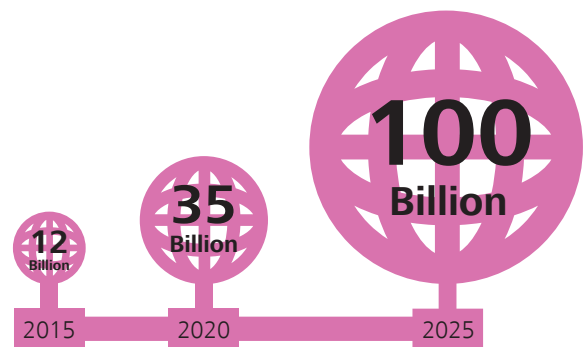
The rapid proliferation of cloud computing, Big data and Analytics, and mobility combined with many significant technology changes have created an ICT environment that has enabled the Internet of Things to rise and become one of the key disruptive forces in our economic lifetimes.

The sheer free fall cost of building and running the future ICT platform will create the environment for innovation like we have never seen before, thus impacting the economic growth opportunities for those countries that take advantage of it. Some of the trends we expect to see continue include:

- The cost of IoT sensors continue to drop in half every 10 years.
- The cost of computer processing improves by seventy-fold in the same period.

In other words, the most important necessity for IoT — connectivity — will become so ubiquitous and widespread that by 2025, sensors will be deployed and connected to a network at a rate of almost 2 million per hour or just over 47 million per day. By 2025, we could see the number of IoT devices installed, connected, and autonomously managed will reach 100 billion, up from 35 billion just five years prior in 2020 (or a staggering 300% growth!).

**BY 2025, SENSORS WILL BE DEPLOYED AND CONNECTED TO A NETWORK AT A RATE OF ALMOST 2 MILLION PER HOUR OR JUST OVER 47 MILLION PER DAY. BY 2025, WE COULD SEE THE NUMBER OF IOT DEVICES INSTALLED, CONNECTED, AND AUTONOMOUSLY MANAGED WILL REACH 100 BILLION**



**Total IoT Connections Forecast**

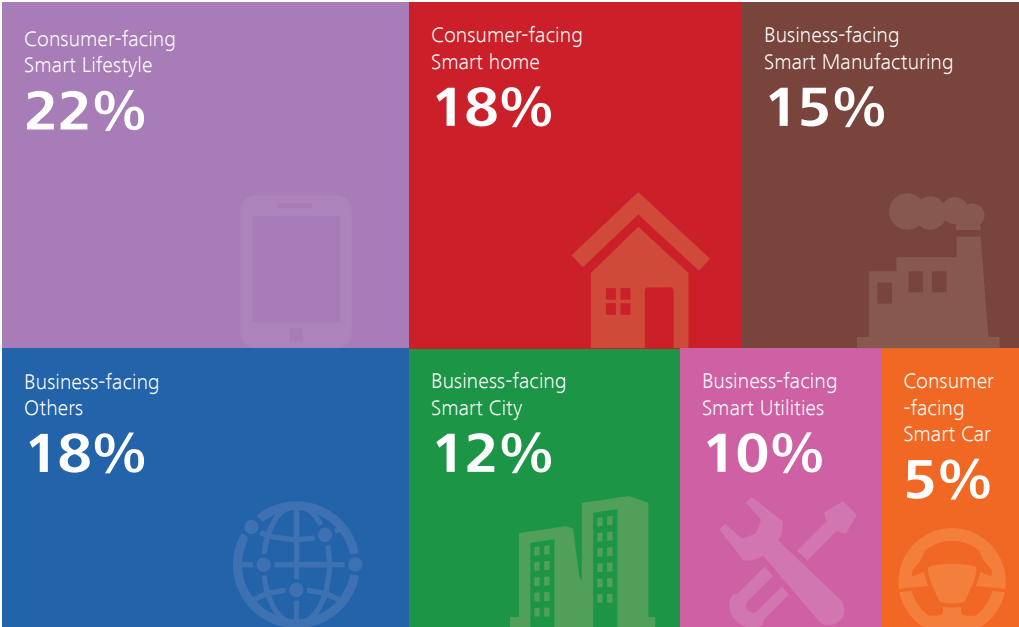


By placing sensors into products, we now change the product to become a “smart, connected” product, and let loose a new industrial revolution era. But connectivity into this data-rich infrastructure allows analytics-based information to flow across a complete supply chain, from design, to manufacturing, to distribution, to consumption. Consequently, the IoT will enable better manufacturing processes to be established with higher asset utilization, better reliability, and new and rapidly deployed functionalities and capabilities. Outbound marketing and after-sales services will be changed forever in companies. However, the biggest change IoT brings

is the massive increase in contact with customers from all industries.

Looking at the major areas in which IoT will be deployed. In 2025, we forecast that about 55% of IoT use cases will come from the business-facing (smart manufacturing, smart city, smart utilities, etc.) representing heavy investment to obtain productivity gains, asset management, and competitive advantage. We see consumer-facing IoTs at 45% comprising smart homes, smart lifestyle, smart car etc. to improve quality of life and sustainability (See figure below).

### 2025 Worldwide IoT Units by Application Areas

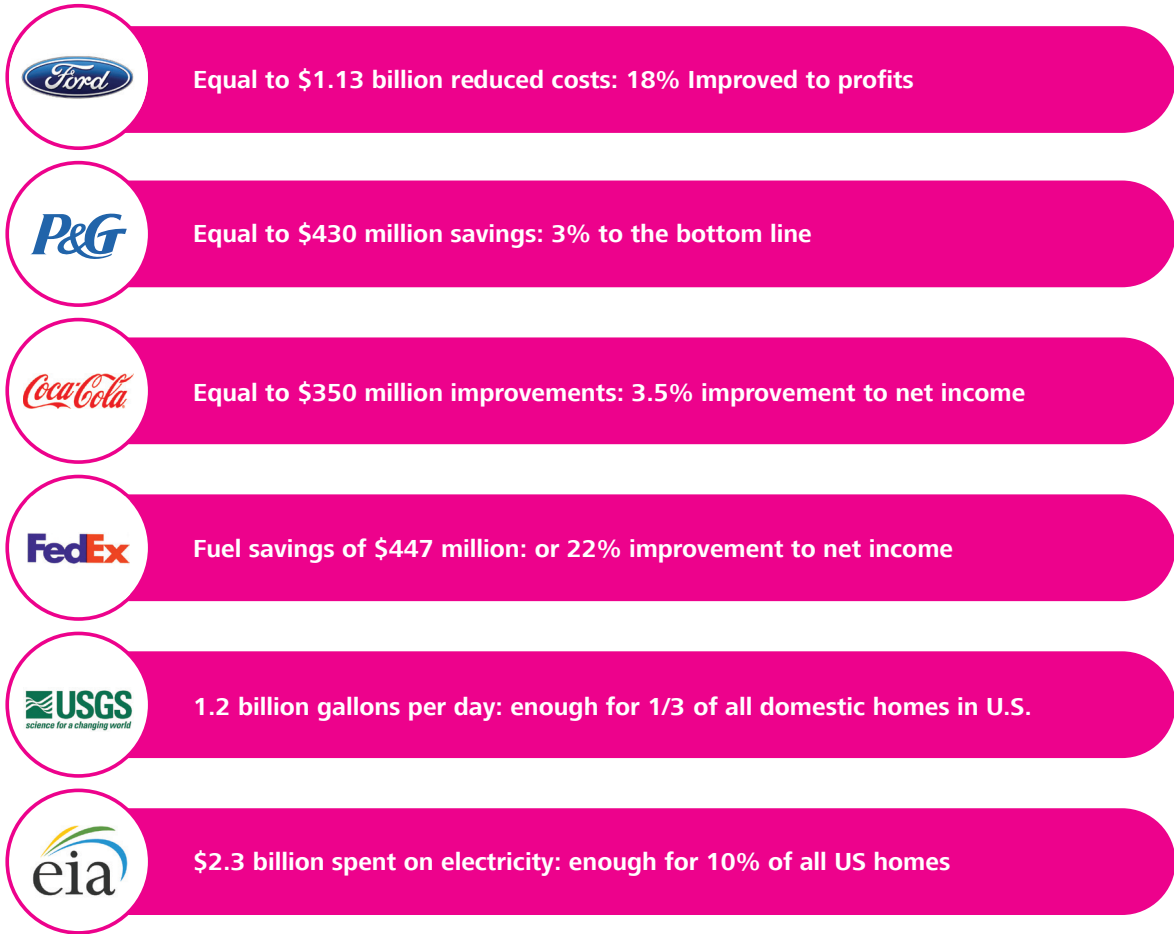


However, organizations often ask for evidence that the Internet of Things will have real or genuine economic impact on their business. To help describe a potential outcome that could happen, we looked at several industrial and public sector use cases to see what 1% of expense savings would look like if a supply chain, a manufacturing process, or workflow became IoT-enabled. The results speak for themselves — IoT brings efficiencies and better ways to do business that simply provide huge economic benefits, that make it hard to argue against not having an IoT strategy.

**IOT BRINGS EFFICIENCIES AND BETTER WAYS TO DO BUSINESS THAT SIMPLY PROVIDE HUGE ECONOMIC BENEFITS, THAT MAKE IT HARD TO ARGUE AGAINST NOT HAVING AN IOT STRATEGY.**



## The IoT 1% Effect Potential



Productivity and cost savings are just a couple of ways at evaluating the economic value of IoT by companies. Governments have a major part in this too, by making sure that the right conditions are in place. They need to encourage the continued build out of high-speed, high-bandwidth networks that will drive and capture the economic business outcomes.

This is the digitally connected world that is quickly evolving and connectivity is not only critical, but it is crucial in transforming the digital economy for each citizen, city, corporation, and country. The transfer of data between businesses, customers, agencies, and so forth is the digital lifeblood that fuels new businesses, services, efficiencies, and overall economic growth, and in fact, determines the digital economic health of any given country.

**GOVERNMENTS HAVE A MAJOR PART IN THIS TOO, BY MAKING SURE THAT THE RIGHT CONDITIONS ARE IN PLACE. THEY NEED TO ENCOURAGE THE CONTINUED BUILD OUT OF HIGH-SPEED, HIGH-BANDWIDTH NETWORKS THAT WILL DRIVE AND CAPTURE THE ECONOMIC BUSINESS OUTCOMES.**



# CONNECTIVITY: THE FOUR CORNERSTONES OF THE DIGITAL ECONOMY

Not only does connectivity drive the health of a digital economy, but also it provides the four cornerstones that hold the digital economy together. But in order for connectivity to reach its full potential it needs to be available, adopted, and provide an inspired experience. In other words, connectivity cannot stand on its own, but must be coupled with sufficient investment in IT in order to realize its full potential. There are four key cornerstones to connectivity that characterize and essentially determine its impact and influence on a digital economy.

**IN ORDER FOR CONNECTIVITY  
TO REACH ITS FULL POTENTIAL  
IT NEEDS TO BE AVAILABLE,  
ADOPTED, AND PROVIDE AN  
INSPIRED EXPERIENCE.**

## The Four Cornerstones of Connectivity



### SUPPLY

Measuring the connectivity supply and availability of infrastructure, network and transformation enablers such as bandwidth, ICT spending, datacenters, wireless coverage, cloud infrastructure, among others.



### DEMAND

Measuring the connectivity adoption or penetration of mobile devices, mobile broadband, ecommerce spending, IoT spending, cloud migration, among others.



### EXPERIENCE

Measuring the connectivity quality or experience as represented by broadband affordability, speed, and customer service throughout the connection. It also involves the quality of services and efficiency of managing the infrastructure among other things.



### POTENTIAL

Measuring the net effect of the combined scores of connectivity supply, demand, and experience on the digital economy, as well as the expected impact on future Research and Development (R&D) spending, spending intent on cloud, Big Data, mobility, and IoT, among others.

Connectivity is the foundation that holds all things together. These “things” include devices (mobile and static) to devices, devices to datacenters, datacenters to datacenters, people to sensors, sensors to clouds, clouds to clouds, and so forth.



# UBIQUITOUS SUPPLY: LAYING THE DIGITAL FOUNDATION

Making the ingredients available is the first step in any recipe, and especially so when it comes to connecting the world. Whether it be infrastructure, wired and wireless coverage, telcos and datacenters, or the data that traverses the world, each ingredient must be abundantly available so that a connection can be made.

Supply is heavily influenced by investments — investments by governments, businesses, telecom providers, cloud service providers — and the rapid rise of IoT infrastructure, platforms, and services. Investments by end users on IT hardware (servers, storage, PCs, among others), software, and services also influence the supply foundation. But investments is not the only influence by supply. Other

indicators like bandwidth use, wireless connectivity coverage, fiber optic connections, and the quality of these measures are also considered in an effort to gauge, quantify, and score the impact of supply on connectivity. Needless to say, however, that ICT investment is a critical measure and factor in bringing about ubiquitous availability of connectivity — laying the foundation for a digital economy.

Investment in datacenter infrastructure core is vital as it is the engine for cloud proliferation, which is the basis for a multitude of other measures that press toward the goal of ubiquitous broadband — a goal that is closer than ever before. But availability is just the beginning.

## 2015 Worldwide Digital Investments

**\$3,800 Billion**  
Worldwide ICT  
Investment



**\$2,227 Billion**  
Worldwide Telecom  
Investment

with 73% coming to services and  
the rest 27% to infrastructure



**\$81 Billion**  
Datacenter  
Investment

with 67% coming to servers and  
the rest 33% to storage



**\$622 Billion**  
Worldwide IoT  
Investment



# INSATIABLE DEMAND: INCREASING THE DIGITAL APPETITE

Having an ample supply of ingredients is useless, of course, if they are not being used or adopted. The goal for any ecosystem is striking a balance between robust demand and ample supply. Hence, the demand for connectivity must be measured and analyzed. People, businesses, and governments adopt technologies at different stages and at different rates depending upon growth plans and spending, and whether or not the technology provides compelling benefits to citizen's lives, corporate operations, or a country's economic foundation.

Once connected, the appetite for data, applications, and services continues to increase — driving the need for more supply and the investment in infrastructure and services. Demand can be measured a number of ways, including the number of mobile device connections and the activity driven from them.

