Technology Reports 5G High Speed - Large Capacity/Low Latency/Massive Connectivity 5G Pre-commercial Service

Special Articles on 5G Pre-commercial Service

Overview of 5G Pre-commercial Service

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NTT DOCOMO launched its 5G pre-commercial service in September 2019 following the allocation of 5G frequency bands in Japan in April 2019. This launch was preceded by the creation of a wide variety of solutions through many field trials carried out with co-creation partners. The key features of 5G are high speed and large capacity, low latency, and massive connectivity. With these exceptional communications specifications, the industrial world has high expectations of 5G as a means of solving social problems and creating new industries. This article describes 5G technical features, presents a system overview, and introduces featured services and terminals in the 5G pre-commercial service.

1. Introduction

NTT DOCOMO has been constantly upgrading its network in step with increasing volumes of data traffic as reflected by its transitions from 3G to 4G, and within 4G, from LTE to LTE-Advanced. Today, data traffic continues to increase, and since we can expect the large-capacity plans and rich content like video services to become increasingly dominant in the future, there is no reason to doubt that this trend toward higher volumes of traffic will continue.

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In addition, mobile communications will generate higher expectations and become all the more important from the viewpoint of solving social problems and creating new industries through the expansion of the Internet of Things (IoT)*1 and the emergence of AI. With this in mind, NTT DOCOMO has been aggressively conducting experimental deployments at 5G trial sites*2 and creating new services that make the most of 5G features (**Figure 1**).

NTT DOCOMO launched its 5G pre-commercial service in September 2019. The purpose of this pre-commercial service is to create new solutions in collaboration with co-creation partners and to provide 5G-unique services to consumers. Additionally, as the millimeter waves*3 in the frequency bands allocated for 5G deployment in April 2019 feature extremely high directional propagation, another objective of the pre-commercial service is to acquire new technologies and knowledge in addition to radio technologies that we have so far developed.

In this article, we describe 5G technical features, present a system overview, and introduce featured services and terminals in the 5G pre-commercial service.

We ask the reader to refer to other articles in this issue for details on services that exploit 5G features, on MY NETWORK*4 that broadens the user's world through "smartphone" × "peripheral devices," and on solutions achieved through the DOCOMO 5G Open Partner Program.

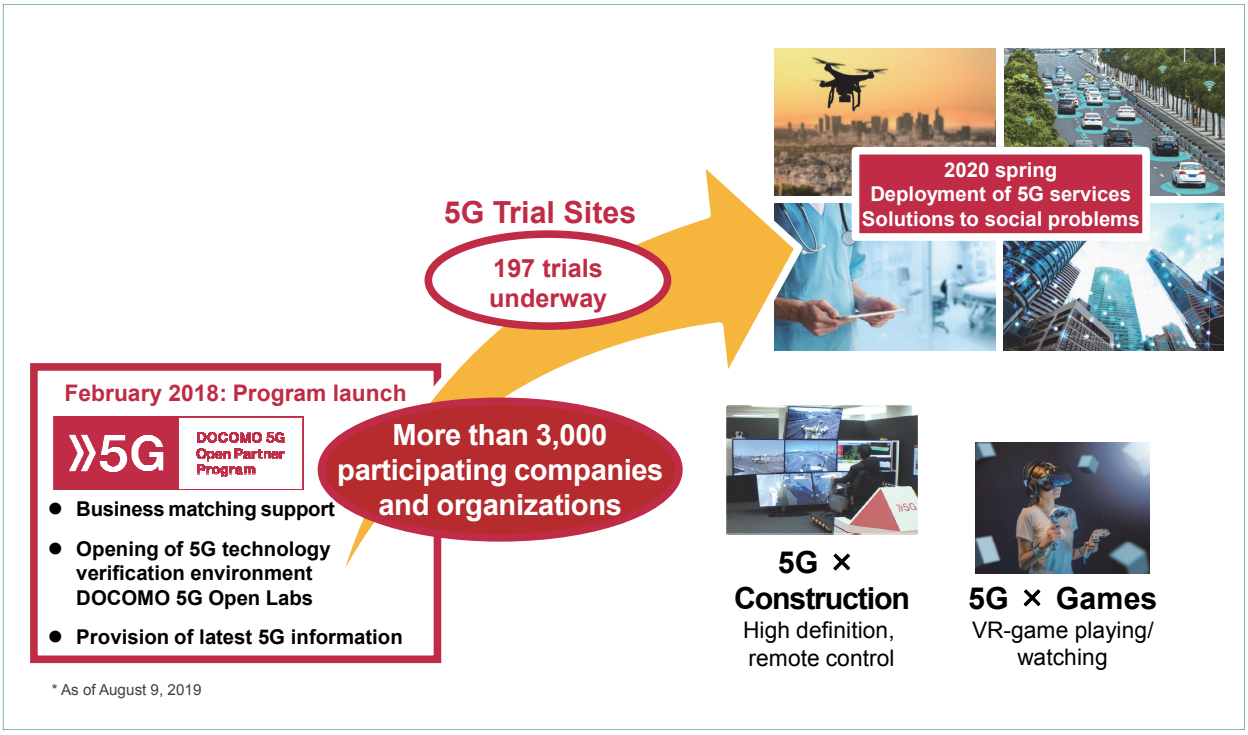

Figure 1 NTT DOCOMO initiatives toward early deployment of 5G services

*1 IoT: General term for the format of connecting all sorts of "things" to the Internet and cloud for control and information communications.

