A Case Study on System Issues and Impact of Mobility in Wireless Mobile Computing

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Abstract- **In Mobile computing there are many Issues and impact that we identify and investigate their technical significance in this research paper. In new research, problems include management of location dependent data, information services to mobile users, frequent disconnections, wireless data broadcasting, and energy efficient data access. The rapidly expanding technology of cellular communications, wireless LAN, and satellite services will make it possible for mobile users to access information anywhere and at anytime. In the near future, millions of users will be carrying a portable computer, often called a personal digital assistant or a personal communicator. These devices will be diskless; store data in clouds. These devices will be powerful laptop computers with large memories and powerful processors. Regardless of size, all mobile computers will be equipped with a wireless.**

Index Terms- **Cellular communication, location depandent data, information services, wireless LAN, satellite service, portable computer**

I. INTRODUCTION

What is really different about mobile computing? The computers are smaller and bits travel by wireless rather than Ethernet. How can this possibly make any difference? Isn't a mobile system merely a special case of a distributed system? Are there any new and deep issues to be investigated, or is mobile computing just the latest fad?

Solutions to communication and synchronization problems in distributed systems have so far been designed
for networks comprising solely of static hosts. In systems with static hosts, connectivity of the underlying
network does not change in the absence of link and/or host failures. On the other hand, mobile hosts are capable of moving between different locations (''roaming'') while maintaining their connection to the network, e.g. via a cellular connection or a wireless LAN. Mobile computers[1] such as laptops and palmtops, frequently operate in a disconnected or ''doze'' mode. Mobility of hosts introduces a new set of issues that were not present in distributed

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systems with static hosts. Firstly, to deliver a message to a mobile host, it is necessary that the destination host be first located within the network. Second as hosts move, the physical connectivity of the network changes. Hence, any logical structure, which many distributed algorithms exploit, cannot be statically mapped to a set of physical connections within the network. Third, mobile hosts have severe resource constraints in terms of limited battery life and often operate in a ''doze mode'' or entirely disconnect from the network. Lastly, communication between a mobile host and the rest of the network occurs via a wireless medium. Such a medium physically supports broadcast communication within a specified region (''cell''). These aspects are characteristic of mobile computing and need to be considered in the design of distributed algorithms. Prior work in related areas include file systems for mobile users [11, 16], data management issues [7, 5, 6, 8, and 2] and network-layer routing protocols and addressing schemes.

Constraints of Mobility

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.

A Wall Street stockbroker is more likely to be mugged on the streets of Manhattan and have his laptop stolen than to have his workstation in a locked office be physically subverted. 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 to rely on a low-bandwidth wireless network with gaps in coverage.

Mobile elements rely on a 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.

II. DEFINING MOBILITY

There is ample evidence of the significant interest in mobility and the issues related to 'being mobile'. The explosive growth in mobile devices, the emergence and convergence of information and communication technologies (ICTs), and substantial investments in wireless infrastructures are some of the many indicators of a society becoming increasingly mobile. A rising interest in the issues surrounding mobility can also be found in the academic community, where the design of mobile information systems, value of mobile applications, use of mobile geographical positioning systems, and the impact of mobile communications are some of the research domains examined (Varshney, 2003). While the importance of mobility and potential value of 'being mobile' are understood, issues surrounding mobility are still explored without a clear understanding of mobility itself. In many cases, the term "mobile" is used in place of "wireless" and "portable" such as mobile devices and mobile applications; other frequent uses of the term include "remote" such as mobile office or "flexible" such as mobile lifestyles (Kakihara & Sorensen, 2001). These

Examples illustrate the diverse ways that the terms are being used today. An understanding of what mobility means, how it has been used, and its underlying dimensions (see Figure 1) are, therefore, critical pre-cursors to determining its enterprise value.

Mobile
1. Capable of movement; movable; not fixed or stationary.
2. Characterized by facility of movement.

Mobility
1. Ability to be moved or to be moved; capacity of change of place.
2. Ability to change quickly or easily; instability, fickleness.

III. ISSUES IN MOBILE COMPUTING

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

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B. Mobility is inherently hazardous.

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C. Mobile connectivity is highly variable in performance and reliability.

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D. Mobile elements rely on a 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. These constraints are not artifacts of current technology, but are intrinsic to mobility. Together, they complicate the design of mobile information systems and require us to rethink traditional approaches to information access.

IV. THE NEED FOR ADAPTATION

Mobility exacerbates the tension between autonomy and interdependence that is characteristic of all distributed systems. The relative resource poverty of mobile elements as well as their lower trust and robustness argues for reliance on static servers. But the need to cope with unreliable and low-performance networks, as well as the need to be sensitive to power consumption argues for self reliance.

