

Fujitsu's Next-Generation Network Vision in 5G/IoT Era

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Our social and business environments are changing drastically with the development of ICT. Today, services provided through ICT are inseparable from our daily activities. Technical fields related to network technology anticipate a wide diffusion of the fifth-generation mobile communications system (5G), which is expected to open up new business opportunities for many enterprises. As business environments undergo such transformations, a network system able to meet diversifying customer needs is critical. To support digital transformations in various business settings, Fujitsu has designed a network architecture that flexibly adapts to diverse forms of ICT usage at customer sites that is suitable for the coming 5G/IoT era. This network architecture is comprised of three layers: one for digital business operations, one for physical networks, and one for connecting the previous two through virtual networks to coordinate their respective value-creation cycles. This paper outlines Fujitsu's perspectives on 5G/IoT era network requirements and describes the three-layered network architecture. It also discusses the creation of social value through this next-generation network.

1. Introduction

A wide variety of services are now being provided over the Internet thanks to advances in ICT. Furthermore, we can expect the rollout of advanced services using new technologies like AI, IoT, and blockchain via the Internet. Next generation networks will play an increasingly important role in providing and using these services.

In particular, the upcoming 5G/IoT era will see the appearance of services that merge the fifth-generation mobile communications system (5G) and IoT, both of which have been receiving much attention of late. Compared with existing technologies, those in the 5G/IoT era will feature a dramatic jump in network performance in the form of ultra-high-speed, large-capacity, and low-latency communications and an increase in the number of concurrent connections. This will require a network system that can effectively connect the real world (physical space) and the information-processing world (cyber space). The development of digital business is anticipated as a means of creating new value and revenues in the information-processing world.

This, in turn, will require the use of digital data to

represent the real world and the use of computers with exceptionally high computing power. Fujitsu intends to play a major role in connecting physical space and cyber space and to provide a network system that integrates digital services and next generation networks.

This paper describes business schemes that are changing due to technologies and services soon to appear in the 5G/IoT era, technology requirements related to 5G, and current trends in this area. It also describes Fujitsu's approach to next generation network systems for achieving digital business.

2. Diversification of needs and business schemes

Today, many enterprises are looking for and investigating IoT devices such as sensors or advanced solutions with the aim of making their business operations in the field more efficient. There are also enterprises that are looking to upgrade their interfaces between ICT and people/sites using the spread of 5G as an opportunity for making this change. The use of IoT is expected to enable the gathering of on-site information in an accurate and real-time manner, the grasping

of on-site problems, and the prompt solving of those problems. It is also expected to strengthen a company's core business and expand its business opportunities.

Up to now, ICT has been used to support corporate activities with the aim of raising the efficiency of core business operations such as product planning, production/order planning, and product support. More recently, however, IoT-related technologies such as sensors and user experience (UX) design have been progressing in addition to conventional ICT. At the same time, the framework of corporate activities has been broadening—examples include improvements in work environments such as creative digital spaces¹⁾ and teleworking, greater productivity through factory automation, and cost reductions and environmental response through eco (green) delivery (Figure 1).

The spread of 5G will create new possibilities in the real world on the end-user's side, such as dynamic advertising through the real-time processing of video, remote guidance through augmented reality (AR), and product experiencing through virtual reality (VR). In this way, networks controlled and managed by an enterprise will extend to sites where direct contact is made with end users. The following phases are essential to maximizing the effect of such extended networks:

1) Achieve smoother control of many and varied

devices as contact points at end-user sites (provide value/UX)

2) Obtain useful information from end-user sites (learn)

3) Handle acquired information safely and securely and convert to helpful information (decide).

The coming of the next generation network era will enable many enterprises to effectively use ICT by digitizing real-world information to achieve a beneficial value cycle in business.

3. New world driven by 5G/IoT

A cyber-physical system (CPS) that merges cyber and physical space in an advanced manner has been proposed as a mechanism for digitizing real-world information and providing new value to enterprises and society through ICT. This system can obtain a massive amount of information from a wide array of sensors in physical space and accumulate and analyze that information in cyber space using AI and other advanced technologies. The results of the analysis are fed back to physical space to solve diverse social problems (Figure 2).

