Power SCADA System for Nagano Branch Office of East Japan Railway Company

Masaru Muramatsu

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Abstract

The traction power distribution control and monitoring system ("Power SCADA System") is an energy management system intended mainly for power facility monitoring and control. The Power SCADA System is enhanced with a variety of functions to support power control operation.

We recently delivered this Power SCADA System to the Nagano Branch Office of East Japan Railway Company. The system has been in operation since 2013. We enhanced many functions and introduced a human centered design approach to build a system pursuing ease of use.

1 Preface

The traction power distribution control and monitoring system ("Power SCADA System") constantly monitors the power supply network consisting of traction substations and other components and handles power shutdown and recovery support for scheduled track-work and various work in the event of complications. This system contributes to a stable power supply and supports railway transportation by realizing efficient power control operation by power controllers and reliability improvement.

This paper introduces the key equipment of the Power SCADA System delivered to Nagano Branch Office of the East Japan Railway Company.

2 System Overview

2.1 System Configuration

Fig. 1 shows the system configuration. By mainly adopting Meiden industrial components, we realized long-term maintainability and high reliability. Figs. 2 to 5 show Meiden industrial components.

2.2 Outline of Functions

Table 1 shows a list of functions. We enhanced many aspects such as load dispatching support, scalability, and on-site work support. The "Designated Power Section Control" is an exclusive new feature that aims to prevent operation error (see Fig. 6).

3 Introduction of Human Centered Design

We have drawn up and made use of the User Interface (UI) design guide where Human Centered Design (HCD) is applied. To be specific, by considering adaptability to physical characteristics, visibility, operability, based on human engineering and cognitive engineering, we realized "ease of use" in the field of equipment design, space design and interface design. This approach has also been applied in building the Power SCADA system.

3.1 What is HCD?

HCD is a design concept where "usability (ease of use)" is pursued in the phase of product and system development so that a system is always designed and built in a customer-centric approach. Since professional knowledge is needed in implementing the HCD-based process, we have product designer at our company with the certification authorized by Human-Centered Design Organization (HCD-Net) as a "Certified HCD Professional."

3.2 Result of Application

(1) Constituent equipment design

For control console design, we substantially reviewed components of "point, line, and plane" in designing the shape of the control console. We applied raw materials, color, and shape fit to these design elements and finished the simple but timeless design. Figs. 7 to 10 show Point (corner), Line

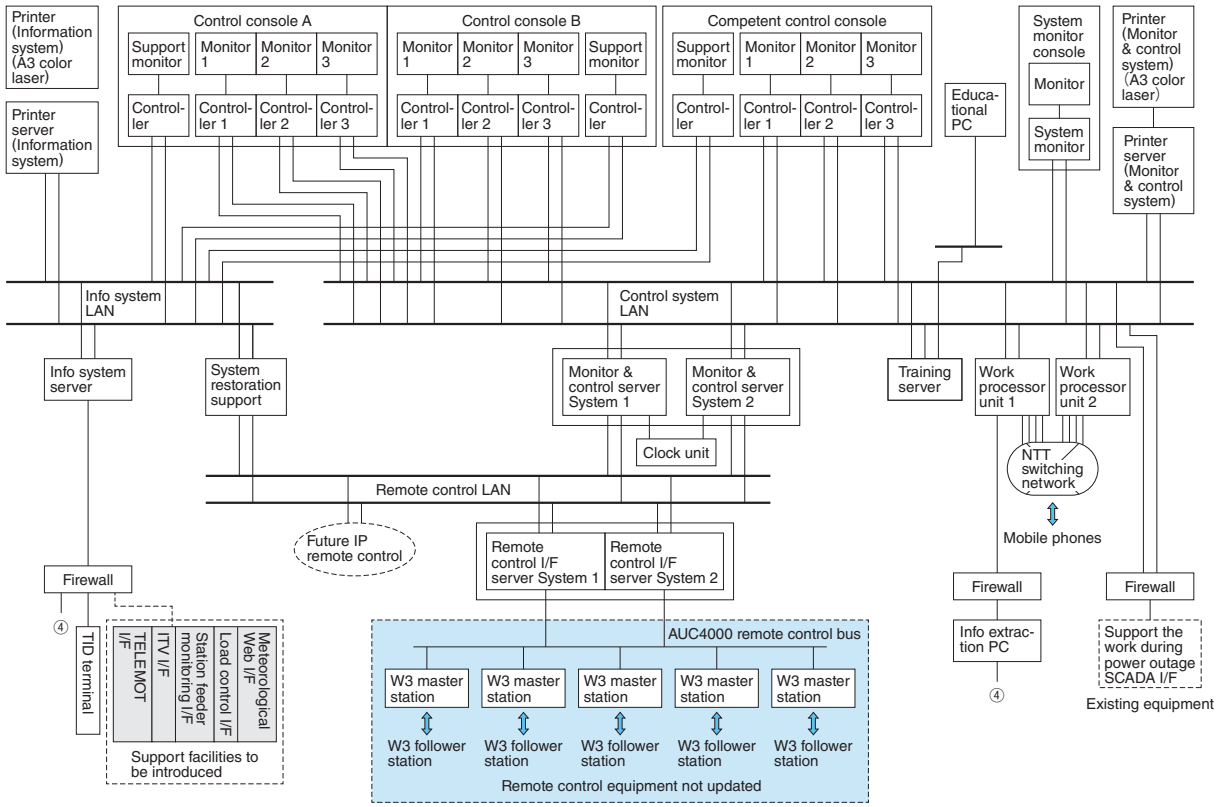

Fig. 1 System Configuration

System configuration is shown.

