Web Browser Conversion | Occupied Band Service | System Switching Control

Technology Reports

Special Articles on WIDESTAR II High-speed Mobile Satellite Communications Service for Diverse Satellite Communications

WIDESTAR II Base Station Maintenance and Monitoring System

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NTT DOCOMO's WIDESTAR II satellite telephone system has been launched in Japan as a successor to its WIDESTAR system, and a new operation system has been developed to support a new maintenance and monitoring system for the satellite base station. While inheriting existing functions, this new operation system adds new functions to support the unique features of WIDESTAR II. These functions include the conversion of the user operation interface to a Web browser, the ability to create and save scenarios for system switching, and the support of a bandwidth-guaranteed packet communication service, all of which have helped to reduce deployment and operating costs.

1. Introduction

In conjunction with the launch of the new WIDESTAR II high-speed mobile satellite communications service in April 2010, a new maintenance and monitoring operation system for the satellite base station has been developed. This system, which is called the Satellite Access-Operation System (SATA-OPS), is based on the Network-OPS (NW-OPS) used for maintaining equipment in the IMT/PDC system while incorporating functions unique to the WIDESTAR II system. In the development of SATA-OPS, particular attention was paid to holding down deployment and operating costs in order to expand the use of data communication and provide them at low rates. In the following, we overview this newly developed OPS in the WIDESTAR II system and describe associated technology.

2. Overview of SATA-OPS

Similar to NW-OPS, SATA-OPS is constructed using a Distributed Data Driven Architecture (D3A) mounting Linux®*1 on small-scale Intel Architecture (IA) servers*2 (**Photo 1**). Adopting a configuration similar to that of NW-OPS enables the deployment and operating costs of SATA-OPS to be kept down. The use of IA servers and DC power supplies also helps to reduce power consumption.

The functions required of SATA-OPS are as follows. To begin with, SATA-OPS requires OPS functions similar to those applied to various types

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*1 **Linux®**: A registered trademark or trademark of Linus Torvalds in the United States and other countries.
*2 **IA server**: A server equipped with an Intel microprocessor.

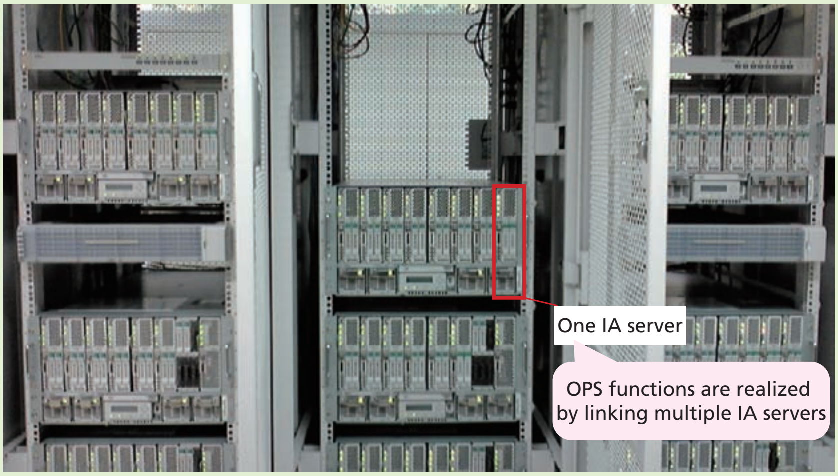


Photo 1 IA server

of IMT/PDC equipment. These include equipment monitoring and control, restriction control[*3], operations management, remote file updating[*4], test-call[*5] registration management and various types of data gathering for traffic/call-processing alarms. Next, SATA-OPS requires OPS functions oriented to the existing satellite system including sun transit automatic control and base station system switching for switching from the currently operating Satellite-Access Point (S-AP) to a reserve S-AP. Finally, SATA-OPS needs functions to deal with the unique features of the new WIDESTAR II system.

A satellite service has the role of providing emergency communications in the event that communications fail in the IMT/PDC system. A satellite-service monitoring system must therefore be able to execute fault-recovery measures and appropriate maintenance in satellite base stations in a prompt and accurate manner.

Additionally, as WIDESTAR II has a system configuration different than that of the existing satellite system, the OPS architecture was newly designed for SATA-OPS. Furthermore, considering that maintenance personnel would work on both the WIDESTAR II system and IMT/PDC system, screen displays and screen operability have been made uniform in the equipment of both OPSs to prevent operational mistakes from being made.

