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THE MOBILE CONFERENCE INFORMATION SYSTEM: UNWIRING ACADEMIC CONFERENCES WITH WIRELESS MOBILE COMPUTING

CHITU OKOLI
Information Systems and Decision Sciences Department
Louisiana State University
CHITU@OKOLI.ORG

BLAKE IVES
Information Systems Research Center
University of Houston

LEONARD M. JESSUP
School of Accounting, Information Systems, and Business Law
Washington State University

JOSEPH S. VALACICH
School of Accounting, Information Systems, and Business Law
Washington State University

ABSTRACT

Wireless mobile computing promises to usher in the next major paradigm in personal computing. Handheld computers in particular are truly portable and they are becoming increasingly capable of meeting most users' computing needs. In this paper we outline a vision for deploying wireless mobile computing technology within the realm of professional conferences by creating a Mobile Conference Information System (MCIS). With detailed descriptions of applications and hypothetical usage scenarios, we describe how the system can be used to access conference information, to network people, and enhance common conference services. We also describe several constraints, limitations, and challenges with this concept, and we suggest how these problems can be overcome. In this paper we consolidate many current applications of wireless networked computing into one comprehensive system; we highlight several of the complexities and challenges that apply to any wirelessly mobile information system; and we offer a vision for a valuable platform for future research on the use of mobile technologies. The MCIS will significantly change how conferences are managed and enhance the experiences of the attendees.

Keywords: handheld computers, mobile computing, wireless networking, conferences

I. INTRODUCTION

Ever since the first viable handheld computers emerged on the consumer market [Rudich, 1998], mobile computing grew quickly in scope and popularity, and now promises to

usher in the next major paradigm in personal computing [Barnes, 2001, Dickson, 1999]. While laptop computers still are popular mobile computing devices, their cost, complexity, and hardware limitations kept them from breaking into new consumer markets. Most laptop users employ them as portable auxiliaries to duplicate the functionality of their primary computer at work or at home. Because of hardware limitations, laptops are not able to fully replace desktops for users who want full functionality, such as accessible printing and Internet access. Furthermore, because of their relatively high cost, those users who would otherwise be satisfied with the laptops' limitations find more value in buying desktop computers. Moreover, although they are portable, laptops are too large to carry around conveniently, and they are inconvenient to use on planes, in airports, or at conferences [e.g., Goldman Sachs, 2001, Schwartz, 2001].

Handheld computers, by contrast, provide consumers with true portability and convenience, at relatively low cost. While tiny screens, uncomfortable input options, and other hardware limitations are still problems [Buyukkokten, 2000, Jones, 1999, Varshney, 1999, Woodward, 1994], the technology is rapidly improving. Overall, for many users who have adopted handheld computers, the convenience of a basic computer handy enough to hold in their palm more than compensates for handhelds' limitations [Dickson, 1999].

The challenge for information system designers and managers is to take advantage of the convenience of handhelds in transforming the way people work and play [Bahl et al., 2001]. Handhelds potentially:

- increase the effectiveness of existing user applications;
- create new applications of computer technology that were previously impractical because the computers are too bulky to carry around conveniently.

For example, people were able to send e-mail messages at any time, but receiving messages required them to be in front of a computer. Laptop users had to pull out their computers, power them up, and connect them to a phone or Ethernet cable. Today, a wirelessly networked handheld device can be left activated in a user's pocket, and a gentle notification sound or silent vibration can tell them they received mail. In a matter of seconds a user can pull out the handheld, tap a single icon, and access e-mail [Harney, 1997, Harvey, 2000, Rudich, 1998].

PROS AND CONS OF WIRELESS MOBILE COMPUTING

Although the technology is still emerging, wireless computing using mobile computers—handheld devices in particular—holds much promise in enhancing computer applications. A number of noteworthy limitations still exist but many of can be expected to mitigate as the technology matures. The potential for handheld wireless computing is beginning to approach the vision of Robert Johansen [1991] when he forecasted "any time/any place" collaboration. Indeed, much of the evolution and potential of wireless mobile computing sits atop the prior group collaboration literature [e.g., Dennis et al., 2001, DeSanctis and Gallupe, 1987, Johansen, 1988, Nunamaker et al., 1991]. We are finally at the advent of this vision.

Without a doubt, the greatest advantage of wireless mobile computing is its convenience. Because handheld devices are small enough to fit in a pocket or purse, they are truly portable and can be carried anywhere a user might want to use computer applications. Through wireless networking, handheld computers are freed from the restriction of wires, which limit where they could be used to their full benefit. This freedom makes them valuable as lifestyle devices that help users do anything from checking sport statistics or stock quotes to making phone calls (as Handspring Visor's phone module enables). Although the capabilities of handheld computers are relatively few at present (compared to full microcomputers) because of their small size, limited computing power, and restricted battery life, capabilities are continually being added that increasingly make these devices a viable replacement for laptops as portable computers.

For example, the investment firm Goldman Sachs reported that the adoption of the Research in Motion BlackBerry wireless e-mail pager led to a 45% drop in the use of laptops [Goldman Sachs, 2001]. In the same study, 19% of BlackBerry adopters stopped using laptops altogether. In a separate report, many sales personnel at First Boston who were required to use the same BlackBerry wireless device spontaneously stopped carrying their laptops—although they were also required to continue using them [Schwartz, 2001]. When these cases are

examined more carefully, it becomes apparent that a handheld computer is not a replacement for a laptop per se. However, the functionality of a handheld does often replace the functionality of a laptop when only certain specific applications are being used; in the case of the BlackBerry, wireless e-mail was the killer app. In such cases, users would typically choose to carry a handheld in their pocket over toting a laptop computer.

The BlackBerry, even though it offers all the standard organizer applications is not strictly called a handheld computer; rather, it is marketed as a "wireless e-mail pager", stressing its most specialized application. However, wireless e-mail is becoming increasingly integrated in full-functional handheld computers, such as the Handspring Treo that combines the full functionality of a cellular phone and Palm OS-based PDA. Moreover, cell phones are increasingly adopting more advanced computer and Internet-browsing functionality, such as the popular iMode phones in Japan and Europe [Barnes, 2001, PricewaterhouseCoopers, 2001]. Thus, it is reasonable to expect that handheld computers with the same functionality as the BlackBerry would produce similar effects of reducing the need to carry around heavier laptop computers.

A major boon to growth in handheld applications is that most handheld computers operate under the same standard technologies, which promotes rapid and widespread development of applications. The Palm and Microsoft Pocket PC operating systems emerged as the two leaders for the handheld devices themselves, and the industry agreed to a number of networking protocols such as 802.11b for wireless network transmission and Wireless Application Protocol for inter-computer communications.

The benefits of wireless handheld computing come at a relatively low absolute cost, when compared to laptop and desktop computers. In all fairness, though, the bargain value of handheld computers depends on an individual consumer's valuation of portability and convenience versus capability. While the portability of a handheld computer is well worth the cost for some consumers, others find that the restricted capabilities, especially when coupled with the clumsy input options and tiny screen size, just are not worth it for them. The pros and cons of wireless mobile computing are summarized in Table 1.

Table 1. Pros and Cons of Wireless Mobile Computing

Advantages	**Disadvantages**
• Truly portable, and convenient to access • Well-standardized hardware and operating system platforms enables rapidly increasing development of new applications • Well-standardized wireless networking protocols allow for network access with many different computing devices and systems • Low cost for devices compared to full-powered computers	• Input options are awkward and uncomfortable; output is limited by the tiny screen • Small size, limited computing power, and short battery life restrict capabilities of devices • For some users, prices are still too high, considering the limited capabilities

WIRELESS MOBILE COMPUTING AT ACADEMIC CONFERENCES

Despite the limitations we acknowledge, the application potential for handheld computers is large [Dickson, 1999]. One area where they appear to offer advantages is at academic conferences. At conferences, a large amount of information is to be shared, several people to network with, and many other functions that could benefit from wireless, mobile computer access. The Association for Information Systems (AIS), for example, annually runs the International Conference on Information Systems (ICIS) and the Americas Conference on Information Systems (AMCIS) as well as being cosponsor of European and Pacific conferences. These conferences attract up to 1000 attendees. The attendees are mostly PhDs, who teach information systems at

the world's major universities. They understand technology, are comfortable around it, and educate others
about it. Like academic conferences in many other fields, these international and regional meetings provide researchers from all over the world an opportunity to meet and interact with one another. People present papers on current research topics, and they receive feedback from their colleagues. Faculty members recruit PhD students and other faculty members for faculty positions. And, of course, people attend conferences to socialize with colleagues, build new relationships, and refresh old friendships.

We see many opportunities to use wirelessly networked handhelds to enhance the experience of conference attendees significantly. In identifying areas where conferences could use improvement, we developed the concept of a Mobile Conference Information System (MCIS, pronounced "EM-sis"), a system that uses wirelessly networked mobile devices to enhance the conference experience. We call these devices "conference digital assistants" (CDAs). Although we primarily have handheld computers in mind, the MCIS is also designed to accommodate laptop computers as conference digital assistants.

