Development Reports

IP Service Control Point and Signaling Gateway for IP Common Channel Signal Network

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We developed the IPSCP and SGW to strengthen the platform of advanced function service nodes and reduce network construction cost in the future DoCoMo network.

1. Introduction

Premised on the conversion of the common channel network to Internet Protocol (IP), to achieve fast and flexible response for an increase in FOMA core network traffic and new services and to reduce facilities cost, systems for constructing the core network must be converted to allow the use of servers and routers. Here, we outline the specifics of IP Service Control Point (IPSCP) and Signaling GateWay (SGW) for IP common channel signal networks and describe the effects of development, the configuration and features of the software and hardware system, and the network configuration.

2. Background of IPSCP and SGW Development

2.1 Current Problems and Development Objectives

The increase in FOMA subscribers as DoCoMo subscribers migrate from Personal Digital Cellular (PDC) to FOMA, has created a need to expand core network facilities; specifically required are increase in New Mobile Service Control Point (NMSCP), which provide advanced service control point functions, and increase in Mobile Multi-Media service Infrastructure (M^3In), which provide mobile multimedia services. Furthermore, increased use rate of links between NMSCP and New Signaling Transfer Point (NSTP) and greater numbers of NMSCP lead to a requirement for more NSTP. We therefore developed the IPSCP and SGW with the objectives of increasing the processing capability of advanced function service control points within the core network and reducing network cost and development cost.

The IPSCP was not only developed as a simple replacement for NMSCP and M^3In, but it is positioned as a basic system that integrates the functions of both of those nodes, and also supports advanced function service control within the future core network, as well as flexibility and efficiency in new service development. We also intend to integrate the subscriber profile database of the Home Subscriber Server (HSS), which is in the IP Multimedia Subsystem (IMS). Because it is first necessary to increase the number of M^3In facilities, we will initially introduce the Specific User Service Control Point (SUSCP), which has the functions of the M^3In and the IMS and maintains a subscriber profile data (keyed on the subscriber number), and the External Business user Service Control Point (EBSCP), which stores the profile data of each provider. For the future need to expand the NMSCP facilities and increase the link utilization rate, we plan to develop and introduce the IPSCP, which has the NMSCP functions in addition to the M^3In functions and IMS functions. The IPSCP migration is shown in **Figure 1**.

Specialized nodes such as the NMSCP and NSTP are expensive and hinder the construction of systems that are flexible in response to demand. With the general-purpose commercial servers used in M^3In, however, there is the problem of the short product life cycle of the products used. For the IPSCP and SGW hardware, we chose to adopt the advanced Telecom Computing Architecture (aTCA) [1], which should solve those problems and is also being introduced in the serving/gateway General packet radio service Support Node (xGSN).

2.2 Effects of Advanced Function Service Node Integration

Systems that are positioned as advanced function service nodes in the current DoCoMo network include the NMSCP, which executes PDC and FOMA location registration and basic call control such as origination/termination call control as well as service control, and M^3In, which executes FOMA packet service control in cooperation with open Internet Service Provider (ISP) and treasure Casket of i-mode service, high Reliability platform for CUStomer (CiRCUS). The NMSCP must be capable of high-speed processing because it performs location registration control, a specific feature of mobile communication networks, as well as origination/termination call control. The M^3In interfaces with external networks such as open ISPs, so it is necessary to ensure security. Because of such differences, these functions are currently implemented separately by the NMSCP and the M^3In.

The subscriber profiles that are needed for implementing the functions described above are respectively stored in the NMSCP and the M^3In nodes. Because the subscriber information is distributed over the nodes, the issue of increasing the memory utilization rate by deploying the subscriber profiles to respective node according to an index key (subscriber number) or other such means arised. There is also the issue of partial redundancy in the development of nodes that have similar functions, particularly in the implementation of service control. The costs of development and maintenance can be reduced by maintaining the subscriber information in a unified manner at a integrated node to achieve efficient use of memory and establish common basic functions for maintaining subscriber information

System name	Function	Function configuration
SUSCP	● M^3In ● HSS (IMS functions)	M^3In HSS
EBSCP	● M^3In	M^3In
IPSCP *NMSCP function configuration also possible	● M^3In ● HSS (IMS functions) ● NMSCP	M^3In HSS NMSCP

…Initial introduction

Figure 1 IPSCP migration (future)

(back-up, customer management, transfer of subscriber management, etc.) to solve those problems.

