Malaysian Technical Standards Forum Bhd

Towards a Space-Based Hyper-Connected Era:

Next Generation Satellite Communication Vision and Strategy

Zaaim Redha

Vice Chair I, Satellite Communications Working Group

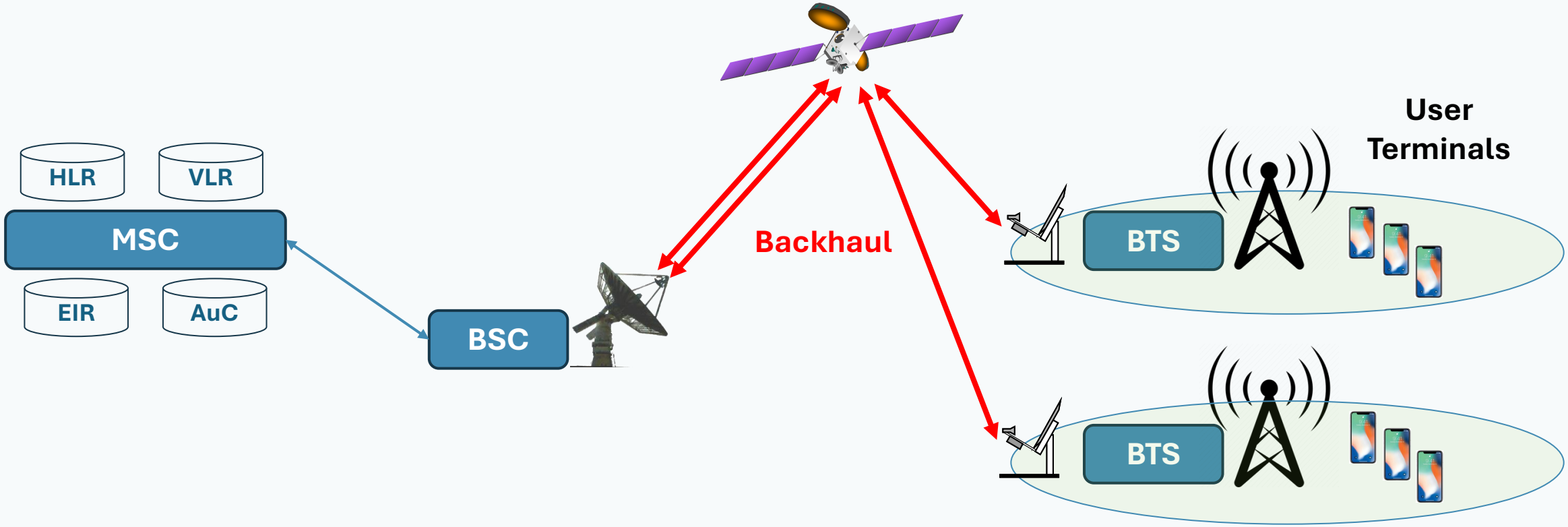
3 Nov 2026 | Tuesday

El Tower, Rep. of Korea



GSM (2G) Architecture

Backhaul via Satellite

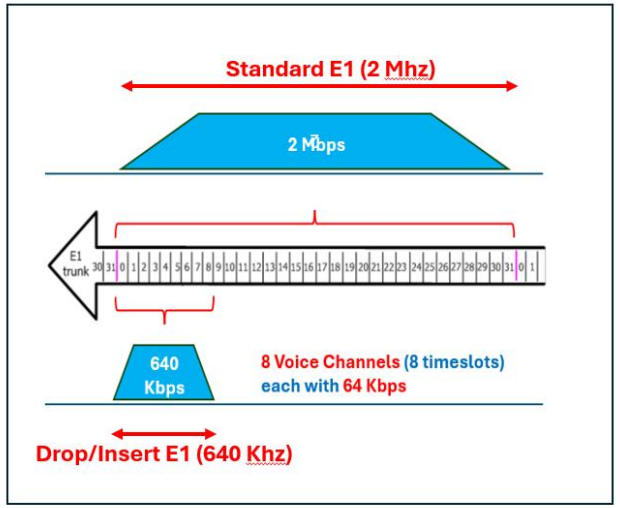


- *Satellite Backhaul using C-band SCPC VSAT System*
- *Satellite footprint coverages are big*
- *Bypassing all terrestrial telecommunication infrastructures*
- *Only takes 2 days to install a SCPC VSAT terminal at a remote destination*

1990s: C-Band SCPC VSAT over GEO Satellite

Drop/Insert SCPC Modem

- ***Full-Duplex, Symmetric (Voice)***
- ***C-band Terminal 2.4-m / 3.8-m antennas (with SCPC Hub)***



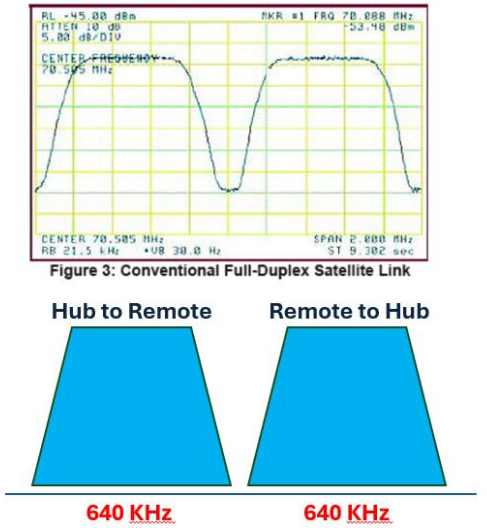
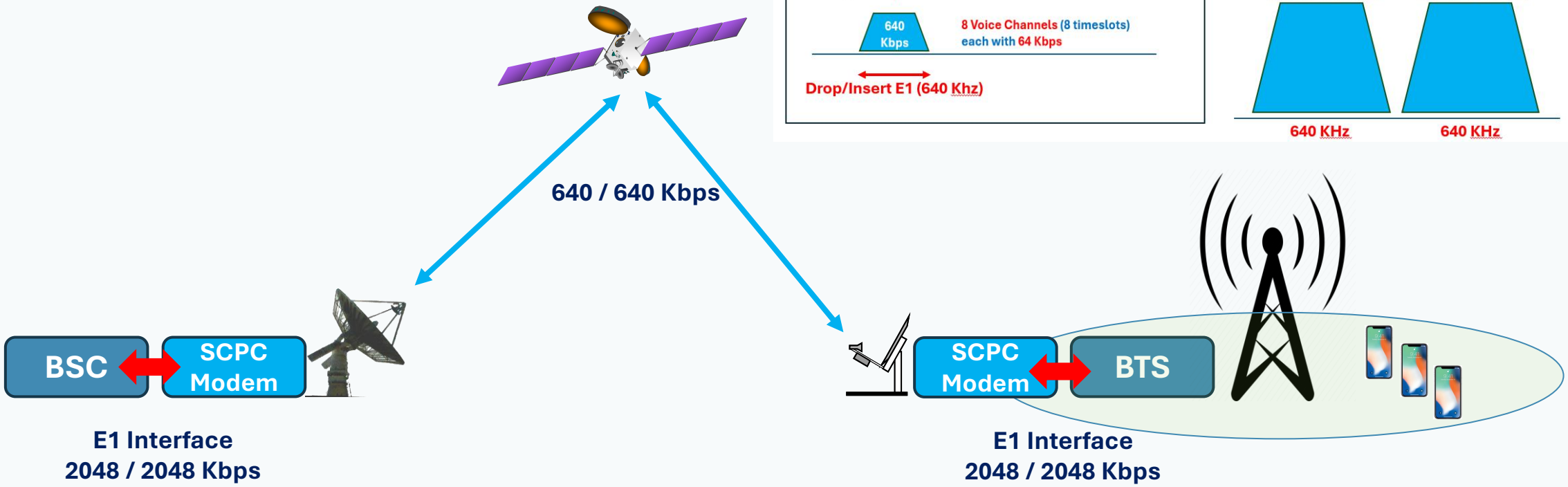


