5G SPECTRUM REQUIREMENTS, HARMONIZATION, INNOVATIVE SPECTRUM UTILIZATION

4G Toward 5G – TDD Spectrum Workshop

ITU Telecom World 2016, 14.11.2016, Bangkok

Global mobile Suppliers Association – GSA

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GSA SPECTRUM GROUP

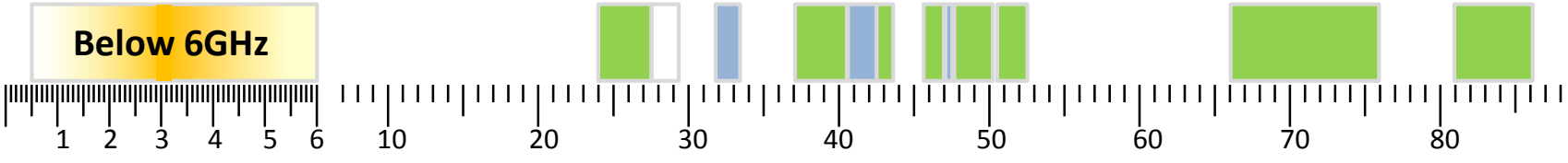
The Spectrum Group within GSA,

is the GSA focus group for policy matters related to the radio frequency spectrum and radio regulatory matters,

pertaining to the successful evolution of International Mobile Telecommunication (IMT) of ITU and associated administrative, operational and technical aspects.

5G NEEDS SPECTRUM BELOW AND ABOVE 6GHZ

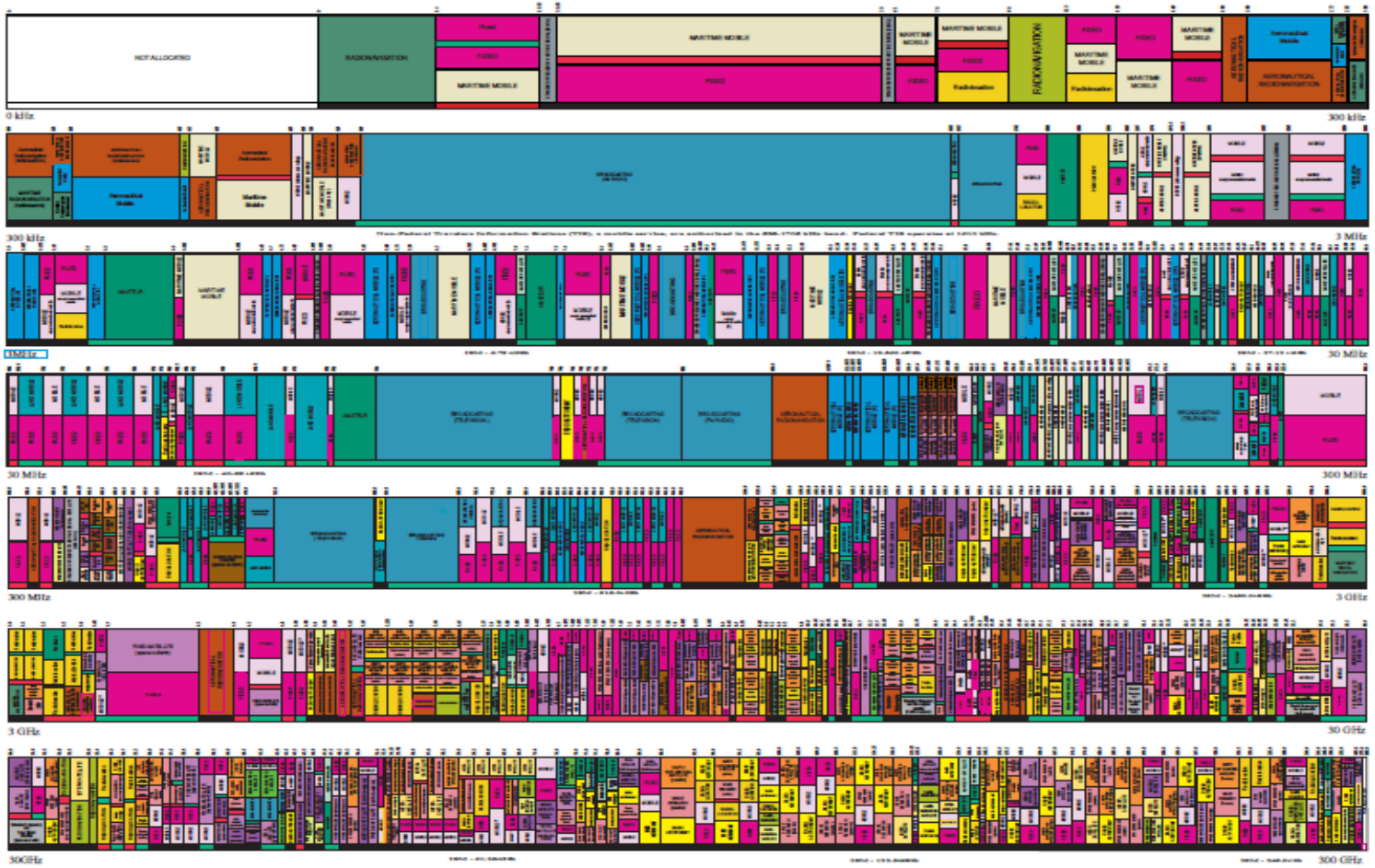
Higher and lower frequencies are both needed to meet multiple use case scenarios - **frequency range = 470 MHz up to 86 GHz…… licensed & unlicensed!**



