

# Wireless Village: Providing Rural Connectivity with CDMA2000

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ITU-BDT Regional Seminar: BWA for Rural and Remote Areas in  
Africa  
Yaoundé, Cameroon  
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# CDMA Development Group

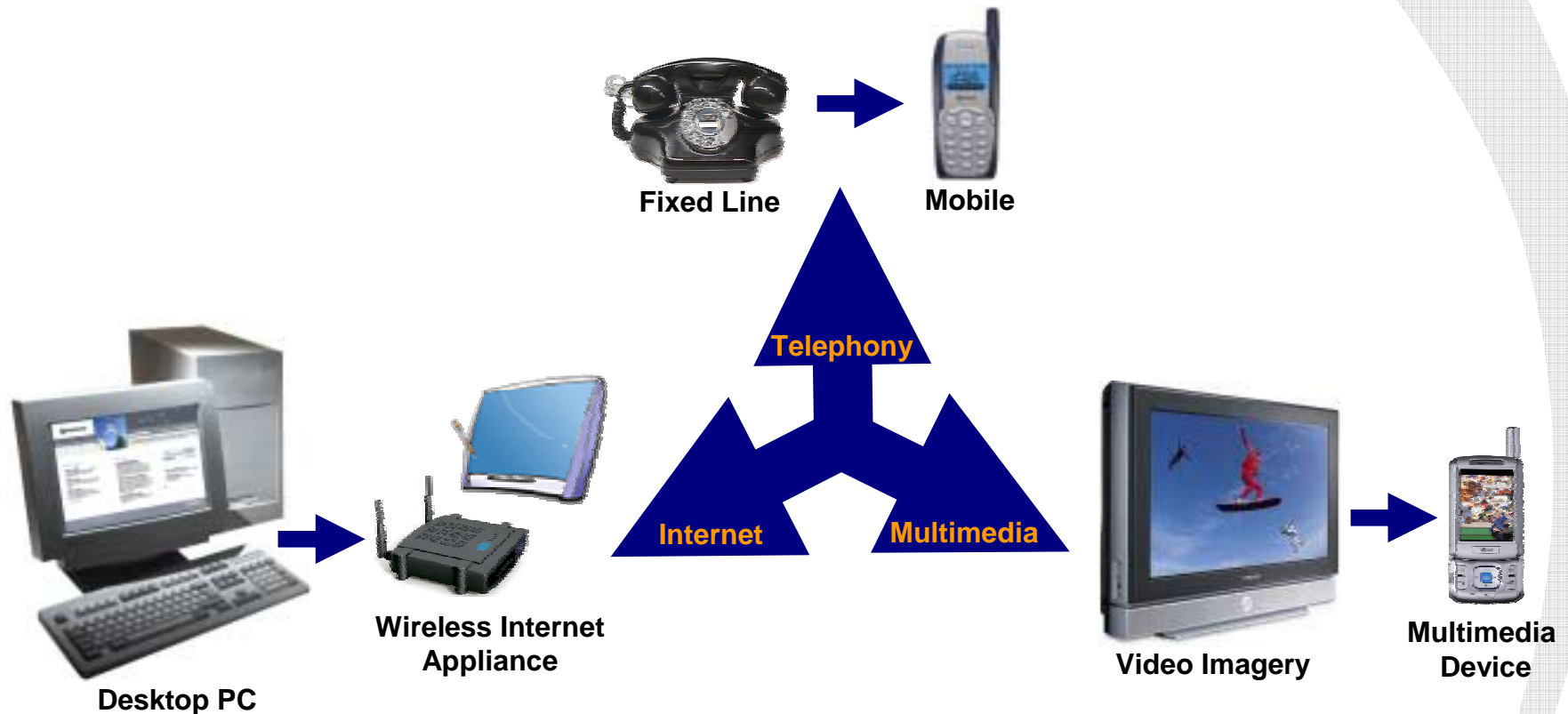
- The CDMA Development Group (CDG), founded in December 1993, is an international consortium of companies who have joined together to lead the adoption and evolution of 3G CDMA wireless systems around the world
- The CDG is comprised of CDMA service providers and manufacturers, application developers and content providers
- CDG's Mission:

To lead the rapid evolution and deployment of 3G CDMA-based systems, based on open standards and encompassing all core architectures, to meet the needs of markets around the world.

- More info: [www.cdg.org](http://www.cdg.org)

# Rural Communications

*Offering telephone, Internet and multimedia access to rural areas without wires*



Providing affordable telephony, Internet, and multimedia access to large coverage areas that have a low population density (< 100 Pops/sq. km.)

# CDMA2000® : The Leading 3G Standard

*CDMA2000 leads the industry in affordable and advanced wireless services*

- **CDMA2000 has a robust and long-term technology roadmap**
  - 2-3 year lead in the commercialization of 3G and mobile broadband data services
  - Integrates several air links in its evolutionary roadmap: CDMA, TDM, OFDM, and OFDMA
  - Will be the first to offer:
    - Multimode OFDMA and OFDM multicast services to deliver content
    - VoIP and other delay sensitive services across 3G networks
  - Will remain ahead in the evolution towards All-IP networks
- **CDMA2000 has a strong and healthy ecosystem of vendors, products, and services with a wide selection of:**
  - Competitive devices from many suppliers
  - Chipsets and software from several suppliers
  - Infrastructure suppliers
  - Revenue-generating applications and services
- **CDMA2000 generates positive results for operators, driving subscriber growth and ARPU**
  - Broadband Internet access, content and application downloading, position location, multicasting, etc.
  - Lowest cost per minute, message, and megabyte

# CDMA2000 Rural Communications

*CDMA2000 offers the best solution for rural communications*

- **CDMA2000 is an affordable rural communications solution that offers:**
  - Carrier-grade telephony, broadband Internet, and multimedia access
  - Large coverage areas
  - Centralized and distributed IP-based core networks
  - A broad selection of affordable devices
  - A broad selection of services
  - The lowest cost per minute, message, and megabyte
  - Network flexibility and scalability
  - Privacy and security
  - Rapid deployment
  - Robust and future-proof technology roadmap
  - Large economies of scale
  - Reliable and mature

