LTE evolution and 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 defined for the evolution of LTE, and the initial plans for 5G

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LTE evolution

Focus on areas significantly expanding LTE platform capability and opportunities

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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**)

  2. **Licensed Assisted Access** to unlicensed spectrum, aka **LAA**

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LTE/Wi-Fi interworking

- Framework developed since the first release of LTE
  - With tighter and tighter forms of interworking added in subsequent releases

- To cater to operators' demand, in Release-13 3GPP defined a number of new interworking features:
  - LTE-WLAN Aggregation (**LWA**)
    - Allows aggregating LTE and WLAN downlink radio links
    - LWA is controlled by LTE eNB, based on UE measurement reporting; no interaction with LTE Core Network
    - Key drivers: performance, mobility, eliminating need for WLAN-specific Core Network nodes
  - LTE WLAN Radio Level Integration with IPsec Tunnel (**LWIP**)
    - Tight radio-level interworking allowing an LTE eNB to quickly toggle between the two radio links
    - LWIP is controlled by LTE eNB, based on UE measurement reporting; WLAN is hidden from CN (except for authentication)
    - UE uses WLAN via IPsec tunnel between eNB and UE
    - Key drivers: fast time to market, use of legacy WLAN infrastructure

- For Release 14 3GPP is working on
  - Enhanced LWA (eLWA): uplink support, enhanced mobility, optimizations for high data rate 802.11 techs
  - Enhanced LWIP (eLWIP): flow control, measurement support over Xw

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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…
  - Key objective: fair coexistence between LTE and Wi-Fi as well as between LTE operators
- License-Assisted Access operation, aggregating
  - A primary cell operating in licensed spectrum to deliver critical information and guaranteed Quality of Service
  - A secondary cell operating in unlicensed spectrum to opportunistically boost datarates
- In Release 13 3GPP defined downlink LAA operation
  - Feature design is essentially frozen, where only essential corrections are allowed (based on consensus)
  - 3GPP is now defining a set of tests to check LAA coexistence performance
- LAA Uplink support likely to follow in Release 14
- Extensive and fruitful dialog with other industry stakeholders, including IEEE and WFA

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Cellular IoT

- In Release-13 3GPP made a major effort to address the IoT market by defining:

1. **eMTC** Further LTE enhancements for Machine Type Communications
2. **NB-IOT** New radio added to the LTE platform optimized for the low end of the market
3. **EC-GSM-IoT** EGPRS enhancements which make GSM/EDGE markets prepared for IoT

- In Release-14 3GPP is enhancing the above technologies
  - Positioning enhancements [*eMTC, NB-IOT, EC-GSM-IOT*]
  - Multicast, mobility enhancements for [*eMTC, NB-IOT*]
  - New power classes, access/paging enhancements [*NB-IOT*]
  - Higher data rates and VoLTE support for [*eMTC*]

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Rel-13 eMTC, NB-IOT and EC-GSM-IoT

	eMTC (LTE Cat M1)	NB-IOT	EC-GSM-IoT
Deployment	In-band LTE	In-band & Guard-band LTE, standalone	In-band GSM
Coverage*	155.7 dB	164 dB for standalone, FFS others	164 dB, with 33dBm power class 154 dB, with 23dBm power class
Downlink	OFDMA, 15 KHz tone spacing, Turbo Code, 16 QAM, 1 Rx	OFDMA, 15 KHz tone spacing, TBCC, 1 Rx	TDMA/FDMA, GMSK and 8PSK (optional), 1 Rx
Uplink	SC-FDMA, 15 KHz tone spacing Turbo code, 16 QAM	Single tone, 15 KHz and 3.75 KHz spacing SC-FDMA, 15 KHz tone spacing, Turbo code	TDMA/FDMA, GMSK and 8PSK (optional)
Bandwidth	1.08 MHz	180 KHz	200kHz per channel. Typical system bandwidth of 2.4MHz. 600 kHz considered feasible for static, small data applications
Peak rate (DL/UL)	1 Mbps for DL and UL	DL: ~60 kbps UL: ~50kpbs (multi-tone), ~20 kbps (single tone)	For DL and UL (using 4 timeslots): ~70 kbps (GMSK), ~240kbps (8PSK)
Duplexing	FD & HD (type B), FDD & TDD	HD (type B), FDD	HD, FDD
Power saving	PSM, ext. I-DRX, C-DRX	PSM, ext. I-DRX, C-DRX	PSM, ext. I-DRX
Power class	23 dBm, 20 dBm	23 dBm, others TBD	33 dBm, 23 dBm

