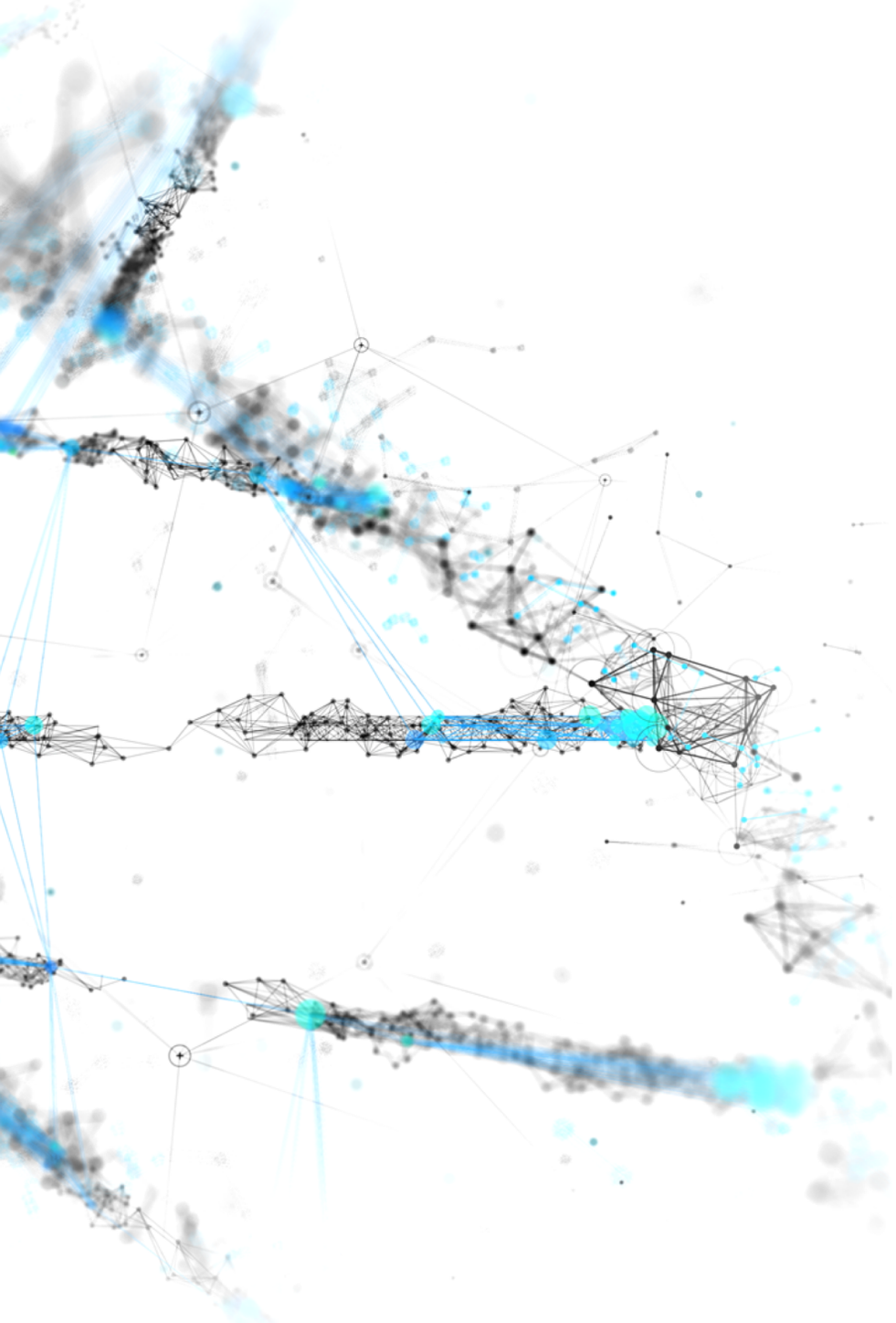

WRC-19

Drivers of the varied Positions- who matters, what matters

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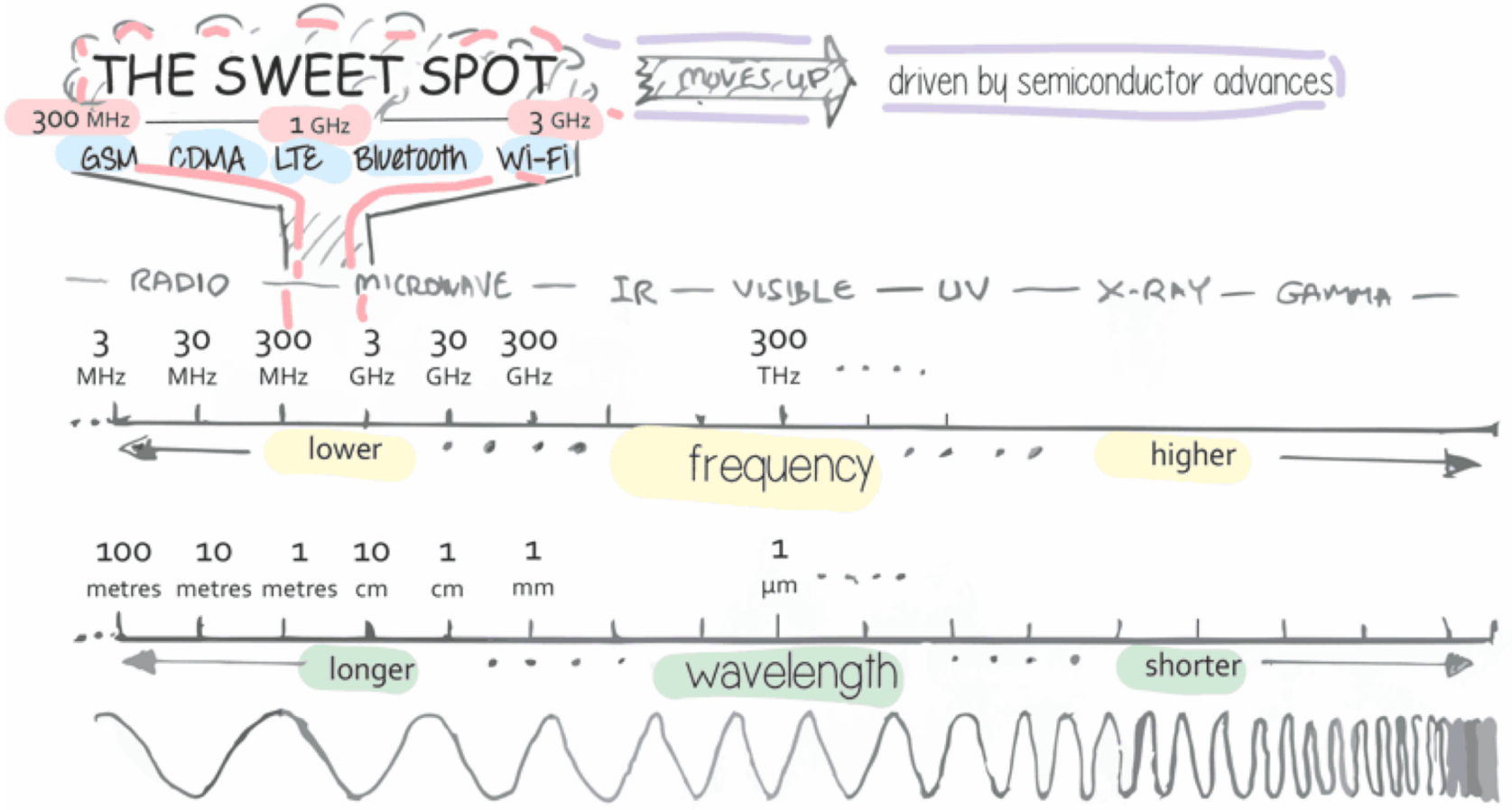
PACIFIC TELECOMMUNICATIONS COUNCIL
PTC'19 | FROM PIPES TO PLATFORMS
20–23 January 2019 | Honolulu, Hawaii

Questions

- What are the drivers to the current regional positions, with respect to A.I. 1.13?
- What are the prospects for international agreements at WRC-19, with respect to A.I. 1.13?

