QUALCOMM

05

3G CDMA Migration Path – Mobile Convergence to the Next Step

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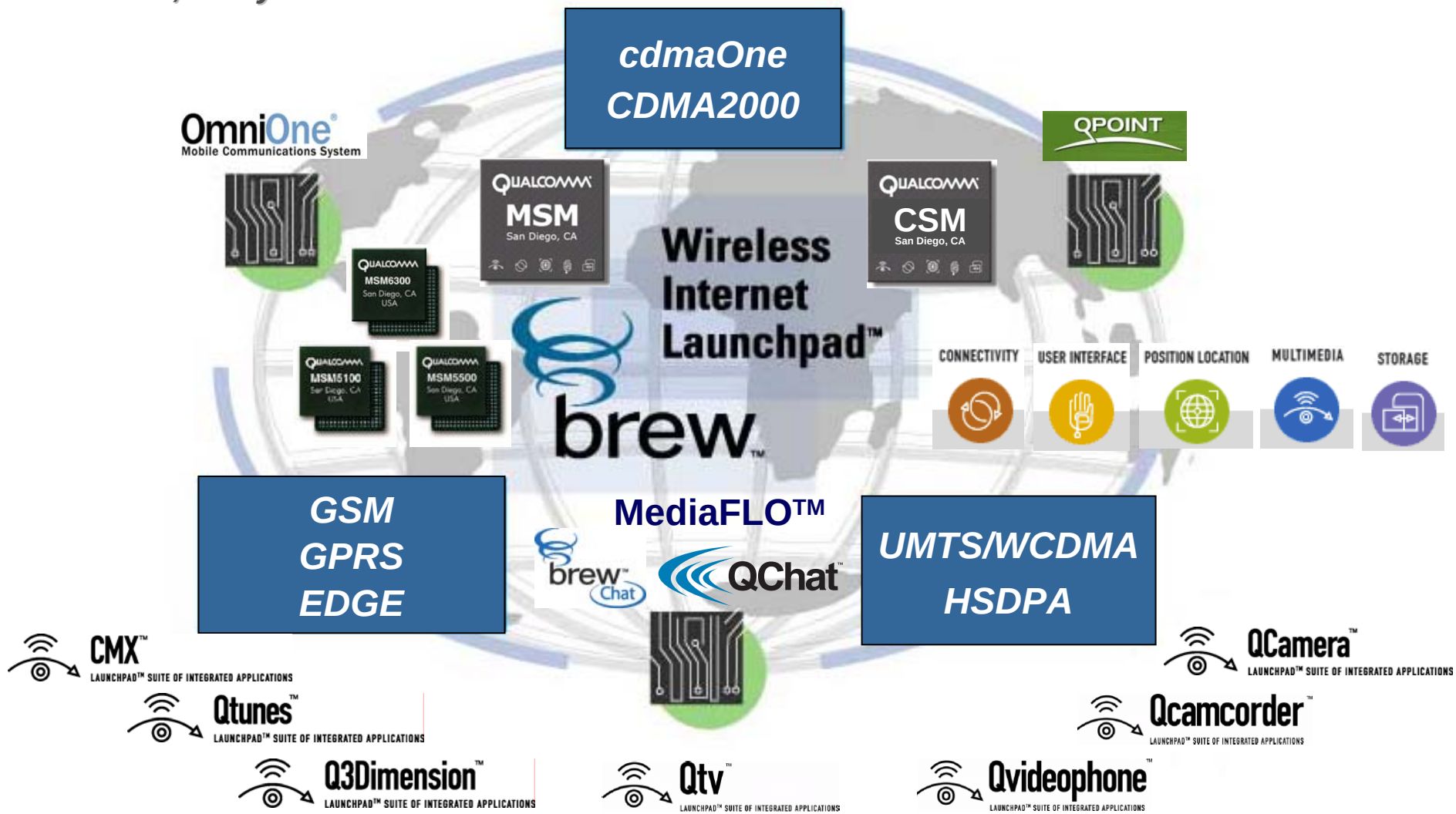
Agenda

- 3G CDMA Technology Evolution
- CDMA2000 1x EV-DO Roadmap
- Data Throughput Comparison on Technologies
- Conclusion

