



QUALCOMM®



HSPA+ Evolution

January 2011



The Biggest Platform in the History of Mankind

>5 BILLION WIRELESS SUBSCRIBERS

>1B

3G SUBSCRIPTIONS
NOW

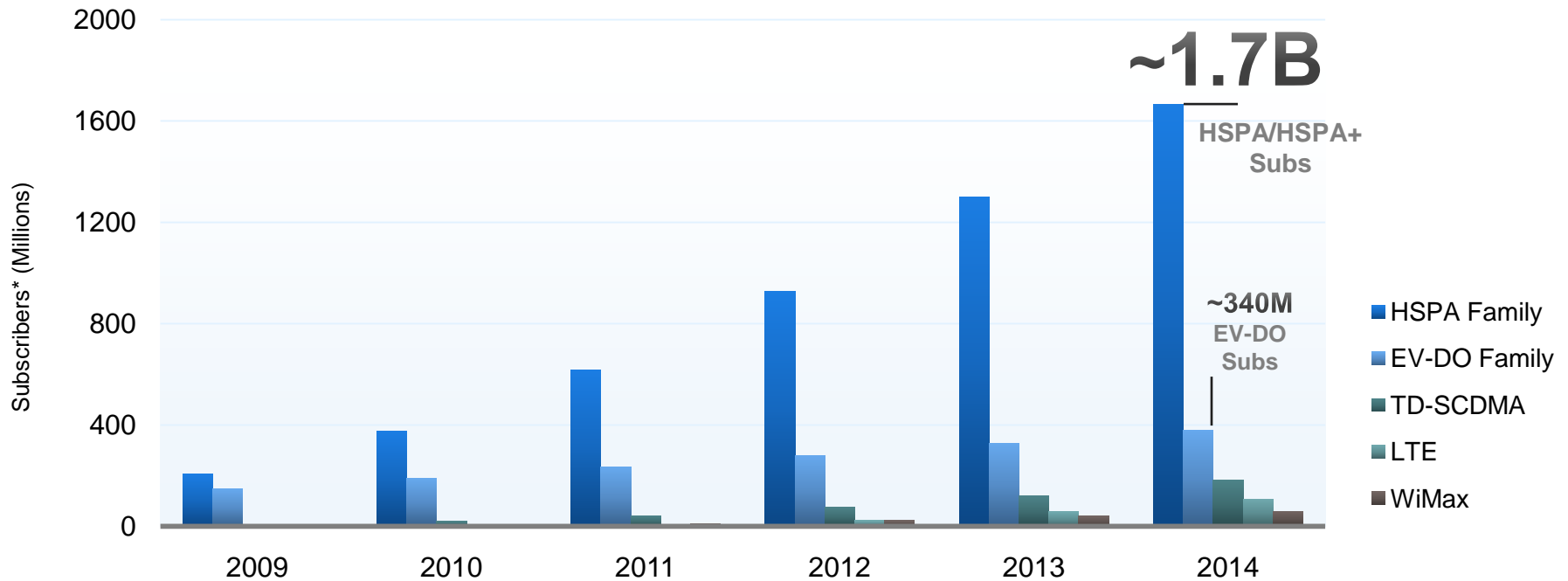
~2.8B

3G SUBSCRIPTIONS
BY 2014

Note : 3G includes CDMA2000, WCDMA and TD-SCDMA.

Source: Wireless Intelligence estimates as of Nov.2 , 2010 for the quarter ending Sep 30, 2010; *number of unique wireless connections.

HSPA+ is The Mobile Broadband Leader



Total 3G* mobile broadband subscribers expected to be ~2.2B by 2014 (of total 2.8B 3G)

Note: * 3G includes EV-DO family, HSPA family and TD-SCDMA, ** number of unique wireless connections.

Source: 3G subs – Wireless Intelligence (Nov-10), LTE – Avg. of ABI (Oct-10) and Yankee (Sep-10) and WiMax - ABI (Oct-10).

HSPA+ is The New Baseline

HSPA+ IS THE NEW BASELINE

103

LAUNCHES

148

NETWORK COMMITMENTS

OPERATORS QUICKLY MOVING TO Dual-Carrier

13

LAUNCHES

Aug 2010

FIRST LAUNCH

HSPA+ DEVICES ACROSS ALL SEGMENTS

>50

DEVICES

>11

VENDORS

Qualcomm is a Leader in HSPA+ Research, Standards and Chipsets

COMMITTED TO CONTINUED HSPA+ EVOLUTION

■ Standards Leadership

- Major 3GPP contributor on all HSPA+ features
- Recognized expertise across all 3GPP groups

■ Industry-First Demos

- MWC 2007: Voice over HSPA
- MWC 2008: Dual-Carrier
- MWC 2009: Dual-Carrier 42 Mbps
- MWC 2010: Uplink Beamforming
- MWC 2011: Multipoint (shown below) and Supplemental downlink

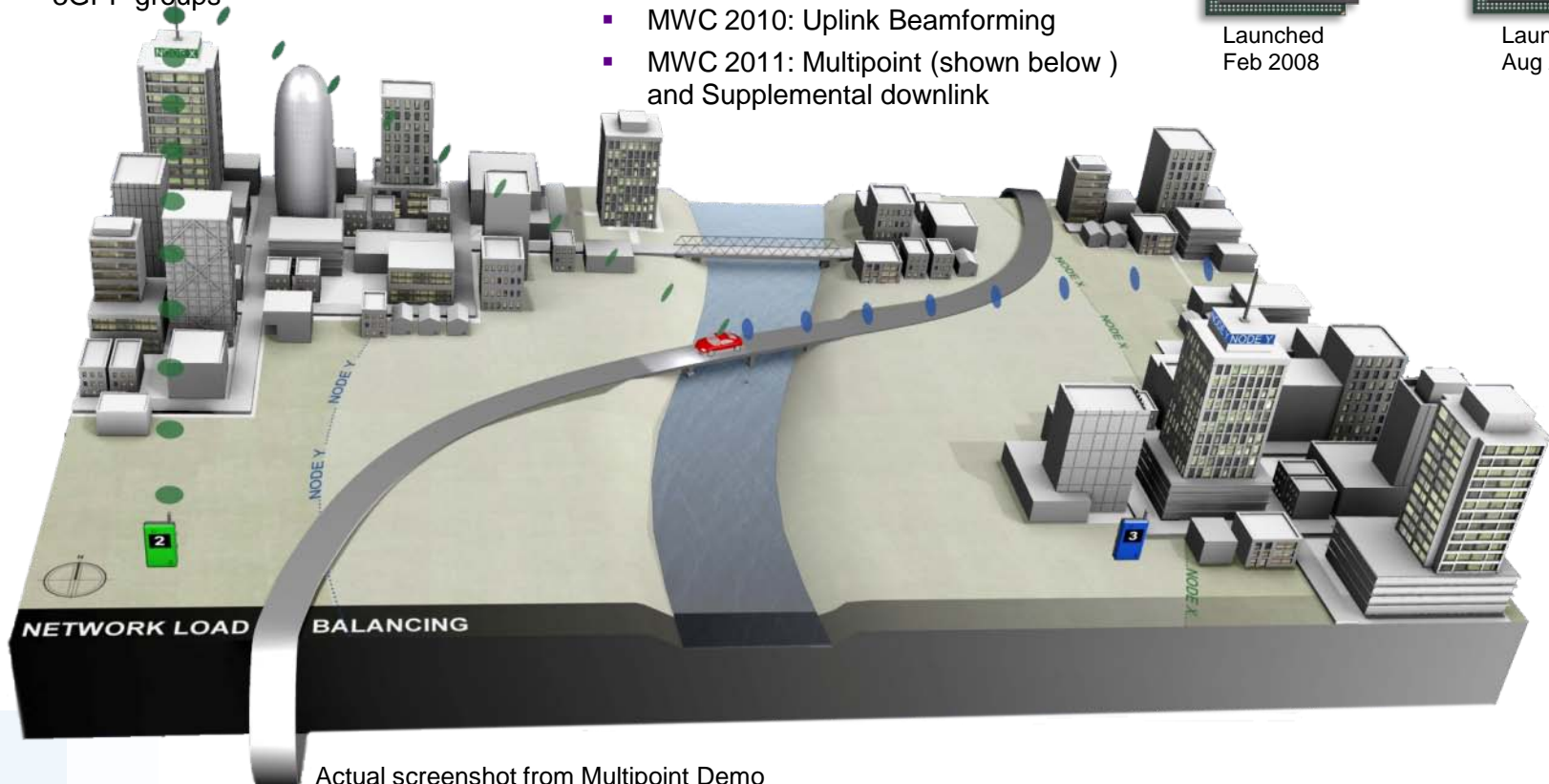
■ Industry-First Chipsets



Launched
Feb 2008

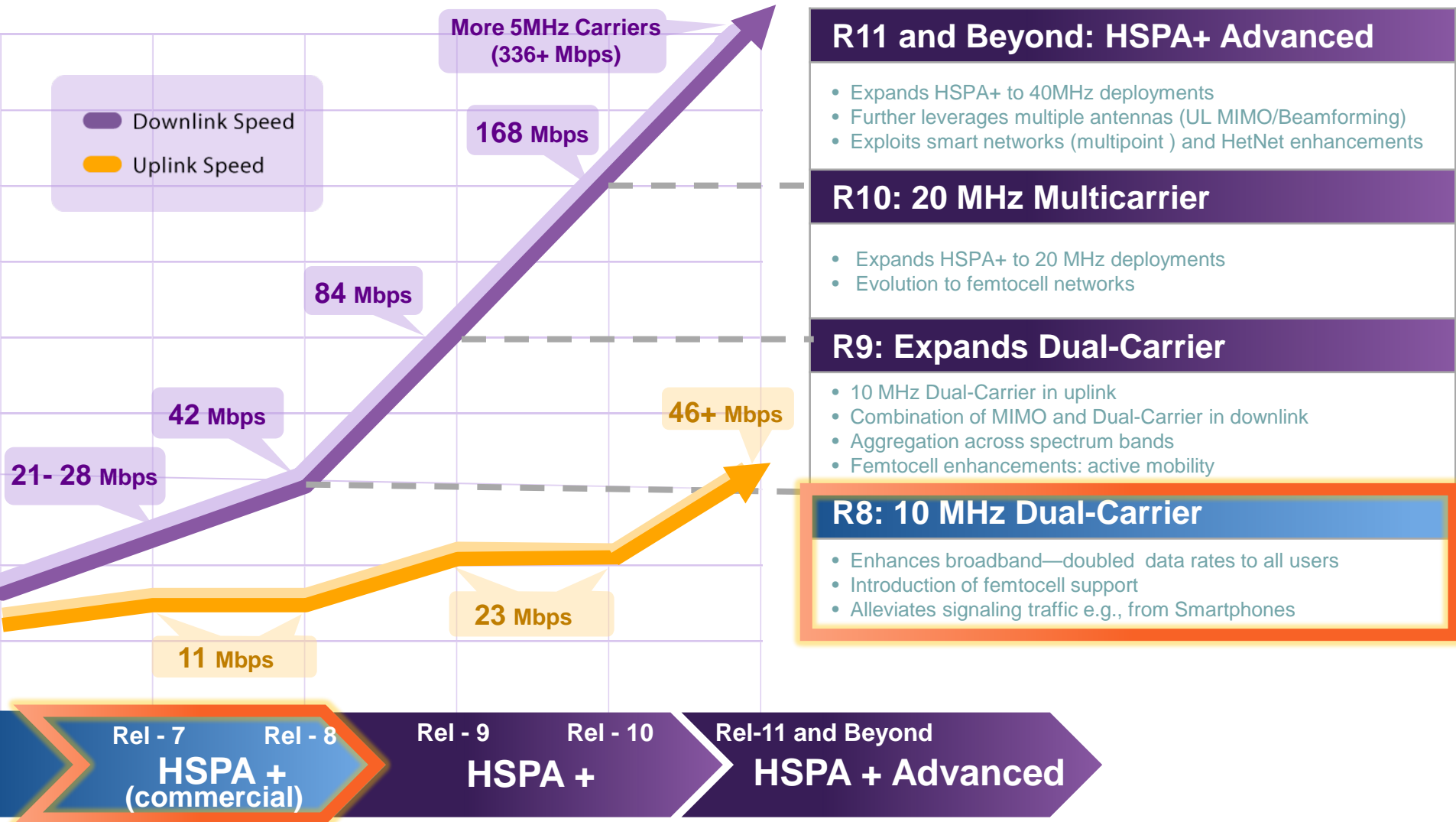


Launched
Aug 2010



Actual screenshot from Multipoint Demo

HSPA+ Has A Strong Evolution Path



Created 01/21/11

Notes: R8 reaches 42 Mbps by combining 2x2 MIMO and HOM (64QAM) in 5 MHz, or by utilizing HOM (64QAM) and multicarrier in 10 MHz. R9 combines multicarrier and MIMO in 10 MHz to reach 84 Mbps peak rates. Uplink multicarrier doubles the uplink peak data rate to 23 Mbps in 10 MHz in R9. R10 expands multicarrier to 20 MHz to reach 168 Mbps. R11 expands multicarrier to 40MHz to reach 336 Mbps.

