Proposal of a Policy Model for the Next-Generation Internet Testbed

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Standing on the cooperative research with G8-GIBN Project about AUP in 1999, we examined the necessity of the proposals for the new internet layer model, as the social implication for the Next Generation Information Infrastructure, on the process of the interconnection among the next internet testbed projects, such as Gigabit Network, CRL-APII Testbed, APAN, AIII, WIDE and so on. It is intended to interconnect among the next Internet testbed projects as an international collaboration.

As the result of the research, it was suggested the necessity of basic information of each projects: Purpose of the network, Information regarding the network's technological features. Financial and technological requirements for users when they try to peer the connection. Rules regarding bandwidth allocation, how to deal with different types of traffic and so forth. Procedures for interconnection Network administration policy. From this study and some discussions, we proposed the novel structure model for Next Generation Internet Research as an International projects.

Keywords
Next Generation Internet, Network administration, Testbed, ATM network, Interconnectivity for advanced networks

1 Introduction

Development of ultra high-speed networks is making rapid progress worldwide, with a next-generation network in view. In addition to the NGI initiative promoted by the U.S. government and the university-based "Internet2," major projects are proceeding in Canada, Europe, and Singapore. In fact, a number of countries are eager to build testbeds and develop technological innovations [1]. Table 1 summarizes the ongoing projects related to the next-generation Internet.

In Japan, the Ministry of Posts and Telecommunications has been promoting a five-year project entitled "Research and Development of the Next-Generation Internet" since 1996. In fiscal year 1998, a total budget of roughly one hundred billion yen was awarded to various individual projects, such as the "Research and Development of the Japan Gigabit Network" (hereafter, "JGN") [2] and the "Research and Development of Multi-Access-Type Internet for Use in Schools" projects[3][4]. Moreover, an idea is currently under consideration [5] to build a global-scale network research testbed by connecting domestic and overseas next-generation Internet research testbeds, as shown in Fig. 1.

The Internet has been grown and spreaded principally by the private sector. The above official actions, however, result from the

Table 1 *List of ongoing projects for the next-generation Internet(in alphabetical order)*

Organization/ Network	Country of Headquarter	URL
APAN	APAN(NPO)	http://apan.net
APII	Japan	http://www.tc.apii.net
CA *net 3	Canada	http://www.canet3.net
CERN	Europe	http://www.cern.ch
CCIRN	Netherlands	http://www.ccirn.org
DANTE	United Kingdom	http://www.dante.net
DFN	Germany	http://www.dfn.de
GARR	Italy	http://www.garr.net
IM net	Japan	http://imnet.tokyo1.jst.go.jp
Internet 2	US	http://www.internet2.edu
NSF	US	http://www.nsfnet.com
RENATER	France	http://www.renater.fr
Rbnet	Russia	http://www.ripn.ru/rbnet/index.html
SINET	Japan	http://www.sinet.ad.jp
SingAREN	Singapore	http://www.singaren.net.sg
TERENA	Europe	http://www.terena.nl
UKERNA	UK	http://www.ukerna.ac.uk
VBNS	US	http://www.vbns.net
WIDE	Japan	http://www.wide.ad.jp

