3GPP LTE Standards Update: Release 11, 12 and Beyond

Technology Leadership Organization

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Lead Technologist

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Agenda

Wireless evolution 1990 – 2012
Deployment update
Summary of Releases 8, 9 and 10 radio aspects
How to navigate 3GPP Releases and work items
Release 11 work items
3GPP RAN Release 12 Workshop
Release 12 work items
Release 12 study items
Summary
Wireless evolution 1990 - 2012

- **2G**
  - PDC (Japan)
  - GSM (Europe)
  - IS-136 (US TDMA)
  - IS-95A (US CDMA)

- **2.5G**
  - iMODE
  - HSCSD
  - GPRS
  - IS-95B (US CDMA)

- **3G**
  - W-CDMA (FDD & TDD)
  - TD-SCDMA (China)
  - E-GPRS (EDGE)
  - cdma2000 (1x RTT)

- **3.5G**
  - HSDPA
  - HSUPA
  - EDGE Evolution
  - 1x EV-DO
  - 802.16d (Fixed WiMAX)

- **3.9G/4G**
  - HSPA+ / E-HSPA
  - LTE (R8/9 FDD & TDD)
  - 802.16e (Mobile WiMAX)

- **4G / IMT-Advanced**
  - LTE-Advanced (Release 10, 11, 12)
  - 802.16m / WiMAX2 WirelessMAN-Advanced

- **W-LAN**
  - 802.11b
  - 802.11a/g
  - 802.11h
  - 802.11n
  - 802.16d
  - 802.16e
  - 802.16m

Increasing efficiency, bandwidth and data rates
**UMTS Long Term Evolution**

<table>
<thead>
<tr>
<th>Release</th>
<th>Stage 3: Core specs complete</th>
<th>Main feature of Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rel-99</td>
<td>March 2000</td>
<td>UMTS 3.84 Mcps (W-CDMA FDD &amp; TDD)</td>
</tr>
<tr>
<td>Rel-4</td>
<td>March 2001</td>
<td>1.28 Mcps TDD (aka TD-SCDMA)</td>
</tr>
<tr>
<td>Rel-5</td>
<td>June 2002</td>
<td>HSDPA</td>
</tr>
<tr>
<td>Rel-6</td>
<td>March 2005</td>
<td>HSUPA (E-DCH)</td>
</tr>
<tr>
<td>Rel-7</td>
<td>Dec 2007</td>
<td>HSPA+ (64QAM DL, MIMO, 16QAM UL). LTE &amp; SAE Feasibility Study, Edge Evolution</td>
</tr>
<tr>
<td>Rel-8</td>
<td>Dec 2008</td>
<td>LTE Work item – OFDMA air interface SAE Work item – New IP core network UMTS Femtocells, Dual Carrier HSDPA</td>
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<tr>
<td>Rel-9</td>
<td>Dec 2009</td>
<td>Multi-standard Radio (MSR), Dual Carrier HSUPA, Dual Band HSDPA, SON, LTE Femtocells (HeNB) LTE-Advanced feasibility study, MBSFN</td>
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<tr>
<td>Rel-10</td>
<td>March 2011</td>
<td>LTE-Advanced (4G) work item, CoMP Study Four carrier HSDPA</td>
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<tr>
<td>Rel-11</td>
<td>Sept 2012</td>
<td>CoMP, eDL MIMO, eCA, MIMO OTA, HSUPA TxD &amp; 64QAM MIMO, HSDPA 8C &amp; 4x4 MIMO, MB MSR</td>
</tr>
<tr>
<td>Rel-12</td>
<td>March 2013 stage 1</td>
<td>New carrier type, LTE-Direct, Active Antenna Systems</td>
</tr>
</tbody>
</table>
Understanding 3GPP Releases

The official scope of each 3GPP release is documented at: www.3gpp.org/releases

Each release comprises a set of work items with three main development stages

- Stage 1: Service description from a service-user’s point of view.
- Stage 2: Logical analysis, breaking the problem down into functional elements and the information flows amongst them across reference points between functional entities.
- Stage 3: is the concrete implementation of the protocols appearing at physical interfaces between physical elements onto which the functional elements have been mapped.

