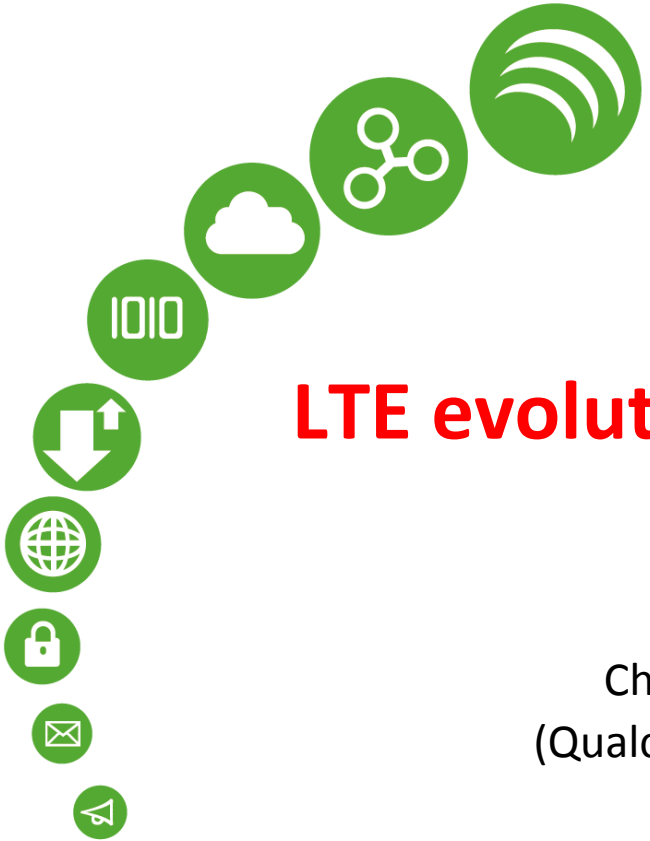

LTE evolution and road to 5G

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Introduction

- 3GPP continues to expand the LTE platform to new services, while improving its efficiency to meet the increasing mobile broadband demand

- At the same time 3GPP has started to work on the standardization of next generation cellular technology, aka 5G, to address the expanded connectivity needs of the future

- This presentation discusses the main features being considered for the evolution of LTE in Release 13, and 3GPP plans for 5G

LTE Release 13: addressing the mobile broadband demand

Offload to unlicensed spectrum

- Licensed spectrum remains 3GPP operators' top priority to deliver advanced services and user experience
- Opportunistic use of unlicensed spectrum will be an important complement to meet the growing traffic demand
- Moving forward 3GPP operators will have two options to offload traffic to unlicensed spectrum:

1. Wi-Fi (via **LTE/Wi-Fi interworking**)
   - Framework developed since the first release of LTE, with tighter and tighter forms of interworking added in subsequent releases
   - In Release 13 this includes aggregation of LTE and Wi-Fi radio links

2. **Licensed Assisted Access** to unlicensed spectrum, aka **LAA**
   - Modified LTE radio to operate in unlicensed spectrum (5GHz)
     - Includes features such as Listen-Before-Talk (LBT), Discontinuous TX, Dynamic Frequency Selection, Carrier selection, Transmit Power Control…
     - Goal is to achieve fair coexistence between LTE and Wi-Fi as well as between LTE operators
   - License-assisted access operation
     - Aggregation of a primary cell and secondary cell
     - The primary operates in licensed spectrum to deliver critical information and guaranteed Quality of Service
     - The secondary cell operates in unlicensed spectrum to opportunistically boost data rate
   - In Release 13 the focus is on downlink operation. Uplink support likely to follow in Release 14

Others

- LTE Carrier Aggregation enhancements
  - Aggregate up to 32 Component Carriers
  - Useful in particular for LAA where large blocks of spectrum are available
- Elevation Beamforming / Full-Dimension MIMO
  - Support of two-dimensional antenna arrays to exploit the vertical dimension for beamforming and MIMO
  - Support of high-order MIMO systems with up to 16 antenna ports at the eNB
- Study on Low latency LTE*
  - Study of techniques that can significantly reduce the latency of the LTE air interface, including solutions for fast uplink access, shortening of the Time-Transmission Interval (TTI) and reduced processing time
  - The goal is to improve performance and user experience of existing services as well as to enable new delay critical services
- Study of downlink multi-user transmission using superposition coding*

