NTT's Strategy for Highspeed Multimedia Communications

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Abstract

This paper explains the NTT's strategy towards the future highspeed multimedia communications. First, NTT's future business plans are explained from the viewpoint of service development and global cooperation among customers, other carriers and manufacturers. Then the key technologies, such as optical subscriber loop, asynchronous transfer mode (ATM) and Intelligent Network, required for the future communications networks and their introduction plans are presented. The possible scenarios towards the future multimedia communications, then, are presented taking account of the special conditions in Japan. Finally specific plans to promote early realization of highspeed multimedia services are outlined. They include the pilot testing of multimedia services to household users using optical fiber distribution technology, and a nationwide highspeed backbone network based on ATM technology aiming for promoting the development of new information providing services and highspeed computer communications.

I. Introduction

Current NTT network provides variety of services including basic telephones, leased circuits, packet-switched data communications, pagers and ISDN services (Fig. 1). It has evolved from the original analog public switched telephone network (PSTN) into a set of subnetworks now suits each demand of specific service. The number of telephone subscribers in Japan has grown rapidly in the last 30 years and it now reached as many as 58 millions which is second only to that in the United States. A major shift in telecommunications is now in progress, however, as the demand for plain old telephone service is becoming saturated, and widespread interest is beginning to focus on new categories of services such as high-speed data transmission among computers, multimedia communications, mobile communications and interactive video on demand (VOD).

Fig. 2 plots the recent growth of three service offerings introduced in 1980's: narrow-band ISDN (N-ISDN) lines, mobile phone subscriptions, and NTT's Free-dial service. These figures demonstrate that users are definitely receptive to advanced communications services. The best indicator is the brisk demand for basic rate and primary rate ISDN lines: NTT's INS-Net 64 and INS-Net 1500 services. As of September 1993, 192,000 basic rate (2B+D) lines and 3,800 primary rate (23B+D) lines are in service. Two sales strategies have contributed to this explosive growth. The first is the quick expansion of service areas. Currently, N-ISDN services are available in almost all areas in Japan. The second factor is the introduction of the N-ISDN packet service (INS-P) that provides an economical alternative to access X.25 packet-switched network (DDX-P) started in June 1990.

