the 5th epoch series
from c21-virtual

Inflight Connectivity

A Paradigm Shift with LEO

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ANUVU

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Prior to joining Anuvu, Karl worked at Hughes Network Systems, O3b Networks and a submarine cable company. Has more than 30 years of experience in satellite communications. Karl has been at Anuvu for more than 10 years and been intimately involved in the IFC products and services offered by Anuvu.

Synopsis

In the past 2 years, traditional GEO based IFC solutions have been dramatically challenged by Ku band LEO solutions. In the next 2 years, there will be a further paradigm shift with new Ka band LEO constellations coming online.

Likewise, the IFC equipment has also changed, but there are still questions related to reliability of flat panel and ESA technologies that remain. An overview of these technologies another impacts to be discussed

Agenda slide

1. Anuvu
2. IFC Overview
3. Satellite Network
4. Hardware
5. Portal & Software
6. Paradigm Shift

About Anuvu

A few of our clients

750+ team members worldwide

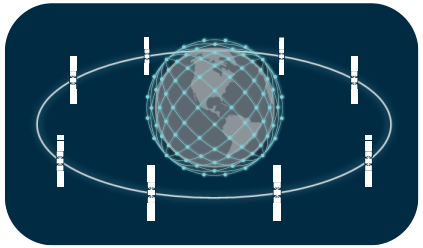
$400M+ in revenue

~50% IFE market share

1,000+ connected aircraft

80% cruise cabin TV/media market share

We’re the only provider with the expertise to provide **connectivity** and **entertainment.**



NETWORK PIONEERS

- Hybrid network GEO, LEO
- Advanced ground infrastructure
- Modern and agile satellites
- Redundancy and reliability

END-USER FOCUSED

- Passenger payment portals
- Modern GUI interfaces
- High speed, uninterrupted Wi-Fi

SERVICES

- Live TV, Movies, TVOD, games, apps, audio
- Network management
- Analytics
- Customer support 24/7

CUSTOM-TO-YOU

- Business strategy
- Customized approach
- Advisory and consultancy services

Only full-service operator for IFEC

End-User

- Passenger Wi-Fi
- Onboard entertainment
- Passenger portal
- Ancillary revenue
- Crew welfare

Services

- Business strategy
- Network mgmt.
- Media & content
- Data analysis
- 24/7/365 support

Hardware

- Flexible onboard shipset

Software

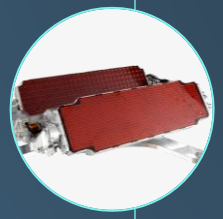
- IFE digital supply chain
- Cloud based-content services
- Data analysis
- Passenger portal
- Connectivity system

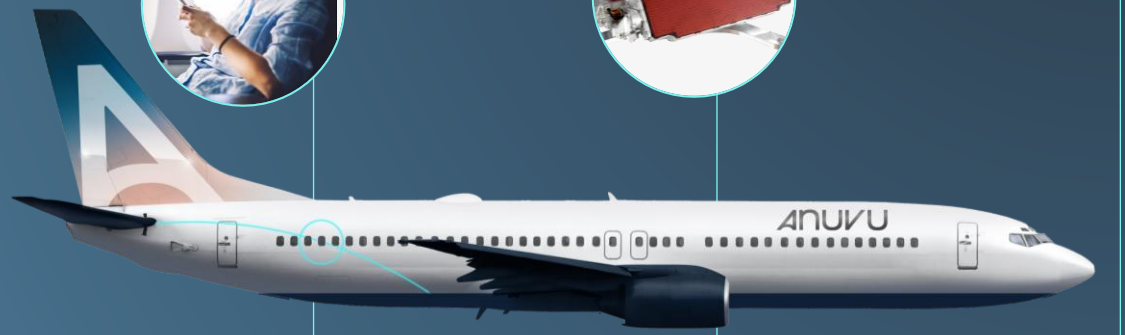
Ground Network

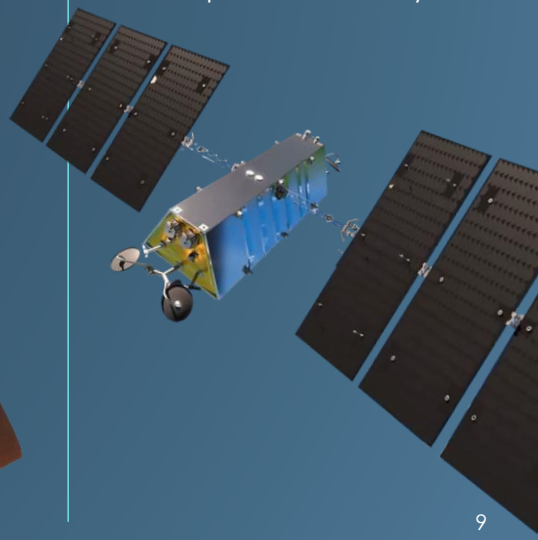
- 22 active teleports
- 2 owned teleports
- Renowned security

Satellite Connectivity

- Hybrid GEO, MEO, future LEO & HEO network
- Ku, Ka, C band
- Anuvu Constellation with microGEOs
- 50+satellites in operation today







IFC Overview

Questions airlines should be asking when assessing IFC provider network offerings

As a satellite system agnostic integrator, we consider the following when evaluating satellites and satellite partners for inflight connectivity applications

Coverage	Does the constellation cover all current and expected flight routes?
Capacity	What is the total network capacity available?
Focus City Performance	What are the peak & minimum capacity levels around major airports?
Regulatory Factors	What priority or interference issues prevent the provider from utilizing the full network?

Resiliency (Ground & Space)	What are the sources of ground and satellite disruption? What are the single points of failure?
Architecture (Open or Closed)	Does the system integrate with third party tools, or does a closed vertical architecture restrict interoperability?
Flexibility	Does the provider allow multiple service offers

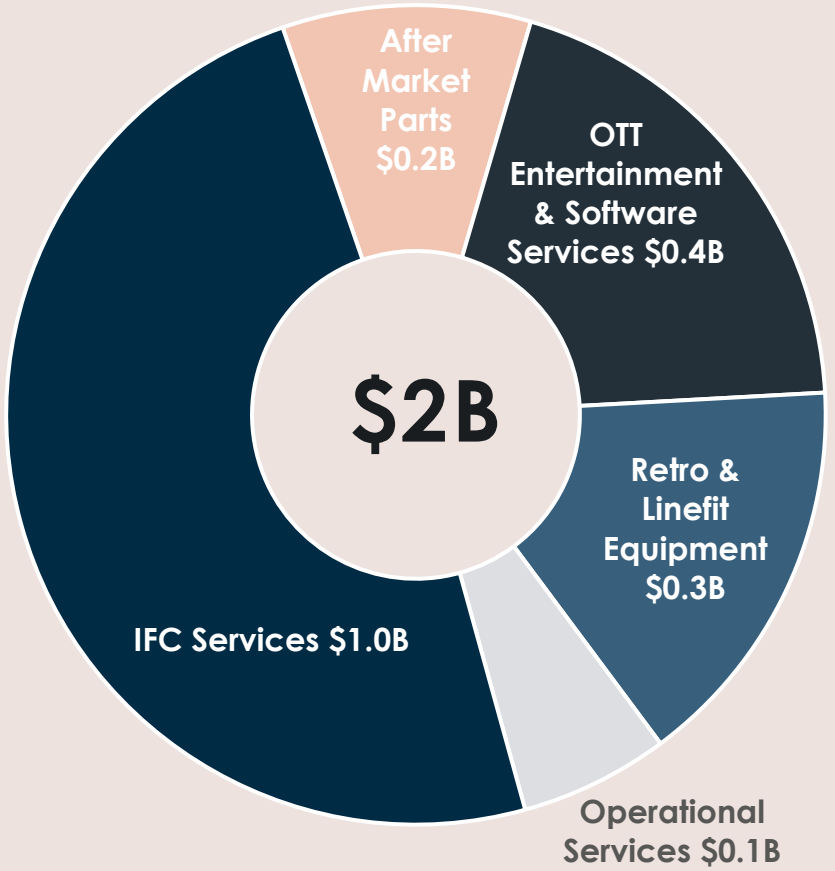
EXPANSION IN SHORT-HAUL SEGMENT AND MIGRATION TO FREE WI-FI

