Tap Into New Growth With Intelligent Connectivity

Mapping your transformation into a digital economy with GCI 2018

gci
global connectivity index

CONTENTS

EXECUTIVE SUMMARY

Tap Into New Growth with Intelligent Connectivity

Thus far, 2018 has been a year of solid economic growth, with global upswings outperforming the most bullish expectations. The IMF predicts that this upward momentum will continue across all sections of the global economy. In light of these inviting prospects, policy makers are exploring ways to make the most of new and unexpected potential, lay the groundwork for sustainability and shore up their countries against economic downturn in the future.

Many have turned to information and communications technology (ICT). Five years into tracking the correlation between ICT infrastructure maturity and GDP growth, the 2018 Global Connectivity Index (GCI) has witnessed pronounced GDP returns among countries with concentrated development and adoption of ICT infrastructure. Those with less proactive investment, by comparison, have seen less stellar results.

Of particular note are developing economies that have turned to ICT as a bulwark against the challenges of economic restructuring, aging populations and drops in labor force participation. They have identified the potential of ICT to revitalize otherwise stagnant industries, and by driving supply-side improvements, they have thrown open the doors to a new economic growth cycle.

By improving broadband coverage, supercharging bandwidth and building out their ability to store and process data in the cloud, some countries have seen jumps as high as three points in their GCI scores over the past year. While this might sound abstract, keep in mind that each incremental rise in GCI score has proven implications for economic well-being – both now and in the future.

To better understand these trends across a spectrum of countries, this year we broadened the scope of the GCI from 50 to 79 nations. In addition to measuring the economic impact of ICT investment and adoption across five main enabling technologies – Broadband, Data Center, Cloud, Big Data and IoT – we have seen the gradual rise of artificial intelligence (AI) as a new and pronounced element in the GCI equation.

> **We have seen the gradual rise of artificial intelligence (AI) as a new and pronounced element in the GCI equation.**

AI is poised to become the next major general-purpose technology that drives paradigm shifts in economic and industrial activity. We already see its influence trickling into all aspects of everyday life, from smartphone assistants and robo-advisors, to multilingual customer service chatbots and investment priorities for national defense.

But something bigger is happening at the confluence of connectivity and AI. Industries are embedding AI in all five enabling technologies, transforming traditional connectivity into Intelligent Connectivity to unleash innovation and economic opportunities on a scale previously unimagined. **Whole new business models, products, processes and services are emerging every day, accelerating growth towards a digital economy worth upwards of $23 trillion by 2025[i] and throwing open the gates to a new economic growth cycle.**

Digital Economy in the Intelligent Society

Scan to listen to the audio book for this chapter.

2018 Highlights

In the 2018 GCI, Frontrunners – the cluster of advanced economies on the GCI S-curve – are using Intelligent Connectivity to accelerate digital economy growth and unearth new opportunities. This comes as no surprise, as the global digital economy has been growing at a rate two-and-a-half times faster than global GDP over the past 15 years.

Advanced economies are in a better fiscal position to make sustained progress in ICT infrastructure development – and now AI – to climb the GCI S-curve and drive greater GDP returns. Against this backdrop, it's imperative that less developed economies in the GCI Adopter and Starter clusters prioritize ICT investment to stay competitive.

This year's GCI saw scores rise, at least incrementally, across all countries in the Index. Growth, however, has been uneven. The distance between countries at the top and bottom of the GCI S-curve continues to expand, indicating an amplification of existing inequality.

This has led to the emergence of a Matthew Effect in global ICT. Nations with sustained development of ICT infrastructure (Frontrunners) are benefiting from a buildup of advantages.

Over time, steady investment and adoption produce a compound effect, allowing advanced countries to pull progressively farther ahead of Adopters and Starters.

The good news for Adopters and Starters is that countries at every level of development have shown the ability to move up the GCI S-curve by focusing ICT deployment on competitive sectors of their local economy. The Philippines and Egypt are prime examples in 2018. Both have focused on building out their fundamental ICT infrastructure to expand affordable Internet access and drive greater participation in the economy.

From 2014 to 2017 the Philippines boosted smartphone use from 30% to 67%, extending primary Internet access to a greater portion of the population and fostering new business opportunities. Its GCI score moved up from 34 to 35, pushing the Philippines over the threshold from Starter to Adopter status.

At the same time, concerted efforts by the Ministry of Communications and Information Technology in Egypt saw mobile broadband subscribers jump from 38% to 62% of the population. Egypt's GCI score also moved up one point in 2018, placing the country at the top of the Starters' cluster.

> **The global digital economy has been growing at a rate two-and-a-half times faster than global GDP over the past 15 years.**

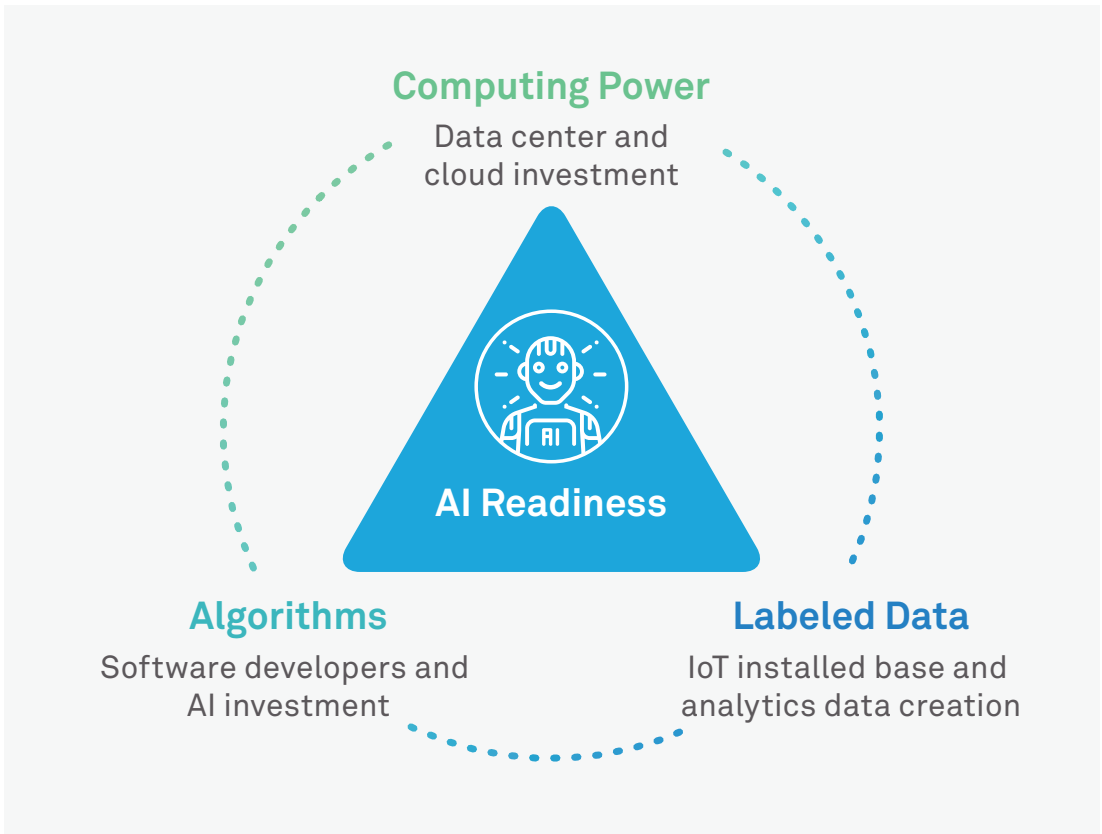
Intelligent Connectivity and The $23 Trillion Opportunity

Regardless of a country's position along the GCI S-curve, policy makers should note that **a single-point increase on the GCI score[ii] can deliver a 2.1% increase in competitiveness, a 2.2% increase in innovation, and a 2.3% increase in productivity across an entire economy –** a testament to the strategic importance of ICT infrastructure. What's more, return on investment for digital technologies is substantial: roughly 6.7 times[iii] the ROI of non-digital investments.

As countries prime themselves for the next wave of economic growth, policy makers in Starter and Adopter countries should explore the value of AI and the multiplier effect that Intelligent Connectivity brings to nations at every level of development. Economic plans should include strategies for harnessing and accelerating AI-driven growth.

For policy makers looking to gauge their country's ability to tap into the $23 trillion opportunity, GCI 2018 includes an **AI readiness index** based on three key components: computing power, labeled data, and algorithms. At the moment, Frontrunners with the most robust ICT infrastructure stand far ahead of Adopters and Starters in all three components, but even advanced economies are far from prepared to leverage AI's full potential.

AI Readiness

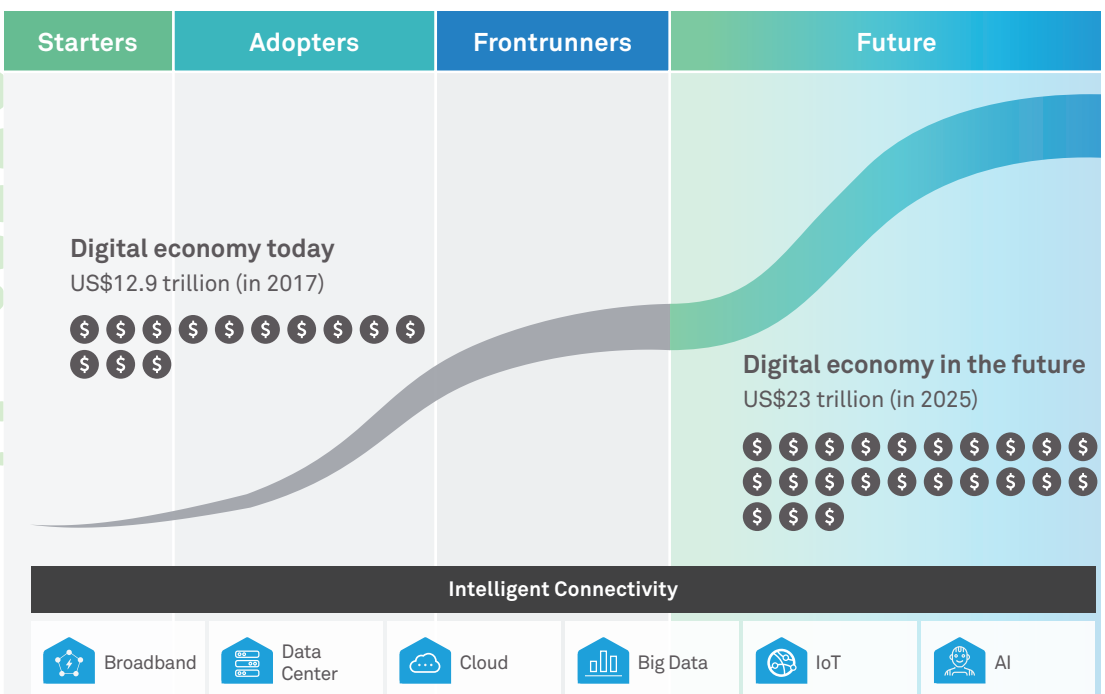


The biggest challenge facing all three clusters is a scarcity of talent for developing AI applications. Governments will need to radically re-think education for a workforce redefined by AI in the future, and start building the foundations of a healthy, collaborative, and open AI ecosystem to attract and retain competitive AI talent.

Adopters and Starters that struggle to find affordable access to AI should not be discouraged by their late start to ICT infrastructure development. The cloud offers a way forward. Cloud provides organizations of all shapes and sizes with the computing power and data storage they need to go digital without huge hardware and software investments for in-house IT and data centers. While Frontrunners prepare for ultra-high-speed, low latency 5G networks to take AI innovation to a higher level, Adopters and Starters with ample broadband coverage can take advantage of AI-powered cloud services to find competitive niches for sustainable growth.

We have good reason for optimism this year. In 2018, advanced economies find themselves on the cusp of new opportunities, while Adopters and Starters are laying the foundations for leapfrog growth through well-planned and focused ICT investment. As GCI Frontrunners reach the limits of growth from their current ICT investment, **AI is turning Intelligent Connectivity into a gateway for a new economic growth cycle.** While no one can be sure where AI will ultimately lead us, all can agree that its potential is enormous, and will impact every aspect of how we live, play, work – and even think.

Intelligent Connectivity: The $23 Trillion Opportunity



COUNTRY RANKINGS

Mapping 79 Nations' Progress to The Digital Economy

Scan to listen to the audio book for this chapter.

COUNTRY RANKINGS

Now Covering 79 Countries, Scores Improve Across the Board

For the past five years, the Global Connectivity Index has tracked investment trends in ICT infrastructure, as well as the relationship between digital maturity and economic growth. This year we have expanded the scope of the study from 50 to 79 countries. Our hope is to present a broader view of how different nations around the world are preparing for the digital economy.

This year's study will explore how these 79 focus countries are deploying broadband networks and investing in a range of enabling technologies that drive the digital transformation of industry, cities and government. While the list of nations covered in this year's GCI has grown, our methodology remains largely the same.

