Powering Intelligent Connectivity with Global Collaboration

Mapping your transformation into a digital economy with GCI 2019

gci
global
connectivity
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Executive Summary

The economic success and productivity gains made possible by digital transformation depend on investment in ICT infrastructure, a fact that's not lost on policymakers or industry leaders. However, it isn't just a case of flexing financial muscle and throwing investment at tech projects – guided investment is necessary to forge a strong digital economy that reflects current economic and technological realities. Investing effectively requires an understanding of how ICT maturity influences productivity, a knowledge of where the tipping points for growth sit, and an insight into national ICT development in the context of an evolving global ecosystem that's based on collaboration.

Huawei's Global Connectivity Index charts the progress that 79 nations are making with ICT infrastructure in relation to previous years, national growth, and each other. It offers a strategic overview that can serve as a springboard for policymakers and industry leaders to set national and business roadmaps for future social and economic development.

This year's report evolves the concept of **Intelligent Connectivity** – the powerful convergence of broadband connectivity, cloud, IoT, and AI that represents the next stage of digital transformation. Underpinned by the emergence of AI, Intelligent Connectivity is shaping a future where everything is beginning to act, react, and collaborate wirelessly and seamlessly with human preferences, commands, and intentions. In this future, we believe that everything will be sensing, connected, and intelligent.

GCI 2019 also considers what we call **AI's Upside Potential** – the potential growth that AI can realize for GDP, and one which has led us to expand our scoring parameters for GCI. New to this year's report is **Ecosystem Stakeholders.** Reflecting the rise of the cross-border collaboration that's shaping the global economic ecosystem, we've identified five stakeholder roles that underpin the digital economy and enable Intelligent Connectivity.

The future is not guaranteed and change is never easy, especially when set against the sluggish economic outlook that's predicted for 2019 and 2020. It will take investment, infrastructure, data, and determination. It will take forethought. And it will take an understanding of how to plan ICT strategies based on the convergence of emerging technologies.

GCI 2019 Findings

GCI 2019 identifies several inflection points where rising GCI scores can potentially trigger higher economic growth.

Intelligent Connectivity

We expect that nations crossing the GCI 65 tipping point with a focus on AI will see more than 1% of potential value added to their GDP growth, marking a significant breakthrough for Frontrunner economies against a backdrop of several years of sluggish growth after having reached the maximum value-add of previous ICT investment.

While many Starters and Adopters lack the ICT infrastructure to fully benefit from deploying AI, it should still be a focus of policymakers' long-term strategy. Broadband connectivity is more important than ever, because distributed computing and the processing capabilities of cloud intelligence reduce the need for local data centers and computing infrastructure, instead requiring access to remote resources. Governments and industry leaders in Starter and Adopter nations should prioritize work on national-level Intelligent Connectivity and AI initiatives to accelerate access to these technologies.

GCI 2019 also finds that when a nation's cloud readiness and IoT readiness scores cross the 50 and 45 mark respectively, AI's impact on their economy begins scaling up. Simply put, a country is required to achieve an IT spend of between 3-4% of GDP to achieve the cloud and IoT readiness levels to reach the tipping point for AI to take off.

As a touchstone of AI readiness, cloud provides the data storage and computational capabilities required by AI. Another precondition for AI readiness is a strong installed base of IoT, which collects and creates the massive datasets that AI systems need to develop insights and expand their capabilities for machine learning.

Adequate investment in IoT and related analytics capabilities are other contributing factors to boost a country's AI capabilities.

AI's upside potential

GCI 2019 finds that nations at every level of digital development are discovering an upside potential to AI that will boost GDP growth when AI is deployed in industries and organizations.

Countries with the highest GCI scores can leverage Intelligent Connectivity to accelerate economic growth up to 2.4 times faster than other nations for every point of GCI improvement.

However, even GCI Frontrunners are relative beginners in the Intelligent Connectivity arena, as they're still learning how to develop, deploy, and train AI to solve real-world challenges. Cloud-based AI is in fact creating more of a level-playing field for Adopters and even Starters to reap the benefits of Intelligent Connectivity, with AI's upside potential more evenly distributed across regions and industries.

5G's rapid rollout will create new economic growth

If the introduction of 5G follows the patterns of previous wireless networks, we can expect a spike in global growth. With each new wireless generation, businesses worldwide have quickly taken advantage of the improved broadband experience to launch new products and services, optimize operations, and boost productivity. Typically, growth from a new-generation wireless network kicks in when global market penetration reaches 10%. However, while it took seven years for 3G to reach 10% of the global market and six years for 4G, we expect 5G to reach the 10% tipping point in four years.

5G starts with a key advantage: more than 40 5G-ready devices, mostly smartphones, will be on the market in 2019. 5G semiconductors and routers are also available today, well in advance of 5G's network maturity and availability.

Ecosystem stakeholders drive collaboration

In an increasingly connected world, success will depend on the ability to collaborate. Intelligent Connectivity and other new technologies are making a global ecosystem possible that will see millions of partners across industries and nations collaborate to create sustainable socioeconomic development.

Intelligent Connectivity ecosystems employing AI, cloud services, and IoT will thrive with the growth in volume and quality of the structured and unstructured data that becomes available. Intelligent Connectivity can then deliver high-quality personalized products and services that engage more users, and in turn increase the quality and abundance of data, thus creating a virtuous cycle.

GCI 2019 identifies five stakeholder roles that can collaborate across domains, break down organizational silos, and deliver fast results to customers: Decision Makers, Data Scientists, Data Collectors, ICT Companies, and End Users. Understanding how to participate and leverage the strengths of these collaborative stakeholders is crucial for policymakers and industry leaders to deliver sustainable growth for their country or organization, especially as the influence of Intelligent Connectivity expands.

GCI 2019 also finds that nations that closely work with other trading country partners have a higher chance to recap the greatest benefits of Intelligent Connectivity, as local, regional, and certainly global ecosystems are increasingly reliant on cross-industry and national collaboration to create value for all participants; i.e., nations, enterprises, and the public.

Intelligent Connectivity as a force for all

This year's report also covered social impact. We realized that Intelligent Connectivity is not only being recognized as a force for economic growth but may be the answer to many of society's most complicated and deeply rooted challenges, including the wealth gap between rich and poor, inclusive development, environmental conservation, and climate change. Technology is an intrinsic part of today's world. However, it shouldn't be available only to those who can afford it. We look forward to policy makers and industry leaders increasing efforts to make technology, applications, and skills accessible to everyone, and bringing digital technology to every individual, home and organization.

The rise of Intelligent Connectivity marks a critical point of acceleration in the global digital transformation that the GCI has tracked for five years. ICT is already having a strong economic impact across countries and regions in every stage of development. While still in its infancy, Intelligent Connectivity's ability to boost productivity, spur innovation, and accelerate the development of new business models will affect virtually every aspect of socioeconomic development in ways yet to be imagined.

Country Rankings

Country Rankings

The GCI has expanded its research methodology in 2019 to provide policymakers with a comprehensive picture of AI's growing influence on the global economy

The Global Connectivity Index tracks the relationship of ICT infrastructure investment and economic growth to provide policymakers with a view of the trends and information they need for sound decision-making. GCI 2019's research methodology has been expanded to better reflect the emergence of AI and Intelligent Connectivity and to explain the technologies that we believe will drive economic growth in the near future.

GCI 2019 follows the digital development of 79 countries, with each assigned a GCI score ranking it along an S-curve graph. Countries on the S-curve are grouped into three clusters – Starters, Adopters and Frontrunners –according to their level of ICT investment, maturity, and economic development. Thanks to the expanded scope of the methodology, GCI 2019 showcases AI's influence on GDP growth, which is particularly important for policymakers in advanced economies who have seen growth slow as they have squeezed most of the available digital dividends from their ICT investment in recent years. In the next chapter, "Economic Impact", we will explain why the Frontrunner nations view AI as a powerful driver enabling them to resume or accelerate economic growth.

GCI 2019 also identifies a surge in average GDP per capita across all three country clusters. The averages of Frontrunners, Adopters, and Starters have increased to US$58,110, US$17,200 and US$3,800 respectively this year. Frontrunners enjoyed the largest 12-month expansion of GDP per capita: US$4,000. Adopters and Starter nations also saw significant improvements in GDP per capita of US$900 and US$100 respectively over the past 12 months.

	FRONTRUNNERS	ADOPTERS	STARTERS
GCI SCORE RANGE	65-85	40-64	23-39
GDP PER CAPITA	US$58,100	US$17,200	US$3,800
CHARACTERISTICS	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.	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 digitalization and economic growth.	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.

Country Rankings

FRONTRUNNERS

RANK	COUNTRIES	SCORE
1	United States	85
2	Switzerland	83
3	Sweden	81
4	Singapore	81
5	Denmark	78
6	Japan	75
7	Finland	75
8	Norway	75
9	United Kingdom	74
10	Netherlands	74
11	Australia	74
12	New Zealand	72
13	South Korea	70
14	Canada	70
15	Germany	69
16	Luxembourg	69
17	France	68
18	Ireland	67
19	Austria	65
20	Belgium	65

ADOPTERS

RANK	COUNTRIES	SCORE	RANK	COUNTRIES	SCORE
21	Estonia	62	38	Greece	50
22	Spain	60	39	Croatia	50
23	UAE	60	40	Bahrain	49
24	Portugal	60	41	Russia	49
25	Czech Republic	58	42	Oman	48
26	China	57	43	Saudi Arabia	48
27	Italy	57	44	Brazil	47
28	Lithuania	56	45	Turkey	46
29	Slovenia	56	46	Kuwait	45
30	Malaysia	54	47	Belarus	45
31	Hungary	54	48	Argentina	45
32	Slovakia	53	49	Kazakhstan	44
33	Chile	52	50	Ukraine	44
34	Bulgaria	51	51	Mexico	43
35	Uruguay	51	52	South Africa	43
36	Poland	51	53	Serbia	43
37	Romania	51	54	Thailand	43
			55	Colombia	41

STARTERS

RANK	COUNTRIES	SCORE
56	Peru	38
57	Vietnam	37
58	Egypt	37
59	Philippines	37
60	Ecuador	37
61	Morocco	36
62	Indonesia	36
63	Lebanon	34
64	Jordan	34
65	India	34
66	Venezuela	33
67	Paraguay	33
68	Algeria	31
69	Bolivia	31
70	Botswana	30
71	Ghana	29
72	Kenya	29
73	Bangladesh	28
74	Namibia	28
75	Nigeria	27
76	Pakistan	27
77	Tanzania	24
78	Uganda	24
79	Ethiopia	23

Contrasts grow as Frontrunners pull further ahead

A quick comparison of how the digital economy developed in the years between the GCI reports from 2015 to 2019 demonstrates the degree to which Frontrunners are pulling ahead of less developed economies. In 2015, the gap in average GCI scores between Frontrunners and Adopters was 21.7 GCI points. That gap grew to 23.1 points in 2019. During the same period, the gap separating the average scores of Frontrunners and Starters grew from 37.5 points to 41.9 points. The GCI point spread between Frontrunners and Starters has expanded on average by 3% annually from 2015 to 2018. Since the publication of GCI 2018, that gap grew by 4%, due in part to the influence of AI, which has accelerated GDP growth for Frontrunners. Since advanced digital economies are better positioned to fully leverage the capabilities of Intelligent Connectivity to drive growth, the Frontrunners of the GCI S-curve have taken a steeper trajectory this year, reflecting a spurt in economic growth from deploying new technologies.

Top movers in one year

- Once again, the US claimed the top spot in the GCI rankings in 2019, followed by Switzerland, which moved ahead of last year's second-ranked Singapore.
- Among the 79 countries ranked in the GCI 2019 report, the Adopter nation Bulgaria enjoyed the largest increase in GCI score, climbing eight positions to reach number 34 in the rankings.
- Other rising stars among the Adopters include Ukraine, which climbed four places from 2018 to rank 50. A few countries, including Bangladesh, China, Japan, Lebanon, Norway, and Vietnam, also rose three ranks in this year's GCI.

