3G CDMA Technologies Enabling Advanced Broadband Wireless Access Services

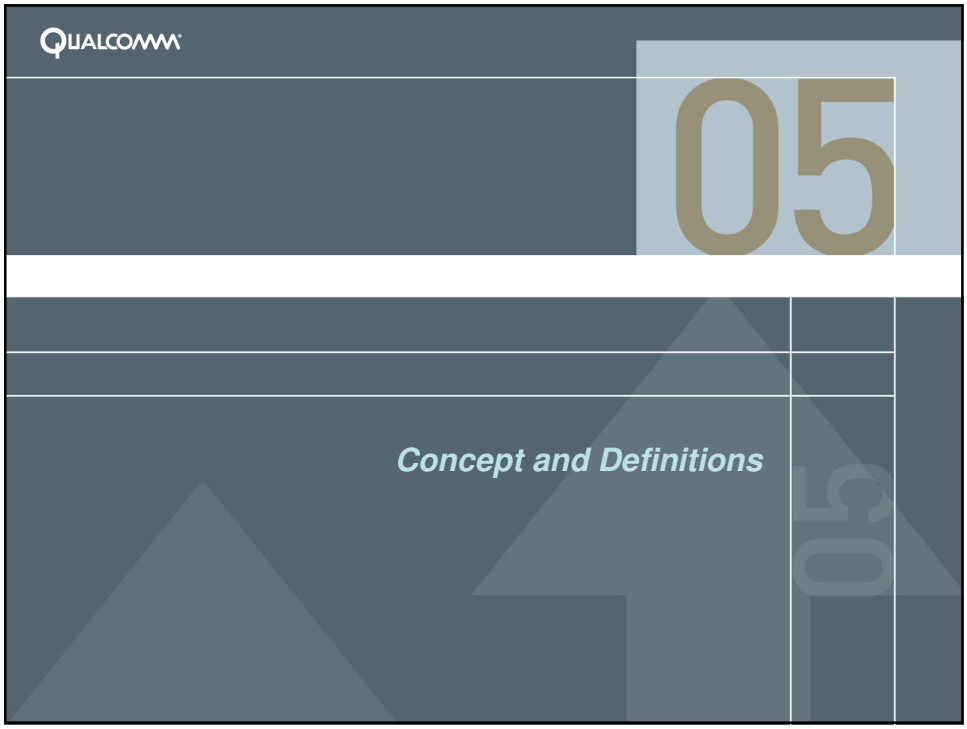
Paulo Breviglieri
Director, Technical Development
Qualcomm

ITU-ANATEL Regional Seminar on Broadband Wireless Access for Rural and Remote Areas for the Americas

May 2005

Agenda

- Concept and Definitions
- 3G Technology Roadmap
  - Standards Overview
  - Technology Evolution
    - CDMA2000 1xEV-DO and Enhancements
    - WCDMA
    - Broadcast and Multicast
  - Worldwide Implementation Update
  - 3G Benefits
- 3G Suitability for Service Provision in Rural and Remote Areas



Concept and Definitions

How to define Broadband Wireless?

- Telemedicine
- Teleworking
- E-Government
- Agriculture
- Distance learning
- Public safety
- National security
- E-commerce
- Entertainment
- Applications for persons with disabilities
- Utility applications
- Small business assistance
- Information gathering
- Tourism

Which technology standard(s) will best serve these applications?

Source: TIA, "The Economic and Social Benefits of Broadband Deployment", October 2003

Concept and Definitions

- **Key Service Aspects**
  - **Coverage**
  - **Average data throughput**
  - **Network economics (cost per MB)**
  - **Device availability & affordability**
  - **Interoperability**
  - **Service availability timeline**
  - **Harmonized spectrum availability worldwide**
  - **Simultaneous voice & data services**
  - **Ancillary business services (customer care, billing, etc.)**

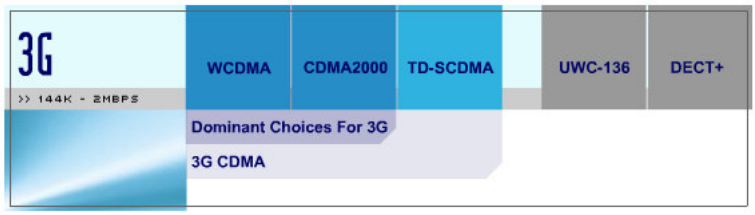
Regardless of any formal definition, broadband wireless access solutions shall address all relevant service aspects

