Session 11: Satellite As Part of the 5G Ecosystem

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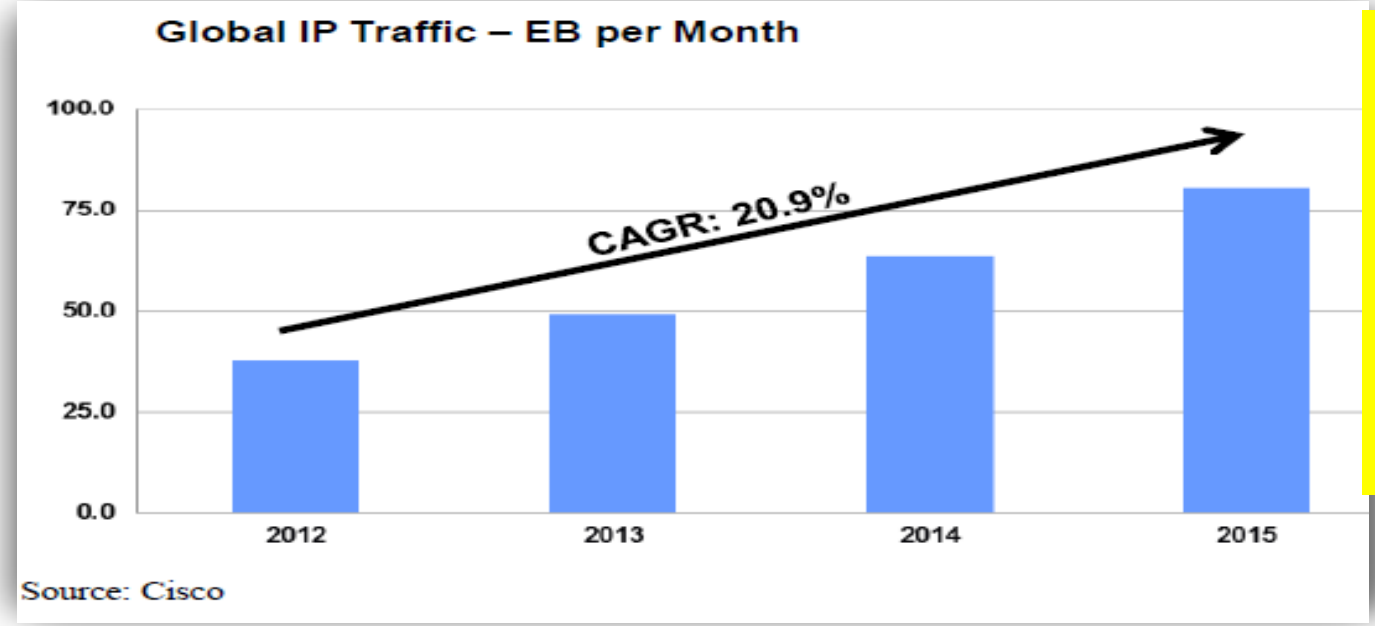
The Connected World



Global Demand for an universal, integrated IP broadband network with the ability to serve anyone, at any time, anywhere

Broadband penetration and speeds increasing

Global IP traffic is expected to more than double between 2012 and 2015
Global mobile data traffic will grow three times faster than fixed IP traffic

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Satellites Are Part of the Key Usage Scenarios for 5G

» **Enhanced mobile broadband**

- Satellites routinely carry high bandwidth **HD and UHD content**
- Satellites already support 2G/3G mobile backhaul in many parts of the world, and **high-throughput satellites (HTS)** in GEO, MEO and LEO will support 4G and 5G mobile networks

» **Ultra-reliable and low-latency**

- International broadcasters, MNOs, governments depend on us every day to ensure ultra-reliable communications
- GEO latency is acceptable for many 5G applications, and new MEO and LEO networks will be able to support more latency-sensitive applications
- Satellites can even help 5G networks meet their sub-1ms latency requirements by delivering common content to mobile base stations

» **Machine-to-machine communications**

- Satellites already support SCADA and other global asset tracking applications today, and can scale to support future machine-to-machine (Internet-of-Things) communications
- New ground technologies, such as smaller, lower cost, electronically steerable, and/or phased-array satellite transceivers are making ubiquitous deployment for IoT feasible

5GPPP vision (www.5G-PPP.eu)

- "**5G wireless will support a heterogeneous set of integrated air interfaces**: from evolutions of current access schemes to brand new technologies. **5G networks will encompass cellular and satellite solutions**. Seamless handover between heterogeneous wireless access technologies will be a native feature of 5G, as well as use of simultaneous radio access technologies to increase reliability and availability."
- "To achieve the expected capacity, coverage, reliability, latency and improvements in energy consumption, the **5G architecture is expected to run over a converged optical-wireless-satellite infrastructure for network access, backhauling and front hauling** with the possibility of transmitting digital and modulated signals over the physical connections."

