R&D Spirits

Development of Next-generation IP Network Design Tools Using Novel User Interfaces

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The Research and Development Department of NTT Comware Corporation has developed visual and intuitive support tools for designing IP networks in collaboration with the MIT Media Laboratory. This system, which features the use of a "tangible user interface" (TUI), aims to simplify the complicated and time-consuming task of network design and has the potential to stimulate innovation in fields other than communications. We asked Atsunobu Narita, Manager of the Research and Development Department at NTT Comware (http://www.nttcom.co.jp/english/), to describe this revolutionary system to us and explain its outlook for the future.

Making network simulation easier to perform and understand

—Mr. Narita, please tell us something about your current R&D efforts.

We are working on the development of a system called the Tangible IP Network Designer in collaboration with the MIT Media Laboratory to support the design, operation, and management of IP networks. This system features a tangible user interface (TUI) as proposed by Professor Hiroshi Ishii of the MIT Media Laboratory. The TUI can be regarded as an evolutionary form of the user interface coming after the character user interface (CUI) and graphical user interface (GUI). As opposed to indirect operations using a keyboard or mouse, the TUI promotes intuitive operations by giving meaning to certain objects and allowing the user to manipulate those objects directly.

The Tangible IP Network Designer actually consists of three systems supporting consulting, detailed design, and network operation and monitoring. Let me give you a brief description of each. First, the consulting support system enables a user to perform real-time simulation of network behavior by moving physical pucks on a TUI device called the "Sensetable" in a game-like manner (**Fig. 1**). Second, the detailed-design support system enables the user to set detailed parameters for real-world simulations using freehand, intuitive devices like an LCD tablet or Anoto pen* (**Fig. 2**). And third, the operation-and-monitoring support system provides a network-monitoring function that can display simulation results in real time using 3D animation and a naked-eye stereoscopic display (**Fig. 3**). In other words, the Tangible IP Network Designer enables the user to obtain an intuitive understanding of a network, which is something that is not visible to the human eye.

—How will this system change the network design process?

By promoting an intuitive understanding of a network, this system can speed up the decision-making process in network design and deployment and make for more efficient network design. It can also be used to make easy-to-understand and persuasive proposals to customers by presenting plans that are intuitively clear even to customers with no technical background.

* Anoto pen: Input technology using a pen and paper developed in Sweden. http://www.anoto.com/

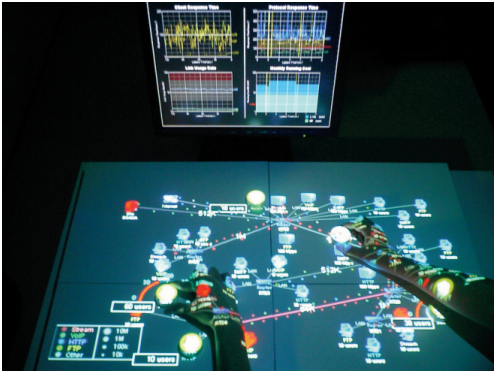

Fig. 1. Consulting support system.

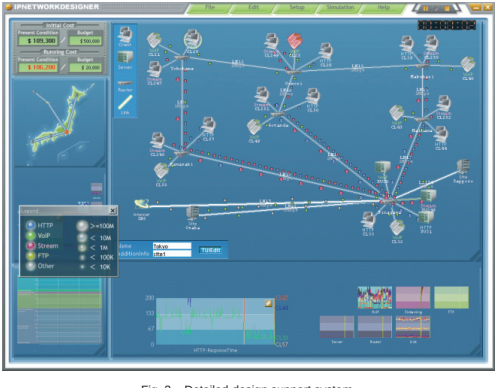

Fig. 2. Detailed-design support system.

