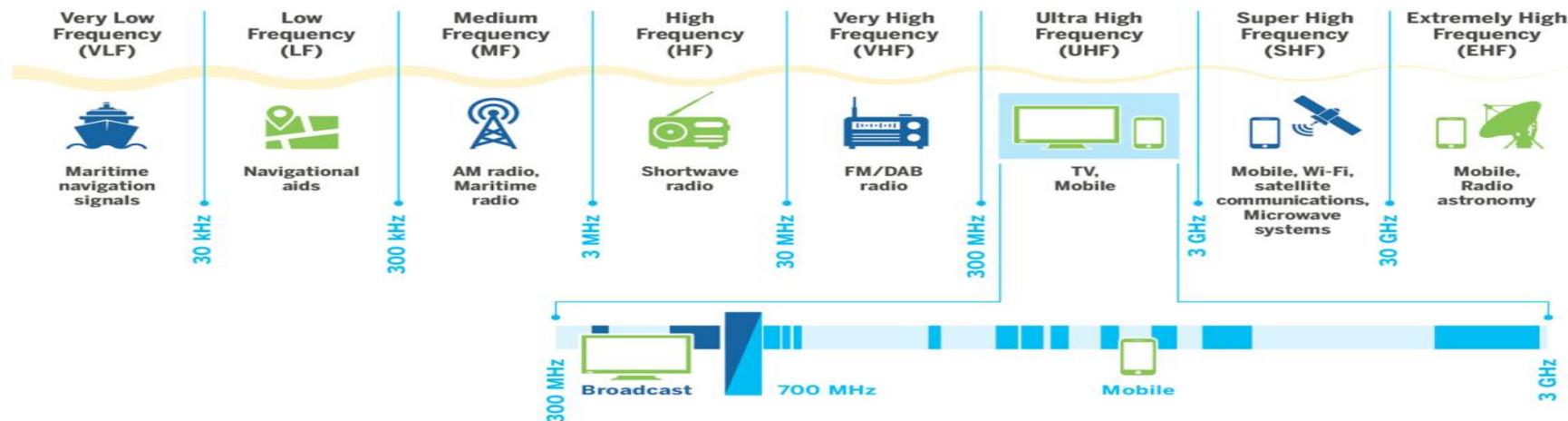




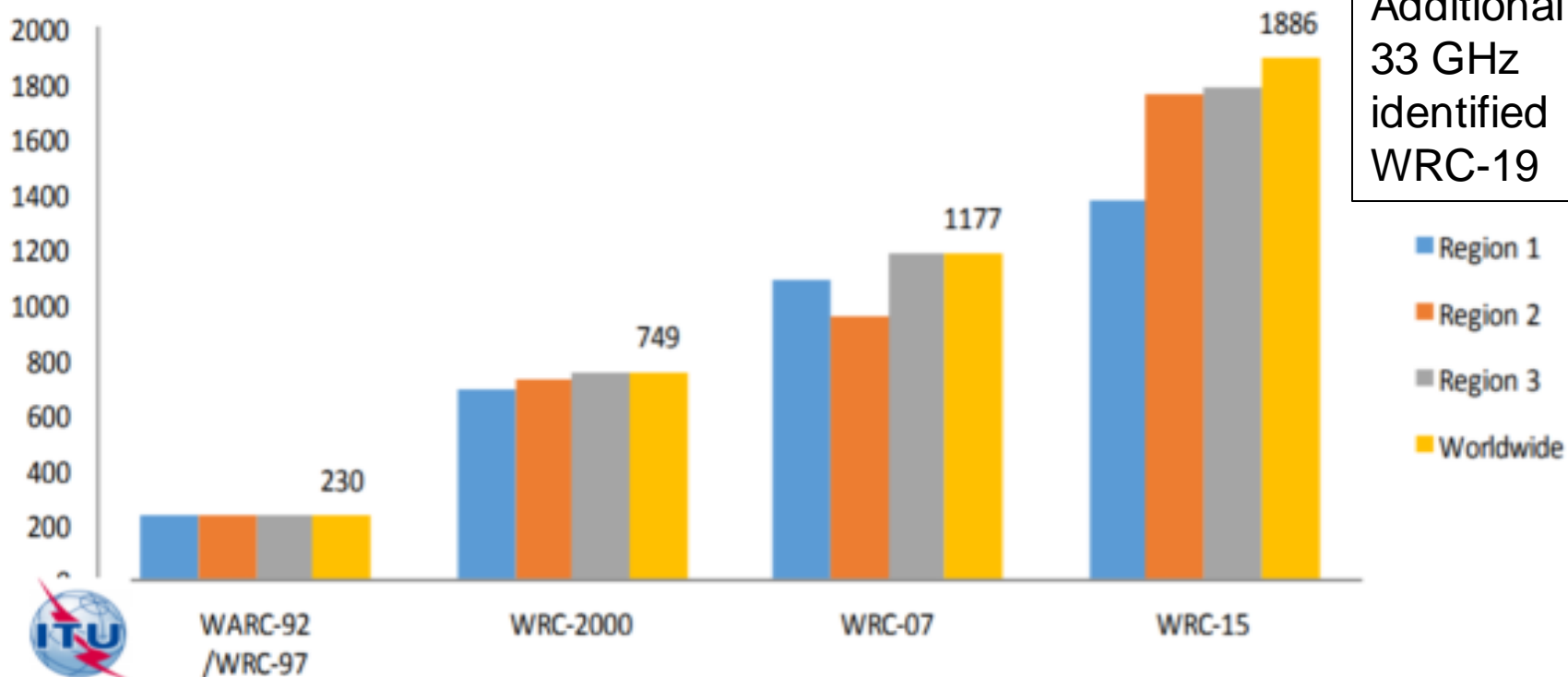
Session 8: Future Spectrum Roadmap for 5G / Satellites