The following two functions are provided in SATA-OPS to support the unique features of the WIDESTAR II system:

- Support for system-switching patterns to accommodate dual homing[*6] in base stations and switching stations and system-switching patterns among satellites, base stations and switching stations during base station maintenance through operation on one satellite on a 30-MHz band.
- WIDESTAR II configuration processing control from station data[*7] generation following user service-contract processing to initial settings for service provision (in support of the occupied band service)

3. SATA-OPS System Architecture

3.1 System Requirements

In NW-OPS used for maintaining and monitoring equipment in the IMT/PDC system, servers were divided into the four OPS function groups of Network Element (NE)[*8] management functions, operations management functions, business management functions and configuration management functions. The WIDESTAR II system, in contrast, installs current-system equipment and reserve-system equipment at two locations as base stations, and features completely redundant connection routes between the switching station and these current-system and reserve-system base stations. Thus, on setting out to design an SATA-OPS architecture, the following requirements for OPS functions were studied.

- Load allocation to each server so that maintenance personnel can always check the connection configuration between the base stations and switching stations targeted for monitoring and the operating state

*3 **Restriction control**: The restricting of location-registration and calling operations in mobile stations to effect an early recovery from a state of congestion caused by a processing anomaly or failure in Satellite-Base station Equipment (S-BE) owing to an accident, disaster, or popular event.

*4 **Remote file updating**: A function for reducing maintenance work in the field by controlling the downloading of station data and control programs to NEs and obtaining equipment log data from NEs all from one monitoring center.

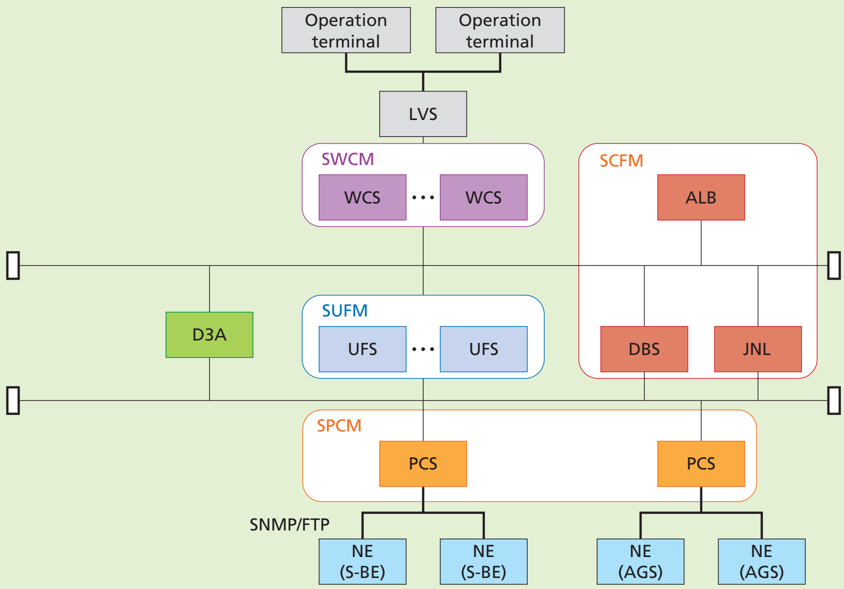
*5 **Test call**: A function for transmitting or terminating test calls to check the operation of radio resources in base station equipment.

of both the current and reserve systems, and so that they can always perform screen operations.

- Consolidation of software function blocks and minimizing of a divided configuration so that communication between function blocks can be reduced.
- Selection of a redundant configuration (all-ACT*9 or ACT/SBY*10) applicable to OPS functional units to deal with an IA-server failure.

3.2 OPS Function Groups

On the basis of our study of OPS functional requirements, we evaluated software and hardware configurations and concluded that the following four functions groups were optimal as function-group definitions for SATA-OPS (**Figure 1**). Compared with the four function groups in NW-OPS, these four function-group definitions minimize the number of IA-servers and achieve higher reliability.



