

# 14 Presence Technologies for Informal Collaboration

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**Abstract.** In this chapter we investigate presence technologies for supporting informal collaboration. Informal collaboration consists of spontaneous and unplanned interactions that occur frequently and transparently within organizations. Informal collaboration is crucial for developing working and social relations, and for long-term learning. We argue that mainstream presence research is focused on formal collaboration, i.e. collaboration that is planned beforehand and occurs in pre-arranged collaboration sessions. Although informal and formal collaborations are highly interconnected and transitions happen in a seamless manner in real world situations, it seems that research in presence technologies for supporting informal collaboration has happened in parallel to mainstream presence research. We believe this has negative consequences for widespread use of presence technologies, and that integration at the technological level is needed. We investigate a number of existing presence applications that are designed to support informal collaboration, and discuss how they are different from presence technologies for supporting formal collaboration. We introduce a system model that attempts to integrate support for presence needed in both informal and formal collaboration.

## Contents

14.1	Introduction .....	210
14.2	Informal collaboration .....	211
14.3	Presence applications for informal collaboration .....	212
14.4	A system model for presence application .....	217
14.5	Conclusions .....	220
14.6	Acknowledgements .....	220
14.7	References .....	220

## 14.1 Introduction

We often take for granted that we are present in the physical world. We spread information about ourselves by merely being embodied in space. By entering our office in the morning and turning on the lights, we signal to our colleagues that we are available for conversation and collaboration. In a university campus, a glance into the cafeteria allows students to see who is available for a chat. Unusual crowds allow us to guess that something extraordinary is happening (e.g. people escaping from a burning building, or colleagues gathered around a water cooler talking about something important or simply gossiping).

In this chapter we investigate presence technology as an enabler for long-term informal collaboration among geographically distributed people. Presence research has contributed greatly to improving the quality of geographically distributed collaboration by informing technologies such as collaborative virtual environments, multimedia conferencing, groupware, and immersive virtual reality. These technologies have helped us a long way in creating virtual presence as an “illusion of non-mediation,” as formulated by Lombard and Ditton [1]. Interaction through presence technology becomes more and more similar to natural face-to-face interaction as the degree of realism increases.

However, in this chapter we argue that presence technology is mainly focused on what is called *formal* collaboration. By being formal we mean that collaborating parts have to explicitly start a collaboration *session* and step into the virtual world before they can collaborate using the technology. This might seem natural, but we will argue that it has severe consequences for long-term collaboration in geographically distributed groups. A large part of collaboration that happens in co-located groups is *informal* collaboration.

Informal collaboration emerges through chance encounters in corridors, impromptu meetings by the coffee machine, and the like. Social and working relationships get established through frequent informal collaboration in the long run. Informal collaboration is almost totally absent when groups are geographically distributed.

Information about other people’s presence plays a crucial role in informal collaboration as it is used to trigger spontaneous interactions. For example, seeing a colleague in the corridor might remind us of a question we wanted to ask her about an ongoing project.

Session-based presence technology does not address this issue simply because it does not take into consideration what happens in between the sessions. In other words, there is no presence information available in between sessions.

Although there is a general tendency within presence research to focus on the issue of realism and how our cognitive perception of technology-mediated presence is compared to face-to-face interactions, there exist a host of applications of presence technology that focus on informal collaboration and the specific requirements such collaboration poses on technology. These applications are developed mainly in parallel to mainstream presence research. Our aim is to integrate the two lines of research addressing formal and informal collaboration. This is crucial because seamless technological support to address both modes of collaboration in a transparent way is crucial for solving everyday problems of geographically distributed groups.

The structure of this chapter is as follows. In Section 2 we will introduce the concept of informal collaboration and will discuss the requirements it imposes on presence technology. Section 3 is a survey of a number of presence applications that are developed to support informal collaboration. In Section 4 we discuss some design issues related to bridging the gap between technological support for formal and informal collaboration.

Section 5 provides a discussion and concludes the chapter.

## 14.2 Informal collaboration

Collaboration with other people constitutes a large part of the activities we are involved in.

