13. 5G Trial
13.1 Introduction
5GMF is publishing "5G System Integrated Verification Trial Report -5G Utilization Project Plan-" [1] in order to provide information on the desired test contents and plans of the upcoming 5G Systems Integrated Verification Trial in Japan, which the 5GMF is facilitating. The 5G System Integrated Verification Trial Promotion Group (5G-TPG) of 5GMF was formed in order to further study these points and the report represents the outcome of their work. This chapter describes an overview of the 5G-TPG's report.

More than 40 proposals on the 5G Utilization Project, generated mainly from members of the 5G-TPG, are categorize into following six broad groups that were decided upon after discussion by the 5G-TPG:
- Entertainment
- Safe and secure society prevented from crime and natural disasters
- Logistics, agricultural and fisheries, offices, factories
- Remote controlled and managed devices such as robots and drones
- Connected cars, autonomous and remote driving
- High data-rate and reliable communication for high speed mobile

These utilizations of 5G as described by the 5G Utilization Project come out of the technological foundations of 5G technology, which are described in this white paper.

Other 5G Utilization Projects in the same field and the broader fields in addition to the 5G Utilization Projects described in the 5G-TPG's report can be proposed and will being investigated by 5GMF. The Ministry Internal Affairs and Communications (MIC) Round-table Conference on Radio Policies 2020 Report discussed nine different fields where vertical industries (industries exploiting 5G) are categorized as the utilization field of the next generation mobile services as shown in Fig. 13.1-1.

Fig. 13.1-1 Nine fields from the MIC Round-table Conference on Radio Policies 2020 Report

This figure provides examples of some practical uses of beyond uses for smartphone consumers, including health care, agriculture, finance, transportation, and various other industrial uses. By unearthing basic needs of industrial applications, such as improving operation efficiency of various industries or making connections increasingly convenient as well as confronting new problems of an advanced industrial nation like Japan, such as a low birth rate rapidly aging society or the decrease in the working population, 5G will not only

217

promote market and industrial growth but will become another tool to help solve social issues.

However, if only those involved in wireless industries attempt to lead 5G R&D and promotion, it will be impossible to uncover the true needs of a diverse range of industrial applications. And it is important to look for specific recommendations and receive proposals from those industries who will actually use these applications. Therefore, we also held 5G application ideathons at public events, which gave us the opportunity to bring new ideas to the forefront of our vision.

In the central technological area, experts in wireless industries introduce 5G technologies in ways that are easily understood by the general public. There are various other industrial 5G applications surrounding the technological area. As the awareness of these technologies is high among those using ICT, the quality of ideas among the collected proposals was very good. This means there is a high level of public understanding among those who use these industrial applications.

In addition, user surveys were conducted by the 5GMF Application Committee. The ways of thinking of the generation of smartphone natives opened a "different dimension" of new ideas from newly discovered needs, beyond the needs of vertical industries. Therefore, we need to add an additional area on the public 5G application ideathons, a "smartphone native student area" that must also be researched.

The public 5G ideathons are one way to collaborate with the public to uncover the real needs of users as well as encourage more awareness generally about 5G. Therefore, as the number of these meetings increase, discussions around 5G will also deepen, ultimately increasing the general public's awareness in 5G.

13.2 5G Utilization Project
13.2.1 Entertainment ([1] 2.1)
The 5G Utilization Projects in this section "Entertainment" foresee 5G's ultra-high speeds, its high capacities, and ultra-low latency will provide users with new entertainment experiences up until now they have been unable to enjoy.

What this means in concrete terms is offering users ultra-high-definition 8K video transmissions including live broadcasting/multicasting and high-presence multimedia data transmissions in which videos are taken by multiple cameras from multiple different points of view, which meet user needs.

Video and data will be delivered to users not only through devices like smartphones and tablets but through the use of head mounted displays and large high-definition signage that require ultra-high-speed data transmissions.

