Design Communication Experimented on an ATM V-LAN network

Study of Communication Tools for Creative Collaborative Design

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Tools and techniques for synchronous design communication are still underdeveloped, because insufficient bandwidth of the present Internet has inhibited practical experiments. Reviewing the results of a design communication test carried out by the authors using a TCP/IP based V-LAN on ATM network, this paper discusses the proposal that synchronous communication using application sharing tools and video conferencing tools will become common in the broadband network age, in addition to the use of bulky data on remote PCs or web databases.

Keywords:*. design communication; broadband network; experiments; network collaboration.*

1. Background and objectives

With the recent development of network communication technology, and advances in the cost performance of digital design tools, the methods and procedures of architectural design are rapidly changing. Many schools have reported successful results in virtual design studio experiments applying asynchronous collaborative design tools, such as web-based groupware and e-mail [Hirschberg 99], [Koraevic 98], etc. It is possible to say that techniques of asynchronous design communication have almost reached the level of practical use.

However, tools and techniques for synchronous design communication are still underdeveloped because insufficient bandwidth of the present Internet has inhibited practical experiments [Maver 99], [Gabriel 99], [Velasco], [Laiserin].

In the fall of 2001, the authors tested various methods of design communication using a broadband network connecting four sites distributed over 1000km-area[i]. After connecting three sites with three 150MB ATM links, and the remaining site to the others using three 40MB ATM links, the authors established a TCP/IP based Virtual-LAN by setting an ATM/ETHER switch on each site. The objective of this paper is to discuss successful methods of design communication that will become common in the broadband network age.

2. Communication model and tools for network collaboration

Reviewing past network collaboration projects, the authors summarized?expected design communication features in the form of a cross table representing design information and incorporating the work style of designers and different document types?(Table 1). The table also listed various types of hardware and software that could support four different work styles, followed by specific names of tools used in the test. These were mostly popular PC tools, except GW-Notebook, which is web-based groupware

[i] *Japan Gigabit Network served as a close network for experimental studies by the Telecommunications Advancement Organization in Japan.*

developed by the authors [Morozumi].

The "whiteboard digitizer" provides an effective interface between an application manipulated on one PC and large audiences gathered not only around this PC, but also remote PCs sharing the application through a network. It consists of application software, and a digitizing unit that is attached with suckers to the whiteboard surface. (Figure 1. bottom right) The attached unit includes a utility that digitizes the location of a special stylus when it touches the whiteboard surface, allowing a user to manipulate any PC application software projected on the whiteboard by simply touching the board surface with the stylus. The stylus controls a PC-cursor, just as a mouse does. Once one displays a keyboard image, it is possible to input a command line or a list of characters. The unit also has a utility for overwriting sketches or comments manually in a window image of applications, as well as the facility to record those images as a memo of discussions. (Figure 1. upper left)

3. Three experiments

The authors conducted three different types of experiment. 1) Packet transmission tests between each pair of sites. 2) Tool performance tests, incorporating systematically listed combinations of working styles, documents of different file sizes[ii], network segments of different bandwidths, and varying numbers of sites working together (Table 2.). 3) Comprehensive tests in practical situations: remote design studio teaching for junior students of Kumamoto University, and a remote discussion between two design offices at the stages of design development and editing layout of a design report.

It was found that ATM passing through network segments of different bandwidth requires careful router setting to minimize packet-loss, especially when used with TCP/IP. After careful setting, the two 156Mbps segments connecting Kumamoto University to another site within Kumamoto city and

[ii] The authors tested at least four different file sizes for each case. The table indicates the size of the largest.

Document types and examples \ **Work style**	**Asynchronous working stage**		**Synchronous working stage**	
	Individual work using:		Discussion and synchronous work using:	
	web data	remote-application	web data	remote-application
Text :Word Spreadsheet :Excel Still graphic :Photoshop Drawing :AutoCAD 3D model :AutoCAD :VRML Int'ctiv graphic :Powerpoint Movie :QTmovie Int'ctiv movie :QTVR	Individually manipulate documents on a web to review, add comments, download file for further work, and upload files studied.	Individually start and manipulate application files on a remote PC, review, revise or add new proposals, and save work file to a PC.	Interactively manipulate documents on a web that is shared among remote PCs, to make presentations and discussions.	Interactively manipulate application software shared among remote PCs to make presentations, discussions, and edit files.
Data system for sharing information within a team	Web: GW-Notebook	File sharing system: windows	Web: GW-Notebook	File sharing system: windows
Tools for exchanging dialogues	Bulletin board on a web (e-mail) : GW-Notebook		Video conferencing tool and chat : Impression Live	
Tools used at each site, where the number of participants stays small	Web browser and plug-in: *Internet Explorer, AutoDesk VoloviewExpress, etc.*	Applications at remote PC: those listed on the left above	Application sharing tool, web browser and plug-ins: *IE, NetMeeting*	Application sharing tool, application at shared PC: *NetMeeting*
Tools simultaneously used at each site, where the number of participants becomes large	PC projector and 'whiteboard digitizer' to display an enlarged image of application window on a whiteboard, and then allow participants to manipulate the application with a special stylus on a projected image: *Mimio* ('whiteboard digitizer')			