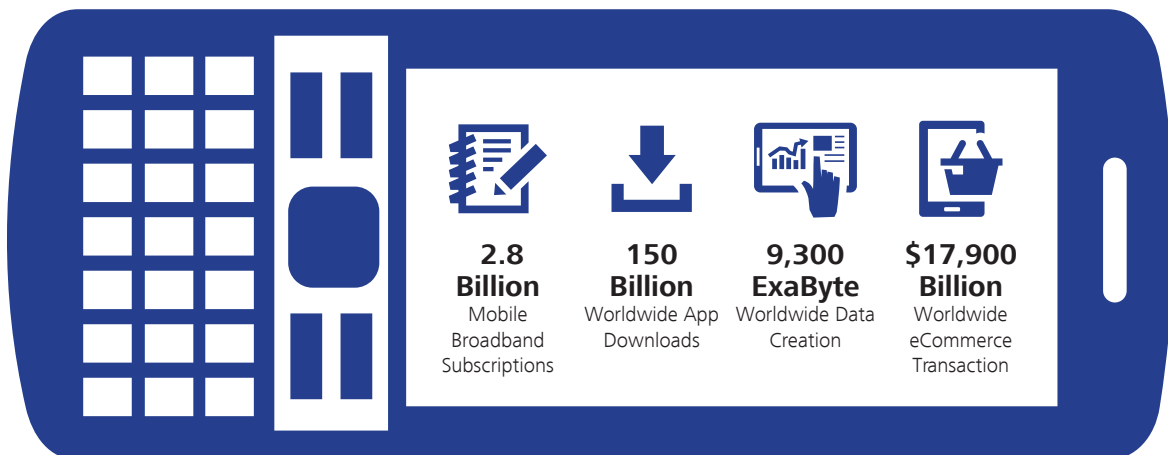
Measures that fuel connectivity's demand category are largely associated with the installed infrastructure and how it is being used. Assuming investment is taking place as noted in the supply category, then an infrastructure emerges and is used. Literal connections to fixed and mobile broadband by an installed base of mobile devices, IoT systems, and servers capture, analyze, and deliver information — all part of connectivity's

demand category. In addition, measures of ecommerce transactions, a movement to cloud-based services, and even the downloading and use of applications all influence demand. In fact, mobile application downloads, one measure of use, are expected to cross 150 billion worldwide in 2015. Although the majority of apps downloaded are entertainment-driven, an increasing number will be enterprise, productivity, and service-based as more connectivity is driven through the different areas of our lives and the things we use and wear.

Responsible for these mobile app downloads are, of course, an ever increasing number of mobile devices, expected to eclipse four billion this year.



## 2015 Worldwide Digital Appetite




# INSPIRED EXPERIENCE: GROWING THE DIGITAL PIE

Assuming ample supply and adoption, sustainability of usage and growth are highly correlated with experience. A good experience increases return customers, while a poor experience decreases return customers. In other words, the quality, value, and dependency of a connection in a world that increasingly is dependent upon a connection is vital to the sustainability of any given business. It impacts customer growth, loyalty, and in the end, spend.

Part of the experience is always related to the speed at which interactions occur — the ease of which information is requested and the speed at which the request is fulfilled. In order to accommodate this move to a real-time, on-demand digital economy, IT managers are integrating flash storage into their architectures. Whether in the form of modules, solid state drives, or all flash enterprise arrays, the growth of enterprise flash adoption is growing exponentially. Capacity shipped into enterprise will increase to nearly 60 petabytes in 2015, driving over US\$6 billion in datacenter spending to decrease latency throughout IT infrastructures, thereby improving the experience across internal and external customers.

Other factors impacting connectivity's experience



**ASSUMING AMPLE SUPPLY  
AND ADOPTION,  
SUSTAINABILITY OF USAGE  
AND GROWTH ARE  
HIGHLY CORRELATED  
WITH EXPERIENCE.**

category include affordability indices, the speed of broadband downloads, customer service, the participation in social networks, as well as datacenter infrastructure management solutions that enable the management of datacenter resource more effectively and efficiently, and is a critical component to datacenter manager's ability to be agile, efficient, and effective.

The government's adoption and use of digital technologies and platforms is a strong influence in leading a country's migration through a digital transformation and should not be discounted. Leading by example is one of the best ways to help a






government's constituents, whether it be businesses or citizens, navigate through transformative processes.

Experience can make or break next-generation businesses built upon data analytics and real-time services. Businesses must seek out ways to provide an inspired experience across their services


and applications and find creative and innovative ways to connect people to people, businesses to businesses in social ways. Social networks are very dependent upon a growing base of active and engaged users and the experience offered to them. A good Experience grows the digital pie and keeps it growing.

### 2015 Worldwide Digital Experience


**22.8 Mbps**  
Average Download Speed




**2.2 Billion**  
Worldwide Social Network Users



**1.52%**  
Average Mobile Broadband Affordability  
In Mature Countries



**5,720 Petabytes**  
Worldwide Enterprise Flash Capacity Shipped



# REALIZED POTENTIAL: BUILDING THE DIGITAL FUTURE

There is a wise saying that goes “If you fail to plan, you plan to fail.” Even if all the supply, demand, and experience related to connectivity are in place, a business cannot sit back and coast — the world is moving at too fast a pace. The IT workforce must be trained, software (SW) developers must be hired, spending on R&D must continue, governments must prepare wireless spectrum for consumption and so on. Realizing that the full potential is not only dependent on a properly trained workforce and government leadership, but also on continued or forecasted investment in the supply measures discussed previously — basically coming around full circle. Hence, the ability to realize full potential is to plan for sustained ICT investments, which typically are revealed in forecasts.

For example, interest and commitment to IoT has resulted in healthy growth projections for IoT-related forecasts. Complementing the IoT forecasts are continued plans to invest in datacenters, and not just internal enterprise datacenters but also datacenter investment in service providers, which demonstrates aggressive growth plans, and intimates continued and growing cloud investment.

**THE ABILITY TO REALIZE FULL  
POTENTIAL IS TO PLAN FOR  
SUSTAINED ICT INVESTMENTS.**

## 2015 Worldwide Digital Potential

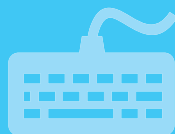
**71K**  
Worldwide ICT  
Patents



**1.3%**  
Worldwide R&D  
Spend as Percent  
of GDP



**16 Million**  
Worldwide Software  
Developers



**46 Million**  
Worldwide IT  
Workforce

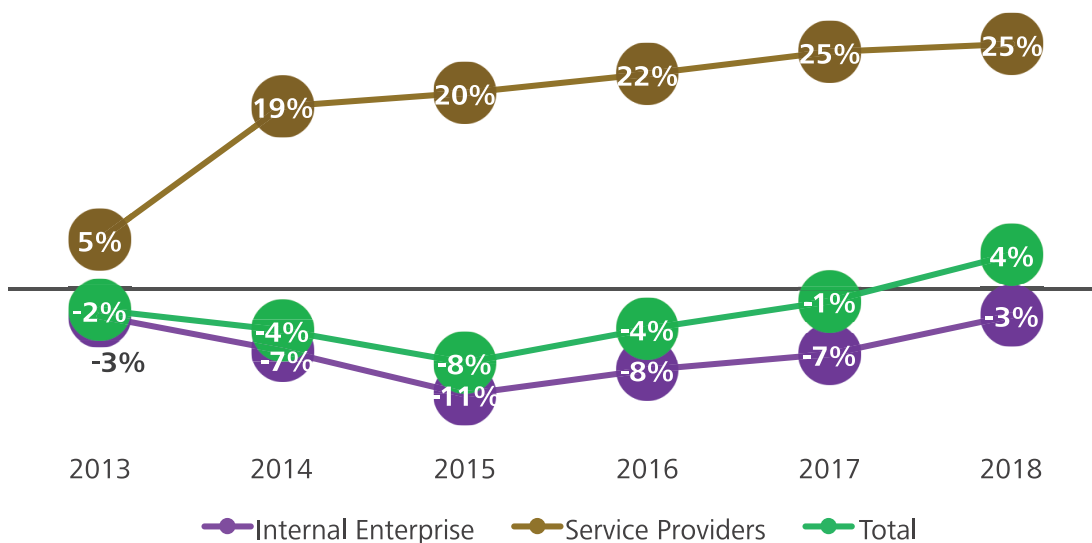


All this must happen if the full potential of connectivity is to be realized to continue building a digital economy future.

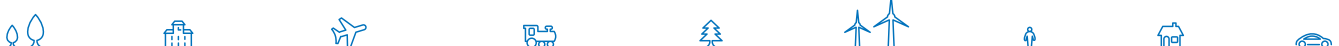
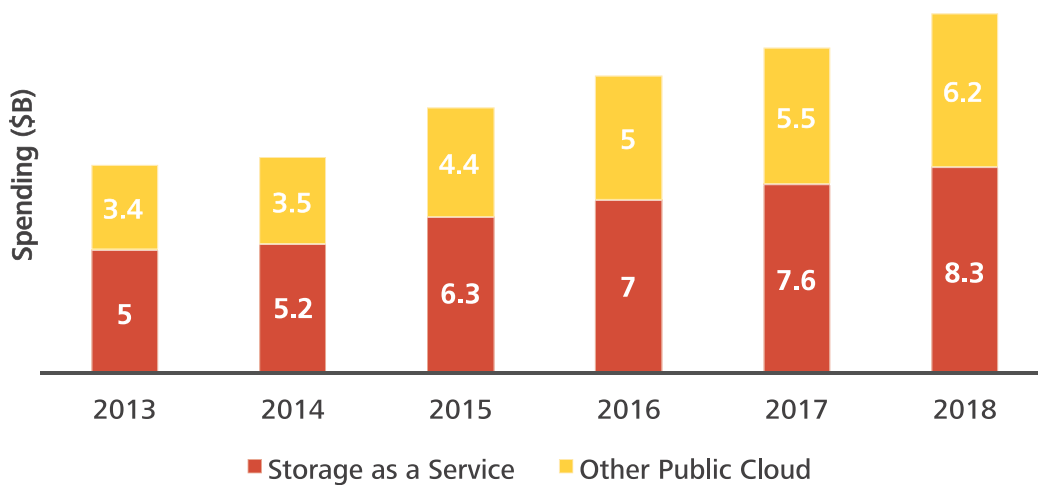
cannot stand alone in determining economic health. Instead, they must be combined in a way that not only allows a country's economic health condition to be determined, but also predicted.

But, just like connectivity, these individual dynamics,

### Growth of New Datacenter Builds — Enterprise versus Service Provider



### Worldwide Storage for Public and Private Cloud 2014–2018 Forecast



# FOUR CORNERSTONES FOUNDATION FOR FIVE TRANSFORMATION ENABLERS

The true power and influence of connectivity is truly vast in today's world, and can be seen and measured in very real and tangible areas such as the five transformation enablers of cloud, the Internet of Things, Big Data, broadband, and datacenter. These five areas are key transformation enablers to drive forward the digital economy.

Any evaluation of the impact of connectivity on a country's digital economy needs to consider the development progress of these five enablers as well. The following chapters detail out how we can integrate all these together into a Global Connectivity Index that benchmarks a country's progress and potential in transforming its economy into a digital economy.

## Five Transformation Enablers



Cloud services is the source of computational capabilities that is needed to create digital assets.



IoT comprises the devices and sensors at the edge of the digital ecosystem that enables the development of new products and services leading to new business models and digital value.



Big Data and analytics is the technology that enables the conversion of digital assets into digital value in the form of services.



Broadband is the road that connects all the digital centers, and makes it possible to deliver digital value in the digital economy. Broadband connects the edge to the core.



Datacenter is the compute and storage core that collects, process, stores, and deploys digital assets that are used to create value in the digital economy.



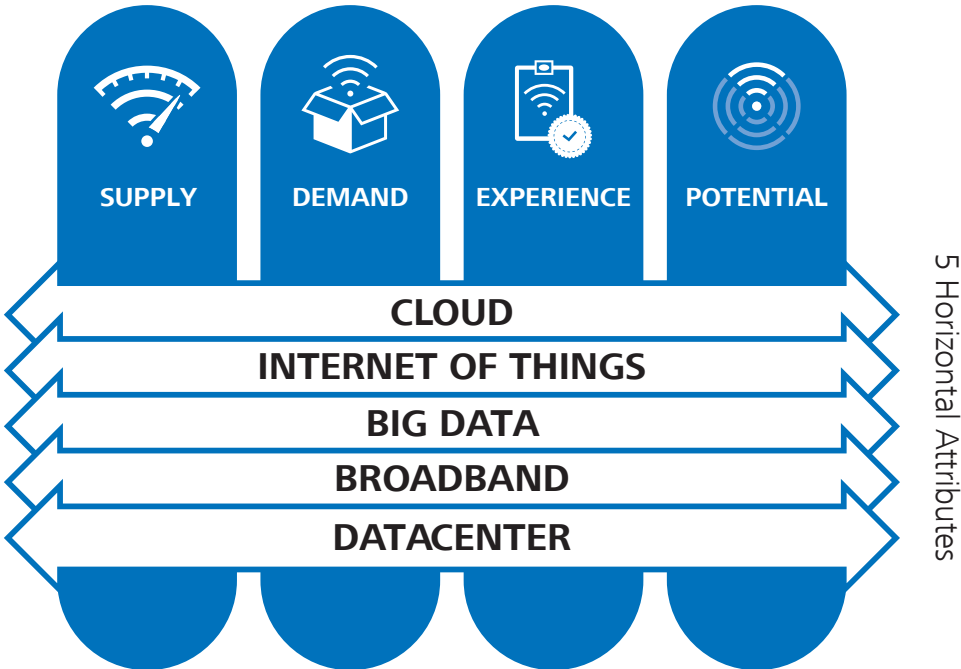
# THE GLOBAL CONNECTIVITY INDEX

The positive impact connectivity can have on any country, socially and economically, is evident and correlates well with the dynamics around supply, demand, experience, and potential. In fact, by measuring, analyzing, combining, and forecasting multiple connectivity dynamics, not only can a country's current status of economic health be determined in relation to others, but it can also be predicted. This can be done by calculating its Global Connectivity Index (GCI).

