

Workshop presentation for the Telecoms Club

Presentation on 5G

20 April 2017

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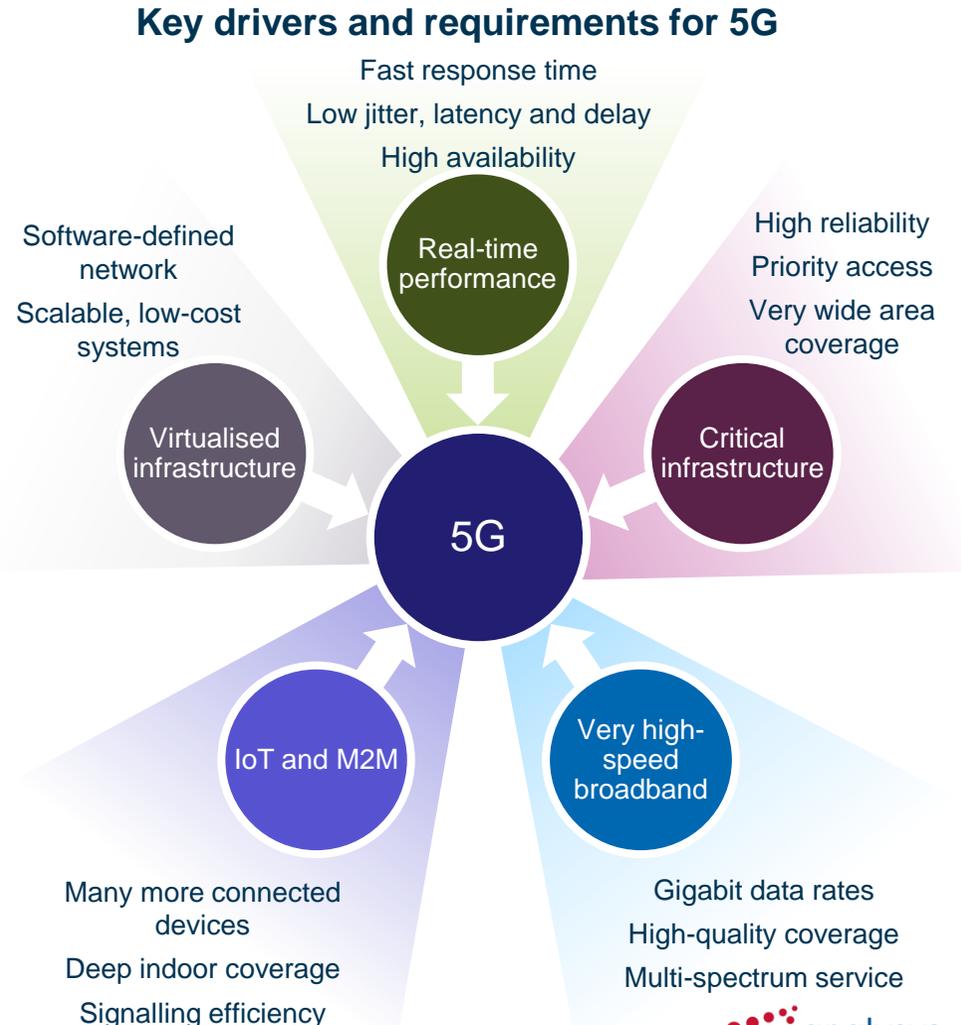
Introduction to 5G

Fixed–mobile convergence

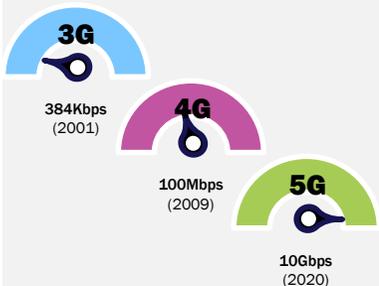
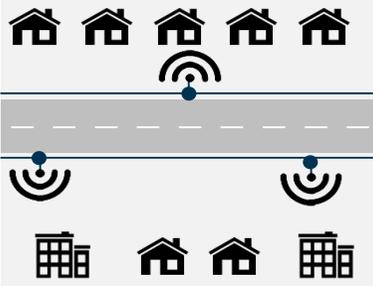
5G spectrum policy implications in Europe

