ATACS (Advanced Train Administration and Communication System)

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Abstract

Track circuits and wayside signals have kept safety of railway system for a long time. With a help of this signaling system, we have improved safety and increased traffic volume. However, it is necessary to lay large amount of metallic cable along railroad. Initial cost and maintenance cost are extremely large in such a signaling system. Also, replacement of large amount of equipment is necessary at a system change. In order to avoid such unnecessary expense, we are now developing some new traffic control systems based on wireless communication system with a view to constructing a railway system toward the 21st century.

We are developing a new system aiming at practical use in near future. This is a new type of ATC system named "ATC-P" which is based on track circuits and onboard autonomous control system. We began to develop this system in 1991. This system will be adopted as a next traffic control system in Yamanote-line at a renewal of the present ATC.

Other than this system, we are developing another traffic control system named "ATACS", which is an abbreviation of Advanced Traffic Control and Communication System. Here, we introduce a concept of the "ATACS", in which a train has an onboard autonomous traffic control system and a digital wireless system to communicate with base stations on the ground. Each base station consists of an intelligent traffic control system and a digital wireless system to communicate with plural trains. The base station, also, communicate with neighbor base stations. In this new system, a train identify its position by itself and transmit its position information to neighbor trains by radio. Also, a train automatically control interval between forward train. Moreover, a train directly send a request to make a route to a point control system in a station.

1 INTRODUCTION

The first passenger railway transport system was began to operate in 1830 between Liverpool and Manchester in The United Kingdom. Afterward, a signaling system was adopted to improve safety and to cope with the increase of traffic volume.

After the Morse code was invented in 1832, the single line blocking system, which guarantee blocking between neighbor two stations, was adopted in 1841. The interlocking device, which make a route and ensure safety, was also invented in 1856. The track circuit, which detect a train position, was invented in 1872. All of these devices contribute to improve safety. Although some modification was adopted after their invention, present signaling systems are based on principles invented in the 19th century. No technical progress can be expected on such signaling systems.

What kinds of evolution will be expected in the 21st century on the present signaling systems? What are problems to be tackled or resolves? It is important for the railway system to offer safe, convenient and cheap transport service in order to be accepted by a society in the 21st century. Railway system is consist of large amount of infrastructure on the ground. Maintenance and renewal are important subject to keep safety and stability of transportation. what kinds of revolution will happen on the railway system if we completely change facilities or mechanism of the railway syetm or if we adopt simple and rational systems in the railway system?

The railway system owes a lot to information technologies since its birth. As symbolized by a word "Multimedia", it becomes available to transmit cheaply and mutually a large amount of information such as characters, voices and pictures, recently. In the present signaling system, ground signaling equipment detect train positions and control train intervals regardless of brake performance of each train. In a new signaling system, taking advantage of new information technologies, each train detect its position itself and receive position information of neighbor trains by radio. It becomes possible to make a simple and safety signaling system without cables and wayside signals. This new system can offer a new service to passengers.

In this paper, we introduce two new railway systems which enable us to increase traffic volume. One is a new ATC system based on the track circuit, which enable us to minimize headway. The other is a traffic control system based on information technologies without track circuits nor wayside signals.

2 TRAFFIC CONTROL SYSTEM BASED ON INFORMATION TECHNOLOGIES

For a long time in the railway signaling system, the track circuit have been used to detect train position and the position information have been transmitted to the wayside signal. We have kept safety by adopting a settlement that two train never exist in one block. We have both improved safety and increased traffic volume. Almost all signaling equipment are placed on the ground, thus initial cost and maintenance cost are extremely high.

Cost down can be expected if we change from ground heterogamous system to onboard
autonomous system in which a train detect its position and speed and transmit these information by radio to neighbor trains, stations, level crossings and track workers. In this new system, trains are autonomously operated according to a diagram. We have started to develop a simple and safe traffic control system "ATACS" (Advanced Traffic Administration and Communication System) in which onboard and ground equipment are optimally distributed based on information technologies.

The ATACS aims at following 3 points.

(1) Safety
    Level up of safety system
    Improvement of safety in track works
(2) Cost down
    Cost down by simplification of ground equipment
(3) New service
    Operation diagram according to driving performance of each train
    Single line operation for track works
    Support for drivers (route notification, dispatch notification)

The distinguishing characteristics are that we aim to solve problems that is difficult to cope with in the signaling system based on track circuits. For example, it is necessary to improve track circuits for a changes of block sections when we perform speed-up or headway-cut in the present signaling system. Also, it is necessary to change position of electric treadle in order not to shorten alarm time of level crossings.

We intend to solve problems on measures to keep safety of maintenance cars in maintenance works, on measures to prevent train accident of track workers and on the procedure at the beginning or ending of track blocking.

We do not use track circuits to detect train position in the ATACS. The ATACS is a system based on a new concept, in which trains detect their position themselves and transmit them to neighbor trains, stations, level crossings and track workers.

3 THE BASIC SYSTEMS OF THE ATACS

The ATACS is composed of following 7 systems.

(1) Dispatch Control System
(2) Onboard Train Interval Control System
(3) Point Control System in each Station
(4) Level Crossing Control System
(5) Safety System in the Maintenance Work
(6) Point Control System in each Train Base
(7) Others

The Dispatch Control System watch traffic operation, schedule of maintenance works and operation status of total system.

The Onboard Train Interval Control System, based on its position information and target stop position information transmitted from ground control base station, calculates a brake pattern, compares it with its speed and controls brake.

The Point Control System in a Station controls points on a route based on a diagram. This control system is based not on interlocking logic (a logic that is based on experience of accident and failure) but on the train position and attribution (train composition and train number). This enable us to simplify equipment of a station. A route information is also displayed on an onboard monitor in a cockpit.