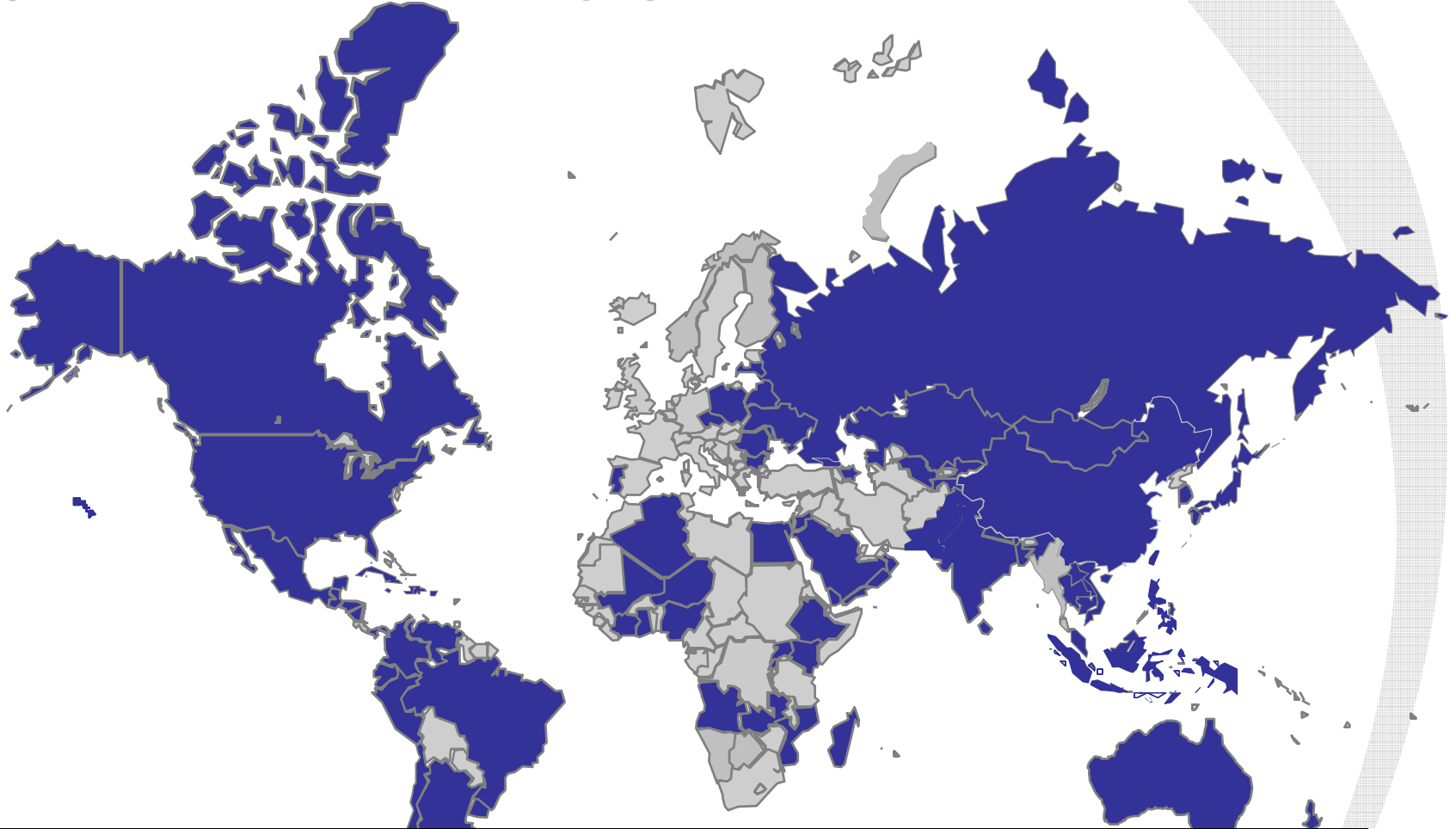
**CDMA2000 is bridging the digital divide**

# **CDMA2000 Rural Deployments**



# Nearly 200 operators have selected CDMA2000

*Many CDMA2000 networks are deployed in rural markets*



**Over the past 3 years, 126 new operators in over 60 countries have selected CDMA2000**

# CDMA2000 Rural Market Testimonials

## *Bridging the “Digital Divide”*

### Sri Lanka Telecom

“Sri Lanka Telecom’s CDMA service, I believe, will be **an important enabler in eliminating the digital divide in the country.**”

CEO Shuhei Anan, Sri Lanka Telecom

October 16, 2005

### Jamano

“**Fixed Wireless Technology (CDMA) or “Jamano” will go a long way in bridging the digital divide ...** between the Gambia and developed countries and between our rural and urban areas, yet avoid the high costs inherent in developing fixed line infrastructure.”

SOS for Communication, Information and Technology Nenneh Macdouall-Gaye

[http://www.statehouse.gm/july22celebration\\_25/index.htm](http://www.statehouse.gm/july22celebration_25/index.htm)

March 27, 2005

### Y’elloline

World over, the CDMA2000 technology deployed by MTN is **the most widely used wireless technology in the 800 MHz band.**

Wireless signals travel further at lower frequencies; thus a cell site at 800 MHz covers more geography than a GSM 1800 or 1900 MHz site; for example using CDMA2000 deployed by MTN, a single site has a radius of up to 29.4 KM at 800 MHz and 13.3 KM at the GSM 1900 MHz frequency. The implication of this is fewer cell sites deployed to cover an area, hence lower deployment and maintenance costs; this advantage is passed on to our valued customers in form of reduced costs.

MTN Uganda, <http://www.mtn.co.ug/business/cdma2000.htm>

### Algeria Telecom

CDMA2000 Wireless local loop (WLL) technology, for example, which is well suited to Algeria's rough, mountainous terrain, can be provided by Chinese firms for **as little as \$10 a connection.**

Oxford Business Group,

<http://www.oxfordbusinessgroup.com/weekly01.asp?id=1989>

May 15, 2006

# CDMA2000 Rural Market Vendor Quotations

*Serving the "Most Remote Places on Earth"*

## Timbuktu

Calling Timbuktu is a "**byword for the most remote places on Earth**," ZTE said it will provide WLL equipment based on CDMA (Code Division Multiple Access) 2000 1X wireless technology to expand the telephone network in Mali's capital, Bamako, and extend access to other cities, including Timbuktu.

WLL technology allows operators to offer telephone service without having to build a fixed-line infrastructure to handle calls. The technology is particularly suited to countries like Mali, where **population density is low and spread out over a large area**.

ZTE Technologies

February 9, 2006

## Algeria Telecom

Algeria Telecom extends its fixed access services to a mobility capability for 520,000 subscribers, adding 30% to its fixed network capacity. This **greatly eases the high demand for fixed network resources**.

Huawei Technologies

## Yemen Telecom

In June 2005, 2.5 years after launching, the number of Yemen Telecom's CDMA subscribers exceeded 180,000 and **the ARPU value each month exceeded US\$20 per month**.

Huawei, <http://www.huawei.com/products/cdma2k/app/view.do?id=74>

### Yemen



### Algeria



# CDMA2000 is fulfilling Universal Service Obligations

*Connecting Citizens to telephone and Internet services*

Rainbow Chalta Firta PCO

- In **India**, Reliance is fulfilling universal service obligations by providing 3G service to 48,310 villages that don't have public phone facilities<sup>1</sup>
- In **India**, Shyam Telecom equipped a fleet of around 200 self-employed rickshaw drivers with a mobile calling office, including fax<sup>2</sup>
- In the **Dominican Republic**, Tricom deployed over 1,700 public pay phones in underserved rural areas. These phones will eventually be used for high-speed Internet access<sup>3</sup>
- In **Brazil**, Anatel demonstrated universal broadband (800 kbps @ 45km) access in the rural areas of Brasilia
- In **Uganda**, MTN provides 3G voice and data services to villagers in rural areas<sup>4</sup>



1. <http://www.thehindubusinessline.com/2004/09/20/stories/2004092002090100.htm>  
2. <http://www.hellorainbow.com/aboutus.asp>  
3. BNAmericas.com, "GEC-Tel, Tricom Partner for wireless Network – Dominican Republic, November 20th, 2004  
4. [www.mtn.co.ug](http://www.mtn.co.ug)