The 5G vision is that networks must be higher performing, and foresees both very low latency, and very high throughput

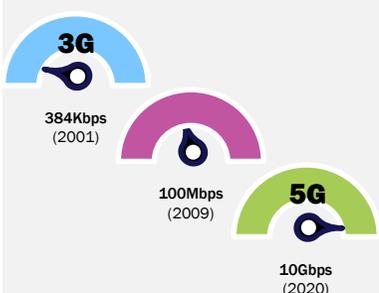
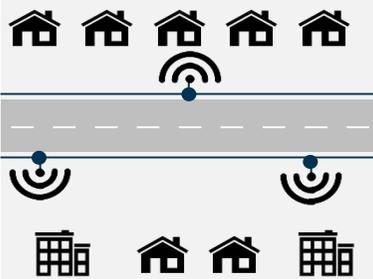
- To date, cellular technology (2G/3G/4G) has evolved to improve spectrum efficiency, coverage and capacity, and to keep up with data traffic growth
- The vision for 5G is more revolutionary, proposing improvements to nearly all aspects of telecoms and service delivery, including:
 - **virtualised infrastructure**, software defined, cloud oriented for lower-cost networks that are more flexible and scalable
 - **service-driven networks**, user experience-driven rather than transport-oriented, offering very high reliability
 - **real-time performance**, supporting augmented reality/virtual reality, immersive video and real time gaming
 - **everything connected**, incorporating M2M and IoT as well as smartphones and other consumer devices



Four groups of use cases are typically identified for 5G, each having different characteristics and network requirements

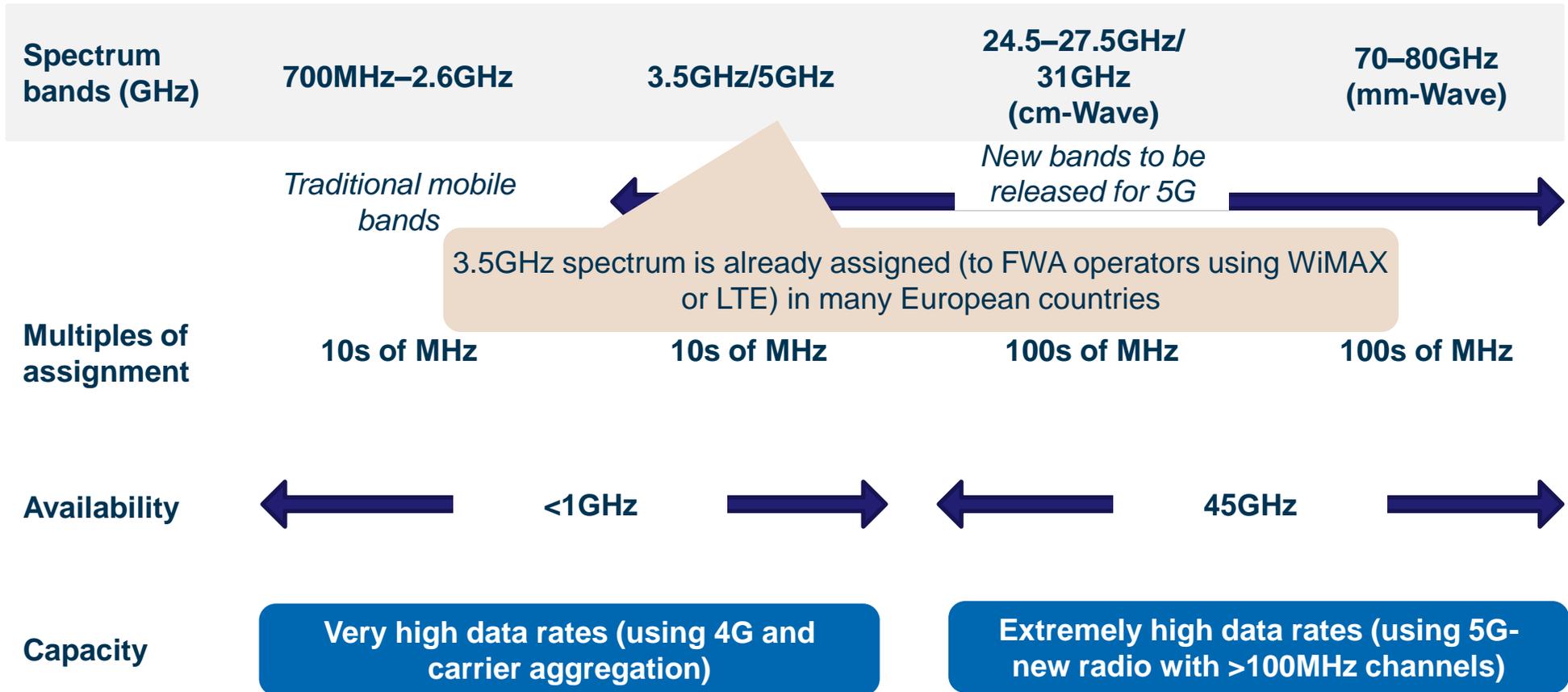
	Enhanced mobile broadband	Massive connections (IoT)	Ultra-reliable networks	Fixed wireless access
Characteristics	 <ul style="list-style-type: none"> Higher capacity/bandwidth than LTE 	 <ul style="list-style-type: none"> Manage large number of connected devices (high/low traffic, mobile/not mobile) 	 <ul style="list-style-type: none"> Low latency, high availability, redundancy 	 <ul style="list-style-type: none"> High capacity without mobility
Trials	<ul style="list-style-type: none"> Trials by AT&T, KT, NTT, SKT, Verizon Wireless, Vodafone, Deutsche Telecom 	<ul style="list-style-type: none"> Trials by MTS/Ericsson (2018 World Cup in Russia), AT&T and Verizon Wireless 	<ul style="list-style-type: none"> BTEE/Ericsson trials in the UK (2017) 	<ul style="list-style-type: none"> Verizon to start pilot in 2017

