Special Article on Operation System
Network Management/Service Management Operation System

In phase two of upgrading project of DoCoMo's new OPS (operation system), (1) the Call Transaction Alarm Server, (2) the Mobile Communication Traffic Control System, (3) the Traffic Data Warehouse system and (4) the Remote File Update System were developed to improve network quality control, traffic control, traffic data management and file provisioning. In this report, we describe these components.

(1) Call-Transaction Alarm Server

Takeshi Yamashita, Naohisa Nakayama, Kenji Ono and Takahiro Makiyama

1. Introduction

In mobile communication, a call can be released (semi-normal call-termination) during call connection or communication for various reasons before it is terminated normally. When this happens, the operation center collects a call transaction alarm, information regarding cause of the release (type) together with subscriber.

We can expect following two effects from collecting call transaction alarms :

(1) The number of call-transaction alarms is tracked by alarm types, so any trend in the deterioration of service quality can be detected quickly, and corrected.

(2) The information collected about the circumstances of an alarm can be used to resolve the customer's complaint.

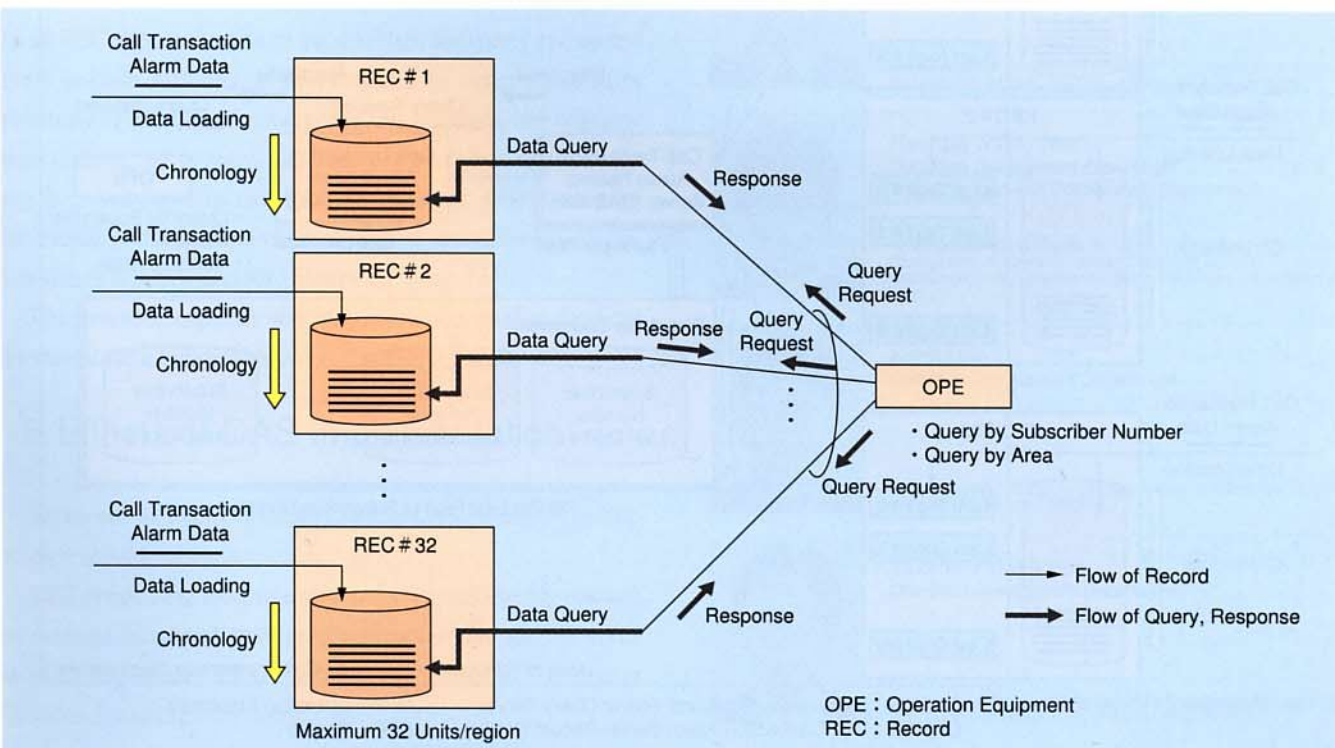


Figure 1 System Configuration Without Call Transaction Alarm Server

Initial development of OPS (Operation System) placed emphasized network monitoring, so a conventional call-transaction alarm processing system was developed to attain the first benefit.

Along with the explosive growth in the number of customers in recent years, the number of call transaction alarms has increased dramatically. While we have come to use these alarms more for the second benefit, as the data searches takes longer and longer, it is becoming more and more difficult to handle customers' inquiries as promptly as we would like. In addition, as because the processing capability of REC (Record) and its database capacity are anticipated to run short in near future, we must to reduce the processing load of REC.

This paper explains CAS (Call Transaction Alarm Server) developed to improve these problems.

2. Objectives of Development of the Call Transaction Alarm Server

Configuration of the conventional call transaction alarm processing system is indicated in Figure 1. In order to achieve :

(1) Prompt search based on customer's subscriber number
(2) Reduction of processing load of REC
(3) Long term storage of history data

We decided to develop CAS which can be used in combination of existing REC.

3. Outline of System

CAS is consisted of CAS-QS (CAS-Query Server) and a record server CAS-RS (CAS-Record Server). Figure 2 shows its logical system configuration.

