1000x, HSPA+ enhancements, WCDMA+, Scalable UMTS. May 2013

What is Next For HSPA+?

QUALCOMM®

HSPA+ continues to evolve to support billions of users

HSPA+ and Small Cells are Key to 1000x

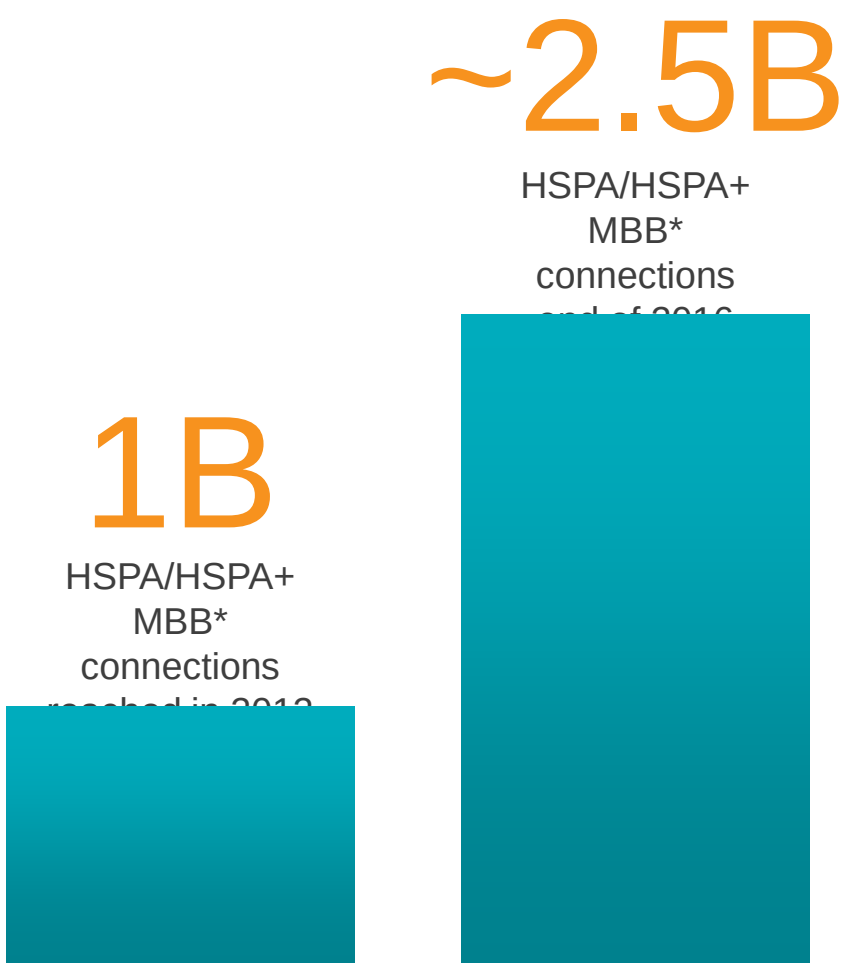
Continued Dual-Carrier Success and Expanded Multi-Carrier Chipset Support

Dual-Carrier across bands, uplink Dual-Carrier, beyond two carriers

Evolution to HSPA+ Advanced

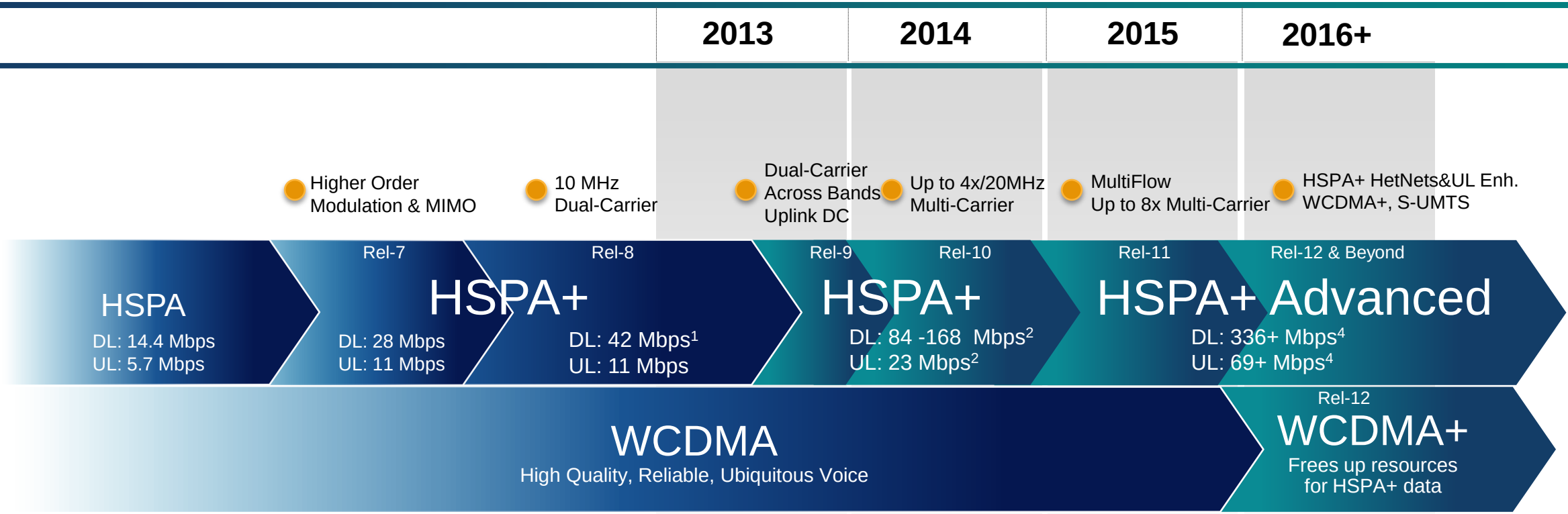
WCDMA+ Triples Voice Spectral Efficient to Support More HSPA+ Data

Also introducing scalable UMTS to enable WCDMA/HSPA+ in ½ and ¼ of 5MHz



Source: Wireless Intelligence (Jan ‘13) . 2,437 Billion HSPA family connections expected Q4 2016

HSPA+ continues to evolve



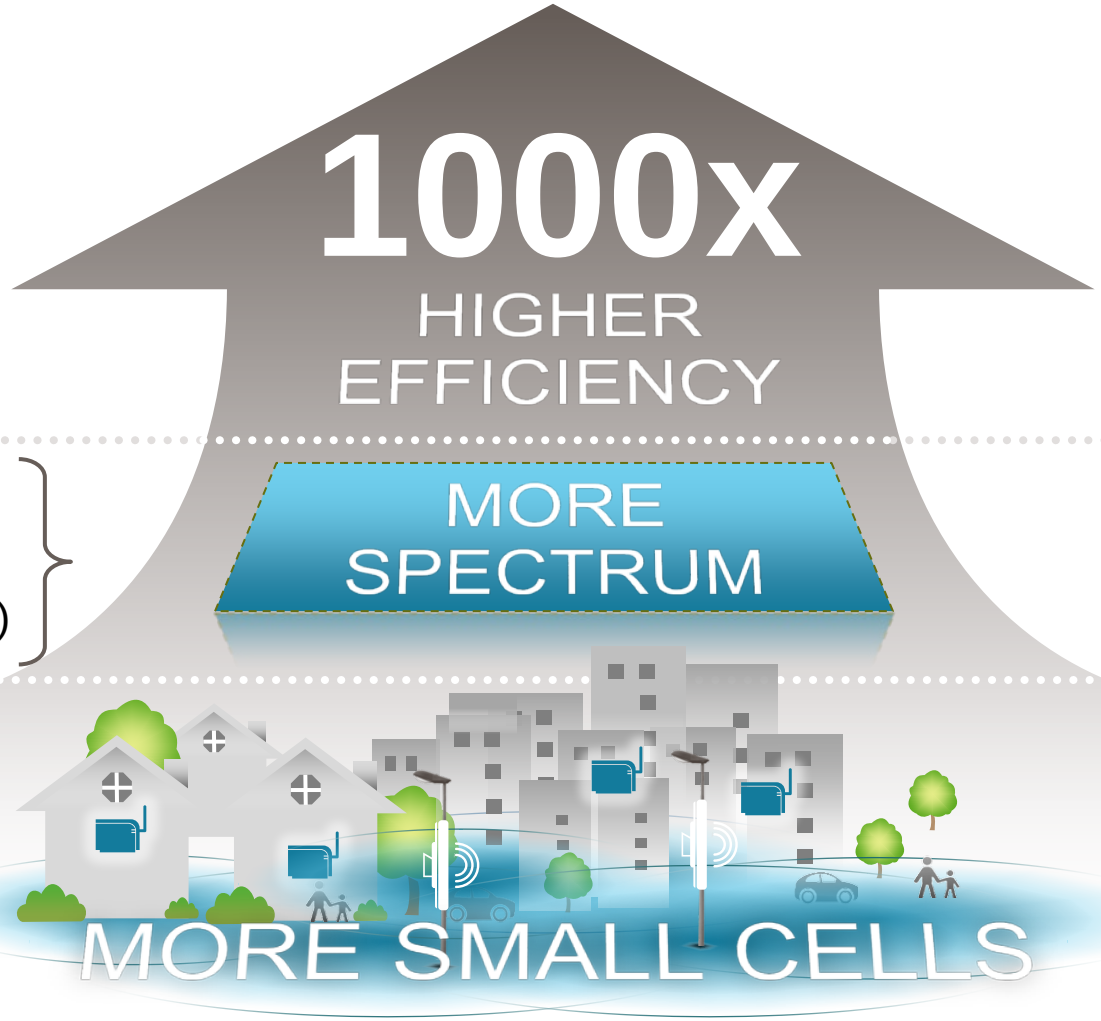
[1]R8 reaches 42 Mbps by combining 2x2 MIMO and HOM (64QAM) in 5 MHz, or by utilizing HOM (64QAM) and multicarrier in 10 MHz.
[2]R9 combines multicarrier and MIMO in 10 MHz to reach 84 Mbps. Uplink multicarrier doubles uplink peak data rate to 23 Mbps in 10 MHz.
[3]R10 expands multicarrier to 20 MHz to reach up to168 Mbps with 2x2 MIMO.
[4]R11 expands multicarrier up to 40 MHz to reach 336 Mbps with 2x2 MIMO, or 20Mhz with 4x4 MIMO. Uplink 2x2 MIMO with 64QAM reaches 69Mbps.