The different use cases have different implications on network developments

	Enhanced mobile broadband	Massive connections (IoT)	Ultra-reliable networks	Fixed wireless access
Example applications	 <ul style="list-style-type: none"> Generic mobile users Traffic hotspots (stadiums, dense urban areas) Broadcast/multicast 	 <ul style="list-style-type: none"> Connected cars Smart city Smart meters 	 <ul style="list-style-type: none"> Remote surgery Factory automation Real-time monitoring 	 <ul style="list-style-type: none"> Can allow FTTH-like speeds at lower cost and faster time to market Broadcast/multicast
Implications on network	<ul style="list-style-type: none"> Extension of 4G Wide-area coverage 	Different applications have different needs: <ul style="list-style-type: none"> Capacity Coverage Cost/battery life 	<ul style="list-style-type: none"> Likely to be (mainly) specific and separate, local radio networks 	<ul style="list-style-type: none"> Specific local, regional and national networks

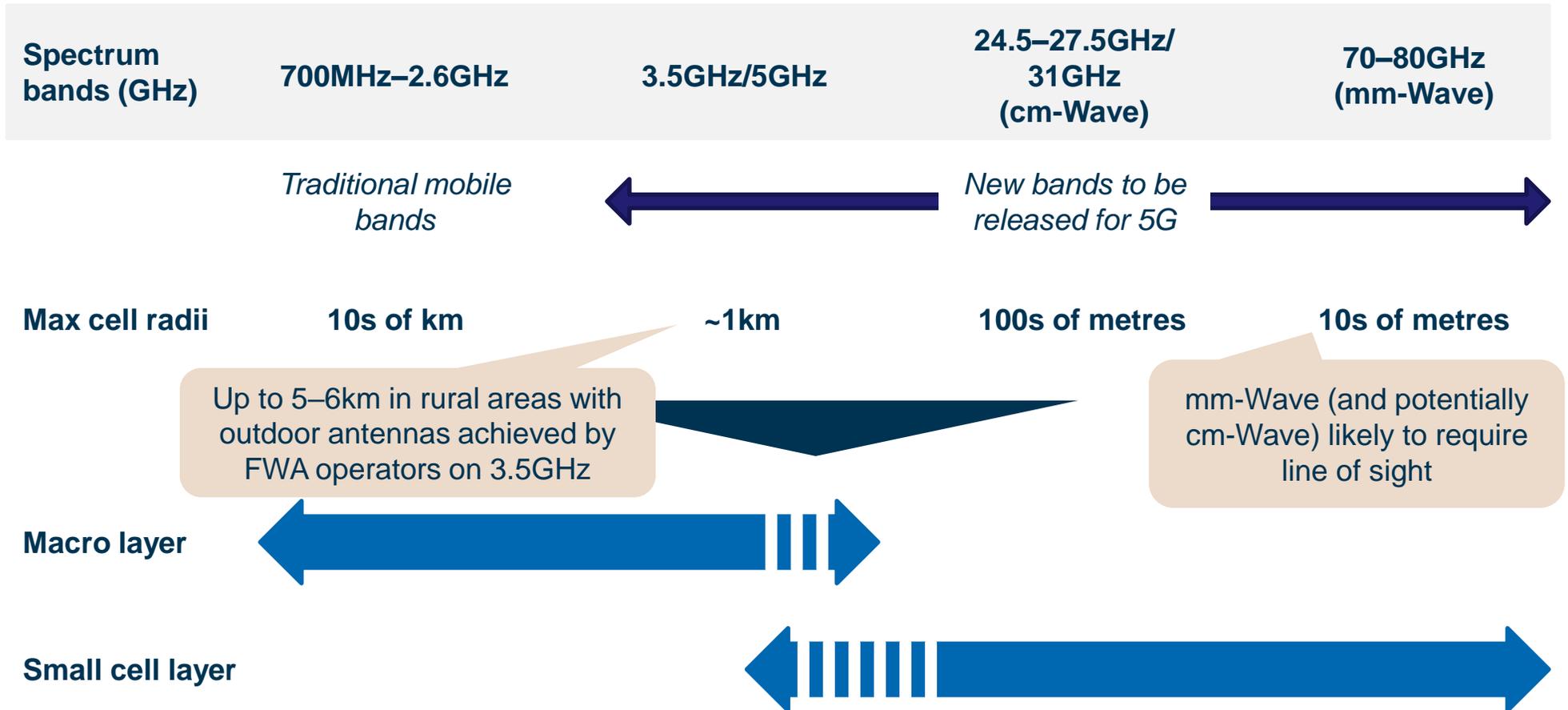
5G is expected to use a range of spectrum bands, including some currently used for mobile and others to be assigned

Spectrum bands likely to be used for 5G and their availability



Due to their low propagation characteristics, higher frequency bands are likely to be used mainly for dense small cells

Spectrum bands likely to be used for 5G and propagation



Recent industry interest in 5G has focused on the 24.25–29.5GHz band in various parts of the world, and 3.4–3.8GHz in Europe, USA and China

	Below 6GHz	6–20GHz	20–30GHz	Above 30GHz
Europe	700MHz 3.4–3.8GHz		24.5–27.5GHz	31.8–33.4GHz
