

## Current and **Future R&D** at **NTT DOCOMO** for the **5G Era**

### Open Innovation with 5G Co-creation Partners

# Views of the Future Pioneered by 5G — A World Converging the Strengths of Partners —

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Currently, efforts to commercialize 5G around the world are in full swing, and many businesses have great expectations for 5G to create new services. This article introduces the new technologies NTT DOCOMO has advanced for the 5G era with its principal global vendors, field trials using the new frequencies, the state of partnerships in a wide range of industries, and the beginning of the DOCOMO 5G Open Partner Program for co-creating new services.

## 1. Introduction

Since first studying 5th Generation mobile communications systems (5G), NTT DOCOMO set 2020 as the target for commercial introduction of these technologies, and began field trials of new technologies and new frequencies for the 5G era in 2014. Then DOCOMO constructed a 5G Trial Sites and has been conducting comprehensive end-to-end experiments including not only radio but also networks and service applications since 2017 [1]. NTT DOCOMO then began the DOCOMO 5G Open

Partner Program in February 2018 [2] to accelerate new 5G service co-creation through various industry partnerships.

This article describes our field trials and initiatives to strengthen partnerships with our 5G business partners.

## 2. The State of 5G Partnerships

### 2.1 5G Field Trials

Many radio access technologies have been studied to support a wide range of frequency bands

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and use cases with 5G. NTT DOCOMO began field trials of promising candidate technologies jointly with principal global vendors in 2014, and has acquired a vast amount of test results and knowledge to commercialize these technologies. These efforts have resulted in global top level achievements such as improvements to spectral efficiency<sup>\*1</sup>, super high-speed radio data transmission, high-speed motion support, and securing of coverage with high frequency bands. Testing will also be accelerated going forward towards commercialization.



Photo 1 4K multistream live distribution at 5G Trial Sites [1]

## 2.2 5G Trial Sites

NTT DOCOMO has been operating 5G Trial Sites<sup>®\*2</sup> at Tokyo Waterfront City Region (Odaiba, Aomi District) and around TOKYO SKYTREE TOWN<sup>®\*3</sup> since May 2017. The sites are used to test consumer services in areas with many customers including tourists and visitors to Japan, and the Odaiba site has been used effectively to perform field trials of the connected car<sup>\*4</sup> technologies over wide areas. To introduce 5G radio communications, the opening ceremony of the trial site was jointly held with Tobu Railway Co., Ltd., and featured 4K multistream live video distribution from the 340 m-high Tembo Deck of the TOKYO SKYTREE<sup>®\*5</sup> to the TOKYO Solamachi<sup>®\*6</sup>, and demonstration of content delivery to a tablet computer onboard a train (Photo 1). Also, experimental results using 5G include successful 4K video transmission to the “EKIMISE” Asakusa station building from the Tembo Deck of TOKYO SKYTREE and the achievement of transmission rates of 10 Gbps in the area surrounding TOKYO SKYTREE TOWN (Figure 1).



Figure 1 5G transmission experiment in the area around TOKYO SKYTREE TOWN

<sup>\*1</sup> Spectral efficiency: The number of data bits that can be transmitted per unit time and unit frequency band.  
<sup>\*2</sup> 5G Trial Sites<sup>®</sup>: A registered trademark of NTT DOCOMO, INC.  
<sup>\*3</sup> TOKYO SKYTREE TOWN<sup>®</sup>: A registered trademark of TOBU RAILWAY CO., LTD. and TOBU TOWER SKYTREE CO.,

LTD.  
<sup>\*4</sup> Connected car: An automobile connected to an external network via a communications device.  
<sup>\*5</sup> TOKYO SKYTREE<sup>®</sup>: A registered trademark of TOBU RAILWAY CO., LTD. and TOBU TOWER SKYTREE CO., LTD.