Commercial

Note: Estimated commercial dates.

Created 4/16/2013

HSPA+ and small cells are key to 1000x



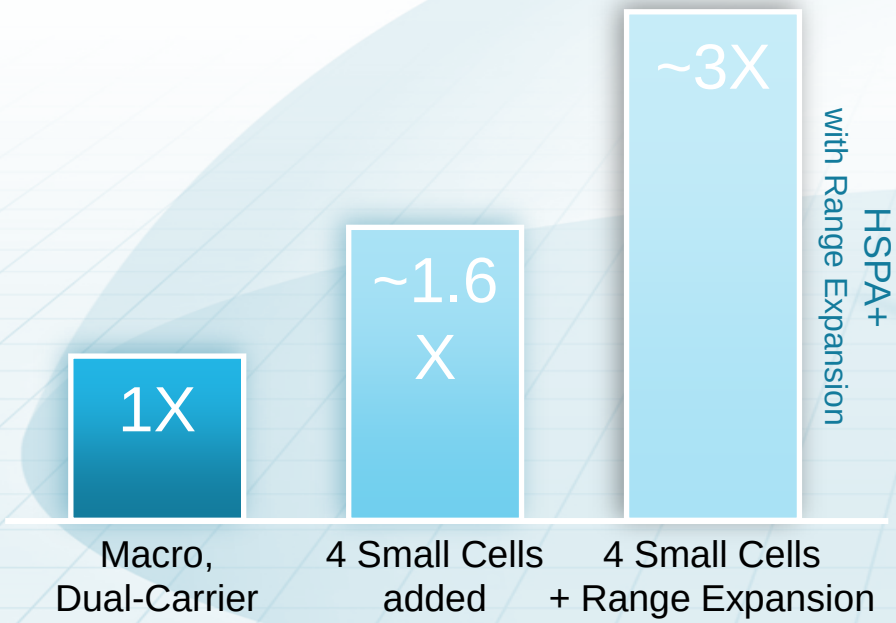
Evolve HSPA+, e.g.
- HetNets Enhancements
- Smartphone signaling

WCDMA+ to free up data

Supplemental Downlink
Scalable UMTS
Authorized Shared Access (ASA)

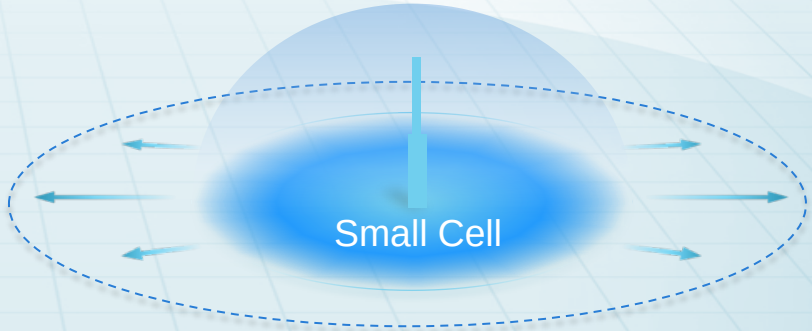
Range expansion today
Neighborhood small cells deployment model

Note: neighborhood small cells and ASA are not covered in this presentation, see www.qualcomm.com/hetNets and www.qual;comm.com/spectrum for more details.



Median Gain[1]

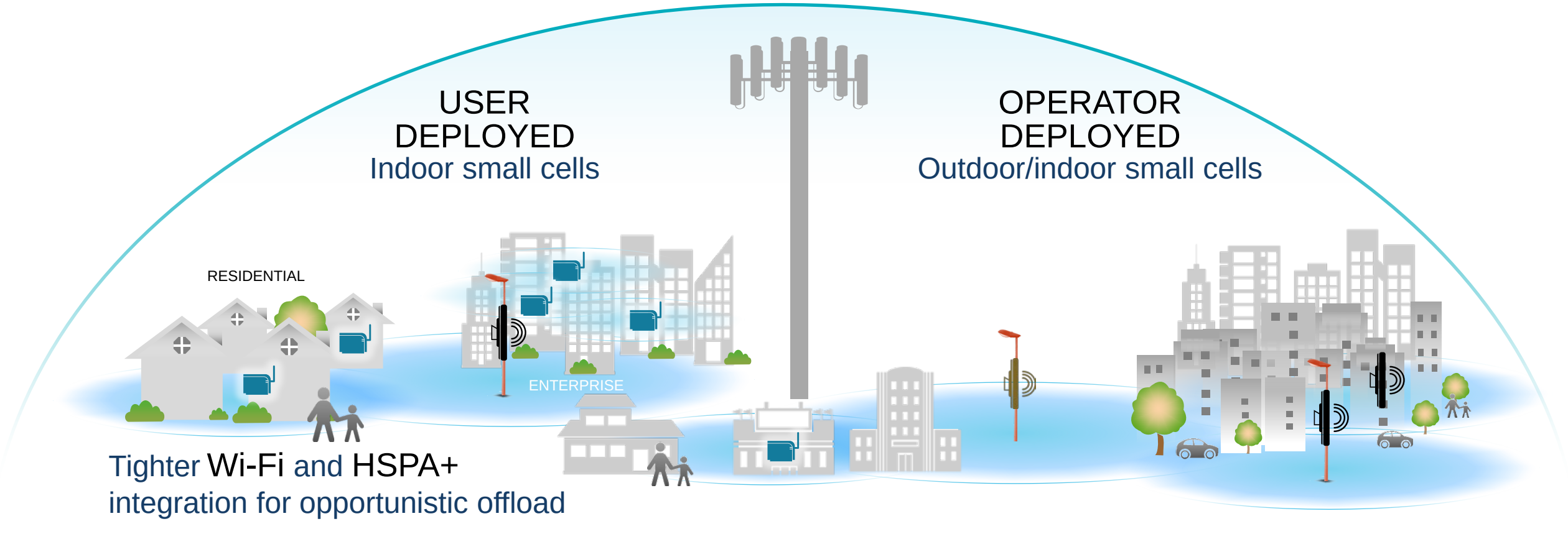
For same amount of Spectrum



Possible With HSPA+ Today

1000x Begins With HSPA+ Optimizations Available Today —HetNets Range Expansion Further Increases Capacity

[1] Gain in median downlink data rate, 4 small cells of pico type added per macro and 50 % of users dropped in clusters closer to picos (within 40m), Model PA3 full buffer ISD 500m. Enabling range expansion features: reduced power on second macro carrier , Dual-Carrier devices and mitigating uplink and downlink imbalance (3dB Cell-individual offset (CIO) and pico noise-figure pad)



