

R&D Spirits

IP Network Technologies for the Ubiquitous Era

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The Emerging Communication Architecture Project of NTT Network Service Systems Laboratories has been promoting research in IP network platform technologies with a view toward the ubiquitous era for the past several years. Now that IPv6 is about to become a standard protocol, we spoke to Project Manager Kouichi Seino about the types of services that will become available and where this field is heading in the near future.

Pursuing three platform technologies supporting networks in the IPv6 era

Editor: Please tell us the theme of your current research and give us a brief overview.

Seino: Our project focuses on three main themes: “IP Nomadic,” “Peer-to-Peer (P2P),” and a software platform known as “Softswitches.” Let me explain each of them briefly. IP Nomadic is an IP service that provides seamless and secure personal communication environments from a wide range of locations. We are currently researching network platforms for these services, including mobile IP technologies, seamless access management technologies, and nomadic presence technologies, and we are also developing systems based on these technologies (Fig. 1).

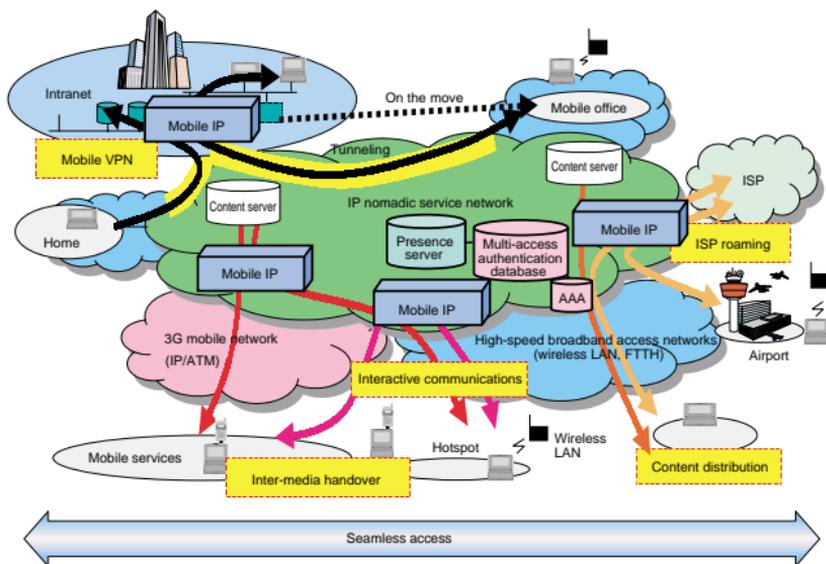
P2P is a new style of using the Internet that shares information and knowledge in real time between terminals and devices participating on the Internet, enabling collaboration in a given task by several “peers.” Conventional telephones have a centralized system in which switching equipment relays calls, but the premise of P2P is that an “equal and smooth relationship” is formed among devices. We are working on developing the mechanisms for these relationships (Fig. 2).

Softswitches are network controllers that achieve a variety of IP services. They control media gateways

and terminate different types of communication protocols, thus enabling call control, session control, and the control of various types of network functions. We have also incorporated standardized technologies and will provide application programming interfaces (APIs) such as Parlay and JAIN. We are also participating in activities concerning the standardization of these interfaces (Fig. 3).

E: What are the main technological points to this research?

S: Each of these three themes involves unique technologies. For the mobile IP technologies in IP Nomadic, we have been conducting research on the practical application of mobile IPv6 agents on a scale of up to 100,000 users in preparation for standardization. Route optimization technology for carrier networks is another area where NTT is offering proposals on a global scale. In terms of seamless access management technologies, we are developing authentication technologies that will enable the user to freely select access methods. In nomadic presence technologies, we are developing functions that have never been available before, for example, functions for obtaining and managing positional information and regional information from network devices, as well as terminal information acquisition and management functions.



VPN: Virtual Private Network
 AAA: Authentication, Authorization, and Accounting
 ISP: Internet Service Provider

Fig. 1. Outline of IP Nomadic service.

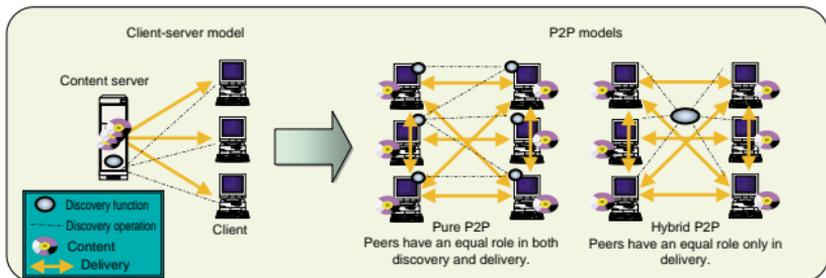


Fig. 2. Characteristics of P2P technologies.