** Note: normative work (if any) for this item is targeted for Release 14*

LTE Rel-13: enablers of new services and connectivity paradigms

Supporting the Internet of Things

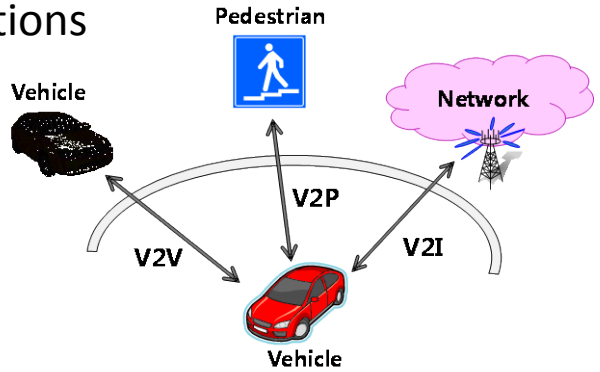
- Further LTE enhancements for Machine Type Communications
  - Building on the work that started in Rel-12 (UE Cat 0, New power saving state for MO-data)
  - 1.4MHz UE narrowband operation (within wider LTE carrier bandwidth deployments)
  - Enhanced coverage (15dB better link budget over existing LTE)
  - Further power optimization (focusing on MT-data)

- Narrowband IoT (NB-IoT)
  - New radio optimized for the low-end of the IoT market
  - Focus is on very low datarate (~100s bps) applications with limited mobility support
  - 180 kHz UE operation
    - Can be deployed “in-band”, utilizing resource blocks within a normal LTE carrier,
    - Or “standalone” in dedicated spectrum. Particularly suitable for the re-farming of GSM carriers
  - Extended coverage (20dB better link budget over existing GPRS)
  - Very low module cost & power consumption

Device-to-Device operation

- Enhancements to the LTE D2D framework (ProSe) standardized in Rel-12
  - To support more advanced proximity services for Public Safety (PS) and consumer usecases
    - Discovery: Restricted Discovery (social-type model); Multicarrier operation, concurrent inter-band D2D and CA combinations
    - Group Communication (PS only): UE-to-Network relays
  - Work to address the necessary requirements for Mission Critical Push-To-Talk (MCPTT)
    - MCPTT: ongoing project to complete support of PS services in the 3GPP platform (based on the requirements coming from various administrations and industry stakeholders)

- Study to expand the LTE D2D framework to V2X applications
  - Initial priority on V2V safety applications
  - Target for initial specification is Release 14



Others

- Indoor positioning
  - Driven by the FCC request to improve positioning accuracy for emergency calls
  - Includes a variety of features considered for standardization
    - Enhancements to OTDOA and E-CID based positioning
    - WiFi-/BT-/Barometric-Sensor based positioning
    - Terrestrial Beacon Systems based positioning

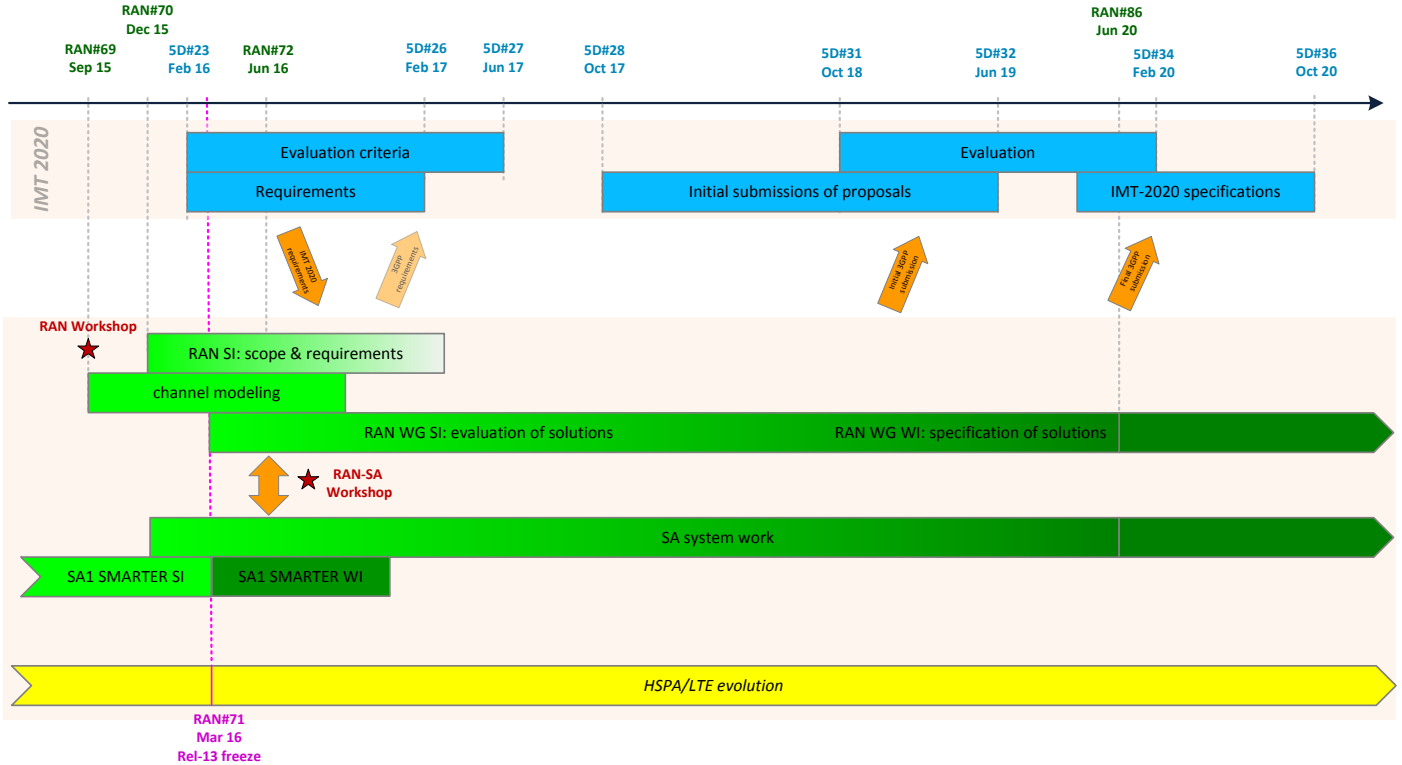
- Single Cell – Point To Multipoint (SC-PTM)
  - Specify support of SC-PTM operation based on the LTE downlink shared channel
  - eMBMS was developed to efficiently deliver multicast services over areas typically spanning multiple cells. But there could be a number of applications that may benefit from efficient multicast service support over a single cell

