

# 5-7 International Distance Learning Experiment Using JGNII

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This paper reports cooperative experiment undertaken by Hokkaido University in Japan and the University of Alaska Fairbanks (UAF) in the United States. The experiment was conducted in January, 2005. A classroom in the IT Education Hall at Hokkaido University, Japan and the Discovery Laboratory of the Arctic Region Supercomputing Center at the University of Alaska, Fairbanks were connected via the Internet and a domestic next-generation Internet research and educational network infrastructure called JGN2 that was operated by the National Institute of Information and Communications Technology (NICT) in Japan. A high definition video conferencing system, a chat system, and a web-based voting system were used in the experiment to promote the establishment of an effective learning environment, particularly for cross-cultural learning.

## ***Keywords***

Collaborative learning, Cross-cultural learning, synchronous, Symmetric, High quality video conferencing

## **1 Introduction**

With the continuing development of computer networks, distance learning has come to play an increasingly significant role in education. The advent of the broadband Internet in particular is making it possible to send/receive text, voice, and image data anywhere in the world at lower and lower cost. In this context, to make distance learning more effective, we must develop educational software specifically for use on IP networks. Since nonverbal communication is an integral part of any language, we cannot underestimate the importance of achieving synchronous (real-time) and symmetric (two-way) communications in distance learning [1][2]. To date, a variety of research papers have been published in this field, including a proposal for a multimedia service framework in an IP/ATM environment

for distance business operations and distance learning [3] and a report on demonstration experiments at relatively low transmission rates [4].

The principal members of this project include Hokkaido University, Waseda University, Stanford University, the University of Alaska, and the National Institute of Information and Communications Technology (NICT). In this project we connected universities in Japan and the United States by a high-speed international IP network. Using a high-definition videoconferencing system with a transmission rate of tens of megabits per second (Mbps) and a web-based educational application program, we have demonstrated the feasibility of information and communications technology (ICT) and the usefulness of international synchronous two-way distance learning. The objective of this project is to

develop a system or form of education that makes use of multimedia and ICT, and to demonstrate the effectiveness of such a system or format. Through the development of such a system, with an emphasis on basic media literacy and communication skills in foreign languages, we intend specifically to improve foreign-language education. To create a so-called “virtual borderless classroom”, the classroom atmosphere must be reproduced with high fidelity. To this end, we developed an Internet-based videoconferencing system featuring image quality comparable to that seen in television broadcasting. Such high-quality transmission allows for the use of an over-100-inch screen, enabling the display of life-size images bi-directionally and in real time (synchronous).

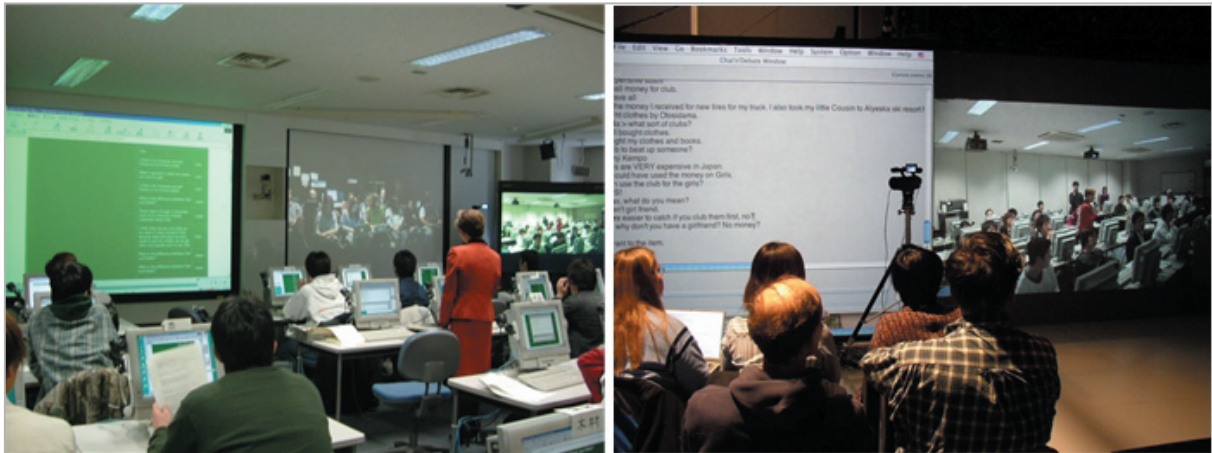
In our advanced information society, English-language skills (particularly writing skills) are considered essential as a basis of communication. Conversational skills are needed for discussions and debates, but it is widely recognized that it is difficult for Japanese students to acquire adequate proficiency in speaking. To address this challenge, we devised a system to develop debating skills that allows real-time or quasi-real-time writing-based communications over networks. By combining this system and high-quality data transmission, we are working to establish a practical multimedia communications technology that can convey not only voice and image data, but also text information and an overall classroom atmosphere.