Extreme Small Cell Densification—Further HetNets Enhancements

Today: Dual-Carrier and Reduced Macro Power—
Range Expansion

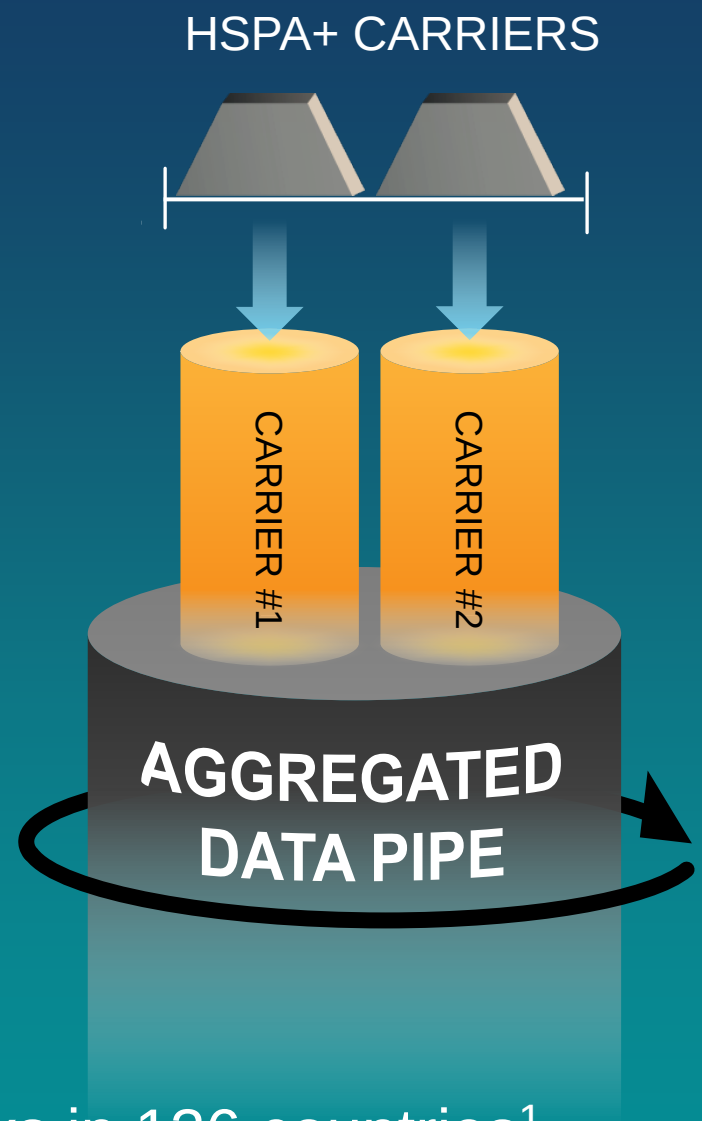
Even Better with MultiFlow (R11)—
Balance Load Across Cells

Advanced Device Receiver Provides Additional Gain—
Q-ICE™

HetNets Interference Mitigation and Mobility Study Item in 3GPP R12

Note: Self-Organizing Networks (SON) techniques HetNets and are standardized already in R10, such as Minimization of Drive Tests (MDT) and Automatic Neighbor Relation (ANR) with continued enhancements in R11 and beyond

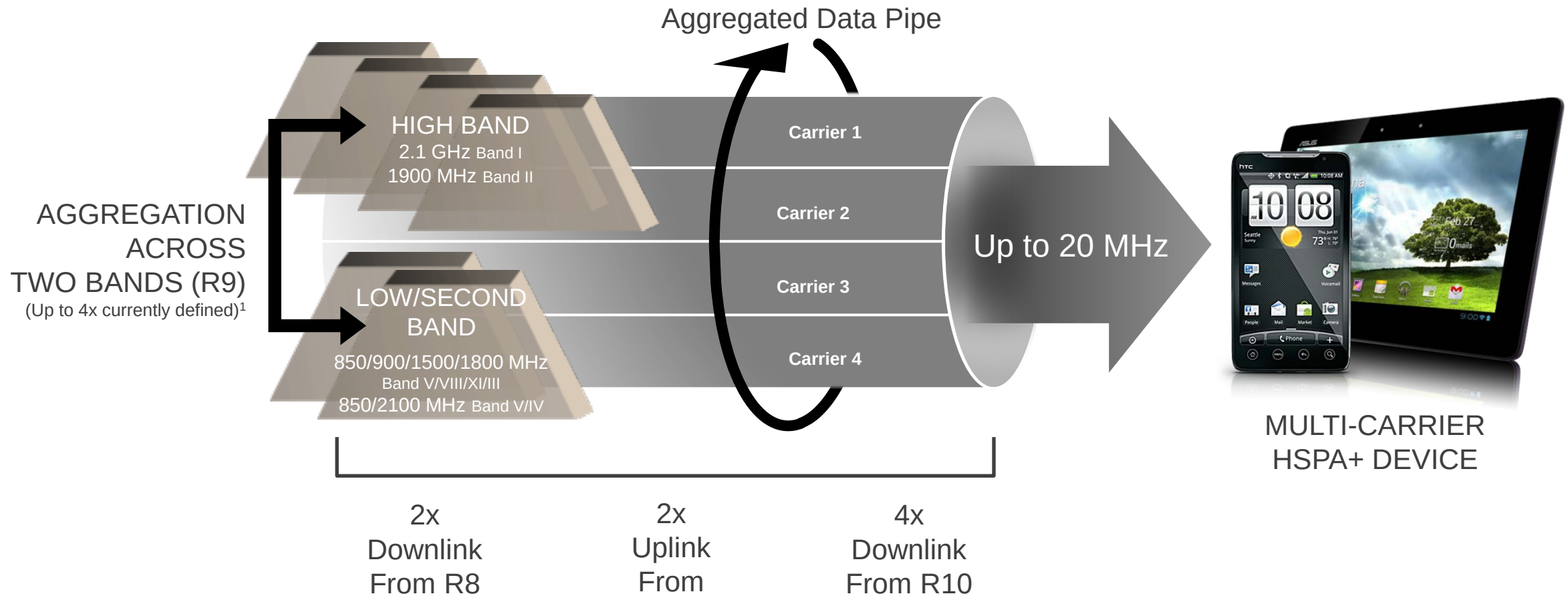
Continued Dual-Carrier Success and Expanded Multi-Carrier Chipset Support



124+ commercial 42 Mbps Dual-Carrier HSPA+ networks in 136 countries[1]

[1] 102 DC HSPA+ networks per GSA March 2013

Multi-Carrier further enhances user experience



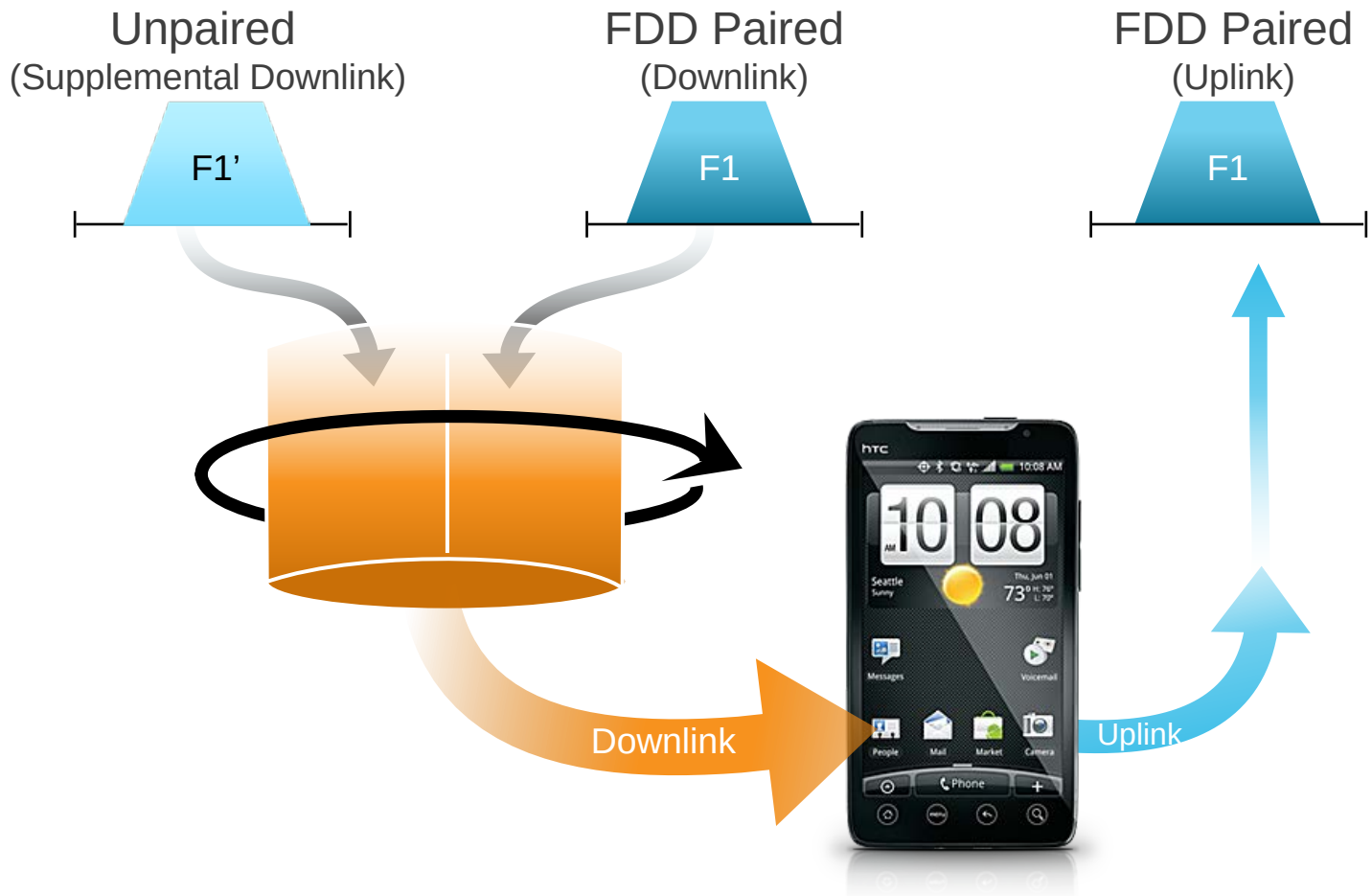
Higher Data Rates to All Users, More 'Bursty' Capacity[2]

