

Starlink: Advanced Networking and Security

cisco Live !

Andrew Benhase
Federal Architect, @CyberSecOps

Session ID: BRKSEC-2037

Cisco Webex App

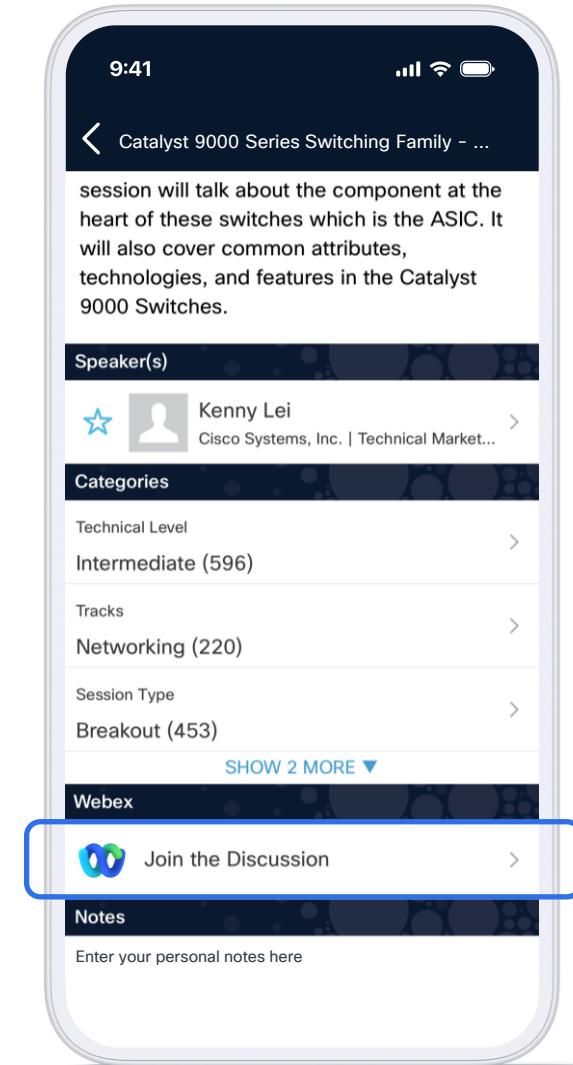
Questions?

Use Cisco Webex App to chat with the speaker after the session

How

- 1 Find this session in the Cisco Live Mobile App
- 2 Click “Join the Discussion”
- 3 Install the Webex App or go directly to the Webex space
- 4 Enter messages/questions in the Webex space

Webex spaces will be moderated by the speaker until 14 November 2025.



<https://ciscolive.ciscoevents.com/ciscolivebot/#BRKSEC-2037>

Agenda

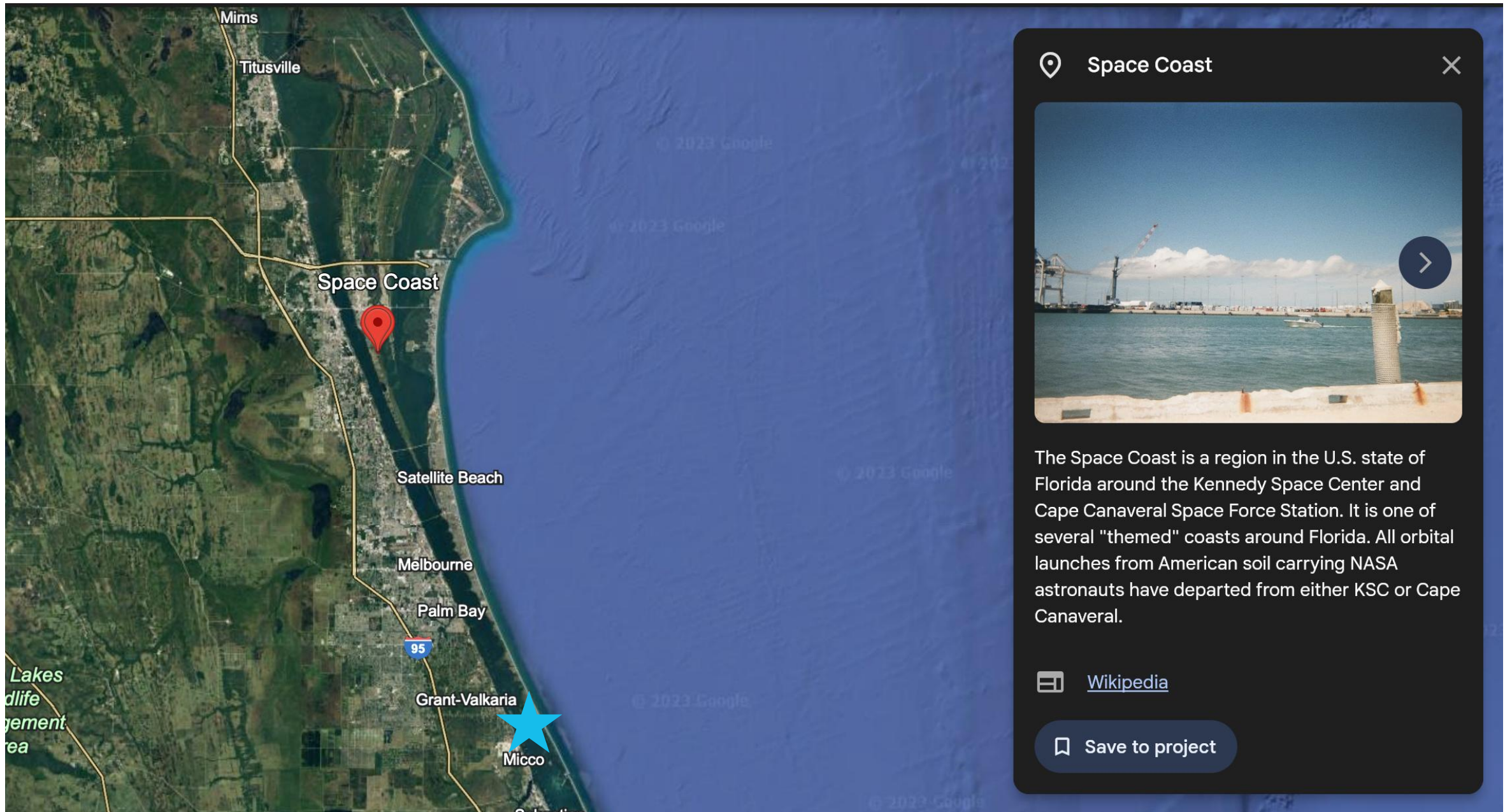
- 01 Catch up on current events
- 02 What is Starlink
- 03 Starlink Security
- 04 Deployment Models
- 05 Thousand Eyes and Network Performance
- 06 Theater Based Concerns
- 07 Quantum Updates
- 08 Direct to Cell
- 09 **SDWAN**

What I do here @cisco

- Federal Security Architect
- At Cisco >24 years, supporting US Federal Government
- 32 years primarily supporting US Defense, Civilian and Intelligence Communities
- Deep focus on defensive cyber operations, advanced encryption, making security work!
- My first Networkers was in 1995...
- <https://www.linkedin.com/in/andrewbenhase/>



@CyberSecOps
@ThreatCowboy
abenhase@cisco.com



Space Coast



The Space Coast is a region in the U.S. state of Florida around the Kennedy Space Center and Cape Canaveral Space Force Station. It is one of several "themed" coasts around Florida. All orbital launches from American soil carrying NASA astronauts have departed from either KSC or Cape Canaveral.



[Wikipedia](#)



Save to project





Latest News Updates (since last year)

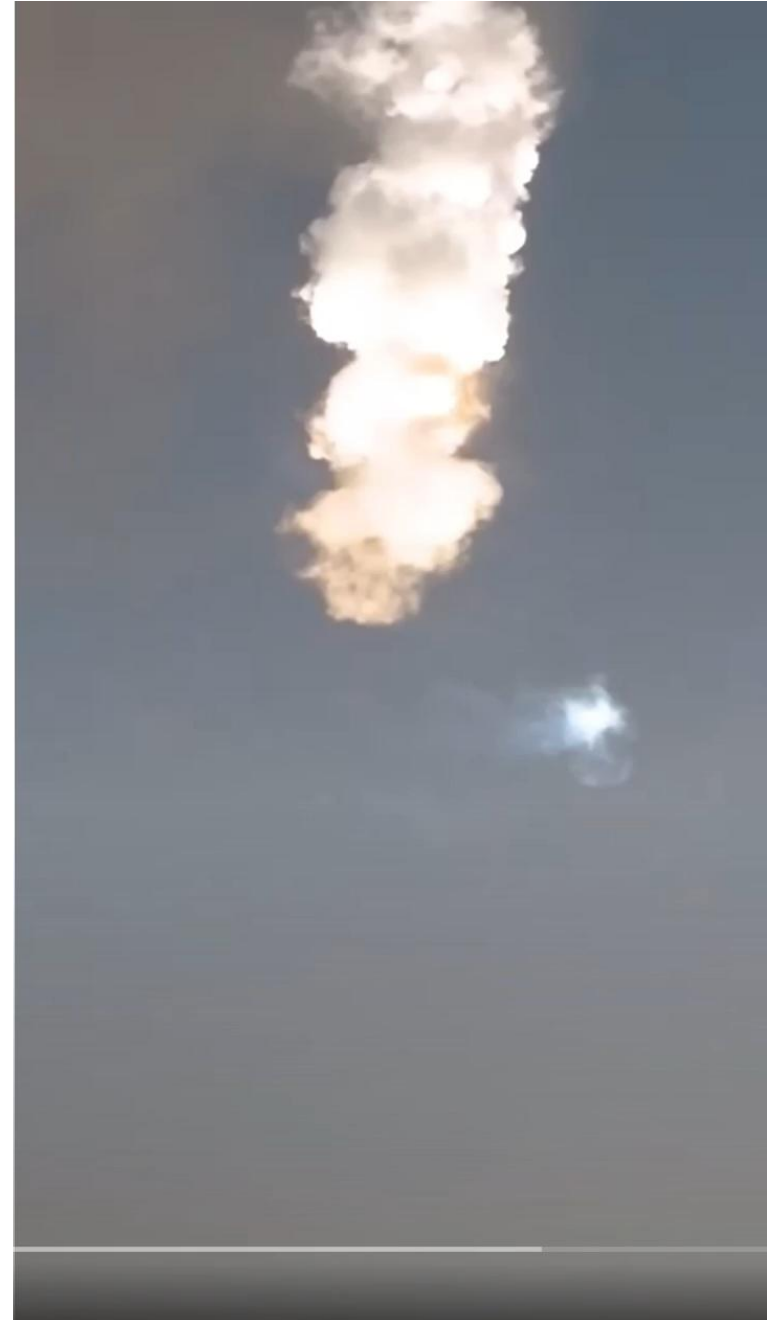
Things with Starship



Why does Starship matter so much?



Starship Booster Capture





13:07 5G

We call them “V2 Mini”. They represent a step forward in Starlink capability



12:37 · 2/26/23 · 843K Views

6,931 Likes 815 Retweets 91 Quotes

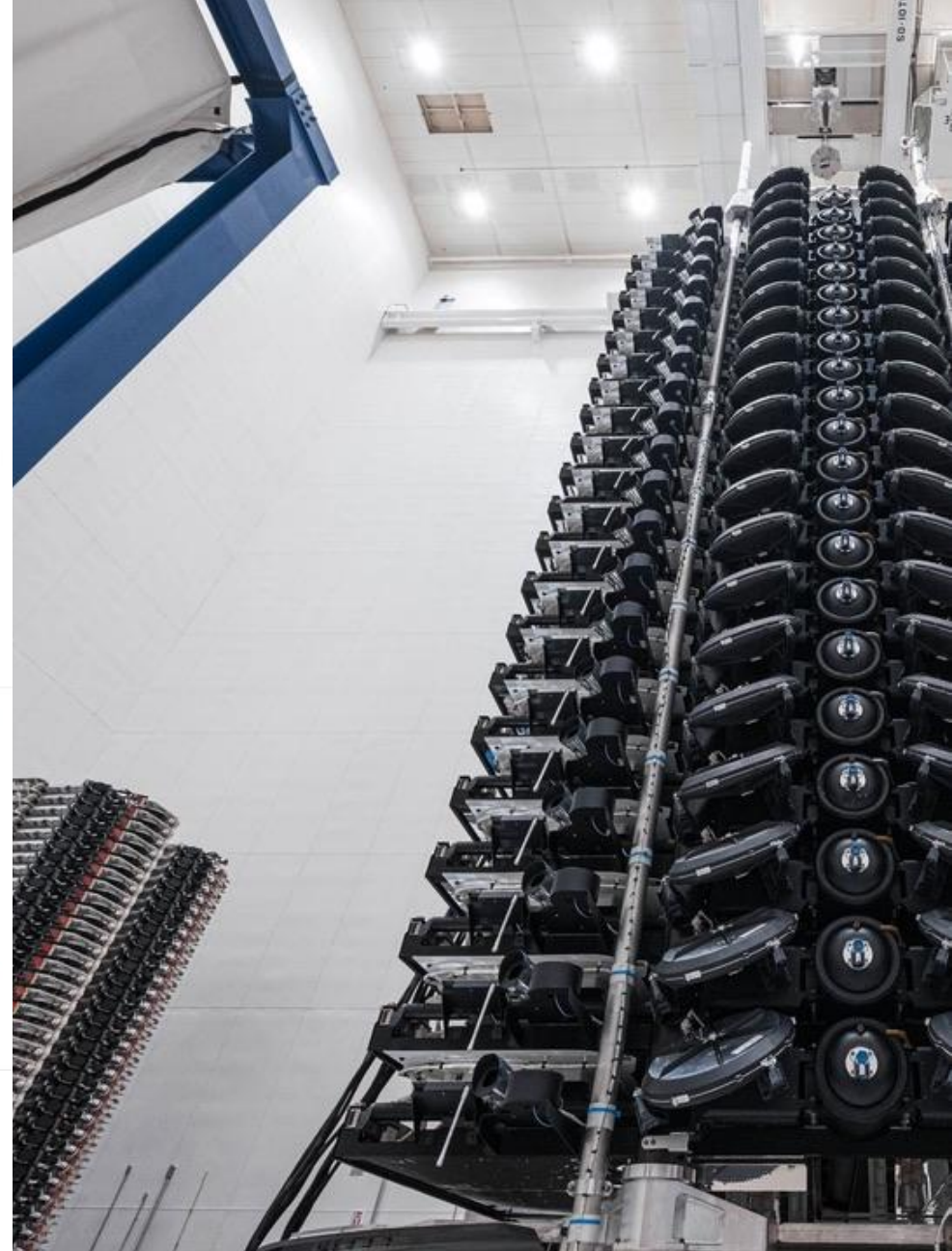
 **SpaceX** @SpaceX · 29m
V2 minis include key technologies—such as more powerful phased array antennas and the use of E-band for backhaul—which will allow Starlink to provide ~4x more capacity per satellite than earlier iterations

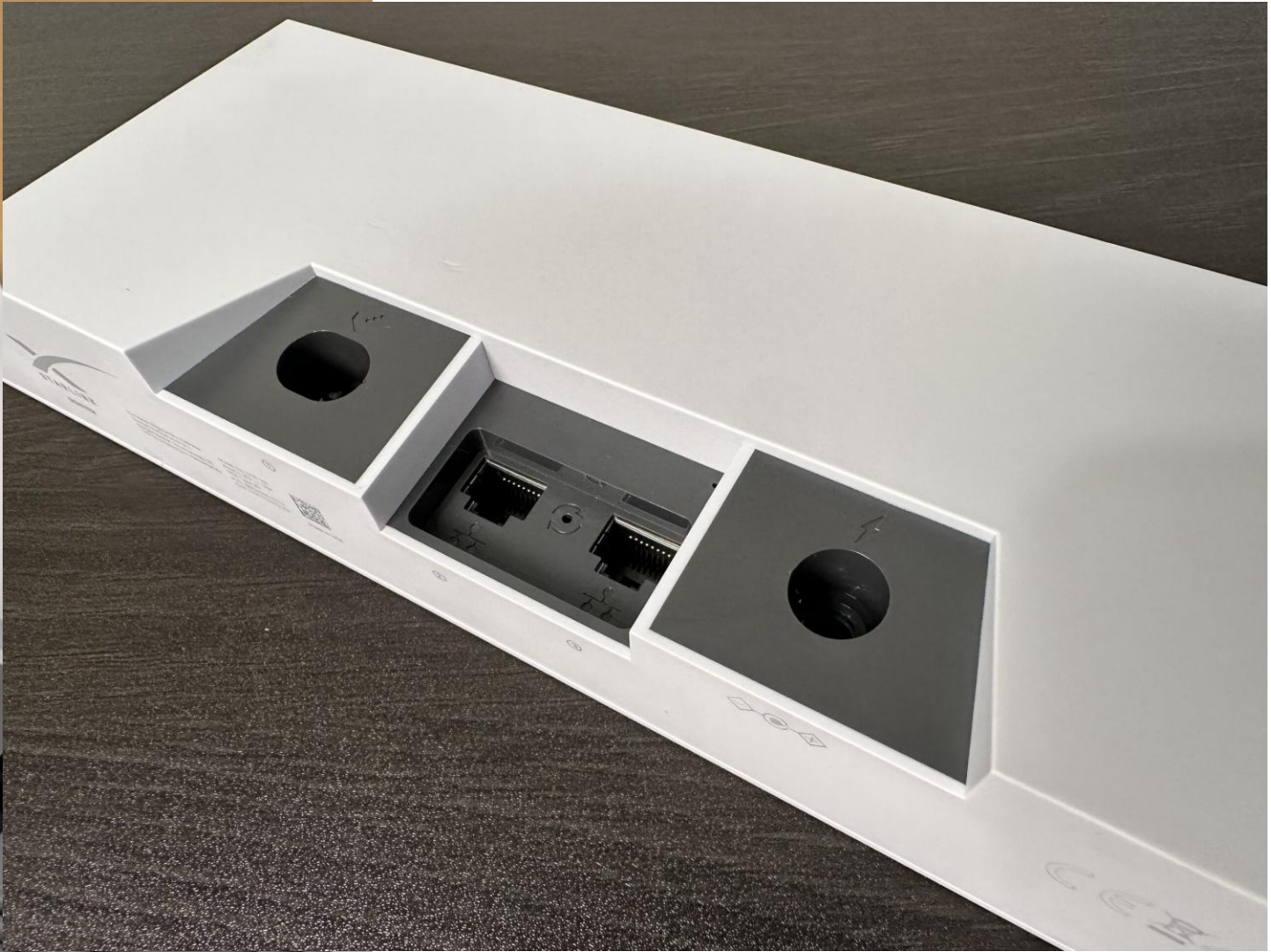
24 115 1,681 166K

 **SpaceX** @SpaceX · 29m
This means Starlink can provide more bandwidth with increased reliability and connect millions of more people around the

 Tweet your reply





17:00

22

<

Statistics

00580d0e-46017919-183530dd

Your Starlink and router just powered on.