CAS-QS receives requests from clients, such as OPE for query of call transaction alarm history data. An unit of CAS-QS is installed in each operation center.

CAS-RS retrieves call transaction alarm history data from REC and stores it into a database. It also processes queries sent by CAS-QS. The number of CAS-RS installed in each

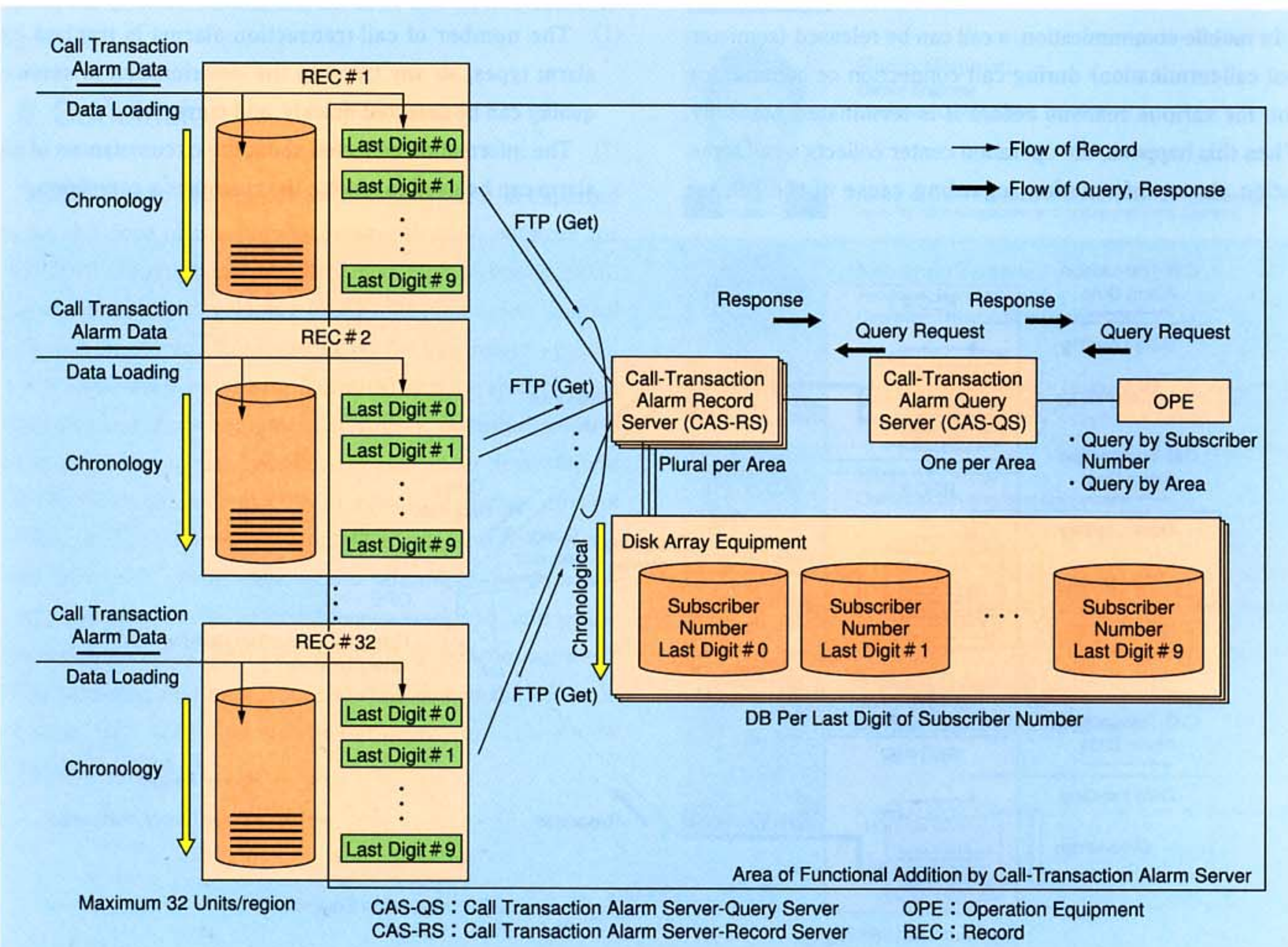


Figure 2 System Configuration with Call Transaction Alarm Server

Table 1 Effects of Call Transaction

	Before CAS Implementation	After CAS Implementation	Note
Query Performance by Subscriber Number	Approx. 50 minutes	10 seconds	Unspecified in area 1 week of query time
Period for Recording	1 week (worst case)	More than 2 months	Dependent on number of BHCA
REC Processing Capability	400,000 BHCA	1.2 million BHCA	BHCA is a referential index for server processing capability

BHCA : Busy Hour Call Attempt CAS : Call Transaction Alarm Server REC : Record

operation center is determined based on the number of call-transaction alarms the center has to manage.

4. Recording to Database

Along with introduction of CAS, we added a function to REC to group and file call transaction alarm history data by last digit of subscriber numbers and made CAS-RS retrieve REC files according this mechanism. Since it eliminates a need to access REC database for every processing of call transaction alarm history query, processing load of REC is reduced. A file of transaction alarm history data created for a certain last digit of subscriber number is registered in the CAS-RS database as it is collected from REC.