05

3G Technology Roadmap

3G Standards

IMT-2000 Requirements Defined by ITU



Dominant radio interface technologies based on Code Division Multiple Access (CDMA)

Increased capacity resulting from superior spectrum efficiency

Enhanced data transmission capabilities

(up to 14 Mbps peak rates with HSDPA)

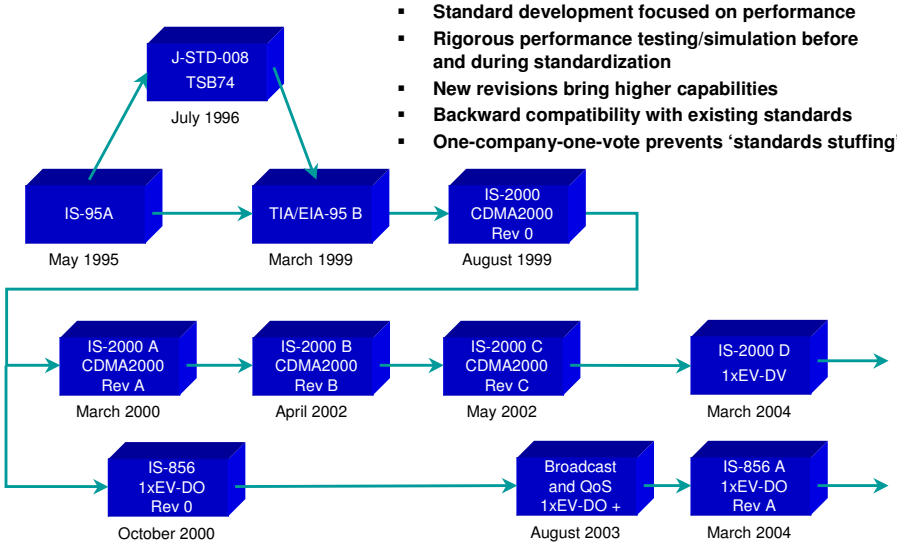
Extensive support to advanced services and multimedia applications

QUALCOMM
May 2005
ITU-ANATEL Regional Seminar on Broadband Wireless Access

Standardization Overview

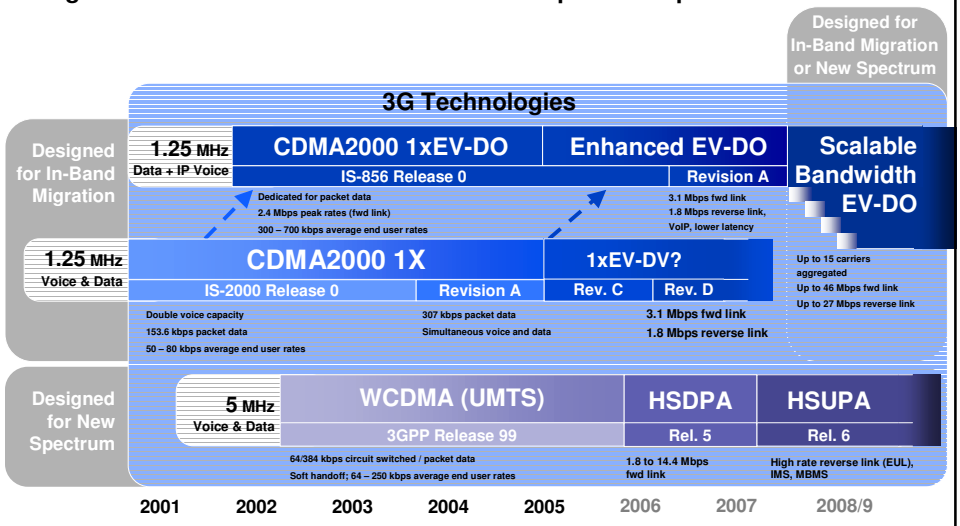
CDMA2000 1X/1xEV-DO Air Interface Standards

- **Standard development focused on performance**
- **Rigorous performance testing/simulation before and during standardization**
- **New revisions bring higher capabilities**
- **Backward compatibility with existing standards**
- **One-company-one-vote prevents 'standards stuffing'**



