ITU-D Regional Development Forum for the Asia Pacific Region

"NGN and Broadband, Opportunities and Challenges"

Yogyakarta, Indonesia, 27 – 29 July 2009

3G Technical Evolution as an evolving broadband solution

Dr Patrick Tsie

Senior Director – Technical Marketing

Qualcomm International Inc

Agenda

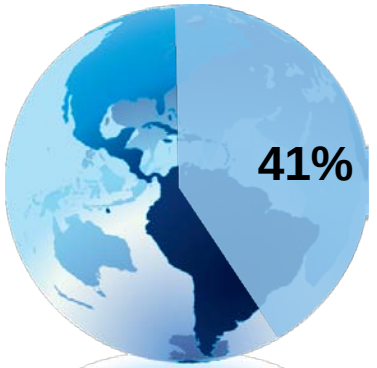
- 3G Market Situation
- 3GPP & 3GPP2 Technology Evolutional Roadmap
- LTE
- What's Next?

3G Solution to Bridging the Digital Divide

Why Wireless Connectivity Matters

Mobile Penetration:
1% increase ➡ 4.7% increase in average per capita income

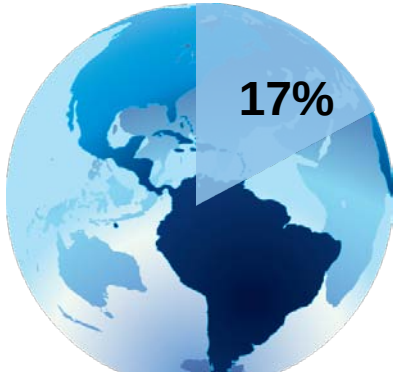
Internet Penetration:
1% increase ➡ 10.5% increase in average per capita income



Global **MOBILE** Penetration

3G: Key solution to bridging the Digital Divide

- **Fast**
- **Affordable**
- **Prevalent**



Global **INTERNET** Penetration

Source: Telecommunications Management Group, Inc (TMG) and ITU World Telecommunications Database Statistics; 2007
World Telecommunication/ICT Indicators Database online 11th edition, 2007.
Retrieved November 13, 2007, from http://www.itu.int/ITU-D/ict/statistics/ict/index.html

3G Eco-System: Strong Global Presence for Mobile Broadband

CDMA2000 Status:

165 EV-DO (>60 Rev. A)

275 CDMA2000 1X

430M CDMA2000 subs/120M EV-DO subs

UMTS Status:

255 HSDPA (>70 HSUPA)

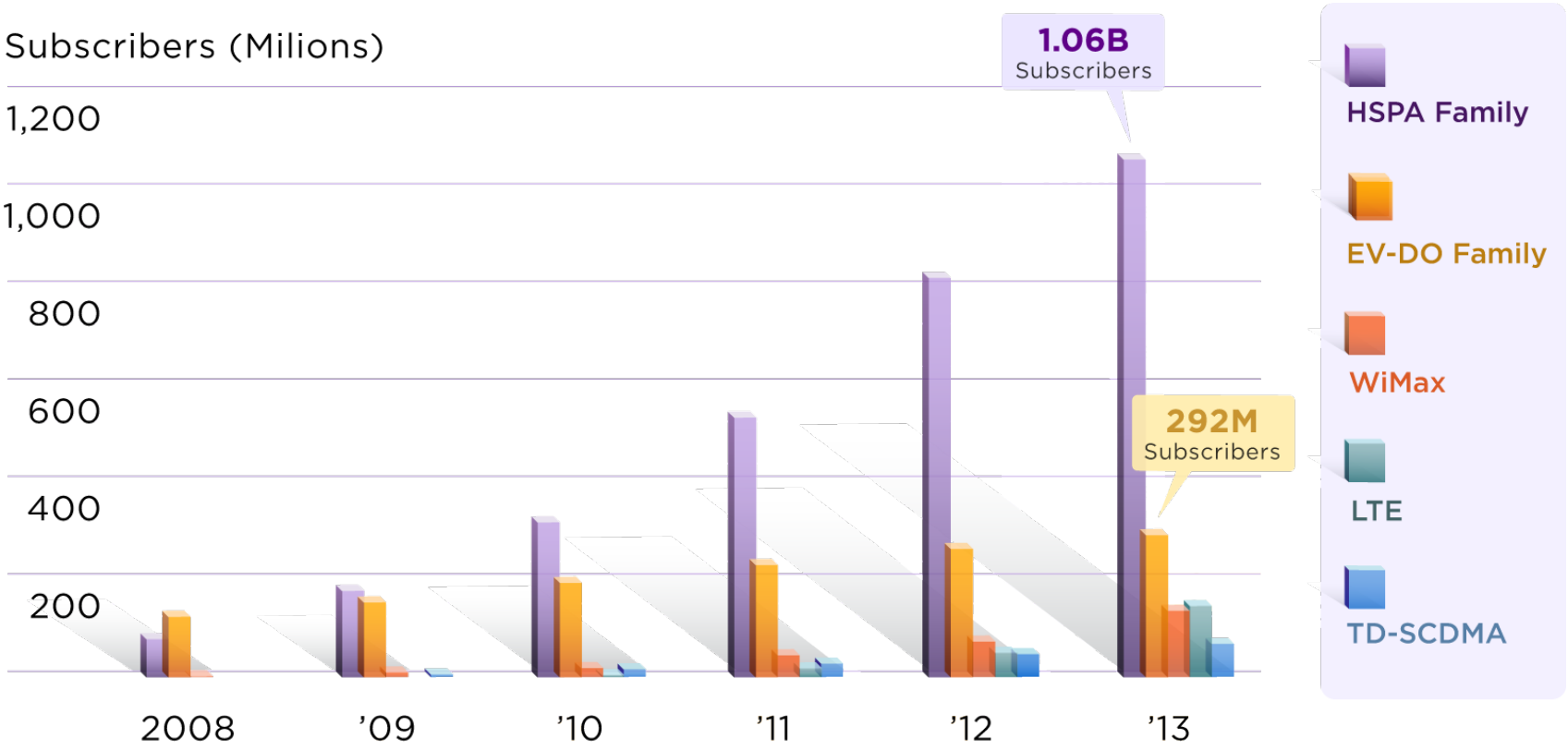
275 WCDMA

350M WCDMA subs/110M HSPA subs

Source: Wireless Intelligence estimates as of April 24, 2009)

CDG as of March 2009 & GSA as of April 2009)

