4G Network Evolution –
Roadmap to IMT-Advanced

Technology Roadmap for HSPA+ Release 11

Panel Moderator:
Chris Pearson, President, 4G Americas
4G Americas will promote, facilitate and advocate for the deployment and adoption of the 3GPP family of mobile broadband technologies throughout the ecosystem – including networks, services, applications and wirelessly connected devices – in the Americas.
Technology Roadmap for HSPA+ Release 11

Moderator:
Chris Pearson
President
4G Americas

Rasmus Hellberg
Senior Director
Qualcomm

Mike Wright
Executive Director - Networks & Access Technologies
Telstra,
Rasmus Hellberg

• 1000x
• HSPA+ R10 and Beyond
  – HET-NETs
  – Multi Carrier and Antenna Evolution
  – Small data bursts
• Voice Evolution
Rising to meet the 1000x Mobile Data Challenge

MORE SPECTRUM IN LOW AND HIGHER BANDS

MORE SMALL CELLS EVERYWHERE!

MORE INDOOR CELLS INSIDE-OUT DEPLOYMENT

1000X HIGHER EFFICIENCY

Evolve 3G/4G/Wi-Fi

HetNets Interference Mgmt/SON

Intelligently Access 3G/4G/Wi-Fi
Small Cell Possible With HSPA+ Today

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

Median Gain¹
For same amount of Spectrum

¹Gain 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)
Many, Many More Small Cells — Means Further HET-NET Enhancements

- Today: Dual-Carrier and Reduced Macro Power—Range Expansion
- Even Better with MultiFlow (R11)—Balances Uneven Load
- Advanced Device Receivers Provide Additional Gain
- HET-NET interference mitigation and mobility study item in R12

Note: Self-Organizing Networks (SON) techniques can also improve Heterogeneous networks (HetNets) and are standardized already in R10, such as Minimization of Drive Tests (MDT) and Automatic Neighbor Relation (ANR).
MIMO and Multi Carrier Evolution

R1: 2 Transmit Antennas
- 28 Mbps
- Downlink Speed

R7: 2x2 MIMO
- 42 Mbps
- Downlink Speed

R8: Dual Carrier
- 84 Mbps
- 2x2MIMO+64QAM

R9: 2x2MIMO+DC
- 168 Mbps
- DC Across bands

R10: 20 MHz Multicarrier (4x)
- 336 Mbps
- R11: More 5MHz Carriers
- (40MHz 8x)
- Or More Antennas
- (Downlink 4x4 MIMO in 20MHz)

R9/R10: Uplink Dual-Carrier (10MHz)
- 23 Mbps
- R11: Uplink 2x2 MIMO
- Uplink Beamforming

R11: UL 2x2 MIMO + 64 QAM
- 69 Mbps

R11: More 5MHz Carriers
- 336 Mbps
- (40MHz 8x)
- Or More Antennas
- (Downlink 4x4 MIMO in 20MHz)

MIMO and Multicarrier Evolution
>10x Higher Capacity for Small Data Bursts

HSPA+ SET THE FOUNDATION BY ENHANCING CELL-FACH¹

HSPA+ ADVANCED MAKES IT MORE EFFICIENT—FE-FACH³

R7/R8

Significantly reduced signaling load (for small bursts, background)

Extended battery life for all applications (for all non full-buffer)²

R11

>10x Capacity (increase in small data burst downlink capacity in FACH compared to R7/R8)

ACCOMMODATING THE SMARTPHONE AND M2M GROWTH

¹R7/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. ²Cell-DCH w/R7 CPC allows non full buffer apps to use connected mode, DCH, more efficiently (DTX/DRX). ³A 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
WCDMA+

Triples Voice Spectral Efficiency
  - To free up resources for data

Can Free Up ~2/3 of a Carrier for HSPA+ Data
  - While supporting the same voice capacity as WCDMA today

Ensures High Quality, Reliable, Ubiquitous Voice
  - WCDMA+ builds on proven WCDMA circuit switched voice

Relevant to All HSPA/HSPA+ Operators
  - The long life of HSPA+ means a long life of WCDMA—Addresses all device segments
~2/3 of a Carrier Freed up for Data by Enhancing Circuit Switched Voice

SAME VOICE CAPACITY USING A THIRD OF RESOURCES

FREED-UP FOR DATA
(UP TO ~2/3 OF A 5 MHZ CARRIER FREED-UP)