# CDMA2000 Coverage

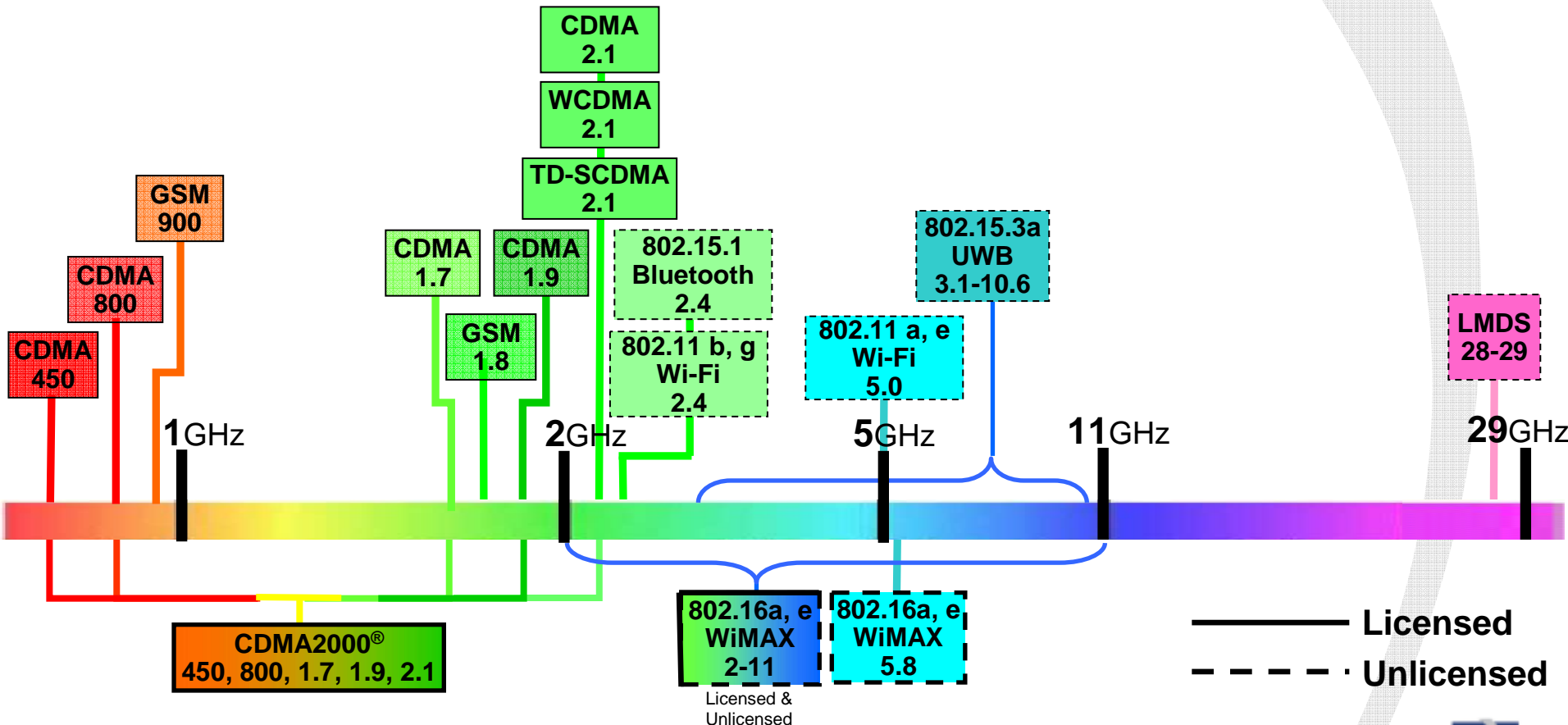


# Spectrum Allocations

*Providing affordable, ubiquitous coverage is crucial in mobile communications*

**The warmer (lower) frequencies are best!**

Greater range (larger coverage areas), less cell sites, better in-building penetration, better mobile performance, less power consumption, higher average data throughputs in an NLOS environment



Using the lower frequency bands is preferable for providing Universal Access for voice communications, Internet access, and multimedia services

# CDMA2000 Theoretical Coverage

*Using RF propagation to its best advantage to serve humanity*

- **Reverse link determines coverage:**
  - The reverse link is used to compare the coverage of different technologies
- **Link budget determines available margin required to achieve a high quality link**
- **Differences in coverage is affected by a variety of factors, including:**
  - Morphology
  - Tower height
  - Power output
  - Hardware used, rate set assumptions, etc.

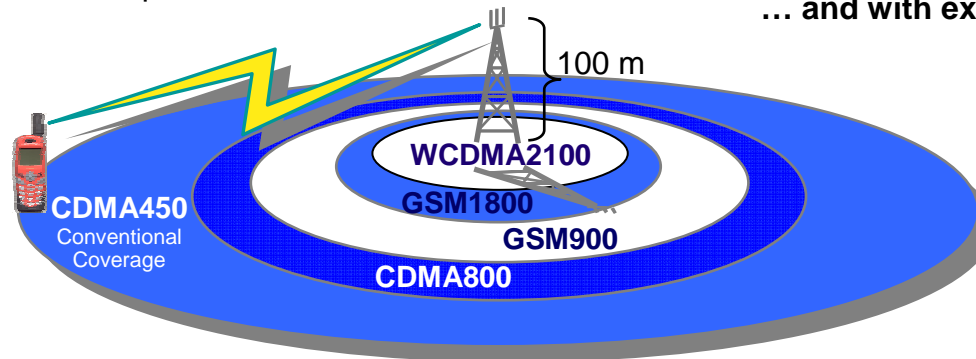
Frequency (MHz)	Cell Radius (km)	Cell Area (km <sup>2</sup> )	Normalized Cell Count
450	48.9	7521	1
850	29.4	2712	2.8
950	26.9	2269	3.3
1800	14.9	618	12.2
1900	13.3	553	13.6
2500	10.0	312	24.1

**CDMA450 coverage area:**

**3x larger than in 900 MHz**

**12x larger than in 1800 MHz & 2100 MHz**

**... and with excellent signal-to-noise ratio**



**CDMA2000 provides the largest coverage area and thus reduces the number of base stations**

Source: Lucent Technologies and Antonio Valente, Vice President of ANATEL, Brazil, May 2004.

Notes: 1. Flat terrain, tower mounted amplifier, 60 m tower height, maximum power output, and no interference.

2. The above 'theoretical' cell sizes may not be able to achieve in certain morphologies and are based on simplistic assumptions. It assumes all parameters are equal: terrain, output power, antenna height, etc.

# CDMA2000 Extended Coverage Rural Solution

*CDMA2000 is designed to provide extended coverage*

- **Requirements:**

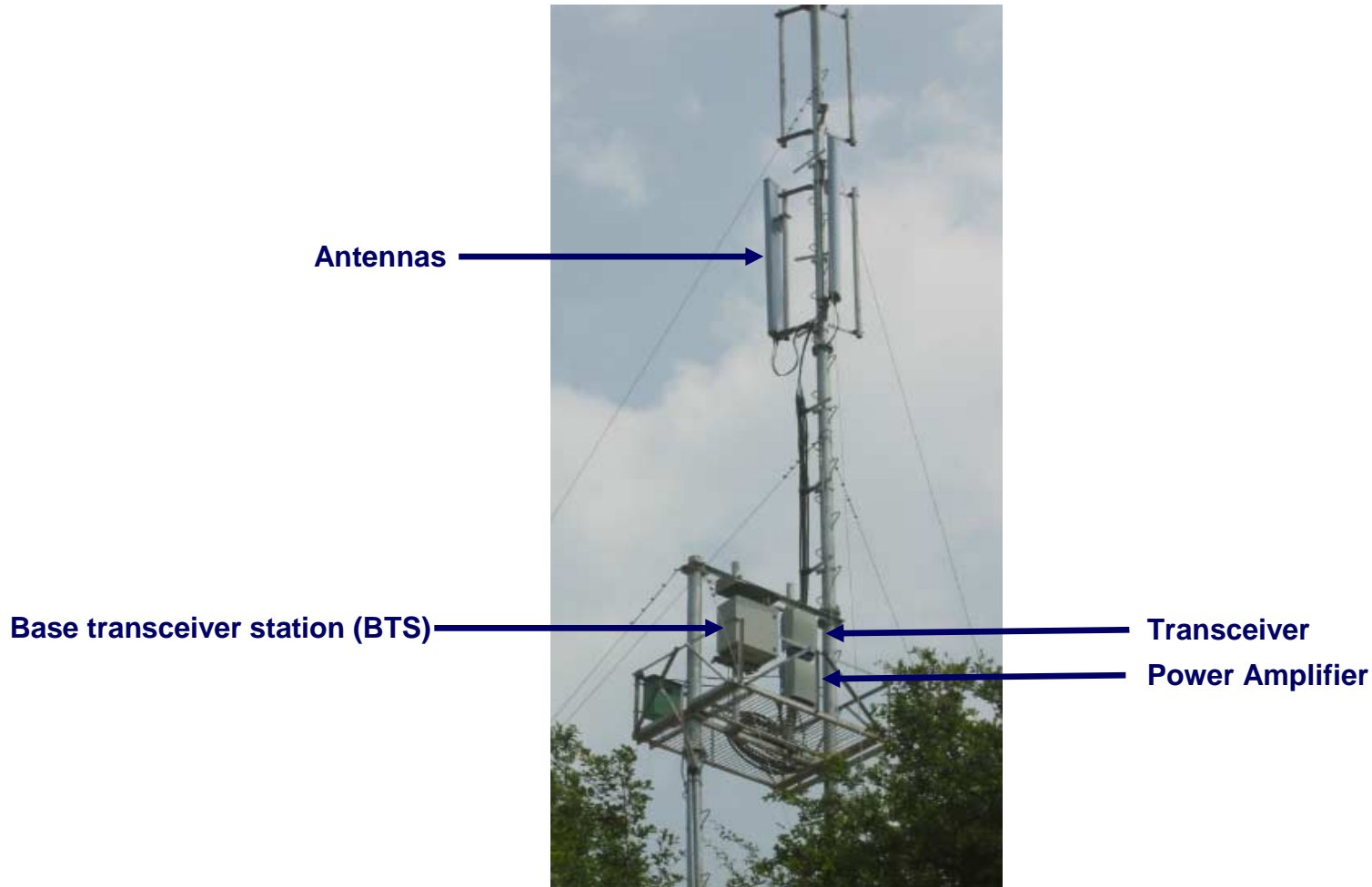
- Plains, coast, countryside, highway, railway, desert or grassland
- Low population density

