

Role of Anritsu 5G LAB in Resolving Industrial Digital Transformation (DX) Challenges

Satoshi Sasaki, Koichi Ryu, Genya Yatsu, Koji Arimochi, Yoshiaki Niwano, Tsutomu Konishi, Makoto Fujii

[Summary]

Progress in digital transformation (DX) using IoT and AI technologies in various industries is advancing against the social background of labor shortages. Collecting digital data to manage factory equipment, monitor cameras and control robots, etc., over a digital network faces key challenges such as not only analyzing network faults, but also predicting and preventing problems. This article introduces Anritsu 5G LAB leveraging our company's long experience in data communications and measurement technologies as a site to test network technologies forming the basis of industrial DX, solve issues, and co-create valuable information freely with customers.

1 Introduction

Progress in digital transformation (DX) is increasing expectations for local 5G as one technology for resolving challenges, such as labor shortages in various industries.

Local 5G is not a communications carrier's business but is instead a dedicated 5G network system installed in buildings and on sites owned by businesses and local governments. The first applications for a license to operate a wireless station were accepted in December 2019, and by late January 2024 there were 1,311 stations operating in the 4.8 GHz band (sub-6 GHz) and 123 stations in the 28 GHz band (mmWave).

Like commercial operators' 5G communications businesses, Local 5G not only features high speed and capacity communication, low-latency, multi-user connections but also has the advantages of high security and resilience to the impact of external traffic due to usage-based design of base stations and networks. Consequently, this technology is being developed widely by businesses and local governments on construction sites, in factories, at disaster-prevention locations, etc. (Figure 1).

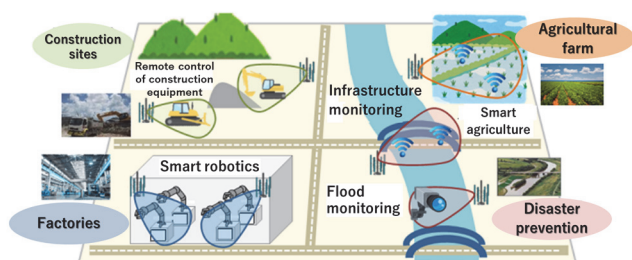
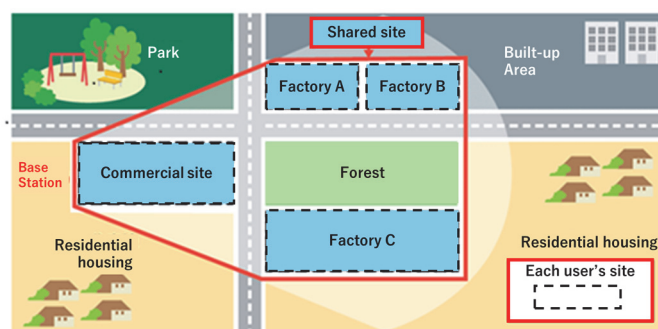


Figure 1 Quoted from FY2020 Ministry of Internal Affairs and Communications Report on "Validating Development of Local 5G, etc., for Solving Regional Issues"

Moreover, since 2023 a shared-use concept has started to develop under certain conditions where Local 5G access is shared between one owner's site and another site, supporting flexible introduction of the technology (Figure 2).



Source: FY2022 Report from the New Generation Mobile Communication System Committee of the Ministry of Internal Affairs.

Figure 2 Shared-Use Concept

However, introduction of Local 5G requires similar work procedures to those of communications operators, ranging from selection of equipment to area coverage design, acquiring wireless license, and post-installation operation and maintenance, all of which require high-level skills that can present major challenges for businesses, local governments, and system integrators (SIer). In addition, due to most of the regarding technologies are still in the demonstration stages, there are few practical environments where people can experience how local 5G can be used to solve local issues faced by business, local governments, and the other organizations yet.

As a result, Anritsu opened the Anritsu 5G LAB (5G LAB) in April 2021 to promote understanding of Local 5G and support technical validation by introducing Local 5G use cases and innovations. The 5G LAB is helping implement smart factories as part of Japan's industrial DX as well as solve

challenges in operating and maintaining Local 5G systems (Figure 3).



Figure 3 Local 5G Service Solutions

This article explains the role of the 5G LAB in supporting solutions for industrial DX challenges using Local 5G in different business fields.

2 Establishment Approach

A project team was established in July 2020, targeting the start of 5G LAB operations in April 2021, and investigation of millimeter wave (mmWave) base station designs was started.