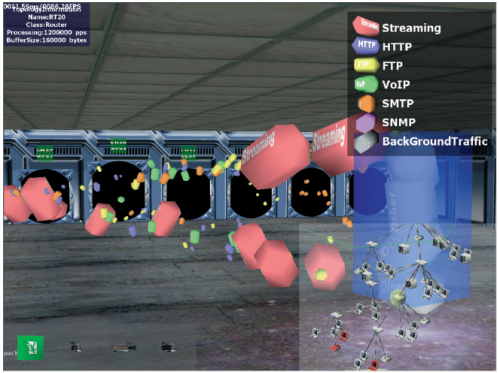

Fig. 3. Operation-and-monitoring support system.

From the beginning, certain aspects of IP network design have depended on an engineer's experience and instinct, and the reality is that problems are often not understood until after starting network operation. Why is this? Well, the reason is that certain features like quality and data transmission rate are not sufficiently evaluated beforehand at the design stage. But in prior evaluation, by which I mean simulation, a key issue is how to simplify the simulation of networks that are becoming ever more complicated with the merging of telephone and IP networks. The 3D stereoscopic displays (which do not require users to wear special glasses) and realtime rendering using a PC grid can provide network designers with an intuitive, three-dimensional understanding of network structure and how various types of packets move within the network (consisting of routers, links, etc.). This technology can also be applied to realtime management of IP networks especially for crisis control. For this reason, we consider customers outside NTT as well as the NTT Group itself to be important targets of the Tangible IP Network Designer. For example, this technology should be applicable to the resonant communication network architecture (RENA), which is part of NTT's HIKARI Vision now being pursued by the NTT Group.

Powerful tools for presentations and customer decision-making

—What were some of the technical issues that you faced in this development?

In the end, the biggest issue was incorporating various types of user interfaces including the TUI. We took on this challenge and developed several groundbreaking interfaces by combining advanced simulation technologies with extensive know-how that NTT Comware has acquired from years of designing and operating networks. Although existing technologies can simulate the behavior of huge and complex networks, setting and changing various parameters has been a formidable input problem, and it has also been difficult for non-specialists to readily understand simulation results output by the system. At the same time, realtime simulation functions enable a network designer to immediately determine the effects of changing parameters on network performance and cost and to efficiently find an optimal network configuration. I am sure that R&D to make network design more efficient is being pursued at a number of research sites, but the significance of our efforts is the adoption of this new TUI concept to enable an intu-

itive approach to network simulation and design. In addition, the application of 3D technology to the real-time management of IP networks enables users to trace IP packets within an IP network in an intuitive fashion, thereby simplifying analysis during network troubleshooting.

—How did your interest in TUI come about?

A network is a complex thing that often evades description, and how best to represent a network and make it easy to understand has been one of my ongoing research themes. This is why I developed an interest in the TUI proposed by Professor Ishii as a next-generation interface. As a result of this interest, I selected the development of a Tangible IP Network Designer as a joint research theme with MIT that would combine TUI technology with IP-network simulation technologies developed by NTT Comware. Our aim here is to support not only consulting work using a TUI but also detailed design using a LCD tablet or Anoto pen and operation and monitoring using 3D input/output technology. In short, we aim to develop an integrated combination of various types of user interfaces including the TUI called "Integrated UI Technology".

—What are the advantages of using a TUI?

The greatest advantage of a TUI is its collaborative capabilities. The Sensetable is an open user interface that enables about 20 pucks to be placed at one time on the table and several people to manipulate them simultaneously. For example, a user can intuitively understand whether a specified link is full or empty and can perform on-the-spot analysis such as "this circuit is full due to streaming—let's try another route." In addition, intuitive operations and easy-to-understand visual representations help to close the "awareness gap" between people with strong technical backgrounds and those without. This facilitates smooth discussions when making business presentations to management-level personnel. Another advantage is the realtime capabilities of a TUI. The Sensetable enables a user to instantly recognize what happens when network elements are changed in some way by moving pucks. The results of simulations on the Sensetable can also be portrayed by 3D animation, and a user can instantly switch from viewing one network location to another as needed. In addition to simulation, such 3D technology can be applied to realtime monitoring of actual networks.

Keeping up with user needs and developing new application fields

—Mr. Narita, could you describe international and domestic trends related to this R&D?

