Real Scale Experiments on Communityware

Toru Ishida, Hideyuki Nakanishi and Saeko Nomura
Department of Social Informatics, Kyoto University
ishida@i.kyoto-u.ac.jp

Abstract

Communityware is for more diverse and amorphous groups of people. Compared to current groupware studies, communityware focuses on an earlier stage of collaboration: group formation from a wide variety of people. We have been working on real scale experiments on communityware for more than 8 years. This paper summarizes our experiences on real scale experiments on communityware: the Mobile Assistant Project, Digital City Kyoto, and the Intercultural Collaboration Experiment.

1. Introduction

With the advance of global computer networks like the Internet and mobile computing, discussion of *virtual community* has become more active worldwide. People realized that the Internet and other network technologies could affect not just industries and economies but also our everyday life. According to Webster's Dictionary, the word community is defined as "a body of individuals organized into a unit or manifesting usually with awareness some unifying trait." More specifically, Hillery reported that there were at least 94 definitions for this word even in the early 1950s. His summary of the factors of community showed that they include *locality, social interaction* and *common tie.* MacIver also pointed out that the concept of community is based on the locality of human life, and is the counter concept of *association*, where people share a common goal. Recently the term *community* is being used as a metaphor for the next stage of computing technologies, including the methodologies, mechanisms and tools for creating, maintaining, and evolving social interaction in human societies. We believe there will be a dramatic shift in computing metaphors: from *team* to *community*. Given that the team metaphor has created research fields like groupware and distributed artificial intelligence, it is quite possible that the community metaphor will generate new fields both in research and practice.

We first address how we extend groupware for human community support. Research into groupware was triggered by advances in local area networks. Various tools have been developed for communication between isolated people, such as desktop electronic meeting systems. Though there is no specific definition of the term *group*, previous research and practice of groupware mainly addressed the collaborative work of already-organized people. A typical example is that project members in the same company synchronously / asynchronously works using workstations connected by local area networks. *Communityware is for more diverse and amorphous groups of people*. We think that the metaphor of community has become important given the advance of global computer networks such as the Internet and mobile computing. Our goal is to support the process of organizing people who are willing to share some level of mutual understanding and experiences. In other words, compared to current groupware studies, *we focus on an earlier stage of collaboration: group formation from a wide variety of people*.

Every community has rules that can be represented logically. The rules may specify how to elect leaders, make decisions, collect monthly fees, and so on. Groupware technologies can provide tools for supporting these formal procedures. In the case of communities, however, people require more than logical support. MacIver pointed out that, for communities, it is essential for members to share feelings such as *we-feeling*, *role-feeling* and *dependency-feeling*. The obvious problem is whether community feelings can be established within a virtual space. A similar question is whether the use of personal digital assistants (PDAs) really encourages people to develop these feelings. Thus, the challenge is to extend the human community beyond physical localities through the use of public computer networks.

The community metaphor can create five different functions for encouraging social interaction in communities as follows:

1. Knowing each other;
2. Sharing preference and knowledge;

3. Generating consensus;
4. Supporting everyday life;
5. Assisting social events.

Large scale trials have to be performed to confirm communityware. The research issue lies in the evaluation of community interaction. In software engineering areas, the *rapid prototyping model* has been widely accepted as a way of developing application software. However, this model assumes that prototypes can be easily evaluated. For example, in the case of window applications, though it is hard to know all specifications in detail in advance, we can assume that their evaluation is possible at a glance. The problem in community computing is, however, that we cannot evaluate software in such a manner. The difficulty is in evaluating the systems embedded in human organizations. Measuring computation / communication efficiencies is not enough for evaluating software for networked communities. For example, people who are interested in digital cities cannot easily determine whether or not the systems are really useful. This is because community support systems are used by a variety of people, not just one person. Therefore, *rapid and community-wide evaluation* is as important as rapid prototyping.

