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Intranet Infrastructure and Its Application by the Electronics & Information Systems Division

Isao Nakaguchi [*1]
Osamu Taniguchi [*1]
Motoki Sawatani [*2]
Yutaka Miyabe [*1]

Abstract:

INTERNET originated in ARPANET which was spread in the US in 1969 was developed explosively from 1994 into 1995 and had prevailed widely over the public through multiplier effects such as the introduction of commercial services, the advent of providers servicing for individual at a low price, the development of area search environments represented by World Wide Web (WWW) and so. Further, a network so-called INTRANET had been generally constructed in which the INTERNET technology was applied to a part of the local area network system. The present paper introduces a utilization of the INTERNET on business and a preparation of network infrastructure, as examples of the INTRANET construction, which have been accomplished in Nippon Steel's Electronics and Information Systems Division. Further, the paper proposes a structural design of the local area network system aiming at a high-degree utilization of the INTERNET.

1. Introduction

In 1996, the word "Internet," began to be used everywhere. Technology from the Internet, named because of its connections between networks, is now being increasingly introduced to companies' inhouse network systems or "Intranets."

The Internet is a fascinating bundle of businesses, technologies, products, and information that is undeniably "flavor of the month." Despite the hype, though, users must have the capability and knowledge to use it. In 1988, Nippon Steel's Electronics and Information Systems Division (hereafter called "EI") joined JUNET (Japan UNIX/University NETwork), the precursor of Internet in Japan. Starting with email correspondence and NetNews, EI has gradually applied the Internet to its information system, accumulating Internet technology and experience along the way.

The knowledge and technological infrastructure obtained as a result has helped in developing a solutions business based on the Internet.

This paper will discuss the utilization of Internet by EI as an information infrastructure.

2. Utilization of the Internet for EI Business

EI is developing an Internet business as part of its solutions business, which offers such services as connecting clients' network systems with the Internet, constructing WWW-based systems offering commercial services on the Internet, and developing various Internet businesses.

On the other hand, the Internet is also very valuable as a busi-

[*1] Electronics & Information Systems Division

ness tool for the authors themselves. Now that all EI staff use personal computers installed with Internet access software, the Internet is the inevitable medium for EI's businesses.

This paper will discuss the present state of the utilization of the Internet as a business tool in EI, outline a view of the future, and touch on problems to be solved.

2.1 Utilization of the Internet as an information resource

More than anything, the Internet is associated with the WWW. EI mainly uses the Internet as an "information antenna" for obtaining external information after infrastructure for connecting to the Internet is in place.

In the business department, the Internet is used for obtaining product information from various manufacturers. The Web provides catalogue specifications and even new product information too recent to be published. In this sense it can be very effective in drawing up proposals. The development department also can obtain the very latest hardware and software product information needed for development and can get information on noncompatible products it has purchased. Some manufacturers with whom we deal are beginning to offer such services as inventory information or product prices, previously available only on a VAN (Value Added Network). It is anticipated that information services will eventually be offered over a VPN- (Virtual Private Network) type medium, which will be described later.

It is now becoming important to utilize the Internet to distribute products. In the past, when one of EI's software products or a product it had shipped was found to be incompatible, EI asked the particular manufacturer how to overcome the incompatibility or received an adapted or upgraded version by mail. Now, however, we can improve business efficiency by obtaining an immediate response by FTP (File Transfer Protocol) or by email. Some manufacturers are beginning to distribute their software products primarily through the Internet and this is almost certain to increase in the future. On the other hand, the security problems related to the corruption of software by viruses will become serious. Electronic signatures and other measures are beginning to be adopted for the distribution of software products and these will become more common in the future.

Public domain technical information, including white papers or attached sample programs or data, can also be obtained through the Internet. Such information has been utilized by scientists and engineers since the days when the Internet was a tool mainly for researchers or academics. To obtain this information, retrieval protocols such as the WWW, WAIS (Wide Area Information Services), Gopher, or Archie are used. The Internet can be more effective than searching hard documents because of the wider contents to be retrieved and of the ability to download information directly to the computer.

As Internet connections become more popular, salespersons or engineers will be able to access the office from virtually anywhere to retrieve for information or obtain software. However, with the possibility of accessing internal information from outside, security measures such as authentication and access control will become important.

