

Technology Reports (Special Articles)

Consumer Services

Corporate Solutions

Network Customization

Special Articles on 5G (2)—NTT DOCOMO 5G Initiatives for Solving Social Problems and Achieving Social Transformation—

Services and Solutions in 5G Communications

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In March 2020, NTT DOCOMO launched 5G services. At the time, utilizing 5G features such as high speed and large capacity, NTT DOCOMO provided seven consumer services such as “Shintaikan Live CONNECT,” which enables multi-angle (multi-viewpoint) and VR live viewing, and 22 corporate solutions.

In this article, we describe 5G consumer services, corporate solutions, and the Network Customization service that supports them.

1. Introduction

When NTT DOCOMO launched its 5th Generation mobile communication system (5G) commercial services in March 2020, it leveraged 5G features such as high speed and large capacity to provide consumers with seven services, including

“Shintaikan Live CONNECT,” which enables multi-angle (multi-viewpoint) and Virtual Reality (VR) live viewing. In addition, for business-to-business areas, as part of efforts to create new use scenarios with a wide range of partners, NTT DOCOMO has been providing the DOCOMO 5G Open Partner Program™ since February 2018, and to date demonstrated

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over 300 5G usage models through co-creation with partners. In addition, at the start of services, NTT DOCOMO began providing 22 solutions, focusing on potential solutions to social issues such as industrial sophistication, urban development, and work style reform.

In this article, we describe consumer services, three solutions of the 22 corporate solutions, and the Network Customization service that supports them.

2. 5G Services

2.1 5G Consumer Services

Consumer services are designed to provide unique experiences to users through NTT DOCOMO's proactive efforts to create brand new, never-before-seen user experiences by combining elements that can be realized with 5G such as 8KVR, multi-angle viewing and XR^{*1}. We believe that the four main areas of 5G in recent times are music and live performance, games, video, and sports, which can easily and directly reflect the characteristics of 5G. In this article, we describe the services provided by NTT DOCOMO in these four areas.

1) Music/live Performance

In the music and live performance area, we offer "Shintaikan Live CONNECT." Shintaikan Live itself has been around since before the advent of 5G, offering new online experiences for live music, such as multi-angle video distribution, AR figures^{*2}, TIG Live^{*3} and comment functions, but by leveraging 5G technology, "Shintaikan Live CONNECT" has further evolved as a video distribution service. Specifically, it has evolved to become an 8K VR live service that enables real-time viewing of 360-

degree VR footage captured by 8K cameras installed in live performance venues. Users can also wear VR goggles and watch via a smartphone to enjoy immersive video that feels like being in the front row of the venue. "Shintaikan Live CONNECT" continues to evolve as a service to enable artists and fans to connect, or fans to connect with each other, and enable new ways to enjoy live performance.

Next, we introduce "Heart-to-Heart Communication - BORDERLESS LIVE 5G" VR live performances by virtual artists in "Live broadcast anime, Intuition × Algorithm ♪," a virtual idol-themed anime created by a Chinese-Japanese cooperation. Transcending limitations such as national borders, BORDERLESS LIVE 5G lets viewers enjoy live events unique to the virtual.

2) Games

High-speed, high-capacity 5G streaming technology will dramatically change the user gaming experience. What was previously enjoyed by purchasing packaged software or by downloading it online is now available in the cloud, and the big hit titles with their massive data, which were mainly played on gaming consoles in the home, can now be played easily on smartphones.

"d Game Play Tickets" provided by NTT DOCOMO lets users play large capacity, console-like games without having to download an app. With d Game Play Ticket, we plan to offer many titles of cloud-based games in the future. Here, we introduce two highly-attractive consumer game titles already offered. The first one is "DYNASTY WARRIORS 8 (Shin Sangoku Musou 8)" from Koei Tecmo Games. This popular action game set in the world of "Romance of the Three Kingdoms" is also offered in a 4K version that takes advantage of high speed and

^{*1} XR: A generic term for Augmented Reality (AR), VR, Mixed Reality (MR), etc.

^{*2} AR figure: A miniature artist that appears in 3D when the user holds a smartphone over to artist goods printed with AR markers.

^{*3} TIG Live: Enables transition to mail-order sites, etc. when the

user touches an object in live video.

large capacity of 5G. The second one is Square Enix's Final Fantasy XV. This is the immensely popular and well-known RPG game.

In addition to the d Game Play Tickets, "Evan-gelion Battlefields," a smartphone game app based on the popular "Evangelion" anime has been customized for NTT DOCOMO 5G. This game enables multiple players to simultaneously match via 5G. In addition to the games introduced in this article, a variety of game titles will be provided in the future, and we will strive to improve new game experiences that make the most of 5G features.

3) Video

We believe that XR and multi-angle viewing will become the standard for 5G-era video. Here, we introduce three services provided by NTT DOCOMO for this new video viewing style.

The first is "Disney VR." Together with Walt Disney Japan, NTT DOCOMO has been offering "Disney Plus" since June 2020 and it has been well received. Now, we offer "Disney's MYTH: Anna and the Snow Queen/Hidden Myth" as the latest VR content. This is the first VR short story set in the world of Disney Animation Studio's feature film "Anna and Snow Queen 2," and is exclusively offered by NTT DOCOMO in Japan. The provision of a trial version of this VR content has commenced in 102 docomo shops across the country.

The second service is two new types of content available through d Anime Store. The first content on offer is "vertical-horizontal content" that utilizes the automatic rotation function of the smartphone screen to switch video by simply changing the orientation of the smartphone while playing back video. First on offer is music videos of a group called Tokyo Jihen when the screen is sideways, and

animations produced by "Kamikaze Douga" viewable when the screen is upright. The second on offer is content that supports multi-angle viewing. The aforementioned "Shintaikan Live CONNECT" multi-angle function lets users freely view 2.5-dimensional stage works based on the highly-popular anime "Kimetsu no Yaiba" by choosing from various positions and angles. This is a new viewing style for the 5G era.

The third service is the "Hikari TV for docomo" multi-streaming function. This 5G smartphone-dedicated function enables up to seven programs to be viewed simultaneously from among the mobile-dedicated channels available on Hikari TV for docomo. Users who want to watch multiple programs simultaneously are happy with this service as it lets them watch their favorite sports matches or keep an eye out for the appearance of their favorite artists that they do not want to miss on music programs while watching other programs.

NTT DOCOMO provides these three services in the video area, and plans to continue to focus on providing new 5G-era video services.

4) Sports

In the sport area, NTT DOCOMO has taken a range of initiatives as a top partner of the Japan Professional Football League (J.League). On Sunday, September 27, 2020, we partnered with Kashima Antlers to provide a new game watching support service leveraging 5G that can be experienced at the stadium, including real-time viewing of video of the game from multiple angles not visible from one's stadium seat, replay viewing at any time, and easy visualization of stats.

From this season, NTT DOCOMO will also become a top partner of the Japanese Table Tennis

League (T.LEAGUE) and use cutting-edge technologies such as multi-angle viewing, 360-degree cameras, XR, AI highlights, and automatic stats generation to provide new viewing experiences to users by collaborating with T.LEAGUE going into the third season. In addition, while promoting joint planning of official services including digital content of player trading cards, the NTT Plala remote production functions^{*4} will be advanced to maximize the spectator experience such as match video and arena production viewing while achieving operational efficiency. Through these efforts, NTT DOCOMO is striving to expand the potential and value of sport.