### 2.3 Activities to Create 5G Services

For a number of years, NTT DOCOMO has been engaging in partnerships in a wide range of industries such as the automotive, railway, travel, construction, manufacturing, medical and healthcare, video and contents, sports and games for experimentation and to demonstrate services (**Figure 2**). These activities have included developments to create the seeds of 5G services, put these into a form that can be seen and experienced and hence create specific services. Going forward, NTT DOCOMO plans to provide support to its partners to promote the creation of services in all industries using DOCOMO's R&D technological assets. In addition, NTT DOCOMO began the DOCOMO 5G Open Partner Program in February 2018 (which has participation from more than 1,600 companies as of end of July 2018). Centering on 5G, this program provides beneficial information on technologies and business, holds related events, provides indoor and field testing environments, and offers opportunities for communication among partners (**Photo 2**).

In particular, as an indoor 5G testing environment, NTT DOCOMO opened the DOCOMO 5G Open Lab<sup>TM\*7</sup> Yotsuya, and will open similar facilities, OSAKA (in Osaka) and OKINAWA (in Okinawa) (as of end of July 2018) [3] [4]. These testing environments are directly connected to cloud computing facilities (a cloud platform), and offer the “DOCOMO 5G open cloud” testing environment for testing telecom cloud technologies [5]. Through these activities, NTT DOCOMO will also cooperate with new partners to expand the potentials for 5G usage scenes, and complete equipment and systems designed for actual implementation with full 5G commercial introduction in 2020. If an effective cooperation system more broadly combining assets between industries can be achieved, it will leave the comprehensive strength of the ICT industry unchallenged. For partners also, these developments promise opportunities to create even better services through interaction with partners in a wide range of industries.

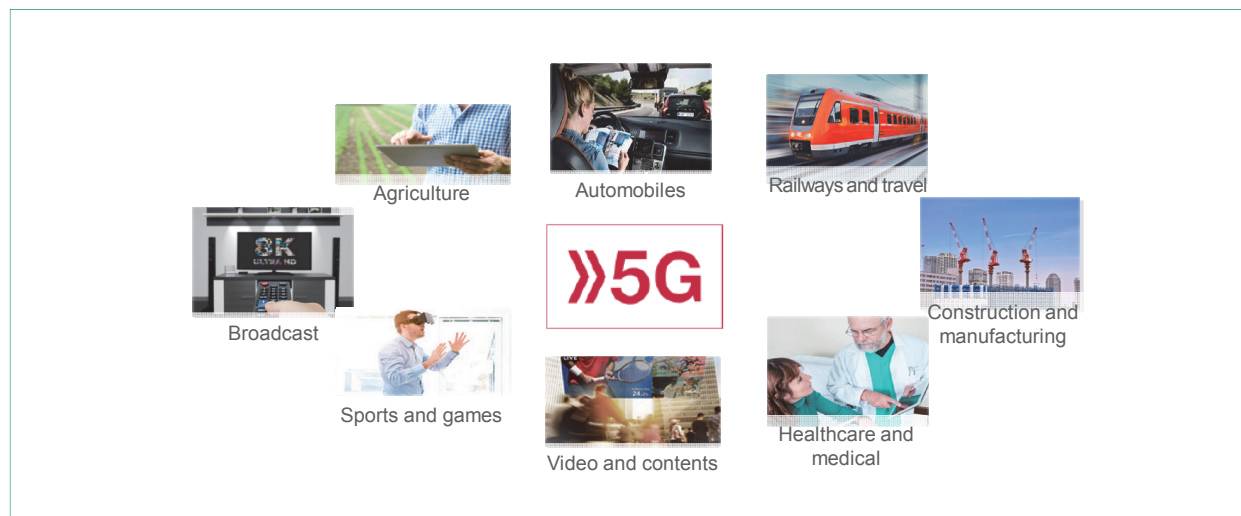


Figure 2 Partnerships in various industries to create 5G services

\*6 TOKYO Solamachi<sup>®</sup>: A registered trademark of TOBU RAILWAY CO., LTD.