Your Starlink and router just powered on. Network performance and statistics should stabilize after about 15 minutes.

Ping success

72.33%

last 9 minutes

Latency

41ms

median, last 9 minutes

Power draw

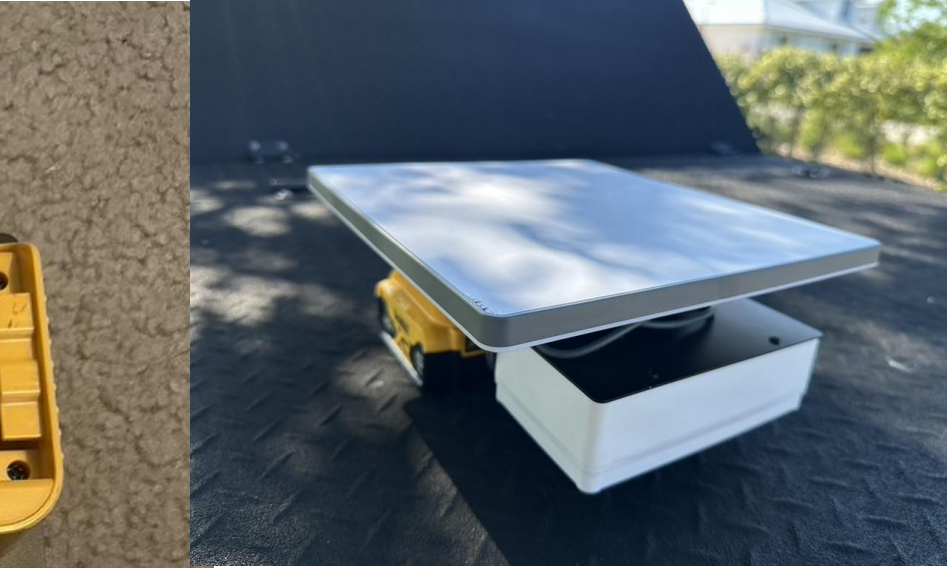
21w

average, last 9 minutes

Throughput

0Mbps

download





Cats still love Starlink



The background of the slide features a dynamic, abstract pattern of flowing, wavy lines in various shades of blue, from light sky blue to deep navy blue. A prominent white rectangular box is positioned on the left side of the slide, serving as a backdrop for the main text.

How do you keep up?

Starlink Federal Room (SL-OSINT)

Starlink Federal

MessagesPeople (64)ContentMeetings+ Apps

+ Add people

Andrew Benhase

Active

AS

Adnan Sadiq

In a meeting

Austin McDaniel

Active

Brandon Adkins

Out of Office until 5/23/23, 4:00 AM • P...

BT

Brent Taylor

Brian Besette

Active

Candice Olson

Active

Chris Ahrens

In a meeting

Chris Johnson

Do Not Disturb until 5/30/23, 10:00 AM

Craig Hill

Out of Office until Friday, 7:00 PM

Darrel Beach

Active 50 minutes ago

Darren Norris

In a meeting

David Caren

Active

David McBrayer

In a calendar meeting

David Prall

Active 1 hour ago

DR

Don Rogers

Active 50 minutes ago

BRKSEC-2037: Securing Starlink Internet Services

Meet

MessagesPeople (3)ContentMeetings+ Apps

CL Amsterdam 2024 added 2 people to this space.

Today

Hey for some good questions in this space both before, during and after the session!

You pinned a message. 12:43 PM



Starlink - SpaceX Satellite Internet Constellation

r/Starlink

Joined



- Posts
- Wiki
- FAQ
- Discord
- Threads



Create Post



- Hot
- New
- Top



161

PINNED BY MODERATORS
Posted by u/TimTri **MOD | Beta Tester** 2 years ago



r/Starlink Availability, Questions & General Discussion

2.7k Comments Share Save



299

News Starlink now available in every active cell on earth!



166 Comments Share Save



Posted by u/ziptested 4 hours ago

About Community

r/Starlink is for news, media, and discussions related to Starlink, the SpaceX satellite internet constellation. This is a fan-run Subreddit. For official news and to sign up for service, visit starlink.com

Created Dec 15, 2008

181k Members 254 Online Top 1% Ranked by Size

Create Post

PREVIEW

cyber_warrior

What's happening with Kuiper?

First Kuiper Launch



December 2 2023



Additional capacity will supplement existing launch contracts to support Project Kuiper's satellite deployment schedule.

Amazon has signed a contract with SpaceX for three Falcon 9 launches to support deployment plans for Project Kuiper, Amazon's low Earth orbit (LEO) satellite broadband network. Project Kuiper satellites were designed from the start to accommodate multiple launch providers and vehicles, allowing us to reduce schedule risk and move faster in our mission to connect unserved and underserved communities around the world. Our [earlier](#)

Kuiper On Orbit

Total planned: More than 3,200 satellites

Currently in orbit: 153

Launch history:

What's happening with OneWeb?

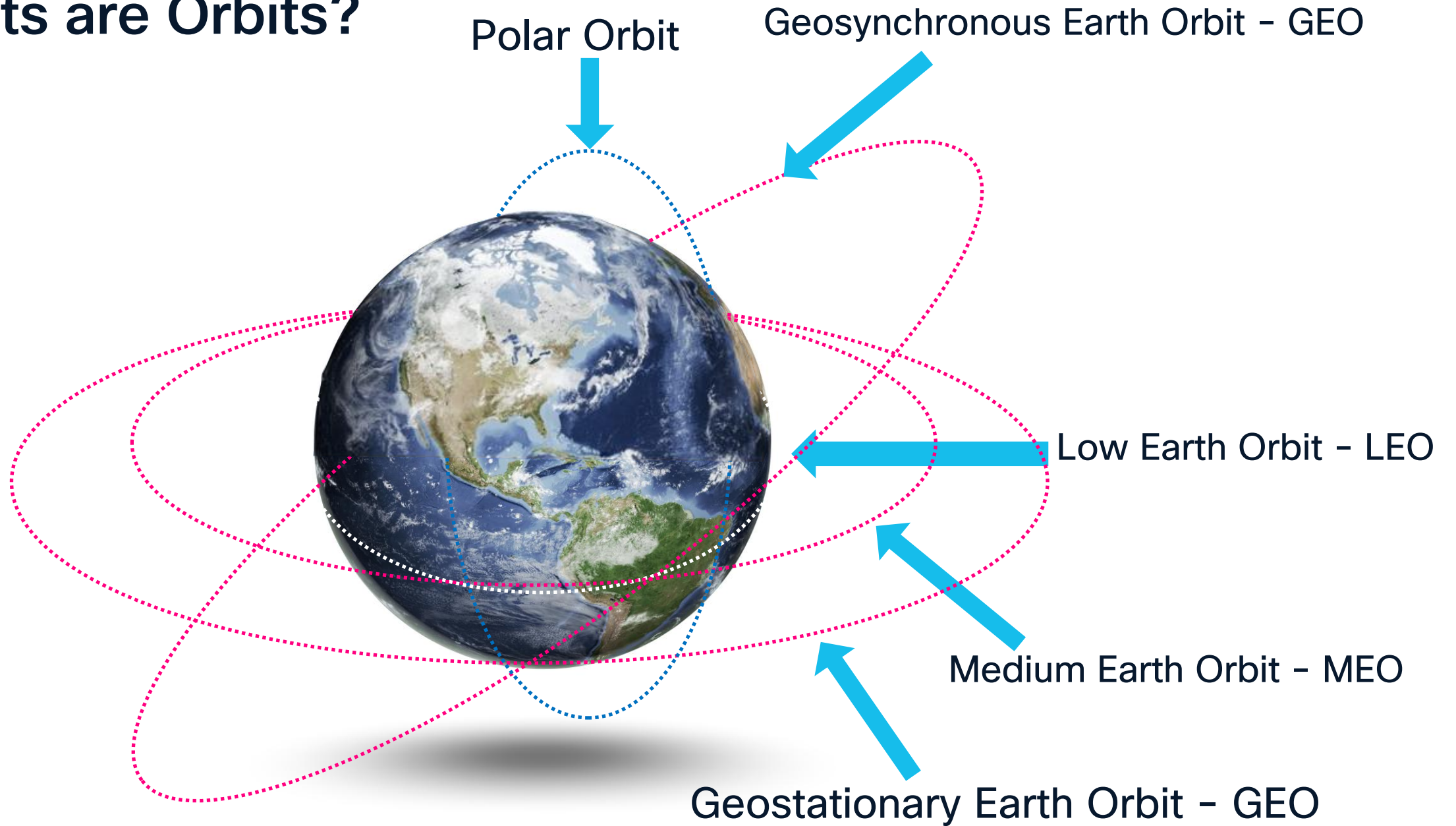
OneWeb- catering towards Enterprise

- Polar Orbits – global coverage achieved with ~600 in orbit
- Higher Orbit – approximately 750 miles (vs 340m for Starlink)
- >Double the coverage radius on a per satellite basis
- 654 satellites in orbit
- Broad Coverage over Australia
- Focused towards Enterprise Networking

The background of the slide is an abstract pattern of flowing, wavy lines in various shades of blue, from light sky blue to deep navy blue. A prominent white rectangular box is positioned on the left side of the slide, serving as a container for the main text.

Orbits are orbits right?

Orbits are Orbits?



**Hey Andrew, this is
Cisco Live....**

**Why do I need to know
about physics, orbits,
altitudes and latency?**



Answer:

**Because this is an Engineering
discussion, not a sales and marketing
pitch 🖥️**

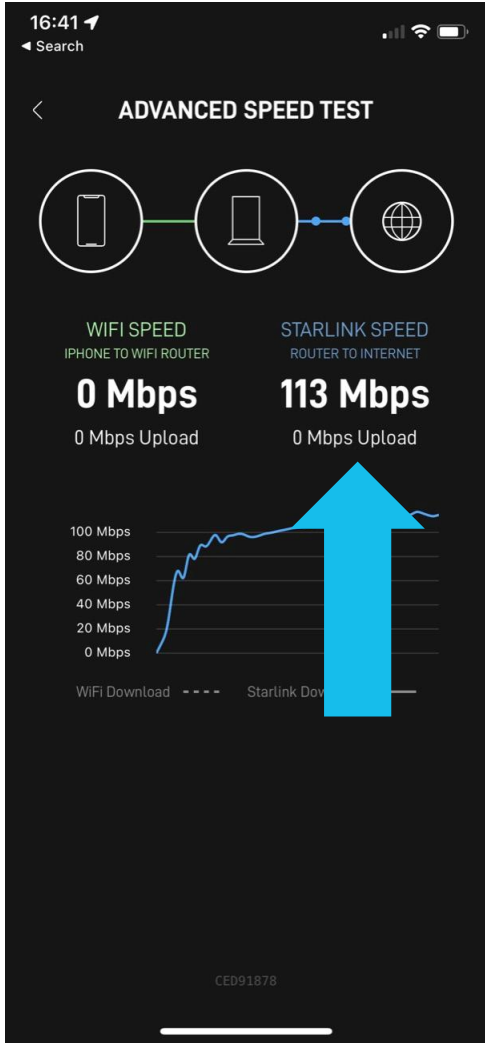
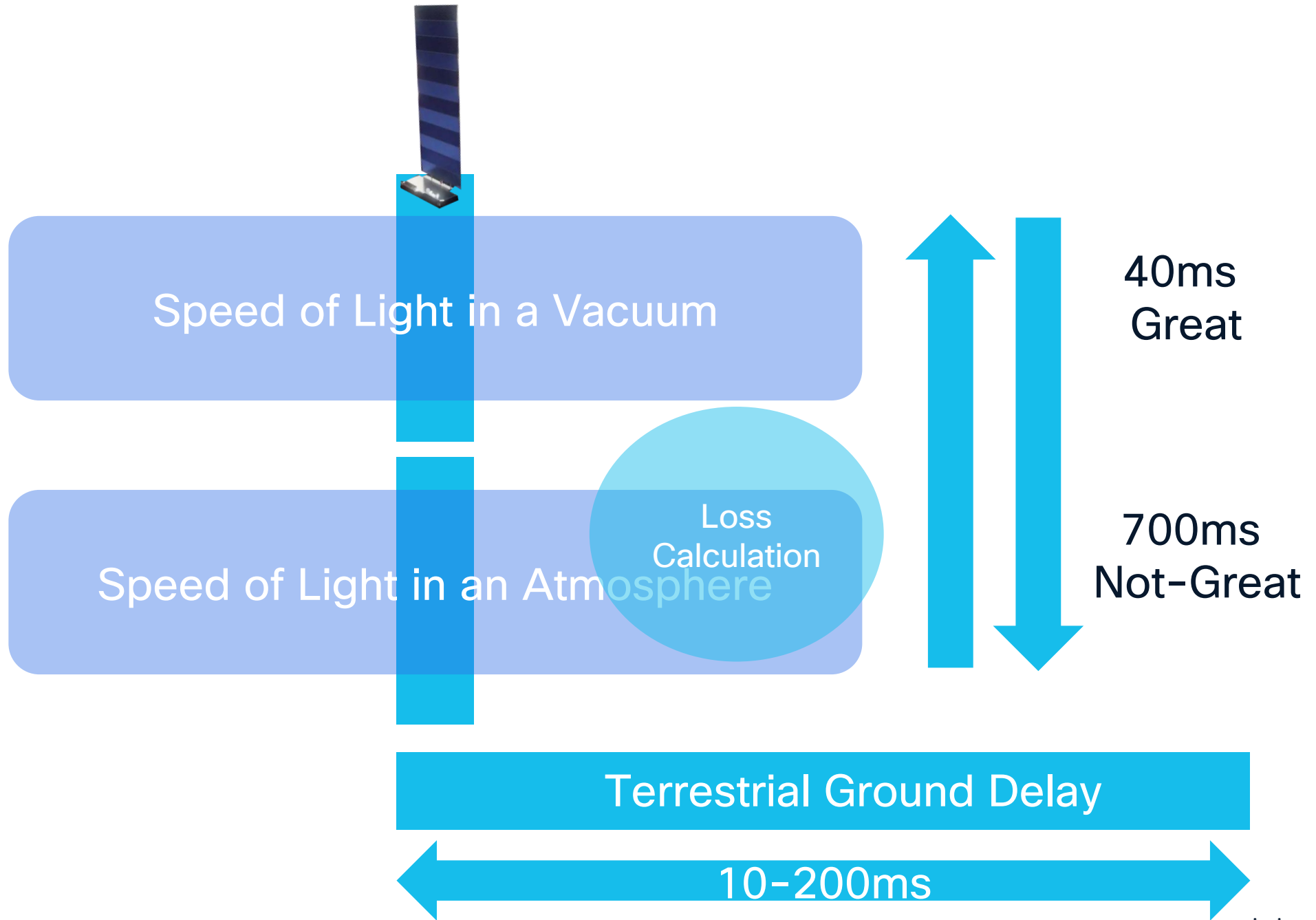
Speed of Light in a Vacuum

$$c = v\lambda$$

Diagram illustrating the equation $c = v\lambda$ and its components:

- c is labeled as **Light (Photons)**.
- v is labeled as **Frequency**.
- λ is labeled as **Wavelength**.