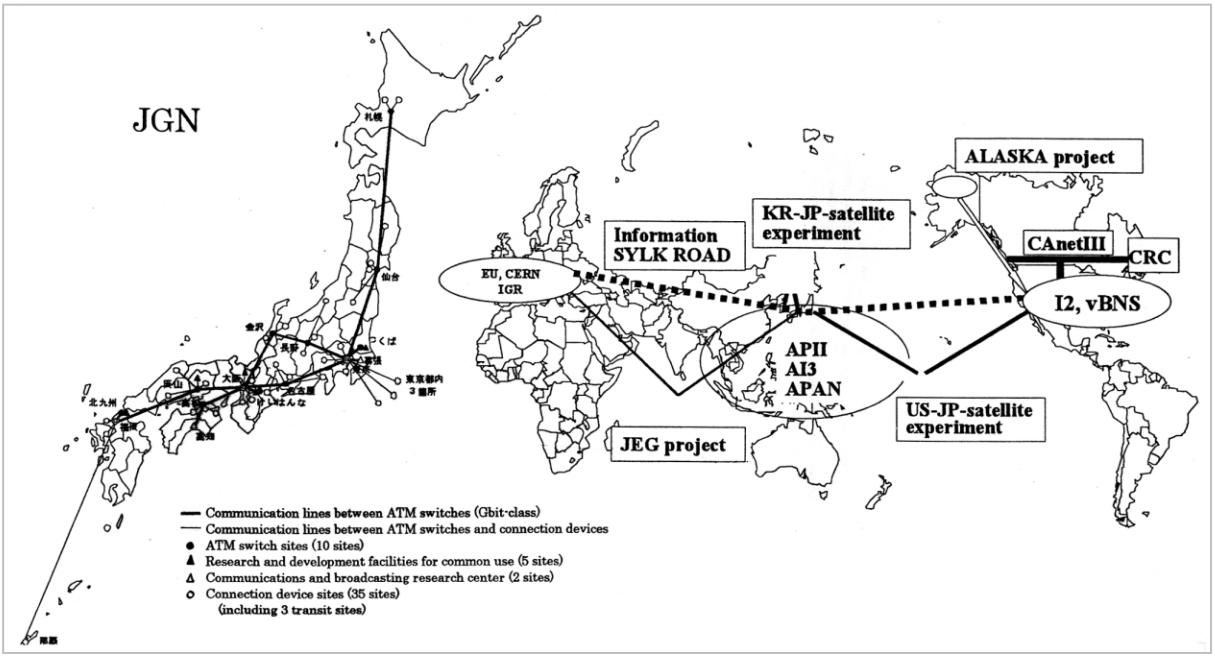

Fig.1 *Overview of Japan Next Generation Internet Testbed project*

recognition[6] of policy-makers that next-generation Internet technology will, in the future, play a central role in a networked society. It has become increasingly clear that we must [7] re-evaluate the direction of such public research and development as we construct and operate next-generation Internet testbeds, from the viewpoint that such public research and development could lead to an interference with human communication (i.e. invasion of private communication).

Based on the survey results concerning AUP (Acceptable User Policies) conducted in cooperation with the G8-GIBN (Global Inter-

connection and Interoperability for Broadband Networks) project team, we have investigated the necessity of creating a new model, one that takes social aspects into account, within the Internet layer model. This was done in the course of improving JGN's AUPs and CRL's (Communications Research Laboratory of the Ministry of Posts and Telecommunications) APII testbed (Table 2) [8] (as well as other networks) for research use, and connecting them to international Internet testbeds such as APAN, AIII, and WIDE.

1.1 Study of G8-GIBN Acceptable Use Policy

The G8-GIBN (Global Interconnection and Interoperability for Broadband Networks) project was launched at the G7 meeting held in Brussels in February, 1995, and was designed to examine interoperability among broadband networks (this project was implemented along with eleven other pilot projects). In this project, network researchers throughout the world conducted high-speed image transmission tests [8][9] as well as other experiments aimed at improving the interconnectivity and interoperability of high-performance networks and testbeds on a global scale, and to encourage the development and operation of more integrated applications and services. Nakagawa et al. pointed out in 1998 that the AUPs of networks could serve as effective tools when building a better environment for interoperability, if these are used jointly, as a primary interface. However, we had to recognize that the AUPs in question were drawn up based on individual standards, within a variety of contexts and in different formats. There may even exist a few networks that did not make their AUPs open and accessible.

In order to understand the current status of AUPs, we first surveyed the extent of AUP disclosure and the contents of AUPs (and their equivalents) open to view within the networks relating to the project referred to above. The goal of this survey was to consider a form of AUP that would best meet the need for higher interoperability among networks. The survey was conducted by sending questionnaires (Reference-1) to networks that had joined the GIBN project. In addition to detailed information on their operations, we gathered open information from their home pages and compared the collected data.

