GSM to WCDMA the Global Choice



Executive Summary

The wireless industry is currently undergoing a transition from 2nd Generation (2G) to 3rd Generation (3G) networks. Unlike 2G networks, the 3G networks will allow operators to offer high-speed wireless data services to their subscribers.

The evolution of GSM, via GPRS to EDGE and WCDMA, is expected to serve at least 80% of the subscribers by 2005. Among handset, infrastructure, applications and content suppliers, the focus will therefore be on the GSM and WCDMA market, which will result in a large variety of products and services.

So what are the advantages of WCDMA? To start with, it is the technology that offers the greatest data throughput capability and superior performance for 3G services. It has the best economy of scale. And offering a very sound business case. WCDMA is designed and optimized specifically for multimedia services and has the capacities one can expect of a new generation system.

WCDMA offers the highest data rates of all 3G systems and by utilizing a wide carrier of 5 MHz, it paves the way to even higher data rates, up to 10.8 Mbps in 3GPP release 5. WCDMA and EDGE are members of the ITU IMT-2000 standard.

The analysis we have made based on operator' traffic models, clearly shows the advantages of using WCDMA for high capacity data usage. WCDMA has as well a cost advantage for voice services in fully deployed networks.

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Introduction

Wideband Code Division Multiple Access, WCDMA, is the most chosen 3G standard in the world today. For GSM operators it is the evolution path when moving forward to 3G services.

Many non-GSM operators are also adopting WCDMA. In Korea and Japan, 70% of the 3G frequency spectrum is allocated for WCDMA, despite no GSM presence today. In Hong Kong, with several different 2G technologies on the market, 100% of the new spectrum is allocated to WCDMA. Another noticeable trend is that operators are increasing their focus on GSM in the 2G spectrum, in order to benefit from GSM international roaming and the evolution path to WCDMA as we are seeing in the US, Canada, Mexico and Singapore.

The ever-increasing presence for GSM is also highlighted in the Americas. Brazil has chosen GSM 1800 for their new licenses and in the US, three of the top five operators have chosen the GSM path forward.

To fully understand why most operators are choosing WCDMA, one must also look at the business cases and some of the non-technical decisions being made, such as what services will be promoted, what handsets and functionality will be available and what the current market demands are?

Evolution from GSM to WCDMA

GSM is the global standard. It is the world-leading standard in terms of both the number of operators and the number of subscribers. Today there are close to 500 GSM operators in 172 countries. At the beginning of 2002, there will be over 700 million GSM subscribers, representing 71% of the total wireless market.

With dual mode handsets, GSM and WCDMA are expected to serve at least 80% of the world subscribers in year 2005, see Figure 1.

WCDMA operators will benefit from the GSM economies of scale. By evolving the GSM core network, WCDMA will be overlaid with the existing GSM radio network along with handover and seamless services between the systems. Roaming features are built into the GSM and WCDMA networks from the start. Revenues from roaming constitute 15–20% of operator revenues in general. The smooth evolution to 3G services provides the operator with the advantage of deploying WCDMA according to the market requirements. Initially, WCDMA will be implemented in urban and suburban areas. As capacity requirements increase, the coverage areas will be extended gradually.

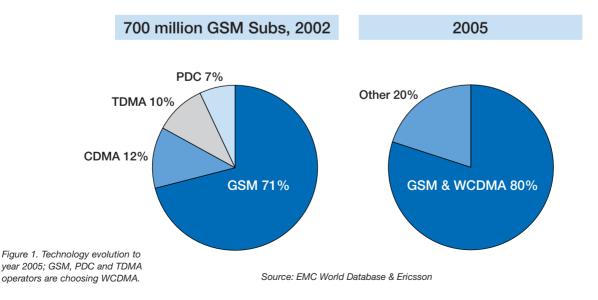




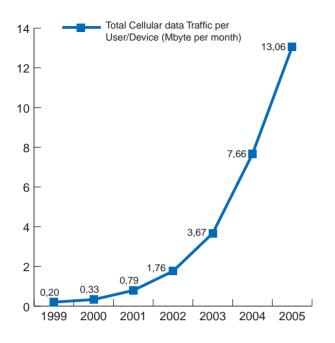
Figure 2. Organizations taking an active part in development of WCDMA.

The benefits that the consumers will enjoy by using the mainstream technology, such as GSM and WCDMA, are broad product offerings, fast product development, very competitive handsets, international roaming, and the most competitive mobile service prices.

