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THE SYSTEM ARCHITECTURE OF CHINESE RITS

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Abstract: Chinese railway has been playing an important role in the economical development and having been confronted with the requirement of higher speed, higher capacity of transport, higher degree of safety and higher quality of services. With the development of artificial intelligence, communication, computer and its related technologies, it becomes feasible to rebuild traditional railway with such advanced technologies in order to establish a new generation railway transport system. Chinese railway started informatics-based construction on train planning, dispatching, interlocking and other special fields from early 1980 successively. The conditions are ready for the transformation of railway transportation system to the railway intelligent transportation system (RITS). According to the experience for the development of intelligent transportation system (ITS) in home and in abroad, establishment of system architecture is the first step to develop RITS. In this paper, the research contents of RITS architecture are given at first based on a brief review on the railway development. The service architecture including 7 service fields, the logical architecture and the physical architecture of RITS are outlined at last.

Key Words: intelligent transportation system, system architecture, railway transportation

1. Foreword

Since 1970s, to meet the growing demand of the social and economic development on "high-speed and high-density", railway transportation system has experienced the process starting from mostly manual work to mechanisation, electroniztion, informationization and is developing into intelligentization. Now, the developed countries have completed their informationization process and the intelligentization process is progressing with a faster speed and higher efficiency. For transforming the traditional railway transportation system into an intelligentized one, intelligentization has become one of the core strategies of the developed countries aiming at upgrading their traditional industries, and thus to maintain and enhance the competition capability of railway industry in the 21 century.

Chinese railways have constantly attached great importance to the progress of science and technology. Since the "Seventh Five-year Plan " period, China has developed and popularized all kinds of advanced business-oriented computerized interlocking system, train operation monitoring system, computerized automatic blocking system and train operation state supervision and control system. For achieving better operation management and service quality, they also cover such nation–wide large scale information systems as the Transportation Management Information System(TMIS), the Ticket Distributing and Booting System(SMARTS) and Dispatching Management Information System (DMIS), for instance, the automatic train number tracing system and the system-wide information transmission-oriented communication infrastructure, including the Wide Area Network,

Metropolitan Area Network, Regional Network, Local Area Network and Access Network. Some of the above business systems have reached or higher than the international level of the time. The application and popularization of these technologies for automization and informationization will result in heavy strike on specialized management mode of Chinese railway that features highly internal task division. Meanwhile, it also has created a foundation for the popularization of intelligentized transportation system.

Entering into 1980s, with the development of national economy and society, the growing demand on railway transportation in terms of higher service quality, faster running speed and better transportation products as well as the inherent disadvantage of other transportation modes have created unprecedented opportunity for railway transportation industry. On the other hand, railway has to encounter severe challenge never met before. The great achievement of modern technologies in each relevant field and the technological development of the railway industry itself have provided railway with feasibility to win higher service quality and faster speed.

Today, Chinese railways are undergoing the most profound transformation in its history. To cope with the need of the market, railway has to provide more and better transportation products, restructure the management mode and upgrade the traditional technical level, In the present and long period of the future, to realize striding development of railway transportation technology, the major challenge encountered by railway industry are summarized as the following:

(1) Provide integrated train operation management system, intelligentized train operation control system and intelligentized inspection,diagnosis and maintenance system to realize the high-speed and high-density transportation system.

(2) Adopt car-born network technology to realize integration of the control for locomotive and car.

(3) Provide centralized management for highly shared information between the subsystems, fully and effectively utilized means and all the relevant information of railway transportation, so as to improve the overall efficiency, prevent the accident that may affect the whole and to ensure harmonic operation of each business subsystem.

(4) Provide the supervision and control systems for the crossing and station, including image identification technology. The system shall guarantee the safety of train operation and prevent the railway and its relevant systems from conflict.

(5) Provide the passenger with detail information service, travel guidance and the transmission and display of the relevant information in the station and the train.

(6) Provide the customers with real time information and inquiry service relating to the goods transportation resources so as to meet the demand of the shipper on the overall process of the transportation for its goods.

(7) Provide the means for real time inspection, review and data collection for the purpose of maintenance on the movable and fixed facilities for the guarantee of operation safety and maintenance efficiency as well as the safety appraisal decision-making system based on the

share of safety data.
(8) Provide the reliable wide-band access approach for data transmission between car-born and way-side devices, so as to satisfy the acquisition and share of the railway moving substance and the fixed facilities.