Getting ready to 5G

Introduction

- 3GPP started to make plans for the standardization of next generation cellular technology, aka 5G
- The objective is to address the expanded connectivity needs of next decade
- A tentative timeline for 5G was endorsed by 3GPP, including plans for a technology submission to the IMT 2020 process in ITU-R
- A 3GPP Workshop took place on September 17-18 in Phoenix (Arizona), US, to discuss vision and planning for the 5G standardization work in 3GPP
  - Emerging consensus & next steps are discussed in the following slides

5G timeline in 3GPP



Usecases & Services

- Three emerging high level usecases for Next Generation Radio Technology (also from IMT 2020 discussion):
  1. Enhanced Mobile Broadband
  2. Massive Machine Type Communications
  3. Ultra-reliable and Low Latency Communications

- The common understanding is that the Next Generation Radio Technology should be able to support a variety of new services
  - Automotive, Health, Energy, Manufacturing …
  - Some of these new services are being described by SA1 in the SMARTER project

New radio

- Emerging consensus that there will be a new, non-backward compatible, radio as part of Next Generation Radio Technology
  - Strong LTE evolution continued in parallel

- The requirements and scope of the new radio will be established by RAN in the Study Item starting in December
  - Working Groups will then proceed with the evaluation of technology solutions in the Study Item starting in March

Phasing

- Emerging consensus that there should be **two phases** for the normative work
  - Phase 1 to be completed by H2 2018 to address a more urgent subset of the commercial needs (to be agreed)
  - Phase 2 to be completed by Dec 2019 for the IMT 2020 submission and to address all identified usecases & requirements

- The above implies the following, tentative, release timing

Note: dates above refer to "stage-3 functional freeze" of specs. Official 3GPP release freeze is typically one quarter after that.

- It also requires that the new radio's design should be **forward compatible** to optimally support the usecase that will be added in the second phase

Prioritization

- Phasing of the normative work will lead to some form of prioritization for phase I

- However at this stage there is lack of consensus on
  - Whether prioritization should already occur in the study phase
  - Whether there should be prioritization of frequency ranges
  - Which usecases should be prioritized

- Ideally the above should be resolved by March 2016 to plan the technology Study Item accordingly

Operation above 6 GHz

- Next generation radio technology will include operation above 6 GHz
- A new study was recently approved on channel modeling for spectrum above 6 GHz
  - The goal is to have sufficient progress by the time RAN Working Groups start to evaluate the new radio technologies
- Next steps for the channel modelling study (RP-151606):
  - In Q4 2015, RAN will identify status & expectations on high frequencies (e.g. spectrum allocation, scenarios of interest, measurements, etc)
  - From Q1 2016, RAN1 will develop a channel model(s) for frequencies up to 100 GHz
- Various channel modeling efforts are ongoing in the industry and RAN may leverage some of this work

Service & system aspects

- Next generation 3GPP platform needs to enable a broad range of new services and connectivity paradigms (besides addressing the future mobile broadband demand)

- 3GPP has started an effort to articulate the service and connectivity vision for 5G by defining the service requirements of next generation platform
  - A study on next generation network architecture is likely to start in December

- 3GPP may then need to design a new system architecture for 5G based on two potential streams of requirements
  1. Radio requirements established by 3GPP RAN
  2. Service/system requirements established by 3GPP SA1/SA2

- A 3GPP workshop on system architecture aspects it is anticipated for H2 2016

Thanks