Country Rankings

FRONTRUNNERS

		SCORE
1	United States	78
2	Singapore	75
3	Sweden	73
4	Switzerland	71
5	United Kingdom	70
6	Finland	68
7	Denmark	68
8	Netherlands	67
9	Norway	65
10	Japan	65
11	South Korea	64
12	Australia	64
13	Luxembourg	63
14	Germany	63
15	New Zealand	62
16	Ireland	62
17	Canada	62
18	Belgium	61
19	France	61
20	Austria	60

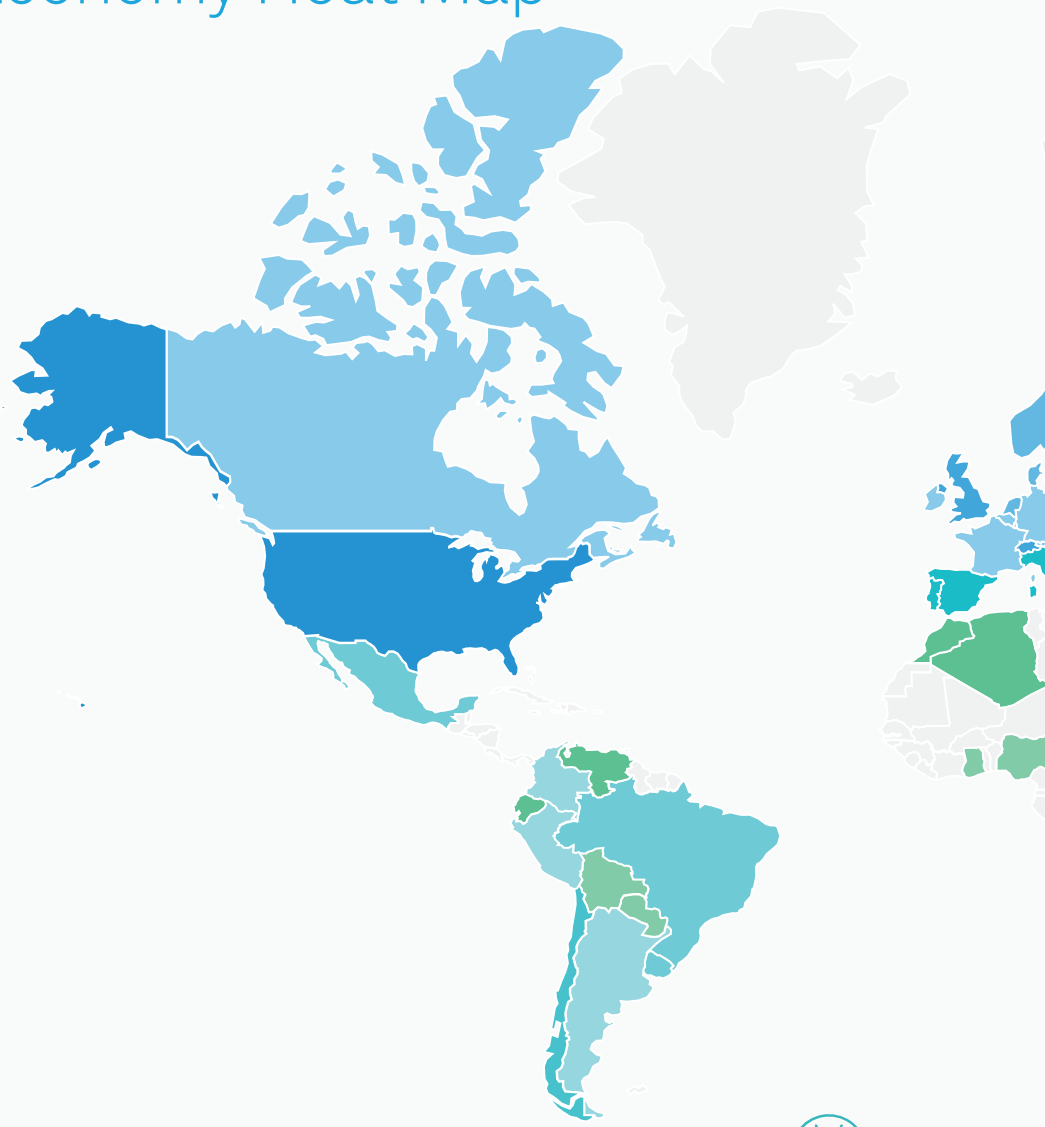
ADOPTERS

		SCORE
21	Spain	55
22	Estonia	54
23	UAE	53
24	Lithuania	52
25	Portugal	52
26	Slovenia	51
27	China	51
28	Italy	50
29	Czech Republic	50
30	Hungary	49
31	Slovakia	49
32	Malaysia	48
33	Chile	48
34	Greece	46
35	Croatia	46
36	Russia	46
37	Kuwait	45
38	Poland	45
39	Romania	45
40	Bahrain	45
41	Saudi Arabia	44
42	Belarus	44
43	Bulgaria	44
44	Brazil	43
45	Kazakhstan	42
46	South Africa	42
47	Oman	42
48	Mexico	42
49	Uruguay	41
50	Ukraine	41
51	Thailand	40
52	Turkey	39
53	Serbia	39
54	Colombia	39
55	Argentina	38
56	Peru	37
57	Philippines	35

STARTERS

		SCORE
58	Jordan	34
59	Egypt	34
60	Lebanon	34
61	Vietnam	34
62	Venezuela	33
63	India	33
64	Indonesia	33
65	Morocco	33
66	Algeria	32
67	Ecuador	31
68	Kenya	29
69	Ghana	29
70	Nigeria	29
71	Botswana	29
72	Namibia	29
73	Paraguay	26
74	Tanzania	25
75	Uganda	25
76	Bolivia	25
77	Pakistan	25
78	Bangladesh	24
79	Ethiopia	23

Digital Economy Heat Map



GCI Score

STARTERS ■

ADOPTERS ■

20

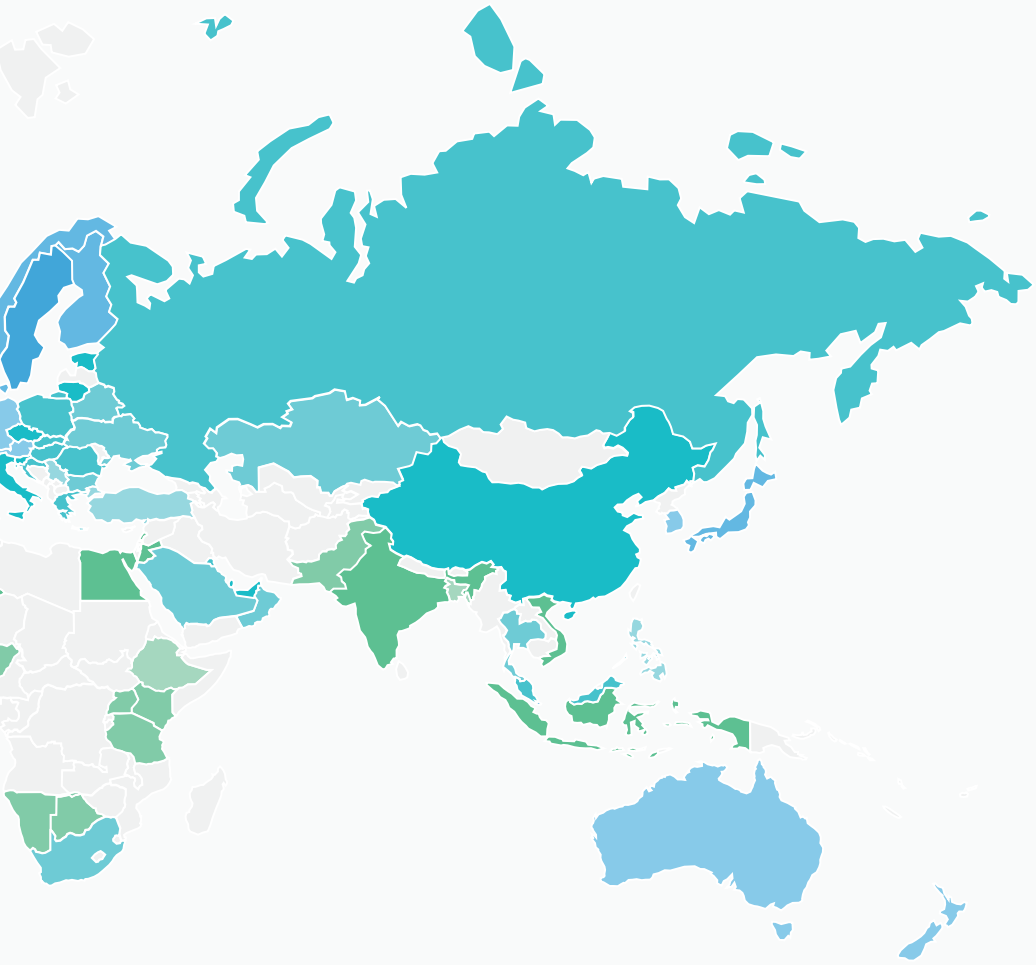
Average GDP Per Capita: US$3,700
GCI Score Range: 20-34

These are nations in the early stage of ICT infrastructure build-out. Their focus is on expanding connectivity coverage to give more people access to the digital economy.

35

Average GDP Per Capita: US$16,300
GCI Score Range: 35-55

Nations in this cluster experience the large
from investment in ICT infrastructure. Thei
increasing demand for high-speed connec
industry digitization and economic growth.



FRONTRUNNERS

56

85

Average GDP Per Capita: US$54,100
GCI Score Range: 56 – 85

These nations are mainly developed economies. Their focus is on enhancing the user experience. At this stage of development, the priority shifts to investment in Big Data and IoT to develop a smarter and more efficient society.

A Look at Top Performers

Expanding the scope of our research caused some reshuffling in country rankings. This year, we broadened the scope of GCI from 50 to 79 countries. To understand what progress the 79 countries have made over the past few years, we retrieved historical GCI data for all the countries reaching back to 2015. Retroactively speaking, Finland would have knocked the United Kingdom out of its top-five position in years prior. However, with a combination of ICT-friendly policy and a focused expansion of network infrastructure, the United Kingdom officially regained its position this year as number five despite the increased competition. In total, the UK achieved a three-point climb in this year's GCI score, jumping from 67 to 70 points. This was the only change in 2018 rankings among the top five countries.

In fourth place, Switzerland's GCI score grew from 69 to 71, and Sweden's score moved from 71 to 73, placing it solidly in third place. Singapore's score remained at 75, and while it remains in second place, the gap is narrowing. Finally, the United States improved its score from 76 to 78 and remains in first place.

Overall, movements in 2018 GCI rankings were for the most part attributable to increased investment and adoption in ICT infrastructure. Though all countries made incremental improvements in their GCI score from last year, as noted, the addition of 29 new countries to the GCI has caused fluctuations in relative performance.

Top Movers and Shakers: Where Investment is Paying Greater Dividends

Quite a few countries made notable achievements this year, some for leaps in their GCI score, and some for progress in ICT infrastructure deployment. The top three movers in this year's index were Slovenia, China, and Egypt. Egypt's progress was especially noteworthy, given its exceptional growth in smartphone use and Internet access. Another prominent country in 2018 was the Philippines, which grew beyond its Starter status to become an Adopter.

The top three movers in this year's index were Egypt, China and Slovenia.

UNITED KINGDOM
Policy-Driven Improvements in Connectivity and Digital Services

The United Kingdom, number five in the GCI, saw its 2018 score climb three points from 67 to 70. Aggressive deployment of ICT infrastructure in recent years helps explain its rise.

Deployment of 4G, for example, expanded from 27% coverage in 2014 to 77% in 2018. IoT investment more than doubled between 2014 and 2017, jumping from $200 to $441 per person. Meanwhile, during the same period, the installed base of IoT devices grew from four per person to 10.

Government initiatives played a significant role in setting the direction for growth. UK policy makers treat broadband and mobile as utilities, with both the public and private sectors benefiting from improved connectivity and access to digital services.

Examples of government-led programs that have helped drive the UK's digital transformation include Digital Catapult, which is designed to bridge the gap between R&D and industry by connecting established companies, startups, and researchers to drive joint innovation and adoption of digital technology; and Future Cities Catapult, a government-supported center that provides shared facilities for business, universities, and city leaders to develop new smart city products, services, and business models.

Two more effective initiatives include the IoTUK, which aims to advance the country's global leadership in the Internet of Things (IoT) by spreading IoT technologies and services to both businesses and the public sector; and the government's comprehensive 5G Strategy[iv], which details the UK's ambitions to become a global leader in 5G, make the most of 5G potential, and cultivate an inclusive digital economy.

THE PHILIPPINES
Connectivity Promotes Digital Inclusion and Trade Opportunities

Expanding digital access to a massive number of new computer and smartphone users helped the Philippines climb to the top of the Starter cluster and jump the gap into the Adopters. The Philippines rounded off the year with a GCI score of 35, up from 34 in 2017.

In the Philippines, like many developing economies, smartphones are the primary gateway to the Internet. Smartphone use in the country expanded from 30% of the population in 2014 to 67% in 2017. Higher-speed 4G coverage, which only reached 2% of the population in 2014, grew to 12%. Other indicators of digital growth are computer use, which grew from 27% to 34%, and cloud migration, which accounted for 17% of total software investment during the same period – up from 6%.

Strong national planning has helped drive this growth. Manila has declared a Cloud First Policy, which highlights its commitment to reduce the cost of government ICT by eliminating duplication and fragmentation. With this policy, the government has upped its cloud adoption and paved the way for the Philippines to move up to the Adopter cluster.

Expanding Internet access, the core of the Philippines' Digital Strategy, has largely been driven by private operators, and has succeeded in creating new business opportunities in previously undeveloped areas. The IT Business Process Outsourcing (BPO) industry also continues to play an important role in the Philippines' digital transformation, enabling micro, small and medium-sized enterprises (mSMEs) to use the Internet as a tool for marketing, innovation and delivery in global markets.

CHINA
Boosting Investment in AI and Enabling Technologies

China's GCI score climbed three points, making it one of this year's fastest movers. Beijing's comprehensive, long-term strategy for digital transformation of the economy is paying off.

Deployment of key enabling technologies is key to China's advancement. Huge investments in 4G technology have helped increase coverage from 7% of the population in 2014 to 69% in 2017. Fiber-to-the-Home (FTTH) coverage reached 64% in 2017, up from 18% in 2014. The growing coverage of both fixed and mobile broadband across China continues to drive e-Commerce, and has equipped entrepreneurs with a solid digital platform for launching small-scale Internet businesses.

Most notable in the past year was China's announcement of the New Generation AI Development Plan, which sets high investment goals in a bid to become an AI leader by 2030. Beyond AI, China has made strong investments in data centers, cloud services, big data analytics and IoT to lay the foundations for its smart city initiatives, which account for nearly 50% of smart cities in the world.

EGYPT
ICT 2030 Strategy Fuels Economic Growth

Egypt is at the top of the GCI's Starters group. In 2018 its GCI score improved by one point, the result of concerted efforts along three fronts: making fixed and mobile broadband more affordable and accessible, increasing the percentage of people who use smartphones, and boosting Internet access for both the public and private sectors.

Smartphone use grew from 19% in 2014 to 49% in 2017. Mobile broadband subscribers expanded from 38% to 62% from 2014 to 2017, and Internet access grew from 29% to 41%.

Egypt's Ministry of Communications and Information Technology has developed a National Broadband Plan that aims to increase high-speed broadband coverage. Priorities for the program include digital transformation of government operations, job creation and reducing the now stark digital divide between urban and rural communities.

Government initiatives have largely looked to promoting e-Commerce to expand the country's digital economy. Egypt's fast-growing e-Commerce sector has attracted foreign direct investment, especially in electronics and ICT, and has helped the country build a workforce equipped with digital skills.

Other Rising Stars on the Horizon

- New Zealand
- Spain
- Italy
- Chile
- Malaysia
- Russia
- Greece
- Brazil
- Mexico
- Ukraine
- Argentina

SUMMARY

RESEARCH SCOPE

Now covering 79 countries; for the first time, GCI scores improved across the board.

TOP MOVERS

United Kingdom—Policy-driven improvements in connectivity and digital services.

The Philippines—Connectivity promotes digital inclusion and trade opportunities.

China—Boosting investment in AI and enabling technologies.

Egypt—ICT 2030 strategy fuels economic growth.

ECONOMIC IMPACT

Intelligent Connectivity: Create a New Cycle of Economic Growth

Scan to listen to the audio book for this chapter.

ECONOMIC IMPACT

ICT Infrastructure and Economic Growth

In 2018, the GCI continues to track a strong correlation between ICT infrastructure investment and economic growth. Both traditional and digital economies indicate positive trends, with the most pronounced growth seen in the digital economy, which is now expanding at a rate two-and-a-half times faster than global GDP growth over the past 15 years, almost doubling in size since the year 2000.

Connectivity is what drives this growth. Connectivity allows us to circumvent the limitations of time and space; it enables communication in near-real time across distances large and small – between people, machines, and a mix of both – which drives new possibilities in business, trade, and production.

In this year's research we found something new: beyond the expected ROI on ICT investment, when countries harness connectivity to enable intelligent systems, they experience accelerated growth. Artificial Intelligence (AI) provides a diverse range of benefits across all sections of society, and is poised to kick off a new wave of stellar economic growth.