The idea of a conference or trade event enhanced by wireless mobile computing is not a new concept. On the contrary, numerous such applications are already implemented or currently in development. For example, Microsoft Research is developing a wireless network infrastructure that enables secure user access to the Internet and intranets in public places such as airports and malls [Bahl et al., 2001]. Washington State University recently developed a wireless classroom that uses handhelds, laptops, electronic whiteboards, and other groupware devices to connect students and enable new models of classroom learning. Boeing is pioneering Connexion by Boeing, offering broadband wireless access on passenger airplanes. Palm handhelds were recently distributed to five thousand educators to increase their administrative and teaching effectiveness [Niles, 2002]. The examples of wirelessly networked applications abound, but none of these incorporates and integrates these technologies to the extent we describe in this paper. The MCIS pulls together a variety of these technologies into one, integrated, seamless system at a scale and scope that has not been done yet.

CONTRIBUTIONS

This concept paper makes the following unique contributions: First, it consolidates many existing and imagined applications into one system, demonstrating how these diverse applications for wireless mobile computing can be integrated beneficially in the specific domain of academic conferences. In so doing, we illustrate new possibilities for academic conferences that were previously difficult or impossible. While various conferences already provide some networking infrastructure to support the meeting, our literature review and experience did not locate any overall, integrated architecture to the extent of what we describe here. Our second contribution is that we highlight several of the complexities and challenges that apply to any wireless mobile information system, presenting a backdrop for project management and risk analysis. While our analysis specifically applies to the MCIS, the challenges apply in general. Our third contribution is that we ground this paper in the literatures on wireless mobile computing and groupware, and thus we offer a vision for a valuable platform for future research on the use of mobile technologies.

ORGANIZATION OF PAPER

We begin this paper by outlining a vision for the capabilities of the MCIS, describing several specific capabilities of a system using wirelessly networked handheld computers that can significantly enhance the experience of academic conferences. We frame the MCIS primarily in the context of AIS conferences, since one of these would probably host the first MCIS. Next, we lay out a general physical architecture for the MCIS, describing the networks, hardware and software required for the system. Finally, we discuss various constraints and challenges to the implementation of such a system now, including some insights obtained from informal interviews of potential users of the MCIS.

II. THE MOBILE CONFERENCE INFORMATION SYSTEM (MCIS)

The core of the Mobile Conference Information System is a central database that contains information about attendees and the conference events. In addition to the central database, several Web-browser-based applications will be provided to facilitate common attendee activities. While the potential applications will continue to grow, at this stage we see three primary applications for the MCIS:

- accessing conference information,
- connecting people to each other, and
- enhancing diverse conference services.

Figure 1 shows three examples of welcome screens for the MCIS.

Figure 1. Sample MCIS Welcome Screens
(Source: NearSpace)

Johansen [1988 p. 44] categorized groupware applications according to how they fit on the dimensions of time (synchronous or asynchronous) and virtual meeting place (face-to-face or electronic). Following his categorization, we list and categorize the various applications of the MCIS in Table 2.

Table 2. MCIS Applications Displayed by
Geographic and Time Dispersion of Participants

	Time	
	Synchronous	*Asynchronous*
Face-to-face meetings	• Enhancing presentation quality and experience	• Spontaneous meetings • Placement services
Electronic meetings	• Finding and interacting with people	• Integrated electronic program • Accessible proceedings • Dynamic program • Conference services • Applications for conference sponsors • Survey collection

CONFERENCE INFORMATION ACCESS

One of the visions that first inspired this project was the goal of replacing much of the paper used in conferences today. A staple of most academic conferences is the voluminous

proceedings, i.e., the published collection of all the papers presented. While this volume is valuable as an archive for reference after the conference, during the conference it is practically useless. Even as an archive, it suffers the limitations of paper records such as search is limited, it is difficult to copy and to share for collaboration. While attendees often want to refer to certain papers during the conference, the printed proceedings are so heavy and unwieldy that they invariably leave them in their hotel rooms, and refer to them only after the daily events are over.

A major step forward is the transfer of proceedings to the World Wide Web, which all AIS conferences and many others took[1].

Accessible Proceedings

The use of handheld computers can help resolve the dilemma of Proceedings not being available for use during conferences. The Mobile Conference Information System will store the entire conference proceedings, so that if any user wants to access a particular paper, they need simply request it from the MCIS, and it will be available to them in seconds, any time during the conference. Since attendees can choose precisely what they want to see, their CDAs will be able to store the content they need day to day, or download requested information as needed.

Depending on the storage characteristics of the computing device, information will be provided to users in different ways. For example, if the computing device has ample storage—as in a handheld with an extended memory module—the entire proceedings could be downloaded to the device when the user arrives at the conference, or even beforehand. Alternatively, for standard handhelds with limited storage capacity, information would be provided as needed (see sidebar). Of course, care must be used to manage network and computing resources so that users have the right information at the right times.

SIDEBAR 1

SQUEEZING PROCEEDINGS INTO YOUR POCKET

One of the chronic problems that handheld users face when they are interested in content-based applications (e.g. e-books, maps, reference) is that handheld memory fills up fast. Virtually all PDAs manufactured today contain at least 8 MB of RAM, with many offering 16 to 64 MB standard. Although this capacity might seem a considerable amount, it is pitifully constrained for those used to the virtually unlimited disk space on desktop and laptop computers.

Many memory extension technologies are available today, and almost all PDAs feature some memory expansion option or the other. The most popular ones are Secure Digital Card (SDC, at 32 to 512 MB), MultiMediaCard (MMC, at 16 MB and 32 MB), Smart Media Card (32 to 128 MB) and Compact Flash (CF and CFII, from 16 MB to 512 MB). Moreover, using a Compact Flash adaptor, some PDAs can connect to an IBM MicroDrive, achieving capacities of 340 MB to 1 GB. The popular Handspring Visor PDAs use proprietary Springboard modules that can accept memory adaptor modules that permit use of the standard large-capacity memory modules. Thus, it is technically feasible to fit entire proceedings on a handheld computer.

Practicality is another matter, though. It would be unreasonable to require users to expand their memory (at significant cost) to make use of the MCIS features. However, a mere 2 MB of free memory would hold about 12 full papers from the ICIS 2001 conference, for example, or alternatively the entire collection of abstracts. Most users wouldn't need to read more than this number of full papers at a conference, and a user with limited space could feasibly download and delete papers back and forth as needed without too much inconvenience.

[1] Some conferences still use CD's in place of printed proceedings. While CDs resolve the problem of portability and take advantage of electronic media for searching after the conference is over, they are often as impractical as proceedings during the actual conference. The only practical way to access them at the conference site is with a laptop computer equipped with a CD-ROM drive; however, many attendees report that they do not like to carry a laptop with them around all day long, partially due to the lack of suitable desk space in most large conference settings [Ives and Okoli, 2002]. Furthermore, many of the lightweight notebook computers are not equipped with an onboard CD-ROM drive. Thus, laptop users, with or without CD-ROM drives, often forego using them throughout the day because of the inconvenience of plugging in the laptops and waiting for them to boot up.

Enabling ready access to the proceedings during the conference is only part of the solution. Even if possible, most people would access these papers mainly after the conference; after all, archiving is the primary value of printed proceedings. For this function, the MCIS will move the proceedings to permanent Web access after the conference via desktop computers, as well as through CDAs [Buyukkokten, 2000]. Users would then have the choice of viewing the proceedings electronically, downloading the entire archive, or printing the specific papers they want. In addition, the many other forms of paper documents that attendees receive in the conference registration packets can also be digitized and accessed the same way.

Integrated Electronic Program

The MCIS would contribute little if all it did was to convert the conference programs, proceedings, and other documents to PDF or HTML format and make them accessible via handheld computers. The real power of digitization is in creating an electronic program with interactive features that are simply impossible with paper. Such a concept has already been implemented, most notably by NearSpace, a provider of integrated PDA applications such as scheduling, event guides, and various location-based services (Figure 2). Such a guide has a number of valuable features that can be tailored to an academic conference:

- An index can list all paper presentations by author, institution, location of presentation, time of presentation, title, subject, or other classification that users might wish to use for browsing.
- When a presentation is found, the user can locate presentation information (such as authors, times, and abstracts), a map of the location, and also a link to immediately download the full paper after reading the abstract.
- The presentation is integrated with the user's scheduling application, so that with the click of a stylus, the user can schedule a presentation into the calendar, to create a personalized schedule for the conference.
- The maps are integrated with the presentations and with each other, so that users can easily navigate to different floors, different buildings, and zoom in and out for different views (Figure 3).

A related feature that is not implemented by NearSpace would give users direct access to presentations currently going on. On one level, these presentations could be identified based on matching the system time on the handheld with the program schedule. An even more advanced implementation would have the MCIS identify physically which room the user is seated in, and provide direct access to the sessions and related information currently underway.

The value of this electronic program would be in integrating the various aspects of conference information into a single application, grouping together and providing links between related information. Integration would take the MCIS beyond a mere electronic presentation of traditional paper information.

Dynamic Program

Another important information source that will be available to the CDAs will be the conference program. The program can be updated dynamically to reflect last-minute changes. While a well-organized conference doesn't traditionally have many program changes, the dynamic nature of the MCIS will permit the coordinators to respond to attendee sentiment to schedule events whose need could not have been predicted beforehand. For example, if a particular presentation proves to be extremely popular, the coordinators could schedule a follow-up session where participants could meet for further discussion.