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How is Satellite Part of the 5G Ecosystem?

- Satellite's ability to extend networks capabilities is **essential for an inclusive digital society** to ensure that the benefits of 5G (or even 4G) are made available everywhere
  - Otherwise, 5G and 4G will only be providing more broadband to those who already have it
- Satellites today already **extend next generation networks** to places they would not otherwise reach – satellite-powered 2G/3G/4G mobile capabilities to end users, rural Wi-Fi, aeronautical and maritime broadband
  - New **High Throughput Satellite (HTS) systems** – both geostationary and non-geostationary – are bringing even higher speeds, lower cost-per-bit, and lower latency (when needed) providing satellite-powered **4G and future 5G/Wi-Gig networks**
  - Satellites also **support many IoT networks** today (e.g. global asset tracking and SCADA) and can scale to meet expanded IoT requirements of the future, e.g. connected cars, planes and ships
  - In order to meet the **low latency (sub-1ms) requirements of future 5G applications**, commonly accessed content will need to be efficiently distributed and stored at the base of every 5G cell site – a multi-cast or point-to-multipoint function at which satellites excel

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High Throughput Satellites in the Asia-Pacific Region

In Service	High Throughput Satellite	Orbit	Frequency bands
2005	Thaicom-4 / IPStar-1	GEO	Ku-band / Ka-band
2013 (batch 1) 2014 (batch 2)	O3b (Batch 1 & 2)	MEO	Ka-band
2017	Inmarsat GlobalXpress (I5 F4)	GEO	Ka-band
	Eutelsat 172B	GEO	C-band / Ku-band
2018	O3b (Batch 3 & 4)	MEO	Ka-band
	SES-12	GEO	Ku-band / Ka-band
	APStar 5C / Telesat 18 Vantage	GEO	C-band / Ku-band
	Horizons 3e	GEO	C-band / Ku-band
2019	Kacific-1 / JCSat-18	GEO	Ka-band
	OneWeb	LEO	Ku-band / Ka-band
2020	SpaceX	LEO	Ku-band / Ka-band
2021	Telesat LEO	LEO	Ka-band
	O3b mPower	MEO	Ka-band

Four Satellite “Sweet Spots” in the 5G Ecosystem

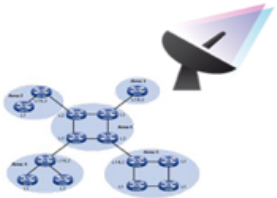
» Four use cases for next generation satellite-based solutions for 5G (IMT-2020)

Comms on the move

Satellites provide a direct and/or complementary connection for users on the move (e.g. on planes, trains, automobiles and ships)

Hybrid Multiplay

Satellites deliver content complementing terrestrial broadband (as well as direct broadband connectivity in some cases)



Trunking and Head-End Feed

Satellites provide a very high speed direct connectivity option to remote / hard-to-reach locations

