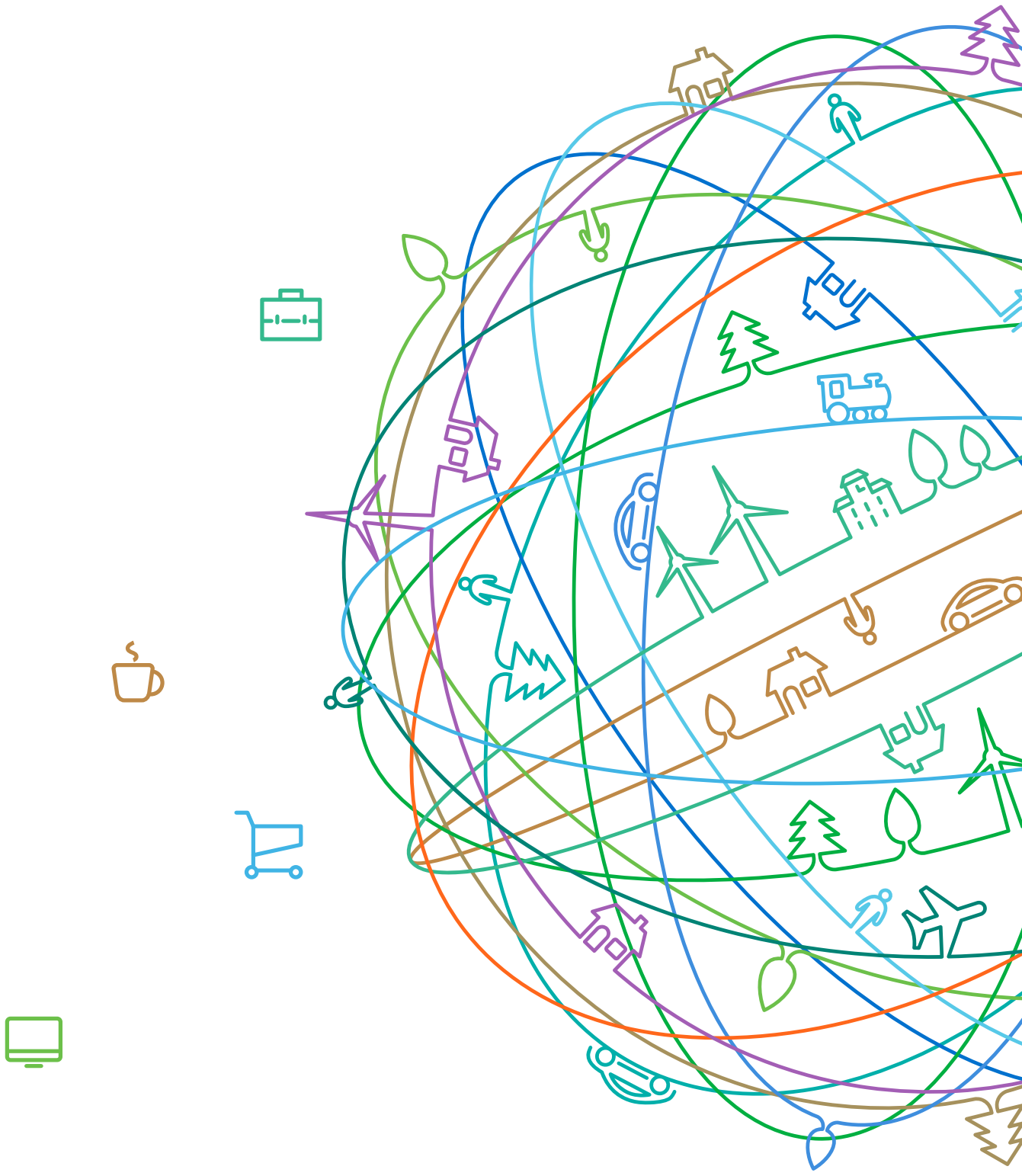
HUAWEI

BUILDING A BETTER CONNECTED WORLD



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Executive summary

The more we connect, the better our world

By 2025, there will be 100 billion connections and eight billion smartphone subscriptions, spread across some six and a half billion people and tens of billions devices – the world is connecting.

We at Huawei believe that a Better Connected World is a good thing, something that we should strive to achieve and not just wait for to arrive. Why? Connection represents the most direct route to unleashed potential, from countries, businesses, individuals, and much more.

A connected five-iron could do the work of a golf instructor. A connected car could lower your insurance premiums. A connected piano recital could enable a proud father on a business trip to be in two places at once. Such innovations are just the beginning. The physical and digital realms themselves are intertwining. Enabled by the growing ubiquity of cameras, sensors and networks, increasingly accurate representations of the physical are taking shape in cyberspace, enabling us to observe, examine, analyze, aggregate data about, and ultimately better understand and predict what happens in our world, without the tremendous inconvenience that this would have once entailed. Not only will this drastically lower the barriers to knowledge, research, and entrepreneurship, it should alleviate some of the uncertainty that currently hampers the global economy. The enterprise realm can reclaim its legacy of action and vision as opposed to incrementalism and cost cutting - the opportunities of a Better Connected World are endless.

Technology does more with less

The technology breakthroughs of today & tomorrow, whether cloud computing, big data and its analytics, SDN/NFV, the Internet of things, or 5G, will enable us to do more with less. This is something the world desperately needs, as our resources presently bear unsustainable strain under the pressures of more – more people, more cities and more consumption.

Our ICT networks, now as vital to the competitiveness and overall well-being of any country or business as roads, bridges, and electricity, also bear the burdens of more – more devices, more content and more uses. Some of the aforementioned technologies will help alleviate these burdens, but a more human commitment will be also needed from our leaders, whether government, ISP/CSP, or enterprise, if the benefits of a Better Connected World are to be enjoyed by all. Huawei has carried out an assessment of the commitments and progress that various countries and industries have made in bettering their own connection, and the resultant value of the same – the Global Connectivity Index (GCI).

The value of connection

A total of 25 countries (representing 68% of the global population) of varying size and stage of development were gauged across two dimensions – Current Connectivity and Growth Momentum. The aggregated score can be considered a relative measure of how much effort has been made, is being made, and will be made in the near future in a certain country to ubiquitize broadband access. Germany was the overall winner, beating out other global leaders such as South Korea, Japan, and the U.S. But for the purposes of this whitepaper, special focus has been given to some of the more surprising entries who scored well for one dimension or overall – New Zealand, Chile and Kenya. We do not consider it a coincidence that all three of these countries are social and technological success stories, attractive to investment and conducive to entrepreneurship.

In parallel, more than 1,000 decision-makers from 10 different industries were surveyed as to their concerns, priorities, and plans for investment in ICT, as well as the benefits their companies have seen from it in terms of innovation, efficiency, and customer engagement. The aggregated score can be considered a relative measure of the degree to which said industry has, on average, embraced digital reformation. Financial services scored the highest overall on the industry index, with education, oil & gas, and the logistics industries close behind. Businesses in these fields are most likely to have created and be executing company-wide transformation, with ICT recognized as the core enabler, encompassing all business elements, including those for product creation, revenue generation, and all other processes. These Transformers recognize ICT as a tool of value creation, not just efficiency, and are starting to use it as such, with excellence shown in the following areas – open innovation, general adaptability, customer convenience, market intelligence, and the service experience itself. This enables Transformers to both seize opportunity and retain advantage in an ever-changing world.

What we must do

For the benefits of a Better Connected World to reach us all, commitment and action are required by three key groups. One, businesses must carry out digital reformation of their infrastructure and business models so that they can disrupt new industries or maintain competitive advantage in their current one. Two, governments & regulators must set clear connectivity targets and lower the financial and regulatory barriers to ICT access so that businesses can more easily become agile innovators who inspire their customers. Three, ICT and telco leaders must work to make the online experience more compelling to those who presently lack connection. They must also continue to enable the integration of CT with IT, which is a far cheaper and more flexible technological domain, and the only one capable of achieving the sort of speed, quality, scalability, security, reliability, and ubiquity of access required in a Better Connected World.

Huawei is committed to building this world. Why? Because connection promises possibilities – infinite possibilities. Barriers will lower. Opportunities will abound. Connections will immerse. Experiences will inspire. It will be a world without distance, where progress will be progress for all, and exclusion will be impossible.

But we are mere pipe builders.
We need lawmakers, trendsetters, visionaries, innovators and standardizers to come together and help give this world meaning, order and beauty.
These stakeholders will make it happen.
Huawei will make it possible.

Join us in Building a Better Connected World

Forces of change

Humanity's progress has been the story of more – more crops grown, more bricks laid, more ships built, and the pace of change is accelerating. However, Earth has limits, and so do our networks. Humanity's forces of change could potentially exceed them. ICT changes the equation, by delivering more with less. It can improve efficiencies and transform industries, while creating better experiences for all.

In a Better Connected World of cameras, sensors and networks, the digital realm will come to mirror the real. Not only will this nullify certain physical barriers (such as distance), it will reduce our consumption as well.

Physical forces of change

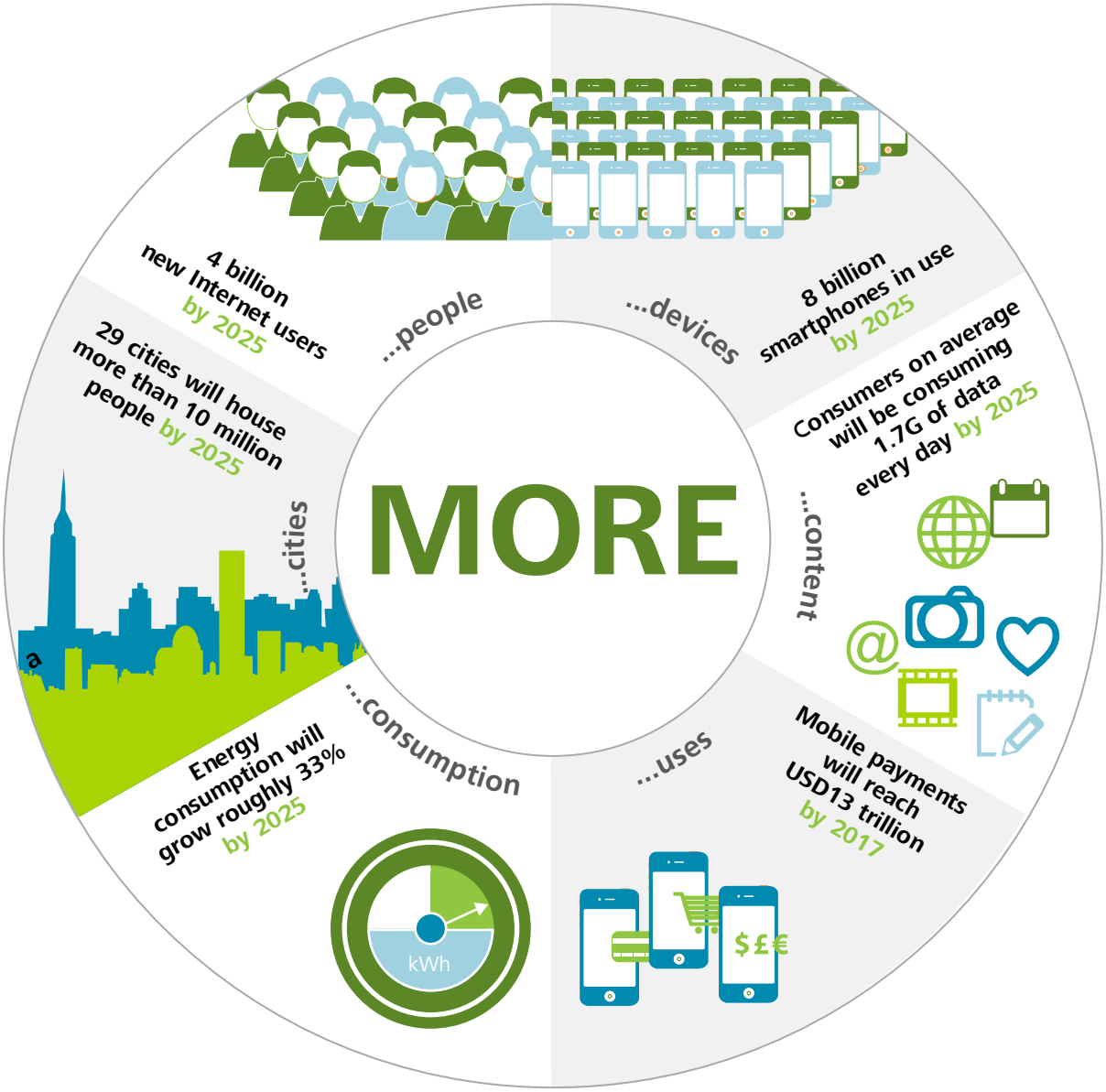
The next 15 years will see both the world and life as we know it remade by the physical pressures of more – opportunities and challenges await.

