Field Trial Group 1 Field trials of Use Cases Employing 5G Ultra-fast Communication in Outdoor Environments

Field Trial Group 2 Field trials of Use Cases Employing 5G Ultra-fast Communication in Mobile Environments

Takashi OKADA
Senior Manager
6G Laboratories
NTT DOCOMO, INC.

Masanori Ichinose
Senior Manager
Solution Services Division
NTT Communications Corporation

1. Introduction

As part of the FY2019 5G Comprehensive Demonstration Tests (hereinafter referred to as "5G Field Trials") initiative of the Ministry of Internal Affairs and Communications[1], NTT DOCOMO and NTT Communications have joined forces to perform field trials of use cases exploiting the benefits of 5G communications[2]. Specifically, we performed an investigation of technical criteria relating to 5G mobile communication systems that facilitate ultra-fast communication at an average of 4–8 Gbps in outdoor environments populated by many base stations and terminals (referred to as use cases involving ultra-fast 5G communication in outdoor environments), and an investigation of the technical criteria relating to 5G mobile communication systems that facilitate high-speed mobile communication at average speeds of over 1 Gbps in mobile communication involving many base stations and terminals (referred to as use cases involving ultra-fast 5G communication in mobile environments). This article introduces the main field trial results.

2. Field trials of use cases exploiting ultra-fast 5G communication in outdoor environments

Field Trial Group 1 NTT DOCOMO, Inc.:
Takashi Okada, Kentaro Fujii, Tomoaki Minamida, Shunsuke Nakamura, Yoshifumi Morihiro, Kensuke Takahashi, Satoshi Suyama, Yukihiko Okumura

Of the field trials conducted in FY2019, we discuss here the field trials conducted with partners regarding use cases where 5G ultra-fast communication is applied to the five fields shown in Table 1. The technical goal of these field trials was to achieve ultra-fast communication at average speeds of 4–8 Gbps in outdoor environments with multiple base stations and multiple terminals.

2.1 Field trials of a real-time cloud editing/relay solution using 5G

In December 2019, we conducted a verification trial in Sendai City, Miyagi Prefecture using the 4.5 GHz band in DOCOMO's 5G pre-service area with a view to implementing a service that facilitates video transmission and video editing over a 5G network during a live event broadcast. In this field trial, 5G was used to seamlessly deliver live video (about 24 Mbps) from four cameras at a remote outdoor

Table 1: List of field trials

Utilization field	Use case	Frequency band	Implementers/partners
Entertainment	Real-time cloud editing/relay solutions*	4.5 GHz	NTT DOCOMO, Inc., Sendai Television, Sony Business Solutions
Offices/workplaces	Ensuring the occupational safety of highly skilled workers*	28 GHz	NTT DOCOMO, Ehime University, Asakawa Shipbuilding, Sumitomo Heavy Industries Transport Systems, Ehime Prefecture
Medicine	Advanced mobile telemedicine	4.5 GHz	NTT DOCOMO, Wakayama Prefecture, Wakayama Medical University, Tokyo Women's Medical University
Smart House/Life	Traditional performing arts instruction (distance learning)*	28 GHz	NTT DOCOMO, CBC Creation, Chubu Nippon Broadcasting, CBC Television
Traffic	Supporting people with hearing impairments by visualizing sounds*	28 GHz	NTT DOCOMO, Sun Electronics

* Projects that won the top prize in the 5G Utilization Idea Contest held by the Ministry of Internal Affairs and Communications in 2018[3]

