Role of Satellite in 5G

The 26-28 GHz India 5G Spectrum Workshop

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The Technology Ecosystem

- **5 G** holds the key to pan Indian digital revolution. The offerings include :-
  - Enhanced Mobile Broadband
    - Multi Gigabits / sec for VR etc
  - Ultra Reliable Communications
    - Very low latency applications eg driverless cars
  - Massive machine type Communications
    - Low cost IoT, rural connectivity etc
- **SATCOM** is the key enabling technology
  - Ubiquitous penetration across geographies
    - Standard performance across mountains, islands etc
  - Proven ability to handle large data volumes with good reliability
    - Control of unmanned vehicles

Potential & Recent Developments

- Indian Telecos have implemented cellular backhauls using SATCOM
  - BSNL – 2000 sites on IPSTAR & plans a 4G backhaul in NE
  - Reliance Jio has a functional 4G backhaul
- Potential growth of 20 K sites that can only be supported by SATCOM
- Academia | Government | Industry committee has suggested a framework for 5G in India
  - Good report for various segments
  - SATCOM industry was inadequately represented
  - SATCOM regulatory aspects need careful examination

Satellite Spectrum & Focus Segments

PC : Dexter

❖ Spectrum assigned (Announce Tier):

- 698-803 MHz | 3300-3600 MHz | 24.25-27.5 GHz & 27.5 – 29.5 GHz.
- Of these, 24.25-27.5 GHz, & 27.5 – 29.5 GHz Bands should be opened free for two years to support rollout trials and indigenous R&D.

❖ Spectrum Identified Tier

- Designated for potential 5G use which can be moved to the Announce Tier after coordination with other domestic users.
- 617-698 MHz | 1427-1518 MHz | 29.5 to 31.3 GHz & 37.0 to 43.5 GHz.
- The 37.0 to 43.5 GHz bands should be opened free for two years to support indigenous R&D.

❖ Study Tier

- 3600-3700 MHz.
- This is a becoming a shared band internationally and will require significant real time co-ordination technology to support sharing. This band should be released after this spectrum sharing technology is available

Global Trends & Indian Context

❖ High Throughput Satellites make Global presence

- Full Ka band satellite with narrow spot beams
- 200 – 300 Gbps with efficient frequency reuse
- Reduced cost-per-bit
- 28 GHz is being used for SATCOM by all leading satellite operators (see inset)

❖ Indian Context

- Ku – Ka hybrid satellites
- At most 8o Gbps per satellite
- Cost per bit is atleast ten times that of HTS

