Chapter 11

Key Drivers of Success for 3G

A Carrier's Perspective

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Abstract: The wireless industry is undergoing a period of rapid transformation and uncertainty. Carriers have deployed or are in the midst of deploying capital-intensive 2.5G and 3G networks. As a result of the commoditization of wireless voice services and subsequent price competition, wireless carriers are relying on the new services made possible by these networks to generate profitable revenue and subscriber growth. This paper discusses the promised vision for 3G and the key drivers that can facilitate the realization of this vision and the success of 3G. A brief introduction to 3G technologies and their status in the U.S. is also provided

Key words: Wireless, 2.5G, 3G, third generation

1. INTRODUCTION

The wireless market is at the beginning of a rapid transformation that is going to profoundly change the business that wireless service providers are in. The market is transitioning from one dominated by voice services to one in which voice is just going to be one of the many forms of data carried on carriers' wireless IP networks. This is happening as a result of the convergence of the Internet world with the wireless world. This convergence, or perhaps collision is a more appropriate term, is going to have significant and profound effects on the way business is done and how people conduct their personal lives.

In this converged World, wireless carriers cannot rely on voice services alone to meet their growth targets and financial goals. Voice service has

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rapidly become a commodity. Wireless carriers must introduce new data services to maintain and grow revenues and margins.

The introduction of 2.5G and 3G wireless technologies in wireless networks provides a foundation for evolving the services provided on existing networks and enabling new services not possible before. 3G technologies are based upon the same network and service philosophies that resulted in the development and realization of the Internet. 2.5G and 3G wireless networks provide a unifying layer that allows a wide range of both voice and data services to be carried on the same network infrastructure. They both enable new services and reduce the cost of providing services.

1.1 The 3G Vision

With speeds that approach those of wireline transport, 3G enables the delivery of new services such as mobile multimedia, enhances the usability of existing wireless services, provides an enhanced mobile Internet, and provides these services on attractive and easy-to-use multi-function devices.

- **Mobile Internet** – Users have the ability to stay connected to the Net from anywhere at any time; mobile web sites will look and feel better, through color and sound.
- **Mobile Multimedia** – No longer is the wireless service experience limited to voice calls, simple text messaging, and slow data speeds. The higher speeds and efficiencies of 3G networks enable voice, text, data, image, audio, and video to be provided to the mobile user.
- **New, Multi-use Devices** – A main draw of 3G for consumers will be futuristic multimedia devices that will enable access to a variety of Internet-based services.
- **Worldwide Roaming** – Using the same device, users have the ability to travel anywhere in the world and access and use the same services as when at home.
- **Converged Networks** – Voice, data, and multimedia services are all provided on one wireless network, not on separate networks as they are today.

1.2 Key Drivers for Realizing the Vision

There are several key drivers that will facilitate the realization of the 3G vision. The success of 3G and the services the technology provides are critical to the long-term success of the participants in the wireless industry. The drivers that are summarized here and discussed later in this paper must be focused on by all of the members of the industry: carriers, application developers, infrastructure providers and device manufacturers. These key drivers are:

- **Realistic expectations** and an understanding of what a 3G network can and cannot do are necessary on the part of customers and the companies that serve them.
- **Application and services** that leverage the unique capabilities of 2.5G and 3G wireless networks need to be developed and available when the networks are available.
- **Devices** must be available and support the services that can be provided on 2.5G and 3G networks.
- A **Viable Ecosystem** must be developed which allows all industry participants to realize profitable businesses.
- **Standards** are always necessary in the wireless industry and go beyond those that are codified to include standards that are not approved by a standards body.

2. STATUS OF 2.5G AND 3G IN THE UNITED STATES

Wireless technology and services have changed significantly since 1983 when the first wireless phone networks were introduced. These first-generation networks were based on analog radio technology. In the U.S., these systems were based on AMPS (Advanced Mobile Phone Service).

U.S. Carriers began implementing digital phone networks in the early to mid-1990s. These second-generation networks provided greater voice capacity and enabled new services such as caller id and text messaging. McCaw Cellular launched the first digital network, TDMA, in 1992. Both CDMA and GSM 2G networks were later rolled-out by other carriers. At the same time, some carriers implemented the first wireless packet data networks as an overlay to their 2G voice networks. One such network

technology is CDPD, which provides wireless data speeds comparable to 9.6 kbps dial-up modems.

Starting in 2001, carriers began adding integrated wireless packet-data service capabilities to their 2G networks creating 2.5G networks. A key feature of 2.5G networks is higher speed wireless data services that are provided on the same infrastructure as voice. AT&T Wireless was the first to launch a 2.5G network in mid-2001 with GPRS. 1xRTT, another 2.5G network technology, is expected to be launched by CDMA technology-based carriers (Sprint PCS and Verizon Wireless) in mid-2002.

The first 3G services will become commercially available in the U.S. beginning in 2003. Some early 3G commercial launches have occurred in Japan and Europe.