Figure 1: Field trials of a real-time cloud editing/relay solution using 5G

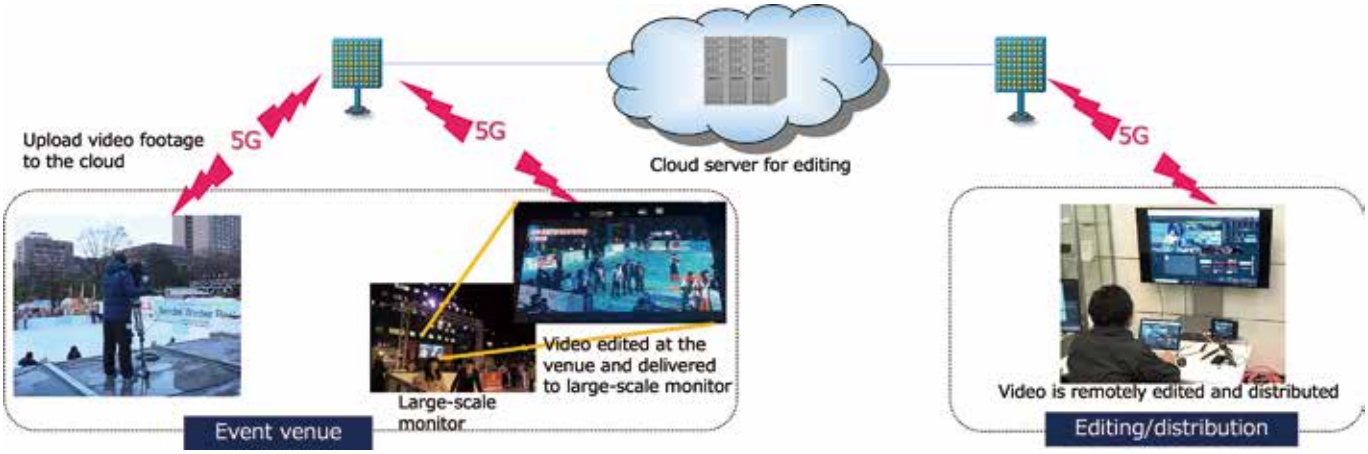


Figure 2: Editing and switching at locations away

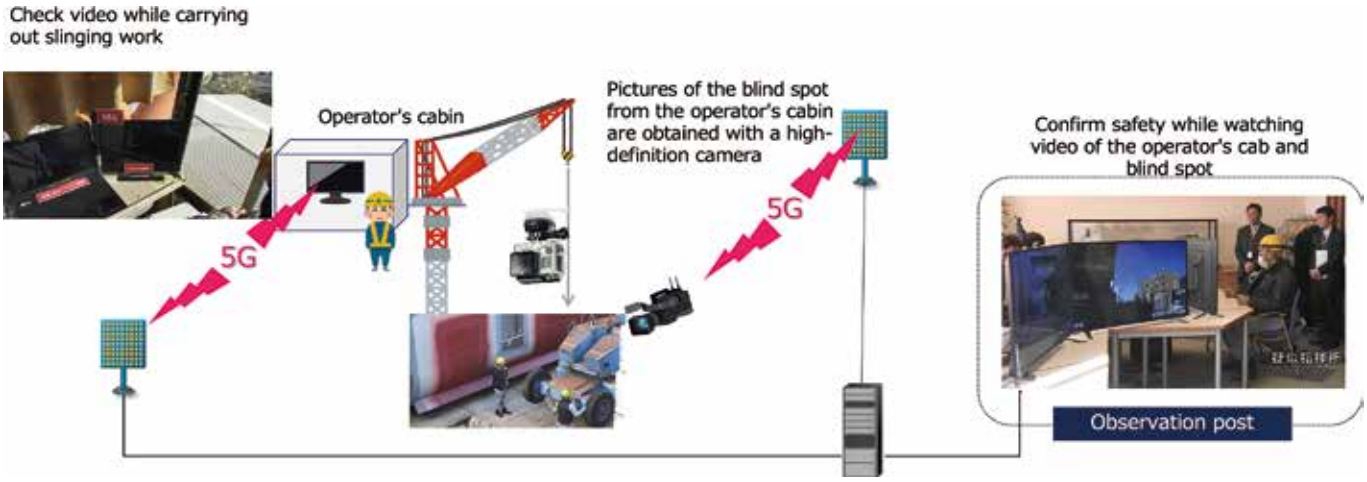
event location, to transmit video for distribution without using large-scale relay equipment, and to perform editing and distribution of full-scale video content even at locations away from the broadcasting station that has specialist equipment and software.

