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# Connecting to the Next Generation Mobile Desktop

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## ABSTRACT

Mobile phones have evolved over the years from a plain device that allowed voice communication to the present day smart phones that are capable of variety of tasks. Much touted smart phone lacks some of the rudimentary business as well as other functions that are available in a traditional laptop/desktop. This article proposes a new system called *Next Generation Mobile Desktop* (NGMD) that provides desktop equivalent functions on a functional mobile phone. Proposed NGMD leverage some of the emerging technologies to offer enhanced services to the user. This article discusses some of the existing as well as new mobile technologies and then proposes the architecture for the NGMD. This article also discusses some of the services offered by NGMD and provides illustrative examples of them. We believe NGMD capable phones would dominate the corporate market and free up the user from carrying multiple devices while on the road.

Keywords: 4<sup>th</sup> generation device, mobile desktop, handheld computer

## INTRODUCTION

Mobile phones have come a long way from the bulky Handie Talkie of the 1940's. Early mobile phones supported voice communication only but in the past decade, we have witnessed rapid extensions to this basic feature. Recent introductions such as Apple's iPhone and Nokia N95 amplify this trend. Newer generation phones include, in addition to voice communications, a host of features such as Web browsing, multi-media messaging, etc. The devices have practically become the corner stone of modern life.

In spite of their technological sophistication, they still lack basic computing functions that are available in traditional desktop/laptop computers. For instance seamless printing of documents or accessing corporate applications on a mobile phone is a difficult task. Because of this, we are still tethered to our desktops. The "mobile lifestyle" demands a new paradigm. This article proposes a new generation mobile platform called "Mobile Desktop" that enables us to access our desktops as well as a host of other features.

In this paper, we will first review limitations of current mobile phone technologies. In the subsequent section we analyze some of technologies that will contribute to the development of next generation mobile desktop (NGMD). The third section outlines the basic architecture for the proposed NGMD system. This article ends with the concluding section analyzing the implications of the proposed device.

## CURRENT MOBILE TECHNOLOGIES

Of the different types of mobile phones currently available, smart phones are the ones capable of rudimentary business functions. They are increasingly popular among business consumers. A recent report indicated nearly 80 million units of them are shipped worldwide in 2006 (Best 2007). Smart phones integrate the functions of cell phone and personal digital assistant and provide limited web browsing capability. Though smart phones provide innovative features to help corporate employees on the move, their support for corporate IS resources are limited. Some of these phones provide limited access to corporate data/files. Smart phones are constrained by their underlying technologies. Current phones hamper consumers due to their limited processing power, low bandwidth, and awkward interfaces (Lee and Benbasat 2003). Here we will discuss some of these limitations.

### Hardware technologies

The processor is at the heart of the smart phone. Currently most of 3rd Generation (3G) mobile devices utilize processors that have speeds of around 800 MHz. In comparison, typical desktop processors have processing speeds in excess of 3.60 GHz. Low speed processors are used to conserve battery power. In general, the faster the processor the more the power consumption and more the heat generated. Processors place limitations on the type of applications that can be used in these phones. Software applications requiring faster processing capability cannot be effectively used in existing smart phones.

Another critical hardware element is the availability of primary as well as the secondary memory in the device. Popular smart phones have primary memory of 128 MB; this smaller capacity memory again pales in comparison to desktop devices where we see typical memory capacities in the 4-8 GB. Unlike desktops, many of the smart phones have Flash ROM based secondary storage instead of hard disk drives.

### Network standards

Cellular standards were initially voice oriented and they were either based on analog or digital technologies. Bandwidth until the third generation was limited to a 100 Kbps. Smart phones utilize 3G Networks for data access services. 3G networks have high bandwidth and utilize Internet Protocol (IP) (Whale 2003). The infrastructure is by no means universal. There are different networks utilizing Global System for Mobile (GSM) or Code Division Multiple Access (CDMA) based cellular technology.