SWITZERLAND

The Swiss have aggressively invested in 4G to make mobile broadband services widely available and affordable for the country's 8.5 million people. Switzerland today enjoys one of the highest broadband penetration rates in Europe and among OECD nations. In 2019, the Swiss government auctioned frequencies on the 5G mobile spectrum for 380 million Swiss francs (US$379 million) to boost the development of IoT, industrial automation, and autonomous vehicles. In addition, Switzerland's Federal Office for National Economic Supply (FONES) published a new ICT minimum standard to protect against cybercrime in 2018. The ICT cyber risk standard aims to strengthen cybersecurity for all sectors of the economy and society and protect the operators of Switzerland's critical infrastructure. Reinforcing its ICT security and installed base of secured servers was an important factor in Switzerland's GCI score increase of five points from 2018 to 2019.

BULGARIA

Over the past year, Adopter country Bulgaria has seen a remarkable improvement in its GCI scores, jumping four points to 51 thanks to its National Broadband Infrastructure Plan and other favorable initiatives. The plan prioritizes building broadband infrastructure for next-generation access and the increased use of the radio spectrum, with boosting access in remote and sparsely populated areas a top priority. It also sets broadband targets in line with the Digital Agenda for Europe: at least 30 Mbps for 100% of the population and 100 Mbps and above for at least 50% of households by 2020.

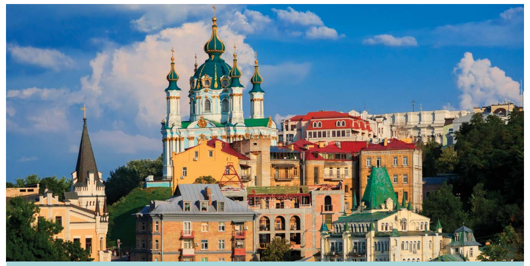
Aspiring to transform into Digital Bulgaria, the European nation solidified its roadmap for achieving its targets. In just 12 months, the nation has made outstanding improvements in mobile broadband access, affordability, and maturity, opening up enormous opportunities for Bulgarian citizens and businesses due to enhanced broadband infrastructure and new digital services.

VIETNAM

Vietnam is the rising star among Starter nations, improving its GCI score by two points to 37 in 2019. With a population of 94.6 million, the Southeast Asian country has significantly increased smartphone penetration and mobile broadband subscriptions. According to Vietnam's Ministry of Information and Communications (MIC), the country's base of 4G subscribers grew to more than 13 million in 2018, which accounts for about 30% of the total number of mobile phone subscribers. While still investing heavily in 4G, Vietnam is already gearing up to become one of the first Southeast Asian countries to roll out 5G. The nation's biggest carrier Viettel has announced plans to launch 5G services by 2021 and is preparing to test a 5G broadcast station in Hanoi with speeds of 600 to 700 Mbps.

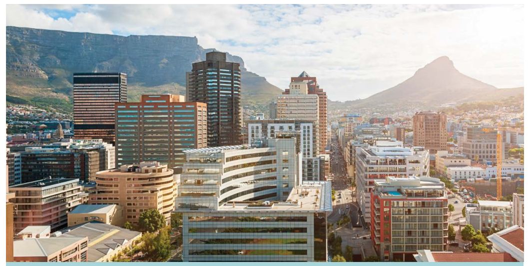
Top movers in four years

From the GCI's first edition in 2015 to the 2019 report, we've witnessed remarkable growth in the global digital economy. During that time, four countries stand out among Adopter and Starter nations for their impressive improvement in GCI scores: Ukraine, South Africa, Bangladesh and Algeria.



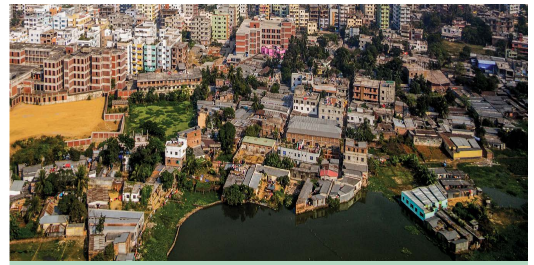
UKRAINE

Ukraine is a rising star among the Adopters – its GCI score has climbed 12 points in just five years. The country's mobile subscriptions jumped from 8% to 95% penetration from 2015 to 2019, and government statistics record that of Ukraine's 26 million Internet users, more than 25 million access the web via mobile broadband. GCI 2019 also found that Ukraine has significantly improved its cybersecurity awareness and ICT laws. Alongside Tunisia, it was one of the first NATO partners to position cybersecurity training as part of the NATO Defense Education Enhancement Program last year. In 2017, HI-TECH OFFICE UKRAINE worked with various Ukrainian cities to launch the Digital City – Digital Ukraine project, which aims to improve e-government services. The program is designed to integrate efforts to create common approaches for the systematic implementation of smart grid projects and initiatives in Ukrainian cities.



SOUTH AFRICA

South Africa has moved up 10 GCI points since 2015. The Adopter nation has invested significantly in ICT and has increased mobile broadband subscriptions from a penetration rate of 51% to 103% over five years. Smartphone penetration also expanded from 33% to 96% over the same period. While ICT availability and adoption are not widespread in South Africa, the government has proposed to use ICT to promote efficiency and effectiveness, with the aim of making government services accessible on digital platforms to more than 57 million citizens. Notable e-government successes include the National Treasury's eTender Publication Portal, eHomeAffairs, and the South African Revenue Service's eFiling system.



BANGLADESH

In less than five years, Starter nation Bangladesh boosted its GCI score by seven points. Since 2015, mobile subscription penetration jumped from 5% to 41% and smartphone penetration from 7% to 34%. In addition to mobile subscriptions, the country's fiber to the home (FTTH) coverage and fixed broadband base also made significant progress. E-government services also grew thanks to the Bangladeshi government's support for public-private dialogue and collaboration on digitalization. A United Nations'[i] report described the Bangladeshi government's support for digitalization and ICT development as "exemplary." As part of Vision 2021, Digital Bangladesh aims to transform the country into a modern, knowledge-based society that promotes digital inclusion by 2021.

ALGERIA

Algeria's GCI score has climbed eight points since 2015. During that time, the North African Starter nation recorded strong growth in mobile broadband and smartphone subscriptions, the penetration of which increased from 21% to 78% and 14% to 55% respectively, due in part to the introduction of 4G services in 2016. As market competition intensifies in Algeria, 4G services have improved and become more widely available for its 42 million citizens. Capitalizing on its 4G success, Algeria is also working today to become an early adopter of 5G network services. Algeria Telecom subsidiary Mobilis successfully tested 5G connections in Oran during the Smart Algeria Forum. The Algerian government has updated its ICT legal framework and introduced a series of new regulations to support the sector's growth, sparking a surge in the number of software developers and new business models in the country. For instance, more than 100 Algerian startups have already contributed to the Algiers Smart City project launched in 2017 as part of the city's' strategic urban development plan.

Expanded GCI methodology reflects AI's impact

The GCI has revised its methodology over time to better capture how technology evolves and provide actionable insights on the correlation between ICT investment and GDP growth. We did so again this year to highlight AI's role in empowering Intelligent Connectivity.

The first change in methodology was to assign AI indicators heavier weight in the model, as AI exercises a positive impact on the other technology enablers as well as having its own direct impact. Each indicator has a scale based on a realistic target value for beyond 2025, with a score of 10 reflecting that the target value has been reached.

Two other notable changes in the research methodology were made: merging the Data Centers parameter into Cloud, and incorporating Big Data into the newly created AI parameter. The new AI parameter includes Data creation, AI Investment, AI-enabled robotics, and AI potential. While the research methodology expanded in 2019, we also did some consolidation. Intelligent Connectivity's five enabling technologies were consolidated into four: Broadband, Cloud, IoT, and AI. The expanded methodology's impact on the GCI is also notable as it clearly shows how AI has turned even the most advanced digital economies into "beginners" that are learning how to apply the new technology. At the same time, the new methodology highlights how Intelligent Connectivity, which includes AI, has opened a new cycle of economic growth for countries on the GCI S-curve. The full score of GCI 2019 has also increased from 100 to 120 to reflect ICT's impact on future economic growth.

The new 40 indicators of GCI 2019

Four Technology Enablers	Four Pillars: SUPPLY	DEMAND	EXPERIENCE	POTENTIAL
	Measures current levels of supply for ICT products and services used for digital transformation.	Gauges demand for connectivity in the context of users and activities relating to digital transformation initiatives.	Comprises variables for analyzing the experience of connectivity for end users and organizations in today's digital economy.	Comprises a forward looking set of indicators that point towards the future development of the digital economy.
FOUNDATION	ICT Investment Telecom Investment ICT Laws International Internet Bandwidth Security Software Investment	App Downloads Smartphone Penetration eCommerce Transactions Computer Households Secure Internet Servers	E-Government Services Telecom Customer Services Internet Participation Broadband Download Speed Cybersecurity Awareness	R&D Expenditure ICT Patents IT Workforce Software Developers ICT Influencing New Business Models
BROADBAND	Fiber Optic 4G Connections	Fixed Broadband Subscriptions Mobile Broadband Subscriptions	Fixed Broadband Affordability Mobile Broadband Affordability	Broadband Potential Mobile Potential
CLOUD	Cloud Investment	Cloud Migration	Cloud Experience	Cloud Potential
INTERNET OF THINGS	IoT Investment	IoT Installed Base	IoT Analytics	IoT Potential
ARTIFICIAL INTELLIGENCE	AI Investment	AI-enabled Robotics	Data Creation	AI Potential

Economic Impact

Intelligent Connectivity Is Set to Drive Global GDP Growth

Economic Impact

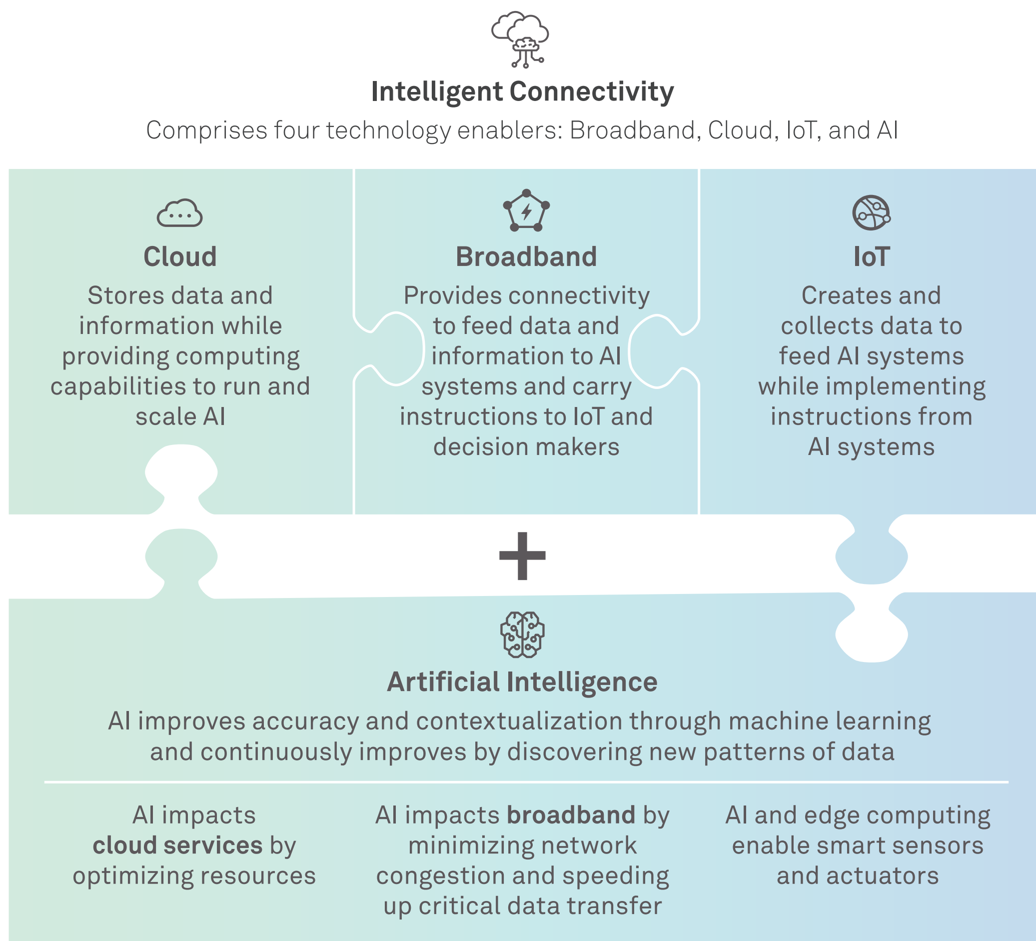
Intelligent Connectivity Is Set to Drive Global GDP Growth

Intelligent Connectivity's ability to drive economic expansion will be a welcome influence in 2019 at a time when the IMF's World Economic Outlook sees global GDP growth slowing due to a toxic cocktail of trade tensions and political uncertainty. Intelligent Connectivity's ability to accelerate technology development to support innovative business models and solutions may offer promising new options to help keep GDP growth on track.