3G Will Drive Mobile Broadband Connections Into the Next Decade

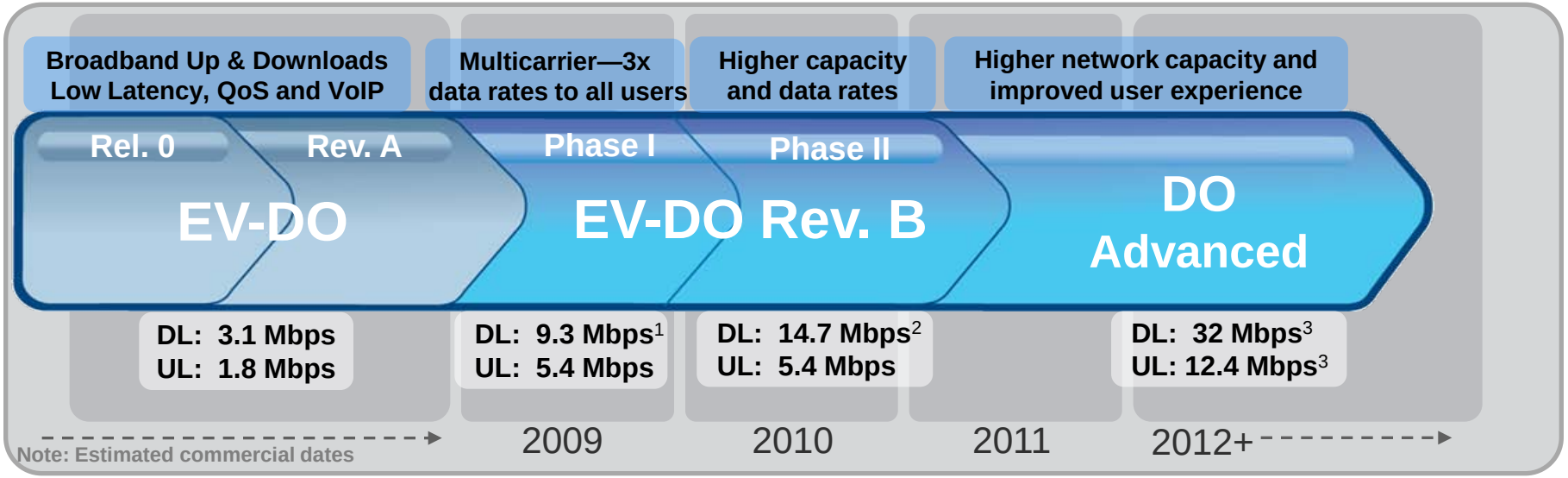


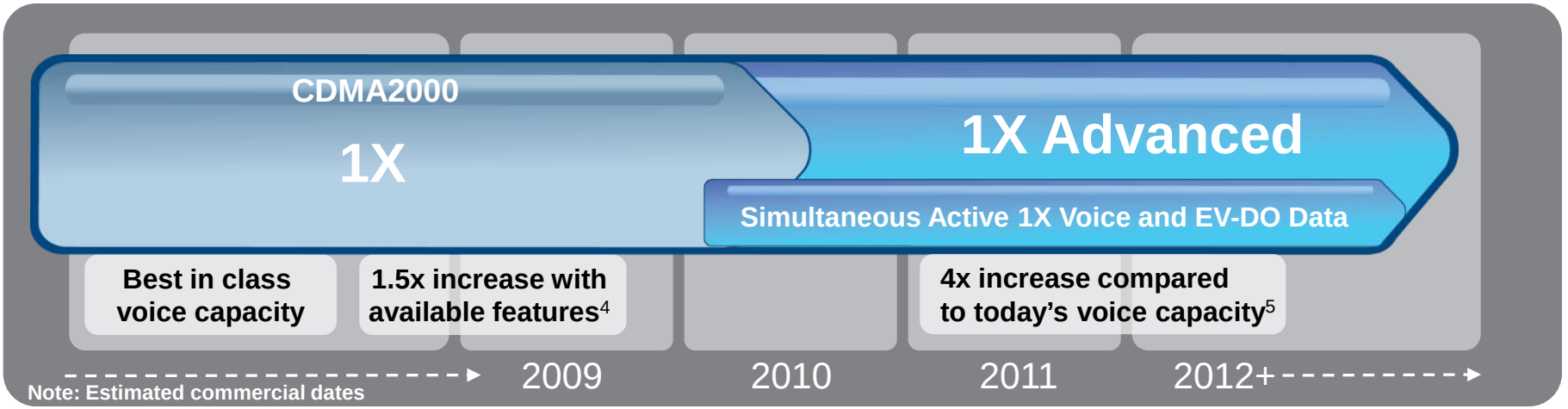
3G will enable **80%** of mobile broadband subscriptions in 2013

Sources: HSPA Family and EV-DO Family - Average of SA, WCIS+, WI, In-Stat and ABI. WiMax - Average of ABI (Q3 2008) and In-Stat (June 2008). LTE - Average of SA, In-Stat and ABI. TD-SCDMA - Average of SA, WI, In-Stat and ABI. Note: Forecasts from In-stat and WI are available only till 2012. Forecasts from WCIS do not have data for 2008.

3GPP2 Technology Evolutional Roadmap

3GPP2 Technology Evolution Paths

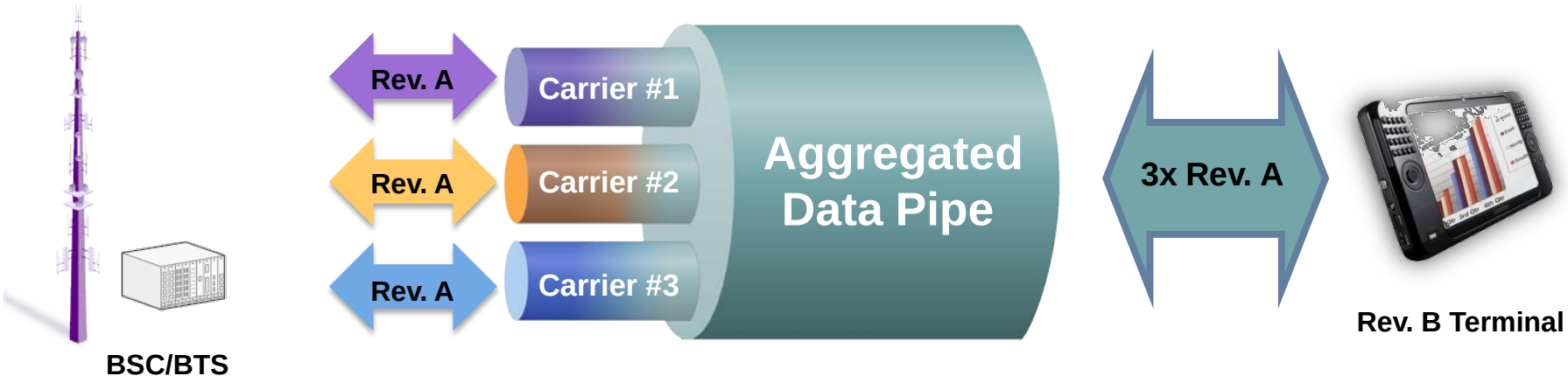




[1]Peak rate for 3 EV-DO carriers supported by initial implementation.
[2]Peak rate for 3 EV-DO carriers with 64QAM in the DL. Rev. B standard supports up to 15 aggregated Rev. A carriers.
[3]DO Advanced peak rate for 4 EV-DO carriers, assumes 2x2 MIMO and 64QAM in the DL and 16 QAM in the UL.
[4]Capacity increase possible with new codec (EVRC-B) and handset interference cancellation (QLIC). [5]4x increase with receive diversity; 3x without

Created 03/27/09

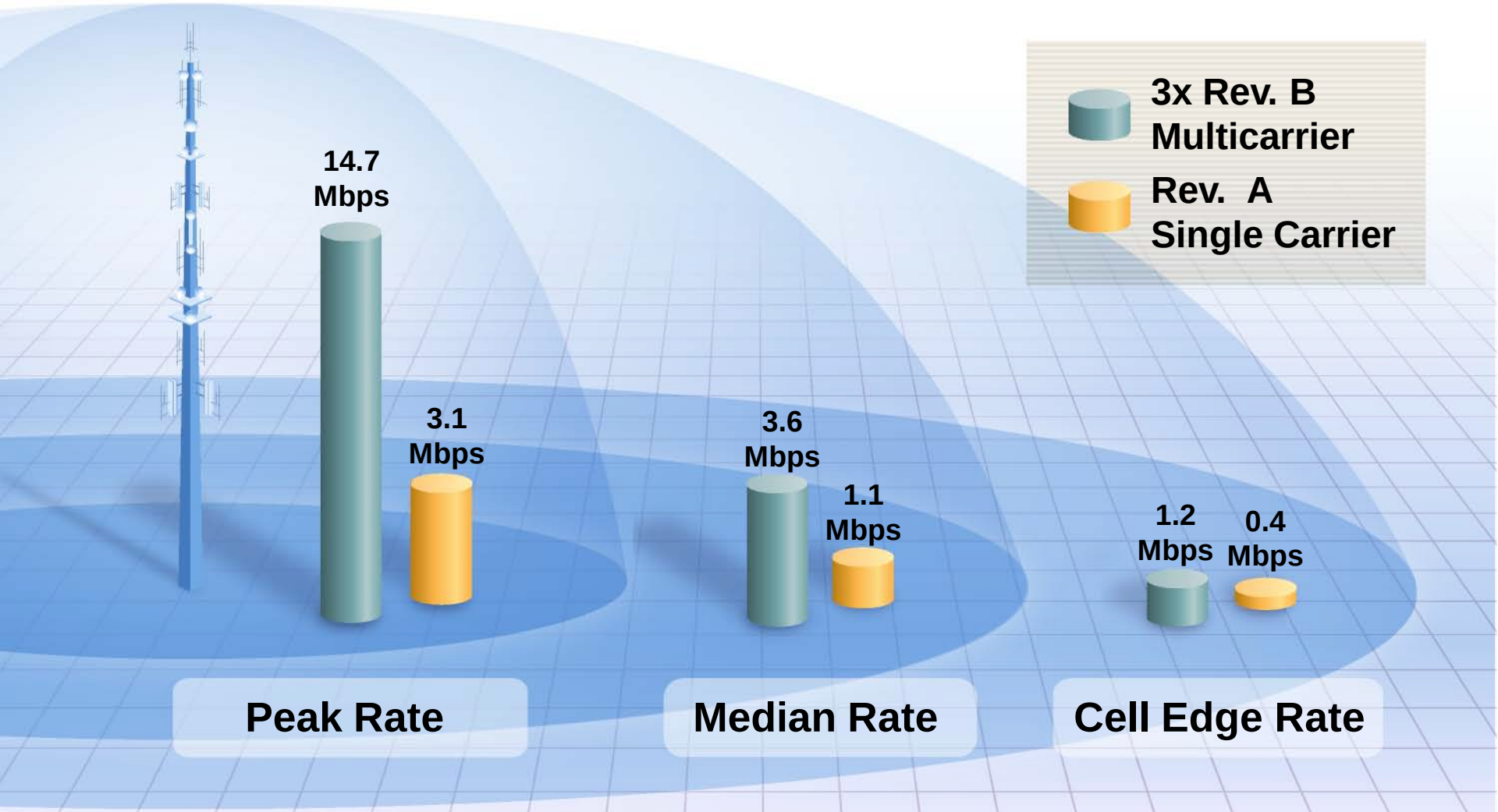
Multicarrier Enhances Broadband Experience



