Opening the Future of Private 5G through Collaboration
Fujitsu's Private 5G Initiatives

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1. Introduction

Private 5G in Japan is currently in an introductory period, but with the institutionalization of private 5G in December 2020 together with increasing recognition and an increasing number of system launches, it looks to be entering a growth period. To this end and to broaden the type of use cases in which private 5G can be effective, many demonstrations using 5G have come to be performed such as "Development Demonstrations for Realizing Local 5G Services to Solve Local Issues"[1]. In the case of 5G, there are an extremely large variety of use cases and devices targeted for connection, and it is expected that 5G systems and services, in addition to being evolved forms of current systems and services, will break new ground and drive an increase in totally new communication scenarios. In particular, the construction of a system using private 5G will require a proposal for a comprehensive solution[2]. This will involve, for example, the construction and rollout of a high-reliability network with a level of performance optimal for the target use case and business scheme as well as the use of an advanced data center and cloud for using 5G functions to the fullest at the system level.

In this article, section 2 describes the institutionalization of private 5G in December 2020, section 3 explains the need for comprehensive solutions in the implementation of private 5G, and section 4 and later sections introduce a "partnership program" in which Fujitsu and partner companies integrate their respective know-how and products/services into systems with the aim of solving corporate and social issues.

2. Institutionalization Revision of Private 5G

Private 5G was first institutionalized with a partial frequency band (28.2 – 28.3 GHz) in December 2019[3]. Then, to support a variety of private 5G needs, an institutional revision was made including an expansion of private 5G frequency bands in December 2020[4].

Compared with the previously institutionalized millimeter-waveband, the added Sub6 band features a wide communication range robust to physical obstacles. The Sub6 enables early system construction using either a 4G-based non-standalone (NSA) system with Sub6 serving as an anchor for control signals or a standalone (SA) system using only 5G signals. This approach minimizes the number of devices needed to build a system and simplifies system construction, operation, and maintenance.

Main institutional revisions to private 5G including this Sub6 band addition are summarized below.

- Addition of Sub6 band (4.6 – 4.9 GHz)
- Expansion of millimeter-wave bandwidth (28.3 – 29.1 GHz)
- Use of another's ground (added to use of one's own grounds under certain conditions)
- Addition of anchor band (1.9 GHz)
- Simplification of modification procedures
- Addition of asynchronous/semi-synchronous operation

This new institutionalization of private 5G went into effect on December 18, 2020 and the acceptance of license applications for these expanded private 5G frequency bands commenced on the same day. Applicants included manufacturers, regional communication operators, universities, and regional public bodies[5]. Fujitsu also submitted license applications for its in-house developed Sub6 SA system and for millimeter-wave frequency-band expansion at multiple bases including Fujitsu manufacturing plants.

At the Fifth Generation Mobile Communication Promotion Forum (5GMF)[6], the Regional Utilization Promotion Committee where I serve as deputy chairman has created and released a manual that details the procedures involved in applying for private 5G licenses with a focus on participating companies[7]. The latest version of this manual reflects the institutionalization of private 5G in December 2020.

3. Need for Comprehensive Solutions

Fujitsu received Japan's first commercial private 5G license from the Kanto Bureau of Telecommunications, Ministry of Internal Affairs and Communications (MIC) in March 2020[8] and begin operating a private 5G network at its Shin-Kawasaki Technology Square office (location: Kawasaki City, Kanagawa Prefecture)[9]. With this network, Fujitsu will implement crime-prevention measures in the building by using private 5G to transmit high-definition video collected by multi-point cameras and analyzing various types of human behavior by AI thereby achieving a security system that can detect suspicious behavior early. System configuration is shown in Figure 1.

A surveillance system of this kind requires the construction of a system that can perform detection through video and data collected from on-site high-definition cameras and a variety of sensors, accurately determine on-site conditions by analyzing that video and data, and immediately feed back analysis results to that site. It is important here that the 5G features of high speed and large capacity, low latency, and massive connectivity be used to the maximum as needed in a flexible manner. However, a high-performance surveillance system cannot be achieved by providing 5G support for only base stations and terminals. In other words,

