

## Chapter IX

# Supporting Proximate Communities with P3-Systems: Technology for Connecting People-to-People-to- Geographical-Places

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### **Abstract**

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*In this chapter we examine systems that link **People-to-People-to-geographical-Places**, which we label **P3-Systems**. Four major **P3-Systems** design approaches have been identified by an analysis of systems prototyped to date: (1) *People Centric P3-System* design that use absolute user location, based on awareness of where somebody is located (e.g., Active Badge); (2) *People Centric P3-System* design based on user co-location/*

*proximity (e.g., Hocman); (3) Place Centric P3-System design based on the use of virtual spaces that contain representations of user's use of physical spaces (e.g., ActiveMap); and (4) Place Centric P3-System design based on the use of virtual spaces that contain online interactions related to physical location (e.g., Geonotes). This chapter explores how proximate community member interactions can potentially be well supported by P3-Systems through the improved geographical contextualization and coordination of interactions and the identification of previously unidentified location based affinities between community members.*

### **“THE MARAUDER’S MAP**

It was a map showing every detail of the Hogwarts castle and grounds. But the truly remarkable thing were the tiny ink dots moving around it, each labeled with a name in minuscule writing. Astounded, Harry bent over it. A labeled dot in the top left corner showed that Professor Dumbledore was pacing his study; the caretaker’s cat, Mrs. Norris, was prowling the second floor; and Peeves the Poltergeist was currently bouncing around the trophy room” (Rowling, 1999, p.192-193).

## **Introduction**

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Improvements in communication and transportation technology over recent centuries have resulted in shifts in community ties from being primarily people-to-people-in-geographical-places to people-to-people irrespective of local geography (Wellman, et. al., 2001; Gillespie & Williams, 1988; Carincross, 1997). Much effort has gone into freeing interpersonal interactions from geographic constraints and into enabling communication any-where, anytime. However, there are many situations in which communication within a local geographical context is desirable. For example, an administrator of a physical university campus may see increased interactive communication between students, faculty, and staff as beneficial to campus life. Similarly, local community activists might see increased interactions between local residents as being of significant value.

Until recently our ability to use technology to seamlessly locate individuals and provide them with geographically contextualized personal information manage-

ment tools was quite limited. However, this situation is now changing with the widespread adoption of wireless technologies, such as the global positioning system, 802.11, Bluetooth, RFID, etc., and geographical routing technologies. Using such technologies, computer mediated communication (CMC) and location data such as the geographic location a user is communicating from or to, can be combined to provide appropriate geographic context to interactions. A number of proof-of-concept systems have explored this possibility. For example, various systems have enabled individuals and groups to associate text notes with locations (Burrell et al., 2000; Marmasse & Schmandt, 2000; Persson et al., 2001). Others have provided users with an interface that provides awareness in terms of the location and availability of “buddies” as means to increase informal interactions (e.g., Griswold et al., 2003). These developments show how the emerging technology environment raises the opportunity for a new and emerging category of information systems that connects **People-to-People-to-geographical-Place**, which we refer to here as P3-Systems.

Proximate communities are communities built around individuals co-located in a physical region. In this chapter we explore how P3-Systems can provide support for proximate community interactions in four steps. First, theoretical concepts of community, proximate community, and online community are examined. Secondly, the emerging technology environment that now enables new P3-Systems to be developed and deployed is described. Thirdly, P3-Systems design approaches are categorized and described. Fourthly, the potential advantages and difficulties associated with various P3-System design approaches for supporting proximate communities are examined. We conclude the chapter with a review of our observations and make suggestions as to key research that could be undertaken to improve our understanding of the utility of various P3-System design approaches.

## **Community and Online Community**

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### **Community (Proximate and Networked)**

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In the literature, the term “community” is replete with ambiguity, and so in this section we will briefly explore the term and state how it is understood in the context of this chapter. In the 1950s, the analysis of various definitions of

community was a thriving sociological industry. The *piece de resistance* was Hillery's analysis of ninety-four definitions in his paper *Definitions of Community: Areas of Agreement* (1955). In the early 1970s, Bell & Newby wrote that, "the concept of community has been the concern of sociologists for more than two hundred years, yet a satisfactory definition of it in sociological terms appears as remote as ever" (1972, p.21). In late 1980s, *The Penguin Dictionary of Sociology* stated that, "the term community is one of the most elusive and vague in sociology and is by now largely without specific meaning" (Abercrombie, 1988).

Part of the problem has arisen from a debate around the relationship between physical space and community. In 1960, Nelson et al. wrote "the confusion of space with the community itself is doubtless a result of the strong influence of space upon human relations" (Nelson et al., 1960). This is in part due to the fact that historically the towns and villages where people lived and worked were automatic places of "community," as people were interdependent and not isolated from each other. By the 1970s it was realized that "community" was independent of the concept of locale. By the end of the 1980s this had led many sociologists to argue for a conceptual revolution in defining the term community in terms of social networks (Wellman et al., 1988).

The social network approach arose in part from sociologists examining how technological changes have affected community (Wellman & Gulia, 1999). Until the 1950s sociologists feared that rapid modernization would mean the loss of "community," which was operationalized to mean that individuals would only have a handful of transitory, disconnected, weakly supportive relationships or "social ties" (Stein, 1960). However, research into the validity of this position concluded that this was not the case, because individuals can maintain strong social networks of kin, friends, and workmates who do not necessarily live in the same neighborhoods (Wellman, 1988). It is now clear that community can survive physical distance and social differentiation. The result of this has been that many sociologists interested in community came to see individual and shared social networks, and the strengths of social ties, as of primary importance. This led such researchers to write about "group communities" and "personal communities," and to define community as "networks of interpersonal ties that provide sociability, support, information, a sense of belonging, and social identity" (Wellman, 1988). In line with this thinking, we adopt the notion of "communities" as a set of individuals with partially overlapping personal social networks that collectively provides a sense of belonging.

It can be concluded from the above that in the modern world connections are dependent on personal networks that are highly mediated by technology and the market system. As a result, people can now occupy the same residential areas or urban work environments while having only very limited number of interactions with their geographic neighbors. This raises the issue of how emerging technologies can be used to build and maintain proximate communities. Proximate communities are communities where the personal social network ties of members are associated with a particular geographic area, place, or region. Proximate communities may be residential geographic communities or may result from a shared work physical work environment such as a university campus or central business district.