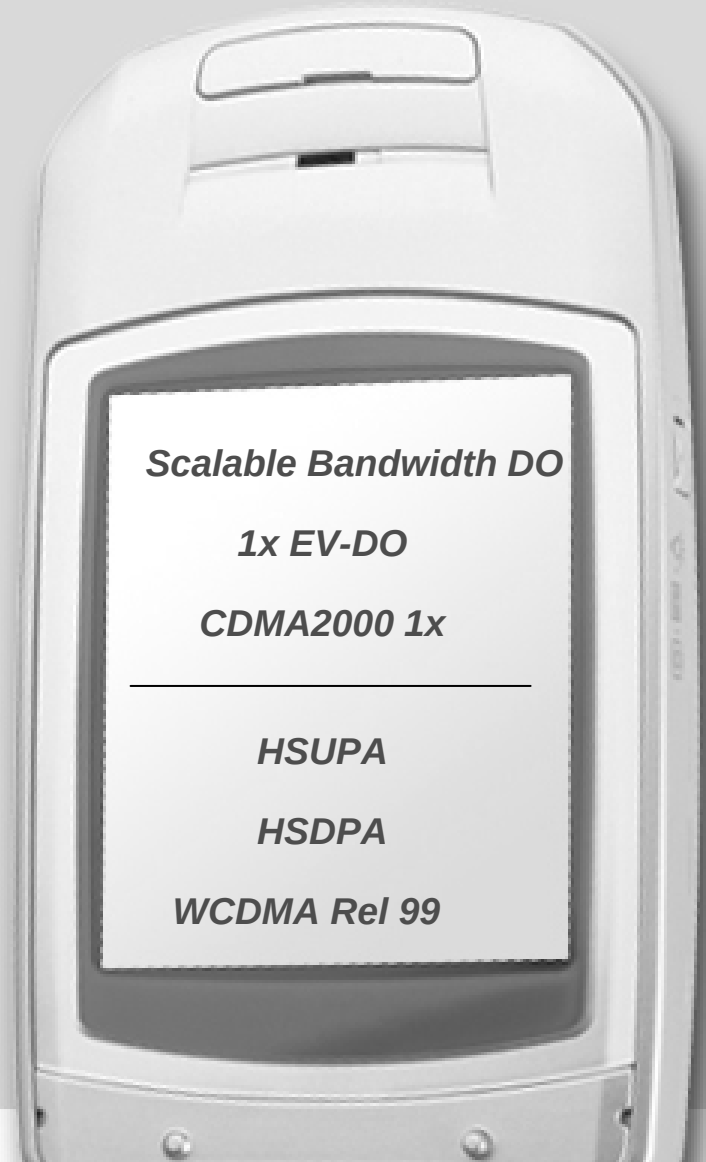
A little bit About Qualcomm

One World, Many Solutions



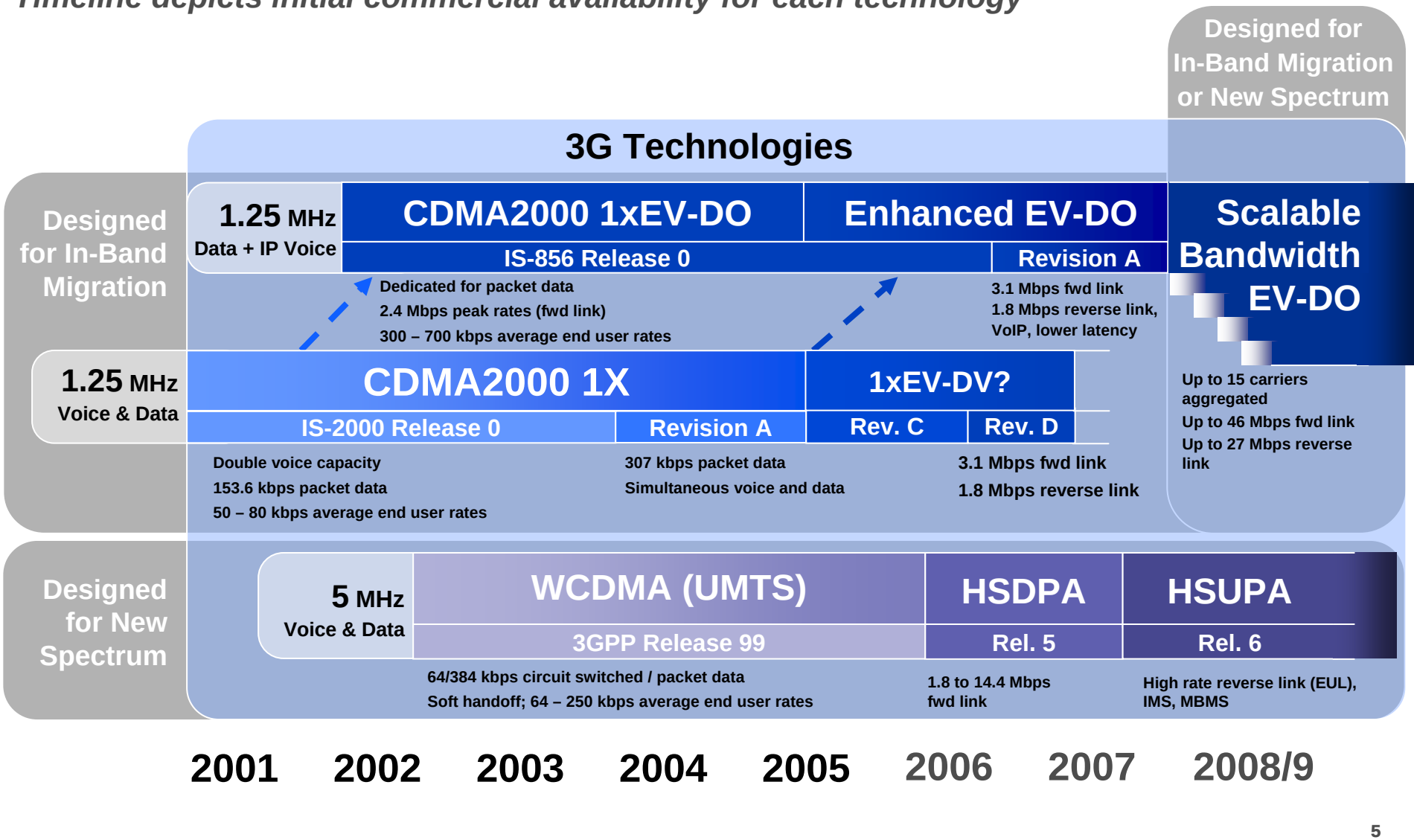
From the largest non-fab supplier of chips & embedded software in the world