Growth prospects for countries in the GCI are increasingly tied to their ability to improve ICT infrastructure by making connectivity smarter. Connectivity can be understood as a mix of ICT infrastructure, including broadband, cloud, and IoT. But when AI is added to the mix, it is transformed into Intelligent Connectivity. With Intelligent Connectivity, AI plays a dual role: the first is to optimize how ICT infrastructure functions together; the second is that AI can help workers make faster and better decisions. Both accelerate the digitalization of society and economies, and help create new products and services. Intelligent Connectivity is shaping a future where increasingly all things will move, act, react, and collaborate wirelessly and seamlessly with human actions, preferences, commands, and even intentions. But this change is not inevitable and will not be painless. It requires investment, infrastructure, data, and above all a willingness to take advantage of the opportunities that the new technologies provide.

In GCI 2018, we forecasted that an additional US$23 trillion in economic potential will be available by 2025 if each country featured in the GCI increases its annual ICT infrastructure investment by 8% (CAGR). Elevating ICT infrastructure to the level of Intelligent Connectivity is a crucial step for countries that aim to achieve sustainable growth.

AI transforms connectivity into Intelligent Connectivity



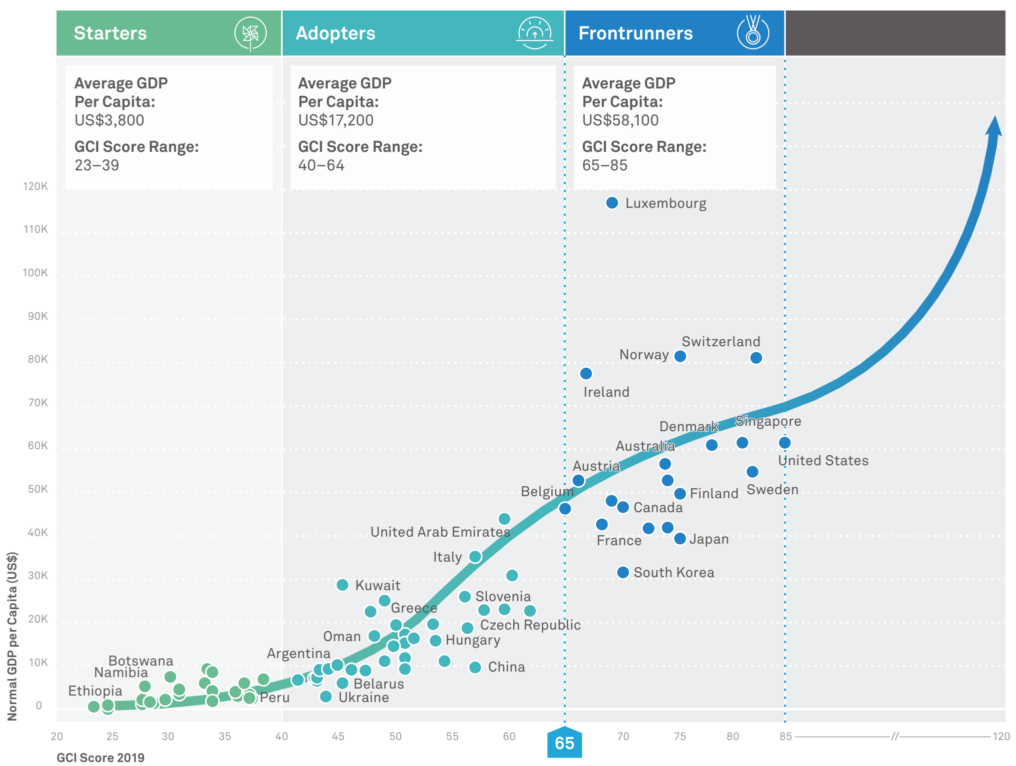
Digital investment inflection points accelerate GDP growth

In 2016, the GCI identified several inflection points where a nation's investment in ICT infrastructure jump-starts GDP growth. These inflection points are ramps to the fast lane of the digital highway. For developing nations working to build basic broadband infrastructure, achieving a GCI score of 35 points typically accelerates digital development and opens a range of Internet-driven business opportunities that boost GDP growth. GCI Starters prepared to take advantage of this inflection point can find themselves on a fast track to digital development and sustainable growth.

Digital economy inflection points are not limited to Starters, however. A major finding in GCI 2019 is that countries higher up the GCI S-curve – in particular Frontrunners with the most advanced digital infrastructure –also benefit from an inflection point that ignites GDP growth, which will help them to enter a new economic growth cycle. Recently, many Frontrunners with a long history of aggressive investment in ICT infrastructure saw growth stagnate due to having exhausted much of the value from existing ICT infrastructure.

When these nations begin to tap the benefits of Intelligent Connectivity, their enhanced digital capabilities will potentially accelerate GDP growth. As Intelligent Connectivity breathes new life into their economies, the US, Switzerland, Singapore, Japan, and other Frontrunners have set in motion a new cycle of digital economic growth. While Starters and Adopters may still lack the ICT infrastructure to leverage the value of AI solutions, the technology should be a focal point in policymakers' long-term strategies. Government and industries in the Starter and Adopter nations need to prioritize work on national Intelligent Connectivity and AI initiatives to speed up access to these technologies, which are set to play a growing role in building the global digital economy.

GCI 2019 – S-Curve



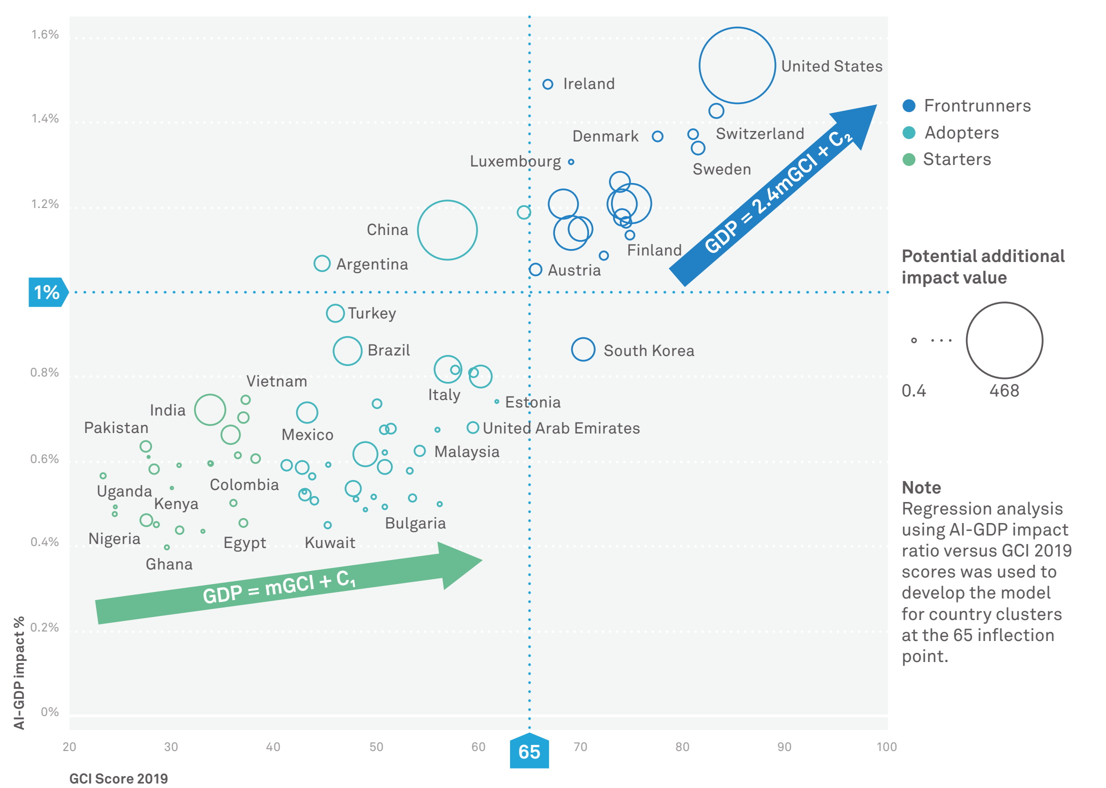
AI's upside potential

Another key finding in the GCI 2019 is that countries at every level of digital development on the GCI S-curve are discovering an "AI upside potential" which, means that tapping the full potential of AI could significantly increase GDP growth.

Much of today's economic benefits from AI still go to the GCI's most advanced nations, as they have the most developed ICT infrastructure, research, and capabilities. However, even GCI Frontrunners are relegated to beginner status with AI technology while they learn how to develop, adopt, and train it to solve real-world challenges. But, with AI algorithms and services readily available on cloud platforms, Adopters, and even Starters will inevitably learn from Frontrunners' experience and find ways to adapt the technology to work in their own ICT environment. Developing economies accessing AI will play an important role in spreading the technology's benefits across regions and industries.

The inflection point seems to be at the 65-point GCI score, as this is where Frontrunners begin to efficiently apply AI solutions. From this point on, we expect AI's impact to add more than 1% of potential value to Frontrunners' GDP growth. What does this 65-point score mean for ICT adoption? We will explain more in later chapters. The chart below also shows that countries with a higher GCI in the top right quadrant can leverage Intelligent Connectivity to grow their economies 2.4X faster than other nations for every point of GCI improvement.

AI's upside potential



For Frontrunners like the US and Japan that possess the most advanced ICT infrastructure, AI upside potential today represents a huge gap in untapped capabilities and economic growth. In the case of the US, AI's current impact on the country's GDP is estimated to be 300% to 400% lower than its potential value.

Adopter and Starter economies like China, Malaysia, India, the Philippines, and Spain are determined not to be left behind, with each working to deploy AI. While still classed as an Adopter, China is among the world's most advanced nations in terms of AI development. Policymakers and business leaders in these nations have much to learn from AI use cases, and will need to become better attuned at identifying niches or business opportunities where they can adapt AI to profitably participate in Intelligent Connectivity ecosystems. As nations improve their GCI scores and develop the infrastructure to support AI, AI upside potential will begin to make itself felt through GDP growth.

Intelligent Connectivity creates value through collaborative ecosystems

Intelligent Connectivity functions and creates value through collaborative ecosystems. If oil was the fuel of economic growth in the 20th century, data is the driving force of sustainable growth in the 21st century. Intelligent Connectivity ecosystems employing AI, cloud services, and IoT thrive and expand in relation to the volume and quality of available data. When more relevant unstructured data is accessible for AI to analyze, Intelligent Connectivity becomes better at predicting user needs. With higher volumes of high-quality data, Intelligent Connectivity can deliver personalized products and services to win new customers and solve real-world problems.

Moreover, higher numbers of engaged users means a greater volume of relevant data will become available. Ideally, this process continues as a virtuous cycle, fostering innovation and generating additional value across the stakeholders who comprise the Intelligent Connectivity ecosystem.

These Ecosystem Stakeholders comprise five roles: Decision Makers (countries, organizations or enterprises), Data Scientists, ICT Companies, Data Collectors, and End Users.

Decision Makers in countries at every stage of economic and digital development will need to realistically evaluate their economy's strengths to determine the best opportunities to participate and succeed in the Intelligent Connectivity ecosystem. They will need to understand the roles of the ecosystem's various stakeholders to develop viable growth strategies for their own countries and industries to participate.

Participants in the ecosystem can expand the scope of their expertise by collaborating across roles and domains, breaking down silos in their organizations, and creating value and more quickly delivering results to customers that increase business opportunities. At its most basic level, stakeholders in the Intelligent Connectivity ecosystem have the potential to create value and sustainable cycles of success where each of the five roles generate value and profit from their work.