Through three demonstration experiments in the past four years, our distance learning project has shown its effectiveness not only in enhancing learning but also in motivating students to learn foreign languages [5] [6]. In an experiment carried out in 2003 [6], we connected Hokkaido University and Stanford University by a high-speed leased line. To implement a videoconferencing system, we developed application software that could send both consumer standard digital video images and high-definition images (720/30p) using an IP protocol.

In this paper, we describe a demonstration experiment on international distance learning conducted at Hokkaido University and the University of Alaska Fairbanks (UAF) in January 2005. We connected a classroom in the IT Education Hall at Hokkaido University and the Discovery Laboratory located in the UAF Arctic Region Supercomputing Center (ARSC), via the Internet and NICT’s JGNII research and development network. We will describe this network and the tools developed for this experiment in detail below. Due to limitations of space, we will not discuss the experiment results in terms of educational technology, which is specifically addressed in another document [7].

## 2 Overview of experimental class

Hokkaido University conducted this experiment as an element of computer-assisted English learning in an English writing course in its second semester of 2004. The class was attended by 24 freshmen in the Faculty of Engineering enrolled in this course. The UAF, on the other hand, participated in the experiment as part of its regular course entitled “JPN 293 Virtual Study Abroad: Language, Culture, and Geography of Japan”. Participants included 11 students studying Japanese. The major significance of this experiment lies in the reciprocal learning of students’ native languages and the rich cross-cultural exchange (as cross-cultural informant) that is the inevitable result. This experiment took place from 1:00 p.m. to 2:00 p.m. on January 18, 2005 in Japan, corresponding to the hours of 7:00 p.m. to 8:00 p.m. on January 17, 2005 in Alaska. Although there was a difference of 18 hours in the time zones of the participants, both universities could hold this event within their regular class hours. Further, despite the several thousand kilometers that separated these two locations, students were able to share the atmosphere of a “virtual borderless classroom” through discussions via the screens. Figure 1 shows the experimental classroom setup at both universities.



**Fig. 1** Classroom in the IT Education Hall, Hokkaido University (right) and Discovery Laboratory, UAF (left)

This class consisted of (1) the exchange of opinions with the use of the multi-participant “Chat’n’Debate” chat system (described in the next section); (2) discussions with the use of the “Culture Box” questionnaire system in ballot form (also described in the next section); and (3) an object lesson. This class was conducted in English, as the UAF students were only beginning their study of Japanese. Nevertheless, some students communicated in Japanese using Roman characters. Two over-150-inch screens were set at the front of the classroom and used one to display the text of the discussion conducted through the chat system. This display played a very important role in bi-directional communication. Moreover, this mechanism helped the students feel “connected”. While it is nearly impossible to make sense of multiple simultaneous student comments, Chat’n’Debate allowed participants to view several comments at once.

Culture Box was also helpful in encouraging the collaborative exchange of information between students at the two universities. This system allows students to answer questionnaires in ballot form. They can also enter comments on the questionnaire results. Changes in the number of votes are instantaneously reflected on the screen. This feature helped stimulate discussion even further.