Why WRCs are important ?



Different bands have different characteristics

- **Lower frequency** signals reach further beyond the visible horizon, and are better at penetrating rain or buildings (operators can **serve a larger area** with one base station)
- Capacity of wireless connection for is dependent on the channel bandwidth (amount of spectrum it uses). **Wider channel bandwidths** are more readily available **at higher frequencies**.
- A network that uses **higher frequency capacity bands** requires **more base stations** to cover the same area, resulting more investment.

Countries failed to find globally harmonized band for <1G band

- 700 MHz Digital Dividend spectrum
  - APT BAND 703-803 MHz (Americas and parts of Asia Pacific)
  - EMEA BAND 694-790 MHz (Europe, Russia, Middle East and Africa)
- Similar issues on Digital Dividend 1 (800 MHz) band
- Similar story for 1-6 GHz Band
- Problem is :
  - Bands were already allocated without global coordination
  - Harmful Interference

ITU proposes, nation disposes

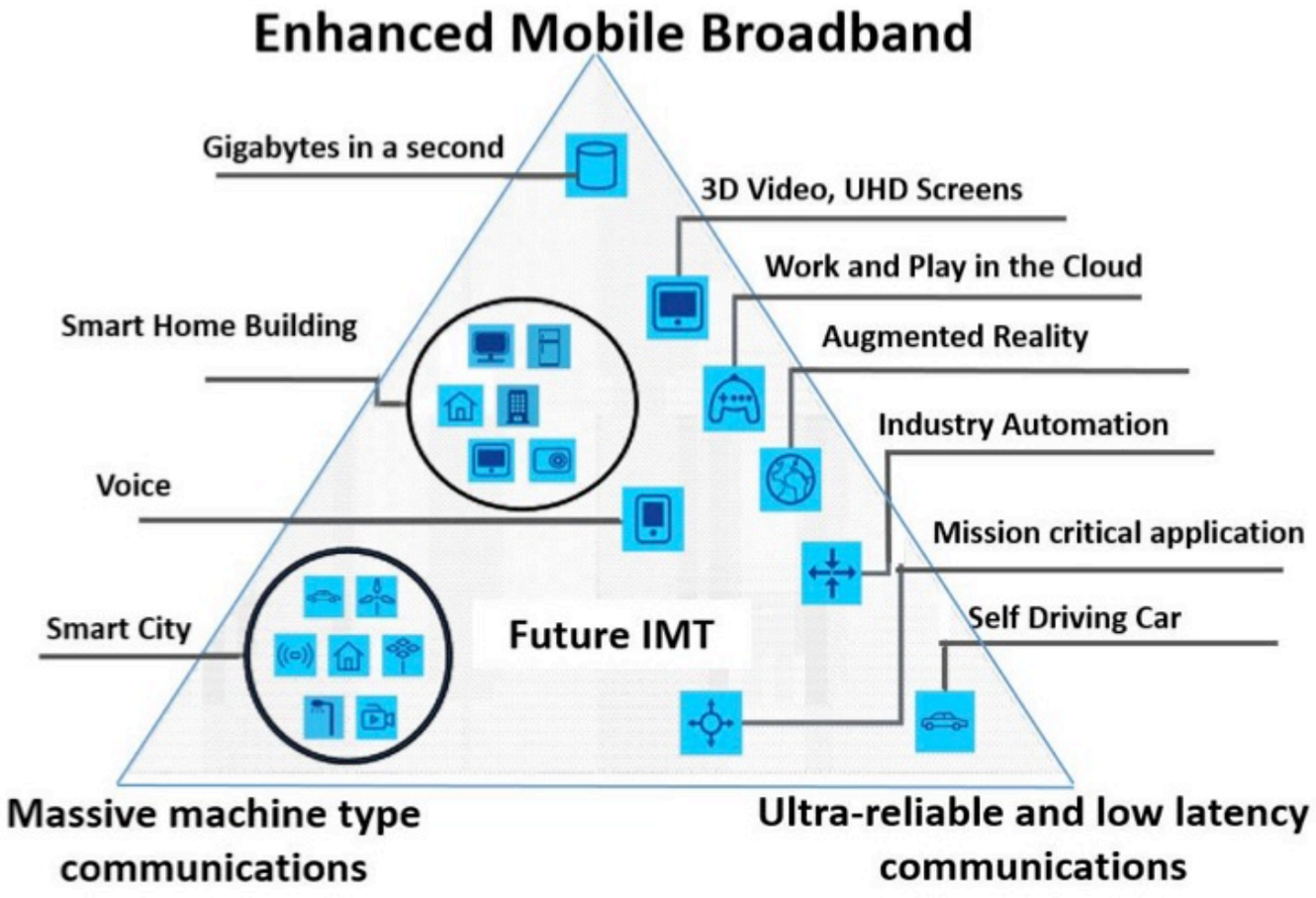
- **Agenda item 1.13:** To consider identification of frequency bands for the future development of International Mobile Telecommunications (IMT), including possible additional allocations to the mobile service on a primary basis, in accordance with Resolution 238 (WRC-15)
- Band allocation is difficult, countries need to agree
- Often they don’t
- But for 5G will they ?

What can WRC do ?

- The WRC reviews and revises the Radio Regulations (RR), which comprise the global International Telecommunications Union (ITU) treaty for radio spectrum.
- The WRC can perform two important functions regarding 5G :
- it could **designate** a mobile allocation for certain bands
- it can “**identify**” that a specific spectrum band may be used for International Mobile Telecommunications (IMT)

Mobile is becoming better !
5G needs more band capacity !

- Enhanced Mobile broadband service (**eMBB**)
  - -per-connection peak, speed, network capacity
- Massive machine type communications (**mMTC**)
  - -scalability to very large number of connections
- Ultra-reliable/low latency communications (**URLLC**)
  - - reliability, latency (mission-critical)



[Figure: www.itu.org]

Spectrum bands for 5G (need 80-100 MHz of contiguous spectrum in mid bands, around 1GHz per operator in millimeter bands)

- Sub- 1G
  - 700 MHz, 800 MHz, 900 MHz, Already used by mobile
  - Will support widespread coverage across urban suburban and rural areas and help support IoT
- 1-6 GHz (mid bands)
  - 1.7 GHz, 1.8 GHz, 1.9 GHz, 2.1 GHz, 2.3 GHz, 2.6 GHz Already used by mobile
  - Good mixture of coverage and capacity. 3.3-3.8 GHz is expected to form the basis of many initial 5G services
- Above 6 GHz (millimeter bands)
  - Ultra high broadband. Currently 26 GHz and 28 GHz bands have most international support

[Info from GSMA 2018: 5G spectrum Positions]

Bands of A.I 1.13

- Key issue : establishing International agreement on 5G bands above 24 GHz
- Protection of services to which the band is allocated to the mobile service on a primary basis :
  - 24.25-27.5 GHz
  - 37-40.5 GHz
  - 45.5-47 GHz, 47.2-50.2 GHz, 50.4-52.6 GHz, 66-76 GHz and 81-86 GHz
- Protection of services which may require additional allocations to the mobile service on a primary basis
  - 31.8-33.4 GHz, 40.5-42.5 GHz and 47-47.2 GHz

So what are the drivers for the spectrum band choices (globally)?

