LEOsats –
Technologies, Use Cases, and Outcomes

Dejan Jakšić, Cisco Solutions Engineer
NOG.hr Meetup 6

18.09.2025.

The same pattern is visible in satellite communications today. Operators present satellite to handset connectivity as a niche product for rural gaps that cover less than 5% of the world's population. Yet the scale of current investments makes that story hard to believe. SpaceX has spent more than $15 billion building Starlink, and in September 2025 committed another $17 billion to acquire EchoStar's AWS-4 and H-block spectrum. Amazon has budgeted $10 billion for Project Kuiper. The European Union is funding IRIS², a sovereign LEO constellation, with a launch target in 2027. These are not projects designed for a marginal market.

Space Launch Economics

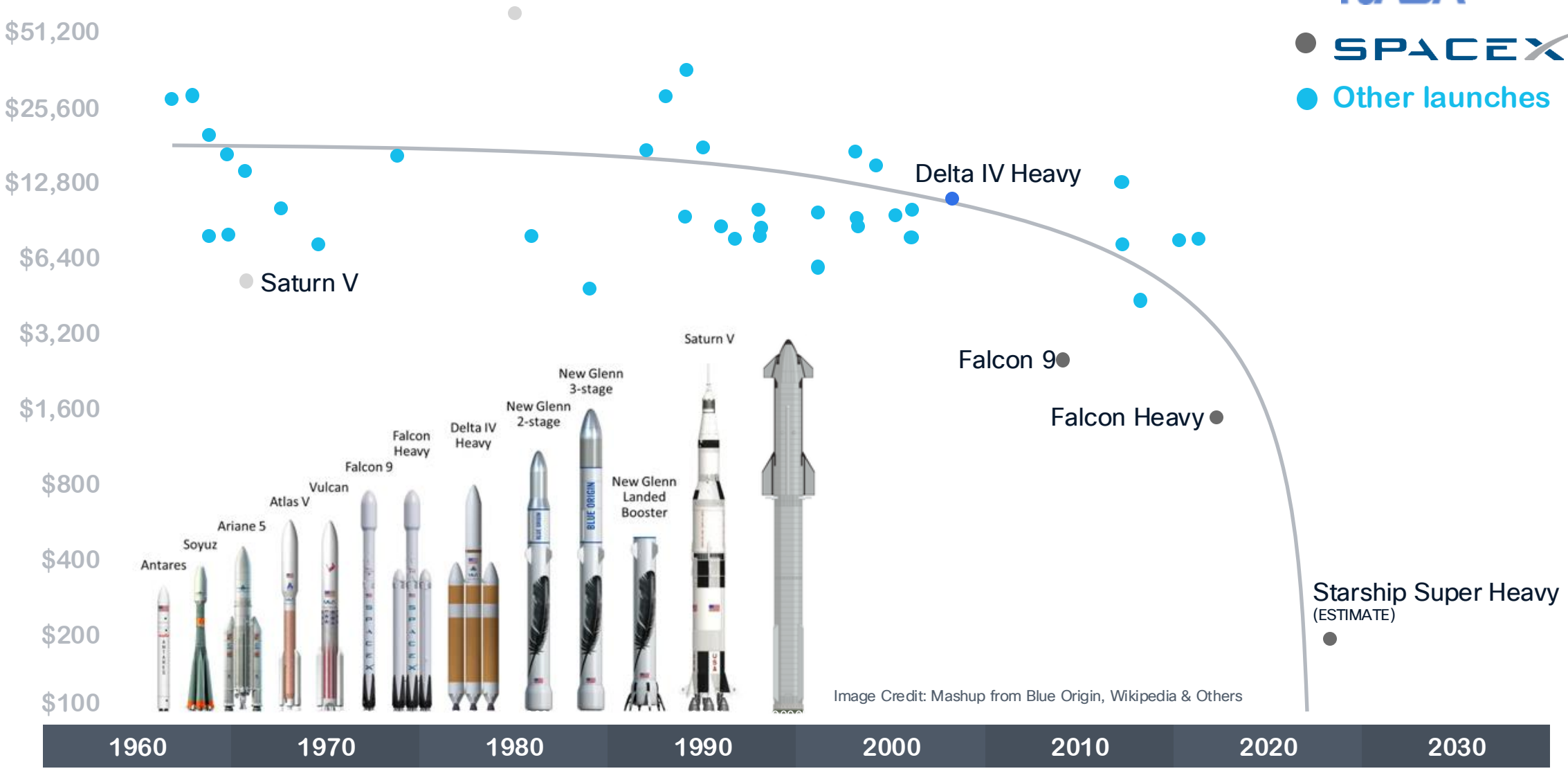
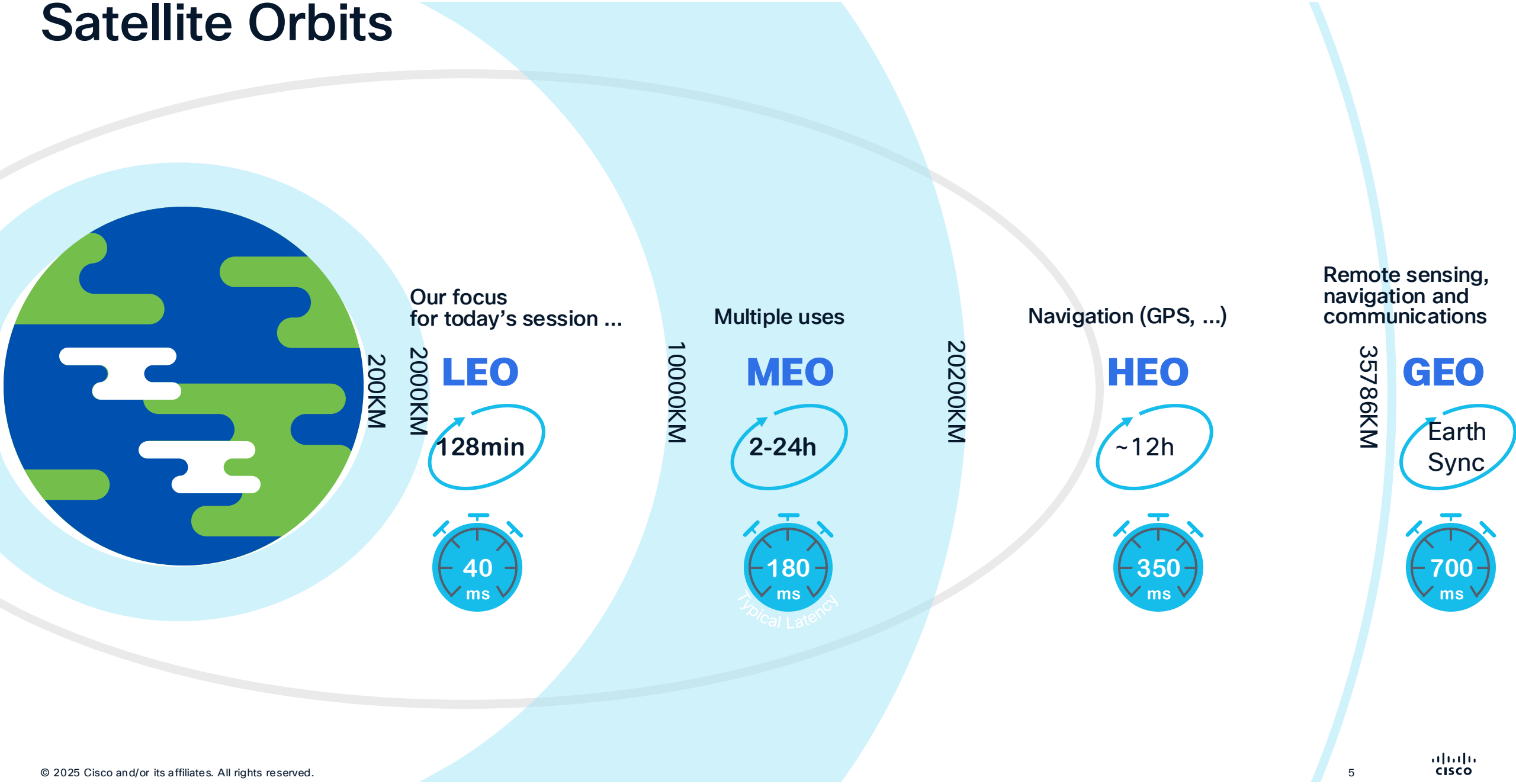


Image Credit: Mashup from Blue Origin, Wikipedia & Others

Satellite Orbits



Low Earth Orbit (LEO) Satellite Constellations

Low Earth Orbit Operation

- Located at ~500 km altitude (varies)
- Constantly moving from ground observer viewpoint
- Many LEO satellites in constellation
- Starlink = 4,425 in initial planned deployment