Any viable approach to mobile computing must strike a balance between these competing concerns. This balance cannot be a static one; as the circumstances of a mobile client change, it must react and dynamically reassign the responsibilities of client and server. In other words, mobile clients must be adaptive.

A. Global Estimation from Local Observations

Adaptation requires a mobile client to sense changes in its environment, make inferences about the cause of these changes, and then react appropriately. These imply the ability to make global estimates based on local observations. To detect changes, the client must rely on local observations. For example, it can measure quantities such as local signal strength, packet rate, average round-trip times, and dispersion in round-trip times. But interpreting evolution of biological species, and its influence on the capabilities of computing systems[4]. Although Hans comments are directed at robotic systems, I believe that his observation applies equally well to a much broader class of distributed computing systems involving mobile elements. Mobility will influence the evolution of distributed systems in ways that we can only dimly perceive at the present time. In this sense, mobile computing is truly a seminal influence on the design of distributed systems.

V. THE EXTENDED CLIENT-SERVER MODEL

Another way to characterize the impact of mobile computing constraints is to examine their effect on the classic client-server model. In this model, a small number of trusted server sites constitute the true home of data. Efficient and safe access to this data is possible from a

much larger number of untrusted client sites. Techniques such as caching and read-ahead can be used to provide good performance, while end-to-end authentication and encrypted transmission can be used to preserve security. This model has proved to be especially valuable for scalability [2]. In effect, the client-server model decomposes a large distributed system into a small nucleus that changes relatively slowly, and a much larger and less static periphery of clients. From the perspectives of security and system administration, the scale of the system appears to be that of the nucleus. But from the perspectives of performance and availability, a user at the periphery receives almost standalone service.

Coping with the constraints of mobility requires us to rethink this model. The distinction between clients and servers may have to be temporarily blurred, resulting in the extended client-server model. The resource limitations of clients may require certain operations normally performed on clients to sometimes be performed on resource-rich servers. Conversely, the need to cope with uncertain connectivity requires clients to sometimes emulate the functions of a server. These are, of course, short-term deviations from the classic client-server model for purposes of performance and availability. From the longer-term perspective of system administration and security, the roles of servers and clients remain unchanged.

A. Caching Metrics

Caching plays a key role in mobile computing because of its ability to alleviate the performance and availability limitations of weakly-connected and disconnected operation. But evaluating alternative caching strategies for mobile computing is problematic. Today, the only metric of cache quality is the miss ratio. The underlying assumption of this metric is that all cache misses are equivalent (that is, all cache misses exact roughly the same penalty from the user). This assumption is valid when the cache and primary copies are strongly connected, because the performance penalty resulting from a cache miss is small and, to a first approximation, independent of file length. But the assumption is unlikely to be valid during disconnected or weakly-connected operation. The miss ratio also fails to take into account the timing of misses. For example, a user may react differently to a cache miss occurring within the first few minutes of disconnection than to one occurring near the end of the disconnection. As another example, the periodic spin down of disks to save power in mobile computers makes it cheaper to service a certain number of page faults if they are clustered together than if they are widely spaced. To be useful, new caching metrics must satisfy two important criteria. First, they should be consistent with qualitative perceptions of performance and availability experienced by users in mobile computing. Second, they should be cheap and easy to monitor. The challenge is to develop such metrics and demonstrate their applicability to mobile computing Initial work toward this end is being done by Ebling [3].

VI. THE ENTERPRISE VALUE OF MOBILE ICT

The potential value of mICTs in enterprises is tremendous. Enabling access to information and people anywhere and anytime, enhancing decision making capabilities, and creating a user-centric environment are some of the exciting examples of mICTs in enterprises (Heck, 2004; Kalakota & Robinson, 2002). While mobility itself offers tremendous value to enterprises, there are several other aspects that make the enterprise adoption and infusion of mICTs compelling.

Unique Characteristics of mICT : mICTs exhibit a number of unique characteristics, which include ubiquity, connectivity, accessibility, reach ability, portability, and localization.

Connectivity: Mobile connectivity is one of the fundamental aspects of mICTs. Mobile connectivity refers to the capability of connecting users to machines (U2M), machines to machines (M2M), and users to users (U2U). In comparison to the wired network environment, people and users are not constrained by the location and availability of network plug-ins. Today, mobile connectivity is constrained by limited wireless network coverage. However, as mICTs continue to advance, network coverage and bandwidth will be abundant, and users will remain permanently connected anywhere.

Accessibility and Reachability: Accessibility and reachability are results of mobile connectivity. A necessary precursor to both accessibility and reachability is that sufficient wireless network coverage is available and that the mobile device is switched on. Reachability builds on the assumption that users and machines have the capability to be in touch and be reached by other entities, while accessibility refers to the capability of access to a wireless network at any place and any time.