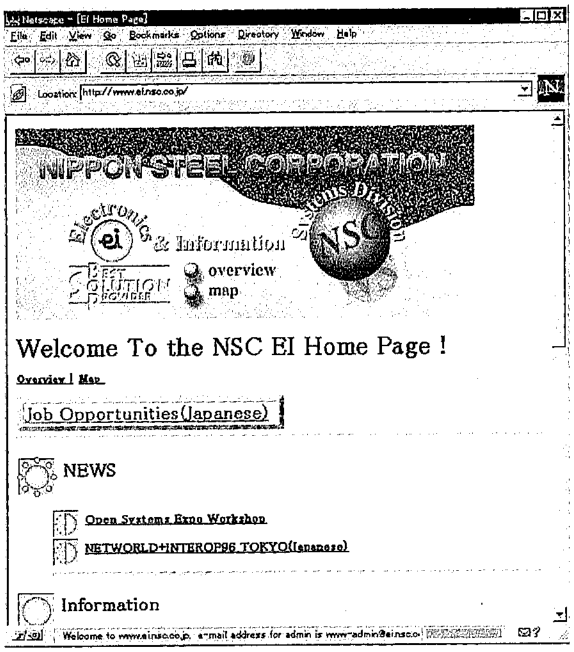
2.2 Using the Internet as a "window of services"

EI utilizes the Internet as a window for offering its services. EI uses a WWW server (www.ei.nsc.co.jp) to offer various kinds of information to the public, including information on EI itself, its products, the technology it uses, events, and to place advertisements for personnel recruitment. Furthermore, EI offers retrieving services based on NSEARCH[*1], a full text retrieval engine developed by Nippon Steel, and offers patch data on operating systems or software related to NSSUN[*2] (OEM-based Sun workstation sales) (See **Fig. 1**)[*3].

EI has started to use email to support clients introducing EI's system solutions and can respond to remote system faults through Telnet. In the future, EI will offer quicker and more carefully designed measures to clients, based on EI's client or claim databases.

2.3 Utilization of the Internet to link companies

EI has used email ever since JUNET started Internet business through UUCP (UNIX to UNIX Copy). Today, email has become an indispensable means of communication like the telephone or facsimile. Its popularity is based on such advantages as its asynchronicity, which allows communication with others regardless of whether they are physically at the end of the telephone line or not, its ability to copy and reuse data as sent, and quicker correspondence as a result of the IP (Internet Protocol), which replaced UUCP.


Netscape - [EI Home Page]
File Edit View Go Bookmarks Options Directory Window Help
Location: http://www.ei.nsc.co.jp/
NIPPON STEEL CORPORATION
Systems Division
NSC
Electronics ei & Information
BEST SOLUTION PROVIDER
overview
map

Welcome To the NSC EI Home Page !

Overview | Map

Job Opportunities(Japanese)

NEWS

Open Systems Expo Workshop

NETWORLD+INTEROP96 TOKYO(Japanese)

Information

Welcome to www.ei.nsc.co.jp, e-mail address for admin is www-admin@ei.nsc.co.

Fig. 1 EI's home page

EI deals with products and technology made in the United States or jointly developed with US companies. In the past, EI staff had to physically travel to the United States to arrange joint projects, or relied on mail and telephone calls, which incurred costs in time and money. Even now, personnel must often physically travel abroad for substantial joint projects or important meetings. "But for smaller projects on workstations or for send-

[*1] NSEARCH is a trademark of Nippon Steel Corporation.

[*2] NSSUN is a trademark of Nippon Steel Corporation.

[*3] In addition to EI's server (http://www.ei.nsc.co.jp/), the division maintains several other servers for outside visitors, including a server for Nippon Steel Corporation (http://www.nsc.co.jp/).

ing or receiving software codes under development or for projects already in hand, Telnet, FTP or email have considerably improved efficiency."

VPN, the topic of the moment, is a natural result of such an electronic business approach. VPN will be realized in the future to develop or acquire information jointly with other companies on a larger scale through the Internet.

In addition, the development of EC (electric commerce) will make it possible to procure goods through the Internet, though some problems remain to be solved. In addition to the security problem, it will be necessary to develop BPR (business process re-engineering), which includes reorganizing present procurement flows and instigating a budget system.

2.4 Utilization of the Internet as public information highway

Considering that the Internet is a form of information infrastructure for everyday individual use like the telephone, it is natural to expect remote access from home or anywhere that might be visited on business.

The first requirement will be access to one's office email server from outside. At present, Internet access infrastructure does not yet fully cater for private individuals. Safe access points have been set up in offices to which a limited number of users can be directly connected through a public telephone line using special email software. However, with universal access to the Internet from anywhere, there will be no necessity for a limited number of access points for a certain number of users, and it will be possible to access company email server as long as sufficient security measures are in place.