\*7 DOCOMO 5G Open Lab<sup>TM</sup>: A trademark or registered trademark of NTT DOCOMO, INC.



Photo 2 The opening of the DOCOMO 5G Open Partner Program

### 3. Examples of 5G Partnerships

#### 1) 5G Field Trials

To date, NTT DOCOMO has driven field trials of the latest radio access technologies jointly with principal global vendors, and has achieved results at the global top level. Recently, we have tested long-distance, high-speed transmission in the so-called “milliwave band” - a promising 5G high-frequency band. These outdoor tests were performed in a macrocell<sup>\*8</sup> environment from the TOKYO SKYTREE Tembo Deck to the Asakusa district more than 1 km away. Also in the Yokohama Minatomirai 21 area, we performed outdoor testing of Ultra-Reliable and Low Latency Communications (URLLC), another promising usage scenario, and verified its requirements. In addition, we succeeded in the world's first 5G 28 GHz radio data transfer and 4K live video broadcast in an ultra high speed moving environment of maximum 300 km/h (**Photo 3**) [6].

#### 2) Connected Car Field Trials Using 5G Communications

There is a lot of anticipation for a variety of

connected car service applications to improve the safety and security of transport systems and lifestyles involving vehicles etc. To achieve the next generation of mobility pioneered by 5G, we have accelerated studies on achieving connected car services by testing them with moving vehicles at the Odaiba 5G Trial Sites and examining collection and distribution of high-precision sensor data with vehicles running on a test course and transport infrastructure such as roads and constructions.

#### 3) Future Construction with 5G

The high speed and low latency of 5G will be extremely useful in meeting the substantial requirements for remote and automated operation of construction equipment in construction sites. Using these characteristics, we have been performing experiments to bidirectionally transmit high-resolution worksite video from cameras mounted on remotely located construction equipment and control signals to the construction equipment in real time (**Photo 4**) [7]. These experiments entailed actual real-time remote control via 5G with clear images of the worksite, and will expand the potential

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<sup>\*8</sup> **Macrocell:** A cellular communications area with a radius from several hundred meters to several tens of kilometers covered by a single base station.