While this feature seems simple, it would permit a significant change in conference structure from what we are traditionally accustomed to. We assume that a conference should have all its sessions planned out beforehand, and only in the case of problems would there be need for changes. However, if it is now practical to make a schedule change based on attendee feedback and to notify all the attendees in sufficient time, this would permit a new kind of dynamic program scheduling that could lead to exciting, unpredictable conferences. Of course, this

enhancement would require the coordinators to leave time slots open for such meetings, but the MCIS would make this practicable.

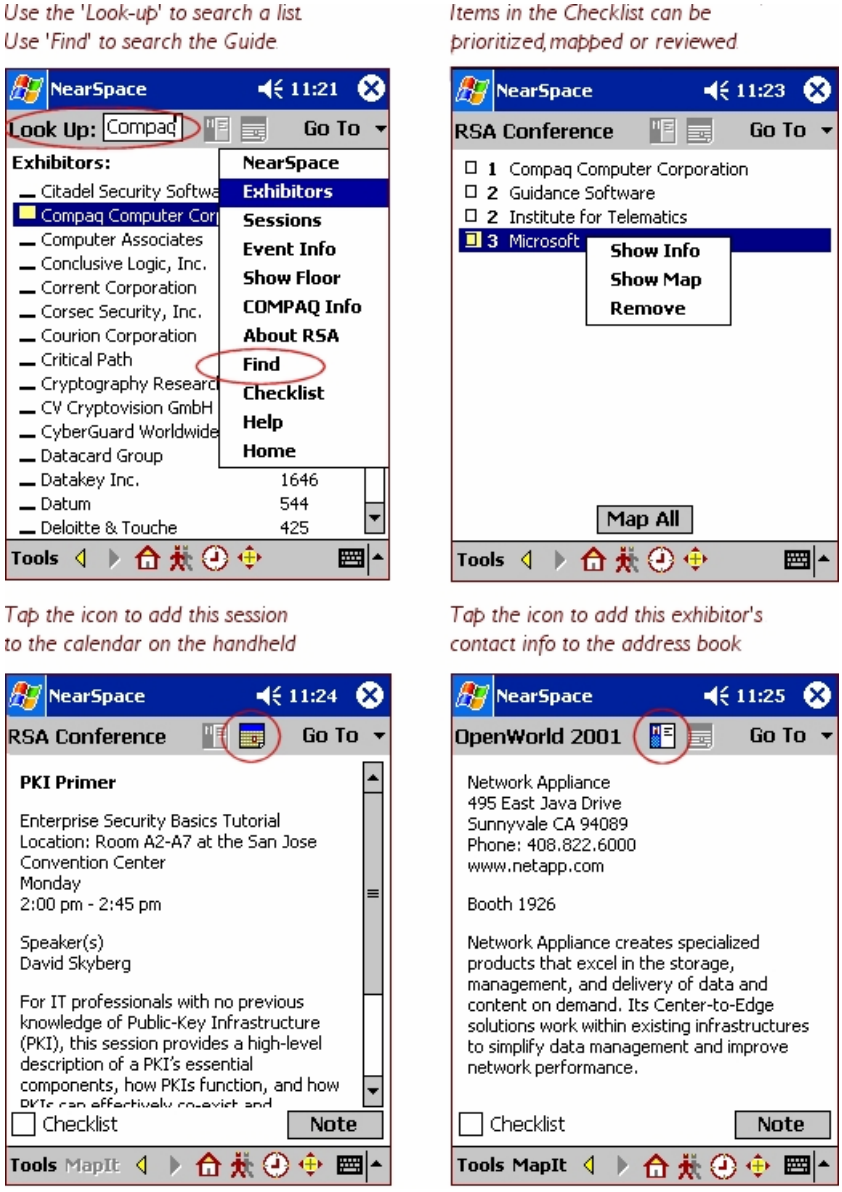

Figure 2. Sample MCIS Integrated Program (Source: NearSpace)

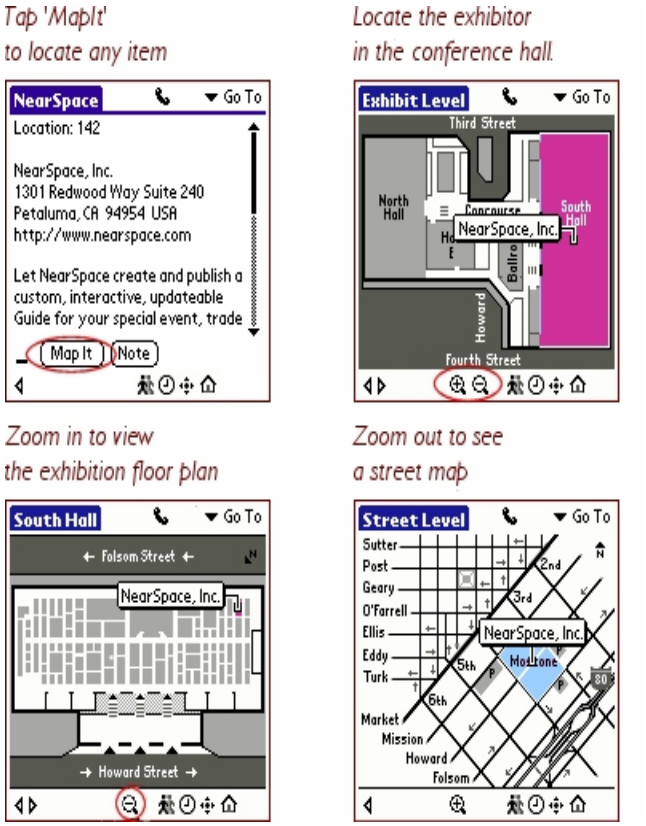

Figure 3. Sample MCIS maps
(Source: NearSpace)

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PEOPLE NETWORKING

Finding and Interacting with People

In an informal survey on why people attend academic conferences in IS [Ives and Okoli, 2000], the number one reason given was to network with other researchers—not merely social mingling (vacation and fun was fourth), but establishing research-oriented relationships and

discussing personal research projects. Technology has made it easier for people to collaborate remotely on research projects, but face-to-face interaction remains a uniquely valuable and productive way to work with colleagues. Furthermore, it is likely that personal interaction provides greater opportunity for establishing new professional relationships than do any electronic means of meeting people. In light of these observations, one of the major goals of the MCIS is to make it easier for people to meet one another and to enhance the quality of their interaction.

The core of this function will be a directory of attendees that will contain all relevant information about them. In addition to their general identification (e.g., name, academic rank, school affiliation, contact info), this database will offer basic information about attendees' research interests, professional affiliations (e.g., Academy of Management), and also the presentations they plan to (or have) attend. It will also provide on-site information such as hotel information so that they can be easily contacted. Of course, since some attendees might not want to be found by just anyone, users will be able to customize what information about themselves is available to others.

In addition to this database that will help people find one another, the CDAs will have standard PDA communications applications such as instant messaging, e-mail, contact database, and scheduling. These applications will not be limited to the MCIS: attendees will be able to use their CDAs to access their regular e-mail accounts to keep in touch with their contacts at home.

Related MCIS resources to enhance attendees' social networking will be information such as local hotel, restaurant, visitor interests, emergency help, and maps. An extension to people- and location-finding applications would be a radio-frequency mapping feature in the MCIS, which would be able to track the CDAs' physical position within the network and thus help direct people to other people or to locations where they might want to go [Varshney, 1999]. A number of commercial vendors already provide such technology such as TruePosition in the U.S. and SK Telecom in South Korea. Privacy is an important concern here. For example, "publicity about location-based services in South Korea peaked when a woman hired a company to track her husband" [Sirkin and Dean, 2000]. For the MCIS, people would be able to make themselves invisible to such a location-finding feature if they so chose.

SIDEBAR 2

CHATTING WITH HANDHELDS

After e-mail, chat and instant messaging (which we will collectively refer to as "chat") are the most popular interpersonal communication technologies on the Internet. These technologies' significant advantage over e-mail is that they are real-time, so that users can talk to each other at the same time. Chat evolved from simple text based, to voice support, to video support, thus emulating telephones and video conferencing technology.

The one shortcoming of these technologies is that users are traditionally tethered to a desktop computer. Thus, it is no surprise that there are major moves towards creating fully functional chat applications for handheld computers. Currently, all the major Internet chat applications (AOL Instant Messenger, MSN Instant Messenger, ICQ, and Yahoo! Messenger) have versions for handheld computers. However, voice and video capabilities are taking a while to be established. Currently, Ruksun produces Voice Messenger Force for voice chat, and Microsoft released a beta version of MS Portrait for video conferencing. Both of these applications currently support only the MSN Instant Messenger working on MS Pocket PC. It shouldn't be long, though, before such applications become mainstream, and voice chatting using handheld computers starts to make a dent in the mobile phone market.

Spontaneous Meetings

To support people's individual networking, the MCIS will have applications that support meetings that people did not plan before they came to the conference. There are two kinds of such meetings.

- In the first scenario, different people who met each other during the conference might decide to do a brainstorming session for an initiative that someone proposed. The people could set a

time and request the MCIS for a dedicated room or meeting table that the conference coordinators set apart for such purposes. The MCIS would log their request, and allow individual attendees to register to join the meeting up until the time scheduled. Fifteen to thirty minutes before the meeting time, the MCIS would assign the meeting a room or table, depending on the number of people registered, and then give directions on how to get to the location.