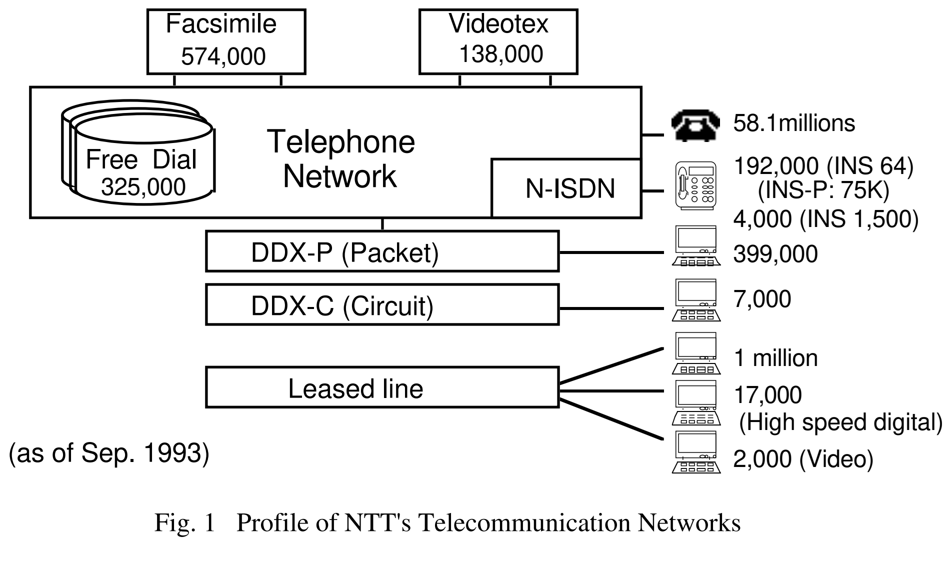

Fig. 1 Profile of NTT's Telecommunication Networks

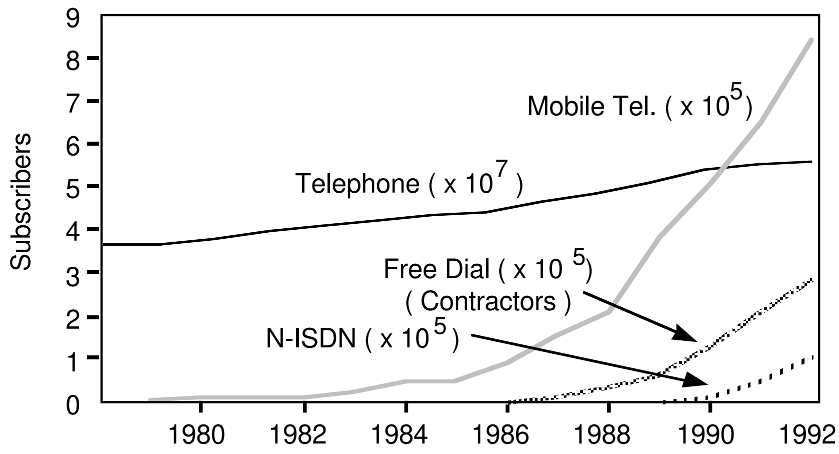

Fig. 2 Growth of New Telecommunications Services

The number of N-ISDN subscribers will probably continue to increase along with the growing demands for economical data communications. In addition to the G4 facsimiles, its use as a small and temporary computer communications link will increase sharply. Although, for the time being, they are best represented by data communications between host computers and point of sales (POS) terminals at retail stores, the use as an on-demand access line to private or public computer networks including the Internet will grow quickly. This will not only promote ordinary households to subscribe N-ISDN services, but also serve as a trigger for the introduction of broadband ISDN (B-ISDN) services eventually. Projecting ahead based on the growth rates, the number of installed N-ISDN lines should top 1,000,000 within the next few years, and the proportion of bandwidth allocated for highspeed data transmission will continue to grow.

In parallel with the digitization of network systems, the introduction of intelligence (computers) into the communications network have been going on for the last decade. This move has initiated the fusion of communications and information processing in telecommunications network. In other words, telecommunications network is beginning to alter itself into a large web of computers connected with dense communications links bringing us tremendous processing power. With the introduction of asynchronous transfer mode (ATM) technology, network facilities and computers will be coupled much more closely due to its similarity of their data handling. This will make its processing capability more powerful and flexible to use for new network applications including multiprotocol internetworking, multimedia communications and intelligent services.

With those transformations of communications networks in mind, NTT has released a strategy to promote the development of highspeed multimedia communications services in January. This paper reveals its basic concept and current activities as the first step aiming for the early arrival of coming multimedia age. First, in Chapter II, NTT's future business plans are explained followed by the explanation of key technologies required for the development of the future communications networks. Then, their introduction plans are presented in Chapter III. Chapter IV presents the possible scenarios towards the future multimedia communications taking account of the special conditions in Japan. Finally in Chapter V, the specific activities to promote early realization of highspeed multimedia services are outlined. They include the pilot testing of multimedia services to household users using optical fiber distribution technology, and a nationwide highspeed backbone network based on ATM technology aiming for promoting the development of new information providing services and highspeed computer communications.

II. Business Strategies

As the demands for communications services become more sophisticated and integrated, the required technologies for those new services became more diversified and fused together. This requires the shift of service development style from the conventional provider-oriented one to the customer-selective one. To take this approach for developing and providing new services, we will need to promote cooperation and tie-ups with customers, hardware and software manufacturers, and information service providers. This chapter explains the NTT's basic attitude in service provisioning and global cooperation towards the coming multimedia age.