AGS : Access Gateway for Satellite
ALB : Access Load Balancing server
DBS : Database Server
FTP : File Transfer Protocol
JNL : Journal Server
LVS : Linux Virtual Server
PCS : Protocol Conversion Server
SNMP: Simple Network Management Protocol
UFS : Unified Function Server
WCS : Web Conversion Server

Figure 1 SATA-OPS function groups

1) Satellite Unified Function Management (SUFM)

This function group enables maintenance personnel to perform base station operations, such as monitoring and control, restriction control, operations management, remote file updating, test-call registration management and data retrieval for traffic/call-processing alarms, from a screen. With this function group, an all-ACT scheme is used as a redundant configuration and load-distribution processing is performed considering CPU usage rate, memory usage and number of executing tasks so that business operations can continue in the event of a server failure.

2) Satellite Cache Function Management (SCFM)

This function group is used to manage the state of base station equipment maintained by SATA-OPS, the occurrence of and recovery from alarms and the state of the system in relation to alarm information classified according to satellite beams, etc. It is also used to manage traffic data, call-processing alarm data and history data. Here, an ACT/SBY scheme is used as a redundant configuration and data is synchronized between the ACT and SBY servers enabling high-reliability data management to be performed and business operations to continue in the event of a server failure.

3) Satellite Web Conversion Management (SWCM)

With this function group, information can be obtained from each OPS server and displayed on the screen of an operation terminal on the basis of requests issued by maintenance personnel. For this function group, an all-ACT redundant configuration is used and load-distribution processing is performed taking the number of requests from operation terminals and processing time into account. This approach enables stable screen operations even

*6 **Dual homing**: A state in which a connection can be made to either of two sets of system equipment to improve network reliability. In the event that communications are cut off, for some reason, to one set of equipment, the signal route is switched to the other set to prevent service interruption.

*7 **Station data**: Data that specifies node operating conditions, information on connections to other nodes, subscriber accommodation conditions, etc.

*8 **NE**: Generic term for a base station, switching station, or relay device that make up the system.

during times of peak load.

4) Satellite Protocol Conversion Management (SPCM)

This function group performs interface control between SATA-OPS and base/switching stations. It also performs protocol conversion between the communications protocol prescribed for base/switching stations and the OPS-internal communications protocol. In addition, it adopts an ACT/SBY redundant configuration enabling high-reliability communications management to be performed.

4. Conversion of User Operation Interface to a Web Browser

Since SATA-OPS makes use of a Web browser (Internet Explorer) as the operation interface, the same as in NW-OPS, the widely used Windows®[*11] terminal has been adopted as the operation terminal. This has the following advantages compared with the existing satellite OPS.

1) Elimination of Middleware[*12] Restrictions

In the existing satellite OPS, the screen-drawing middleware suffers from restrictions governing button size, graphic components, etc. In SATA-OPS, screen-drawing middleware has been eliminated establishing uniformity with NW-OPS. Screen layout has also been upgraded so that information common to multiple screens is provided on an integrated display, thereby reducing the number of screens and improving operability and readability for maintenance personnel.

2) Reduction of Deployment Cost for Operation Terminals

While the existing satellite OPS uses UNIX terminals, SATA-OPS uses general-purpose Windows terminals to reduce the cost of deploying operation terminals. The adoption of general-purpose products can also eliminate vendor dependence with respect to operation terminals.

5. System Switching Function

A satellite system supporting high-speed communications should duplicate all pieces of equipment to ensure redundancy, and it should be able to switch between the current and reserve units of each piece of equipment to maintain operations. Thus, with the adoption of dual homing in the WIDESTAR II system, the four system-switching patterns of the existing satellite system have become six switching patterns. In addition, settings for each system-switching pattern differ making maintenance work more complicated compared with the existing satellite system. When controlling a base station from OPS in a system-switching procedure, for example, the need for restriction control, High Power Amplifier (HPA)[*13] ON/OFF control, call removal control, etc., will differ from one pattern to another, as will the procedures for carrying out specific control tasks and the parameter settings for each control task. To make system switching easier and faster, SATA-OPS introduces a function for creating and saving system-switching scenarios. This function consolidates the state-verification screens for control execution and completion with regard to complicated control tasks (**Figure 2**).

1) Information Consolidation on Execution Screen

To enable the execution of various system-switching control tasks as a procedure on one screen, multiple control commands can be manipulated in units of "scenarios" each of which describes an execution sequence. Screen information is arranged so that the status of individual control tasks can be checked.

