Introduction

Smartphones, also known as feature phones, are used by mobile subscribers to access the applications that go beyond basic voice and Short Message Service (SMS) found in second generation mobile phones. Smartphones are designed to take advantage of both the 3rd Generation (3G) and 3.5G networks that have been established during the past several years.

This paper focuses on the smartphone and why it has become the mobile user’s preference for accessing mobile networks and the benefits that can be achieved by using them.

Trend toward Mobile Data Applications

It wasn’t long ago that the sole purpose for mobile phones was voice communications. The introduction of the Internet to the masses fueled a wave of data applications and services, which many now use daily. The next logical step was mobile access for these applications and services.

However, that next step is a big one. First, standards organizations needed to define a mobile network environment that enables devices to perform new and different tasks. Second, mobile handset and infrastructure vendors then would need to use these definitions, or standards, as blueprints to make the equipment to host these new applications and services. Third, carriers also would need these blueprints to build the networks people eventually would use. Somewhere along this timeline it was hoped that government regulators would realize that more spectrum would be needed and allocate more for mobile broadband services.

The good news is that all this took place over time. Standards organizations established guidelines, such as the 3rd Generation Partnership Project (3GPP). The 3GPP is responsible for the development of 3rd generation mobile standards in the Global System for Mobile (GSM) communications family. The 3rd Generation Partnership Project 2 (3GPP2) is responsible for the CDMA2000 3G standards. Vendors, both handset and infrastructure, were then able to develop and test the equipment. Carriers were able to build their upgraded networks. Government regulators were able to re-allocate available spectrum for mobile wireless services.

Defining Smartphones (Feature Phones)

Since the focus of this paper is on smartphones, it is necessary to give a basic definition. Although there are many ways a smartphone could be defined, the following description will be used to provide the context.
A smartphone is a handheld device, capable of providing wireless voice communications along with support for other applications. Data applications typically include messaging (both text and multimedia), e-mail, audio players, and Web surfing via a Graphical User Interface (GUI)-based browser (versus the more primitive type of handheld devices with text-based browsing).

Another trait of a smartphone is a built-in camera for taking snapshots, with some smartphones able to capture video clips. An important feature is docking with a PC via a USB connection or wireless connection for uploading and downloading data. These data transfers typically include photos, music, videos, and data files that are used in office application suites.

An important function of office applications is the capability of synchronizing data entries for contacts (phone/address book), calendars, and to-do lists. Data can be entered either on the PC or the smartphone and then synchronized between the two (or more) devices, eliminating the manual entry of data on each device. This also eliminates the laborious task of manually reentering data when a new device is purchased.

**From Keypad to Alphanumeric Keyboard**

Text messaging was the first, widespread data application for cell phones introduced in the Global System for Mobile communications (GSM) standard in the early 1990s. However, the challenge was using a phone’s keypad to type text messages. Pressing a key several times enabled a single key to represent several letters. For example, the number 5 key pressed once represented the letter “J,” twice for the letter “K,” and three times for the letter “L.” Although this design provided a solution, it was a very slow and tedious way of entering a text message. Entering the word “hello” would cause a user to press the buttons on the keypad 13 times.

The T9 translator method was later introduced to greatly improve the process, reducing the amount of keystrokes required. It uses an algorithm to guess the word being typed after each key was pressed once. The algorithm worked due to the fact that there are limited combinations of buttons that actually spell words. A great web site to see how this works is: [http://www.t9.com/us/](http://www.t9.com/us/).

For many wishing to advance to using a Web GUI interface or corresponding through e-mail, even T9 is not an ideal solution. It was important for handset vendors to come up with a solution of incorporating an alphanumeric keyboard into the confined space of a small handheld device.

The challenge to a good design is getting enough separation between keys so it isn’t too easy to press two or more keys at the same time. One method is horizontal separation (creating a larger footprint, which makes the smartphone less compact) or vertical separation by rounding the tops of the keys to help create separation (creating a smaller footprint), which theoretically reduce the probability of typing errors. Good designs for keyboard layouts have been created, but there are also some less cleverly designed keyboards that simply create a frustrating experience for a user.

A physical keyboard with many keys also creates another design issue: the amount of remaining service area in which to embed a reasonably-sized graphics display to support common applications like e-mail and web
browsing. One clever idea (introduced by emerging smartphone manufacturers) was a keyboard that either
opens or slides out from the body of the device, introducing another and perhaps larger graphics display. The lat-
ter is a more costly design.