- A second kind of meeting would occur when an individual wanted to start a discussion about a topic of interest—say, the economic viability of the free ISP model—and request a time for such a meeting. The MCIS would publicize all such open meetings, and anyone interested would be able to sign up as in the previous case.

Of course, existing group support system technology environments that are deployed on the Web could be used to support these meeting-related and discussion activities [Dennis, 1998, Johansen, 1988].

Enhancing Presentation Quality and Experience

Centering more directly on the paper presentations, another problem that the MCIS could address would be the limited interaction that presenters often experience during their presentations. Even in the best-designed conferences, often little time is available for the presenter to field questions, and even less time for scholarly discussion. For each presentation, the MCIS could host an electronic discussion forum for each presentation so that interested people could read the paper beforehand and comment online. These comments would help the presenters know how to steer their discussion for the expected audience. After the presentation, even if there is limited time for follow-up discussion (and the session is not popular enough to justify an extended session as described earlier), the discussion of the few people interested can continue on the online forum, during and after the conference.

CDAs would enhance the presentation experience in other ways as well. Notes taken during a session could be linked to the user's copy of the paper or abstract of the presentation being given. Users could also automatically check-in to the MCIS when attending a presentation, so that the system could keep track of who attended a specific presentation, and so that presenters could contact people who attended their presentations. Again, privacy would be a paramount concern; the system will not report any information without the user's explicit consent.

COMMON CONFERENCE SERVICES

Placement Services

Another major purpose for attending academic conferences is to participate in recruiting. Schools with open positions often send representatives to recruit available PhD students and other candidates who, in turn, attend to be interviewed and attain visibility by presenting papers and interacting with other researchers. Many conferences, and most Information Systems conferences in particular, already have some electronic systems set up to support placement services, but the wireless mobility of the MCIS could significantly enhance these.

The MCIS will be linked to a website where registered interviewers and job-hunting PhD students could submit their profiles before the conference, and manually schedule interviews. While such applications are already available, the MCIS would add the ability to access this placement database at the conference and dynamically reschedule interviews at the conference. It is common for a student to become interested in a school after listening to a presentation or talking to someone from that institution; and likewise interviewers often don't know whom to specifically solicit until they meet them at a conference. The wireless mobility of the CDAs will be a great help in meeting the dynamic scheduling needs of the interviewing process.

Conference Services

The gathering of researchers in one place provides a valuable opportunity for professional societies and other academic conferences to inform about and advertise their offerings. The MCIS could provide information about these other societies, and allow people to register for membership and participation directly from their CDAs.

Applications for Conference Partners

The MCIS will provide promotional information about the conference sponsors, both for the attendees' benefit and to help fund the conference and the MCIS itself. To the extent that the local hotels where attendees stay support the technology, the MCIS would integrate their information, such as remote room service requests, hotel restaurant menus, and general hotel information. The MCIS could contain electronic versions or samples of textbooks and research books, which attendees might find more convenient than walking through the vendor exhibits. In addition, attendees could use their CDAs to request an examination copy of a new textbook without having to go through the business card exchange ritual.

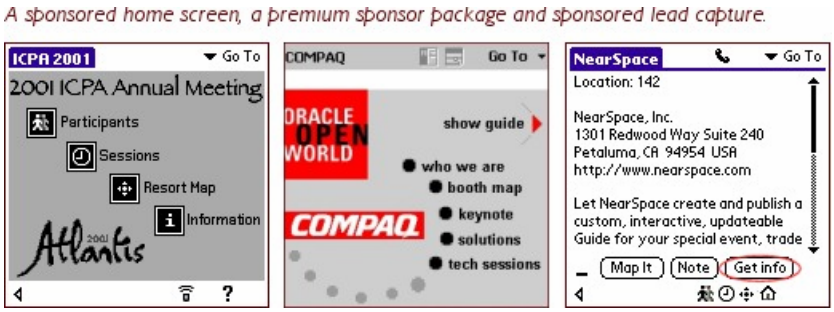

Figure 4. Sample sponsor applications
(Source: NearSpace)

While sponsor applications and guides might be of debatable value to users, such sponsorship would provide funds that could make the other applications a reality. With careful design, tailoring sponsor information to related content, the sponsor information could serve more as extended information sources and less as advertising.

Survey Collection

It is common for conference coordinators to request feedback from attendees; the MCIS would allow these surveys to be filled out using CDAs. In addition, with the permission of the conference coordinators, any researcher who has a project can distribute their surveys to be filled out with the CDAs, which might be more cost effective and convenient than paper or Web surveys. Quick, on-the-spot surveys during paper and panel sessions would provide valuable information to conference management for future sessions and speakers, or for making best-paper awards.

The applications we described would enhance the quality of conferences, enabling attendees to fulfill their goals more effectively. With the complexity and variety of these ideas, it would only be possible to implement these applications incrementally, and with time even more useful applications will be identified and developed for the MCIS.

III. ARCHITECTURAL CONSIDERATIONS FOR THE MCIS

Various wireless network topologies are possible, including an ad hoc point-to-point network [Li et al., 2000]. However, since the Mobile Conference Information System is based on a central database, it will operate on a client-server network with a star topology, which depends on a central server to which all clients connect. The architecture will use multiple servers to assure redundancy and availability, and they will be physically distributed between the hosting site and the conference center. Figure 5 shows the architecture of the MCIS. Given that the state of the art for server and networking architectures is continually changing, this architecture represents one possible configuration for the MCIS. It is likely, especially in the future, that more alternative designs are feasible.

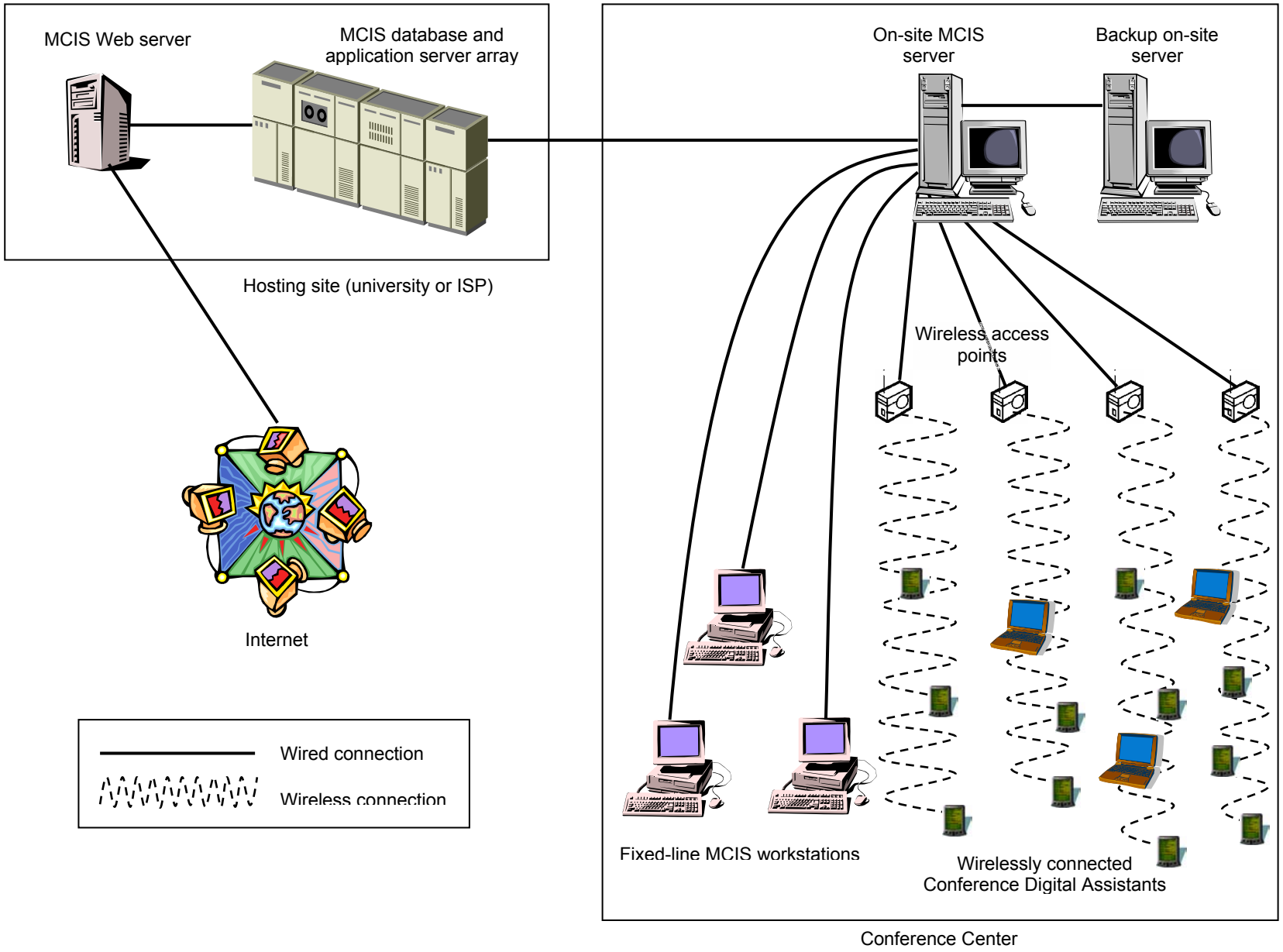

Figure 5. Architecture for the Mobile Conference Information System

MAIN MCIS HOSTING SITE

MCIS Servers

The MCIS will be hosted either at the site of one of the MCIS hosts (e.g. in the computing resources center of a university) or at an Internet Service Provider that gives sufficient access to manage the system effectively online. The main MCIS "server" will actually consist of an array of three physical servers[2], which would be the most powerful computers in the MCIS architecture. The servers will deliver two general classes of content: the continuously updated MCIS database, and static content. The primary MCIS database stores user profiles, registration information, dynamic program information, and any other data that changes during the course of an MCIS-enabled conference. The static-content database primarily stores information about the proceedings, maps, sponsors, and data that is fixed during the course of the conference.