This paper summarizes our experiences on real scale experiments on communityware: the *Mobile Assistant Project* in 1996, *Digital City Kyoto* from 1998 to 2001, and the *Intercultural Collaboration Experiments* started from 2002.

1) Internet services are often provided at large social events. However, it seems that people use the services mainly for reading and writing e-mail messages. More intimate computing is needed to assist socialization. The challenge here is to apply mobile computing to assist social events, and also to explore mobile computing with a large number of terminals. The ICMAS'96 Mobile Assistant Project was the first such experiment in an actual international conference; 100 personal digital assistants (PDAs) and cellular phones were used.

2) The concept of digital cities is to build an arena in which people in regional communities can interact and share knowledge, experiences, and mutual interests. Digital cities integrate urban information (both achievable and real-time) and create public spaces in the Internet for people living/visiting in/at the cities. The project for Digital City Kyoto was established in October of 1998. In August 1999, the Digital City Kyoto Experiment Forum was launched. The forum includes several universities, local authorities, leading computer companies, as well as local companies, temples, photographers, volunteers and so on. Researchers and designers from overseas have joined the project. Besides technological problems, we have encountered numerous non-technical research issues such as security, privacy, and intellectual property rights.

3) Intercultural Collaboration Experiment 2002 (ICE2002) is an experimental project among East Asian universities. In this project, 32 students from Kyoto University (Japan), Shanghai Jiaotong University (China), Seoul National University and Handong University (South Korea), and University of Malaya (Malaysia) developed software over the Internet. Since ICE2002 pursuit collaboration among heterogeneous groups across country borders, participants never see each other and communicate in their mother languages supported by machine translation.

2. Mobile assistant project

The Internet services at international conferences become quite popular now. Several tens of desktop terminals are usually served at the conference site. However, the services are constrained in both space and time: the services are only accessible from terminal rooms during daytimes. On the other hand, the salient feature of mobile computing is that users can play their PDAs at anytime and anywhere. The challenge of this trial is to apply mobile computing to an actual international conference and to clarify its role quantitatively.

Unfortunately, though the Internet service at international conferences is common, no analysis has been reported. Similarly, in the mobile computing literature, a number of papers has been published concerning their technologies and applications, but none for the analysis on human communications. Substantial efforts by HCI researchers are mainly on multimedia communication and conferences by relatively small teams. Several reports are available on large groups in business applications, education, and home computing. However, there is no report on human communications via mobile computing with a large number of users.

In this paper, therefore, we report the experiment called ICMAS'96 (the second international conference on multiagent systems) Mobile Assistant Project. This conference was held in Kyoto, Japan from December 9th to 13th in 1996. The project provided (a) E-mail and Internet access services, (b) conference, personal and tourist information services, and (c) forum and meeting arrangement services. In this experiment, around 100 personal digital assistants (PDAs) with wireless phones were loaned to conference participants without any charge to try out the system. To our best knowledge, it was the world's first experience of applying mobile computing to international conference support. By reducing the time and space constraints of desktop computing, mobile computing guarantees timely use of network services. As a result, the demands of the various information services (such as conference, personal and tourist information services) are significantly revealed. It will be shown that mobile computing technology is effective in network services at international conferences, and to be combined with conventional desktop computing technology.

The goal of the ICMAS'96 Mobile Assistant Project is not only to support communication services like E-mail, but also to provide various information required at international conferences through PDAs. PDAs were provided to around 100 people, roughly one third of the conference attendees. People can use them in the conference site, lobbies, hotel rooms and outdoors. Figure 1 depicts a participant using the service in the event hall where the conference was held. We implemented (1) communication services, (2) information services, and (3) community services as displayed in Figure 2. These services consist of commercial services like E-mail, and various original services developed by around 20 people in NTT, Kyoto University and Nara Institute of Technology. Since most services were developed just for this experiment, we could embed enough codes to obtain log data.

