3rd Generation Mobile Wireless

A Presentation on the Opportunities and Challenges of Delivering Advanced Mobile Communications Services

August 7, 2001

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Market Summary

A number of factors are driving the wireless Internet and wireless information...

Societal trends

- Emerging computer literate society
- Increasing travel and mobility
- Desire for entertainment
- Need for enhanced productivity

Technology enablers

- High speed, cost effective mobile systems
- Integrated multimedia applications
- Small, powerful, application-rich user devices

Market trends

- Rapid growth in mobile
- Rapid Internet adoption
- Accelerating pace of electronic commerce (aka M-commerce)
- Rapid growth of portable and palmtop computers

…enabling exciting vertical and horizontal applications

Enterprise Workgroup

- Specific IT Applications
- Business Verticals
- Group Chat, Email, Instant Messaging
- Wide Area Intranet
- Mobile Workforce Management (dispatch), Telematics

Mobile Professional

- Business General
- Horizontal Business
- Internet / Intranet
- Email, Chat, Instant Messaging
- Personal Information Management

Consumer

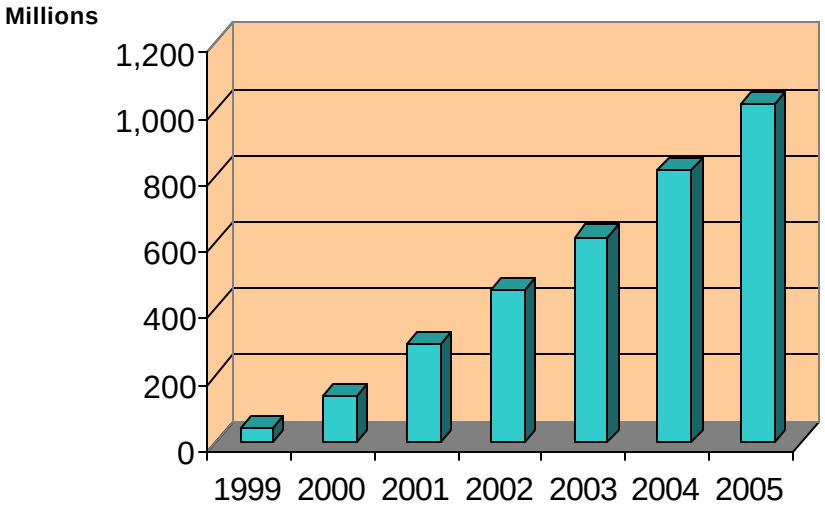
- Personal Interest
- Horizontal Consumer
- Internet
- Entertainment, Infotainment, Lottery, Sports
- Navigation, Map Search
- Electronic Cash (M-Commerce)

Weather, Travel, News, Gaming, Stock Quotes

Email, Intranet Access, Legacy Applications Access, Vertical Applications

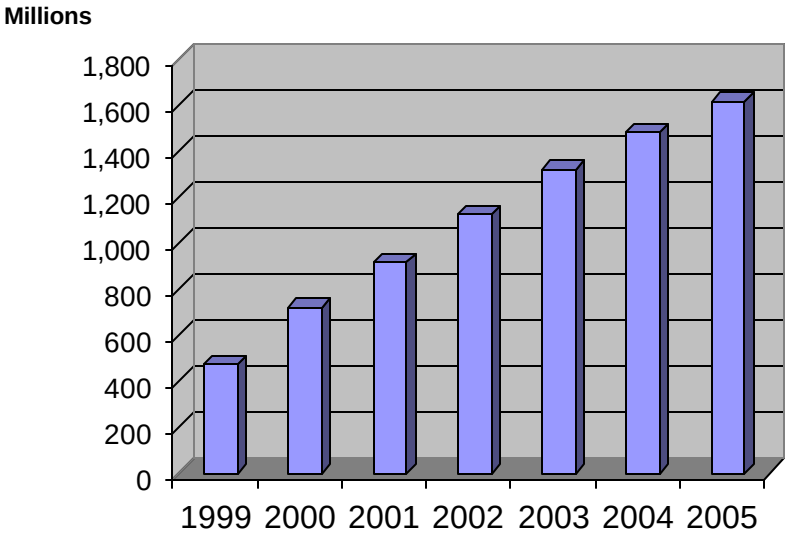
Data indicates that this convergence is creating enormous opportunity for the wireless industry

Wireless Data Users



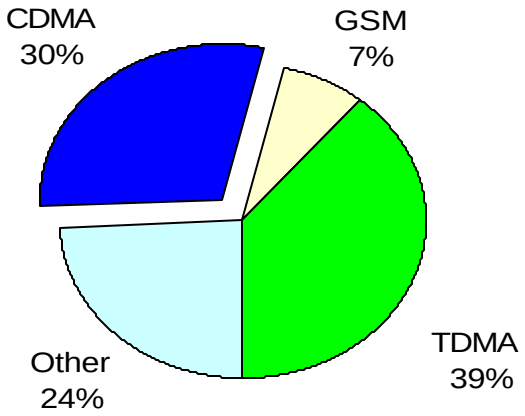
Source: The ARC Group, Wireless Internet Report, 2000

Worldwide Wireless Subscribers



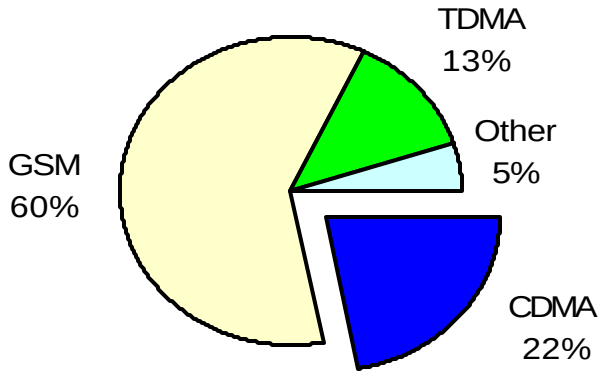
Source: EMC Database, 2001

Looking more closely at wireless technologies, CDMA continues to grow share and is becoming a key enabler of the wireless Internet



Americas Market Share: Subscriptions June 2001

CDMA in the Americas accounted for 30% of the wireless marketplace while GSM was just 7%



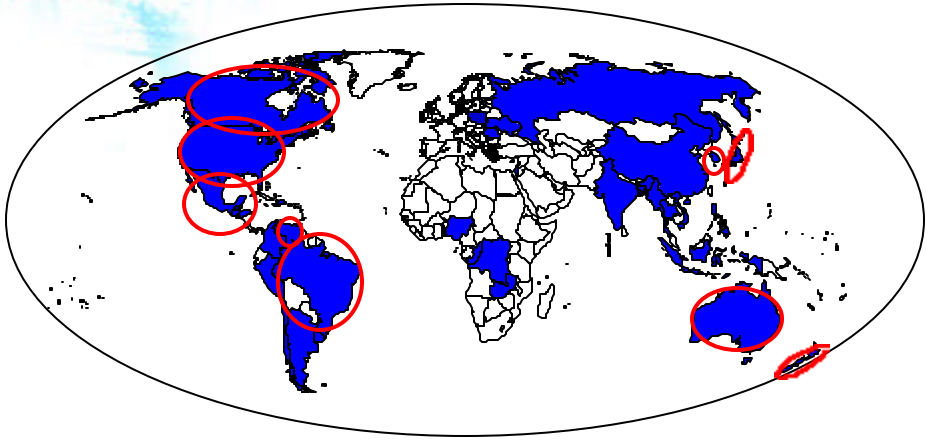
World Market Share: Subscriptions end of 2005

Worldwide, CDMA will account for 22% of the wireless marketplace

Source: EMC Database, June 2001

CDMA (2G and 3G) will very likely be the predominant global wireless technology

Going forward, addressable population will be a key driver of technology market share



Countries able to deploy CDMA2000 in existing **cdmaOne** networks represent **over 4.18 billion** pops

Countries announcing CDMA2000 deployments represent **806.5 million** pops

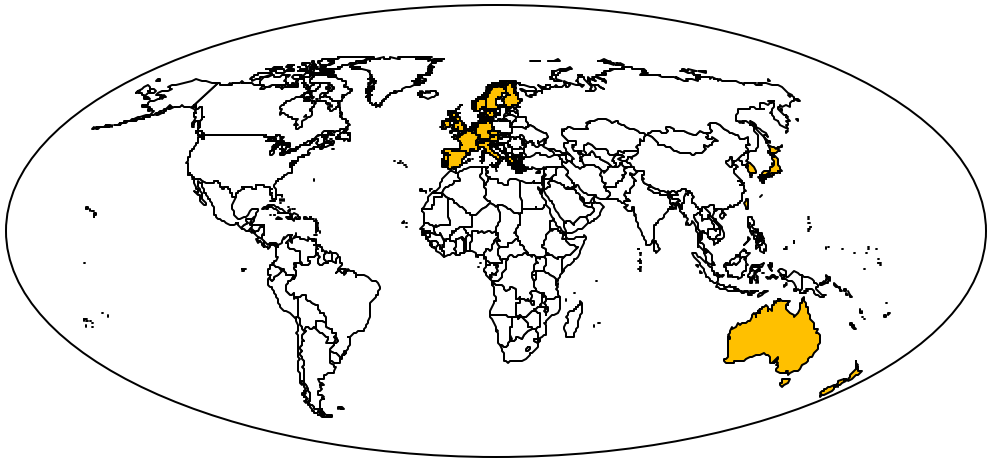
Countries with Commercial CDMA Networks

Countries with CDMA2000 Networks, Plans or Trials

Countries that have awarded UMTS spectrum represent only 672 Million pops:

J-WCDMA = 175 million
(Japan, Korea)

UMTS = 497 million
(Western Europe/Asia)



Countries with **UMTS** Licensed Spectrum at 2.1 GHz

Sources: CIA World Factbook, EMC World Cellular Database June 2001, CDG 2001, Public Announcements

3G Drivers and Key Considerations

Certain factors are critical for making 3G a success

- ✓ Solutions that are globally recognized and meet adopted, international standards
- ✓ Solutions that work, enable quick time-to-market and meet industry expectations
- ✓ Spectrum flexibility, efficiency and cost
- ✓ Capacity to meet future demand
- ✓ Seamless and cost effective migration from today's systems
- ✓ Broad range of competitively-priced devices for end users (consumers, enterprises)
- ✓ Broad range of applications for end users

This section addresses each of these success factors

✓	Solutions that are globally recognized and meet adopted, international standards
	Solutions that work, enable quick time-to-market and meet industry expectations
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The ITU formed the IMT-2000 program to coordinate standards to meet these needs

IMT-2000 Terrestrial Radio Interfaces

IMT-2000 CDMA Direct Spread	IMT-2000 CDMA Multi-Carrier	IMT-2000 CDMA TDD	IMT-2000 TDMA Single Carrier	IMT-2000 FDMA/ TDMA
WCDMA (UMTS)	CDMA2000	UTRA TDD & TD-SCDMA	UWC-136/ EDGE	DECT

3G CDMA

Although there are five terrestrial standards, most of the attention and energy in the industry has been toward the CDMA standards

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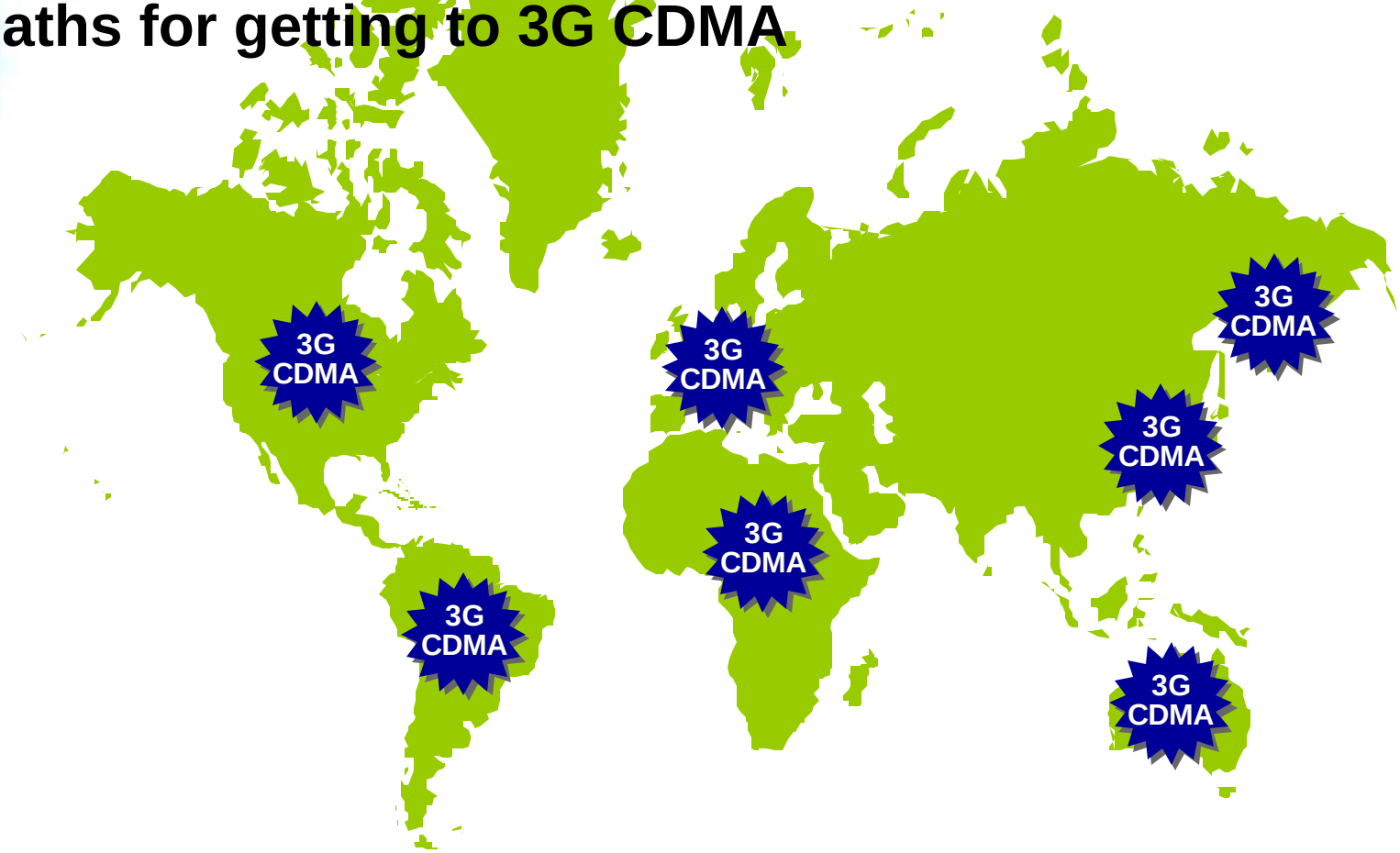
Regions worldwide have outlined migration paths for getting to 3G CDMA



