5G Standards Overview & 3GPP Tech Evolution Trends

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• Advisory Board Member UK5G
• Board Director CW

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Agenda

1. **5G Standardisation Overview** (who, when, what)

2. **3GPP Technology Evolution Trend**
   - 3GPP Overall Timeline & Release Features
   - 3GPP Technology Roadmap

   2.1 IoT in 5G
   - NB-IoT, LTE-M Evolution into 5G
   - NR-IIoT: New Radio Industrial IoT

   2.2 5G for Automotive
   - LTE-V2X Background
   - Cellular V2X (C-V2X)

   2.3 Positioning in 5G
   - 3GPP Technology Roadmap for cellular positioning
   - 5G NR Positioning Trend

3. **Take-away**
## Core Technologies

<table>
<thead>
<tr>
<th>P</th>
<th>C</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Positioning</strong></td>
<td><strong>Cellular Communication</strong></td>
<td><strong>Short Range Communication</strong></td>
</tr>
<tr>
<td>Integrated Circuits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modules</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Services and Solutions
- CellLocate® (modem based positioning)
- AssistNow™ (world wide GNSS assistance service)
- GNSS Correction Data (for high precision)*
- FOTA (Firmware over the air)
- Lifetime Security

*through Sapcorda, a JV with industry partners

### Core Markets Served
- Automotive
- Industrial
- Consumer

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approved Rel-15 Standalone 5G NR radio specs
5G Standardisation Overview
Who defines it and how?

ITU-R

IMT-2020
‘5G’ encompasses a range of features
• Ultra low latency
• High reliability
• Advanced antenna tech
• mmWave
• Massive IoT
• Spectrum flexibility

SDOs
(Standard development organizations)

3GPP

ETSI
IEEE
Etc.

Usage Scenarios

eMBB
Enhanced Mobile Broadband

uRLLC
Ultra Reliable Low Latency Communication

mMTC
Massive Machine-Type Communication

5G NR (new radio)

NSA (non-standalone)

SA (stand-alone)

‘5G LTE’
5G Timeline

5G = 5G NR + LTE Evolution

LTE EVO.
- 4G LTE-Advanced Pro

5G NR
- 5G Phase 1
  - NSA + SA
- 5G Phase 2
  - mMTC + URLLC

WRC
- Vision
- Requirements
- IMT-2020 Global Specifications

Now

- WRC’15
- Q1
- 2015
- Rel-13
- 2016
- Rel-14
- 2017
- Rel-15
- 2018
- Rel-16
- 2019
- Rel-17
- 2020
- Q4

WRC’19

LTE Evolution in the 5G Era

5G Proposals

Eva

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# Overview of LTE Categories (From Cat-NB1 to Cat-19)

