Network Technology to Support PC Communication Services

Yasushi Yamanaka†, Shuji Esaki, Akira Shibata, Shinya Takada, and Saburo Seto

Abstract

This article presents an overview of the network technology that supports the PC Communicator (PCC). It introduces several products of NTT's R&D efforts that provide carrier-grade dependability and functionality (SIP server, presence server, address resolution server, billing system, and service activation system) and describes the main elements of the network architecture for the PCC system.

1. Network architecture of the PCC system

An overview of the network architecture underlying the PC communicator (PCC) [1] is shown in **Fig. 1**. By linking various access networks such as Internet service provider (ISP) networks, mobile service provider networks, and the public switched telephone network (PSTN), the PCC system makes possible high-resolution, easy-to-use, affordable multipoint video communication possible. It creates video and audio connections between PCC clients using SIP (session initiation protocol) call control. It also enables communication between a PCC client and a mobile device (a FOMA terminal) through the mobile gateway (FOMA-GW), which connects to a mobile service provider's gateway exchange (called IWE (interworking equipment)) [2]. The PCC system includes several products of NTT's R&D efforts, which are described in the next section.

2. Network technology enabling interactive video and audio communication

2.1 SIP server "Type1-CA (SS)"

NTT has developed a SIP server with the name Type1-CA (SS) (CA means call agent and SS indicates this is a type-1 call agent for a SIP server). It uses SIP to manage the call state and integrates the location server and registrar using a proxy server for connection control. Because the SIP server complies with SIP protocols defined in RFCs (requests for comments) published by the IETF (Internet Engineering Task Force), it can interconnect with other compliant SIP servers.

This SIP server supports a keepalive mechanism that complies with draft-ietf-sip-session-timer-08: if no new session traffic arrives before the session expiry time, then the session is automatically considered to have timed out. This mechanism reduces billing mistakes and clears the session state.

The SIP server was designed to meet the severe requirements of telecommunication carriers for high dependability and functionality. Service availability is increased through clustering, and a failover function protects existing calls from interruption when equipment fails. Furthermore, the SIP server contains unique features including connectivity to mobile devices and functionality to counter DoS (denial of service) attacks. When a video connection is made between a PCC client and a mobile device, mobile connectivity to the mobile service provider's network is made possible by a connection from the SIP server to the user network interface (UNI) via FOMA-GW. Countermeasures against DoS-attacks include functions that block packets coming from a certain IP address if the number of packets from that address exceeds a predefined value in a certain time period, which minimizes the disruptive effect on legitimate

† NTT Service Integration Laboratories
Musashino-shi, 180-8585 Japan
E-mail: yamanaka.yasushi@lab.ntt.co.jp

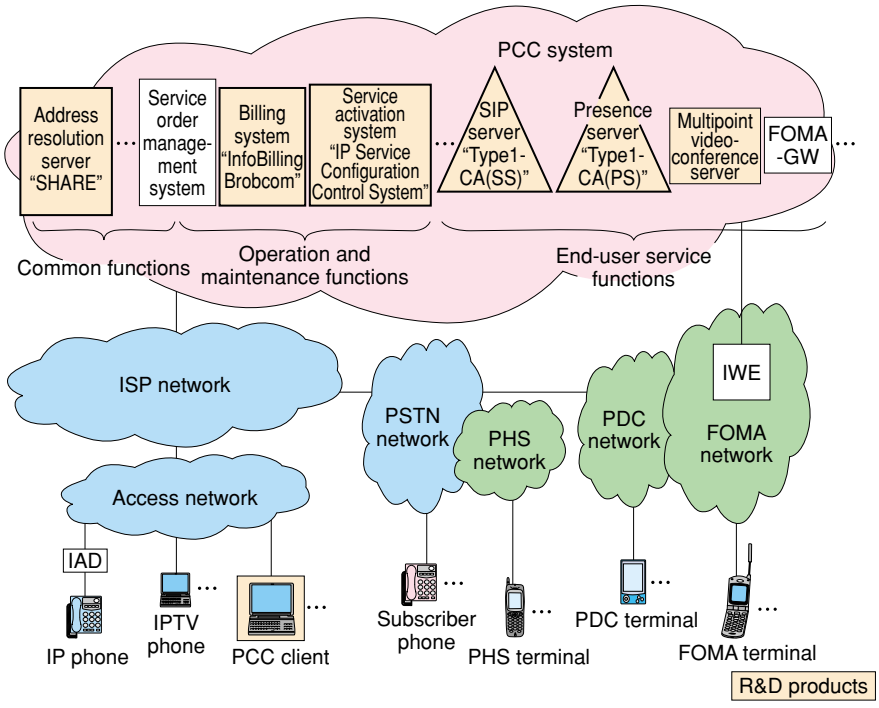

Fig. 1. Overview of network architecture.

calls. Legitimate server IP addresses are registered on a white-list so that they are not mistakenly judged to be sources of DoS attacks.