The conventional REC database was configured to store call transaction alarm data simply as data arrive from the switch it looks after. Consequently, because all history data in all REC (Record)s had to be searched for query requested for a certain number, it was difficult to return a prompt response (Figure 1). To overcome this problem, the new system is designed to have database per each last digit of subscriber numbers in the CAS-RS, so that search can be restricted to database of the last digit of the subscriber number query is requested for (Figure 2).

The database capacity was also increased so that data can be stored for a longer time.

5. Effects of CAS Implementation

As shown in Table 1, implementing CAS improved performance considerably.

REC processing load was also reduced sufficiently enough to manage increased amount of call transaction alarms in the digital system PDC (Personal Digital Cellular Telecommunication System).

6. Conclusion

We have described the call transaction alarm server we developed to improve the processing capability and functionality of the conventional call processing alarm system was discussed. Besides the effects listed in Table 1, this system has enabled us to take the first step toward full utilization of call transaction alarm history data for customer service. Efforts are being made so that it will improve our customer service for our current system and IMT-2000 (International Mobile Telecommunications-2000) system.

(2) Mobile Network Traffic Control and Management System

Haruo Mizumoto, Katsuyuki Tsumita and Hideo Kuroki

1. Introduction

The increasing number of mobile users has led to frequent congestion and reduced connection rates, which have an adverse impact on society. As the network expands, it has become more difficult to identify bottlenecks in network equipment.

To overcome these problems, we developed the MTCS (Mobile Network Traffic Control and Management System). This system collects real-time traffic information over network equipment to help reduce the workload required for controlling congestion in network equipment and preventing the loss of revenue as a result of the congestion. It also transfers information needed for planning equipment and managing operations to the TRAD (Traffic Data Warehouse).

2. Development Objectives

MTCS is designed to reduce the workload required for collecting traffic information by automating the collection of real-time traffic information at switches. Its objectives are to reduce the number of operations relating to equipment planning and management by utilizing generic software, thus simplifying the way traffic data is processed, and to reduce the number of operations relating to network control to prevent the loss of revenue due to network congestion.

To achieve these objectives, MTCS controls traffic (automatically and manually) when abnormalities or congestion occurs at a core network node, such as a MLS (Mobile Local Switch), MGS (Mobile Gateway Switch), NMLS (New Mobile Local Switch), MSCP (Mobile Service Control Point), or NMSCP (New Mobile Service Control Point).

3. System Configuration

As Figure 1 shows, when MTCS is connected to an existing OPS (Operation System), the functions of the entire system can be improved. The green areas in the figure represent MTCS.

4. System Features

The main features of the system are summarized in Figure 1.

(1) Automatic collection of real-time traffic at switches (MLS, NMLS)

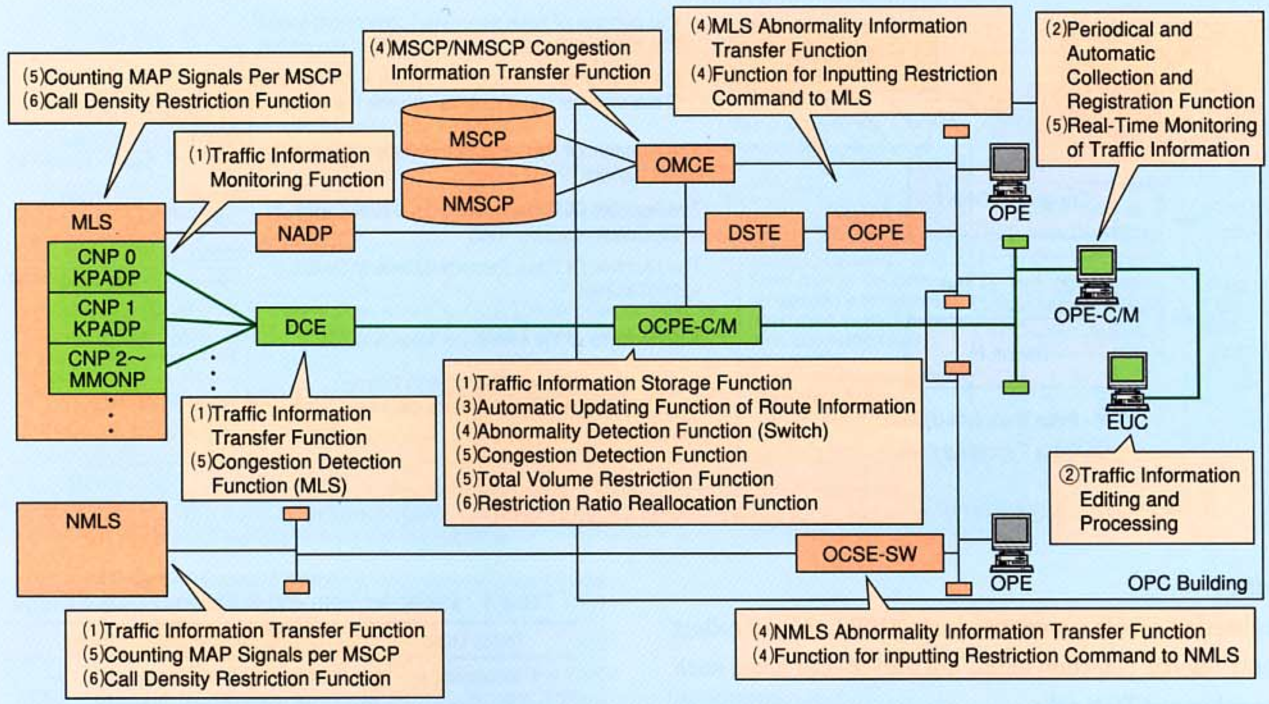
For preventing an overload of a MLS, a KPADP (Bus Conversion Control Circuit Package) and a MMONP (Mobile Communication Interface Monitor Package) are externally mounted on each CNP (Call Control Processor equipment) and MCP (Main Call control Processor equipment) of the switch to monitor traffic information. These packages monitor memory-write information of KP (High-Speed Multiplex Processor) bus signals in the switches and they transfer traffic counter information from DCE (Data Collection Equipment) to the MTCS server which (OCPE-C/M : Controls the Switching Processing Equipment Traffic Control/Management) for storage. Since NMLS does not have an interface for external traffic data collection, it transfers traffic data directly to the OCPE-C/M by command route for storage.