Understanding how to participate and leverage the strengths of the collaborative ecosystem is crucial for policymakers and industry leaders that aim to deliver sustainable growth for their country or organization. These stakeholders are expected to play a growing role in economic development as the influence of Intelligent Connectivity expands. A closer look at how the Intelligent Connectivity ecosystem functions and the five stakeholder roles is as follows.

Decision Makers:

- **Function:** The initiators of Intelligent Connectivity ecosystems. They launch the ecosystems that create value, improve productivity, and expand the scope of their operations and opportunities.
- **Positioning:** Typically, a large enterprise or government entity that identifies business cases or social programs where AI can be applied through an Intelligent Connectivity ecosystem to improve operating efficiency. The strategy for ecosystem-building often involves cross-industry players that collaborate to enable innovation and expand opportunities beyond the capabilities of any single participant.
- **Examples:** Decision Makers are seen in GCI Frontrunners such as the US, Japan, Singapore, Germany, the UK, France and South Korea. China stands out among Adopter nations for its advanced work in AI and the ability to develop Intelligent Connectivity ecosystems and complete supply chains.

Data Scientists

- **Function:** They analyze the data flowing through the ecosystem to obtain insights and provide innovative use cases for downstream deployment by ICT Companies and Decision Makers. Data Scientists might also have the industry know-how to better understand business processes. Other industry experts are Decision Makers or industry leaders.
- **Positioning:** They offer expertise in data analytics as well as experience in developing and deploying machine learning algorithms. Their work requires advanced infrastructure services and skills supported by consulting groups, universities, and research organizations. Data Scientists represent the highest value element of an ecosystem due to their high labor costs and focus on creativity and services. They are in short supply worldwide – currently there are only an estimated 300,000 AI professionals in the world, of which only about 10,000 (3.3%) are qualified as 'specialists' according to the World Economic Forum[iii]. Millions of Data Scientists will be needed as Intelligent Connectivity ecosystems expand around the world. The demand for experienced Data Scientists has made this group a mobile workforce, moving to follow career opportunities, and in some developing nations causing a brain drain of these specialists.
- **Examples:** Advanced economies, such as the UK, Singapore, Switzerland, and Finland, have become centers for Data Scientists where government and business support the education and research infrastructure needed to develop AI solutions.

Data Collectors

- **Function:** They collect and share the data necessary to create actionable insights, train AI systems, develop business models, and provide customized services for ecosystem players. Data Collectors can come from countries at any level of economic development – from a business executive providing feedback on a business-class flight to a farmer monitoring and sharing crop data to a senior citizen making their opinion heard on a government service.

- **Positioning:** They play an indispensable role in supplying the basic data that drives the ecosystem. Once data is collected, it is passed to other players for further analysis to become productive. The key to the success of Data Collectors is their ability not just to access data, but to access the most relevant and useful data the ecosystem requires. The nature and aims of Data Collectors vary: they can be, for example, paid workers or volunteers, farmers or fishermen paid to deliver crop or fisheries data, a museum visitor offering feedback on their experience, or HR or logistics departments that collect data for a company. Feedback from End Users across all business sectors or government services also plays a role in data collection.

- **Examples:** Nations at every level of economic development may be data rich and generate vast amounts of both structured and unstructured data relevant to an ecosystem's success.

ICT Companies

- **Function:** They provide a wide range of technical knowledge and support (both software and hardware, including infrastructure, platforms, and systems) and systems know-how (for example, AI robotics, data management, and network skills) that support the ecosystem's technical platform. They can also be scientists or R&D personnel working in a laboratory or a field engineer monitoring how systems function.

- **Positioning:** While not in short supply like Data Scientists, ICT Companies must be vigilant that their teams are constantly upgrading their skills to keep pace with the ecosystem's often fast-changing requirements. Likewise, nations must continually invest in their Intelligent Connectivity platforms to support the development of ICT Companies, or top talent will follow job opportunities elsewhere.

- **Examples:** Adopter and Starter nations, such as India, China, and the Czech Republic, play important parts in developing ICT Companies to serve ecosystems due to their often large, high-quality, and typically lower-cost ICT talent pool.

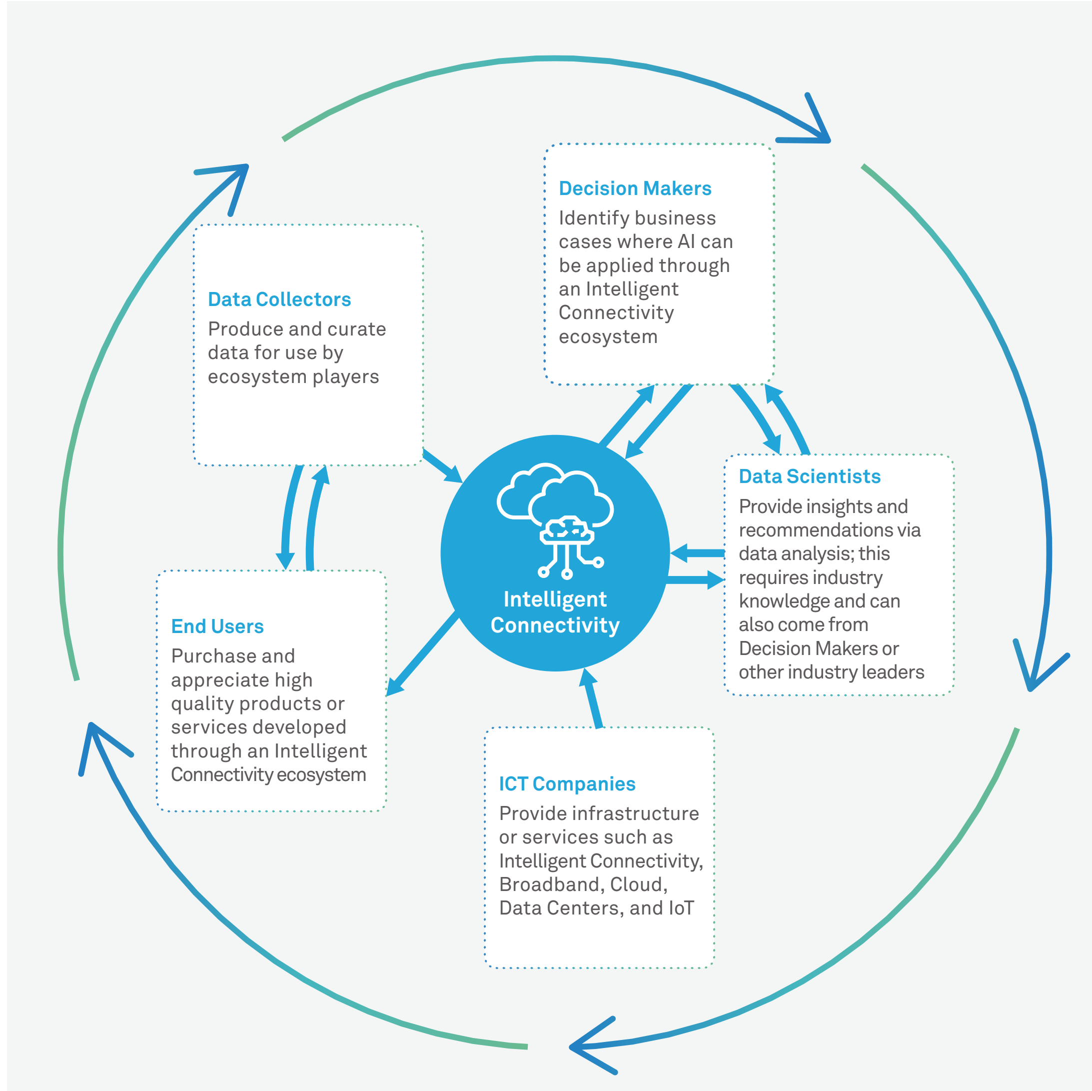
End Users

- **Function:** They benefit from Intelligent Connectivity by receiving and supporting an ecosystem's services and products and, as customers, are crucial to the ecosystem's success. When End Users can appreciate the value, products or services developed and provided by the Intelligent Connectivity ecosystem, they provide the motivation for ecosystem players to sustain and further develop the system.

- **Positioning:** They can be individuals, devices, companies, governments or even international organizations. Typically, they have little to do with the ecosystem's development and may even be unaware of it. In addition to their primary role, End Users are both Data Providers and Data Collectors.

- **Examples:** Products or services enjoyed by End Users could be funded by local governments, policymakers, global NGOs, and bodies like the World Bank and Asian Development Bank, with policy agendas such as alleviating poverty. Conversely, End Users can be companies or individuals acting as consumers of the ecosystems' products and services. End Users can also simply be individual customers.

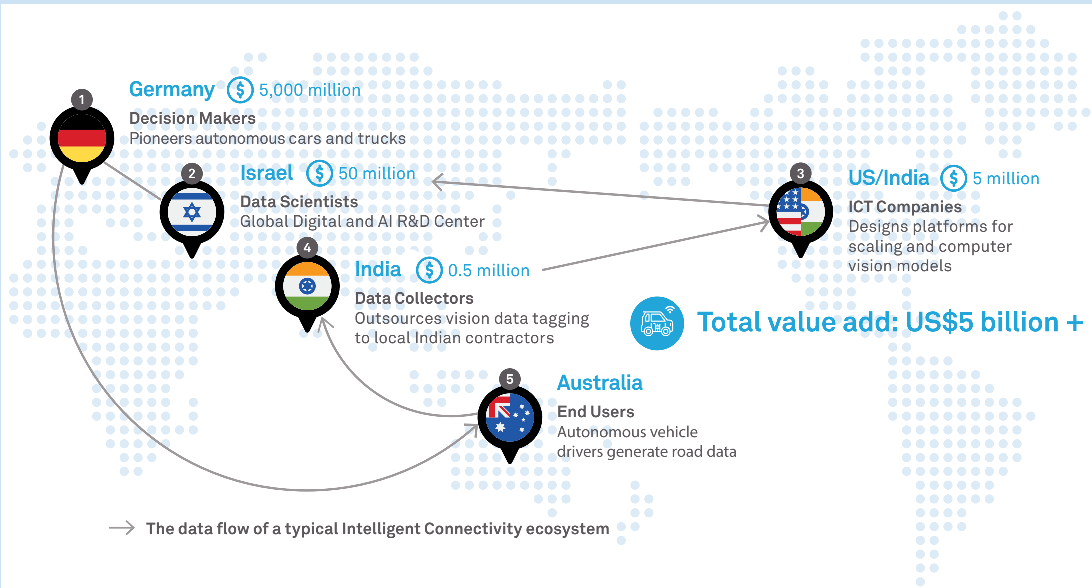
A typical Intelligent Connectivity ecosystem



It takes a global Intelligent Connectivity ecosystem to build the autonomous vehicle

Success for automakers in the 21st century will increasingly mean optimizing global operations via an Intelligent Connectivity ecosystem. Let's suppose a European multinational automaker planned an Intelligent Connectivity ecosystem to design and manufacture autonomous vehicles. A global ecosystem could look something like the following example.

A typical Intelligent Connectivity value chain



In step one, the company or Decision Maker invests in designing and developing autonomous vehicles at its European headquarters. Once the initial planning is settled, step two sees the Decision Maker identify and bring onboard a team of Data Scientists and machine learning (ML) engineers based in Israel. This team is charged with developing models and analytics for the proposed new vehicles.

The Data Scientists' program is then tasked with designing computer vision models that interpret changing road views. In step three, this group identifies and invests in a US/Indian computer vision platform that can outsource visual image data tagging or Data Collector work efficiently and cost effectively in India. Next is step four, where the new application's End Users could then be the buyer of a fleet of autonomous vehicles to serve as rental cars in Australia. But even the End User can also play a role of data provider and data collector in the ecosystem, as the vehicle generates massive amounts of data that can later be analyzed by the Data Scientist team in India. When the direct and indirect benefits of this Intelligent Connectivity ecosystem beyond the revenue generated are finally considered, they can include fewer injuries or even deaths from road accidents, lower cost of ownership or operations for drivers, and more efficient, sustainable resources for the ecosystem's participants.

