Mobile communications: global trends in the 21st century

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Abstract: The paper presents an overview of the mobile communications industry. Many aspects of the industry are analysed including the importance of mobile communications, brief history of the industry and mobile applications such as mobile phones, satellites, other handheld devices, wireless computing and m-commerce. The competitive landscape of the mobile phone market is explored based on competing protocols or standards, airtime carriers and handset providers. Trends and forecasts predicted by experts for the industry are also outlined. The key characteristics of the US mobile market are compared with that of European and Asian markets.

Keywords: mobile communications; mobile market; mobile applications; m-commerce; wireless computing.

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1 Introduction

In the current information era, mobile communications has enabled us to use laptop personal computers linked to the internet without a 'wired' LAN. Simply put, if the internet gave us the ability to access any web address on a desktop, mobiles have given us the access at any time and from anywhere. This capability, derived from modern telecommunication technology, is crucial in conducting international business operations.

Nevertheless, due to various mobile protocols and networks available in different parts of the world nowadays, for example, analogue, GSM, TDMA or CDMA, it becomes challenging for the airtime providers to expand their services across technological incompatibility. The developing Third-Generation (3G) standard is attempting to unify all new-generation mobile devices in a single platform. With the new standard, the mobile gadgets may replace desktop PCs, laptop PCs, credit cards or even wallets in the near future! [1].

2 Why go mobile?

Mobile communication allows people to stay in touch with each other at anytime, almost anywhere and through handheld devices. Unconstrained by wires, mobile-system users can communicate while travelling as fast as about 60 miles (100 km) per hour. The mobile phone converts the speaker's voice into radio waves that travel through the air until they reach a receiver at a nearby base station. The base station then sends the call through the telephone network to the intended recipient.

The initial impetus for developing and marketing mobile telecommunications systems was to offer consumers mobility. At first, many consumers were not enticed by this capability due to its higher cost compared with fixed lines. However, that difference is declining as companies create national or regional networks and alliances that offer pricing plans without roaming fees (charges for calls outside the carrier's service area). Unlike most countries in the world, in the USA, mobile phone users incur charges, whether the call is incoming or outgoing, thus bearing higher total cost.

The full-feature capabilities of digital phones along with declining service charges have reduced the importance of pagers in the wireless industry. The introduction of two-way paging (which enables users to receive, store and play digitised voice messages) met with a disappointing response. The cellular phone is far more versatile in comparison.

Short message service (SMS), based on GSM technology, is one of the fastest-growing services in mobile communications today on a global basis. Nearly 32 billion messages per month were transmitted globally via SMS in February 2003 [2].

2.1 Mobile vs. wireless

The terms, mobile and wireless, used in the Telecommunications industry, have their own specific meanings, but they share some common characteristics. For example, mobile vs. stationary indicates the ability to access while the device is moving. Similarly, wireless vs. wired means ability to access while the device is not physically connected by a wired line.

In this paper, the reader will find both terms interchangeable. Even though mobile/wireless technologies can transmit voice and data by means of radio waves, infrared rays, microwaves and electromagnetic waves, this paper mainly discusses merely applications utilising radio waves as the medium due to its popularity.

2.2 History [3]

Digital wireless and cellular roots go back to the 1940s when commercial mobile telephony began or even as early as in the beginning of 1910s when radio transmission was first tested. Compared with the furious pace of development today, it may seem odd that mobile wireless has not progressed further in the last 100 years. Where are our video watch phones? There were many reasons for this delay, but the most important ones were technology, cautiousness and federal regulation.

As the loading coil and vacuum tube made possible the early telephone network, the wireless revolution began only after low cost microprocessors and digital switching

became available. The Bell System, producers of the finest landline telephone systems in the world, moved hesitatingly and at times with disinterest toward wireless. Anything AT&T produced had to work reliably with the rest of their network and it had to make economic sense, something not possible for them with the few customers permitted by the limited frequencies available at the time. Frequency availability was in turn controlled by the Federal Communications Commission (FCC), whose regulations and unresponsiveness constituted the most significant factors hindering radio-telephone development, especially with cellular radio, delaying that technology in the USA by perhaps 10 years.

In Europe and Japan, though, where governments could regulate their state run telephone companies to a lesser extent, mobile wireless came no sooner, and in most cases later than the USA. Japanese manufacturers, although not the first with a working cellular radio, did equip some of the first car mounted mobile telephone services, and their technology was equal to whatever the USA was producing. Their products enabled several first commercial cellular telephone systems, starting in Bahrain, Tokyo, Osaka and Mexico City.

Table 1 lists the key technology milestones in the mobile communication industry.

Table 1 Key technology milestones in mobile communication industry

Year	*Technology milestone*
1901	Guglielmo Marconi's first wireless telegraphy sent signals across the Atlantic ocean
1910	The first car-telephone by Ericsson
1946	The first commercial American radio-telephone service by AT&T and Southwestern Bell
1969	The first commercial cellular radio system by Bell System
1973	The first handheld cell phone by Motorola
1978	First generation of analogue cellular systems by Bahrain Telephone Company
1982	The rise of GSM in western Europe
1990	North American set IS-54B standard up for digital cellular systems using TDMA technique

3 Mobile applications [4]

A number of widely used mobile applications are briefly described in this section. These include: mobile phones, mobile satellites, handheld devices, wireless computing and mobile commerce (m-commerce).

