

HSPA+ R9 and beyond

March 2010



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HSPA+ R9 & R10 Expands Multicarrier

H
S
P
A
+

R9
R10

84 to 168 Mbps Peak Data Rates

10 MHz (R9) or 20 MHz (R10)

Enhanced Broadband Experience in 10 to 20 MHz

Combining multicarrier and MIMO (R9), uplink multicarrier (R9), and 20 MHz (R10)

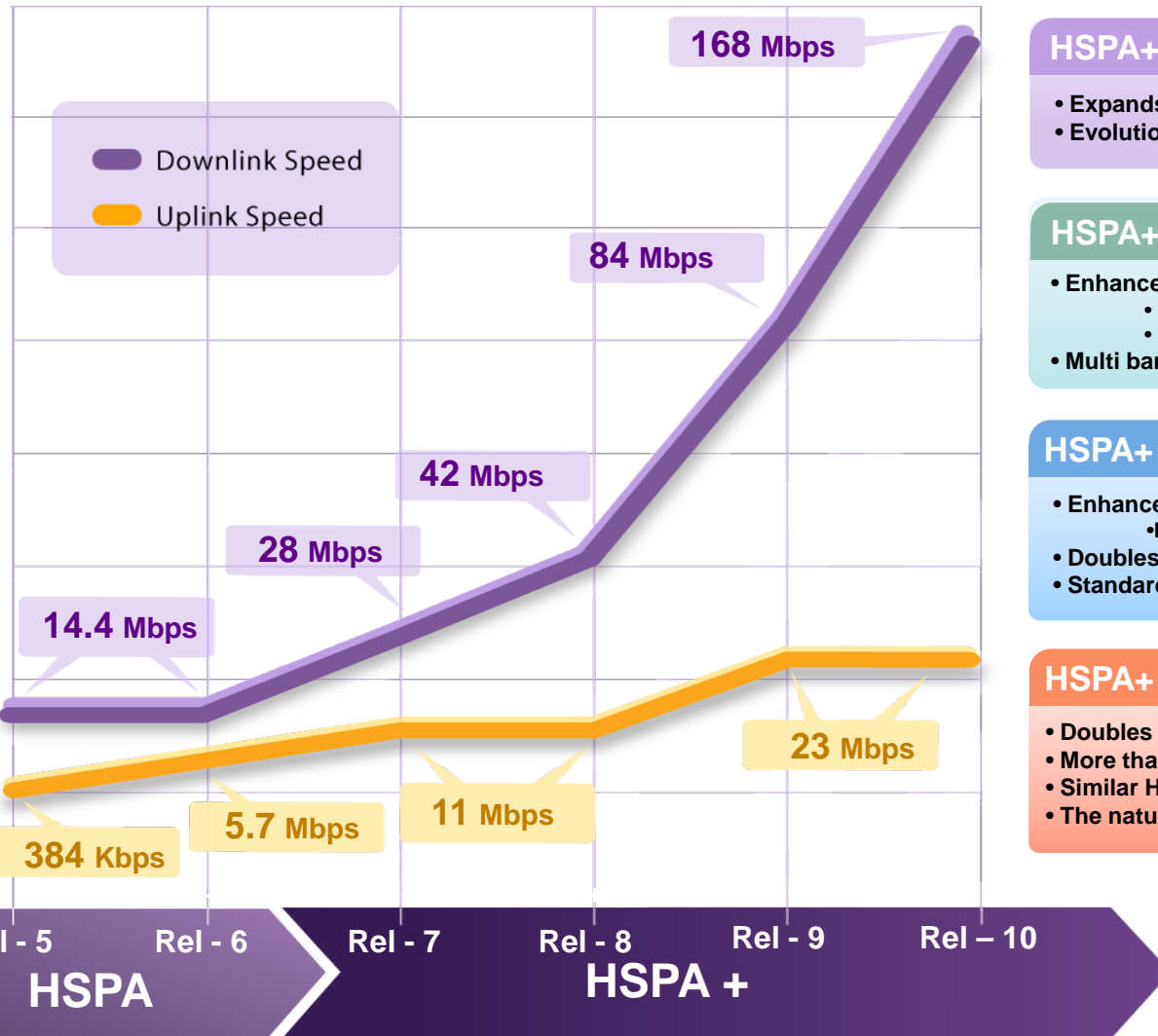
Multicarrier Aggregation Across Bands

Aggregate e.g. high band 2.1GHz and low band 900 Mhz (R9)

Bring Network to User for Next Performance Leap

Leverage topology with femtocells—evolution towards femtocell networks

HSPA+: A Strong Evolution Path



HSPA+ R10: 20 MHz Multicarrier

- Expands HSPA+ to 20 MHz deployments
- Evolution to femtocell networks

HSPA+ R9: Expands 10 MHz Multicarrier

- Enhanced performance in 10 MHz
 - Uplink multicarrier
 - MIMO support with multicarrier
- Multi band multicarrier—aggregation across bands

HSPA+ R8: 10 MHz Multicarrier (dual carrier)

- Enhances broadband experience
 - Doubles data rates to all users
- Doubles bursty application capacity
- Standardized femtocell support

HSPA+ R7: Next Gen. Performance Today

- Doubles data capacity
- More than doubles voice capacity
- Similar HSPA+ and LTE performance
- The natural evolution at a lower cost

HSPA+ Has Strong Industry Support

41 Launches in 26 Countries



Strong Operator Interest (~40)