<table>
<thead>
<tr>
<th></th>
<th>Downlink</th>
<th></th>
<th>Uplink</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max DL Mbps</td>
<td>Max DL BW (MHz)</td>
<td>Max DL MIMO</td>
<td>Max DL QAM</td>
</tr>
<tr>
<td>Max UL Mbps</td>
<td>Max UL BW (MHz)</td>
<td>Max UL MIMO</td>
<td>Max UL QAM</td>
<td></td>
</tr>
<tr>
<td>DL Cat</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NB1</td>
<td>0.027</td>
<td>0.2</td>
<td>-</td>
<td>4 (QPSK)</td>
</tr>
<tr>
<td>NB2</td>
<td>0.08*</td>
<td>0.2</td>
<td>-</td>
<td>4 (QPSK)</td>
</tr>
<tr>
<td>M1</td>
<td>1**</td>
<td>1.4</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>M2</td>
<td>4**</td>
<td>5</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>20</td>
<td>-</td>
<td>64</td>
</tr>
<tr>
<td>1bis</td>
<td>1</td>
<td>20</td>
<td>-</td>
<td>64</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>20</td>
<td>-</td>
<td>64</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>20</td>
<td>2</td>
<td>64</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>20</td>
<td>2</td>
<td>64</td>
</tr>
<tr>
<td>4</td>
<td>150</td>
<td>20</td>
<td>2</td>
<td>64</td>
</tr>
<tr>
<td>5</td>
<td>300</td>
<td>20</td>
<td>4</td>
<td>64</td>
</tr>
<tr>
<td>6</td>
<td>300</td>
<td>2*20</td>
<td>2 or 4</td>
<td>64</td>
</tr>
<tr>
<td>7</td>
<td>3000</td>
<td>5*20</td>
<td>8</td>
<td>64</td>
</tr>
<tr>
<td>9</td>
<td>450</td>
<td>3*20</td>
<td>2 or 4</td>
<td>64</td>
</tr>
<tr>
<td>10</td>
<td>600</td>
<td>4*20</td>
<td>2 or 4</td>
<td>64 or 256</td>
</tr>
<tr>
<td>13</td>
<td>400</td>
<td>2*20</td>
<td>2 or 4</td>
<td>256</td>
</tr>
<tr>
<td>14</td>
<td>4000</td>
<td>5*20</td>
<td>8</td>
<td>256</td>
</tr>
<tr>
<td>15</td>
<td>800</td>
<td>5*20</td>
<td>2 or 4</td>
<td>64 or 256</td>
</tr>
<tr>
<td>16</td>
<td>1000</td>
<td>5*20</td>
<td>2 or 4</td>
<td>64 or 256</td>
</tr>
<tr>
<td>17</td>
<td>25000</td>
<td>32*20</td>
<td>8</td>
<td>256</td>
</tr>
<tr>
<td>18</td>
<td>1200</td>
<td>6*20</td>
<td>2 or 4, [8]</td>
<td>64 or 256</td>
</tr>
<tr>
<td>19</td>
<td>1600</td>
<td>8*20</td>
<td>2 or 4, [8]</td>
<td>64 or 256</td>
</tr>
</tbody>
</table>

* based on 1HARQ  
** based on FD-FDD

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R13 NB-IoT: Cat-NB1 → R14 NB-IoT: Cat-NB2 → R13 LTE-M: Cat-M1 → R14 LTE-M: Cat-M2

Per 3GPP TS 36.306

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3GPP Rel-8  
3GPP Rel-10  
3GPP Rel-11  
3GPP Rel-12  
3GPP Rel-13  
3GPP Rel-14

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NR UE Categories (on-going)

• Discussions are on-going in 3GPP

• 5G UE will not signal UE categories anymore explicitly to the network

• Definition will be in the spec but just for marketing concept

• Likely KPI to define UE categories: peak data rate, reflecting the best achievable data rate among the operation modes supported by the UE

• 5G NR spectrum allocations are unclear in certain regions (impact data rate)
New 3GPP 5G NR Operating Bands

Different requirements, RF specifications for different frequency ranges (FR)