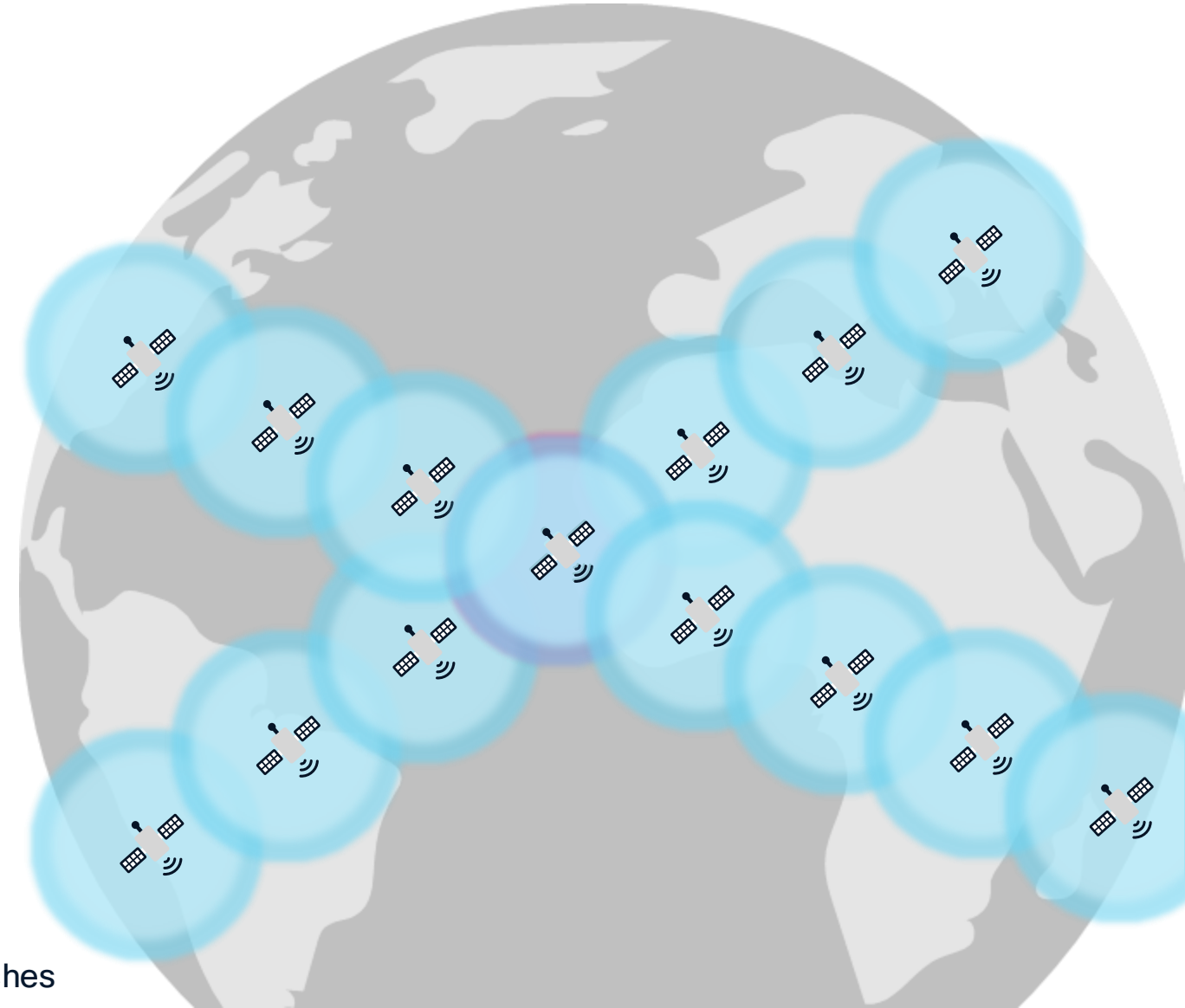
Improved performance

- Throughput~: 200 Mbps down, 25 Mbps up (Starlink ~8x increase)
- Latency~: 20–40 msec typical, ~10x+ decrease
- Smaller spot coverage due to closer satellite location
- Per-satellite bandwidth of ~20 Gbps currently
- Aggregate bandwidth of ~80 Tbps+ across 4,425 satellites

SpaceX Starlink – Initial Deployment

First launch Feb 22nd, 2018 – Operational since November, 2019

2020 Public Testing	8395 Satellites in Orbit*	Available in most locations on Earth
Ka Band 26.5-40 GHz	6M+ Active Subscribers*	Ku Band 12-18 GHz

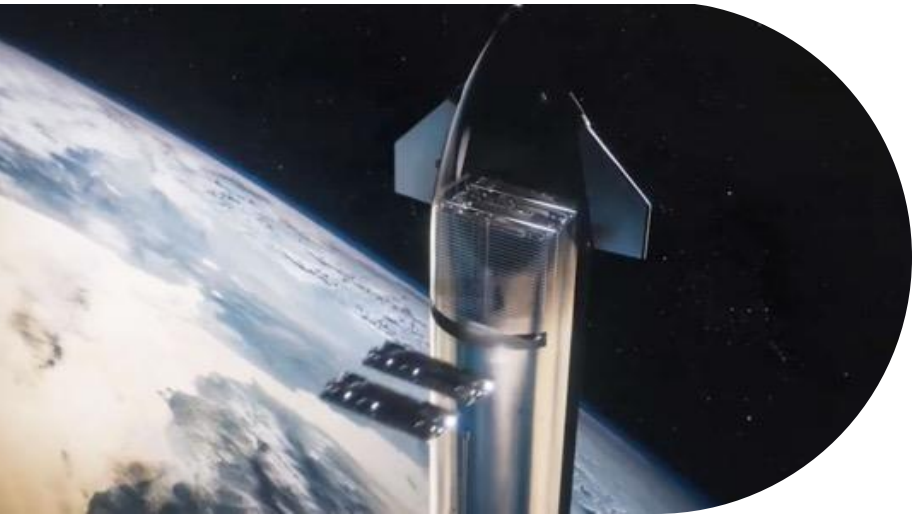


* As of September, 2025

https://findstarlink.com/

https://www.spacex.com/launches

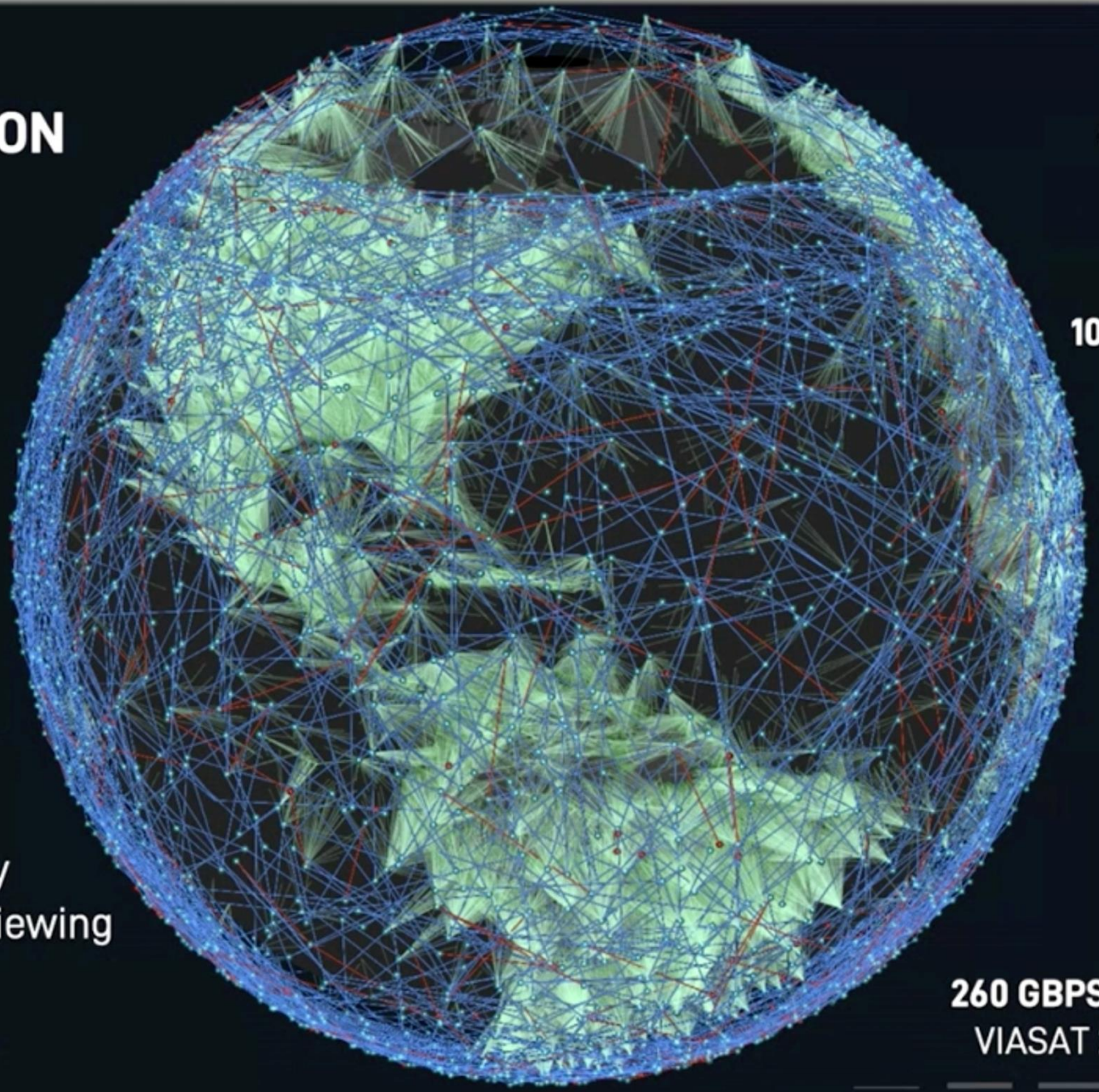
Starlink Launch Config



~60 typically deployed in a single launch
~5-10 years in orbit

https://en.wikipedia.org/wiki/Starlink#/media/File:Starlink_Mission_(47926144123).jpg
https://www.nasaspaceflight.com/2023/01/Starlink-5-2-launch/

CONSTELLATION



> 4,000,000 GBPS

100,000 GBPS
>1,000 GBPS
launched
per week

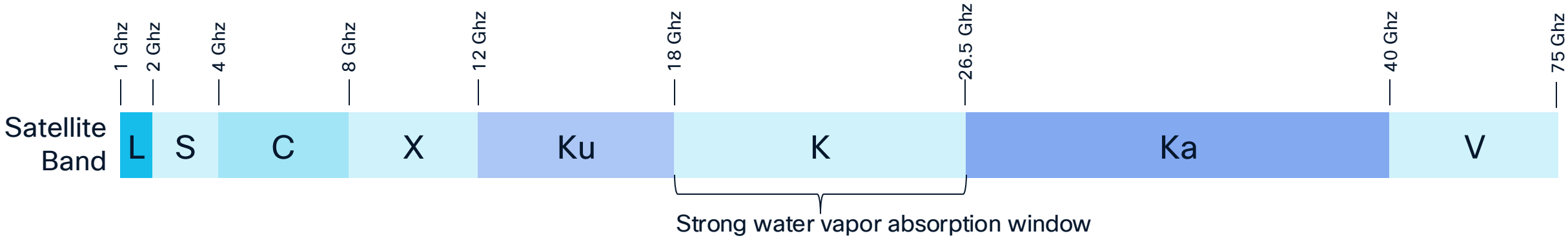
STARLINK (TODAY)

