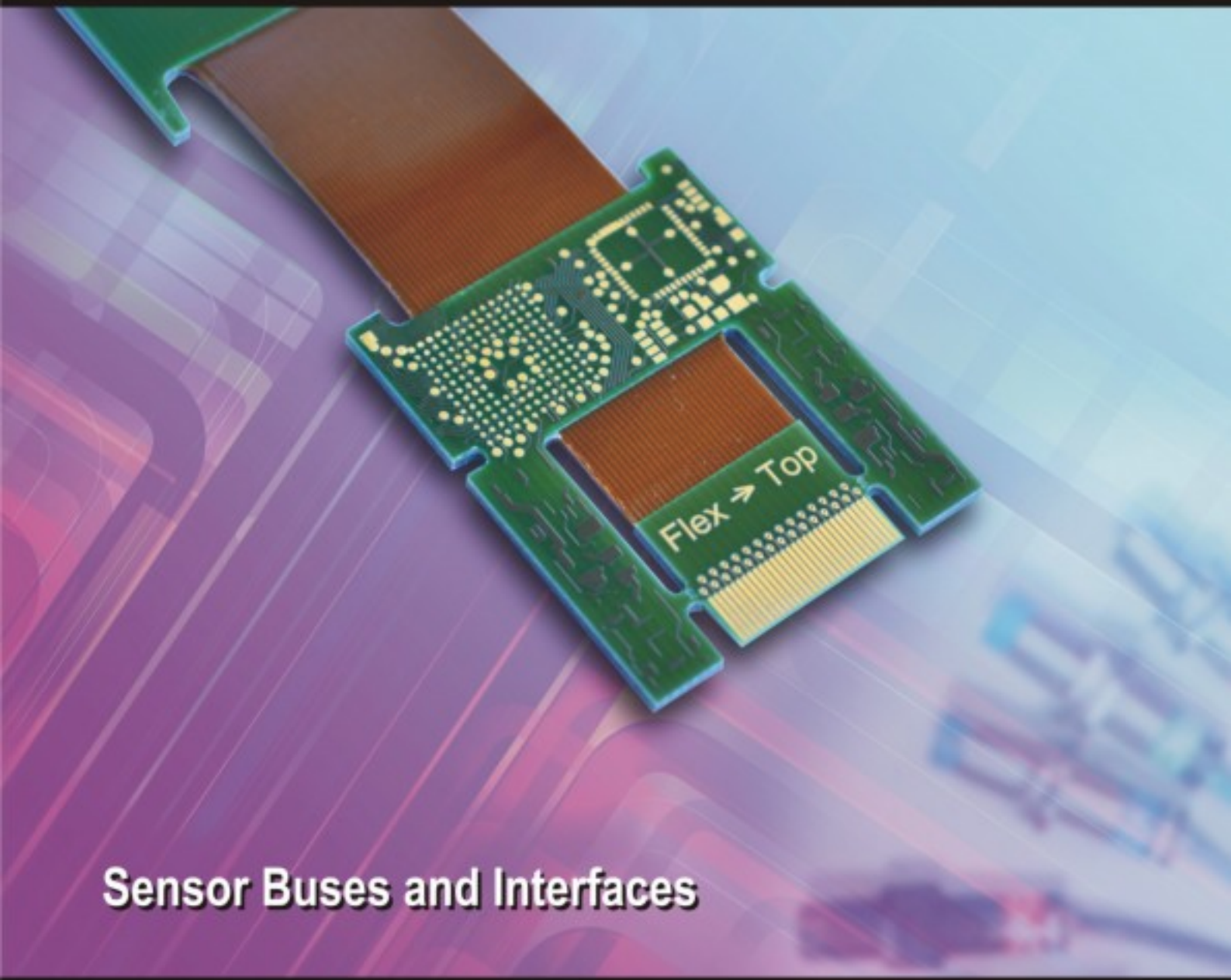
ISSN 1726-5479

SENSORS & TRANSDUCERS

vol. 152
5/13



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International Official Journal of the International Frequency Sensor Association (IFSA) Devoted to Research and Development of Sensors and Transducers

Volume 152, Issue 5, May 2013

IFSA Publishing: Barcelona • Toronto

Printed in the USA.

Sensors & Transducers

Volume 152, Issue 5, May 2013 | **www.sensorsportal.com** | **ISSN 2306-8515 e-ISSN 1726-5479**

Sensors & Transducers Journal

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Volume 152
Issue 5
May 2013

www.sensorsportal.com

ISSN: 2306-8515
e-ISSN 1726-5479

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Sensors & Transducers, Vol. 152, Issue 5, May 2013, pp. 89-97

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Research on the Special Railway Intelligence Transportation Hierarchy and System Integration Methodology

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Received: 8 April 2013 /Accepted: 15 May 2013 /Published: 27 May 2013

Abstract: Following the rapid development of information technology in the field of railway transportation, the problems of establishing a digital, integrated and intelligent special railway system need to be solved immediately. This paper designs and implements the intelligent transportation information system based on the unique pattern of transportation organization, the characteristics of transportation operations and the workflow of special railway. Through the detailed analysis of system architecture and framework design, the main subsystems and the internal comprehensive integrated principle, business system from a system integration perspective of the special railway is optimized, which can be able to realize the integration of all kinds of information resources. The implementation of integration and the special railway intelligent system is a great change in terms of maximizing transportation capacity, improving efficiency and guaranteeing the safety of special railway transportation. *Copyright © 2013 IFSA.*

Keywords: Special railway, Intelligent transportation, Information system, Data Integration, Business synergy.