Figure 1. Participants using mobile services

The project became larger than we expected. Thirty telephone lines were newly introduced and connected to the server machine (HP9000 model 800I60), which was placed at the conference site. The server machine was connected to the Internet to provide E-mail and information services. We found a serious communication prblem between 100 PDAs and the server machine. Since the traffic of mobile communication at this experiment differs from usual telephone services, it appears that existing facilities are not enough to cover our demand. After negotiation with the local wireless telephone company, the situation was substantially improved to allow several ten calls at the same time from the conference site. The project was announced to conference attendees beforehand so that they can apply for PDAs. We requested all participants to fill the pre-questionnaire together with the application form. Around 100 people out of 280 conference attendees applied for this project, and everyone received a PDA and a wireless telephone.

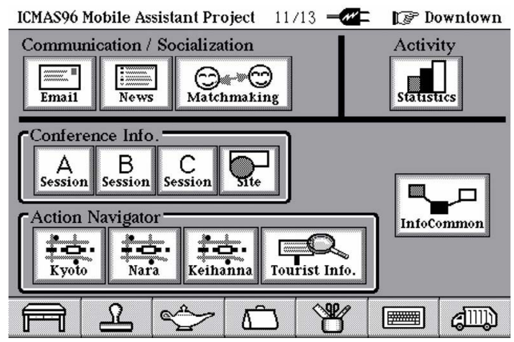

Figure 2. Mobile services

The target of data analysis is to clarify the demands in international conferences by investigating how provided services are used during the conference. Figure 3 describes the weekly trends of participants' activity. The activity is low on December 9th and 13th, because the PDAs are loaned and returned on these days. At the first glance, except the two days, the activity is high at the beginning and gradually decreases to the end of the conference. However, there exists more structural background behind the data as follows. There exists a fairly stable demand for E-mail services during the conference. The number of related events (sending / receiving messages) is independent of the progress of the conference, but rather depends on the number of PDAs in use. On the other hand, demand for information services changes dynamically. Conference information services are mostly used on December 11th, when technical presentations start. The demand for personal information services is high at the beginning of the conference but getting lower day by day. Though the number of accesses is not large, the demand for statistics feedback shows a similar behavior to personal information services: actively used at the beginning of the conference and less active towards the end.

The demands for E-mail services are steady, while those of information services are dependent on the conference structure strongly. In previous conference support, desktop computing mainly provided E-mail services so that users can continue their business at the conference site. Mobile computing, however, can support more conference-oriented information services. The results of log data analysis emerge a picture in which people use PDAs after dinner in their hotel rooms to get extra information of other people who met this afternoon and to make a schedule for the next day.

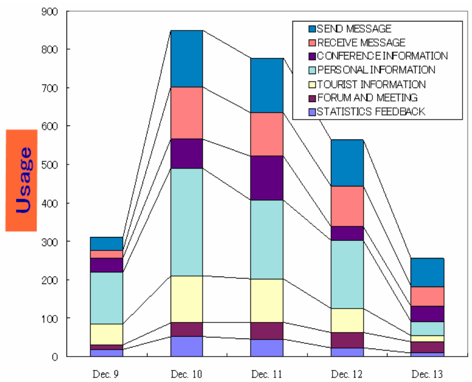

Figure 3. Weekly trends of participants' activities

The next target of data analysis is to find correlation among the utilization of services so to figure out users' behavior. The following observations are obtained from Table 2. The positive correlation appears between sending and receiving E-mail messages. Though the fact is intuitively clear, it is useful to know the factor of this case to interpret other cases. There exists considerably strong correlation among personal information retrieval, statistical feedback, and forum and meeting arrangements. All these events are to satisfy the interests in other participants. The positive correlation also appears among any two information services. On the other hand, there is almost no correlation between E-mail services and information services. No correlation means that E-mail users do not always actively use information services and vice versa. This result differs from that reported by the HomeNet Project, where active E-mail users also use information services. In the HomeNet Project, since users are novice and the period of project is considerably long (more than 50 weeks), this positive correlation shows the divergence of users some of who become familiar to computers and others who do not. In the Mobile Assistant Project, however, since our users are all professionals of computers, and the period is short (5 days), the different divergence appears: the demand of E-mail services mainly from outside of the conference and the demand of information services purely from inside of the conference.

