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Contents

Annual Report of Technical Committee on Network Systems

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1. Introduction

This report covers the annual activities of the IEICE Technical Committee on Network Systems (NS). It describes activities at the monthly technical meetings, recent research topics of the committee, and the research awards for 2007.

2. Technical meetings

The schedule from April 2008 to March 2009 consists of eight technical meetings and one workshop (Table 1), one meeting fewer than normal to avoid conflicting with the APSITT 2008 organized by the Technical Committees on NS and Information Networks (IN). Several of these meetings are co-located with the RCS (Radio Communication Systems), CS (Communication Systems) and IN (Information Networks), ICM (Information Communication Management), CQ (Communication Quality), or PN (Photonic Network) committees. In addition, the May technical meeting is co-sponsored by the ITC (International Teletraffic Congress) Japan Committee chaired by Dr. Hiroshi Saito of NTT.

Recently presented papers mainly focus on technologies that support ad-hoc and sensor networking, traffic control/measurement, quality of service (QoS), P2P networking, and security issues. At each technical meeting, we host lectures by invited speakers who are experts in their fields. During this fiscal year, we have had invited lectures on P2P, ad hoc, overlay, security, Next Generation Network (NGN), New Generation Network, and other topics. The number of papers presented at our meetings in recent years is shown in Fig. 1. In general, the number of papers is increasing, but those from industry are gradually decreasing.

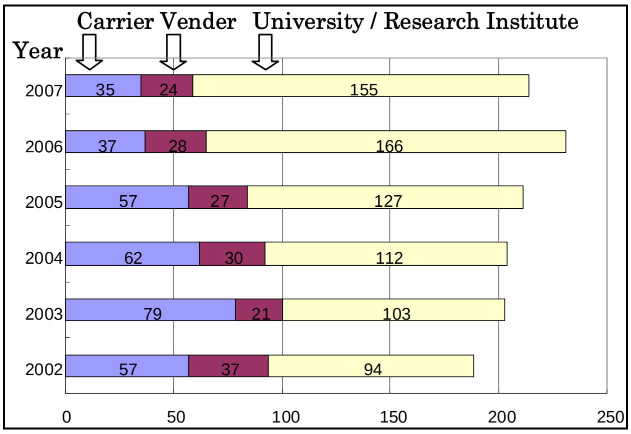

Fig. 1: Number of papers.

Tab.1 Technical meeting schedule for fiscal 2008.

Date	Location	Theme	Co-locating with
May 15-16	Future University Hakodate (Hokkaido)	Traffic, Post IP Networking, Protocol, Network Control, Network Estimation/Analysis	ITC Japan Committee
June 19-20	Nagaoka University of Technology (Niigata)	Network Software	
July 17-18	Kyoto University (Kyoto)	Seamless Wireless and Wired Network, Network Control, Wireless Network	RCS
September 11-12	Tohoku University (Miyagi)	Overlay Network, VPN, DDoS, Network Security, P2P Communication, Network Software	CS, IN
October 23-24	Kansai University (Osaka)	Network Architecture (Ubiquitous NW, Scalefree NW, RoN, Active NW), High Speed Ethernet, Grid NW, Sensor NW	
November 13-14	Nihon University (Fukushima)	Network Management, Next Generation Network Architecture, NGN Operation Architecture, Traffic Monitoring/Modelling, QoS, Ovelay Network	ICM, CQ
December 18-19	Kobe University (Kobe)	Photonic Network System, Optical Routing, Broadband Application	PN
January 22-23	Saga University (Saga)	Routing System (Adaptive Routing, QoS Routing, Multicast), Network Application (IP-TV, Streaming, Web 2.0)	
March 3-4	Okinawa Zanpamisaki Royal Hotel (Okinawa)	General, NS+IN workshop (March 2-3)	IN

Since June 2003, we have fostered the work of young researchers who have presented papers at technical meetings by inviting them to give a follow-up talk some months later. We call these the "incentive lectures." We invited 11 young researchers to give such lectures in the past year. We will continue this activity.

3. Research Awards 2007

The Technical Committee selected recipients of the Network System Research Award from among more than 200 papers that had been presented at monthly technical meetings from January to December 2007. The award is given to the authors of the three or four best papers of each year. The 2007 recipients attended the award ceremony at the IN/NS Workshop (Fig. 2) held in Okinawa in March 2008. The abstracts of the four papers that won awards in 2007 are shown below.

Takehiro Kawata and Hiroshi Yamada: "A study on cross-layer optimization for real-time applications over 802.11 WLANs" (incentive paper) [1]

With the deployment of IEEE 802.11 wireless LANs (WLANs), there is a strong requirement to support real-time applications with stringent QoS requirements on these networks. IEEE 802.11 supports the link adaptation function. If the wireless-link conditions deteriorate, a lower transmission rate is chosen to reduce bit errors and achieve maximum throughput while a higher transmission rate is chosen if the link conditions are fair. However, selecting a lower transmission rate results in a reduction in the available bandwidth of the link, which may cause the delay and loss of packets to increase. On the other hand, IEEE 802.11e EDCA provides a QoS mechanism for WLAN with prioritized and parameterized QoS access to the wireless medium. However, such a QoS mechanism in the MAC layer is not sufficient to guarantee the quality of real-time applications under fluctuating wireless-link conditions.

To resolve these problems, we have proposed a layer interaction algorithm for VoIP over IEEE 802.11 called the adaptive multirate VoIP (MRV). MRV is based on cross-layer designs, which break the layering principles by allowing interdependencies and joint design of protocols crossing different layers. In MRV, the adaptive voice encoder selects an appropriate voice-encoding rate and packetization interval according to the transmission rate in the PHY layer.