Figure 3: Conventional Full-Duplex Satellite Link



2000s: C-Band SCPC VSAT over GEO Satellite

Carrier-in-Carrier SCPC Modem
Voice Compression

- ***Full-Duplex, Symmetric (Voice)***
- ***C-band Terminal 2.4-m / 3.8-m antennas (with SCPC Hub)***

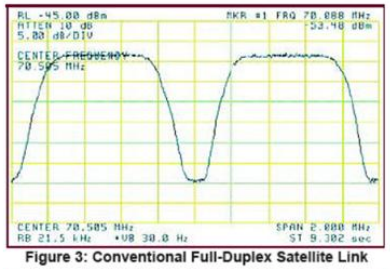


Figure 3: Conventional Full-Duplex Satellite Link

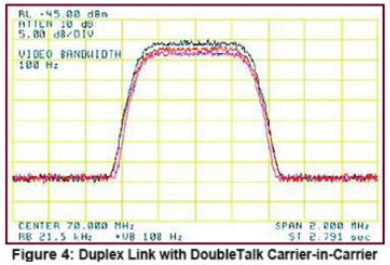
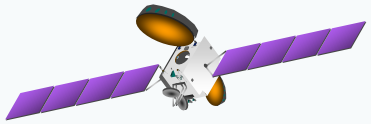


Figure 4: Duplex Link with DoubleTalk Carrier-in-Carrier



640 Kbps

32 Voice Channels (8 timeslots) each with 16 Kbps



640 / 640 Kbps

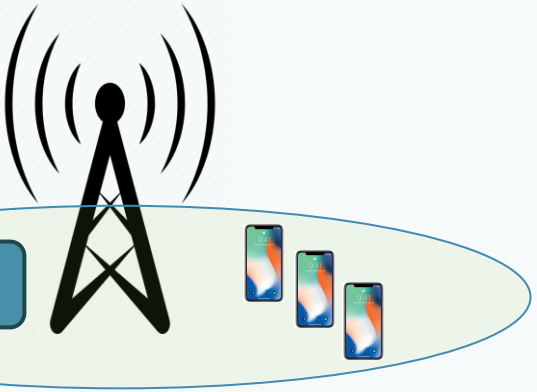


BSC — SCPC Modem

E1 Interface
2048 / 2048 Kbps



SCPC Modem — BTS



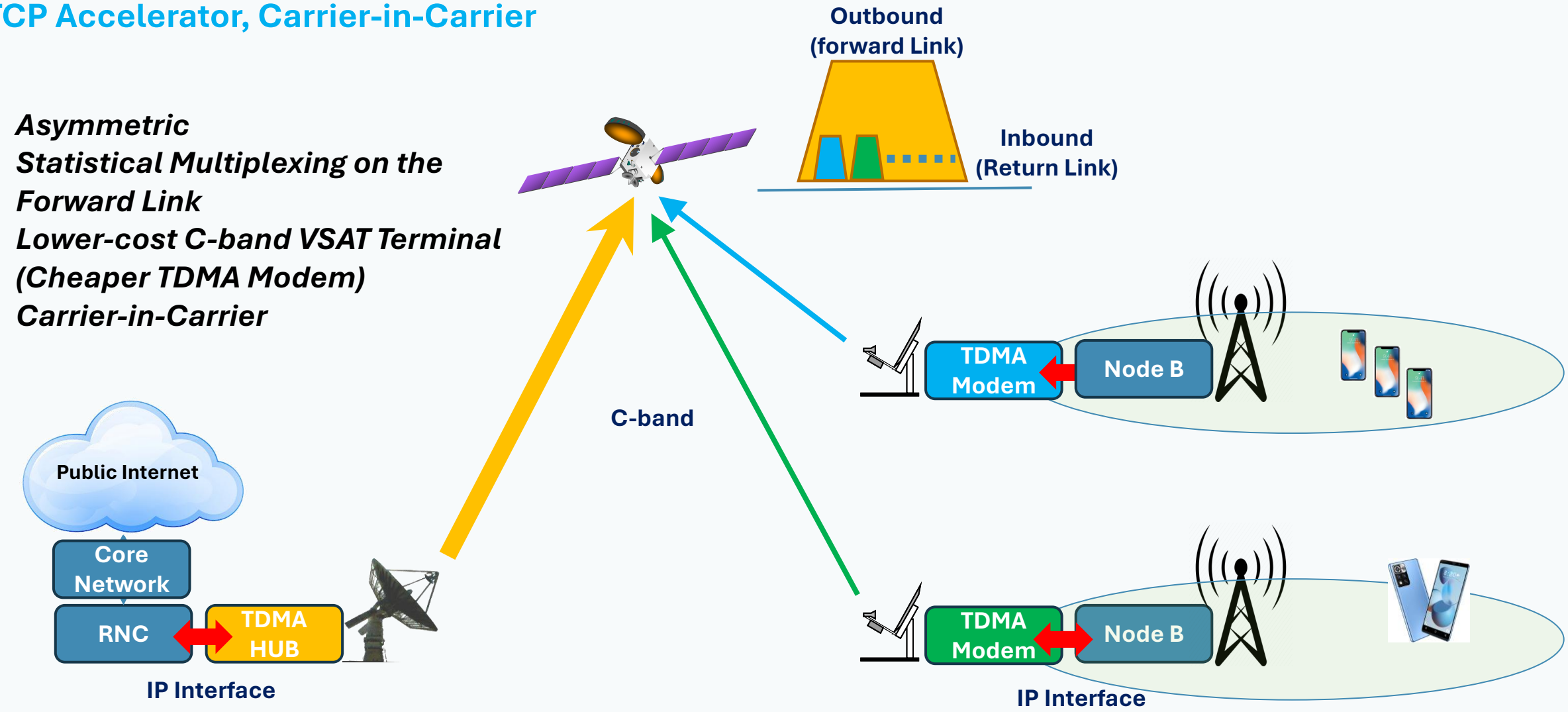
E1 Interface
2048 / 2048 Kbps

2000s: C-band TDMA VSAT over GEO Satellite

3G, IP based

TCP Accelerator, Carrier-in-Carrier

- *Asymmetric*
- *Statistical Multiplexing on the Forward Link*
- *Lower-cost C-band VSAT Terminal (Cheaper TDMA Modem)*
- *Carrier-in-Carrier*

