North American Wireless Market Review
Personal Location Based Services
Navi

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CONTENTS OF THE ASSIGNMENT

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1 NORTH AMERICAN WIRELESS MARKET

1.1 Standards and Technologies

The North American Wireless market by its dynamic nature is a fragmented market both in terms of service providers and technology solutions used. As a result there is a great deal of choice and competition for the provision of wireless voice and data solutions.

Currently there are no fewer then nine major network technologies over which wireless data services are available to mobile users. Table 1 shows the prime network technologies that are in use and some of the major wireless providers that are using them. The cellular market itself is divided into 734 distinct regions for the issuance of cellular spectrum. Combined with other spectrum services, like satellite and WLAN, this makes the market very competitive for service providers and their associated content and infrastructure partners.

NA Data Networks	Frequency	Data Throughput	Major Operators
GSM	1900 MHz	9.6 kbps	Voice Stream,
CDMA	1900 MHz	14.4 kbps	Verizon, Sprint,
TDMA	1900 MHz	14.4 kbps using	AT&T
Mobitex	900 MHz	8 kbps	Cingular
Datatec	806-870	4.8 -19.2 kbps	Motient
CDPD	800-900	19.2 kbps	AT&T, US Cellular,
Ricochet	900 MHz	128 kbps	Metricom
GPRS	1900 MHz	128 kbps	AT&T, Voice Stream,
WLAN 802.11b	2.4 GHz	11 Mbps	Mobilestar

Table 1 Data Networks in North America

Aside from the Unlicensed Spectrum technologies and GPRS there are 3 popular packet data networks in use in the US and Canada. They are Mobitex, DataTAC and CDPD.

The Mobitex wireless network technology, developed by Eritel in 1984 for Swedish Telecom, has become an international data communications standard. There are 30 Mobitex networks around the world, in 23 countries. This wireless network technology is now managed by the Mobitex Operators Association (MOA), which controls the specifications for this open standard. Mobitex is a secure, reliable, wireless packet switching network specifically designed for wide-area wireless data communications. Mobitex networks in the United States and Canada operate in the 900 MHz range. Throughput is up to 8kbps. Cingular operates the Mobitex network in the US, which they lease to partners like Research In Motion (RIM).

The DataTAC (ARDIS) wireless network technology was originally developed in 1984 by Motorola for IBM's field service organization. DataTAC has become an international data communications standard. DataTAC networks in the United States and Canada operate in the 800 MHz range. Motient owns and operates the DataTAC network that combines terrestrial and Satellite technology. Throughput on the Motient DataTAC network can be as high as 19.2 kbps. Currently they sell their network capacity and technology to businesses providing dispatch, 2 way paging, email, and other communication services.

The Cellular Digital Packet Data CDPD concept was originally developed as a joint cooperation between IBM and MaCcraw Cellular in 1991 in order to overlay a packet network over the existing analog networks at that time. CDPD is the 2-way packet data enhancement to traditional analog cellular services. It takes advantage of the fact that there is already a cellular telephone infrastructure in place with near-ubiquitous coverage. However it not only an airlink specification but also an architecture specification for use over additional RF standards. Therefore it operates as a hybrid network technology for packet of analog and digital networks. AT&T operates the largest CDPD network in the US.

Currently CDMA is the dominant cellular technology in North America. Figure 1 shows a breakdown of the major cellular technologies being used to deliver wireless communication services. While Digital technologies are expanding rapidly in the market it is still heavily dominated by analog services that hold nearly 35% of the market by user base. North American users have been slower to migrate to digital services based on a lack of non-voice services and a misstep in quality voice service delivery in the earlier introduction of digital services. As most consumers are using phones for emergency services and many are using calling card services they have continued to prolong the life of analog networks. In many rural areas there is no digital coverage available.

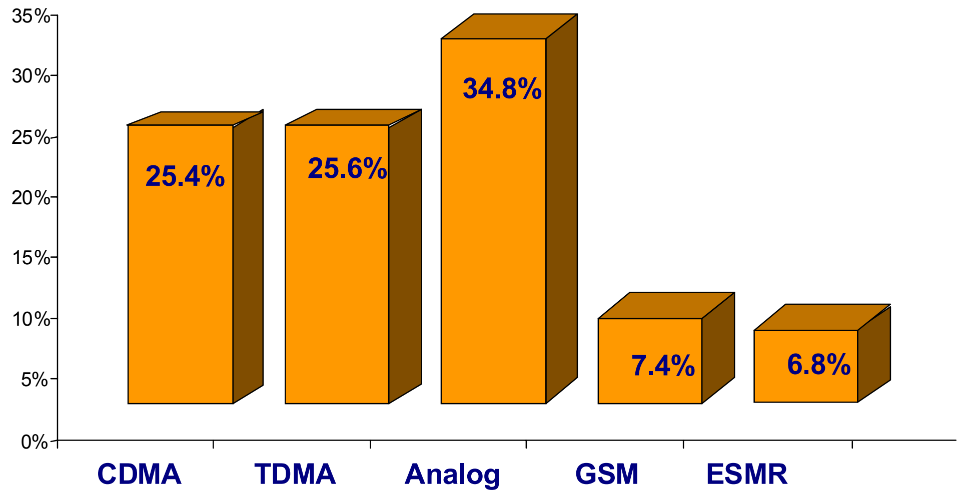


Figure 1 US Market Share for Wireless Standards
Source: CTIA 2001

Table 2 shows the breakdown of subscribers in the thousands for each technology standard. As a percentage of the digital market GSM represents 12.7% as of the end of 2000. However it is growing quite quickly as a result of the TDMA network operators transition to a GSM overlay as part of their migration path to 3G technologies. Nextel operates the iDEN network in the USA based on a Motorola's proprietary Enhanced Specialized Mobile Radio technology (ESMR) which is based on TDMA. It provides both cellular and mobile radio dispatch functionality in one handset is very popular with corporate users for it's ability to create virtual functional groups of any size using its SMR technology. While providing some of the best data over wireless functionality, it will continue to be marginalized by the growth of other technology standards in the market (Table 2)

Technology	Subscribers	Market Share (%)	Digital Market Share (%)
Total GSM Subscribers *	**7,999**	**7.4**	**12.7**
Total CDMA Subscribers	**27,357**	**25.4**	**43.5**
CDMA Subscribers, 800 MHz	13,857	12.9	22.0
CDMA Subscribers, 1900 MHz	13,500	12.6	21.5
Total TDMA Subscribers	**27,573**	**25.6**	**43.8**
TDMA Subscribers, 800 MHz	24,401	22.7	38.8
TDMA Subscribers, 1900 MHz	3,172	3.0	5.0
Total Digital Subscribers	**62,928**	**58.5**	**100.0**
Total AMPS Subscribers	**37,398**	**34.8**	**NA**
Total ESMR Subscribers	**7,176**	**6.7**	**NA**
Total Cellular Subscribers, 800 MHz	**75,655**	**70.4**	**NA**
Total PCS Subscribers, 1900 MHz	**24,671**	**22.9**	**NA**
Total Cellular / PCS / ESMR Subscribers	**107,502**	**100.0**	**NA**

* All figures= Thousands of Subscribers

Table 2 US Subscribers By Technology
Source: CTIA Jan. 2001

1.1.1 Growth of GSM

Global System for Mobile (GSM) communication operates on the digital cellular or Personal Communication System (PCS) standard. Similar to that used throughout the world, the key distinction for North America is that GSM in NA operates in the 1900 MHz spectrum frequency range. While GSM has been the global standard, in North America it has been traditionally over shadowed by CDMA and TDMA networks operated by the national wireless service providers. Figure 2 shows the growth of technology standards on a global basis.

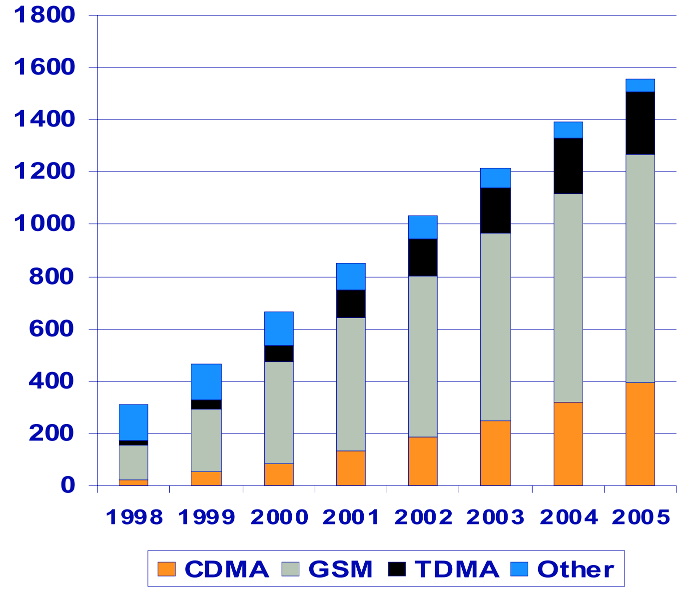
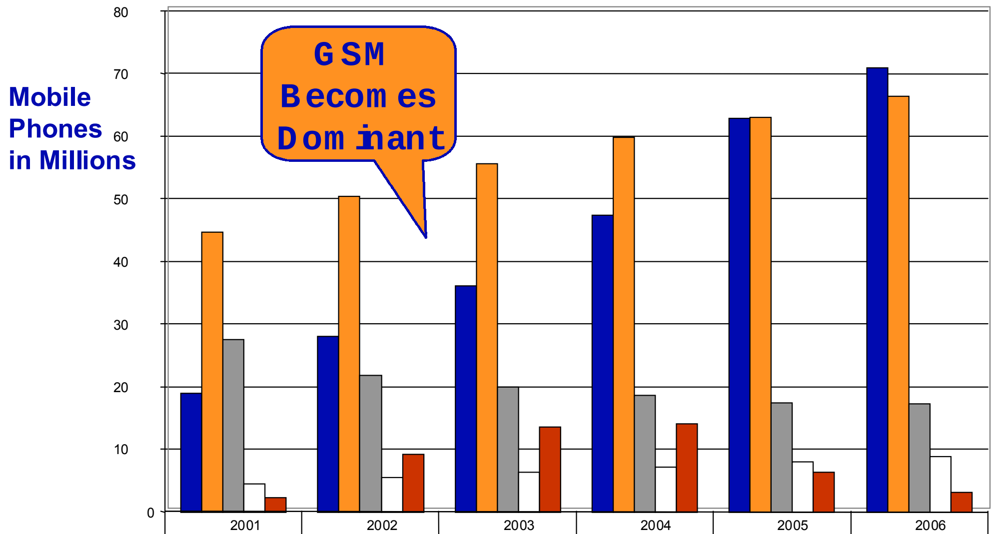


Figure 2 Worldwide Installed Digital Technology Standards
Source: Strategy Analytics 2001

GSM technology has seen study growth in the market. The availability of tri-mode phones has hastened the global standards appeal in North America. Voicestream is the first true national provider of GSM services in North America. It has continued to acquire or develop its network. Last year VoiceStream was acquired by Deutche Telecom. When Docomo expanded it's equity stake in AT&T it marked a turning point in the development of AT&T Wireless's network (see 3G migration for more information). Last year it was announced that AT&T Wireless would overlay GSM/GPRS over their existing network. Cingular announced in 2001 that it would continue to expand its GSM network and focus on the rollout of GPRS services as a prelude to 3G services. In Canada Rogers Cantel also announced that they would be overlaying GSM/ GPRS over their existing TDMA network. Figure 3 shows the distribution of technologies based mobile phone. It excludes analog networks. It can be seen that with the combined TDMA/GSM and pure GSM networks, sometime in 2003 GSM will surpass CDMA as the dominant network technology in North America



	2001	2002	2003	2004	2005	2006
GSM	18,9	28,0	36,1	47,3	62,9	70,9
CDMA	44,7	50,4	55,5	59,7	63,0	66,3
TDMA	27,4	21,7	19,9	18,6	17,3	17,2
iDEN	4,4	5,4	6,3	7,1	8,0	8,7
GSM/TDMA	2,2	9,1	13,5	14,0	6,2	3,0

Figure 3 GSM Dominance in North America
Source: Bell Mobility 2001

1.2 Data Access Services & Pricing

Currently there is a large divergence in the types of services that are being provided by carriers and other wireless service providers in the USA. Many carriers claim to be offering advanced data services, but do so on a flat fee basis because of limited billing capability. In most cases services are only offered in certain markets even for carriers that have national coverage. Table 3 looks at the top 7 national carriers and identifies the list of data related value services they are offering.

Carrier		Cost	Access
AT&T	PocketNet basic	Free with rate plan	Unlimited Access to featured sites
	PocketNet plus	6.99**	Unlimited access to expanded list of sites
	PocketNet Premium	14.99**	Unlimited access to all sites
Cingular	My Wireless Window/Wireless Internet	$6.99-$15.99**	Unlimited access to all sites
	MyBiz/Wireless Internet	$6.99-$15.99**	Unlimited access to all sites
	Wireless Internet Express	$14.99 - $21.99*	Unlimited access to all sites
Sprint PCS	My Sprint PCS Wireless Web	$5**	Unlimited Access to featured sites
Verizon	Mobile Web, MYVZW	$7**	Unlimited Access to any sites
Nextel	Nextel Online	$5**	Unlimited Access to featured sites
	Nextel Online Plus	$10**	Unlimited Access to featured sites
Alltel	BrowseNow	$15	Unlimited Access to Any site
VoiceStream	iStream	$2.99-$39.99*	Unlimited Access to Any site

**GPRS per Kilobyte billing in Seattle*

*** plus airtime*

Table 3 Data Services and Pricing
Source: Carriers 2001

Nearly all major NA wireless carriers offer a digital One Rate (DOR) pricing plan. As an extension of these plans data has in many cases been added as flat fee service. Customers typically purchase a bundle of MOUs or Minutes-of-use on a nationwide or nearly nationwide basis without incurring roaming or long distance charges. Data services are then added for a flat fee but whether voice or data is used is not relevent, carriers bill on a per minute basis. Only recently has the rollout of GPRS services come with the added capability of carriers to bill on a per kilobyte usage basis (excluding data exclusive services like CDPD and Datapac).

Cingular's GPRS service was launched commercially in August 2001 in Seattle making them the first to make it Commercial in the USA. Table 4 shows their pricing plan for this service. These prices are paid in addition to the regular voice service plan. As a contrast to this service Table 5 shows what the regular internet access service cost with messaging included. The key distinction between the plans is that the Express plan is the first to be offered by Cingular that does not include data access usage against the MOUs purchased by a customer.

Cingular's GPRS service is available via the Motorola Timeport 7389I tri-band phone. Cingular also offers corporate email service via Research In Motion's Blackberry 950 and 957 devices across the same GPRS network. Cingular has been one of the most aggressive and progressive carriers in North America to promote and deploy data services.

Wireless Internet Express			
Package Price	$14.99	$17.99	$21.99
Included Kilobytes	500	500	500
Price per Kilobyte	$0.07	$0.07	$0.07
Included Messages	100	250	500
Price per Message	$0.10	$0.10	$0.10
Internet Access	Yes	Yes	Yes
Related to GPRS services whrere available			

Table 4 Cingular GPRS Pricing Plan
Source Cingular 2001

Cingular	Interactive Messaging Pay Per Use	Interactive Messaging 100	Interactive Messaging 250	Interactive Messaging 500
Included Messages	0	100	250	500
Monthly Rate	$0.00	$6.99	$9.99	$13.99
Add'l Messages	$0.10	$0.10	$0.10	$0.10
Internet	No	Yes	Yes	Yes

Table 5 Cingular Data (Internet) Pricing Plan*Source Cingular 2001*

All carriers no longer place restrictions on site access when using their internet access services. AT&T's Pocketnet service was originally based on the CDPD technology. AT&T still operates their PocketNet service but now also offer data access over their digital cellular networks which include GSM, TDMA and now GPRS. For their non-premium service they restrict access through their gateway servers to sites that are identified as partners. As an example, to locate services around a specific site like a hotel a person might be staying at, basic users must use the "Ten Best" site.

In addition to Cingular, Sprint, AT&T, Microcell (in Canada) and Voicestream have all introduced their GPRS services now. Each has been rolling out the service as they make it available. All are initially targeting their corporate customers and have priced the service at a premium relative to existing data access services. As an example, Table 6 shows pricing for VoiceStream's GPRS services. The pricing plan is in addition to a minimum voice plan of $29.99 that gives 200 weekday minutes national usage. AT&T offers the most expensive GPRS service plan. The expectation is that these services will all decrease in price as competition and usage increase.

VoiceStream Smartphone	PDA (Windows-CE based Pocket PC)	Laptop	Any Device
$2.99 per month	$19.99 per month	$39.99 per month	$10.00 per MB
1 Megabyte† (MB) (about 500 phone screen pages)	5 Megabytes (MB) (about 90 web pages or 850 e-mails)	10 Megabytes (MB) (about 180 web pages or 1,700 e-mails)	Roaming outside of the iStream network.
300 *Ping Pong*™ text messages	300 *Ping Pong*™ text messages	300 *Ping Pong*™ text messages	
Get access to information on your phone.	Connect your phone to your Windows® CE-based PDA.	Connect your phone to your laptop or Windows® CE-based PDA.	
$10.00 per additional MB	$5.00 per additional MB	$4.00 per additional MB	

Table 6 VoiceStream GPRS pricing plan
Source: VoiceStream 2001

1.2.1 Mobile WISPs

Table 7 lists the top 4 independent services for wireless internet access that are not carrier controlled. These Mobile Wireless Internet Service Providers (WISP) typically offer services on a flat fee monthly charge and bundle the sale of that service with the sale of a wireless access modem operating on the Cellular Digital Packet Data (CDPD) network. CDPD networks cover 167 major metropolitan areas (MSAs), encompassing over 172 million people in the USA. Some WISPs like RIM and Palm.net also use the Mobitex network. They also offer the services under other internet service provider labels and in one case under a carrier service. Mobile WISPs should not be confused with “last mile” fixed wireless ISPs. There are more then 100 Fixed wireless broadband ISPs that are using various technologies for access. Some of these claim mobile access, but only for mobile lap tops and only in limited applications.

Service Provider	Subscriber Base
OmniSky	41,000
GoAmerica	100,000
YadaYada	25,000
Palm.net	190,000

Table 7 Wireless Internet Service Providers

There are a number of GPS related services available that use GPS data and map routing software to provide location based information. These however do not operate in real-time. Devices instead rely on loaded applications in the handheld device for Information. These services are therefore focused on users of laptop and PDA devices.

1.2.2 Omnisky

Omnisky is a publicly traded company based in San Francisco California with about 41,000 customers as of August 2001. Omnisky is currently suffering from slow revenue growth, seeing it's stock price decline from $12.50 to $0.20 in the last 52 weeks (Nov 15, 2001). They lease their network from the 4 major CDPD carriers AT&T, Alltel, Verizon and Cingular. They support a number of handheld devices including the following:

1. Palm V/Vx
2. Handspring Visor
3. Compaq iPAQ
4. Casio E-125
5. HP Jornada
6. HP Pavilion Notebook PC

They offer a number of different service plans and also provide corporate application hosting services through their OmniSky Oxygen service While normally adversaries, OmniSky has been able to resell it's services through Verizon and even AOL. In the case of the ISP AOL they provide a wireless access service to AOL's instant messaging, email and internet access. AOL offers their services through a number of wireless providers. Verizon wireless is currently offering the Omnisky Oxygen service to their corporate customers.

Omnisky's Oxygen service is based on a set of modular hosted services and applications that enables carriers, devices manufacturers and online service providers to quickly introduce customized wireless services for the consumer and enterprise market under their own brand. They divide their content services into Messaging, Content Delivery and Location-based categories. They promote their location based services as "ground Breaking" and define them as services that combine real-time and stored location-specific content. It lets users access local merchants, conduct e-commerce and obtain online restaurant information, movie guides, real-time directory services, and interactive maps as a function of their location, which must be entered manually

1.2.3 GoAmerica

GoAmerica is a publicly traded company that grew out of providing wireless solutions to the Taxi and trucking industry. They are currently trading near their 52 week low (Nov. 2001) with a decline in stock price of more then 90%. They offer more traditional ISP access over any network type that their affiliated carrier partner offers. They are partners with AT&T, Verizon, Cingular and Rogers Wireless (Canada), but only for the application services they provide to those carriers corporate customers.