2 Findings of the Survey

We sent the questionnaire to 18 networks. Half of them responded in the first round. We obtained data from all 18 sites by pushing them for responses and by searching home pages on the world wide web ("WWW"). The questionnaire had two sections of questions relating to the network profile (first layer) and to operational policy (second layer). In the analysis of the first layer, we asked whether the basic information on the home page was written in a widely understood language (namely, English) and whether the contact address was provided as a communication interface. In our analysis of the second layer, we examined whether the sites provided information necessary for interconnection and cooperative research work - namely, technical and organizational information, application procedures, financial and technical requirements, and handling rules for various types of traffic. All of the networks provided contacts on their home pages and around one-third of them had English AUPs on their home pages. Half of them represented networks in countries where English is the mother tongue. There were no significant differences among the networks in respect of the scope of the network and background of users, while some differences were noted in network structure and backbone configuration. All of the networks disclosed relevant information on their home pages, though on a few networks this information was not provided in English.

With regard to billing methods, bandwidth allocation, and the handling of different types of traffic, differences were noted among networks. Around one-fifth of them made such information public. All of the networks adopted user screening rules set by a steering com-

Table 2 *Proposed Experimental Items on APII testbed*

Experiment Title	Brief Description of Experiment	KR-JP	SG-JP
RSVP Backbone Establishment	RSVP Backbone establishment or application of Internet Multimedia	*	*
Measurement of Performance	System development for network performance measurement and characterization for traffic	*	*
MBone (Global High Performance Multicasting)	MBone system development for High Performance application such as remote classroom, video conference, broadcasting	*	*
IPv6 Protocol and other Internet technologies	To explore experimentation with and development of Next Generation Internet middleware and applications, especially over long distances		*
Caching (Global Hierarchical Caching)	Development of Network Cache technology for operation of several data networks including High Performance Network	*	
End to End Performance and Evaluation of ATM QoS	Establishment of the general test model (physical layer, ATM layer and etc.) in APII Test-bed based on ITU-T and ATM Forum documents, and test the performance	*	
GEO-Giga Net	Creation of future global gigabit applications and test of interoperability between gigabit LANs connected with high-speed international circuit(ATM)	*	
MVL (Multimedia Virtual Laboratory)	The MVL represents a system, which produces the same results as if they were engaged in research activities at a single laboratory, connecting geographically distributed researchers with a high-speed network, in order to promote world wide collaborative research		*
Cancer Center Collaboration	Establishment of teleradiology, telepathology and teleconsultaion systems, tele-conference system and cancer database	*	*
Teleconference System in Spinal Surgery	Clinical demonstration like transfer radiographical image (X-ray, CT, MR), tele-conference and etc.	*	
Bioinformatics Applications	To set up a bilateral experimental linkage to carry out large scale integration of molecular biology and biotechnology databases and will enable project participants from both sides to create a distributed biocomputational infrastructure		*
Advanced Multimedia Applications	To jointly develop advanced multimedia applications and services and to perform field trials in both countries Applications may include video conferencing, video-on-demand and browsers transmission of large graphical image		*
A Distributed Virtual Reality Conference	Establishment of conferencing environment based on the virtual reality system	*	
Tele-conference	ATM based high quality virtual conference experiment	*	
Real-time VLBI Experiment	Connection of the KAO's 14m antenna and the CRL's 34m antenna via APII, and Real-time VLBI Experiments to measure accurate positions, etc.	*	
Ionospheric Data Exchange Using Multimedia Environment	Ionospheric data exchange for studying radio propagation in the ionosphere	*	

mittee whose role was to examine and approve user applications. Only one network disclosed the details of its application procedures and user requirements on its home page. With regard to the detailed contents of network operation rules, three networks described the definition of each steering committee's accountabilities in detail, while two networks only briefly described the basic relevant points. With regard to network monitoring, most networks simply monitored the total traffic (probably due to problems in monitoring technology); their responses were ambiguous. Based on the above survey findings, we concluded that, regarding WWW disclosure in English and disclosure of contacts and specific network operation rules, the following should be further described in detailed operation rules in the second layer:

(1) Objective of network
(2) Technological basis
(3) Requirements for connection, including information concerning user charges
(4) Rules of bandwidth allocation and handling of traffic
(5) Network monitoring method
(6) Backup systems

It was also found that the degree of disclosure was not great enough to meet the requirements of network interconnection. On the other hand, there were a number of different forms of next-generation Internet testbed projects, designed, for example, to:

(1) Provide users with ultrahigh-speed Internet connection services
(2) Pursue innovative programs of research and development through network-based cooperation, by combining individual network research with testbeds connected to the Internet
(3) Conduct ultrahigh-speed network experiments within a single network (and not offering Internet connection service to public users)

As a result of such variable approaches, the definition of each network's role was not always clear [10].

3 Discussion

Fig. 2 shows an example of ATM-based testbeds, technical negotiations between networks in each layer, and the kinds of research activity applicable to each project.

Networks like vBNS and CAnetIII, which were included in the scope of the previous GIBN survey, were assumed to be networks of a single-layer Internet type, consisting of physical links, ATM switches, and routers. In the case of ATM-based networks, so-called "link owners" (such as governmental institutions) finance the costs of physical links or their construction, and of the basic hardware necessary for building a network. Therefore, in most cases, these link owners may make the final decisions on network operation policies. The budget allocation for the construction of physical links determines the policy described in the AUP because the objective of a network is to operate that network and actively support research projects based on that policy. The Internet-type connection is realized by the sharing of a single physical link across many projects (each with a different objective) and by the exchange of routing information on the network. The conventional Internet testbed was realized by the connections at the level of information routing (Layer 3) combined with the connection of the physical link (high-speed serial lines, for example), as shown in Fig.2. Therefore, a physical link formed only one single-layer Internet segment. However, thanks to ATM technology introduced in about 1997, it has now become possible for a number of projects (not all of which are required to be Internet-type) to share a single physical link, as shown in Fig. 2. In many cases, link owners have authority over the operating hardware comprising the network, and they establish connection-device settings in accordance with user requests. From a theoretical viewpoint, however, link owners do not have direct operational authority in cases where a user has access to a Layer-2 network testbed through a Layer-2 physical link and subsequently provides Layer-3 type services on this

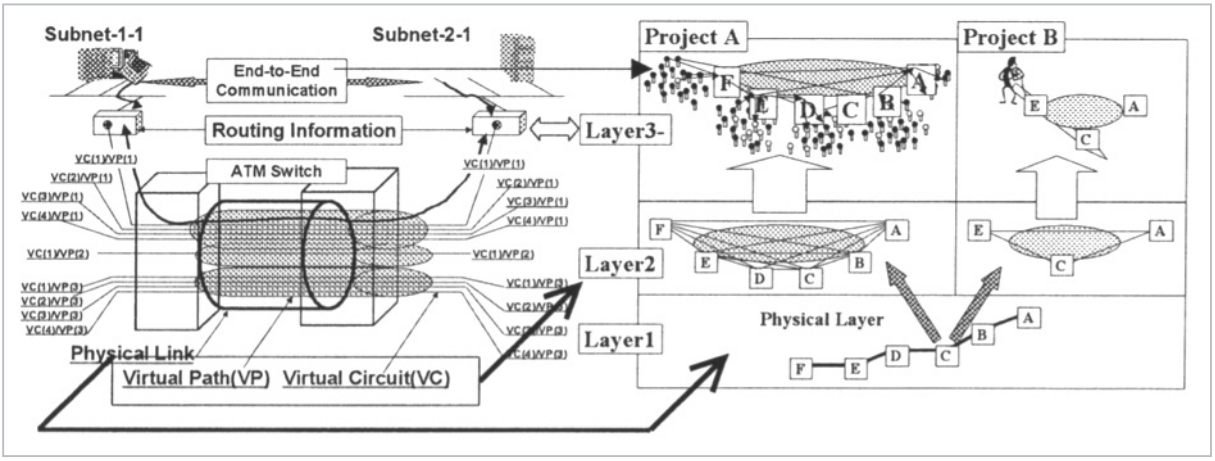

Fig.2 *Structure of ATM-based testbeds and relationship between research projects*