3G CDMA Technology Evolution

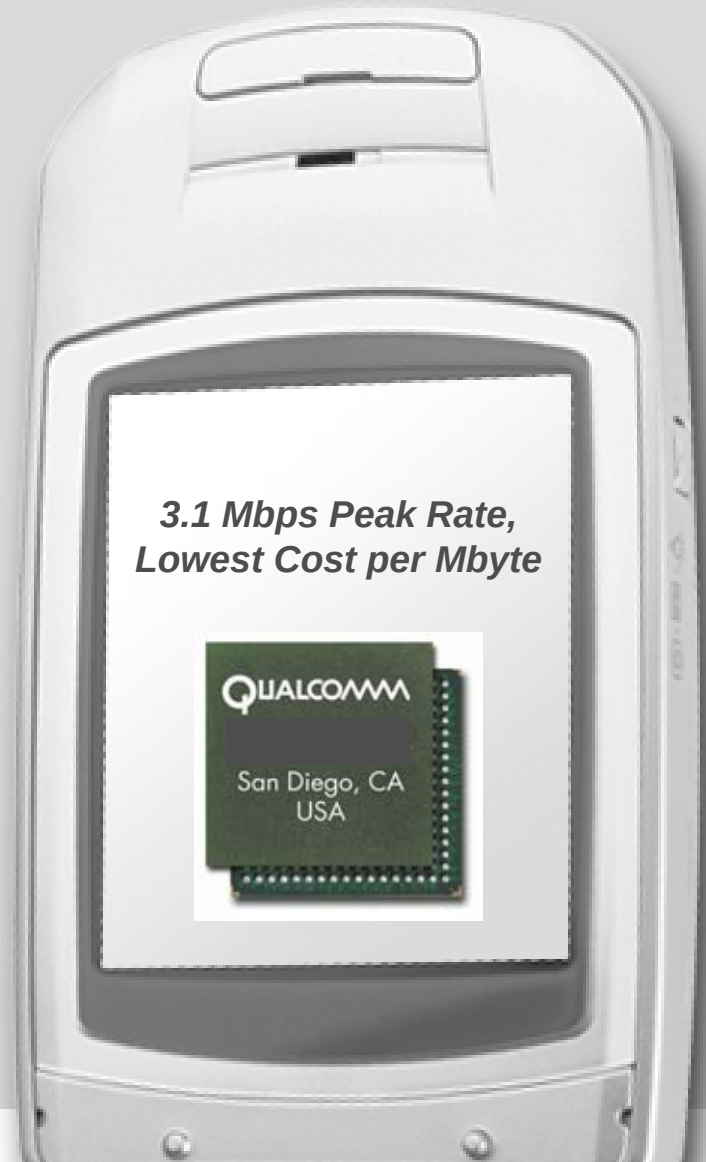


3G Evolution – Today & Tomorrow

Timeline depicts initial commercial availability for each technology



CDMA2000 1xEV-DO Evolution



CDMA2000 1xEV-DO Roadmap

Serving the future needs of CDMA2000 operators – evolve in 3 dimensions

High peak rates

Release 0
2.4 Mbps DL / 153 kbps UL
Avg 300-600 kbps DL

Revision A
3.1 Mbps DL / 1.8 Mbps UL
Avg 600-1300 kbps DL

Capacity Gain

- **Receive Diversity**
- **Equalizer**

Improving Voice/data capacity

Enhanced services

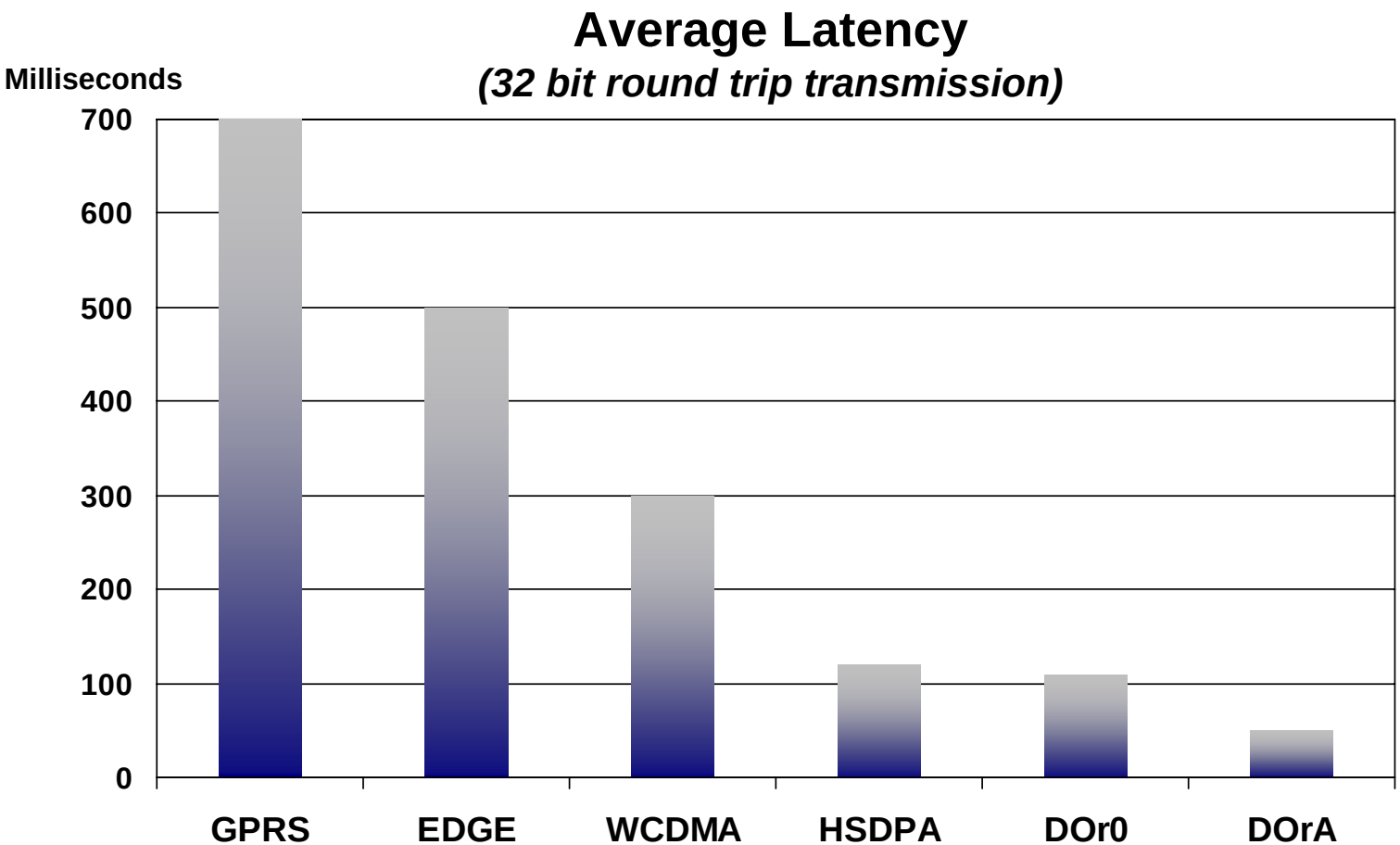
- Low Latency **down to 30ms**
- Quality of Service (QoS)
  - > Video Telephony
  - > Instant Multimedia (IMM)
  - > VoIP (Voice Over IP)
- Multicast

Gold Multicast
Media delivery at 409.6 kbps/sector

Platinum Multicast
Media delivery at 1.5 Mbps/sector

Latency Comparison

Low Latency Networks are Enabling Delay Sensitive Applications



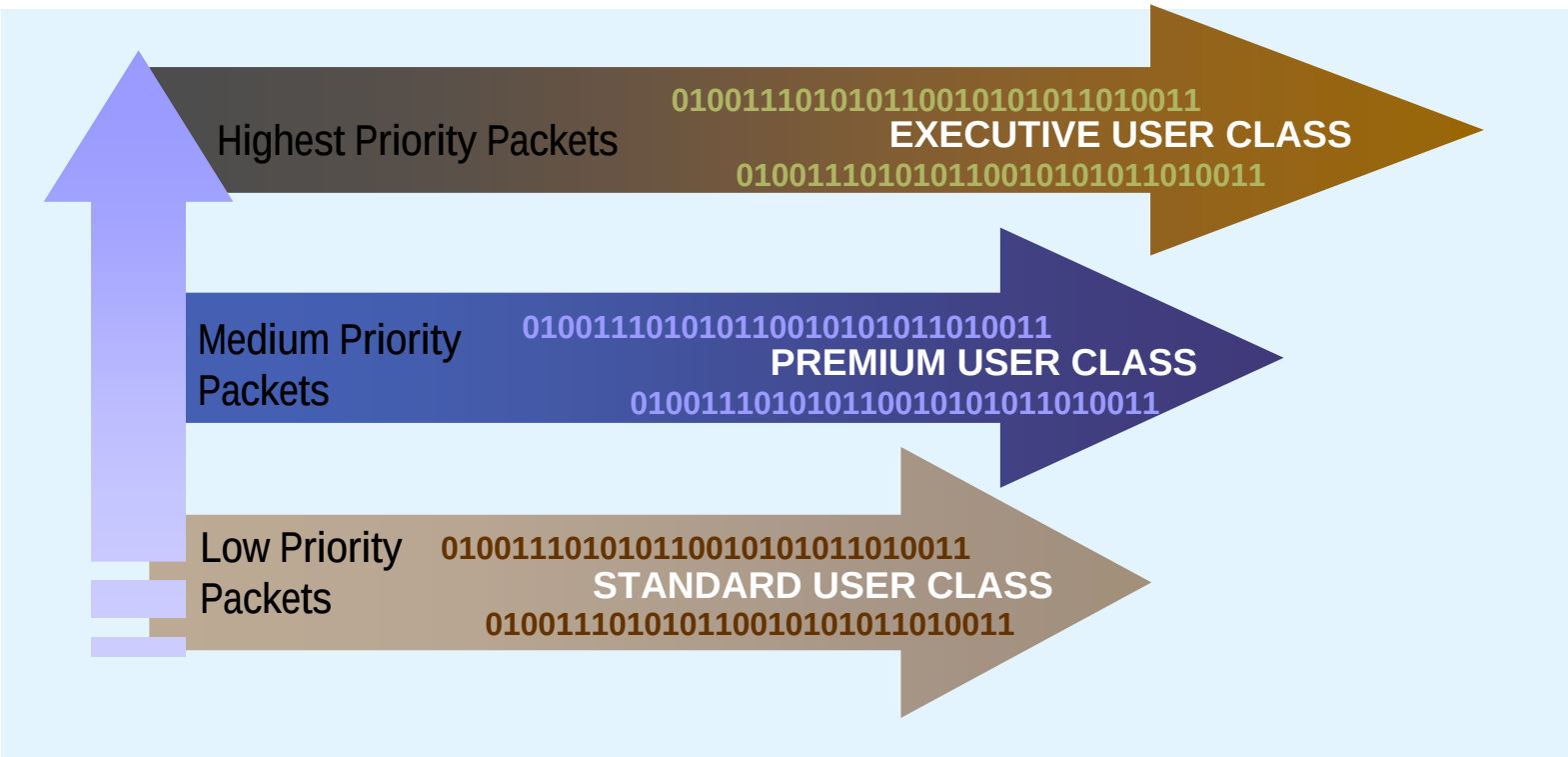
Smaller packets achieve better packing efficiency, plus shorter transmission times results in lower latencies