2.1 Two Primary 3G Technology Platforms

The International Telecommunications Union (ITU) initiated the IMT-2000 project to define third-generation wireless systems. IMT stands for International Mobile Telecommunications and 2000 refers to both the target frequency 3G would operate as well as the targeted availability date. IMT-2000 defines the functional requirements of 3G networks. Key requirements include:

- Voice quality comparable to wireline
- Packet-switched data
- High spectral efficiency
- Support for 384 kbps data rates over a wide area (mobile)
- Support for 2 Mbps data rates within a local area (fixed)

Seventeen technology standard proposals were submitted to the ITU in 1998. All seventeen proposals were accepted as IMT-2000 ("3G") standards. The two primary technology platforms are Wideband-CDMA (W-CDMA) and cdma2000. W-CDMA, also referred to as UMTS, is the 3G evolution path for GSM and TDMA. cdma2000 is the 3G evolution path for cdmaONE. Both technologies utilize a code division multiple access (CDMA) airlink, but are not compatible with each other. This means that a device designed to operate on one network technology will not work on another technology. EDGE (Enhanced Data rates for Global Evolution) is an additional 3G technology that is part of the 3G GSM and TDMA evolution.

Most carriers worldwide have chosen W-CDMA as their 3G technology. cdma2000 has been chosen by carriers primarily in North America and Asia.

Over 80% of the world's wireless subscribers are on the W-CDMA evolution path.

2.1.1 Wideband-CDMA

Wideband-CDMA (W-CDMA) is the solution for 3G proposed by the European Telecommunications Standards Institute (ETSI). Wideband-CDMA is also referred to as UMTS, which stands for Universal Mobile Telecommunications System. As mentioned, W-CDMA is the 3G evolution for GSM. Most TDMA carriers as well have chosen this as their 3G technology path

W-CDMA uses a 5 MHz wide radio channel as opposed to the 200 kHz and 30 kHz channels used by GSM and TDMA respectively, hence the term *Wideband.* W-CDMA also utilizes a code division multiple access (CDMA) airlink as opposed to a time division multiple access (TDMA) airlink used by both GSM and TDMA. The bandwidth needs of W-CDMA mean that for many operators new spectrum is needed for deployment.

2.1.2 EDGE

EDGE (Enhanced Data for GSM Evolution) is an upgrade to GPRS that provides data speeds up to 384 kbps. EDGE uses a higher modulation scheme than GPRS to achieve higher data rates on the same 200 kHz channel. In many cases, EDGE can be implemented as a software upgrade to the carriers' radio access network (basestation) infrastructure. This allows GSM/GRPS carriers to upgrade to 3G data speeds without needing new spectrum or significant additional capital.

2.1.3 cdma2000

cdma2000 is the 3G standard supported by the CDG (CDMA Development Group) and the 3GPP2 (Third-Generation Partnership Project 2) as the 3G evolution of cdmaONE (IS-95). cdma2000 is also commonly referred to as 1x. 1x refers to using one times the frequency bandwidth of cdmaONE. This indirectly touts the fact that cdma2000 uses the same radio channel bandwidth (1.25 MHz) as cdmaONE implying that new spectrum is not needed for deployment. cdma2000 is a family of technologies referred to as 1xRTT, 1xEV-DO, and 1xEV-DV, which provide for a phased approach to 3G deployment for CDMA carriers.

2.2 Wireless Network Evolution

The evolution of wireless from 2G to 2.5G to 3G is following two primary paths. The accompanying figure shows these paths and timeframes. The figure is illustrative of North America from a timing perspective.

GSM and TDMA carriers are migrating to 3G through the deployment of 2.5G GPRS networks. GPRS initially became commercial in 2001 followed by complete deployment by most GSM carriers in 2002. Carriers then migrate directly to W-CDMA or upgrade their GPRS network with EDGE followed by a W-CDMA deployment. Early trials and launches of W-CDMA and EDGE began in 2002 with full commercial offerings expected in 2003 and 2004. After W-CDMA, the next step is to HSPDA (High-Speed Packet Downlink Access), which provides data speeds up to 10.8 Mbps. This technology will be available commercially in 2004 at the earliest.

CDMA carriers are upgrading their cdmaONE (IS-95) networks with a family of technologies referred to as cdma2000. The first cdma2000 upgrade is 1xRTT, which increases both voice capacity and provides packet data speeds up to 153 kbps. Although some CDMA operators and infrastructure providers tout 1xRTT as 3G, it should really be viewed as a 2.5G technology since it does not meet the ITU defined data speed requirement of a 3G network. Wide commercial availability of 1xRTT is occurring in 2002. The next step is the deployment of 1xEV-DO. The EV stands for *Evolution* and the DO for *Data Only*. 1xEV-DO is the deployment of a separate channel to support just high-speed data at speeds up to 2.4 Mbps. 1xEV-DO would exist side-by-side a 1xRTT network. 1xEV-DO will not be widely available commercially until 2003 or 2004. The final 1x step is to 1xEV-DV. In this case, the DV refers to *Data & Voice*. 1xEV-DV provides for both data and voice on the same network. 1xEV-DV will not be commercially available until 2004 or later.