The efficient and cost-effective development of the successful autonomous vehicle depends on the participation and value-add from each group and country involved from around the world. Thus, the concept of Intelligent Connectivity is not the sole domain of a few Frontrunners, as every country can play a role in these ecosystems and profit from them. Policymakers from the Adopter and Starter countries should start planning how they can best tap the benefits of this new economic model.

Global win-win collaboration is the key to success

While "Decision Makers" and "End Users" might be expected to derive the lion's share of benefit from an Intelligent Connectivity ecosystem, ROI may in fact be more evenly apportioned to nations and industries across the development spectrum than initially supposed. The idea that Intelligent Connectivity's benefits accrue only to the most technologically advanced countries is a misconception.

In fact, policymakers and industry leaders in nations at every stage of economic development are discovering ways to participate in Intelligent Connectivity ecosystems. However, those with isolationist and protectionist inclinations stand to fall behind, as ecosystems at the local, regional, and global scale will increasingly rely on cross-industry and international collaboration to create value. The collaborative nature of the ecosystems makes the model a win-win for all participants – nations, enterprises, social enterprises, and individuals. Although it's still early days for Intelligent Connectivity ecosystems, the new economic value, growth opportunities, and win-win business models created can be expected to help solve an array of socioeconomic challenges and set the pace for global GDP growth in future.

However, this does not mean that countries should let up on their GCI progress to develop Intelligent Connectivity. Using the case study earlier as an example, countries with higher GCI scores tend to have more Decision Makers and enjoy much higher benefit from the Intelligent Connectivity ecosystem than everyone else.

The rise of Intelligent Connectivity marks a critical inflection point in global digital transformation, and is already having a significant economic impact in countries at all development stages. While still in its infancy, the potential of Intelligent Connectivity to drive GDP growth via innovative problem solving and the development of new business models and technologies will affect virtually every aspect of society and national economies in ways yet to be imagined.

SUMMARY

We expect nations that cross the GCI tipping point of 65 and at the same time focus on AI adoption to develop the potential to add more than 1% to their GDP growth. For Frontrunner economies, this will be a breakthrough after several years of sluggish growth caused in part by reaching the maximum value-add of previous ICT investment.

The most advanced Frontrunners leveraging Intelligent Connectivity could grow their economies 2.4X faster than other nations for each point of GCI improvement.

The five types of stakeholders in an Intelligent Connectivity ecosystem reflect the rise of cross-border collaboration and thus business opportunities.

Technology Impact

New Opportunities On the Horizon with Technology Convergence

Technology Impact

Cloud and IoT Investment Set the Stage for AI and 5G Business to take off

The convergence of technologies – broadband, cloud, IoT, and AI – first seen in GCI 2018 have come together under the banner of Intelligent Connectivity to put AI to work accelerating the development of new technologies and applications, disrupting established business models and turbocharging economic growth. 5G's much anticipated speeds will soon complement Intelligent Connectivity with real-time capabilities to activate autonomous vehicles, augmented reality, and an array of other as yet-unimagined applications.

Intelligent Connectivity today is primarily the domain of countries with advanced ICT infrastructure – the GCI's Frontrunners and a handful of Adopters. For others, it remains a work in progress as policymakers' direct investment to build out the underlying technologies needed to deliver Intelligent Connectivity. Accessing the potential of this powerful new technology should be a high priority for policymakers in countries at every stage of digital development, as Intelligent Connectivity is expected to fuel a new wave of global GDP expansion. The formula for success is simple: Governments should invest in Intelligent Connectivity's foundation technologies with a particular focus on two critical preconditions needed for AI to be effective – cloud and IoT.

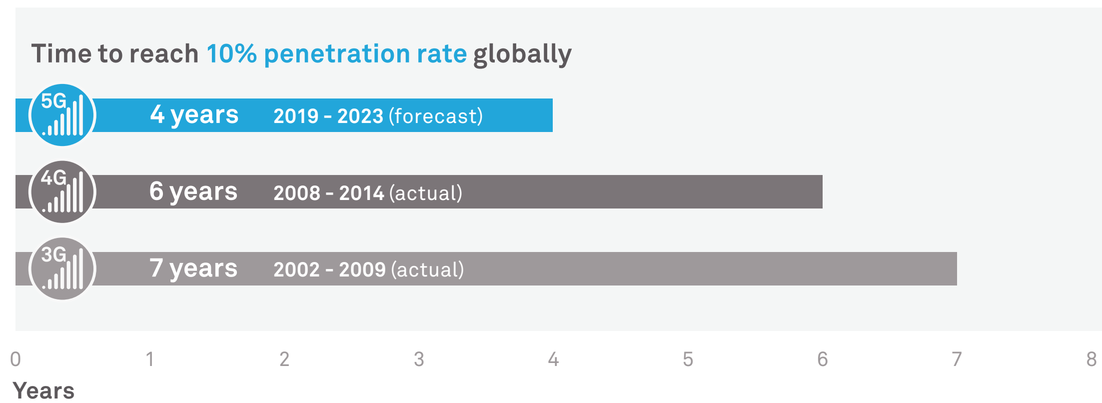
5G's rapid rollout will create new economic growth

With 5G field trials nearly complete, new high-speed networks are finally becoming a reality. After commercial rollouts in South Korea and the US in 2019, more than 70 mobile operators around the world announced 5G launch plans, with more than 50 scheduling 5G mobile services to begin by year-end 2020. While it's still premature to predict 5G's eventual impact on the global economy, its addition to the Intelligent Connectivity mix is expected to spur change on a seismic scale.

If 5G's introduction conforms to what we saw when previous wireless generations from 2G to 4G were launched, then we can predict a spike in global GDP growth. With each new wireless generation, businesses worldwide have been quick to take advantage of the improved broadband experience to introduce new products and services, optimize operations, and boost productivity to drive growth. Typically, this growth explosion occurs as a new generation wireless network reaches 10% global market penetration. What is different for each new wireless generation is the timeline for reaching 10% global penetration. For example, it took seven years for 3G to cross the 10% global penetration mark in 2009, but only six years for 4G to do the same. We expect 5G to reach the 10% tipping point in only four years.

The reason for the condensed timeline is that 5G has started its roll-out with several distinct advantages. Unlike the launches of 3G and 4G technology, 5G will have more than 40 5G-ready devices, mostly smartphones, already available in the market in 2019. In addition, 5G semiconductor devices and routers are available on the market today, in advance of 5G network availability. This up-front 5G infrastructure is expected to give the technology a strong head-start and shorten its adoption timeline.

Mobile broadband evolution from 3G to 5G



AI requires a solid base of cloud and IoT

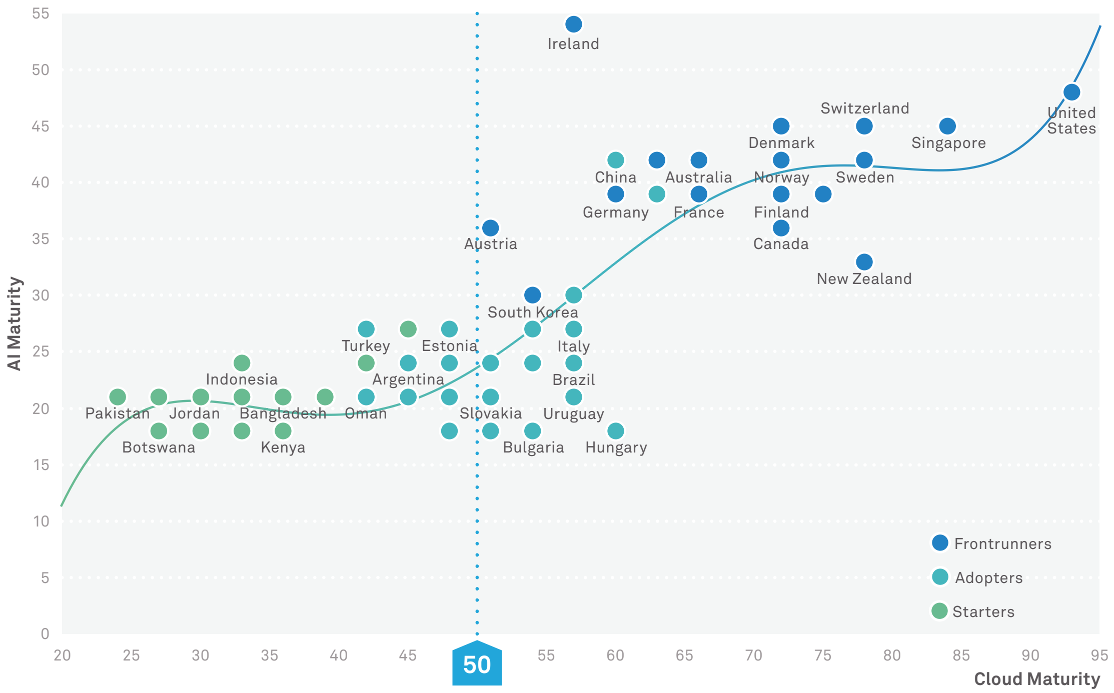
Investing in broadband infrastructure has long been the focus of policymakers' ICT strategy. Today, their investment strategy is looking to a broader range of technologies and opportunities beyond Internet-driven businesses. AI readiness is increasingly the focus of policymakers and industry leaders, and this first requires strengthening the ICT platform for Intelligent Connectivity. At the same time, attention must be paid to the two touchstones of AI readiness – cloud and IoT.

Cloud provides the data storage and computational capabilities and IoT delivers the data that AI systems require to scale and deliver analytical power. Another precondition for AI readiness is a strong installed base of IoT, which collects and creates the massive datasets that AI systems need to develop insights and expand their capabilities for machine learning. This year we found that when a nation's cloud readiness score and IoT readiness score cross the 50 and 45 mark respectively, AI's impact on their economy begins scaling up.

Another major finding of this year's GCI 2019 is that a country is required to achieve ICT investment between 3% to 4% of its GDP to achieve the cloud and IoT readiness levels needed to create the tipping point for AI to take off. Policymakers planning for the long-term benefits of deploying AI need to be aware that a solid foundation in these two technologies is the key to activating the AI capabilities necessary to drive strong economic growth.

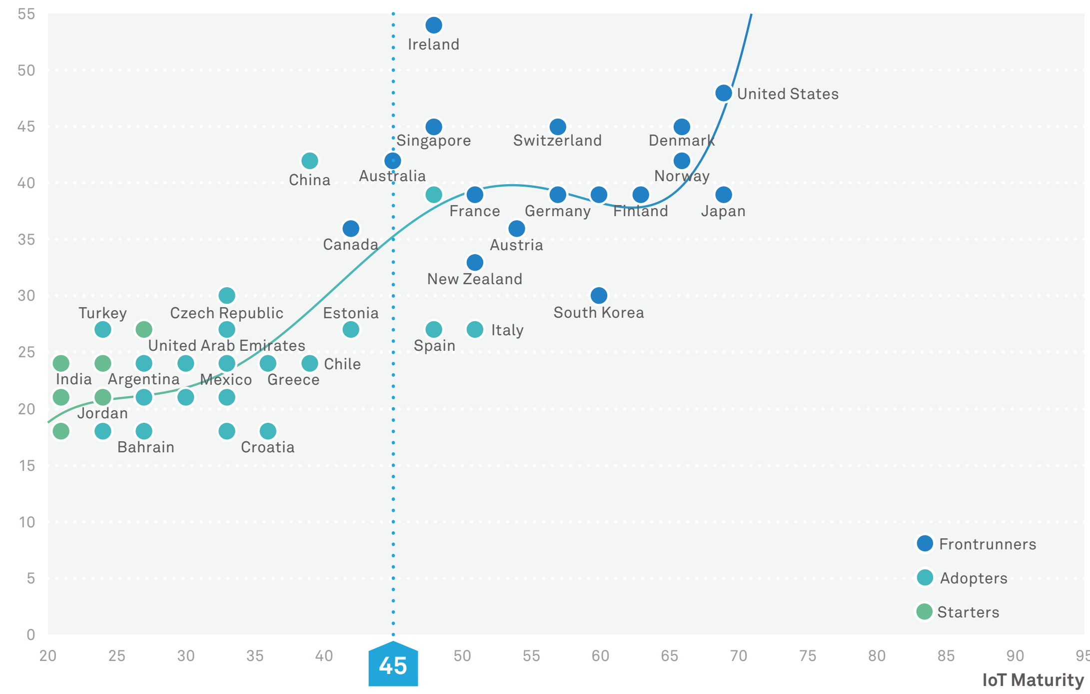
The AI tipping points of cloud and IoT

Cloud



Cloud investment per GDP – 0.02%
Cloud migration rate – 23%

IoT



IoT investment per Capita – US$250
IoT devices installed base – 6
IoT analytics per Capita – US$6