Thirty eight variables divided across four Cornerstones of connectivity (Supply, Demand, Experience, and Potential) were measured, analyzed, and intersected for fifty countries (see methodology section for full explanation). The findings of this analysis not only validate expected correlations between economic growth and technology investment and adoption, but also reveal some surprising insight around the impact of the five transformation enablers, namely, cloud, IoT, Big Data, broadband, and datacenter

**THE FINDINGS OF THIS ANALYSIS NOT ONLY VALIDATE EXPECTED CORRELATIONS BETWEEN ECONOMIC GROWTH AND TECHNOLOGY INVESTMENT AND ADOPTION, BUT ALSO REVEAL SOME SURPRISING INSIGHT AROUND THE IMPACT OF THE FIVE TRANSFORMATION ENABLERS, NAMELY, CLOUD, BIG DATA, IOT, BROADBAND, AND DATACENTER.**

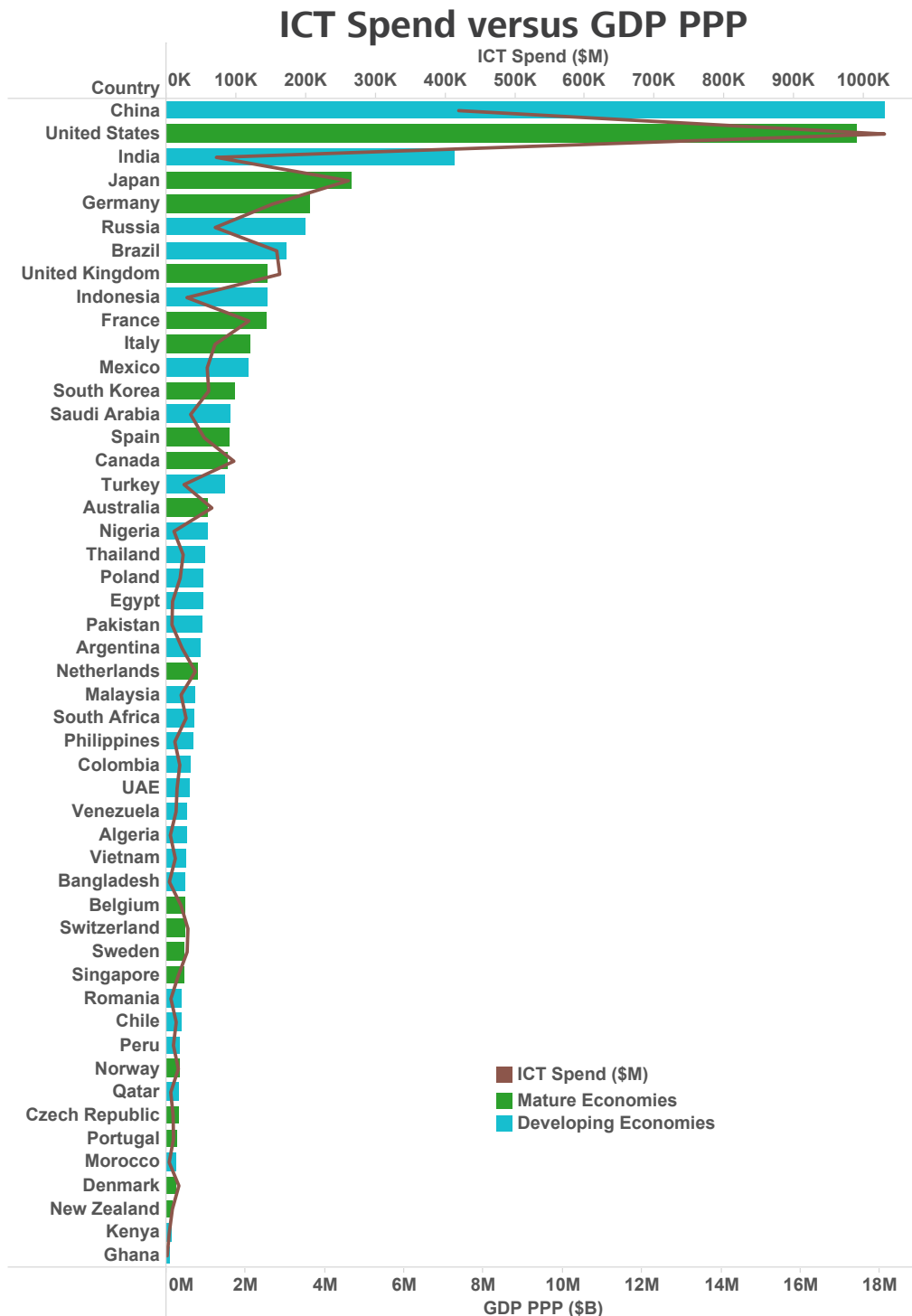
## GCI Scoring Model



# THE STRONG CORRELATION BETWEEN GCI AND THE ECONOMY

Outside of unpredictable events that can influence the world economies in positive and negative ways, the GCI metric is a reliable indicator of a country's progress toward transforming into a digital economy.

It is not surprising to see a strong correlation between a country's ICT spending and its GDP. The natural conclusion is that the more a country invests in ICT, the more positive impact it has to its GDP. See figure below.



When mapped against GDP performance, the GCI provides a similar correlation, helping to validate the GCI as an indicator of digital economy.

**Countries with higher GCI scores are also countries with higher GDP per capita.** Developed economies, as defined by the International Monetary Fund (IMF), tend to have made better GCI progress with the exception of a few countries such as Spain, Italy, Portugal, and Czech Republic. There are anomalies such as Saudi Arabia, UAE, and Qatar (off chart) that are heavily dependent on oil and thus have a disproportionately high GDP per capita relative to its GCI performance. However, if you remove these anomalies, we can see that overall, the GDP per capita correlates with the GCI performance.

Moreover, this study has shown a 20% increase in ICT investment will grow GDP of a country by 1%. And let

us not forget that the web and electronic commerce platforms now handle almost 20% of the value of all sales of goods and services, or that the ICT sector has created around 50 million jobs worldwide. Yet other studies have established a direct link between specific areas of GCI investment (e.g., broadband) and advances in productivity, net income, and gross output.



**With the strong correlation between the GCI and GDP per capita, it is clear that investment in global connectivity has a direct and tangible impact on economic growth and performance.**

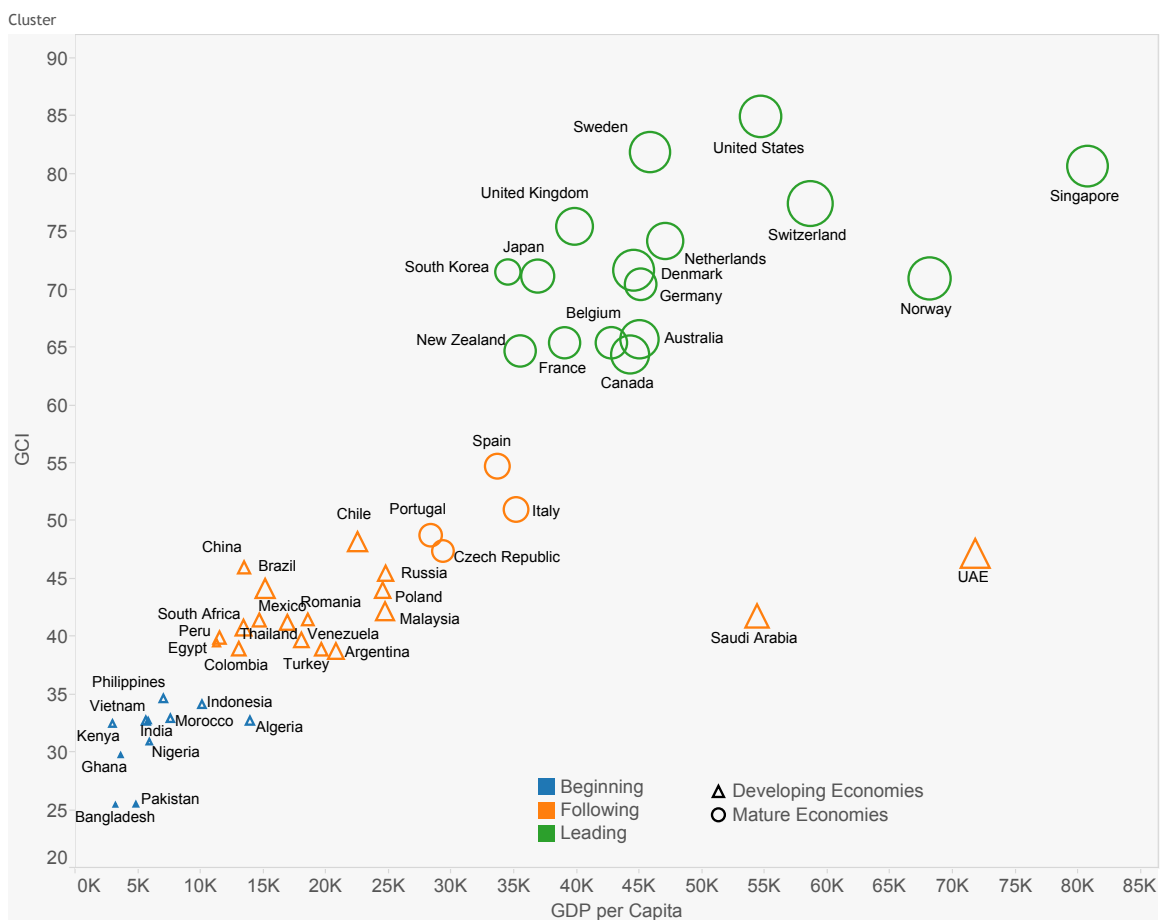
# GCI RANKINGS AND GROUPINGS

Because of the methodology behind the calculation of the GCI, not only is it an influencer of GDP, but it is also a measure of a country's progress toward total digital transformation.

When comparing the GCI performance with GDP per capita, we can see three clusters of countries based

on their GCI and GDP performances. The resulting graph reveals three layers or clusters of countries that can be identified as countries that are Leaders, Followers, and Beginners. This provides an interesting segmentation that allows us to begin evaluating countries against their peers and across various spectrums.

## GCI versus GDP per Capita



While there is much in common with the leading countries, there are at times large differences that signal opportunities for investment. In addition, the grouping of these countries is more scattered, which exposes weaknesses, as well as strengths, for certain countries.

For example, Singapore has the third highest GCI score at

81 and clearly leads from a GDP per capita perspective. In fact, it is the only leading country that scored above the average of its peers on all the connectivity categories (supply, demand, experience, and potential), as well as all the horizontal attributes. Indeed, Singapore has distanced itself from the rest of the leaders by focusing on a well-balanced ICT investment strategy that earns it a leading GCI score, as well as maximizes its GDP





per capita. Singapore’s Smart Nation strategy seeks to circumvent the limitations of natural resources, and leads to the development of “Digital Fuel” as the “new oil” to drive its economy forward.

With the top GCI score, the United States finds itself fourth among its peers from a GDP per capita

perspective. The United States scored “above average” of its peers in all the connectivity categories and across all the horizontal attributes except one, that is, broadband. This is a result of lagging behind significantly in the proliferation of fiber to the home (FTTH), thereby reducing the availability of high speed experience throughout its population.

## GCI Ranking Table

Leaders	Followers	Beginners
1  United States <b>85</b>	17  Spain <b>55</b>	40  Philippines <b>35</b>
2  Sweden <b>82</b>	18  Italy <b>51</b>	41  Indonesia <b>34</b>
3  Singapore <b>81</b>	19  Portugal <b>49</b>	42  Morocco <b>33</b>
4  Switzerland <b>78</b>	20  Chile <b>48</b>	43  Algeria <b>33</b>
5  United Kingdom <b>78</b>	21  Czech Republic <b>48</b>	44  India <b>33</b>
6  Netherlands <b>74</b>	22  UAE <b>47</b>	45  Vietnam <b>33</b>
7  Denmark <b>72</b>	23  China <b>47</b>	46  Kenya <b>33</b>
8  South Korea <b>72</b>	24  Qatar <b>47</b>	47  Nigeria <b>31</b>
9  Japan <b>71</b>	25  Russia <b>46</b>	48  Ghana <b>30</b>
10  Norway <b>71</b>	26  Brazil <b>44</b>	49  Bangladesh <b>26</b>
11  Germany <b>71</b>	27  Poland <b>44</b>	50  Pakistan <b>26</b>
12  Australia <b>66</b>	28  Malaysia <b>42</b>	
13  Belgium <b>66</b>	29  Saudi Arabia <b>42</b>	
14  France <b>66</b>	30  Romania <b>42</b>	
15  New Zealand <b>65</b>	31  Thailand <b>42</b>	
16  Canada <b>65</b>	32  Mexico <b>41</b>	
	33  South Africa <b>41</b>	
	34  Peru <b>40</b>	
	35  Venezuela <b>40</b>	
	36  Egypt <b>40</b>	
	37  Colombia <b>39</b>	
	38  Turkey <b>39</b>	
	39  Argentina <b>39</b>	

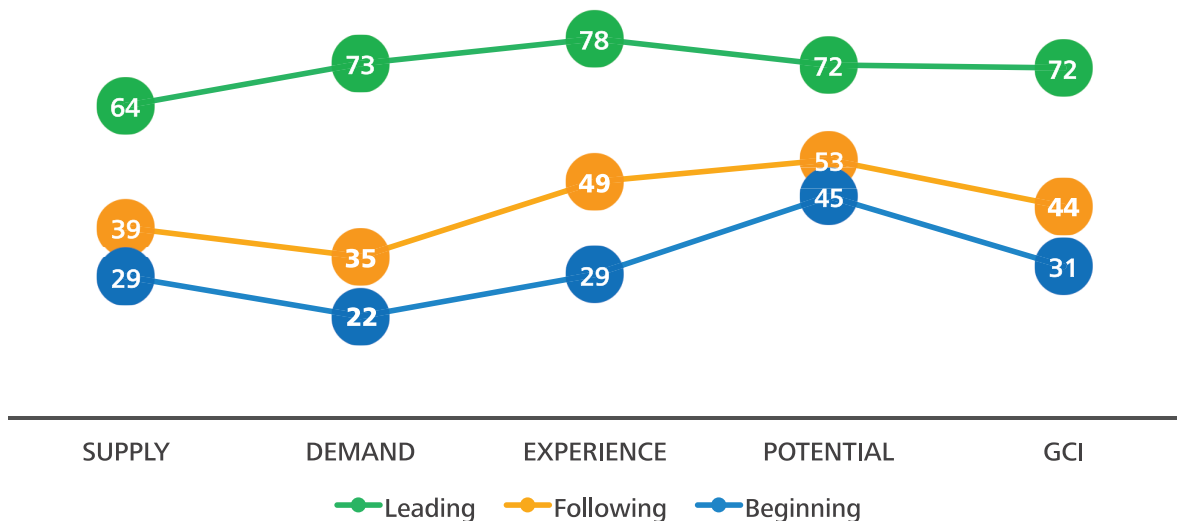


The next grouping of countries can be referred to as Followers — some are fast followers, and others less aggressive. Spain is an example of a fast follower, but is also one of four “mature” countries that did not make it into the leadership category. The “follower” countries is the largest segment of the 50 countries investigated. These are mainly developing economies. The countries, with a couple exceptions (notably Saudi Arabia and the United Arab Emirates) are more tightly grouped than the leading countries and perform more similarly with their peers.