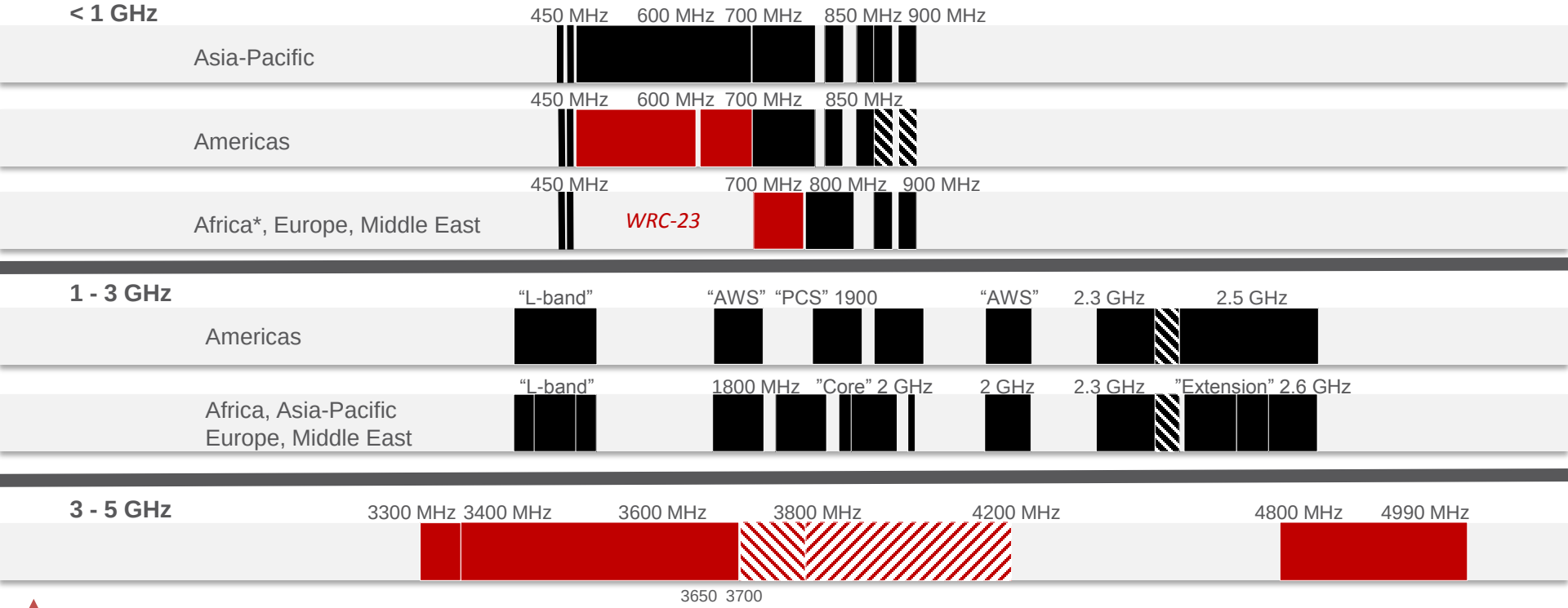
- **Spectrum below 6GHz**
  - **Wider coverage** allowing cost effective delivery of mobile services
  - **Outdoor to indoor coverage (**especially at early phase of 5G)
  - **Bandwidths** considerably wider (in the order of 100s of MHz) than those of today, providing a combination of capacity and coverage
  - **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

….BUT THERE IS NO “FREE” SPECTRUM…..