IFC: Market Growth Drivers

- **Connectivity now 'Table Stakes'**
  - Passengers demand reliable, fast WiFi – critical to satisfaction scores
  - Integration of connectivity into aircraft systems with real-time data transfer
- **Expansion Into Low-Cost and Regional Airlines**
  - Focus on ancillary revenue generation opportunities
  - Drive efficiency improvements in airline operations
- **Passenger Demand and Usage**
  - **Work:** Wi-Fi use for email, meetings, and other tasks
  - **Entertainment:** Digital media streaming via OTT personal devises
  - Advertising and sponsorship opportunities for entertainment over connectivity
- **Transition to Free Wi-fi**
  - Additional differentiation; expected by premium passengers
  - Will increase bandwidth requirements onboard
- **Expansion Through Fleet Growth**
  - Acceleration in new aircraft builds and deliveries
  - Will increase bandwidth requirements onboard

Source: Stratview research As of Dec-24

IFC Services Market (2025)



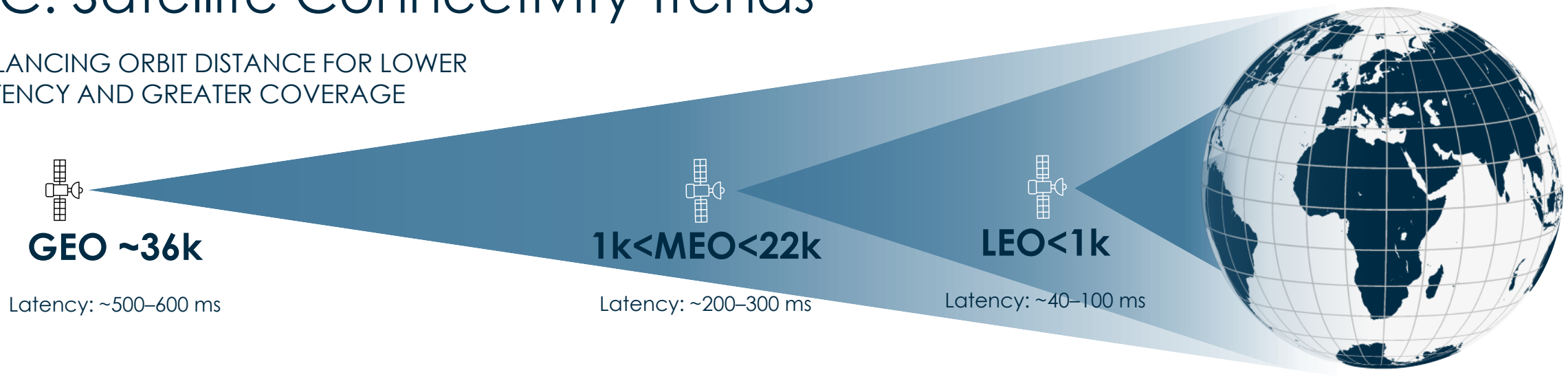
(USD, Billions)

Satellite Networks

SATELLITE NETWORKS

IFC: Satellite Connectivity Trends

BALANCING ORBIT DISTANCE FOR LOWER LATENCY AND GREATER COVERAGE



GEO

- Dominant communications satellite orbit today
- Optimal coverage for most frequent routes
- Regulatory clearance in most industrialized geographies
- High reliability but distance-based latency limits certain types of applications

MEO

- Reduces distance-based latency by 50% from GEO
- Reduced satellite count compared to LEO
- Better coverage compared to LEO, but lower capacity over specific points
- Still sensitive to specific latency requirements

LEO

- Constellations from Starlink, Telesat, OneWeb, SpaceSail and Kuiper
- Low latency to more closely mimic "home" experience
- Highest cost for constellation deployment – limited pool of competitors by 2030
- Regulatory factors limit use over specific geographies; congestion in major metros

Multi-Platform

- Some airlines adopting LEO; regulatory and technical limitations may limit usage
- Hybrid models provides best combination of coverage, performance and cost
- Airlines need service integrators for last-mile delivery of complex multi-orbit solutions

Multi-orbit or GEO or LEO - a latency experience ?