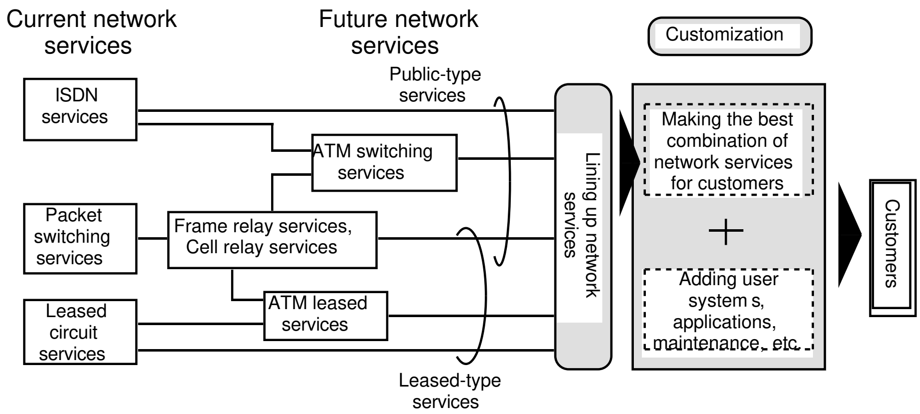

Fig. 3 Customization of Network Services

II.A. Services

NTT will maintain and sophisticate its telephone services as part of its reliable universal services. At the same time, NTT will develop attractive new services through cooperation with customers, manufacturers and information service providers. Those include:

- High-speed computer communications services among LANs, which are in high demand,
- Personal communications such as personal handy phones (PHPs) known as PCS or PCN,

  and
- Visual and multimedia communications services integrating a variety of services.

NTT will also provide users service customization capabilities to attain the best combination of network services for each user. This will include the combination of network services and user systems, applications, etc. (Fig. 3). In addition, to give customers a wider choice, NTT will continue its efforts to open its telecommunications networks preparing for the equal conditions assuring fair competition in the market.

Affordable rate is another important target for NTT. We will endeavor to set rates that ensure easy access to our services aiming to provide sophisticated services to every user and making efforts to expand customer choices.

II.B. Global Cooperation

NTT will strengthen its international activities to respond to globalization. Major overseas carriers have been active foreign investors and they are strengthening collaborations with other carriers to provide services such as one-stop shopping, in response to global changes including the emergence of borderless economies. NTT will seek further collaborations with domestic and foreign carriers and vendors to quickly respond to global trends.

NTT will also promote collaborations with domestic and foreign companies to reinforce its capabilities in developing services and technologies. This will respond to emerging new business fields, demands for inter-business data exchange services and ongoing globalization, which have been made possible by technological innovation and diversified needs for information.

III. Technologies for Future Networks

The evolution plan for NTT networks towards the 21st Century is shown in Fig. 4 [1][2]. NTT has already digitized its long-distance transmission network covering all of Japan. We are now concentrating our resources on the digitization of local switching systems. The replacement of the switches is planned to be completed by fiscal 1997. When the replacement is completed, any subscriber can have access to 64 kb/s digital channel. We expect the demands for N-ISDN to be 20 million lines by the year 2005.

Along with its efforts on expanding N-ISDN services to general public, NTT is assembling all necessary elements of B-ISDN in preparation for the global information age in the 21st century where the services will be more user-oriented and customized to suit individual and diverse demand. The followings are the fundamental technologies required for the construction of future communications networks.

