DISTANCE EDUCATION BY SATELLITE COMMUNICATION TECHNOLOGY IN JAPAN*

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INTRODUCTION

Science and technology today are advancing rapidly and the obsolescence of knowledge and technology becomes more evident every year. And the business environment is changing dynamically with the rapid advancement of information technology under increasingly competitive situations. On the other hand, advancing computers and communications technology has brought to education and training new technologies of multimedia collaborative communication on broadband wide-area networking as well as the Internet. Hence the concept of the virtual university or an on-line university is coming into existence.

In order to maintain a leading edge in competitive business situations in this information age, industries have adopted innovative management systems and reengineered their business processes. One of the greatest challenges facing companies today is keeping their knowledge workers informed quickly, accurately and economically of the latest developments in technology, products, and services, and of their effect on strategic direction. Additionally, improving employees trained and retrained to be able to make better decisions through enhancing their skills in solving problems is equally important. As a consequence, more time- and cost-efficient systems that can educate and train today's knowledge workers are in strong demand.

To cope with these problems, videoconferencing combined with satellite communication technology provides a solution that has many advantages, such as wide-area coverage, broadcasting capability, broadband video transmission and multiple accessibility. Video offers effective interaction in a collaborative distance learning environment as a medium for expressing information in the process of knowledge transfer.[2] Videoconferencing with satellite communication is able to easily expand a well-organized conventional interactive classroom into geographically distributed remote classrooms. It provides the visual dynamics of live motion video of the instructors and educational materials, and includes the far-reaching versatility of one-way broadcast video and the face-to-face impact of two-way interactive video.

Some major companies in Japan in the electronics, telecommunications and securities industries have been providing education and training and corporate communications to employees directly at their working locations by means of satellite communication technology, as well as in the conventional way of gathering employees in their training facilities.[3] Under these circumstances Japanese industries have requested that institutes of higher education deliver up-to-date knowledge to graduate engineers, technical professionals and managers at their working

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locations. In order to respond to these demands, the Japanese Ministry of Education has been studying refresher education with experimental deliveries and promoting the use of multimedia technology including satellite communication in education.

In the pages that follow, the state of the art of distance education systems in Japan mainly from the standpoint of educational interactivity will be examined, drawn largely from the experience with NEC's corporate distance education system utilizing satellite communication, but also on a broader context including academic satellite networks, some experimental satellite communication projects in Asia and the Pacific region as well as experiments on multimedia computer-supported collaborative learning systems (CSCL) on wide-area ATM (Asynchronous Transfer Mode) networks.

A CORPORATE DISTANCE EDUCATION SYSTEM: THE NESPAC SYSTEM

Overview of the network

NEC introduced the NESPAC (NEC Satellite Pedagogical Network for Advanced Creative Education) system in 1987 as a strategic tool to establish educational networking among NEC Group companies. Since then the system has been operated by the NEC University, Ltd., a company spun off from the Human Resources Development Division of the NEC head office.[4]

NESPAC started its deliveries using Nippon Telephone & Telegraph's (NTT) satellite communication service. Since 1989 NEC has been leasing one transponder operating in the 12/14GHz (Ku) band with 27MHz bandwidth on a domestic commercial communications satellite (JCSAT-1) from Japan Satellite Systems, Inc. The transponder had been dedicated to NESPAC and divided into both digital and analog bands, which transmitted two types of NESPAC deliveries until August 1996. The digital band was used for transmitting two-way compressed video educational information of the NESPAC system. The analog band of 20MHz bandwidth was for the one-way video channel of the NESPAC-TV.[3]

Occasionally, these networks have been extended flexibly through linking with each other and linking into other communication systems, including corporate cable TV networks, corporate videoconferencing network via ISDN (Integrated Services Digital Network), and internationally via KDD connection through Intelsat.