And some less formal stages

- Stage 0: Used to describe 3GPP feasibility studies (study items)
- Stage 4: Used to describe the development of test specifications
Tracking work items and study items

The complete list of 3GPP work items back to Release 99 can be found at http://www.3gpp.org/ftp/Information/WORK_PLAN/

The list can be filtered by many attributes including the release, work item name and committee resource

Links are given to the latest work item descriptions and status reports

RAN, SA and CT plenary documents for meeting XX are at: ftp://ftp.3gpp.org/tsg_ran/TSG_RAN/TSGR_XX/Docs/
ftp://ftp.3gpp.org/tsg_sa/TSG_SA/TSGS_XX/Docs/
ftp://ftp.3gpp.org/tsg_ct/TSG_CT/TSGC_XX/Docs/
Link work items to the affected specifications

If you know a work item code you can find out all the specifications that changed as a result of that work item

Go to:

http://www.3gpp.org/ftp/Specs/html-info/FeatureListFrameSet.htm

Select a release from the tabs at the top

Click on a feature or study item on the left hand side

Click on a unique ID (UID) on the right to see a list of affected specifications
Frequency bands – Release Independent

An important aspect of frequency bands when it comes to the 3GPP releases is that they are “release independent” This means that a band defined in a later release can be applied to an earlier release.

This significantly simplifies the specifications

<table>
<thead>
<tr>
<th>Release</th>
<th>FDD</th>
<th>TDD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Release 8</td>
<td>1 – 17 (excl. 15,16*)</td>
<td>32 - 40</td>
</tr>
<tr>
<td>Release 9</td>
<td>18 - 21</td>
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<td>Release 10</td>
<td>22 - 25</td>
<td>41 - 43</td>
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<tr>
<td>Release 11</td>
<td>26 - 29</td>
<td>44</td>
</tr>
<tr>
<td>Release 12</td>
<td>30?, 31?, ...</td>
<td></td>
</tr>
</tbody>
</table>

* Bands 15 and 16 are specified by ETSI only for use in Europe
There is a lot of overlap between band definitions for regional reasons.
The Duplex spacing varies from 30 MHz to 799 MHz.
The gap between downlink and uplink varies from 10 MHz to 680 MHz.
Narrow duplex spacing and gaps make it hard to design filters to prevent the transmitter spectral regrowth leaking into the receiver (self-blocking).
Bands 13, 14, 20 and 24 have reversed uplink downlink frequencies.
Bands 15 and 16 are specified by ETSI only for use in Europe.

<table>
<thead>
<tr>
<th>Band</th>
<th>Uplink MHz</th>
<th>Downlink MHz</th>
<th>Width</th>
<th>Duplex</th>
<th>Gap</th>
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<td>1980</td>
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<td>2170</td>
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<td>1910</td>
<td>2110</td>
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<td>6</td>
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<td>840</td>
<td>865</td>
<td>875</td>
<td>10</td>
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<tr>
<td>7</td>
<td>2500</td>
<td>2570</td>
<td>2620</td>
<td>2690</td>
<td>70</td>
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<tr>
<td>8</td>
<td>880</td>
<td>915</td>
<td>925</td>
<td>960</td>
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<tr>
<td>9</td>
<td>1749.9</td>
<td>1784.9</td>
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<tr>
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<td>1475.9</td>
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<tr>
<td>12</td>
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<td>728</td>
<td>746</td>
<td>18</td>
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<tr>
<td>13</td>
<td>777</td>
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<td>875</td>
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<td>25</td>
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<td>1995</td>
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<td>852</td>
<td>869</td>
<td>17</td>
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<td>28</td>
<td>703</td>
<td>748</td>
<td>758</td>
<td>803</td>
<td>45</td>
</tr>
</tbody>
</table>