### Software components

Smart phones utilize diverse operating systems and this markedly differs from traditional PCs where there are only a few dominating operating systems. Some of these operating systems are: Windows Mobile, Symbian OS, Mac OS, Blackberry OS, Linux, various proprietary OSs etc. Divergence of operating systems itself places constraints in terms of interoperability of the software applications.

### Features provided

Current generation smart phones are inadequate to serve the varied needs of business consumer. These devices, apart from providing traditional phone service also provide access to personal information management, productivity tools, e-mails, and World Wide Web. Smart phones come along with physical or virtual QWERTY keyboard and support multiple means of wireless connectivity. Though smart phones provide innovative features to help corporate employees on the move, their support for corporate IS resources are limited. Some of these phones have limited capability to access corporate data/files and this provision is usually done through special software applications. Many times the features provided by the smart phone are even limited by the cell phone service provider itself. Following table 1 compares the functionality/technical specifications of some of the popular smart phones.

Phone	Blackberry 8830	IPhone	Nokia E90	Motorola Q
Business oriented features				
E-mail- push	Yes with Enterprise Server	Yes, with Yahoo mail	Yes, Nokia software	Yes, with third party services
Productivity tools	PIM, Organizer	Widgets	Notes, calendar	Contacts, Calendar and Tasks
View File types	Text, Word, Excel, images and PDF	Text, Word, Excel, images and PDF	Quickoffice tools with editors	Text, Word, Excel, PowerPoint and PDF
Web browser	Yes	Yes	Yes	Yes
Corporate data access	Yes, with add-on services modules	Not mentioned	Not mentioned	Yes, with third party applications
Technical Specifications				
Keyboard	QWERTY	Onscreen	QWERTY with notebook style	QWERTY
Operating system	Blackberry	Mac OS X	Symbian	Windows Mobile
Cellular connectivity	CDMA, GSM	GSM	GSM	CDMA/GSM
Wireless Connectivity	Bluetooth	WI-FI, Bluetooth	WI-FI, Bluetooth	WI-FI, Bluetooth
GPS	Yes	No	Yes	Yes
Memory (RAM)	64 MB	128 MB	128 MB	64MB

**Table 1. Comparison of popular smart phones**

In this article we propose a device, called next generation mobile desktop (NGMD) and it provides access to desktop services and utilizing various emerging technologies. Next section discusses the underlying technologies that enable our next generation mobile desktop.

### **NEXT GENERATION MOBILE DESKTOP TECHNOLOGIES**

In order to provide more feature rich services, the proposed mobile desktop utilizes some of the latest technologies such as 4th Generation networks and emerging software architectures. Following paragraphs discuss these key technologies.

#### **Mobile Hardware**

Constraints of existing hardware components play an important role in the availability of feature rich phones. Some of the constraints are imposed by the limited processing capacity, power availability, and memory storage capacity. Next generation architecture requires improvements in hardware technologies.

One area where improvements are foreseen is the availability of more powerful processors. Of late major vendors of mobile processors such as Intel and ARM are planning to release processors that deliver over 800 MHz of processing speed with lower power consumption. This increase in speed and power should allow more data intensive applications.

#### **4G Networks**

The bandwidth of current 3G wireless networks are limited to few Mbps, for instance CDMA 2000, a popular 3G technology provides maximum data transmission speed of 3.1 Mbps (Kalavakunta and Kripalani 2005). Fourth generation (4G) networks are being currently developed that are expected to be deployed between 2008 and 2010 (Dekleva Shim Vanhney and Knoerzer 2007). These networks are expected to achieve data transmission speeds in excess of 100 Mbps. Another development in this area is the convergence of WiMAX and cellular data transmission technologies. WiMAX is an upcoming wireless standard that promises to offer higher speed networks for laptops and other portable devices. WiMAX networks could have range of 31 miles and offer peak data transmissions speeds of 268Mbps (Dekleva et al. 2007).