- **Available Solutions:**

- Extended cell configuration: Max cell radius = 250 km (0~2048 chips)
- Increased receive sensitivity (greater than -128 dBm)
- 40-50W power amplifiers (increases forward link coverage)
- Tower mounted RF elements (increases coverage)
- Tower mounted power amplifiers (reduces cable loss)
- Mounting antennas as high as possible
- Directional antennas with dual polarization and power divider (increases gain)
- Higher gain, dual antenna, terminals (increases reverse link coverage)
- Single sector directional antennas
- Satellite, microwave, HDSL, fiber, WiMAX, etc. backhauls

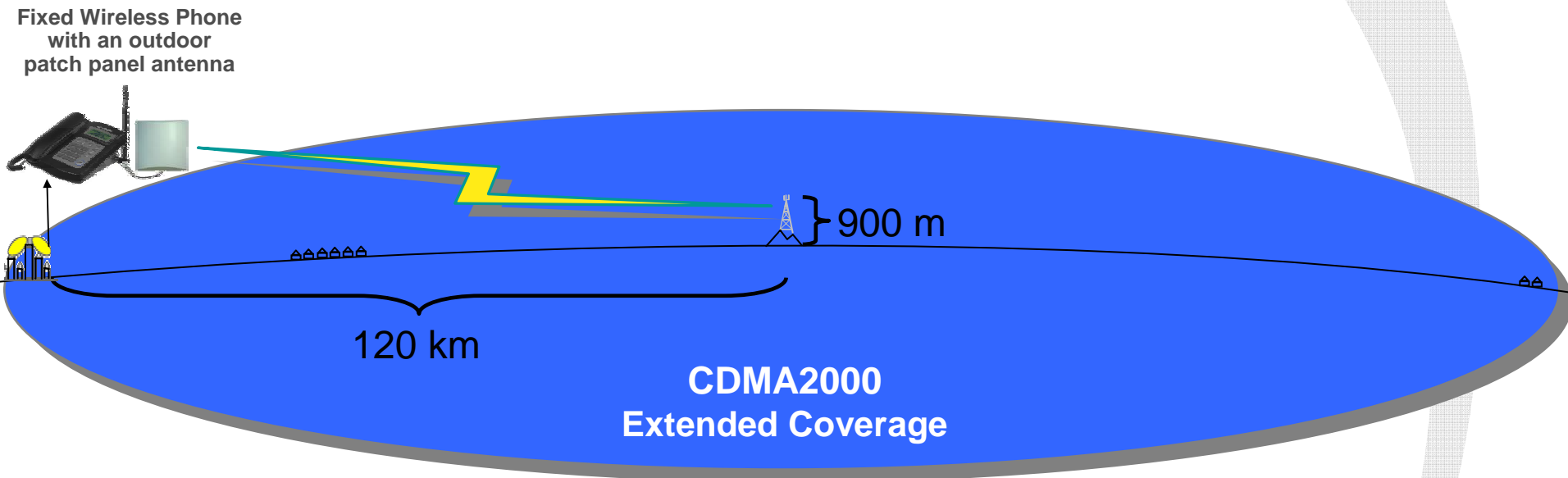
# CDMA2000 Extended Coverage Base Stations

*Flexible micro base station installations that maximize rural coverage*



# CDMA2000 Actual Coverage in Commercial Use

*Coverage increases with antenna height and use of outdoor phone antennas*



**Source:** Huawei Technologies. CDMA2000 extended coverage installations in the Guangxi and Xingjiang provinces of China and Uzbekistan.

**Note:** Range shown reflects a best case scenario: Flat ground with little grass or trees, 450 MHz, less than 3 users per sector, a single amplifier for the carrier, a received signal strength indication (RSSI)  $\leq -108\text{dBi}$ , no interference, and an externally mounted (12 dBi gain) antenna for the wireless phones. As additional subscribers use the base station, coverage will diminish.

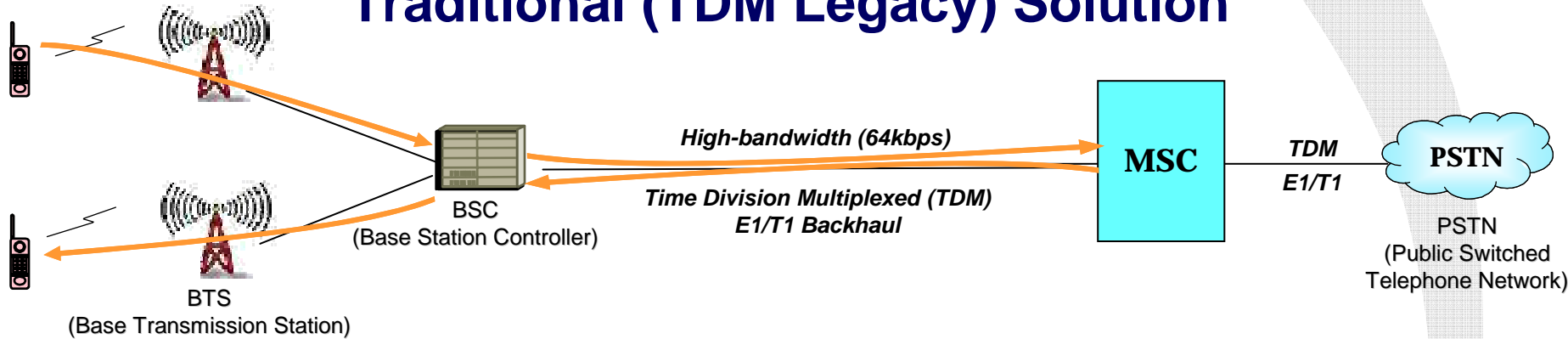
# **CDMA2000 IP Core Networks**



# Comparing Legacy and All-IP Networks

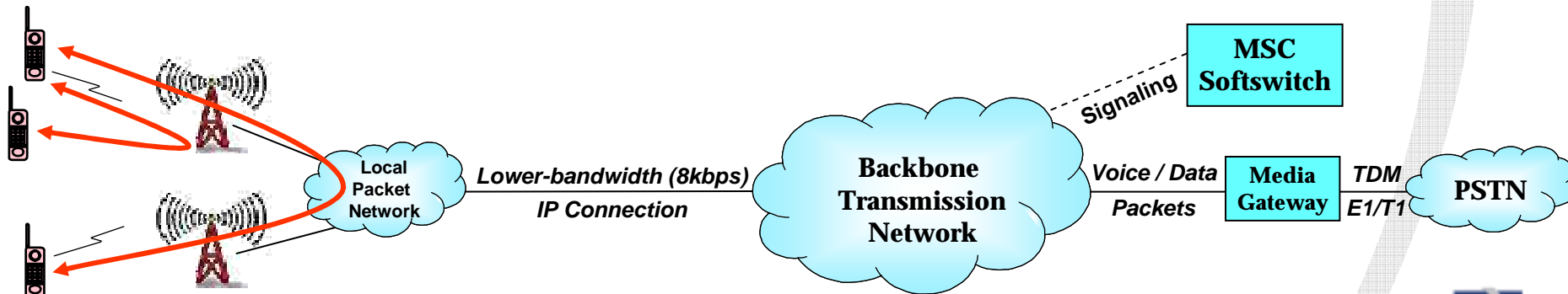
*All-IP packet solutions handle “mobile-to-mobile” voice calls using fewer resources*