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<tr>
<td>33</td>
<td>1900</td>
<td>1920</td>
<td>20</td>
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<tr>
<td>34</td>
<td>2010</td>
<td>2025</td>
<td>15</td>
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<td>35</td>
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<td>36</td>
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<td>43</td>
<td>3600</td>
<td>3800</td>
<td>200</td>
</tr>
<tr>
<td>44</td>
<td>703</td>
<td>803</td>
<td>100</td>
</tr>
</tbody>
</table>
Nov 2004 LTE/SAE High level requirements

- Reduced cost per bit
- More lower cost services with better user experience
- Flexible use of new and existing frequency bands
- Simplified lower cost network with open interfaces
- Reduced terminal complexity and reasonable power consumption

Spectral Efficiency
3-4x Rel-6 HSDPA (downlink)
2-3x HSUPA (uplink)

Latency
Idle → active < 100 ms
Small packets < 5 ms

Downlink peak data rates (64QAM)

<table>
<thead>
<tr>
<th>Antenna config</th>
<th>SISO</th>
<th>2x2 MIMO</th>
<th>4x4 MIMO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak data rate Mbps</td>
<td>100</td>
<td>172.8</td>
<td>326.4</td>
</tr>
</tbody>
</table>

Uplink peak data rates (Single antenna)

<table>
<thead>
<tr>
<th>Modulation</th>
<th>QPSK</th>
<th>16 QAM</th>
<th>64 QAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak data rate Mbps</td>
<td>50</td>
<td>57.6</td>
<td>86.4</td>
</tr>
</tbody>
</table>

Mobility
Optimized: 0–15 km/h
High performance: 15-120 km/h
Functional: 120–350 km/h
Under consideration: 350–500 km/h

SPEED!

Downlink peak data rates (64QAM)

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<td>57.6</td>
<td>86.4</td>
</tr>
</tbody>
</table>
Release 9: Summary of key radio features (Dec 2009)

Home base station (femtocell)
MBMS – completion of MBSFN
Positioning Support (AGNSS)
Multicarrier / Multi-RAT Base Station (Multi Standard Radio)
Local Area Base Station (picocell)
Dual layer beamforming (TM8)
Self Organizing Networks (SON)
Release 10: Stage 3 frozen March 2011
Summary of key radio features

Carrier Aggregation (CA) – www.agilent.com/find/LTEwebcasts

Enhanced uplink transmission
- Clustered SC-FDMA
- Simultaneous PUCCH and PUSCH
- Transmit diversity, two- and four-layer spatial multiplexing

Enhanced downlink transmission
- Eight-layer spatial multiplexing including UE-specific RS (TM9)
- Channel State Information Reference Symbols (CSI-RS)

Relaying – continued in Release 11

Enhanced Inter-cell Interference Coordination (eICIC)

Minimization of Drive Test (MDT)

Machine Type Communications (MTC)

Inter-band (non contiguous) MSR - www.agilent.com/find/LTEwebcasts

SON enhancements for self healing
Release 11: Stage 3 frozen Sept 2012
Summary of key radio features

New carrier aggregation combinations (18)

Verification of radiated multi-antenna reception performance of UEs in LTE/UMTS (MIMO OTA)

Signaling and procedure for interference avoidance for in-device coexistence

Coordinated multi-point operation for LTE

Public Safety Broadband High Power UE for Band 14, Region 2
### Rel-11 Carrier Aggregation combinations