Next Generation Performance in 5MHz

H
S
P
A
+

R7

28 Mbps—Evolution to 168 Mbps

Doubles Data and Voice Capacity

Enhances User Experience

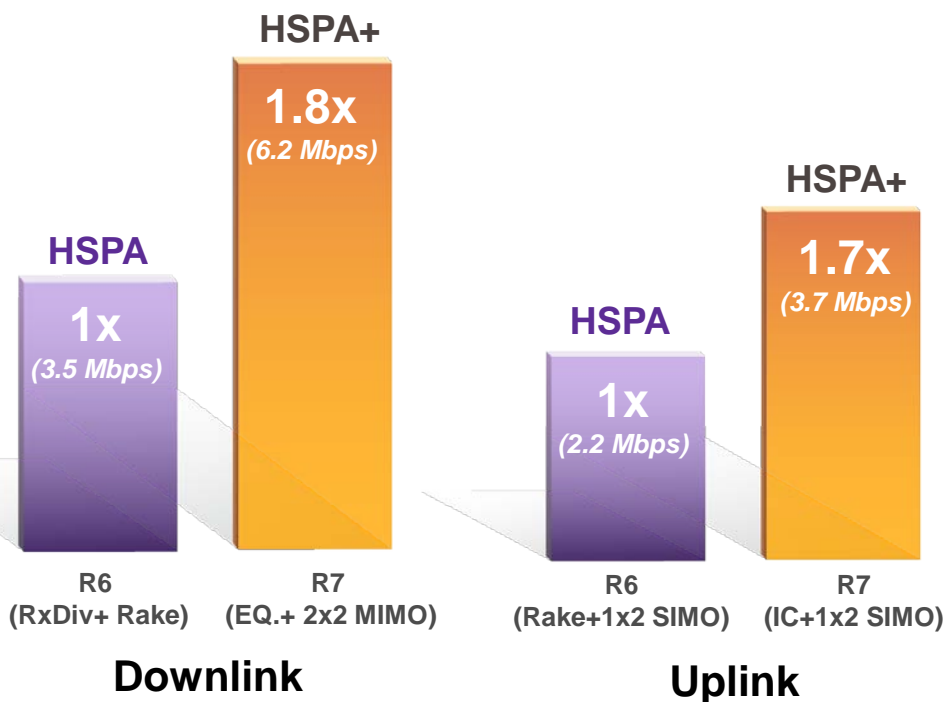
Enhanced responsiveness and better 'always-on' experience

Similar HSPA+ and LTE Performance

For same amount of spectrum and number of antennas

HSPA+ R7 Doubles Data and Voice Capacity

Data Capacity Per Sector (5 MHz)¹



Voice over HSPA Capacity²
AMR 12.2 kbps

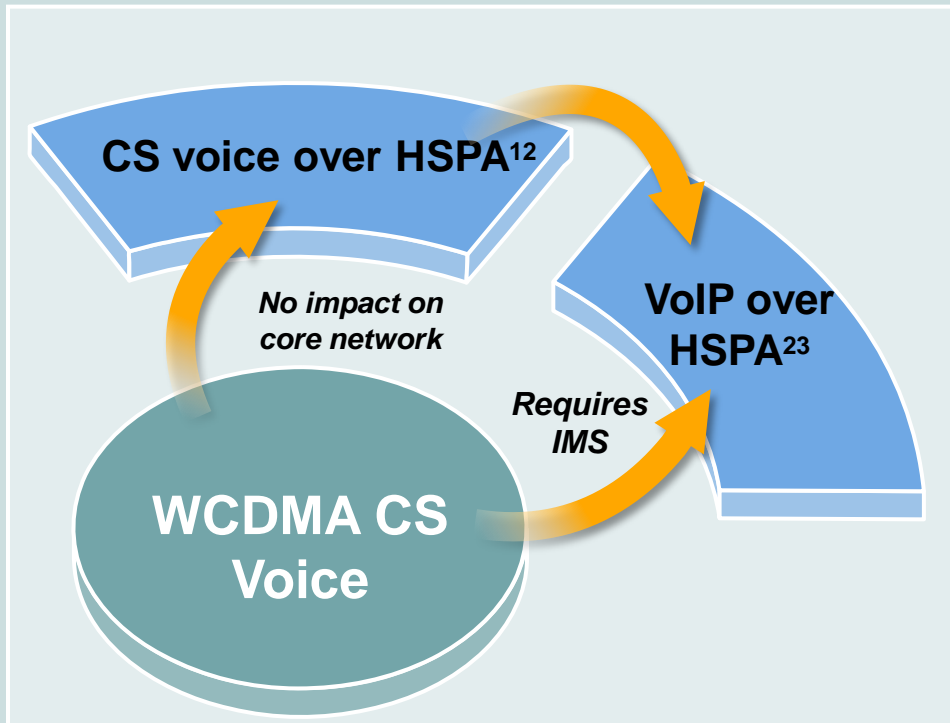


When also leveraging advanced receivers
(Handset Equalizer & Node B Interference cancellation)

¹Source: 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. ²Source: QUALCOMM simulations for VoIP, 3GPP Channel Mix 1km inter-site distance. HSPA+ includes NodeB IC. CS voice over HSPA would result in 15 % to 20% lower capacity.

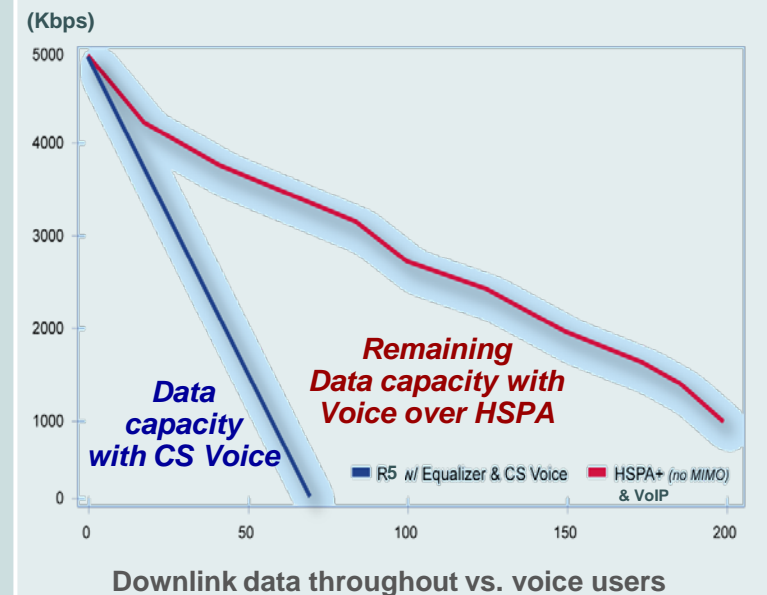
Voice over HSPA Frees Up Resources for Data

MORE THAN DOUBLES VOICE CAPACITY
UP TO 50% EXTENDED TALK TIME



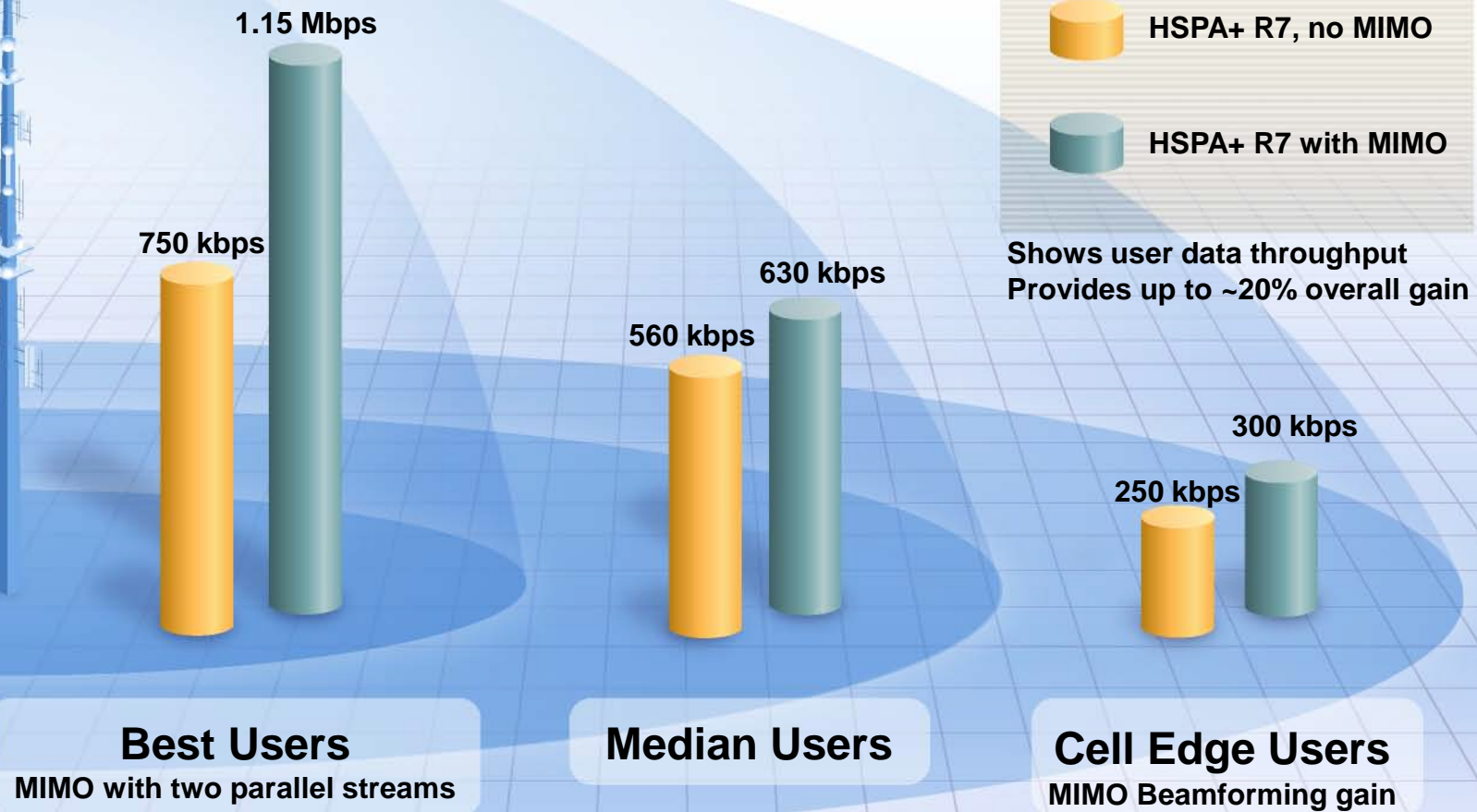
Voice over HSPA is either CS voice over HSPA or VoIP over HSPA

FREES UP RESOURCES FOR DATA



¹ Network support for "CS over HS" in HSPA+ R8, but UE capability in R7 enabling early implementation. ² Enhanced mobility, E-SCC is part of R8 and required for high capacity voice over HSPA. ³ The R8 feature VCC enables call continuity outside VoIP coverage. Source: QUALCOMM simulations for VoIP, 3GPP Channel Mix 1km inter-site distance and AMR 12.2 Kbps codec. HSPA+ includes NodeB IC. CS voice over HSPA would result in 15% to 20% lower capacity.