GoAmerica claims to be the leading US WISP with more then 100,000 subscribers to their service as of August 2001. They charge based on access to the CDPD network like OmniSky, but offer rates a low as $9.95 for the first 25 KB of data and a per KB charge thereafter. They offer their services on a number of devices including the following:

1. RIM 850
2. RIM 950
3. RIM 957
4. Handspring Visor
5. HP 620/660 LX
6. LG Phenom Express / LG Phenom Express (2.1)
7. NEC 750 C
8. HP Jornada 820
9. Sharp Mobilon Pro / TriPad
10. Compaq iPAQ

1.2.4 Yadayada

Yadayada was founded in 1999 and follows the same CDPD leasing model (primarily from AT&T) of the other WISPs noted here. They started with $25 million in venture capital and also are believed to be running into financial difficulty. They package their service with a wireless modem for $39.95/month. Like the other providers they discount the cost of the modem when an extended service plan is signed. They currently have service using their HTML browser and do not support Java applications. The service is available on the following devices

1. Palm V/Vx

2. Handspring Visor
3. Compaq iPAQ
4. HP Jornada

1.2.5 Palm.net

Palm.net is available to users of the Palm VII and VIIx PDA devices. Launched in 1999 along with these products, Palm does not publish the number of subscribers to the service but it was estimated to be about 190,000 (IDC May 2001). Considering that Palm has sold more then 300,000 Palm VII devices this does not reflect well on the usage rate for mobile wireless data access with the device. It would be assumed that the device was puchased for its connectivity capability.

Palm.net operates primarily on the CDPD networks that Palm leases capacity from similar to the other WISPs mentioned here. In order to boost service they had to cut the cost of the Palm VII from its introduction price of $599 (2000) to $199 USD (August 2001). Service plans range from $9.95 to $44.95 with unlimited access.

1.3 Revenue Sources

With the declining economy in North America in 2001, wireless carriers are focused on cutting costs and increasing revenues in their core service offerings. As a result many of the unsubstantiated projections for revenue associated with value added services (VAS), specifically those associated with wireless data, have been down played. Carriers in North America earn 95% of their revenue from voice services (Cahnes In-Stat 2001). As a market differentiator, wireless carriers continue to promote new services, but focus has reverted to revenue generation in the short term. North American wireless carriers do not expect to see significant gains in their Average Revenue Per User (ARPU) in the next year. Table 8 shows ARPU figures as reported by the carriers for Q2 2001. The numbers range from a high of $75 for Nextel to a low of $46.50 for US Cellular. ARPU numbers are an indication of profitability and usually also reflect an inverse relation to churn as customers become more dependent on carrier value added services.

Company	ARPU
1. Verizon Wireless	$52
2. Cingular	$49.5
3. AT&T Wireless Services	$68.5
4. Sprint PCS	$59
5. Nextel	$75
6. Alltel	$49
7. VoiceStream	$52
8. US Cellular	$46.5
9. Western Wireless	$65
10. Powertel, Inc.	$53

Table 8 North American Wireless ARPU
Source Q2 2001 reports carriers

In addition to some of the value added services that are shown in Nokia's "hypermarket of services" figure 4, carriers are also planning to rely on the increased revenue potential with wireline replacement of land line phones and software specific services associated with new Java enabled phones. Telus Mobility in Canada acquired Clearnet, the national iDEN operator in Canada, in 2000. They have embarked on a media campaign to encourage users to replace their landline phone with a wireless phone fromTelus. Sprint in the US has also been promoting this service in select regions. The biggest barrier to these services is that carriers are still not able to offer location based billing. Location based billing when introduced will provide wireless carriers with leverage to convince customers to use cell phones all the time based on localized rates when at home or in the office.

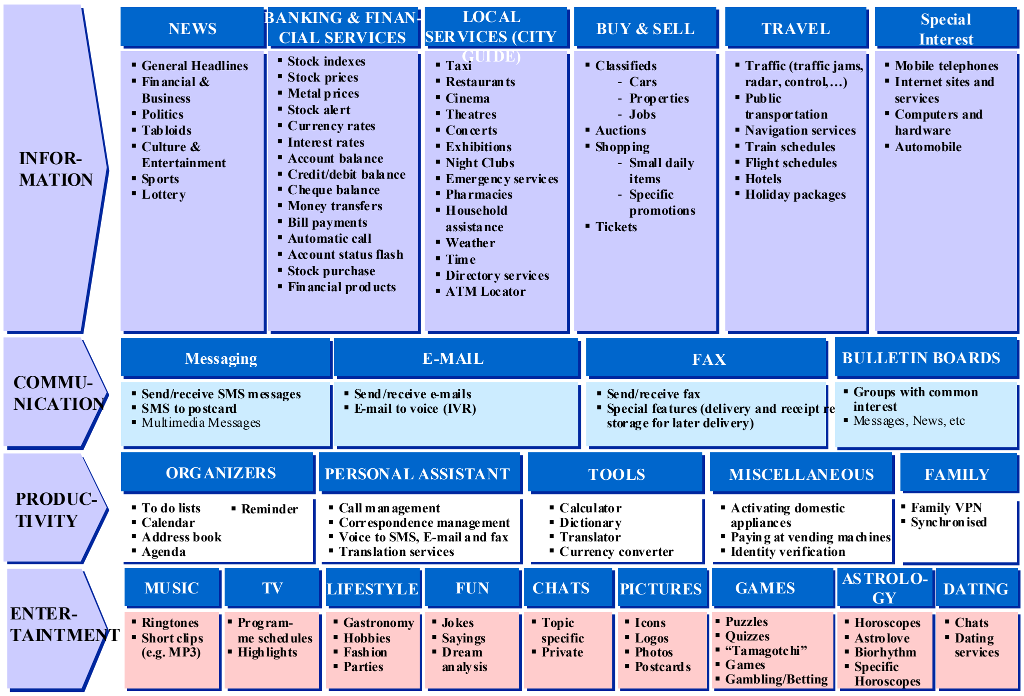


Figure 4 Nokia's Hypermarket of Services
Source: Nokia 2001-12-10

1.4 Billing Issues

One of the major issues affecting the implementation of VAS for wireless carriers is the sophistication of their billing system and the flexibility it provides the carrier to implement new services. Cahners In-Stat Group says that over the next 12 months 40% of North American Carriers plan to replace their billing system in order to meet customer service levels and introduce new services. In many cases multiple billing vendor partners are working to integrate their different databases as an ad-hoc solution to expanding services and a scaling customer base. This may be part of the reason that some carriers in the US have not introduced multiple revenue VASs based on a per transaction billing and have instead opted to offer just bandwidth and packaged data messaging services. The 5 largest NA billing vendors are mentioned here, as is SignalSoft because of it's location based billing that has gained some critical acclaim but little in the way of real world implementation.

1.4.1 Billing Vendors

Amdocs
Amdocs provides customer care, billing and order management systems for communications and Internet services providers, and business support systems for directory publishing companies. The are one of the largest

companies in this field and one of the most progressive for component billing using their Ensemble product.

Amdocs' Ensemble system provides an integrated voice-WAP solution with an advanced billing infrastructure. Ensemble features content-based rating and billing. The system collects usage records from the carrier's WAP gateway or various network elements including remote access servers, value-added application servers and e-commerce servers. This enables carriers to bill by URL and other content parameters, volume, QoS, and parameters determined by usage of services such as e-mail, or any combination of these.

Geneva
Geneva Technology Ltd., focuses on the development, implementation and support of Geneva, a rating and billing system designed for the telecom market. The system is designed to make it easier to introduce cross-product packages, including loyalty points and discount schemes. Geneva has an open architecture and can be integrated with other products, including legacy billing systems. Service providers who are enhancing legacy systems can use their existing billing systems with Geneva and produce a single convergent bill. The system enables multi-service billing for voice and mobile technologies such as GPRS, WAP and UMTS.

Kenan (lucent)
Kenan is the software products group of Lucent. They make the Interprenet product set for billing, customer care, order management and decision-support to single- and multi-service communications and energy companies. The have a number of Mobile Service Suites to address carrier needs for GPRS and other future technology introductions

Portal
Portal builds the business infrastructure for the Internet by providing the customer management and billing software for Internet and next-generation communications services. Portal's Infranet® software links Internet/IP services, subscribers, and revenues enabling service providers to develop, price, and provision new services and effectively manage customer usage and billing in real time.

NTC
NTC, a wholly-owned subsidiary of Illuminet Holdings, Inc., is based in Dallas, Texas. They provide a variety of telecommunications services, including automatic prepaid roaming under iRoam(SM), unregistered roaming services via its American Roaming Network(SM), and prepaid wireless services under SmartPay Wireless®.

SignalSoft

SignalSoft's Location Sensitive Billing (LSB) allows wireless network operators to charge for calls based on a subscribers' current location. Unique geographic boundaries, or rate zones, are set up for each individual subscriber in the system. Using LSB, network operators offer their customers wireline competitive rates when they use their wireless phones at home, while preserving standard mobility rates when subscribers fully enjoy the benefits of mobile communications.

1.5 Target Customers

Most services associated with wireless data are targeted currently towards the corporate user. These have been the tradional early adopters of technology associated with productivity increases. Nextel claims the highest user base of corporate vs. consumer customers because of the dual RF and cellular nature of their network. They also claim the industries highest ARPU. The corporate market for wireless data is expected to grow by 1000% over the next 3 years (Strategis Group 2001). Wireless data subscribers in the U. S. are expected to grow from 5 million mostly corporate users today to 172 million mostly consumer users by 2007. This will value the US Wireless data market at $12 billion USD by 2005 (Strategis Group 2001)

A survey conducted by strategy Analytics in early 2001 showed usage rates based on the type of device used. It shows more then 71% of those surveyed that do not currently own cell phone or wireless PDA device, would use such a device for wireless internet access. However it also shows that only 14% of the current 45% of cell phone users would use it for wireless data access (internet access). See Figure 5 for details.

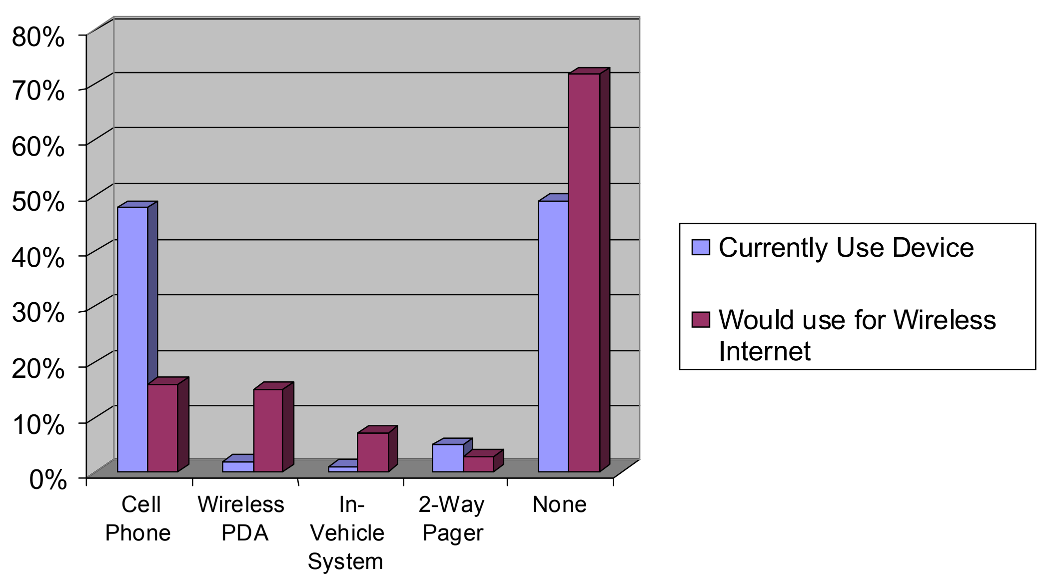


Figure 5 Interest in Wireless Internet

Source Strategy Analytics 2001

New services being introduced using GPRS are in some cases only available to corporate customers. AT&Ts initial launch of their GPRS service in Seattle targets only corporate clients. Research In Motion (RIM) has tried the reverse, offering a low cost version of it's email service through AOL earlier this year but has had limited success. Almost all of RIMs user base remains as corporate customers.

Some studies have indicated that many consumer customers see location based services as a priority based on recent security concerns. Table 10 in the legislation section of this report shows how a random sampling of survey participants ranked emergency E911 service functionality on their wireless phone as a priority. That survey asked users to rank based on a given list of services. A survey conducted by Greenfield Online via the internet asked survey participants to list why they would or do use wireless data. Table xx show the results of the survey. Email and general web access still rank as top priority for users. Consumer markets have been slow to adopt these services but as penetration rates of data capable phones grow and carriers reduce prices, carriers will continue to target services these services to consumers on an expanded basis as they have corporate clients.

Reason	Percentage
Send and receive email	62
Surf the internet	45
Play games online	23
Check and trade stocks	12
Plan their next vacation	9
Look for a new job	8

Table 9 Survey of Internet Capable Phone Usage
Source: Greenfield Online 2001

1.6 Value Chains

The shifting value chains for the North American wireless data industry have several new categories as a result of the need to address and process location information. Key to changes in any value chain is the introduction of new technologies and new competition. Typically the introduction of new technologies precipitates new competition. In a market as dynamic as the US it is difficult to track traditional models as they are constantly changing with new partnerships that are necessitated with the new technology entering the market.

Traditionally the value chain for wireless carrier information was modeled after the example in Figure 6. Information and applications are provided by a content or application creator or source and passed to a point of access provider, i.e. a portal or other form of aggregator. This platform hosts access for the service delivery partners (carrier) who provides the access point to multiple aggregators/portals via the wireless infrastructure. Typically the carrier can be defined as the final customer billing partner.

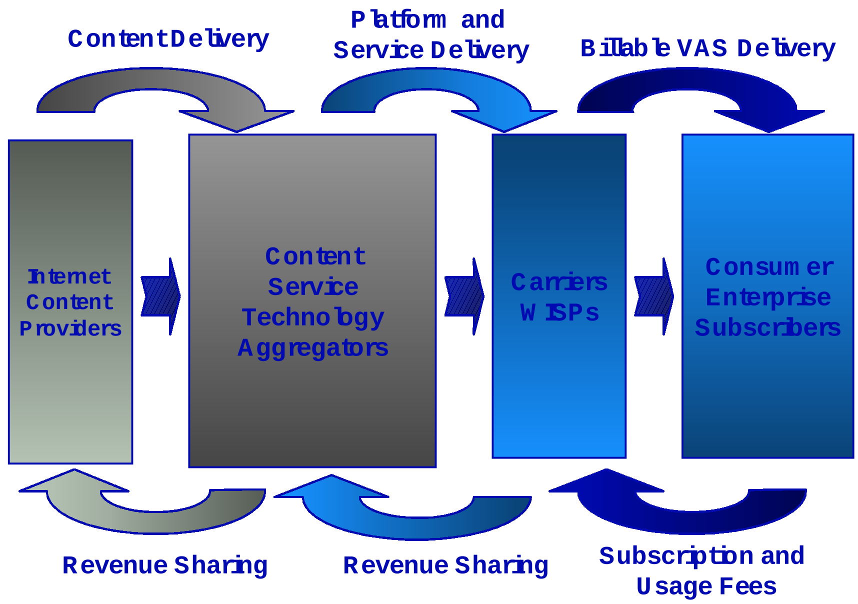


Figure 6 Traditional Wireless Data Delivery Value Chain

1.6.1 Shifting Along The Value Chain

Of course there are no clearly defined boundaries between these roles in the value chain as defined in Figure 6. A need for carriers to increase revenues and a need for service and content providers to be less dependent on the carriers has seen a migration up and down the value chain (Figure 7). Perhaps the biggest change has been in the creation of the Wireless Internet Service Providers (WISP) category. Initially there have been a large number of wireless focused portals, aggregation points that have specifically targeted the needs of a mobile customer. The shift came when companies like Omnisky and Go America began to lease incumbent carrier network access and capacity to operate their own virtual networks and bill customers for access directly. Unfortunately they have struggled in the last year, with their financial viability in question (see WISPs Section).

In fact the high cost of moving up the value chain has put many smaller well financed businesses out of business. The demise of Ricochet is perhaps the best of example of an excellent service that focused on competing in the delivery of high speed wireless data access with existing wireless carriers. Metricom started the Ricochet network with large high profile investors like Paul Allen (Microsoft founder) and Worldcom. It delivered high speed data access via unlicensed RF modems at the 900 Mhz bandwidth range. It had 51,000 customers in August 2001 before it shut down due to lack of funds. They left more then a $1 billion USD in debt after their demise

Some parallels are now being drawn between what some of these access providers are experiencing and what competitive Local Exchange Carriers (CLECs) experienced in the last five years when deregulation of the local wireline phone markets created a rush of companies to compete with incumbent wireline carriers. None was able to sign up customers quickly enough to compensate for the huge cashflows associated with building a network infrastructure. To most investors today CLEC is consider a non-starter for investment dollars. Most have either consolidated or have gone out of business. The latest casualty in the wireless data delivery business was Mobilestar. Mobilestar delivered public access 802.11 service via airports, campuses, coffee shops, malls and hotels (see alternative access section for more information). It shut down in October 2001.

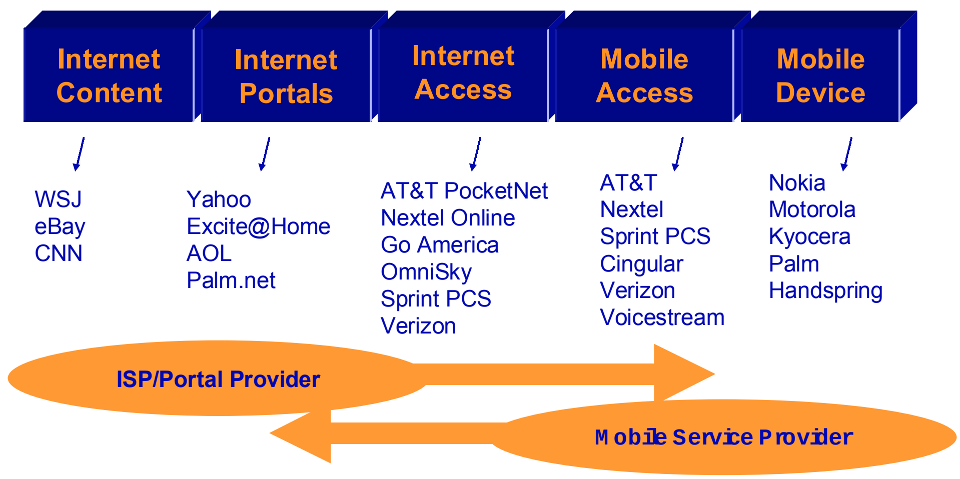


Figure 7 Migration Along The Value Chain

For carriers moving down the value chain, they have sought to brand their own portel services and act as the consolidater (although most outsource the actual hosting, system integration and content/application creation). As such they are seeking to control more of the mobile access. Originally some carriers like AT&T, Sprint and SBC (now Cingular) introduced the "walled garden" approach to web access. When alternative WAP/dial gateways became available they could no longer charge partners for the right to show through their gateway (Figure 8.). Now all control only the menu (premium) positioning (AT&T still has limited access on it's basic service).

Most carriers believe that they will have to gain more then just user fees for access to premium content.

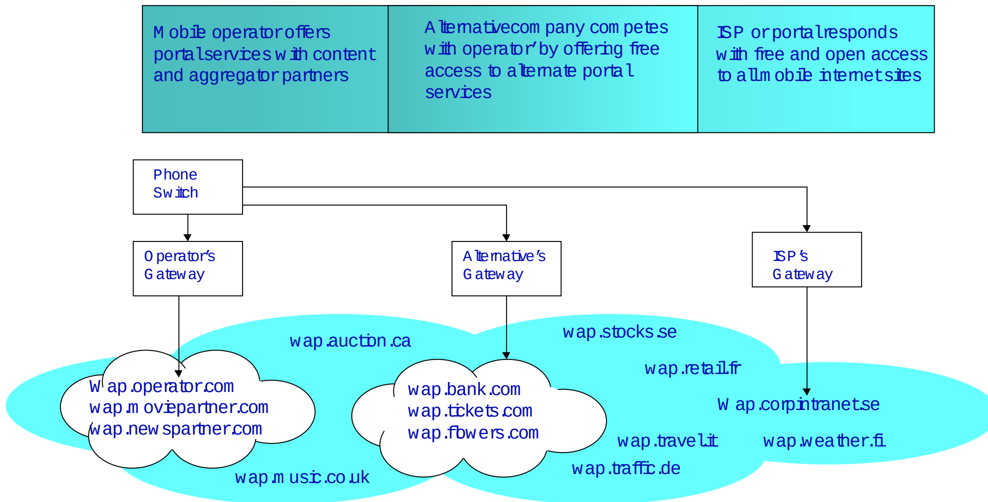


Figure 8 Shift in Wireless Carrier Value Model

1.6.2 Who Controls The Value

Customer contact and directing billing capability play an important role in the delivery of wireless content. Figure 9. Shows the value pyramid with customers at its apex. Carriers, with their billing capability have traditionally controlled all value below. WISPs have now moved into the transport section, but have had little success in 2001. Revenue can be generated throughout the value chain in the form of licenses and fees, but the bulk of income is still expected to come from enduser access. Advertising revenues are still expected to be marginal in 2002, even with the location specific prospects in the future. Other negligible fee sources are the sale of consumer data, transaction fees for content and service, technology and content license fees.

