First Learning’s from LTE Rollout & Optimisation

Preparing LTE-Advanced

Luís Santo, Optimus, 5th June 2013
LTE WORLD EVOLUTION

4G @ OPTIMUS

ROLLOUT & OPTIMISATION

LTE-ADVANCED
LTE WORLD EVOLUTION

LTE LAUNCHES WORLDWIDE

Source: http://www.gsacom.com

175 LTE commercial networks by May 2013. 100 Operators launching per year

GSA forecasts 248 commercial LTE networks in 87 countries by end 2013

Commercial Networks (per Technology)

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>EDGE</td>
<td></td>
<td></td>
<td></td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>HSDPA</td>
<td></td>
<td></td>
<td></td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>HSPA+</td>
<td></td>
<td></td>
<td></td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>DC-HSPA+</td>
<td></td>
<td></td>
<td></td>
<td>134</td>
<td></td>
</tr>
<tr>
<td>LTE</td>
<td></td>
<td></td>
<td></td>
<td>175 (Q2)</td>
<td>146</td>
</tr>
</tbody>
</table>

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### FREQUENCY BANDS & DEVICES

#### LTE Commercial Networks (per Freq band)

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Operators</th>
</tr>
</thead>
<tbody>
<tr>
<td>1700 (AWS)</td>
<td>17</td>
</tr>
<tr>
<td>800</td>
<td>18</td>
</tr>
<tr>
<td>700</td>
<td>21</td>
</tr>
<tr>
<td>2600</td>
<td>55</td>
</tr>
<tr>
<td>1800</td>
<td>76</td>
</tr>
</tbody>
</table>

#### UE Devices (per Freq band)

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triband</td>
<td>176</td>
</tr>
<tr>
<td>900</td>
<td>58</td>
</tr>
<tr>
<td>2100</td>
<td>163</td>
</tr>
<tr>
<td>AWS</td>
<td>172</td>
</tr>
<tr>
<td>700</td>
<td>188</td>
</tr>
<tr>
<td>800</td>
<td>207</td>
</tr>
<tr>
<td>1800</td>
<td>233</td>
</tr>
<tr>
<td>2600</td>
<td>280</td>
</tr>
</tbody>
</table>

Source: [http://www.gsacom.com](http://www.gsacom.com)

- **1800 MHz**: 76 Commercial operators in 43 countries
- 149 (/175) live LTE networks use 800 or 1800 or 2600 MHz
- 821 LTE devices, 562 are +3G. 2013: >400 new devices/year.
- 176 are 800/1800/2600 MHz. 307 LTE 1800/2600 MHz devices.
LTE WORLD EVOLUTION

SUBSCRIBER EVOLUTION

LTE 20 million new subscriptions added in Q1-13
2G: +30M, 3G: +60 M

<table>
<thead>
<tr>
<th>Service Type</th>
<th>2011</th>
<th>2012</th>
<th>2018</th>
<th>Ratio</th>
<th>CAGR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>5800</td>
<td>6300</td>
<td>9100</td>
<td>1.4x</td>
<td>6%</td>
</tr>
<tr>
<td>Smartphones</td>
<td>850</td>
<td>1200</td>
<td>4500</td>
<td>3.8x</td>
<td>25%</td>
</tr>
<tr>
<td>Mobile PC/Tablet/Router</td>
<td>250</td>
<td>300</td>
<td>850</td>
<td>2.8x</td>
<td>19%</td>
</tr>
<tr>
<td>Mobile BB</td>
<td>1100</td>
<td>1600</td>
<td>7000</td>
<td>4.4x</td>
<td>28%</td>
</tr>
<tr>
<td>GSM/EDGE Only</td>
<td>4200</td>
<td>4300</td>
<td>2100</td>
<td>0.5x</td>
<td>-11%</td>
</tr>
<tr>
<td>WCDMA/HSPA</td>
<td>950</td>
<td>1200</td>
<td>4300</td>
<td>3.6x</td>
<td>24%</td>
</tr>
<tr>
<td>LTE</td>
<td>9</td>
<td>65</td>
<td>2000</td>
<td>30.8x</td>
<td>77%</td>
</tr>
</tbody>
</table>

