Future Spectrum Roadmap – Industry Perspective

The importance of C-band to Satellite Services

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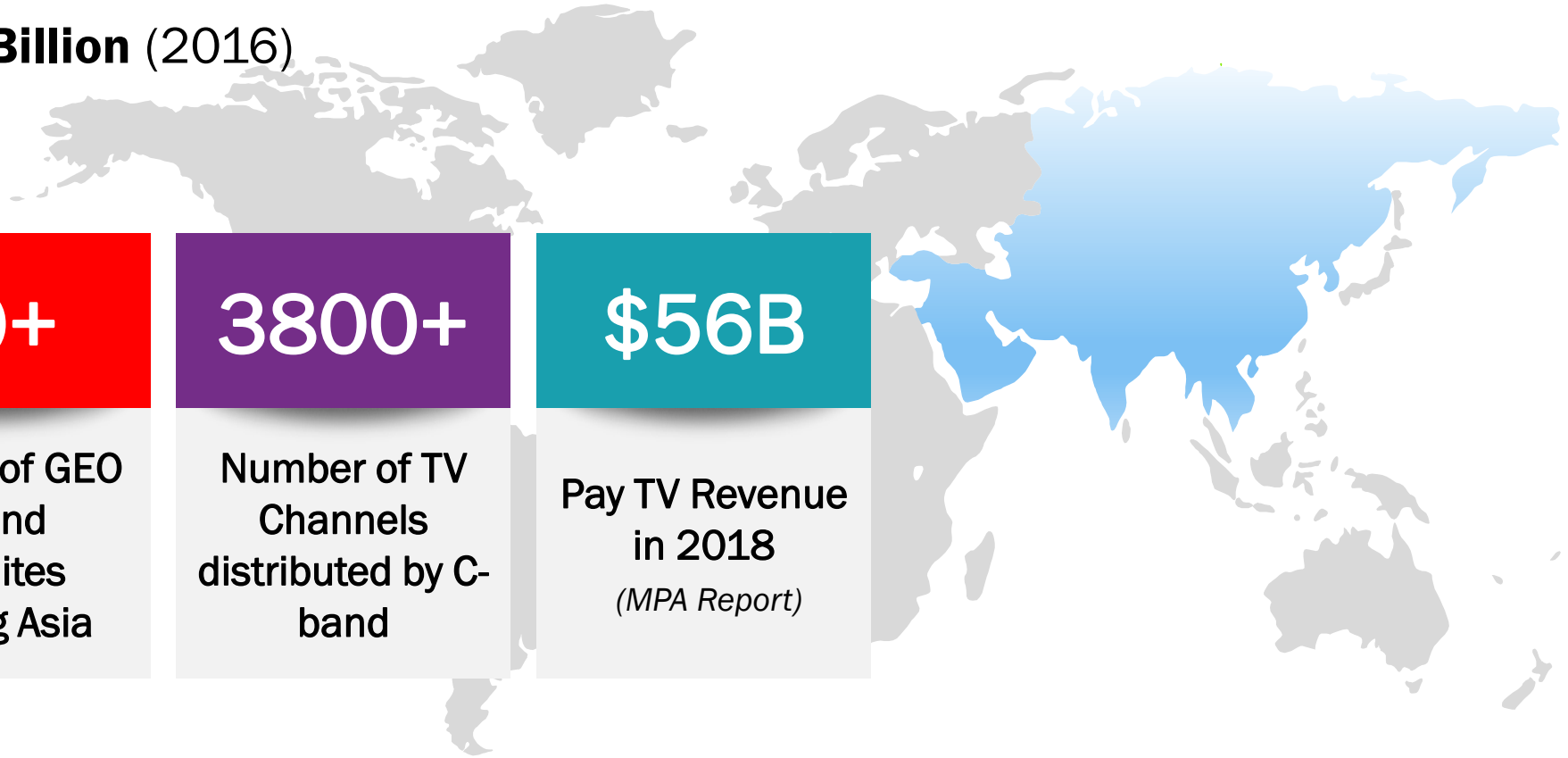
C-band facts & figures for Asia