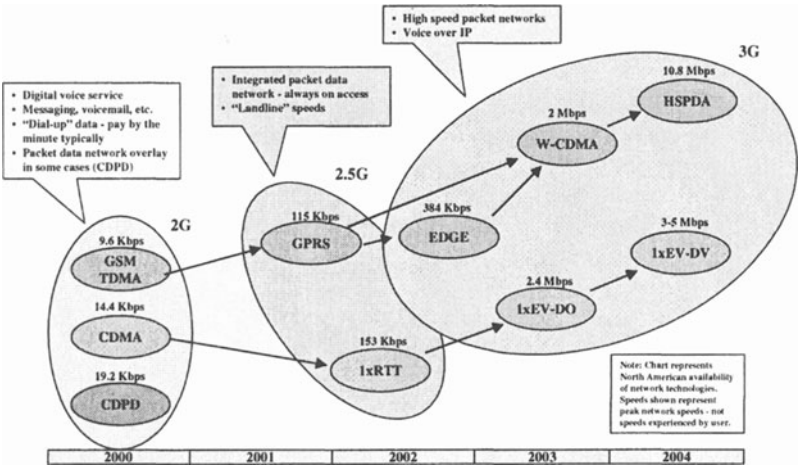

Figure 1. Wireless Network Evolution

2.3 3G Plans of U.S. Wireless Carriers

Table 1 indicates the announced or anticipated 2.5G and 3G plans of the six largest U.S. wireless carriers.

Carriers with a 2G network based on GSM are on a GPRS to EDGE to W-CDMA path. VoiceStream is on this technology path. VoiceStream currently has GPRS available in all its markets.

The TDMA community has also announced support for W-CDMA. In the U.S., the largest TDMA operators have begun building and launching GSM and GPRS networks as a step toward 3G. A key factor in these carriers' decisions was the selection of the most widely supported wireless technology worldwide. Commercial GPRS availability began in mid-2001. These carriers' deployments of 2.5G GPRS are either complete or will be complete by the end of 2002.

The two largest CDMA operators, Sprint PCS and Verizon Wireless, have announced plans for 3G based on 1xRTT and 1xEV. Commercial

availability of 1xRTT is expected by mid-2002 with nationwide availability shortly after. Despite assertions being made by the CDMA industry that 1xRTT is 3G, the performance of 1xRTT is comparable to GPRS.

Nextel utilizes iDEN for its 2G network. This network technology provides digital voice and low-speed packet data. More important is that iDEN provides one of the few technology-based differentiators in existence – push to talk. Despite the success that Nextel has achieved with iDEN, the technology does not have a defined evolution path. Nextel is currently testing and evaluating 1xRTT but has not made any commitments.

The first commercial launch of 3G in the U.S. will probably be based on EDGE and may occur before the end of 2002. W-CDMA and 1xEV-based 3G commercial services should begin in 2003 with nationwide availability in 2004. The speeds of these deployments are going to be affected by the success of 2.5G services and the overall health of the wireless industry.

Table 1. 3G Plans of U.S. Carriers

Carrier	2G Technology	2.5G Technology	3G Technology
AT&T Wireless	TDMA & GSM	GPRS	EDGE & W-CDMA
Cingular Wireless	TDMA & GSM	GPRS	EDGE & W-CDMA
Nextel	IDEN	Testing 1xRTT	None announced
Sprint PCS	CDMA	1xRTT	1xEV
Verizon Wireless	CDMA	1xRTT	1xEV or W-CDMA
VoiceStream	GSM	GPRS	EDGE & W-CDMA

2.4 Why Carriers Are Migrating to 2.5G and 3G

Carriers are migrating to 2.5G and 3G for several reasons. 2.5G and 3G technologies increase the capacity for both voice and data services by making more efficient use of existing spectrum. This reduces the cost of providing service, making various new services economically feasible.

2.5G and 3G technologies also provide faster wireless data transport. This allows new services and applications to be provided that were not technically possible before, such as video telephony.

The combination of decreasing the cost of providing service with increasing capabilities of the networks allows new services and applications to become available. Figure 2 shows some examples of service evolution and creation.

Clearly, staying on competitive par is going to be a driver for migration to 3G. However, that alone is not enough to justify the necessary capital investments. In an environment where voice service is a commodity with declining margins, carriers must provide new services to maintain revenue and subscriber growth.

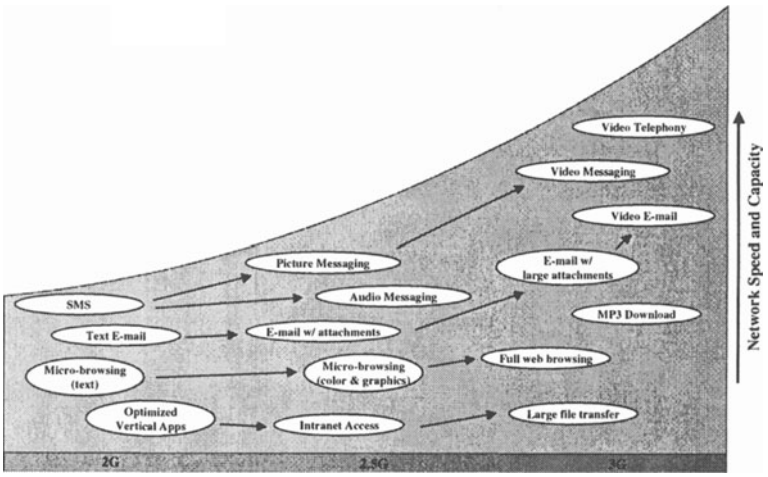

Figure 2. Evolution of Applications with Technology

3. KEY DRIVER: REALISTIC EXPECTATIONS

A key driver for the ultimate success of 3G is going to be the setting of realistic expectations for what 3G can provide. This is important both in terms of what the network can do and how it is used. The speeds that are often quoted for the network technologies are the peak theoretical speeds of the network. These are not what a user of the network is going to typically experience.