This also allows the smooth introduction of the PushTalk service and other such services that require cooperation between the NMSCP functions (dwell information management and service control in the core network) and the M^{3}In functions (service control with open ISP and CiRCUS, FOMA location information service control, etc.). This also decreases signals between nodes.

2.3 Effects of Converting the Common Channel Signaling Network to IP

When inheriting function from NMSCP to IPSCP, we developed SGW that centralizes the conversion of the common channel and IP, not deploying common interface to IPSCP. This eliminates the need for providing a common channel interface for new nodes that will be developed in the future. The SGW is positioned as IP version of the NSTP and so is equipped with the same signal transmission and network management functions as the NSTP (failure detection, convergence control, signal re-routing control, etc.).

3. IPSCP and SGW System Configuration

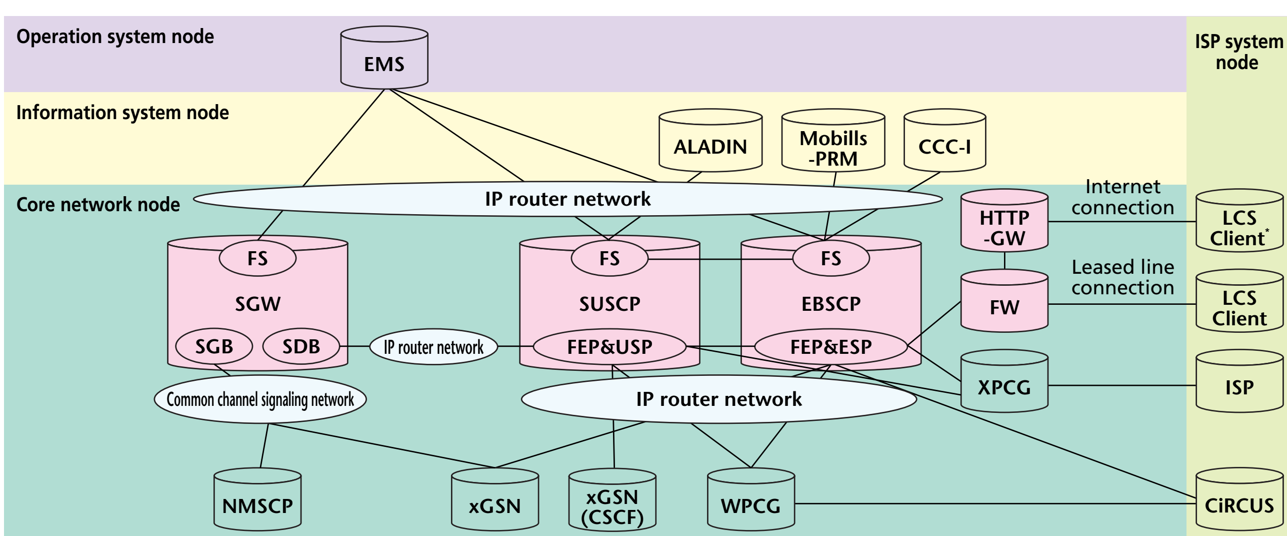
3.1 Network Configuration

The SUSCP, EBSCP and SGW network configuration is shown in **Figure 2**. The SUSCP connects to the Element Management System (EMS), which is an operation system node, and the ALl Around DoCoMo INformation systems (ALADIN), which is a customer system node. Also, by connecting to the xGSN and Wireless Protocol Conversion Gateway (WPCG)/eXtended wireless Protocol Conversion Gateway (XPCG) core network system node and the NMSCP, the PushTalk service, the FOMA location information service and other such services are provided. An SGW is placed in the connection between the SUSCP and the NMSCP for signal conversion of common channel and IP signals. A feature of this network configuration is that the connections to all nodes are made via an IP router network.