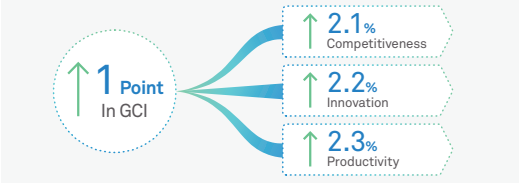
In this chapter, we will explore two layers of correlation between ICT infrastructure and the economy. First, we will touch upon the current boost that ICT technology gives to GDP. Then we will explore how different countries can tap into a new wave of digital economic growth by embedding each layer of ICT infrastructure with intelligence.

Strong ICT Infrastructure Improves the Quality of Economic Growth

Five years of GCI research has established that strong ICT Infrastructure plays a vital role in expanding a nation's economy. GCI scores are not abstract numbers; they have a direct correlation to real-world economic impact.

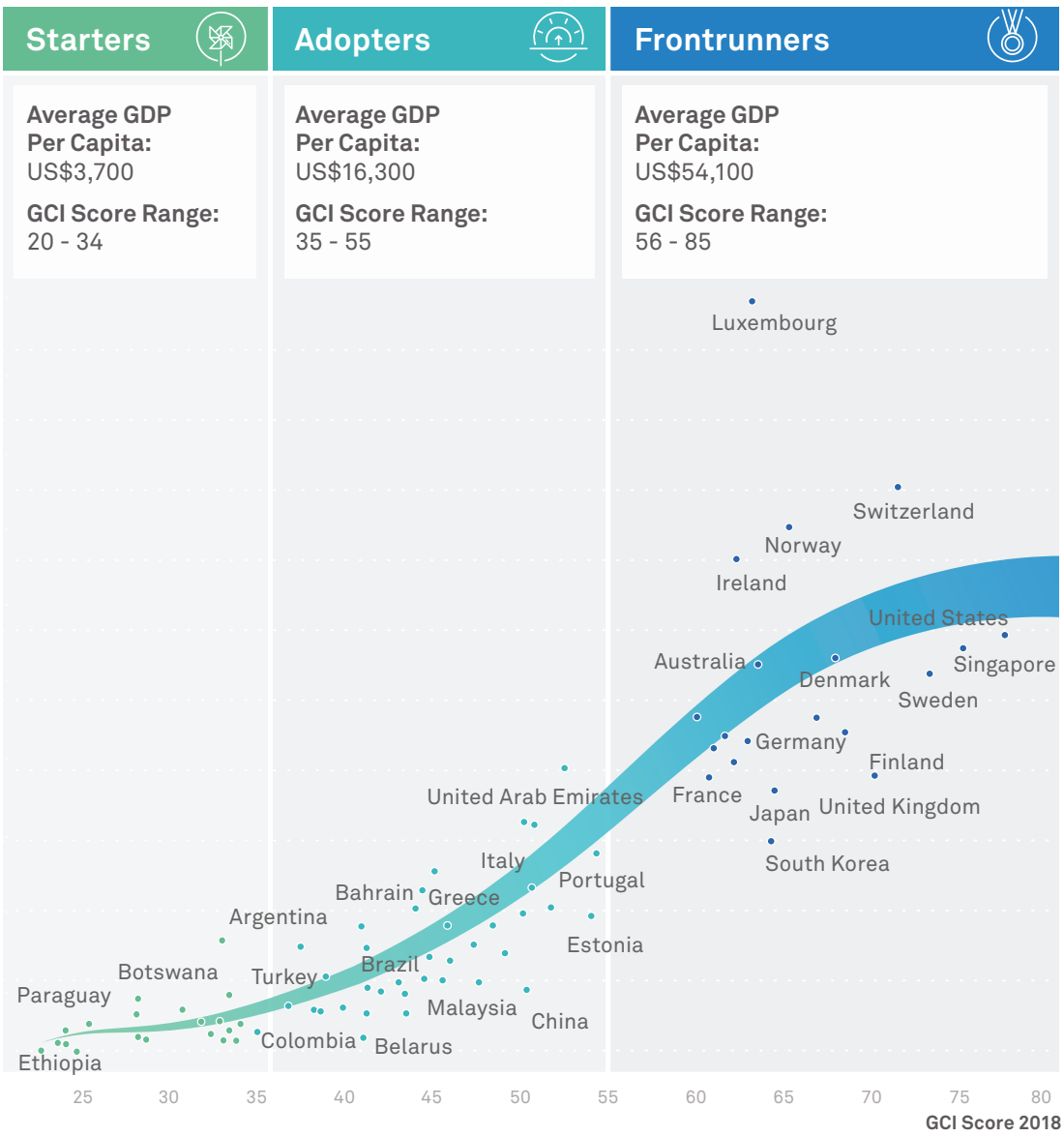
In strict monetary terms, digital investments deliver returns that are 6.7 times greater than any other form of investment; on average, a $1 investment in ICT infrastructure today will yield $20 in returns from now to 2025. As for the relationship between GCI scores and broader economic trends, our research shows that a one-point increase in GCI score equals a 2.1% increase in competitiveness, a 2.2% increase in national innovation, and a 2.3% increase in productivity. In short, an increase in GCI score is directly related to economic development.

Impact of 1 Point of GCI



The 79 nations ranked in this year's GCI are plotted along a S-curve, illustrating the relationship between GCI score and each nation's GDP. Along this curve, there are three clusters of nations, indicating different stages of ICT maturity: Starters, Adopters, and Frontrunners.

GCI Performance versus GDP



These are nations in the early stage of ICT infrastructure build-out. Their focus is on expanding connectivity coverage to give more people access to the digital economy.

Nations in this cluster experience the largest GDP growth from investment in ICT infrastructure. Their focus is on increasing demand for high-speed connectivity to facilitate industry digitization and economic growth.

These nations are mainly developed economies. Their focus is on enhancing the user experience. At this stage of development, the priority shifts to investment in Big Data and IoT to develop a smarter and more efficient society.

Frontrunners Running at Full Speed, but with Slowing Returns

Today, Frontrunners – or the nations with advanced ICT infrastructure – are reaping the most positive economic outcomes from their ICT investment. Ongoing investment has pushed all Frontrunners across the 60-point mark.

While all Frontrunners are making steady progress towards more advanced ICT, leaders like the US, Singapore and Sweden have seen their growth plateau, at least temporarily, as their ability to squeeze more dramatic economic growth from ICT investments may have reached a limit.

Adopters are Catching up with Amplified Returns

Meanwhile, Adopters are still in the sweet spot, receiving exponential returns on their investment in ICT infrastructure. Driven by strong government initiatives to increase connectivity, improve broadband speeds, and build out a solid foundation for cloud computing, Adopters are continually increasing investment and seeing greater returns. In 2018, they narrowed the gap with the Frontrunner cluster to 5 GCI points, from 6 points in 2017.

Spain led the way for the Adopter cluster this year with a GCI score of 55. Today, Spain is poised right on the cusp of the Frontrunner group, which begins at 56 points. As a group, Adopters have moved up along the GCI S-curve with an average gain of 1.5 points, moving from an average 43.6 points in 2017 to 45.2 points in 2018.

Some Starters are Progressing, While Others Risk Falling Behind

After a nation's GCI score reaches 35 points[vi], their return on investment for ICT infrastructure will experience a strong multiplier effect. Some Starters like Jordan, Egypt, Lebanon and Vietnam are close to this tipping point. If they continue to enhance their foundations by expanding and improving broadband connectivity, they will put themselves on the fast track to Adopter status. This will give them greater returns on their investment.

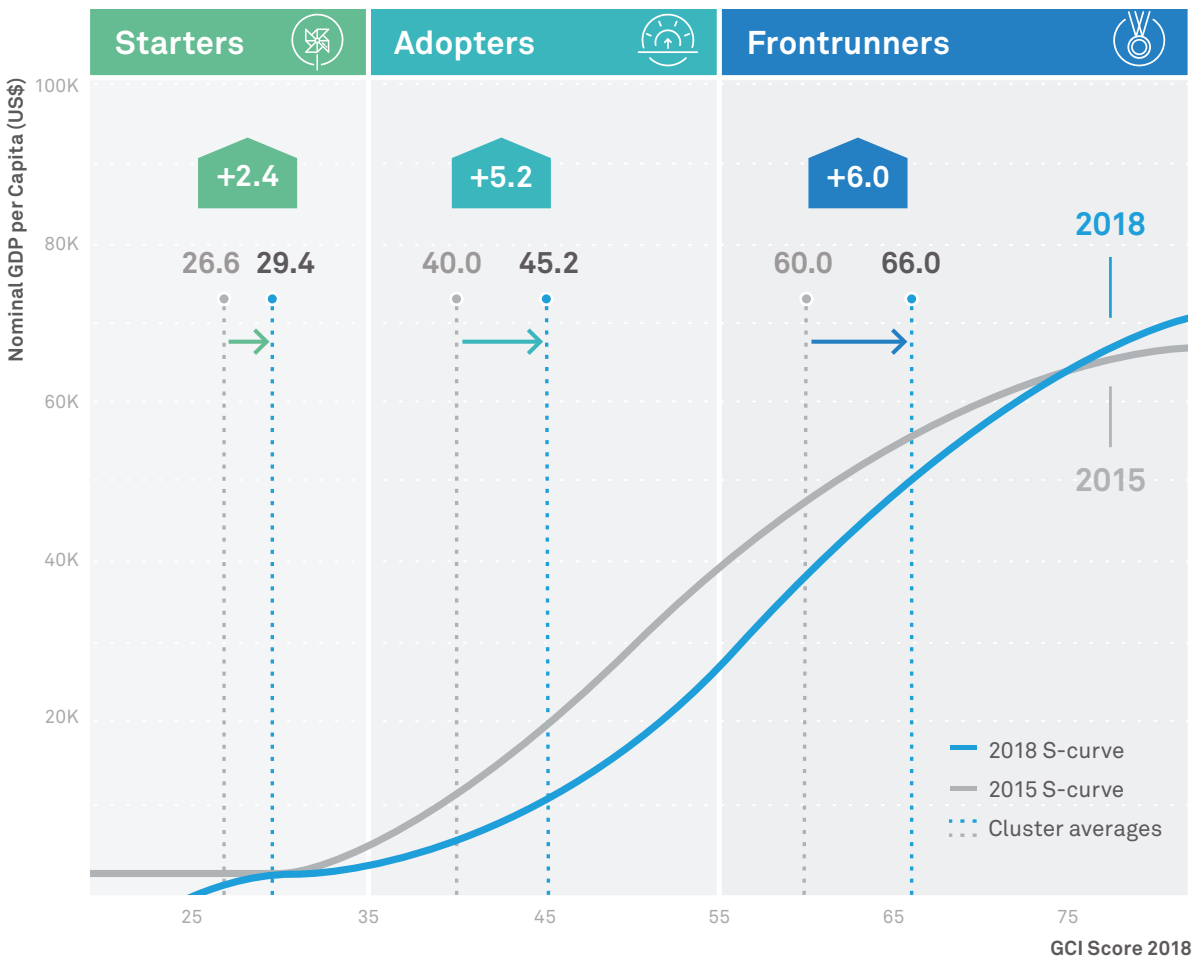
However, many Starters still have work to do. The average GCI score of Starters remained relatively unchanged from last year, while the distance between Starters and Adopters has expanded. We first discussed this trend in the GCI 2017 – the Matthew Effect, where accumulated advantage produces unbalanced benefits. Essentially, countries with a buildup of investment in ICT infrastructure – the "haves" – receive far more benefits than the "have nots," and over time they leverage that initial advantage to pull even farther ahead. This trend remains true and shows signs of growing more pronounced in 2018.

The Matthew Effect: The Digital Divide is Still Expanding

Movement within the Starters group has broken it into two sub-groups. Leaders in the group are pulling ahead due to aggressive infrastructure investment, while some of the least-developed economies struggle to find the capital to invest. If the leaders in this sub-group – which includes nations such as Jordan, Egypt, Lebanon, Vietnam, India and Indonesia – can maintain the momentum of their investment, they will be better equipped to make the jump to the Adopters' cluster. This year there was precedent for just such a jump: with impressive leaps in download speeds and cloud investment, the Philippines passed the 35-point threshold and crossed over from the Starters to the Adopters.

As noted in last year's report, Starters at the low-end of the GCI S-curve should not be discouraged. The development of ICT infrastructure is unique in that, unlike traditional infrastructure, the process can be revolutionary rather than evolutionary. Simply put, countries don't need to incrementally modernize their mobile networks from 2G to 3G, then from 3G to 4G to achieve the speed and bandwidth of 4G networks. They can simply modernize their 2G networks by leapfrogging – investing directly in a 4G build-out, and then start yielding returns.

An Expansion of the S-curve (GCI score vs. GDP) Shows the Inequality Between Starters, Adopters and Frontrunners



There's more good news. As AI evolves into a practical enabling technology, new economic potential awaits countries in all three clusters. Whether to address stagnated growth challenges for Frontrunners or limited resources for Starters, redefining what "connectivity" looks like and steering the focus towards Intelligent Connectivity can help all countries drive ahead to unlock new growth.

Redefining Connectivity with AI

In 2018, GCI research suggests that some Frontrunners may have already reached the maximum economic potential of their broadband investment due to exhaustive network coverage. Returns on investment in basic infrastructure remain stable, but are unlikely to grow. The most developed nations may be at an inflection point, where the next phase of growth will come from redefining the concept of connectivity altogether – using AI to power Intelligent Connectivity.

By introducing AI to the mix of the five enabling technologies – Broadband, Data Center, Cloud, Big Data and IoT – basic connectivity can be transformed into Intelligent Connectivity. As a holistic system, Intelligent Connectivity produces synergistic returns across all five enablers that are greater than the sum of their parts. It can enhance human creativity and innovation, and speed the transition from traditional economy to digital economy.

The benefits of this transformation will not be exclusive to the Frontrunners. Adopters and Starters will also have access to AI and the value it produces along their digital transformation journey.

From Connectivity to Intelligent Connectivity

Can Less-Developed Countries Use AI?

The answer is yes, but the scope is limited. ICT enablers are layered, and each layer builds on the layers "below" it. Without sufficient broadband, you can't deploy cloud. Without cloud, big data analytics is impractical. And without big data and IoT, you won't have much clean data to feed your AI systems.

However, you don't need 100% 4G coverage and gigabit speeds to support cloud, and you don't need data centers on every street corner to power analytics. There's a degree of overlap, and understanding how each technology works, along with how it enables its peers, is key to knowing when and how to invest. As countries move up the ladder of ICT maturity, their ability to use AI – and the value they derive from it – will increase.

The following is a breakdown of each enabler and its relation to AI.

High-speed Broadband: High-speed broadband is necessary for AI to function across an economy and provide value in all facets of everyday life. Broadband provides the connections that collect and transport data, distribute it for processing, and send instructions back to the smart devices – or people – who need it. Frontrunner countries have an advantage here, because they have the most expansive and high-speed broadband networks. Without sufficient broadband, Adopter and Starter countries run the risk of getting left behind. It goes without saying that, as the most fundamental component of ICT infrastructure, broadband is a necessary investment.