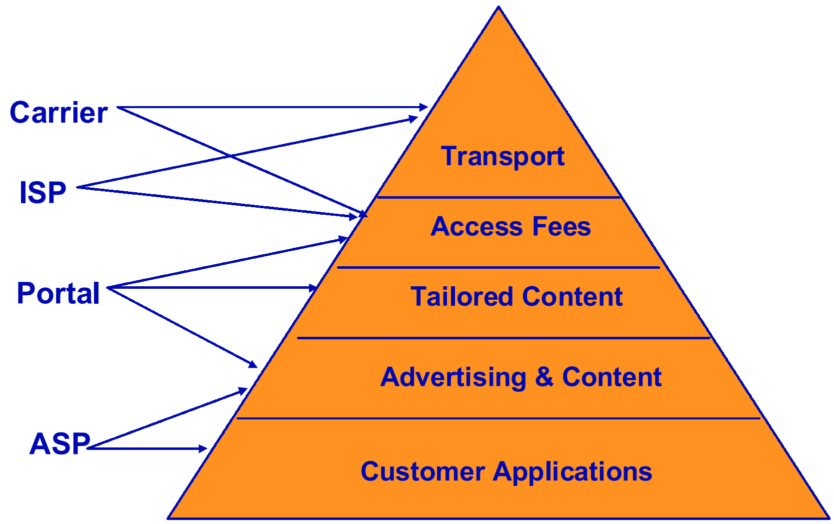


Figure 9 Value Pyrimid

One of the other key changes in the value chain in addition to shifting roles between wireless carriers and wireless ISPs and portal providers is the introduction of application capable portable devices in the form of larger memory Java capable phones and PDA phones. This has the potential to increase the value of application service providers. Revenue in this market could shift from corporate users to consumers as things like downloadable games move into the mainstream through enhanced functionality of the device. And also the streamlining of the billing process. Today most of the revenues associated with hosting applications for mobile users comes from corporate users with laptops and PDAs that use them to access corporate content.

Some carriers are now anticipating the changes the handset specific applications will have on the revenue model. Sprint PCS has developed a program called Wireless Application Manager (WAM) that will rollout in mid 2002. This development program is meant to streamline the increasingly difficult and complicated value chain issues that have arisen based on the hundreds of partnerships Sprint PCS has and the anticipated thousands it will have in the future with application and content providers. However the increasing complexity of the network has also dictated this process (Figure 10) The program will automate and standardize how Sprint PCS develops value chain relationships. More about this program is listed in Section 3 of this report.

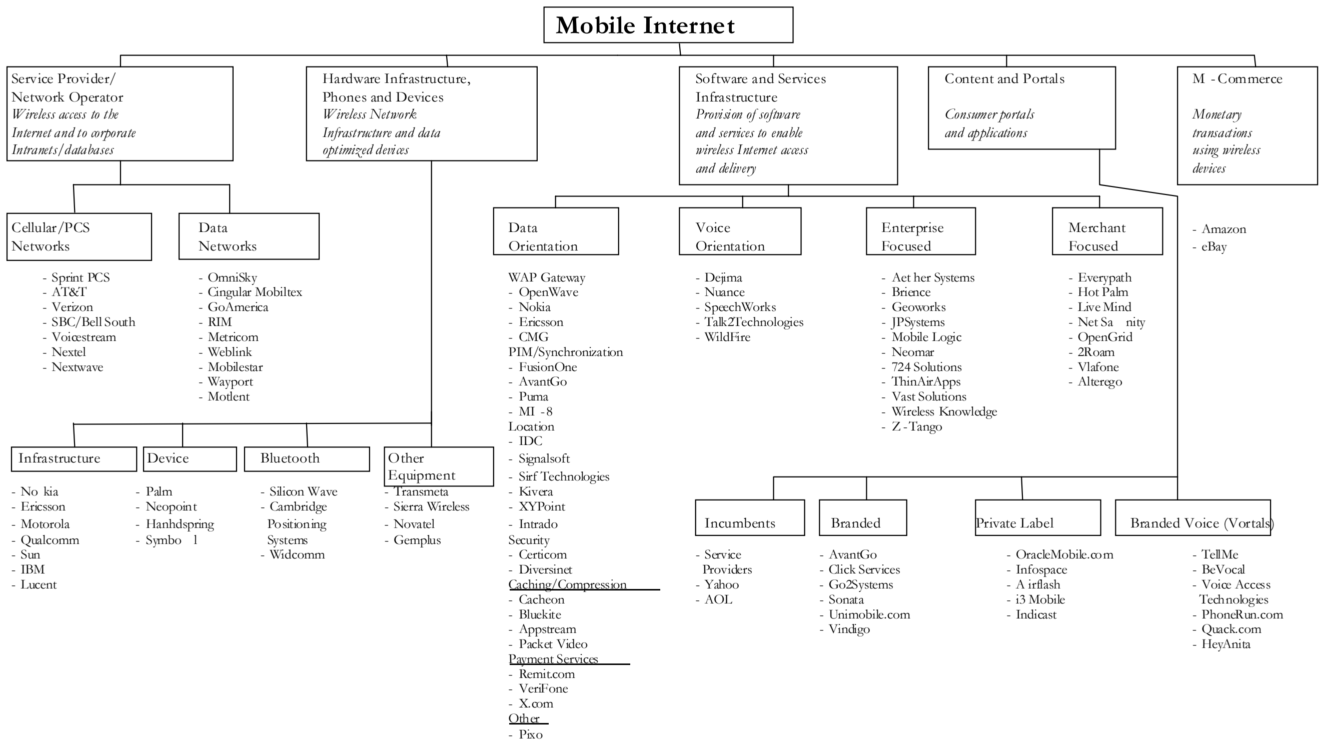


Figure 10 Mobile Internet Value Players

As part of the development program Sprint will also introduce third party micro billing called "Bill on Behalf of" (BOBO). According to Sprint PCS the BOBO program will allow developers, partners and content providers to establish a billing relationship with Sprint PCS. Any usage of third party web applications and contents may be billed to the user using the standard Sprint PCS invoice. This will simplify the billing of multiple Web services and contents purchased by the Sprint PCS users, and this will also ease the billing issues on the part of developers.

1.6.3 The Impact of Location Information

The shift in the management of location has meant that new companies have arisen to meet the needs of processing information in real-time associated with location information. The impact it has to the actual value chain will be more associated with what is delivered and less to do with who is delivering it. Some concern has been raised by content providers, like banks and advertisers, that carriers might hoard location information in order to develop services that give them a competitive advantage over the content provider (see Privacy section). Location information like all consumer usage data will have value unto itself that most likely only carriers will benefit from financially as they have the final customer contact.

Figure 11. shows a slightly more detailed version of the basic value chain for content delivery. It makes a distinction between what a service provider is and what a platform provider is. In many cases hosting for the delivery of content is performed not by the service provider but by the technology aggregator. As carriers move more into providing their own services, platform aggregators that host services will become more common.

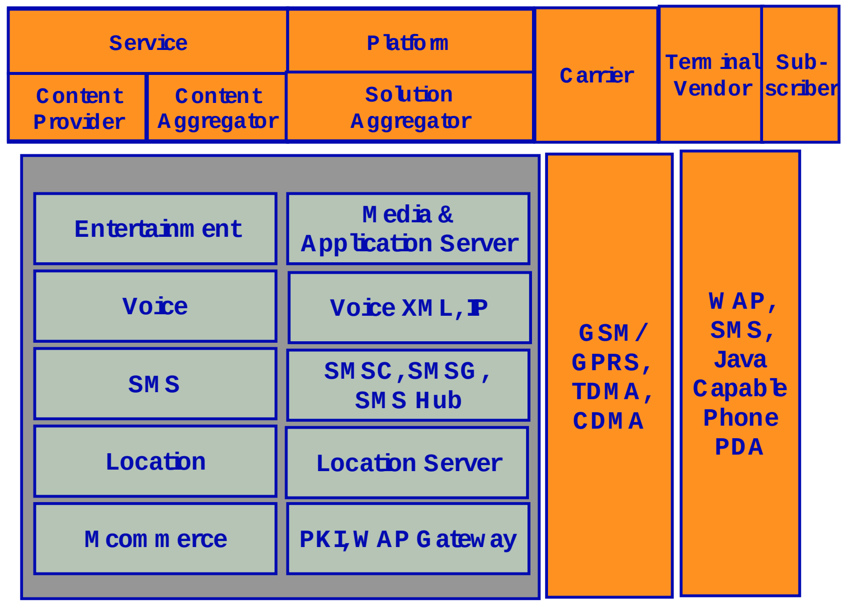


Figure 11 Value Chain Service Delivery

1.7 Legislation

Perhaps the single biggest barrier to the deployment of personal location based services in the US markets is the legislation associated with wireless E911 services. Many industry analysts feel that the implementation of E911 services by the major carriers is acting as catalyst to associated revenue generating services for wireless location based services. Unfortunately a survey by the National Emergency ;Number association (NENA) found at the beginning of 2001 that 91 of 129 wireless carriers in the United States said that they "can't determine" when they will comply with the FCC mandates. Things have not changed much since then.

Why is E911 so important? In recent years wireless carriers have focused their non corporate consumer advertising dollars on emphasizing the added security of a wireless phone. This has resulted in typical non-users acquiring phones with a calling card for emergency use only. In fact declining Average Revenue Per Unit/User (ARPU) has been a direct result of these types of customers. Recently the terrorist events of September 11th, have drawn increased media attention towards the use of cell phones in emergencies and in particular for locating injured and trapped individuals. In a case reported in the New York Times, one survivor, a man trapped in the rubble where previously a courtyard existed between the twin World Trade Center towers, was rescued after he was able to call for help using his mobile phone. The man knew his approximate location, enabling rescuers to find and remove him. But in many accidents and disasters, people calling for help usually do not know their precise location, and are often left to describe their surroundings to emergency response services.

A recent survey conduct by Harris Interactive polled 1000 people on what they considered the most important features of a wireless phone. They were asked to rank their top three choices out of a list of six in order of importance. The results in Table 10 show that Enhanced 911 was the number one choice. The Strategis Group conducted a similar wireless phone usage survey in 2000 in which safety services also received the highest rating, 30% of respondents, with the next highest rating for receiving information at 20%. The Strategis poll involved a survey group of 500 people. Both surveys indicate that Americans remain safety conscious and view the use of a cell phone as a key tool for security.

Ranking:	1st	2nd	3rd
E911	59%	6%	2%
Email	7%	23%	10%
Camera	4%	11%	11%
FM Radio	1%	5%	11%
Video games	1%	3%	5%
MP3 Player	1%	3%	5%
None/no response	27%	49%	56%

Table 10 Phone Functionality Ranking

Source: Harris Interactive 2001

1.7.1 The 911 Act

In the early 90's it was found that emergency response services were receiving increasing calls from wireless phones. Unlike land line phones that were traced automatically for emergency service calls to the national 911 dial (similar to the European 112 service), wireless services could not be traced. In a series of initiatives that were legislated by the FCC in 1999 but began back in 1996, the agency had required wireless carriers to implement

E911 (enhanced 911) service, subject to certain conditions and schedules. The wireless 911 rules applied to all cellular licensees, broadband Personal Communications Service (PCS) licensees, and certain Specialized Mobile Radio (SMR) licensees. Although focused on carriers with national coverage, it applied to all licensed carriers with implementation leniency given to carriers with smaller coverage

In August 2000, the FCC adopted an Order to implement the Wireless Communications and Public Safety Act of 1999 (911 Act), enacted on October 26,1999. The purpose of the 911 Act was to enhance public safety by encouraging and facilitating the prompt deployment of a nationwide, seamless communications infrastructure for emergency services that includes wireless communications. The FCC initiated the implementation proceeding to address the provisions of the 911 Act and to fulfill the Congressional mandates set forth.

The 911 Act also added provisions dealing specifically with wireless location information (47 U.S.C. 222), the section of the Communications Act that governs treatment of customer proprietary network information (CPNI) and subscriber list information (SLI). For more information see the section on privacy.

The basic 911 rules require wireless carriers to transmit all 911 calls to a Public Safety Answering Point (PSAP) without regard to validation procedures intended to identify and intercept calls from non subscribers. Under the rules, therefore, both subscribers and non-subscribers can dial 911 and reach emergency assistance providers without having to prove their subscription status. The FCC adopted a 2 phase approach.

Phase one required that as of April 1, 1998, or within six months of a request by the designated Public Safety Answering Point (PSAP), whichever is later, covered carriers are required to provide to the PSAP the telephone number of the originator of a 911 call and the location of the cell site or base station receiving a 911 call.

Phase two required wireless carriers to provide Automatic Location Identification (ALI) as part of Phase II E911 implementation beginning in October 1, 2001. The FCC divided this implementation time schedule into two based on the technology solution chosen by the wireless carrier.

For carriers using handset-based ALI that required modified or upgraded handsets (such as GPS-based technology) they could phase-in deployment of Phase II subject to the following requirements:

Begin selling and activating ALI-capable handsets no later than October 1, 2001; Ensure that at least 25 percent of all new handsets activated are ALI-capable no later than December 31, 2001; Ensure that at least 50 percent of all new handsets activated are ALI-capable no later than June 30, 2002; and Ensure that 100 percent of all new digital handset activated are ALI-capable no later than December 31, 2002 and thereafter. By December 31, 2005, achieve 95 percent penetration of ALI-capable handsets among its subscribers.

The above was to be completed independent of a PSAP. Once a PSAP request was/is received, the carrier would provide in the area served by the PSAP, within 6 months or by October 1, 2001, whichever was later:

Install any hardware and/or software in the CMRS network and/or other fixed infrastructure, as needed, to enable the provision of Phase II E911 service; and begin delivering Phase II E911 service to the PSAP.

For network-Based ALI Technology: As of October 1, 2001, within 6 months of a PSAP request, carriers employing network-based location technologies must provide Phase 2 accuracy information for at least 50 percent of the PSAP's coverage area or population. Within 18 months of a PSAP request the carriers must provide Phase two information for 100 percent of the PSAP's coverage area or population.

In September 1999, the FCC revised its rules to better enable carriers to use handset-based location technologies to meet the Phase II requirements. In particular, the FCC established separate accuracy requirements and deployment schedules for network-based and handset-based technologies. The accuracy for both implementation methods was revised and defined as follows:

For handset-based solutions: 50 meters for 67 percent of calls, 150 meters for 95 percent of calls;
For network-based solutions: 100 meters for 67 percent of calls, 300 meters for 95 percent of calls.

The FCC required wireless carriers to report their plans for implementing E911 Phase II, including the technology they planned to use. Most carriers choose to provide plans that were vague and did not hold promise of ever becoming a reality. Carriers like AT&T redefined their entire plans several times, switching from a network solution to a handset solution to a blend of both. Originally, the FCC's rules envisioned that carriers would need to deploy network-based technologies to provide ALI. However many manufacturers made technology advances to for handset manufacturers. As an example, Qualcomm made significant advances with their Snaptrack initiative for deploying GPS chipsets for handsets.

The 2 phase approach also had numerous updates to address specific requirements. For instance in May 1999, the FCC adopted requirements to improve the ability of rural cellular phone users to complete wireless 911 calls. The 911 call completion rules were intended to improve the security and safety of analog cellular users, especially in rural and suburban areas.

This revision meant that all mobile phones manufactured for sale in the United States after February 13, 2000, that were capable of operating in an analog mode, including dual-mode and multi-mode handsets, would include a special method for processing 911 calls. When a 911 call was made, the handset must override any programming that determines the handling of ordinary calls and must permit the call to be handled by any available carrier, regardless of whether the carrier is the customer's preferred service provider. Handsets capable of operating in analog mode must incorporate any one or more of the 911 call system selection processes endorsed or approved by the Commission.

1.7.2 Public Safety Answering Points

The E911 Phase I requirements, as well as certain parts of the Phase II requirements, are applicable to wireless carriers only if the administrator of the designated Public Safety Answering Point (PSAP) has requested the service and is capable of receiving and utilizing information provided (also called a 911 Call Center). In November 1999, the FCC revised its E911 rules to remove the prerequisite that a cost recovery mechanism for wireless carriers be in place before carriers are obligated to provide E911 service in response to a PSAP request. The PSAP must have the means of covering its costs of receiving and utilizing the E911 information, however, in order to make a valid request for E911 service the FCC's rules do not mandate any specific state action nor specify any particular mechanism for funding the technology and service capabilities necessary to enable the PSAP to make a valid service request. In 2001 the National Emergency Number Association (NENA) petitioned to have as much as $25 million set aside by the US federal government for updating PSAPs for wireless E911 support. In an effort to make the support costs more manageable some carriers (AT&T) eliminated the per user charge it had originally said it would bill the public safety service organizations in its coverage areas.

In the US there are more then 5000 PSAPs responding to more then 190 million 911 calls, 40 million of which come from wireless phones (NENA RCN publication 1999). However most PSAPs are not yet capable of using the number, call back and location information in their systems. A survey conducted by the Association of Public Safety Communications Officials found less then 10% of the 4300 police stations could process the wireless call information associated with phase 1 and far fewer for phase 2 as it becomes available. It is believed that fewer then 50% of emergency call centers have made formal requests for implementation of the services from the wireless carrier (Source NENA RCN update 2001).

With the recent waiver rulings by the FCC commission in October the commission also clarified (although not officially) what constituted an official or valid request by PSAPs to carriers for E911 service data receipt. Originally a valid request met the following rules

1. The PSAP has a cost-recovery mechanism in place.
2. Any upgrades to the PSAP's network or facilities necessary to enable it to receive and utilize E911 data will be completed no later than six months following its request.
3. The PSAP has made a timely request to the appropriate local exchange carrier for the necessary trunking and other facilities to enable the E911 data to be transmitted to the PSAP.

The amendment will also include the following rules associated with the receipt of E911 data to provide the service via wireless.

The PSAP will be deemed capable of receiving and utilizing the data elements associated with the service requested if it is Phase I-capable
The PSAP has a Non-Call Path Associated Signaling (NCAS) methodology in place.

1.7.3 Delays and Revisions

The last FCC commission meeting meant that carriers all won delays in the deployment of E911 services. At the beginning of October , 2001 the FCC convened a hearing to review the status of it's E911 initiative. It corresponded with the deadline for the Phase 2 implementation of E911 wireless services. All major carriers filed waiver petitions prior to this meeting as none could meet the deadline. As a result the FCC granted extensions to all the major carriers.

The FCC has also delayed deciding the fate of smaller carriers, mostly in rural areas, which have not filed any waiver requests. The enforcement delay was for a short unspecified period of time. Such lack of specifics indicates that the FCC is unwilling to enforce these smaller carriers in the tough economic times that are forecast in 2002.

The delays allowed by the FCC don't push back the deadlines to have in place a system to locate 95 percent of those that dial 911 from a cell phone. That deadline is still Dec. 31, 2005. Instead, the FCC granted delays for carriers to meet certain steps in the process. AT&T, as an example, was given a month more time to begin building its network and said it would ship only E911 compliant phones by the end of 2002. Nextel won the biggest of the delays. It was supposed to begin selling cell phones that are E911-ready by Oct. 1, but it now has until December, 2002. This is really because Motorola, the proprietary provider of handsets and infrastructure for Nextel has said they will not have them until the end of 2002. And it will not be until 2004 until each phone sold is E911 compliant. Sprint has said they will ship only E911 compliant phones by the end of 2002 also. Verizon has said they will not have 100% E911 compliant phones only until the end of 2003. However none of the carriers is sure of the timelines for network upgrades to support E911 services.