3.1 Mobile phones

This would be counted as the most obvious example of mobile applications based on number of users, as many as 1.3 billion worldwide in early 2003. Table 2 shows a statistics snapshot of the mobile industry as of February 2003 according to Cellular Online [2].

The mobile utilisation can be classified according to geographic distribution given in Table 3.

Table 2 Mobile statistics snapshot as of February 2003

Total analogue users	34 million
Total US mobile users	140 million
Total global GSM users	793 million
Total global CDMA users	159 million
Total global CDMA 2000 users	30 million
Total TDMA users	120 million
Total European users	320 million
Total African users	34 million
Total 3G users	130 million
Total South African users	14 million
European prepaid penetration	63%
European mobile penetration	70.2%
Global phone shipments 2001	393 million
Global phone sales 2Q02	96.7 million
#1 mobile country	China (200 million)
#1 GSM country	China (130 million)
#1 SMS country	Philippines
#1 handset vendor 2Q02	Nokia (37.2%)
#1 network in Asia	Unicom
#1 network in Japan	DoCoMo
#1 network in Europe	T-Mobil (22.3 million)
#1 in infrastructure	Ericsson
Global monthly SMS/user	36
SMS sent globally 4Q02	95 billion
SMS sent in UK 12/02	1.3 billion
SMS sent in Germany 4Q02	30 billion
SMS sent 2002	366 billion
GSM countries on air	190
GSM association members	574
Total cost of 3G licenses in Europe	110 billion Euros

Table 3 Mobile use by geographic distribution

Geographic region	*Mobile use* (%)
North America	21
Asia Pacific	33
Africa	1
Europe	36
South America	8
Middle East	1

3.2 Mobile satellite

To complement the cellular phone and wireless computing networks, mobile satellites offer a combination of all-digital transparent voice, data, fax and paging services to and from handheld telephone devices. The systems share an air interface standard named Geostationary Mobile Satellite Standard (GMMS) that is similar to GSM. This means that the Satphone customers will be able to use mobile phones that are compatible with satellite systems in any country where GMSS is offered; in effect, creating roaming capabilities that normal land-based mobile phone users need to pay extra for when the handsets are used in areas outside the network coverage.

Nowadays, there are over 1000 satellites orbiting the globe. The number will climb to over 1500 satellites in 2008. They can be positioned in orbits with different heights and shapes (circular or elliptical). Based on the orbital radius, all satellites fall into one of the following three categories: Low Earth Orbit (LEO), Medium Earth Orbit (MEO) and Geostationary Earth Orbit (GEO) as illustrated in Figure 1.

Table 4 summarises the design issues related to different types of satellite constellations [5].

Figure 1 Mobile satellites in various earth orbits: LEO, MEO and GEO

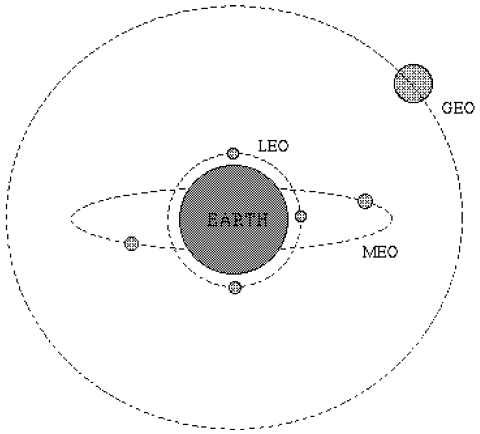


Table 4 Design issues associated with different types of satellite constellations

Constellation	*LEO*	*MEO*	*GEO*
Altitude	100–1500 miles	6000–12000 miles	22282 miles
Line of sight time	15 min	2–4 hours	24 hours
Pros	• Lower launch costs • Very short round trip delays • Small path loss	• Moderate launch cost • Small roundtrip delays	• Covers 42.2% of the earth's surface • Constant view
Cons	• Very short life: 1–3 months • Encounters radiation belts	• Larger delays • Greater path loss	• Very large round trip delays (0.1 s) • Expensive earth stations due to weak signal

Another method to classify existing satellite systems is by their functions.

- *Voice communications*. These universal satellites provide telecommunication services consisting of not only voice, but also data, fax, and paging. The providers include *Iridium*, *GlobalStar*, and *ICO*.

- *Satellite radio*. There are two major satellite radios providing music on demand aiming to niche markets, i.e. coast-to-coast drivers who like to stick to their favourite channels wherever they go. Thus, *XM Radio* allied with General Motors (GM) to install receivers in its cars, while Sirius Radio partnered with Ford Motor and BMW to put *Sirius radios* in their cars. In the portable electronics segment, Sony and Sharp are also interested in embracing XM Satellite Radio in their Walkmans [6].

- *Broadband networking*. In 2005, *Teledesic* will offer broadband data services through the current 288 (rather than 840 as originally designed) satellites orbiting about 500 miles away from earth. The in-operational rival, *SkyBrigde* – a satellite-based broadband access system – has started offering internet access and videoconference services since 2000.

- *Data messaging*. Orbcomm provides narrow band two-way digital messaging, data communications and global positioning services. http://www.orbcomm.com/about.htm

- *Geodesy & Navigation*. Global Positioning System (GPS) is a space-based triangulation system utilising satellites and terrestrial computers to measure positions anywhere on earth. It was first and foremost developed by the US Department of Defense for navigation purposes. Now, the system is more utilised in the public sector for positioning persons or objects that carry transmitters. *Glonass*, a GPS in Soviet version, is mainly utilised in military and aviation units in the former USSR.