- **Must be managed to ensure effective use**
 - Governments and regulators must consider public & commercial benefits
- **Spectrum should be allocated appropriately**
 - Based on the 3 types (either “Beauty Contest”, Unlicensed, Auction (price based) approaches)
- **Economic considerations are necessary**
 - Scarcity of spectrum demands efficient use and management

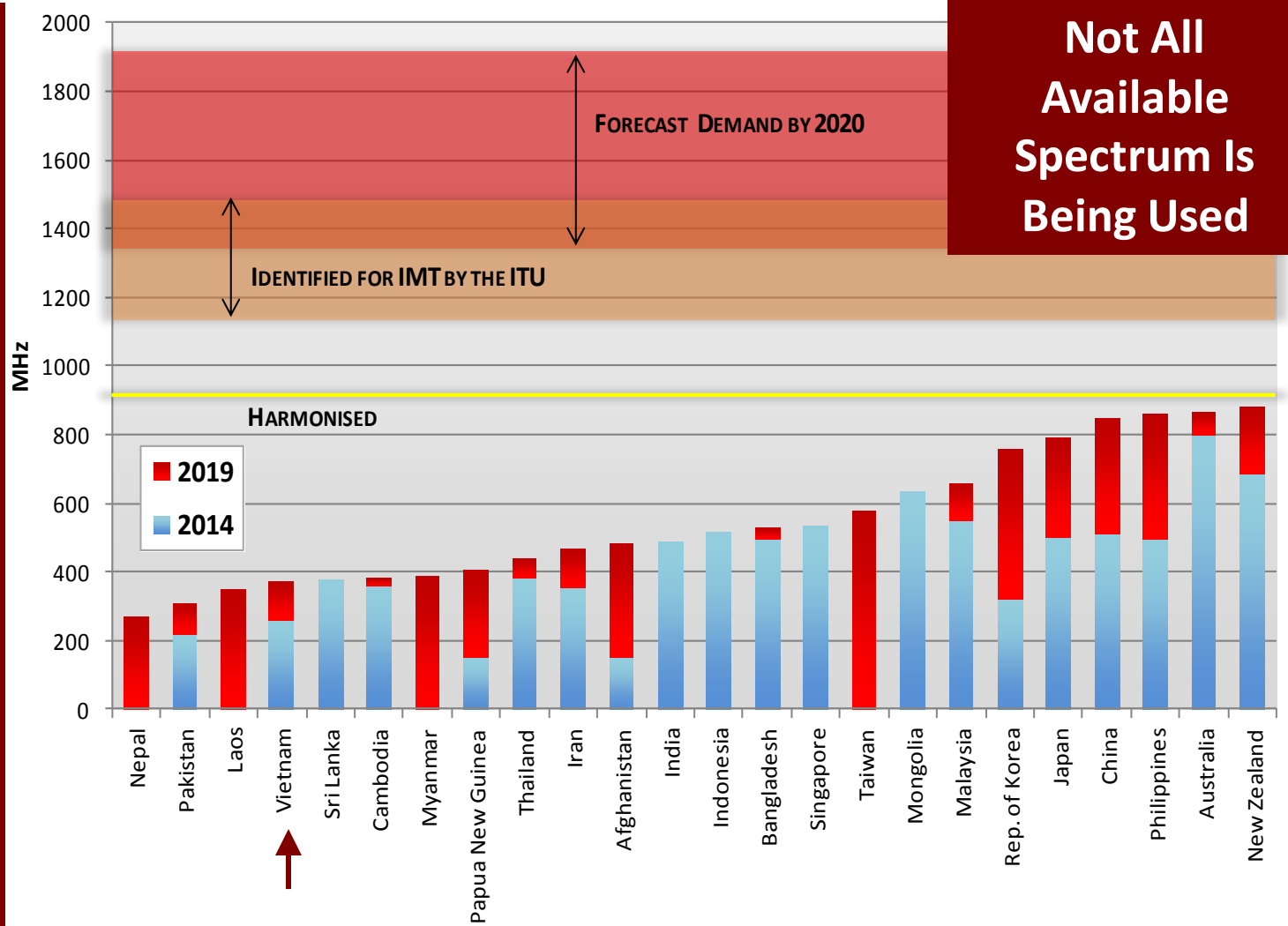


Total Spectrum Identified for IMT

Total amount of spectrum identified for IMT (MHz)



- ◆ Blue bars: how much spectrum was licensed in 2014
- ◆ Red bars: how much has been licensed since 2014
- ◆ Yellow line: harmonised spectrum for IMT in Region 3
- ◆ Orange: Spectrum identified by the ITU for IMT
- ◆ Pink zone: IMT's own predicted requirements for 2020