Asia Population: 4.46 Billion (2016)



16+	80+	3800+	$56B
Number of indigenous C-band Satellite Systems	Number of GEO C-band Satellites Serving Asia	Number of TV Channels distributed by C-band	Pay TV Revenue in 2018 *(MPA Report)*

There is no substitute for C-band Satellite Services Asia

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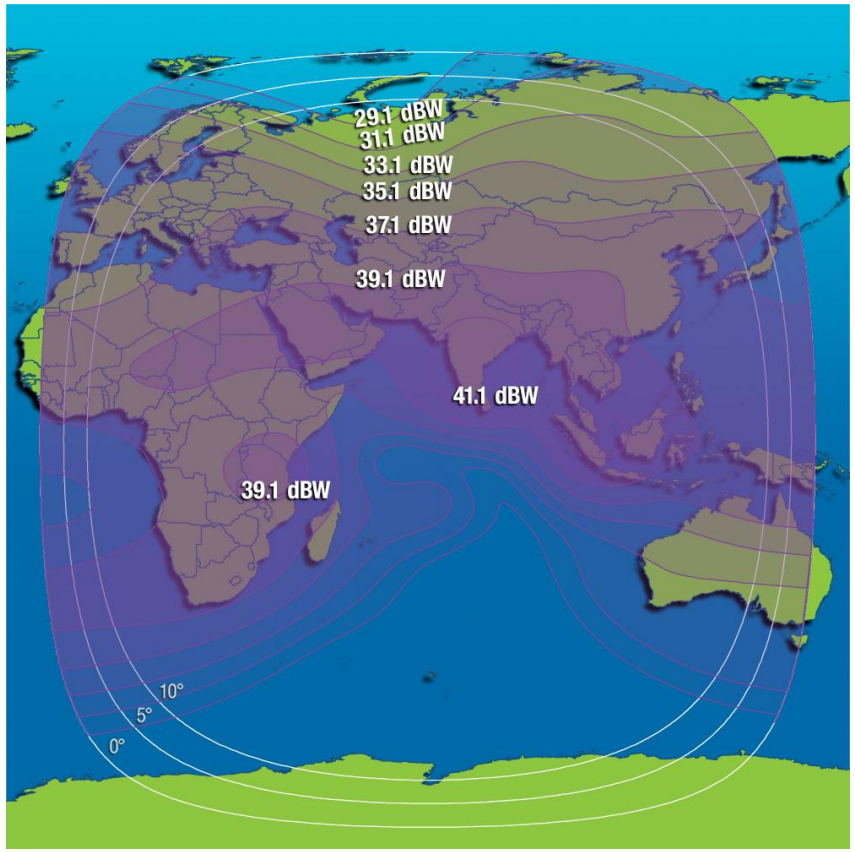
Why C-Band remains the distribution platform of choice

The most efficient, reliable, and economical medium for distribution of Media distribution



Intelsat 20 at 68.5° E

- **REACH:** C-band beams cover large geographic areas, facilitate intercontinental and global communications.
- **ECONOMICS:** 100s of thousands of installed earth stations around the world; over a hundred satellites in orbit, global reach, and distribution efficiency
- **RESELIENCE:** C-band has unique propagation and coverage characteristics that cannot be replicated in other frequency bands

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Critical telecom sectors rely on FSS C-band

Mobile Backhaul: the only way to bring mobile telephony to remote areas

Broadcasting: the only robust way to bring TV and next generation video across the whole territory

Oil & Gas: the most reliable way to connect exploration sites and offshore platforms

Humanitarian Programs: C-band recognized as a standard by the UN for emergency communications

Air Navigation & Meteorology Services: the only solution for high reliability and wide coverage