EVERYTHING IS SNAPPIER WITH LEO – IT'S ALL ABOUT THE LATENCY

Data from actual testing of Telesat Lightspeed demonstration satellite

CNN

277% faster

Amazon

1400% faster

Airline Website

567% faster

Oracle:
Approve Invoice

133% faster

Sharepoint: Save
3MB PowerPoint

875% faster

Minecraft: Load
& Chop First Tree

925% faster

Send 3 MB Email

267% faster

Receive 3 MB Email

80% faster

SATELLITE NETWORKS

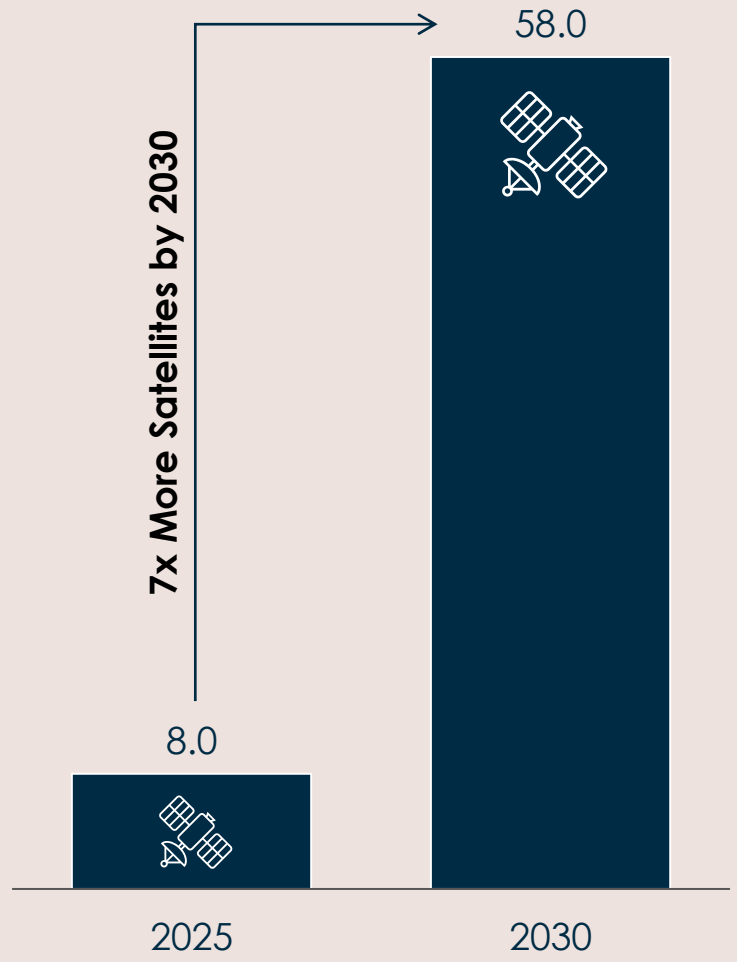
IFC: Growing Integrator Opportunity

- **LEO OPERATORS SPECIALIZE IN GLOBAL NETWORKS, NOT LAST-MILE DELIVERY**

- **LEO operators launching petabytes of capacity through 2030, focusing on global sales through direct and reseller models**
  - Airlines require aircraft-level integration and cabin capabilities
  - Service must be reliable across geographies and passenger demand
- **Last-Mile Integration Critical for Airline Service Delivery**
  - LEO brings faster data capability – airlines need accountability
  - Aircraft installations and performance can differ by sub-fleets
  - Passenger log-in and throughput levels need monitoring
  - Airlines need framework for monetization and loyalty integration
- **IFC suited to integrate with new LEO networks**
  - Global footprint – local teams and capabilities from Americas to Asia
  - In-house engineering, network software and passenger delivery
  - Analytics platform for real-time monitoring and management
  - IP-level expertise to leverage multiple networks

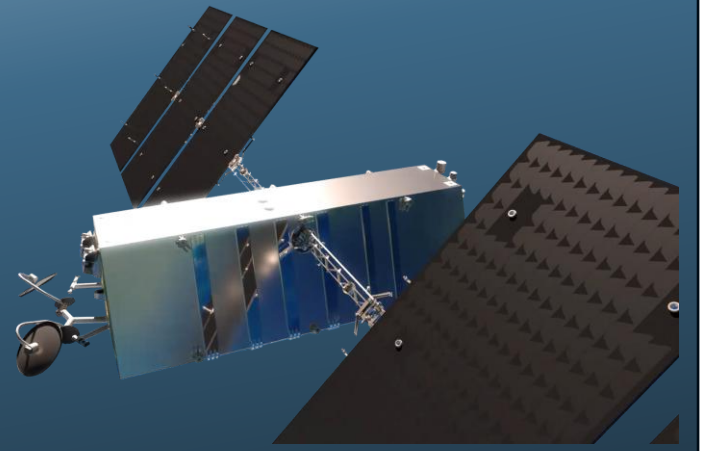
Source: Market research, GAO (Gov Accountability Office)

LEO Satellite Deployments

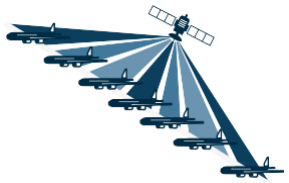


(Units in Thousands)

LEO for Fiber-like Experience – Lightspeed for IFC

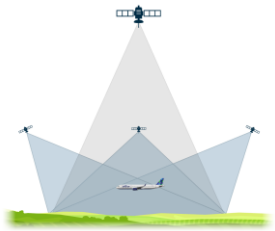


HIGH THROUGHPUT



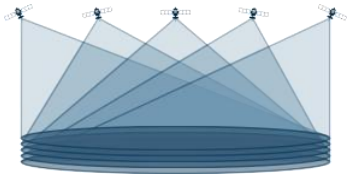
- Hundreds of dedicated Mbps to each plane
- Scalable network by design
- 3x higher upload speed from the plane vs. GEO/MEO
- 8x more overall upload capacity

LOW LATENCY



- < 50 ms
- Cloud and business VPN
- Fast social media, heavy web pages; real-time operations data

CONCENTRATED CAPACITY

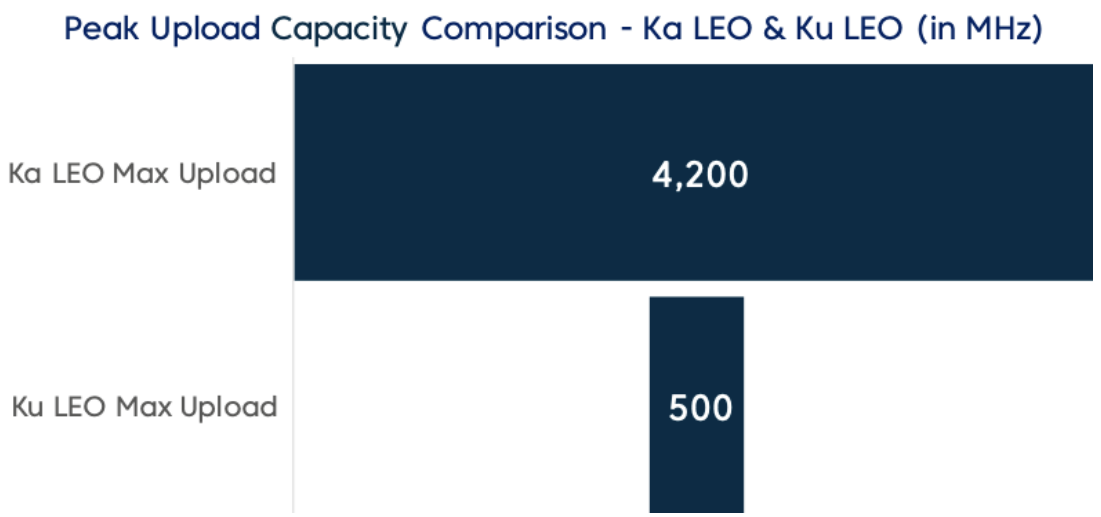


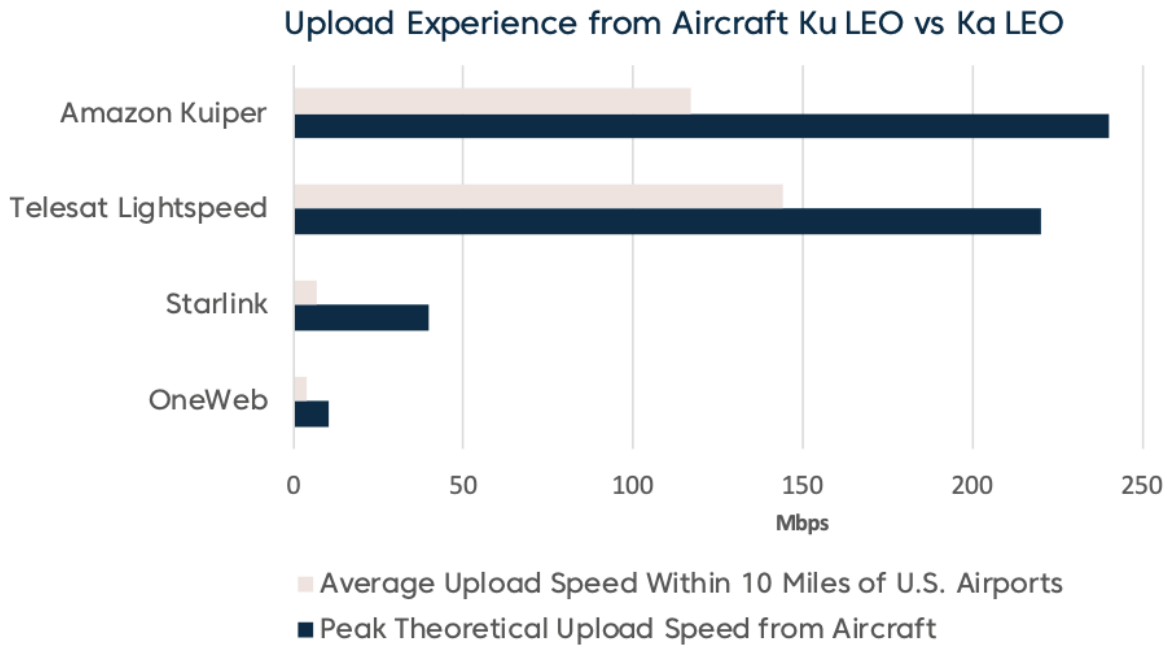
- Tens of Gbps concentrated around busiest airports
- Anuvu NMS enables hybrid GEO/LEO use
- Doesn't compete with consumer applications

