5G standards towards 2020

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Chairman of 3GPP RAN
Outline

3GPP – an ever expanding global effort

Release 15 – the first 5G release

Release 16 – expanding the horizon of cellular

Summary
3GPP – ever expanding global effort
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, with the goal to address the expanded connectivity needs of the future.
3GPP facts and figures

- 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?

<table>
<thead>
<tr>
<th>Feature</th>
<th>3G</th>
<th>4G</th>
<th>5G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downlink waveform</td>
<td>CDMA</td>
<td>OFDM</td>
<td>OFDM, SCFDMA</td>
</tr>
<tr>
<td>Uplink waveform</td>
<td>CDMA</td>
<td>SCFDMA</td>
<td>OFDMA, SCFDMA</td>
</tr>
<tr>
<td>Channel coding</td>
<td>Turbo</td>
<td>Turbo</td>
<td>LDPC (data) / Polar (L1 contr.)</td>
</tr>
<tr>
<td>Beamforming</td>
<td>No</td>
<td>Only data</td>
<td>Full support</td>
</tr>
<tr>
<td>Spectrum</td>
<td>0.8 – 2.1 GHz</td>
<td>0.4 – 6 GHz</td>
<td>0.4 – 90 GHz</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>5 MHz</td>
<td>1.4 – 20 MHz</td>
<td>Up to 100 MHz (400MHz for &gt;6GHz)</td>
</tr>
<tr>
<td>Network slicing</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>QoS</td>
<td>Bearer based</td>
<td>Bearer based</td>
<td>Flow based</td>
</tr>
<tr>
<td>Small packet support</td>
<td>No</td>
<td>No</td>
<td>Connectionless</td>
</tr>
<tr>
<td>In-built cloud support</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Release 15 – the first 5G standards
Accelerated timeline – can it be met?

**Non-standalone 5G**
- Uses LTE core and LTE radio anchor with 5G radio in DC configuration
- Mobile BroadBand capacity boost

**Standalone 5G**
- Uses 5G core and 5G radio anchor
- 5G overlay
- Unlocking the true potential of 5G

<table>
<thead>
<tr>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q4</td>
<td>Q1</td>
<td>Q2</td>
</tr>
<tr>
<td>Q3</td>
<td>Q4</td>
<td>Q1</td>
</tr>
<tr>
<td>Q2</td>
<td>Q3</td>
<td>Q2</td>
</tr>
<tr>
<td>Q3</td>
<td>Q4</td>
<td>Q3</td>
</tr>
<tr>
<td>Q4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- 5G initial study
- 5G phase-1 Non-standalone
- 5G phase-1 full (incl. Standalone)
- 5G evolution studies for phase-2
- 5G phase-2
Focused functionality

Focus on eMBB and Ultra Reliable Low Latency (URLLC)
- Basic physical layer capabilities for URLLC

Variety of spectrum bands and band combinations (next slide)
- Ever growing number of bands and combinations
- Low band for coverage, Mid band for capacity, High band for ultra-densification

Uplink sharing between LTE and 5G

<table>
<thead>
<tr>
<th>Frequency ranges for NR</th>
<th>Operators whose request is included in the frequency range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1710-1785MHz (UL)/3.3-4.2 GHz (DL&amp;UL) NOTE1</td>
<td>China Telecom, China Unicom, CMCC, Deutsche Telekom</td>
</tr>
<tr>
<td>832-862MHz (UL)/3.3-4.2 GHz (DL&amp;UL) NOTE1</td>
<td>Orange, Telefonica, Etisalat, Deutsche Telekom</td>
</tr>
<tr>
<td>880-915MHz (UL)/3.3-4.2 GHz (DL&amp;UL) NOTE1</td>
<td>CMCC</td>
</tr>
<tr>
<td>703-748MHz (UL)/3.3-4.2 GHz (DL&amp;UL) NOTE1</td>
<td>Orange, Telefonica, Etisalat</td>
</tr>
</tbody>
</table>
## Variety of 5G bands