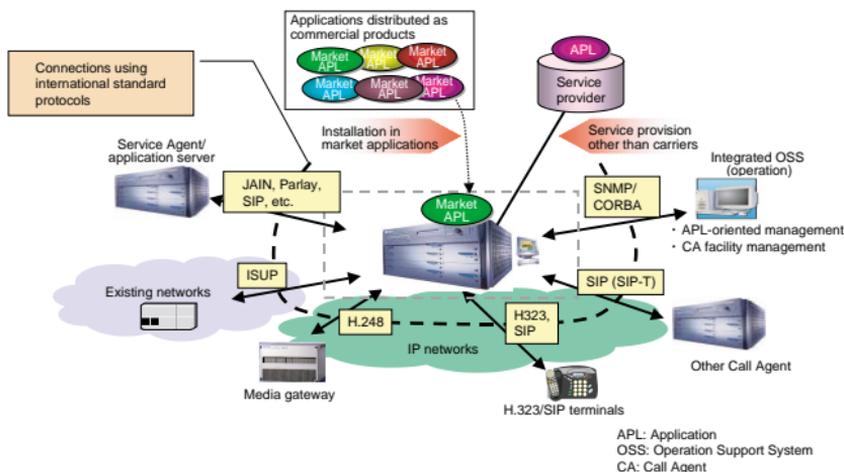


Fig. 3. Overview of Softswitch.

In P2P, we are working to resolve problems currently being faced, such as the large amount and concentration of management, by distributing content management, storage, and processing capacity among peers.

In Softswitches, we are working on technologies for separating transport networks from service control functions to achieve greater economy and independent development of networks. At the same time, we are promoting the development of related technologies to enable signal processing and greater reliability through software, as well as call control protocol processing in conformance with IP networks.

From visions to reality: toward Resonant Communication

E: Where will these new technologies be used?

S: Stated very simply, these technologies will be used to achieve "Resonant Communication," which is NTT's vision for the ubiquitous era. For example, the application of mobile IP in public networks will enable continuous communication across a variety of networks. Seamless access management technologies will be used in authentication to accommodate multiple accesses, and nomadic presence will be used for

real-time location management while the user is on the move, thus enabling services to be provided in a variety of locations in keeping with the user's requirements.

The field where P2P has been attracting attention recently is Grid computing. Here, massive computations, such as the analysis of genetic information, are distributed among PCs throughout the world to enable performance exceeding even that of supercomputers. P2P is used for a series of mechanisms in which the circumstances of individual PCs (peers) are matched in real time and programs are loaded onto available PCs.

The most common area where Softswitches are used is in VoIP (voice over Internet protocol), but they will have a wide range of other applications as keys for interactive multimedia communications. There are still a number of issues related to the development of VoIP services, but we are moving ahead with our technical investigations to cope with them.

E: What form do you think these technologies will take in the next three to five years?

S: We expect that the specifications for mobile IPv6 will probably be fixed by the end of this year. When that happens, all vendors will most likely begin devel-

oping commercial products. For the time being, IPv4 and IPv6 may well be mixed together. In a few years, mobile IP will become an integral part of public, corporate, and household networks. Mobile routers will be installed in trains and automobiles, opening the way to applications in ITS (Intelligent Transport Systems) as well. Then, as home information appliances become more popular, PDAs and other personal mobile terminals will handle all mobile control as a kind of mobile router, eventually evolving into "personal area networks."

Recently, illegal copying has been a major black mark against P2P, but copyright management and other security technologies are expected to become available for general use very soon. In the future, we will see the formation of network communities that cooperate, combine, and divide, reflecting each member's sense of values; in these communities, individual terminals will play a leading role. That is, these communities will form spontaneously and multiply.

Regarding Softswitches, it's hard to imagine any major changes in architecture. Platform-independent trends will continue to strengthen as an extension of current developments. However, I think some variations will arise with the proliferation of VoIP and SIP (Session Initiation Protocol). That is to say, we will see demands for greater reliability as these networks become social lifelines, trends toward cost reduction when switches become specialized for use in SIP signaling, and the enrichment of added service functions like class 5 switching. Another possibility is that these elements will all be integrated into a new form of service.

E: What are the directions for research in the future?

S: We will strive to achieve more advanced ubiquitous environments. For example, right now, mobile communications takes place only on the level of individual terminals, but in the future, we may see cases in which entire community networks move. Taking this type of development into account, mobile IP technologies will have to evolve even further. Specifically, we are planning to promote research and development in layered mobile IP technologies in which mobile management is carried out on global and local layers, and in applications targeting public access to ad hoc networks. We will move ahead with research focusing on the development of IP Nomadic for personal area networks in combination with home information appliances, to achieve more personal, highly convenient communication services, and will

also consider incorporating sensor network technologies with IP Nomadic technologies. In any case, we will carry out our research and development activities based on NTT's vision as a carrier with close attention to user needs.

Leading the world with original technologies and making major contributions to standardization

E: Tell us about the international and domestic trends in this research.

S: Regarding IP Nomadic, Hotspot™ services appeared on the scene a few years ago, using high-speed wireless LANs. And as you may know, NTT currently leads the world in the field of third-generation mobile phones. The next stage will probably focus on the development of services using mobile management on the IP level, but since mobile IPv6 has not yet been completely standardized, commercial products have not appeared in full force. We are the first in the world to begin research and development in this area.