The functions and performance of base stations from both Japanese and overseas makers were compared and a Nokia product was selected due to its excellent functions, performance, availability, and cost. To acquire knowledge about the procedures from obtaining a radio license to starting operations, each of these procedures were handled by ourselves. Figure 4 shows the required stages from obtaining the license to starting operations.



Figure 4 Local 5G Base Station Qualification Process

2.1 Area and Site Design

The area coverage and site designs to minimize interference are the most important procedures in obtaining a license.

A key principle in deploying Local 5G is use only within owned sites and structures and taking strong countermeasures to prevent radio waves leaking outside the above range and stop radio interference with other radio stations. On the other hand, the radio wave must be easily available within the usage range, requiring careful planning to satisfy both needs by simulating changing base station conditions, such as output power, and antenna height, gain, and directivity to

design the area and site and create the final distribution map in conformance with the license standards. The distribution map is created using the commercial coverage simulation KCAMP software from KOZO KEIKAKU ENGINEERING Inc. (Figure. 5).



Creating Heat Map by Processing Geographic Tiles

Figure 5 Local 5G Base Station Coverage Simulation

2.2 Interference Adjustment

The distribution map created by KCAMP shows the radio wave power range in the 5G LAB coverage area as well as areas where there may be an impact on other services (Adjustment target area). In addition to use as reference materials at inspection by the Ministry of Internal Affairs and Communications (MIC), the created map was also used for adjusting to prevent outside leakage and interference with nearby communications operators. An application was made to MIC after exchanging the agreement documents and the 5G LAB received a license in February 2021.

Licensing of the NEC Sub-6 GHz base station used the same procedure as the mmWave base station. The license was obtained, and operations started in February 2022.



Figure 6 28 GHz Band Local 5G Base Station



Figure 7 4.8 GHz Band Local 5G Base Station

3 Role of 5G LAB

The role of the 5G LAB includes radio wave visualization using instrumentation, measurement and verification services for brought-in systems and demonstration test of use cases.

3.1 Observing Waveforms with Test Instruments

Although there are expectations for using Local 5G as a high reliability wireless network technology for mission critical applications, sometimes the wireless environment is affected by small changes in the local environment, such as the movement of people and vehicles and changes in the layout. The 5G LAB uses resources, such as test instruments and metal shields, to analyze the impact of obstructions, reflections, multiple transmission paths, etc., on changes in the radio-wave power, transmission speed, and latency. The information obtained by this analysis can be used to test equipment layouts and troubleshoot problems to help optimize the site design and prevent faults.

Securing optimum area coverage as well as stable communications quality requires both simulation and actual survey evaluations. The 5G LAB uses measurements with test instruments for evaluating coverage to visualize the impact of people in the vicinity of the base station and UE, changes to structures, etc., on radio-wave propagation that simulations are unable to determine.



Figure 8 Visualizing 5G Waveform using Test Instrument

5G operators commonly want to continuously monitor changes in the radio environment from moment-to-moment. As a result, we developed the Local 5G performance monitor (EX1001A) to visualize radio waves by combining the results of simulated radio-wave propagation technology and actual measurements using multiple probe terminals capturing data simultaneously at multiple test points. This supports visualization of radio waves as a heat map as well as confirmation of the status before and after faults using time-series graphs (Figure 9).

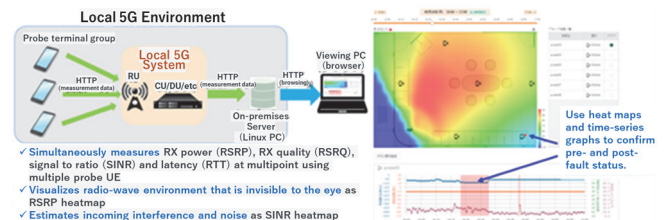


Figure 9 Performance Monitor Outline

The performance monitor is being tested in a 5G LAB environment to verify its usefulness and to improve its functions while discussing needs and issues with visiting customers.

3.2 Testing and Validating Visitors' Carry-in Systems

To stably use the system developed in the 5G environment, we have built an environment that can evaluate communications stability, improve dead zones, and evaluate communication performance.

(1) Evaluating Communications Stability

A customer system (real-time viewing system for in-vehicle camera images using local 5G) was experiencing noise in the video, and there was a consultation to solve the problem. As a result of comparing and verifying the measured values of each of the customer

system and 5G LAB, it was possible to analyze that the instantaneous transmission delay (spike delay) was the cause of the noise (Figure 10).

