Regulatory and Standards Aspects:

Future 3GPP RAN standardization activities for LTE

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Outline

- What is “ETSI” and “3GPP”?
- How does standardization work in 3GPP?
- What are “releases” and what is “Long Term Evolution (LTE)”?
- What is the difference between LTE and LTE-Advanced?
- REL-12 schedule and RAN workshop
- Requirements identified for RAN in REL-12
- Potential technologies identified for RAN in REL-12
- Next steps for RAN in REL-12
- Summary

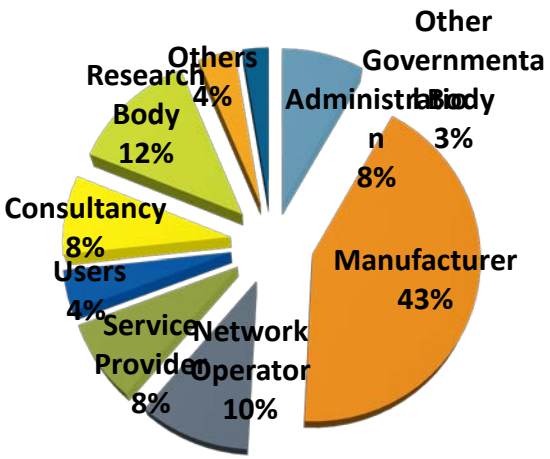
ETSI

- European Telecommunications Standards Institute (www.etsi.org)
- independent, not-for-profit organization, created in 1988
- ~120 staff + contractors, based in Sophia Antipolis, France
- about 750 member companies (>600 from Europe) from more than 60 countries

- pre-standardization/standardization activities in areas common to telecommunications, information technology, sound/television broadcasting
  => “world class standards for ICT”
  e.g. DECT, TETRA, GSM, SIM card, DAB/DVB
- European Standards Organization producing Global Standards
- Service Providing Organization: services such as interoperability testing, forum management etc.

- about 80 partnerships with International Standards Developers, EU Agencies /int. Organisations, Regional Organisations, Fora/Consortia, Trade/Industry Associations, Research
- one main partnership project of ETSI is 3GPP which is supported by ETSI’s Mobile Competence Centre (MCC)

ETSI Full and Associate Members:



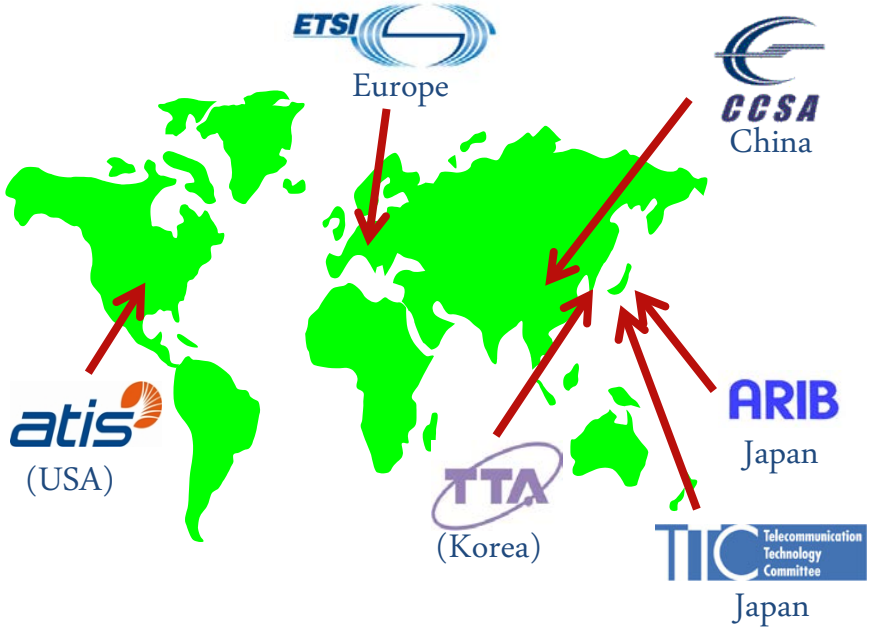
ETSI clusters:

3GPP

- 3rd Generation Partnership Project (www.3gpp.org), created in Dec.1998
- unites 6 Organizational Partners (OP): regional standards organizations with their member companies
- almost 400 member companies:
  Region 1: Europe, Middle East, Africa ~42%
  Region 2: Americas ~19%
  Region 3: Asia ~39%

- 13 Market Representation Partners representing the broader industry

- 3GPP started with specification of the 3G Mobile System (UMTS/HSPA)
- includes further GSM evolution (GPRS, EDGE)
- 3GPP specifications are transposed by OPs into regional/national standards
- efficiency/success of 3G partnership
  => 3GPP continued 4G specification (LTE/LTE-A)