platform. Although there were some networks that described Layer-3 policies in the AUP, almost no network clearly discussed AUP for Layer-2. It thus appeared that a new policy definition would be necessary for testbed interconnection. This issue is substantially the same as that related to peering and transit in Layer-3 for commercial IX. Interconnectivity becomes effective in most commercial Internet services of the "at-your-own-risk" type if they agree among themselves on cost issues. On the other hand, in the case of publicly financed testbeds (having academic and research-related goals), policymaking may become complex, as each network must assume financial accountability, as well as being able to fulfill user needs. A few networks did not offer the important service of direct connection to other networks, placing too much priority on accountability with regard to their network budgets. A stopgap solution to such a problem is to use Layer-2 for transit, making Layer-2 invisible from Layer-3. However, using L2 switching in this way for the purpose different from that for which it was designed (i.e. to avoid accountability), will not only render connection information exchanged among networks invisible to users, but will forestall a true solution and will otherwise distort the problem.

3.1 Proposal of Layer Model in NGI Testbed

Fig. 3 shows the overall views of the operational forms of current NGI testbeds and research projects.

The qualities of physical links and their experimental lines have not been defined yet. Currently, the Network Research Community installs probes (detecting needles and other measurement devices) directly in the experimental lines, to observe network behavior and to introduce new technologies. Operative networks being formed in this manner, known as "network resource-consuming projects" (with user communities in their center) consume the bandwidth of the testbed, while the network research groups provide feedback on innovative technologies. JGN has adopted this form of operation and research. What is important in managing network projects in Japan is a willingness to foster developing network technologies through a productive relationship of technological development and network demand. Instead of simply consuming the network hardware resource to its end, it is important to create productive traffic data, which can then form a constituent element of network research. Discussions [11][12] have taken place concerning the collection of traffic data in experimental networks. The GIBN-AUP survey indicated that almost no networks specified in their AUPs that traffic data would be gathered. It is noted [13][14] that a potential