Technology Evolution

Migration to VoIP and Scalable Bandwidth - Up to 46 Mbps in 20 MHz



Timeline depicts initial commercial availability for each technology

QUALCOMM
May 2005
ITU-ANATEL Regional Seminar on Broadband Wireless Access

Technology Evolution

3G CDMA High Performance Enables Rich Applications

- 3G CDMA provides high spectral efficiency
  - 1xEV-DO Rev. A standard offers 3.1 Mbps FL and 1.8 Mbps RL peak data rate (1.25 MHz)
  - HSDPA will deliver ~10 Mbps peak data rate (5 MHz)
- Well optimized for fixed and mobile multi-user environment
  - Advanced techniques such as multi-user diversity, hybrid ARQ and incremental redundancy
- Ubiquitous coverage with seamless hand-offs
  - Well optimized soft-handoffs and power control mechanisms
- Operate in lower frequency bands (400-2700 MHz)
  - Better in-building penetration, wider coverage, link budgets and QoS
  - CDMA450 networks have achieved 45 km in trials and are operational in several countries providing wider rural/semi-urban coverage
- Well established value chain
  - Large base of chipset makers, infrastructure manufacturers, handset suppliers, fixed and mobile operators and highly innovative application developers

Technology Evolution
CDMA2000 1xEV-DO Evolution

- DOrA – Higher Data Rates
  - 3.1 Mbps DL
  - 1.8 Mbps UL
  - Average 600-1300 kbps DL
- DOrA – Low Latency
  - 30ms, optimized signaling & net access
- DOrA – VoIP
  - 1X-like spectral efficiency/ voice capacity/quality
  - Packet switched networks
- Video Telephony
  - Packet voice and video
- Quality of Service (QoS)
  - Multiple QoS concurrent flows
  - Selected by user or application
- Capacity & Quality Gains
  - Equalizer, antenna diversity
  - Interference cancellation
  - Vocoder improvements
- Push To Talk, Instant Messaging & Instant Multi-media
  - Audio and video
  - < 750 ms PTT
- Gold Multicast / Platinum Multicast
  - High rate media delivery

QUALCOMM
May 2005
ITU-ANATEL Regional Seminar on Broadband Wireless Access

Technology Evolution
WCDMA Evolution

- Release 5
  - High Speed Downlink Packet Access (HSDPA)
    - Overlay on top of regular R'99 WCDMA
    - Peak data rates of 14.4 Mbps
    - Average sector throughput from 2.2 to 4.2 Mbps in 5 MHz
  - Hybrid ARQ
    - Incremental redundancy
    - Soft combining
    - Fast re-transmissions
  - Adaptive Modulation and Coding
    - Channel sensitive scheduling
      - Based on Channel Quality Information feedback
    - Higher order modulation (QPSK & 16QAM)
- Release 6
  - High Speed Uplink Packet Access (HSUPA)
    - Design Objectives
      - Reduce delays
      - Increase cell coverage
        - Improve link efficiency
        - Minimize energy per effective transmitted bit
      - Increase achievable average data rate
        - Peak data rate is not a critical driving factor
    - Frame Duration
      - 10 ms / 2 ms
    - QPSK Modulation
    - Hybrid ARQ
      - L1 Retransmissions
      - Incremental Redundancy (IR)
    - Peak Data Rate
      - 4.096 Mbps

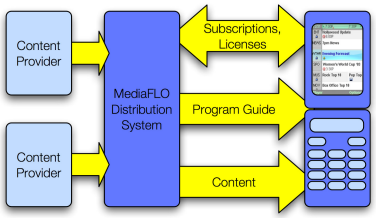
Broadcast and Multicast
Standardization Update

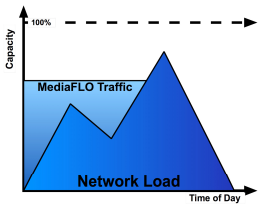
- **Standardization Activities**
  - **3GPP MBMS – Multimedia Broadcast and Multicast Services**
  - **3GPP2 BCMCS – BroadCast and MultiCast Services**
  - **Both standards define basic principles on how to efficiently transmit the same data to multiple users**
- **MBMS**
  - **High bit rate multimedia content delivery to many users in UMTS/WCDMA networks**
  - **Supports two UMTS/WCDMA QoS classes (Background and Streaming)**
  - **Service is controlled by Broadcast/Multicast Service Center**
- **BCMCS**
  - **TIA-1006**
  - **Provides multimedia content multicasting in CDMA2000 networks**
  - **BCMCS services are provided by enhancing the capabilities of Forward Link FCH and SCH**
  - **Enhanced BCMCS services based on OFDM technology are also being proposed in 3GPP2**