FULL GLOBAL COVERAGE

- Pole-to-pole coverage
- Consistent service across entire long-haul flight routes
- Full oceanic coverage; **No gaps—at all**

LEO network offers improved upload capability





LEO solutions that offer full service level availability (SLA) guarantees

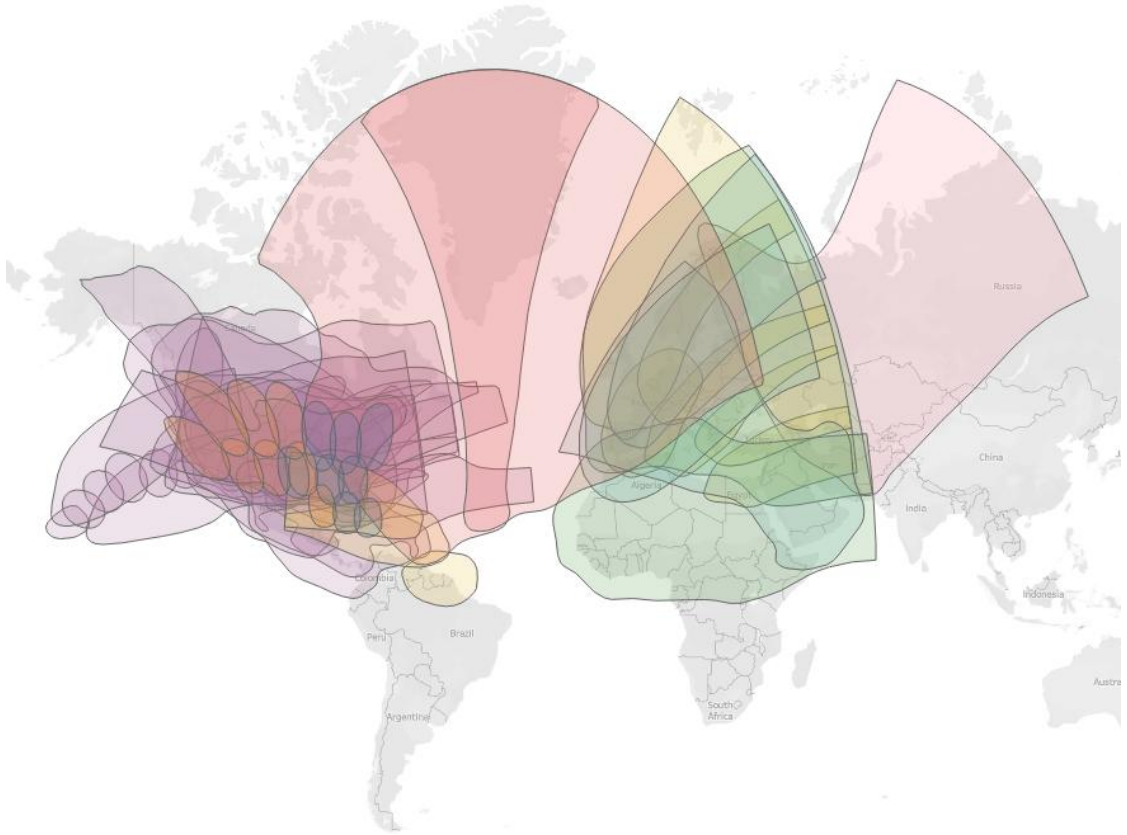
Social media and business apps need more upload: GEO and Ku-LEO suffer an upload bottleneck

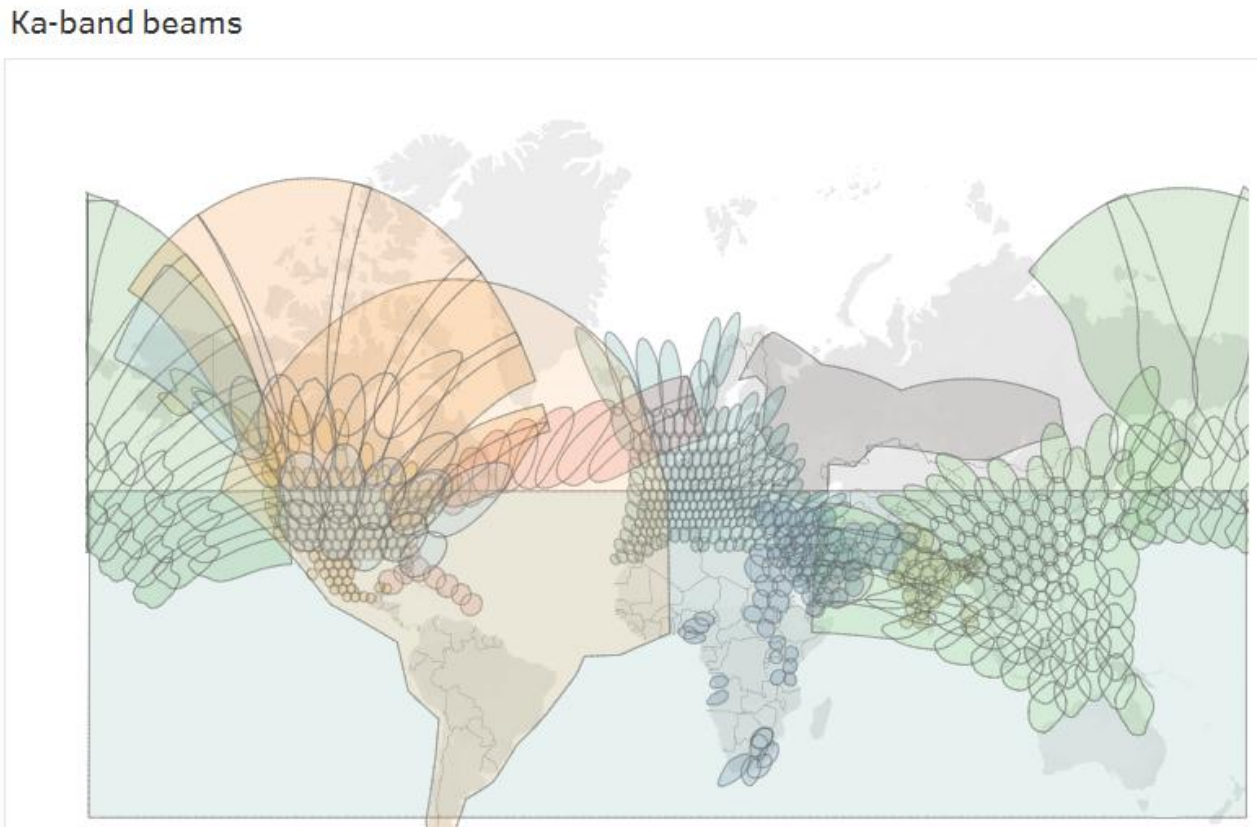
Upload trending higher every year: 1:8 upload to download ratio in 2015, now 1:2.5

Ka LEO meets the need: Lightspeed and Amazon LEO use the Ka-band and two polarities