(9) Provide the comprehensive information management and automation system for the marshalling yard that can meet the requirement of heavy load and high speed and applicable to the fast and effective disassembling and sorting of the cars.

(10) Provide complete railway disaster prevention, rescue, decision-making and command information systems feature with prompt respond capability. They should be based on the real time inspection of system status, taking system that including the language, data, static and dynamic image transmission as the information support and adopting the GPS/GIS as the positing means.

(11) Provide the local and nation-wide decision-making-oriented system to enhance the capability coping with the requirement of the market and improve the efficiency and benefit of the railway operation.

(12) Provide the information platform to share and interact the information with other transportation modes to satisfy the demand of the inter-modal transportation.

In view of the demand of the objective variation and the diversification, the dispersed business system is not able to meet the new challenger, because it is not suitable to share the information and resources with other systems. Therefore, to realize informationization and further the intelligentization has become the necessity of Chinese railway transportation system in its history. To cope with the above demand and meet with the challenge, railway transportation system has to integrate organically large scale of the latest achievements of science and technology, making them as the brain and neural system of the railway transportation system. The existed technological accumulation and the newly emerged innovative technologies have provided technical support and guarantee for building up the railway transportation system of new generation, which is based on the existing business system and taking the integration as the means. The technologies include the car-born electronic information system, modern electronics, data and image processing system, distributed computer test and control system, modern communication technology, fuzzy control and decision-making system, network, AI and DAI, as well as magnanimous data transmission, storage and exploitation technology, etc. This railway transportation system featuring integrated technologies is named the Railway Intelligent Transportation System (RITS), which will make railway transportation system undergoing a revolutionary change.

2. System architecture of Chinese RITS

As is mentioned above, the Railway Intelligent Transportation System (RITS) is to be built as a new generation railway transport system. It will integrate Hi-Tech of various fields, such as electronics, computer, modern communication, state-of–the–art information processing, control and system, automation, mechanization, management and decision-making. By fully and effectively utilize all the railway transportation related movable and fixed facilities, space and time as well the human resources to improve the safety, transportation efficiency, operation and management as well as quality of service at lower cost.

In short, the RITS is realized by the acquisition, transmission and processing of information, management and control, transportation service and intelligentization corresponding infrastructure and the auxiliary technologies to achieve the intelligentization of the nation-wide railway transportation system. Of which, to improve the transportation efficiency and upgrade the service quality is the fundamental purpose and to creation other subsystems and the details are the key approaches to its goal.

Establishment of system architecture is the first step to develop national RITS. It defines the functions that must be performed to implement a given user service, the physical entities where these functions inside, the interfaces/information flows between the physical systems and the communication requirements for the information flows. In addition, it identifies and specifies the requirements for the standards needed to support national and regional interoperability, as well as product standards needed to support economy of scale consideration in deployment. As the foundation and starting point of the entire RITS development, the study on the national RITS system architecture will be one of our focus in short term. Its objective is to combine the practical characteristics of the railway transport system o f China and to provide evidence and guidance for planning, design, implementation, standard and management for the RITS with Chinese characteristic.

3. Service architecture of RITS

Discussing user services is the first step in studying of China national RITS architecture. The users may include railway operators, passengers, consigner, information service providers, operators of other transportation modes, etc. Aiming at three key objectives, i.e. higher efficiency, higher safety and higher quality of service, the service fields of national RITS include 7 fields and 21 sub-fields as shown in Fig. 1 and Table 1.