*2 5G trial sites: An environment using the NTT DOCOMO 5G network.

*3 Millimeter waves: Radio signals in the frequency band from 30 GHz to 300 GHz as well as the 28 GHz band targeted by 5G that are customarily called "millimeter waves."

*4 MY NETWORK: A trademark or registered trademark of NTT DOCOMO.

2. 5G Technical Overview

2.1 Three Technical Features

Featuring high speed and large capacity, low latency, and massive connectivity, 5G will provide compelling services in a wide range of use cases.

1) High Speed and Large Capacity

The 5G system will enable data transfers at speeds and capacities much higher than existing systems. This feature will make it possible to deliver high-definition video including Virtual Reality (VR)[*5] and Augmented Reality (AR)[*6] so that many people will be able to access and enjoy high-presence video and services.

2) Low Latency

This 5G feature will enable control with high real-time characteristics by making delay times even shorter. It will make even greater contributions to automation, for example, by enabling the grasping, controlling, and operating of plant and machine conditions in real time.

3) Massive Connectivity

In 5G, simultaneous connection of not just smartphones but also of all sorts of things such as sensors and electronic devices will become possible thereby furthering the penetration of IoT and enhancing the use of information helpful to life (such as vending-machine and meter information).

2.2 Major 5G Radio Technologies

1) Technologies for Achieving High-speed and Large-capacity Transmission

These technologies include high-frequency/ultra-broadband transmission and antenna techniques typified by Massive Multiple Input Multiple Output (MIMO)[*7].

While LTE has been using frequency bands up to 6 GHz, 5G is expected to supplement those frequency bands with high frequency bands up to 100 GHz to achieve ultra-broadband capabilities. In particular, the 25 – 40 GHz band, which includes the 28 GHz band used by NTT DOCOMO's 5G pre-commercial service, features signal propagation characteristics different than those of existing frequency bands, so new specifications appropriate for using high frequency bands have been specified and a basic bandwidth of 400 MHz has been set.

Massive MIMO is a technology that uses many antenna elements to control the shape of the transmit/receive beam (beam forming) and configure an optimal area according to the environment. It can be used to expand an area by combining individual antenna elements and concentrating energy in one direction and to achieve a high-capacity system by simultaneously generating multiple beams and increasing the number of simultaneously connected users.

2) Technologies for Achieving Low Latency

New Radio (NR), a newly introduced radio access technology, achieves even shorter delays in the radio interval by shortening the smallest unit of radio transmission. While the transmission unit in conventional LTE was 1 ms, NR will transmit data in units of 0.25 ms at the time of 5G deployment. Furthermore, to achieve low latency in services, it will be necessary to shorten delays on an end-to-end basis, so combining low latency in the radio interval with low latency on the fixed-line interval will be critical. Specifically, end-to-end low latency can be achieved by combining NR with

*5 VR: Technology for producing "virtual reality" using a computer.

*6 AR: Technology for superposing digital information on real-world video in such a way that it appears to the user to be an actual part of that scene.

*7 Massive MIMO: A generic term for MIMO transmission technologies using very large numbers of antennas. MIMO is a signal technology that improves communications quality and spectral efficiency by using multiple transmitter and receiver antennas to transmit signals at the same time and same frequency.

Multi-access Edge Computing (MEC) that deploys computing resources at locations even closer to terminals. To test the effectiveness of these low-latency measures, the 5G pre-commercial service will provide services and solutions in combination with the docomo Open Innovation Cloud*8 that NTT DOCOMO provides as one form of MEC.

3) Technologies for Achieving Massive Connectivity

These technologies include IoT technology as part of the continuous evolution of LTE/LTE-Advanced (enhanced LTE (eLTE)*9) and other technologies such as LTE-M*10 and NarrowBand (NB)-IoT*11 introduced for the purpose of simplifying signal processing. They make it possible to install many IoT terminals (environmental sensors, meters, etc.) that transmit small amounts of data with low frequency within a certain area and to achieve massive connectivity [1].

3. System Overview

3.1 Concept of 5G Deployment

NTT DOCOMO plans to deploy 5G by combining NR and eLTE, where the former achieves dramatic jumps in transmission-speed and capacity performance using a wide range of frequency bands and the latter enables the provision of a basic coverage area*12 and services such as broadcast.

