Mobile Computing:

Real-time support of remote collaboration and integrated knowledge management through intelligent mobile agents.

A Personification White Paper

Introduction

The rapid growth in mobile telephony in recent years provides a strong model for the adoption of similarly untethered mobile computing. The Strategis group recently estimated that there will be around 500 million mobile phone users worldwide in 2001, and 700 million by 2003. Consistent with this projection, Nokia estimated that there will be a billion mobile phone subscribers worldwide by 2005. The rapid transition from fixed to mobile telephony will almost certainly be followed by a similar transition from fixed to mobile computing in the near future. Some of the key factors that are driving the evolution and adoption of mobile computing are:

- Greater reliance on computing and communication technologies.
- societal shifts toward a more mobile workforce
- increasing need for remote communication, computing and collaboration
- Greater geographical mobility among corporate individuals
- Greater need for communication and collaboration at all levels
- Greater criticality of time and effective decision making within narrow windows of opportunities
- increasing availability of wireless connections at affordable rates
- new and important requirements for mobile computing support such as intelligent mobile agents and mobile knowledge networking.

Mobile computing is the fourth wave of an ongoing computing revolution. It follows the earlier mainframe, minicomputer, and microcomputer waves. Much recent effort in mobile computing has been concerned with shrinking the computer desktop down into ever smaller form-factors of portable, laptop, and handheld computers. Comparatively less effort has been put into the critical functionality of mobile information access, which is a unique focus for Personification Inc.

Perhaps not surprisingly, today's overwhelming need for mobile information access was recognized and articulated thirty years ago by Marshal McLuhan:

> "Men are suddenly nomadic gatherers of knowledge, nomadic as never before, informed as never before, free from fragmentary specialisms as never before..." (page 358 in Understanding Media by Marshall McLuhan)

Mobile computing is a natural next step in the evolution of information technology as it adapts more and more to people's needs and capability. Mobile computing includes the following desirable properties:

1. ubiquitous access (anytime, anywhere)

2. ready incorporation into tasks and activities

3. greater transparency (technology doesn't have to be "in your face")

4. greater emphasis on communication and collaboration

New applications are increasingly being enabled by small, light weight, and sometimes inexpensive portable devices. The most successful of these are known as “personal digital assistants,” and have the form factor and functionality of a variety of existing devices, including small notebooks, address books, and day timers. Mobile technology can provide significant competitive advantages to virtual corporations, leading to agile business practices. Exploitation of this opportunity requires investment in mobile computing infrastructures and information architectures. More importantly, however, it requires new methods of organizing and marking up information so that it can be played back in a format that is suitable for mobile playback. Mobile computing is not just about mobile devices and wireless connectivity, it is also about restructuring information and tasks so that mobile information access and collaboration is both natural and productive.

The Problem with Being Tethered

Desktop computing requires people to be tethered. The user sits down at a workstation, connected to the power supply and the network. However, using a laptop with a wireless connection and batteries does not fully alleviate the problem. Users still have to adopt a seated posture and screen out everything around them to work on the computer. As the person works at the computer, the eyes and hands are fully captured.

The problem with being tethered is that tasks can only be carried out at certain times, and in certain places. Whether it be the physical tethering of the desktop computer, or the virtual tethering of the laptop, important and useful tasks cannot be carried out. This lack of mobility in computing is illustrated in the following comparison between how laptops are used and how mobile phones are used.

Location	Laptop	Mobile Phone
Parkbench	Ok but uncomfortable	Easy
Walking	Impractical	Ok
Driving	Impossible	Ok (when used responsibly and hands-free)

True Mobility

In true mobility people do not have the luxury of sitting in one place, nor of watching a single location. For true mobility, one must be able to get up, move around, watch where one is going, while still carrying on the information access task. True mobility means that computing can be carried out any time, and anywhere. This is the wave of the future, as reflected in the following quotation from a U.S. National Research Council report.

> ***"A person's physical location at any time during the day will make less and less difference to his or her ability to carry out most any activity associated with information processing, communication, and electronic transactions." (U.S. National Research Council Report on Every-Citizen Interfaces to the Nation's Information Infrastructure, 1997, p. 35).***

The eyes are overloaded in modern society, but not the ears. People like to hear information, which is why news and talk radio survive in the age of television. True mobility is eyes free, so you can see where you are going. Listening while we move through our environment is natural and enjoyable.

True mobility is enhanced when information is not only available anywhere and anytime, but when it is also personalized so that the acquisition of information is efficient and tailored to the user's needs. With personalization, people can be supplied with exactly the right information that they need, when they need it, while they carry on their regular routines such as commuting, childminding, or taking a stroll. People cannot rollerblade while surfing on a desktop, but they can while using a product like Persona Radio.

Based on extensive research on the topic, Personification has developed the following postulates of true mobility.