(2) EUC (End User Computing) support function

A function is provided that enables a PC terminal to retrieve traffic data from OPE-C/M in the FTP (File Transfer Protocol) format. This enables generic software such as EXCEL to be used for the editing and processing of traffic data automatically collected at the switches (see Chapter 5 (4) periodical automatic collection of traffic).

(3) Automatic update of route information of the switches (equipment data collecting function)

For quick and accurate control of the network, we need to secure route information (equipment data), which includes important information such as that on the connections between switches and TGN (Trunk Group Number). The system automatically updates office data of each switch via OCPE or OCSE-SW at certain intervals, consequently reducing the data collection workload.



DCE : Data Collection Equipment
DSTE : Information Distribution Equipment
EUC : End User Computing Terminal
KPADP : Bus Conversion Control Circuit Package
MAP : Mobile Application Part
MLS : Mobile Local Switch
MMONP : Mobile Communication Interface Monitor Package
MSCP : Mobile Service Control Point
NADP : Network Element Added Equipment
NMLS : New Mobile Local Switch
NMSCP : New Mobile Service Control Point
OCPE : Operation Control and Processing Equipment for Exchange
OCPE-C/M : Operation Control and Processing Equipment (Traffic Control/Management)
OCSE-SW : Operation Control Information Storage Equipment-SW
OMCE : Operation MJ Information Collect and Distribute Equipment
OPC : Communication Service Operation Center
OPE : Operation Equipment
OPE-C/M : Operation Terminal Equipment (Traffic Control/Management Terminal)

※Numbers in parentheses match numbers in the Chapter 4 : System Features

Figure 1 Outline of System Configuration and Features of Syste

(4) Effective utilization of existing OPS for monitoring and controlling core network node

Some of the information concerning abnormalities and congestion of core network nodes that is output from existing OPS is monitored and displayed at the OPE-C/M (Operation Terminal Equipment-Traffic Control/Management Terminal) of the system. Restriction commands are sent to the switches from the system via OCPE or OCSE-SW.

(5) Reduction of time required for traffic control

Signs of congestion at the core network nodes are monitored around the clock by collecting traffic data from DCE or NMLS. This monitoring enables the user to be notified of traffic congestion in advance.

Since control commands are automatically generated in MTCS according to the operator's instructions which can be simply input through a GUI (Graphical User Interface), the time required for controlling traffic is significantly less than the time required for manual command input to the switches.

(6) Maximum traffic secured

Since the percentage restriction method of controlling traffic flow allows the quantity of calls passing through the switch to increase in proportion to the amount of generated traffic, it is difficult to control traffic effectively. To restrict the number of calls flowing into a switch to a determined quantity, MTCS employs a total volume restriction method, which permits the maximum amount of traffic to be maintained under the restriction (Figure 2).

After the initial traffic restriction is set, MTCS collects traffic information every minute, recalculates the restriction rate according to the collected data, and updates the restriction every five minutes so that the maximum amount of traffic can be secured regularly.

5. System Functions

System functions are explained below :

(1) Function for collecting, storing, and displaying switch

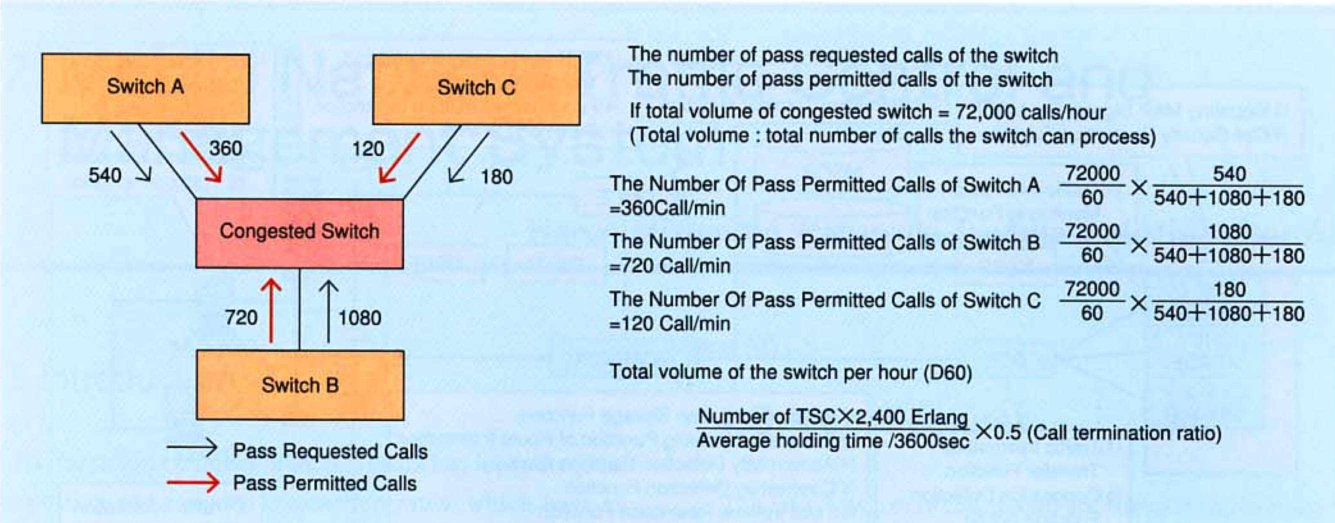


Figure 2 Total Volume Control

traffic

Registering simple commands in the OPE-C/M can collect not only regular detection items, but also special items such as the volume of TGN calls.