More people: Our global population didn't reach one billion till the 1800's, and yet 6.2 billion have been added since then. By 2025, we'll see a billion more, but they won't be more of the same – our children will grow up in a very different world, a world where the body of netizens will grow from 2.5 billion to 6.5 billion over the next 15 years.

More cities: A century ago, less than one in five people lived in cities. Fifteen years from now, more than half will. With the bulk of global GDP already being generated in the world's largest cities, they will only grow. By 2025, 27 megacities (10 million residents or more) will exist, with 21 of them located in the emerging countries of Africa, Asia and Latin America. Urbanites will demand more engagement with social services, and put extraordinary pressure on public transportation, hospitals, waste management systems, and the power grid.

More consumption: A global middle class is emerging, one that has an affinity for red meat, cars, and homes with guest bathrooms – all are resource-intensive. With energy consumption in the emerging economies expected to triple their 1990-levels by 2025, and carbon emissions doubling as well, feeding, housing, transporting, and healing these consumers will be a real opportunity, and a concern.

Figure 1: Global physical and digital forces



Source: United Nations Educational, Scientific and Cultural Organization (UNESCO), United Nations World Water Assessment Programme (WWAP), UN-Water (Geneva: March 2012) Ohio State University

Digital forces of change

Technology is a powerful force for change. Our interactions with it continue to evolve, most visibly in terms of diversity and scale.

More devices: By 2025, there will be over eight billion smartphones in use across the world, and 100 billion connections. Miniaturized sensors and geotags are now starting to be embedded in anything and everything, from coffee machines to garments, from cars to shipping containers. Once connected to a network, these objects begin talking with us and with each other. In aggregate, these small pulses of conversation represent a deluge of data, one that can deliver unprecedented insights into our environment with the right tools.

More content: Online content is already following us through our screens, and its volume and reach continue to grow. What was once text, email and voicemail has become chats, tweets, music and video, with a lot of it user-generated. With 4K video,

augmented reality and virtual reality on the horizon, the sheer volume of content is getting truly unfathomable. Today, the average Internet user consumes about 16GB per month. In 2025, that number will more than triple, with the amount of uploaded content only growing – a difficult situation as most networks in use today prioritize download.

More uses: Through a diverse body of business-to-business or business-to-consumer models, people will continue to discover more effective ways to nullify distance through automation, social networking, gaming, business apps, streaming customer service, teleconferencing, video product introductions, web-based learning, and product demonstrations & diagnostics. And don't forget the Internet of things.

ICT does more with less

Some people feel that Earth has plenty left to give, but resource acquisition is growing in cost, both economic and environmental. ICT, through its ability to streamline the way we work, play, and consume, can keep these costs in check. Its breakthroughs have greatly increased the efficiency, flexibility, and management of resource consumption, with greater gains yet to come.

In a Better Connected World, services will replace ownership of consumer goods, minimizing the burdens of the latter, and consuming fewer resources as well. Why own a PC when a thin client could bring you more resources? Why own a car in a world of automated taxis? As our economy embraces subscriptions, efficiencies will increase dramatically, with exciting new avenues of value creation sprouting up across a range of industries.

ICT will be an key enabler, through its ability to support and leverage new business models. Ubiquitous broadband will ensure instant access to massive real-time data, stored and analyzed in the cloud, while enabling fluid service provision anytime, anywhere. With such capacities at hand, a vast range of industries will amaze and delight their customers, with great efficiency.

A Better Connected World is taking shape

A Better Connected World promises an inspired quality of life, greater productivity, more innovation, and less poverty. As mankind transcends physical limitations, a way of life will emerge where ideas and experience will be our most valued currency.

ICT is the catalyst

In a Better Connected World, the impact of ICT technologies will be assessed by how individuals, businesses, and society at large benefit from them.

- **Society:** Connectivity allows the benefits of progress to reach those it touches, making for a more just and sustainable future.
- **Business:** Connectivity enables more agile organizations where innovation, collaboration, and disruption can all be part of the DNA.
- **Individuals:** Connectivity empowers us through lower barriers to access, inspires us through an immersive online experience, and enlightens us through the vast expansion of what we can learn.

Connectivity has become the norm, and it will continue to be fruitful and multiply, to the tune of 100 billion connections worldwide by 2025.

However, basic connectivity will not be enough. It needs to be better, and by that we mean higher speeds, zero wait-time, real-time display, reliability, security, and ubiquitous coverage. More frequent, more diverse and more dynamic conversations will result from a Better Connected World – between people, between people and things, and between things.

When people connect

The promise of ideas and the desire to share them creates a better life and better world. What moves us forward is the power of technology to make this happen – quickly, reliably, and without fail.

With connectivity, we can...

- **Help those in need:** Today, there is one doctor for every 390 people

Connectivity has become the norm – and connections will continue to multiply. By 2025, 100 billion connections are forecast, including eight billion smartphone users.

in the United States, but only one for every 50,000 in less developed counties. In fact, 80% of Tanzanians will never see a doctor in their entire lives. Connectivity will lower the barriers to healthcare. Not every problem will be solved, but with pragmatism and expediency, outcomes can be improved. It takes eight years to train a doctor, but only months to build a network. Remote access to health services has already helped millions of people interact with physicians, resulting in lives saved and improved quality of life – there's more to come.

- **Reach out at zero distance:** High-quality connectivity will make true online immersion a reality. With the prevalence of 4K/8K video, haptics and immersive tools, interaction will transcend physical barriers. This will mean a quantum leap in professional communication and collaboration, where we can brainstorm, innovate, talk and listen, without the need to be in the same room. It will also make true-to-life experiences with education, healthcare, and shopping the norm, bringing huge business opportunities. And, of course, it will mean ways to connect and make memories with family and friends like never before – an inspired quality of life.
- **Solve challenges:** Crowdsourcing via gamification can stimulate problem-solving through play. A textbook example is Foldit, an online video game that works out the complex three-dimensional structures of certain proteins, a critical step in the creation of new disease-fighting drugs. Foldit gamers solved research puzzles in just three weeks that had baffled scientists for years, using their home computers and collaborating in the cloud via broadband – bigger challenges await.

When people and things connect seamlessly

As connected devices become more pervasive, expertise will be a click away, entertainment will be more inviting & immersive, and we will all be more aware, both of our world and each other.

Intelligent virtual life aid: In China, an hour of a golf instructor's time can cost 300 U.S. dollars, but for a fraction of that you can purchase one year's access to an online clubhouse of sorts where your swing is recorded through your smartphone, analyzed automatically, compared side-by-side with those of pro golfers, and feedback, tutorials and other advice are available on demand. Today, this is available through products such as Feedback Collect. Tomorrow, it will be the golf clubs and golf balls themselves collecting the data for cloud analysis, revealing trends in your game that you might never have learned, like the fact that you strike the ball better after five waggles instead of three. In a Better Connected World, expert advice will be available to all.

Round the clock care: Through a "body-area network" of connected wristbands and other sensors, we'll share data about our heart, lungs and other organs with our physician's healthcare cloud for instant analysis, and these capabilities will transform how we fight chronic disease, care for our elders, and think about our health. Couple this awareness with

Tasty financial results

McDonald's launched a 'Mein Burger' (My Burger) campaign in Germany. Consumers were encouraged to create the first crowdsourced burger. The figures:

- 7M page impressions – Most successful single McDonald's campaign.
- 45,000 'burger creations' in the first seven days. After five weeks, this figure had risen to 116,000 (one every 26 seconds).
- 12,000 people created their own marketing campaigns.
- 1.5M people voted for their favorite.
- Reached 17M people – every fourth German Internet user.

Never before has a campaign brought in "so many additional customers," sold "more promotional burgers" or earned "more total revenue."

Source: Prexamples

proactive care, and wellness will be redefined, with the burden lessened on our hospitals – a good prognosis.

Fandom redefined: Imagine a hyper-connected football game of the near future, with cameras placed everywhere, even on the players' bodies, capturing the action like never before. Fans, whether on site or tuning in, can get real-time stats on their screens, and change perspectives at will, taking in or replaying what the officials see, what their favorite player sees, or what his opponent sees – a "better-than-life" experience that will open up revenue streams yet unthought of.

When things connect

In a Better Connected World of cameras, sensors and geotags, our tools, appliances and other things will be present and accounted for in cyberspace, whispering to each other through an increasingly dense global mesh. On its own, this hushed conversation will herald a new era of automation and efficiency. When we listen in, we'll be able to work, play and live smarter.

Sustainable living: With connected devices populating our homes, we'll know exactly when it's cheaper to run our washing machine or charge our electric car. We'll also develop a sixth sense of our environmental footprint, and a culture of sharing information about it. This process is starting in cities such as Copenhagen, which aims to be the world's first carbon-neutral city, as cyclists there are already sharing data on air pollution and traffic congestion through their smartphones.

Driving without drivers: Self-driving vehicles are still in their infancy, but they are already proving safer than human drivers, who are responsible for the majority of the world's traffic accidents and jams. A world of such vehicles would mean drastically shorter commute times, accelerated logistics, less resources consumed, and more peace of mind. It might even make the notion (and great cost) of individual car ownership redundant.

Connected wisdom: As the physical world is increasingly mirrored in cyberspace, we will be able to

Doctors tell us that an ounce of prevention is worth a pound of cure. In the spirit of that maxim, eHealth systems have doled out millions of doses of prevention, saving lives.

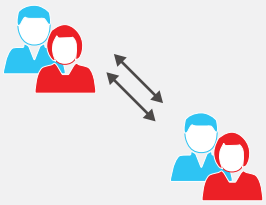
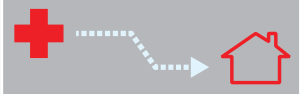
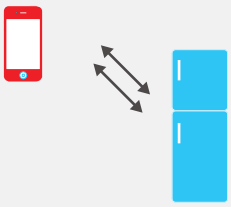
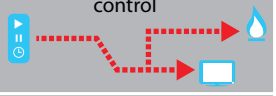
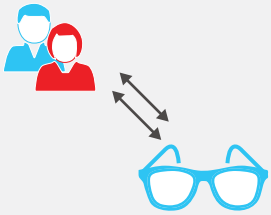
Connected stadium

In a Better Connected World, the stadium experience will mean so much more:

- Share the experience in the stadium with friends and loved ones as it happens.
- Receive real-time player background, game analytics and media commentary.
- Switch angles to view what the officials see, what your favorite player sees, what his opponent sees, or what your friends see.
- Shorten your wait times by ordering & paying for concessions in advance.

explore it, study it, test theories about it, and predict it like never before. This should improve how we govern, do business, assess, and live, through the introduction of a sort of wisdom born of all the data now available and accessible – "connected wisdom."

Figure 2: Benefits of connectivity

CONNECTIVITY	BENEFITS			EXAMPLES
	Social	Industrial	Personal	
People to people 	Inclusiveness	Extended reach	Accessibility	Remote healthcare 
	Collective wisdom	Customer engagement	Community participation	Crowdsourcing 
Things to things 	Resource saving	Efficient logistics	Safe transport	Driverless cars 
	Less emissions	Lower costs	Convenience	Smart appliance control 
People to things 	Unleashed potential	Increased user base	Expertise on-demand	Intelligent life aids 
	Healthier population	More and better services	Personalized healthcare	Round-the-clock care 

Global Connectivity Index

Investment, a competitive market, affordable services, and excellent service quality all combine to provide an inspired experience for consumers, businesses, and society at large. It's up to governments, regulators and service providers to ensure that all are in place. Countries that embrace ICT will compete and progress; those that do not will fail their citizens. Businesses that embrace digital reformation will adapt and prosper; those that do not will simply fail.