Data Center: Most AI systems are installed, trained and run in data centers. Demand for data storage, micro-processors and servers have skyrocketed in response to AI requirements, reshaping the data center industry. For instance, deep learning – a subset of AI – requires massive volumes of data to train, test and validate its neural network algorithms. GPU-based processing is ideal for these types of applications, so requirements for data centers that support GPU-based processing are growing.

Cloud: Deep learning frameworks for AI create scalability challenges that can only be met by cloud services. Apart from governments, telecommunications companies and a few global IT providers, few companies are willing to spend the amount needed to scale out data centers to meet the growing demands of AI. Building AI-capable systems at scale can be prohibitively expensive, largely because training algorithms require a huge amount of computing power. Cloud computing has vast stores of affordable computing power and storage that present cost-effective ways to build AI applications. Cloud with broadband connectivity is the critical infrastructure platform that enables AI adoption throughout an economy.

Big Data: Big data is set to grow as we create and consume more digital content, and as daily life and business becomes more dependent on digital technology. We see explosive growth of data created by video for entertainment, industry, communications and security. The growth of IoT is massively contributing to data creation too. Every day, millions of gigabytes of data need to be stored, managed, tagged and processed for AI to make use of it. In time, this relationship will become a loop as analytics forms the investigative and learning capability for AI, and AI in turn improves the way that data is collected, managed and analyzed.

Internet of Things (IoT): If AI systems are like a digital brain, then IoT devices are like the sensory organs that collect information, and the arms and legs that respond to decisions. IoT sensors provide AI systems with data to understand a given environment, and decisions made by AI systems are then carried out by IoT machines and other devices. An IoT sensor network and smart machines are necessary to unleash the full functionality of AI across an economy.

Intelligent Connectivity sparks a new cycle of economic growth

Intelligent Connectivity: The $23 Trillion Opportunity

The digital economy is currently valued at $12.9 trillion – or 17.1% of global GDP. The outstanding performance of the digital economy in its current form is mainly attributable to a consumer-driven Internet – that is, the Internet as we currently know it. At present, the digital economy is largely built on e-Commerce, entertainment, and online services. Although these sectors remain strong, growth has started to slow, and the world economy is ripe for a new wave of growth.

The next wave of explosive growth in the digital economy will come from industrial digitalization. The digital transformation of industry aims to create more integrated connections between all things, machines, and people in industrial settings. It uses massive computing power and data analytics to provide business intelligence, new depths of automation, and greater flexibility throughout the production process. Full transformation of industry will be built on Intelligent Connectivity, designed specifically to support better business outcomes.

Powered by Intelligent Connectivity, industries across the board can tap into unprecedented growth opportunities. On average, if all countries increase their investment in ICT Infrastructure by 8% every year (CAGR), it will produce $23 trillion in new economic potential by 2025[vii], breathing new life into the S-curve for all economies.

Upward Mobility: Opportunities and Priorities by Cluster

Not all countries will have equal access to this $23 trillion in new growth opportunities. There are four major Innovation levels, each of which corresponds with greater innovative capacity and potential gains in GDP. As countries move up the ladder of innovation stages, they can achieve greater degrees of Intelligent Connectivity, and the value they derive from their investments will increase. While an average 8% annual increase in global investment is key, there are some variations in investment targets across each cluster.

Starter Target: Increase Annual Investment by 13%

Most Starters are in the first innovation stage: foundation building, where countries should focus on breadth of connectivity, increasing annual investment by 13% in broadband coverage and data centers. At this level, innovation based on Intelligent Connectivity is limited, but connecting more people and bolstering existing networks lays a solid foundation for new business opportunities.

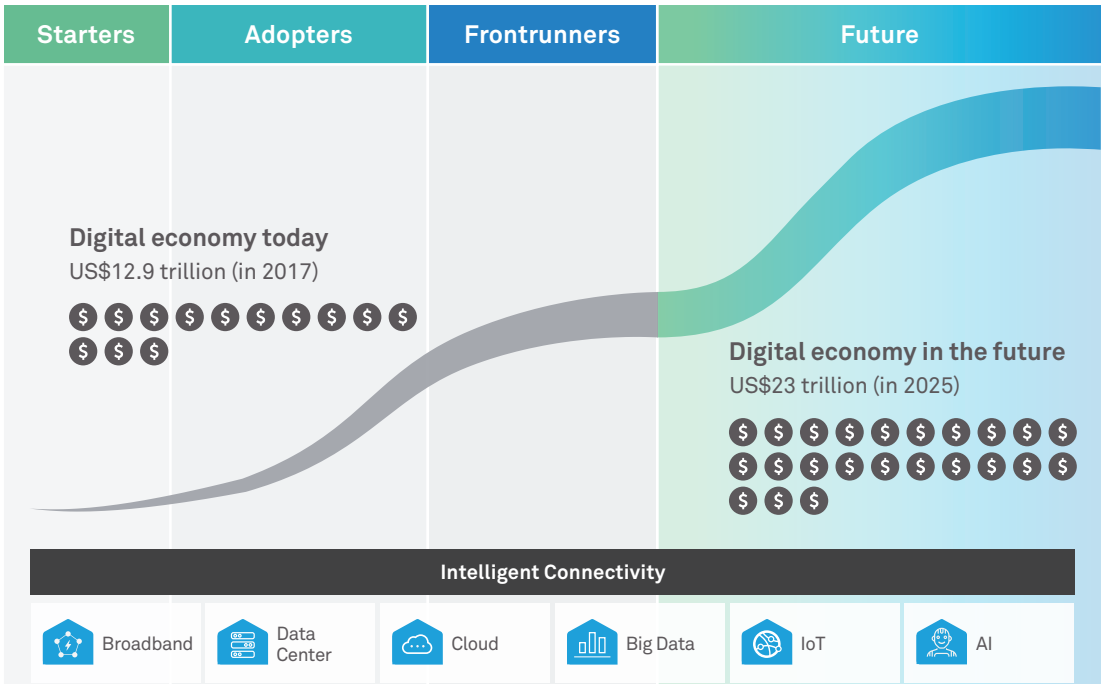
Adopter Target: Increase Annual Investment by 10%

The next stage up is Internet innovation, where Adopters with more advanced ICT foundations can start producing practical value through connectivity itself. To make the most of this value, Adopters should increase annual investment by 10% to boost broadband speeds, bandwidth, and coverage, and further develop their cloud infrastructure. This will lower the cost and raise the availability of computing power and give industries early access to specialized AI applications.

Frontrunner Target: Increase Annual Investment by 6%

After Internet innovation comes data innovation, where Frontrunner countries are leveraging their strengths in cloud and big data to transform industries, optimize processes, and explore automation. The coin of the realm is data, so countries in this cluster need to apply their 6% increase to data centers, next-generation networks, IoT and AI applications. With greater Intelligent Connectivity comes more accessible forms of intelligence, which can be applied to all forms of creation and consumption in everyday life.

Intelligent Connectivity: The $23 Trillion Opportunity



Growing Towards Intelligent Innovation

The fourth stage is intelligent innovation, where all things and people are connected. Fully ambient AI will give rise to new forms of organization, resource allocation, and management that transcend physical barriers and the limitations of the human mind. Declining GDP growth from ICT investment will see a sudden upswing in new growth potential as routine tasks and information processing are automated, and innovation itself becomes the focus of human work.

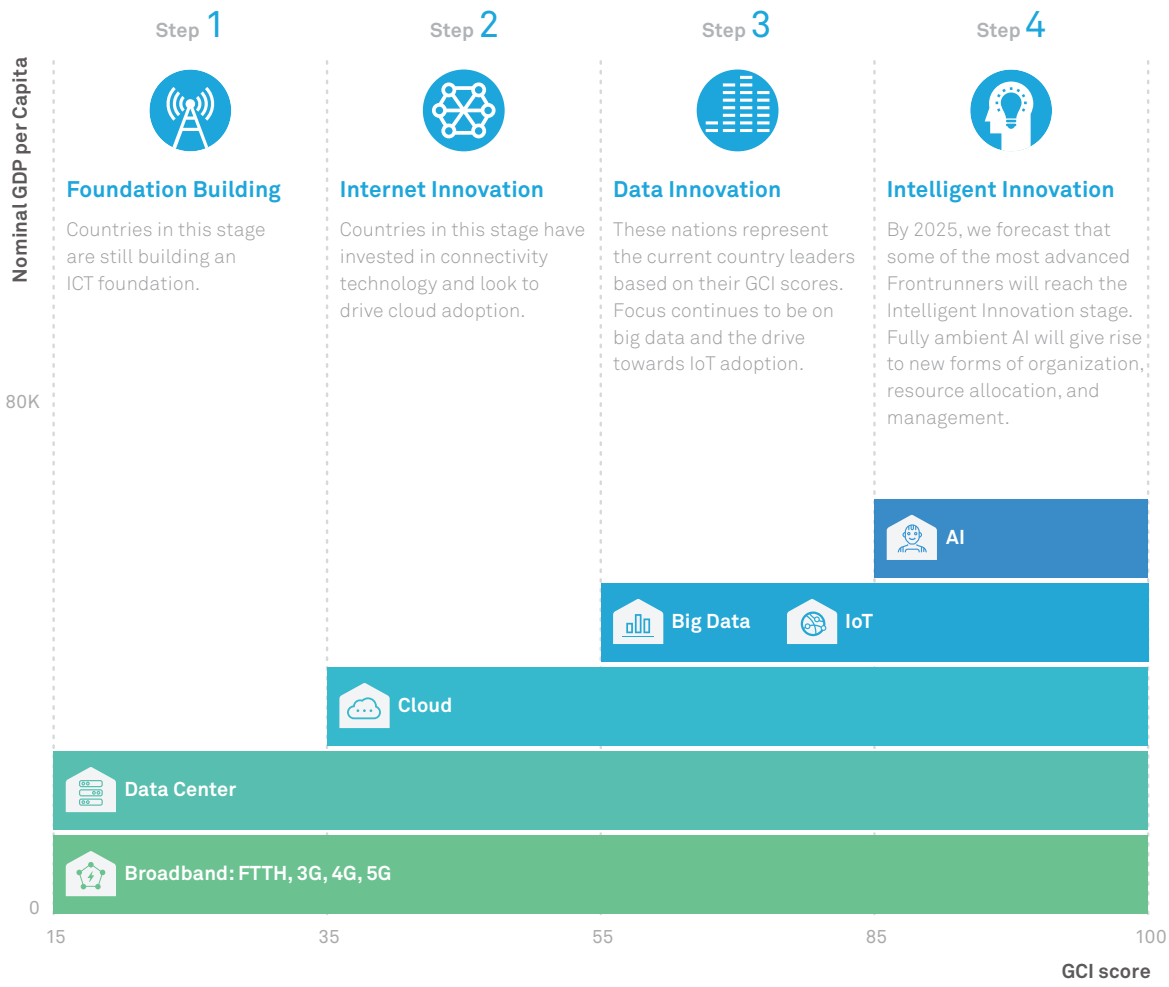
Upward mobility is possible. Investment in one layer of ICT infrastructure is also an investment in the layer above it. The following is a roadmap of investment priorities and benchmarks for countries in each cluster, along with the economic potential they can expect to tap at each level. As always, greater investment drives movement up the GCI S-curve and produces greater returns in GDP.

(Note: Further investment guidance and development recommendations can be found in Chapter 5: Next Steps.)

Investment Priorities for Starters, Adopters and Frontrunners

CLUSTERS	2025 DIGITAL ECONOMY OPPORTUNITY	INVESTMENT PRIORITIES
Starters 13% investment increase (CAGR)	**US$1.2 trillion**	**Broadband** • Increase fiber networks to reach over 20% of households (currently 2%) • Expand 4G coverage to 40% of the population (currently 11%) **Cloud** • Increase investment in cloud services to over 10% of total software investment
Adopters 10% investment increase (CAGR)	**US$6.9 trillion**	**Broadband and Data Center** • Expand 4G coverage to at least 70% of the population (currently 37%) • Increase data center investment by a factor of four (0.16% of GDP) **Cloud and Big Data** • Expand cloud investment to over 20% of software investment (currently 11%) • Double analytics investment to over 2% of total enterprise IT investment to build a foundation for AI
Frontrunners 6% investment increase (CAGR)	**US$15 trillion**	**5G, IoT and AI** • Accelerate adoption and deployment of 5G networks to provide the high-speed and low latency connections needed for Intelligent Connectivity • Increase deployment of IoT devices used by people and machines to generate more data for analytics and AI (currently 9 units per person; needs to be 30) • Double analytics investment to 4% of total enterprise IT investment to strengthen foundation for AI

Move up the Technology Stack to Drive GDP Growth and Enter the Intelligent Innovation Stage



Intelligent Innovation Will Open a New Cycle of Economic Growth

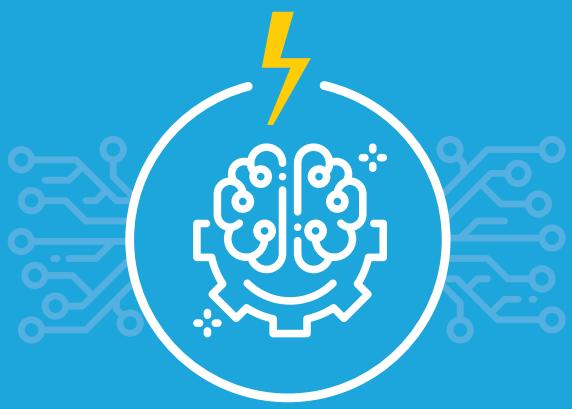
In the next chapter, we will explore the spread of the $23 trillion Intelligent Connectivity opportunity across vertical industries and provide an in-depth look at how these opportunities will take shape in three specific domains.

SUMMARY

Strong ICT infrastructure improves the quality of economic growth.

The Matthew Effect—The digital divide is still expanding.

AI is turning Intelligent Connectivity into a gateway for a new economic growth cycle.



INDUSTRY IMPACT

How Intelligent Connectivity Drives Industry Transformation

Scan to listen to the audio book for this chapter.

INDUSTRY IMPACT

Maximizing ICT Value with Intelligent Connectivity

The integration of AI with five enabling technologies – Broadband, Data Center, Cloud, Big Data, and IoT – is redefining the concept of connectivity. Artificial intelligence, when applied with practical focus, enhances the inherent value of ICT infrastructure with greater automation and intelligence. The result is Intelligent Connectivity.

Intelligent Connectivity builds on the existing functionality of each individual enabler, boosting productivity and economic impact. Most importantly, Intelligent Connectivity drives greater synergy among all enablers, which further multiplies the value they deliver. For example, whereas high-speed broadband provides rapid download speeds, broadband coupled with AI can provide faster, more secure networks with fewer faults. IoT sensors provide massive amounts of data; with the addition of AI, governments and industries can extract actionable meaning from IoT data, enable new business models and services, and automate decision-making.