## Traditional (TDM Legacy) Solution



## All-IP Packet Solution

*Independent of underlying transport, bearer, and provisioning technologies*



**CDMA2000 All-IP solutions support a distributed architecture approach**

# CDMA2000 All-IP Network Value Proposition

*CDMA2000 offers a high-performance and cost-effective solution*

- **Greater Performance**
  - Next Generation network technology
  - High-performance 3G radio access links
  - Enterprise and Campus LAN-to-macro WAN hand-offs are supported
- **Lower Cost**
  - Reduced infrastructure costs (CAPEX)
    - Scalable, modular, and low-cost IP network elements
  - Reduced transmission costs
    - Less backhaul capacity is needed
    - Local “mobile-to-mobile” calls are handled within a local IP network (LAN) – No need to go through entire transmission network
    - High bit-rate TDM (64 kbps) E1/T1 transport is replaced with low bit-rate EVRC (8 kbps) IP voice packets
    - BSC functions are distributed to the PCF, BTS, etc.
    - Transcoding of speech codecs is not necessary within the local IP network
  - Reduced operating costs (OPEX)
    - A single switching center can manage the distributed RF IP network elements
    - Switching center staff can support twice the number of IP network elements vs. traditional network
- **Faster Deployment**
  - Site acquisition is simplified with the fiber-link distribution of remote RF subsystems

# CDMA2000 Network Flexibility and Scalability

*CDMA2000 offers the best solution for rural communications*

CDMA2000 networks offer the following configuration options:

- **IP Core Network Options:**

- Rural, suburban, urban, and dense urban topologies
- Mobility, limited mobility, wireless local loop (WLL), or fixed wireless access
- Wide area, metro area, enterprise, and campus networks
- Multiple frequency bands: 450, 800, and 1900 MHz
- Voice, data, broadband Internet access, and multicasting services
- Circuit-switched or packet-switched transmissions
- Centralized (legacy) or distributed IP network elements (star, ring, or chain)
- Integrated IP-based PBX services
- ANSI-41 or IP core networks

- **IP Radio Access Network Options:**

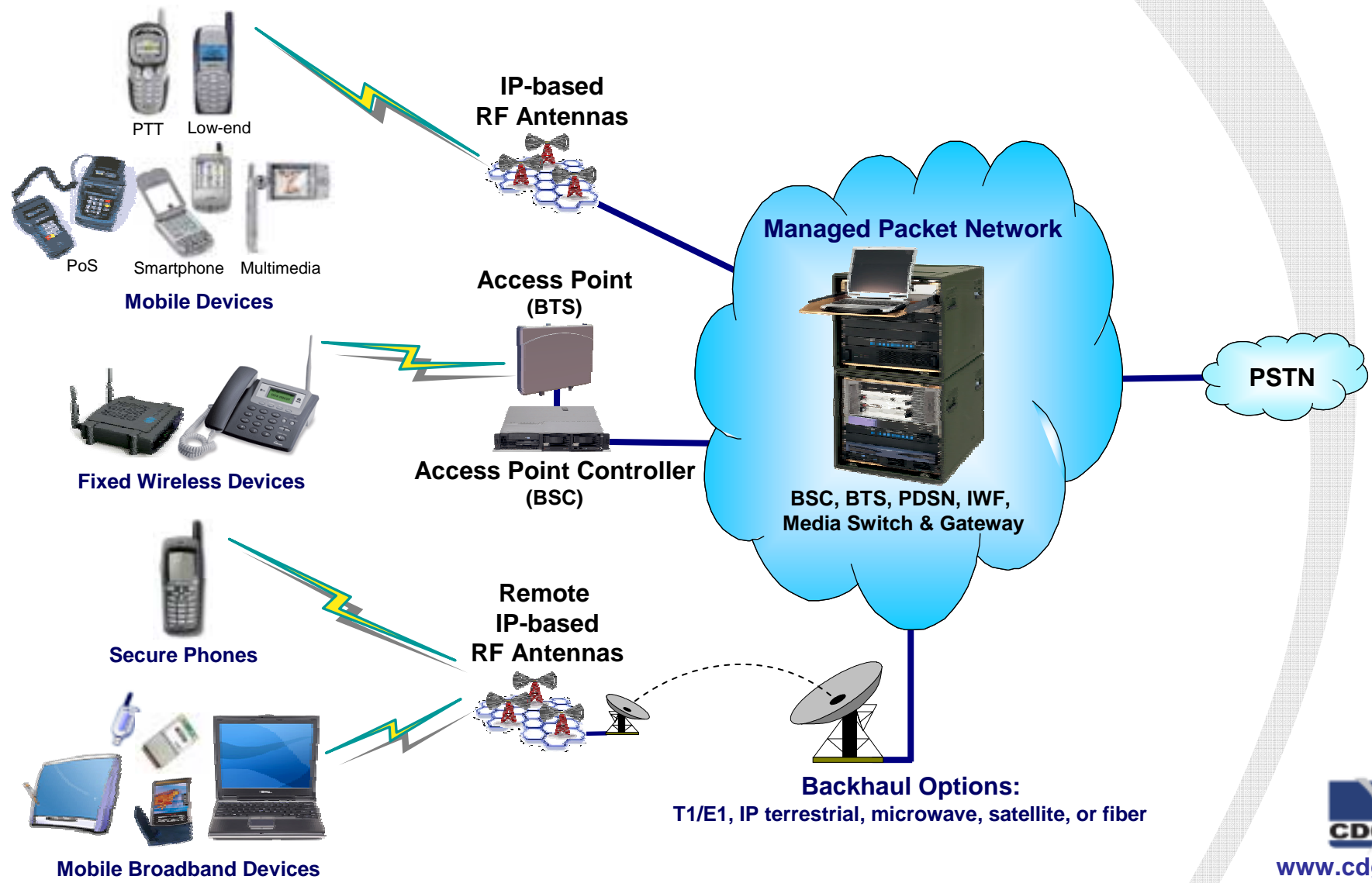
- Extended, macro, micro, pico, compact, repeater, remote, and optical distributed RF elements
- Indoor, outdoor, tunnels, dead spots, etc.
- Distributed Antenna Service (DAS) for enterprise and campus environments
- Building, tower, or pole mounted
- Single or dual frequency bands
- Underlay or overlay broadband data coverage
- Low or high capacity (# of antennas, sectors, carriers, channels, etc.)
- Channel element pooling across sectors
- Operation in 450, 800, 1900, and 2100 MHz

- **Backhauls:**

- Time division multiplexing (TDM) or Internet Protocol (IP)
- T1/E1, IP terrestrial, microwave, satellite, fiber, etc.