Collaboration happens in different occasions and takes different forms. Our interest in this chapter is connected to the degree of *formality* in collaboration. A formal collaboration is characterized by being intended, scheduled in advance, having preset agenda etc. A typical example is a project review meeting. On the other hand, informal collaboration is opportunistic or spontaneous, lacks predefined agenda and schedule, is short, and involves random participants [2]. Degree of formality in social interactions varies on a continuous spectrum. Kraut et al. [2] distinguish between four major modes of interaction with decreasing degree of formality: *scheduled*, *intended*, *opportunistic* and *spontaneous*. The major factor influencing the degree of formality is whether collaboration is planned or not, i.e. whether the participants had the intention to collaborate or they came in a situation that gave them the opportunity to collaborate.

As a result of a series of empirical investigations of a large R&D company, Kraut et al. [3] found that a large part of observed collaboration (up to 85%) was characterized by a low degree of formality, i.e. being opportunistic or spontaneous. Similar results have been obtained in numerous other studies (see for instance [4, 5]). Informal collaboration contributes strongly to learning [6], developing working and social relations [2], and effective knowledge management [7].

Presence information is of direct importance to both formal and informal collaboration. In formal face-to-face collaboration, detailed presence information about the participants and their actions is considered as a crucial resource [8]. This type of presence information helps participants to coordinate their actions in the context of a shared activity. An example is when we are working together with our colleagues in a meeting room. In such a setting, all the explicit and implicit actions of the participants, e.g. their body language and gestures, their gaze, their location with respect to each other, contribute to the overall performance of the activity.

Maybe not so evident is the important property of presence information as a trigger for informal collaboration. The mere knowledge of others' presence offers to us *opportunities for communication*. In this case it is not the detailed, realistic presence information about others that is central, but an overall awareness of the fact that people are present in our immediate surroundings. This type of presence information is continuously available to physically co-located groups, and results in frequent informal collaboration among the participants.

In real life situations formal and informal collaborations are highly interconnected, which makes the distinction purely analytical. Seamless transitions from one kind to another happen frequently and transparently. However the distinction between formal and informal collaboration has important consequences for presence technologies. Mainstream presence research is focused on formal collaboration in session-based environments (see [9, 10] for examples of such technologies). The important contribution of the majority of presence technologies is to simulate face-to-face interactions through increasing the degree of perceived realism. The resulting technology is often limited in usage due to high prices, the need for special technological settings, and more often than not due to complexity [11].

Informal collaboration is facilitated through high quality communication channels, low cost of initiating communication, and high frequency of opportunities for communication [3]. Our view is that presence research has mainly contributed to developing technologies that support the first point (i.e. high quality communication channels), while low cost of initiating communication and support for spontaneous communication have been less emphasized by the current state of the art. For supporting informal interactions we will therefore propose two complementary requirements:

- Presence technology should support continuous and long-term virtual presence in order to provide geographically distributed users with frequent opportunities for interaction.
- Presence technology should provide lightweight, easily available, and easy to use mechanisms to facilitate the actions needed for initiating spontaneous interactions among geographically distributed users.
- Although the major part of presence technologies supports only formal collaboration, there is a group of applications that are specifically designed to support informal interactions.

These applications originate from research within multimedia, cooperative virtual environments, computer supported cooperative work, augmented reality and others. Next section will provide a survey of such applications before we discuss some design issues in Section 4.

### 14.3 Presence application for informal collaboration

Desire to overcome the barriers of space and time has motivated the development of a wide range of computer applications. The promise of “being there” underlies most of this development. Normally, the realism of physical proximity is used as a yardstick for evaluating the affordability of particular technologies in supporting presence.

Virtual presence is defined to be “*the perceptual illusion of nonmediation*” [1]. In other words, technology is often developed to simulate the naturalness of physical space as medium.

There are different kinds of applications that take radically different approaches to supporting this illusion of nonmediation:

- Multimedia applications: The goal is to use technology to project people’s actions across disjointed physical locations. People see each other “through the technology.” The actions themselves are totally performed in the physical space, and presence information is mediated without being modified. Examples are telephone, video conferencing, and media spaces. See for instance [12] for an overview of video technologies and applications.
- Virtual reality applications: The goal is to use technology to create an abstract virtual space where people and their actions are simulated and shared. People see each other “within the technology.” The virtual space gives the illusion of being connected, as opposed to the disconnected physical space. Actions are perceptually performed (simulated) within the virtual space, and presence information is shared in an abstract form within the virtual space. Examples are Multi-User Dungeons (MUDs) and Collaborative Virtual Environments (CVEs). See [10] for an overview of virtual reality technologies.
- Augmented reality applications: Technology is used to transfer people’s actions in one physical location to actions in another physical location. People “act through technology.” Physical space is augmented with presence sensors and presence displays. Similar to multimedia applications, actions are performed in the physical space. The difference is that a simulation of the action is performed in the physical space on the other side. Examples are tangible user interfaces [13]. Related themes are ubiquitous computing and ambient intelligence. See [9] for an overview of this technology.