3GPP structure

- 4 Technical Specification Groups (TSG) which control their Working Groups (WGs)
- TSGs meet 4 times/year, WGs in 1 or 2 times (for 1 week) between TSGs
- WGs have up to 350 participants & handle up to 1300 Technical Documents per week
- results are TSG approved Change Requests (CR) to modify Technical Specifications

Project Co-ordination Group (PCG)

TSG GERAN
GSM EDGE Radio Access Network

- **GERAN WG1** Radio Aspects
- **GERAN WG2** Protocol Aspects
- **GERAN WG3** Terminal Testing

TSG RAN
Radio Access Network

- **RAN WG1** Radio Layer 1 spec
- **RAN WG2** Radio Layer 2 spec Radio Layer 3 RR spec
- **RAN WG3** Iub spec, Iur spec, Iu spec UTRAN O&M requirements
- **RAN WG4** Radio Performance Protocol aspects
- **RAN WG5** Mobile Terminal Conformance Testing

TSG SA
Service & Systems Aspects

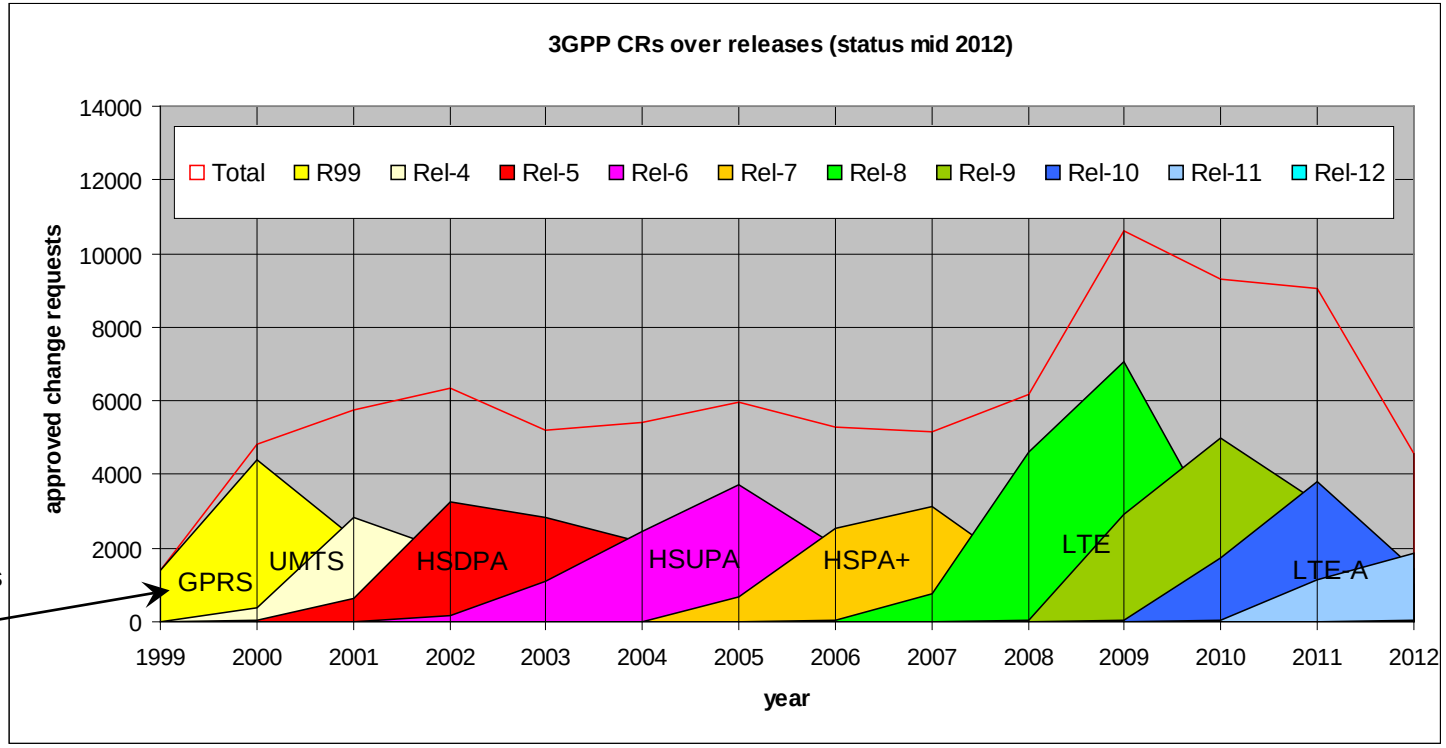
- **SA WG1** Services
- **SA WG2** Architecture
- **SA WG3** Security
- **SA WG4** Codec
- **SA WG5** Telecom Management