Source: Rysavy Research, September 2004 and Qualcomm simulations

Note: DOrA dynamically assigns variable packet lengths to optimize latency in lieu of increasing data throughput capacity.
Multiple small upper layer packets from “one” or “more” users can be multiplexed into a single DOrA physical later packet to optimize latency

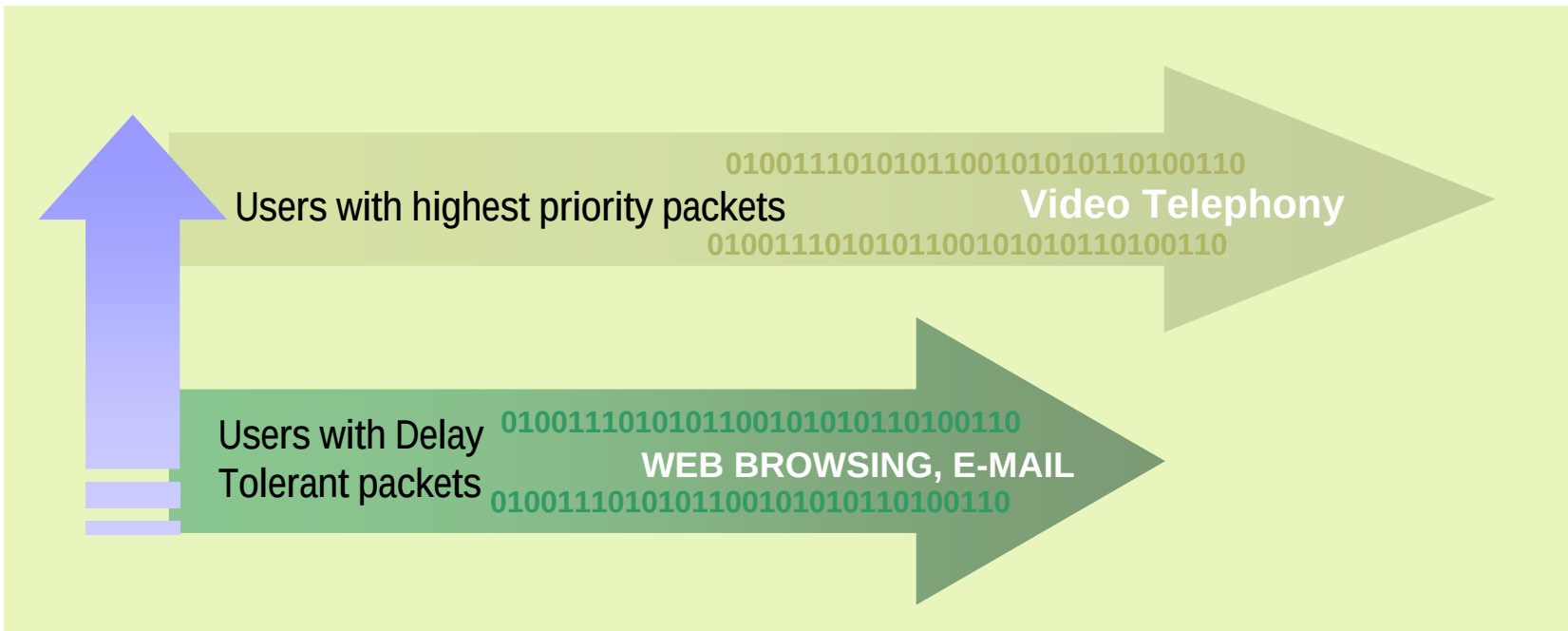
QoS Software Upgrade: Prioritize Users

- **User-Based QoS:**
  - Enables system to treat users with different levels of priority based on their subscription level (Executive, Premium, Standard)
  - User profile determines priority level and available applications
  - Implemented in EV-DO Rel 0 networks with minimal software



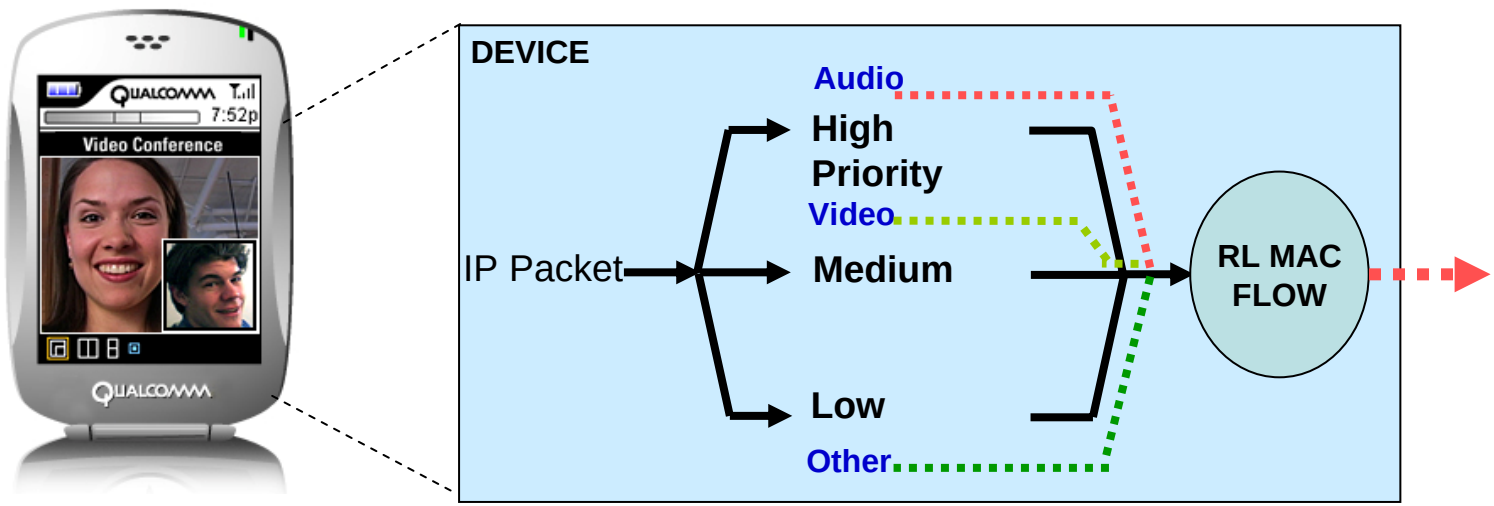
QoS Software Upgrade: Prioritize Applications

- **Application-Based QoS:**
  - Enables system to treat users with different levels of priority based on the current application utilized (e.g., Instant Multi-Media is high priority)
  - User's status elevated once high priority application launched
  - Once status elevated, all of the user's packets are treated in same high priority manner
  - Software upgrade to EV-DO Rel 0 networks



