5G SPECTRUM
OPPORTUNITIES & CHALLENGES

REZA AREFI
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EVOLUTION TO A SMART AND CONNECTED WORLD

2G

Cellular Comms.

Few MHz
< 1 GHz

3G

Data and the emergence of apps

10s of MHz
< 2 GHz

4G

Faster data rates
The app revolution

Several 10s of MHz
< 4 GHz

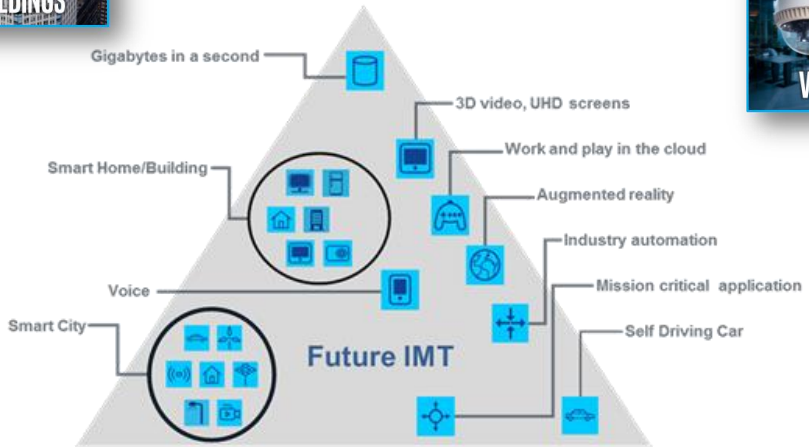
5G

Reactive, smart, and connected devices

Several 100s of MHz
From < 1 GHz to > 70 GHz

5G: USAGE SCENARIOS AND SPECTRUM

Enhanced Mobile Broadband



Massive Machine Type Communications

Ultra-reliable, Low-latency Communications

Source: Recommendation ITU-R M.2083 “IMT Vision - Framework and overall objectives of the future development of IMT for 2020 and beyond”

Enabling new “5G” applications requires access to a variety of spectrum bands: low, mid, and high frequencies)

SPECTRUM NEEDS OF 5G

Access to sufficient spectrum in a variety of bands with economies of scale is key to success in 5G

5G applications drive technical requirements, including type and amount of spectrum

< 1 GHz – for wide area applications, e.g. sensor networks, etc.

< 6 GHz – for coverage/capacity trade-off, e.g. massive MIMO, outdoor-to-indoor

Higher – for apps needing ultra-wide channels, e.g. 4k/8k video, VR, etc.

Continuous flow of sufficient, adequate, new spectrum is key to:

Expansion of wireless market to 5G and beyond, and

Building a strong and healthy eco-system

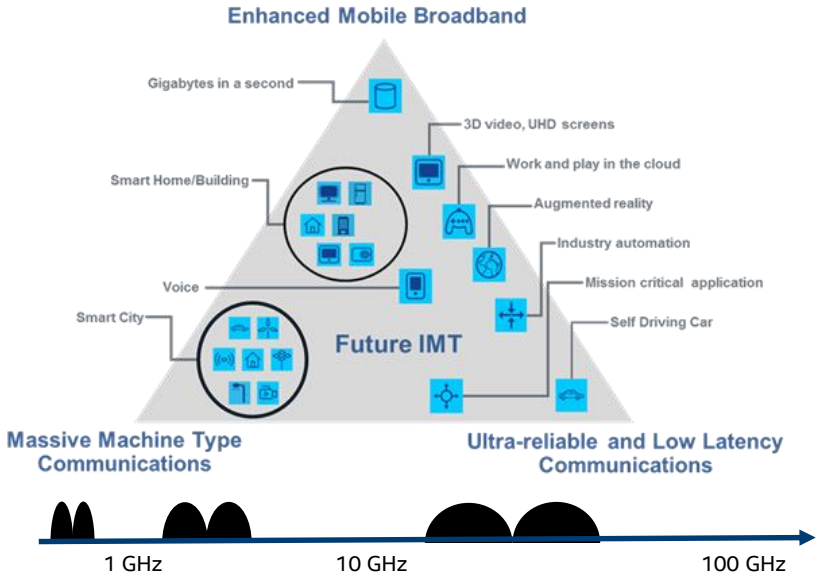
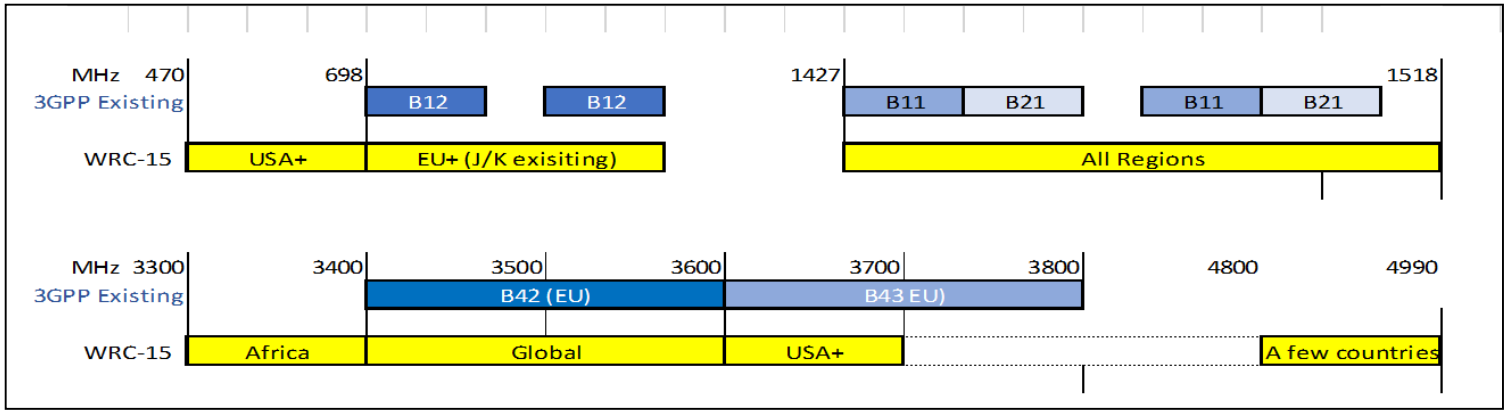