- IoT and AI based technologies are already in the immerging markets
- Most of the countries kept above 6GHz mostly unoccupied
  - Regulators were mostly worried about <1GHz
  - Few influential countries wants win the 5G IoT race
  - Govts wants to back their mobile companies operating in their markets
- Regional organizations are influenced by influential countries
  - Origin countries of vendors and operators are the leaders
  - In APT China, Japan, Korea are the leading
- Different technologies need different spectrum bands for their operation
  - It is not only about QoS problem anymore
- International organizations of vendors and operators are ever more persuasive
  - Joint research publications backed by vendors from around the world

New Technologies are proliferating our surroundings- 5G will make it better

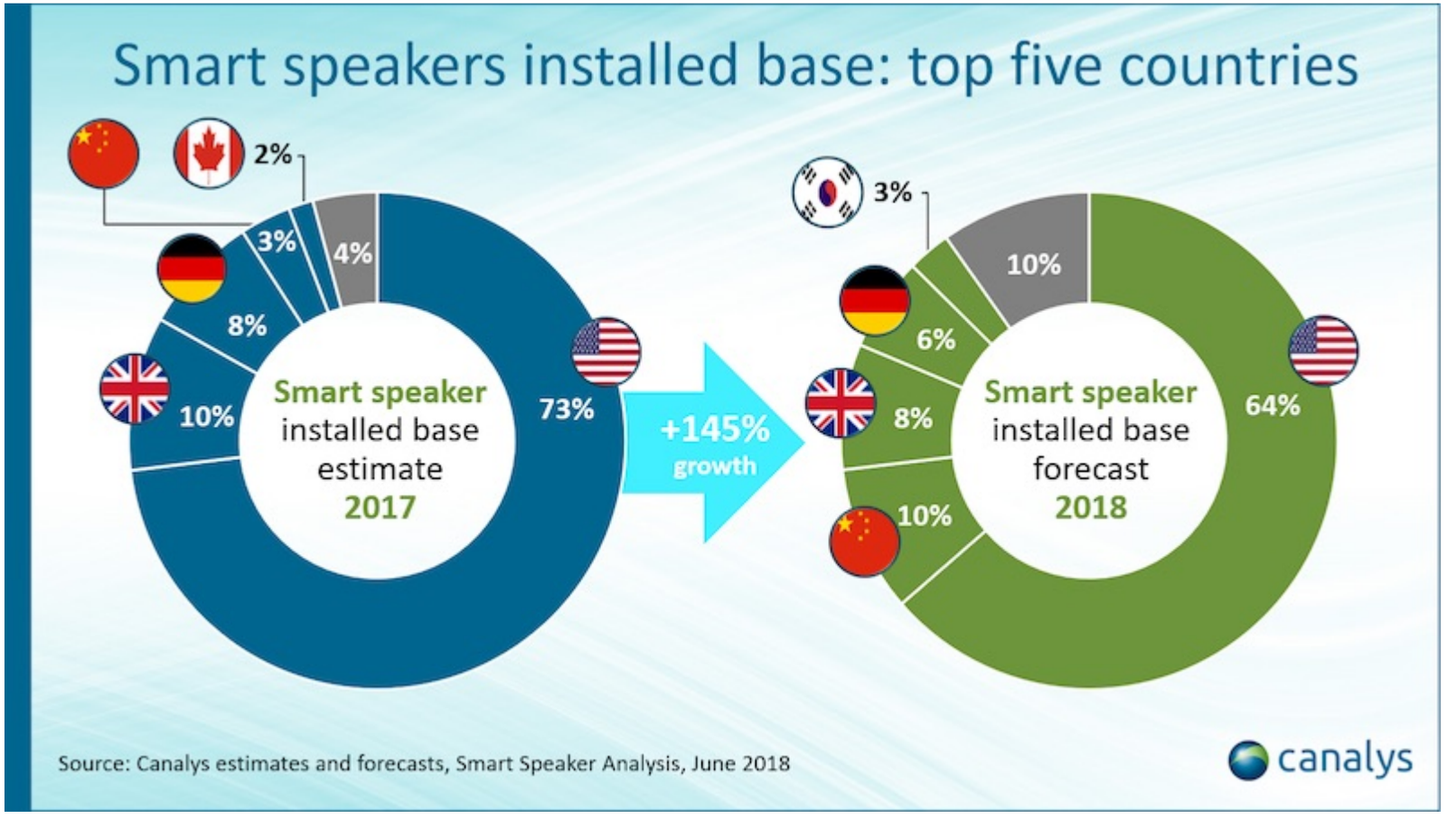
Agricultural insurance - Kenya

*An automated weather station installed in East Africa. The station collects and automatically transmits measurements to the **Kilimo Salama** cloud-based server every 15 minutes.*

Rio de Janeiro City Hall Operations Centre to manage complex city environments, incidents and emergencies. sensors contribute to data feeds about weather, traffic, police and medical services in real-time

World will become flat very soon (technology will drive)

- More countries in purchasing spree
- Technology adoption is increasing
- New technologies are well received in the developing world
- Harmonized bands are needed for economies of scale



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Many countries did not think of allocating the high–bands until 5G came

- Above 6GHz band not in the conventional “sweet spot”
- WRC-15 clearly defined their possible use

The table shows : WRC-15 decision on High-Band spectrum to be studied for consideration at WRC-19 (From : 5G Americas 5G spectrum recommendation)

Band	Action	Future activity
24.25-27.5 GHz	Existing allocation to mobile on primary basis	Sharing and compatibility studies for IMT identification
31.8-33.4 GHz		Consider a mobile allocation & IMT identification
37-40.5 GHz	Existing allocation to mobile on primary basis	Sharing and compatibility studies for IMT identification
40.5-42.5 GHz		Consider a mobile allocation & IMT identification
42.5-43.5 GHz	Existing allocation to mobile on primary basis	Sharing and compatibility studies for IMT identification
45.5-47 GHz	Existing allocation to mobile on primary basis	Sharing and compatibility studies for IMT identification
47-47.2 GHz		Consider a mobile allocation & IMT identification
47.2-50.2 GHz	Existing allocation to mobile on primary basis	Sharing and compatibility studies for IMT identification
50.4-52.6 GHz	Existing allocation to mobile on primary basis	Sharing and compatibility studies for IMT identification

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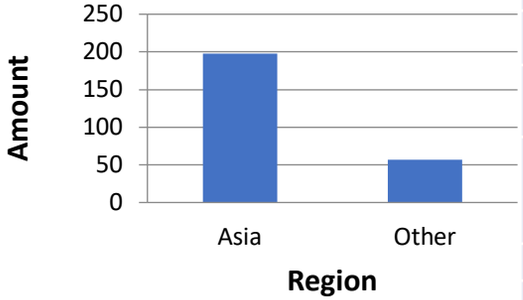
China, Korea, Japan are the Top manufacturers