Cellular networks provide slow speed connectivity over a wide area while wireless local area network provides high speed connectivity over a small geographical area (Salkintzis Fors and Pazhyannur 2002). Integrating these two networks allows us to have regions where sophisticated applications are possible. Alerting mobile users of an impending storm or flight delays in an airport are examples. Already there are efforts to link these technologies so that devices can seamlessly utilize either one of these technologies depending on availability (Mohanty 2006; Park Yu and Ihm 2007).

#### **Mobile IPV6**

Internet Protocol (IP) has become a de facto standard in accessing the Internet. Implementation of IP on mobile devices is critical in maintaining Internet sessions even when the mobile device moves from one network to another network. Mobile phones are inherently not tied to a particular location and this call for the use of Internet addressing mechanism that allows the mobile device to be able to send and receive data packets no matter what the location or network technology be. The Internet Engineering Task Force (IETF) specified mechanisms for the mobility management of these devices. Mobility management ensures that the mobile device can be reached irrespective of its current location in order for voice/data communications can be completed. Mobility management is achieved by having the mobile agent to constantly update its home network agent of its position by providing it with a care-of address.

IPV6 is the next generation protocol, apart from addressing limitations of older IPV4 protocol, allows significantly more Internet address space to be allocated in line with proliferation of devices on the Internet (Durand 2001). Mobile IP has also seen the introduction of IPv6 and IETF was tasked with formulation of Mobile IPv6 standards. Mobile IPv6 is claimed as the solution for supporting terminal mobility on the global internet (Johnson Perkins and Arkko 2004). Still several developments are taking place in this area to further improve the data transmissions between the various nodes and the mobile device and one such development is the use of Hierarchical Mobile IPv6 for mobility within a local domain (Soliman Castelluccia El Malki and Bellier 2005). When mobile devices move from one location to another frequently, there will be delay in completing the handoff procedures and lot of signaling data is also sent between the various nodes involved in data transmission. Hierarchical Mobile IPv6 utilizes Mobility Anchor Point (MAP) which acts as the proxy home agent for mobile nodes within the local domain. It eliminates the need for a mobile node to frequently send updates on its location to its home network (Osborne 2005). Developments addressing data transmission and security mechanisms on the Internet for mobile devices would greatly facilitate the proposed features of NGMD.

### **Location Awareness**

Contemporary mobile phones are inherently location aware due to the requirements of the Wireless Communications and Public Safety Act of 1999. This act has mandated cellular providers to provide public safety officials with a caller location to a greater degree of accuracy in order to provide required services. This feature is already used by cellular carriers to provide users with driving directions, maps, etc.

Location awareness facilitates context awareness of the devices and the provisioning of various services (Kaasinen 2003). Some of the services enabled by location awareness of mobile devices are navigation and direction-giving, geographic messaging, geographic advertising, who-is-around service, neighbor-and-service discovery such as Bluetooth, and source-position identification for emergency situations (Tseng Liao and Chao 2001). Unlike traditional desktops, proposed next generation desktop should be location aware and this aids in the provisioning of services that utilize NGMD's location. For instance, based on the location of user, NGMD can enhance the security of communication channels to provide varying levels of security for data transmission. Likewise, if the user is in a public location, then NGMD can proactively deny certain services available to the end user.

### **Service Oriented Architecture**

One of the important components of NGMD is the kind of software architecture it has. As mentioned earlier, NGMD provides rich suite of software services. Service-oriented architecture (SOA) is an emerging concept in the software engineering field. Services are the foundation for SOA based applications (Papazoglou and Georgakopoulos 2003). SOA departs from traditional ways of building software application by disaggregating the specific business processes and making these available through services. Because of this, services can be assembled and reused in response to changing business requirements (Cox and Kreger 2005).

Already there are attempts to create mobile services called Simple Mobile Services(SMS) based on concepts from SOA (Bartolomeo BlefariMelazzi Cortese Friday Prezerakos Walker and Salsano 2006). SMS provides variety of services to mobile users based on his location and users can easily find, use, and trust these services. Currently mobile phone operators limit the kind of services available to mobile devices and according to Bartolomeo et al. (2006), SOA should make it technically feasible to offer variety of services provided by third parties also.