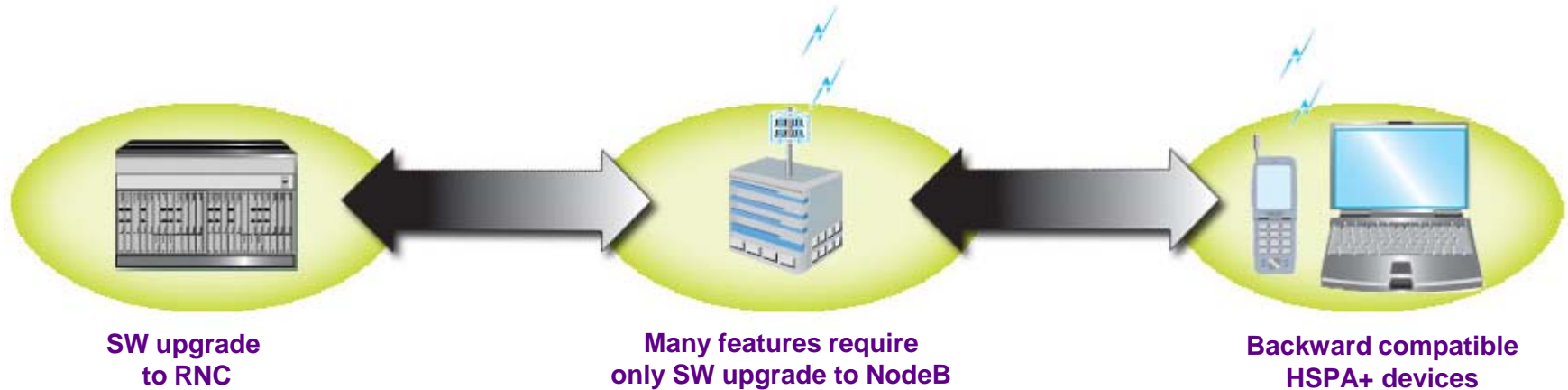


32 Devices by 11 Vendors



HSPA+: The Natural Evolution at a Lower Cost

Incremental and cost-effective upgrade



Large and Growing Device Ecosystem

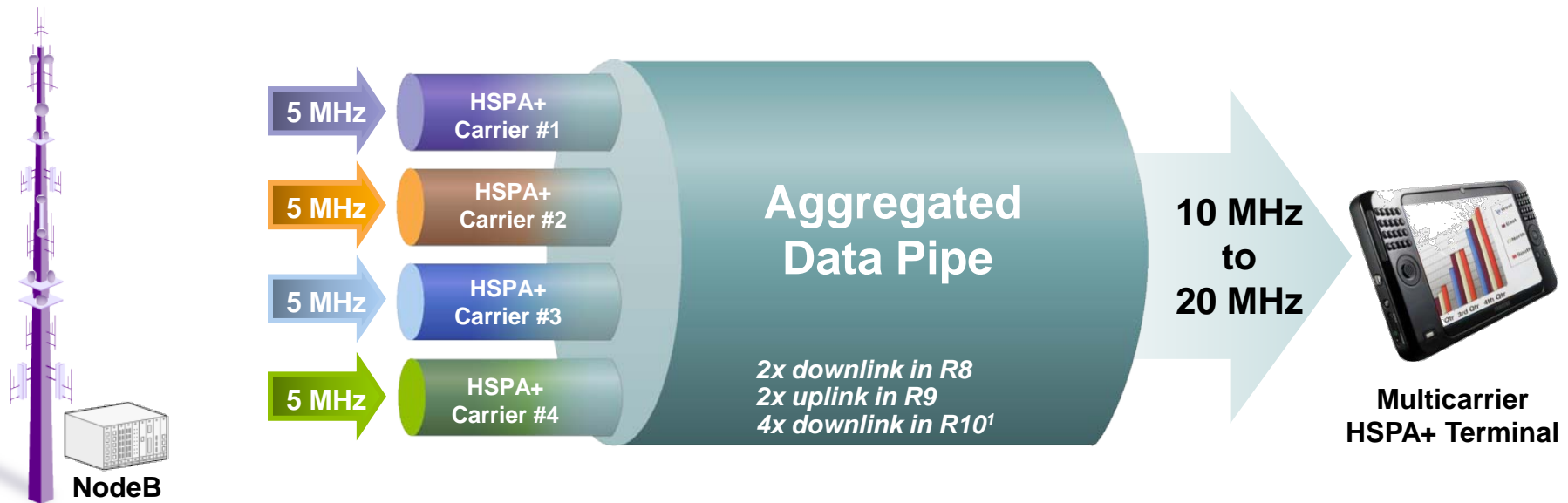
HSPA >2,137 device models
with more than 190 suppliers

Deployed Worldwide on a Large Scale

WCDMA >325 networks, > 450 million subs
HSPA >315 networks, > 217 million subs
in over 130 countries

HSPA+ leverages existing investments and large ecosystem

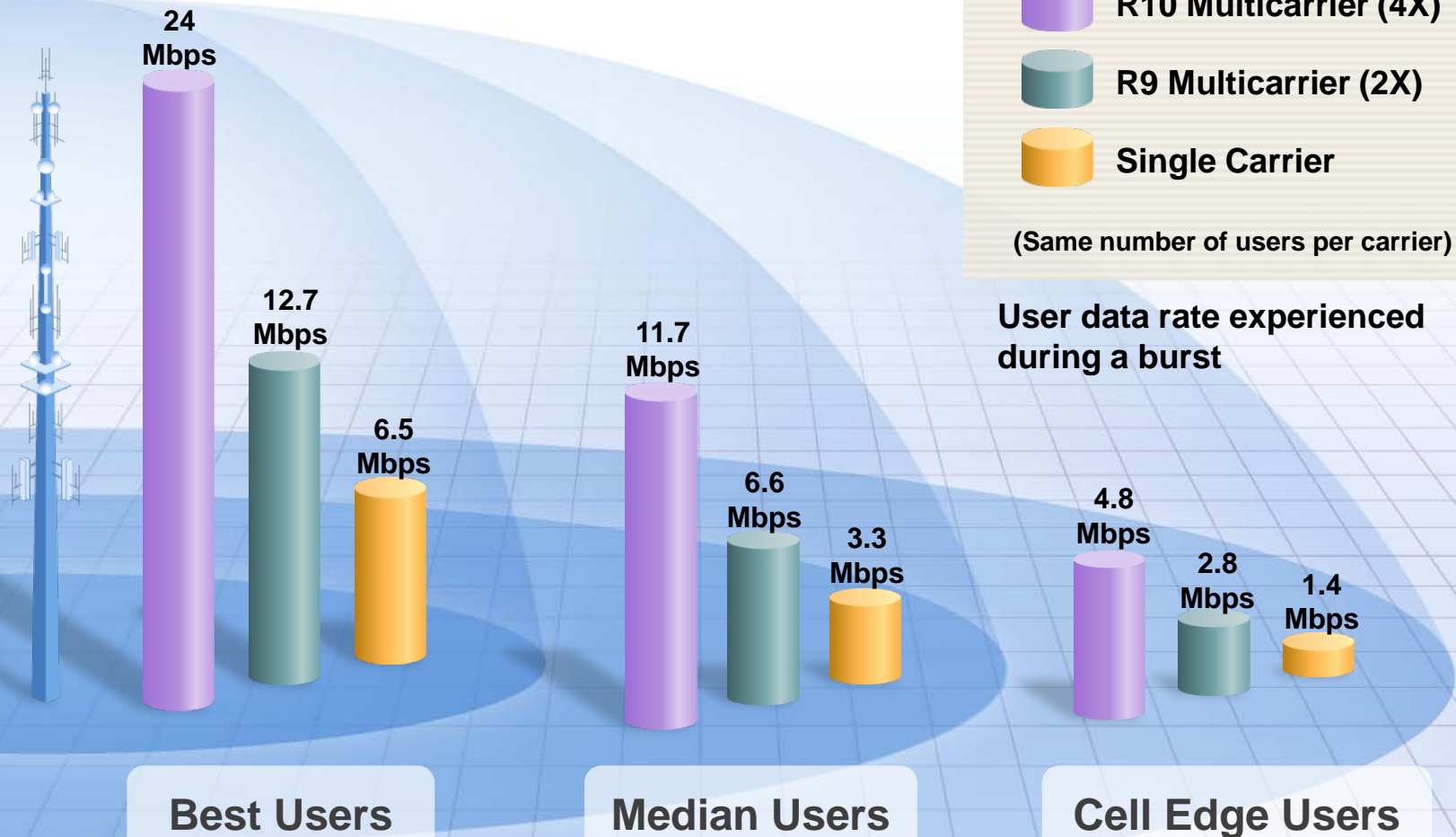
Multicarrier Enhances Broadband Experience