Finally, students gained firsthand experience of the differences between Japan and the

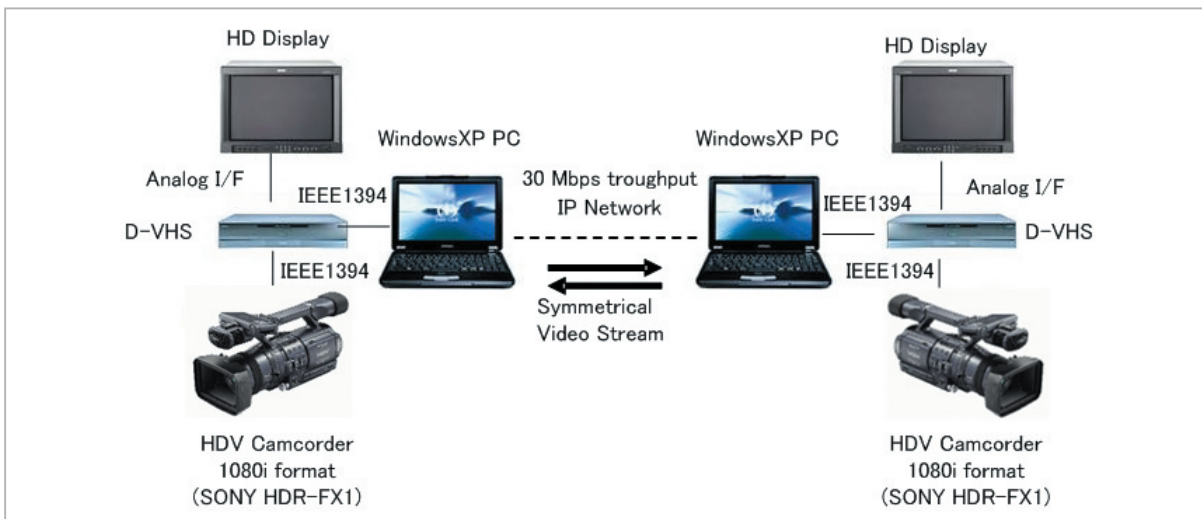
U.S.—for example in the physical distance between speakers in conversation and in differences in the students’ personal effects. In the former case, students noticed a significant difference between their cultures in terms of the physical distance between speakers, and were surprised at the further cultural differences when they showed each other the personal belongings they had at hand.

### 3 Network and tools used in experiment

#### 3.1 High-definition videoconferencing system

NICT and Tokyo Electron Ltd. have been jointly developing videoconferencing systems that can send high-quality images and voice, in general anticipation of the needs of the coming ubiquitous society. These organizations developed a consumer high-definition digital video (HDV) system at required bandwidths of either 20 Mbps or 30 Mbps. This was used as a videoconferencing system in the demonstration experiments on distance learning. Figure 2 shows the configuration of this HDV transmission system.

A main feature of this system is its significantly low cost relative to conventional HD transmission systems. Conventional systems require an expensive HD camera and an encoder/decoder for use in compression and



**Fig.2** IP transmission system using consumer HDV camera (1080i)

decompression of image and voice data. However, the latest consumer HDV cameras feature a built-in encoder and are available at 150,000 to 400,000 yen. These cameras can perform decoding through the use of a consumer D-VHS tape recorder or software decoder installed on a notebook PC (although performance depends on the computing capacity). In this experiment, we used high-resolution images in 1080i format. A high-definition transmission system has the following advantages when used in videoconferencing: (1) images are of sufficiently high definition to be displayed on an over-100-inch screen; (2) the horizontal angle of view is so wide that images of the entire classroom can be transmitted without the need to move the camera; and (3) even facial expressions (of many students) can be conveyed. On the other hand, one disadvantage to the system is seen in the delay of approximately one second before input images are output as a result of the inter-frame compression used to achieve high compression. However, this delay may be reduced by an increase in the bandwidth of future communications network. During this experimental class, Japanese and American students showed each other what they had in their pockets, and noted differences in the types of daily necessities and the amount of money carried from country to country (i.e., from cul-

ture to culture). They also exchanged views or questions about these personal effects using the chat system described below. High-quality images allowed them to share even the smallest items, which fostered both improved understanding and the motivation to learn more.

### 3.2 Chat'n'Debate

Chat'n'Debate is a web-based chat system implemented as a Java applet. This tool was developed at Hokkaido University. Figure 3 shows a screen shot of this chat system.

In our advanced information society, English-language skills (particularly writing skills) are considered essential as a basis of today's communication. We developed Chat'n'Debate as a debating tool enabling students to exchange opinions in real time or in quasi-real time. In distance learning sessions, this chat system provides each student with the opportunity to join the discussion on an equal basis.

