Performance Evaluation of Communication Network for Train Control System Using Radio Communications

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1. Introduction

As information communication technology matures, practical applications of a train control system using radio communications are being developed for railways. This system allows communications between the ground and on-board devices of control information related to safety, such as train position or the position to stop the train.

An overview of the train control system using radio communications is shown in Fig.1. It is important for a designer of a train control system to use stable radio communications and to fully understand network performance including the effects of loads and delays in transmission of control information between devices. Therefore we have developed a simulator for evaluating such network performance.

2. Simulator development

The simulator we have developed is designed to be operated by combining the models to control the timing of transmitting control information for each of the devices shown in Fig.1. The communication functions are divided in a hierarchical structure, patterned after the Open Systems Interconnection (OSI) Reference Model. The communication functions are classified into two main groups, the control processing section which corresponds to an application layer and the transfer processing section for transferring control information. In this simulator, various types of communications protocols can be used including the Transmission Control Protocol/Internet Protocol (TCP/IP) which is widely used in industries. Therefore, the simulator is capable of comparing and verifying the performances of various communication networks without being affected by the difference in protocol performances.

3. Evaluation of network performance

The simulator we have developed enables us to simulate the communication network of a scale equivalent to the real line section on a computer as shown in Fig.2 and check the delay condition and load tendency of the control information. Fig.3 shows a graph indicating a distribution of the transmission delays between the wayside and on-board control equipment (turnaround time starting with the wayside equipment, proceeding through the on-board control equipment, and finishing with the wayside equipment). We can see from this chart that the delay of control information does not exceed a certain period of time and consequently the simulation can confirm the stable operation of this system.

In the future, we would like to utilize this simulator for designing and evaluating more systems. We also intend to enlarge and strengthen its functions, combine it with other simulators for train operations and passenger behavior, and further develop the simulator so that we can evaluate the performance requirements for communication networks from the perspective of the effects on train operations.

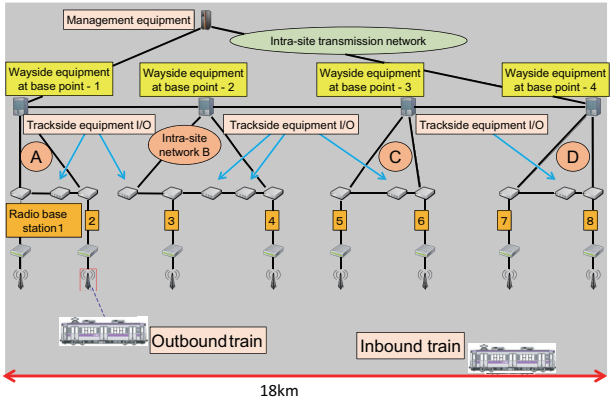

Fig.2 Overview of Network Construction and Simulation

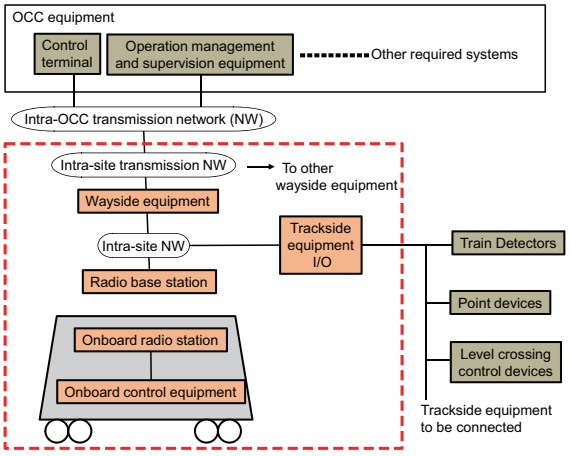

Fig.1 Overview of Structure of Train Control System Using Radio Communications

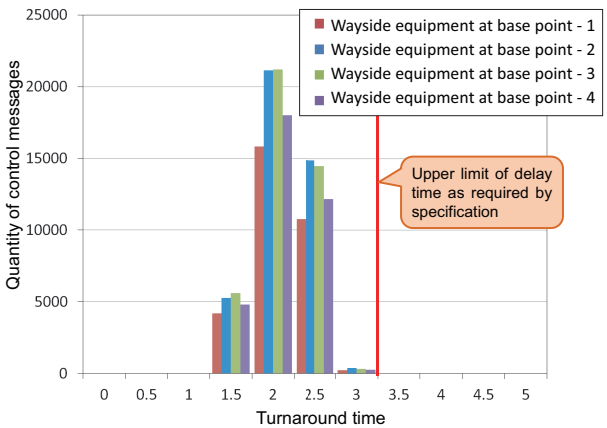

Fig.3 Distribution of Turnaround Time