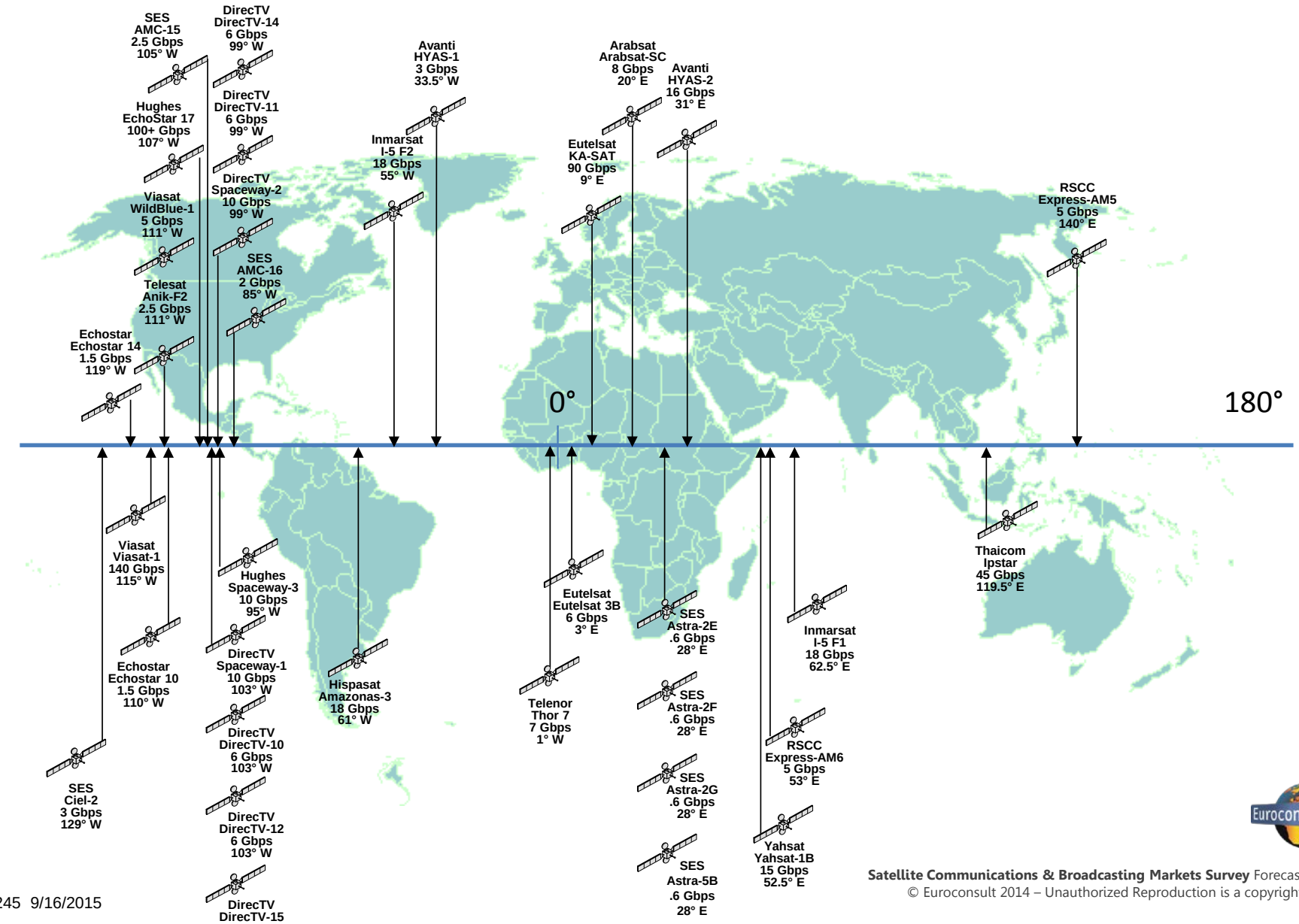
❖ Assessment

- 28 GHz can be used for outdoors only
- Best suited for backhaul & IoT over SATCOM
- Millimeter frequencies are unusable due to rain fade

Existing mobile allocation	No global mobile allocation
24.25 – 27.5 GHz	**31.8 – 33.4 GHz**
37 – 40.5 GHz	**40.5 – 42.5 GHz**
42.5 – 43.5 GHz	
45.5 – 47 GHz	47 – 47.2 GHz
47.2 – 50.2 GHz	
50.4 – 52.6 GHz	Europe has harmonised the **27.5-29.5 GHz** band for broadband satellite and is supportive of the worldwide use of this band for ESIM. This band is therefore **not available for 5G**.
66 – 76 GHz	
81 – 86 GHz	