In this paper, we analyzed the performance of voice packets over IEEE 802.11 WLAN with EDCA in fluctuating wireless-link conditions by simulation experiments. The results demonstrated that the delay and loss of voice packets increased regardless of the QoS mechanisms of EDCA when the link conditions were poor. Then we showed that MRV reduced the delay and loss dramatically under such conditions even if best-effort traffic coexisted. We also discussed the problems of the existing admission control schemes under such a fluctuation in the available bandwidth. Finally, we presented a basic idea of the admission control architecture for EDCA in cooperation with MRV.

Satoshi Ohzahata and Konosuke Kawashima: "An identification and evaluation for a pure P2P application traffic" [2]

Internet applications are changing and traffic volume continues to increase. A large proportion of the traffic volume is occupied by P2P traffic because huge files are shared via the overlay network, and this has a large impact on the network. However, the characteristic of the traffic is still not well known because the architecture is constructed in an anonymous way and no administrator exists for the network. When we undertake research on Internet traffic, we have to identify the types of traffic.

To address this problem, we proposed an improved service port number identification method specifically designed for pure P2P application traffic. In the proposed method, the service port number is identified even in situations where pure P2P applications do not use their default service port numbers. A decoy peer joins a P2P network and collects the IP addresses and service port numbers of the other peers. Then, the pure P2P traffic is identified by the patterns of connection to the service/ephemeral ports used in communication between the peers.

To evaluate the accuracy, we applied the proposed method to Winny, which is one of the most popular pure P2P file sharing applications in Japan. Our experiment shows that our identification of false negative probability is 0.060–0.095 while that of false positive probability is lower than 0.0001. We also give characteristic evaluations for the identified traffic measured in an ISP network. Ten percent of the number of flows and 30% of traffic volume are occupied by Winny traffic. The flows of larger than 64 KB occupy 17% of the flows and are used for file transfer. The sum of the over-64-KB flows produces 95% of the total traffic. This shows that the small number of flows produces huge volumes of traffic and has a large impact on the network.

Marat Zhanikeev and Yoshiaki Tanaka: "Applications of IP aggregation for network anomaly detection" (incentive paper) [3]

Many methods exist today in the general area of traffic anomaly detection. Both malicious attacks and traffic artifacts originating from social phenomena are generally referred to as traffic anomalies. Although a number of tools exist today that are able to detect various network anomalies, the reality is that each tool is normally very specific as to which kind of anomaly or attack it should be applied against. Generally, such tools are the result of a prior research that targeted only a specific anomaly in the first place. On the other hand, tools that are able to detect and analyze many traffic anomalies at once are very rare.

As the basis of traffic anomaly detection, there are several primitive traffic characteristics such as byte/packet/flow counts, throughput, and throughput jitter among others. Because counters are used to measure some of these characteristics, the measurement is performed in a sampling manner using a fixed time interval. Now, it is a well-established fact that many traffic anomalies exhibit identical trends when viewed through the above list of primitive characteristics. This is the major shortcoming of all detection methods that are based on sampled traffic characteristics.

On the other hand, the IP address space of the traffic in question is neglected entirely in traditional research. IP aggregation is a method of aggregating IP addresses to form traffic nodes where each node is a group of IP addresses that fit into a given bitmask. The bitmask is used to ignore several bits at the end of an IP address and is also referred to as an IP address suffix. As was proved by the authors' research, the use of variable length suffix on IP addresses spawns a number of useful traffic characteristics that can successfully distinguish one traffic anomaly from another. Given that each traffic anomaly affects traffic IP space in a unique way, this direction in research offers much room for reliable simultaneous detection of a large number of traffic anomalies.

Satoshi Imai and Toshio Soumiya: "A resource admission control mechanism for large-scaled network systems" (incentive paper) [4]

This paper proposes a scalable resource management mechanism for network systems. With the progress of large-scaled networks, network systems should manage effectively enormous and diversified information to ensure stable operations in a resource-constrained environment. The resource management mechanisms have been discussed in many fields of system management, and many mechanisms that resolve the resource allocation problem by scheduling jobs based on resource reservations are proposed. However, these mechanisms assume that admission control functions grasp resource usage per requested job in advance. If the system cannot grasp the resource usage per job exactly and has to handle enormous jobs in a short time, managing resource usage appropriately is difficult and not scalable execute job processing in real-time.

Therefore, we propose a general resource management mechanism that judges randomly whether or not to accept newly requested jobs without grasping the resource usage per job. The mechanism only works when the system does not ensure stable operations as the result of resource depletion. To provide a fair admission control for requested jobs, the proposed mechanism is characterized by adjusting dynamically the probability for acceptance of requested jobs according to total usage of system resources. In this mechanism, we apply a feedback control law as the job admission control scheme. Additionally, the parameter conditions for achieving a stable control were derived by analyzing the resource management mechanism as a feedback model. As the result, we achieve effective resource management and stable operations in a target system.

Fig. 2: Research award recipients with former chair Dr. Miyake and chair Prof. Yamamoto.

Furthermore, we introduce the application examples for "a session admission control system based on the bandwidth measurement for a bottleneck link" and "a packet sampling control system based on the CPU utilization measurement" and demonstrate the effectiveness of the proposed systems in simulation and prototype evaluations.

4. Future Plans

The Technical Committee is preparing a special edition of the IEICE Transactions on Communications B (to appear in December 2008) covering P2P networking technology, a key application in the era of broadband services. The Program Committee is chaired by Dr. Kou Miyake of NTT.