TSG CT
Core Network & Terminals

- **CT WG1** MM/CC/SM (Iu)
- **CT WG3** Interworking with external networks
- **CT WG4** MAP/GTP/BCH/SS
- **CT WG6** Smart Card Application Aspects

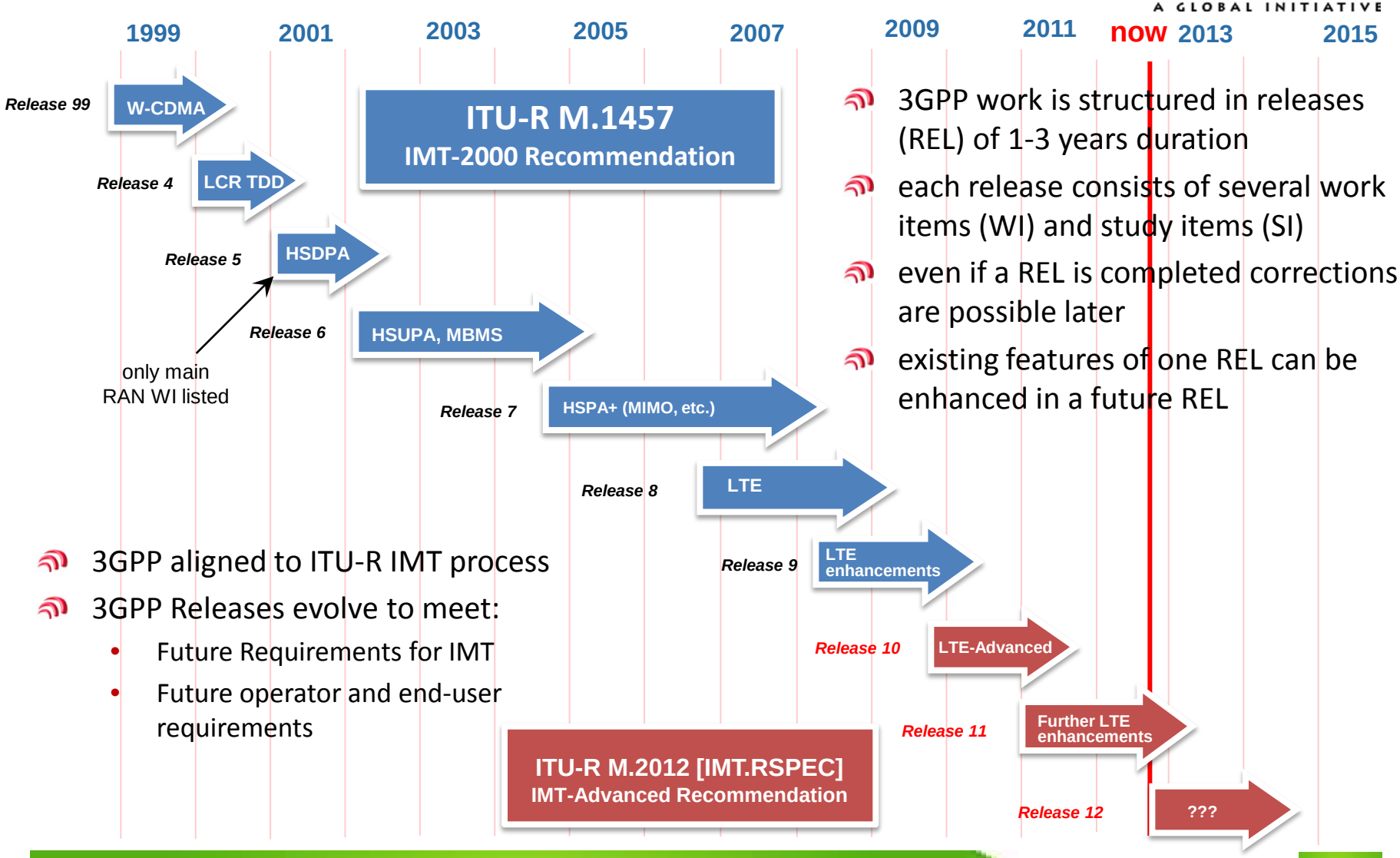
Change Requests

- several 1000 change requests (CR) approved every year in 3GPP
- a CR is dedicated to 1 or more work items (WI)
- latest release is active but still maintenance to former releases



Note: Only main radio features listed here but CR numbers includes also core network and overall system