To examine and illustrate how ICT adoption drives competitiveness, Huawei has created its Global Connectivity Index (GCI) for countries (GCI-C) and industries (GCI-I).

The country index is derived from an examination of the state of connectivity in 25 select markets and illustrates how ICT stimulates investment, boosts innovation, and nurtures entrepreneurship. In other words, the GCI-C can be considered a proxy for a country's overall competitiveness.

The industry index assesses ICT investment and usage in 10 different industries in terms of current investment, planned investment, and effects on the bottom line, across areas such as business efficiency, innovation, and customer engagement. In other words, the GCI-I provides a relative measure of who is embracing ICT, who isn't, and what benefits are being seen. It also provides a guide as to what leadership looks like in today's business world, making for a clearer picture of how industry can innovate, transform, and grasp the opportunities that abound in a Better Connected World.

As a whole, the GCI demonstrates who is ahead in the ICT race and who is behind. Indirectly, it hints as to how business should be done and where it should be done.

Figure 3: Current Connectivity breakdown

Indicator	Measurement
Infrastructure: Int'l bandwidth per user	Available international bandwidth divided by number of Internet users.
Investment: Telco investment as % of GDP	Telco investment divided by GDP in a certain country.
ICT activity per person	Number of IP addresses divided by total number of Internet users in a certain country.
Regulation: QoS enforcement by telco authority	Gauges services tracked in terms of QoS (voice, data, fixed, or mobile) and who does the tracking (telco data, authority tracking, or crowdsourcing).
FBB affordability	Total monthly spending on fixed broadband divided by FBB subs divided by GDP per capita/month.
MBB affordability	Data revenue (non-SMS) divided by data subs divided by GDP per capita/month.
Avg. broadband download speed	Average speed test results (ookla.com) of a sizable number of households in country.
FBB penetration	Number of fixed broadband connections divided by total number of households.
MBB penetration	Number of mobile broadband connections divided by population.
Smartphone connections	Number of smartphone connections.
App downloads	Number of mobile app downloads.

Figure 4: Growth Momentum breakdown	
Indicator	Measurement
MBB subscriber growth	Compound annual growth rate of mobile broadband subscribers (2011-2018).
Smartphone connections growth	Compound annual growth rate of smartphone connections (2012-2017).
National broadband planning	Presence/absence of a national broadband plan, its timeframes, progress and allocated budget.
Growth of domestic online production activity	Growth of IP per capita from early-2012 to early-2014.
Projected app downloads	Compound annual growth rate of app downloads per mobile broadband subscriber per month (2011-2018).

1.1 GCI - Country

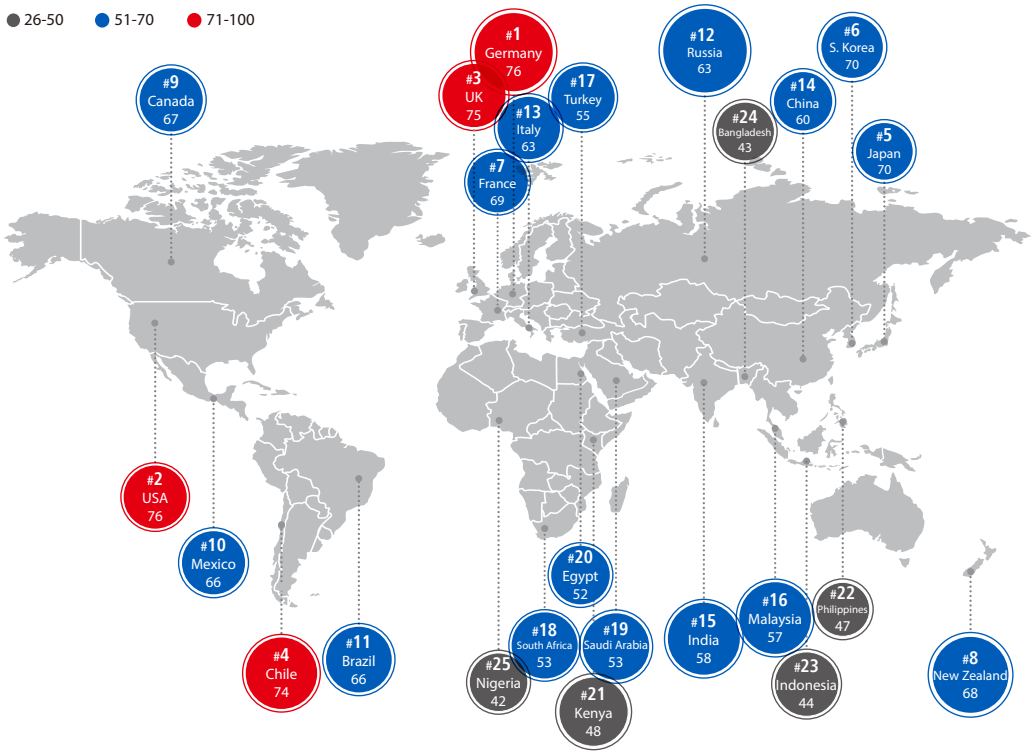
Huawei's GCI-C is a quantitative ranking of 25 countries that account for 68% of global GDP. The index is composed of 16 indicators comprising two variables – Current Connectivity and Growth Momentum. Categories and indicators are weighted according to their relative import in demonstrating the connectivity of each market.

Exploring the GCI-C

This index is composed of two sub-rankings – Current Connectivity, and Growth Momentum. Current Connectivity ranks markets in terms of penetration, affordability (as a percentage of average income), international average bandwidth, download speed and telecom investment. Growth Momentum incorporates projections for increased broadband subscribers and connections, as well as future government broadband plans and private sector consumption in terms of mobile application downloads.

Germany took the top spot on the GCI-C, thanks to its strong ranking in Current Connectivity (third among all countries ranked) and relatively high Growth Momentum (second among developed countries), but the real

Figure 5: Listing of countries ranked



surprises on the leaderboard are Chile (fourth overall) and Kenya (first in Growth Momentum), The other surprises were South Korea and Japan, two countries renowned for their ICT leadership and capabilities, ranking fifth and sixth, respectively. This can be attributed to a relative lack of affordability compared to some of the other leaders, coupled with the fact that both markets are already very advanced, hence less Growth Momentum, which is strongest in Africa, with Kenya, Egypt and Nigeria ranking first, third and fourth on the list, respectively.

Latin America also deserves honorable mention for fielding three countries that made the top eleven, beating some wealthier countries in the process. Huawei views it as no coincidence that these three countries (Chile, Mexico, and Brazil) are considered major socioeconomic success stories, while some other countries of comparable wealth but farther down the list are not.

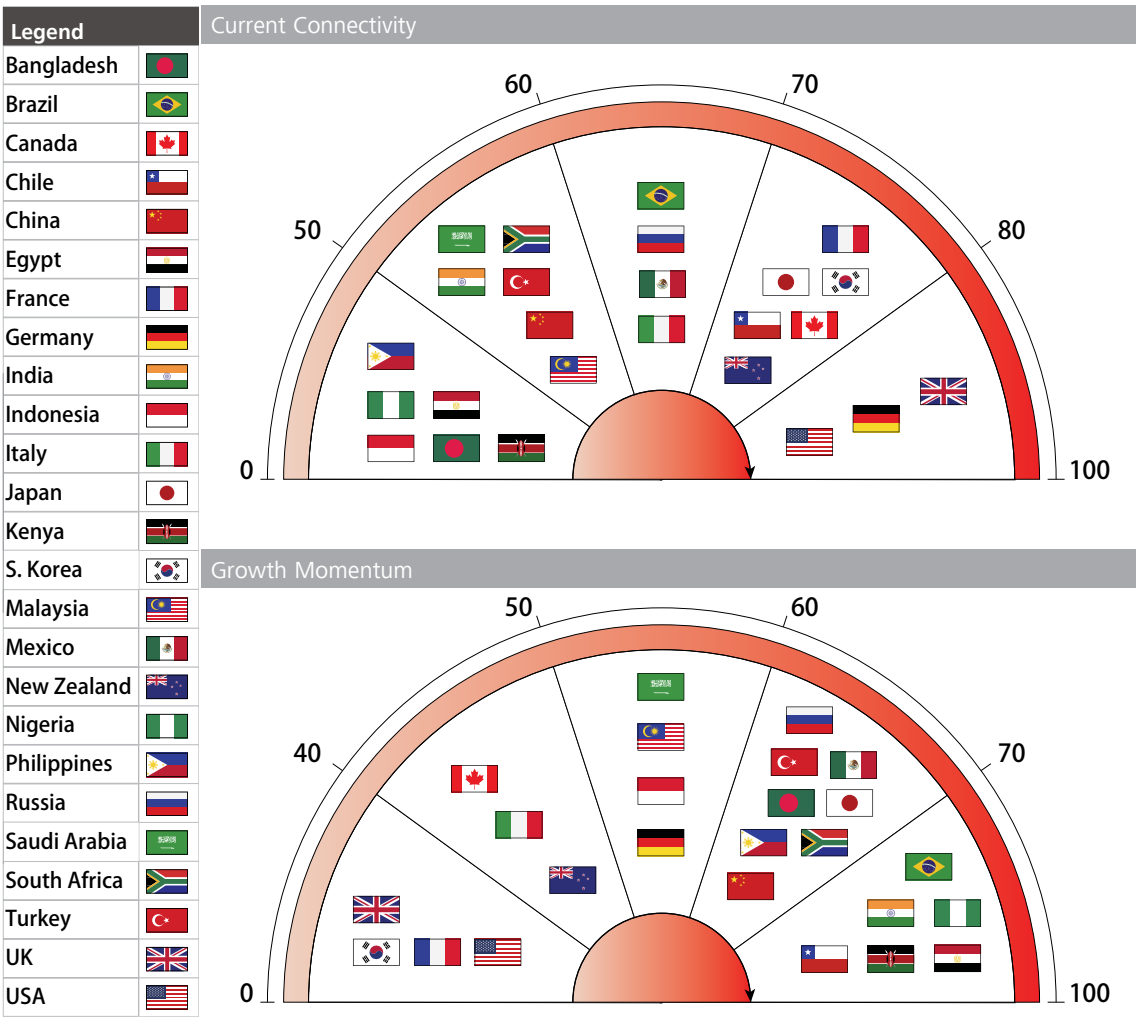
New Zealand: Affordable and far-reaching broadband

The importance of broadband affordability cannot be overstated. According to a survey of 218 policy-makers and telecommunications executives conducted for the Economist Intelligence Unit's *Redefining the Digital Divide* report, nearly one-third (29%) say the digital divide, despite efforts to address it, is widening in their country. Affordability was cited by 63% as the most serious contributing factor to the digital divide, while 48% said that increasing affordability would have greater economic benefit than any other means of closing the divide.[1]

In many countries, the issue of adoption is as vital as coverage. New Zealand owes its eighth ranking primarily to its high fixed broadband adoption rate, driven partly by very affordable service (1.6% of mean income).

Alongside South Korea, New Zealand has the highest household broadband penetration rate of the 25 countries surveyed, with mobile broadband

Figure 6: GCI-C dimension quintile scores



New Zealand

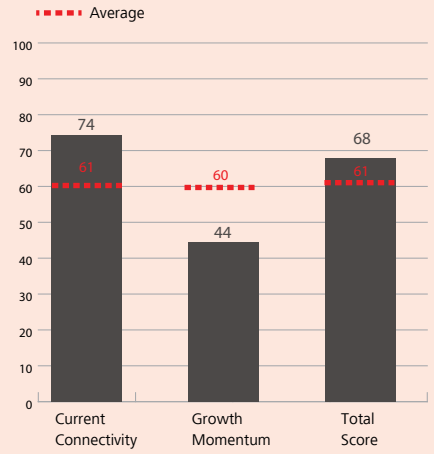
The liberalization of New Zealand's fixed broadband network has triggered a decade of broadband growth.