These services will be offered where users congregate, such as concert or event venues, stadiums and race tracks like those used at the Olympics. These services will also be able to offer users the chance to experience and participate in events remotely that they cannot attend in person. In addition, utilizing virtual reality, history and art museums will also be able to provide remote experiences, hold remote chats from multiple locations, and hold remote competitions and games and as well as provide full body experiences from festival locations.

For example, a super live immersive virtual reality experience in festivals is introduced briefly. Festivals are an important part of Japanese culture. The data processing power in a 5G network environment can provide an immersive virtual reality experience for people from beginning to end as shown in Fig. 13.2.1-1. This will allow even foreigners abroad the chance

to experience a festival, strengthening the Japan brand, which will create more demand for experiencing local cultures and local lifestyles. Putting various values on the live streaming by full use of motion sensors, augmented reality (AR) and computer graphics (CG), a real immersive virtual experience, that can't be experienced at the festival venue, will be provided.

Fig. 13.2.1-1 Overview of a super live immersive virtual reality experience

It is planned to provide some of the above mentioned services as part of a new entertainment experience to be able to more deeply enjoy the 2020 Tokyo Olympics and Paralympics.

13.2.2 Safe and secure society prevented from crime and natural disasters ([1] 2.2)

The 5G Utilization Projects in this section aim to help ensure a safe and secure society through the use of cameras and sensors to provide information, so that victims of disasters, accidents, or crimes can receive proper information and feedback, ensuring that this technology can help people feel secure in their lives in a safe society. 5G's special characteristics of ultra-high speeds, high capacities, and ultra-low latency can be used to collect data and provide feedback in real time. These capabilities can be used to offer many services to provide a safe and secure society for everyone.

For example, cameras spread around community areas collect data which is aggregated in the cloud, and with big data analysis, natural disasters or crimes can be predicted as shown in Fig. 13.2.2-1. Wearable devices can also receive spatial images, giving individuals immediate feedback on the area. In places where many people gather, video taken from fixed, wide area observation cameras as well as security wearable cameras can detect abnormal behavior or suspicious people. Users can also request finding lost children or friends.

Depending on a person's situation, anything from an alarm to evacuation assistance can be provided in real time, which can minimize any damage or prevent a crime from happening, creating a safe and secure society. By using information from a GPS-equipped security device, outbreaks of civic disturbances can be detected and video information with location information can be collected, the existence of said disturbance can be verified, and if confirmed, analyzed information can be offered to police agencies. In addition, search for suspects can be conducted and information can be sent to policy agencies and family members of the victim in real time.
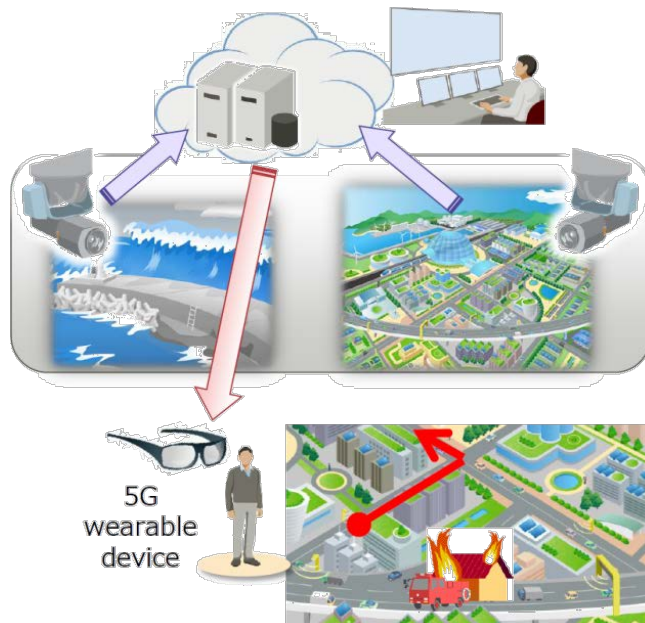
Fig. 13.2.2-1 Prediction of natural disasters and individuals immediate feedback

13.2.3 Logistics, agricultural and fisheries, offices, factories ([1] 2.3)

The 5G Utilization Projects in this section offer new lifestyles through broadly separated areas such as efficiency in logistics, an optimized heterogenous wireless environment, a network environment that can be used anytime anywhere, which can be offered do to the ability to freely choose from 5G special characteristics, such as massive connectivity, ultra-high speeds, and high capacities.