Table 1. Correlation between various services

	SEND MESSAGE	RECEIVE MESSAGE	CONFERENCE INFORMATION	PERSONAL INFORMATION	TOURIST INFORMATION	FORUM AND MEETING	STATISTICS FEEDBACK
SEND MESSAGE		**.630**	-.090	-.044	.030	.068	-.097
RECEIVE MESSAGE	**.630**		-.013	-.024	.029	.006	-.130
CONFERENCE INFORMATION	-.090	-.013		**.468**	**.414**	**.492**	.324
PERSONAL INFORMATION	-.044	-.024	**.468**		**.500**	**.585**	**.679**
TOURIST INFORMATION	.030	.029	**.414**	**.500**		**.415**	.366
FORUM AND MEETING	.068	.006	**.492**	**.585**	**.415**		**.624**
STATISTICS FEEDBACK	-.097	-.130	.324	**.679**	.366	**.624**	

3. Digital City Kyoto

Kyoto was the capital of Japan for more than a thousand years, and has been a cultural center of Japan for even longer. To begin a digital city project for Kyoto, we started with its design policies. The first policy for designing Digital City Kyoto is to make it *real* by establishing a strong connection to physical Kyoto. Our digital city is not an imaginary city existing only in cyberspace. Instead, our digital city complements the corresponding physical city, and provides an information center for everyday life for actual urban communities. Digital activities will become an essential part of the real city in the near future. We think "digital" and "physical" make things "real." We are thus working on a digital part of the real city. The second design policy is to make the digital city *live* by dynamically integrating Web archives and real-time sensory information created in the city. We will not produce contents nor select them. We will provide a tool for viewing and reorganizing digital activities created by people in the city.

We propose the three layer model as a system architecture suitable for digital cities. The first layer is called the *information layer* where Web archives and realtime sensory data are integrated and reorganized using the city metaphor. The geographical database is used for the integration of different types of information. The second layer is called the *interface layer* where 2D maps and 3D virtual spaces provide an intuitive view of digital cities. The animation of moving objects such as avatars, cars, busses, trains, and helicopters demonstrate some of the dynamic activities in the cities. If an animation reflects a real activity, the moving object can become a tool for social interaction: users may want to click the object to communicate with it. The third layer is called the *interaction layer* where residents and tourists interact with each other. Communitywareg experiences have been applied to encourage interactions in digital cities.

To explain Digital City Kyoto, we start with the first layer, the *information layer*. Operations on current Web sites are mainly by text: users search information by keywords and software robots retrieve information. This search-and-retrieve metaphor works well, especially if the needed information is distributed worldwide. If the Internet is to be used for everyday life, however, the geographical interface will become more important. GIS is the core of our digital city. The geographical database connects 2D/3D interfaces to WEB/sensory information. From the viewpoint of system architecture, introducing the geographic database allows us to test various interface/information technologies independently.

After digital cities become popular, people will directly register their pages to the geographical databases, but until then, we need some technology to automatically determine the XY coordinates of each WEB page. In Kyoto, however, since the city is 1200 years old, there are various ways to express the same address, and this makes the process very complicated. So far, we have processed 4800 pages that refer to public spaces including restaurants, shopping centers, hospitals, temples, schools, bus stops. Figure 4(a) shows the results of locating the pages on the map. We can see how Web pages (restaurants, schools, temples, shopping centers, etc.) are distributed in the city. Various data retrieval methods that involve this map are under development.