From Hard Keys to Touch-Screen
The next brilliant stroke of genius in the evolution of smartphone design was the introduction of the touch-
screen. This design allows the graphics display to encompass nearly the entire footprint of the smartphone itself,
leaving some room on the surface and along the edge, perhaps, for a few buttons, like a power switch and menu
selection.

Touch-screens are not a new idea. Several years ago, there were many handheld Personal Digital Assistants
(PDAs) that had a touch-screen, more appropriately referred to as a tap-screen. The user used a stylus to select
an area on the graphics display, and the internal computer would interpret the action the user wanted by detect-
ing the area pinpointed with the stylus. Note that the integration of the handheld PDA with cellular technology
and improved graphics displays became the basis for today’s smartphone.

When Apple® launched the iPhone®, they incorporated a “finger friendly” design approach. The graphics display
on the iPhone is still one of the largest available for smartphones. The device also contains built-in acceler-
ometer, which detects the orientation of the display to the user. It displays either a vertical or horizontal soft
keyboard (appearing on the graphics display) when the user is prompted to enter information by a program
requiring alpha-numeric input.

The “finger-friendly” touch-screens have now become state-of-the-art for smartphones. Not all users care for
touch-screens though; some believe the tactile keyboards allow them to input information more easily. It largely
depends on personal taste and what one feels able to adapt to.

Purchasing Tip: Before purchasing of a smartphone; try-out different models in person and take your time
before deciding. Ensure that there is a reasonable return policy in case you do not adapt so well to a device you
tested for only a brief period. Most cellular contracts that subsidize the hardware cost usually last for two years.
That is a long time to be stuck with a device you may not like very much.

Smartphone Features
Display-Imaging
As mentioned previously, the major shift in display technology for smartphones was the introduction of touch-
screens. They enabled manufacturers to keep the device compact while either putting a slide-out keyboard
underneath the body of the phone or using a touch-screen keyboard that appears when needed and disappears
after it is no longer needed to allow the user to have a larger viewing area for the application running, such as a
web page.

Proximity sensor is a term used to show that the device has touch-screen capability. There are different technol-
ogies used and they are not all alike. This was one of the key attributes that created such a high adoption-rate of
iPhone users. Two of the chief complaints of users are the inaccuracy of the area touched on the display and the lack of sensitivity (how hard or how long your finger or pointing device must touch the surface before the action takes place).

Since web pages have generally been designed for larger PC monitors and not small form-factor displays, another issue is reading the tiny print, images, etc., that exist when viewing the display on a smartphone. Another brilliant design of Apple’s iPhone was the introduction of the finger pinching and spreading motion the user can make to zoom out and in on the object being viewed. Other manufacturers have begun to introduce this type of technology in their products.

Here are some important aspects to think about when comparing models. First, the size of the display is measured in pixels by giving two numbers, one for the vertical aspect and the other for the horizontal. If the device has an accelerometer, it can be shifted between portrait and landscape views by the user physically changing the orientation of the device (i.e., turning it to the vertical or horizontal position). Color depth is another important characteristic that will relate to the definition of graphics displayed. The more colors that can be displayed, the greater the color depth. The higher-end products provide the capability of 16.7 million different colors.

Network Access
There are two core cellular standards, the GSM family (3GPP) of standards and the CDMA (3GPP2) standards. One of the most important specifications is whether the smartphone you may be interested in has the technology that will work with the carrier you wish to use.

GSM, GPRS, and EDGE standards typically operate in four different frequency bands: 850 and 1900 MHz bands (generally in the US and Canada) and 900 and 1800 MHz bands (generally throughout Europe, Middle East, some parts of Central/South America, and Asia). The term “quad-band phone”, usually refers to the support for these four common frequency bands.

When the Wideband CDMA (W-CDMA) air interface was introduced, the bands shifted somewhat as new spectrum was introduced to support 3G services. The most common bands are 900, 1900 and 2100 MHz.

Other Important Smartphone Features
Audio media players are available on many smartphones now. MP3 and AIFF (Apples’ proprietary format) are the two most common audio formats used. Combining video support for the media players is also becoming extremely common.

Because smartphones are becoming more like multimedia computers, it is important for them to have a lot of onboard storage capability. It is also important that smartphones have enough capacity. Many system’s internal memory is measured from 1 GB to 32 GB. MicroSD memory cards are an important addition – they allow users to add more storage capability to their devices.
Cameras are now a very common inclusion for smartphones. Key features for built-in cameras are the resolution quality measured in megapixels, zoom capabilities, video recording, and lens quality. One of the newest features for smartphones is support for video calls.