### FR1 (<6GHz)

<table>
<thead>
<tr>
<th>NR operating band</th>
<th>Uplink (UL) operating band BS receive / UE transmit</th>
<th>Downlink (DL) operating band BS transmit / UE receive</th>
<th>Duplex Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>n1</td>
<td>1920 MHz – 1980 MHz</td>
<td>2110 MHz – 2170 MHz</td>
<td>FDD</td>
</tr>
<tr>
<td>n2</td>
<td>1850 MHz – 1910 MHz</td>
<td>1930 MHz – 1990 MHz</td>
<td>FDD</td>
</tr>
<tr>
<td>n3</td>
<td>1710 MHz – 1785 MHz</td>
<td>1805 MHz – 1880 MHz</td>
<td>FDD</td>
</tr>
<tr>
<td>n5</td>
<td>824 MHz – 849 MHz</td>
<td>869 MHz – 894 MHz</td>
<td>FDD</td>
</tr>
<tr>
<td>n7</td>
<td>2500 MHz – 2570 MHz</td>
<td>2620 MHz – 2690 MHz</td>
<td>FDD</td>
</tr>
<tr>
<td>n8</td>
<td>880 MHz – 915 MHz</td>
<td>925 MHz – 960 MHz</td>
<td>FDD</td>
</tr>
<tr>
<td>n20</td>
<td>832 MHz – 862 MHz</td>
<td>791 MHz – 821 MHz</td>
<td>FDD</td>
</tr>
<tr>
<td>n28</td>
<td>703 MHz – 748 MHz</td>
<td>758 MHz – 803 MHz</td>
<td>FDD</td>
</tr>
<tr>
<td>n38</td>
<td>2570 MHz – 2620 MHz</td>
<td>2570 MHz – 2620 MHz</td>
<td>TDD</td>
</tr>
<tr>
<td>n41</td>
<td>2496 MHz – 2690 MHz</td>
<td>2496 MHz – 2690 MHz</td>
<td>TDD</td>
</tr>
<tr>
<td>n50</td>
<td>1432 MHz – 1517 MHz</td>
<td>1432 MHz – 1517 MHz</td>
<td>TDD</td>
</tr>
<tr>
<td>n51</td>
<td>1427 MHz – 1432 MHz</td>
<td>1427 MHz – 1432 MHz</td>
<td>TDD</td>
</tr>
<tr>
<td>n66</td>
<td>1710 MHz – 1780 MHz</td>
<td>2110 MHz – 2200 MHz</td>
<td>FDD</td>
</tr>
<tr>
<td>n70</td>
<td>1695 MHz – 1710 MHz</td>
<td>1995 MHz – 2020 MHz</td>
<td>FDD</td>
</tr>
<tr>
<td>n71</td>
<td>663 MHz – 698 MHz</td>
<td>617 MHz – 652 MHz</td>
<td>FDD</td>
</tr>
<tr>
<td>n74</td>
<td>1427 MHz – 1470 MHz</td>
<td>1475 MHz – 1518 MHz</td>
<td>FDD</td>
</tr>
<tr>
<td>n75</td>
<td>N/A</td>
<td>1432 MHz – 1517 MHz</td>
<td>SDL</td>
</tr>
<tr>
<td>n76</td>
<td>N/A</td>
<td>1427 MHz – 1432 MHz</td>
<td>SDL</td>
</tr>
<tr>
<td>n77</td>
<td>3300 MHz – 4200 MHz</td>
<td>3300 MHz – 4200 MHz</td>
<td>TDD</td>
</tr>
<tr>
<td>n78</td>
<td>3300 MHz – 3800 MHz</td>
<td>3300 MHz – 3800 MHz</td>
<td>TDD</td>
</tr>
<tr>
<td>n79</td>
<td>4400 MHz – 5000 MHz</td>
<td>4400 MHz – 5000 MHz</td>
<td>TDD</td>
</tr>
<tr>
<td>n80</td>
<td>1710 MHz – 1785 MHz</td>
<td>N/A</td>
<td>SUL</td>
</tr>
<tr>
<td>n81</td>
<td>880 MHz – 915 MHz</td>
<td>N/A</td>
<td>SUL</td>
</tr>
<tr>
<td>n82</td>
<td>832 MHz – 862 MHz</td>
<td>N/A</td>
<td>SUL</td>
</tr>
<tr>
<td>n83</td>
<td>703 MHz – 748 MHz</td>
<td>N/A</td>
<td>SUL</td>
</tr>
<tr>
<td>n84</td>
<td>1920 MHz – 1980 MHz</td>
<td>N/A</td>
<td>SUL</td>
</tr>
</tbody>
</table>

### FR2 (24.25GHz – 52.6GHz)

<table>
<thead>
<tr>
<th>NR operating band</th>
<th>Uplink (UL) operating band BS receive / UE transmit</th>
<th>Downlink (DL) operating band BS transmit / UE receive</th>
<th>Duplex Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>n257</td>
<td>26500 MHz – 29500 MHz</td>
<td>26500 MHz – 29500 MHz</td>
<td>TDD</td>
</tr>
<tr>
<td>n258</td>
<td>24250 MHz – 27500 MHz</td>
<td>24250 MHz – 27500 MHz</td>
<td>TDD</td>
</tr>
<tr>
<td>n260</td>
<td>37000 MHz – 40000 MHz</td>
<td>37000 MHz – 40000 MHz</td>
<td>TDD</td>
</tr>
</tbody>
</table>

