

5G Development and Spectrum

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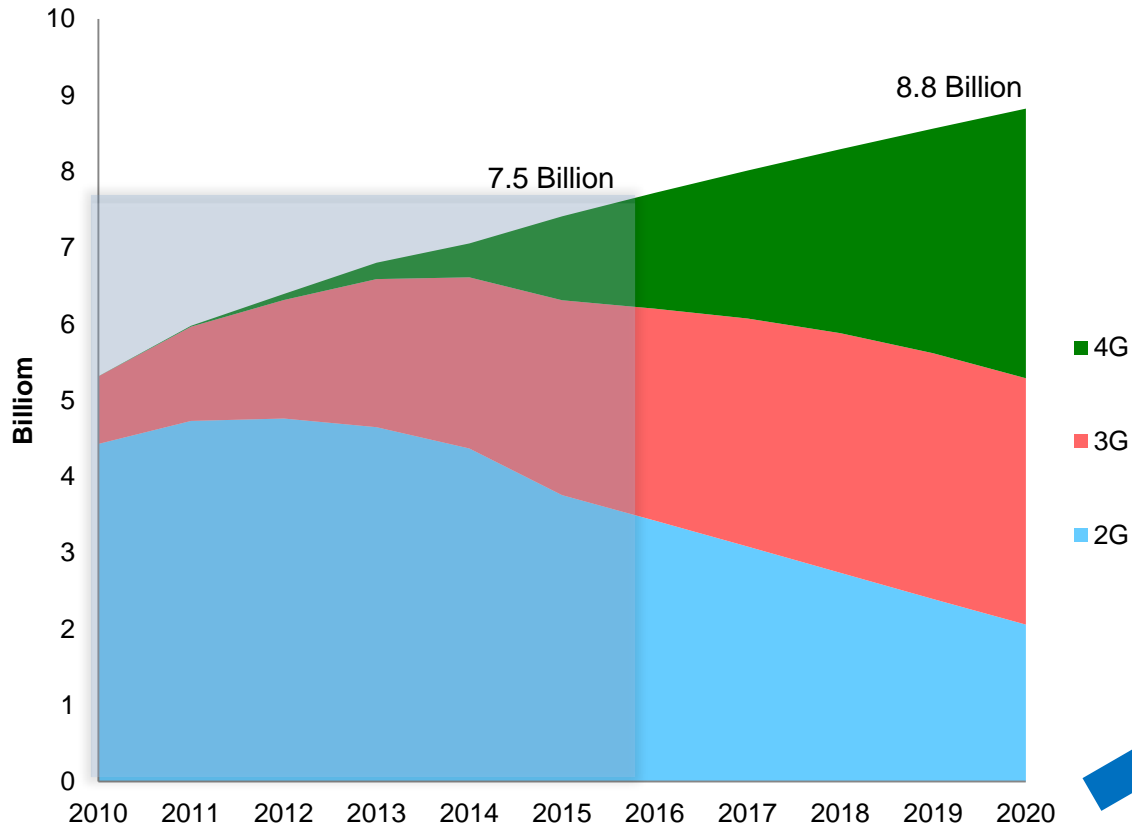
Quan Yu, Chief Strategy Officer, Huawei Wireless Product Line

“Forward Thinking for Spectrum – Getting ready for 5G” workshop
November 16th 2016 at ITU Telecom World, Bangkok



Continuing growth of mobile broadband

Global Mobile Subscribers 2010-2020 (forecast)



Source: Mobile Network Trends, Huawei, November 2015

1.3 billion new subscribers will be connected to mobile networks – mainly 4G/LTE – from 2016 to 2020 (excluding M2M)

