



Position paper

TELCO: INVESTMENT, INNOVATION
AND COMPETITION IN ICT INFRASTRUCTURE

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Executive Summary

ICT development is an important trend that significantly benefits economics and societal wellbeing

Information and communication technology (ICT), the key for information gathering, storage, processing, transmission and display, has been experiencing a rapid and steady growth around the globe in the past two decades.

With the rapid growth of ICT infrastructure, including fixed and mobile networks, connected devices, data centers, as well as cloud computing infrastructures, etc., ICT has become fundamental features of modern society, and to some extent, internet access is even considered as a basic right for human in this information society.

ICT has enormous potential to help achieve sustainable development of human society. More specifically, it demonstrates the ability to act as enabler or accelerator for both economical and societal development of a country and society, which raises attentions from governments around the globe.

At a macro-economic level, it is a consensus is that ICT development has positive impact on national economic growth. This position paper conducted a regression analysis based on a data set of 125 countries for the period 2010 to 2016, during which 4G mobile network becomes dominating, and came to a conclusion that with 16-20% increment in ICT capital services, the GDP is about to raise 1%.

In addition to ICT's impact on national economic growth, ICT also supports societal wellbeing and public affairs. It contributes to promoting education accessibility and cultural communication, reducing unemployment rate, ensuring both public and personal safety and security, improving government efficiency and transparency, etc.

Government should act as enabler to create a favorable environment for ICT investment, innovation, and competition

Government should make ICT policy not just a subject for sector policy (e.g. telecommunications) but a subject for national policy. The development of ICT and relevant infrastructure cannot be realized by solely relying on participants in the ICT ecosystem. Instead, it requires supports from the government in three major aspects: investment, innovation, as well as competition. The government plays a vital role in forming a favorable environment to enable the fast and healthy development of ICT industry.

Government supporting and stimulating investment in ICT infrastructure

- Public-private partnership
- Tax relief and subsidy
- Tariff concession
- Infrastructure construction collaboration
- Right of Way
- Open to innovative technologies for ICT infrastructure, e.g. WTTx and other alternatives

Government encouraging ICT innovation

- Innovation hub and incubator
- Funding and investment
- Talent training and cultivation
- Cyber security and privacy
- Intellectual property protection

Government guiding and regulating ICT competition

- Operator competition regulation (including market entry authorization and competition monitoring)
- Frequency spectrum allocation and management

1. ICT Infrastructure and Connectivity are Fundamental to Modern Society

The rapid growth of ICT infrastructure and improving connectivity of the world

Information and communication technology (ICT) has been experiencing a rapid and steady growth around the globe in the past two decades. This is evidenced by the development of ICT infrastructure, such as fixed and mobile networks, information gathering, processing, and display devices, etc., improved internet penetration for individuals and households, the ever-expanding bandwidth and speed of connection, and more.

ICT infrastructure

Fixed and mobile network has been developing fast, which is mainly shown by the global optical cable demand and mobile wireless sites.

Optical cable:

Underpinning global communication worldwide fiber optical cable deployment has been increasing with double-digit growth, 14-16% p.a. in the past decade.

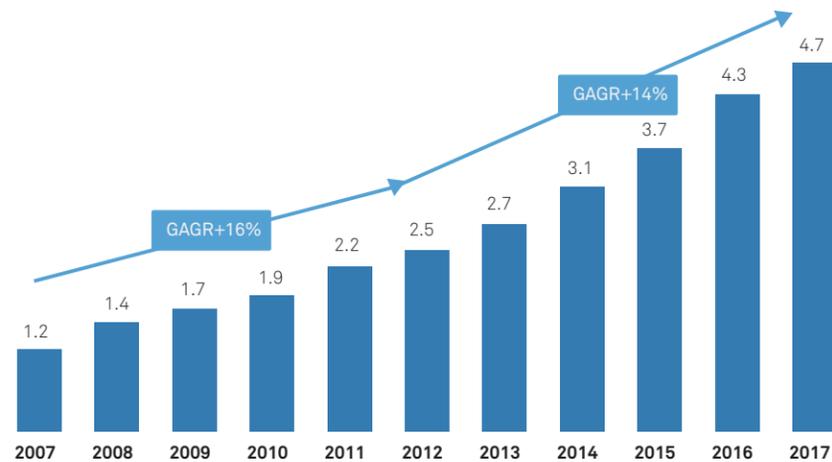


Figure 1: World total optical cable demand [00' Million Fiber-km]
Source: CRU; Roland Berger

Mobile wireless cell sites:

As the central infrastructure for transmitting cellular data among mobile phones, the number of mobile wireless cell sites has been growing quickly.