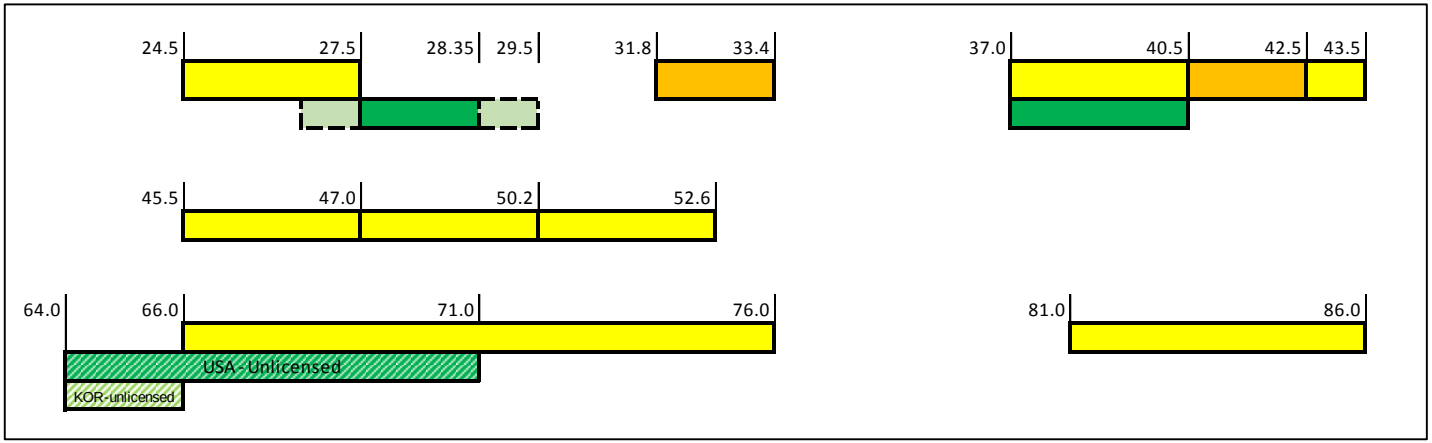
Image Source: Recommendation ITU-R M.2083 “IMT Vision - Framework and overall objectives of the future development of IMT for 2020 and beyond”

WRC-15 OUTCOMES BELOW 6 GHZ



Crucial to make sufficient spectrum sub 6 GHz available in a timely manner to enable 5G.

BANDS ABOVE 6 GHZ TO BE STUDIED TOWARDS WRC-19



Primary Mobile Allocation Exists | No Primary Mobile Allocation | FCC Spectrum Frontiers Bands

ITU-R will study the above bands (yellow, orange) to prepare for WRC-19

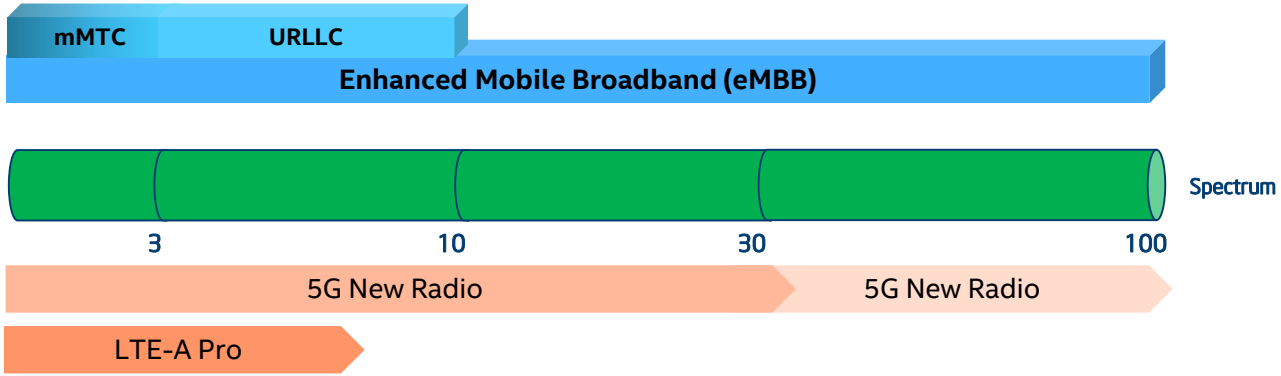
If approved by WRC-2020, timeframe of availability ~2020+