- *Remote sensing*. The remote sensing market has traditionally been the domain of single specialist dedicated satellites for sensing global climates and natural events. Comprising of 12 satellites, *FUEGO* is devoted to wild fire detection and named 'Forest Fire Earth Watch'. *RapidEye*, a satellite-based geo-information service, provides global climate information, i.e. hail, storm, frost, drought, etc., as well as agricultural produce prediction services. *Cosmo-Skymed* provides remote sensing services, such as disaster monitoring, urban monitoring, law infringement and environmental and agricultural monitoring, only to customers living around the Mediterranean Sea.

Table 5 compares and contrasts some important satellite communication systems.

Table 5 Comparative information on the important satellite communication systems

Name	*Orbit*	*Satellites*	*Lifetime (years)*	*Services*	*Operational*	*Cost*
Iridium	B-LEO	66	5	V, D, F, P	Nov. 1998	Handset: $3000 Airtime: $1.50/min
GlobalStar	B-LEO	48	10	V, D, F, P, GPS	1999	Airtime: $1–1.20/min
ICO	MEO	10	12	V, D, F, P	2000	Handset: $700 Airtime: $0.50–3/min
Teledesic	Brdband LEO	288	10	Brdband	Est. 2005	N/A
SkyBridge	Brdband LEO	80	N/A	Brdband	2000	Terminal: $700 Airtime: $30–40/month
Orbcomm	LEO	36	4	D, F, GPS	1998	Terminal: $1000
GPS	MEO	33	17	GPS	1995	Receiver: $500–30000
Glonass	MEO	21	N/A	GPS	1995	N/A

B-LEO: Big LEO – an orbital height over 1000 miles from level; V: Video services; D: Data services; F: Fax service; P: Paging service; Brdband: Broadband services; GPS: Global Positioning Service.

In general, it seems somewhat gloomy for this industry since all terrestrial networks like phone lines and fibre optics as well as land-based wireless infrastructure have spread into almost all urbanised parts of the world leaving only few abandoned places where there is low density of population to utilise the bandwidth. How could the satellite communications survive in business when the total cost of ownership for end-users is relatively high? No surprise, they cannot!

Based on the global market size of telecommunication in 2002, satellite communications revenues attributed to less than 5% of total global telecommunication. The following are some examples of big players in the industry who have failed to pursue the business:

- Iridium filed for Chapter 11 bankruptcy on Friday, 13 August 1999, but was saved by the new group of owners of Iridium Satellite in December 2000 [7].
- ICO Global Communications has successfully emerged from Chapter 11 bankruptcy protection following completion of a $1.2 billion investment led by telecommunications pioneer Craig McCaw and a group of the USA and international investors [8].
- In mid-February 2002, GlobalStar filed a voluntary petition under Chapter 11 of the US Bankruptcy Code in the US Bankruptcy Court in Delaware, and the company is continuing to work with its creditors and the court to finalise a formal business plan aimed at restructuring the company's finances and allowing the newly organised company to successfully emerge from the Chapter 11 process [9].

There have been a number of satellite operators like the examples given above who eventually went bankrupt due to lower incomes than expectations. The reasons for this hardship can be described by the following:

- the satellite industry has a long wait between design and profitability, i.e. it can make money only after 10 years in orbit and needs to build the entire network before signing up its first customer
- manufacturers must lock down technology more than 3 years before launches
- the industry bets on a market up to 15 years.

These are the major negative factors most satellite communication providers are encountering nowadays. Some analysts still see good opportunities for this industry, for example, Futron [10], a technology management consulting firm based in Maryland, predicts that the satellite transponder business will grow more than 75% within 10 years from now. This would be a good opportunity for satellite operators to turn to focus on video/audio and broadband markets rather than sticking to only the voice market, which is forecasted to stay flat for the coming decade.

3.2.1 Handheld devices

These devices have come a long way in the past few years, growing from little more than electronic organisers into useful business tools like pocket PCs or PC tablets. The devices can be categorised based on their applications and complexity as follows:

- *Personal Digital Assistant (PDA)*. A term for any small mobile handheld device that provides computing and information storage and retrieval capabilities for personal or business use, often for keeping schedule calendars and address book information handy. The hardware controls are supplied by either Palm OS or Microsoft Pocket PC. The major players in the hardware market include *Palm* (31%), Hewlett Packard (21%), Sony (8%), Toshiba (6%) and Casio (6%). At the end of 2002, the industry shipped 2.6 million units to consumers; a 0.9% increase from the previous year. [11].

- *Smart Phone*. A wireless phone with text and internet capabilities. It can handle wireless phone calls, hold addresses and take voice mail and can also access information on the internet and send and receive e-mail and fax transmissions. It can be viewed as a combination of a mobile phone and a PDA in a single gear.

- *PC Tablet*. A new generation of slate-style portable computers from Microsoft and its partners promise to combine the flexibility of paper notepads with the best attributes of powerful notebook PCs. Microsoft has added a program called Microsoft Journal, which is intended to be a note-taking replacement for the pad of paper you would typically take to a meeting. Everything you write on the pad is stored as graphics – called digital ink – unless you highlight an area and ask the machine to recognise what you wrote. PC makers working on Windows XP Tablet PCs include Acer, Compaq, Fujitsu, Tatung and Toshiba.