Current Connectivity

- Fixed household penetration stands at 91% and has been growing at 12% per annum for the last seven years.
- The Commerce Commission has ensured excellent quality of service, partly through its continuous broadband speed measurement initiative.

Growth Momentum

- As a mature market, growth in take-up of broadband will be stagnant, but the government is investing USD1.35 billion in its Ultra-Fast Broadband Initiative.



Chile

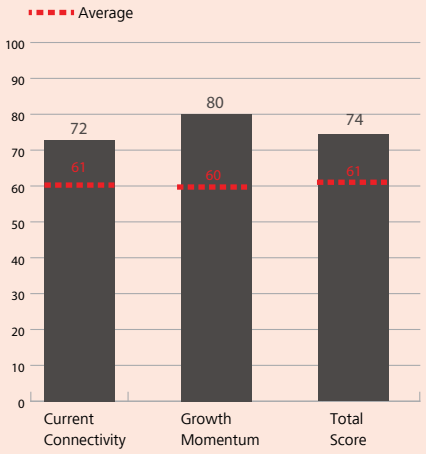
A complete digital ecosystem is steadily formalising around the most successful tech hub in Latin America, Chilecon Valley.

Current Connectivity

- Government investment in telecommunications equates to 0.9% of GDP.
- Mean broadband download speed in Chile is 14Mbps, compared to 11Mbps in Mexico and 9Mbps in Brazil.

Growth Momentum

- On average each consumer in Chile will download 60% more apps every year to 2018.



Chile's high-tech ecosystem has encouraged 43% of its active population to consider entrepreneurship.

affordability also ranking in the top quintile. Nine out of ten households in New Zealand have access to broadband, and ongoing initiatives to push ultrafast broadband (UFB) and services into rural areas will drive growth. The government projects that by 2020, three out of every four broadband subscribers in New Zealand will be served by UFB, with 98% coverage for all rural areas.

New Zealand is one of the few countries to actually have a national broadband network up and running. In fact, the ITU has shown that the mere existence of a national broadband plan has a positive impact on broadband access, as countries with such a plan have a fixed broadband penetration on average 8.7% higher than those countries without. The effect is much the same for mobile broadband penetration. The most effective plans will emphasize the role of broadband in national competitiveness and will create a greater awareness across all layers of the population of the power of broadband-enabled services and applications.

Quality matters: The emergence of Chilecon Valley

Governments and regulators are increasingly launching monitoring

Kenya

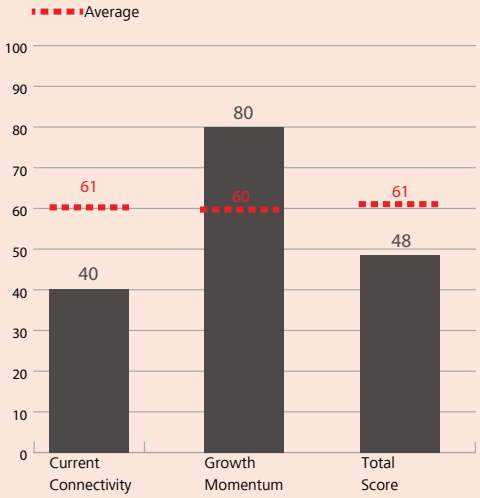
Fast becoming known as a technology hub for East Africa, the rest of the continent is taking note of Kenya's role as a springboard for service innovation.

Current Connectivity

- Government investment in telecommunications equates to 2.4% of GDP, more than any other market in the GCI.
- Although Kenya scores relatively poorly for this variable, its average broadband download speed of 6Mbps exceeds that for South Africa.

Growth Momentum

- Kenya is expected to double its IP activity annually based on fast-growing fixed broadband penetration (33% annually) and computer literacy.



schemes to test the reliability and speed of broadband services. Brazil, for instance, scored well in the quality of its service, and this was largely due to Brazilian regulator Anatel's efforts to publish mobile broadband measurements on a monthly basis, with the country's operators obliged to achieve specific reliability targets in terms of service.

And while this is certainly good, Chile is doing even more, with telecom investment comprising on average 0.9% of GDP (as compared to 0.5% in Brazil). Subtel, Chile's regulator, also now uses quality of service (QoS) monitoring in granular detail, and this comprises a vital part of its plan to stimulate innovation.

As a result of sound QoS enforcement, growth of IP addresses per capita is 71% higher than average amongst ranked countries, and projected smartphone connections are 31% higher. Numbers like these make it easy for the government to present Chile as an ICT hub. "Start Up Chile" is a government accelerator program that hosts 100 Chilean start-ups every year, with the intent of creating an ecosystem that fosters innovation, and it now encompasses over 800 start-ups from over 60 countries, all vital players in the emergence of what is called "Chilecon Valley." According to a recent survey, such an innovative ecosystem is forming, as 70% of respondents in Chile now consider entrepreneurship a desirable career choice.

This sentiment is starting to be felt in the e-health sector. ClickMedix, Medko and MedSensation are all start-ups facilitating patient-doctor interaction. ClickMedix connects patients with doctors via telemedicine. Medko connects patients with the right doctor. MedSensation assists the self-diagnosis process. Innovations such as these, enabled by investment from government and the ICT industry, has propelled Chile to number four on the country index.

Kenya: Top-down investment, grassroots innovation

Apart from the more obvious obstacles, developing markets face two major barriers to broadband adoption. One is poor or non-existent fixed infrastructure; the other is a lack of local applications and content. Both problems can seem daunting, almost insurmountable, but in the case of Kenya, it only took one killer app to get the ball rolling.

Kenya invests 2.4% of its GDP annually into connectivity, the highest percentage amongst the countries surveyed.

Kenya ranks poorly in the GCI-C overall due to its relatively undeveloped status (fixed broadband penetration for 2018 is only projected to be 4%), but it tops the Growth Momentum dimension.

It's high ranking can be attributed to two factors. One is a strong government commitment to connectivity, totalling 2.4% of GDP, the highest percentage in the index. The other reason is M-Pesa.

M-Pesa is the world's most successful mobile money program, launched in 2007 by Kenyan telco Safaricom. The program now reaches over 18 million users in the country (four in ten Kenyans), many of them unbanked, and accounts for a double-digit percentage of the country's GDP. This is good for Safaricom, which enjoyed record profits in H1 2013, with 18%

ICT network infrastructure is now as vital to the prosperity, competitiveness and overall well-being of any country as its roads, dams, bridges, waterways and electricity.

of revenue accounted for by M-Pesa. In M-Pesa's wake, a slew of innovations has emerged, as has a commitment to increase the mobile broadband adoption rate from 9% in 2011 to 57% at the end of 2018.

This commitment has not gone unnoticed by the global tech industry, with such names as IBM and Philips having established their African innovation hubs in Kenya's capital, Nairobi. Konza Technology City, a USD10 billion+ industrial park expected to provide 100,000 jobs by 2030, has also not gone unnoticed, and Kenya's government expects this project to be the heart of its efforts to make the country the center of tech on the African continent. This would represent a serious step up in the value chain for a country whose single largest revenue stream thus far has been tourism. It also represents a potential model for other developing markets to follow, a mobile-first leapfrog to the middle and upper income brackets that could deliver the sort of miracles once reserved for the Asian tigers.

Leaders must lead

None of the three countries profiled in this section achieved ICT leadership solely through market forces; all needed strong leadership from the public sector. If other countries hope to do the same, governments and regulators must ensure that national broadband and QoS initiatives do in fact encourage greater levels of broadband connectivity and attract the sort of innovation that will increase a market's competitiveness. The private sector has a role to play here as well, as it must leverage ICT not just as a mere efficiency tool, but as an enabler and catalyst for transformation, enabling a more direct relationship with customers and end users.

If both sides do their part, the digital divide can be bridged, with affordable broadband access enabling innovation, service transformation, and national competitiveness.

1.2 GCI - Industry

How do organizations create value? Historically, it's been achieved through control over assets such as land, labor, production tools and capital. But ICT infrastructure transforms our concepts of production. Today, ICT remains a significant business support element, but its integration with production is increasing, thus driving value creation. In other words, connectivity has become a business asset.

Not only does ICT enable new types of products, it also enables innovation, entrepreneurship and new business models, often by tearing down the physical boundaries between enterprises and customers.

Empowered by ICT infrastructure, industries old and new are shifting from the selling of commodities, goods, and services to selling experiences and transformations. Take insurance for example; why buy an automotive policy for your teenager when you can buy an insurance package with GPS tracking and a mobile driving app that coaches them to become safer drivers?

Toward digital reformation

ICT is no longer just the concern of CIOs, CTOs or the IT department. Nine out of ten business leaders see ICT investment as critical to their business, according to a global survey of more than 1,000 enterprises commissioned by Huawei. Nevertheless, fewer than half of business leaders believe their

Figure 7: GCI-I breakdown

Category	Indicator
ICT intensity	Planned ICT budget growth.
	Perception that ICT is critical to organization.
Efficiency	ICT process improvement achieved.
	ICT time-to-market improvement achieved.
Innovation	ICT product/service innovation achieved.
	Planned use of ICT for innovation & new revenue.
Engagement	Range of customer engagement channels used.
	Reliance on digital sales (current/future).

Digital reformation is a process where ICT is integrated and leveraged to the maximum degree in the operational & strategic elements of any business.

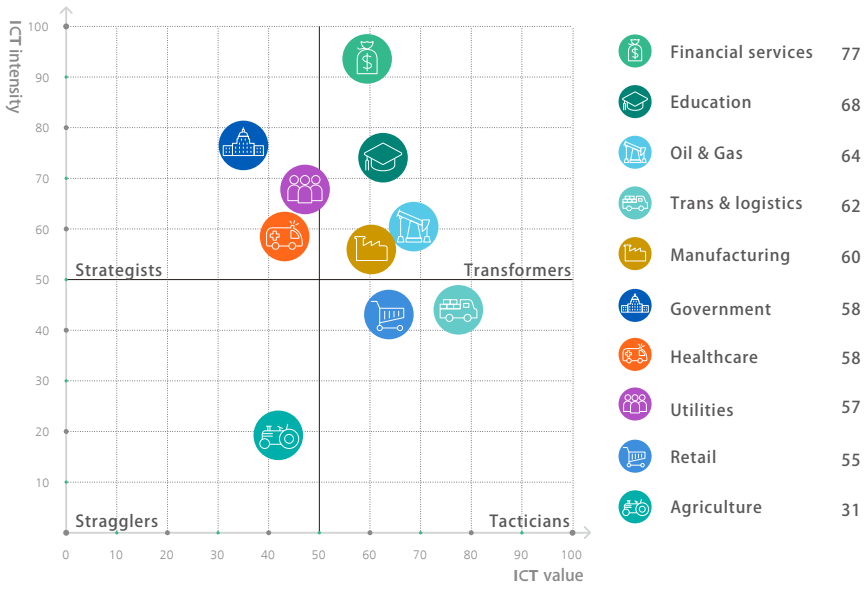
organization's current use of ICT is state-of-the-art.

They must embrace digital reformation – a process where ICT is integrated and leveraged to the maximum degree in the operational and strategic elements of any business. It is a reformation of both the corporate mind and body through ICT, with insights and gains achieved in either domain influencing the other. The end result is a state of synergy between technology and strategy where any and all business opportunities can be adapted to and seized with minimal hassle. Many organizations believe there is a positive correlation between the use of ICT and business performance in terms of operational efficiency, innovation capability and the delivery of inspired customer experience. However, quantitative assessment across key industries is lacking.

Exploring the GCI-I

To understand how organizations are moving toward digital reformation and to demonstrate what leadership looks like,

Figure 8: Listing of ranked industries



Transformers are accelerating ICT investment and are highly motivated to rethink their business model – this may stem from industry stagnation, restructuring or threat.

we created the GCI for industry to assess how organizations benefit from ICT.