ENHANCED CIRCUIT SWITCHED VOICE¹

¹Improvements such as overhead optimizations, early termination and new codec (EVS) 5.9kbps. single receive antenna assumed. WCDMA+ enhancements targeted for 3GPP R12.
Circuit Voice Has A Long Life During The Transition to Richer, Carrier Grade VoIP

IMS VoIP: Rich Voice – Ubiquity vs. OTT VoIP

VolTE Timing is Operator Specific
VoIP over HSPA+ Driven by VoLTE

2013 Fallback solutions

Proven Circuit Voice: High Quality, Reliable, Ubiquitous

WCDMA+: Long life of HSPA+ means long life of WCDMA
1X Advanced Commercial (1H 2012)

2020+

1Thanks 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
Qualcomm is Committed to Continued HSPA+ Evolution

**STANDARDS**
- Major 3GPP contributor
- Recognized expertise

**PROTOTYPING**
- 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: HetNet Range Expansion

**CHIPSETS**
- FSM
- Small cells

Actual screenshot from HetNet Demo, first shown at MWC 2012
Thank You!

Rasmus Hellberg
Senior Director
Mike Wright

Executive Director –
Networks & Access Technologies
OUR NEXT G® NETWORK
A HYBRID HSPA+/LTE NETWORK

2.3 Million km² Land
- Plus over 1 Million km² out to sea.

99% Wireless BB
- 99% Population coverage of HSPA+
- No requirement for 2G fall back
- 80% DC-HSPA, 40% LTE Pops covered^.

High performing Network
- Multi-Gigabit capable Ethernet fibre to sites covering >93% of pops.
- Well under 1% voice drop rate
- World’s largest HD Voice footprint (circuit voice)
- Low band 850 MHz HSPA for wide and deep coverage
- JD Power award for superior network

High performing business
- 13.8M Services, +1.6M in 12 months 11/12
- Low churn rate
- > 500k 4G services to June 2012, > 100K iPhone 5’s added in less than 4 weeks.
**OUR ROADMAP:**
DELIBERATING WORLD LEADING CAPACITY & PERFORMANCE

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<table>
<thead>
<tr>
<th>Year</th>
<th>Technology</th>
<th>Download Speeds</th>
<th>Upload Speeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>HSDPA</td>
<td>3.6Mbps^</td>
<td>550kbps</td>
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<tr>
<td>2006</td>
<td>HSDPA+</td>
<td>14.4Mbps^</td>
<td>550kbps</td>
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<tr>
<td>2007</td>
<td>HSUPA</td>
<td>1.9Mbps^</td>
<td>300kbps</td>
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<tr>
<td>2008</td>
<td>HSUPA</td>
<td>5.8Mbps^</td>
<td>300kbps</td>
</tr>
<tr>
<td>2009</td>
<td>HSPA+ DC</td>
<td>42Mbps^</td>
<td>1.1Mbps</td>
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<tr>
<td>2010</td>
<td>4G LTE</td>
<td>1Mbps</td>
<td>10Mbps*</td>
</tr>
<tr>
<td>2011</td>
<td>4G LTE</td>
<td>1800MHz</td>
<td>2Mbps - 40Mbps*</td>
</tr>
<tr>
<td>2012</td>
<td>LTE Advanced</td>
<td>2600/700MHz</td>
<td>Speed TBA*</td>
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<tr>
<td>2013</td>
<td>LTE Advanced</td>
<td>Speed TBA*</td>
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<tr>
<td>2014</td>
<td>LTE Advanced</td>
<td>Speed TBA*</td>
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<tr>
<td>2015</td>
<td>LTE Advanced</td>
<td>Speed TBA*</td>
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^ 1.9, 3.6, 5.8, 14.4, 21, 42Mbps are technology rated peak downlink and uplink speeds. Typical customer speeds are lower as shown.

* 4G SPEEDS: With capable devices customers can experience typical download speeds of 2Mbps – 40Mbps, and typical upload speeds of 1Mbps – 10Mbps in all capital CBD’s (meaning within 5km from the GPO), associated airports and selected regional areas (meaning 3km of the regional town centre) covering more than 40% of the population. In other coverage areas, customers will automatically switch over to Telstra’s fastest available 3G HSPA (High Speed Packet Access technology) enabled network speeds.