2.2 Using 5G to ensure the occupational safety of skilled workers

In December 2019, we performed a field trials during slinging work by a crane situated in Asakawa Shipbuilding in Imabari City, Ehime Prefecture, to examine the possibility of using 5G equipment operating in the 28 GHz band to relay high-definition

Figure 4: Field trials to ensure the occupational safety

Figure 3: Field trials to ensure the occupational safety using 5G

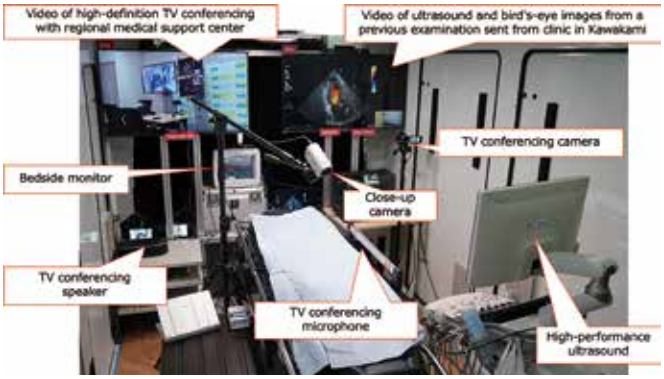


video images of a blind spot to the crane operator's seat in order to create a safer working environment. In this field trial, 5G was used to stably transmit 2K low-latency video images of the blind spot (50–60 Mbps) to a display installed in the operator's cabin to provide the operator with high-definition video images to ensure that slinging work and crane operations could be performed more safely. It is expected that this approach could be used to improve the safety of crane operations in the shipbuilding industry by transmitting video images of places that cannot be seen by the operator, not only for viewing blind spots, but also for purposes such as confirming the center of mass of loads carried by the crane.

2.3 Using 5G to deliver advanced remote mobile medical care

In January 2020, we continued with a field trial in Hidakagawa Town, Wakayama Prefecture that had been started in FY2018 to examine the potential for improving the quality of remote diagnosis as a means of addressing the disparity between urban and rural healthcare provision. In FY2019, in addition to the verification trials conducted up to FY2018, we also used 5G wireless equipment operating in the 4.5 GHz band to transmit video images from high-definition cameras and medical equipment in a mobile medical unit ("Hyper Doctor Car") capable of supporting high-quality diagnosis and treatment. We confirmed that the ability of 5G to deliver high-definition video images made it possible to perform medical examinations together with specialists in remote clinics and even in other mobile medical units. Doctors at university hospitals were able to observe patients via 5G video just as clearly as if they were right in front of them, and reported that this new technology constituted a major step forward from conventional systems. In this demonstration, we confirmed that mobile medical units can be used to perform more advanced forms of diagnosis, and we expect that they will be able to improve the level of medical care available in mountainous areas.

Figure 6: Medical equipment and a bed in a mobile medical unit ("Hyper Doctor Car")



2.4 Using 5G to support traditional performing arts (through remote education)

In October 2019, a field trial was conducted in Nakatsugawa City, Gifu Prefecture to connect a Kabuki master with multiple Kabuki classrooms via 28 GHz band 5G wireless devices to

