5G VISION, CHARACTERISTICS AND REQUIREMENTS

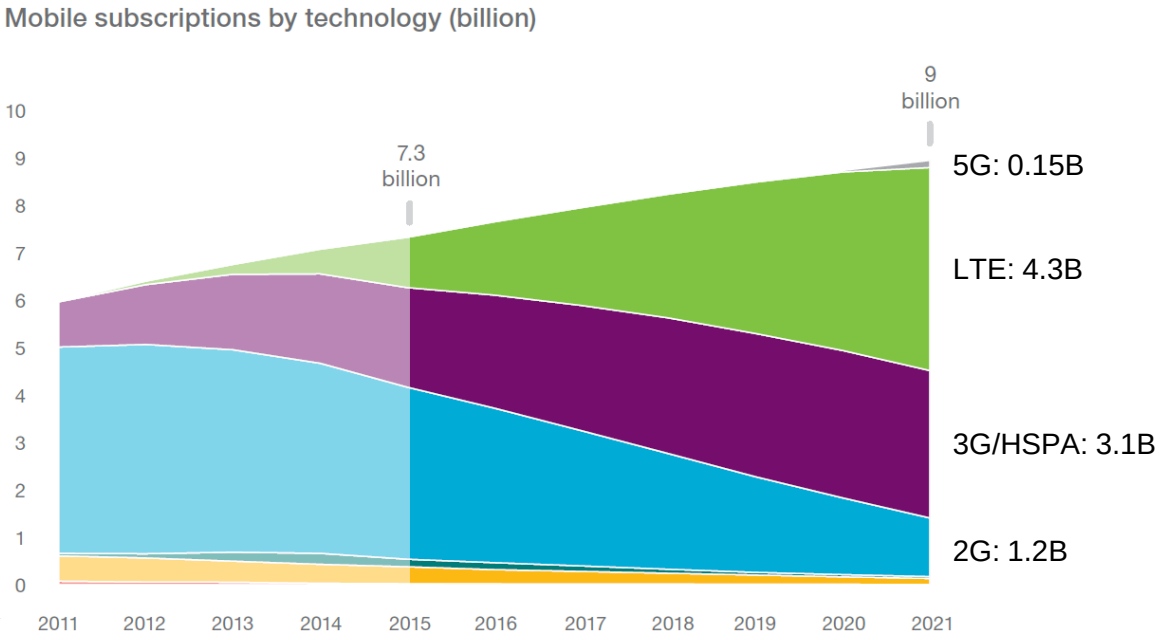
Presented by Hu WANG, GSA Spectrum Group CJK Coordinator

Workshop on Collaboration in Asia for 5G Spectrum
June 28th 2016, Shanghai

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CONTINUOUS GROWING OF MOBILE COMMUNICATIONS

Forecast on mobile subscriptions and connected devices



Source: Ericsson Mobility Report, June 2016

Connected devices

Great IoT potential

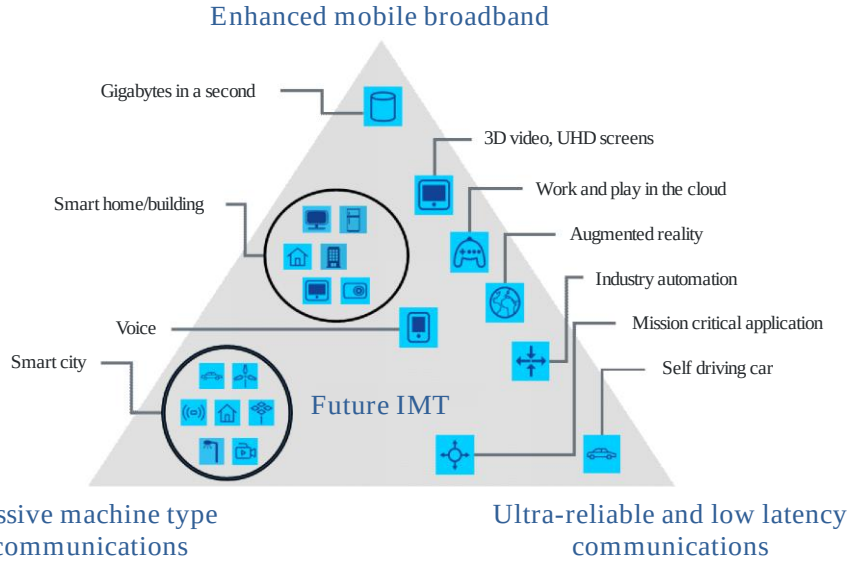
	15 billion	28 billion	CAGR 2015–2021
Cellular IoT	0.4	1.5	27%
Non-cellular IoT	4.2	14.2	22%
PC/laptop/tablet	1.7	1.8	1%
Mobile phones	7.1	8.6	3%
Fixed phones	1.3	1.4	0%
	2015	2021	

