



QUALCOMM®



Overview on mobile broadband technologies

EBU workshop on mobile broadband technologies
12th May 2011



Qualcomm

About our role and convergence

INNOVATE



ENABLE

EMPOWER

Outline

Technology vision

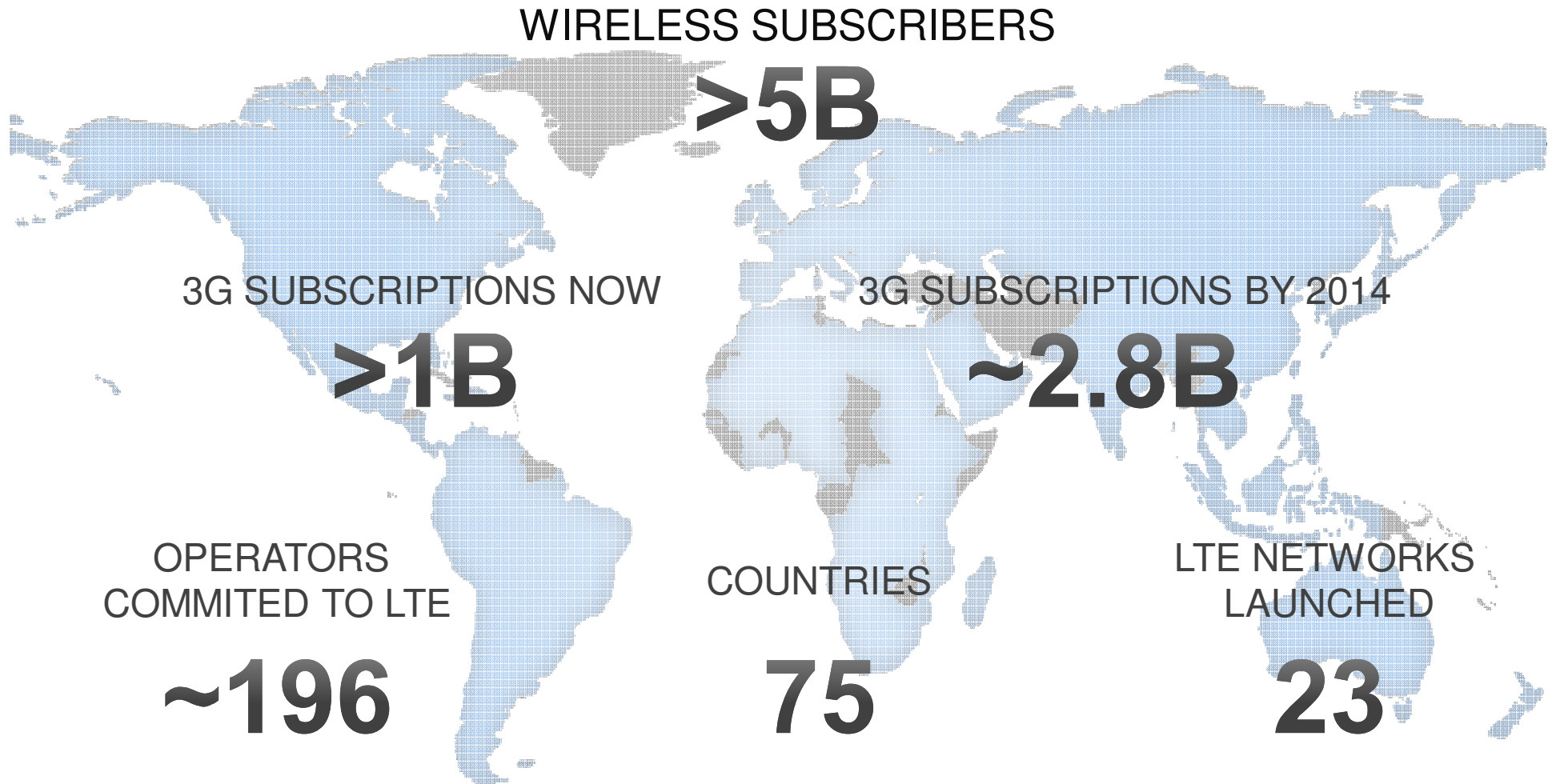
- Mobile bands and air interface evolution
 - What's next?
 - HSPA, HSPA+, HSPA Advanced, LTE, LTE Advanced, LTE TDD
- Spectrum mapping
- MBB for the delivery of mobile multimedia
 - Supplemental downlink
 - eMBMS

Outline

Technology vision

- **Mobile bands and air interface evolution**
 - What's next?
 - HSPA, HSPA+, HSPA Advanced, LTE, LTE Advanced, LTE TDD
- Spectrum mapping
- MBB for the delivery of mobile multimedia
 - Supplemental downlink
 - eMBMS

Mobile: Biggest Platform in History of Mankind

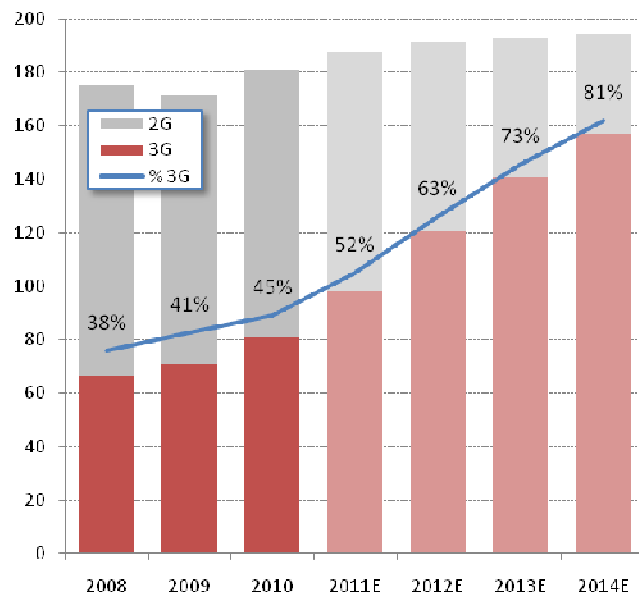


Note : 3G includes CDMA2000, WCDMA and TD-SCDMA.

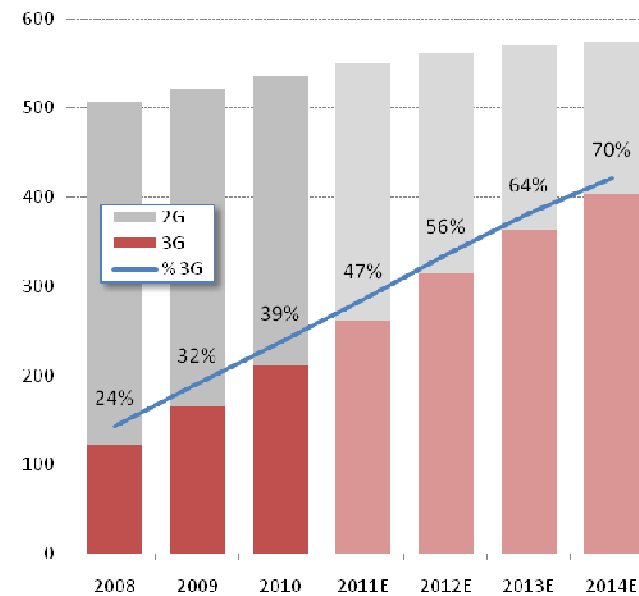
Source: Wireless Intelligence estimates as of Nov.2 , 2010 for the quarter ending Sep 30, 2010; *number of unique wireless connections.