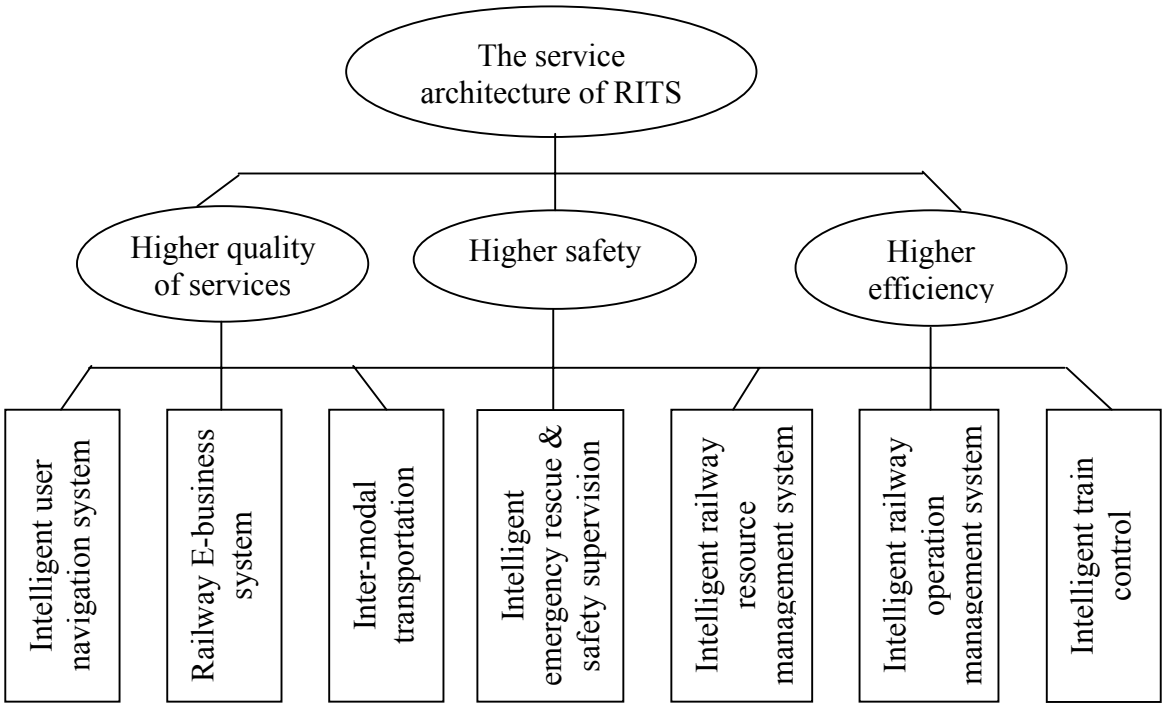

Fig. 1. The service architecture of RITS

1) Intelligent User Navigation System (IUNS)

The plentiful achievements in computer and communication technologies make it feasible for providing highly sophisticated passenger service. This user service is to be used for helping passengers or owners of goods to make an optimal travel or consignment plans and providing a lot of railway transport-related information such as timetable, ticket price and latest train operation conditions by the way of Internet, mobile phone and so on.

2) Railway E-business System (RES)

This user service is used to develop national railway e-business system. It includes passenger traffic e-business aimed at ticket-booking and toll collection of ticket, hotel, and railway-related services in Electronic payment ways through Internet or other means, and freight traffic e-business oriented to realize door-to-door transportation in e-business.

3) Inter-Model Transportation System (IMTS)

This user service is used to exchange Data among inter-model transportation systems including road, air, sea transmit and assist passenger or owner of goods to make decision for changing to other model with intelligent decision technologies.

4) Intelligent Emergency rescue &Safety supervision System (IESS)

The main objective of this user service is to Alarm the emergency status to neighbor trains and rescue organization automatically in emergent time, and to detect the latest states of infrastructure and assist to make decision for maintenance of infrastructures in order to guarantee safety of infrastructure in normal time.

5) Intelligent Railway Resource Management System (IRRMS)

This user service is used to manage all financial, floating and static resources. It includes financial resource management, infrastructure management, and maintenance management system. Its main object is to make integrated decision about resource configuration and management in optimizing way by sea-level data mining technologies.

6) Intelligent railway Operation Management System (IOMS)

This user service is used to optimize transportation planning according to user requirement and to adjust train schedule in the case of disorder as quickly as possible. It includes passenger traffic management, freight traffic management, container management and Marshalling management systems.

7) Intelligent train control & dispatching system (ITCDS)

This user service is used to realize more advanced features of communication-based and location-based train control system and integrated dispatching with considering all transport

resources including car, rolling stock, track, power supply and so on. This service will excavate the potential ability of infrastructure to the root.