Release schedule & RAN features

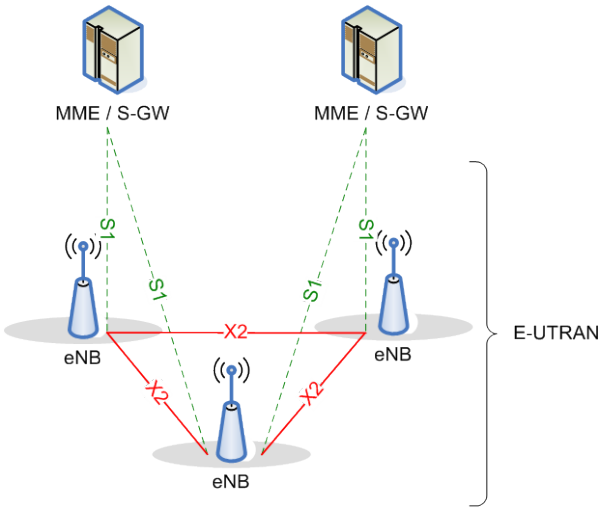


- 3GPP work is structured in releases (REL) of 1-3 years duration
- each release consists of several work items (WI) and study items (SI)
- even if a REL is completed corrections are possible later
- existing features of one REL can be enhanced in a future REL

- 3GPP aligned to ITU-R IMT process
- 3GPP Releases evolve to meet:
  - Future Requirements for IMT
  - Future operator and end-user requirements

LTE Release 8 Key Features

- LTE = Long Term Evolution: based on a different radio access technology than UMTS but developed in the same forum => Compatibility & inter-working with UMTS
- High spectral efficiency
  - OFDMA in Downlink: robust against multipath interference
  - DFT-Spread-OFDM ("Single-Carrier FDMA") in Uplink: low Peak to Average Power Ratio
  - Multi-antenna application
- Very low latency for setup and handover
- Support of variable bandwidth: 1.4, 3, 5, 10, 15 and 20 MHz
- Simple protocol architecture: Shared channel based, PS mode only with VoIP capability
- Simple Architecture: eNodeB as the only E-UTRAN node
  - Smaller number of RAN interfaces
    - eNodeB ↔ MME/SAE-Gateway (S1)
    - eNodeB ↔ eNodeB (X2)
- FDD and TDD within a single radio access technology
- Inter-working with other systems, e.g. cdma2000
- Support of Self-Optimizing Network (SON):
  Self configuration, Basic self-optimization
- Home eNode B (HeNB): closed access mode only
- Reduced deployment/operational cost (CAPEX and OPEX)