1. Introduction

As an important supplement of the national railway net, the special railway is an effective component of railway transport production processes and an effective connection line between related enterprises and the national railway. The total construction and operation length has reached nearly half of the national railway [1]. Therefore, the special railway plays a very important role in the organization and operation of railway transportation management process and has great significances in China.

Since series of intelligent digital system widely used in the whole railway, the method of the railway transportation management and operation has been changed, with the level improving. However, the special railway information system still has some serious problems, such as relatively fragmented built, incoherence between business processes and management processes and so on [9]. Distributed information resources will affect the efficiency and accuracy of the decision- making, which is bound to reduce the efficiency of business operations as well as the in-depth of the digital construction process [2].

As the special railway transportation has the characteristics such as freight-based and widely carrying out the business [10], based on the dispersion building of the special railway information system and not a high degree of system integration, this paper designs a special railway intelligent transportation system by using information science, computer science and digital communications, and many other disciplines and technologies, thus

completing the special railway transportation business, management, analysis and decision support.

2. Architecture Design of Dedicated Railway Intelligent Transportation System

2.1. Overall Framework of Special Railway Intelligent Transport Systems

The overall framework of the special railway intelligent transportation system is designed for serving the strategic objectives of the enterprise intelligent transportation. The division of the overall framework of the digital system will more closely connect business systems together to ensure the cohesion of the internal system functions and information, and reduce the dependence and redundancy of datum.

Referring to the advanced division ideas in the foreign railway business systems and the application of China railway information technology application system-level structure, around a special railway transportation core service, the core services digital system is designed, which has many components, such as transportation organization digital system, capacity resources management digital system, operation management digital system, security management digital system and collaborative office digitization system. The overall framework is shown in Fig. 1.

2.2. Digital System of Transport Organization and Management

Transportation organization is the most important core service of the special railway transportation, which includes many multi-type and multi-link joint operations such as lane, scheduling and freighting [11]. The digital system of transportation organization organically integrates business information and management information in the transportation organization system to collect, transport, store and share the data of driving, scheduling and freighting in the maximum limit.