5G: commercial deployment will start from 2020

5G vision and spectrum requirements

Low frequency of wide bandwidth

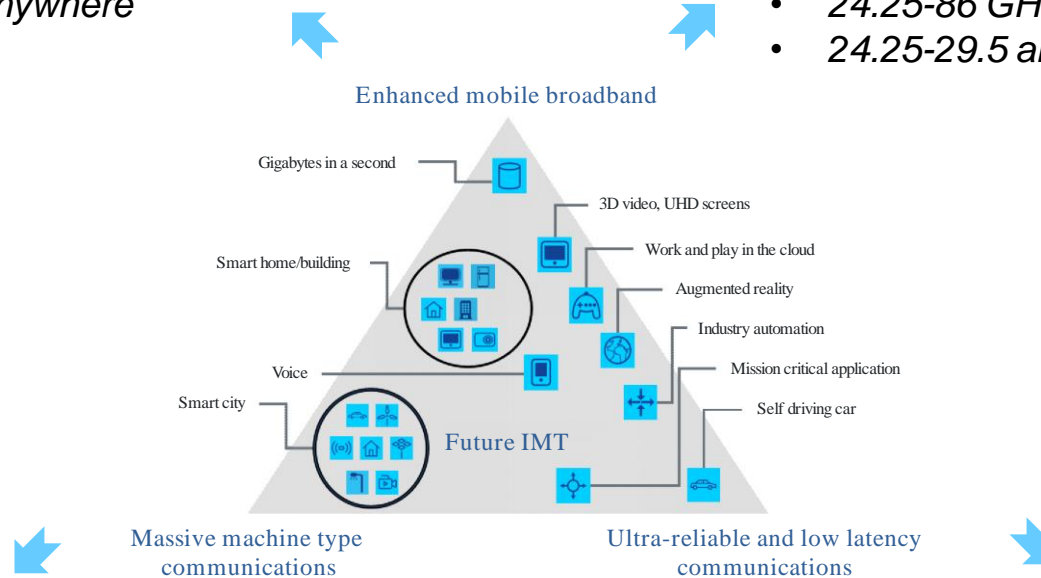
To guarantee user experienced data rate of 100 Mbps anywhere

- C-band

High frequency of very wide bandwidth

For extremely high peak data rate: 20 Gbps

- 24.25-86 GHz range
- 24.25-29.5 and 37-43.5 GHz preferred



Lower frequency (below 1GHz)