Table 1 indicates the types of traffic data and the amount of time they are stored.

3-minute data, 60-minute data, and most-frequent data can be displayed when needed for equipment management and planning. After abnormalities or congestion is detected, or while traffic is being restricted, real-time traffic information is displayed and updated every minute until normal traffic resumes.

(2) Function to detect abnormalities and congestion (Figure 3)

① Detection of congestion with MSCP and NMSCP

Each MSCP aggregates the MAP (Mobile Application Part) signals of all switches. If the aggregate exceeds a threshold value, or if the OMCE (Operation Major information Collects and Distributes Equipment) outputs a notification indicating MSCP congestion, MSCP is determined to be congested.

② Detection of switch restart repeat

Restart is determined with a restart message from the switch and information on the console lamp. If a restart occurs a certain number of times within a specified amount of time, a restart repeat is detected.

③ Detection of switch congestion

To detect congestion of the MLS, the DEC checks use efficiency of the central control equipment every 20 seconds and the transaction hunt NG rate and the number of calls processed by the switch every minute. If one of these three factors exceeds its threshold value, the switch is determined to be congested.

Table 1 Collected Data and Duration of Data Storage

Traffic Data	Duration of Data Storage
1 Minute Data	40 hours
3 Minute Data	8 days
60 Minute Data	40 days
Most-Frequent Data	by day : 40 days by week : 55 days by month : 2 years Top 50 days : 1 year

To detect congestion of the NMLS, the OCPE-C/M checks CC (Central Control Equipment) use efficiency, total busy rate, and the number of calls processed by the switch every minute. If one of these three values exceeds its threshold value, the switch is determined to be congested.

(3) Traffic restriction and control function (Figure 3)

① Automatic restriction

To manage MSCP/NMSCP congestion and restart repeat of the switches, MTCS automatically executes the entire restriction process, which includes detection of signs of congestion/restart repeat, determination of the switches to be controlled, selection of measures, and actual control (total volume restriction method).

② Automatic restriction and interference

In the case of congestion of the switches, MTCS automatically executes the first part of the restriction process, including detection of congestion, determination of the switches to be controlled, and selection of measures. The operator initiates control (total volume restriction method).