USA	3.4–3.6GHz		27.5–28.35GHz	Identified as a 'band of interest' in Europe (RSPG)
Korea			26.5–29.5GHz	40.5–43.5GHz
China	3.4–3.6GHz			Growing interest in Europe
Japan	4.4–4.9GHz		27.5–29.5GHz	
	Benefits of below 6GHz Good bandwidth available Licensing frameworks are already being defined (e.g. in Europe) 3GPP standardised BUT – not full 5G capability	6–20GHz Not much being proposed (this range is already heavily utilised for fixed links and satellite services) Some interest in 10–10.4GHz band	20–30GHz Key focus of equipment development and trials to date Exact bands vary by region from 24.5GHz up to 29.5GHz	Above 30GHz Not an initial priority for 3GPP standards but growing industry interest in future options e.g. 40.5–43.5GHz

5G will combine a range of different solutions and technologies

5G

- Networks will be a **mixture/portfolio of different technologies and solutions**
- Based around a **new flexible air interface** for high-bandwidth and high-latency/reliability applications
- Expected to include **direct device-to-device connection** (not yet widely implemented)

Likely to be initially deployed mainly as small cells (>6GHz)

End-user devices could directly connect to remove latency while the network connection provides validation and verification services

LTE-A

- Likely to be **used for macrocells in the early years** (expectation is until at least 2025)
- Will gradually be replaced by **5G air interfaces** as end-user devices become compatible
 - LTE will be incorporated into and integrated with 5G and may evolve to converge with 5G
 - narrowband IoT (currently under development in 3GPP) may be used for mass-market M2M/IoT