Future-ready: Upload to download ratio expected to be 1:2 by 2027

Typical GEO Coverage for IFC requirements





SATELLITE NETWORKS

Ku LEO Constellations

Design

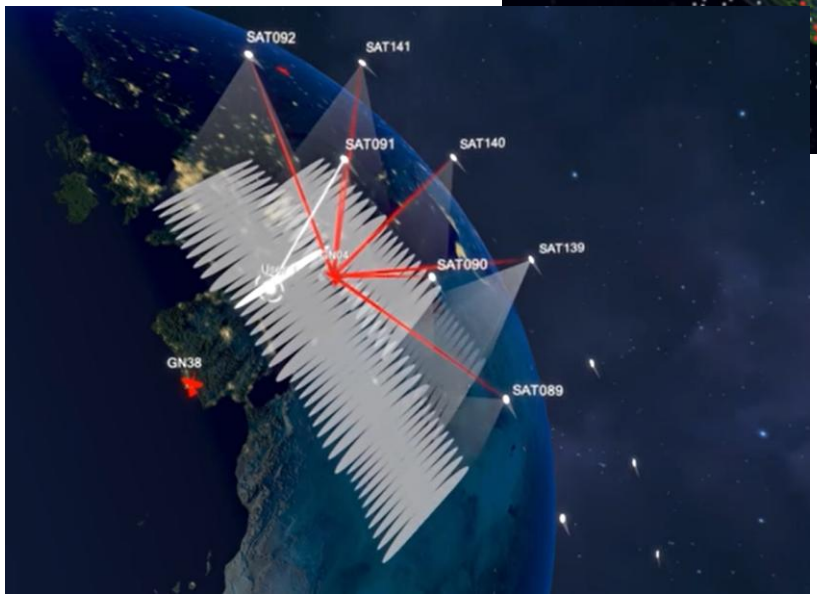
- 100s to 1,000s Satellites
- Ku Band
- Inter-satellite links (Starlink only)
- Multi-use
- Global Coverage

Strengths

- High data rate satellite links (Starlink)

Weakness

- Regulatory approvals
- Closed architecture
- Some have throughput limitations in certain geographic regions



SATELLITE NETWORKS

Ka LEO Constellations

Design

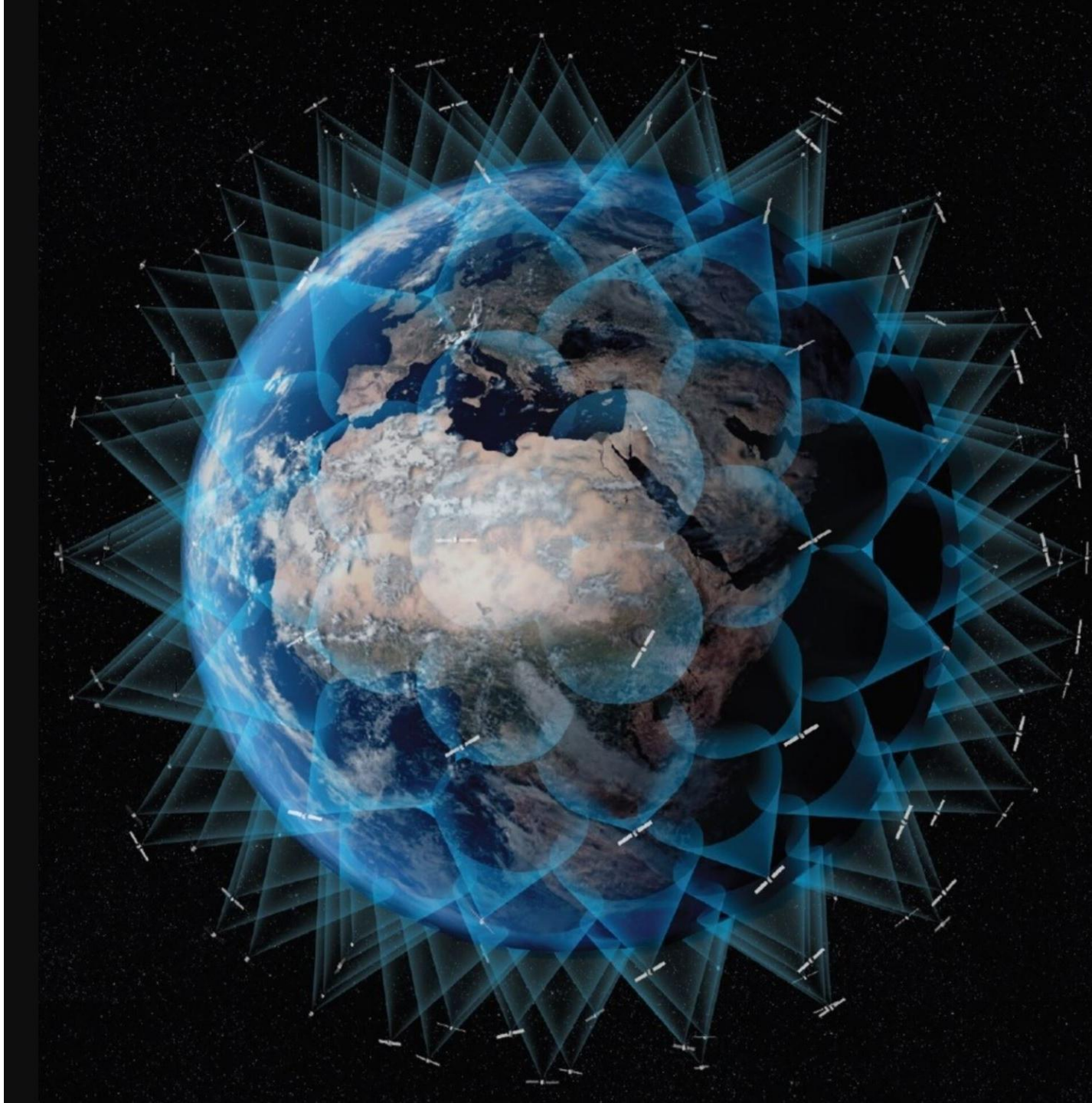
- 100s to 1,000s Satellites
- Ka Band
- Inter-satellite links
- Multi-use
- Global Coverage