Furthermore, workers of the future will enjoy remote access not only to email server but also to files on servers in the office, and will be able to perform development on a machine in the office from a third location, thus realizing the SOHO (small office, home office) ideal. But many problems must be solved before this can be realized, including the problems of the present system structure, security, and the development of working systems.

3. Utilization of an Intranet in the EI Division

3.1 What is an Intranet?

An Intranet realizes an office automation system using Internet technology and applications. As communications protocols, the Internet standard protocols are used, including TCP/IP, used as the base, SMTP (simple mail transfer protocol), used for Internet mail, and HTTP (hypertext transfer protocol), used for the WWW.

It is generally recognized that Intranets contribute to cost reduction. This is because Intranets use open Internet technology and can be constructed with inexpensive or free Internet software. In addition, by using a WWW browser, it is possible to enjoy a unified GUI (graphical user interface) regardless of the client's machine (terminal), which does not need to be specified. But how inexpensive is it really to introduce an Intranet, an office automation system? Is it enough to rely on applied Internet technology only? The following discusses these questions in relation to EI's own Intranet construction.

3.2 Introduction of Intranet to the EI Division

3.2.1 EI-OA

For the ten years since the Division started, the EI division has been constructing an office automation system (EI-OA). The following is an outline of the history of the EI-OA.

(1) Electronic mail

EI joined JUNET in 1988, and ever since has used email for quick information transfer. In 1988, personal computers were still expensive and the merits of email and whether results would justify its cost were still not apparent. At first, personal computers used for business, development, or design were also used for email. One computer was used by four or five members of the Division. Email was used by only some staff at first but gradually became used by all.

When email was first introduced, not everybody could use it comfortably. Some were still uneasy about personal computers themselves. Such people were encouraged not to use wordprocessors but to use wordprocessor software on personal computers. As a result, all the staff became comfortable with personal computers and email.

As utilization of email increased, its convenience was recognized by every member of the staff and its use increased further. Everyone was forced to use email because it was used for correspondence on important meetings or for business communications. Today, a network infrastructure is in place and everyone in the Division has their own computer.

In the EI Division, email is used not only for transferring information, but also for electronic meetings or collaboration based on mailing lists.

(2) Business systems

As mentioned above, personal computers replaced word processors in the Division, which is now developing systems for running other businesses and services on personal computers too. For example, PC-based systems have already been developed for reserving conference rooms or rooms at Nippon Steel's own resort facilities (in the past a special terminal was used), for applying for education programs, for business trip expense accounting, and for controlling staff duties. Such tasks are now based on client PC terminals.

(3) WWW servers

With email, the same information can be sent to multiple destinations at the same time. Email is a very effective means of specifically targeting information. But it is not realistic to simultaneously send a message to tens or hundreds of people because of the high load this places on the network. In such cases, an electronic bulletin board system is more effective because many people can access it. While promoting the use of email, EI set up a WWW server as a bulletin board, accessible by all EI staff. (See **Fig. 2**.)

(1) EI offers Internet/Intranet construction as a business.

(2) Each member of the research department has a WWW server and an individual home page.

(3) Many departments used WWW servers for promoting projects.

As a result, EI has accumulated WWW server technology and knowhow and has applied this to the construction of a bulletin board.

Employee magazines, house instructions, and information on seminars, which used to be distributed in written form, are now delivered through the bulletin board, resulting in a smoother delivery of information. As a result, if information is needed, all that is required is access to a WWW server. It is no longer necessary to stack up papers on one's desk or store bulky materials on shelves. The latest information is always available on a WWW server and users do not have to store or otherwise be responsible

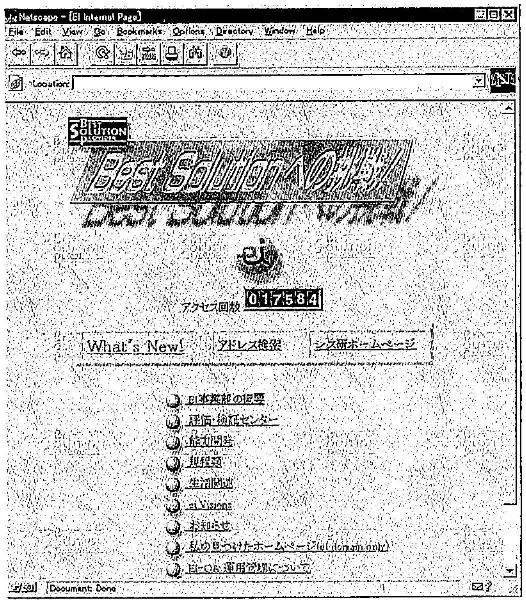


Fig. 2 EI's office automation system home page

for it.