MIMO Improvements Across the Cell



3G Advanced Receivers Increase Capacity, Coverage and User Experience

Qualcomm Provides the Latest Generation of Advanced Receivers

Device:

Receive diversity
Equalizer
Interference cancellation etc.



Base station:
Receive diversity
Interference cancellation
Etc.

Extended coverage



Higher Capacity
(data throughput or voice capacity)

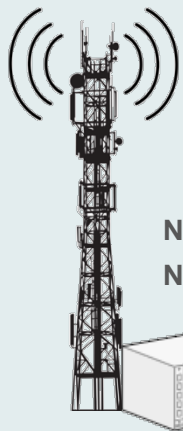


Enhanced user experience
(Higher user data rates, improved voice quality)



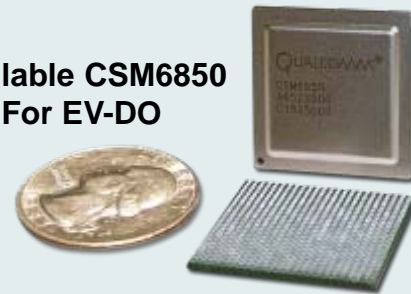
Interference Cancellation now Available

- ~ 65% MORE UPLINK DATA CAPACITY¹
- ~ 45% MORE VOICE CAPACITY (VOICE OVER HSPA²)



NodeB Channel Card upgrade
No handset impact

Available CSM6850
For EV-DO



Supports total interference cancellation

- Qualcomm provides reference design for HSPA+ NodeB interference cancellation³
- Qualcomm supports device interference cancellation improving downlink

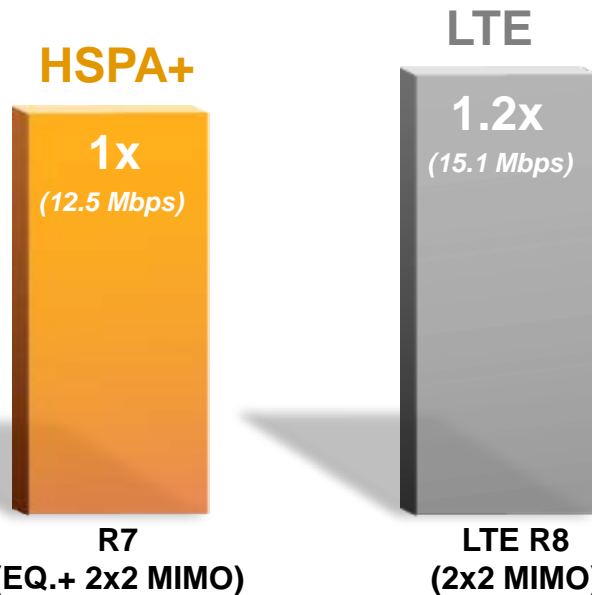
Interference Cancellation Bridges OFDMA and WCDMA Performance

¹Gain for full interference cancellation compared to no IC. ²The voice gain is achieved through voice over HSPA,(Circuit Switched voice over HSPA or VoIP). ³Refer to infra vendor for commercial availability

Similar HSPA+ and LTE Performance

Similar Spectral Efficiency

with same number of antennas and bandwidth
(Downlink sector capacity in 10 MHz FDD)¹



Note: HSPA+ spectral efficiency would improve with multicarrier.

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	168 Mbps ²	150 Mbps

Note: Assuming 2x2MIMO. LTE supports 4x4MIMO but initial deployments will be 2x2 MIMO. LTE takes required overhead into account, 172 Mbps possible per standards

Similar RTT Latency

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

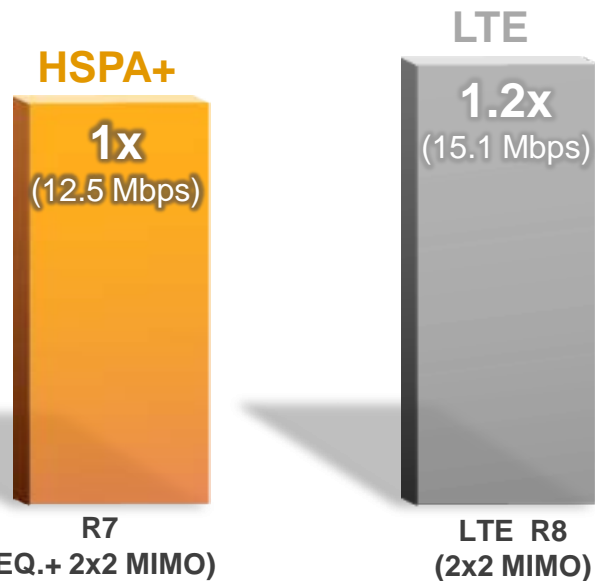
	HSPA+	LTE
RT T ³	28 ms + Transport network	22 ms + Transport network

¹ Source: Qualcomm Simulation, details in 3GPP R1-070674. NGMN 500m ISD, HSPA+ R7 results scaled up from 10 MHz. HSPA+. HSPA+ multicarrier (R8 and beyond) and DL Interference Cancellation not considered and would narrow the gap with LTE. ²168 Mbps in 20MHz beyond HSPA+ R9. ³Source: Qualcomm assuming similar operating points, processing delays, excludes transport network delay that is dependent on actual network used

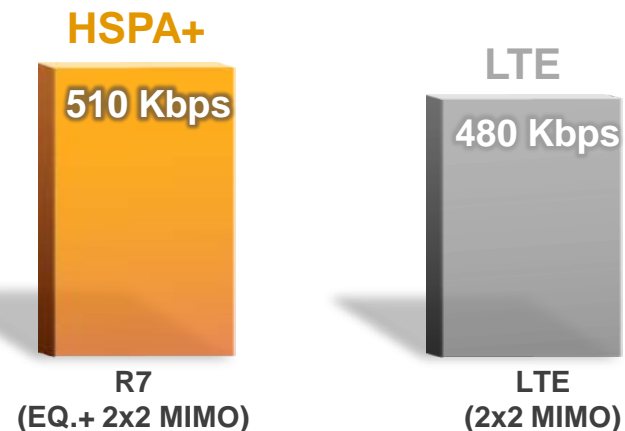
Similar HSPA+ and LTE Cell Edge Performance using Fair Comparison

Similar Spectral Efficiency

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



Fair Comparison: Similar Cell Edge Performance

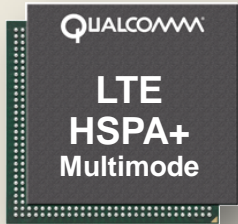


Note: HSPA+ spectral efficiency would improve with multicarrier.

Cell edge performance can be traded for even higher cell capacity at the expense of fairness

¹ Source: Qualcomm Simulation, details in 3GPP R1-070674. NGMN 500m ISD, HSPA+ R7 results scaled up from 10 MHz. HSPA+. HSPA+ multicarrier (R8 and beyond) and DL Interference Cancellation not considered and would narrow the gap with LTE.

HSPA+ and LTE are on Parallel Evolution Paths



Industry's first LTE multimode solutions

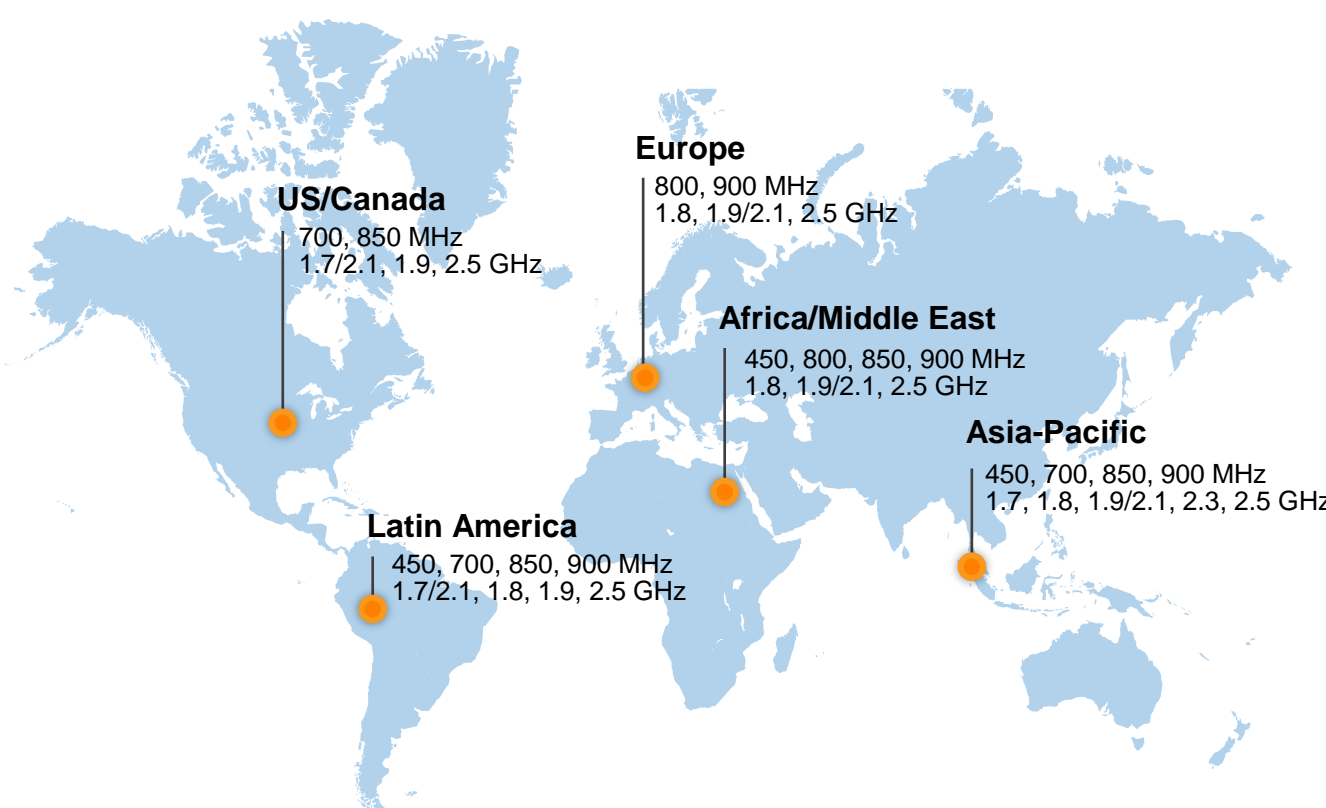
- LTE leverages new, wider spectrum to boost data capacity
- WCDMA/HSPA+ provides ubiquitous data and voice
 - Provides global broadband experience in global bands (900/2100 + 850/1900)
 - LTE deployed across a fragmented set of bands and in a fragmented set of scenarios.
- Seamless service continuity from day one with multimode devices

LTE (*FDD or TDD*)

HSPA+ Coverage

HSPA+ ensures similar user experience outside the LTE coverage

Worldwide Mobile Broadband Spectrum



FDD 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)	✓	✓	

NEW, WIDER BANDWIDTH 10 MHz AND BEYOND SUITABLE FOR LTE DEPLOYMENTS (E.G. 2.6 GHz AND DIGITAL DIVIDEND)

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

HSPA+ Enhances User Experience



- More responsive user experience
 - 50% reduction in call setup¹
 - 50% reduction in transitions time between inactive and connected states²
- Better ‘always-on’ experience
 - User can stay longer in connected state without compromising battery life (CPC)³
- Higher peak and user data rates
- More Enhancements in R8 and beyond
 - Further alleviates signaling load and extends battery life

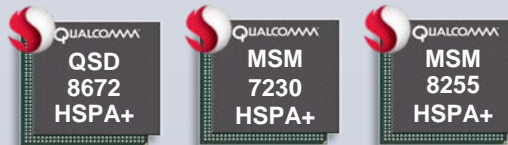
¹Paging messages sent over HSDPA channels in CELL_PCH state. ²Up to 50% reduced time over the air (from PCH to CELL_FACH/DCH state) compared to R6 with Enhanced CELL_FACH/PCH. ³Users can stay in connected state longer without compromising battery life and experience faster state transitions thanks to CPC (DTX and DRX).