Thus the NESPAC networks have been operating for 10 years. In this decade communication technologies have changed from analog to digital, and the two-way NESPAC system which was based on analog technologies became obsolete and had some maintenance problems in key components including video codec. The company decided to stop the NESPAC two-way video deliveries by the end of March 1997 and change the NESPAC-TV broadcast from one analog video channel to two digital video channels with 6Mbps bandwidth in MPEG2 format from August 1996.

Though the NESPAC system is not so sophisticated now, its concept and functions described as follows are thought to be worthwhile to study even now as a typical distance education system via satellite.

NESPAC: A Point-to-Multipoint Two-way Interactive Video Network

The two-way video NESPAC network utilized two 1.5Mbps satellite digital lines for forward and backward links. One satellite digital line was used for broadcasting the lecture from an instructor sitting at the front of a Centre Classroom in one of the Satellite Education Centres and the other for broadcasting the return video and audio from one of the distant Satellite Classrooms on an on-demand basis. The NESPAC network had been deployed over 10 major cities in Japan where NEC's main branch offices are located. Among them the Satellite Education Centre is located in Tokyo.[4,5]

NESPAC-TV: A One-way Video Network

The one-way video NESPAC-TV network broadcasts information mainly from the NESPAC Tokyo Satellite Education Centre. A network of television receive-only terminals (TVROs) are at each organizational site of subscribing organizations and companies. There are now around 220 reception sites by antenna-base or 300 sites by decoder-base around the country and the network is expanding. These sites include manufacturing plants, R&D centres, sales branches, subsidiary companies and retail dealers.

The downlinks to the head office building and major plants are connected with the dedicated NESPAC channel of the in-house cable television networks in order to provide NESPAC-TV programs to conference rooms and desktop TV monitors in the offices.[3]

Educational Communications in the NESPAC System

Instructor-Students Interaction Model

The strong interactivity between instructors and students is one of the key factors for effective education in the total integration of the learning processes. So the NESPAC system was designed to expand a well organized conventional classroom, in the sense of two-way interactivity among the instructor and students in the classroom, to geographically distributed classrooms without sacrificing the quality of education. The key interactive educational communication among the instructor and distant students can be modelled as follows:[5,8]

1. A presentation is made by using multimedia course materials from the instructor to the students using PCs, document cameras, VCRs or blackboards.

2. The responses from the students to the instructor are made through Q&A sessions, debates or student response devices.

3. Discussions and collaborative workshops are made among the distant students.

All the above communications are viewed through large video screens in life-size and/or heard in-person quality by all the students attending the class.

Point-to-Multipoint Two-way Video Interaction in the NESPAC

The two-way NESPAC system should realize an equal environment for the educational communications to all participating students wherever they are attending classes with or without the instructor. In order to efficiently realize the interactivity between the instructor and the students or discussions among students located in different classrooms using two satellite digital lines on a real-time point-to-multipoint basis during the class, the following functions were implemented:[5]

1. Real-time two-way video and two-way audio communications like face-to-face

2. Simultaneous transmission of two channels of motion video by frame multiplexing technology

3. Multipoint communication control by any distant student's request for asking questions and/or by the instructor's initiatives

These enabled to send both *emotional information* by life-size picture of the instructor and *knowledge* by on-camera course materials separately, or to send the picture of the asking student in a distance classroom and the picture of the atmosphere of a classroom for display on two large (70 inches) video screens in front of each of the participating classrooms.

Interaction in the One-way Broadcasting NESPAC-TV

Most NESPAC-TV programming incorporates two-way audio to complement the one-way video broadcast. In a typical NESPAC-TV site setup, a room seating 20-30 people is equipped with a TV monitor of 30-45 inches, a VCR, a telephone and a facsimile.[3,8]

Attendants in remote receiving sites can ask questions to the on-camera experts directly by phoning a dedicated number, and questions are answered live, on video camera. When a remote attendant wants to make a presentation by showing some document materials, he/she sends a fax and can explain by telephone while viewing the materials on document camera. This ability to talkback gives live NESPAC-TV instruction considerable interactivity. It also has an impact of timeliness that is unequalled by other media. The same message can be simultaneously broadcast to all NESPAC-TV sites in branch offices and subsidiaries.