In the following sections we will survey example applications from each category above.

The examples are all developed specifically to support informal collaboration among the members of a geographically distributed group.

#### 14.3.1 *Multimedia*

Using different types of technological medium to realistically simulate face-to-face synchronous communication is commonplace in multimedia research and development.

Audio, video and images are used to enrich mediated communication in different ways. This type of application is maybe the one that is most obviously related to creating an illusion of nonmediation. Although available technology still falls short of simulating face-to-face social interaction (see for instance [14]) multimedia applications have an appeal to everyone who is interested in virtual presence. We can predict that research towards increasing realism in multimedia communication will continue to provide us with interesting results.

However, what we are interested in here is not directly related to the realism aspects of multimedia. We are interested in how this type of technology can support a feeling of co-presence in the long run, and how it can help initiate spontaneous interactions among geographically distributed users.

The prominent example of this perspective is the *media space* initiative at Xerox PARC and EuroPARC during late 80's and early 90's [15]. From a technological point of view, a media space is quite similar to a multi-point video conferencing application. It consists of a number of nodes (a collection of communication equipment such as video camera, television, microphone, speakers) and a switchboard for connecting and disconnecting different nodes. The main difference is that a media space is permanently on, both when being used actively and otherwise. A media space is defined to be "a mix of audio, video, and computation that extends the world of desks, chairs, walls, and ceilings. This space formed by video connection is always 'there,' always 'present'—so present as to become part of the background of everyday work, just like furniture" [16, p. 274]. Audio and video is used not primarily as a means to give an illusion of nonmediation but to permanently connect distributed physical spaces to each other: "Although facial expressions, gestures, side conversations, and intonation are important aspects of working dialogue, the ability to see and be seen, to speak to one another or to pass by are the more frequent activities of the media space environment" [16, p. 293].

PARC media space has a flexible structure. Users can easily connect and disconnect nodes from the media space, and move nodes from one location to another (e.g. from public rooms to private offices). The gradual evolution of the media space in line with the activities of the people using it is a characteristic feature.

Later experiments in using media space in EuroPARC have focused on the long-term effects of living within a media space. A slightly different type of media space, called RAVE (Ravenscroft Audio-Video Environment) was used to connect the private offices of the employees through audio and video links. Some of the long-term effects of using RAVE are documented in [17] and include issues such as evolution of individual behavior (e.g. adopting new ways of gesturing and positioning oneself in the media space), evolution of culture (e.g. innovative collective ways of using the media space), and the use of media space as a permanent presence space as well as a communication tool.

A variation of the media space is Portholes [18], developed at Xerox EuroPARC. Portholes allows a group of geographically distributed colleagues to be continuously aware of each other's presence by sharing updated images of their offices. While the original Xerox media space was using permanent video links, Portholes is implemented for

networks with lower bandwidth and quality of service (e.g. the Internet). Portholes uses periodically taken snapshots, and in this way provides an approximation of permanent video links. Audio connections are supported through audio messages that can be attached by each user to his own image. A user can convey information to those watching him by attaching text messages, contact information, or audio messages to his own snapshot. A user can also “glance” into a remote office by clicking on the proper snapshot. A glance is a one-way live video connection lasting for a few seconds.

### 14.3.2 Virtual reality

Multimedia technology has been used mainly to implement a metaphor of social interaction that can be called “hole in the space.” Presence information is delivered to remote locations as it emerges, with as little modification as possible. The applications we will look at in this section make use of abstractions. Presence information is shared in a virtual room in form of abstract symbols. The abstractions themselves may vary from advanced 3D images used in immersive virtual reality, to simple textual icons in MUDs.