Sources: Global Mobile Suppliers Association (GSA) (April 16, 2010)/UMTS Forum

2G to 3G migration is happening



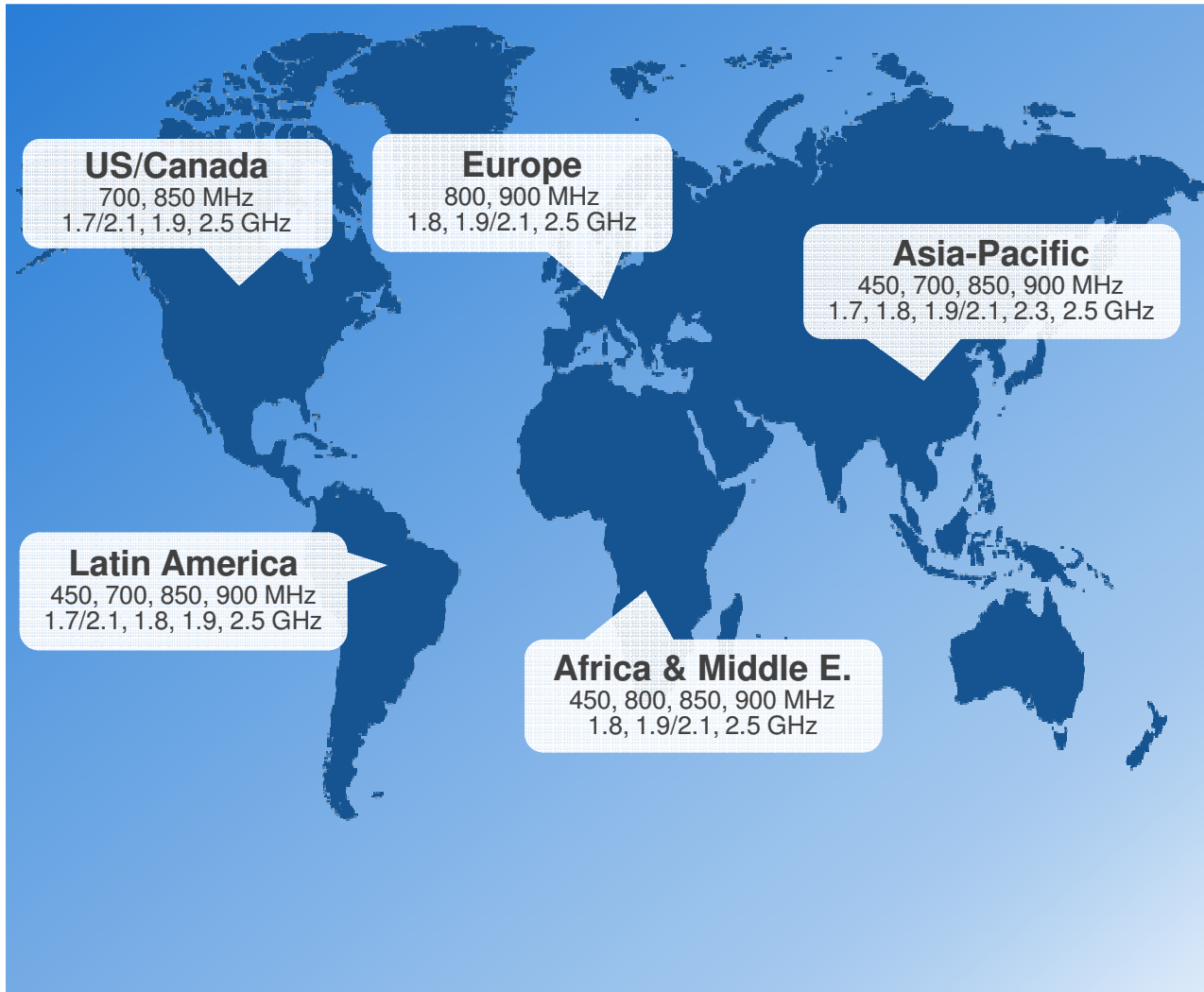
Western Europe handsets sales (m)



Western Europe subscribers (m)

Consolidated analyst views

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)	✓	✓	

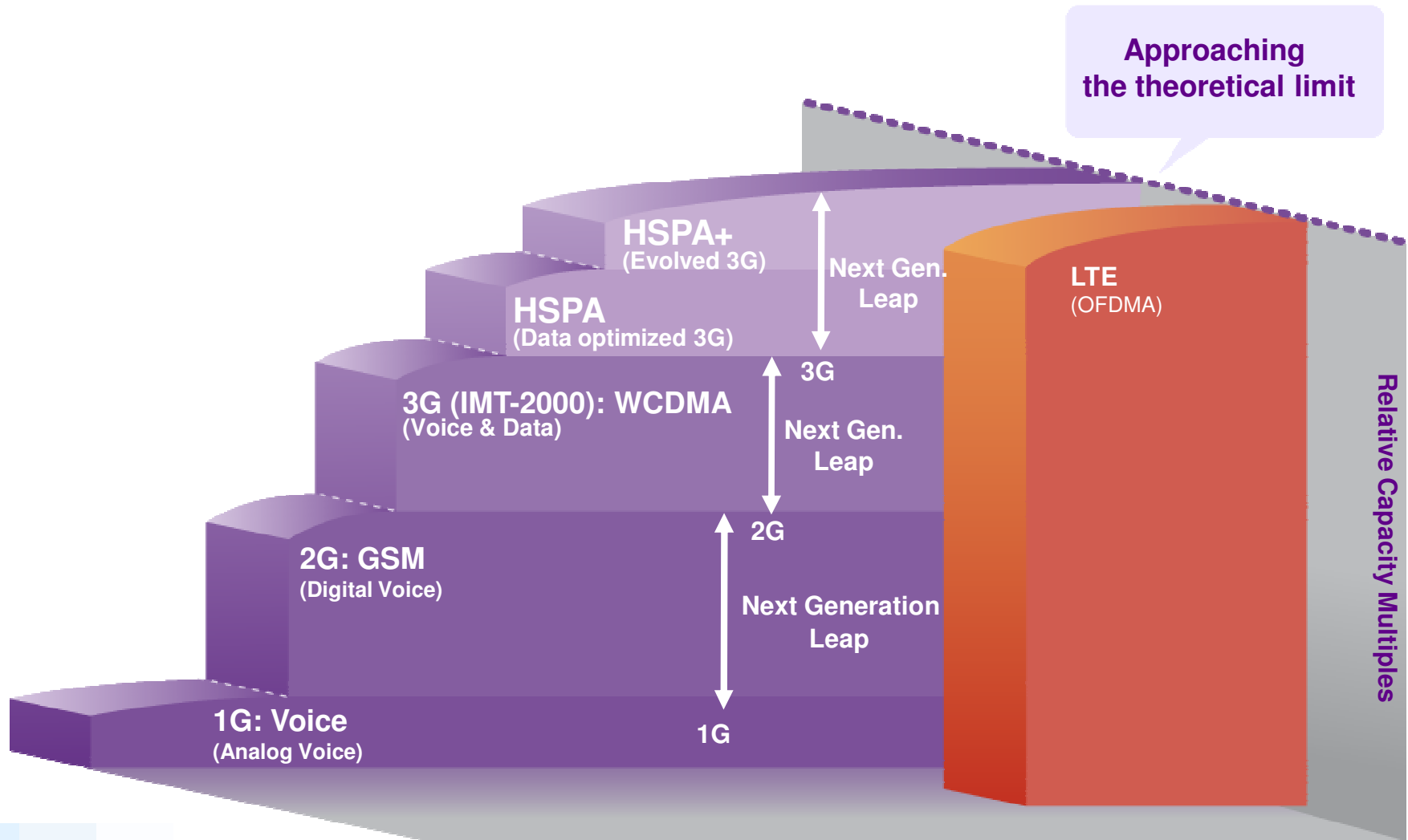
¹Usable spectrum blocks for product implementation. ²IMT extension 2500 to 2690 MHz, 70 MHz+70 MHz FDD in most countries. ³Digital dividend; Region 1 (Europe, Middle East and Africa) 790-862 MHz, Region 2 (Americas) 698-806 MHz. Region 3 (Asia) – some 698-790 MHz (e.g. China, India, Japan, Bangladesh,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