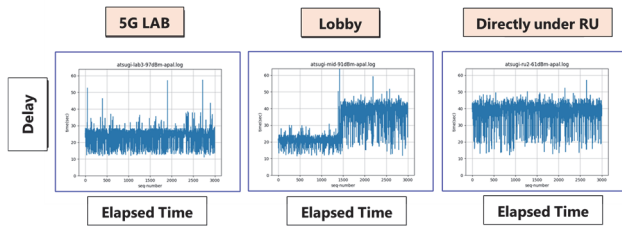


Figure 10 Comparison of Latency Measurements

(2) Improving Dead Zones

Reflectors are expected to guide radio waves in the highly linear 28 GHz band to areas that cannot be reached from the base station and were evaluated using the 5G LAB environment.

The 5G LAB evaluated an approximate 10 dB improvement in the strength of highly directional 28 GHz band radio waves by using a reflector plate to divert the signal from the base station into a dead-zone region created intentionally using a metal plate (Figure 11).

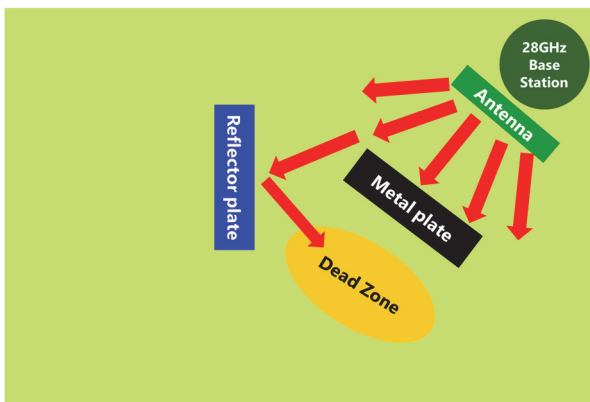


Figure 11 Reflector Evaluation Configuration

(3) Evaluating Communications Performance

5G LAB provides the required environment for measuring the communications performance, such as throughput and propagation latency of customers carried-in systems.

For customers testing introduction of Local 5G at their own factories, there can be issues with wireless propagation delays for industrial controller equipment, such as Programmable Logic Controllers (PLC). Consequently, 5G LAB examines the possibility of adopting Local 5G using the Monitoring Manager3

(NF7201A) and PureFlow (NF7501A) to monitor, collect, and analyze actual traffic data and measure propagation delay (Figure 12).

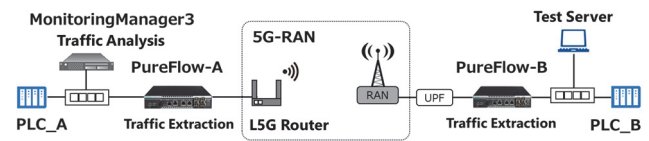


Figure 12 Typical Configuration for Measuring PLC Communications Delay

3.3 Proving Use Cases

5G LAB is a site for testing possible Local 5G use cases, such as control of aerial drones, a field with potential to change society.

When inspecting key social infrastructure, such as bridges and wind-power generators, drones must transmit video in real-time to a remote operator. Currently, video data is recorded to an onboard SD card, frequently requiring a return flyby if there is missing data.

By testing the usefulness of real-time video capture, 5G LAB helps clients obtain an experimental license to operate a drone with onboard Local 5G to advance examination of actual future operation.

4 5G LAB Usage Status

Since its 2021 opening, 5G LAB has been used by more than 300 companies from a wide range of fields, including Local 5G Sier, business handling service applications, and factories testing Local 5G introduction to promote understanding of potential solutions and building of collaborative relationship.

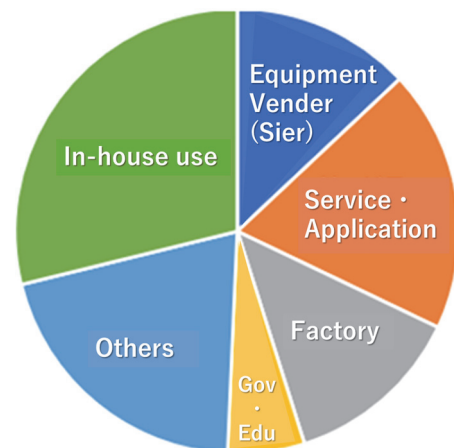


Figure 13 5G LAB Users

5G LAB is even used in-house by Anritsu. For example, it is used for various purposes, including development, and testing of Local 5G equipment; to prepare exhibition demonstrations; for in-house training and recruitment activities; for stockholder announcements; neighborhood school social studies visits, etc. In addition, 5G LAB helps understand and gather knowledge about the real challenges in configuring and operating Local 5G environments.

5 Collaborating with Partners

Due to worker shortages and work style reforms, how to reduce workloads and improve efficiency have become problems at construction sites and in factories.