1 Additional spectrum bands and band combinations continuously defined in 3GPP. [2]Non-contiguous aggregation within a band. 2 For typical bursty applications and typical partial carrier load, Multi-Carrier supports more bursty application users.

Aggregate unpaired spectrum for more downlink capacity—supplemental downlink

L-Band 1.4GHz Harmonized in Europe[1]

- L-Band has 40 MHz of idle unpaired spectrum available[2].
- Uses Dual-Band DC-HSPA+ (Aggregating across two bands)
- February 21 2013: L-Band supplemental downlink network trial in Toulouse with Orange and Ericsson
- Commercial launch 2014/2015

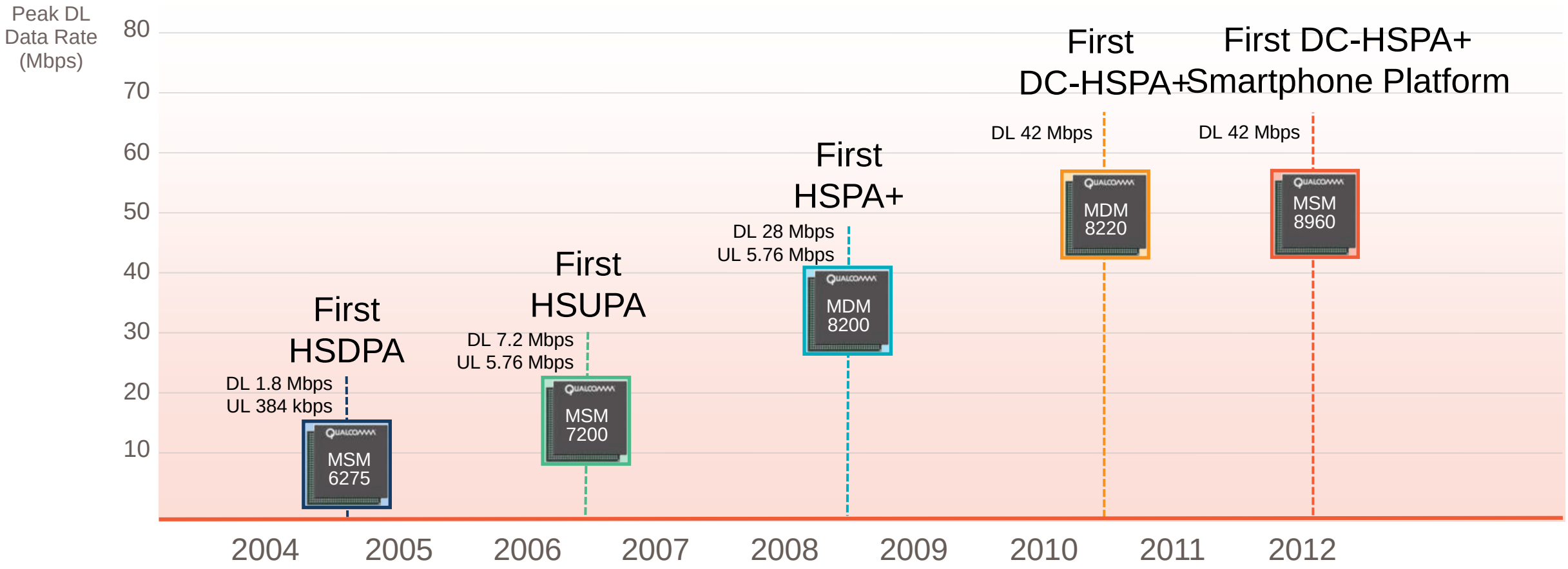


HSPA+ DUAL-CARRIER ACROSS BANDS[2]

1 L-Band in Europe: 1452 MHz to 1492 MHz, sometimes referred to as 1.4GHz or 1.5GHz spectrum.
2 Aggregation across bands is supported in HSPA+ R9 for two downlink carriers and LTE R10, but each specific band combination, e.g. combination of band 1 and L-band, has to be defined in 3GPP.
3 AT&T is planning to deploy supplemental downlink in lower 700 MHz (12 MHz of unpaired spectrum) using LTE Advanced.

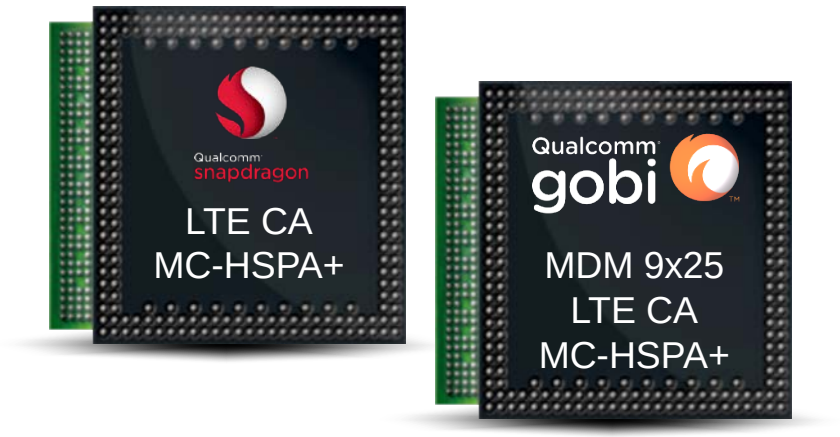
Qualcomm modem technology leadership

A history of time-to-market and product superiority



Multi-Carrier HSPA+

Snapdragon 800



- Multi-Carrier uses deployed HSPA+ assets more efficiently
- Uplink Dual-Carrier improves user experience and increase network capacity for smartphone traffic
- Dual Band Dual-Carrier is designed to take advantage of expanding HSPA+ footprint in new bands (e.g. 900 MHz)

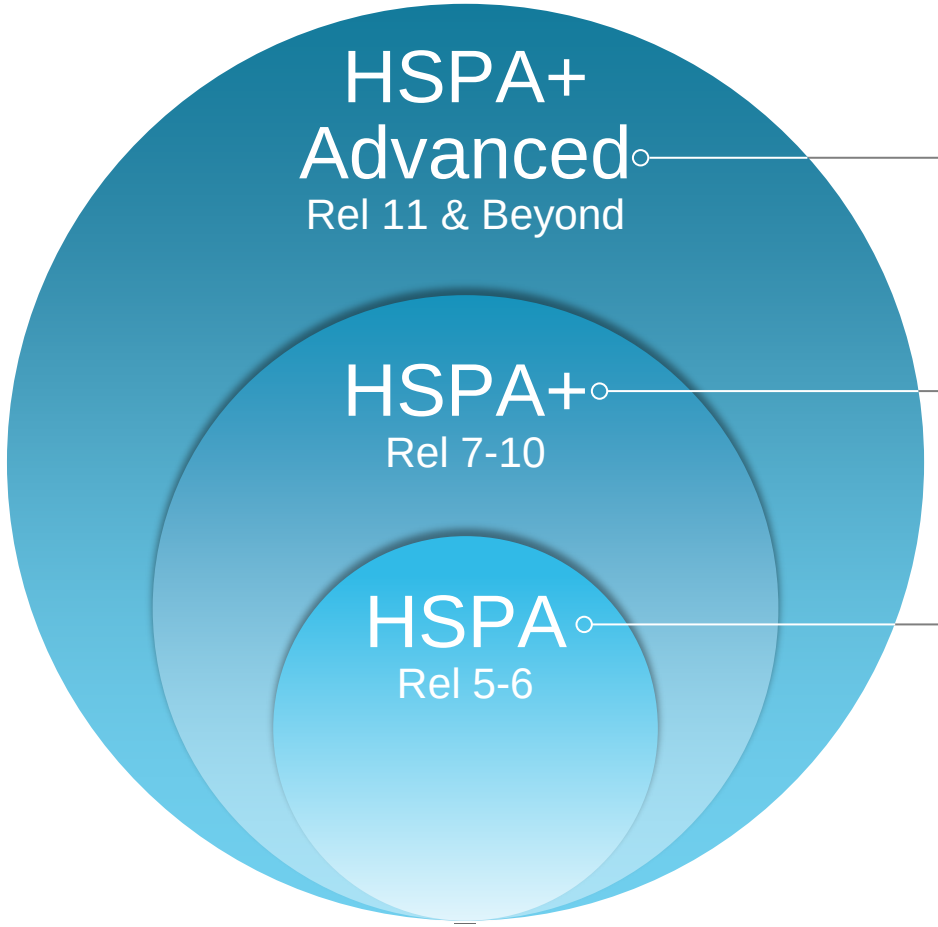
Increased data rates and lower latencies for all users in the cell