Outline

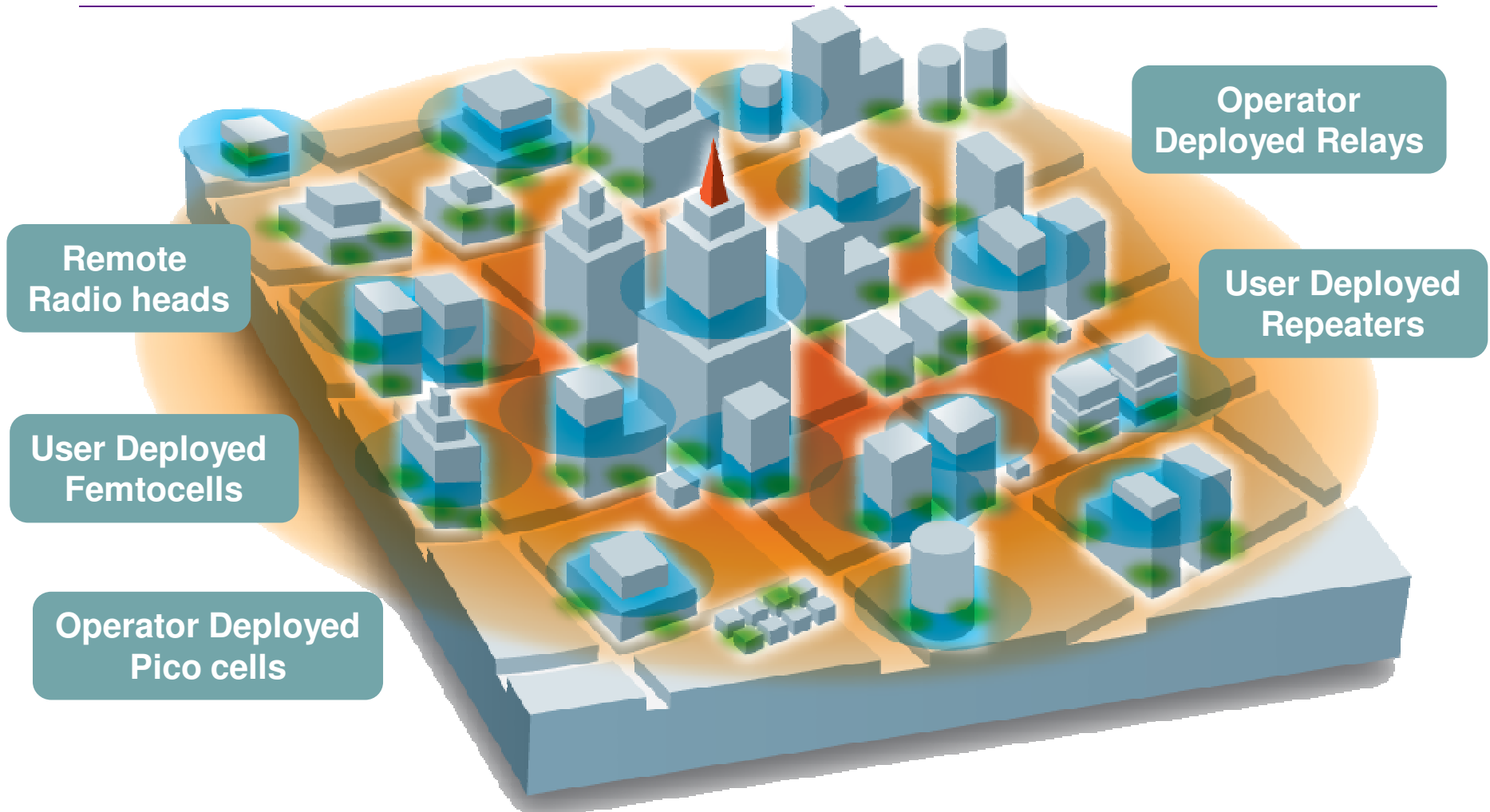
Technology vision

- **Mobile bands and air interface evolution**
 - What's next?
 - HSPA, HSPA+, HSPA Advanced, LTE, LTE Advanced, LTE TDD
- Spectrum mapping
- MBB for the delivery of mobile multimedia
 - Supplemental downlink
 - eMBMS

Radio Link Improvement is Slowing, What is Next?



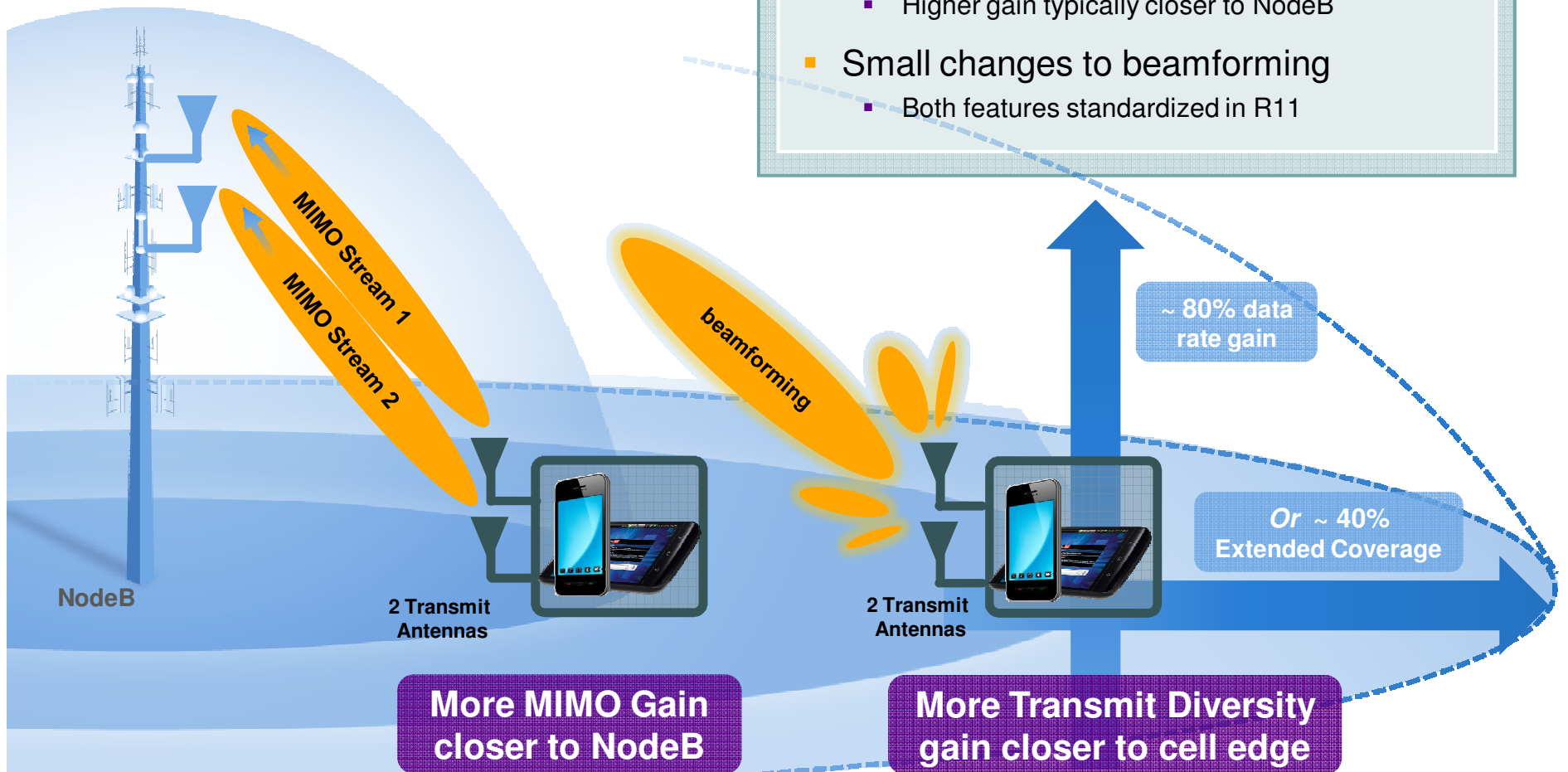
Network Topology Gain



The Next Significant Performance Leap
Increasing spectral efficiency per coverage area

Multiple Antennas Gain

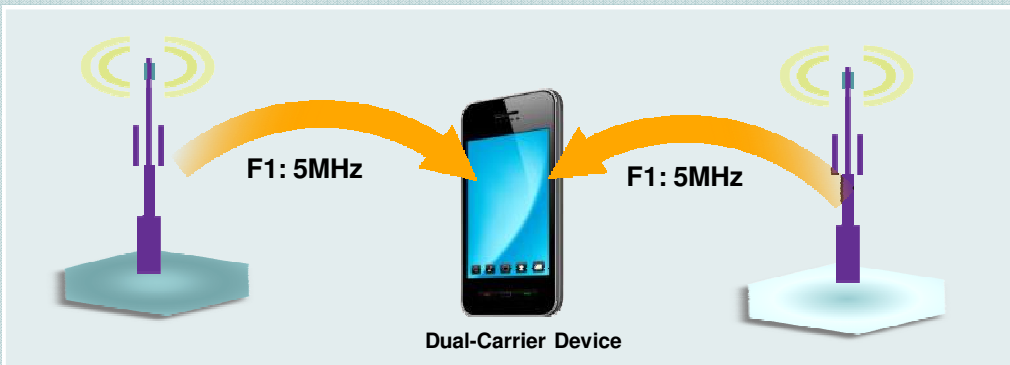
- Complements beamforming
 - Higher gain typically closer to NodeB
- Small changes to beamforming
 - Both features standardized in R11



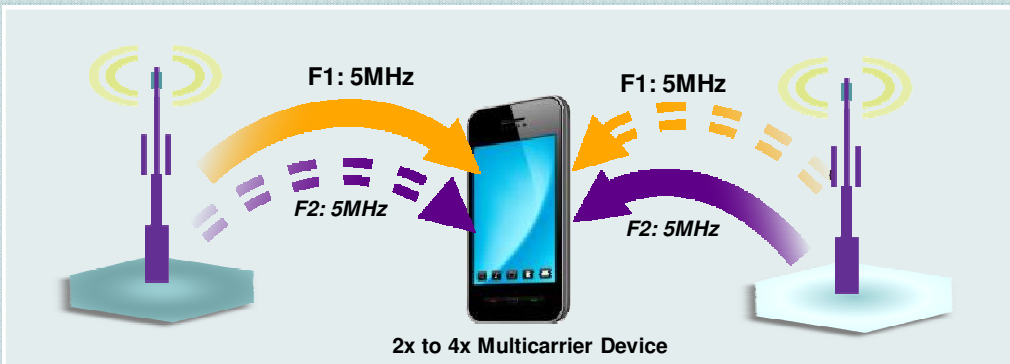
¹ Source: Qualcomm simulation for closed loop beamforming.3GPP framework PA3, 4UEs per cell, 2.8km ISD. Shows data throughput gain for the median and the 5% worst (Cell edge) users. Gain depends on propagation environment and the UE speed with lower gain for faster moving users. The open loop gain would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