3.2 5G System Configuration

NTT DOCOMO has achieved a 5G pre-commercial service through a non-standalone*13 format in which terminals connect to the mobile network through both the NR and eLTE radio access systems. Specifically, it leverages the know-how obtained in deploying an Advanced Centralized Radio Access Network (C-RAN)*14 in LTE to provide high-speed communications through Dual Connectivity (DC)*15 using two radio access systems in an area in which both NR and eLTE can be used. A system configuration diagram of the 5G pre-commercial service is shown in **Figure 2**.

4. Overview of 5G Pre-commercial Services/Solutions and Terminals

In the 5G pre-commercial service, NTT DOCOMO will roll out a variety of services and solutions that exploit the 5G features of high-speed/large-capacity transmission starting with spectator support services such as multi-angle (multipoint) viewing and high-presence public viewing. The plan is to provide even more new 5G services and solutions for the Tokyo 2020 Olympic and Paralympic Games to be held in the summer of that year.

For the 5G pre-commercial service, 5G-compatible terminals will perform NR communications using a 100 MHz bandwidth in the "sub-6" 3.7 GHz and 4.5 GHz frequency bands and a 400 MHz bandwidth in the "millimeter-wave" 28 GHz frequency band. Using wide frequency bandwidths not available in past systems makes it possible to achieve the 5G feature of high-speed/large-capacity transmission. On the other hand, in addition to wide frequency bandwidths, millimeter waves correspond to frequencies having extremely high directional propagation, so there will be a need for advanced radio technologies enabling high-frequency and ultra-broadband transmission not provided in past systems.

*8 Docomo Open Innovation Cloud: A trademark or registered trademark of NTT DOCOMO.
*9 eLTE: An LTE communication specification conforming to 3GPP Rel. 15 or later.
*10 LTE-M: An LTE communication specification for terminals that communicate at low speed using narrow bandwidth, for IoT devices (sensors, etc.).
*11 NB-IoT: An LTE communication specification for terminals that communicate at even lower speed and narrow bandwidth than LTE-M, for IoT devices (sensors, etc.).
*12 Coverage area: The area over which a single base station can communicate with UE (cell diameter). As coverage is increased, the number of base stations required decreases.
*13 Non-standalone: An operation format that provides services through a combination of NR and an LTE area—in this format, a service area cannot be provided by NR alone.

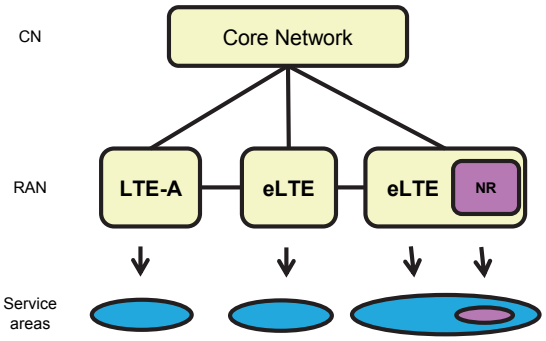

Figure 2 System configuration diagram

5. Service Areas

NTT DOCOMO plans to construct and roll out a variety of service areas in sequence for the 5G pre-commercial service such as major train stations/airports and stadiums in urban and regional areas as well as diverse facilities in collaboration with co-creation partners.

6. Conclusion

This article provided an overview of NTT DOCOMO's 5G pre-commercial service.

At NTT DOCOMO, we began 5G-related studies in 2010, and our efforts in accelerating the drafting of standard specifications in collaboration with major mobile operators throughout the world led to the completion of these specifications in December 2017. Then, after moving forward with more 5G-related R&D, we received our frequency allocation for deploying 5G in April 2019 and launched the 5G pre-commercial service in September 2019.

The full rollout of 5G commercial services is scheduled for spring 2020. NTT DOCOMO will be providing a variety of 5G services at the Tokyo 2020 Olympic and Paralympic Games to be held in the summer of that year. In this way, 2020 looks to be a memorial year in the history of 5G, and looking to the future, NTT DOCOMO is intent on making positive contributions to the worldwide dissemination of advanced and forward-looking technologies through 5G services.

REFERENCE

[1] S. Abeta, et al.: "Radio Access Network in 5G Era," NTT DOCOMO Technical Journal, 25th Anniversary, pp.16–24, Dec. 2018.

*14 Advanced C-RAN: A new centralized radio access network (C-RAN) architecture proposed by NTT DOCOMO. Being controlled by the same base station, a radio access network makes a linkage between a macro cell (which covers a wide area) and a small cell (which covers a local area) by applying carrier aggregation.

*15 DC: A technology that connects multiple base stations and performs transmission and reception using multiple component carriers supported by those base stations.