- Aggregating multiple Rev. A carriers creates a bigger data pipe
- Up to 3x user data rates and lower latency throughout the cell
- Dynamic bandwidth allocation

Cost-effective software upgrade to multicarrier

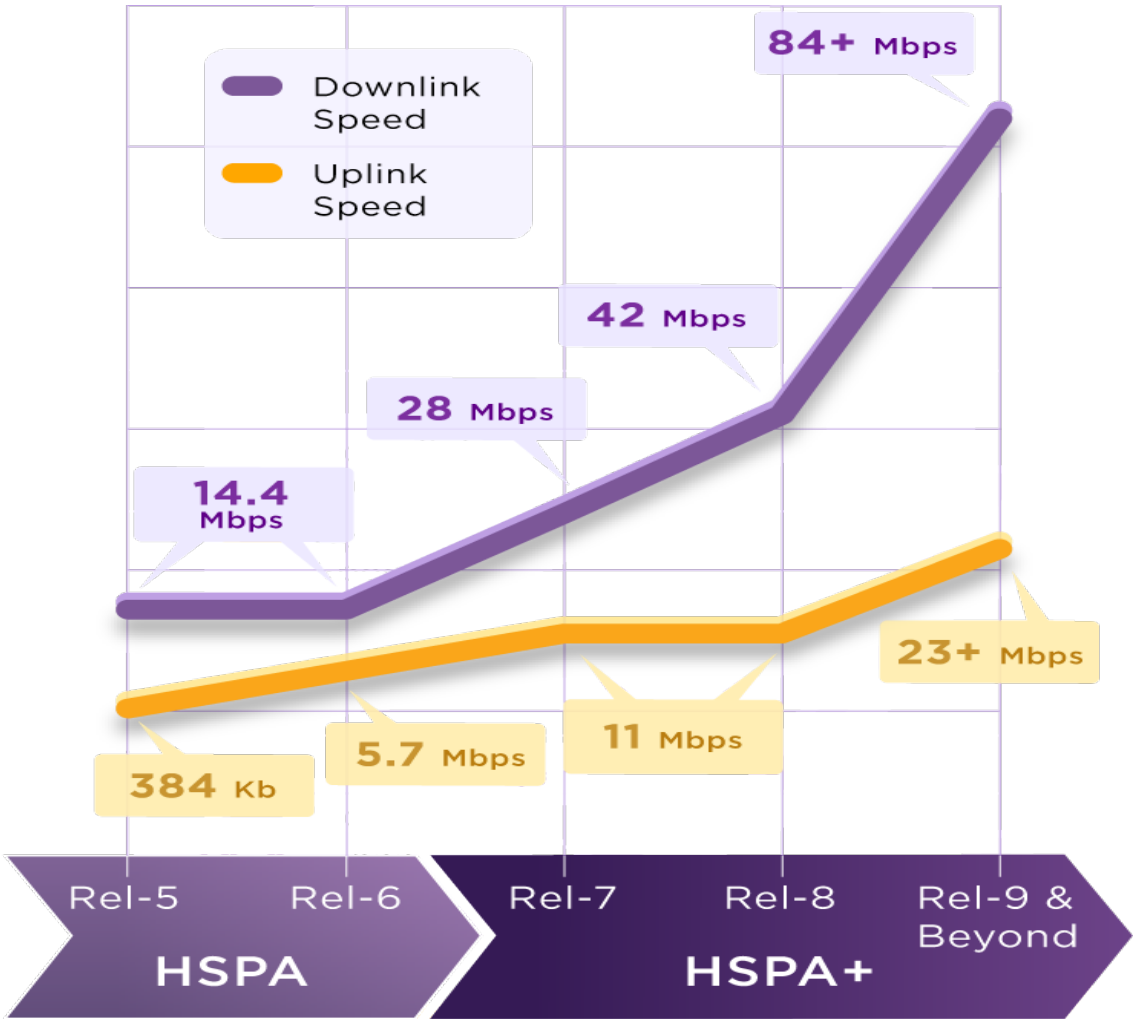
Multicarrier Triples Data Rates to *All* Users



Source: Peak rates are as defined in standards. The median and cell edge rates are based on Qualcomm simulations, using mixed channel model with Rev. B Phase-II devices supporting 64 QAM

3GPP Technology Evolutional Roadmap

HSPA+: A Strong Evolution Path



HSPA+ Devices

BandRich Inc. · HUAWEI · NOVATEL WIRELESS · SIERRA WIRELESS · OPTION · ONDA · ZTE中兴

4 HSPA+ Launches

Telstra · StarHub · mobilkom austria · CSL

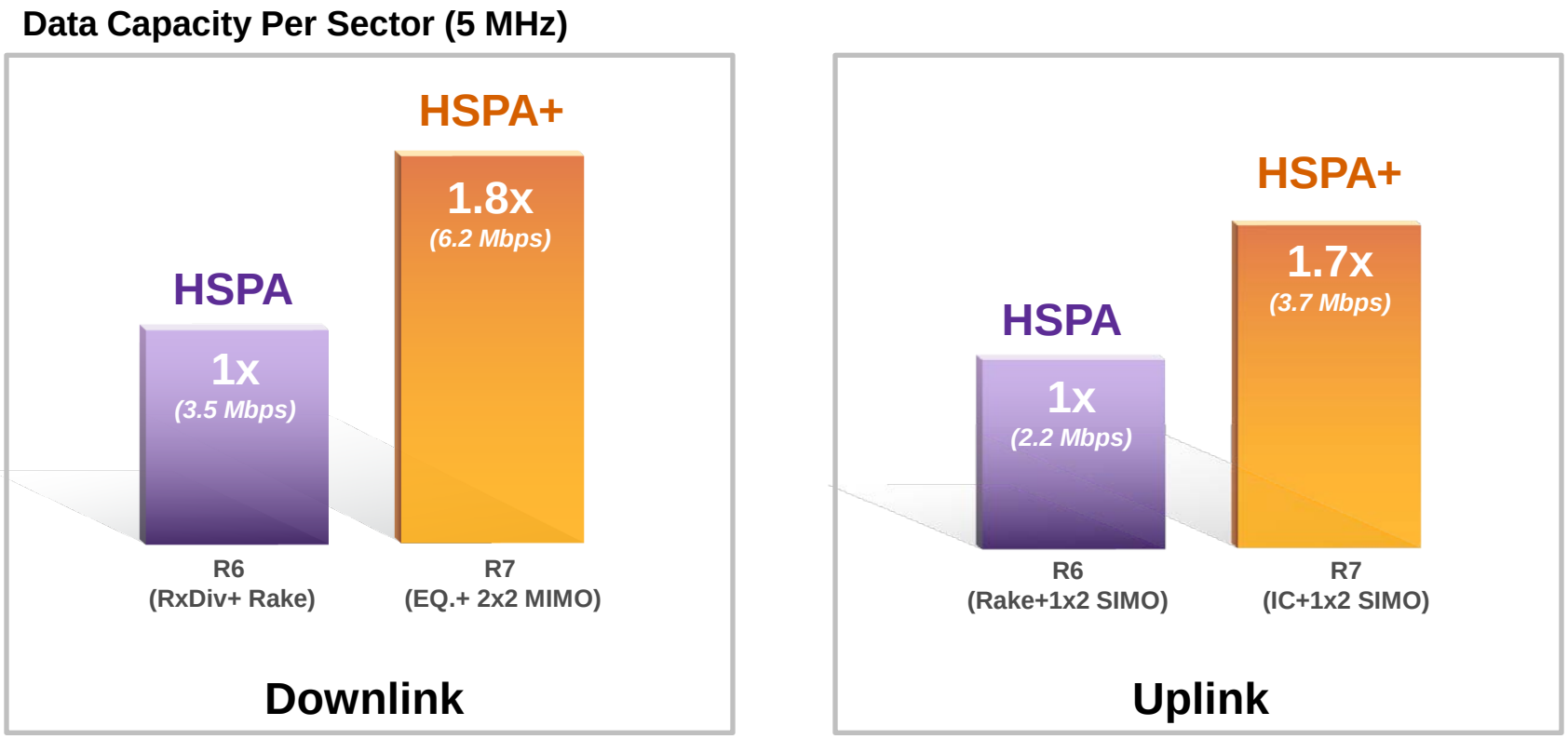
Strong Operator Interest (36+)

vodafone · O2 · Telefónica · TELECOM ITALIA · at&t · Telecom New Zealand · 3 · PCCW · SK telecom · Telecom · M1 · SingTel · Dialog Telekom · SoftBank · etisalat · EMOBILE