## **Online Communities**

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Like the term “community,” no dominant definition of the terms “virtual community” or “online community” exists (see Jones, 1997 for a history of the term). Instead, a wide variety of definitions and understandings abound that can be clustered into three groups. The first, oldest, and broadest use of the term is as a descriptor of a group of people who share characteristics and interact in essence or effect only (e.g., Hill et al., 1995). While this definition is logically coherent, its usage has gone out of fashion, because it is overly broad, and is therefore not used here. The second way that the term has been used is to describe computer mediated group-discourse spaces (e.g., Hagel & Armstrong, 1997) or what is referred to here as online community spaces (see the section below). However, this is problematic as “discourse spaces” and “communities” are not equivalent. Online community spaces can be “empty” but communities cannot. Further, while it might be possible to create through programming a computer-mediated discourse space, it is not possible to program social interactions. Therefore, online community is not equivalent to online community space where users interact. It follows then, that it is important to distinguish a virtual community from its medium or platform through which its users or agents build social relations. This leads to the third definition of virtual or online communities used here, as a set of individuals with partially overlapping personal social networks tied together by computer technology that collectively provides a sense of belonging. For many sociologists, this follows naturally from analogy to real communities (e.g., Wellman & Gulia, 1999). From this perspective, both are based around social networks, although in the case of online communities they are computer-supported social networks (CSSNs).

Online communities can be “networked communities;” communities whose interactions are mediated primarily through the Internet (Carroll & Rosson, 2003) with non-geographic affinities leading to shared social ties. They can also be formed through “community networks” which are computer-mediated communication systems that aim to support interactions among geographical neighbors (Schuler, 1994). So online communities may or may not be closely related to proximate communities. Proximate communities are typically comprised of individuals that have heterogeneous attitudes, beliefs, and interests. As such, there are special difficulties with motivating user participation in online community systems, because in part meaningful affinities between people are not always readily apparent (Millen et al., 2001).

## **Online Community Spaces**

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Online communities are often built through “online community spaces.” Online community spaces are symbolically delineated computer mediated spaces such as email lists, newsgroups, Internet Relay Chat (IRC) channels, graphical avatar chat spaces (e.g., [www.thepalace.com](http://www.thepalace.com)), etc., which enable a wide range of individuals to attend and contribute to a shared set of computer-mediated interpersonal interactions, and can therefore be considered relatively transparent and open. These spaces support online communities by providing a space in which ties can be formed between people through public shared interactions. Such spaces are different from personal spaces, such as email inboxes, where interactions are not publicly shared between members of the online community.

The notion of online spaces, such as email lists, may be confusing to readers who conceptualize space in terms of day-to-day activities in physical space. Because cyberspace transcends physical space, it highlights the need for a different conception of space – one that recognizes the boundaries to computer mediated actions. Cyberspace, like geographical or physical space, is relational and needs to be understood as socially constructed (Curry, 1995, 1998).

The utility of online community systems and spaces relates not just to how well they support different forms of interactive communication, but also how they help individuals manage the process of enabling communication to take place at all. This has been described as *outeraction* (Nardi et al., 2000), which is defined as “communication processes outside of the direct information exchange that enables people to reach out and enhance the information exchange” (p.79). Outeraction includes such tasks as the use of information communica-

tion to negotiate an individual's availability (e.g., "when can we talk?") and media preference (e.g., "can I call you on the phone?").

Through distinguishing between online community and online community spaces we are able to understand how the impact of basic design decisions on the ability of a CMC system to support community. By enabling users to be mobile, locatable, reachable and capable of rich multimedia communication, the current wave of handheld communication devices raise the opportunity for new types of online community spaces that better support proximate communities. This is because they increase the means for relating online community spaces, associated messages, and users, to physical location, and thus increase the possibility of finding and utilizing location-linked affinities. It is from this perspective that we examine the potential of P3-Systems for supporting proximate community interactions.

## **The Emerging Technology Environment**

By definition, a key commonality that members of specific proximate communities have is a shared relationship to a physical location — the area or region or place that makes the community "proximate." Building information systems that utilize that commonality to support interactions between proximate community members has been difficult. This has been, in part, due to the technological limitations of available consumer technology. However, a number of changes in the technological environment are slowly changing this situation by providing large numbers of people with one or more devices that enable mobile, location aware, hi-speed, and multimedia communication.

There is a general movement to provide Wi-Fi (802.11 standard high-frequency wireless local area network) coverage by universities, public network activists, cities, rural communities, and businesses (Schmidt & Townsend, 2003). A number of telecommunication companies offer user access to a range of wireless sites in the United States (e.g., T-Mobile) and internationally. An example of how coverage is expanding and will probably change the way we work, is the systematic roll out of Wi-Fi coverage at U.K. train stations and plans to provide coverage on the trains themselves (<http://news.zdnet.co.uk/story/0,,t269-s2135177,00.html>). Many new top end laptops and personal digital assistants (PDAs) now have Wi-Fi built in. Wi-Fi is fast enough to enable high-speed delivery of rich multimedia. In parallel, many operators are

offering mobile phones capable of playing, recording, and delivering multimedia. Further, PDA phones are coming to market with both broadband capabilities and Wi-Fi connectivity (Vaughan-Nichols, 2003).

U.S. Federal Communications Commission rulings (initially Docket 94-102) require that cellular operators, personal communications services and specialized mobile radio carriers provide precise location information to 911 call centers (Zagami et al., 1998). The European Union is preparing similar legislation referred to as e112. These legal imperatives apply not just to the abilities of the cellular network, but also to a significant proportion of new communication devices coming to market, which must be enabled by the global positioning system. At the same time, cellular operators are aware of the economic and competitive advantages inherent in being able to offer customers location-specific services such as recommendations about nearby shops and restaurants, or directions to the nearest gas/fuel station. The result is that in the near future mobile phone network operators should be able to detect a subscriber's exact whereabouts for the provision of location-based services, and a large proportion of subscribers will be able to utilize their location data independent of network operators. There is also technology coming to market that enables the locating of devices on Wi-Fi networks (e.g., [www.ekahau.com](http://www.ekahau.com)).

