

High-Speed Railway Train Operation Control System

Bei Wang

Lanzhou Jiaotong University school of Railway Technology, China

Abstract. Train operation control system is an important equipment to ensure train safety and efficient operation. The Beijing-Shanghai line is a comfortable, high-speed passenger transport vehicle that is very comfortable and has proven its value. It plays a crucial role in economic and social development. In order to play its role, the latest technological achievements are introduced to produce locomotives, vehicles, tracks, power facilities, etc., and these computer-aided operations are controlled. It can be said that Beijing-Shanghai line is a typical modern railway that operates under the entire system. In this article, we will explain the conditions required to operate a high-speed railroad running train control system and how to meet these conditions.

1. Introduction

A train operation control system is required for the establishment. It can totally differ from the traditional railway control system. One of the conditions that can be attributed to the difference is unmatched high speed. The traditional way in which the driver operates his train by noticing roadside signal indications will never work. For this purpose, we use the cab signaling system with the so-called ATC (Automatic Train Control). In order to meet another mass transit condition, CTC (Centralized Traffic Control) is working, although this is not new. However, like high-speed public transport like the Beijing-Shanghai line, CTC has been proven to be an effective means of smooth dispatch and transportation. With the increase in the number of trains after 2010, and because a large amount of information has entered the control center, relying solely on the government will not help dispatch. Therefore, the CTC must use computer backup. That is to make the computer control the train running as much as possible, collect data, classify and transmit the data, which makes the dispatcher feel free to use the computer for judgment. In order to meet this demand, COMTRAC (computer-aided traffic control system) was introduced.

2. The Excellent Characteristics of Train Operation Control System

In order to safely, accurately, and efficiently run high-speed trains in large batches, the basic requirement for train operation control is to enable all elements of the system to work together smoothly under a specified plan (train diagram and work schedule). Unlike other modes of transport, trains operate on specific orbits. Obviously, when they are operating under well-planned charts, they can achieve high efficiency rather than operating in a casual manner. Even if there is confusion for some reason, all components of the control system may work as a whole for the purpose of “resuming the prescribed plan”. One of the outstanding features of train operations is that it works according to all plans. When train operations are severely affected by train accidents or natural disasters, it is also possible for the control system to control all of its elements to partially change the plan. Unlike other industries, train operation is a kind of commodity that cannot be stored. It must be provided to meet the needs of passengers. Therefore, a comprehensive revision of the train map will be carried out



within two to three years, and internal revisions will be conducted on a quarterly basis. The train operating system with these characteristics is shown in Figure 1, divided into planning, doing and seeing three functions.