In CPS, networks will play the role of connecting physical and cyber space. Functions for making such connections will become increasingly sophisticated

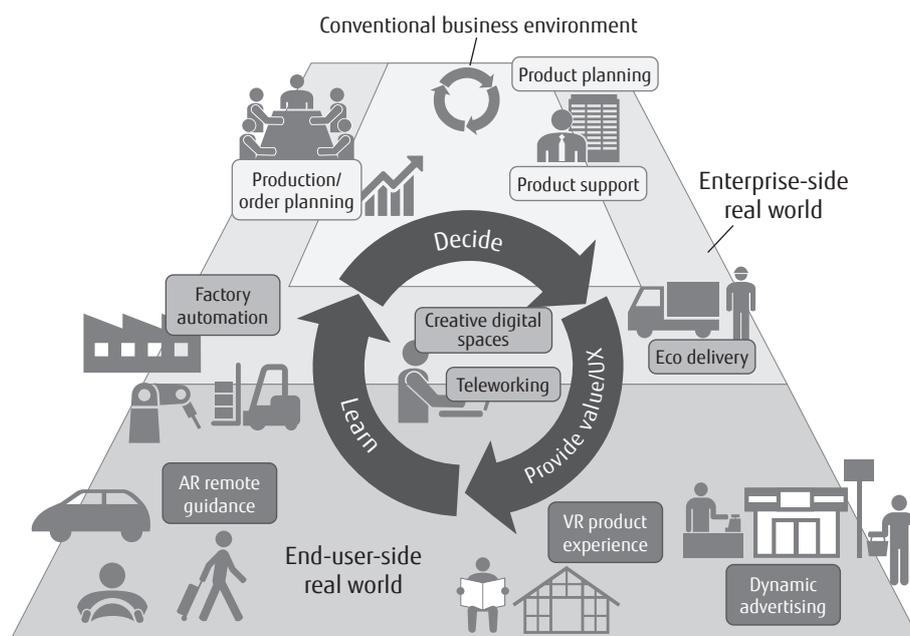


Figure 1 Transformation of customer's business environment.

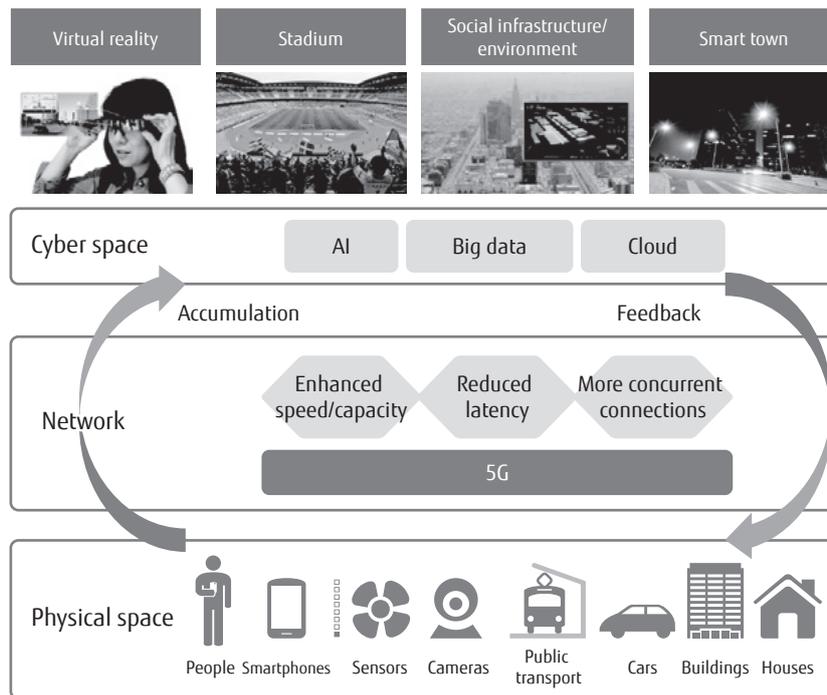


Figure 2
New world driven by 5G.

making it possible to connect to cyber space things in physical space that had not been connected before.

Compared with the current mobile communications system (4G), the aim of 5G is to achieve communication speeds and capacities more than 100 times greater, delay times one order of magnitude smaller, and concurrent connections more than 100 times greater in number. Features such as high-speed, large-capacity, and low-latency communications will make it possible to achieve heretofore unheard of real-time video services using AR, VR, and other technologies. In addition, an increase in the number of concurrent connections will enable attractive services for situations in which many people are gathered in one place such as event venues and sports stadiums. Also envisioned will be the application of 5G to services related to social infrastructures, environmental sensing, and smart towns that collect data in real time from a large number of sensors.