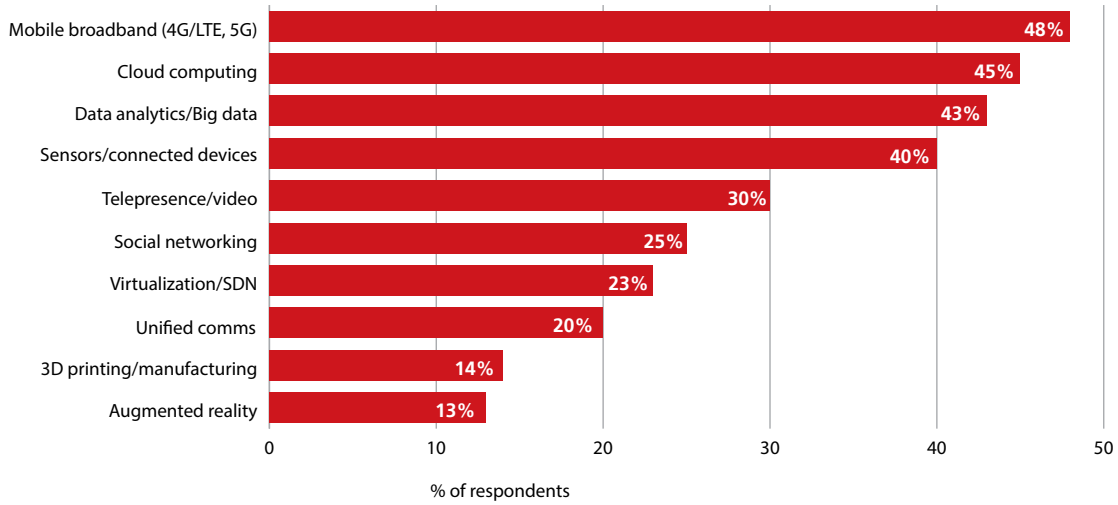
We believe that an organization demonstrates its commitment to digital reformation through its corporate mindset, with the GCI-I reflecting the following areas (see Figure 7).

- **ICT intensity:** An organization that scores well here views ICT as intrinsic to business success, with long-term ICT planning the norm. ICT investment is not solely devoted to solving immediate business problems and this is reflected in the proactive growth of ICT budget and planned investment in transformative technologies such as cloud computing and big data analytics.
- **Efficiency:** Beyond pure cost savings, an organization rating high here has seen clear time-to-market and process improvements through ICT. With these improvements in hand, such organizations often migrate to bolder uses of technology to achieve new business objectives.
- **Innovation:** Organizations scoring high here have successfully leveraged ICT to stimulate the creation of new products and services. They have also set ongoing targets to maintain or accelerate this momentum. In other words, ICT is being used to increase business agility and help make innovation core to the business culture.
- **Engagement:** A high score here indicates that digital channels are already delivering measurable improvements in customer satisfaction, loyalty and revenue growth, and that these businesses are increasing their use of these channels to provide greater accountability to customers. This builds trust and can also lead to revenue diversification.

Today, differing attitudes towards ICT and digital reformation divide organizations into clusters (Figure 8).

- **Stragglers:** These organizations usually invest in ICT reactively as a means to solve immediate problems, with ICT primarily viewed as a means to cut costs and keep the lights on.
- **Tacticians:** Organizations in this cluster expect a lot from ICT, but often resist full-scale transformative

Figure 9: Key technologies expected to drive future revenue growth



investment. This is partly due to institutional caution and perhaps regulatory compliance, with lack of funds and general fear also possible playing a role here. These organizations are more likely to make highly selective investments in ICT, and prefer quick wins that are easy to explain.

- **Strategists:** These industries have extensive ICT experience that has already enhanced innovation and competitiveness. With their strong commitment to ICT for the long term, companies in these fields stay on top of the transformation curve, but must avoid becoming complacent.
- **Transformers:** These organizations are accelerating their ICT investments the most and are highly motivated to rethink their business model. This bold attitude may be the result of industry stagnation, restructuring, or threat. Organizations in this grouping are most likely to have created and be executing a company-wide business transformation program (digital reformation). ICT is recognized as the core enabler of change across all business activities, including processes, product creation and revenue streams.

Although individual experiences vary widely, organizations in certain industries definitely demonstrate greater drive to and velocity of change in regards to ICT.

Defining Transformers

Any organization can become a Transformer, whatever its industry, size, location or starting point. What's required is digital reformation.

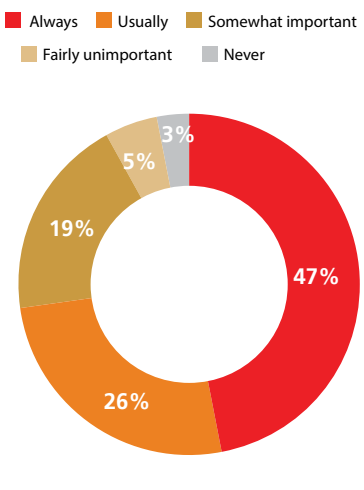
Five common behaviors differentiate Transformers from their peers.

- **Transformers seek open innovation:** Transformers welcome innovation from outside their organization – and increasingly their industry. This is often reflected through the use of digital tools such as social networking to crowdsource new ideas from customers, employees and partners.

  Example: When it comes to cars, Silicon Valley is increasingly in the driver's seat, supplanting Detroit as a key source of disruptive innovation. The Renault-Nissan Alliance now has offices directly across from Google headquarters, and has a mission to build relationships with leading technology firms. Nissan's award-winning Leaf electric car reflects ICT's profound impact on the automotive industry, integrating sophisticated touchscreen displays, in-vehicle Internet connectivity, and telematics. It's supported by Nissan's Carwings cloud-based control center, which tracks real-time battery performance, vehicle location, speed and energy usage. The Leaf is now the world's best-selling plug-in electric vehicle (EV), and is diversifying Nissan's revenues into an EV market expected to grow to 3.8 million units per year by 2020.

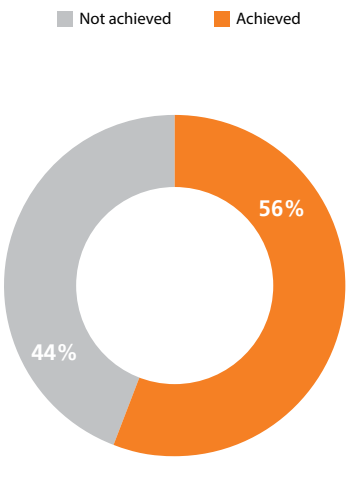
- **Transformers prize customer convenience:** Often said, but rarely achieved, Transformers don't define customer convenience by the physical proximity of their brick-and-mortar storefronts to the customer. What matters is the diversity and utility of how they interact with customers. It must be anywhere the customer is, anytime, by whatever

Figure 10: ICT solves business challenges



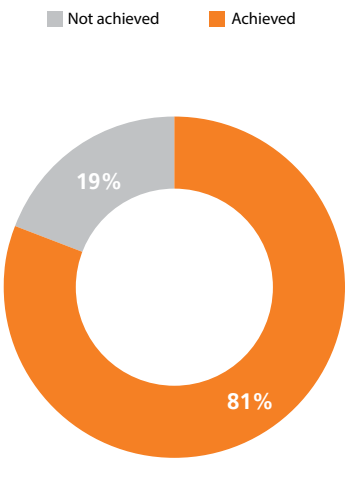
Respondent %

Figure 11: Social media tools have improved organizational performance



Respondent %

Figure 12: Enterprise ICT investments have delivered new and improved services



Respondent %

means is preferred. This interaction is increasingly digital, with unified management for all communications.

Example: China Merchants Bank (CMB) positioned itself in 1987 as a bank focused on customer experience. CMB launched China's first online banking platform, and delivers 95% of its services online – accessed largely via smartphone. It competes effectively with larger competitors with just 10% of the number of branches and 15% of the costs that a traditional bank typically incurs. Now ranked in the Global Fortune 500, and one of the world's top 100 banks, CMB has kept customer satisfaction levels consistently at 95% or more by offering access to its services anytime and anywhere.

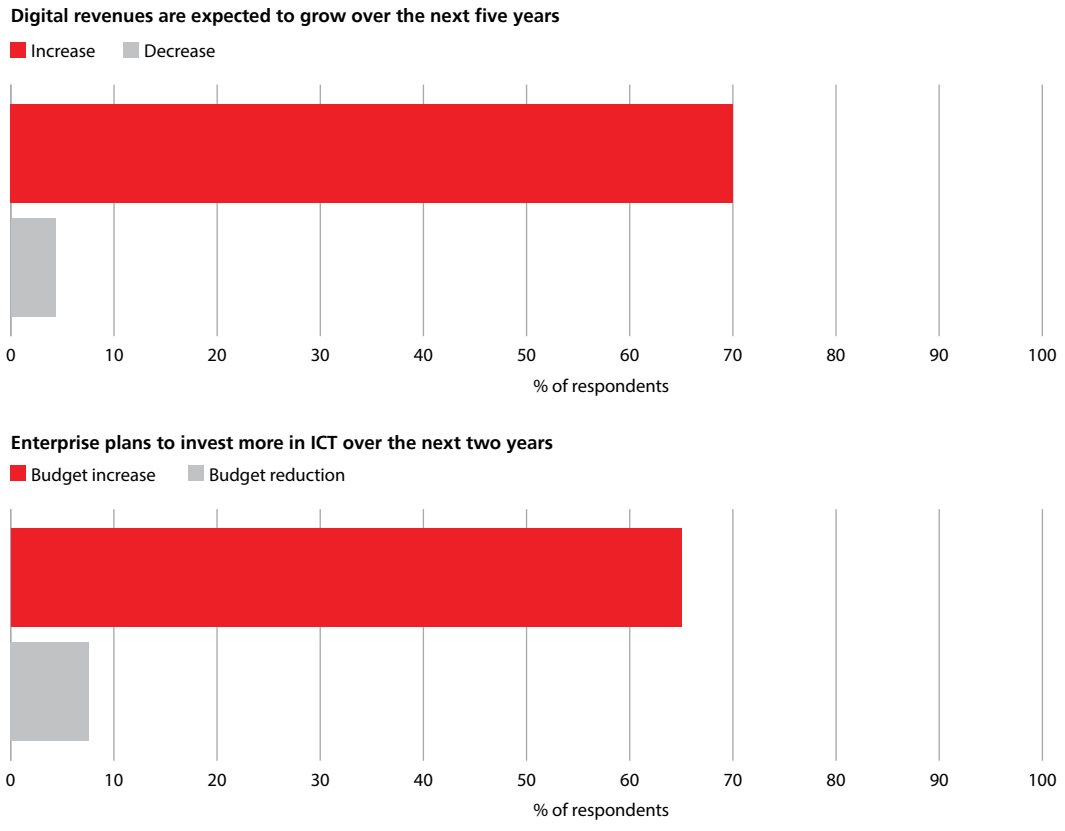
- **Transformers sell service experiences:** Transformers think that their service wrap is as important as the product within it. In fact, they believe that the emerging subscription economy creates new ways to engage with customers after a product sale, so that promises are kept concerning a product's performance, and ongoing feedback is obtained.

Example: Rolls Royce Aerospace has transformed its business model through ICT, creating a new KPI in the process – "power by the hour." Using connected sensors and cloud computing, customers pay for the performance but not the ownership of Rolls Royce's jet engines, which are tracked and maintained remotely across the world. This process may sound complex, but the benefits are clear. Half of the company's revenues today are now generated from services, which deliver higher profit margins and require fewer assets than traditional manufacturing activities.

- **Transformers are the first to know:** Transformers depend on real-time information and service delivery to differentiate against competitors, delight customers and boost efficiency. They seek new insights by constantly analyzing data from a range of sources, from the customers themselves to remote assets in the field.

Example: Online finance firm Kabbage believes that real-time customer tweets, Facebook "Likes" and online shipment volumes can say as much about a company as its bank records. Over the past three

Figure 13: ICT investment and digital revenue growth



years, Kabbage has successfully provided USD250 million in loans to small businesses that traditional banks and lenders usually turn down. Using big data techniques to assess and profile applicants, the process is lightning-quick, which is particularly valuable for small businesses that usually struggle to manage cashflow and inventory. Loans can be approved with funds transferred in less than five minutes.

- **Transformers are adaptable to change:** Transformers thrive in a hyper-connected world, using ICT to accelerate and adapt to change. Indeed, ICT helps large organizations become Transformers by enabling them to do what startups do well already – experiment and iterate quickly.