Wider and deeper coverage for massive IoT connections

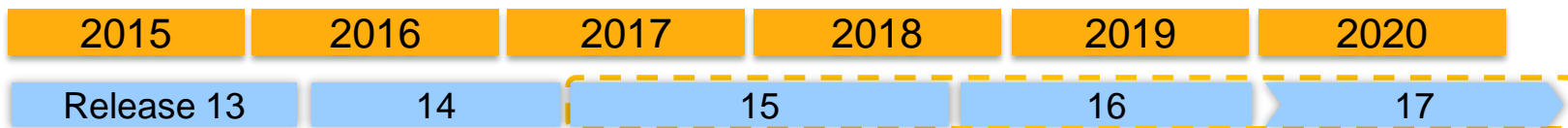
Low frequency preferred

For coverage and reliability

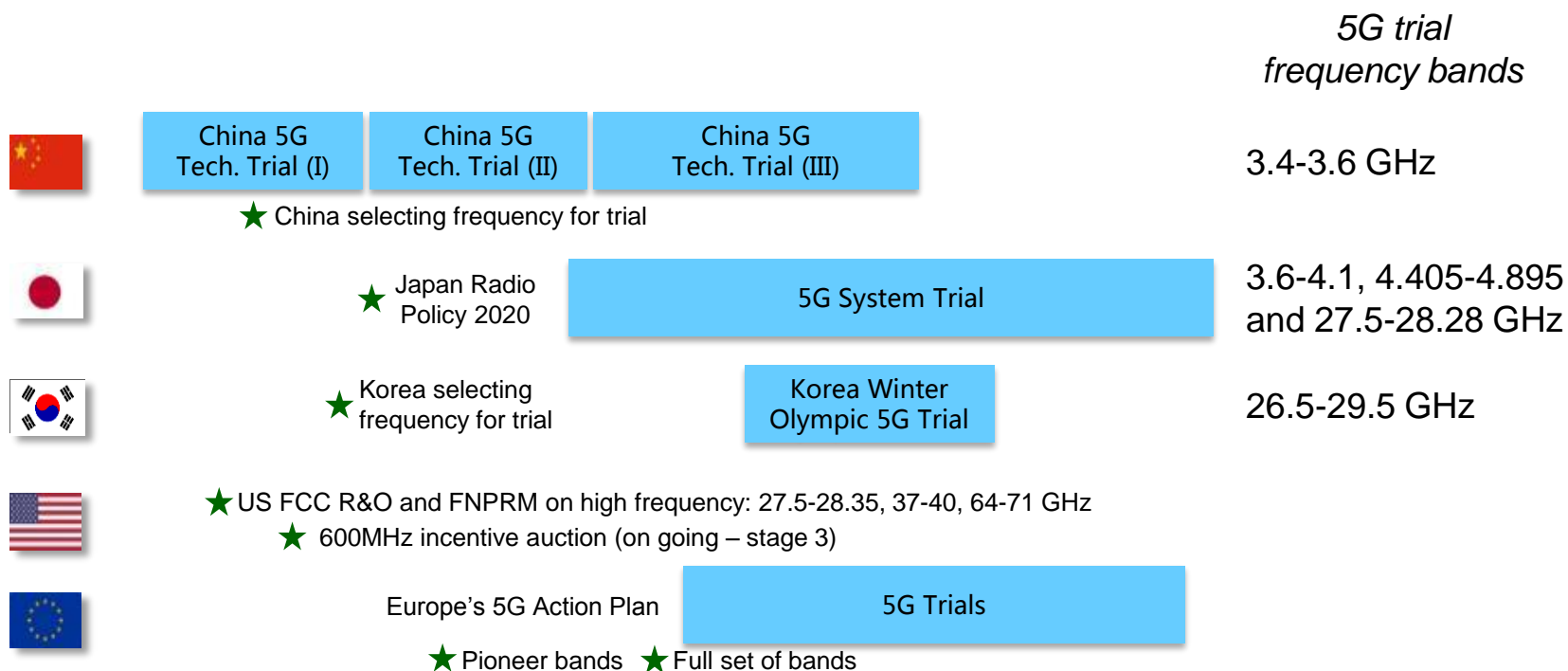
Existing IMT frequency bands should be allowed for 5G