Although 2G systems may be coming from different starting points, future systems will largely be based on CDMA

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More importantly, 3G services are available today with CDMA2000

Sources: Company Press Releases and Statements, News Articles and Analyst Reports

SK Telecom (Korea) launched the world's first commercial IMT-2000 3G system in October 2000. LG Telecom and KT Freetel (Korea) launched CDMA2000 service in May 2001. 4700 CDMA2000 base stations are deployed in Korea, allowing more than 400,000 users to realize data rates of over 150 kbps.

Launch dates for other 3G technologies are much less clear:

- Japan WCDMA has been postponed from May 2001 to at least October 2001
- Europe WCDMA (UMTS) won't likely be deployed until after 2004
- EDGE deployment is an uncertainty

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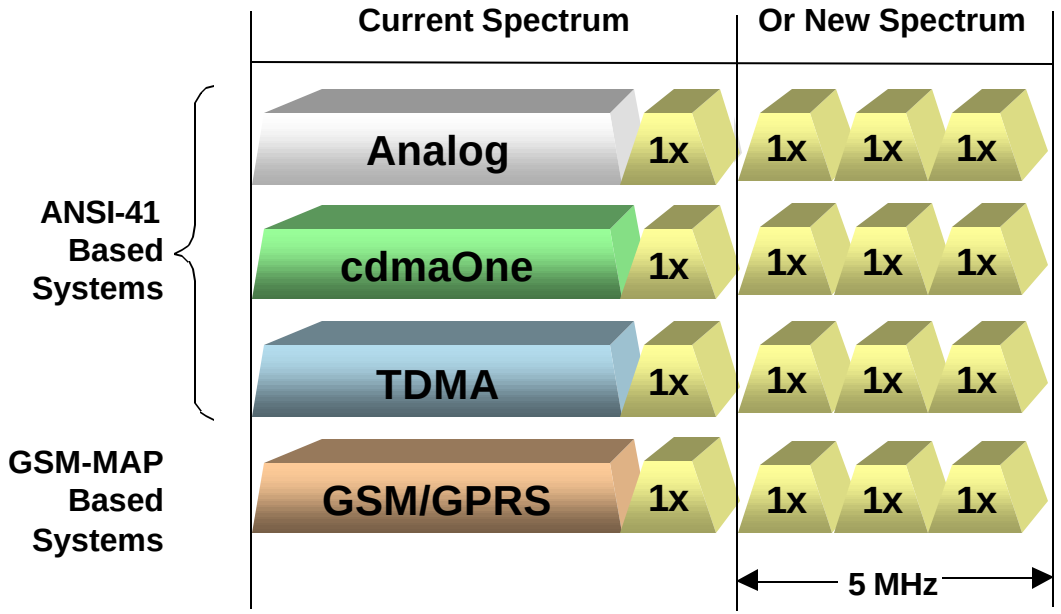
Spectrum flexibility is a key consideration for any technology...

CDMA2000 3G services operate in a small amount of spectrum

- Effective use of spectrum, significant to ALL operators
- Effective both in overlay or greenfield deployments

CDMA2000 is not constrained to only the IMT-2000 band. Defined to operate in existing and IMT spectrum:

- 450 MHz
- 700 MHz
- 800 MHz
- 900 MHz
- 1700 MHz
- 1800 MHz
- 1900 MHz
- 2100 MHz



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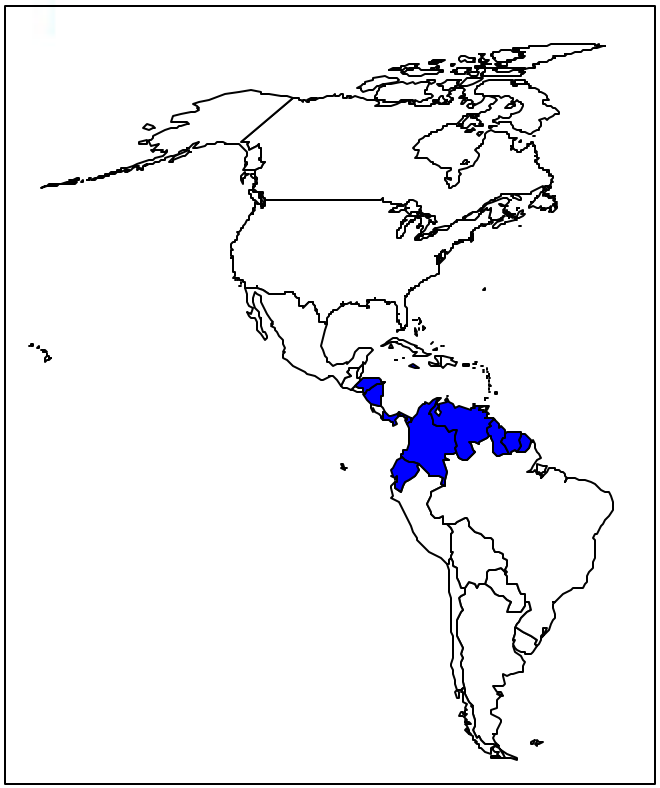
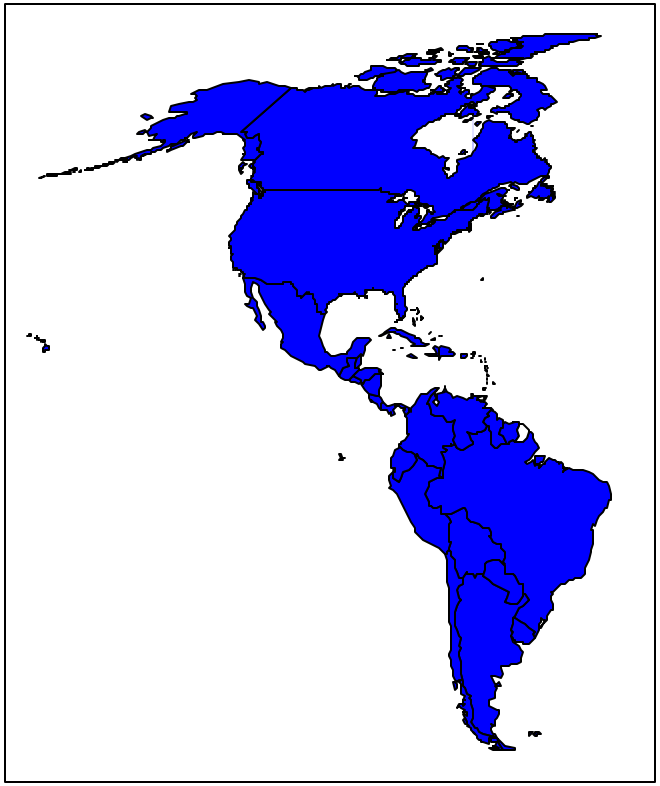
…which can be a decisive factor for operators wanting to move to 3G



Americas: Countries that can potentially deploy Europe WCDMA*



Americas: Countries that can deploy CDMA2000 in existing spectrum

Source: EMC World Cellular Database, 2001

***1900 MHz band [required for Europe WCDMA] not already occupied**

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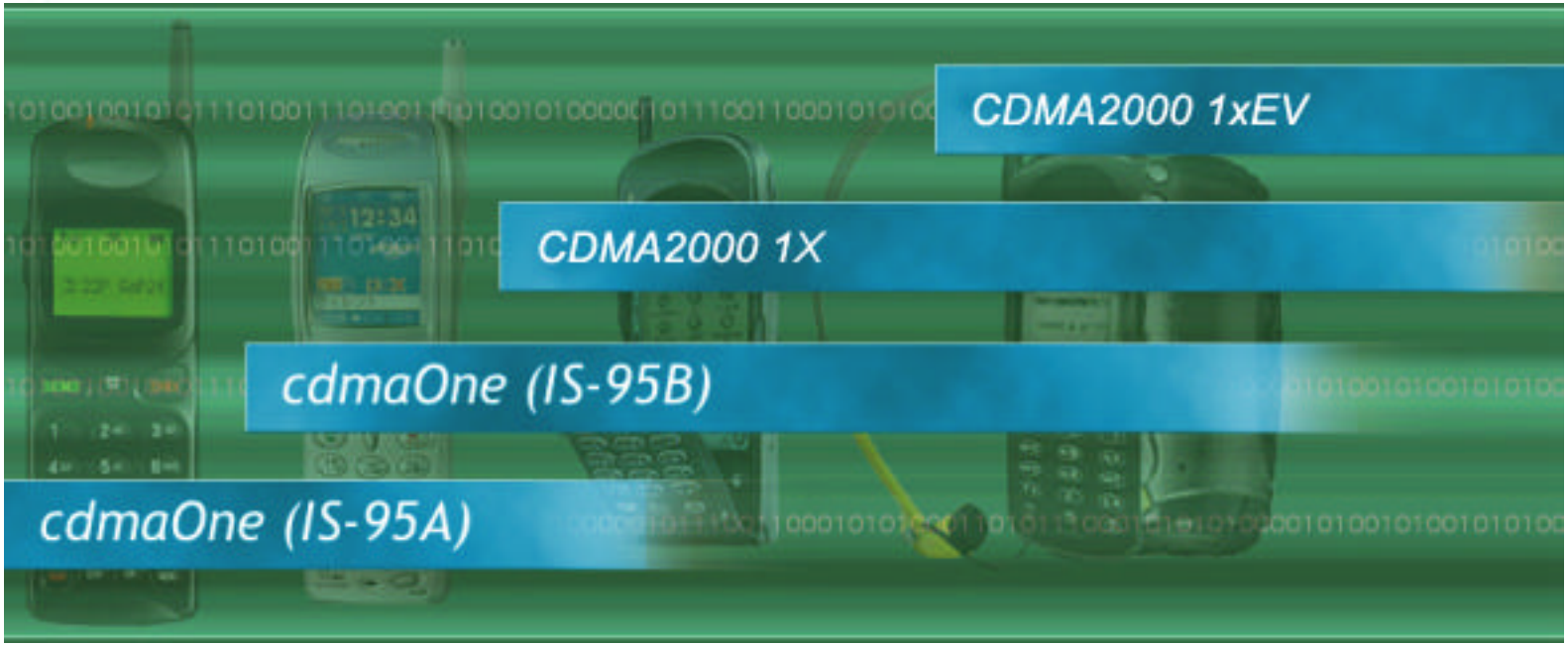
The CDMA2000 evolution path is flexible and future-proof...