In the present level crossing system, electric treadles are used as start trigger of level crossing alarm. In the new Level Crossing Control System, a train itself send a trigger signal to level crossing equipment. Also, it becomes possible to keep alarm time constant. A driver can grasp present status of level crossings by onboard monitor.

Safety System in the Maintenance Work, based on a maintenance schedule, prevents collision of maintenance car, controls points in a station for maintenance car and transmits an alarm to track workers that a train is approaching.

Capability of single line operation of double line is one of the other functions. This is a function to keep maintenance time. This is effective to increase efficiency of maintenance works.

4 SYSTEM COMPOSITION OF THE ATACS

4.1 Ground Equipment Of The ATACS

The ATACS composed of ground equipment and onboard equipment. The ground equipment consist of dispatch systems, base control systems, base radio stations, level crossing control systems, transponders and clearance detection systems. The dispatch system watch a diagram, schedule of

maintenance work and total system. Among all above equipment, the base radio station and the base control system are important. The base radio station communicate control data with trains. The base control system trace position and speed of trains and control points in stations and level crossing equipment.

(1) The Base Radio Station
The base radio stations are placed every 3km along railroad. Taking advantage of time sharing system, one base station control up to 8 trains in its zone. The transmission rate is 4.8kbps. We intend to keep bit error rate less than 10-4 order. with a help of front error correction device. So far, we do communicate through leak coaxial cable Based on the results of the test in Joetsu Shinkansen, in which leak coaxial cables are used, we intend to use normal base radio station.

(2) The Base Control Station
Some base control stations are placed along the railroad. They control train intervals, route and level crossings. Based on the train position information from the base radio stations, the base control system trace train positions and transmit target stop position information to each train through the base radio station. The base control station also control points in stations. The control system is based on simple control logic.

4.2 Onboard Control System Of The ATACS

Onboard control system consist of a speed and position detection system, an interval control system and a radio station. Most popular method to detect speed is to use tachometer as speed meter. Doppler radar system is an alternative as a speed meter. Transponders help to correct absolute position. Speed meter, permissible speed, block clear indicator, and route indicator in a station are displayed in a cockpit.

5 SUMMARY

We have introduced a new traffic control system named ATACS that is based on information technologies. This system is applicable both to the conventional railways and the Shinkansen because basic principle of this system is same for both railway systems. The ATACS is simple and low cost control system that is suitable for the 21st century. The ATACS play an important roll in next century. In order to put the ATACS to practical use early in the next century. We planed to finish all of the tests on this system in this century.

REFFERENCE

(1) Y. Hasegawa & H. Inage, A New Concept of Future Train Control and CARAT, *RTRI report*, 1993, Vol.7, No.5

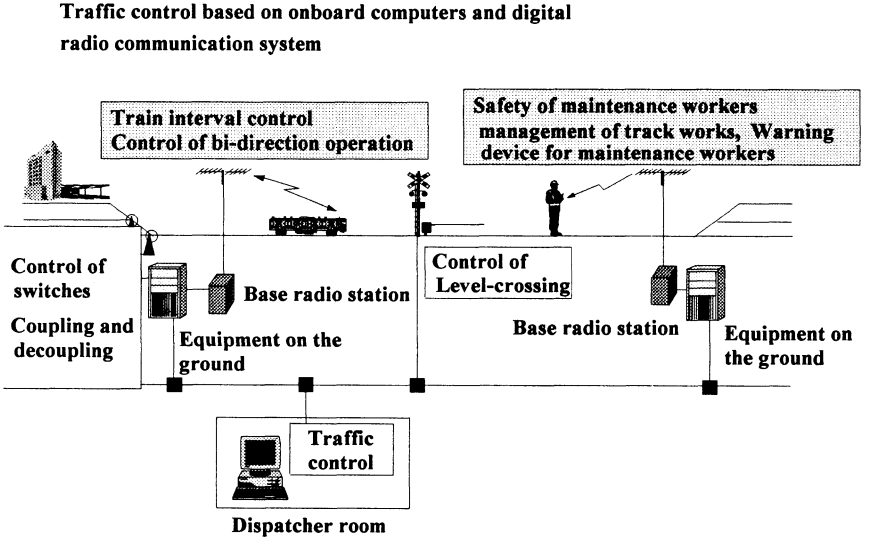

Figure 1. ATACS system image

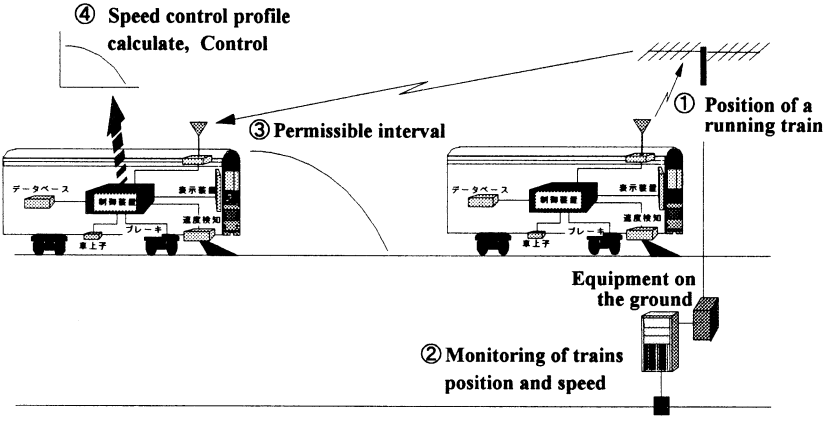

Figure 2. Image of train control