300,000 km/s



Orbits and Networking

- LEO – 1000 kilometers and below
 - Starlink 540km (345 miles)
 - One way latency – ~12-25ms
 - RTT – ~25-50ms
- MEO – 8000 kilometers (5,000 miles)
 - ~RTT 350ms
- GEO – 36,000 kilometers (22,000 miles)
 - ~RTT 725ms



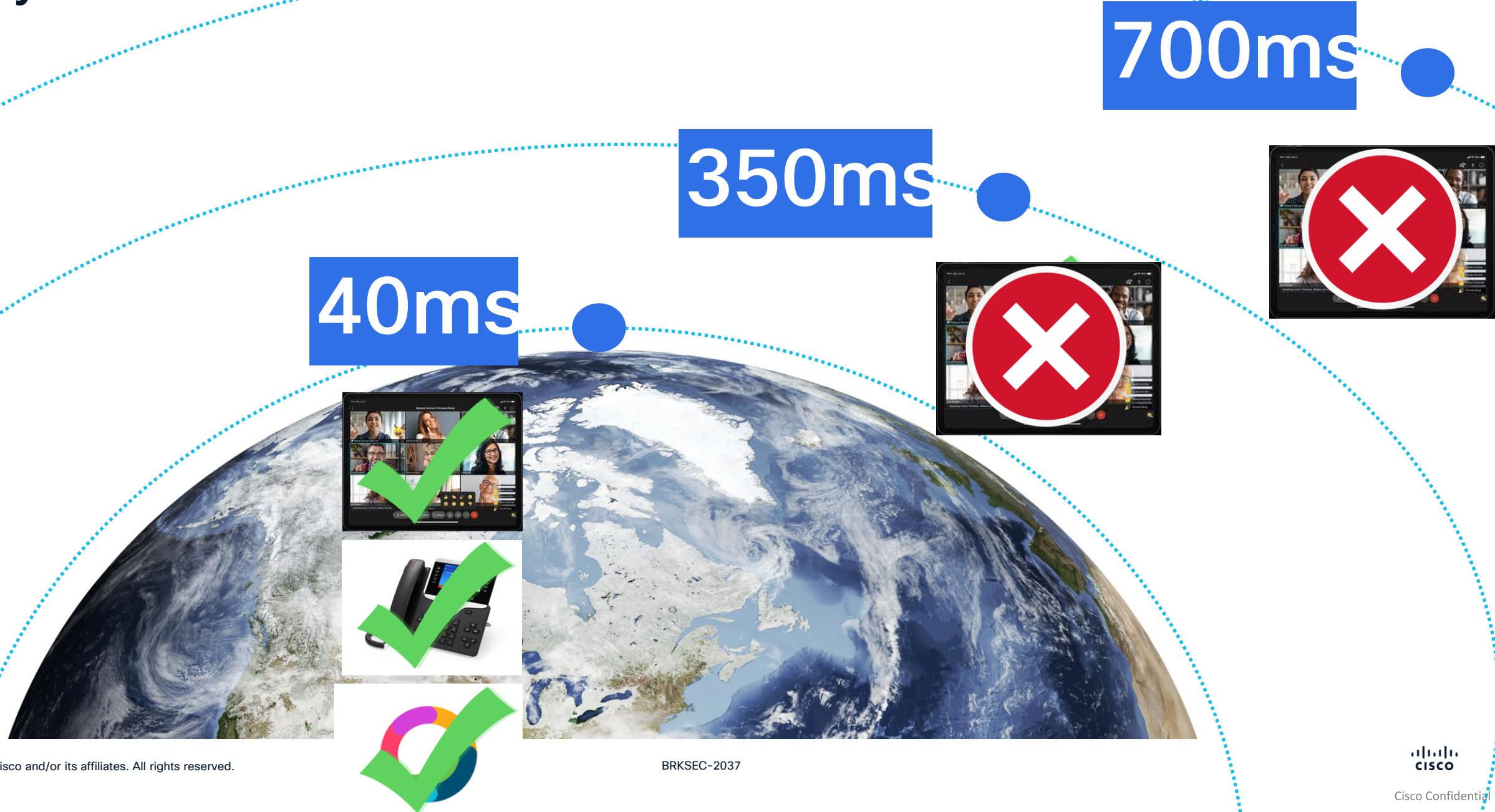
Happy Network Zone



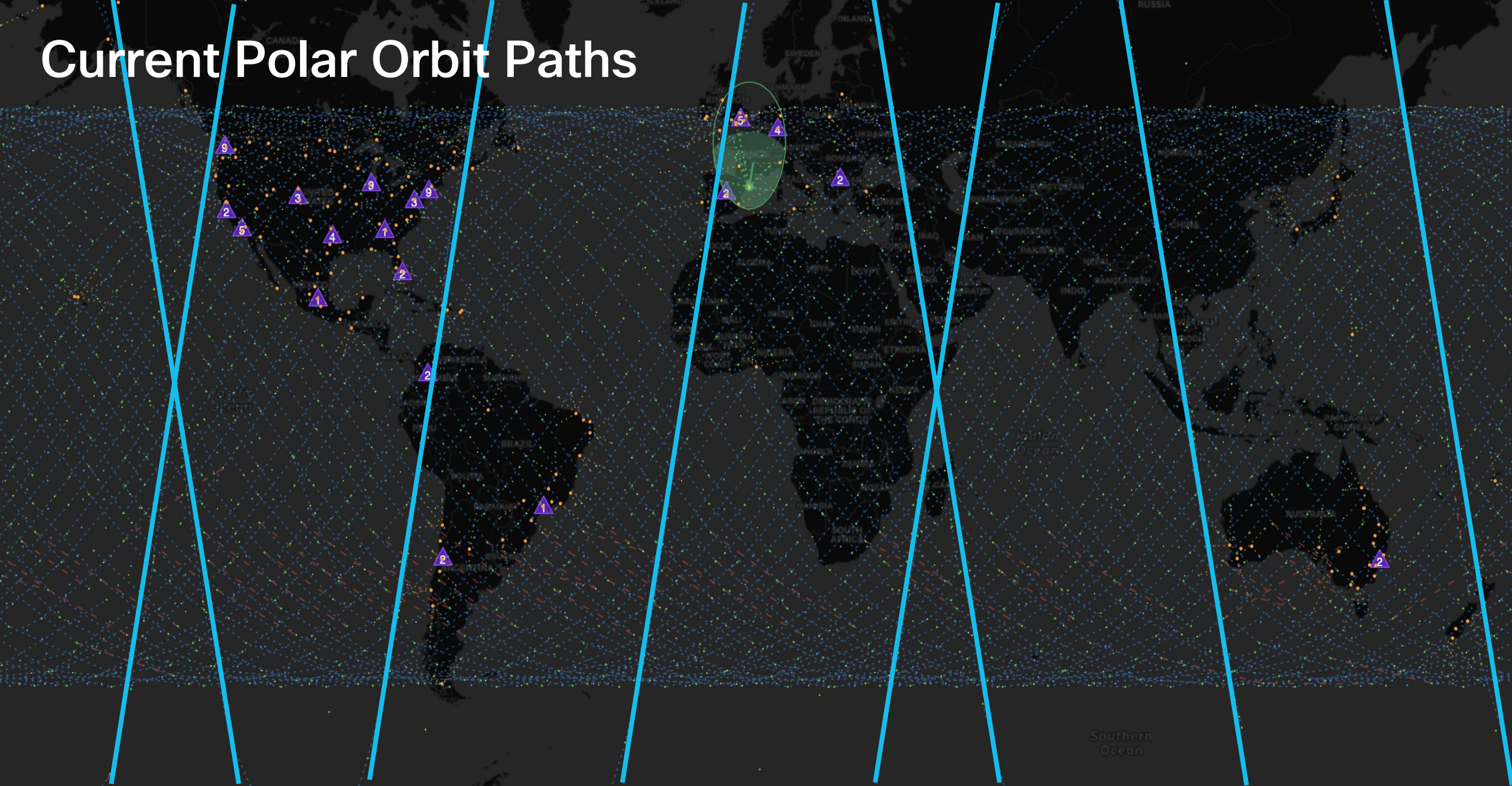
Sad Network Zone



Physics Matters



Current Polar Orbit Paths



What really is Starlink?

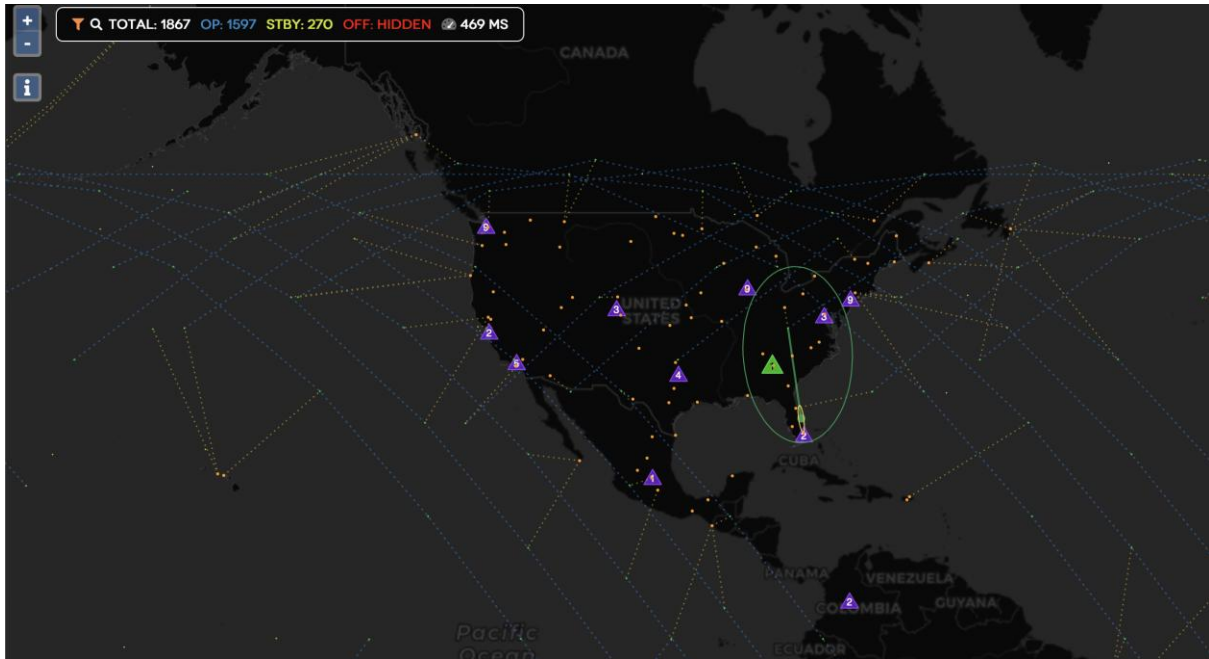
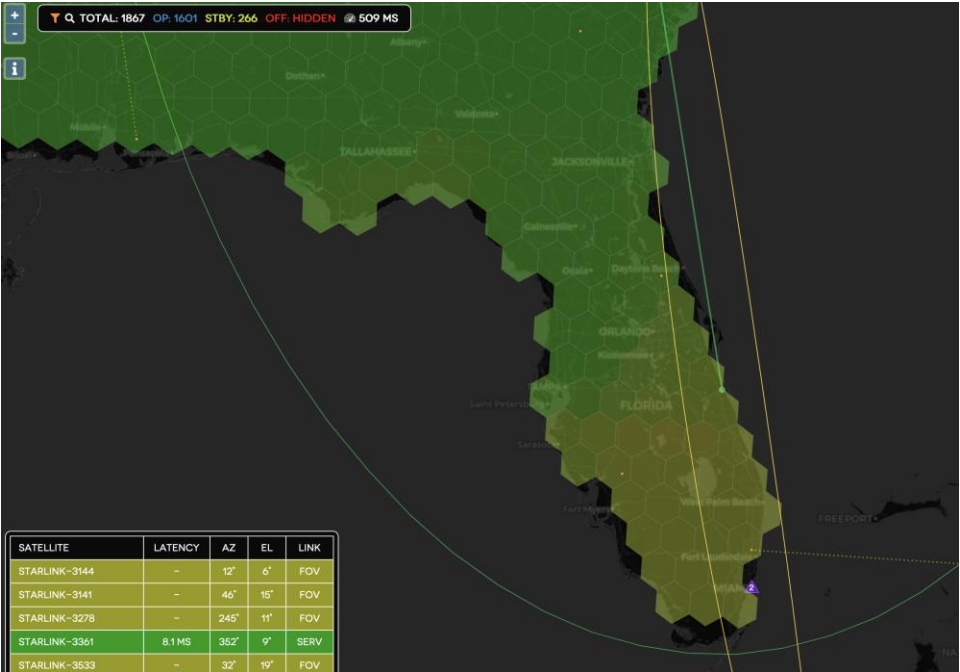
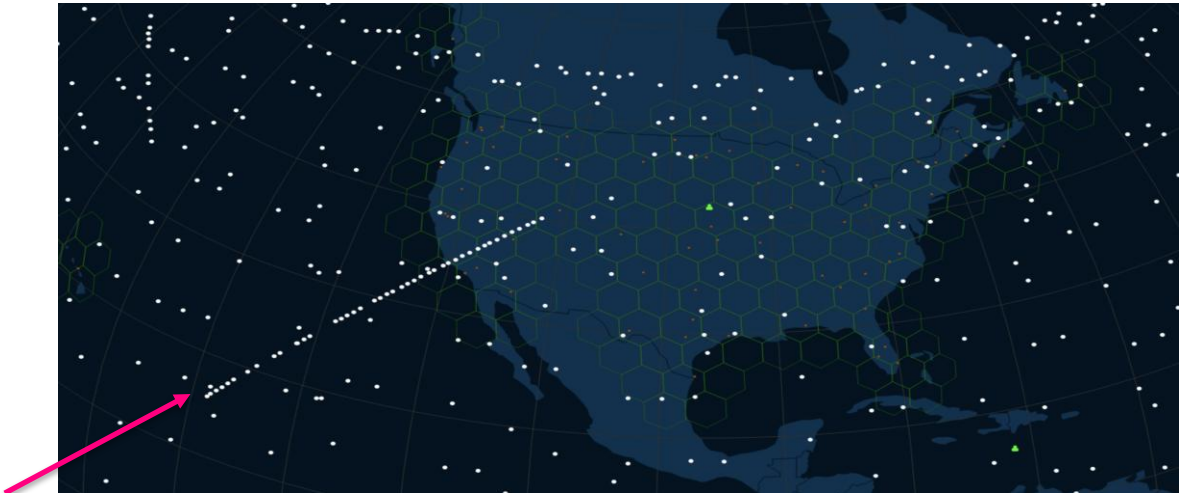
Starlink Australia

- Estimation of pathing using currently published ephemeris
- Broad coverage of urban areas
- Rural areas would be serviced by polar orbits
- Coverage in remote area may be inconsistent



What is Starlink?

