ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 8, August 2013

Challenges of Mobile Computing: An Overview

Rahul B. Mannade[1], Amol B. Bhande[2]

System Analyst, Govt. College of Engineering, Chandrapur, India [1]

Assistant Manager, Network Operations, Vodafone India Ltd., Pune, India [2]

Abstract: Mobile computing is a new computing paradigm in which mobile devices are used to access information from anywhere, at any time. Wireless network greatly enhances the utility of a portable computing device. The field of mobile computing is merger of the portable computing device and wireless communication with the aim of providing seamless computing environment for mobile users. Mobility implies that network needs to cope with moving users. Wireless communication faces more obstacles than wired communication due to environmental interferences. As a result wireless communication is characterized by lower bandwidth, higher error rates and more frequent disconnections. Mobility can also cause wireless connectivity to be lost or degraded. Unlike typical wired network, number of mobile users varies dynamically and large convention and public events may overload the network capacity. Mobile devices are characterized by smaller size, light in weight and low power. Hence while designing wireless networks as well as mobile application softwares all these issues should taken in consideration.

Keywords: Mobility, Bandwidth, Portability, Address Migration, Access Point, Wireless Communication, Disconnections.

I. Introduction

Mobile Computing constitutes a new paradigm of computing which is expected to revolutionize the way computers are used. The combination of wireless communication infrastructure and portable computing devices has laid the foundation for a new computing, which allows users access information and collaborate with others while on the move [1]. Such mobility can take the form of users moving between fixed terminals anywhere in the world or users taking mobile devices with them wherever they move. In both cases, the user should have a consistent working environment with access to their usual files, email, and so on. Mobility should therefore support the seamless movement of people, data, and/or applications between different locations. Wireless mobile networks are generally characterized by several constraints such as storage space, bandwidth, battery power, rapid fluctuations in availability of these resources; it makes difficult for system software to guaranteed quality-of-service. Also mobile users are always tend to move anywhere at any time, users may be disconnected from the network often and even user may switch off their mobiles intentionally to save battery power; thus disconnection management is critical issue in designing mobile networks.

In general, a mobile-computing network consists of multiple mobile agents that require access to (i) information generated at multiple geographically dispersed sites and (ii) computing engines to execute their decisions. It may include one or more stationary agents that perform information acquisition and propagation to the mobile agents. While a static interconnection network may link the stationary agents, a dynamic interconnection network will connect the mobile agents to the stationary nodes. The mobile nodes may connect to specific nodes asynchronously, i.e., at irregular intervals of time, to acquire information, and following completion they will disconnect. The mobile and stationary agents are located at geographically dispersed sites. While both stationary and mobile nodes may have computing and communication needs, the relative weights and frequency are problem-specific.

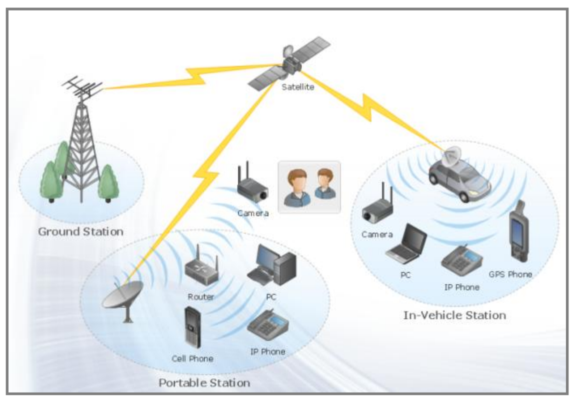

Fig. 1: Typical Mobile Computing Environment

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 8, August 2013

Several articles which have identified the fundamental challenges in mobile computing. Mobile systems are (i) resource poor (ii) less secure (iii) have poor connectivity to the wired infrastructure and (iv) have less energy since they are powered by battery. In order to deal with these characteristics the mobile systems should employ dynamic adaptation schemes. One of the implications is that the solutions developed for mobile systems should be interoperable since as mobile clients move one domain to another they should be able to operate in the new domain. The mission of mobile computing is to allow users to access any information using any device over any network at anytime. However, wireless networks and mobile devices are introducing new requirements to software engineers due to their limited resources. A new architecture design model for software development for mobile devices needs to be adopted. The new model has to address the mobile computing constraints to success in supporting mobile information access. In addition, the system must be designed to accommodate evolutionary growth. That is, the system must continue to function and deliver relatively undiminished performance as the cumulative number of stationary and mobile entities increases with time.