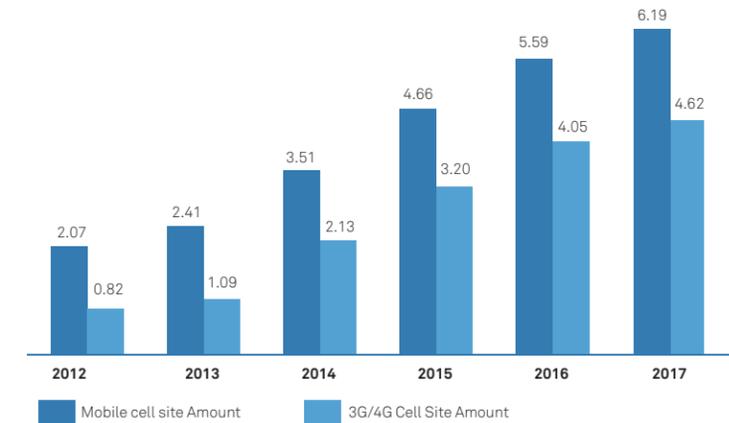


Figure 2: Number of mobile wireless cell sites in China [millions]
Source: Ministry of Industry and Information Technology; Roland Berger

Information gathering, processing, and display devices are also expected to keep growing its total amount and penetration, as well as other relevant infrastructures such as data centers.

Internet access & connectivity

Both individuals and households have experienced increasing Internet access. Individual Internet users grew from nearly 1 billion in 2005 to about 3.6 billion in 2017; approximately 48% of the global population is now connected to internet (Figure 3). On top of that, households with internet access at home have grown from 19% in 2005 to 54% in 2017 (Figure 4).

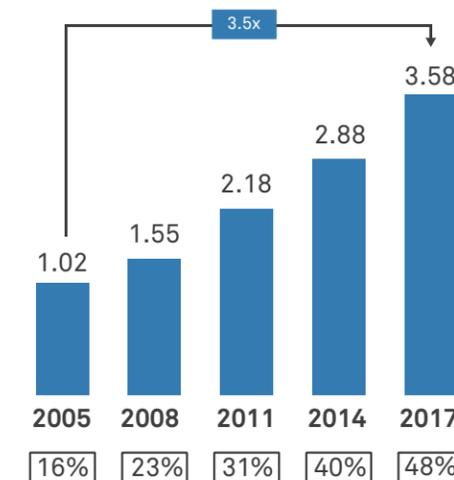


Figure 3: Global individual using the internet [billions] and % of population connected to internet
Source: ITU; Roland Berger

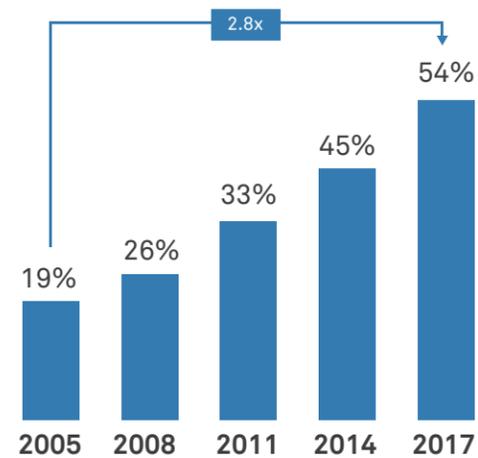


Figure 4: Global households with internet access at home
Source: ITU; Roland Berger

ICT becoming fundamental to modern society and helping achieve sustainable development of human society

With the rapid growth, ICT has become fundamental features of modern society. Given the prevalence of connectivity, to some extent, internet access is even considered as a basic right for human in this information society. ICT not only forms the backbone of today's digital economy, but also has enormous potential to help achieve sustainable development of human society, and improve people's lives fundamentally (Figure 5).