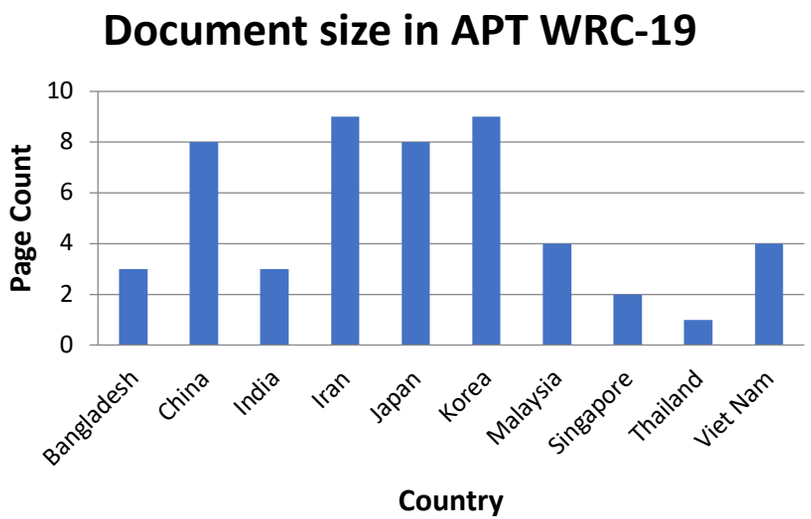


2018 Top Global Cell phone making companies

1	Huawei (China)
2	Lenovo Group (Hong Kong)
3	Xiaomi Tech (China)
4	ZTE (China)
5	Panasonic (Japan)
6	Philips (Netherlands)
7	Samsung Electronics (South Korea)
8	Acer (Taiwan)
9	Apple (US)
10	BLU products (US)
11	FT Group (Vietnam)
12	Bullitt Group (UK)
13	Microsoft Mobile (US)
14	Google Nexus (US)
15	Blackberry (Canada)

*Data source : http://www.worldstopexports.com/cellphone-exports-by-country/

Countries hosts most vendors/operators are more interested to contribute in working groups?



We counted number of pages of country position papers, presented for **APG19-3**

Big countries (China, Japan, Korea, Iran) create larger coalitions that has more weight during negotiations ?

APT Countries that manufactures mobile phones (2018)

*Ref: htt

Country representation in the APT working group for WRC-19 (APG 19) shows some countries are not it the team !

- APT has 38 members, 4 associate members. NRAs are encouraged to participate in regional activities for WRC preparation in order to resolve differences prior to WRCs

But

- What is the distribution of officials based on their country origin ?
  - Chairman : Republic of **Korea**
  - Vice chairman : Australia, **China**,
  - Editorial Chairman : New Zealand
  - Special Senior adviser : **Iran**
  - Working party chairmen: **China** 10 , Thailand 1, **Indonesia** 7, **Japan** 7, **Korea** 3, **Iran** 3, New Zealand 1, Malaysia 1, Viet Nam 2, Australia 1

[Info from : Preparation of the API for WRC-19 presentation available at www.apt.org]

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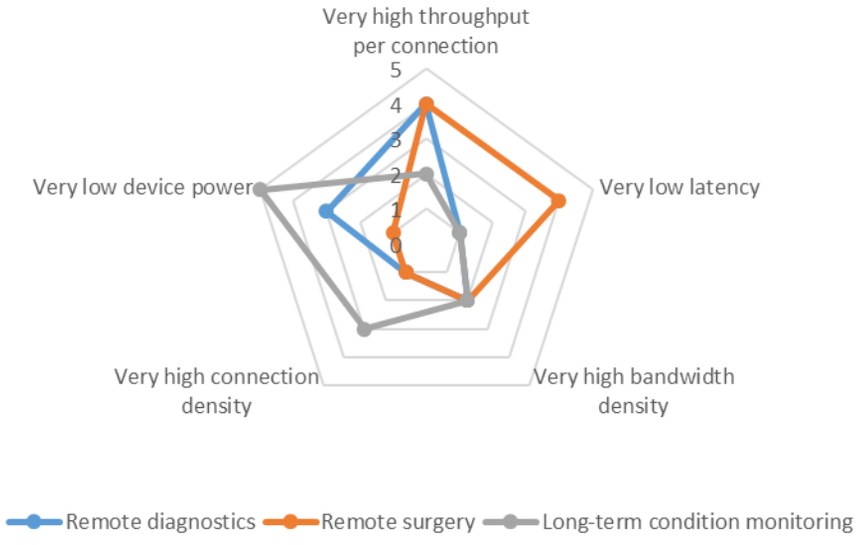
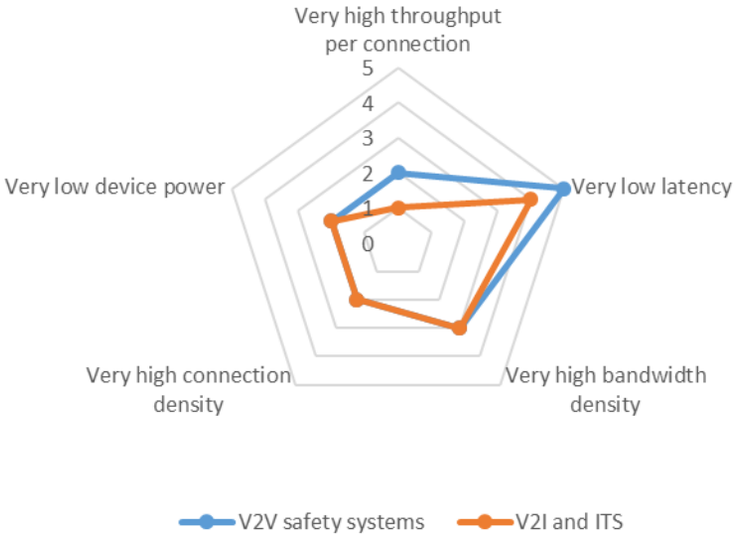
Different technologies have different infrastructural/spectral needs



Wireless network requirements for future health applications



Wireless network requirements for future transportation applications

Figures are from GSA (global mobile suppliers association)

So what are the drivers for the spectrum band choices (globally)?