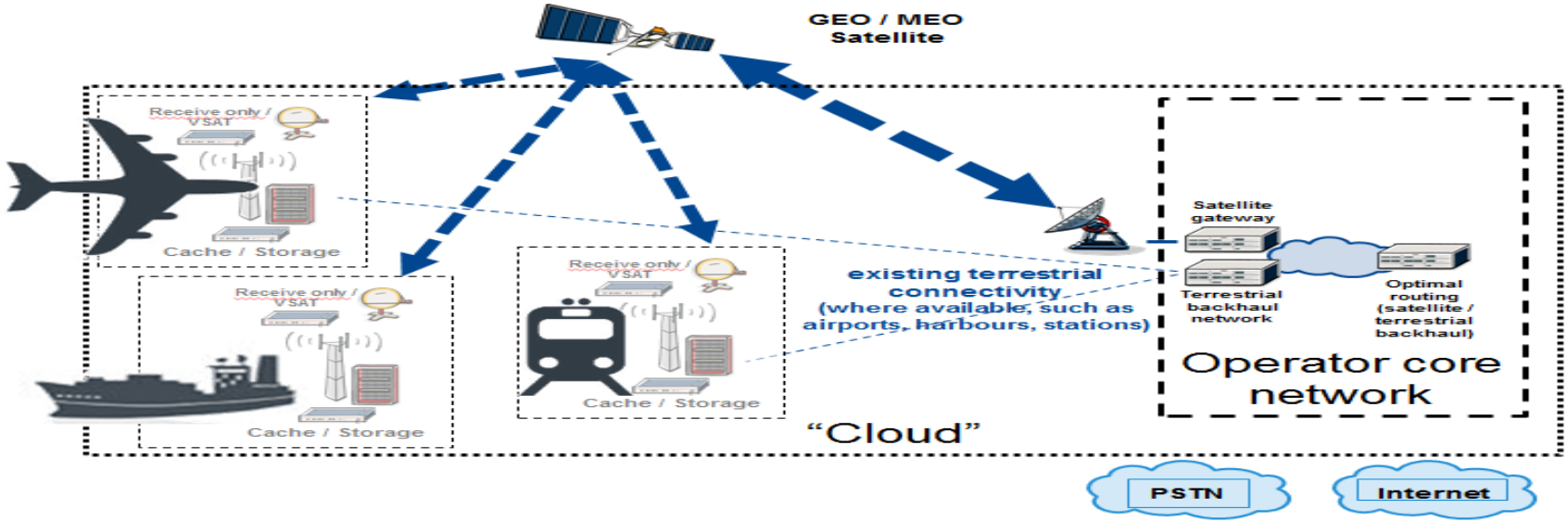
Backhauling and Tower Feed

Satellites provide a high speed connectivity complement (incl. multicast content) to wireless towers, access points and the cloud

These four “sweet spots” leverage the advantages of satellites – **high bandwidth** and **ubiquitous coverage**