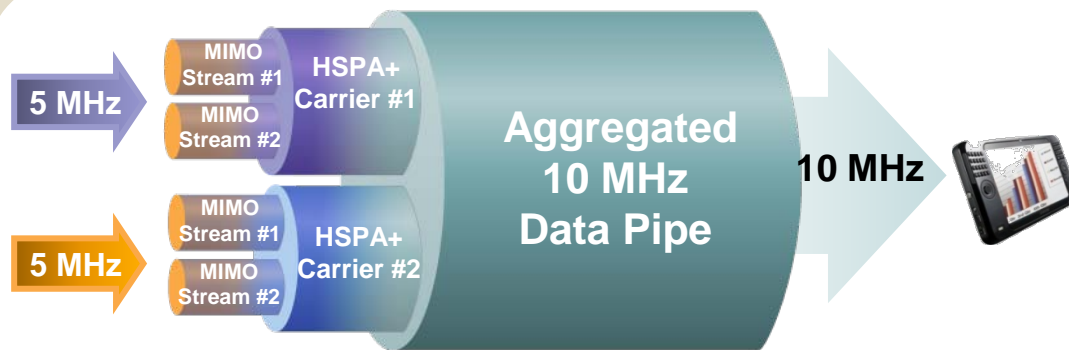
- Increased data rates and lower latencies for all users in the cell
- Can double capacity for bursty applications, e.g., Web apps
- Dynamic load balancing

Cost-effective software upgrade to multicarrier

Multicarrier Increases Data Rates to All Users



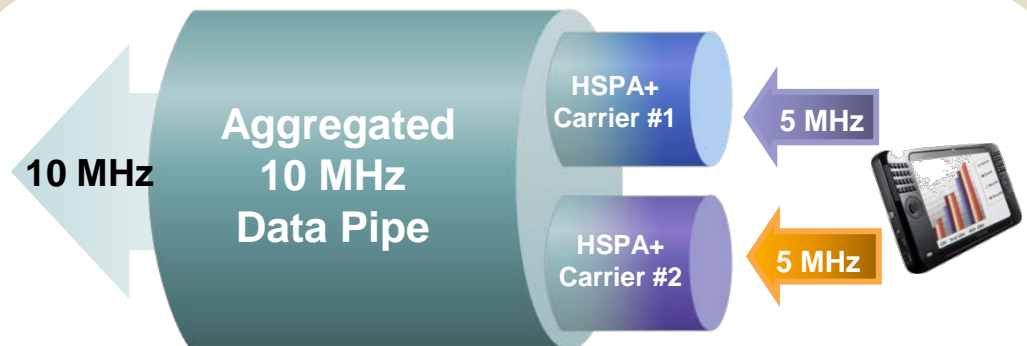
HSPA+ R9 Multicarrier—Enhanced Performance in 10 MHz



MIMO supported with Downlink Multicarrier

- 84 Mbps downlink peak rate
- Increased spectral efficiency with MIMO (~20%)
- Benefits all users in the cell
 - Both MIMO and Multicarrier improvement across cell and cell edge¹

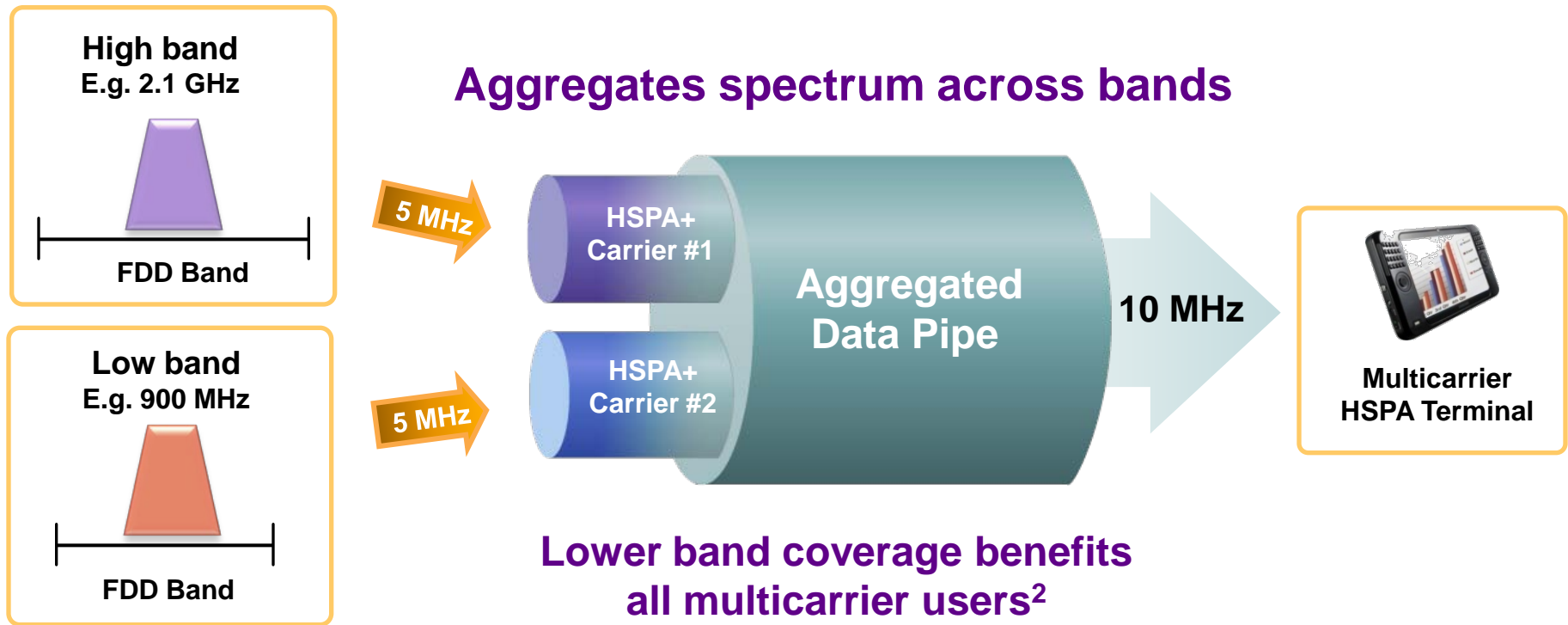
- 23 Mbps uplink peak rate
- Benefits all users in the cell²
- Increased bursty application capacity—similar to downlink



Uplink Multicarrier

¹MIMO downlink transmit beamforming increases cell edge data rates. ²Higher rates throughout the cell for users with available power headroom