The EBSCP is connected to the EMS operation system node. Furthermore, there are connections to the WPCG/XPCG core network system node, the MObile communication BILLing Systems-Partner Relationship Management system (Mobills-PRM) customer system node and the Calling rate Charge Center-IMT (CCC-I) billing system node to provide services such as the FOMA location information service and send charges information for those services. There is an interface to nodes outside of the DoCoMo network for connections to CiRCUS, ISP system nodes and various providers. To maintain stronger security, a HyperText Transfer Protocol-GateWay (HTTP-GW) is placed outside the FireWall (FW) for authentication of external connections to prevent direct connections from the outside.

3.2 Hardware Configuration and Features

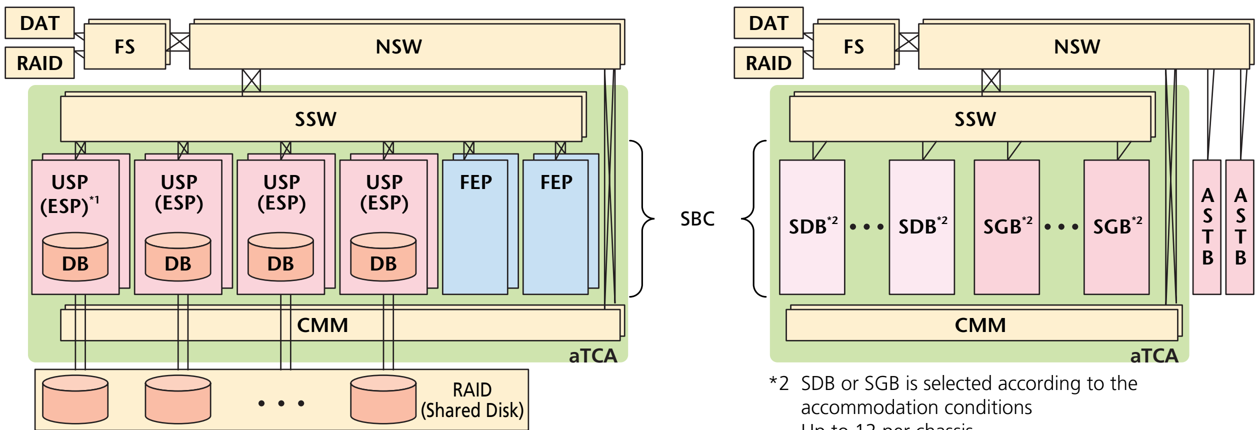
The IPSCP and SGW hardware configurations are shown in **Figure 3**. The basic hardware configuration comprises an File



CSCF: Call State Control Function

*LCS Client: Provider of the FOMA location information service current location notification function and location provision function

Figure 2 SUSCP, EBSCP and SGW network configuration



*1 For EBSCP, the blade name is ESP

(a) IPSCP hardware configuration

*2 SDB or SGB is selected according to the accommodation conditions
Up to 12 per chassis

(b) SGW hardware configuration

ASTB: ATM Signaling channel Terminations Box
DAT: Digital Audio Tape
RAID: Redundant Arrays of Inexpensive Disks

Figure 3 IPSCP and SGW hardware configurations

Server (FS), which is a server unit that mainly has data storage and maintenance interface functions, Single Board Computers (SBCs) that have call processing functions, a Shelf SWitch (SSW) for connections between SBCs, and a Node inside layer2 SWitch (NSW) for connections between the SBCs and the FS. In the IPSCP, the SBCs correspond to the User Service Processor (USP), External business Service Processor (ESP) and Front End Processor (FEP); in the SGW, they correspond to the Signal Domain agent Blade (SDB) and the Signaling Gateway Blade (SGB). A server group configured of an SBC, SSW and Chassis Management Module (CMM) adopts the aTCA standard described in Section 2.1. A feature of this server is that it is both smaller and configured of less hardware than a conventional switch, it has advantage of ease of securing the space required for installation and shortening installation time.