EI specifically designed its WWW server to be visually comfortable and user-friendly. It offers such information as train and bus timetables and canteen menus so that even Internet "newbies" can feel comfortable and get used to using a server. Our server also offers a facility for retrieving the email addresses and telephone numbers of all EI staff.

Approximately 10% of the Intranet menu items currently offered are for "recreation and enjoyment." Such items offer convenience to users and improve awareness and utilization of WWW servers.

3.2.2 Evaluation and verification center[1-3)]

To keep abreast of the rapid progress of information technology, the solutions business promoted by EI must strengthen systems that combine the optimum hardware, software, and technology. It is essential for EI not to depend on the technological capability of its individual members, but to acquire technology as a company to improve EI's ability as a multivendor to propose attractive solutions.

The WWW server bulletin board mentioned earlier transmits information, but this transmission is only one way. We therefore constructed the "evaluation and verification center" on our WWW server to make the bulletin board a "joint information ownership" board. Staff magazines or house instructions are only for certain users to access. On the other hand, the point of "joint ownership of information" is to share the information possessed by each EI member, and to make that information the joint property of the whole division. We therefore constructed a system through which each member of the staff can not only access but also send information, permitting the exchange and sharing of up-to-date information and knowhow previously known only to an individual or group.

The "evaluation and verification center" is a forum where the whole EI division can access or offer information. It is a virtual organization that breaks down the barriers between departments. The "evaluation and verification center" consists of several different systems corresponding to different roles. Each system is described below.

(1) Bulletin board for technological contributions

This is a bulletin board to which each member of EI can contribute technical knowledge obtained through his or her business or collected from outside the company, allowing each EI member to share the information.

Generally, only specific controllers can transmit information through a WWW server. To allow multiple and unspecified users to freely transmit information requires groupware or the construction of a special system. The Division therefore prepared a system that allows anyone to contribute information through the WWW server easily and freely. This system allows users to create free input display templates and has a database function for controlling such details as the period to display the information posted on the bulletin board. This system, which facilitates information retrieval and display, is offered to clients as a part of SI (systems integration) for providing solutions. (See **Fig.** 3.)

(2) Bulletin board for technological information

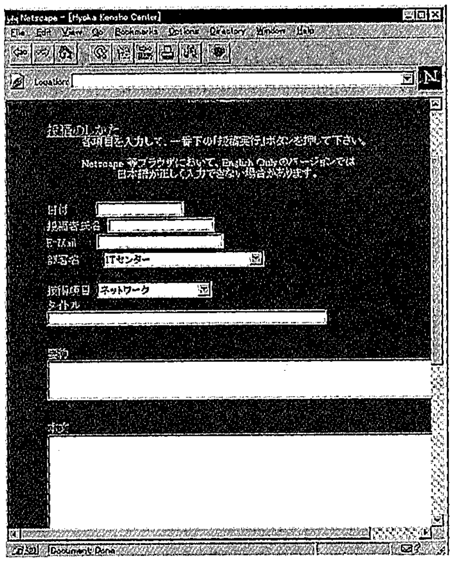
This system allows all EI staff to access, up to an approved level, not only the knowledge and knowhow of other staff, but also technological information obtained regularly or otherwise from outside the company. Such sources might include hardware and software vendors, information vendors, academic groups, or other associations. Up-to-date information on R&D results is also available on this bulletin board. In this way, EI promotes the disclosure of the latest technological information and makes efforts to cope with rapidly changing information technology.

Some information on the WWW server is available only to managers or directors, or to specified people. The system can specify the permitted users through the access control function.

(3) Q&A on technological information

While the bulletin board for technological contributions is a noticeboard where each individual can post information, often the information required is not on the bulletin board, particularly in the case of knowhow that cannot be jointly shared.

In the past, it was necessary to track down out the persons


Netscape - [Hyoka Kensho Center]
File Edit View Go Bookmarks Options Directory Window Help
Location:
Document: Done

投稿のしかた

各項目を入力して、一番下の「投稿実行」ボタンを押して下さい。

Netscape 等ブラウザにおいて、English Onlyのバージョンでは
日本語が正しく入力できない場合があります。

日付
投稿者氏名
E-Mail
部署名 ITセンター
技術項目 ネットワーク
タイトル
要約
本文

Fig. 3 Bulletin board input display template for contributing technological information who had the knowhow and telephone or visit them to ask questions. However, if the persons belonged to different groups or departments, or their offices were widely dispersed, this was difficult, and sometimes asking questions was awkward. For those reasons, we constructed a universally accessible system that anyone can use to freely ask questions when information is required.

