5G Spectrum Challenges

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### 5G use cases: evolution of current use cases and new use cases

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Description</th>
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<tbody>
<tr>
<td>Broadband access everywhere</td>
<td>50+ MBPS EVERYWHERE</td>
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<tr>
<td>Broadband access in dense areas</td>
<td>PERSVATIVE VIDEO</td>
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<tr>
<td>Higher user mobility</td>
<td>HIGH SPEED TRAIN</td>
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<tr>
<td>Massive Internet of Things</td>
<td>SENSOR NETWORKS</td>
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<tr>
<td>Extreme real-time communications</td>
<td>TACTILE INTERNET</td>
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<tr>
<td>Lifeline communications</td>
<td>NATURAL DISASTER</td>
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<tr>
<td>Ultra-reliable communications</td>
<td>E-HEALTH SERVICES</td>
</tr>
<tr>
<td>Broadcast-like services</td>
<td>BROADCAST SERVICES</td>
</tr>
</tbody>
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Source: NGMN 5G white paper, executive version
5G technology: evolution of current standards and integration with new technologies

- Wi-Fi
- 4G
- 5G
  - mm-Wave
  - Low-cost wide area M2M
  - Low-latency ultra-rel. M2M

Timeline:
- 2000
- 2010
- 2020
- 2030
Impact of emerging technologies on spectrum

- **Incremental**
  - **Massive MIMO (<6GHz)**
  - **new waveforms**
  - **Full duplex access**

- **Disruptive**
  - **LAA**
  - **Low-latency/high-reliability M2M**
  - **Low-cost, high volume M2M**
  - **MMW access**

- **Technology**
  - **Evolutionary**
  - **Radical**
Wide area M2M: is there the need for a completely new design?

- Cellular systems have been traditionally designed to work in region R1 and R2, i.e. to maximise the throughput for a given amount of devices

- Optimising the system for Regions R3 and R4 might lead to completely different designs
  - E.g. coupling between data and control plane, new types of nodes, transmissions optimised for short data blocks, new waveforms,…

What approach should be taken to mmW spectrum?

• At lower frequency regulators typically slice spectrum into bands and award
  – Beauty contest, Auctions or Reverse auctions

• Licensing bands or locations originates from a need to manage interference that different spectrum users cannot manage themselves

• **Is this the right approach at these high frequencies?**
  – Limited range due to poor propagation (especially above 40 GHz).
  – Directional antennas used to improve link budgets.
  – Large amounts of available frequency – supply exceeds demand?

• Any restriction of shared access reduces use of band by others and may reduce innovation and flexibility

• **How good will 5G be at managing interference? How well will it share?**
Bands above 6GHz
Challenges and Questions

- WRC-15 Agenda Item 1.1 has focused on spectrum for mobile broadband <6GHz
- 5G suggests significantly greater bandwidths >6GHz are necessary – several GHz
- Spectrum implications of 5G need consideration - recognising real life constraints on availability, for example thinking about clever ways of sharing / minimising co-existence issues
- Tasking ITU with finding spectrum between 6GHz – 100GHz does not seem viable
  - More work and consensus to establish candidate bands is necessary
  - What characteristics would these bands have?
    - Frequency (max and min)
    - Bandwidth – how wide, contiguous or aggregated?
    - Licensed, Shared, Pooled between operators, Exempt?
    - Geographic availability
Conclusions

• 5G is not only about mm-Wave

• Frequencies below 6GHz seem very important
  – for capacity & coverage
  – to provide a *consistent* QoS across time and space
  – to support wide-area M2M
  – to support ultra-reliable services

• 5G will be a network for communication and *control*
  – what does this mean for spectrum licensing for e.g. car-2-x?
  – is there really a need for exclusive access at >40GHz?

• We believe there is a need to focus on what mmW bands should be considered
  • >6GHz is too broad
  • Sharing studies are required