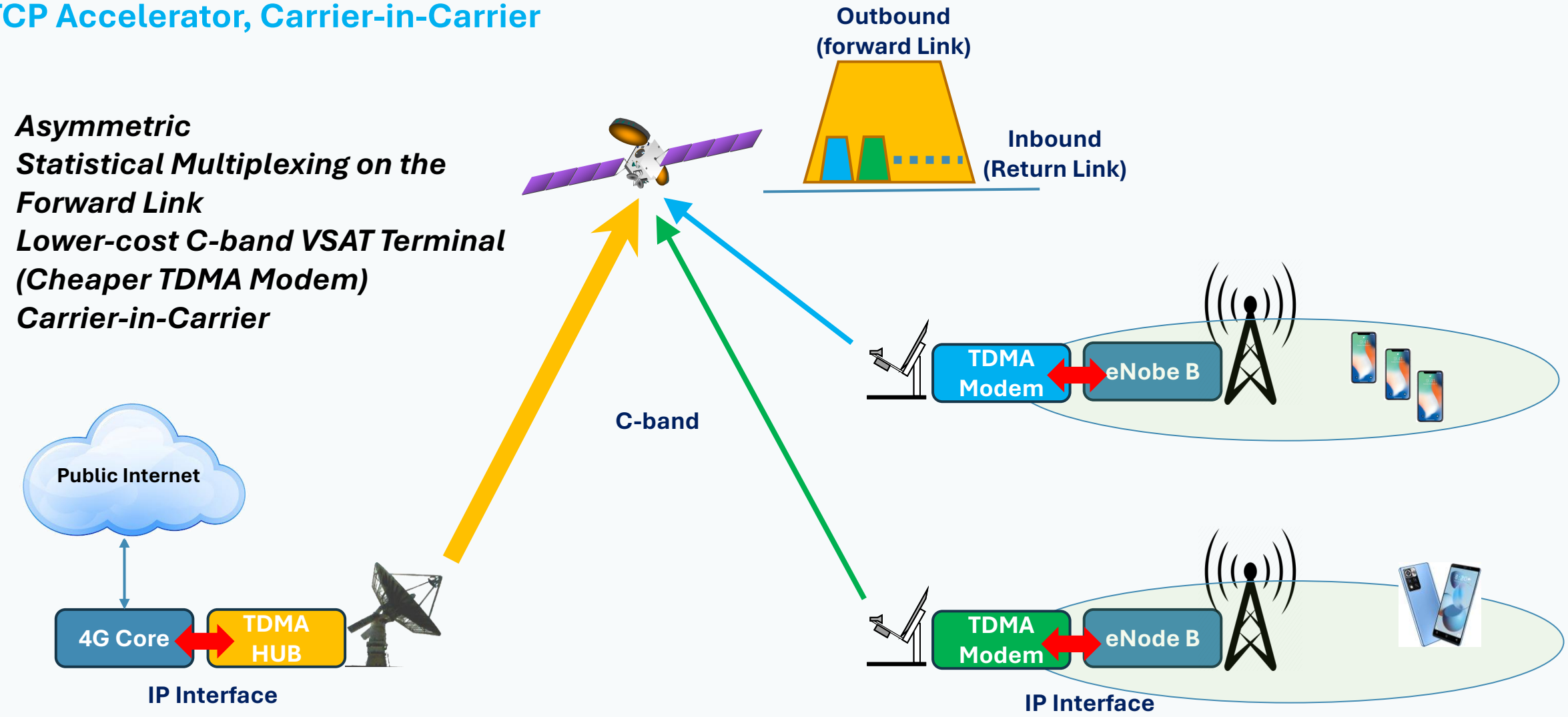


2010s: C-band TDMA VSAT over GEO Satellite

4G, IP based

TCP Accelerator, Carrier-in-Carrier

- *Asymmetric*
- *Statistical Multiplexing on the Forward Link*
- *Lower-cost C-band VSAT Terminal (Cheaper TDMA Modem)*
- *Carrier-in-Carrier*