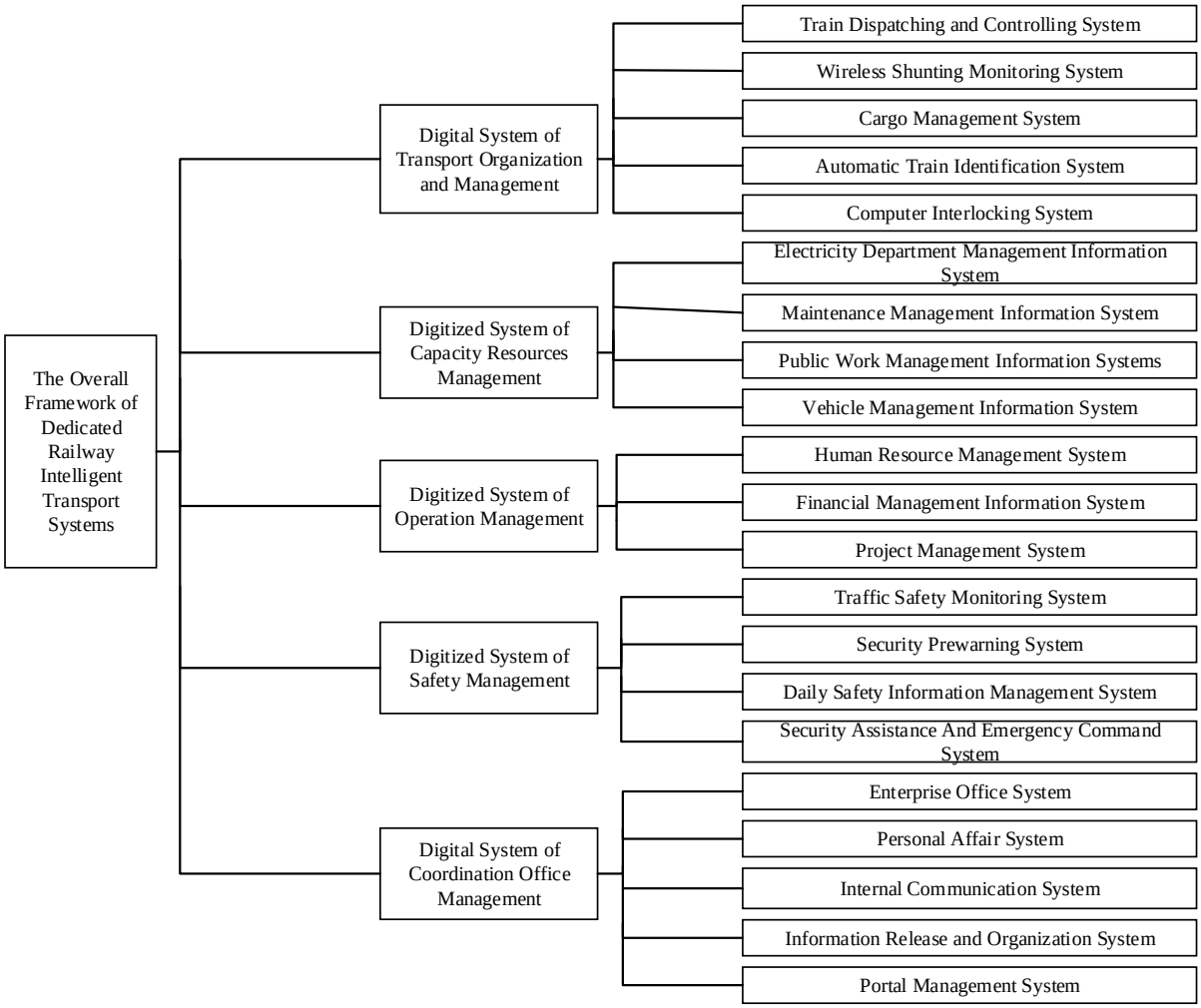

Fig. 1. The Overall Framework of Dedicated Railway Intelligent Transport System.

The digital system of transportation organization and management is mainly constituted by the following systems: Train Dispatching and Controlling System (TDCS), Wireless Shunting monitoring system, cargo management system, Automatic Train Identification System, and computer interlocking system. The train dispatching command system, wireless the shunting monitoring system and freight management system are mainly responsible for the three main businesses - driving, shunting and freight operations. ATIS system and computer interlocking system play a key role in information collection and transmission of the main business above. Information interaction mode of transport organization systems is shown in Fig 2.

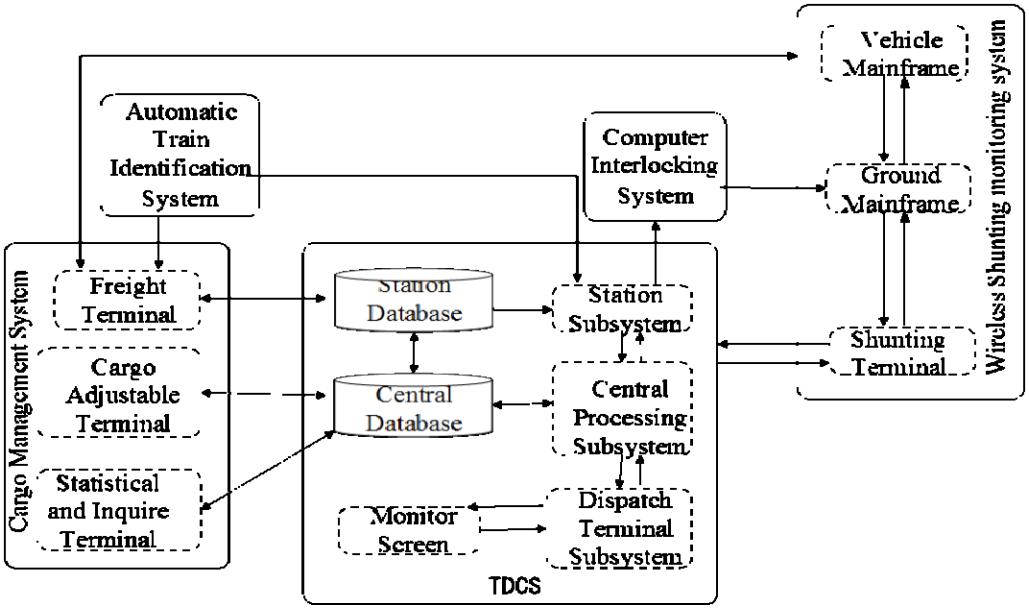

Fig. 2. Information Interaction Mode of Transport Organization Systems.

Completing the exchange of the information between the locomotive and the ground through interaction with other subsystems, the TDCS can make train operation be transparently commanded, adjusted in real time, centralized controlled by the railway transportation scheduling at all levels. In the meantime, wireless shunting monitoring system receives the information from the station yard code points by the computer interlock device and the truck loading and unloading operations plan and the shunting work requisition issued by freight management information system and the TDCS so that the organization and traffic dispatching terminal operations of the dedicated railway freight handling operations can be completed. And the subsystems in the freight management system connect closely with TDCS central database and the station database, thus assigning the job of loading and unloading trucks and cargo transport tasks.

2.3. Digital System of Capacity Resources Management

This system involves basic information management of the works, electric service, locomotives, vehicles and other departments and overhaul, maintenance, maintenance et al., and it is directly related to the smooth development of driving, adjustment freight and other core business. It mainly contains electricity department system, maintenance management information system, the Public Works Management information systems and vehicle management information system. Specifically electrical service, public works, rolling-stock and other departments collect the basic information of the capacity of resources, which will be stored and displayed then. According to the paragraphs capacity equipment technical indicators, maintenance personnel successively examine, repair and maintain the equipment, ultimately the related decision-making section will analysis capacity resources by using data obtained. The capacity resource is effectively managed and monitored during the business process. Meanwhile, the equipment and information can be obtained in good time for the special railway transportation organization operating.