The Technical Committee will organize open Symposia in the IEICE Conferences, one of which will be on "Technologies for Service Realization in Next Generation Network (NGN)" at the IEICE Society Conference in September 2008.

(For more information, please see our home page.
URL: http://www.ieice.org/cs/ns/index.html)

References

[1] T. Kawata and H. Yamada, "A study on cross-layer optimization for real-time applications over 802.11 WLANs," *IEICE Tech. Rep.*, NS2006-150, Jan. 2007.

[2] S. Ohzahata and K. Kawashima, "An identification and evaluation for a pure P2P application traffic," *IEICE Tech. Rep.*, NS2007-8, April 2007.

[3] M. Zhanikeev and Y. Tanaka, "Applications of IP aggregation for network anomaly detection," *IEICE Tech. Rep.*, NS2007-33, June 2007.

[4] S. Imai and T. Soumiya, "A resource admission control mechanism for large-scaled network systems," *IEICE Tech. Rep.*, NS2007-84, Oct. 2007.

Two-year Activities of Technical Committee on Brain Communication - From Brain Communication to Brain and Bio Communication -

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[†]Hitachi, Ltd., [††]KDDI R&D Labs., [†††]RIKEN, [††††]ATR

1. Introduction

The Technical Committee on Brain Communication (Brain) was established in June, 2006 as a two-year limited-term committee to promote interdisciplinary activities on Brain Science and Information Technology. Our research fields included a wide range of topics such as brain-machine interface and neural prosthesis, biofeedback in biomechanical systems, brain functional imaging and signal processing techniques, communication of thoughts and *kansei*, models of memory and learning in cerebral cortex, and neuroinformatics and retrieval methods (see Fig.1).

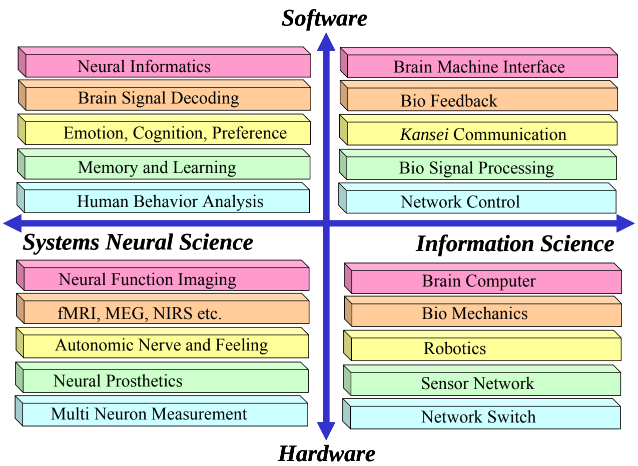

Figure 1 Scope of the Brain Communication Activities

2. Summary of the 2-year Activities

We have held four workshops and five brain-storming meetings in Kanto or Kansai areas alternatively, and one co-sponsored workshop in Tohoku area. Table 1 depicts a list of main topics of invited talks.

Table 1 List of Main Topics from Invited Talks

1st Workshop (11 Oct., 2006)	- What is necessary information for brain communication? (Taro Maeda) - Points and lines of optical topography (Atsushi Maki)
2nd Workshop (28 Feb., 2007)	- Intelligent Medical Image Processing for anatomical and functional human brain analysis (Syoji Kobayashi) - Brain Communication with ALS Patients (Masayoshi Naito) - Neurosurgical brain mapping and applications (Amami Kato)
3rd Workshop (22 June, 2007)	- Electroencephalogram-Based Control of an Electric Wheelchair (Kazuo Tanaka) - Machine learning and BMI (Hiroyuki Nakahara) - Cerebro-cerebellar Communication System for Learning and Flexible Switching of Internal Models (Hiroshi Imamizu)
4th Workshop (18-19 Oct., 2007)	- Measurement, Understanding, Guarding, Nurturing Brain (Atsushi Maki)
5th Workshop (15-16 May, 2008)	- A car with intention reading (Takashi Omori) - Neural Representation and Plasticity in the Auditory Cortex (Hirokazu Takahashi) - Technology to Create "Growth" and "Happiness": X-Microscope (Kazuo Yano)

Figure 2 shows the trend of the participants across the five workshops, where the 4th workshop was co-sponsored by the technical committees of Neurocomputing (NC) and Brain Communication (Brain). The ratio of academics and industries was almost 50-50% to 40-60% in all cases.

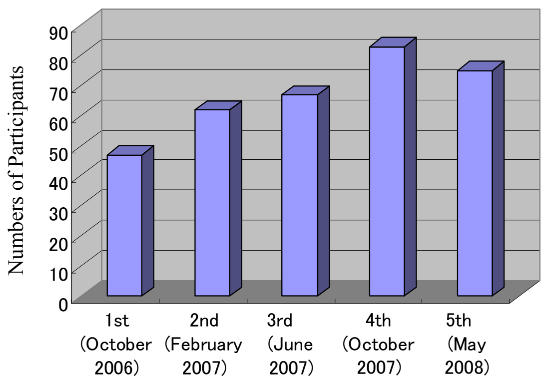

Figure 2 Trend of participants

Figure 3 shows a snapshot of the 5th Workshop held at ATR Computational Neuroscience Laboratories located in Keihanna Science City, Kyoto prefecture. Prior to the workshop, an ATR Lab tour was conducted, where the participants had an opportunity to see the recent imaging apparatus and robotics research. There were 12 presentations and about 75 attendees, and we had fruitful discussions and technical exchanges throughout the workshop and the reception. On this occasion, we would like to thank Dr. Kawato and all the local staffs who successfully steered this workshop.