Our interactive information exchange system was constructed using the NetNews function of the Internet. NetNews was employed for the following reasons. It is open technology like the WWW and because the client is not restricted, anyone can access it from a PC or workstation. Q&A information can be shared because past Q&A items are archived and access is available to all users. One section of EI has used NetNews for nearly 10 years and has accumulated considerable knowhow on it. As the WWW browser also serves as a news reader, the system is easy to operate by those unfamiliar with NetNews. NetNews can be constructed by combining a news reader and the WWW.

(4) Retrieval function

A retrieval function is also provided to separate specific "trees" (items of information to be searched) from the "woods" of various types of information stored in the evaluation and verification center.

Ultra-fast information retrieval software (NSEARCH) developed and marketed by EI was used to construct an internal system that allows retrieval for a whole sentence at ultra high speed. This allows specific technological information to be easily found from a large amount of data. Various functions are provided to easily locate the right "tree." The system can be used to simultaneously retrieve and display technological information stored in various systems such as WWW and NetNews. Multiple keywords can also be combined using "and" and "or," and the system can restrict the pages to be retrieved (for example, to Q&As on technological information). (See **Fig. 4**.)

4. Network Architecture

Now, let us turn to some inhouse network designs that reconcile security with availability for multiple sites using different network operation policies in the same company. EI's Intranet was based on the network infrastructure demonstrated here.

4.1 Background

When interconnecting an inhouse network with the Internet, companies use firewalls to allow internal users access the Internet at low cost while preserving the security of the company's internal network. Generally, by limiting interconnection (on ramps) to the Internet to one and setting a firewall at that point, the security of the whole organization can be protected.[4,5]

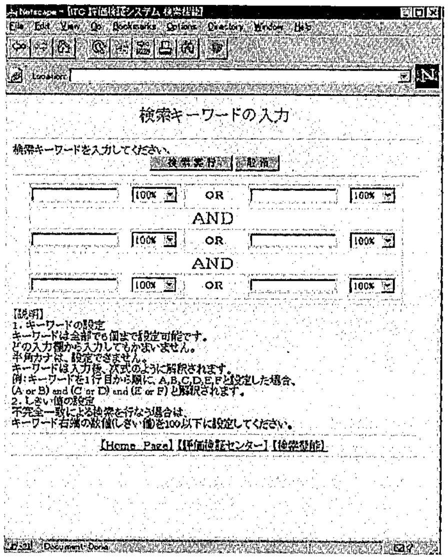
Firewalls are constructed on the premise that:

- Policy for network operation, management, administration and use (hereafter simply called "policy") is plain and simple,
- The internal network is safe and users can be relied upon,
- Services required by users can be relayed through a gateway.

However, as networks are used increasingly frequently, the following four problems are appearing.

(1) Internal policy is not simple

The same company may contain sites that use the Internet merely as casual users and others that use the Internet for business or research. The demands of the former can be generally satisfied by providing limited access to some Internet services (such as the WWW). But the latter may require access from outside the company (login ability, for example).



Netscape - [ITC 評価検証システム 検索機能]

検索キーワードの入力

検索キーワードを入力してください。

	100%	OR		100%
		AND		
	100%	OR		100%
		AND		
	100%	OR		100%

【説明】
1. キーワードの設定
キーワードは全部で6個まで設定可能です。
どの入力欄から入力してもかまいません。
半角カナは、設定できません。
キーワードは入力後、次式のように解釈されます。
例：キーワードを1行目から順に、A,B,C,D,E,Fと設定した場合、
(A or B) and (C or D) and (E or F) と解釈されます。
2. しきい値の設定
不完全一致による検索を行なう場合は、
キーワード右端の数値(しきい値)を100以下に設定してください。

[Home Page] [評価検証センター] [検索機能]

Fig. 4 Retrieval function

If a certain section within a company grants a joint partner from outside the company the same rights to access sites or resources as its own staff, the security of other internal sites or resources may be jeopardized.

(2) Internal networks are not necessarily safe

Some inhouse sites use terminal servers and modem pools capable of receiving mail from users out on business. However, such sites can lay themselves open to intrusion by others slipping into the internal network.

Since Internet service providers (ISPs) began connections to individual users, anybody can be easily connected to the Internet. Non-vigilant administrators or inexperienced users can inadvertently make settings that leave internal networks open to backdoor entry from outside the company.

(3) Special connection with outside required

Some organizations require special connections (a dedicated line to a joint developer, for example) for close contact with a partner without connecting through an outside connection point or the Internet.

