University of
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Use Cases & Enabling 5G NR Technologies

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CEPT Workshop on New Spectrum Solutions for Industry
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bristol.ac.uk/smart   **bristol.ac.uk/engineering/research/csn/**

UK 5G Test Beds & Trials: Culture Events

Full video available from: https://youtu.be/1ZgrC1M-Zco
www.bristol.ac.uk/engineering/research/smart/events/layered-realities-weekend/

UK 5G Test Beds & Trials: Tourism

Press article: http://www.bristol.ac.uk/engineering/research/smart/projects/smart-tourism/
Full video available from: https://www.bbc.co.uk/rd/blog/2019-02-5g-mobile-augmented-reality-bath

Enhanced Connectivity to Trains:

We propose the use of millimetre wave wireless modems to connect the train to the internet

Press Announcement https://www.firstgroupplc.com/news-and-media/latest-news/2019/25-02-19.aspx
Full video available from: https://www.youtube.com/watch?v=OlDOihcqJZg

Connected and Autonomous Vehicles

Press Article: http://www.bristol.ac.uk/news/2019/march/flourish-research.html
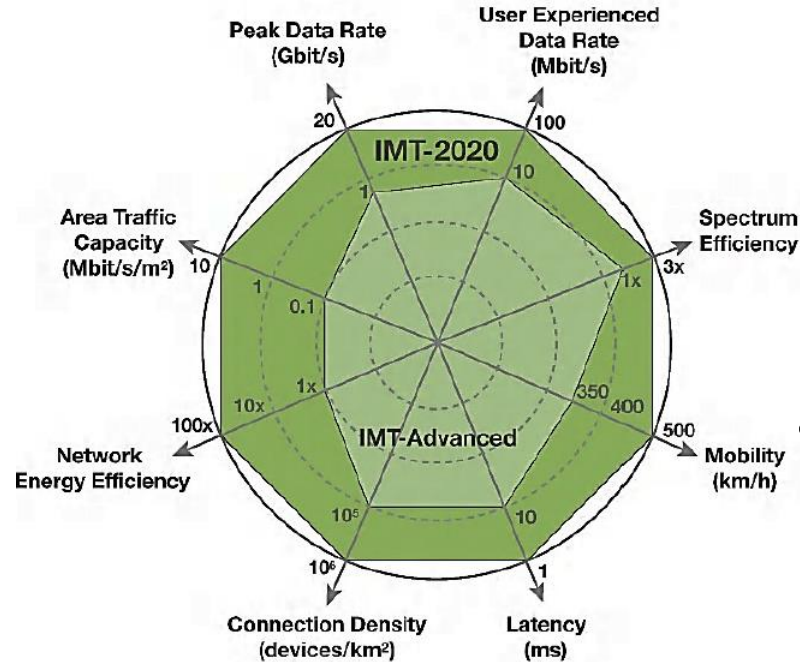Full video available from: https://youtu.be/bZIPbGMEoMA
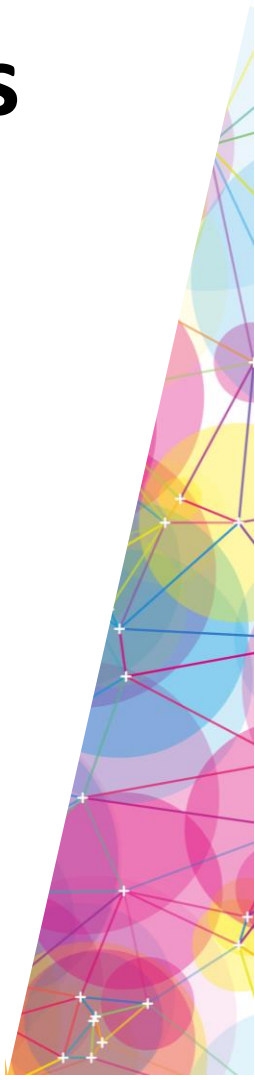
5G – Networked Society
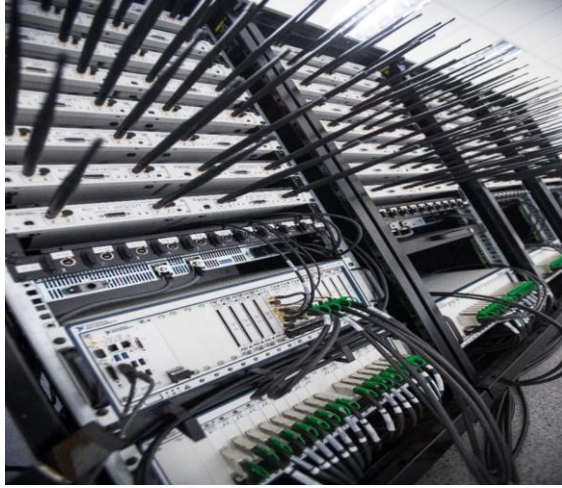