Similar to multimedia, a major part of VR research and development focuses on creating the illusion of nonmediation. Technology is used to create a virtual reality that is as much similar to real world as possible. Examples of the most crucial technologies for creating a realistic virtual world include [10]:

- Displays: Visual, aural, haptic and other displays that “immerse the user in the virtual world and that block out contradictory sensory impressions from the real world” [10, p.16]. Examples are head-mounted and panoramic displays.
- Graphics rendering systems: For generating detailed and realistic images of the virtual world as it changes. Speed is a determinant factor since a realistic view of the virtual world will require 20-30 generated frames per second.
- Tracking systems: For tracking the movements of the user’s body in order to relate these to movements in the virtual world. Tracking can be done using inertial, optical, ultrasonic or magnetic technologies.
- Database systems: For building and maintaining detailed models of the virtual world.

Together, these technologies are used to create a feeling of realism. An important class of VR applications, called Collaborative Virtual Environments (CVE), focuses on supporting the collaboration that takes place among the human inhabitants of a virtual world. VR applications, including CVEs, normally support formal collaboration.

However, a group of VR applications exists that focuses on virtual presence as enabler for informal interactions. These are normally stripped-down versions of more advanced VR applications. In particular, input and output devices are limited to the more familiar desktop monitors, mouse and keyboard (or pen and PDA displays for mobile versions).

This simplification is necessary because more advanced VR technology, e.g. wearable displays and tracking systems, are not suited to be used permanently over long periods of time. In fact most such technology requires special-purpose technological setup and laboratory-like environments, which makes it difficult to use as a permanent and transparent part of users’ working environment [11].

On the other hand, the applications we survey in this group are more available, cheap and easy-to-use. The basic idea is to have simplified abstract information (a so-called *social proxy* or *avatar*) represent a user in the virtual world. A social proxy represents the user through different kinds of presence information, such as his identity, his location in

the physical space, and his level of activity (e.g. moving around in the space or interacting with mouse and keyboard). Presence information is updated automatically or manually.

Many of these applications are implemented specifically to be used as a permanent part of the user's work environment in form of a background element providing continuous presence information about other users.

Forum [19] is an example of a CVE developed to support informal collaboration. Forum implements an interactive VR representation of users in form of avatars. Forum consists of two main parts, Contact Space and Meeting Space. Contact Space is a virtual space for supporting informal interactions, while Meeting Space implements a virtual meeting room with audio conferencing mechanisms to facilitate face-to-face formal interactions.

Interactions among users in Forum happen in a shared information landscape where each user is represented through his avatar. Based on the current activities of the users, their avatars take different forms or appear in different parts of the landscape. For instance, when a user opens a whiteboard application, the avatar is shown in Forum as standing in front of a whiteboard. Similarly, when a user is working on a document his avatar appears in the shared information landscape close to the concept representing the contents of that document.

By placing users' avatars close to each other based on what the users are working with, Forum provides opportunities for interaction that fit current activities of users (this kind of interactions are mainly opportunistic). Forum also demonstrates how transitions between formal and informal collaboration can be supported through VR technology. A similar system making use of a mixture of multimedia and VR is Piazza [20].

While Forum employs a 3D graphical representation of users and their activities, there are also a number of other presence applications that use a more simplified representation of users. One such application is the Unix Who, a well-known and popular tool that is part of the Unix operative system. Who might be the first presence application for informal collaboration ever developed. It is a quite simple command line tool that gives an overview of logged-on people in a Unix network. The output of a Who command in Unix contains a list of current users of a specific computer, together with information about the type of connection, the time the connection was established, and from which computer the connection was established.

One of the most notable variations of the Unix Who is MIT Media Lab's Visual Who [21]. Instead of a more or less cryptic character-based output, Visual Who creates a graphical view of currently present users within a network. People logged on to a network are shown with colored nametags. The boldness of each nametag is an indicator of how active the corresponding user has been lately. In addition, Visual Who allows users to define specific measures for aligning themselves towards different research (or other) topics.

In this way each user's nametag is displayed in the graphical view closer to the topics that the user is more interested in. This alignment functionality visualizes active communities of practice in a network. Visual Who is designed to be placed in the background (of the user's desktop, for instance), and to provide continuous awareness of other users' presence and activities. In this way, Visual Who creates a virtual world that focuses on ease-of-use and long-term availability. Input and output devices are much less advanced than what one associates with VR systems, but the feeling of presence is compelling. Visual Who can be compared to Portholes discussed in the previous section.