ICT helps realize United Nations Sustainable Development Goals (SDG)

<p>3 GOOD HEALTH AND WELL-BEING</p>	<p>Good Health and Well-Being Ensures fast health information exchange in diagnostic services and emergency response, etc.</p>	<p>9 INDUSTRY, INNOVATION AND INFRASTRUCTURE</p>	<p>Industry, Innovation and Infrastructure Ensures fast health information exchange in diagnostic services and emergency response, etc.</p>
<p>4 QUALITY EDUCATION</p>	<p>Quality Education Improves education accessibility in online learning, certification, student advisory, etc.</p>	<p>11 SUSTAINABLE CITIES AND COMMUNITIES</p>	<p>Sustainable Cities & Communities Allows cities to operate by interconnected, digitized systems to work on, etc.</p>
<p>5 GENDER EQUALITY</p>	<p>Gender Equality Improves Information accessibility for women: communication and collaboration among women, etc.</p>	<p>13 CLIMATE ACTION</p>	<p>Climate Action Improves weather forecasting, early warning systems, etc.</p>

Figure 5: ICT related United Nations Sustainable Development Goals
Source: United Nations, Roland Berger

Digital divide & ICT investment to close it

However, ICT development varies across countries and different geographic areas. The noteworthy Digital Divide describes the gap in development in ICT infrastructure, accessibility and utilization, which can be explained by the "Matthew Effect" as well, indicating deepening inequality and obstacles for laggards to compete with pioneers. Governments of developing countries need to pay more attention to ICT development, and especially ICT infrastructure. Investment in ICT infrastructure is a way to close the gap and break the vicious cycle that continues to cause laggards to miss out on the benefits of ICT development as well as economical and societal value created by ICT.

2. ICT's Impact on National Economic Development

That the development of ICT is necessary for economic growth is no longer theoretical, but supported by a large body of statistical research from academics, government, and industry. The researches include both qualitative and quantitative results, based on regression analysis. Although different data samples (time frame, countries, etc.), regression models, sets of independent variables, were used in these researches, all in all, the overarching consensus is that ICT development has positive effects on national economic growth (i.e. GDP growth), no matter in the developing or developed countries.

This position paper conducted a regression analysis on a data set of 125 countries for the period 2010 to 2016, during which 4G mobile network becomes dominating, and concluded that with 16-20% increment in ICT capital services, GDP is about to raise 1%. (Figure 6)

In addition, Huawei and Oxford Economics (GCI report) have evaluated the magnitude of digital spillover effect of ICT investment: every \$1 invested in digital technologies over the past three decades has added \$20 to GDP, on average. This is an enormous return compared to non-digital investments, which delivered an average return of around US \$3 to US \$1 invested.

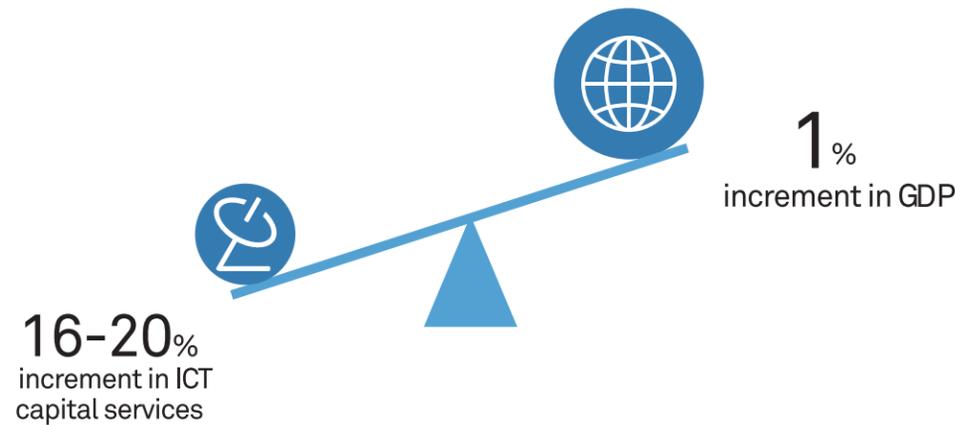


Figure 6: Impact of ICT investment on GDP growth
Source: Huawei, Roland Berger

More specifically, there are three major impact modes of how ICT development affects the economy. For traditional industries, such as agriculture, manufacturing, tourism, etc., ICT can bring either "improving" or "transformational" impact by serving as a fundamental infrastructure. Besides, development of ICT enables the birth and innovation of emerging technologies like cloud computing, and AI enabled industries, which is considered to be "disruptive" impact to economy. (Figure 7)