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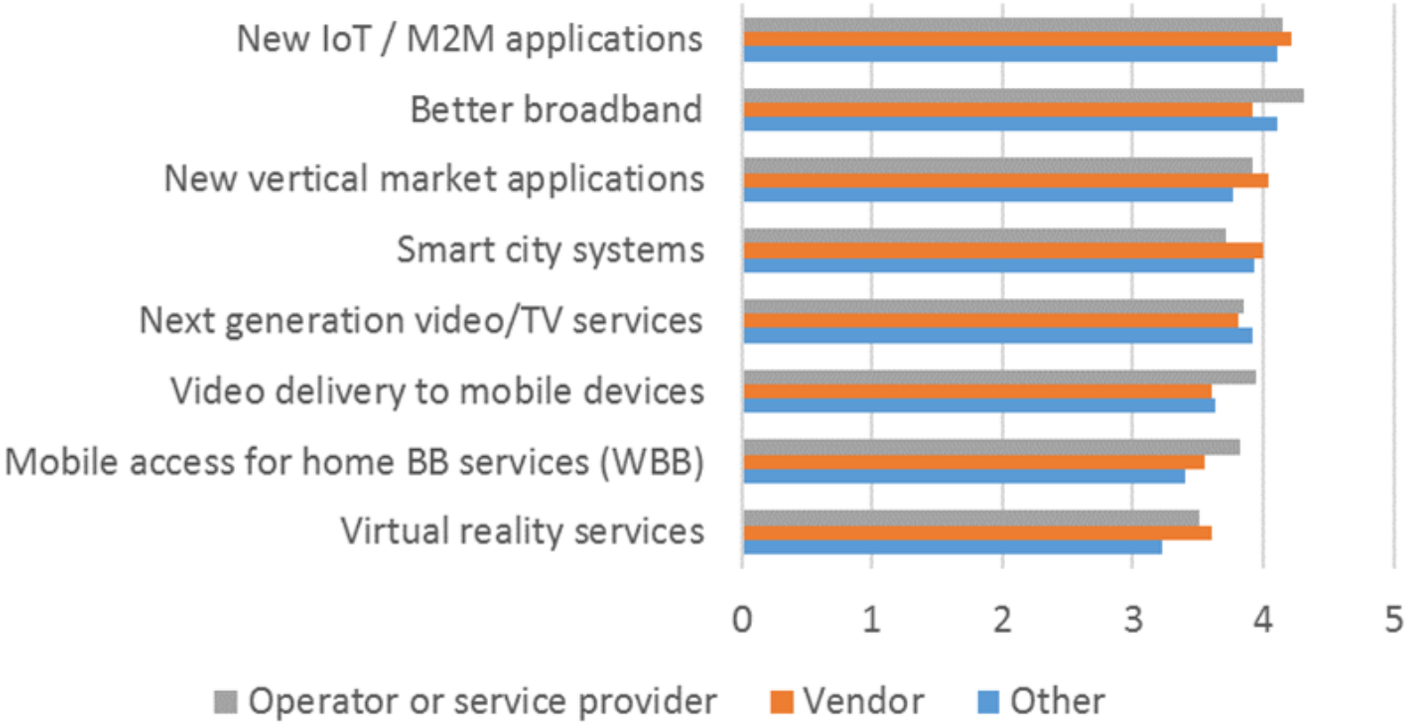
Views of the Operators and Vendors for above 6 GHz bands

- GSMA recommends supporting the 26 GHz, 40 GHz, and 66-71 GHz bands for mobile
- GSA (Ericsson, Huawei, Qualcomm) wants harmonized spectrum and air interface technology standardization
  - World remembers CDMA vs. GSM technology war where Qualcom was had no friends on board



Survey : How important are these potential use cases for 5G
Source : GSA 2015, the road to 5G

Industry is gearing up !-looks like 24.25-27.5 GHz

- **Intel**, its 5G Modem supports 5G operation in both sub-6GHz bands and **28 GHz** spectrum in the U.S., Korea, and Japan with a single device implementation. It pairs the 5G RFIC with the 28 GHz RFIC—supporting 5G New Radio features including low latency frame structure, advanced channel coding, massive MIMO, and beamforming
- **Qualcomm**, has announced the availability of its Snapdragon™ X50 5G NR modem family with 4G/5G multi-mode support, dual connectivity and up to 5 Gbps download speeds. Commercial solutions supporting mmWave and sub-6 GHz band will be available in late 2018 allowing for commercial devices in the first half of 2019.
- **Samsung Electron**ics, has unveiled its end-to-end portfolio of 5G mobile network products and solutions for 2017 which included chipsets, consumer devices for fixed wireless access connectivity, a 5G Radio Base Station (5G Access Unit) and Next Generation Core Network infrastructure.
- **Ericsson**, is planning to release 5G base stations for **24.25 – 27.5 GHz** and **26.5 – 29.5 GHz** by the first half of 2019
- **Huawei**, will be ready to provide E2E 5G commercial products compliant with the 3GPP standard in 2018, including New Radio and New Core equipment.
- **Nokia**, equipment for **28GHz** is already available for trials since early 2017 as part of NOKIA 5G FIRST solution and commercial availability is planned for 2019. This RF can also be used for early trials at 26 GHz in the upper 1 GHz of the band.