To benefit from very high spectral efficiency and other improved performances

National 5G trial plans and spectrum

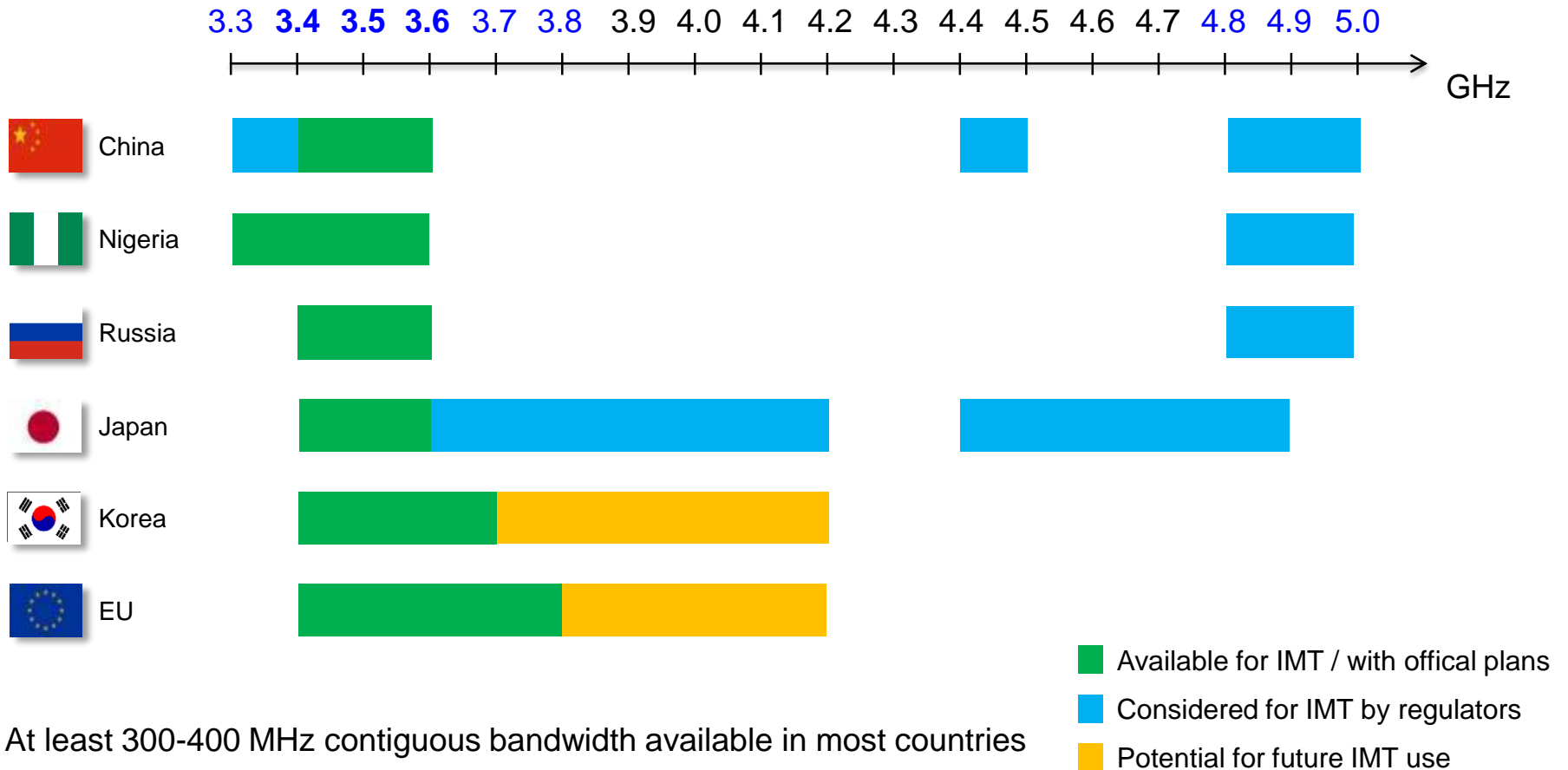


National 5G trial plans and spectrum



Industry research and trial activities (by companies) Various bands used for industry 5G trials

C-Band: potential for 5G globally

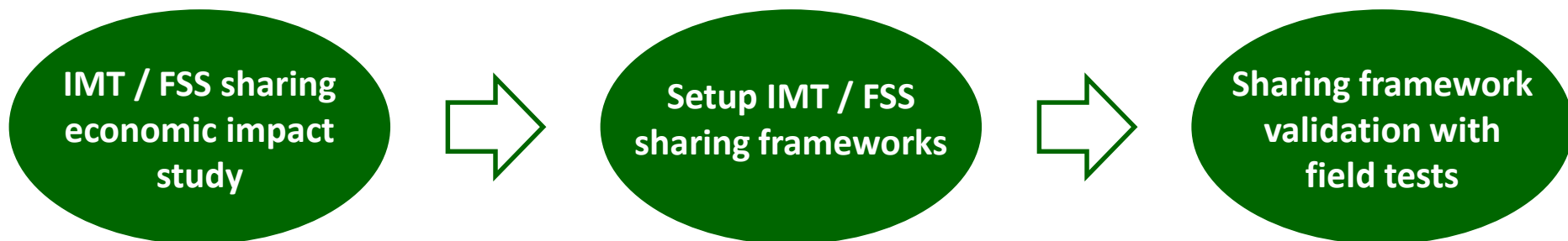


At least 300-400 MHz contiguous bandwidth available in most countries

- 100 MHz and more contiguous assignment per MNO
- Support 5G user experienced data rate of 100 Mbps anywhere

