

The Role of Satellite in 5G



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Introduction

SES & O3b

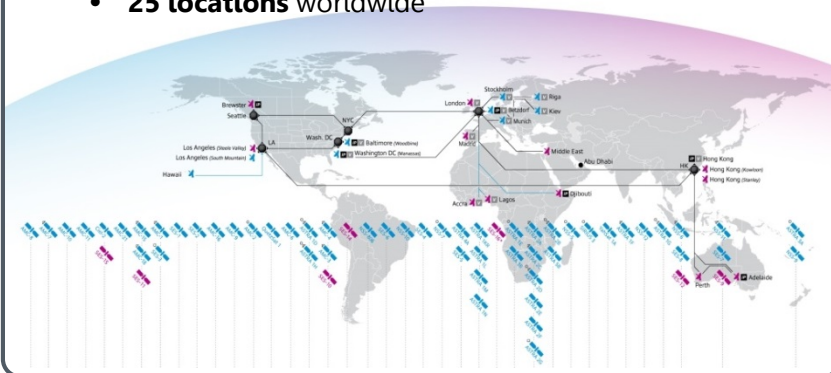
Who we are



SES worldwide

World-leading satellite operator and dynamic market leader

- ▲ Global satellite fleet operator and parent company of O3b Networks
 - **Over 50 satellites in GEO** covering 99% of the globe
 - **12 O3b satellites in MEO**
- ▲ Partner of choice for major global broadcasters, telcos, enterprises, governments and institutions
 - Technical **reach of 325 million households** in 2016
- ▲ Global reach, regional support
 - Over **2,000 employees** around the globe
 - **25 locations** worldwide



SES in the Pacific

A strong base of quality data customer in the region



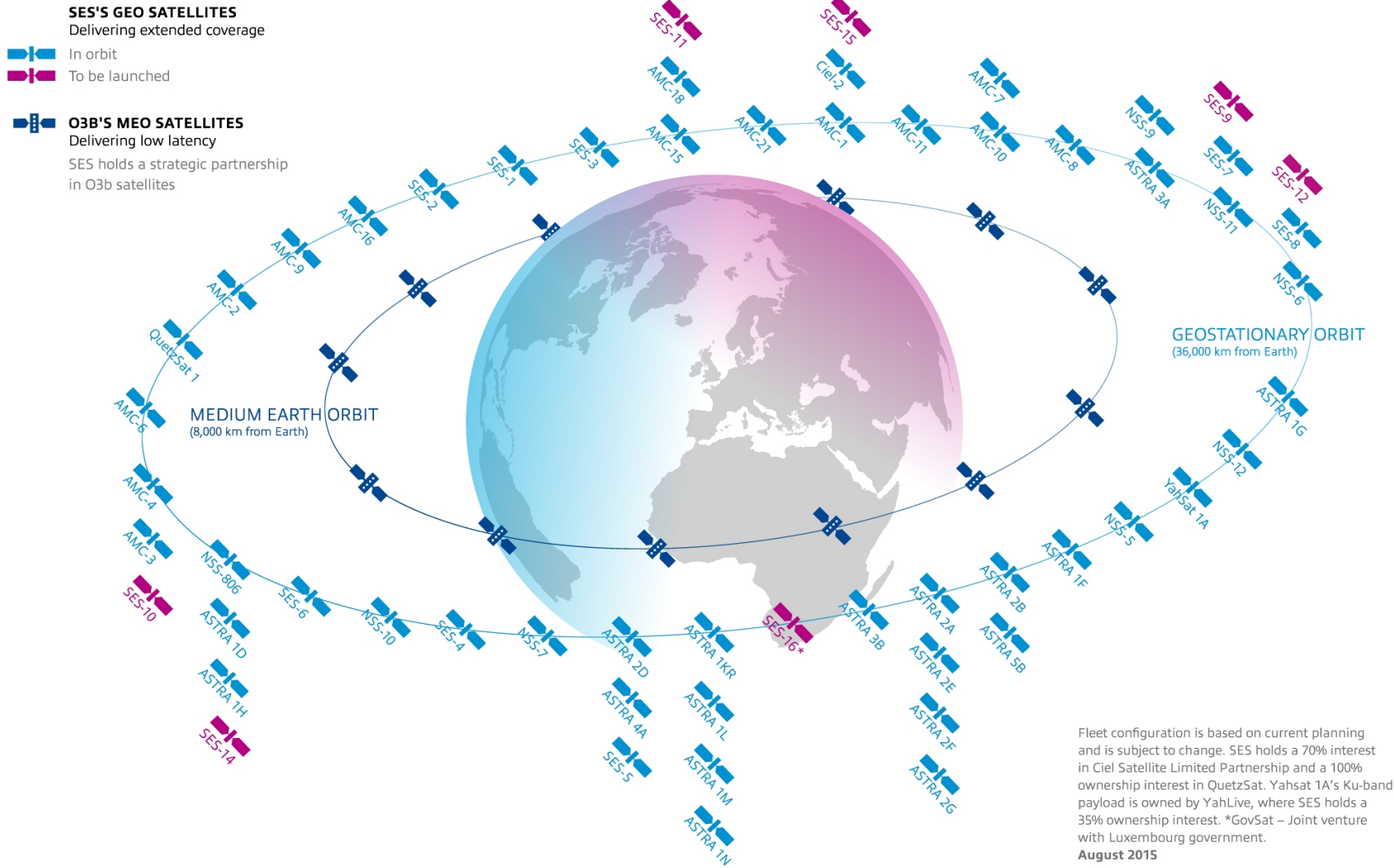
Digicel
Expect More. Get More.