In addition to wireless personal communication infrastructure and devices becoming more sophisticated, "things" are getting smarter with the advent of technologies such as radio frequency identification (RFID). Such technologies make every significant object in the environment potentially identifiable through ubiquitous digital labeling. The extent to which this appears to be becoming a reality is reflected by the world's biggest retailer, Wal-Mart, deciding in 2003 to demand that its 100 largest suppliers use RFID tags to track inventory (something like 8 billion tags a year). RFID potentially enables communication to be placed within a very rich geographic-digital context. The trend appears to be towards numerous real world environments in which everything is digitally labeled, everything is connected, and everyone can communicate from anywhere. At the same time, no single technology for computing location and proximity and digitally describing the world appears to be gaining universal dominance.

There are still numerous problems in supporting proximate communities with location aware devices and networks. For example, as evidenced by field study experiences of the *ActiveCampus* group (Griswold et al., 2003) that found that the short battery life of current devices (4 hours or so), and the ease with which personal user data can be lost (often as a result of the short battery

life), resulted in an extremely high user drop out rate. Despite the current difficulties, it is clear that the emerging technological environment will allow for the creation of new types of information systems that have the potential to ground users' interactions in geographic place.

## **Categorizing Features of Systems that Link People-to-People-to-Geographic-Place**

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In the above discussion we noted that proximate communities have strong associations with physical spaces and have suggested that they would be well supported by information systems that can tie user interactions to geographic places, which we refer to as P3-Systems. A number of P3-Systems have been prototyped since the early 1990s, but each has implemented only a limited set of features. In fact, each system developed has been a narrow exploration of a design space whose overall characteristics remain unknown. This is not simply because of technological constraints but also because the building of such systems has lacked a firm theoretical foundation.

A theoretical framework for understanding the utility of various designs of a particular class of system can only come about after the class of systems under discussion is recognized as distinct. Information systems that systematically link people-to-people-to-geographic-place have not been considered as a related or distinct category. This is probably on account of the dearth of location aware systems that seamlessly link people-to-people-to-geographic-places. However with an exponential growth in the number and types of such systems being prototyped, it is now apparent that a new collective term is needed. Further, while terminology such as "location based services," "augmented reality," "virtual reality," "teleportation" and "mixed reality" can be used to explain some of the technology utilized, these terms on their own do not describe the functional similarities of these systems. As such, we have coined the term P3-Systems to describe various information systems that systematically link people-to-people-to-geographic-place. P3-Systems that have been prototyped to date have incorporated only a limited number features from the potential design space. Recognition of P3-Systems as a distinct class of applications allows us to distinguish between basic design features, and to provide a theoretical/conceptual framework for future development in this area.

Traditionally, the starting point for categorizing a CMC system has been in terms of whether it supports synchronous or asynchronous communication (Rafaeli & Newhagen, 1996). While this categorization can be applied to many systems, it should be noted that such categorical distinctions are not clear-cut. Communications created using synchronous technologies can be stored and made persistent and searchable, thus enabling asynchronous use of the medium. Further, “synchronous communication” is not always real-time. For example, Internet Relay Chat (IRC) requires that users hit the carriage return before the information they have typed is shared. The result is that individuals using IRC, and many other chat systems, can change what they were going to say before having said it. On the other hand, asynchronous communication tools such as email can be used for quick message exchanges that make the interactions near synchronous. These issues highlight both the elasticity of synchronicity and the importance of understanding the significance of making interactions persistent (Erickson & Laff, 2001).

Synchronous and asynchronous systems can be viewed as two sides of a continuum. Consequently, while the division into these two categories may help us understand various design possibilities and implications, they should not be considered absolute. Further, this categorical distinction will be extended to include synchronous and asynchronous location awareness for systems that do not involve traditional forms of communication. “Synchronous location awareness” refers to the provision of current information about user location. This location awareness need not necessarily be reciprocal, in the sense that the system may provide a user with a buddy’s location without necessarily providing the buddy with the user’s location. “Asynchronous location awareness” refers to the provision of historical information about user location. Collectively synchronous communication and synchronous location awareness data is created with the expectation that it will be processed in near real-time, whereas asynchronous communication and location awareness data is produced with the expectation of an unpredictable delay between data creation and consumption.

Beyond questions of synchronicity, existing P3-Systems primarily adopt two basic design approaches to linking people-to-people-to-geographic-place. First, **People Centric P3-Systems** are those that use user location to improve contextualization and coordination of interactions, and to enable the identification of previously unidentified affinities between users. People Centric P3-Systems are people centric in the sense that the user interface provided is focused not on a particular location but on the movements of people in physical

spaces. People's location can be understood in both absolute and relative terms. So a person could be located at a particular latitude, longitude and altitude (absolute location), or the individual could be located near a friend (relative location). The second design approach is **Place Centric P3-Systems** that use virtual spaces that represent physical locations. These systems are place centric in the sense that they use physical space/s to delineate virtual space/s in which an associated user's actions and interactions can be seamlessly represented. The virtual spaces that represent physical locations either contain online representation of people's use of physical space or online interactions related to physical location.

From the above discussion, we derive four basic P3-Systems design approaches:

- (1) People Centric P3-Systems based on absolute user location.
- (2) People Centric P3-Systems based on user co-location / proximity.
- (3) Place Centric P3-Systems based on use of physical spaces by users/people.
- (4) Place Centric P3-Systems based on interactions in virtual spaces representing physical locations (Matching Virtual places).

Each of these four basic design approaches can be instantiated synchronously or asynchronously; as a result there are 8 distinct categories, which we outline below. Table 1 summarizes these categories. While the design features of most

*Table 1. P3-system features*

P3-System Design Approaches		Synchronous Communication or Synchronous Location Awareness	Asynchronous Communication or Asynchronous Location Awareness
People Centric	(1) Absolute User Location	Utilizes remote awareness of current user location	Utilizes people's location histories
	(2) Co-location/Proximity	Utilizes real-time inter-user co-location for the exchange of social information	Utilizes co-location history to enable future interactions.
Place Centric	(3) Use of Physical Spaces by People	Utilizes online representation of user's current use of physical spaces.	Utilizes history of people's use of a particular space
	(4) Interactions in Matching Virtual Places	Utilizes synchronous online interactions spaces related to physical location.	Utilizes asynchronous online interactions related to physical location.

categories will be described using examples of systems identified from the literature, a few will be described using theoretical or hypothetical systems.

## **People Centric P3-System**

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As described above, People Centric P3-Systems use community member's location to improve contextualization and coordination of interactions, and enable identification of previously unidentified affinities between users. They can be divided into two sub-categories. These are: (1) absolute user location, i.e., based on awareness of where somebody is located; and (2) user co-location, i.e., based on inter-user proximity. These two categories in turn will be examined according to whether they primarily support synchronous or asynchronous interactions/awareness.