~20 additional operators have announced HSPA+ plans

Source: GSA (May09) and Informa Telecoms & Media (May09)

HSPA+ R7 Doubles HSPA Data Capacity

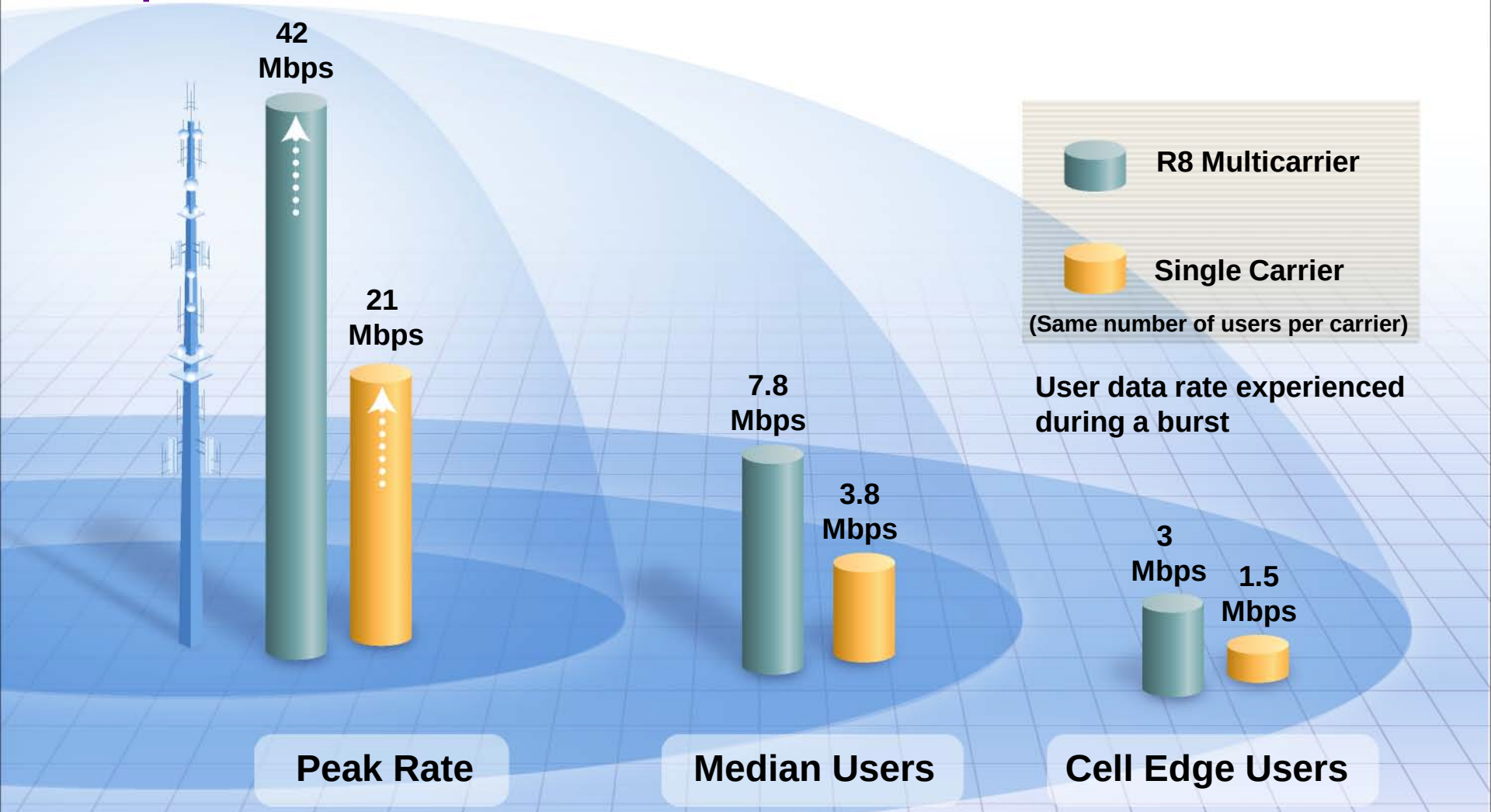


When also leveraging advanced receivers

(Handset Equalizer & Node B Interference cancellation)

[1] Source: Qualcomm Simulation, details in 3GPP R1-070674. NGMN D1 500m ISD. 16QAM not considered for the UL and UE IC not considered for the DL. HSPA+ multicarrier and DL Interference Cancellation would further increase the capacity.

R8 Multicarrier Enhances Broadband Experience —Doubles Data Rates to *All* Users

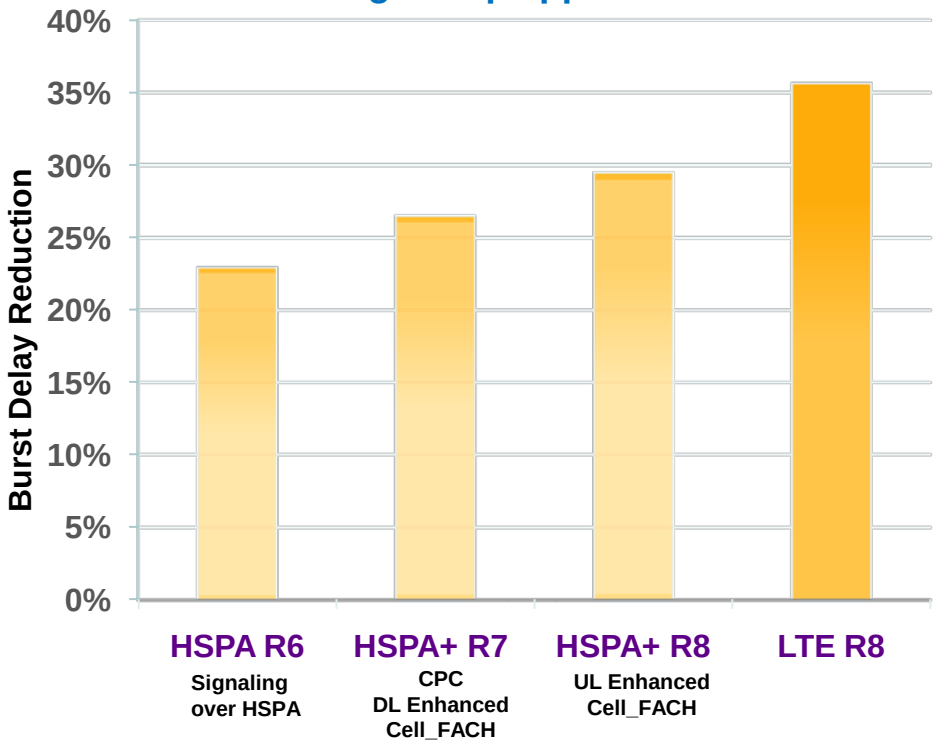


Qualcomm simulations. Each scenario is based on the same total number of users (eight users) per carrier, see 3GPP R1-081890 for details. Shows the theoretical peak data rata and the burst data rate for the median users and the 10% worst (cell edge) users. No MIMO with Multicarrier in R8. Peak data rates are scaled down by a factor of 2 in the picture.