Source: Ericsson Mobility Report, June 2013

Source: http://www.gsacom.com

LTE Subs World Distribution

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92.1% of resident Population has a mobile subscription (Marktest)

Mobile penetration: 158%, with 124% of SIMs with effective usage (ANACOM)

MBB 4.3M (-2.3% Q412, +7.5% YoY)

Total sales to final subscribers: 530M€ (-7.3% YoY)

Effective usage showing the lower penetration rate registered since 2010
LTE MILESTONES

2010
• Technology Assessment
• Visiting LTE Networks
• Trial Clusters Setup & First Calls

2011
• Extensive tests & Demos
• Spectrum Auction
• Vendor & Equip Selection
• Network Rollout

2012
• Network Rollout Cont.
• Commercial Launch
• SON & Optimisation

2013
• Network Rollout Cont.
• Advanced features testing
• LTE-Advanced demo (CA, UL CoMP & MIMO 4x4)
• WOW
• ...

4G @ OPTIMUS

4G Launched in 15th March 2012. Required more than 2 years preparation, and a whole company to drive it...
REVENUE OPPORTUNITIES & NEW SERVICES

Improved QoE & Capacity
- through improvement in user experience and increased capacity – higher ARPU

New Services
- by exploring services previously restricted to wireline and fostering service innovation

Fixed Mobile Substitution
- by providing 2P services for underserved areas
- 2P less data demanding segments

Downside Pressures
- Better latency, increase of VoIP
- Higher adoption on OTT (Netflix, etc.)

LTE enables or accelerate the adoption of a significant number of new services
4G @ OPTIMUS

4G OFFER

Smartphones
- CSFB (2G & 3G)
- Up to 50 Mbps

Kanguru, Hotspots & Pads
- Up to 150 Mbps
- Unlimited volume offers available

WŐW
- 20/40/100 Mbps unlimited offers
- 2P Fixed Substitution

Cobertura
- 80% national coverage
- 800/1800/2600 MHz bands used
The WÖW product challenges the 4G technology to a “fixed like” usage profile.
4G vs. 3G Global Vol: 5x
4G vs. 3G Smartphone Vol: 10x

4G traffic growing exponentially (>60%/quarter, Q113)

4G is a smartphone dominated network from day one

Video/Flash Video is the dominant application in DL. P2P dominates UL

4G dominated by smartphone devices. Different profiles per device. Video dominates DL

Upstream

Browsing: 20 a 40%
Voice&Video: <10%
File Sharing: 40 a 60%
WHY REFARMING GSM1800 TO LTE

Better Coverage & Capacity
- 1800 coverage area nearly 2x 2600 MHz
- 1800 refarmed allows for same 20 MHz

GSM1800 Asset Reuse
- Antennas, radio units (SDR), feeders, passive components (e.g. diplexers, DAS, etc.)

Device Ecosystem Building
- 233 1800 MHz LTE devices available
- Growing fast - roaming band candidate

Allows for LTE-A C.A. Expansion
- Up to 300 Mbps when C.A with LTE2600
- Up to 225 Mbps when C.A with LTE800

Reinforce 2G Capacity
- TRX & Abis upgrade

Improve 900MHz Freq Reuse plans
- Mitigate interference and optimise MA frequencies

AMR & Power Ctrl
- AMR codec configured
- Interference/Power Ctrl Optim

MRAB Optim & 3G Traf Steering
- Optimise voice 3G on 2G hotspots
- Traffic load sharing

1800M strategy allows superior QoE. Need to control interference increase in GSM900
OPTIMISING 4G CHALLENGES

**OFDMA vs CDMA**
- Limited ICIC
- Need to control cell overlap

**Optimizing PCI and RACH Planning**
- Define coverage and service areas
- Watch overshooting in LTE800

**Mobility and iRAT**
- Ensure X2 and HO performance
- Ensure adequate idle/dch mode reselection

**Antenna Design & Optim**
- Optimise tilts for different bands
- Evaluate antenna change impact to 2G/3G services
OPTIMISING 4G CHALLENGES