Four Satellite "Sweet Spots" in the 5G Ecosystem

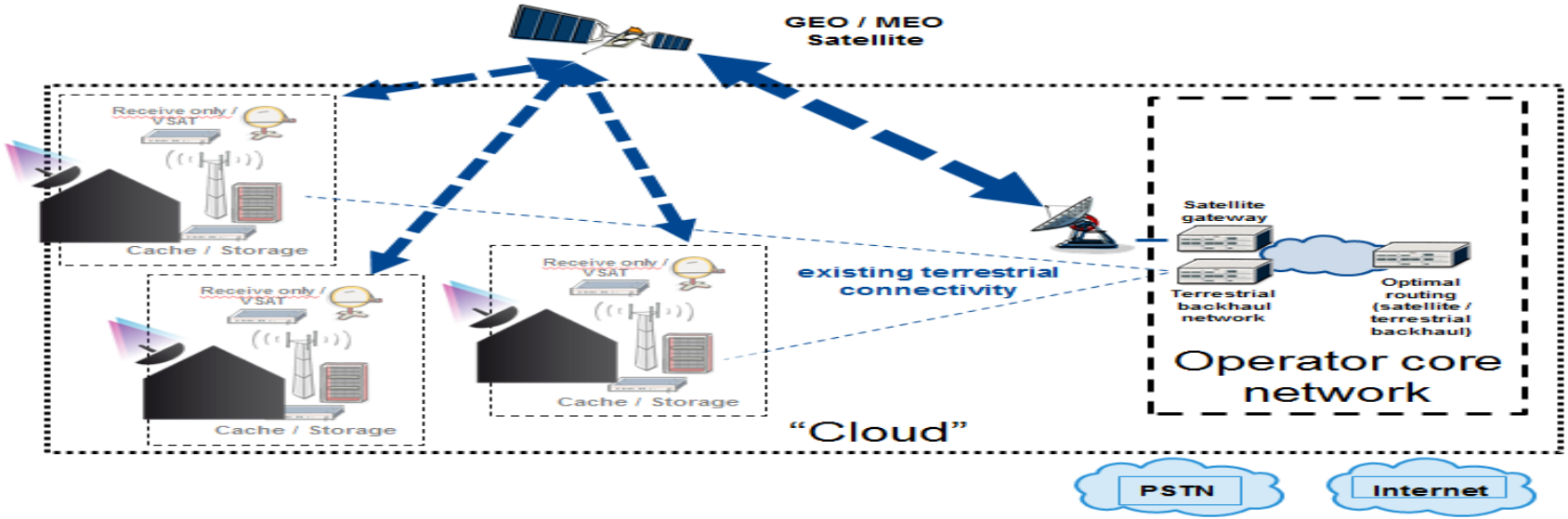
Communications on the Move



- Very high speed, multi-cast enabled, satellite link (up to 1 Gbps or more) direct to plane, train, car or vessel, from geostationary and/or non-geostationary satellites would enable:
  - Backhaul connectivity and multicasting of (video, HD/UHD TV and non-video data) where it may not be otherwise possible
  - Direct connectivity and/or efficient backhauling of aggregated IoT traffic

Four Satellite "Sweet Spots" in the 5G Ecosystem

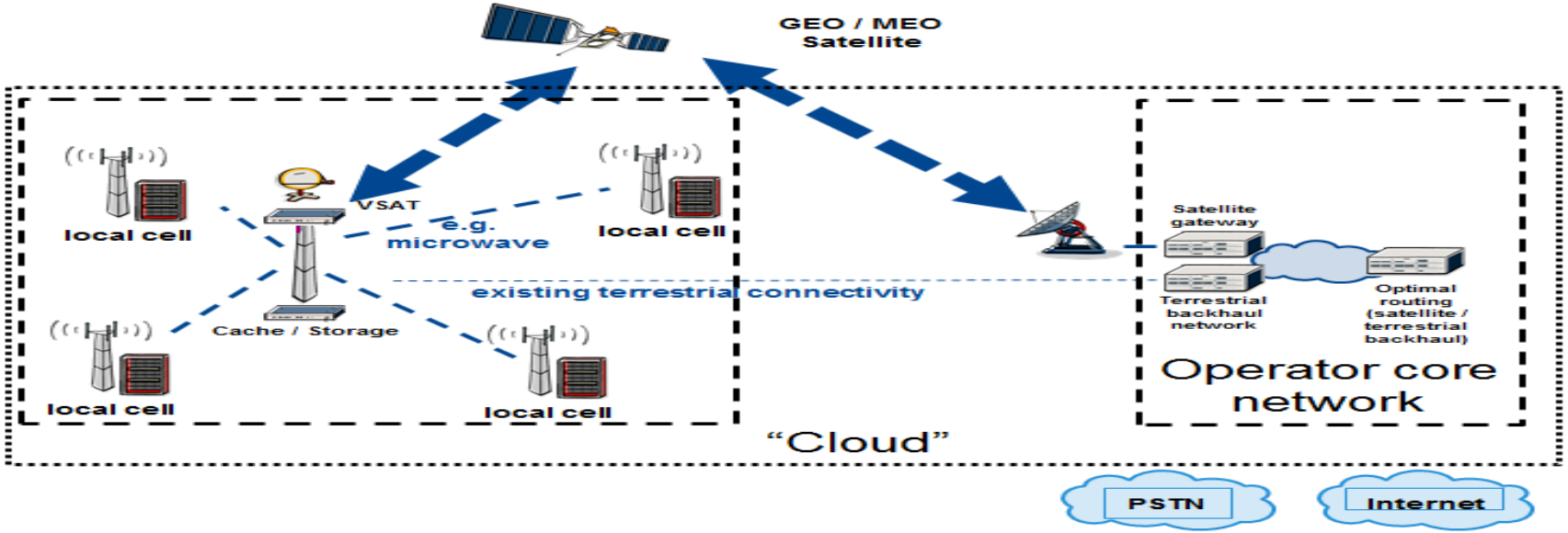
Hybrid Multiplay



- Very high speed (up to 1 Gbps or more) satellite connectivity to individual homes and offices, with the ability to multicast the same content (video HD/UHD TV, and non-video data) across a large coverage area (e.g. for local storage or consumption)
  - The same capability allows for efficient broadband connectivity for aggregated IoT data
  - Further in-home or in-office distribution via Wi-Fi or very small 3G/4G/5G nano-cells