The challenge for massive M2M/IoT is not the traffic generated but managing connections and signalling

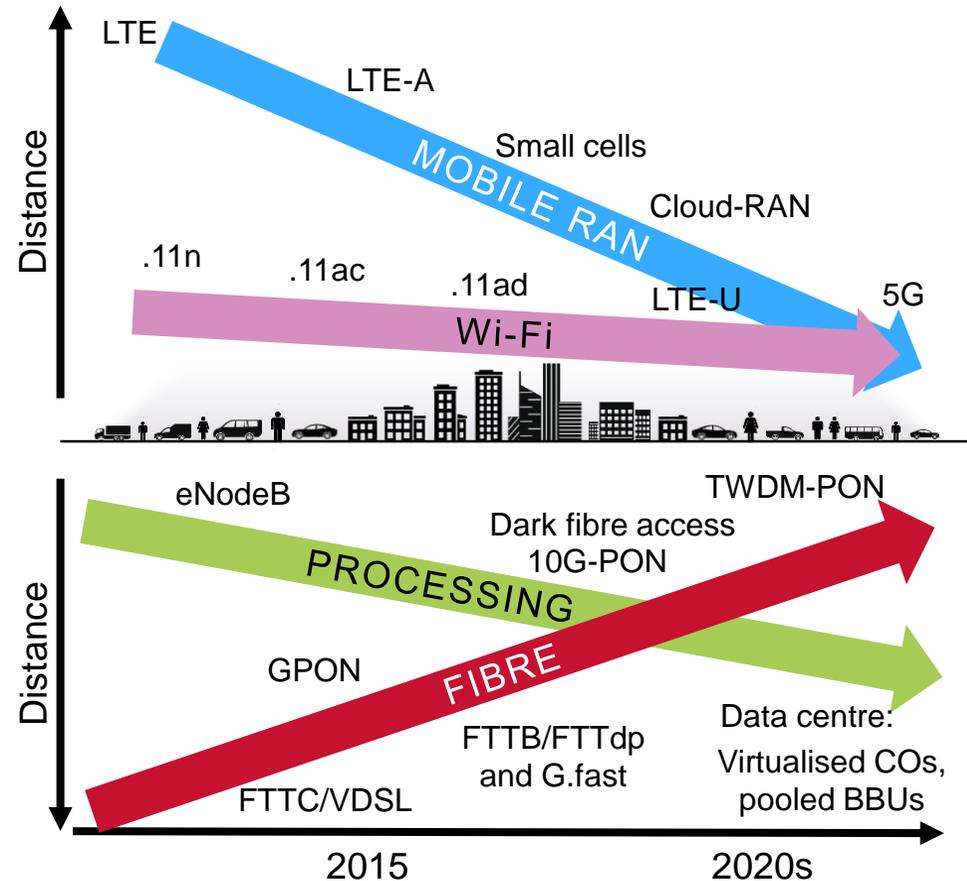
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As fibre and wireless nodes get distributed closer to the user, the network costs between fixed and wireless become more aligned

- **Densification:** 5G cell radius is tending towards low hundreds of metres or less
- **Virtualisation:** centralisation of processing (C-RAN) requires fatter pipes than traditional backhaul
- The main cost of a new 5G network will not just be in radio technology, but also in:
 - core infrastructure, rental, physical access, planning and site upgrades



US operators are exploring the 5G fixed wireless access concept in the 28GHz band

Verizon

- First '5G' application will be a fixed wireless service:
"Propagation and penetration testing across residential single and multi-dwelling units built in field locations has validated the feasibility of millimetre wave systems"
- However, rooftop likely to be in the mix
- Late 2017 launch pencilled in

Google Fiber

- Google Fiber is also investigating how massive beamforming on high-frequency wireless could accelerate a Google Fiber deployment
- Webpass acquisition P2P wireless backhaul for wired access in MDUs
- Considers 3.5GHz to be a milestone on way to 5G
- Indication of what you would do if you were starting from scratch – no legacy 4G or fixed