Unlike the leading countries, however, their performance does not exceed that of developing

countries by near the margin. For example, on average, the GCI score of the leading countries was 65% more than the average score of following countries and 130% more than the beginning countries. However, the average GCI score of a following country was 40% more than the average of a beginning country. It is therefore concluded that the Follower countries as a group are closer to the Beginners than the Leaders, and this bears out with many of the performance scores. In the figure below, the Follower country line is closer to that of Beginners, with a substantial gap from the Leaders. But, there are some interesting areas of promise if some of the Follower countries take note and invest wisely.

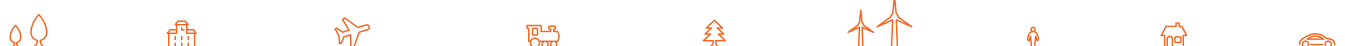
### GCI Performance by Clusters



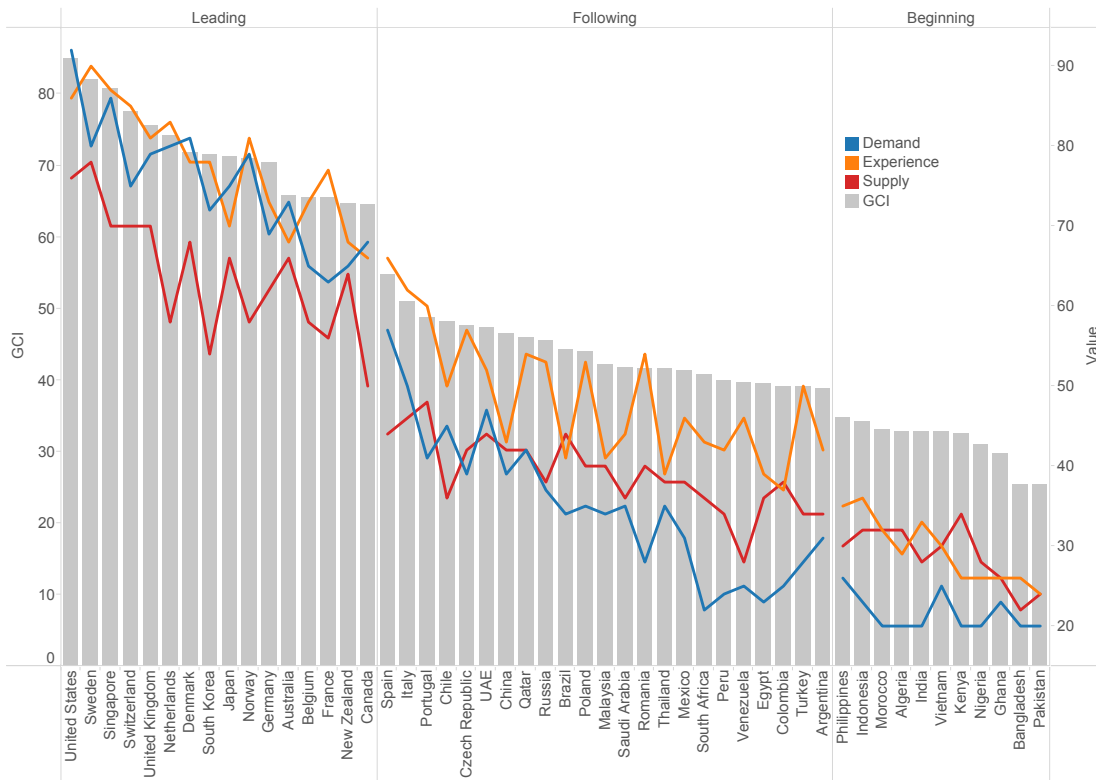
There are several mature economies that fall into the Follower cluster. They are Spain, Italy, Portugal, and Czech Republic. Although these countries have been defined as mature economies by the IMF, their GCI performance puts them in the realm of developing economies. It is likely that the economic slowdown of current years has crimped their investment in developing their connectivity systems, thus leading to lower performance. These countries are at risk of being overtaken by developing economies and further losing their competitiveness in this era of digital economy. We will discuss more of this in the

subsequent section.

When we take a deeper look into the performance of each cluster in terms of Supply, Demand, Experience, and Potential, we see that the Leaders often have “Demand” and “Experience” rating better than “Supply.” This indicates that countries that lead in the digital economy have not only invested to build the necessary supply of connectivity services but have also invested effort in ensuring higher adoption and use of the technology as well as a better experience for the users.



# GCI Performance by Countries



On average, Leaders have “Experience” scores that are over 1.6 times the Followers and “Demand” scores that are more than double those of the Followers. This indicates that it is not enough to just build supply but that countries need to also invest to grow the adoption and use of the technology, especially the transformation enablers such as

cloud, Big Data analytics, and IoT. Part of helping to drive higher adoption and use is to ensure that the experience is up to par at a level good enough to stimulate widespread adoption. For example, having broadband coverage without ensuring sufficient download bandwidth and affordability makes it a poor experience and thus would result in lower demand or adoption.



# MATURE ECONOMIES HAVE BALANCED THE SUPPLY OF CORE AND THE EDGE

All the leading countries are mature economies. These countries have built out their network to the edge to support the digital economies, but they have also invested in the center core to support transformative technologies of cloud, Big Data analytics, and IoT.

If there was one measure in which the Follower countries were closer to as the leading countries, it is in the area of the broadband attribute. On average, 3G coverage and fiber to the home (FTTH) are almost the same for the

Follower countries as they are for the Leader countries. Network QoS is quite high and similar for all countries.

Although bandwidth remains a lagging issue, the Follower countries have invested to push out their 3G networks and FTTH and ensured appropriate QoS similar to the Leaders. This indicates the Followers have built out their networks to the edge, but they lag behind quite considerably in building out the core to support the entire edge of connectivity.



**Building the core.** Datacenter investment and related ICT and telecom investment are much higher for Leaders compared with Followers. The Leaders have spent effort to build out their core and not just the network to the edge. To better realize their broadband investments into digital value, the Followers and Beginners need to invest to build the core. Countries such as Sweden and Singapore have benefited from strong government incentives to develop datacenter clusters in the country to support its citizens, businesses, and government to move to the digital economy.



**Analytics spend.** To monetize the digital environment, countries need to invest in data analytics to turn digital content into valuable products or services. Sweden has invested in building out its Big Data analytics industry with QlikTech as one of its more well-known startups. This is a critical step in realizing a digital economy. Followers have yet to ramp up their data analytics supply.



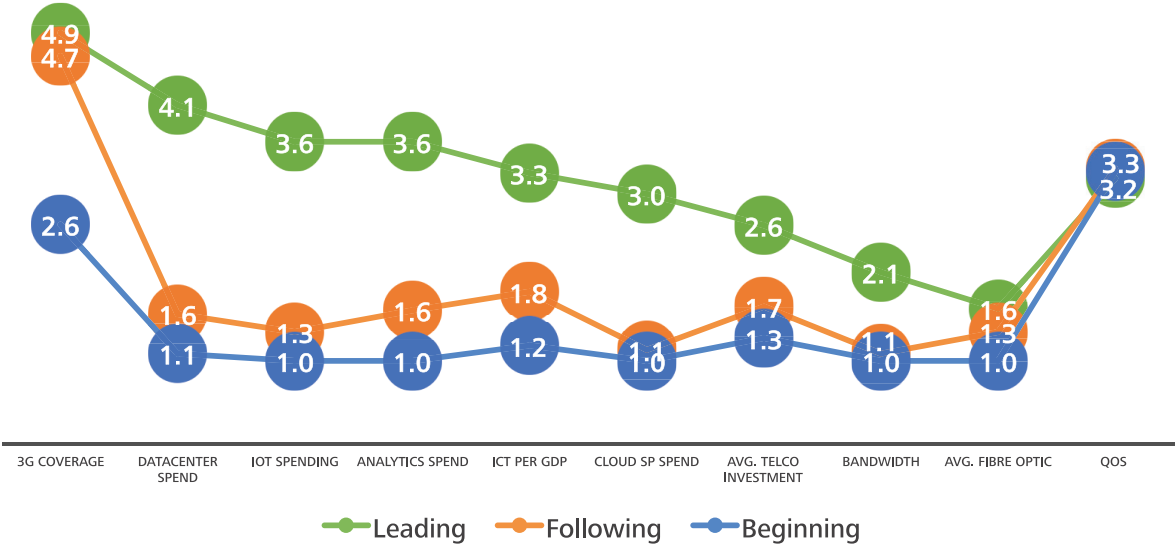
**Cloud service provider spending.** Service providers in the leading countries have been investing quite heavily to build their cloud capabilities. In this aspect, the Followers' spending is similar to that of the Beginners and far behind the Leaders.



Followers and Beginners need to ramp up their investment to build an adequate supply of core systems and transformation enablers and not just focus on pushing out the network. For countries to

improve their GCI, they need to ensure that both the core and the edge get balanced investment attention. The edge does not exist without the core.

### Cluster Performance by Supply Factors



# MATURE ECONOMIES HAVE SUCCESSFULLY DRIVEN DEMAND BESIDES PROVIDING GOOD SUPPLY

In general, while Leader countries scored better throughout all the various connectivity measures, they especially outperform the Followers and Beginners in demand factors. “Demand” was the strongest of these measures and indicates a much stronger investment in broadband, especially mobile, and a greater percentage of ICT budgets that have migrated to cloud platforms. Better experience and more affordability performance also drive ecommerce,

which fuels more innovation and investment.

As seen in the figure below, the demand factors that have the largest performance gap between Leaders and the rest is in the higher adoption of data analytics, ecommerce activity, and IoT devices installed. Other factors include the higher penetration rate of mobile broadband and cloud use compared with Followers and Beginners.



**Mobile broadband.** Adoption of mobile broadband is usually determined by experience factors such as the quality of the download speed and affordability. Lower mobile broadband adoption by developing countries (despite a higher number of mobile users) means a large proportion of its population is still using the mobile devices only for basic communication purposes. Mature economies such as the United States and United Kingdom have over 60% mobile subscribers as mobile broadband users. However, developing countries average about a 20% rate.



**Cloud migration.** Cloud adoption is dependent on the buildout of datacenters and adequate broadband performance. We can see that fixed broadband and server installed base (as a proxy for datacenter demand) are also areas that Leaders have outperformed the rest with a substantial gap, which may be affecting adoption of transformation drivers such as cloud, Big Data analytics, and IoT.



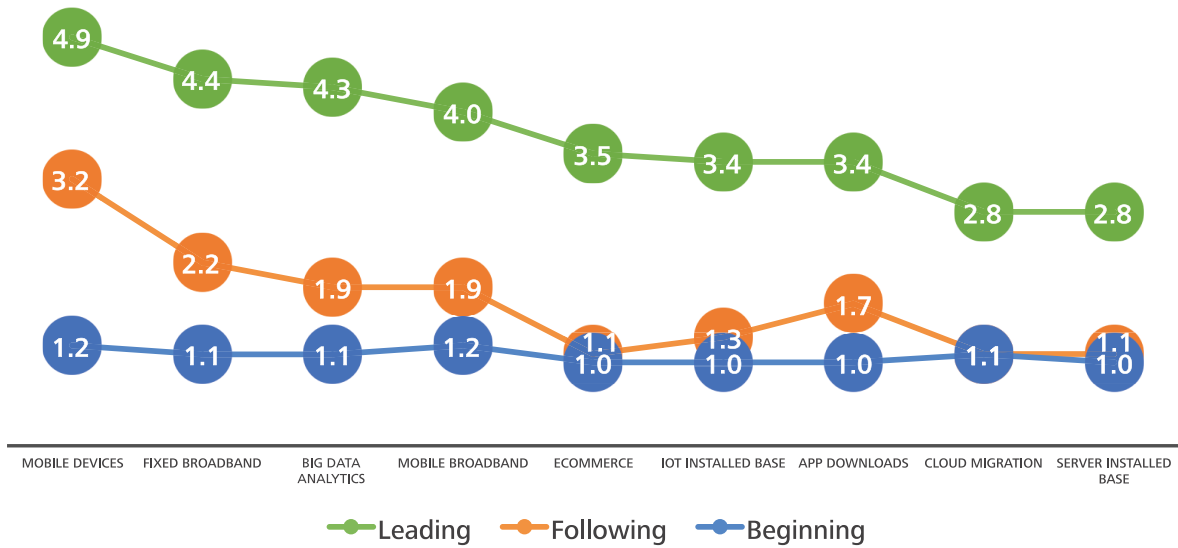
**Data analytics.** The lower mobile broadband penetration rate and the lack of cloud usage by Followers and Beginners have an impact on the supply of data for analytics. This lack of data as fodder for the analytics sector will hinder the use of data analytics for smart decision making, thereby affecting IoT implementation as well.



**eCommerce.** Although apps download is one of the higher-performing areas for developing markets, it has not moved on to value-creating ecommerce activities. Developing countries would need to move more of commerce to the digital platform by improving its broadband performance and helping companies move to a digital business model hosted on the cloud.