While Portholes provides realistic images of users' offices and locations, Visual Who creates an abstract virtual image of the users.

Other interesting examples of VR applications for informal collaboration are the so-called buddy lists. Buddy lists make use of simple text-based representations of users (in form of "buddies" in a list). These representations are dynamically updated with

information about availability and presence of the corresponding users. A rather advanced example of a buddy list with support for mobile devices is ConNexus/Awarenex [22].

Although buddy lists are considered by many as availability tools and not presence applications, we believe they support some aspects of informal collaboration by being permanently on and integrated into the background of users' work environment. However, buddy lists normally have a too simplified representation of the virtual world and employ limited interaction mechanisms.

### 14.3.3 *Augmented reality*

The distinction between augmented reality and the previous two classes of presence applications is less clear-cut. Augmented reality is often associated with visually augmented reality. Here, similar to [9], we also include technologies that augment reality through other senses than the visual. We choose to include under the augmented reality banner all applications that augment our everyday physical environment with presence information about remote people in form of sounds, images, haptic feedback, smell, etc.

Presence information is normally collected through some kind of sensor, and is delivered through visual, audio or other kind of displays. We also assume that virtual presence in augmented reality applications is created through interaction with familiar physical objects in our environment. Some of the applications we have already discussed might partly fall into augmented reality class (e.g. media spaces where a node is tightly integrated with our home furniture, or a framed Visual Who graphical image that is hanging on a wall in our living room). We hope that a number of examples will illustrate the main differences and similarities.

As with the other discussed technologies, there is also here a major branch of research and development that focuses on simulating face-to-face formal collaboration sessions with a high degree of realism. Examples include physical proxies for people in remote locations.

From early studies of video conferencing it was observed that users often desired a means for controlling the remote camera in order to see better what is going on in the remote site during a video conferencing session. This type of control is for example designed in GestureCam [23], a video camera mounted on a mechanical hand controlled by the remote participant. Other examples with a focus on formal session-based interactions are Hiroshi Ishii's TeamWorkStation and ClearBoard [24] that integrate physical desktops with digital desktops. Our focus is on long-term virtual presence and lightweight technologies that are permanently integrated into our environment and that can support informal interactions through augmenting the physical space around us. Digital family portraits [25], developed at Everyday Computing Lab of Georgia Institute of Technology, provide a good example.

A digital family portrait is a framed picture of a remote family member (e.g. an elderly member). The picture itself is a normal portrait, but the frame is a presence indicator that changes its appearance according to a selected set of activities of the remote person it represents.

Events at the remote site that contribute to changes in the appearance of the frame include the level of activeness (e.g. whether the person at the remote site has been out or has had visitors) and other information that is often associated with a normal life style for a senior member of family<sup>1</sup>.

Digital portraits implement virtual presence in order to "promote the peace of mind necessary for those senior family members to age in place" [25, p. 333]. In addition to providing a permanent source of presence information, digital family portraits do not have

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<sup>1</sup> Note that there are no sensors for registering this type of activity. Instead, the researchers at the Everyday Computing Lab contact the monitored person by phone and interview him, in order to later enter the necessary data manually into the system.

the alienating effect that technological devices might have in an otherwise peaceful and cozy home environment.

The idea of creating presence displays that fit well into our home environment is also tried out in the Casablanca project [26]. Here, the researchers have designed “presence-enabled” variations of conventional consumer products. For instance, a “presence curtain” is used to signal one’s presence to others. Users can open the curtain in order to indicate to their friends that they are at home. Another example from Casablanca project is a “lampshade” that has the form of a normal lamp, but is used as a communication device between two homes. When both homes indicate their presence the lamp is lit.

A third example of augmented reality is AROMA [27], a presence and awareness support system for CSCW applications developed at the University of Roskilde, Denmark. AROMA captures audio, video and haptic data from a location, creates a synthesis of the data, and displays the data in another location. The synthesis is done “through recognition of certain high level objects in the captured data, as well as through identification of patterns in series of events” [27, p. 53]. AROMA is developed as a platform, with a number of example prototypes that demonstrate the idea of abstracting presence information. One such example is the “inner office windows” prototype that collects presence information from an office through video/audio equipment. The data is used in other offices to determine the speed of a merry-go-round, to set the sound level in a seashore audiotape, to adjust the temperature of a mouse pad, or to set the speed of drifting clouds on a display, in this way providing an ambient type of presence display. AROMA demonstrates how abstract representations of presence information can be used to create so-called affective interfaces towards virtual worlds. Other similar examples are ambient fixtures and tangible user interfaces by Hiroshi Ishii et al. See for instance [13].