Can more than double capacity for bursty applications, e.g., Web apps

Leverages all spectrum assets

Note: Snapdragon 800 includes 8974

HSPA+ Advanced—taking HSPA+ to the next level

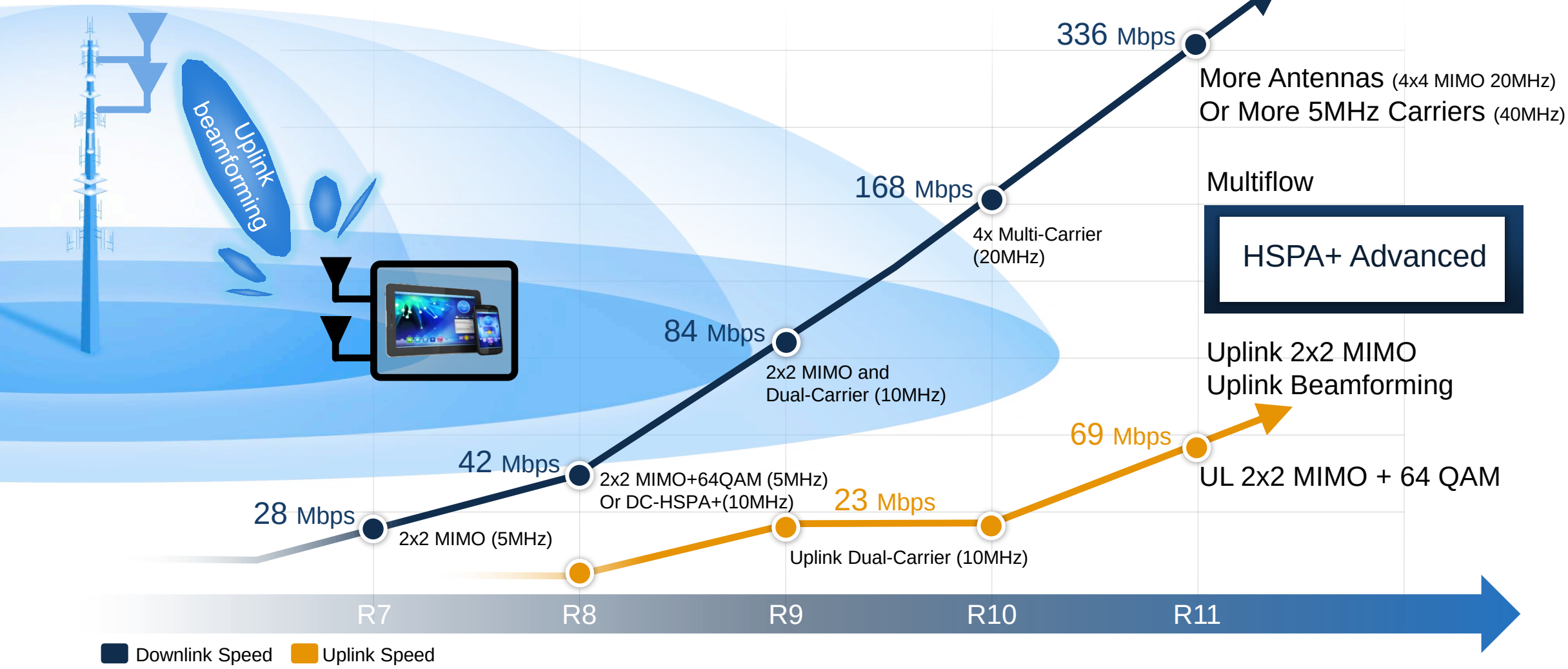


Maximizing HSPA+ investments

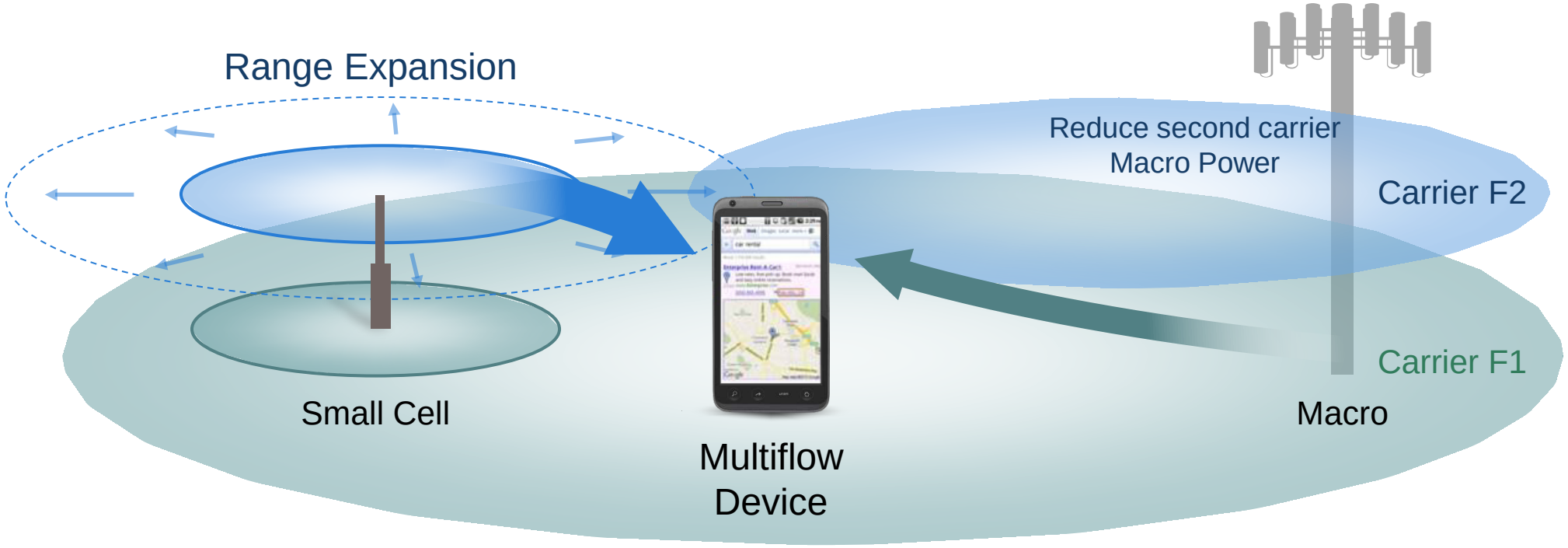
HSPA+ is the new baseline

100% of operators have upgraded to HSPA

Continued multiple antenna and multi-carrier evolution



HSPA+ Advanced: further hetNets enhancements



Further range expansion—even better small cell offload

Mitigate up/downlink imbalances—such as extended range/reconfiguring of power offsets and further enhanced advanced receivers

Multiflow optimizations to balance load across cells

Such as mobility support to switch from dual-carrier to multiflow in the region where up/downlink are imbalanced

Mobility enhancements between small cell & macro

Such as further enhanced serving cell change procedures, and load based serving cell change

Note: All these are 3GPP R12 study items. In addition, Self-Organizing Networks (SON) techniques and are standardized in R10, such as Minimization of Drive Tests (MDT) and Automatic Neighbor Relation (ANR) with continued enhancements in R11 and beyond

HSPA+ Advanced

Continued optimizations for the explosion of interconnected low-traffic devices

Such as R11 FE-FACH, R12 uplink enhancements, R11/12 Machine Type Communication (MTC) Enhancements

The Smartphone Explosion

~5 BILLION CUMULATIVE SMARTPHONE SALES BETWEEN 2012–2016[1]

The Internet Of Everything

THE NEXT ERA OF NETWORKING AND COMPUTING, WHERE EVERYTHING IS INTELLIGENTLY CONNECTED

1 Source: Average of Gartner, Oct. '12; Strategy Analytics, Aug.

Ever increasing smartphone application traffic

Excessive signaling due to frequent small data bursts in the background[1]

1) Higher ‘Signaling’ Pipe Capacity—FE-FACH

2) Compress uplink data

3) Smart Pipe—Gate Background Requests[2]

[1]Applications push notifications, updates, messages to users, even when application is not active, could be multiple times per hour. This causes excessive network signaling due to setting up and tearing down the data channel for small, short, but frequent data bursts.
[2]Offered as part of our CnE solution, device connectivity engine.