Global Momentum

WCDMA is the major technology in the IMT-2000 standard and has gained an enormous worldwide momentum. The 3rd Generation Partnership Project, 3GPP, is specifying the complete standards for WCDMA, and also holds the responsibility for the evolution of GSM. 3GPP has more than 380 members and is backed up by major regional and national standardization bodies worldwide. The drive from the market is also extensive. Organizations like the UMTS Forum with more than 260 members, including major operators, suppliers and regulators, promote WCDMA and work for a successful launch of 3G services on the global market. A number of industry initiatives have also been formed. Some of which can be viewed in Figure 2. This global momentum has also highly raised the interest for WCDMA among non-GSM and Greenfield operators.

The global momentum has brought WCDMA into focus for handsets and infrastructure suppliers, offering the best products earliest and at the most competitive prices. Likewise, it will be the focus of the applications and content providers to prioritize fast time to market with their offerings.



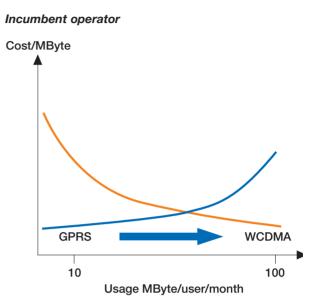


Figure 3. Mobile data traffic forecast.

Figure 4. GPRS is a cost-effective solution for low data usage, while WCDMA is the best solution for high data usage.

Business Case

The demand for mobile data traffic is increasing. Figure 3 shows the forecast for the traffic increase per average data user per month over the next four years.

The business case, the traffic models and assumptions being used are all based on experiences from actual business cases where Ericsson and over 30 different operators around the world have worked together on their individual business cases for the inclusion of WCDMA.

These cases are based on a capacity usage of up to 10 Mbytes for low end usage and up to 100 Mbytes for high end usage per user per month. The traffic models consist of a mixture of applications and services, such as voice, e-mail, Mobile Multimedia MMS, Chat, Gaming and Music/video download. For example, an average MP3 song is about 3 Mbytes.

We will look at two different scenarios, one for the incumbent GSM operator and one for the Greenfield operator. The calculations are based on an evenly distributed subscriber base, for a certain area, given a specific traffic density.

The calculations include 80% co-located sites, core network and radio access network investments, and network OPEX such as O&M, power and site rental. Costs for running and maintaining the network are included.

The result is the delta between running voice only and running both voice and data in a network. The cost is the average over five years and comparisons are made from a cost per Mbyte point of view.

Figure 4 shows that GPRS is a very cost-effective solution for data at low usage whereas WCDMA will be most costeffective at high usage. The arrow describes how an operator can stay at the lowest cost possible as they compliment their GPRS with WCDMA for the increased capacity requirements. It is therefore important to consider WCDMA spectrum issues at an early stage of GPRS deployment.

As indicated in Figure 5, the cost per Mbyte for the Greenfield operator starts at approximately 50% less per MByte than for the incumbent operator in Figure 4. This is because of the data only calculation. Voice

Greenfield operator

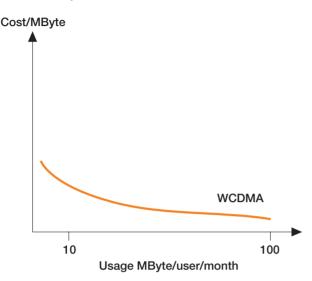


Figure 5. WCDMA is cost-efficient for both voice and data, already at low data usage.

traffic is now part of WCDMA and Figure 5 only describes the needed capacity expansion for data applications. Using WCDMA for voice and data therefore allows for WCDMA to be cost efficient even at low data usage.

A major advantage by using WCDMA in this scenario is the flexibility to have voice and data applications running on the same radio transceiver. Since the cost efficiency of WCDMA for voice traffic is also significantly higher than for voice over GSM in fully deployed networks, this results in a cost advantage for the Greenfield WCDMA operator.

Applications and Handsets

When evolving the current 2G network into a WCDMA network, operators will be able to offer new subscriber services. The evolution process is not just a matter of choosing the 'right' technology. It should rather be handled with a consumer driven approach, with focus on how to satisfy the consumer needs. With applications as the focal point for GPRS/WCDMA, customer oriented applications and the packaging of them have become more important than ever. Another part in this story is the increased operators' involvement in deciding upon the range of applications to offer their customers. An example of this is Japan and South Korea where they successfully have marketed subscriber services based on customer demands and not technology.

Since more than 70 percent of all subscribers today are hosted in the GSM technology, the operators have a great opportunity to successfully develop a seamless network that can be used in GSM, GPRS, EDGE and WCDMA. With a common service network, the industry faces new conditions where any type of third party developer can find its way through and improve the 3G markets in all aspects.