4. Features of the IPSCP and SGW

4.1 IPSCP Database Configuration

The features of the IPSCP database configuration (i.e., the differences from the NMSCP database configuration) are described below.

1) Integration of the M^{3}In Subscriber Data and the NMSCP Subscriber Data Profiles

Focusing on the future NMSCP function development, we choose a common profile that is capable of defining both the M^{3}In subscriber data and the NMSCP subscriber data.

2) Expansion of Numbering with Mobile Number Portability (MNP) Considered

To reduce hardware cost after introduction of the MNP, we made it possible to define 60 million numbers at the IPSCP. The number of subscribers accommodated, however, is one million, the same as for the NMSCP. The number of defined numbers and the number of subscribers accommodated for the IPSCP and the NMSCP are listed in **Table 1**.

The specific differences in database configuration for NMSCP and IPSCP are described below.

For the NMSCP, the number of subscribers accommodated and the number of numbers defined are the same. There is thus a one-to-one correspondence in management between the search management part and profile management part in the NMSCP database configuration, and profile search is done according to a number range.

The IPSCP database management method is shown in **Figure 4**. The IPSCP has 60 million defined numbers, so if the NMSCP database management method were applied without modification, the profile management part would also have to maintain memory space for 60 million numbers in surplus. Therefore, a variable area management scheme in which only profiles for contracted subscribers are kept in memory in the profile management part is used for the IPSCP, thus allowing

Table 1 Numbers of subscribers accommodated and numbers defined for IPSCP and NMSCP

	Number of subscribers accommodated	Number of numbers defined
IPSCP	1 million	60 million
NMSCP	1 million	1 million