- *Pager*. A small telecommunications device that receives (and, in some cases, transmits) alert signals and/or short messages. This type of device is convenient for people expecting telephone calls, but who are not near a telephone set to make or return calls immediately. It is estimated that there will be 260 million pager users worldwide by 2003. The overall market revenue for paging/messaging is predicted to be $11.92 billion in 2005 (Wireless Week, 'The Future of Paging', Oct 1999) [12].

3.2.2 Wireless computing

Wireless computing or Wireless Local Area Network (WLAN) is the technology that enables a user to receive information such as e-mails and files directly from the internet or any networks to one's laptop, without the sender's knowledge of the serving network IP address, which may be a wireless LAN. The technology allows for the rerouting of information to the served network for wireless computing just as it does for mobile data services based on 2.5G and 3G technologies.

For this application, there are two competing technologies in this field; Bluetooth and 802.11b or Wi-Fi:

- *Bluetooth*. An open specification for seamless wireless short-range (less than 30 feet) communications of data and voice between both mobile and stationary devices. For instance, it specifies how mobile phones, computers and PDAs interconnect with each other, with computers, and with office or home phones. The first generation of Bluetooth permits exchange of data up to a rate of 1 Mbps, even in areas with a large amount of electromagnetic disturbance.

- *Wi-Fi (802.11b)*. Provides for wireless Ethernet transmission primarily between laptops or PDAs and local access nodes that attach to a standard corporate LAN. Today's 802.11b products transmit in the unlicensed spectrum at 2.5 GHz, and are capable of speeds of up to 11 Mbps. This standard, despite higher speed, is not suitable for mobile applications or moving devices.

3.2.3 M-commerce

M-Commerce is the use of radio-based wireless devices such as cell phones and PDAs to conduct business-to-business and business-to-consumer transactions over wired, web-based e-commerce systems [13]. This application should be seen as a complement of existing e-commerce, which focuses on different groups of customers. Nowadays, we might see examples of m-commerce in forms of m-banking, m-payment and latest, e-vending [14]:

- *M-banking*. Piloted by NTT DoCoMo, now Japanese mobile phone users can make payments and withdraw cash via mobile phone handset. The technology allows people to withdraw and deposit money at cashpoints in convenience stores and supermarkets using mobile phones instead of cash cards [15].
- *M-payment*. The m-Payment service allows users to initiate a payment by sending a text message with their password, the amount they want to send and the recipient's mobile phone number. The users can also include a short message. As long as the person is on the GSM network, the service will transfer the funds and the recipient is notified via SMS. The system providers anticipated launching the technology with ticket reservation and restaurant businesses [16].
- *E-vending*. Cellenium, a mobile commerce technology provider, and Coca-Cola Beverages (CCB) AG in Switzerland are launching a text of wireless intelligent vending that will communicate real-time data to allow remote monitoring of machine functions and inventory. The vending machines will also be equipped to accept m-payments from consumers using their cell phones to purchase drinks. Cellenium will provide both the telemetry and the m-payment technologies combined in one solution [17].

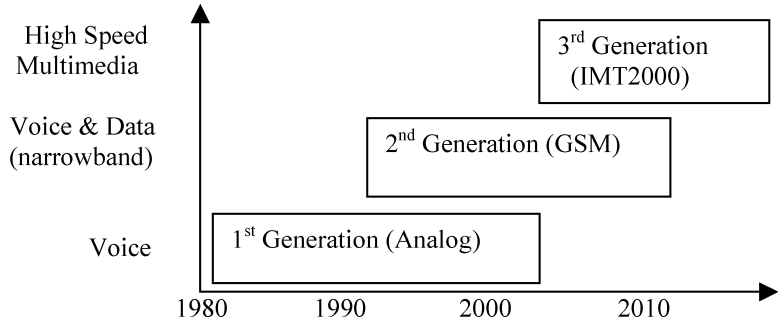
4 Competition landscape

In the competition landscape of mobile phone market, we can group the battlefields into three areas – protocols or standards; airtime carriers; and handset manufacturers – as described in this section.

4.1 Competing protocols/standards [18]

The evolution of various protocols for mobile communications over the past two decades began with first-generation voice–analogue devices. These were followed in the early 1990s by the introduction of second-generation voice and data devices based on the GSM technology. In early 2000, third-generation high-speed multimedia devices were introduced based on IMT 2000 Project standards. The progression is shown in Figure 2.