Smart Networks/Het Nets

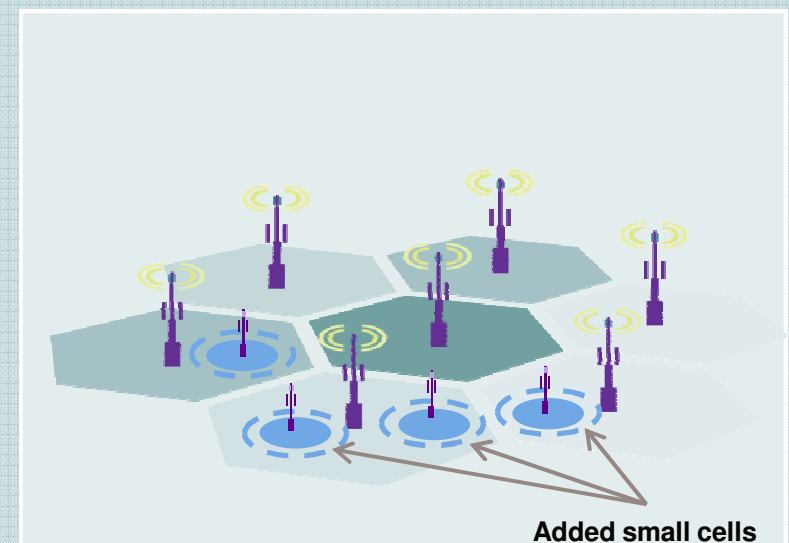
EXTENDS BENEFITS TO 5 MHz DEPLOYMENTS



BENEFITS MULTIPLE CARRIER DEPLOYMENTS



RANGE EXPANSION—MORE USERS BENEFIT FROM SMALL CELLS



More overlapping coverage with small cells—Multipoint effectively expands its range¹

¹Benefits HetNets (mix of macro networks with added small cells like picocells) due to more overlapping coverage with small cells.

Carrier Aggregation

Spectrum Examples:

2.1 GHz (Band I)

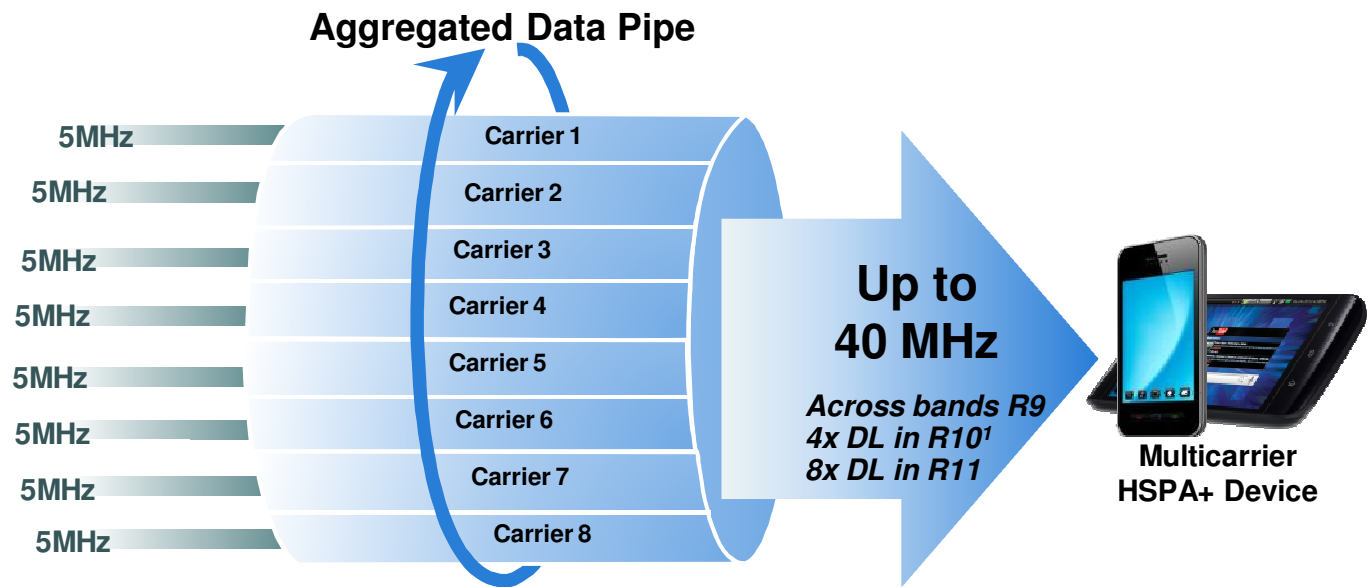
1900 MHz (Band II)

1800 MHz (band III)

1700 MHz (Band IV)

900 MHz (Band VIII)

850 MHz (Band V)



Additional spectrum bands and band combinations continuously defined in 3GPP²

¹With 4x multicarrier in R10 (and 8x in R11), 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, beyond 4X combinations expected to be added in R11

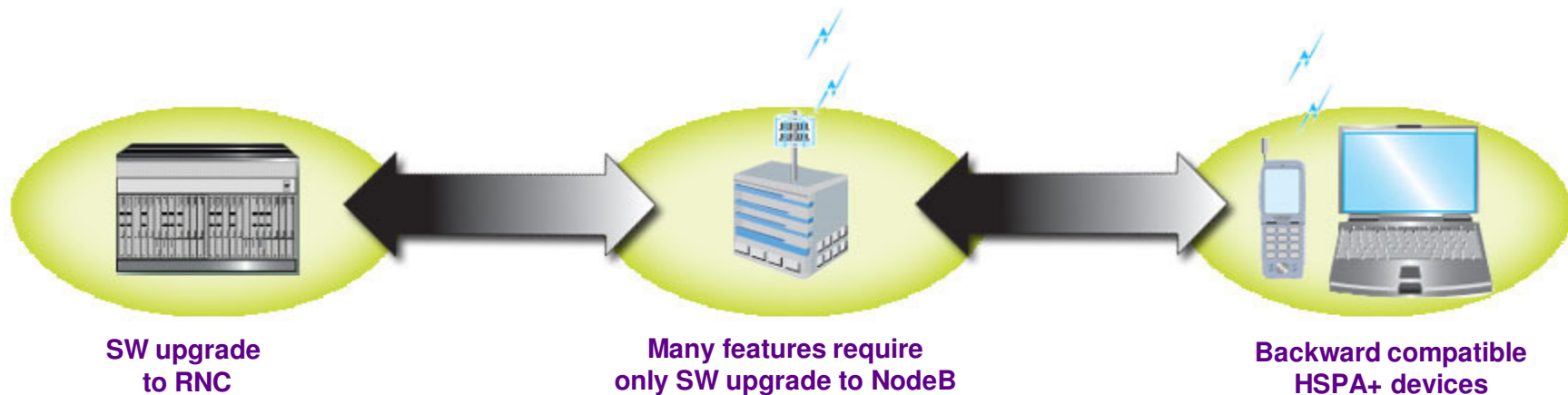
Outline

Technology vision

- **Mobile bands and air interface evolution**
 - What's next?
 - HSPA, HSPA+, HSPA Advanced, LTE, LTE Advanced, LTE TDD
- Spectrum mapping
- MBB for the delivery of mobile multimedia
 - Supplemental downlink
 - eMBMS

HSPA+: The Natural Evolution at a Lower Cost

Incremental and cost-effective upgrade



Large and Growing Device Ecosystem

HSPA >3071 device models
with more than 262 suppliers

Deployed Worldwide on a Large Scale

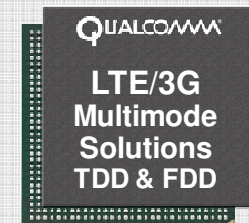
WCDMA >400 networks, > 632 million subs
HSPA >398 networks, > 342 million subs
in over 130 countries

HSPA+ leverages existing investments and large ecosystem

LTE Boosts Data Capacity in Dense Urban Areas

- 3G provides ubiquitous data coverage and voice
- Seamless service continuity with 3G from day one
- 3G/LTE multimode devices required