The FCC has decided to get tougher with carriers as they feel that they are not seriously observing the requirements as set out in their original mandate for wireless E911 services. According to the FCC, the carriers will have to start filing quarterly updates on their progress, beginning next year. They are also considering fines and sanctions as penalties for enforcement. Beginning February 1, 2002 through February 1, 2006, each carrier must file on February 1, May 1, August 1, and November 1 of each year with the Chief of the Wireless Telecommunications Bureau. These reports are intended to provide specific, verifiable information to allow the Commission to monitor E911 progress.

The FCC Commissioner Michael Powell said in his October report "I am disappointed and unsatisfied with the progress we have made…..I know and respect that carriers have made concerted strides in this area, but those efforts must be redoubled. It goes without saying that there is a new sense of urgency around using mobile phones as important safety devices. They have become indispensable tools for calling for help and for delivering help. Thankfully, we are only at the beginning of the implementation of this process and not at the end." (source FCC 01-299 par. 1, October 2001)

As a result of the missed October 1st 2001 deadline the top five national carriers committed to the following implementation technologies, schedules and conditions as set out in the FCC report issued from their October meetings (source FCC 01-294 to FCC 01-299 October 2001).

AT&T Wireless

AT&T Wireless' request to deploy E-OTD technology for its GSM network was granted by the FCC with the conditions noted below. Since E-OTD requires handset modifications to be effective, AT&T will be subject to all of the requirements applicable to handset-based technologies except as specifically waived or modified in this order.

Effective October 1, 2001, AT&T's E-OTD-capable handsets must provide ALI with an accuracy of 100 meters/67 percent of calls and 300 meters/95 percent of calls.

Effective October 1, 2003, AT&T's E-OTD-capable handsets activated on or thereafter must comply with an accuracy of 50 meters/67 percent of calls and 150 meters/95 percent of calls.
To the extent AT&T cannot comply with these accuracy requirements, AT&T must use another ALI methodology that comports with the accuracy requirements of the Commission's rules.

Cingular Wireless
Similar to AT&T Wireless, Cingular's request to deploy E-OTD technology for its GSM network was also granted, subject to the specific conditions noted below.

October 1, 2001: Cingular must begin selling and activating E-OTD-capable handsets and ensure that at least one entry-level E-OTD-capable handset model is available.
December 31, 2001: 25% of new handsets activated nationwide must be E-OTD- capable.
March 31, 2002: 40% of new handsets activated nationwide must be E-OTD- capable.
June 30, 2002: 65% of new handsets activated nationwide must be E-OTD-capable.
September 30, 2002: 100% of all new digital handsets activated nationwide must be E-OTD-capable.
December 31, 2005: 95% of subscriber handsets in service must be E-OTD-capable.
Effective October 1, 2001, Cingular's E-OTD-capable handsets in service must provide ALI with an accuracy of 100 meters/67 percent of calls and 300 meters/95 percent of calls.
Effective October 1, 2003, Cingular must ensure that all new E-OTD-capable handsets activated on or thereafter provide an accuracy of 50 meters/67 percent of calls and 150 meters/95 percent of calls. To the extent Cingular cannot comply with these accuracy requirements, Cingular must use another ALI methodology that comports with the accuracy requirements of the Commission's rules.
On or before December 1, 2002, Cingular must complete Ericsson and Nortel switch upgrades.
On or before December 31, 2002, Cingular must complete deployment of Phase II service in markets with valid PSAP requests received on or before June 30, 2002.
On or before March 31, 2002, Cingular must begin deploying its "safety net" location capability for subscribers without E-OTD handsets and have completed deployment throughout its network by June 30, 2002. This technology must provide location information with an accuracy of 1000 meters or better for 67 percent of calls.
With its February 1, 2002 Quarterly Report, Cingular must submit a Phase II rollout plan describing how it will prioritize PSAP requests and deploy Phase II service.

Nextel

Nextel's request to deploy A-GPS technology for its iDEN network was granted, subject to
compliance with the noted conditions below.

October 1, 2002: Nextel must begin selling and activating A-GPS-capable handsets and ensure that least one entry-level A-GPS-capable handset model is available.
December 31, 2002: 10% of new handsets activated nationwide must be A-GPS-capable.
December 1, 2003: 50% of new handsets activated nationwide must be A-GPS-capable.
December 1, 2004: 100% of all new digital handsets activated nationwide must be A-GPS-capable.
December 31, 2005: 95% of all subscriber handsets in service nationwide must be A-GPS-capable.

Sprint PCS

Sprint's request to deploy A-GPS technology for its CDMA network was granted, subject to compliance with the noted conditions below.

October 1, 2001: Sprint must begin selling and activating A-GPS-capable handsets and ensure that least one entry-level A-GPS-capable handset model is available. July 31, 2002:
25% of all new handsets activated nationwide must be A-GPS- capable.
December 31, 2002: 100% of all new handsets activated nationwide must be A-GPS- capable.
December 31, 2005: 95% of all customer handsets in service nationwide must be A-GPS-capable.
On or before May 30, 2002, Sprint must complete its Phase II conversion of all Lucent switches for its CDMA network.
On or before August 1, 2002, Sprint must complete its Phase II conversion of all Nortel switches for its CDMA network.
On or before December 31, 2002, Sprint must complete any additional software and infrastructure upgrades necessary to support Phase II and to complete all outstanding valid
PSAP requests for Phase II service received on or before June 30, 2002. Sprint must complete valid PSAP requests received on or after July 1, 2002 within six months of receipt, as provided in the Commission's rules.
With its February 1, 2002 Quarterly Report, Sprint must submit a Phase II rollout plan describing how it will prioritize PSAP requests and deploy Phase II service for its Nortel switches.

Verizon Wireless

Verizon's request to deploy A-GPS/AFLT technology for its CDMA network was granted, subject to compliance with the noted conditions below.

Verizon must comply with the following timeline with respect to its A-GPS-capable handsets:
December 31, 2001: Verizon must begin selling and activating A-GPS-capable handsets and ensure that least one entry-level A-GPS-capable handset model is available.
July 31, 2002: 25% of new handsets activated nationwide must be A-GPS-capable.
March 31, 2003: 50% of new handsets activated nationwide must be A-GPS- capable.
December 31, 2003: 100% of new digital handsets activated nationwide must be A-GPS-capable.
December 31, 2005: 95% of all customer handsets in service nationwide must be A-GPS-capable.
On or before April 1, 2002, Verizon must complete deployment of the network-assisted portion of A-GPS/AFLT in its switches and cell sites for Lucent markets.
On or before August 1, 2002, Verizon must complete deployment of the network-assisted portion of A-GPS/AFLT in its switches and cell sites for Nortel markets.
On or before March 1, 2003, Verizon must complete deployment of the network-assisted portion of AGPS/AFLT in its switches and cell sites for Motorola markets.
In areas where Verizon receives a valid PSAP request where the majority of the PSAP's coverage area is covered by the Verizon analog-only network, Verizon must take affirmative steps in order to comply with the Commission's Phase II rules.
On or before December 31, 2002, Verizon must complete all valid PSAP requests received on or before June 30, 2002, except in markets served by Motorola switches. In Motorola markets, on or before March 31, 2003, Verizon must complete all valid PSAP requests received on or before September 30, 2002. In markets served by Lucent and Nortel switches,
Verizon must complete valid PSAP requests received on or after July 1, 2002 within six months of the request, as provided in the Commission's rules. In markets served by Motorola switches, Verizon must complete valid PSAP requests received on or after October 1, 2002 within six months of the request, as provided in the Commission's rules.
Verizon must install a network-based technology in the following counties where there are Phase II requests and previously tested network components, according to the following schedule:
December 31, 2001: Verizon must provide Phase II capability to 100% of St. Clair County, Illinois (St. Louis) and Lake County, Indiana (Gary-East Chicago market).

April 1, 2002: Verizon must provide Phase II capability to 100% of Cook County, Illinois (Chicago), St. Louis County, Missouri (St. Louis) and Harris County, Texas (Houston).
On or before April 1, 2002, Verizon must deploy Enhanced Forward Link Trilateration (EFLT) Phase II solution, with an accuracy on average of within 250 to 350 meters, without the assistance of a modified handset, in all markets served by Lucent and Nortel switches.

1.8 Privacy Issues

In 1999 the US Congress enacted the Wireless Communications and Public Safety Act which amended the telecommunications Act (WCPS) of 1996. The amendment says that location information derived from carrier services is "customer proprietary network information" (CPNI). This means that the carrier must disclose that information to whom ever they wish to have it via written consent of the customer.

The WCPS Act requires carriers to get prior authorization before they disclose location information. The exceptions to this are disclosure for the purpose of providing the service, like billing (but could go further for VAS) and also for legal issues like protecting the carriers property rights or for the purposes of criminal investigation (no warrant required).

Table 11 shows the three largest misconceptions of what pertains to legal requirements associated with location information. It should be noted that FCC restrictions associated with the WCPS act pertain only to the legal definition of a "telecommunications carriers" and have no jurisdiction over non telecom carrier companies.

Once gathered, carriers own location information	FALSE
Carriers may not legally disclose location information without the customers consent.	FALSE
User consent will eliminate privacy problems.	FALSE

Table 11 Misconceptions of Location Information

Prior authorization does not mean written consent though. This part of the 1999 WCPS Act is ambiguous at the moment because of legal precedence set by a successful court challenge of the FCC subscriber consent rules in 1999. The precedence setting case of US West vs. FCC 182 F.3d 1224 10th circuit court. This found the FCC rules unconstitutional. At this moment the WCPS act therefore interprets customer authorization to include written, oral and electronic, including "click throughs". Users of location services could therefore be consenting to disclosure of there location when accessing unrelated site services like general map directions that might be sponsored by a local retailer. That retailer could then provide location specific promotions. However this is not likely based on the issue of maintaining a certain level of trust between the carrier and the customer.

In an attempt to clarify privacy issues for wireless users of location services the Cellular Telecommunications Industry Association (CTIA) submitted recommendations based on the CTIA's privacy principles in November 2000. These guidelines were produced not only for carriers but also manufacturers and other service partners that may have access to location related information. The four basic recommendations were as follows:

1. LBS providers, both carrier and non Carriers should make customers aware of the collection of location information
2. Allow the customer to consent to it's use
3. Ensure the security and integrity of collected data and permit the customer reasonable access to the data
4. Provide uniform rules and privacy expectations so that consumers are not confused

The Electronic Privacy Information Center (EPIC), is non profit resource and educational organization that examines the privacy and civil liberties implications of emerging technologies. As a leading advocate, EPIC has identified the development of location tracking systems as a significant new challenge for policymakers and the public. According to EPIC "These technologies, which enable the creation of detailed daily itineraries for millions of consumers, have the potential to fundamentally alter the nature and use of wireless communications systems. While there are likely to be some location-based services that will appeal to many consumers, there are likely to be many others that will be perceived as invasive and undesirable." As such EPIC endorsed the petition submitted by the CTIA to the FCC for rule making to establish fair location information practices. The FCC has not ruled on these issues yet

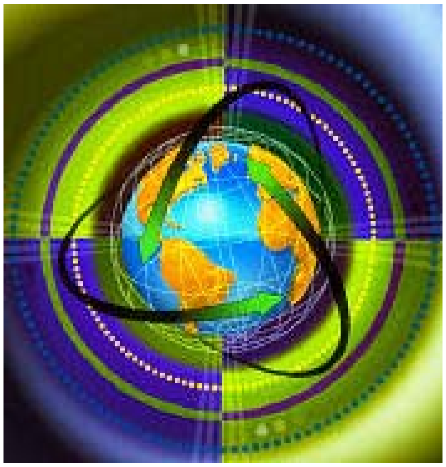
Privacy issues are not ruled only by federal law in the US. Although no US state statutes specifically address location privacy for telecommunications they do have consumer protection bills that afford a certain amount of privacy protection. Nine states have explicit privacy guarantees (Arkansas, Arizona, California, Florida, Illinois, Louisiana, Montana, South Carolina and West Virginia). Many of these grew out of a lack federal protection on an individuals right to privacy. Amendments also came from consumer protection plans that had their origins in telemarketing and direct mail marketing list sharing.

With the increased us of telematics many states are also legislating privacy bills that expressly address the monitoring of vehicles as well. There are number of cases before the courts involving rental vehicles. Most of these are challenges by consumers that are refusing fines imposed by rental car agencies associated with vehicle monitoring systems. These rental companies have imposed speed and location restrictions, enforceable with in vehicle monitoring equipment and written them into the rental agreement. Consumers have challenged these as a breach of privacy even if written consent was given. Texas, Tennessee and Hawaii all have statutes now that define the electronic monitoring of vehicles and include clauses associated with the written consent of vehicle monitoring.

Location information remains a sensitive issue for consumer advocates. They feel that like much of the information gathered on consumer spending patterns, it will be abused. Many product and service retailers in the ecommerce area feel that carriers while restrict this information to their own benefit when it comes to mcommerce. However it is likely that carriers will maintain a certain amount of consumer trust through prudent use of this information.

As a result of the US public sensitivity towards privacy, many carriers have or are adopting rigorous privacy agreements for themselves their customers and their partners and content provisioners. As an example Sprint claims that it will make revenues from the service and not through the exploitation of it's customer database to third party marketers. As part of their Wireless Application Manager (WAM) program they will launch in 2002 with their first 3G initiative, they will allow customers to browse and use the Internet anonymously. Subscribers to the Sprint PCS 3G network will be offered anonymity protection with the ability to opt-out. The subscriber's identity will be protected while browsing partner Web sites anonymously within the Sprintpcs.com Portal environment. Partner Websites will not be able to identify a subscriber from the HTTP header information. Partners requiring personal information about a subscriber will only be able to request the information from "Sprint PCS WAM My Profile". Information will be shared only if the subscriber has explicitly granted permission for the Web service or content provider to access the requested information.

In the implementation of middleware access technologies for carriers most Location Platform vendors are developing or integrating partner technology into their product. As an example, Telecommunication Systems integrated their Xypoint Location Platform with One Name Corps. XNS privacy software to deliver what they call a "global identity system" which will enable custom privacy and permissions based on a subscribers wishes.



2 CARRIERS

2.1 Size, Market penetrations and technology investments

The new features and affordability of digital wireless phone service in the United States and Canada are driving huge increases in demand and usage. With present growth prospects, it appears the industry could grow by 50% in size over the next 4 years, although this will greatly depend on the value proposition of new services, including wireless Internet applications. Table 12 shows growth projections for wireless penetration in the USA. It is expected that by 2004 there will be over 200 million users in the US alone.

In the United States, the fragmented wireless industry is undergoing significant change, as the large operators, such as Bell Atlantic/GTE/ Vodafone AirTouch, SBC etc have combined to improve their operating performance. With consolidation, the U.S. operators are increasing coverage to the top 100 markets, typically considered national coverage. The larger networks provide operating scale economies, with fewer roaming charges paid out to other operators. The consolidation is necessary not only to increase profitability, but also to increase internal cash flow to fund:

(a) large capital programs to complete national build-outs
(b) the huge licensing fees extracted by the FCC for new spectrum.
Figure 1 shows the estimate growth of the USA market.

Year	2000	2001	2002	2003	2004
U.S. Population	276.9	279.2	281.5	283.7	286.0
% Penetration	38.6%	46.4%	54.7%	62.7%	71.0%
Additional Subscribers	13.7	22.5	24.5	24.0	25.0
Total Subscribers	107	129.5	154	178	203
% Growth	12.8%	17.4%	15.9%	13.5%	12.3%

Table 12 US Wireless Subscriber Projections in Millions
Source: Yankee Group 2000, Myers Mediaenomics 2001

The wireless carrier companies will likely continue to consolidate until four or five national carrier networks remain. This means the small to mid-size operators will likely merge, or align themselves to operate in niche areas.

The expectation is that penetration rates in the USA will exceed 50% in 2002. Carrier growth in 2001 has continued rather rapidly. The terrorist events of September 11th had an adverse effect on the USA macro-economic climate. But the effects on cell phone uptake are expected to be positive as cell phone use received positive media attention during the crisis and individuals are now turning to security conscious activities including the ownership of a cellphone.

In the USA their are more then 129 individual operators for wireless services. Most of these are regional. National carriers are slowly acquiring smaller regional operators as industry consolidation continues. Figure xx shows an example of the consolidation that has occurred in the past. Shown is a listing of the operating companies over which US Cellular operates (Source FCC filing 2001).

1200 Bay St, Suite 604, Toronto, ON M5R 2A5, Canada
3 Stanford Landing, Suite 250, Stanford, CT 06902, USA
1900 Embarcadero Rd, Suite 100, Palo Alto, CA 94303, USA
1300 Post Oak Blvd, Suite 1990, Houston, TX 77056, USA

Bangor Cellular Telephone, L.P.
California Rural Service Area 1, Inc.
Canton Cellular Telephone Company (IL)
Cedar Rapids Cellular Telephone, L.P.
Central Florida Cellular Telephone Company, Inc.
Charlottesville MSA Limited Partnership
Crook County RSA Limited Partnership
Davenport Cellular Telephone Company
Dubuque Cellular Telephone, L.P.
Evansville Cellular Telephone Company (for Appleton WI)
Farmers Cellular Telephone Company, Inc.
Florida RSA #8, Inc.
Georgia RSA #11, Inc.
Georgia RSA #13, Inc. (For WV7)
Green Bay Cell Telephone Co.
Hardy Cellular Telephone Company

Ohio State Cellular Phone Company (For Roanoke)
Oregon RSA No. 2 Limited Partnership
Oregon RSA No. 3 Limited Partnership
Peace Valley Cellular Telephone Company
Racine Cellular Telephone Company
Sheboygan Cellular Telephone Company, Inc.
Tennessee RSA No. 3 Limited Partnership
Tennessee RSA #4 Sub 2, Inc.
Texahoma Cellular L.P.
Texas #20 Rural Cellular, Inc.
United States Cellular Operating Company of Columbia
United States Cellular Operating Company of Des Moines
United States Cellular Operating Company of Medford
United States Cellular Operating Company of Richland
United States Cellular Operating Company (for IN-8)
United States Cellular Operating Company (for W1-10)
United States Cellular Operating Company (for W1-8)
United States Cellular Operating Company (for W1-9)

Illinois RSA #3, Inc.
Indiana RSA No. 4 Limited Partnership
Indiana RSA No. 5 Limited Partnership
Iowa 13, Inc.
Iowa RSA No. 12 Limited Partnership
Iowa RSA No. 9 Limited Partnership
Jacksonville Cellular Telephone Co.
Janesville Cellular Telephone Company
Joplin Cellular Telephone Company, L.P.
Kenosha Cellular Telephone L.P.
La Crosse Cellular Telephone Company, Inc.
Lar-Tex Cellular Telephone Company, Inc.
Lewiston Cell Tel Co. Partnership
Madison Cellular Telephone Company
Main RSA No. 4 Limited Partnership
Main RSA No. 1, Inc.
Manchester-Nashua Cellular Telephone, L.P.
McDaniel Cellular Telephone Company
Minford Cellular Telephone Company
Missouri #15 Rural Cellular, Inc.
NH #1 Rural Cellular, Inc.
North Carolina RSA No. 6, Inc.
North Carolina RSA #4, Inc.
North Carolina RSA #9, Inc.
Ohio RSA No. 1 Limited Partnership (For KS 15)
Ohio State Cellular Phone Company (For Iowa 5)
Ohio State Cellular Phone Company (For Lynchburg)
Ohio State Cellular Phone Company (For NC3)

United States Cellular Operating Company (Milwaukee)
United States Cellular Telephone Company (Greater Knoxville L.P.)
United States Cellular Telephone Company (Greater Tulsa L.L.C.)
USCOC of Corpus Christi, Inc.
USCOC of Cumberland, Inc.
USCOC of Hawaii 3, Inc.
USCOC of Idaho RSA #5, Inc.
USCOC of Illinois RSA #1, Inc.
USCOC of Illinois RSA #4, Inc.
USCOC of Iowa RSA #16, Inc.
USCOC of Iowa RSA #1, Inc.
USCOC of Missouri RSA #13, Inc.
USCOC of Missouri RSA #3, Inc.
USCOC of New Hampshire RSA #2, Inc.
USCOC of North Carolina RSA #7, Inc.
USCOC of Oklahoma RSA #10, Inc.
USCOC of Oregon RSA #5, Inc.
USCOC of Pennsylvania RSA #10-B2, Inc.
USCOC of South Carolina RSA #4, Inc.
USCOC of Tallahassee, Inc.
USCOC of Virginia RSA #2, Inc.
USCOC of Virginia RSA #3, Inc.
USCOC of Washington – 4, Inc.
USOC of Rockford, Inc.
Vermont RSA #2-B2, Inc.
Victoria Cellular Corporation
Virginia RSA #4, Inc.
Virginia RSA #7, Inc.
Waterloo Cedar Falls CellTelCo
Wausau Cellular Telephone Company L.P.
Western Sub – RSA Limited Partnership
Wilmington Cellular Telephone Co.
Wisconsin RSA #7, Inc.
Yakima MSA Limited Partnership

Figure 12 US Cellular Operating Companies
Source FCC E911 Waiver Filing

As a result of consolidation the top 5 wireless carriers now dominate the market in the US. Table xx shows Verizon is the largest wireless carrier with 24.7% marketshare. The top 5 carriers account for 72.5 % of the overall market.