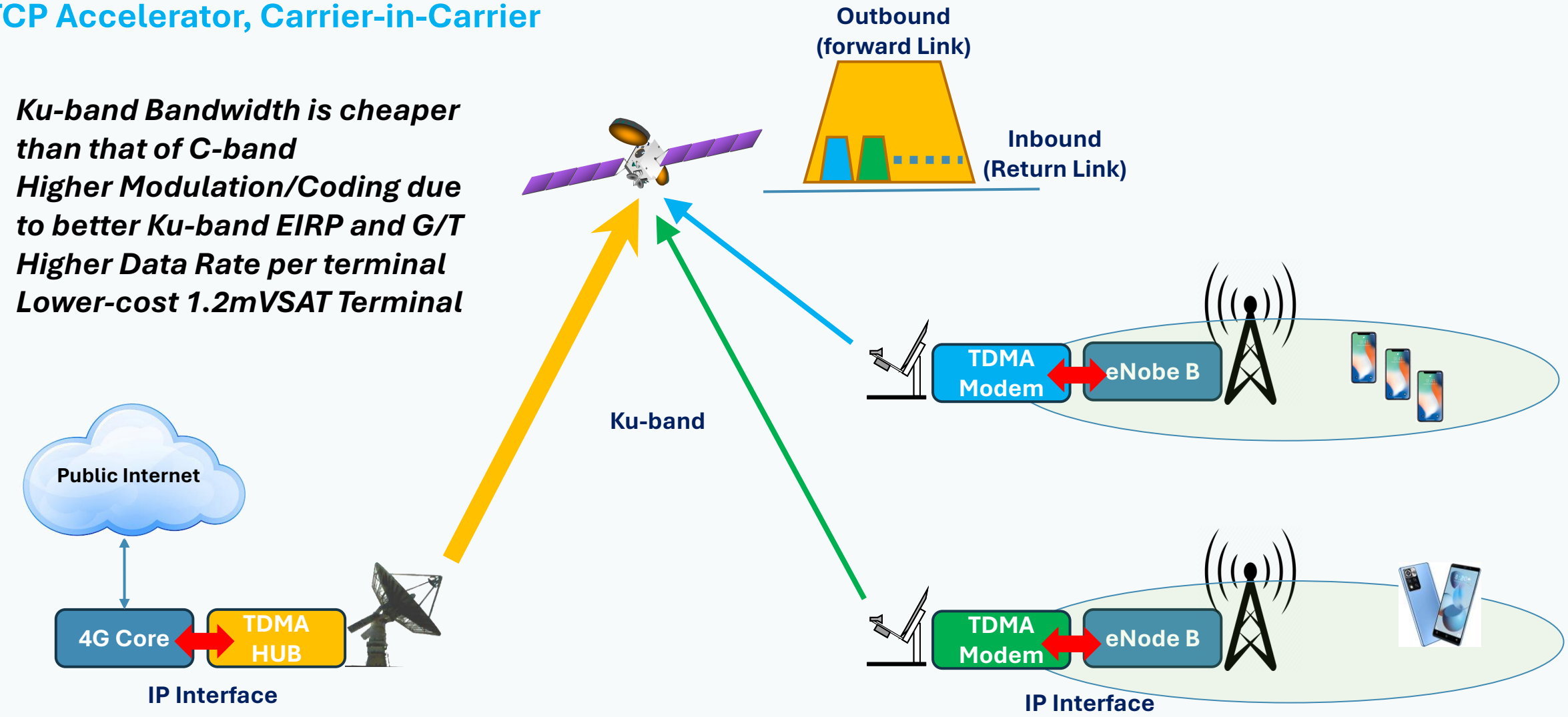


2017: Ku-band TDMA VSAT over GEO Satellite

4G, IP based

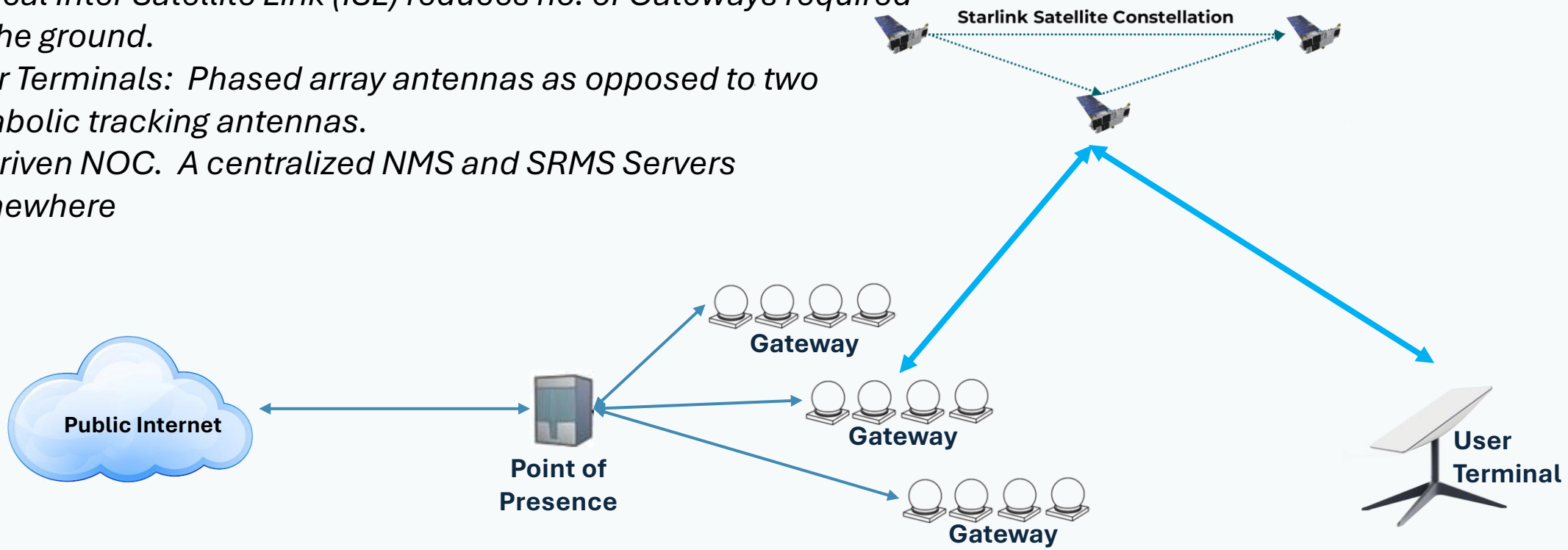
TCP Accelerator, Carrier-in-Carrier

- *Ku-band Bandwidth is cheaper than that of C-band*
- *Higher Modulation/Coding due to better Ku-band EIRP and G/T*
- *Higher Data Rate per terminal*
- *Lower-cost 1.2mVSAT Terminal*



LEO Broadband Internet Architecture

- *Multiple GWs interconnected to a PoP and Internet*
- *Each GW consists of several tracking parabolic antennas. Two antennas required for each orbital plane.*
- *High-capacity fiber backhauls, depending on no. of antennas/orbital planes*
- *Optical Inter Satellite Link (ISL) reduces no. of Gateways required on the ground.*
- *User Terminals: Phased array antennas as opposed to two parabolic tracking antennas.*
- *AI-driven NOC. A centralized NMS and SRMS Servers somewhere*



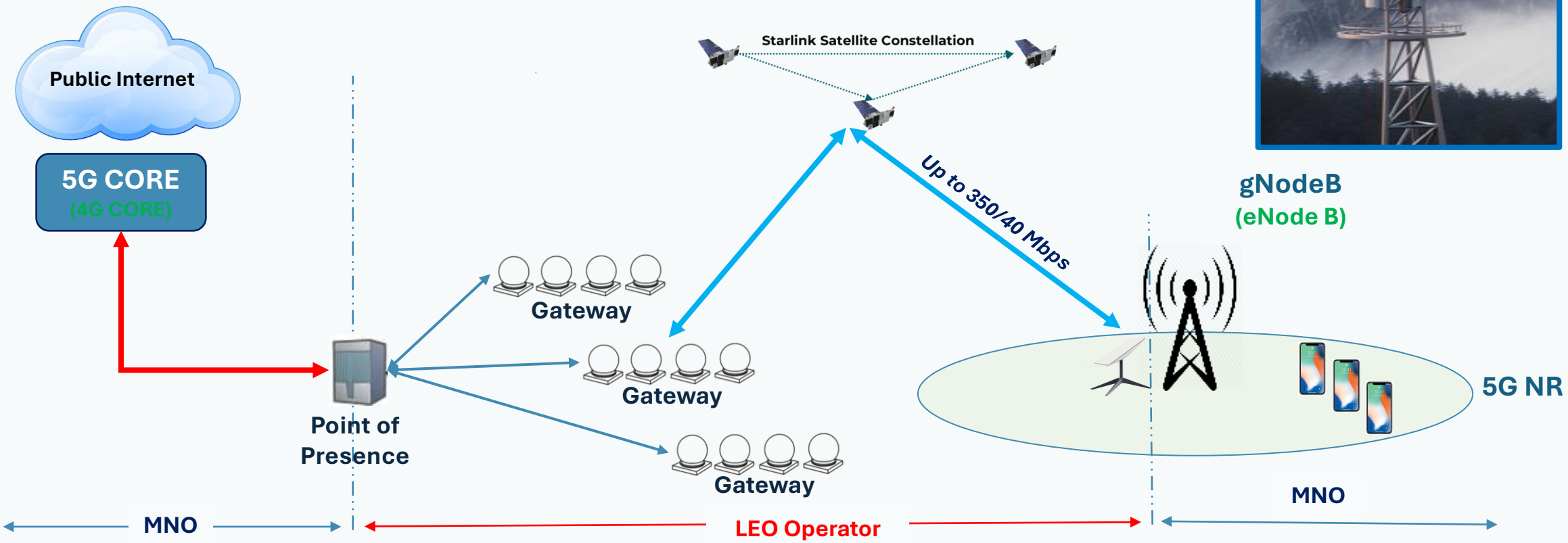
2024: Mobile Backhaul over LEO Satellite