Industry's first LTE/3G multimode solutions



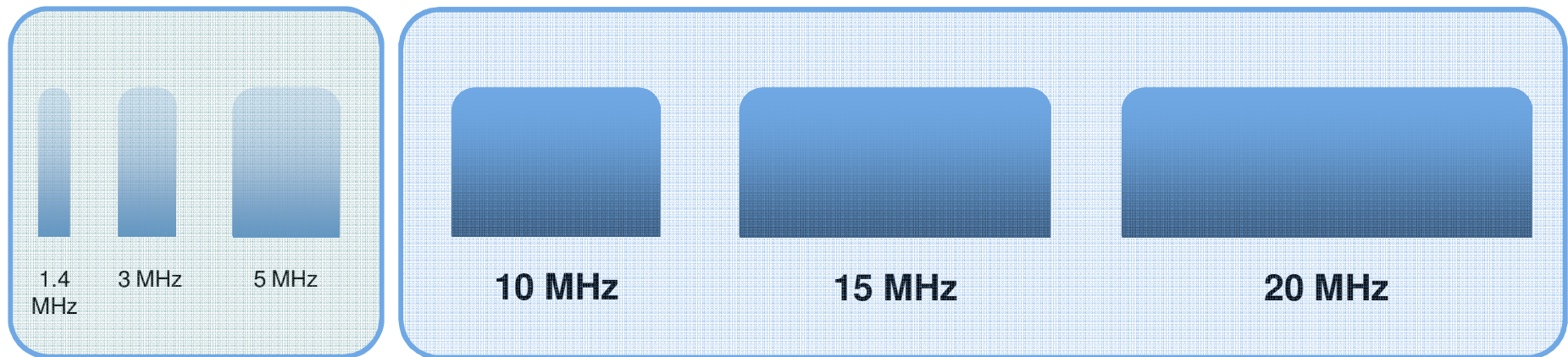
3G Coverage

Evolved 3G ensures similar user experience outside LTE coverage

LTE Leverages New and Wider Spectrum

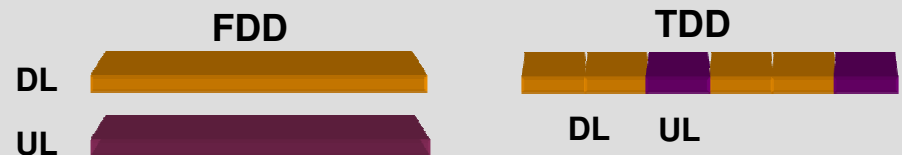
Available in smaller bandwidths

Best suited to leverage new and wider bandwidths



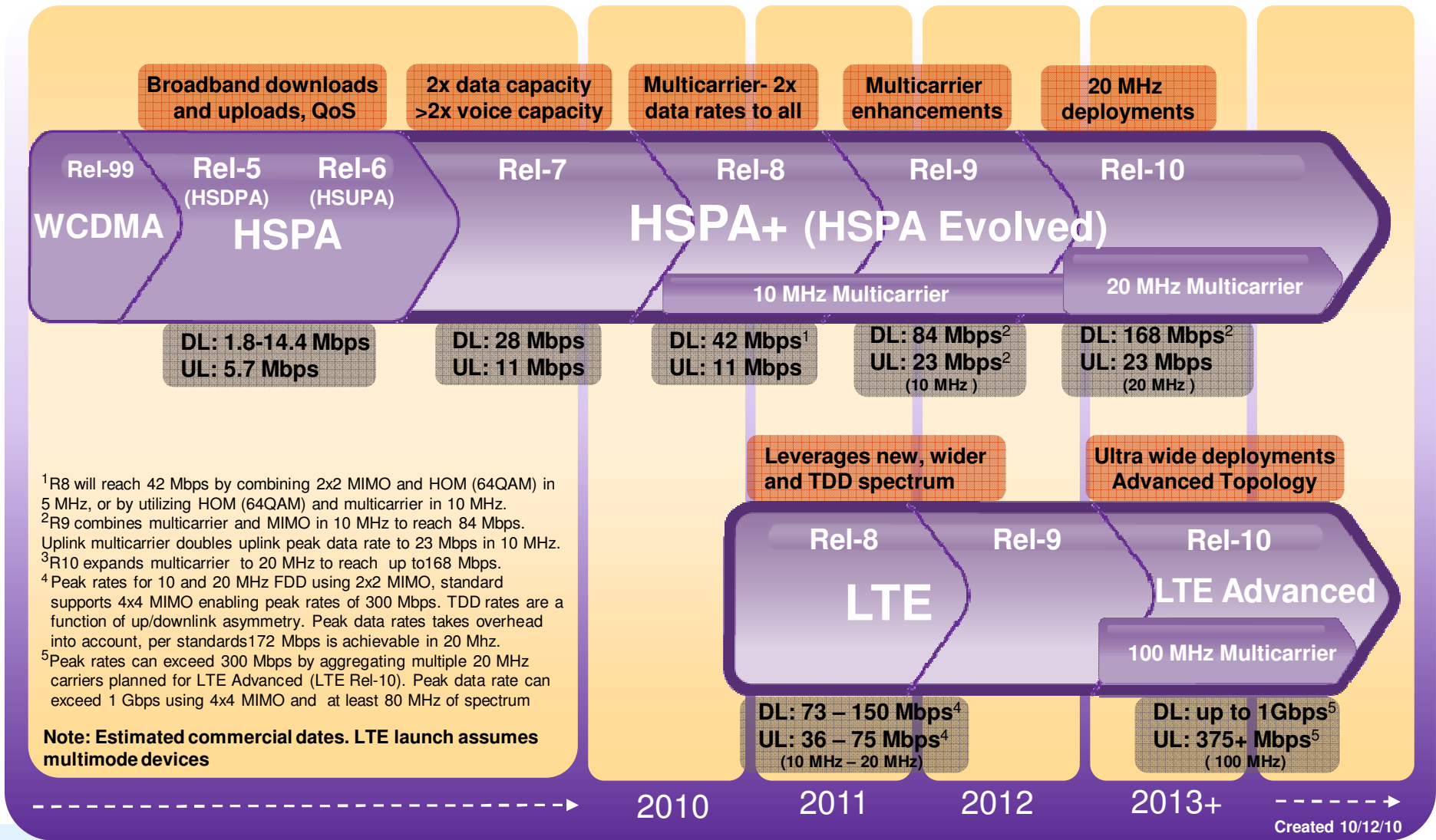
LTE relative performance decreases with bandwidth due to higher overhead; 40% overhead in 1.4 MHz vs. 25% in 20 MHz results in 25% better relative performance in 20 MHz vs. 1.4 MHz.

LTE-TDD Optimal Technology for Unpaired Spectrum



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

Parallel Evolution Paths of HSPA and LTE



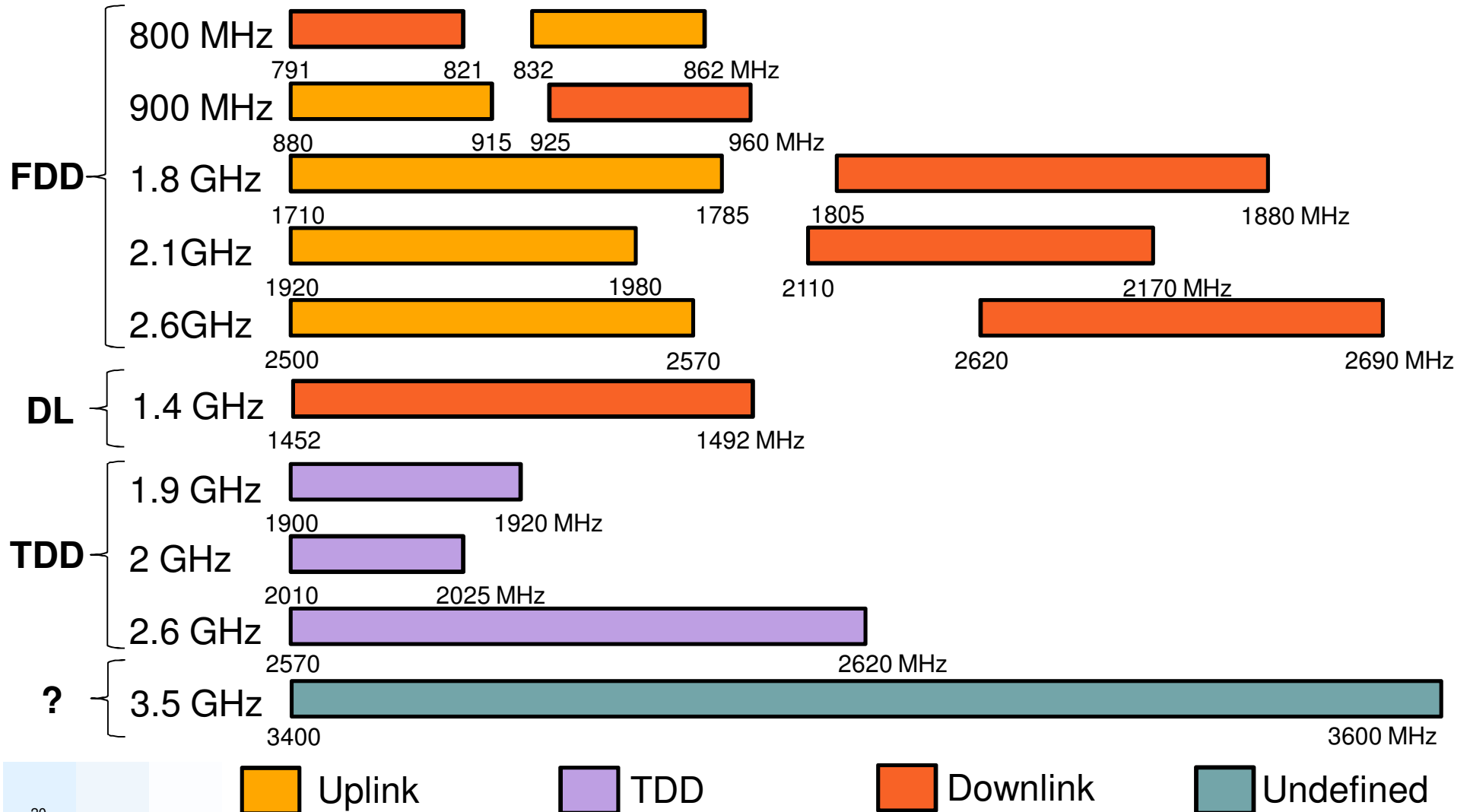
Outline

Technology vision

- Mobile bands and air interface evolution
 - What's next?
 - HSPA, HSPA+, HSPA Advanced, LTE, LTE Advanced, LTE TDD
- Spectrum mapping
- MBB for the delivery of mobile multimedia
 - Supplemental downlink
 - eMBMS