Short Message Service (SMS), a text-based application, is now giving way to Multimedia Message Service (MMS). MMS allows transmission of richer content, including photos and video clips, between users.

There is one more thing that is worth mentioning. When selecting a smartphone, pay close attention to what reviews have to say regarding battery life. 3G and WiFi radios use a lot of power. If you are a mobile Web surfer, you will want something that has a good report on battery life. A handset of any kind is of little use with a dead battery. So find a device that has the battery power that is matched to the kinds of applications you use. And don’t forget to bring along your charger. There are many portable chargers on the market, including the iGo charger system, which can come in handy when an outlet isn’t nearby for easy access.

A Sampling of Smartphone Manufacturers

It simply isn’t feasible to cover all the smartphone manufactures and each device in their product line. Even if it were possible to accumulate such a list, it would be outdated within a month, since new products enter the market all the time. The aim here is to select a few companies that have made notable achievements in the area of smartphones for a quick comparison for what they offer in the market.

Apple

Apple is famous for the introduction of the iPhone – an innovation that raised the bar for feature-rich smartphones. The original iPhone used the EDGE (Enhanced Data-rates for GSM Evolution) standard for the data connection, so it wasn’t initially introduced as a 3G phone.

The next model was the iPhone 3G, which supports the UMTS (Universal Mobile Telecommunications System), with HSDPA (High Speed Downlink Packet Access) supporting a 3.6 Mbps downlink connection.

The newest model is called the 3GS, which was introduced in June 2009. iPhone supports a 7.2 Mbps HSDPA downlink connection but is still limited to 384 Kbps in the uplink, because it doesn’t support HSUPA (High Speed Uplink Packet Access). Apple has not implemented the HSUPA standard in its current iPhone, even though it provides far better uplink speeds over 384 kbps. This model also has a 3-megapixel camera, a WiFi radio, and an A-GPS receiver that is linked to software with a built-in compass. The smartphone has two data storage configurations, 16GB and 32GB. The display is a 3.5” touch-screen that is 480x 320 pixels.

Along with the introduction of the iPhone 3GS, Apple has also released the iPhone version 3 Operating System (OS). In large part, Apple has succeeded with its foray into the smartphone market because of a remarkably compact hardware design and a user interface that resonates with how people intuitively think, making it easy to navigate the various applications installed on the phone. Speaking of applications, the innovation of the Apple Store that has allowed so many applications to become available for the iPhone will be covered later in this paper.
AT&T has an exclusive operator agreement in the U.S. with Apple. So technically, the iPhone only works on the AT&T cellular network, since no other U.S.-based carrier is currently allowed to sell the iPhone. Programs, known as jailbreak applications, can unlock the phone, allowing Subscriber Identity Modules (SIMs) from other GSM/UMTS wireless carriers to be used. However, the iPhone user runs the risk of bricking (ruining) the phone. If a software update is downloaded and installed, it could disable the phone, once the iPhone detects its unlocked status.

Nokia

For many years, this Finnish company had enjoyed the greatest market share of cellular phones of any company in the world. Their overall market share has been decreasing the last couple of years, however, with the introduction of newcomers that are making headway into the smartphone market. This has spurred the company to create a winning product to compete with Apple’s iPhone and various touch-screen models, like those introduced by Samsung, HTC, Palm, and other competitors.

Nokia has had success with their popular E71 smartphone model in the U.S. after striking a deal with AT&T to release the E71x. Prior to this arrangement, E71s had to be purchased unlocked to operate on U.S.-based GSM/UMTS networks such as AT&T and T-Mobile. Because AT&T now offers it in their inventory, subscribers can acquire it for significantly less (and in some cases, for virtually no out-of-pocket costs) with a two-year contract. It appears that the difference between the E71 unlocked phone and the AT&T E71x version is a newer software feature pack (Feature Pack 1 versus Feature Pack 2, respectively). Both have the Symbian S60 Operating System (OS) 3rd edition.

The E71 features a 3.2 megapixel autofocus camera with built-in flash. It also has an integrated A-GPS receiver, supports HSDPA (High Speed Downlink Packet Access), contains a WiFi (802.11g) radio, and has a physical keyboard.

Nokia introduced the N97 in the first half of 2008, which has a large, high-resolution graphics display touchscreen with a physical keyboard that slides out from under the 3.5”, 640x360 display. The phone runs the Symbian 9.3 Series 60 (5th edition) OS. The chief complaint among reviewers is that the OS appears outdated when compared with Apple’s iPhone OS 3.0 and Palm’s new WebOS.