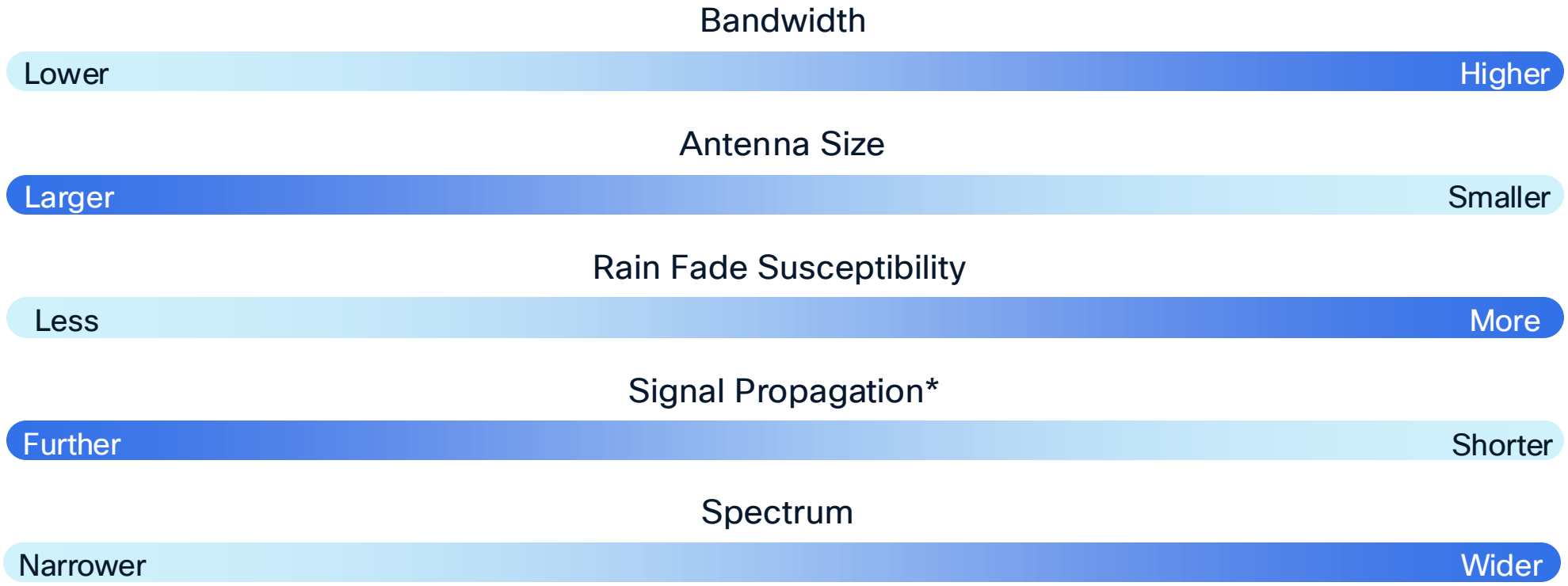
STARLINK (2025)

Satellites significantly
enlarged for ease of viewing

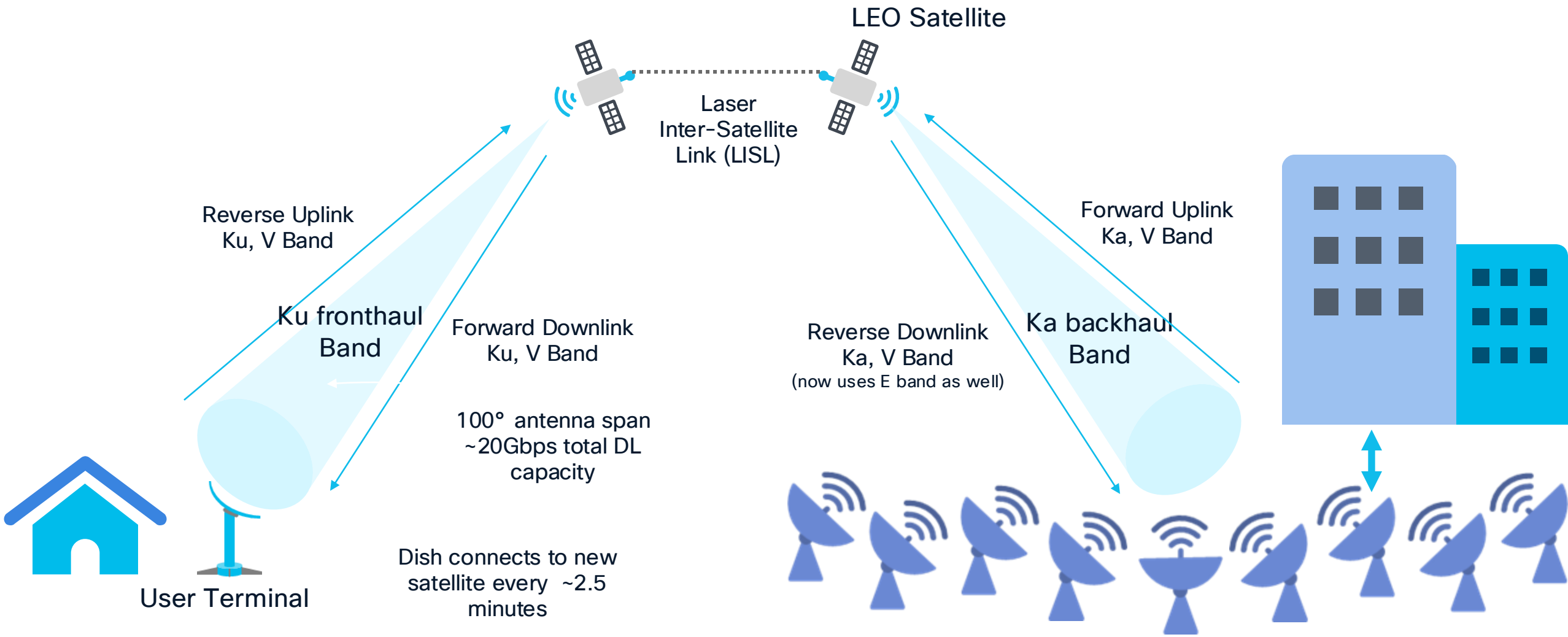
260 GBPS
VIASAT 2

Satellite Bands





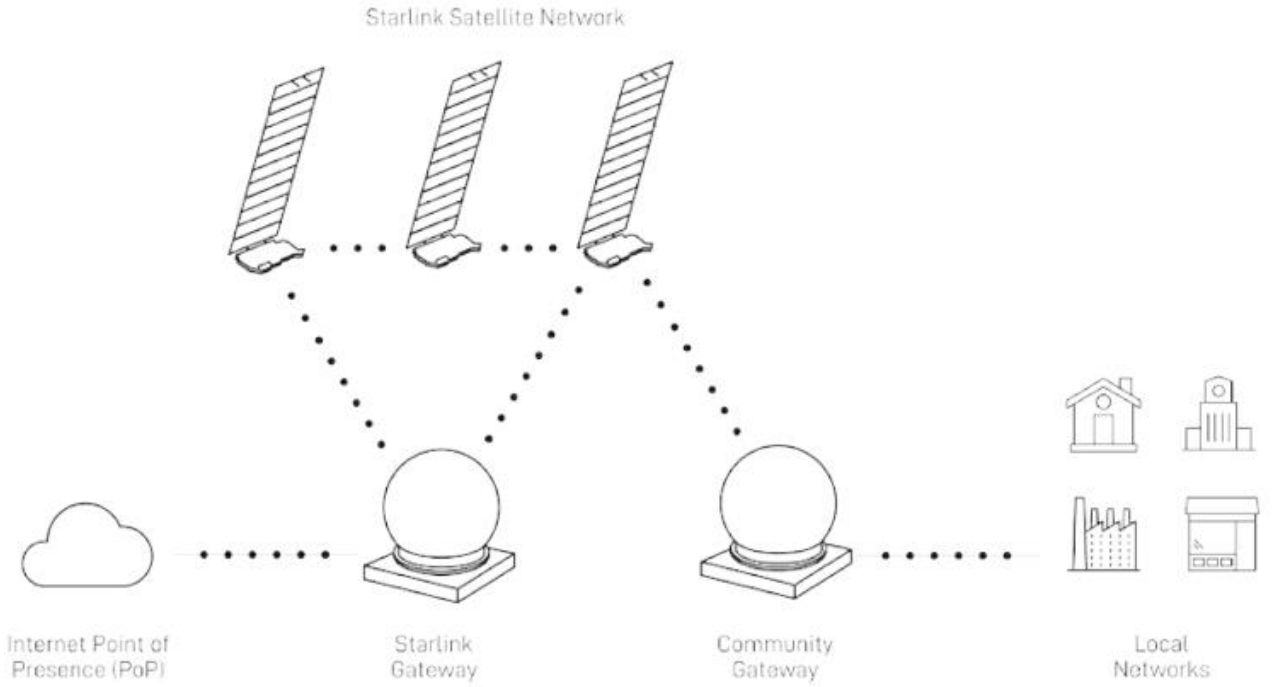
Starlink Operational Architecture



Source: https://www.redorbit.com/spacex-plans-to-reduce-number-of-v-band-starlink-satellites/
Source: https://dgtlinfra.com/elon-musk-starlink-and-satellite-broadband/

Ground Stations

https://www.starlinkinternet.info/community-gateway



Starlink Community Gateways

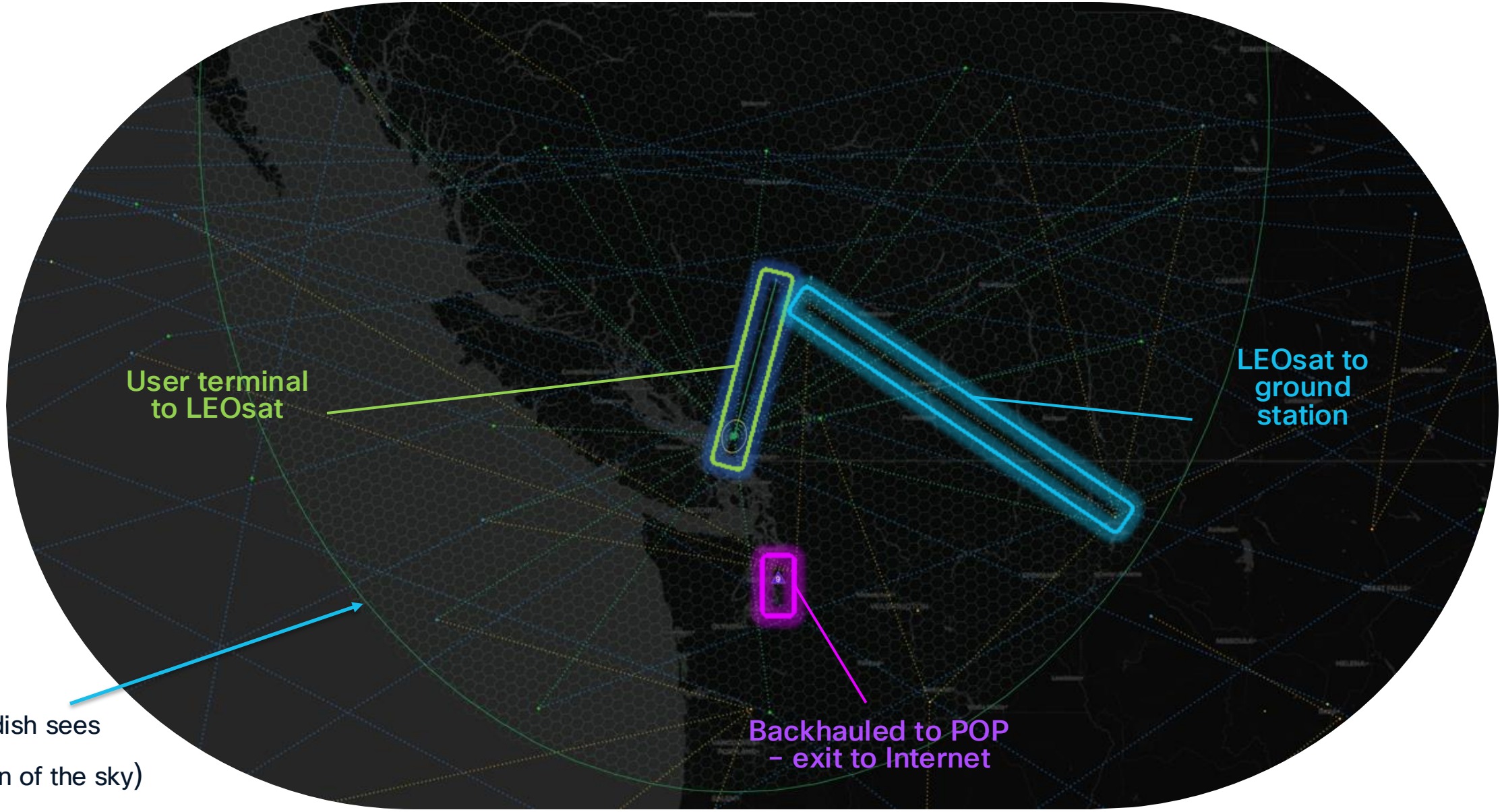
With Community Gateways, Starlink satellites are able to deliver fiber-like speeds with local providers distributing connectivity to homes, businesses, and governments using last-mile fiber, fixed wireless and mobile wireless.