5G (or 4G), IP based

- ***Dedicated line** from 5G/4G Core to the PoP*

- *Entel Chile*
- *KDDI Japan*
- *TelkomSel Indonesia*

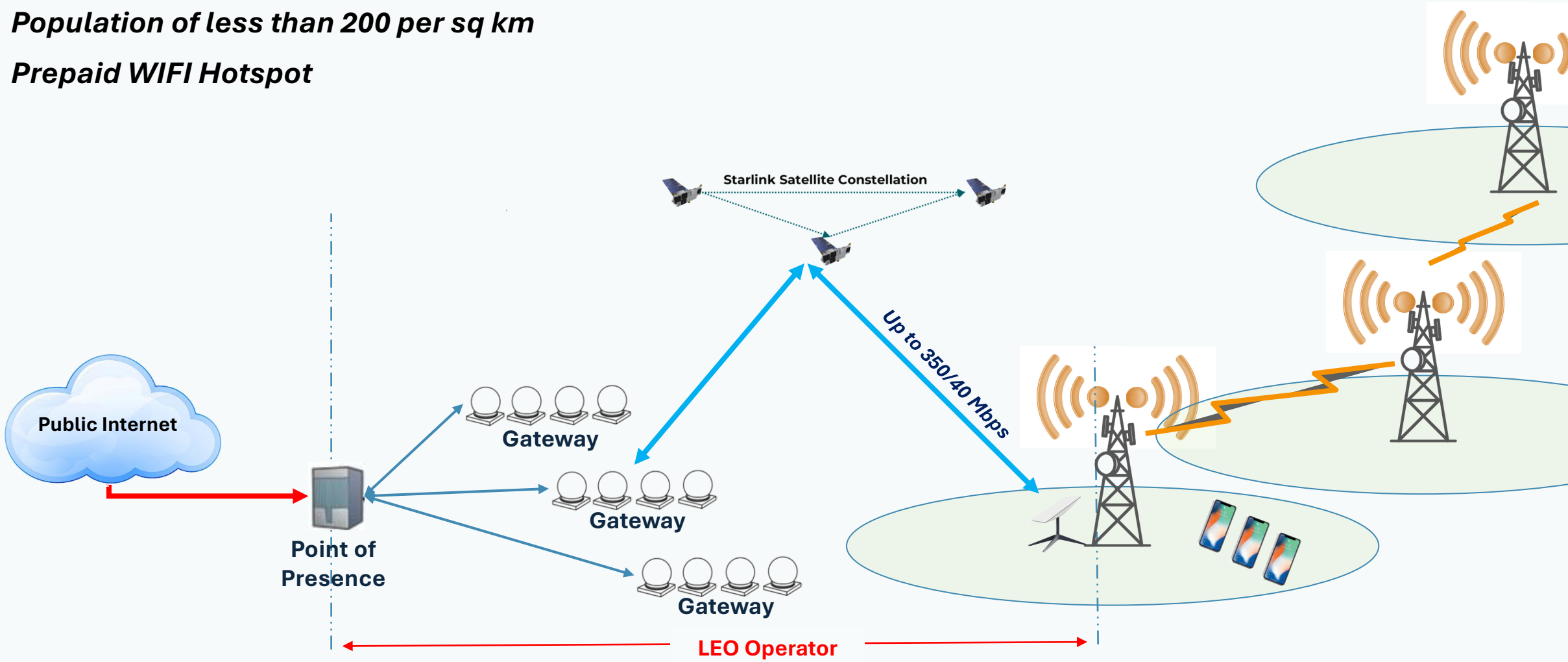




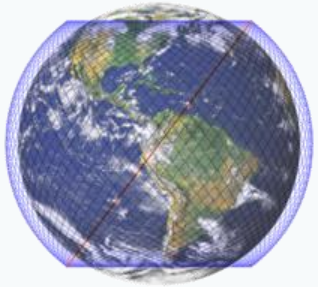
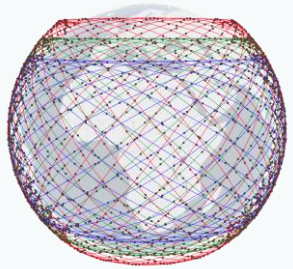
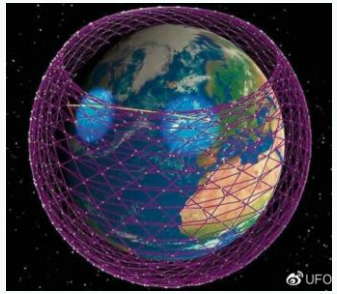
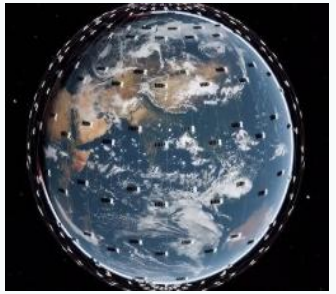
2024: WIFI Hotspots backhauled by LEO Satellite

IP based

- *Population of less than 200 per sq km*
- *Prepaid WIFI Hotspot*



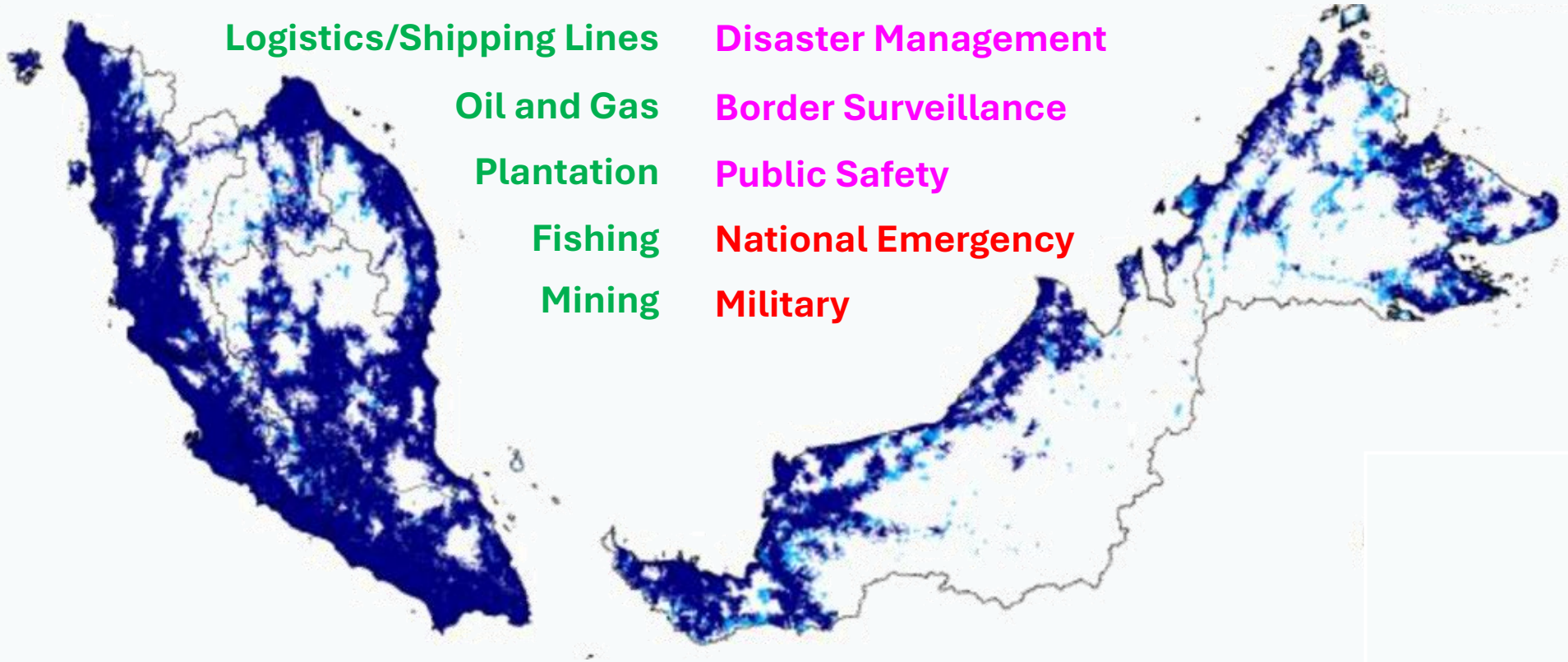
LEO Broadband Internet


	Starlink SpaceX	Amazon LEO (Kuiper) Amazon	GuoWang (SatNet) China Gov	Qianfan (SpaceSail) Shanghai Gov	OneWeb EutelSat
No of Satellites	42,000 (11,156+ now)	3,236 (392 sats now)	12,990 (204 sats now)	13,904 (261 now)	648 (Completed)
Orbit Altitude (KM)	LEO 550 ~ 590	LEO 590 ~ 630	LEO 500 ~ 1145	LEO 1160	LEO 1200
Spectrum	Ku-band	Ka-band	Ku-band	Ku-band	Ku-band
Suite of Services	Broadband Internet	Broadband Internet	Broadband Internet	Broadband Internet	Private Network, Broadband Internet
Target Market	Enterprise, Government, Consumer Now	Enterprise, Government, Consumer Mid 2027	Enterprise, Government, Consumer	Enterprise, Government Q1 2027	Enterprise, Government Now

Malaysia is now at 99.83% COPA

Coverage Over Populated Areas



Logistics/Shipping Lines
Oil and Gas
Plantation
Fishing
Mining

Disaster Management
Border Surveillance
Public Safety
National Emergency
Military

Next Target is 100% COGA

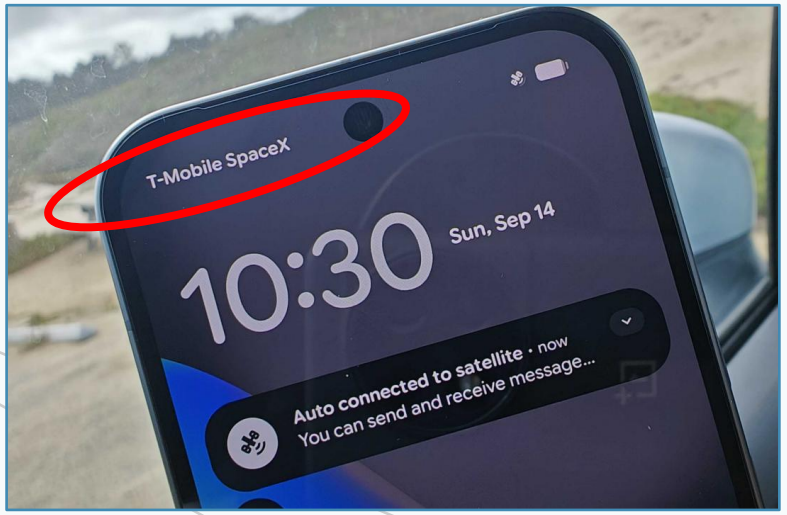
Coverage over Geographical Areas

NTN D2D



Starlink D2C

Roaming from Terrestrial to Non-Terrestrial Network
Starlink D2C V1, using IMT Bands