Qualcomm: Industry's First HSPA+ Chipsets

HSPA+ R7

HSPA+ R8

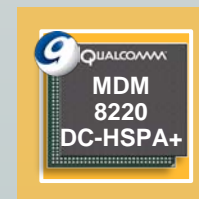
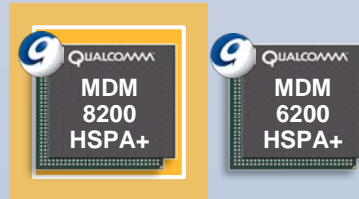
Smartphones, Tablets
& Other Smart Devices



Feature & Basic Phones



Modems & Data Cards



* Only Select Chipsets Shown



 Industry First Launches

Operators Quickly Moving to Dual-Carrier

H
S
P
A
+

R8

Dual-Carrier Enhances Broadband Experience

42 Mbps peak—doubles data rates for all users

Dual-Carrier Can Double Bursty Appl. Capacity

For typical network load (partially loaded carriers)

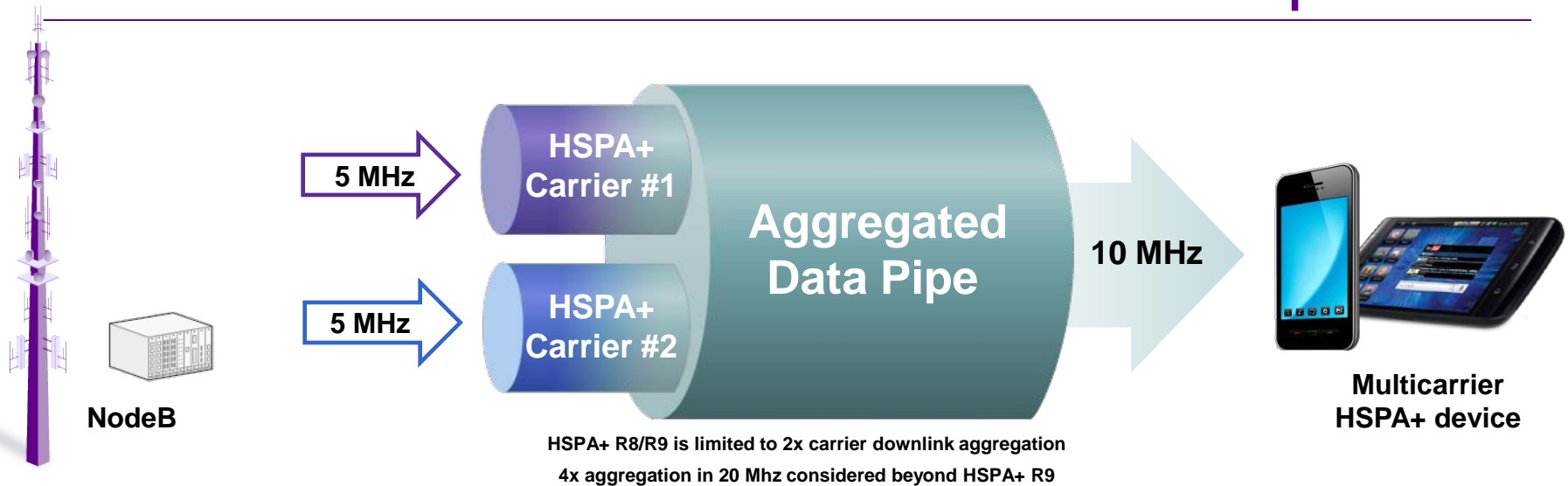
Femtocells—The Next Leap In Performance

Introduction of femtocell support

Meets Smartphone Growth

Alleviates signaling load and extends battery life

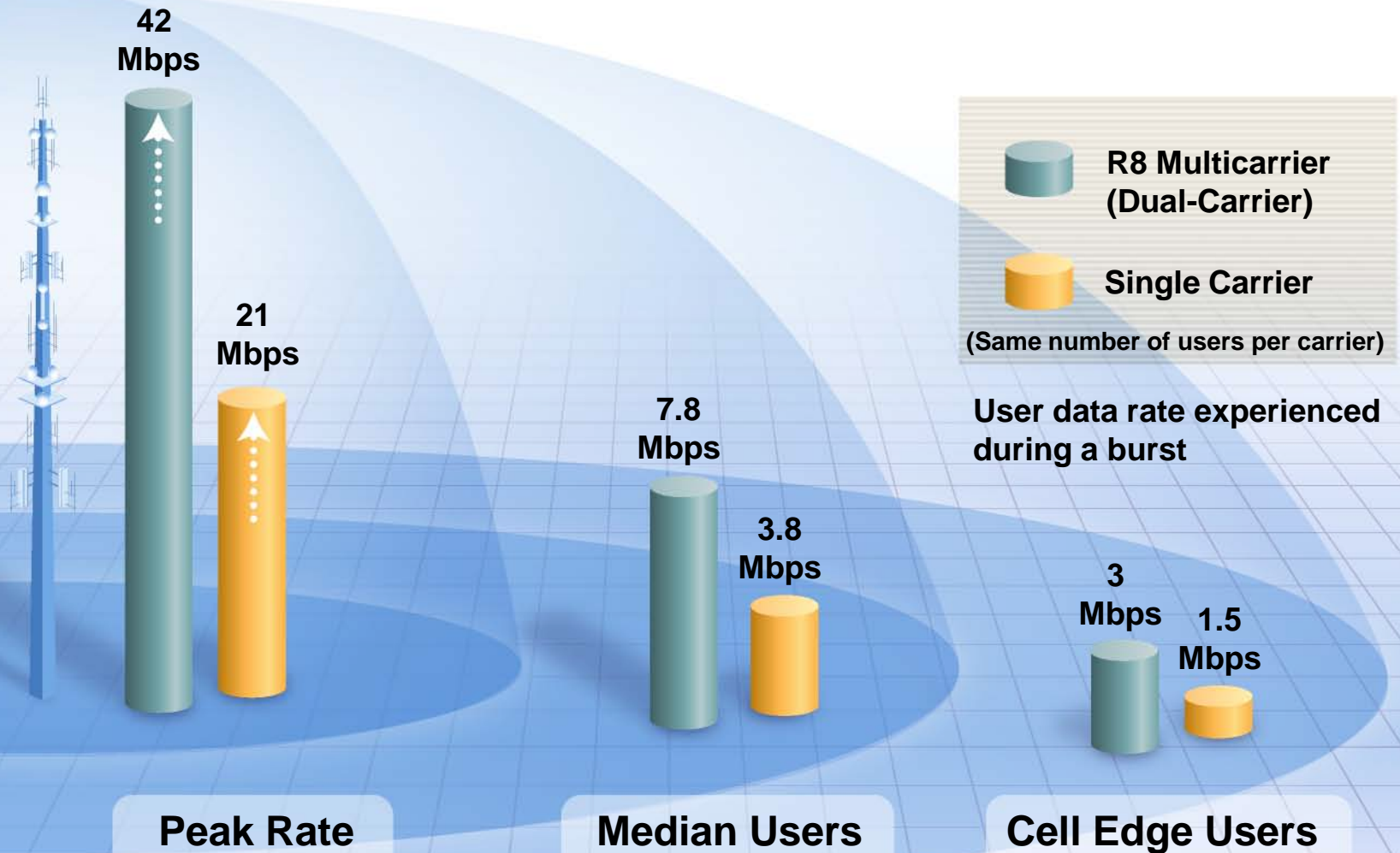
Dual-Carrier Enhances Broadband Experience



- Doubled data rates and lower latencies for all users
- Increased capacity for bursty applications, e.g., Web applications
- Dynamic load balancing