2.2 Presence server "Type1-CA (PS)"

The presence server Type1-CA (PS) uses SIMPLE (SIP for instant messaging and presence leveraging extensions) and, through the deployment of service control providing presence and messaging service, furnishes the location server and registrar functions. Like the SIP server, the presence server complies with relevant SIP RFCs published by the IETF. Furthermore, it controls the access of requests for presence information by providing functions for permitting or denying the sharing of a certain user's presence information (called "presentity") to a watcher (a user referring to another user's presence state).

Like the SIP server, the presence server meets the demanding dependability and functional requirements of telecom carriers. Its clustered architecture provides it with a failover mechanism to minimize service interruption time when equipment fails. Furthermore, this server is equipped with NTT-developed functions for countering DoS attacks and providing tenant functions (a tenant might be a company, for example). The DoS attack countermeasures are the same as explained above for SS. The tenant function administers the presence server's resources for each user group and achieves independence for presence and messaging for each user group by defining a group communication policy.

2.3 Address resolution server "SHARE"

An overview of the address resolution method used by PCC is given in **Fig. 2**. PCC uses SHARE (secure and high-performance address resolver), a high-performance, carrier-grade DNS (domain name system) server developed by NTT, to provide secure and reliable address information. For security purposes, SHARE can finely control the disclosure of address information using its "user view access control" function. Furthermore, from the initial design stage, priority has been placed on creating a high level of security to guard against existing security threats such as cache poisoning[*1].

SHARE's high performance is achieved by using semantic division index technology[*2], which can achieve many times (or many tens of times) the throughput of BIND9, which is widely deployed as a

*1 Cache poisoning: A service attack that overwrites DNS server entries and causes the server to return bogus IP address information to the querying client.

*2 Semantic division index technology: This technology indexes the address space based on the semantic structure of domain names and telephone number, etc.

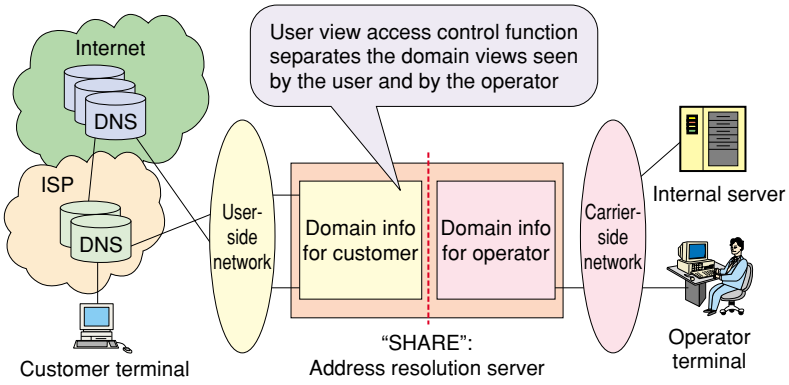

Fig. 2. Overview of address resolution server "SHARE".