HSPA+ Evolution Enhances User Experience

- More responsive user experience
  - 50% reduction in call setup (R7)[1]
  - 50% reduction in transitions time between inactive and connected states (R7 & R8)[2]
- Better ‘always-on’ experience
  - User can stay longer in connected state without compromising battery life (R7)[3]

Example of decreasing delay using Google map application[4]

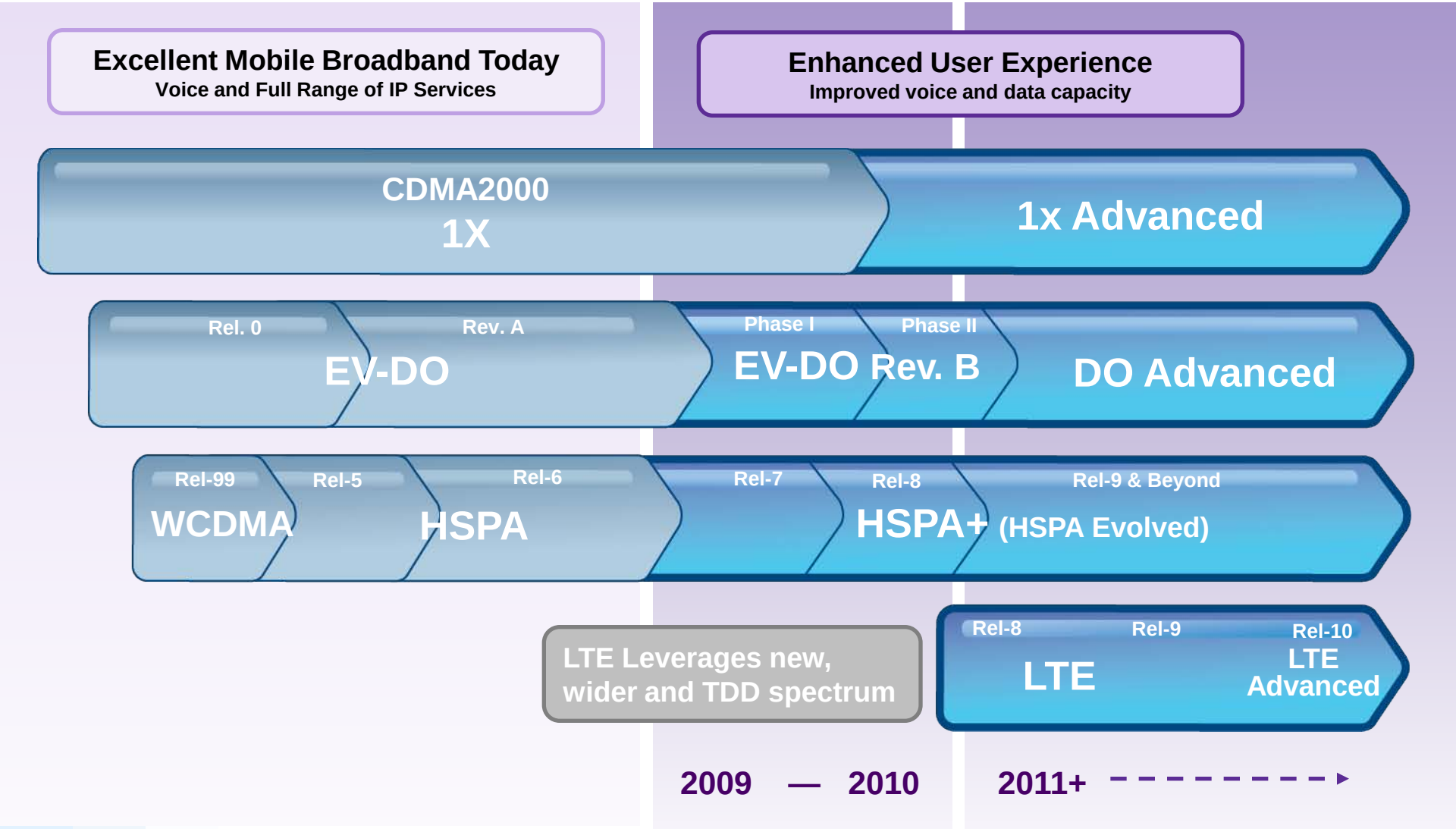


Baseline: R5/R6 UE with signaling over dedicated channels

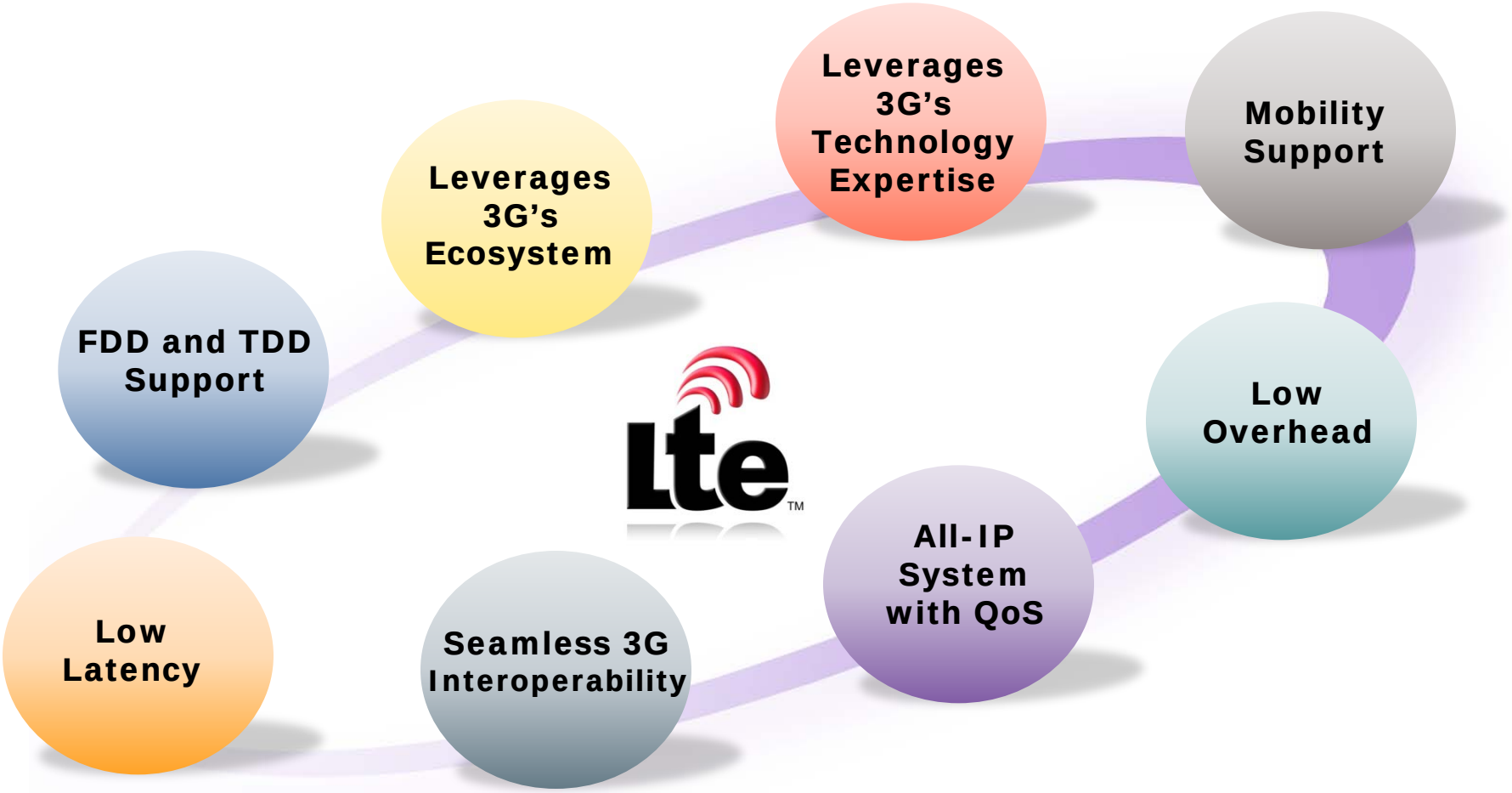
[1] Paging messages sent over HSDPA channels in CELL_PCH state.[2] Up to 50% reduced time over the air (from PCH to CELL_FACH/DCH state) compared to R6 with Enhanced CELL_FACH/PCH [3]Users can stay in connected state longer without compromising battery life and experience faster state transitions thanks to CPC. [4]Qualcomm simulations, Traces collected from running application (Google Maps). The metric used is traffic burst over-the-air delay (no network delays included) Simulation also includes initial transitions from idle to connected state .

