Satellite in the 5G Eco-System

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Satellite Vision for 5G

⇒ 5G is not just the next "G"

⇒ 5G is a *Network of Networks* unleashing new markets & driving growth

⇒ A Paradigm Shift in Connectivity enabled through heterogeneous networks

Evolution of Satellite Operators • Innovation Across the Value Chain

From Intergovernmental Organisations	To listed companies with diverse (& terrestrial) investors
From wholesale providers of bandwidth	To value-added partners
From a proprietary, non-interoperable technology	To working on standards for integration with terrestrial networks

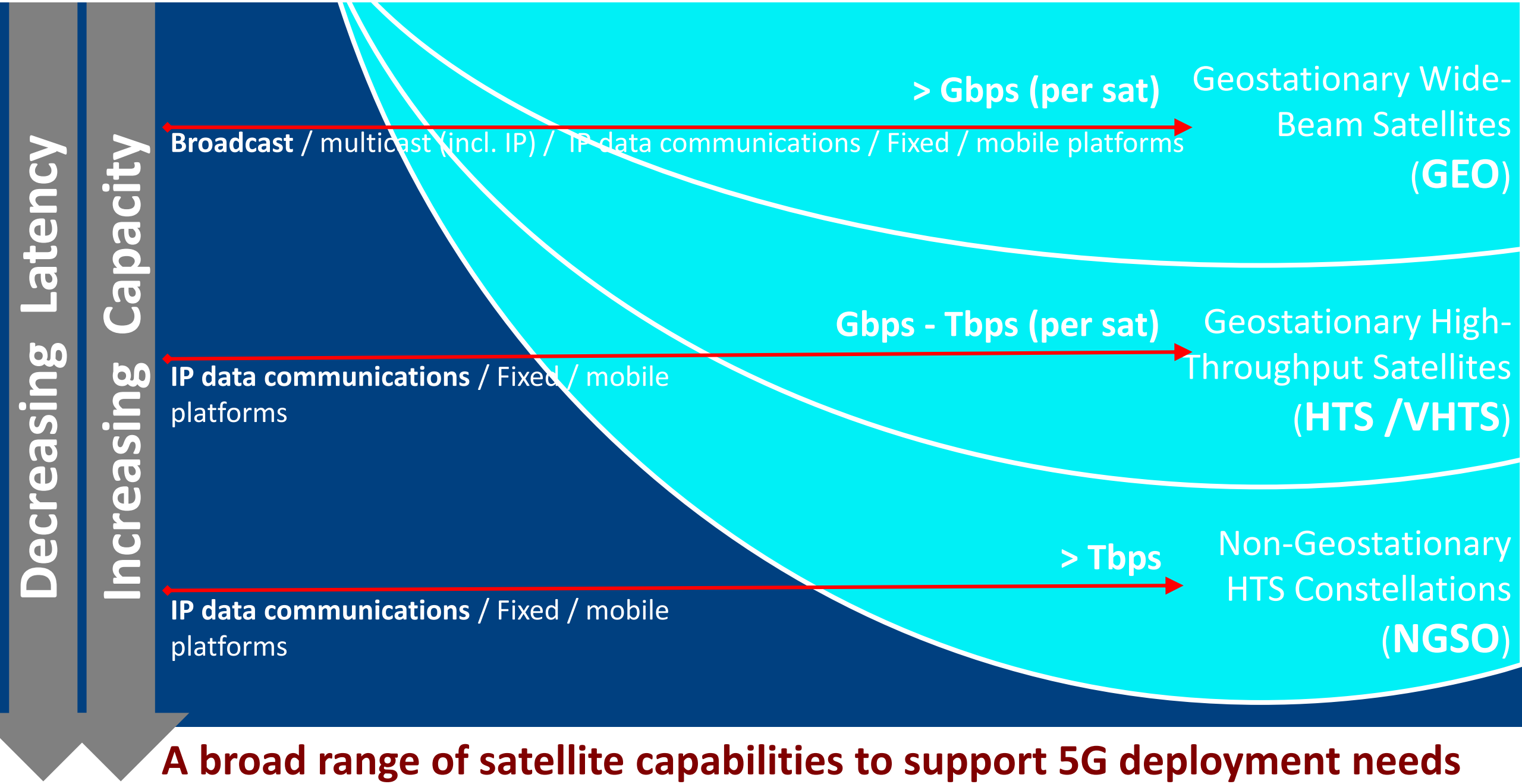
SPACE SEGMENT

- More throughput in different orbits reduces cost per bit & increases satellite capabilities
- Increased Payload Flexibility using open ‘all IP’ Architecture