Verizon	24.7%
Cingular	18.3%
AT&T	14.1%
SprintPCS	9.2%
Nextel	6.2%
	72.5%

Table 13 Top 5 US Wireless Carrier Marketshare

Table 14 shows the top 10 US carriers and the dominant network technology employed by each of them. The figures are as of the beginning of 2001. Some more recent subscriber rates are given under each of the carrier sections. Now all of the top 10 have over 1 million subscribers, Verizon being the largest with a total subscribers of 26.6 million.

Company	Technology	Subscribers
1. Verizon Wireless	(CDMA, TDMA/GSM) 800MHz & 1.9GHz,	26.6 mil
2. Cingular	(TDMA/GSM) 800MHz & 1.9Ghz	19.7 mil
3. AT&T Wireless Services	(TDMA/GSM) 850MHz &1.9Ghz	15.2 mil
4. Sprint PCS	(CDMA) 1.9GHz	9.85 mil
5. Nextel	(iDEN,SMR)	6.67 mil
6. Alltel	(CDMA) 800 MHz	6.24 mil
7. VoiceStream	(GSM) 1.9Ghz	3.9 mil
8. US Cellular	(CDMA, TDMA) 800MHz	3.06 mil
9. Western Wireless	(Analog, TDMA) 800MHz	1.05 mil
10. Powertel, Inc.	(GSM) 1.9Hz	906,000

Table 14 Top US Wireless Carriers
Source: Teleclick, CTIA Jan. 2001

2.2 Wireless Messaging and Data Usage

The North American Market has been slow to adopt wireless messaging and data technologies for the mobile market. Figure 13 shows the relative market penetration for SMS and it's associated usage. Market penetrations will be about 8% in 2001 growing to about 18% by 2004. Total SMS messaging in 2001 for the US market is expected to hit 4 billion messages. This compares to a project global total of 200 billion messages (GSM Association 2001)

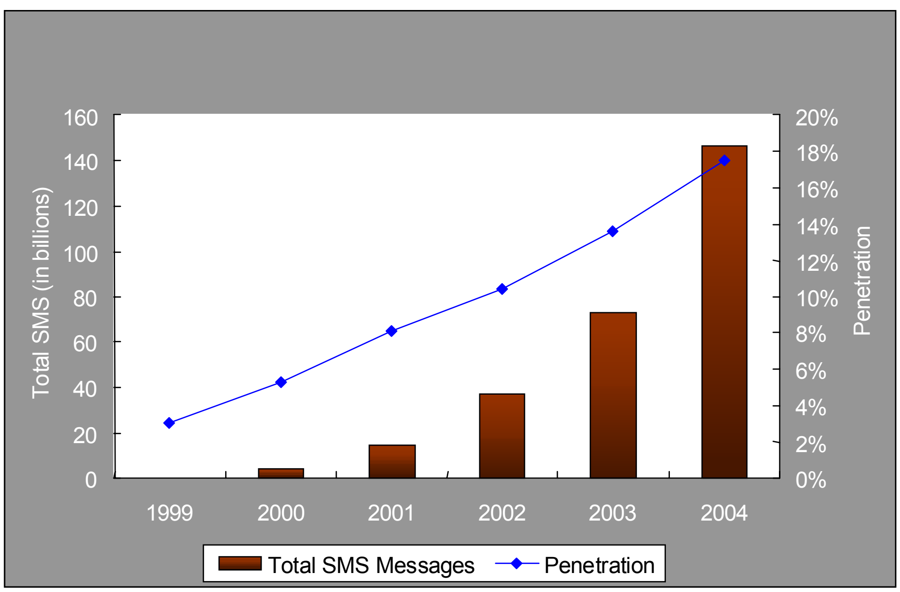


Figure 13 SMS usage in the US
Source CGEY 2000, GSM Association 2001

According to the Strategis Group growth of mobile access to wireless portals in the US is expected to reach 24.8 million subscribers by 2006 (Figure 14). By 2005 60% of US cellular users will own a wireless data enabled mobile phone. But similar to the SMS usage, far fewer will actually be using the phone to browse the internet. As seen in Figure 15 only about 20% or 45 million subscribers will be browsing the wireless internet with a mobile phone

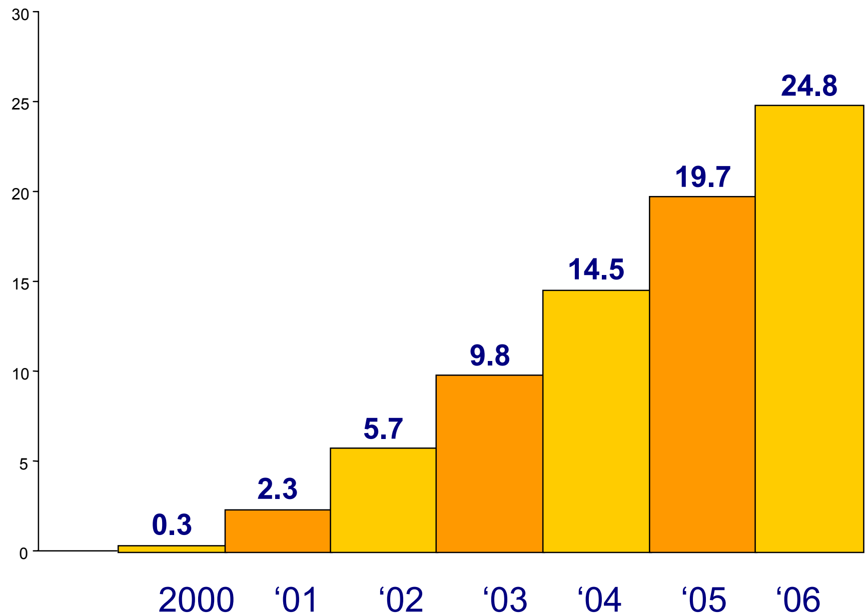


Figure 14 Growth of Mobile Portals (in millions)
Source The Strategis Group 2000

	1999	2000	2001	2002	2003	2004	2005
Own a wireless phone	32%	38%	44%	50%	54%	59%	62%
Own a browser-enabled wireless phone	1%	6%	12%	25%	39%	51%	60%
Browse the Net on a wireless phone	0.1%	0.3%	1%	3%	7%	13%	20%

Table 15 Internet Access Via Cell Phones
Source: Yankee Group Oct. 2000

2.3 AllTel

Alltel began its wireless division in 1985. They have been steadily acquiring orphan and overlap coverages from other carrier mergers over the last decade and a half. They are now the 5th largest wireless carrier in the USA with 6.2 million customers. In 1999 they acquired Aliant Communications in Nebraska and Liberty Cellular in Kansas. In 2000 they acquired some holdings from Bell Atlantic, GTE and SBC to expand their wireless coverage into 14 states and their total communications coverage into 40 states. They have coverage in over 120 million POPs. They are based in Little Rock Arkansas and had $7 billion in revenues as of their fiscal year end 2000.

Alltels networks operate on AMPS and CDMA at 800 MHz with their reciprocal roaming agreements they have digital coverage in 95% of their network footprint.

2.4 AT&T

AT&T Wireless, a former division of AT&T Corp., is a provider of local and long distance cellular and CS services, and has the third largest consolidated subscriber base in North America with 16.8 million customers at the end of their Q2 2001. The Company has a national network that covers 121 million people and provides both digital and analog service. Last year AT&T issued a wireless tracking stock that raised approximately $10.1 billion in equity financing. In July 2001 AT&T converted it's holdings in the AT&T wireless stock making AT&T Wireless wholly independent. Approximately $7 billion of the proceeds are being used to fund the group's large capital expenditures. In November 2000 Japan's NTT Docomo acquired a 16% interest in AT&T for $9.8 billion USD. NTT Docomo also acquired warrants to purchase 41 million more shares.

AT&T Wireless' network is one of the largest digital wireless networks in North America, as it covers 65% of the U.S. population. The Company is licensed to cover 94% of the U.S. population. AT&T Wireless offers service in 120 wholly owned markets, which include 42 of the 50 largest metropolitan areas in the United States. Currently, 80% of the Company's subscriber base uses digital service based on TDMA technology. AT&T will be overlaying GSM/GPRS network as part of it's 3G migration path. This is partly a result of the benefits the NTT Docomo equity stake had. AT&T Wireless has been expanding its subscriber base through both internal growth and through acquisitions.

AT&T Wireless will launch GSM/GPRS (2.5 G network) service in markets representing approximately 40 percent of the population it serves in 2001 and markets that cover 100 percent by the end of 2002. The company, with its partners and affiliates, has enough spectrum to roll out GSM/GPRS and EDGE in almost all the top 100 markets, and to launch full 3G(UMTS) in more than 70 of the top 100 markets.

2.5 Verizon

In 2000 GTE Wireless joined the third and fourth largest wireless providers in the U.S., Vodafone-AirTouch (9 million subscribers) and Bell Atlantic (7.7 million subscribers) to form Verizon Wireless based in New Jersey. Verizon is the largest wireless provider in the U.S. They have 26.6 million subscribers (end of 2000) and a national footprint that covers 95% of the population of the U.S. It has immense economies of scale, and efficiencies relate to its large size. It operates networks based on both TDMA and CDMA technologies. Verizon also has 4 million paging subscribers.

While Verizon has some common technology platforms there remain issues associated with incompatibilities for digital and analog services. For instance GTE (a merger partner) offers digital service only in 24 of the 144 markets it serves. These are their largest markets, but roaming is not possible except with a dual band multi mode phones, as they operate on separate frequencies.

2.6 Nextel Communications

Nextel has one of the largest digital networks in North America. Nextel Communications, Inc. provides wireless service to more than 6.6 million subscribers across the United States (end of 2000). Nextel operates an enhanced specialized mobile radio network (ESMR) based on the Motorola iDEN network technology and provides coverage in 94 of the country's 100 most populated Metropolitan Statistical Areas (MSAs). They also operate a PCS network independent of the iDEN network.

Nextel Communications, Inc. offers analog and digital wireless communications to business users. Its digital service is compatible to that of Telus (Clearnet's) digital PCS and "Mike" (iDEN/trunk radio) services in Canada. Nextel's service operates on an integrated digitally enhanced network (iDEN) developed by Motorola and uses a Time Division Multiple Access (TDMA) based platform. Nextel primarily focuses on providing its services to mobile workers in professional services such as transportation, delivery, property management, construction and landscaping. However in

2000 Nextel made a large push to acquire "white collar" corporate subscribers spending more then $125 million to market to this segment. Approximately 50% of Nextel's subscriber base are made up of white-collar workers such as information technology professionals. Its service packages bundle basic phone service, two-way radio service, as well as other features together for use in one mobile handset.

They are headquartered in Virginia.

2.7 Cingular Wireless (BellSouth and SBC)

Cingular Wireless is a joint venture between the wireless divisions of SBC and BellSouth. It is the 2nd largest operator in the USA. With service to more than 19.7 million customers in 38 states (end of 2000). SBC and BellSouth share control of Cingular Wireless. Ownership in the new company is 60 percent for SBC and 40 percent for BellSouth, based on the value of the assets both contributed to the venture. Given the recent mergers in the industry to increase size and service areas, and a failed takeover bid for Sprint the pressure was on BellSouth Wireless to expand its coverage. The two wireless operations were a good fit with little market overlap and similar technology platforms, and create a new national network to compete with the other existing national networks SBC operated both a TDMA and GSM network

SBC Wireless' services are conducted under several well-recognized wireless brand names: Southwestern Bell Wireless, Ameritech Cellular, Pacific Bell Wireless, Nevada Bell Wireless, SNET Wireless and Cellular One. They have incurred high costs associated with moving about 2 million Ameritech customers from a CDMA platform to their TDMA infrastructure. Including swapping out handsets.

BellSouth Wireless Service was the domestic U.S. wireless operations of BellSouth corporation prior to the merger. Most of their network was TDMA prior to the merger

2.8 Sprint PCS

Based in New Jersey, Sprint PCS is a division of Sprint Corporation that began offering wireless services late in 1996. Sprint PCS comprises Sprint Spectrum Holding Company L.P., PhillieCo L.P., SprintCom, APC, and Cox Communications PCS, L.P. Sprint PCS offers service to 9.85 million (end of 2000). Sprints network is national and covers all 50 of the largest metropolitan areas in the United States. Sprint PCS has an all-digital nationwide network that operates on a Code Division Multiple Access (CDMA) platform and provides coverage to over 280 metropolitan areas. Sprint PCS is the fastest growing carrier in the US. For the third calendar quarter of 2001 Sprint PCS had the highest net increase in new subscribers, adding 1.2 million new customers.

2.9 US Cellular

U. S. Cellular provides cellular telephone service in 26 states to 3 million subscribers, covering 10% of the markets it serves. It is the eighth largest wireless carrier in the USA. The Company is 80.9% owned by Telephone and Data Systems, Inc., a diversified telecommunications company, which also provides telephone (wireline) services. U.S. Cellular manages and invests in cellular systems throughout the United States, primarily in small markets and mid-sized cities. The Company's strategy is to own or operate controlling interests in cellular markets in areas in close proximity to form clustered service areas. The clusters provide savings in capital and operating expenses, through shared facilities, personnel and other costs. The Company's digital service is a combination of 2 different technology platforms CDMA and TDMA, depending on the technology platforms used by its largest roaming partners.

2.10 VoiceStream Wireless (Deutche Telecom)

VoiceStream's merger with Omnipoint (completed February 2000) and Aerial (completed May 2000) created a national PCS provider with over 2.2 million subscribers across 23 of the 25 largest U.S. markets end of (2000). In terms of the subscriber base, the combined VoiceStream is the smallest of the national wireless providers, smaller than Cingular (16.2 million subscribers), AT&T Wireless (12.1 million subscribers), Sprint PCS (6.5 million) and, Nextel (4.5 million). As each of the companies share the same GSM technology platform. VoiceStream's combined licenses cover a population of 154 million people (not including unconsolidated joint ventures) with more than 6,900 operational cell sites. In February 2000 VoiceStream acquired a 15% equity interest in non–voting convertible shares of Microcell, a Canadian PCS provider that also uses the same GSM technology platform (if fully converted this would represent a 22.6% voting interest). The companies will jointly develop new wireless data services (via Microcells i5 division – now defunct) , as well as plan next generation GSM wireless networks. In July 2000 Voicestream agreed to be acquired by Deutche Telecom for $50.7 billion USD and the sale was completed in May 2001.

2.11 Canada

The Canadian wireless market has the lowest average rates for wireless services in the world. 55% of cellular users remain on analog networks and are resistant to move over to digital services although all the metropolitan regions covering 78% of the population are covered by multiple digital networks (source CWTA 2000). The penetration rate for mobile wireless users in Canada was only 26% in 2000 This compares to 38% in the USA at the end of 2000. Table 16 gives actual and future growth projections for the wireless markets in Canada. Based on projections Canada lags behind average European wireless penetration rates by about 2 years. The deployment of VAS services is similarly about 1 year behind Europe.

	2000	2001	2002	2003	2004	2005
Population	31.3	31.9	32.4	33.0	33.5	34.1
% Penetration	28.1%	33.4%	35.9%	40.4%	44.4%	48.4%
Total Subscribers	8.7	10.3	11.6	13.3	14.9	16.5
% growth	26.8	20.4%	16.4%	14.5%	11.8%	10.8%

Table 16 Growth of Mobile Portals (in millions)

Source Yankee Group 2000, CWTA 2001

There are 4 national carriers in Canada, Bell Mobility, Telus, Roger Cantel and Microcell. There are also still some regional carriers but they represent less the 1% of subscribers in the market (CWTA). The market is fairly evenly divided amongst the top three, with Microcell, the only GSM operator holding 11.1% of the market in 2001 (see Table 17)

Operator	2000	2001
Bell Mobility	36.00%	36.4%
Cantel	29.00%	28.3%
Telus	24.40%	24.2%
Microcell	10.70%	11.1%

Table 17 Canadian Wireless Carrier Marketshare

Source CWTA 2001

In some ways Canada has taken a lead in wireless mobile data services over carriers in the US. Especially when it comes to interoperability. With regards to SMS text messaging, the 4 national carriers recently announced that they would cooperate in order to allow subscribers to send SMS between their respective networks. At the moment no carriers support recipricol text message capability between networks. This has less to do with interoperability and more to do with arbritating and managing the billing between the carrier partners. They are adopting CMG Wireless Data

Solutions technology to implement the service, but have set no timeline for it's arrival. No such preliminary agreements have been set in the US yet.

2.12 Bell Mobility

Bell Mobility was created in 1999 with the dissolution of Mobility Canada. It is a wholly owned subsidiary of BCE Canada. By the end of 2001 Bell Mobility will have 3.75 million subscribers on its cellular and digital PCS networks. Their networks cover 100% of the Canadian population and operate on the CDMA standard.

2.13 Cantel (Rogers AT&T)

Rogers AT&T Wireless has an approximate 28% subscriber market share. In August 1999, British Telecom and AT&T took a 33% equity share of the company for approximately $1.4 billion. They operate a TDMA network for their digital PCS service covering all major metropolitan markets. They also have extensive analog coverage with 31% of subscribers still using analog service.

Recently Cantel announced that they would be overlaying a GSM/GPRS network as part of their 3G migration path.

2.14 Telus (Clearnet)

With the October 20, 2000 acquisition of Clearnet by Telus Corp., Telus Mobility became the largest wireless provider in Canada in terms of annual revenues, customer growth and wireless spectrum position, but not by subscribers. Telus Mobility is a subsidiary of Telus Corporation. Post Clearnet merger, Telus Mobility has more than 2.5 million customers. They have spectrum license to provide coverage to 99% of the population. and an existing digital network coverage for more than 21 million potential customers from coast to coast. Because Telus operated mostly in Western Canada and Clearnet in the east, the merger has been a good fit

Clearnet Began operations in 1996 with an ESMR network similar to the Nextel network. The technology is Motorola proprietary providing RF and cellular service similar to CDMA. In 1997 they began their CDMA PCS service. Prior to the Telus acquisition they had 20.8 million POPs or 68% of the total population. They now have 100% coverage based on current license agreements.. Even prior to the Telus acquisition they were the largest spectrum holders in Canada.

Nextel, which operates a similar network in the USA owned 14% of Clearnet. Motorola is also a large shareholder.

Telus has partnered with DoCoMo to offer an I-mode wireless web solutions in their network.

2.15 Microcell

They are the only GSM operator in Canada with about 11% marketshare and 55% population coverage with their network and 94% with analog roaming agreements (mostly with Bell Mobility). Microcell has one of two national 30 MHz PCS operating licenses in Canada (Bell Mobility has the other) operating at the 1900 MHz range. The company is made up of four independent subsidiaries that operate under a single management company. These subsidiaries are: Microcell Connexions, responsible for network deployment, operations and wholesaling; Microcell Solutions, national provider of PCS services under the Fido® brand name; Microcell Labs, a PCS research center; and Microcell Capital, a venture-capital company operating in the PCS sector. They recently shut down another Division i5 for the development of data services over their network when they announced a cut of $100 million out of their $275 million Cdn budget.

They are late to market with data services. GPRS was supposed to role out in Q4 2000 but was delayed until Q4 2001. Voicestream owns 14% of Microcell. As part of Microcells PCS License agreement, the Canadian Radio and Television Commission (CRTC) required them to open their network on an equal footing to 3rd party operators. This has created a number of "boutique" virtual carriers. Of the 4 virtual carriers using Microcells network in 2000 only one remains.

2.16 3G Migration

Within the North American market there has been a slow progression to deliver 3G services. With so many different technologies in use in the market it has become questionable what will be delivered, when and by which carriers. In some cases carriers have opted to skip interim technologies as part of their development plan. Table 18 shows migration options for the existing CDMA, TDMA, GSM networks.