Table 1. The sub service fields of RITS

Service units	Sub service
1 Intelligent User Navigation System (IUNS)	1.1 information providing and decision-making for passenger and owner of goods before departure
	1.2 information providing and decision-making for passenger aboard and owner of goods when freight in transit
	1.3 passenger navigation at station
2 Railway E-business System (RES)	2.1 passenger traffic e-business
	2.2 freight traffic e-business
	2.3 railway e-business platform
3 Inter-Model Transportation System (IMTS)	3.1 data share for inter modal transport
	3.2 decision-making assistance for inter modal transport
4 Intelligent Emergency rescue &Safety supervision System (IESS)	4.1 intelligent emergency rescue
	4.2 intelligent train Safety supervision and maintenance decision-making assistance
	4.3 intelligent disaster protection
	4.4 intelligent supervision for rail-road intersection
5 Intelligent Railway Resource Management System (IRRMS)	5.1 traffic infrastructure management
	5.2 intelligent traffic resource maintenance
	5.3 advanced financial management
6 Intelligent railway Operation Management System (IOMS)	6.1 intelligent passenger traffic management
	6.2 intelligent freight and container traffic management
	6.3 intelligent marshalling work management
7 Intelligent train control & dispatching system (ITCDS)	7.1 intelligent train control
	7.2 integrated traffic control
	7.3 intelligent station work control

4. The logical architecture of RITS

Based on the service architecture mentioned above, the logical architecture establishes the functions that RITS must perform to meet user requirement and the information flows among these functions. The logical architecture only decides what the RITS to do and don't care how to do, so the logical architecture is independent of management system and technical factor and have excellent stability. The logical architecture is described by DFD.A simplified top-level logical architecture of RITS is presented as Fig.2.

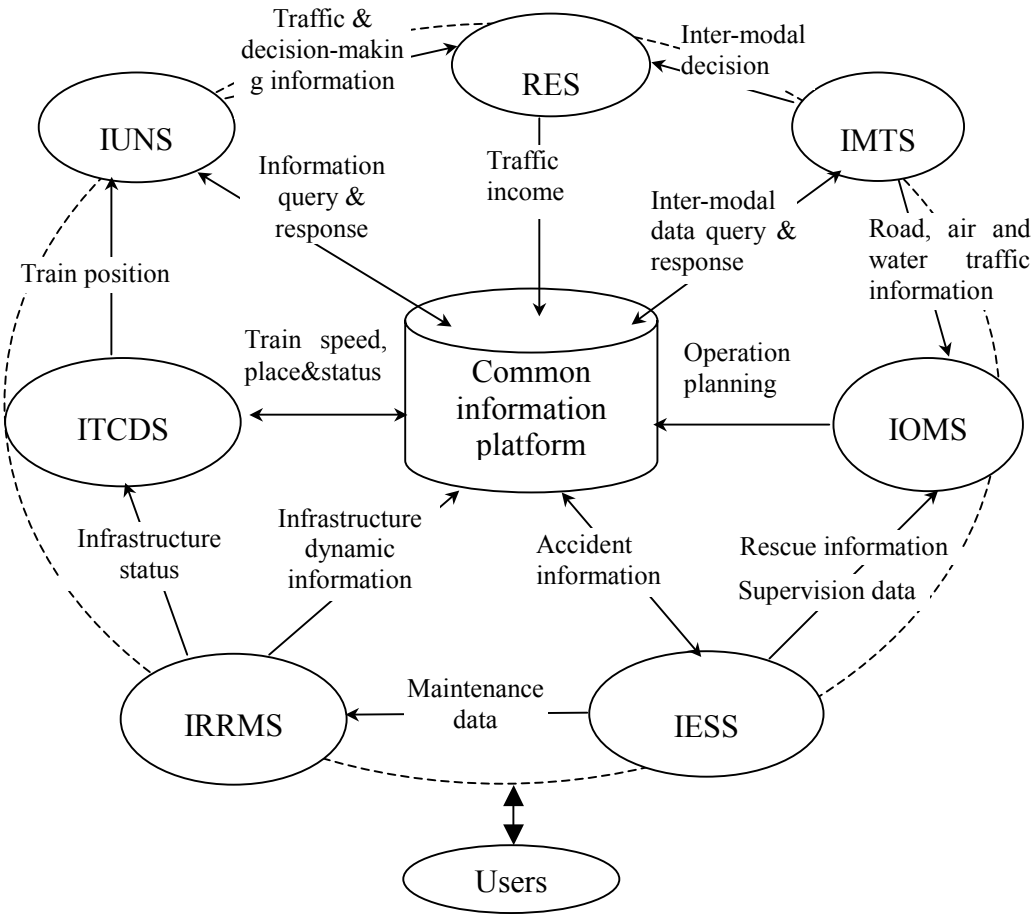

Fig.2 The top-level logical architecture of RITS

5. The physical architecture of RITS

The physical architecture divided the functions defined by the logical architecture into systems and subsystems based on the functional similarity. A top-level diagram of physical architecture is shown as Fig.3.The physical architecture of China national RITS includes 6 systems: user system, Service system, center system, trackside system, train system and station system.