Example of United States Frequency Allocations from 9 kHz to 300 GHz



IMPLEMENTATION OF BANDS FROM WRC-15 AND EARLIER



*) In some countries in Africa, the band 850 MHz is used in some countries

HARMONIZATION OF EARLY 5G SPECTRUM

North America

600, US700, US850, AWS1700, AWS1700Extension, US1900, US2600, and US3500

Europe

CEPT700, CEPT800, CEPT900, CEPT1500, CEPT1800, 2100, 2300, CEPT2600, CEPT3500, and CEPT3700

Latin America

US850, CEPT900, APT700, AWS1700, AWS1700Extension, CEPT1800, US1900, CEPT2600, 2300, and 3500

Middle East and Africa

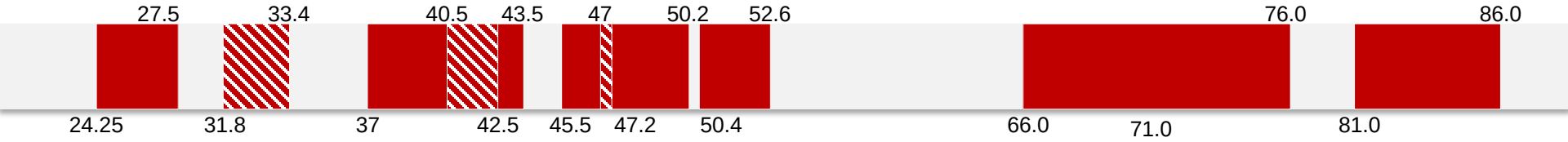
CEPT 700, CEPT800, CEPT900, US850, 2100, CEPT1800, CEPT2600, APT700, and CEPT3500

Asia-Pacific

APT700, US850, CEPT900, CEPT1500, J1500, CEPT1800, 2100, 2300, CEPT2600, APAC2600, J2600 and 3500

WRC-19 AGENDA ITEM 1.13

Nominated bands for ITU WRC-19 studies in the range 24.25 – 86.0 GHz



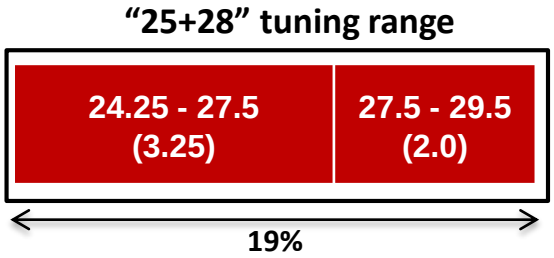
allocations to the mobile service on a primary basis

may require additional allocations to the mobile service on a primary basis

TUNING RANGE IN THE BAND 24.25 – 29.5 GHz

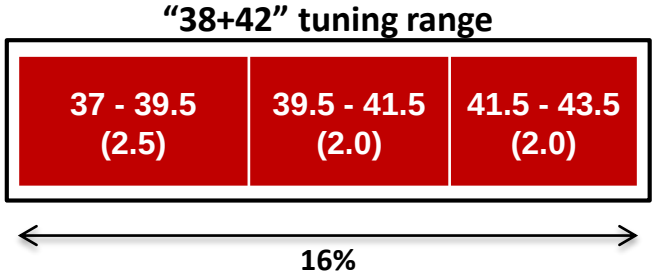
"Tuning range" approach allows to benefit from early developments in different Regions, maximizing economies of scale and reducing fragmentation of spectrum

- Feasibility and time availability of tuning ranges are impacted by various factors inlcuding the required width and the compatibility and sharing requirements for existing services
- Early access to the 28 GHz band is driving the development of the first 5G infrastructure and devices for early trials and deployments in 2017/2018
- The 24.25 – 27.5 GHz band is the pioneer band for Europe
- The implementation of this band is further supported by the upcoming 5G trials in Korea where the 26.5-29.5 GHz range will be used, and early deployment in the US is 28GHz. Japan considering.