Cost-effective software upgrade

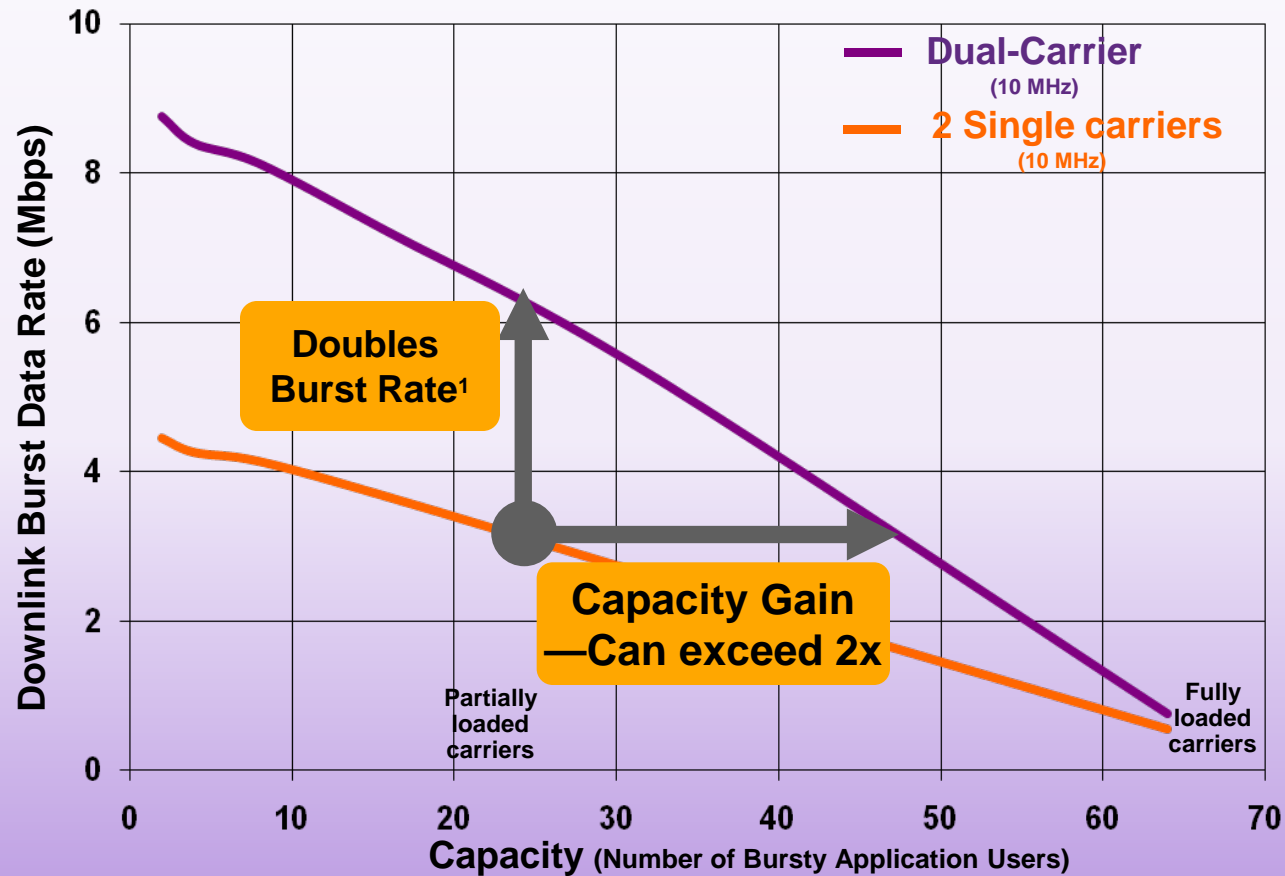
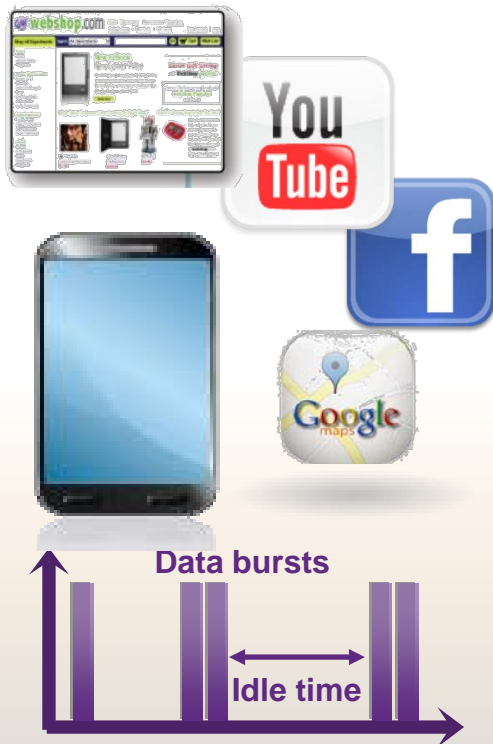
Dual-Carrier Doubles Data Rates to All Users



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 rate 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.

Another Capacity Dimension: Dual-Carrier Can Double Bursty App Capacity

Bursty Data Applications



¹For all users, which reduces over-the-air latency ~50% for all users in the cell

Femtocell—A Low Cost Solution to Enhance Coverage and Capacity

Operator Benefits:

Enhanced Coverage and Capacity

Bring network to user—offload macro network

Reduced Churn and Cost

Indoor coverage main churn reason. Reduce backhaul, site cost

New Revenue and Services

Additional ARPU—home tariffs, bundles, home zone services



End-User Benefits:

Enhanced User Experience

Better voice quality and higher data rates with existing devices

Attractive Home Zone Plans and Bundles

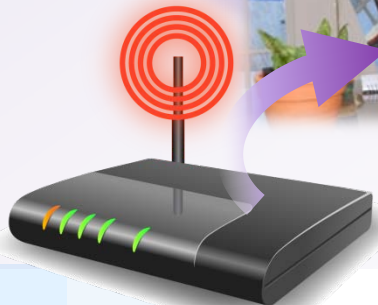
Wireless substitution, one gateway for all home entertainment

New Home Zone Services

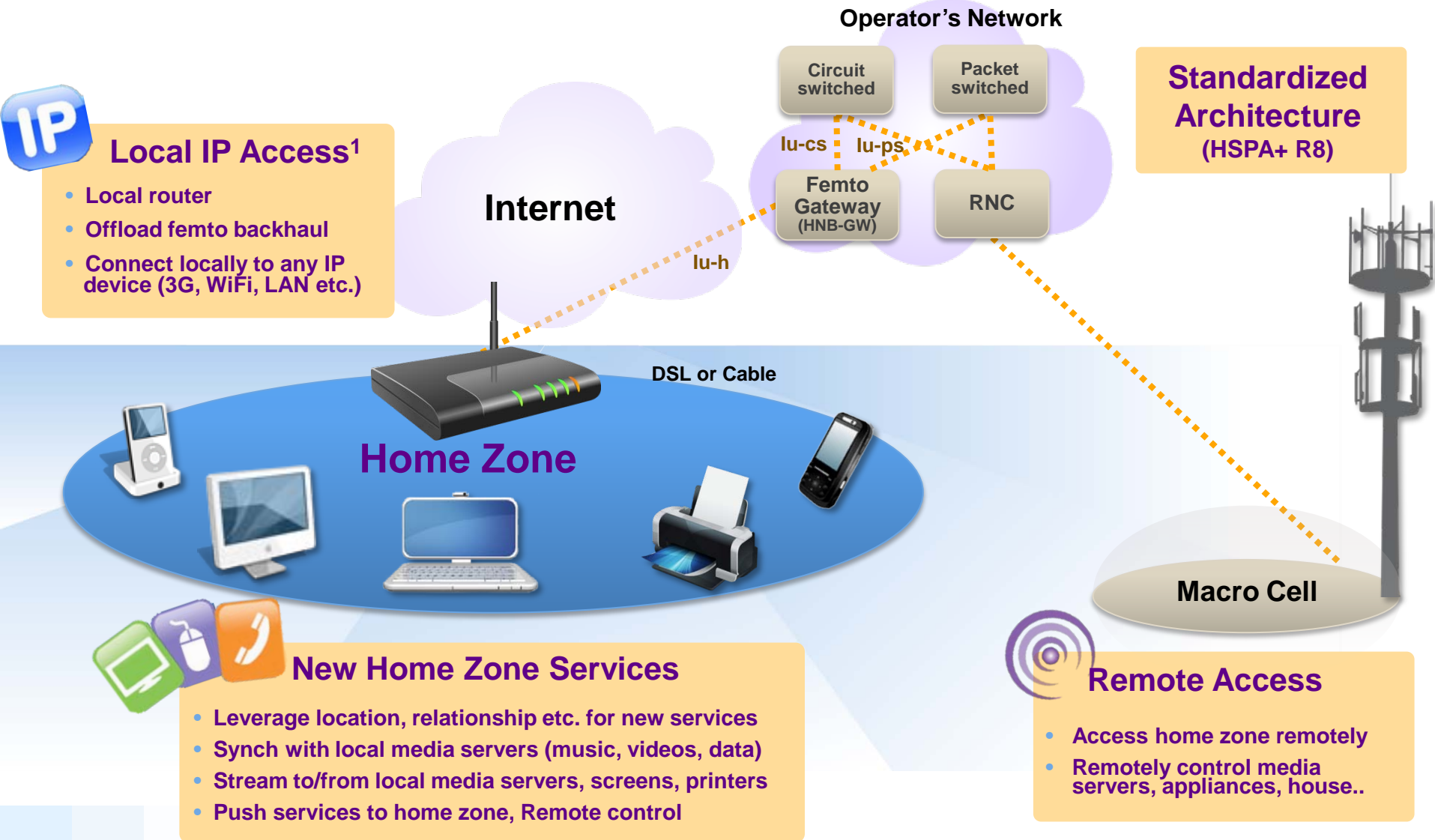
Based on location, interaction with home media, etc...