When a NESPAC-TV program needs live video interaction between any remote sites with videoconference equipment, the backward video and audio are transmitted to the studio-classroom equipped with up-to-date video codecs by means of terrestrial ISDN connection and are re-broadcast via satellite, thus enhancing and improving interactivity.

Non-Real-time Asynchronous Interaction

For prerecorded NESPAC-TV programs or pre- or post-course communication in NESPAC/NESPAC-TV, electronic mail, fax, telephone, company mail and express mail have been the means for interaction between students and instructors, although computer conferencing or electronic forums are also available.

The NESPAC Classes

The NESPAC Use

The network and classrooms/viewing sites are selected and connected for a NESPAC/NESPAC-TV class according to the objectives of the program, the teaching content, the number of participating students, the geographic distribution of the target students and/or the teaching style. Two different programs can be simultaneously delivered using the two different networks. Sometimes a NESPAC class is relayed to the NESPAC-TV network to expand participating sites. And sometimes a wide-spread NESPAC-TV based program is integrated with NESPAC classrooms in order to enhance interactive sessions.

Many educational programs are provided by the two-way NESPAC which cover EDP systems engineering, software education, management education, technology education and sales education. As for the type of class, the lecture with a Q&A session is frequently used for various courses. Most courses of this type are delivered from the Centre Classrooms, while some of them are delivered from one of the Satellite Classrooms that is convenient for the visiting instructor. Discussion-oriented classes are often used for training of conceptual skills, software management, etc.[6,7] By using the two-way NESPAC environment, multipoint panel discussions can be held. In this case a coordinator or a moderator usually sits in the Centre Classroom, and panellists and audience participate at their most convenient Satellite Classrooms.

A Typical Collaborative Learning by Two-way NESPAC Environment: The Satellite Business College

One of the typical two-way NESPAC-oriented programs is called the "Satellite Business College" (SBC) started in October 1989.[9,10] The common objective of the SBC is to enhance employees' problem solving capabilities. Currently two SBC courses are delivered: a marketing course for sales staff and a systems course for systems engineers, while a production course has been temporarily paused for curriculum revision.

These courses provide basic and practical education by the originally designed curriculum targeted for employees with over six years' experience. Typically the courses last for 12 days with 90 hours over six months. The courseware for the SBC courses is developed in close cooperation with the instructors in order to increase the interactivity between the instructor and distant students to be as good as in the Centre Classroom where the instructor and the students are facing each other. It mainly uses a discussion-oriented class including case methods, role playing and seminars as well as lecture with Q&A sessions.

Each course is delivered mainly via two-way NESPAC but in some parts of the course NESPAC-TV and collective intensive workshops are applied according to the teaching strategy of the curriculum. The students can participate in the class at their most convenient Satellite Classrooms among 10 sites located across the country. The discussions through face-to-face-like communications with two-way video and two-way audio between classrooms as well as the discussions within the classrooms can enhance and stimulate the mutual information exchange and development among the students.

A typical NESPAC case method class progresses in four stages: individual pre-study by each student, group discussion and presentation at each Satellite Classroom, networked class discussion and/or presentation from each Satellite Classroom, and summaries by the instructor. One group consists of five to seven students so that group dynamics may work.

The NESPAC-TV Programming

NESPAC-TV expands the classroom with interactive capabilities that allow attendants at any site to call in and ask questions during the broadcast. Training oriented programs include latest product updates, information technologies, market trends, marketing strategies, production management, accounting, quality control, preparatory programs for systems engineer qualification, and product liability. Sometimes live video lectures are received via satellite uplinked from universities and rebroadcast via NESPAC-TV to group employees. This kind of broadcast is provided ad hoc in just an experimental project to establish a way to provide refresher education to knowledge workers by the Japanese Ministry of Education since 1992.