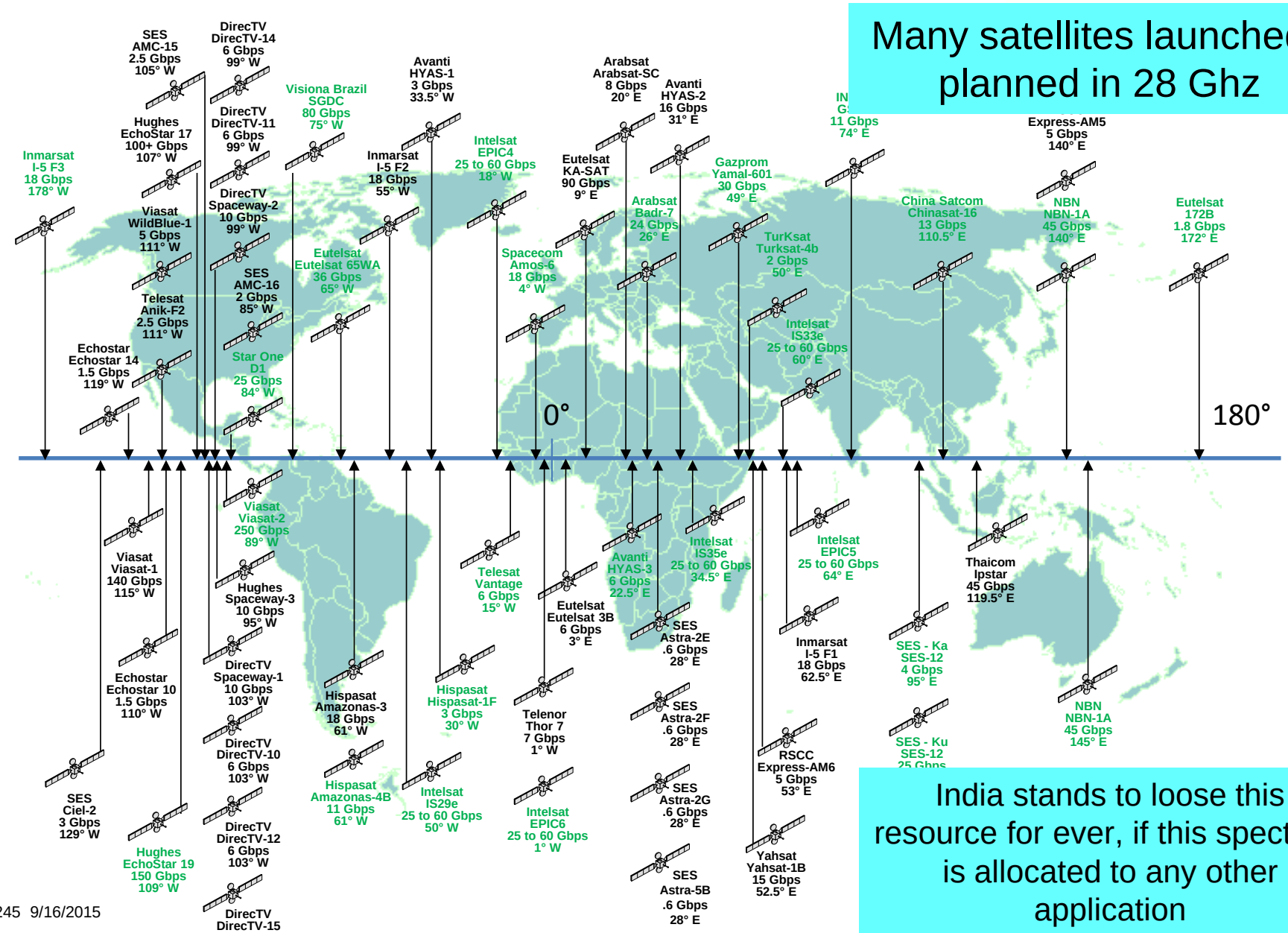
Reference: CEPT presentation APG19-2 Denpasar Jul17

HTS Satellites Launched by 2015



Satellite Communications & Broadcasting Markets Survey Forecasts to 2023

HTS Launches By 2018



Many satellites launched / planned in 28 Ghz

India stands to loose this resource for ever, if this spectrum is allocated to any other application

Role of Satellite Operators

❖ International Satellite Operators

- Play a complementing role to cover the last 10-15% of the populace in terms of reach
- Focus on cost-per-bit using HTS frequency reuse efficiently
- Full Ka – Ka implementations to deliver 300+ Gbps satellites

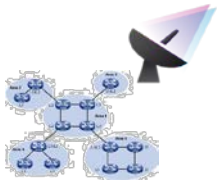
❖ ISRO

- Capability driven limited use of the spectrum
  - GSAT 11 – 10 Gbps | GSAT 20 - 80 Gbps
- Masked use of international capacity