In addition, with the 2020 Olympics and Paralympics in mind, new forms of entertainment will be offered through transmitting of high-definition video from new locations. Scenarios also include ways 5G technology will be able to offer new styles of work.

For example, logistical efficiency is introduced briefly. By tagging objects (such as daily goods, food and drinks, etc.), which will make managing goods in supply chains more efficient, especially for retail stores management, following customer purchases and restocking support as shown in Fig. 13.2.3-1. This 5G Utilization Project will show how to use 5G to manage the logistics process of delivering goods from warehouses to retail shops to consumer at home as well as how to efficiently manage household goods.
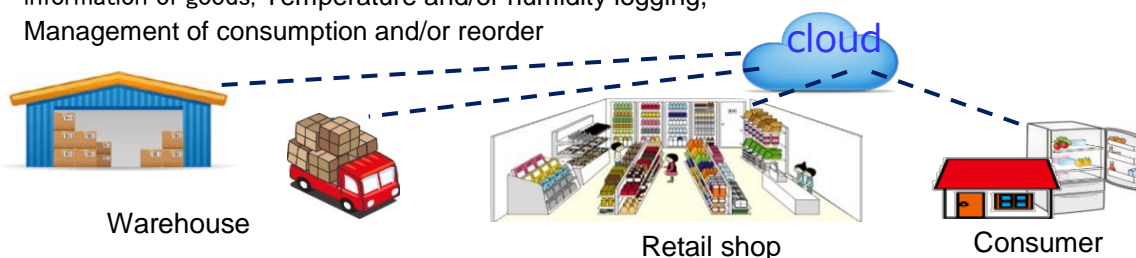

Fig. 13.2.3-1 Managing logical efficiency from warehouse to an individual's home

13.2.4 Remote controlled and managed devices such as robots and drones ([1] 2.4)

The 5G Utilization Projects in this section see the role of 5G in of remotely controlled and managed devices such as robots and drones in the following situations, remotely controlled robots, surveillance using camera-equipped robots or drones, autonomously cooperative distributed control of connected machines. They include the aspects such as the type of connected devices, HD cameras equipped for monitoring activities, as well as a way to deploy monitoring and control systems for edge computing.

From these scenarios, by exploiting 5G's special characteristics of high-speeds, high-capacity, and low-latency, a variety of new services such as sightseeing, livelihood support, and safety measures can be imagined and created.

For example, robot monitoring and remote control is introduced briefly. Various kinds of facilities, such as shopping malls and stadiums, train stations, airports, can utilize service robots to provide information to meet the various needs of regular customers or meet the demands of a sudden increase of foreign tourists. In order to make this a reality, large numbers of robots need to be operated in a safe manner so remote observation and control of the robots is essential. Robot systems, as shown in Fig. 13.2.4-1, need to ability to process audio, images, and languages and be able to send and receive observation and control commands to the operation center, so it can oversee the various robots its location.