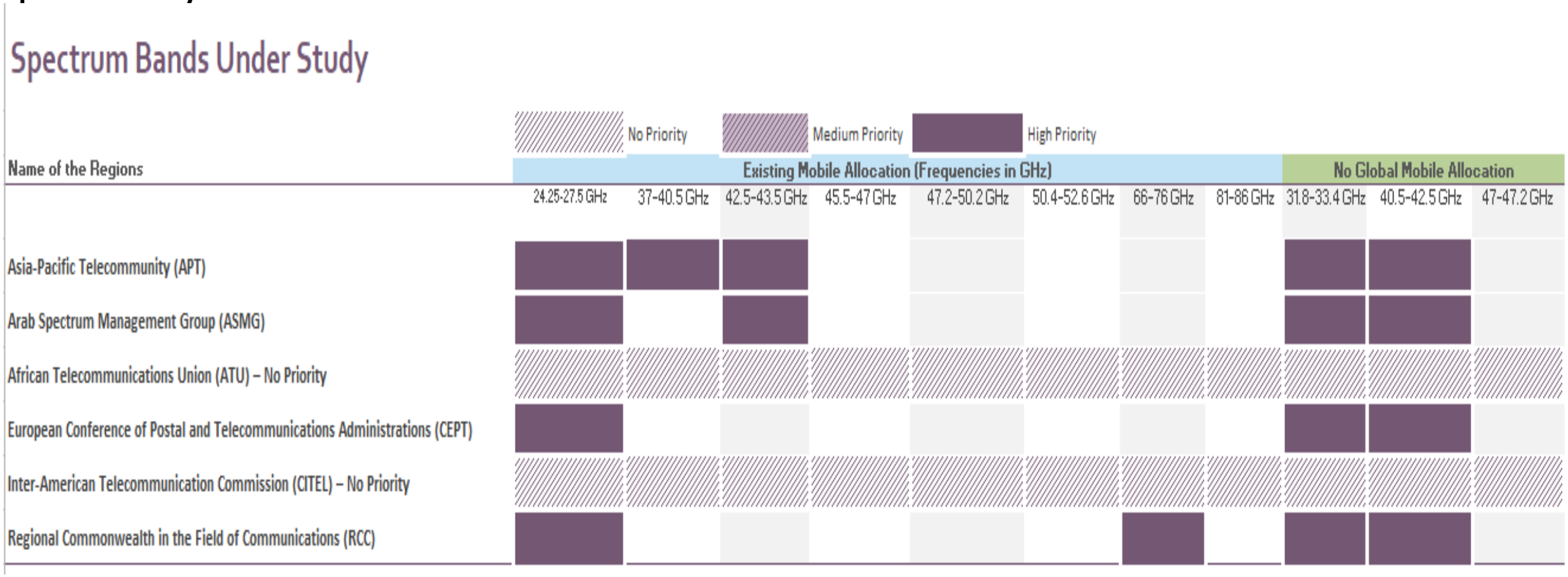
Prospects for international agreement

Countries are obliging

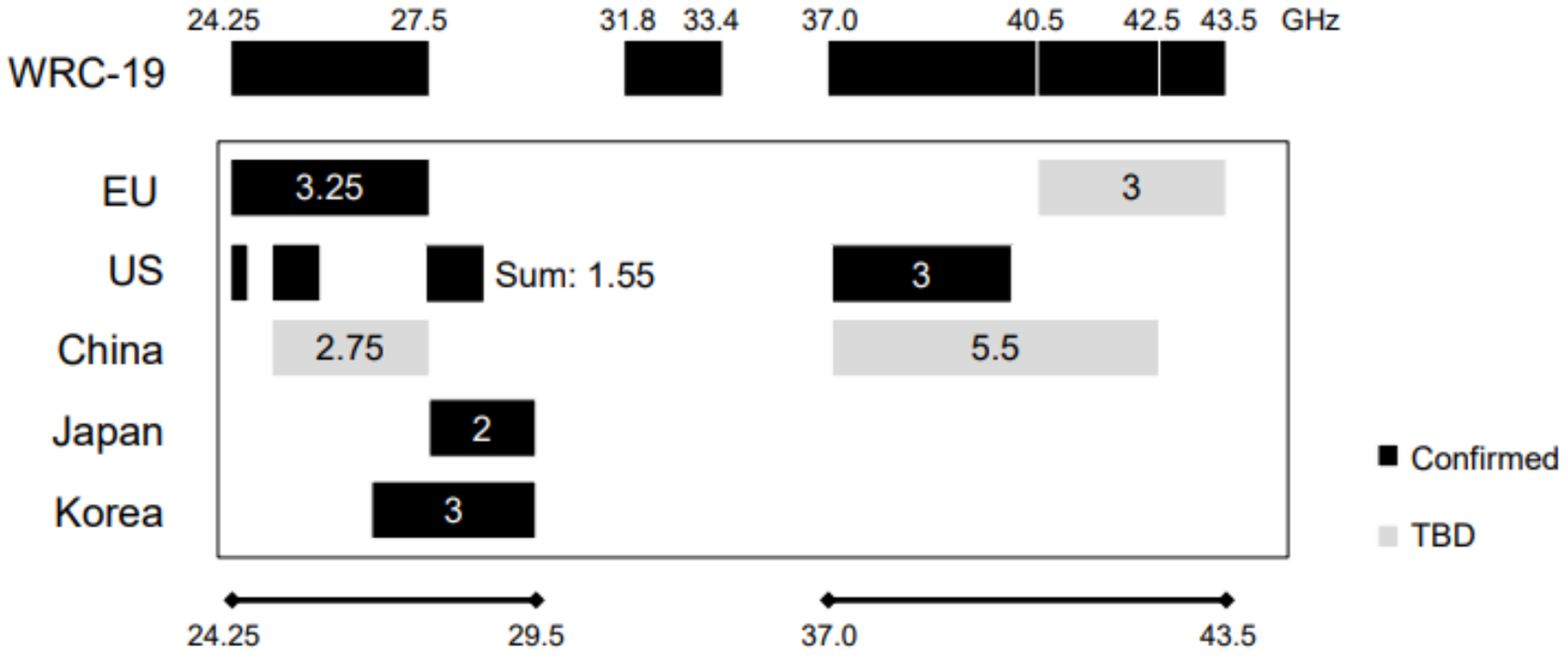
Country	Middle frequency bands	High frequency bands	Commercial time plan
China	• 3.3-3.6 and 4.8-5.0 GHz: release in 2019 • Consider 4.4-4.5 GHz	• Consider 24.75-27.5 and 37-42.5 GHz bands for 5G	2020
Japan	• Release maximum 500 MHz from 3.6-4.2 and 4.4-4.9 GHz in 2019Q1 • 3.4-3.6 GHz: already used for LTE	• Release 27.0-29.5 GHz or a part in 2019Q1	2020
South Korea	• 3.42-3.7 GHz: auctioned in 2018	• 26.5-28.9 GHz: auctioned in 2018	2019 Q1
EU	• 3.4-3.8 GHz: auctions have started	• Release (auction) of 24.25-27.5 GHz band (or a portion) auctions started	2020
USA	• 3.55-3.7 GHz (CBRS) • Consider 3.7-4.2 GHz	• 27.5-28.35 and 39 GHz trials underway with commercial deployments in 2018 • Auction additional 28 & 24 GHz in 2018	2018

Some regional organizations have pin-pointed their priority bands

Spectrum Bands Under Study



Among these the range 24.25–29.5 and 37-43.5 GHz is the most promising high frequency band for early 5G commercialization



Prospects for international agreement

Band	APT	CEPT	CITEL	Operators	Vendors	Comment
24.25-27.5	s (C*, J,K,Nz,V)	s	s(US,Ca,Br)	GSMA for IMT	In, Er, Hu, Qu	Pioneer Band, 24.25-27.5, 26.5-29.5
31.8-33.4	s (J,K,Nz)	ns				Major airports use (at present)
37-40.5	s (C, J,K,Nz)		s(US,Ca,Br)	GSMA for IMT	Er, Hu, Qu	CEPT doesn't want for IMT use, Industry pushing for Global harmonization
40.5-42.5	s (C, J,Nz)	s				Satellite use (at present)
42.5-43.5	s (J,Nz)		s(US,Ca,Br)			
45.5-47						ITU-R studies are incomplete
47-47.2						Amateur-satellite services use
47.2-50.2			s(US,Ca,Br)			Satellite use (at present)
50.4-52.6			s(US,Ca,Br)			Satellite use (at present)
66-71	s (C)	s	s(US*,Ca)	GSMA on technology neutral basis		US pushing for WiGig
71-76		ns				5G backhauling, vehicular radars
81-86	s (C)	ns	s(US,Ca)	GSMA		5G backhauling, Satellite Passive Sensors

References

- Constitution of the International Telecommunication Union (ITU) https://www.jus.uio.no/english/services/library/treaties/07/7-06/itu_const.xml
- The Road to 5G: Drivers, Applications, Requirements and Technical Development, A GSA Executive Report from Ericsson, Huawei and Qualcomm , November 2015
- PPT ITU, https://www.itu.int/en/ITU-R/seminars/rrs/RRS-17-Americas/Documents/Forum/9_ITU%20Diana%20Tomimura.pdf
- PolicyTracker,https://www.policytracker.com/cept-drops-support-for-key-mmwave-bands-ahead-of-wrc-19/; https://www.policytracker.com/26-ghz-harmonisation-on-its-way-after-europe-agrees-concerning-details/;
- Huaweii, https://www-file.huawei.com/-/media/CORPORATE/PDF/public-policy/public_policy_position_5g_spectrum.pdf?la=en.

BACKUP

ITU Agenda ITEM 1.13: IMT 2020/5G

- Possible new spectrum allocations suitable for delivery of terrestrial wireless broadband in **the frequency range 24.25-86 GHz,** where large bandwidths are potentially available to provide higher data rates and lower latencies;
- Input on national spectrum needs in various countries collected to understand the spectrum needs for the terrestrial component of IMT;
- Sharing and compatibility studies conducted as other radiocommunication services with allocations in this frequency range may be potentially affected.