Source: Ericsson Mobility Report, June 2016

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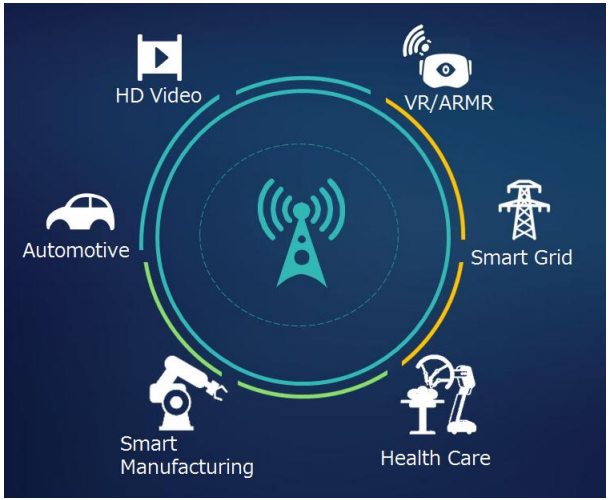
5G: EXPAND TO NEW TERRITORIES

Usage scenarios of IMT for 2020 and beyond



Source: Recommendation ITU-R M.2083 on IMT-2020 Vision

5G: one network infrastructure serving multiple industry sectors

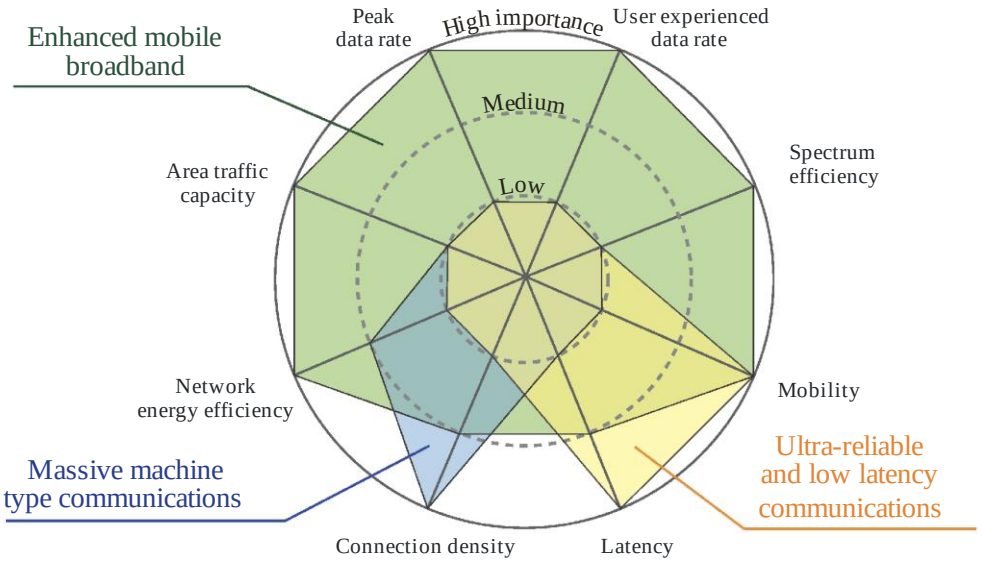


Source: Huawei

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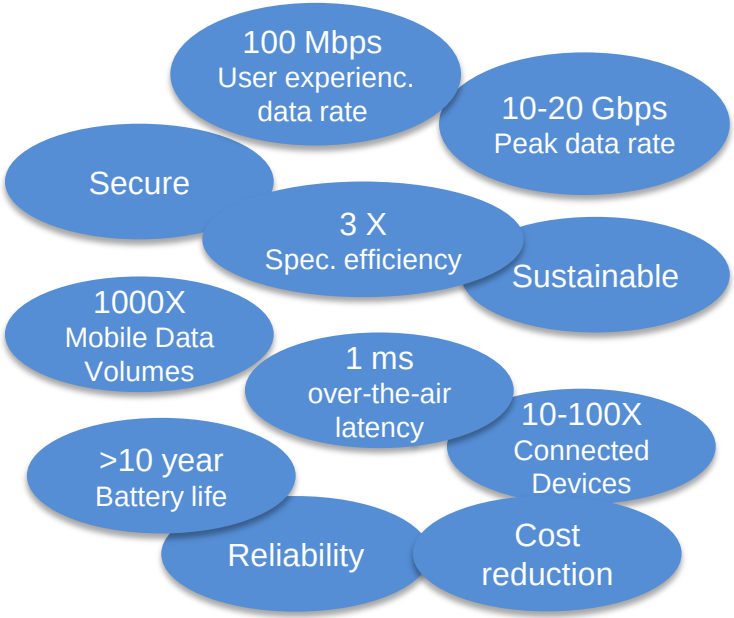
5G REQUIREMENTS

The importance of key capabilities in different usage scenarios



Source: Recommendation ITU-R M.2083 on IMT-2020 Vision

5G capabilities / requirements

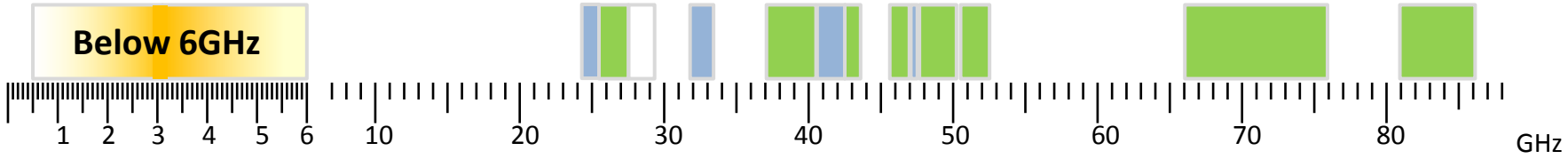


Note: ITU-R Working Party 5D is developing minimum technical performance requirements for IMT-2020.

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5G NEEDS SPECTRUM BELOW AND ABOVE 6GHZ