2) Scenario Create/Save Function

Using a scenario creation screen, a scenario describing a procedure for executing control commands in system switching can be easily created and saved by selecting a control command and associated parameters and repeating this for as many control commands as needed (Fig. 2 (1)). Thus, scenarios can be prepared for typical system-switching patterns and saved in the OPS. Selecting a previously prepared scenario enables changes to the system configuration to be made in a flexible and prompt manner after service deployment (Fig. 2 (2) (3)) and minimizes the impact on services during maintenance work and at the time of a failure.

*9 **All-ACT**: A system configuration in which multiple servers performing the same function are simultaneously active. It improves processing speed during normal operations through parallel processing and cuts off only problem servers at the time of a fault, enabling degenerate operation that prevents a service interruption.

*10 **ACT/SBY**: A system configuration in which two servers perform the same function with one server in active mode (ACT) and the other in standby mode (SBY). Service interruptions are prevented by immediately continuing operations on the SBY server whenever a fault occurs on the ACT server. The SBY server is kept in the same state as the ACT server during normal operations in preparation for switching.

6. Support of Bandwidth-guaranteed Packet Communication Service

To support the bandwidth-guaranteed packet communication service, it must be possible to modify channel allocations defined in station data at the base station. In SATA-OPS, control functions are provided for creating and saving station data, transferring station data to a remote base station, and initiating (activating) the service all from one operation terminal (**Figure 3**).