II. CONSTRAINTS OF MBILIE COMPUTING

Mobile computing is characterized by following four major constraints:

Mobile Device Constraints

As mobile devices are small in size, they have limited resources such as processor speed, storage space, display size and screen resolution. Due to this, mobile application designers have a great challenge on how to meet these constraints while satisfying fast user interactive mobile computing environment.[2] Power limitations of mobile devices are also to be addressed in terms of what an application should do when it recognizes a very limited power to use.

Network Constraints

Wireless networks are less reliable as compared to wired networks. Wireless networks will continue to have limited bandwidth, high latency and frequent disconnection due to power limitations, available spectrum and mobility. The most critical aspect of these is the bandwidth. As bandwidth increases, power consumption also increases which shorten the battery life of mobile devices. Hence, energy restrictions of mobile devices will limit the effectiveness of data throughput to and from the device even if wireless networks connections deliver stable high bandwidth. Therefore, data access technique must be designed for users to overcome these limitations of bandwidth, latency, disconnected operation and still satisfy user's expectations [3].

Mobility Constraints

- Mobile elements are resource-poor relative to static elements.

For a given cost and level of technology, considerations of weight, power, size and ergonomics will exact a penalty in computational resources such as processor speed, memory size, and disk capacity. While mobile elements will improve in absolute ability, they will always be resource poor relative to static elements.

- Mobility is inherently hazardous.

Mobile devices can be easily stolen by thieves. In addition to security concerns, portable computers are more vulnerable to loss or damage.

- Mobile connectivity is highly variable in performance and reliability.

Some buildings may offer reliable, high-bandwidth wireless connectivity while others may only offer low-bandwidth connectivity. Outdoors, a mobile client may have t o rely on a low-bandwidth wireless network with gaps in coverage.

- Mobile elements rely on finite energy source.

While battery technology will undoubtedly improve over time, the need to be sensitive to power consumption will not diminish. Concern for power consumption must span many levels of hardware and software to be fully effective.[4]

Product	RAM	MHz	CPU	Batteries		Weight (lbs.)	Display	
				(No. Hrs.)	(Type)		(pixels)	(Sq. in.)
Amstrad Pen Pad PDA600	128 kb	28	Z-80	40	3 AA's	0.9	240x320	10.4
Apple Newton Message pad	640 kb	20	ARM*	50	4 AAA's	0.9	240x336	11.2
Apple Newton Message pad 110	1 mb	20	ARM*	50	4 AA's	1.25	240x320	11.8
Casio Z-7000 PDA	1 mb	7.4	8086	100	3 AA's	1.0	320x256	12.4
Sharp Expert Pad	640 kb	20	ARM*	20	4 AAA's	0.9	240x336	11.2
Tandy Z-550 Zoomer PDA	1 mb	8	8086	100	3 AA's		320x256	12.4
AT&T Eo-440 Personal Communicator	4-12 mb	20	Hobbit	1-6	NiCad	2.2	640x480	25.7
Portable PC	4-16 mb	33-66	486	1-6	NiCad	5-10	640x480 to 1024x768 (color)	40

*Advanced ROSC Processor

Table 1: Comparison of Mobile & Static Devices[6]

III. CHALLENGES OF MOBILE COMPUTING

Challenges in mobile computing can be categorized into three major areas as: *communication*, *mobility*, and *portability*. Of course, special-purpose systems may avoid some design pressures by doing without certain desirable properties. For instance, portability would be less of a

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 8, August 2013

concern for mobile computers installed in the dashboards of cars than with hand-held mobile computers. However, we concentrate on the goal of large-scale, hand-held mobile computing as a way to reveal a wide assortment of issues.

1. Wireless Communication

Generally wireless computers have fewer resources relative to stationary (wired) computers, this is because wireless computers are required to be smaller, lighter and consume less power than stationary computers. Wireless communication is more difficult to implement than wired communication because of the interaction of the surrounding environment with the message signal. Problems caused by the environment include blocked signal paths, echoes and noise. Hence wireless connections are more error prone, have much lower bandwidths, and have frequent spurious disconnections when compared to wired connections.[5] These factors can increase communication latencies due to error control checks, retransmissions, time-out delays and brief disconnections.

