

Introduction to the 1X Network

(A CDMA2000 1X Primer)



TELUS Mobility's introduction to the 1X Network (A CDMA2000 1X Primer)

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1. executive summary

This paper is intended to explain the benefits of CDMA2000, otherwise known as 1X, TELUS Mobility's next generation of wireless networks. We focus particularly on the network and the services offered to clients who need access to information and data services while they're on the road. It will help set realistic expectations for this next step in the wireless network evolution, and develop a wireless network vision for personal users and for those in positions to influence technology adoption within their organization, such as IT managers and business executives.

We begin by explaining where 1X fits into the framework of wireless network solutions and what the generations of wireless network are. The diverse wireless network choices are explained, along with TELUS Mobility's service offering, to assist you in making an informed decision about which wireless network and mobile operator offers you the best services. We conclude with a glossary of terms and list of further reading for your reference.

This paper discusses PCS networks, which provide both voice and data services, and does not include information about data-only networks, like CDPD (Cellular Digital Packet Data), ARDIS or Mobitex. It does not discuss TELUS Mobility's Mike network, an iDEN service, which combines the capabilities of a digital cellular telephone, two-way radio, alphanumeric pager, and data/fax modem in a single network.

2. introduction

The emergence of the computing network has been a crucial component of our business and personal lives, allowing us to gather, process and distribute information. These networks can be differentiated by coverage area, be it personal, local or wide area.

- **PAN (Personal Area Network)**. This network covers a radius of several meters, allowing easily carried electronic devices to communicate with one another.
- **LAN (Local Area Networks)**. Organizations are able to use this network to connect a number of computers and resources, regardless of their physical proximity within a building.
- **WAN (Wide Area Network)**. At home we are able to access the largest repository of information, the Internet, through a WAN.

2.1 wireless networking

Our ability to access these networks has been limited by a physical connection to the network. At home it may be through a DSL connection (Digital Subscriber Line – a technology for bringing high-bandwidth information to homes and small businesses over ordinary telephone lines), or in the office through Ethernet (the most widely installed LAN technology). A variety of wireless technologies have emerged that free us from our desks, but still allow us to access our preferred sources of information, be it the Internet, office e-mail, or even corporate servers.



A wireless PAN (Personal Area Network) is designed to allow electronic devices, such as wireless phones, PDAs (personal digital assistants), pocket video games, pagers and other devices to communicate over the air with one another within a 10 metre radius. Wirelessly networking these devices eliminates the need for multiple connectivity-cables.

The PAN is designed for high speed, short distance communication, so you still need to be within metres of a network connection to access your e-mail and the Internet.

One such wireless PAN solution is Bluetooth. For more information, please see www.bluetooth.com.



A wireless LAN (Local Area Networks) allows wireless clients to connect to other computers, printers, scanners and databases without the need for laying out in-building network cables. A user may roam within the building with their laptop and still have access to all these resources.

These networks are limited to "hotspots" in airports, hotels, libraries or even coffee shops. When outside of the building and it's network you can not access the information you need.

Emerging technologies include Wi-Fi (802.11b) and 802.11a. For more information, please see www.80211-Planet.com.



A wireless WAN (Wide Area Networks) allows clients to access the Internet and their corporate network anywhere wireless coverage is provided by wireless operators, such as TELUS Mobility.

Wireless WANs allow mobile workers to be more effective and efficient in carrying out their daily tasks by allowing them to access information, applications, and e-mail, regardless of their proximity to a wall-jack.

Technology includes CDMA, iDEN, TDMA, GSM, GPRS and the 3G technology, 1X.

These three network groups are distinct from each other because of the different coverage areas for which they were developed. There is no seamless integration between them.

The focus of this paper is on wireless WAN technology, such as 1X, and how it's deployed by wireless operators, such as TELUS Mobility.