Not All Available Spectrum Is Being Used

Balancing Different Variables

Infrastructure
investment

Harmonised
spectrum policy

A robust &
inclusive solution

Resilience &
redundancy

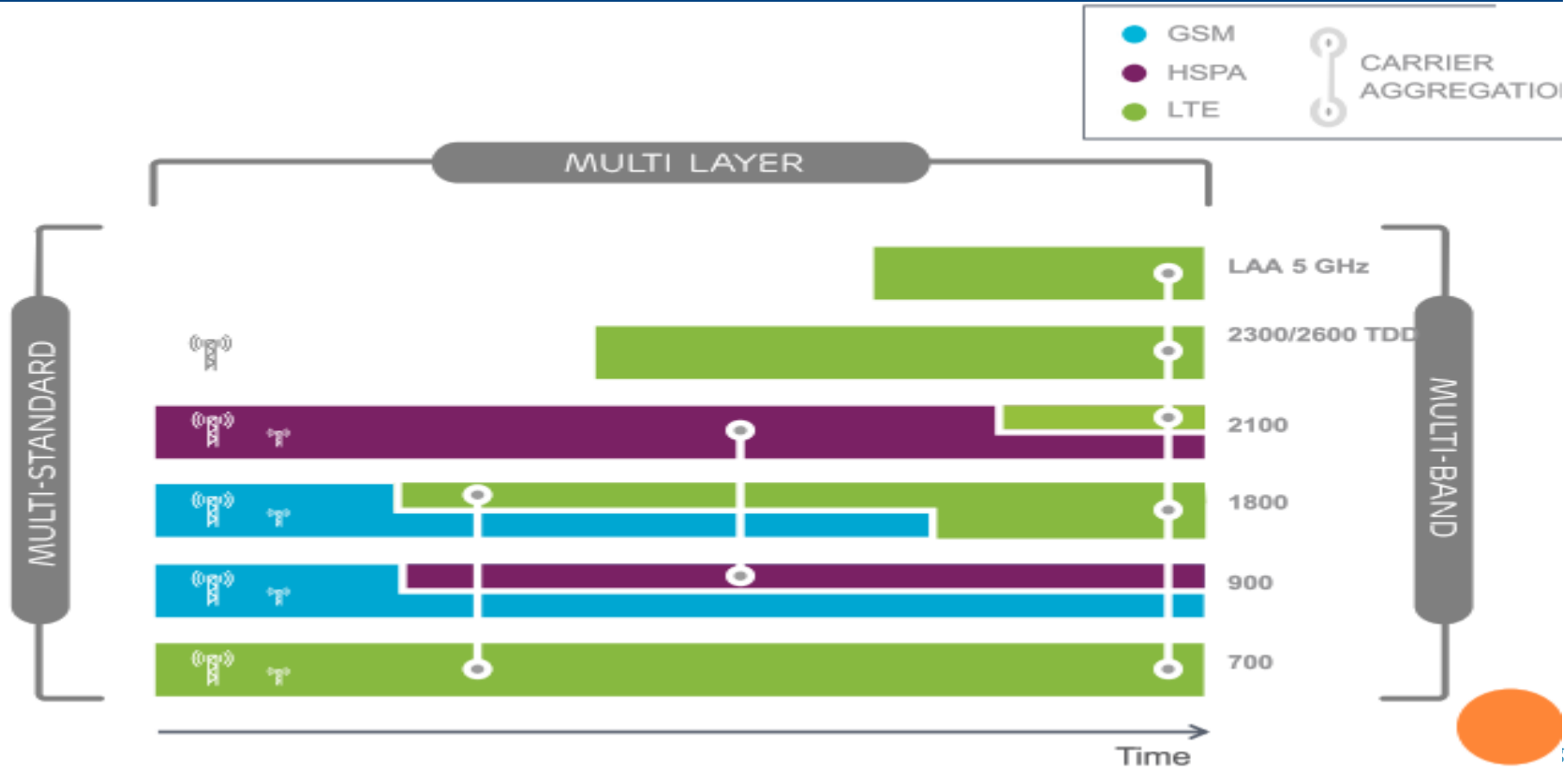
Ubiquity

Affordability/
efficiency

Digital Divide

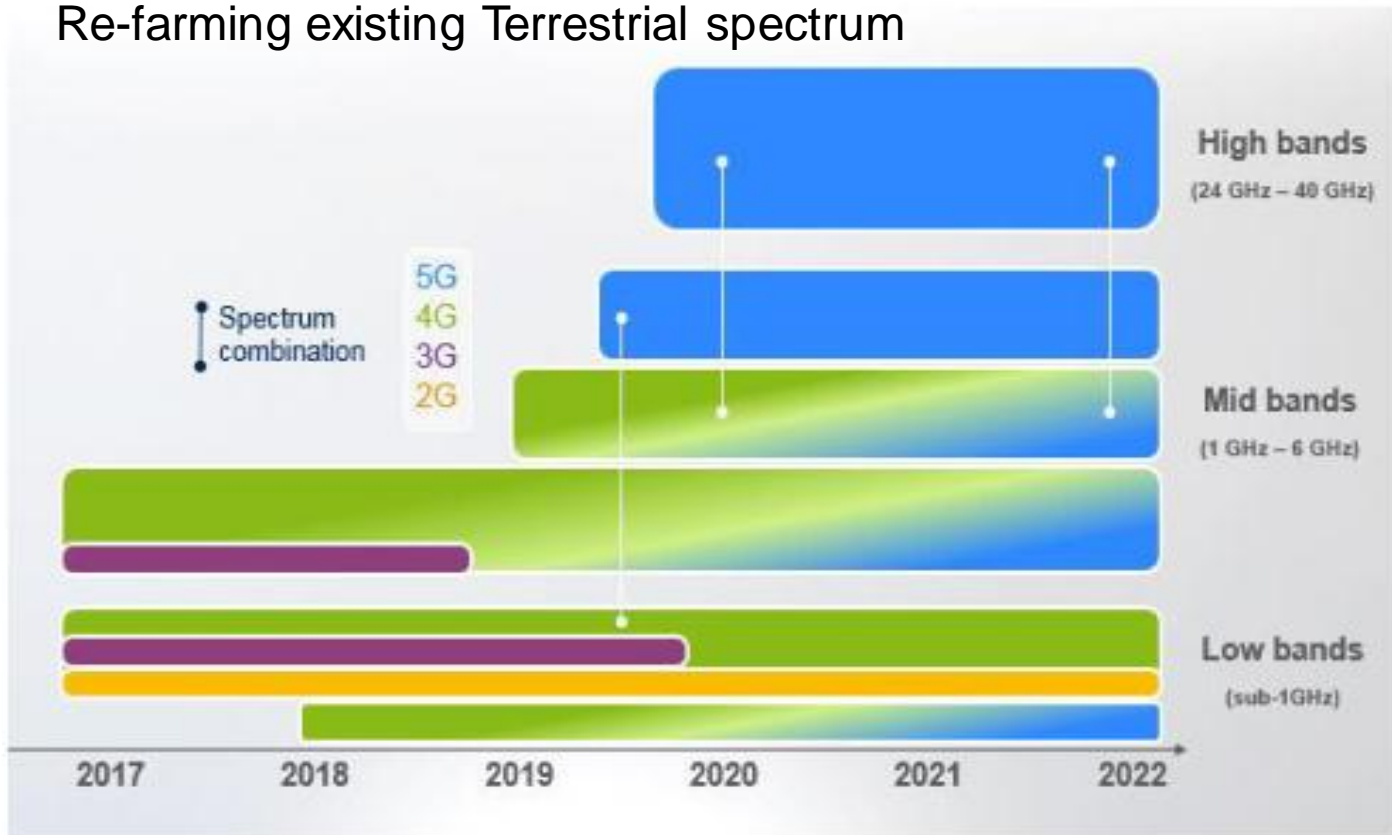
Cyber
Security

Spectrum & Technology Evolution



Likely Evolution of Spectrum Use

Re-farming existing Terrestrial spectrum



- Initial 5G deployments likely to be non-standalone configurations in mid bands.
- Combination of 4G and 5G bands is expected as traffic increases and new use cases mature.
- Standalone 5G deployments will gradually get access to 4G spectrum in mid-low bands.