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Limited cell overlap is critical for high performance. Complex iRAT mobility settings
ROLLOUT & OPTIMISATION

LTE800 & TDT CO-EXISTENCE

TDT Interference from Spain
- TDT in Spain still using LTE800 spectrum
- High usage of CH 67 to 69

Illegal usage of CH69 in PT
- Self oscillating TV amplifiers still radiating in default CH69

No relevant impact to CH56 TDT PT
- Insignificant incidence of LTE800 inducing problems to TDT reception (blocking)

Spain TDT Refarming in 2015
- Announced shutdown until end 2014
- Court troubles with TV operators – delay?

LTE800 interference mitigation: PUCCH optimised configuration
LTE Advanced Objectives (3GPP R10)

LTE R-10 is to provide higher bitrates in a cost efficient way, and at the same time fulfil the requirements set by ITU for IMT

- Increased peak data rate, DL 3 Gbps, UL 1.5 Gbps. increased number of simultaneously active subscribers
- Higher spectral efficiency, from a maximum of 16bps/Hz in R8 to 30 bps/Hz in R10
- Improved performance at cell edges, e.g. for DL 2x2 MIMO at least 2.40 bps/Hz/cell.

Most relevant new Features: Carrier Aggregation, UL CoMP and MIMO 4x4
LTE-ADVANCED
CARRIER AGGREGATION & MIMO 4x4

Frequency Bands
- C.A 1800 & 2600 MHz, MIMO 4x4 in 1800
- 2x 20 MHz, 300 Mbps peak

UE Device & LTE SW
- Lab unit provided by Huawei
- Consisting of 2 receivers (1 per band)

300 Mbps obtained in live
- Very good radio conditions, indoor
- Similar for CA and MIMO 4x4

CAT 5 UE: 64 QAM UL tested
- Up to 68 Mbps (75M Theoretical Peak)
- Difference due to cell setup

Optimus was the first operator to demo LTE-Advanced Carrier Aggregation, with Huawei Tech.
UPLINK COORDINATED MULTI-POINT (CoMP)

**Mecanism to reduce ICI**
- Intra enode initially
- Minimizes inter cell interference

**Support to legacy UEs**
- Feature at eNodeB level
- No specific EU requirement (R8)

**UL Throughput Gain**
- > 5% at average capacity
- > 10% at peak throughput

**Stringent requisites to IP transport**
- X2 low latency for intra eNodeB
- Requires high eNodeB processing power

UL CoMP can improve 4G UL up to 14% at cell edge. Supported in legacy UEs

Source: http://www.gsacom.com
5G IS BUILDING UP (...ITS FIRST STEPS)

- UK speeds up signals on 5G introduction (Ofcom consultation on new spectrum)
- Fresh €50 million EU research grants in 2013 to develop '5G' technology
- Samsung To Launch 5G By 2020, Hits Speeds Of 1Gbps In Tests
- University of Surrey secured £35M for new 5G research centre, joint funded between UK Gov + Suppliers (2012)

5G is likely to have a more technology integration perspective than new radio technologies
175 LTE commercial networks by May 2013. 100 Operators launching per year.
4G Smartphones to grow 3x. Video will account for 50% of volume (2018)

LTE enables or accelerate the adoption of a significant number of new services
4G dominated by smartphones. Different profiles/device. Video dominates DL

1800M strategy allows superior QoE. Need to control interference increase in GSM900
Limited cell overlap is critical for high performance. Complex iRAT mobility settings

Most relevant new Features: Carrier Aggregation, UL CoMP and MIMO 4x4
UL CoMP can improve 4G UL up to 14% at cell edge. Supported in legacy UEs
FINAL THOUGHTS
TELECOM, AS OTHER BUSINESSES, IS CHANGING FASTER

It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change (Darwin)

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