(4) Services not relayed through a gateway

Firewalls are structured in denial of the principle that "any two hosts on a TCP/IP network are connectable." To allow connectivity between an internal and an external host it is necessary to relay a packet through a gateway.

Usually, transport gateways such as SOCKS (TCP relay) or udprelay (UDP relay), and proxy servers such as CERN httpd are used as gateways. When transport gateways are used, general relay services can be offered for TCP or UDP (user datagram protocol), but as not all relay services can be accepted by client applications, client programs (generally on internal computers) should be modified for the gateway (proxy connect(), bind(), etc.). With proxy servers, client programs should be modified for the gateway, and the services available are restricted to those offered by the gateway manager (WWW, FTP, Gopher, and others).

It is impossible to meet all the requirements of users with one firewall or a single policy. An overall security policy should be determined with due allowance for sites with poor security or those that require high-level security. Unless this is in place, users may make arbitrary settings. Especially when company sites are widely distributed, the company cannot cover all sites, resulting in the failure of the network from inside. Such cases are expected to increase in the future.

Solving these problems requires the following network policy guidelines:

- Divide internal networks into subnetworks, according to each network operation policy,
- Construct a firewall for each subnetwork, and
- Interconnect subnetworks,

EI designed structural architecture and an internal network, and mounted a structure called netsys/IXA (netsys-proj Internet Exchange Architecture) as a demonstration network (netsys-proj is an abbreviation used by the research and development team).

netsys/IXA was designed according to the following principles:

- Construct an incompany backbone system with a network traffic exchange function
- Pay due regard to the policy of each organization connected
- Clarify the control border between the backbone and each organization to be connected
- Each site should connect to the backbone based on a policy of "protecting its own interests"
- Accept each site's own connection
- Maintain connectability to the Internet at multiple points
- Guarantee direct connection from each site to the Internet when necessary

4.2 Structure

Fig. 5 shows an example of netsys/IXA design.

Fig. 6 shows the current structure of netsys/IXA.

netsys/IXA-Sagamihara, netsys/IXA-Oita, and netsys/IXA-Shinjuku, known as "network operation centers" (NOC), were established with a backbone of dedicated lines or frame relays. The EI Systems Research and Development Center, to which the authors belong, the EI Division Sagamihara, and the WIDE (wide area integrated distributed environment) project joint research environment are connected to netsys/IXA-Sagamihara. The Oita Works and (part of) the Yawata Works are connected to netsys/IXA-Oita. The EI Division in Shinjuku and the head office are connected to netsys/IXA-Shinjuku. Other Works can be connected through head office.

To realize the policy of protecting one's own interests, each site puts up a firewall and connects to the netsys/IXA backbone.

4.3 Addressing and routing

To secure a direct connection between each site and the Internet, a global address (not a private address) is assigned to the firewall of each site connected. To assign the necessary number of addresses to the necessary sites for effective use of IP addresses, each site is assigned variable-length masking from 27 to 29 bits (unnumbered, or 30-bit masking for point-to-point) and OSPF (open shortest path first)[6] is employed as the route control protocol.

Table 1 shows the result of the traceroute from a computer on the WIDE Internet to the CS center of Yawata Works (csc.nsc.co.jp). Internet reachability is provided from the Internet into the company starting from the point of connection with a provider (9th line).

The site (EI, for example), which is connected to netsys/IXA at multiple points, maintains a link as a backup route for the netsys/IXA backbone.