③ Manual restriction

When the operator's manual interference is required for

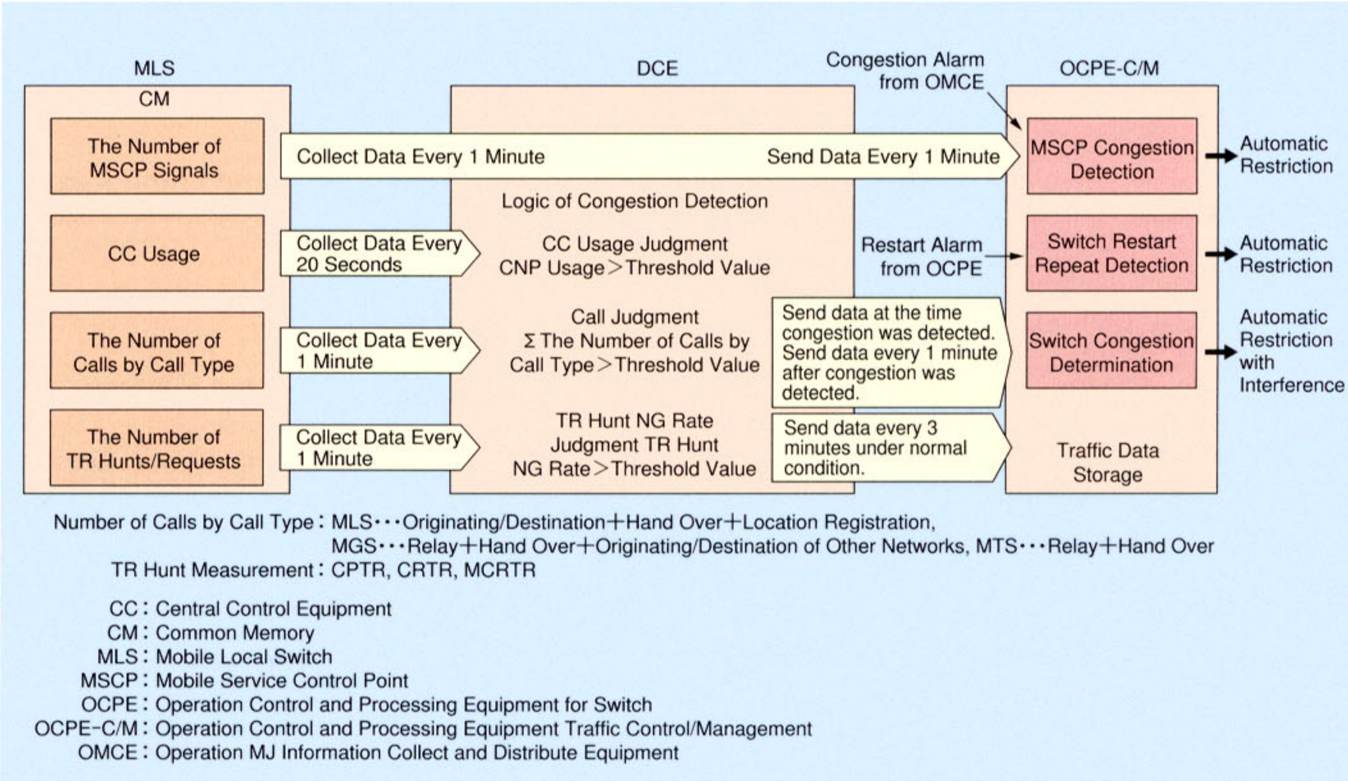


Figure 3 Flow from Detection of Congestion to Automatic Restriction

restricting traffic in certain situations, the switches that need to be controlled can be automatically displayed according to equipment data collected from the switches. The operator can input the necessary restriction commands in a single operation.

(4) Function for automatic and periodical collecting of traffic data

When the EUC (End User Computing) support function is used, the user registers requests such as the time interval for data collection and unit/traffic-related items to OCPE-C/M in advance. The OCPE-C/M periodically and automatically collects traffic information accordingly, and information is converted to a file in the CSV file format and stored in the OCPE-C/M's hard disc.

6. Conclusion

The I-MTCS traffic monitoring and control system is currently being developed for the IMT-2000 (International Mobile Telecommunications-2000), which is scheduled to be launched in the spring of 2001. I-MTCS will be deployed in combination with the real-time monitoring system of network traffic status, the radio traffic control OPS, and MTCS in order to achieve efficient, quick, and accurate traffic control.

(3) Traffic Data Warehouse System

Kazuaki Terunuma and Shinji Kamiya

1. Introduction

As networks expand, traffic management is taking on a more important role in quality control and equipment engineering. However, the lack of a computer system to systematically support this management task makes it a time-consuming effort to collect, process, and analyze traffic management data.

The TRAD (Traffic Data Warehouse) system was developed by DoCoMo to collect various types of traffic data and to support efficient analysis of the data. It supports three key functions :

① Automatic collection of traffic data
② Automatic editing of traffic data
③ EUC (End User Computing) using a simple data search tool (OLAP)

These functions make it possible to analyze various types of traffic data quickly.

2. System Configuration

The TRAD system is illustrated in Figure 1.