The formats of NESPAC-TV broadcasts include lectures, panel discussions, interviews, and interactive forums, featuring subject experts from NEC, universities, and consulting firms, as well as from other major corporations. Normal work-day hours on the network are used for seminars, conferences and classes where real-time interaction is critical.

Evaluation

Each delivery of NESPAC programs is carefully evaluated by the class students using a survey at the site. Students are asked to rate various aspects of the program, including the appropriateness of the content to their work. The fact that both the difference of the ratings of students satisfaction between the NESPAC classes and traditional collective classes and the difference between the Centre Classroom and Satellite Classrooms were very small, proved the NESPAC classes to be almost completely accepted by employees.[4]

The NESPAC system is a fast and effective way to reach geographically dispersed employees with information and training that are critical to their jobs. The companies benefit from cost-effective and timely training and dissemination of information updates, as well as from increasing the number of employees reached at one time and from sharing limited qualified expertise resources. Employees benefit from the increase of educational opportunities to access experts without re-arranging on-going work responsibility, and consequently reduced backlogs.[8]

ACADEMIC SATELLITE NETWORKS

Intra-university Network: The PINE-Net

Although inter-campus distance education systems using videoconferencing have been running since the 1980s, for example, the Tokyo Institute of Technology (fibre optic transmission),[11] Shinshu University (digital microwave links), and Kyushu Institute of Technology (ISDN), the PINE-Net (Promoting Information Network for Education - Network) is the first university distance education system using satellite communication in Japan.[12,13] Hokkaido Information University in Ebetsu, a northern city in Japan, has been operating the system to

deliver correspondence courses since 1994. Originally it was developed to deliver courses to the remote computer colleges that belong to Electronics Development Computer College in 1991. Students attend PINE-Net classes at 16 remote education centres and subcenters which are attached to the computer technical colleges. The courses include computer hardware, software engineering, data communication, programming languages, C, UNIX, on-line systems design, and so on.

An effective two-way interactive communication has been realized in the PINE-Net classes utilizing video transmission via satellite and response data transmission via ISDN as follows:

1. Sending two different lectures simultaneously by live video via satellite from Ebetsu

2. Responses from remote students via ISDN that include requests for asking questions, student response data, and still pictures of classroom monitoring images

3. Individual learning by CAI (Computer Assisted Instruction) sessions that follow each lecture

Inter-university Network: The Space Collaboration System

In advanced research requiring high expertise, instructors, students, and researchers are dispersed. In order to improve education and research activities, expertise of different universities can be effectively exchanged by networking universities. Thus the Space Collaboration System (SCS) was developed by the National Institute of Multimedia Education (NIME) as an inter-university videoconferencing network using satellite communication.[14-17]

The SCS is a Very Small Aperture Terminal (VSAT) network appropriate to the multimedia age. The Ministry of Education started the project in 1995. The hub station is installed at NIME for easy operation of remote VSAT stations. Eighty-nine VSAT stations are located at 73 participating national institutions for higher education, including universities, technical colleges and research institutions as of the end of March 1997 and the network is continuing its expansion.

The features include 1.5Mbps video and data exchange with H.261 videoconferencing codec format, controlled VSAT by the hub station and no need for specially qualified staff at each university VSAT station.

The system has been used in such applications as exchange of lectures with Q&A among participating universities, exchange of presentations with discussions in seminars and symposiums and ordinary videoconferencing sessions.

The Refresher Education Project

In order to investigate the feasibility and issues of refresher education by satellite communication, NIME conducted experimental deliveries four times from 1992-94.[18] The deliveries included enlightening lectures, lectures of topics in advanced science and technology, a series of lectures on information science and multipoint panel discussion on the promotion of refresher education. These deliveries were received directly at companies and universities or

relayed to in-house satellite networks including NESPAC-TV and PINE-Net.