- Voice
- Data up to 14.4 kbps

- Voice
- Data up to 115 kbps

- 2x increases in voice capacity
- Up to 307 kbps packet data on a single (1.25 MHz) carrier
- First 3G system for any technology worldwide

- Optimized, very high-speed data (Phase 1)
- Up to 2.4 Mbps packet data on a single (1.25 MHz) carrier
- Integrated voice and data (Phase 2); up to 4.8 Mbps

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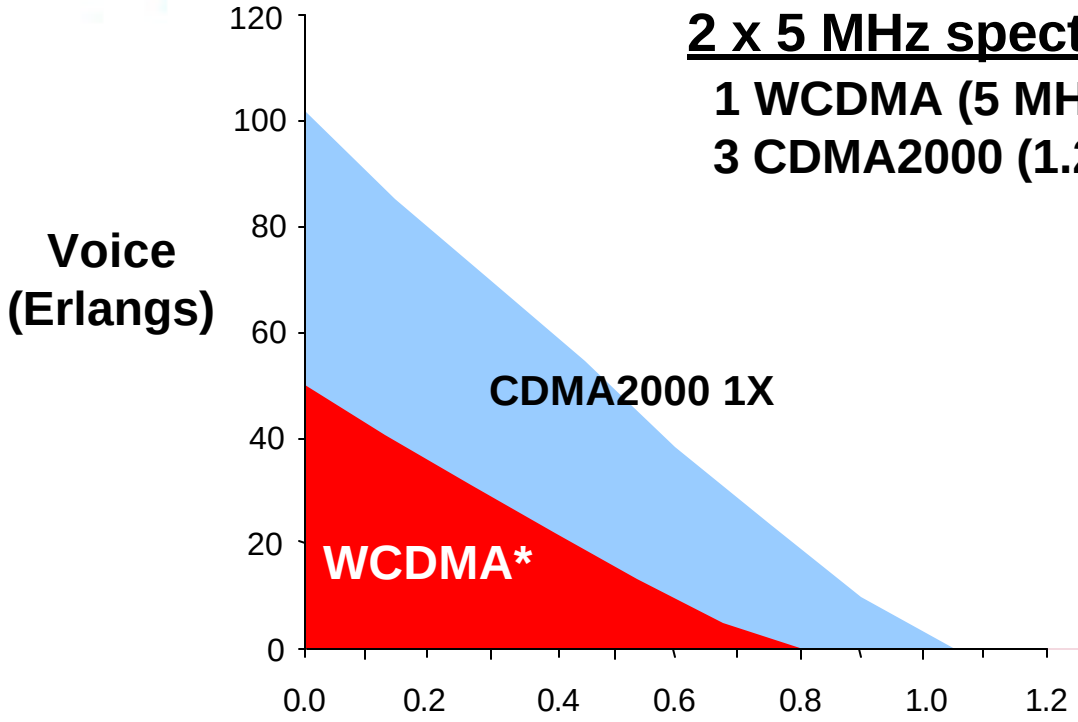
…providing significant spectral efficiency benefits for operators

2 x 5 MHz spectrum available:

1 WCDMA (5 MHz) Carrier or

3 CDMA2000 (1.25 MHz) Carriers



**Source: "WCDMA for UMTS", Radio Access for Third Generation Mobile Communications, John Wiley & Sons, Ltd.*

Erlangs per sector and data throughput per sector

Other Sources: Qualcomm

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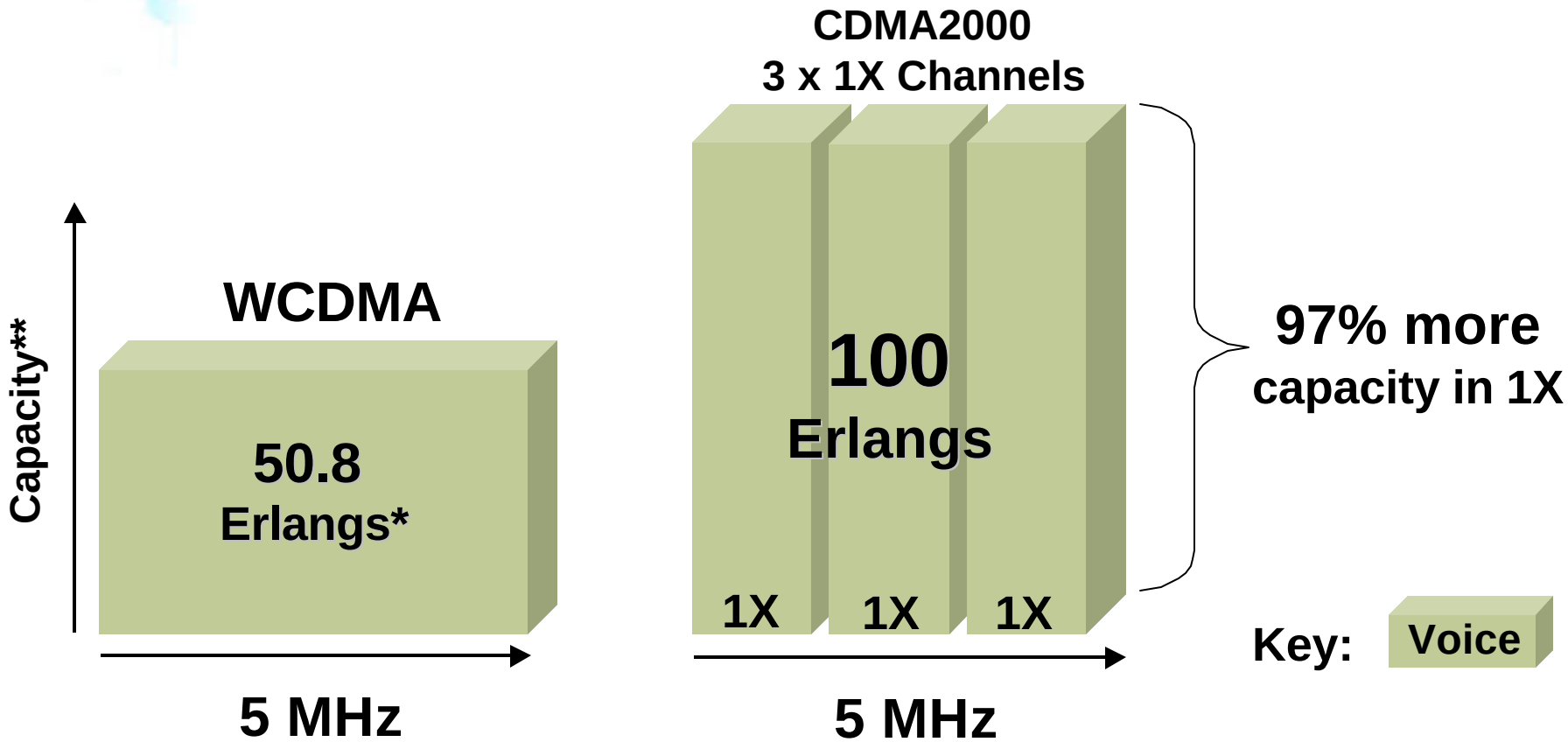
Capacity is a key consideration for 3G services

Scenario 1: 100% Voice



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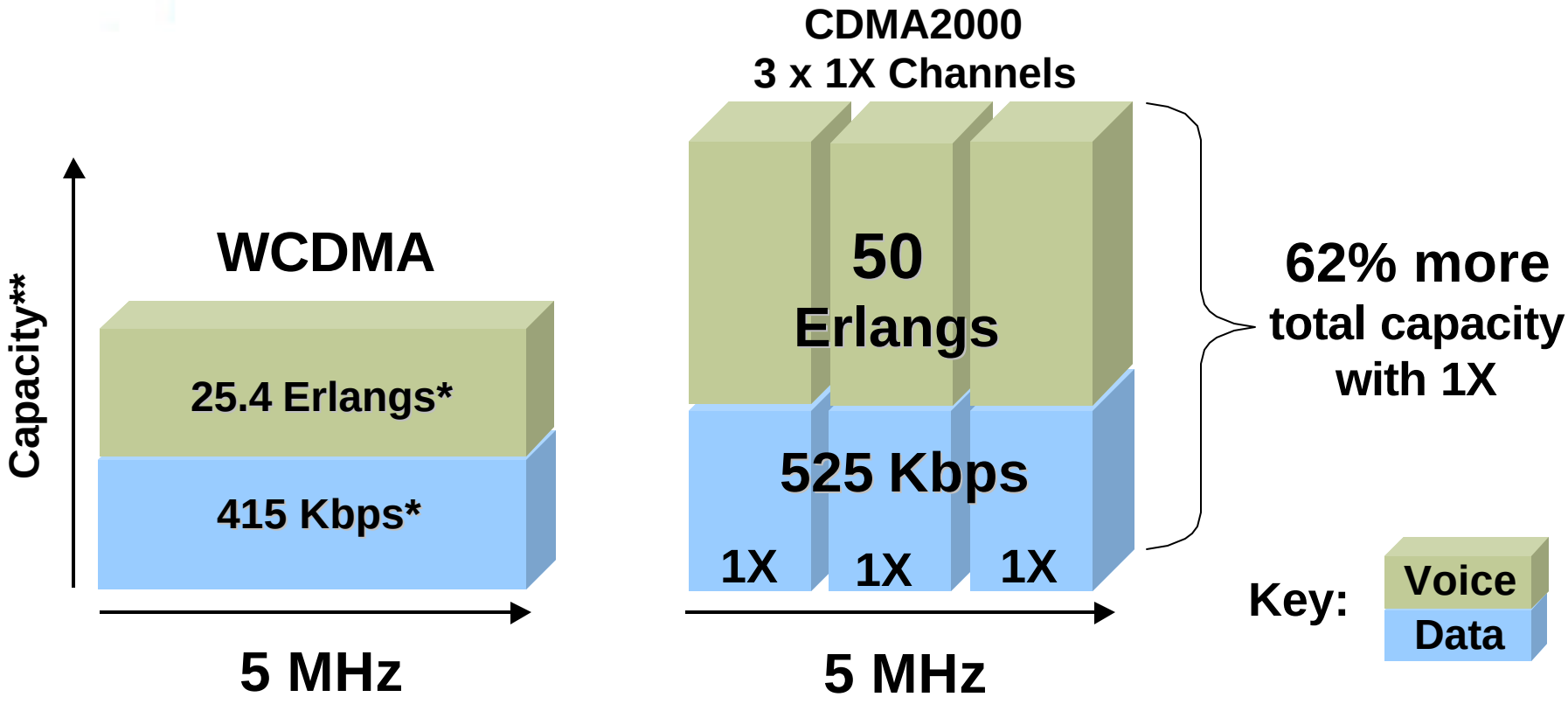
Capacity for mixed voice and data traffic

Scenario 2: 50% Voice, 50% Data



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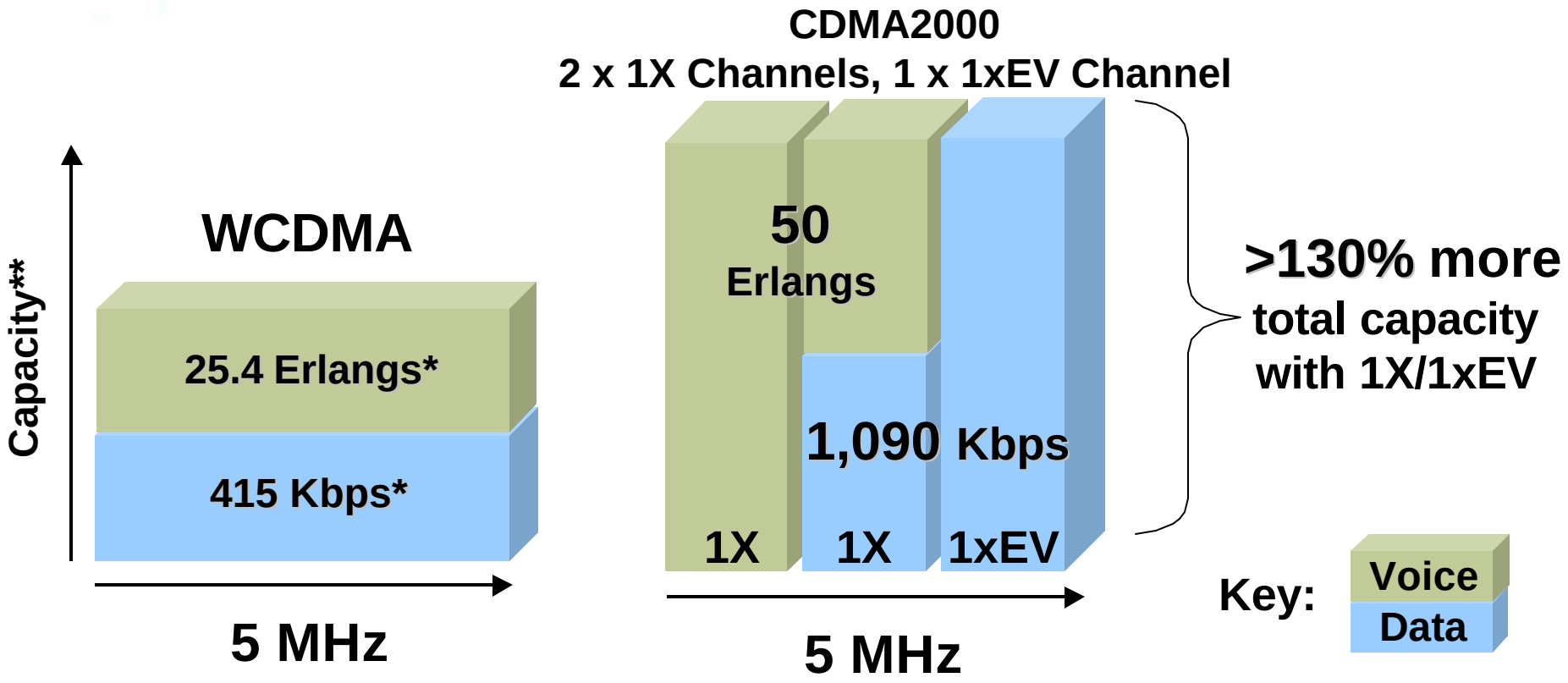
CDMA2000 1xEV further improves the capacity of the 3G network