Figure 5: Field trials to deliver advanced remote mobile medical care using 5G

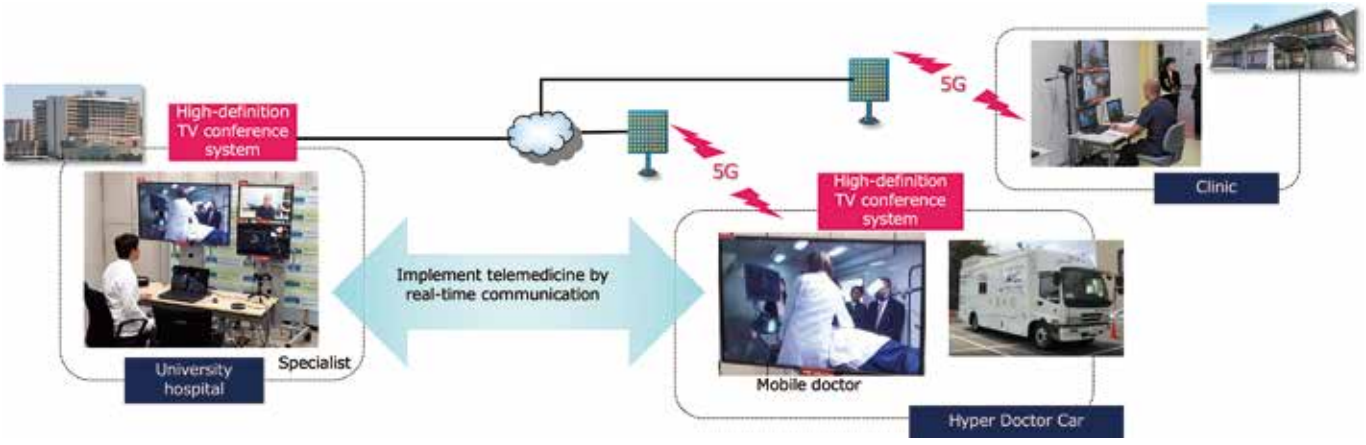


Figure 7: Field trials to deliver remote education using 5G

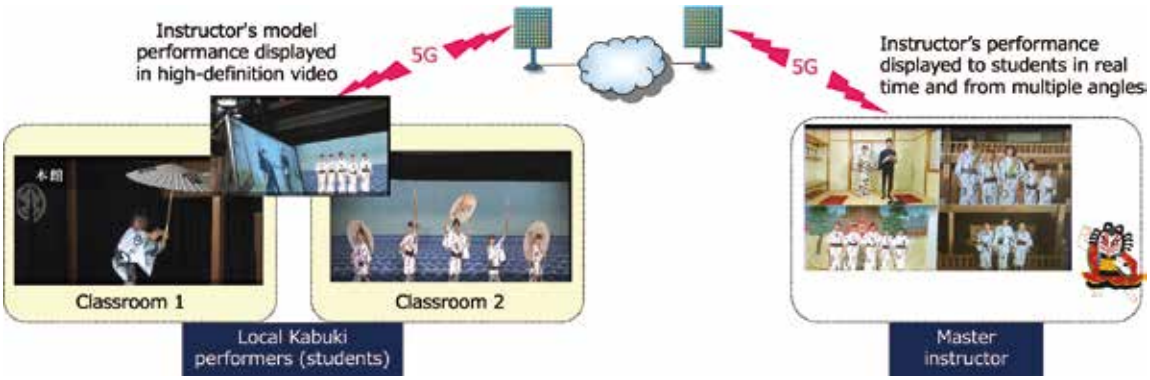


Figure 8: Providing guidance on performances while over a 4K two-way video link

provide guidance on performances while over a 4K two-way video link. We confirmed that four streams of live 4K video can be transmitted simultaneously, and that it is possible to provide remote instruction with such a level of reality that even small details such as eye movements can be conveyed between teachers and students in Kabuki classes. Multi-point remote lessons are expected to support efficient tuition regardless of location, making them a suitable way of handing down traditional performing arts skills that are in danger of being lost due to Japan's dwindling and aging population. By providing greater numbers of people with the opportunity to experience Kabuki through television broadcasting and the like, it is hoped that there will be a resurgence of interest in the art, thereby contributing to the revitalization of Japan's tourism industry.

2.5 Supporting everyday life by using 5G to visualize sounds

In October 2019, with the aim of providing hearing-impaired people in Nakatsugawa City, Gifu Prefecture with new lifestyle support services based on 5G wireless devices operating in the 28 GHz band, we conducted verifications trials of a service that detects dangerous sounds in the vicinity and conveys them as visual information. This information is analyzed and presented to the user via smart glasses. We were able to confirm that this system was able to provide users with warnings and other content, including playing back videos and 3D model data describing the danger, within one second of detecting a dangerous noise. In addition to supporting people with auditory impairments, we expect that this technology could also be used in various other fields including entertainment as a means of displaying content in response to sounds.