Of the three MCIS servers at the main hosting site, one would be designated the primary MCIS server and the other two would be secondary servers. All three servers would store the entire static-content databases, but only the primary server would store the dynamic-content databases. Thus, there will be one central location for this changing information without the need to manage the complexities of database replication to maintain consistency. By the nature of the information it contains, we do not expect that the dynamic-content database will be accessed as frequently as the static content. Therefore, we believe it is sufficient to provide this data off a single server. However, we expect that the static content, containing the proceedings, will be accessed constantly throughout the course of the conference; thus, we will need three servers to deliver this information. Server load balancing software will be used to distribute users' access to each server evenly, easing the load on each server and particularly relieving the primary server of its double duty of delivering both dynamic and static content.

These main servers (and all the servers in the MCIS) will use disks that implement RAID level 3 or higher to ensure redundancy in case of system failure. In addition, we will implement backup policies, a firewall, virus protection, and other standard security measures.

Internet Gateway

The main MCIS hosting site will also have a fourth dedicated server that connects the MCIS to the Internet. This Web server would receive information from the three MCIS servers and make them accessible to users who wish to access the MCIS via the conventional Internet, such as to download the proceedings or MCIS applications before the conference. This Web server will also pass through HTTP and POP requests for MCIS users who wish to access the Web or e-mail respectively.

Each of the three MCIS servers will implement a gateway for Wireless Application Protocol (WAP) to convert the HTTP Web requests to a format optimized for the microbrowsers of handheld computers. We believe that it is best to place the WAP gateways on these servers (as opposed to the server at the conference center) because of the physical power of these three servers, and because of their physical and logical proximity to both the Web server and the MCIS databases.

CONFERENCE CENTER INFRASTRUCTURE

MCIS Server

At the actual conference site, an on-site server will be connected to the main MCIS server through a physical Internet connection, a connection that is provided by virtually all conference centers today. In contrast to the main MCIS servers, which serve dynamic and static content from the MCIS database, this on-site server will mainly be an application server. For example, it will store the user authenticating (RADIUS) server and the Jabber server for instant messaging described below. Moreover, the on-site server will serve as a gateway to deliver the

[2] Three servers is a minimum number for a design with a primary server for mostly dynamic content, and two secondary servers that share the delivery of most of the static content. More precise architectural and load analysis might indicate that more servers would be needed for conferences with very many attendees.

content from the main MCIS servers to the wireless access point and to the wired MCIS workstations. For security and redundancy, all the data on the primary off-site MCIS server (that is, the dynamic and static MCIS databases) will be replicated and maintained on the onsite server. However, these databases will not be accessed directly by the CDAs; they will be stored on-site in case the connection between the main MCIS site and the conference site should fail. In such a situation, the MCIS will be able to continue operating, without Internet gateway functionality, until the connection is restored.

For redundancy and data security, a backup server on-site will dynamically replicate all the data on the main on-site server: MCIS applications, and dynamic and static content databases. The hardware specifications and features of the backup server will be identical to those of the main server. Unlike the three-server array at the main hosting site, this backup server will not be a partner server. Its function is purely backup for security purposes: If the main on-site MCIS server fails for any reason, the backup server will be able to replace its full functionality quickly.

Conference Digital Assistants

The on-site MCIS server will be connected to a number of wireless access points that will be located throughout the conference building in the rooms and areas that users would access the MCIS. Without knowing the specific layout of the rooms or the size of the conference, we cannot specify how many access points will be needed. With the increasing power and range of access point technology, it probably would not take that many. For example, the airPointPro by smartBridges broadcasts 11 Mbps (the maximum for 802.11b) at a range of 800 m (over 2,600 feet) in open air. The range through walls depends on a variety of factors, including the distance of the walls from the access point and the materials with which they are constructed.

The Conference Digital Assistants themselves will have wireless networking capabilities and versatile Web browsers—both essential for the Web-based applications of the MCIS. Currently, almost all major handheld vendors provide viable options for 802.11b wireless networking. Palm produces an i705 model with a built-in wireless card, and Intel/Xircom provides an expansion module for some of the newer Palm models. Xircom also provides an expansion module for Handspring Visor handhelds. Handhelds based on Pocket PC can use a number of different 802.11b cards, most via a Compact Flash module. For Web browsing, a number of different browsers provide access to full HTML—and the WML subset—that work on both Palm OS and Pocket PC platforms. Thus, our basic approach of 802.11b wireless networking for physical connectivity and standard Web browsers for software applications is sufficiently standardized for most handheld users to have access to the MCIS.

To connect to the MCIS, the users will need to set a Service Set Identifier (SSID, also called a Network Name) on their wireless network cards that identify them to the wireless LAN. (An SSID is similar to a Windows domain, a Unix workgroup, or an AppleTalk zone.) The users sets their cards to receive an IP address automatically from the MCIS server via Dynamic Host Configuration Protocol. The pool of IP addresses comes from the MCIS hosting institution, most likely the organization that hosts the main MCIS servers (see above).

MCIS Software Applications

For the actual software applications, there is a bit of a dilemma in choosing between two conflicting development philosophies.

1. We are committed to using open standards that would assure that those who have already purchased equipment would fully benefit from the system. Moreover, open standards provide the most flexible platforms for the customized applications the MCIS would require.

2. Many of the MCIS applications are quite complex. It would be impractical for anyone, particularly an academic host of an MCIS-enabled conference, to develop all of these applications from scratch. Attempting to create all these applications will inevitably result in falling short of some of the expectations for MCIS applications, or creating applications of sub-standard quality.

We propose to take a middle ground that will involve starting from ready-built applications and customizing them to create the specific applications envisioned in this paper. However, we will strive as much as possible to work with platforms based on open architectures that allow flexible customization and support universal standards. For example, we plan to use Jabber, an

open-source system, for our instant messaging applications. A Pocket PC client exists for this system, as well as a client usable on Palm OS via Java Micro Edition.

Thus, the MCIS applications will all be implemented with open Web standards such as HTML, XML, XSL, WML, Java and WAP. These technologies are flexible enough that applications can be designed that display differently on multiple devices, with specially optimized views for handheld or laptop computers [Jones, 1999]. With simply a functional microbrowser and an 802.11b wireless network card, any user will be able to access and use the system.

Alternative Access to the MCIS

The MCIS is designed for wirelessly networked mobile computers. However, we recognize that many of its applications will be valuable even if the user is constrained to a fixed location. Thus, we intend to make all the MCIS applications available on regular desktop computers for those users who don't have or don't want to use a handheld device. Because of the open-standard design, porting the applications to standard desktop computers should be seamless.

A related concern is that some of the CDA applications will involve keyboard entry beyond what is convenient for the typical handheld computer. Therefore, we plan to provide user access to portable keyboards that work with the most popular handheld computers[3]. We might also provide dedicated keyboarding stations where attendees can sit to key data into their CDAs. Although such an implementation would seem to defeat the benefits of mobility, we want to provide measures to increase user participation. Thus, we believe this intermediary strategy of providing keyboarding stations will be helpful and appreciated by those users whose computing mentality (and equipment) is not fully "untethered". Over time, we expect the user interface for handheld devices continues to improve with advances in handwriting and voice recognition, as well as improved input devices like built in micro-keyboards. These improvements should lead to more attendees bringing wireless equipment with them.

IV. PLANS FOR IMPLEMENTATION OF THE MCIS

Although the Mobile Conference Information System is visionary at this stage, various elements described here are already implemented to varying degrees at information systems- and computer science-related conferences. For example, NearSpace provides PDA applications that lay out the program of a conference or event, integrating this data with schedules, maps of locations, and other pertinent information. This application was used at major computing conferences such as SIGGRAPH 2001 in Los Angeles and COMDEX Fall 2000 in Las Vegas. In 2002, Adobe released Palm OS and Microsoft Pocket PC versions of their free Acrobat Reader, enabling PDA users to access files in PDF format, a very common format for electronic versions of conference proceedings. Moreover, the 2001 International Conference on Information Systems (ICIS 2001) in New Orleans, USA provided PDF versions of its program and simple maps of the conference hotel.

An increasing number of conferences now provide wireless LANs that can be accessed by users with 802.11b network cards. Recent IS conferences that included such facilities include ICIS 2001 and the 2002 Hawaii International Conference on Information Systems (HICSS). The wireless access points in both cases were limited in scope to the areas where wired Internet access was also provided, in contrast to the wide physical range that the MCIS envisions. For ICIS 2001, we (the authors of this paper) helped arrange for wireless access, while the conference hotel arranged the wireless access for HICSS 2002.