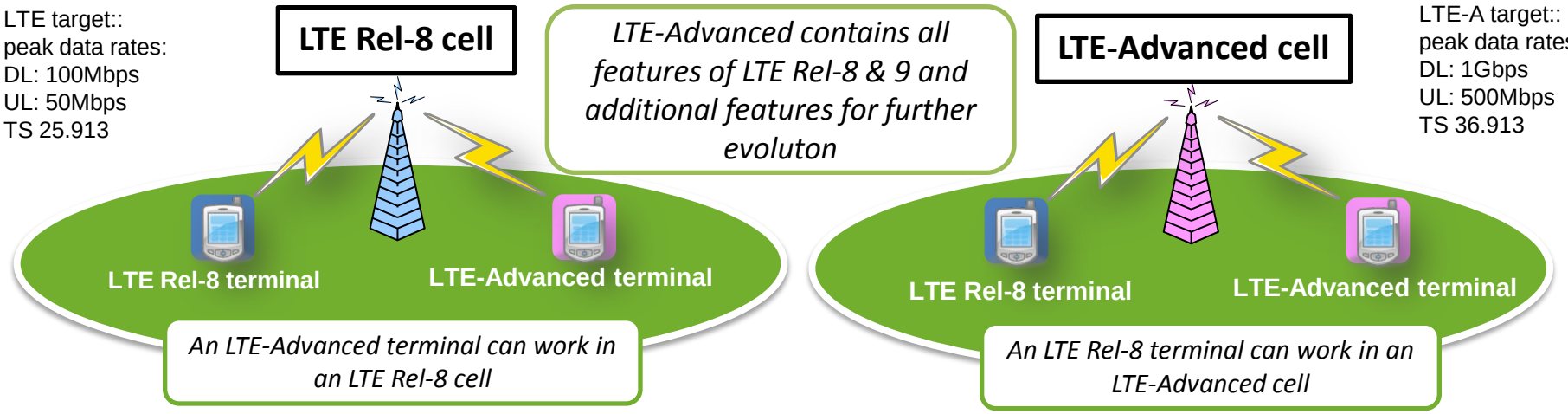


source: TS 36.300

From LTE to LTE-Advanced

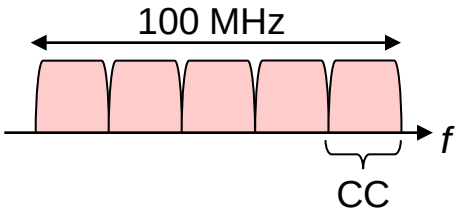
- REL-9: mainly addition of LCS (Location service) & MBMS (Multimedia Broadcast Multicast Service) & enhancement of others (e.g. SON, HeNB)
- Main motivation to introduce LTE-A in REL-10:
  - IMT-Advanced standardization process in ITU-R for 4G
  - Additional IMT spectrum band identified in WRC07
- LTE-Advanced (REL-10/11 ...) is an evolution of LTE (REL-8/9), i.e. LTE-Advanced is backwards compatible with LTE

  ➔ Smooth and flexible system migration from Rel-8 LTE to LTE-Advanced

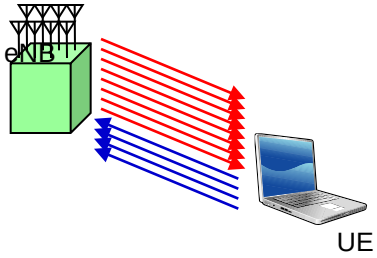


Main Features in LTE-A Release 10

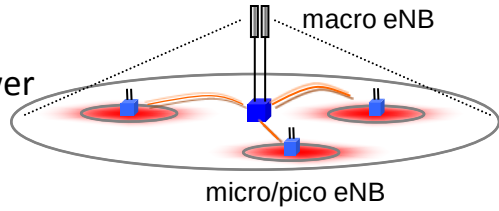
- Support of wider bandwidth (Carrier Aggregation)
  - Use of multiple component carriers (CC) to extend bandwidth up to 100 MHz
  - Common L1 parameters between component carrier and LTE Rel-8 carrier
  - ➔ Improvement of peak data rate, backward compatibility with LTE Rel-8



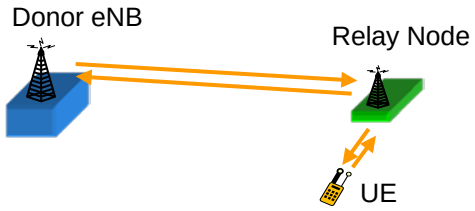
- Advanced MIMO techniques
  - Extension to up to 8-layer transmission in downlink (REL-8: 4-layer in downlink)
  - Introduction of single-user MIMO with up to 4-layer transmission in uplink
  - Enhancements of multi-user MIMO
  - ➔ Improvement of peak data rate and capacity



- Heterogeneous network and eICIC (enhanced Inter-Cell Interference Coordination)
  - Interference coordination for overlay deployment of cells with different Tx power
  - ➔ Improvement of cell-edge throughput and coverage

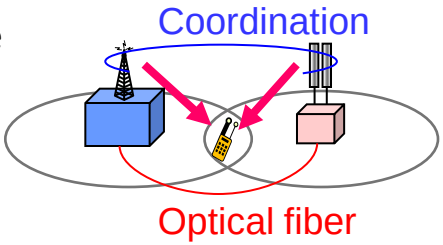


- Relay
  - Relay Node supports radio backhaul and creates a separate cell and appears as Rel. 8 LTE eNB to Rel. 8 LTE UEs
  - ➔ Improvement of coverage and flexibility of service area extension



- Minimization of Drive Tests
  - replacing drive tests for network optimization by collected UE measurements
  - ➔ Reduced network planning/optimization costs

LTE/LTE-A REL-11 features



- Coordinated Multi-Point Operation (DL/UL) (CoMP):
  - cooperative MIMO of multiple cells to improve spectral efficiency, esp. at cell edge
- Enhanced physical downlink control channel (E-PDCCH): new Ctrl channel with higher capacity
- Further enhancements for
  - Minimization of Drive Tests (MDT): QoS measurements (throughput, data volume)
  - Self Optimizing Networks (SON): inter RAT Mobility Robustness Optimisation (MRO)
  - Carrier Aggregation (CA): multiple timing advance in UL, UL/DL config. in inter-band CA TDD
  - Machine-Type Communications (MTC): EAB mechanism against overload due to MTC
  - Multimedia Broadcast Multicast Service (MBMS): Service continuity in mobility case
  - Network Energy Saving for E-UTRAN: savings for interworking with UTRAN/GERAN
  - Inter-cell interference coordination (ICIC): assistance to UE for CRS interference reduction
  - Location Services (LCS): Network-based positioning (U-TDOA)
  - Home eNode B (HeNB): mobility enhancements, X2 Gateway
- RAN Enhancements for Diverse Data Applications (eDDA):
  - Power Preference Indicator (PPI): informs NW of mobile's power saving preference
- Interference avoidance for in-device coexistence (IDC):
  - FDM/DRX ideas to improved coexistence of LTE, WiFi, Bluetooth transceivers, GNSS receivers in UE
- High Power (+33dBm) vehicular UE for 700MHz band for America for Public Safety
- Additional special subframe configuration for LTE TDD: for TD-SCDMA interworking
- In addition: larger number of spectrum related work items: new bands/band combinations