The issues to advance this type of education have been discussed. They include development of course programs, training of instructors, notification of program information to students, interactivity of educational communication, collection for tuition fees, academic credits, and organization of operation and so on. The experiences of the National Technological University (NTU) in the United States are thought to have been helpful to realize these issues.

Tokyo Institute of Technology has installed a system called the Academic Network for Distance Education by Satellite (ANDES) and has started delivery of continuing education to corporate knowledge workers outside university campuses as well as exchanging lectures with Hitotsubashi University since July 1996.

EXPERIMENTS IN THE ASIA-PACIFIC REGION

In this chapter, some experimental projects conducted by Japanese institutions in cooperation with institutions from the Asia-Pacific region are described. They include satellite workshop experiments, distance CAI experiments, and satellite-Internet experiments.

International Satellite Workshop Experiments

The International Satellite Workshop (SAWS) Experiments were conducted by the National Institute of Multimedia Education (NIME) in cooperation with 10 institutions from six countries, which include King Mongkut's Institute of Technology Ladkrabang in Thailand, the Institute of Technology Bandung in Indonesia, the University of Technology in Papua New Guinea, PEACESAT of the University of Hawaii and University of South Pacific in Fiji and four Japanese institutions, including NIME, NASDA, the University of Electro-Communications and the Communications Research Laboratory of the Ministry of Posts and Telecommunications. The SAWS project is part of the Pan-Pacific Regional Telecommunications Network Experiment & Research using Satellites (PARTNERS) project supported by the Japanese Ministry of Posts and Telecommunications.[19]

The objectives of the SAWS experiments were to exchange engineering and cultural information and topics among participating institutions and to study systems requirements for VSAT-based educational networks as well as to increase mutual understandings. The SAWS experimental workshops used the ETS-V satellite which transmitted 64kbps compressed video signals.

A series of SAWS workshops were held during 1993-95 and showed the usefulness and the effectiveness of videoconferencing over the VSAT network for exchanging education and research activities as well as the feasibility of an inter-university videoconferencing network which was realized as the "Space Collaboration System" (SCS) as described in the previous chapter.

Distance CAI Experiments

Another project conducted by the Japanese Ministry of Posts and Telecommunications since 1996 is an experimental distance learning project called the Research and Development on

Multimedia Human Resources Development (HRD) Systems Network Technologies in the Asia-Pacific Region.[20] The project is coordinated by the Telecommunications Advancement Organization of Japan. Participants of the project include Ebetsu Research Centre in Hokkaido, located in the northern part of Japan as the central station, King Mongkut's Institute of Technology Ladkrabang in Thailand and Nanjing University in China.

This project intends to develop human resources in telecommunications technology by means of a multimedia distance learning system which consists of simultaneous and synchronous teaching system incorporated with an individual and asynchronous learning environment by CAI (Computer Assisted Instruction).

The lectures in MPEG2 video format and the CAI courseware are forwarded from Hokkaido Information University in Ebetsu by a 6Mbps satellite channel of the JCSAT-3 communication satellite to the classrooms in KMITL and Nanjing University. Backward video is compressed and transmitted via satellite in 384Kbps to the Ebetsu studio. In addition to the satellite channels, the terrestrial ISDN transmits PC data and still pictures among the studio and participating classrooms.

Satellite-Internet Experiments

A lot of effort has been made to develop the international Internet environment. In order to achieve a better and efficient information infrastructure around the globe, there are very strong and urgent demands in the Asia-Pacific region, especially intra-Asia-Pacific communications via the Internet, for a practical working environment where engineers and researchers in related fields work cooperatively.[21]

The Widely Integrated Distribute Environment (WIDE) project that is a research consortium in the Internet area of studies in Japan and Japan Satellite Systems, Inc. (JSAT), which is one of commercial satellite communications companies in Japan, have started a joint project called the Asian Internet Interconnection Initiatives (AIII) in October 1995. The AIII project aims to construct a testbed network and to make a series of research activities.