Four Satellite "Sweet Spots" in the 5G Ecosystem

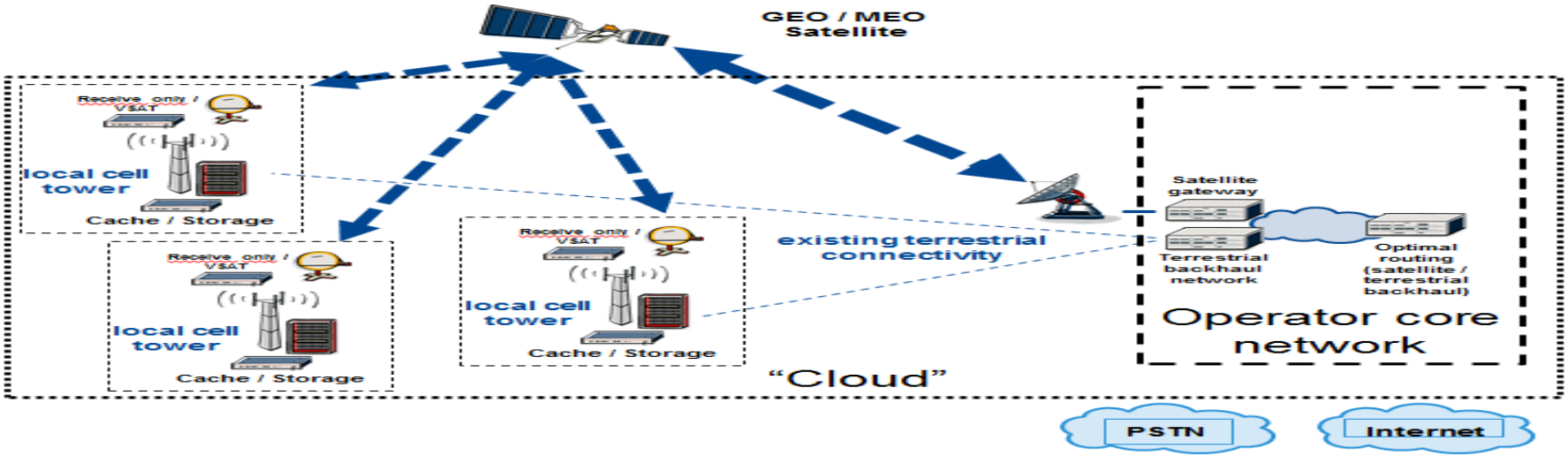
Trunking and Head-end Feed



- A very high speed satellite link (up to 1 Gbps or more) from geostationary and/or non-geostationary satellites will complement existing terrestrial connectivity to enable:
  - High speed trunking of video, IoT and other data to a central site, with further terrestrial distribution to local cell sites (3G/4G/5G cellular), for instance neighboring villages.

Four Satellite "Sweet Spots" in the 5G Ecosystem

Backhauling and Tower Feed



- A very high speed satellite link (up to 1 Gbps or more), direct to base stations, from geostationary and/or non-geostationary satellites would complement existing terrestrial connectivity and enable:
  - Backhaul connectivity to individual cells with the ability to multicast the same content (e.g. video, HD/UHD TV, as well as non-video data) across a large coverage area
  - Efficient backhauling of aggregated IoT traffic from multiple sites

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Satellites Can Even Help Achieve sub-1ms Latency

- Sub-1ms latency is a challenge, even for 5G mobile networks
- According to GSMA Intelligence, “Understanding 5G” (December 2014):
  - “Achieving the sub-1ms latency rate … will likely prove to be **a significant undertaking in terms of technological development and investment in infrastructure**.” (at p.12)
  - “[S]ervices requiring a delay time of less than 1 millisecond must have all of their content served **from a physical position very close to the user’s device**. … possibly **at the base of every cell, including the many small cells** that are predicted to be fundamental to meeting densification requirements.” (at p.12)

Thus, satellites achieve sub-1ms latency by multi-casting content to caches at the network edge, anywhere they provide service.

This is one of the satellite “sweet spots”!

