CHAPTER 1.2

The Convergence of Information and Communication Technologies Gains Momentum

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In the past few years, the boundaries between information technology (IT)—which refers to hardware and software used to store, retrieve, and process data—and communications technology (CT)—which includes electronic systems used for communication between individuals or groups—have become increasingly indistinguishable. The rapid convergence of IT and CT is taking place at three layers of technology innovation—cloud, pipe, and device—which are described in detail in this chapter. As a result of this convergence, industries are adapting and new industries are emerging to deliver enriched user experiences for consumers, enterprises, and the private sector.

Several factors are driving the convergence of IT and CT and, consequently, contributing to the integration and transformation of cloud, pipe, and device technologies (Figure 1). For example, as the mobile penetration rate nears 90 percent globally, more people are able to communicate with each other through mobile devices. Many of these devices can interconnect through cloud computing services when accessed via the Internet. Adding to this momentum are innovations in smartphones, which allow users to send and download music and images, to use the Internet to purchase products, and to pay retailers and financial institutions electronically. In addition, more than 50 countries have invested in national broadband projects that lay solid foundations for bandwidths adequate to drive ICT convergence.

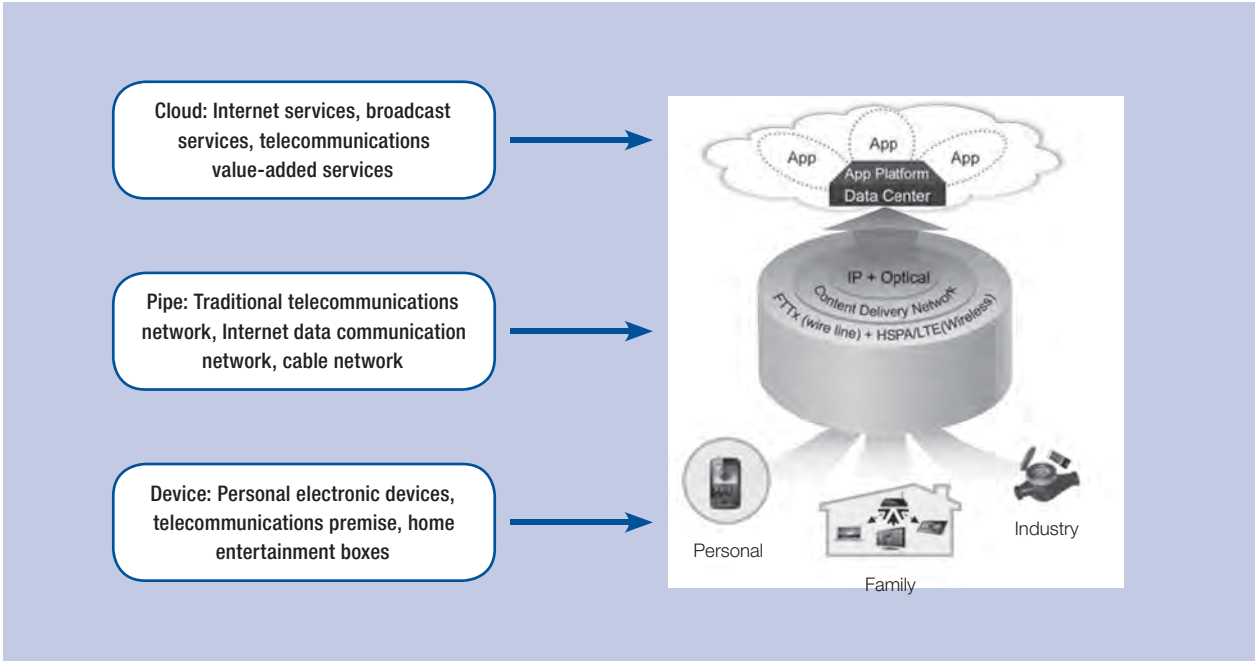
After years of evolution, Internet services, telecommunications value-added services, and even media services are converging for both consumers and industry. Services carried by optical networks and other modern wireless "pipes" are moving to the cloud, and both industries and consumers are utilizing those services through a variety of integrated smart devices.

THE CLOUD: A CATALYST FOR ICT CONVERGENCE

The IT and telecommunications industries will converge for cloud services. In addition to providing bandwidths for cloud services, telecommunications carriers will gradually move their IT systems, value-added services, and Internet data centers into the cloud to provide services to a variety of industries. To integrate their services successfully, telecommunications and IT industries will seek a common understanding on standards, interfaces, and security specifications. Most important will be the unification of industry standards. Uniform standards will significantly drive down the cost of the cloud, making interconnection a reality and facilitating its rapid development. Cloud services, such as e-government, e-education, and e-healthcare, will be able to better cater to the needs of governments, industries, and enterprises.

Although convergence presents many challenges to IT and CT, ICT convergence will strengthen both industries by accelerating the development of cloud computing services. As a groundbreaking business model and

Figure 1: ICT sector revenues and growth rate, US$ million



Source: Huawei Technologies.

an innovative technology, cloud computing is becoming a powerful catalyst in the restructuring and integration of IT and CT. Traditional IT and CT once tried to integrate with the Internet, but without the uniform standards that are required to enable cloud computing, the integration provided limited results. However, the current integration of the Internet with IT and CT is transforming both industries and enabling the development of next-generation technologies (Figure 2).