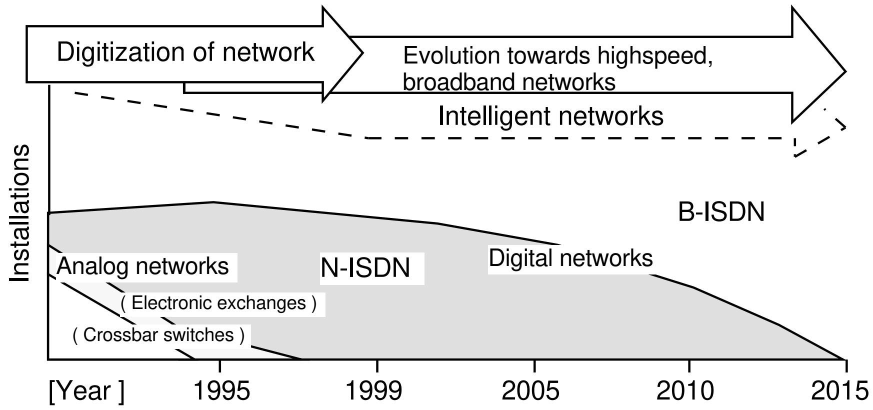

Fig. 4 Network Evolution towards B-ISDN

III.A. Optical Subscriber Loop Technology

An important factor in constructing B-ISDN is the complete preparation of basic telecommunication facilities. Optical fiber technology is crucial to the building of this infrastructure [3]. With its enormous transmission capacity, optical fiber has already become the medium of choice for interoffice trunks. These facilities belong to the network provider, and do not yet extend all the way to residential subscribers. Fiber has to move into the last mile of the loop before the full power of fiber optics can be exploited to bring high-bandwidth services to customers. This is known as fiber to the home, or FTTH, and is the ultimate subscriber configuration in the age of B-ISDN.

III.B. Asynchronous Transfer Mode (ATM) Technology

ATM is a fast packet switching technique that multiplexes and switches short packets called cells at extremely fast rates [4]. Cells contain 48 octets of user information and five octets of addressing and control information used to route the cell to its destination. Because of its fixed cell length, the switching of ATM cells is simple and can therefore be implemented in hardware to accommodate very high throughput rates. ATM's capability of high-speed processing means it can handle a heterogeneous mix of data, and can flexibly accommodate uncertain diverse demands in the future.

III.C. Intelligent Network Technology

To flexibly provide services that require intelligent and high-speed processing, functions that manage and control the services must be incorporated into the network. At NTT, networks are built by separating the basic transmission layer and the intelligent layer [5]. The basic transmission layer consists of transmission and switching facilities, and carries out the connection and switching functions common to all services. The intelligent layer realizes advanced services by managing various service scenarios and controlling the basic transmission layer. By using this type of network structure, it is possible to modify service attributes without changing the function of the transmission layer by redefining service management and control functions (software) of the intelligent layer. Access to these capabilities will allow us to flexibly and swiftly introduce services to meet the growing demands of users, providing us the basic platform for multicarrier networks as well.

IV. Evolution Scenarios towards Highspeed Multimedia Communications

The construction of advanced communications networks requires a huge investment and a long period of time. Therefore, new technology will be introduced as an "overlay" to the conventional networks slowly emerging to the main body of the network. The key to a successful evolution towards the future network greatly depends on where to start. Among many possible scenarios realizing the future communications networks, the following two scenarios are plausible.

IV.A. Evolution from Computer Communications

Since the historical experiment of video telephone, many multi-media communications terminals have been developed. Because the cost of computation has been prohibiting to adopt advanced signal processing techniques including information rate compression, the required speeds for transmission line were quite high. In addition, these terminals basically used their own data formats and communications protocols.