  Example: After seeing profit margins slide across its industry, chemicals giant Dow Corning launched Xiameter, a global online-only discount channel for its commodity silicone products, in order to recapture cost-sensitive customers who were fleeing to low-cost rivals. Instead of bundling more value-added services with its premium products, Dow Corning created new revenues by using ICT to diversify and go downmarket. Despite the fact that this move went against conventional business logic, the company managed to recoup its e-commerce investment within three months, and online sales now represent a third of the company's overall revenues – roughly three times the industry average.

What business leaders must do

In a Better Connected World, ICT will be the core of a customer-oriented business and production culture.

Digital reformation is a mindset that embraces the proactive use of technology for efficiency, innovation and engagement. To achieve it, and turn a little profit in the process, business leaders must do the following.

- **Make ICT a strategic priority:** ICT gives business leaders more strategic options, as it makes it easier to move beyond the confines of a traditional business, access new markets, and launch new products and services.

- **Embrace innovation:** Prioritizing innovation is the best strategy to reignite growth or respond to disruptive challengers. With an agile ICT infrastructure, business leaders can test new ideas swiftly, execute on them and transform their market positioning.

- **Deliver inspired experiences:** ICT transforms customer interaction into an ongoing relationship, particularly when organizations seek to co-create with customers to meet their needs and aspirations. Real-time insight, greater accountability to customers, and stronger loyalty are the results.

Transformers depend on real-time information and service delivery to differentiate against competitors, delight customers and boost efficiency.

Engines of transformation

In 2025, ICT infrastructure will be serving 100 billion connections and six billion users, producing some 176ZB of data per year. This deluge of data will pose huge challenges for the networks that carry it, and great opportunities for those who can harness it. Cloud computing, SDN/NFV, big data solutions, and the Internet of Things (IoT), all synergized through 5G, are the tools that will prove the difference between harvesting the waves and treading water

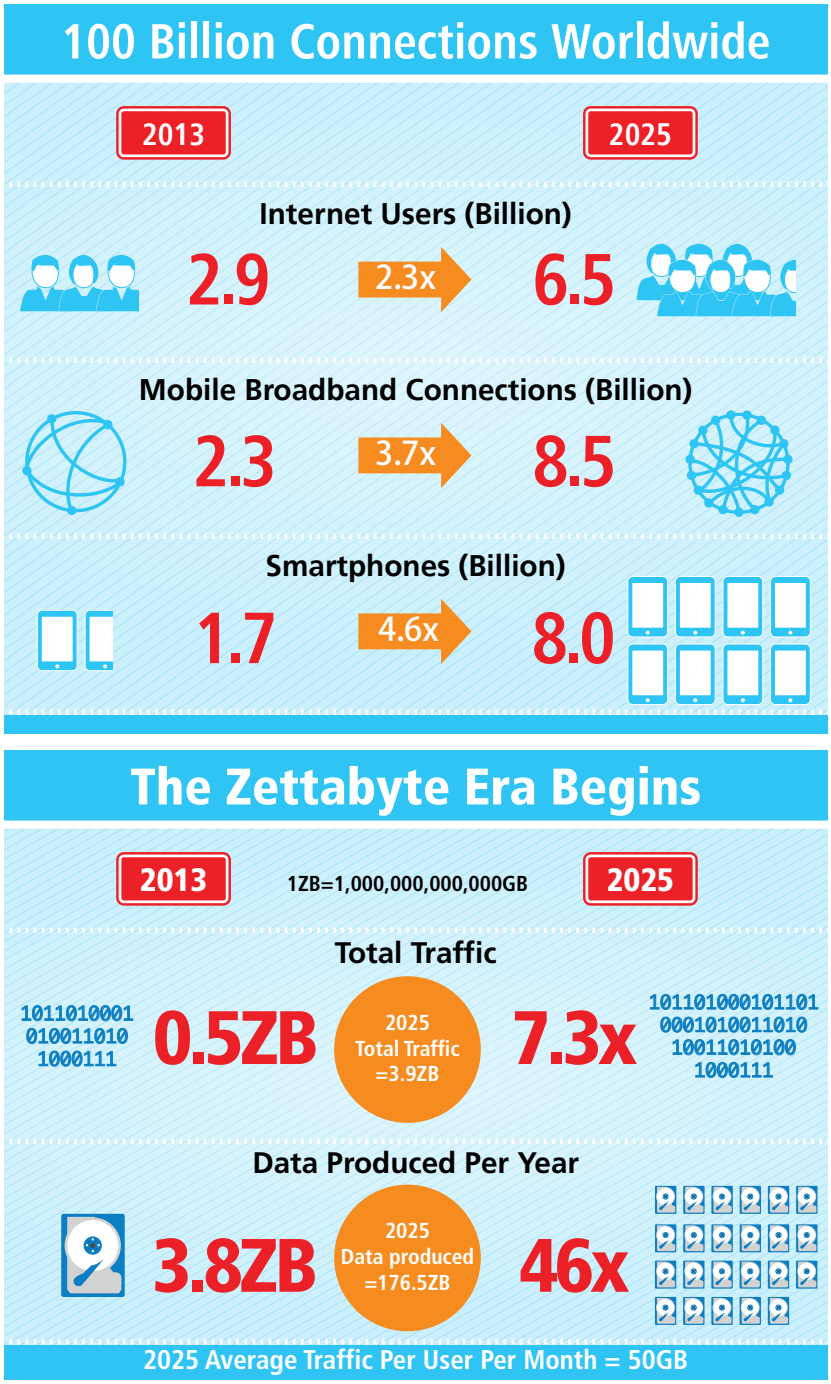
A Better Connected World will float on an ocean of data, requiring a pipe of unfathomable capacity and reach that can keep both the high-volume and low-volume data flowing timely and properly.

Today's ICT users enjoy network connections of a few to a few hundred megabits, and this will probably not be enough to support feature- and content-rich applications such as 4K video and virtual reality. But the network will not be the only challenge for a Better Connected World – data storage and processing are still major areas requiring advancement, especially since the data each user generates is going to explode over the next few years.

Huawei estimates that total data traffic during 2012 was 391 Exabytes (EB), and this number will increase tenfold by 2025. In terms of connected devices, Huawei expects massive growth, with nearly 10 billion end-user devices online by the same year (excluding M2M and IoT). Apart from the traffic demands these devices will generate, the sheer number of connections will also certainly strain the network.

Information technology (IT) is now leading the way in ICT network innovation and development. A Better Connected World demands this, as traditional CT infrastructure tends to be specialized, unidirectional and proprietary, and thus very expensive. It also scales poorly, making it ill-suited to ubiquitous high-speed connectivity, new communication domains, easier service creation, or tens of billions of devices. Thus, a radical re-think of how CT networks are designed, deployed and operated, oriented along IT lines, is currently underway – one that can promote innovation, reduce time to market, drive down costs structurally, and ensure a high-quality customer experience. It is underpinned by the following technologies.

Figure 14: Usage and data growth for 2025



With the adoption of SDN/NFV, an enterprise IT system can be deployed in as little as three minutes and telecom network utilization can double to 80%.

Source: Huawei MI

SDN & NFV

Software-defined networking (SDN), a key facilitator of network function virtualization (NFV), is perhaps the most straightforward example of how IT is transforming CT. With its adoption, an enterprise ICT system can be deployed in as little as three minutes, and telco network utilization can be doubled – both tremendous boosts to efficiency.

Key advancements

For both telco and enterprise networks, the industry is now moving to software-based architectures, where

Cloud computing is now the single most important ICT resource, as its leverage enables businesses and ISPs to better deliver their services through economies of scale, while reducing cost through centralized infrastructure.

network deployment, control and maintenance are rendered much more scalable and flexible, enabling quick response to user demands and creating new business value.

The key element of SDN/NFV is programmability. Traditional CT hardware is typically inflexible, inefficient and proprietary, requiring intensive configuration and costly upgrade, but programmability changes the game, as configuration, adjustment, upgrade, maintenance, and, in many cases, self-healing, can all be done through software.

Value of enabler

SDN/NFV, through its ability to shorten the service lifecycle from quarters to days, is essential to the success of any business, or telco. Costs are driven down further through the use of commoditized hardware platforms and open software, and ecosystems will spring up to create new services and value around these platforms.

In other words, telcos will be able to lease their ICT resources as services in the enterprise space, opening new revenue streams that should accelerate the ROI of their current network expansions. However, it also enables non-traditional players to do the same thing, as Amazon has done – telcos must be wary.

Use cases

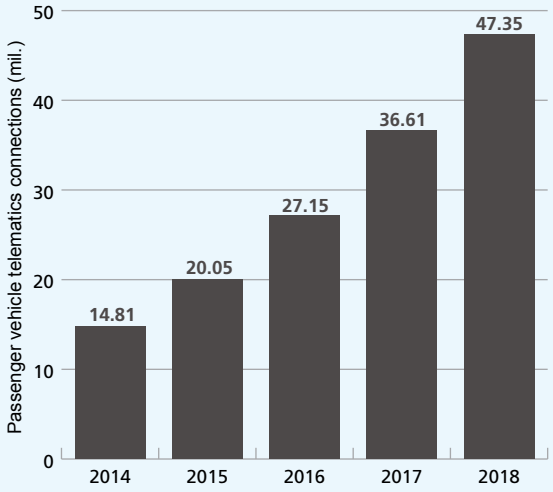
Connected cars may require separate virtual networks to carry data traffic associated with collisions, accidents and congestion statistics. SDN can route this traffic accordingly, while NFV can create a complete virtual network to enable SLA-relevant communications for this vertical. Such a network may enable new partnerships between ICT service providers and car manufacturers.

Connected vehicles

Today, more and more cars are connected to the Internet. But the current "self-driving" car still needs to be enabled by a navigation system. In fact, to realize the driverless car, breakthroughs need to be made in several key technological areas:

- Reliable broadband network coverage.
- High-speed network connection.
- Short latency.
- Real-time collection, transmission and processing of a huge amount of data.

Through technologies such as 5G, big data, cloud computing and the IoT, the driverless car will soon be on the road.



Source: Yankee Group

Cloud computing

Cloud computing is now the single most important ICT resource, as its leverage enables businesses and ICT service providers to better deliver their services (through economies of scale) and reduces cost through centralized infrastructure.

Key advancements

The supporting technologies that make cloud computing possible are advancing and creating new synergies. Software, storage, computation and connectivity are interdependent and allow for a scalable, convergent platform. Cloud computing centralizes processing, storage and networking to create economies of scale that were not possible with in-house ICT networks. Storage and processing in the cloud may be distributed across different media and processors, which allows services and users to repurpose resources in real time to address new requirements or business opportunities. Server virtualization allows services to run anywhere, while increasing the utilization of infrastructure.

Value of enabler

Since cloud computing is enabled in the data center through standard IT platforms, flexibility, scalability and upgradability are guaranteed, in contrast with CT networks, where equipment is enabled by proprietary hardware and software platforms. Cloud computing improves internal processes by centralizing intelligence and allows ICT service providers and businesses to launch new services faster than before.

In the enterprise domain, IT departments can lease cloud services, capacity or even energy in a data center rather than owning infrastructure, which will in turn reduce costs and increase efficiency. For small-and-medium businesses, enterprise-grade infrastructure capabilities can be enjoyed. Rather than buy and deploy, they can rent both an ICT network and its applications, as services.

Use cases

The use of cloud computing can revolutionize both CT and IT domains and extend to new areas of business. For example, the healthcare vertical may be enabled through a centralized cloud, where health records are centralized and distributed across hospitals and health professionals at the national level. Enterprises may centralize computing and storage capabilities, which may drive efficiency and simplicity when coupled with thin clients. This will in turn

5G networks will support thousand-fold gains in capacity, at least 100 billion connected devices, and a 10Gbps user experience – all with a latency of less than one millisecond.

Figure 15: 5G technology requirements

5G Requirements	Network Impact
1,000-times greater wireless area capacity	New air interface, unlicensed spectrum, mm-wavelengths
90% energy reducation per service provided	Energy-efficient networks
Less service creation time from 90 hrs to 90 min	Flexible, software-driven networks
Very dense deployments of wireless infrastructure	HetNets, small cells, Wi-Fi
Advanced user controlled privacy	Context-aware networks

Source: 5G-PPP

The IoT is making everything smart, from trucks to toothbrushes. This will mean a new era of automation, efficiency, logistics, and feedback, which will greatly businesses & consumers.

offer advanced security and control compared to traditional desktop computing, and easier rollout of new enterprise services.