Figure 3 5th Workshops at ATR Computational Neuroscience Laboratories

3. Next 2year-activities of the Technical Committee on Brain and Bio Communication

The council of technical committee representatives admitted next two-year activities between June, 2008 and March 2010 of The Technical Committee on Brain and Bio Communication (BBC), renamed from the Technical Committee on Brain Communication (Brain) . In these activities, we will focus on the novel communication technologies using recent brain-science results, and strengthen the co-operation with the Technical Committee on Communication Quality (CQ) and Medical Information and Communication Technology (MICT). In addition to the scopes in Fig. 1, we will include the intelligent robotics and its artificial approaches. We have invited seven new members from universities and industries and held the 1st meeting in July, 2008 to exchange the topics (see Fig. 4). In this year, we plan a CQ-joint tutorial session on 17 September, 2008, at Ikuta campus, Meiji University and a NC-joint workshop on 23-24 October, 2008 at Tohoku University. For more details, please visit our Web site at http://www.ieice.org/cs/brain/.

Members of the Technical Committee on Brain and Bio Communication:

Chair: Kazuhiko Sagara (Hitachi)
Vice Chair: Hiroshige Takeichi (RIKEN)
Secretary: Hajime Nakamura (KDDI R&D Labs.)
Okito Yamashita (ATR)
Assistant: Sumaru Niida (KDDI R&D Labs.)
Masamitsu Harasawa (NHK)
Members: Ryohei Hasegara (ASIT)
Shin'ichiro Kanoh (Tohoku Univ.)
Tohru Yagi (Tokyo Institute of Technology)
Kazutoshi Ebe (Toyota Central R&D Labs.)
Makio Kashino
(NTT Communication Science Labs.)
Takanori Hayashi (NTT)
Masaki Aida (Tokyo Metropolitan Univ.)
Kazuteru Komine (NHK)
Yasuto Tanaka (Miki Optical Lab.)
Hiroshi Tamura (Osaka Univ.)
Naoki Wakamiya (Osaka Univ.)
Fumito Kubota (NICT)
Hiroaki Kawashima (Kyoto Univ.)
Advisory:
Mitsuo Kawato (ATR)
Masamichi Sakagami (Tamagawa Univ.)
Taro Maeda (Osaka Univ.)
Yutaka Ishibashi (Nagoya Institute of Technology)
Ryuji Kohno (Yokohama Univ.)

Figure 4 Members of the Technical Committee on Brain and Bio Communication

Report on 7th Asia-Pacific Symposium on Information and Telecommunication Technologies (APSITT 2008)

Motonori Nakamura*, Noriaki Kamiyama*, Keisuke Ishibashi*, Hiroshi Saito**,
Ichiro Inoue***, and Takashi Miyamura***
*Organizing Committee of the conference, NTT
**Organizing Committee Co-Chair of the conference, NTT
***Secretary of the conference, NTT

1. Introduction

The Technical Committee on Information Networks and the Technical Committee on Network Systems successfully organized the 7th Asia-Pacific Symposium on Information and Telecommunication Technologies (APSITT), held at Bandos Island, Maldives on Apr. 22-24, 2008, sponsored by the IEICE Communications Society.

2. Concept and Brief History of APSITT

APSITT was established with the aim of raising the prosperity of the Asia-Pacific region by presenting opportunities for academic forums for mutual understanding and friendship among researchers and leaders in the information and telecommunication fields. The 7th APSITT followed the six conferences shown below.

1st: Nov. 1993, Bangkok, Thailand
2nd: Mar. 1997, Hanoi, Viet Nam
3rd: Aug. 1999, Ulaanbaatar, Mongolia
4th: Nov. 2001, Atami, Japan/Kathmandu, Nepal (held by video conference)
5th: Nov. 2003, Noumea, New Caledonia
6th: Nov. 2005, Myanmar Info-Tech, Myanmar

3. Overview

In total, 45 papers were accepted among 71 submitted papers from Asian countries as well as some European countries. The key facts and statistics on APSITT 2008 are as follows.

- Sponsor:
  IEICE Communications Society
- Technical Co-Sponsor:
  IEEE Communications Society
- Organizers:
  Technical Committee on Information Networks
  Technical Committee on Network Systems
- Conference Dates:
  Apr. 22-24, 2008
- Conference Venue:
  Bandos Island, Maldives
- Participants:
  About 60 from Japan
  About 30 from other countries

4. Opening Session

We had four speeches in the Opening Session. The first speech was the welcome and opening remarks by His Excellency Mr. Mohamed Saeed, Minister of Transport and Communications. The second speech was the opening remarks by Professor Yoshiaki Tanaka, General Co-Chair, Waseda University. The third speech was the program committee overview by Professor Miki Yamamoto, Co-Chair of the Technical Program Committee, Kansai University. The last speech was the keynote speech by Professor Tomonori Aoyama, Keio University.

His Excellency Mr. Mohamed Saeed stressed the importance of the information and telecommunication technologies and gave a welcome message to all the participants in the opening remarks shown in Fig. 1.

Professor Yoshiaki Tanaka touched on the concept and brief history of the conference and expressed gratitude to the host country on behalf of the conference organizer.

Professor Miki Yamamoto summarized the review process of the conference and announced the number of submitted and accepted papers.

Professor Tomonori Aoyama, who is a member of the International Advisory Board of the conference, outlined the concept and progress of the new generation network.