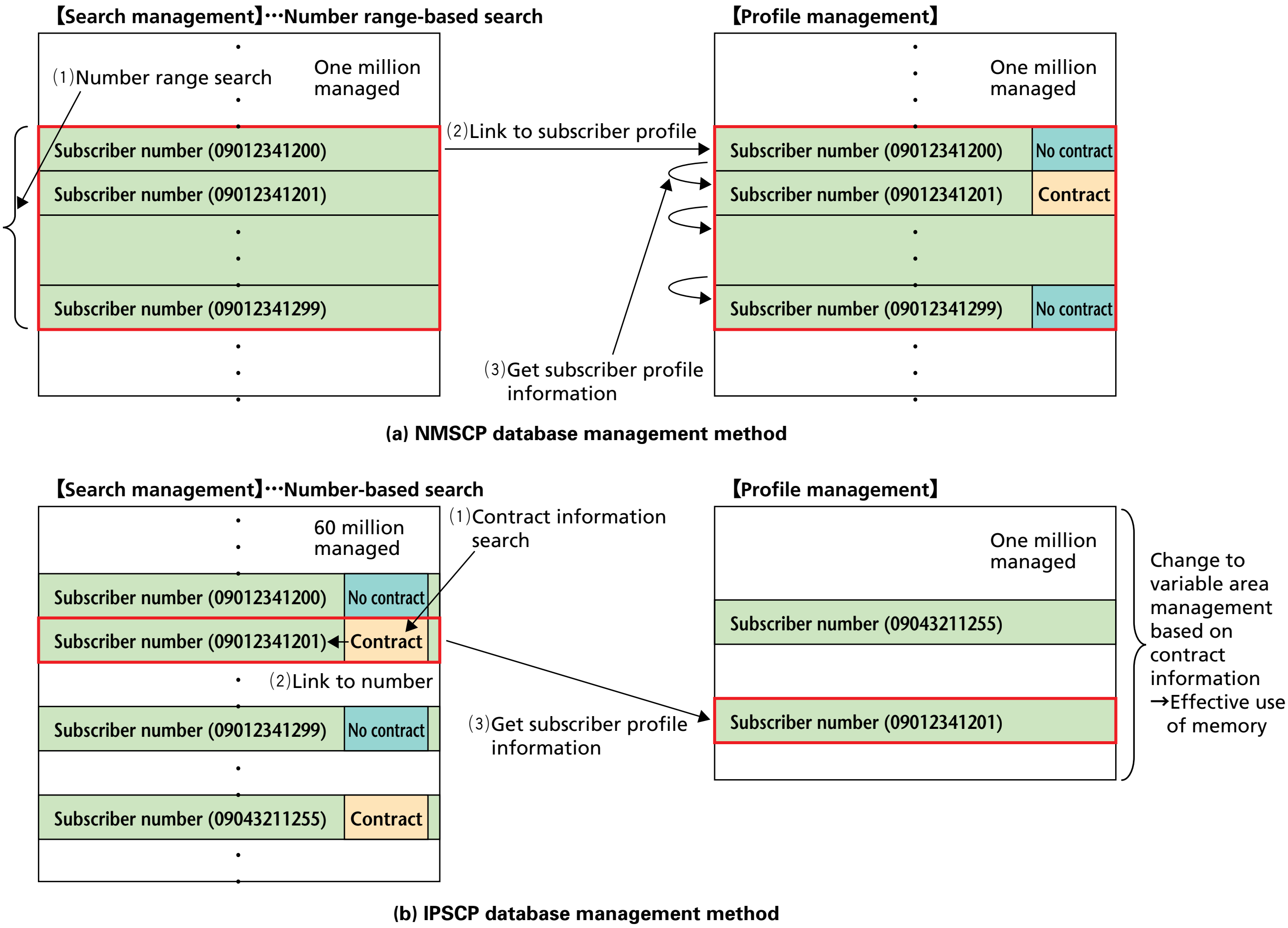


Figure 4 Database management methods of the NMSCP and IPSCP

efficient use of memory. Concerning profile search, using the NMSCP database management method of search by number-range would mean searching through a number-range of 60 million numbers, which would take some time. For that reason, the search method used in the IPSCP involves maintaining contract information for each number in a search management part, making it possible to search the contract information first and then link to the profile information by number to achieve high-speed database search.

4.2 IPSCP Software Configuration

The types of IPSCP hardware include the SUSCP and EBSCP, which have M^3In functions and IMS functions, and the IPSCP, which additionally has the NMSCP functions. The software for them, however, will be developed as in integrated file rather than individually developed programs. The IPSCP software configuration is shown in **Figure 5**.

Development as an integrated file allows common development of the basic maintenance functions (node data management function, traffic collection function, database management function, etc.) as well as some of the protocol functions. Re-use of function also reduces development cost. We are also re-using programs from the xGSN, which shares the same platform, and re-use of programs in new equipment to be developed in the future is also possible.

On the other hand, however, integrated file development brings the following concerns.

1) Memory inefficiency caused by program integration
2) The effects of problems on other programs that arise as program scale increases

The first of the above concerns is eliminated with a control that prevents programs that are not used at a particular node from being placed in memory at that node. The second concern is eliminated by partitioning the memory space allocated to the programs and not permitting programs to access the memory spaces allocated to other programs.