<table>
<thead>
<tr>
<th>Band</th>
<th>Lead company</th>
<th>Uplink</th>
<th>Downlink</th>
<th>Uplink</th>
<th>Downlink</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA-B3_B7*</td>
<td>TeliaSonera</td>
<td>1710 - 1785</td>
<td>1805 - 1880</td>
<td>2500 - 2570</td>
<td>2620 - 2690</td>
<td>FDD</td>
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<tr>
<td>CA-B4_B17</td>
<td>AT&amp;T</td>
<td>1710 – 1755</td>
<td>2110 - 2155</td>
<td>704 – 716</td>
<td>734 - 746</td>
<td>FDD</td>
</tr>
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<td>CA-B4_B13</td>
<td>Ericsson (Verizon)</td>
<td>1710 – 1755</td>
<td>2110 - 2155</td>
<td>777 - 787</td>
<td>746 - 756</td>
<td>FDD</td>
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<td>Cox Communications</td>
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<td>2110 - 2155</td>
<td>698 - 716</td>
<td>728 - 746</td>
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<td>Huawei (Orange)</td>
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<td>791 - 821</td>
<td>2500 - 2570</td>
<td>2620 - 2690</td>
<td>FDD</td>
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<td>CA-B4_B5</td>
<td>AT&amp;T</td>
<td>1710 – 1755</td>
<td>2110 - 2155</td>
<td>824 - 849</td>
<td>869 - 894</td>
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<td>1805 - 1880</td>
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<td>China Unicom</td>
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<td>CA-B1_B7</td>
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<td>3600 - 3800</td>
<td>3600 - 3800</td>
<td>3600 - 3800</td>
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</table>

* Carried forwards from Rel-10
Combinations of carrier aggregation and layers

There are multiple combinations of CA and layers that can meet the data rates for the new and existing UE categories.

The following tables define the most cases for which performance requirements may be developed.

<table>
<thead>
<tr>
<th>Downlink</th>
<th>Capability [#CCs/BW(MHz)]</th>
<th>DL layers [max #layers]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 6</td>
<td>1 / 20MHz</td>
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<tr>
<td></td>
<td>2 / 10+10MHz</td>
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<tr>
<td></td>
<td>2 / 20+20MHz</td>
<td>2</td>
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<tr>
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MIMO OTA: Verification of radiated multi-antenna reception performance of UEs

Unlike SISO OTA performance which was entirely a function of the DUT, MIMO OTA performance is intricately linked to the channel and operating conditions

Expected performance is impacted among other things by:

• Choice of channel model
• Doppler speed
• Degree of spatial diversity
• Impact of adaptive modulation and coding
• Noise and interference conditions
• Transmission mode used and transitions between modes
MIMO OTA test methodologies

Seven test methods have been proposed for the study item

They can be grouped into three main methods:

Multi-antenna anechoic chamber methods

– Configurations vary from simple two antenna with no fading up to as many as a ring of 32 antennas with fading

Reverberation chamber methods

– These vary from simple single chamber to more complex multi-chamber with or without the addition of a fading emulator

Antenna pattern method and two-stage method

– Antenna-only methods and the more advanced two-stage method involving throughput measurement
Ring of probes anechoic method

- Emulates the spatial channel
- Conceptually simple
- Requires new anechoic chamber design with probably 16 x 2 cross polarized probes – (a less flexible single cluster solution simplifies this)
- System calibration likely to be challenging to verify “quiet zone” performance
- Extending to 3D adds further cost and complexity

Example 8 antenna configuration
Two-channel anechoic method (Decomposition approach)

A test point is defined by:

- Signal from BS Emulator, e.g. frequency, MCS, data rate, MIMO mode, …
- Fading characteristics (if applicable) and antenna polarisations
- Antenna positions
- UE position elevation, azimuth

- Two independent line of sight signals rotate around the DUT at different angular separations
- The measurement then uses the quantities CQI, RI and PMI for a quick evaluation of the channel characteristics for each given test point
- Low cost – channel emulation not essential
- 3D capable
- Can’t emulate standard channel models
Reverberation chamber methods

- The basic power delay profile (PDP) is modified using absorbers
- Adding a fading emulator can further modify the PDP
- Chambers can be cascaded or nested to create more complex signals
- Cost effective
- Good for assessing self-blocking
- No direct control over spatial aspects – angle of arrival is random
Antenna pattern and two-stage method