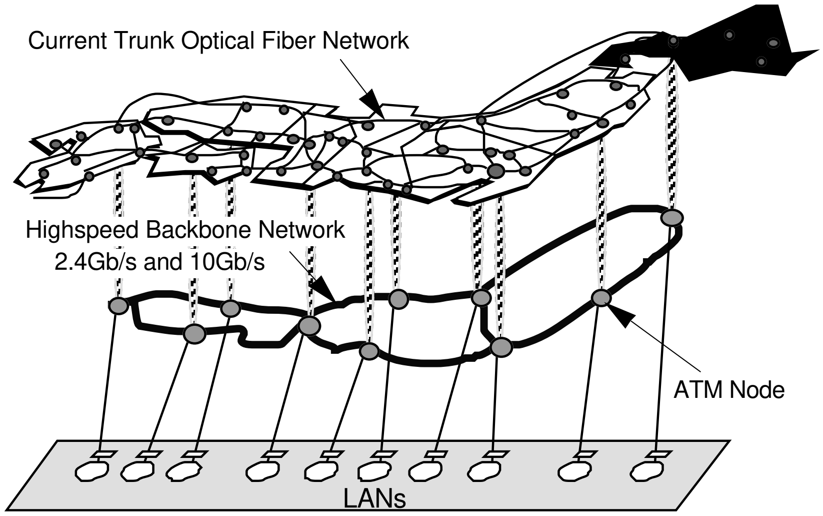

Fig. 5 Nationwide Highspeed Backbone Network

The recent advancement of microchip technology, however, made the signal processing an easy task for inexpensive micro-processors. Modern multi-media terminals fully utilize those computational power to reduce transmission rates effectively. This means that those terminals are based on personal computers (PCs) or workstations (WSs) and the data handled on them have the characteristics similar to the ordinary computer data. It is, therefore, possible for us to take the multimedia communications in the framework of computer communications. Backed by the growing demands for large scale computer communications such as LAN to LAN interconnections, this scenario is most likely.

IV.B. Evolution from Visual Communications Services

Subscriber facilities of modern cable television systems now have potential capability of supporting duplex communications channels between a switching hub and subscribers. The one deploying the latest optical technology together with the conventional coaxial calbes will be able to offer the speed up to 1.5 Mb/s for each subscriber, which is fast enough for video telephony and other video applications.

With the adoption of ATM technology in these cabel television subscriber systems, those wide bandwidths can be utilized more flexibly by assigning it on demand. This will allow users to use real broadband services such as high definition video transmission with relatively small investment. In the United States, this scenario is likely to happen because the facilities have been widely deployed there.

Japan, on the other hand, will lead different path because the deployment of cable television is rather limited at the moment. That is, we will aim at the construction of full optical subscriber systems for the service from the start (FTTH,).

V. Current Activities

To achieve the goal following the scenarios described in the previous chapter, NTT is promoting two specific experimental plans. Those plans will be conducted with the cooperation of customers, manufacturers and information service providers.

V.A. Pilot Test of Highspeed Backbone Network

With the downsizing of computers and the move towards distributed processing, user needs for high-speed computer are rapidly increasing. In addition to the conventional applications such as LAN interconnections and file transfers, new types of applications are emerging rapidly especially in the Internet that require much wider bandwidth. They are new information retrieval tools such as the World Wide Web (WWW) and multimedia applications such as the Network Video (NV).

To respond to such user needs, NTT is closely involved in ATM technology development and is now at the stage of commercializing it. Utilizing a combination of ATM and optical fiber technologies, NTT will construct a highspeed nationwide backbone network as part of its intracompany networks operating at gigabit level. Fig. 5 shows the configuration of the backbone network used for this pilot project. It is built on Synchronous Digital Hierarchy (SDH) transmission systems at the speeds of 2.4 Gb/s, 10 Gb/s, etc., and provides 156 Mb/s ATM User Network Interface (UNI) to users. Through this project, NTT will establish construction and management technologies as well as new applications for the broadband network.