Figure 1: Configuration of security system using private 5G

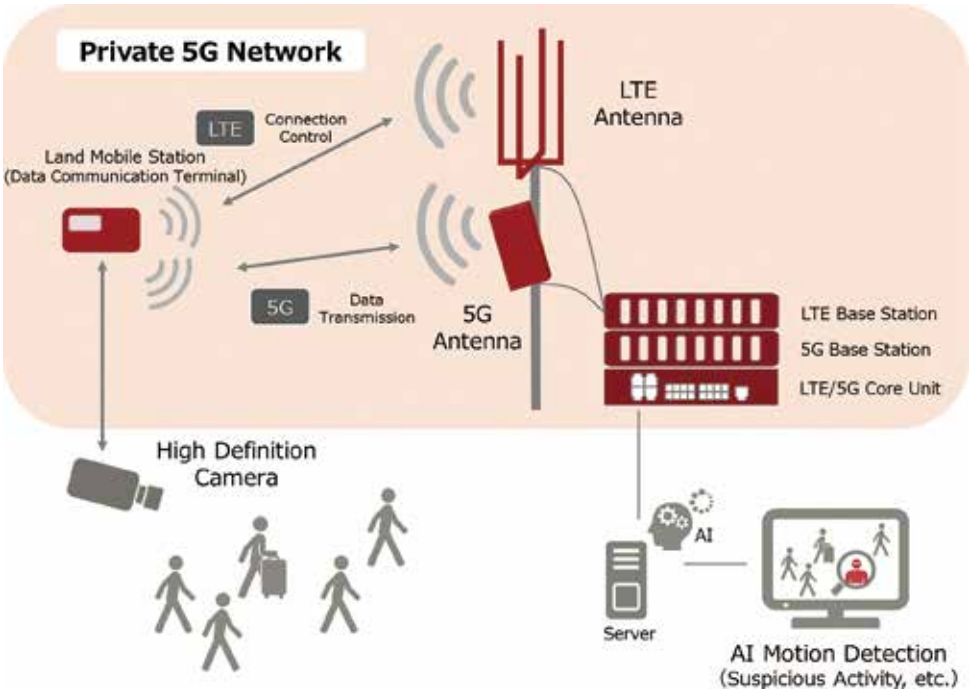

Figure 2: Fujitsu Collaboration Lab

a comprehensive combination of technologies is essential, such as digitalizing real-world information at "sensors," converting that information to value by "AI," and connecting that value by "5G" while ensuring "security." Linking technologies in this way has the potential of creating new work styles never before imagined and revolutionizing not only the means of doing business but business itself.

4. Private 5G Partnership Program

Putting technology to practical use while co-creating with diverse partners and fostering innovation is an important key to solving a variety of social issues. To this end, Fujitsu has established a "Private 5G Partnership Program"[10] to integrate solutions based on the knowledge and products/services of Fujitsu and its partner companies and "Fujitsu Collaboration Lab"[11] (Figure 2) (location: Kawasaki City, Kanagawa Prefecture) as a facility for verifying those solutions.

In this way, Fujitsu is providing private 5G network technology and a wide range of industry know-how at the program's site to create and realize private 5G use cases together with partner companies possessing advanced technologies. Support is also provided for implementing use cases at customers' sites. In addition to testing connections to a private 5G network, participants in the Private 5G Partnership Program can create

solutions that include devices and applications of partner companies and propose solutions to specific problems. The Private 5G Partnership Program consists of the following two subprograms:

(1) Connection verification program
(2) Solution co-creation program

4.1 Connection verification program

This program verifies interoperability between Fujitsu's network and products to be connected to a private 5G network. The testing consists of connection verification and performance tests, and determining the actual items to be tested according to the types and specifications of target devices (which may include a variety of sensors, cameras, unmanned vehicles, and IoT gateways) is included. Fujitsu is testing private 5G terminals in collaboration with Japanese and overseas partner companies with the support of communications chip manufacturers and is working on expanding the lineup of private 5G terminals that currently come in only a few types.

4.2 Solution co-creation program

This program drives business innovation and co-creates solutions to problems faced by companies and society using private 5G by integrating Fujitsu's network technologies and wide range of industry know-how with the products, services, and advanced technologies of partner companies. It features the following three components.

(1) Collaborative study of co-created solutions

Performs collaborative studies of solutions based on the devices, private 5G, applications, knowledge, etc. brought by each company participating in the Private 5G Partnership Program

(2) Tests and demonstrations of co-created solutions

Performs technical tests of collaboratively studied solutions within a private 5G network environment

(3) Collaborative demonstrations and proposals

Performs collaborative demonstrations and proposals with respect to studied solutions for companies and local governments that are contemplating the introduction of private 5G.

5. Fujitsu Collaboration Lab

This section introduces Fujitsu Collaboration Lab as a facility for co-creating solutions using private 5G and verifying connection with a variety of devices.

The private 5G network presently being used at this facility is configured with a NSA system consisting of millimeter-wave 5G and 2.5-GHz-band 4G and a Sub6 SA system as well. In addition to private 5G network equipment, Fujitsu Collaboration Lab provides a variety of measuring instruments and monitors as well as the equipment and materials needed for reproducing a pseudo environment for radio-wave propagation. These provisions enable the construction of a test environment corresponding to the target usage scenario. The facility is also equipped with 4K cameras and other devices that enable testing using the "transmission of high-definition video" based on the private 5G feature of stable, large-capacity communications (Figure 3). There is also a space for conducting tests with partner companies and a working area for development work and meetings, all of which facilitate connection verification and solution co-creation.

6. Example of Solution Co-creation

This section presents an actual example of solution co-creation. In this example, Fujitsu collaborated with Microsoft Japan Ltd. to verify the effectiveness of a system that uses private 5G to visualize data within a manufacturing site in real time with a view to the digital transformation (DX) of manufacturing sites[12].

Using Fujitsu's private 5G network at the Fujitsu Collaboration Lab, this system analyzes high-definition video of people, unmanned vehicles, etc. moving within the facility and operating data obtained from cameras, mobile terminals, servers, and other devices on an edge-computing platform. It also performs unified visualization of human behavior, the control of unmanned vehicles, and equipment operating conditions on industry applications. Integrating private 5G with edge computing and a cloud system in this way achieves a system optimized for network and application processing loads.