ICIS 2003 in Seattle, USA is targeted for the first significant implementation of the Mobile Conference Information System described in this article. Two of us, (Jessup and Valacich), are the general co-chairs for this conference, and will have full control over implementing such a wide-ranging information system. At the very least, we plan to have a wireless infrastructure available for people to connect in to with their own devices, and we hope to have that network will spread throughout the common, high traffic areas of the conference. In addition, we hope to make some devices and cards available for people to use. Some dedicated staff should be available to

[3] We could determine which ones are most popular by asking attendees which unit they plan to bring when they pre-register for the conference

assist people. The extent to which we implement the specific applications described will depend on the availability of funding. Incorporating a mix of existing commercial technologies, such as NearSpace guides and Acrobat Reader, with custom-designed applications, we hope to provide many of the applications we have envisioned.

V. HYPOTHETICAL USER SCENARIOS

The MCIS could radically enhance the experience of conference attendees in many ways. In this section we present user scenarios to illustrate a few ways in which enhancements might occur. In our scenarios, we follow a fictitious information systems professor, Jack, who is attending an MCIS-enabled conference for the first time.

TRYING TO SAVE TREES

On the evening of the initial conference reception, the day before the conference officially starts, Jack walks up to the registration desk in the convention center. After confirming his registration, the assistant at the desk takes his credit card number and hands him his Conference Digital Assistant, a handheld computer wirelessly connected to the Mobile Conference Information System. The assistant also gives him a fold-up keyboard for the CDA, which Jack puts in his pocket.

Walking away from the desk, Jack turns on the CDA. A window pops up asking him to please fill out his profile information. Jack wants to get to the fun stuff, so he clicks “No” and looks at the MCIS browser screen in front of him. He sees options to view all the essential conference documentation on his CDA—the programs, electronic directory of attendees, and maps of the venue. He also has an option to view the proceedings, which allows Jack to browse the presentation titles and choose which papers he wants to download to his CDA.

Though Jack is an IS professor, he still likes the handiness and flexibility of good old paper. He frowns, not liking being forced to read from a PDA screen. But then he notices a “Print” button on the screen that lets him print any documents or articles that he checks off. Relieved, he checks the boxes by the program and one of the papers he wants to examine, and he presses “Print”.

As he does so, Jack wonders where to pick up his printout. He looks around, but can’t see any printer in sight. Just as he’s about to go back to the registration desk for help, he glances at his CDA, and notices an option to find his printout. Clicking on the link, he finds a map and instructions that give him step-by-step directions to the printer where his program has been printed.

COLLEAGUE CONNECTION

After picking up his printed program, Jack takes a closer look at the MCIS application on his CDA, and sees a tab that says “Find People”. “Now, who might be here already?” Jack wonders. “I know, Peter Chiang is one of the organizers, so he should be around somewhere.” He types in Peter’s name, but the system cannot find him. But it does give him a message that says, “Your profile is not publicly visible on the Mobile Conference Information System. Would you like to become visible so that people can find you?”

“Placing a guilt-trip on me, heh?” Jack smiles, and he clicks “Yes”. He pulls the CDA’s keyboard out of his pocket, unfolds it and snaps it on. Then, sitting in a comfortable chair in the lobby, he enters his information into the Profile Wizard application. As requested, he fills in extra information about himself such as his hotel room and phone number, and his research interests. Then at the end he chooses to make his profile public for other attendees to view. Having played around enough, Jack folds up his keyboard and puts the CDA in his pocket. Then he strolls around the reception hall, finding old acquaintances and meeting new people.

About half an hour later, Jack’s CDA beeps, and he pulls it out of his pocket. A window has popped up on his screen: “Peter Chiang is trying to reach you. Would you like to chat with him?” Jack sees a button on the side labeled, “View Peter Chiang’s Profile”. He ignores the profile button, and clicks “Yes” to establish an instant messaging session with Peter. He unfolds and snaps on the keyboard, then types:

Jack: hey peter! whats up![4]
Peter: Keeping my head above water here! Glad to see you made it in!
Jack: tried to reach you a moment ago on the system ... said it couldnt find you
Peter: Yeah, that's because I'm not publicly visible. As an organizer I need to lay low electronically sometimes, or else people would be bugging me all the time. But the system told me when you tried to message me, so after I got done taking care of some stuff, I got back with you. Welcome to Seattle!
Jack: thanks! just got in this morning ... havent had a chance to look around the city yet. but dont want to take up too much of your time right now ... maybe we can get together for dinner tonight
Peter: Sure, that'd be great. We could invite Sally Pearce and Sweta Vedamurthy as well. I saw them around earlier.
Jack: yeah lets invite them. so where are you staying
Peter: I'm at the Renaissance Hilton ... you know where that is?
Jack: no not really
Peter: Well, it's right down the street, from the front entrance .... You know what, why don't you just look up my profile, it's all on there. I'll add you to my buddies list so you can look me up even when I switch my profile to private. You could look up the others too, if they've turned on their profiles.
Jack: sure thanks! ill take a look at that. but what if they havent checked in with registration yet
Peter: Oh, the system will tell you. And then you could set up a dinner date on the scheduling application. Just go ahead and add us at whatever time will work for you. When we confirm the meeting, we'll propose a time change if that doesn't work out. Okay?
Jack: sounds good! id better let you get back to work ... ill probably actually see you in person some time before the reception is done :-)
Peter: Yeah, we'll bump into each other somewhere. Again, welcome to Seattle! Talk to you later!

Jack ends the instant messaging session, and uses the system to find his other friends. But although both of their profiles are public, neither of them has their CDAs turned on at that moment. The MCIS automatically converts his message into e-mail so that they can see it when next they check. Then Jack finds the scheduling feature and without much trouble he figures out to how to use it to set up a dinner meeting for 7 pm that night at Peter's hotel, and invites Peter, Sally, and Sweta to join him.

DYNAMIC RESCHEDULING

The next morning, Jack enters the conference hotel at 8:30 am and walks quickly towards his first session. He's running a bit late to his session: "Managing the Information Systems that Information Systems Managers Use." Not his favorite topic, but there's nothing better going on at this time slot. Glancing at the paper program that he printed out yesterday, Jack knows which room he needs to go to. All the same, he pulls out his CDA and turns it on, just to see if he has any messages.

On the "Conference Program" page, there's a message about the controversial session that he wants to attend this afternoon: "E-nough! Good Riddance to E-commerce"[5]. The message tells him that the session was rescheduled to 8:30 a.m.—it is beginning right now! The system explains that the afternoon session was originally scheduled at the same time as the workshop

[4] For realism, the chat session described here retains the spellings (and misspellings) that are often found in real life [Romei, 1997].
[5] These scenarios are purely fictional, and the session titles have no bearing on the authors' personal preferences. In fact, we love e-commerce.

"Marketing Yourself as an IS Researcher", but both sessions turned out to be immensely popular. Yesterday, Jack indicated to the MCIS that he would like to attend both sessions, even though they were both scheduled for 1:30 p.m.

In response to popular demand, "Good Riddance to E-commerce" had been moved to 8:30 a.m. this morning, at a time when the MCIS had determined would provide the least conflicts for all the attendees who had reported their interests on the system. Normally, the conference organizers would never make such a drastic schedule change. If they did, however, they would have announced the change during a plenary session—if they had even been able to accurately predict the popularity of two parallel sessions. But there was no plenary session this morning, so without the notification of the MCIS, either the organizers would have foregone making the change, or they would hand out notification fliers, hoping to at least inform some people of the change in time. So much for the helpfulness of the paper program!

LIVING, INTERACTIVE SESSIONS

Jack enters the presentation room for "Good Riddance to E-commerce". The room is packed, and he looks around for a seat. Fortunately, he finds one in the very front of the room. After a few minutes, the presenter begins.

"I had originally intended," she says, "to direct my discussion by going through the history of the economic impact of technological revolutions, as I did in my paper. But I've been following the pre-presentation discussion groups on the MCIS for this session, to which many of you here contributed. It seems that most of you are more interested in how hypercompetition and globalization impacts e-commerce, so I've decided to switch gears and focus on that perspective instead."

She continues her presentation along that perspective. Jack is very excited about her analysis, though he doesn't quite agree with her on some points. He looks around. He can see a lot of people taking notes, some on paper and others on their CDAs. He can tell that this session will probably be one with a lot of good questions and potential for stimulating discussion. But it's also pretty clear, with the number and enthusiasm of the attendees, that time will run out before many questions and comments can be discussed.

But Jack was playing around some more with the CDA last night, and he goes back to a neat feature he discovered under the "Session Applications" area. The MCIS lets him enter a question or comment he has for the speaker, and see those of other people present. Not only does it show the questions, but the system also lets him vote for any number of questions that he would like to ask. He first looks through the list of questions that people have already posted, and he finds a couple that are similar to questions he wants to ask, so he votes for these. Then he also posts a question that he doesn't see already on the list.

After the presenter is done, the discussant in the front looks at the list of questions on his CDA, and based on the number of votes received, he chooses a few interesting ones to be asked. There isn't time to ask every question, but at least the ones asked and discussed were the ones that the most people were interested in, rather than the questions that happened to be asked first.