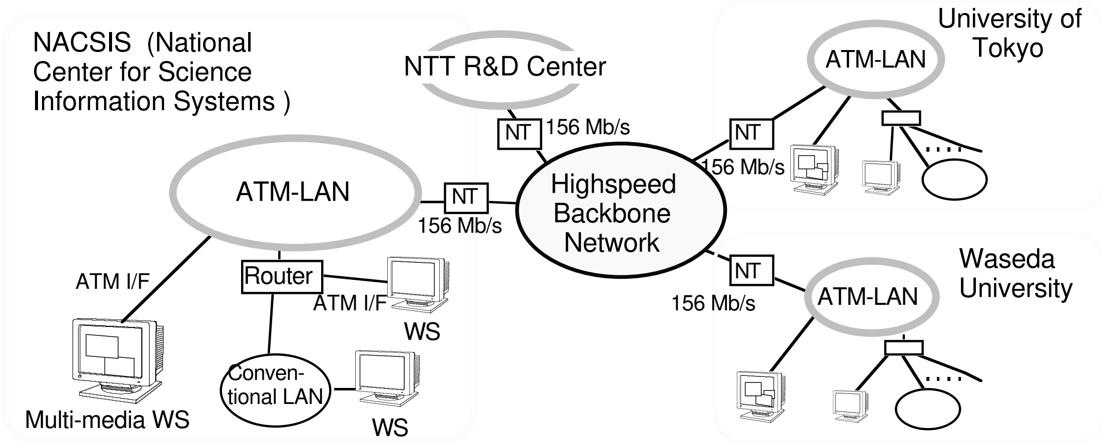

Fig. 6 Highspeed ATM Network Testbed

In addition, NTT is conducting joint pilot testing on this network with research institutes and universities interested in the use of highspeed communications link and potential users of multimedia services. The first program has been jointly started by National Center for Science Information Systems (NACSIS) last year. Fig. 6 shows the configuration of the testbed used for this project. It will use the highspeed backbone network for interconnecting the test facilities located at each university. The research programs conducted on this testbed includes highspeed video transmission, multimedia transport protocols, traffic control and multicasting using ATM technology. This network will start its operation at the end of September 1994. The second program will provide ATM UNI at the speeds of up to 156 Mb/s to information service providers who are interested in developing new service applications. On this platform, applied users and NTT will jointly study many aspects of advanced multimedia communications we have yet to encountered.

The provisioning of the Internet services on the backbone network is also under consideration in this pilot project. In Japan, for lack of large backbone IP network comparable to the NSFnet in the United States, the penetration of computer communications has been almost limited to research institutes and universities. To break this bottleneck and promote the use of advanced computer communications among industries and ordinary households, NTT's digitized infrastructure can be utilized effectively to construct very highspeed infrastructure for computer communications network. If the conditions permit, NTT will provide some sort of IP services using the highspeed backbone network described earlier.

In order to provide individuals or small business customers an easy and economical access to the Internet-like networks, the provision of higher-layer protocol (such as IP) interface to users will be a good solution. In addition, deploying routing functions of those higer-layer communications protocols within the network would be appreciated by users [6]. This type of service configuration will also be beneficial to carriers because it can constitute a new value-added service that is more profitable than the basic physical layer connection services in the B-ISDN era. Higher layer functions close to the application layer should also be provided. They include security and directory services and are of great importance. We will continue to study the architecture suitable for providing those services on ATM networks, together with the study on operation and management systems taking care of the overall network composed of multiple carriers and private networks.

V.B. Pilot Test of Multimedia Services

Due to advances in technology, interactive video communications such as video on demand (VOD) have been developed and are expected to result in great market demand. In the United States, cable television companies, telecommunications carriers and computer manufacturers are collaborating with each other and planning experiments for developing highly sophisticated information communications services in the multimedia age. In Japan, the Ministry of Posts and Telecommunications (MPT), in a January 1994 report entitled "Toward the Creation of a New Info-communications Industry," announced its policy of "coping with issues pertaining to merging broadcasting and communications systems."

Under this background, NTT will conduct pilot tests on integrated systems that provide communications circuits to cable television companies and highly sophisticated services such as VOD along with its existing telephone services. The experiment targeting ordinary home users will be launched in 1995. Fig. 7 shows the configuration of this pilot testing. The test program includes the provisioning circuits for cable television companies, a trial test of VOD, and telephone services.