# Deployable IP-Based CDMA2000 Cellular System

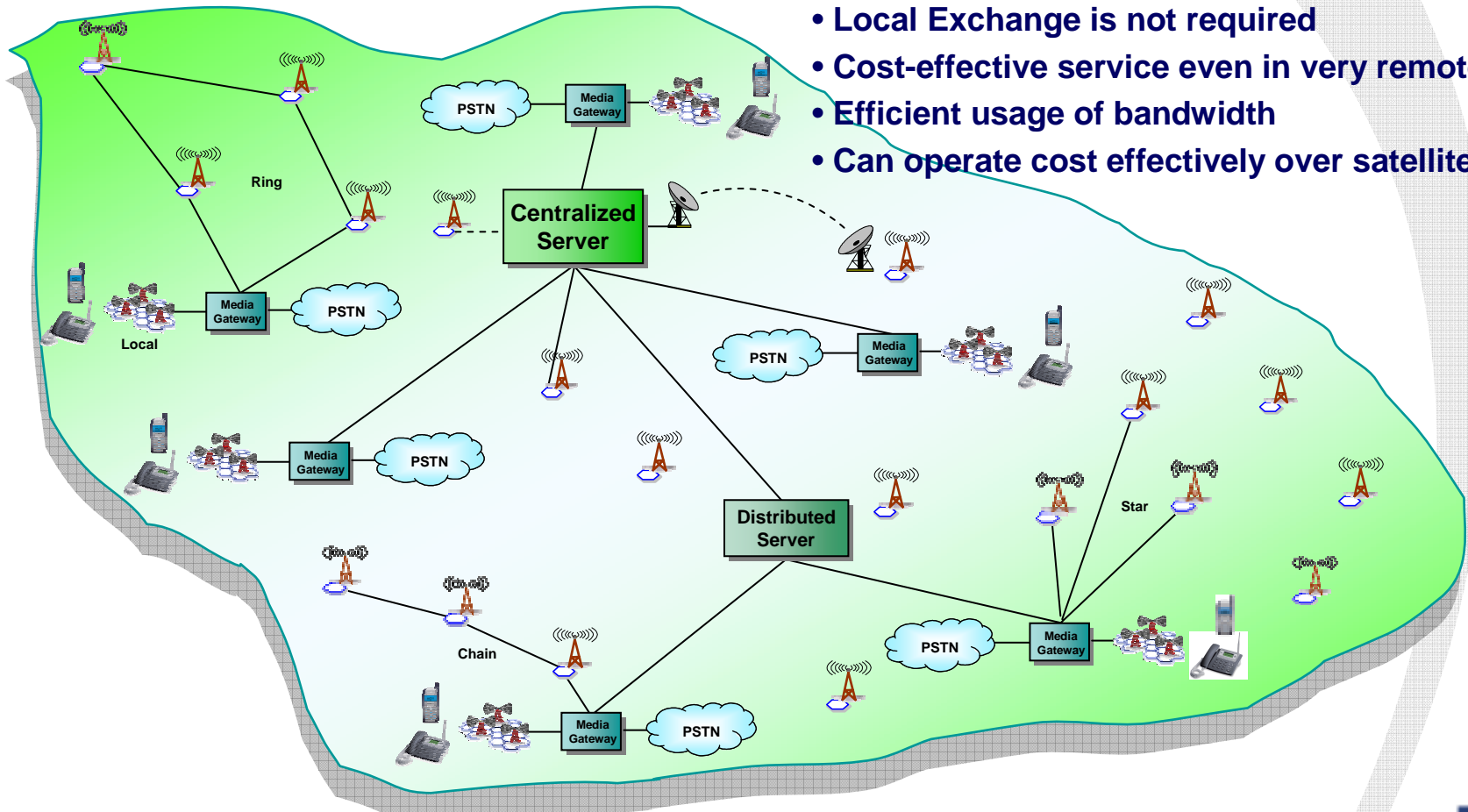
*A versatile and affordable cellular system for rural communications*



# CDMA2000 All-IP Deployment Scenarios

*A Packet-based network for unified voice, broadband data, and multimedia services*

- Centralized or Distributed network configuration
- Local Exchange is not required
- Cost-effective service even in very remote areas
- Efficient usage of bandwidth
- Can operate cost effectively over satellite links



Although backhaul of remote RF network elements will remain a significant cost, an all-IP CDMA2000 solution can significantly reduce the overall system cost.

# CDMA2000 Performance



# CDMA2000 Benefits

*A solution that provides affordable network coverage in rural areas*

- **Operation in the 800 MHz and 450 MHz bands:** Valuable spectral resources

- **800 MHz and 450 MHz offers excellent RF propagation characteristics:**

- Signals can travel longer distances
- Fewer base stations are needed to cover wider areas
- Network investment and operating costs are significantly reduced

- **A 3G technology:** An excellent performance & value proposition

- **CDMA2000 is a spectrally efficient technology:**

- Economically supports toll-quality voice, and “always-on” broadband data, and multimedia services
- Unmatched network capacity and coverage
  - Up to 168 users (155 Erlangs) of voice traffic per 5MHz sector/carrier <sup>1</sup> - **More than 4 times GSM** <sup>2</sup>
  - Up to 2.4 Mbps peak data rate per user - **More than 10 times that of an EDGE network** <sup>3</sup>
- Improved security and privacy
  - SSL 3.0 with 128 bit key encryption and support of digital signatures through public key infrastructure
  - No eavesdropping
- Numerous value-added services designed to increase operator revenue
- An easy migration path and robust roadmap towards next generation services, that preserves your investment

**Cost**

**Clarity**

**Capacity**

**Coverage**

**Compatibility**

**Customer satisfaction**

Notes: 1. CDMA2000 1X with 1-way receive diversity at handset and 4-way Rx diversity at BTS (assuming 1% blocking).

2. GSM with AMR vocoder and re-use of 1:1

Sources: 1. "Further Capacity Improvements in CDMA Cellular Systems", QUALCOMM Inc, Roberto Padovani

2. "GSM AMR Vocoders: Facts About Increased Voice Capacity", QUALCOMM Internal Paper: Rao Yallapragada

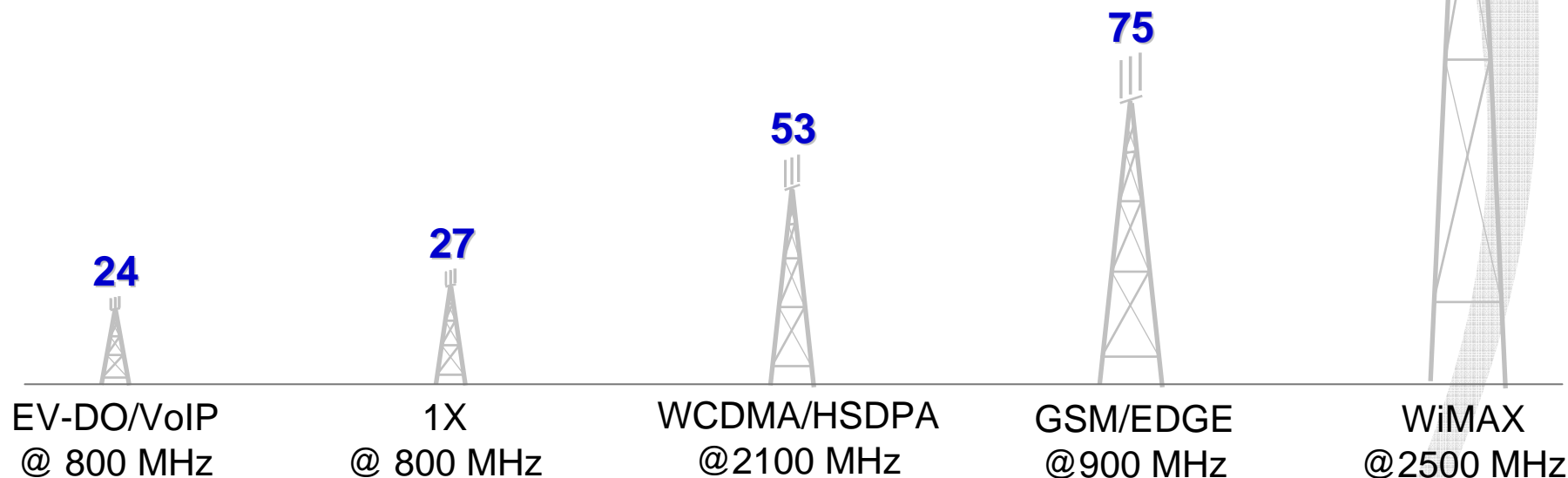
3. "EDGE Performance Evaluation", Alecsander Eitan and Amir Gazit, Qualcomm Israel Ltd., March 2003