2.4. Digital System of Operation Management

The digital system of operation and management establishes a modern management system by integrating the people, financial resources and materials in the special railway transportation. It

includes human resource management system, financial management information system and project management system. There into, human resource management system has open, dynamic system architecture, which almost unified manages the data related to all human resources in a centralized database. The special railway financial management system contains information flow and cash flow management, focuses on cost control and combines the actual business and financial software to achieve full efficient integration of the financial information. The browser/server (B/S) structure is used in the special management information railway project management system, in order to monitor the schedule and quality.

2.5. Digital System of Safety Management

As railway transport safety is the most important task of the railway [12], security information and security precaution, emergency command and decision-making support are highly integrated in the digital system of the safety management.

From the data flow analysis, the subsystems of the digital system of safety management play different roles in the special railway operation safety, but at the same time they have a deep inner contact. The digital system of safety management system information interaction mode is shown in Fig. 3.

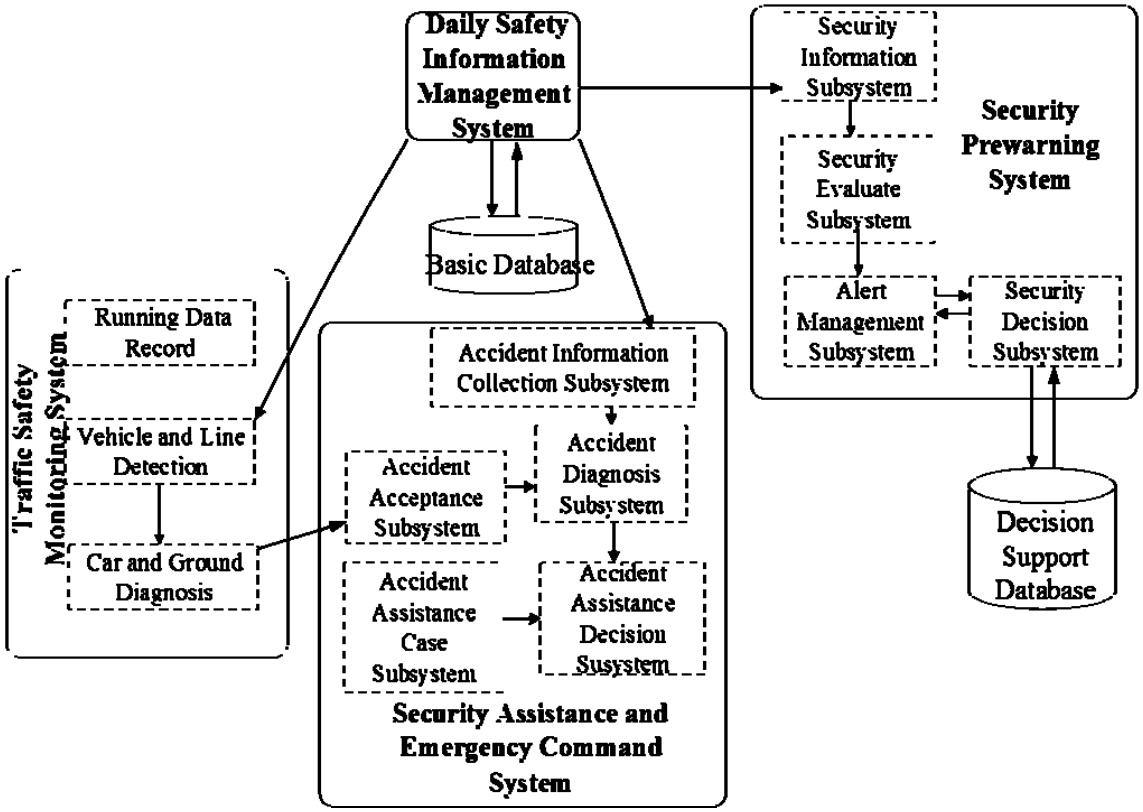

Fig. 3. Digitized System of Safety Management System Information Interaction Mode.

The traffic safety monitoring system can monitor and update the data of the equipment working status in train arrival and departure, shunting work, cargo loading and unloading, and other arrangements. Security precaution system can analyze and forecast the safety conditions and unfavorable factors of the railway transport production system based on the data in the daily safety information management system, which takes the safety evaluation of basic information from the functional departments as the data input, thus advanced preventing and controlling the railway accidents in the management decision-making. When emergencies happen, one department can operate in full synergy with the other departments. And Security Assistance and emergency command system not only can obtain the information from multiple business system, but also can get the supporting by the decision support libraries in the railway security precaution system.

2.5. Digital System of Coordination Office Management

The digital system of coordination office management for the special railway can integrate the operating management, capacity resources management, transport organization, security

management and other business to a unitive information office platform. The system is divided into the enterprise office systems, personal affair system, internal communication system, information release and organization system, portal management system. The architecture design is mainly based on the three-decker of internal LAN, LAN and Internet. Finally related business system and office automation system seamless link and couple together, that improves office efficiency and management efficiency.