## Cluster Performance by Demand Factors



What differentiates the Followers from the Beginners is that they have higher mobile devices adoption, higher fixed broadband penetration rate, and moderately higher use of data for analytics and application downloads. However, the Followers need to invest efforts into driving up adoption of

connectivity to break away from the Beginners and join with the Leaders. There is no shortcuts to the digital economy; building out the demand on top of investing in supply is a necessary stage of development.



# DEVELOPING COUNTRIES NEED TO RAMP UP THEIR EXPERIENCE FACTORS TO BECOME GCI LEADERS

Unlike the “supply” and “potential” performance in which the Follower countries have a smaller gap with the Beginners, in “experience” factors, the Followers are performing closer to the Leaders and further from the Beginners. Note the following areas in which the Follower countries have opportunity to significantly improve their GCI score.



**Broadband affordability.** One of the largest gaps is in fixed broadband and mobile broadband affordability. In this area, while the Followers lag behind the Leaders, they are quite far ahead of the Beginners. Increasing broadband availability and making it affordable are areas that Followers need to improve to stimulate demand as mentioned earlier.



**Datacenter quality.** Datacenter quality and network latency is hindering the adoption of cloud and also network-dependent technologies such as IoT. While the telecommunication quality is rated quite well, there lacks the investment in the core to improve the datacenter and network latency. Latency, in particular, is performing at the level of the Beginners and has the widest gap with the Leaders, indicating a need to improve the network experience to support cloud, IoT, and data analytics.



**eGovernment.** The experience of government can be used as an indicator of the experience of a digital economy. Public services touch all communities and businesses in the country, and the quality of government digital services is an indicator of digital experience. In this respect, due to the lower performance of broadband and datacenter, it affects the government quality, slowing down digital adoption by the country. It is not surprising that countries with good government performance also has good broadband quality such as Singapore and Canada.

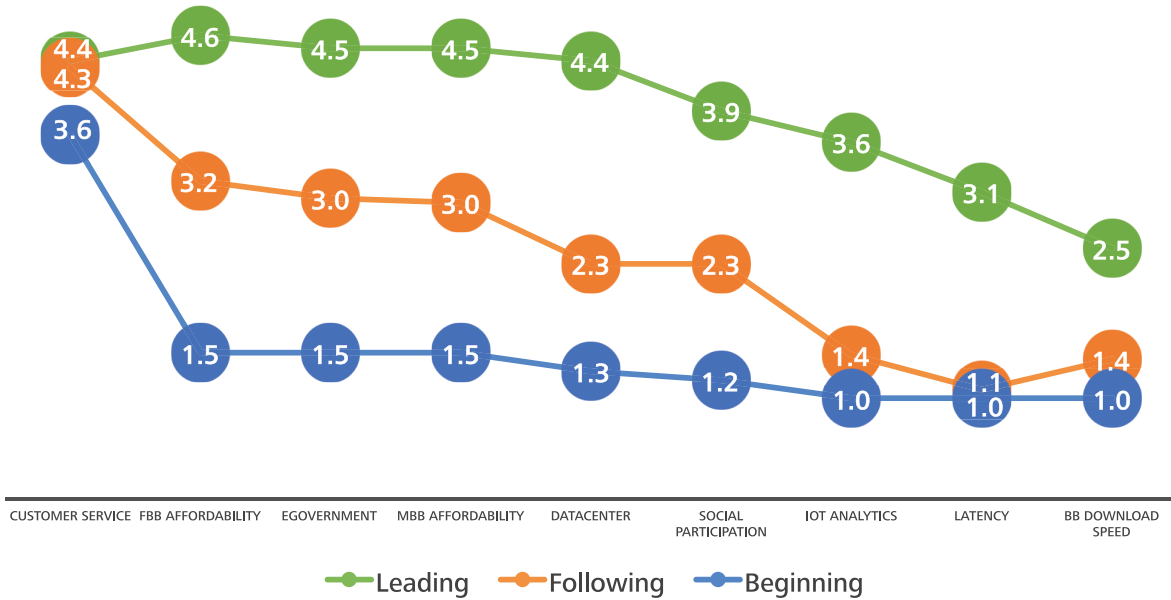


**IoT.** IoT analytics is an indicator of IoT experience. IoT devices create value by providing information and insights into our daily routines and processes. This runs on data analytics, and the lack of adequate data from social, commercial, and personal sources in a digital form hinders the adoption and quality of the IoT systems. This is a critical area that is linked to the aforementioned factors. Without decent broadband and datacenter setups, there is lower experience of digital services leading to lesser data for analytics and IoT use.





## Cluster Performance by Experience Factors

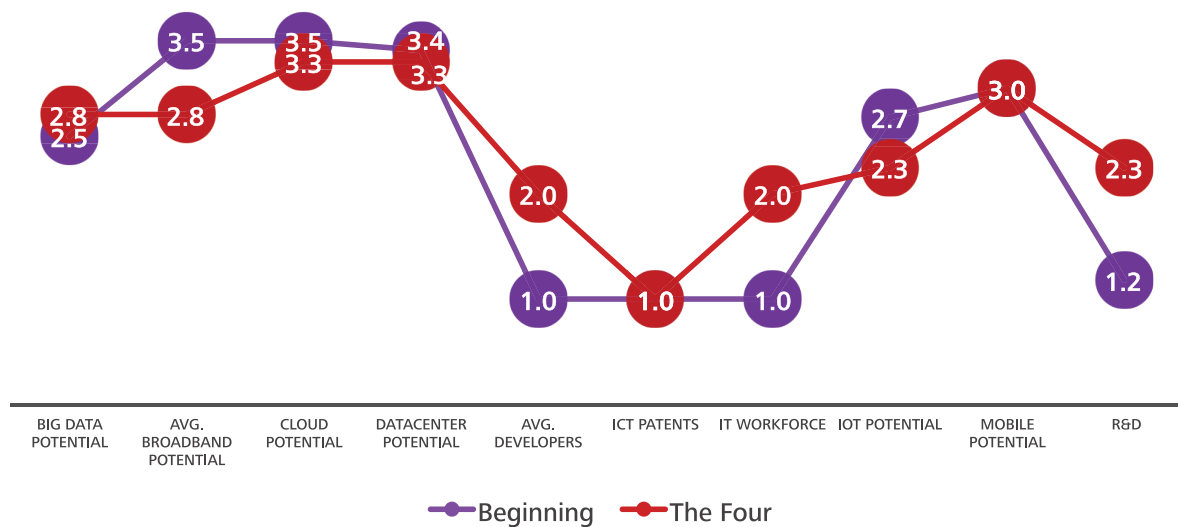


It is not just the breadth of connectivity but the quality of the experience that drives demand and moves a country toward the digital transformation of society and economy.



# FOUR MATURE COUNTRIES AT RISK OF FALLING BEHIND

## Four Mature Countries Performance by Potential Factors



Spain, Italy, Czech Republic, and Portugal are all considered to be mature countries for all intents and purposes, yet these four countries stand separately within the “following” segment from the other mature countries that are positioned well within the “leading” group of countries.

One needs only to compare these four countries in aggregate with the other country groups to discover the risk they are facing. The figure above illustrates the essence of why these four mature countries are at risk of falling further in the GCI rankings — “potential” performance.

Part of the “potential” score is based on in-country research to ascertain the intent of companies and governments to invest in the five transformation

technologies. On average, these four countries actually scored lower than beginning countries on all but one attribute: Big Data...and this just barely. It points to a lack of vision by business leaders and government organizations. Digital transformation does not happen without deliberate decisions, actions, and spending, and these four countries are not displaying any vitality or will.

Interestingly, these countries, on average, have a skilled workforce and software developers and R&D spending that exceeds the average performance of the Follower countries. However, these four countries performed no better than the Beginner countries on ICT patents, pointing to a skilled IT workforce that is dwindling without a solid vision and investment strategy from their IT and government leaders.



# DEVELOPING COUNTRIES HAVE SIGNIFICANT POTENTIAL TO RAMP UP THEIR GCI

Nearly 20% of the 50 countries are characterized as Beginners based on the clusters analyzed in figures earlier. It is interesting to note that as the GCI scores decreased, the groupings became tighter or more densely packed. This is indicative of the synergistic ties between connectivity measures — sometimes, one variable may influence another variable’s performance directly, indirectly, or have a multiplying or compounding effect resulting in greater variations of scores.

Countries that are not in the leading group must not despair, but instead, must take steps to improve their GCI in logical and prioritized ways. On average, Leader countries are significantly ahead of Follower and Beginner countries by over two times, and in some cases over three times (such as demand), but there are two areas in which Follower and Beginner countries are much closer, like “potential” and “broadband.”



**Potential.** The “potential” score is heavily influenced by the surveys that took place in each country, investigating and analyzing future market growth potential across the horizontal connectivity attributes. Unfortunately, desire is one step — one big step — away from doing, and without deliberate and concrete plans or directives, it is easy for governments and IT managers to put off spending and other technology decisions based on near-term dynamics. Nevertheless, digital transformation begins with a plan and an investment strategy that should make sense, but begin logically: prioritize the datacenter and infrastructure spending.



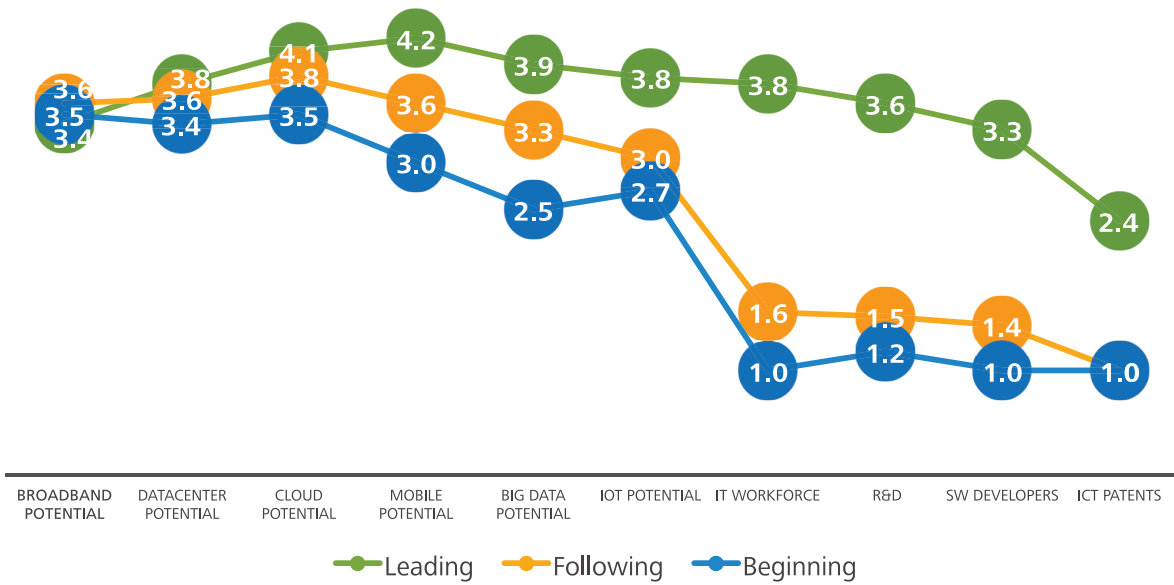
**Broadband potential.** The future potential of the country to grow its GCI based on its fixed broadband and datacenter plans is high for Followers and Beginners and similar to Leader countries. This shows that the developing countries are able to close the gap with the mature economies by continuing the buildout of their connectivity core and edge infrastructure to support their digital transformation journey.



**Cloud, mobile, Big Data, and IoT potential.** The gap widens here between the Leaders and the Followers and Beginners. The potential for the developing economies to leverage these transformation enablers to drive their digital economy is somewhat muted as they still need to invest to improve their datacenter core as well as drive up demand and experience of their connectivity.



## Cluster Performance by Potential Factors



**Digital economy enablers.** Perhaps one of the greatest weaknesses resulting in low potential performance is the general lack of ICT patents, which is a result of a lack of skilled IT workers and professionals. Both Follower and Beginner countries, which are mostly developing economies, showed a large gap. Countries (Followers and Beginners) wishing to improve their potential in transforming their economies must find ways to develop and train skilled IT workers, as well as to attract non-native workers to improve their ability to adopt and develop new technologies that can propel their own businesses and societies, as well as to share with other countries. This lack of technically skilled workforce also tends to dampen R&D spending — another measure in which leading countries are spending two to three times more. These are key soft areas that developing countries need to focus its development on besides the “hardware” aspects mentioned earlier. There is more discussion of this in the subsequent chapters of this study.

One Beginner country that may be a surprise is India. There is very little that stands out when evaluating India’s connectivity scores against its peers. Having a massive and dispersed population is somewhat of hindrance and challenge, but other countries such as China, the United States, and Brazil have managed to progress much further with digital transformation. China has benefited by taking on the manufacturing needs of the world, having to integrate technology to build manufacturing facilities, lines, and products. The country has invested in training skilled IT professionals to help bring about efficiency in its processes and workforce. Brazil, on the other hand, leads China and India in its ICT spending per capita, which has been shown already to correlate well with GDP and digital transformation. India, while

it has some manufacturing base, has focused more on services and software, which requires knowledgeable and skilled IT workers, but perhaps does not lend itself to some of the measures around connectivity and the GCI such as datacenter and cloud investments. This is not to say that India must attract manufacturing to aid its digital transformation path, but instead, must focus on ICT investment in cloud-based services, leveraging its vast population with increased mobility and broadband, in which India has very low performance compared with its peers.

While the GCI is a useful index to gauge a country’s stage of progress toward transforming its economy,



there are other indicators of a country's potential, which include looking at its current penetration rate relative to mature economies and estimating what is the untapped potential given its size.

Developing economies have substantial growth momentum to leverage their untapped users to accelerate their GCI. Brazil, Russia, India, Indonesia, and China (BRIIC) show tremendous growth potential being trillion-dollar economies but severely lagging behind in their ICT spending as a percentage of their GDP compared with the mature economies. The only exception is Brazil, which has been ramping up its spending and has one of the higher GCI scores among the developing countries. China presents a large juggernaut in terms of its economy and the potential of its GCI growth if it moves to grow its ICT spending to 3% of GDP. It is on the way to do that with one of the highest IT spending growth CAGR for the next five years. Indonesia now has to catch up, and its growth momentum is large, given its growth CAGR as well as its small 1% of GDP spending.