The above introduced 5G services NTT DOCOMO provides in four areas. Nevertheless, we will further evolve our initiatives to provide new experiences to users and continue to make every effort to create new value for the era of high speed and large capacity through 5G popularization.

3. 5G-enabled Solutions

3.1 Remote Work Support Solution “AceReal® for docomo”

AceReal for docomo is a remote support and technology transfer solution for on-site workers created through collaboration between SUNCORPORATION and NTT DOCOMO. By transmitting footage of cameras mounted on AceReal to remote locations, skilled workers in remote locations can support on-site workers as if they were at the work site (Figure 1).

AceReal for docomo is a service that combines hardware and software. The service enables highly confidential information to be exchanged without any Internet connection through a cloud server constructed on DOCOMO Open Innovation Cloud (Figure 2).

At Tokyo Reiki Kogyo Co., Ltd where AceReal was implemented, work time was reduced to one-quarter when skilled workers in their offices

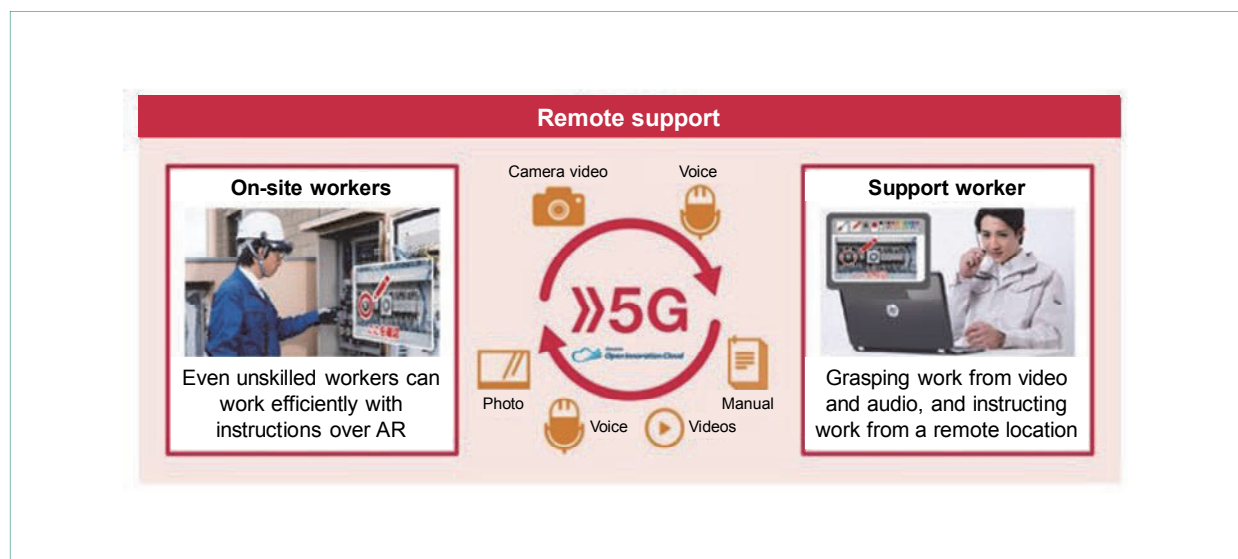


Figure 1 Remote support by AceReal for docomo

^{*4} Remote production functions: Consolidating production functions such as editing and video archiving in a single location reduces facilities, operations and costs at each venue.

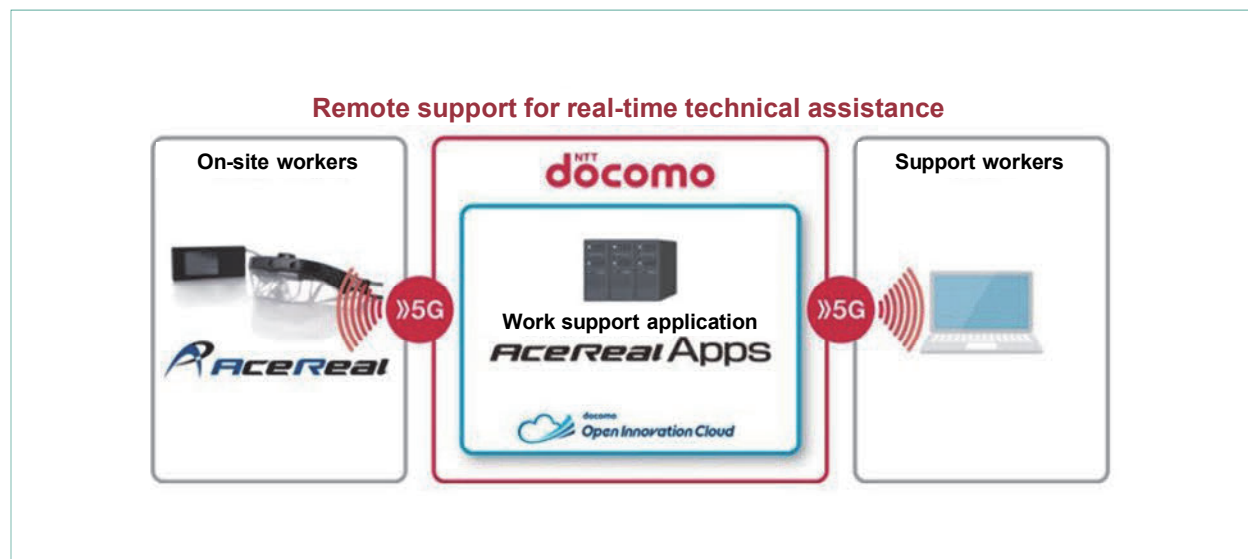


Figure 2 Structure of AceReal for docomo

provided instructions while viewing video from the site in real time and the on-site workers responded to their instructions.

Being not only for inspection and maintenance purposes, usage scenarios are expanding with inquiries from municipalities across the country about remote technology transfer, promotion of smart agriculture and support for medical professionals, etc.

3.2 Facial Authentication Entry and Exit Management Solution “EasyPass powered by SAFR”

This is a facial recognition-enabled entry and exit management solution, built in the DOCOMO Open Innovation Cloud, by combining the SAFR™ high-speed, high-precision AI facial authentication software from RealNetworks, Inc. with the highly open Security Center Synergis™ entry and exit management system from Genetec™ Inc., which enables linkage with cameras from a wide range of manufacturers.

Pointing a camera on a smartphone with a dedicated app at the faces of people entering and exiting enables real-time comparison with preregistered facial photo data to identify whether people have been approved for admission (Figures 3 and 4). The solution also enables attendance status management, authentication result recording and confirmation of the history of recorded authentication results, etc.