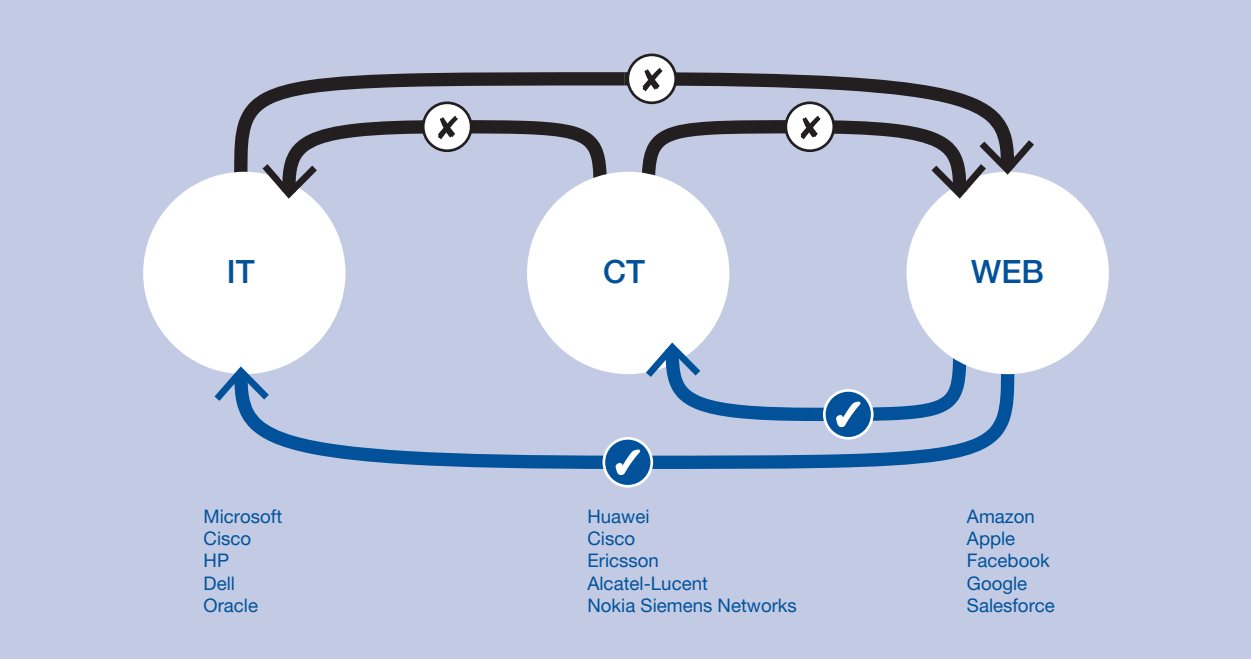
Traditional IT centers on data, whereas traditional CT centers on connection-based networks. Converged IT and CT produce ICT, which is the cornerstone of what we often refer to as *cloud computing,* a technology focused on interaction and collaboration between users and systems.

Before the transformation of CT into ICT, real-time voice services played a dominant role in CT. At that time, the telecommunications industry focused on finding solutions that empowered customers to roam with their mobile phones over a mobile network with acceptable price points for both the carrier and the subscriber. Since the transformation of CT into ICT, media services and breaking news are widely available via mobile networks and have replaced the previously dominant real-time voice services in CT. Today, the telecommunications industry focuses on the customer need for seamless services supported by integrated mobile networks (Figure 3). The very meaning of the word *pipes* has also changed. Although the term still refers to a data connection—with a pipe being analogous to bandwidth or throughput—it has evolved from a physical connection, such as a cable, to all–Internet protocol (all-IP) networks. Likewise, when telecommunications companies referred to *networks* in the past, they meant *connected networks.* Today, the same word also refers to data transmitted via ICT.

Just as traditional CT has changed since its transformation into ICT, IT is also rapidly evolving. In recent years, new IT enterprises in consumer markets have leveraged cloud computing's open and interconnected resources to aggressively challenge traditional IT in industry markets. A key challenge for traditional IT is its inability to keep pace with today's fast-paced industry markets. Traditional IT build-outs and management models face several inherent obstacles, including inflexibility, low resource utilization, high energy consumption, prolonged time frames for systems going live, and high software and management costs. Unlike the early days of IT, merely expanding hardware equipment is no longer sufficient to overcome these challenges.