Scenario 3: 50% Voice, 50% Data



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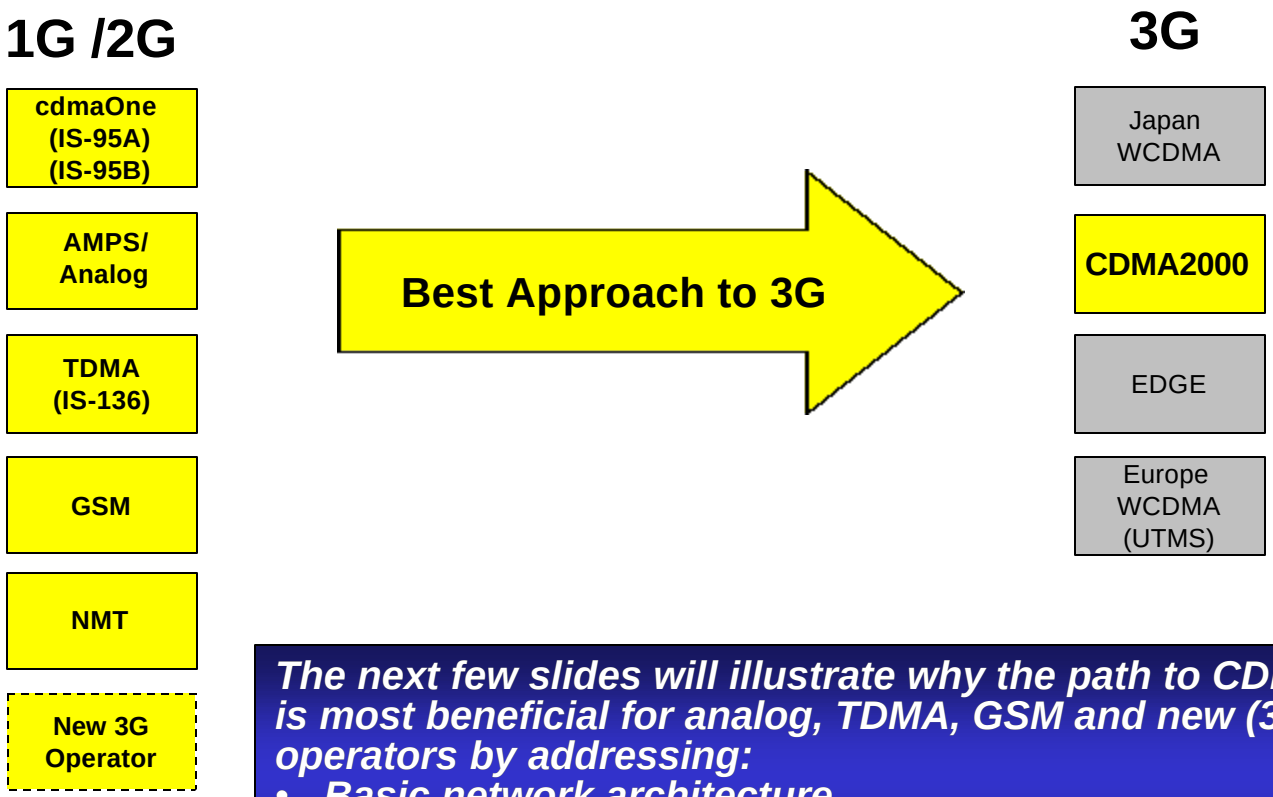
Operators are faced with a few migration alternatives to 3G



The next few slides will illustrate why the path to CDMA2000 is most beneficial for analog, TDMA, GSM and new (3G) operators by addressing:

- ***Basic network architecture***
- ***Ease of migration***
- ***Cost of migration***

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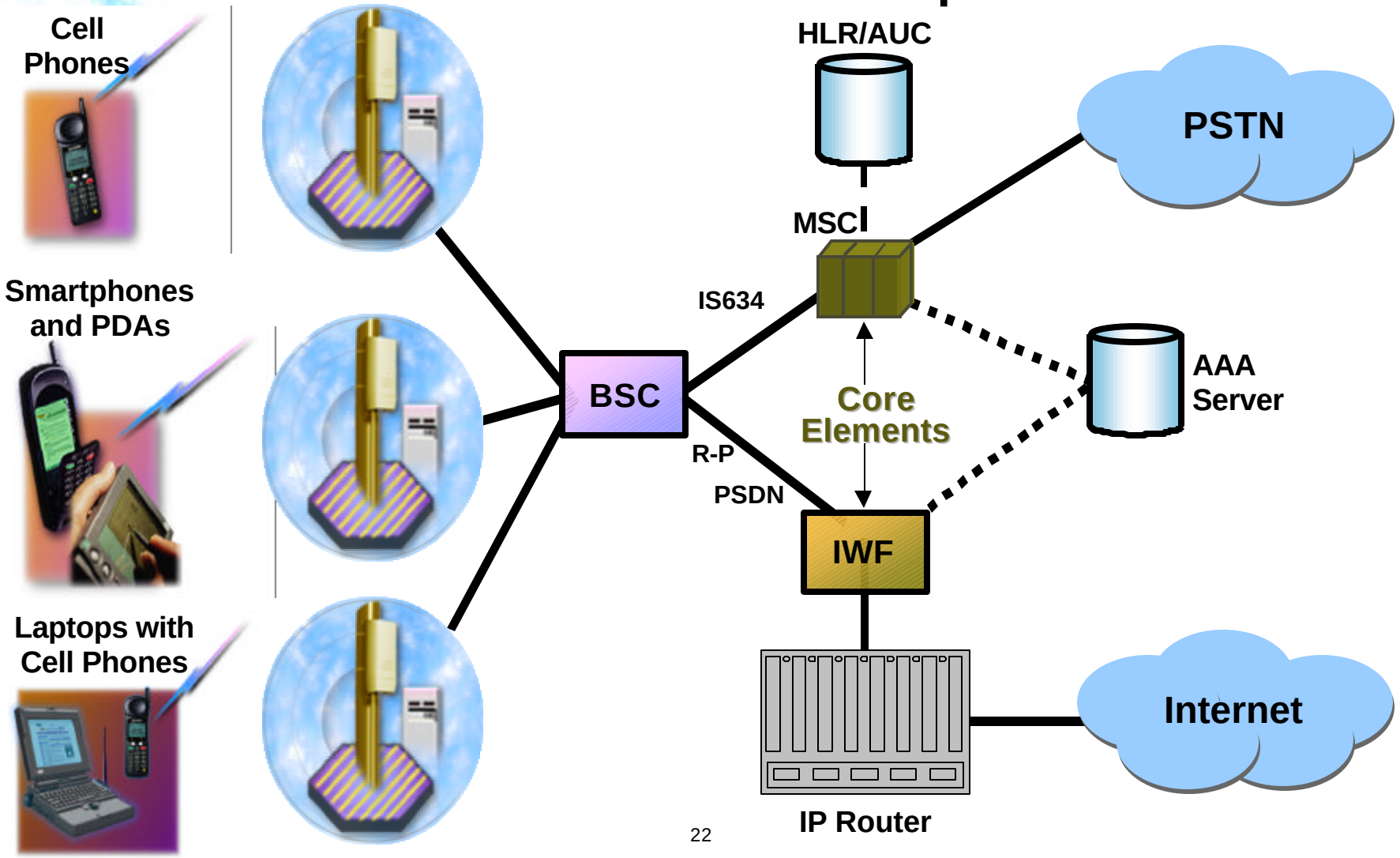
The architecture for CDMA2000 is quite clean



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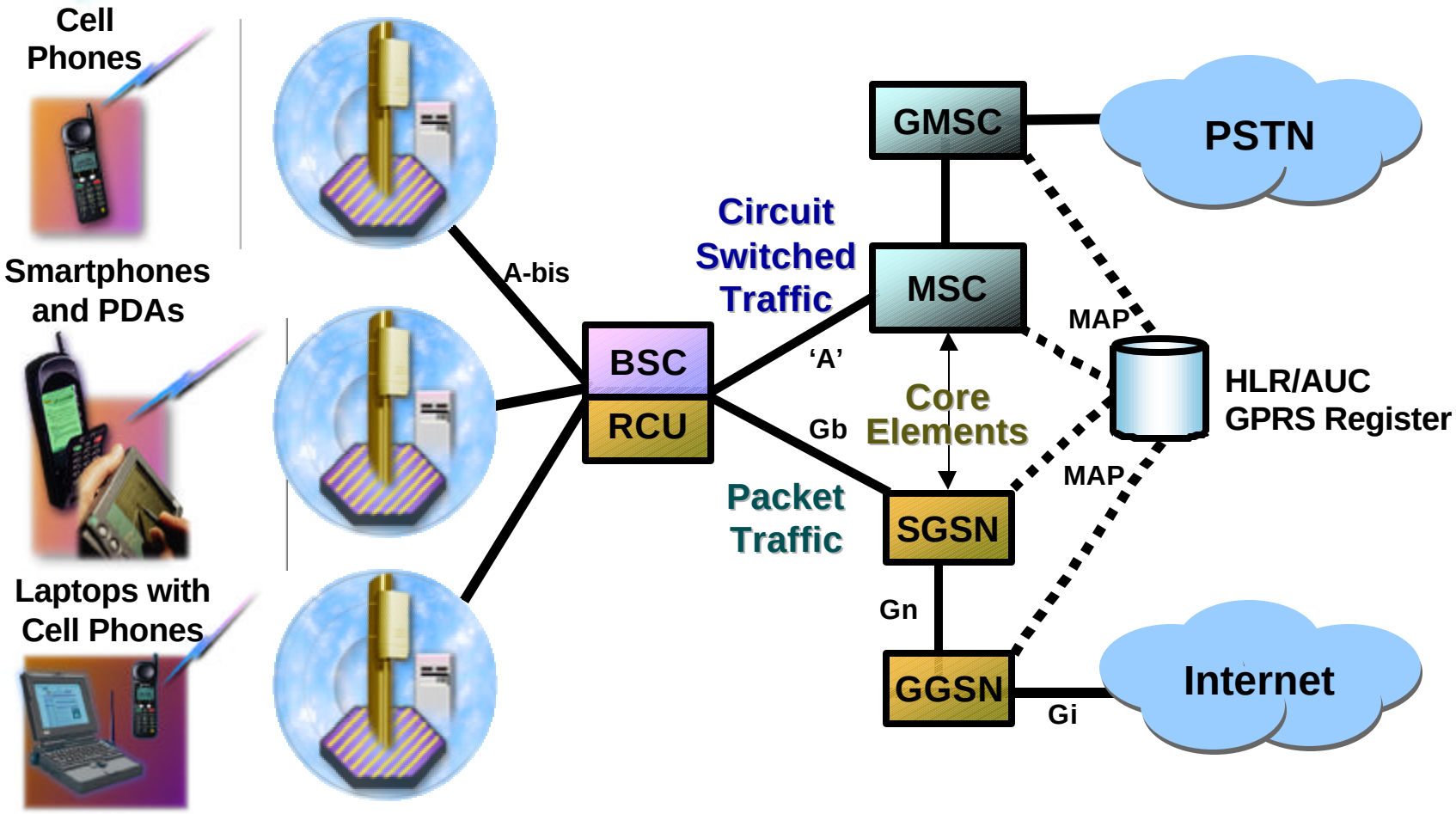
Whereas that for GSM/GPRS/EDGE/WCDMA requires a parallel network of service nodes