5G

5G wireless networks will support thousand-fold gains in capacity, connections for at least 100 billion devices, and a 10Gbps individual user experience – all with a latency of less than one millisecond.

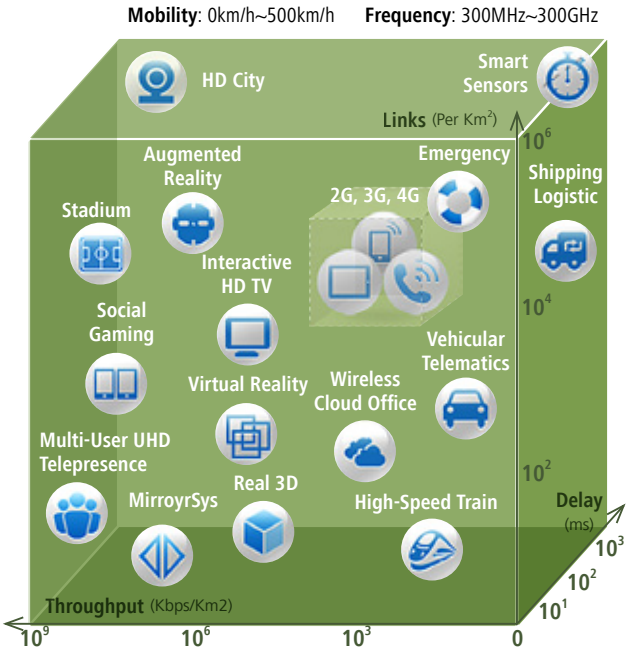
Key advancements

The majority of connected devices from now on will rely primarily on mobile connectivity, hence the increasing interest in the next generation of mobile networks – known as 5G. According to Huawei forecasts, mobile data speeds in developed markets will need to be as high as 1Gbps by that time, and this will exceed the projected limits of current CT. Figure 14 lists 5G characteristics and associated requirements.

5G will rely on new technologies and protocols to provide ubiquitous high-speed connectivity in cities, towns, and rural areas. Apart from a breakthrough in the air interface (where non-OFDM candidates are being discussed, with some tailored for HetNet), a radical redesign of the deployment model is likely, where small cells, Wi-Fi, direct device-to-device (D2D) communication, and high-frequency/unlicensed spectrum are used to provide a seamless experience to end users. The efficient operation and maintenance of these networks is also likely to become an area of development, as today's support systems will not be able to cope with such demands.

Value of enabler

Figure 16: 5G HyperService cube



5G will create a new level of efficiency for the transport of data in mobile networks. Although 5G will not be specifically designed to aid the creation of new services, it will prove a multiplier for all the other enablers of ubiquitous connectivity mentioned in this whitepaper. It is expected to build on the success of LTE and LTE-Advanced technologies, while enabling a sea change in its own right in terms of network coverage, capacity, density and latency.

Use cases

5G is more a means than an end, one that will support a tremendous variety of services, with network demands that vary along three dimensions – capacity, latency, and density (Figure 15). For example, virtual reality will require very high capacity and low latency, while augmented reality will require less capacity but more density. Most IoT applications will not be data-intensive, but connected vehicles will certainly need extremely high density and zero latency. As a whole, the job of 5G will be to ensure to that the Better Connected World is a seamless one.

Internet of Things

The Internet of things (IoT) will be a cornerstone of a Better Connected World. Intelligent, low-energy consumption modules, connected through a ubiquitous network, will be the cement. Combined, they will make our world smarter.

Key advancements

The prices of sensors, cameras, chipsets, and wireless transceivers are coming down. Combine this with innovations in powering & charging, ubiquitous coverage, context-awareness (AI), service-oriented architecture (IT) and other developments that will enable the proper prioritization of data traffic (such as 5G) and a world of connected things will take shape.

Value of enabler

The IoT is making everything smart, from trucks to toothbrushes. This will mean a new era of automation, efficiency, logistics, and feedback, with all benefiting businesses and consumers greatly. It will also underpin the miracles being promised for big data (see next section) and many of the other revolutions now being prognosticated – smart cities, self-driving cars, e-healthcare, etc. Telcos will be at the center of it all; they can go in almost any direction, horizontal or vertical, and find new revenue streams.

Use cases

Use cases beyond 2025 will be too numerous to effectively illustrate here, but preliminary applications will likely center on industries under heavy cost pressures or that are greatly time-sensitive, such as shipping, food, healthcare, and energy. They will also likely center on countries where labor shortages are becoming an issue, such as China.

Big data

As the IoT creates an increasingly accurate reflection of the physical world in cyberspace, precise, timely, and cost-efficient analysis of big data will change how we obtain knowledge, verify theories, and gain insight – the next paradigm shift will be only a click away.

As the IoT creates an increasingly accurate reflection of the real world in cyberspace, big data analytics will change how we obtain knowledge, verify theories, and gain insight – the next paradigm shift will be a click away.

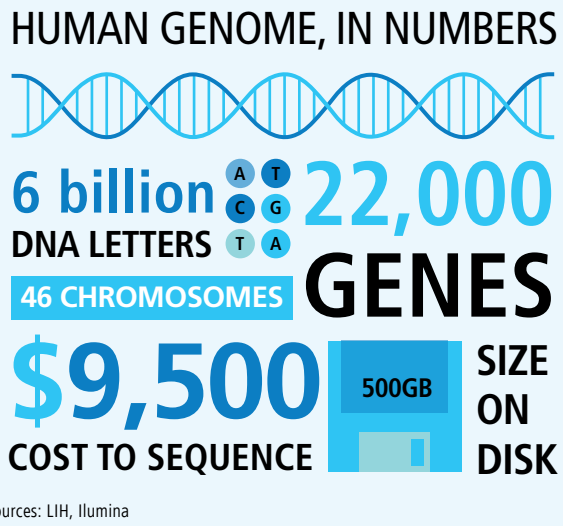
ICT Aspects in Healthcare

ICT contributes to the enhancement of healthcare sectors in two dimensions: data processing and analytics, and through the IoT. On the data-processing front, ICT continues to contribute in these areas.

- Genomic medicine
- Standard electronic health records
- Aggregated public health data

While IoT is enabling interesting healthcare solutions.

- Remote clinical care
- Remote diagnostic processing
- Electronic patient monitoring
- Mobile healthcare



Sources: LIH, Ilumina

Key advancements

Data is already being generated constantly – user location, customer enquiries, user experience metrics, and sales figures, to name just a few, with the IoT waiting in the wings. The primary challenge of big data is to collect, store and process unstructured (not easily categorized) data in real time and create value from it, no small order given that data generation in 2025 is expected to be 50 times greater than 2012 levels. Breakthroughs in scalable computing and data modelling are helping, but there's a long way to go.

Network architecture will also have to adapt. In addition to the requirements already mentioned for 5G and the IoT, networks will need to be both internally transparent and externally secure, so that user- and device-level granularity can be obtained without anyone's privacy being breached.

Value of enabler

Big data is the oil of the 21st century. Its value in the business world will be immeasurable. Efficiencies can be improved, maintenance can be reduced, scenarios can be planned for, and opportunities can be unearthed. Taken together, this will mean a more certain economy, one more inclined to hire and invest again. Enterprise will reclaim its name as a realm for vision and achievement and not just cost and incrementalism, and this should make our all of our jobs just a little more fun.

Telcos will also enjoy these benefits, and they should manifest through better network planning, construction, operation, upgrade, operational efficiency, and cost efficiency. A further benefit will be that, as their pipes will be the ones carrying it, telcos will become suppliers, aggregators, and analyzers of this digital oil – an enviable position.

Big data's benefits to society in general will also be immeasurable, but in a different way. Presently, most of what we learn on the Internet is not reality, but someone else's perception, interpretation, or fabrication of reality. But big data will give us access to a veritable fountain of facts and data concerning the real world, enabling us to learn, test our theories, and gain insight like never before, making for a mindset that might be called "connected wisdom."

Use cases

ICT decision-makers in the enterprise world see business data and intelligence as requisite to proper ICT investment prioritization, both in terms of business outcomes and expenditure. According to the GCI-I, four in five businesses have made improved customer satisfaction a key goal of their ICT strategy, and they seem prepared to back this up with budget, as 48% of decision-makers say that they will increase analytic expenditures up to 5% over the next two years, while 10% plan even greater increases, especially in the retail and healthcare sectors.

Example: Using big data to track diseases before an outbreak. Telefonica Digital collected data from its network and ran a simulation to track a hypothetical H1N1 epidemic involving two million infected people. Results showed that a 10% decrease in number of infections could be achieved through a 30% decrease in population mobility, mandated by government.

Call to action

For ubiquitous broadband, agile innovation and inspired experience to benefit all nations, industries and people, a number of key stakeholders must step up to the plate. For some, the obligation will be to lead and inspire action, for others it will be to invest and innovate, and for others still it will be to act on and react to the benefits connectivity will bring.

A Better Connected World will usher in a new wave of development for not only the ICT industry, but all industries, whatever their heritage, product or service. But for ubiquitous broadband, agile innovation and inspired experience to benefit all industries, countries, and citizens, a number of key stakeholders must get involved

ICT is accelerating us towards a Better Connected World, with some countries and industries moving faster than others, but no one is actually there yet. Broadband connectivity is still far from ubiquitous, and our use of technology is still basic.

How can we get to this new world quicker, and who is positioned to help? We all are. For some, the obligation will be to lead and inspire action. For others it will be to invest and innovate, or to act on and react to the benefits connectivity will bring.

Gov't and regulators:

1. Encourage broadband market dynamism through NBN and QoS commitments, CSP competition (through expanded network coverage) and cooperation (through network sharing whenever appropriate to reduce costs), and reduce red tape so that the full potential of entrepreneurs and citizens can be unleashed.

2. Create a better spectrum allocation mechanism to reduce mobile broadband cost to the end user.

3. Internetize touchpoints and processes for social services, taxation, licensing, etc., to encourage broadband uptake by other parties.

Business leaders:

1. Embrace digital reformation of infrastructure, organization, and strategic priorities to adapt and prosper in a Better Connected World.

2. Do not treat ICT merely an efficiency tool, utilize it to create value and facilitate transformation of your business model.

3. Take customer-centricity to the next level through the proper leverage of ICT, whether it be through big data analytics, real-time engagement, or an inspiring experience that makes business feel personal.

ICT & CSP industry:

1. Invest in technology enablers such as SDN/NFV and 5G to manage traffic more efficiently and enhance quality (speed and coverage) of broadband services.

2. Demonstrate that faster network speeds, ubiquitous connectivity and the IoT will in fact spawn new revenue/service opportunities.

3. Reach out to low-income users and unconnected citizens to better understand what offerings, services and features would motivate them to embrace broadband, and diversify your offerings accordingly.

4. Work to drive down the cost and accelerate the rollout of smart devices, set-top boxes, Wi-Fi routers, and other equipment involved in bridging the digital divide.

Why is this essential?

- **We as citizens expect it:** Citizens need better connection with basic social services such as education, healthcare, transportation and administration. Our children and succeeding generations will collaborate by nature and this will make constant connectivity fundamental to what they deem the good life.

- **We as a society demand it:** With inequality growing, job security waning, and the earning power of a college degree in decline, the need for invention, innovation and entrepreneurship has never been greater. In a Better Connected World, it will only take a broadband connection, a terminal, and an idea to start a business.

- **We as a world need it:** Our population is growing and the systems sustaining our civilization are fragile. We need a more robust infrastructure with streamlined supply chains so that the production and distribution of food, medicine and other essentials is more timely and sufficient.

Join us in Building a Better Connected World

Appendix A

Country Connectivity Index Methodology

Definition

The Huawei Global Connectivity Index-Country (GCI-C) is a quantitative assessment of a country's efforts and achievements in the drive towards ubiquitous broadband.

Purpose

GCI-C examines the state of connectivity in selected markets in an attempt to illustrate how ICT boosts innovation, inspires netizens, and enhances a country's overall competitiveness.