Figure 2 Protocol competition over time



- *First generation*: *Analogue*. Looking at the above timeline, the protocol competition can be routed back to the first-time hand phone, which was introduced in the market with analog cellular networks in 1978. Analogue cellular operates in the 800 MHz frequency range and is available across 95% of the USA. Analog cellular service sends a voice through the air using continuous radio waves. As the voice signals travel through the air, they weaken with distance. Equipment in the cellular network returns the signal to its original strength, or amplifies it. This technology is the predominant system in use today and is also known as Advanced Mobile Phone System (AMPS).
- *Second Generation: Digital*. Digital cellular shares the 800 MHz frequency band with analog and is usually available wherever analog service is offered. In digital transmissions, a conversation is converted into the ones and zeros of computer code. Unlike analog transmissions that are sent out as a continuously varying electrical signal in the shape of a wave, digital transmissions are a combination of on-and-off pulses of electricity. Several incompatible air interfaces are used to implement digital cellular networks, including Code Division Multiple Access (CDMA) and Time Division Multiple Access (TDMA).
    - *Code Division Multiple Access (CDMA)*. This is a spread spectrum approach to digital transmission. With CDMA, each conversation is digitised and then tagged with a code. The mobile phone is then instructed to decipher only a particular code to pluck the right conversation off the air. The process can be compared in some ways to an English-speaking person picking out in a crowded room of French speakers the only other person who is speaking English.
    - *Time Division Multiple Access (TDMA)*. This is a digital–air interface technology designed to increase the channel capacity by chopping the signal into pieces and assigning each one to a different time slot, each lasting a fraction of a second. Using TDMA, a single channel can be used to handle simultaneous phone calls.
    - *Global System for Mobile Communications (GSM)*. GSM is a type of TDMA digital wireless network that has encryption features. GSM is being rapidly deployed worldwide and is the standard in Europe and Asia at 900 MHz. In the USA, carriers are deploying GSM at 1900 MHz, making GSM phones sold in the US incompatible with European GSM phones, and vice versa. It has the capability to transmit data at a rate of 9.6 kps.
- *Third Generation: 3G.* Third Generation (3G) is considered a new standard that promises to offer increased capacity and high-speed data applications of up to 2 MB. The most important feature of 3G is the fact that it is designed to allow global roaming. Third Generation should be considered the next generation of wireless technology beyond personal communications services. The World Administrative Radio Conference (WRC) assigned 230 MHz of spectrum at 2 GHz for multimedia 3G networks. These networks must be able to transmit wireless data at 144 Kbps at mobile user speeds, 384 Kbps at pedestrian user speeds and 2 Mbps in fixed locations. The International Telecommunication Union (ITU) seeks to coordinate 3G standards through its International Mobile Telecommunications-2000 (IMT-2000) project.

To see how fast a 3G mobile can access the internet, we can consider the time to download a 1 Mb file by a 3G phone as compared with capacities of other devices as follows:

- Fixed line modem 3 minutes
- GSM cell phone 15 minutes
- Enhanced GSM phone 1–5 minutes
- 3G phone (outdoor) 21 seconds
- 3G phone (indoor) 4 seconds

Table 6 summarises market share as number of subscribers of the mentioned protocols in February 2003 [2].

Table 6 Number of subscribers of analogue, digital and 3G protocols

Protocol	*#Subscribers* (million)
Analogue	34
Digital	1072
• CDMA	(159)
• TDMA	(120)
• GSM	(793)
3G	130
Worldwide	1300

4.2 Global airtime carriers [19] (as of Q2-02)

Tables 7 and 8 show the number of subscribers and revenues worldwide of global airtimecarriers, respectively.

Table 7 Number of subscribers worldwide of global airtime carriers

Operators	*Country of service*	*#Subscribers* (million)
China Mobile	China	74.6
NTT DoCoMo	Japan	40.8
China Unicom	China	32.9
Verizon Wireless	USA	29.7
Telecom Italia Mobile	Italy	24.5
T-Mobile Deutschland	Germany	23.0
Vodafone	UK	21.5
Cingular Wireless	USA	21.3
AT&T Wireless	USA	19.5
Telcel	Mexico	17.9

Table 8 Worldwide revenues of global airtime carriers

Operators	*Country of service*	*Revenue* (billion $)
NTT DoCoMo	Japan	39.9
Vodafone Group	28 countries	24.8
KDDI	Japan	17.6
Verizon Wireless	USA	17.4
Cingular Wireless	USA	14.5
AT&T Wireless	USA	13.6
China Mobile	China	12.1
Sprint PCS	USA	10.5
Telecom Italia Mobile	Italy	9.2
Nextel Communications	USA	7.7

4.3 US airtime carriers [20] (as of Q2-02)

Table 9 gives profiles of key US airtime carriers.

Table 9 Profile of leading US airtime carriers (for the second quarter of 2002, except as noted)

Carrier	*Number of subscribers*[1]	*Market share* (%)	*Quarterly net adds*	(%) *of total adds*	*Service revenues* (Mil. $)	*ARPU* ($)	*Churn*[2] (%)	*Capital expenditures* (Mil. $)
Verizon	30,307,000	26.3	723,000	24.8	4369.0	49.00	2.30	812.0
Cingular	22,183,000	19.3	353,000	12.1	3492.0	52.11	NA	906.0
AT&T	20,000,000	17.4	417,000	14.3	3625.0	58.60	2.60	866.0
Sprint PCS	14,588,000	12.7	308,000	10.5	3018.0	60.00	3.00	603.0
Nextel	9,636,200	8.4	471,000	16.1	2200.0	71.00	2.10	448.0
VoiceStream	8,026,000	7.0	525,000	18.0	1152.0	52.00	2.50	433.0
Alltel	6,843,411	5.9	80,197	2.7	965.5	47.30	2.19	225.6
US Cellular	3,547,000	3.1	43,000	1.5	501.2	47.48	1.80	125.6
Total	115,130,611	100.0	2,920,197	100.0	–	–	–	4419.2

NA: Not available;

[1]Directly owned customers (excluding proportionate customers in affiliates and equity investments);

[2]Average monthly churn, calculated as the number of customers terminating service in second quarter of 2002, divided by 3, as a percentage of total customers for the period. ARPU-Average revenue per user.

Source: Company reports.

The eight largest US airtime carriers accounted for 108.4 million subscribers in 2001, or 84% of the total, and $71.7 billion in revenues. In the first half of 2002, the eight largest service providers had 5.9 million net subscriber additions and generated $36.8 billion in revenues.

The largest domestic wireless carrier in the first half of 2002, based on total subscribers and revenues, was Verizon Wireless, a joint venture between Verizon Communications, Inc., and Vodafone Group PLC. Verizon had 30.3 million total subscribers and generated revenues of $8.4 billion in the first half.