In addition, there is the perception that 3G is going to have the same use and economics as competing wireline technologies such as DSL or local area wireless technologies such as 802.11. This often leads to thinking of 3G as a technology that extends the same wired Internet applications to a wireless environment.

3.1 The Reality of Wireless Data Speeds

The wireless data speeds for 2.5G and 3G networks that are generally stated are the peak network speed. This speed assumes optimal conditions and limited or no mobility (i.e., the wireless user is not moving). Table 2 lists the peak network speed for the 2.5G and 3G network technologies.

The peak speed the network is capable of providing may not be achievable by the devices operating on the network. On GPRS and EDGE networks, the airlink is divided into 8 timeslots. Most devices for these networks are only capable of receiving data on 3 or 4 timeslots and transmitting data on 1 timeslot. Hence, the peak device speed for GPRS and EDGE is lower than the peak network speed. For spread spectrum airlink technologies (W-CDMA, HSPDA, 1xRTT, and 1xEV), the peak device speed is the same as the peak network speed.

Most GPRS and EDGE devices are not designed to utilize the entire bandwidth available from the network because of design considerations concerning power consumption and heat output. The same design issues hold true for devices on spread spectrum (CDMA) airlink based network technologies. Power consumption, heat output, and processing power will limit the devices to wireless data speeds that are significantly below the peak network speeds of their respective network technologies.

Factoring in real world conditions and device capabilities, the accompanying table lists the data speeds that would be typically experienced by an end user in two different scenarios: Internet browsing on a wireless-enabled PC and media streaming (audio or video) to a wireless-enabled PC. The "bursty" nature of Internet browsing allows the user to experience higher data speeds, on average, than with media streaming. Streaming media places a relatively constant data throughput demand on the network. Because data throughput in a wireless environment can be highly variable, a wireless streaming media application runs at a lower speed to minimize the effects of the variability of the data airlink. However, even with this limitation, spread spectrum airlink networks are better able to support streaming media than GPRS or EDGE networks as shown in the table.

Table 2. Wireless Data Network Speeds Comparisons: Peak vs. Experienced

Network Technology	Peak Network Speed	Peak Device Speed	Average PC Browser Speed (loaded network)	Average Streaming Media Speed (loaded network)
GPRS	115 kbps	53 kbps	20-30 kbps	10-20 kbps
EDGE	384 kbps	237 kbps	80-130 kbps	20-40 kbps
W-CDMA	2 Mbps	2 Mbps	200-300 kbps	Up to 384 kbps

Network Technology	Peak Network Speed	Peak Device Speed	Average PC Browser Speed (loaded network)	Average Streaming Media Speed (loaded network)
HSPDA	10.8 Mbps	10.8 Mbps	~850 kbps	Up to 384 kbps
1xRTT	153 kbps	153 kbps	40-60 kbps	~64 kbps
1xEV-DO	2.4 Mbps	2.4 Mbps	120-300 kbps	50-100 kbps

3.1.1 Creating Confusion

A war of sorts has been waging around 3G technology for years. This initially was started by companies and countries with much at stake in the decisions being made about 3G standardization. The two primary sides were the proponents of W-CDMA and cdma2000. Now, with the majority of the world having chosen W-CDMA, this war is primarily being fought in North America.

Today this war takes the form of competing comparisons of 3G network technologies. Usually this comparison is in the form of claims about network speeds or the costs to deploy and operate a given technology. At its simplest, the arguments can be summarized as "my network is faster than your network" or "my network is cheaper to own and operate than your network."

The reality is that both technologies are relatively on par with each other from the perspective of what the user is going to experience in real world conditions. The real issue is that the wireless industry in general is currently not doing a good job of setting realistic expectations about what the networks can do and they should be used. The potential impact of this is confusion or dissatisfaction on the part of wireless customers.

3.2 A Different Kind of Internet

3G is not about making the Internet *wireless*. It's about creating a *wireless Internet* - a new world with its own ecology: applications, content, devices, and customers. The wireless industry in general has done a poor job of setting the right expectations with customers for wireless data. It has confused customers with messages that lead to an expectation that the wireless Internet is the same experience as the wired Internet. Greater focus has to be given to creating services and experiences that leverage the differences and unique capabilities of an Internet that is wireless. These differences also need to be communicated to wireless subscribers and reinforced by an experience on the wireless Internet that highlights its unique value.