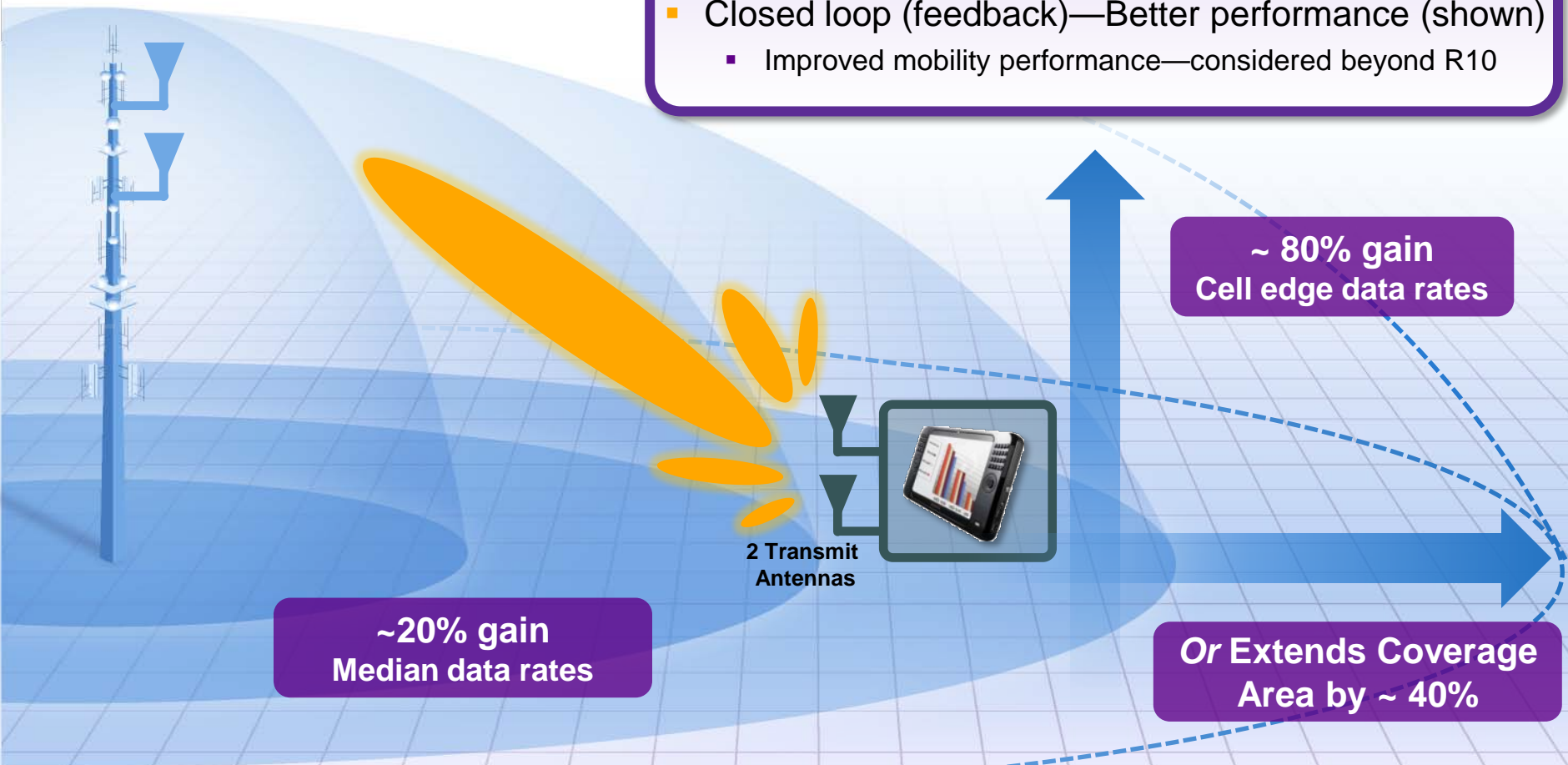
HSPA+ R9: Multicarrier Across Spectrum Bands



¹As opposed to only a fraction of users who are assigned to lower bands. With 4x multicarrier in R10, carriers within the same band need to be adjacent and inter-band aggregation can span two different bands

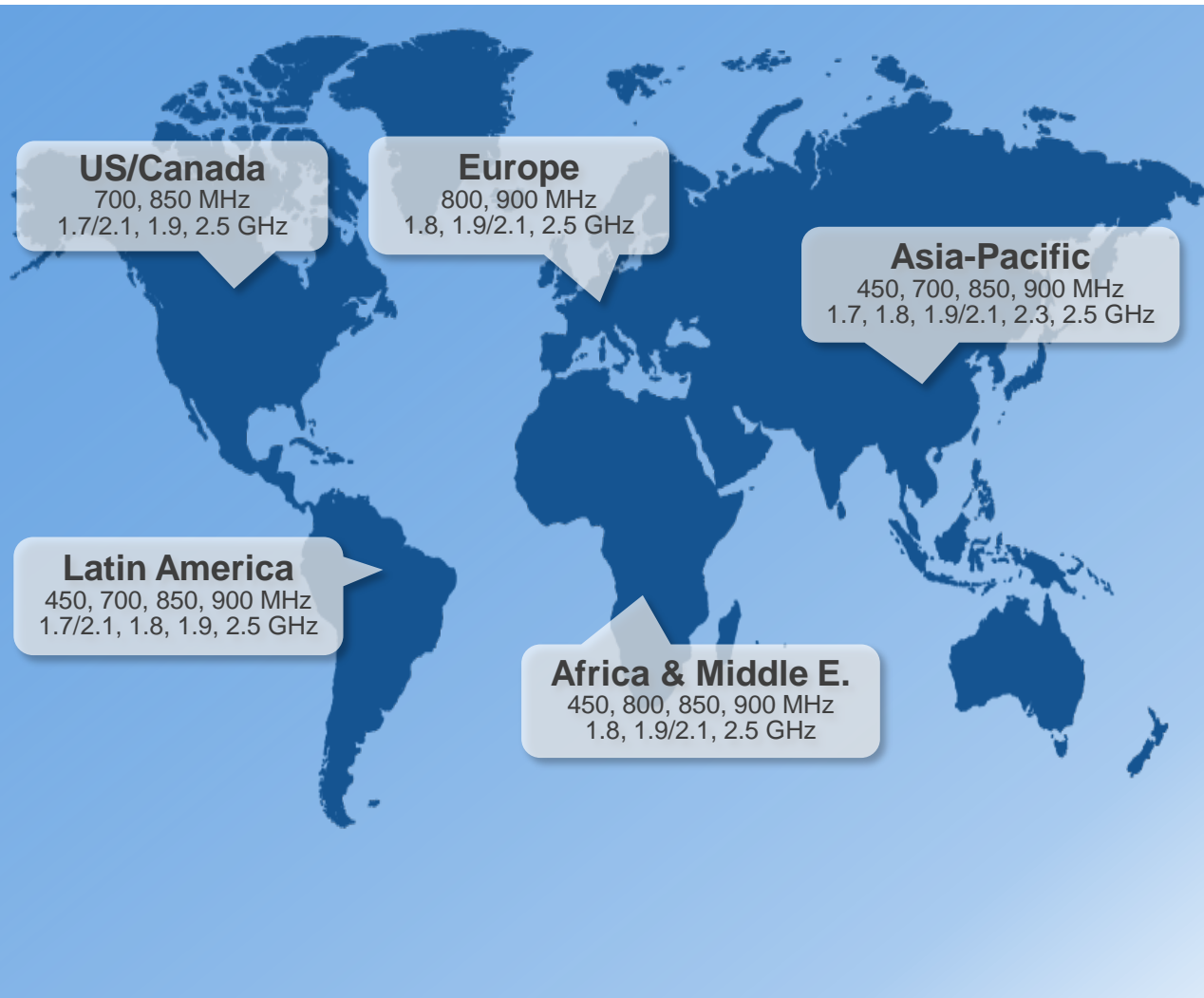
Mobile Transmit Diversity Improves Uplink Data Rates or Coverage

- Open loop (no feedback)—No network impact
 - Good gain for stationary users (performance spec in R10)
- Closed loop (feedback)—Better performance (shown)
 - Improved mobility performance—considered beyond R10



¹ Source: Qualcomm Simulation for closed loop .3GPP framework PA3, 4UEs per cell, 2.8km ISD. Shows data throughput gain for the median and the 5% worst (Cell edge) users. Gain depends on propagation environment and the UE speed with lower gain for faster moving users. The open loop gain would be slightly less.