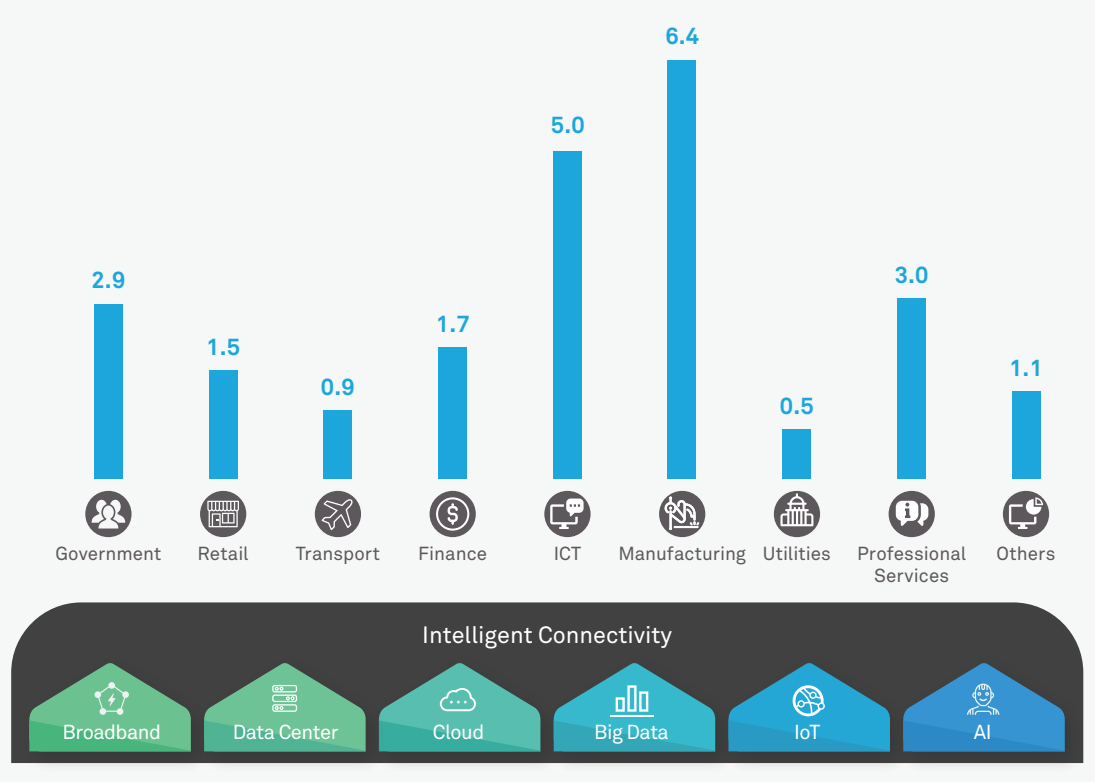
Intelligent Connectivity can trigger innovation on a scale previously unknown. New business models and applications arising from Intelligent Connectivity will change the way business is run, how products and services are consumed, and drive expansion of the digital economy.

Intelligent Connectivity and the Digital Economy

Intelligent Connectivity will unleash a new wave of innovation and economic activity. According to Huawei and Oxford Economics' Digital Spillover research[vii], this will spur new growth in the digital economy, which will reach an estimated value of $23 trillion by 2025 (from $12.9 trillion in 2017). In other words, by 2025, the percentage of digital economy will increase from 17.1 percent to 24.3 percent of global GDP.

The true value of the digital economy lies in the positive impact that investments in ICT infrastructure and artificial intelligence have on productivity and the optimization of economic structures. To reap the true benefits of digital transformation, it is paramount for industry leaders to have a sound, long-term investment strategy in place, because long-term return on investment in digital technologies is 6.7 times that of non-digital investments.

Intelligent Connectivity Enables Industry Transformation to Shape a $23 Trillion Digital Economy by 2025



Source: EU KLEMS, Oxford Economics, Huawei

Manufacturing is expected to be one of the main beneficiaries of Intelligent Connectivity. In terms of digital economy, the addition of Intelligent Connectivity to traditional manufacturing industries is forecast to produce an additional market value of $6.4 trillion by 2025. By leveraging intelligent technologies, traditional industries will be well-positioned to maximize their digital spillover and contribute more to the overall digital economy.

Other industries with tremendous growth projections include those that are typically more data-driven, and therefore more likely to be early adopters of AI. Sectors like ICT, professional services, and finance are expected to prosper in the digital economy. They will see additional market growth of $5 trillion, $3 trillion and $1.7 trillion, respectively. Industries such as social and personal services, retail, transportation and utilities are also on track to achieve digital transformation on a timeline now accelerated by Intelligent Connectivity.

Where Intelligent Connectivity Creates Opportunities

When experts say AI will be a game changer, they are talking about how it will impact virtually every aspect of life in the future. Today, AI use cases still rely on a significant level of human intervention and decision-making. For example, in smart grid applications, an engineer still needs to monitor power grids to optimize electricity distribution in parallel with AI systems. While AI programs assist users with predictive analytics to assess massive datasets or information from sensor networks, the process is still not fully autonomous. Coupled with Intelligent Connectivity, AI will run analytics and impact decision making for more efficient and autonomous processes in the future. It will also accelerate digital transformation by analyzing customer trends, processes and other data to propose better means to design the transformation, as well as what specifically to transform.

The number of fully deployed AI use cases for any country is tied directly to its investment in AI and enabling technologies. While this may sound like a hollow – if not somewhat uninspired – claim, the fact of the matter is that countries with the infrastructure to support AI are likely to have the most fully deployed use cases (relative to pilots and other preliminary forms of exploration).

With a solid foundation in high-speed broadband, data center and cloud, countries with targeted AI and ICT investment are better positioned to use AI to accelerate digital transformation across all industries and grow their digital economy. It should be noted that access to actionable use cases plays an important role in driving the digital transformation process. In some situations, countries with a higher number of use cases relative to their GCI score have moved more slowly toward digital transformation than might otherwise be expected. This typically occurs when use cases have a more siloed impact on the country's economy, which is caused by a lack of sufficiently extensive ICT foundation for AI development.

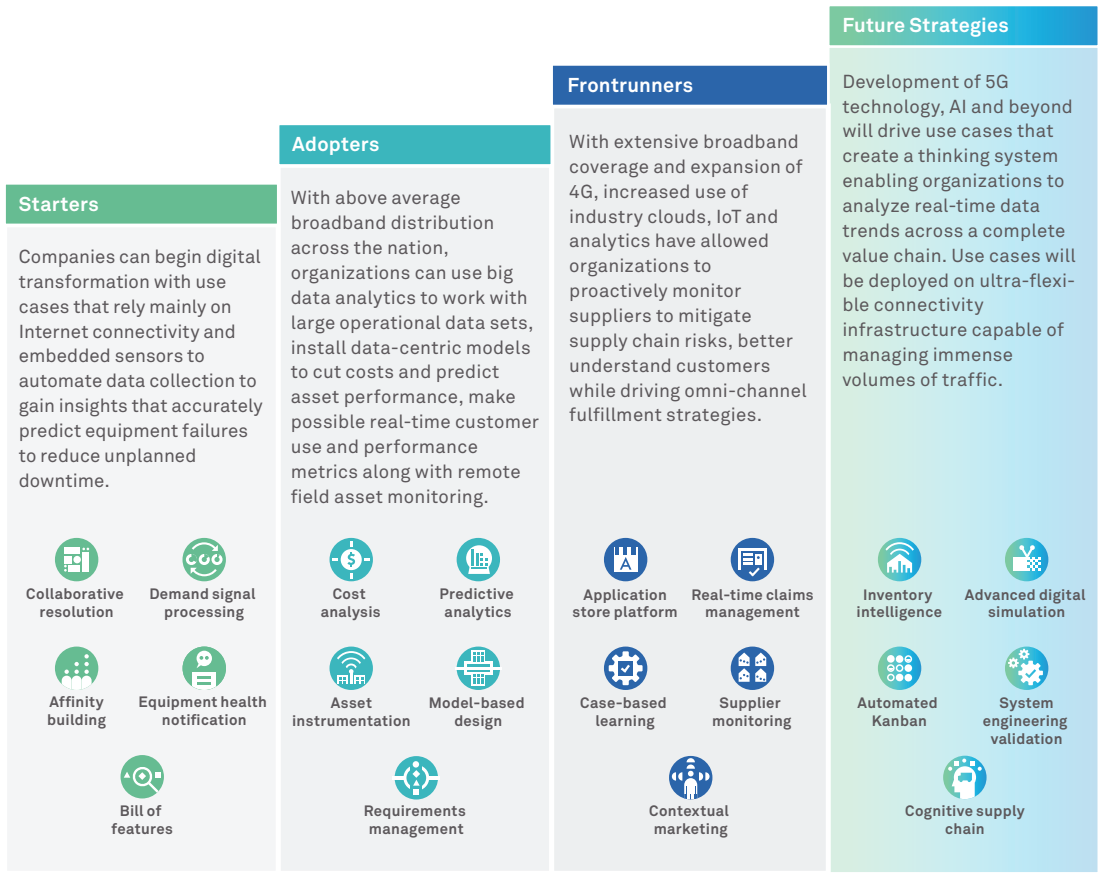
The following are use case scenarios that provide insight into the practical value that AI-powered Intelligent Connectivity provides in utilities, government and manufacturing. These scenarios' plot actions that nations at each level along the GCI S-curve can take – Frontrunners, Adopters and Starters – as well as projections for scenarios that we can expect to see in the more distant future.

Coupled with Intelligent Connectivity, AI will run analytics and impact decision making for more efficient and autonomous processes in the future.

INTELLIGENT MANUFACTURING $6.4 TRILLION

Connecting the Dots Along the Value Chain

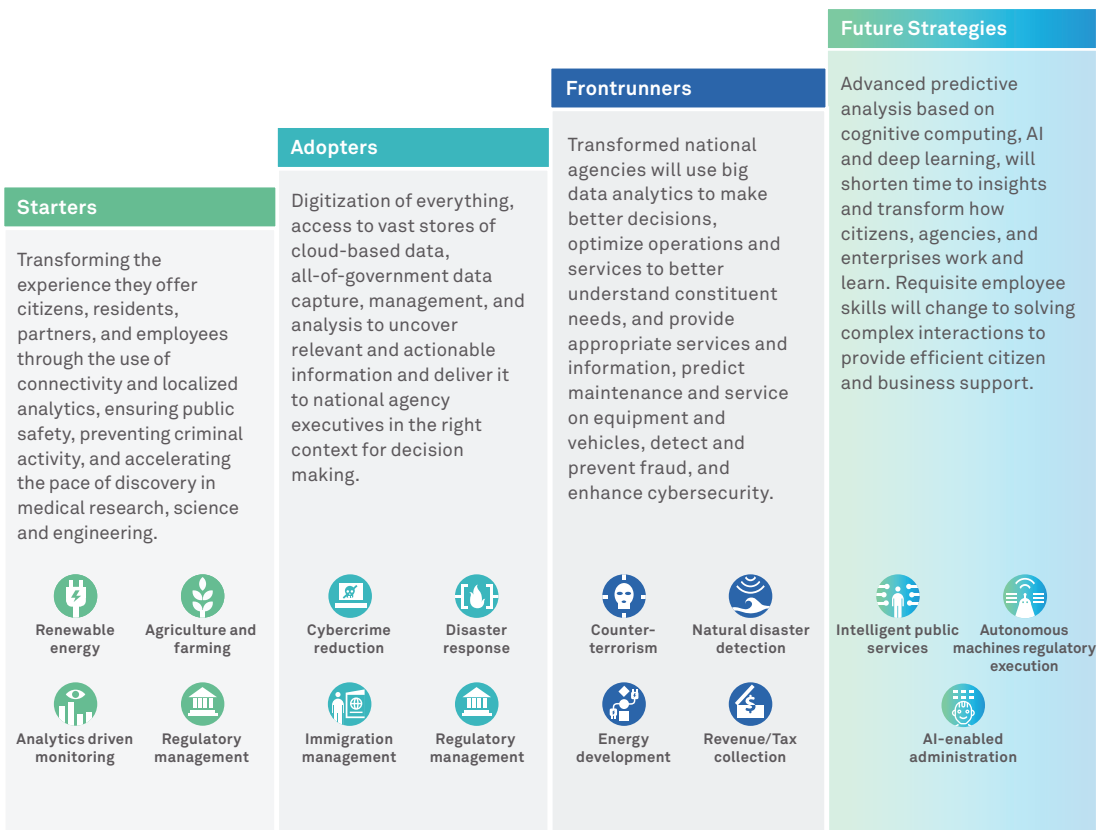
Cloud, big data, IoT, AI and robotics are dramatically reshaping the manufacturing ecosystem. In the era of smart manufacturing, Intelligent Connectivity automates data collection and insight generation to increase efficiency, productivity and transparency while proactively monitoring suppliers to mitigate risks along the supply chain.



INTELLIGENT GOVERNMENT $2.9 TRILLION

Optimizing Efficiency, Management and Service Delivery

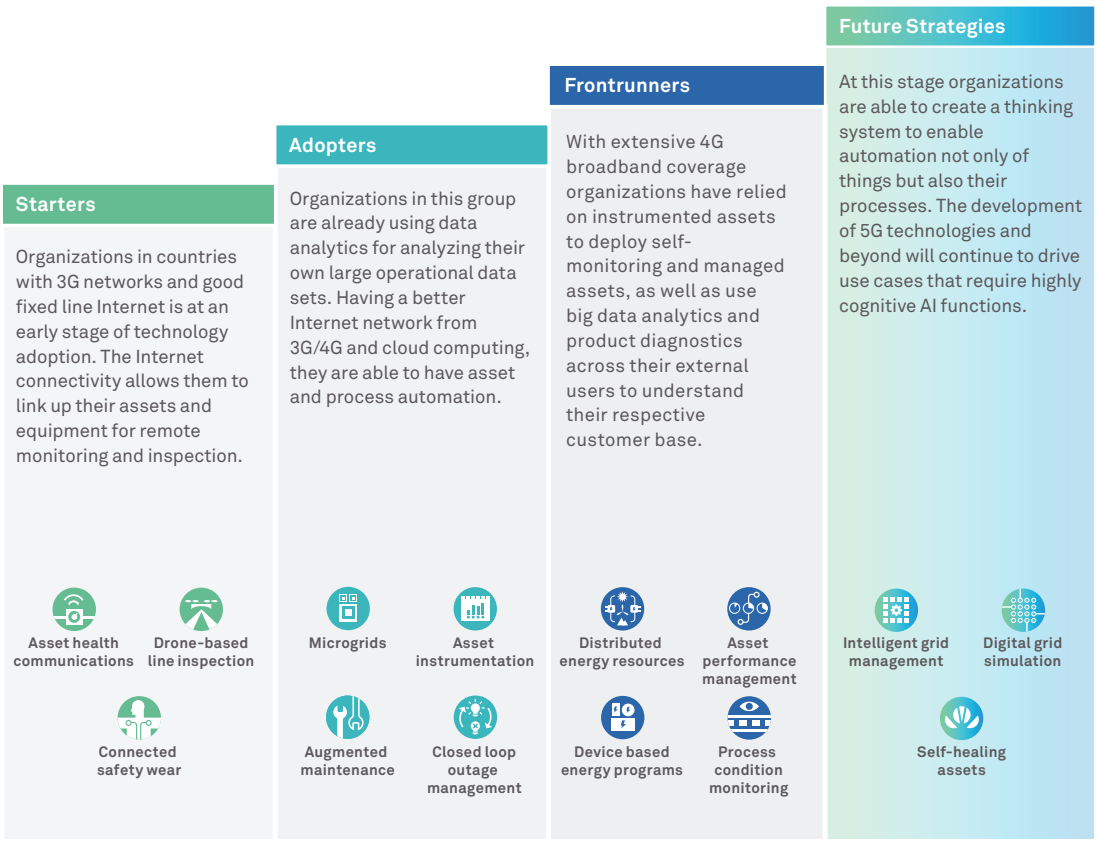
Going digital and embracing intelligence is central to making government operations and processes more efficient. Cloud, big data and IoT help transform national agencies, streamline processes, and facilitate the flow of information from government to its citizens, from citizens to government, and multidirectional flow within government. As a government undergoes digital transformation, mission success will increasingly be defined by the government's ability to leverage the power of big data to fulfil mandates and service requirements. Key areas include providing universal access to services, promoting public safety, and accelerating the pace of economic growth, job creation, medical research, science and engineering.