- A global satellite network in Low Earth Orbit currently consisting of ~3000 satellites*



Satellite v1.5

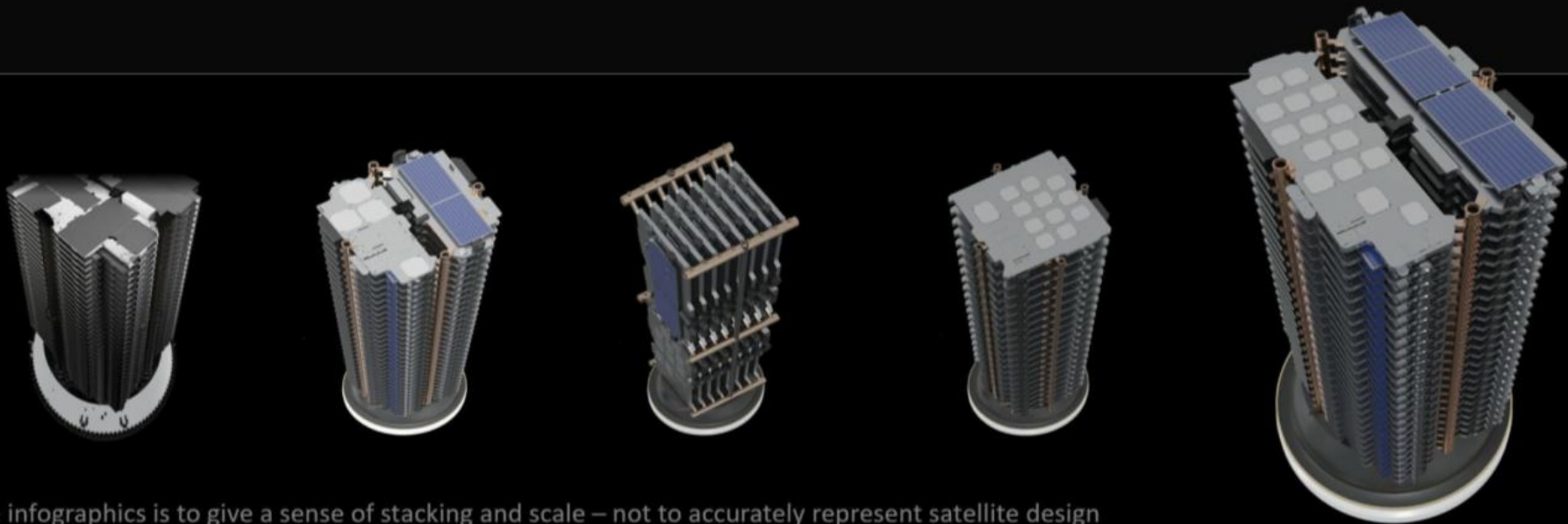
- Each satellite features four antennas in Ku band, one for uplink, three for downlink
- Each antenna is capable of projecting eight beams in two polarizations (RHCP/LHCP), for a total 48 downlink beams and 16 uplink beams.
- The maximum bandwidth available to Starlink in Ku band is 8x 250 MHz channels in downlink (total 2 GHz), and 8x 62.5 MHz channels in uplink (total 500 MHz)
- Each Satellite nominally operates at 10Gbps capacity with future expansion to 20Gbps

Faced towards Ground



Credit: Starlink

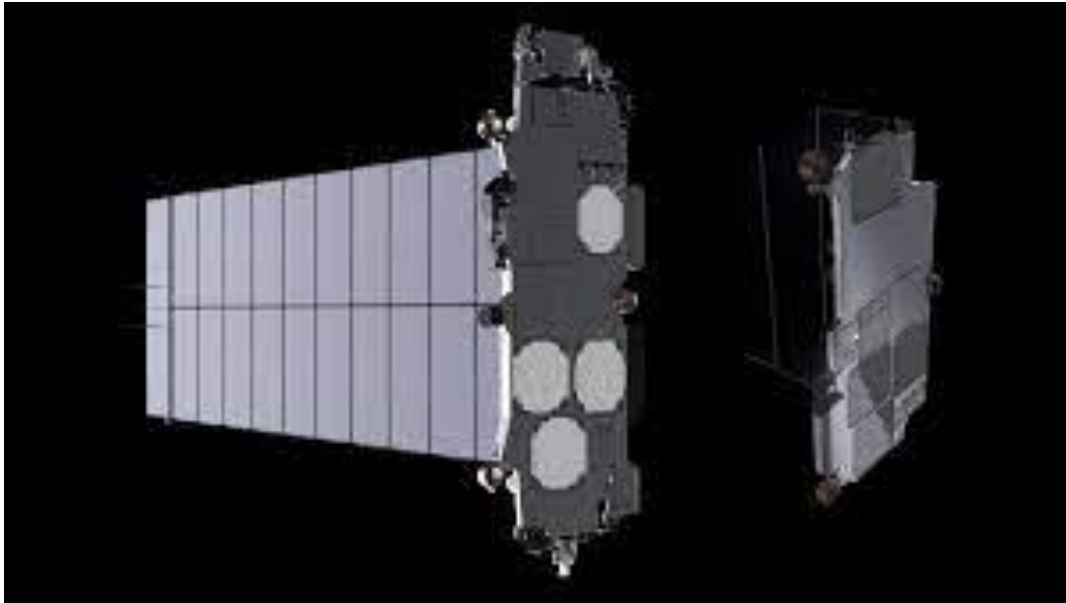
Satellite v2.0 and v2.0 Mini



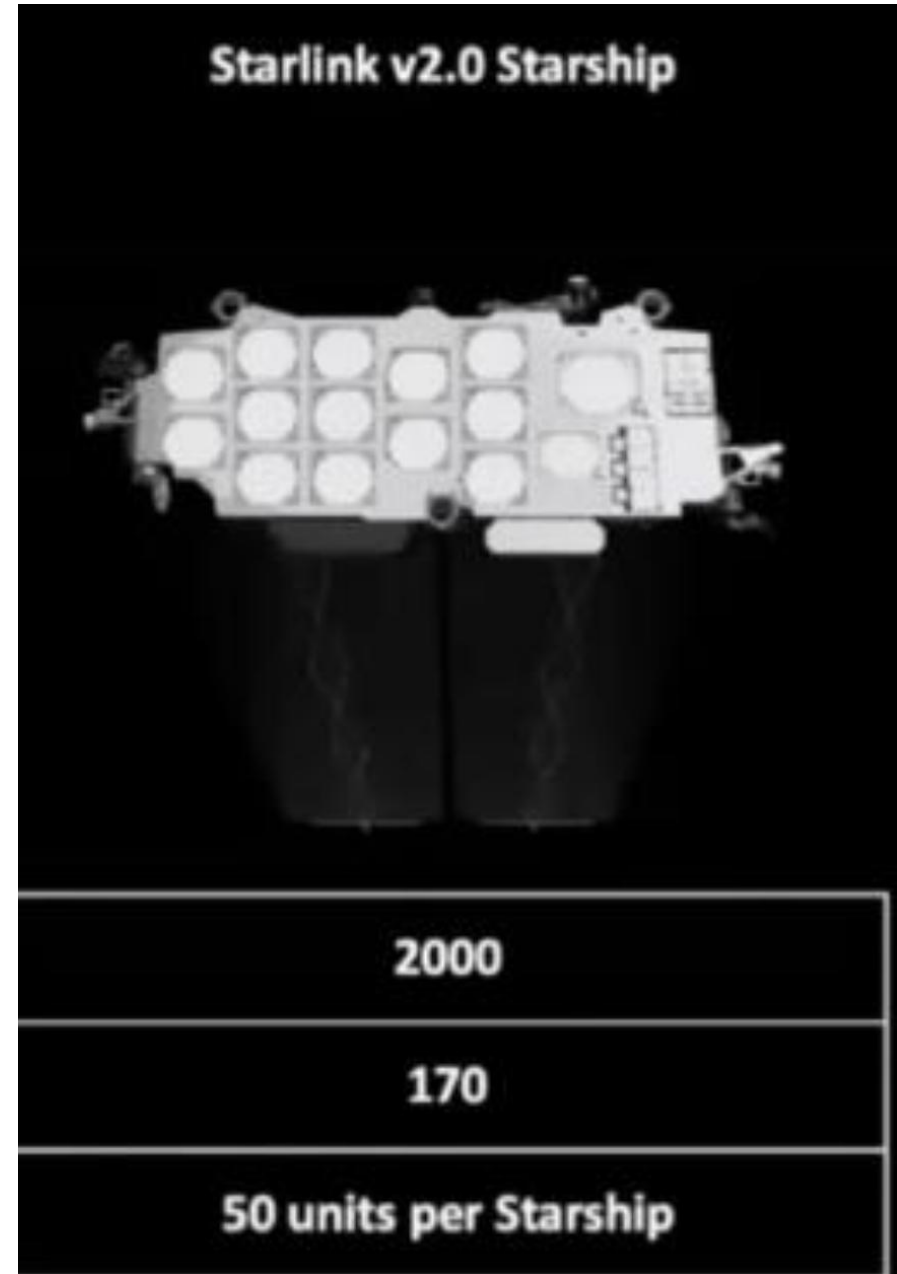
The goal of these infographics is to give a sense of stacking and scale – not to accurately represent satellite design

Assumptions	Designation	Starlink V1.5	Starlink V2 F9-1	Starlink V2 F9-2	Starlink V2 mini	Starlink V2 Starship
	Status	Launched	FCC filing – may not realize	FCC filing – may not realize	Launched	FCC filing
	Mass kg	306	303	800	800	2000
	Gbps / sat	15	18	70	60	170
	Launch	60 units per Falcon 9	60 units per Falcon 9	16 units per Falcon 9	21 units per Falcon 9	50 units per Starship
	Tbps / launch	0.9	1.1	1.1	1.3	8.5
	m\$ / launch	Sats 18 + launch 30 = 48m\$	Sats 18 + launch 30 = 48m\$	Sats 11 + launch 30 = 41m\$	Sats 15 + launch 30 = 45m\$	Sats 60 + launch 15 = 75m\$
	\$ / Mbps	53	45	37	35	9

V2.0 Satellite



V1.5 Satellite



Observations of the Starlink Network

- CGNAT Employed
- Array to Satellite to Ground Station are all Flat
- Appears that Ground to NAP is a series of Exit MPLS Networks
- Exit Routing is based on your specific Terminal
- *Network Configuration changes are frequent and unannounced
- Exit Path is currently static based on your Service Class
- Portability, Marine, RV, Aviation means that you can be placed in different exit VPNs, we assume dynamically



Infrared “Space Lasers”

- 3 Beam Optical Head using Infrared Laser
- Same Orbital Plane Operation
- Theoretically could offload to parallel polar plane satellite



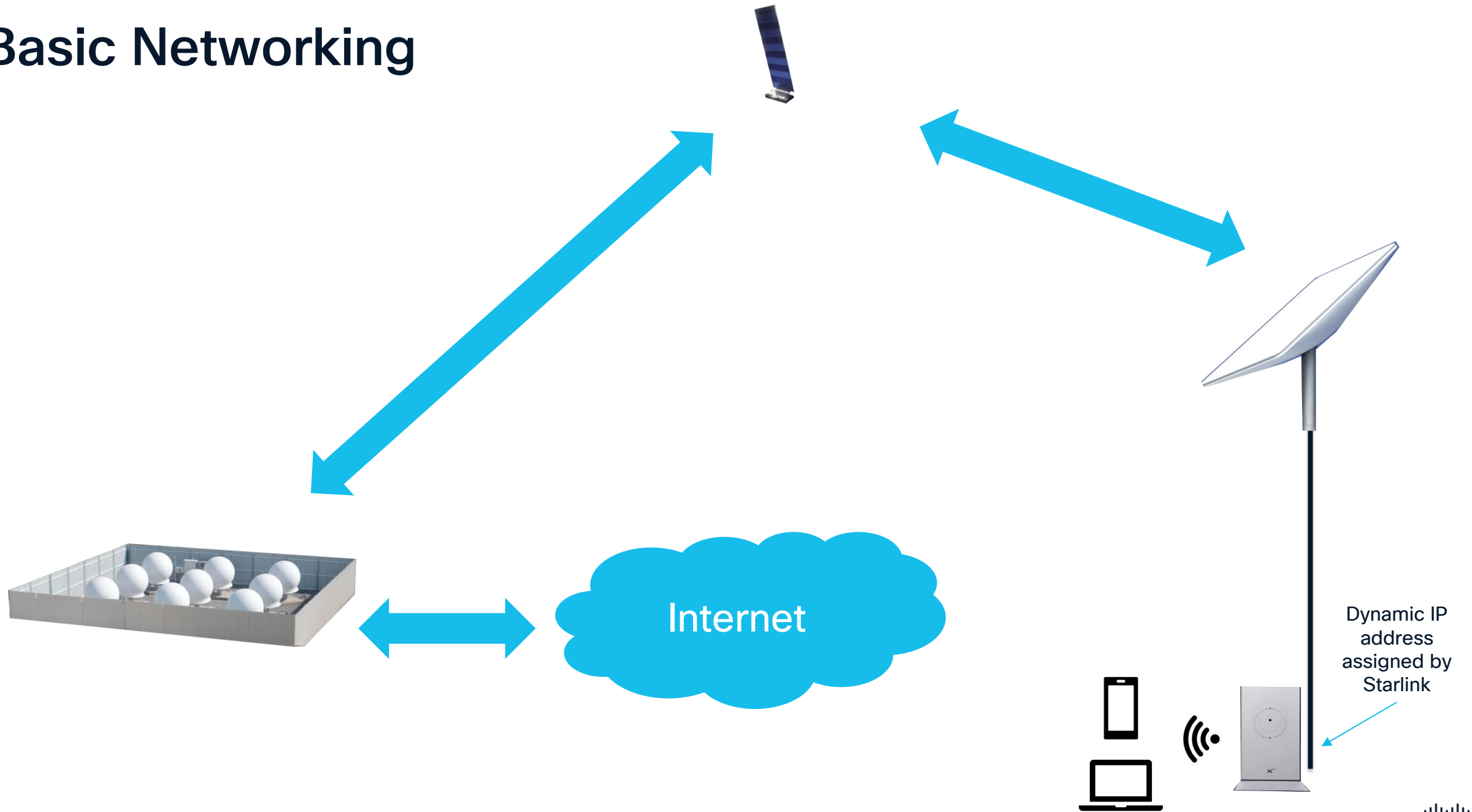
Credit: SpaceX/Starlink

Ground Station

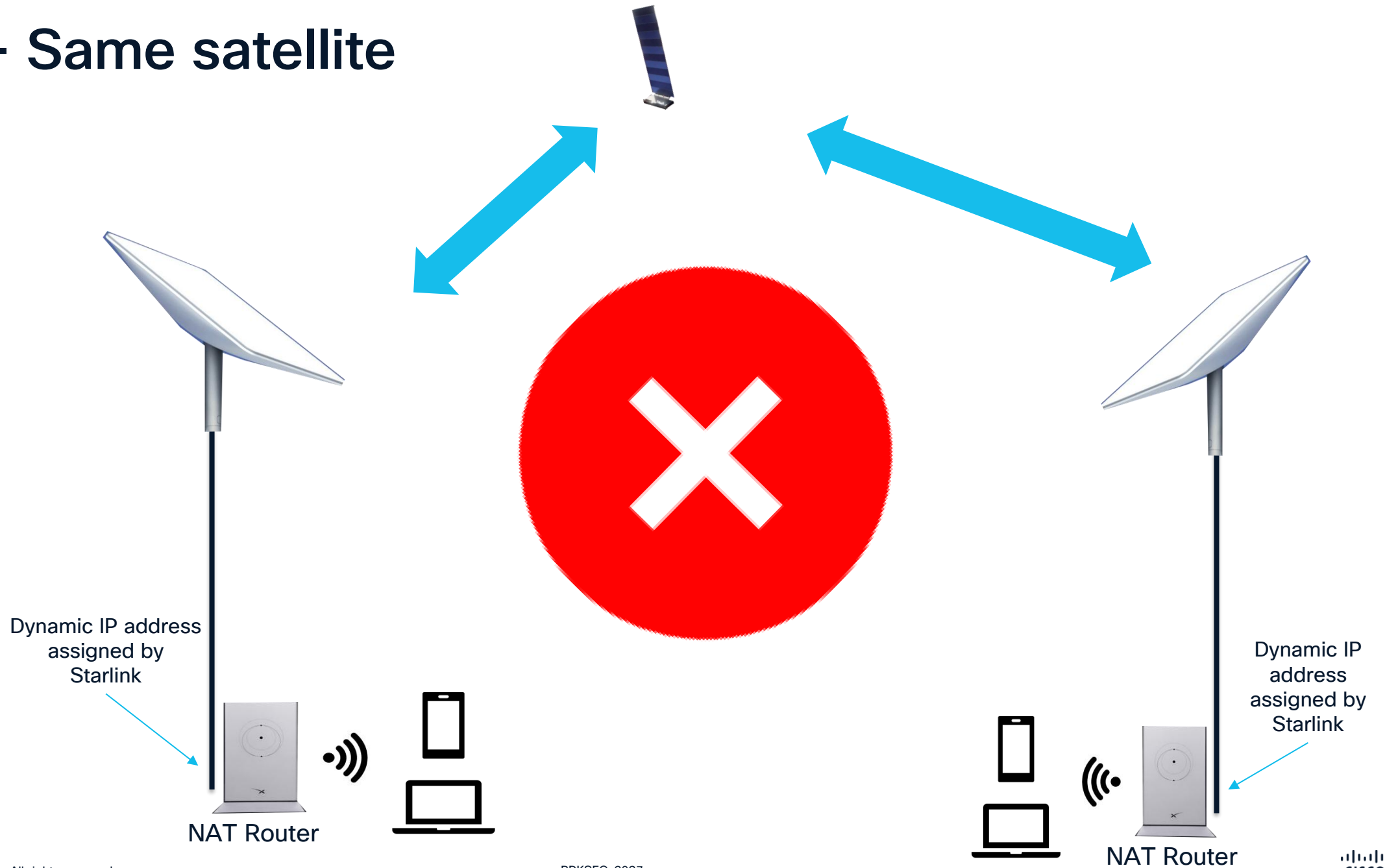
- Each gateway antenna has available a maximum of 4x 500 MHz channels (total 2 GHz) in uplink, and 5x 250 MHz channels (total 1.25 GHz) in downlink
- In this configuration – where 8 antennas are active – would be 10Ghz total active Down and 6Ghz Up per site
- Ground stations are positioned on top of existing Fiber Paths
- Each Parabolic Antenna can support 10Gbps x 2)
- So that's up to 1.6Tbps theoretical bandwidth for a site with 8 active