Figure 3: Connection verification environment

6.1 Purpose of test

The purpose of this test was to verify the usefulness of a private 5G use case envisioned for manufacturing sites and the effectiveness of a system that integrates edge computing using private 5G and a cloud system.

- Verify the effectiveness of integrating a private 5G network with an edge-computing platform and cloud system
- Achieve video analysis and real-time processing through edge computing
- Achieve uniform management of site equipment and information on the cloud

6.2 System overview

System overview is shown in Figure 4. In this test configuration, the system uses edge computing to perform AI analysis of large-capacity video data with the aim of achieving "real-time sensing by high-definition video analysis" using private 5G. It also implements a cloud-linking function for visualizing the analyzed real-time data, performing a statistical analysis on that data, and linking analyzed data between sites. The system includes a distribution function for edge servers to support version upgrades of AI functions.

(1) Transmit high-definition video capturing the movements of people and unmanned vehicles and operating data obtained from mobile terminals, servers, and other devices to edge computing via private 5G

(2) Perform video analysis by AI of the movements of people and unmanned vehicles on the edge-computing platform and use the results of analysis to perform remote control (Figures 5 and 6)

(3) Transfer analyzed data to the cloud system

Figure 4: Test configuration of system integrating private 5G, edge computing, and cloud

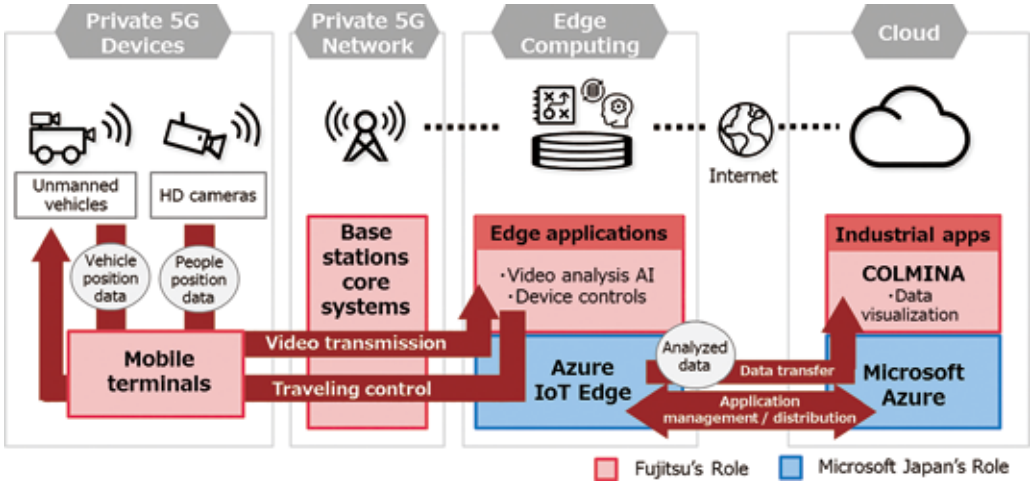

Figure 5: Joint testing of high-definition video analysis using edge computing

Video analysis (edge computing) Testing work

Figure 6: Joint testing of unmanned vehicles using edge computing

Video analysis, position detection (edge computing)

Prototype of unmanned vehicle equipped with a camera and 5G communication module

Figure 7: Dashboard display screen (cloud)

(4) Coordinate business applications on the cloud system and visualize the accumulated analyzed data (density of people, positions of unmanned vehicles, paths of movement, operating conditions of high-definition cameras, mobile terminals, servers, and other devices within the site) on a dashboard (Figure 7).

(5) Manage the versions of edge applications such as AI-based video analysis on the cloud system and distribute applications to edge computing.

6.3 Test results

We achieved a system optimized for network and application processing loads by integrating private 5G, edge computing, and a cloud system. This confirms that the system is effective for operating unmanned vehicles and performing remote monitoring/control using high-definition video as envisioned for manufacturing sites.

At Fujitsu's Oyama plant (location: Oyama City, Tochigi Prefecture), a manufacturing base for Fujitsu network equipment, Fujitsu is working with Fujitsu Telecom Networks Limited, which is involved in the manufacturing of this equipment, to test the utility of products and systems tested in the Private 5G Partnership Program. Here, the plan is to test support for work procedures and the running of unmanned vehicles using high-definition video and AI.

7. Conclusion

This article explained the need for comprehensive solutions toward the use of private 5G and described a partnership program now in progress.

Looking to the future, we can expect private 5G to undergo a wide rollout to solve a variety of issues and to be widely used in projects to provide support for solving both corporate and regional issues. Through its partnership program, Fujitsu seeks to contribute to the solving of diverse social issues by engaging in co-creation activities with a wide range of partners and combining Fujitsu and partner technologies in an integrated manner.

References
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Cover Art

Kyotomeishonouchi Gionsha Secchiyuu (Gion Shrine in Snow)

Utagawa Hiroshige (1797~1858)

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