

Current Situation and Solutions of High Speed Railway Communication System

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Abstract—With the rapid development of social economy, railway trains are developing towards high speed and quasi-high speed. In order to improve train safety, we should pay attention to man-machine control on trains and information flow inside trains. A reliable and stable railway communication system can effectively improve transport efficiency and traffic safety. At present, GSM-R communication system is the main system in China's trains. The next step is to promote the formulation of relevant standards for LTE-R communication system, and to transform the railway communication system more in line with the characteristics of modern railway transportation by combining the 5G technology under study.

Keywords—Railway transportation communication system, GSM-R, LTE-R, 5G

Communication system is one of the key infrastructures of the railway, which carries the tasks of railway dispatching and command, train operation control, fault warning, danger announcement, emergency rescue and so on. Railway communication applications are diverse, such as in-car, between compartments, train-to-rail and so on. Railway operators usually apply narrow-band and broadband wireless communication technologies to train wireless communication systems at the same time, such as TETRA, digital mobile radio (DMR), GSM and Wi-Fi.

I. CHARACTERISTICS OF RAILWAY COMMUNICATION TECHNOLOGY

- ①Communication hubs are far apart, and each communication station needs to cover a wide range of services.
- ②The total number of users participating in the communication is relatively small, and the communication distance is relatively long. Usually, communication through multiplexing terminal equipment is needed to ensure the quality of communication effectively.
- ③Communication technology is responsible for the main responsibility and task of conveying railway information on the running train, so the data transmitted must be absolutely reliable.
- ④The communication network must be able to withstand natural disasters and emergencies to a certain extent, but still be able to respond effectively, and in emergency practice, there is a pre-set emergency plan as a supplementary force, the recovery time to a minimum.
- ⑤Railway communication system technology can strengthen the communication and contact between different management level personnel in the process of railway transportation, and then better solve various problems in the course of train operation.
- ⑥In areas with unstable or discontinuous signals, wireless network technology can be used to deal with emergencies in order to ensure the quality of communication.

Nowadays, communication technology has been widely used in railway transportation, but there are still some unsatisfactory aspects, such as communication facilities are vulnerable to electromagnetic interference, radio wave penetration capability, resulting in large band loss, bandwidth utilization is difficult to improve.

II. CURRENT SITUATION OF RAILWAY COMMUNICATION TECHNOLOGY

In the past few decades, China's railways have undergone a series of historical changes, such as heavy-haul freight transportation, electrification, wire speed-up, and the gradual laying of passenger dedicated lines. During this period, the demands for communication systems are changing. Since 1960s, railway mobile communication has been constantly updated and its system has been improving. In wireless train dispatching, plane shunting, interval movement, single channel intercom, crossing wireless, DMIS infinite number of vehicles transmission, tail part pressure wireless transmission, infrared temperature wireless transmission and other aspects have great development.

At present, GSM-R system is widely used in railway communication system in China, but because GSM-R system has only 4MHz band and 19 frequency points, the general design of interval cell is 2 frequency points and station cell is 3 frequency points. In some large railway stations and traffic hub areas, the same frequency and adjacent frequency interference have appeared. In order to better meet the internal needs of the railway, China is vigorously promoting LTE-R system, and combined with the 5G technology under study, greatly improve the transmission speed record and spectrum utilization, can transmit integrated video surveillance, PIS and other bandwidth-demanding data services.

A. GSM-R System.

Since 1994, China has conducted in-depth research on dedicated mobile communication technology. At that time, the focus was on the comparison between GSM-R (Global Mobile Communications-Railway) system and TETRA (Trans European Trunked Radio) system. By comparison, GSM-R is more suitable for the characteristics of China's railway transport at that time and has a more complete technical system, more in line with the needs of the development of communication signal integration technology, the most important thing is that GSM-R supports the sustainable development of railway mobile communications, so at the end of 2000, GSM-R was officially regarded as China's railway mobile communications industry. Direction of development.

B. Business Model

GSM infrastructure based on GSM and its voice dispatching services (ASCI), which include enhanced multi-priority preemption and eMLPP, VGCS, and provide railway-specific dispatching services, such as function addressing, function number representation, access matrix and location-based addressing; and as an information platform for railway departments to use Users can develop various railway applications on the information platform again. Fig.1 is the business mode hierarchy diagram of the GSM-R system. Therefore, the business model of GSM-R can be summarized as:

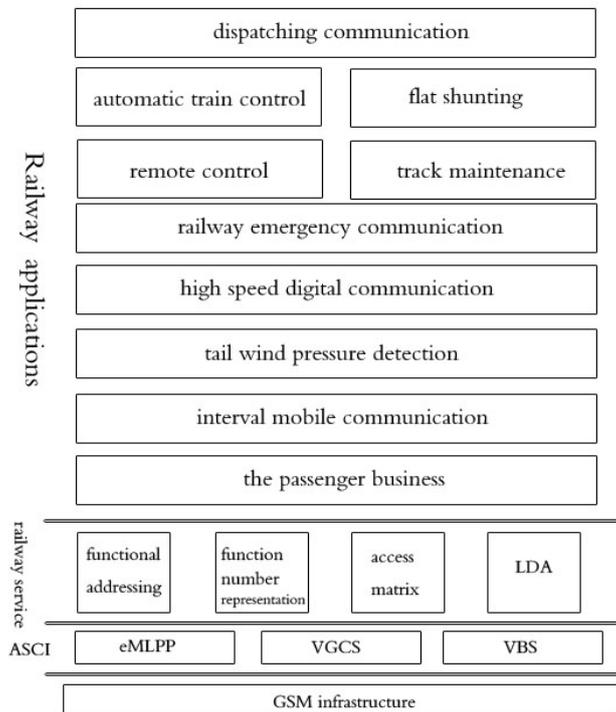


Figure 1.GSM-R System business model

$$\text{GSM-R Business} = \text{GSM Business} + \text{Voice scheduling service} + \text{Railway application}$$

GSM-R system retains the basic structure of GSM, but also requires a register to store group call attributes to achieve network functions - GCR. GCR is actually equivalent to a database that stores information about group calls. It is considered a new network node, which can be placed in PABX directly connected to MSC, in MSC, or as part of HLR.

C. LTE-R System

The application of LTE-R (Long Trem Evoulution for Railways) broadband communication in the next generation of high-speed railway communication system is the development trend. However, our country still faces many obstacles to LTE-R communication system service, the most important is how to accurately obtain fast changing channel state information.

In order to ensure the reliability of high-speed railway communication, high-speed railway wireless communication system consists of two parts, namely, ground subsystem and vehicle subsystem. The ground subsystem consists of two units, BBU (Building Baseband Unit) and

RRU (Radio Remote Unit RRU), and the two units of the surface subsystem are connected by optical fibers. Vehicle subsystem consists of three parts: VS (Vehicular Station), R (Repeater) and UE (User Equipment). The base stations on both sides of the railway are distributed at equal intervals, and the railway is divided into different sections along the railway. The communication signal can cover the railway operation area in all directions. The LTE-R communication system model is shown in Fig 2.

At present, LTE-R has been widely applied in some countries and formulated corresponding standards. LTE-R technology

is 4G technology, which has the characteristics of flexible bandwidth, high spectrum utilization, high data rate, wide coverage, good real-time service, strong bearing capacity and support for high-speed mobile. LTE-R technology can meet the business characteristics of railway communication system to a large extent.

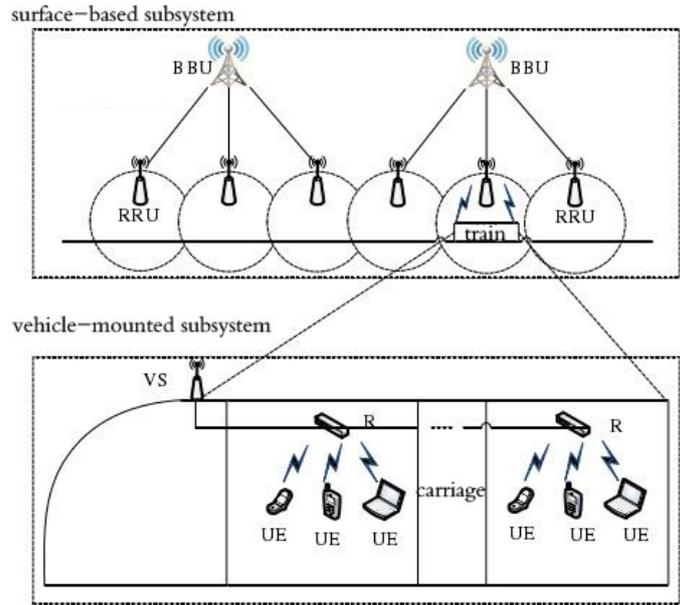


Figure 2 Network structure of high speed rail wireless communication system

D. LTE-R and 5G Technology

5G technology is currently in the stage of scale verification, and ITU-R has identified its name as IMT-2020. From the relationship between 5G technology and LTE-R, both follow the 3GPP system standards, 5G technology and LTE core network can be compatible, wireless BBU can achieve hardware compatibility.

5G technology uses full-duplex interface technology. Applying this technology to train operation can make different links in the system communicate smoothly, and effectively improve the utilization of resources, significantly improve the efficiency of equipment information transmission, and also make the train operation information in the monitoring state, effectively guarantee the safety of train operation. However, the full-duplex interface technology still has some shortcomings: the same frequency signal will affect the received signal, the use of digital domain method to eliminate interference can only be achieved in the theoretical level, lack of practical experience.

III. CONCLUSION

Railway communication system is a powerful tool to improve driving safety and transport efficiency. With the development of railway transportation in China, the requirements of railway communication system are increasingly stringent. Therefore, only based on the development process, understand the status quo, and combined with the new areas being explored in order to grasp the context of mobile communication technology.

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