European Mobile Spectrum

All potential future bands



Outline

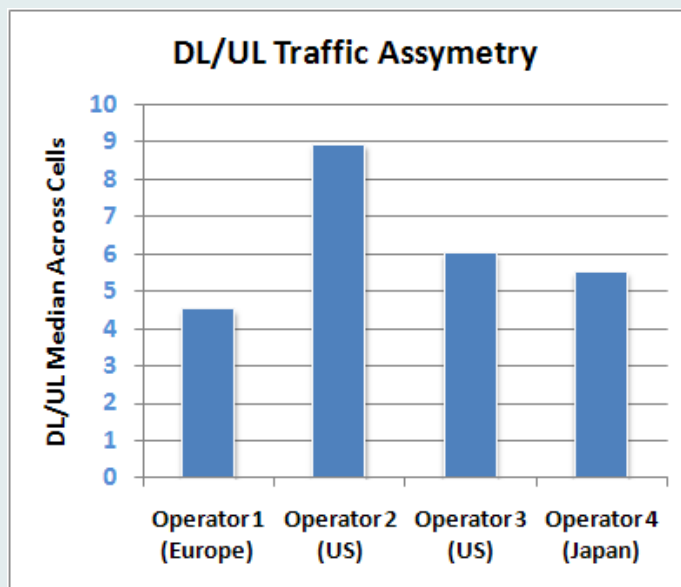
Technology vision

- Mobile bands and air interface evolution
 - What's next?
 - HSPA, HSPA+, HSPA Advanced, LTE, LTE Advanced, LTE TDD
- Spectrum mapping
- **MBB for the delivery of mobile multimedia**
 - Supplemental downlink
 - eMBMS

Mobile Traffic Typically Downlink Centric

NEED MORE DOWNLINK CAPACITY²

MAJORITY OF TRAFFIC ON
DOWNLINK (DL)¹



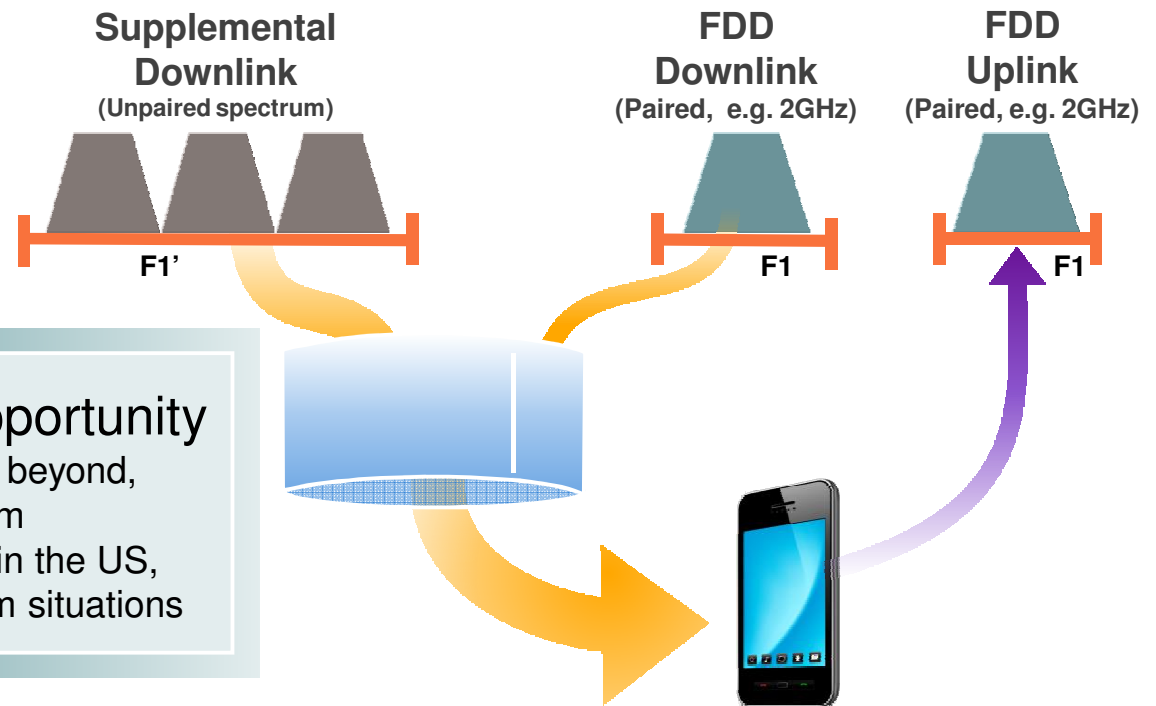
MORE DOWNLOAD, MORE VIDEO AND
RICH MEDIA TO NEW DEVICE SEGMENTS



¹ Based on measurements in live networks. Median shown. ²Uplink is also important, not only for capacity reasons: downlink improvement can be used to extend coverage. Faster TCP/IP feedback on the uplink means faster downlink. Applications like social networking will drive more uplink data.

Supplemental Downlink Addresses Traffic Asymmetry

- Leverage unpaired spectrum for more downlink capacity
- Carrier Aggregation (CA) is enabled in: HSPA+ R9¹ (and beyond) or LTE R10¹ (and beyond)



