5G NR standards in 3GPP

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NOKIA
Outline

- 3GPP – facts and figures
- What is 5G
  - Timeline and key technology components
- Where is 5G
  - Expansion to new spectrum bands
- Where will 5G take us
- Challenges
- Summary
3GPP facts and figures
3GPP mission

- 3GPP will expand the LTE platform to improve its efficiency to meet the mobile broadband demand.

- 3GPP has an aggressive timeline for the standardization of 5G NR with the goal to address the expanded connectivity needs of the future.
514 Companies from 45 Countries

50,000 delegate days per year

40,000 meeting documents per year

1,200 specifications per Release

10,000 change requests (CRs) per year

New Release every ~18 months
What is 5G
Overall timeline as agreed in March/2017

How can this aggressive timeline be met?
Stepwise approach

**Non-standalone NR**
- Uses LTE core and LTE radio anchor with NR in DC configuration
- Mobile BroadBand capacity boost

**Standalone NR**
- Uses 5G core and NR anchor
- 5G overlay
- Expansion of the wireless ecosystem
What is 5G NR?

- Operation from **low to very high** bands: 0.4 – 100Ghz
  - Including standalone operation in unlicensed bands
- Set of **different numerologies** for optimal operation in different frequency ranges
- Native **forward compatibility** mechanisms
- **Ultra wide** bandwidth
  - Up to 100MHz in <6GHz
  - Up to 400MHz in >6GHz
- **New channel coding**
  - LDPC for data channel, Polar coding for control channel
- Native support for **Ultra Reliable Low Latency**
- **Flexible and modular** RAN architecture: split fronthaul, split C-U plane
- Native end-to-end support for **Network Slicing**
Latest news...

3GPP RAN plenary in late September re-enforced the timeline commitment

Focus for the “early drop” (December/2017)
- Focus on LTE-anchored LTE-NR dual connectivity
- Several functions moved beyond December/2017, e.g.: FDD half duplexing, power control for NR-NR DC, transmit diversity, etc...

Focus for the full Rel-15 (June/2018): standalone NR with new 5G Core
- Focus on NR control plane functionality (RRC, etc...)

Explicit signaling to be developed for “problematic” LTE-NR band combinations

NR UE categories: no explicit signaling, “just” a marketing concept

Uplink sharing between LTE and NR
- UL sharing from the NW perspective to be supported in early drop
- UL sharing from the UE perspective to be supported in June/2018 release

ITU submission (IMT2020) – important from the perspective of WRC-19 spectrum debates
Where is 5G – the spectrum expansion
Expansion to high bands

5G phase-1
0.4GHz – ~50 GHz

5G phase-2 onwards
Potentially ~50 GHz – 100 GHz (TBD)
The global landscape

Low Band
- 1 GHz
  - EU
  - USA
  - Korea
  - Japan
  - China
  - India

Mid Band
- 3 GHz
- 4 GHz
- 5 GHz
  - 3.1–4.2 GHz
  - 4.4–4.99 GHz

High Band
- 20 GHz
- 30 GHz
- 100 GHz
  - 26/28 GHz
  - 38/42 GHz

600/700 MHz

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Where will 5G take us?
The 4th industrial revolution

From Industrie 1.0 to Industrie 4.0

First Industrial Revolution
through the introduction of mechanical production facilities with the help of water and steam power
- First mechanical loom, 1784

Second Industrial Revolution
through the introduction of a division of labor and mass production with the help of electrical energy
- First assembly line, Cincinnati slaughterhouses, 1870

Third Industrial Revolution
through the use of electronic and IT systems that further automate production
- First programmable logic controller (PLC), Modicon 084, 1969

Fourth Industrial Revolution
through the use of cyber-physical systems

Source: DBK (2011)
Autonomous driving

- V2V (Vehicle to Vehicle)
- V2P (Vehicle to Pedestrian)
- V2I (Vehicle to Infrastructure)

Vehicle
Pedestrian
Network
Some technology studies already ongoing
- Operation in unlicensed bands, Non-orthogonal Access, Non-terrestrial access, etc...

Next wave of technology study approvals expected in June/2018
- eV2X, MIMO enhancements, Positioning, High-speed UE support, >52.6GHz support,...
Key challenges
Key challenges

- Number of spectrum bands and band combinations growing exponentially
  - Global fragmentation more substantial than ever

- Interoperation and co-existence of LTE and NR
  - Challenges in RF design
  - Challenges in evolution path

- Balancing demands from wireless carriers and vertical industry players
  - Realizing the full 5G vision goes way beyond current carrier footprint

- Managing accelerated innovation vs deployment realities
Summary
Summary

Accelerated timeline – full commitment from the industry

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- 5G initial study
- 5G Rel-15 Non-standalone
- 5G Rel-15 full (incl. Standalone)
- ASN.1
- 5G evolution studies for Rel-16
- 5G Rel-16

The realization of the full 5G vision will take several Releases over the next decade

- Success of the full vision needs wide-scale buy-in from vertical industries

Spectrum will continue to be an (even more) critical resource
Thank you!

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