QUALCOMM
May 2005
ITU-ANATEL Regional Seminar on Broadband Wireless Access

Broadcast and Multicast
MediaFLO™* Enabling Unicast in 1xEV-DO Networks

- **Client/Server "clipcasting" solution**
- **Efficient distribution of encrypted content (operator controlled) across wireless networks**
- **Network scheduled delivery allows the operator to predict network loading and costs**
- **Unified interface for content providers**
- **Unified user interface (MediaFLO™ Program Guide) for both network scheduled and streaming content**
  - **"2 clicks to video"**
  - **Interactivity**
  - **Advertisement**
- **Subscription based billing is predictable and easy to understand**





* FLO – Forward Link Optimized

Broadcast and Multicast

Multicast Technologies

EV-DO Gold Multicast
Multicasting Software Upgrade

- Compatible with EV-DO Rel 0 & Rel A (DOrA)
- Leverages EV-DO capabilities
- Enables multimedia content clipcasting & streaming
- > 400 kbps throughput per sector at the physical layer (1.25 MHz)
- Dynamic channel allocation for unicast or multicast services
- Standard published in March 2004 (TIA 1006)

EV-DO Platinum Multicast
Evolution of EV-DO Standard

- Compatible with EV-DO Rel 0 & Rel A (DOrA)
- A revision to the BCMS standard with no changes to upper layers
- 1.5 Mbps throughput per sector at the physical layer (1.25 MHz)
- Uses EV-DO TDM and OFDM forward link waveforms
- Forward link adaptive space-time equalization
- Optimal combining and interference cancellation

FLO™ Technology
A New Airlink & Overlay Technology

- A Forward Link Only (FLO) overlay to CDMA2000 & WCDMA networks
- 7 Mbps throughput at the physical layer (6 MHz)
- Uses CDMA2000 & WCDMA Reverse Link for channel selection
- Optimized power consumption and rapid channel acquisition
- Capacity for broad range of streaming and clip-cast content

QUALCOMM
May 2005
ITU-ANATEL Regional Seminar on Broadband Wireless Access

Worldwide Implementation Update

3G Today – Over 170 Commercial 3G Operators

CDMA2000
- 1X 87 operators
- EV-DO 19 operators

WCDMA
- 67 operators

Source: 3Gtoday.com April 2005; Global Mobile April 2005

Worldwide Implementation Update

3G Today – Over 170 Commercial 3G Operators (March, 2005)

EV-DO Operators
~13 M subscribers

ACS, Midwest Wireless, vivo, verizon wireless, Eurotel, Zapp, pelephone, KDDI, First in Mobile KTF, SK Telecom, Telstra, APBW, Bermuda Digital Communications Ltd., canty movilnet, smartcom, BELLSOUTH, WIRELESS, VÉSPER, Telecom

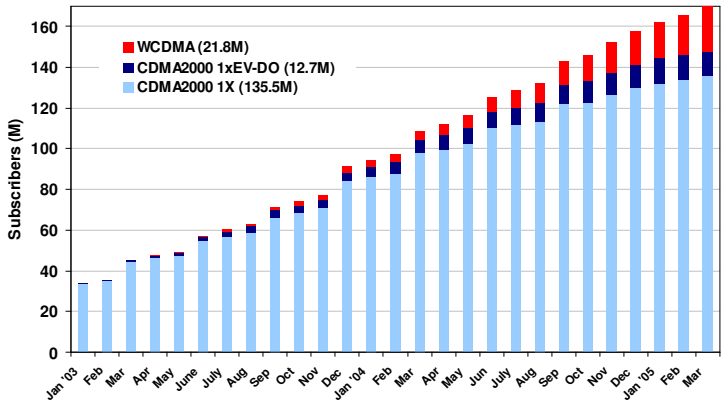
WCDMA Operators
~22 M subscribers

vodafone, cingular WIRELESS, T-Mobile, 3, TELECOM ITALIA, Telefónica, orange, mmO2, swisscom