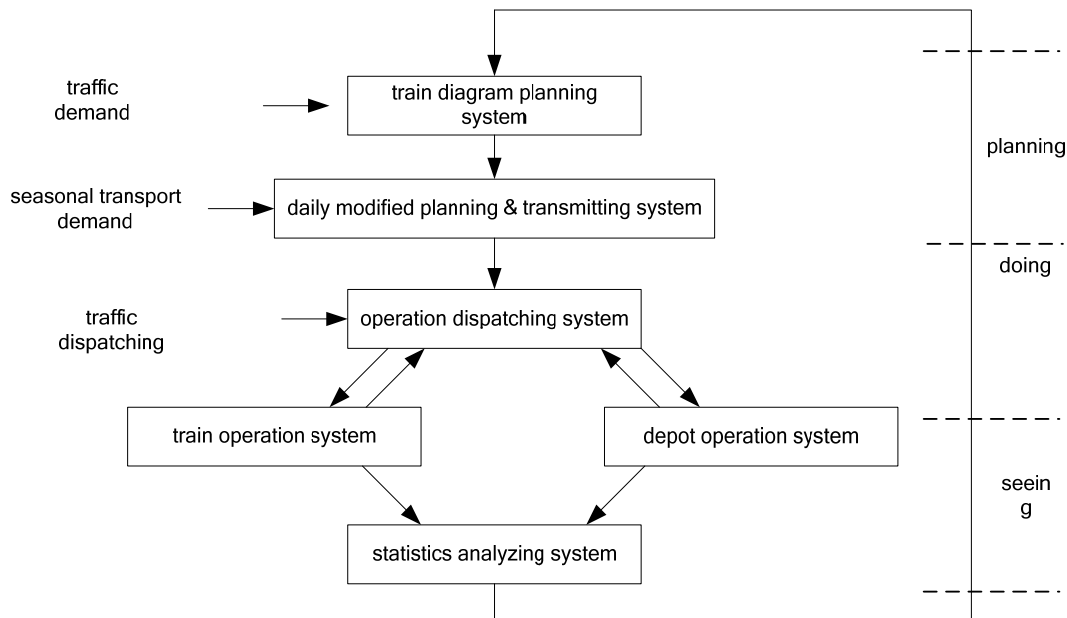


Figure 1. Train Operation Control System

3. The Basic Definition of Reliability Design

The various functions shown in Figure 1 are closely linked to complete the function. When reliability, data quality, amount of data processed, the response time are scheduled, see Figure 2 (COMTRAC reliability characteristics). The entire operation control system is seen in the stair structure. The lower the steps, the higher the reliability and the better the real-time performance. The higher the step, the higher the data accumulation and the judgment of complications. Another point to note is that the operation control system is composed of such components. Once the superior function fails, the next step of the function will be invalid. With this transformation, the stair structure was adopted in the COMTRAC system. Because the lower function requires higher reliability and response, while the higher function requires more data accumulation and the complexity of the judgment, the functions of the system are divided into two groups according to the evaluation criteria. That is, these functions strongly demand that reliability and responsiveness be included in the route control system, while another set of functions requires the operation of various data and other higher-level judgments in the regulation system. As upper-level functions require more and more data that cannot be processed by computers and more and more manual judgments, human-machine systems are needed, so that lower-level functions require less manual intervention to perform.

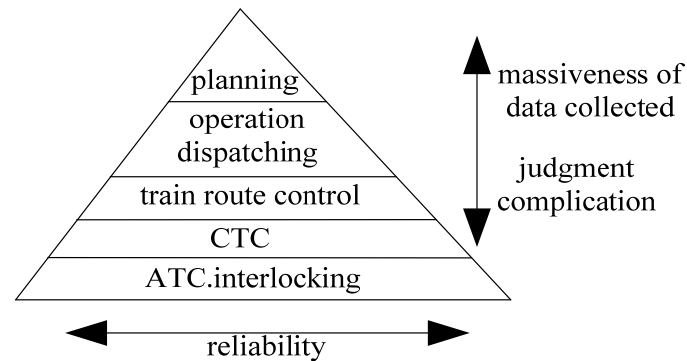


Figure 2. COMTRAC reliability features

Among the many functions required for traffic control, COMTRAC is designed in this way. You can perform the following functions that consist of five subsystems.

a). The planning subsystem will prepare plans to introduce trains and vehicle sales according to the basic plan and non-ordinary plan of train operation.

b). The dispatching subsystem monitors whether the train is operating properly according to the train operation diagram prepared by the planning subsystem of the day. If confusion of the graph is detected, the computer automatically displays the judgment if the situation is simple. For example, if the confusion is serious due to a train accident, the train diagram is predicted to be 4 to 5 hours by simulation, and the system creates the next train diagram to show it on GD (Graphic Display). Chart changes determined by the computer are automatically sent automatically to relevant places.

c). The route control subsystem tracks each train according to the trajectory of the planning and scheduling subsystem and automatically configures the route. We also monitor the signals of all stations.

d). The subsystem provides data for station notification. By automating the route control, the system can detect the position of the train, detect the delay of the train, and use this information for station announcement. Signs from the train to the site on the platform are also automatically controlled.

e). It prepares statistical analysis subsystem, reports of various traveling trains, and prepares management reference materials.