Fig. 1 Opening session in main hall.

5. Technical Sessions

45 papers were presented in 10 sessions covering various areas on information and telecommunication. Below is the list of the technical sessions and the numbers of presentations in each session.

- Next Generation Network (4)
- Wireless (10)
- Routing & Traffic Engineering (6)
- Ubiquitous (9)
- Traffic & QoS (5)
- Optical Networking (3)
- Network Architecture (4)
- TCP & Flow Control (4)

Fig. 2 Guests from the Maldives and committees.

6. Activities with Local Entities

The Maldives government has regarded information technology as important and has promoted international technical exchanges in the IT field. They evaluated the conference highly, and the minister of the Transport and Communications, attended the opening session and gave the opening remarks. Journalists from the Maldives TV visited us and broadcasted the opening session on the TV news. Maldives VIPs including the chief operations officer of Wataniya Telecom Maldives also attended the opening session as well as the conference banquet. Before the opening session, the committee members of the conference deepened their relationships with the Maldives guests. The committee members and Maldives guests are shown in Fig. 2.

Prior to the conference, the organizing committee members of the conference visited the Telecommunications Authority of Maldives (TAM) to show their appreciation for the cooperation of the local government. Dr. Kou Miyake, Co-Chair of the Organizing Committee, NTT, gave a monument to Mr. Mohamed Nasih, Deputy Director General and Acting Chief Executive, TAM, to show our gratitude, as shown in Fig. 3.

Fig. 3 Visiting at TAM.

Some staff members of TAM attended the technical sessions to observe the presentations. We felt their strong enthusiasm to learn IT technologies. We believe that this conference was a valuable chance for them and us to promote academic exchange between the two countries.

Fig. 4 Banquet at Harbor Restaurant.

At the conference banquet, Mr. Mohamed Nasih, Deputy Director General and Acting Chief Executive, TAM, expressed his gratitude for having the opportunity to hold APSITT 2008. Professor Yoshiaki Tanaka, General Co-Chair, Waseda University, expressed gratitude to the host country on behalf of the conference organizer. Professor Yoshiaki Tanaka is shown in Fig. 4. Dr. Kou Miyake, Co-Chair of the Organizing Committee, NTT, also expressed gratitude to the host country and gave the closing speech at the banquet. We felt we were welcome guests. We hope that the academic exchange between Japan and the Maldives will continue to progress after this start at APSITT 2008.

7. Information

Further information on APSITT2008 is available at the following URLs.

APSITT 2008:
http://www.ieice.org/cs/in/APSITT/2008/

Technical Committee on Information Networks:
http://www.ieice.org/cs/in/jpn/

Technical Committee on Network Systems:
http://www.ieice.org/cs/ns/jpn/

Call for Participation: 11th Asia-Pacific Network Operation and Management Symposium

22-24 October, 2008, Beijing, China

Kitawaki Jun*, Uno Hiroshi**
*Publicity of the conference, Hitachi
** Vice chair of the conference, NTT

1. Overview of APNOMS 2008

The 11th Asia-Pacific Network Operations and Management Symposium (APNOMS 2008[1]) will be held at the Park Plaza Beijing Science Park[2] in Beijing China from October 22nd to 24th, 2008. APNOMS 2008 is organized by IEICE ICM Committee and KICS KNOM with support from IEEE Communication Society, IEEE CNOM, IEEE APB, TMF, IFIP WG 6.6, CIC, CCSA TC7, and BK21 POSTECH FIT. The theme of APNOMS 2008 is "Network and Service Management for Business Agility." Recently, various convergences in wired and wireless networks, and convergence of telecommunications and broadcastings are taking place for ubiquitous multimedia services. APNOMS 2008 will provide excellent opportunities for researchers, engineers, network planners, service providers and network operators in telecommunications to learn and share ideas, views, technologies and experiences on network/service operations and management.

Beijing is the capital of China and the hosting city of 2008 Summer Olympic Games. Beijing is the political, educational, and cultural center of China, where the participants can also enjoy the Chinese ancient as well as modern culture. The famous tourist sites such as Tiananmen Square, Forbidden City, Temple of Heavens are within the city and the Great Wall and Ming Tombs are nearby.

2. Topics

In APNOMS 2008, the topics of technical sessions, short paper sessions, poster sessions, special sessions, tutorials, keynotes, exhibitions and distinguished experts panel include:

1) Network Management
- Management of IP-based Networks
- SLA/QoS Management, Traffic Engineering
- Management of Ad-hoc/Mesh Networks
- Management of 3G/4G Networks
- Management of Sensor Networks
- Management of DWDM, Optical Cross-connect
- Home Network Management
- Management of Wireless LANs
- Virtual Network Provisioning and Operation
- Network Monitoring and Measurements

2) Architectures, Methods & Technologies
- Architectures and Models
- Autonomic Management
- Control Theoretic Management Approaches
- Peer-to-Peer Management
- Web/Java Based Management
- Mobile Agent-based Management
- Policy-based Management
- Next Generation OSS Platforms
- Converged Networking Issues
- SNMP, CMIP, NETCONF, Web Services, XML

3) Service Management
- Security Management
- Accounting and Billing
- Applications and Service Provisioning
- Seamless Service with Roaming and Handover
- Regulatory Issues
- Management Architecture for Ubiquitous Computing
- Ubiquitous Service Platforms
- Signaling for Application Sessions and Networking

4) Business Management
- ISP/ASP/CSP Management
- Business Process Engineering
- Customer Care and Self Operations
- e-Business Management

5) Experiences
- Trial Results, Migration and Case Studies
- Interoperability

3. References

http://www.apnoms.org/2008
http://www.parkplaza.com/beijingcn_sciencepark

Fig. 1 Buildings of Beijing

New Generation Network and its Research Activities


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1. Introduction

Before starting the discussion on New Generation Network research, we mention briefly about the currently available three types of communication networks – telephone, broadcast, and the Internet – and their limitations.