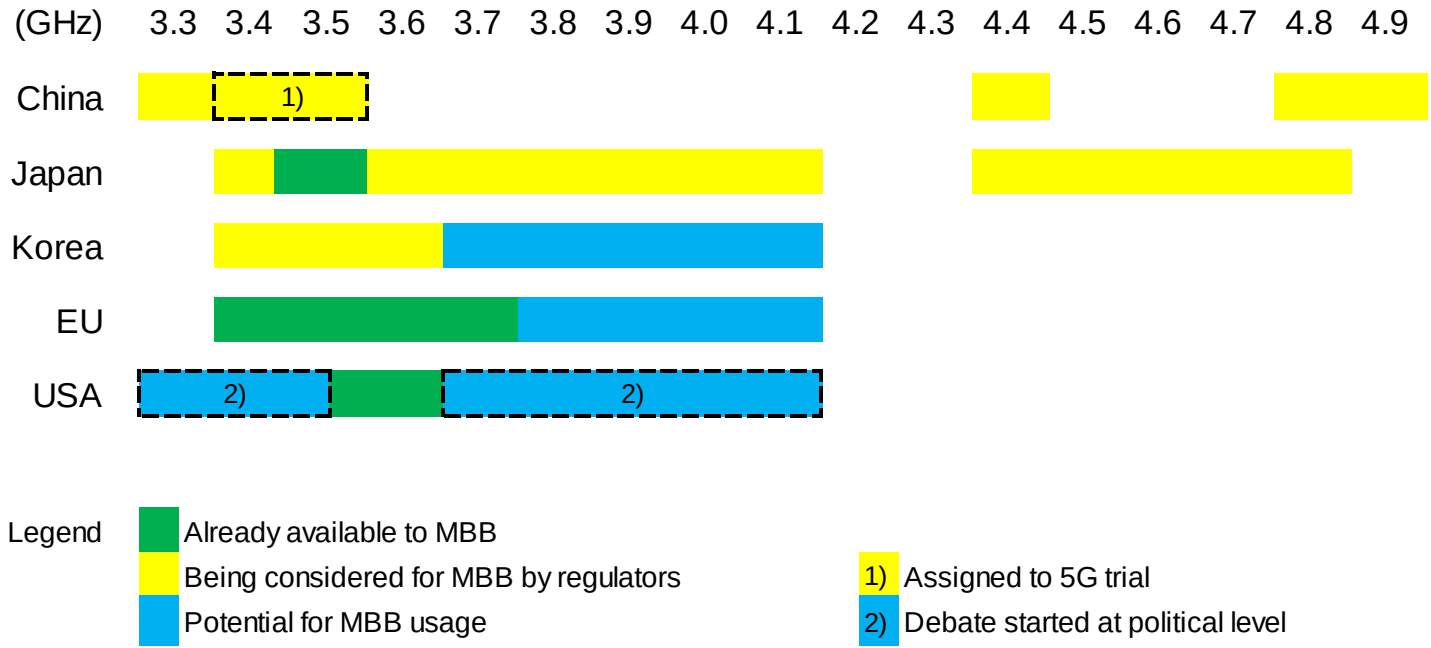
Higher and lower frequencies are both needed to meet multiple use case scenarios



- **Spectrum below 6GHz**
  - **Wider coverage** allowing cost effective delivery of mobile services
  - **Bandwidths** considerably wider (in the order of 100s of MHz) than those of today, providing a combination of capacity and coverage
  - **New bands** below 6GHz should be made available for 5G
- **Spectrum above 6GHz**
  - Needed for applications requiring **extremely high data rates**
  - May accommodate **wider channel bandwidths** (e.g. up to 1GHz per MNO) within a coverage area that may reach 100s meters
  - **Propagation characteristics** may lead to higher spectrum reuse and may facilitate sharing with existing services

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Strong potential for **harmonization for 5G**



Source: Huawei

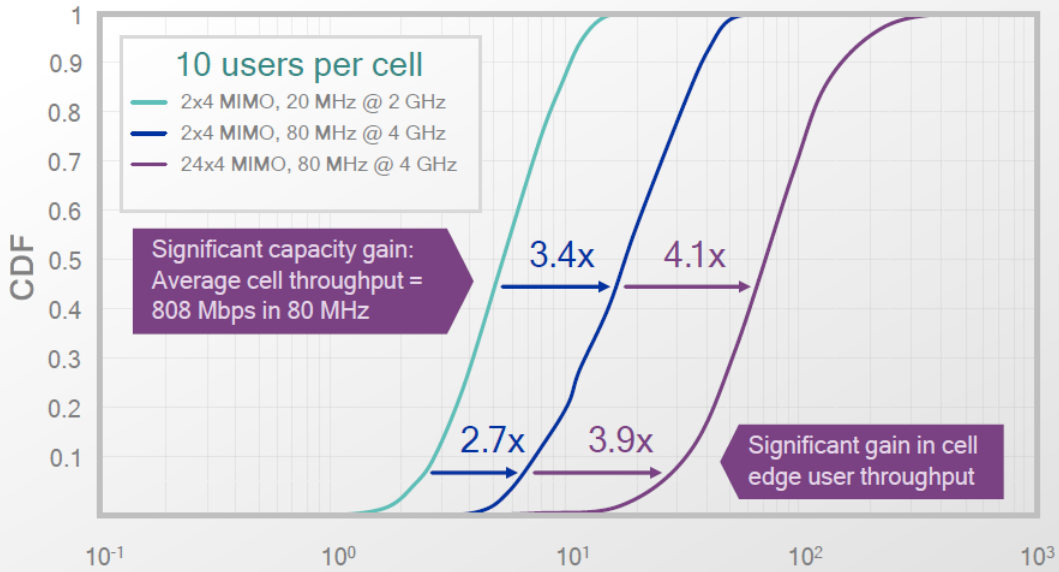
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Massive MIMO at 4 GHz allows reuse of existing sites