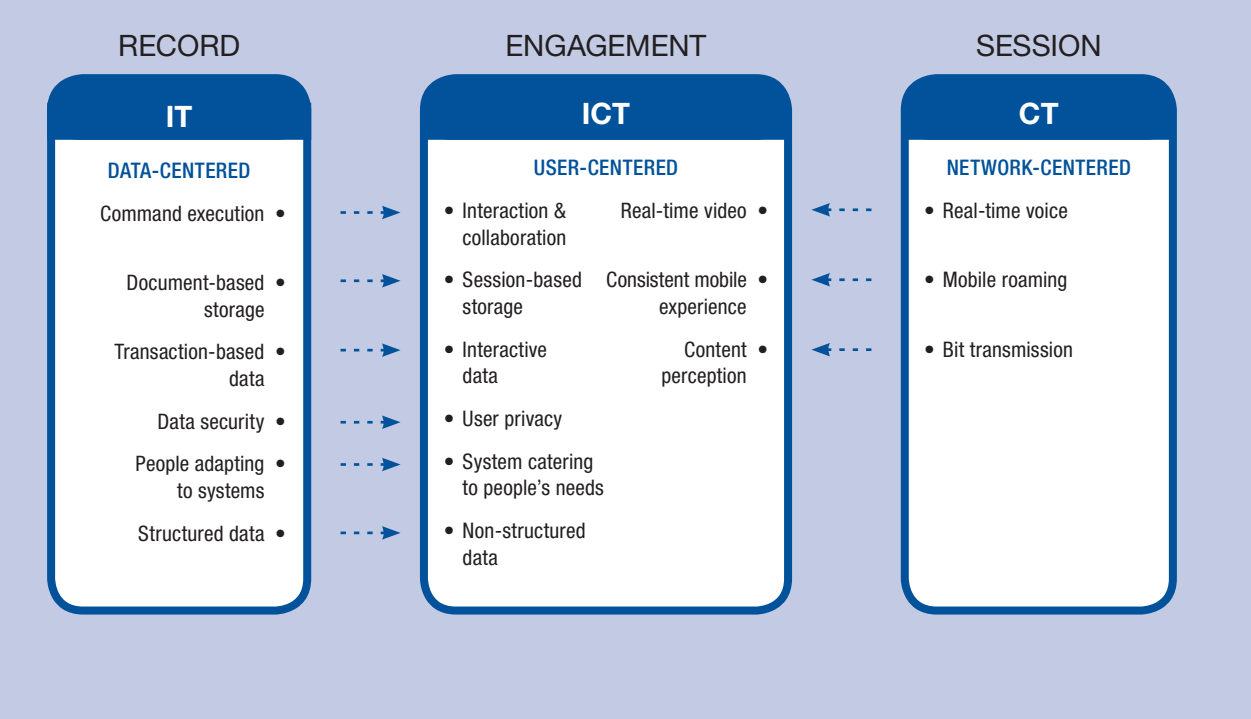
The evolution from traditional IT to ICT has significantly changed the IT landscape. For example, data centers based on document storage were once at the heart of traditional IT. In today's ICT era, cloud computing based on interactive sessions has replaced traditional data centers. Other aspects of traditional IT have also shifted. For example, although traditional IT was concerned with data security, today's ICT security focus has shifted to user privacy. Traditional IT also required people to adapt to systems, but today's systems are designed to cater to people's needs, instead of the other

Figure 2: The convergence of IT, CT, and web capabilities



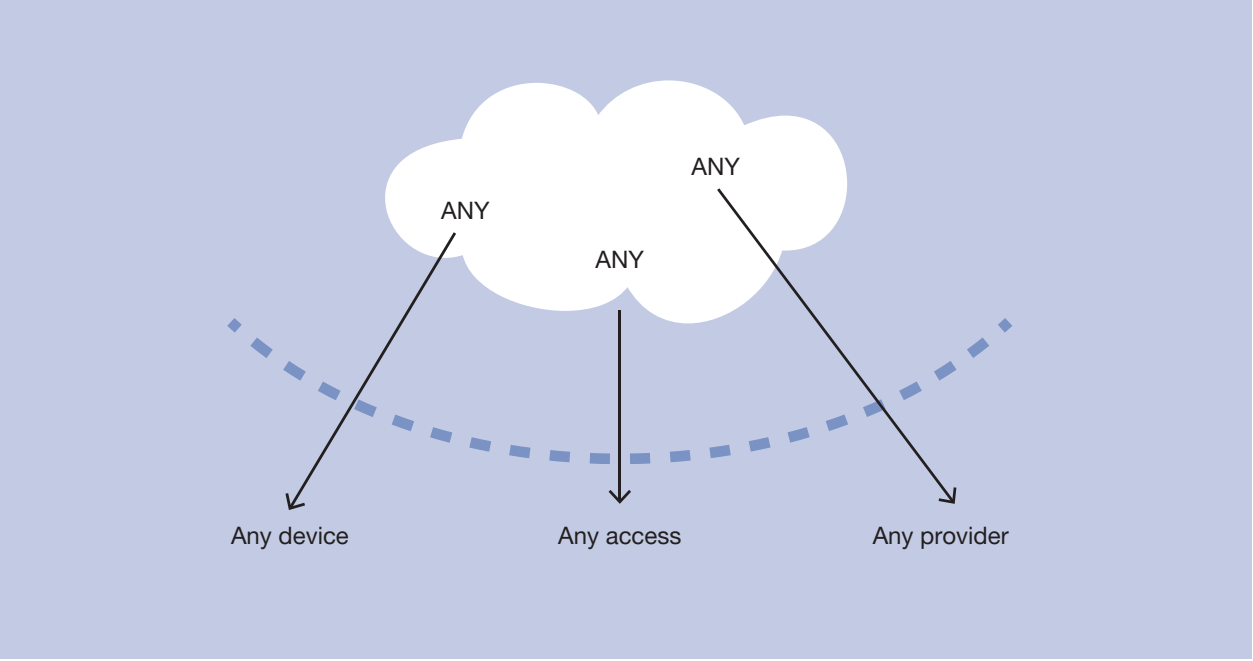
Source: Huawei Technologies.

Figure 3: Dynamic connections of ICT services



Source: Huawei Technologies.

Figure 4: Cloud computing from a user's perspective



Source: Huawei Technologies.

way around. Similarly, structural data were replaced as a main concern for traditional IT with ICT's large amounts of semi-structured or unstructured data.