Increase deployment speeds and reduce deployment costs

Manage costs of 5G mobile

Expand availability of home broadband

Experiment, disrupt, new business

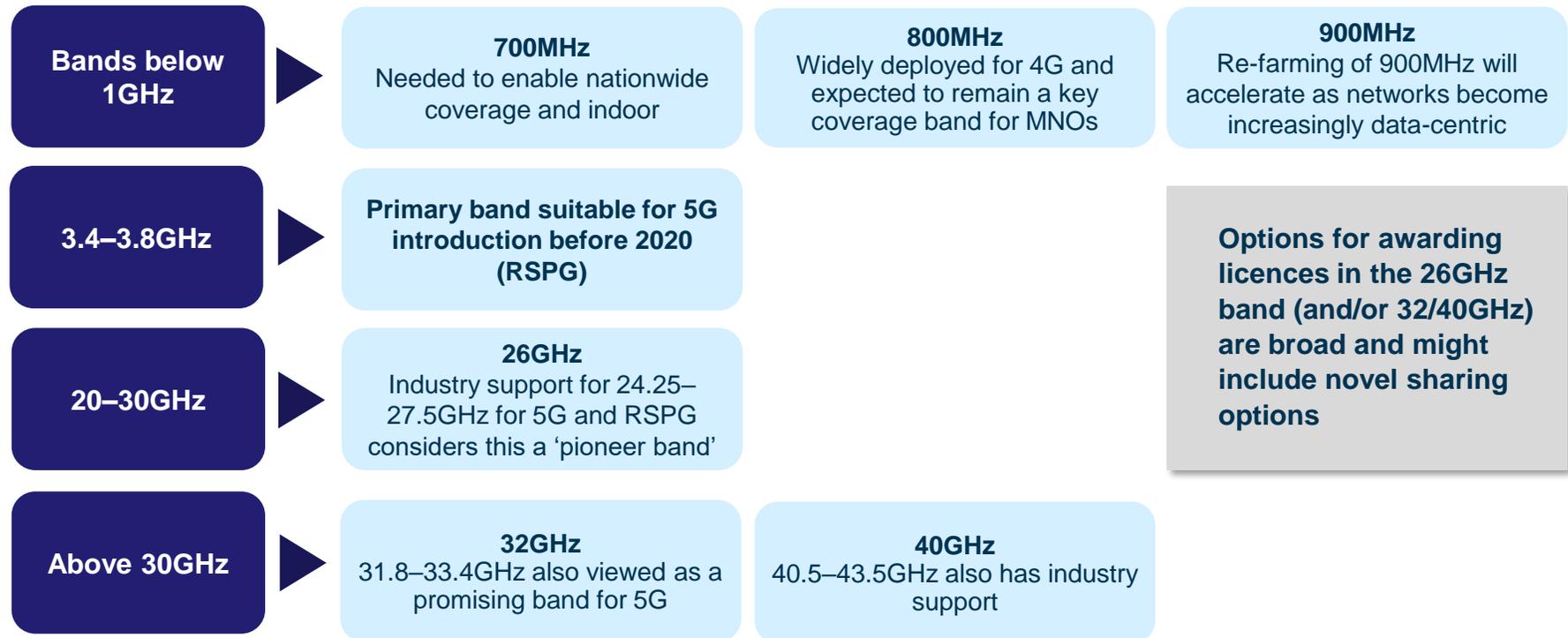
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The RSPG¹ identified a strategic roadmap for 5G introduction in Europe during 2016, endorsing 26GHz as a pioneer band for early implementation

Strategic roadmap for 5G in Europe



Regulators will need to consider how to bring different 5G bands to market with varying use cases and demand

The ITU World Radio Conference in 2019 (WRC-19) will study spectrum requirements for 5G in selected bands based on Resolution 238 of WRC-15 (includes mm-Wave above 24.5GHz, but excludes 28GHz)



The use cases of mm-wave 5G potentially focus on very high capacity indoor and outdoor hotspot coverage as well as 5G 'fixed wireless access'

Some 5G use cases will require lower frequency bands for wide-area coverage, such as 700MHz. Other bands, such as 3.4–3.8GHz, can also be used for 5G macro coverage



Reliable 5G coverage is essential for use cases such as connected cars and transport, requiring continuous coverage for high-speed vehicles and low-latency connections

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