3. Research Method

3.1. Special Railway Intelligent Transportation Systems Business Interaction Analysis

According to the condition of the business relation and information exchange among the subsystems, each integration solution to digital system for the special railway can share the internal data and optimize business process. As the special railway transport is a process that multi-type of work joint operate, the departments and the types of work need to closely and all core business can cooperate interact in integration through the business interaction [3]. Eventually the cooperative ability of the transportation process can improve a lot.

The business interaction and data set among the digital systems are extensive. For example, in the digital system of transportation organization and management, the status messages like the line and the rolling stock provided by the digital system of capacity resources management, the information like the staff, facility and cost provided by the digital system of operation management and the digital system of coordination office management and the information like safety alerting provided by the digital system of safety management support and guarantee orderly and efficient operations of the digital system of transport organization and management. In the same time, the digital system of transportation organization and management provide the business dynamic information of the equipment to the digital system of capacity resources management, the dispatching, freight and other statistical analysis information to the digital system of coordination office management and the digital system of operation management and the operating status information of the equipment to the digital system of safety management. The output and share of all the information will help realize the smooth operation of the related systems and functions.

The specific business interactive mode is shown in Fig. 4. Each function module in the digital system of intelligent transportation for special railway effectively integrate and data share among them, that make the business among them cooperate, reduce the cost of the resources and ensure transportation safety.

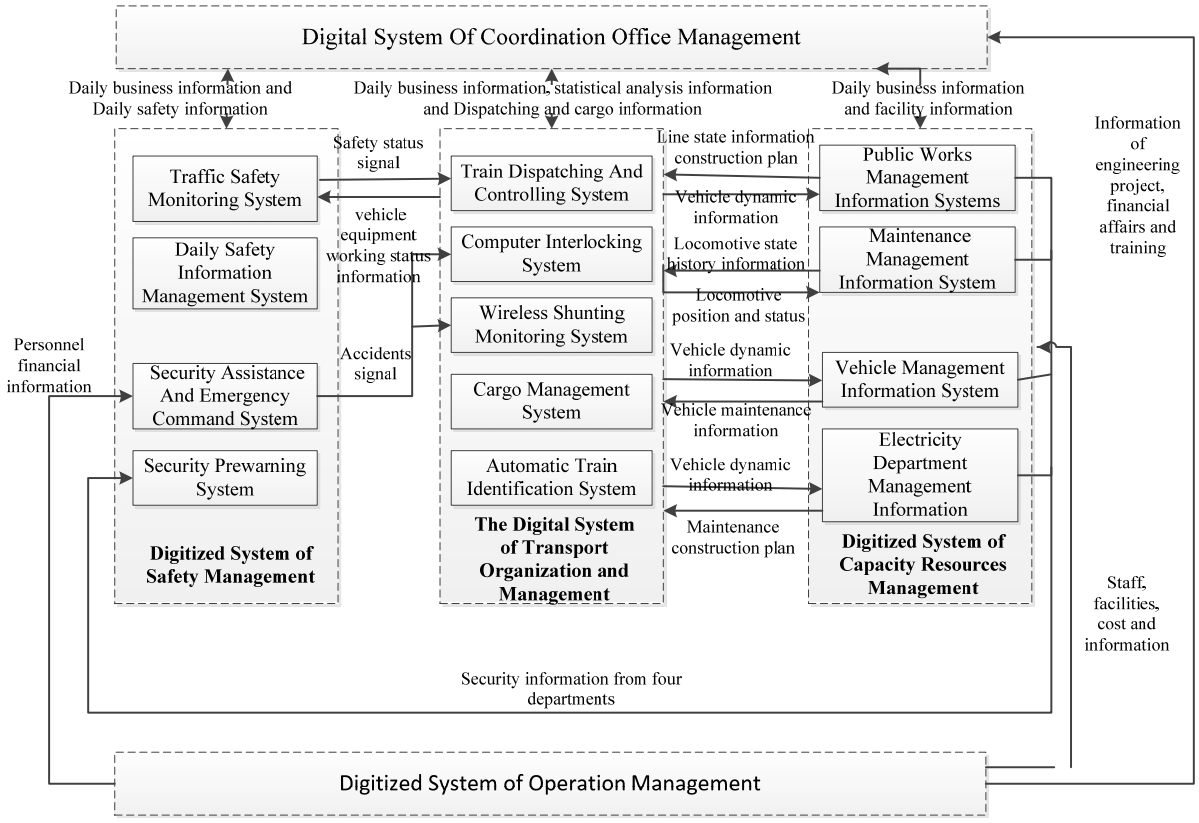

Fig. 4. Special railway intelligence transportation digital systems business interaction.

3.2. Integrated Analysis Methodology

Integration methodology is an important support for the successful completion of the integration process [4]. System integration technology is not the technical interconnection at all, but the one that make all the separated subsystems a new integrative and more powerful system and cooperate each other to achieve the overall optimal performance [8]. The integrated analysis methodology of the special railway intelligence transportation digital hierarchy is composed by system data integration technology, system environment supporting technology, business management and decision-making technology, standardized technology, enterprise modeling technology and system development and implementation technology. The form of the integrated analysis methodology is shown in Fig. 5.