Telephone networks, which were introduced more than 100 years ago, are based on circuit-switching technology. They provide voice services with a reasonably good quality of service by exclusively reserving network resources – timeslot or frequency band – to set up a dedicated end-to-end traffic channel. The exclusive reservation of network resources for each and every user leads to under-utilization of the resource, thus increasing the service cost. Two types of telephone networks are currently serving society, fixed and mobile, which generally require two separate subscriptions and user terminals.

Broadcast networks serve videos or television programs to a mass of users over wireless TV channels or cable networks. Broadcast networks are traditionally meant to carry only one-way transmission of video signals from a single source to multiple user terminals such as TV sets.

The Internet, introduced about 40 years ago, has its foundation on Internet Protocol (IP) which runs over the packet-switching technology. Since the Internet is a loosely-connected global network of several autonomous small networks, there are no central controlling entities or functions, no dedicated control channels, no end-to-end resource reservation, and no defined responsibilities of the component network operators. These open features of the Internet bestow it with both advantages and disadvantages. They allow a component network operator or user to easily expand the Internet by simply setting up a local network and connecting it to the Internet through a router. Users can also create and run a number of applications over the Internet by optimally utilizing the network resources. However, the openness as well as the lack of a central control makes it difficult to provide such services that require a guaranteed quality service (QoS), security and reliability in end-to-end data transport.

Although the current Internet is not suitable for interactive voice/video services, we have been experiencing wide use of the IP technology for voice and video services in recent years. Many Internet service providers (ISP) and telecom operators are providing triple-play services, i.e., voice, video and data services, to users under a single subscription. To facilitate this trend through standardization, the International Telecommunication Union (ITU) has been developing standards for the Next Generation Network (NGN) for last a few years.

Next Generation Network

NGN has already entered into the deployment phase in some developed countries and is expected to expand into several other countries within few years. NGN is an operator-centric network in which operators control and manage their state-of-the-art IP-based networks to support application-oriented QoS control, fixed mobile convergence (FMC), and security. NGN is supposed to maintain safety and reliability at the level of current telephone networks, while providing the quadruple-play services – voice (Voice over IP, or VoIP), video (Internet Protocol Television, or IPTV), data, and FMC. The FMC service enables an NGN subscriber to seamlessly handover voice, video and data services from a fixed network to a mobile network, and vice versa.

Limitations of Next Generation Network

It is noteworthy that NGN does not focus on user-oriented services that can be locally generated and freely distributed to optimally fulfill local community needs. In the future ubiquitous society, not only operators' networks but also locally established and managed wireless sensor networks, mesh networks, personal area networks, and home networks will play a vital role in creating new user-centric communication services in which users disseminate information that they freely created, collected or processed. Therefore, taking the future ubiquitous network-oriented societal requirements into consideration, we have been pursuing research and development of the dynamic access system of the New Generation Network (NWGN) that will go into deployment around 2020. NWGN is the future Internet that could be based on radically different networking concepts to be free from all constraints of the current networks.

This article is organized as follows. In Section 2, we outline the Japanese research activities on NWGN. In Section 3, we present a new concept of identifier/locator split which is an important component of the NWGN architecture. In Section 4, a wireless mesh network service platform is briefly explained. Section 5 summarizes this article and mentions briefly about the research environment in the authors' organization.

2. New Generation Network (NWGN)

The National Institute of Information and Communications Technology (NICT), Japan, has set up the AKARI Architecture Design Project to research and develop the basic architecture of NWGN that will go into the deployment phase around 2020. The AKARI project, established in 2006, includes several Japanese university professors and NICT researchers. The project organizes two workshops every year by inviting experts from academia as well as industries to promote and share NWGN research activities leading to the creation of the NWGN architecture. The project has produced the AKARI Architecture Conceptual Design white papers that outline the basic design principles and candidate technologies for the NWGN architecture. The white papers can be freely downloaded from the project website [1].

Figure 1 shows the conceptual positioning of NWGN, along with the Next Generation Network and the current as well as past networks. We have been pursuing the clean-slate approach that allows us to introduce completely new technologies for NWGN without being hindered by the existing networks' constraints. The clean-slate approach is necessary to overcome the concerns that if research and development is performed based on current technologies, the direction taken by the development process for the future network-oriented society will reflect corporate interests or be reduced to local optimizations. Therefore, our goals are first to design and develop NWGN in a new paradigm and then to modify the Next Generation Network to migrate from it to NWGN.

Dynamic Access System

The access networks of NWGN are expected to be very dynamic and heterogeneous because they are required to smoothly incorporate enormous number of small networks consisting of various types of communication devices ranging from tiny sensors, handheld devices, automobiles, and robots, to huge supercomputers. The size and topology of these networks change randomly as devices join or leave the networks by physically moving or logically changing their association from one network to another. In such a dynamic access system, as shown in Fig. 2, end users may exchange information through a number of devices and access networks such as multi-hop mesh networks, wide area wireless networks, and local area wireless networks provided by the user community or telecom operators.