❖ Assessment

- Healthy competition and pragmatic approach is needed in the satellite space like the aviation industry
- Many international satellite operators have already submitted applications with ISRO in this spectrum and is essential to exploit the full potential of HTS
- ISRO and Dept of Space needs to consider these proposals favourably as these would aid the country at large, albeit at some small cost to ISRO

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

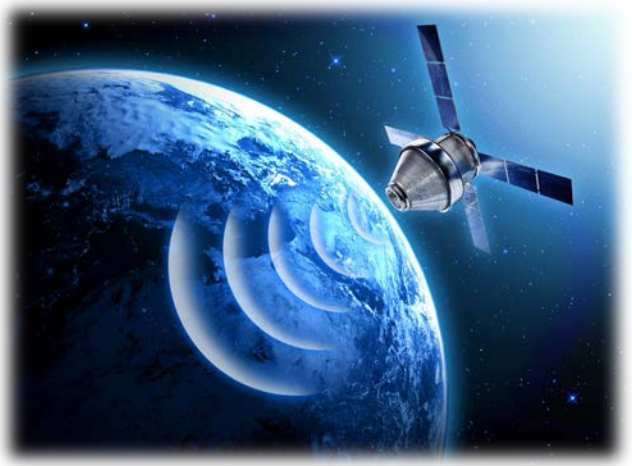
Comms on the move

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)

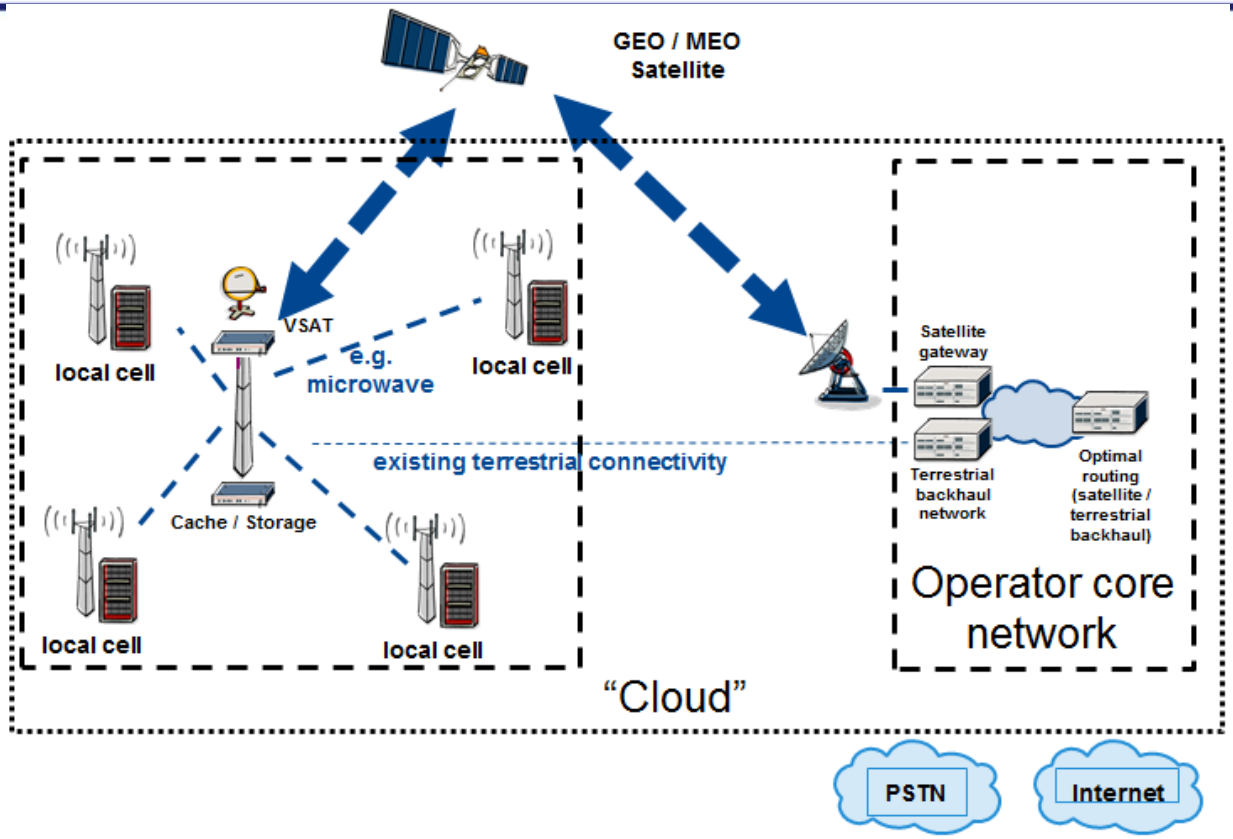
- Four main use cases can be identified for the integration of satellite-based solutions into 5G (IMT-2020):
  1. Trunking and Head-end Feed
  2. Backhauling and Tower Feed
  3. Communications on the Move
  4. Hybrid Multiplay