The monitoring center and the robots located at various areas around a given site need to be able to connect to a broadband network that can efficiently accommodate many devices as well as provide low latency times in order to enable real time observations and control of large numbers of robots. This ability to provide highly precise control management with high confidence needs to be tested.
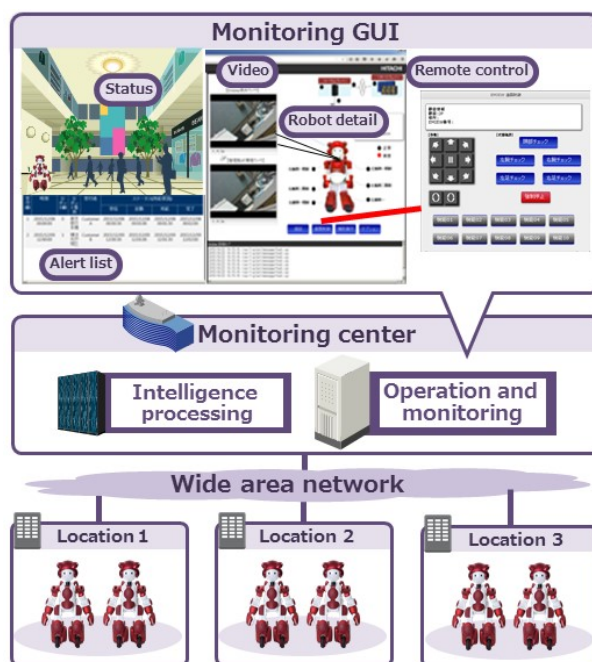

Fig. 13.2.4-1 Robot monitoring and remote control

13.2.5 Connected cars, autonomous and remote driving ([1] 2.5)

The 5G Utilization Projects in this section see that 5G's special characteristics, mainly

ultra-high speeds and capacity, high reliability and low latency, will be able to explore new users by bringing about a safe and secure society through the use of connected cars, remote control and monitoring of railway cars, and autonomous driving.

The 5G mobile communication systems from, will be able to assist in autonomous driving through the collection of traffic information data and the creation of dynamic maps, services which can be offered through 5G's high speeds and capacity. In addition, the 5G offers the needed ultra-low latency, high capacity, high speed communications for autonomously driven cars (smart automobiles) or at a mining site with remote controlled, remotely monitored very large-scale construction vehicles.

As an example, regarding the smart automobiles, by installing cameras at intersections where it is difficult to see, through high speed image processing, people and cars who enter the intersection can be monitored in real time, as illustrated Fig. 13.2.5-1. If a car or pedestrian is detected entering the intersection, through use of the 5G network's low latency, cars will be notified of the danger and will be given the order to slow down. In addition, automobiles will be sent a warning if there anything dangerous occurs around the area of the intersection, as well. In this use case scenario, the verification includes 1) clarifying requirements for low latency communications by managing cars through connecting to the 5G network; and 2) proving the safer autonomous driving by combining autonomously driven vehicles with the warning notification system.

Through these technologies, the large-scale growth in the autonomous vehicle market is anticipated, and users of advanced vehicles from family cars to large scale construction vehicles will be able to use the 5G network to help bring about a safer, and more secure and pleasant society.
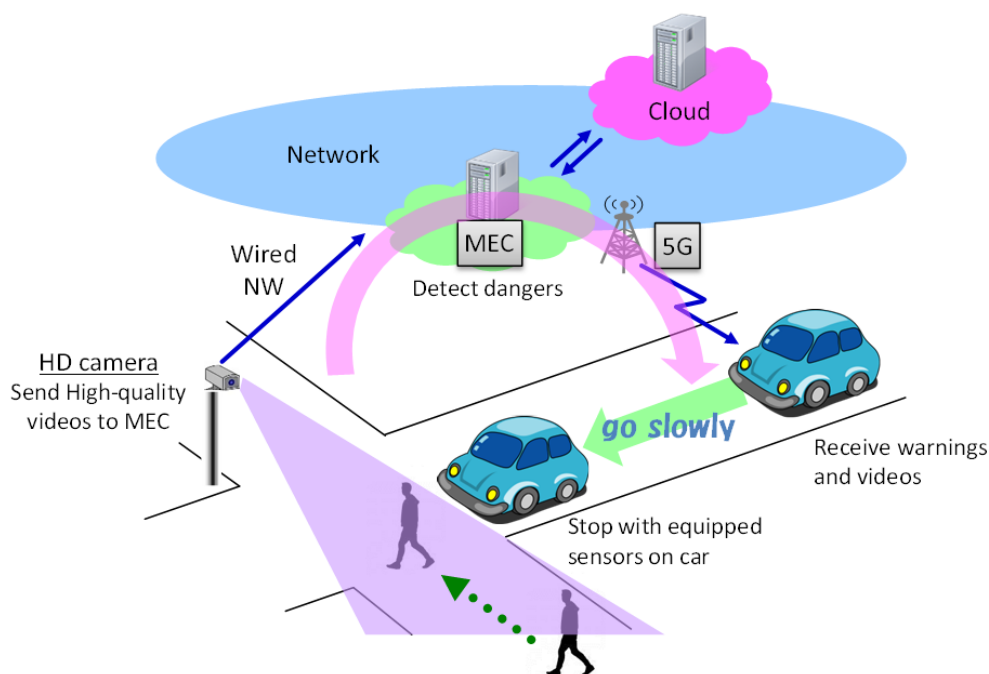