Table 1. Type of Documents and Example of Tools used in a Network Collaboration by styles of work

Figure 1. Discussion using a whiteboard digitizer to manipulate a shared application

another located 200km away reached 60Mbps, and the 40Mbps segment connecting Kumamoto University and a site 1000km away reached 13Mbps. There were longer delays for more remote sites.

4. Discussions

A broadband network provided a convenient environment for asynchronous work using application files of bulky documents on a remote PC as well as those on a web database. Though 40Mbps segments had to wait a little less than a minute before starting some applications, a 2880 x 480 pixel sized linked QTVR-movie and a SVGA (800 x 600) sized 20 frames per second Qt-movie could be played on a distant PC through that segment. There were no significant differences in the quality of sound and graphics between movies played with CD-ROM and those played through the network. The 156Mbps segments allowed designers to manipulate remote files of almost all types and sizes tested.

Both segments provided a smoother and more stable environment for multi-point videoconferencing. Though there were delays of approximately two-seconds in transmitting video conferencing data, this did not lead to an unnatural impression during discussions in remote studio teaching. Operational factors such as video camera handling, microphone setting, and sound input level tuning were more important in upgrading the impression of live performance.

They also allowed designers to manipulate bulk data applications shared among remote PCs using an XGA or even SXGA display. A 50Mbyte-sized CAD file could be smoothly manipulated even when it was shared among four sites. But PCs faced difficulties in synchronizing display images when sharing applications whose display image changed continuously. As this occurred even when a Pentium IV, 1.7 GHz CPU PC and a Pentium III, 1.0 GHz CPU PC were directly connected at a hub, the specifications of a commercial PC, OS, and application do not meet requirements.

A whiteboard digitizer provided quite a convenient and effective environment for discussion between remote sites, especially when audiences consisted of groups. When an architect start sketching on a GW-Notebook image using this tool in the last experiment of remote studio teaching, the discussion became quite vivid. In the questionnaire, almost all students indicated that the system made it easier to understand advice.

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Table 2. Summary of tool tests for practical use

Tested Documents	Max File size tested	Asynchronous individual work using web data 150Mbps delay & eval		40Mbps delay & eval		remote file 150Mbps delay & eval		application 40Mbps delay & eval		Synchronous work sharing web data Points connected 2pts eval	3pts eval	4pts eval	remote application Points connected 2pts eval	3pts eval	4pts eval
[Still type]	MB	Sec		Sec		Sec		Sec							
Word	10	3.1	G	13.4	G	2.5	G	59.1	A	G	G	G	G	G	G
Excel	10	1.0	G	13.9	G	3.7	G	55.8	A	G	G	G	G	G	G
Photoshop	30	1.0	G	10.7	G	2.1	G	53.1	A	G	G	G	G	G	G
AutoCAD	10	2.8	G	16.1	G	5.5	G	16.8	A	G	G	G	G	G	G
	50	17.6	G	95.5	N	23.2	A	83.1	N	A	A	A	G	G	G
[Dynamic type]															
Powerpoint	11	1.1	G	15.5	G	14.5	G	26.2	A	A	A	A	A	A	A
Flash	6	0.4	G	5.4	G	--	-	-	-	A	A	A	-	-	-
VRML	5	0.4	G	4.1	G	3.3	G	10.4	G	A	A	A	A	A	A
QTmovie	175	-	-	-	-	2.6	G	11.8	G	-	-	-	N	N	N
QTVR	1500	-	-	-	-	3.5	G	15.2	G	-	-	-	N	N	N
Whiteboard Digitizer: Mimio										G	G	N	G	G	N

Notes G: good for practical use (less than 20 second delay in the case of asynchronous tests)
A: acceptable for practical use (less than 60 second delay in the case of asynchronous tests, and faced loss of image frames or slow reactions from time to time in the case synchronous test)
N: no good for practical use
- : not tested
At least four different file sizes were tested for each case, but the table indicates maximum size only.
Still type: documents or applications whose PC image display stays still, except when user inputs commands.
Dynamic type: documents or applications whose PC display image changes sequentially.

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