### 3.3 Culture Box

Culture Box is a Web-based voting system written in PHP that features a comment entry function. This tool was also developed at Hokkaido University. Figure 4 shows a screen shot of the Culture Box. Participants cast votes for answer options, and can also add

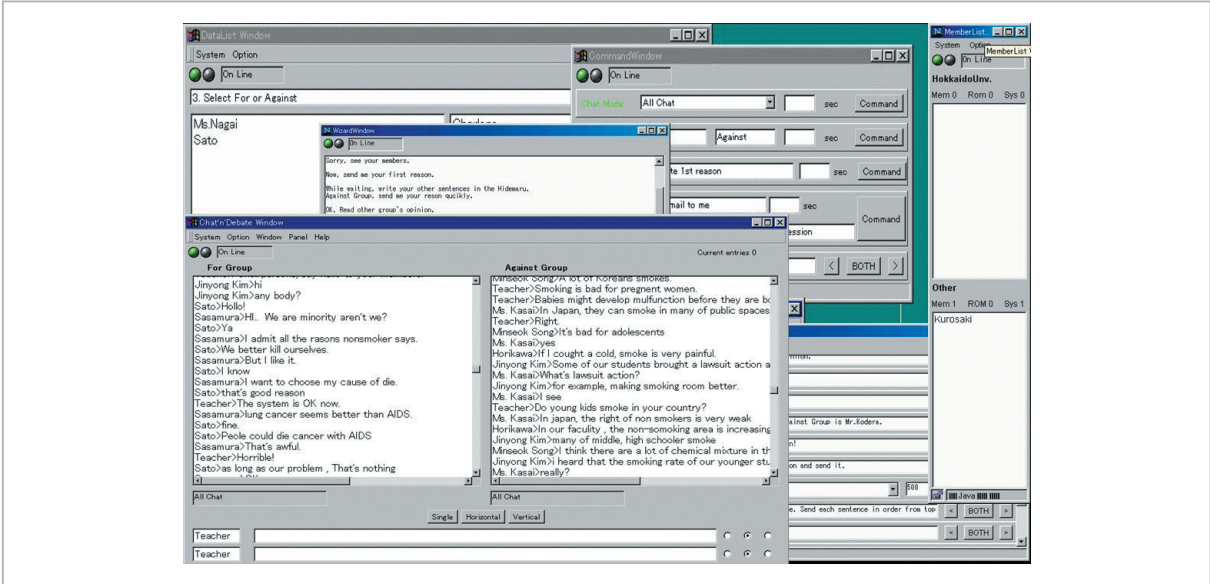


Fig.3 Chat'n'Debate screen shot

comments to their answers. During this experimental class, for example, one student asked, “How do Japanese university students address their fathers?” After voting, students compared answers (by Japanese students) with guesses (by American students). There was also a question directed to American students: “How do American university students address their fathers?” They then similarly compared their answers and guesses. The students then had a lively discussion by entering comments and responses on the results.

### 3.4 Network configuration

Figure 5 shows the network configuration used in this experiment. This network was designed with the following three points in mind:

- Use of the Internet in a trans-Pacific connection
- Use of JGNI for local connection in Japan
- Enabling communication of data to multiple points, in addition to direct point-to-point connection between the two countries

We connected the domestic segments by JGNI and the remaining segments by the Internet. Since this experiment coincided with