C-band: sharing with incumbent services is feasible

- A 3-steps approach to facilitate releasing C-band for IMT while protecting satellite and fixed link services where protection is required
- CEPT developed regulations and operational guidelines to enable IMT usage on C-band
- Results from field tests show: IMT operation on C-band while protecting incumbent services is clearly feasible



- Study for mega-cities in Europe and Asia: MBB capacity crunch will start to occur in 2020 if C-band is not released ¹⁾
- Benefit of deploying 3.4-4.2 GHz in the UK is estimated: at least Euro 1.4B ²⁾

ECC Report 254: Operational guidelines for spectrum sharing to support the implementation of the current ECC framework in 3600-3800 MHz range

Field tests are in progress

References:

- 1). GSMA Report, http://www.gsma.com/spectrum/wp-content/uploads/2015/10/GSMA_C-Band_Report.pdf
- 2). PLUM Report, http://plumconsulting.co.uk/pdfs/Plum_Jun2015_Use_of_C-Band_for_mobile_broadband_in_Hungary_Italy_Sweden_and_UK.pdf

Lower frequency bands (below 1 GHz) is critical

Below 1GHz spectrum can cost effectively address massive M2M communications which have lower bandwidth requirements but demanding wider and deeper coverage

Coverage requirements for mMTC



Wider



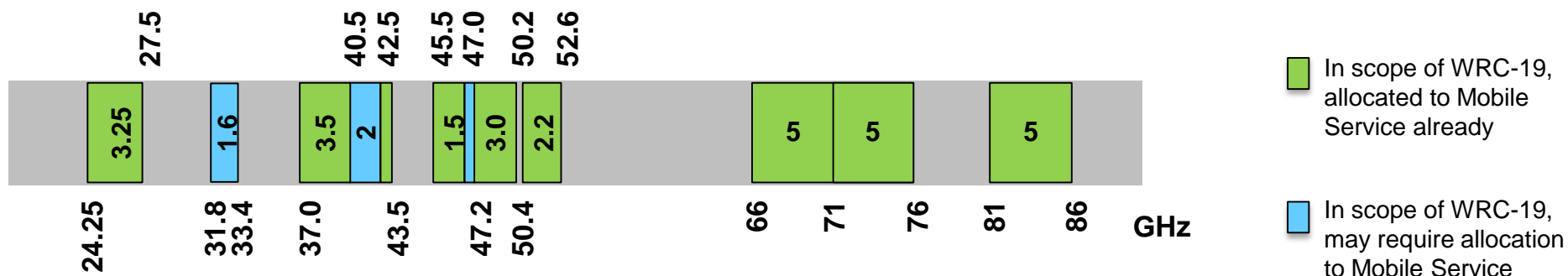
Deeper

- 700 MHz band
 - LTE-Adv. deployment started
 - EU may label this band for 5G
- Sub-700 MHz band
 - The US incentive auction is in progress
 - APT and CITELE studies on band plan

Regulatory update to allow 5G on existing IMT frequency bands

- For efficient usage of spectrum resources: 5G spectral efficiency is at least 3 times high of 4G
- Existing IMT bands, in particular those below 1 GHz, have similar propagation characteristics as 700 MHz, which can support 5G coverage requirements, not only for mMTC, but also for URLLC and eMBB