Strengths

- High data rate satellite links
- Carrier grade services
- Open Architecture

Weakness

- Regulatory approvals



SATELLITE NETWORKS

LEO & MEO Constellations

Design

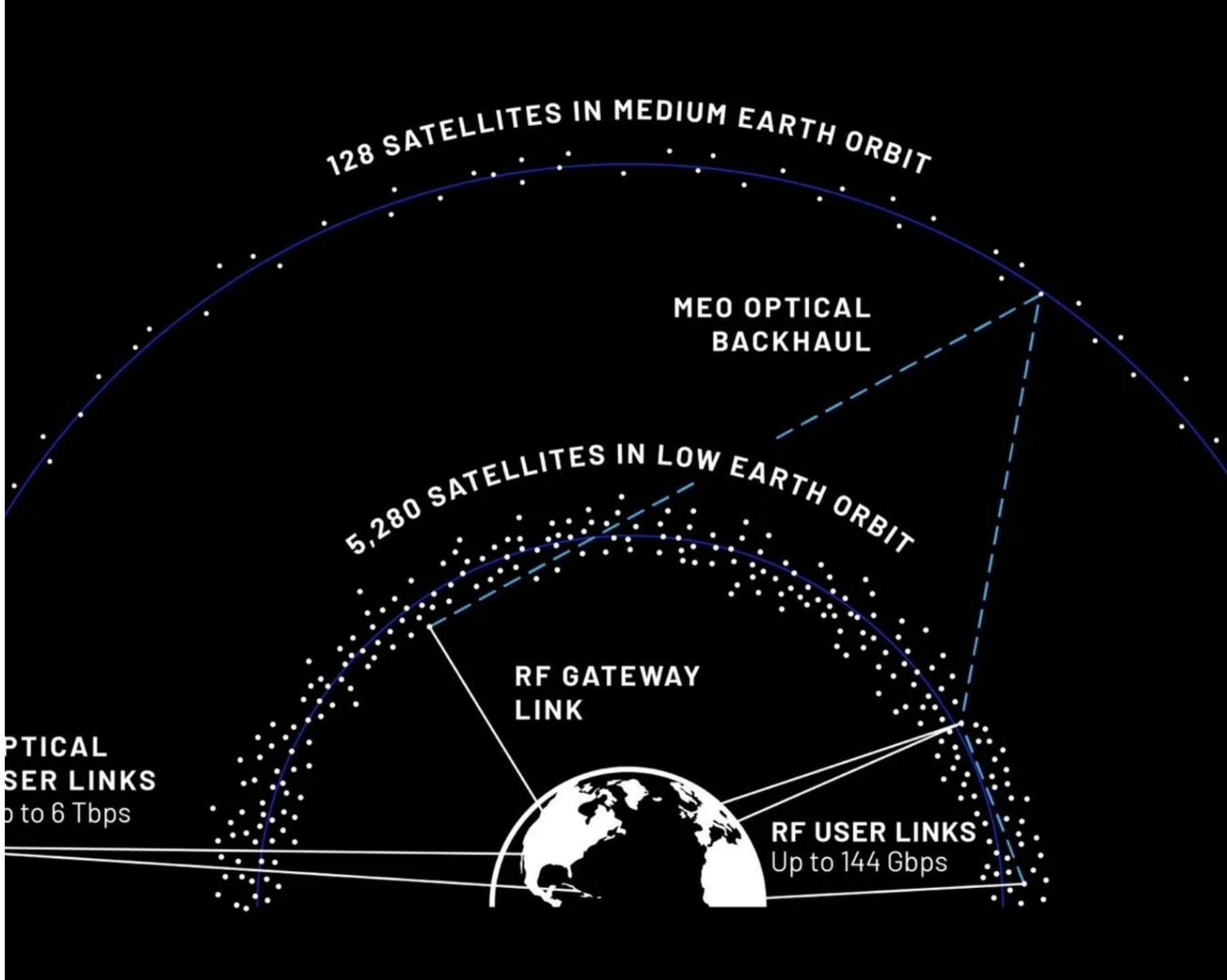
- 100s to 1,000s Satellites
- Q/V Band & Optical
- Inter-satellite links
- Multi-use
- Global Coverage

Strengths

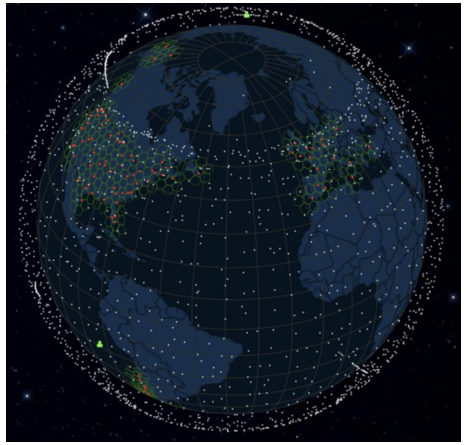
- High data rate satellite links

Weakness

- Regulatory approvals
- Execution risk

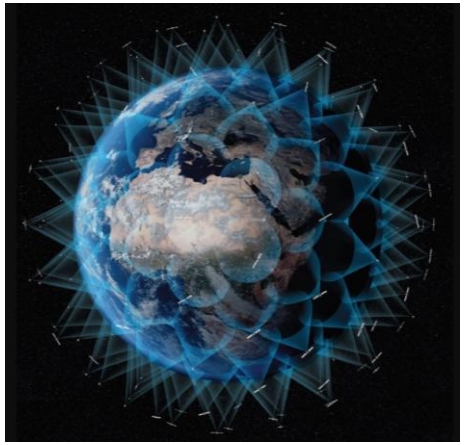


Looking ahead



Ku Band LEOs

Current Ku band LEO Constellations have a first mover advantage with Starlink taking the lion share



Ka Band LEOs

Next generation Ka Band LEO networks (Amazon LEO & Lightspeed) will offer significant more flexibility and data rates with Blue Origin Q/V Band and optical TeraWave also in play