One of the major goals of the AIII project is to develop an information sharing infrastructure for accelerating more cooperative work among people in and around the Internet in Asian countries. For this goal, the project installed its testbed network using VSAT satellite communication channels. The VSAT satellite links for the testbed network utilized a 2Mbps channel from the Asian zone beam of Ku-band provided by the JCSAT-3 communication satellite, which covers several East and Southeast Asian countries and regions.

The AIII task force members and partners as of April 1996 included the Asian Institute of Technology in Thailand, the Institute of Technology Bandung in Indonesia, Hong Kong University of Science and Technology in Hong Kong and three institutions from Japan, the WIDE Project, Japan Satellite Systems, Inc. and the Nara Institute of Science and Technology. More partners have been expected to participate to the project from Korea, Vietnam, Singapore and Malaysia.

VIRTUAL UNIVERSITY IN THE MULTIMEDIA AGE

On-Line University Project

The On-Line University (OLU) Project is an experimental project conducted as one of the Multimedia Joint Projects with NTT from April 1995 to March 1997. The Joint Project had 127 institutional groups participating from universities, institutions and corporations.[22] Eighteen universities and laboratories with NTT and companies participated in the OLU Project and connected to each other with an experimental ATM network called OLU-net. ATM is an emerging technology that enables transmission of multimedia with high bandwidth up to 156Mbps on a broadband ISDN network. OLU-net connected many workstations, PCs as well as six super parallel computers.[23]

One of the five sub-projects of the OLU Project was focused on distance education in an ATM network environment. The education sub-project aims to utilize educational resources in the ATM network, to develop advanced teaching strategies and to identify users' requirements for effective utilization of resources.[24] The experiments include distributed Video-on-Demand (VOD) services and distance lecture systems.

The distributed VOD aims to retrieve compressed digital video files located in distributed servers linked through the ATM network. The distance lecture systems are videoconferencing networks using video compression formats of motion-JPEG and MPEG2 of the ISO standard. The lecturer's video image with voice and the asking student's video and voice were separately multicast through the network and every audience could see both images separately in the two large screen monitors in front of classrooms and/or two different windows in a workstation screen monitor. The experiments showed that the size of the lecturer in the video screen and video quality that depends on the bandwidth of the network are important to create vivid presence in remote classrooms.

Global College Concept

NEC proposed the "Global College" concept and demonstrated it at Telecom95 in Geneva in October 1995. It is an open university where students from all over the world can study at anytime. Professors from various disciplines are registered at one location designated as the university centre. This centre functions as a network base covering the entire world. Students with PCs or other computer terminals are free to take lectures of their choice from any professor.

"Global College" is a system platform that allows anyone, anywhere, regardless of age or background to conduct cross-cultural exchange through broadband networks. It utilizes a distributed multimedia education system platform for the global information society. It features multimedia presentations, virtual classrooms, direct communications with experts such as educators and professors and educational development through computer supported groupware.

The system uses two-way multimedia real-time communication, multimedia collaboration and Multimedia-on-Demand (MOD) to allow communication on a multipoint, multilocation basis. Other functions include real-time communication of high definition television (HDTV), large screen HDTV displays and the multimedia support system. The key technologies include NEC's

multimedia collaboration system called MERMAID[25], MOD server technology, broadband wide-area ATM networking and satellite communication.

Learning styles at the Global College include real-time remote lecture, real-time collaborative education and non-real-time asynchronous learning through accessing stored learning resources in an on-demand basis.

DISCUSSION

The characteristics of the systems discussed in the previous pages are summarized in Table 1 in relation to the methods of educational interactivity. The key factors for characterizing distance education are bandwidth for video transmission, reachability of distribution, interactivity with collaborative learning, retrievability of stored information such as recorded lectures, structured hyper-text course materials, and real-timeliness (synchronous/asynchronous). The cases are compared with computer mediated communication on the Internet that is strongly emerging and has become most popular in recent years.