- 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

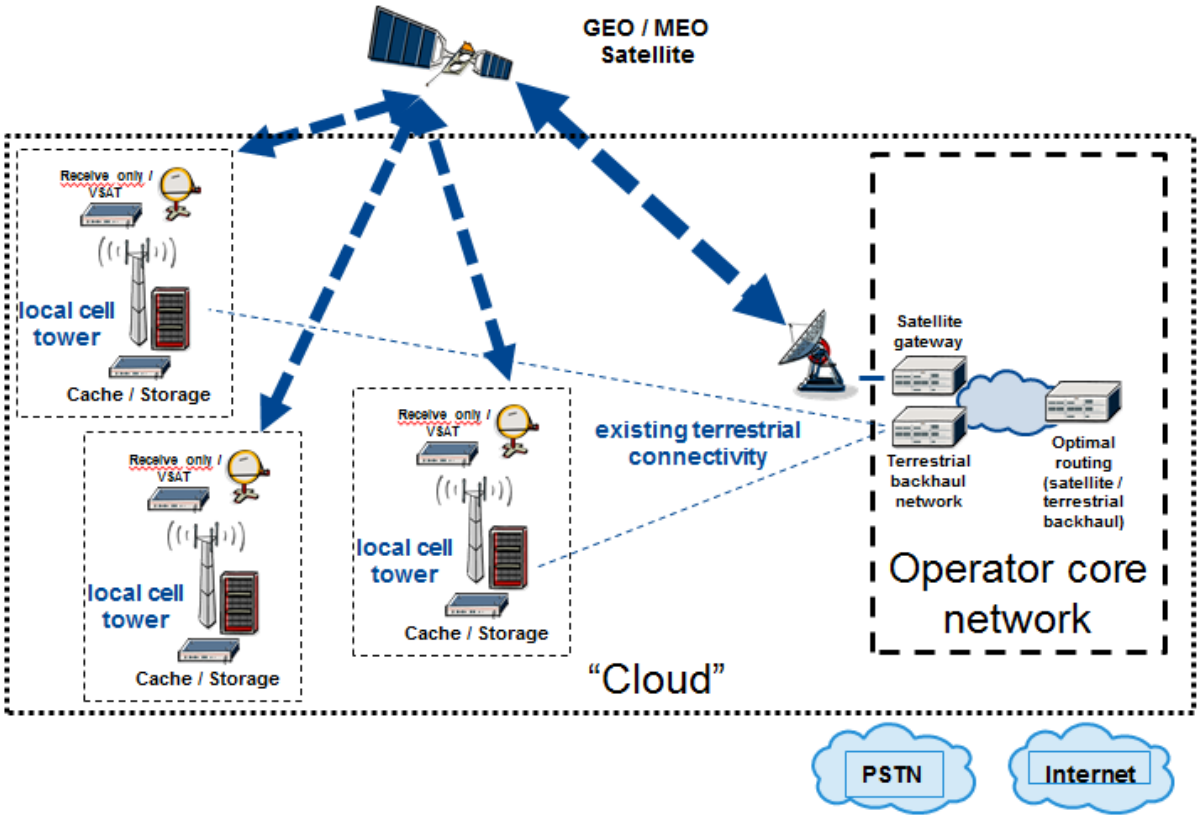
Trunking and Head-end Feed



- 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

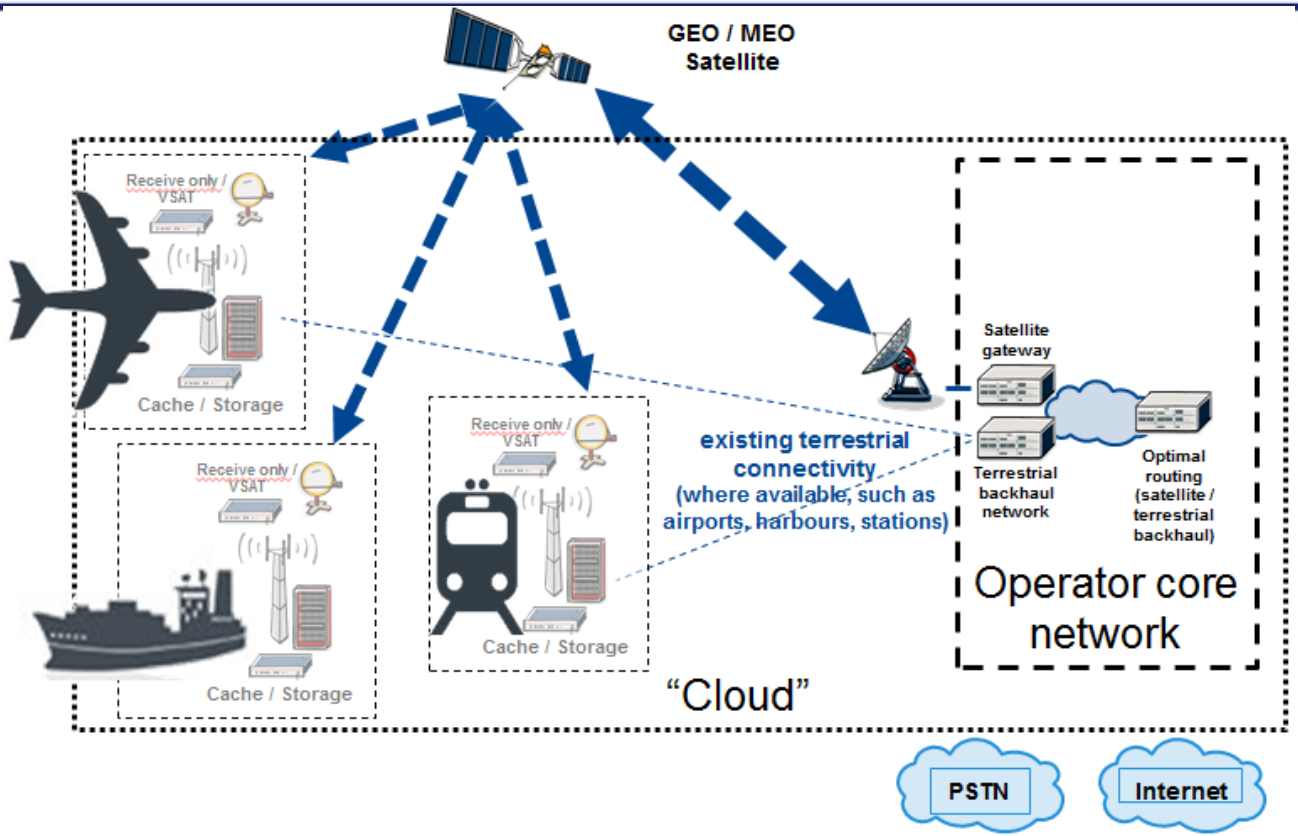
Backhauling and Tower Feed



- 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