**DEVELOPING ECONOMIES HAVE SUBSTANTIAL GROWTH MOMENTUM TO LEVERAGE THEIR UNTAPPED USERS TO ACCELERATE THEIR GCI. BRAZIL, RUSSIA, INDIA, INDONESIA, AND CHINA (BRIIC) SHOW TREMENDOUS GROWTH POTENTIAL BEING TRILLION-DOLLAR ECONOMIES BUT SEVERELY LAGGING BEHIND IN THEIR ICT SPENDING AS A PERCENTAGE OF THEIR GDP COMPARED WITH THE MATURE ECONOMIES.**

## ICT Spending Potential Based on GDP Percentage



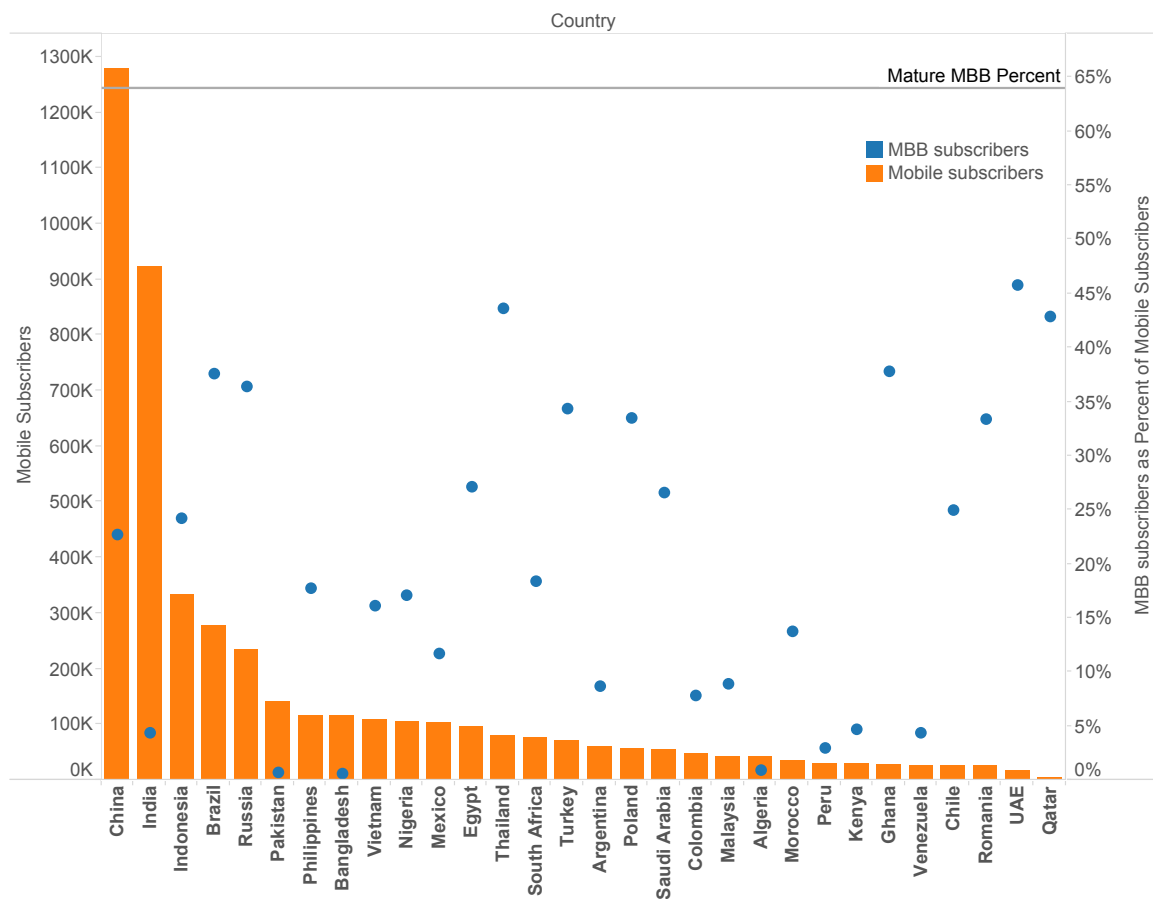
While the chart may indicate ICT spending intensity based on GDP, it is also important to consider where the spending happens whether in the supply areas or in driving up demand and experience. Singapore and South Korea may have a lower intensity in terms of ICT Spending per GDP but their investments in the Demand and Experience areas have resulted in a high GCI score.

Going beyond dollars, we also see tremendous growth momentum in another indicator: the uptake of mobile broadband as a percent of all mobile subscribers. The figure below shows the developing countries' mobile subscriber base and their mobile broadband penetration rate. Compared with the

64% penetration rate average of mature economies, the developing countries have a significant upside as they have only about 20% of mobile subscribers on average.

Again, the BRIIC countries have a large upside growth momentum if they look into investing to improve the demand and experience of their mobile users. Looking ahead, we expect that the developing economies will have strong growth momentum that is able to propel the digital transformation of their economies much faster than the mature economies — provided the developing economies pay heed to address the gaps raised earlier.

## Growth Momentum as Represented by Mobile Broadband Subscribers



# DEVELOPING ECONOMIES NEED TO INVEST IN TRANSFORMATION ENABLERS

When we consider the five transformation enablers that drive digital economy growth, we see that the broadband performance and cloud performance of developing markets have the least gap. However, the datacenter gap is quite substantial. This again highlights the issue of developing markets needing to balance the buildup of the core with the network and the edge. Big Data analytics and IoT have the largest gap among all the areas. Developing markets are mainly still using technology to improve productivity as an operational tool but have not moved on to leverage technology to transform their economy with new capabilities, products, and services as a strategic tool.



**Cloud.** The buildout of broadband and datacenters enable service providers to provide cloud services to the market, thereby helping to adopt new services and processes that were previously too expensive or not possible due to their immobile nature of computing. Countries with strong datacenter and broadband performance tend to have good cloud performance, such as the United States and Singapore.



**IoT.** Mature countries have already realized the importance of collecting data from multiple sources. Investment in the necessary infrastructure and software is happening to manage and analyze this data to provide compelling services, as well as to drive efficiency and agility into datacenter infrastructures. This has led to more aggressive IoT strategies and spending intent. Mature countries understand that to realize the full potential of IoT and Big Data, there needs to be continued investment in connectivity as it relates to networks and datacenters.



**Big data analytics.** Several mature countries such as Sweden, United States, Singapore, and Germany have realized the importance of data analytics to convert large amounts of data and information into valuable insights. This is a necessary enabler for countries to improve their competitiveness in a digital economy.



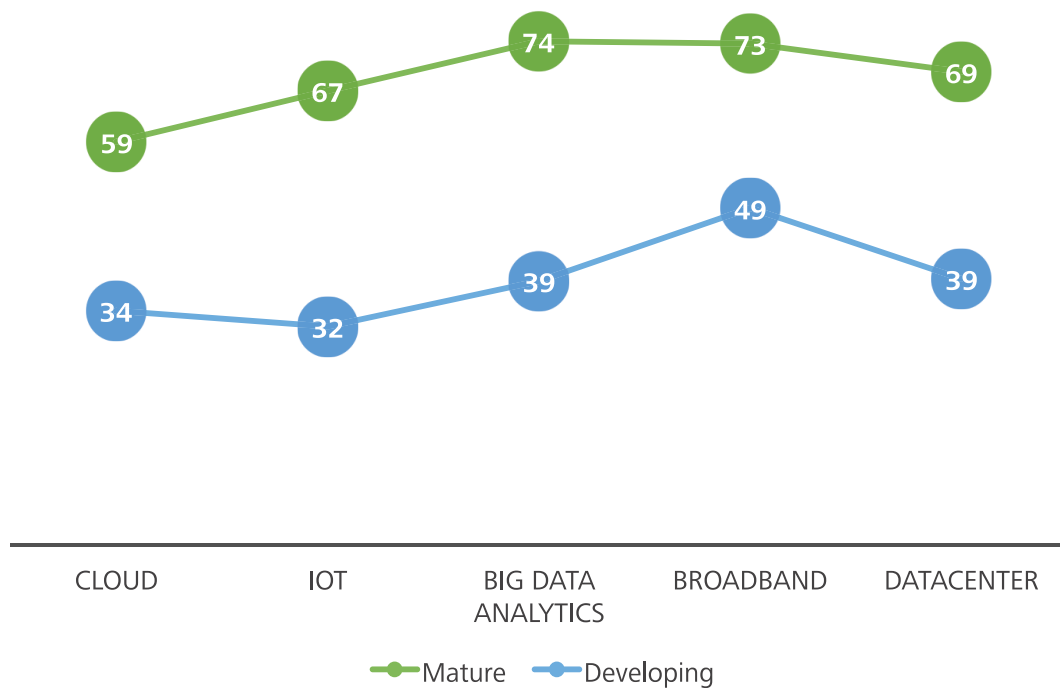
**Broadband.** Ubiquitous broadband continues to be one of the top priorities for countries. The increasing amount of data being captured, delivered, and analyzed only to be delivered again continues to increase exponentially. Broadband is a key element to successful connectivity measures, including QoS, latency, speeds, social networks, and ecommerce. Developing countries can take solace that this is an area in which they are performing close to mature economies that make up the Leaders.





**Datacenter.** Not only are developing countries investing insufficiently in datacenters, the investment in servers and other datacenter infrastructure is less than half of mature countries. While the intent to invest in datacenters is nearly as strong as the leading countries, there continues to be a deliberate need to follow through with ICT investment strategies, including datacenters.

### Five Technology Scores for Mature and Developing Economies





# THE FOUR ASPECTS OF THE DIGITAL ECONOMY

Besides the hard technology indicators mentioned previously, we also looked at four other aspects in assessing the progress toward a digital economy. They are as follows:

## ICT Spending

Ongoing ICT spending is crucial to maintain the transformation momentum towards a digital economy. Mature economies tend to spend at least 3% of their GDP on ICT investments.

Within the developing markets, Brazil stands out as the most aggressive (ahead of Singapore and South Korea) with respect to the ICT spending cornerstone measure. Of the rest, China, South Africa, Chile, and Spain tend to be leading the rest of the developing countries, with Turkey, Romania, and Egypt representing the least aggressive countries investing in ICT as it relates to the strength of their overall economy.

## ICT Skills

Comparing the horizontal layers, there is a notable and strong correlation between IT workforce and IoT/Big Data. This highlights the necessity to invest in education and training to create a workforce with the ability to leverage the economic benefits of data analysis and IoT. The lack of local language ICT skills is a major hindrance for a country to build, adopt, and use digital technologies to grow the local digital economy.

“There are no shortcuts to Big Data and IoT.” It will take sustained, deliberate actions to attract the talent and skill sets necessary to capitalize on Big Data analytics and IoT, which have a very tight relationship. Corporations should invest in universities and advanced training programs to build up a vibrant base of sophisticated and innovative technologists who cannot only manage and analyze the deluge of information that comes with increasing connectivity, but can also create innovative solutions and services that will drive agility into businesses and innovative experiences throughout their societies.

Standing at the forefront of the leaders are South Korea and United States, with Sweden, Singapore, Switzerland, and Canada following quickly. South Korea has the highest percentage of IT workers within its population, while Sweden has the highest percentage of software developers within its population compared with its peers.

Big Data and IoT depend on strong ICT skills and workforce — there are no substitutes.



## eGovernment

“Governments must lead by example.” eGovernment can be a catalyst to drive mobile adoption. (Governments play a critical role in technology adoption and enablement — they should lead by example.)

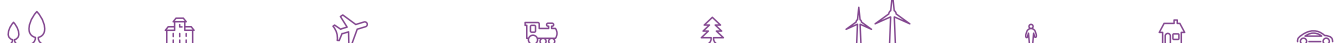
There is a strong correlation between mobile (horizontal layer) and eGovernment. This is the most unexpected correlation, but speaks to the strong role that governments have to play in driving consumer adoption of technology by enabling digital access to government services. By setting an example through rapid digitization and investment in connectivity, governments can help to stimulate the supply and demand of mobile ICT services. Spectrum should not be too prohibitive to discourage telcos from expanding their coverage.

eGovernment correlates tightly with the maturity of a country in almost all cases. Governments can and should accelerate digital transformation within their respective countries by putting forth goals and incentives for businesses, dealers, traders, and citizens for adopting and investing in IT.

## eCommerce

eCommerce is closely correlated with broadband in the country and provides the means to convert digital assets into economic value for example the sale and delivery of music, videos and other digital goods. Economic value is also created through the more efficient selling of non-digital assets (e.g. electronics, tickets, etc) resulting in increased profit, or the access to new markets (geographical or demographical market segments that were previously not profitable to serve). New services that is made possible by connectivity (e.g, direct customization of goods and services made possible by data analytics or new services like smart parking, smart healthcare that is made possible by IoT) grows the economic pie and converts the traditional economy into a digital economy.

Generally, economies with large populations or populations that have higher purchasing power will be at an advantage as they are able to drive the volume (think China’s 11.11 online sales) or the higher value of commerce (think affluent markets in North America and Western Europe). However those countries that have more dispersed and poorer populations have an opportunity to improve their country’s digital economic foundation and growth by delivering affordable fixed line connectivity, robust mobile connectivity, superior experience across social networks, and most importantly, for governments at all levels to not only embrace technology, but also to encourage its citizens and businesses to do likewise. This will grow the country’s participation in the digital economy through eCommerce.



# UPHILL CHALLENGES

Transforming an economy to new digital heights does not happen automatically and can benefit from investing in connectivity, prioritizing with the connectivity cornerstones. However, no journey is without its challenges, and the digital transformation journey has plenty.