**Each technology is evolving, Each has a role to play,
Each requires continued access to spectrum**

Wi-Fi Eco-System is Evolving: Gigabit WiFi chips + devices becoming available: 200m radios shipped in 2017, 2020: >1bn *“WiGig”*

Satellite Eco-System is Evolving: HTS, VHTS, GSOs + NGSOs using L,S,C,Ku,Ka bands & in future Q,V bands as well

Mobile Eco-System is Evolving:

Germany, Italy, Australia: carrier aggregation delivering up to 900 Mbps
Field Tests in UK & US: >20 Gbps delivered in 70GHz bands



- On commercially viable basis •
- No interference with / loss of existing services •
- Using Existing Spectrum •



Asia Population: 4.58 Billion (2019)

16+

Number of
indigenous
C-band Satellite
Systems

80+

Number of GEO
C-band
Satellites
Serving Asia

3800+

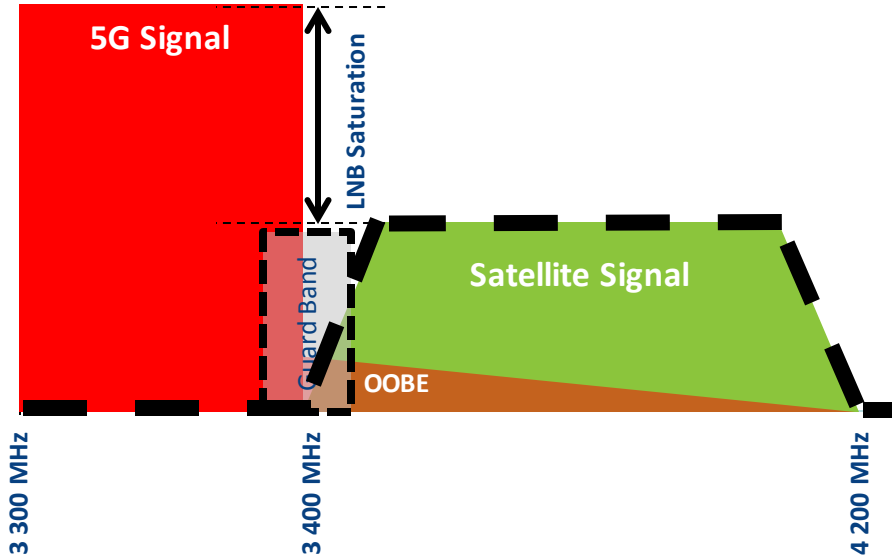
Number of TV
Channels
distributed by
C-band

\$56B

Pay TV Revenue
in 2018
(MPA Report)

There is no substitute for C-band Satellite Services Asia

Co-existence between FSS and 5G in adjacent bands must be carefully managed



- ◆ Satellite earth stations are very sensitive to terrestrial interference
- ◆ 5G signals can interfere with FSS receive earth stations in two ways:
 - Saturate the LNB of the earth station, even if the 5G signal is adjacent to the satellite signal
 - Out-of-Band-Emissions (OOBE) of the 5G signal can cause in-band interference to FSS signals
- ◆ Currently, OOBE levels specified in 3GPP standards do not protect FSS signals in adjacent bands