Starlink
EPC

Gateway ES

S8HR 3GPP
Interfaces

Public Switched
Telephone Network

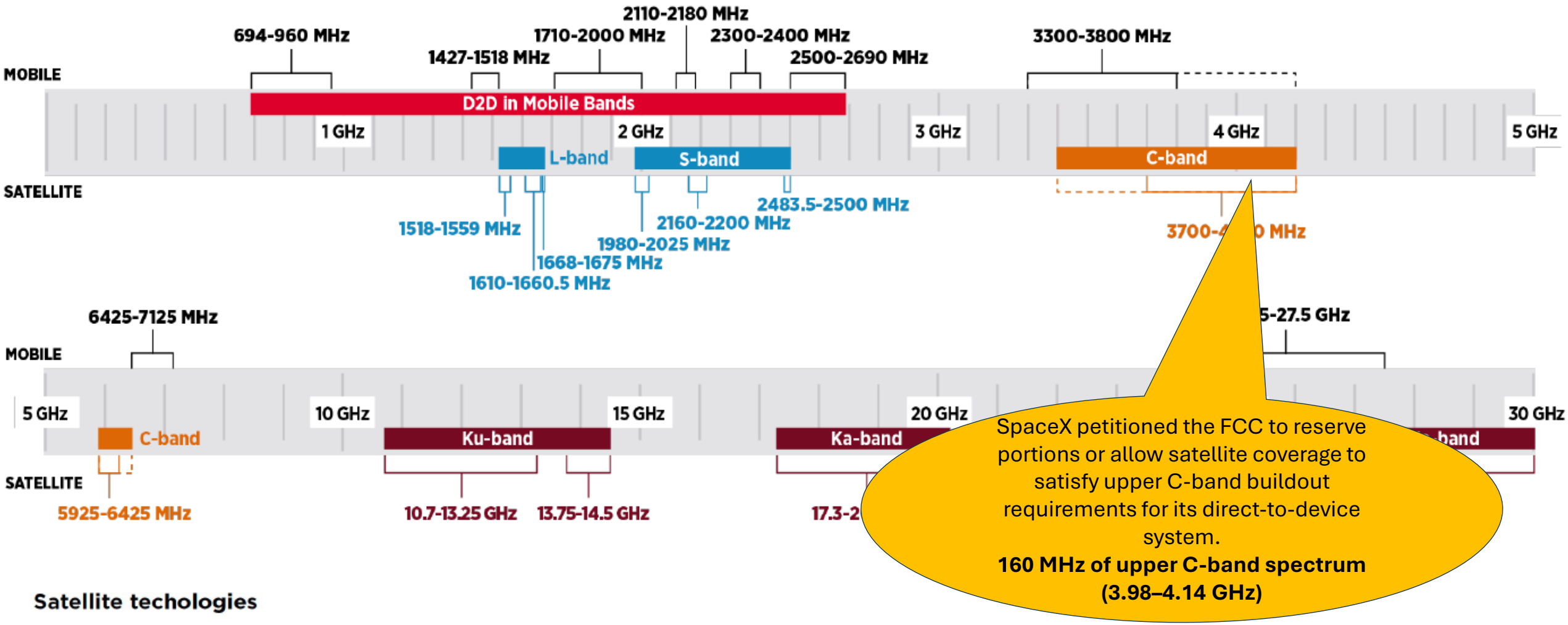
Public Internet

Participating
MNO
EPC

Unmodified
4G Phones

Spectrum for mobile and satellite networks

GSMA



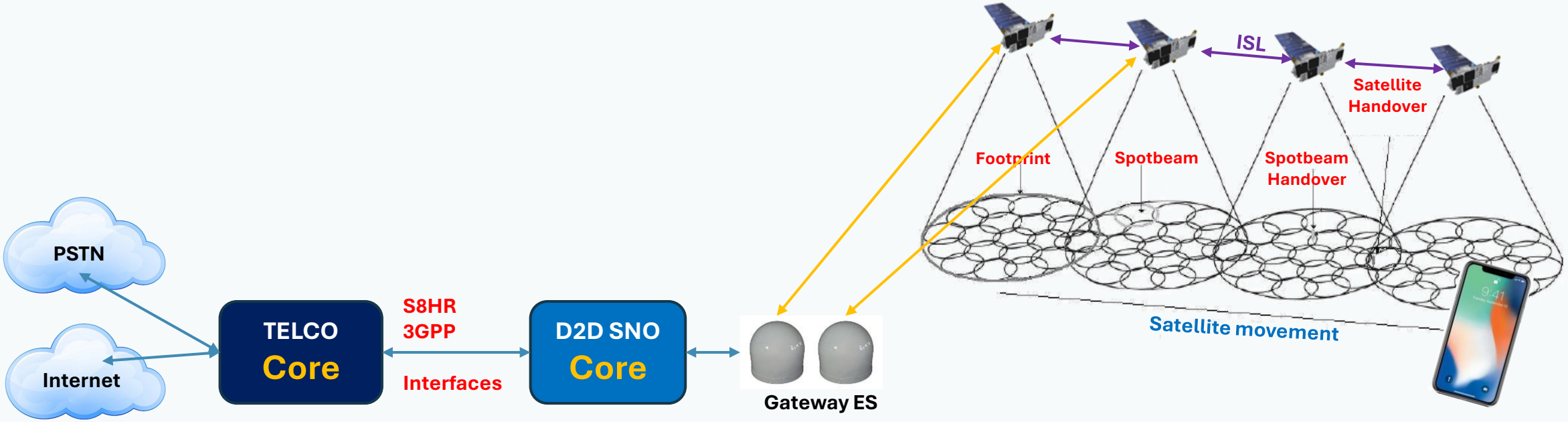
SpaceX petitioned the FCC to reserve portions or allow satellite coverage to satisfy upper C-band buildout requirements for its direct-to-device system.

160 MHz of upper C-band spectrum (3.98–4.14 GHz)

Satellite techologies

- D2D in Mobile Bands
- D2D in MSS (Mobile Satellite Service) Bands
- Broadband via Satellite and Satellite Backhaul
- Legacy Satellite Backhaul

NTN Direct-To-Device



Interfaces
- S8HR 3GPP Interface
- route roaming traffic back to the user's home network

Feederlinks
- Ka-. Q/V-, E-, W- band
- Future D-bands

Gateway ES
- Multiple Gateways

Userlinks
- IMT bands now
- MSS Bands next

Inter Satellite Link
- Optical/FSO

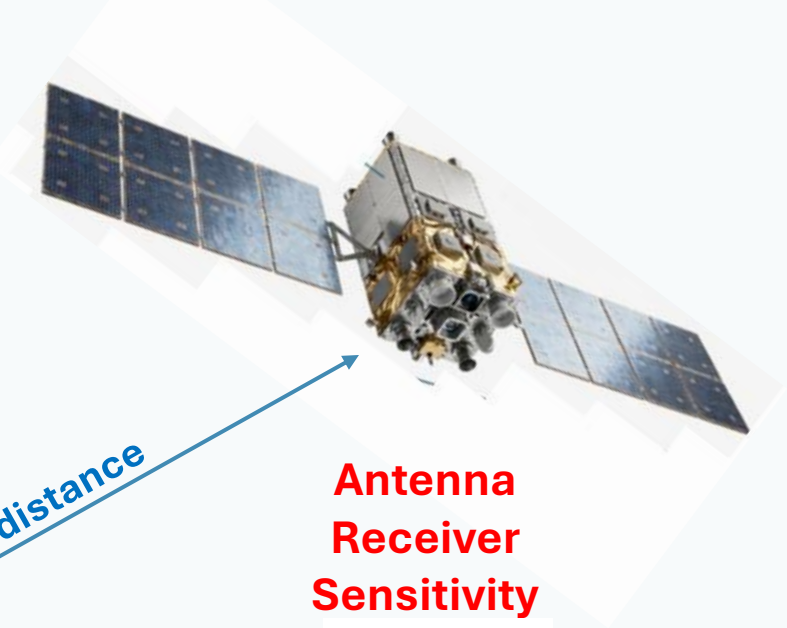
User Equipment
- Unmodified LTE Phones
- A new RF Chipset being developed to cover both IMT and MSS bands (2027)