R&D projects focusing on TUI for real business are still few and far between even on a world-wide basis. In fact, I think we are the only group to associate TUI with network design. From here on, though, I think the TUI will be attracting more attention leading to more collaboration on an international level.

—What kind of response has your work received in Japan and overseas?

We have had several opportunities to demonstrate our Tangible IP Network Designer and have attracted interest from various areas. In particular, this system generated a huge response as a completely new approach at an MIT sponsors meeting held in October of last year and at the World Summit on the Information Society (WSIS) held last December in Geneva, Switzerland. The WSIS is a UN-sponsored event dealing with communication technologies that attracts visitors from around the world. One visitor from Japan was Taro Aso, the Minister for Public Management, Home Affairs, Posts and Telecommunications, who expressed considerable interest in the Tangible IP Network Designer, commenting that it was an extremely unique idea. The Tangible IP Network Designer was also written about last November in an article appearing in BusinessWeek, the American business periodical.

—What stage are you currently at in achieving a practical system?

Our efforts toward a practical, working system are progressing and we are approaching the product stage. At present, we are engaged in a number of discussions regarding deployment, and while I cannot go into detail, I can tell you that our talks with several customers including overseas telecommunication carriers are reaching an advanced stage. Furthermore, considering the urgent need to train network engineers in developing countries in the construction of network infrastructures, we are also holding discussions and performing studies on applying the intuitive properties of TUI and 3D input/output to the field of education and training.

—What direction do you see this development taking and what issues do you expect to encounter along the way?

One issue of prime concern is developing new applications. The technology that we have developed here is actually a form of middleware, and because NTT Comware's specialty is designing, operating, and maintaining telephone networks, this middleware took form as a network-design support application that we called Tangible IP Network Designer. Nevertheless, there is no reason why this middleware cannot be applied to other industries that have a need to present large-scale and complex simulations in an intuitive manner. As a matter of fact, the R&D department here at NTT Comware is now developing a business-processes consulting-support system using TUI. A prototype version of this system was presented at MIT sponsors meetings held in March and May of this year, attracting a lot of interest.

I also think that our technology could be applied to such disparate fields as traffic control, distribution, and military planning. And if we create a general platform for driving applications that use Sensetable, it should be possible to apply TUI to a variety of fields in a flexible and quick way. These developments open up the possibility of further business expansion for NTT Comware.

Another important topic for study here is a platform that can construct optimal user interfaces for an application by combining advanced user interfaces including TUI, 3D, and Anoto technologies. We refer to the technology behind this platform as "Integrated UI" technology, which we expect to be useful in building all kinds of systems.

Toward R&D that strikes a balance between theory and reality

—Mr. Narita, please tell us something about your research and work history.

Well, I entered NTT in 1992 and worked on developing operations systems for the telephone network until 1997. Then, in 1998, I was transferred to the U.S. office of NTT Communicationware (now NTT Comware) where I surveyed trends in the operations support system (OSS) of the telephone network in US and studied and supported its introduction in Japan. After three and a half years of this work, I returned to Japan in 2002 and soon became involved in joint research with MIT as well as the Telecommunication Standardization Sector of the International Telecommunication Union (ITU-T) activities, which brings me to the present.

—Are you involved in international activities such as academic societies?

Yes, I have presented a paper at the Computer-Human Interaction (CHI) conference and have participated in the Next Generation Networks (NGN) project in ITU-T. In relation to NGN, the appearance of VoIP and other new technologies is requiring telecommunication carriers to make new investments, but they have unfortunately lapsed into a business phase in which profits are decreasing. Under these conditions, I think it is very important to consider how to construct new networks and how to provide diverse and sophisticated applications to run on those networks. The next-generation network is currently one of the hottest topics at ITU-T.