Figure 9: Field trials to support everyday life by using 5G to visualize sounds

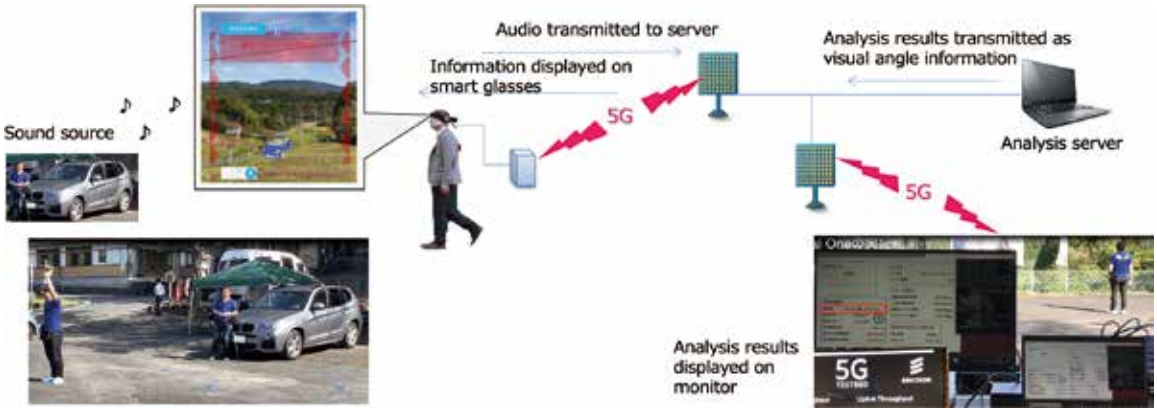


Figure 10: Analyzing sounds in the vicinity and provide users with warnings

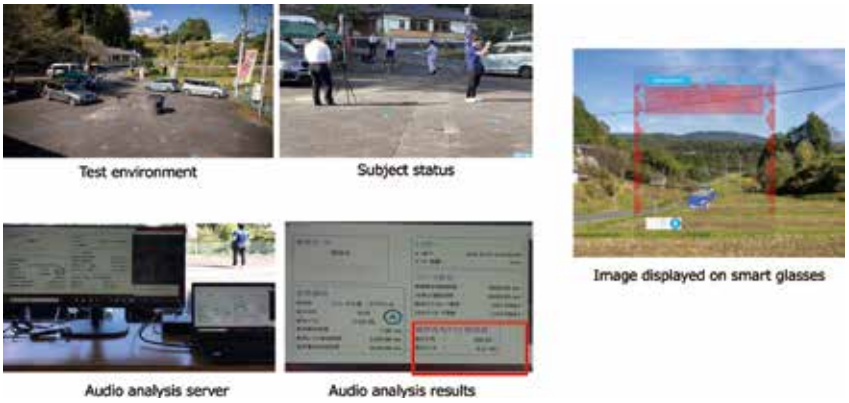


Table 2: List of field trials

Utilization field	Use case	Frequency band	Implementers/partners
Sport	Providing on-course support for golfers*	28 GHz	NTT Communications, MIRAIT, Nagano Keikyu Country Club, Fujitsu, NTT DOCOMO
Smart cities/areas	Subway safety assurance support*	28 GHz	NTT Communications, Hanshin Electric Railway, ITOCHU Techno Solutions, Fujitsu BSC, NTT DOCOMO
Traffic	Providing driving assistance in dense fog*	4.5 GHz	NTT Communications, Oita Prefecture, Autobacs Seven, Oita Prefecture Fog Countermeasures Council, T Plan, NTT DOCOMO

* Projects that won the top prize in the 5G Utilization Idea Contest held by the Ministry of Internal Affairs and Communications in 2018[3]

3. Field trials of 5G ultra-high-speed communication in mobile environments

Field Trial Group 2 NTT Communications Corporation:
Masanori Ichinose, Ichiro Nakagawa

Of the field trials conducted in FY2019, we discuss here the field trials conducted with partners regarding use cases where 5G ultra-fast communication is applied to the three fields shown in Table 2. The technical goal of these field trials was to achieve high-speed communication at average speeds of over 1 Gbps in mobile environments with multiple base stations and multiple terminals.

3.1 Using 5G to provide support on a golf course

In November 2019, we constructed a 28 GHz band 5G communication area at the first hole of the Nagano Keikyu Country Club in Nagano City, Nagano Prefecture, and we performed a field trial in which AI was used to analyze video captured by a 4K 360° camera in order to estimate the landing spots where balls came to rest, and to show the state of play as live video on a next-generation display cart. With this system, we were able to achieve stable transmission of live 4K video in an environment with many connected base stations and terminals, even when the