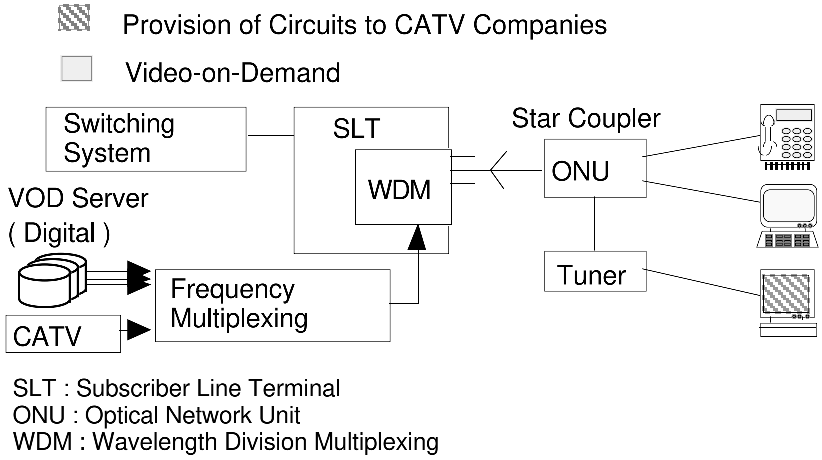

Fig. 7 Pilot Testing of Multimedia Services for Home

Attempts are being made in the United States to launch multimedia communications through cable television networks. Once multimedia communications are fully developed, a major shift to FTTH (Fiber to the Home) is foreseen due to the high demand for stable, high-capacity transmissions. In Europe, the condition of subscribers (e.g., the distance between NTT and home) is similar to that of Japan, so the shift to FTTH may be achieved more quickly than in the United States. Both European countries and the United States are expected to shift to FTTH in the forthcoming multimedia age.

NTT has worked on FTTH from early on and, in the field of optical communications, is a recognized world leader. NTT hopes to contribute to further developments in the communications field by implementing its optical access network. Because the establishment of optical access networks is crucial to meeting diversified, highly sophisticated needs for information, NTT is concentrating on lowering the cost of its optical access networks to private homes, focusing on the following three points:

- Lowering the costs of Optical Network Units (ONU) and Subscriber Line Terminals (SLT),
- Lowering the cost of optical fibers,

  and
- Developing new wiring and construction methods.

By integrating available resources, NTT hopes to bring down the cost of using the optical access network to private homes to about the same level as that for existing metal wiring sometime between 2000 and 2005 (Fig. 8).

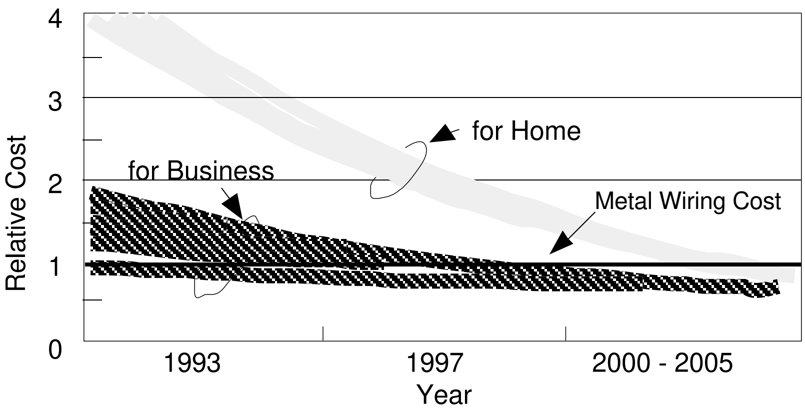

Fig. 8 Expected Economization of Optical Network Facilities

VI. Conclusions

This paper revealed the NTT's strategy to promote the development of highspeed multimedia communications services published in January. First, NTT's future business plans are explained from the viewpoint of service development and global cooperation among customers, other carriers and manufacturers. Secondly, the three key technologies required for the future communications networks: optical subscriber loop, ATM and Intelligent Network, and their introduction plans were presented. Then, the possible scenarios towards the future multimedia communications were explained taking account of the special conditions in Japanese market. Finally, two specific plans to promote early realization of highspeed multimedia services are outlined. The first is the construction of nationwide highspeed backbone network using ATM technology, aiming for accelerate the development of new information providing services and the applications for highspeed computer communications. The second is the pilot testing of multimedia services to household users using optical fiber distribution technology. NTT will continue its effort to promote early realization of sophisticated multimedia services with the cooperation of users and manufacturers.

VII. References

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Author Information

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Hisao Uose received the B. E. and M. E. degrees in electrical engineering from Kumamoto University, Kumamoto, Japan, in 1978 and 1980, respectively. Since he joined NTT in 1980, he was involved in the research on learning control method for telecommunication traffic problems and issues related to design and control of ATM networks. His current interest includes computer communications on B-ISDN. Mr. Uose is a senior research engineer at the NTT Telecommunication networks laboratories and a guest assistant professor of the National Center for Science Information Systems (NACSIS).