Compared with 3G centered about voice calls and text transfers and 4G centered about the Internet and mobile data communications, 5G will greatly change the way that enterprises and organizations use mobile communications. It will enable a deeper understanding

of information from end-user sites and therefore enable the provision of value and UX tailored to users and the enhancement and expansion of services.

4. Next-generation network architecture

The network architecture in the 5G/IoT era must be able to provide flexible support for usage forms that can change from moment to movement at end-user sites. Fujitsu's next generation networks vision features a three-layered network architecture: physical network, digital platform, and virtual network. Fujitsu plans to coordinate the operation cycles of each of these layers to roll out specific solutions and products (**Figure 3**).

4.1 Network architecture

1) Physical network

In the real world, services are provided in a variety of fields over the Internet. From here on, these services will become increasingly sophisticated requiring the networks to evolve accordingly toward high-speed, large-capacity, and low-latency communications and an increase in the number of concurrent connections. The physical network will support this evolution through

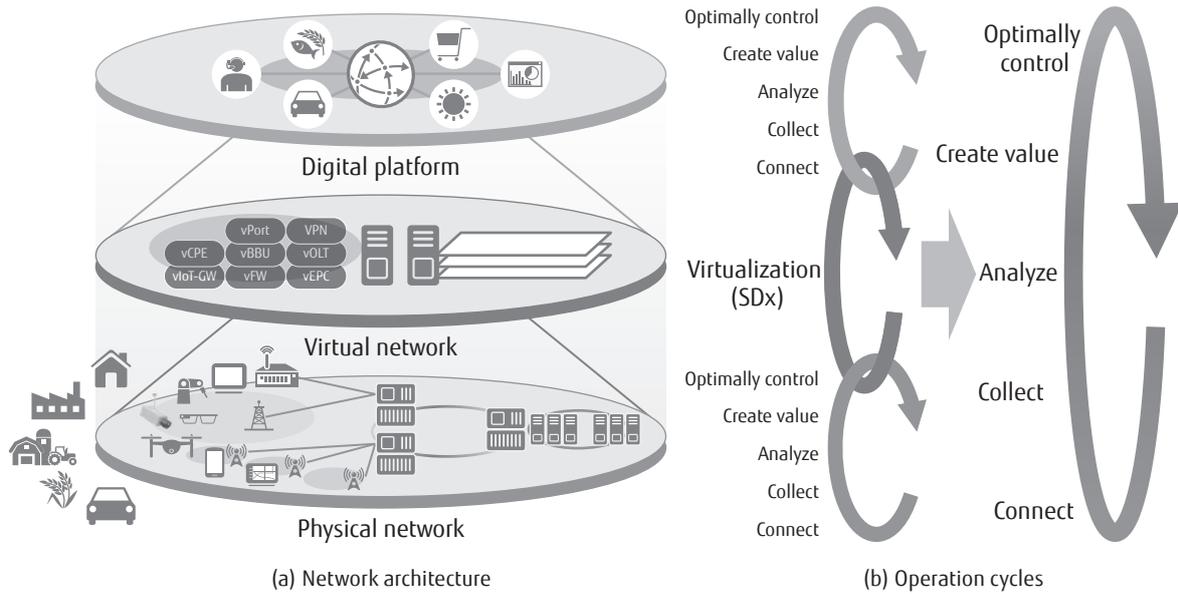


Figure 3
Next-generation network vision.

the use of diverse technologies such as millimeter-wave support and distributed antennas in the wireless technology area optical transmission technology supporting transmission speeds of 400 Gbps, and edge computing for distributing information processing.

2) Digital platform

Many kinds of things will come to be digitized through IoT and other technologies at business and manufacturing sites and living environments, and the results of that digitization will come to be consolidated and processed on a digital platform producing uniform data. In other words, new value will come to be created using AI analysis and other advanced techniques on the basis of on-site data, environmental information, etc.

3) Virtual network

The digital platform and physical network must be coordinated to enable users to make use of services in cyber space. On the other hand, handling the physical network having complicated functional layers and diverse devices directly from cyber space is difficult. So, the need arises for a virtual network to virtualize the physical network. The role of the virtual network will be to dynamically allocate network resources and provide optimal virtual network services for different users and usage forms on the digital platform.