Other national players include Cingular Wireless, a joint venture between SBC Communications, Inc., and BellSouth Corp (22.2 million subscribers and $6.8 billion in revenues), AT&T Wireless Services, Inc. (20.0 million; $7.0 billion), Sprint PCS Group (14.6 million; $5.9 billion), Nextel Communications, Inc. (9.6 million; $4.1 billion) and VoiceStream, owned by Deutsche Telekom AG (8.0 million; $2.2 billion). The largest regional carriers are Alltel Corp. (6.8 million; $1.5 billion) and United States Cellular Corp. (3.5 million; $1.0 billion).

4.4 Handset manufacturers [21] (as of Q2-02)

Table 10 shows the market share of leading handset manufacturers. Nokia is the absolute number one in the world, with a market share of 37.2% in the second quarter of 2002. The latest Strategy Analytics wireless forecast reports that there were 96.7 million handset shipments in Q2, maintaining their estimate of 417 million shipments for the full year 2002.

Table 10 Market shares of leading handset manufacturers

Handset manufacturers	*Market share* (%)
Nokia	37.2
Motorola	17.3
Samsung	9.8
Siemens	8.5
Sony-Ericsson	5.2

5 Trends and forecasts

The following is a collection of excerpt predictions by experts about the future of mobile/wireless technology and markets based on a publication in the ComputerWorld magazine [22]:

- With the notable exception of the i-mode service in Japan, the most significant mobile/wireless applications have been in the enterprise market rather than the consumer market, and this situation is likely to persist through 2004. The existing enterprise applications have largely been used by ‘field-force’ employees (sales people, service technicians, delivery people, etc.). During the next two years, these will be supplemented by applications used by a wider variety of professionals and by more horizontal applications. Tablet PCs will make mobile access to conventional desktop applications more attractive and could lead to mobile computing being used as much in the office as it is out in the field – *Eric M. Berg, technology forecaster, PricewaterhouseCoopers, Menlo Park, California.*

- By 2020, the use of mobile computing in healthcare will extend average life spans by 20–25 years. Implanted wireless devices will continuously monitor our health, enabling the medical profession to treat most diseases in their absolute infancy. Mobile computing will also be used to monitor our diet and its effects on our health, control unhealthy habits such as smoking and alcohol consumption, and enable us to maximise the effects of exercise. Diseases such as diabetes will be virtually controlled through wireless monitoring and corrective-action devices, which will automatically adjust insulin levels without the patient even knowing – *Phil Asmundson, deputy managing director of the Technology, Media & Telecommunications Group, Deloitte & Touche LLP, Stamford, Connecticut*.
- By 2004, more than 1 million remote and mobile devices will be integrated with enterprise applications. Early adopters will include industrial, oil and gas, manufacturing, and utilities. Typical applications will include homeland defence sensors, monitoring flow and pressure of petroleum production, meter readings, and field communications – *Bob Ross, WebSphere integration program director, IBM Software Group, Somers, New York*.
- Mobile devices such as cell phones and PDAs will merge and become indistinguishable. The device itself may even take the place of all credit cards and physical money, and become an automatic transmitter for recorded personal preferences such as room temperature, favourite TV programs and food preferences. Wherever we go, this information will be with us; for example, when you check into a hotel room, your device will automatically set the temperature, TV and dinner menu choices – *Brian Terr, director of advanced products, Edmunds.com Inc., Santa Monica, California*.
- By the end of next year, there will be more than 50,000 publicly accessible 'hot spots' around the world for Wi-Fi communications. The vast majority will be created by major wireline carriers around the world, but some will be created by packet wireless carriers and cheap 'Wi-Fi-in-a-box' products. Virtual network aggregators will be the glue that binds together all these Wi-Fi 'islands'. By 2004, different network variants will begin to merge into a seamless, 'wireless broadband' global network for roaming purposes. End users would not care what acronym or standard is used; they will just want 'wireless broadband' – *John Rasmus, vice president, GRIC Communications Inc., Milpitas, California.*
- By 2007, PDAs and cell phones will have merged into single devices. They will have 802.11 (whatever flavour), Bluetooth, 3G and, possibly, direct satellite capability. They will be voice-controlled and use a heads-up holographic display. Laptops will become unnecessary for most folks – *Doug Jackson, director of technology customer services, University of Texas at Dallas*.
- The really interesting platform for mobile applications is the automobile. It has a big battery and the ability to generate electricity. It has space for all kinds of devices. People spend a lot of time in them. Look for in-car telematics to include GPS, data storage, docking for multiple types of handheld devices, hard-copy output and so on. All of this already exists in law enforcement – and the new bus-based, 48-volt auto system standards will accelerate the vehicle telematics explosion – *John Parkinson, chief technologist, Cap Gemini Ernst & Young US LLC, Rosemont, Illinois*.

- Within the next five years, all front-end user interfaces for computing will be wireless – *Sumit Deshpande and Don LeClair, technology strategists, Computer Associates International Inc., Islandia, New York.*
- In five years, we will see a dramatic build-out of wireless LAN hot spots – there will be as many hot spots as there are ATMs, a lot of them actually colocated with the ATM so that a banking customer can retrieve cash as well as their e-mail – *Pontus Bergdahl, president and CEO, Columbitech AB, Stockholm.*
- Instant messaging in the wired world has been the fastest-growing communication channel in history. Instant messaging in the wireless world is going to even outpace the wired adoption. Evidence is strong: Short Message System is already popular on wireless devices in Europe and Asia. Online 'presence detection' – the ability to know when someone you want to communicate with is immediately available – is one of the unique compelling features of instant messaging. This will be the 'killer app' for wireless devices – Glen Vondrick, president and CEO, FaceTime Communications Inc., Foster City, California.