# 3G HSPA ENABLED SPEEDS: With capable devices customers can experience typical download speeds of 1.1Mbps – 20Mbps in all capital CBD’s, airports, much of the associated metropolitan areas and many regional areas covering more than 80% of the population. Outside these areas, the remaining metropolitan areas and many other regional and rural locations typical download speeds are 550kbps to 8Mbps covering more than 97% of the population, and elsewhere 550kbps to 3Mbps. Typical customer upload speeds are 300kbps-3Mbps in all capital cities and major regional areas covering more than 93% of the population and elsewhere 300kbps-1Mbps.

° Subject to government auction process.

NOTE: Speeds may vary due to factors such as location, distance from the base station, local conditions, concurrent users, hardware and software configuration. For more details on speed & coverage areas visit: [http://www.telstra.com.au/mobile/networks/coverage](http://www.telstra.com.au/mobile/networks/coverage)

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**OUR ROADMAP:**
DELIVERING WORLD LEADING CAPACITY & PERFORMANCE
# Indicative Wireless Roadmap

## 2010-2016

<table>
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<td>2010</td>
<td>HSPA+ 21 Mbps</td>
<td>DC-HSPA+ 42 Mbps</td>
<td>LTE 75-150 Mbps (10MHz - 20MHz)</td>
<td>HSPA+ MIMO + Multi channel</td>
<td>HSPA+ (MBand) 168 Mbps</td>
<td>LTE-A 150 Mbps++</td>
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<tr>
<td>2011</td>
<td>HSPA+ 21(28)/5.8 Mbps</td>
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**All speeds quoted are peak network speeds. Customer download speeds are lower.**

### Devices

- **1800MHz devices**
- **2600MHz devices**
- **900MHz Devices**
- **VoLTE Devices**
- **eMBMS & 4x4 MIMO devices**
- **LTE 700MHz device Availability**

**VoLTE Devices**

- LTE-A & CAT4 device Availability

### Core

- **3GPP & Wi-Fi interworking**
- **RCS**
- **eMBMS**

**TD-LTE timeframes are generally ~12 months behind FDD**

- Small Cells (e.g., HetNets) embedded in macro network
- LTE-A carrier aggregation 900MHz + 1800MHz
- eICIC & CoMP

### Integrated Antennas

- Active or Smart Antenna

**“Mothball” GSM**

**Mothball” GSM**

- **VoLTE**

** existing/committed decision to be made**

- **Existing/Committed Decision to be made**

**uncertainty around how quickly the 900MHz and 700 MHz APAC devices ecosystem will gain momentum**

**Huawei CAT4 device early 2013**
### KEY HSPA RELEASE-11 FEATURES

#### 8C-HSDPA; 4x4 MIMO in downlink; UL MIMO + 64 QAM

<table>
<thead>
<tr>
<th>Year</th>
<th>Q3</th>
<th>Q4</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q1</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>60% / 0%</td>
<td>70% / 60%</td>
<td>4x4 MIMO</td>
<td>30% / 5%</td>
<td>10% / 0%</td>
<td>13% / 0%</td>
<td>100%</td>
</tr>
<tr>
<td>Core Perf</td>
<td>HSPA-Advanced</td>
<td>8 carrier HSDPA</td>
<td>4x4 MIMO</td>
<td>Uplink Transmit Diversity for HSPA – Closed loop</td>
<td>Uplink Transmit Diversity for HSPA – Open loop</td>
<td>Non-contiguous multi-carrier HSDPA operation</td>
<td>HSDPA multi-flow transmission</td>
</tr>
</tbody>
</table>

**Other improvements**
- Further enhanced CELL_FACH
- Multiflow HSDPA transmission
- Non-contiguous MC-HSDPA
- Uplink transmit diversity
- Closed loop/Open loop Minimization of drive tests
- SON
- Active Antenna Array Systems (AAS)
KEY ISSUES FOR TELSTRA

- The national HSPA network layer will continue to underpin Telstra’s national wireless broadband footprint strategy for many years to come.

- Key features of the HSPA+ roadmap will continue to be required to improve and manage performance.

HOWEVER:

- LTE is emerging faster than any previous WBB technology

- How long will we continue to rely on the underlying 3G/HSPA+ coverage layer for voice CS fallback?
  - Requires a full national (700MHz LTE) layer and VoLTE to transition

- What are the costs of implementation and benefits of the next generation of HSPA+ improvements?
  - Some features and use of carrier aggregation may drive hardware upgrades
Thank You!

Mike Wright
Executive Director
Networks & Access Technologies
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