Maritime: the only solution for vessels in remote regions/ long routes

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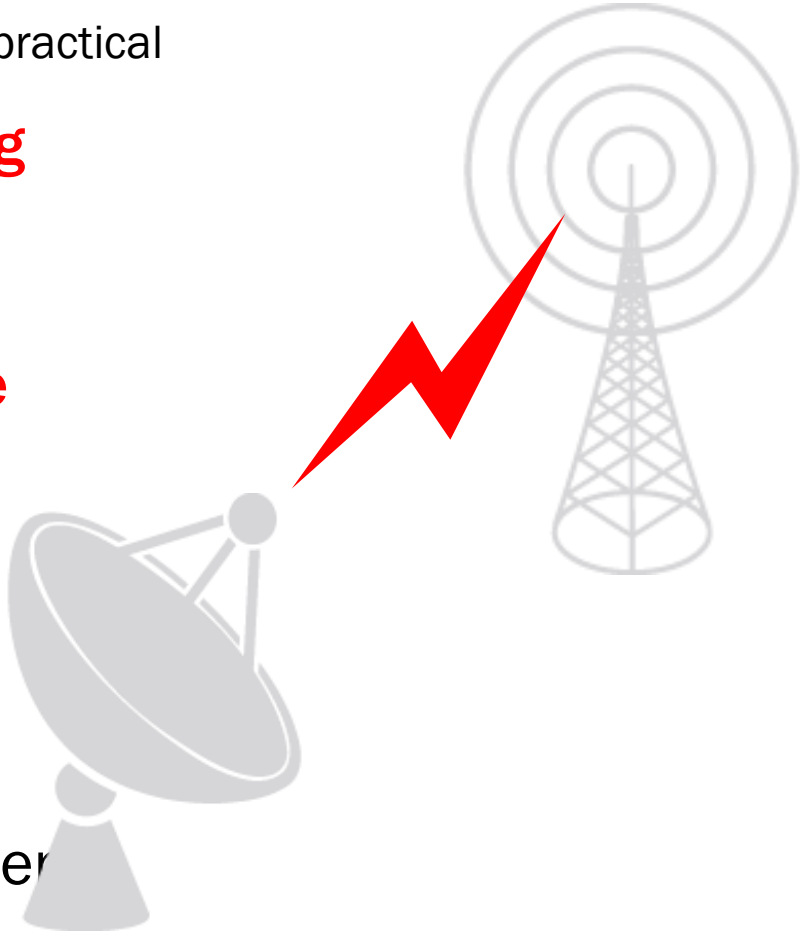
FSS and mobile co-frequency sharing is not feasible

FSS operators & mobile operators agree that co-frequency sharing is not practical

- Numerous studies showed that **co-frequency sharing** between 5G and FSS is **not feasible**
- Statements made by Ericsson and Nokia to the FCC confirmed that sharing was not feasible due to **large exclusion zones** around earth stations
- Even when 5G and FSS operate in **adjacent bands,** interference into FSS will occur, unless carefully managed
- **5G** signals are considerably **more powerful** than satellite signals; this complicates coexistence between mobile and FSS



Due to millions of customers in C band you cannot simply seek a migration plan for existing customers