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Satellites as Part of the 5G Ecosystem

- Satellite industry is actively engaged in developing the key technologies and standards needed to enable satellite solutions for future generation networks
- "SaT5G" – or Satellite and Terrestrial Network for 5G – is an industry-led consortium funded by the European Commission that will research and validate the key technology enablers for integration of satellites into 5G, and demonstrate them in live 5G test beds
  - 16 partner companies consisting of satellite and terrestrial operators, equipment manufacturers, universities and research centers
  - 30-month project that will run from June 2017 to November 2019
- "SATis5" is a European Space Agency demonstrator project for satellite-terrestrial integration in the 5G context that considers both mobile backhaul and direct connection architectures
  - 24-month project launched in October 2017

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Conclusions

- Satellites will play an important role in digital inclusion such as by extending 5G networks to hard-to-serve, under-served and un-served areas of the world
- Regulatory and technical decisions should enable, and not preclude, satellites from playing a role in the 5G ecosystem
- Spectrum decisions relating to terrestrial mobile 5G should not and need not be mutually exclusive of current and next-generation HTS and VHTS systems, especially when there is ample spectrum under study that is not used or planned to be used by satellites

Key Issues for Satellite Industry – 28 GHz Spectrum

28 GHz is Critical for Satellite Broadband

3.5GHz of Ka-Band spectrum used today to deliver satellite broadband

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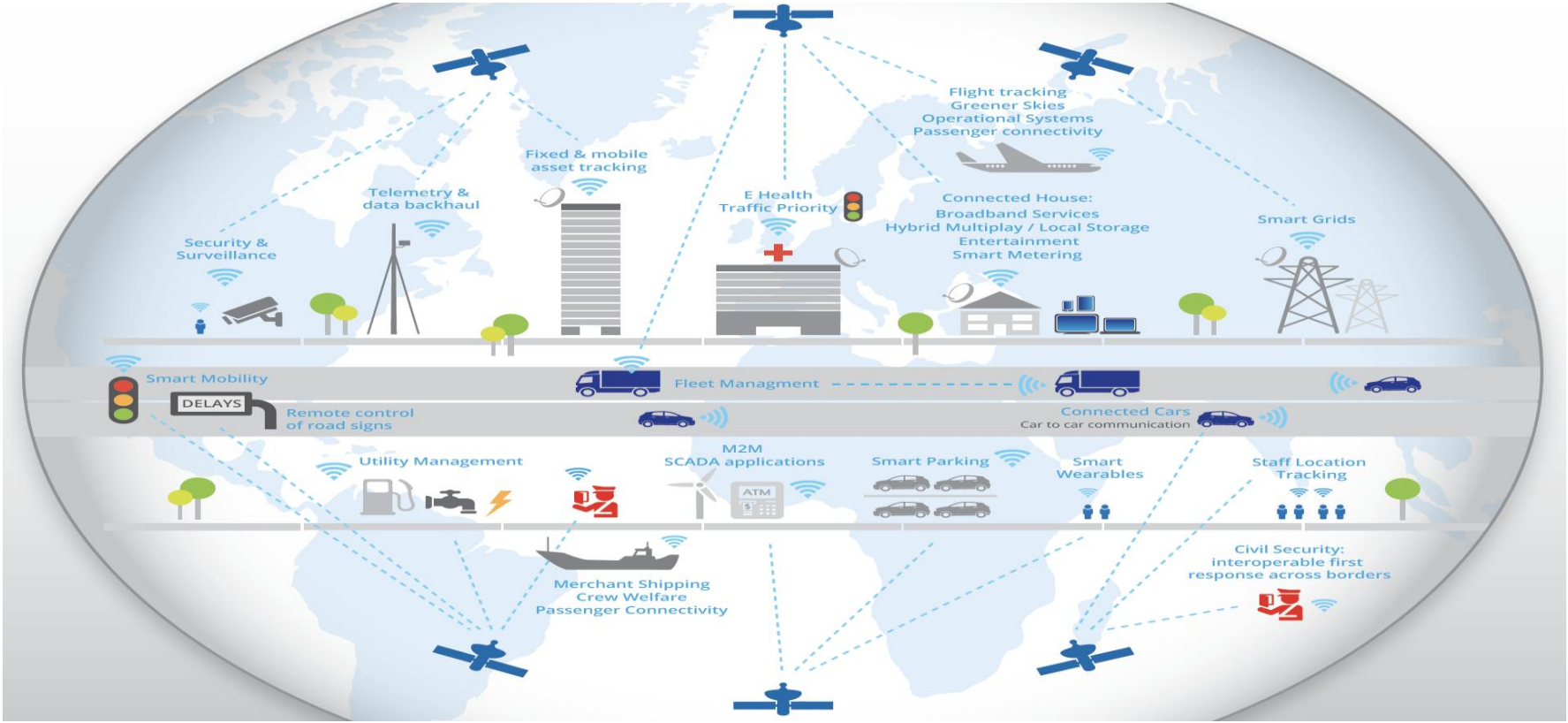
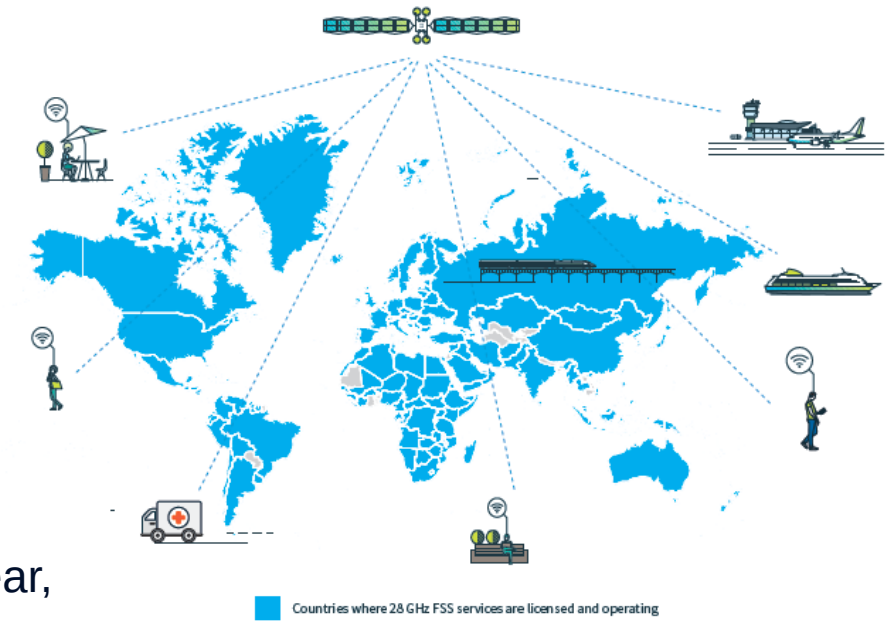
Paradigm Shift in Global Connectivity: Satellite is Part of the 5G Ecosystem