1200 Bay St, Suite 604, Toronto, ON M5R 2A5, Canada 3 Stanford Landing, Suite 250, Stanford, CT 06902, USA
1900 Embarcadero Rd, Suite 100, Palo Alto, CA 94303, USA 1300 Post Oak Blvd, Suite 1990, Houston, TX 77056, USA

Standard Name	Other Names	Upgrade path for	Expected
CDMA	IS-95, IS-95A cdmaOne	N/A	Currrent
GSM/TDMA	N/A	N/A	Current
1XRTT	G3G-MC-CDMA-1X; 2.5G for CDMA	CDMA	2002
GPRS	2.5G for GSM	GSM and potentially CDMA	2001-2002
EDGE	2.5G for GSM and TDMA	GSM or TDMA	2002
Wideband CDMA (W-CDMA)	W-CDMA; FDD-1; G3G-DS-CDMA	GSM or TDMA	2003-2004
cdma2000	3XRTT,FDD Mode 2; G3G-MC-CDMA-3X	CDMA	2003-2004
High Rate Data (HDR)	HDR	Not true 3G upgrade	2002

Table 18 3G Migration options

Table 19 shows the migration plans for Sprint, Verizon, Cingular, AT&T and Nextel. Each has initiated steps to deliver 3G services. AT&T and Cingular are following paths that will eventually deliver them to a wideband CDMA network via GSM/GPRS overlay of their existing TDMA networks. In most cases carriers are not relying on additional spectrum to implement the 1XRRT and GPRS portions of their networks.

Sprint:	CDMA/1XRR/HDD/CDMA2000
Verizon:	CDMA/1XRR/HDD/CDMA2000
Cingular:	TDMA/GSM/GPRS/EDGE/UMTS
AT&T:	TDMA/GSM/GPRS/EDGE/UMTS
Nextel:	ESMR/CDMA2000

Table 19 3G Migration Paths

AT&T Wireless and Cingular are implementing a GSM overlay of their existing TDMA networks. They will rely on GAIT handsets to allow access to their full network as the transition. The phones will allow for GSM and TDMA voice calls and GPRS data access. The next phase will be a software upgrade to support EDGE AT&T claims that they will begin to deploy EDGE software in their network beginning in 2002. They claim that since they will be using the same data core technology from the GPRS implementation the transition to EDGE will be easier. AT&T likens the transition to the implementation of adaptive multi-rate vocoders (AMR) in their network. This will increase spectrum efficiency for voice and is part of their overall upgrade plan. Similarly EDGE will triple throughput for GPRS as they migrate to WCDMA also known as Universal Mobile Telecommunications System, or UMTS.

Cingular is also implementing AMR but has been less forward about the technology path it will follow for 3G services. It operates both TDMA, GSM and still some CDMA properties. They have stated that they need to access the lowest cost infrastructure and terminals. To do this they plan on following global standards which will be TDMA-GSM to GPRS and EDGE/WCDMA. Dave Williams, Vice President of Strategic Planning, Cingular Wireless has stated that Cingular believes the handset cost delta will be as much as $15 USD between CDMA and TDMA/GSM. Making it much more competitive to pursue this model. At the same time Cingular believes that like analog services it will take at least ten years to phase out TDMA services.

Sprint, Nextel and Verizon all plan to launch limited deployment of 1XRTT service at the end of 2001 and beginning of 2002. This will allow throughput speeds of up to 144 kbps. In March 2001 Verizon signed a 3 year $5 billion USD contract with Lucent technologies to deploy their 3G network infrastructure. Following Verizons deployment of 1XRTT they will launch 1XEV-DO as the next step in increased bandwidth and network efficiency. Verizon has had some friction with Vodafone, which owns 45% of Verizon. Vodafone has put pressure on Verizon to implement WCDMA instead of CDMA2000, in keeping with the majority of European standards.

2.17 Location Based Services At The Carriers Portal

The definition of personal location services (LBS) are services or applications that use spatial information relevant to the needs of the mobile individual. In such a definition information or applications associated with local needs would be considered location based. Hence local merchant comparison shopping using a mobile browser would be an LBS application. Some of the more popular mobile portal services that are provided through carrier sites are listed in Table 20. There are hundreds of services associated with delivering either community guides, retail locators, government services, routing services, asset tracking, traffic services etc. As of now there are no carrier based LBS associated with tracking the mobile device as there are no mobile devices capable of being tracked sold in the US. The one exception is the Samsung SPH-N300 which is being sold by Sprint and

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1900 Embarcadero Rd, Suite 100, Palo Alto, CA 94303, USA 1300 Post Oak Blvd, Suite 1990, Houston, TX 77056, USA

is more a public relations need to meet FCC E911 mandates rather then a useful tool at the moment.

LBS	Definition
LocalFrontPage.com	Read the front-page headlines and stories from your hometown newspaper when you're traveling.
MapQuest	Never worry about being lost again. Simply enter a starting point and destination and receive instant detailed driving directions for your trip. Don't let traffic delays slow you down. Receive real-time information on the top traffic, construction and roadway incidents in your area. [MapQuest]
Moviefone	AOL Moviefone: the nation's largest movie showtime and ticketing service, which provides millions of moviegoers each week with a free directory of current movie information.
mySimon	mySimon compares prices on millions of products at thousands of online stores. mySimon is fast, easy, comprehensive and free. mySimon is the leader in comparison shopping
NextBus	NextBus brings real-time arrival information to passengers of public transit. NextBus provides valuable arrival predictions - not schedules - on the Internet and direct to you on your wireless device. In a matter of seconds, NextBus puts the rider back in control.
ontheroad.com	Snapshot: an overview for each city with detailed information about a current week's business and entertainment events. It includes restaurant recommendations and insider tips from ontheroad.com. [ontheroad.com]
RealCities	Get news, sports and more from the best newspapers nationwide, no matter where you are. Find updated headlines based on a state, ZIP code or newspaper you choose. [Real Cities]
RestaurantRow	RestaurantRow.com is the on-line and wireless site that operates the largest "go to" destination for restaurant information and reservations, covering 110,000 restaurants and over 7,000 cities.
SalesMountain	SalesMountain.com is the number one resource used by millions of active shoppers to "Find the Sales" --- all the Sales -- from national, regional and local brick and mortar retail stores and service providers nationwide. SalesMountain is the leader in Sales information and displays over 60,000 continuously updated Sales everyday! You can access Shoppers can search for Sales by item, location, brand, price, store or department.
SavvyDiner	SavvyDiner is the Internet's premier reservation service and dining guide featuring North America's Best restaurants. Since 1997, business professionals and leisure travelers have been using SavvyDiner to make their dining arrangements in advance of business trips, vacations, and special occasions. Are You A Savvy Diner?
SnoCountry	SnoCountry Mountain Reports is the world's largest snow collection and distribution source for snow conditions and mountain resort information. SnoCountry Mountain Reports include information about skiing, snowboarding and resort details to enhance the enjoyment of participating in snow sports.
Ticketmaster	ticketmaster.com is the world's leading online ticketing site and live event portal and one of the largest e-commerce sites on the Web
UPS	With a few commands, quickly access information about your UPS shipments wherever you may be. Track packages. Find out shipping costs and time in transit. Get the addresses of the closest UPS drop-off locations. All the UPS shipping information you need delivered instantly to your wireless device. [UPS]
Brandfinder	Looking for the nearest Starbucks coffee, Shell gas station, or Old Navy store? BrandFinder can help you find the best-known brands no matter where you are. [Vicinity BrandFinder]
Wcities	WCITIES provides in-depth multi-lingual local coverage of the world's top cities from Los Angeles to London, New York to Tokyo, Paris to Buenos Aires and all major points in between. All facets of city life including hotels, restaurants, sporting events, entertainment, shopping and sightseeing
Weather.com	Get current Current Conditions, Weather Headlines and a Three Day Forecast from The Weather Channel and weather.com, your trusted weather source.
Realtor.com	Worlds largest database of homes for sale Just enter the local infromation by map or zip code and get the listings
10best	10best offers travelers a subscription service for local information on the best restuarants, hotels etc

Table 20 Section of LBS Sites

Source (Random Carrier Sampling)

The use of sites such as those listed in Table 20 are typically unrestricted. Like any Value Added Service (VAS) access is billed by subscriber fee or on a per transaction.

3 TERMINAL DEVICE MANUFACTURERS AND DEVICES IN NORTH AMERICA

3.1 Convergence

When Nokia first introduced their 9000 series Communicator product it was bulky for a phone and far from a economic success. However it did give an indication for where the market would be going. A phone is defined as a device for voice, the word smart indicates the ability to access and manipulate data. A PDA on the other hand is not a phone and is not meant to convey voice traffic but by definition is portable and allows for the manipulation of data. It is likely that the future will see four categories of devices emerge for portable communication and data.

1. Basic Cell Phone (voice centric)
2. Smart phones (data centric)
3. PDA phones
4. Portable Computers

Basic cell phones will be used for those not interested in data access, strictly voice conversations. Smartphones will become the largest category for consumers and business users over the next 2 years as internet entry via a mobile becomes the primary means of access (see Figure 15). 22% of business mobile phone users will add wireless internet services over the next year (Cahners In-Stat 2001). According to Strategy Analytics, web phones will account for 70% of the volume and 60% of revenues in 2005 for mobile devices. PDA phones will become more popular as PDAs become mobile data access devices. Cradle solutions have been the first to expand to include voice on the palm's data only functionality, but recently Kyocera and Research In Motion have each introduced an integrated voice capable PDA.

Headsets and Bluetooth have created the ability to separate the ear and mouth piece from the phone and so recreate the form factor for phones into wider, bigger screen, bigger functionality devices. The device no longer constrained by a voice centric design to span the distance from mouth to ear and be held in the hand to do so. Research in Motions recent introduction of the BlackBerry 957 with voice capability running on GPRS networks is the first such device, in North America, to make the transition from PDA to phone using only a wired headset.

From the 4 categories mentioned, the first 2 device categories will be voice first data second devices. The second 2 device categories will be data first voice second. A distinction is made between PDA and Smart phone based on its evolution, manufacturer, market positioning and less on its overall function. In four years the categories will likely be one.

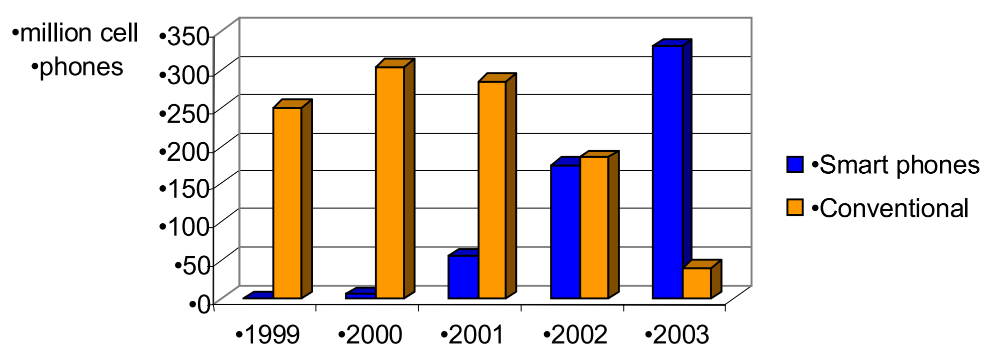

Figure 15 Global Shipments of Smart phones
Source: Cahners Instat 2000

3.2 PDAs and Wireless PDAs

Worldwide PDA unit shipments nearly doubled to 9.4 million in 2000 compared to 5.1 million the previous year (Gartner Group 2000). Unit shipments are expected to grow to 30 million globally in 2004 (Gartner, IDC 2001) A growth rate of 21%. In the first half of 2001 unit shipments were 6.2 million (Gartner Group 2001). In the USA palm holds 55% and Handspring has 28% marketshare (Gartner Group 2001). The remaining market is divided amongst a number of late entry players, Compaq, HP, Sony, Casio and Sharp.

Palm dominates the PDA market globally but is losing market share. New entrants such as the Compaq iPAQ and the HP Jornada are having a high degree of success. Palm's success in Europe has been less stellar where all vendors combined will ship less units then Palm is in North America. Palm derives most of their revenues in North America. Europe represents only 14% of sales and actually declined in the 1st quarter by 12% (fiscal Q1 2001). This compares with growth of 33% in North America (fiscal Q1, 2001). Their overall European shipments were just over 300,000 out of more then 3 million units shipped in 2000.

Nokia Ericsson and Psion have had very little success in the European markets relative to Palm in North America. Most of this is the result of users in Europe having a office centric approach to data access and a voice centric need for their portable devices. This may have more to do with the rapid market penetration of the cell phone in Europe vs North America. This is changing as users, both business and consumer, are becoming more interested in data access via wireless.

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Mobile operators will also drive the mainstream use of PDA devices as they become voice enabled by subsidizing their cost as part of access packages. Eventually data will surpass voice on their networks, as it has on wireline networks, and they will subsidize data only products.

The top 10 manufacturers in this product segment are shown in Table 21.

Phones	PDAs
Nokia	Palm Computing
Motorola	Handspring
Ericsson	Casio
Siemens	Psion
Panasonic	NEC
Mitsubishi	Sharp
Kyocera	HP
Phillips	Phillips
Panasonic	Texas Instruments
Alcatel	Compaq

Table 21 Top Phone and PDA Manufacturers Globally

Because Palm dominates the market, it has more applications available to it. Palm claims more then 10,000 different applications are available. For wireless capability Palm offers the Palm VII series models with integrated wireless modem, or a detachable modem can be added from one of the many wireless modem vendors in conjunction with services from a WISP. Palm promotes the Novotel Minstrel wireless modem for their Palm III and V series PDAs and a phone internet attachment kit for its m series product.

Palm has a web clipping application that is part of the browser functionality. Web application sites have to support the clipping service function and so must partner with Palm. When using it in conjunction with Palm.net (Palms own WISP service using CDPD), Palm.Net applications use the location information, entered manually, to provide users with specific content. Brandfinder, for example, locates stores, hotels, gas stations, and other nearby businesses, displaying the results on display map. Moviefone allows a person to locate what's playing locally, purchase tickets and can also provide directions, all based on the entry of the persons current Zip or street information. Palm lists over 400 location related applications, although most are things like track your travel expenses and have nothing to do with location services. A sample list of service applications:

- 10Best.com
- Shopping.com
- BarPoint.com

- Citysearch
- Conferenza
- Digital City
- Traffic Touch
- Fodors.com's
- Frommer's City To Go™
- Go2online
- LocalFrontPage.com
- MapQuest

3.3 Cell Phones

The overall market for wireless phones in 2000 was 412 million, of which Nokia made 128 million of them. The second largest producer is Motorola with 17% of the market.

Table 22 shows US market numbers for the year 2000 with Nokia expanding it's marketshare to 41% and Ericsson losing share and the number 2 position in the market to Motorola (Source: Gartner Dataquest 2001). Market growth in North America is projected to continue at about 20% for the next 4 years. About 8 million analog phones were shipped in 2000

	Shipments 2000
Nokia	24,883.8
Ericsson	7,923.8
Motorola	7,846.3
Audiovox	6,116.2
Kyocera	6,080.9
Samsung	5,745.3
LGIC	2,487.6
Mitsubishi	2,040.3
Others	2,598.9
Total	**65,723.1**

Table 22 Digital Mobile Handset Shipments in USA (Thousands of Units)
Source: CTIA 2001

There are a number of what are considered "smartphones" shipping or almost shipping in the US. Some of these data centric devices are listed in Table xx. The Microsoft Stinger based devices are said not to be data centric, but the impression is they will be quite functional as a PDA and web access device. Ericsson was the first to ship its Epoc platform based RS380 smartphone. It has an integrated WAP browser with 1.2 Mb of memory. Not enough to run significant applications and provide sufficient storage by PDA comparisons. The Kyocera QCP 6035 is more PDA like offering 8 Mb of memory. As is the Samsung SPH-I300. The Samsung device offers a number of features like speaker phone and colour LCD that make it very useful for navigation and map viewing via applications using voice recognition and map services. The Motorola I85s and i50sx phones are Java capable, but with only 384 kB of memory, applications will have to be lean. Only 4 applications are available. Nextel offers the phones. While not functional, Nextel claims that users will be able to load Java Applications over the air. The expectation is that many more will ship in 2002. More then 1200 developers have signed up for Nextel's Java developer program.

Manufacturer	Model	OS/Browser
Ericsson	R380	Epoc/WAP 1.2.1
Kyocera	QCP 6035	Palm OS/EudoraWeb (clipping)
Sendo/Samsung/HTC	Z100/NA/NA	Stinger (PocketPC) HTML/WAP
Samsung	SPH-I300	Palm OS/UP4.1 (clipping)
Motorola	i85s, i50sx	Java

Table 23 SmartPhones in the USA

3.4 Telematics Shift To Wireless Devices

This report does not look at the market for telematics. Telematics being the systems that combine the functionality of internal vehicle electronics, wireless communications, and information technology such as the Internet and Global Positioning Systems (GPS) for the delivery of information, services, communications and applications. However there is a shift in the in car telematics systems that will also migrate and integrate with personal location services market for handheld devices. The trend is to create integrated vehicle and phone/PDA systems. The consideration is that these systems will come in "on-board" and "off-board" (not server but mobile) configurations.

Some even envision the major car companies becoming resellers of wireless voice and VAS. It estimated that 80% of wireless calls in the US take place form a vehicle. Automakers recognize that with mobile services they could brand their own service with the vehicle sale. The latest legislation in New York, the first restrict phone usage in vehicles has prompted interest in the development of integrated vehicle systems. 35 other US states are also looking at legislation to restrict cell phone use.

Technologies such as Bluetooth should create the ability to provide the on board telematics systems of today, like GMS OnStar, with a hand set interface. DaimlerChrysler AG said in October 2001 it will offer a voice-activated, hands-free cellular-phone system in its vehicles using Bluetooth in 2002. But some companies are moving the entire GPS and communications portion of the telematics system into the handset so that the non-vehicle services are portable. The intent is to have the system mobile from the vehicle.

Currently General Motors OnStar has shipped with almost 2 million vehicles. It provides navigation services, emergency response, voice email, cellular calling and limited internet information from GMs portal. They offer the service free (where available) to purchasers of 80% of GM vehicles for the first year. After the first year they charge for a basic package at $199 or a premium package at $399 which includes the navigation and cell and internet capabilities. They claim a 70% renewal rate for the service

GM uses Verizons analog network to deliver services. They use analog services because almost 70% of the US geography is not served by digital networks, although 95% of the population is. They sell voice minutes using a prepaid calling service that is billed to the users credit card.

Ford and Qualcomm formed a partnership in 2000 to provide a telematics system that was both on-board and off-board. They formed a company called Wingcast. Their services are essentially the same as GMs with the exception that they will also offer them on phone and PDA devices.

Ford does offer telematics in it's luxury vehicles and recently announced an integrated system using a Motorola Timeport phone and the Sprint PCS network on it's 2002 luxury Lincoln series vehicles. Like GMs the product has a 3 button system built into the vehicle that includes a button for SOS (also initiate when airbags are deployed) handsfree calling and navigation. The Hands free calling and dialing is part of the Motorola Timeport phone. The GPS receiver is built into the vehicle. Users must purchase a Sprint PCS calling plan for the service. Chrysler has partnered with Motorola and AT&T to offer a similar service that integrates the phone function with the onboard telematic system for hands free voice control and phone use.

MobileAria is one of the first companies to offer a portable vehicle telematics system. Although it is not being distributed by a carrier partner yet, it is being sold in limited quantities directly for testing. They were created by a joint venture of Delphi, a major auto parts maker, and Palm, the PDA maker. Their system offers a hands free kit with in-vehicle components (wireless steering wheel-mounted remote control, central unit, speaker/mic, and optional GPS receiver) as well as a Bluetooth cell phone (Ericsson) and Bluetooth USB adapter for a laptop. There are number of other companies partnering to offer the same types of portable telematic solutions, Cellport Inc. and Airbiquity Inc.,

3.5 Devices Supporting Positioning Technology

When one considers the rapid growth of on-board telematics it seems strange that there are surprisingly few phone and PDA devices with functional location service capabilities. Currently there is only the one previously mentioned Samsung phone shipping in the USA that has built in GPS functionality. Unfortunately the network, Sprint PCS, does not support any applications for delivering location information services that can use the phones direct built in capability. And there are no commercial cellular networks based position technologies available with the exception of test locations (St Clair County Ill.).