When the time for the session is up, Jack gets up and starts heading for the next session. Although the question he asked wasn't chosen, one of the ones he voted for was discussed. Usually, that would be the end of it, but he knows that he can follow up on his questions using the ongoing discussion threads for the session he has just left. Before the end of the day, Jack is pleasantly surprised to receive a message on his CDA from the presenter of the controversial e-commerce session: She has invited him out to dinner so they can discuss his question in person.

VI. CONSTRAINTS TO THE MCIS VISION

In this paper we laid out our vision for the Mobile Conference Information System, and we presented a scenario. Our perspective so far is primarily optimistic, describing what we hope to accomplish. However, we recognize several constraints that will make our goals challenging to achieve, or might delay our implementation. Some of these constraints are technical, restrictions due to the current state of wireless networking and handheld computer technology. Others are behavioral concerns, which put the success of the project at jeopardy because users might not be

willing to adapt to use the technology. Finally, we will lay out organizational constraints that restrict our ability to accomplish the MCIS project successfully.

TECHNICAL CONSTRAINTS

Limited Battery Life

Battery life is always a concern for portable computers [Buyukkokten, 2000, Havinga and Smit, 2000]. Currently, laptops normally run up to four to six hours, and handhelds twelve or more hours, between battery charges. However, the MCIS is based on wireless networking, an extremely power-hungry procedure, especially when transmitting data. With always-on connections, battery life could be cut short to just about one hour with current battery technology.

This constraint could drastically limit the creation of the useful wireless applications that we described in our scenarios. When considering the user behavior challenges, it would probably be too much to ask for users to adapt to using the CDAs *and* expect them to be satisfied with having to recharge their devices every hour.

Our primary idea for addressing this problem—other than delaying the project until battery technology advances sufficiently —is to design our system and applications around the battery-life constraints [Havinga and Smit, 2000]. The key to our work-around is that wireless receiving takes relatively little power, (devices can go a day without recharging), while wireless transmission is power-intensive. We could design the always-on applications to receive data from the MCIS, but to transmit data only when they really need to. This approach is quite similar to the current operation of cell phones, which can roam for up to three days (receiving only), and have about twelve hours of talk time (transmitting). Moreover, we would have to design the MCIS and wireless access points to transmit data to the devices without expecting them to constantly transmit back to signify their presence to the system.

This network optimization problem is challenging, and would best be implemented on the operating system level of the CDA devices. We would probably need to collaborate with the manufacturers of a handheld operating system to have them design their devices to minimize wireless transmission so as to maximize battery life. A drawback of this approach is that it would move us away from our commitment to using standard systems and protocols. Yet, the success of our project might very well depend on such an approach. Moreover, the process of developing battery-sensitive wireless devices would be a valuable contribution to the wireless networking community, beyond its utility to the MCIS Project. It would be a challenging but profitable endeavor for a builder of wirelessly networked mobile computers to assist us in solving this problem.

Other Technical Concerns

Our other major technical concern is that the MCIS be secure enough to permit only authenticated users access the network and the database. Unlike the World Wide Web, for which security was added later as an afterthought, current wireless protocols like 802.11b and Wireless Application Protocol were designed from the ground up with security very much in mind. We will make it a priority to ensure that only authorized users access the system. This policy is vital to insure the privacy of personal information, and the security of payment systems that we might want to establish in future applications. Virus scanning is also important, to guard against the new handheld-computer viruses [Hancock, 2000].

One other noteworthy technical concern is assuring that our wireless access points are optimally located to ensure that they can handle the loads at peak usage times, such as during plenary sessions and during presentations. For such uses, the access points would need to be physically concentrated in the rooms of such high usage, rather than being evenly distributed, as for regular usage in hallways during coffee breaks.

USER BEHAVIOR CONCERNS

In any information systems project, the biggest challenges usually are not technical. Technical problems can usually be overcome as long as there is adequate expertise involved. The people issues are typically the fuzziest and most difficult to overcome. Particularly in the case

of wireless mobile computing, the Boston Consulting Group reported on the seriousness of user adoption concerns [Sirkin and Dean, 2000: 13]:

> Mobile technology, as much as it has improved, does not live up to all the marketers' boasts, leaving many consumers disappointed and frustrated. Some have stopped using m-commerce applications. … The much-vaunted Wireless Application Protocol (WAP), which was supposed to usher in a new wave of attractive applications, has instead proved difficult to use and subject to glitches. … And there are still many technical issues, as well as privacy concerns, to be resolved before services tied to a user's location can come into their own.

In this section, we describe issues that we anticipate would affect users' adoption of a mobile information system, and of the MCIS in particular. The resolutions of these concerns might not be immediately clear at this point, but their identification from the outset will guide the design of the system to ensure a successful implementation, where "success" is defined as user acceptance and adoption [Davis et al., 1989, Marakas et al., 1998].

Responses from Potential MCIS Users

In December 2000, at the International Conference on Information Systems in Brisbane, Australia, we conducted a series of informal interviews to get an idea of how potential users of the Mobile Conference Information System felt about using such a system. Overall, the feedback was positive after describing many of the applications that we detail in this paper[6]. However, users also raised important concerns and considerations about the usefulness of such a system for their conference experience. Understanding such concerns is vital to designing a system that will be valuable to users. In this section, we discuss interviewee's responses to questions about their general impressions, how they expect the MCIS to help them, and the perceived shortcomings of the system. Note that this is not a formal report of the results of the interviews, but a snapshot of user concerns that have bearing on the design and development of the MCIS.

What Are Your General Impressions about the MCIS?

Overall, users sounded rather impressed by the scope of the system and the suite of applications we proposed. Respondents felt that we are moving in the right direction, in terms of taking advantage of applying emerging technology, and for information systems researchers placing themselves in the vanguard:

> It sounds very good. That's the way it's going to be. It will take care of a lot of problems, because PDAs will allow you to locate people. Nokia and Vodafone are working on mobile phones that will allow people to geographically locate people. If you're walking along, past a music shop, and you've indicated you're interested in music, you'll get a message that tells you that there's a discount.
>
> Also, the people-finding tool would be helpful.

Some respondents were concerned, though, that the project should be realistically paced, and avoid being over-ambitious:

> From what I hear [from our description of the system], I think it's definitely the way to go. ICIS should be taking leadership in using the technology to enhance their own activities. It probably should be incremental; it would be disastrous if the system were rejected at first; that would make it harder to accept in future years. Only hand out what you think will work.
>
> More access to information is good, as long as it isn't cumbersome to use and access.

Different interviewees valued different aspects of the system, as expected, and suggested some related features, such as emergency telephone numbers, that would enhance their conference experience.

[6]Some of the MCIS ideas were introduced or modified based on feedback from the interviews.

> The mobile part of it all isn't so high value, except placement—that's very valuable. I don't have trouble scheduling. What is valuable, though, are: Proceedings available beforehand, printing on site, placement services (both sides).
>
> I would like the system to provide information on how to call home through the multiple local long-distance providers. What are the emergency numbers? It would be good to have personal information like that on a PDA. Also functional numbers like convention center contact info.

One rather surprising response from more than one interviewee was the concern that the availability of proceedings would detract from the actual proceedings. But then, this concern is related to the debate as to whether making conference papers available reduces actual conference attendance:

> On one occasion, I read the proceedings, and then I felt no need to go to the sessions. But now, I don't think that was a good idea; it seems counterproductive to have too much information. I think overall, though some features might be counterproductive, it would be beneficial, especially the abstracts and papers being available before the conference.
>
> But why would anyone come if they can see the proceedings? Not such a good idea to make the entire presentations available, just abstracts and a couple pages would be fine.

Overall, the interviewees sounded guardedly optimistic abut the MCIS idea in general. In answering this first question, they readily told us which aspects of the system they liked best, so we asked a further question to elicit more details about the interviewees' specific reservations about the system.

What Important Goals Do You Have for Which the MCIS Probably Would Not Help You Much?

Some of the users were unimpressed with certain specific applications of the MCIS. In some cases, they are satisfied with current systems that are not optimized for access via mobile computers:

> Registration at other systems. Also, the placement services might be redundant.

In other cases, while they appreciated the general value of the applications for attendees, they felt that they just didn't fit their style; that is, they didn't feel it would enhance the way they liked to do things, or that it provided a sufficiently compelling case for them to change their behavior:

> Personally, I prefer to handle coordination of interviewing myself, but it would probably be helpful to most interviewers.

Other users, while they might like the general idea of the MCIS, were unable to articulate their doubts on the real benefits of the system:

> I would like to see this at a conference, but I can't be exactly sure how it will enhance the experience, but I'm sure it will be helpful.
>
> It probably wouldn't help much with the content of presentations. But, then again, it should with all the feedback.

These informal interviews are a good start in addressing user concerns, but we need to conduct further, more formal requirements-gathering exercises to understand better the user issues that will make or break the MCIS. Based on the insights derived from the interviews and from our experience, we describe several other user behavior concerns that we believe are

important considerations in designing and building a valuable system to enhance academic conferences.

Input and Output Constraints

The greatest strength of handheld computers ironically poses a persistent problem: they are so small. The screens are tiny and inconvenient to read [Jones, 1999], and the input options are clumsy (graphical keyboard) and imperfect (handwriting recognition). While fold-up keyboards are available to supplement the built-in input options, they are one more thing to carry, and require a flat surface for comfortable input. As implementation of the MCIS moves forward, we will strive to make input as simple as possible and will optimize information display for smaller display screens.