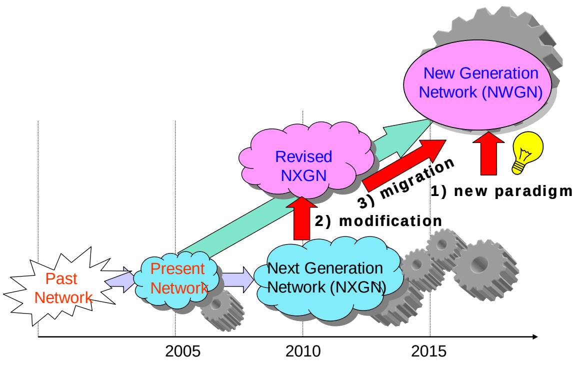

Fig. 1 Conceptual positioning of New Generation Network

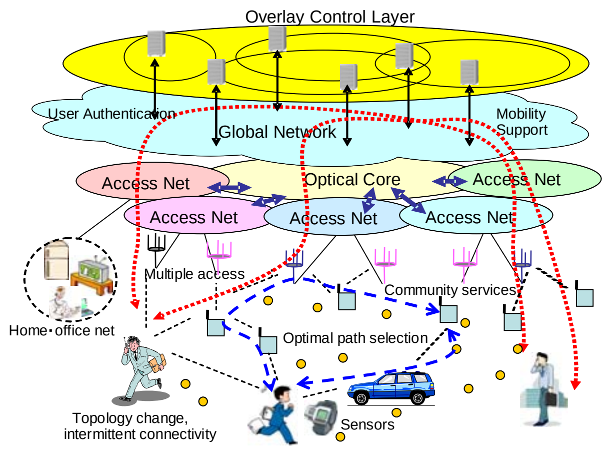

Fig. 2 Dynamic access systems in New Generation Network

In the access system of NWGN, node's location may change frequently when the node physically moves or logically changes its network association due to dynamic changes in the network topology. To maintain ongoing communication services even when the node changes its association from one network to another, this type of network environment demands a new paradigm of network design, called identifier (ID)/locator split or separation. In an ID/locator split network architecture, the node ID does not change often so that a communication service or session associated with the ID remains unaffected even when the node's locator that represents the node location in the network topology changes frequently.

Similarly, the access system of NWGN may have several multi-hop physical paths available for communication between any two nodes, as shown in Fig. 2. To provide locally generated information services in a reliable manner to the local community, it is very important to setup a few robust logical paths and dynamically select an optimal path that satisfies the service requirements and policies.

In the following sections, we further elaborate on the concepts of ID/locator separation and service-oriented logical path setup over the community mesh network. Note that besides these two research issues, there are several other technological challenges that need to be properly addressed for realizing NWGN.

3. Identifier/Locator Split Architecture

We have been developing an ID/locator split network architecture that uses separate sets of identifiers and locators. In this context, the identifier is an entity that identifies a node as the endpoint of a communication session and the locator is another entity that denotes the location of the node in the network topology. The ID/locator split architecture eliminates certain problems that have been associated with the conventional Internet which uses IP addresses as node identifiers in the application and transport layers and as node locators in the network layer.

The ID/locator split concept helps us design optimal solutions to mobility and multihoming management, scalable routing, network renumbering, traffic engineering, security and privacy, because these network functionalities require disassociation between identifiers and locators so that nodes can change locators while continuing a communication session associated with identifiers. It is also helpful to satisfy others requirements of NWGN, like supporting heterogeneity access networks/nodes and dynamic path selection in multi-path, multi-hop access networks. In the ID/locator split architecture, the end-to-end communication semantic is associated with end node identifiers, rather than with locators, so that the communication session is not disrupted even when locators change due to mobility, multihoming, routing optimization, or other reasons. The architecture requires a secured, scalable, dynamic database system for storing/updating/retrieving identifier-to-locator mapping information and allowing a node identifier to associate with many locators simultaneously or at different instances of time.

Issues Related with ID/Locator Split Architecture

The major issues are concerned with the configuration of identifiers, locators, and their mapping systems. Configuring globally suitable identifiers and locators are challenging, yet crucial to realize the ID/locator split architecture. The identifiers and locators can have a hierarchical or flat structure. The hierarchical structure of identifiers may provide hints in resolving them into locators, but may require a central entity to assign the hierarchical components, thus preventing nodes from self-generating many identifiers that may be required for privacy or security reasons. On the other hand, the flat identifier structure allows nodes to generate many identifiers as needed. In the case of locators, since they are associated with routing mechanisms, their hierarchical structure is helpful in designing a scalable global routing system by allowing us to aggregate many locators into a single entry in the routing table. Similarly, maintaining a scalable, global ID-locator mapping database is very important for implementing the ID/locator split architecture.

An Example ID/Locator Split Architecture

In the following paragraphs, we briefly describe our ID/locator split internetworking architecture (for detail refer to [2]). As shown in Fig. 3, in our node identifying architecture, an identifier can exist in two forms: name and ID. The name and ID are used for different purposes in communication.

The name can be local or global. Local names are unique in the local network and are used for local node identification and network management. They are generated by combining a node's feature words, such as the node's usage, owner, location, serial number, installation date and time. Examples of node names are *my.pc, my-pc-20071112, home-phone*, etc.

We use the Identity Management Server (IMS) for supporting global mobility and secured network accessibility. The generated local name is registered with the IMS, which checks for uniqueness. If the name conflicts with an existing node's name, the IMS may ask the node to generate another name or suggest to the node some possible names by simply adding additional features or numbers. Global names are formed by combining local names and the IMS name, which is assumed to be in a domain name format, such as *mynetwork.com*. Global names are thus in formats similar to the following: *my.pc#mynetwork.com* or *home-phone#mynetwork.com,* where *my.pc* and *home-phone* are local names for a node and the "#" is a concatenation sign.