### *People Centric P3-System Features Based on Absolute User Location*

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#### **Synchronous Communication or Synchronous Location Awareness**

Belonging to this category is the earliest location aware P3-System, “*Active Badge*,” which provides real-time information about people's location. Conceived, designed and prototyped between 1989 and 1992, the *Active Badge* system provides a means for locating individuals within a building by determining the location of their “*Active Badge*” (Want & Hopper, 1992; Want et al., 1992). The *Active Badge* device worn by personnel transmits a unique infrared signal every 10-15 seconds that is detected by one or more networked sensors within an equipped building. The location of the badge (and hence its wearer) can thus be determined on the basis of information provided by these sensors. System users use the command — FIND (name) — that provides the current location of the named badge, and a list of all the locations it has been sighted at in the last five minutes. The system is designed to coordinate communication between individuals. For example, internal and external phone calls could be routed to the phone nearest to the location of an individual based on the location of the *Active Badge* bearer. The *Active Badge* system has an online community space that could be used to locate employees without a public-address system or without telephoning all the possible locations at which they might be found. Although the system was not designed with the aim of

linking people-to-people-to-geographic-place, by providing awareness of people's movements in remote locations, this system enables such links.

It is not hard to imagine various applications that can be supported by the remote locatability feature of the *Active Badge* system. For example, a location-aware descriptor could be provided next to an instant messaging buddy. In fact, commercial services that allow for the remote location of mobile phone users are already in use. For example *Ulocate* (<http://www.Ulocate.com/>) allows users to see the location of all family members using the system displayed on a map on a 24/7 basis.

An alternative to the above approach is to reverse the process, so that instead of a person seeking out the location of somebody they wish to communicate with, the system provides details of the location of the originator of an incoming communication. For example, the caller-ID of incoming phone calls could also contain a location descriptor, or the message lines in a private online chat could contain details of the location of the sender. This approach is used by the *ActiveCampus Explorer*, where users can have the system automatically index their instant messaging messages with a descriptor of their current location (Griswold et al., 2003).

### **Asynchronous Communication or Asynchronous Location Awareness**

Systems under this category provide asynchronous location awareness. Group calendars that systematically describe the location of individuals over time fall under this category. Systems that provide details of the location of the originator of an incoming asynchronous communication also fit here. For example, an email could be indexed by the location of the sender. In fact, some moblogs (mobile phone web logs) contain pictures that are time and location stamped. In other words, by linking location awareness to asynchronous communication these systems render the location awareness asynchronous.

### *People Centric P3-System Features Based on Co-location / Proximity*

### **Synchronous Communication or Synchronous Location Awareness**

This category of people centric P3-Systems uses inter-user proximity or co-location to electronically collect or manage the exchange of social information. A simple application of this approach is chat between co-located individuals, such as that provided by *Cybiko* ([www.Cybiko.com](http://www.Cybiko.com)) a sophisticated child's

toy using Radio Frequency communication. *Cybiko* allows ad hoc networks to be formed between individuals that are within a short distance so that they can interact electronically. Similarly, the *Hummingbird*, a small portable device, supports social awareness between people who are co-located. The *Hummingbird* uses wireless communication to give members of a group continuous auditory and visual indications of other group members in the vicinity. The designers of *Hummingbird* hoped to support face-to-face interactions by visualizing group member proximity.

Another system that provides support for face-to-face interactions using co-location is Borovoy et al.'s (1998) "*Meme Tags and Community Mirrors*" System. Meme tags are a class of groupware tags designed to build, in the authors' own words, "community" (p.159). The system has both a personalized online space (individual *Meme-Tags*) and a community space (*Community Mirrors*). In this system a meme is an idea or opinion, expressed as a short piece of text. The Meme Tag contains community relevant memes that a participant has chosen. Inter-user proximity enables the spread of memes from person to person synchronously. This is meant to encourage people-to-people interactions. The purpose of the *Community Mirrors* is to convey a variety of information about meme exchanges between users in near real-time to other users. Included within these displays are the actual texts of the memes, popular ideas, dying ideas, as well as information about group dynamics, such as the "cliquishness" of the gathering. These *Community Mirrors* also give users a sense of what other participants know. The system design aims to facilitate the formative stages of interaction by providing people with additional common reference points for conversation.

Co-location can also be used specifically for social matching. To date, the social matching has typically been in terms of supporting dating rather than proximate community, but the design approach is of potential value in both situations. A system that illustrates this basic design idea is the Japanese dating toy *LoveGety* (Reuters/Wired News, 1998). When a blue (male) *LoveGety* and a pink (female) *LoveGety* are within 15 feet of one another, they beep and flash, telling the user that another *LoveGety* owner is close by. Codes such as "talk," "karaoke," and "get2," with a variety of meanings are used to communicate what the user is interested in. This system design encourages real-time face-to-face interactions around the idea of "dating," however the proximity approach can logically be used to encourage interactions based on many other types of social matches.

Another, example of a social matching system is Proxy Lady, a mobile system for informal, opportune face-to-face communication, running on a PDA

equipped with a radio transceiver (Dahlberg et al., 2000). *Proxy Lady* lets the user associate information items (e.g., emails) with other people, called “candidates for interaction.” When a “candidate for interaction” is in the proximity, *Proxy Lady* notifies and provides the user with the associated information item (e.g., the email message), and if suitable, is followed by an informal face-to-face interaction.

“*Social Net*” infers interest matching from patterns of co-location over time to recognize social relationships and infer affinities between users (Terry et al., 2002). The *Social Net* handheld client records the time and duration of physical co-location synchronously, and searches for recurring patterns of co-location to asynchronously infer shared interests between users. The system contains two lists, a “friends list” that contains users who are friends, and an “unknown list” that contains users who are not friends that one comes in proximity or contact with in some sort of consistent pattern. This is achieved by recording of encounters between co-located users, as well as their time and duration, in an encounter record. Periodically, the encounter record is examined and if a suitable pattern of co-location is observed between individuals, the name is included in the unknown list. While the friends list is manually created by the user, the unknown list is automatically and synchronously generated by the system and not visible to the user due to privacy concerns. When two “friends” come in contact with each other, their systems communicate by comparing their “unknown lists.” On detection of a friend by one system in the other system’s unknown list, the system informs the user of a potential new friend recommendation that can be made.