Privacy

We repeatedly acknowledged privacy as a paramount concern, especially in applications that involve people finding each other. Within all applications, we will allow users to customize precisely how much information they want to be viewed by which particular users. And, of course, we will not make any personally identifiable information available to third parties—including fellow researchers—without a users' explicit permission. In the small world of IS research, where people can often be identified by knowing just the country and research interest, this commitment requires extreme caution on our part to keep personal information private.

SIDEBAR 3

SECURING AIRWAVES

As wireless networking grows rapidly, security is a major concern. Wireless network protocols were not initially designed with security as a top priority, and the low processing power of handheld computers inhibits industrial-strength security algorithms on the client side. In response to the need, IEEE standardized a server-side security protocol for the predominant 802.11b wireless standard, called Wired Equivalent Privacy (WEP). However, before long, WEP was successfully cracked, and hacking algorithms were posted to the Web. Secondary standards were developed and are in design to close the security holes of WEP. IEEE is currently designing WEP2, but at this time, one of the strongest wireless security protocols for 802.11 is the Remote Authentication Dial-In User Service (RADIUS) protocol [Currier, 2001]. Very simply, a RADIUS server works by authorizing each unique wireless network card that can access the server. Every network card manufactured contains a unique ID, and users of a RADIUS-secured network must first register their network cards to access the network. Thus, a snooper with an unregistered card would not be given access to the wireless network. For an MCIS-enabled conference, the registration of the wireless network card would be a special pre-registration step, so that users would be able to use their handhelds to go through the normal conference registration process.

Adaptation to Using Handheld Computers

Although handheld computers promise a lot of convenience to their users, they require people to change many of their current habits [Woodward, 1994]. For example, users will need to get used to the idea of typing their notes instead of writing them down (assuming handwriting recognition technology is not satisfactorily perfected by the time the MCIS would be implemented); of scrolling through pages instead of flipping them; of beaming contact information to associates rather than exchanging business cards. Handheld computers require even such simple behaviors as being extra careful when you realize that you are carrying $500 in a ten-ounce package. While many of our users will already be familiar with these computer-technology behaviors, most will not have made this a normal part of their lives.

Network Effects

Another obstacle is that many of the applications, such as people finding, involve strong network effects: they are useful only if many people use it. If just a few use it, then people would

be discouraged from what they might perceive as wasting their time, thus not achieving the necessary critical mass. This Catch-22 situation requires us to promote the use of the MCIS aggressively, ensuring that enough people start out using it so that it can be truly useful for them. Even if we launched the system with only a subset of all the attendees, we could carefully target closely knit groups within the Information Systems community, such as the doctoral consortium fellows or AIS Executive Committee, who would likely use the system extensively with one another.

Limited Time for Learning

User behavior changes are even more formidable when considering that each conference lasts just three or four days. While people might eventually learn new behaviors when they believe it will help them for the long run, they would probably be more reluctant to change in such a short period of time if they believe that the conference would be their only use of the new technologies. Usually, only the more technologically curious and adventurous would take the time to do so.

Fortunately, our plan of deploying the MCIS within the Information Systems discipline would ease some adoption issues, because the field is populated with technophiles who study the use of technology in organizations. Moreover, the IS researchers who attend often already use handheld computers, or are thinking of doing so. The experience of the MCIS would expand their imaginations about what the technology can do, and encourage those who haven't yet acquired handhelds to do so even after the conference is over. Thus we believe that we can very well overcome these user behavior challenges in our case.

CHALLENGES IN ORGANIZING THE MCIS PROJECT

Implementation

We laid out detailed plans for the applications we want to create for the MCIS, but on all levels the implementation of the project will be very challenging. While some aspects like setting up the wireless backbone are now standard procedures, other pieces like the Web connection and the central database are not so straightforward. Furthermore, while pieces of many of the applications are now commonplace, such as instant messaging, others like dynamic presentation feedback are more innovative and will need to be customized.

Other than the technical implementation, it can be sometimes challenging to persuade the necessary stakeholders to cooperate with our implementation. For instance, the hotels where the conferences will be held will have to be willing to support our infrastructure, and conference program committees must take the risk of setting up new technology. Fortunately, the implementers of the MCIS Project include senior executives of the AIS—including a past president—and people with many years of experience in organizing conferences.

Economics of the MCIS

Wireless and handheld projects are quite expensive to implement. They invariably eventually recoup their costs in the savings from mobility, so the investment is easily justified. One major challenge in funding the MCIS is that conferences that would implement such a system last for just a few days at a time. It will be very difficult to see savings from the MCIS in this short period; so the cost justification is not as obvious. However, once the MCIS is implemented and fine tuned, it can be replicated for several different conferences throughout the year, including those not affiliated with the AIS. It is in this wider application that we hope to justify the time and money spent developing the MCIS.

VII. CONCLUSION

The objective of this paper was to outline a vision for deploying wireless mobile computing technology within the realm of professional conferences by creating the Mobile Conference Information System. With detailed descriptions of applications and hypothetical usage scenarios, we have described how the MCIS can be used to access conference information, to network people with each other, and enhance common conference services. We

also detailed several constraints and limitations to our vision, including some insights obtained from informal user interviews, and suggested how we intend to overcome several of them.

This paper provides a valuable contribution to the literature on wireless computing and group support systems in the following ways:

- It consolidates many current applications of wirelessly networked computing into one comprehensive system;
- it highlights several of the complexities and challenges that apply to any wirelessly mobile information system; and
- it offers a vision for a valuable platform for future research on the use of mobile technologies.

Three key design criteria are necessary to make the MCIS a success.

1. First, the MCIS must be based on open standards, such as a Web-browser-based interface and widely available radio frequency networking, allowing a multiplicity of devices to be used and making the MCIS independent of any proprietary hardware or software.
2. Second, the MCIS must provide useful applications that enhance the experience of users and must be extremely easy to use; if the system does not act to simplify the lives of users, then the system will not be adopted.
3. Third, the MCIS must have strong security features so that users can feel confident that their privacy and information are secure. We will need to continue interacting closely with users as we design the system to ensure that the implemented MCIS will provide value to its users.

We expect that in designing and implementing the MCIS, we will learn many valuable lessons about the use of wireless mobile computing. The development process will provide a valuable platform for research. We can study the requirements analysis process of determining users' needs for a mobile information system, and compare in what significant ways the requirements differ from those of non-mobile systems. We can measure how the interactive applications we described for enhancing conference presentations affect the satisfaction and productivity of the sessions. We can study the situation of technology adoption with systems that users will employ for only short periods, such as in conferences and similar meetings. These are only a few of the possible research topics and learning opportunity that the MCIS provides. From this platform for research, much will be learned about designing infrastructure and applications as well as gaining valuable understanding of how the MCIS concept can be migrated to various other applications.

We believe that there are endless possibilities of how wireless mobile computing can be used to enhance professional meetings. The Mobile Conference Information System will significantly change how conferences are managed and how they enhance the attendee experience.

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ABOUT THE AUTHORS

Blake Ives is Past President and a Fellow of the Association for Information Systems and Director of the University of Houston's Information Systems Research Center. He is a past Editor-in-Chief of the *Management Information Systems Quarterly* and twice served as Conference Chair for the International Conference on Information Systems. Blake is also a founder of ISWorld. A frequent contributor to *CAIS*, Blake also published in *MIS Quarterly, Information Systems Research, Sloan Management Review, Journal of Management Information Systems, Decision Sciences, Management Science, Communications of the ACM, Decision Sciences, IBM Systems Journal*, and variety of other journals. He has been a visiting Fellow at both Oxford and Harvard. He currently holds the Charles T. Bauer Chair of Business Leadership at the C.T. Bauer College of Business at the University of Houston.

Leonard M. Jessup is the Dean of the College of Business and Economics and the Philip L. Kays Distinguished Professor in MIS in the School of Accounting, Information Systems and Business Law at Washington State University. Specializing in Collaboration and Group Support systems, he has authored several books and many scholarly and industry papers.

Chitu Okoli is a doctoral student in information systems and decision sciences at Louisiana State University. Besides researching the use of wirelessly networked mobile computers, his major research interests are applications of the Internet in Sub-Saharan Africa, and using the Internet for competitive advantage. He also does work in information systems usage and satisfaction.

Joseph S. Valacich is the M.E. Smith Presidential Endowed Chair and Hubman Distinguished Professor in MIS at Washington State University. His primary research interests include technology mediated group collaboration, e-business, emerging technologies and their diffusion, and distance education. His work has appeared in *MIS Quarterly, Information Systems Research, Management Science, Academy of Management Journal, Communications of the ACM, Decision Science, Journal of Management Information System*, and numerous other outlets. He previously served on the editorial boards of *MIS Quarterly* (two terms), and is currently serving on the boards at *Information Systems Research* and *Small Group Research*. Professor Valacich has been active in the design of national curriculum standards and is currently on the Board of Directors for the Computing Sciences Accreditation Board (CSAB), representing the Association for Information Systems (AIS). He is the general conference co-chair for the 2003 International Conference on Information Systems in Seattle and was the vice-chair of ICIS 1999 in Charlotte.

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