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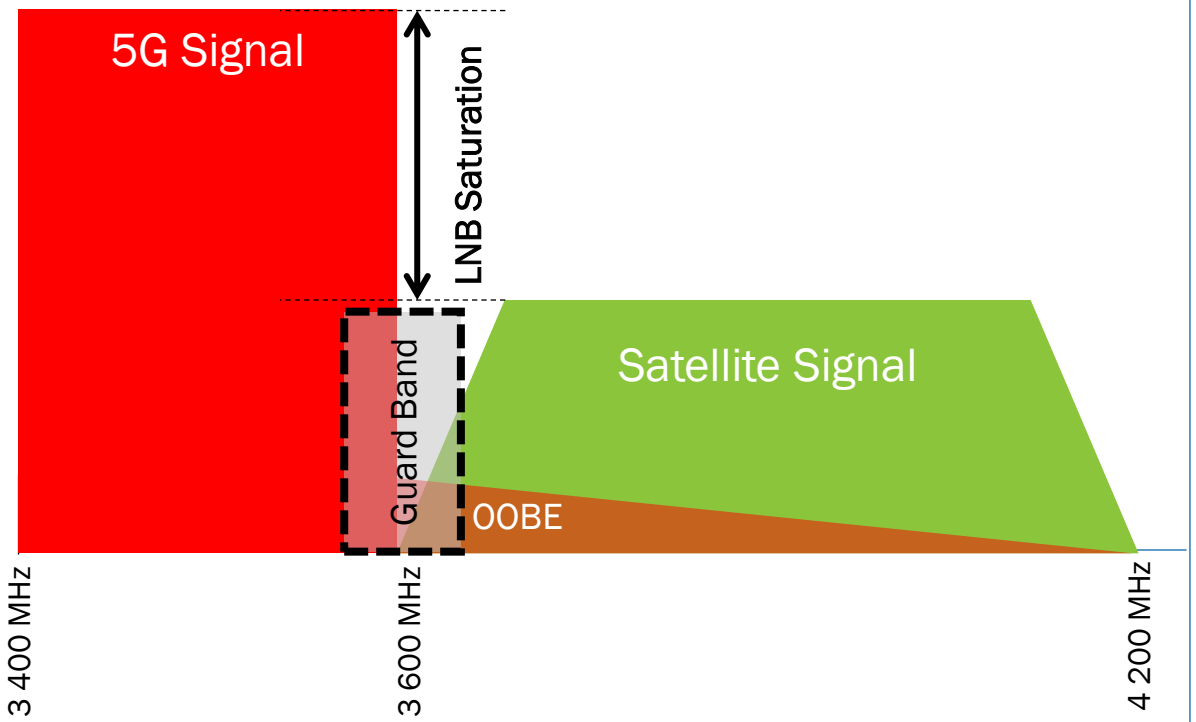
5G signals must be carefully managed



- 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
- **Using a guard band and imposing strict OOBE on 5G are required to ensure protection of FSS earth stations**

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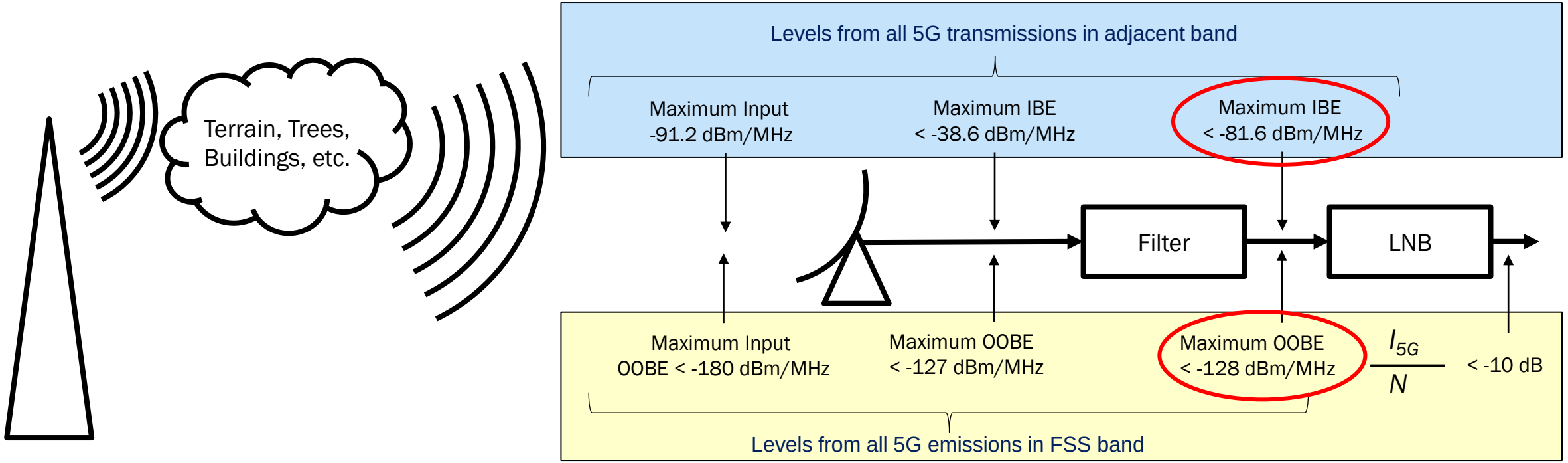
How 5G affects C-band FSS receivers