Generations of Mobile Communication Systems

- **1G**: analogue systems from 1980s (e.g. NMT, AMPS, TACS, C-Netz)
- **2G**: first digital systems of 1990s (e.g. GSM, CDMAone, PDC, D-AMPS)
- **3G**: IMT-2000 family defined by ITU-R (e.g. UMTS, CDMA2000)
- **4G**: fulfilling requirements of IMT-Advanced defined by ITU-R (e.g. LTE-A, WiMAX)
- **5G**: ?
  - too early to be a topic in standardization, further 4G enhancements expected before
  - driven by requirements from customers & network operators
  - restricted by spectrum limitations
  - often influenced by new technologies/applications

Release 12

- **3GPP time plan for REL-12** (decided in TSG #56 in June 2012):
  - start: Sep.2012
  - stage 1 (requirements) freeze: March 2013
  - stage 2 (functional description) freeze: Dec. 2013
  - stage 3 (all details) freeze: June 2014

- **RAN Workshop on Rel-12 & onwards**
  held in June 11-12, 2012 in Ljubljana, Slovenia:
  - about 250 participants
  - 42 presentations (http://www.3gpp.org/3GPP-News)
    from leading network operators and manufacturers
  - scope:
    - Requirements
    - Potential technologies
    - Technology roadmap for Releases 12, 13 and afterwards

  Note: Workshop covered also UMTS but only LTE is considered here.

Note: TSG SA plans a similar REL-12 workshop on SA topics in Dec.12

Requirements for RAN in REL-12

- Common requirements identified by the workshop:

- Capacity increase to cope with traffic explosion
- Energy saving
- Cost efficiency
- Support for diverse application and traffic types
- Higher user experience/data rate
- Backhaul enhancement

2010 => 2020: 500x more & more smart phones & tablets; most data traffic indoor

network operation / expanding costs, eNB/UE power consumption

new apps, MTC, device to device, interworking, public safety

can become bottleneck with larger data traffic increase

user expects higher data rate for similar costs

Potential Technologies identified by REL-12 Workshop (1/3)

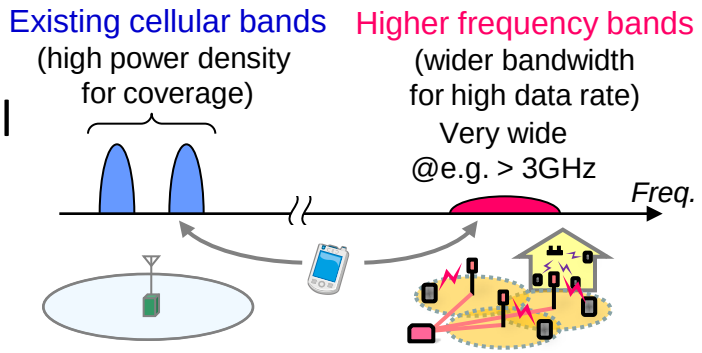
- A great majority showed interest in Small Cell Enhancement for LTE.

Technologies proposed by many members:

- Interference coordination / management
- Dynamic TDD

dynamic UL/DL timeslot allocation TR 36.828

- Enhanced discovery / mobility
- Frequency separation between macro and small cells with higher frequency band, e.g. 3.5 GHz band, for the small cells