The Community Gateway traffic transits through Starlink's global laser mesh network and utilizes our high bandwidth Gateways operating in a dedicated Ka spectrum band.

Photo Credit: Starlink gateways near North Bend (Reddit User: /u/daedalus_j)

How the LEOsats Move – Example

https://starlink.sx/



LEOsat Competitor Space

GeeSpace
240 LEO Planned

Lynk
5110 LEO Planned

Starlink
~8,400 LEO Active
(4396 – Phase 1)
(7518 – Phase 2)
~12000 in total by 2027

OneWeb
648 LEO Active
(as of mid 2025)

AST SpaceMobile
170 LEO Planned

TeleSat
15 GEO Active

VIASat
4 GEO Active

Iridium Certus
75 LEO Active

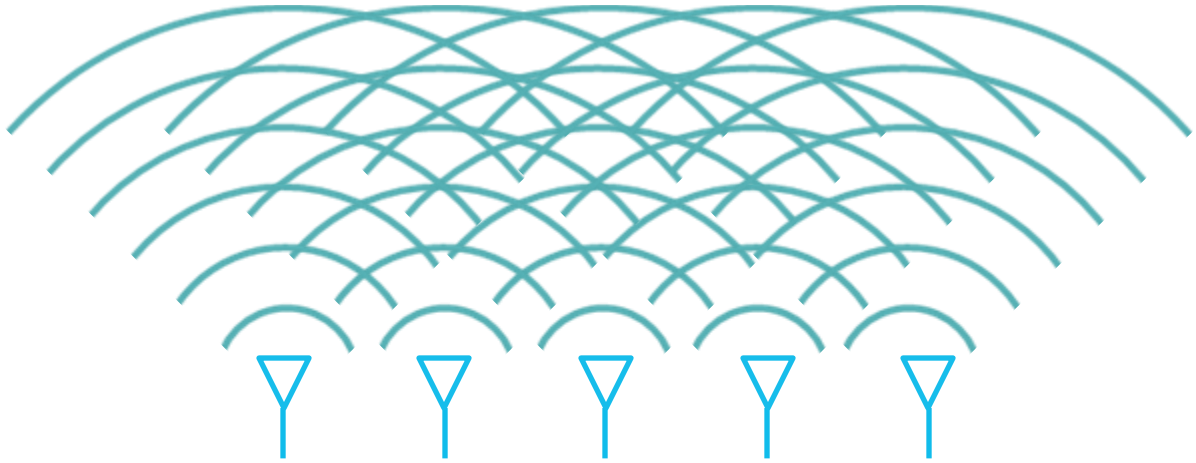
AMAZON Kuiper
3236 LEO planned
(active ~100)

Source:
https://interestingengineering.com/innovation/Starlink-here-are-6-of-spacexs-biggest-rivals-for-satellite-internet-dominance

Phased Array Antennas – Controlling Direction and Beam

Phased array antennas can contains 100s of antenna elements

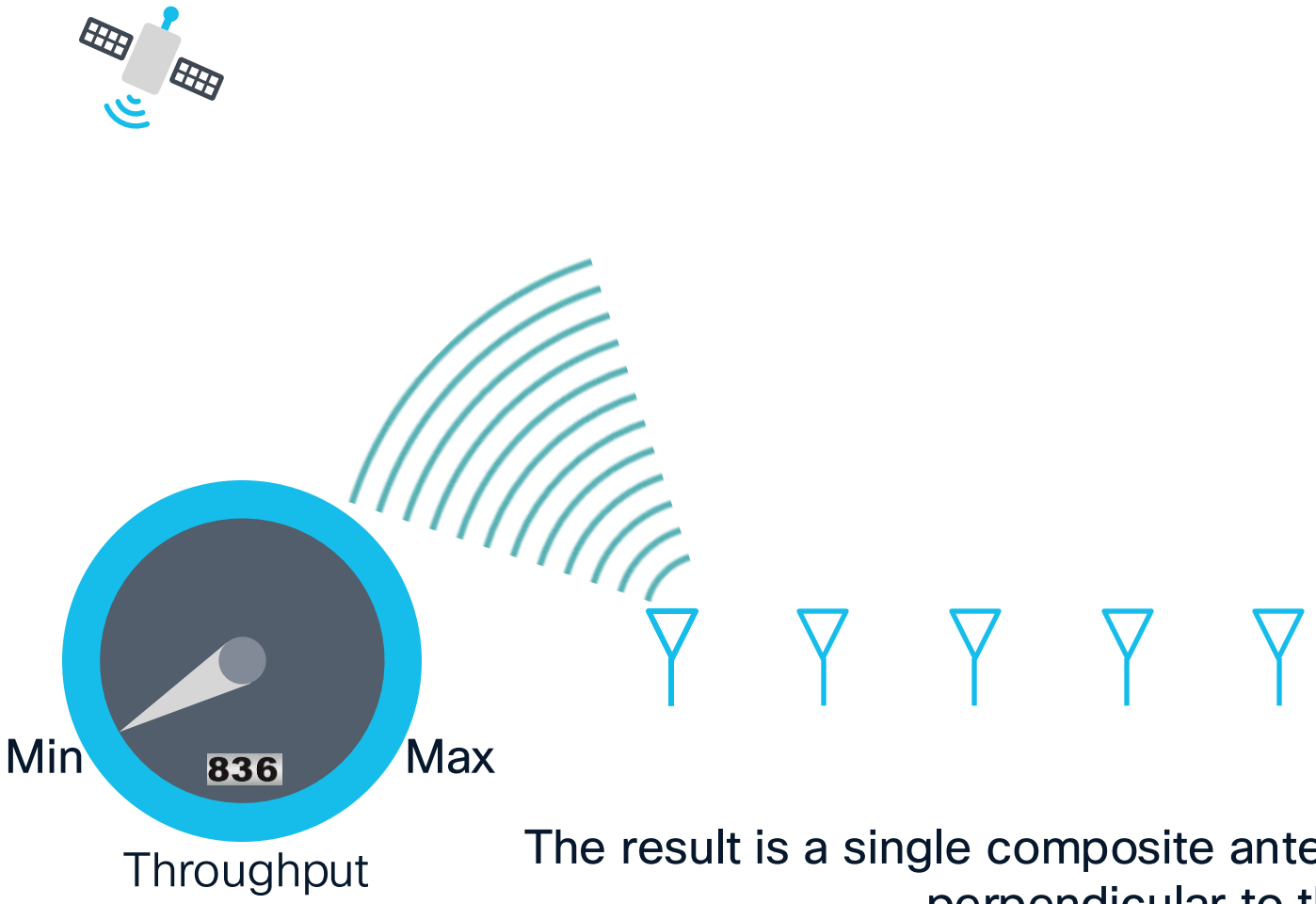
Through software we can concentrate the beam in one specific direction and cancel out in all other directions
By adding a slight delay to each signal



The result is a single composite antenna with a very narrow beam perpendicular to the antenna

Phased Array Antennas – Throughput

Throughput will vary whilst connecting and as the LEOsat moves across the sky

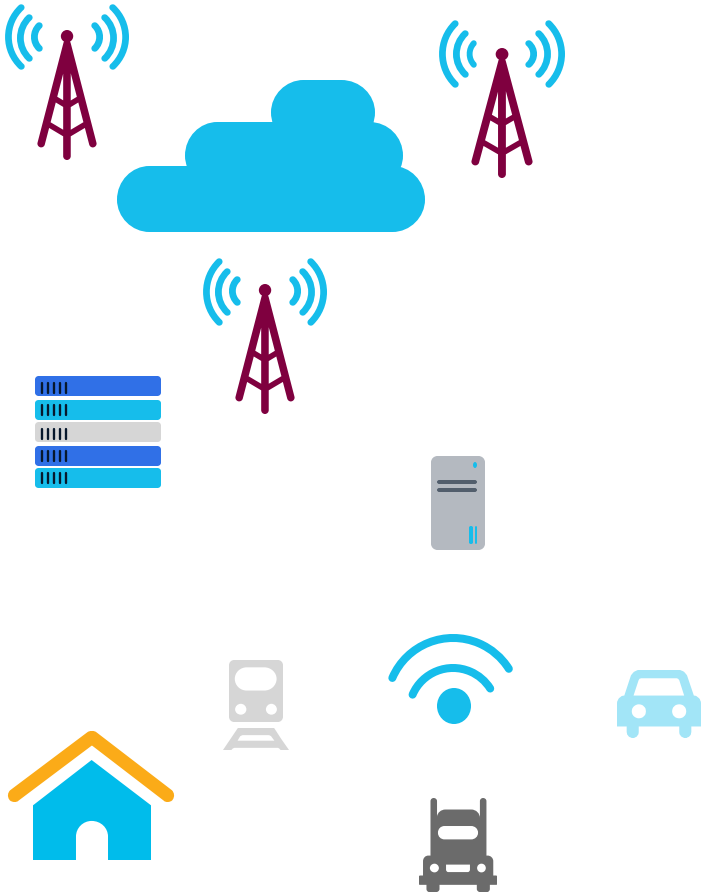


For illustrative purposes only.