Like traditional IT, the traditional CT industry needs to make further changes to realize the many benefits offered by ICT convergence. However, numerous business models, services, and individualized requirements emerging from the Internet are overwhelming today's communications industry. With the help of new technologies, this industry can continue to use its switching capabilities for a while longer. But if it does not keep pace with ICT convergence, traditional CT could find itself in the dark when it comes to communications control and monitoring. Alone, the communications industry is not knowledgeable enough about content exchange and does not know how to apply data control. In the era of ICT convergence, where cloud computing delivers data to any device anywhere, the pipes of the communications industry can no longer fully reflect its business value.

From a user's perspective, cloud computing blurs the lines between IT and CT to deliver superior and consistent experiences based on the ANY–ANY–ANY concept illustrated in Figure 4. The widespread use of smartphones and tablets has made user demand increasingly prominent for access from any device at any time using any service provider. Traditional IT or CT technologies alone cannot provide such an experience, which is why it is time to restructure these technologies.

Cloud computing has reshaped the IT industry. The new cloud model for computing storage and network resource management uses a distributed computing architecture to reshape the traditional single-server computing architecture. This new computing model adopts two key technologies—distribution and virtualization—to decouple software and service and help move data centers and services into the cloud. Resource sharing in the cloud increases the utilization and flexibility of resources, significantly accelerates service deployment, and improves processing capabilities.

Cloud computing also points CT in a new direction that goes beyond pipes to exploring the value of broadband for handling the large datasets that cloud computing can store and transmit. We think of the cloud as an information factory that is now overturning the traditional business models of software, hardware, and media to transform user focus from purchasing products to purchasing services. Not only is cloud computing desirable from a user's perspective, but it also enables IT and CT to enhance and transform each other (Box 1).

PIPE: IP+OPTICAL IS THE FUTURE OF PIPE INTEGRATION

For many years, telecommunications networks have been evolving into all-IP networks. This evolution has significantly reduced the cost of network operations (e.g., the cost of per-bit data transmission has dropped dramatically). All-IP networks have also accelerated the convergence of fixed with mobile telecommunications

networks. Currently, tremendous progress has been made in the all-IP model. The next objective is likely to be the IP+Optical network model.

On future networks, the majority of traffic will be video, which will increase the volume of data traffic dramatically. Optical technology will alleviate the pressure caused by large-capacity demands, whereas IP technology will make networks more flexible and ease interconnection. The IP+Optical model will significantly improve efficiency and reduce total cost of ownership. A joint article by BT and Huawei analyzing the economy of networks notes that when data traffic increases 6.5 times, the IP+Optical solution will reduce network construction costs by about 30 percent, diminish the area required for equipment rooms by 50 percent, and help decrease power consumption by about 55 percent.[1]

Cost is the primary driver for the convergence of multiple networks, including telecommunications networks, the Internet, broadcasting networks, and even electric power networks. For consumers, converging services have reduced charges and improved services. For carriers, IP technologies have lowered operating costs. As an example, look at the transmission networks of mobile carriers several years ago. At that time, mobile carriers often leased E1 channels, which are used to connect to medium and large companies, from fixed carriers for their mobile backhaul networks. Mobile carriers also employed non-IP technologies. As a result, they paid very high leasing fees. After IP backhaul technology was adopted, the cost to the carrier in many places went down by as much as 80 percent and the pressure from increased traffic was adequately addressed. More importantly, all-IP technologies have gradually standardized products and decreased network construction costs.

A seamless user experience is the second driver for the convergence of multiple networks. Separating networks from services leaves many users dissatisfied and leaves many carriers unable to address their own service convergence needs. The direction in which pipes develop has nothing to do with services, as all services can run in the same pipe. This means that networks of the future will become increasingly flattened and simplified.

Quality of service and quality of experience are the primary factors that need to be resolved in converged pipes, especially for converged Internet and traditional telecommunications networks. After the convergence of these two network types, multi-play carriers that combine mobility, video, Internet, and voice telephone services need to consider how to use carrier-class network capabilities to ensure a high quality of experience for these communications services, which traditionally required separate networks. The multi-play quality of experience solution must be end-to-end and must ultimately improve the consumer experience. This may mean end-to-end centralized strategy control centered on users and services at the network resource layer, or fast troubleshooting and self-healing capabilities at the network layer, or redundancy backup and hot swapping for key components at the equipment layer. In any case, multi-play carriers must ensure that consumers have a perfect carrier-class quality of experience while enjoying diversified multi-play services.

As Internet videos and Internet protocol television (IPTV) become popular, video services will constitute 90 percent or more of the services provided by future networks. Video usage, sharing, and storage trends will rapidly drive up traffic, which will place tremendous pressure on networks. A content distribution network (CDN) will effectively solve this problem. The Pareto principle (also known as the 80–20 rule) often applies when analyzing the proportion of traffic that users allocate to the contents they like. In other words, 80 percent of user traffic involves 20 percent of user content. Statistics show that 80 percent of peer-to-peer video content is transmitted via backbone networks. Therefore, many problems can be resolved if important video content is smartly cached via the CDN.