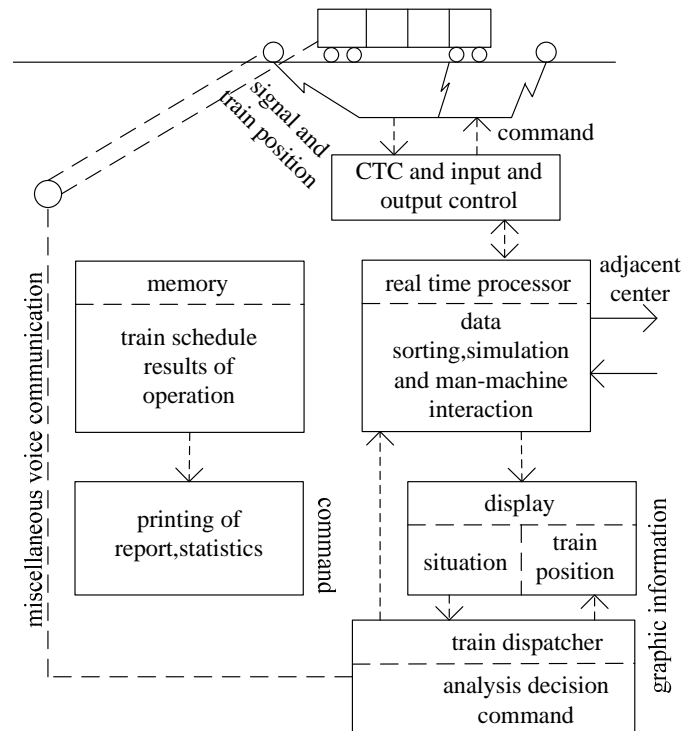


Figure 3. COMTRAC system

4. System Configuration Concept

When generating a computerized system for the above functions, it is necessary to clarify the reliability and response time of each function and carefully consider the inherent characteristics of each function. Routing control systems directly related to train operation are completely process control systems and train paths are set up via central data and train diagrams collected by CTC. This is the last output part of COMTRAC, the highest reliability is required, and the data processed here also needs high reliability. The dispatching system detects image confusion by tracking the data provided by the routing control system of each train and actually starts to display its function. Since it is considered that the part of automatic discrimination is similar to the monitoring function under the driving condition of the train, better execution is possible with the routing control system and the target of the response time of the graph simulation function is considered to be one minute. With regard to the data transfer function, I believe that it will be of little importance if the change is confirmed within minutes after receiving the planned changes. The man-machine interface is mainly for GD (graphical display) and is used for complicated judgment simulation and simple project simulation centered on CD (character display). Other trains are centered around the use of the display part of the coordinating device of the data processing system, the back part of the idea, around the control line, a reliable system, divided into two parts by multiple computers.

With this combination, operation efficiency is 99.99%, train dispatch system is 99.9%, and CTC with less than 10 minutes parking time is more reliable. In order to achieve these goals, we developed a 3: 3 computer system for the routing control system and developed a DSC (Dual System Controller) for the train operation control system. Since the train dispatch system can handle a large amount of data, two large computers are required for redundant operation.

Another failure of programming is the lack of input by the dispatcher due to human-machine problems. To satisfy demand, you can control various trains - the demand of users of major Chinese traffic arteries and the long-term driving of the bullet train will change according to the season. Various types of trains will run as necessary. Therefore, the introduction of COMTRAC presents complex transport modes that operate multiple types of trains to meet user needs. More dispatchers

automatically check the number of dispatchers before and after COMTRAC by route setting. Under the Ph - 1 system, data transmission and vehicle turnover control are not performed, but the system had the effect of checking the number of dispatchers. Systemization also plays an important role in converting dispatcher work from routing configuration to main job (train operation adjustment, etc.). With the introduction of the Ph-2 system, data transmission and vehicle management were implemented, and more and more temporary employees were checked to see if they would increase the impact.

5. Summary

COMTRAC is essential as more types of high-speed mass transport trains must operate in the network. For preparation, it is necessary to expand control range, improve functions, and continue to develop for train operation management system, develop into a traffic control system, and combine with MARS (seat reservation system) which is a railway vehicle control system. It will be managed for the information system to provide services suited to traffic needs.

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