Femtocell
Your personal
3G access

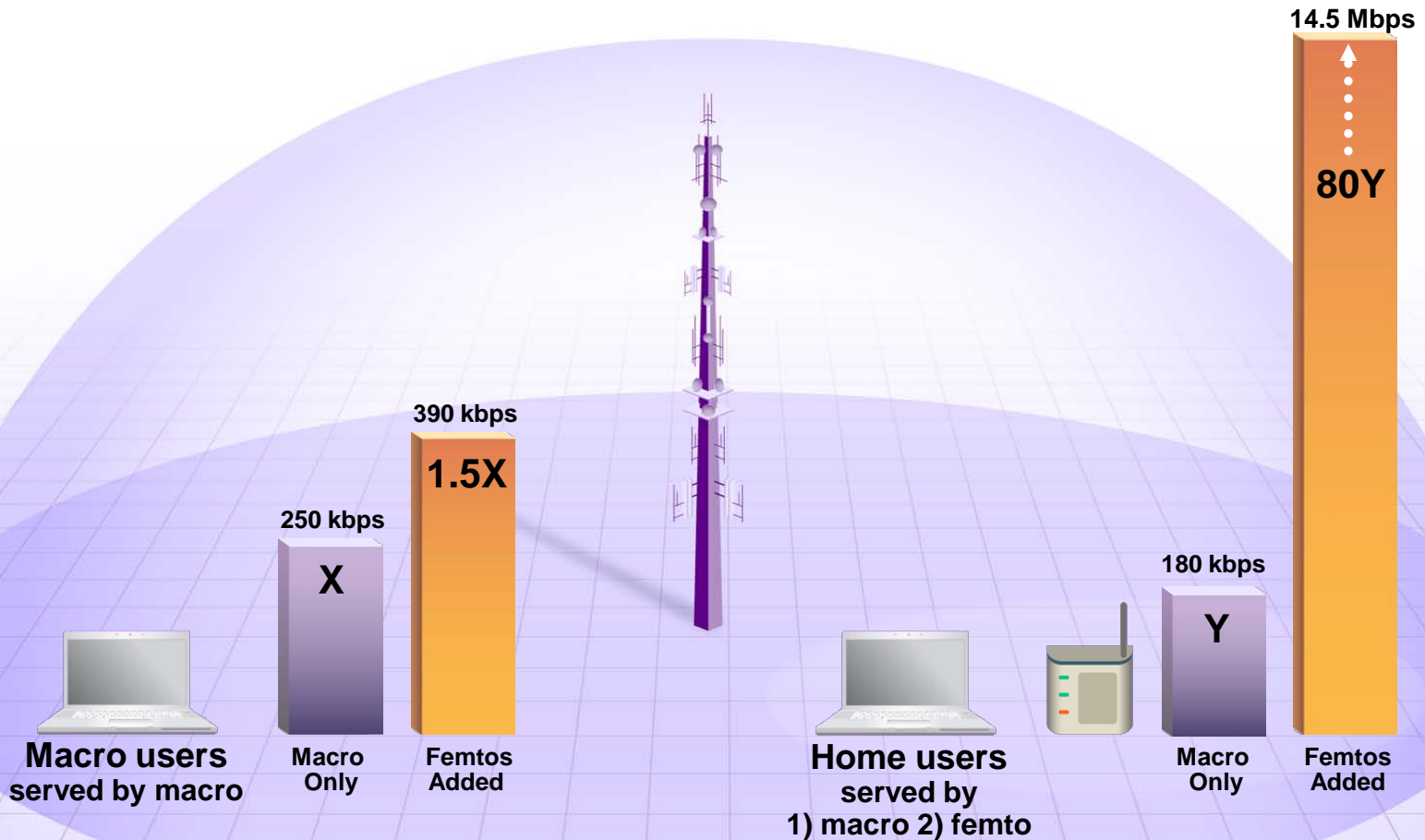


New Femtocell Home Zone Services —Access Locally or Remotely



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

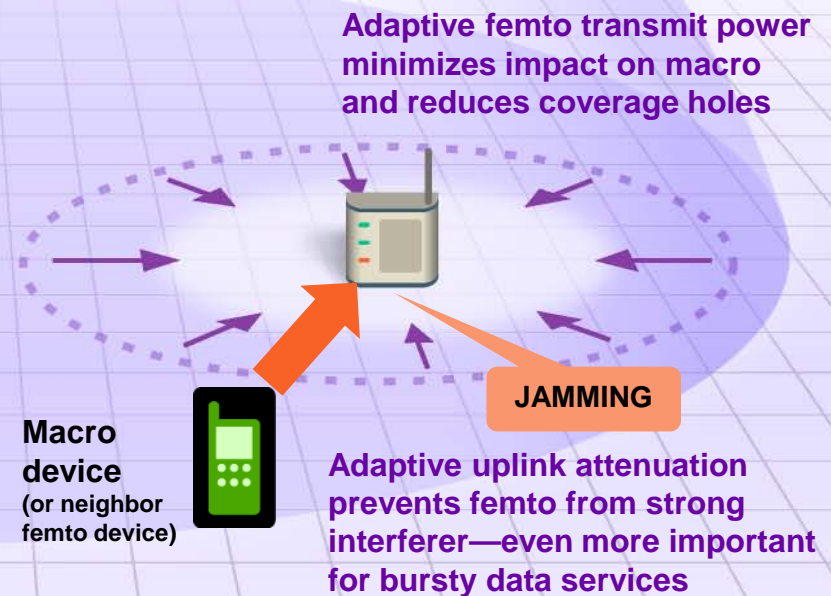
Assumptions: Dense urban system HSPA+ simulation. 16 Users per cell for HSPA+: 10 macro users and 6 home users served either by macrocell or added femto cells. Rx diversity and MMSE Equalizer used. The median user data rates are shown. Note: Also, the worst 10% of macro users get ~15% higher throughput with proper interference management techniques.

Innovative Interference Management Required for Large Scale Deployments

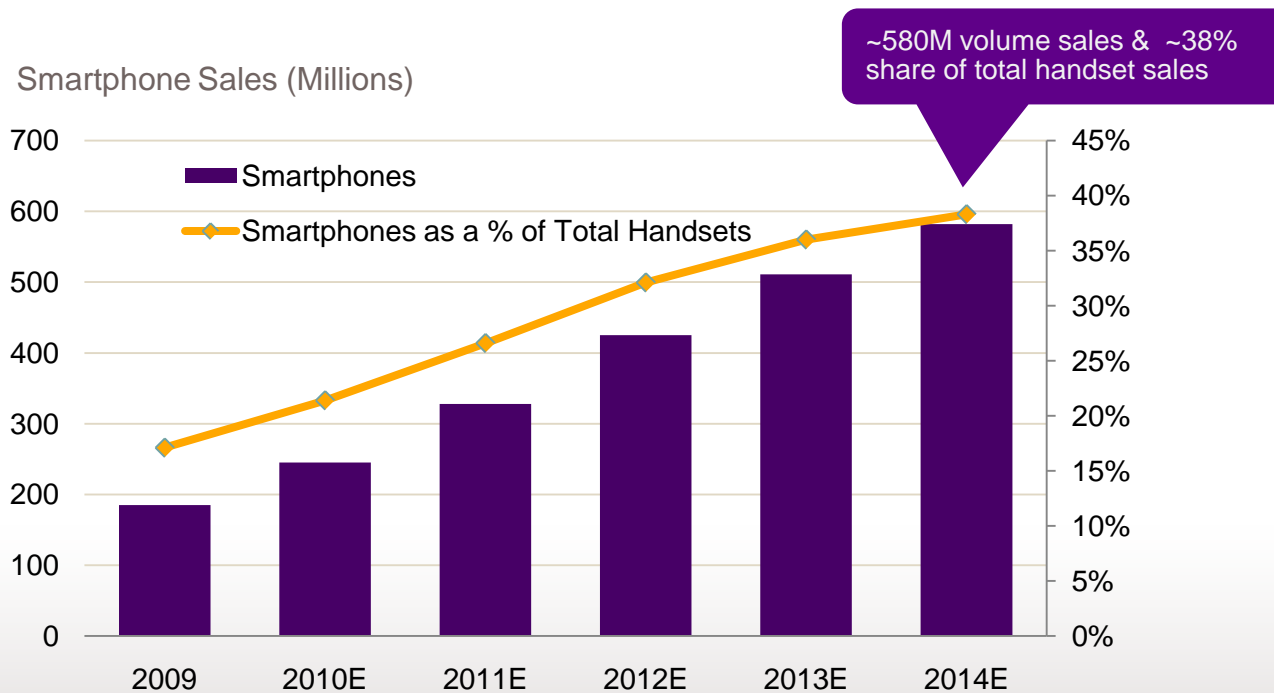
Required due to restricted access, shared macro spectrum, “unplanned” femtos

Interference management¹

- Adaptive transmit power /self-calibration
 - Network listen to select carrier, transmit power etc.
- Femtocell range tuning
 - Fine tune range with handset assistance
- Home user protection
 - Adaptive uplink attenuation
- Guest user protection
 - Detect guests/macro users and throttle femto power



Smartphones: The Fastest Growing Segment of Mobile Devices Market



50% of smartphone data sessions exchange < 5kB of data on the downlink¹

1 in every 3 phones sold in 2012 will be a smartphone

Global smartphone volumes rose 43% y-o-y to 60M units during Q2010**

Smartphones create more signaling load due to chatty apps

HSPA+ Enhances User Experience and Improves Signaling Capacity

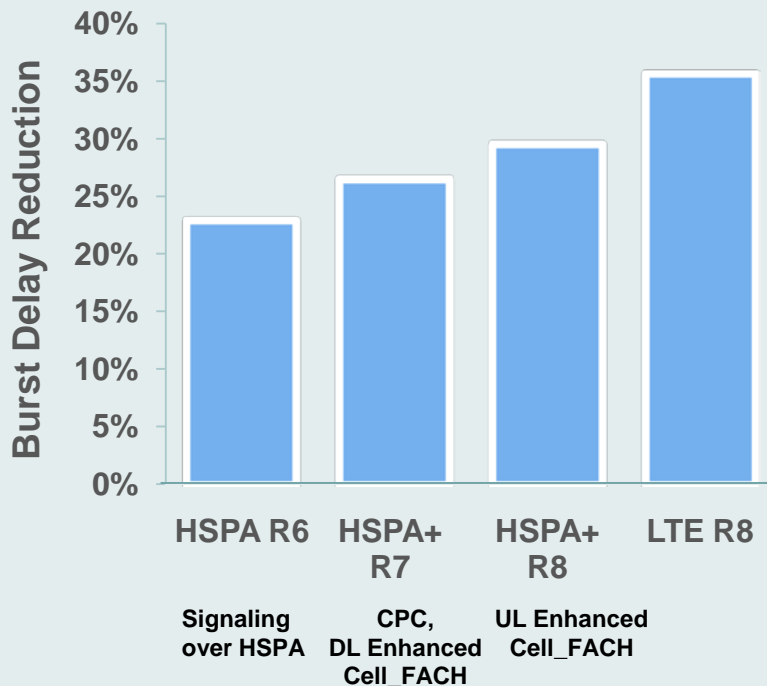


- Enhanced responsiveness—LTE like immediacy
- Up to 90% reduced signaling load³
- Extended battery life for all apps

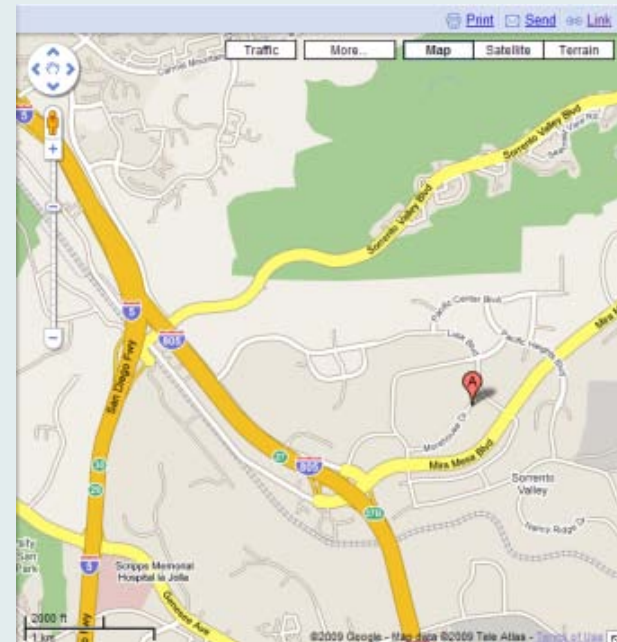
¹ Allows small amounts of data, e.g. appl. signaling, to efficiently be transported in CELL-FACH state. ² Allows non full buffer application to use connected mode, DCH, more efficiently (DTX discontinuous transmission when there is no data to transmit). HSPA+ R8 introduced HS-FACH with DRX and uplink HS-RACH. ³ For Social networking, gain depends on application

Example—Enhanced User Experience

PERCENTAGE DELAY DECREASE WITH HSPA+ AND LTE



IMPROVED USER EXPERIENCE EXAMPLE USING GOOGLE MAPS



Baseline: R5/R6 devices with signaling over dedicated channels (WCDMA)

HSPA+ R9 & R10 Expands Multicarrier

H
S
P
A
+

Up to 168 Mbps in 20MHz
4x aggregation (R10)

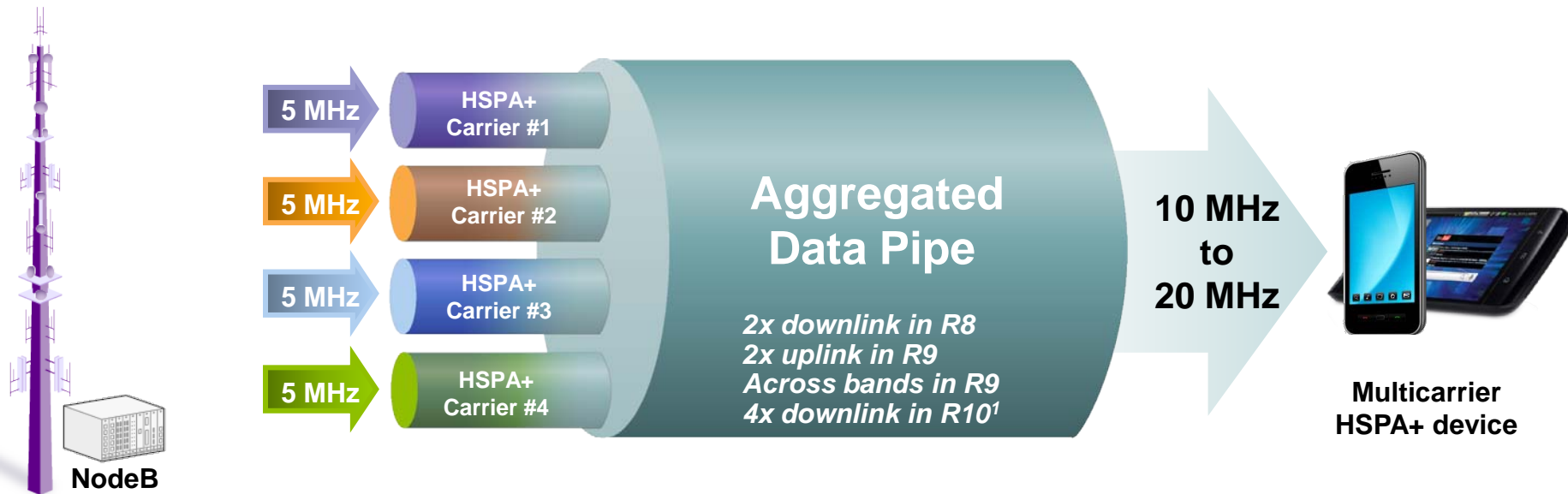
Enhanced Performance in 10 MHz
Combining Dual-Carrier and MIMO, uplink Dual-Carrier (R9)