**FR1:** 26 new NR bands (450MHz-6000MHz)
- <1GHz: 600MHz, 700MHz
- <3GHz: LTE band re-farming
- 3 – 6GHz: highest global interest bands: n77 & n78 (3.3-4.2GHz) (100MHz BW)

**FR2:** 3 new NR bands (24.5 – 52.6GHz)
- Suitable for hotspot coverage, high capacity
- Highest interest n257 & n258 (24.25-29.5GHz) (400MHz BW)
3GPP Overall Timeline & Release Features

- **Rel-15 5G NR Phase 1**
  - NR Voice
  - Cat-M1/NB1
  - High precision pos
  - FDD/LTE
  - Short TTI
  - eMBB
  - Enhanced indoor pos
  - 5G new RAT study
  - 5G use case & requirements start (new channel model)
  - NR in unlicensed (SI)
  - Other LTE enh

- **Rel-16 5G NR Phase 2**
  - NR Voice
  - Cat-M2/NB2 Enh
  - High precision pos
  - FDD/LTE
  - Short TTI
  - eMBB
  - Enhanced indoor pos
  - 5G new RAT study
  - 5G use case & requirements start (new channel model)
  - NR in unlicensed (SI)

**ITU-R IMT-2000 Recommendation**
- Rel-15 5G NR Phase 1
- Rel-16 5G NR Phase 2

**ITU-R IMT-Advanced Recommendation**
- Rel-9
  - LTE-A
  - Location service (A-GNSS)
  - MBMS support
  - MIMO
  - MIMO with HSPA
  - HSPA+ support
  - SON
  - LTE-A
  - Dual-layer beamforming

- Rel-10
  - LTE-M
  - CoMP
  - eLAA
  - eLTE
  - eIMT
  - eMBMS
  - 3GPP/5GSA

- Rel-11
  - Cat-M
  - Cat-NB1
  - CAT-NSIM
  - LTE-V2X
  - LTE-V2X
  - LTE-M
  - LTE-M
  - LTE-M
  - LTE-M

- Rel-12
  - Cat-M
  - Cat-NB2
  - LTE-V2X
  - eLAA
  - Enhanced indoor pos
  - 5G new RAT study

- Rel-13
  - Cat-M1
  - Cat-NB1
  - LTE-V2X
  - MIMO
  - eMBMS
  - 3GPP/5GSA
  - 3GPP/5GSA
  - 3GPP/5GSA

- Rel-14
  - Cat-M2
  - Cat-M2
  - Cat-M2
  - Cat-M2
  - Cat-M2
  - Cat-M2

- Rel-15 & 5G Phases 1
  - NR-15
  - NR-15
  - NR-15
  - NR-15

- Rel-16 & 5G Phases 2
  - NR-16
  - NR-16
  - NR-16

**Timeline**
- 2009
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020

**Key Dates**
- 03/2010
- 05/2011
- 03/2012
- 03/2013
- 03/2014
- 03/2015
- 06/2017
- 09/2018
- 01/2020

**Chips expected**
- Rel-16

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3GPP Technology Roadmap

3GPP 5G Phase 1 Priority
- Enhanced mobile broadband, high-mobility
- Ultra reliable and low latency communications
- Massive machine type communications

*NSA: Non-Standalone 5G eMBB, accelerated and completed in Dec’17 (core)
*SA: Standalone, completed in June’18

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IoT in 5G
NB-IoT, LTE-M Evolution into 5G

NB-IoT and LTE-M, including their evolutions, are expected to be the vital 5G components to address LPWA use cases in the 5G era.

IMT-2020 5G mMTC requirements:
- 20dB CE
- 1M devices per km²
- >=10 Years lifetime

**4G LTE-Advanced Pro**
- Rel-13: R13 NB-IoT
  - Cat-NB1
- Rel-14: R14 NB-IoT
  - Cat-NB2

**5G**
- 5G Phase 1 (Rel-15):
  - FeNB-IoT
  - R15 NB-IoT
- 5G Phase 2 (Rel-16):
  - R16 NB-IoT

**NR-IIoT**
- Rel-17

**LTE-M**
- R13 LTE-M
  - Cat-M1
- R14 LTE-M
  - Cat-M2

**Part of IMT-2020 submission**
**Continue to address LPWA use cases**
NB-IoT, LTE-M Evolution into 5G

NB-IoT and LTE-M, including their evolutions, are expected to be the vital 5G components to address LPWA use cases in the 5G era.