- 5G BS power level + 5G deployment = ES received power level
  - Impact of receive power level depends upon ES antenna and filter performance



Notes

1) Required levels for < 0.5 dB satellite link degradation
2) Assumes noise floor post LNB of -118 dBm/MHz
3) Filter rejection in 5G band = 43 dB; Filter insertion loss FSS pass band = 1 dB
4) Earth Station receive gain = 52.6 dBi

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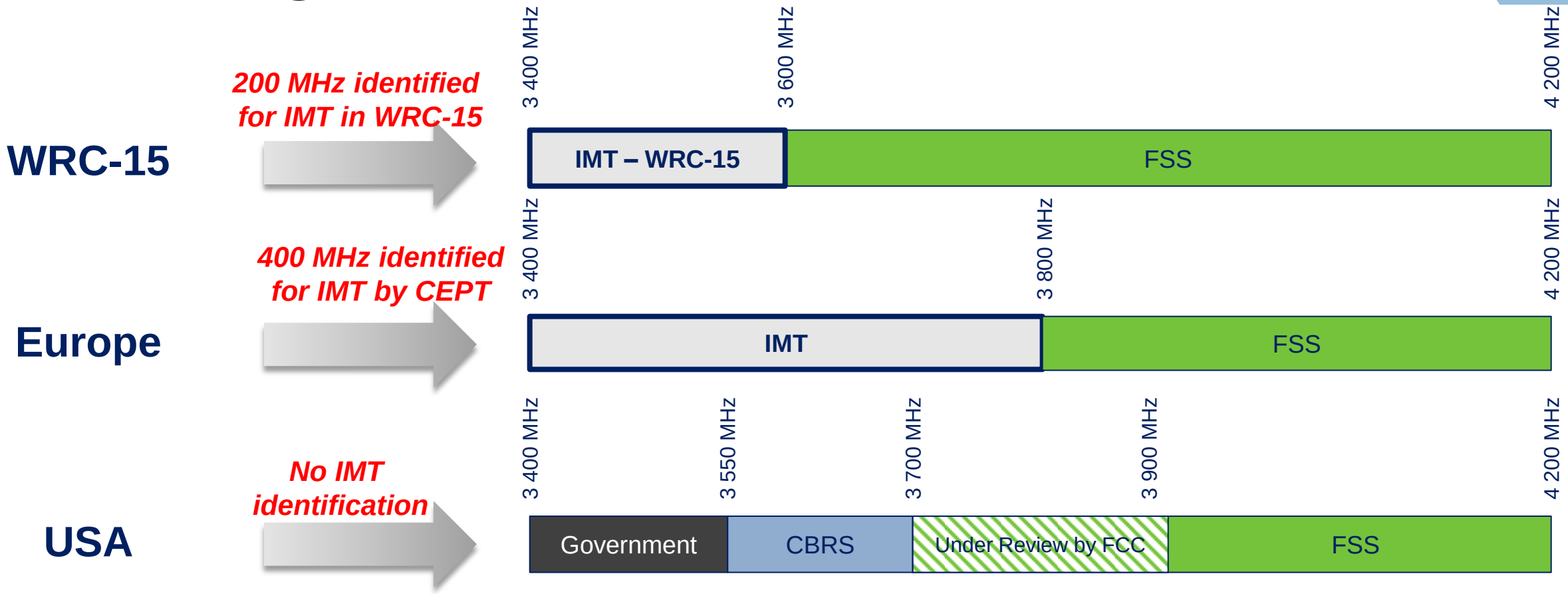
C-band usage varies around the world



Every region has different spectrum needs and realities – Asia depends on C-band satellites