GROUND SEGMENT

- Smaller, lighter, DIY antennae - no moving parts, flat panels, etc.
- Electronic steering: ‘Broadband Comms on Move’ (portable/vehicular/aero/maritime)

SPACE SEGMENT: Massive increase in available bandwidth



A broad range of satellite capabilities to support 5G deployment needs

Why Satellite is So Relevant To 5G / Future Telecoms Ecosystem

⇒ More than just about the Digital Divide

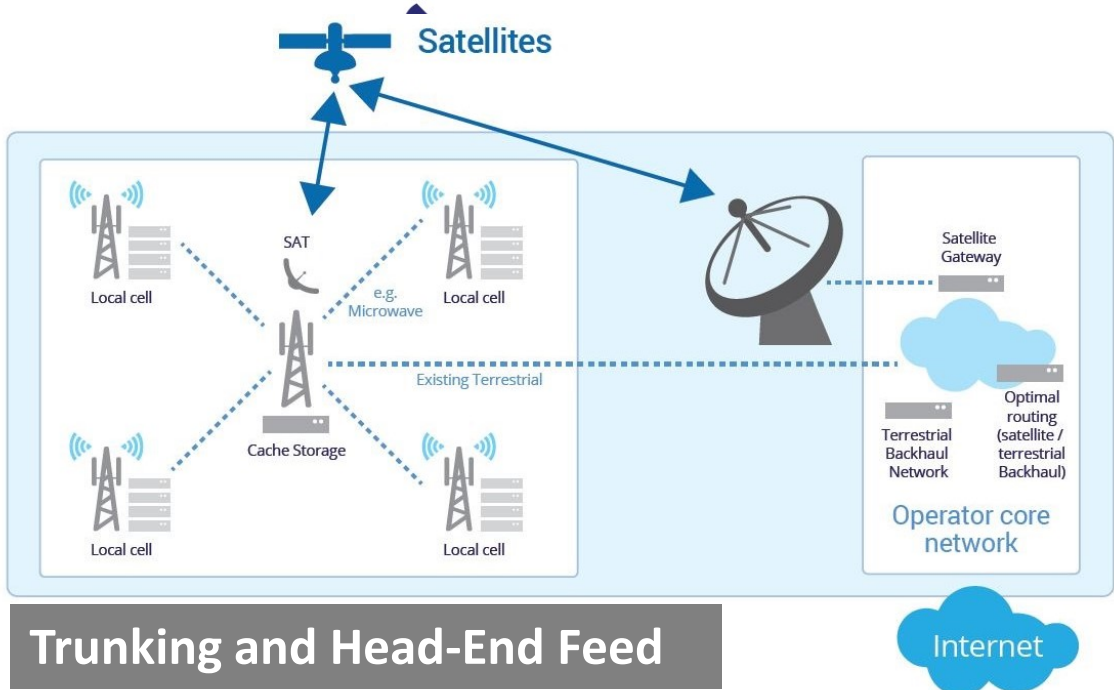
⇒ Contribute to overcoming fundamental challenges faced by land-based technologies whether in delivering the Sustainable Development Goals (SDG) or 5G

⇒ Global connectivity requirements need existing & emerging strengths of satellite technologies