- As connections increase, so do privacy concerns. Privacy is one of the top issues being discussed within governments, social settings, and businesses, and in reality, nearly every aspect of our lives. The more data we choose to give up as users of technology, the more opportunities there are to personalize our experience — this can be a good thing and desirable in many cases (e.g., healthcare). Yet, at the same time, the more data we give up, the more data that can be used to expose information about us that we want to keep private. Increasingly, maintaining our privacy will be a challenge as our personal connectivity increases.
- Security is a close relative to privacy, but not the same. Every new connection must ensure that the data traversing through the network is kept for only those for which it is intended. Security technology must get ahead of threats to take a proactive stance against those that would desire ill-intent.
- The abundance (or overabundance) of data will be overwhelming for those that increase their connections. The IoT will spawn an ever increasing deluge of data on which companies will need to make real-time decisions. Deciding how much data to keep and for how long are important decisions, given the costs to store data for a long term. For individuals, decisions and recommendations based on data will be desired, and it is responding to this dynamic in which new and innovative businesses will be built. Algorithms to ingest and analyze data captured from a variety of sources must be quickly turned around and delivered to provide recommendations or directions for the intended individuals.
- Investment in infrastructure must continue as a foundation for our digitally transforming societies, but it is the software and services built atop this foundation that will require new skill sets that are not only technically savvy, but also able to create inspiring experiences that protect privacy, yet capitalize on personalization. Attracting and retaining this type of talent is no easy task, and will be challenging for many countries – nevertheless, whether its attracting talent or training it up, it must be done.



# MOBILIZING FOR TRANSFORMATION

Digital transformation can take shape in a number of ways, at different speeds, and with different priorities. Even with all these considered, the GCI can be used to help understand what stage a country finds itself, how it compares with its peers, how close it is to breaking out of its stage into a more advanced stage, or the risk it has in falling behind. By using the GCI and the 38 integrated variables (with intentional horizontal attribute analysis), regardless of the path a country takes toward digital transformation, the following advice can help government and business leaders navigate the daunting march toward a digitally transformed economy.

- Governments should lead the way. Governments must be more assertive in pushing for development and not just rely mainly on market forces which may not be sufficient or have different priorities. One of the best ways to learn is by having an example, and governments should pave the way for businesses and citizens by incorporating technology into its infrastructure, as well as its services to the society at large. In doing so, you will not only compel others to follow, but you will be increasing the variables necessary to increase your GCI and influence your GDP.
- Governments must change the paradigm and not look at spectrum or licensing as a revenue source. Instead, governments need to consider the greater economic impact and tax revenue from a fast-growing and more competitive digital economy.
- ICT investment must begin at the core — without a robust infrastructure/foundation, anything built atop of it risks falling prey to low usage due to poor experience. Along with this investment should be directives to push IT budgets toward cloud-related projects and services. Data is at the heart of the digital economy and it needs to be shared, connected, and analyzed through a robust infrastructure.
- Invest in IoT and Big Data. Every connection introduces new sources of data, and decisions will need to be made on that data: Keep it? How long? Leverage where and how? Private? Secure? And many more. Generally, more data is a good thing, but only if something is done with it to create value, improve business, or to create innovative experiences. The leading companies are all moving to capitalize on IoT and Big Data — and there is still ample time to follow.



- Invest in people. There are no shortcuts in transforming into a digital economy, especially when it comes to the IoT and Big Data. While leading countries have plans to invest in IoT, it does not mean they have done so, but they have an advantage in skilled experts. Governments and businesses must not delay in developing or attracting the necessary talent so that they can harness the benefits of a digital economy.
- Improve experience to sustain demand. Experience can sometimes be in the body of the beholder, but when it comes to a digital economy, there are things that can happen that will not only disrupt one's experience, but also destroy business opportunities as well as technology adoption. Leading countries are moving fast to adopt technologies such as enterprise flash to improve the speed and agility of aging infrastructures. New flash-enabled systems excel at accelerating workloads, response times, and analytics on databases and data sets, structured or unstructured. There are plenty of other ways to improve experience, but ubiquitous broadband, real-time interactions, and speedy downloads are guaranteed to compel more use and more innovative solutions and applications.
- Plan, be deliberate, do not delay, and stay the course. Our surveys on the intent of business leaders and governments to invest in ICT across all the horizontal attributes were some of the least differentiated across the tiers of countries. In other words, intentions are always high, but unfortunately, intentions are a huge step away from actually doing. Our advice is to engage in strategic planning and prioritization around improving your GCI. Most of the time, businesses and governments cannot do everything all at once — there is simply no enough resources. Focus on the four cornerstones of connectivity and be deliberate, decisive, and most importantly, devoted in seeing the plan through.



# **APPENDIX A**

## GCI METHODOLOGY

The GCI was developed to analyze the full spectrum of connectivity measurements and provide a detailed map of the global digital economy. The objective of the index is to benchmark 50 countries according to current levels of ICT connectivity and digital transformation and to act as a leading indicator for future development and growth.

There are four components to the GCI, which encompass the entire chain of ICT development and digital transformation to provide a 360-degree view of the digital economy:

- **Supply** — Is used to measure current levels of supply for ICT products and services.
- **Demand** — Gauges demand for connectivity in the context of users and activity.
- **Experience** — Variables that analyze the experience of connectivity for end users and organizations.
- **Potential** — A forward-looking set of indicators that point toward future development of the digital economy.

Each of the four sections of the GCI contains a collection of data indicators, as listed below. Complete definitions for these indicators can be found in the Appendix B.

- **Supply:** Bandwidth, telco investment, cloud service provider, IoT spending, ICT spending, 3G coverage, FTTH, data analytics, telecom QoS, and datacenters.
- **Demand:** Fixed broadband households, mobile broadband users, mobile devices, app downloads, ecommerce, cloud migration, data for analytics, IoT devices, and datacenter servers.
- **Experience:** Fixed broadband affordability, mobile broadband affordability, download speed,

latency, customer service, social network users, egovernment, IoT analytics, and datacenter management services.

- **Potential:** ICT patents, IT workforce, R&D, software developers, and market projections for IoT, cloud, Big Data, broadband, mobile, and datacenters.

The variables are measured against factors such as GDP, number of households, and total population to assess the full picture of connectivity for each country (for example, app downloads per capita or FTTH penetration of total households). As such, the index is intended to benchmark countries according to their overall rate of connectivity across the entire economy and population. It is important to note that connectivity levels for major metropolitan areas tend to be much higher than overall scores in emerging markets, which are still at an earlier stage of ICT adoption than mature economies. This is an important metric to understand the potential for increased economic benefits that these emerging markets are likely to realize over the next decade and beyond as they close those digital divides through rapid investment and adoption programs.

For each variable, a country receives a rating of 1 to 5 (1 is low, 5 is high) depending on the relevant data input. Inputs are first converted to a scale of 1 to 100 using standard multipliers, and countries are allocated ratings depending on their subsequent calculated score within each quintile (a calculated score of 1–20 receives an index rating of 1, and so on). In all cases, the data inputs are first measured against a normalizing variable (e.g., population size) to ensure that the index is benchmarking countries according to relative levels of connectivity rather than absolute market sizes, which would be more reflective of the size of the economy.

The ratings are then aggregated to form a score for each of the four GCI segments: supply, demand, experience, and potential, on a scale of 1 to 100.



Each segment comprises 9 to 10 variables. These variables were weighted according to their elevated importance and relevance to overall connectivity. The final index score is then calculated by aggregating the four segments, and dividing by 4 to convert to a scale of 1 to 100:

- GCI Total =  
(Supply+Demand+Experience+Potential)/4

A full list of data category definitions and sources can be found in the Appendix.

The GCI thus provides a deep and broad analysis of digital transformation that transcends basic levels of connectivity and extends to supplementary, advanced technologies that will drive the next wave of economic benefits resulting from ICT investment. The index was also structured to enable horizontal analysis of five key segments, which are crucial signposts to help benchmark the relative strength, weaknesses, opportunities, and challenges of digital economies: Cloud, mobile, Big Data, IoT, broadband, and datacenter. Each horizontal layer includes one variable from each of “supply,” “demand,” “experience,” and “potential” to provide a complete analysis.

- **Cloud:** Cloud service provider (supply), cloud migration (demand), latency (experience), cloud growth (potential).
- **Big Data:** Data analytics (supply), data for analytics (demand), social network users (experience), Big Data growth (potential).
- **IoT:** IoT spending (supply), IoT devices (demand), IoT analytics (experience), IoT growth (potential).
- **Broadband:** FTTH, 3G coverage (supply), mobile broadband users, broadband household penetration (demand), mobile broadband affordability, download speed (experience), mobile growth, broadband growth (potential).

- **Datacenter:** Datacenters (supply), servers (demand), datacenter management services (experience), datacenter growth (potential).

Most of these variables are self-explanatory in terms of their relevance, but several merit specific explanation:

- **Data for analytics.** The total volume of nontransitory data (PB) generated and classified as target-rich data suitable for analytics to extract Big Data value, used as an indicator for Big Data demand on the assumption that the volume of data to be analyzed will correlate with and act as primary driver for the demand to perform analysis.
- **Social network users.** The total de-duplicated number of users participating in online social networks (Facebook, Google+, etc.) at least once during the calendar year, used as an indicator for Big Data experience on the assumption that greater social network participation will drive a greater volume of target-rich data with particular value for commercial organizations and governments.
- **Latency.** Adoption of flash storage being used as a measurement to indicate relative levels of latency, which is seen as a key determinant for the experience of cloud services.

Additionally, a horizontal layer was embedded to enable analysis from four aspects of the digital economy foundations through consideration of the groundwork areas, which correlate most strongly with ICT growth and development.

- **ICT spending.** The bedrock of connectivity is investment in the necessary infrastructure and software to deliver connectivity services. For example, capital spending on network infrastructure is a necessary prerequisite for development of fixed and mobile broadband services.





- **eCommerce.** A key indicator of demand for connectivity and digital transformation is the extent to which the economy is now situated on electronic transaction platforms. Where an economy relies upon digital connectivity for the transfer of funds and the sale of goods and services, demand for advanced connectivity will be higher.
- **eGovernment.** Governments can stimulate the process of digital transformation by acting as case studies and examples and also improve the experience of connectivity services by enabling individuals and businesses to participate fully in governance and administration through advanced e-government channels.
- **IT workforce.** A strong base of technological skills (on both the supply and demand side) is vital to the digital transformation process, and especially for the advancement of new connectivity services such as Big Data and IoT, which require specific skill sets.

groups of countries based on their performance in the indicators.

The GCI therefore represents a rich and deep data set that can serve as a blueprint for individuals and organizations to analyze a wide range of factors relating to digital transformation, ICT development, and the economic benefits of connectivity. Additionally, the overall index rankings provide a snapshot of the current state of connectivity across the worldwide digital economy, as well as a leading indicator for the next decade of ICT expansion and evolution.

Thus, the GCI can be analyzed both vertically (supply, demand, experience, and potential) and horizontally (cloud, Big Data, IoT, broadband, datacenter). This allows for extremely detailed analysis of the relative strengths and weaknesses of individual countries, pinpointing the areas in which additional investment is needed to advance overall levels of connectivity and economic benefits. Additionally, this structure enables detailed analysis of correlations between advanced connectivity services (e.g., IoT) and key areas of supply, demand, experience, and potential to understand the most successful road maps to growth and development (and some areas in which “leapfrog” technology adoption has proved more successful than others).

**Clustering analysis:** In identifying the 3 clusters of countries by GCI performance, we ran cluster analysis using SPSS to identify naturally occurring



# **APPENDIX B**

## GCI DEFINITIONS

# SUPPLY

## Bandwidth

“International Internet bandwidth” refers to the total used capacity of international Internet bandwidth, in megabits per second (Mbit/s). It is measured as the sum of used capacity of all Internet exchanges offering international bandwidth. If capacity is asymmetric, then the incoming capacity is used. International Internet bandwidth (bit/s) per Internet user is calculated by converting to bits per second and dividing by the total number of Internet users.

*Calculation: per Internet User*

## Telecom Investment

This refers to telecom service provider (“telco”) investment in infrastructure. To create the 2014 score, aggregate spending over the five-year period of 2010 – 2014 is included to provide a more holistic measurement of telco infrastructure investment in the context of cyclical periods and economic wild cards that can affect spending levels in a single year.

*Calculation: per GDP*

## Cloud Service Provider

This includes spending by cloud service providers on Cloud infrastructure. This variable provides a measurement of the current levels of investment by cloud service providers in the hardware necessary to supply cloud services. The data is normalised against the overall size of the economy (GDP).

*Calculation: per GDP*

## IoT Spending

This refers to spending on IoT products including intelligent systems, IoT devices, IoT purpose-built platforms, and IoT-related infrastructure and services (including security). Weighed against the size of the population (IoT per capita).

*Calculation: per capita*

## ICT Market

This refers to the overall size of the ICT market in each country, as defined by the total amount of end-user spending on IT hardware (servers, storage, PCs, devices, peripherals, and network equipment), software, IT services, and telecom services. The total market size is measured against the size of the economy, which provides a measurement of market supply maturity.

*Calculation: per GDP*

## 3G Coverage

This refers to the percentage of the population that has access to at least a 3G network. This measurement is not based on geographic land mass, so is a more accurate measurement of the supply of 3G services to individuals and organizations.

*Calculation: per Population*

## Fiber Optic

The number of FTTH subscriptions is measured against the total number of households in each country. “Fiber to the home” is defined as a communications architecture in which the final connection to the subscriber’s premises is optical fiber. The fiber optic communications path is terminated on or in the premise for the purpose of carrying communications to the subscriber.

*Calculation: per total households*



# DEMAND

## Analytics Spending

This refers to investment in analytical software tools that are used to supply actionable data to individuals and organizations. These analytical software tools include content analysis tools, CRM analytics, advanced analytics (standalone and embedded), data warehouse generation, data warehouse management, end-user query, reporting and analysis software, financial performance and strategy management applications, production planning analytics, services operations analytics, spatial information analytics, supply chain analytics, and workforce analytics.

*Calculation: per total ICT spending*

## Quality of Service

This is the measurement of government QoS policies and enforcement with regard to the provision of telecom voice and data services. Each country was allocated standardized scores according to the existence of QoS policies, frequency of monitoring, and enforcement mechanisms.

*Calculation: N/A*

## Datacenter Spending

This refers to the overall investment in servers for the supply of datacenter services. The value of servers is based on total ASP including processors, memory, disk storage, bundled operating systems, and software. Volume, midrange, and high-end servers are included. A "server" is defined by two primary characteristics: a multiuser device and with no user interface (unlike a client device, a server does not have a user interface that is intended for human-machine interaction).