QUALCOMM
May 2005
ITU-ANATEL Regional Seminar on Broadband Wireless Access

Worldwide Implementation Update

170 Million 3G CDMA Reported* Subscribers (March, 2005)

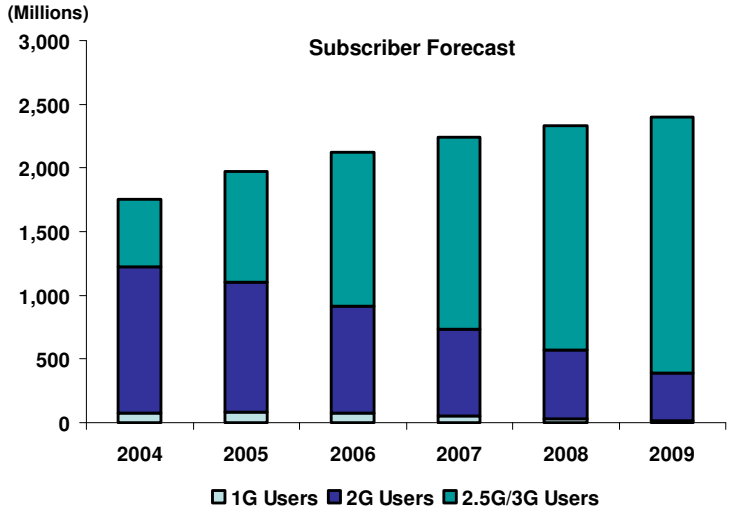


*103 of the 147 operators have reported 3G CDMA subscriber totals at some point. 79 of those operators have updated their 3G CDMA subscriber totals for Mar 2005. 44 operators have yet to report 3G CDMA subscriber numbers.

Source: 3Gtoday.com

Worldwide Implementation Update

Growth from Technology Transitions



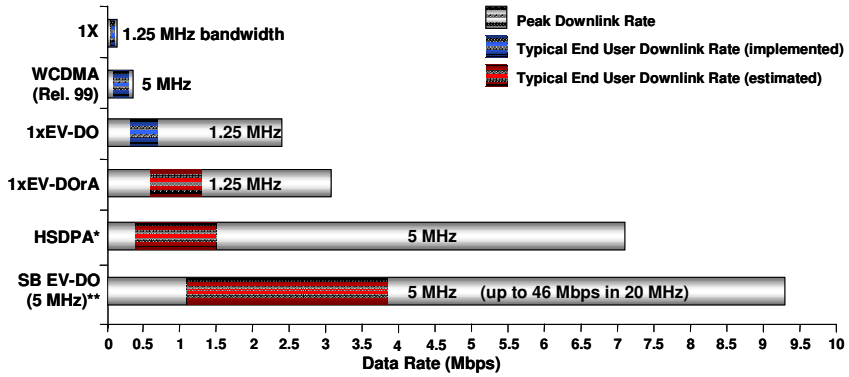
Source: Yankee Group Global Wireless Mobile Forecast, March 2005