HSPA+ continues to accommodate smartphone growth

Small data bursts

Up to 90% reduced signaling load over HSPA

Another >10x capacity over HSPA+

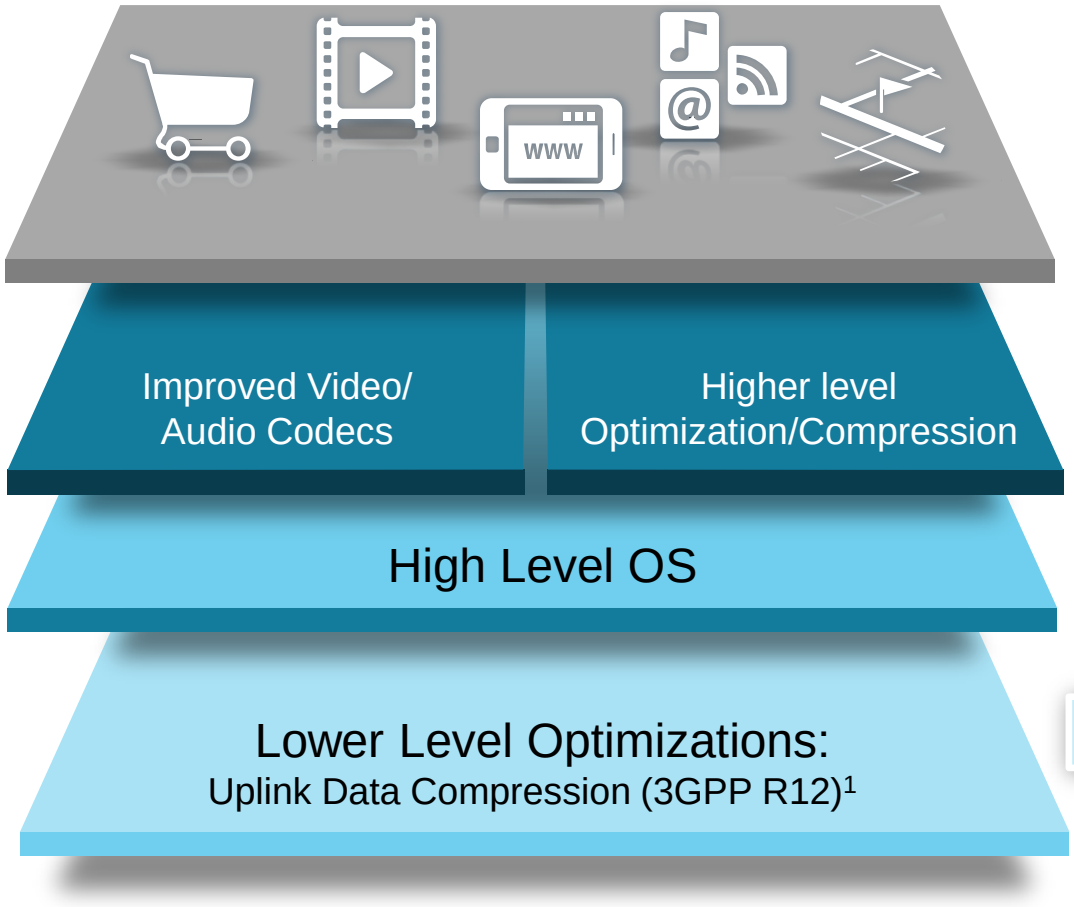
Non full-buffer applications

Extended battery life over HSPA[2]

Further extended battery life

[1]R7/R8 allows small amounts of data to be efficiently transported in CELL-FACH state: up to 90% reduction in network signaling load due for social media example. [2]Cell-DCH w/ R7 CPC allows non full buffer apps to use connected mode, DCH, more efficiently (DTX/DRX). [3]A main enhancements is downlink triggered feedback (CQI) and acknowledgements on the FACH reverse link, which makes FACH efficient like a regular HSPA link, see simulation assumptions in R1-112679

Efficient compression and other uplink enhancements



Uplink data compression is part of a group of 3GPP R12 uplink enhancements for improved coverage, capacity and load-balancing.

- ~70% reduction in signaling[2]
- 30-40% improved uplink throughput
- Improved battery life

[1] 3GPP R12 proposal: Add payload (e.g. HTTP GET & POST packets) compression to the PDCP layer, header (RoHC/IPHC) compression already resides in PDCP. Uplink compression is suitable since highly compressible HTTP packets are ~70% of uplink smartphone data volume (based on Qualcomm logs). 2Reduction in Radio Resource Control (RRC) transitions, which drives network signaling, frees up resources for more data capacity

Machine to machine communication enhancements

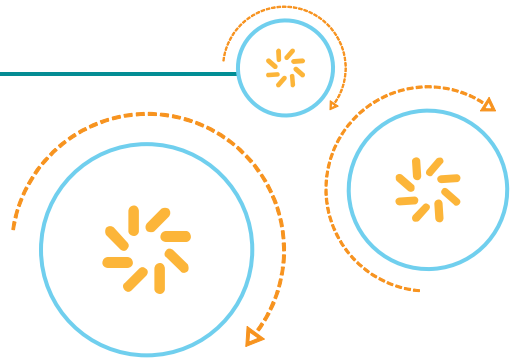
FURTHER 3GPP R12 ENHANCEMENTS SUCH AS:

- *Very long DRX Cycle - days*
- *Fast return to Idle State*
- *Reduced measurements*
- *Reduced signaling*