	Improving	Transformational	Disruptive
Concept	Efficiency, productivity and effectiveness improvement of traditional industries	Significant changes of activities along value chain of traditional industries	Creating new business models or new industries within an economy
Definition	Breadth of impact: relatively low , as ICT only involved in limited activities of the specific industry Depth of impact: relatively low , as ICT acts as supporting technology to improve efficiency and effectiveness of activities	Breadth of impact: relatively high , as ICT involved in most of the important activities Depth of impact: relatively high , as ICT brings significant changes to activities along value chain of the specific industry	Breadth and depth of impact: high , as ICT creates a business model or industries that never ever existed before in an economy
Examples	Agriculture industry Tourism (e-travel) Healthcare service (e-health)	Manufacturing Finance (FinTech) Retail (e-commerce)	Emerging technologies, such as AI (Artificial Intelligence), cloud computing

Figure 7: Introduction of three impact models to the economy
Source: Huawei, Roland Berger

3. ICT's Impact on Societal Wellbeing and Public Affairs

ICT is deeply rooted in public life as a building block of modern society, supporting societal wellbeing and public affairs through its infrastructure and various applications. It contributes to promoting education accessibility and cultural communication, reducing unemployment rate, ensuring both public and personal safety and security, improving government efficiency and transparency.

ICT changes education approach and increases accessibility

As many cutting-edge teaching and learning methods and tools are enabled by ICT, education accessibility improves significantly, especially for people in rural and remote areas. More diversified education options also increase teaching efficiency, effectiveness as well as recreational experience.

ICT promotes culture communication and exchange

ICT supports the flow of cultural exchanges around the globe, enabling more people than ever before to connect, get to know each other, understand each other from different cultural backgrounds, and create and maintain this new sense of collectivity.

ICT helps relief unemployment issues

The development of ICT is transforming the employment market, creating new job opportunities and making labor markets more accessible, inclusive, and globalized, through innovative tools enabled by ICT infrastructure.

ICT improves safety and security of both individuals and society

Public and personal safety and security also benefit from ICT development. Not only can ICT provide timely alerts on natural disasters to protect the essential safety of individuals, but it can also help preventing crime and other man-made damage within a society.

ICT enhances efficiency and transparency of government affairs

With the utilization of ICT to enhance the efficiency and effectiveness of service delivery by the public sector, a new term, e-government, has come into being. The rise of e-government greatly improves government efficiency and promotes citizens' participation in public affairs. More and more countries are making an effort through e-government to ensure that public institutions are more inclusive, effective, accountable, and transparent.

4. Government Creating a Favorable Environment for ICT Investment, Innovation and Competition

There are several participants within the ICT ecosystem, such as network element providers, network operators, downstream platform, application and content providers (Figure 8). The health of ICT ecosystem is crucial to ICT development, but ICT development requires supports from not only the ecosystem player but the government in three main aspects: investment, innovation, as well as competition (Figure 9). The vital role of government in forming a favorable environment enables the fast and healthy development of ICT industry.

