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THE SERVICE ARCHITECTURE OF CHINESE RITS

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Abstract: In this paper, the research process of the service architecture for RITS is given and the results of user requirement are outlined. On this basis, the service architecture for RITS with 7 service fields and 21 sub-service fields, which including intelligent user navigation system, railway E-commerce system, inter-modal transport system, intelligent railway resource management system, intelligent operation management system, intelligent train control & dispatching system and intelligent emergency rescue & safety supervision system, are presented. The basis for the research of following logical architecture and physical architecture of RITS are established.

Key Words: Railway Intelligent Transportation Systems (RITS), System architecture, Service architecture

1. INTRODUCTION

As one of the kernel components of the system architecture, the service architecture of Railway Intelligent Transportation System (RITS) defines the function that RITS should do from the user's perspective and decides the development scopes and goals of RITS. The experience for research on the system architecture of ITS in developed countries have indicated that service architecture is the jumping-off point for the development of system architecture, the logical architecture, physical architecture and operation theory must be developed on the basis of definitude of the user requirement for RITS.

This paper is divided into 4 parts. The research procedure for the service architecture of Chinese RITS is given in the first part, the user group and whose requirement for Chinese RITS is outlined in the second part, the service architecture of Chinese RITS, which consists of intelligent user navigation system (IUNS), railway E-commerce system (RES), inter-modal transport system (IMTS), intelligent railway resource management system (IRRMS), intelligent operation management system (IOMS), intelligent train control & dispatching system(ITCDS) and intelligent emergency rescue & safety supervision system(IESS), is put forward on the basis of user requirement analysis in the third part, and the conclusion and following research envision for RITS is introduced in the fourth part.

2 THE RESEARCH PROCEDURE OF RITS SERVICE ARCHITECTURE

Referred to the method for construction of ITS system architecture, the service architecture for RITS is established. The user's requirements are firstly analyzed. On the basis of comprehensive requirement analysis, the same kind of requirement is united and the potential requirement is excavated. On this basis, the service fields and service functions of RITS are decided. The detailed procedure for research on RITS service architecture is as follows.

The user group as the precondition and basis to define user's service and sub-service is

defined firstly. According to the current practice of Chinese railway, the user group is divided into 3 kinds: external railway users such as passengers and consigners, internal railway users such as operation management dept., dispatching management dept. and so on, and related transportation branch such as road transportation, water transportation and air transportation.

Secondly the user service requirement from user group is analyzed in order to define user's service. Requirement analysis is not only the important foundation to divide the service fields of RITS but also one of key elements to ensure the success for construction of RITS. The mission of requirement analysis is to describe the system functions and characteristics that user needed. As the foundation to define user service and sub-service, user requirement is the most important task in the phase to define user's service. The following principle is adopted when analyzing the requirement of Chinese RITS.

1. To combine current requirement with future requirement

RITS is a huge system that covers various fields of railway transportation and has very complex behaviors, whose construction need long period to realize as usual. The user's requirement must be forecasted in the phase of system design. As the same time, the influence to system architecture of RITS with the continuous change of user requirement and the development of techniques should be decreased in order to keep the stability of the system architecture of RITS. Therefore the current user requirements and the new requirements that arose by technique development must be jointly considered in the phase of user's requirement analysis.

2. To integrate bottom-to-up and up-to-bottom strategy

The bottom-to-up and up-to-bottom strategy is integrated when analyzing user requirement. The requirement comes from various professional fields such as dispatching, infrastructure, communication, etc. is advanced firstly, and then the elementary user requirement of RITS is formed according to the sequence from bottom to up. Secondly goal-driven method is applied to decide proper and accurate user requirement of RITS which aims at "Higher safety, higher efficiency and higher quality of services" according to the sequence from up to bottom.

3. To fully absorb the experience for construction of large-scale ITS system

The research on the system architecture of ITS have been done in a lot of countries and regions in recent years. The service fields of ITS have became international standards, which provided a good foundation for the research of the service architecture of RITS.

4. To combine requirement analysis with requirement mining

The requirement analysis not only makes for the construction of RITS in the near future but also makes plan for long-term development of RITS. So the user's requirements analysis should be combined with future technical development, the trends of national transportation policy and alterable user travel requirement and be deeply mined by intelligent data-mining technologies in order to get the analysis results that suit to current user requirements and also in favor of the future development of RITS.

3 USER REQUIREMENTS OF RITS

The users of RITS are divided 6 groups: railway external users, passenger transportation management department, freight and container management department, train dispatching center, railway infrastructure management department, safety and emergency management department. Their requirements for RITS is shown as table1.