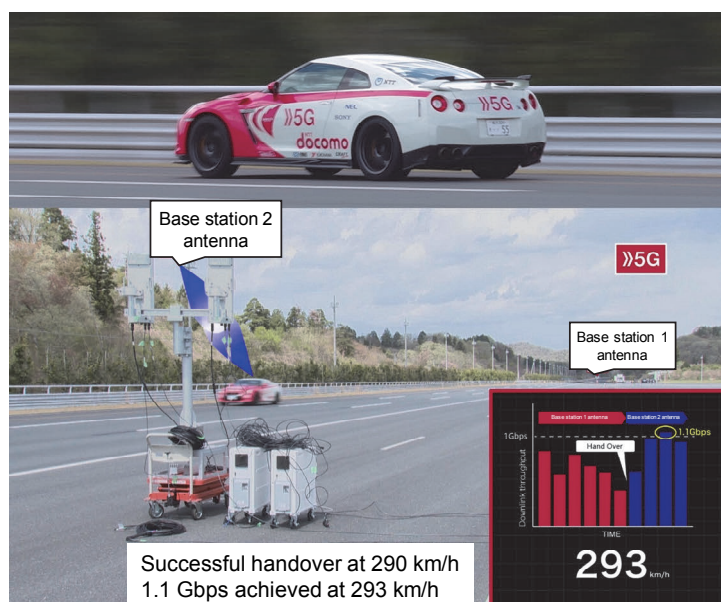


Photo 3 5G radio communications test in a high-speed moving environment

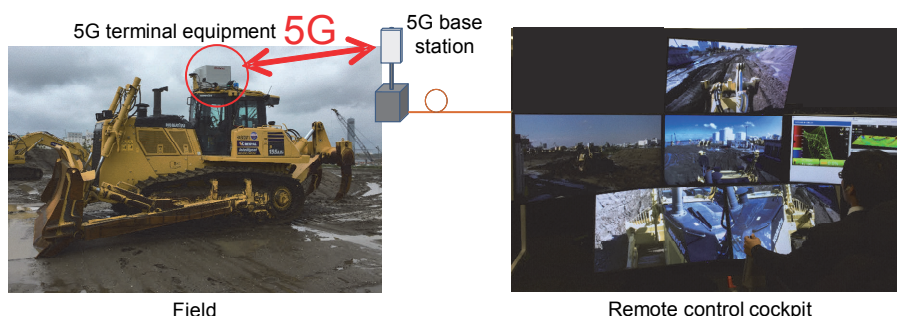


Photo 4 Demonstrating remote control in construction

for Internet of Things (IoT) at construction and mining sites while enabling the highly efficient and safe workplaces of the future.

#### 4) 5G FACTORY®\*9

Using 5G to operate robots in remote locations will enable rapid, safe and secure disaster recovery operations. NTT DOCOMO has jointly developed 5G technology to achieve remote control of robots, etc. in production worksites using free view-point video technology (Augmented Reality (AR),

Virtual Reality (VR) technologies) (Photo 5) [8]. In addition to this achievement, the technology can be applied in a wide range of scenes from factories and production workplaces through to distribution warehousing, and holds promises for providing new solutions for labor shortages.

#### 5) New Sports Viewing, Games and Live Performance with AR/VR

We propose new ways to view and enjoy sports with AR by acquiring comprehensive sports data

\*9 5G FACTORY®: A name for technologies and systems that will achieve the factories for the future using 5G. A registered trademark of NTT DOCOMO, INC.



Photo 5 Demonstrating 5G FACTORY III in MWC2018

covering a wide area of sport, such as stats data<sup>\*10</sup> that pop up in the view when the user looks out across the entire soccer stadium and focuses on the player who has the ball or any interesting player. Combining 5G with interactive games and so forth will also make it possible to enjoy games without stress by sharing ultra-high-resolution images in ultra-low latency communications environments. We are also developing a new virtual entertainment experience project with the latest NTT Group technologies including 5G, which will enable network distribution combining live performances from various locations around the world into one image in real time etc [9].

#### 6) Remote Medical Treatment

In the medical field, as part of the Ministry of Internal Affairs and Communications “5G comprehensive demonstration test,” we have tested remote

treatment services in Wakayama Prefecture using high-resolution images by connecting an urban general hospital with a clinic in a remote area using high-speed communications networks with 5G [10]\*. In addition to achieving a 4K TV conferencing system for medical examination, we confirmed advances to telediagnosis services and reduction of doctor work load with real-time transmission of 4K diagnostic closeup camera images and images from medical equipment such as ultrasonic imaging (ultrasonography) diagnosis devices and MRI devices with 5G ultrafast communications (**Photo 6**).

## 4. Conclusion

To create even better services in the 5G era, we are continuing to cooperate with an increasing number of partner companies in a wide range of

<sup>\*10</sup> Stats data: Statistical numeric values of details about athlete and team player performance in sport.

\* This experiment was contracted from the Ministry of Internal Affairs and Communications in FY2017, and conducted by NTT DCOMO as “Contracted survey and study on technical conditions etc. of 5th generation mobile communication systems to enable super high-speed communications exceeding 10 Gbps in populated areas”.



Photo 6 Testing remote medical treatment in Wakayama Prefecture [10]

industries. Going forward, DOCOMO R&D aims to proactively continue open innovation to improve co-creation environments in +d<sup>\*11</sup> partnerships, and further expand its partnerships.

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<sup>\*11</sup> +d: Name of NTT DOCOMO initiative for co-creating new value with partner companies.