- NR Specifications:
  - 10Gbit/s Peak
  - 100Mbit/s, where ever needed
  - X100 – x1000 Capacity
  - X10 battery life
  - Reduced Latency (0.5ms)
- 5G Physical Layer Requires:
  - Enhanced Spectrum Efficiency Massive MIMO for sub-6GHz
  - Use of New Spectrum Millimetre wave bands
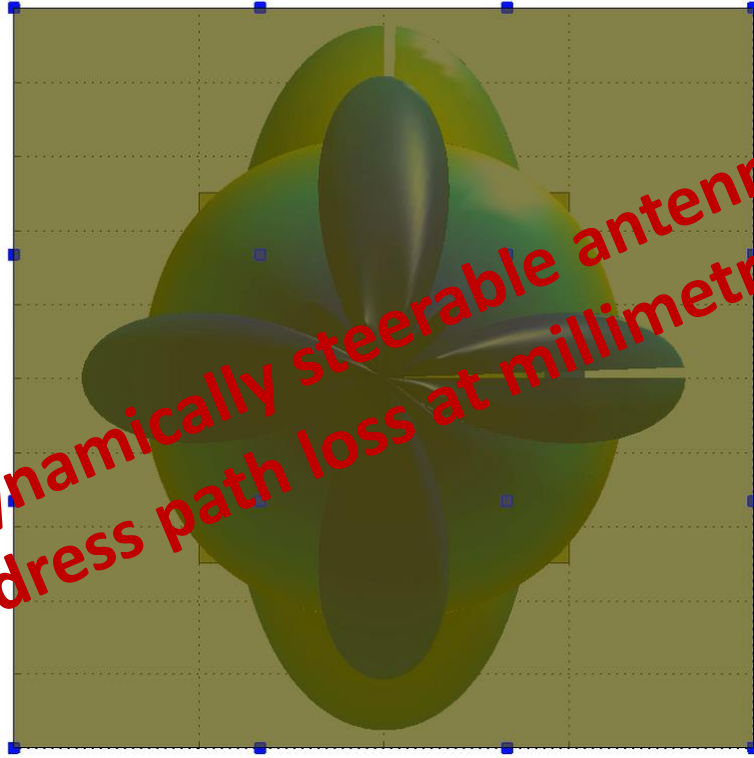
Use of the term *Massive MIMO*

Millimetre Wave 5G Access: Massive Arrays for Beamforming Array Gain Analogue Phase control. Beam tracking functionality

Sub 6GHz: Massive Arrays with Signal Processing per element for enhanced Spectrum Efficiency or multiple beamforming functionality

Antenna Arrays and Beamforming

Use of dynamically steerable antenna arrays to address path loss at millimetre wave

Cost Effective Millimetre Wave Testing

- Highly integrated RF Transceivers
  - No galvanic connectors
  - Requires Over the Air (OTA) Testing
  - Existing sub-6GHz OTA doesn't scale
- Bristol's Elliptical OTA method
  - Emulates 3D spatially dynamic environments
  - Spatially sparse channel: 1 to 3 simultaneous signals
  - Optimised for the *Dynamic Spatial Testing* of **Beam Management functions, Radio Resource Management (RRM) and Receiver Demodulation**
  - Minimal number of mechanically moving parts
  - Inherently supports two-way communication
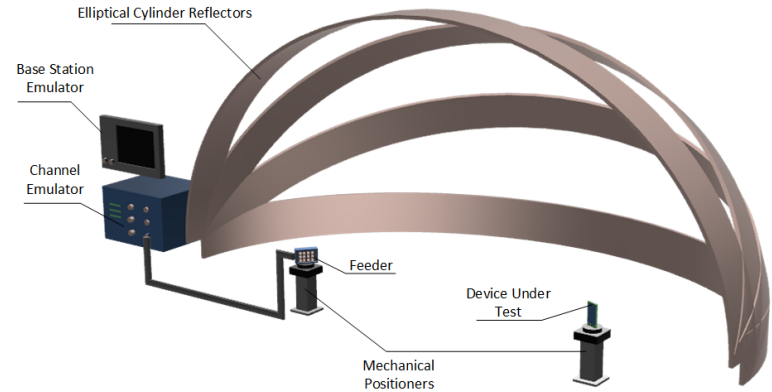
Take Aways:

- Ever expanding number of *Use Cases* for 5G, some applications requiring occasional access to spectrum:
  - Potential for Spectrum Sharing or Dynamic Spectrum Access (DSA)
  - 5G Spatial Access methods (Massive MIMO) align well
  - Evolving 'analogue' SDR technologies for agile transceivers
- New testing paradigm, in particular for millimetre wave beamforming technology
  - Required for design optimisation
  - Potential candidate for 3GPP conformance testing based on an elliptical test chamber