SpeedCast



SES & O3b Combined Fleet Map



Fleet configuration is based on current planning and is subject to change. SES holds a 70% interest in Ciel Satellite Limited Partnership and a 100% ownership interest in QuetzSat. Yahsat 1A's Ku-band payload is owned by YahLive, where SES holds a 35% ownership interest. *GovSat – Joint venture with Luxembourg government.
August 2015

What is 5G (IMT-2020)?

What is 5G/IMT-2020?

Key Usage Scenarios

▲ GSMA, “5G Spectrum: Public Policy Position” (Nov. 2016):

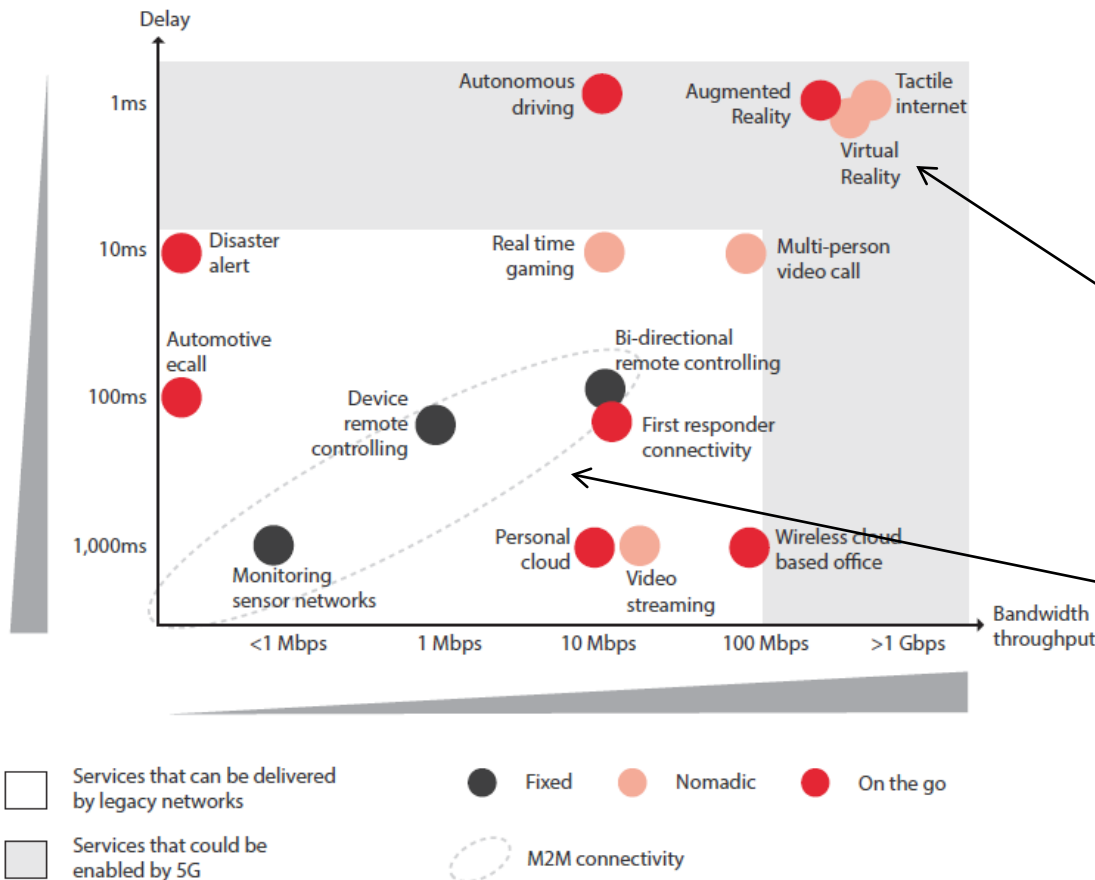
5G is expected to address three key usage scenarios:

- 1. Enhanced mobile broadband:** Including multi-gigabit per second (Gbps) data rates for applications like virtual reality and the ability to support extensive data traffic growth.
- 2. Ultra-reliable communications:** Including very low latency (sub-1ms) and very high availability, reliability and security to support services such as autonomous vehicles and mobile healthcare.
- 3. Massive machine-type communications:** Including the ability to support a massive number of low cost IoT connections with very long battery life and wide coverage including inside buildings.

What is 5G/IMT-2020?

Diverse Usage Scenarios

▲ GSMA Intelligence, “Understanding 5G” (Dec. 2014)



Observations

“5G-only” use cases are few and challenging even for mobile networks

Most use cases are achievable using existing technologies

Figure 1: Bandwidth and latency requirements of potential 5G use cases

Source: GSMA Intelligence

Satellite's Role in the 5G Ecosystem

Satellites Can Support the Key Usage Scenarios for 5G

▲ Satellites can support **multi-gigabit per second** data rates for **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

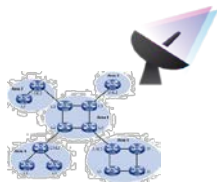
▲ Satellites can support **ultra-reliable communications**

- Our customers – international broadcasters, MNOs, governments – depend on us every day to ensure ultra-reliable communications
- GEO latency of 250ms (500ms round-trip) is acceptable for many 5G applications, and new MEO and LEO networks will be able to support even more latency-sensitive applications
- Satellites can even play a role in helping 5G networks meet their sub-1ms latency requirements by delivering commonly accessed content to mobile base stations

▲ Satellites can support **massive 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
- Investments in new ground segment technologies, such as smaller, lower cost, electronically steerable, and/or phased-array satellite transceivers are making ubiquitous deployment for IoT feasible

Four Satellite “Sweet Spots” in the 5G Ecosystem



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



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)