** In terms of MCL target. Targets for different technologies are based on somewhat different link budget assumptions (see TR 36.888/45.820 for more information).*

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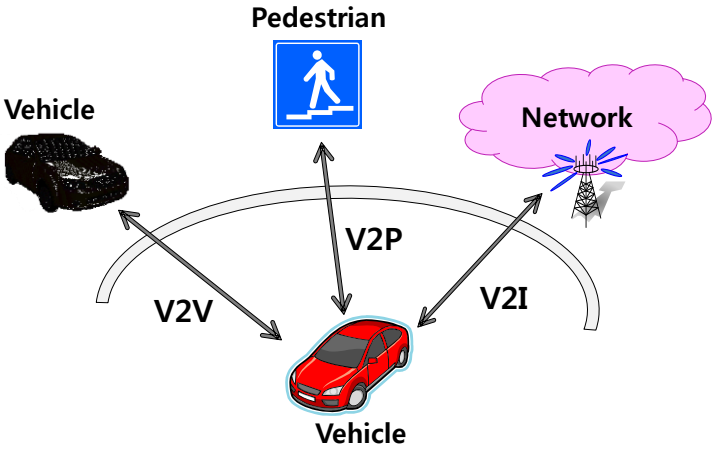
LTE-based V2X

- In Release 14 3GPP is expanding the LTE platform to support V2X applications
- V2X will include two complementary transmission modes
  - Direct communication:
    - Building upon LTE D2D with enhancements for high speeds, high density, improved synchronization and low latency
  - Network communication:
    - Enabling broadcast of messages from a V2X server to vehicles and beyond; Vehicles can send messages to server via unicast
- The initial features needed to support V2V safety applications were finalized in September 2016
- The broader V2X framework will be finalized in March 2017



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Low latency LTE

- 3GPP is working on a major enhancement to the LTE air interface to shorten latency over-the-air
- The goal is to improve performance and user experience of existing services as well as to enable new delay critical services
- Target enhancements:
  - Shortened processing time to be completed by March 2017
  - Shortened TTI operation (2-symbol, 4-symbol, and 1-slot) to be completed by June 2017

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Others: a lot more going on…

- Work Items
  - RP-160680, Downlink Multiuser Superposition Transmission for LTE
  - RP-160623, Enhancements on FD-MIMO for LTE
  - RP-160675, eMBMS enhancements in LTE
  - RP-160664, Uplink Capacity Enhancements for LTE
  - RP-160676, SRS Carrier Based Switching for LTE
  - RP-160667, L2 latency reduction techniques for LTE
  - RP-160540, Signalling reduction to enable light connection for LTE
  - RP-160636, Mobility enhancement in LTE
  - RP-160538, Further Indoor Positioning enhancements for UTRA and LTE WI
  - RP-161856, Voice and Video enhancement for LTE
  - RP-161896, Flexible eNB-ID and Cell-ID in E-UTRAN

- Study Items
  - RP-160665, Further enhancements to CoMP operation
  - RP-160633, Study on Context Aware Service Delivery in RAN
  - RP-160571, Study on HSPA and LTE Joint Operation
  - RP-161181, SON for eCoMP for LTE

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5G

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3GPP submission to IMT-2020

- 3GPP submission to IMT 2020 (aka 5G) will include
  - “New Radio of 5G”, aka NR
  - LTE

- It is for later discussion whether this will be done in a single or two RITs (formal submissions) and how the evaluation process will be organized
  - This will also depend on the criteria defined by WP5D for IMT-2020 technologies

- NR shall eventually address all identified requirements and use cases

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Timeline & phasing

- There will be **two phases** for the normative work
  - The first release of the 5G specification will be completed by Sep. 2018/Release-15, addressing the more urgent subset of the commercial needs
  - The second release of the 5G specification to be completed by Mar. 2020/Release-16, for the IMT 2020 submission and to address all identified use cases & requirements

- With the following, tentative, release timing

Note: dates above refer to official 3GPP release freeze (ANS.1 freeze)

- Key requirement: NR design should be **forward compatible** at its core so that features can be added in later releases in an optimal way