3.5.1 GPS Phones

Sprint PCS offers the only GPS enabled phone in the US (Figure 16). Unfortunately there are no supporting applications to use the location functionality of the phone. Sprint introduced the Samsung SPH-N300 phone only as a public relations effort to say that they had met the FCC's October 1, 2001 mandate to have a available such a GPS assisted phone. Sprint sells the phone for $149.99 and makes no mention of its GPS capability in the product purchase site at the sprint webstore. In addition to the GPS functionality it also has all the expected phone functionality, i.e. voice dialing, PIM, phone book etc. It is also data enabled and comes with Openwaves UP4.1 HDML browser

Figure 16 Samsung SPH-N300 GPS Phone From Sprint PCS

3.5.2 GPS Receivers for PDAs

There are a number of GPS modules that come as plug ins or as cradles for PDA devices. Megellan dominates this category as they do for their stand alone GPS receivers. Most GPS modules are sold with a suite of software to perform navigation functionality. The most popular are mentioned here.

The Megellan GPS Companion™, from Thales Navigation Inc. in California, comes in both a cradle and plug in version depending on the PDA configuration that it is attached to. This is the leading GPS PDA receiver sold in North America. It has the functional ability to provide position location to within 15 meters. The software it ships with called NAV Companion and MAP Companion provides navigation and route management capability and allows the user to download detailed maps with preloaded landmarks. A photo of the device is shown in Figure 17.

Magellan partnered with MarcoSoft, Inc. to provide the GPS Companion's mapping software. MarcoSoft developed the MAP Companion™ software exclusively for Magellan using the Quo Vadis™ mapping software platform. Because the product supports National Marine Electronics Association (NMEA), NMEA 0183 v2.1 standard, it will support most mapping applications that also support the standard to receive GPS dated into their application

The product does not provide for real-time access to internet applications as it occupies the space that might be used by a wireless modem and it does not work with built-in modem PDAs. For the Palm it works with the Palm V and Vx and for the Handspring it works with the Visor

Figure 17 Megellan GPS Companion With Handspring Visor PDA

GeoDiscovery's Geode receiver currently ships only for the Handspring Visor expansion slot. It receives upto 12 channels of GPS and WAAS signals providing relaible location information. Like the Megellan Companion it ships with navigation and mapping software called GeoView. This allows the user to download and use map libraries. The reciever also has expansion slots for multi-media cards to store upto 64 MB of map and navigation data. Figure 18 shows a photo of the device.

Figure 18 GeoDiscovery Geode With Handspring Visor PDA

Nexian based in California, is a company that offers the HandyGPS GPS receiver as a plugin for the Visor Handspring and uses their own proprietary GPS signaling board. They offer one of the lowest priced solutions, $199.99 SRP USD, in the GPS receiver for PDA category. They bundle their product with one of two mapping software applications. One from Nexigate, the UbiGo package or one from Rand McNally, the Streetfinder package. Nexian claims an accuracy of 25m. Figure 19 shows a photo of the device

Figure 19 Nexian's HandyGPS GPS Receiver For Handsping's Visor

Pretec Electronics makes the CompactGPS navigation expansion pack for PocketPC devices It ships with Microsofts Streets and Trips 2002 software. It also includes Portable Internet's Prot@ble Guide application. Pretec uses its on compact flash navigation module for their device (see Figure 20)

Figure 20 Pretec Electronics CompactGPS Receiver

3.5.3 Other GPS Devices

Traxsis incorporated a GPS receiver into the battery of Nokia 51xx/61xx series phone. It's functionality is limited the collection of GPS data either to the built in compact flash built in or for transprot via SMS from which it can be accessed via the web. They have not announced any partners supporting the product. Airbiquity Inc. Has a similar product that operates on the Nokia 51xx/61xx/71xx series phones. There are no services from carriers for phones equiped with this device (Figure 21)

Figure 21 Airbiquity GPS Battery

The first consumer tracking device to use GPS and cellular services for security is the Wherify Inc.'s Locator System. The product is a wristwatch-sized device that combines a GPS receiver with a cellular signaling unit. This product will ship in 2002 using Sprint PCS's network (see figure 22).

Figure 22 Wherify Locator

3.5.4 GPS Receiver Chipsets

The growth of the GPS reciever market is being driven by some of the new GPS chipsets, that are both lower cost and higher functionally. Two of the most popular GPS chipsets are Qualcomm's GPSOne (MSM3300 for 2G, MSM5100 for 3G) and Sirf's SiRFstar series product.

Qualcomm started SnapTrack in 1995 as a wholly owned subsidery. It's focus has been to deliver GPS solutions targeted at carriers, in the US partly to meet the E911 FCC mandates. The only GPS enabled phone commercially deployed by a carrier (Sprint PCS) in the US, the Samsung SPH-N300, uses the GPSOne chipset from Qualcomm. The chipset is designed for assisted GPS (A-GPS), so it also takes signals from the carrier network. It was made for Global markets operating across most air interfaces. It has been widely licensed to most major wireless handset manufacturers. The technology has also been licensed by other chipset makers Motorola and Texas intruments. Qualcomm has an areement with TechnoCom Corp. for assisting carriers in deploying their product.

SnapTrack's Wireless Assisted GPS products include the SnapSmart location server software system, the SnapCore multimode GPS solution, and the SnapWARN GPS reference service.

3.6 Standards and Technologies

3.7 Standards

From a device perspective there are a number of standards and standards bodies that should be considered for the North American market. Key to these is the browser interface protocols supported and the network interface protocols for the conveyance of location information. Aside for those standards associated with network based E911 calling (which for GSM are now international) and those specific to the greater deployment of HDML based browsers there are no North American centric standards associated with handsets shipped in North America. Therefore most standards, as standards should be, are international in scope.

Open interoperability standards and standards bodies for location services are shown in Table 24. Standards bodies in some cases means consortiums or forums that seek to influence official standards bodies like the ISO and European Telecommunications Standards Institute (ETSI) in relation to LBS functionality. Therefore they represent an influencing group.

Organization	Standard/Working Doc	Purpose
Magic Group		The MAGIC Services™ Initiative is a cooperative effort to develop a standard method for remote delivery of core geographic functionality to location-aware applications on mobile devices. Target applications include personal navigation, telematics, and location-based services.
ETSI/Committee T1/3GPP	TS 144	The ETSI finalised the GSM standards through the original T1P1.5 LBS working group that they established through the T1 committee in the US. The standards included all operational definitions for LBS using three positioning technologies; Time of Arrival (TOA), Enhanced Observed Time Difference (E-OTD), Assisted Global Positioning Satellite (A-GPS) The 3rd Generation Partnership Project (3GPP) has already completed most of the equivalent standards applicable to 3G networks.
ISO	ISO/TC204	ISO/TC204 is responsible for the standardization of information, communication, and control systems in the field of urban and rural surface transportation, including intermodal and multimodal aspects, public transport, commercial transport, emergency services and commercial services in the transport information and control systems (TICS) field.
ISO	ISO/TC211	ISO/TC211 is responsible for the creation fo an entire family of geospatial standards, ranging from exchange formats to metadata to spatial data models
Open GIS Consortium		The Open GIS Consortiums mission is to develop spatial interfaces to enable the delivery of more capable products and services.
Open LS		Part of the OGC, The goal of the the first activity under the OpenLS Initiative (the OpenLS Testbed) is to develop candidate interface specifications in support of interoperable location services to be made available through mobile terminals and to develop multi-vendor, specification-based mobile demonstrations of these interfaces in action. The candidate interface specifications, may become official OGC Specifications and, potentially, may be contributed to other standards bodies The OpenLS focuses test bed to help fast track the development of standards to meet market demand for robust useable location services.
Location Inter-operability Forum	LIF TS 101 v2.0	LIF is a global industry initiative formed jointly by Ericsson, Motorola and Nokia with a goal of developing common and ubiquitous solutions for Mobile Location Services (MLS)

Table 24 LBS Standards Bodies

Location Interoperability Forum (LIF)
This group was founded in September 2000 by the big three wireless handset and infrastructure companies Nokia, Motorola and Ericsson. It has since gained a membership of more then 100 companies.

LIF's objective is to standardize, support and assist in the interoperable location services solutions that allow user appliances and internet-based applications to obtain location information from the wireless networks independent of their air interfaces and positioning methods. Current LIF focus includes:

1. Define a simple and secure access method that allows user appliances and Internet applications to access location information from the wireless networks irrespective of their underlying air interface technologies and positioning methods.

2. Promote a family of standards-based location determination methods and their supporting architectures, that are based on CellSector-ID, Cell-ID and Timing Advance, E-OTD (GSM), AFLT (IS-95), and Assisted-GPS.

3. Work with industry experts and organizations to define/adopt common solutions that facilitate billing and revenue sharing of location services and applications in multi-network, multi-vendor and multi-service environments.

4. Work with industry experts and organizations to define/adopt common solutions that facilitate provisioning of location services and applications in a multi-network, multi-vendor and multi-service environments.

5. Establish a framework for contributing to the global standard bodies and specification organizations to define common methods and procedures for the testing and verification of the LIF-recommended access method and positioning technologies.
Source: LIF 2001

Magic
In an effort to standardize Application Protocol Interfaces (APIs) and communication protocols for location service applications across multiple handhelds, a small consortium of development platform vendors formed Magic in 2000. They have tried to address the divergent and proprietary APIs and protocols that function with a limited number of devices, systems and data types. The group consists of Alpine Electronics, Inc, Increment-P Corporation, Panasonic Industries Europe GmbH, Microsoft Corporation, MobileGIS Ltd, Telcontar, Tele Atlas N.V., VDO/Siemens, Webraska and Xanavi Informatics Corporation. There goal has been to create a common set of XML libraries and corresponding APIs for the LBS industry.

3.8 Location Technologies

The Federal Communications Commission (FCC) originally initiated the call for Location Based Services (LBS) standards when it implemented it's E911 mandate. The ETSI finalised the GSM standards through the original

T1P1.5 LBS working group that they established through the T1 committee in the US. The standards included all operational definitions for LBS using three positioning technologies; Time of Arrival (TOA), Enhanced Observed Time Difference (E-OTD), Assisted Global Positioning Satellite (A-GPS).

The 3rd Generation Partnership Project (3GPP) has already completed most of the equivalent standards applicable to 3G networks.

The Enhanced Observed Time Difference (E-OTD) positioning method measures the time at which signals from the Base Transceiver Station (BTS) arrive at two geographically dispersed locations - the mobile phone/station (MS) itself and a fixed measuring point known as the Location Measurement Unit (LMU) whose location is known. The position of the MS is determined by comparing the time differences between the two sets of timing measurements. To triangulate at least 3 BTS signals are required. Figure 23 shows an example of E-OTD. This method is similar to Time Difference of Arrival (TDOA) with the exception that the signal measured originates from the MS and not the BTS. Because the phone enables the measurement E-OTD requires a change to the phone and is considered a handset solution with the accompanying higher accuracy set out by the FCC for E911 network and handset solutions.

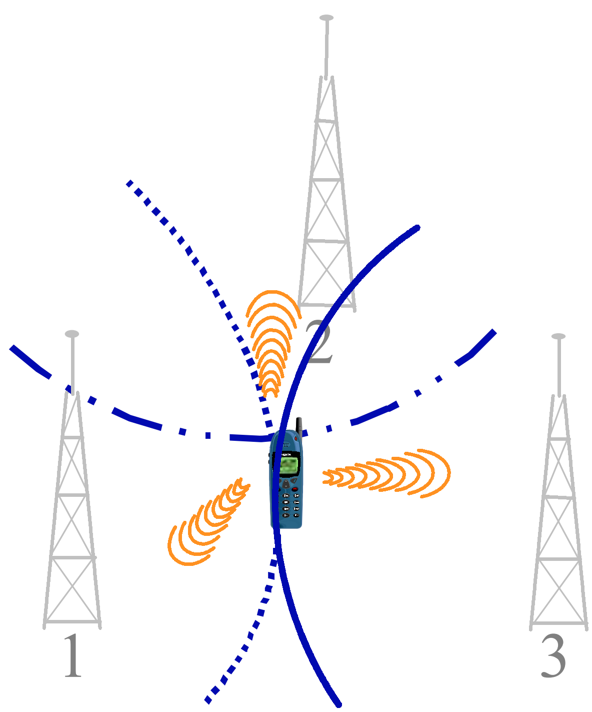

Figure 23 E-OTD

Time of Arrival (TOA)
The differences between the times of arrival of the signal from a handset measured at three BTSs is used to calculate the location of the handset. This requires a precise syncing via a clocking mechanism of the BTSs to accurately measure the relative signals. At the time of writing there will be limited availability of TOA solutions from

In standard GPS, signals from at least four GPS satellites are received by a GPS receiver unit incorporated in a mobile handset. In A-GPS the handset must first communicate with a location server that has a fixed GPS receiver that can provide differential positioning information. The LS provides the MS with assistance information, including which satellites to lock on to. The handset then returns measurement data to the network computer, which calculates the handset's location (Figure 24).

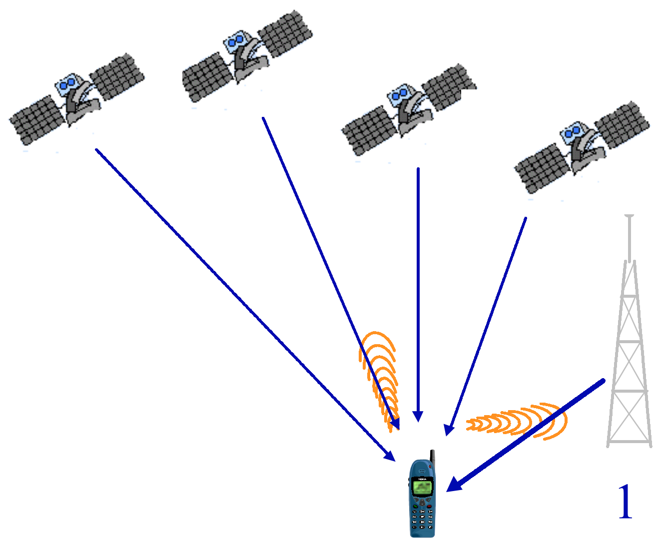

Figure 24 A-GPS

Angle of Arrival (TOA)
The intersecting angle of arrival of the signal from a handset measured at two BTSs is used to calculate the location of the handset. This Method requires only two sites (Figure 25.).

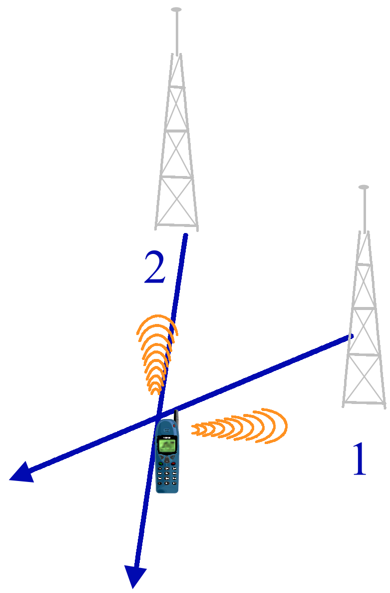

Figure 25 AOA

At the present time carriers have announced that they will be employing different technologies as is needed and available for their networks Table 25 shows the announced plans. In its last filing with the FCC on E911, AT&T said that they would be using either TruePosition Inc.' E-OTD or Grayson Wireless' technology solution for their AOA and E-OTD needs. TruePosition is supplying Cingular with a E-OTD network solution and AOA for the TDMA and analog portions of it's network. Voicestream are testing an E-OTD solution with Cursor Systems but will eventually have AGPS solutions.

AT&T has already established a E-OTD based service in one county of one state in the US. As a result of field testing their St Clair County in Illinois is the first in the US to have support for E911 network based solution using E-OTD.

Carrier	Primary Network	Technology
Alltel	CDMA	AGPS
AT&T	GSM	AOA/E-OTD
Cingular	TDMA/GSM	AOA/E-OTD
Nextel	iDEN-ESMR	AGPS
Qwest	CDMA	AGPS
Sprint PCS	CDMA	AGPS
Verizon Wireless	CDMA	AGPS/AFLT
VoiceStream	GSM	E-OTD

Table 25 Wireless Carrier Location Technology

3.9 Alternatives to SMS and WAP (WML)

Because 2 way SMS and WAP had slow adoption rates in North America, some of the alternatives are noted here. However as WAP dominates the functional capability of shipping phones, it is considered the default standard. Cahners In-Stat predicts that by the end of 2001 327 million phones or 99% will be WAP-enabled.

3.9.1 Compact-HTML

Unlike WAP, which is an XML-defined language, Compact-HTML is a subset of HTML 2.0, HTML 3.0 and HTML 4.0 and is optimized for small information appliances such as smart phones, smart communicators and PDAs. Because of the success of DoCoMos I-mode service, every major carrier in North America has made a trip to Japan see why 48,000 new users a day or 1.5 million users a month are signing up. There are an estimated 15,000 cHTML sites in Japan. The only North American carrier to public announce the possible use of cHTML is Rogers Cantel (Canada). Many see the migration of cHTML to J2ME in Japan and so it may be a non starter in the USA.

3.9.2 HDML

One major problem in the United States has been that even though WML is obviously technologically superior to HDML, many content providers still use HDML. There are many phones in the US with the Openwave Mobile Browser, formerly the UP.Browser, which is HDML. So for now, HDML has the advantage and the installed base. Because Openwave (Phone.com) has implemented every HDML based service in North America and they were one of the original inventors they have a large advantage and interest in maintaining the status quo. Most major carrier Software Developer Kits (SDK) are in fact Openwaves SDK. Now that Openwaves Mobile Browser is compliant with WML v1.1 it is expected that HDML will now begin to fade.

3.9.3 HTML

Because of the delays in launching wireless web services, the lag in deployment could result in HTML remaining the defacto standard. As bandwidths increase with the deployment of GPRS, WAP will become less of an issue for optimizing bandwidth. Convergence of PDAs and phones and the introduction of colour will make the want for rich websites that more interesting. A 2000 study by the Yankee group found that less then 30% of users that had tried the wireless web via a handset, would want to use it again. They sited the poor quality of display and slow speeds as the main detractors.

The main benefit of HTML is that it is device and operating system independent.

3.9.4 Operating Systems

The four main operating systems for mobile devices in North America are shown in Table. 26 The Epoc system has little exposure in the market in North America despite the large handset makers interest in it. There is little developer interest in the market as well, so it unlikely to see a large exposure for applications that are North American specific. The dominant operating system is Palm OS because it has the largest installed base and ships on the number one and two PDA unit shippers in the market (Palm and Handspring). However in the last year they have lost considerable ground to Microsoft and the Pocket PC products that have been manufactured. Microsoft is also working on a smartphone OS code named Stinger. Part of the issue has been that corporate users are requiring support on both a mobile and desktop device. Like the Apple Macintosh situation of the past, company IT managers want to support only one operating system.

Company	Operating System	Key Features	SDK	Registered Developers	Hardware Platforms
Microsoft	Windows CE Pocket PC	Windows GUI, integrated MS Office, Instant-On, pen-based	Yes	2.3 million	Compaq, Hewlett-Packard, Casio, Siemens, Toshiba Samsung, SAGEM
Palm Computing, Inc.	Palm OS	Pen-based GUI, Integrated PIM	Yes	175,000	Palm, Handspring, Nokia, Kyocera, Samsung,
Symbian	EPOC	Multi-form factor OS, embedded PIM, pen-based	Yes	34,000	Symbol, IBM Motorola, Psion, Matsushita, Panasonic, Philips Nokia, Ericsson,
Research in Motion Ltd	BlackBerry	Integrated PIM	Yes	15,000	RIM, Compaq

Table 26 Mobile Device Operating Systems

3.9.5 Java

Sun is aggressively pushing it's concept of distributed network computing to the wireless realm. The Java 2 Micro Edition (J2ME) is gaining popularity in the wireless software development environment in the USA. J2ME targets a variety of devices with limited memory and display categories, PDAs, tablets, cell phones and household appliances. Once J2ME is embedded onto or downloaded onto a device it can run all of the applications within the J2ME library.

While GPRS will bring the first mobile application of always connected capability to wireless devices expanding the built in functionality will reduce network usage time. Because flat fee access for wireless internet will remain for a long time carriers will look for ways to reduce network load and save on infrastructure.

Java's commonality across multiple devices is also appealing to IT managers. For the same reason that Microsoft is gaining ground in the mobile market Java has appeal because it can be loaded on multiple device that support Java applets. Nextel has been aggressive in promoting it's Java capable phones from Motorola because it caters to corporate clients interested in running applications for increased efficiency. It also creates less dependence on the browser functionality and the need to always be connected. when using the application.