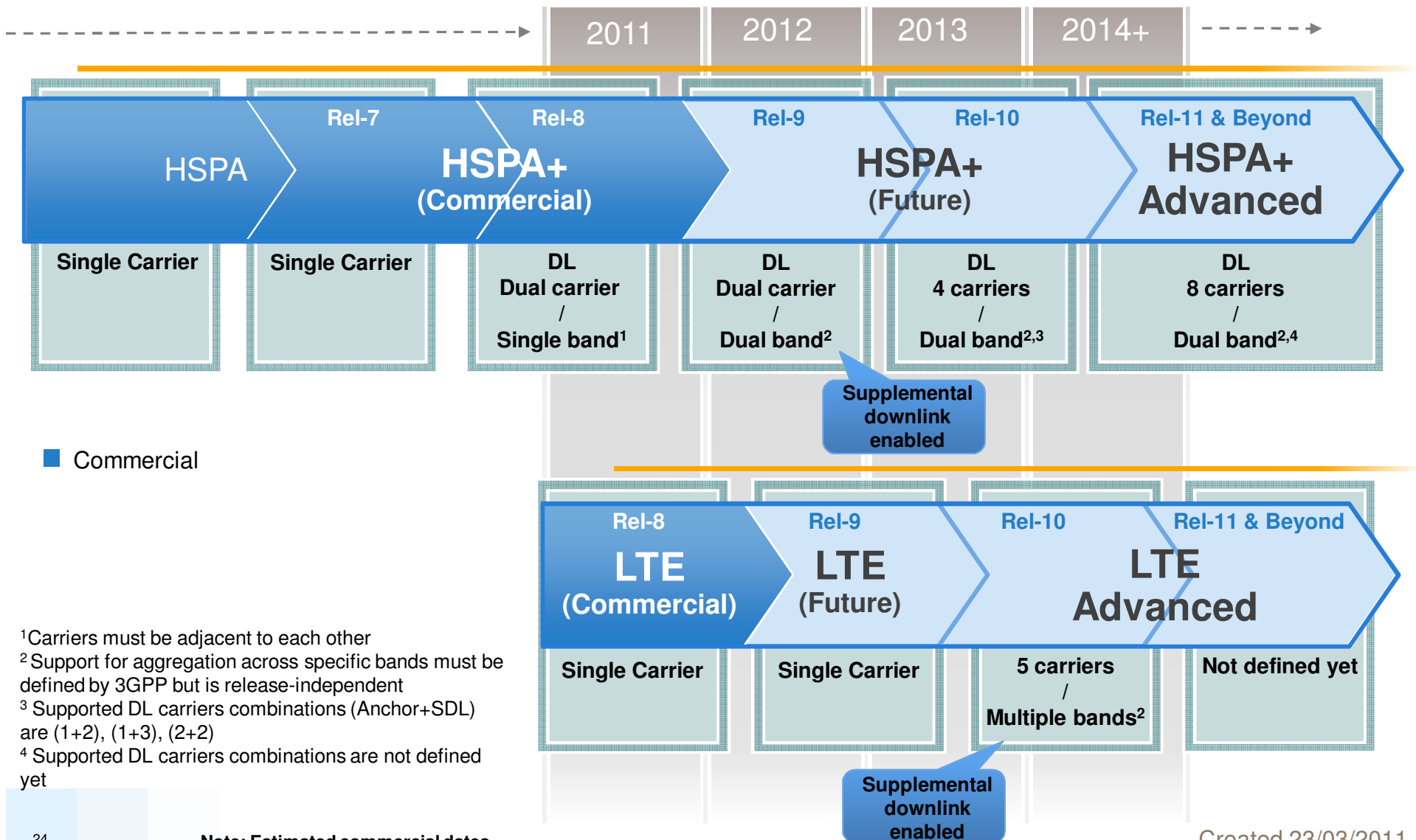
L-Band³ (1.4/1.5 GHz) key opportunity

- Harmonization possible in Europe and beyond, with up to 40 MHz of unpaired spectrum
- Other opportunities, such as 700MHz in the US, depend upon country-specific spectrum situations

¹Aggregation across bands is supported in HSPA+ R9 (and beyond) and LTE R10 (and beyond), but each specific band combination, e.g. combination of band 1 and L-band, has to be defined in 3GPP.

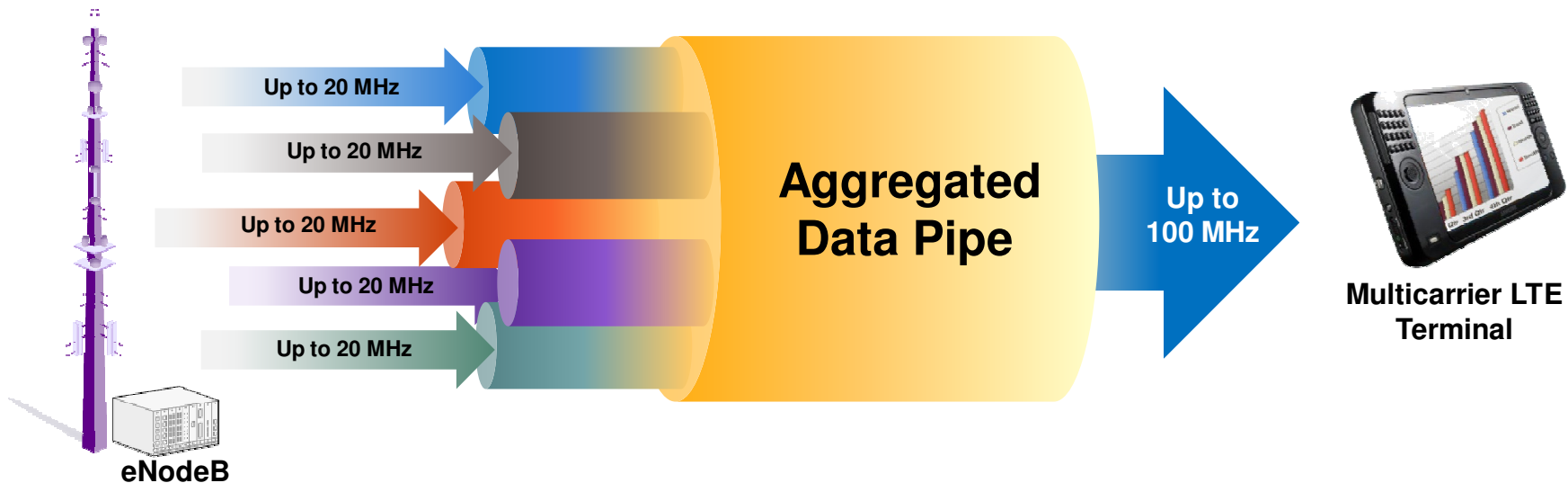
³L-Band in Europe: 1452 MHz to 1492 MHz, sometimes referred to as 1.4GHz or 1.5GHz spectrum

LTE and HSPA+ support Supplemental Downlink



LTE R10 capabilities for SDL

Aggregation 40 MHz to 100 MHz, across frequency bands



- Increased data rates and lower latencies for all users in the cell
- Data rates scale with bandwidth—Up to 1 Gbps peak data rate
 - Aggregating 40 MHz to 100 MHz provide peak data rates of 300 Mbps to 750 Mbps¹ (2x2 MIMO) and over 1 Gbps (4x4 MIMO)

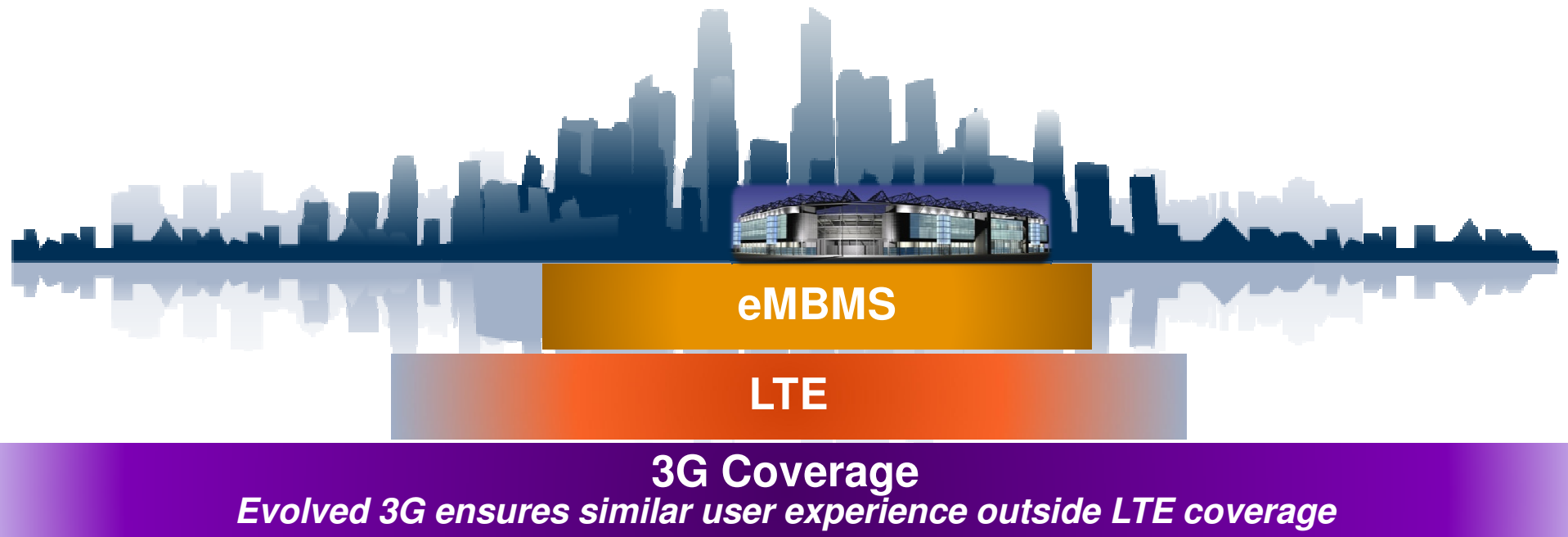
Outline

Technology vision

- Mobile bands and air interface evolution
 - What's next?
 - HSPA, HSPA+, HSPA Advanced, LTE, LTE Advanced, LTE TDD
- Spectrum mapping
- MBB for the delivery of mobile multimedia
 - Supplemental downlink
 - eMBMS

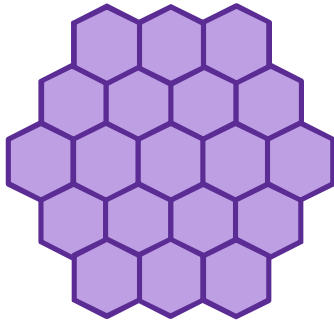
eMBMS Enables “Broadcasting” on LTE

- evolved Multimedia Broadcast Multicast Service
- Delivers multicast/broadcast capacity to mass audiences for rich media and video content
- 3G/LTE provide ubiquitous data coverage and voice