Worldwide Mobile Broadband Spectrum



Bandwidth Deployment Options¹

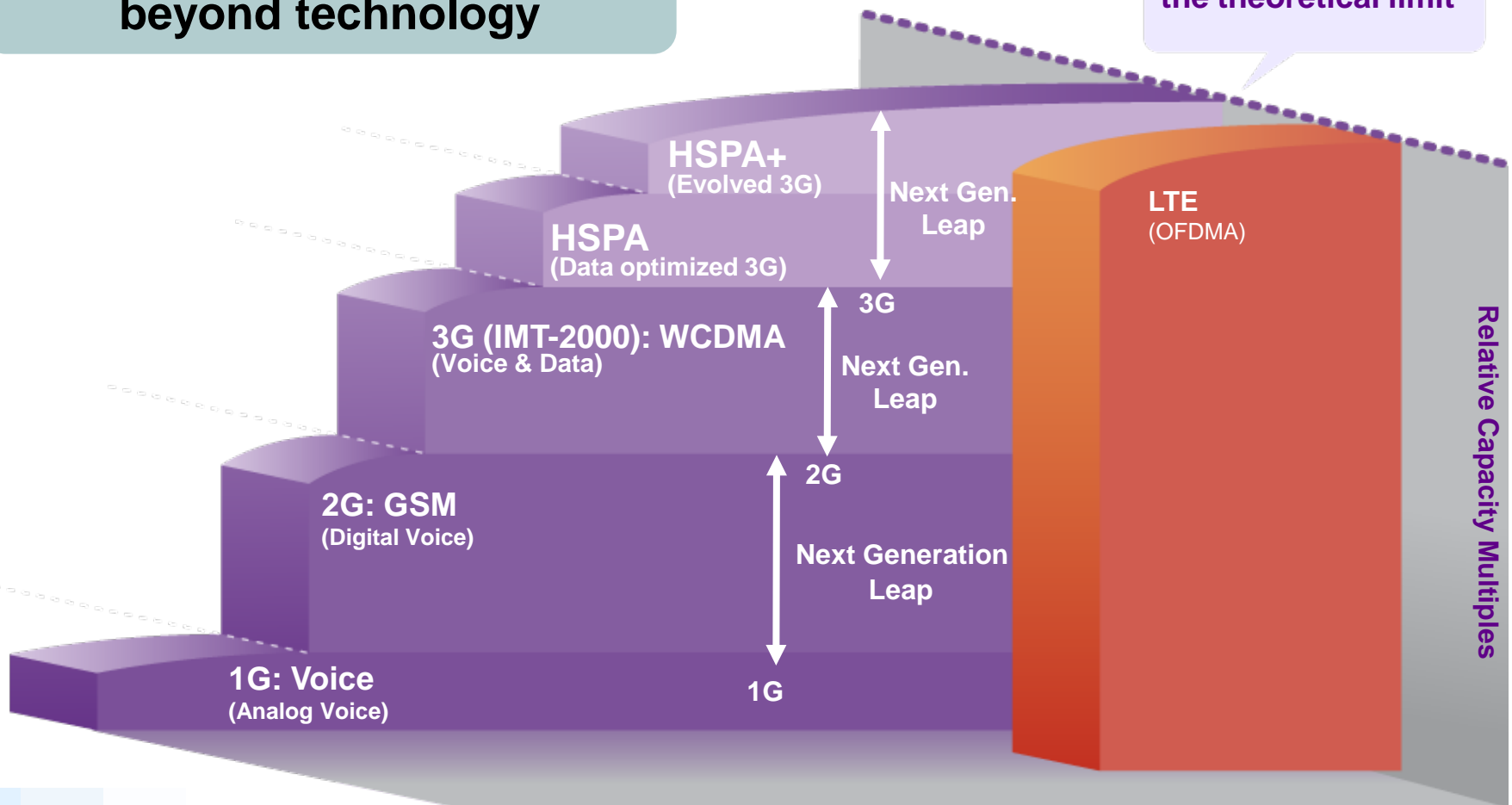
FDD Blocks/ Spectrum band	5 MHz	10 MHz	20 MHz
2.5/2.6 GHz ²	✓	✓	✓
2.1 GHz (1.7 or 1.9 uplink)	✓	✓	
1.5, 1.7, 1.8, 1.9 GHz	✓	✓	
900 MHz	✓		
800/850 MHz	✓		
Digital Dividend ³ (700 to 800 MHz)	✓	✓	

¹Usable spectrum blocks for product implementation. ²IMT extension 2500 to 2690 MHz, 70 MHz+70 MHz FDD in most countries. ³Digital dividend; Region 1 (Europe, Middle East and Africa) 790-862 MHz, Region 2 (Americas) 698-806 MHz. Region 3 (Asia) – some 698-790 MHz (e.g. China, India, Japan, Bangladesh, Korea, New Zealand, Papua New Guinea, Philippines and Singapore) others 790-806 MHz

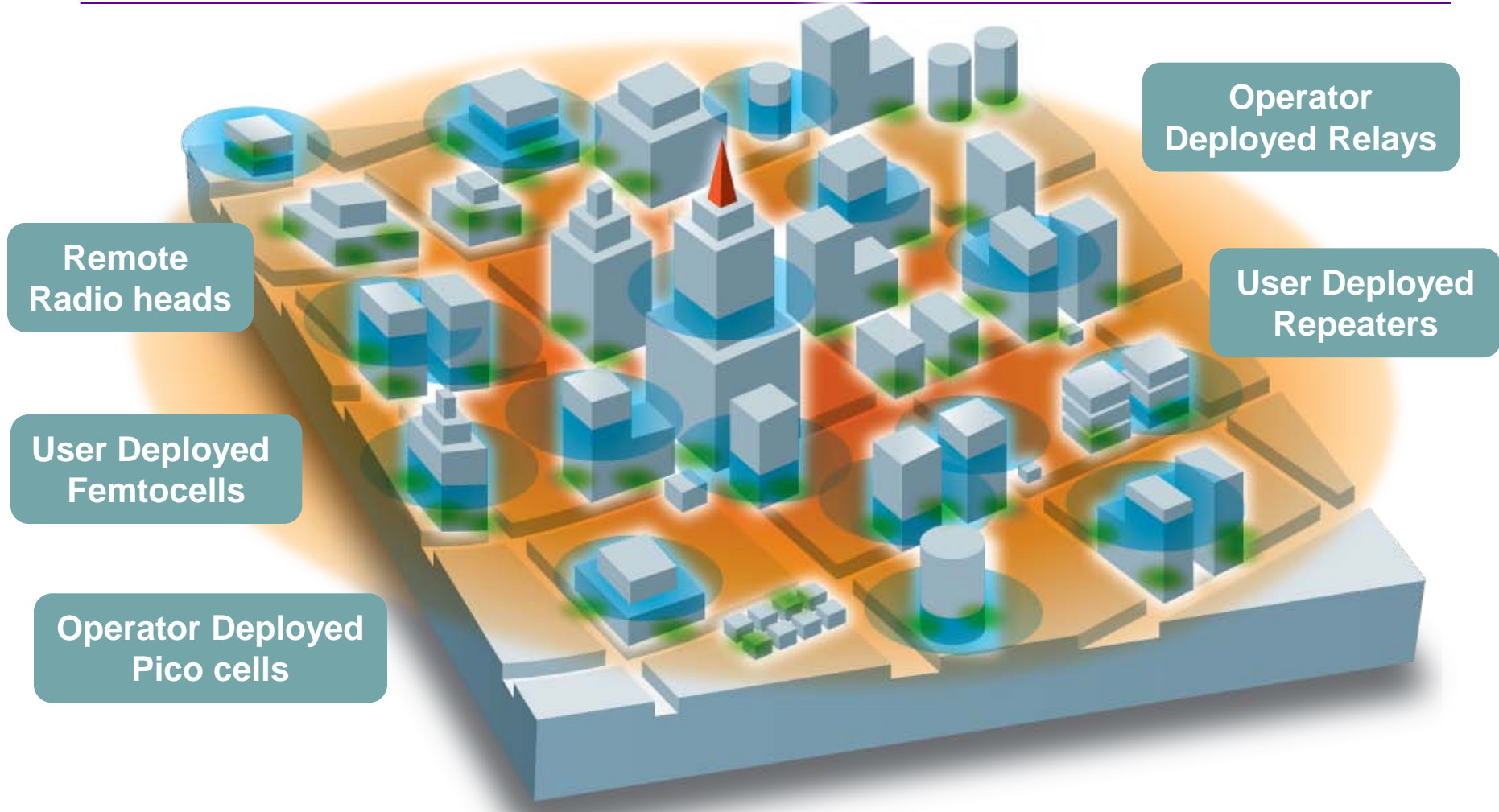
Radio Link Improvement is Slowing, What is Next?