→ Significantly increased battery life

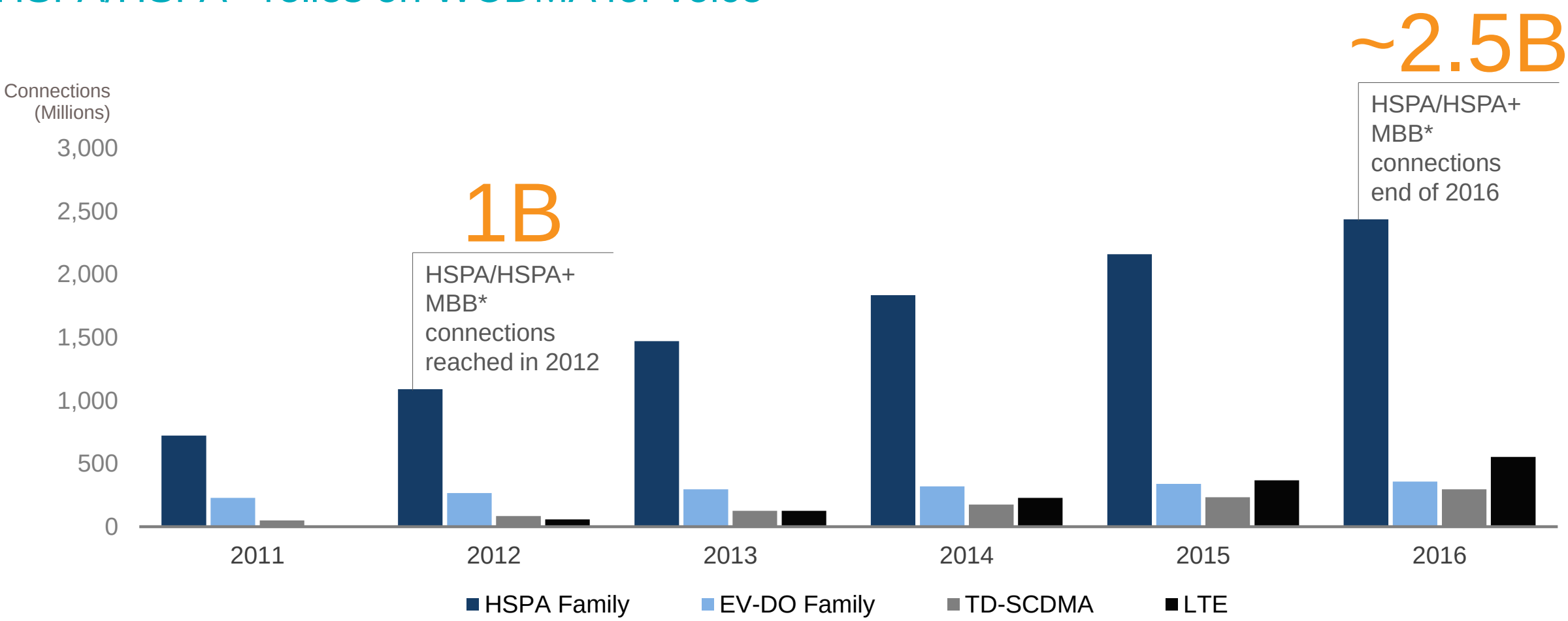
→ Increased Capacity

WCDMA+ Triples Voice Spectral Efficiency to Support More Data



Billions of WCDMA Voice users for the foreseeable future

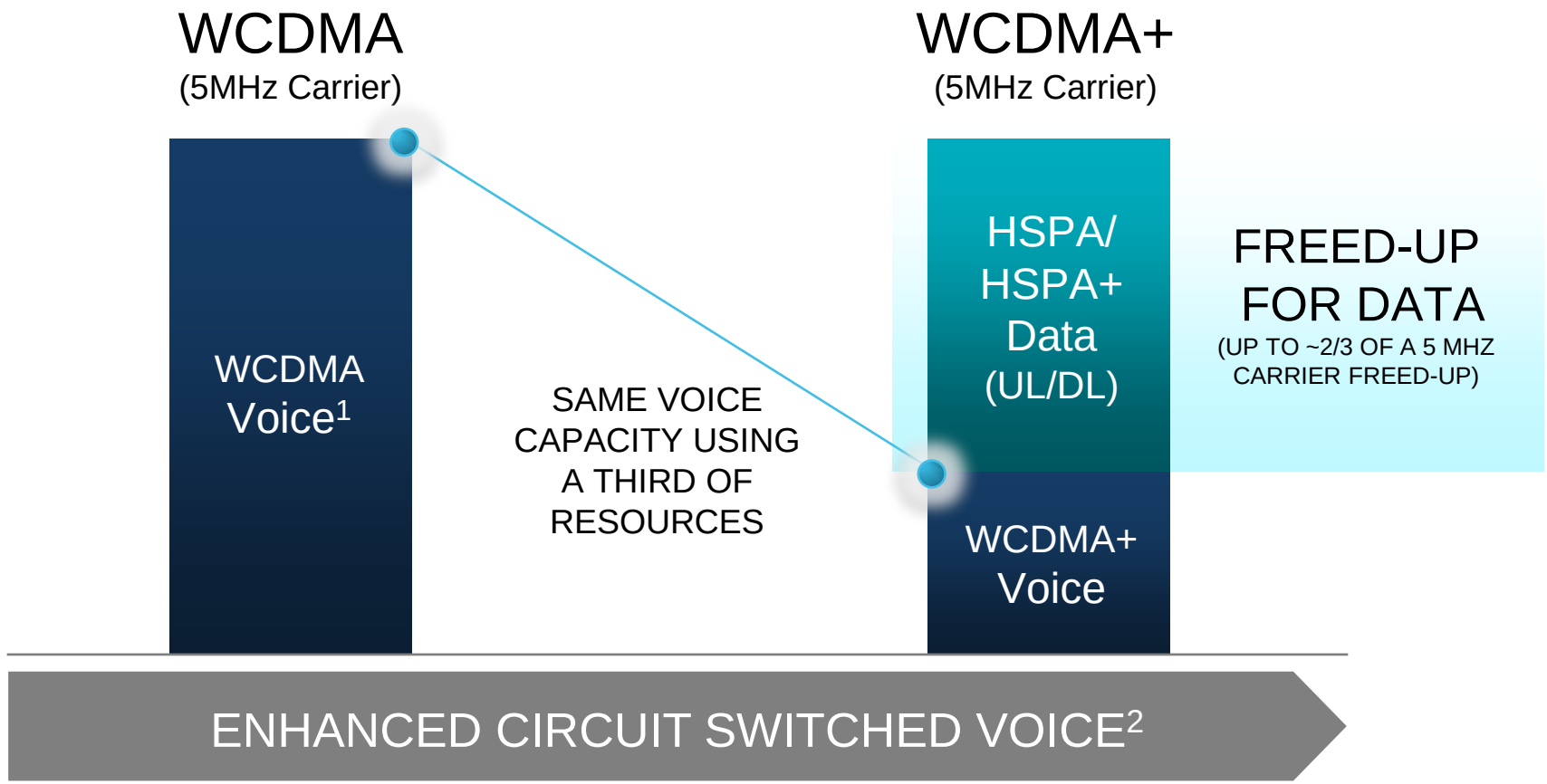
HSPA/HSPA+ relies on WCDMA for voice



Source: HSPA, EV-DO ,TD-SCDMA and LTE subs – Wireless Intelligence (Jan '13) . 2,437 Billion HSPA family connections expected Q4 2016

WCDMA+ can free up ~2/3 of a carrier for data

Triples voice spectral efficiency



1 There is ~10% DL data capacity available at max voice capacity not shown in the graph for WCDMA .Assumptions: single receive antenna and rake receiver assumed for voice, dual receive diversity assumed for data. .

2 WCDMA+ is a 3GPP R12 candidate which proposes 1) radio link enhancements and 2) EVS 5.9kbps Source Controlled Variable Bit Rate (VBR) Wideband mode instead of AMR 12.2k vocoder

WCDMA+ ensures high quality, reliable, ubiquitous voice

Builds on Proven WCDMA Voice[1]

Extended Talk-Time[2]
~30% reduced modem current consumption

Global Roaming in Global Bands

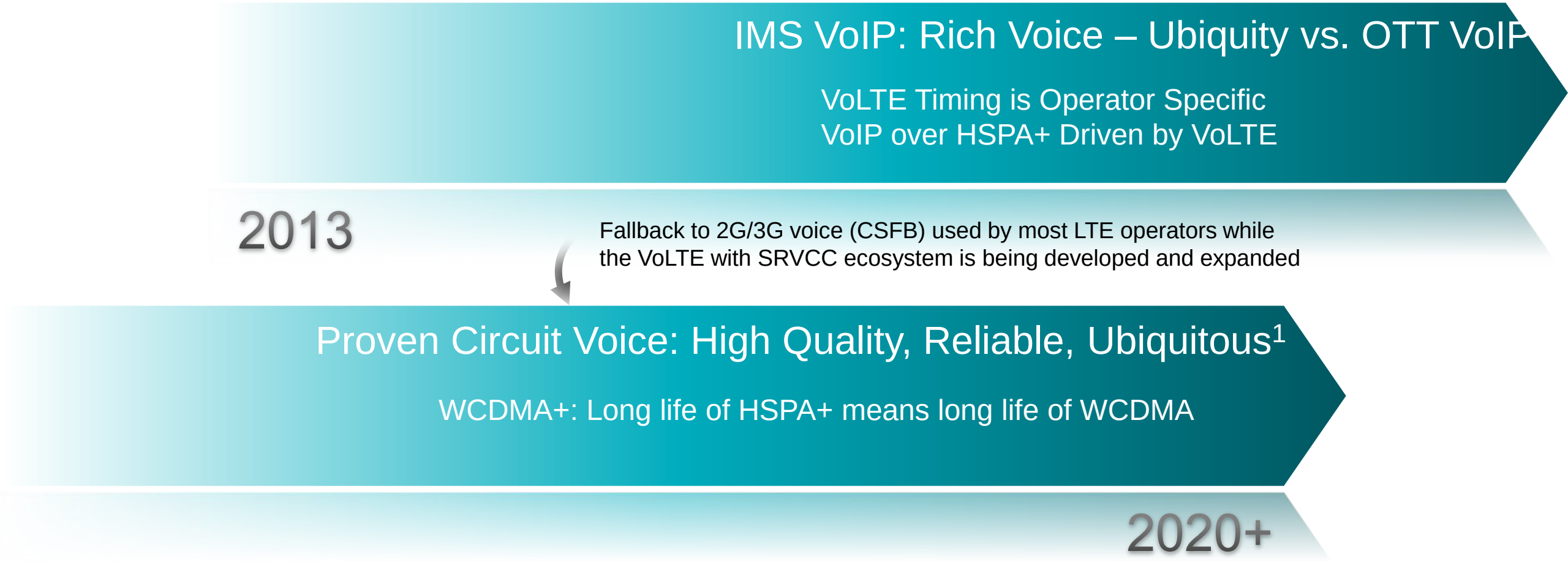
Simultaneous Voice and HSPA+ Data

Leverages Existing Investments

Proven Robustness with Soft-Handover

[1] High quality tanks to soft handover, proven interoperability and 10+ years of WCDMA circuit switched voice optimizations. [2] Current modem consumption reduced by ~30% with WCDMA+ compared to WCDMA.