QoS App: Packet based Video Telephony

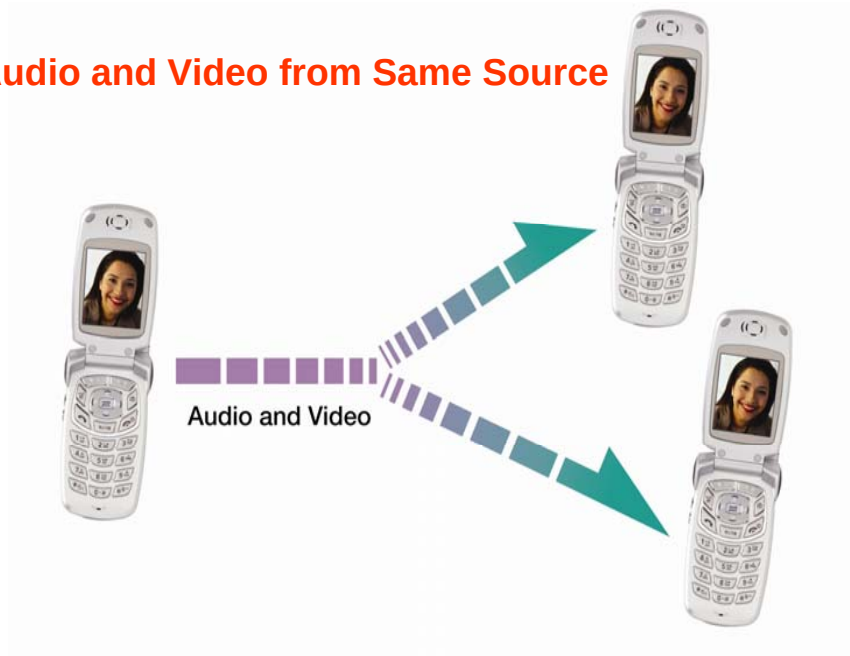
- **Video Telephony - a Full Duplex Service with Audio, Video, and Control Flows**
- **Packet VT More Efficient than Circuit Switched**
  - Transmit less data over the air in silent periods & lower video rates
  - More freedom in balancing available bandwidth & video quality
    - Improve video quality when resources available, degrade in higher loading conditions
  - Easier Integration with Other Packet-based Services (e.g., IM)



QoS Application: Instant Multi-Media

- Combines the best of video conferencing and group services
- Everyone in the group receives audio and video from the originator
- Both audio and video can come from one user or two different users
- Higher efficiency than video conferencing (only one RL at any time)

Audio and Video from Same Source



Audio and Video from Two Different Sources

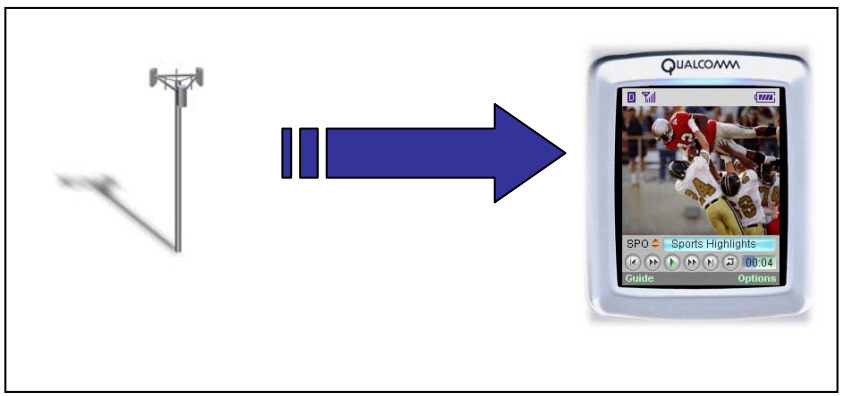
Rev A QoS Application: VoIP

- **Rev A QoS Enables Delay Sensitive Applications, such as VoIP**
- **Telco Quality VoIP Performance Goals Comparable to 1x Circuit-Switched Voice**
  - **58 simultaneous users / sector (2-Rx diversity devices, PIC)**
  - **Average mouth-to-ear delay**
    - 125 mSec (mobile to land)
    - 175 mSec (mobile to mobile)
    - Add approximately 50 mSec for 98 percentile case
- **VoIP Tests Underway, that if Successful (Simulations are Quite Positive) may cause Growth in Voice Traffic to be Accommodated by EV-DO**
- **VoIP allows Airlink to be used Flexibly between Voice and Data, Especially as Data Traffic Continues to Increase**
  - Voice becoming richer and more integrated with data and video (e.g., Telco Quality VT)
  - Operators can utilize idle voice capacity and clip-cast multimedia content to user devices

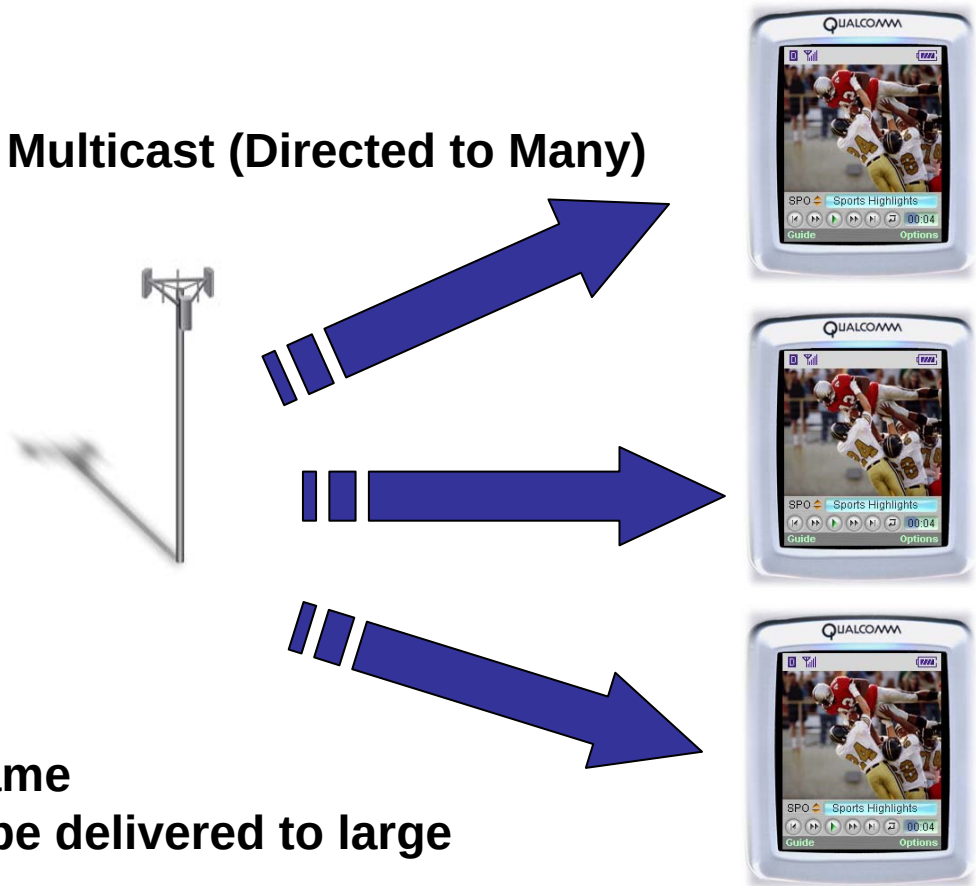
Multimedia Multicasting Innovations

Driving Down the Cost of Mobile Multimedia Delivery

Unicast (Directed to One)