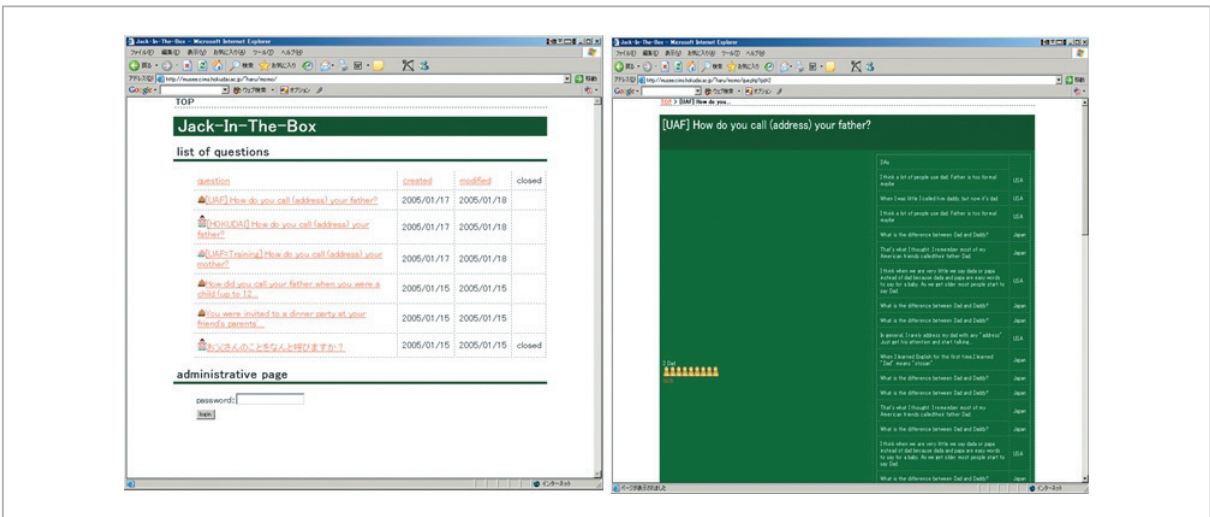
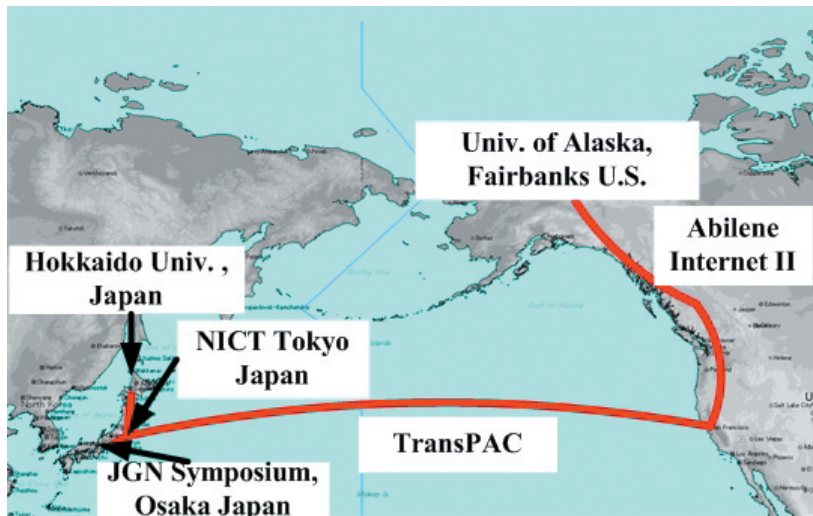


Fig.4 Culture Box screen shot



**Fig.5** Network configuration

the JGNII Symposium held in Osaka, we showed the class at the symposium sites in Osaka and Tokyo (NICT Koganei) as a demonstration of the technology involved. Dozens of visitors viewed the class at the two sites.