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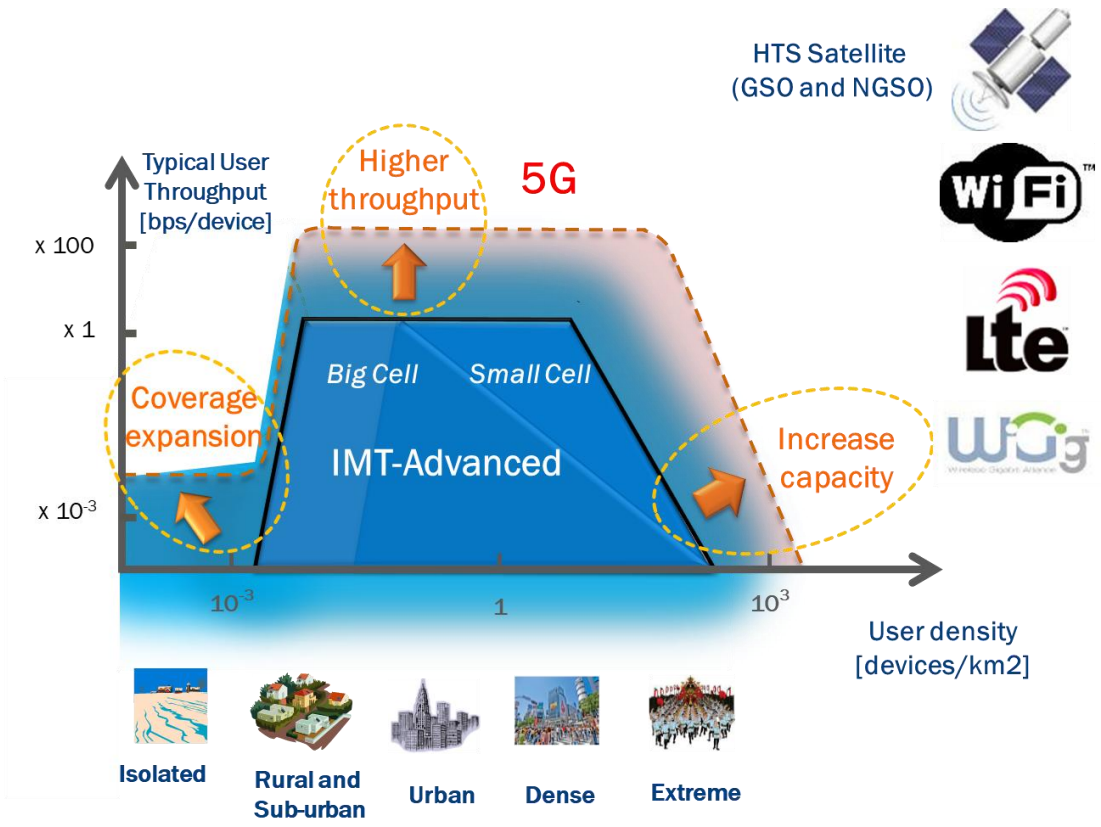
Role of satellites in 5G ecosystem

- IMT/ 5G is NOT about mobile technology only – it is more than just “Cellular” it is “Wireless”
- 5G is an end-to-end ecosystem of different technologies – a network of networks
- Satellites today can deliver data rate of > 100 Mbits/s – 1 Gbit/s in “broadcast / multi-cast” mode
- By 2020 - 2025, satellite systems can deliver > 10 Gbit/s services and will require certainty and viability in spectrum access



Final thoughts

One size doesn't fit all

- C-band satellites is critical to Asia's telecommunications infrastructure
- 3.4-3.6 GHz is available and more than adequate to meet the 5G demands, at least for the foreseeable future –also re-farm 2G and 3G spectrum
- When deploying 5G in 3.4-3.6 GHz, OOBE limits must be imposed on 5G to ensure protection of FSS earth stations
- Satellites have a role to play in 5G deployment
- Regulatory certainty is vital to all telecom sectors

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Thank you

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