The 24.25 – 29.5 GHz tuning range enables the development of an early ecosystem for global availability

GLOBAL POTENTIAL IN THE 37 – 43.5 GHZ RANGE



- In line with the wide support during the WRC-15, different portions of spectrum within the 37.0 – 43.5 GHz range are now being considered for 5G in various regions, e.g.:
  - 37 – 40 GHz already decided in the USA
  - 40.5 – 43.5 GHz in Europe
  - Considered in China

DYNAMIC TDD

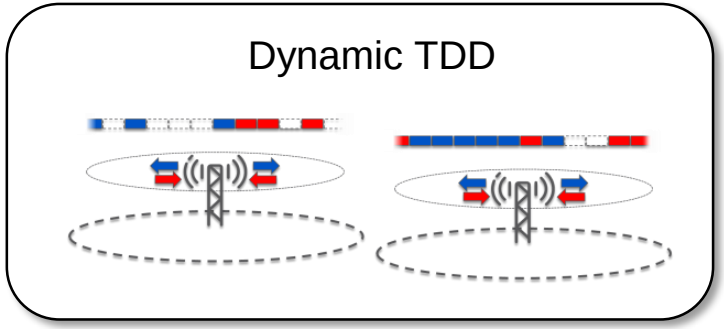
- Allow for dynamic assignment of resources to downlink and uplink
  - UE listens/receives on downlink unless explicitly or implicitly scheduled to transmit on uplink
  - Network scheduler configured for semi-static or dynamic assignment depending on scenario

- Conventional (“macro”) deployments
  - Less dynamic traffic variations
  - Important to avoid “TDD-specific UL/DL allocation interference”

⇨ **Semi-static assignment**

- “Small-cell” deployments
  - More dynamic traffic variations
  - “TDD-specific UL/DL allocation interference” less critical

⇨ **Dynamic assignment**



NR Duplexing Modes
Regulatory Implications

ECC (Europe): FDD UL spectrum can NOT be used as DL

- The current CEPT framework for the FDD bands as defined in the relevant ECC Decisions does not allow to use the FDD uplink as downlink nor the other way around.

ARIB (Japan): FDD UL spectrum can NOT be used as DL

- Land mobile relay stations are not allowed to use the FDD uplink as its downlink.
- Base stations are not allowed to use the FDD uplink as its downlink.

China: No explicit regulation

South Korea: Potential to support

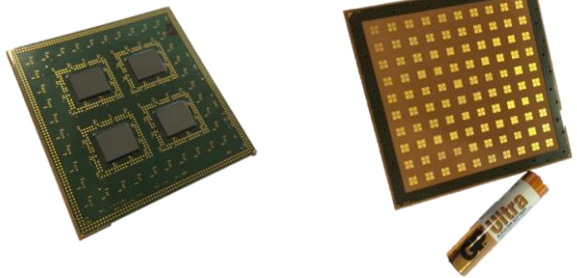
FCC (USA): Most of UL spectrum can be used as DL

Range (MHz)	3GPP band UL	Description	Technical rules (Part & Subpart)	Power limits & frequencies
699-716	12, 17	Lower 700	Part 27 Subpart C	27.5, 27.50(c)
777-787	13	Upper 700	Part 27 Subpart C	27.5, 27.50(b)
814-824	26	SMR	Part 90 Subpart S	90.613, 90.635
824-849	5, 26	Cellular	Part 22 Subpart H	22.905, 22.913
1695-1710	TBD	AWS-3 unpaired	Part 27 Subpart C	27.5, 27.50(d)
1710-1755	4	AWS-1	Part 27 Subpart C	27.5, 27.50(d)
1755-1780	66	AWS-3 paired	Part 27 Subpart C	27.5, 27.50(d)
1850-1915	2, 25	PCS	Part 24 Subpart E	24.229, 24.232
1915-1920	TBD	H block	Part 27 Subpart C	27.5, 27.50(d)
2000-2020	23	AWS-4	Part 27 Subpart C	27.5, 27.50(d)
2305-2315	30	WCS	Part 27 Subpart C	27.5, 27.50(a)
2496-2690	41	BRS/EBS	Part 27 Subpart C	27.5, 27.50(h)

No regulatory change needed to support Dynamic TDD.
Regulatory changes needed to enable Flexible Duplex for FDD.

MM-WAVE FILTERING FOR HIGH FREQUENCIES

- mm-wave filters which are feasible to be integrated in a large antenna array are a technological challenge
- For mm-wave frequencies, the possibility of integration and size really matter.