Stage 1
Antenna pattern measurement

Stage 2
Throughput measurement

• Cost effective
• Uses standard SISO anechoic chamber for first stage only – then test on bench
• Precisely model any 2D or 3D channel using correlation or geometry methods
• Requires UE test mode for non-intrusive antenna pattern measurement
• Self-interference solution in development

Cost effective
Uses standard SISO anechoic chamber for first stage only – then test on bench
Precisely model any 2D or 3D channel using correlation or geometry methods
Requires UE test mode for non-intrusive antenna pattern measurement
Self-interference solution in development
What should we expect from MIMO in median conditions?

Variation due to fading and statistical interference

Approaching 2x gain at low correlation and high SNR

Variation due to antenna correlation

(Additional variation in the channel and frequency domain not shown)

In median conditions the capacity gain of MIMO is very small making it difficult to distinguish between good and bad performance

50% of microcell activity is centred on 5 dB SNR
Signaling and procedure for interference avoidance for in-device coexistence

Due to the growing complexity of multiband and multi-format radios it is no longer possible to guarantee a UE transmitter will not block one of its own receivers.

To help mitigate this potential a new in-device coexistence (IDC) indication message has been defined for the UE.

This message enables the UE to alert the network of an interference issue and provide information regarding the direction and nature of the interference, which may be identified in either the time or frequency domain.

Upon receipt of the IDC message the network will take appropriate steps to alleviate the problem by reallocating radio resources.
Coordinated Multi-Point – (CoMP)

By coordinating transmission and reception across geographically separated locations (points) it is possible to enhance network performance.

This includes coordinated scheduling and beamforming as well as joint reception.

Full performance requires baseband connection between points.
CoMP Scenarios
TR 36.819

Figure A.1-1: Scenario 1 - Homogeneous network with intra-site CoMP
Figure A.1-2: Scenario 2 - Homogeneous network with high Tx power RRHs
CoMP Scenarios
TR 36.819

Figure A.1-3- Reference CoMP Coordination Cell Layout for Scenario 2
In scenario 3 the transmission/reception points created by the RRHs have different cell identifications than does the macro cell and for scenario 4 the cell identifications are the same as that of the macro cell.
CoMP Downlink Categories

Joint Processing (JP)

• Joint Transmission (JT)
  – This is a form of spatial multiplexing that takes advantage of decorrelated transmission from more than one point within the cooperating set. Data to a UE is simultaneously transmitted from multiple points; e.g., to coherently or non-coherently improve the received signal quality or data throughput.

• Dynamic Point Selection (DPS) / muting
  – The UE data is available at all points in the cooperating set but is only transmitted from one point based on dynamic selection in time and frequency. This data includes dynamic cell selection (DCS).

• DPS may be combined with JT, in which case multiple points can be selected for data transmission in the time-frequency resource.
CoMP Downlink Categories

Coordinated scheduling and beamforming (CS/CB)

- Data for a UE is only available at and transmitted from one point in the CoMP cooperating set but user scheduling and beamforming decisions are made across all points in the cooperating set. Semi-static point selection (SSPS) is used to make the transmission decisions.

Dynamic or semi-static muting may be applied to both JP and CS/CB.

Hybrid JP and CS/CB

- Data for a UE may be available in a subset of points in the CoMP cooperating set for a time-frequency resource but user scheduling and beamforming decisions are made with coordination among points corresponding to the CoMP cooperating set. For example, some points in the cooperating set may transmit data to the target UE according to JP while other points in the cooperating set may perform CS/CB.
CoMP Uplink Categories

Joint reception (JR)

- The PUSCH transmitted by the UE is simultaneously (jointly) received at some or all of the points in the cooperating set. This simultaneous reception can be used with inter-point processing to improve the received signal quality.