Satellite Broadband Services in 28 GHz Today

- High-speed, affordable serve to millions
- Reaching beyond terrestrial networks
- Satellite powered ubiquitous Wi-Fi
- Video services to millions
- Mission critical government services

- Expanding mobile applications
- Trains, ambulances, ships, buses, cars
- Connecting over 100+ M inflight devices/year, plus cockpit, “black box”



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ITU and Regional Support for Satellite in 28 GHz

- ITU 5G report recognizes WRC-15 excluded 28 GHz from studies toward international harmonization of mmWave bands for IMT by WRC-19
- WRC-15
  - explicitly recognized critical and vital use of 28 GHz delivering valuable Ka-band satellite services by existing and planned GSO and NGSO Ka-band satellite systems
  - EXPRESSLY excluded 28 GHz band from scope of WRC-2019 agenda (agenda item 1.13) for above 24 GHz IMT-2020 spectrum.
  - placed on WRC-2019 agenda the topic of expanding satellite broadband in 28 GHz via Earth Stations in Motion (ESIMs) (agenda item 1.5)
- CEPT 5G Roadmap identifies 28 GHz for satellite broadband/ESIMs and says it is not for IMT/5G
- CEPT, ATU, RCC *all* support adjacent 26 GHz band for IMT/5G, none supports introducing IMT/5G at 28 GHz
- No basis to “bring back” 28 GHz to a future WRC in the scope of IMT-2020 spectrum identification

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Billions Invested in 28 GHz Satellite to Meet Demand

- About 130 28 GHz satellites in orbit; about 2 dozen more in the next few years
- *These new satellite networks will provide connectivity to new markets (new products and services), enhance existing terrestrial markets (new geographies), and create competition v. existing terrestrial markets (particularly, legacy wireline and satellite networks).*

  Morgan Stanley, October 2017

- Satellite broadband is changing lives by providing never-before available connectivity, and by offering choice and competition
- Increasing broadband connectivity grows economies and stabilizes communities
- 28 GHz is the satellite spectrum that makes this all possible
- All countries deserve choices of broadband technologies