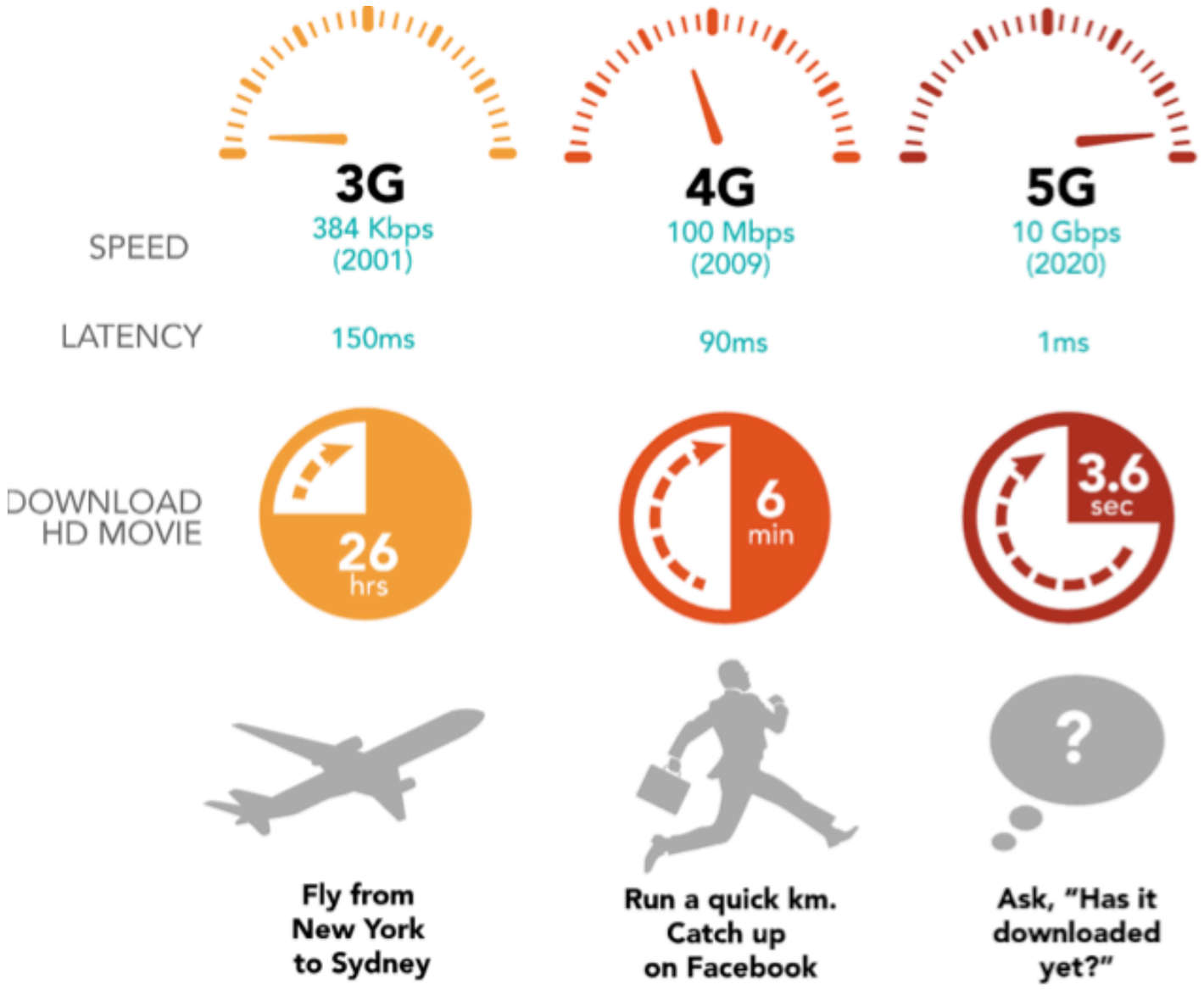


Figure: from ITU

5G spectrum need

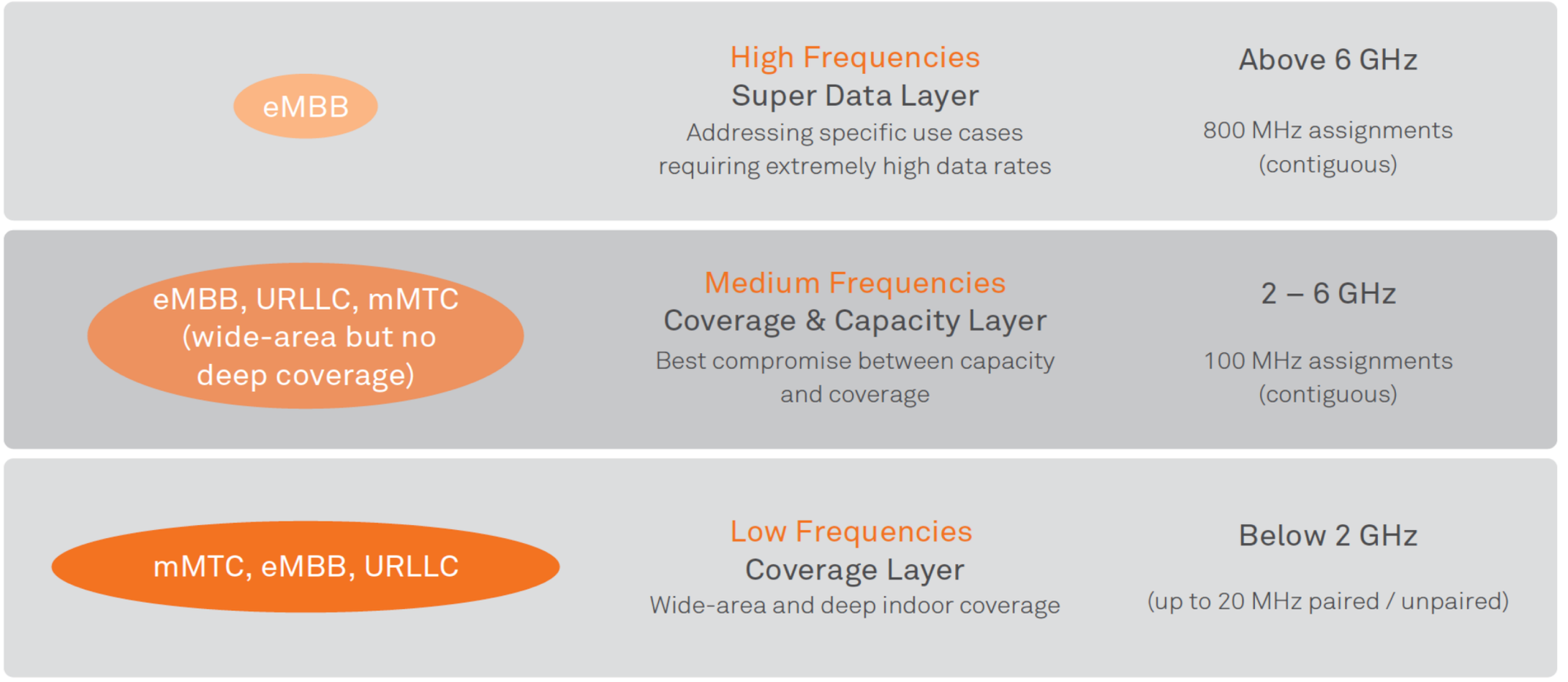


Figure 2: Multi-layer frequencies approach for 5G usage scenarios

Source: Huawei

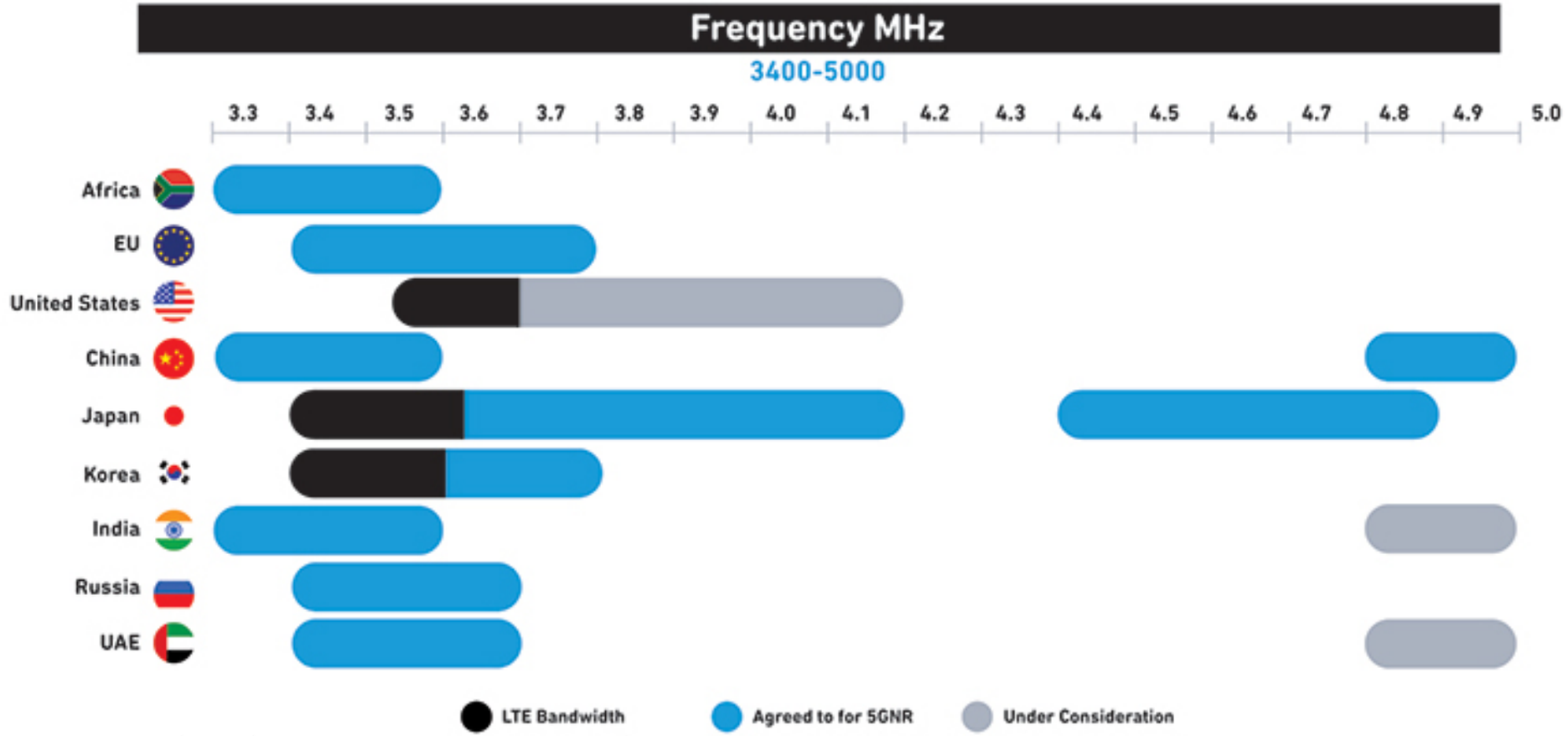
What will change when 5G (IMT-2020)arrives

- It will be a paradigm shift but for today's discussion the followings are important to note
  - Explosive increase of traffic from new emerging bandwidth-hungry services –UHD-TV, AR, Video Conferencing, remote medical treatment
  - Heavily centralized architecture of existing IMT networks will disappear and more robust distributed network architecture will appear

All current IMT frequency bands and bandwidth

Frequency Band (MHz)	Bandwidth (MHz)
450-470	20
470-608	138
614-698	84
698-960	262
1427-1452	25
1452-1492	40
1492-1518	26
1710-2025	315
2110-2200	90
2300-2400	100
2500-2690	190
3300-3400	100
3400-3600	200
3600-3700	100
4800-4990	190

3.4-5 GHz spectrum band allocation shows differences



Ref: https://www.electronicdesign.com/power/evolving-5g-landscape-creates-new-rf-challenges

Past APG activities

- 1st APT Conference Preparatory Group (APG) for WRC-19: 26 - 28 July **2016**, Chengdu, China
- 2nd APG-19: 17 - 21 July **2017**, Bali, Indonesia
- 3rd APG-19: 12 - 16 March **2018**, Perth, Australia
- 4th APG-19: 7 - 12 January **2018**, Busan, Korea (Rep. of)

APG bands and technologies

- Target bands
  - Allocation on a primary basis: 24.25-27.5 GHz, 37-40.5 GHz, 42.5-43.5 GHz, 45.5-47 GHz, 47.2-50.2 GHz, 50.4-52.6 GHz, 66-76 GHz and 81-86 GHz