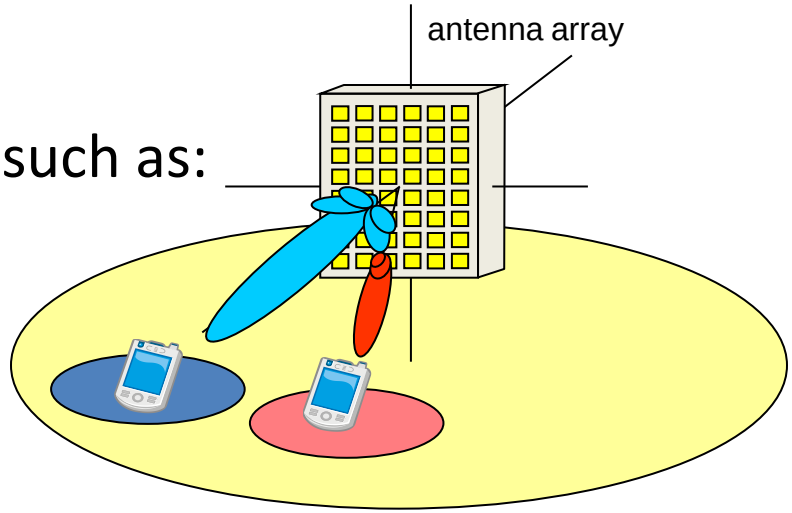


- Inter site CA / macro cell assisted small cells
- Wireless backhaul for small cell

allows flexible data rate increase via carrier aggregation avoiding ctrl signalling in small cells

Potential Technologies identified by REL-12 Workshop (2/3)

- Very clear interest related to LTE Multi-Antenna/site technologies such as:
  - 3D MIMO/beamforming to allow beam control in both horizontal and vertical directions
  - Further CoMP/MIMO enhancements



- New procedures and functionalities for LTE to support diverse traffic types proposed by many members:
  - Control signaling reduction, etc.

Potential Technologies identified by REL-12 Workshop (2/3)

- Good interest in:
  - Interworking with WiFi
  - Continuous enhancements for:
    - Machine type communications (MTC)
    - Self-organizing network (SON)
    - Minimization of drive test (MDT)
    - Advanced receiver
  - Device to Device (D2D)
  - Further enhancements for HSPA including interworking with LTE

e.g. for offloading to Wifi

so far just overload handling; signalling overhead & UE power consumption to be studied in future

cost reduction when introducing larger number of small cells

more traffic => more interference => interference cancellation

important for public safety (communication without NW); proximity detection for social networks TR22.803

REL-12 progress after the workshop

- RAN #57 Chicago, USA in Sep. 2012
  - approved:
    - Study on Scenarios and Requirements for LTE Small Cell Enhancements
      - target Dec.2012, rapporteur: China Mobile Communication Corp.
      - progressing mainly via email discussions on RAN email reflector
        - » first round about considered scenarios already completed
        - » second round about requirements starting
      - results will be captured in TR 36.932
    - WI Further Downlink MIMO Enhancement for LTE-Advanced
    - WI New Carrier Type for LTE
    - WI Further enhancements for H(e)NB mobility-Part 3
  - further 25 WIs/SIs were postponed till Dec.2012 (next slide)
- prediction for RAN #58 Barcelona, Spain in Dec. 2012
  - majority of REL-12 SIs / WIs will be introduced there

So far postponed REL-12 LTE WIs/SIs

Small Cell Enhancements:

Study on Small Cell Enhancements for E-UTRA and E-UTRAN – Physical-layer Aspects	SI
Study on Small Cell Enhancements for E-UTRA and E-UTRAN – Higher-layer Aspects	SI

MIMO/CoMP Enhancements:

Enhanced CoMP for LTE	WI
Study on Full Dimension MIMO for LTE	SI
Study on 3D-channel model for Elevation Beamforming and Massive MIMO studies for LTE	SI
Study on LTE Downlink Enhancements for Elevation Beamforming	SI

Further enhancements of WIs of previous REL:

Further LTE (UL) Carrier Aggregation Enhancements	WI
RAN aspects of Machine-Type and other mobile data applications Communications enhancements	WI
Enhancement II of Minimization of Drive Tests for E-UTRAN	WI
Study item on LTE extensions to Minimization of Drive Tests	SI
Further Enhancements for Diverse Data Applications for LTE	WI
eMBMS enhancements for LTE	WI
Study Item on next-generation SON for UTRA and LTE	SI

Interworking with HSPA/WLAN:

RAN aspects for LIPA Mobility and SIPTO at the Local Network	WI
Study for LTE and HSDPA Carrier Aggregation	SI
Study Item Proposal on WLAN/3GPP Radio Interworking	SI
Study on RAN Enhancements for UMTS/HSPA and LTE Interworking	SI

Other WIs/SIs:

LTE Coverage Enhancements	WI
Hetnet Mobility Enhancements for LTE	WI
Further Enhancements to LTE TDD for DL-UL Interference Management and Traffic Adaptation	WI
Study on Enhanced Interference Suppression for LTE	SI
Study on Further Enhanced Receivers for LTE UEs	SI
Study on LTE device to device proximity discovery	SI
Study on Push to talk over Cellular for LTE	SI
Study on Small Data Transmission Optimization for High Mobility in LTE	SI