Portability: The most unique and distinguishing characteristic of m-ICTs is the ability to physically move computing and communications products and services with the user. Traditional wired computing environments limited users to the location of the device and network plug-in.

Localization: Localization refers to the ability to locate the geographical position of a user or mobile device. Similar to portability, localization is one of the unique characteristics of mICTs. Localization is particularly important when the user requires location-specific information, or the location context itself wants to provide feedback to the user.

Ubiquity: The ultimate form of mobility includes the integration of all the aforementioned characteristics. Users have the capability to access the network at any place and any time, and be in touch, be reached, and located at any place and any time using always connected portable devices. Ubiquity therefore exemplifies the ultimate form of spatial, temporal, and contextual mobility (Junglas & Watson, 2003).

Efficiency: It is human nature to try to make everyday activities as efficient as possible. With the use of mICTs enterprises provide a mean to utilize their desks and on-the-go are capable of having access to information and people from anywhere, raising the overall productivity level. Mobile professionals that travel frequently can utilize their "dead time" at airports or hotels more efficiently by checking, updating, and viewing important corporate information (Kalakota & Robinson, 2002).

Fundamentally, mICTs change the way people work and interact. In addition to being able to address time-critical and instantaneous needs, mICTs also enable enterprises lower cost expenditures. Using a single device to perform a variety of tasks reduces the overall equipment costs an enterprise often has to bare with traditional wired network environments and computing services (Anckar & D'Incau, 2002). In essence, mICTs applied in the right functional areas and deployed to the right users therefore lead to a more agile, adaptive, real-time, and cost-efficient enterprise (Gribbins, et al., 2003).

Effectiveness: An equally significant contribution of mICTs is the contribution to task effectiveness. Time-critical and location-sensitive tasks are excellent candidates for mobilization. By providing information at the point-of-action, task effectiveness improves (Tarasewich, 2002). In this paper, the author goes one step further and proposes that a higher potential of task and decision-effectiveness is achieved when the right information is delivered to the right place, at the right time and to the point-of-thought. Convenience. mICTs offer several conveniences.

First, it delivers a whole new way of interacting. The convergence of wireless communications and the Internet allows users to interact and communicate via voice, data, or multimedia (Deans, 2002; Shapiro & Varian, 1999). Users can check their voice mail, send an e-mail or view the latest video conference, all from a mobile device. This leads to the second convenience of mICT. The use of mobile applications often involves the operation of only a single, integrated device. The ability to perform several different tasks with a single device increases a user's familiarity, proficiency and utilization (Anckar & D'Incau, 2002). While personalization of services has been used extensively in the traditional wired environment, it is an even more important condition in the mICT domain. This is mainly due to the limited screen size and computing capabilities of today's mobile devices, where personalized and localized information adds significant value to the user (Tarasewich, 2002).

It should be cautioned that the mere adoption of mICTs does not necessarily lead to increased levels of efficiency, effectiveness, and convenience. In fact, there are some tasks that are more suitable than others for enablement through mICTs. (Gribbins, et al., 2003) argue that mICTs implemented in the right enterprise functions and processes, and made available to the right set of users, will provide the greatest value. The implementation of mICTs, hence, requires a detailed understanding on which types of tasks, functional areas, and users will benefit from it. Other challenges exist as well. Security, privacy, and user identification are some examples. Adoption and implementation strategies will therefore differ from enterprise to enterprise (Ward & Peppard, 2002). The next section discusses some of the critical issues that enterprises should consider when planning to adopt, implement, and infuse mICTs.

VII. CONCLUSION

Understanding the value of mobility is a critical step when planning to adopt and implement mICTs. This research argues that mobility fundamentally changes the way users and enterprises interact. Mobility is not constrained to geographic movement, but also applies to spatial, temporal, and contextual aspects. As mICTs continue to advance, mobility provides enterprises with a number of important value propositions. When integrated and deployed appropriately, mICTs can deliver higher levels of efficiency, effectiveness, and convenience. However, the discussion above also illustrates the complexity and challenges of successfully adopting and implementing mICTs. These challenges are what require further analysis and which provide a number of exciting research opportunities. The emergence of mobile computing invalidates these assumptions and additionally introduces new physical characteristics to the resulting computing environment such as different operating modes, wireless broadcast communication and constraints on battery power consumption at mobile hosts. In this paper, we first presented a system model that explicitly incorporates mobility of hosts and highlights the effects of host mobility on the static segment of the network. We then looked at how mobility of hosts and the new physical features of mobile hosts will fundamentally affect the design of distributed algorithms. Finally we discussed some new research issues that we are currently investigating under this model. It is our thesis that introduction of mobile computing will require and stimulate a fresh approach to distributed computation.

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