### **Software Components**

The kind of software installed on the mobile device also plays an important role in the kind of services NGMD can perform. As stated earlier, there is plethora of operating systems governing mobile devices. The recent move to standardize the mobile software application development by the Open Handset Alliance (OHA) by thirty four companies (Reardon and Mills 2007) is important. OHA promises to enhance the availability of standardized applications for mobile devices. These standardization efforts could potentially help the NGMD platform and provide mobile software applications that are more compatible with variety of mobile devices. These developments could also potentially lead to greater compatibility between mobile and desktop software applications as OHA promotes open platform that is based on Linux and Java.

### **KEY FEATURES OF THE NEXT GENERATION MOBILE DESKTOP**

The most appropriate paradigm for the next generation desktop is not the current desktop, but a smarter version of it to support the mobile professional in his/her dynamic work day. The intelligence will primarily be centered around the "context" of device usage. A mobile professional could be walking, travelling, working from a surrogate office and so on. During these activities, he/she may be accessing files, sending emails, updating databases etc. The device has to automatically detect context and adjust system settings such as interface, security and archival. More specifically, the device has to be "location aware." In current generation devices, location awareness is intended for law enforcement and public safety rather than for applications and mobile services. In NGMD, this feature will be exploited along with other technologies such as wireless networks and SOA. Thus the next generation mobile client will have certain technical features that are briefly discussed in the following paragraphs.

#### **Context Awareness**

Context awareness is the ability of the device to sense its location and usage mode. This is a requirement for location-based applications such as driving directions or emergency services. Some 3G phones provide this facility. Security and interface settings in NGMD will partly depend on the context. Context awareness goes beyond identifying geographical position; it involves intelligent sensing such as whether the cell phone owner is in a train, in his/her office or on the beach.

#### **Dynamic Interface Mode**

Mobile users are in a number of situations and contexts that place restrictions on the mode of interaction. For example, in bright sunshine or on the beach, monitors are difficult to see. Similarly, in places where a user is in close proximity to other

people such as in trains, visual displays are not expedient. Thus the mode of interaction must be capable of being switched dynamically depending on context. In available cell phones, interaction via audio, keyboard and touch are available although on a limited basis. It is necessary to be able to switch between these modes, but this places restrictions on services that can be provided. Extended text editing, for example, does not lend itself well to voice commands, whereas typing a document is a natural voice application.

### **Dynamic Security**

Currently, mobile communications using CDMA and Wideband CDMA technologies are encrypted, but this does not always guarantee security such as if the device were stolen. For desktop usage, additional security measures such as authentication are required but an elaborate security framework will defeat the so-called “cellular lifestyle.” A balance is required between performance and level of security provided. The device should be capable of detecting its location and adjusting its security level. Thus dynamic security and location awareness are necessary features.

### **Provision of support services**

Current generation cellular phones support services including multi-media messaging, web browsing and information downloads. Web capability will mean that there is scope for offering additional services such as email alerts, information on stocks, emergency etc. We envision that desktop services will be part of a broader framework that encompasses the previously mentioned services. Access to them will be governed by a key distributed by the cellular operator.

### **Archival**

The interruptibility of service is a nuisance in current phones. To ensure reliability, any business usage will require buffering of communications as well as archival of important documents. Archival refers to frequent saving of work during usage. Both security and archival functions tend to impact performance and ought to be governed by users as settings.