LTE

LTE is A Parallel Evolution Path to 3G



LTE: An Optimized OFDMA Solution

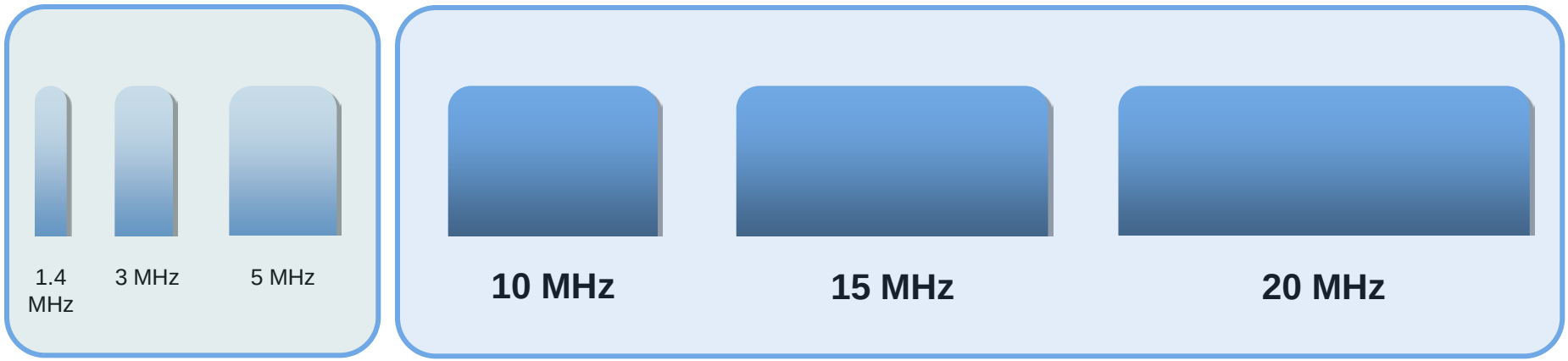


Continuing 3G's track record of mobility and high spectral efficiency

LTE Leverages New and Wider Spectrum

Available in smaller bandwidths

Best suited to leverage new and wider bandwidths



LTE relative performance decreases with bandwidth due to higher overhead; 40% overhead in 1.4 MHz vs. 25% in 20 MHz results in 25% better relative performance in 20 MHz vs. 1.4 MHz.

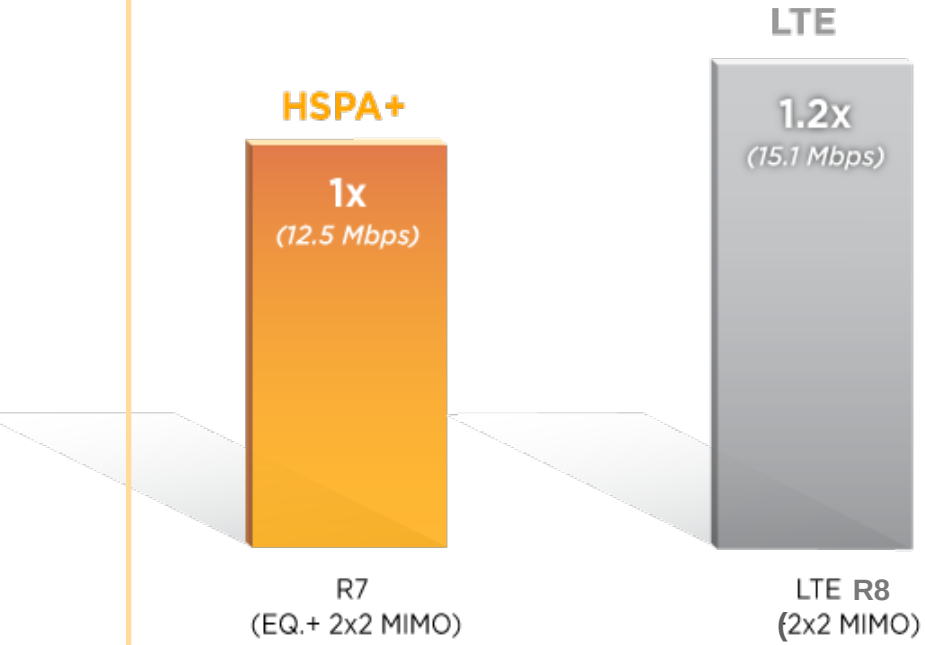
Optimal Technology for Unpaired TDD spectrum

TDD 2:1 shown as an example. LTE also supports half-duplex.

Similar HSPA+ and LTE Performance

Similar Spectral Efficiency

with same number of antennas and bandwidth
(Downlink sector capacity in 10 MHz FDD)



Note: Handset Interference Cancellation and HSPA+ multicarrier would further improve HSPA+ spectral efficiency.

Similar Peak Data Rates

with same bandwidth and number of antennas
(Downlink peak data rate)

Bandwidth	HSPA+	LTE
5 MHz	**42 Mbps**	**37 Mbps**
10 MHz	**84 Mbps**	**73 Mbps**
20 MHz	**Beyond R9**	**150 Mbps**

Note: Assuming 2x2 MIMO. LTE supports 4x4 MIMO but initial deployments will support 2x2 MIMO.

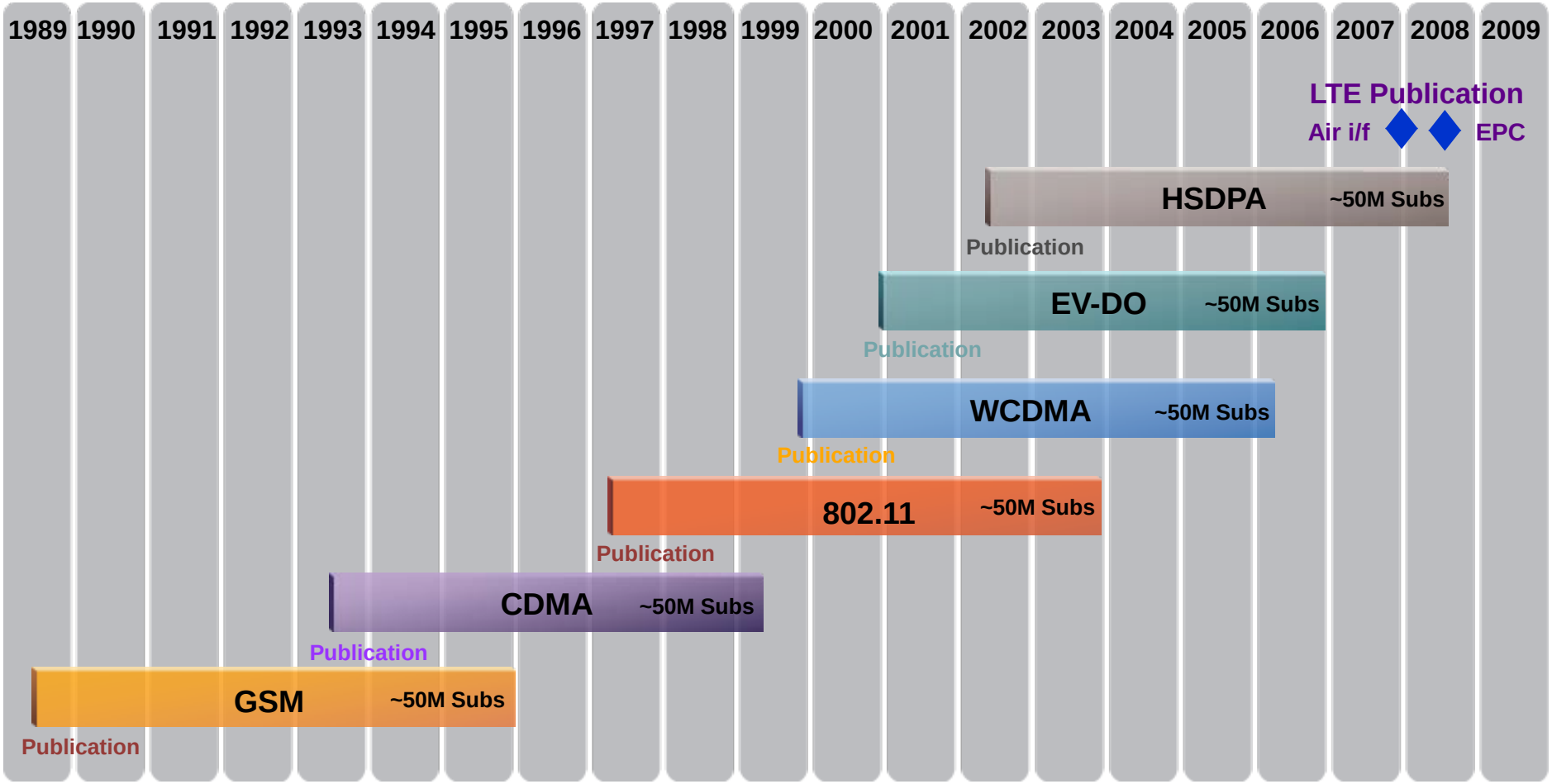
Similar RTT Latency

Transport NW key for low latency—can be same for LTE&HSPA+

	HSPA+	LTE
RT T[2]	**28 ms +** **Transport network**	**22 ms +** **Transport network**

[1] Source: Qualcomm Simulation, details in 3GPP R1-070674. NGMN 500m ISD, HSPA+ R7 results scaled up from 10 MHz. HSPA+: 16QAM not considered for the UL and UE IC not considered for the DL. HSPA+ multicarrier and DL Interference Cancellation not considered and would narrow the gap with LTE.
[2] Source: Qualcomm assuming similar operating points, processing delays, excludes transport network delay that is dependent on actual network used