Fig. 2 Plant System Computer, PS6000

A server unit with scalability, high performance, and high reliability is shown.

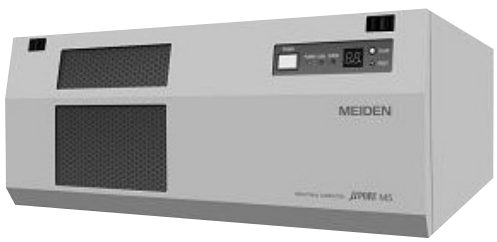

Fig. 3 Industrial Computer, μPORT M5

A highly reliable controller is shown.

Fig. 4 Industrial Switching Hub, SW900

This device is provided with a highly demanded port configuration for the market where high reliability and high environmental durability are required.

Fig. 5 Industrial Switching Hub, SW200

A compact industrial switching hub is shown.

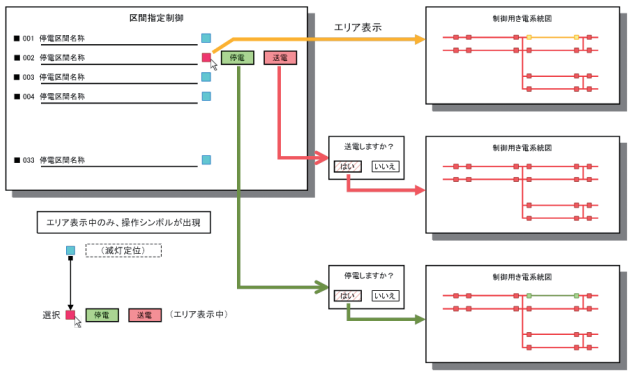

Fig. 6 Designated Power Section Control

When the name of a power outage section is selected from the section list, the power outage area is displayed in yellow on the power network diagram. When a power outage or power transmission is selected in this state, the designated section will be under control.

Table 1 List of Functions

List of functions is shown.

No.	Function	No.	Function
1	Basic control	17	Electric energy retrieval / save
2	VE control	18	Electric energy printout
3	Automatic re-closure	19	System configuration control
4	CPU inter-linkage backup	20	System monitoring
5	Faulty point assessment	21	Power outage-period work support data linkage
6	Display data processing	22	Command Sequence Execution
7	Control console management	23	Work management
8	Operation control log	24	Designated power section control
9	Operation control log editing	25	Telephone calling function
10	Automatic save of operation control log	26	Field work management with mobile phone
11	W3 remote control linkage	27	Statistical data processing
12	Examination	28	Remote control simulation
13	Journal collection / save	29	Save Fault
14	Journal printout	30	Replay fault
15	Control data retrieve / save	31	Fault recovery support
16	Control data printout	32	TID terminal

(column), Plane (door), and Color Scheme (server panel), respectively.

(2) UI design

HCD for UI has been promoted based particularly on the following four points. The adopted system design is created with due consideration to visual esthetic feeling.

(a) Operability

One can intuitively imagine how to operate it.

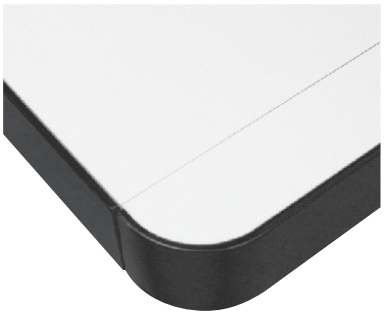

Fig. 7 Point (Corner)

Round corner design and the use of soft resin mitigate an impact when someone or something bumps into the corner.

Fig. 8 Line (Column)

Black belts on the control console provide a stable visual feeling and function as columns and supports.

Fig. 9 Plane (Door)

Contradictory functions like “rigidity and numerical aperture” are best balanced. As a result, it provides a well-balanced beauty.

(b) Visibility

Information can be grasped easily.

(c) Visual attraction

Important information is easily noticed.

Fig. 10 Color Scheme (Server Panel)

"High contrast" consisting of only white and black has been adopted for a policy of color allocation. This policy is applied to equipment other than control consoles in order to produce a unified design feeling in the system.

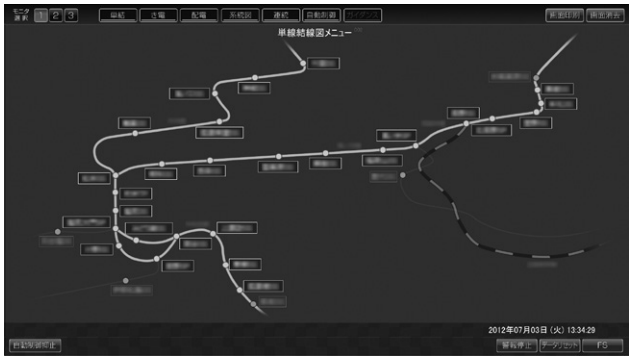

Fig. 11 Single-Line Menu

A single line menu is shown to reflect the actual line network map. As a result, the screen is easily recognizable both visually and geographically.