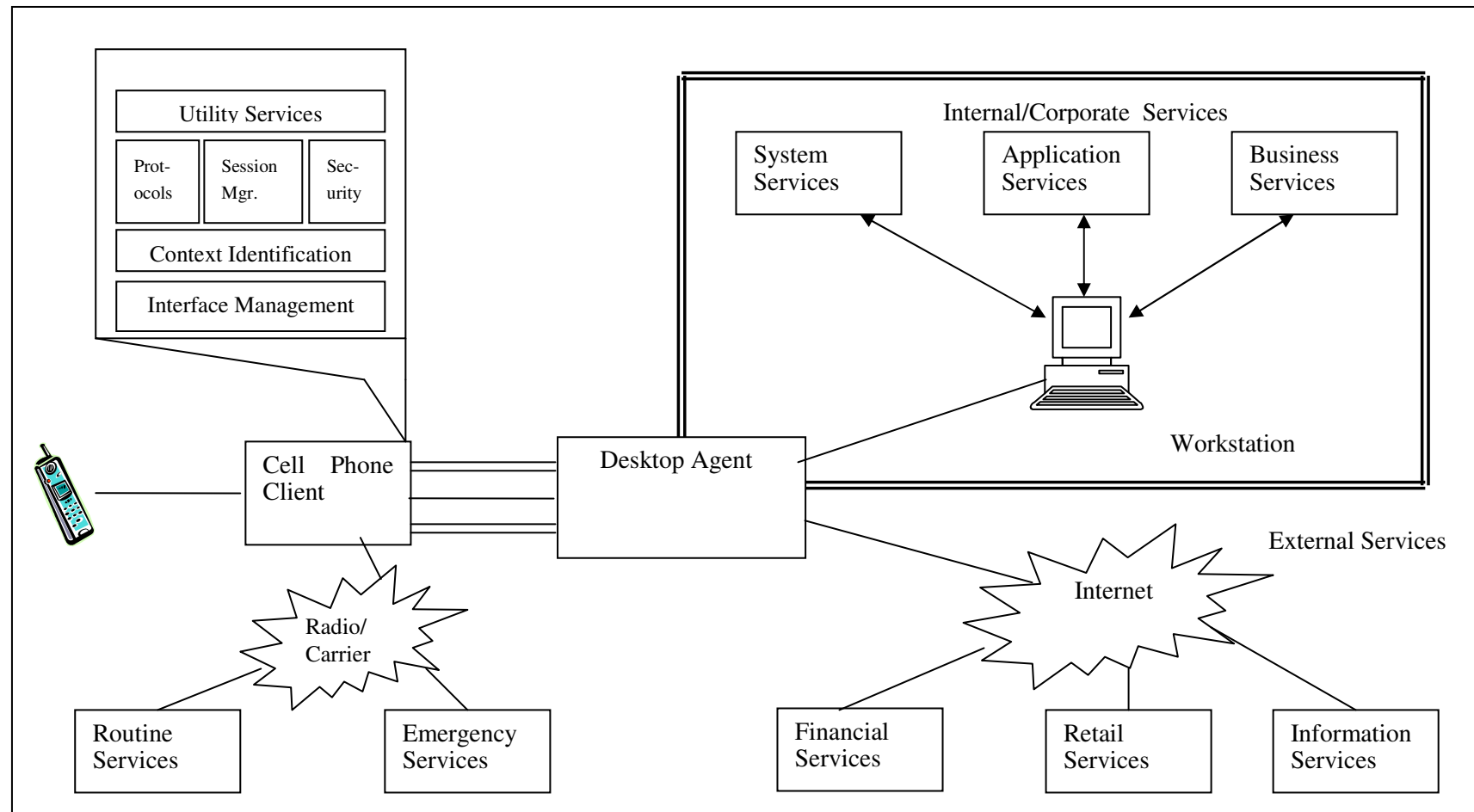
## **AN OVERVIEW OF THE NEXT GENERATION ARCHITECTURE**

A functional model for the next generation mobile desktop (NGMD) is shown in figure 1. The NGMD is based on the client server architecture for two compelling reasons. First, this architecture can reduce processing demands on clients by using server resources. This is important because the cell phone is a mass consumer product where it is necessary to reduce costs and conserve battery power. Secondly, the client/server architecture allows a number of different services to be offered in different locations by different vendors.