Features of EasyPass™ powered by SAFR are as follows:

- Smartphones eliminate the need for major construction and shortens the lead time to implementation.
- Facial authentication employs SAFR, the fastest and lightest of the algorithms that achieved a person rejection rate of less than 0.0335% in the WILD Face test in July 2019 conducted by the National Institute of Standards and Technology (NIST) in the United States
- Maintains high authentication accuracy even

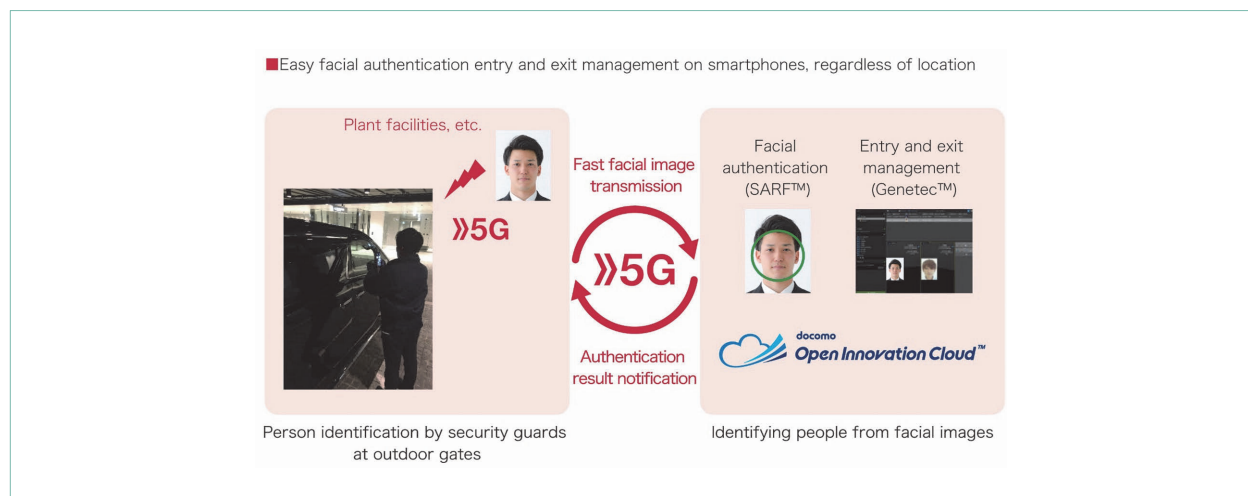


Figure 3 Solution overview

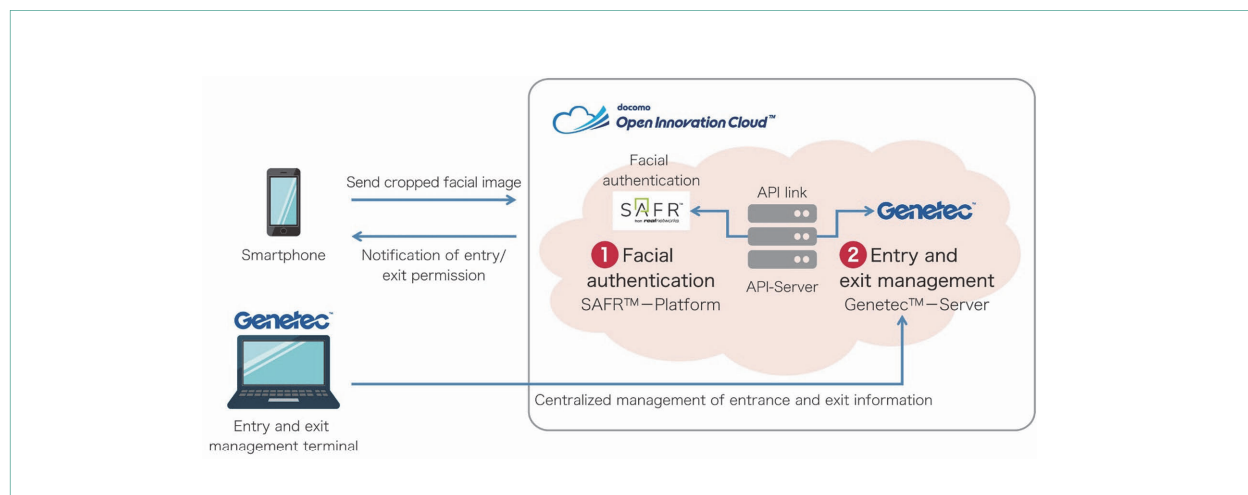


Figure 4 Overall structure

when wearing a mask*¹

- High security with the Cloud Direct option available

Although entry/exits control will be presumably utilized at factories and plant entrances mainly in the manufacturing industry and secondary industries such as electricity and gas, this technology also has promise for usage in non-contact

type physical security as part of novel coronavirus measures.

3.3 LiveU

LiveU is a 5G video transmission solution. Simply connecting the camera and the LiveU transmitter makes it possible to transmit video of relays, interviews, live, or sports video (Figure 5, Photo 1).

LiveU has two features.

*1 When adding optional SARF functions.

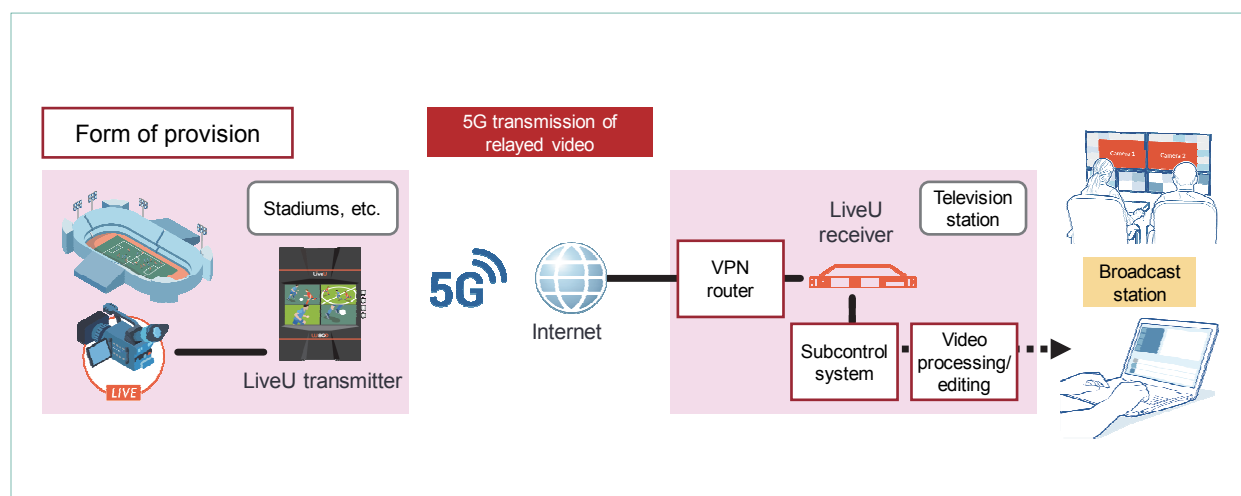


Figure 5 LiveU overview



Photo1 LiveU transmitter

The first is that it takes advantage of the high speed and large capacity of 5G to transmit 4K video. Meanwhile, patents have been acquired for bonding technology, which bundles different communication standards such as 5G, 4G, and Wi-Fi, enabling stable transmission through radio communications (**Figure 6**).

Second, it is possible to operate the LiveU transmitter in the cloud. This feature enables field personnel to focus on capturing camera video and enables relay activities with fewer relay crews (**Figure 7**).

Relay systems can be easily assembled, making

them available for industries other than media.

4. docomo 5G Open Partner Program Future Initiatives

Demonstrations and trials of over 300 cases in various fields have been conducted under the docomo 5G Open Partner Program through provision of 5G information and venues for 5G experiences and testing, like docomo 5G Open Lab.