The IDs are generated from node names (and an additional parameter) using a cryptographic hash function. A node will have, in general, only one name, but may have several IDs derived from the same name using additional parameters in the hash function. Nodes are equipped with mechanisms to verify whether an ID

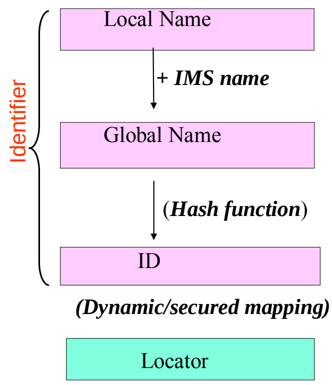

Fig. 3 Identifier structure for ID/locator split architecture

corresponds to a given name. The ID generation process is not reversible, that is, it is very difficult, if not impossible, to derive a node's name from its ID. The bit length of an ID is adjusted to a "mapping scope" so that packets containing the ID are uniquely identified in the scope. The IDs are included in the identity header of packets to identify the source and destination nodes.

We utilize two types of mapping servers in our architecture: (1) IMS for storing dynamic information, such as the mapping between names, IDs and locators; and (2) Name Management Server (NMS) for storing comparatively static information such as the mapping between the IMS name and its locator(s), which we assume does not change often.

If a node wants to communicate with another node, the former (called *requester*) has to know the latter's (called *responder*) name. To initiate communication, the requester is required to know only the responder's global name, which is resolved into the responder's IDs and locators through querying the NMS and the IMS. After getting the responder's locator the requester may either start data transport immediately or after establishing a secured communication path through exchanging additional control messages with the responder.

To support our node identifying architecture, we inserted a new layer, called the identity layer, between the transport and network layers of the end node protocol stack. The identity layer maps identifiers to locators (and vice versa) and separates the regions where identifiers and locators are used in the communication protocol stack. The identity and upper layers use identifiers for node identifying purposes. The network layer uses locators for node locating and packet routing. While traversing the network, a packet's locators may be changed for optimally routing the packet to its destination.

4. Mesh & Sensor Networks for Community Services

Many developing regions that have sparse population and low economic activities may not be lucrative to ISPs and mega telecom operators to set up their commercial networks. In such regions the local communities have to setup their own networks. These local networks should include different types of nodes such as content creators, servers, and consumers. The combination of sensor networks and wireless mesh networks is best suitable for freely creating and distributing services that satisfy the diverse needs of a single region or individual.

Therefore, to realize a ubiquitous network-society, NWGN should fully incorporate these local community networks. As a part of the NWGN access system research project, we have been designing a service platform that provides communication services best suitable for local regions, individuals, and communities [3]. In this platform, services are freely constructed for each community, and functions such as user-centric multicasting or guaranteed communications when faults occur are provided by configuring logical paths with a many-to-many mesh topology on a physical wireless mesh network. Technologies for automatically building and managing networks, collecting and managing remote device information, and distributing spot-specified information will be incorporated to the platform in the future.

5. NWGN and NICT

In the preceding sections of this article, we outlined the limitations of the Next Generation Network and the necessity of the clean-slate design of the New Generation Network (NWGN). In Japan, the National Institute of Information and Communications Technology (NICT), which the authors of this article belong to, is leading the NWGN research activities. NICT has established the AKARI Architecture Design Project in 2006 to research and develop basic technologies that constitute the NWGN architecture. NICT is also leading the New Generation Network Forum (http://nwgn-forum.nict.go.jp/), which is recently established for the nation-wide promotion of NWGN research through collaboration and information sharing among industries, academia and the government agencies.

NICT is the independent research institute fully funded by the Japanese government to carry out research and development of ICT technologies for realizing the government's visions for the future ubiquitous society. NICT's headquarters are located in Tokyo, while its branches are spread in many places throughout Japan. NICT has been providing equal opportunities to the foreign researchers. Currently more than 10% of the NICT's researchers are foreigners. Although most of the foreign researchers are Japanese university graduates, foreign university graduates with a doctorate degree are also welcome to apply for the vacant positions.

6. Reference

[1] AKARI Architecture Design Project, http://akari-project.nict.go.jp/

[2] V. P. Kafle, K. Nakauchi, and M. Inoue, "Generic identifiers for ID/locator split internetworking," Proc. ITU-T Kaleidoscope event, Innovation in NGN – Future Network and Services, May 2008.

[3] M. Inoue, K. Nakauchi, V. P. Kafle, H. Morino, T. Sanefuji, "Community Service Platform using Wireless Logical Mesh Paths," to be presented at WPMC, Sept. 2008.

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From Editor's Desk

● IEICE Society Conference in Kawasaki

The IEICE Communications Society Conference is coming. The next conference is held at Meiji University in Kawasaki from September 16(Tue.) to 19(Fri.). Kawasaki is just located between Tokyo and Yokohama, also near from Tokyo International Airport (Haneda) and very accessible. On the first day of the conference, the event called "welcome party" is to be held by the IEICE Communications Society. The welcome party is like a casual social gathering and we plan to offer opportunities to enjoy short speeches by active young researchers in telecommunications industries and frank conversation. Some food and drink will be served for free in the party. We hope that many members of the Communications Society, especially student members and young members, join the party and have a good time. Please attend the conference in Kawasaki and enjoy the welcome party!

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