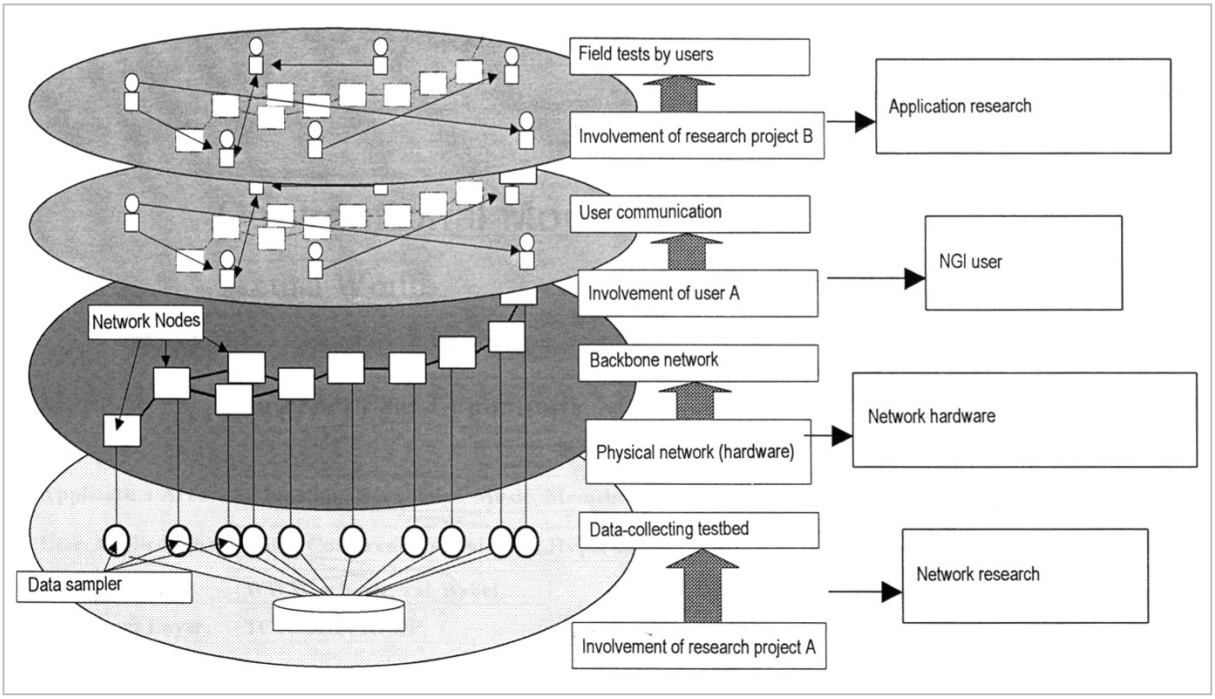

Fig.3 *Elements of next-generation Internet research projects*

problem for current Internet services is the gathering of traffic data without the consent of users. Nakagawa et al. defined the relationship between users and network researchers in the area of NGI testbeds as an issue of interference with human communication [7], citing a particular scheme used in clinical medicine. The above problem was thereby attributed to rapid innovation and to the diversification of physical Internet links and network technology, as well as to the immaturity of network research projects that are designed to deal with user needs and to manage user traffic. As shown in Fig. 4, we have now redefined the "policy layer," the part of the network relevant to network operation that has not been defined within the conventional OSI model, namely, elements directly related with traffic generation (such as AUP, rules for interconnection, and filtering rules within the network gateway).

The so-called Layer-2 network topology may be modified by emerging physical layers (such as WDM and D-WDM) in the near future. Therefore, we propose to define a switching layer, expanding the conventional layer defined as a "Physical Link," which will be affected by that modification. The issues in network interconnection are expected to be further clarified by such a new model. The invented model has been used on a trial basis for the Network Operation Workshop rules, for AUP, for the JGN user manual, and for the AUP of the CRL-APII testbed, all in connection with efforts to verify its effectiveness. This network, which has no direct connection to overseas networks at present, is expected to grow as an international next-generation Internet project. It has already provided domestic users with a connection to global experiments (such as the APII testbed project). Its future challenge is to effect cooperation with international next-generation Internet testbeds, while providing interconnection services for domestic networks.