4. KEY DRIVER: APPLICATIONS & SERVICES

Applications that exploit the value of a wide-area wireless network and customers' needs and desires need to be in place for 3G to succeed. Too much focus has been placed on multimedia, specifically video, without providing relevant examples of how multimedia is valuable in a mobile environment. Even though 3G networks can support video and high-fidelity audio, the cost of wireless transport is going to make these types of services premium offerings.

As stated in the previous section, the real promise of 2.5G and 3G wireless networks is not in making desktop, broadband applications portable. It is in the enablement of applications and services that leverage the unique capabilities of the wireless environment. These capabilities are:

- Personal and Ubiquitous
- Location and Presence

4.1 Personal and Ubiquitous

Wireless networks from their inception were designed to be both personal and ubiquitous. These two characteristics are necessary to meet the basic need that a wireless network is designed to meet - allowing people to communicate.

Personal as a wireless characteristic has several facets. It means having a device that is always with an individual and that is addressable to that individual. Combined with a ubiquitous network, this provides a wireless subscriber the ability to connect to and be connected by the people and information that is important to them - no matter where they or the subscriber are. Personal also means delivering information that is specific to that individual as compared to radio or television that broadcasts the same information to everyone.

A key aspect of the usefulness of the wireless Internet is its ubiquity and always-accessible nature. Always connected, always on, and always with you – this is a key differentiator of the wireless Internet over the wired Internet. This not only means that someone can access information at any moment, but that information can be delivered in real-time to someone without needing to request it.

The wireless Internet is a more useful environment for delivering personal, useful information to someone than the wired Internet. The wired Internet is generally an experience where someone sits down and requests information. Even if an Internet user has subscribed to an info-service that is personalized for them, it either requires accessing email to get to the

information or accessing a website that has been profiled for them. The always-accessible nature of the wireless Internet allows a mechanism to deliver information directly to users in real time since they have an addressable device that is always connected and with them. This is a key differentiator that should be leveraged in creating wireless applications.

The quest for the killer application has almost taken on the same mythical proportions as the quest for the *Holy Grail.* There is no one killer application for 2.5G and 3G wireless networks. However there is one killer application category. Consistently, applications that provide person-to-person communication and interaction have been successful on wireless networks. For first-generation and second-generation networks the primary service has been voice. On 2G networks, an increasingly popular and successful service has been two-way text messaging. For 2.5G networks, early success may be garnered in the areas of e-mail, instant messaging, and multimedia messaging (specifically photo messaging).

4.2 Location and Presence

The capability to locate a wireless device is currently being implemented by wireless carriers. The FCC requires this capability of U.S. carriers to support locating subscribers calling E911. Many carriers are extending the ability to determine a subscriber's location to third parties to location-enhance their applications. For privacy reasons, location information is only provided to third parties with the permission of the subscriber.

Many different kinds of applications can be enhanced with network provided location information. More obvious uses are for "Find It" applications in which the wireless subscriber is looking for a place such as a restaurant. Network provided subscriber location adds value by not requiring the subscriber to enter in an address to provide current location. A location-enhanced "Find It" application can then provide a list of places of the type that the user is looking for in the area of the subscriber. Step-by-step directions from the subscriber's location to the place can then be provided.

Location can also be used to enhance a calendar application. Instead of getting an alert 15 minutes before the start of a meeting, the calendar application could be aware of the subscriber's location and provide an alert with sufficient notice to allow for travel time. Business travellers are often confronted with the dilemma of needing to know how long it's going to take to get from point A to B and can they extend the meeting they are in a little longer?

Location capabilities also allow the creation of a new category of applications where the purpose is determining where other wireless

subscribers are located. This could be a "Friend Finder" application to find out if there are any friends nearby. A parent could use the same type of application to check on the location of a child. In the entertainment category, location-enabled games can be created in which players compete with other geographically co-located players for neighbourhoods in a virtual reality.

Closely related to knowing where a subscriber is located is knowing whether the subscriber is even available on the network. This capability if referred to as *Presence*. Providing third party applications with presence information allows those applications to know whether a subscriber can be contacted or reached with information. Applications such as *instant messaging* rely on presence knowledge.

5. KEY DRIVER: DEVICES

Devices are also going to be a key driver for the success of 2.5G and 3G networks and services. As stated earlier, 3G is not about making the Internet wireless. In the same vein, the success of 3G is not going to be driven by wirelessly enabling larger "portable" devices such as laptops. Many of the locations where laptops are used, such as offices, hotels, airports and other public spaces, are being outfitted with high-speed access in both wired and wireless forms such as WiFi. The types of devices that are going to ultimately drive the success of 3G wide area networks are those that are personal and portable; and are designed with data services in mind.

5.1 Personal and Portable

Today's generation of wireless phones are an example of a highly personal and portable device. For many individuals, these phones are like a wallet or purse; they are always carried on the person. This has been enabled by the reduction in size of the phones and the increased longevity of the batteries. Many wireless phones are always powered on and have even become a replacement for the home phone. For many users, a wireless phone is the primary means of being contacted in both their personal and professional lives.