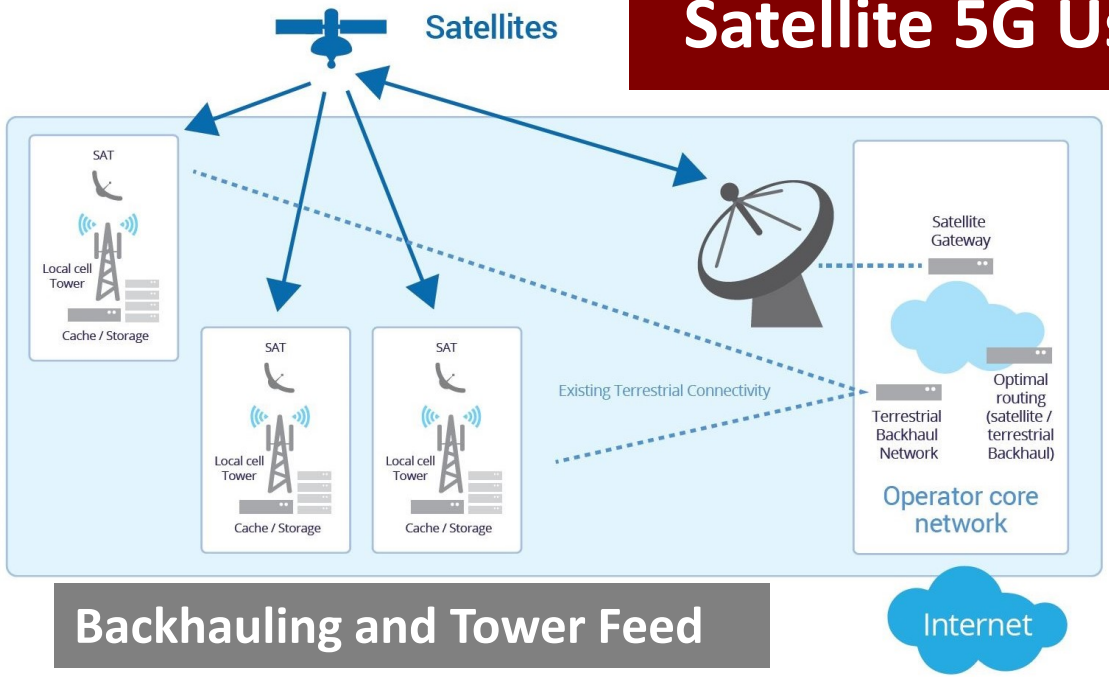
Collaboration is the best way forward for both satellite & terrestrial operators to *deliver future services & grow our markets*

- Investment economics
- Reliability
- Coverage
- Capacity
- Continuity of Service
- Quality of Service
- Network Stability