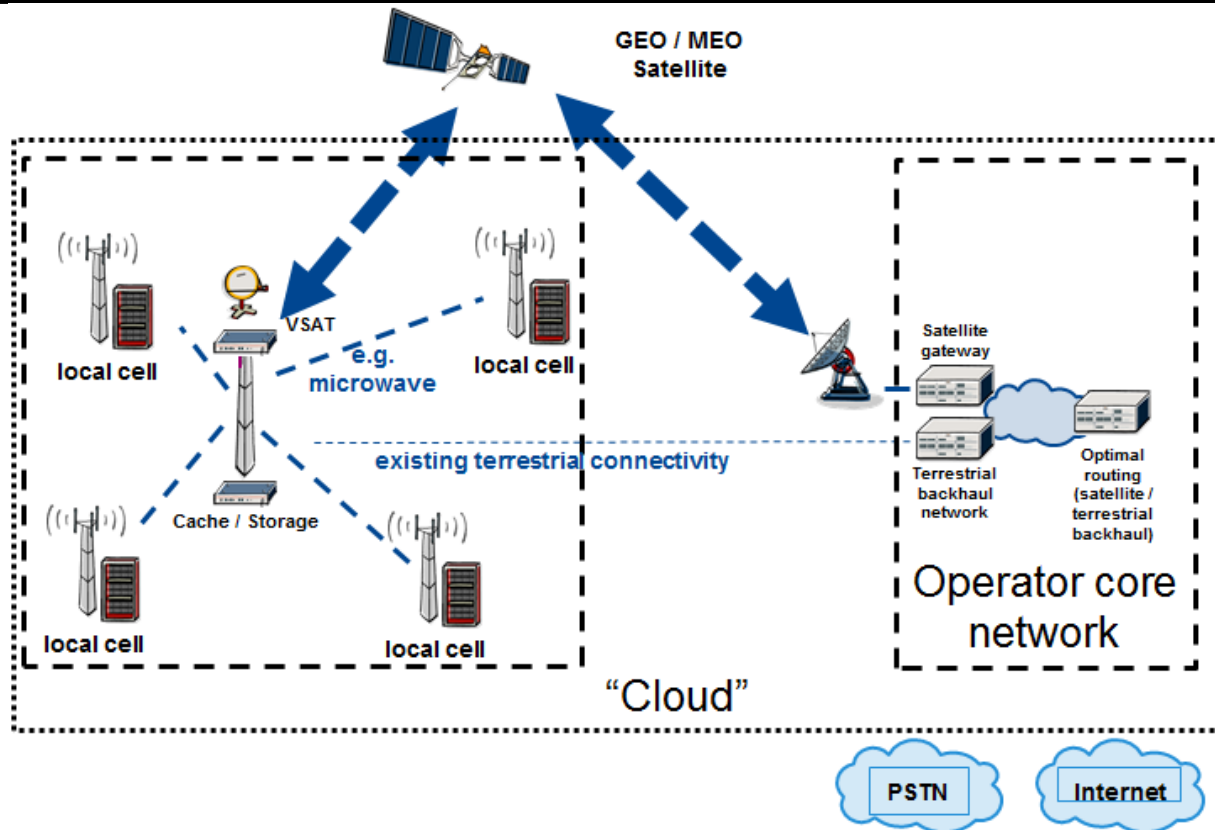
▲ Four main use cases can be identified for the integration of satellite-based solutions into 5G (IMT-2020):

1. Trunking and Head-end Feed
2. Backhauling and Tower Feed
3. Communications on the Move
4. Hybrid Multiplay

▲ These four “sweet spots” leverage the advantages of satellites – **high bandwidth** and **ubiquitous coverage** – to enable and extend terrestrial 5G networks