The Nokia N97 mini has been introduced more recently; it’s a slightly smaller, lighter version of the N97 for consumers looking for more compactness. The phones are feature-rich, but very expensive. No U.S. operators are currently subsidizing the purchase. The list price (at the time of this writing) is about $700–$750.

However, what really seems to be the big news regarding Nokia’s latest smartphone development is the N900. This is a Linux-based OS, with the particular version called Maemo. The OS is coupled with the OP5-E fully-multiprocessing processor, manufactured by Optima Technology, a company based in China.[1] The scheduled release of this product was set for October, 2009. This device, Nokia’s most recent entry into the smartphone product line, has similar features to the N97 and appears to have a preliminary retail price of $799. Again, a high price tag, but can it compete with Apple’s iPhone and Palm’s Pre?
Research In Motion® (RIM®)

RIM, maker of the BlackBerry®, is based in Waterloo, Ontario, Canada. In the past, RIM focused on the corporate customer. However, their latest success brings rapid growth in the consumer market. It is interesting to note that one of their hottest selling products is the BlackBerry Curve™, which isn’t even a current product. It has moved from the corporate space to the consumer space and is popular among teens and younger adults interested in social network applications.

The BlackBerry Bold began selling in 2008, and was an important move into faster 3G devices. One of RIM’s newest products is the BlackBerry Tour, which appears to combine some of features of the Bold and Curve models. It has a physical keyboard with a 2.4 inch display that has a 480 x 360 pixel resolution. The smartphone also contains a zippy processor for fast downloading and a 3.2 megapixel camera, but it does not have a WiFi radio (so no support for the WiFi hot spot or home network you may otherwise have access to with other smartphones).

The Blackberry Storm features a touch-screen display that measures 480 x 360 pixels. Again, the disappointment is no WiFi radio. Reviews detail problems with the touch-screen, saying it has a slow response time when typing. However, the new, improved version of Storm 2, scheduled to be released sometime in late 2009 for Verizon customers, will include a WiFi radio along with the promise of an enhanced touch-screen.

Samsung

Samsung is based in South Korea. They have been involved in consumer electronics for many years. Their corporate roots date back to the late 1930s, but they began manufacturing CDMA handsets in 1996. [2]

Samsung released the Blackjack (SGH-i607) back in 2006, sporting a physical keyboard and a good quality display. More recently, they have released the Jack, which runs Windows Mobile 6.1 Standard Edition OS. This smartphone, offered through AT&T in the U.S., includes a GPS receiver, a 3.2 megapixel camera (fixed focus), and a WiFi (802.11b/g) radio. It has a physical keyboard like its predecessor, the BlackJack, and a 320 x 240 display resolution (no touch-screen capability).

Samsung has made deals with AT&T, Sprint, T-Mobile, and Verizon Wireless to carry their many different models. This is a different strategy from other handset manufactures, which have reached agreements to offer their phones exclusively through one carrier.

With the introduction of touch-screen capability, Samsung has lunged at the opportunity to compete in the top-tier of smartphone technology. Samsung has released several different models of touch-screen smartphones. Partnering with all the major U.S. carriers, Samsung has indeed made tracking and comparing all the different models they offer almost mind-boggling. They want to offer what carriers desire to provide to their customer base. Since touch-screen technology is a big hit with customers, they have come up with many different models, which in turn requires support for different wireless platforms (e.g., GSM/UMTS and CDMA2000/EV-DO).

The Instinct (SPH-M800) works on the Sprint network, which operates on their 3G EV-DO Rev.A network. It has an integrated GPS receiver, a 2 megapixel camera, memory expandable up to 8 GB and a 3.1-inch touch-screen with a 432 x 240 display resolution.
T-Mobile (USA) offers the Samsung Behold. This phone has two other designators it is known by: Roxy and SGH-T919. The 3-inch display has a display resolution of 240x320 and works on HSDPA networks, the faster overlay for 3G UMTS networks. This phone contains a 5 megapixel camera but does not have a WiFi radio.

The Samsung Glyde (SCH-U940) is offered through Verizon Wireless. This is a CDMA2000-based phone. The GSM/UMTS version of this model is the Samsung F700. The Glyde has a 2.75-inch tough-screen and also has a slide out QWERTY keyboard, 2 megapixel camera and GPS receiver.

Samsung offers the Solstice through AT&T. This model is also referred to as the SGH-A887. This touch-screen design has a 3-inch display with a 400x240 pixel resolution. It contains a 2 megapixel camera, and a GPS receiver.