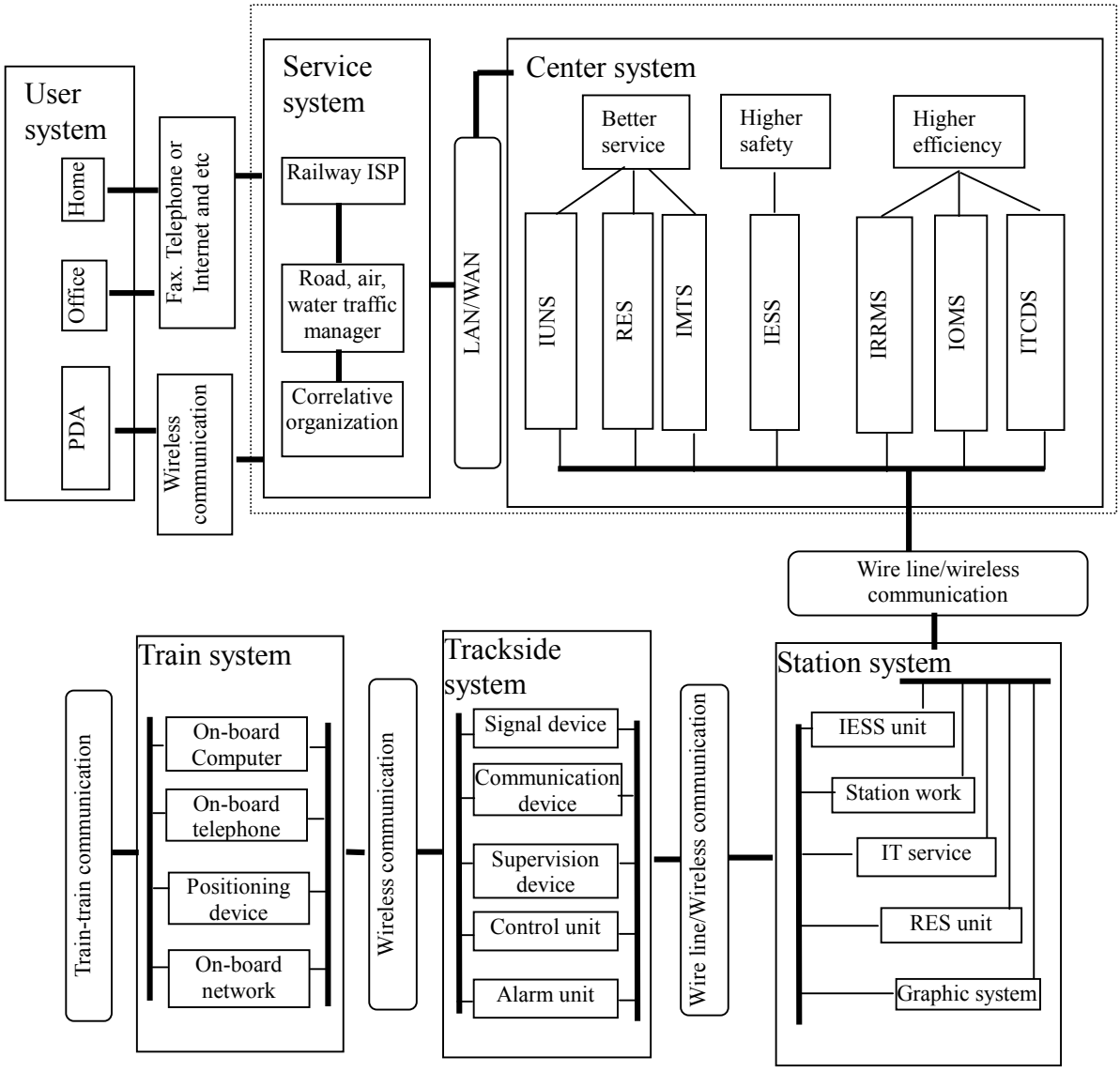

Fig.3 The top-level physical architecture of RITS

6. The architecture for common platform of RITS

RITS is a huge and complex system that integrated lots of sub-system that includes abundant spatial and attribute data, so acquisition of information, free transmitting of information flow and the sharing of the information are the key problem of RITS. The common platform of RITS is an important way to integrate such spatial and attribute data, which will establish the standard of structures and transmitting methods for railway transport and build a series of data warehouse used for organization, storage, quarry, and communication of common information. According to the current railway management system, the common data platform for RITS can divide into 3 level systems: Ministry-level common platform, Bureau-level common platform, and Sub-bureau level common platform.