Obviously WCDMA is also about handsets and there must be quantity, quality and reasonably priced handsets on the market for a successful evolution to WCDMA. The advantage of having over 70 percent of the mobile systems market using GSM networks will certainly have an impact on the development of future generations of handsets.

A new service concept

In the 3GPP specifications, the Virtual Home Environment concept is striving towards personalized services for all subscribers. This is provided by a layered architecture with open standard interfaces. The open interfaces set off application and service creation to third party application developers and will boost both local and global innovation. By using a 5 MHz carrier, several sessions such as voice calls, data transfers, and web browsing are possible to access simultaneously.

Applications

With 3G applications, the subscriber is in focus. Today we are only a few steps away from Virtual Home Environment with personalized services. Soon we will be able to access our office and control our home remotely. We will also be able to use the handset as a wallet, a camera and a personal navigator. Applications are designed with regard to social communication, empowerment, timesaving and entertainment in mind.

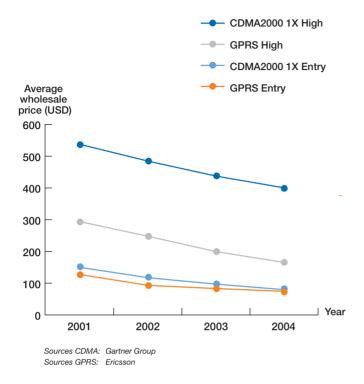


Figure 6. Average wholesale prices (USD) show that GPRS handset prices are favorable compared to other technologies.

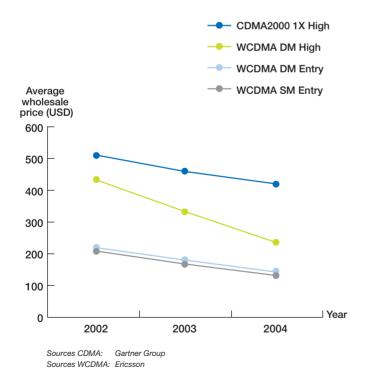


Figure 7. Average wholesales prices (USD) of WCDMA Dual Mode and Single Mode handsets compared to CDMA2000 handsets.

Handsets

Already today, one can see that GPRS handset prices are very favorable, because of high volumes and tough competition in technology development, see Figure 6.

A significant market share is expected for WCDMA handsets and is a major incentive for reduced handset size and price, see Fig 7. The latest chipset technology competition is another important factor which confirm WCDMA as the leading 3G technology. Minimum product size is not only based on the electronics. Battery, keypad, LCD and antenna are also delimiters for product size.

The main technology differentiator of WCDMA is the 5 MHz carrier. The wide carrier in WCDMA can resolve paths better than a narrow carrier. The advantage of this is that the better the path resolution, the more path diversity is gained. Thus, for reasonable outdoor propagation models, WCDMA will have advantageous performance. Better link performance means that less power is needed to meet a certain requirement. This can be translated into a mixture of longer talk time and smaller size batteries and antennas.

For standby time, the definition of sleep modes is the dominant factor. The WCDMA sleep mode operation decreases the signalling load and battery power consumption of the handset.

WCDMA Technology Advantages

The global acceptance of WCDMA is also the result of the characteristics and capabilities of the technology. WCDMA shows superior performance in capacity for voice and data services.

Capacity and coverage

In WCDMA capacity, coverage and Quality of Service can be flexibly traded depending on what is prioritized. To maintain coverage when the system is heavily loaded, capacity can be limited, or delays and data losses can be allowed for certain types of traffic. This means that initially, when traffic and capacity requirements are low, the coverage is large. As shown in Figure 8, the initial state of WCDMA provides a

	Number of sites required	Range
GSM 1800 Voice	100%	0dB (ref)
WCDMA Voice	40%	+7,5 dB
WCDMA 384 kbit Data	60%	+4 dB

Figure 8. Fewer sites with WCDMA than with GSM 1800 at initial deployment.

better coverage than GSM 1800. Only 40 percent of GSM 1800 sites are needed to provide the same voice coverage in the same area.

Regarding best effort packet data, approximately 60 percent of the sites are needed compared to GSM 1800. As traffic increases, new base stations are added for capacity and quality. The capacity increase can also be handled by adding new frequency carriers at the existing sites. This flexibility allows for the operator to expand the system at a pace corresponding to market demands.

The WCDMA technology has the capabilities for hierarchical cell structures to allow maximum use of micro cell technology as required for congested areas and indoor applications.

Seamless network

In the near future, a majority of the existing GSM operators will operate a WCDMA network with multimode GSM and WCDMA handsets, and a range of advanced subscriber services. A seamless network, where GSM and WCDMA can be handled as one common resource, provides many important advantages.