Table 1. User's requirement for RITS

User group	User's requirement
Railway external users ● Passengers ● Consignors ● Related transport branch	● Make an optimal travel or consignment plans according to their requirement; ● Provide a lot of railway transport-related information such as timetable, ticket price and latest train operation conditions; ● Automatically deal with business related to passenger traffic, freight transport and other business of railway in the E-business way; ● Share transport data among railway, road, air and water transport; ● Assist to make decisions for inter-modal transport.
Passenger Transportation Management Department	● According to passenger requirements and railway transportation resources, the operation plan for passenger-train is made intelligently ● Based on passenger flows and distribution information, the analysis and forecast models of the fastigium and off-season railway passenger flows will be set up ● The decision-making system for ticket price and transportation resource adjustment system will be built ● The automation of selling, returning, booking and long-distance purchasing for passenger tickets will be implemented
Freight and Container Management Department	● According to consignor's requirement and railway freight transportation resources, freight transportation scheme is made optimizinglly. ● Transportation plans are automatically drew up according to freights category, weight, quantity, volume, departure station, arrival station, route restriction and etc. ● Based on freight flow and distribution information, flow analysis and forecast model for fastigium and off-season railway freight are set up ● Realize cargo tracing management from consignment to delivery. ● Automatically control car's arrival, decomposing, marshalling and departure operation process and optimizinglly draw up operation schedule.
Train dispatching center	● Unfixed and fixed railway transportation resources are dispatched optimizinglly, taking all related factors such as railway line, traction power supply, signal mode, block system, vehicle dynamical character, train operation and organization into account

	● Decision to adjust train flow is made according to distribution of serviceable car, carrying capability of equipment, locomotive and etc. ● Intelligent interlock controls train's operation in station and automatically arrange train's arrival and departure.
Railway infrastructure management department	● Build uniform infrastructure databases for the whole China Railway industry to manage railway transportation resources effectively; ● Realize the uniform management and the rational liquidation for the financial resources of the whole China railway industry; ● Build knowledge databases to make decisions for infrastructure maintenance to optimize equipment maintenance plans according to real-time data of railway transportation resources and to realize long-distance decision-making supports when failures occur; ● Build financial management information system to keep all kinds of business records and manage, analyze, inspect transportation cost, transportation income and enterprise capital, and build enterprise business activity analysis and decision-making support system
Safety and emergency management department	● Monitor all railway transportation resource dynamically; ● Make decisions to defend disasters and to rescue in emergency; ● Level crossing supervision

4 THE SERVICE ARCHITECTURE OF CHINESE RITS

According to the user requirements analysis of RITS, the service architecture of RITS is divided into 7 service fields: intelligent user navigation system, railway E-commerce system, inter-modal transportation system, intelligent railway resource management system, intelligent operation management system, intelligent train control & dispatching system and intelligent emergency rescue & safety supervision system as shown in Fig.1. The detailed definition of service fields and service contents are as follows.

4.1 Intelligent user navigation system

This service is to help passengers or consigners to make an optimal travel or consignment plans according to their requirement and to provide 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 etc. It divides into 3 sub service fields.

4.1.1 Providing information and making decision for passengers before departure

(1) To release railway production information, all kinds of rail service and its manner, rules for railway transportation, stations and agencies and etc. by the way of Internet.

(2) To provide passengers with train timetable, real-time ticket sale information, ticket

purchase guide, related service information, etc. and to assist passengers to make an optimal travel plans by intelligent optimization technique taking passengers' requirements as objects and taking timetable, ticket price, arrival station and departure station as limitations.