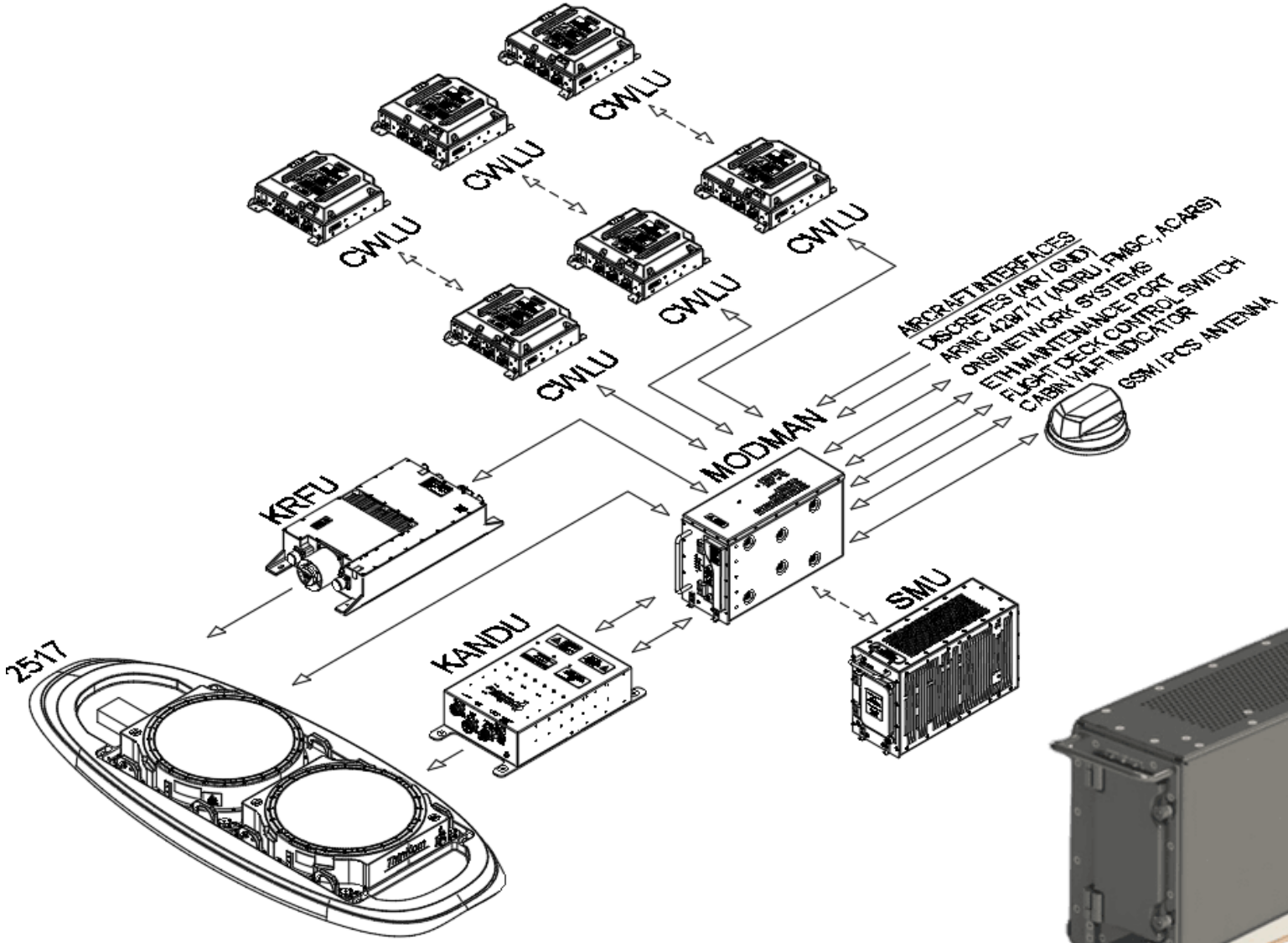
IFC Shift

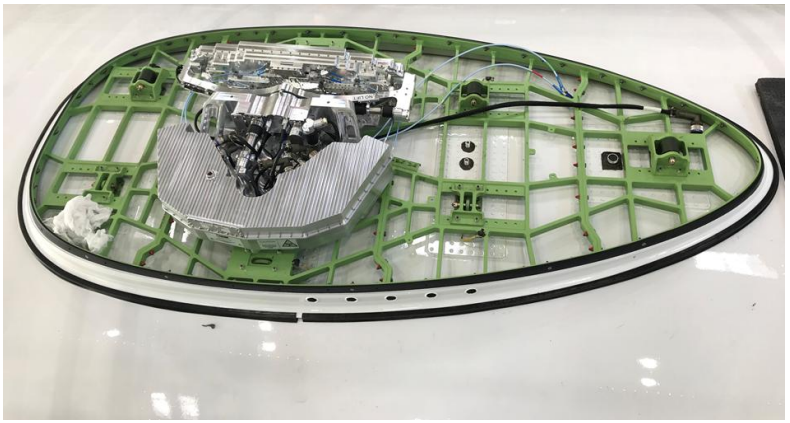
- Higher data rates
- Enterprise grade SLAs
- Cheaper
- Bundled with additional value propositions
- Open Architecture