In addition to social matching, proximity can also be used to enable or support synchronous information exchanges, which in turn is often supported by various asynchronous components. For example, *Hocman*, a mobile peer-to-peer application, supports social interaction between motorcyclists (Esbjörnsson et al., 2003). *Hocman* users provide personal information of themselves and their bikes in HTML pages, which is exchanged with other bikers equipped with a *Hocman*, typically at traffic light stops. This synchronous interaction is accompanied by audio notifications. There is also a major asynchronous component to *Hocman*, which will be discussed in the section below. Similarly, *RoamWare* (Wiberg, 2001) uses proximity to semi-automatically identify when individuals get together for ad-hoc meetings, and then supports synchronous *ad hoc* mobile meeting note taking. Mobile meeting notes can then be shared asynchronously using a suite of CMC tools once users return to their desktop computers. Finally, *FolkMusic* (Wiberg, 2004) uses proximity to trigger services for music sharing between co-located individuals. The fully instanti-

ated system will also use GPS receivers to map audio traces left by individuals to geographic locations, resulting in music files being associated with specific locations.

### **Asynchronous Communication or Asynchronous Location Awareness**

To date, no P3-systems based on user proximity that we know of provide an interaction/communication framework that is primarily asynchronous. *RoamWare* with its focus on seamlessly connecting planned and mobile *ad hoc* meeting through the distribution of mobile meeting notes using synchronous chat and asynchronous email through the *RoamWare Desktop* makes aspects of the ad hoc meetings asynchronous. As mentioned above, *Hocman*, the application that supports social interaction between motorcyclists has a significant asynchronous component. That is, the system is designed so that when the biker ends her/his journey, s/he browses the pages received from other motorcyclists. *Social Net* also allows for asynchronous exchanges between users, by waiting for friends to interact before exchanging information about unknown but potential friends.

It is possible to imagine numerous designs of hypothetical systems that would fit into this category by more extensively utilizing asynchronicity. Some possible systems are those that stretch our understanding of proximity to include asynchronous use of shared physical space rather than synchronous use of physical space. This would be similar to *Social Net* but would require a history of a user's use of various geographical locations. This would allow the identification of affinities such as similar routes of travel to work, use of gyms, etc., even if they occurred at different times of the day. This in turn could be used to encourage face-to-face interactions when individuals are co-located synchronously. This design would still be people centric because it would be based on individual location history data, however, it should be noted that this is perhaps most easily achieved by taking an absolute rather than relative proximity approach to user location. An alternative approach is to asynchronously use, at a later, more convenient time, the data recorded synchronously by the system when individuals were co-located in real time. While this is done by *Hocman*, the early prototypes described in the literature did not strongly support interaction post data exchange. A stronger example might be a system that automatically exchanges individual's business cards electronically when co-located, and then encourages asynchronous interactions through the provision of personal card-exchange histories tied to a social network visualization and an asynchronous communication system such as email.

## Place Centric P3-Systems

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Place Centric P3-Systems use physical space/s to delineate virtual space/s in which associated users' actions and interactions can be seamlessly represented. In other words, this approach uses virtual spaces that represent physical locations. These can be divided into systems that are built around virtual spaces that contain online representations of people's use of physical space and those that contain online interactions related to physical location. The first approach can be used to provide users with a remote understanding through virtual spaces of how an associated physical space is used. It is only with the recent advent of person-locator technology that it is now possible to seamlessly provide such data, and the review of this approach will be fairly brief. The second approach is where virtual space/s representing physical space/s are used to manage user interactions, such as message exchanges. This is one of the traditional approaches adopted by community networks and digital cities projects to support community interactions.

### *Place Centric P3-System Features Based on Use of Space by People*

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#### **Synchronous Communication or Synchronous Location Awareness**

A number of Place Centric P3-Systems exist that provide visualizations of current use of defined geographical areas/spaces. *ActiveMap* is a software application that enables users to visualize the location and movement of users within a workplace environment, providing large-scale, real-time awareness (McCarthy & Meidel, 1999). The application provides a window with a background showing a map of the physical layout of the workplace. In the foreground, images of the faces of people in that workplace are superimposed over the locations in which they were last seen. Similarly, the *ActiveCampus* System's *ActiveCampus* Explorer Map enables such a feature by overlaying online maps with avatars representing online buddies at a physical location (Griswold et al., 2003). The *Active Badge* system also provides a similar feature with the - LOOK (location) command, which supplies users with details about the badges that are currently in the specified location. A number of operators of Wi-Fi networks provide visualizations of the physical location of users connected to their network, although this is typically in an anonymous format. An example of this is *CMUSky*, which shows usage of CMU's Wireless Andrew System ([http://www.cmusky.org/map\\_usercentric.html](http://www.cmusky.org/map_usercentric.html)). All these

systems provide synchronous location awareness of users in either an identified or anonymous manner.

### **Asynchronous Communication or Asynchronous Location Awareness**

The visualization of use of physical space online can be based on historical (asynchronous) use of the space in question. In a sense online room calendars providing information about the usage of room spaces are such systems. Using location technology, such systems can be extended to include a mechanism for noting attendance in a physical space and making the data available in persistent historical format. This works similarly to the people-centric asynchronous systems, however, the focus here is on defined physical places rather than people's use of multiple locations. *FolkMusic* (Wiberg, 2004), when fully instantiated, system will use GPS receivers to map audio traces left by individuals to geographic locations, resulting in music files being associated with specific locations. Result would be a labeling of a physical space by the musical preferences of people who use the space in question.

### *Place Centric P3-System Features Based on Interactions in Matching Virtual Places*

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As noted above, this approach involves virtual spaces, which represent physical space being used to manage user interactions, such as message exchanges. This is the traditional method used by community networks and digital cities projects to support community interactions. "Community networks" aim, through computer-mediated communication systems, to support interactions among geographical neighbors (Schuler, 1994). An example of a community network system can be something as simple as an email list for and about residents of a small township or something more complex such as a MOOsburg. The MOOsburg community network system of Blacksburg, Virginia in the United States provides a choice of tools including an interactive map that can be panned or zoomed to locate and navigate to virtual representations of geographical places, along with a related chat area, and location linked web board (Carroll & Rosson, 2003).