  - Additional allocation: 31.8-33.4 GHz, 40.5-42.5 GHz and 47-47.2 GHz
- Why needed? Diverse usage scenarios and applications
  - eMBB
  - mMTC
  - URLLC

APT positions: bands supported

	Frequency bands (GHz) mentioned in Resolution 238 (WRC-15)											
	24.25-27.5	31.8-33.4	37-40.5	40.5-42.5	42.5-43.5	45.5-47	47-47.2	47.2-50.2	50.4-52.6	66-71	71-76	81-86
IND	S	S	S									
KOR	I	I	I									
NZL	X	X		X	X							
AUS[1]	S		S	S	S					S	S	
Japan	S	S	S	S	S							
SNG	S	S	S	S	S							
MLA	X											
VTN	I	S	S	S	S							
CHN[2]	X[3]		X	X						X	X	X
BGD	X	X										
LAO	S											

Symbol	Definition
S	Support sharing and compatibility studies with priority
X	Support potential IMT identification with priority if sharing is feasible under the framework of agenda item 1.13
I	Support potential IMT identification with priority under the framework of agenda item 1.13 based on internal sharing and compatibility studies in their countries and interim results of sharing and compatibility studies by ITU-R to be completed by August 2018

Bands that are conflicting with existing air traffic control, satellites

1.13 IMT Res. 238 (WRC-15) Frequencies in GHz (TG 5/1)	1.6 NGSO FSS Res. 159 (WRC-15) Frequencies in GHz (WP 4A)	1.14 HAPS Res. 160 (WRC-15) Frequencies in GHz (WP 5C)	9.1 (issue 9.1.9) FSS Res. 162 (WRC-15) Frequencies in GHz (WP 4A)
24.25-27.5	-	24.25-27.5 (Region 2)	-
37-40.5	37.5-39.5 (s-E*)	38-39.5 (globally)	-
40.5-42.5	39.5-42.5 (s-E*)	-	-
47.2-50.2	47.2-50.2 (E-s*)	-	-
50.4-52.6	50.4-51.4 (E-s*)	-	51.4-52.4 (E-s*)
* E-s: Earth-to-space; s-E: space-to-Earth.			