Leverage higher spectrum band using same sites and same transmit power



- 1.7 km inter-site distance
- 46 dBm transmit power



Source: Qualcomm Technologies, Inc. simulations; Macro-cell with 1.7km inter-site distance, 10 users per cell, 46 dBm Tx power at base station, 20MHz@2GHz and 80MHz@4GHz BW TDD, 2.4x Massive MIMO

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SPECTRUM BELOW 6GHZ
UHF

Below 1GHz spectrum can cost effectively address 5G usecases for IoT which have lower bandwidth requirements but demanding good coverage

- 700 MHz
  - LTE networks already deployed on this band in some countries, including Australia, New Zealand, Japan
  - European Commission legislative proposal (Feb.'16) for a common schedule for making the band effectively available for wireless broadband by 2020
  - Substantial benefits for 5G if made available before 2020 with a coordinated approach
- 470-694 MHz
  - For 5G deployment in longer term
  - IMT identification in a number of countries during WRC-15
    - Region 2: 470-608 & 614-698 MHz: Bahamas, Barbados, Canada, Mexico, U.S.; 614-698 MHz: Belize, Colombia
    - Region 3: 470-698 MHz: Micronesia, Solomon, Tuvalu, Vanuatu; 610-698 MHz: Bangladesh, Maldives, New Zealand
  - Added to the preliminary agenda for WRC-23 for Region 1

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SPECTRUM ABOVE 6 GHZ
SPECTRUM HARMONIZATION

Spectrum harmonization remains important for the development of IMT as it allows for:

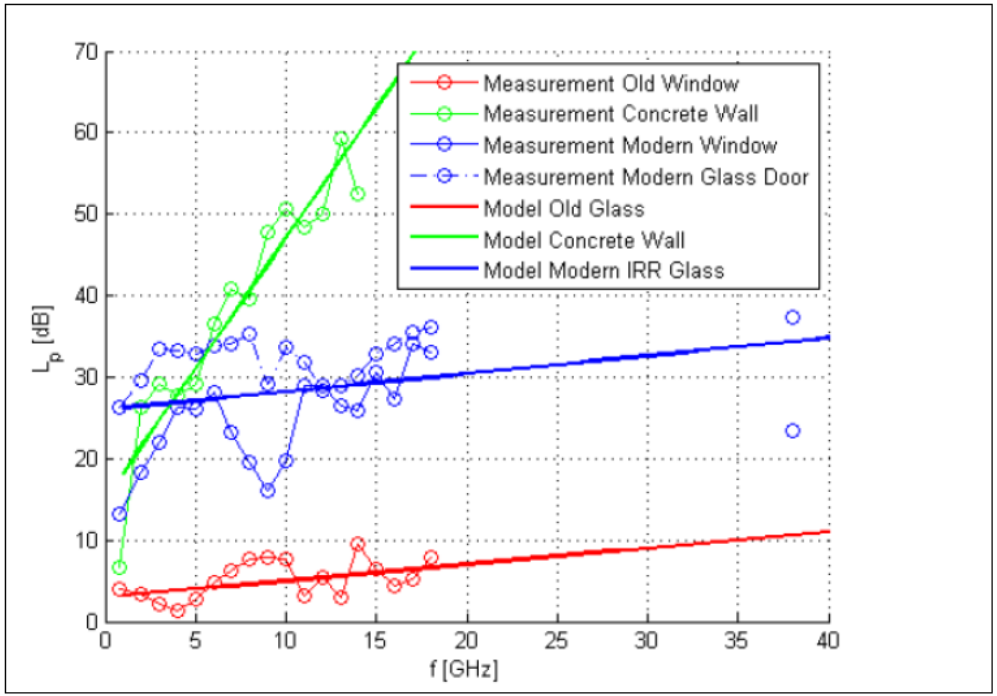
- Adequate economies of scale for cost effective solutions for end users
- Global roaming for end user devices
- Reduced efforts in cross border coordination
- Reduced equipment design complexity, preserving battery life, and improving efficiency in spectrum use
- There may be challenges in the Implementation of multiple sets of radio components to support non-contiguous bands (above 6GHz) in the same device – in the initial stage especially