Basic Networking



BLOS - Same satellite

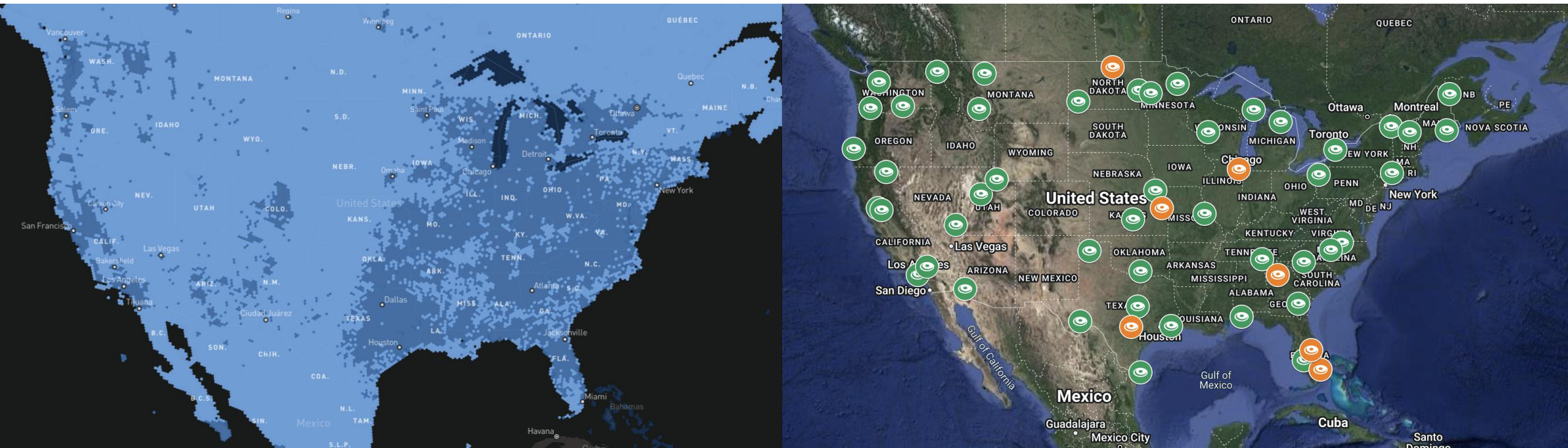


List of Australian Starlink Ground Stations

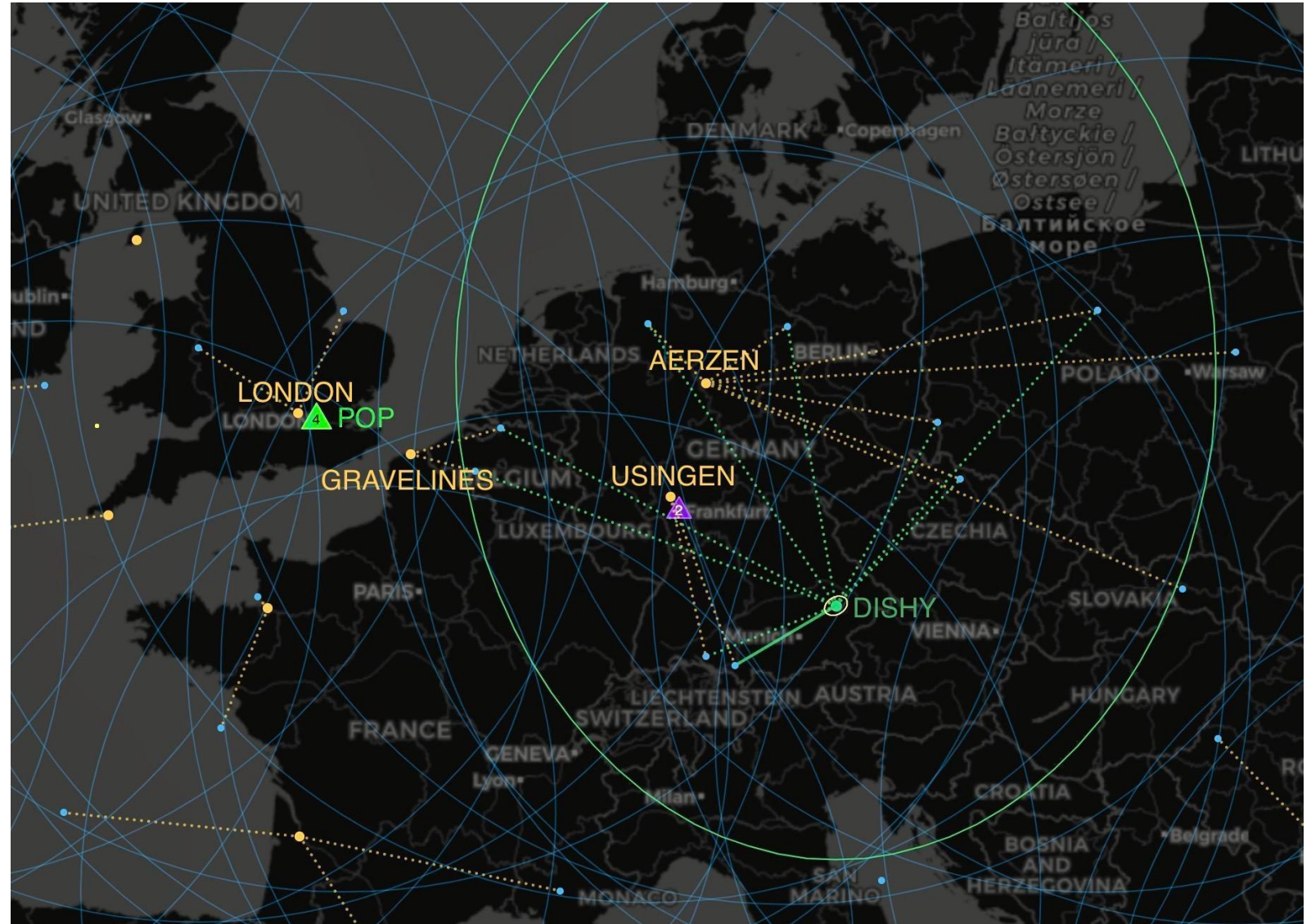
Cataby, WA	Springbrook Creek, NSW
Merredin, WA	Tea Gardens, NSW
South West of Coolgardie, WA	Ki Ki, SA
Wagin, WA	Anankie, VIC
Ki Ki, SA	Koonwarra, VIC
Pimba, SA	Torrumbarry, VIC
Broken Hill, NSW	West of Emerald, QLD
Boorowa, NSW	Toonpan, QLD
Calrossie, NSW	Warra, QLD
Canyonleigh, NSW	Willows, QLD
Cobargo, NSW	Bulla Bulling, WA



US Gateway Locations



EMEA Gateway Locations

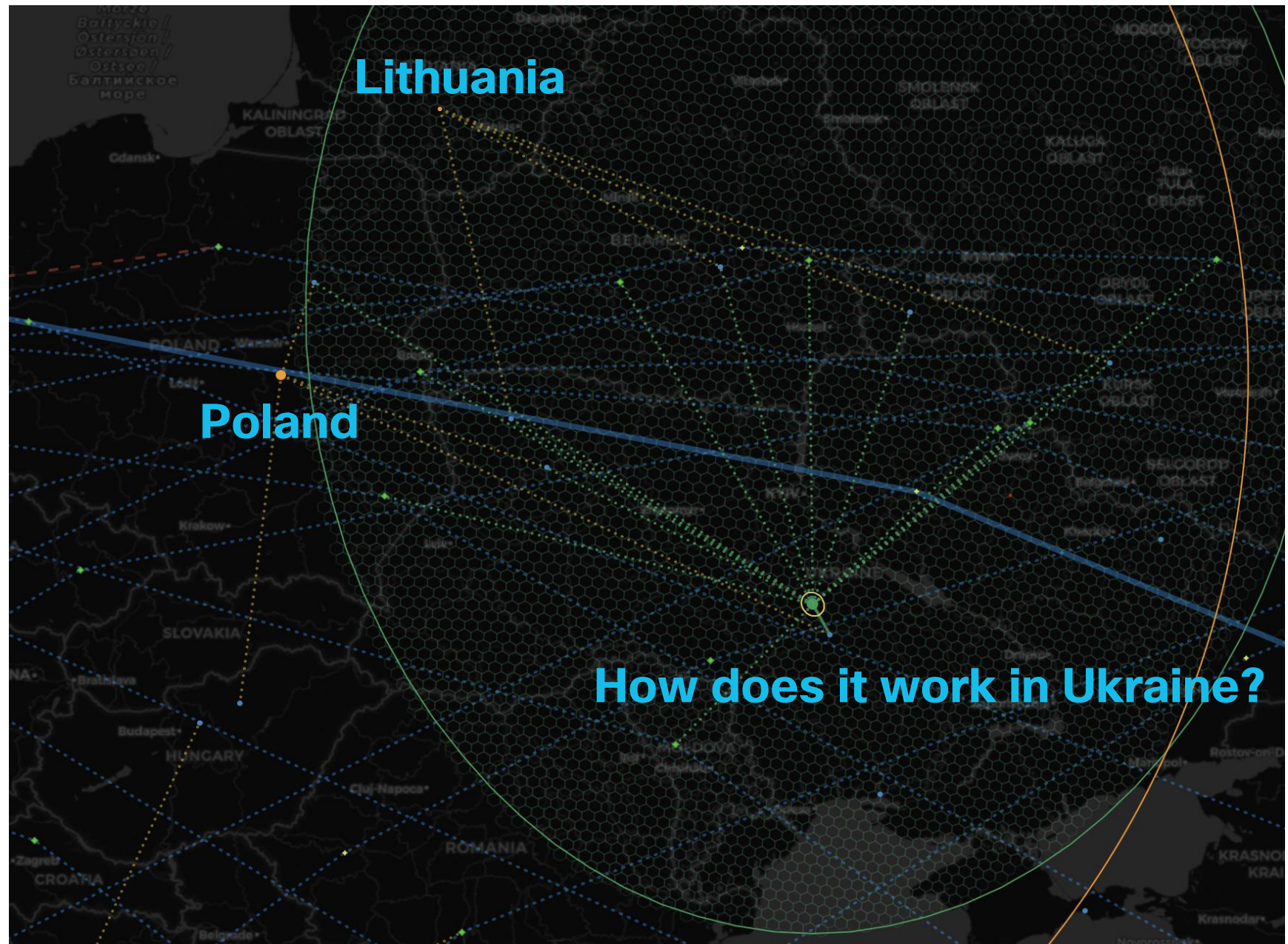


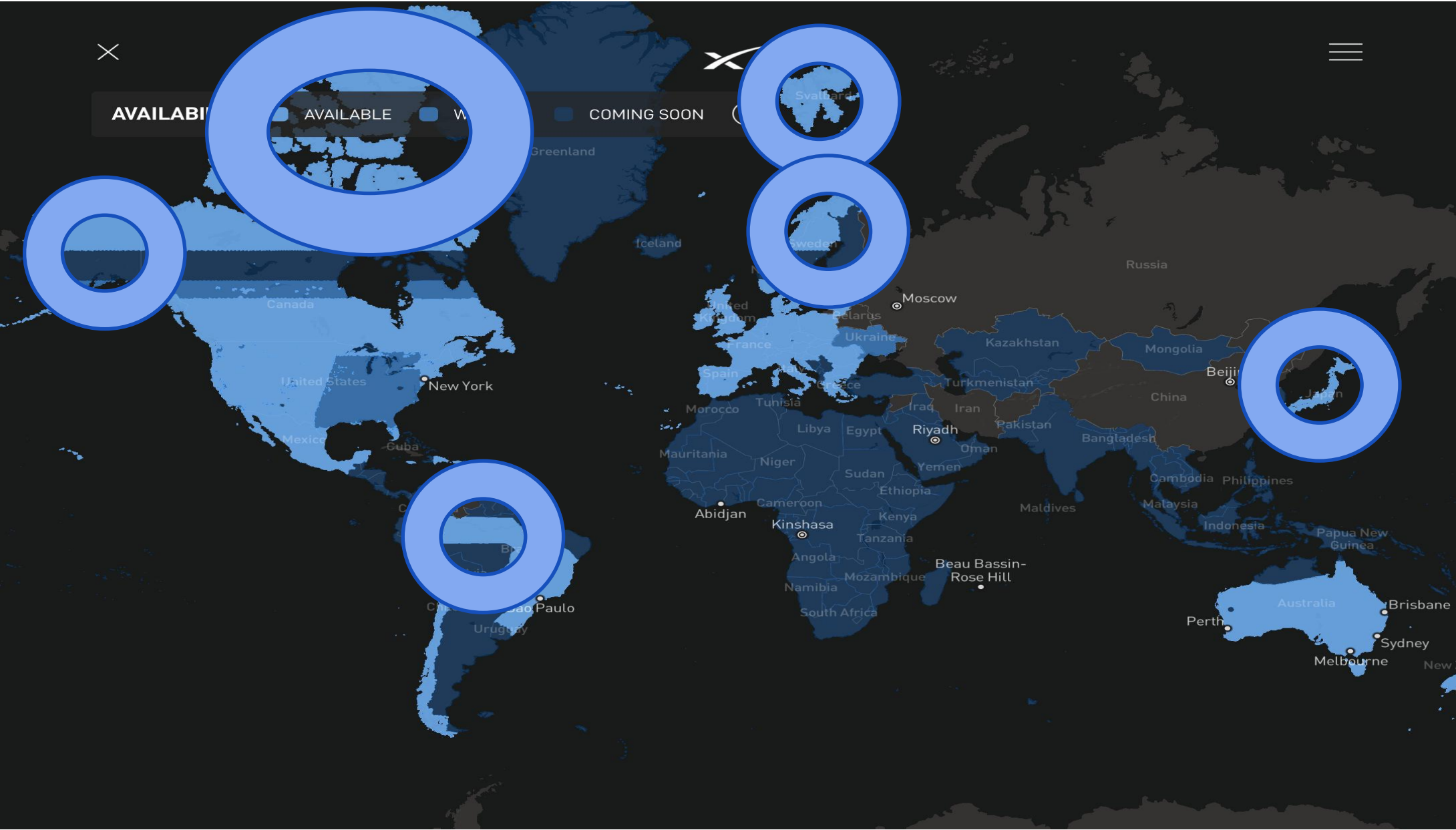
Radio Gateways

Lithuania
Poland

Internet Gateways

Frankfurt
London







STARLINK

RESIDENTIAL

BUSINESS

RV

MARITIME

AVIATION

IOT

AVAILABILITY



AVAILABLE



WAITLIST



COMING SOON



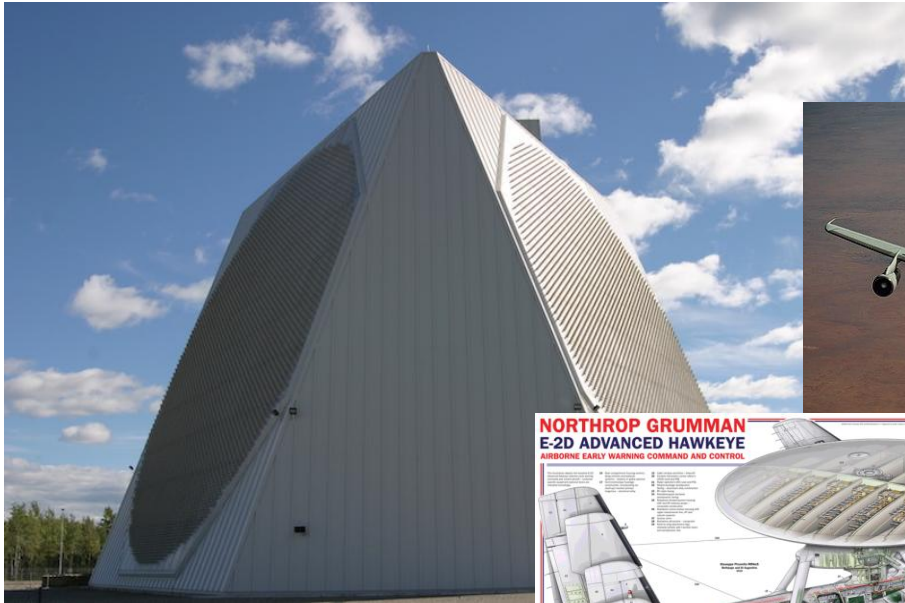
Things we know

- Dense Orbital shells are extremely robust
- Frequency shifts can be simple software operations
- Receive only satellite arrays are critically important
- Low observability packages are important
- Low cost Software Defined Radios (SDRs) are being used for offensive hunt operations