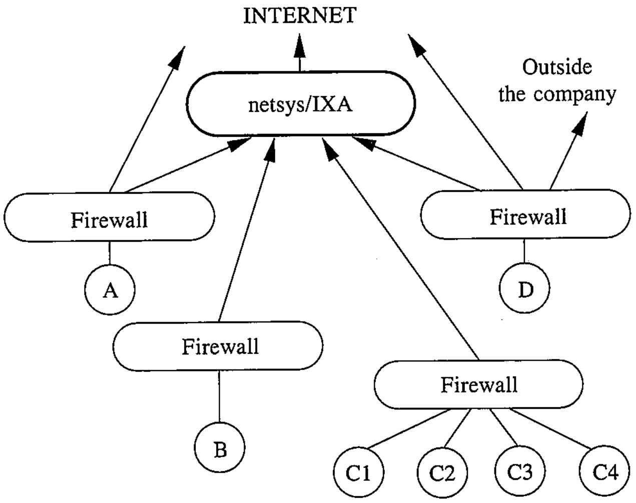


Fig. 5 netsys/IXA Design Concept

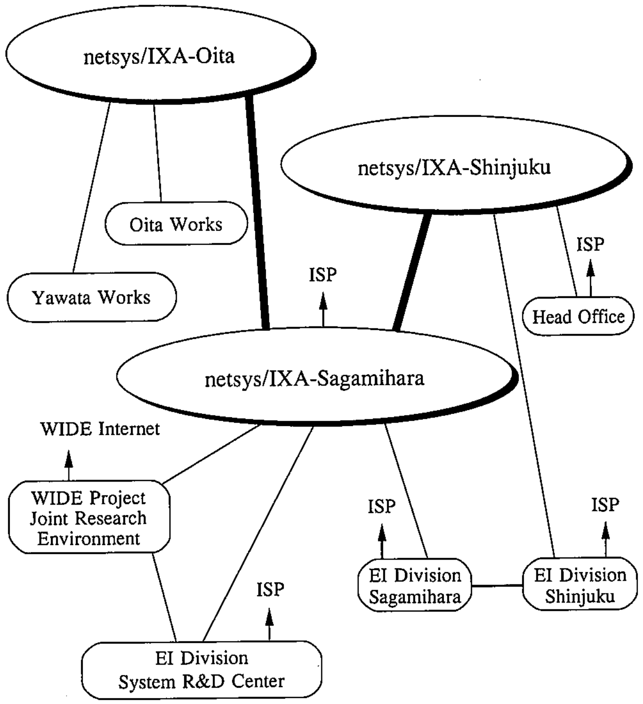


Fig. 6 Current Structure of netsys/IXA

When the netsys/IXA backbone is unavailable, EI will determine whether this internal link can be used by other sites as a backup route. Some sites may be permitted transit, but others may be denied. To realize this route control (EI's policy), each connected site will be made an AS (autonomous system) and the routes between the AS will be exchanged using BGP (Border Gateway Protocol)[7]. This method is generally used for interconnecting providers. However, we did not apply the method to an internal network this time because of the amount of control and limitations on routers (some routers cannot correspond to BGP,