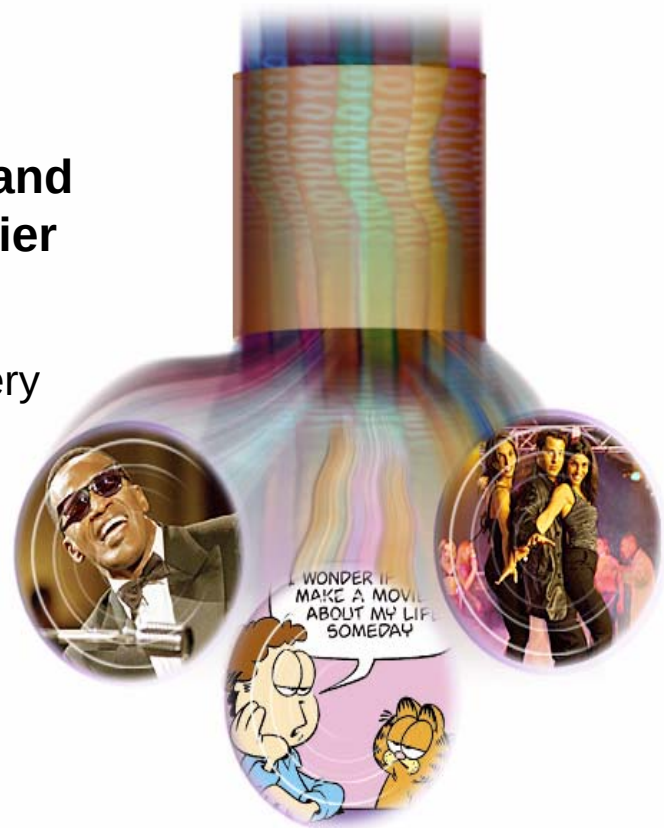
Multicast (Directed to Many)



- **Enable multiple channels of the same video, audio and other content to be delivered to large numbers of users simultaneously**
- **Increase capacity and reduce cost**

EV-DO Gold Multicast (BCMCS, TIA-1006)

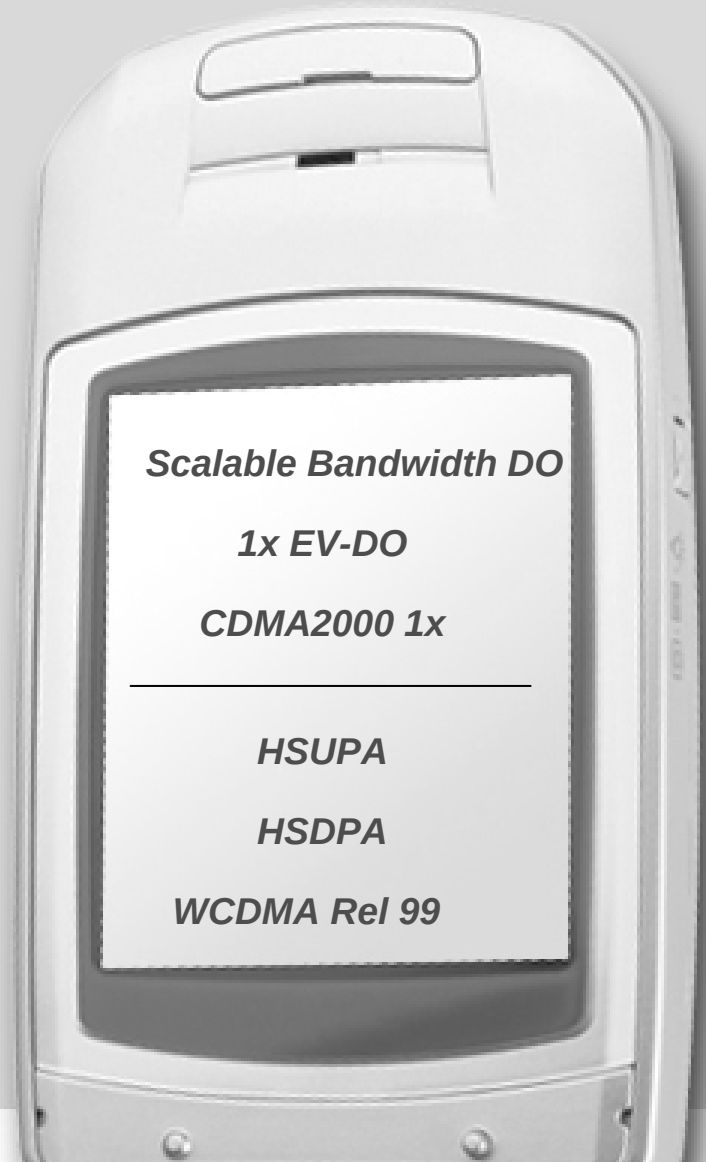
- **409.6 kbps capacity per sector with 99% coverage**
- **No Physical Layer changes to EV-DO Rel 0**
  - Software upgrade only
- **Flexibility in dynamically allocating Unicast and Multicast services in the same 1.25 MHz carrier**
- **Forward Link traffic only (no reverse link)**
  - Reed Solomon code replaces RLP for error recovery
- **Standard authentication and security mechanisms**
- **Operates in all environments**
  - Indoor and outdoor
  - Mobile, portable and fixed



EV-DO Platinum Multicast (proposed as TIA-1006-A)

- **Substantial capacity gains**
  - Approximately 3-4 times the capacity of EV-DO Gold Multicast
  - 1.5 Mbps per sector with > 98% coverage
- **Much improved system economics**
  - Cost/bit transferred over the air
- **OFDM modulation incorporated into EV-DO TDM FL**
  - No RF changes
  - Only baseband affected
- **Same network architecture and security mechanisms as Gold Multicast**
  - Same upper layers
- **Same flexibility as EV-DO Gold Multicast**
  - Can dynamically allocate between Unicast and Multicast services
- **Operates in all environments**

