A number of measuring devices need to be installed on trains in building a wayside equipment monitoring system using trains in operation. An efficient method of controlling measurement data by those devices is collective management of the data. We thus developed an onboard data controller with an eye to installing that to trains in operation as a method to achieve the goal of collective management. This controller has two functions. One is receiving operation-related information of train cars such as speed information by the maintenance server and delivering such information to measuring devices via terminals on each car. The other is collecting and recording information on operational status and measurement data of the measuring devices in the maintenance server, also via terminals. We have installed this onboard data controller to the MUE-Train and checked its operation in running tests.

Keywords: Monitoring, Transfer control

1 Introduction

Maintenance and inspections are carried out to secure safe and stable train operation of railway wayside equipment. But in actuality, measurement by measuring cars and visual inspections on foot patrol are conducted just a few times a year. We thus need to identify signs of failures by increasing frequency of inspections and reduce labor in patrol and other inspection work. In this context, we are now studying a monitoring method for increasing measurement frequency by installing measuring devices to trains in operation. That will enable us to detect and monitor predictive signs of failures and the deterioration status of wayside equipment. In this method, it is not efficient to separately manage individual onboard measuring devices. So we have developed an onboard data controller for monitoring wayside equipment that can collectively control necessary information and measurement data of those measuring devices (hereafter “onboard data controller”).

2 Development Overview

We decided to provide the onboard data controller system to be developed with the following three functions.

(1) Operation information delivery and display function
This is a function where a dedicated server obtains from the train control system (to be explained later) operation information such as kilometerage, speed and time and delivers it to measuring devices. With this function, the controller can display real-time information on the running train as well.

(2) Measuring device operational status check and measurement data collection function
This is a function where the onboard data controller collects in a dedicated server information such as status monitoring information (information that devices are properly working), alarm information in case of device failure and measurement data sent by measuring devices.

(3) Data recording function
This is a function where the onboard data controller stores information such as train information obtained by the dedicated server, collected information on measuring devices and measurement data on a dedicated hard disc.

Since we had a plan in which the functions of the onboard data controller system would be checked using MUE-Train, a test train for conventional lines that JR East developed in 2008, we have allowed communication to and from the MON8 system. MON8 is the name of the train control system installed on MUE-Train.

3 System Configuration

Fig. 1 shows the configuration of the onboard data controller developed this time. Maintenance servers on cars No. 1 and 7 obtain data from MON8 and deliver that data to measuring devices. Those maintenance servers are also used to register measuring devices, manually obtain measurement data from the devices, set the data accumulation volume limit and display alarms. The purpose of installing maintenance servers to both leading cars (No. 1 and 7) is to build a master/slave system. If the maintenance server of the master system can no longer accomplish its functions due to situations such as failure, the maintenance server of the slave system backs that up. We planned to install measuring devices to cars No. 5 and 6 from the MUE-Train planning stage, so we have installed maintenance terminals to them too. The cars thus have functions of receiving data sent
In October 2008, we installed the onboard data controller system to MUE-Train. We then checked operation of the system until December using the data obtained in the running test using MUE-Train.

Fig. 4 shows installation of the maintenance server, Fig. 5 the maintenance terminal and Fig. 6 the “A” terminal. From maintenance servers, delivering that to measuring devices, obtaining measurement data of measuring devices and sending that data to maintenance servers.

Measuring devices are also installed on cars No. 1 and 7 where maintenance servers that have the same functions as maintenance terminals play a similar role. Taking into account that an increasing number of items will be tested by MUE-Train using wayside equipment monitoring devices, we made so maintenance terminals can be added to cars No. 2 and 3 where no terminals are currently installed.

Passing of data between cars is done by high-speed metal line transfer through terminals called “A” terminals on each car. These “A” terminals have a function to allow transfer data sent by a maintenance server or maintenance terminal to and from the adjacent car.