They are categorized into three types:

1. Type1: Multipoint Two-way Videoconferencing Network Utilizing Satellite Communication, which includes the two-way NESPAC, Space Collaboration System and Distance CAI experiments.

2. Type2: One-way Video Broadcasting Satellite Network with Backward Links, which includes NESPAC-TV, PINE-Net, and Refresher Education experiments. The backward links varies in the wide range from real-time telephone, fax, ISDN to non-real-time asynchronous E-mail as well as computer conferencing.

3. Type3: Full Multimedia CSCL on Wide-area ATM Network, which includes the On-Line University Project and Global College incorporated with wideband transmission networks of both satellite and terrestrial with MOD(Multimedia On Demand) and WWW technology.

Table 1: *Characteristics of the Distance Education Systems via Satellite*

	Current technology		Near future technology	
System Type	Type1	Type2	Reference	Type3
Case	NESPAC SCS, SAWS Int'l Distance CAI	NESPAC-TV PINE-Net	CMC on the Internet	OLU-Project Global College
transmission media	satellite	satellite	the Internet	ATM network and/or satellite
video conferencing	two-way multi-point	one-way broadcasting	two-way point-to-point	two-way multi-point
reachability	restricted	yes	yes	yes
interactivity(synchronous) forward link	(yes) video(VSAT)	(yes) video(VSAT)	(restricted) e-mail	(yes) multimedia
backward link	video(VSAT)	phone/fax	e-mail	multimedia
asynchronous interactivity	phone, FAX, ISDN, e-mail, computer conferencing CAI(Distance CAI)			
retrieval(Hypertext)	no	no	yes(WWW)	yes(WWW)
retrieval(Video)	no	taped/downloaded	no	yes(VOD)

CMC: computer-mediated collaboration; V/C: videoconferencing; VOD: video-on-demand;
MOD: multimedia-on-demand; WWW: world wide web; VSAT: very small aperture antenna

Each type of distance education system can be enhanced in its educational interactivity by utilizing asynchronous/non-real-time computer mediated collaborative systems such as electronic mail, and computer conferencing systems. The systems of Type1 and Type2 are based on current telecommunication technology, while the systems categorized in Type3 feature VOD/MOD with emerging WWW technology of the Internet and can satisfy students' learning needs on an on-demand basis (EOD; Education On Demand).

Between the Type1&2 group and Type3, there is a bandwidth problem in transmission of continuous media of audio and video. Time is needed before a broadband ATM network is available in a widearea, although standardization of ATM networking technology is in progress and ATM-LANs have been introduced in some major plants and universities' campuses recently. Distance education systems that utilize satellite communication with MPEG2 format downlinked to local MOD servers and ATM-LAN are considered to be probable for an interim stage to Type3 systems incorporated with the Internet. In this sense the NESPAC-TV has been changed from analog to two channels of digital video of MPEG2 format in order to use the transponder more effectively and to make possible interoperability with the corporate information highway on which EOD (or WBT; Web-Based-Training) services are provided.

CONCLUSION

The case studies on the distance education systems using satellite communication technology, either academic or corporate, show that the educational satellite networks have the capabilities as follows:

1. Educational interaction like face-to-face by either two-way videoconferencing or one-way video broadcasting with terrestrial backward links

2. Reachability of education and training to from undergraduate students to postgraduate knowledge workers/professionals with keeping quality of education by cost-efficient way

3. Exchanging lectures, educational information and resources among academic institutions

And the study of the experimental demonstrations of the On-Line University Project and Global College showed that although multimedia groupware technology and VOD systems incorporated with wide-area networking have great capability for full collaborative distance education, the quality of video as a key interactive medium is restricted by the bandwidth of the network infrastructure.

Computer-mediated communication technology and the WWW as asynchronous interactive media can be utilized as means for enhancing interactivity between the instructor and the students or among the students in a remote course where students receive lectures via broadcast video either live or prerecorded. WWW technology is also a means for delivering courseware and online education and training.

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