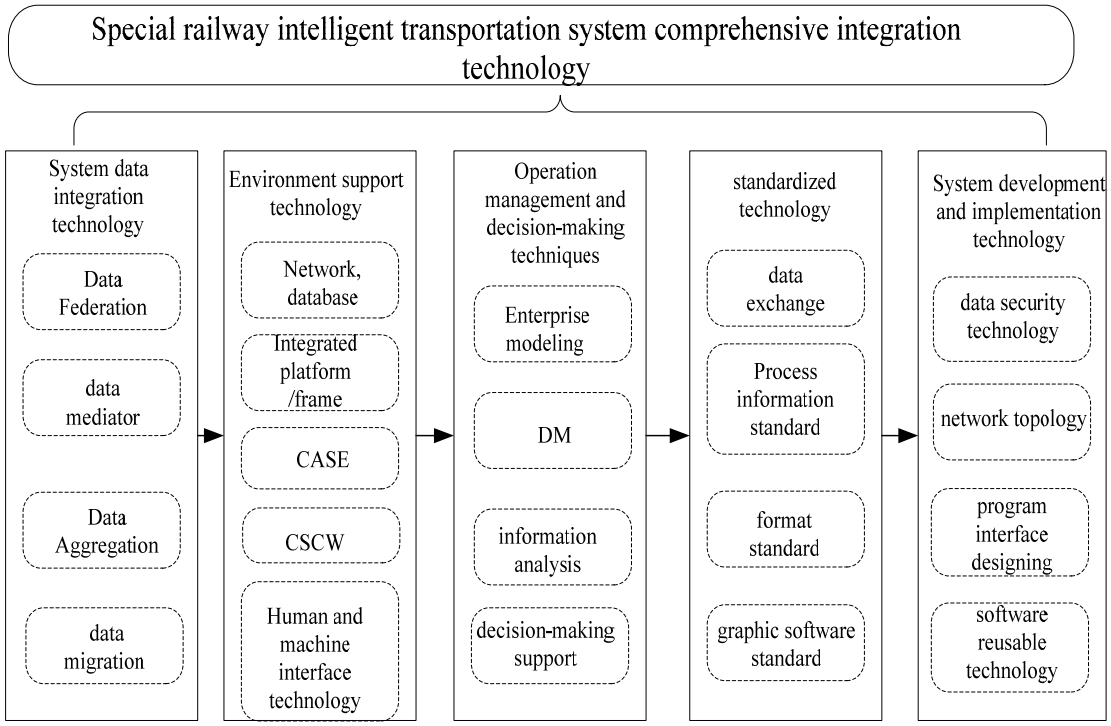

Fig. 5. Special railway intelligence transportation system of digital integrated technical structure.

The data integration is the basis of business collaboration and the core issue of the special railway intelligence transportation hierarchy [5]. The business systems are based on different database management systems and their basic data have a lot of differences in semantics and structures, so it is difficult to share the information. In the intelligence transportation hierarchy, data and information can be integrated together. In the meantime, the interconnection among different business information can be enhanced.

The data integration pattern is shown in Figure 6. The data of each digital hierarchy is firstly preprocessed by the data processing server, and then it will be analyzed. Common data of the digital hierarchy will be transferred to the special railway basic database, and the system-specific data to the subject database. Every business hierarchy for special railway transportation can get the basic data not only from internal database, but also the shared database when it needs to use and analyze the data. Thus shared database is the core of the entire data layer. On the one hand, it can extract and update shared data from internal system database, on the other hand, it can provide the source data to the subject database and application system. Data is mined, visited and finally presented to the application in many dimensions, thus the various application systems can be integrated.

4. System Integration Mode and Implementation

4.1. System Integration Process

System integration aims to integrate all human thinking, cognitive experience and a variety of data and information and rise from a wide range of qualitative understanding to a quantitative understanding [6]. Based on aforementioned system integration mode and integration technology, the system integration process and model can be analyzed and realized. The integration process is divided into system integration early stage, middle stage and late stage, as shown in Fig. 7.