Aggregation Across Bands
Aggregate high and low band (R9)

R9
R10

Evolution Towards Femtocell Networks

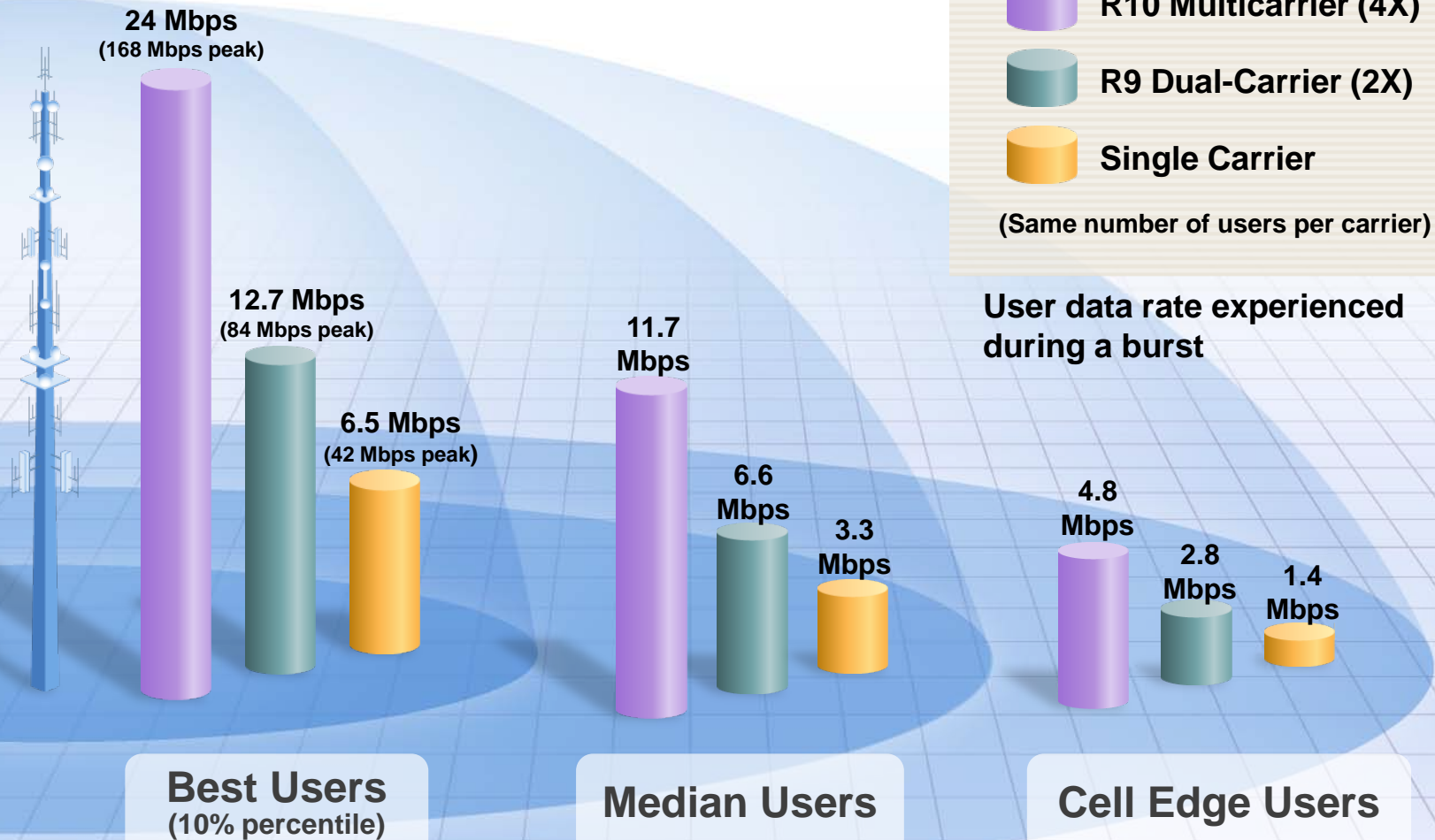
The Multicarrier Evolution Continues to Enhance Broadband Experience



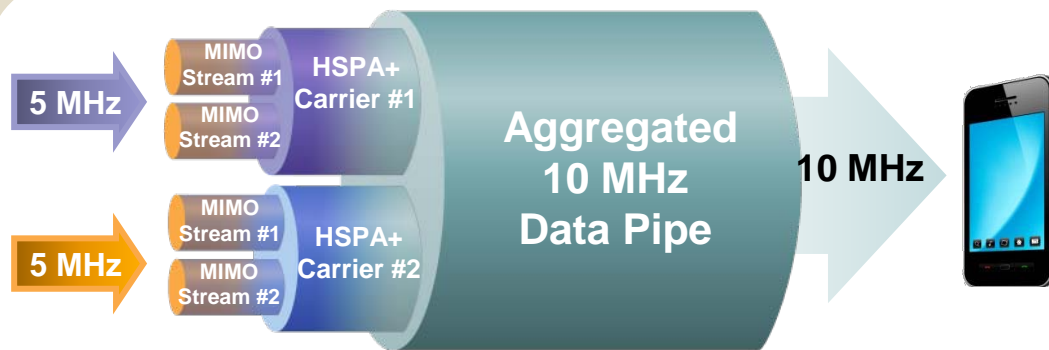
- Increased data rates and lower latencies for all users in the cell
- Can double capacity for bursty applications, e.g., Web apps
- Dynamic load balancing

Software upgrade—leverages all spectrum assets

Data Rates Increases with Bandwidth —All Users Improved



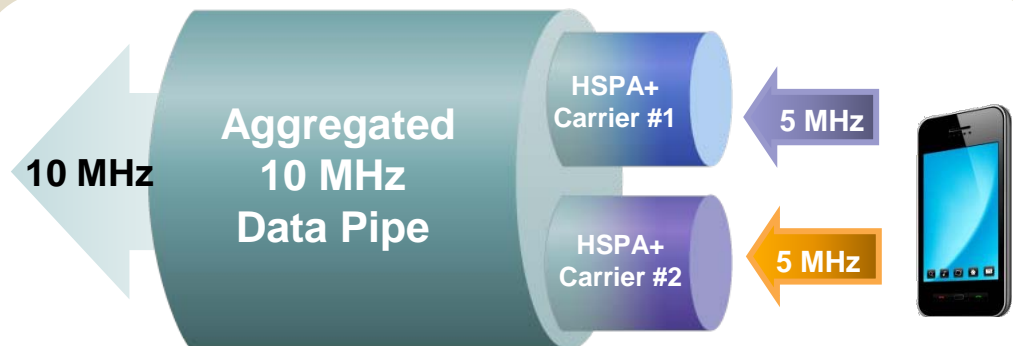
Enhanced Performance in 10 MHz (R9)



MIMO supported with Downlink Dual-Carrier (R9)

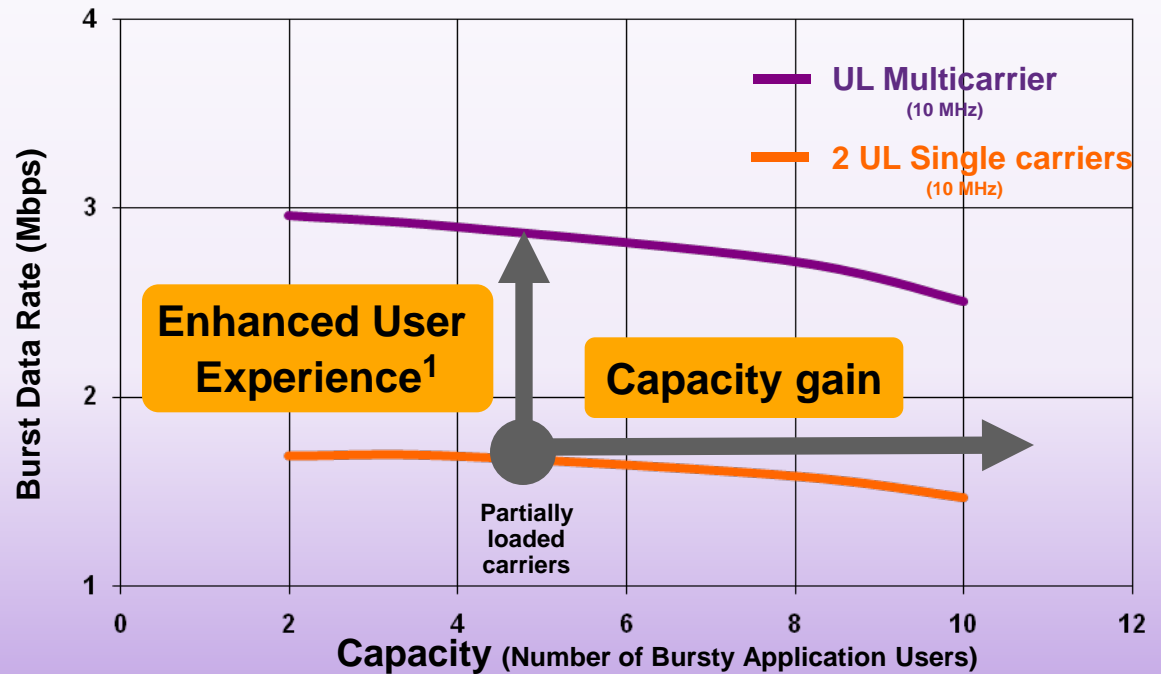
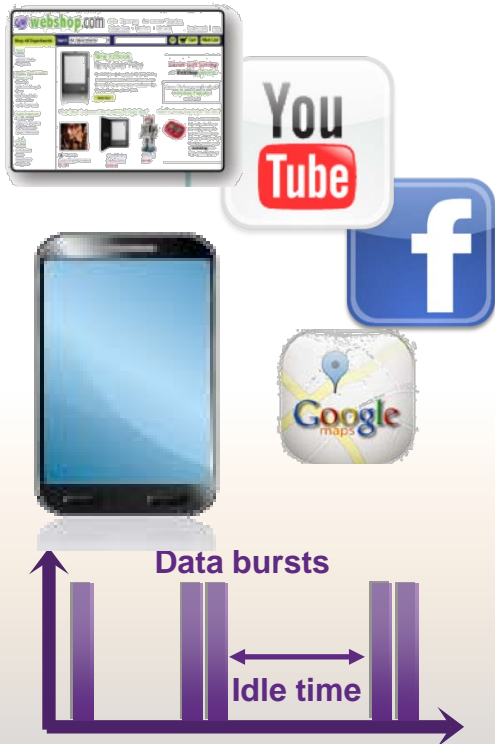
- 84 Mbps downlink peak rate
- Increased spectral efficiency with MIMO (~20%)
- Benefits all users in the cell
 - Both MIMO and Multicarrier improvement across cell and cell edge¹

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



Uplink Dual-Carrier (R9)