Coordinated scheduling and beamforming (CS/CB)

- User scheduling and precoding selection decisions are made with coordination among points corresponding to the cooperating set. Data is intended for one point only.
CoMP Performance

Extensive simulation has been carried out for the four scenarios under different operating conditions.

Results are mixed and vary from negligible gain or small loss of performance up to around 80% gain for specific TDD cases where the eNB can exploit channel reciprocity for channel estimation purposes. Typical gains are in the 10% - 30% range.

The release 11 work item will focus on:

- Joint transmission
- DPS, including dynamic point blanking
- CS/CB, including dynamic point blanking.

Specifying performance requirements will be very difficult due to the interaction between UE reporting and network algorithms.
Public Safety Broadband High Power UE (HPUE) for Band 14, Region 2 (USA)

Most commercial networks target 95% population coverage but US public safety is targeting 99% - this last 4% requires a 60% larger coverage area

Solving this with a more dense network would be very expensive

The alternative is to specify a new 33 dBm power class UE

This can benefit from much higher performance vehicular mounted antennas

In general most RF requirements become 10 dB harder to meet

Existing SAW duplex filters will probably need to be replaced by much larger ceramic or cavity filters
Release 11: Stage 3 freeze Sept 2012

Other radio features

LTE RAN enhancements for diverse data applications
- Dealing with consequences of everything from IM to streaming video

Further Enhanced Inter-cell Interference Coordination (FeICIC)

Network energy saving for the E-UTRAN

Enhanced downlink control channel(s) for LTE-Advanced

Improved minimum performance requirements for E-UTRA: interference rejection
- Using more complex realistic interference models

Additional special subframe configuration for LTE TDD
- Optimizing use of special subframe for data transmission
In June 2012 3GPP RAN held a workshop on Release 12. Around 50 companies submitted their future vision. The submissions and report can be found at:


The broad areas for future evolution were identified as:

- Energy saving
- Cost efficiency
- Support for diverse application and traffic types
- Backhaul enhancements
The following proposals from the workshop were identified as most likely to be developed in Release 12:

- Interference coordination and management
- Dynamic TDD
- Enhanced discovery and mobility
- Frequency separation between macro and small cells, using higher frequency bands in small cells (e.g., 3.5 GHz)
- Inter-site carrier aggregation and macrocell-assisted small cells
- Wireless backhaul for small cells.
Other possible areas for study included:

- Support for diverse traffic types (control signaling reduction, etc.)
- Interworking with Wi-Fi
- Continuous enhancements for machine-type communications, SON, MDT, and advanced receivers
- Proximity services and device-to-device communications
- Further enhancements for HSPA including interworking with LTE.
Current Work Items

The Release 12 work items that have been defined so far are:

• New frequency bands
• 13 new carrier aggregation scenarios
  – Bringing the total to 31 for Rel-11 & 12 to date
• Carrier-based Het-Net ICIC for LTE
  – Extends existing co-channel ICIC to include network-based carrier selection
• New Carrier Type for LTE
  – The so-called “lean” carrier – not backwards compatible with Rel-8. Less control channel overhead, can be switched on and off based on load
• Further Downlink MIMO Enhancement for LTE-Advanced
• Further enhancements for H(e)NB mobility (part 3)
  – Inter H(eNB) and H(e)NB to macro
Release 12: New Frequency Bands

Three new FDD frequency bands will be defined:

- Downlink 1670 MHz–1675 MHz, uplink 1646.7 MHz–1651.7 MHz
  - for ITU Region 2 (US)
- Downlink 461MHz–468 MHz, uplink 451–458 MHz
  - for Brazil
- Downlink 2350–2360 MHz, uplink 2305–2315 MHz
  - US Wireless Communications Service (WCS) band

There is also a study item for:

- Uplink 1980–2010 MHz and downlink 2170 MHz–2200 MHz.
  - This is currently widely allocated for satellite communications but terrestrial use now being considered, particularly for ITU Region 3.
  - The potential for 110 MHz pairing with band 1 is also being considered.
Release 12: New Intra-band CA scenarios