2.1 Main functions

(1) Data collection and loading

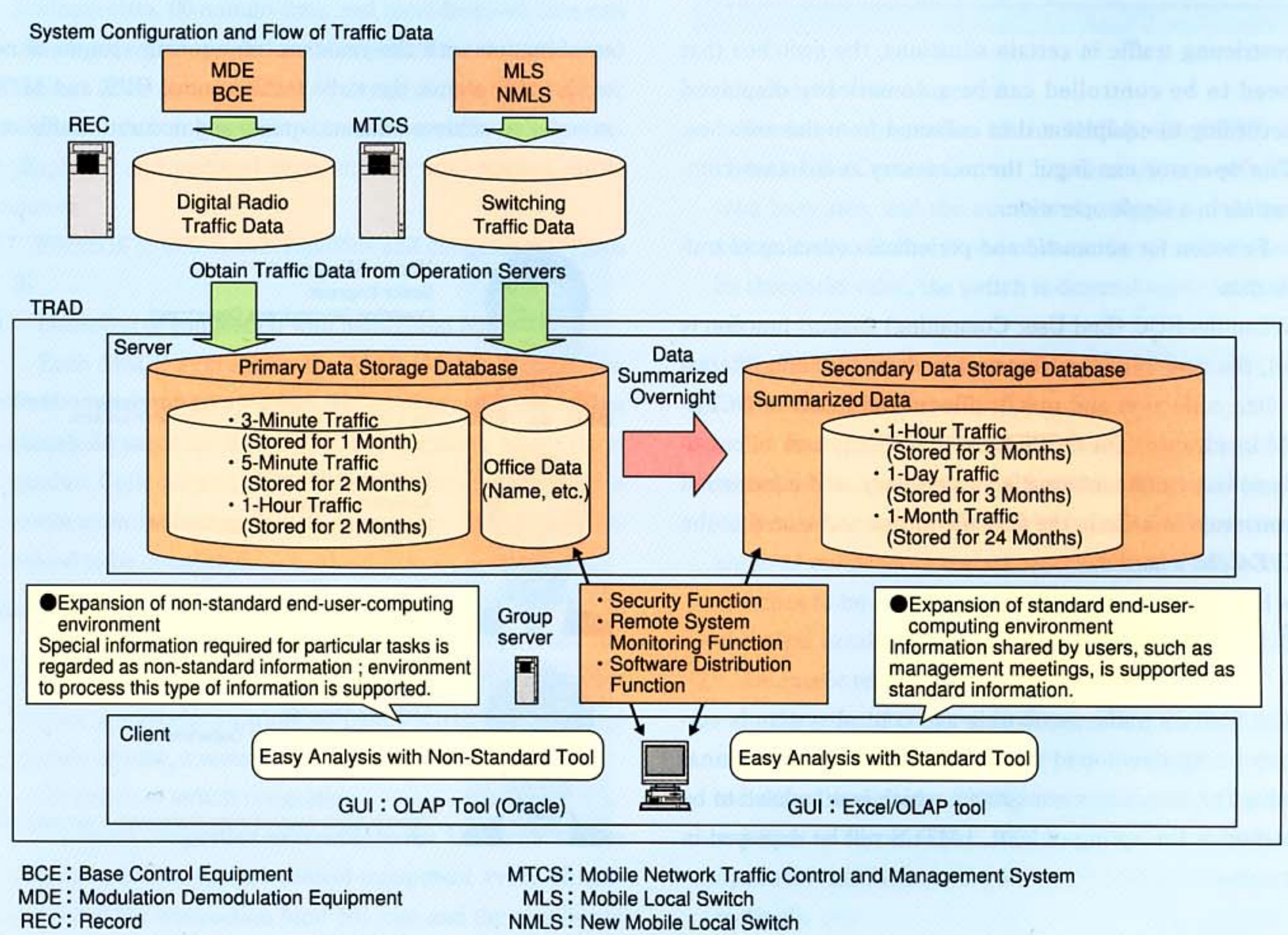


Figure 1 System Configuration

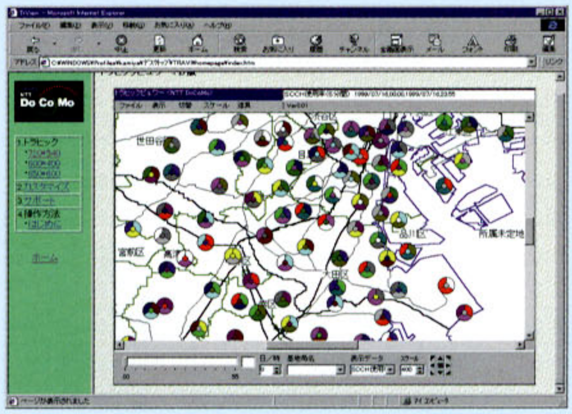


Figure 2 Example Traffic Display Map

Traffic data is collected periodically (every 30 to 60 minutes) from the servers [REC (Record) and the MTCS (Mobile Network Traffic Control and Management System)] which have an interface with NE (Network Element). The data is stored in a primary database.

(2) Data summarization

The data in the primary database is summarized overnight and itemized into a standardized list. The summarized data is then stored in an analysis database.

(3) Search/list output

The list supports standard and non-standard formats. Standard format facilitates information sharing among users, while non-standard format enables users to create a special list to conduct a detailed analysis needed to perform a particular task.

(4) Traffic display on map of base stations

Traffic-related items supported in the non-standard format can be plotted over a map of the base stations according to their latitude and longitude. This makes it possible to more easily understand the geographical characteristics of traffic. Figure 2 shows an example map display.

3. Conclusion

Traffic data from the PDC (Personal Digital Cellular Telecommunication System), the digital radio communication system, the PDC switching system, and the PBS (Pocket Bell System 6PBS) have already been loaded in the TRAD system. Data from the packet and highway systems will be loaded in Spring 2000. Radio and switching data from IMT-2000 (International Mobile Telecommunications-2000) will be loaded after service commences in Spring 2001.

(4) Remote File Updating System

Kazuaki Terunuma and Satoshi Namie

1. Introduction

The rapid increase in the number of mobile subscribers has led to a frequent expansion in the number of NE (Network Element). This continuing expansion requires that office data files, system files, etc. be updated continuously. Efficient NE file updating is now regarded as a pressing problem that we have to overcome.

The expansion in the number of NEs also increases the workload for inputting and updating the data used in the systems that monitor and control NEs. It is urgent that we make this provisioning work more efficient.

The remote file updating system described in this report provides functions for the online transfer of NE files created by the equipment and development divisions and for the remote download of NE files from the OPS (Operations System) to NEs, making it possible to immediately download files. The system also provides functions for automatically generating operational data using office data and automatically distributing common office data, making it possible to simplify input operations.