However, the CDN cannot resolve all problems. Gigantic data traffic makes it hard for some traditional technologies and architectures to sustain satellites, microwaves, and traditional routing architectures. The optical network will be an effective solution for large-capacity transmission. But the bearer mode adopted by traditional optical networks is too rigid to allow adequate flexibility in service provisioning and cross connections. Previously, Internet services used traditional Internet routers, which

Box 1: Cloud computing will reshape IT and CT

- IT and CT will enhance each other to produce a consistent experience across any device, any time, any where.
- The telecommunications and IT industries will integrate services and adopt common standards to:
  - drive down costs;
  - facilitate development; and
  - help cloud services cater to governments, industries, and enterprises.
- The IT computing model will change from a traditional single-server computing architecture to a distribution computing architecture that helps move data centers and services to the cloud.
- The CT model will shift from its focus on real-time voice services to accommodate increased multimedia content through integrated mobile networks and broadband.

Box 2: Converging pipes with IP+Optical networks

- IP technology:
  - makes networks more flexible and eases interconnection,
  - reduces the cost of network operations, and
  - accelerates convergence of fixed and mobile networks.
- Optical technology:
  - increases transmission speed for large-capacity transmissions (video), and
  - uses IP over DWDM to reduce operating and capital expenditures for high bandwidth transmissions.

were too flexible and reduced efficiency. If users clicked a movie link via the Internet, for example, the download often went through many routers. The IP+Optical model uses optical networking to reduce the number of hops for the routers and increase transmission speed. Therefore, the synergy of IP and optical networks has created a viable new solution.

From a service-bearing perspective, the IP+Optical model will make IP over dense wavelength division multiplexing (DWDM) a practical option for services requiring high bandwidths. In this way, data packages can be transmitted directly via relatively cheap optical networks, which will reduce the number of routers used and help conserve energy while also reducing the space required for equipment rooms. In addition, the combined effect of IP+Optical networks at the service protection, network management, and maintenance layers will make this solution highly feasible (Box 2).

THE DEVICE: SMART DEVICES WILL USE THE CLOUD TO EVOLVE INTO PERSONAL MEDIA CENTERS

Up to now, mobile phone usage has centered around conventional communications functions. This will change with the convergence of IT and CT services, which has been helped along by the wider use of smart devices. Since consumers are craving a variety of impressive applications, we believe that in the future smart devices will become deeply intertwined with the cloud to support popular services and applications. As the situation stands today, users often have a bad experience because of disconnects between devices and the cloud, dispersed applications, and unstable service quality. Closely interweaving devices with the cloud will give consumers a better user experience while also accelerating widespread use of industry applications.

Integration of home devices

Gradually, devices used inside and outside of the home are becoming increasingly integrated. Users who connect mobile phones, flat-panel television sets, and personal computers (PCs) with the Internet via broadband or Wi-Fi networks can better leverage the capabilities of each device to make phone calls, watch movies and television programs, play games, or access information online. Thanks to advancing ICT technologies, conventional television sets that once used analog signals now use digital signals. This transformation has turned television sets into smart devices that are able to serve as open platforms for smartphones and PCs. The large high-definition display on these smart television sets vividly projects the full complement of smart applications that users are running on mobiles phones and PCs.

Compared with using just a mobile phone or television set, integrated home devices deliver an enhanced user experience that is customized to the individual tastes of each member of the household. This integration allows users to enjoy a fuller and more animated experience when watching movies and television programs or playing games than they can have by merely watching a conventional television.

Integration of industry devices

Like home devices, industry devices are becoming integrated amid the widespread use of ICT technologies. The integration of industry devices promises to gradually disperse the boundaries between industries. Adding to this trend is the ever-growing convergence of multiple networks (including broadcasting networks, telecommunications networks, and the Internet). This convergence allows IT, television programming, the Internet of Things, gaming, and other technologies to be incorporated into each of the integrated devices.

With the advancement of telecommunications infrastructure networks and the arrival of the era of high-speed mobile communications, network-supported functions can become increasingly versatile. Consider an example from the automotive industry, which wants to cater to today's consumer demand for smarter vehicles. It is because of this demand that integrated automotive devices—including automotive global positioning systems (GPSs) and mobile communications devices—have been developed for consumer markets. Through integration, automotive devices can deliver more versatile and easily accessible functions. These functions may include navigation services provided by call centers that specialize in the automotive domain; automotive security services; and Internet-based provisioning of communications, entertainment, and lifestyle resources.

As mobile devices become integrated on a large scale, people require data both in higher frequency and in massive amounts. To keep up with this integration trend, cloud computing solutions are coming

into widespread use for more and more mobile devices (Box 3). With the help of cloud computing, users can acquire, store, and use data more efficiently and cost-effectively.

ICT CONVERGENCE IMPACTS CONSUMERS, INDUSTRIES, AND GOVERNMENTS

The rapid convergence of ICT has significant meaning for consumers, enterprises/industries, and governments. Consumers and enterprises are benefiting from this transformation, and governments are in a position to facilitate this transformation.

ICT convergence and consumers

The mobile Internet is one of the most important sectors of the ICT industry. In many places around the world, mobile Internet users (e.g., 3G, or third-generation, mobile phone subscribers) outnumber fixed Internet users (e.g., PC users). In Africa, for example, the number of mobile phone subscribers has exceeded 500 million, and there are far more users who access the Internet with their mobile phones than those who access the Internet with their PCs. In Japan, users of devices powered by mobile communications networks also outnumber PC users.