USA and some other countries are going forward with 28 GHz in 2016-2018 timeframe

Challenge

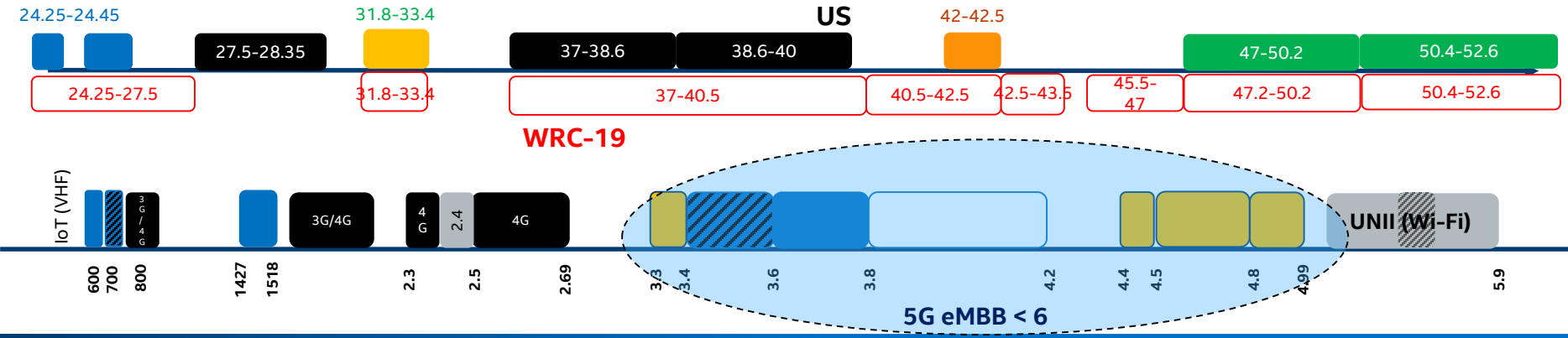
Sharing conditions are expected to be difficult in some bands under study

TECHNOLOGY AND SPECTRUM IN 5G ERA



Sub-6GHz to 100GHz with scalable bandwidth

Multi-band and multi-mode support



5G AND THE INTERNET OF THINGS

By 2016...

6.4B connected things[1]

By 2019...

$1.3T worldwide spending on the Internet of Things[2]

By 2020...

8.6B connected things in Asia Pacific[3]

1 Gartner Group http://www.gartner.com/newsroom/id/3165317
2 Worldwide Semiannual Internet of Things Spending Guidhttp://www.idc.com/getdoc.jsp?containerId=IDC_P29475
3 IDC http://www.idc.com/getdoc.jsp?containerId=prHK25553415

SPECTRUM NEEDS OF IOT

How much spectrum does IoT need?

- Determined by each application's throughput, but also latency, requirements
  - For a given spectral efficiency (b/s/Hz), the lower the latency requirements the larger the bandwidth needed to send a given amount of data
- While many IoT applications might not need high speed connections and/or have very stringent latency requirements, some might

And in what frequency bands?

- Determined by each application's range and coverage requirements, but also bandwidth needs of the applications
- Range and coverage requirements also depend on deployment scenarios
  - Point-to-point, mesh, broadcast, multi-cast, etc.

DEDICATED "IOT" SPECTRUM?

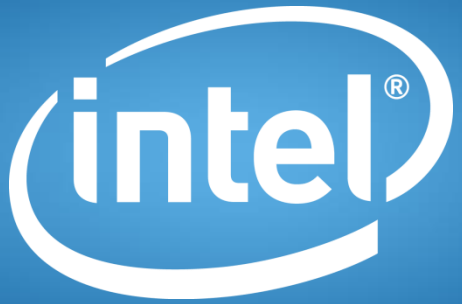
Pros

- Global harmonization of spectrum increases economies of scale
- Dedicated spectrum might help lower spectrum management risks

Variety of existing bands (cellular, unlicensed) could emerge through industry consensus in leading markets without any WRC action

Cons

- Achieving global harmonization on band(s) for IoT might prove very difficult, if not impossible
- Need for ITU-R/WRC action on dedicated spectrum could delay deployments and implementations
- Many gov'ts strongly opposed to dedicated spectrum for IoT
- Increases the risk of more dedicated spectrum – less flexibility



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