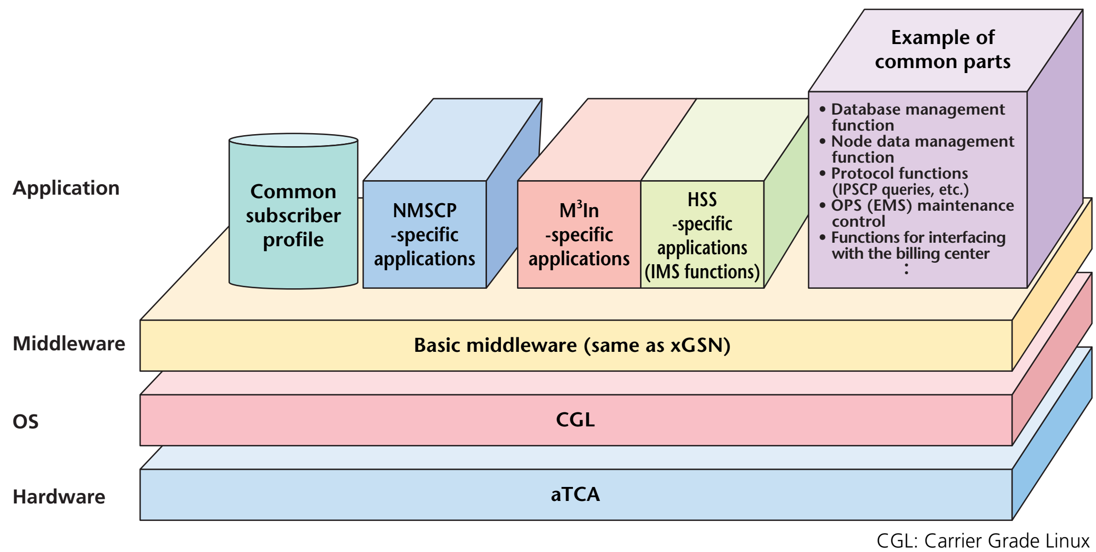
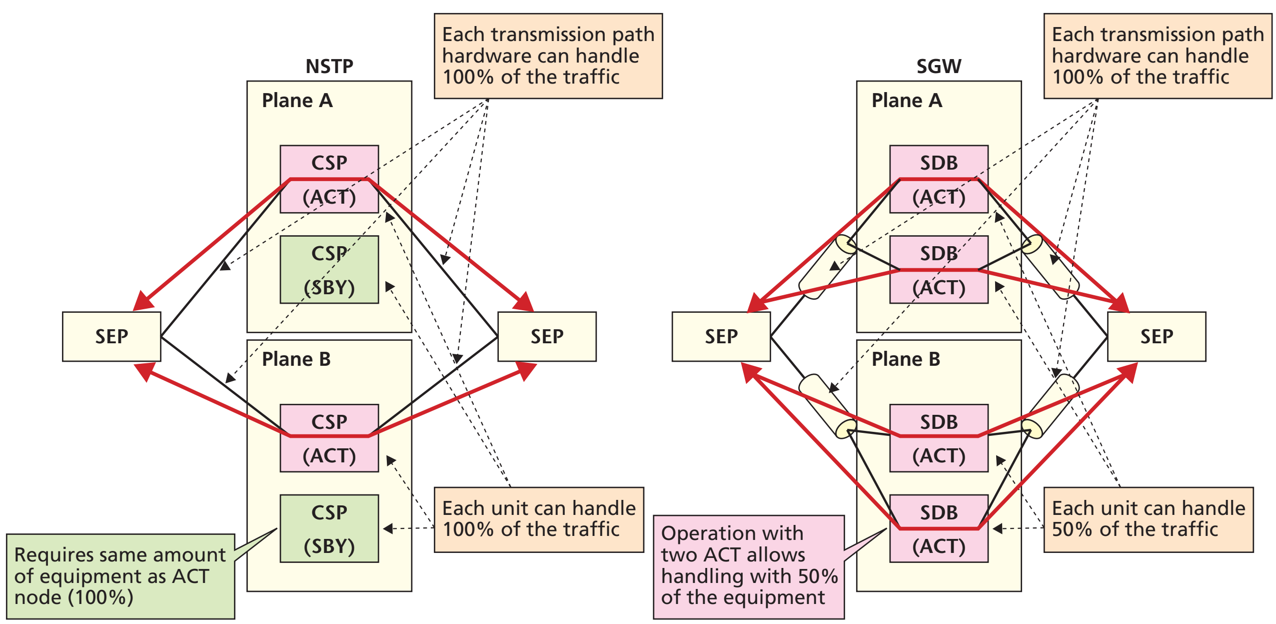