Data Throughput Comparison on Technologies



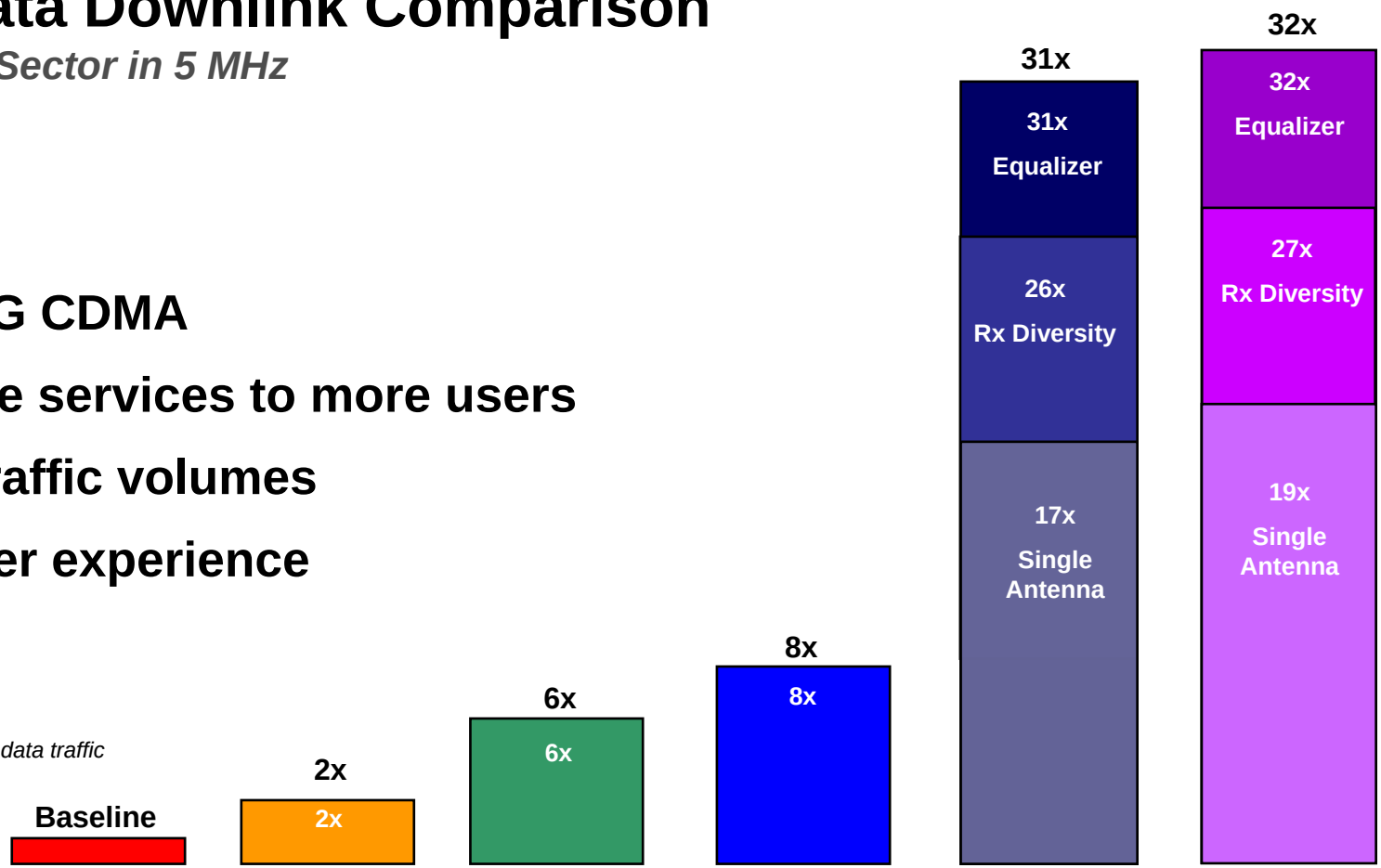
Average Data Downlink Comparison

Throughput per Sector in 5 MHz

Wireless 3G CDMA

- Affordable services to more users
- Greater traffic volumes
- Better user experience

Note:
Assumes 100% loading of data traffic
Pedestrian Mobility

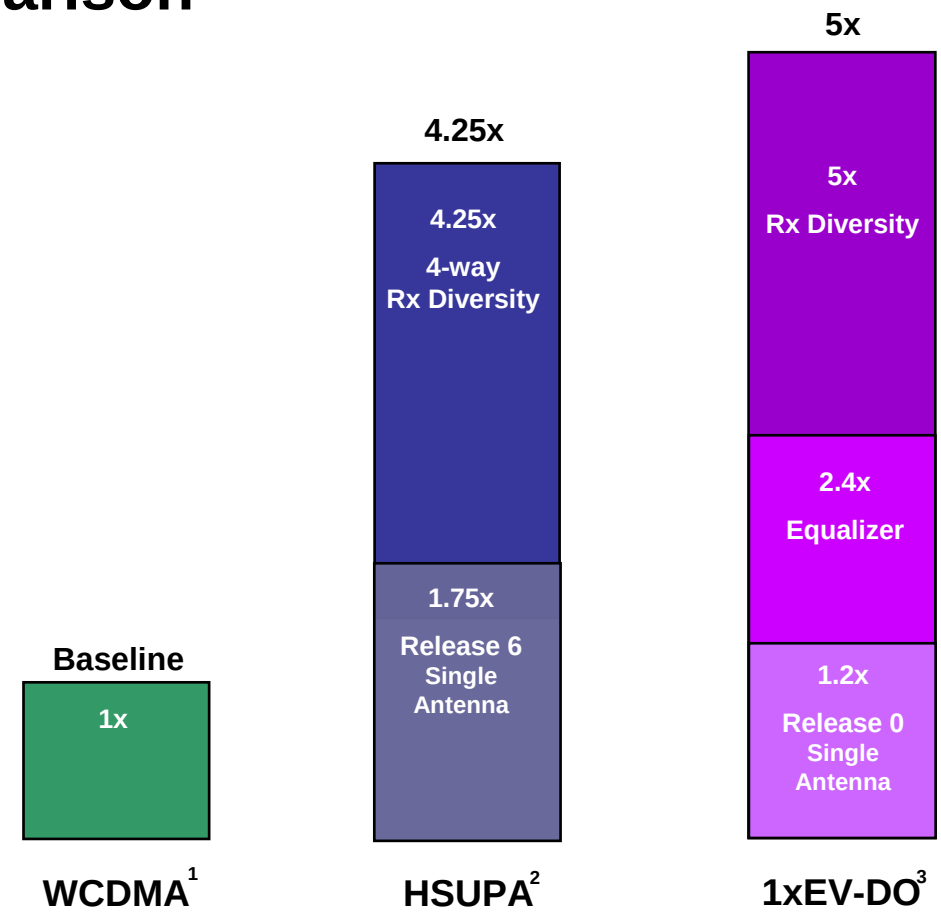


	GPRS [1]	EDGE [2]	WCDMA [3]	CDMA2000 1X [4]	HSDPA [5]	1xEV-DO [6]
Avg. Throughput (per sector)	140 kbps	430 kbps	800 kbps	1,050 kbps	2,400-4,400 kbps	2,610-4,500 kbps
Re-use	1/3	1/3	1/1	1/1	1/1	1/1

1 Assumes 10 kbps per slot, 35% loading
2 "EDGE Performance Evaluation", Alecsander Eitan and Amir Gazit, Qualcomm Israel Ltd., March 2003
3 "Comparing HSDPA vs R99 Capacity v7", QUALCOMM Internal Paper: Thomas Klingenbrunn
4-6 QUALCOMM Simulations, see assumptions page for details

Average Data Uplink Comparison

Throughput per Sector in 5 MHz



Note:
Assumes 100% loading of data traffic
Pedestrian Mobility

	WCDMA[1]	HSUPA[2]	1xEV-DO[3]
***Average Data Throughput** (per sector)*	800 kbps	1,400-3,400 kbps	975-3,975 kbps