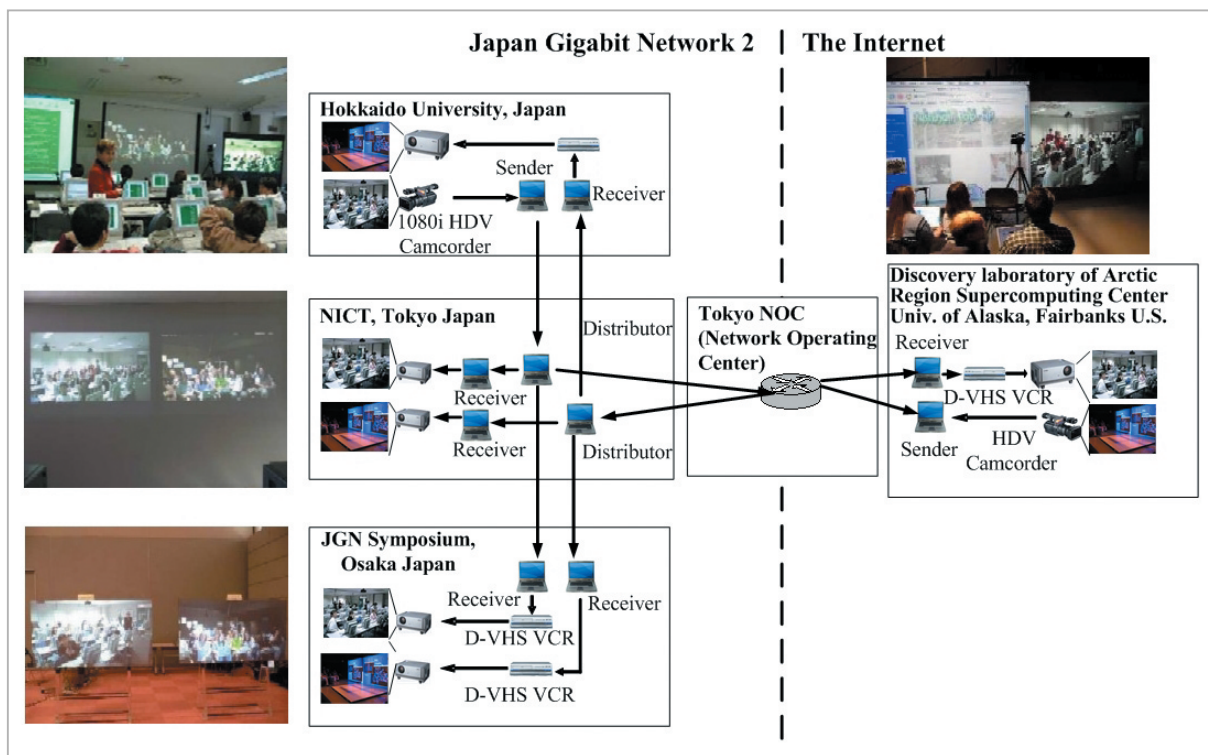
Figure 6 shows the network configuration in detail. All sites in Japan were connected by virtual LAN within the same subnet. This subnet was connected to the Internet via a router installed at JGNII. We used a shared 100-Mbps network to connect this router and Hokkaido University.

We used a U.S. Internet service to connect Hokkaido University and the Discovery Laboratory in the ARSC of the UAF. According to a preliminary experiment on the network using UDP, we were able to send data from the JGN segment at NICT Koganei to ARSC at 70 Mbps or higher with the loss of only a few packets. This rate was possible principally because we conducted this experiment just before the end of the winter vacation, and therefore traffic was relatively low within the campus networks. The Discovery Laboratory has an immersive display system that consists of several over-150-inch rear-projection displays. They used this system to display images and text sent from Hokkaido University,

enabling the students to view life-size images in the course of the experiment.

There are several methods of distributing images of a distance learning session to multiple locations. We selected IP unicast in this experiment because the experimental network featured an Internet segment in which multicasting (usually more efficient for such purposes) was difficult. Our high-definition videoconferencing system consumes a bandwidth of about 30 Mbps on the IP layer. To send image data from Hokkaido University to three locations using unicast, the system will require a bandwidth of approximately 90 Mbps, which is comparable to the network capacity between Hokkaido University and the JGNII router. To use bandwidth most efficiently, we adopted a star topology consisting of distribution servers located in Japan. Figure 6 shows the network configuration in detail.

During the actual experiment, data transmission was affected by traffic associated with the JGNII Symposium. It became difficult to send stable images of the U.S. side from the distribution server in Tokyo to Hokkaido University. Therefore, we sent this data directly from UAF to Hokkaido University. At that time, the data stream was approximately 60 Mbps from UAF to Japan. We can conclude



**Fig.6** Details of network configuration

from these results that it is possible for other universities to hold a high-definition video-conference using their ordinary campus LANs, provided the network connection conditions are good.

## 4 Conclusions

In this paper we described a demonstration experiment on international distance learning conducted at Hokkaido University and the University of Alaska Fairbanks in January 2005. We connected a classroom in the IT Education Hall at Hokkaido University campus and the Discovery Laboratory located in the UAF ARSC using the Internet and NICT's JGNII research and development network. We

presented the objectives and outline of this experiment as well as the tools we used. As a next step, we intend to conduct experimental classes in which participants at three or more locations (or, in three or more different countries) are simultaneously connected, learning each other's languages and sharing their respective cultures.

## Acknowledgements

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