Uplink Dual-Carrier Provides Similar Gain as Downlink

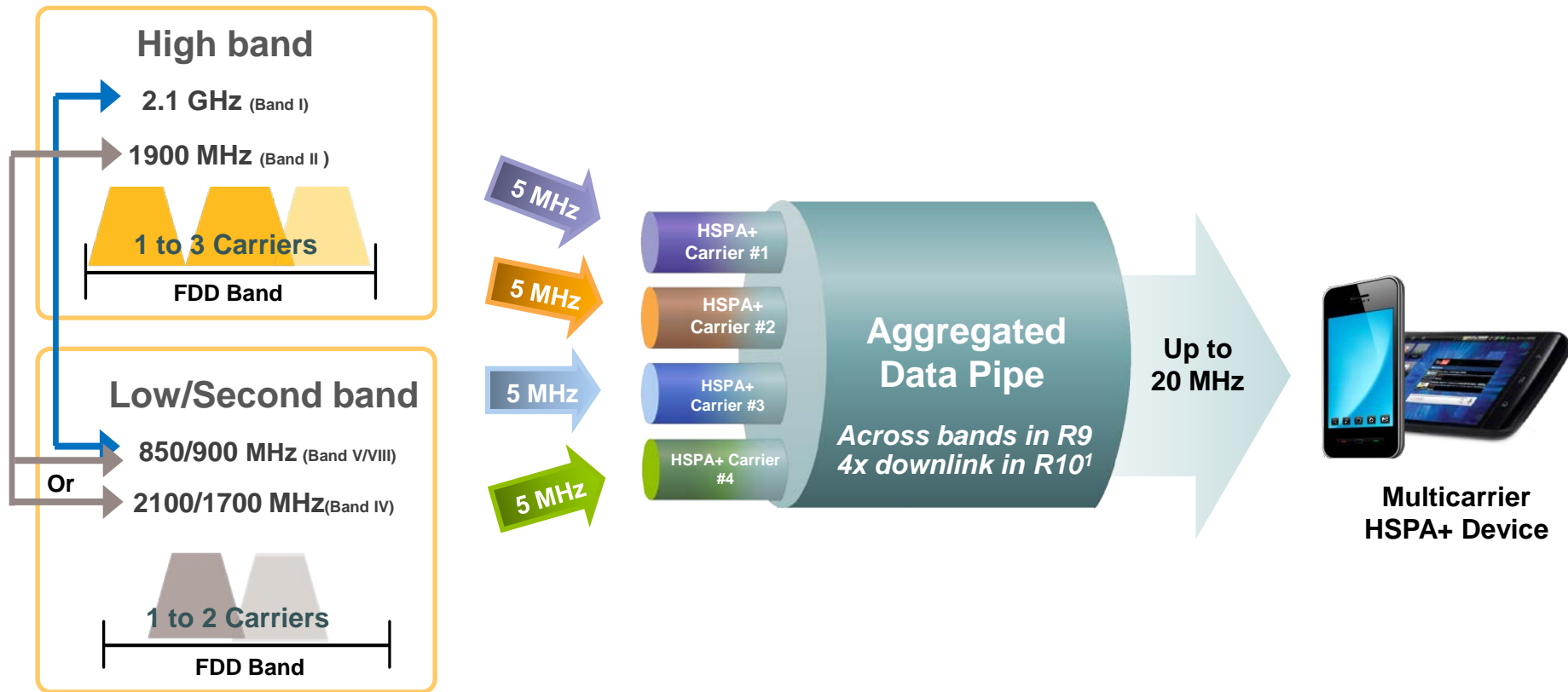


- Increased data rates and lower latencies for all users (within current power head room)
- Increased capacity for bursty applications, e.g., Web applications

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

Aggregation Across Bands to Leverage All Spectrum Assets



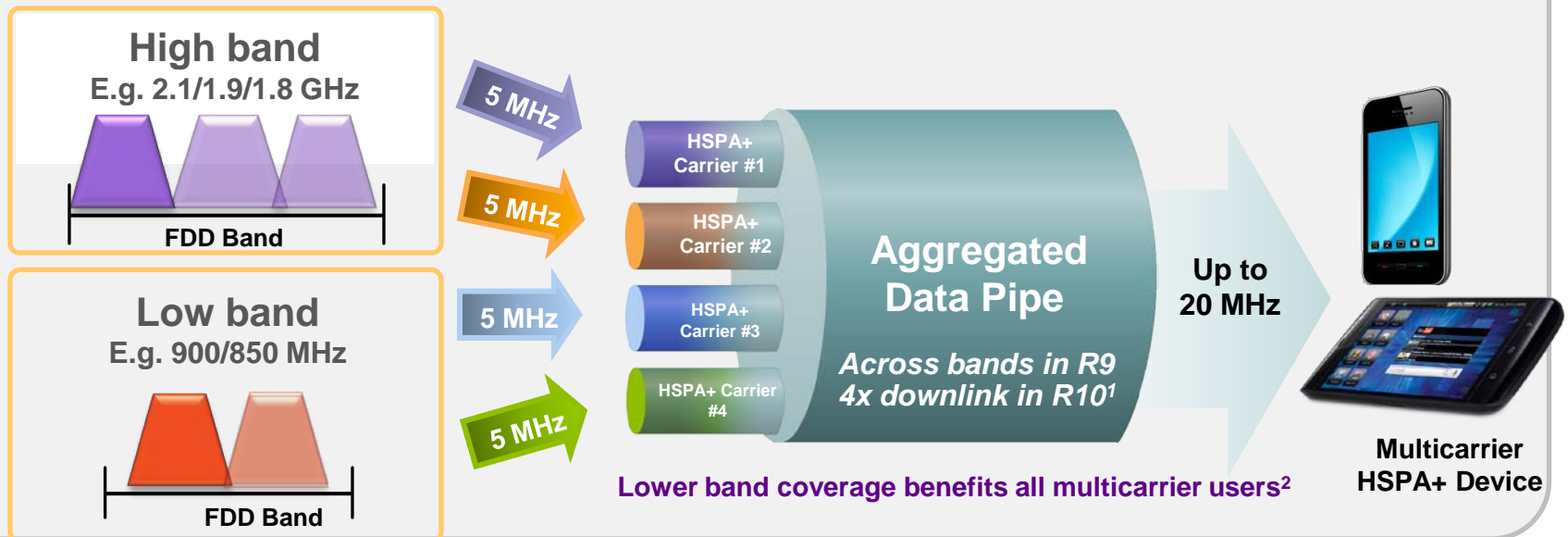
Additional combinations continuously defined in 3GPP²

¹With 4x multicarrier in R10, carriers within the same band need to be adjacent and inter-band aggregation can span two different bands.²E.g. support for band XI (1500MHz Japan) combinations has been added and band III (1800MHz) is being added..

Multicarrier Helps to Free Up 2G Spectrum for More Efficient 3G

- UMTS900 almost closes 2G/3G coverage gap—eliminates 3G porosity
- Additional 2G bands such as 1800MHz suitable for 3G refarming
- UMTS900 enabled devices >50% of monthly sales in EU5¹

Multicarrier Across Bands—Another Driver for refarming 900 MHz and 1800 MHz for HSPA+



Femtocells Initially Target Hot-Spots —Evolve Towards Femto Networks

Today: Hot-spots

- Deployed by user—“unplanned”
- Plug & Play—self configuration
- Supports restricted access
- User’s broadband connection
- Scalable femto network architecture

Residential

Enterprise

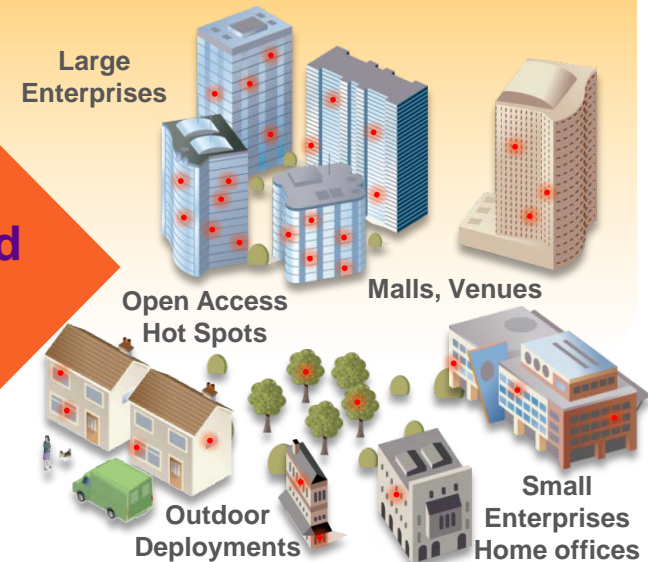


Femtocells gradually used
as traditional Picocells

Small
Enterprises

Future: Denser deployments
and more open access

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



HSPA+ Advanced: Maximum Performance in Multiple 5 MHz Carriers



**HSPA+
Advanced**

Utilizes Smart Networks

Exploit uneven network load

Evolves Multicarrier

Aggregation of up to 8 carriers, unpaired spectrum

More Antenna Gain

Such as uplink beamforming and MIMO

Continues to Leverage HetNets

Connecting a Very Large Number of Devices

Optimizations for the explosion of interconnected low -traffic devices (e.g. M2M, Smartphones)

Summary: HSPA+ Will Continue to Drive Mobile Broadband This Decade

H
S
P
A
+

Similar HSPA+ and LTE Performance

For same amount of spectrum and antennas

Meets Smartphone Growth

Alleviates signaling load and provides LTE like immediacy

Multicarrier Enhances Broadband Experience

Increases data rates to all—peak rates up to 168 Mbps, across spectrum bands

Continued Evolution to HSPA+ Advanced

Questions? Connect with Us



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m.qualcomm.com/technology



BLOG

<http://www.qualcomm.com/blog/contributors/prakash-sangam>



➤ Additional Slides

HSPA+ R7 Key Features

<i>Feature</i>	<i>Key Benefits</i>	<i>Notes</i>
<i>2x2 Multiple Input Multiple Output (MIMO)</i>	Doubles peak data rates Increases capacity across cell	
<i>Higher Order Modulation (HOM)</i> <i>(64 QAM in DL and 16 QAM in UL)</i>	50% higher DL data peak rate Doubles UL data peak rate	
<i>Continuous Packet Connectivity (CPC)</i>	Better “always-on” experience Improves voice over HSPA capacity Up to 50% extended talk time	
<i>Enhanced CELL_FACH /PCH state operation (Downlink)</i>	Faster call set up Better “always-on” experience	
<i>CS Voice over HSPA</i> <i>(a.k.a. CS over HS)</i>	More than doubled voice capacity with no core network impact ~50% extended talk time	UE capability in R7
<i>UL Interference Cancellation (NodeB IC)</i>	Improves uplink capacity and user data rates – beneficial for VoIP	Standards independent
<i>DL Interference Cancellation (UE IC)</i>	Higher downlink cell edge data rates Increases downlink capacity	Standards independent

Key HSPA+ R8 Features

<i>Feature</i>	<i>Key Benefits</i>
<i>Multicarrier HSPA+</i> (2X downlink in R8)	Enhanced user experience across cell Doubled average & cell edge rates Increased bursty application capacity
<i>MIMO and 64 QAM Combined</i>	42 Mbps peak rate in the downlink
<i>Enhanced Serving Cell Change</i>	Improved handover reliability Higher voice capacity (allows F-DPCH)
<i>Voice Call Continuity (VCC)</i>	VoIP service continuity to WCDMA/GSM
<i>Enhanced CELL_FACH state operation</i> (DRX on downlink and uplink HS_RACH)	Enhanced user experience with extended battery life and reduced signaling load
<i>Support for Home NodeB</i> RAN architecture with new Iuh interface to HNB gateway	Standardized support for femtocells (Home NodeB)

Key HSPA+ R9 and R10 Features

<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 Features</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>Home NodeB Enhancements</i> Examples: Local IP Access, Femto to femto HO	Enables Femto networks (e.g. femto to femto handover)