3GPP Release

<table>
<thead>
<tr>
<th>3GPP Release</th>
<th>4G LTE-Advanced Pro</th>
<th>5G</th>
<th>5G Evo (?)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rel-13</td>
<td>5G Phase 1 Rel-15</td>
<td>5G Phase 2 Rel-16</td>
<td>Rel-17</td>
</tr>
<tr>
<td>R13 NB-IoT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>180 kHz bandwidth</td>
<td>Power consumption reduction (e.g. Release assistance indicator, NWUS, MWUS)</td>
<td>* Network operation and efficiency improvement (e.g. UE-group wake-up signal)</td>
<td>* Migration to 5G Core networks</td>
</tr>
<tr>
<td>20dB CE</td>
<td>* Use case extension (e.g. PC6 14dBm, OTDOA support, TDD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-band, standalone, guard-band deployment mode</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R13 LTE-M</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4MHz bandwidth</td>
<td>Coverage enhancements (CEModeA, CEModeB)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20dB CE</td>
<td>Lower power class (20dBm)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Use case extension (e.g. PC6 14dBm, OTDOA support, TDD)
* Network operation and efficiency improvement (e.g. UE-group wake-up signal)
* Migration to 5G Core networks

1.4MHz bandwidth
Coverage enhancements (CEModeA, CEModeB)
Lower power class (20dBm)

NR-IIoT: New Radio Industrial IoT

To address IIoT use cases: factory automation, transport industry, electrical power distribution

Key technology enablers:
- NR URLLC (short TTI, reliability)
- TSN (Time Sensitive Networking)
  - Accurate ref timing
  - QoS for wireless Ethernet
  - Ethernet header compression
- Spectrum (licensed + unlicensed)
## Industrial Automation Perf. Requirements for 5G

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Availability</th>
<th>Cycle Time</th>
<th>Typical Payload</th>
<th># of Devices</th>
<th>Typical Service Area</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motion control</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Printing machine</td>
<td>&gt;99.9999%</td>
<td>&lt; 2 ms</td>
<td>20 bytes</td>
<td>&gt; 100</td>
<td>100 m x 100 m x 30 m</td>
</tr>
<tr>
<td>Machine tool</td>
<td>&gt;99.9999%</td>
<td>&lt; 0.5 ms</td>
<td>50 bytes</td>
<td>~20</td>
<td>15 m x 15 m x 3 m</td>
</tr>
<tr>
<td>Packaging machine</td>
<td>&gt;99.9999%</td>
<td>&lt; 1 ms</td>
<td>40 bytes</td>
<td>~50</td>
<td>10 m x 5 m x 3 m</td>
</tr>
<tr>
<td><strong>Mobile robots</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooperative motion control</td>
<td>&gt;99.9999%</td>
<td>1 ms</td>
<td>40-250 bytes</td>
<td>100</td>
<td>&lt; 1 km²</td>
</tr>
<tr>
<td>Video-operated remote control</td>
<td>&gt;99.9999%</td>
<td>10-100 ms</td>
<td>15-150 kbytes</td>
<td>100</td>
<td>&lt; 1 km²</td>
</tr>
<tr>
<td><strong>Mobile control panels with safety functions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assembly robots or milling machines</td>
<td>&gt;99.9999%</td>
<td>4-8 ms</td>
<td>40-250 bytes</td>
<td>4</td>
<td>10 m x 10 m</td>
</tr>
<tr>
<td>Mobile cranes</td>
<td>&gt;99.9999%</td>
<td>12 ms</td>
<td>40-250 bytes</td>
<td>2</td>
<td>40 m x 60 m</td>
</tr>
<tr>
<td>Process automation (process monitoring)</td>
<td>&gt;99.99%</td>
<td>&gt; 50 ms</td>
<td>Varies</td>
<td>10,000</td>
<td>devices per km²</td>
</tr>
</tbody>
</table>