How mobile and FSS can coexist side by side:

1. All earth stations must be fitted with bandpass filters
2. Impose a guard band between FSS & 5G
3. Impose strict OOBE limits on 5G

GEO satellites

- ◆ **SES** Astra 2E, 2G, 3B, 4A, 5B
- ◆ **Arabsat** BADR7, 5A, 6A
- ◆ **Avanti** Hylas 1, 2 & 4 with 3 (2019)
- ◆ **Inmarsat Global Xpress** Inmarsat-5 F1 (2013), F2 (2015), F4 (2017), GX-5 (2019), Inmarsat-6 (2020-2021)
- ◆ **Eutelsat** KaSat, future Konnect
- ◆ **Intelsat** EuropeStar, Epic IS-29e/ IS-33e/ IS-37e/ IS-36/ IS-20
- ◆ **Hispasat** H30W-6, H36W-1
- ◆ **OHB** future H2Sat
- ◆ **Telenor** Thor 7
- ◆ **Turksat** 4B, 5B in 2020
- ◆ **ViaSat** Viasat-2, future ViaSat-3
- ◆ **Yahsat** AY1, AY2, AY3

Non-GEO satellites

- ◆ **O3b** 16 MEO satellites in-orbit; 4 more in Q1 2019
- ◆ **OneWeb** next-gen LEO constellation (2019)
- ◆ **SpaceX** next-gen LEO constellation (2020)
- ◆ **Telesat LEO** next-gen LEO constellation (2021)
- ◆ **O3b mPower** next-gen MEO constellation (2021)
- ◆ **Leosat** next-gen LEO constellation (2021)

⇒ Stick to WRC-15 Identified Study Bands for IMT

26 GHz (24.25 - 27.5 GHz)

Candidate Band for Global Harmonisation

- Protect existing & planned use by FSS, ISS, SRS, EESS passive
- Sustainable basis without undue constraint

28 GHz

NOT on the shopping list!

- Many satellite networks extensively use 28GHz globally
- Not in Res. 238.

37 - 43.5 GHz

NOT Candidate Band for Global Harmonisation

- Future satellites (in construction) will use 40/50 GHz
- 2GHz of spectrum is needed for HDFSS user terminals
- Needs appropriate shared basis for coordinated FSS earth stations
- Regional harmonization for IMT is sufficient

47 - 52.6 GHz

NOT Candidate Band for Global Harmonisation

Above 66 GHz (66 - 71 GHz & above)

Candidate Band for Global Harmonisation

- Close to 57-66 GHz: already designated / used for WiGig
- Existing primary ITU allocation to for terrestrial mobile
- Doubles available spectrum for terrestrial mobile 5G services so provides future-proofing for 5G/IMT-2020

- ◆ Satellite is an integral part of today's and tomorrow's digital eco-system, including 5G
- ◆ Neither C nor 28 GHz bands are on WRC15 'shopping list' for IMT
- ◆ Plenty of other spectrum is available for license & use by IMT in Region 3,
- ◆ 33 GHz of spectrum other than C & 28 GHz are already under consideration
- ◆ 3.3-3.4 GHz is already available & more than adequate to meet 5G demands for the foreseeable future - also re-farm 2G & 3G spectrum
- ◆ Region 3 has extensive reliance on satellite services & it is growing
- ◆ IMT cannot replace these satellite services: there is NO alternative

5G - A Network of Networks

MNOs will continue to invest in 4G / LTE

The WiFi Ecosystem continues to evolve
Gigabit WiFi = WiGig

MNOs & Vendors Trial high-data rate in mmWave bands

High Throughput Satellites available with global coverage

The 5G/IMT-2020 ecosystem will be dominated by 5G mobile devices using MULTIPLE RADIOS

Cellular • WiFi/WiGig • Satellite

4.5G LTE

Low band frequencies
< [3.6] GHz

Up to 5Gbps

RLANs

2.4 GHz
+ 5 GHz

<20 Gbps

WiGig

Unlicensed
60 GHz

High-data Rate

High frequency bands
66 GHz (3 x 5GHz contiguous)

>20 Gbps

Makes commercial sense | No interference with other services



ADR



ADR



“Big Challenges Require Many Solutions”



Next Session 7: Session 7: Key Issues for Satellite Industry at WRC19