The seamless network, Figure 9, WCDMA and GSM consists of three parts: a common core network including a number of common solutions and components, the GSM radio access network with global coverage, and the WCDMA radio access network with coverage starting in urban areas. The seamless network concept integrates GSM and WCDMA into one system.

To facilitate seamless services, cost-efficient rollout and operation, several solutions are provided. A main component in combining the GSM and WCDMA radio access, is to have a traffic control function that is able to handle all spectrums allocated by the two systems as one. Adaptive Traffic Control ensures full utilization of the combined spectrum and resources with a seamless handover, and transfer of connections between the two systems.

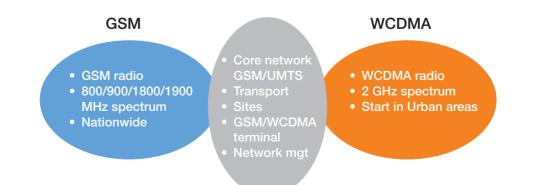


Figure 9. Seamless Network for GSM and WCDMA. GSM = GSM, GPRS and Edge

With the base station site representing a large part of the network investments, there is a lot to gain by sharing the site infrastructure as much as possible. For GSM operators, it is estimated that as much as 80 percent of the WCDMA sites can be shared with the existing GSM sites.

With a network management solution designed for a combined GSM and WCDMA network, the effort to configure and optimize the radio network is reduced. Through proactive and focused operations this results in increased airtime availability, as well as an optimized, reliable network in each phase of the evolution.

Shared Networks

Sharing infrastructure between operators is a fast way to revenue. It reduces the risks and initial CAPEX and OPEX. Sharing radio infrastructure enables early launch with large initial coverage. As the sites are effectively shared and the number of antennas reduced, it also provides environmental benefits. By using shared networks, the position of the operators is strengthened and results in the traffic and revenue increases that are necessary when evolving into wholly owned networks. Shared Networks offer several solutions that can meet varying regulatory conditions as well as specific market and customer requirements in almost all situations, see Figure 10. Each solution can be combined with each operator's individual WCDMA network.

Common Shared Networks allow sharing of the entire base station and its capacity. It is a solution for operators that do not have their own license. By cooperating with a licensed operator, they can offer GSM and WCDMA services.

As an additional feature, WCDMA offers Shared Radio Networks, where almost all elements at a site, e.g. power, antennas and feeders can be shared. For two sharing operators, the base station has to be a dual carrier base station, where each operator will have its individual carrier, Mobile Network Code and settings.

In the Geographically Split Networks, the GSM and WCDMA operators build individual networks and allow subscribers of other networks to use parts of them. In the boarder areas, cell relations to the other networks are configured, to support cell reselection and handover.

Sharing Sollution	Sharing of:
Common Shared Network based on National Roaming	 Parts of Core Network Radio Network Controller Radio Base Staions
Shared Radio Network	 Radio Network Controller Radio Base Stations
Geographically Split Networks based on National Roaming	Core NetworkRadio Network ControllerRadio Base Stations

Figure 10. Solutions for Shared Networks

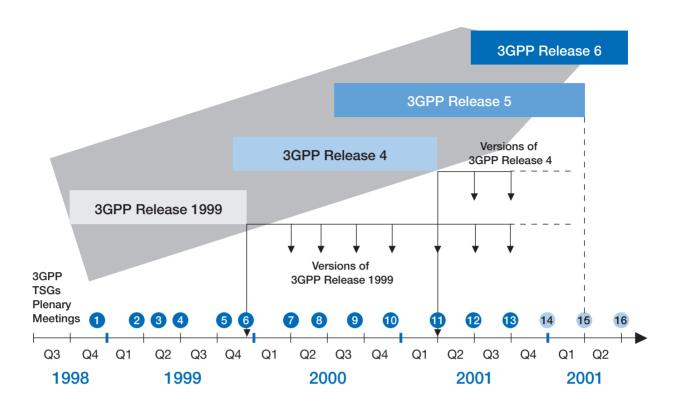


Figure 11. WCDMA is based on 3GPP releases.

Technology evolution and 3GPP releases

In 3GPP release 5, the enhancement of WCDMA uses higher order modulation and fast link adaptation in the downlink to give the end user higher data rates. The corresponding enhancement of CDMA2000 1X is called 1x EV-DO. Both enhancements are used to increase data rates in the downlink.

The 3GPP release 5 enables speeds up to 10.8 Mbps on the downlink to the handset and is used for best effort data services. The increase in maximum data rate will give significant improvement of the services, in positions with good signal quality e.g., close to the cell site. Figure 11 shows the planned rollout of 3GPP releases.