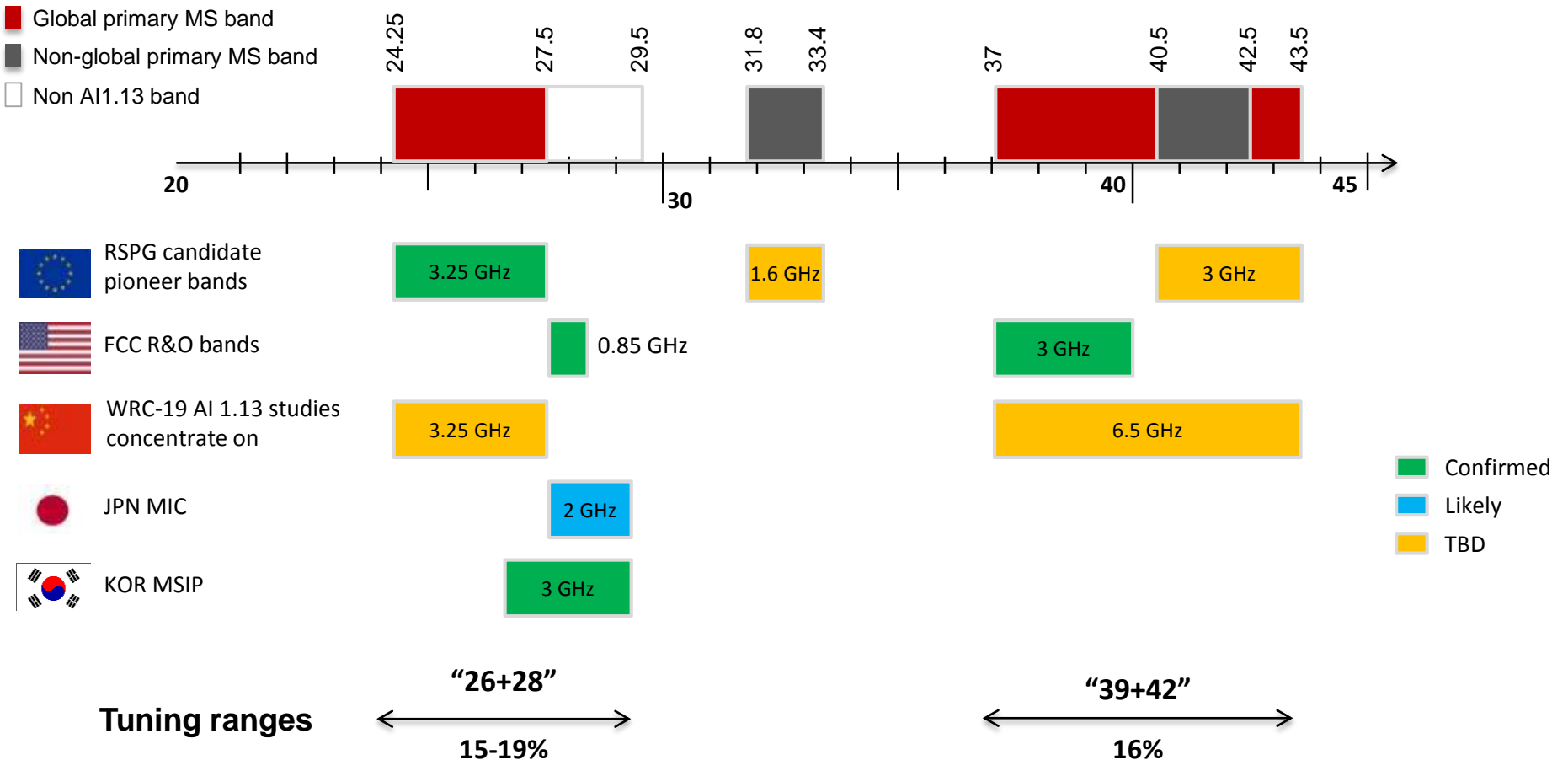
Bands above 6 GHz to meet extremely high data rate



- Bands between 24.25 GHz and 86 GHz are being studied for [WRC-19](#) (AI 1.13)
- Spectrum harmonization remains important for 5G development on high frequencies
 - 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](#)