2.2 wireless wide area networking evolution

In a little more than twenty years, the wireless market has grown from a few wireless options to diverse competition of cellular network technologies. The evolution of these technologies is generally referred to in terms of generations:

GENERATION	DESCRIPTION
<p>1G analog</p>	<p>What... The first-generation of wireless was introduced in the early 1980s, using analog radio transmission technologies such as AMPS (Advanced Mobile Phone System).</p> <p>Why... Offering mobile voice communications for clients who were away from the office, while on the road or waiting in a client's offices. Analog data modems allowed the transmission of data on this voice-only network at around 2.4 to 9.6Kbps.</p> <p>But... Due to the susceptibility to interference, the signal quality was highly variable and there was no security in the transmission.</p>
<p>2G digital</p>	<p>What... The second-generation of wireless WAN is digital circuit-switched wireless, which was implemented in the early 1990s. The generic name in North America for such digital mobile voice-and-data services is PCS.</p> <p>Why... Data communication no longer requires special modems as in 1G, and a connectivity data cable turns your Web-ready phone into a wireless modem.</p> <p>Digital transmission provides clearer voice-signals (equivalent to landline), improved battery life, and allows data to be transmitted at around between 9.6 – 14.4Kbps, while encrypting signals for security.</p> <p>But... Second-generation technologies are circuit-switched, which means that a wireless channel is temporarily dedicated between the two communicating parties, until the call is completed. Data services are restricted to dial-up similar to a wireline modem.</p>
<p>3G digital packet</p>	<p>What... The next evolution in wireless communication is digital packet-switched. Rather than creating the physical path, as found in circuit-switched, the data is divided into small units, called packets, which are routed through the network to an address contained within.</p> <p>Why... Packet switched data allows low-cost transmission and enables flexible routing so that packets may take different, optimal, routes to the same destination where they are reassembled, boosting transmission rates. Packet data allows devices to connect to the network quicker, no longer requiring a dial-up connection.</p>

2.3 today's wireless wide area networks

Mobile telephone networks allow us to talk on the move and the Internet gives us access to useful information and services. The promise of 3G is to provide a dramatic increase in data transmission rates to mobile devices, allowing the wireless WAN and Internet to converge. In North America, there are currently three 2G PCS networks which offer the client voice and circuit-switched dial-up connection to the Internet: CDMA, GSM and TDMA. TELUS Mobility uses the CDMA network.

The migration paths for 2G networks to 3G have been defined, ensuring that the network will not become an orphan technology. The choice of 3G technologies is either CDMA2000, or W-CDMA. 1X is the first phase of CDMA2000 and GPRS is the first phase of W-CDMA. In order to better understand the implications of the transition from 2G to 3G, we begin by giving a high level review of what differentiates the network technologies from each other and then by discussing how the migration path will impact you.

2.3.1 CDMA

The CDMA (Code Division Multiple Access) protocol divides data into binary signals that travel on a spread spectrum of frequencies. CDMA encrypts the signal using a digital code known only to the wireless mobile device and base station.

data transmission

- Data is transmitted as binary on a circuit switched network
- Bandwidth is optimized by use of spread spectrum coding
- Data transmission rates of up to 14.4Kbps

3G migration path

The next step for CDMA towards 3G is 1X. This network offers always-available connection and data transmission rates of up to 144Kbps, through a packet switched data channel. 1X is backward compatible with cdmaOne, so a user may roam with a 1X phone, or data card, from a 1X network to a legacy cdmaOne network and continue to use voice and data, albeit at the 2G data-rate. We discuss 1X in more detail later in this paper.

Further high data rate technology may increase the data rates to as much as 2.4Mbps with the continued efforts in developing 1xEV-DO and 1xEV-DV, which are further evolutions of CDMA.