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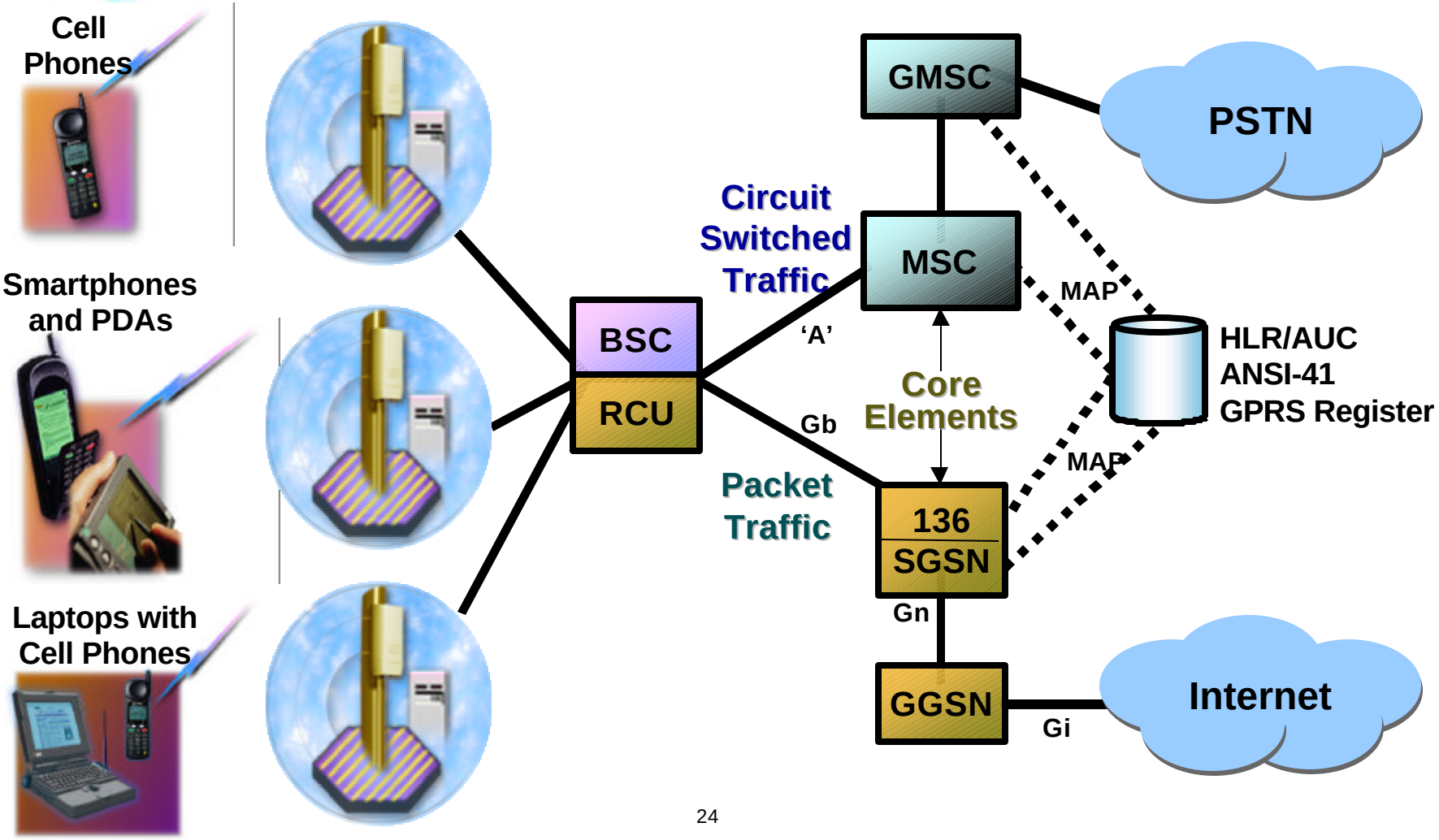
As does the architecture for TDMA/GPRS/EDGE/WCDMA



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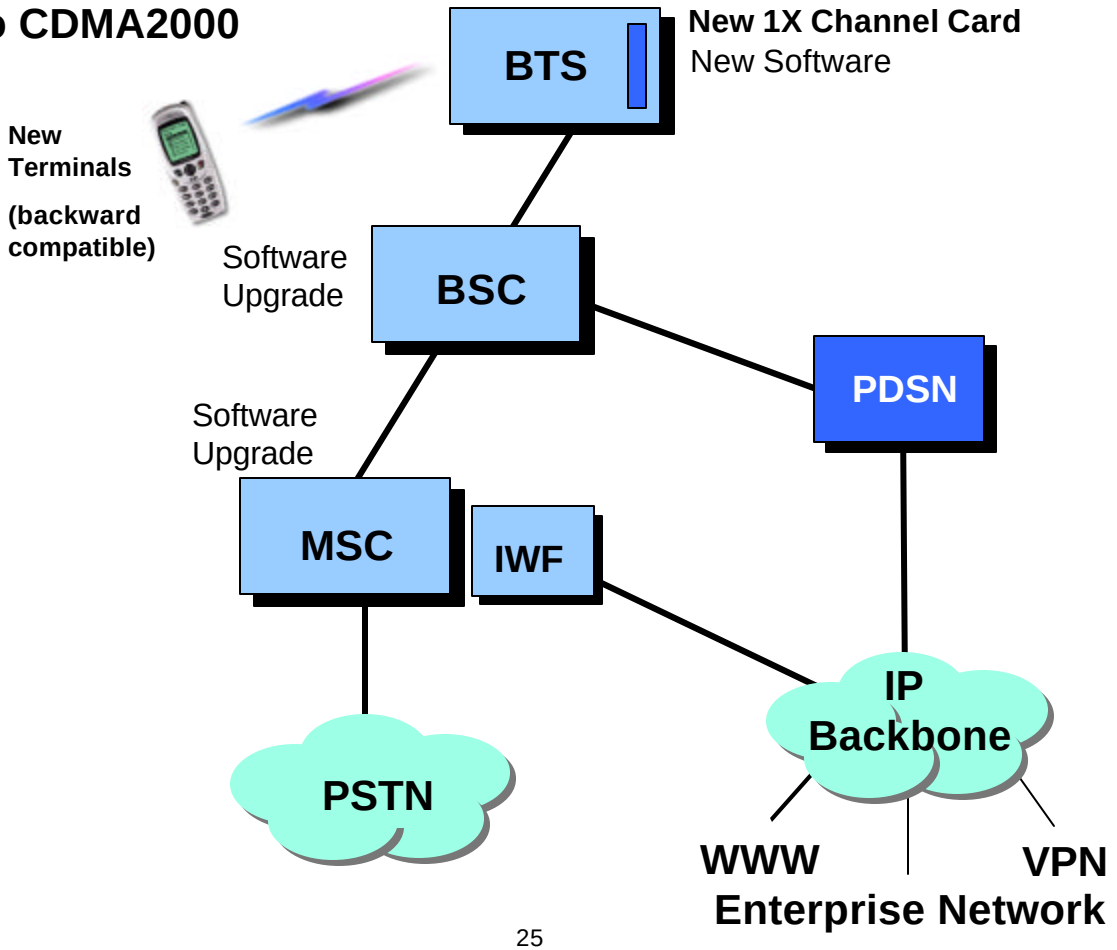
Evolving cdmaOne to CDMA2000 1X is a logical proposition

Evolving to CDMA2000



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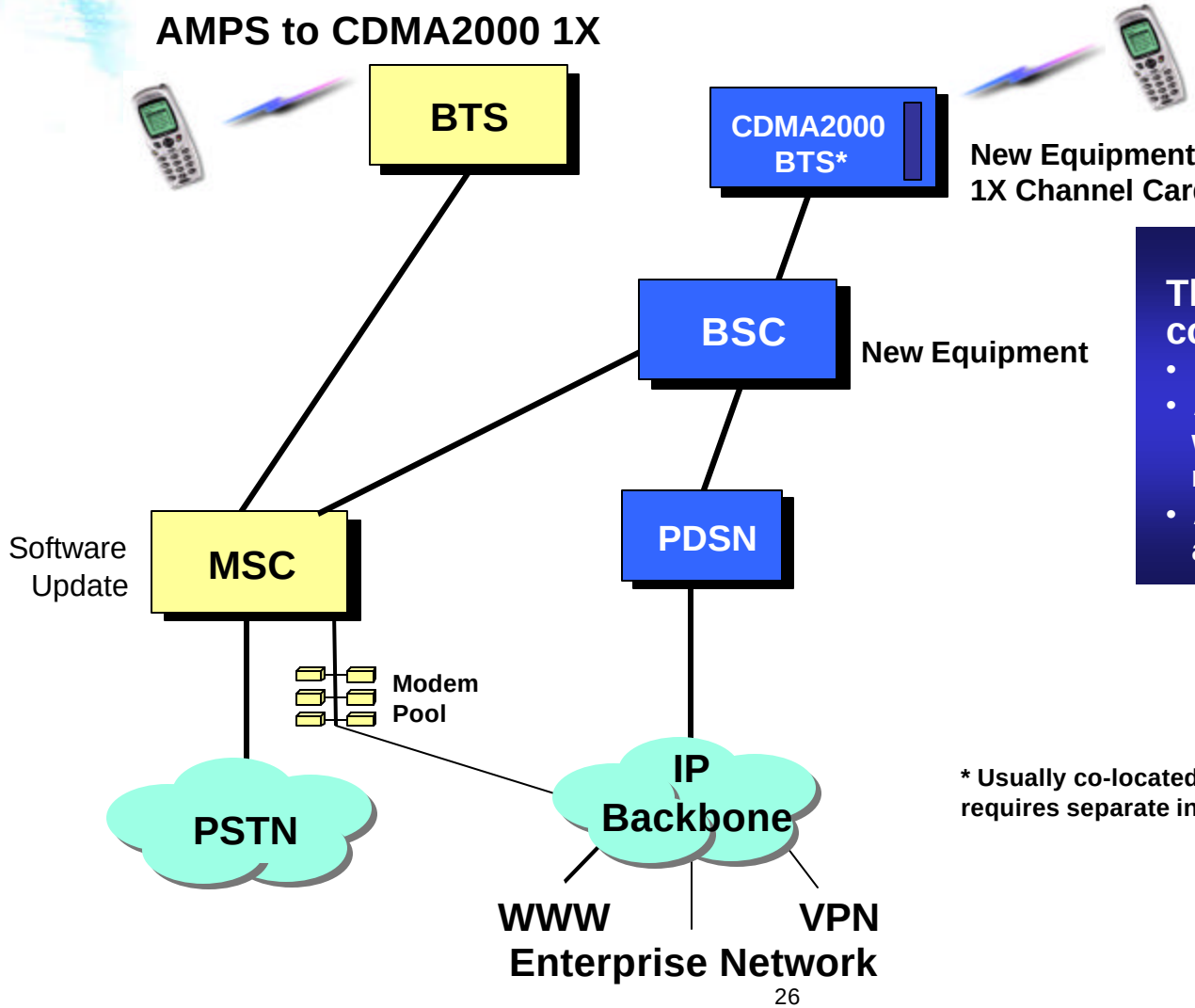
AMPS to 3G: Practical solution to CDMA2000



This path is particularly compelling due to:

- Re-use of the core network
- Ability to deploy 3G in-band, without the cost of buying new spectrum
- Ability to deploy 3G in only a small amount of spectrum

*** Usually co-located with AMPS equipment, requires separate interface protocols**

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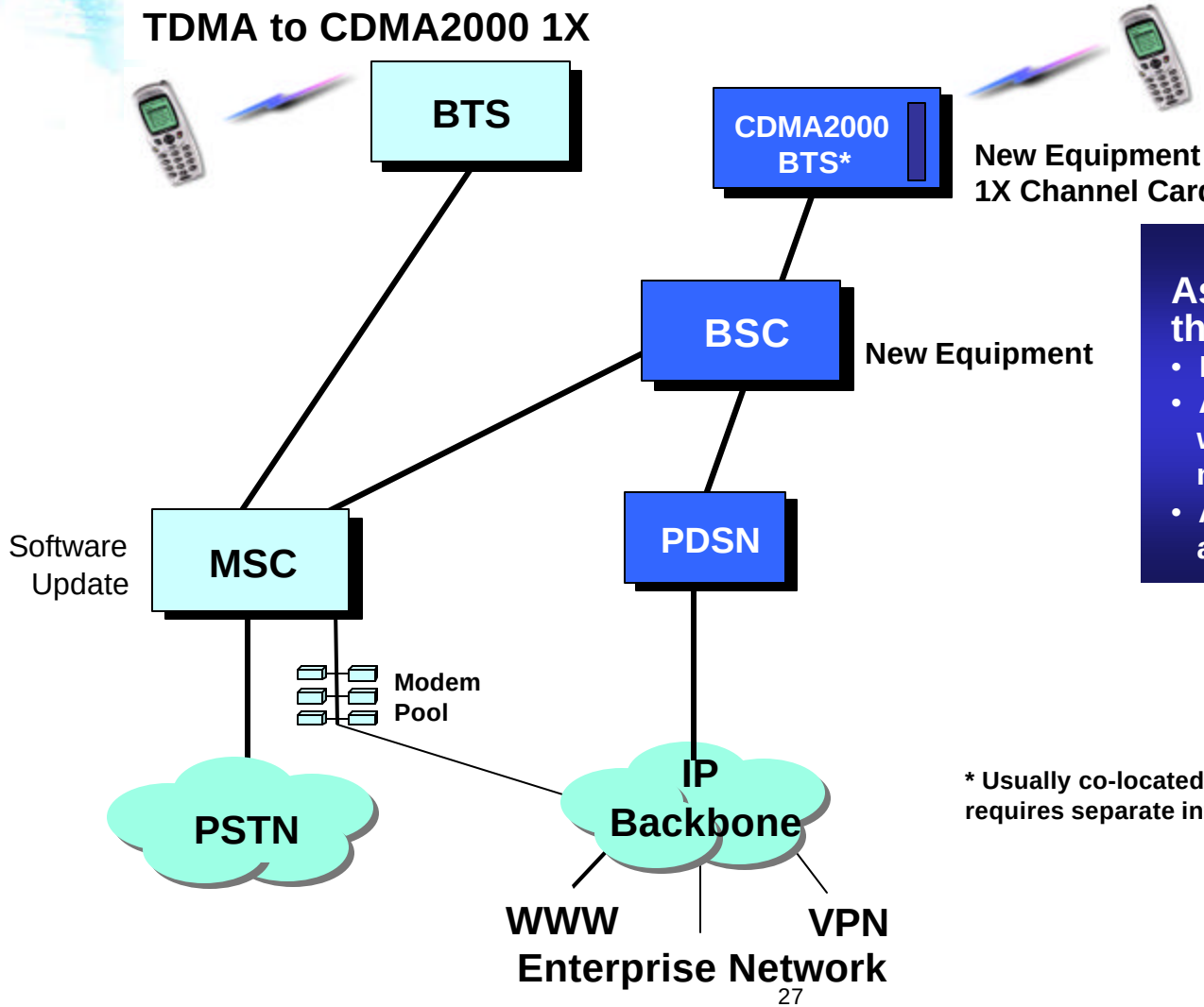
TDMA to 3G: Practical solution to CDMA2000