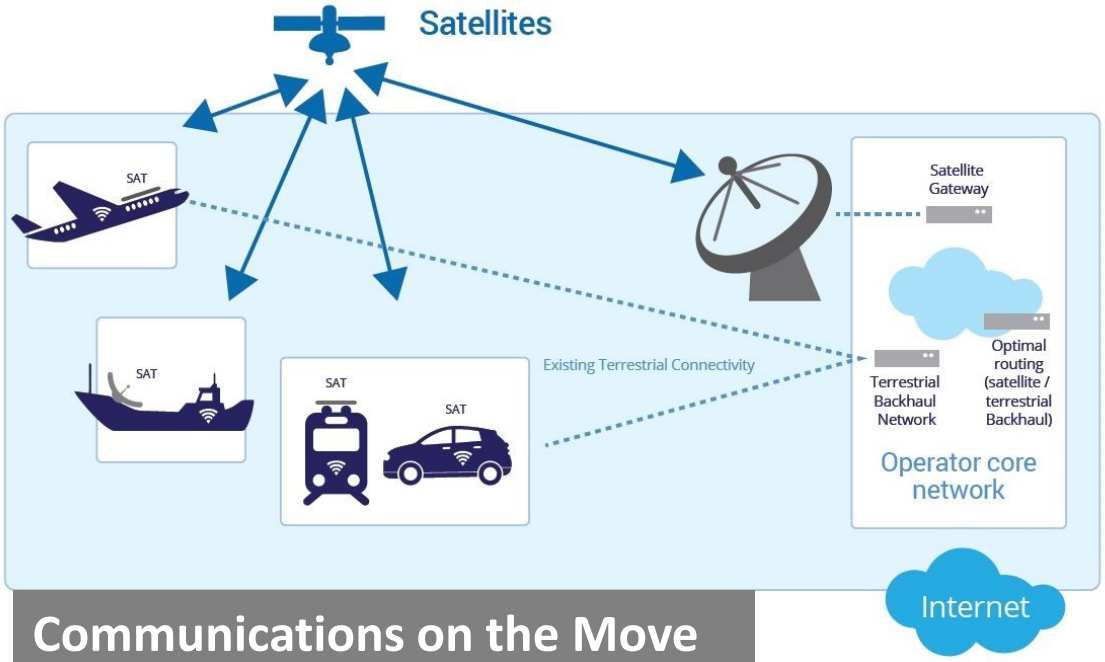
Satellite 5G Use Cases



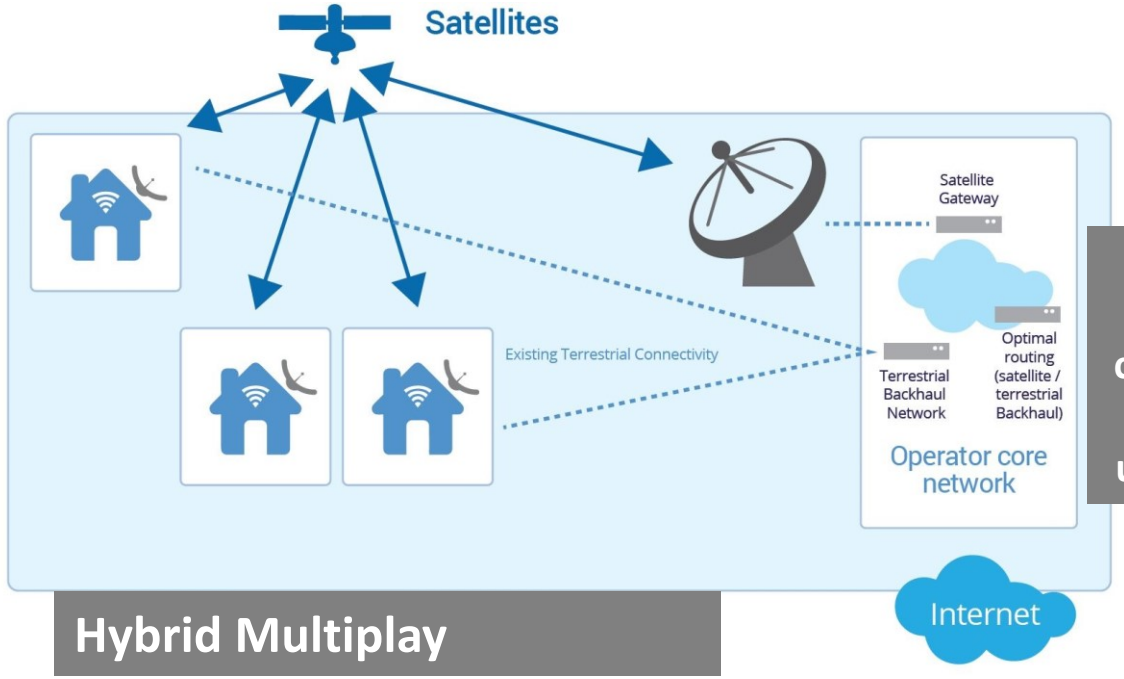
Trunking and Head-End Feed



Backhauling and Tower Feed



Communications on the Move



Hybrid Multiplay

Includes direct connectivity to users/home

5G Standards Integrating Satellite

- The satellite industry is part of the 3GPP's 5G standards setting process
- ESOA is a "Market Representation Partner":
  - Provides political support to on-going technical study items in 2 3GPP groups:
    - Radio Access Network
    - System Architecture
  - Feeds 3GPP with satellite operator requirements to support technical work
- Satellite (non-terrestrial networks, NTN) elements will be part of 3GPP Release 17 due in June 2021

June 18-21, 2018

3GPP Document TR 22.863 also includes a 5G rural connectivity requirement:

"Broadband Access Everywhere over long distances for low density areas … including both humans and machines shall be supported."