Digital cities integrate urban information and create public online spaces for people living or visiting those cities. "Digital cities" typically provide online interaction spaces. For example, America Online's Digital City, Inc., service (<http://digitalcity.com>) provides online interaction spaces for local chat and personals in addition to standardized location-relevant content such as hotels,

restaurants, amusement parks, day trips and itineraries, airport information and shopping. “Digital city 2” projects in Europe and Japan use high-fidelity, Internet-based simulacra of cities, updated continuously via cameras and other sensors to provide data (Ishida, 2002). Digital City Kyoto, like many digital city projects, addresses a wide range of goals spanning technology development, new information services and applications, and support for community life (Ishida, 2002; <http://www.digitalcity.gr.jp/>). However, such a broad assortment of features can reduce the chances of gaining broad community support, participation and collaboration (Aurigi, 2000).

### **Synchronous Communication or Synchronous Location Awareness**

Synchronous online interaction spaces used by “community networks” and “digital cities” are of this type. With the creation of more immersive online environments, the specificity of the representations of physical geography is increased as it allows interactions to be associated with specific areas of cartographic visualizations. Wireless network coverage is also used to increase geographic specificity of interactions by both enabling and limiting the geographic area in which a set of online interactions can occur. For example, Wi-Fi (802.11) access points can offer community chat (e.g., Michigan wireless AP chat) that is limited to the geographic range of the access points in question. Interactions can be tied to a place through visualizations of the interactors using the space. The *ActiveCampus Explorer* system’s makes this possible by allowing for nearby buddies displayed on a community map to be messaged (Griswold et al., 2003). However, this approach is place centric rather than people centric because the interaction space is not simply created by interpersonal proximity, rather it is framed within an online map which represents physical location.

### **Asynchronous Communication or Asynchronous Location Awareness**

Perhaps the most common type of online interaction space used by community networks and digital cities is of this type, using traditional asynchronous communication tools such as email lists and web boards to support online community interactions for or about a particular physical location. Some interesting examples of system design approaches developed outside of the framework of community networks and digital cities include: spatially (latitude/longitude) addressable web-based bulletin boards, such as IBM’s *World Board*, that enforce the *geocoding of messages* (Spohrer, 1996); “community geoblogs” (<http://www.brainoff.com/geoblog/>); and systems that allow com-

puter mediated messages to be linked through virtual post-it notes or graffiti to location. These digital notes behave like electronic Post-its, visible to authorized users on their mobile devices when they enter the vicinity (Brown, 1995) or remotely (Burrell & Gay, 2001). In the systems that do allow the reading of such messages remotely, messages are indexed by locations, which can be searched or found through the navigation of online maps. Examples of such systems include *E-Graffiti* (Burrell & Gay, 2001), *Geonotes* (Espinoza et al., 2001), and the “graffiti” function of the *ActiveCampus Explorer* (Griswold et al., 2003).

## Summary

Table 2 below summaries the systems and major system features reviewed in this section.

Table 2. P3-systems and key design approaches

P3-System Design Approaches		Synchronous Communication or Synchronous Location Awareness	Asynchronous Communication or Asynchronous Location Awareness
People Centric	Absolute User Location	<ul style="list-style-type: none"> <li>• <i>Active Badge</i> Find Command</li> <li>• <i>Ulocate</i> current user location.</li> <li>• IM buddies with Location Descriptors</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Ulocate</i> user location history.</li> <li>• Hypothetical Group Calendar with detailed Individual Location tracking data.</li> </ul>
	Co-location/Proximity	<ul style="list-style-type: none"> <li>• <i>Cybiko</i> chat</li> <li>• <i>Meme-Tags</i> and <i>Community Mirrors</i></li> <li>• <i>Proxy Lady</i></li> <li>• <i>LoveGety</i></li> <li>• <i>Hummingbird</i></li> <li>• * <i>Hocman</i> motorcyclist data exchange</li> <li>• * <i>Social Net</i> user co-location monitoring</li> <li>• *<i>RoamWare</i></li> <li>• *<i>FolkMusic</i></li> </ul>	<ul style="list-style-type: none"> <li>• * <i>Hocman</i></li> <li>• * <i>Social Net</i> recommendations</li> <li>• *<i>RoamWare Desktop</i> - distributes information about collocated ad hoc meetings.</li> </ul>
Place Centric	Use of Physical Spaces by People	<ul style="list-style-type: none"> <li>• <i>ActiveCampus Explorer</i> Buddies Map</li> <li>• <i>Active Badge</i> – Look</li> <li>• <i>ActiveMap</i></li> <li>• <i>CMUSky</i></li> </ul>	<ul style="list-style-type: none"> <li>• Online Room Calendars</li> <li>• *<i>FolkMusic</i></li> </ul>
	Interactions in Matching Virtual Places	<ul style="list-style-type: none"> <li>• Digital Cities And Community Network Chat</li> <li>• Map based Instant Messaging of Nearby Buddies</li> <li>• Wi-Fi AP Chat</li> </ul>	<ul style="list-style-type: none"> <li>• Community Network and Digital Cities Spaces</li> <li>• <i>Geonotes</i></li> <li>• <i>E-Graffiti</i></li> <li>• <i>Active Campus</i> Graffiti</li> <li>• <i>IBM-World Board</i></li> </ul>

\* Systems Approaches dependent on both synchronous and asynchronous use of data

## **Analysis of P3-System Design Approaches to Support Proximate Communities**

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We defined “community” in the second section as a set of individuals with partially overlapping personal social networks, which collectively provide a sense of belonging. Further, we noted that “proximate communities” are communities built around individuals co-located in a physical location. They can also be understood as communities where the personal social network ties of members are associated with a particular geographic area, place, or region. Proximate communities may be residential communities or may result from a shared physical work environment such as a university campus or central business district. In this section we will explore how P3-Systems can be used to support interactions in proximate communities. We do this because we believe that P3-Systems are by their very nature well suited to support proximate communities, since by definition they aim to link people-to-people-to-geographic-places.

Wellman et al. (1988) note that communities can provide various social functions such as sociability, support, a sense of belonging, and social identity. However, P3-Systems do not provide social functions directly to users, as these functions are generated by people or users of a system, rather than the mediating technological infrastructure. For this reason, the P3-System design approaches will be examined in terms of their ability to support people-to-people-to-geographic-place interactions. The P3-Systems support such interactions through the provision of user location awareness, making apparent location-related interpersonal affinities, and the geographical contextualization of public or private interactions.

Table 1 classifies existing P3-System design approaches into eight basic categories. In this section we will first compare the significance of the division into synchronous and asynchronous communication/awareness. This will be followed by an examination of the two people-centric and two place-centric design approaches in terms of their ability to support proximate community interactions.