There are a number enterprise platform development companies working with content, application delivery and enterprise partners to deliver their services independent of the type of mobile device using Java. Everypath Inc. is the largest provider of mobile application platforms based on JAVA.

Other alternatives to Sun's J2ME are Kada's Acquaviva and Qualcomm's BREW (only operates on CDMA networks). Binary Runtime Environment for Wireless (BREW) that allows developers to create applications once and then compile them for different phones. The advantage of BREW over Java is that the applications are optimized and compiled for each type of phone microprocessor so they run faster than Java applications that are interpreted on the fly.

The US is quickly becoming polarized with Java supporting devices and PocketPC supporting devices. Both Palm and RIM now offer support for Java development on their platforms. Motorola has declared that every handheld device they manufacture will be Java enabled by the end of 2002.

One of the biggest concerns with Java capable devices, especially those that are considered data centric phones, is the potential for application conflicts and the increase in needed support. This has been a problem in Japan where phones were recalled or had to reload the operating system due Java application conflicts.

3.10 Application Development

Network Support Applications

All the national carriers have application development programs associated with the mobile devices SDK and the browsers SDK. In the past with voice they did not have to deal with income sharing issues as they represented nearly the entire value chain. Now they must deal with a turnkey solution that also takes into account the needs of multi-level value chain. Carriers are only now beginning to develop mechanisms for dealing with different levels of that value chain, whether it's middle wear software providers, vertical application providers or content providers.

As handset functionality migrates to Java enablement the scope of applications will grow with what Sun claims are the potential of 2.4 million application developers. As an example, Sprint operates a program for wireless data application development partners that allows for Solutions developed around LBS using Java.

Handset Application Development
Each device manufacturer supports a certain level of application development on their platform.

As an Example, Palm offers a comprehensive application developer program at 2 levels for beginners basic membership is free and more experienced developers can pay $500/year for the Advantage Program. The only difference is a quarterly resource CD and access to marketing support. They provide all the tools necessary for partner developers to write applications that run on the handheld and also have a number of ROM Emulators to test applications on. Palm places restrictions on Non US developers. Non-US developers must sign up for the Developer basic or advantage Program before they can access ROM images.

Applications are created on a desktop computer and compiled to run on the Palm OS via the Palm Resource File format compiler (PRC). Applications are installed via the cable HotSync connection of the Palm. Developers creating syncing applications with a need to update with a PC or server will have to create a conduit application.

Wireless applications can be created that take advantage of the web clipping function of the Palm web clipping application (WCA). Each web clipping application looks like an individual application in the handheld's application launcher, and users select and run it as they would a normal handheld application. This launches an internal web browser with your web clipping, which can display static pages or receive dynamic information from an outside web server.

Palm places no License restrictions on the use of it’s development tools and charges no fees associated with the development beyond the Advantage program fee. They boost the largest number of third party applications for a mobile device, more then 10,000, and more then 175,000 third party developers.

There are over 400 WASP’s currently serving the US market.. Table 27 is a sample of the supposedly more than 100 members listed as ASP’s in the CTIA. Directory.

@Road	**GiantBear**	**Strategy.com**
Air2Web	**IBM**	**TeleMessage**
Aether Systems	**i3Mobile**	**Televigation**
Avantgo	**iMedeon, Inc**	**Unimobile, Inc.**
Bantu, Inc	**Infinite Technologies**	**ViAir**
BitFlash, Inc.	**Lightbridge**	**Xpoint**
Everypath	**OracleMobile**	**Ztango**
GoAmerica Communications Corp	**Phone Online**	

Table 27 Wireless Application Service Providers

Source: CTIA

For Location Services

Within North America there are a number of location server platforms and development tools for the support of location services across a carrier network. Table 28 shows some the more popular technologies in use. Most of these companies grew out of the application platform development environment or the gateway/middleware environment.. Most now support extensive development tools for delivering custom applications for LBS.

Company	Platform/Tools
SignalSoft	Location Manager
GE Smallworld	EAI
TCS	Xypoint Platform
Mapinfo	Location Management Platform
Autodesk	LocationLogic Solution
ESRI	ArcIMS
Airflash	Smartzone
Intrado	9-1-1Connect

Table 28 Location Platforms and Development Tools

1200 Bay St, Suite 604, Toronto, ON M5R 2A5, Canada 3 Stanford Landing, Suite 250, Stanford, CT 06902, USA
1900 Embarcadero Rd, Suite 100, Palo Alto, CA 94303, USA 1300 Post Oak Blvd, Suite 1990, Houston, TX 77056, USA

4 UNLICENSED SERVICES

In the Unlicensed spectrum range there are a number of wireless technologies that are being developed and are currently in use to deliver voice and data services. Most of these do not have widespread commercial deployment in public networks in the US yet. Table 29 shows each of the technologies.

Specification	Band	Speed
IEEE-802.11b	2.4GHz	11Mbps
IEEE-802.11g	2.4GHz	22Mbps
Home RF	2.4GHz	1.6Mbps
ETSI-HiperLAN2	5GHz	upto 54 Mbps
IEEE-802.11a	5GHz	upto 54 Mbps
IEEE-802.15	4 GHz	40/100 Mbps
Part 15 ISM	.900 MHz	144 kbps
SIG-Bluetooth	2.4GHz	v2.0 upto 2 Mbps

Table 29 Alternative Spectrum

The 802.15 will use Ultra Wideband (currently in FCC approval) based on high-frequency microwave pulse transmissions. Ultra Wideband can cross spectrum layers without interference to existing signals, although some carrier testing disputes this. The 802.11a and HiperLAN2 are not in wide use yet at this time. Bluetooth products are expected to ramp up significantly in 2002. Part 15 of ISM band is for radio modems typical in the industrial sector.

4.1 Bluetooth WPAN

Originally conceived by engineers 1994 at Ericsson Mobile, it was forwarded as an open global standard for devices to communicate over short ranges (less then 10m) at low powers using the 2.4 GHZ ISM (industrial, scientific, medical) unlicensed spectrum. Bluetooth Named after the Danish King Harold Blutooth (940-981 AD) has become an industry standard. There are now 451 products (including component products) qualified by the Bluetooth Special Interest Group (SIG). The Bluetooth SIG itself now has several thousand corporate members and associated members. Originally doubts grow about it's deployment and ability to coexist with the WLAN standard that occupies the same frequency space. But recently it has begun to show it's potential in the market with the release of so many products in 2001.

Depending who you are to believe, Bluetooth unit device shipments will be anywhere from 400 million (Frost and Sullivan 2000) to 1 billion (Ericsson 2001) to 1.15 billion (Micrologic, 2000) to 1.5 billion (Myrill Lynch, 2000) in the year 2005. With each subsequent report the number is going up. These forecasts are global and include all devices from phones to refrigerators that will be Bluetooth enabled. Obviously these forecasts are quite divergent and are based on speculation of the popularity and acceptance of Bluetooth technology. However the general consensus is that it will be prolific. Figure 26 shows the expected deployment scenario for Bluetooth.

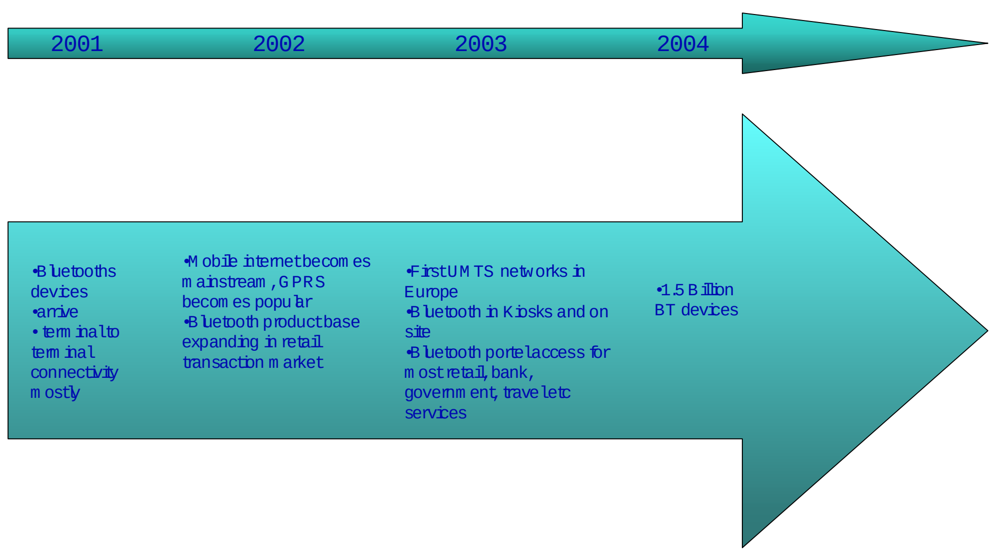

Figure 26 Bluetooth Deployment

Where does it fit?

Bluetooth differentiates itself from other wireless technologies through its lower cost, low power consumption and likely widespread adoption in most portable devices especially those that currently have lower power and price points. The expectation is the entire chipset including the RF portion will cost only $5 in volume, although it is still just over $20 today (Source Motorola 2001). By way of comparison technologies like 802.11 have higher power consumption requirements, have a higher component cost and so are wholly unsuitable for embedding into PDAs and mobile phones. 802.11 is best suited to office and public/campus LAN laptop-based scenario's.

Bluetooth is based in a license-free allocation that also has the distinct advantage over cellular of being a global frequency allocation. This enables a manufacturer to design a single, global Bluetooth-enabled product and then to market it worldwide.

While primarily considered a wireline replacement for devices in cars and consumer items like headsets, it is also suitable for creating personal networks between individuals and fixed connection points (Figure 27). The capability of a wireless internet bridge is what many would suggest is the opportunity for public space applications. Similar to wireless LANs, a network connection would be set up with the query request based on an individual entering the network environment.

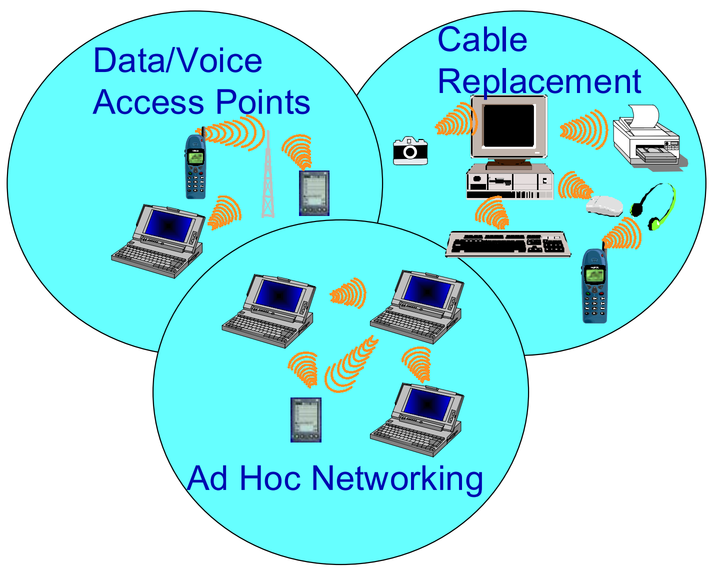

Figure 27 Bluetooth Applications

Bluetooth should compliment the licensed spectrum technologies like GPRS and UMTS as they become available. As an example, Bluetooth can provide multicast capabilities from local GMS receivers like the Swedish company Unwire is looking to implement.

Some companies, Classwave Wireless Inc and HereUare Inc. are looking to exploit Bluetooth/802.11 in public space applications.

Classwave is focused mainly within the hospitality industry where is offering it's polyphony server that allows any bearer service, Bluetooth, WLAN or 2G/3G cellular, connectivity to access information. HereUare offers a turnkey server system that allows partners to turn their location into a bluetooth/802.11 capable environment for patrons on a pay per use basis.

While WAP currently serves a different market from Bluetooth the success of Bluetooth will be dependent on WAP. Nokia in cooperation with Elektrobit of Finland is actively developing support for WAP over Bluetooth applications. While Bluetooth will offer bandwidths that would not require WAP's functional bandwidth optimization, WAP supporting devices will dominate the market and provide a connectivity interface. Nokia and other carrier suppliers must be careful of announcing functionality that would allow a WAP over GSM enabled phone user to roam off of a carriers network seamlessly onto a Bluetooth network. Many Bluetooth SIG members also belong to the WAP Forum. Ericsson and Red-M have partnered to develop WAP over Bluetooth solutions.

4.2 802.11 WLAN

Wireless Local Area Network (WLAN) technology encompasses a number of different technologies. It was originally defined by the Institute for Electrical and Electronics Engineers (IEEE). Originally 802.11 and HomeRF were created to serve the corporate and SOHO markets respectively as a wireless extension of wired LANs. 802.11 has become the dominant of the two standards. HomeRF is now consider to be losing ground to 802.11 in the consumer market as well. As shown in Table 29 the 802 standard has a number of migration paths. Typical signal ranges are 30m for the 802.11b standard.

Forrester is predicting that 22 million WLAN-enabled devices will ship in 2006.

Industry support especially for the current mobile operators will have to be achieved. Currently it is in the best interest of carriers to promote services that use their network. As carriers rely more on VAS revenues they will seek to expand access to those services via wireline and alternative wireless access like Bluetooth. Nokia is supporting this notion with the implementation of their Operator Wireless LAN solution (Figure 28)

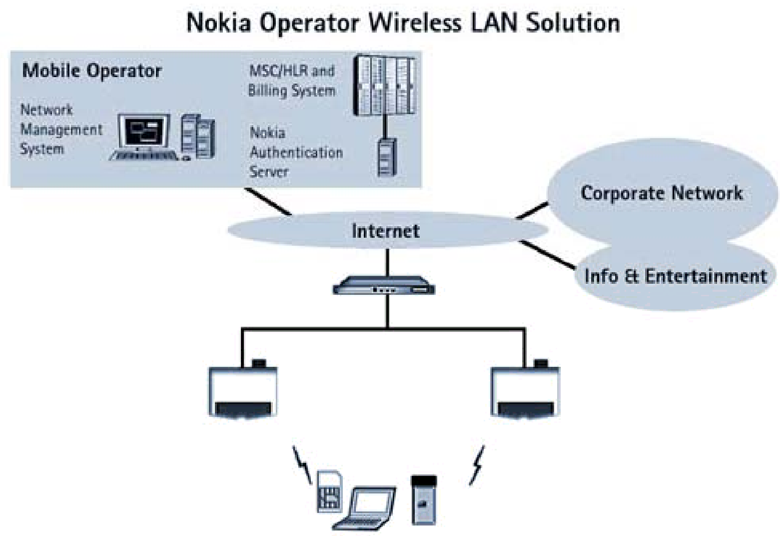

Figure 28 Nokia WLAN solution for Operators
Source: Nokia 2001

A report by Forrester Research published in late 2001 suggested wireless carriers get more involved in Wireless LAN and Bluetooth . It suggested they buy up "hotspot" real estate, such as in shopping centres and airports, where such short-range networks can be successfully established.

"To protect their GPRS and UMTS business cases, mobile operators must take part in the hotspot land grab now, before the most attractive hotspot locations and most lucrative business customers have been taken by competitors like MVNOs (mobile virtual network operators) and new wireless ISPs," it says. No carriers are operating these types of network extensions in North America

The Nokia Operator Wireless LAN enables global roaming using a SIM-based authentication and billing system. Users with a VPN can establish a working environment and services similar to those provided on their office network.

The recent bankruptcy of MobileStar suggests that the market is not available or ready for this type of data access. MobileStar had about 41,000 customers when it went bankrupt in October 2001. It offered a flat fee service to travelers that allowed them to access their VPN or the internet via a WLAN connection using a 802.11b modem in their laptop. They had access gateways in lounges, hotels and restaurants. Part of the high costs associated with placing receivers and leasing land lines in airport lounges and “Starbuck” coffee houses may have been part of their problem. VoiceStream is assuming their assets and will keep the service running. Because VoiceStream will have part of the backbone infrastructure they may be able to offer the service under a better cost structure. Some have suggested that this is a good way for carriers to build out their data networks in areas where they do not have enough licensed spectrum.

4.3 Emerging spectrum technologies

There are always competitive technologies that will emerge. One interesting development is the Ultra Wideband (UWB) specification, 802.15 using pulse technology. Ultra wideband can transmit 1.25 million bits a second up to 80m using just 0.5 milliwatts, or one-thousandth the power used by Bluetooth, based on prototype testing (see Figure 29). It could be approved for release in the USA by the end of the year. The FCC has said that ultra wideband devices "appear to be able to operate on spectrum already occupied by existing radio services without interference," making it a strong candidate for the transmission of very high data rates over short distances. Carriers and others are disputing this sighting studies that show it ahs some impact on their signals.

Sprint conducted studies that showed degradations of cell phone service in the presence of UWB signaling. The National Association of Broadcasters opposed FCC approval for UWB out of concern for spectrum used by remote camera crews and for satellite-based content distribution. Others say UWB emissions can potentially interfere with many other users of the EM spectrum. Users of Global Positioning Systems (GPSs), particularly those in the aviation industry who use GPS data for navigation and landing, have serious reservations about widespread mobile devices that introduce even very low levels of interference into the 1.2GHz and 1.5GHz bands.

The FCC has issued a Notice of Proposed Rule Making with respect to UWB technology, with a decision expected before the end of 2001. UWB proponents have requested that their devices be governed by Part 15.209 rules, which set class A and B EM emission limits for most electronic devices.

Figure 29 Pulse Vs Normal Frequency Transmission

If costs are comparable to Bluetooth it may circumvent Bluetooths future success before the technology can become ubiquitous. Though there are working groups evaluating the UWB technology in North America, most of the telecomm business in Europe has yet to become familiar with the concept. It seems to be a US phenomena. Originally it was the carrier USWest (Cingular) that funded much of the development through investment in the company Time Domain. They are still a private company that has now developed a chipset called PulseON that uses their UWB technology for radar, communications and location technologies. Now there are 150 member companies of an unofficial advocacy group called the UWB Working Group. Key vendors developing technology in this area are Intel, Aether Wire and Location, Multi Spectral Solutions, Pulse-Link and Xtreme Spectrum

4.4 LBS Using Alternative Technologies

One of the interesting applications associated with UWB is that in addition to the transport of data it can also be used as a way of locating things. In fact much of the initial development over the last two decades has been military based for radar applications in addition to the data transport applications.

Location information is determined using pairs of transceivers that resolve their separation by cooperatively exchanging an electromagnetic signal. The accuracy of this range determination is a function of the bandwidth of the exchanged signal. With conventional sinewave technology, the bandwidth of the signal relative to the carrier frequency is very small, at most a few percent using spread spectrum. However, it is possible to transmit and receive electromagnetic impulses, which have a relative bandwidth approaching 100%. This "nonsinusoidal" radiation is currently being used for anti-stealth and ground-probing radar, under the more common heading of ultra-wideband or impulse radar.

Time Domain is the only company with a test product to implement applications for location services, they and partners have not announced any services for this yet until regulatory approval is reached with the FCC. There product is call the PulseON chipset. They claim that it will have application in the following areas

- Through wall motion detection and tracking
- In-building personnel and asset tracking
- High-speed local area networks
- Home networks
- Invisible security domes and fences
- Collision avoidance sensors
- High precision positioning/tracking systems

Because of Bluetooths and 802.11s limited range tracking inside a pico cell has not made a lot of sense. However one company is offering technology to do this. Bluesoft (based in Israel) has a technology that can be integrated into 802.11 and Bluetooth integrated circuits that allows them to be located. and tracked. Primary applications initially are for inventory control. But they are also targeting navigation services, targeted advertising, location-based information services and access control. Bluesoft has partnered with the company Bluetags of Sweden. Bluetags makes intelligent tags for tracking objects. The have an agreement with Sabre, the large travel booking service company, to track checked lugguage. The Bluetags/Bluesoft partnership is also developing applications for safety tags for children that warn when they leave a certain area. They expect to make there products commercially available in mid 2002.

Metricom operated a wireless data network called Ricochet on the license free Part 15 902-928 MHz ISM band, 2.4 GHZ band and the 2.3 GHz lic band for backhauling there access points. This gave them 110 MHz of available spectrum. Using packet radios to forward to the subscribers RF modem data to an access point on the wired web they could create low cost cells. Ricochet used spread spectrum, frequency-hopping technology across 160 channels that allowed maximum throughput. Metricom grew the network to 51,000 subscribers in 17 cities before it ran out of cash and was forced to close in August 2001. Recently Aerie Networks has purchased their assets and plans to restart the network.