Samsung’s innovation may prove to be a real crowd pleaser. The OMNIA has a 3.2-inch touch-screen with a 240x400 display resolution. The phone is designed for GSM/UMTS with support for HSDPA and has a WiFi radio. The current OS is Windows Mobile, version 6.1. The Web browser installed on the phone is Opera Mobile 9.5. It also has a 5 megapixel camera with autofocus and image stabilization.

HTC

HTC (formerly, High Tech Computer Corporation) is based in Taiwan. The company was started in 1997, primarily focused on mobile handset designs that used Microsoft’s Windows Mobile OS.[4, 5] One of the biggest differentiators present when comparing HTC to other handset manufactures is the fact that they were the first to release a smartphone with the open source Android OS.

HTC is a member of the Open Handset Alliance. This was established for handset manufacturers that wish to incorporate the open source Android operating system in their products.

HTC’s Dream was the first Android smartphone, released as the G1 by T-Mobile in the U.S. on September 23, 2008.[3, 4] Since then, HTC has released the Magic, which T-Mobile introduced as the myTouch 3G, made available in August, 2009.

The latest smartphone by HTC, based on the Android OS, is the Hero, released in July 2009. It became available in several European countries. Sprint has offered the Hero since October, 2009. The latest improvement includes a 3.2-inch touch-screen display with 320 x 480 pixel resolution, a 5 megapixel camera, a WiFi radio, a dual-band HSPA radio and supports quadband GSM.

If you prefer the Windows Mobile OS, HTC has the Touch Pro2. This smartphone possesses a slide-out keyboard along with a touch-screen with 800 x 480 pixel resolution. It also has a 3.2 megapixel camera and a WiFi radio.

Motorola

Motorola was once a global leader in manufacturing mobile handsets, dating back to the beginning of cell phones when analog cellular networks were being built. The company has been through difficult times during the past couple of years with a deep slide in market share. In 2008, Motorola decided to spin off the mobile
handset business from its core business. However, market conditions did not allow this decision to be immedi-
ately implemented.

Instead, Motorola decided to streamline the variety of software platforms they were using for handset develop-
ment. They focused on implementing handsets based on three different operating systems, Windows Mobile
(proprietary), Android (open source), and their own proprietary platform for lower-end handsets, which would
not be categorized as smartphones.

According to a Bloomberg article (Motorola Banks on Android to Revive Phone Business) dated August 28, 2008,
Motorola is using Android as the software platform of choice for their mid- to high-tier smartphones. Currently,
there are not many handset manufactures that have jumped on the Android bandwagon, limiting the current
market share, as of mid-2009 to about two percent.

The Android OS could be the key to increasing Motorola’s market-share if it can prove to be highly reliable and
gain enough acceptance that third-party developers will want to build an applications catalog.

Conclusion
This paper has covered the trend toward mobile data applications and the features that define a smartphone.
The hardware of these devices moved to high-resolution, large displays compared to 2nd generation phones.
From keypads to alpha-numeric keyboards, to touch-screens, today’s smartphones resemble a mini multimedia
computer rather than a mobile phone. And although there have been many exciting changes in smartphone
technologies, innovation and competition will ensure that there are many more changes to come.

Learn More
Learn more about how you can improve productivity, enhance efficiency, and sharpen your competitive edge.
Check out the following Global Knowledge courses:
  Telecommunications Fundamentals
  Voice over IP Foundations

For more information or to register, visit www.globalknowledge.com or call 1-800-COURSES to speak with a
sales representative.

Our courses and enhanced, hands-on labs and exercises offer practical skills and tips that you can immediately
put to use. Our expert instructors draw upon their experiences to help you understand key concepts and how to
apply them to your specific work situation. Choose from our more than 1,200 courses, delivered through Class-
rooms, e-Learning, and On-site sessions, to meet your IT and business training needs.
About the Author

Donald Hill is president of ProActive Technical Solutions (PTS), Inc. PTS is a consulting company that helps small- and medium-sized businesses with their voice communication systems and networking needs. He has been working as a contract Instructor for Global Knowledge for 10 years. Don also developed the Telecommunications Fundamentals curriculum, which he has been involved with for eight years. He also has nine years of experience as a telecommunications manager for industry-leading financial services and manufacturing companies.

References


The Trademarks RIM, Research in Motion, and BlackBerry and BlackBerry Curve are owned by Research In Motion Limited and is registered in the United States and may be pending or registered in other countries. Global Knowledge Training, LLC, is not endorsed, sponsored, affiliated with or otherwise authorized by Research In Motion Limited.

Apple and iPhone are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.