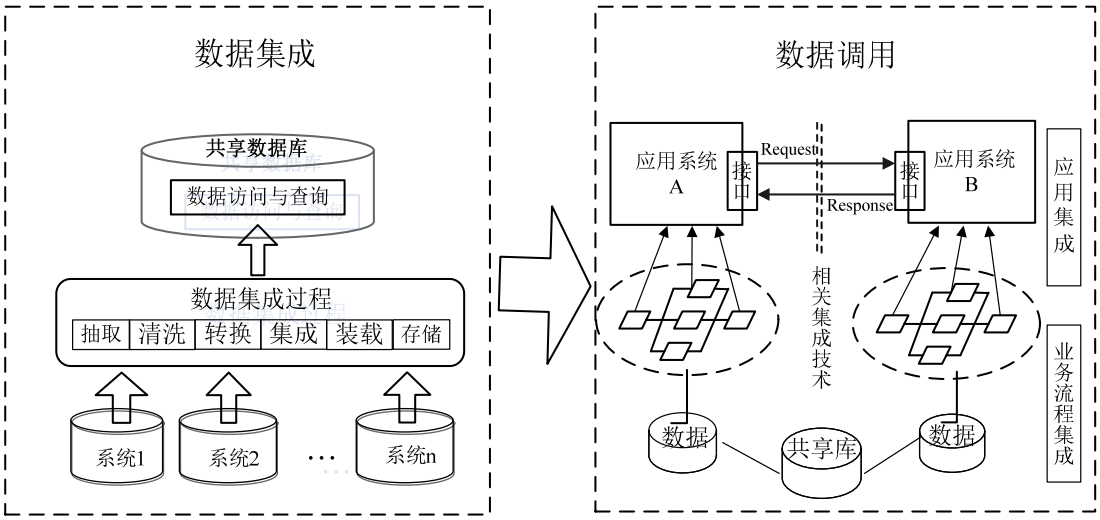

Fig 6. Special railway intelligent digital system data integration model.

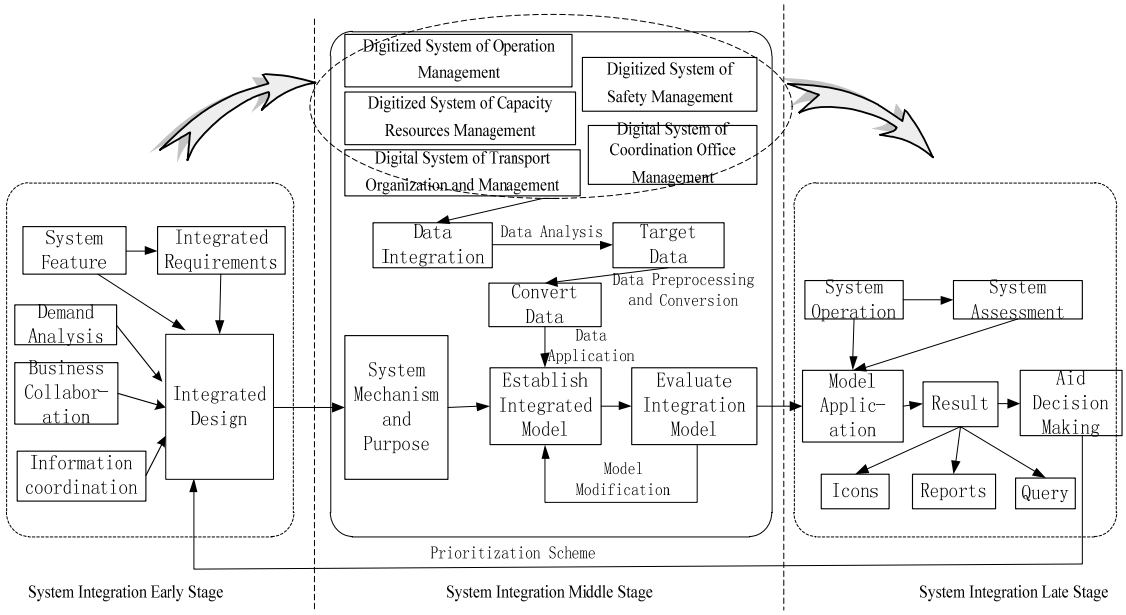

Fig. 7. Special railway intelligence transportation digital system integration process.

4.2. System Integration Model

As the business processes of the special railway is complex, the range is large and the data flow is dispersive, the special railway intelligent transportation hierarchy takes the architecture of the system integration model as the basic framework of the system analyzing and designing [7]. Based on the basic idea of complex systems "divided into parts, then conquer", the entire system will progressively develop and analyze in the application model, the logical model and physical models.

According to the main business of the special railway transportation, the conceptual model of the intelligent transportation system integration is abstracted from five service subject domains: the special railway transportation organization, capacity resources, operation management, security management and collaborative office. And the functional requirements are shown by a combination of data assemble and the sub service of each service domain. Based on the analysis of data flow diagram (DFD) structured process modeling tools, logical model not only can determine all the details of the information and the relationship in the intelligent transportation system, but also analyze all the internal logic structure of the system. Based on the operation of these two models, the physical models complete the physical implementation of the special railway digital system integration and design the entire system integration from three aspects of the infrastructure, data flow and application system, which has all the implementation details of the system. The special railway intelligent transportation digital physical model is shown in Fig. 8.