Topology will provide gains
beyond technology

Approaching
the theoretical limit



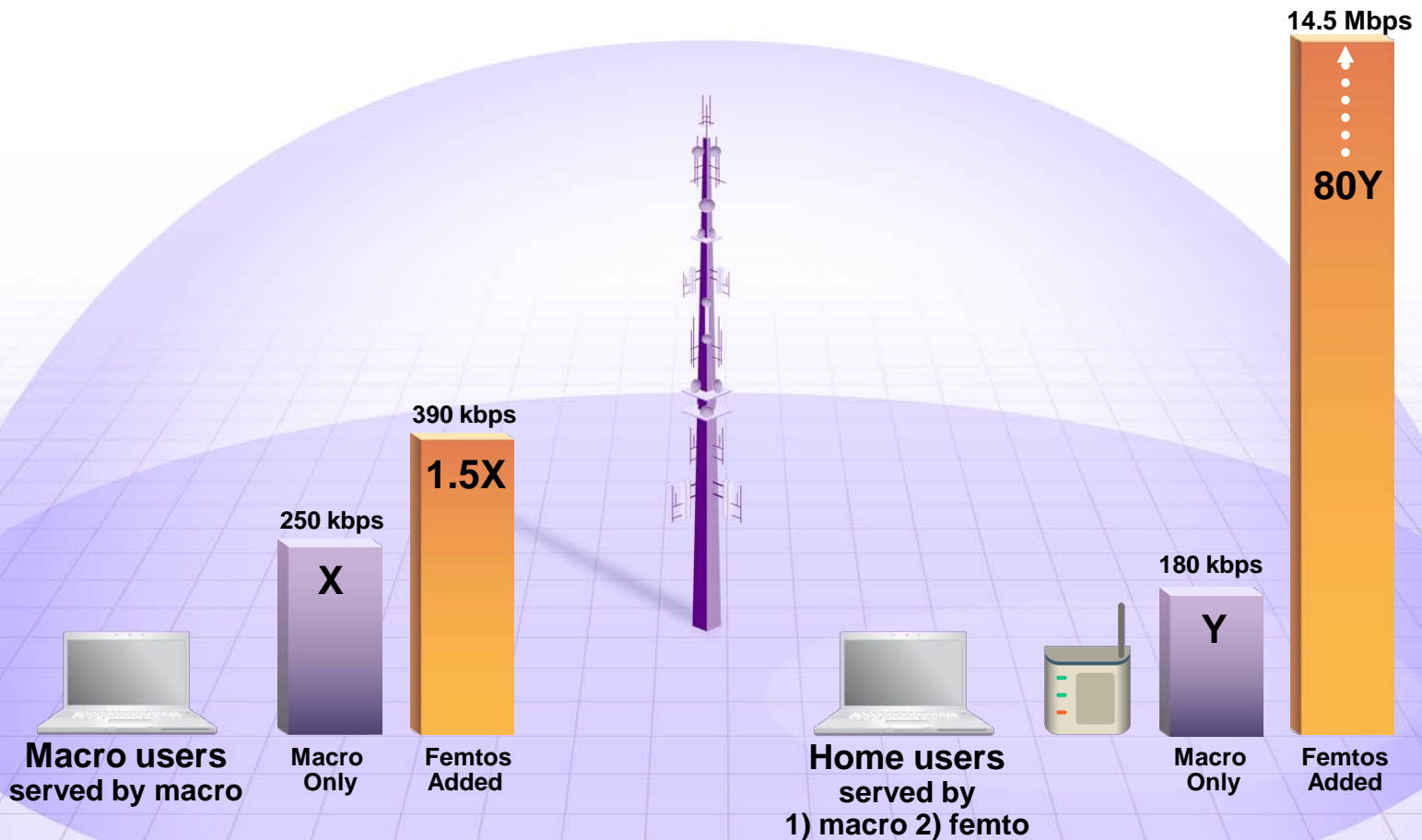
Bring Network Closer to User for Uniform User Experience and Increased Capacity



The Next Significant Performance Leap
Increasing spectral efficiency per coverage area

Bring Network to User—Femtocells Can Provide Next Significant Performance Leap

All users improved—home user served by near peak data rates



Macro Network Offloaded—Capacity Gain Can Exceed 10x

Assumptions: Dense urban system HSPA+ simulation. 16 Users per cell for HSPA+: 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. Note: Also, the worst 10% of macro users get ~15% higher throughput with proper interference management techniques.

Femtocells Evolving Towards Femto Networks

Today: Hot-spots

- Deployed by user—"unplanned"
- Plug & Play—self configuration
- Typically restricted access
- User's broadband connection
- Scalable femto network architecture

Residential

Enterprise



Femtocells gradually used as traditional Picocells

Future: Dense deployments and more open access

- Unplanned, also deployed by operator
- More open access
- Inter-femto service continuity
- Interference coordination (femto to femto/macro)
- Towards self-optimizing networks



Summary: HSPA+ R9 & R10 Expands Multicarrier

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R9
R10

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Enhanced Broadband Experience in 10 to 20 MHz