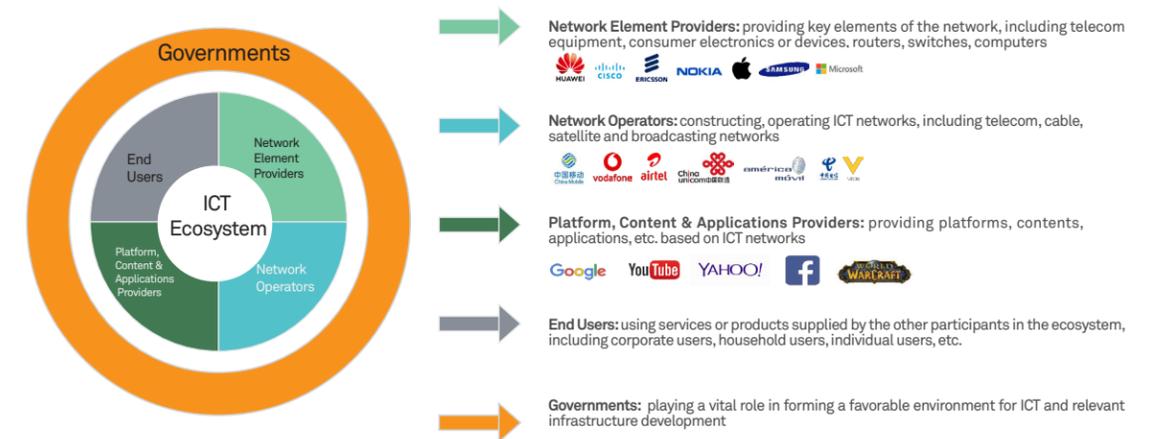


Figure 8: ICT ecosystem and government's role for ICT development
 Source: Huawei, Roland Berger

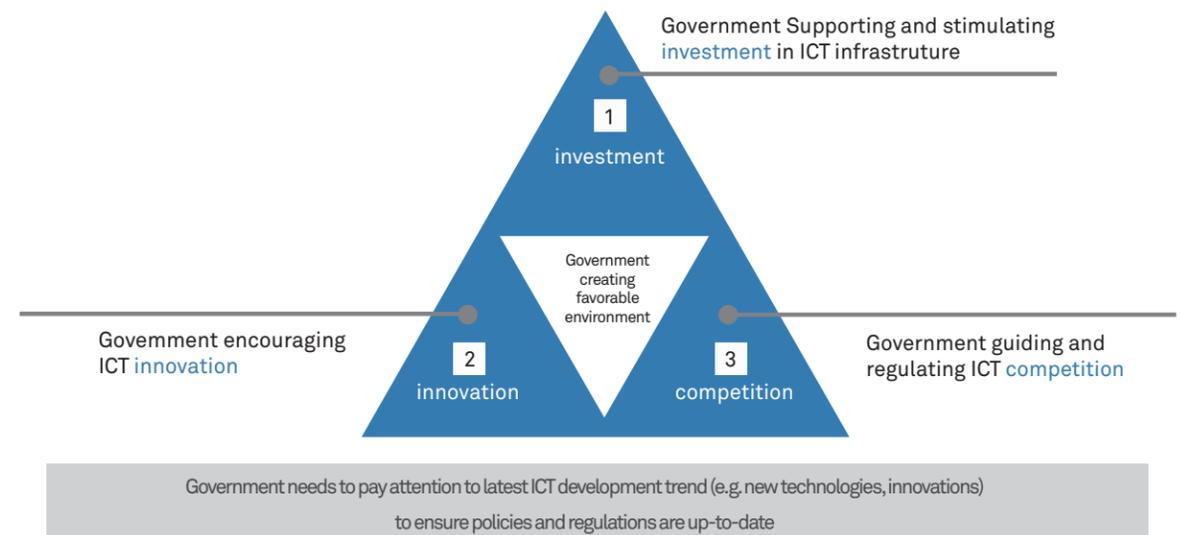


Figure 9: Government creating favorable environment for ICT development from three major aspects
 Source: Huawei, Roland Berger

4.1. Government supporting and stimulating investment in ICT infrastructure

The development of ICT and relevant infrastructure relies heavily on ICT infrastructure manufacturing, installation and operation. Governments should set up appropriate ICT infrastructure development objectives based on the development stage of the country, which act as a leading guide and convey the government's attitude towards ICT development to all the participants within the ICT ecosystem. Development objectives include broadband coverage, connection quality and speed, etc.

To achieve the ICT infrastructure development objectives, government usually supports and stimulates investment in ICT and relevant infrastructure with the following methods and policies:

- **Public-private partnership**

Often seen in ICT infrastructure construction; currently most countries choose to use the Build-Operate-Transfer (BOT) model of PPP in ICT construction, where governments mainly provide public resources and favorable policy supports to attract social capital, instead of making heavy investment directly

- **Tax relief and subsidy**

Tax relief and subsidy can also help stimulate ICT development indirectly by giving financial incentive to companies involved in ICT industry

- **Tariff concession**

Cutting down on tariffs of certain importing ICT infrastructure-related items, to ensure the supply in developing countries, esp. those with the limited R&D capability and production capacity