Making use of this acquired know-how and promoting business matching among partners, the aim is to expand the circle of co-creation across Japan

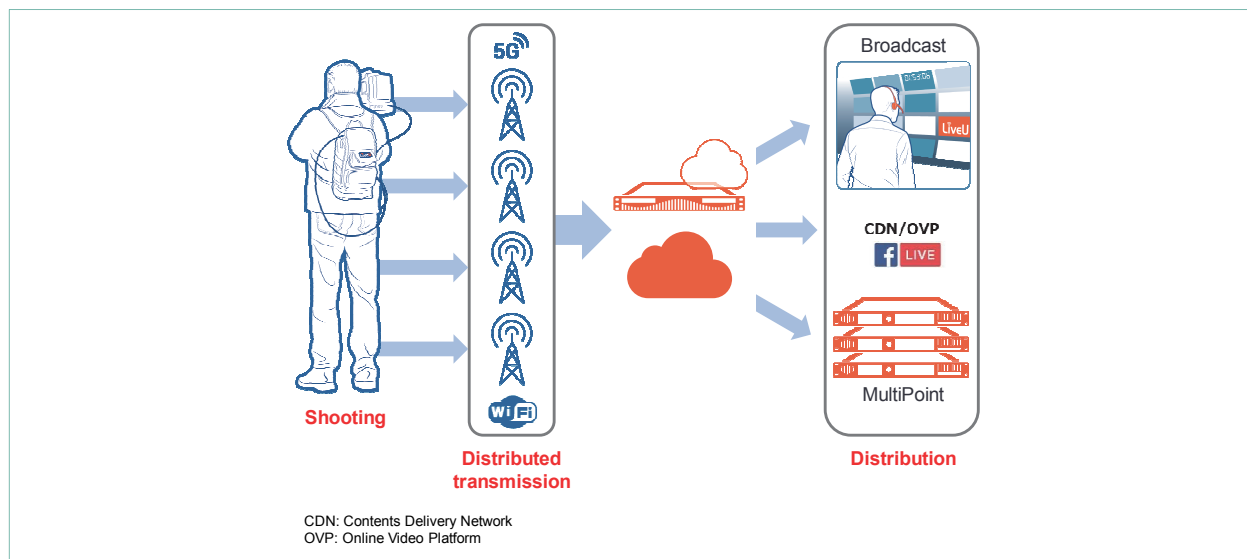


Figure 6 Distributed transmission technology

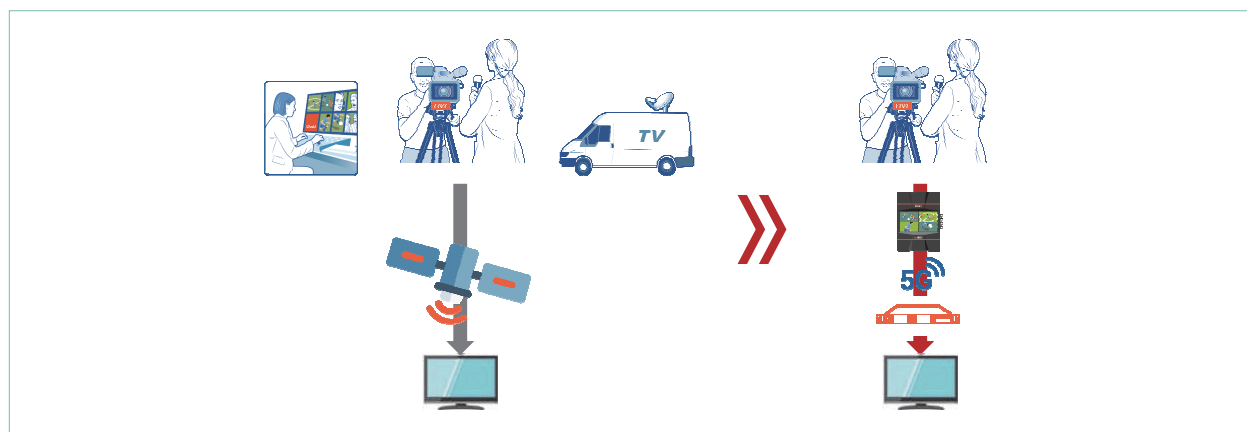


Figure 7 Reduction of photography crews and equipment

by solving social issues with municipalities and companies.

The docomo 5G DX AWARDS 2020 was also held as a business matching initiative. This award promotes the discovery of unique technologies, products and services (hereinafter referred to as “assets”) owned by a wide range of companies, not only large, but also small, medium-sized and venture companies, to further accelerate initiatives to

create new solutions with 5G.

With the themes of industrial sophistication, work style reform, urban development, education and health care, this award is presented for unique assets owned by companies that are reviewed and commended for the significance of their use as commercialized 5G services. We aim to put assets that won this award into service quickly through the docomo 5G Open Partner Program as collaborative

solutions.

5. Network Customization

Since March 25, 2020, NTT DOCOMO has been providing Network Customization, a comprehensive consulting service for networks that supports 5G and other communication networks. Network Customization offers everything from area surveys to construction design and deployment assistance tailored to customer requirements.

The service consists of multiple network solutions and currently offers the following four menus (Figure 8):

- (1) Wireless technology consultancy: The service accepts inquiries about issues related to overall networks and makes the best suggestions for customers, including general purpose network technologies such as LTE and Wi-Fi as well as DOCOMO 5G.
- (2) Local 5G construction support: Based on its accumulated know-how, NTT DOCOMO supports customers who want to build local 5G for applications such as automated production

lines aimed at eliminating labor shortages in factories, and provides support for applications to ministries, area surveys and network equipment selection through to installation.

- (3) Carry 5G: Provision of portable 5G base stations to create temporary 5G areas in a short period of time for live relay from event venues, etc.
- (4) DOCOMO Open Innovation Cloud: Cloud services with Multi-access Edge Computing (MEC)*5 features such as low latency and high security

Each menu is described below.

5.1 Wireless Technology Consultancy

This service accepts inquiries about issues related to overall networks and makes the best suggestions for customers, including general purpose network technologies such as LTE and Wi-Fi as well as DOCOMO 5G (Figure 9).

Wireless technology consultancy has two features:

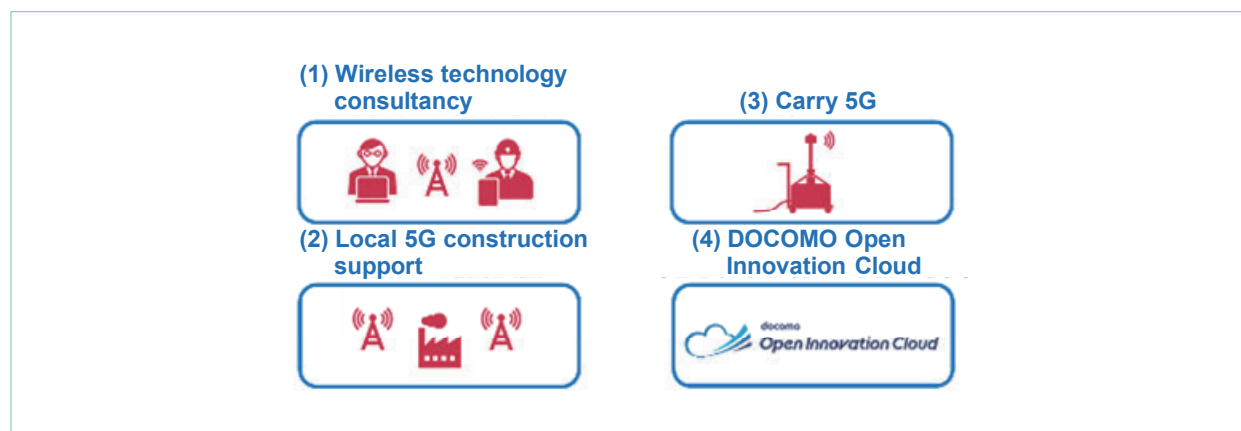


Figure 8 Network Customization 4 menus

*5 MEC: A mechanism of installing servers or storages within a carrier network, at locations near users.