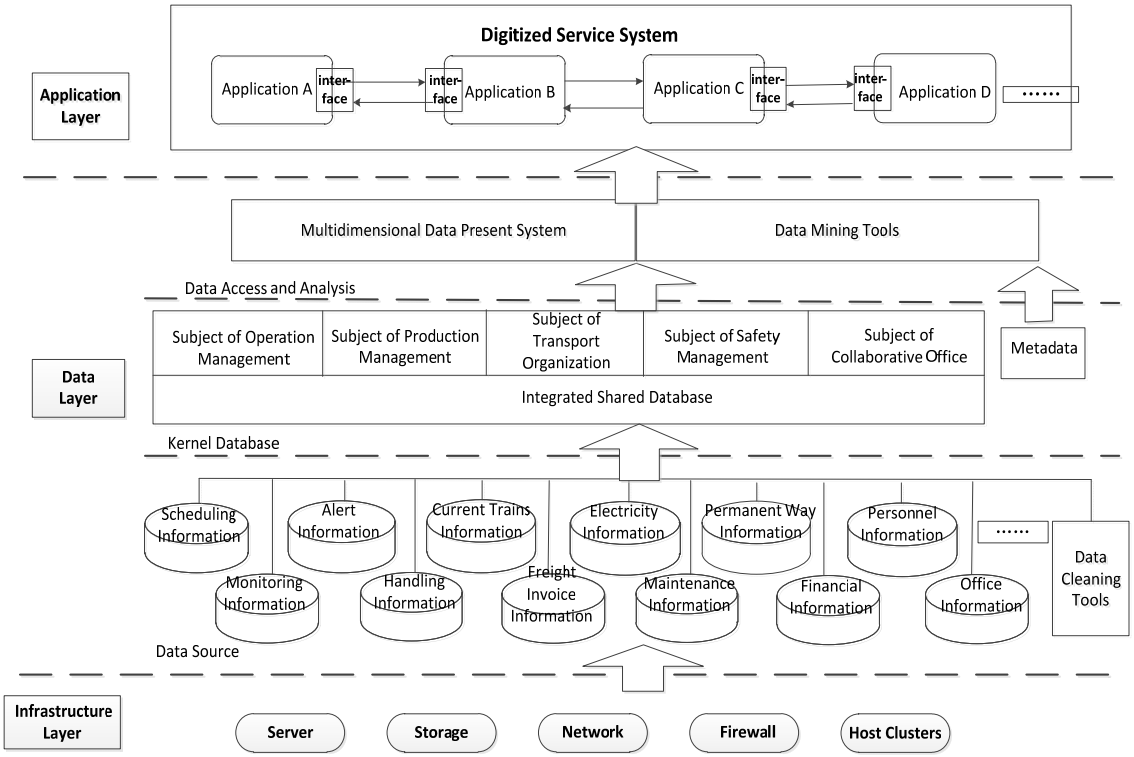

Fig. 8. Special railway intelligent transportation digital system integration physical model.

From Fig. 8, the implementation of the digital hierarchy of the special railway consists of three levels, which are facilities layer, data layer and application layer. The facilities layer includes the hardware structure supporting the entire system. The facilities integrate and construct in accordance with the connection among the system requirements, business and function. The shared database is established by using data sharing and integration technology in the data layer to make data share. These two levels provide the physical support and protection of infrastructure, as well as data and information support for the realization of the application layer. The physical model of the special railway intelligent transportation system integration is the guidance of the entire system construction and application, which provides an integration of various data in the system, completes a high degree of integration and sharing of data, and ultimately makes the system and applications work together.

5. Conclusion

The special railway intelligent hierarchy realizes the integrative management and control of special railway organization, so it is a new change for special railway transportation organization, command and control, operations management, et al. The major pioneering work of digital hierarchy of intelligent railway follows:

(1) This is the first time to effectively integrate the various subsystems in the digital hierarchy of the core business of special railway, optimize the bottom-up workflow, make the management more transparent and thus increase the efficiency of transportation and production.

(2) The various types of data in the production of railway transportation have been managed and updated together in time, so that information from each system of the digital hierarchy can interact with each other more freely, and also avoid a large number of security risks.

(3) The effective integration and centralized use of the resources of the special railway enterprises will help business interact and collaborate. In the meantime, it can avoid duplicate storage of the data and duplicate construct of similar function module between different systems, reduce production costs, improve the operation and management and advance the service quality.

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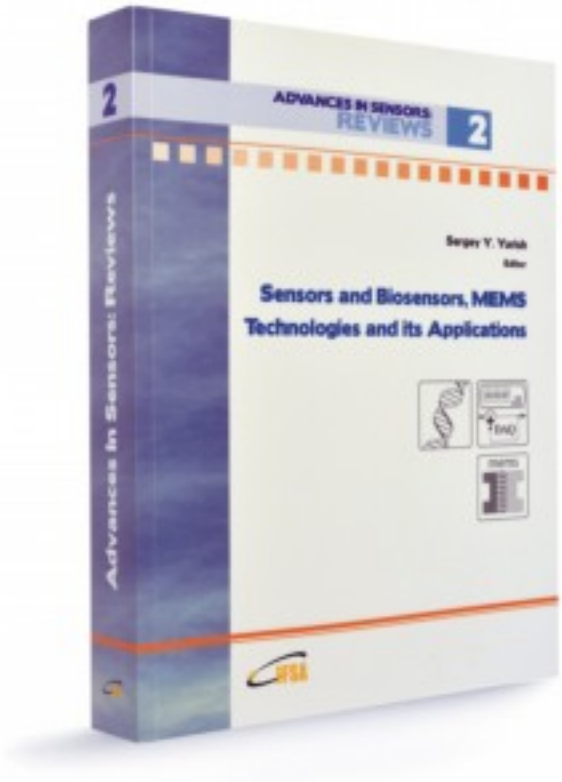

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