6 Mobile market in the USA compared to Europe and Asia

Two opposing forces are actively shaping the current US mobile market:

- American consumers who are demanding secure and reliable wireless services that are as well matched to their culture and lifestyle as those designed for Asian and European consumers.
- Economic recession and incompatible, competing engineering standards that cause delays in introducing innovative new mobile services that are secure and reliable.

Table 11 shows that the USA has a significantly lower mobile phone penetration rate than much of the developed world. Compared to Asia and Europe, the US mobile market is 1–2 years behind in the rate of wireless internet use and adoption and is likely to remain that way for a while. This is due to a general lack of demand among users of mobile phones for wireless internet services. Others cite the expense and complexity of using a mobile phone to access and browse the net. Added to that is the American consumer's current lack of necessity and interest in sending text messages using a keypad.

Table 11 Mobile phones per 100 inhabitants in 2000 and 2001 [23]

Country	*2000*	*2001*
Taiwan	80.3	96.6
Hong Kong	63.6	85.5
Italy	73.7	83.9
Norway	70.3	82.5
Israel	70.2	80.8
Austria	78.6	80.7
Sweden	70.3	79.0
UK	67.0	78.3

Table 11 Mobile phones per 100 inhabitants in 2000 and 2001 [23] (continued)

Country	*2000*	*2001*
Finland	72.6	77.8
Portugal	66.5	77.4
Belgium	54.9	74.7
Netherlands	67.1	73.9
Denmark	66.5	73.7
Singapore	68.4	72.4
Switzerland	64.5	72.4
Germany	58.6	68.3
Spain	60.9	65.5
South Korea	56.7	60.8
France	49.4	60.5
Japan	52.6	58.8
Australia	44.6	57.8
US	40.0	44.4
Canada	22.6	32.0

Other more systemic factors are perpetuating the market gap:

- *Spectrum shortages*. Spectrum is still a limited resource in the USA, just as the demand for e-mail, internet/data services, and m-commerce over wireless phones and handheld devices is beginning to take off. There are six major carriers in the USA – AT&T Wireless, Cingular, Nextel, Sprint PCS, T-Mobile and Verizon, sharing available spectrum with the US government. Most of the spectrum is taken up by the US Department of Defense or licensed from the Federal Communications Commission (FCC).
- *Double billing systems*. Unlike Asia and Europe, in the USA, both the caller and receiver of the call or data pays. This double billing system is another factor working against the rapid acceptance of the wireless internet and m-commerce in the US market.
- *Incompatible and competing standards*. The major carriers in the USA use incompatible and competing network standards. Some carriers use GSM, while others use CDMA or TDMA.

The US mobile market has been slower to adopt 3G technology, Java-based phones and applications compared to Asia and Europe. Competing technology standards, the enormous investment in existing large-scale systems and a slow economy have kept innovations to a smaller scale that do not impose a large financial risk for companies already under massive debt.

Other reasons for the disparity include:

- The lack of versatile Java-based or 3G handsets that are fun, useful and easy-to-operate
- The lack of exciting, new applications and content accessible from all types of handheld devices.
- The faster adoption of the newer wireless services in Asia and Europe is caused by cultural as well as business factors. For example, eight out of 10 people in the UK aged between 12 and 74 now own a mobile phone.
- Asian and European consumers are more accustomed to longer hours using mass transit. The percentage of at-home PCs in Asia and Europe is much lower than in the USA, which means overseas consumers are more dependent on mobile phones for internet access and m-commerce.
- In Europe and Asia, the government is a more active player in the development of large-scale telecommunications systems. This yields two critical advantages: uniform engineering standards and greater investment in research and development by carriers that are not operating under a massive debt load.
- Overseas markets tend to be consumer-driven. Consumer applications that prove to be popular in the consumer market work their way into the enterprise market packaged for business use. The US market is enterprise-driven with applications designed for enterprise use such as e-mail and scheduling eventually find their way to the consumer side.

Table 12 summarises key characteristics of US, European and Asian mobile markets.

Table 12 Comparison of key characteristics of the US mobile market with Asian and European markets

US market	*Asian and European markets*
Slower 2G and 2.5G speeds	Speed advantage with 3G
Competing standards	Uniform technology standards
Serious spectrum shortages	Availability of wider spectrum
PC-based lengthy messages	Mobile user-based short messages
Both ends pay cell time	Caller pays and prepay
Large geographical gaps	Densely populated coverage
Well-developed land-based systems	Suitable for wireless infrastructure
Lack of 3G handsets	Abundance of 3G choices
Lack of wireless apps and content	More mature wireless content market
Enterprise leads technology adoption	Consumers lead technology adoption

In order to be in a leading position in this business in the US market, mobile devices and wireless providers have to realise the facts and adjust strategies to encompass market into the desired direction. For the US market, Dr Nakamura of NTT DoCoMo USA, believes that noticeable applications for the wireless internet in the US may well be a product designed for the youth market. He predicts that games combined with music and

colourful graphic displays would be very attractive options for the US wireless market. In Asia, digital cameras built into a mobile phone have become very popular with teenagers in the past 2 years. They are able to send e-mails with photos – on the spot – at a party, a sporting event, or a music concert using their mobile phones. In November 2002, Sharp Electronics started to sell 3D image phones [24].