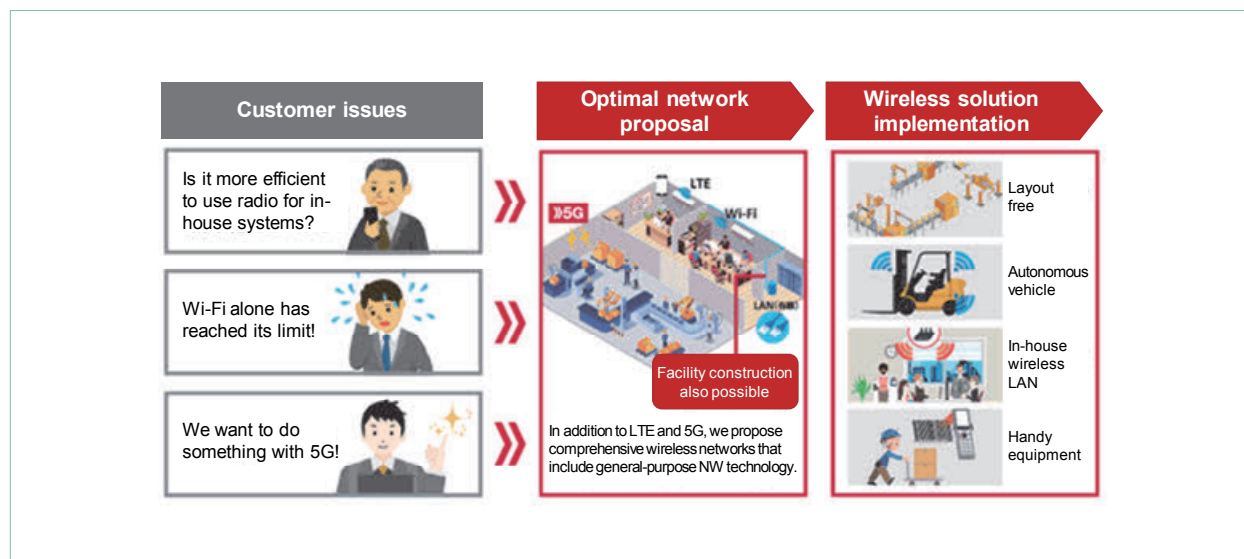


Figure 9 Wireless technology consultancy

- (1) Comprehensive consultant proposals including Wi-Fi, etc.

In addition to wireless consultancy with LTE/5G utilizing NTT DOCOMO's long experience and know-how in building wireless facilities, the service also offers proposals of comparative studies with communication environments such as Wi-Fi and Low Power Wide Area (LPWA)*6.

- (2) Pre-testing with 5G radio waves

This consultancy verifies the size of the 5G area by emitting 5G test radio waves in the customer environment such as the factory or office slated for installation, and also provides communications testing with customer systems to avoid the anxiety associated with 5G implementation.

5.2 Local 5G Construction Support

Local 5G is a private network isolated from the public network that offers construction of network

environments with excellent independence, flexibility and stability. However, highly specialized area design and radio wave applications make it difficult for customers to build these themselves.

This support service leverages NTT DOCOMO's radio system operational know-how as a telecommunications carrier for building local 5G network for customers (Figure 10). The service helps customers reduce construction time, build high-quality coverage areas and optimize costs.

Local 5G construction support is broadly divided into the following three types (Figure 11).

- (1) Consulting/design for optimal antenna placement design, and research and examination of antenna mounting methods
- (2) Selection, proposal and provision of network equipment to meet customer requirements
- (3) Installation of network equipment and antennas, interference adjustment, and license application

*6 LPWA: Wireless communications technology that can support a wide communications area on the kilometer level with low power consumption.

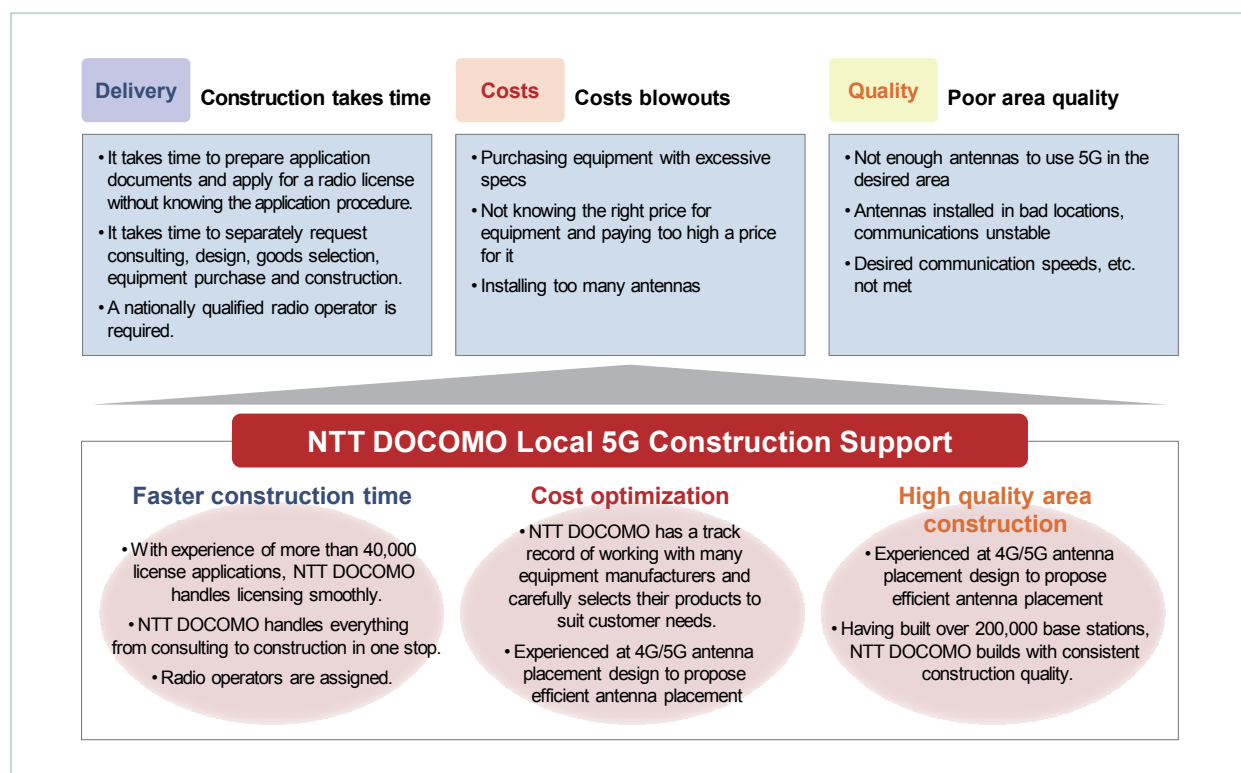


Figure 10 Challenges of local 5G construction by customers and the effectiveness of NTT DOCOMO support for local 5G construction