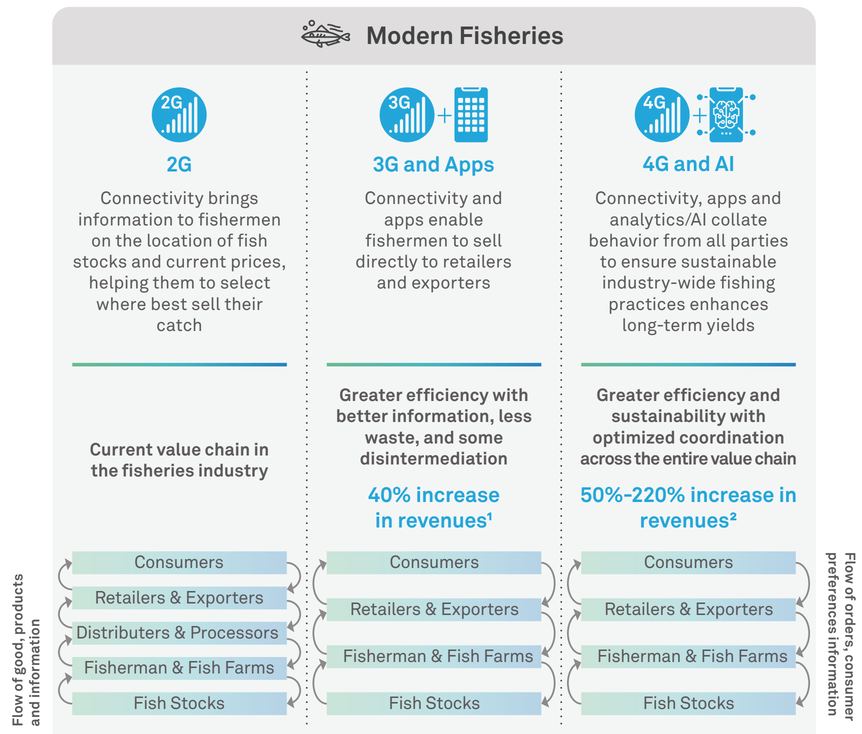
Intelligent Connectivity offers opportunities to transform industries

The core value of the Intelligent Connectivity platform is its ability to make AI accessible. This is an important breakthrough as AI opens economic growth possibilities by accelerating the development of new technologies and applications, enabling business leaders to re-imagine industries and helping entrepreneurs to create innovative new business models. In fisheries management, for example, an often tradition-bound business is discovering new methods to improve efficiency and profits using mobile broadband technologies. The current fisheries industry value chain comprises fish stocks, fishermen and fish farms, local distributers and processors, retailers and exporters, and finally consumers.

Prior to the availability of the new connectivity, interaction among stakeholders was limited to direct, one-on-one communications. Bringing 3G and 4G mobile apps into the mix, however, is now empowering fishermen to directly monitor trends in prices and demand and thus disintermediate some local distributers. One immediate saving derived from the new mobile technology in fishermen's hands is reduced waste. It's estimated that if a fisherman can reduce the time and work spent on catching and processing fish that consumers are not currently interested in buying, they can increase revenue by as much as a 40%.

With Intelligent Connectivity, we have begun to see monitoring of the entire fisheries value chain, usually via a regulatory agency. This new connectivity in the fisheries value chain optimizes different parts of the system to achieve longer-term value add, and, ideally, build sustainability into the system. Select fisheries that have adopted such holistic management practices have seen revenue improve in a range of 50% to 220% in just a few years.

How Intelligent Connectivity changes the value chain in fisheries



Source 1: Johns Hopkins University Bloomberg School of Public Health. 'Nearly half of US seafood supply is wasted,' Accessed May 1, 2019: https://phys.org/news/2015-09-seafood.html

Source 2: Tindall, 2012; MARG, 2010 based on select fisheries in US and NZ

Connecting everything for an intelligent world

We expect 5G networks to reach critical mass for the world's population much faster than 3G and 4G. As 5G's global uptake grows, it is predicted that it will begin to converge with other technologies that enable Intelligent Connectivity such as cloud, IoT, and AI from 2025 onwards. 5G's role in delivering agile and low-latency connectivity will gradually become the foundation for the converged technologies to work optimally and intelligently to address an array of socioeconomic challenges. As this mix of technologies begins to connect virtually everyone and everything in the future, we can expect it to fill critical gaps by intelligently optimizing scarce resources, improving productivity, and creating new business models.

As the technologies that underpin Intelligent Connectivity start to cross and converge, they will spur innovation with the potential to profoundly change our everyday lives. For example, delivery companies today are already developing drones to deliver parcels and food by tapping the capabilities of cloud, IoT, and ultra-low-latency mobile broadband. We can expect entrepreneurs to develop and deploy disruptive new technologies such as AR to develop innovative solutions across many industries. In healthcare, for example, scenario-based AR can be used to train medical students and provide them with the diagnostic and surgical skills to serve remote areas.

Smart Cities is another area where technology convergence will play a major role. By 2050, some 66% of the world's population will live in cities, according to UN estimates[iv]. Transforming fast-expanding urban areas into Smart Cities today has become the goal of countries aiming to tackle socioeconomic challenges like traffic congestion, waste management, e-government services, energy, healthcare, security, social engagement, and much more.

The technologies that support autonomous vehicles will also have a role to play in transforming the way we live in the future. Consider that there are 1.4 billion vehicles on the world's roads today around the world. The challenges they present aren't limited to the growing need for energy to run these vehicles, or the need to manage the traffic congestion they create. They have another, more profound impact: close to 1.25 million people die each year in traffic accidents, making such accidents the 9th leading cause of death and accounting for 2.2% of all deaths globally[v]. There are other downsides to the growing number of vehicles on the world's roads as well: air pollution, the cost of vehicle ownership, and a lower quality of life for many due to congestion and long commute times – all of which will be addressed by Smart Cities.

Intelligent Connectivity is predicted to play a key role in managing transportation issues. For example, Intelligent Connectivity will enable the data collected from smart sensors and actuators on each vehicle, on streetlights and highways, and in traffic blackspots and car parks to be delivered to a central transportation system via the cloud. AI systems in the cloud will then identify and deliver insights for traffic controllers who will advise drivers (or autonomous vehicles directly) on the shortest, fastest, and safest routes to their destinations, and offer tips on how to avoid collisions. From a city government perspective, autonomous cars could communicate with street lighting in the areas they're driving through, so only roads in use need to be illuminated, saving energy and money while keeping drivers safe. It's not difficult to imagine the potential impact that technology convergence will have, reducing traffic and mortality rates while improving public safety and optimizing the overall transportation system.

SUMMARY

The convergence of technologies – broadband, cloud, IoT and AI – comes together under the banner of Intelligent Connectivity to activate the power of AI, enabling development of innovative new business models, services, and opportunities.

5G's rapid rollout will create new economic growth.

Cloud and IoT are the touchstones of AI readiness. AI will start to scale as the capabilities of these fundamental technologies begin to dial up.

Social Impact

Intelligent Connectivity As a Force For All

SOCIAL Impact

Intelligent Connectivity As a Force For All

Intelligent Connectivity is recognized as a powerful business tool, but it also has the potential to provide innovative solutions for many of the world's most difficult and longstanding social problems

Policymakers and corporate Decision Makers today are quickly learning how to manage Intelligent Connectivity and AI's capabilities to drive economic growth. But at the same time, and perhaps less visibly, there is equally important work taking place among NGOs, social enterprises, and entrepreneurs that are applying and scaling up Intelligent Connectivity and AI to address some of society's most pressing challenges. Among their early targets are healthcare, hunger, education, inclusion, environmental conservation, safe cities, and crisis response. Financial inclusion, environmental conservation, and improving medical diagnoses are three areas where Intelligent Connectivity is today being actively applied for the public good.

Financial inclusion: Intelligent Connectivity has a unique role to play combating global poverty, with mobile networks expanding financial inclusion. Egypt stands as an example of how mobile phones can make a difference for the poor. In Egypt, cash remains king and electronic payments account for only a tiny proportion of transactions. Out of the nation's population of 100 million, the World Bank estimates that just 10-15% of Egyptians have a bank account, one of the lowest penetration rates in the world. With few bank branches and Automatic Teller Machines (ATMs) per capita compared to countries with similar per-capita income, and most services concentrated in urban areas, many Egyptians are cut off from economic opportunities and severely limited in finding means to improve their financial prospects.

With Egypt's population expanding at about 2% or 2 million people a year, demand will increase for all services, including those offered by the government, creating more opportunities for digital solutions. Developing Egypt's financial sector and broadening the range of available services to be more inclusive is crucial to promote economic growth in a country where youth unemployment exceeds 30%. Increasing access to financial services is an important step to reducing poverty, according to the World Bank, as it accelerates job creation, reduces vulnerability to the financial shock common to lower income groups, and increases investment in human capital. The World Bank[v] is clear in stating that poverty will not be eradicated without financial inclusion.

For Egypt and other developing economies, financial inclusion typically starts with payments. Payments open access to services like saving accounts, credit, and insurance. As financial inclusion spreads, people increase their ability to save, access credit, and conveniently make and receive payments.

The digitalization of payments promises to change the lives of unbanked Egyptians. Think of the loss of productivity, not to mention inconvenience, of having to pay bills by cash in person during office hours. Add to that the opportunities for corruption in a cash-centric society. Since Egypt's unbanked are not entrenched in the traditional banking practices of branches, ATMs, and credit cards, they're more open to accessing banks and conducting payment transactions on their mobile phones. The latest updates to the World Bank's Global Findex database in 2018 notes that the availability of mobile phones among the poor worldwide offers the opportunity to increase financial inclusion via mobile accounts, especially if governments lend credibility by taking the lead. Digital services offer the unbanked a safer way to handle transactions, since workers do not have to carry cash. These services also have the added advantage of helping the poor avoid many transaction fees and the need to submit to corruption.

With Egypt's mobile penetration rate of 102% and 28 million smartphone users, Fintech offers Egyptians the best chance to access financial products and services. Overseas workers' remittances are a case in point. The ability to receive remittances via a mobile phone is having a significant and growing impact in Egypt. Money from Egyptians working abroad is important not only to support families, but also to invest in new businesses. In 2016, remittances accounted for an estimated 20% of capital used to launch new businesses in Cairo, according to the World Bank. On average in 2018, foreign remittances of US$200 were charged a fee of US$14, or 7%, a significant amount for low-wage workers. Egypt isn't alone in relying on such remittances. The World Bank estimates that some US$530 billion in remittances were sent globally in 2018.

Today, Egypt aims to pioneer digital payments in the North Africa region, according to the country's National Telecommunication Regulatory Authority. In 2018, Egypt introduced regulatory reforms designed to tap the potential of mobile money and expand financial inclusion, according to a GSMA report. Early indications are that these programs are making progress. The nation's Central Bank states there were 20 million mobile money accounts in 2018, and the Bank aims to increase that to 40 million accounts in two years.

An estimated 1.7 billion adults worldwide still have no access to a bank account, according to the World Bank. But there is good news too. About two-thirds of these unbanked own a mobile phone that they can use to access financial services. Making that connection to Fintech services is the key to expanding financial inclusion and an important step in combating poverty for unbanked consumers in Egypt and globally.