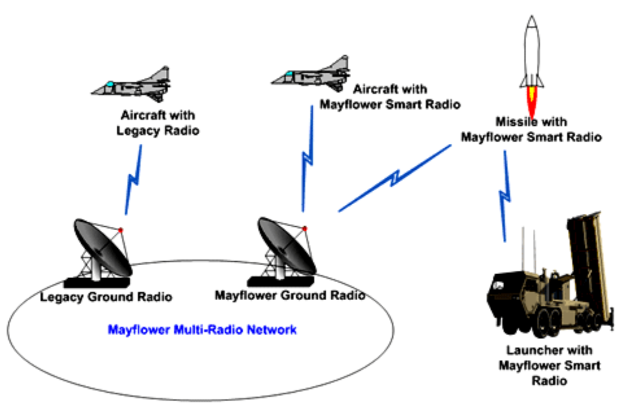

Fig. 2: Wireless Communication [11]

1.1 Disconnections:

Since wireless communication is so susceptible to disconnection, it is of great concern when designing successful mobile computers. Resources can be allocated to handle disconnections more elegantly, or to try and prevent those disconnections from happening. In environments with frequent disconnections it is better for the mobile computer to act as a stand-alone unit rather than a mobile terminal (i.e. splitting the application and the user interface across the network). For wide-area networks, round-trip RPC delays will tend to be expensive in terms of wasted processor clock cycles, hence round-trip latencies and brief disconnections can be made less expensive by operating asynchronously. The advantages of using synchronous systems include a substantially simpler design, implementation and debugging. Whereas the asynchronous model will yield considerably higher performance because the receiver does not block waiting for the requested data. Caching techniques could be used to enhance the performance of weakly-connected and disconnected operation, but preserving cache coherence under weak connectivity can be expensive. The Coda file system solves this problem by maintaining cache coherence at multiple levels of granularity and by the use of callbacks. In the Coda solution, fast cache validation is performed by comparing version stamps maintained by the clients and servers, then preserving the validity through callbacks. This approach provides a trade-off between precision of invalidation for speed of validation.

1.2 Low Bandwidth and Bandwidth Variability

Wireless networks deliver lower bandwidth than wired networks, hence mobile computing designs need to be very concerned about bandwidth consumption. The deliverable bandwidth per user depends on the number of users sharing a cell. The network's capacity can be measured by its bandwidth per cubic meter. This value can be improved in two ways:

- Maintain multiple cells at different frequencies. This technique, although more flexible, is limited by the range of frequencies of the electromagnetic spectrum available for public consumption.
- Limiting transmission ranges so that more cells can fit in a given area. This preferred approach is simpler, reduces power requirements, and may decrease corruption of the signal. It is also known that transceivers covering less area can achieve higher bandwidths.

Besides these, techniques such as compression, logging (making large requests out of several short ones), perfecting (guessing which files will be needed soon), and write-back caching can help cope with low bandwidth. System performance can be further enhanced by scheduling communications intelligently.

Mobile computing designs must cope with much greater variations in network bandwidth than traditional designs. A good design would be able to adapt to the currently available resources, providing the user with a variable level of quality. As a mobile element leaves the range of one network transceiver it switches to another, and there may also be places where they can access multiple transceivers on different frequencies. Concurrent use of a wired network and a wireless network maybe possible too. There may be a need to change access protocols, for example when switching from cellular coverage to satellite coverage.

1.3 Security Risk

Precisely because connection to a wireless link is so easy, the security of wireless communication can be compromised much more easily than that of wired communication, especially if transmission extends over a large area. This increases pressure on mobile computing software designers to include security measures. Security is further complicated if users are allowed to cross security domains. For example, a hospital may allow patients with mobile computers to use nearby printers but prohibit access to distant printers and resources designated for hospital personnel only [6]. Secure communication over insecure channels is accomplished by encryption, which can be done in software. Security depends on a secret encryption key known only to the authorized parties. Managing these keys securely is difficult, but it can be automated by software.

2. Mobility

The ability to change location while connected to the network increases the volatility of some information. Certain data considered static for stationary computing becomes dynamic for mobile computing. For example, a stationary computer can be configured statically to prefer the nearest server, but a mobile computer needs a mechanism for determining which server to use. As volatility increases, cost-benefit trade-off points shift, calling for appropriate modifications in the design. Mobility introduces several problems: A mobile computer's network address changes dynamically, its current location affects configuration parameters as well as answers to user queries, and the communication path grows as it wanders away from a nearby server.