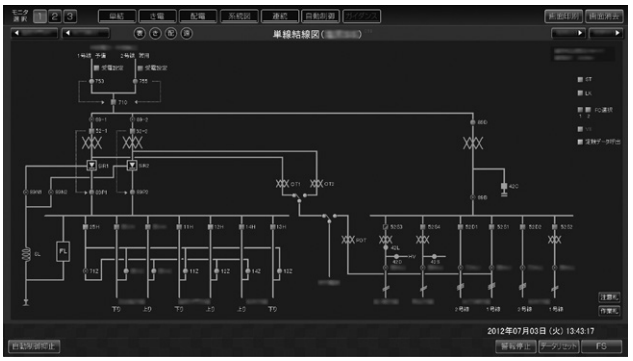

Fig. 12 Single Line Connection Diagram Screen

A single line connection diagram of a currently monitored area is shown.

(d) Simplicity

Information comes in a proper volume.

Figs. 11 to 16 show examples of screens.

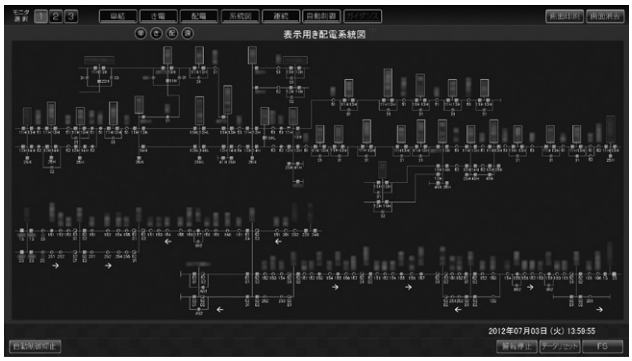

Fig. 13 Traction Power Network Display Diagram Screen

By adjusting the contrast, we realized an easily visible screen.

Fig. 14 Command Sequence Execution Process Screen

A screen is shown for the confirmation of the pattern status for the Command Sequence Execution control.

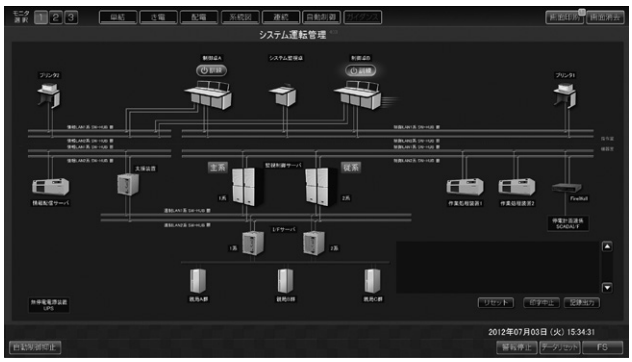

Fig. 15 System Operation Control Screen

Layout of the screen configuration is arranged to establish a network screen. An emphasized color is used among simple colors so that important information can be quickly identified.

(3) Receiving Japan's Good Design Award

Our HCD approach received an objective good evaluation earning the Fiscal 2012 Good Design Award (sponsored by Japan Institute of Design Promotion) in the category of SCADA systems for Railway. This award is based on the evaluation of a design about overall efficiency and usefulness, as

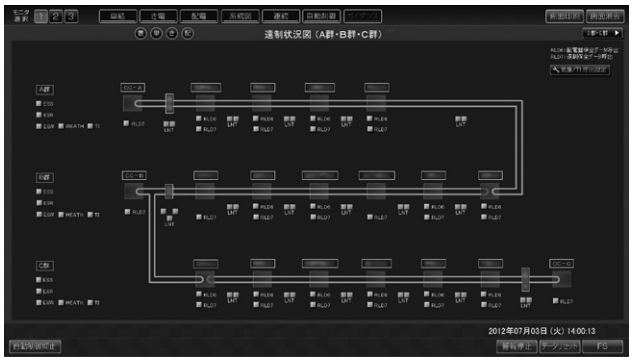

Fig. 16 Remote Control Status Diagram Screen

Chroma is reduced to increase the visibility of necessary information.

just an external good visual design is not enough to be eligible for this award.

4 Postscript

A required maintenance period of 15 years for a SCADA system can be considered a very long time, when we think about the recent rate of ICT technology progress. When introducing new technology, careful product review is imperative when considering a long maintenance period. In addition, consideration of ease of use is also required.

In this system, by introducing the HCD approach and applying it to the Power SCADA System that is the integration of proven technologies, we pursued system building with due consideration of ease of use, while introducing a new technology. Through these efforts, we earned certain evaluation such as the Fiscal 2012 Good Design Award.

Lastly, we express our sincere gratitude to the East Japan Railway Company and its related individuals for their kind suggestions and cooperation relating to the supply of this system.