Four Satellite “Sweet Spots” in the 5G Ecosystem

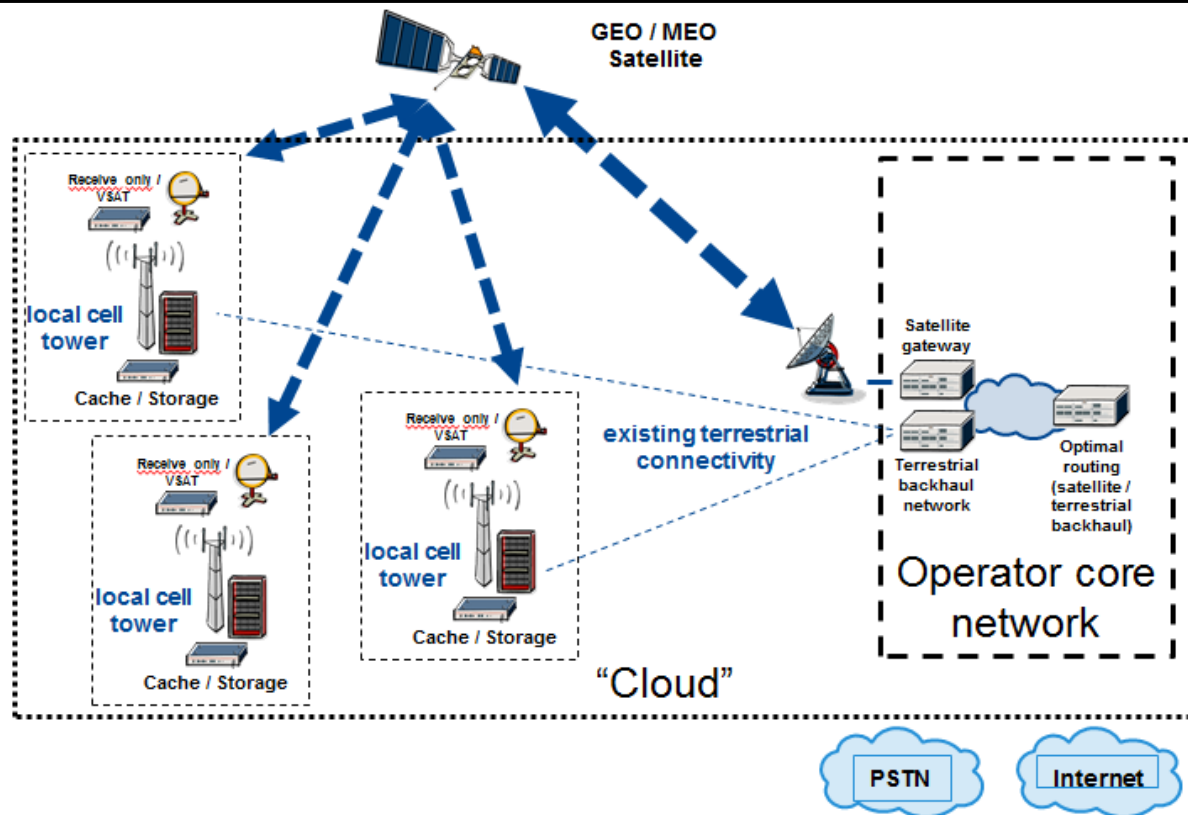
Trunking and Head-end Feed



- ▲ 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

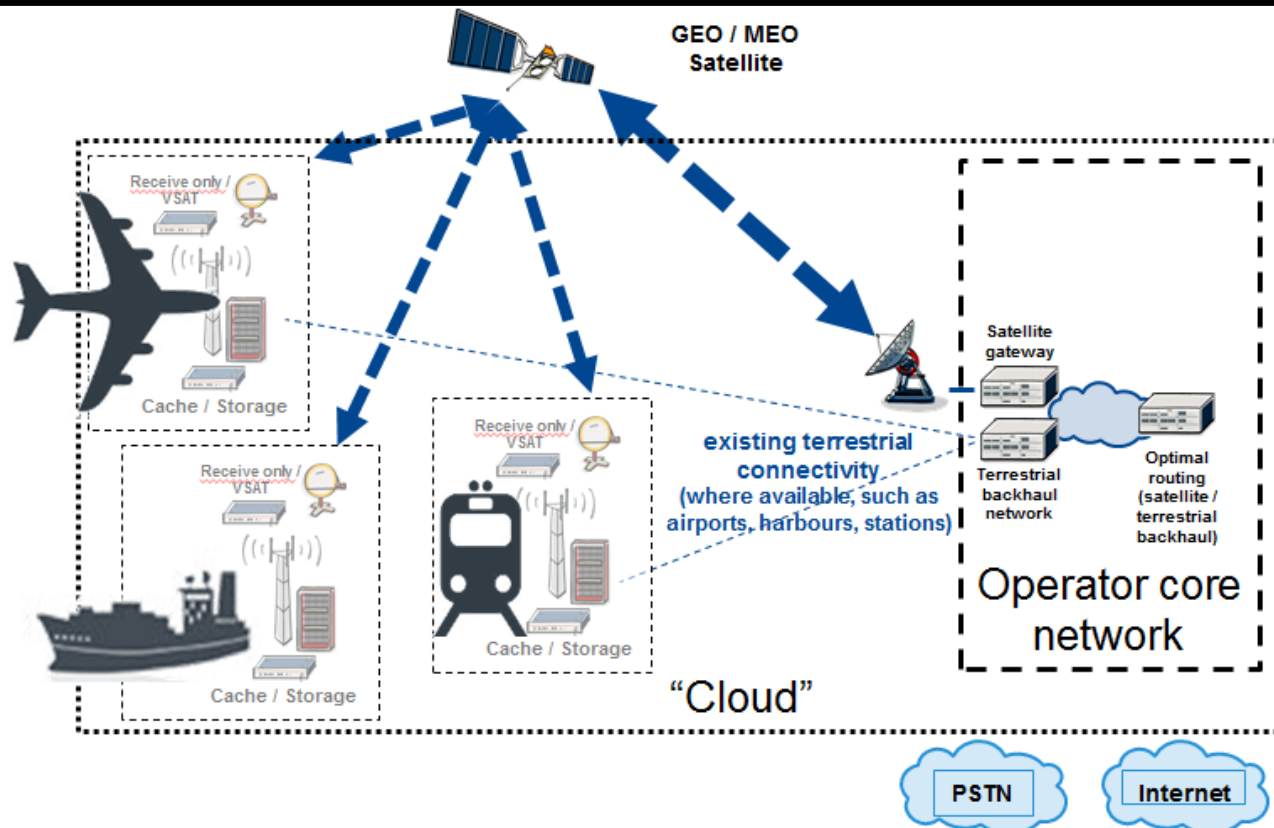
Backhauling and Tower Feed



- ▲ 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

Four Satellite “Sweet Spots” in the 5G Ecosystem

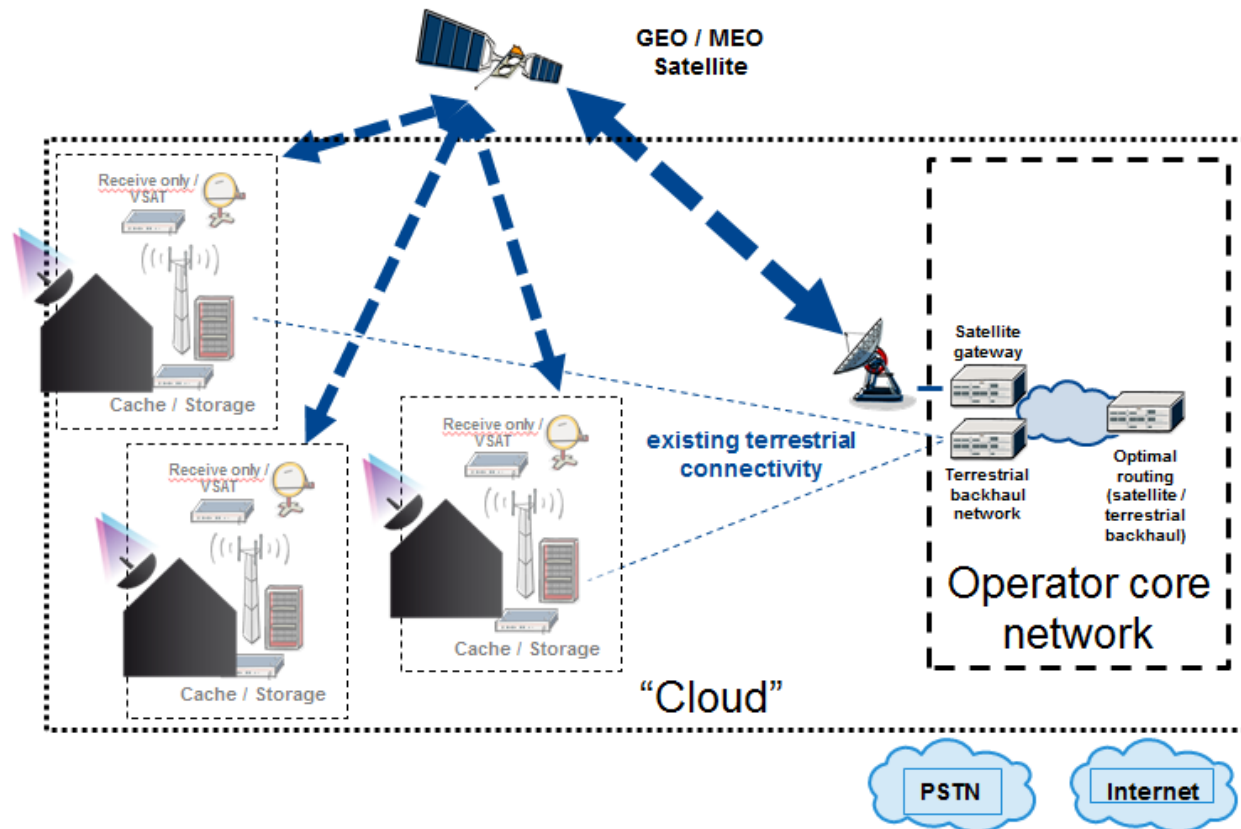
Communications on the Move



- ▲ 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

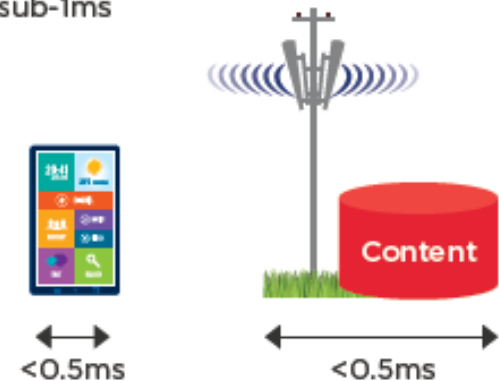


- ▲ Very high speed (up to 1 Gbps or more) satellite connectivity to individual homes and offices, with the ability to multicast the same content (video HD/UHD TV, and non-video data) across a large coverage area (e.g. for local storage or consumption)
 - The same capability allows for efficient broadband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