2.3.2 GSM

GSM (Global System for Mobile communication) uses a variation of TDMA (Time Division Multiple Access), which varies the spectrum on which the signal travels, dividing a radio frequency into time slots and then allocating slots to multiple calls. In this way, a single frequency can support multiple, simultaneous data channels. GSM is not compatible with the TDMA implementation, so a GSM device can not use a TDMA network and vice-versa.

data transmission

- Data is transmitted as binary on a circuit switched network
- A temporary, randomly generated, ciphering key encodes and decodes the transmission
- In North America the data transmission rate is up to 9.6Kbps

3G migration path

The natural transition from GSM is to GPRS (General Packet Radio Service), which offers higher data transmission rates of around 115Kbps.

2.3.3 TDMA

TDMA (Time Division Multiple Access) divides a radio frequency into time slots and then allocates slots to multiple calls. The implementation of TDMA used in North America is TDMA/IS-136.

data transmission

- Data is transmitted as binary
- Data transmission rate is up to 14.4Kbps

3G migration path

Although the choice for TDMA operators is either migrating to 1X or to GPRS, many wireless operators have chosen GPRS as the next step (see “GSM or CDMA: The commercial and technological challenges for TDMA operators” in section 7 “more information on 1X”, for a more complete discussion). Regardless of the choice, the TDMA mobile operator faces two transition barriers:

1. Deploying a separate network – the operator is faced with the challenge and cost of deploying a separate CDMA or GSM network that would parallel the established TDMA network to facilitate voice and dial-up services.
2. Using that separate network – the operator is faced with the challenge and cost of supporting and maintaining that separate network to make the 3G transition.

3. future friendly

1X is the natural evolution of CDMA technology and incorporates packet data services in existing digital service areas. CDMA operators can implement 1X data services using existing base stations and overlaying the existing CDMA network. The transition to this technology is relatively seamless. A cdmaOne phone or data card can continue to use the network after the transition since the technology is backward compatible, but the user will not realize the enhanced service offerings until they upgrade to a 1X phone or data card.

Due to this natural evolution, TELUS Mobility can continue to support clients with existing services without any negative client impact. However, 1X introduces packet data services and greater wireless data rates that will allow data clients to access the Internet or corporate LAN. The benefits of this network include:

faster data rates

Up to 144Kbps uncompressed. One notable obstacle to deploying wireless data historically has been performance rates. Applications that work well on a corporate LAN or via a landline dial-up, such as VPN or gaming, are not always scalable to the lower data rate 2G networks.

always available connections to the wireless network

No dial-up required. 1X packet data does not require the user to explicitly connect to the network. As with Ethernet networks in the office or DSL modems at home, clients will be asked to enter their user name and password and, upon authentication, are immediately connected to the Internet. This “instant on” functionality greatly improves the usability of the Internet and allows clients to access the network immediately.

better battery life for PDA devices

Packet has less power requirement. Packet data networks improve battery life of devices because there is a much lower demand on the modem when data is not being transferred. It is common for Web users to download a page then spend a couple of minutes reading it. In a 2G environment, the data session remains active and the modem is in constant communication with the network. With 1X, the modem remains idle when data is not being requested.

billing based on data transferred not connect time

Don't pay for idle time. Another key difference with the 1X packet data network is billing. In a traditional cellular model, clients are billed for their airtime based on a per minute charge. Pricing for the 1X packet data services will be based on data transferred rather than time connected. This means that clients will be better able to manage their wireless networking costs by monitoring the volume of data sent. Since packet networks will bypass long distance charges, as the Internet does today (though, there may be roaming costs), mobile clients will no longer need to sign-up and pay an ISP to get access to the Internet or the corporate network when they are on the road.

national wireless wide area network coverage

1X will be deployed by TELUS Mobility across our Canadian digital footprint. Roaming agreements with mobile operators will be established to ensure a network footprint that spans within Canada and the USA.

new modem devices that make wireless connections seamless

While most people think of the cell phone when they think wireless, new wireless modems are being released that provide wireless wide area networking for laptops, PDAs, and beyond. TELUS Mobility will offer clients a PC Card modem that can be used with most Windows laptop and Pocket PC devices that support PCMCIA Type II cards such as the Sierra Wireless Aircard® 555, which will be available through TELUS Mobility.