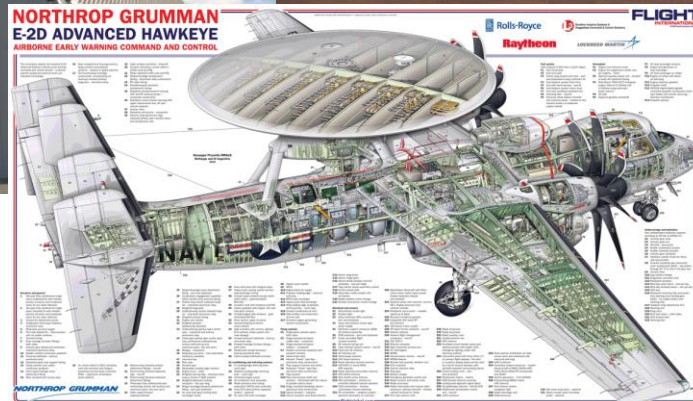
Phased Array Antenna

Examples of Phased Arrays

Space Observation Radar



E-3 Sentry
AWACS



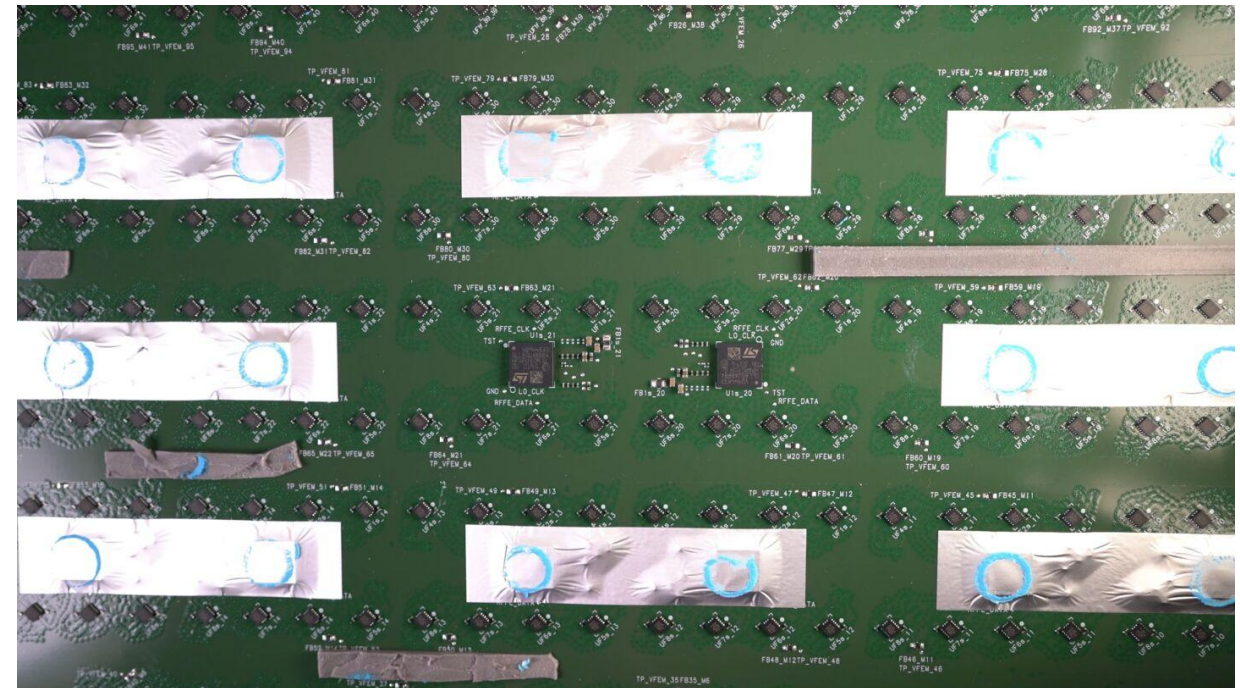
E-2D
Early Warning

- AN-SPY-1 Phased Array
- AEGIS Deployed and Ashore



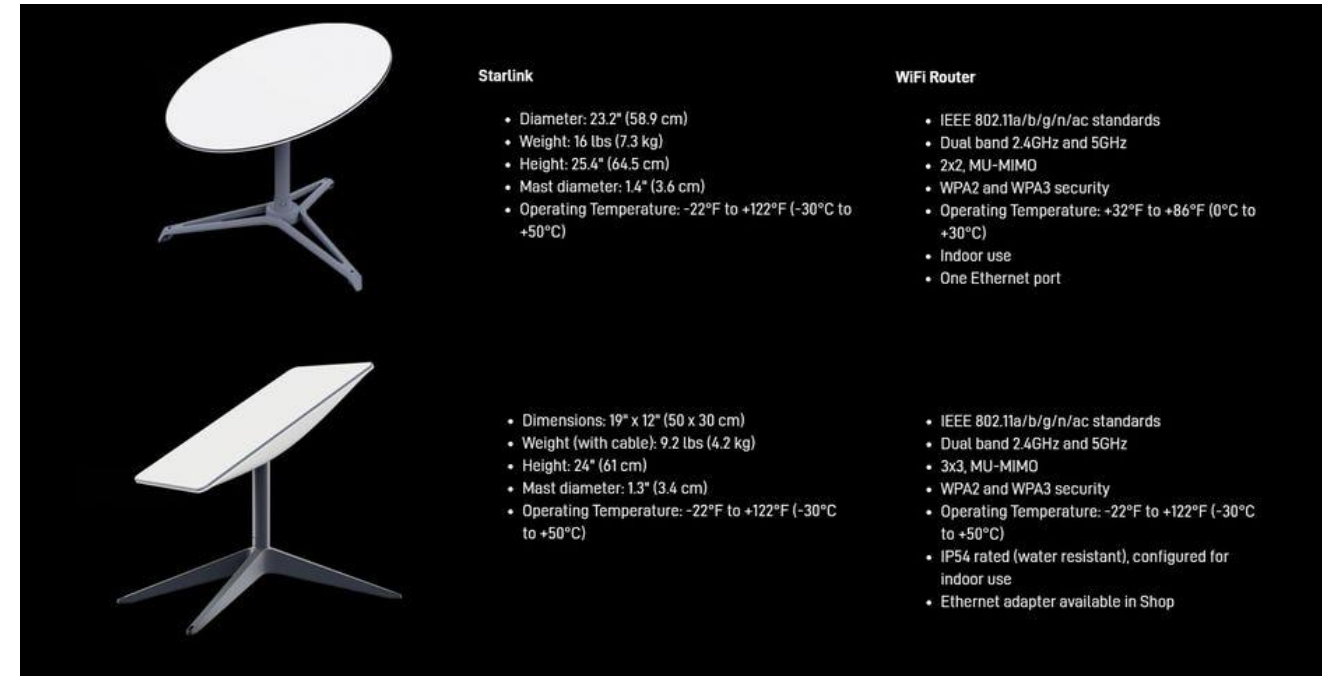
How does Starlink work?

- Up / Down configuration
- Ground Terminal is a phased array antenna in one of two current configurations – Round (Gen1) or Rectangle (Gen2)
- Each array has hundreds of transceivers
- 12-18 and 26.5-49 GHz bands



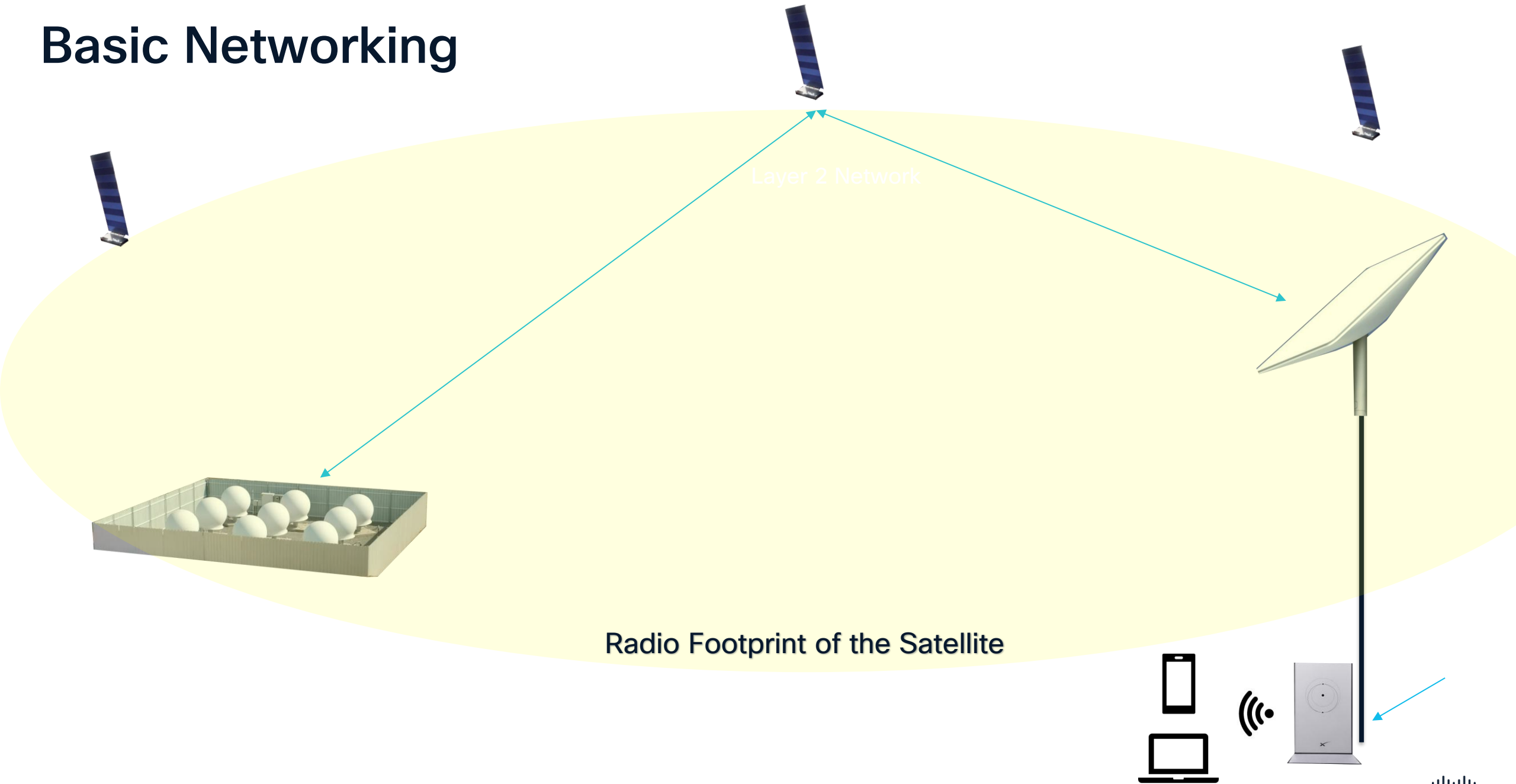
Ground Terminal

- Phased Array Antenna
- Starlink Router (more on that later)
- Ethernet Cable with proprietary ends



Basic Networking

Basic Networking

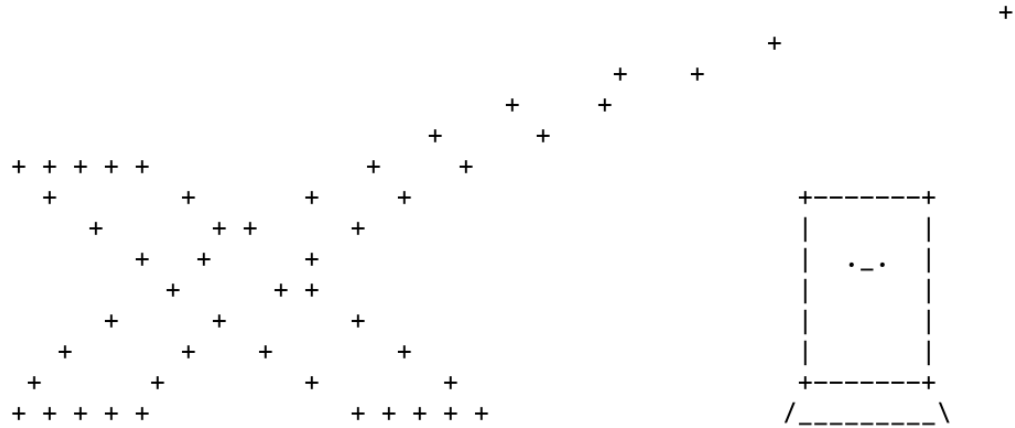


Starlink Router

- Micro Linux Router
- NAT Operations
- 60 second boot time
- 192.168.128.0 NAT Pool



Starlink Router



When I was a kid, I wanted to be a WiFi router more than anything in the world. I stretched my arms out wide, and I hid in the corner. I tried to glue antennas to my head, I had ethernet cables, I had an LED indicator. Everybody knew me and was afraid of me. And one day, my dad said, "Bobby, you're 17. It's time to throw childish things aside," and I said, "OK, Pop." But he didn't really say that. He said, "Stop being a WiFi router and become a Dishy."

2022.19.0.mr13442

Router-010000000000000000001F2F12

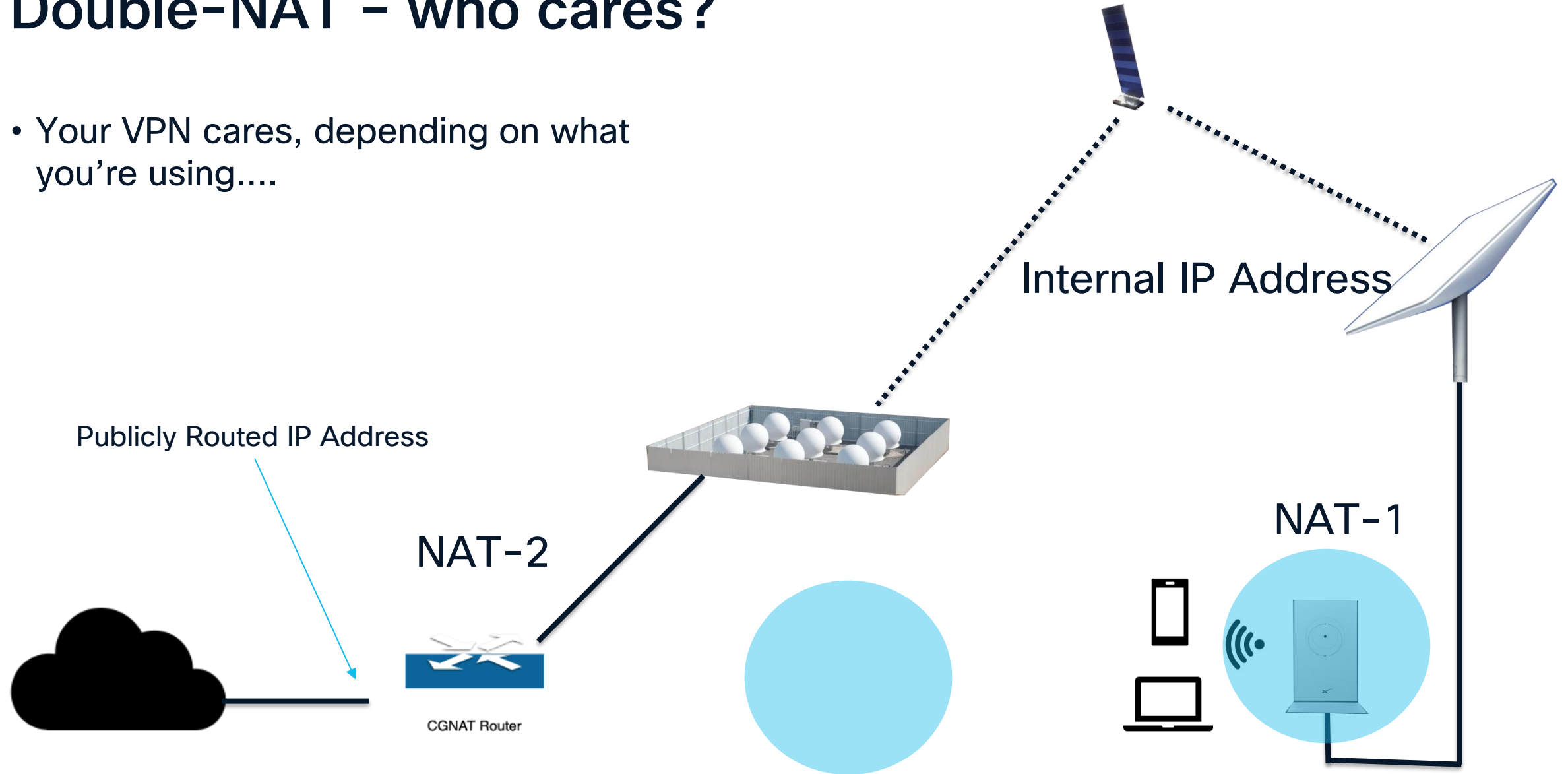
```
abenhase@192.168.1.1: Permission denied (publickey,keyboard-interactive).
abenhase@ABENHASE-M-526H .ssh %
```

- Nmap scan report for 192.168.1.1
- Host is up (0.0040s latency).
- Not shown: 994 filtered tcp ports (no-response)
- PORT STATE SERVICE
- 22/tcp open ssh
- 53/tcp open domain
- 80/tcp open http
- 9000/tcp open cslistener
- 9001/tcp open tor-orport
- 9002/tcp open dynamid
- Nmap done: 1 IP address (1 host up) scanned in 45.68 seconds