May 2005
ITU-ANATEL Regional Seminar on Broadband Wireless Access

3G Benefits

Technical Performance

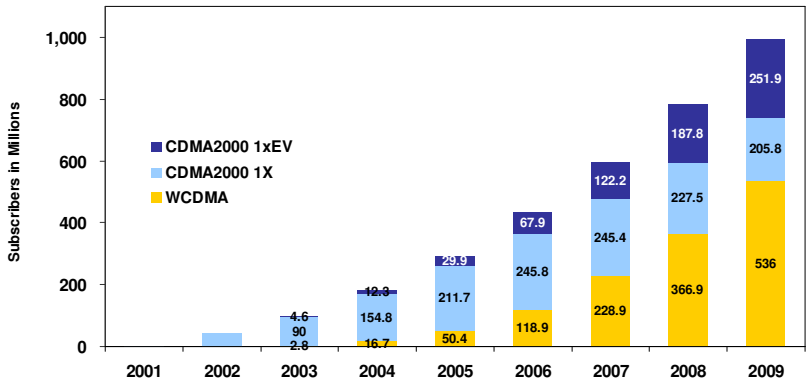
3G Peak and Average End User Data Rates



Peak end-user and typical average end-user forward link data rates are depicted.
1X, 1xEV-DO and 1xEV-DO Rev. A rates are achieved in a 1.25 MHz carrier bandwidth
WCDMA, HSDPA (WCDMA Rel. 5 and 6) and Scalable Bandwidth (SB) EV-DO rates are achieved in 5 MHz.
1xEV-DO Rev. A DL rates are achieved with equalizer and dual receive antennas
HSDPA FL peak rates are device-dependant, with devices supporting up 7.2 Mbps
*Peak data rates could increase to 10.2 Mbps and the standard supports 14.4 Mbps
**Scalable Bandwidth (SB) EV-DO data rates shown are for 5 MHz and are preliminary estimates. Channel Bandwidths up to 20 MHz are possible.

3G Benefits
Scale & Cost

3G Subscriber Forecasts by Technology
Approaching 1 Billion by 2009

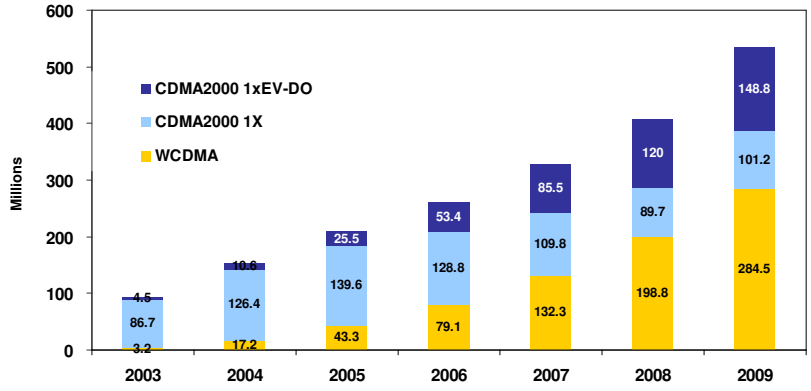


Blended Forecast: Strategy Analytics (Dec. 2004) and Yankee Group (March 2005);
1xEV includes 1xEV-DO and 1xEV-DV subscribers

May 2005
ITU-ANATEL Regional Seminar on Broadband Wireless Access

3G Benefits
Scale & Cost

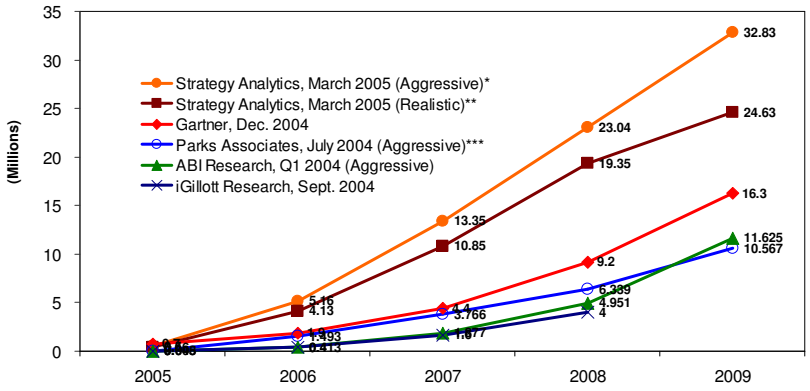
3G Device Forecasts by Technology
Over 500 Million by 2009



Blended Forecast: ABI (2004), Gartner (2004), IDC (2004), The Shosteck Group (2004),
Signals Ahead (2004), Strategy Analytics (Dec. 2004) and Yankee Group (March 2005)

3G Benefits
Scale & Cost

WiMAX Subscriber Forecasts (Fixed, Nomadic/Portable and Mobile)

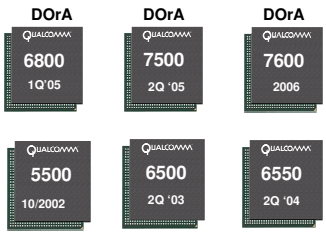


*According to Strategy Analytics, this forecast includes the evolution from fixed to nomadic and mobile applications, reflecting the 'dream' of WiMAX proponents.
**According to Strategy Analytics, this forecast reflects view of WiMAX as primarily a solution for 'last mile' fixed broadband access and connectivity.
***Parks Associates figures derived from 2005-2009 "802.16REVd" subscriber forecast plus 2005-2009 "Aggressive Forecast of Worldwide Nomadic/Mobile Broadband Wireless Service Subscribers" times 2009 802.16e market share of these nomadic/portable broadband subscribers by technology. All figures derived from Parks Associates "Untethering Broadband: WiMAX, 802.20, and Others"