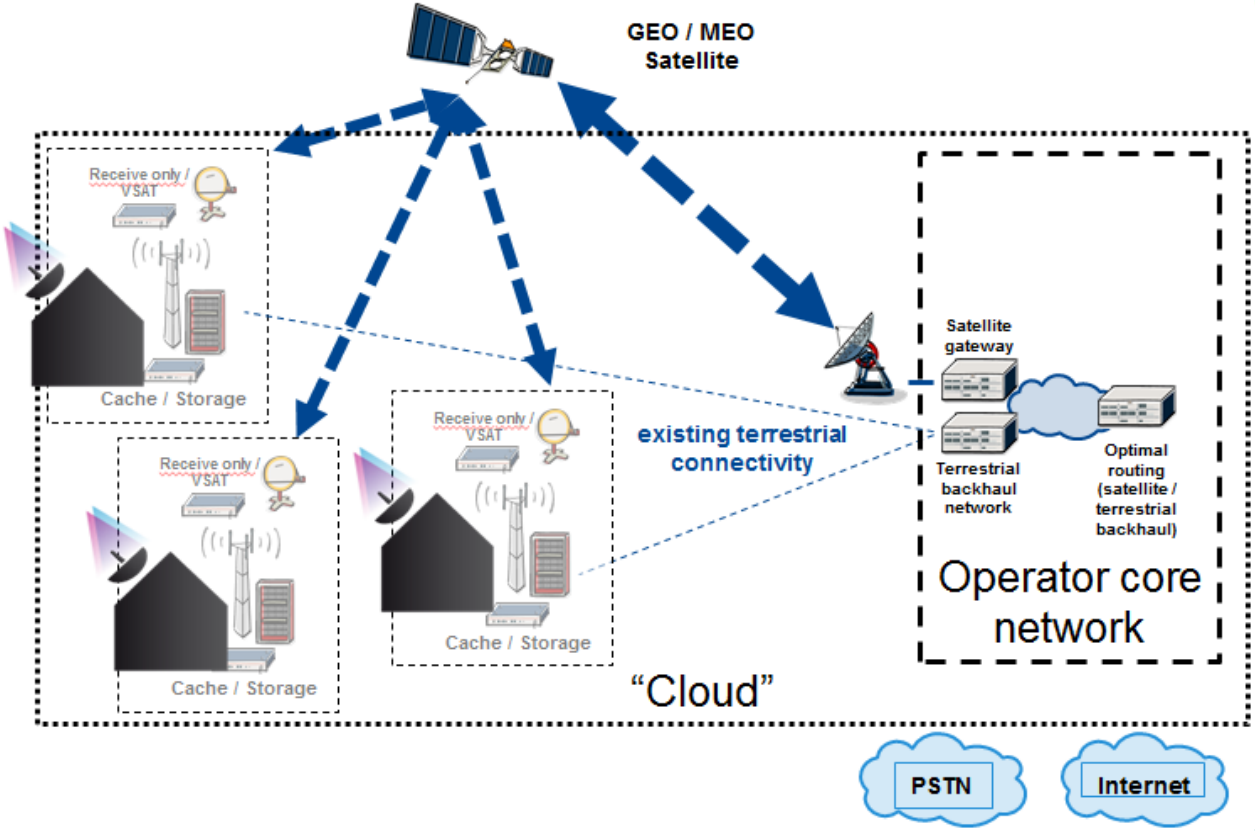
Communications on the Move



- 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

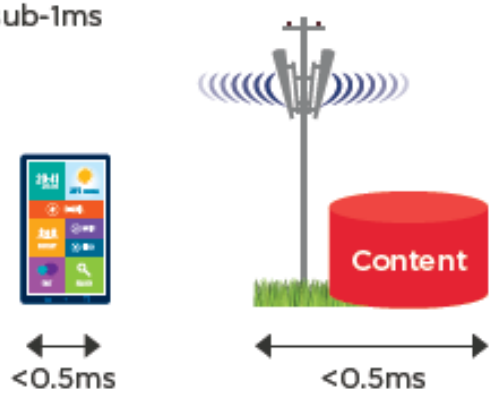
Hybrid Multiplay



- 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** 5G service sub-1ms predicted to be fundamental to meeting densifi
  - Illustrated by Figure 3 (at p.13):



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”!

Conclusion

Retain 28 Ghz for SATCOM in India too

Make judicious use industry trends

SATCOM can complement 5 G like it did of 2/3/4 G

Encourage global SATCOM operators