TDMA to CDMA2000 1X



As with AMPS, benefits of this path include:

- Re-use of the core network
- Ability to deploy 3G in-band, without the cost of buying new spectrum
- Ability to deploy 3G in only a small amount of spectrum

*** Usually co-located with TDMA equipment, requires separate interface protocols**

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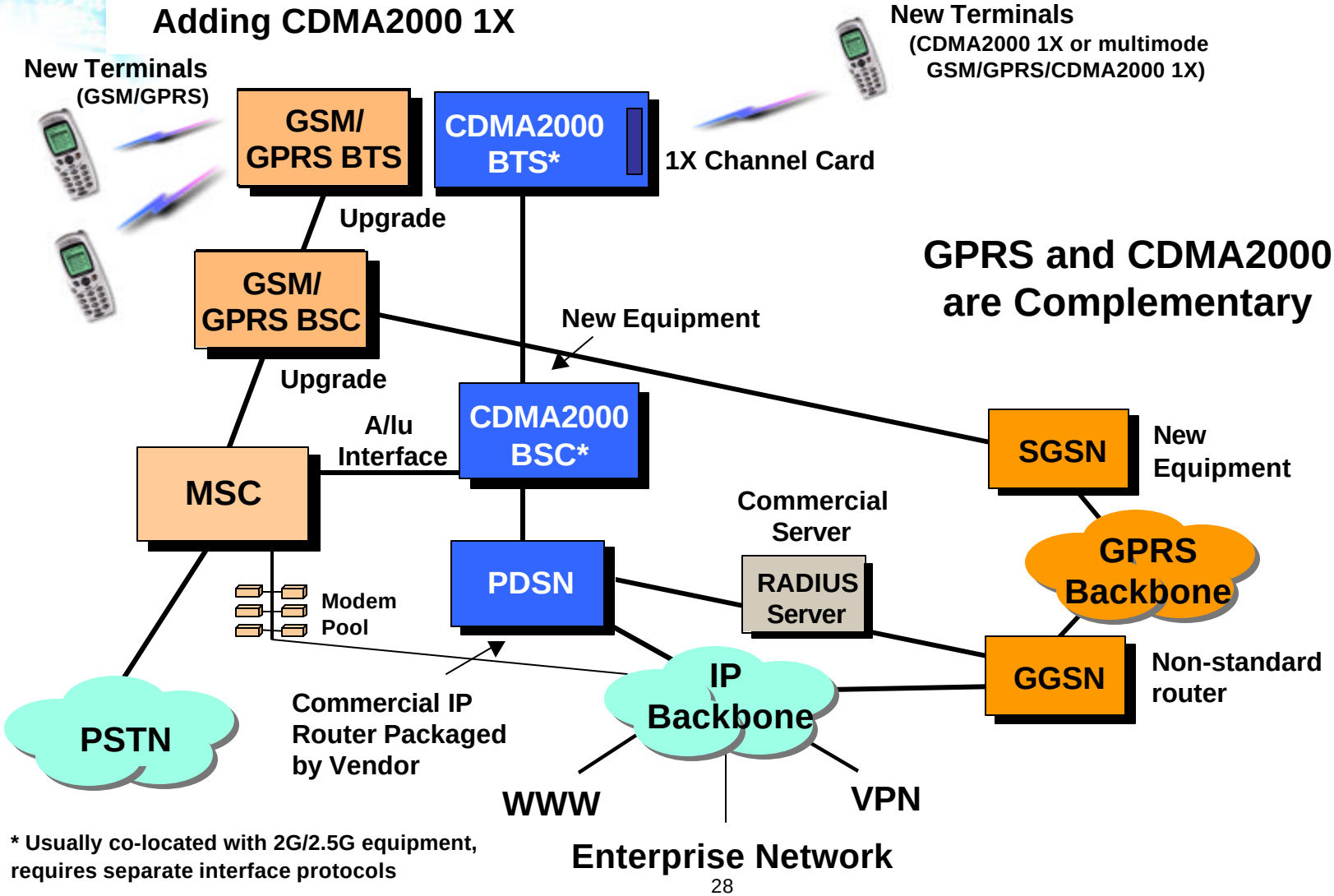
GSM to 3G: Practical solution to CDMA2000

Adding CDMA2000 1X



* Usually co-located with 2G/2.5G equipment, requires separate interface protocols

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Migrating from GSM to CDMA2000 is an attractive evolution to 3G

GSM operators need new spectrum to deploy UMTS

- Many GSM carriers will not have access to new UMTS spectrum

GSM carriers can use CDMA2000 1X-MAP (IS-833) in existing spectrum

- 1X-MAP (IS-833) applies the CDMA2000 radio interface to GSM-MAP networks
  - Allows GSM operators to retain international roaming capability
- 1X-MAP is an ITU standard, developed by 3GPP2 with support from 3GPP
- 3GPP also included changes in Release 99 for 1X-MAP support

CDMA2000 for GSM:

- CDMA2000 1X-MAP (IS-833)
  - CDMA2000 1X lower layers using GSM signaling

Developed by 3GPP2 with support from 3GPP

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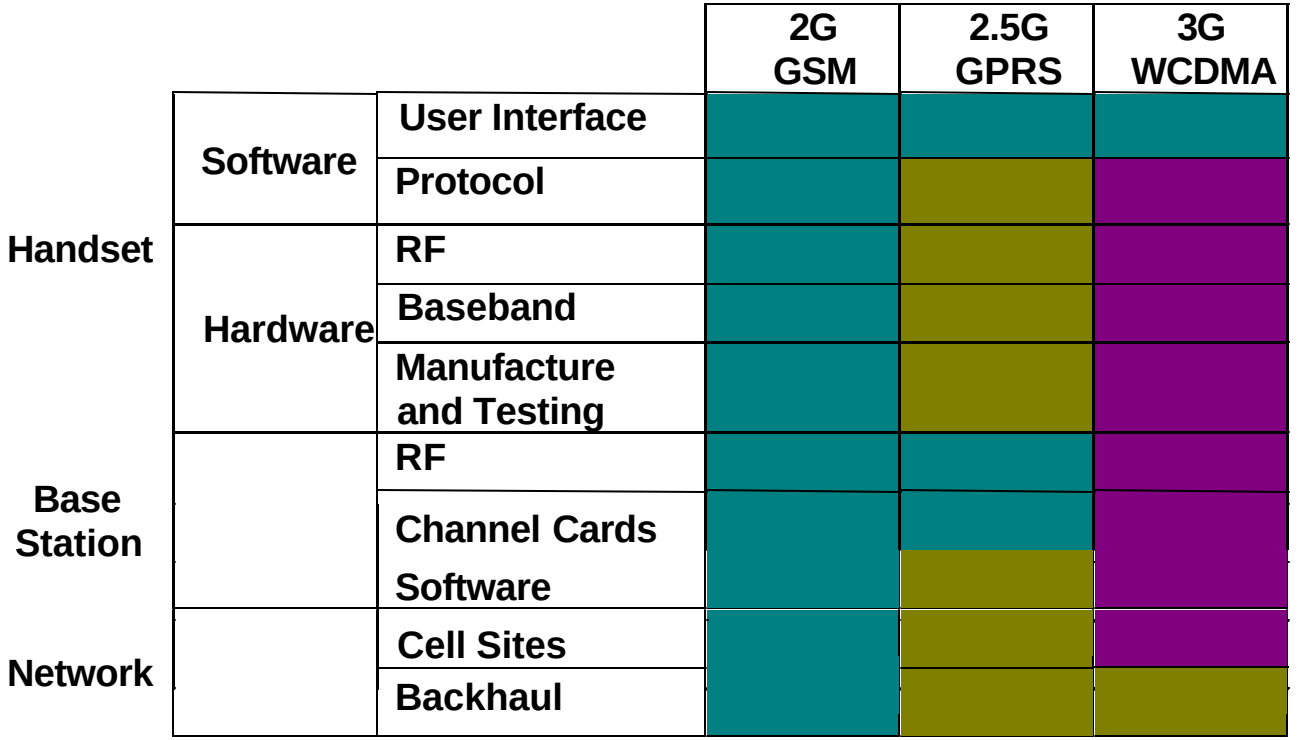
Effort to upgrade GSM to GPRS/WCDMA is quite significant



TDMA and analog operators following the GSM path will have to pay the price of this investment

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On the other hand, effort to go from cdmaOne to 3G CDMA2000 is modest

			2G cdmaOne (95A)	2.5G cdmaOne (95B)	3G CDMA2000
Handset	Software	User Interface			
		Protocol			
	Hardware	RF			
		Baseband			
		Manufacture and Testing			
Base Station		RF			
		Channel Cards			
		Software			
Network		Cell Sites			
		Backhaul			

TDMA and AMPS operators maintain the same core network as cdmaOne operators, and therefore realize the same migration benefit

Generation Independent

Upgrade Required

Chipset change only

New Equipment Required

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✓	Broad range of competitively-priced devices for end users (consumers, enterprises)
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Multiple CDMA2000 terminal products are already available in the market

Samsung SCH-X100

Samsung SCH-X120

Samsung SCH-X110

SK TeleTech IM-2400

Samsung SCH-X130

Samsung SCH-X200

Samsung SPH-X1000

LG Cyber X-1

Samsung SCH-X2000

SK TeleTech IM-2300

Motorola V671C

GTRAN DotSurfer 1X

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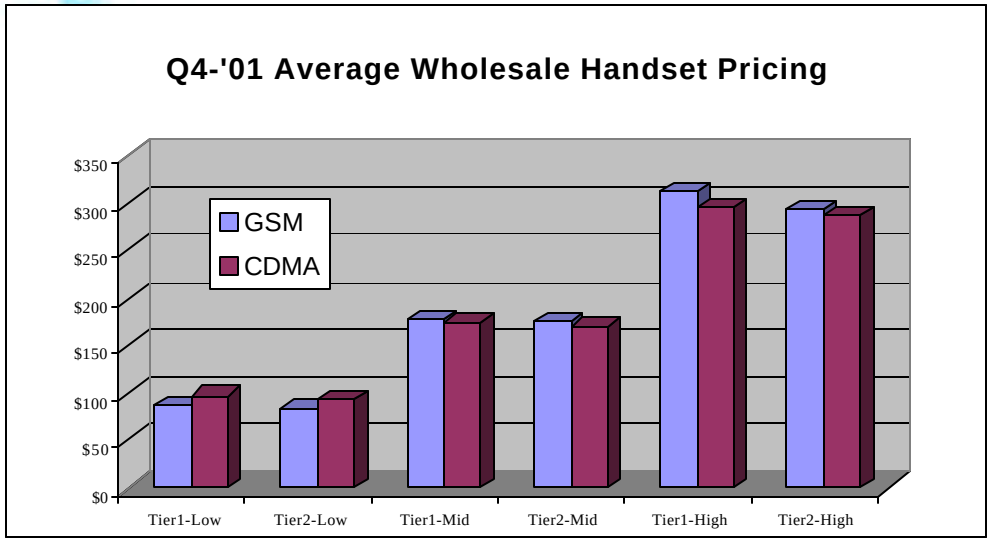
✓	Broad range of competitively-priced devices for end users (consumers, enterprises)
	Broad range of applications for end users

CDMA terminals are reaching price parity with GSM



Source: Gartner Group, April 2001

In a recent study comparing phones from the top tier vendors, CDMA is reaching price parity with GSM and achieving lower prices in some price tiers

Sub-$100 phones are available for cdmaOne and GSM

cdmaOne cost curves and economies of scale directly benefit CDMA2000

Comparison of average unsubsidized wholesale terminal prices from Tier One and Tier Two manufacturers. Grouped by product tier.

	Average*	**High-End Smartphone**
GSM	$186	Nokia 9210 $1407**
CDMA	$188	Kyocera QCP-6035 $499***

Tier 1 vendors: Perceived by the market as supplying the best overall quality for a specified product at a particular price point. The most important characteristic of a Tier 1 vendor is market share. Since Tier 1 vendors normally have a strong brand, they are typically able to levy a premium for their products.

