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TRANSFORM IN MOBILE COMPUTING

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Abstract
Storage capacity and communication bandwidth are two factors that significantly impact the design and implementation of mobile systems. Furthermore, storage density is increasing at an exponential rate faster than the associated communication bandwidth. High-density storage in very small form factors will enable new classes of applications that would not be possible in systems which rely heavily on communication. These applications, which involve continuous capture, pre-loaded content, and proactive data loading, will help overcome some of the barriers presented to mobile systems. Researchers would be prudent to recognize these trends and better understand how technology growth will impact their research agenda.

Key Words: Storage Capacity, Communication Bandwidth, Mobile Applications, Future Trends.

Mobility has happen to a very fashionable word and quickly rising part in today's computing region. An unbelievable growth has appeared in the expansion of mobile devices such as, smart phone and laptops with a range of mobile computing, networking and security technologies. In addition, with the development of wireless technology like WiMax, Ad Hoc Network and WIFI, users may be surfing the Internet much easier but not limited by the cables as before. The mobile devices have been accepted by more and more citizens as their first choice of functioning and leisure in their everyday life.

Feature for Mobile Computing
The study of the scope of technology that greatly changes the design of mobile computing platforms: communication bandwidth and storage mass. Memory and communication can to some extent play off against each other. If you are mobile and have a high bandwidth connection to the Internet, then it is less important how much data you are carrying with you; the communication linkage can be used to get the data on claim. On the other hand if the communication bandwidth is minute or commonly engaged, then carrying as much data as probable in the mobile device is attractive, ensuring contact even during communication blackouts.

At some given time the high-tech in the capacity of storage and communication bandwidth, and the comparative costs of each solution, will have significant impact on the design choices made for commercial mobile systems. Already at this time a Compact Flash™ card with 1GB of flash memory can be purchased commercially and IBM has sold a miniature magnetic disk in a similar package since year 2000. It is therefore instructive to look cautiously at these technology trends and try to know their implication.

A logarithmic plan of magnetic disk storage density against year shows that disks of a fixed physical size are approximately doubling in power at an annual rate [11]. Following the development forward, by 2010 the storage density of a disk will be around 1TB per square inch, appropriate for a mobile device using a compact flash card form factor. Communication, on the other hand, is also humanizing, but the tendency for improved available bandwidth is less steep. Computer users have enjoyed improvements in LAN and modem technology for 10 years, seeing broadband-to-the-home data rates of up to 1.5Mbps. For the mobile user, wide-area wireless connection speeds have amplified from 19.2kbps, provided by CDPD services, to a highest of about 100kbps service supported by General Packet Radio Service (GPRS), still a far cry from their wired counterparts. When 3G services roll out we are promised 2Mbps, but it is widely accepted that the actual bandwidth will be variable and a more typical realization will be closer to 100kbps.

An extra reason to keep in mind is that these latter services require considerable investment in infrastructure, and will not be deployed ubiquitously for some time. Moreover, the parent companies have spent substantial amounts of money to acquire licenses for wireless bandwidth, an investment that can only be recovered from the consumer. As a result, these services will likely remain costly for some time. WiFi [2] networks, on the other hand, offer reliable few Mbps coverage but are presently only available as "hotspots" with changeable availability. However, this is a rising marketplace and has taken the cellular company by surprise. Today, there are signs that a grass-roots WiFi network is start to be created and might lastly be deploy wherever it is desirable. But no matter what happens, it will take time for such a network to become established and there is some uncertainty that the 802.11b standard is the one that will finally prevail for wireless Local Area Networks.

For these and other reasons, the inclination in reasonable communication development is therefore on a much slower way than that of storage density. When designing a mobile device there will regularly be engineering tradeoffs that shape its capabilities and physical form. The resulting design compromises must in turn be based on a prioritized list agreed upon by the design team. For example, a necessity for a device to be small might be at odds with it having a long operating time: operating time is linked to battery ability, which in turn is linked to battery size. The current state of the art for any particular technology (e.g., battery, display, processor clock, memory or type of radio) is clearly a defining limitation of a design that uses it. It is the projected improvements, and limits, of storage density and communication that are the focus of our assessment.

This paper discusses the implications of these trends. Section 2 is a concise past study of the system design options that result from trading off communication bandwidth and storage capacity. Section 3 examines novel applications that are enabled by the exponential growth of storage and how this may basically change the way we use mobile devices. In Section 4, we create some predictions for the future, and Section 5 concludes with recommendations to researchers working in this field, in terms of the relative importance of system issues that should be considered when pursuing research in ubiquitous and enveloping computer systems.

Variety of Options
Traditionally, storage has been a major aspect effecting the capabilities and design of computer systems. Early computer systems relied completely on local storage, while other models used communication to access remote data sources. It was not until the convergence of storage and communication that the modern day Internet took off to create computing as we know it today. Similar patterns can be seen with consumer video utilization, through technologies such as broadcast TV, and Digital Video Recorders (DVRs). Mobile systems are starting to repeat some of the related trends as “inactive” computing; conversely, mobility brings exclusive opportunities and challenges which will require new solutions and open up new function domains.

Premature systems were isolated islands of storage: capable of performing their self-contained tasks, but required significant amounts of manual try to move things approximately. This model was sufficient for spreadsheets and many personal efficiency applications, but did not encompass the power of “distant” substance. This scenario is equivalent to a VCR and TV without an antenna or cable – it would allow you to watch movies but not tap into the dynamic nature of “exist” media. Furthermore, it has been impractical to carry all your data with you on a mobile device; however, in the last couple of years storage trends have enabled laptops and PDAs to provide for most of our immediate storage needs. In the future, increasing storage densities will enable applications such as portable media collections, to enable me to carry all movies, wherever I go.