Five new intra-band scenarios will be defined:

• Band 1 (contiguous)
• Band 3 (non-contiguous), carried over from Release 11
• Band 3 (contiguous)
• Band 4 (non-contiguous)
• Band 25 (non-contiguous).
Release 12: New Inter-band CA scenarios

An additional eight inter-band scenarios will be defined

- Bands 3 and 5 with two uplink carriers
- Bands 2 and 4
- Bands 3 and 26
- Bands 3 and 28
- Bands 3 and 19
- Bands 38 and 39
- Bands 23 and 29*
- Bands 1 and 8.

Band 29 is being specified as part of Release11. It is a downlink-only band from 717 to 728 MHz and to be used only for the purposes of carrier aggregation with other bands.
Further Downlink MIMO Enhancement for LTE-Advanced

The scope of the work item will cover the following topics:

- Four transmit antenna PMI feedback codebook enhancements to provide finer spatial domain granularity and to support different antenna configurations for macro and small cells, especially cross-polarized antennas, both closely and widely spaced, and non-co-located antennas with power imbalance.
- New CSI feedback mode providing subband CQI and subband PMI.
- Finer frequency-domain granularity.
- Enhanced control of the reported rank and corresponding assumptions for CQI/PMI derivation to improve support for MU-MIMO.
Release 12: Current Study Items

Passive Intermodulation Handling for UTRA and LTE Base Stations

- Consequence of high power multicarrier transmission

Mobile Relaying

- High speed train scenario – relay on board with group handover

Positioning based on RF pattern matching

RF and EMC Requirements for Active Antenna Array System (AAS)

Scenarios and Requirements of LTE Small Cell Enhancements

LTE-Direct
Active Antenna Systems (AAS)

The exploitation of multiple antennas in base stations has been ongoing for years but has never been standardized

- This is changing since radio link assumptions of simple three-sectored cells no longer represents network reality
- The challenge is how to specify eNB performance in the spatial domain

General AAS Radio Architecture (TR 37.840 Figure 4.2-1)
AAS: Visualization of 8 antenna beamforming using multi-channel phase coherent analysis

IQ Constellations of layer 0 and 1

Detected Resource Allocations

UE-specific RS Weights

Layer 0

Layer 1

Cell-specific RS Weights & Impairments

Antenna Group 0

UE-specific & Common Broadcast Antenna Beam patterns

Antenna Group 1

EVM Metrics

Layer 0 OFDM Meas

Layer 1 OFDM Meas

Layer 0 UE-specific RS Weights

Layer 1 UE-specific RS Weights

Layer 0 Antenna Group 0 Beam Pattern

Layer 1 Antenna Group 0 Beam Pattern

Layer 0 Antenna Group 1 Beam Pattern

Layer 1 Antenna Group 1 Beam Pattern

Layer 0 Detected Allocations Time

Layer 0 UE-specific RS Weights & Impairments

Layer 1 UE-specific RS Weights & Impairments

Layer 0 UE-specific RS Weights & Impairments

Layer 1 UE-specific RS Weights & Impairments

Layer 0 UE-specific RS Weights & Impairments

Layer 1 UE-specific RS Weights & Impairments

Layer 0 UE-specific RS Weights & Impairments

Layer 1 UE-specific RS Weights & Impairments

Layer 0 UE-specific RS Weights & Impairments

Layer 1 UE-specific RS Weights & Impairments
Spatial ACLR measurements for 4 Tx eNB

A: Spectrogram for TX1
B: ACLR for TX2
C: ACLR for TX3
D: ACLR for TX4
E: ACLR @ -30°
F: ACLR @ 0°
G: ACLR @ 30°

Noise at channel centre is due to omnidirectional control channels.
Scenarios and Requirements of LTE Small Cell Enhancements

For a considerable time the focus of RAN standardization activities has been on wider bandwidths and higher spectral efficiency. Both lead to higher system performance.