*Calculation: per capita/GDP (blended)*

## Fixed Broadband

This refers to the total number of households that access the Internet through a wireline (including satellite) broadband Internet connection.

*Calculation: per total households*

## Mobile Broadband

This refers to the total number of subscribers of mobile broadband services, measured in relation to the overall number of mobile service subscribers to gauge the demand for high-speed mobile data services.

*Calculation: per total mobile subscribers*

## Mobile Devices

This includes installed base of smartphones per capita. These mobile devices contain a high-level operating system such as Android, iOS, Blackberry OS, Windows, WebOS, or Symbian in addition to telephone capabilities. This covers smartphones/converged mobile devices running operating system software that provides a standardized interface and platform for application developers. They are always connected to the web once enabled and generally have larger screens than feature phones. Also excluded from this number, in addition to feature phones, are highly specialized devices that are not sold to the public.

*Calculation: per capita*

## App Downloads

App Annie tracks iOS and Google Play downloads, free and paid-for, which is used to create this measurement of total app downloads per capita in each country.

*Calculation: per capita*



# EXPERIENCE

## eCommerce

eCommerce is the process by which an order is placed or accepted via the Internet (i.e., a buyer clicks the “Order” button on the Internet), therefore representing commitment for a transfer of funds for goods or services. Total ecommerce measures the volume of all ecommerce transactions, both business to business (B2B) and business to consumer (B2C) (including volume purchases).

*Calculation: per GDP*

## Cloud Migration

This includes an index based on the percentage of traditional ICT budgets that has migrated to cloud platforms to measure demand for public cloud services in relation to overall ICT spending.

*Calculation: per total ICT spending*

## Data for Analytics

The amount of data (GB) created in a single year that is non-transitory, target rich, and available for data analysis.

*Calculation: per capita*

## IoT Installed Base

This refers to the total installed base of IoT devices and systems (including intelligent systems).

*Calculation: per capita*

## Server Installed Base

This refers to the total installed base of servers (high-end, midrange, and volume servers, including integrated storage) as an indicator of demand for datacenter services.

*Calculation: per capita*

## Fixed Broadband Affordability

The “fixed broadband” sub-basket refers to the price of a monthly subscription to an entry-level fixed broadband plan. For comparability reasons, the fixed broadband sub-basket is based on a monthly data usage of (a minimum of) 1 GB. It is calculated as a percentage of a country’s average monthly GNI per capita.

*Calculation: per GNI*

## Mobile Broadband Affordability

The “mobile broadband” sub-basket refers to the price of a monthly subscription to prepaid and postpaid data services across a variety of service plans and device types.

*Calculation: per GNI*

## Broadband Download Speed

This refers to the average download speed for each country as monitored and published by [ookla.com](http://ookla.com). These metrics leverage billions of Internet and mobile network tests to provide a current view and analysis of global Internet access speeds.

*Calculation: N/A*

## Latency

This is based on adoption of flash storage to provide an indicator of relative latency and its impact on network/system performance. As flash storage provides a proven and significant speed bump in relation to traditional HDD storage, penetration levels of flash storage in terms of the installed base of Petabytes (in relation to the overall size of each population) can be used as an indicator of “experience” in terms of data read/write speed, especially for the provision of cloud services.

*Calculation: N/A*



## Customer Service

This measures current service levels provided by telecom operators, based on previous research and surveys conducted within each country market.

*Calculation: N/A*

## Social Participation

This refers to the de-duplicated total number of individuals participating in online social networks (e.g., Facebook, Google+) as a percentage of the total size of the population. This number counts the number of users who engaged with online social networks at least once during the 12-month period (2014) via wireline and/or mobile Internet access.

*Calculation: per capita*

## eGovernment

These scores are sourced directly from the United Nations E-Government Survey 2014, which benchmarked countries according to ratings derived from a survey to assess the e-government development status of all UN Member States.

*Calculation: N/A*

## IoT Analytics

This refers to the total spending on analytics software specifically related to IoT data analysis. These software tools are deployed to extract value from the mass of data being created on the IoT to improve the experience of a country or organization with a developing IoT platform by transforming IoT data into an actionable information.

*Calculation: per capita*

## DCIM

This refers to the enterprise spending on datacenter infrastructure management solutions, which enable management of datacenter resources more effectively and efficiently (in which context, it is used here as a measurement of datacenter experience). Datacenter infrastructure management encompasses software tools and services to manage, optimize, and plan for resources in datacenters, including IT hardware, power, cooling, and physical space. DCIM solutions, as defined by IDC, see components on the IT side (such as servers, storage systems, network switches, and routers, or virtual machines) and components on the facilities side (cooling unit, power distribution unit [PDU], uninterruptable power supply [UPS], sensors, and generators). Access to these resources requires input and coordination between the facilities organization and IT organization to create a holistic view of the datacenter. In IDC's definition, DCIM does not include proprietary software designed to monitor a single product.

*Calculation: per total ICT spending*



# POTENTIAL

## ICT Patents

This refers to the total number of patents filed under the PCT within the ICT technology domain in the inventor's country of residence, as measured and tracked by the OECD (stats.oecd.org).

*Calculation: per capita*

## IT Workforce

Total employment in the supply and management of IT for each country. This includes workers employed directly in the IT industry (hardware manufacturers, software vendors, service providers and channel organizations) in addition to IT staff employed by end users in IT departments for the management, deployment, support, and strategic implementation of technology solutions.

*Calculation: per capita*

## R&D Expenditure

Expenditures for research and development are current and capital expenditures (both public and private) on creative work undertaken systematically to increase knowledge, including knowledge of humanity, culture, and society, and the use of knowledge for new applications. R&D covers basic research, applied research, and experimental development.

*Calculation: per GDP*

## Software Developers

This refers to the total number of software developers in each country. Professional software developers are persons engaged in gainful employment in which the primary activity is the construction of software or the direct supervision of such activity.

*Calculation: per capita*

## Market Potential

This refers to the scores for the market potential of IoT, datacenter, cloud, mobile, Big Data, and broadband derived from a structured survey conducted with local analysts based in 50 countries. Analysts provided quantitative responses according to a defined scale, which was designed to measure future market growth potential based on their local market knowledge derived directly from existing research and surveys previously conducted (in-country) with end users and suppliers.

*Calculation: N/A*

For those variables weighted against GDP, we use GDP at Purchasing Power Parity (PPP) calculation. This is generally the most appropriate for calculating in-country purchasing power adjusted for the cost of living, as it measures the relative wealth of a country in terms of its ability to purchase goods and services within the national economy.

The data is always the most recent available, depending on the source.

Data sources: OECD, ITU, World Bank, Ookla, IDC, Huawei MI etc.

We estimated the data for missing values based on geographical cohorts.



# **APPENDIX C**

## FREQUENTLY ASKED QUESTIONS



# ABOUT HUAWEI GLOBAL CONNECTIVITY INDEX (GCI)

## 1. What does Huawei GCI mean?

Huawei GCI stands for Huawei Global Connectivity Index. GCI is an ICT assessment framework that measures, analyzes, combines, and forecasts multiple connectivity dynamics on the impact of a country's digital economy and the value generated for its industry transformation toward digital economy. This white paper is focused on the GCI of countries.

## 2. What is Huawei's vision of designing the GCI?

The Huawei GCI is a barometer of a new emerging economy — the digital economy — emphasizing the importance of ICT technology to industry transformation. Through the GCI, Huawei's vision is to act as a Country ICT Planner. In addition, via collaborating with other leading entities, Huawei envisions to create a comprehensive global index covering every aspect (rather than ICT technology alone) of the industry chain, making GCI a part of the worldwide index. Leveraging the study, Huawei strives to partner with policy makers and enterprise leaders to identify, capture, and create new opportunities that ICT makes possible, to build a Better Connected World.

## 3. What does digital economy mean? What is the relationship between the Huawei GCI and digital economy?

A digital economy is a kind of new emerging economy. It is different from the traditional machine-based or electricity-based economy. The digital economy can be defined as an economy in which its participants (governments, businesses, and consumers) are adapting to disruptive changes in their business models, ecosystems, and individual lives by leveraging

digital technologies (e.g., connectivity, applications, storage, and compute), to create new business models, products, and services that blend the digital and physical seamlessly resulting in new business and customer experiences and behaviors, improved operational efficiencies, organizational performance, and customer accessibility.

At the center of the digital economy is connectivity. Connectivity does not only lay the cornerstone for digital economy, but also glue the GCI factors together to drive economic growth and also transform the ways to generate economic value.

## 4. How does Huawei GCI differentiate from other leading indices?

There are other globally well-known indices, such as ITU and WEF. The Huawei GCI is different from these indices, as it emphasizes the value of pan connection. Pan connection stands for "Network + Compute + Storage," creating a large-scale network pipe, datacenter, and cloud computing capacity, among others. This also represents ICT infrastructure enabling applications and services.

## 5. Huawei published its very first GCI white paper in 2014. What is the major difference with this year's white paper from last year's?

With a consistent "Supply-Demand Model" being the core, the Huawei GCI 2015 blends IT and CT elements to better reflect economic dynamics globally (e.g., pan connection). In contrast, Huawei GCI 2014 is very much CT focused. In addition, Huawei GCI 2015 sees a more comprehensive and advanced framework and methodology, with 38 CT and IT variables



(as against 16 in Huawei GCI 2014) measured, analyzed, and intersected for 50 countries (as against 25 in Huawei GCI 2014), as a result to find correlations between technology investment and adoption and economic growth.

## 6. To be specific, what ICT technologies are covered in Huawei GCI 2015? How does the white paper position these ICT technologies?

Five major ICT technologies are covered in this white paper, namely, cloud, the Internet of Things (IoT), Big Data, broadband, and datacenter. Huawei believes that these technologies work interactively to drive the digital economic growth.

Through the research, we learned that broadband and datacenter are considered as the core technologies. Without them, connectivity cannot be built up. On the other side, cloud, Big Data, and IoT are deemed as executions to bring about economic dynamics. They cannot be viewed as separate factors, but an interactive and combined force for digital economy.

## 7. What are the components of the Huawei GCI?

There are four components of the Huawei GCI, which encompass the entire chain of ICT development and digital transformation to provide a 360-degree view of the digital economy. The four components can be represented by the acronym SDEP.

- Supply — used to measure current levels of supply for ICT products and services
- Demand — used to gauge demand for connectivity in the context of users and activity
- Experience — are variables that analyze the experience of connectivity for end users and organizations

- Potential — used to point toward future development of the digital economy through a forward-looking set of indicators.

## 8. What does a GCI score mean to a country?

A country's GCI is rated on a scale of 1–100. Based on 38 indicators, 50 countries are, by means of cluster analysis, ranked and categorized into 3 groups, namely the Leaders (GCI score of 60 and above), Followers (GCI score of 36–59), and Beginners (GCI score of 35 and below).

## 9. Can I assume that all the developed countries fall into the Leaders group, and developing economies into the Followers and Beginners groups?

The answer is no. Leaders are mainly mature economies, Followers are mainly developing economies. However, four mature countries such as Spain, Italy, the Czech Republic, and Portugal have fallen into the Follower group.

## 10. Can you give the top 3 developed countries according to their GCI? What about the top 3 developing economies?

Mature countries lead the GCI with the United States, Sweden, and Singapore at the top. Chile, China, and the United Arab Emirates (UAE) lead the pack for developing countries.

## 11. Amongst developing economies, which three countries have the biggest potential?

They are Chile, South Africa, and China. A country's potential is analyzed based on various indicators, such as ICT patents, IT workforce, research and development (R&D), software developers, and market projections for IoT, cloud, Big Data, broadband, and datacenters. Among the developing countries, Chile leads in ICT skills that cover IT workforce and software developers, while China leads in ICT patents and



R&D. In contrast, South Africa leads in market projections for cloud, IoT, Big Data, broadband, and datacenter.

## 12. What does Huawei GCI mean to economy transformation; and thus, individuals, enterprises, and governments?

The Huawei GCI is an ICT assessment framework that measures multiple connectivity dynamics on the impact of a country's digital economy and the value generated for its industry transformation toward digital economy (digital transformation). An increase in GCI score means the creation of new businesses, improved operational efficiencies, organizational performance, and customer accessibility to enterprises and governments in a country. Meanwhile, an increase in GCI score can lead to a much improved customer experiences to individuals.

## 13. What is one of the most interesting predications that Huawei GCI white paper addresses?

There are many eye-catching predications and forecasts presented in the white paper. One, among the most interesting predications, is that in the next 10 years, developing countries like China, India, Indonesia, and Brazil, among others, will enjoy a faster digital transformation than mature economies. This could become a game-changing factor in remaking the world order, since the future economy is largely represented by the digital economy.

## 14. What are Huawei's general recommendations for the countries to transform into a digital economy?

To begin with, all countries should have a vision that ICT investment must begin at the core. And governments should lead the way. Second, countries should invest in IoT and Big Data, and more importantly in people. Third, to achieve sustainability, experience needs to be improved on a continuous basis. Finally, plan, be deliberate, do not delay, and stay on course.

## 15. Almost everyone is talking about IoT. What benefits can IoT generate for Huawei from a business value point of view?

The white paper emphasized that the Internet of Things will have great economic impact on its business. The adoption of IoT will power a 1% improvement. After examining and analyzing several industrial and public sector use cases of IoT, the white paper explored what 1% of expense savings would look like if a supply chain, a manufacturing process, or workflow became IoT-enabled. IoT brings efficiencies and better ways to do business that simply provide huge economic benefits, which make it hard to argue against not having an IoT strategy.

## 16. What key takeaways does Huawei expect readers to get from this white paper?

"Get on board or be left behind," is the battle cry of the digital economy, as the future of digital transformation and the new digital economy is unstoppable.

Our future is replete with the benefits and conveniences that come along with digital transformation. This disruption is bound to happen, thus economies should get on board or risk being left behind. A freight train is often used as a metaphor for something that is difficult to stop because of its mass and momentum. Such is the case with the digital transformation of our world. It is not that it needs to be stopped — on the contrary — it is not going to stop and if you are not on it, then it is going to pass you by.