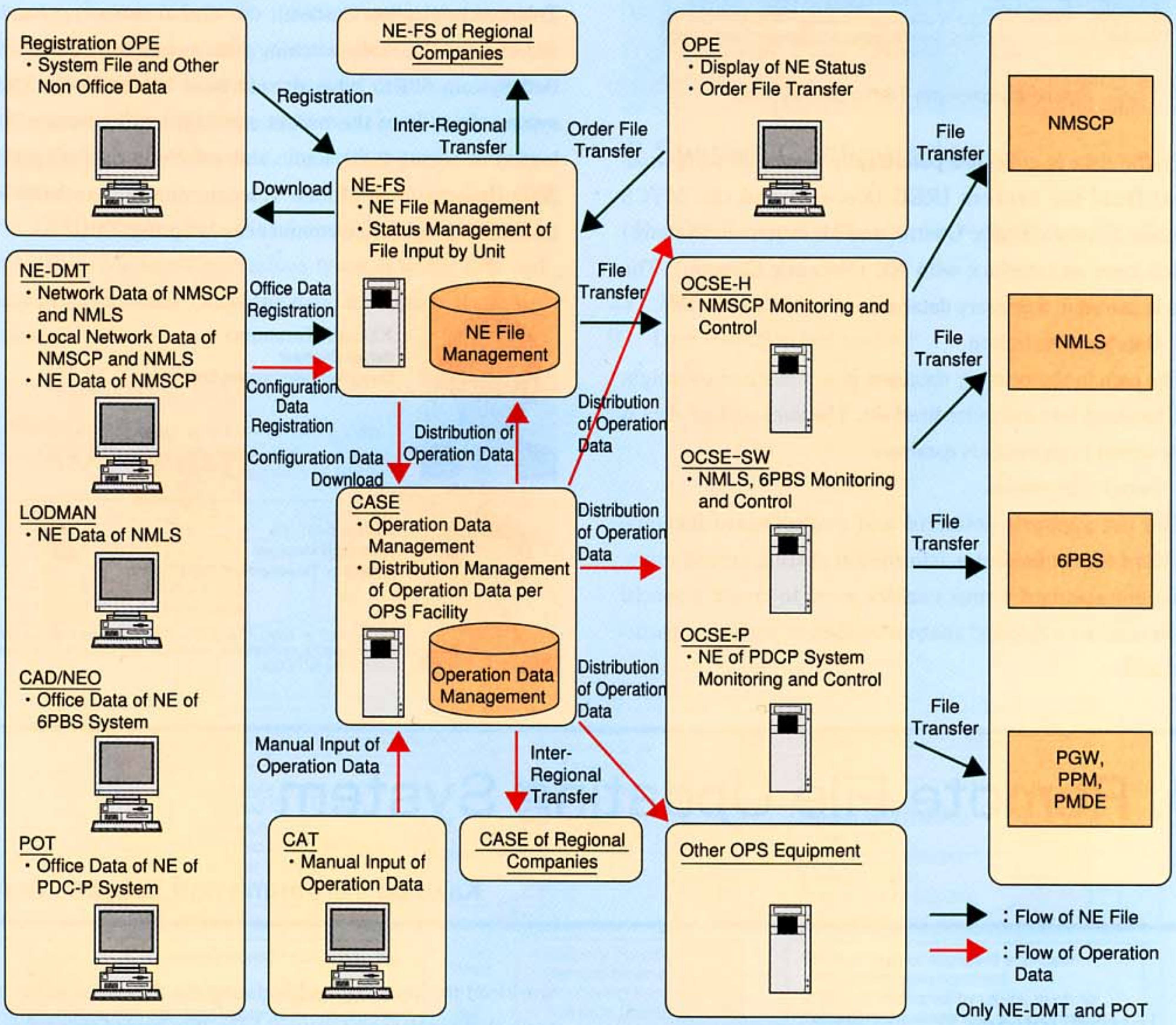
2. Outline of System

The flow of NE files and operational data is illustrated in Figure 1. The functions of the system are as follows.

2.1 Main Functions of NE-FS (Network-Element File Server)

(1) Registration and generation control of NE files

Multiple versions of NE files and office-data files are controlled ; file status is controlled by version and by unit. It is thus easy to identify versions, preventing mistakes in file selection. With this version-control function, we can specify the required number of versions for each NE file in order to



BS : Base Station
CAD/NEO : Computer Aided Design/New Office Data Generator
CASE : Configuration Administration Server Equipment
CAT : Configuration Administration Terminal
OPE : Operation Equipment
LODMAN : Logical Office Data Making Assist Network System
NE-DMT : Network Element-Data Making Tool
NE-FS : Network Element File Management Server
NMLS : New Mobile Local Switch
NMSCP : New Mobile Service Control Point
OCSE-H : Operation Control Information Storage Equipment-H
OCSE-P : Operation Control Information Storage Equipment-P
OCSE-SW : Operation Control Information Storage Equipment-SW
OPS : Operation System
PGW : Packet Gateway Module
PMDE : Packet Modulation Demodulation Equipment
POT : Packet Office Data Terminal
PPM : Packet Processing Module

Figure 1 System Configuration

save disk capacity.

(2) NE file transfer

The system is linked to the OCSE-H (Operation Control Information Storage Equipment-H) of the NMSCP (New Mobile Service Control Point), the storage equipment of the OCSE-SW (Operation Control Information Storage Equipment-SW), and the storage equipment of the OCSE-P (Operation Control Storage Equipment-P). Files can thus be transferred online to NEs. The NE-FS manages the status of files transferred to NEs based on the results of file transfer and file update.

2.2 Main Function of CASE (Configuration Administration Server Equipment)

When OPS operation data overlaps NE office data, the overlapping data is obtained via the NE-FS as configuration data from the NE-DMT (Network-Element Data-Making Tool) and the POT (Packet Office-data Terminal). If there is no data in the NE office-data file, the required data is input at the CAT (Configuration Administration Terminal) and assembled so it can be managed as operation data.

The consistency of the operation data is verified in CASE to guarantee its validity.

2.3 Common Key Functions of NE-FS and CASE

(1) Inter-regional data transfer

Both the NE-FS and CASE have a function to automatically transfer files from one region to another. This data sharing eliminates the need to input identical data at regional companies.

(2) Dual configuration and back up

Because the NE files and operation data stored in the NE-FS and CASE are critical data for communication service, disks have a dual configuration, and data is periodically offloaded to separate media for back up.

3. Conclusion

Though improvements in provisioning operations will greatly help reduce costs in terms of manpower and time, it requires intensive tie-up with NEs, so we prioritized our development tasks to start with the ones that promise the highest improvement effect. We plan to apply this prioritizing mechanism to the radio and switching NEs of the IMT-2000 (International Telecommunications-2000) in Spring 2001.