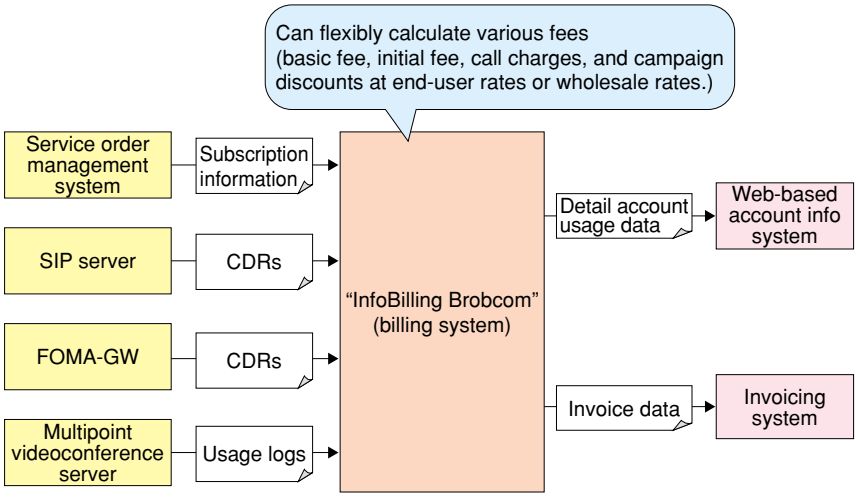

Fig. 3. Overview of "InfoBilling Brobcom" billing system.

DNS server, assuming equivalent hardware and software conditions. Even if the number of domains administered in one zone is increased to one million entries, there is almost no degradation in performance as the authoritative server for zone information.

SHARE supports IPv6[*3], ENUM[*4], and ONS[*5] and it can be installed in a low-end Unix server to maximize cost performance.

2.4 Billing system "InfoBilling Brobcom"

As the billing system in the PCC system, InfoBilling Brobcom [3], which was originally developed for VoIP and data services, is applied to calculate fees for the video and audio communication service and generate data for invoicing and about customer usage (**Fig. 3**). It regularly collects call detail records (CDRs) output by the SIP server and FOMA-GW and the logs generated by the multipoint videoconference server. It calculates usage charges based on CDRs, logs, and users' subscription information, which is acquired from the service order management system. Types of charges that are calculated include monthly basic fees, initial fees, and call charges.

By determining the type of service being provided based on an analysis of the CDRs and logs for each call, InfoBilling Brobcom can calculate a wide variety of calling rates for the various interactive video and audio communication services. It also supports the calculation of discounts for various campaigns, which is important for marketing strategies. Furthermore, it can calculate two types of rates: end-user

*3 IPv6: Internet protocol version 6.
*4 ENUM (telephone number mapping): A mechanism for providing support for telephone numbers by Internet services.
*5 ONS (object name service): A method for managing the electronic product code used by RFID (radio frequency identification) tags and the server associated with those IDs.

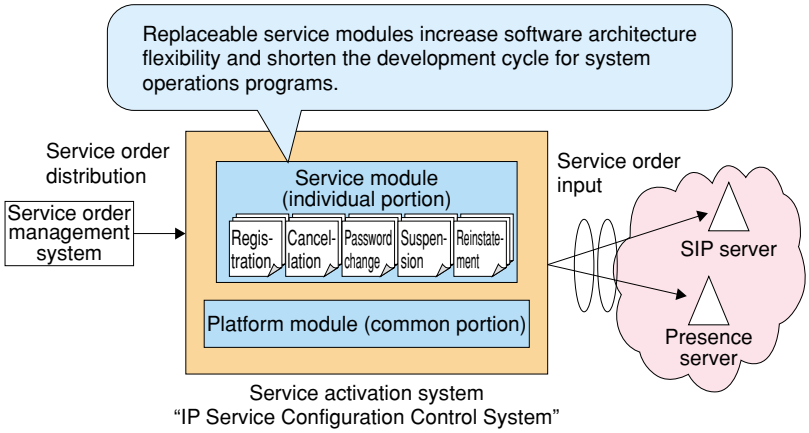

Fig. 4. Overview of service activation system "IP Service Configuration Control System".

retail rates and wholesale rates. Retail rates are the rates that an ISP charges directly to end-users, while wholesale rates are the rates that a service wholesaler charges to ISPs. InfoBilling Brobcom can set different rates for each ISP, and it supports flexible expansion of the number of ISPs supported by a service wholesaler. Billing data can be converted into the various formats required by ISPs' invoicing systems including their Web-based account information systems.

In this way, InfoBilling Brobcom flexibly supports the wide variety of rate calculations necessary for offering wholesale services.

2.5 Service activation system "IP Service Configuration Control System"

The "IP Service Configuration Control System" for interactive video and audio communication supports service order configurations for both the SIP and presence servers. Various flow-through improvements have been achieved for system operations input to both servers such as improvements in the work flow for handling subscriber registration, password changes, subscription cancellation, suspension, or reinstatement, and video option changes. The functions required by the service activation system vary greatly depending on the provided services, types of nodes, network environment, and operators' know-how level. Manually coding such specialized functional requirements into software would be very difficult and would increase the amount of time needed to introduce new services. With this in mind, the IP Service Configuration Control System was designed with an architecture based on separating the platform and service layers and separating the various services into distinct service modules (**Fig. 4**). This design enables new services to be introduced simply by replacing a service module.