Satellites Can Even Help Achieve Sub-1ms Latency

- ▲ Sub-1ms latency is very difficult to achieve, 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)
- Illustrated by Figure 3 (at p.13):

5G service sub-1ms



Thus, satellites can help 5G networks achieve sub-1ms latency by multi-casting content to caches located at individual cells, even in places without fiber.

This is one of the satellite “sweet spots”!

Conclusions

Conclusions

What does all this mean?

- ▲ Regulatory and technical decisions should enable and not preclude satellites from playing a role in the 5G ecosystem
 - Satellites will play a particularly important role in extending 5G networks to hard-to-serve, underserved and unserved areas of the world

- ▲ For example:
 - Spectrum decisions relating to 5G should not be mutually exclusive of current and next-generation High Throughput Satellite (HTS) and Very High Throughput Satellite (VHTS) designs
 - Multicasting support will be necessary in 5G specifications to optimize network bandwidth use, and especially important in order to take full advantage of satellite capabilities
 - Intelligent routing, dynamic cache management and adaptive streaming and quality-of-service features will have to be incorporated into 5G network designs and concepts to optimize use of different transmission technologies in the network for different types of content (e.g. latency sensitive vs. latency insensitive, high bandwidth vs. low bandwidth)
 - Satellite network elements will need to be implemented and managed based on the same Network Virtualization and Software Defined Networks philosophy as the rest of the network

- ▲ SES and others in the satellite industry are actively engaged in technical standards bodies (e.g. 3GPP) and international forums (e.g. ITU, CEPT, 5G PPP) in order to help make 5G a truly inclusive reality