As shown in the model, each mobile device has a client that carries out a number of functions in support of desktop access (Barbeau Labrador Winters Perez and Labib 2006). These include utility, protocols, session management, archival etc. In operation, necessary protocols are carried out to establish a session. They include those that are part of the communications infrastructure as well as those related to desktop access. For example, a roving NGMD has to register itself to a visiting register attached to the carrier’s mobile switching station; packets addressed to the phone are correctly forwarded to the IP address located in the device’s home switching station and this concept is same as the one used in the case of Mobile IP (Johnson et al. 2004). The context identification module will use a number of tools including GPS and motion sensing to make intelligent decisions regarding security and archiving. The context module will utilize rules such as:

- If user is in public place, security level = high.*
- If user is travelling, archival setting = frequent.*
- If user is browsing the web, then security level = low.*
- If the user has a choice of networks, use the one with the greatest bandwidth.*
- If user is in his/her corporate home area, use the corporate network for all communications.*
- If user is utilizing corporate applications, give priority for both processor and memory capacity for it.*

These will be made in a dynamic, ongoing fashion. Depending on security policy, the necessary authentications are executed by the security module and verified by the desktop agent. If the user passes muster, a session is then established between the desktop and the client. If archiving is requested by the user, the various states of the session are saved. In the event of an interruption the session is restarted from the archive. The options for restarting and other settings are also part of the client functionality, but are not shown in the diagram. Similarly, functionality to operate the various gadgets that are now part of cell phones (video for example) is also not shown in the diagram.



**Figure 1. Model for the Next Generation Desktop Services**

The client connects to the physical desktop via a desktop agent. For most situations, the desktop will be the employee's physical desktop. The desktop agent is necessary to regulate access to desktop services. The concept is similar to the use of "authentication keys" used to install software in the windows environment. An authentication key in this case allows legitimate users to install the software. In the same way, the NGMD user will enter the key to access desktop services. An unauthorized person using a different device might gain access into the desktop, but unless they have the key, they would not be able to carry out any activity. The keys are distributed between the desktop agent and the security module in the client at the time of signing up with the carrier. Authentications based on bio-metrics are also essential to secure the system. NGMD phones will be equipped with devices for physical authentication such as fingerprints. A second important rationale for the desktop agent is to serve as a gateway for services. Services are designed based on the "onion skin" concept used to characterize system architecture. Thus there are system services, application services and business services (see Table 2) and these services are supplemented with other types of services such as external and utility services although utility services are provided directly by the client. Services are registered to the agent in much the same way as new software is registered to system after installation.

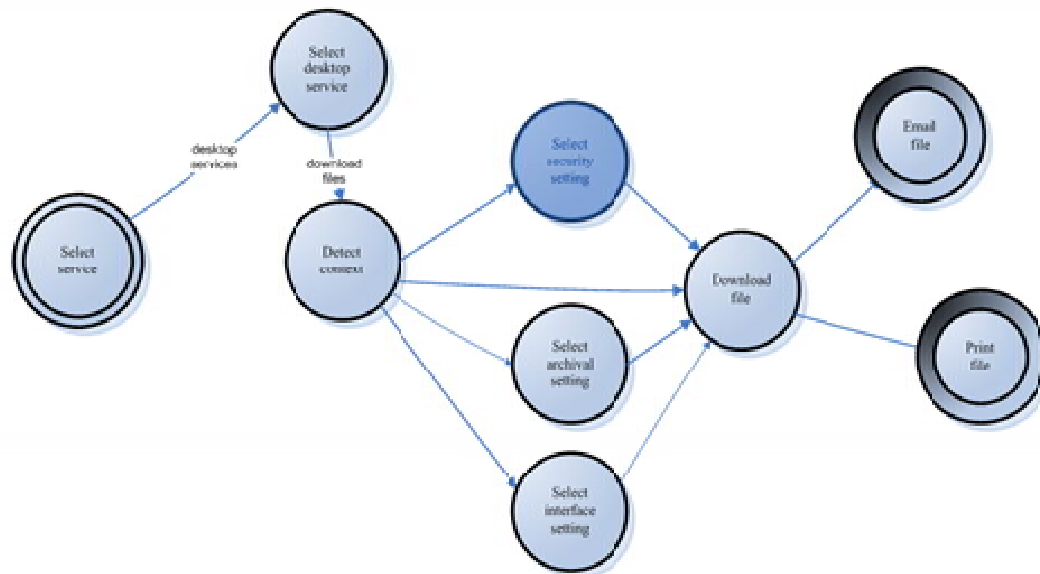
Type of Service		Examples
Internal/ corporate Services	System	Grant/revoke privileges, search files, list directory.
	Application	Send mail, update expense file, create reminder, make a note.
	Business	File expenses, call a meeting, fill form.
External Services	Financial	Transfer funds, authorize transactions, invest in financial instruments.
	Retail	Buy tickets, order a book, make a reservation.
	Information	Find supplier, get annual report, look up a building code.
Utility Services	Routine	Traffic, news, financial alerts.
	Emergency	Weather, police.