The final score and ranking can be considered absolute and relative measures, respectively, of how much effort has been made, is being made, and will be made in the near future in a certain country to ubiquitize broadband access.

Countries

A total of 25 countries, which represent 68% of the global population, were selected for the Index. They range from highly-developed to less-developed, representing a cross-section of geographies, demographics, and other relevant conditions.

Subject countries were: Bangladesh, Brazil, Canada, Chile, China, Egypt, France, Germany, India, Indonesia, Italy, Japan, Kenya, South Korea, Malaysia, Mexico, New Zealand, Nigeria, the Philippines, Russia, Saudi Arabia, South Africa, Turkey, the U.K. and the U.S.

Index breakdown

The GCI-C aims to measure each country's degree of broadband access in both its current and future state. It is composed of 16 indicators across two dimensions: Current Connectivity and Growth Momentum. The former assesses the current status of each country and determines its position in the race towards ubiquitous broadband, while the latter assesses its rate of progress towards the same.

Supply category breakdown

Indicator	Measurement
Infrastructure: Int'l bandwidth per user	Available international bandwidth divided by number of Internet users.
Investment: Telco investment as % of GDP	Telco investment divided by GDP in a certain country.
ICT activity per person	Number of IP addresses divided by total number of Internet users in a certain country.
Regulation: QoS enforcement by telco authority	Gauges services tracked in terms of QoS (voice, data, fixed, or mobile) and who does the tracking (telco data, authority tracking, or crowdsourcing).

Experience category breakdown

Indicator	Measurement
FBB affordability	Total monthly spending on fixed broadband divided by FBB subs divided by GDP per capita/month.
MBB affordability	Data revenue (non-SMS) divided by data subs divided by GDP per capita/month.
Avg. broadband download speed	Average speed test results (ookla.com) of a sizable number of households in country.

The GCI-C has theoretical underpinnings in the conventional supply & demand theory of pricing (affordability), with an experience category introduced. Supply and demand are positively correlated; increases in supply (access/bandwidth) increase affordability and enhance user experience, which in turn drive demand. When demand increases, experience expectations rise, thus stimulating supply.

Growth Momentum examines what might be called "demand+" – the growth of key factors that drive demand, while taking into account investment and commitment from government.

Scoring

Step 1

For each of the 16 indicators listed in the aforementioned sub-dimension tables, countries are ranked in order of their scores. As an example, for the MBB penetration indicator, countries are ranked in order of penetration as of the end of 2013, with the percentile formula applied for 20th, 40th, 60th and 80th percentile demarcation points of the ranked scores. Quintile scores are then applied to the five groups, ranging from 1 (worst performing) to 5 (best performing).

Step 2

A sum-product is applied for the indicators within each dimension using the weightings. Countries are ranked within each dimension, and finally, a sum-product is applied between the dimension scores with set weightings to produce overall ranking for each country.

Demand category breakdown

Indicator	Measurement
FBB penetration	Number of fixed broadband connections divided by total number of households.
MBB penetration	Number of mobile broadband connections divided by population.
Smartphone connections	Number of smartphone connections.
App downloads	Number of mobile app downloads.

"Demand+" category breakdown

Indicator	Measurement
MBB subscriber growth	Compound annual growth rate of mobile broadband subscribers (2011-2018).
Smartphone connections growth	Compound annual growth rate of smartphone connections (2012-2017).
National broadband planning	Presence/absence of a national broadband plan, its timeframes, progress and allocated budget.
Growth of domestic online production activity	Growth of IP per capita from early-2012 to early-2014.
Projected app downloads	Compound annual growth rate of app downloads per mobile broadband subscriber per month (2011-2018).

Categories and indicators are weighted evenly at the same level. Key data sources include Huawei MI, Ovum, ITU and IMF.

Appendix B

Industry Connectivity Index Methodology

Definition

The Huawei Global Connectivity Index-Industry (GCI-I) is a quantitative assessment of an industry's ICT investment and resultant business benefits.

Purpose

Our objective was to assess how business leaders in diverse industries value ICT in their organization, whether technology is delivering quantifiable benefits, what those benefits are, and how technology is expected to drive further benefits.

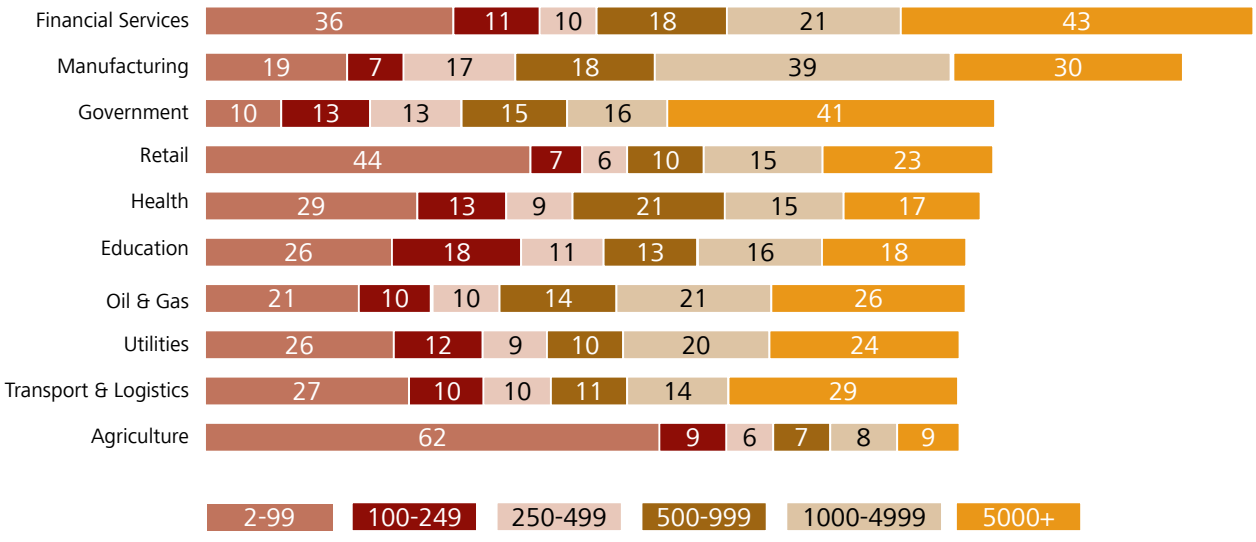
The connected world will lead to huge opportunities for business, but grasping of those opportunities requires "digital reformation" – a process whereby ICT is integrated and leveraged to the maximum degree in the operational and strategic elements of any business. It is a reformation of both the corporate mind and body through ICT, with insights and gains achieved in either domain influencing the other. The end result is a state of synergy between technology and strategy where any & all business opportunities can be adapted to and seized with minimal hassle.

Many organizations believe there to be a positive correlation between use of ICT and business performance, specifically in terms of operational efficiency, innovation capability and the delivery of an inspired customer experience. However, quantitative assessment across key industries is lacking.

The GCI-I examines organizational alignment and success in using ICT to achieve business goals, with a particular emphasis on the use of ICT to enable innovation. The index is structured to provide insight as to an industry's degree of ICT usage, but the methodology is applicable to any organization. If ICT is being used to the highest degree, the organization in question is a Transformer – an organization that uses ICT fluently to achieve digital reformation.

Survey sources

Enterprises by number of employees



The primary data source for the GCI-I is a global survey of 1,093 enterprise decision-makers (including ICT specialists), carried out online in February and March of 2014.

Respondents

As successful implementation of technology requires buy-in from the entire organization, and usage impacts the entire workforce (directly or indirectly), the GCI-I reflects data collected from different areas at the various businesses.

- Respondents were drawn from all business lines across organizations, from the C-suite to operations.
- All respondents were managers, with a third ranging from senior management to C-suite, 40% in middle management, and the rest in junior management.
- Just over two-thirds of respondents had direct involvement or influence in ICT decisions.

Geography

The survey was run in 14 leading economies that collectively generate 61% of global GDP and represent 57% of the population. The survey was fielded in 10 languages, with 1,093 enterprise decision-makers responding (70 to 80 from each country).

Surveyed countries were: Brazil, China, France, Germany, India, Indonesia, Italy, Malaysia, Mexico, Poland, Russia, South Africa, the U.K. and the U.S.

Industries

Industries surveyed were: Agriculture, Education, Financial Services, Government, Health, Manufacturing, Oil & Gas, Retail, Transport & Logistics, and Utilities. For each selected industry, enterprises of all sizes were surveyed, from below 100 employees to over 5,000 (see graphic below).

Index breakdown

The GCI-I examines selected industries along two dimensions – ICT Intensity and ICT Value, with each consisting of two indicators (as shown in the table below). The dimensions and indicators combined reflect an industry's pace of digital reformation and the extent of ICT recognition as its core enabler across all business elements, including product creation, revenue generation, and all other processes.

ICT Intensity: The degree of perception of technology as a positive force for change within an organization.

ICT Intensity assesses the relative importance of ICT in an organization, in terms of strategic priority and resultant investment. It is partly a measure of perceived status; does a cross-section of employees (in technical and non-technical functions) believe that ICT has a role in solving the principal business issues of the organization? To assess if an organization is following through on this perception, ICT investment status is assessed, and weighted more heavily. If belief in ICT is strong and ICT investment is set to rise, then an organization can be viewed as ICT intensive

ICT Value: The level of ICT integration with key business activities and its resultant benefits.

- **Efficiency: The ability to use ICT to achieve operational agility and effGCI-Ient productivity.**

Indicator	Measurement	Variables
ICT Intensity	Strategy	Perception of ICT value to organization.
	Investment	Planned ICT budget growth.
ICT Value	Efficiency	ICT process improvement achieved.
		ICT time-to-market improvement achieved.
	Innovation	ICT product/service innovation achieved.
		Planned use of ICT for innovation/new revenue growth.
	Engagement	Range of digital customer engagement channels used.
		Reliance on digital sales (current/future).

Efficiency assesses whether ICT is delivering quantifiable operational benefits within an organization. This involves the use of ICT to achieve process improvements in manufacturing and production, or the use of ICT to achieve improvements in time-to-market, which in this context includes the logistics of delivery and distribution of products & services. Time-to-market is weighted more heavily as it has a consequent impact on sales achieved and cashflow, which in turn keep operations running.

- **Innovation: The ability to apply ICT successfully as a creative tool.** Innovation assesses an organization's creative drive and success in using technology to launch new products and services. First, corporate mindset is assessed by asking business leaders about the core purpose of ICT investment. A higher score is given where respondents state that the purpose of ICT investment is to increase product & service innovation and to create new revenues (as compared to cutting costs or keeping the lights on). Weighted more heavily are responses to the question of whether ICT has actually achieved product & service innovation.

- **Engagement: The ability to use ICT successfully for open interaction with customers that creates quantifiable financial reward.** Engagement assesses whether organizations are exploiting digital channels and how said channels are impacting revenue generation. Organizations are assessed by the number and range of traditional and digital customer engagement channels that they use, including social media. Organizations with the most diverse number of channels in operation are considered the most customer-oriented. Engagement is also the product of a composite variable – whether digital channels are generating revenue, the scale of said revenue today, and expected growth rates. This composite variable is weighted more heavily in determining overall Engagement score.

All indicators are used to create a score for the corresponding dimension by industry. However, each key indicator is weighted differently due to their relative strategic importance

Scoring

Step 1

Scores relate to respondent answers to specific survey questions. Responses are placed in 5 groups (quintiles), according to the range of survey responses received.

The groups range from 1 (worst performing) to 5 (best performing). Placement in a given group generates a score, expressed as a percentage:

Score for Group 1= 20%
Score for Group 2= 40%
Score for Group 3= 60%
Score for Group 4= 80%
Score for Group 5= 100%

Note: If composition of a variable relies on responses to multiple questions, then the average of responses by industry is taken to produce the industry score.

Weightings are applied to each indicator to produce each dimension score.

Step 2

Apply a sum-product for the two dimensions using the weightings of relative importance to determine overall score by industry. The higher the percentage shown, the higher the momentum and achievement of digital reformation in the given industry.

For more information about
Huawei Global Connectivity Index,
scan for mobile reading