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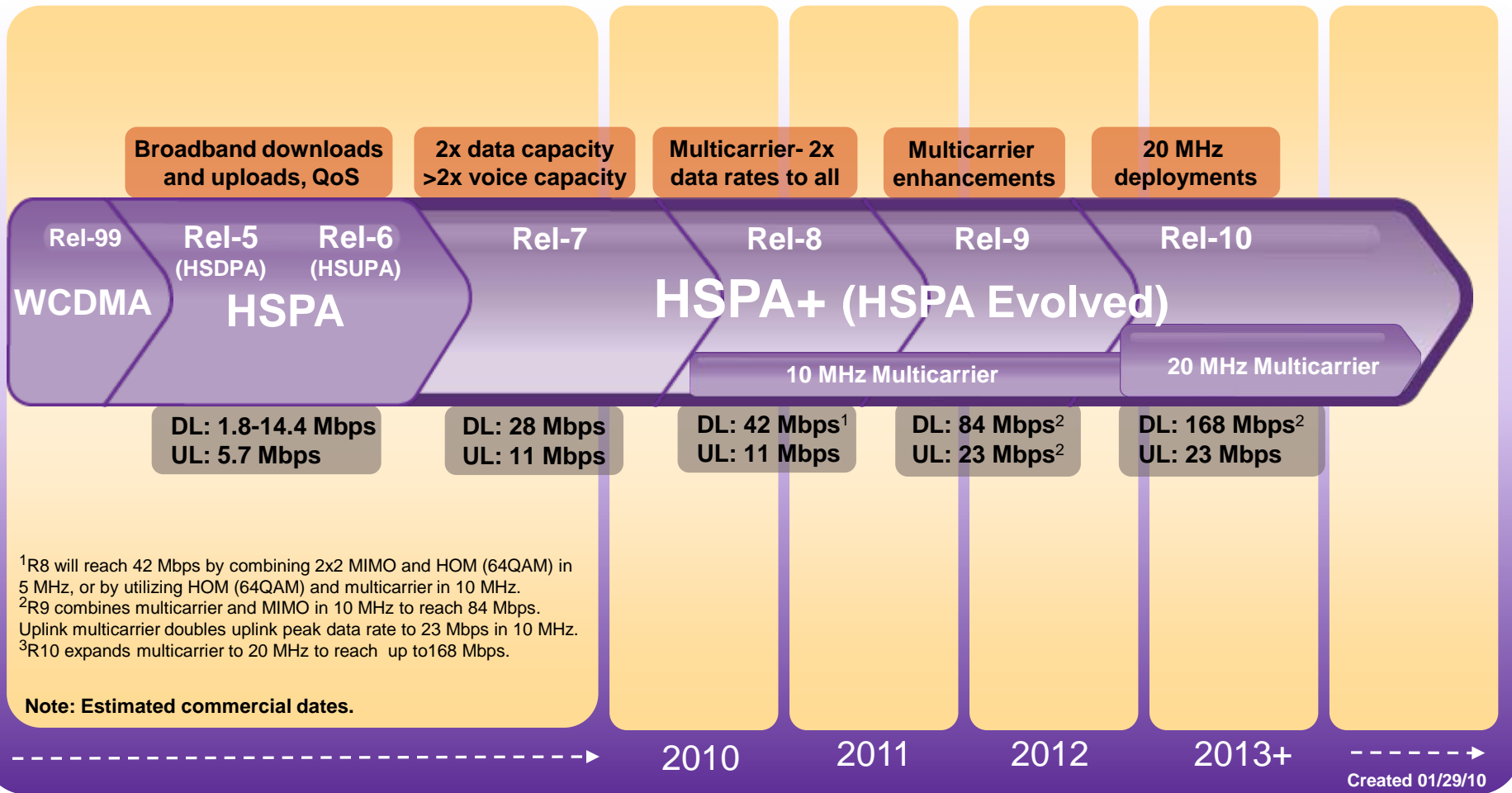
Bring Network to User for Next Performance Leap

Leverage topology with femtocells—evolution towards femtocell networks



➤ Additional Slides

HSPA+ Has A Strong Evolution Path



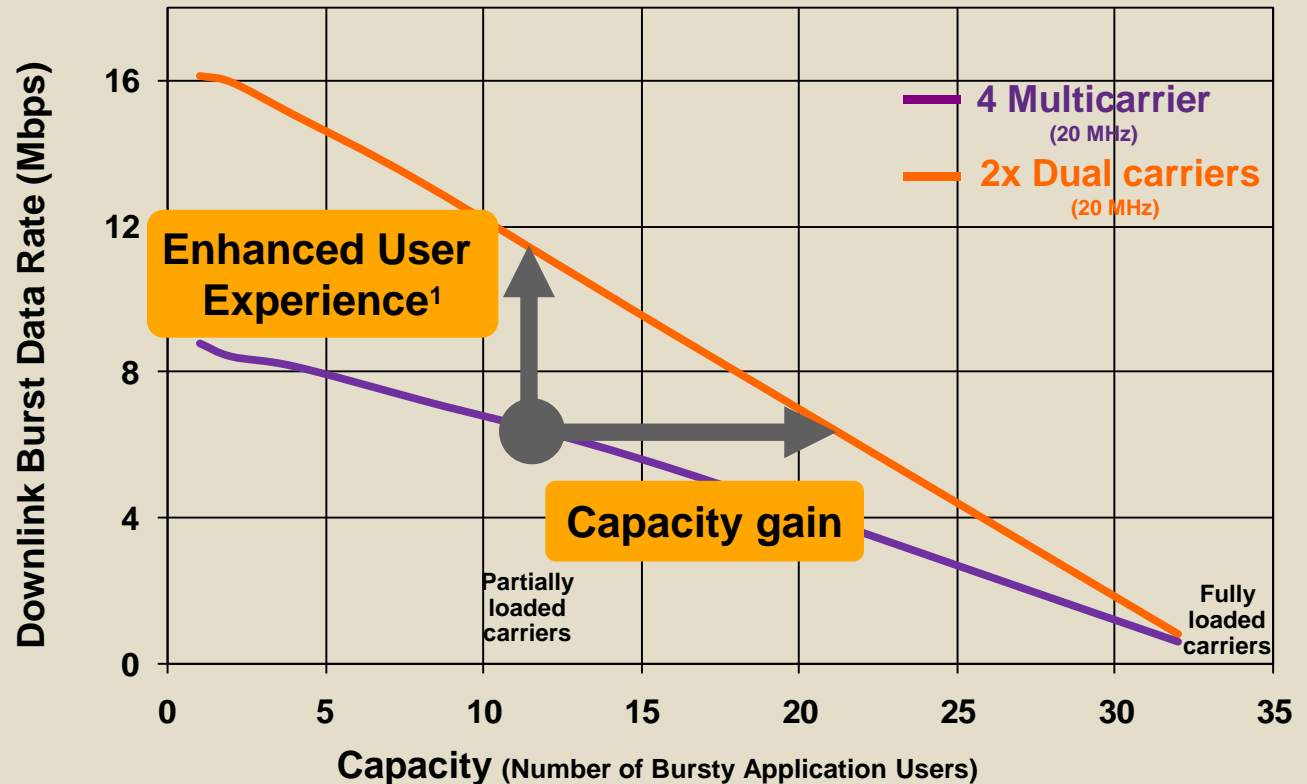
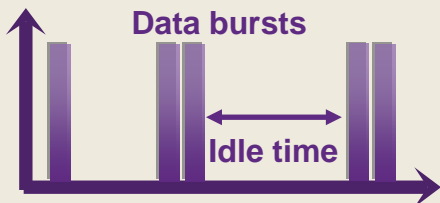
HSPA+ peak data rates up to 168 Mbps in 20 MHz