The result is a single composite antenna with a very narrow beam perpendicular to the antenna

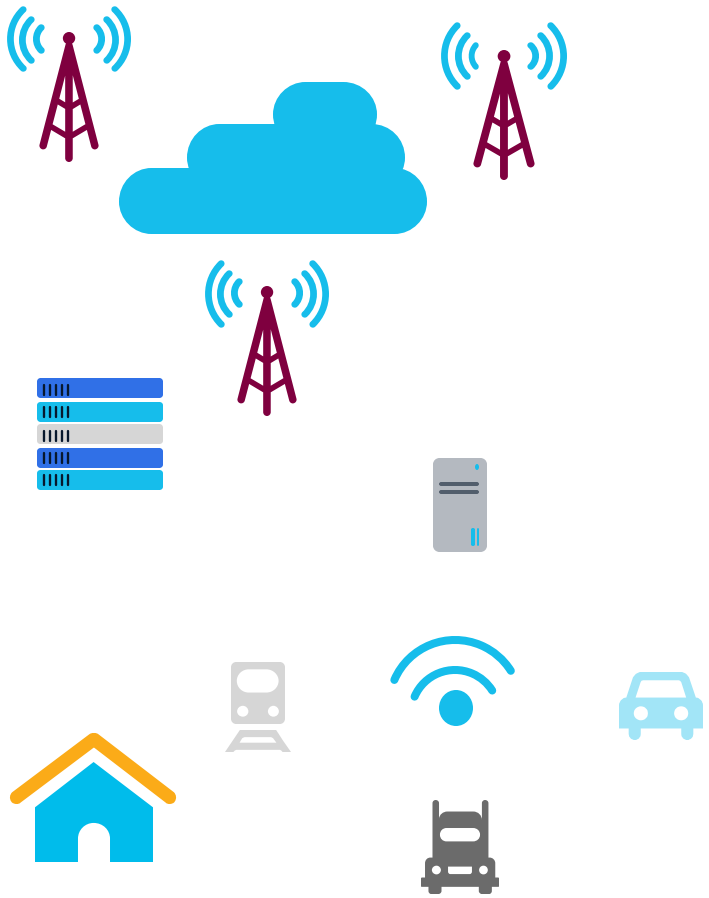
Mobility

Traditional

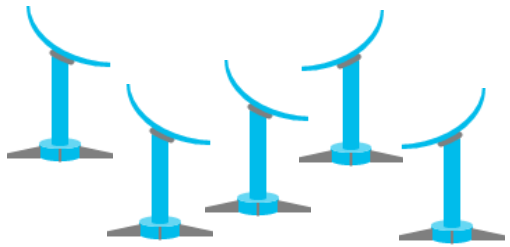


Mobility

Traditional

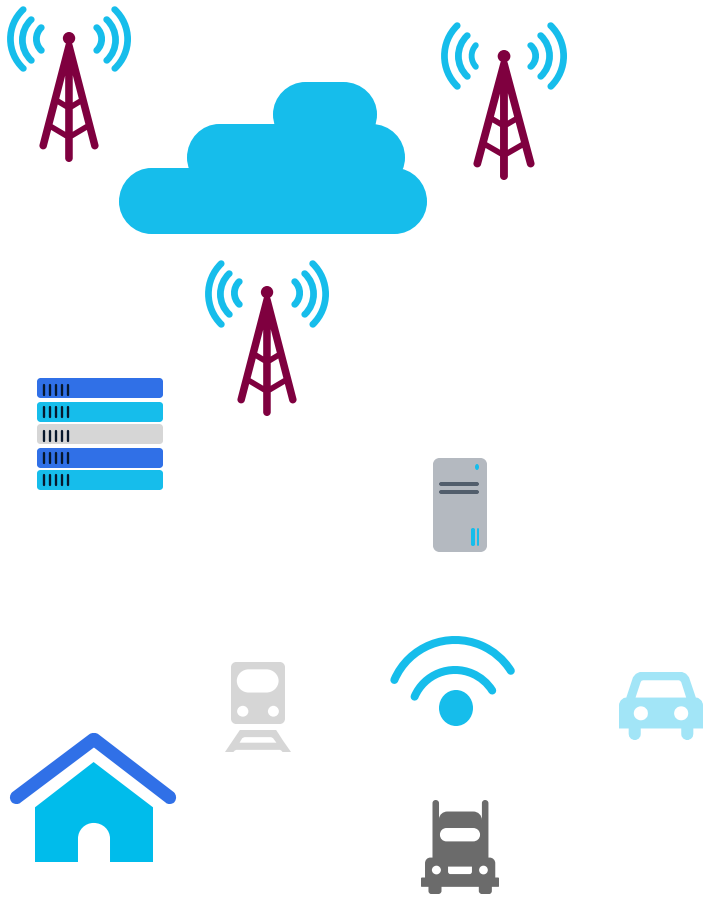


LEO



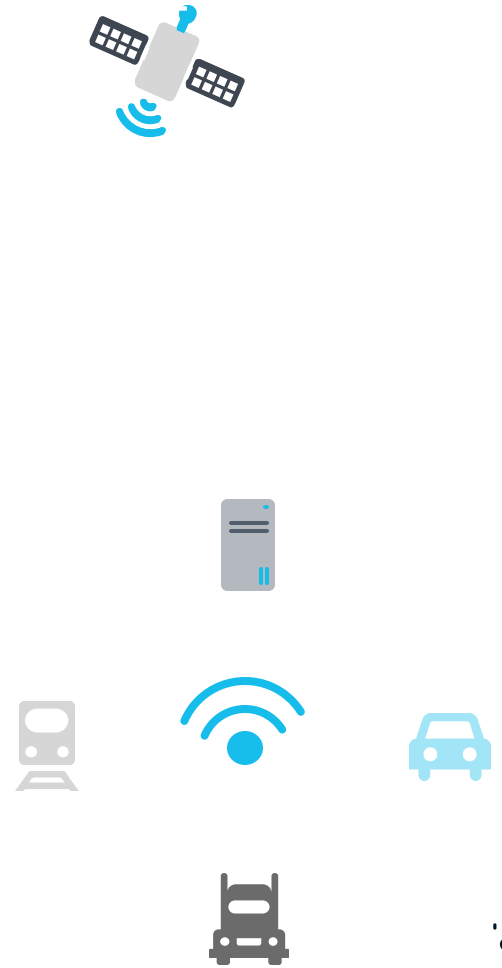
Mobility

Traditional

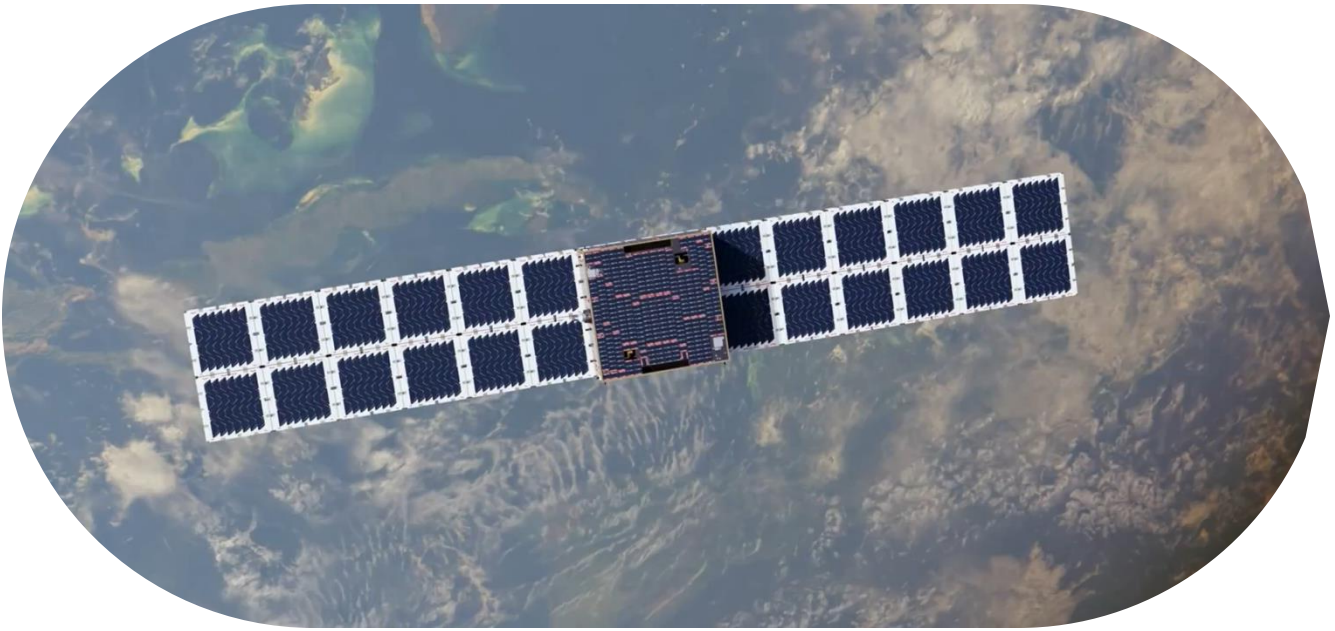


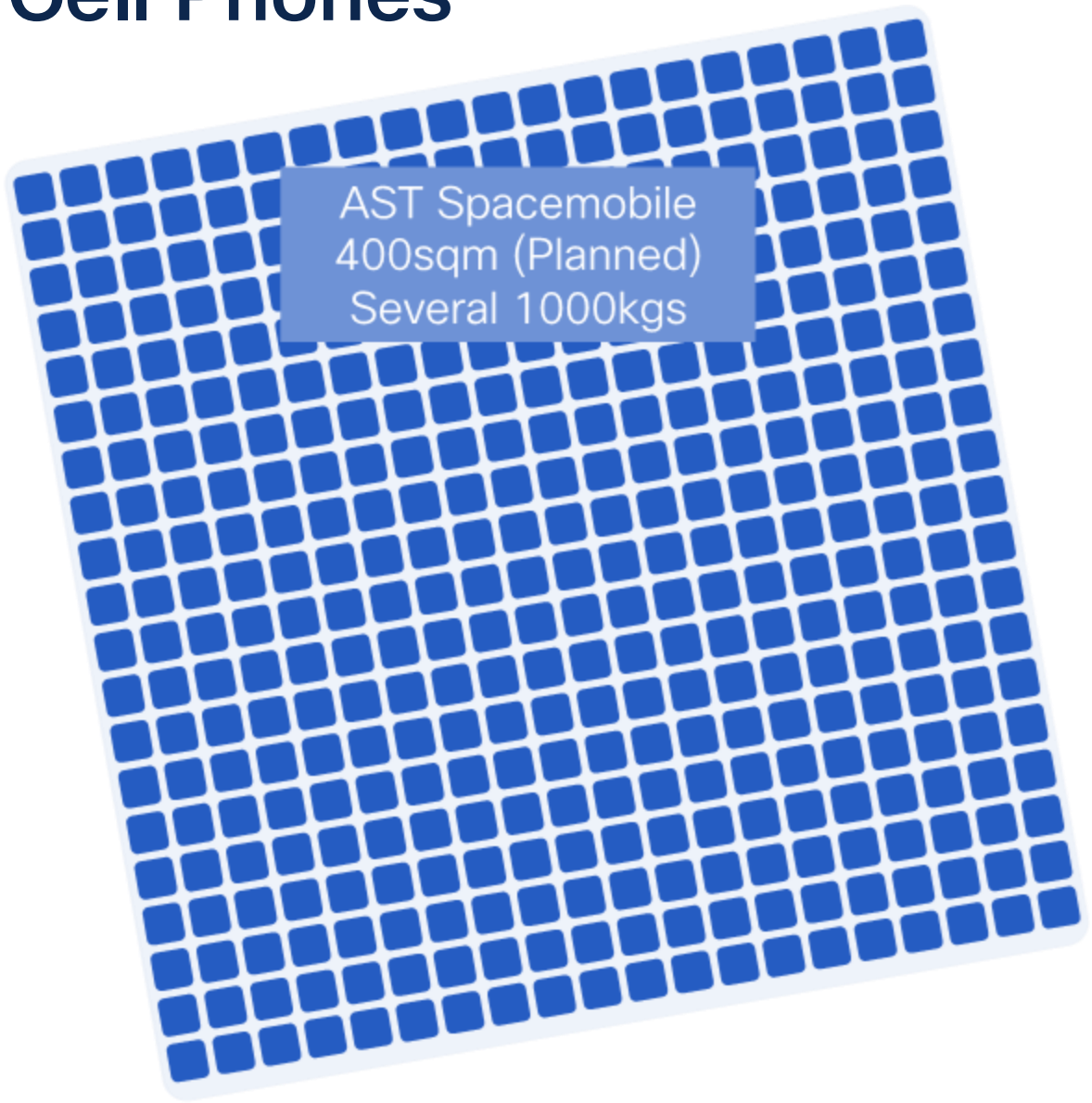
LEO

LEO Mobility



Larger Antenna & More Power – Cell Phones





Lynk
4sqm

Starlink Gen2
25sqm
1250Kgs

A Marriage Made In Low Earth Orbit

Many partnerships are being formed