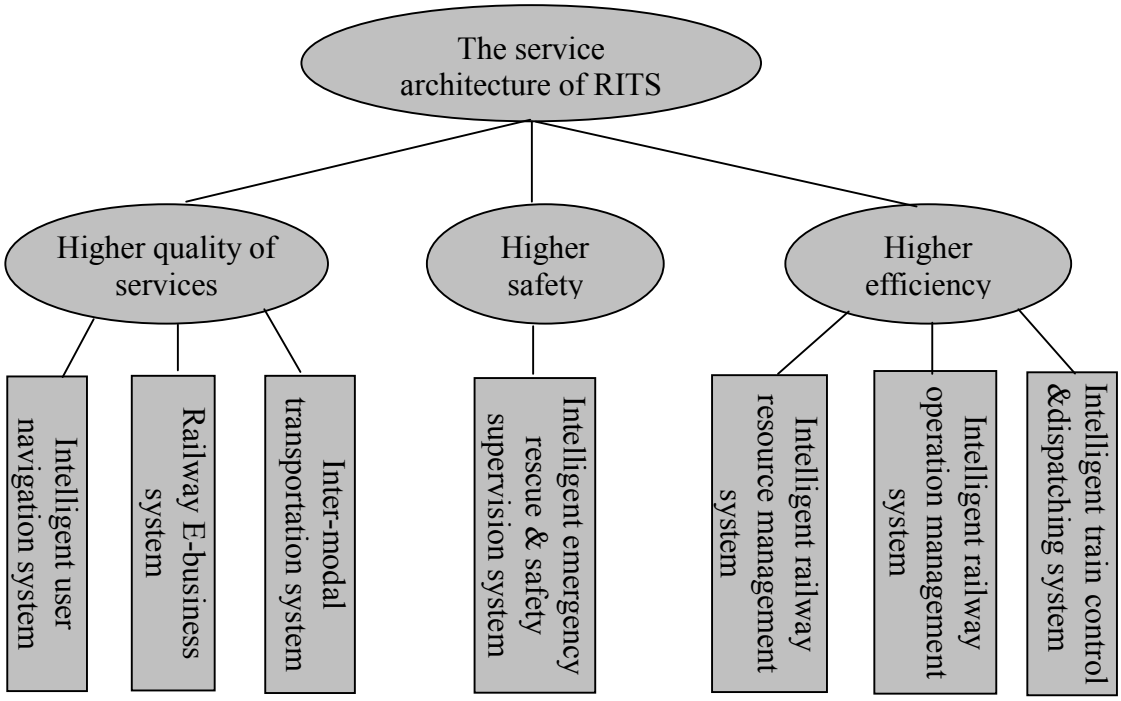

Fig.1 the service architecture of Chinese RITS

(3) To provide consigners with regulations for all kinds of freightage, rolling stock situation, transportation fee, etc. and to assistant consigners to make an optimal consignment plans by intelligent optimization technique according to the requirements of owner, such as shortest time, cheapest fee, etc.

4.1.2 providing information for passenger aboard and consigners when freight in transit

(1) To provide passengers with the scheduled timetable, actual timetable, arrival time and stopping time at next station, the time to change to other transport modes at main traffic station, onboard service information, etc.

(2) To provide consigners with the train situation, real-time freight position and status, freight arrival time, time to change to other transport modes, etc.

4.1.3 passenger navigation at station

To provide passengers with the service for ticket price query, travel assistant decision and automatic fare collection& validation and integrated service navigation.

4.2 Railway E-business System

This service is used to automatically finish business related to passenger traffic, freight traffic and other business of railway in the e-business way. It divides into 3 sub service fields as

follows.

4.2.1 passenger traffic e-business

To provide passengers with traffic services such as online query and ticket booking, purchase or return by electronic cash, credit card, electronic burse and so on.

4.2.2 freight traffic e-business

To provide consigners with consignment services that includes the application for freightage plan, putting order form, payment for cartage in the e-business way and to finish electronic data interchange (EDI) between railway and cooperated companies in order to provide door-to-door transportation service.

4.2.3 railway e-business platform

To support inquiry price, quote price, contest price, contract negotiation and contract sign by Internet in order to fulfill railway material purchase and marketing.

4.3 Inter-Model Transportation System

This service is to exchange transport data among railway, road, air and water traffic in order to realize integrative and harmonious inter-modal transportations, and to assist passengers or consigners to make inter-modal transport decision. It divides into 2 sub service fields as follows.

4.3.1 data share for inter modal transport

To exchange and share data among multi-transportation modes including railway, road, air, and water transport. It allows other transport modes access railway transport information through special interface, including dynamic information of railway network, railway transport status, train timetable, passenger ticket, etc. and static information for location of passenger transport station, storage station of freight, wagon type, freight price and plan, etc. At the same time, it can also transfer the dynamic and static information of other transport modes to railway by the interface.

4.3.2 decision-making assistance for inter modal transport

To assist passengers or consigners to make decision for inter-modal transportation with intelligent decision techniques according to their requirements and to provide the door-to-door transport service.

4.4 Intelligent Railway Resources Management System

This service is to build a uniform database about whole Chinese railway to manage railway transportation resources, to establish knowledge database for maintenance decision-making in order to fulfill the real-time and remote maintenance, and to uniformly manage and liquidate financial resources of whole Chinese railway. It divides into 3 sub service fields as follows.

4.4.1 Transportation Resources Management

To build uniform infrastructure databases about transportation, locomotive, rolling stock, permanent way, communication, signal, etc. based on GIS technologies in order to realize the uniform management, releasing, querying, maintenance for all kinds of railway infrastructure.

4.4.2 Intelligent Maintenance Management

To manage maintenance records of various infrastructure and to build knowledge database to make equipment maintenance plan according to actual data of railway infrastructures and to provide remote decision-making support when failures occur.

4.4.3 Financial Resource Management

This service is to build railway financial resource management system to manage, analyze, inspect railway transportation cost, income, etc. and to analysis the business activity of railway industry and to support decision making. At the same time, to build transportation income liquidation system in order to realize the income liquidation among passenger transportation, freight transportation and parcel system.