Link Budget Analysis

Buildings adds losses in the Link Budgets

~10 dB → timber and regular glasses
~20 dB → bricks and coated glasses
~30 dB → concrete roofs and walls

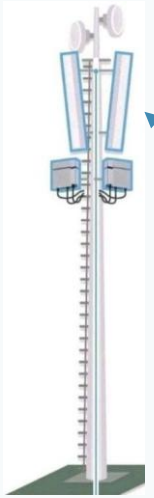
D2D won't work inside buildings!



Free Space Loss at 1.8 GHz and 550km distance
~47.55 dB

Antenna Receiver Sensitivity





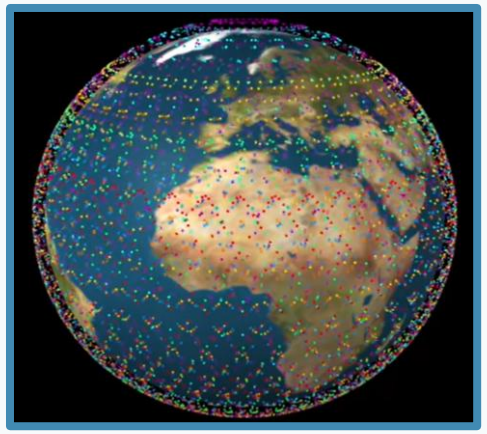


Signals get lower with distance & blockages

-75 dBm → a highspeed connection
-110 dBm → a poor connection
~ -120 dBm → loses connectivity

Non-Terrestrial Network (NTN) / Direct-to-Device (D2D)

Loew Earth Orbit (LEO)





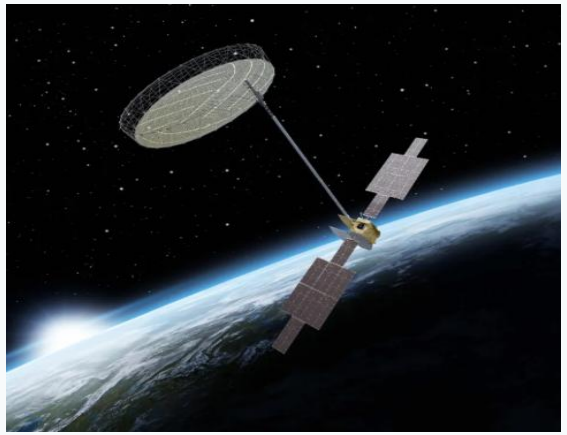


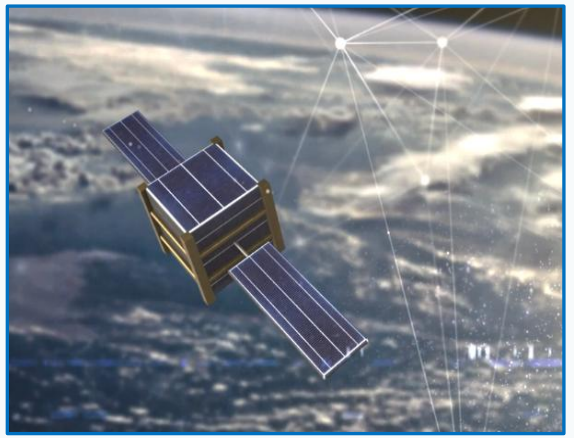


	Starlink Mobile (V2 Upcoming 2027)	AST SpaceMobile (Upcoming 2027)	GlobalStar HIBLEO-XL-1 (Amazon)	Iridium Stardust (RocketLab)
Number of Sats	15,000	248	3080	66 ?
Orbit Type Altitude	LEO 326 ~ 335 KM	LEO 508 ~ 740 KM	LEO 485 ~ 700 KM	LEO 780 KM
Service Link Spectrum	L and S-band (65+14 MHz) MNO Partner IMT Spectrum	L-band (45 MHz) MNO Partner IMT Spectrum	L and S-Band (25 Mhz) Terrestrial 2.4GHz midband (11.5 MHz)	L-band (9 Mhz)
Service Suites	3GPP Standard based	3GPP standard-based	3GPP standard-based	3GPP standard-based
Partners/Remarks	2nd Gen/V2 150 Mbps Acquired Echostar MSS Spectrum	Up to 98 Mbps Acquired Ligado MSS Spectrum	Acquired by Amazon Backed by Apple Inc	Acquired by RocketLab

Non-Terrestrial Network (NTN) / Direct-to-Device (D2D)

Multi-orbit





	Equatys (Space42 and Viasat JV)	Alveo Mobile (Lynk Global/OmniSpace, backed by SES)
Number of Sats	LEO: 2800 GEO: Space42, Viasat/Inmarsat	LEO:320 MEO: SES O3B Mpower GEO: SES Satellites
Orbit Type Altitude	Multi-Orbit GEO, LEO	Multi-Orbit GEO, MEO and LEO
Spectrum	> 100 MHz MSS L-band Spectrum	60 MHz MSS S-band Spectrum MNO Partner IMT Spectrum
Service Suites	3GPP Standard based	3GPP Standard based
Remarks/MNO Partners	Pooled Global MSS Spectrum 160+ markets	Contracts with 56 mobile operators Covering 60 countries.

KESSLER SYNDROME

It is a matter of time before it happens!

Every SpaceX Starlink satellite has to dodge a collision almost weekly, and experts fear the worst