Environmental conservation: Deforestation has long been ignored as the price of progress. But the loss of forest land is now playing a major role in climate change. Deforestation today accounts for nearly 20% of the world's total carbon emissions. Turning this disaster around will be difficult as up to 90% of deforestation is due to illegal logging. One non-profit group, Rainforest Connection (RFCx), is putting Intelligent Connectivity and AI to work to fight deforestation and protect the millions of species that inhabit the earth's rainforests. Acting as an Intelligent Connectivity ecosystem "Decision Maker", RFCx looked to Huawei Cloud and Data Scientist expertise to help develop conservation solutions. RFCx came up with a solution that mixes a low-tech common-sense approach with the data-crunching capabilities of AI. RFCx has upcycled old Huawei phones to create a fully connected intelligent ecosystem to monitor the world's rainforests. The phones communicate continuously with AI-equipped servers and when suspicious sounds such as chainsaws or trucks are detected in a forest, rangers on the scene are notified in real time to investigate. This Intelligent Connectivity-based solution is already deployed across forests in 10 nations including Brazil, Indonesia, Peru, Romania, the US, and South Africa, protecting more than 2,500 km^2 of forest – an area equivalent to almost 200,000 football stadiums.

RFCx is also developing Intelligent Connectivity ecosystems to tackle animal conservation and thus slow the rising extinction rate, which is now estimated to be 50,000 species a year, seriously undermining the health and biodiversity of rainforests. RFCx chose to focus on a species it considered to be a bellwether of forest health – the Spider Monkey. RFCx developed an Intelligent Connectivity ecosystem to protect the Spider Monkeys that play a key role in the seed dispersal that's essential for rainforest sustainability. Habitat destruction, often due to illegal logging, has left Spider Monkeys a critically endangered species. RFCx turned to Huawei to develop a platform capable of detecting Spider Monkey sounds. Upcycled old Huawei phones were placed in boxes in trees to capture audio from the forest that is streamed to the cloud where Huawei Cloud AI analyzes the animals' behavior and movements. RFCx is currently optimizing its first voice-detection model by adopting a high-precision recognition algorithm to reduce the false positive rate and eliminate user fatigue caused by the work to invalidate false positives.

Diagnostic accuracy: Healthcare is another area where Intelligent Connectivity is already making a difference by augmenting the work of skilled medical specialists. The world today faces a shortfall of 7 million doctors and nurses, a situation that is particularly acute in developing nations. The challenges facing doctors and other healthcare professionals can be overwhelming; for example, managing massive volumes of paperwork, which in turn limits face-time with patients, keeping up with the latest research; rising costs; and the increasing likelihood of errors. Intelligent Connectivity, however, is enabling innovative new technologies such as virtual nurses, health assistants, robotic nurses, automated diagnoses, and treatments. These new capabilities have the potential to revolutionize the practice of medicine.

Intelligent Connectivity today is already enabling innovative new tools to fight diseases affecting millions around the world. Cervical cancer, which the World Health Organization cites as the fourth most frequent cancer women face, is an example of how Intelligent Connectivity is opening the way to new screening tools to save lives.

Early diagnosis is critical to survive cervical cancer; however, the availability of PAP tests carried out during a pelvic examination is limited by a shortage of licensed pathologists required for screening. China, despite its high incidence of the disease. suffers from a shortage of 90,000 pathologists, according to one 2018 study. KingMed Diagnostics, a Chinese medical diagnostic test company worked with Huawei Cloud engineers to develop an AI-assisted test to compensate for this shortage. The tool it developed is over 99% accurate and testing is done at one-tenth the cost in a fraction of the time it takes for a PAP test.

To train, validate and test the AI, developers fed it with 32,000 samples collected from over 43 million cervical screenings from around the nation. While pathologists on average spend six minutes examining samples under a microscope for a PAP test, the new AI-assisted test takes only 36 seconds. KingMed is now exploring applications for the technology to be applied to pathologies for the digestive system, kidney, blood, and breast.

How Intelligent Connectivity transforms healthcare

Healthcare

Before Intelligent Connectivity Shakes Up Healthcare

- Shortfall of 4 million doctors and 3 million nurses globally
- Worse in rural areas and developing countries with high population growth
- Shortfall of nurses trained to meet needs of older patients in developed countries with aging populations
- Medical errors are the third leading cause of death in the US
- Paperwork takes up half a doctor's time
- On average doctors read one research paper a month
- Doctors make most of their decisions based on advertising

Patient Benefits from Intelligent Connectivity

- **Health assistants:** Personal health guide and symptoms' checker (e.g. YourMD medical chatbots)
- **Virtual nurses:** Smart watch provides remote monitoring and support for common and high-cost medical conditions such as diabetes
- **Diagnosis and treatments:** Identification of skin cancer (Stanford); eye scans to prevent blindness (DeepMind / NHS); and IBM for oncology
- **Record keeping and operations:** Health catalyst, Cortex
- **Develop new drugs:** Enable drug development to be quicker, cheaper, and more effective

Healthcare Professionals' Benefits from Intelligent Connectivity

- **Health assistants:** Cuts time spent by doctors on trivial matters, frees up doctors' time and reduces waiting times
- **Virtual nurses:** Reduces number of false alarms; keeps doctors better informed of the latest research on disease and treatments; allows nurses more time with patients
- **Diagnosis:** AI typically provides fast and accurate diagnoses 99% of the time. The result is increased productivity for doctors and nurses
- **AI enabled record-keeping:** Reduces a doctor's time spent on paperwork and systems by 30%

SUMMARY

Intelligent Connectivity could be the answer to many of the world's most complicated and deeply rooted social challenges.

Financial inclusion: The digitalization of payments allows people, especially the unbanked, to increase their ability to save, access credit, and more conveniently make and receive payments.

Environmental conservation: By harnessing the power of Intelligent Connectivity, countries can fight deforestation and improve animal conservation to promote the health and biodiversity of rainforests.

Diagnostic accuracy: Intelligent Connectivity will enable an array of new technology-driven capabilities such as virtual nurses, robotic health assistants, and AI powered automated diagnostics that will improve healthcare access and outcomes. For example, AI-assisted PAP tests for cervical cancer can increase diagnostic accuracy to 99% while reducing the cost of tests by 90%.

Recommendations

How to Leverage the Power of Intelligent Connectivity

Recommendations

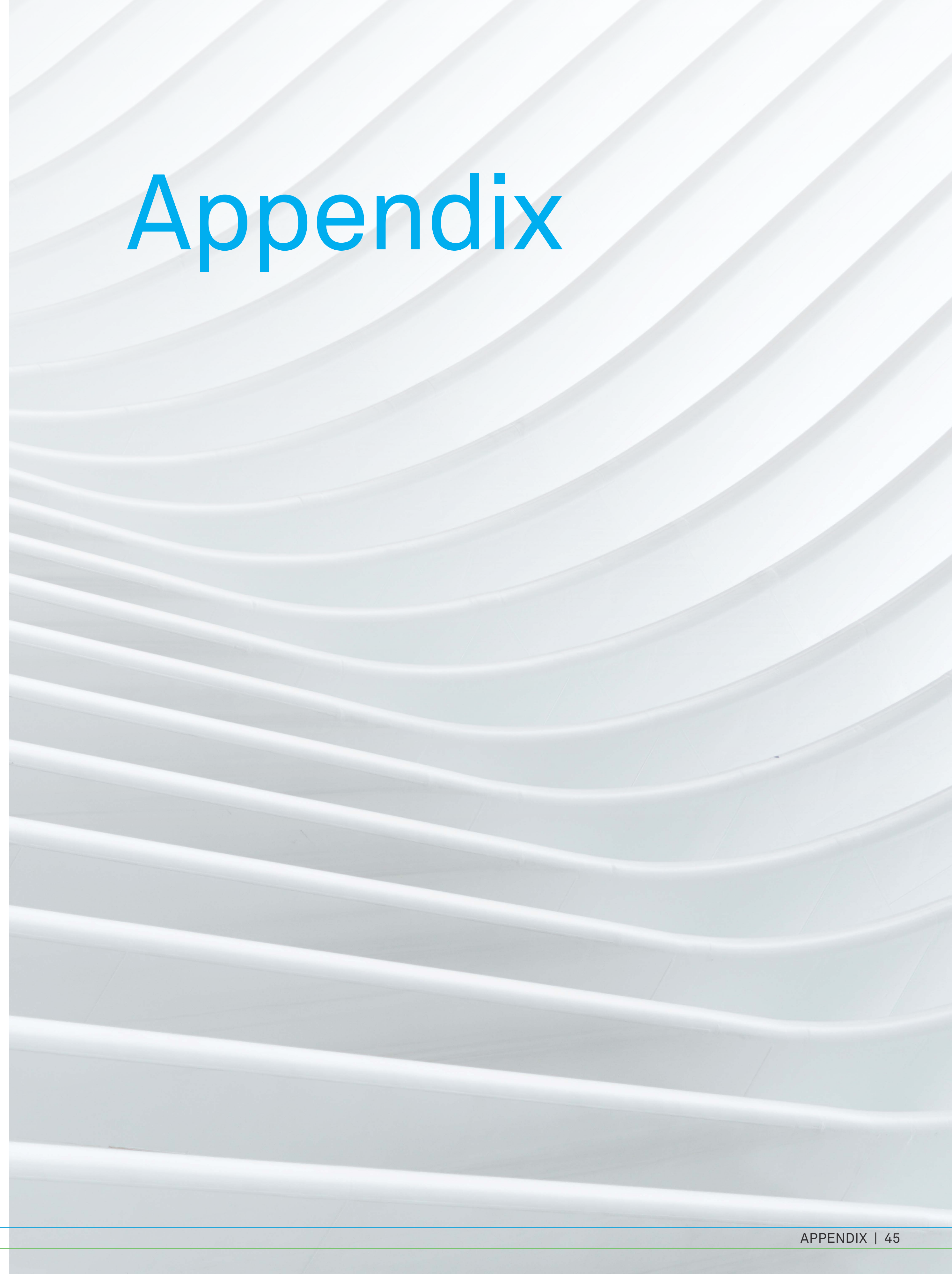
How to Leverage the Power of Intelligent Connectivity

The growing influence of Intelligent Connectivity and its role in enabling AI is one of the most notable findings of GCI 2019. This year's GCI found that a country's success in deriving value from ICT infrastructure investment and its ability to create economic growth and address social issues increasingly depends on its readiness to develop and participate in Intelligent Connectivity ecosystems. A policymaker who fails to grasp the importance of the new technologies and doesn't identify ways to participate in the collaborative, often global ecosystems may find their country isolated from the digital dividends of the new economic order.

While countries at different stages of economic – and digital – development face their own unique market conditions, needs, and challenges, the underlying principles of developing and participating in Intelligent Connectivity ecosystems are essentially the same. The GCI 2019 report's recommendations for policymakers are as follows:

NEXT STEPS	RECOMMENDED ACTIONS
1 **Invest in Intelligent Connectivity – ensure the prerequisites are in place to participate in collaborative ecosystems**	• **Ensure the availability of a stable electricity supply:** Data Collectors, often the group that takes the lead for less developed economies to participate in Intelligent Connectivity ecosystems, need a stable electricity supply and adequate connectivity – this is especially important for regions prone to natural disasters and power outages. • **Invest in ICT strategically:** Countries, especially those in the early stages of digital economy development, should strengthen cloud and IoT adoption to reach the AI tipping points identified by GCI 2019. The AI tipping points unleash a round of productivity by accelerating access to the benefits of Intelligent Connectivity. • **Promote technology convergence:** Policymakers should collaborate with ICT companies and start-ups to identify and overcome technology bottlenecks in key industries.
2 **Prioritize AI expertise**	• **Conduct competitive analysis:** Audit competitive advantages (national and industries) in relation to other participants in global Intelligent Connectivity ecosystems. • **Focus on existing industries:** Identify expertise in particular national industries and areas where AI can expand opportunities and drive growth. These can vary widely, for example, from rubber plantations in Malaysia and fish farms in Botswana to silk manufacturing in Pakistan or medical tourism in Thailand. • **Prioritize social problems:** Develop a taskforce of government officials, social enterprises, and NGOs to identify a country's most challenging social issues and determine where AI can help. These will vary, but typically include financial inclusion, healthcare, education, and disaster relief.
3 **Put support functions in place for Intelligent Connectivity ecosystems**	• **Implement structural education reform:** To meet the needs of AI-enabled workplaces, policymakers should promote the reengineering of their country's education system, curriculum, resource allocation, and staffing strategies. • **Resource allocation and incentivization:** Provide adequate resources and incentives for Data Scientists and ICT Companies to develop Intelligent Connectivity – and where appropriate, develop these resources internally or work with external providers. • **Adopt a coordinated approach:** Orchestrate efforts by government bodies, enterprises, interest groups, academia, and the wider community to share research, use cases, data and findings to advance ecosystem development. • **Fair play:** Be fair and ensure that Decision Makers, End Users and data owners are treated equally to share the benefits of Intelligent Connectivity solutions.
4 **Make Intelligent Connectivity affordable and accessible to all**	• **Affordability and accessibility:** Provide organizations and individuals with the means to access and engage with Intelligent Connectivity ecosystems. Support measures to foster understanding of and interest in analytics and AI systems. • **Avoid 'tragedy of the commons' situations:** Intelligent Connectivity is especially vulnerable to situations where the benefits are privatized to the advantage of a few stakeholders while the costs are shared globally across the entire ecosystem.