Source: 3GPP, 22.804
5G for Automotive
LTE-V2X Background

- Technology base: LTE, LTE-D2D
- V2X Candidate solutions: IEEE 802.11p/DSRC, LTE-V2X
- 3GPP is expanding LTE into automotive verticals
- GSA forecasts by 2025, annual sales of new connections for connected cars will reach 91 million units/year, with global installed base approaching 527 million

Types of V2X:
- V2V: vehicle to vehicle
- V2P: vehicle to pedestrian (e.g. handheld terminal carried by a pedestrian, cyclist, driver or passenger)
- V2I: vehicle to infrastructure application, where infrastructure is RSU (Roadside Unit)
- V2N: vehicle to network

Enablers (3GPP technologies):
- ProSe or D2D communications
- MBMS & SC-PTM: provide efficient delivery of broadcast, multicast or unicast services, to be used in: group call session, live TV broadcasting, public warning message delivery etc.
- Non-3GPP technologies enablers: DSRC and 802.11p
Cellular V2X (C-V2X)

Evolve from LTE-V2X to NR-V2X

<table>
<thead>
<tr>
<th>4G LTE-Advanced Pro</th>
<th>5G Phase 1</th>
<th>5G Phase 2</th>
<th>5G Evo (?)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rel-13</td>
<td>Rel-15</td>
<td>Rel-16</td>
<td>Rel-17</td>
</tr>
</tbody>
</table>

LTE-D2D

LTE-V2X

NR-V2X

V2X Phase 1
- Basic services
- Introduced sidelink or PC5 via Band 47 (5.9GHz)
- Sidelink mode 3 and 4

V2X Phase 2
- Low-end eV2X services
- PC5 latency reduction, CA
- Support higher order modulation on PC5 (64QAM)

V2X Phase 3
- Cover challenging high-end V2X services with 5G NR technologies

NR-V2X Use Cases
- Vehicles Platooning
- Extended Sensors
- Advanced Driving
- Remote Driving

Positioning in 5G
**3GPP Technology Roadmap – Highlighting Cellular Positioning**

**Observations**
- Since 3GPP Rel-11, OTDOA & E-CID have been the flagship cellular positioning technologies
- Additional D2D based ranging solutions are gaining momentum in V2X use cases

Looking forward, 5G cellular positioning will evolve based on existing E-CID, OTDOA, UTDOA or D2D positioning solutions. In addition, leveraging RAN-independent technologies, incl.: GNSS, RTK, IMU, Wi-Fi, TBS, Bluetooth, towards hybrid solutions, to cover a wider range of use cases.
Overview of 5G NR Positioning in 3GPP

- **Requirements** - 3GPP identified high-level 5G NR potential positioning requirements (incl. highly accurate positioning, hybrid positioning)
- **Use cases** – study on 5G positioning use cases covers diverse use case and scenarios (IoT, V2X, Industry 4.0, emergency services, Aerials, Location based Services)
- **Next**: New 5G NR Positioning Study to start in Rel-16 (Oct’2018)
- Some potential NR positioning benefits: wider bandwidths expect to provide better ToA resolution, massive antenna systems, beam angles and ToA triangulation, flexible NR network architecture; RTK for precise positioning
Take-away

- Transition to 5G is an **evolution**, but could also **transfer** verticals
- 5G NR is designed for long term **coexistence** with 4G LTE
- 5G systems evolution direction: **connecting verticals**; need more inputs from verticals, more **collaboration**
- Existing **LPWA** (LTE-M and NB-IoT) solutions are 5G ready and will be forward-compatible with 5G core networks
- **NB-IoT and LTE-M**, including their evolutions, are expected to be the vital 5G components to address LPWA use cases in the 5G era
- **NR-IIoT** to address IIoT use cases: factory automation; leveraging NR URLLC and TSN
- 5G UE will not signal **UE categories** anymore explicitly to the network, definition however will be in the spec for marketing concept
- **NR-V2X** to address advanced V2X use cases
- NR Positioning: highly accurate positioning (**centimetre**), hybrid positioning
Thank you!

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