Figure 11: Field trials to provide support on a golf course using 5G

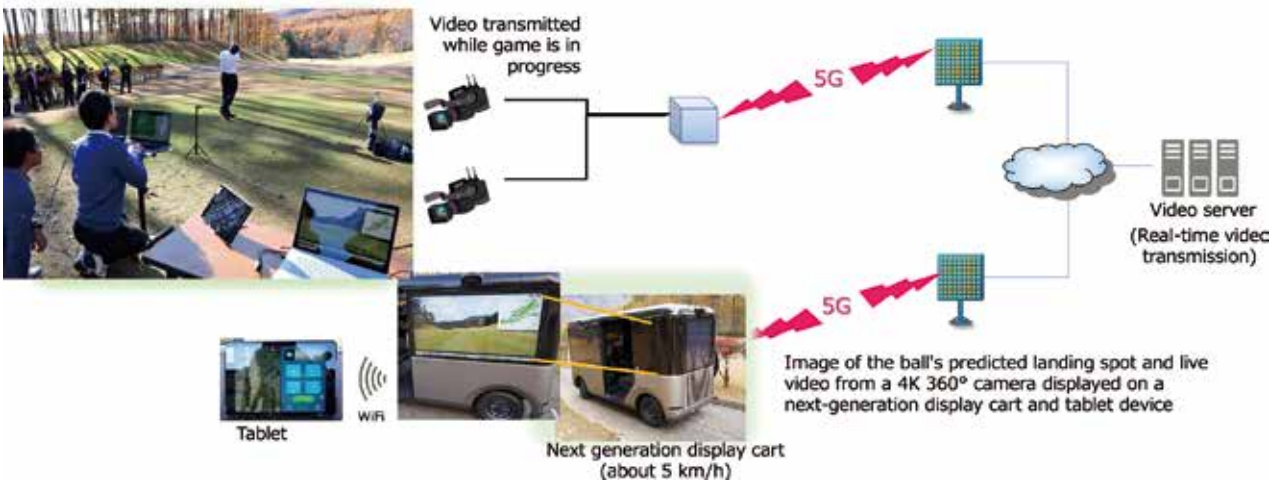
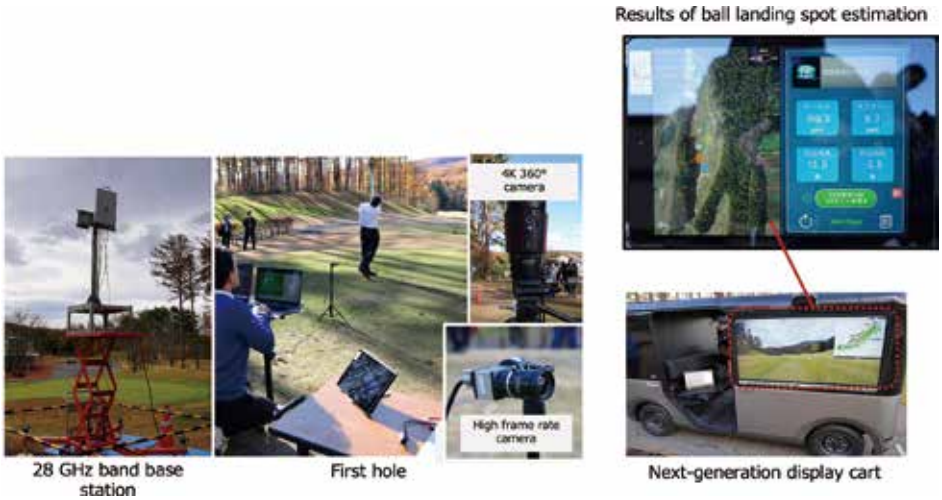


Figure 12: Field trials to provide support on a golf course



next-generation display cart was moving. This system is expected to have several benefits, including an improved play turnover rate due to the ball landing spot estimation service, the ability to implement alternative services where a caddy is not required, and the ability to provide a service that attracts golfers from further afield.

3.2 Using 5G to provide subway safety assurance support

In January 2020, at Fukushima Station on the Hanshin Electric Railway in Osaka, images from inside trains and from station platforms were transmitted via 5G to an AI analysis server that automatically looked for people behaving abnormally or entering restricted areas, and alerted station staff by sending messages to their smart phones. We confirmed that this system was capable of providing stable safety assurance support. In this field trial, train-mounted mobile stations were able to use the 28 GHz band to connect to the base station from a distance of about 300 m outside the line of sight, allowing video to be transmitted before the train reached the platform. We confirmed that this made it possible for station staff to deal with abnormal situations. We also confirmed that abnormalities could be detected correctly and reported to station staff without human intervention. It is expected that this could be used as a safety assurance support service to avoid dangerous behavior such as rushing towards an arriving train.