Tier 2 vendors: Regarded as providing mediocre quality for a specified product at a particular price point. Tier 2 vendors do not obtain a premium for their products and will sell them for a price less than that charged by a Tier 1 vendor, even if product specification were similar.

Source: Wholesale Price Analysis of Wireless Devices Report, Gartner Group, April 2001
**Average Price - Source: Nokia*

***Retail Price - Source: Orange:*
http://www.the order.co.uk/orange_contract/Orange_nokia_9210_contract.asp
****Retail Price - Source: Verizon Wireless*

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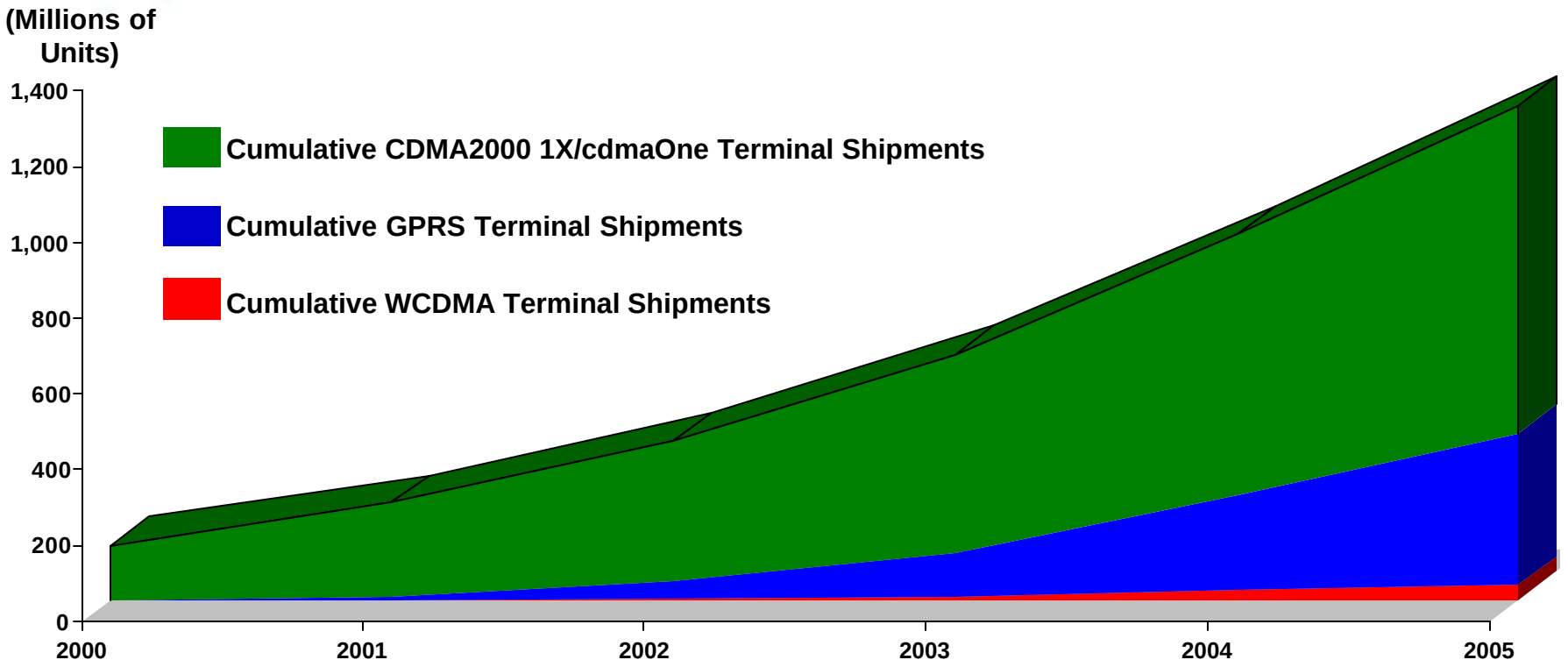
CDMA2000 terminals have a time-to-market advantage...



Sources: EMC World Database, June 2001 and Marcus Evans, March 2001

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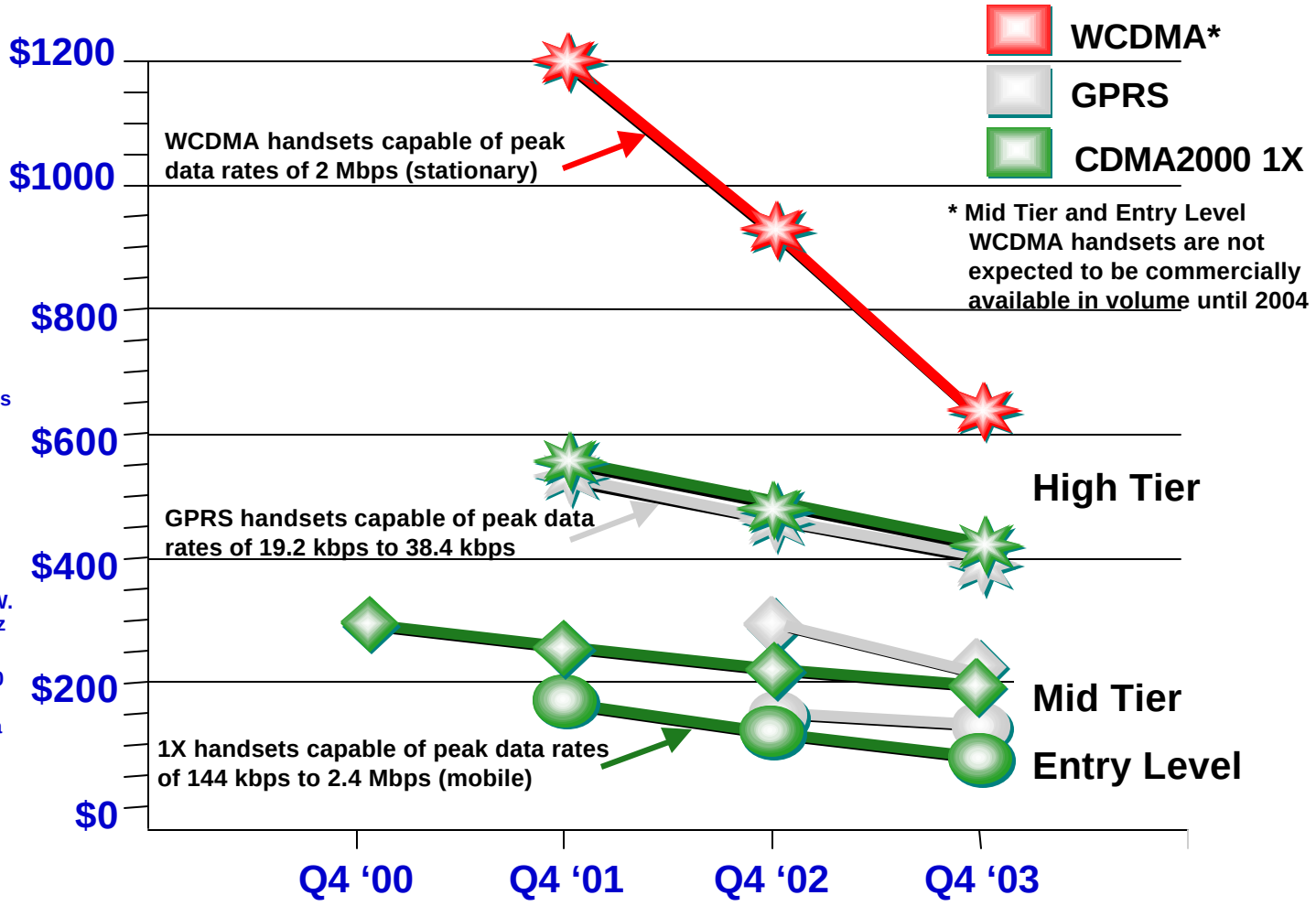
…that will translate to better economies and pricing



Notes:

- Average Q4 wholesale pricing for CDMA2000 is based on 300,000 unit shipments.
- WCDMA pricing is based on smaller volume shipments since Gartner does not expect volume order for WCDMA until after 2003.
- WCDMA pricing represents single mode 2.1 GHz and multimode dual band terminals for W. Europe and Asia.
- GSM/GPRS pricing represents 900 MHz and 900/800 MHz terminals for W. Europe and Asia, plus GSM 1900 MHz terminals for N. America.
- CDMA2000 1X pricing represents 800 MHz and 1.9 GHz, single mode, dual mode and tri-mode handsets for Asia and N. America.

Source: Gartner Group, April 2001

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Handset pricing and availability

By 2002, the difference in the average wholesale price for entry-level CDMA and GSM handsets will be approximately $10

The difference between the average wholesale price for mid-tier and high-tier CDMA and GSM handsets is negligible

In 2001, users will be able to purchase 3G CDMA2000 handsets at an average wholesale price that is less than 2.5G GSM/GPRS handsets

In 2001, users will be able to purchase CDMA2000 handsets at an average wholesale price significantly less than WCDMA handsets

Low-end 3G capable CDMA2000 handsets will be available more than four years ahead of mid-tier and low-end WCDMA handsets

Source: Gartner Group, April 2001

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Handset migration is another key consideration in the success of 3G

GSM

GSM roadmap is discrete with no forward and backward compatibility

CDMA

CDMA terminals are fully forward and backward compatible

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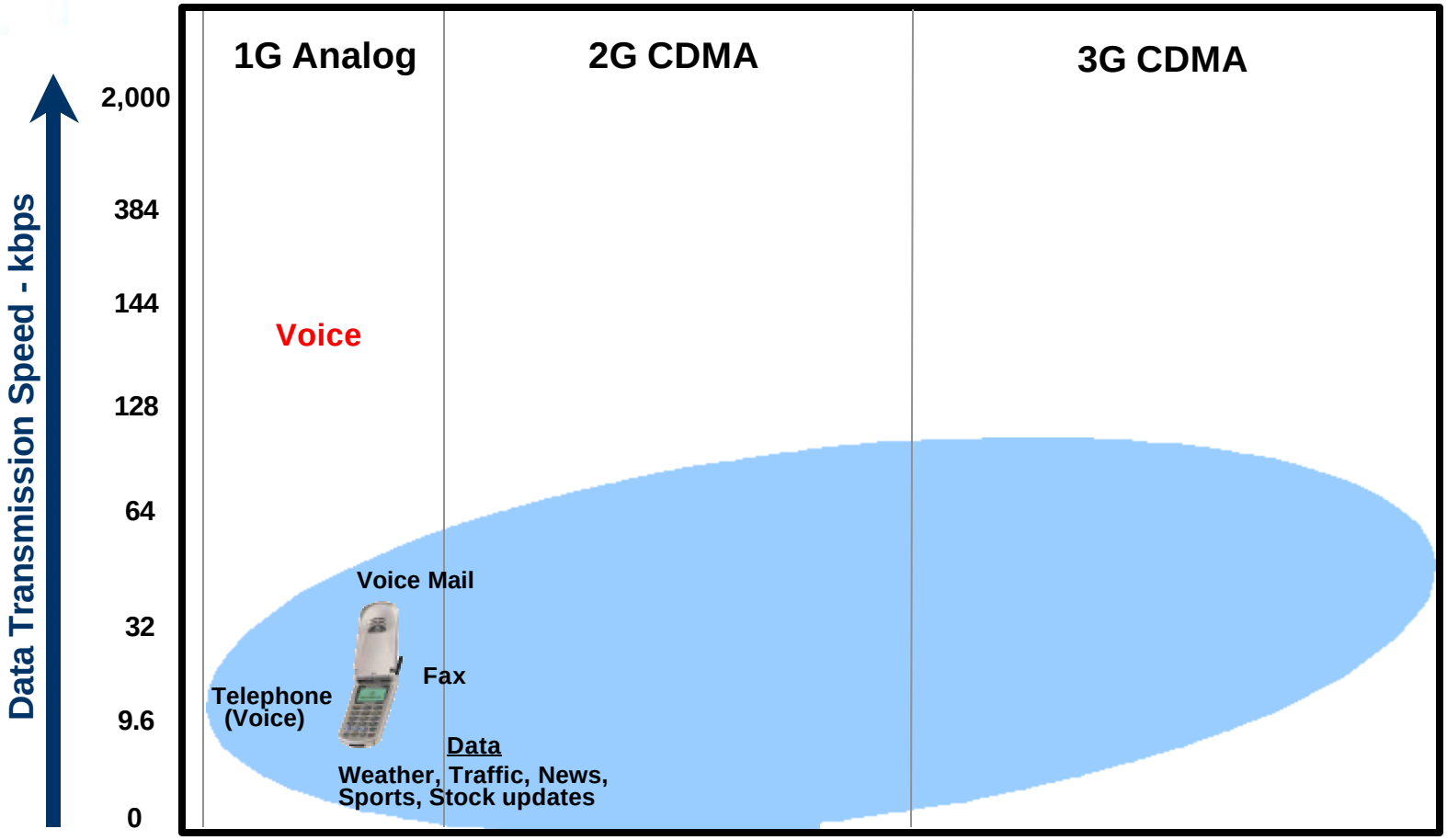
CDMA enables the kind of capabilities needed to realize significant advancements in services...