The largest division of design approaches described in Table 2 is into Synchronous Communication/Synchronous Location Awareness or Asynchronous Communication/Asynchronous Location Awareness. An examination of the systems described in the fourth section suggests that this division appears to

closely parallel our understanding of how the level of synchronicity impacts on computer mediated communication in general. Synchronous communication and synchronous location awareness data provided by P3-Systems is created with the expectation that it will be processed in near real-time, whereas asynchronous communication and asynchronous location awareness data is produced with the expectation of unpredictable delays between data creation and consumption. The result is that synchronous data is more useful for management of user actions in real-time within the physical spaces of proximate communities. This is because synchronous system design allow users to address issues such as, “where is somebody,” “who is there,” and “who is around me,” which can be expanded to questions such as “who is around to eat or chat with right now.” In other words, synchronous P3-Systems are well suited to the task of supporting ad hoc interactions grounded in geographic place. Asynchronous system designs, on the other hand, allow users to make long-term plans in relation to their use of space, by the provision of information such as “how is this space used over time,” “who uses this space like me,” “what do others thinks about this place,” etc. The synchronous and asynchronous design approaches are complementary with the provision of one approach, not negating the possibility of the provision of the other, and with each supporting different social requirements.

The most important division of the design space provided by *Table 2* for our purposes is the four basic P3-System design approach types: (1) Absolute User Location; (2) Co-location/Proximity; (3) People’s Use of Space; and (4) Interactions in Matching Virtual Places. These four types will be examined and compared in terms of how systems can be used to support proximate community interactions. This will be achieved by an examination of the ability of various design approaches to enable the following. First, proximate community outeraction processes (processes outside of the direct information exchange that enables people to enhance and coordinate information exchanges). That is, those that relate to the management of people-to-people-to-geographical-place interactions. Secondly, proximate community interactions through either personal or online community interaction spaces. These outeraction and interaction process can be done publicly through online community spaces or privately through online personal spaces. The provision or lack thereof of such spaces in P3-Systems has a profound impact on the formation of social ties, privacy management, and scaling.

## **P3-System Designs Based on Absolute User Location**

Systems under this category, such as *Active Badge* and *Ulocate*, provide clear support for proximate community outeraction processes. This is because they provide users with information about the location of others, so that users are better able to coordinate their interactions. Seeing a user's history of movements in space can also help coordinate interactions in a manner similar to that of a conventional day planner. The location information also allows users to contextualize their proximate community interactions. For example, a student might ask another student to bring him coffee if he sees that remote student near the cafeteria. Similarly knowing the location from which a person sent a message will inform recipients as to the environment in which the message was composed. Further, a community system that knows of people's collective habits, schedules, appointments, and location could use individual's trajectories to better manage face-to-face community interactions. For example, if an individual was running late, the system could use awareness of his location, calendar data, and analysis of his trajectory to, where appropriate, semi-automatically advise others to delay the meeting.

P3-Systems based on absolute user location focus on location awareness rather than interactive communication. *Active Badge* system provides a listing of the current location of *Active Badges* that are available to the community of users. This raises some design issues in regards to scaling. For example, if the listing of the number of users expands greatly, then it becomes harder to gain an instantaneous feel for the whereabouts of community members. Cartographic visualization may be able to display larger groups in a slightly better fashion, but they too have their limits. Further, such a design approach using cartographic visualization of all community member locations would lean towards making the system Place Centric rather than People Centric.

Of the four P3-System design approaches we review here, this is the most problematic in terms of management of privacy. This is because, by definition, the design approach discussed here focuses on the provision of personal location data of individuals to others. Monitoring or tracking somebody's whereabouts can be extremely invasive. To address this issue the designers of *Active Badge* limited the storage of location history information to a one-hour period, and made that data available to users through a specific user history command (Want et al., 1992). However, the lack of location data history does not resolve the privacy issue associated with real time monitoring of the users' locations. The other obvious mechanism to address privacy concerns is by

simply taking off the badge when one desires not to be monitored. This however also fails to truly address the problem because of the likely social implications for anybody deciding to opt out of wearing the badge even if it be for a brief time. In fact, differing perspectives on privacy and personal freedom were noted as reasons for successful and unsuccessful implementations of the *Active Badge* in early field studies (Harper, 1992).

### **P3-System Designs Based on Co-location/Proximity**

The P3-Systems of this type systematically support opportunistic meetings (Kraut et al., 1990) and informal communication through outeraction processes, such as proximate location awareness, and the finding of affinities based on location histories. In addition, co-location data can be used to support ongoing community interactions through the use of online community spaces. For example, “*Social Net*” could be expanded to include a related online community space, which enables affinities to be inferred not only from pair-wise patterns of co-location but also community location histories. Another example is *Hocman* where proximate exchanges could be systematically uploaded to a public website so that users could gain a community perspective and proximate interactions could be used as a spring-board for community discourse. Of course, the storing and utilization of people’s interaction histories could potentially result in significant privacy problems. To address this problem the designers of *Social Net* do not make the history of proximate interactions stored on the device known to the user, however they acknowledged that this resulted in users complaining that they were not sure why a social recommendation was made. Hence, for the systems examined here, there is a clear tradeoff between overall utility and the provision of potentially private personal location data.

### **P3-System Designs Based on People’s Use of Space**

Place centric P3-Systems that provide online visualizations of current use of defined geographical areas/spaces that have been prototyped to date are useful in terms of outeraction. That is, the provision of awareness of how a space is being utilized, or where a person is within a predefined area, to support the coordination of future and current activities. These systems present user

location data that is public and anonymous, public and identified, and or private/restricted. Using the *Active Campus* Explore Map, users can see only those individuals that make their location data available to everybody, or those included in the represented user's buddy list. In this case privacy issues arise with the added complexity of location data ownership. For example, do individuals wandering in a private office complex own their location data, or does the owner of the physical space have some rights to the location data of people that using his or her physical space?

## **P3-System Designs Based on Interactions in Matching Virtual Places**

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P3-Systems designed around this approach by definition enable proximate community interactions. Further, because they link messages to locations, they are also good at enabling outeraction processes. For example, a user could leave a digital Post-It note/graffiti in a room notifying people about an upcoming event, this in turn could help other users coordinate their activities.