Sierra Wireless AirCard® 555 –1X wireless network card

- Used in any Windows Laptop or PDA that has a PC card slot
- Easy access to Internet, LAN/Intranet and remote software applications
- Reliable wireless Internet access using CDMA next generation technology
- Supports data transmission rates of up to 144Kbps
- Backwards compatibility to cdmaOne
- Minimal power consumption achieved by superior card power management



Additional modem devices will be launched that support wireless data connections for Palm PDAs. Finally, 1X modems will be integrated into a number of PDAs to provide seamless integration of the computer and the network.

1X provides wireless operators and clients with the most seamless transition to 3G. For wireless operators, using existing network infrastructure and skill sets means the migration to 3G will be less expensive so more capital is available to improve and enhance services. For clients, 1X provides a platform for deploying new packet based applications that are effective, relevant long-term solutions.

4. 1X and GPRS

Although the data rates that are commonly quoted for 1X and GPRS are attainable under ideal lab conditions, there are external network factors that impact the actual data rate for both. TELUS Mobility is building a 1X data service that provides around 40 - 60Kbps connection.

There are a number of factors that reduce the actual transfer rate for all RF (radio frequency) communication technologies to one extent or another, including:

- Number of clients on the network – the more clients loaded onto a network, the less bandwidth there is to share. Less bandwidth per client results in lower data transfer rates than the theoretical maximum.
- Network capacity – the greater the network capacity, or number of radio frequency channels available to the wireless operator, allows more clients to be loaded on to the network, therefore lower data transfer rates are experienced.
- Environmental factors – background noise, the distance to a cell site.

There are also important practical limitations imposed by the phones and wireless modem cards themselves, such as data rate restrictions and the efficiency of battery usage. Additionally, there are data rate limitations imposed by the chosen implementation of network technology. We will now discuss these points in more detail.

synchronous data rates in 1X

The 1X network is capable of uncompressed data rates of 144Kbps in both upload and download (to or from the device to the network). GSM-GPRS devices can use more time slots for download than they do to upload, so a user may experience a higher data transfer to their device than they will by sending data from their device.

strong battery performance in 1X devices

The transmission power required for 1X and GPRS, is dependent on the amount of data being transmitted. A short message requires less power than a video clip, for example, making 1X and GPRS more efficient than 2G protocols. However, 1X varies the power based on the number of bits being transmitted, whereas GPRS uses a less refined method of allocating data radio channels. The battery usage is less efficient on GPRS devices than 1X devices.

efficient 1X network capacity

1X coding algorithm effectively doubles network capacity, while more spectrum may need to be bought by the wireless operator for expansion in GPRS.

1X data devices

1X phones and data-cards are capable of up to 144Kbps data transmission rates. GSM-GPRS data users, however are further limited by their phones and data-cards, which are unable to deal with the power demands placed upon them.

5. the TELUS Mobility advantage

The value proposition that TELUS Mobility brings to the data network client is based on two fundamental needs:

- Having what it takes to meet the needs of the client;
- TELUS Mobility's unique advantage.

5.1 having what it takes

we offer you:

coverage

With TELUS Mobility, you have access to our extensive network and our strategically selected roaming partners (keep checking www.telusmobility.com/wirelessweb details). We are continually enhancing our coverage with hundreds of additional cell sites in TELUS Mobility networks across Canada each year and with technologies such as 1X.

network reliability

At TELUS Mobility our network reliability is monitored 24 hours a day to ensure maximum performance.

client care

At TELUS Mobility, we know that client care is important, we have 2.3 million clients across Canada. That is why we have, not only a Client Care team that can assist with general inquiries, but one that is dedicated to data.

competitive price

TELUS Mobility is a market leader. We know that our price is competitive for products and services and we offer extra value built right in.

the TELUS Mobility brand

The TELUS Mobility brand means more than offering wireless voice, data and Internet services across Canada. It means more than 5,000 team members across Canada who bring a fresh and innovative approach to digital wireless. Team members who have impressive wireless resources and experience.