Source: GSA

24.25-29.5 GHz and 37-43.5 GHz as pioneer bands



The 24.25-29.5 & 37-43.5 GHz are the most promising bands for early 5G commercialization

Sub6G Multi-User Field Trial

World's First Large Scale Trial



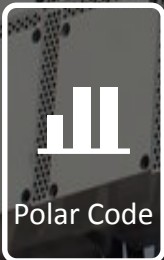
SCMA

UL **3X** connections
DL **>1.5X** throughput



F-OFDM

Saving guard band
Asynchronous transmission



Polar Code

0.5~1.2dB gain compared
with LTE Turbo Code



MU-MIMO

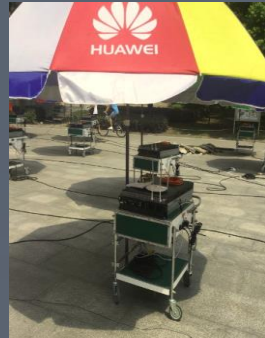
24 layers
3.6Gbps Peak Rate per cell

Chengdu (China)

24 TUE

Sub6GHz

100MHz



High & Low Band Hybrid Networking

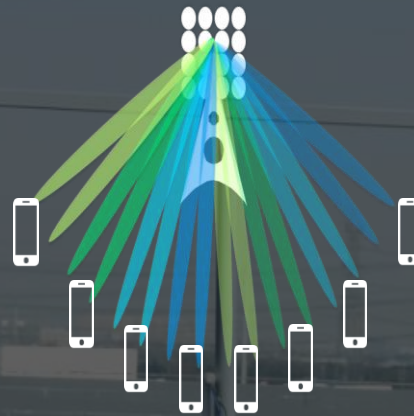
High Spectral Efficiency

C-band MU-MIMO



- **10+Gbps**@200MHz BW
- 3D Beamforming
- **26 Layers**

cmWave MU-MIMO



- **40+Gbps**@1GHz BW
- 8 Users
- **16 Layers**

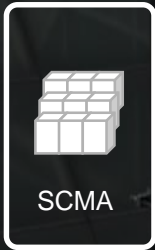
C-band & cmWave Dual Connectivity



- **5Gbps+15Gbps**
- 8 + 8 Layers

Joint Efforts to Bring 5G into Reality

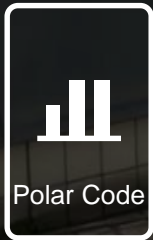
5G NR Technologies Trial



SCMA



F-OFDM



Polar Code

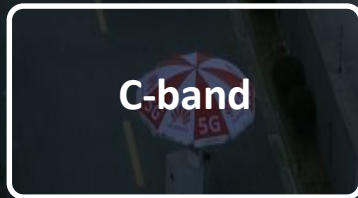


MU-MIMO

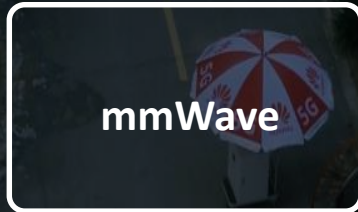


UCNC

Full Spectrum Access Field Trial



C-band



mmWave

5G Network Architecture Trial



Network Slicing



CloudRAN



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Summary

- To make the IMT-2020 Vision into reality, 5G needs spectrum below and above 6GHz
- Low frequency of wide bandwidth
 - To guarantee the required user experienced data rate of 100 Mbps
 - **3.3-3.8 GHz and 4.8-4.99 GHz bands**: for global / regional developments
- High frequency of very wide bandwidth
 - For extremely high peak data rate
 - **24.25-29.5 GHz and 37-43.5 GHz bands**: pioneer high frequency bands
- **Frequency below 1GHz**
 - Wider and deeper coverage for massive IoT connections
- Regulatory update to allow 5G on **existing IMT frequency bands**
 - To provide 5G services of eMBB, mMTC and URLLC while benefiting from very high spectral efficiency

Thank you

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