1. The overloaded visual channel and the underloaded auditory channel.

People need more and more information that is targeted and personalized. Vision is overloaded with computer screens, televisions, watching the road, reading the newspaper, watching people while we talk to them, monitoring the environment for danger, watching over children, checking out the scenery, watching sports, etc. We have too many things to look at. On the other hand our ears are always open and ready for information while we are awake. Often we switch on the radio so that we will have something to listen to. There are many occasions when we look for opportunities just to listen, whether it be to the radio, at a concert, or a pleasant phone conversation. The ambient noise of traffic and computer fans does not give us the auditory information that we crave and that was readily available to people in earlier times when the art of conversation was more frequently practiced.

2. Transferring information reception to the auditory channel., building a model for eyes-free Web browsing.

Books on tape have been very successful because they transfer the task of acquiring information from the overloaded and overworked visual channel to generally underutilized hearing. Radio thrives in the age of television because radio is built for "eyes-free mobility" and television isn't. Radio is a great way to receive information, but with a limited number of channels it cannot provide targeted and personalized information. The Web on the other hand, has ample scope for personalization. The problem is that at present we are tied to the desktop in an eyes-captured mode in order to browse the Web. The Web while benefiting people in many ways, has forced them back to stasis and yet more visually mediated information reception, and away from mobility. We need to adapt the Web to the requirements of true mobility.

3. Auditory eyes free processing is the key to mobility

True (or self-guided) mobility requires visual attention to the environment. This is different from mediated mobility, where one is sitting down in a vehicle (e.g., a train or plane) that is being driven or piloted by someone else.

4. Aside from communication, email and news are the killer apps.

This should be no surprise. For most people, communication is the number one function that they perform, right after digestion and sleeping. The first killer app for mobility (the mobile phone) has already hit. Email and news are the next killer apps, but for many tasks they should work in an eyes free fashion, else there is no true mobility with them. Note that we are not saying that all email and news

should be handled in a true mobility, eyes free fashion. There are certainly occasions when email etc. on PDAs will be useful. However, there is also a potentially large set of applications and a lucrative market segment where true mobility is needed. This will be supplemented by other segments that also need information in the form of speech, including the functionally illiterate and the visually disabled.

5. The Walkman is a better model for mobility than is the PDA or HPC.

If your mobile device needs a bigger screen you are not designing for true mobility. You don't want a pen either. Just one or two buttons that can be located by touch. A small screen might be useful for some situations, but you shouldn't need to consult the screen in order to operate the device.

User-Centred Design

Consumers are already becoming used to mobile phones, digital pets, and electronic organizers (e.g., the PalmPilot), with sales of each of these products in the millions. Consumers are also very used to getting information via radio, and in using radio in mobile settings (in handheld and "Walkman" form factors).

Translating the goal, tasks, and informational needs of the user into the design of the mobile system can help determine the level of mobility required. Must the device be used while walking, or while driving a car? Does the user require hands-free or eyes-free use? These issues must be examined and considered during design for specific applications. The following table provides some guidelines for user-centered design of mobile computing.

Category	Design Guidelines
Designing for the User	***1. Understand the goals and intentions of the user:*** Design to help users attain their goals. ***2. Understand the information needs and tasks of the user:*** This is universally important for any design work, for any domain. Ensure that any solution helps meet the needs of the user. Support their strategies and tasks. ***3. Focus on the user)*** User-centred design guidelines should be followed to help ensure any design is usable and useful. Guidelines such as: Early Focus on Users, User Testing, Iterative Design, and Integrated Design.
Mobility	***4. The system must support to appropriate level of mobility*** Is the user in a car, on foot, on horseback, on a bicycle? Does the user require eyes-free or hands-free computing? The level of mobility required will dictate the type of input-

	output methods required. ***5. The system must provide a constant channel of communication*** Information (e.g., email) must be available at anytime and from anywhere.
Improving access to Information	***6. Provide users with access to required information anytime, anywhere.*** Users should have access to up-to-date environmental and situational information that is relevant to them.

Case Studies

Globalization of businesses is creating enormous mobility among workers and a consequent need for mobile information access and communication. The resulting requirements for mobility are affecting every aspect of information technology: people, systems, applications and data.

The various architectures for mobile computing solutions range from occasional remote connectivity to continuous remote monitoring, and from small scale to large scale applications. Mobile computing encompasses both simple data transfers over a network and intelligent decision support while on the move. More complex applications include mobile, real-time collaboration support, integrated knowledge management through intelligent mobile agents and real-time data tracking from distributed database systems. Two examples of mobile computing applications are described briefly below.

Miah and Bashir (1997) described a client server mobile computing architecture in a scenario based on a hospital ward. Each doctor was equipped with a PDA and each ward or a group of wards was equipped with a server providing patient records. As a doctor visited a patient in a ward, the patient's record was accessed from the server onto the PDA. The doctor then updated the record and sent the update back to the server.

Kristoffersen and Ljungberg (1998) described MobiCom, a research project aimed at realizing information technology support for dispersed groups of networking, mobile knowledge workers. MobiCom focussed on two issues in dispersed computing: work coordination and collective sharing of experiences. The MobiCom project was based on studies of work and information technology use in a pharmaceutical research company.