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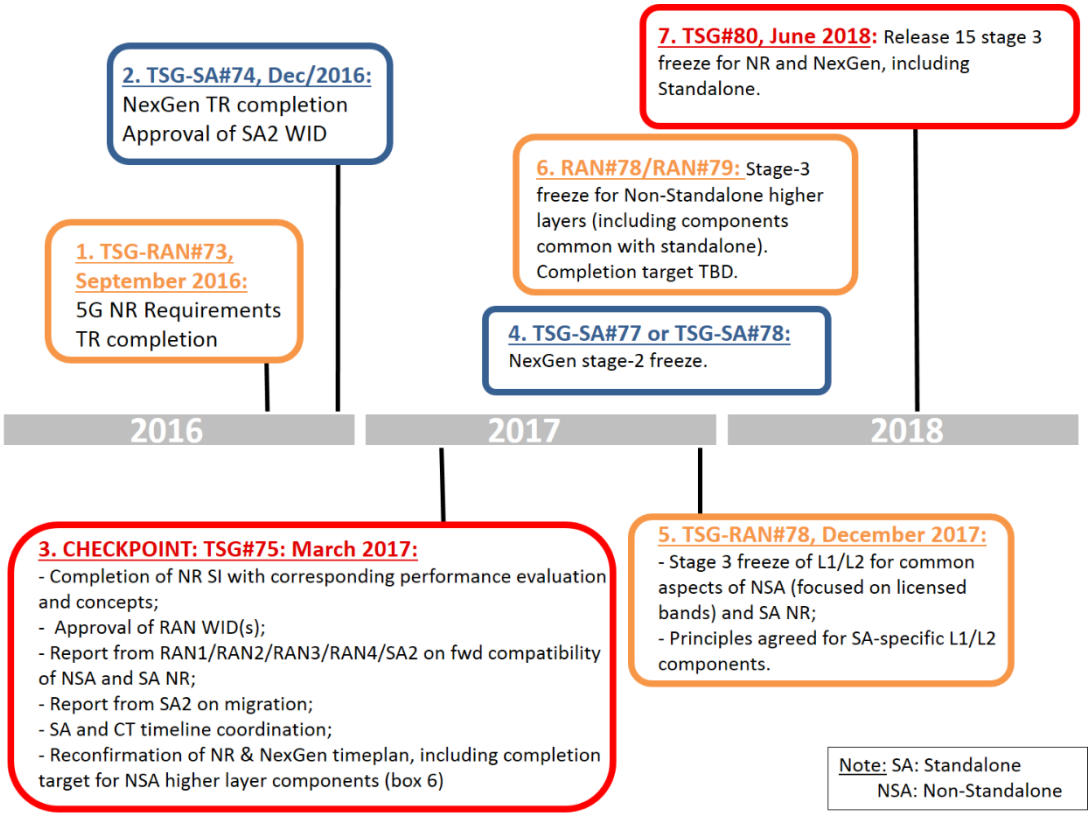
Release-15 workplan



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Release-15 targets

- Two main deployment scenarios:
  - Non-Standalone (NSA) NR deployment
  - Standalone (SA) NR deployment

  NSA NR in this context implies using LTE as control plane anchor. SA NR implies full control plane capability for NR

- Different architecture options being evaluated
  - Decisions as to which option will be standardized will be taken in Dec. 2016 or Mar. 2017

- Use cases
  - Enhanced Mobile Broadband
  - Some Low Latency and High Reliability capabilities

- Frequency ranges below 6GHz and above 6GHz

- **Forward compatibility** between scenarios

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5G studies in TSG RAN (Radio)

- Scenarios and Requirements for Next Generation Access Technologies
  - Target completion on Dec. 2016
  - Latest progress in TR 38. 913
- Channel model for frequency spectrum above 6 GHz
  - *Completed on Jun. 2016*
  - New channel model described in TR 38.900
- New Radio Access Technology
  - Target completion on Jun. 2017
  - Working Groups have started evaluating technology solutions for NR

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5G studies in TSG SA (System Aspects)

- SMARTER (New Services and Markets Technology Enabler)
  - Study concluded on Jun. 2016
  - Service requirements defined in:
    - TR 22.861 for the Massive Internet of Things use case
    - TR 22.862 for the Critical Communications use case
    - TR 22.863 for the Enhanced Mobile Broadband use case
    - TR 22.864 for the Network Operation uses case
  - Normative work targeting completion in Mar. 2017

- Architecture and Security for Next Generation System
  - Target completion on Sep. 2016
  - Latest progress in TR 23.799 (*draft*)

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Thanks

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