INTELLIGENT UTILITIES $0.5 TRILLION

Sending Resources When and Where They're Needed

Existing electric grids are stretched to capacity. As the population continues to expand and our reliance on electric-powered equipment grows, power companies need more efficient and intelligent ways to manage power outages, recover from disturbances, and efficiently send electricity where it needs to go. Fed by data from smart sensors, predictive analytics infused with AI can help the electric power industry take demand and operation management to the next level. For instance, smart diagnostics and prognostics enables engineers to predict demand swings in the power grid, conduct real-time diagnostics and troubleshooting, as well as improve asset performance.



Intelligent Connectivity fuels industry transformation and opens enormous opportunities

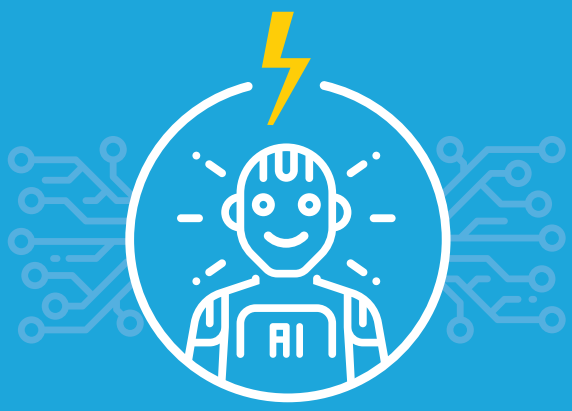
SUMMARY

Intelligent Connectivity will unleash a new wave of innovation and economic activity.

Intelligent manufacturing is connecting the dots along the value chain with the sector expected to reach a value of $6.4 trillion by 2025.

Intelligent government is optimizing efficiency, management and service delivery to foster economic growth of $2.9 trillion by 2025.

Intelligent utilities are allocating resources more efficiently with the industry forecast to reach $0.5 trillion by 2025.



TECHNOLOGY IMPACT

How Countries Can Ramp Up for AI

Scan to listen to the audio book for this chapter.

TECHNOLOGY IMPACT

AI Readiness Integral to Digital Economy Success

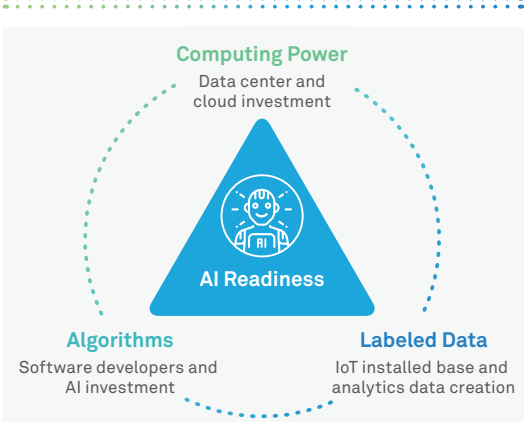
AI, long the mainstay of science fiction, is today a very real presence in business, manufacturing, government operations and an array of other sectors as AI applications take on a growing number of tasks. AI is accelerating the transition from the traditional to digital economy, and at the same time shaping the outlines of the emerging digital economy and society. Policy makers will need to have a good grasp of the basic requirements for AI as well as its potential as this technology is set to have a big impact on economic development.

While many countries report they have developed national AI initiatives, most are, in fact, localized AI deployments limited to a specific ecosystem of partners. To effectively deploy AI on a large scale in industry or government operations, countries must have three equally important components in place: computing power, access to data – easy access to massive datasets is the key here – and, finally, AI algorithms. These three must be cultivated in tandem, as the strength of each one is reliant on the other two.

To assess a nation's readiness for AI, we compiled a checklist of five GCI indicators, combined with an additional sixth indicator that identifies AI investments, to evaluate a country's AI readiness.

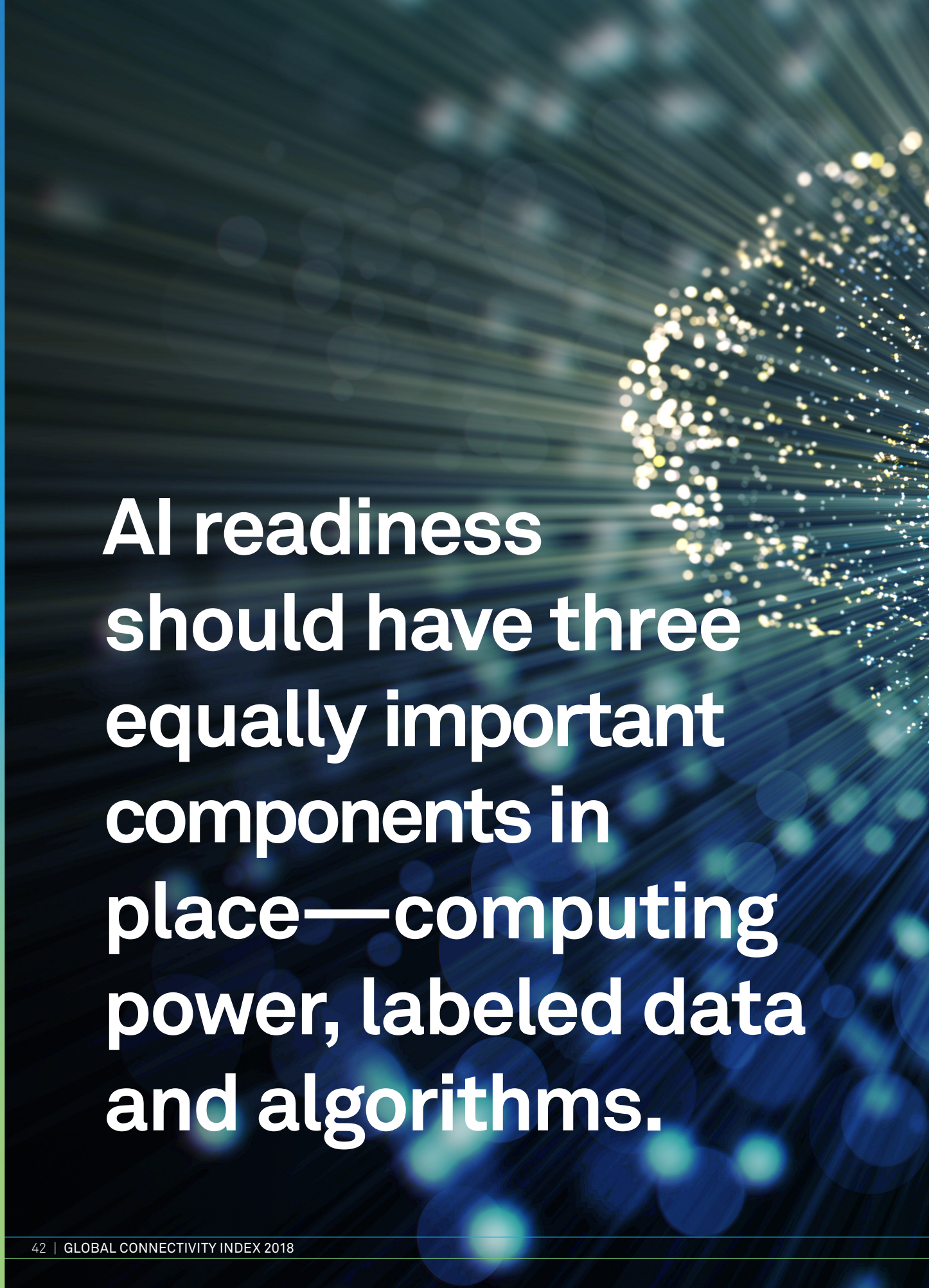
Three Building Blocks of AI Readiness

Based on a set of six indicators, we can map a nation's readiness to effectively use AI. These indicators assess whether the three pre-conditions for AI are in place: computing power, labeled data and algorithms.



The Three Components of AI Readiness

Computing Power GCI indicators: Data center and cloud investment	AI requires significant compute and storage capabilities provided by data centers, as well as scalability afforded by the cloud. The saying "data is the new oil" is more than a truism when training AI systems. High Powered Computing (HPC) systems will be needed for AI to run learning algorithms, process massive amounts of data, learn from events and implement decisions.
Labeled Data GCI indicators: IoT installed base and analytics data creation	Imagine the volume of data processed to train an AI-powered robot or an autonomous vehicle; running simulations involves assessing petabytes of data. Countries will need to ensure data is being created, properly stored, cleaned, tagged, analyzed, and protected against cyberattack. Data can be gleaned from smart or IoT devices, increased digital communication, and from voice, text and video.
Algorithms GCI indicators: Software developers Additional indicator: AI investment	According to Tencent Research Institute[viii], there were only about 300,000 AI experts worldwide in 2017, while millions are needed. With AI in its infancy, education is now a bottleneck. Preparation to work in AI requires knowledge of high-level mathematics, statistics, programming and data science. In the US, for example, newly minted PhDs command salaries up to $300,000 As competition for AI experts intensifies in markets like the US, China, the UK and other technology centers, expect talent to become highly mobile to take advantage of opportunities worldwide. Just as we require data scientists, programmers, and statistics talent to create value from big data, the same is true for AI, where specialized talent is needed to develop the uses, structures and learning algorithms for AI. Until the AI talent pipeline begins to fill up, which is expected to take years, competition for AI talent could be an important part of a new level of digital divide or Matthew Effect as talent migrates toward the Frontrunner nations.



AI readiness should have three equally important components in place—computing power, labeled data and algorithms.

Policy Makers Need to Include AI in Growth Strategy

With AI emerging as an indicator of a country's ability to excel in the digital economy, we assessed AI readiness in the three country clusters. Based on their strength across the three components – computing power, labeled data, and algorithms – Frontrunners scored far higher than Adopters and Starters due to the robustness of their ICT infrastructure.

But the Frontrunners' advantage in AI does not mean other nations will be excluded. Adopters and Starters can look to commercial AI applications or systems provided by business partners for a start. Unlike Frontrunners, many Adopters and Starters are not weighed down with the baggage of large legacy systems, and in some cases entrepreneurs with sufficient investment will be able to adopt new technology and jump ahead faster than companies in more developed countries.

GROUP	COMPUTING POWER (A)	LABELED DATA (B)	ALGORITHMS (C)	AI READINESS (A+B+C)/3
Frontrunners	11.47	10.05	7.42	9.65
Adopters	3.74	4.00	3.78	3.84
Starters	2.25	2.00	2.50	2.25

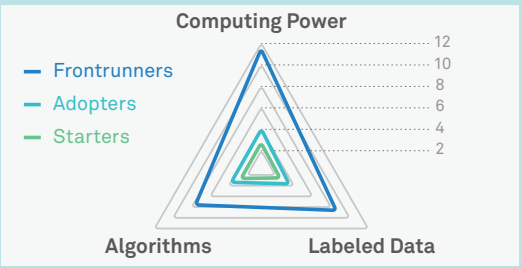
Full marks for AI readiness across all three building blocks is a total score of 20. While the Frontrunners' robust infrastructure enables an average score for the cluster of 9.65, far ahead of Adopters at 3.84 and Starters at 2.25, countries in all three GCI clusters have a long way to go to prepare for AI.

The Adopters face their own unique set of challenges in boosting AI readiness. While they may have a solid foundation in computing power and massive data, their infrastructure is not fully sufficient for managing and processing massive AI datasets at scale. Software developers in the Adopters may be ready to work on AI, but will be limited by supporting infrastructure. They may be tempted to follow the market for higher-paying developer jobs in the Frontrunner countries, which have infrastructure better suited to AI development.

Starters that are still fleshing out their fundamental ICT infrastructure do not have the three essential AI components in place to be AI-ready. However, that does not preclude them from benefiting from AI. Companies in these countries can look to commercially available AI software, such as chatbots for call centers, or AI for robotics that can be used in factories and supply-chain centers. Starting small is important. In places where computing power and network resources are limited, focused AI applications with a practical, narrow scope are more likely to provide measurable value – value that can then be reinvested in the systems themselves, making them incrementally more robust.

The scarcity of talent to develop AI algorithms is the most prominent roadblock that countries in all three clusters face. Companies and governments in the Frontrunners have an advantage as they are better prepared financially to attract and retain top talent. AI talent in Adopter and Starter countries may not have the same opportunities as Frontrunners to get hands-on experience in the first major wave of AI development, but it is imperative for countries in these clusters to incorporate AI in educational curriculum and vocational training to equip the next generation with the skills they need when infrastructure is ready to support AI.

AI Readiness of Frontrunners, Adopters and Starters



High-speed Broadband and Cloud Open the Way to AI

The combination of high-speed broadband and cloud computing presents a cost-effective means to deploy AI across organizations, industries, and countries. The promise of cloud is data and shared computing power that is more available and affordable – eliminating the need for huge individual investments in data centers, hardware and software. As such, cloud is particularly important for governments and businesses in Adopter and Starter nations that are looking for affordable access to AI. Today, cloud services are helping level the playing field for AI adoption by offering a fast-growing range of packaged applications.

Countries with a solid foundation in cloud and readily accessible high-speed broadband will see AI deployment take off, followed by a more significant impact on industry and society. Several of the most developed Frontrunner economies – including South Korea, Japan and the US, to name a few – aim to make the most of AI's potential by deploying 5G networks. With ultra-fast, low-latency networks in place, they can make full use of AI in complex applications that require the collection, transfer, and assessment of mountains of data in real time, such as autonomous vehicles and smart factories.

Regardless of the application, high-speed broadband and cloud should be the strategic focus of ICT investments to accelerate the deployment of AI across whole economies.

A Look at How Broadband and Cloud Support Industrial AI

Even in the most advanced factories that exist today, most factors of production – including software, hardware, and human effort – are not fully linked throughout the manufacturing process. Each factor exists on its own technology and process island, distinct and separate from those around it.

This creates a number of inefficiencies in factory design, resource allocation, coordination, maintenance and repair – inefficiencies that are multiplied exponentially when spread across different production facilities along a global value chain. Low productivity, waste, higher costs and longer down times all lead to suboptimal business outcomes.

To address these challenges and more, factories will be among the earliest adopters of AI. Intelligent systems will help inform human supervision and decision-making, make sense of complex operational environments, and step in when people aren't available – or when their presence isn't cost effective. But what do factories need to take full advantage of AI?