~28 GHz prototype with 64 cross polarized antennas and 128 integrated transceivers
Size: ~ 7 cm x 7 cm

	FDD	TDD	Implication
TX/RX isolation	High duplex isolation required	**Not applicable** as TX and RX are separated in time	Complex filtering for FDD
Performance	High insertion losses due to high attenuation and signal routing losses.	Significantly less losses due to less complex band-pass filter with less needed attenuation instead of duplex and high routing of signals.	TX power and RX sensitivity for FDD degraded implying less coverage for FDD.
Duplex gap	~~Many times~~ larger duplex gap compared to operating FDD bands due to limitation in filter attenuation	**Not applicable** No duplex gap is needed for TDD	Less spectrum usage for FDD due to large duplex gap as compared to TDD

SUMMARY ON HARMONIZATION OF EARLY 5G SPECTRUM

- "Early bands" for 5G
  - 600/700 MHz (Americas/EU/Asia)
  - 3300-3800 MHz (Europe/Asia – Americas partly and with wider band?)
  - 4400-4990 MHz (Japan/China/Asia)
  - 24.25-29.5 GHz (Americas/EU/Asia)

  For further discussion:

  - 37 – 43.5 GHz (US, Europe?, China?)
- TDD working assumption for "early bands" except 600/700 MHz
- FDD and other advanced duplex methods above 3 GHz is FFS

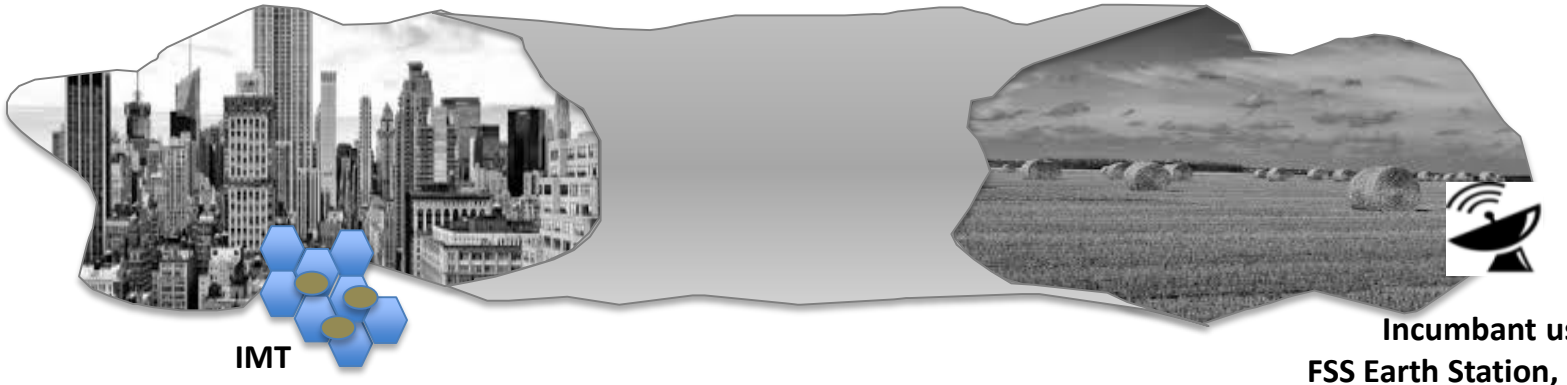
SPECTRUM ACCESS SCHEMES

- The assignment of **exclusive spectrum usage rights** (i.e. “licensed spectrum”) will remain of central importance also for 5G as key enabler for:
  - Mission critical applications
  - Low latency applications
  - Guaranteed Quality of Experience (QoE) to end users

- Shared spectrum access schemes (e.g. License Shared Access) could be considered as a complementary option if the band cannot be cleared
  - While defining sharing frameworks to protect an incumbent services in a certain band, Administrations need to find the appropriate trade-off between the complexity of the framework, degree of spectrum use and QoS to be assured for end users and time to market

SPECTRUM SHARING EXAMPLE IN C-BAND

Targeting protection of incumbent users AND maximized spectrum utilization



IMT
heterogeneous networks

Incumbant user
FSS Earth Station, Radar,…

IMT Macro + Small Cell
In urban areas

“Buffer zone”
(exclusion / restriction / protection zone)

Ubiquitous / specific
FSS Earth Stations
outside of urban areas

Global mobile Suppliers Association

Promoting the Mobile Broadband Technology Roadmap

http://gsacom.com/