By taking advantage of burgeoning mobile communications networks in the United States, 58 percent of US adults are using mobile network applications, such as mobile email, image downloading, and map searching. Moreover, the increasing popularity of mobile phones and widespread network deployments have given rise to new businesses, such as mobile phone–based shopping and payment. About one-sixth of the population in Kenya uses mobile phone–based banking functions to get financial services. In China, 46 percent of mobile phone subscribers surveyed said that they have purchased something using the access services provided by their mobile phones.[2] The sky is the limit as we learn to leverage the full potential of integrated smart devices, the full complement of peripheral devices, ubiquitous networks, and robust cloud data centers.

Raising the levels of integration will allow users to easily upload documents, photos, songs, and videos recorded on their smart devices to the cloud or to freely download data from the cloud. Life becomes much more convenient with this type of cloud-powered accessibility and back-end backup. Users will also be able to access the network with their smart devices while on weekend getaways or extended road trips to directly view satellite maps and real-time traffic conditions, get recommendations from online friends about scenic spots and nearby restaurants, or easily reserve hotel rooms. In addition, users will be able to play content, such as music, stored in their smart devices on their automobile's sound system to make driving more enjoyable.

Box 3: The future of smart devices

- Smart devices will use the cloud to support popular services and applications.
- Interweaving devices with the cloud will offer a better user experience and accelerate the widespread use of industry applications:
  - Integration of home devices (mobile phones, flat-panel television sets, PCs) with the Internet delivers an enhanced, customized user experience.
  - Integration of industry devices and the convergence of multiple networks (broadcasting, telecommunications, Internet) are gradually merging the boundaries between industries.

Giving full play to the power of this integration will impact users in all aspects of their lives (Box 4). Consumers will be able to use smart devices to search for sales of their favorite clothes at nearby shopping malls; they will be able to improve their diets by using smart devices to check the calorie content of their favorite foods and decide whether they have the nutrition their bodies need.

Combining smart devices and peripheral devices leads to a smarter lifestyle. Linking a smartphone to a conventional television set through an interface device allows users to effortlessly transfer songs, photos, and videos stored in their smartphones to their television sets. This capability not only revolutionizes the functionality of a conventional television set, it gives users a fresh new experience.

Integrating smart devices with compatible medical peripheral devices creates mini smart medical devices. The peripheral devices capture basic vital signs—such as cardiopulmonary status, oxygen saturation, temperature, and pulse—while the built-in applications of the smart devices analyze these signs and then upload them to the cloud. By using smart devices this way, users can analyze their overall health locally and keep an eye on trends in their data. Health professionals can use these data to update personal health records stored in the cloud and to make suggestions for preventative care.

ICT convergence and enterprises/industries

One huge advantage that ICT convergence introduces is cloud computing for businesses, which allows employees to work anywhere that has network coverage rather than merely in their offices (Box 5). By connecting devices, such as mobile phones and PCs, to the cloud, employees can handle urgent tasks at home, on-the-go during business trips, or even on a beach during

Box 4: Implications of ICT convergence for consumers

Raising integration levels between smart devices, peripheral devices, ubiquitous networks, and robust cloud data centers allows consumers to:

- upload documents, photos, songs, and videos from smartphones to the cloud;
- download data from the cloud;
- use smart devices on trips to access maps and traffic reports or find hotel rooms;
- play content from smart devices on automobile devices for enjoyable driving;
- search for local sales;
- check calorie count of favorite foods;
- transfer songs, photos, and videos to television for a fresh experience; and
- track and analyze vital signs for better preventative healthcare.

vacation. The access to resources and the manageability of the deliverables are similar to being physically present in the office.

Another advantage of ICT convergence for enterprises is that employees can boost their production efficiency by leveraging collaborative tools that synchronously deliver intense functions, such as instant messaging, audio and video communications, data sharing, whiteboard sharing, and interactive polling. This applicability allows multinational enterprise teams to cooperate across geographic regions while slashing communications costs. Having virtual teams across the world that work as "one world, one team" is no longer just a dream.

In addition to location-independent accessibility and a boost in production efficiency, ICT convergence also provides high-definition videoconferencing solutions that enable attendees to meet with others in a virtual environment that simulates talking face to face. Attendees on both sides can see each other in real-life proportions and pick up on each other's facial expressions, body language, gestures, and even eye expressions. This functionality minimizes the need for senior management to travel frequently for meetings, which substantially decreases the time and cost for the enterprise.

ICT convergence promises positive impacts on product applications by allowing any industry a greater degree of customization. For example, education, medicine, finance, and government can all benefit from ICT convergence.

In traditional education, students trained primarily in physical classrooms. This method of education does not satisfy the constant need for new expertise that keeps people competitive in a knowledge-based economy. Among the drawbacks of traditional education methods are inadequacies in teaching resources, constraints on time and locations, repetition of effort, lack of consideration for individual learning modes, a potential for out-of-date knowledge, and an inability to meet stiff requirements for collective or off-the-job training. By capitalizing on such comprehensive technologies as cloud computing, cooperative communications, and high-definition videoconferencing, the modern distance education system turns small classrooms scattered around the world into one huge classroom or virtual community. Isolated schools can share resources, and numerous students can attain access to lessons taught by excellent teachers.