Satellite in the 5G Eco-System is a reality

Trials & Demos

Satellite-5G Demonstration	Date & Venue
EUCNC 2018 June 18-21 European Conference on Networks and Communications | Ljubljana, Slovenia SAT 5G Satellite and Terrestrial Network for 5G	June 18-21, 2018 Ljubljana, Slovenia
FUSECO Forum 2018 FUTURE SEAMLESS COMMUNICATION SATis5	November 14-15, 2018 Berlin, Germany
GSMA MWC19 Barcelona 25-28 February 2019 SATis5	February 25-28 2019 Barcelona
	7 May 2019 UK

LTE Coverage

Big Challenges Require Many Solutions
The only right answer is a MIX of TECHNOLOGIES

WiFi

~~OR~~ **AND**

Mobile

~~OR~~ **AND**

Satellite

By 2020, LTE will cover

63% of the worlds population but only

37% of the landmass

Source: OpenSignal

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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**

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C-band facts & figures for Africa

246

Number of active C-band satellites by 34 operators

100s of Millions

industry in the past five years launching 52 C-band satellite

$56B

Pay TV Revenue in 2018

(MPA Report)

20M+

passengers in Angola, Nigeria, & DRC who rely on C-band air navigation

There is no substitute for C-band Satellite Services in Africa

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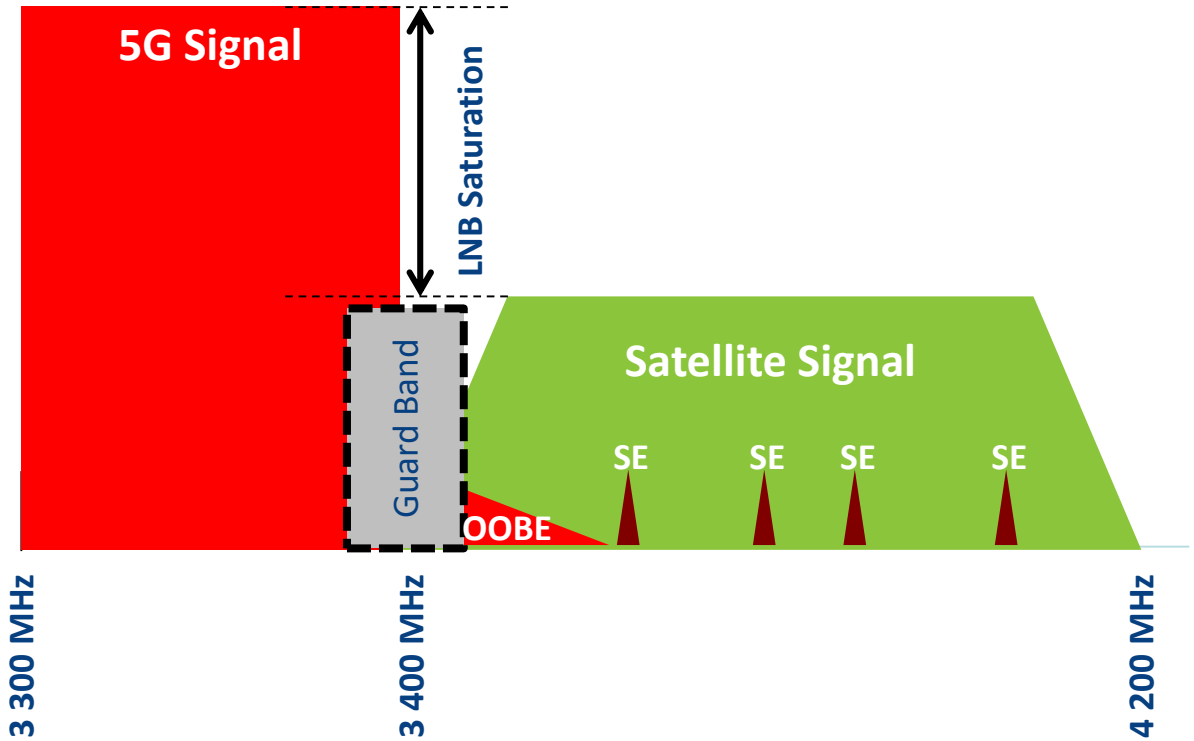
Co-existence between FSS and 5G in adjacent bands must be carefully managed



- 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) and Spurious Emissions (SE) of the 5G signal can cause in-band interference to FSS signals
- OOBE & SE 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

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Current & Future Satellites in 28 GHz