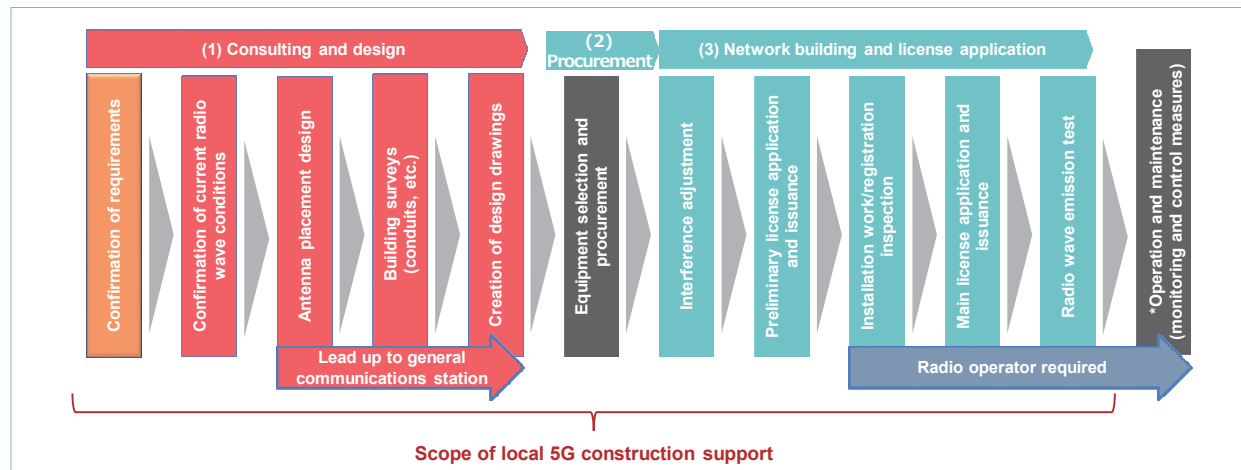


Figure 11 Contents of local 5G construction support

Partial support also available according to customer requests, such as area design support only or license application support only.

With Local 5G, only the 28.2 to 28.3 GHz frequency band has been systemized, and is separate from the bands allocated to NTT DOCOMO, although

the 4.6 to 4.9 GHz and 28.3 to 29.1 GHz bands are expected to become available by the end of 2020 (Figure 12).

Although there are two types of local 5G configurations - NSA (Non-Stand Alone) and SA (Stand Alone) - only NSA configurations can be provided at this time (Figure 13). An overview of each is given below.

- NSA

A network configuration that combines a 4G (enhanced LTE (eLTE)^{*7}) control signal network called an “anchor” with a 5G network.

- SA

A network configuration that does not use an anchor and only operates on a 5G network (local 5G equipment).

NTT DOCOMO 5G is currently an NSA configuration using NTT DOCOMO eLTE as the anchor. However, NTT DOCOMO eLTE cannot be provided as an anchor for local 5G at this time. Therefore, the NTT DOCOMO local 5G construction support service provides construction support for both a 5G network and a private LTE network to serve

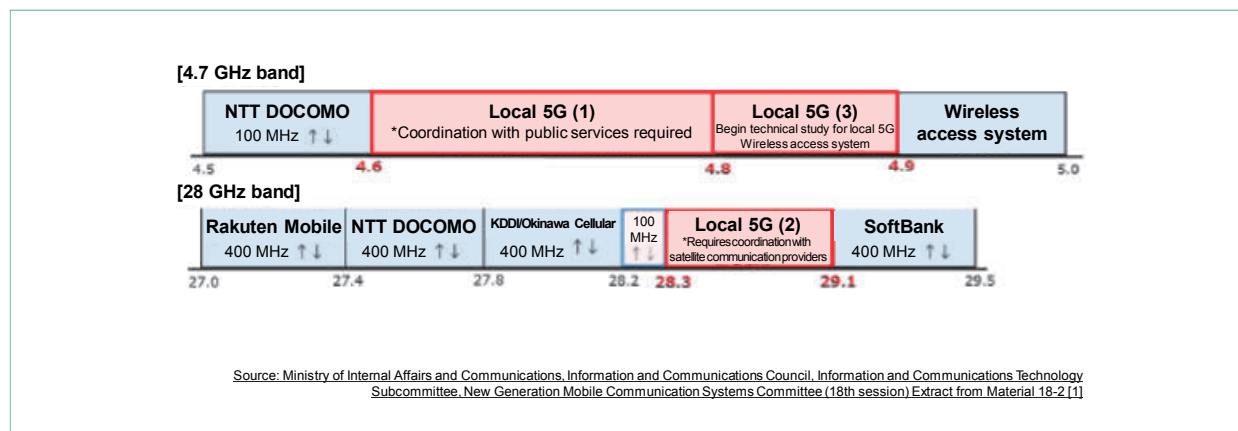


Figure 12 Frequency allocation for local 5G

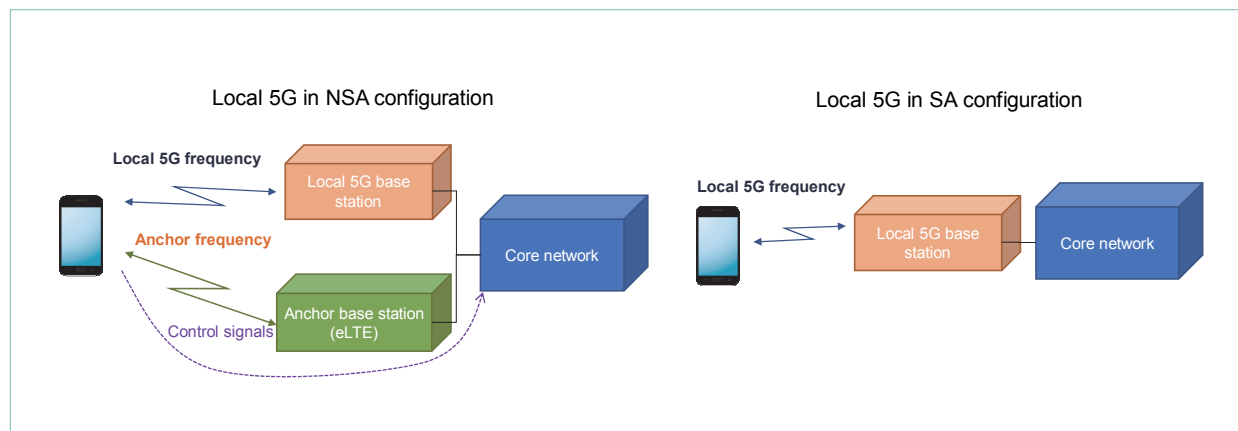


Figure 13 Local 5G configuration in NSA and SA

^{*7} eLTE: A radio access system extending LTE that conforms to 3GPP Rel. 15 or later.

the anchor. We expect it will be possible to provide SA configurations after 2021.