Main features of 3GPP releases: Release 4:

Revenue generation

- Streaming service (best effort)
- Multimedia messaging
- API (application Platform Interface) for M-commerce

Cost efficiency

• IP transport in the core network

Release 5:

Revenue generation

- IP Multi Media (best effort), basic SIP functionality for the provision of IP based multimedia services
- Location services for PS/GPRS
- IPv6 (Internet Protocol no. 6)
- HSDPA

Cost efficiency

- Load sharing UTRAN(Radio Network for WCDMA)/GERAN (Radio Network for GSM/EDGE)
- WCDMA in 1800/1900 MHz frequency spectrums
- Mobile Execution Environment (MExE) support for Java and WAP applications
- Enhancements of packet streaming with improved Quality of Service

	EDGE		CDMA2000		WCDMA	
	Existing standard	Enhanced standard	Existing standard	1XEV	Existing standard	release 5
Max data rate per carrier	480 kbps	2 Mbps	600 kbps	l 2,4 Mbps I	2 Mbps	10,8 Mbps
Data rate at cell boarder	128 kbps	128 kbps	128 kbps	l 128 kbps 	384 kbps	384 kbps

Figure 12. Data rates.

Release 6 targets

Revenue generation

- Multicast/Broadcast Multimedia Services (MBMS)
- IMS enhancements for support of conversational services
- WCDMA/WLAN interworking
- Speech Recognition
- Digital Rights Management
- UE Functionality split
- Common Radio Resource Management (UTRAN/GERAN)

Packet Data Performance

WCDMA is specified and designed specifically with the 3G requirements for multimedia applications in mind. It also fulfills the requirements for evolution, by the definition of interoperability between GSM and WCDMA, increasing affordability and deployment options for the operator. EDGE and CDMA2000 have been developed as an evolution of the existing GSM and cdmaOne standards, respectively.

As seen in Figure 12, WCDMA provides the highest

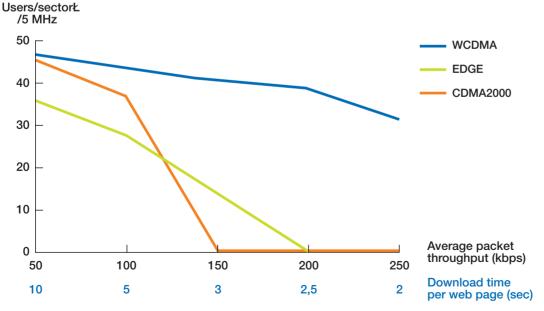


Figure 13. WCDMA supports more users than CDMA2000 and EDGE. EDGE supports a higher Quality of Service than CDMA2000 at low loads.

data rates in both initial and enhanced deployment.

To get an idea about the performance of the different systems, the throughput of data at different loads needs to be considered. In Figure 13, the average throughput in kbps is given for different loads, i.e. users per sector using a 5 MHz carrier. It also states the download time for the specific throughputs when downloading a web page (60 kByte). The figure also describes how WCDMA supports more users and higher QoS than CDMA2000 and EDGE.

Data capacity depends on the type of service and the desired QoS, which is measured as the response time experienced by the user. For each system, the capacity and QoS will also depend on the bearer used for packet data, which is then shared between the users. For WCDMA a 384 kbps bearer is assumed, as supported by first generation mobiles. For CDMA2000 the bearer is 153 kbps which first generation mobiles will support. EDGE is assumed to use 4 time slots on the downlink, which results in a 236 kbps bearer.

Both 3GPP release 5 and CDMA2000 1x EV-DO are based on higher-order modulation, fast link adaptation, fast scheduling and fast Hybrid ARQ. In WCDMA; it is possible to share a single carrier for different WCDMA services. In CDMA2000, the downlink operates on a separate carriers for voice and data.

Summary/Conclusion

There are several reasons for choosing a WCDMA network when evolving to 3G. WCDMA is the world's most selected 3G technology with support from all major regional standardization bodies and market representatives worldwide. It has also been identified as the best and most suitable evolution path for GSM operators when they are evolving their networks to 3G.

The global branding of GSM and WCDMA supports operator decisions to choose WCDMA for 3G services. For example, WCDMA operators will benefit from the GSM economy of scale and international roaming. Other advantages of WCDMA are the commercial availability and the significant cost effectiveness.

The benefits that the consumers will enjoy by using a "mainstream" technology, such as WCDMA, are broad product offerings, fast product development, very competitive handsets, international roaming, and the most competitive mobile service prices.

WCDMA provide operators with a very wise choice for their 3G networks, offering a very sound business case.

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