Fig. 13.2.5-1 Overview of smart automobiles with over the horizon accident prevention

13.2.6 High data-rate and reliable communication for high speed mobile ([1] 2.6)
The 5G Utilization Projects in this section will demonstrate the viability of high data rate-high quality transmissions to high speed moving vehicles, including trains, buses, aircraft/helicopters and ships.

The ultra-high data rate, high quality, and low latency are 5G's special characteristics and will offer devices which are moving at high speeds with high data rate broadband services, as well as management and monitoring services.

New optimal services can also be offered by integrating a variety of wireless systems, to deliver the high definition video (4K/8K) to trains, train stations, street corners and cars, and to provide users with high-data rate wireless connections (WiFi, WiGig) as shown in Fig. 13.2.6-1.

The relevant technologies are liner cell, RAN virtualization, Single Frequency Network, MIMO or multiple antenna technology, backhaul and fronthaul technologies, 3-D beam tracking, and Mobile Edge Computing.

The ultimate aim is to show the merits of 5G networks to both users on high speed vehicles as well as transportation firms.
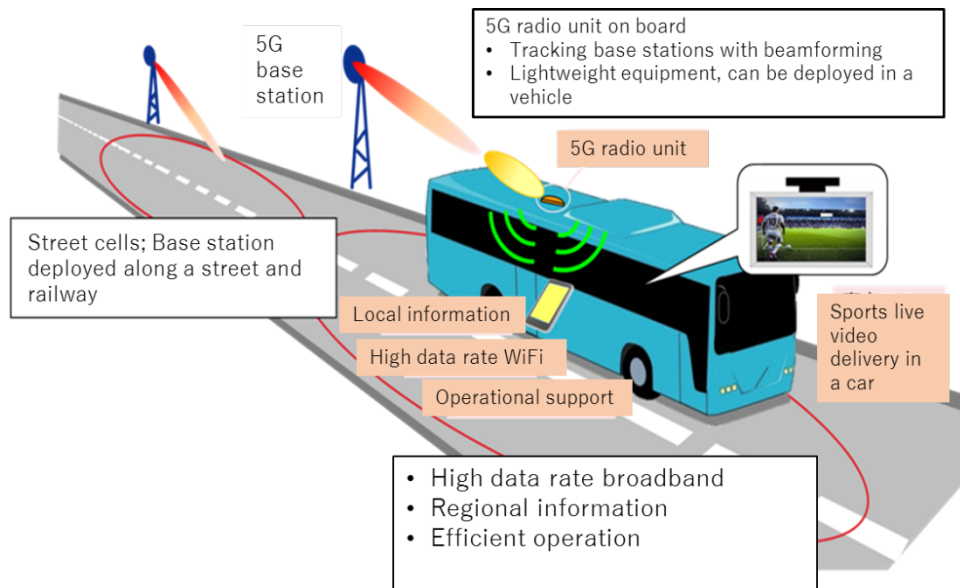

Fig. 13.2.6-1 High data rate-high quality transmissions to high speed moving vehicles

References

[1] "5G System Integrated Verification Trial Report -5G Utilization Project Plan-" 5G System Integrated Verification Trial Promotion Group, 5G Mobile Communication Promotion Forum (5GMF), ver. 1.0, Sept. 2017.