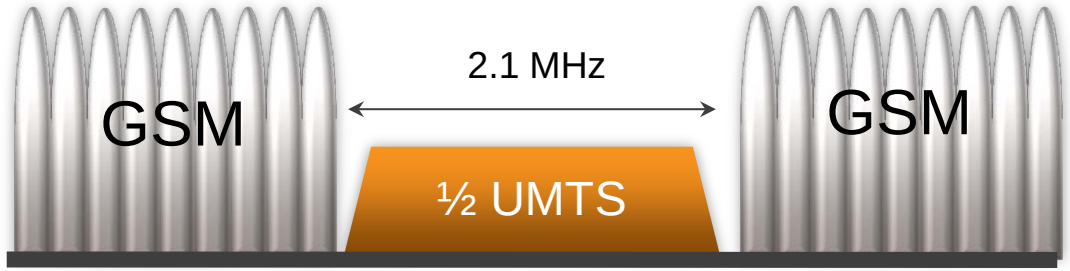
Circuit switched voice has a long life during the transition to richer, carrier grade VoIP



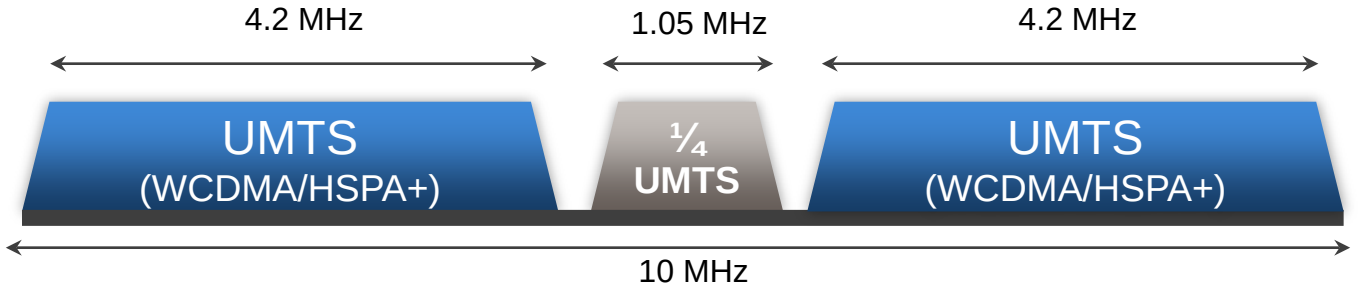
[1] Thanks to soft handover, proven interoperability and 10+ years of 1X/WCDMA optimizations. OTT=Over-The-Top, voice just like any data service without Quality of Service

Scalable UMTS to re-farm fragmented GSM

UMTS in < 5 MHz
Bandwidth (1/2,1/4)



E.g. GSM 850/900 MHz



E.g. UMTS 2.1 GHz

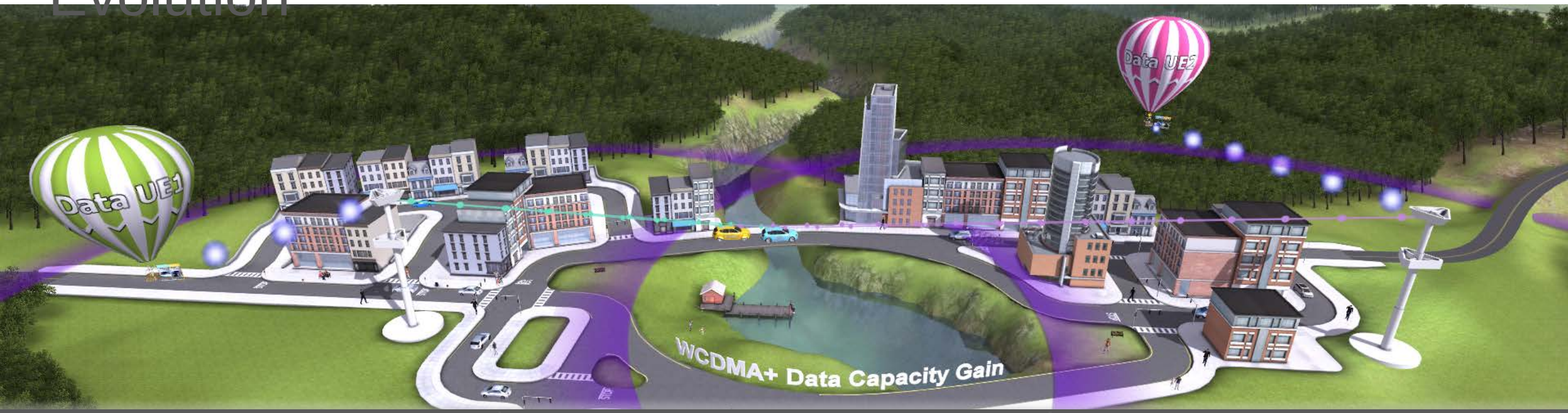
Maintains Spectral Efficiency

Maximizes Utilization of Available Spectrum

Maintains Coverage

Note: Scalable UMTS is a 3GPP R12 candidate

Qualcomm is Committed to Continued HSPA+ Evolution



STANDARDS LEADERSHIP

- Major 3GPP contributor
- Recognized expertise

INDUSTRY-FIRST DEMOS

- MWC 2007: Voice over HSPA
- MWC 2008: Dual-Carrier
- MWC 2009: Dual-Carrier 42 Mbps
- MWC 2010: Uplink Beamforming
- MWC 2011: MultiFlow and Supplemental Downlink
- MWC 2012: HetNets Range Expansion
- MWC 2013: WCDMA+, Scalable UMTS

INDUSTRY-FIRST CHIPSETS

MDM 8200 HSPA+	MDM 8220 DC-HSPA+	MDM 9x25 MC-HSPA+
Launched Feb 2009	Launched Aug 2010	Launching 2013

Actual screenshot from WCDMA+ Demo, first shown at MWC 2013

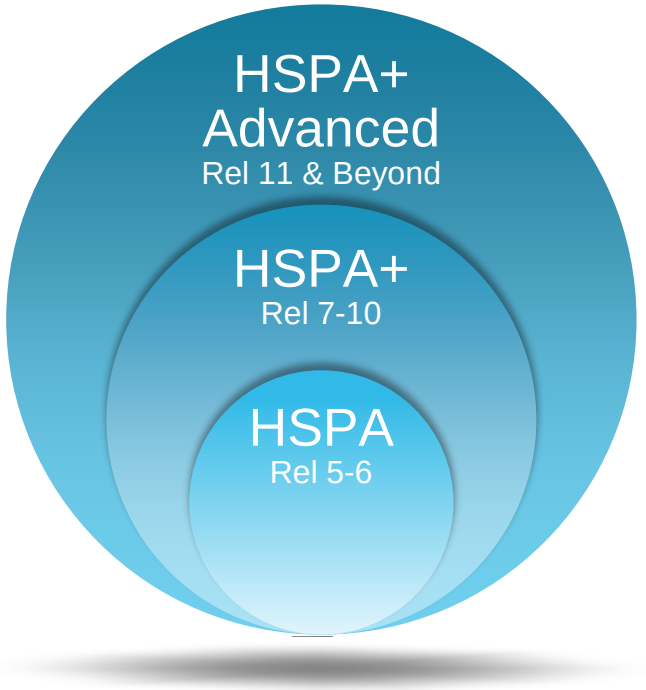
Driving network evolution

www.qualcomm.com/1000x

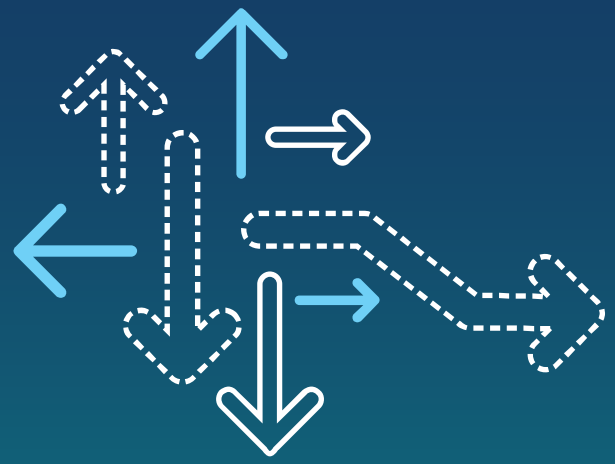
to learn more about 1000x

www.qualcomm.com/hspa_plus

to learn more about the HSPA+ evolution



Questions? - Connect with Us



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