In P2P, the highest profile activities are being undertaken by Sun Microsystems, which is distributing its JXTA architecture free of charge, and Microsoft, which is advocating P2P networking on its .NET™. We at NTT have also developed a P2P platform called SIONet, which offers links to digital rights management. The key to P2P is letting the user easily obtain the desired information from among the huge volume available, so research on efficient search algorithms is advocated. We are promoting efficient searching technologies using "distributed hash tables (DHTs^{*1})," such as CAN, Chord, and Freenet, and of course we are working on our own evaluations and further studies as well.

Regarding trends in Softswitches, SIP has shown great potential for some time now, and its use has spread rapidly since Microsoft adopted it in Messenger. Aside from Microsoft, venture companies have been very active in the field of SIP servers. Nevertheless, core VoIP systems are gradually being narrowed down, mainly to the major switching device vendors.

E: What types of activities are being undertaken by international agencies and commissions?

^{*1} The locations of the values are registered in places (PCs or peers) determined by a hash function, and the values can be referenced rapidly.

S: NTT announced the IP Nomadic concept at WTC/ISS2002 as the main technology for making this a reality. We have also proposed mobile IP route optimization technologies to the IETF (Internet Engineering Task Force) as an Internet draft, and in both cases we have received excellent responses. We feel that disseminating information about the development of terminals and supporting mobile IP technologies will be essential to promote the proliferation of IP Nomadic services. Establishing a global mobile IP roaming environment will also be indispensable. We are thus promoting individual collaboration with influential terminal software vendors and undertaking activities with various industries in an open forum. The Certification Working Group—an assembly geared toward the advancement and proliferation of IPv6—is a perfect example; in this Group, as the leader of the mobile IP-SWG, NTT has been a driving force behind the creation of standard installation specifications and other activities. Regarding P2P, NTT is also a member of the Global Grid Forum (GGF), into which the former P2P Working Group was merged. As for Softswitches, we participate in the MSF (Multiservice Switching Forum) and Parlay's interconnectivity events, and also offer proposals for application programming interfaces.

E: How do you think NTT is regarded from outside of Japan?

S: NTT has many leading technologies in this field, and attracts considerable attention even on an international scale. We are recognized as world leaders in many technical areas and known for our active participation in scientific conferences and standardization forums. For example, the Certification Working Group is expected to play a central role in Logo Committee activities at the recent IPv6 Forum, and we feel that our activities have been very well received there as well. As a result, we have received many requests for meetings to exchange ideas and opinions. Given the evolution of new technologies, corporate competition, and other conditions currently facing the industry, we are very much aware that the eyes of the world are upon us.

Being trend-setters in our own field and creating new innovations

E: What types of research themes have you been involved in up to now?

S: My original field of specialization was mathematics, and in graduate school I was working on approximate analysis in Banach space using function theory. The reason I came to NTT was that I wanted to contribute to society through research that would be useful in real-life situations. NTT covers a wide range of activities, from fundamental research to applied research, so I felt that I would have many opportunities to do something useful. For a long time after I entered the company, I was working on research targeting practical applications of large-scale network software in new node systems—that is, in the switching segments that form the basis of communication systems. There are many different types of switching system technologies, but my work focused mainly on circuit switching, packet switching, and ATM switching. The technologies used in the Internet are a combination of packet and ATM switching. I was very lucky to be able to work for so many years on technologies that are being put to use now.

E: What are your aspirations as a researcher?

S: The thing that has been on my mind most recently is that I want to be able to handle change well. The world is changing every moment, and we must be able to adapt to those changes flexibly. As researchers, though, there's no reward in just chasing after changes all the time. We always feel that we want to put something into the field in which we are working. To do that, of course, we must also work at getting our vision accepted at scientific conferences and seminars, but if the result is that the technologies we have developed actually change people's lives, we are really motivated. My greatest hope is to be able to create innovations in the future—like those brought about by the mobile phone—and to contribute to society in the process.

E: How do you see the NTT Laboratories?

S: To me, NTT is like a bottomless treasure chest of research opportunities. Even more, though, it's a place where I can find many outstanding researchers in a wide range of fields. Participating in discussions with many different specialists, there's always something new to learn, and because I can maintain a broad perspective in this way, it's relatively easy to keep myself on track in my own research. In research, you sometimes have to take detours, but if you don't stay focused on your own field, then you run the risk

of getting off track and not finding your way back. Working at NTT has allowed me to come as far as I have, even though I've made detours along the way. The most important thing is to take advantage of this great research environment, maintain a positive attitude, and just keep moving ahead steadily, one step at a time.

Interviewee profile**Career highlights**

1980 Graduated from Waseda University, Graduate School of Science and Engineering (Masters Program); entered NTT Public Corp. (now NTT Corp.)
Worked on DDX packet switching and circuit switching systems and research targeting practical applications of DDX operation systems. From 1991, worked on research targeting practical applications of ATM switching systems.
Currently engaged in research targeting practical applications of mobile IP, P2P, and Softswitches.

Major awards

1994	NTT President's Award
1995	Laboratory Director's Award
1996	Laboratory Director's Award
1999	NTT President's Award