Spectrum harmonization is even more important for higher frequencies

In order to support the development of the new ecosystem for them.

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Outdoor-to-Indoor challenge



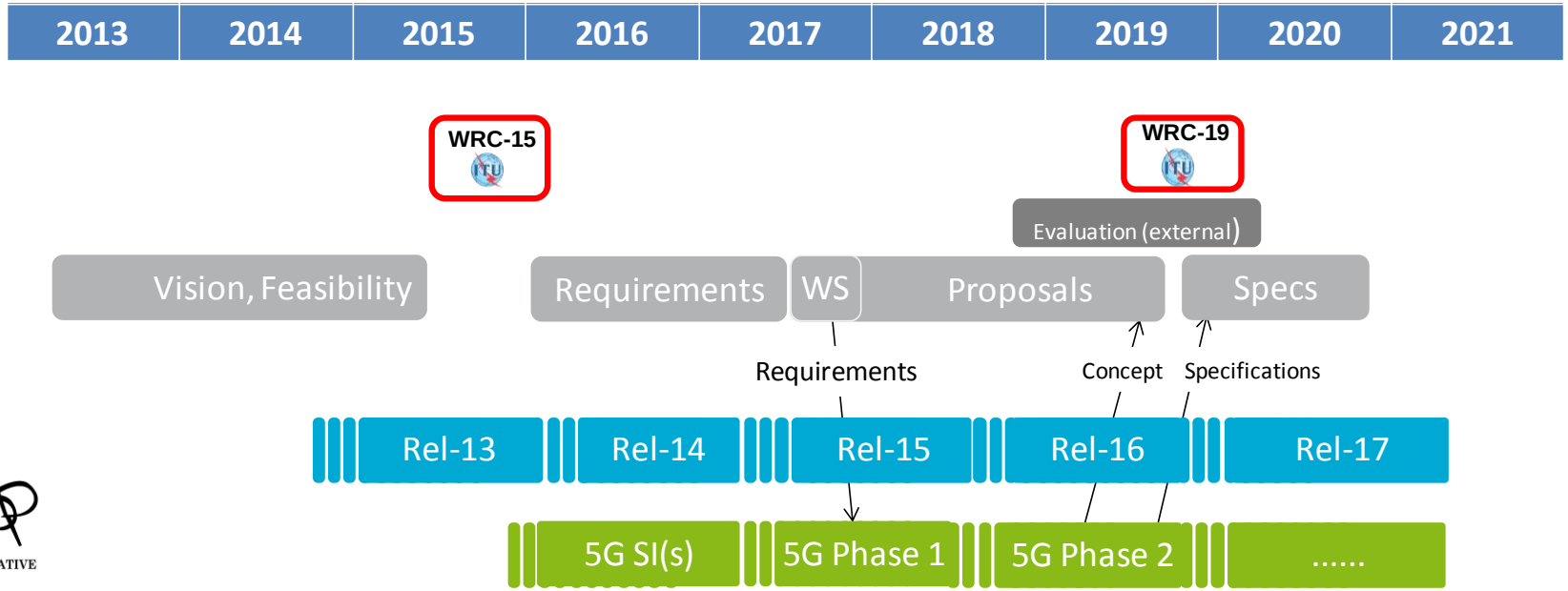
- Indoor penetration loss increases with higher frequency
- Some indoor penetration through windows
- No penetration through concrete walls
- Indoor cells will be needed at cm and mm waves