May 2005
ITU-ANATEL Regional Seminar on Broadband Wireless Access

3G Benefits
Time to Market

EV-DO and DOrA
QUALCOMM Chipset Solutions



DOrA – Higher Data Rates
3.1 Mbps Downlink
1.8 Mbps Uplink
Average 600-1300 kbps Downlink

Capacity/Quality Gains
Equalizer, Antenna Diversity
Interference Cancellation
Vocoder improvements

Note: Engineering sample dates
*DOrA=CDMA2000 1xEV-DO Revision A

3G Benefits
Time to Market

QUALCOMM Enabled WCDMA / HSDPA Devices

Samsung

Z130 Z140 Z300 Z500 Z700

LG

U8200

Siemens

SXG75

Sierra Wireless

850 [MSM6275]

Sanyo

S750 S-103

Huawei

D208 E600

Option

GlobeTrotter Fusion

BenQ

X4

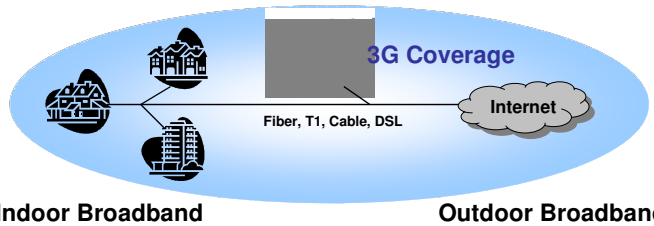
Announced Customers

SAMSUNG, LG, SIEMENS, SANYO, Huawei Technologies, CURITEL, SIERRA WIRELESS, OPTION, ZTE, BenQ, VITELCOM, NEC, Hisense, SEIKO, NOVATEL WIRELESS, TOSHIBA

May 2005
ITU-ANATEL Regional Seminar on Broadband Wireless Access

3G Benefits
Business Case and Market Application

Existing 3G + WLAN + Landline Provide Extensive Coverage and Capabilities



Indoor Broadband (WLAN, DSL, Cable, T1, etc.)

Wi-Fi / 802.11n provide untethered high speed access in enterprise, home and campus locations

Going from high 100s of kbps to 100s of Mbps

80%+ Wi-Fi access points sold today are for home use*

Outdoor Broadband (HSDPA and 1xEV-DO)

The 3G evolution provides wide area broadband access leveraging existing fixed and mobile operator networks

Going from 100s of kbps to 10s of Mbps

Majority of mobile devices will be 3G by end of this decade**

Sources * Intel 2004
** Source: consensus of industry analyst forecasts. Some firms expect 3G device crossover to occur as early as 2008.

QUALCOMM

05

3G Suitability for Service Provision in Rural and Remote Areas

05

3G Suitability for Service Provision in Rural and Remote Areas

Extended Coverage in Lower Frequency Bands

- **CDMA2000 has proven to be an effective technology to provide vast coverage benefits to rural areas in regions such as Australia, Russia, Brazil, China and India**
- **Lower bands – such as 800 MHz and 450 MHz – are ideal for wide coverage**
  - **Large areas are otherwise difficult to reach using fiber and copper**
  - **Favorable propagation characteristics of lower frequencies grant significant cost advantages**
  - **Less infrastructure equipment required**
- **Such capabilities have been taken into consideration by selected countries, who have pursued harmonized regulatory conditions for the introduction its effective usage**

3G Suitability for Service Provision in Rural and Remote Areas
CDMA2000 1xEV-DO at 450 MHz – SCD Pilot Project in Brazil

- Initiative pioneered by ANATEL to demonstrate CDMA2000 1X / 1xEV-DO capabilities and coverage at lower frequencies for universal broadband access
- Bus visits government agencies and rural public schools to provide broadband access
- Broadband data coverage, distance from the base station:
  - 800 kbps peak @ 45 km

QUALCOMM
May 2005
ITU-ANATEL Regional Seminar on Broadband Wireless Access

3G Suitability for Service Provision in Rural and Remote Areas
CDMA2000 1X for Internet Access – Public Schools in Ecuador