Because frequency bands and network configurations differ from NTT DOCOMO 5G in this way, NTT DOCOMO 5G terminals cannot be used with local 5G and dedicated terminals must be provided. In addition, since the local 5G facilities are in their early stages, there is a compatibility problem between devices and terminals, and it is not easy to secure terminals for each network configuration. However, in the NTT DOCOMO local 5G construction support service, terminals with a proven connection to equipment can be introduced and provided.

5.3 Carry 5G

Base station facility construction requires large-scale works not only for the installation of radio equipment, but also antenna equipment such as steel

towers, power poles and various other accompanying processes, and a certain period of time is required from pre-preparation to facility construction.

Addressing these issues, Carry 5G™ is a service that delivers 5G areas to the customer's desired location more easily without requiring the conventional large-scale construction.

Carry 5G can provide a solution for temporarily use of 5G outside a 5G area, for example, at various event venues such as stadiums, at work sites such as tunnel drilling or building construction, or for new system and solution verification (Figure 14).

Proposing various solutions such as video transmission in one package when building 5G areas with Carry 5G maximizes the value of NTT DOCOMO 5G, supports customer in problem solving and new value creation.

1) Carry 5G Features

(1) Response to requests for temporary use of

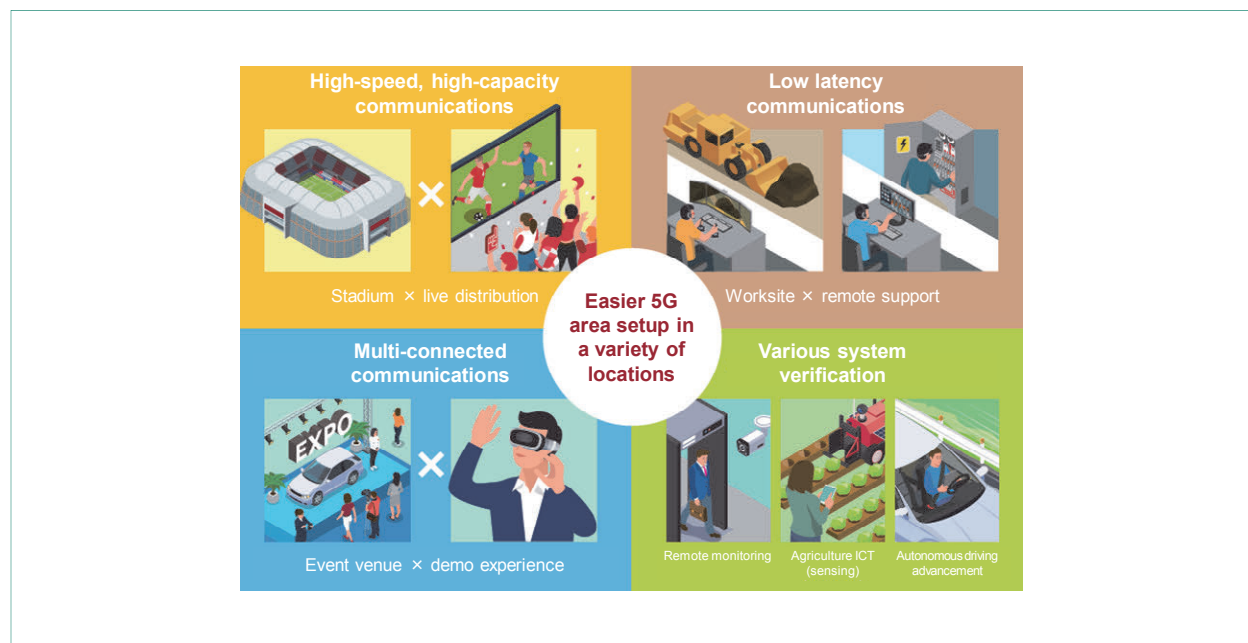


Figure 14 Image of usage scenarios

- 5G by providing NTT DOCOMO 5G areas
- (2) Specialized trolley with 5G communications equipment installed in the requested area
 - (3) Provides 5G areas cheaper and faster than the conventional
- 2) System Configuration Image

Some of the processes required for normal base station construction (location securing, antenna installation design and construction) can be omitted

by installing a complete set of 5G communication equipment on a trolley, making it possible to provide a 5G area more cheaply and more quickly (**Figure 15**).

3) Operational Patterns

This service has been operated at various events and featured in the media, and has gained high local attention and popularity (**Photo 2**).

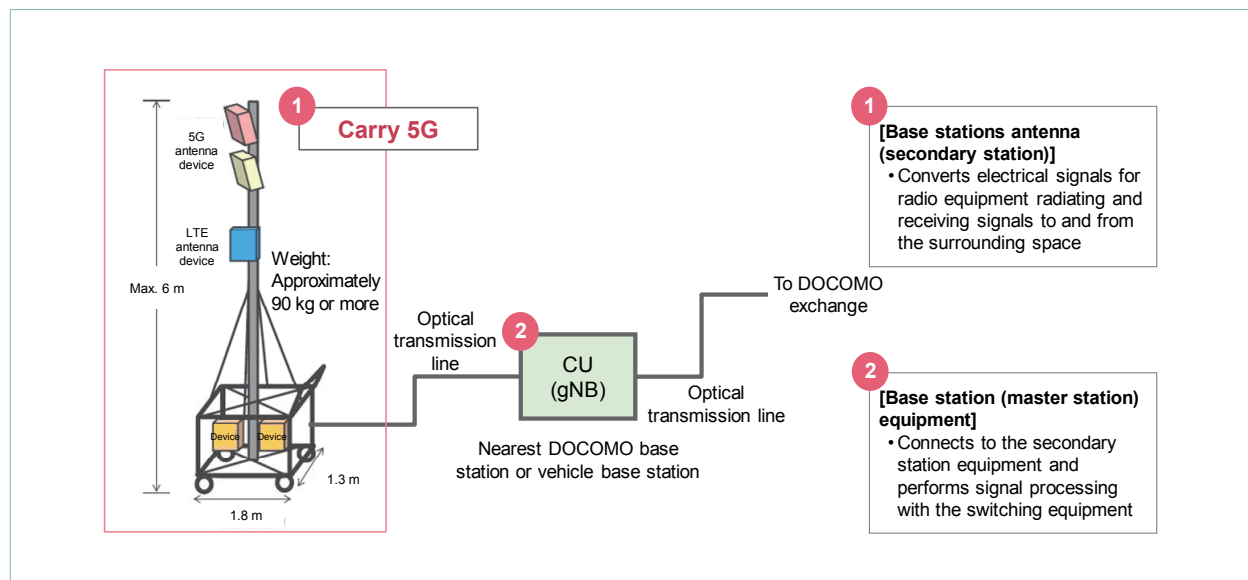


Figure 15 Carry 5G system structure



Photo 2 Operating at various events

5.4 DOCOMO Open Innovation Cloud

1) Overview

Since March 2020, NTT DOCOMO has been providing DOCOMO Open Innovation Cloud, a commercial service that offers cloud computing facilities connected to the DOCOMO network (hereinafter referred to as “cloud infrastructure”).

DOCOMO Open Innovation Cloud is a cloud service with the characteristics of MEC, such as low latency and high security, and is enabled by building cloud infrastructure in facilities on the DOCOMO network (Figure 16).