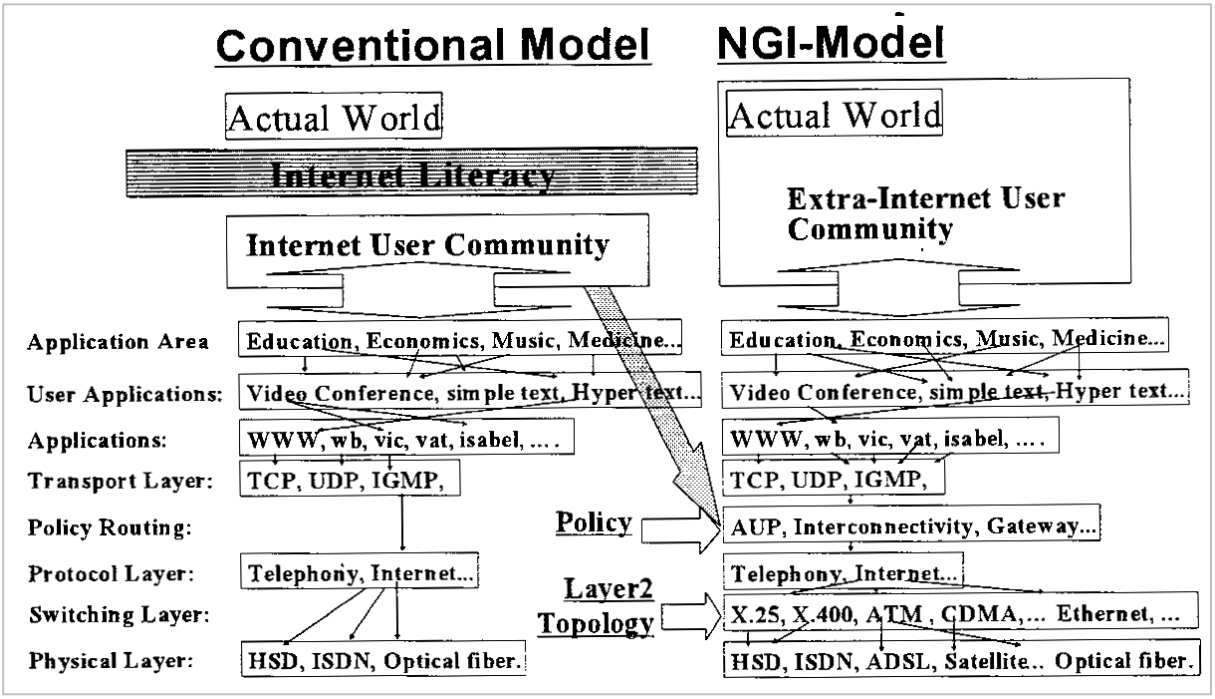

Fig.4 *New multi-layer model, built on NGI network architecture*

References

1 Tohru ASAMI, *"Next Generation Internet Backbones"*, IPSJ MAGAZINE Vol.40, No.07, pp.708-715.

2 http://www.tao.go.jp/JGN/index.htm,1999.

3 http://www.mpt.go.jp/whatsnew/school/net9901_ref6.html,1999.

4 http://www.mpt.go.jp/whatsnew/school/net9901.html,1998.

5 S.Nakagawa, K.Kuroiwa, F.Kubota, Y.Kitamura, S.Isobe and F.Takahashi, *"Proposal for 'Information SILK-ROAD' forming the Global 360 Testbed for NGI Research"*, G8-GIBN Workshop, Wiena, 1998.

6 CRL, *"ZISEDAI JOHOKIBANKENKYU NO SUISHIN NI KANSURU TYOSAKENKYUKAIHOKOKUSYO"*, 1999 (in Japanese).

7 S.Nakagawa, K.Ishikawa, M.Nakayama, S.Sano, et al, *"Inducing the human-intervention model for the Internet operation-comparison between Internet operations and Medical model-"*, IPSJ-EIP-2, pp.41-48, 1997 (In Japanese).

8 F.Kubota, T.Komine, H.Otsuki, E.TSANG & A.Vincent, *"High Definition Video Teleconference over Trans-Pacific Hetero-geneous ATM Networks using MPEG2 System-Application Experiment between Japan and Canada on Cardiovascular Surgery and Care-"*, 3rd International Distributed Conference (IDC '98), Lisbon, Sep., 1998.

9 T.Komine, G.Hamada, R.Suzuki, E.Tsang, F.Kubota, *"GIBN Multimedia Network Experiments-ATM Satellite Communication Experiments between Japan and Canada-"*, 20th Annual Pacific Telecommunications Conference (PTC '98), Waikiki, Jan., 1998.

10 S.Nakagawa, F.Kubota and K.Kuroiwa, *"Harmonization of Acceptable Users Policies of the Networks"*, IPSJ Symposium Series, Vol99-7, pp.357-361, 1999.

11 NEW ELECTRONIC HEALTH INFORMATION PROVISIONS POSE PRIVACY RISKS (CDT POLICY POST Vol.2(30) 1996:(1):http://www.cdt.org/privacy/health/

12 FUJIWARA SHIZUO, *"KOJIN DETA NO HOGO"*, IWANAMIKOZA GENDAINOHO10 (JOHO TO HO), pp.187-205, 1997 (in Japanese).

13 http://www.edu.ipa.go.jp/mirrors/netiquette/enc/admin.html, 1996.