As the real-time sensory information, we are considering bus schedules, traffic status, weather condition, and live video from the fire department. In Kyoto City, more than three hundred sensors have already been installed and they are gathering the traffic data of more than six hundred city buses. Each bus sends its location and route data in every few minutes. Such dynamic information makes our digital city live. The first trial collects real-time bus data and displays them on the digital city. Real-time city information is more important for people who are doing something in the physical city than for those who are sitting in front of desktop computers. For example, people would like to know when the next bus is coming, where the nearest vacant parking lot is, whether they can reserve a table at a restaurant, and what is on sale at the department store just in front of them. We are now implementing a prototype application that provides live information to mobile users through wireless phones.

(a) GeoLink

(b) 3D Kyoto

Figure 4. Digital City Kyoto

The 3D graphic technology becomes a key component of the *interface layer*, when used in parallel with the 2D maps. The 3D aspect to a digital city allows non-residents to get a good feel for what the city looks like, and to plan actual tours. Residents of the city can use the 3D interface to pinpoint places or stores they would like to visit, and to test walking routes. Figure 4(b) shows the 3D implementation of Shijo Shopping Street (Kyoto's most popular shopping street). We use 3DML, which is not well suited to reproducing gardens and grounds, but has no problem with modern rectilinear buildings. Since 3DML is easy to use, college students in Kyoto have started to join us in cooperatively building the 3D Kyoto. This follows the "bazaar approach" to software development. We hope that have contributors from all over Kyoto will keep the project from being a small handful of stagnant areas, and make this a vast and dynamic city.

At the same time, we started discussing various problems with the shopping street community: since we are using photos, information in the photos becomes old; the advertisements in the photos quickly become out-of-date; and some photos include registered trademarks. It is important for engineers, researchers and shop owners to start thinking of these issues. One solution we are working to implement, is a Web and FTP interface to allow individual shopkeepers to update the advertisement photos on their 3D buildings by themselves.

Social interaction is an important goal in digital cities. Even if we build a beautiful 3D space, if no one lives in the city, the city cannot be very attractive. We plan to use cutting-edge technologies to encourage social interaction in Digital City Kyoto. One trial for developing social interaction in digital cities uses avatars in the 3D space to bridge residents and visitors. Figure 5 shows the software agents walking in a 3D city. The technology allows a number of agents to walk around the city in real-time. By making links between the agents and the people walking in the corresponding physical city, we can realize communication between digital tourists and physical residents. As the walking motion can be generated by the user's machine via a Web browser plug-in, only the walking position / velocity and direction need to be downloaded. Thus, a large number of agents can be created rapidly in real-time. Aside from the "known" agents, adding a virtual population will activate the digital city and make it more attractive. We have started working on disaster management simulations in digital cities.

Figure 5. Agents in Digital City Kyoto

4. Intercultural collaboration experiments

Toward the dramatic Internet diffusion in East Asian countries, the intercultural collaboration support system, which surpasses the sense of values and language differences, is necessary to be constructed. Differing from the face-to-face communications, to the computer mediated communications, machine translation services can be easily applied. This technological advancement drastically increases availability of intercultural collaboration beyond the language barrier.

Although natural language processing researchers have conducted rigorous research on machine translation for years, the translation quality is hardly adequate to be applied to practical worksites. The preceding studies evaluate machine translation on written documents, and do not take into account “interaction factor” to refine translation quality. We, on the other hand, apply machine translation to human-to-human collaboration, and try to analyze the interactive translation refinement procedures implemented between humans and between human and machines. This section reports about the result of Intercultural Collaboration Experiment 2002 to consider the applicability of machine translation to multinational collaborative works.

Figure 6 shows the participants of ICE2002. In this trial, multilingual communication tools, named TransBBS and TransWeb were provided to participants. These tools incorporate translation services among Chinese, Japanese, Korean, Malay, and English. TransBBS, a multilingual bulletin board system, is utilized as a daily discussion space. TransWeb enabled participants to browse software development documents in their first languages. Communications in ICE2002 are held only on TransBBS and TransWeb.