~6-7 Years from Standards Publication to ~50M Subs for Successful Wireless Standards

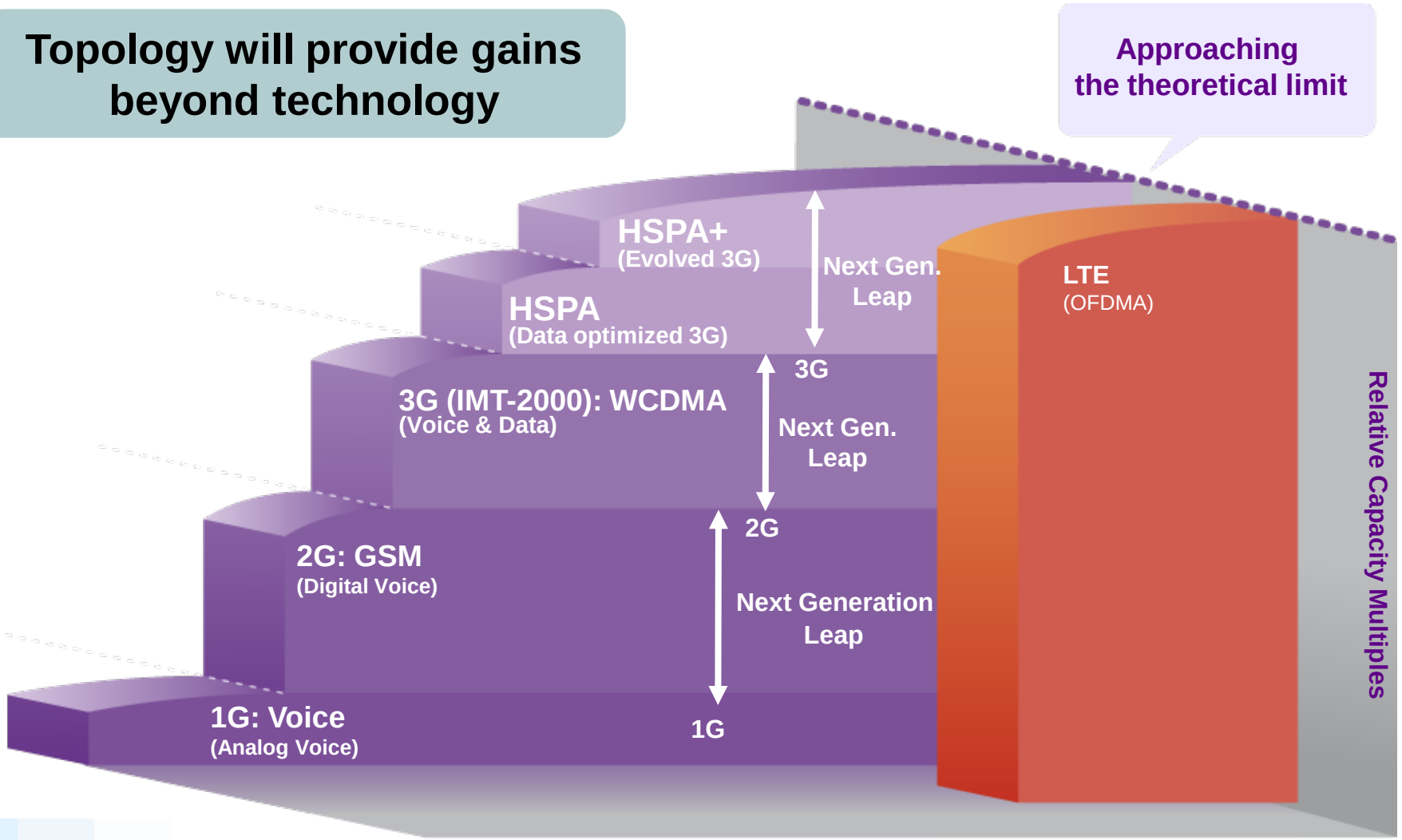


Sources: CDG, Qualcomm, Ericsson, IEEE, 3GPP2 and GSMA. The "first reference publication" date **used is the earliest** publication date where Qualcomm feels that a set of reasonably complete **and** consistent specifications were available. Note that the LTE air interface publication date **shown is** 12/2007, but the core network (EPC) was published mid 2008. A stable ASN.1 code is required for commercial implementation of the standard (LTE R8 ASN.1 freeze expected 1H 2009**).**

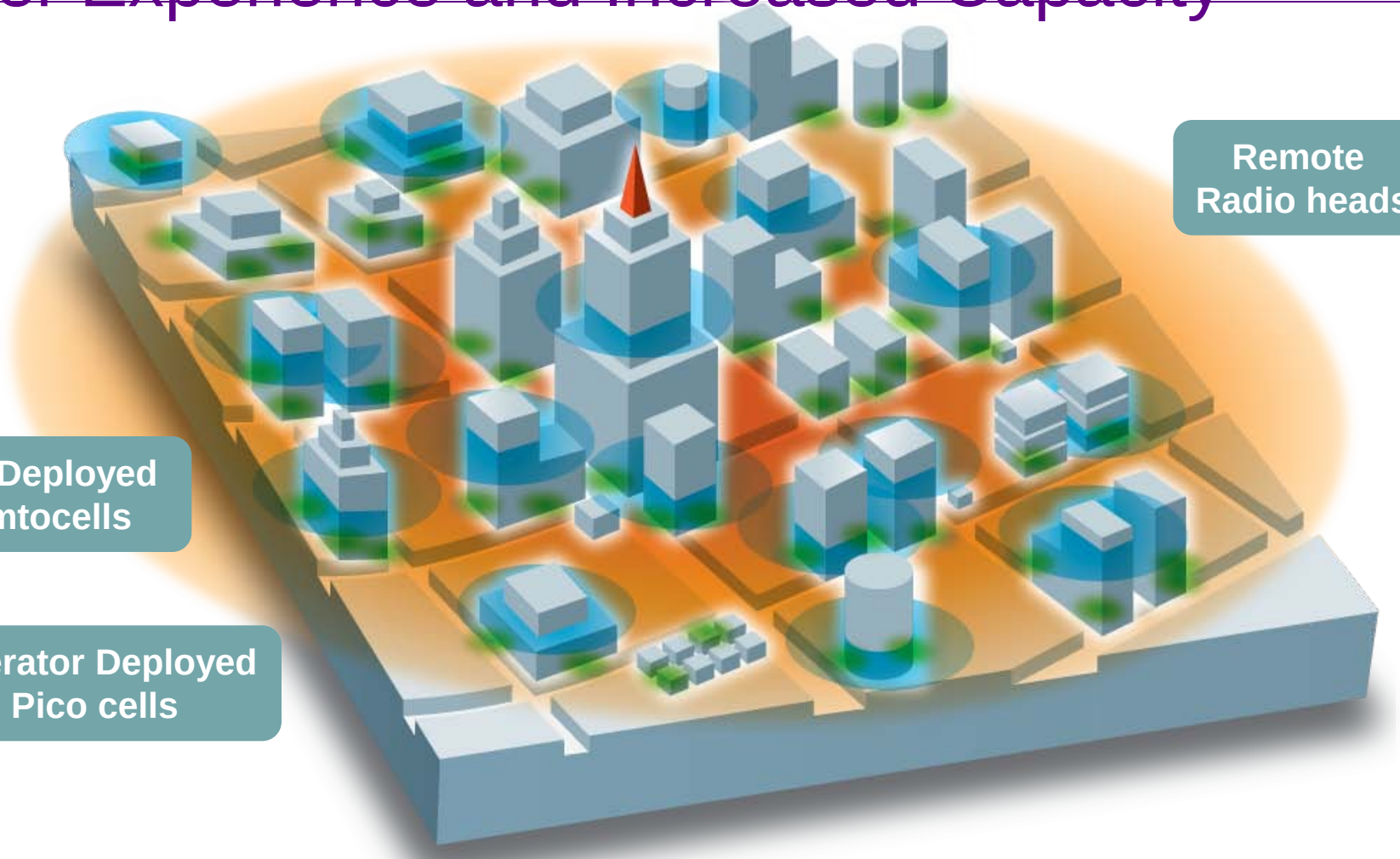
What's Next ?

Radio Link is Reaching Limit, What is Next?