<table>
<thead>
<tr>
<th>Frequency range/LTE band</th>
<th>Operators whose request is included in the frequency range</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3-4.2 GHz</td>
<td>DOCOMO, KDDI, SBM, CMCC, China Unicom, China Telecom, KT, SK Telecom, LG Uplus, Etisalat, Orange, Telecom Italia, British Telecom, Deutsche Telekom</td>
</tr>
<tr>
<td>4.4-4.99 GHz</td>
<td>DOCOMO, KDDI, SBM, CMCC, China Unicom, China Telecom,</td>
</tr>
<tr>
<td>24.25-29.5 GHz</td>
<td>DOCOMO, KDDI, SBM, CMCC, KT, SK Telecom, LG Uplus, Etisalat, Orange, Verizon, T-mobile, Telecom Italia, British Telecom, Deutsche Telekom</td>
</tr>
<tr>
<td>31.8-33.4GHz</td>
<td>Orange, Telecom Italia, British Telecom</td>
</tr>
<tr>
<td>37-40 GHz</td>
<td>AT&amp;T, Verizon, T-mobile</td>
</tr>
<tr>
<td>1.427-1.518G</td>
<td>Etisalat</td>
</tr>
<tr>
<td>1710-1785MHz/1805-1880MHz (Band 3)</td>
<td>CMCC, China Telecom</td>
</tr>
<tr>
<td>2500-2570MHz/2620-2690MHz (Band 7)</td>
<td>CHTTL, British Telecom</td>
</tr>
<tr>
<td>880-915MHz/925-960MHz (Band 8)</td>
<td>CMCC</td>
</tr>
<tr>
<td>832–862MHz/791–821MHz (Band 20)</td>
<td>Orange</td>
</tr>
<tr>
<td>703-748MHz/758–803MHz (Band 28)</td>
<td>Orange, Swisscom, Telecom Italia, Telefonica, Vodafone</td>
</tr>
<tr>
<td>2496-2690MHz (Band 41)</td>
<td>Sprint, China Telecom, C-Spire, China Unicom</td>
</tr>
<tr>
<td>1710-1780MHz/2110-2200MHz (band 66)</td>
<td>T-mobile, Dish</td>
</tr>
<tr>
<td>1920-1980MHz/2110-2170MHz (Band 1)</td>
<td>China Unicom, China Telecom, KT</td>
</tr>
<tr>
<td>1695-1710 MHz/1990-2020 MHz (Band 70)</td>
<td>Dish</td>
</tr>
<tr>
<td>663-698 MHz/617-652 MHz (Band 71)</td>
<td>T-mobile, Dish, DT</td>
</tr>
</tbody>
</table>
5G spectrum arrangement

High Bands ("mm-Wave")
- 26GHz, 28GHz, 37GHz, 70GHz
- Airports, Stadiums, Malls,...
- Extreme Bandwidths
- Supports full extreme mobile broadband

Mid Range
- 3.5 GHz layer ("C-Band")
- Dense urban coverage
- Large Bandwidth
- Reusing sites for 1800/2100/2600 MHz

Low Bands
- 700MHz, 600MHz
- Massive IoT and ultra reliable low latency
- Reusing existing sites for 800/900 MHz

Example 5G coverage

Role of licencing schemes
Modular RAN architecture

- Split Fronthaul with a standardized interface between Central Unit (CU) and Distributed Unit (DU)

- Split Control Plan and User Plane to allow separate dimensioning

→ **Added flexibility for operators**

→ **Add Slicing** - ready to expand
Release 16 – expanding the reach of cellular
Targeting full IMT2020 capability

- System level URLLC support, including critical IoT
- Expanding beyond 42.5 GHz bands and into unlicensed bands
- Alternative non-orthogonal access schemes
- Vehicular and Satellite
Internet of Things (IoT)

3GPP is making continuous effort to address the IoT market:

1. **LTE-M**  
   LTE-based Machine Type Communications (1MHz bandwidth)  
   Higher data rates, VoLTE support, mobility, multicast, positioning

2. **NB-IOT**  
   NarrowBand-IoT radio added to the LTE platform  
   Optimized for Low Power Wide Area  
   Several power classes, positioning support

5G will address the following segments

- Critical MTC with Ultra Reliability and Low Latency
- Massive MTC – is expected later
3GPP is expanding the LTE platform to support V2X apps

V2X will include two complementary transmission modes
- Direct communication
  - High density, synchronization and low latency
- Network communication
  - Broadcast from a V2X server to vehicles and beyond

5G to address potential add-on capabilities
- Low latency and high reliability
- High data rate
- Spectrum above 6 GHz (e.g., 63-64GHz allocated for ITS in Europe), efficient V2X carrier aggregation
- Advanced positioning
Unlicensed spectrum

Licensed spectrum remains 3GPP operators’ top priority to deliver advanced services and user experience.

Use of unlicensed spectrum will be an important complement to meet the growing traffic demand.

Currently operators have 2 options to offload traffic to unlicensed spectrum:

1. Wi-Fi (via LTE/Wi-Fi interworking)
2. Unlicensed LTE Access aggregation with a Licensed LTE carrier (LAA)

5G will add the capability to support Standalone Unlicensed Access

- Expected in Release-16 (target Dec/2019)
3GPP will address enhancing 5G for non-terrestrial networks

- Extending the reach to areas that cannot be optimally covered by terrestrial 5G network.
- 5G service reliability and resiliency for public safety systems
- Connectivity on board airborne vehicles (e.g. air flight passengers, UASs/drones, etc.), other moving platforms (vessels, trains)
3GPP will deliver 5G standards as planned...  
... but needs industry consensus on the exact functionality...

5G’s true success will depend on successfully expanding the wireless ecosystem

Architecture expansion is a key vehicle
Thank You!

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