For example, a high-reliability, low-latency service for a specific application in a certain time period could be provided as a virtual network service. Additionally, the physical network could be converted to Software-Defined Everything (SDx) by the virtual network so that the network as seen from an upper-level service or application can be handled on the same level as software.

4.2 Coordination of operation cycles

In general, the physical network will create new network value through the following operation cycle:

- 1) Establish network connections (connect)
- 2) Collect information on the network (collect)
- 3) Analyze the collected information (analyze)
- 4) Extract value leading to services and improvements (create value)
- 5) Optimally control the network (optimally control)

This procedure will facilitate the flexible allocation of network resources and the optimal provision of network services.

The digital platform, meanwhile, must repeat a cycle of new business creation in much the same way as the physical network. This cycle will connect various kinds of businesses and people, collect information useful for business, analyze that information to uncover value necessary for services, and construct and control

Table 1
Progress in digital transformation.

	On-demand and matching	Service creation and smartness
Digitize existing business (digitization)	<ul style="list-style-type: none"> • Convert infrastructure operations to software by SDN, NFV, and network disaggregation • Digitize business by AI, RPA, etc. 	<ul style="list-style-type: none"> • Convert products equipped with IoT technology such as connected cars to services • Equip infrastructures using remote operation of drones, devices, etc. with smart technologies (automatic driving, real-time facility monitoring, image analysis, etc.)
Create new business models (digitalization)	<ul style="list-style-type: none"> • Open API innovation by converting IoT services to APIs (Soracom, etc.) and expanding xxTech domains (Fintech, etc.) • Expand sharing economy with on-demand features (crowd sourcing, Uber, Airbnb) • Expand application of blockchain technology beyond virtual currencies (transaction recording for customer management, eco systems, etc.) 	<ul style="list-style-type: none"> • Expand data markets (new information businesses such as information banks and information trusts) • Expand subscription model (transition from product ownership to product use) • Expand service co-creation with different types of businesses (UNIQLO's virtual company concept, etc.) • Provide new user experiences (AI-based conversational UI, AR/VR, etc.)

SDN: Software-defined networking
 NFV: Network functions virtualization
 RPA: Robotic process automation
 API: Application programming interface

optimal business solutions for maximizing that value.

Finally, the virtual network layer will coordinate these operation cycles on the physical network and digital platform through SDx. This will have the effect of integrating these operation cycles and generating a new operation cycle over the entire three-layered structure to produce new value.

5. Social value creation targeted by Fujitsu

As described above, we can expect the fundamental role of a network to “connect” to expand considerably in the next generation networks of the 5G/loT era. In these networks, the connection between physical and cyber space will become increasingly advanced thanks to a 5G infrastructure, loT services, etc. In addition, the application of full-fledge virtualization technology to the connection of physical and digital spaces will greatly expand the level of network value creation. Applications based on blockchain technology and distributed computing already in use will increase on these infrastructures.

In short, the role of a network will evolve from one of connecting point A to point B to one that connects value beyond the traditional constraints of time and space.

In recent years, digital transformation (DX) has been gathering attention as a new trend in co-creation

between enterprises brought about by the use of loT. In particular, DX is seen as a progression from the digitizing of existing business (digitization) to the creation of new business models using digital technologies (digitalization). We can expect the domain of this social value creation to progress from “on-demand and matching” to “service creation and smartness” (Table 1).

Fujitsu has been advocating the concept of a “human-centric” approach as the core element of its future vision. Through its Fujitsu Technology and Service Vision published annually since 2013, it has repeatedly taken up the challenge of how best to create social value through “human centric innovation.” The 2018 theme was “Human Centric Innovation Co-creation for Success.”⁽²⁾ Here, Fujitsu considers that the role of an enterprise is to “drive innovation by connecting a wide variety of things and applying the knowledge derived from data to empower people” and that value creation comes out of co-creation between enterprises.

Focusing on the products and services that it will provide for the next generation networks, Fujitsu intends to intensify its role of connecting knowledge and value derived from diverse activities through the network.

6. Conclusion

This paper described Fujitsu’s approach to the next generation networks of the 5G/loT era with a focus

on a three-layered network architecture and associated operation cycles for creating new value.

In the 5G/IoT era, the role of a network will evolve from its traditional role of connecting "things" to one of connecting "value." Thinking that technical innovation will continue into the future and that networks will become increasingly important, Fujitsu seeks to provide solutions and products that can contribute to the success of its customers' business operations in an ongoing manner.

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