ICE2002 had two tracks. The first track was conducted from May to July, and the second one from October to December. To ensure smooth communication and software development, each track was divided into the following two 4-week-phases. In Software Design Phase, Intercultural collaboration software is designed. The goal of this phase is to submit a system design proposal to implement software. In Software Implementation Phase, Software based on the design proposal is implemented. The goal of this phase is to complete and release an intercultural collaboration tool.

In ICE2002, intercultural collaboration software, which consists of Web-based email, SMS, search engine, is proposed as an outcome by a multinational team. We observed how participants achieved their goal with communications in a noisy media.

Figure 6. ICE2002 participants

To analyze translation-mediated collaboration on TransBBS, the conversation and content analysis were applied. We found different communication patterns between phases: The following two methods were observed: *Other-initiated repair*: Collaborative translation-error repair process between message contributors and receivers to achieve sharing common knowledge. The repair process is initiated by a message receiver's reaction. *Self-initiated repair*: Before posting a message, a message contributor repeats repairing by him/herself to refine translated results. In ICE2002, we confirmed *repair organization* especially in the process of translation-error eliminations.

5. Conclusion

With the advance of global computer networks, a dramatic shift in computing metaphors has begun: from team to community. Understanding that the team metaphor has created various research fields including groupware and distributed artificial intelligence, it seems that the community metaphor has the potential to generate new directions in research and practice. In this paper, we described three trials taken in the past ten years.

1) *Mobile Assistant Project*

We clarified the role of mobile computing in network support at international conferences. We have provided around 100 personal digital assistants (PDAs) with wireless telephones and various communication / information services at an actual international conference. After the conference, we have analyzed a large amount of log data and obtained the following results. (a) People continuously use PDAs not only at the conference site but also in their hotel rooms after dinner. Compared to desktop computing, they tend to use PDAs more frequently but shorter for each time. (b) E-mail services are used independently of the conference structure, while the load of information services peaks reflecting the progress of the conference. (c) No correlation is observed between the use of E-mail and information services, and the combination of their usage varies depending on each user. To our best knowledge, there is no analytic report on conference support services including desktop computing. We believe it is valuable to provide the results of log data analysis to other researchers, who perform similar experiments in near future.

2) *Digital City Kyoto*

We see the concept of digital cities as being a social information infrastructure for urban everyday life (including shopping, business, transportation, education, welfare and so on). We have been working on Digital City Kyoto, the old capital and cultural center of Japan, based on the newest technologies including GIS, 3D, animation, agents and mobile computing. We propose the three layer architecture for digital cities: a) the information layer integrates both WWW archives and real-time sensory information related to the city, b) the interface layer provides 2D and 3D views of the city, and c) the interaction layer assists social interaction among people who are living/visiting in/at the city. During this project, we found the digital cities have many directions: tourism, commerce, transportation, urban planning, social welfare, health control, education, disaster protection, politics and so on. Digital cities attract people because different experts can contribute to building a new city, and provide an opportunity to people to create a new information space for their everyday life.

3) *Intercultural Collaboration Experiment*

We analyzed the communication patterns on ICE2002. By observing the ICE2002, following two points were found in the collaboration process in which people share a common goal; Emergence of *Human adaptation to machines*: People tend to adapt themselves to machine translation capability to convey remarks properly to other team members. Achievement of *Human to human collaboration*: Even if a translation does not work perfectly sentence by sentence, people work out intentions of other members' remarks. That is to say, we confirmed that machine translation indeed supported intercultural collaborative works. The approach of this research is to use translation function in collaborative context. We continue to analyze the human-to-machine interaction, especially the human recognition and adaptation process to machine translation. We then propose the human-to-machine interaction model to natural language processing researchers. Our ultimate goal in this research is to develop translation-mediated communityware, which can be applied to East Asian open projects. The research is continuing and the further report will be available in near future.

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