#### **14.4 A system model for presence application**

The applications discussed in the previous section demonstrate radically different approaches to presence support for informal interactions. Although this variety is a great help in understanding different usability issues and the influence of technology on social interactions, there is a need for unifying the different approaches into a common system model before the applications can enjoy a wider user acceptance. The need for unification and/or interoperability among presence applications arises because of a number of reasons:

- Normally, not all people using these presence applications are members of an isolated organization where a standard service platform exists for everyone. Users will most probably use different service providers, different kinds of telecommunication networks, and different access methods. A presence application should seamlessly support different communication infrastructures.
- Presence support for informal interactions should be implemented as lightweight services that can be utilized on different (possibly mobile) devices and appliances in addition to traditional PCs or complex equipment. These devices and appliances might possess capabilities to handle multimedia, virtual reality, or textual information. Most probably we will have to deal with a large number of operative system for information appliances for a long time ahead. A presence application should be able to support different types of user devices and appliances.
- The distinction between formal and informal interactions is transparent in real world situations. A presence application for informal interactions should allow for seamless switches from an informal spontaneous interaction to a more formal collaboration session.

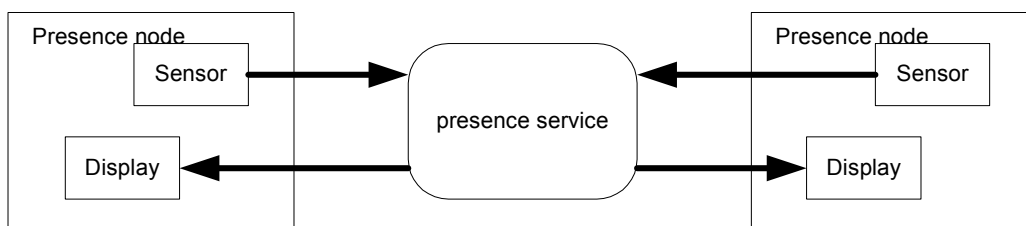
- Presence applications are not isolated from other kinds of applications. Presence information can be used in different contexts within different applications. A well-defined interface to presence services is necessary in order to create an independent presence service that can be used by stand-alone presence applications as well as other “presence-aware” applications.

An ideal situation is where vastly diverse presence applications could work together. This could for instance mean that VR applications get their presence information from a video stream captured in a media space node. Another example would be to announce changes in presence information captured in a video stream in form of natural language or musical output over a speaker in a remote node. A unified system model that can enable interoperability among presence applications creates an infinite number of innovative scenarios for virtual presence. In this section we will describe such a model. Although the individual applications we have seen in the previous section may vary greatly, it is not difficult to see some similarities. In particular, all these applications adopt a model of presence that is based on what we will call a *sense-compute-display* system model. This model is shown in Figure 14.1. The three main elements in the model are *sensors*, *presence service*, and *displays*.

Sensors collect raw presence information from an environment. Presence service does some computation on the raw presence information and creates processed presence information.

Displays are used to display this processed information to users in remote locations. The applications discussed earlier fit well into this model, e.g.:

- In Xerox PARC media space sensors are video cameras and microphones and displays are TVs and speakers. Presence service in this case does not modify the collected presence information, but does some computation to find out where each stream of collected data will be displayed.
- In the Visual Who example, sensors are normally manual or automatic switches that are used to change one’s status (from “online” to “offline”) and displays are graphical images in a conventional user interface. Visual Who and similar applications might use automatic detection (sensing) by keeping track of users’ interactions with physical sensors (e.g. mouse and keyboard), and can produce raw presence information automatically. (This is for instance the case for CoNexus/Awarenex.) Presence service processes discrete high-level messages in form of notifications.
- In AROMA the most critical job is that of presence service. Raw presence information is processed in quite complex ways, and abstract presence information or control signals are sent to displays. Sensors are video cameras and microphones, and displays are physical objects with mechanical movements (such as a marry-go-round).