However, the potential for the third dimension of frequency reuse as a means of improving system performance:

- Many RAN features already exist to facilitate spectral reuse such as femtocells and Heterogeneous networks but the propagation, mobility, interference, and backhaul needs of small cells are very different to the assumptions that were used to define the original heterogeneous model.
- This study item will take a strategic look at how the RAN may be improved to maximize the benefits of small cells.
For both the past and the future, the growth of wireless capacity is dominated by the number of cells (small cell spectrum reuse).
The final Release 12 study item of interest represent a fundamentally new concept in device communications

The scope is in two main phases:

- Device to device discovery
- Device to device (D2D) communication

The application for the first phase is to enable devices to “express” their identity to other UE in the local area

- This can be used for a variety of purposes including location based advertising

The second phase of D2D has all kinds of uses including public safety involving communication in the absence of a network
Device discovery can be enabled by the eNB scheduling periods in the uplink when different UE can broadcast their identity

- The mechanics of this are not complex but the interference potential to the network including new device to device co-existence issues needs to be thoroughly studied
- The UE would need to be enabled with an uplink receiver which creates in-device co-existence issues with the UE transmitter
- Security and privacy aspects are also of significance

For D2D in the absence of a network there would need to be a complete rethink about synchronization

- This is not likely to be tackled within the Release 12 timeframe
Agilent LTE Design and Test Portfolio

- **SystemVue (BB)**
  - ADS/GG (RF/A)
  - Baseband Generator and Channel Emulator

- **RF Module Development**
  - RF Proto → RF Chip/module
  - BTS and Mobile BB Chipset Development
    - L1/PHY
    - FPGA and ASIC
  - Protocol Development
    - L2/L3

- **RF and BB Design Integration**
  - L1/PHY
  - DigRF v4
  - BTS or Mobile

- **System Design Validation**
  - System Level RF Testing

- **Pre-Conformance**

- **Conformance**

- **Manufacturing**

- **Network Deployment**

- **Scopes and Logic Analyzers**
  - RDX for DigRF v4

- **Signal Analyzers with LTE Measurement Apps**

- **Battery drain characterization**

- **89600 VSA/WLA**
  - For Signal Analyzers, Scopes, LA, SystemVue and ADS

- **Baseband Generator and Channel Emulator**

- **RF & Protocol test platforms**
  - LTE signalling conformance test

- **Manufacturing test platforms**
  - N5972A IFT Software
  - Systems for RF and Protocol Conformance

- **RF Handheld Analyzers**
  - N7109A Multi-Channel Signal Analyzer

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3GPP Standards Update: Release 11, 12 and Beyond
Moray Rumney
25th October 2012
First to Market Solutions for LTE-Advanced

SystemVue
- Baseband library
- DPD for 4G
- MIMO Channel

Signal Generators
PXB Channel Emulator

Signal Studio

RF Module Development
- RF Proto
- RF Chip/module

Design Simulation

BTS and Mobile
BB Chipset Development
L1/PHY
- FPGA and ASIC

RF and BB Design Integration
L1/PHY
- DigRF v4
- BTS or Mobile

Protocol Development
L2/L3

System Design Validation
System Level RF Testing

Pre-Conformance

Conformance

Manufacturing

Network Deployment

Greater insight. Greater confidence. Accelerate next-generation wireless Now in LTE-Advanced

3GPP Standards Update: Release 11, 12 and Beyond
Moray Rumney
25th October 2012
Summary

The evolution of LTE since Release 8 continues apace

Many of the most important innovations are recognizing the importance of network aspects towards improving end user performance rather than the traditional focus on spectral efficiency and peak channel bandwidth

- Heterogeneous networks
- Frequency reuse
- Mobility – heterogeneous carrier aggregation
- Inter-RAT aggregation including Wi-Fi
Questions