- **Infrastructure construction collaboration**

Leveraging existing infrastructure in regions that have already finished the construction and installation of other infrastructure but need to draw in or upgrade ICT infrastructure; binding different types of new infrastructure construction together in the first place in newly developing regions to avoid re-working later

- **Right of Way**

Proper and simplified Right of Way rules expedite the deployment of underground (optical fiber) and over ground (mobile towers) ICT infrastructures

- **Open to innovative technologies for ICT infrastructure**

Being technology neutral and actively adopting innovative technology (e.g. WTTx and other alternatives) to improve network coverage in a more cost-effective way

4.2. Government encouraging ICT innovation

To fully leverage the ICT infrastructure and benefit both economic and societal development of a country, encouraging ICT innovation from government is very critical.

- **Innovation hub and incubator**

Setting up ICT innovation infrastructures such as hub and incubators is typical supportive policy, which helps nurture rising internet and high-tech startups.

- **Funding and investment**

Other than setting up physical environment for ICT innovation, government can also set up incentive policies to provide corresponding funding and investment to encourage ICT innovation.

- **Talent training and cultivation**

In addition, to achieve ICT innovation, it requires large amount of ICT talents, and therefore governments can take various actions to attract, cultivate and provide training to talents dedicated to ICT development.

- **Cyber security and privacy**

With fast pace innovation in ICT application and content, cyber security and privacy problems requires attention. To address such concerns, governments have to establish various rules and laws to ensure a safer cyber environment to protect all users in the digital world.

- **Intellectual property protectio**

For innovative internet and high-tech startups, as they are technology-intensive, intellectual property protection is very important for keeping their innovation passion and motivation.

4.3. Government guiding and regulating ICT competition

In addition to stimulating ICT investment and encouraging ICT innovation, government also needs to guide and regulate competitions within ICT industry, especially regarding operator competition regulation, as well as spectrum management and frequency allocation.

Operator competition regulation

Operator competition regulation is crucial topic for ICT development to ensure high quality and cost-effective network service provision. Market entry authorization and competition monitoring are two major issues.

Regarding market entry authorization, the trend is towards adopting multi-service and technology neutrality and gradually away from technology-specific authorization. Another advent of new licensing approach is to bundle broad categories of services together to achieve service neutrality. As for monitoring competition and eliminating inefficiency due to potential monopoly, governments also takes various actions to monitor operators' activities, esp. mergers and acquisitions, as well as their performance.

In addition to market entry regulation, government has to monitor the competition among network operators, and eliminate inefficiency due to potential monopoly, e.g. mergers and acquisitions between network operators.

Despite the difference in market entry authorization and competition monitoring among different countries, majority of the countries have one or two fixed line operators, and two to four mobile operators, due to the macroeconomic situation and the scale effect of network operation.

Frequency spectrum allocation and management

With limited resource, selection is necessary for spectrum licensing, and auctions for frequency spectrum are now widely leveraged in frequency spectrum allocation. License authorization and renewal process should be predictable, timely and open to provide sufficient certainty to support substantial network investment from the operators. License authorization should also be technology and service neutral. An increasing number of countries have moved towards allowing more flexible use of spectrum.

5. Conclusion and Recommendations

To conclude, government should recognize that ICT is a fundamental feature of modern society, and realize that ICT development could bring both economical and societal value to the development of a country. Hence government should actively contribute to a healthy ICT ecosystem by setting up favorable environment with proper policy and regulation, in three major aspects: investment, innovation and competition.

Stimulate ICT investment

- Public-private partnership to better allocate resource and attract capital
- Tax relief, subsidy and tariff concession to encourage infrastructure development
- Infrastructure collaboration and relaxed right of way rules to support construction
- Innovative technology to improve coverage with lower cost

Encouraging ICT innovation

- Funding and investment, together with innovation hub and incubators to incentive innovation from the downstream demand side, esp. platform, content and application providers
- Talent cultivation program to nurture sufficient talents for ICT industry
- Cyber security rules to maintain healthy environment for the digital world

Regulate ICT competition

- Operator authorization, competition monitoring and spectrum allocation to maintain the competitive market order

Thereby, by creating a favorable environment for ICT development, government can help a country to better benefit from ICT development, in both national economic and societal well-being, together with all participants in the ICT ecosystem.



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