A design issue that confronts these types of systems is how to explicitly link a message to location. This has been in one of three ways: 1) through labels that describe the matching virtual place; 2) through use of cartographic visualizations; and 3) through user locatability. An example of the user locatability approach is that used by *Geonotes* which allows only local/in situ reading and authoring of "*Geonotes*" so that a user clearly knows the location to which a message is relevant. This contrasts with the visualization approach of the *Active Campus* Explorer Graffiti, which allows both local and remote reading and authoring, but ties messages to location by placing the messages on an online map.

Privacy is an issue with these systems if messages posted are identified by author or if physical presence in location is required. However, it is clearly possible to design a system that allows for anonymous postings and remote authorship as discussed above. Further, in the majority of situations it is likely that message posting would be voluntary, meaning that users make the decision as to when they are willing to reveal themselves.

## **Global P3-System Design Issues**

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The review of the four basic P3-System design approaches leads us to discuss a number of interrelated issues that designers of all P3-Systems must address. These are scalability, online community space construction, geographical contextualization of interactive communication, and approaches to the management of privacy.

Scalability refers to the extent to which the system maintains functionality and usability as the number of users being located, geographical coverage, and interactive communicators increases. If functionality is reduced then users may lose sense of what is happening in a geographic area covered by the system, or suffer from information overload (Jones & Rafaeli, 2003b).

Closely related to scalability is the issue of use of online community space segmentation strategy (Jones & Rafaeli, 2000) and approaches to geographical contextualization. Online community spaces through labeling or visualization can be used to geographically contextualize interactive communication, although it is not required. Online community spaces support online community by enabling ties between people to be formed through public shared interactions. While online community spaces are of value, their use is not automatic (as noted above in regards to *Social Net*). A decision by designers not to provide an online community space may arise for a variety of reasons, such as privacy concerns, which may be amplified if users' locations are publicly shared. For example, the use of location-aware descriptors next to each instant messaging buddy on a buddy list would geographically contextualize instant messaging discourse, but not through use of an online community space. If online community spaces are to be used, then to make the system scalable, an online community space "segmentation strategy" has to be adopted. "Segmentation strategy" refers to any systematic method used to divide the overall interaction space into a number of related online community spaces. For example, Amazon.com's segmentation strategy is that each book has its own online community space. As the number of books Amazon sells grows, the number of online community spaces it maintains expands. For P3-Systems based on enabling interactions in matching virtual spaces, an online community space segmentation strategy could be tied to cartographic visualizations, i.e., linking each online community space to a different point on an online map.

In building P3-Systems, designers have to address how user location data will be managed. In other words, designers have to deal with location privacy

management. Privacy management needs to be addressed as both a social and design issue. For example, the adoption of a big brother approach to the public tracking of users raises various ethical and social issues but does not represent a major technological design challenge. On the other hand, we are a long way from knowing how to design systems that enable seamless user control of location data to satisfy personal data privacy needs while maximizing overall system utility. Here we are only interested in privacy as a design issue. In this regard, the focus in the privacy literature has been on ensuring data privacy, using means such as including access control lists (providing a list of users that must be authenticated in order to access some information), and cryptography (to protect the data being transmitted). However, in this case, the important issue to be addressed is in what situations should personal location data be made public and when should it be kept private. This is complicated by the fact that the precision of data about individuals (e.g., individual, member of subgroup, anonymous user), location (room, building, street, city, state, etc.), and time can be adjusted. The question then becomes, when and how, and in what situations, are users willing to share their location data with other users, at varying levels of precision. For example, an individual might be willing to share with a friend or member of his family that he is in a restaurant but not with anybody else. On the other hand, that same individual might be willing to share with everybody anonymously that there were 20 people in the restaurant on Saturday afternoon and that the food was quite good. There are a very wide variety of ways to address this issue. These range from privacy management practices being hard coded by designers through systems that enable full user control of their location data, to systems that use emergence to enable utility through the aggregation of anonymous location data.

## **Future Research Areas**

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As discussed earlier, P3-system designs are still rudimentary. The comparative utility of the four main P3-System design approaches described to support proximate community members is to a large extent unknown. This is not simply because of the need to address privacy concerns, but also because it is not completely clear in what situations individuals would wish to use one system design approach over another. Further, we do not know which interaction and outeraction processes supported by various P3-system design approaches

would result in the strongest people-to-people ties and the extent to which those ties are grounded in geographic places.

A number of approaches can be used to help address our lack of understanding of the comparative utility of P3-System designs:

1. The design approaches could be assessed using the comparative prototyping methodology (Trevor & Hilbert, 2002). This usability research methodology uses a three step process of: 1) designing various alternative applications that vary only around the key variable to be studied; 2) deployment of the system in various situations; and 3) the use of qualitative and quantitative field data to compare and contrast the alternative designs.
2. The utility of various features of P3-Systems could also be assessed through research into P3-System recommendation tools (Terveen & Hill, 2001). Such tools would help users choose appropriate interaction and awareness spaces for the task and situation at hand. This will be crucial in a future in which highly dense small urban environments might contain large number of P3-System users that wish to interact with each other virtually, without suffering from information overload. The value of any recommendation would relate to the underlying algorithms used, which in turn would relate the extent to which it took into account the utility of P3-System features available to the user. Of course determining such utility would require development and deployment in the field of various designs and then determining in what situations users would find different features and spaces of value. We hypothesize that such recommender tools would have to take into account online community space interaction dynamics (such as critical mass and discourse overload, see Jones & Rafaeli, 2000), users' preferences, social, and seasonal rhythms (Handel & Herbsleb, 2002), inter-personal interaction histories, user physical location, and various P3-System design approaches.
3. Rather than simply comparing the usability of various features, large-scale long-term field studies could be used to understand how P3-Systems impact on social network formation and maintenance. Such studies could also be used to understand how wireless information technology could transform the social networks of proximate communities of various types, such as residential communities and university campus communities.

Until the writing of this chapter, information systems that systematically link people-to-people-to-geographic-place have not been considered as a related or distinct category. However, with the recognition of P3-Systems as a distinct class of applications we were able to distinguish between basic design-features, and provide a theoretical/conceptual framework for future development in this area. While we view the classification approach of P3 systems adopted here to be still nascent and emerging with future modifications probably being required as new systems arise, value has been demonstrated in trying to understand the design space. In fact, it is the authors' hope and belief that the recognition of the P3-System category will encourage and help us develop and enhance the future quality of P3-Systems.

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