5.2 Data Focused

Wireless devices also have to move beyond being voice-centric. Most manufacturers have done a poor job of building wireless phones that allow the limited data services available on them to be easy to use. One of the biggest obstacles to the success of WAP has been the size of the screens and

the lack of rich graphic support. Three-line monochrome displays do not support much more than text messaging. Micro-browsing on a phone is a much better experience with a large color screen like those found on most phones in Japan. The experience is so much better it's akin to moving from DOS to Windows in a PC environment.

Apart from visual output, wireless phones must also become more usable and rich in terms of input. Input devices such as joysticks and jog dials enable simpler navigation of the wireless Internet. Voice command capabilities can also make devices easier to control and safer to use in vehicles. Predictive single-tap text input technologies such as Tegic's T9, make text input much easier than the multi-tap default option.

Multimedia capabilities such as multimedia messaging service (MMS) are going to require the ability to capture audio, still images, and even video. Digital cameras may become a common feature on wireless phones and, at a minimum, need to be available as an accessory. Audio capture is needed for voice messaging.

Finally, with all the media that is being delivered or input into these devices, memory capacity becomes increasingly important. Memory is an expensive medium and manufacturers, especially phone manufacturers, tend to limit the amount provided to keep costs down. To add flexibility while at the same time keeping costs down, wireless phones need to have a key feature that PDAs increasingly have – memory card slots. This would allow users to customize their device based on the memory demands of the applications they use.

5.3 Variety

In the not too distant past, a wireless subscriber had a limited set of handsets to choose from. The choice in colors was even more limited: black and possibly grey. Today, wireless devices have become increasingly diverse and varied to meet the needs of different users and uses. Multiple device ownership is going to become more common as wireless subscribers purchase devices for different uses, for example, business versus personal.

The ability to personalize a device is a common feature. Many handsets have faceplates that can be changed. New ringtones and display graphics can also be downloaded. A wireless device is one of the few items that someone has with them at all times. Being able to personalize this device meets a fundamental human need for self-expression. New device capabilities that are coming with 2.5G and 3G devices such as color screens and polyphonic or better ringtones make these devices even more personalizable.

The increased variety and capabilities of 2.5G and 3G devices provide reasons for subscribers to migrate to these new networks. Wireless subscribers often make purchase decisions based on the device and not the service. "Cool" devices by themselves can lead to subscribers choosing and using 2.5G & 3G networks and services.

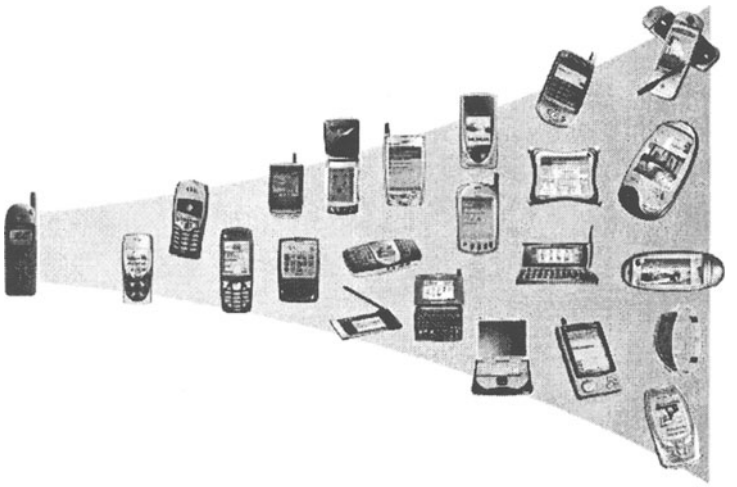

Figure 3. Device Evolution

5.4 Open Application Environment

As wireless devices add more data capabilities, it will also be important for them to become more flexible. Flexibility in this case is defined as being able to add new capabilities and services to the device after it has been manufactured. In the PC environment this is achieved by being able to install and run new applications. Similarly, wireless devices should have the ability to download new applications. This is important because it is impossible to anticipate all the applications and services that people are going to want.

One way this capability can be enabled is by having an open operating system with an application environment. Symbian, PocketPC, and Palm are operating systems that are being implemented in wireless devices. Devices

with these OSs support the loading of new applications. These devices are often referred to as Smartphones. They are in a category between wireless phones and PDAs that combines the features of each. These devices look like traditional wireless phones with a larger screen or have a PDA-like appearance.

5.4.1 Symbian

The Symbian OS, formerly known as the EPOC OS, is an operating system developed through a joint venture of Psion, Nokia, Ericsson, Motorola, and Matsushita. Several manufacturers, notably Nokia and Ericsson, have commercial products available based on the Symbian OS. Many more products are scheduled to be released over the next year. Nokia predicts that in the near future, the majority of the phones they manufacture are going to be Symbian based. A large developer community has been growing in parallel with the increasing availability of Symbian devices.

5.4.2 PocketPC

The other major OS for mobile devices is Microsoft's PocketPC. Like Symbian, the PocketPC OS is designed to operate on different form factors. The Stinger platform is designed for a wireless phone (smartphone) form factor. At present, Sendo has the only commercial Stinger phone. Microsoft is having more success in the wireless PDA space. There are several commercial or near-commercial wireless devices in the traditional PDA PocketPC form factor. These include the XDA manufactured by HTC and being sold by mmO2 and the Mitsubishi Mondo. Increasingly, PDAs such as ones based on the PocketPC OS are being developed with the ability to access wireless networks built-in.