# Site Count Comparison By Technology

*CDMA2000 requires the least number of cell sites for rural markets*

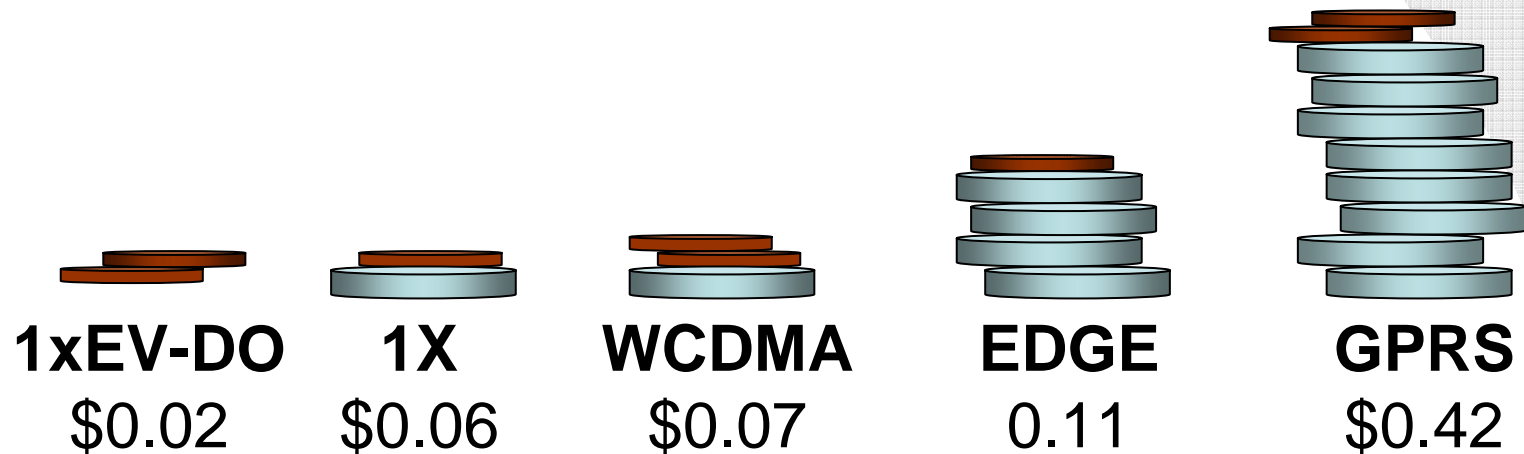
## Assumptions:

1. Coverage area = 1,000 sq. km.
2. Subscriber density = 31 Subs/sq. km
3. Available spectrum = 5 MHz
4. Average voice traffic per sub = 200 MoU/month
5. Average data traffic per sub = 5 Mb/month
6. Wireless penetration = 50%, Carrier market share = 25%
7. Voice usage = 100%, Voice BH = 10%
8. Data usage = 100%, Data BH = 12%
9. Simultaneous Calls/Sector/Carrier: EV-DO = 44, 1X = 35, GSM/EDGE = 6, WCDMA/HSDPA = 60, WiMAX = 25
10. Physical Layer FL data throughput (kbps): EV-DO = 1280, 1X = 350, GSM/EDGE = 86, WCDMA/HSDPA = 3600, WiMAX = 2300



# CDMA2000 Cost per Megabyte Comparison

*CDMA2000 networks support the most affordable delivery of bits*



## Spectral efficiency affects cost

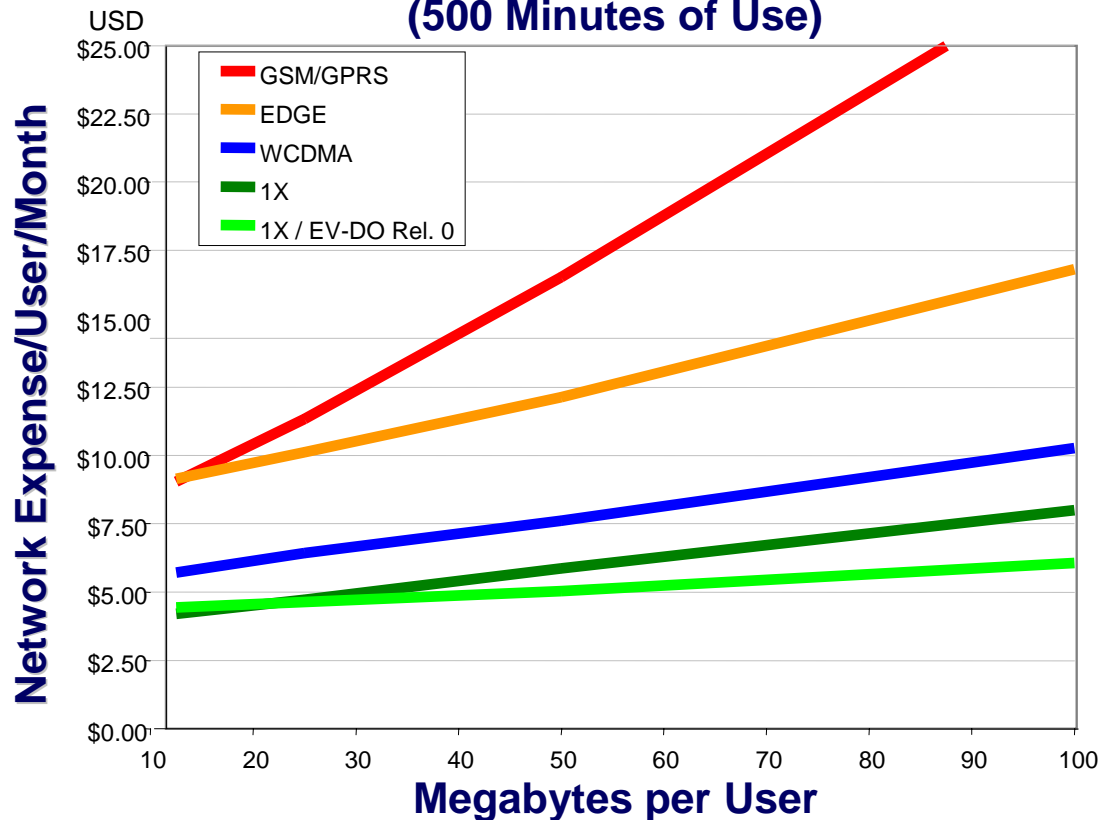
Cost = “Greenfield” Network Operations Expenses + Depreciation on Capital

**Affordable and evolutionary mobile broadband technologies are enabling the mass market adoption of mobile multimedia services**

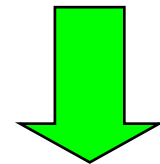
# CDMA2000 Enables Lowers Tariffs

*CDMA2000 1X and EV-DO enables the lowest cost per bit and Erlang*

## Combined Voice and Data Network Expense (500 Minutes of Use)



**The Lower  
the better!**



**Operators prefer network technologies that are affordable and evolutionary**

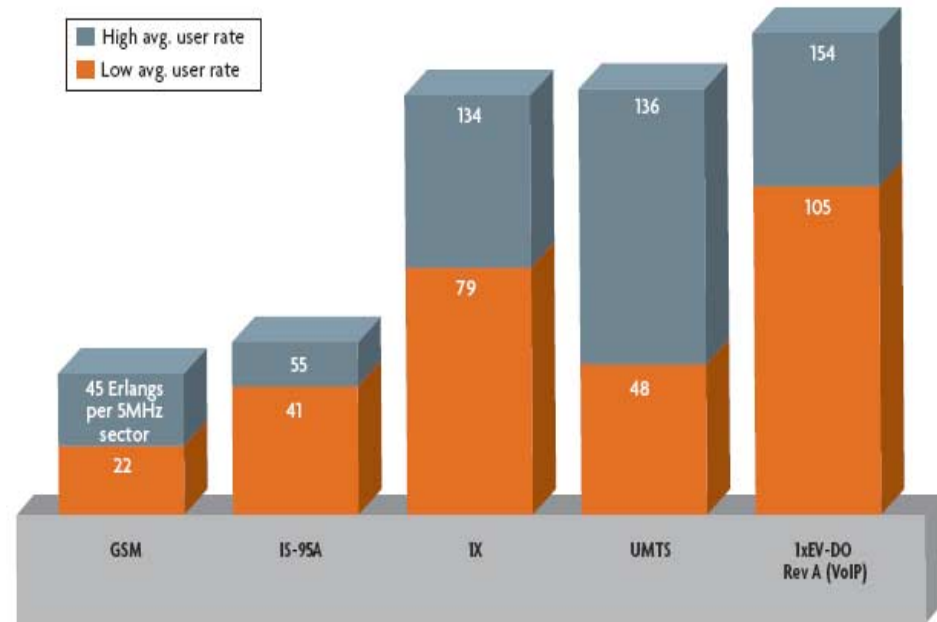
**1xEV-DO Rev A:  
Another opportunity  
to reduce the total cost of  
offering voice and data**