First, they need data. This comes from sensors in equipment, robots, and even raw production materials, and also from unstructured sources like sound and video. All data needs to be collected and sent to a centralized system for processing.

This is where high-speed networks come in. For applications like smart robotic arms and video-based quality control, low latency is critical, as are unprecedentedly high upload speeds. For some machine vision applications, 10 Gpbs upload speeds are needed to ensure that AI systems can process high-definition images in real time.

Ultimately, this processing will happen primarily in the cloud, with some exceptions at the network edge. Cloud provides the computing power necessary to run resource-hungry AI applications, and provide the storage for sharing data across previously unconnected data siloes.

With floods of data streaming in from sensors and devices of all types, fast networks to get the data where it needs to go, and cloud-based AI systems to turn raw data into business intelligence, individual factories and interconnected groups of factories will have full transparency across the value chain. They will grow more intelligent by the day and equip themselves to react in real time to changes in supply, demand, and business strategy.

If countries hope to unlock these new levels of productivity and economic value for their own manufacturing sectors, the three building blocks in the AI triangle are necessary investment targets.

How Countries Can Ramp Up for AI

While Frontrunners and some Adopters have the infrastructure and talent to produce economic value with AI, it remains out of reach for most countries on the GCI S-curve. Nevertheless, policy makers in countries at every level of development need to prepare for AI's influence on their economy and find ways to leverage its benefits.

Of the three building blocks of AI development, the scarcity of people to develop algorithms stands out as the most prevalent problem that all three GCI clusters face. At present, that talent scarcity is most acutely felt by Frontrunners that already possess the infrastructure to develop AI applications. IT talent with the skills needed for a future workforce are scarce in many areas besides AI, where digital transformation is slowed by talent deficits in software development, data science and robotics.

First-world problems aside, Adopters and Starters also need to start building their pipeline of AI talent to prime themselves for future growth. Countries vying for AI talent should consider a two-level approach. The first is to strive for first-mover advantage by cultivating an ecosystem that attracts and retains existing talent. The second is to re-think education – both to prepare the next generation of workers, and also to retrain today's workforce for a future workplace dependent on AI, automation and robotics. This applies to all countries along the GCI curve.

Winning the Battle for AI Talent

Attracting and retaining AI talent isn't as straightforward as offering people more money (although that certainly helps). The overall ecosystem is important too. This includes the strategic importance that countries place on AI development, as well as the infrastructure that supports AI innovation across different domains. The two are interrelated.

Including AI in top-level national strategy is essential to allocate the necessary funding for research and development. It also helps guide policy towards AI-friendly outcomes. Types of policy worth exploring are those that encourage public-private partnerships in infrastructure deployment, as well as those that incentivize entrepreneurship, strengthen basic STEM education, and promote greater data sharing between public and private sectors. This sets the stage for a healthy, collaborative, and open ecosystem that is fertile ground for a new discovery – an environment that's attractive for people exploring new territory.

Including AI in top-level national strategy is essential to allocate the necessary funding for research and development. It also helps guide policy towards AI-friendly outcomes.

Educating a New Generation of AI Scientists and Programmers

Preparing schools to churn out greater numbers of AI talent is important, but so is educating the next generation of talent for the changes that AI will bring.

For lower-skilled workers in Adopter and Starter nations who are expected to be the most affected by automation and AI, learning new skills where possible must be the focus. Governments and industries will need to launch upskilling initiatives to address today's global shortage of qualified workers. Emerging domains like cognitive computing and AI, next-generation security, and cloud architecture will all be in high demand.

In the meantime, for students in non-STEM domains, there should be a strategic shift towards – or integration of – ethics and the humanities. The key is to focus on things machines will be "less good at for longer," says a 2017 report by the UK Parliament's Science and Technology Committee[ix]. According to the report, school and university curriculum will need to be updated to reflect the world we live in and how it is changing – where problem-solving and creativity are the most important assets.

The more education is reformed at every level to prepare students for the new world of AI, the sooner countries will be able to leverage the technology to prepare for the digital economy. All countries, regardless of their ICT maturity, can – and should – prioritize education to ensure even development across all three building blocks of AI readiness.

Ireland's Road to Becoming the European Union's AI Hub

Ireland presents a useful example of a Frontrunner nation that is aggressively investing in AI to win a competitive edge in the digital economy. Ireland boasts low taxes, good connectivity, and a submarine cable system to France that will bypass the UK, which is set to launch in 2019.

The government is active in its support for companies building data centers on the island, and as a result, Ireland has seen a significant increase in data center and cloud computing capacity. Companies like Amazon and Microsoft have large data centers near Dublin that provide cloud computing services and support for the growing computing needs of the European Union's AI programs. The Industrial Development Authority (IDA) of Ireland has also developed the first dedicated master's program for AI in the country to build the skillsets needed to turn Ireland into a leading AI hub for the EU.

At year-end 2017, Ireland[x] had 66 companies working on AI, employing 2,500 people and taking advantage of the country's growing computing power. Dublin's aim is to leverage that talent and the abundance of EU data to develop AI solutions for healthcare, travel and industry.

SUMMARY

A country's AI readiness should have three equally important components in place—computing power, labeled data and algorithms.

Governments will need to radically re-think education for a workforce redefined by AI in the future, and start building the foundations of a healthy, collaborative, and open AI ecosystem to attract and retain competitive AI talent.

NEXT STEPS

Policy Recommendations for Digital Transformation

NEXT STEPS

Policy Recommendations for Digital Transformation

In 2018, the GCI focused on trends that are already starting to affect the way nations invest in ICT infrastructure and digital transformation. While the basics of ICT investing have not changed, this year's GCI identified two new, potentially transformative ingredients in the mix: Intelligent Connectivity and AI. In the face of economic uncertainty and stiff competition, these technologies will provide policy makers with an indispensable tool to accelerate digital economy growth and unearth new opportunities.

The GCI 2018 recommendations for policy makers follows:

ICT Infrastructure Priorities

- **Broadband:** Foster broader collaboration between governmental organizations, regulatory bodies, industry associations, environmental watchdogs and ICT experts to speed up the build-out of ultra-fast broadband networks on a national level. To increase investment in national broadband, nations at all levels of development should encourage a diversity of investment models to attract private capital investment to improve broadband coverage, speed and stability. For example, incentivising utility companies to build fiber optic networks along their electric grid, sell the "right of way" to private companies to lay fiber optic cables alongside power cables, or release more spectrum for companies to build 4G/5G networks.
- **Cloud and Data Center:** These two enabling technologies are critical infrastructure for data-heavy sectors such as financial services, retail and logistics. Promote them as regional data center hubs to establish common data-sharing platforms for countries to enhance data access, transparency and insight generation across industries as well as attract foreign investment to consolidate regional business. As more traditional industries (e.g., manufacturing, healthcare and energy) go digital, cloud and data centers will provide the computing power and storage they need to succeed.
- **IoT:** IoT devices should act as both sensors and effectors to carry out instructions of the Intelligent Connectivity. Countries should facilitate deployment of more IoT sensors and actuators in wearables, homes, offices, factories and public places so individuals and companies can introduce new products

and services to grow the digital economy. Countries need to upgrade wireless and fixed broadband networks to support easier deployment of IoT devices by adding edge computing nodes and utility boxes where any user can easily plug in to deploy IoT devices.

- **AI:** Establish a special innovation taskforce within government ministries responsible for ICT development. The taskforce should be responsible for evaluating, tracking, investing and deploying technologies like deep learning, machine learning and smart robotics to optimize government operations and service delivery. Introduce an open and broad regulatory framework to support development and deployment of next-generation digital technology and foster balanced competition.

Industry and Company Priorities

- **Collaborate with the Public Sector:** Industry leaders should take the initiative to promote regular bilateral discussion and collaboration with key industries. Creating a favorable business environment is vital to success. Industry leaders should focus on building the infrastructure needed to support large-scale digital transformation, promoting and sharing best practices, and driving business model innovation.

- **Industries and Enterprises:** Invest in ICT infrastructure and use it to strengthen existing advantages – combining ICT and operational technology, for example – to improve operations, develop new products and services, and create new paths to growth.

- **Encourage Open Source Frameworks:** Open source frameworks allow higher participation by the developer community, especially in creating viable new use cases pertinent to a specific industry. Novel ways to create customer engagement models and integrate them with social media channels offer new avenues for vendors both to assess and understand their respective products.

- **Build Ecosystem Collaboration:** Innovations based on new technologies are increasingly coming from outside the company, most likely within the industry or ecosystem. Industry players need to collaborate with these external parties. Adopt cloud platforms for innovation and R&D as an offshoot of these collaborations. Industry leaders need to push development of the Intelligent Connectivity in their industry to drive collaboration for faster innovation.

Workforce Priorities

- **Cultivate Talent and Improve Resource Planning:** Work closely with education and labor departments, educational institutions and technology providers for long-term planning in areas of digital knowhow, upskilling, talent cultivation and resource planning. Put infrastructure and processes in place to ensure digital resources are widely and readily accessible. Cultivate specific subsets of the workforce to meet future needs.

ICT Policy Priorities for Starters

FOCUS AREAS	RECOMMENDED ACTIONS
ICT Infrastructure Priorities in 2018 Focus on improving high-speed network access (e.g. FTTH and 4G)	• Expand public-private partnerships for ICT infrastructure to accelerate build-out and control costs • Expand high-speed broadband coverage: increase Fiber-to-the-Home (FTTH) networks to reach over 20% of households (up from 2% in 2017), and 4G coverage from 11% of the population in 2017 to 40% • Invest in data centers to provide cloud services once high-speed network coverage expands • Boost access to affordable computing devices and smartphones to over 60% of the population • Promote Internet use to cross the 70% threshold, up from an average of 38% today
Industry and Company Priorities Focus on e-Commerce and cloud	• Increase investment in cloud services to over 10% of total software investment to create a transformation platform for industry automation • Promote adoption of e-Commerce and social marketing to reach international markets • Grow e-Commerce transactions by a factor of five, to more than $5,000 per capita
Workforce Priorities Focus on education for cloud services and big data	• Develop education programs to ensure workforce will be capable of using digital devices and have skills needed in the digital economy • Build programs to upgrade the skills of current workers to meet the needs of digital transformation and industry automation • Develop advanced programs to prepare IT workers for cloud services, big data and IoT. These workers will play a vital role in moving the country through digital transformation

ICT Policy Priorities for Adopters

FOCUS AREAS	RECOMMENDED ACTIONS
ICT Infrastructure Priorities in 2018 Focus on 4G and data centers	• Improve the quality of connectivity by doubling telecom investment to 0.6% of GDP • Expand 4G coverage from today's 37% to over 70% coverage • Attract enterprise investment in data center construction: grow data center investment four times to 0.16% of GDP
Industry and Company Priorities Focus on cloud and big data to build foundation for AI	• Double analytics investment to 3% of total ICT investment by enterprises to build a foundation for AI • Drive industry transformation by doubling overall ICT investment through investment in transformation use cases as described in this report • Expand cloud investment to over 20% of software investment (up from 11% today), and expand big data investment from 1.2% to over 2% to move from a computerized economy to an intelligent economy
Workforce Priorities Focus on big data education	• Develop education programs that include analytics skills and capabilities to prepare the workforce for the digital economy • Facilitate sharing and protection of private data to build a rich data environment for developing new business models and products • Transform industry from a product-centric model that relies on lower margin manufacturing to a higher-level services model

ICT Policy Priorities for Frontrunners

FOCUS AREAS	RECOMMENDED ACTIONS
ICT Infrastructure Priorities in 2018 Focus on IoT and ultra-fast broadband buildouts	• Accelerate adoption and deployment of 5G networks to provide the high-speed and low-latency connectivity needed for Intelligent Connectivity • Foster deployment and adoption of IoT devices used by people and machines to generate more data for analytics and AI • Increase FTTH coverage to over 50% to facilitate the deployment of IoT devices and AI in the home.
Industry and Company Priorities Focus on increasing investment in AI and analytics	• Continue driving cloud adoption to develop industry ecosystems that promote open collaboration and drive transformation • Ramp up analytics investment to build Intelligent Connectivity platforms for companies and industries involved in AI R&D and deployment • Boost AI investment in pilot applications to build intelligent systems in logistics, manufacturing and service delivery to unlock additional levels of productivity, driving economic value creation
Workforce Priorities Focus on education curriculum that prepares workers for an AI-enabled future	• Prepare citizens for an AI-enabled future by retraining for skills that AI can complement, such as digital fluency, design and creative skills, analytical and data handling skills, and skills for jobs that are non-routine and non-repetitive such as personalized services, education and healthcare • Build a pool of software developers who specialize in AI applications and algorithms

APPENDIX

GCI METHODOLOGY

The GCI analyzes the full spectrum of measurements for connectivity and provides a detailed map of the global digital economy.

The index benchmarks 79 countries according to their performance in 40 indicators that track the impact of ICT on a nation's economy, digital competitiveness and future growth. Combined, these countries account for 95 percent of global GDP.

Research Framework

The GCI analyzes digital transformation from basic levels of connectivity to supplementary, advanced technologies. These advanced technologies – Broadband, Data Centers, Cloud Services, Big Data, and IoT - are key enablers that will drive the next wave of economic benefits resulting from ICT investment. They are built on a foundation layer of technologies like telecom infrastructure, e-Commerce, and the overall adoption of computers, smartphones, and the Internet - all of which have been key determiners of the growth and development of digital economies over the past two decades. GCI also includes forward-looking factors such as ICT patents and R&D.

The research framework thus covers a complete combination of advanced and fundamental technologies, enabling us to analyze how yesterday, today, and tomorrow intersect.

The Four Pillars: SDEP

The four pillars encompass the entire chain of ICT development and digital transformation to provide a 360-degree view of the digital economy. Each pillar has a set of 10 data indicators.

Four Pillars

SUPPLY	DEMAND	EXPERIENCE	POTENTIAL
Measures current levels of supply for ICT products and services used for digital transformation. **Supply indicators:** ICT investment, telecom investment, ICT laws, international Internet bandwidth, fiber optics, 4G coverage, data center investment, cloud investment, big data investment, and IoT investment.	Gauges demand for connectivity in the context of users and activities relating to digital transformation initiatives. **Demand indicators:** App downloads, e-Commerce transactions, smartphone penetration, computer households, fixed broadband subscriptions, mobile broadband subscriptions, data center equipment, cloud migration, analytics data creation, IoT installed base.	Comprises variables for analyzing the experience of connectivity for endusers and organizations in today's digital economy. **Experience indicators:** Government services, telecom customer services, internet participation, broadband download speeds, fixed broadband affordability, mobile broadband affordability, data center experience, big data experience, cloud experience, IoT experience.	Comprises a forwardlooking set of indicators that point towards the future development of the digital economy. **Potential indicators:** R&D expenditure, ICT patents, IT workforce, software developers, and market potential Index calculations for broadband, data centers, cloud services, big data, and IoT experience

The Five Technology Enablers

The index allows the horizontal analysis of five technology enablers that are crucial signposts to help benchmark the relative strengths, weaknesses, opportunities and challenges facing digital economies: broadband, data centers, cloud, big data, and IoT.