Wireless systems coupled with handheld devices such as PDAs improve communications between organizations and their employees in the field. On-board computing systems have improved the safety and management of fleets of road transport vehicles by providing effective communications between mobile units and control centres, and by combining GPS systems with the mobile units (Sterzbach and Halang, 1996). These and other mobile computing solutions improve efficiency, communication, and information access.

The Personification Approach

Getting information from the Web is like drinking from a fire hydrant. Personification is developing new families of information products that:

• channel information for specific tasks and groups, and that provide convenient access in a wide variety of locations, from office to beach and golf course.

• use both sight and sound to maximize productivity, turning downtime into productive time, mobility into an information access opportunity.

• are information-rich, cost-effective, and bandwidth-friendly.

Persona Radio is the Web surfing version of the Walkman. Information on the Web is converted into a set of channels that can be played back on an MP3 player or other device equipped with wireless headphones, providing the ultimate in convenience and portability. Channels (e.g., weather, sports, news, etc.) are selected with button presses. Unlike radio though, the Web channels can be personalized based on the user's interest profile. This convenient mobile surfing device can be used for general information and entertainment, or for business applications such as sales force automation, training, and briefing on strategic information in general. Advertising can also be embedded within channels, just as in conventional radio.

How it works

A user profile is used to query Web content and construct a set of Web pages on the server side for the various channels for the designated user. The Persona radio content can then be downloaded to the handheld device for later use or else accessed remotely through a wireless connection. During playback, the auditory interface allows users to skim the story, back up over interesting material, and select segments of stories to email to themselves or to other people. The general architecture of mobile information access using the client server model is shown in the following figure.

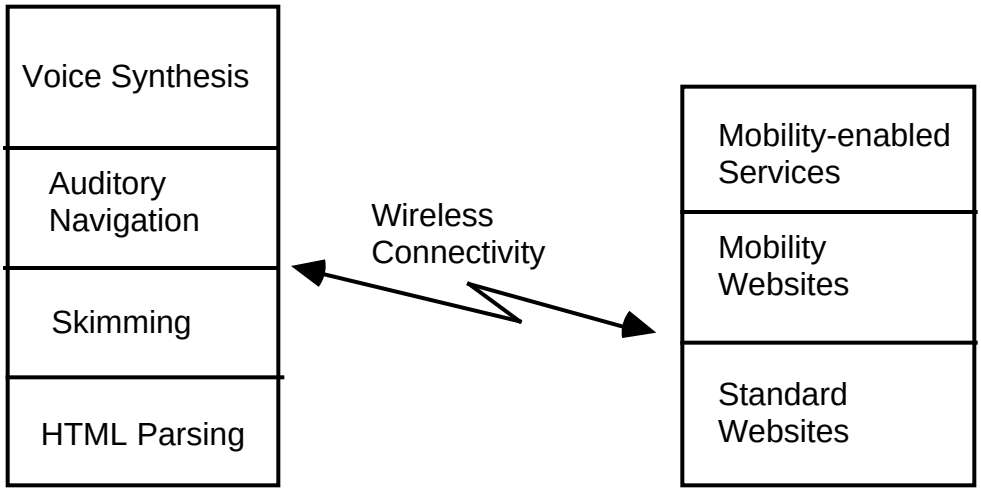

Figure 1. Client (left side of figure) Server (right side) mobile information access.

On the client side, the layers will include basic operations for parsing the text from a Website. This text will then be available for skimming or for more sophisticated auditory navigation. Some commands will operate on the text already stored in the client, while other commands will launch requests to remote Websites, just as conventional browsers do.

On the server side, three main tiers of services are available. At the lowest level, all standard sites can be browsed. This type of general browsing is already done by Web on Call and by auditory Web browsers for the visually disabled. At the next level some sites will be specifically designed as mobility or eyes-free Websites. They may include special embedded tags and index terms to facilitate auditory navigation. The most mobility aware sites will provide specialized services for mobility applications using the product. These may include specialized email, conferencing, banking, etc. services.

Conclusions

Guiding principles for Personification products for mobile computing include:

- Packaging of information into targeted information channels for specific groups or individuals
- Use of voice input and voice prompts where appropriate and feasible to allow "eyes-free" navigation
- Integration and synchronization of mobile and desktop applications
- Design of information access interfaces and information presentations that minimize mental workload and maximize productivity.

Enthusiastic users of eyes free computing will include the visually impaired, people who listen to news radio, specialized applications in a wide variety of areas (e.g., mobile eyes free email access, sports on demand, the gossip channel, sales force automation, education and training, etc.). Tasks that they will perform will include remote collaboration, integrated knowledge management through intelligent mobile agents and real-time tracking of people, data and systems.

Personification information access and knowledge management solutions are based on targeted channels that can be delivered both to desktops and to handheld devices. Information organization and markup are used to enhance true mobility within a client-server model of mobile computing. Handheld devices

equipped with Personification software allow anytime anywhere targeted information access, e.g., when driving to work, sitting in trains and planes, or working out. This truly mobile information access will allow people to be more productive in those situations where the body is busy but the mind is free.

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