A FEW Examples

GEO satellites

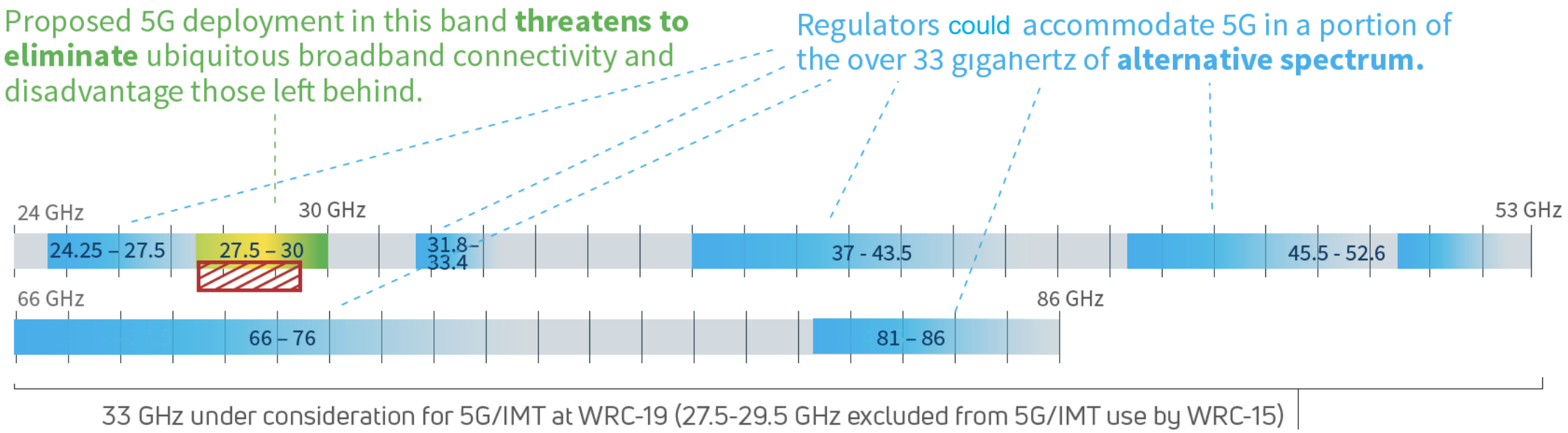
- **APStar** Apstar 5C/6C, 6D (2019), 7 (2022)
- **AsiaSat** AsiaSat 7/8/9
- **Inmarsat Global Xpress** Inmarsat-5 F1/F2/F3/F4, GX-5 (2019), Inmarsat-6 (2020-2021)
- **Eutelsat** KaSat, future Konnect
- **Intelsat** EuropeStar, IS-20/33e/36/37e
- **Kacific** Kacific-1
- **MEASAT** Measat-3d
- **NBNCo** SkyMuster 1/2
- **SES** Astra 2E/2G/3B/4A/5B, AMC-15/16, SES-11/12/14/15
- **Thaicom** Thaicom/IPStar
- **Turksat** 4B, 5B (2020)
- **ViaSat** Viasat-1/2, future ViaSat-3

Non-GEO satellites

- **O3b** 20 MEO satellites **in-orbit**
- **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)

28 GHz band must be retained for satellite

- High, Mid and Low band spectrum outside 28 GHz is available for IMT/5G
- IMT/5G designs incompatible with 28 GHz satellite broadband
- Satellite broadband uses 28 GHz spectrum today to connect and compete



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Ensure Future Growth & Innovation