7 Conclusion

Evidently, the mobile communications industry has grown very rapidly in the past decade. There are a number of major players involved in mobile communications. Consumers around the globe have a mixed response to this industry. One of the challenges faced by this industry is that not all consumers value the wireless internet enough to use it or care about it. On the other hand, consumers value mobile phones as sales are reported to be going up every year. The goal to attain globalisation of the mobile communications industry would be achievable if strong long-term partnerships are developed that give equal benefits to all partners. Each partner will have to contribute a needed service or technology, or a large number of consumers. There is no doubt that mobile communications will be a key influence in the world economy in this century.

References

1 Kumar, S. and Stokkeland, J. (2003) 'Evolution of GPS technology and its subsequent use in commercial markets', *International Journal of Mobile Communications*, Vol. 1, Nos. 1/2, pp.180–193.

2 'Stat Snapshots: February 2003' (2003) Cellular Online, http://www.cellular.co.za/stats/stats-main.htm

3 Farley, T. (2003) 'Mobile telephone history', *Digital Wireless Basics*, http://www.privateline.com/PCS/history.htm.

4 Sian, K. and Shen, Z. (2003) 'Mobile communications and mobile services', *International Journal of Mobile Communications*, Vol. 1, Nos. 1/2, pp.3–14.

5 Wood, L. (2003) *Lloyd's Satellite Constellations: Overview*, University of Surrey, UK, http://www.ee.surrey.ac.uk/Personal/L.Wood/constellations/overview.html.

6 Hesseldahl, A. (2001) 'Ten O'clock Tech: Satellite Radio's Big Launch', Future Tech, Forbes.com, *01.05.01,* http://www.forbes.com/2001/01/05/0105satradio.html.

7 Reuters and the Associated Press (2000) Iridium satellite buys iridium', *Wired News Report,* December 12, http://www.wired.com/news/business/0,1367,40629,00.html.

8 'New ICO Emerges from Bankruptcy Protection' (2000) *ICO Press Release,* May 17, http://www.ico.com/press/releases/200005/000517.htm.

9 'Globalstar Reaches New Financial Agreement' (2003) *Globalstar Satellite Phone: News Release*, February 17, http://www.globalstar.com/view_pr.jsp?id=328.

10 'Satellite Steer into The Future: Course is Strong, If Not Steady' (2002) *Futron White Paper*, August, http://www.futron.com/pdf/Futron2002ForecastWhitePaper.pdf.

11 Gubbins, M. (2002) *Interview: Palm Solutions Group chief Todd Bradley*, VNUNet.com/ Hardware/Analysis, November 7, http://www.vnunet.com/Analysis/1136641.

12 Picov, N. (2002) *The Next Page in Wireless Messaging*, Speechlink.com White Paper, http://www.speechlink.com/THE%20PAGER%20MARKET.pdf.

13 Lau, A.S.M. (2003) 'A study on direction of development of business to customer m-commerce', *International Journal of Mobile Communications*, Vol. 1, Nos. 1/2, pp.167–179.

14 Yuan, Y. and Zhang, J.J. (2003) 'Towards an appropriate business model for m-commerce', *International Journal of Mobile Communications*, Vol. 1, Nos. 1/2, pp.35–56.

15 'DoCoMo to Offer Cashpoint Access via Mobile Phone' (2002) *Cellular Online*, http://www.cellular.co.za/news_2002/082202-doCoMo-cashpoint-access.htm.

16 'New m-commerce payment platform launched' (2002) *Cellular Online*, http://www.cellular.co.za/news_2003/011503-new_mcommerce_payment_platform_l.htm.

17 'Cellenium & Coke Switzerland Launch Wireless Intelligent Vending Test' (2002) *Cellular Online*, http://www.cellular.co.za/news_2003/011203-cellenium_and_coca.htm.

18 Burns, J. (2000) *3G Mobile Overview*, Aegis-System White Paper, http://www.aegis-systems.co.uk/download/3g.pdf.

19 'Global Carriers by Revenue' (2002) *By The Numbers RCR Wireless News Editor's*, May 13, http://www.rcrnews.com/files/global%20carriers.pdf.

20 Rosenbluth, T. (2002) *Industry Profile: Wireless Carriers Enter Adulthood*, Standard & Poor's Industry Survey, Telecommunications, Wireless, October, http://www.netadvantage.standardandpoors.com/netacgi/nph-rpt?d=SPIX&tos=QS&l=25&u=X&f=G&p=1&r=1&Sect5=PDF&docnum=1&S1=%22%22.qsip.&pdf=tws_1002.pdf.

21 'Mobile Phone Market Share in Q2-02' (2002) *Cellular Online*, http://www.cellular.co.za/news_2002/082202-2q02-global-phone-shares.htm.

22 Betts, M. (2002) 'More predictions on the future of mobile/wireless computing', *ComputerWorld Story,* December 16, http://www.computerworld.com/mobiletopics/mobile/story/0,10801,76656,00.html.

23 'North America Wireless Market: On the Road to 3G' (2002) *eMarketer.com: Executive Summary*, http://www.wow-com.com/market_research/documents/e-marketwire_no_am_09_02_es.pdf.

24 Threat, J.T. (2003) 'Strategies for the U.S. mobile internet market: opportunities and challenges for moving forward', *Wireless Business & Technology*, February, Vol. 3, No. 2, p.14.