2.1 Address Migration

As people move, their mobile computers will use different network access points, or "addresses." Today's networking is not designated for dynamically changing addresses. Active network connections usually cannot be moved to a new address. Once an address for a host name is known to a system, it is typically cached with a long expiration time and with no way to invalidate out-of-date entries. In the Internet Protocol, for example, a host IP name is inextricably bound with its network address; moving to a new location means acquiring a new IP name. Human intervention is commonly required to coordinate the use of address. To communicate with a mobile computer, messages must be sent to its most recent address. As mobile computers change location, they will use different network access points, or 'addresses'. To communicate with a mobile computer, its latest address must be known. Several techniques may be used to determine the current network address of a mobile unit. [7].

- *Selective Broadcast:* If a mobile computer is known to be in a set of cells, then a message could be 'broadcasted' to these known cells asking the required mobile unit to reply with its current network address.
- *Central Services:* A logically centralized database contains the current addresses of all mobile units. Whenever a mobile computer changes its address, it sends a message to update the database.
- *Home Bases:* This is essentially the limiting case of distributing a central service, i.e. only a single server knows the current location of a mobile computer.
- *Forwarding Pointers:* This method places a copy of the new address at the old location. Each message is forwarded along the chain of pointers leading to the mobile computer. This requires an active entity at the old address to receive and forward messages.

2.2 Location – dependent Information

Because traditional computers do not move, information that depends on location such as local name server, available printers, and the time zone, is typically configured statically. One challenge for mobile computing is to factor out this information intelligently and provide mechanisms for obtaining configuration data appropriate to each location. Additionally, a mobile computer carried with a user is likely to be used in a wide variety of administrative domains. Dealing with the multitude of conventions that current computing systems rely on is another challenge to building mobile systems.

1) Privacy: Answering dynamic location queries requires knowing the location of another mobile user. In some cases this may be sensitive information, more so if given at a fine resolution. Even where it is not particularly sensitive, such information should be protected against misuse. Privacy can be ensured by denying users the ability to know another's location. The challenge for mobile computing is to allow more flexible access to this information without violating privacy [8].

3. Portability

Conventional desktop computers are not meant to be carried, so designers take liberal approach to space, power, cabling

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 8, August 2013

and heat dissipation. In contrast, designers of hand-held mobile computers should strive for the properties of a wrist watch: small, light, durable, operational under wide environmental conditions and requiring minimal power usage for long battery life. Some design pressures caused by the portability constraints are as follows:

3.1 Low Power

Batteries are the heart of any mobile device. Batteries are the largest single source of weight in a portable computer. While reducing battery weight is important, too small a battery can undermine the value of portability by causing users to recharge frequently, carry spare batteries, or use their mobile computers less. Minimizing power consumption can improve portability by reducing battery and lengthening the life of a charge. Power consumption of dynamic components is proportional to CV^2F, where C is the capacitance of the circuit, V is the voltage swing and F is the clock frequency. This function suggests that power can be saved by i) Reducing the capacitance by greater extent of VLSI design, ii) Reducing the voltage at the time of chip design and iii) Reducing the clock frequency so that trading the computational speed for power saving.

Power can be conserved not only by the design but also by efficient operation. Power management software can power down individual components when they are idle, for example, spinning down the internal disk or turning off screen lighting. Recently, Li et al. determined that for today's notebook computing it is worthwhile to spin down the internal disk drive after it has been idle for just a few seconds.[9]

Applications can conserve power by reducing their appetite for computation, communication, and memory, and by performing their periodic operations infrequently to amortize the start-up overhead.

3.1 Risks to Data

Making computers portable increases the risk of physical damage, unauthorized access, loss and theft. Breaches of privacy or total loss of data become more likely. These risks can be reduced by minimizing the essential data kept on board. Obviously, a mobile device that serves only as a portable terminal is less prone to data loss than a stand-lone computer. To help prevent unauthorized disclosure of information, data stored on disks and removable memory cards can be encrypted. For this to be effective, users must not leave authenticated sessions (logins) unattended. Keeping a copy that does not reside on the portable unit can safeguard against data loss. However, users often neglect to make backup copies and even when they do; data modified between backups is not protected. With the addition of wireless networks to portable computers, new or modified data can be copied immediately to secure, remote media.