Another example of product advancement through ICT convergence comes from the medical industry. Healthcare opportunities vary significantly from one region to another around the world and are usually quite low in rural areas. ICT convergence can help people in less-developed areas gain access to superior healthcare resources. Once connected and linked up to converged networks, high-definition video equipment and medical apparatuses can transmit complete and vital data (such as onsite operation data, electrocardiogram data, monitoring equipment data, computed tomography data, and patient medical records) in real time to medical experts located hundreds or thousands of miles away. Medical experts can even diagnose patients by observing such visible indicators as skin tone and physique.

ICT convergence also offers financial institutions a competitive edge in attracting customers by presenting an alternative to waiting in long lines for banking services. Mobile banking systems and multifunctional self-service devices, which converge both IT and CT technologies, can extend the scope of banking services beyond business center networks and offer customized financial services 24/7.

Government agencies can use ICT convergence to build safer cities by fully leveraging smart monitoring devices, highly reliable transmission networks, large data storage capacity, and smart analytics. It is possible for government authorities to use a daily work platform to see how a city looks in real time and rapidly respond to various emergencies—including fires, car accidents, and floods—to minimize loss of life and financial loss.

ICT convergence and government policy

As the convergence of IT and CT gains momentum, so does the role of governments in facilitating the evolution of ICT. Governments can encourage ICT convergence in three key ways. First, they can reform policies and regulations to remove investment barriers and create a

level playing field for competitors. Next, they can offer financial incentives to firms that deploy advanced ICT services. Finally, they can support and accelerate ICT convergence by directly investing in infrastructure and services.

Responding with effective regulations

With ICT industries already subject to volatile technological and market changes, it is important for regulators of the telecommunications, IT, and broadcasting network industries to respond to changing conditions. By effectively enabling ICT convergence, government regulations can act as catalysts for network and economic development. For example, to build a national broadband network, government agencies need to provide adequate spectrum so the ICT industry can deploy mobile broadband networks that enable rural area residents to benefit from national initiatives. However, the spectrum in many countries is a scarce resource mainly used by the military, broadcasting, telecommunications, and IT industries. This lack of broadband spectrum availability restricts services, ICT convergence, and opportunities for economic development. One way to maximize this scarce resource is to allocate spectrum resources based on industry efficiency.

Switzerland's long-term evolution (LTE) auction provides an example of a regulatory action that drives network and economic development for multiple stakeholders. LTE is a wireless communication standard for high-speed data for mobile devices and data terminals. Switzerland offers an 800 MHz spectrum auction to encourage mobile telecommunications development as a universal access and service tool. The local regulator of this auction established the rule that the auction's winner would be responsible for providing mobile broadband services for rural residents. The regulator allocated the 800 MHz spectrum to the mobile industry for two reasons: the 800 MHz band helps mobile operators deploy LTE networks, and mobile technology is more efficient than IT or broadcast. By adding mechanisms to manage the radio-frequency spectrum, Switzerland helped accelerate ICT convergence for multiple stakeholders.

Several countries have reformed their policy and regulatory frameworks to enable convergence while simultaneously focusing on market forces. Kenya and Singapore, among others, have moved toward technology-neutral licensing regimes that allow service providers the flexibility to deploy the most efficient networks. Some countries—such as Malaysia, the Republic of Korea, and the United Kingdom—have restructured their entire legal and regulatory frameworks to align with convergence and allow multiple players without restriction. There is also an emerging trend in Finland, Japan, and Moldova that simplifies licensing for some services.

Box 5: Implications of ICT convergence for industry

- Extend employee productivity with location-independent access to resources.
- Boost production efficiency across dispersed teams with collaborative tools.
- Minimize executive travel with high-definition videoconferencing.
- Customize products for specific industries:
  - **Education industry:** Improve access to education with modern distance education systems.
  - **Medical industry:** Transmit real-time data and vital signs to distant medical experts for better healthcare access in less-developed areas.
  - **Finance Industry:** Attract customers with 24/7 customized financial services.
  - **Governments:** Build safer cities with monitoring devices, reliable transmission networks, large data storage capacity, and smart analytics.

Policymakers today have the opportunity to promote competition as they undertake policy reform. Creating a competitive market for a variety of different service providers has been recognized as the most effective means to drive growth and encourage efficiency in ICT while reducing prices and improving quality. One way governments can encourage new market entry and subsequent investment in ICT is to remove restrictions on foreign ownership of licenses. This is particularly true in developing countries, where capital availability may be limited. In fact, foreign license regulations can impede ICT convergence. For example, when the Spanish telephone company Telefónica attempted to acquire a stake in Brazil's pay television provider Way TV, regulatory approval took about six months because of foreign ownership issues.

Some countries are introducing new regulatory tools to encourage network investment by smaller market players. Ireland, for example, has found that rather than imposing national broadband rollout and coverage obligations on large-scale operators, it can achieve greater success by allowing wireless broadband providers to enter small local service areas. This has led to a significant rise in new broadband subscribers in non-urban areas.[3]

Traditionally, countries have been very protective of access to government land by private industry. By streamlining and standardizing the application process for access to pole attachments and railway, electrical grid, and road rights-of-way, governments can stimulate the development of broadband infrastructure.