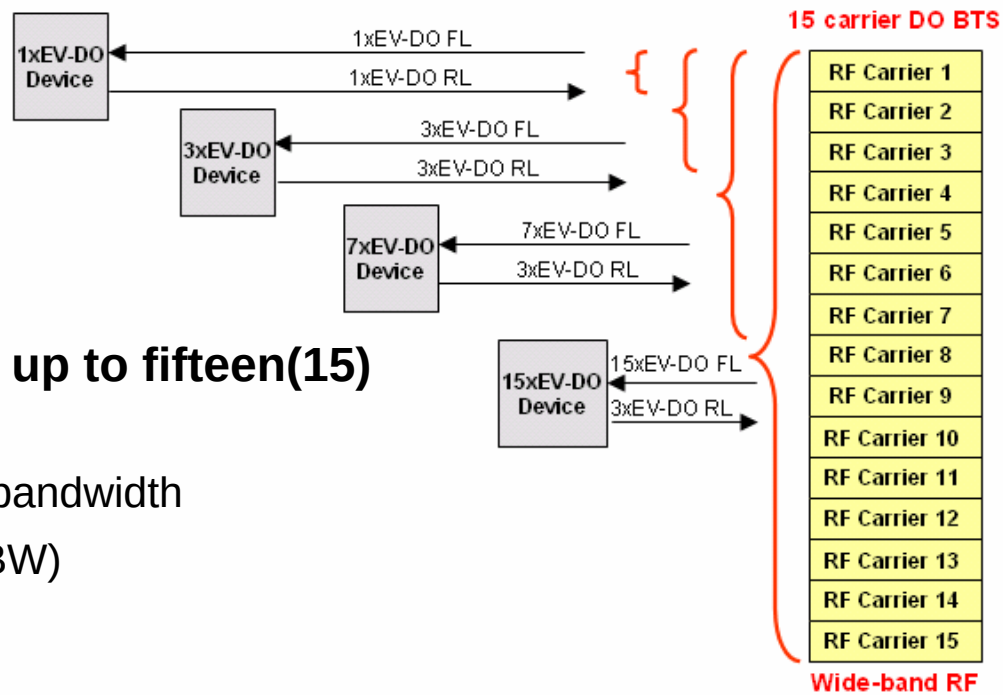
Simulation Assumptions

1. Channel Models: Modified ITU - 30% PedA 3kmph, 30% PedB 3kmph, 20% VehA 30kmph, 20% VehA 120kmph, 10 ms TTI
2. Channel Models: Modified ITU (3GPP TR 25.896) - 30% PedA 3kmph, 30% PedB 3kmph, 20% VehA 30kmph, 20% VehA 120kmph, Cell Radius 1.4km, Link Budget (3GPP TR 25.896), Simple Receiver - No Interference cancellation at BTS, 2ms TTI, 10 users per sector
3. Channel Models: ITU Channel Models - PedA 3km/h (1 path) 30%, PedB 10km/h (3 paths) 30%, VehA 30km/h (2 paths) 20%, PedA 120km/h (1path) 10%, Rician (1 path) 10%, Simple Receiver - No Interference cancellation at BTS, 10 users per sector

Next step of EV-DO Evolution

Scalable Bandwidth EV-DO

A Scalable Solution when Increased Bandwidths are available



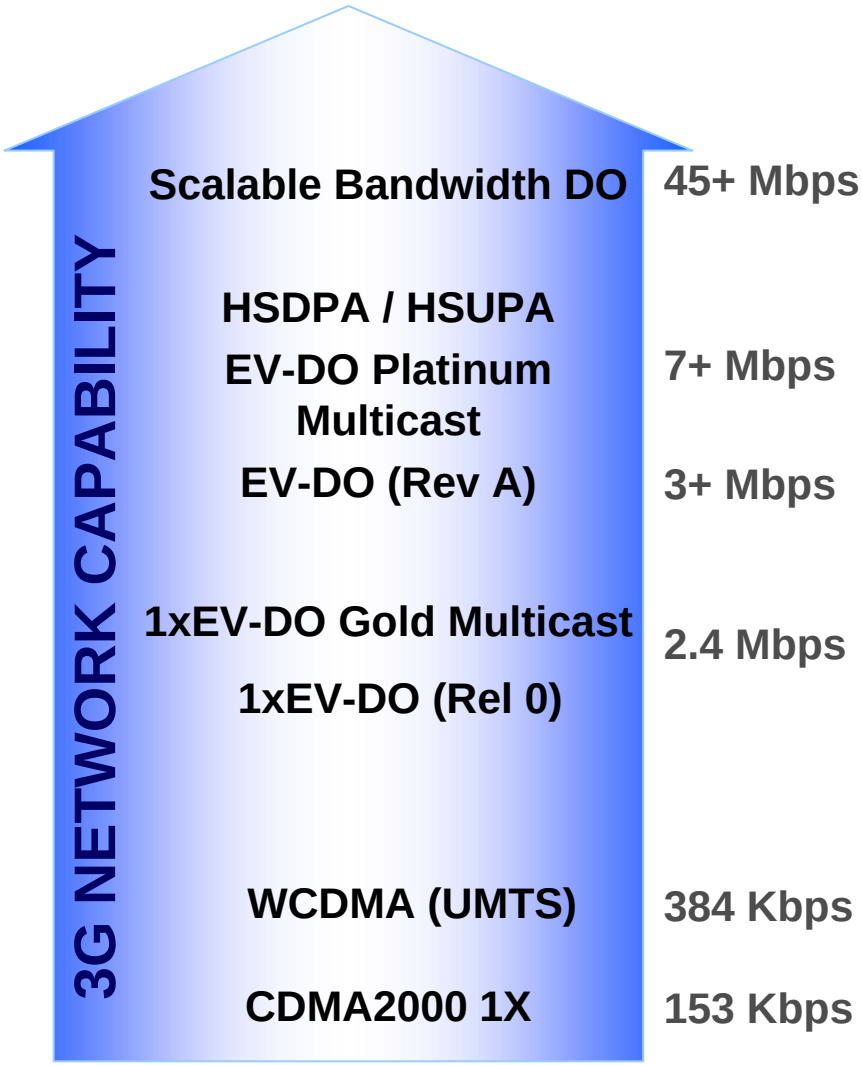
- **Scalable approach for aggregating up to fifteen(15) 1.25 MHz carriers**
  - Peak data rates increase linearly with bandwidth (46 Mbps FL / 27 Mbps RL in 20 MHz BW)
  - No loss in spectral efficiency
- **Backward & Forward compatible with existing EV-DO Networks**
- **Can be deployed in Cellular, PCS, and Other Frequency Bands (2 – 3.5 GHz)**
- **Minimal Standards Impact focusing on higher Layers**

Conclusion

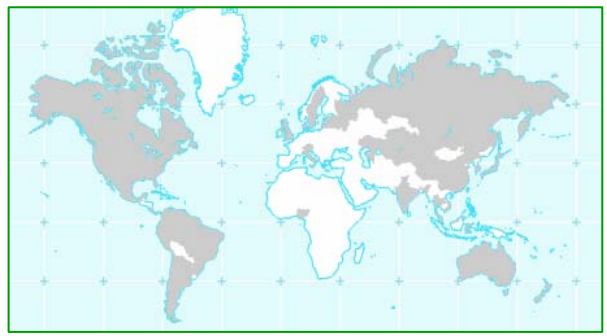

OmniOne
Mobile Communications System
cdmaOne
CDMA2000
QPOINT
MSM
MSM
Wireless
Internet
Launchpad™
brew
GSM
GPRS
EDGE
UMTS
WCDMA
HSDPA
Qtunes
Qcamcorder
Q3Dimension
QChat
Qvideophone
CMX
QCamera
brew chat
Qtv
MediaFLO

The Future of Wireless

The Foundation for Future Wireless Growth: 3G Networks



Strong Global Demand *



- Over 147 3G CDMA operators
- Over 175M 3G subscribers
- Over 674 3G mobile devices
- Over 50 mobile device vendors

3G networks set the foundation

- Increased voice penetration
- Compelling applications
- Increased earnings opportunity

*Source: www.3Gtoday.com, as of April 2005

Conclusion

- **3G CDMA technology for today**
  - Provide much larger voice and data capacities than 2G technologies
  - Offer high packet data rate to support 3G multimedia apps
- **Upcoming New features provide**
  - Higher data throughput and capacities for Wireless Broadband solution (such as EV-DO Rev A)
  - Better QoS and Lower Latency to support delay-sensitive apps, such as VoIP
  - New Channels defined to offer multicast / broadcast services efficiently
- **Smooth Migration on 3G Evolution with Full Backward Compatibility**
- **Next Step on 3G CDMA Enhancement**
  - Continue to improve data throughput and increase the spectral efficiency, for lower the cost of mass adoption on Wireless Broadband service

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Thank You