Source: Nokia

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STANDARDIZING 5G – ITU AND 3GPP

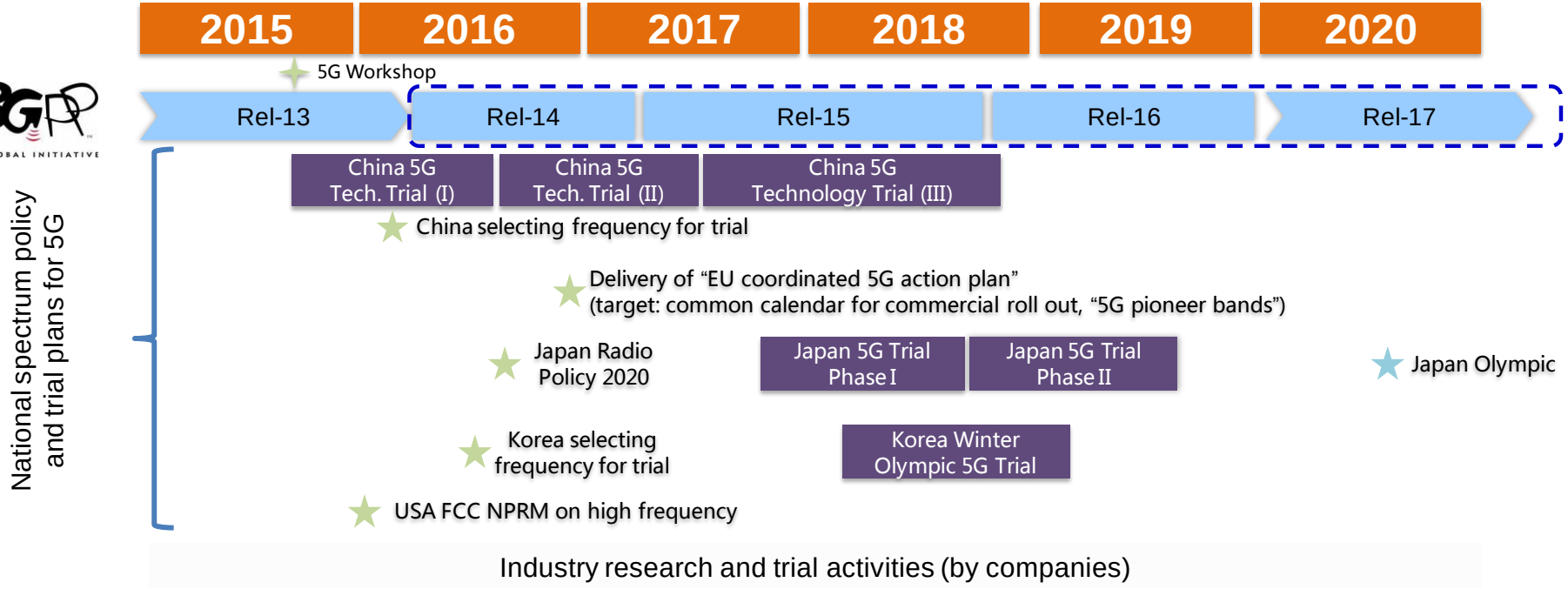
5G standardization time plans



Source: Ericsson

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NATIONAL SPECTRUM POLICY AND TRIAL PLANS FOR 5G



Frequency bands selected or considered:

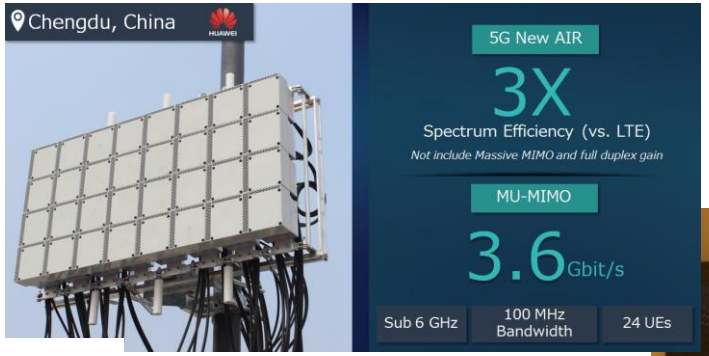
- *China: 3.4-3.6 GHz (for trial); other candidate bands include both sub-6GHz and 24.25~86 GHz*
- *Korea: 26.5-29.5 GHz (for trial; 1 GHz bandwidth per operator); other bands may be decided later*
- *Japan: Radio Policy 2020 will soon be announced; candidate bands include 3.6-4.2, 4.4-4.9, 27.5-29.5 GHz and all the bands in WRC-19 AI 1.13*
- *USA FCC NPRM: 27.5-28.35, 37-40, 64-71 GHz*

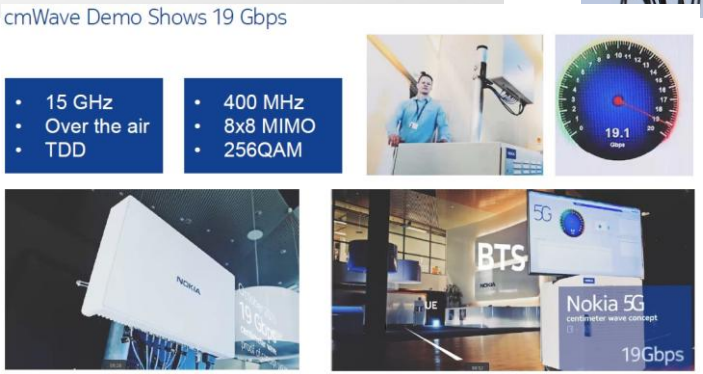
Source: Huawei

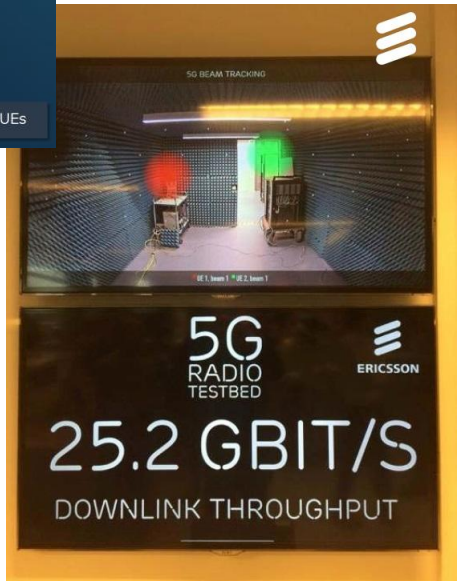
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5G DEVELOPMENT: PROTOTYPE AND TRIALS BY GSA MEMBERS









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SUMMARY

- 5G will provide new applications together with much enhanced user experiences
- 5G: a common network platform to enable ICT transformation serving multiple industry sectors' requirements to communications
- Global harmonization of spectrum for 5G continues being a very key factor for the success of mobile communications
- 5G needs both higher and lower frequencies bands to meet multiple use case scenarios
- GSA Spectrum Group is willing to cooperate with administration and regulators as well as our partners to achieve the goal of a sustainable and successful development of 5G

Thank You!

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