LYNK

Many MNO

AST SpaceMobile

Many MNO

STARLINK

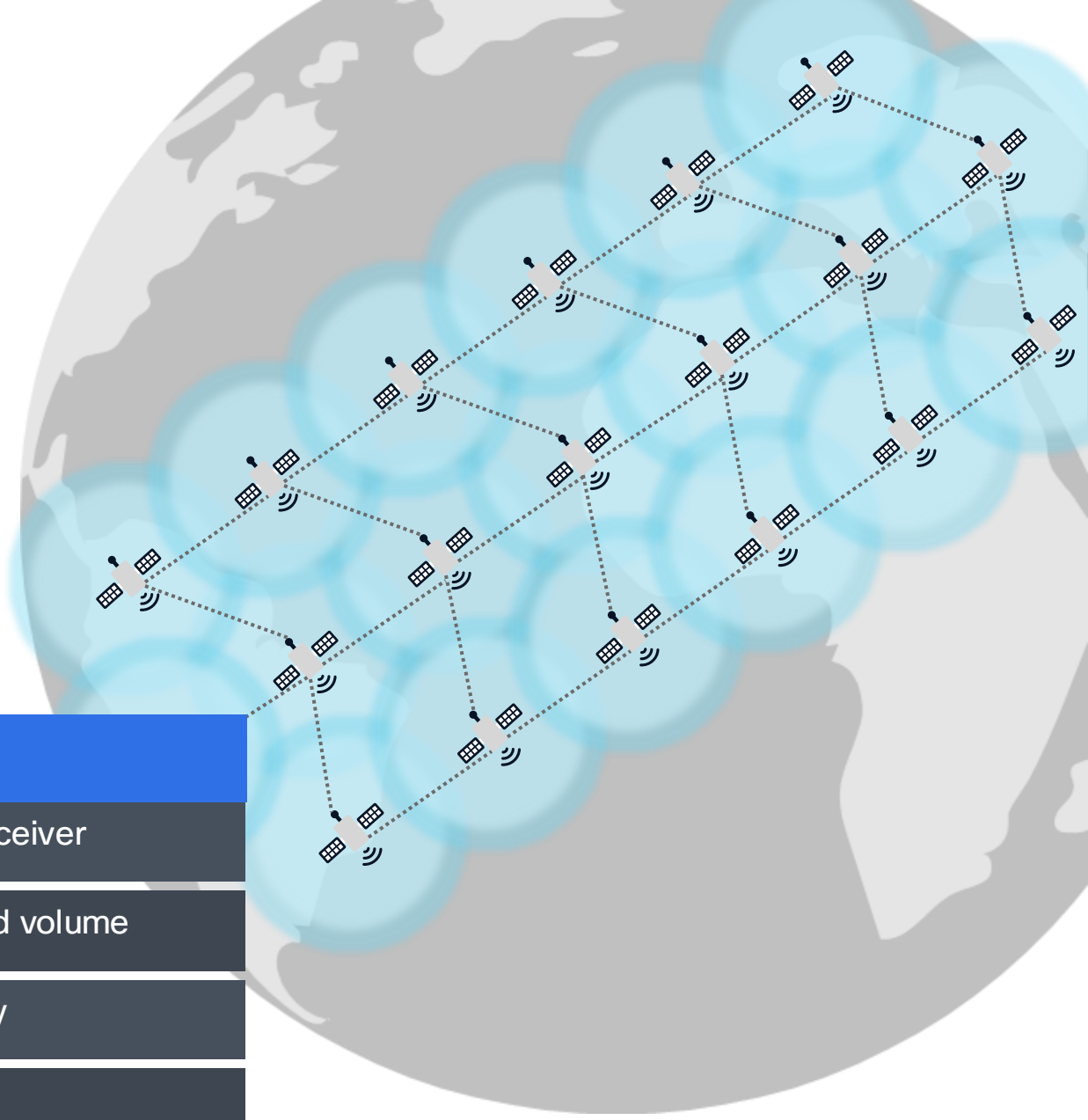
T-Mobile

Globalstar

Initial offers are texting services and low BW broadband

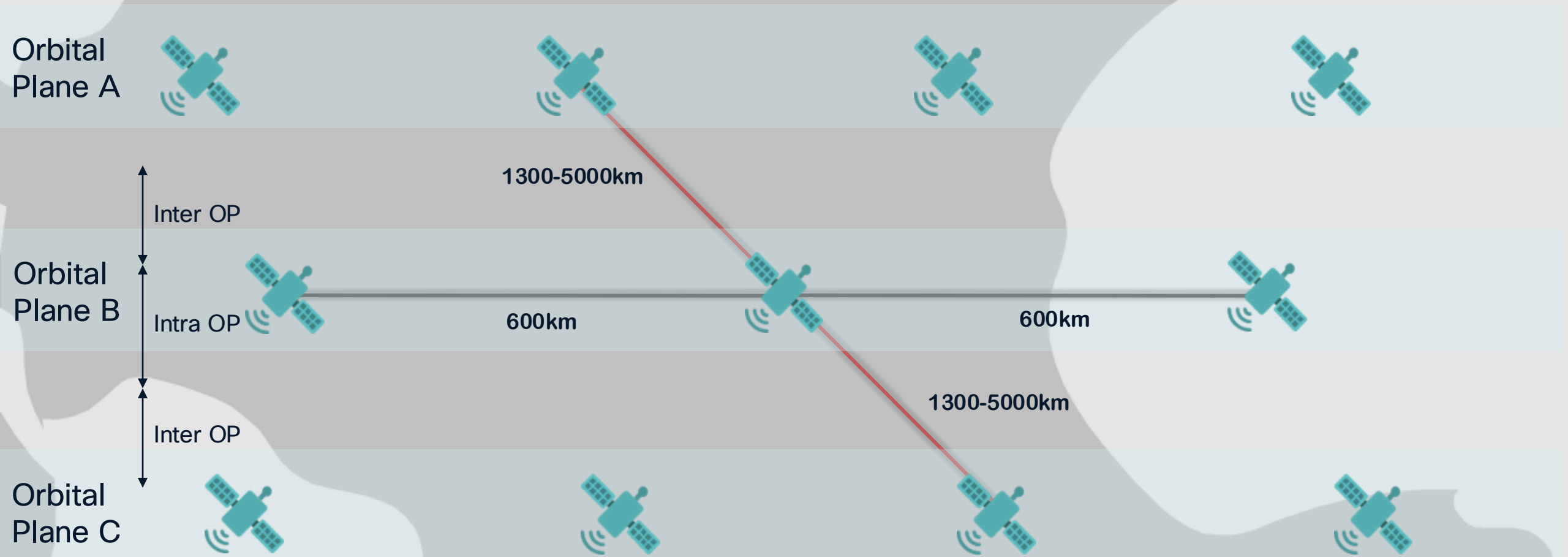
Laser Inter-Satellite Links

Signals in FREE SPACE
REDUCE LATENCY



Advantages of Laser over RF	
Higher Capacity	Up to 200 Gb/s between one laser transmitter & receiver
Antenna Size	Smaller antenna sizes, resulting in lower weight and volume
Narrow Beam	Eliminates interference and provides higher security
Low TX Power	Due to lower beam spread and higher directivity