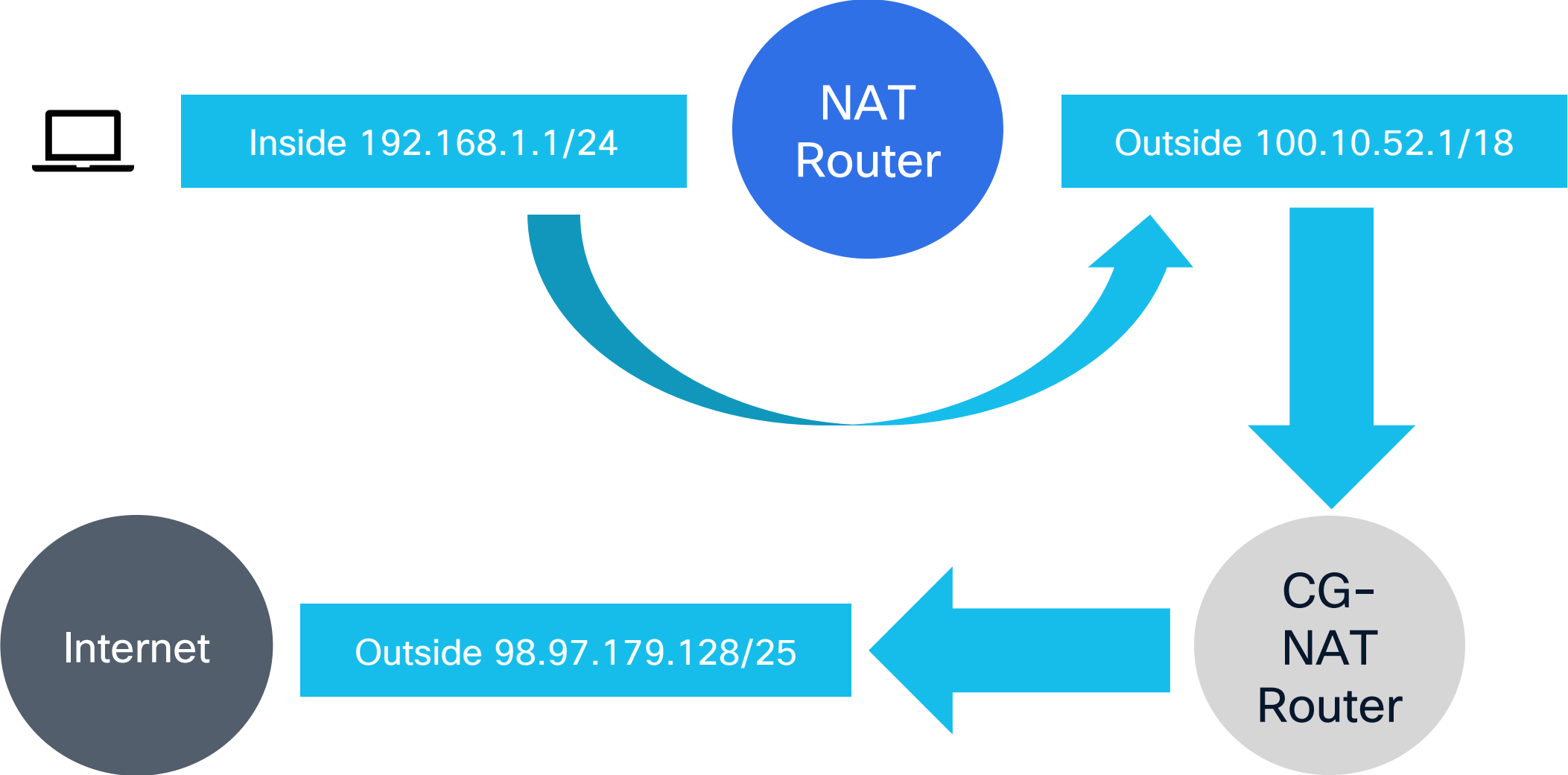
Double/Triple NAT

Double-NAT – who cares?

- Your VPN cares, depending on what you're using....



Why is NAT an issue?



Things that Fix NAT Problems

Static NAT configuration – impossible with Starlink and CG-NAT carriers

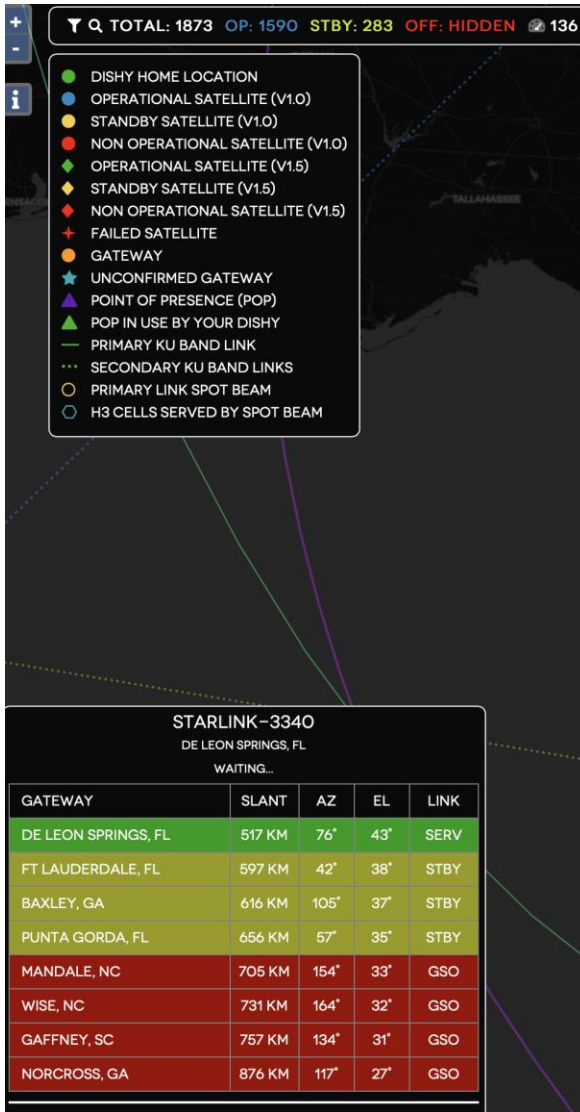
GRE/IPSec+NAT-T Tunnels

Straight NAT-T Tunnels

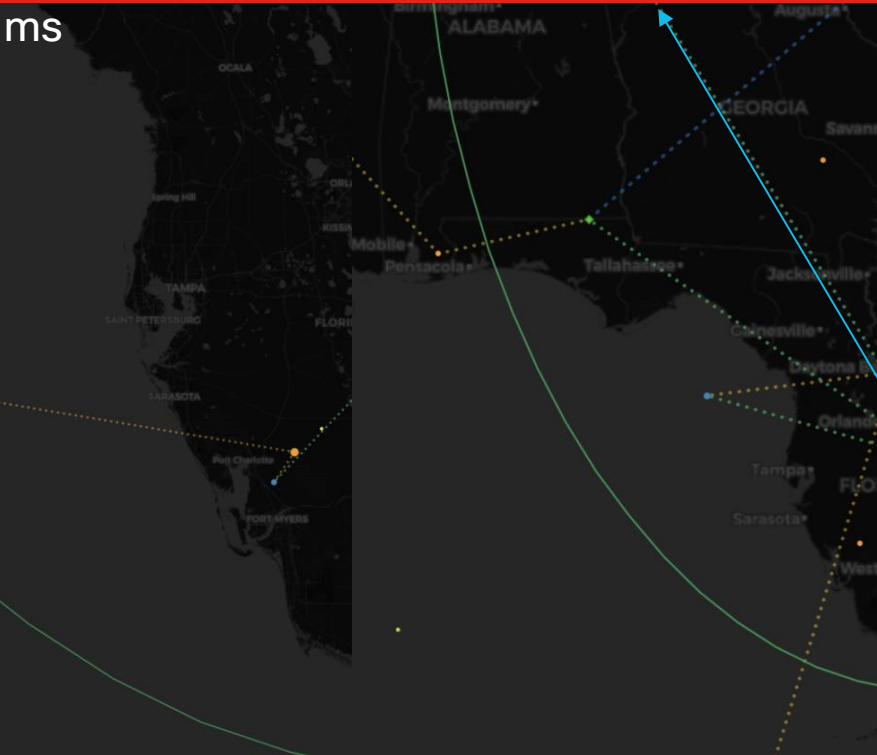
IPv6**** (maybe)

TCP VPN Tunnels

How the network works



1 gi0-0-0-18.221.agr13.mia01.atlas.cogentco.com (66.28.3.217) 0.661 ms 0.727 ms 2
te0-5-0-1.ccr21.mia01.atlas.cogentco.com (154.54.6.57) 0.896 ms te0-0-0-
11.ccr22.mia01.atlas.cogentco.com (154.54.31.229) 0.998 ms 3
be3087.ccr41.mia03.atlas.cogentco.com (154.54.88.234) 0.839 ms
be3081.ccr41.mia03.atlas.cogentco.com (154.54.88.226) 0.843 ms 4
mai-b2-link.ip.twelve99.net (213.248.75.1) 0.606 ms 0.625 ms 5
atl-b24-link.ip.twelve99.net (62.115.113.48) 14.858 ms 14.762 ms 6
spacex-svc080559-ic370374.ip.twelve99-cust.net (62.115.146.55) 14.741 ms 14.796

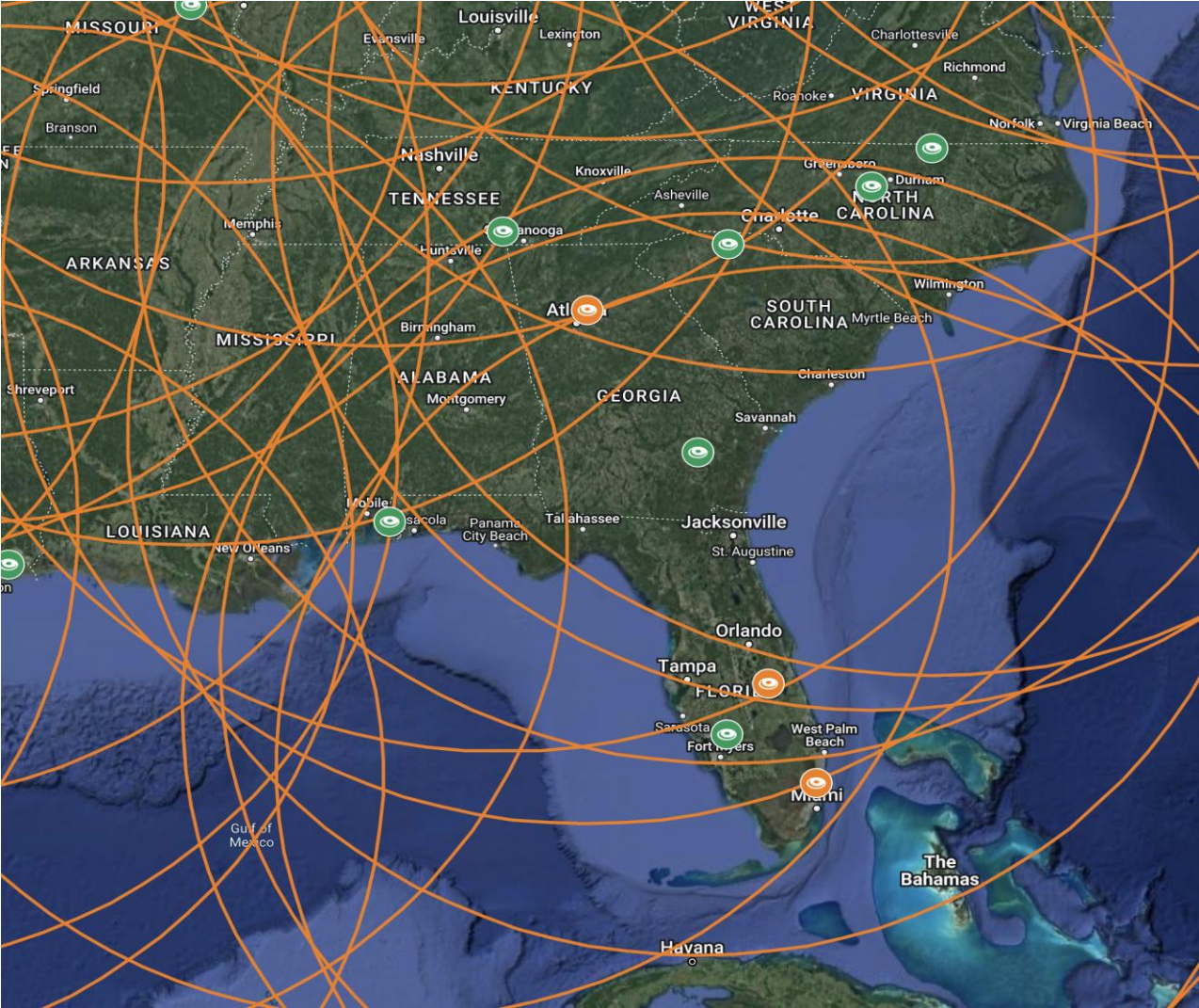


Country	🇺🇸 United States
Domain	spacex.com
ASN	AS14593
Registry	arin
Hosted IPs	128
ID	NET-SUB-98-97-178-0

WHOIS Details

NetHandle:	NET-98-97-178-0-1
OrgID:	C08091088
Parent:	NET-98-97-128-0-1
NetName:	NET-SUB-98-97-178-0
NetRange:	98.97.178.0 - 98.97.178.255
NetType:	reassignment
OriginAS:	14593
RegDate:	2021-11-05

How the network works



IP range details

98.97.179.128/25

AS14593 · Space Exploration Technologies Corporation

Summary

Country	United States
Domain	spacex.com
ASN	AS14593
Registry	arin
Hosted IPs	128
ID	NET-SUB-98-97-178-0

WHOIS Details

NetHandle:	NET-98-97-178-0-1
OrgID:	C08091088
Parent:	NET-98-97-128-0-1
NetName:	NET-SUB-98-97-178-0
NetRange:	98.97.178.0 - 98.97.178.255
NetType:	reassignment
OriginAS:	14593
RegDate:	2021-11-05

Polar Orbits and “Space Lasers”