News By Tereza Pultarova | Published July 15, 2026

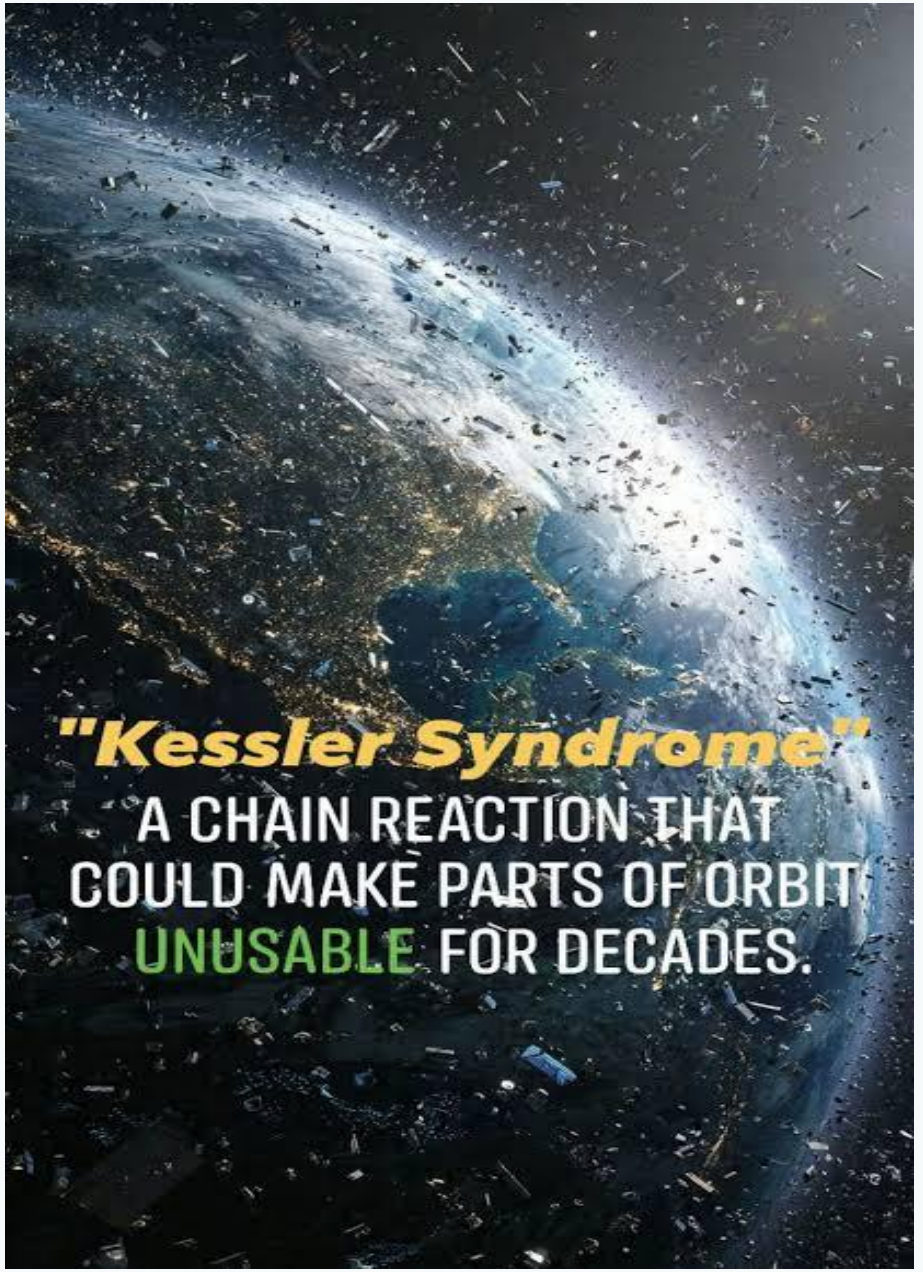
16 Sep, 2026

Starlink satellites dodged collisions over 207,000 times in six months

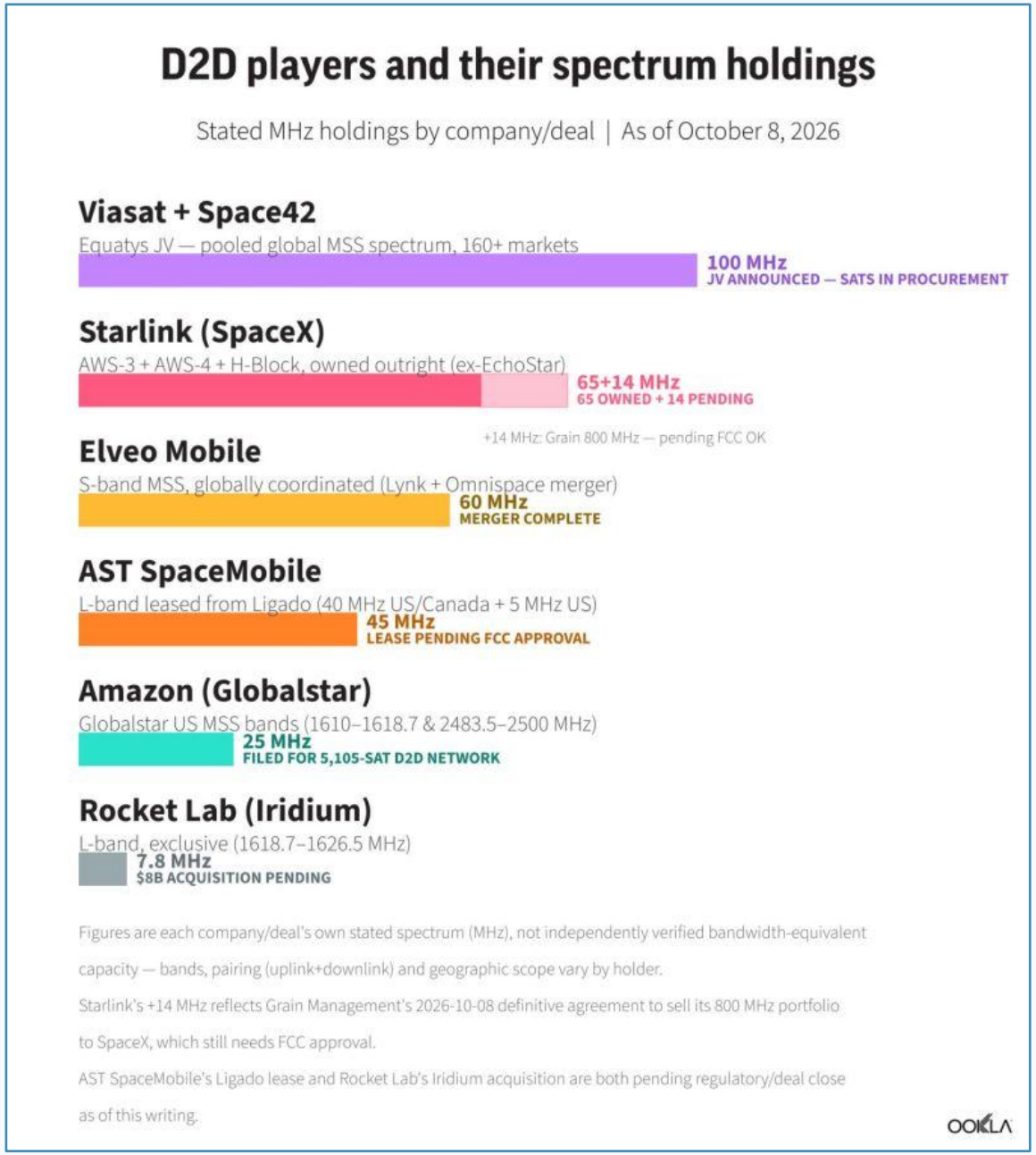
SpaceX's Starlink encourages every satellite operator to share data with Stargaze platform, for safety

Musk company proposes international cooperation on satellite tracking in a one-way street relationship with SpaceX

October 16, 2026 By: Laurence Russell Have your say



- Spectrum → Capacity
- MSS Spectrum are globally harmonized



D2D NTN Disruptions

- **Rural expansions may slow down as satellites fill the gap**
  - ❖ Fewer RAN orders in remote builds and lesser conventional satellite backhaul requirements
- **Roaming margins may compress**
  - ❖ Basic messaging & emergency connectivity bundled into premium plans
  - ❖ Roaming - from a standalone profit engine into a background feature
- **Satellite networks could become global connectivity aggregators**
  - ❖ Operators to rely on NTN D2D ecosystem partnerships for global coverage extension
- **The world may split into terrestrial-first and satellite-first zones**
  - ❖ Dense cities to continue depend on terrestrial 5G/6G capacity
  - ❖ Highways, oceans, aviation, mining, logistics, utilities, and remote infrastructure to become satellite-first connectivity environments
- **Regulation may become the real battleground**
  - ❖ Satellites do not align neatly with national borders, spectrum ownership models, or lawful interception frameworks.



Industry Pivoting Toward
Hybrid Integration of Terrestrial + Satellite

- Integrate satellite + terrestrial networks into a unified customer experiences
- Use local spectrum rights, billing, and compliance frameworks as strategic advantages
- Shift focus from consumer roaming to enterprise-grade hybrid connectivity for logistics, maritime, mining, utilities, and industrial IoT

In the next era of connectivity, the sky isn't the limit

it is the network!

Malaysian Technical Standards Forum Bhd

THANK YOU!

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