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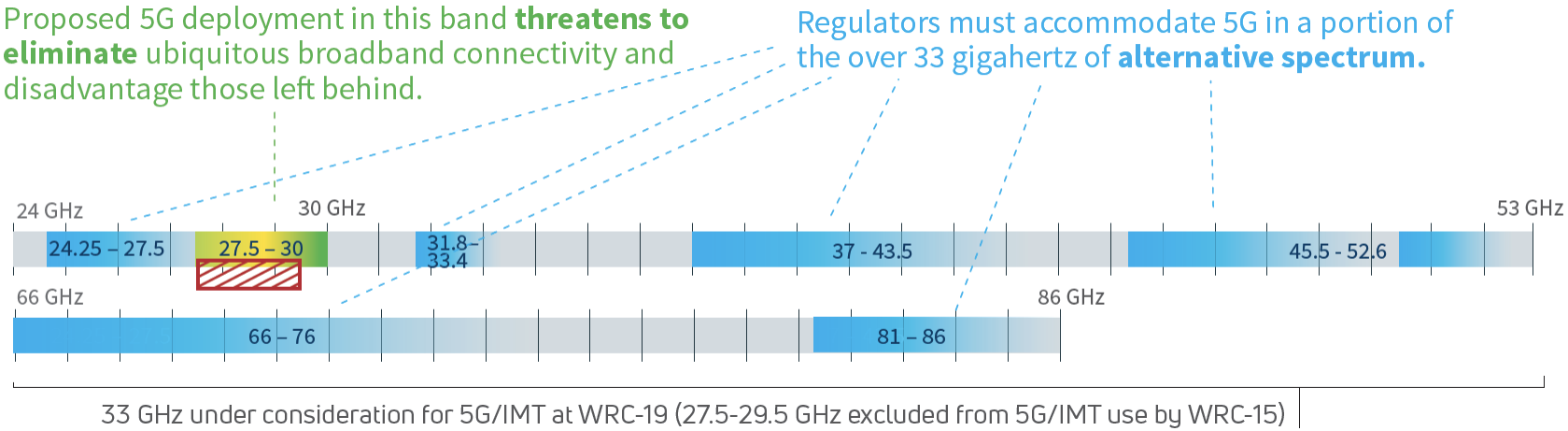
28 GHz Must Be Retained for Satellite

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

IMT/5G should not be introduced into 28 GHz at the national level



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Why 28GHz should NOT be used for IMT

Inputs from USA IMT Industry Union on 28GHz

- 28 GHz needs line of sight - generally - whether fixed or mobile; satellite or terrestrial
- 28 GHz cellular/IMT high speed performance without line of sight is limited to a 500-800 metre radius - compared to 1 - 6 GHz mid-band 6.,5km; sub 1 GHz low-band 29 km
- 28 GHz cellular/IMT is thus not suited for rural deployments - and has thus not been deployed, nor planned to be deployed, even by cellular/IMT companies that have allocations in ITU Region 2

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Why 28GHz should NOT be used by IMT

- Note that:
- 28 GHz) satellite line of sight is typically easier to achieve than IMT tower line of site in rural areas - except at the most northerly and southerly latitudes - Antarctica apart, not relevant to ITU Region 3

- (28 GHz) satellite line of sight is typically easier to achieve in rural areas than in urban areas - except mountain-occluded areas, for example

- (28 GHz) satellite can provide services direct to users, communities and vital backhaul and trunking infrastructure for rural cellular/IMT networks -

Allocation of 28GHz to IMT would further broaden the digital divide, as compared to maintaining the existing allocation to satellite

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Why 28GHz should NOT be used by IMT

- . "The mmWave bands—for example, the 28 GHz band — provide broad spectrum channels because mmWave communications are physically more like light beams than a shared wave, mmWave networks can theoretically set up individual paths to each device, reusing the same spectrum for many users simultaneously. This is what makes it possible for an antenna site to have enormous aggregate capacity, and for individual users to have very-high-speed connections." [para 31, p81 of the proceedings]

- "However, mmWave requires proximity and/or line of sight to function well. If there are obstructions in the line of sight, the mmWave signal scatters and bounces. If the user and the device are close together, they may still be able to connect using scattered signals. Using the 28 GHz band, for example, if the device is more than one-third to one-half of a mile away, without a line of sight, the performance of mmWave will begin to deteriorate, high-speed connections must be made with the mid-band and low-band spectrum (i.e., 3.5 GHz and below).“ [para 32, p81 of the proceedings]