Figure 13: Field trials to provide subway safety assurance support using 5G

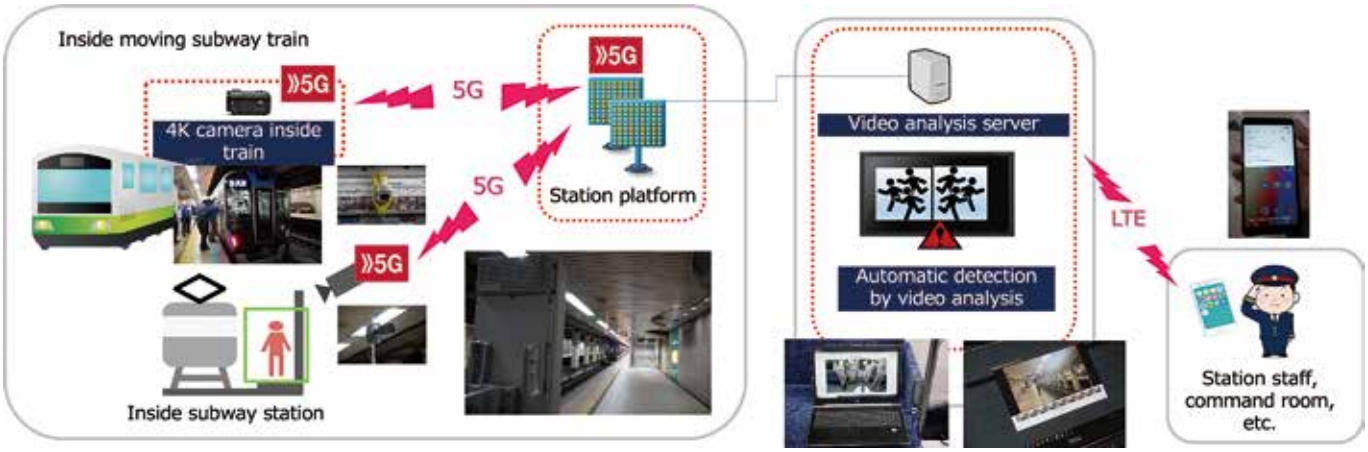
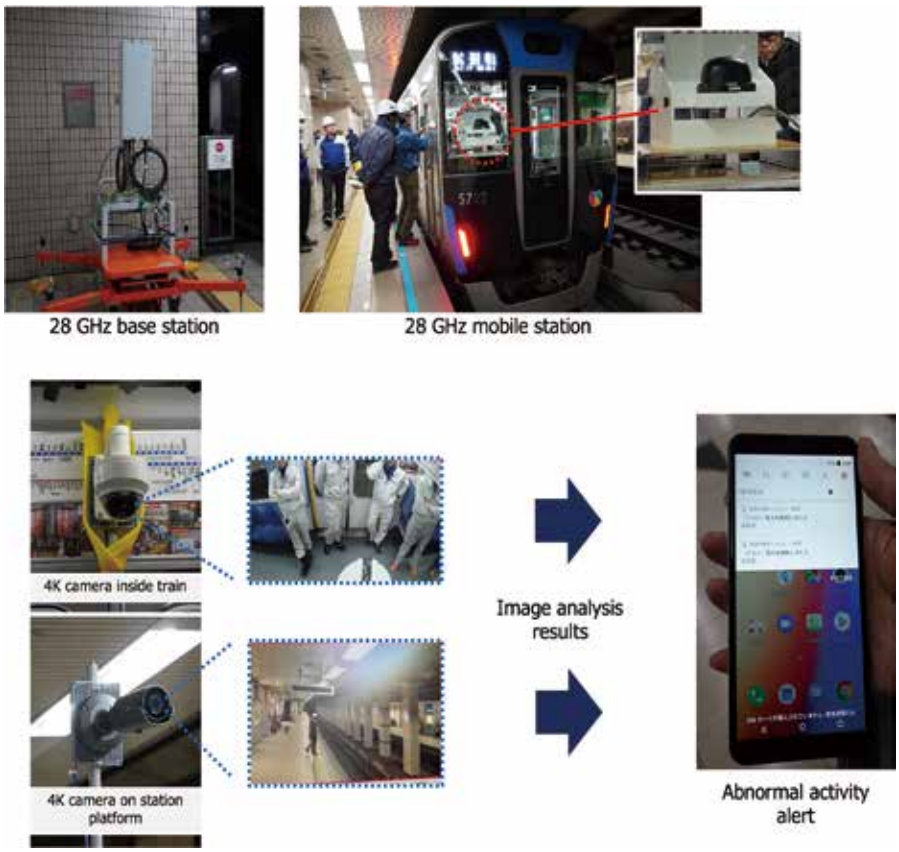