The NGN is a packet-based, multi-service platform in a ubiquitous, broadband environment providing services independent of access method and media type for all types of users. A wide variety of players will be needed to promote NGN including telecommunication carriers, service providers, hardware/software vendors, and users. And because next-generation networks will extend across national borders, standardization at the international level will be essential. At present, various standardization bodies are expanding NGN-promotion activities. In ITU-T, for example, the "NGN 2004 Project" is progressing with the aim of completing initial documents by the end of 2004 within Study Group 11, Study Group 13, and Special Study Group. The work of collecting NGN architecture requirements is being performed, in particular, by SG11, which has adopted a document submitted by our R&D department as a baseline document for NGN basic architecture. In fact, our department has become the editor of this document, and we are currently revising this document with the aim of finalizing by the end of 2004.

—What have you been aiming for in your R&D life up to now?

Well, I can say that I am currently aiming for the creation and realization of an NGN vision that I was just talking about. Making the transition from the existing telephone network to an NGN featuring packet-based, integrated networks will enable all kinds of media including voice, video, and broadcasts

to be transmitted in real time. This capability, in turn, will bring forth diverse applications in rapid succession far beyond what is possible at present. Here, it must be possible for new communication technologies like wireless technologies and RFID to be easily incorporated into NGN as elemental technologies. In this regard, I would like to create an NGN platform that can handle such diverse technology elements and applications in an integrated manner and combine various service elements at the same time. Such a platform will enable a carrier to quickly provide original services by simply selecting and incorporating only those technology elements that are needed. The Tangible IP Network Designer that we are currently working on is a network management system geared toward NGN.

The ideas behind NGN have a lot in common with the RENA concept, especially the need for supporting broadband applications, ensuring communications quality, and achieving more intuitive, advanced interface technologies. I believe that the NGN technologies now being studied at ITU-T can also be applied to RENA and that the establishment of more integrated technologies is possible.

—From your point of view, what are some good points of NTT Comware?

As a member of the NTT Group, NTT Comware has long been involved in the operation of Japan's telephone network and in the development, operation, and maintenance of switches. The company's major strength lies in the mechanism and know-how behind its total handling of such a large and complex network system. In this sense, NTT Comware has an excellent foundation for advancing studies of architecture design and signal systems for NGN. These studies will target, for example, technology for migrating the Internet from the existing telephone network to a next-generation network and provisions for migrating to network operation technology. Both of these are company strong points that I think should also be utilized for future NTT Comware business.

—Could you comment on NTT or NTT Laboratories for us?

When participating in ITU-T activities, we always act in step with NTT Laboratories and the NTT Group. For example, we hold regular meetings with NTT Network Service Systems Laboratories and NTT Service Integration Laboratories to exchange information on NGN design and standardization. We also agree on a common direction and generally interact with each other quite well. In the future, I would like to capitalize on NTT Comware's strengths and promote various types of collaboration with NTT Laboratories and the companies in the NTT Group toward the realization of NGN. I have a strong desire to cooperate with the hope of stimulating a quantum leap in the NTT Group, and to this end, I look forward to working with all concerned.

—To conclude, what are your current aspirations, Mr. Narita?

I think it is essential for R&D efforts to target cutting-edge technologies and make them practical for real-world use. In this regard, I would like to promote the standardization of an NGN vision through ITU-T and then create a large set of technology elements that can be used to develop services that all kinds of customers including carriers and ISP providers can use. If advanced applications above and beyond voice communications by VoIP can be developed and if each network-related enterprise can distinguish itself and create new revenue sources, the communication business will no doubt undergo major changes in the years to come. Looking to the future, I hope to contribute to the expansion of the entire NTT organization making good use of the technical strengths of the R&D department at NTT Comware.

Interviewee profile

■ Career highlights

Atsunobu Narita graduated from the University of Tokyo with a master's degree in information science in 1992. He joined NTT in 1992 and engaged in the development of an operations support system (OSS) for the telephone network. In 1998, he moved to the US branch of NTT Communicationware (now NTT Comware) in San Jose, California and worked for new business development in the area of Telecom OSS. In 2002, he moved to the R&D department and is involved in a project on the design and development of a next-generation network (NGN). He is also contributing to NGN-related work in ITU-T.