Each horizontal layer includes at least one variable from each of the four pillars: supply, demand, experience and potential.

Thus, the GCI can be analyzed both vertically (supply, demand, experience, potential) and horizontally (broadband, data centers, cloud, big data, and IoT).

This allows an extremely detailed analysis on the relative strengths and weaknesses of individual countries to pinpoint the areas in which additional investment is needed to advance connectivity and economic benefits.

Additionally, this structure enables the detailed analysis of correlations between advanced connectivity services like IoT and the key areas of supply, demand, experience, and potential. This reveals the most successful roadmaps for growth and development, and possible areas where leapfrog technology adoption has proved more successful than others.

The GCI is a rich and deep dataset that serves 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. The overall index rankings provide a snapshot of the current state of connectivity across the global digital economy, forming a leading indicator for the next decade of ICT expansion and evolution.

Four Pillars

Five Technology Enablers	SUPPLY	DEMAND	EXPERIENCE	POTENTIAL
FUNDAMENTALS	ICT Investment Telecom Investment ICT Laws International Internet Bandwidth	App Downloads Smartphone Penetration e-Commerce Transactions Computer Households	E-Government Service Telecom Customer Servce Internet Participation Broadband Download Speed	R&D Expenditure ICT Patents IT Workforce Software Developers
BROADBAND	Fiber Optic 4G Coverage	Fixed Broadband Subscriptions Mobile Broadband Subscriptions	Fixed Broadband Affordability Mobile Broadband Affordability	Broadband Potential Mobile Potential
DATA CENTERS	Data Center Investment	Data Center Equipments	Data Center Experience	Data Center Potential
CLOUD	Cloud Investment	Cloud Migration	Cloud Experience	Cloud Potential
BIG DATA	Big Data Investment	Analytics Data Creation	Big Data Experience	Big Data Potential
IoT	IoT Investment	IoT Installed Base	IoT Experience	IoT Potential

The ICT Fundamentals

The five technology enablers need to function on a platform of robust core measurements of ICT fundamentals for a nation to transform into a digital economy and build upon these fundamentals in a self-reinforcing loop.

Examples of these fundamentals and their functions are as follows:

ICT laws are essential for Supply: They set down regulatory boundaries that govern privacy, confidentiality, and safe and legal use. The digital IPs, digital assets, identities, and privacy of businesses and consumers must be protected against abuse and misuse.ICT laws make it feasible for the public and private sectors to invest in supplying ICT products and services to the mass market safely and under regulations.

Applications drive Demand. Delivered on broadband networks, stored in DCs, and distributed via cloud services for mass consumption, they enable technology to produce outcomes. Applications feed data to analytics solutions for processing into information that can effect changes through IoT devices.

Customer experience is driven by quality of service (QoS). It ensures that ICT services meet the expectations and requirements of businesses and consumers in a way that encourages greater use and investment. For example, a country could have strong investment in cloud solutions but poor network performance or reliability, which will hinder the ability of end users to derive economic benefits.

Patents lead to potential. They form the basis that stimulate the innovation of new products and services. High demand coupled with a good experience builds strong future potential to accelerate digital transformation and make economic gains. The five tech enablers require patents for innovation.

A strong IT workforce ensures that a skilled and technology-literate population is available to drive future digital transformation through innovation based on real-world use. A shortage of skilled workers can be a significant inhibitor to a country's potential transformation. Equally an educated workforce is needed to make the most of digital technology.

Other fundamental layer measurements include telecom infrastructure investment, Internet bandwidth, e-Commerce, smartphone and computer penetration, e-government, Internet participation, average download speed, R&D expenditure, and number of software developers.

Measurement and normalization

The variables are measured against factors such as GDP PPP, number of households, and total population.

These factors assess the full picture of connectivity for each country, including measurements like app downloads per person or fiber optic penetration against total households.

In emerging economies, connectivity levels in major metropolitan areas tend to be much higher than their national scores, because these nations are still in the early stages of ICT adoption. This provides an important metric for understanding the potential of the increased economic benefits that these emerging economies will probably see over the next decade and beyond, as they close the digital divide through rapid investment and adoption programs.

In all cases, the data inputs are first measured against a normalizing variable like population size, so the index can benchmark countries according to relative levels of connectivity rather than absolute market sizes, which would be more reflective of economy size.

Scoring and Aggregation

For each variable, a country receives a rating of 1 (low) to 10 (high), depending on the data inputted.

Each indicator has a scale based on a realistic target value for beyond 2020, with a score of "10" reflecting that the target value has been reached.

These target values are extrapolated from market penetration projections based on the highest ranked countries, historical market performance, and expert opinions. Each country's score is then determined by its normalized raw data value in relation to this scale. In most baseline cases, a value that is less than 10 percent of the target value will be allocated a score of 1. A value of between 10% and 20% of the target value is allocated a score of 2, and so on. This is shown in the table:

VALUE (% of target value)	GCI SCORE
1-10 %	1
11-20 %	2
21-30 %	3
31-40 %	4
41-50 %	5
51-60 %	6
61-70 %	7
71-80 %	8
81-90%	9
91-100%	10

Where the average values are significantly lower than the median, the formula is adjusted to include meaningful differentiation at the lower end of the scale and avoid excessive clustering of countries with equal (low) GCI scores.

For example, for Fiber Optics, we use a formula that differentiates between a value of 1% to 5% of the Target (GCI Score=1) and a value of 6% to 10% of the Target (GCI Score=2). This reflects the fact that average Fiber Optics penetration rates are much lower than the median value.

These indicator scores are then aggregated to form a total score for each of the four GCI pillars: Supply, Demand, Experience and Potential. These run from a scale of 10 to 100 (where 10 is the lowest possible total score, equivalent to a score of 1 for each of the 10 indicators within a segment).

The final index score is then calculated by aggregating the four segments:

GCI Total = (Supply + Demand + Experience + Potential) / 4
See "GCI Definitions" for a full list of data category definitions and sources.

AI Readiness

To assess a nation's readiness for AI, we compiled a checklist of five GCI indicator scores (i.e. data center investment, cloud investment, IoT installed base, analytics data creation and software developers), together with an added sixth indicator that identifies an AI investment score.

AI investment score is calculated based on total investment in AI software platforms against GDP. AI software platforms provide the functionality to analyze, organize, access, and provide advisory services based on a range of structured and unstructured information. These platforms facilitate the development of intelligent, advisory, and cognitively enabled applications, including intelligent assistants. The technology components of AI software platforms include text analytics, rich media analytics (such as audio, video, and image), tagging, searching, machine learning, categorization, clustering, hypothesis generation, question answering, visualization, filtering, alerting, and navigation.

These six indicators are grouped into three components namely, Computing Power, Labeled Data and Algorithms, which are the core aspects of AI development. Algorithms consist of Software Developers and AI Investment. Labeled Data consists of IoT Installed Base and Analytics Data Creation. The Computing Power consists of Data Center and Cloud Investment.

AI Readiness is then calculated by aggregating the three components:

AI Readiness = (Computing Power + Labeled Data + Algorithms) / 3

Additional Notes

For variables weighted against GDP, we use the GDP at Purchasing Power Parity (PPP) calculation. This is generally the best way to calculate in-country purchasing power after it has been adjusted for the cost of living. This measures the relative wealth of a nation in terms of its ability to purchase goods and services within the national economy.

The data is always the most recent that is available, depending on the source. Data sources include: OECD, ITU, GSMA, WEF, World Bank, United Nations, Ookla, IDC, and Huawei. We've estimated the data for missing values based on geographical cohorts. Numbers in the charts might appear different from direct calculation due to rounding adjustments. Historical data shown in GCI 2018 may be different from data used in GCI reports of previous years, as it has been updated with the most recent actual data to improve accuracy.

GCI DEFINITIONS

SUPPLY

measures current levels of supply for ICT products and services.

ICT Investment

Overall size of ICT investment in each nation, as defined by the total amount of end-user investment in 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

Telecom Investment

Investment by Telecom Service Providers (Telcos) in infrastructure. To create the 2018 score, aggregate spending over the 5-year period 2012-2016 was considered, so as to account for cyclical periods and economic wild cards that can affect spending levels in a single year.

Calculation: per GDP

ICT Laws

A World Economic Forum survey on how developed a nation's ICT laws are (e.g., electronic commerce, digital signatures, and consumer protection).

Calculation: N/A

International Internet Bandwidth

Total used capacity of international Internet bandwidth in megabits per second (Mbps). This 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 (bps) per Internet user is calculated by converting to bits per second and dividing by the total number of Internet users.

Calculation: per Internet User

Fiber Optic

The number of Fiber to the Home (FTTH) subscriptions, measured against the total number of households in each nation. "Fiber to the Home" is defined as a communications architecture in which the final connection to the subscriber's property 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

4G Coverage

Percentage of mobile connections that use a 4G/LTE network. Users who haven't subscribed to 4G services but who use a 4G phone aren't counted.

Calculation: % of mobile data connections

Data Center Investment

Overall investment in servers for all data centers (on-premise and off-premise). The value of servers is based on total ASP, including processors, memory, disk storage, bundled operating systems, and software. Volume, mid-range, and high-end servers are included.

Calculation: per GDP

Cloud Investment

Total investment by public cloud service providers in infrastructure (servers, storage, and ethernet switches). This variable measures current levels of investment by public cloud service providers in the hardware infrastructure necessary to supply public cloud services. The data is normalized against the overall size of the economy.

Calculation: per GDP

Big Data Investment

Investment in analytical software tools 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 queries, 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 IT spending

IoT Investment

Investment in IoT products including intelligent systems, IoT devices, IoT purpose-built platforms, and IoT-

Calculation: per capita

DEMAND

gauges demand for connectivity in the context of users and activity.

App Downloads

The total number of new mobile application downloads in the calendar year on all major mobile platforms (Android, iOS and Windows phones). This is measured against the overall size of the population, and refers to new app downloads, not the existing installed base.

Calculation: per capita

e-Commerce Transactions

e-Commerce involves orders placed on the Internet (i.e., the buyer clicks an order button on the Internet) in a commitment for paid goods or services. Total e-Commerce measures the volume of all e-Commerce transactions, both B2B and B2C (including volume purchases).

Calculation: per capita

Smartphone Penetration

Smartphone penetration expressed as a percentage of total connections (excluding M2M). A smartphone is defined as a mobile handset with advanced access to Internet-based services and computing functions.

Calculation: share of total Connections

Computer Households

The number of households with access to a computer – a fixed desktop computer, laptop, or tablet (or similar handheld computer). Excludes smartphones.

Calculation: % of households

Fixed Broadband Subscriptions

Total number of subscriptions that access the Internet through a wireline (including satellite) broadband Internet connections.

Calculation: per capita

Mobile Broadband Subscriptions

Total number of mobile broadband services subscribers, measured in relation to the overall size of the population.

Calculation: per capita

Data Center Equipment

Annual spending on on-premise data center hardware and equipment (servers, storage, and network equipment). Excludes cloud infrastructure.

Calculation: per capita

Cloud Migration

The percentage of commercial software budgets that have migrated to Cloud platforms, used as a measurement of demand for Cloud Services in relation to traditional on-premise deployments.

Calculation: SaaS/PaaS per Total Software

Analytics Data Creation

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

Calculation: per capita

IoT Installed Base

Total installed base of IoT devices and systems (including intelligent systems).

Calculation: per capita

EXPERIENCE

analyzes the experience of connectivity for end users and organizations.

e-Government Service

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

Calculation: index

Telecom Customer Service

Current service levels provided by telecom operators based on previous research and surveys conducted within each nation.

Calculation: index

Internet Participation

The total number of individuals accessing the Internet at least once during the 12-month period, via wireline and/or mobile Internet access.

Calculation: per capita

Broadband Download Speed

Average download speed for each nation, as monitored and published by ookla.com. These metrics use billions of Internet and mobile network tests to provide a current view and analysis of global Internet access speeds.

Calculation: N/A

Fixed Broadband Affordability

The price of a monthly subscription to an entry-level fixed-broadband plan. These entry-level plans may include a variety of data and download speed allowances. The calculation is a percentage of a nation's average monthly GNI per capita.

Calculation: per GNI

Mobile Broadband Affordability

The price of a monthly subscription to postpaid handset-based data services with a minimum of 500 MB data allowance. This is calculated as a percentage of a nation's average monthly GNI per capita.

Calculation: per GNI

Data Center Experience

An index for measuring the data center experience of enterprises based on two key inputs: (1) Security, based on enterprise investment in security software to protect the integrity of the data centers; (2) Quality of Service, based on local market surveys that analyze the quality of data center services provided inside the nation. The two inputs are combined into the final index with equal weightings.

Calculation: index

Cloud Experience

An index that measures the quality of service provided by cloud service providers to customers in each nation. This is combined with Broadband Affordability, Quality of Service, and Average Download Speed.

Calculation: index

Big Data Experience

An index that measures the quality of service provided by vendors of big data products and services to customers in each nation. To improve the experience of this technology, the scalability of created data needs to be considered. The index is thus weighted by Analytics Data Creation to provide an overall measurement of Big Data Experience

Calculation: index

IoT Experience

Total spending on analytics software relating to IoT data analysis. These software tools that extract value from the mass of data being created via IoT to improve the experience of a nation or organization with an IoT platform that transforms IoT data into actionable information.

Calculation: per capita

POTENTIAL

comprises a forward-looking set of indicators that point towards the future development of the digital economy

R&D Expenditure

Expenditure on R&D means current public and private capital expenditure on creative work 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

ICT Patents

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

Calculation: per million capita

IT Workforce

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

Calculation: per Capita

Software Developers

The total number of software developers in each nation. Professional software developers are engaged in employment where the primary activity is constructing software or supervising its construction.

Calculation: per capita

ICT Market Potential

An index derived from local nation survey data on the potential for market development and the economic benefits to be derived from adoption of adopting Broadband, Data Centers, Cloud, Big Data and IoT Solutions

Calculation: index

The Evolution of the GCI: Benchmarking the Digital Economy Journey

Technology Impact		Economic Impact
AI readiness is integral to success in the digital economy	 **2018** **Tap Into New Growth with Intelligent Connectivity**	AI is turning Intelligent Connectivity into a gateway for a new cycle of economic growth
ICT infrastructure investment initiates a chain reaction to digital transformation, with cloud as a potent catalyst	**2017** **Harnessing The Power of Connectivity** 	The digital divide becomes a digital chasm: the rich get richer and the poor get poorer
Countries need to move up the technology stack to drive further GDP gains	 **2016** **Connect Where it Counts**	A one point increase in GCI correlates with a 2.1% increase in national competitiveness, 2.2% increase in innovation, and 2.3% in productivity
Realizing economic transformation with five enabling technologies	**2015** **Benchmarking The Digital Economy Journey** 	A 20% growth in ICT investment will increase a country's GDP by 1%
Broadband investment is a key requirement identified by industries to build a digital economy	 **2014** **New Economic Barometer**	A one point increase in GCI correlates with a 1.4% -1.9% increase in GDP

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gci
global
connectivity
index

Global Connectivity Index 2018 benchmarks where a country stands on the transformation journey into a digital economy. More importantly, it's a tool that will help you see the connections that matter, and empower you to take action based on that intelligence.

HUAWEI