3. Plans for the future

PCC is a service system for both point-to-point and multipoint audio and video communication. As there is a demand for this type of communication in the business world, our efforts will focus on strengthening our suite of products for the business market and expanding the offering to include network services including forwarding services. For SHARE, we plan to introduce a high-performance service for ENUM/RFID and further strengthen its security including providing countermeasures against DDoS (distributed DoS) attacks. For the billing system, we plan to further expand the number of patterns for rate calculation including patterns to support calls originating from mobile phones in order to support the FOMA-GW interface connection between networks (network-to-network interface (NNI) connection) and patterns to support charging based on the number of calls. The IP service configuration control system currently allows service order entry only in batches. We plan to add support for realtime service order entry, which should expand the number of applications where PCC can be used.

References

[1] T. Murakami, S. Hayama, T. Yoshida, and S. Ishibashi, "Video Communication Technology for Resonant Communication, "NTT Techni-

cal Review, Vol. 3, No. 10, pp. 12-17, 2005.
[2] H. Takeda, D. Ando, S. Sakauchi, S. Onishi, and H. Jozawa "Functions of PC Communicator: PC-to-FOMA IP Videophone Technology," "NTT Technical Review, Vol. 3, No. 10, pp. 18-24, 2005.
[3] T. Sato, K. Kanishima, S. Takada, and M. Hanaki, "Billing/Settlement Platform "InfoBilling BrobCom" for VoIP and Data Services," NTT Technical Review, Vol. 1, No. 1, pp. 73-77, 2003.

Yasushi Yamanaka
Senior Research Engineer, Supervisor, NTT Service Integration Laboratories.
He received the B.E. and M.E. degrees in engineering from Kyushu University, Fukuoka in 1981 and 1983, respectively. He joined Yokosuka Electrical Communication Laboratories, Nippon Telegraph and Telephone Public Corporation (now NTT) in 1983. He has been engaged in R&D of subscriber transmission systems and telecommunication management systems. Currently, he is working on the verification of IP video communication systems and SIP interoperability testing for the next-generation network. He is a member of the Institute of Electronics, Information and Communication Engineers (IEICE).

Shuji Esaki
Senior Manager, Network Development Division, Service Development Department, NTT Resonant, Inc.
He received the B.E. and M.E. degrees in engineering from Osaka University, Osaka in 1984 and 1986 respectively. Since joining NTT in 1986, he has engaged in R&D of the intelligent network. From 1999 to 2002, he worked on the development of the commercial IP network service systems in NTT West corporation. After returning to NTT in 2002, he worked on developmental research on the multimedia communication service systems. He moved to NTT Resonant Inc. in 2004 and is active in IP communication systems including VoIP. He is a member of IEEE, IEICE, and the Information Processing Society of Japan.

Akira Shibata
Senior Research Engineer, Communication Platform SE Project, NTT Information Sharing Platform Laboratories.
He received the B.E. and M.E. degrees in electrical engineering from Waseda University, Tokyo in 1991 and 1993, respectively. In 1993, he joined NTT Communication Switching Laboratories, Tokyo. Since then, he has been engaged in R&D of intelligent network systems, IP network service systems and next-generation network service systems. He is currently engaged in R&D of secure and high-performance DNS systems. He is a member of IEICE.

Shinya Takada
Research Engineer, Network Application Platform Project, NTT Information Sharing Platform Laboratories.
He received the B.S. and M.S. degrees in physics from University of Tokyo, Tokyo in 1996 and 1998, respectively. In 1998, he joined NTT Software Laboratories, Tokyo. His current research area is billing-related systems, especially usage-related aspects.

Saburo Seto
Engineer, Network Management Development Project, Second Promotion Project, NTT Network Service Systems Laboratories.
He received the B.S. and M.S. degrees in information science from the University of Tokyo, Tokyo in 1996 and 1998, respectively. In 1998, he joined NTT Network Service Systems Laboratories, Tokyo. Since then, he has been engaged in developing operation support systems.