Starlink Laser Inter-Satellite Links

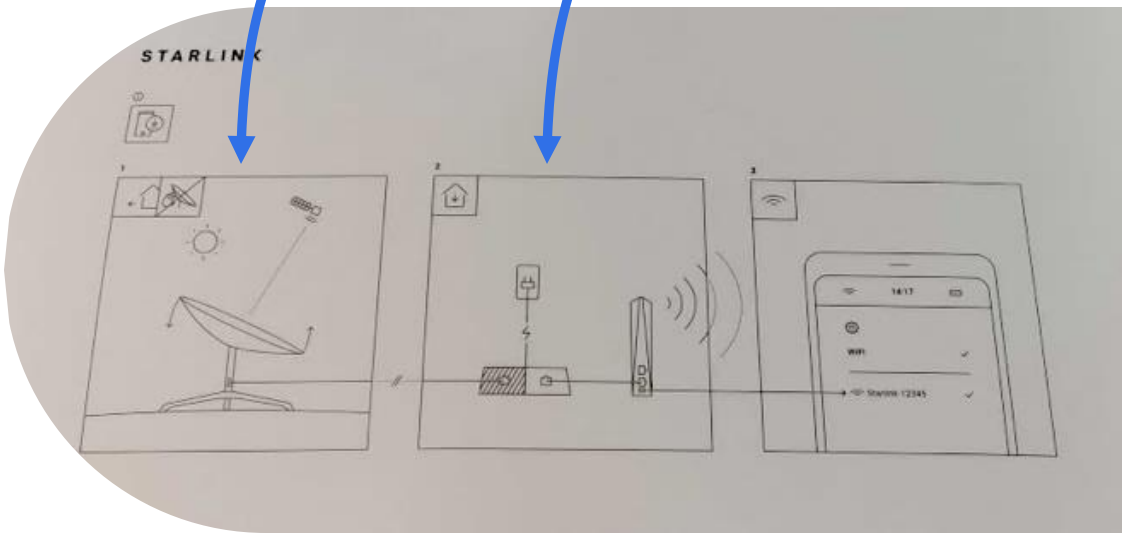


Delivering 42 PETABYTES
of customer data a day (42 million gigabytes)

https://arxiv.org/abs/2103.00056

Mesh routing in space

Deployment @ Home



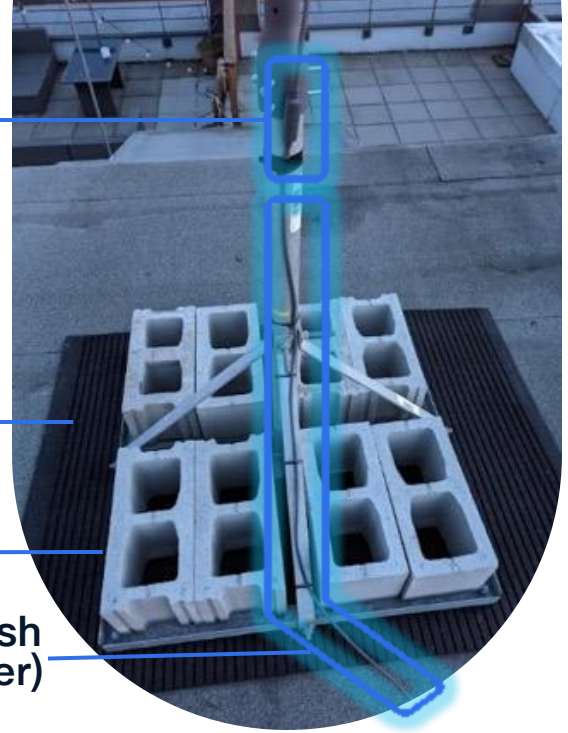
Installation Instructions

Starlink Review (Gen 3)

Deployment @ Home

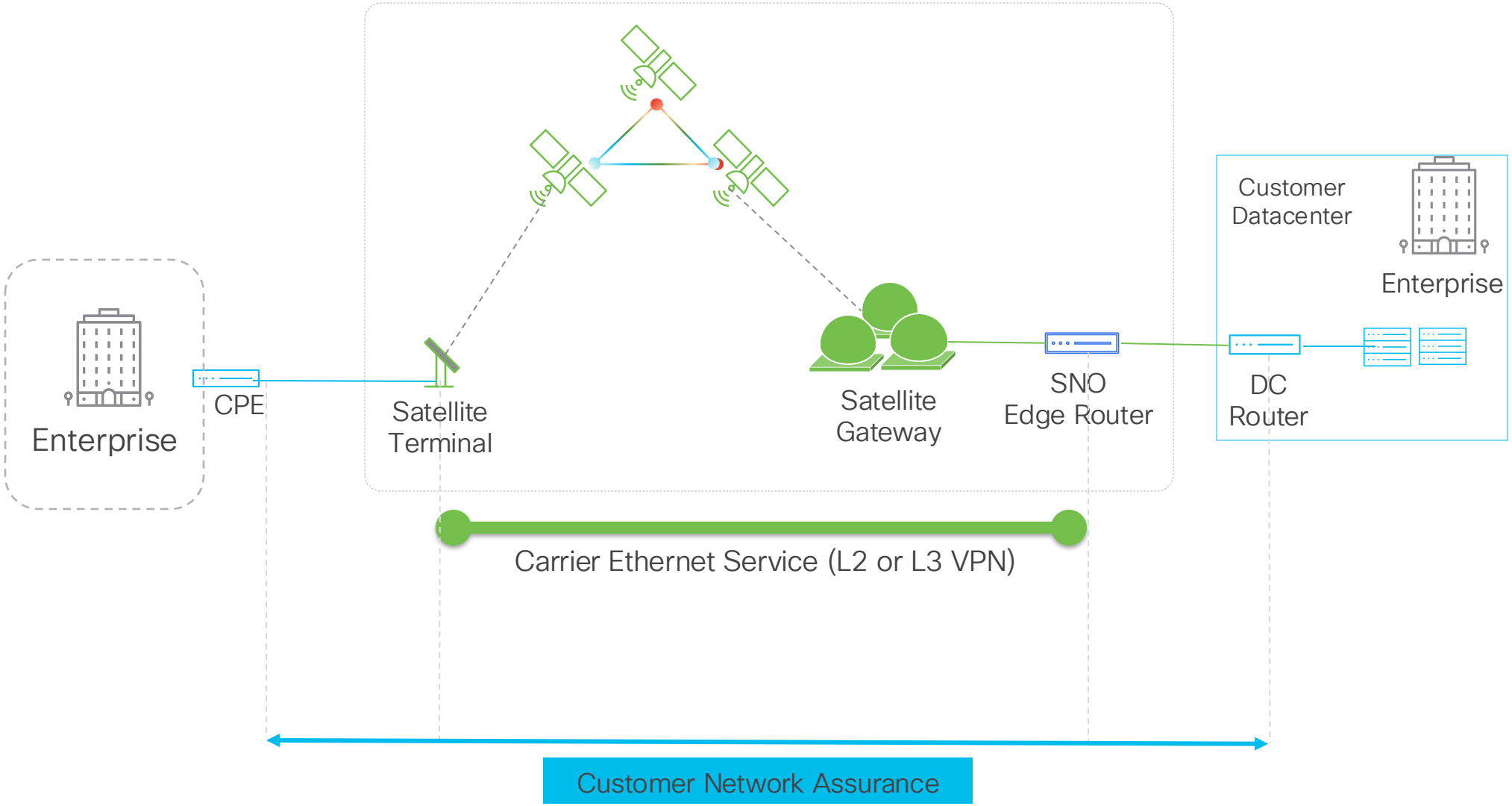
Of course, there is always more to it than that ...

Finished the initial installation
as night fell in Vancouver, BC ...



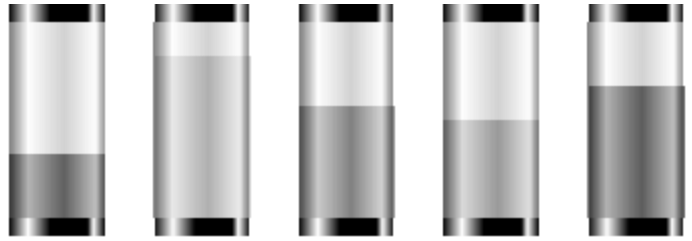
MEF L2 for Enterprise Connectivity

SNO Satellite Network Operator



Methodology

- Tested upload/download speeds using **Ookla's Speedtest**
  - Captured 15 Speedtest measurements per agent (fair use, controlled test number/frequency)
  - Identified average values across 15 measurements
- **Deployed 6 iPerf servers around the globe within GCP**:
  - 3 in United States: US East (Virginia), US Central (Iowa), US West (Oregon)
  - 2 in Europe: EU East (London, UK), EU Central (Frankfurt, Germany)
  - 1 in Australia: AU East (Sydney, Australia)
- iPerf Server locations were selected based on proximity to Starlink POPs
- Each of iPerf servers had 1Gbps+ ingress/egress connectivity (as per GCP instance selection)
- **Sustained throughput measurements using iPerf3:**
  - 7200 data points (2 hours)
  - Tested download/upload separately
  - Each agent deployed behind Starlink tested to/from every iPerf server within the continent
- Tests conducted using TCP



Speedtest Results: Europe

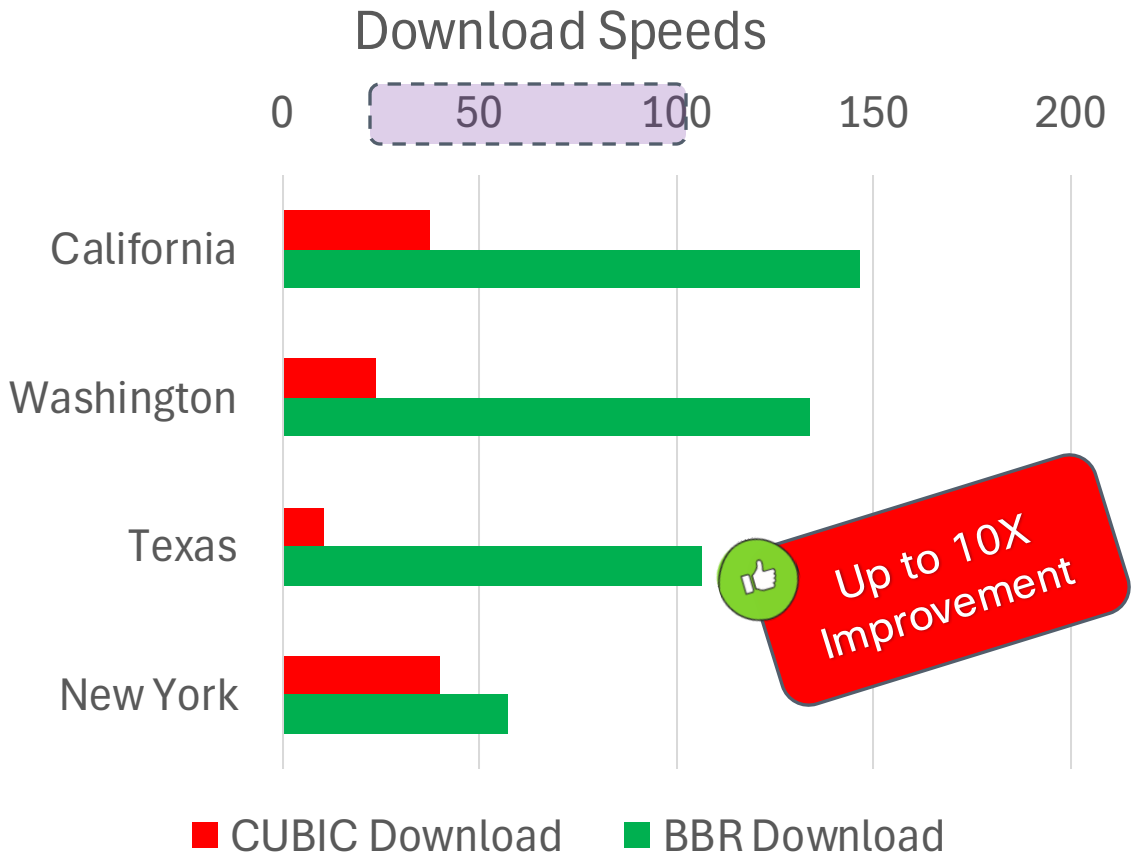
Location	Download	Upload	Latency
Jaen, Spain	261.688 Mbps	32.840 Mbps	33.061 ms
Weinstadt, Germany	74.111 Mbps	12.063 Mbps	38.508 ms
Bakewell, United Kingdom	134.602 Mbps	18.470 Mbps	31.925 ms
Epe, Netherlands	157.409 Mbps	21.838 Mbps	36.142 ms
Stockholm, Sweden	164.968 Mbps	17.139 Mbps	56.662 ms
Klek, Croatia	106.350 Mbps	16.133 Mbps	45.633 ms