NEXT STEPS	RECOMMENDED ACTIONS
5 **Evolve and scale**	• **Start small, learn fast:** Start small and gather data from across all aspects of the Intelligent Connectivity ecosystems to fine-tune the program. The aim must be to ensure that ecosystems can be continuously improved and self-perpetuating in a virtuous cycle. • **Scale locally:** Leverage a country's local market scale to become End Users and Data Collectors in ecosystems by collaborating with countries and enterprises around the world. • **Demonstrate value:** Show value to the ecosystem's stakeholders. Leverage initial success to attract investment and scale up operations. • **Commercialize:** Commercialize products or solutions derived from the ecosystems where possible, and license those products or services to countries or industries with similar market needs or challenges.
6 **Codify fair practices in regulations and rules**	• **Data privacy and liability:** Sustainable Intelligent Connectivity ecosystems will require laws and regulations around data privacy and liability to ensure that the rights and responsibilities of various stakeholders are well-defined and satisfied. Introduced in 2018, the European Union's General Data Protection Regulation (GDPR) has become a de facto gold standard of data privacy regulation.



Appendix

GCI Methodology 2019

The GCI analyzes the full spectrum of measurements for intelligent 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. The GCI has adapted its methodology over time to capture how technology evolves and to better evaluate the correlation of ICT investment with GDP growth. In 2019, the GCI's methodology has been expanded again to highlight Intelligent Connectivity's role in boosting the digital economy. We consolidated Intelligent Connectivity's four enabling technologies into four: Broadband, Cloud, Internet of Things, and Artificial Intelligence. Two notable changes we made were to merge the Data Centers perimeter into Cloud and incorporate Big Data into a newly-created AI perimeter. Please refer to the diagram below for details.

These advanced technologies are built on a foundation layer of technologies such as 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. The GCI also includes forward-looking factors such as ICT patents, R&D and the outlook for each technology's compound annual growth rate.

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

Four Pillars

Four Technology Enablers	SUPPLY	DEMAND	EXPERIENCE	POTENTIAL
	Measures current levels of supply for ICT products and services used for digital transformation.	Gauges demand for connectivity in the context of users and activities relating to digital transformation initiatives.	Comprises variables for analyzing the experience of connectivity for end users and organizations in today's digital economy.	Comprises a forward looking set of indicators that point towards the future development of the digital economy.
FOUNDATION	ICT Investment Telecom Investment ICT Laws International Internet Bandwidth Security Software Investment	App Downloads Smartphone Penetration eCommerce Transactions Computer Households Secure Internet Servers	E-Government Services Telecom Customer Services Internet Participation Broadband Download Speed Cybersecurity Awareness	R&D Expenditure ICT Patents IT Workforce Software Developers ICT Influencing New Business Models
BROADBAND	Fiber Optic 4G Connections	Fixed Broadband Subscriptions Mobile Broadband Subscriptions	Fixed Broadband Affordability Mobile Broadband Affordability	Broadband Potential Mobile Potential
CLOUD	Cloud Investment	Cloud Migration	Cloud Experience	Cloud Potential
INTERNET OF THINGS	IoT Investment	IoT Installed Base	IoT Analytics	IoT Potential
ARTIFICIAL INTELLIGENCE	AI Investment	AI-enabled Robotics	Data Creation	AI Potential

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.

The Four Technology Enablers

The index allows the horizontal analysis of four technology enablers that are crucial signposts to help benchmark the relative strengths, weaknesses, opportunities, and challenges facing digital economies: Broadband, Cloud, IoT, and AI

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, Cloud, IoT, and AI).

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.

The ICT Fundamentals

The four 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 IP, 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 data centers, 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 four technology 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 size, 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 input.

Each indicator has a scale based on a realistic target value for 2025, and beyond with a score of "10" indicating 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% 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.

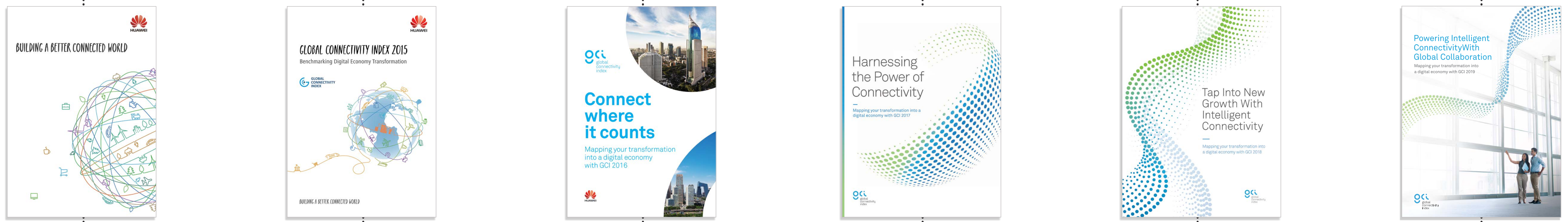
Additional Notes

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 2019 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.

The Evolution of the GCI: Benchmarking the Digital Economy Journey

CONNECTIVITY (2014–2017) | INTELLIGENT CONNECTIVITY (2018–)



	2014	2015	2016	2017	2018	2019
	New Economic Barometer	Benchmarking The Digital Economy Journey	Connect Where it Counts	Harnessing the Power of Connectivity	Tap Into New Growth with Intelligent Connectivity	Powering Intelligent Connectivity with Global Collaboration
Technology Impact	Broadband investment is a key requirement identified by industries to build a digital economy	Realizing economic transformation with five enabling technologies	Countries need to move up the technology stack to drive further GDP gains	ICT infrastructure investment initiates a chain reaction to digital transformation, with cloud as a potent catalyst	AI readiness is integral to success in the digital economy	Cloud and IoT investment set the stage for AI to take off
Economic Impact	A one-point increase in GCI correlates with a 1.4% -1.9% increase in GDP	A 20% growth in ICT investment will increase a country's GDP by 1%	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	The digital divide creates a digital chasm: the rich get richer and the poor get poorer	AI is turning Intelligent Connectivity into a gateway for a new cycle of economic growth	Intelligent Connectivity creates value through collaborative ecosystems
Social Impact						Tech4all: Intelligent Connectivity can be the answer to many of society's complicated and deeply rooted challenges.

GCI Definitions

SUPPLY

International Internet Bandwidth

International Internet bandwidth refers to the total used capacity of international Internet bandwidth, in megabits per second (Mbps). Used international Internet bandwidth refers to the average traffic load of international fiber optic cables and radio links for carrying Internet traffic. The average is calculated over the 12-month period of the reference year and takes into consideration the traffic of all international Internet links. International Internet bandwidth (bps) per Internet user is then calculated by converting to bits per second and dividing by the total number of Internet users, and this is used to calculate the index scores.

Calculation: per internet user

Telecom Investment

Telecom Service Provider investment in modern network infrastructure over an aggregated five-year period. This focuses on key carrier network technologies that are integral to the delivery of cloud, mobile, and high-speed data services including service provider routers, service provider switches, and wireless infrastructure (including 3G, 4G, and 5G). Aggregate spending over the most recent five-year period is used to provide a more holistic measurement of Telco infrastructure deployments in the context of carrier investment cycles and economic wild cards.

Calculation: % of 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

IoT Investment

Spending on IoT solutions and deployment including systems, sensors, modules, infrastructure, networks, specialized devices, security, software, connectivity services, IT and installation services, content services, OT (operational technology), and ongoing services (including consumer services). Weighed against the size of the population (IoT per capita).

Calculation: per capita

ICT Investment

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

Calculation: % of GDP

4G Connections

The percentage of mobile device connections that access a 4G/LTE network. This measurement is not based on geographic landmass, and is therefore a more accurate measurement of the actual supply of 4G services to individuals and organizations. Users who haven't subscribed to 4G services but who use a 4G phone aren't counted.

Calculation: % of mobile data connections

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: % of total households

Security Software Investment

Investment in software relating to the security of ICT resources and data. These security products may be deployed in data centers, on networks, and on devices. Spending by all end-user segments is included (private and public sector). The data is weighted by the total size of population.

Calculation: per capita

AI Investment

The sum of investments for the deployment of artificial intelligence (AI) solutions by private and public institutions. This includes AI-related investments in hardware systems, software platforms, and professional services.

Calculation: % of GDP

Cloud Investment

Overall investment in cloud infrastructure services (Infrastructure as a Service), leveraged for the supply of server (compute) and storage infrastructure resources in a cloud environment. This provides a direct measurement of the supply of services from cloud infrastructure deployments to end users. It is weighted against GDP.

Calculation: % of GDP

DEMAND

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

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

App Downloads

The total number of new mobile application downloads in the calendar year on all major mobile platforms (Android and iOS). 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

Cloud Migration

An index based on the percentage of traditional software budgets that have migrated from traditional on-premise licensing to 'as a service' cloud deployments, thus measuring demand for advanced Public Cloud Services in relation to overall ICT spending.

Calculation: % of total annual software investment

AI-enabled Robotics

Total annual investment in robotics deployments partly enabled by artificial intelligence for advanced use cases across multiple vertical end-user industries. Example use cases include customer service, medical surgery/therapy, autonomous vehicles, and advanced inspection/diagnosis.

Calculation: per capita

IoT Installed Base

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

Calculation: per capita

Secure Internet Servers

Secure Internet Servers (per 1 million people) refers to the number of distinct, publicly-trusted TLS/SSL certificates according to the Netcraft Secure Server Survey.

Calculation: per capita

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 total households

EXPERIENCE

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

Broadband Download Speed

Average download speed for each country. These metrics leverage billions of Internet and mobile network tests to provide a current view and analysis of global Internet access speeds.

Calculation: n/a

Cybersecurity Awareness

The Global Cybersecurity Index is a trusted reference that measures the commitment of countries to cybersecurity at a global level. As cybersecurity has a broad field of application, cutting across many industries and various sectors, each country's level of development or engagement is assessed along five categories: Legal Measures, Technical Measures, Organizational Measures, Capacity Building, and Cooperation. It is then aggregated into an overall score. Scores are derived from an online survey, which also allows for the collection of supporting evidence. Through consultation with experts, these survey responses are then weighted, giving the final index scores.

Calculation: n/a

Telecom Customer Services

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

Calculation: n/a

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

E-Government Services

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: n/a

IoT Analytics

Total spending on analytics software relating to IoT data analysis. These software tools 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

Data Creation

Based on the estimated availability of target-rich, actionable data (TB) that can be leveraged by Artificial Intelligence (AI) platform and analytics tools to enhance the experience and ROI of organizations investing in the deployment of AI solutions. To improve the experience of this technology, the scalability of created data needs to be considered.

Calculation: TB per capita

Cloud Experience

An index that measures the quality of service available to customers of public cloud service providers in each nation. This is calculated on the basis of Broadband Affordability and Average Download Speed.

Calculation: n/a

POTENTIAL

ICT Patents

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

Calculation: per capita

IT Workforce

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

Calculation: per capita

R&D Expenditure

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: % of GDP

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 adopting Cloud, AI, IoT and Broadband solutions. To assess future potential for development, the five-year forecast for CAGR (compound annual growth rate) is used for the time period through 2022. This CAGR accounts for current market assumptions relating to technological development, penetration rates, macroeconomic growth and the ability of customers in each country to invest in these ICT markets.

Calculation: n/a

ICT Influencing New Business Models

Based on a survey conducted by the World Economic Forum where respondents were asked to evaluate the extent to which ICT enables new business models.

Calculation: n/a

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