The data accumulated in the two maintenance servers is recorded in the data transmission PC on car No. 7. Since recording is done per test run, testing staff can take the data all together from the data transmission PC and manage that for each test run. The data transmission PC also has a function to show the information on the running train on the display.

**4 Configuration Test**

Before installing onboard data controller to MUE-Train, we carried out an advance operation check for it in the factory with the same connection as on the train of a maintenance server, maintenance terminals and a data transmission PC. Fig. 2 and 3 show testing.

In this configuration test, we tested situations such as data transmission and reception and changeover of the master/slave system of the maintenance server. The test confirmed correct operation of the data controller.

**5 Test on MUE-Train**

In October 2008, we installed the onboard data controller system to MUE-Train. We then checked operation of the system until December using the data obtained in the running test using MUE-Train.

Fig. 4 shows installation of the maintenance server, Fig. 5 the maintenance terminal and Fig. 6 the “A” terminal.
confirmed that information such as kilometerage, speed and time was correctly recorded. We also confirmed that such information was correctly displayed with the real-time display function. Fig. 7, 8 and 9 show the display screens.

Fig. 7 Speed Display Screen

Fig. 8 Notch Display Screen

Fig. 9 Overhead Contact Line Voltage Display Screen

We carried out operation checks of the following functions.
(1) Functions of the onboard data controller
(2) Network functions

5.1 Operation Check for Functions of Onboard Data Controller
We checked the following three functions of the onboard data controller.

5.1.1 Operation Information Delivery and Display Function
We took from the maintenance server operation information data from the train control system (MON8) in test runs and

Time is shown on the top of the screen. On the speed display screen, speed is shown on the vertical axis and kilometerage on the horizontal axis of the graph. On the notch display screen, the vertical axis is notch and the horizontal axis is kilometerage. On the overhead contact line voltage display screen, the vertical axis is overhead contact line voltage and the horizontal axis is kilometerage.
5.1.2 Measuring Device Operation Check and Measurement Data Collection Function

For status monitoring information, alarm information and measurement data of measuring devices, we compared the data temporally stored on each device and the data collected on the maintenance server. As a result, we confirmed that those were correctly recorded. Based on the alarm information data, operational status of each measuring device can also be checked on the display of the maintenance server. When a measuring device is operating correctly, the status of the device is shown in green. If an error occurs with the device and alarm information is given, the status of that device is shown in red. Fig. 10 shows the display screen.

Fig. 10  Alarm Display Screen

5.1.3 Data Recording Function

We confirmed that data was correctly recorded by comparing the data recorded in the data transmission PC and the data temporally stored in the maintenance server.

5.2 Network Function Check

We checked the two items shown below for network functions.

5.2.1 Data Transfer Speed Between “A” Terminals

We measured and verified the data transfer speed between “A” terminals. The method used was that applied in network performance tests of the cars in operation equipped with an “A” terminal. Measurement of the data transfer speed demonstrated that the speed is higher than that for “A” terminals are equipped to cars in operation, showing good results.

To evaluate the load on the network applied by applications of the onboard data controller, we compared the data transmission speed while the controller was in operation (delivering data, receiving measurement data, etc.) and the speed while the controller was off. The difference of data transfer speeds was found to be small. That clarified that the load on the network by applications would not be a problem in terms of practical use.

5.2.2 Data Transfer Speed to Maintenance Server or Terminal

Measurement of network data transfer speed showed that speed drops as the distance to the maintenance server or terminal increases. But, the speed did not decrease to a level that affected functions of the onboard data controller. That clarified that there would be no problems in terms of practical use.

On evaluating the load on the network by the application as done in 5.2.1, we have found no problems there either.

6 Conclusion

The aforementioned results clarified that the onboard data controller satisfies the function requirements. For further confirmation that the system is reliable, we have been continuing data collection and checking in running tests using MUE-Train.

Our goal is to apply the results of the development of the onboard data controller for monitoring wayside equipment to actual trains in operation. We will therefore proceed with studies on such application.