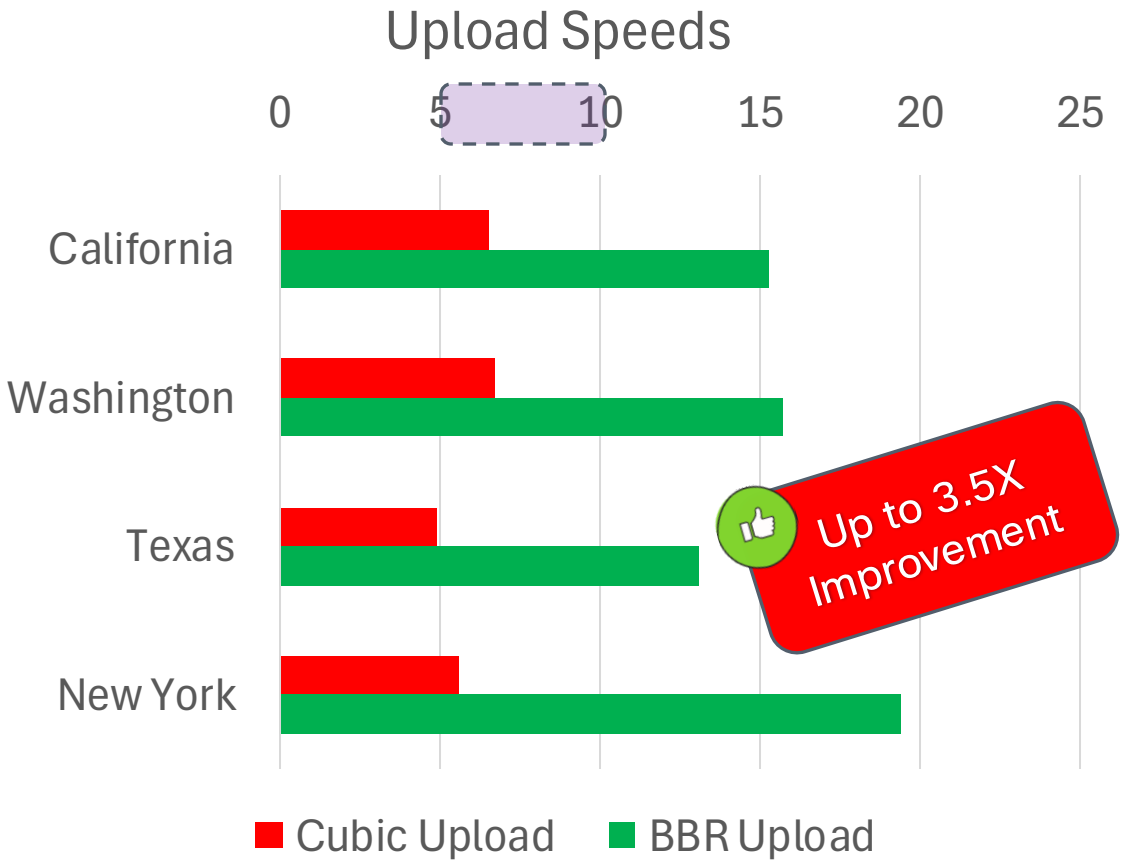
Speedtest Results: United States

Location	Download	Upload	Latency
San Francisco, California	156.109 Mbps	17.840 Mbps	29.412 ms
North Bend, Washington	124.667 Mbps	12.374 Mbps	30.637 ms
Georgetown, Texas	111.875 Mbps	12.703 Mbps	25.519 ms
Selkirk, New York	220.374 Mbps	33.184 Mbps	22.046 ms

Average Download/Upload speeds and Latency across 15 measurements

US West: Comparison between BBR and CUBIC





Average Download/Upload speeds across 7200 data points to/from US West using iPerf

Advertised speeds

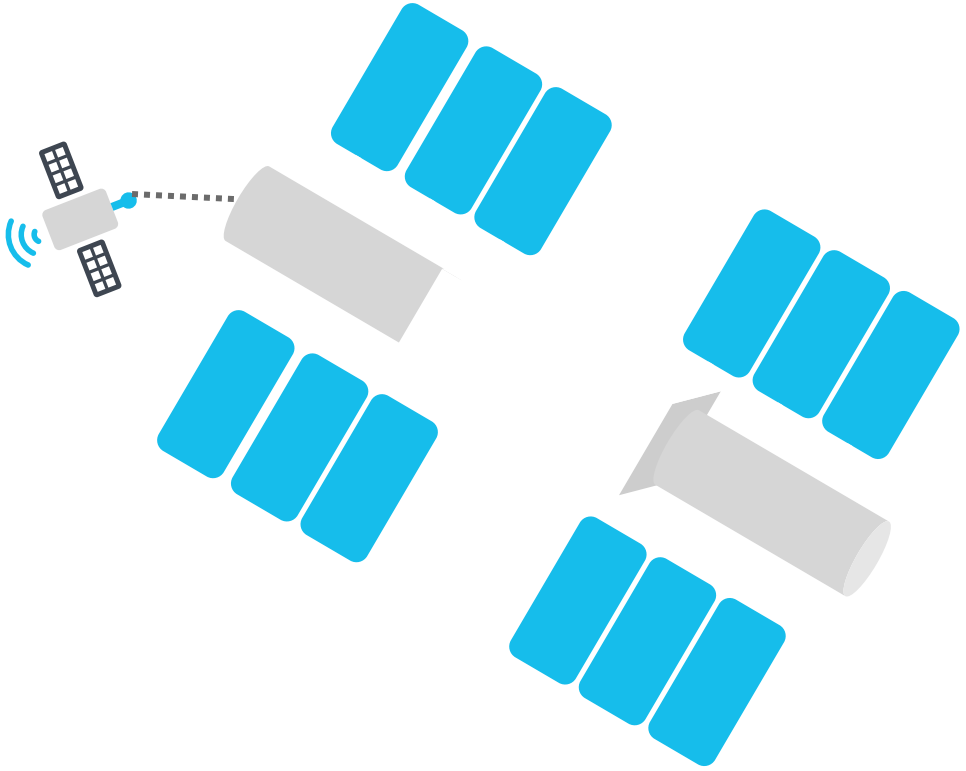
Starlink and Microsoft Azure Bring You Azure Space

Microsoft teams up with SpaceX to launch Azure Space to bring cloud computing into the final frontier

By Chelsea Gohd October 21, 2020

- Azure Modular Data Centre
- Self-contained
- Deployable Anywhere
- For remote connectivity or expansion of existing

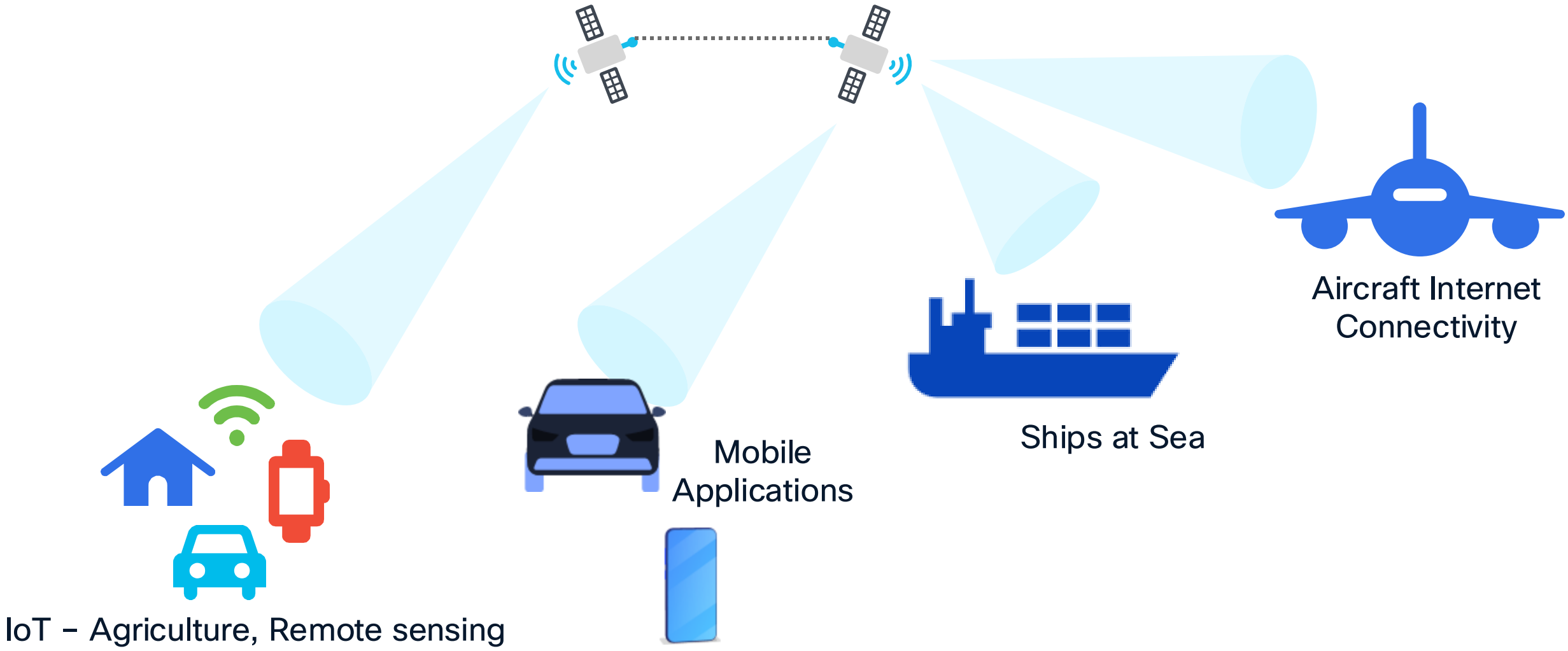
Edge Computing in Space



Possibility: Edge Compute on ISS
LEO ~408 km orbit

What goes up, doesn't necessarily have to come down…

The LEOsat Revolution – Unlimited Use Cases




CISCO