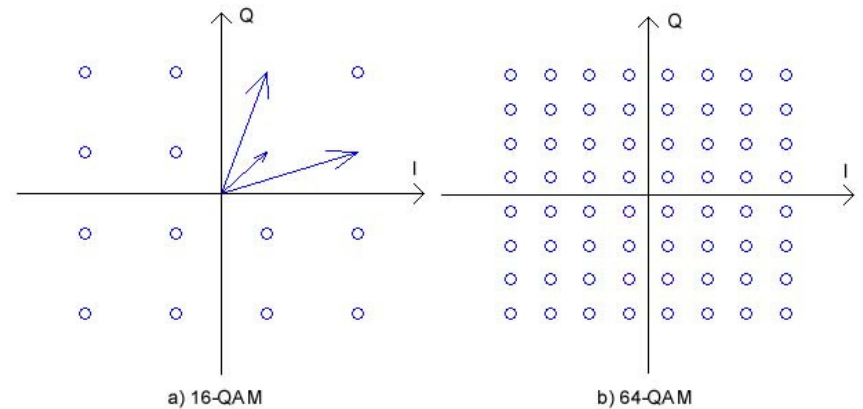


Overview of eMBMS for LTE

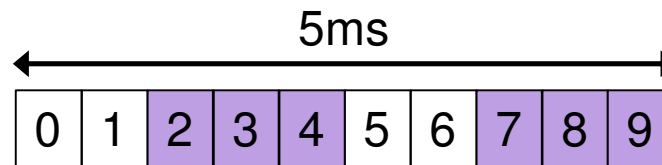
SFN



16/64-QAM



TDM of unicast/Multicast-broadcast

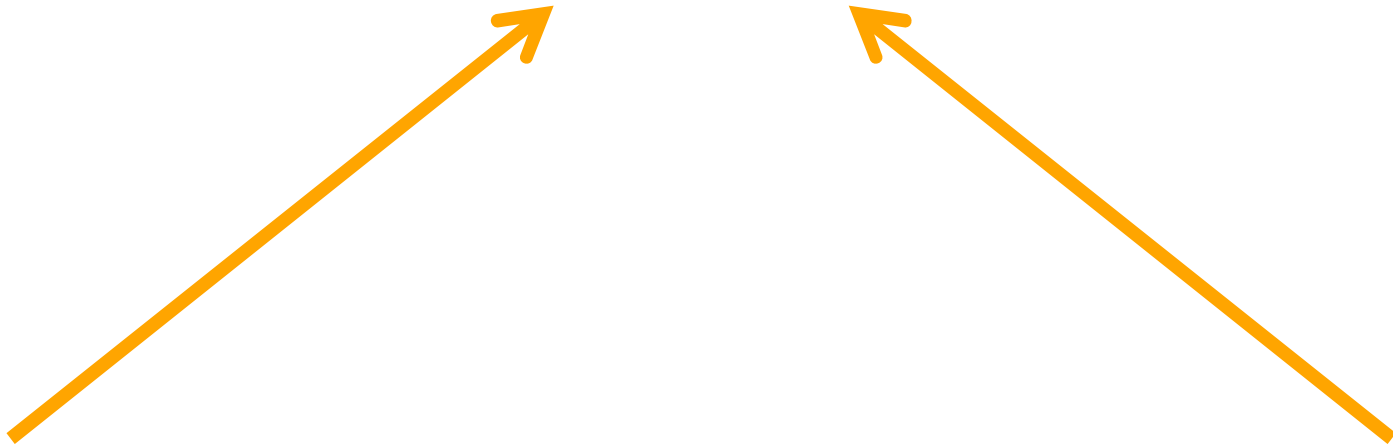


up to 60% subframes for multicast/broadcast

Conclusion

A lot more than convergence

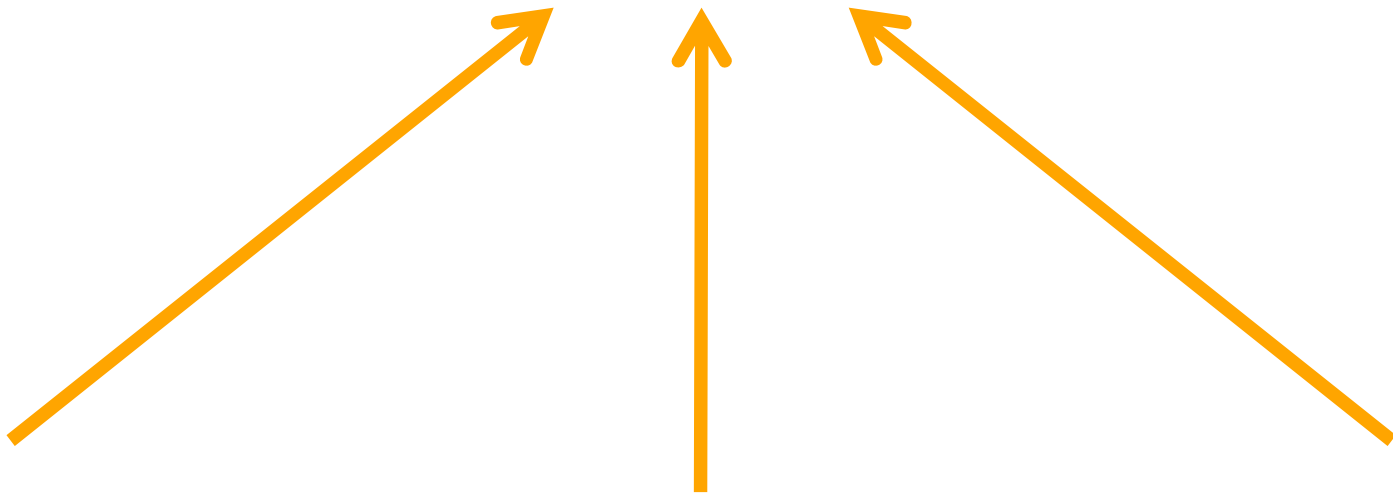
Convergence?



Conclusion

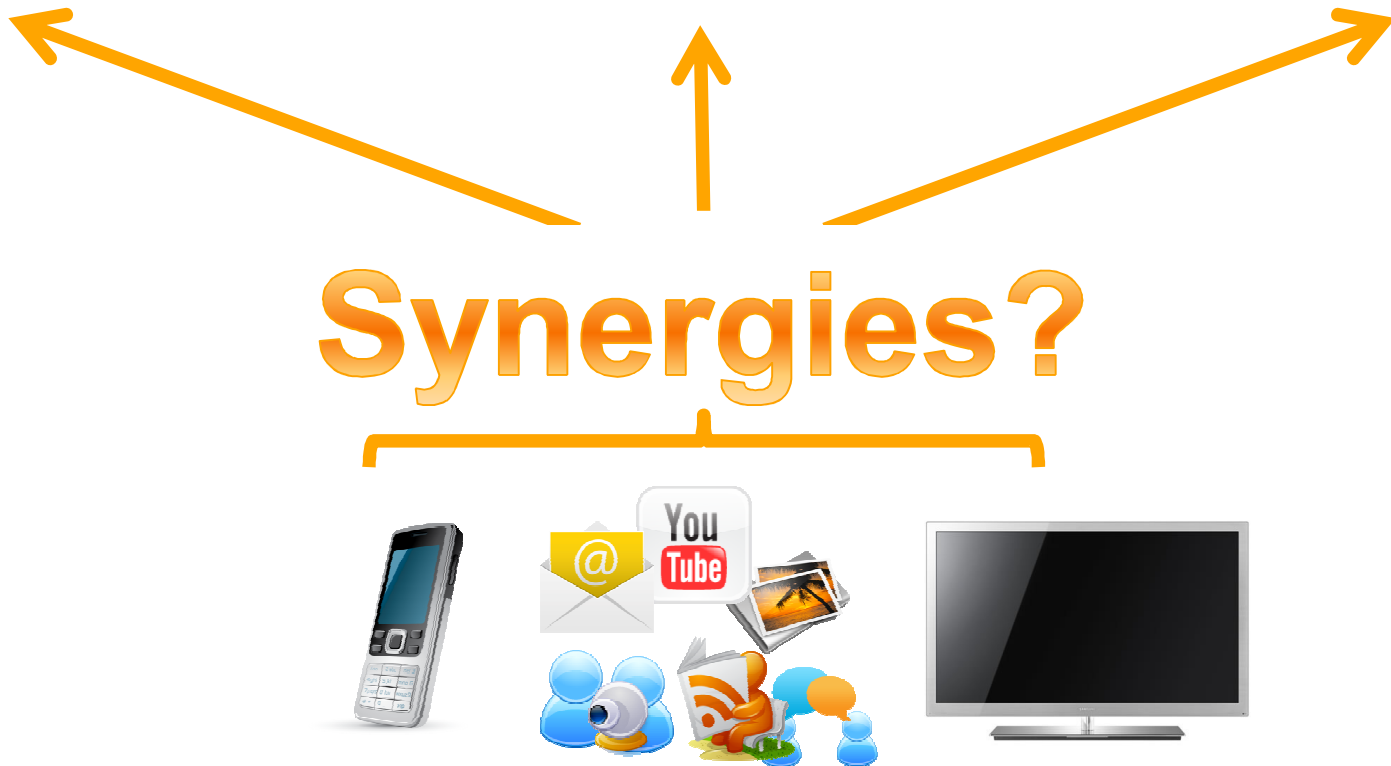
A lot more than convergence

Convergences?



Conclusion

A lot more than convergence



Questions

QUESTIONS?