Figure 14: Field trials to provide subway safety assurance support



3.3 Using 5G to provide driving assistance in dense fog

In February 2020, on the expressway in Oita Prefecture and at the Oita Dome stadium, we performed Japan's first verification trials of a driving support system that uses thermal cameras and 4K cameras together with 5G transmission to allow the driver to check in front of and behind the vehicle even in fog with poor visibility. For this field trial the fog was generated artificially, and the video pictures from the vehicle-mounted thermal cameras and 4K cameras were transmitted to a cloud-based image analysis AI system, taking advantage of 5G's high-speed, high-capacity and low-latency characteristics to provide a head-up display of obstacles to the front and rear of the vehicle. Based on the AI analysis detection results, we confirmed that vehicles can be driven safely by providing the driver with auxiliary information about obstacles and the like that are difficult to visually confirm.

Figure 15: Field trials to provide driving assistance in dense fog using 5G

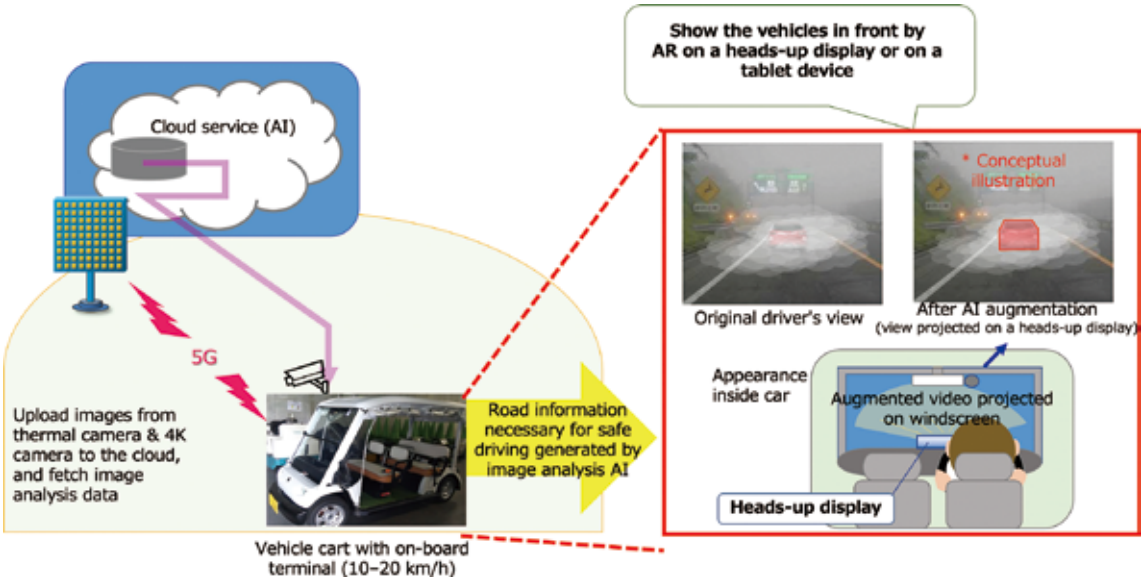


Figure 16: Field trials to provide driving assistance in dense fog

4. Conclusion

We have introduced the field trials performed in FY2019 as part of the 5G Field Trials initiative of the Ministry of Internal Affairs and Communications ("field trials of use cases employing 5G ultra-fast communication in outdoor environments" and "field trials of use cases employing 5G ultra-fast communication in mobile environments"). In the future, we plan to build on the experience of these field trials to continue working towards the realization of diverse 5G applications.

Acknowledgments

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References

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[3] Ministry of Internal Affairs and Communications: "5G Utilization Idea Contest," https://5g-contest.jp/, Jan. 2019.