5.2 unique advantages

TELUS Mobility offers a unique blend of Future Friendly™ products, services, and networks to give you the choices you need to craft the wireless business solutions you require.

future friendly™

What is Future Friendly? Simply put, it is TELUS Mobility's commitment to you to make wireless technology easier, more productive, more integrated and more transparent in your daily business practices. This starts with our product evaluation and quality assurance – making sure our wireless products and services work in intuitive ways that enhance your business and offer true return on investment. It continues with our sales channels, ensuring that our representatives are wireless specialists with whom you can consult during the sales process. We are committed to offering superb after sales support. There is always a knowledgeable representative ready to answer your questions and provide concise answers. Finally, Future Friendly represents our desire to listen and learn from you, a valuable client.

unique products and innovative solutions

We at TELUS Mobility are passionate about developing products that your business wants and needs. We are stepping up to the challenge of creating or finding those products so you get the very best in wireless technologies. For example, product development teams are continuously exploring horizontal applications like wireless e-mail or vertical applications like automatic vehicle location or remote monitoring. TELUS Mobility already has an impressive portfolio of wireless solutions and we are expanding every day.

industry leaders

The voice of experience – that's what TELUS Mobility represents. We've been offering data solutions for almost a decade. We have the knowledge, the experience, the people, and a host of satisfied clients.

strategic partnerships

There are some things outside our areas of expertise. Often it is necessary to have inside industry knowledge to craft an appropriate wireless solution. Extending our team through strategic partnerships with device manufacturers, system integrators, value-added resellers, and specialized consultants ensures that we fill in any gaps that might exist. Our focus is creating the team you need to develop your wireless solution.

6. summary

With the ever-increasing gathering, processing and distribution of information in both our work and personal lives, the ability to connect multiple devices allows us to share resources more effectively. Access to information when you need it, regardless of where you go, allows you to work away from your desk.

With wireless technologies such as 1X, the installation of the hardware and connection to the network is not only simple, but also faster and more reliable. Although the theoretical data transfer rates are not yet attainable because of external factors (such as environmental factors and network capacity) and, in the case of GPRS, due to device restrictions, the actual client experience is still several times faster than current technologies. The ability to roam freely into other 1X networks, and even other areas that may still have CDMA networks, makes this the technology of choice for TELUS Mobility and for clients who benefit from its services.

As these wireless technologies evolve and mature, the ability to use software that was traditionally limited by being connected through a LAN in various wireless environments, makes the mobile user more efficient and effective than before.

Not only is 1X itself an important factor in the TELUS Mobility network evolution but with it more applications and services are made available that directly benefit the user. With our experience with the CDMA network and existing horizontal and vertical services, TELUS Mobility is strongly placed to provide you with the ability to use these applications, tools and resources that were limited to the LAN environment:

improved Web experience

Surf the Web and use instant messaging and other Web-enabled applications with a fast data transfer and a quick connection to the internet while you're away from your desk.

access your corporate Intranet and online databases

Access the corporate network and benefit from the resources such as databases, your address book and agenda to schedule a meeting and check your calendar in real-time.

use existing tools to send and receive e-mail, faxes and file attachments

Use familiar fax and e-mail tools, such as Outlook and Lotus Notes, to check business and personal e-mail, or continue to access an ISP e-mail account through the Internet

All of these applications run closer to the speed of an office LAN or your DSL at home, without you having to look for a telephone jack or pay long-distance charges. Consider the time taken to transfer a 255 Kb file (an e-mail with file attachment) either down to a mobile device, or up to the network, as set out in the chart below:

Network Protocol	Actual Data Rate (Kbps)	Upload Time (minutes:seconds)	Download Time (minutes:seconds)
1X	40 – 60	0:51 to 0:34	0:51 to 0:34
GPRS	13.4 - 26.8 (upload) 40.2 - 53.6 (download)	2:33 to 1:16	0:51 to 0:38
cdma One	14.4	1:22	1:22
GSM	9.6	2:31	2:31
TDMA/136	14.4	1:22	1:22

7. more information on 1X

- CDMA Development Group - CDMA advocacy group, a good information site for the cdmaOne world.
- "GSM or CDMA : The Commercial and Technology Challenges for TDMA Operators"; Analysis by THE SHOSTECK GROUP; Published by the CDMA Development Group [www.cdg.org/]
- Qualcomm CDMA Technology - learn about CDMA from a leading developer of CDMA technology. [www.qualcomm.com/cdma/]
- PCIA's 3G Demand Forecast - a comprehensive description of 3G with a demand forecast. [<http://www.pcia.com/industryconnect/3gstudy.htm>]
- International Telecommunications Union (ITU) - the ITU plays a central role in 3G (IMT-2000) development. This section of the ITU site is dedicated to 3G issues and information. [www.itu.int/imt/]

8. glossary

Term	Definition
1G	First generation of wireless networks. Analog.
1X	A wireless network technology which provides voice and data capabilities within a standard 1.25 MHz CDMA channel for outstanding spectral efficiency and flexibility. CDMA2000 builds on earlier CDMA technology (known as cdmaOne) to provide a simple, seamless evolution to third-generation services. It doubles the voice capacity of cdmaOne systems and also supports packet data services.
2.5G	A half step network upgrade towards 3G network standards
2G	The second generation of wireless circuit switched, digital networks, e.g. CDMA is a 2G network.
3G	A new generation of wireless systems, which provide data transmission at speeds of up to 144Kbps and higher and Internet Protocol (IP) based services in fixed, portable, and mobile environments.
AMPS	Advanced/Analog Mobile Phone System – the North American, first generation, analog network
CDMA	Code Division Multiple Access – a digital wireless technology that uses a “spread spectrum” technique to scatter a radio signal across a wide range of frequencies. CDMA provides greater total capacity than other technologies, along with outstanding voice quality and fewer dropped calls. CDMA is the technology of choice for new third-generation systems.
CDMA 1xEV	A two-phase evolution of this “data optimized” version, is an approved 3G standard.
CDMA/IS-95	Code Division Multiple Access IS-95. See cdmaOne
CDMA2000	1X formerly called CDMA / IS-95-C, CDMA 1X, or CDMA2000 1X
cdmaOne	A brand name of the CDMA Development Group, a vendor association for the present CDMA/IS-95, the most popular wireless network implementation of CDMA in North America
EDGE	Enhanced Data Rates for Global Evolution
FDMA	Frequency division multiple access
GPRS	General Packet Radio Service, the 2.5G upgrade to GSM networks
GSM	Global System for Mobile communications – a digital communications technology developed in the early 1980s.
IMT-2000	The process undertaken by the International Telecommunications Union designed to co-ordinate global third-generation wireless standards
ITU	International Telecommunications Union – Agency of the United Nations with the goal to establish standardized communications practices.

Kbps	Kilobits per second
Mbps	Megabits per second
PCS	2G networks encompassing the competing technologies in North America CDMA, TDMA, GSM
RF	Radio frequency
TDMA	Time Division Multiple Access - a digital wireless technology that divides a narrow radio channel into framed time slots (typically 3 or 8) and allocates a slot to each user.
UMTS	Universal Mobile Telephone System (see W-CDMA)
W-CDMA	Wideband Code Division Multiple Access - Wideband CDMA is an approved 3G standard which utilizes one 5 MHz channel for both voice and data, offering data rates up to 2 Mbps. (also known in Europe as UMTS)