4.5 Intelligent Railway Operation Management System

This service is to optimize transportation planning according to passengers and freight-owner's requirement and railway transportation resources, provide high quality service and use railway resources optimizationly. Using uniform intelligent and automatic management method to manage marshalling work process in order to make train's arriving, splitting, assembling, classifying and departure effectively and rationally.

4.5.1 Intelligent Passenger Transportation Management

According to passenger requirement and passenger transportation resource, the operation plan for passenger train is established intelligently. Based on passenger flow and distribution information, analysis and forecast model for railway passenger flow in fastigium and off-season is set up. Ticket price decision-making system and transportation resource adjust system is built in order to adjust train operation plan and price automatically.

4.5.2 Intelligent Freight and Container Management

According to freight-owner's requirement and railway freight transportation resources, using intelligent optimizing technologies to make optimum transportation scheme. Automatically create freight transportation plan according to freight character, weight, quantity, volume, departure station, arrival station, wagon flow, route restriction and etc.

Based on freight flow and distribution information, set up fastigium and off-season railway freight flow analysis and forecast model in order to adjust freight transportation plan optimizationly.

Build information management system for whole process from freight work origin to

dispatching center to establish standard and efficient information flow and realize process management for freight from consignment to delivery.

4.5.3 Intelligent Marshalling Yard Management

Automatically control and tracing car's arriving, splitting, assembling, classifying and departure operation process in Marshalling yard. Create and execute operation plan for Marshalling yard such as day operation scheme, splitting and assembling scheme, and etc.

4.6 Intelligent Train Control and Dispatching System

Adopting intelligent control technologies to make train's operation automatically, applying intelligent decision-making technologies to schedule all railway transportation resources, and adopting advanced technologies to get train's position automatically.

4.6.1 Intelligent Train Control

Using intelligent control technologies realize automatic train operation, protection and supervising. It includes ATC (Automatic train operation), ATP (Automatic train protection) and ATS (Automatic train supervising).

4.6.2 Integrated Train Dispatching System

Taking all related factors such as railway line, traction power supply, signal mode, block system, vehicle dynamical character, train operation and organization into account, to make integrated dispatching plan for train, locomotive, vehicle, power supply, maintain, communication and permanent way. And according to transportation situation and equipment fatigue condition, assist to make decision for permanent way maintenance and train flow adjusting.

4.6.3 Intelligent Station Work Control

Applying intelligent interlock control technologies to control train's operation in station automatically in order to improve the safety and efficiency of train's operation in station.

4.7 Intelligent Emergency and Safety System

Monitor all railway transportation resource dynamically, manage train safety information, and establish decisions to defend disasters and to rescue in emergency. Emergency rescue and management, train safety and maintenance support, railway integrated disasters protection, and highway-rail intersections supervision is included in the system.

4.7.1 Intelligent Emergency rescue and management

Locating the accident site accurately by LBS, and rapidly providing information about terrain, landscape, hydrology, hospitals and fire protection around with the GIS technology.

Transferring dynamic images of the locale to the manage center by related technology in time to enhance real-time monitor on the accident site.

Establishing emergency information database and rescue knowledge database, and providing decision for rescue plans.

Assisting to make decision for allocation of resources, distribution of rescue equipments, and selection of proper routes. providing emergency and maintenance services, and analyzing accident reasons.

4.7.2 intelligent train safety and maintenance decision support

Periodically inspecting status of equipments related to train safety, including locomotive, line, bridge, tunnel, intersection, etc. Establishing safety database and managing above status information by train safety information system.

Building safety standards to analyze data and estimate equipment status. Constructing decision support system for maintenance and prediction-alarm system.

Establishing automatic maintenance system to transfer detailed inspection data and decision suggestion to the station.

4.7.3 intelligent integrated calamity protection

Establishing and maintaining integrated disaster protection database with GIS. Monitoring real-time calamity data, providing prediction and estimation of disaster by establishing applied analysis model including prediction model, decision model and evaluation model.

Providing decision support for the places where calamities occur frequently, and for rescue when disaster has taken place. Simulating accident to assist accident prevention and analysis.

4.7.4 Highway-rail intersection monitor

Monitoring highway-rail intersection by video or laser technology, transferring images and data to relative sections, estimating safety status of intersections by video identification, and solving dangerous factors of intersections to insure its safety.

5 CONCLUSIONS

The establishment of service architecture of RITS is one of important task in the research for the system architecture of RITS, which will decide the development direction of RITS. Aimed at the realization of new generation railway transportation, which has a character for higher efficiency, higher safety and higher quality of services, the service architecture of RITS with 7 service fields and 21 sub services is established based on the user requirement analysis in this paper. It gives a conferential framework for the composing of RITS and also becomes a foundation for the establishment of following logical architecture and physical architecture.

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