As an optional cloud infrastructure service, Cloud Direct offers low-latency^{*2}, high-security 5G communications and has been commercially available since June 2020 in the four data centers of Tokyo, Kanagawa, Osaka, and Oita. The service enables direct connection of terminals to cloud infrastructure to optimize the communication path (Figure 17).

2) Features of Cloud Direct

(1) Reducing network transmission latency

The communication path between the 5G communication terminal and cloud infrastructure is optimized to reduce transmission latency.

(2) Closed network access for highly secure communications

Cloud services can be accessed through highly secure communications environments by directly connecting cloud infrastructure and the DOCOMO network to implement closed network communications that are separated from the Internet. Connections from lines other than those registered on the DOCOMO network in advance are rejected to enable secure usage.

(3) Network-on-demand that enables changing the connection destination of the mobile line

As a Cloud Direct management function,

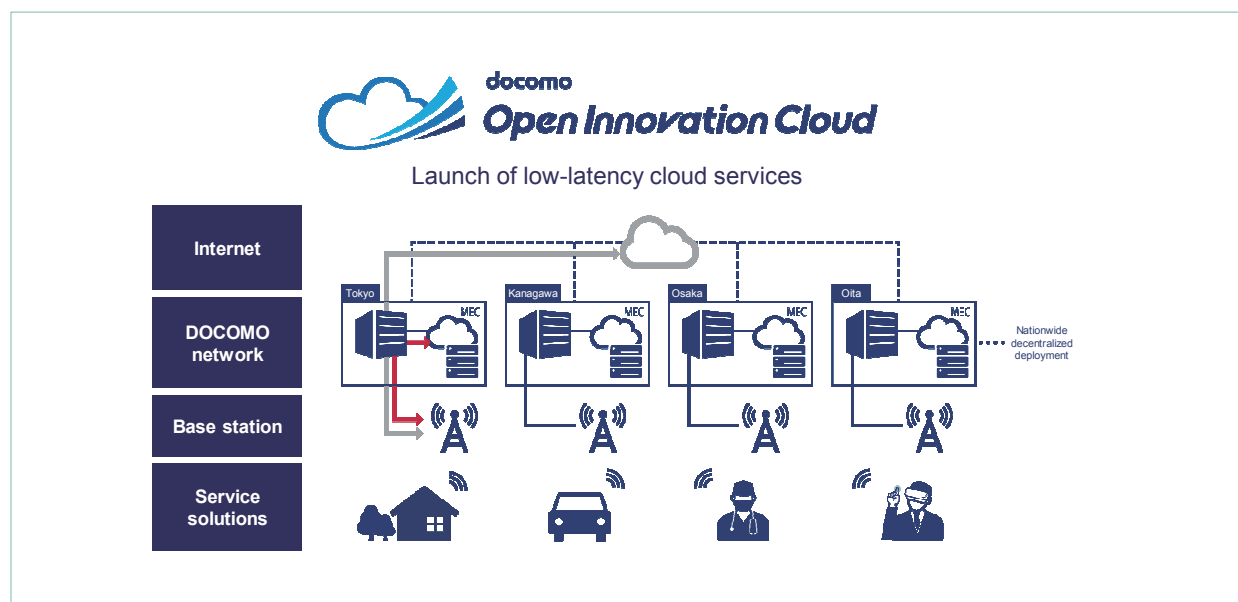


Figure 16 DOCOMO Open Innovation Cloud

^{*2} Since the latency time varies depending on various conditions of radio and wired sections, there is no guarantee that the transmission latency on the network will always be less than a certain amount.

“network-on-demand” lets users adaptively change the destination cloud base of their mobile line. Having a cloud base close to the location of the connected terminal selected as the connection destination further reduces transmission latency.

3) On-board Solutions

During the 5G pre-service period from September 2019, DOCOMO Open Innovation Cloud provided a trial environment for partners participating in the DOCOMO 5G Open Partner Program, and technical verifications were conducted with 33 companies. It was agreed with partners to install 11 solutions on cloud infrastructure for video transmission and VR/AR, etc., and commercial provision commenced. In addition, cloud infrastructure also includes the DOCOMO image recognition platform^{*3} developed by NTT DOCOMO. Expanding these solutions and features step-by-step, cloud infrastructure is expected to be widely utilized for

5G-era solutions and services.

6. Conclusion

This article has described consumer services, three corporate solutions in 22 solutions, and the Network Customization service that supports them.

As a consumer service, we will continue to provide additional new experiences and create new value. We will also take business-oriented initiatives to combine DOCOMO Open Innovation Cloud that reduces network transmission latency and provides secure cloud environment and Network Customization that proposes construction of optimal communication environments from 5G-centered communication networks through to local networks with the aim of social implementation of 5G solutions.

Diversification of customer needs has also led to diversification of communications needs. We will continue to add Network Customization menu items step-by-step to respond to the diverse needs of

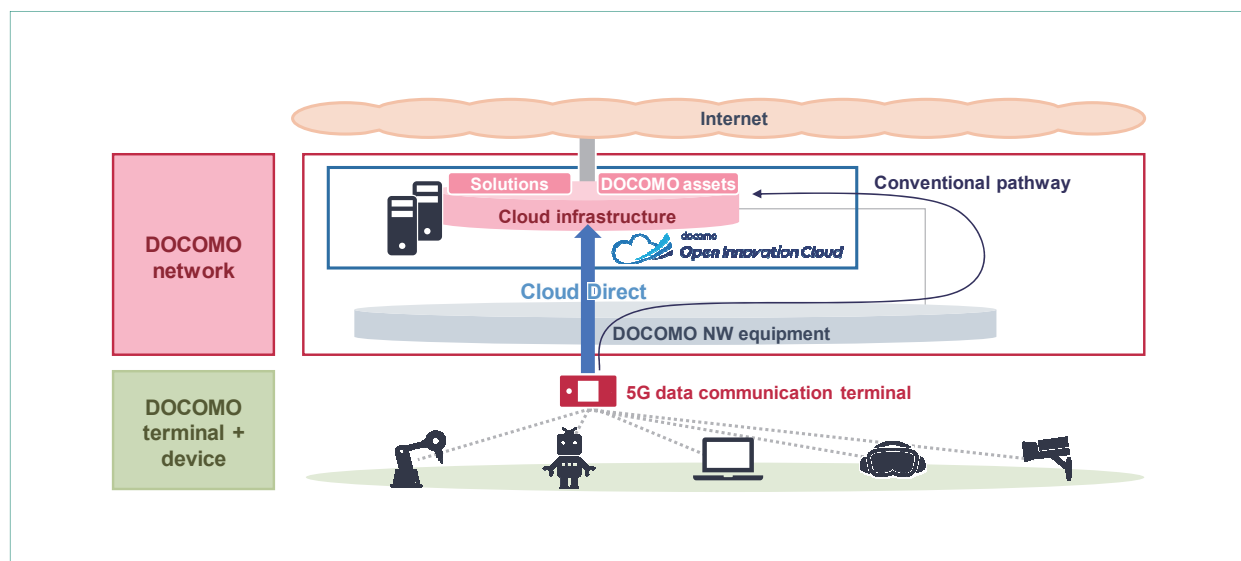


Figure 17 Cloud Direct

^{*3} Part of this image recognition technology is technology that comprises the “corevo” AI of the NTT group.

customers and propose construction of optimal communication environments.

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