**Table 2. Examples of Next Generation Mobile Services.**

These concepts are illustrated with the following scenario and a corresponding state transition diagram in figure 2. User presses a button designated "services" on his/her cell phone, from a waiting room at an airport. The context module detects the location, and after consulting user preferences, decides that there is sufficient privacy to enable the transaction. Because of Wi-Fi access, it sets archival frequency to low and security to "modest." Had it not been in a waiting room, the security would have been set to high. The interface is set to LCD display. The user is offered a choice of "Corporate" or "External" or "Utility services." User selects "Corporate services" and is presented with a further list of corporate services. The list is somewhat similar to a list of printers in a networked office with multiple printers. From among these, the user asks for "downloading a file." The desktop agent asks the user to enter a key. The user touches a finger print reader on the back of the cell phone. He/she is asked for the last five digits of the key. He/she quickly enters the key, downloads and views a file. Since he/she is still logged into the agent, he/she is offered a choice of next actions such as email, store, delete etc. Thus depending on the location and mode of interaction, the client will be able to choose an appropriate service. The client will take advantage of local offerings such as using printers or downloading regional music.

In the past, services have been part of the client functionality with the exception of concierge services, which are services (e.g. reservations for a special event) carried out by human operators. Due to ongoing labor substitution, it is expected that they will play less of a role. Now the services are displaced to the desktop to allow a "thin client" design. The desktop agent rather than the client will be a gateway for work-related as well as leisure services. Utility services are still part of the client because they are device dependent and need to function independently of the cellular network. The architecture that we described is currently feasible, but subject to integration of cellular standards. Developing a uniform network infrastructure and a standardized method by which services are registered and made available to users are key to achieving the mobile desktop.





**Figure 2. State chart showing sequence of actions in using a desktop service**

## CONCLUSION

Mobile computing has many of the characteristics of a “good system” (Amaravadi 2004). The networks are pervasive and ubiquitously accessible. Usage has become almost universal. Improvements are constantly being made to the technology. Physically, the devices have shrunk to the size of a very thick credit card. Along with technological improvements, functional improvements are essential. The next generation cell phone will be a hybrid between desktop and cellular services. The evolution of these two systems has paralleled one another, but has remained more or less independent. We have proposed a framework that integrates the two and brings desktop services to the mobile phone. The framework rests on the SOA paradigm to provide both internal (desktop) and external services. A desktop agent uses corporate policies and device context to regulate access to the services. The law of evolution dictates that technology will move towards the most efficient form unless otherwise constrained. Mobile communication exhibits this trend. It has become small and cost-effective. It has almost displaced land-line-based communications and is here to stay and evolve. The use of 4th generation technologies such as SOA will hasten the integration and enhancement of mobile services. It is hoped that the mobile desktop will be part of this evolution.

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