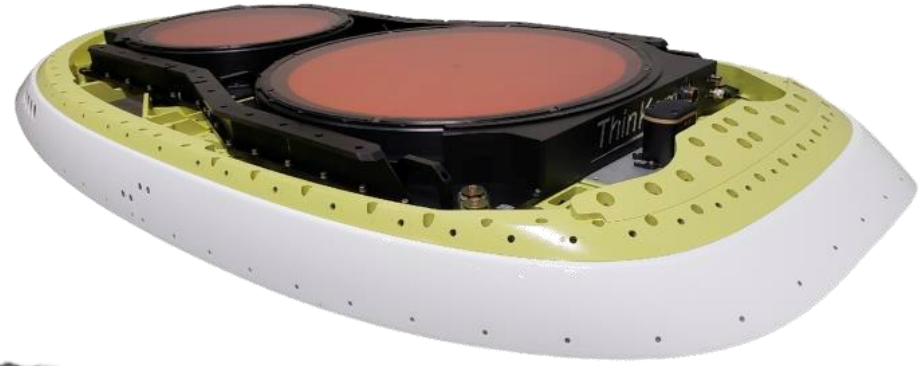
Hardware

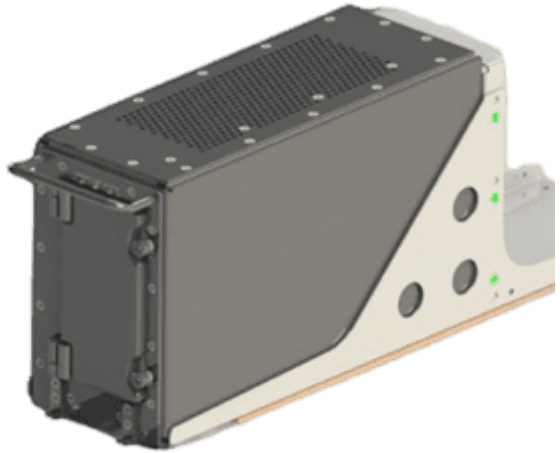
HARDWARE

Traditional GEO Hardware



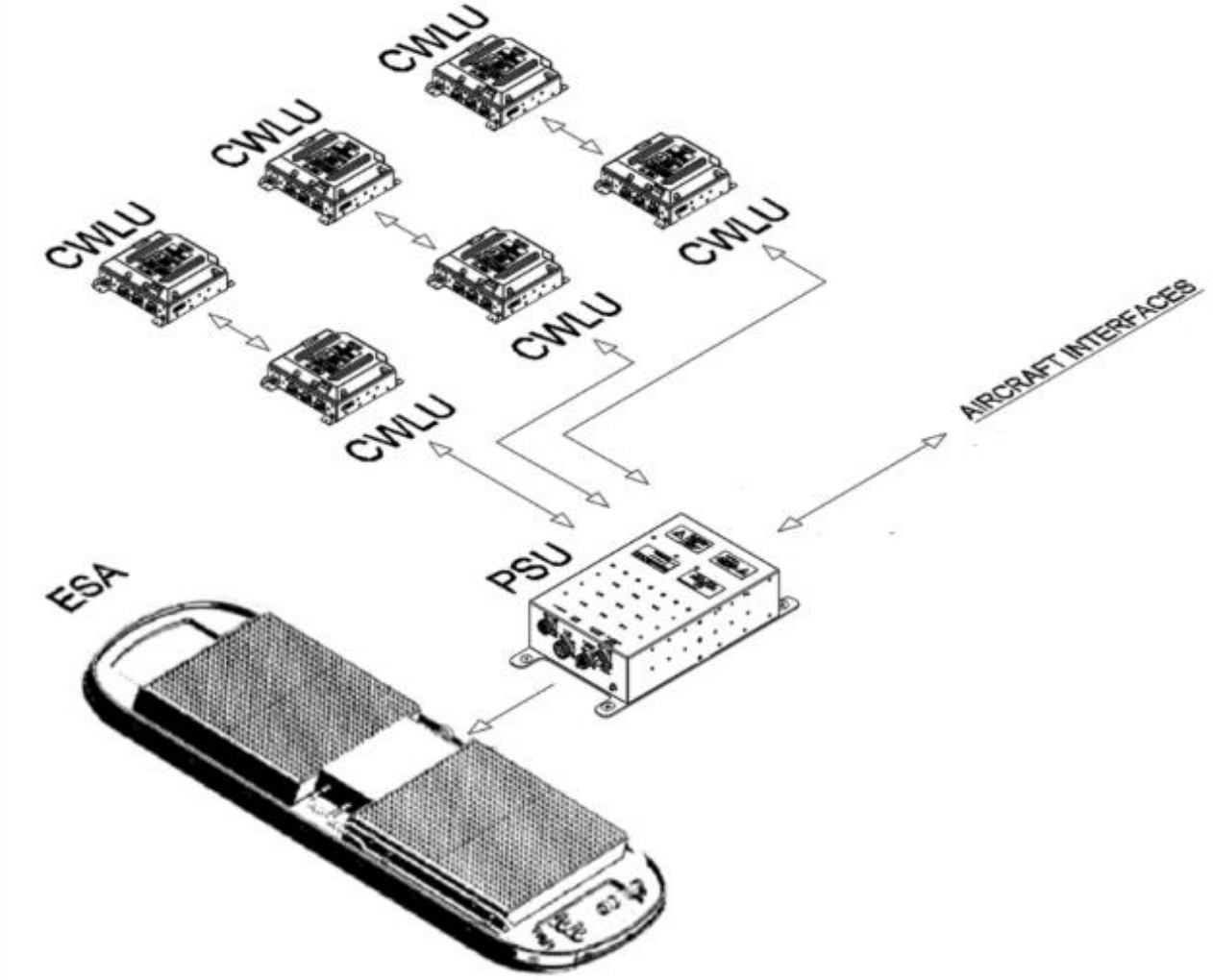


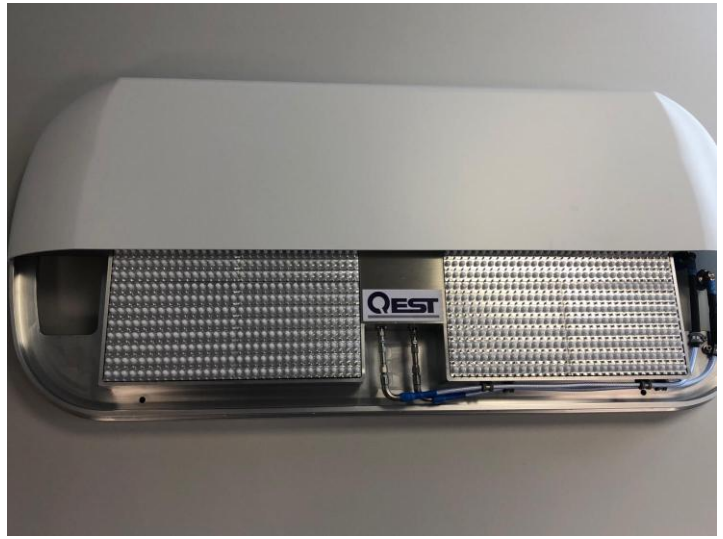




HARDWARE

LEO Hardware

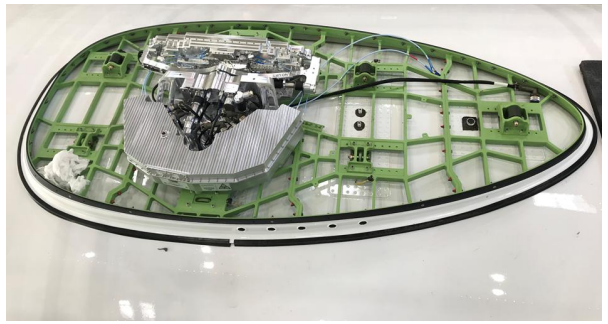


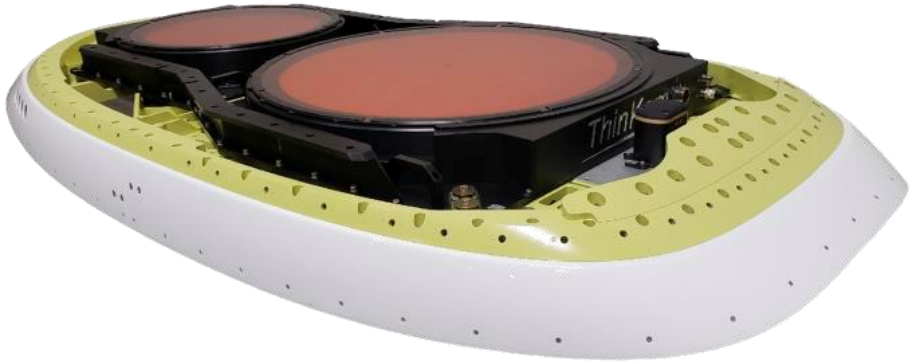


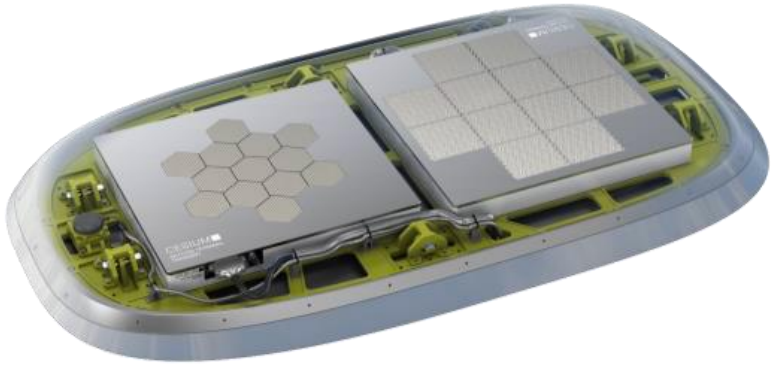
Access point configuration depends on the aircraft.

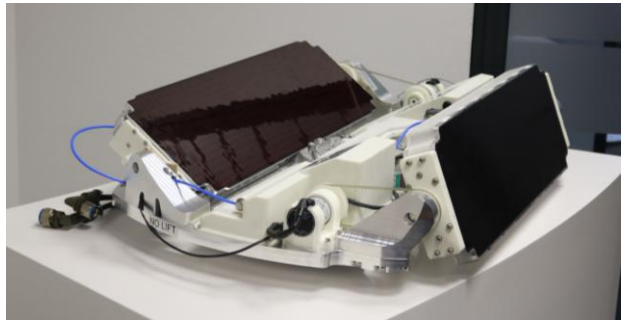
HARDWARE

IFC Satellite Antennas









- Deployment of antennas for multi-orbit
- Limitation of polarization
- Power usage (limitation for gate-to-gate
- Reliability

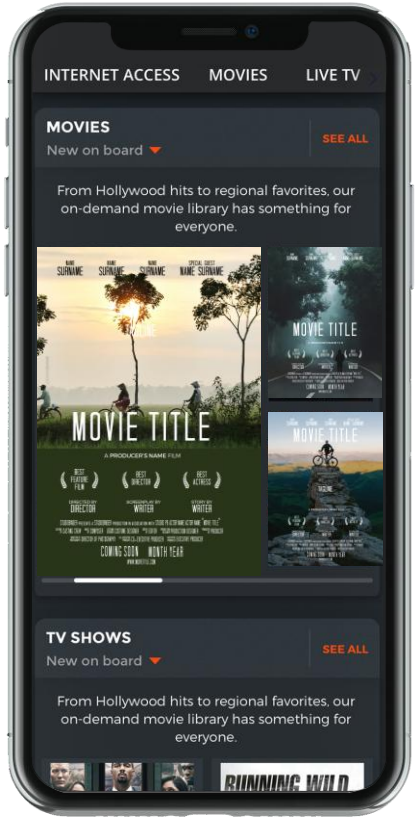
Portal & Software

PORTAL & SOFTWARE

Software

GEO

- Portal/GUI located on aircraft
- Latency causes significant performance issues for ground based portals
- Basing portal onboard requires onboard processing
- Adding complexity & cost



LEO

- Ground based Portal/GUI
- No latency performance issues
- Enables cloud based applications
- Removes need for compute onboard
- Reduces complexity & cost
- Opens opportunity for streaming applications

PORTAL & SOFTWARE

Paradigm shift

- Higher data rates
- More symmetric link
- Enterprise quality
- Simpler, cheaper shipsets
- Faster installation times
- Value added services
- Open architecture networks

Airlines passengers in for a huge change in onboard IFC experiences


AnTuTu