Box 6: How governments can facilitate ICT convergence

- Reform policies to promote competition and remove investment barriers:
  - remove restrictions on foreign ownership of licenses;
  - adopt rules to provide for infrastructure sharing of towers, ducts, and support facilities;
  - add mechanisms for managing radio-frequency spectrum;
  - encourage wireless broadband providers to enter small local service areas;
  - streamline the process for accessing rights of way and pole attachments; and
  - monitor dominant operators.
- Provide government incentives to firms that deploy advanced ICT services, such as:
  - interest-free credit;
  - subsidies, attractive loans to compensate providers who deploy networks in unprofitable areas; and
  - preferential tax rates.
- Invest in infrastructure and services:
  - fund the construction of open-access fiber optic networks;
  - fund digital education initiatives;
  - include network conduits in road projects or incorporate cable arrays in new electrical grids; and
  - support local community initiatives to provide broadband access.

Offering financial incentives

In addition to reforming policies, governments can accelerate ICT convergence by providing incentives to firms that deploy advanced ICT services. The government of Japan, for example, provided interest-free credit, subsidies, preferential tax rates, competition-enhancing rules, and other measures to promote the deployment and use of fiber optic broadband networks.[4] This helped Japan lead the world in fiber optic home subscriptions, with more than 8 million homes connected in 2007.

In 2010, the European Commission (EC) exchanged its old regulatory framework for one that recognized the need to stimulate large-scale fiber investments differently.[5] In the new regulatory framework, governments are allowed to subsidize the rollout of fiber networks in rural and unprofitable areas, and operators can adapt pricing regimes to different market contexts in different geographical areas. The EC expects commercial players to invest in more densely populated urban areas and public authorities to support development in more rural areas. Government can help cut commercial costs by (1) mapping suitable infrastructure, (2) ensuring that civil engineering projects involve potential investors and exploit synergies among all network infrastructures, and (3) clearing rights of way.

Investing in infrastructure

Finally, some countries facilitate ICT convergence by directly investing in infrastructure and services. Government investment can provide a significant advantage during the early stages of convergence and serves to make the government's policy stance clear to stakeholders (Box 6). One study demonstrated that connecting homes with fiber optic networks is financially feasible in cities only if more than 25 percent of homes subscribe, mainly because of the high costs of deployment.[6] Direct investment in community initiatives to provide broadband access can help cities defray deployment costs and jumpstart development.

As part of their investment in ICT convergence, governments can lead the development of advanced networks or create an open-access infrastructure to attract private investment. By 2008, 65 percent of households in France had broadband service,[7] and multiple service providers had benefited from the unbundling of the incumbent France Telecom network. Now national and local governments are investing in the rollout of open-access fiber networks that private service providers will pay to use. Included in this plan are opening sewers and conduits to allow competitive service providers to lay their fiber optic cables within already-existing networks. According to one estimate, this will reduce costs of network deployment by up to 60 percent.[8]

In 2007, the Australian federal government initiated the National Secondary School Computer Fund to ensure that students in grades 9 through 12 had access to school computers.[9] Other initiatives by the Australian government include a commitment of A$81.9 million over three years to fund the Vocational Education Broadband Network, which will create a single high-speed broadband network for post-secondary school training and further education.

Direct government investment in ICT includes risks and challenges. For example, a government's preferential treatment of one or more service providers could distort the market and potentially reduce competition. To address this issue, the EC created rules requiring justification for state intervention and an analysis of the impact of aid on competition in the market. In areas where competing private operators are present, the EC can prohibit state investment if intervention could crowd out existing or future investments by market players.[10]

CONCLUSION

Several factors have contributed to the rapid convergence of IT and CT, including widespread mobile phone penetration, innovations in smart devices, and the advent of cloud computing. As ICT convergence gains momentum, multiple networks will continue to converge, using a combination of IP and optical technology to drive down costs and improve the user experience.

Technology innovations at the level of cloud, pipe, and device are stimulating new industries to meet the expectations of consumers and enterprises for integrated services. As ICT convergence advances, integrated smart devices will gain prominence in homes and enterprises. These devices will use the cloud to support popular services and applications. Consumers will interact with each other and access information in new ways, providing the impetus for new businesses such as mobile phone–based shopping and payment services. ICT convergence will free employees from the office setting and boost production efficiency with collaborative tools such as videoconferencing that allow widely dispersed employees to come together as a single team.

Governments can play a key role in facilitating ICT convergence by creating a framework that promotes competition and innovation. New policies and the removal of regulatory restrictions can help stakeholders of all sizes expand their opportunities while improving access to information for residents in remote regions. Beyond policy reform, governments can stimulate investments through financial incentives. They can even directly invest in infrastructure and services as a way to empower their citizens and remain competitive with other countries. This three-stage process—reform policies, provide incentives, invest in infrastructure and services—provides a roadmap to economic development by encouraging technological innovation and meeting market demand.

NOTES

1 He et al. 2009.

2 See the *ITU Statistics Newslog: Mobile Applications* at http://www.itu.int/ITU-D/ict/newslog/CategoryView,category,Mobile%2Bapplications.aspx.

3 ITU 2006.

4 Dow Jones International News 2000, available at www.dowjones.com.

5 Beardsley et al. 2011.

6 Sigurdsson 2007.

7 Paul Budde Communication, 2009, available at http://www.budde.com.au/.

8 Paul Budde Communication 2008.

9 See details about this program at http://www.deewr.gov.au/Schooling/DigitalEducationRevolution/ComputerFund/Pages/NationalSecondarySchoolComputerFundOverview.aspx.

10 Papadias et al. 2006, p. 13.

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