Trials of 5th Generation Mobile Communication Systems in Indoor Environments

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1. Introduction

In anticipation of the realization of 5th generation (5G) mobile communication systems and new markets created using them, the Ministry of Internal Affairs and Communications (MIC) began conducting 5G system trials starting in FY2017. In these trials, the communications industry providing 5G and various other industries that will use 5G have cooperated, conducting tests in six groups to ensure that the many and diverse applications and features of 5G (high speed, many-connections, very low latency) are all covered.

The authors participated in the fourth group (G IV), collaborating with other agencies in 5G testing related to ultra-high speed communication in indoor and enclosed environments. This article reports on performance tests of 5G radio propagation characteristics using the 28 GHz band and with 5G applications.

2. Evaluation test locations

The following three types of environment were selected for evaluation in indoor and enclosed environments.

Environment	Location	Region
Stadium	Okinawa Cellular Stadium Naha	Naha City, Okinawa Prefecture
Inside train station	Keikyu Railway, Haneda Airport International Terminal Station	Ota Ward, Tokyo
School	Maehara Elementary School	Koganei City, Tokyo

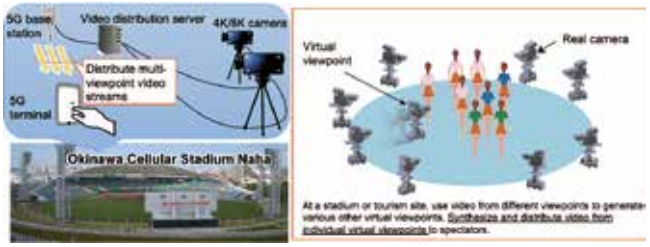
3. Application concepts and evaluation details

In these tests, 5G performance was evaluated in anticipated use cases for various services and applications. The application concepts at each of the test locations are described below.

(1) Stadium

Distribution of free-viewpoint video is being studied as an application to develop entertainment in a stadium further, utilizing the ultra-high-speed and high capacity of 5G. In FY2017, 28 GHz reception characteristics at spectator seats in a stadium were studied, and multiplexed high-resolution video distribution tests were conducted.

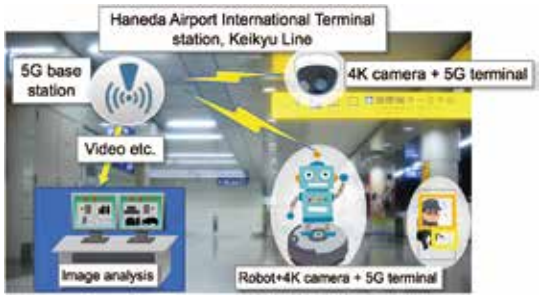
Figure 1: Stadium application concept



(2) Train station

To ensure much greater safety and security in train stations, a system is being studied, which transmits 4K or other high definition video using 5G features, processes it with an image analysis application to detect dangerous articles or behavior that needs attention, and deals with it quickly and effectively. In FY2017, preliminary studies and evaluation were done on the basic performance of an image analysis application for high-definition video (2K and 4K class).

Figure 2: Train station application concept



(3) School

Use cases requiring the high-speed and high-capacity of 5G are being studied as applications that can stimulate classroom activity in an elementary school, such as simultaneously accessing high-volume content using multiple terminals. In FY2017, preliminary studies and evaluations were done, examining the performance of simultaneous access to high-volume content using existing 4G networks.

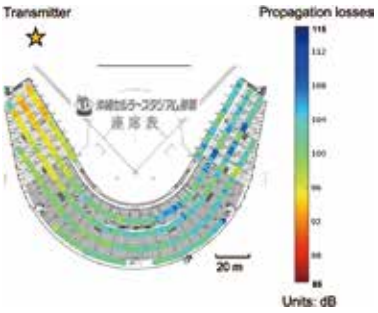
■ Figure 3: School application concept

4. Test results

(1) Stadium

The reception characteristics in the spectator seating at Okinawa Cellular Stadium were studied when transmitting in the 28 GHz band from the lighting tower near the third-base side. 28 GHz band propagation losses at spectator seats in the stadium were measured as shown in Figure 4, generally demonstrating good reception conditions.

■ Figure 4: Map of propagation losses in the stadium



Then, antennas transmitting 28 GHz band 5G signals were mounted on the third-base side lighting tower (Figure 5), and 25 5G terminals each were positioned in the spectator seats on both the first-base and third-base sides. High-definition video (2K and 4K class video) was distributed simultaneously from the transmitter, and all 50 5G terminals were able to receive the video normally (Figure 6).

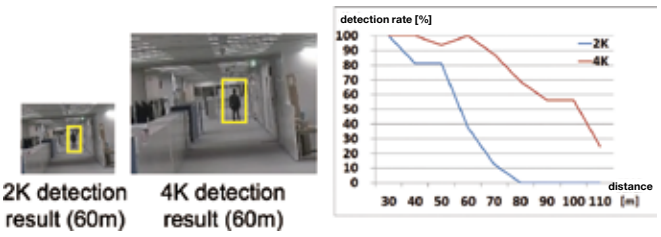
■ Figure 5: View of stadium and transmitter antenna location

■ Figure 6: High definition video reception tests using 5G terminals

(2) Train station

In FY2017, the basic system for an application to detect people by analyzing 2K and 4K-class high-definition video was built and evaluated. The evaluations compared performance in detecting people when using 2K class and 4K class video. As shown in Figure 7, people could be detected at approximately twice the distance when analyzing 4K class video, relative to 2K class video, demonstrating the utility of high-speed 5G transmission and its ability to transmit 4K class high-definition video.

■ Figure 7: Detection performance of high-resolution image analysis application



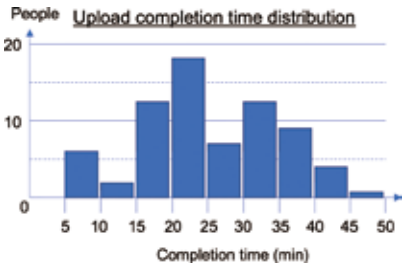
(3) School

In FY2017, to study the requirements for accessing high-volume content simultaneously from many terminals in an elementary school, we evaluated the performance of tasks such as simultaneously uploading large content using multiple 4G terminals.

■ Figure 8: Performance evaluation system using 4G

In the performance tests, two classes of grade four students (36 children/class) uploaded video and watched streaming video all at once. As shown in Figure 9, up to 45 minutes was needed to upload a video. In separate discussion with the elementary school teachers, they stated that ability to upload videos within one minute during class would be desirable, so there is a clear need for the high-speed, high-capacity transmission capabilities of 5G.

■ Figure 9: Distribution of time required for video upload (using 4G)



5. Conclusion

This article describes performance evaluation tests conducted in FY2017 using applications anticipated to utilize the ultra-high-speed characteristics of 5G in the 28 GHz band, for indoor and enclosed environments. We plan to conduct further tests with 5G in train stations and schools in the future.

Acknowledgements

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References

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