As a result, there are high hopes for technologies to observe production status using high-definition video and low-latency video transmissions facilitating remote control of construction machinery as well as for AI technology to quickly ‘understand’ and analyze factory problems.

5.1 Partnering with Low-Latency Camera Technology

While 5G technology facilitates low-latency data transfer, real-time video streaming required for remote operation cannot be achieved using conventional cameras.

Konica Minolta Inc. (Konica) is researching the latest technologies for monitoring people’s safety and security using video and is in the process of developing low-latency cameras but faces challenges at the live-network evaluation stage.

To solve these issues, Anritsu’s 5G LAB in Kanagawa Prefecture and Konica’s 5G Open Laboratory in Osaka were network connected using Anritsu’s traffic analysis system to evaluate low-latency camera transmission performance. Moreover, mobile robots with built-in low-latency cameras have been remote-controlled over 5G to confirm the possibility of unmanned inspection work. Additionally, both Anritsu and Konica are working to understand how issues other than latency, such as jitter and packet loss degrade video quality, etc.

5.2 Partnering with AI Technology

Konica has AI technology for recognizing people and things from camera images and is exploring use cases to support on-site monitoring operations.

Food processing plants face many problems with labor shortages and worker monitoring to prevent accidents and contamination. To solve these issues with easy-to-

understand use cases, the 5G LAB is conducting a demonstration of detecting human falls and intrusions by skeletal detection that combines video surveillance and AI technology. Both Anritsu and Konica use the 5G LAB with these new technologies as a marketing test site.

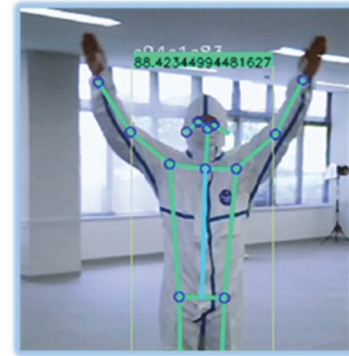


Figure 14 Frame Detection using AI Technology



Figure 15 Example of Fall Detection Warning

6 Conclusions

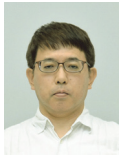
Opening the 5G LAB, obtaining a license, and building our own test environment taught us a lot about supporting businesses examining Local 5G introduction. Additionally, the 5G LAB proved its value in collaboration with partners with use-case demonstrations in a 5G environment using Konica’s leading technologies and as well as in partnering with customers aiming to create AI solutions.

Future plans are to create an environment not just for advanced-technology businesses but also to create value for other business types, such as power-related businesses working in carbon-neutral energy and local governments promoting infrastructure resilience during natural disasters.

Authors



Satoshi Sasaki
1st Sales Dept.
Sales Div.
Environmental Measurement Company



Koichi Ryu
2nd Business Development Dept.
Business Development Div.
Environmental Measurement Company



Genya Yatsu
2nd Business Development Dept.
Business Development Div.
Environmental Measurement Company



Koji Arimochi
3rd Business Development Dept.
Business Development Div.
Environmental Measurement Company



Makoto Fujii
3rd Business Development Dept.
Business Development Div.
Environmental Measurement Company



Yoshiaki Niwano
3rd Business Development Dept.
Business Development Div.
Environmental Measurement Company



Tsutomu Konishi
3rd Business Development Dept.
Business Development Div.
Environmental Measurement Company

Table 1 Local 5G Base Station Specifications

	4.8 GHz Base Station	28 GHz Base Stations	
System Type	5G SA	5G NSA	
Band	n79	B41	n257
Center Frequency	4849.98 MHz	2585 MHz	28249.92 MHz
Communication Technology	TDD (Synchronous)	TDD (Synchronous)	TDD (Synchronous)
Bandwidth	100 MHz	20 MHz	100 MHz
Antenna Power	4.58 W	0.312 W	0.126 W
TRx Systems	2	2	192 (V: 96 H: 96)
Antenna Type	Omni	Omni	Active Phased Array
Beamforming	Not supported	N/A	Supported
Modulation Method (Primary Modulation)	UL: QPSK 16QAM 64QAM DL: QPSK 16QAM 64QAM 256QAM	UL: QPSK 16QAM 64QAM DL: QPSK 16QAM 64QAM 256QAM	UL: QPSK 16QAM 64QAM DL: QPSK 16QAM 64QAM 256QAM
MIMO	UL: SISO DL: 2×2	UL: 2×2 DL: 2×2	UL: 2×2 DL: 2×2

Publicly available