1) Station-data Create/Save Function

In the existing satellite OPS, a function for creating station data is incorpo-

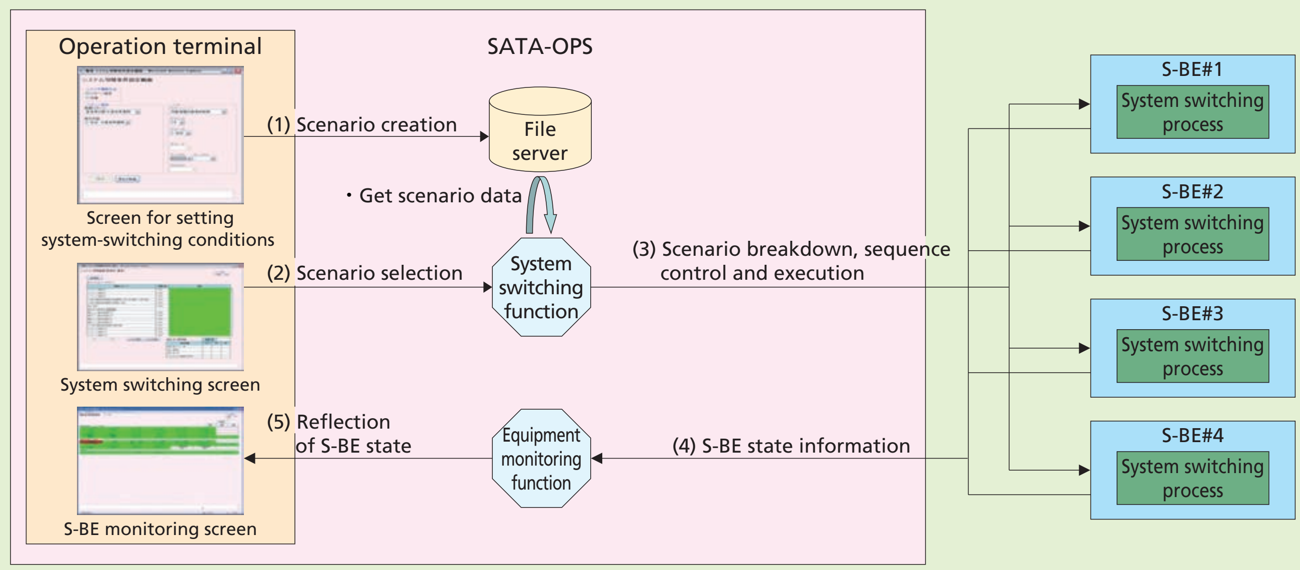


Figure 2 Scenario create/save function for system switching

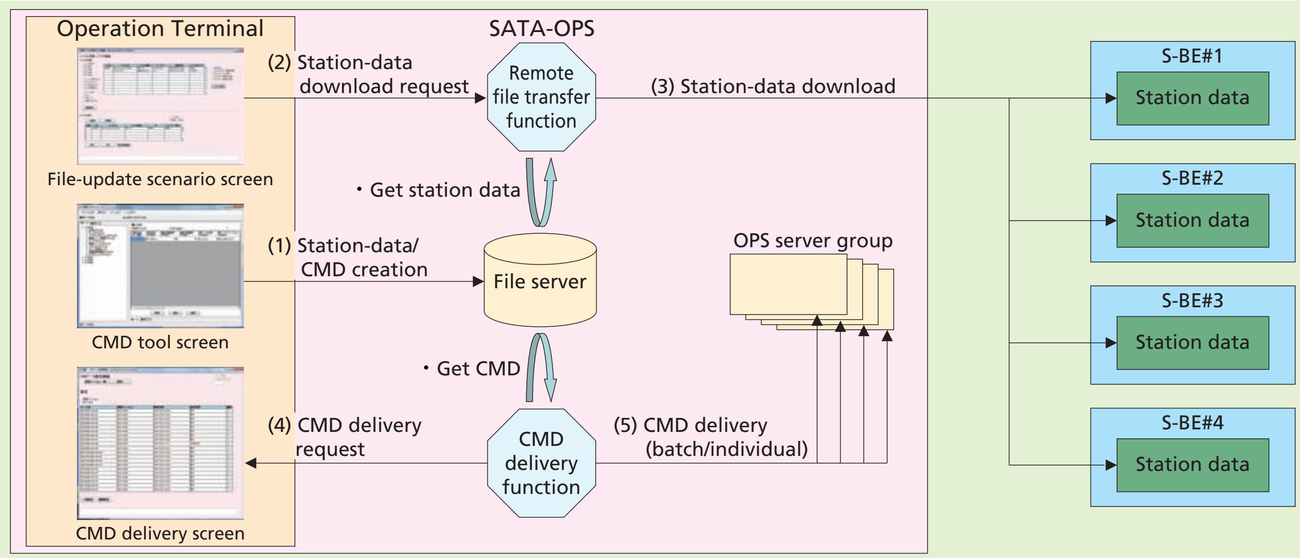


Figure 3 Station-data creation/remote-transfer function

*11 **Windows®**: A registered trademark or trademark of Microsoft Corp. in the United States and other countries.

*12 **Middleware**: Software positioned between the OS and actual applications providing common functions for diverse applications thereby making application development more efficient.

*13 **HPA**: Equipment for amplifying signals. The transmission distance of radio signals can be increased through amplification.

rated in an independent operation terminal dedicated to creating station data. In contrast, SATA-OPS enables maintenance personnel to call up a station-data creation tool called the Construction Memory Data (CMD)[*14] generator from the screen of the operation terminal and to create and save station data as needed (Fig. 3 (1)).

2) Station-data Remote Transfer Function

This function enables created and saved station data to be downloaded to a remote base station from SATA-OPS and to perform online updating of station data without having to reboot on the base station side (Fig. 3 (2) (3)).

3) Service activation function

Although preparations on the base station side are completed once station data have been updated, the timing of service activation must be flexible enough to meet user needs. In SATA-OPS, equipment can be controlled to activate this service at any time, enabling service changes to be made in a speedy manner. A resource monitoring function is also provided so that the results of a service change can be followed directly by real-time traffic monitoring or other means after the start of service provision. In addition, data associated with this service can be uniformly managed in SATA-OPS, thereby improving the maintainability of this service.

7. Conclusion

This article described the configuration of the new SATA-OPS introduced in NTT DOCOMO's WIDESTAR II system and the SATA-OPS support of functions particular to WIDESTAR II such as system switching and bandwidth-guaranteed packet communications. By improving system architecture, a variety of SATA-OPS functions, including the conversion of the user operation interface to a Web browser, the introduction of scenarios in the system switching function, and the support of a bandwidth-guaranteed packet communication service, have helped to achieve a high level of performance befitting the WIDESTAR II system and to reduce deployment and operating costs.

Going forward, NTT DOCOMO aims to bring the performance of its WIDESTAR II system to even higher levels and reduce operating costs even further.

*14 **CMD**: Data defining the internal configuration of an S-BE such as number of mounted cards, S-BE IP address, etc., for use by OPS.