5.4.3 Palm

An additional operating system that is showing up in wireless devices is the Palm OS. Palm Computing, Inc. helped establish the PDA market in the mid-1990s and devices based on its Palm OS continue to lead in market share over the PocketPC. However, this share has decreased significantly and the lead may shift in the near future. Palm both manufactures devices based on their OS and licenses the operating system to other manufacturers. Several commercial wireless devices have been released based on the Palm OS. These include phone form factor devices, like the Qualcomm pdQ smartphones, Kyocera QCP 6035, and the Handspring Treo, and PDA form

factors like the Palm VII. Palm Computing believes that their future is in wireless and has shifted their strategic focus accordingly.

5.4.4 Java and BREW

In addition to the operating systems discussed, application environments in the form of Java and Qualcomm's BREW (Binary Runtime Environment for Wireless) are showing up in wireless devices. In fact, these capabilities on wireless handsets are going to be more common than the operating systems discussed previously. They may eventually become a standard feature in all wireless devices.

BREW and Java in the form of J2ME (Java 2 Micro Edition) allow wireless users to download small applications to wireless devices over the wireless network and then run them locally on their devices. Several advantages are garnered from this capability. After the application is on the device, a network connection is not necessarily needed to run the application. Also, richer applications can be supported than can be done using a micro-browser such as WAP. In the case of J2ME, there is also a very large base of Java developers that can create new applications for wireless handsets or possibly port over existing Java applications to the wireless environment.

Both J2ME and BREW are cross-platform application environments with the promised ability to allow an application developed for J2ME or BREW to work on a variety of different wireless devices. The goal or intent, however, is different from the current reality. Implementations of J2ME can and are different across wireless devices with manufacturers adding different extensions to J2ME and creating proprietary API's. The effect of this is that an application that works on one manufacturer's device may not work on another manufacturer's device. Even if the implementations across devices were identical, differences in the user interface of the device such as screen size and buttons make it difficult to develop just one J2ME or BREW application that is going to run on any wireless device. Although not transparently portable, an application developed for one device can be modified without too much effort to work on another device.

5.5 Bluetooth

Bluetooth is a key enabling technology that is emerging in the device space. Bluetooth is a wireless technology that supports high-speed, short-range data transmission between Bluetooth-enabled devices. It has been designed as a low-cost enhancement for portable devices such as wireless

phones, phone accessories, PDAs, and laptops. Bluetooth serves two important functions: replacing cables and enabling of personal area networks.

Bluetooth can serve as a replacement for the cable that links one device to another. For wireless devices, it enables cordless headsets and the elimination of a physical connection between a wireless phone and a PDA or laptop for wireless data use.

More important is that Bluetooth enables personal area networks. The concept of a personal area network is that all the personal digital devices a user has are able to communicate with each other wirelessly. This communication can take the form of information exchange and synchronization. The devices in a personal area network (PAN) are able to connect to the rest of the computing world and to the Internet through the user's wireless phone or other wireless wide area network (WAN) enabled device.

Bluetooth enables a wireless phone to serve as a network access point for any Bluetooth-enabled digital device. The power of this concept is that wireless WAN access does not have to be built into every device for which such access is desirable. For example, it is very desirable to be able to wirelessly email images directly from a digital camera, but it is also too expensive to build a wireless modem into every digital camera. The low-cost addition of Bluetooth to a digital camera or other device can enable wireless connectivity to the rest of the world.

6. KEY DRIVER: VIABLE ECOSYSTEM

The past two years have seen a shakeout in the wired Internet with many companies going out of business for lack of a profitable business model. For companies operating in the wireless Internet and providing 3G-based services, it is no less important to create and participate in a viable ecosystem.

Wireless carriers have a key role in the wireless ecosystem that is different from the role played by transport providers in the wired Internet. Their role goes beyond being just a pipe provider. At this point in the development of the wireless industry, carriers must facilitate the development and health of enhanced services provided by third parties on their networks. Also, because customers often assume that their wireless service provider is involved in providing the third party services rendered through their wireless device, a carrier often has to handle care calls related

to these services. The ecosystem must support the costs incurred as a result of this developing and caring role.

Carriers are also in a position to provide extremely valuable services beyond the wireless pipe. *Location* and *presence* capabilities are being deployed in wireless networks that enable or enhance a wide range of services and applications. Application and service providers need interfaces to dip into the wireless network to get this location and presence information. Carriers can also provide *preference* and *profile* information on subscribers to enable the services being provided to them to be more personalized. These capabilities allow the content and applications provided to wireless users to be much richer and better targeted at user preferences. This increases their value to subscribers, and therefore the amount they are willing to pay for them. All of these capabilities assume the subscribers active participation in allowing this information to be shared.