Table 1 Example of a traceroute

```
          nakaguch@sh.wide.ad.jp% traceroute csc-gw.csc.nsc.co.jp
   traceroute to csc-gw.csc.nsc.co.jp(202.230.50.147),30hops max,40byte packets
 1  sun1.tokyo.wide.ad.jp(133.4.2.2) 8 ms 8 ms 8 ms
 2  cisco9.tokyo.wide.ad.jp(133.4.3.27) 11 ms 11ms 11 ms
 3  tokyonet.nspixp.wide.ad.jp(202.249.3.38) 9 ms 9 ms 9 ms
 4  harajuku-bb.TokyoNet.AD.JP(202.239.61.2) 144 ms 144 ms 144 ms
 5  otemachi-bb6.TokyoNet.AD.JP(202.239.61.6) 206 ms 207 ms*
 6  router00-Fddi2-0.tokyo1.TokyoNet.AD.JP(202.230.255.162) 281 ms *220 ms
 7  router01-Serial1-3.yokohama.TokyoNet.AD.JP(202.239.61.250) 231 ms 235 ms 208 ms
 8  router04-Ethernet0.yokohama.TokyoNet.AD.JP(202.239.62.5) 271 ms 252 ms*
 9  tokyonet-cisco-0.netsys-ixa.nsc.co.jp(202.230.50.1) 252 ms 247 ms
10  sagamihara-cisco.1.netsys-ixa-nsc.co.jp(202.230.50.2) 205 ms 183 ms 215 ms
11  oita-cisco-0.netsys-ixa.nsc.co.jp(202.230.50.49) 253 ms *287 ms
12  oita-cisco-1.netsys-ixa.nsc.co.jp(202.230.50.52) 248 ms 257 ms 252 ms
13  yawata-ixa-cisco.csc.nsc.co.jp(202.230.50.145) 277 ms 300 ms*
14  csc-gw.csc.nsc.co.jp(202.230.50.147) 293 ms 228 ms*
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or limitations exist in the memory capacity of routers). At present, the route corresponding to the policy of each connected site is calculated in the netsys/IXA backbone protocol, then converted to the route control protocol (RIP (Routing Information Protocol) or OSPF), which each site requires, at the border router between the backbone and the site, and is sent inside the site.

4.4 Joint use segment

Let us consider provision of a computer which can be jointly used by site A and site B, each having different policies. Site A would trust site B and relax restrictions on the firewall so that site B could be permitted access to the jointly used site A computer. But if site B was invaded from outside, site A could also be damaged by the intrusion.

To prevent this from occurring, a joint use segment was established and the following packet filter was set at the routers.

- Access from sites A and B to the joint use segment allowed
- Access from the joint use segment to sites A and B denied

If site B should be invaded, the joint use segment could be damaged, but it would be very difficult to invade site A. (See **Fig.** 7.)

4.5 Applications on EI-OA

For historical reasons, the policy adopted by the EI system research and development center (elelab.nsc.co.jp) differs from that in other EI departments (ei.nsc.co.jp).

To realize interconnection that respected the other's policies, each site constructed a firewall and connected to the netsys/IXA backbone. Some shared computers (eg, EI's shared WWW server) were placed in the joint use segment.

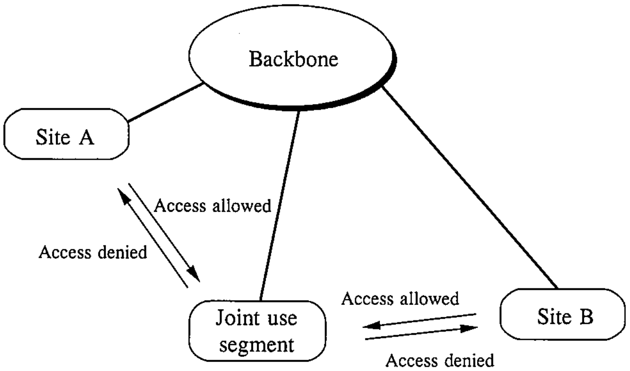

Fig. 7 Joint use segment

Since there is no need for look-up from the Internet, a private address was assigned to the joint use segment.

Reverse look-up for private addresses and internal host names that need not be looked up from the Internet are controlled by the netsys/IXA root name server. The sites connected to netsys/IXA can look up addresses/names on the Internet as well as private addresses/internal names using the netsys/IXA root name server instead of the root name server on the Internet (eg, A.ROOT-SERVERS.NET).

5. Conclusion

This paper outlined EI's business use of the Internet, the Division's internal use of the Internet, and the network topology technology that forms the basis of this utilization.

The technological information infrastructure in the Division that combines the WWW, email, NetNews, the database, and groupware as EI's Intranet is beginning to be universally utilized in the EI Division from the manager down to the newest employees. In contrast to the distribution of information through Nippon Steel's organizational strata (departments, sections, and subsections, etc.), this information infrastructure has resulted in horizontal (between people in the same positions in different organizations) distribution and co-ownership of information. Accordingly, the system is particularly important for technological information. This distribution of information, which allows people to speak freely and frankly, improved organizational cohesiveness without upsetting the conventional structures. To realize highly sophisticated applications and fully support key company business in the future, the whole business flow must be systematized by introducing at division level groupware now operated by individual departments.

This paper also presented netsys/IXA, a network infrastructure for constructing an Intranet, as an example of an internal network when several operational policies operate in one company. If each site connects to the Intranet based on a policy of "protecting its own interests itself," the freedom of each site will not be restricted by the different policies of other sites operating the same network. Thanks to netsys/IXA, a safe internal network giving due consideration to the operation policies of each site was realized. The research and development for this network started in 1994 and since 1995 has been utilized as the overall network infrastructure in EI as well as in some Works.

A future technological problem to be solved is the coexistence of availability and security at a higher level. In constructing the Intranet, information services for individuals and support for joint tasks within the same operation policy (organization) were realized. At present the shared segment is used for convenience in joint tasks between different organizations or sites.

In the future, interconnection not by firewall but by a combination of IP tunneling and encryption-authentication technology, now under development, will be necessary. In designing an Intranet, it will be necessary to consider such issues as which information should be shared, who will be permitted access, how far a user can be trusted. This will be significant at the first stage of maintaining security, that is, to answer the questions: why the protection (purpose)?, what is being protected (subject to be protected)?, and what is the information being protected from (danger)? The answers to these questions will also help control investment in security and keep security policy tightly focused.

References

1) Tasaka,H.: Intranet Operation, Seisansei Shuppan, 1996
2) Kuroda,Y.: MEDIA REPORT from the West Coast, Tokyo Kaleidoscope, http://www.smn.co.jp/JPN/features/mr/index.html
3) Intranet for Executives, NTT America, Inc. http://www.nttca.com/library/NowInternet/3/
4) Cheswich, W. R. and Bellovin, S. M. Firewalls and Internet Security - Repelling the Wily Hacker, Addison-Wesley, 1994
5) Report on 1993 WIDE Project Research
6) Moy, J.: "OSPF Version 2", RFC1583, March 1994
7) Rekhter,Y., Li, T.: "A Border Gateway Protocol 4 (BGP-4)", RFC1654, July 1994