- Edumasters, a US-based company, has introduced students to the Internet at public schools throughout Ecuador using CDMA2000 1X wireless data services
- Small kiosk at each school with a computer and a 1X data connection
- Free Internet access paid for by organizations and corporations that advertise on the kiosk
- Edumasters is looking to replicate this model elsewhere in Latin America (next target market is Panama)

* Source: www.edumasters.net

3G Suitability for Service Provision in Rural and Remote Areas
CDMA2000 1xEV-DO – Rural Schools Provided with Broadband Access

- **Pilot project implemented by BellSouth Chile in September 2004**
- **CDMA2000 1x EV-DO broadband access provided to a school at Placilla (141 km from Santiago)**
- **Part of a Government plan to bridge the digital divide (more than MUS$ 4 to connect rural schools to the Internet)**
- **More than 51,000 students will benefit from this project at 667 schools across the country**

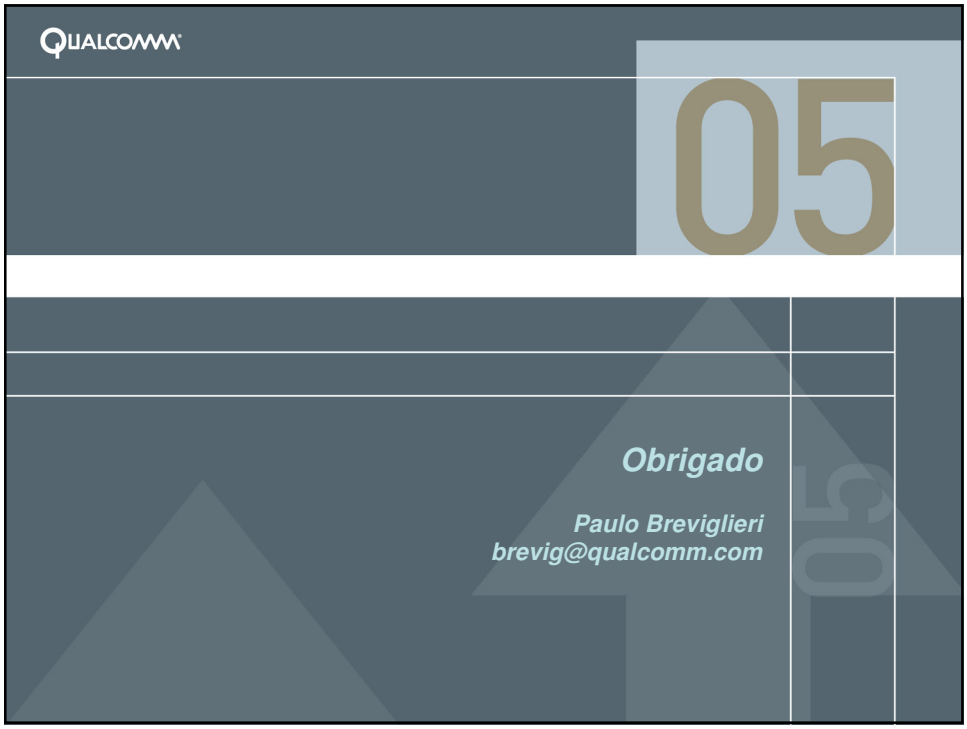
Minister of Communications, Javier Etcheberry, launches the pilot project using CDMA2000 1xEV-DO to connect schools to the Internet in rural areas

* **Source: www.subtel.cl/servlet/page?_pageid=57&_dad=portal30&_schema=PORTAL30&p_language=e**

QUALCOMM
May 2005
ITU-ANATEL Regional Seminar on Broadband Wireless Access

Conclusions

- **3G technologies have been developed on a comprehensive standardized basis and enjoy a solid evolution path**
- **The successful commercial launches of 1xEV-DO and the impending launches of HSDPA leave little room for alternative technologies in a metropolitan area network (MAN) environment**
- **Scalable Bandwidth 1xEV-DO and HSDPA / HSUPA will offer better peak rates, throughputs and performance than alternative technologies**
- **Massive 3G CDMA device shipments have led to economies of scale that competitive technologies may never reach**
- **3G has played a relevant social role in fulfilling universal service obligations, granting citizens voice & broadband access services, particularly in sparse remote and rural areas in the Americas**


QUALCOMM
05
Obrigado
Paulo Breviglieri
brevig@qualcomm.com
05