# EV-DO Rev A offers higher voice and data delivery efficiencies

- EV-DO Rev A offers the highest spectral efficiency of any existing 3G technology
  - **10-30% more capacity** than CDMA2000
  - Higher capacity reduces the number of cell sites when networks are capacity constrained
- EV-DO Rev A (VoIP) uses an all-IP core and transport network
  - Up to **50% transport savings**
  - Eliminates expensive circuit switched network elements (e.g., MSC's)
- Higher throughput capabilities can also be used for bandwidth intensive data services, thus favorably impacting revenues

Voice Capacity in Erlangs  
(5 MHz sector)



Source: Various and Signals Research Group, LLC

# For new deployments, Rev A is a compelling solution for VoIP and broadband data services

- EV-DO Rev A offers substantial CapEx/OpEx cost savings
  - 33% lower total cost of ownership versus UMTS/HSUPA
  - 27% lower total cost of ownership versus 1X/EV-DO Rel 0
  - The price premium for EV-DO Rev A base stations is more than offset by the reduced number of cell sites required
- EV-DO Rev A (VoIP) significantly reduces the core network CapEx
  - EV-DO Rev A (All-IP) Core Network CapEx is 70% lower than circuit switched implementations over a ten year period
  - CapEx savings also translates into lower OpEx
- EV-DO (All-IP) Transport OpEx is nearly 50% lower than leased lines over a ten year period

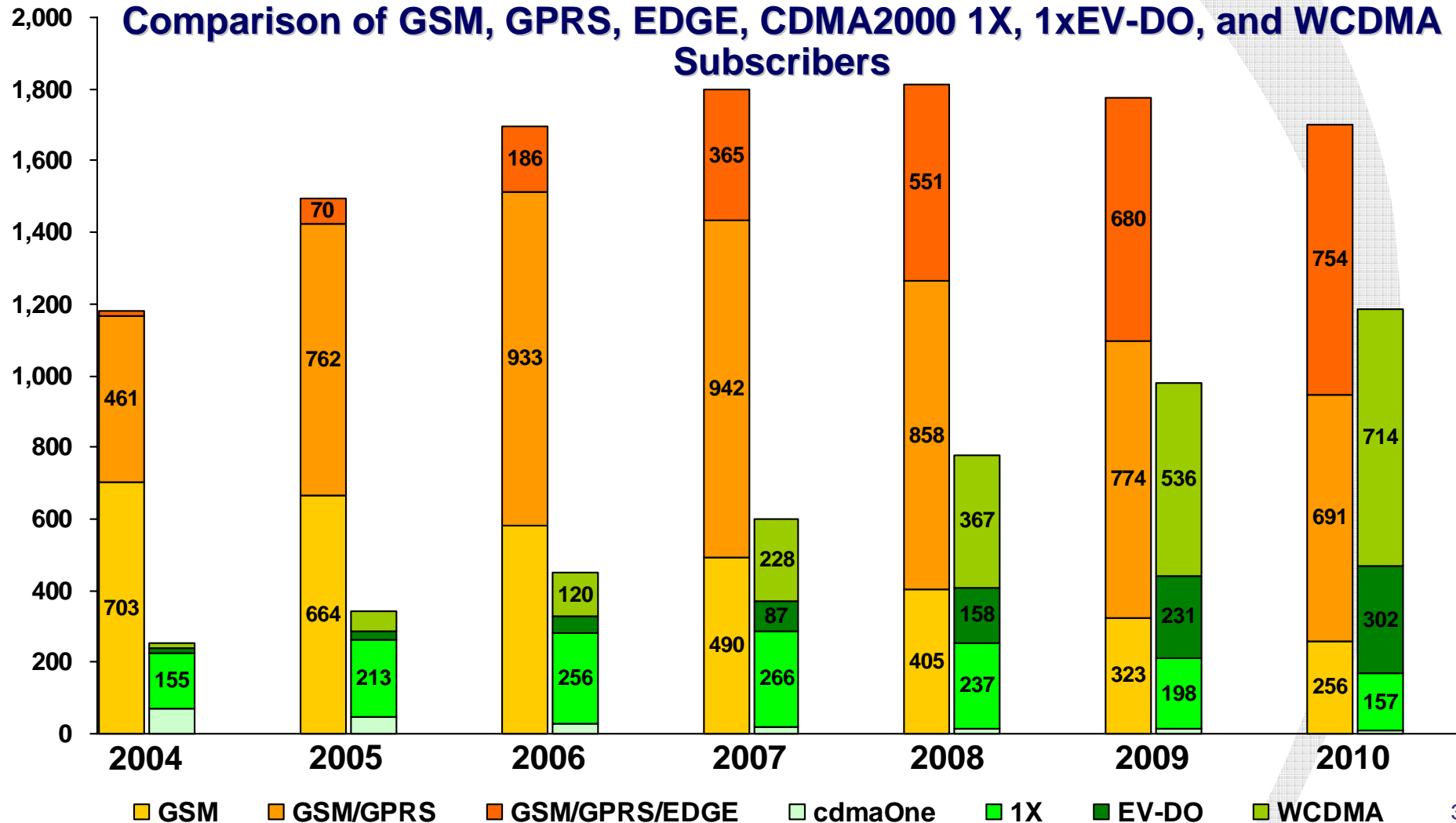
# **CDMA2000**

## **Economies of Scale**



# Worldwide Subscriber Growth

*The migration to 3G CDMA is occurring rapidly -- creating enormous economies of scale*



# Conclusion

- The “CDMA2000 Rural Connectivity Solution” offers affordable telephony, Internet and multimedia access to large coverage areas that have a low population density
  - **Rural Services:** CDMA2000 addresses a country’s national objectives by increasing telephony, Internet penetration, enterprise productivity, and improving vital services such as:
    - Telemedicine, remote learning, public safety, asset management, emergency and disaster relief, national security, telemetry, transportation and utility services, agriculture, tourism, etc.
  - **Coverage:** CDMA2000 enables the largest coverage area using the lower (warmer) 450 and 800 MHz frequency bands and extended base station coverage solutions.
  - **Network Costs:** The spectral efficiency of CDMA2000 and its All-IP architecture reduces the Total Cost of Ownership (TCO) of a network, improves performance and enables faster deployments.
  - **Entry-level Devices:** A large selection of entry-level CDMA2000 handsets are currently available. The average price for these devices is expected to approach **\$33** by 2009.

# Conclusion (Cont.)

- **CDMA2000 has been widely deployed in emerging and rural markets worldwide**
  - **Universal service:** CDMA2000 is bridging the digital divide by providing affordable telephony and Internet access to some of the most remote places on earth.
  - **Flexibility and Scalability:** CDMA2000 has enabled operators to address both sparsely populated rural areas and densely populated urban areas, equally well.
  - **Return on Investment:** The evolutionary and backward compatible CDMA2000 Roadmap enables significant performance and economic advantages, while preserving existing investments.
- **The CDG is here to support you!**

**Thank You**