**Figure 14.1** The sense-compute-display system model for presence applications

The computation that occurs within the presence service is normally based on a conceptual model of presence. This is typically a simplified model of presence in the real world, and indicates how presence service should aggregate, analyze, change, route etc. the presence information from sensors to displays.

Implicitly, the model assumes that each user will have a combination of sensors and displays enabling him to get the same type of information about others' presence that others get about his. If not, the resulting system will be a surveillance system and not a presence system. The combination of sensors and displays for each user constitutes a *presence node* in the model. From users' point of view sensors and displays may reside in the same (physical) object, but for the model they are separated conceptually and technically. (An example is the vibrating mouse [28] that is used both as a sensor, i.e. indicator of user's activity level, and as a display, i.e. indicator of others' presence through vibrating.)

The model opens for a number of interesting scenarios that enable us not only to integrate different types of presence applications for informal collaboration, but also to support transitions between formal and informal collaboration. Creating an abstraction for a presence node allows us to separate the processing and distribution of presence information from the process of collecting and displaying the information. This means that the same conceptual model of presence can be used to process presence information from different kinds of sensors (ranging from video cameras and microphones, to more simple discrete event sensors generating notifications).

Transitions between informal and formal collaboration are enabled by adjusting the quality of presence information flowing among different nodes. For instance, two users who are not collaborating formally (i.e. are not involved in a collaboration session) can be permanently connected using low-quality images being updated every few minutes. When they switch to formal collaboration, the frequency and quality of images can be increased to become a video stream. (A similar concept is used in [29].)

This model raises a number of technical issues. The level of "recommended" computation in each part of the model is not easy to decide. Generally, it is better to have as little computation as possible in both sensors and displays. This makes it easier to change or upgrade sensors with better ones with little changes to presence service; also, a presence service that takes on most of the computation will not require devices with high computation power, so lightweight sensors and displays can be deployed [30].

Another important technical issue is combining discrete presence notifications and continuous streams of presence information. An example is the AROMA platform, which creates discrete presence information and control signals based on continuous streams of video and audio. Although from a user's point of view the two types of information should be fully integrated, from a technical point of view this will pose some implementation challenges.

The presence model above does not live in a vacuum. It has to co-exist with a number of existing system elements. In particular presence service might need to interact with already-existing communication services (for instance, Visual Who might allow the user to initiate a telephone call to a user represented by a nametag), directory and user profile services (in order to eliminate duplication of user data), and context building and maintenance services (in order to use proper presence information according to the current context of the user). For this co-existence to happen, the presence model should provide clearly defined interfaces to other applications and services.

## 14.5 Conclusions

In this chapter we have argued for the importance of technological support for informal collaboration in addition to support for formal collaboration that is found in the majority of existing presence applications.

We have surveyed a number of innovative applications that are designed to support informal collaboration among geographically distributed users. These applications are roughly divided into three classes (multimedia, virtual reality, and augmented reality) based on the enabling technologies used. We have outlined a system model as an attempt to support virtual presence.

The model is being implemented as part of our research in the area of presence support in telecommunication networks. Our goal is to enable the development of advanced presence applications that not only fulfill the requirements of informal collaboration (i.e. support for spontaneous interactions in the long run through high-quality and easy-to-use communication means) but also support seamless transitions between formal and informal collaboration.

An important factor we have not discussed in this chapter is that of privacy. Due to their "always on" nature, presence technologies for informal collaboration are highly sensitive to privacy issues. The reasons are many. Unfamiliarity with technology (e.g. how it works, what it can do, what it cannot do) is one major reason why virtual presence technology might be perceived as intrusive, even in cases it is designed specifically not to be so.

Another reason is the lack of translucence, i.e. inability of a user can see what the others see of him [31]. Privacy issues need to be built into any technology that is developed to support informal interactions among groups of people. Privacy is a central part of our work on presence.

Our future work is focused on developing prototypes of the model we have presented in this chapter.

We are in the process of defining a suitable conceptual model in order to be able to capture the presence phenomenon as correctly as possible. We are also implementing demonstrators of interoperable presence applications. The demonstrators utilize state-of-the-art middleware technologies in order to allow for interoperability and seamless support for formal and informal collaboration.

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