14 K.C.Laudon, Ethical Concepts and Information Technology, CACM 38(12), pp.33-39, 1995.

Questionnaire on AUP (G8 GIBN Project)

[Section A: Questions on baseline data]

Q1. Objectives of the network: a. Research on network, b. Research on natural science, c. Technology, d. Application development, e. Software development, f. Education, g. Communication, h. Infrastructure services, i. Medical care, j. Finance, k. Other

Q2. Owner of the network: a. Governmental institute, b. Telecom carrier, c. Educational institute, d. Other

Q3. Sponsor of the network: a. Government (annual budget US$), b. Telecom carrier(annual budget US$), c. Other: please specify annual budget US$ and institute

Q4. Access fee: a. Required (annual or monthly fee US$), b. Free

Q5. Who pays the fee: a. User, b. Organization the user belongs to, c. Telecom carrier

Q6. Network backbone length: a. 10,000 km or longer, b. 1,000-10,000 km, c. 1,000 km or less

Q7. Maximum backbone bandwidth: a. 10 Gbps or larger, b. 1-10 Gbps, c. 600 Mbps (OC12)- 1 Gbps, d. 100 Mbps (OC3)- 600 Mbps (OC12)

Q8. Number of nodes in the network: a. 20 or more, b. 10-20, c. 5-9, d. 4 or less

Q9. Number of users in the network(approximately): a. 10,000,000 or more, b. 1,000,000 - 10,000,000, c. 100,000 - 1,000,000, d. 10,000 - 100,000, e. 10,000 or less

Q10. Major background of user: a. Network researcher, b. Scientist, c. Medical, d. Sociologist, e. Economist, f. Government officer (excluding research institutes), g. Governmental research institute staff member, h. Private institute, i. Member of the general public

Q11. Network administrator hired based on: a. Authorized qualifications, b. Interview, c. No specifics, d. Other

Q12. Number of network administrators in the network:

Q13. Salary of network administrator:

Q14. The network administrator works as: a. Regular employee, b. Contract employee salaried by the network organization, c. Temporary worker belonging to a contracted external institute, d. Volunteer, e. Volunteer and contract employee

[Section B: Questions on end-side connection]

Q1. Requirements of user for access: a. Submission of specific experimental plans (please specify the form), b. Submission of overall research plan (plan of individual experiments not required), c. No need to submit a research plan (user's participation in experiments is more important)

Q2. Access rights are maintained through: a. Submission of plans each time access rights are acquired, b. Decision of review committee, c. Ongoing payment of fee, d. Decision of network organization

Q3. Maintenance /Discontinuation of connectivity: a. User connectivity may be discontinued, if the research activity is judged as faulty, b. User connectivity may be discontinued, if academic performance (such as papers and presentations) are poor, c. User is not subject to discontinuation of connectivity based on research-activity performance alone

Q4. Commodity-type traffic: a. All commercial traffic is denied, b. Commercial traffic involved in network experiments is allowed, c. All commercial traffic is accepted, d. Judged on a case-by-case basis, e. No specific rules

Q5. Handling of external transit traffic: a. No transit traffic is accepted, b. Transit traffic is accepted

Q6. Connection to the Internet: a. Allowed, b. Prohibited

Q7. Actions taken upon network emergency: a. Rapid notification to users of the problem and risks involved, b. Notification of the end-site network administrator, c. Notification of the network administrators of each net-

work operation center, d. Notification is not deemed mandatory

Q8. Are there any legal protections for network administrators?

Q9. Policy for bandwidth allocation

Q10. Connection to an external network: a. Steering committee examines and permits the connection, b. Steering committee decides by vote, c. Researchers decide, d. Permitted on an at-request basis, for researchers and users

[Section C: Questions on network management]

Q1. Structure of the network management organization

Q2. Responsibility and authority of the network management organization

Q3. Research organization of the network

Q4. Responsibility and authority of the research organization

Q5. Liability of the network provider

Q6. Position within the network research network

Q7. Organization and structure of the user or researcher institute

Q8. Methodology of network monitoring

Q9. Structure of the network backup system

Q10. Functions of the network backup system

Q11. Person who takes overall responsibility and who handles administrative organization

Q12. Power of the personnel and organization of the individual described in Q11

Q13. Procedures for modifying the network organization

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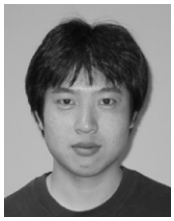

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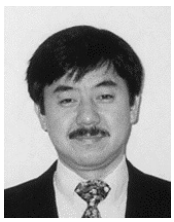

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