Television and cell-phones are two popular examples of this technique – lots of accessible content with small or no local storage. For computers, there have been many systems that have explored computation platforms without relying on local storage capability. The difficulty with these communication-centric models is that they are dependent upon the remote source of information, which makes it very complex to optimize, personalize, or sometimes just work the system. Without a VCR, for example, you are necessary to watch a particular explain when it’s on, not when you want to watch it. The constraints of mobile devices, such as restricted battery life and changeable network availability, exasperate these problems and make local storage a very successful means to improve device function.

The models, which offer both the capability of local storage and communication, access the best of together worlds and supply very compelling user knowledge. Digital Video Recorders, such as DVR or TiVo, allow users to proactively download media content to local storage and view it whenever they want, considerably changing their TV viewing experience. For PC systems, combining local storage and the Internet allows us to efficiently handle collections of own photographs and simply send them to all. In addition, local storage allows for “hidden” optimizations such as local image caching which dramatically improves the web-browsing experience. Mobile devices are starting to see similar benefits from the confluence of storage and communication technologies: laptops with wireless connectivity, phones as PDAs, and emerging devices such as the Apple iPod[3], and Intel’s Portable Media Player (PMP) , which will enable access to dynamic media whenever and wherever we want it.

The private Server is an emerging research project that allows access to personal content, stored on a mobile device, through any suitable interface: accessing my address book through your laptop, for example. By breaking down the barriers between devices, the project aims to increase the utility of mobile computing and bring personalization to the environment around us. Another focus of this project is to take advantage of localized communication technologies, such as Bluetooth [12], to avoid service provider costs, and some of the bandwidth and power limitations. In this example, a different kind of ubiquitous communication is being used, one based on local spheres of connectivity in combination with local storage to achieve the desired mobile result. Internet Suspend Resume [5], on the other hand, enables anytime/anywhere access to a familiar computing environment by migrate a complete execution environment through the network to a local virtual machine. By relying on local storage capacity, this technique enables new forms of mobile computing that do not rely on the limited capabilities of a mobile device.

Together these projects unite storage and communication to provide unique capabilities tailored to mobile contexts. As storage capacity and density continue to increase, these models will allow ubiquitous access to content without compromising accessibility, content, or convenience.

Forecast for Future Mobile Devise

There are ultimately going to be physical limits for the storage density achieved by rotating magnetic disk technology; however, storage is on a speedy research path and it appears there are more physical options that can be functional to improving storage density than exist for improving communication bandwidth or processing capability. These include 3D stacking of memory essentials, polymer memories, and MEMS based nano-memories. Given the trends we have described in Section 1, and the huge potential of the examples we have provided, it is clear that massive portable storage capabilities will play a significant role in the design of mobile systems in the future. We can expect that PDAs and cell phones will take advantage of the new storage capacity as it comes available.

The notion of Proactive Computing [10], which can be an effective tool for justifying some of the difficulties of mobile computing. Autonomous agents will be the key to moving beyond current models of omnipresent computing, particularly as the number of available devices expands beyond what is reasonable for us to manage. Massive file systems enable the practical statistical research of data: store information in case it might be needed – justifying a computer's incapability to make accurate predictions with high-density storage space.

Latest Opportunities in Mobile Computing

To illustrate this point we provide examples of mobile applications that are based on the potential exhibited by exponential storage trends: looking forward to what will be available in the next 5 years as the result of exponential improvements in this technology.
Example: Data caching for portable devices.

Data caching is a powerful technique for trading storage for bandwidth – reducing the need to download new data by remembering what has been seen before. Currently, desktop systems typically cache text and images from pages directly accessed by the user. Utilizing increased storage capacity, it would be possible to proactively cache not only the top-level web page, but also secondary web pages [8], high-resolution images (for zooming) or web applications with complete datasets. For example, if a person is browsing for travel directions while at home using a high-bandwidth connection, they may not need the details of every turn and street corner until they're actually lost on the road. By proactively caching the details, their mobile device won't need to download any information over an expensive wireless link when on the move.

Following this line of reasoning, it would be similarly possible for specialized agents to download content just in case it might be useful. For example, if your calendar has an entry that says "Bangalore" in it, the system might just download interesting content about Bangalore – assuming you're either taking a trip there or even just thinking about it. Similarly, an agent could continuously download new content to your device, e.g., recommended new music based on your listening habits, which would then be available to you just in case you had some free time while on the road. (This content could be unlocked dynamically just like the preloaded media in the previous section.) By proactively transferring data while the device is connected to a host computer with a high-bandwidth serial link (perhaps while charging), the system again trades local storage for reduced communication while mobile.

The problem with cached or preloaded data is that it can't handle dynamic changes in content, but advanced optimizations can be used to minimize the amount of data to be transferred. For example, you might get caught in a heavy shower if you're relying on a long-rage forecast downloaded last week! Techniques such as the Low-Bandwidth File System [7], sends content as changes to previous versions, relying on information stored on the local device: the more data that can be stored locally, the less needs to be transferred over the wireless link. New versions of large data-sets, such as a dictionary or encyclopedia, would only have to be transmitted as small updates to existing text or a few additional entries.

Conclusion

We have focused on the relative capabilities of communication and storage over time, it is worth identification that these are just two proportions among many that influence the design of mobile computing. In almost any dimension we can judge, with displays, processors, handwriting recognition, voice recognition, power management and energy storage, the equipment improvements predictable in the next decade will continue to make mobile devices, and the systems that support them, and stimulating part of the research.

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