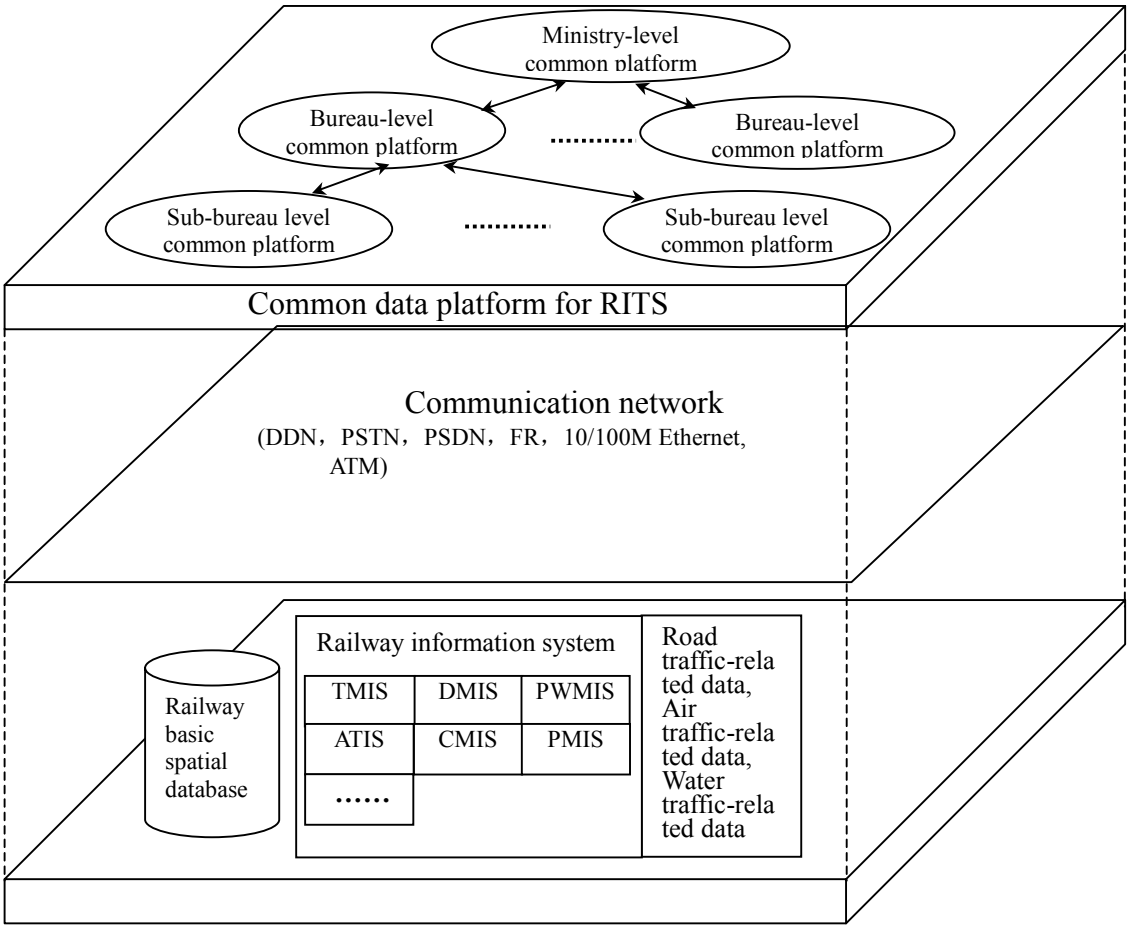

Fig.4 The architecture for common platform of RITS

7. Conclusion

The system architecture defines the service architecture, logical architecture, physical architecture and common platform of RITS and provides a favorable basis for the further development of RITS. Under great support of the government and the Ministry of Railway, and with the enhancement of R&D and application of RITS, Chinese Railways will not only realize rapid progress in technology but also promote the application of related Hi-Tech in the railway and development of Hi-Tech and equipment industry. At the same time, the application of RITS will play a positive role in promoting the change of the railway operation and management mode and increasing market competitiveness.

8. References

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