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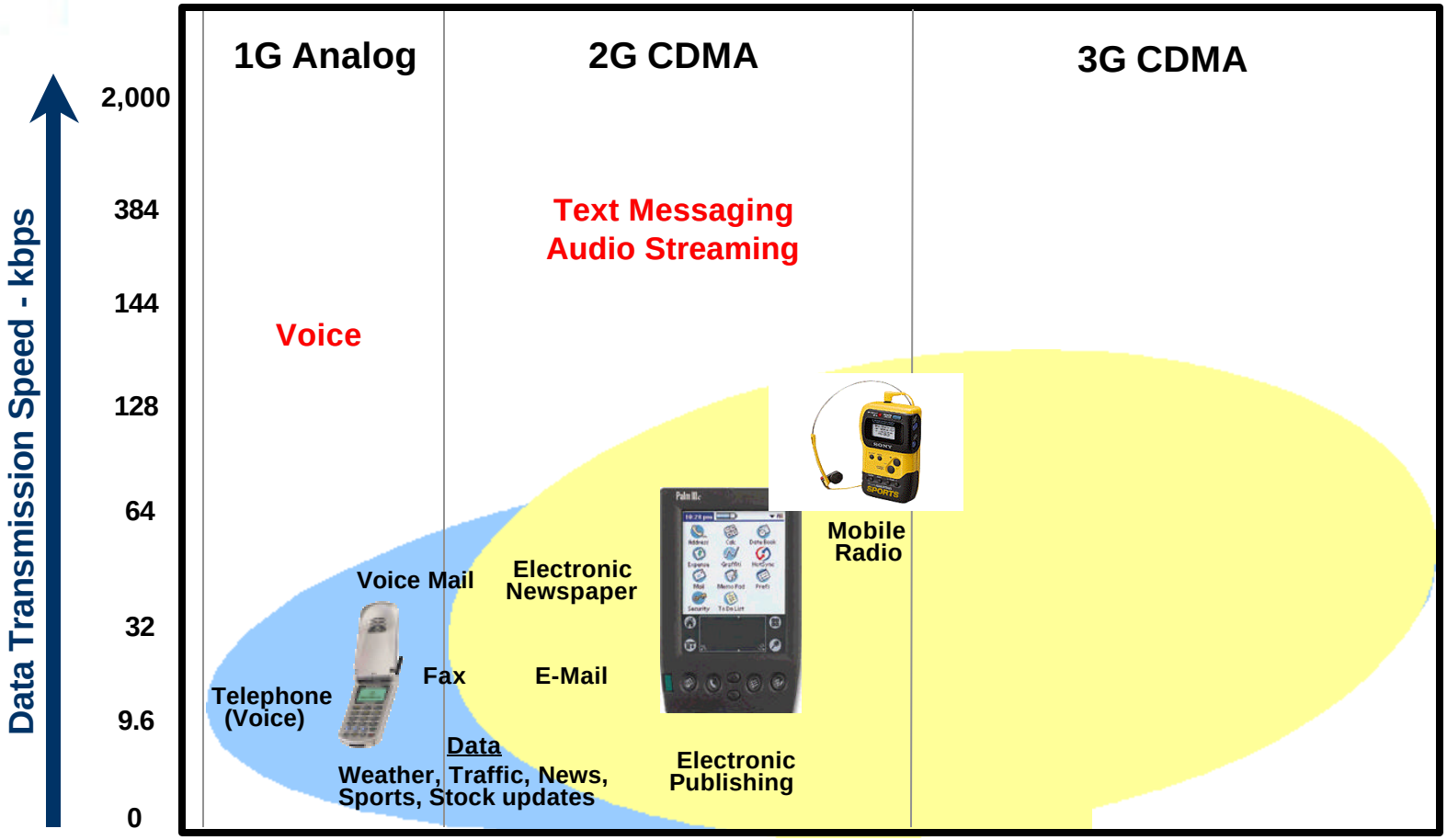
CDMA enables the kind of capabilities needed to realize significant advancements in services (cont.)



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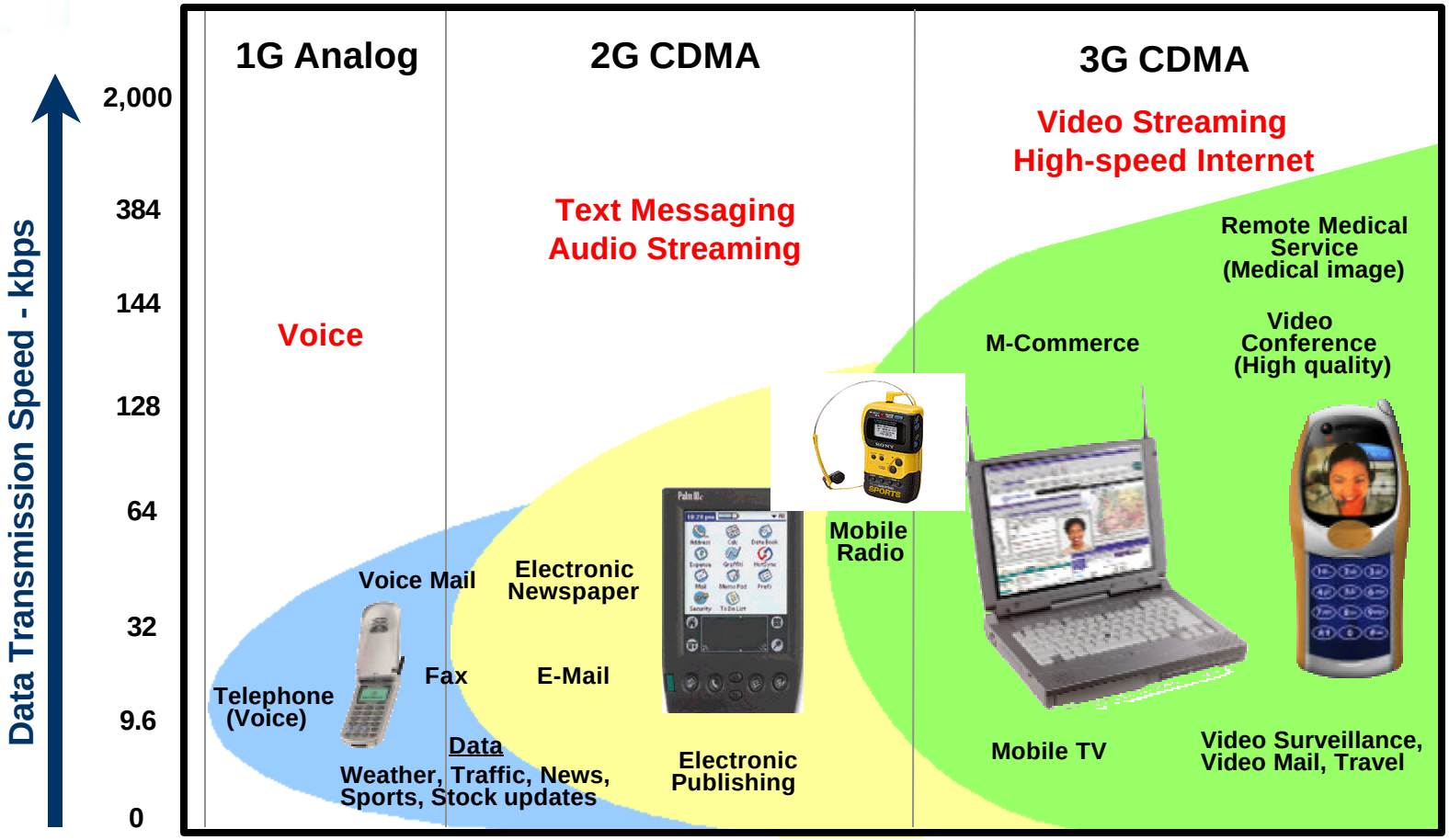

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…and significantly enhances the user's wireless experience

Approximate transfer times for a 3 minute MP3 song file

Tx Standard	Data Rate	Download Time	Commercial
GSM	9.6 kbps	2466 (41 minutes) ouch!	Commercial
cdmaOne (IS-95A)	14.4 kbps	1852 (31 minutes)	Commercial
GPRS	45 kbps	526 (8.8 minutes)	Commercial
cdmaOne (IS-95B)	56 kbps	417 (7 minutes)	Commercial
WCDMA phase 1	56 kbps	417 (7 minutes)	??
CDMA2000 1X	307 kbps	77 (1.3 minutes)	Commercial
WCDMA phase 2	306 kbps	77 (1.3 minutes)	2004+
CDMA2000 1xEV	2-5 Mbps	13-6 (0.2-0.1 minutes)	2002

Myths and Facts

Some common myths and facts about 3G

Myth	Fact
WCDMA will experience far better economies of scale (compared to CDMA2000)	CDMA2000 economies will be significant, yielding comparable benefits of scale
CDMA2000 will be limited to the US	CDMA2000 has already been deployed in Korea, and will be deployed in Japan, the US, Canada, Mexico and Brazil in 2001
GSM/GPRS/WCDMA is the default migration path for TDMA operators	TDMA operators, since they use the same core network as CDMA operators, can migrate much more easily to CDMA2000 from TDMA today
CDMA2000 1X is 2.5G	CDMA2000 1X is an approved, IMT-2000 3G standard
CDMA2000 can only be deployed by current CDMA operators	CDMA2000 can be deployed by any operator
CDMA2000 deployments will be "islands" of service	Today's CDMA networks have full roaming capability, and CDMA2000 will be compatible with current and future systems to connect worldwide systems

Some common myths and facts about 3G (cont.)

Myth	Fact
3G is still some time off	CDMA2000 is commercially deployed; UMTS will likely not be deployed until 2004
3G systems can only be deployed in the 2GHz band	CDMA2000 can be deployed in any band, including the IMT band
Korea, a cornerstone of 2G CDMA, is going to WCDMA	Korea has already commercially deployed CDMA2000, and will have deployments in PCS, cellular and IMT bands
Japan will deploy a fully capable, WCDMA system in May 2001	NTT DoCoMo has delayed their deployment of WCDMA from May to October, but will likely roll out a 64 kbps service. KDDI, using **cdmaOne**, has had 64 kbps packet data service since early 2000.
All flavors of WCDMA are the same	WCDMA for Japan and Europe have different technical parameters, impacting roaming, interoperability, etc.

Summary

Summary

The wireless industry is on the verge of enabling applications and services never before imagined

Operators are faced with different alternatives for enabling these capabilities with 3G systems

In the end, certain factors are critical to determining which alternative is most beneficial, including:

- Global recognition of the technology
- Viability of the technology, and ability to deliver
- Flexibility in solutions
- Cost competitive solutions
- Broad range of products and applications

CDMA2000 is delivering on 3G, and addresses these factors

Appendix

Abbreviations and acronyms

3G-GGSN	Gateway GPRS Support Node + UMTS upgrade
3G-SGSN	Serving GPRS Support Node + UMTS upgrade
3GPP	3rd Generation Partnership Project
3GPP2	3rd Generation Partnership Project 2
AAA Server	Authentication, Authorization, and Accounting Server
A-bis	Interface between BSC and BTS
A Interface	Interface between GSM MSC and BSS
AMPS	Advanced Mobile Phone System
BSC	Base Station Controller
BTS	Base Transceiver Station
CDMA	Code Division Multiple Access
DECT	Digital European Cordless Telecommunications
EDGE	Enhanced Data Rates for Global Evolution
FDMA	Frequency Division Multiple Access
Gb Interface	Interface between SGSN and BSS
GGSN	Gateway GPRS Support Node
Gi+ Interface	Interface between 3G-GGSN and Data Networks
Gn Interface	Interface between SGSN and GGSN
Gn+ Interface	Interface between 3G-SGSN and 3G-GGSN
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
HLR/AUC	Home Location Register/Authentication Center
IP-Router	Internet Protocol Routers
ITU	International Telecommunications Union
IWF	Interworking Function

Abbreviations and acronyms (cont.)

kbps	Kilobits per second
Iu-bis	Interface between RNC and Node B
Iu CS	Interface between 3G-MSC and RNC for Circuit Switched traffic
Iu PS	Interface between 3G-SGSN and RNC for Packet Switched traffic
Mbps	Megabits per second
MAP	Mobile Access Protocol
MSC	Mobile Switching Center
Node B	Group of WCDMA cells (~BTS)
NMT	Nordic Mobile Telephone
PDA	Personal Digital Assistant
PDSN	Packet Data Serving Node
PSTN	Public Switched Telephone Network
RF	Radio Frequency
RNC	Radio Network Controller (~BSC)
R-P Interface	Interface between Radio Access Network (RAN) and PSDN
SGSN	Serving GPRS Support Node
TDMA	Time Division Multiple Access
TD-SCDMA	Time Division - Synchronous Code Division Multiple Access
UMTS	Universal Mobile Telephone System
UTRA TDD	Universal Terrestrial Radio Access Time Division Duplex
VPN	Virtual Private Network
WCDMA	Wideband Code Division Multiple Access