Key HSPA+ R9 Features and R10 Candidates

<i>R9 Features</i>	<i>Key Benefits</i>
<i>2x Uplink Multicarrier (10 MHz)</i> (single UL in R8)	Up to 2x user data rates in the uplink 23 Mbps UL peak data rate
<i>Multicarrier aggregation across bands</i>	Leveraging all spectrum resources
<i>Multicarrier and MIMO combined</i>	Peak Data rates of 84 Mbps in 10 MHz Improved spectral efficiency with multicarrier
<i>Home NodeB Enhancements</i> Examples: Active Hand in, hybrid access	Hand-in to femto cell and other optimizations
<i>R10 Candidates</i>	<i>Key Benefits</i>
<i>4x Multicarrier (20 MHz)</i> (2x downlink in R8 and R9)	Up 4 times higher user and peak data rates 168 Mbps UL peak data rate
<i>Multicarrier UL Transmit Diversity</i> (Open Loop—performance specifications)	Higher uplink capacity Higher cell edge data rates or extended coverage
<i>Home NodeB Enhancements</i> Examples: Local IP Access, Femto to femto HO	Femto networks (e.g. femto to femto handover) Optimizations for dense femto networks

Multicarrier Can Double Capacity for Bursty Applications

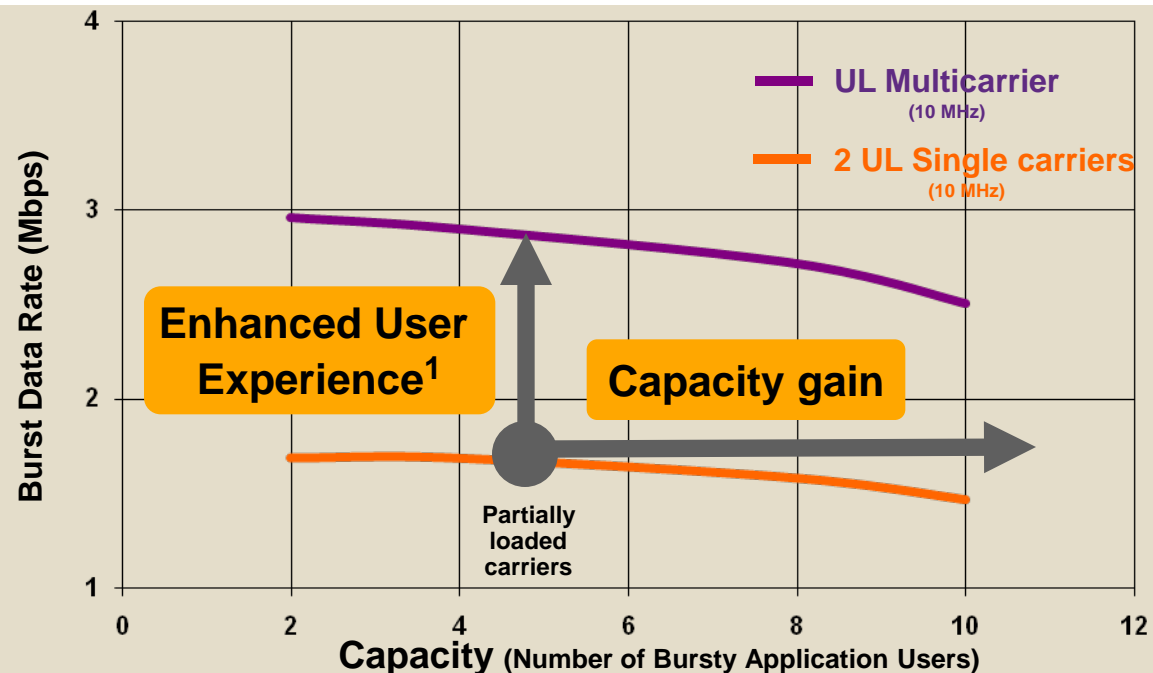
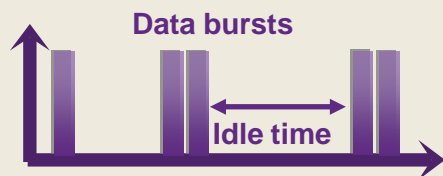
Bursty data application
(e.g. Web browsing)



¹ Increases the burst data rate and reduces over-the-air latency for all users in the cell

Uplink Multicarrier Provides Similar Gains as Downlink Multicarrier

Bursty data application
(e.g. Web browsing)



- Increased data rates and lower latencies for all users (within current power head room)
- Increased capacity for bursty applications, e.g., Web applications

¹Reduces over-the-air latency by up to ~50% for all users in the cell (within power head room)

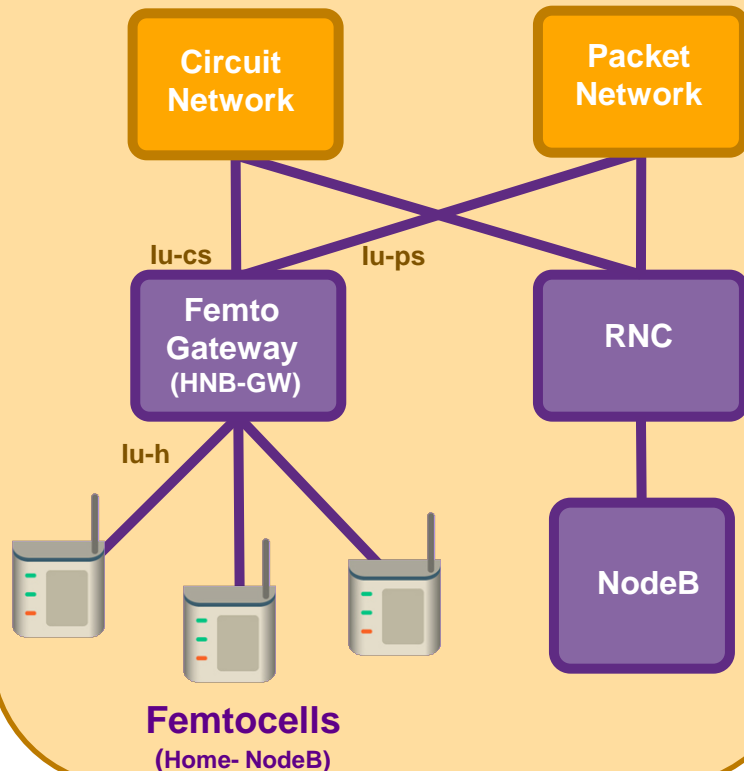
Assumptions: 3GPP Framework, PA3 Channel, No-IC, 16QAM, no-CPC, 24dBm UE, 1km ISD, 250 kb fixed burst with 5 sec average inter-burst time and exp. distributed

Femtocells Continue to Evolve

Pre-standards solutions already deployed

Standardized architecture

Femto Gateway (HNB-GW) concentrates multiple femtocells



- R8 introduces femto standard
 - Support for restricted access
 - Standardized architecture
- R9 enhances femto support, examples:
 - Active hand in to femto
 - Support for hybrid femtos
 - Open access but with preferential access for member devices
 - Enhanced femto discovery for new devices
- R10 and beyond further enhances femto support
 - R10 being defined during 2010, examples of possible features:
 - Femto to femto handover
 - Local IP access
 - Enhanced network and device support for interference management, e.g. cooperation between neighbor femtos
 - Femtocell Interference Cancellation¹