Topology will provide gains beyond technology



Bring Transmitter Closer to User for Uniform User Experience and Increased Capacity

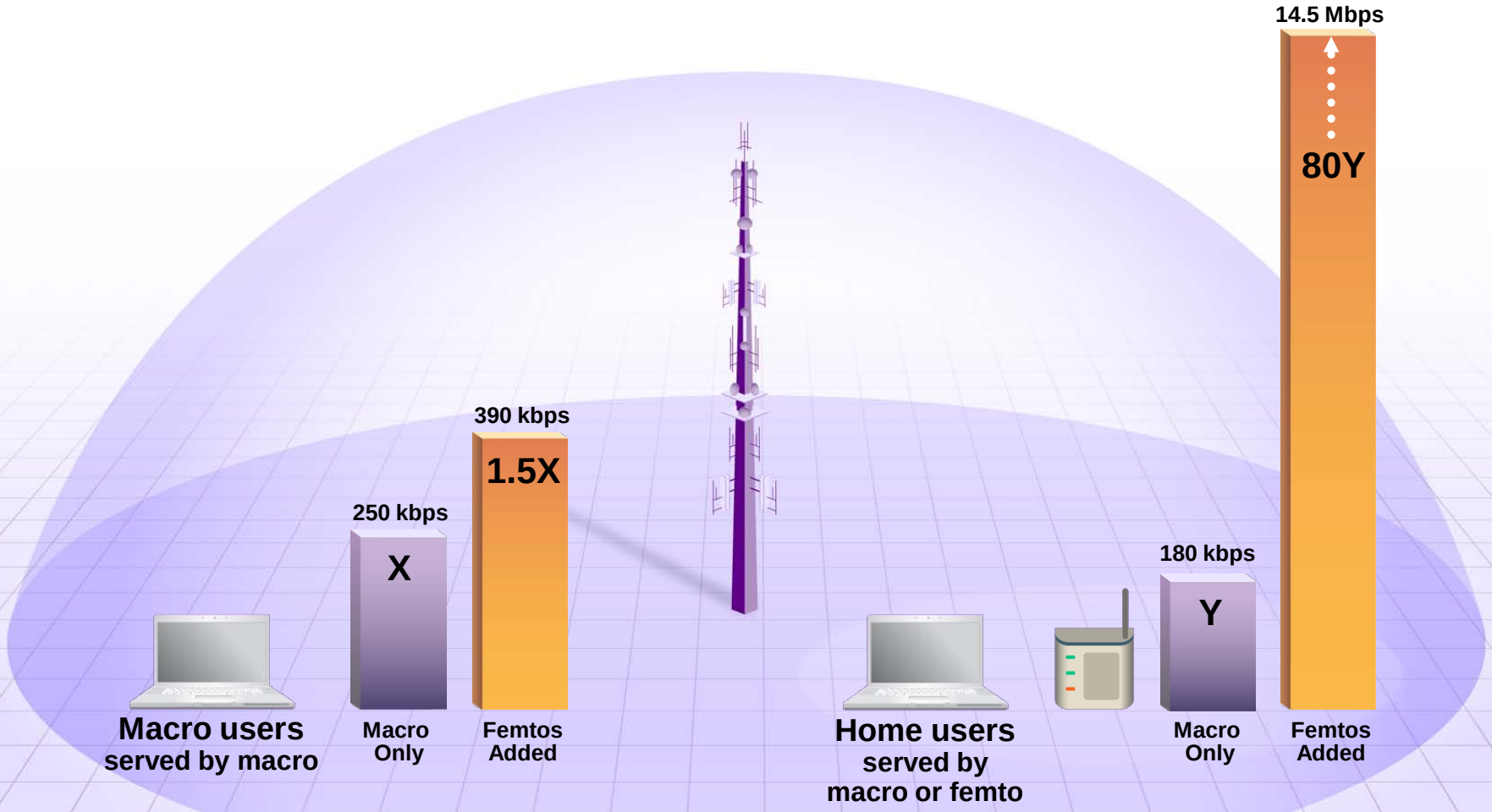


The Next Significant Performance Leap

Increasing spectral efficiency per coverage area

Femtocells Easily Increase Capacity Beyond 10x

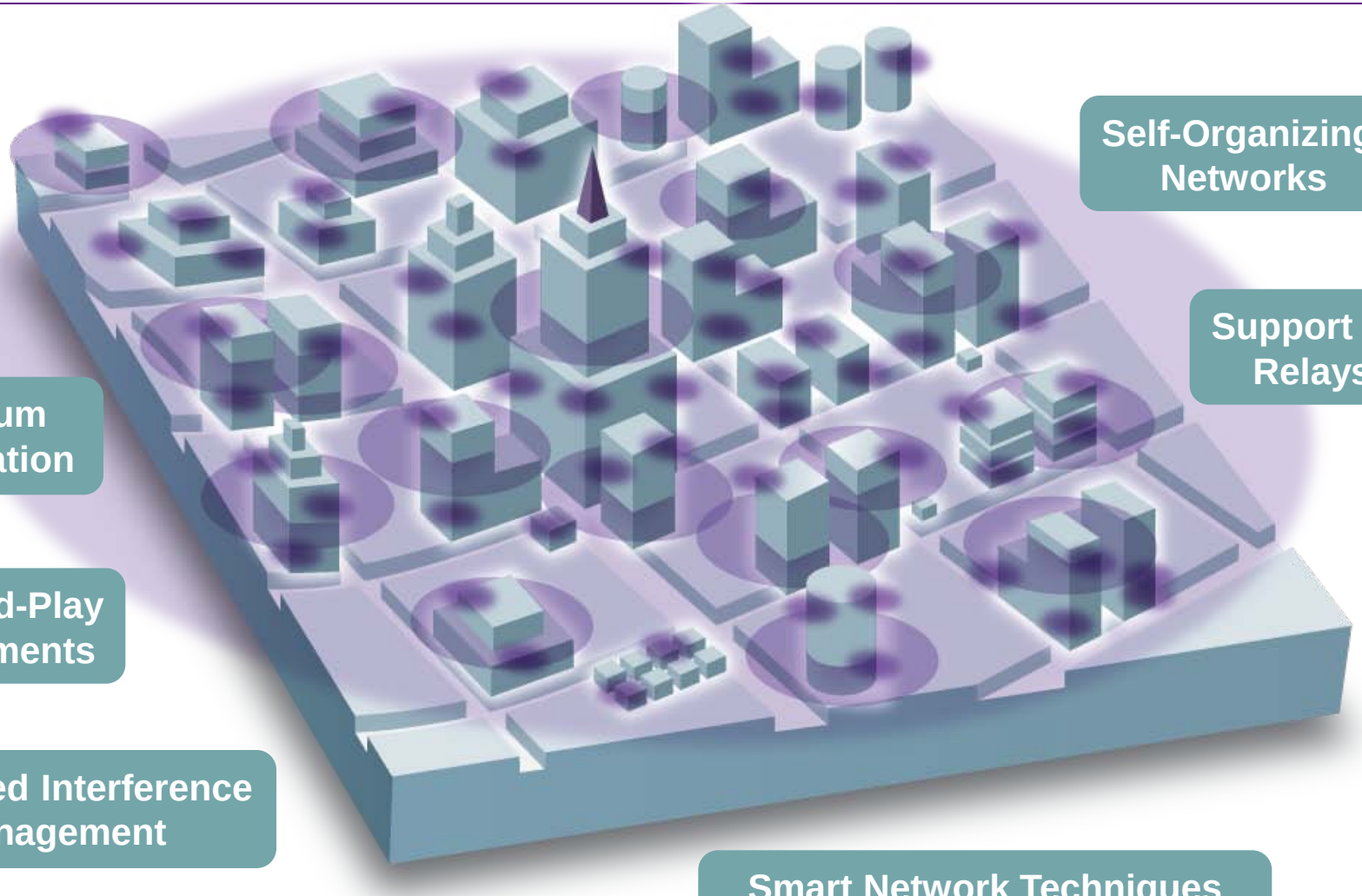
—Beyond what Technology Alone Could Provide



Note: Also, the worst 10% of macro users get ~15% higher throughput with proper interference management techniques.

Assumptions: Dense urban system simulation. 16 Users per cell: 10 macro users and 6 home users served either by macrocell or added femto cells. Rx diversity and MMSE Equalizer used. The median user data rates are shown. MIMO not considered

Advanced Topology Networks Further Improves Performance



Self-Organizing Networks

Support for Relays

Spectrum Aggregation

Plug-and-Play Deployments

Advanced Interference Management

Smart Network Techniques Adapting to Varying Load

Conclusion

Smooth Technology Evolutional Path for 3GPP & 3GPP2

Cost Effective to provide wireless broadband solution

Multicarrier Enhances Broadband Experience

Increases data rates for all users and provides much higher peak data rate

LTE - Parallel Evolution Path to 3G

Similar performance with same bandwidth

Leverages Topology for Gains Beyond Technology

Optimizes performance for macros with a mix of picocells and femtocells

Thank You