Figure 5 IPSCP software configuration



(a) NSTP hardware configuration

(b) SGW hardware configuration

Figure 6 NSTP and SGW transmission paths and configuration of the handling hardware

4.3 Redundant Configuration of SGW Handling Equipment and Hardware Configuration Method

Because there is a leased line in the connection between the Signaling End Point (SEP) and the NSTP, the number of links between hardware units is doubled and twice as many transmission paths must be provided. There is also duplication in the transmission paths and, as shown in **Figure 6**, an ACTive (ACT)/StandBY (SBY) configuration is used for the NSTP line handling equipment to maintain network reliability, so 400% line handling equipment is required in order to cope with 100% of the traffic with that configuration. This is because, in the No. 7 signaling network, when one of the planes A/B plane configuration is down, the other plane can perform at 100% capacity. However, the transmission path is only set in the line handling unit of the ACT. Nevertheless, even if the number of links between the same pair of nodes is doubled by conversion to IP, operation with a transmission path comprising the same amount of hardware is possible, and reliability can be maintained even when operating with an ACT/ACT configuration with half of the line handling hardware of the SGW. By applying this between the SEP and SGW, the hardware cost of the SGW line handling equipment can be reduced by half. Although the ACT/SBY configuration allows 100% communication with up to a triple failure of the line handling equipment, the ACT/ACT configuration (half as much hardware) allows 100% traffic only up to a double failure. In the event of a triple failure, 50% of the traffic can be handled, but the rate of occurrence for a triple line handling equipment failure is extremely small compared to other aspects of network reliability, so we chose to use the ACT/ACT configuration.

5. Conclusion

We have described the development of an IPSCP and a SGW for IP common channel signal network, which are positioned as advanced function service control points in the DoCoMo network. We have presented the background for the introduction of these systems and described the system configuration, the network configuration, and the effects of this development. These systems will give the core network speed and flexibility in coping with new services, lower costs, and promote the use of servers and routers.

In future work, we will expand the IPSCP basic functions developed in the work described here, complete the transition to the NMSCP functions and implement the provision of new services, MNP, etc.

References

[1] H. Morikawa et al.: "FOMA Core Network xGSN Packet Processing Nodes," NTT DoCoMo Technical Journal, Vol. 6, No. 3, pp. 33–42, Dec. 2004.

Abbreviations

ALADIN: ALl Around DoCoMo INformation systems
aTCA: advanced Telecom Computing Architecture
CCC-I: Calling rate Charge Center-IMT
CiRCUS: treasure Casket of i-mode service, high Reliability platform for CUStomer
CMM: Chassis Management Module
EBSCP: External Business user Service Control Point
EMS: Element Management System
ESP: External business Service Processor
FEP: Front End Processor
FS: File Server
FW: FireWall
HSS: Home Subscriber Server
HTTP-GW: HyperText Transfer Protocol-GateWay
IMS: IP Multimedia Subsystem
IP: Internet Protocol
IPSCP: IP Service Control Point
ISP: Internet Service Provider
M^3In: Mobile Multi-Media service Infrastructure
MNP: Mobile Number Portability
Mobills-PRM: MObile communication BILLing Systems-Partner Relationship Management system
NMSCP: New Mobile Service Control Point
NSTP: New Signaling Transfer Point
NSW: Node inside layer2 SWitch
PDC: Personal Digital Cellular
SBC: Single Board Computer
SDB: Signal Domain agent Blade
SEP: Signaling End Point
SGB: Signaling Gateway Blade
SGW: Signaling GateWay
SSW: Shelf SWitch
SUSCP: Specific User Service Control Point
USP: User Service Processor
xGSN: serving/gateway General packet radio service Support Node
WPCG: Wireless Protocol Conversion Gateway
XPCG: eXtended wireless Protocol Conversion Gateway