Carriers also have billing relationships with their customers. These billing capabilities can be leveraged in the form of *Billing-On-Behalf-of-Others (BOBO)* for third party application and service providers. This allows these providers to avoid having to absorb the cost of billing. Small transactions for electronics goods (i.e., content subscriptions) fit this model well. The success of NTT DoCoMo's iMode service is partially attributed to providing this capability and enabling third party app and content providers the ability to make money.

Carriers may also have to facilitate the development of other business models that generate compensation for third parties, for example an advertising-supported business model. Advertising on wireless devices is becoming more feasible as these devices get larger, color-enhanced screens and multimedia capabilities. The development of creative models in which third parties somehow get compensated for the generation of revenue-increasing traffic may also be required.

Standards-based network technologies and an open, competitive market level the playing field for wireless network transport. A point of differentiation for carriers is how easy they are to do business with and how well they facilitate the provision of third party services on their networks. For carriers to be successful in 3G, they must:

- Make it easy to create applications and services for their networks
- Make it easy to put these applications and services on the networks

Application developers and content providers need more than just a pipe. They need a platform on to which develop and provide applications. For example, interfaces to the carrier's wireless network need to be provided in multiple areas: location, presence, billing, profile/preferences, provisioning, packet network transport, and messaging systems. These interfaces must

meet the needs of the application and content providers. They must be well documented and have a simple, understandable process for working with them.

Because of the variety of wireless devices, the application and service providers also must develop for many different application platforms in order to reach the broadest audience. These include micro-browsers (WAP, cHTML, etc.), JAVA, and the mobile operating systems (PocketPC, Symbian, and Palm). Strong developer programs must be in place to facilitate this development.

Although the wireless carriers play a key role in developing an ecosystem for wireless and 3G, all the participants must actively share in its development.

7. KEY DRIVER: STANDARDS

Standards have played a key role in the success of wireless and are going play an even more important role in driving the success of 2.5G and 3G services. Standards also go beyond the industry-driven kind from groups like the International Telecommunications Union and 3GPP. They include items that do not get codified by a standards body, like common user interfaces.

7.1 Global Harmonization

One of the goals and promises of 3G is that will work globally. Wireless users will be able to take their device anywhere in the world and get access to the same services they have at home. The value of global harmonization goes well beyond worldwide roaming. A world standard also means that companies developing services and devices for 3G have a global marketplace to develop for.

Having access to a global marketplace means that much greater economies of scale are achievable. For example, a network infrastructure provider developing a new network feature can spread the cost of this feature across a much larger customer base. This reduces the cost of the infrastructure, which ultimately reduces service costs for the wireless customer.

A global marketplace also supports greater device and service ingenuity and diversity. A handset developed for Europe can be sold in the Americas and Asia with minimal customization. Manufacturers can take on the risk of developing new device types and form factors because there is a larger base of potential customers. Service providers can create services targeted toward

small customer segments because this segment and many additional customers may exist in other parts of the world. All of this translates into customers having a greater selection of devices and services that meet their particular needs and desires.

7.2 Technical Standards That Work

Defined international standards are only useful if they work. True interoperability within a system must exist end-to-end. This requires work and openness on the part of the industry participants. WAP has been slow to become successful because of interoperability issues between browsers and gateways and between browsers and content providers. A content provider developing content for WAP has to build to the different browser implementations that exist. This increases the cost of development, which is deadly in an environment where viable business models aren't common yet. The wireless industry must work much harder at interoperability and testing.

7.3 Not Just Technical or "Open" Standards

Even if standards are implemented well and there are no interoperability issues, application and content providers are still faced with the issue of there being a multitude of user interfaces on wireless devices. In just the microcosm of browser-enabled phones, there are multiple screen sizes and input mechanisms. Well-designed applications and content require taking into account the user interface and designing for it. In the same way that designing for different browser implementations increases work and cost, different user interfaces on phones also have this effect.

The scale of this issue doesn't exist in the PC environment. The PC industry has standardized to a consistent set of screen size and input methods (QWERTY keyboard and mouse with buttons). The emerging PDA market is standardizing for the most part on a standard set of user interfaces as well, especially in the cases of the Palm OS and the PocketPC OS.

In the wireless handset environment, standardized user interfaces don't exist, with a few notable exceptions. Handsets built for NTT DoCoMo and iMode are one of these exceptions. DoCoMo specifies the UI for different phone models that they purchase. This benefits both the wireless user and the content/application developer. The user can switch devices without having to learn a new interface. The developer can render the application and content in the best manner possible for a limited and defined set of UIs.

The ultimate success of 3G is going to be impacted by the ability of the industry to evolve to a common set of UI's. This is going to require handset

manufacturers to relinquish one of their points of differentiation.

8. CONCLUSION

Ralph Waldo Emerson wrote, "This time, like all times, is a very good one, if we but know what to do with it." Skepticism abounds about whether or not 3G can be successful. Declining ARPUs, slowing subscriber growth, and falling market capitalizations reflect challenging times for the wireless industry. The success of 3G and the return to better times is quite achievable by focusing first on making 2.5G successful, which will lay the necessary foundations for the success of 3G. The key drivers that have been discussed are applicable to both 2.5G and 3G and provide some of the opportunities by which the industry can ensure success.