3.2 Small User Interface

For smaller and more portable devices current windowing techniques are inadequate. It is impractical to have several windows open at the same time on a small screen even at high resolutions. Due to a shortage of surface area of portable computers, it may be feasible to trade buttons for some other form of input. The forms that may be feasible are hand writing, voice and gesture recognition. Most PDAs implement hand writing recognition, and are typically 96-98% accurate when trained. Common pointing devices such as a pen or a mouse are used with mobile computers because of their ease of use while mobile, their versatility and their ability to substitute the keyboard.

3.3 Small Storage Capacity

Storage space on a portable computer is limited by physical size and power requirements. Traditionally, disks provide large amounts of nonvolatile storage. In a mobile computers computer, however, disk drives are a liability. They consume more power than memory chips, except when off line, and they may not really be nonvolatile when subject to the indelicate treatment a portable device receives. Hence, none of the PDA products have disk drives.

Storage constraints can be solved using compression of files automatically, accessing remote storage over the network.

A novel approach to reducing the size of program code is to interpret script languages instead of executing compiled object codes, which are typically many times larger than the source code.

IV. CONCLUSION

Mobile computing is a new paradigm of computing which is excepted to revolutionize the way computers are used. Mobile computing enables access to digital resources at any time, from any location. From a narrow viewpoint, mobile computing represents a convenient addition to wire-based local area distributed systems. Taken more broadly, mobile computing represents the elimination of time-and-place restrictions imposed by desktop computers and wired networks. Wireless communication brings challenging new problems. Mobility makes information dynamic. Portability

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 2, Issue 8, August 2013

entails limited resources available on board to handle the variable mobile computing environment. The challenge for mobile computer designers is to incorporate wireless communication, mobility, and portability to adapt the system designs that have worked well for traditional computing.

REFERENCES

[1] Abhishek Kumar Gupta,"Challenges in Mobile Computing", Proceedings of 2nd National Conference on Challenges & opportunities in Information echnology (COIT-2008) RIMT-IET, Mandi Gobindgarh. March 29, 2008
[2] Jo Stichbury "Symbian OS Explained", John Wely & Sons Ltd.
[3] J. R. Lorch and A. J. Smith. "Software strategies for portable computer nergy management", IEEE Personnel Communication, 5(3): 60-73, June 1998.
[4] M. Satyanarayanan, "Fundamentals Challenges in Mobile Computing", in ACM Principles of Distributed Computing, 1996.
[5] Pradip Loganathan "The Challenges and Requirements of Mobile Computing".
[6] George H. Forman and John Zahorjan "The Challenges of Mobile Computing", Raster Imaging & Digital Typography RIDT'94.
[7] Jun Wei, et al., " Challenges of Communication in Mobile Computing", IEEE Computer, 1999.
[8] G.P. Picco, "Lime: Linda Meets Mobility", ICSE98 International Workshop on Computing and Communication in the Presence of Mobility, April 25, 1998".
[9] D. Duchamp, S. K. Feiner, and G. Q. Maguire Jr. ,"Software Technology for Wireless Mobile Computing", IEEE Network Magazine, Vol. 5, No. 6, Nov. 1991, pp. 12-18
[10] http://www.conceptdraw.com/samples/network-diagram-wireless-network.
[11] http://www.mayflowercom.com/images/wireless_com1.gif

BIOGRAPHY

Rahul B. Mannade received the Bachelor of Engineering degree in Information Technology from the Dr. Babasaheb Ambedkar University, Aurangabad (Maharashtra) and pursuing M.Tech. (CSE). Currently he is with Government of Maharashtra (GCOE, Chandrapur), as System Analyst. His research interests include Wireless Networks, Mobile Computing and Web Mining. He is a member of the CSI, ISTE, IAENG, CSTA and ACM.

Amol B. Bhande received the Bachelor of Engineering degree in Electronics & Telecommunication Engg. Dr. Babasaheb Ambedkar University, Aurangabad (Maharashtra) and pursuing M.B.A. in Operations. Currently he is with Vodafone India Ltd., as Assistant Manager, Network Operations. His research interests include Micro-Communication, Network Synchronization and Telecom OSS. He is a member of the IAENG.