⇒ 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

47 - 52.6 GHz
NOT Candidate Band for Global Harmonisation

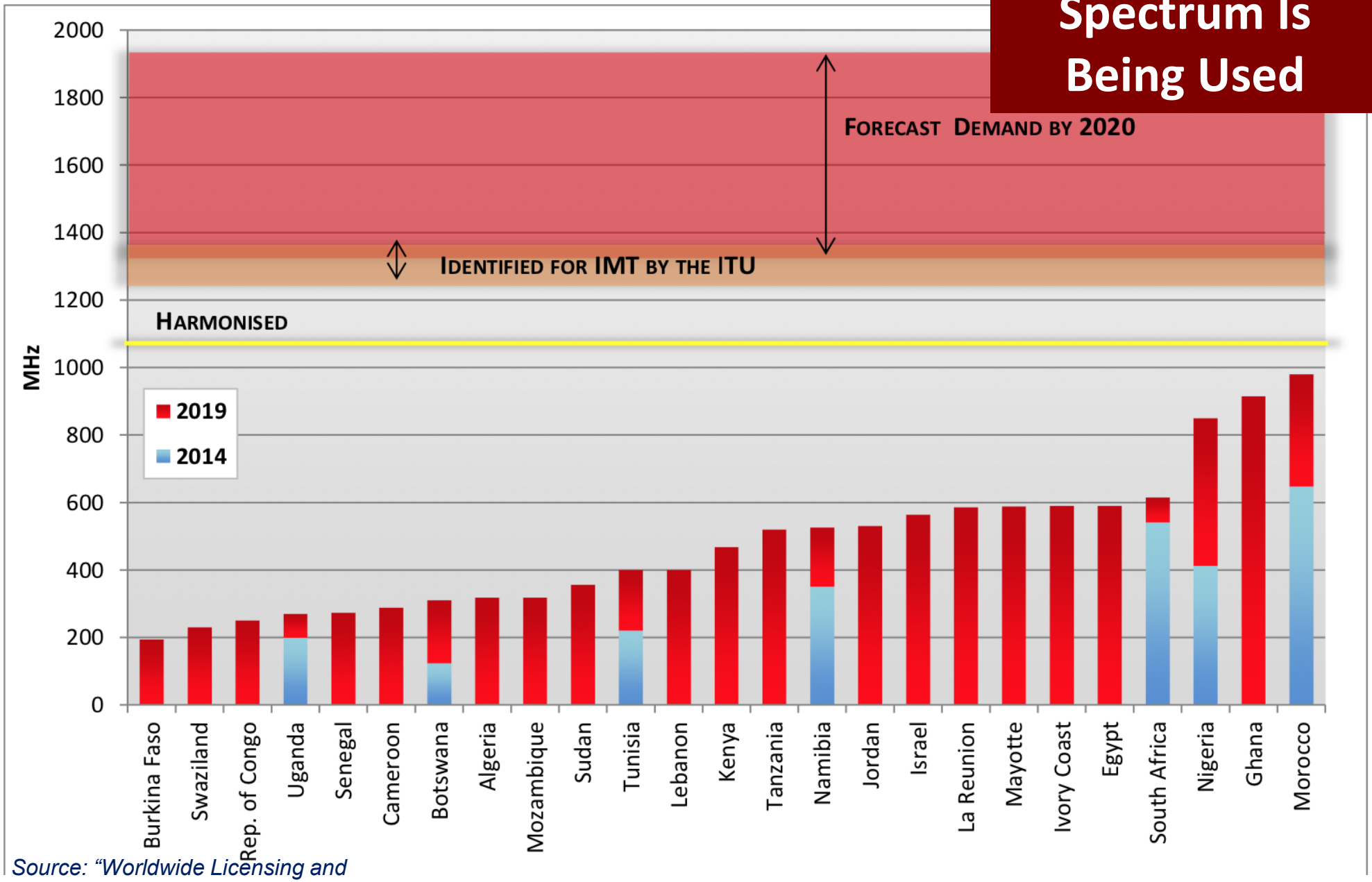
- Future satellites (in construction) will use 40/50 GHz
- 2GHz of spectrum is needed for HDFSS user terminals
- Needs appropriate shared basis for coordinated FSS earth stations
- Regional harmonization for IMT is sufficient

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

Not All Available Spectrum Is Being Used

- 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 Africa
- Orange: Spectrum identified by the ITU for IMT
- Pink zone: ITU prediction for IMT requirements for 2020



Source: "Worldwide Licensing and Use of IMT Spectrum", LS telcom

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SUMMARY: Why Africa should not consider C-Band & 28 GHz Band for IMT

- 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, as both bands are extensively used by satellite all around the world
- Plenty of other spectrum is available for license & use by IMT in Africa: 33 GHz of other spectrum already under consideration
- 3.3-3.4 GHz and 26 GHz will be more than adequate to meet 5G demands for the foreseeable future - also re-farm 2G & 3G spectrum
- No need to cut off international connectivity and flexibility for national 5G
- Africa has extensive reliance on satellite services & it is growing
- IMT cannot replace these satellite services: there is NO alternative