Small Cell Enhancement: Considered Scenarios so far

- Note: This SI is not focussing on Home eNB enhancements; CSG/hybrid CSG is excluded.
- power: pico/femto eNBs with less power than macro eNB
- deployment: hotspot indoor/outdoor with low to medium (3-30km/h) UE speed, sparse/dense deployment, with/without macro overlay; priority on synchronized small cells but unsynchronized case not excluded
- backhaul: ideal (fiber, LOS microwave) & non-ideal (xDSL, NLOS microwave, relay etc.)
- traffic: very fluctuating user distribution expected in small cells
- spectrum scenarios:
  - macro on band X and Y, small cell on band X
  - macro on band Y and small cell on X
  - macro & small cell on band X (co-channel): lower priority case
  - in general: macro on lower and small cell on higher band (e.g. 3,5GHz band); max. 100MHz aggregated bandwidth in REL-12; band-independent solutions
- backward compatibility: Pre-REL-12 UEs should be able to operate in small cells otherwise features need to justify non-backward compatibility by sufficient gains

Summary

- 3GPP:
  - specified LTE in Rel-8 & LTE Advanced in Rel-10
  - will finish Rel-11 enhancements in the next 4-5 months
  - RAN workshop held in June 12 about Rel-12 and beyond,
    most Rel-12 RAN work items to be started in Dec.12: LTE-A enhancements
- envisaged REL-12 topics (to be completed by June 14):
  - main topic: small cell enhancements to cope with data traffic explosion
  - further multi-antenna enhancements (3D MIMO, CoMP enhancements)
  - D2D/public safety, offloading via Wifi, MTC will bring new aspects
  - further enhancements of existing features (e.g. SON, MDT, CA)
- future:
  - further 4G enhancements expected before 5G (if 5G then led via ITU)
  - driven by requirements from customers & network operators
  - often triggered by availability of new spectrum and influenced by new technologies/applications and costs

Thank You !

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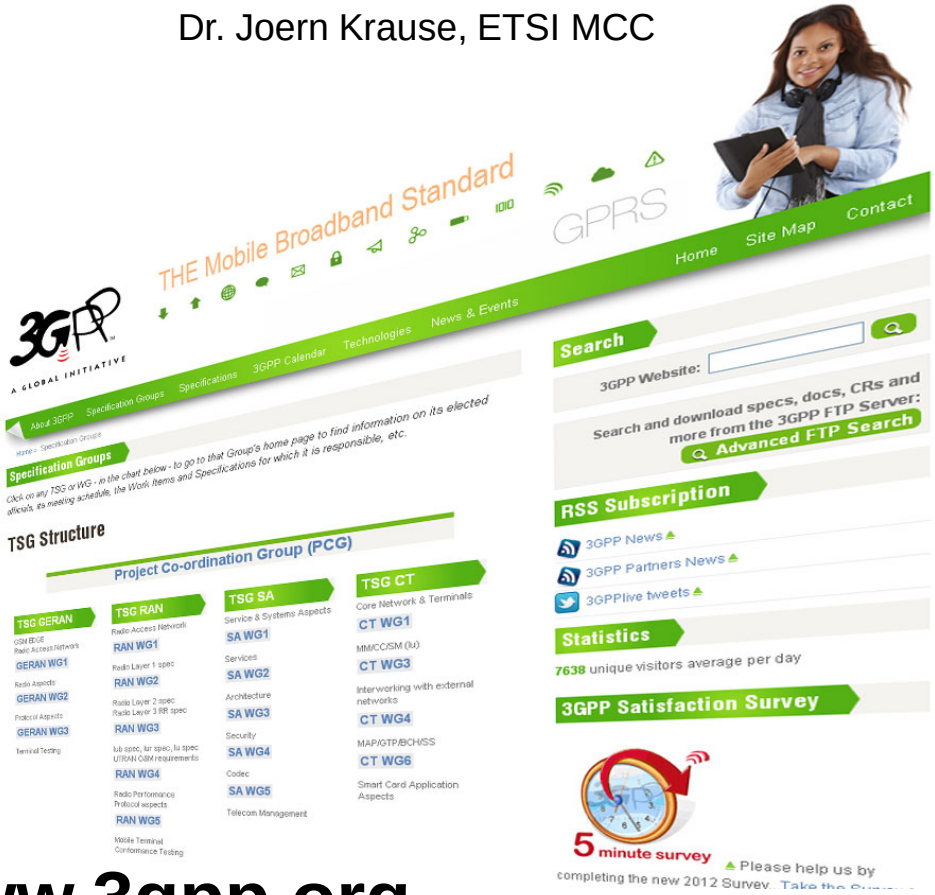
More Information about 3GPP:



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