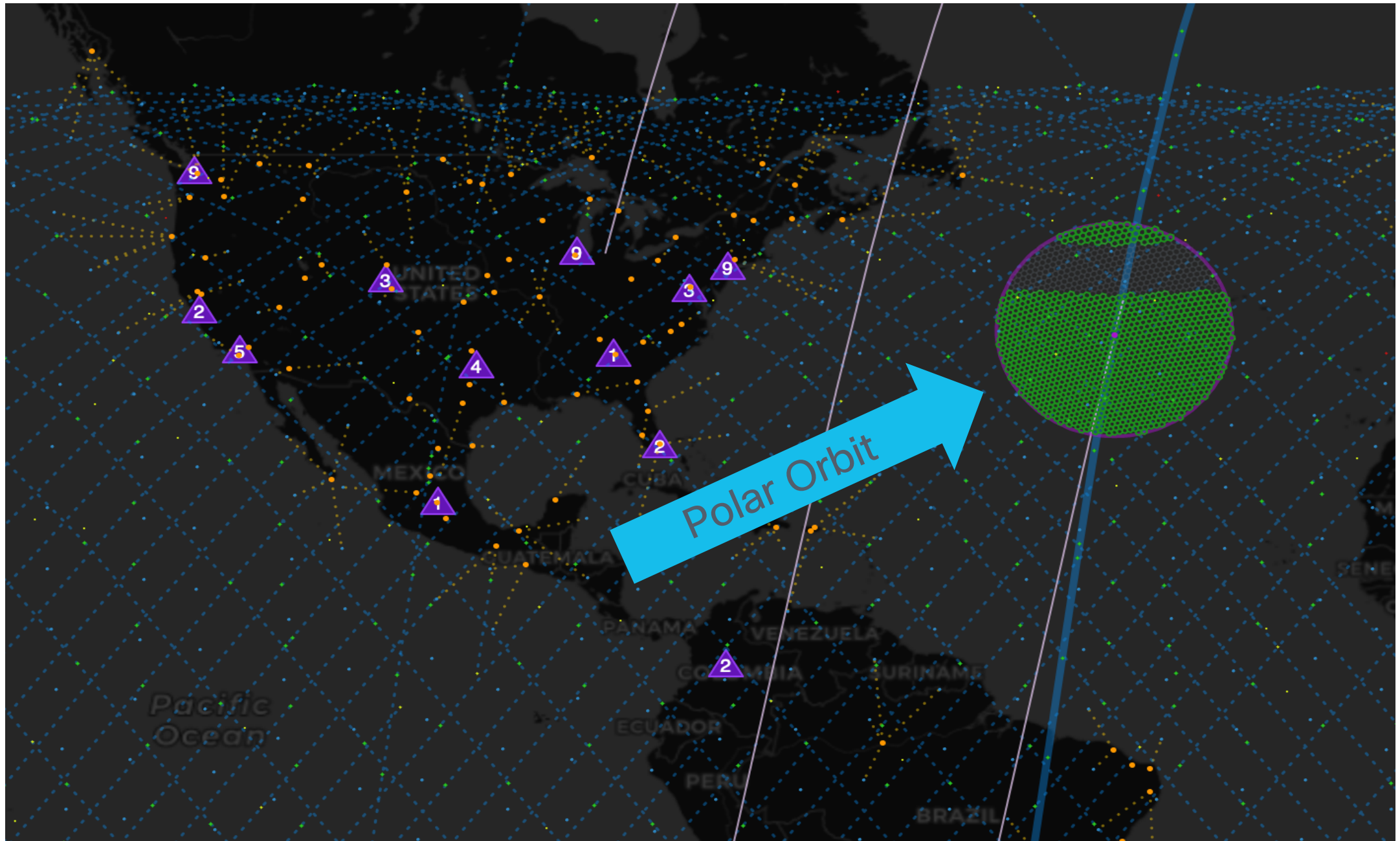
Satellite Truths and Myths

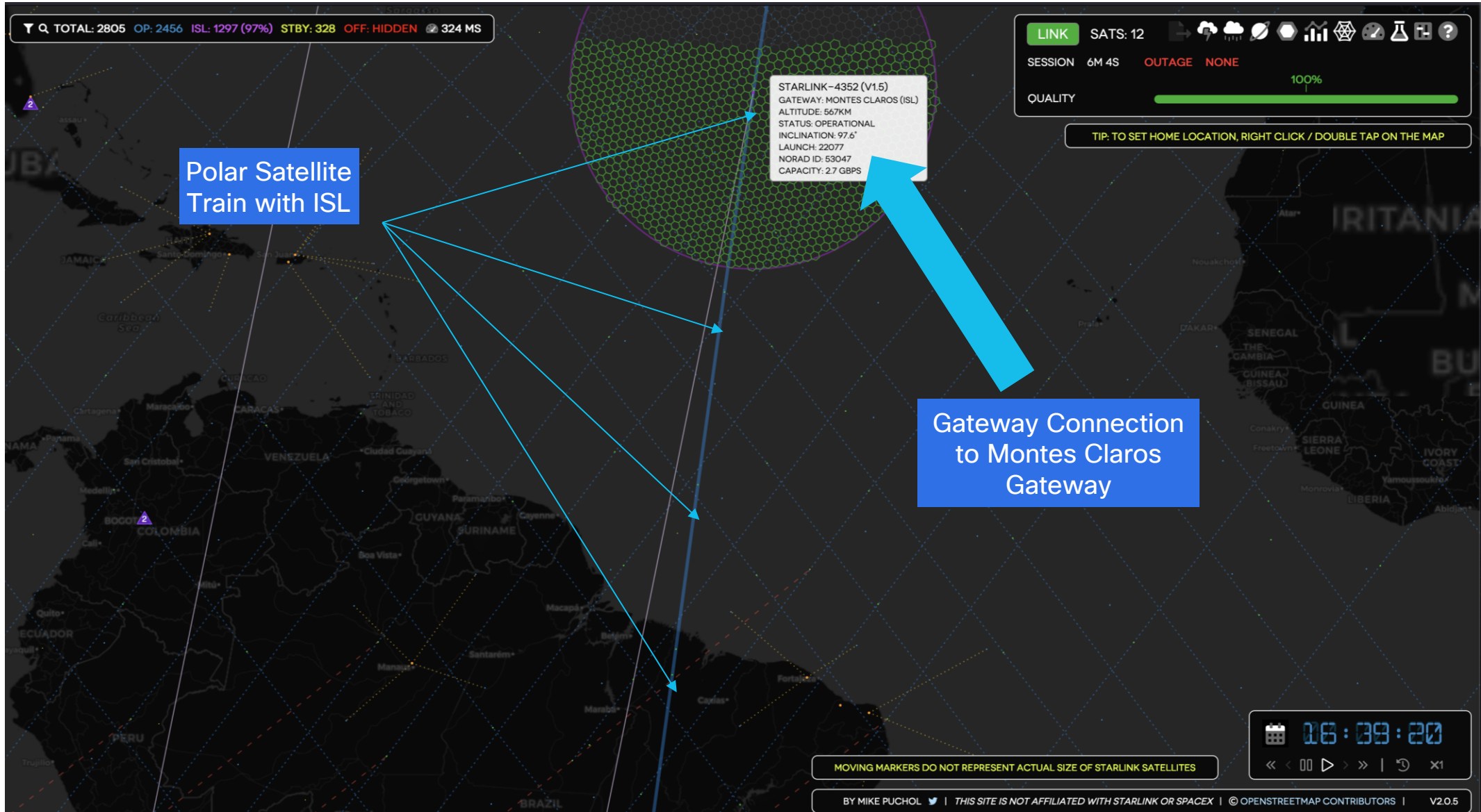
- All Starlink Satellites have “Lasers” – **FALSE**
- All Starlink Satellites can cross communicate to each other – **FALSE**
- Some Starlink Satellites have laser based optics that can point ahead of them to the next satellite – **TRUE**
- On-orbit Satellites can calculate multi-planar ephemeris to dynamically communicate to satellites in different orbits – **FALSE**

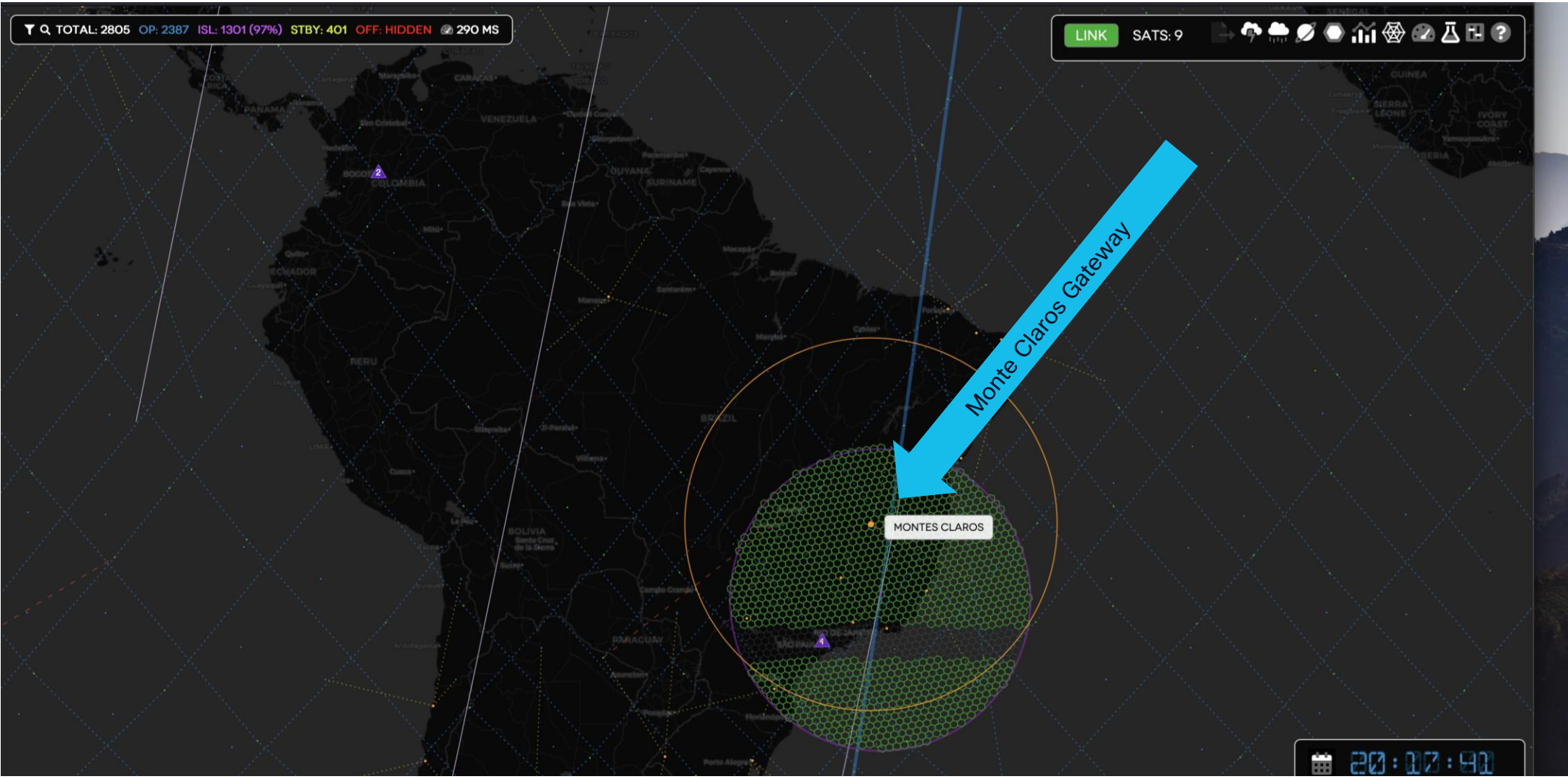
Polar Orbit Satellites and Free Space Optics

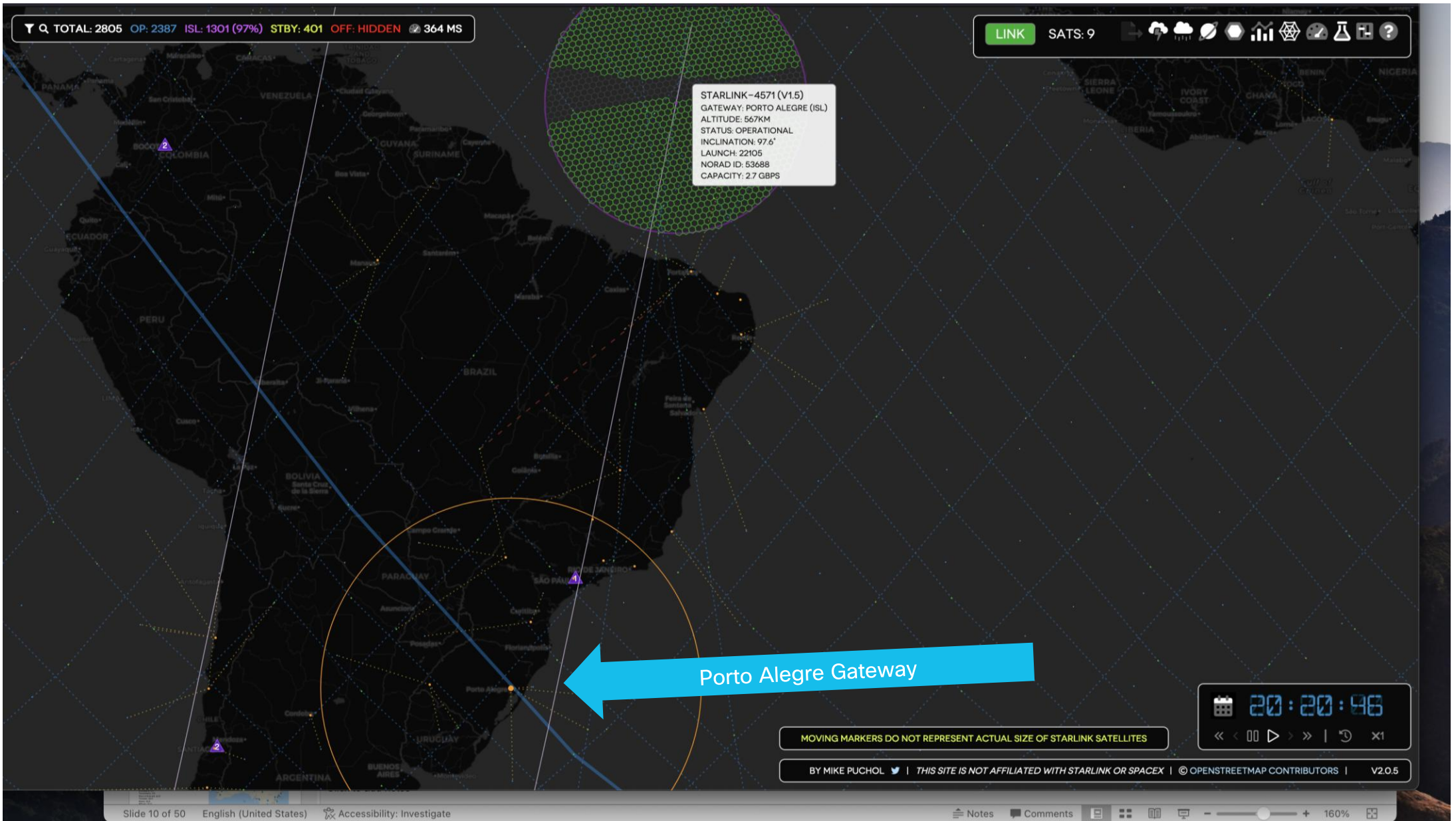
- Generation 1 Satellites are **Radio Only**
- Generation 1.5 and 2.0 Satellites are capable of Inter-Satellite Links (ISL)
- ISL Links work currently in a follow-me configuration
- A polar string of satellites provide hop to hop communications in single file
- Closest Radio Gateway provides the downlink for the chain of satellites
- Only use for satellites in polar orbits and where there is a Gateway connection
- **You may not pop-out onto the Internet in a country that you expect**
- **You may not come out in a country you want**

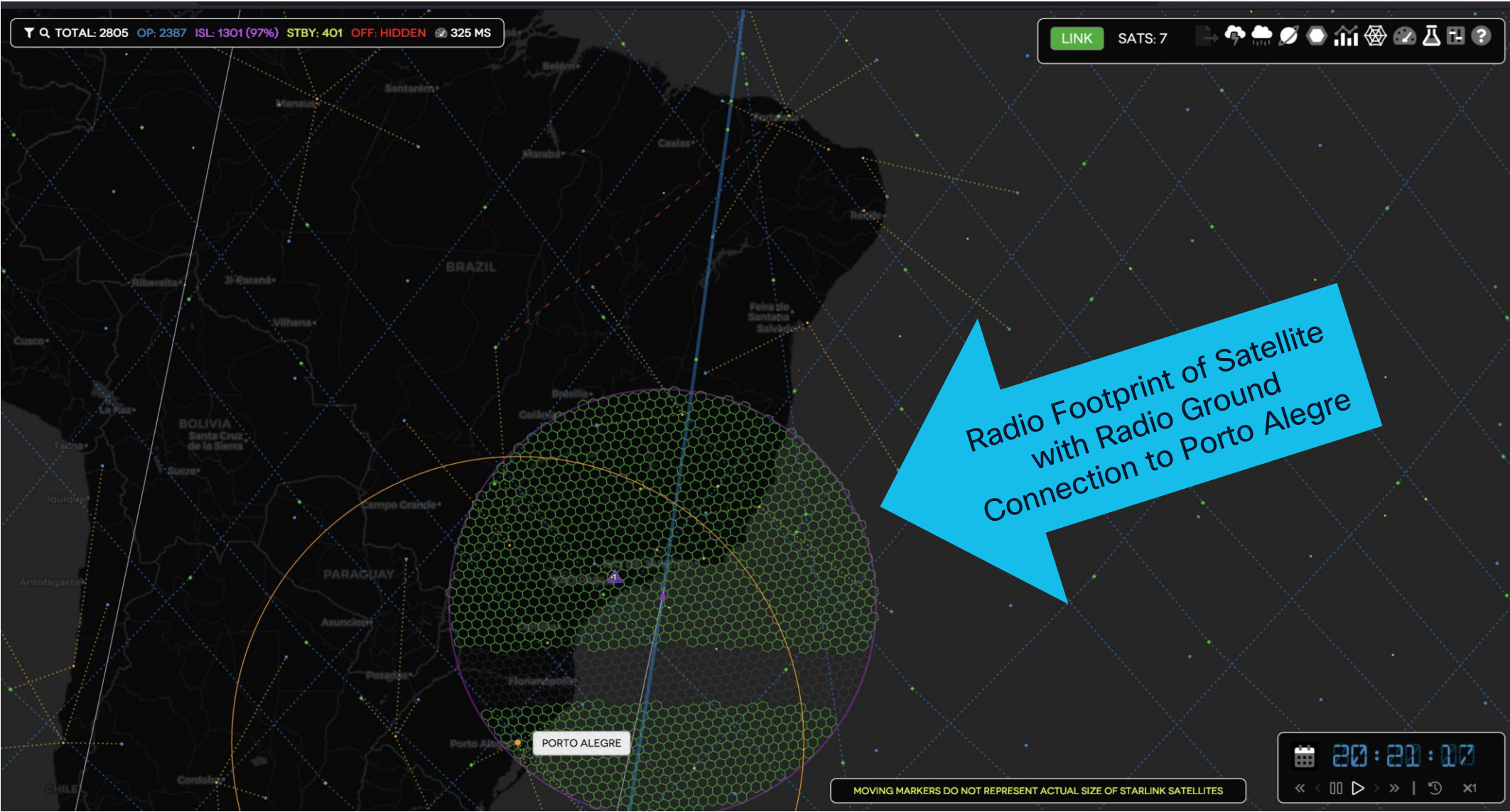
**Space Lasers fix my
networking issues**

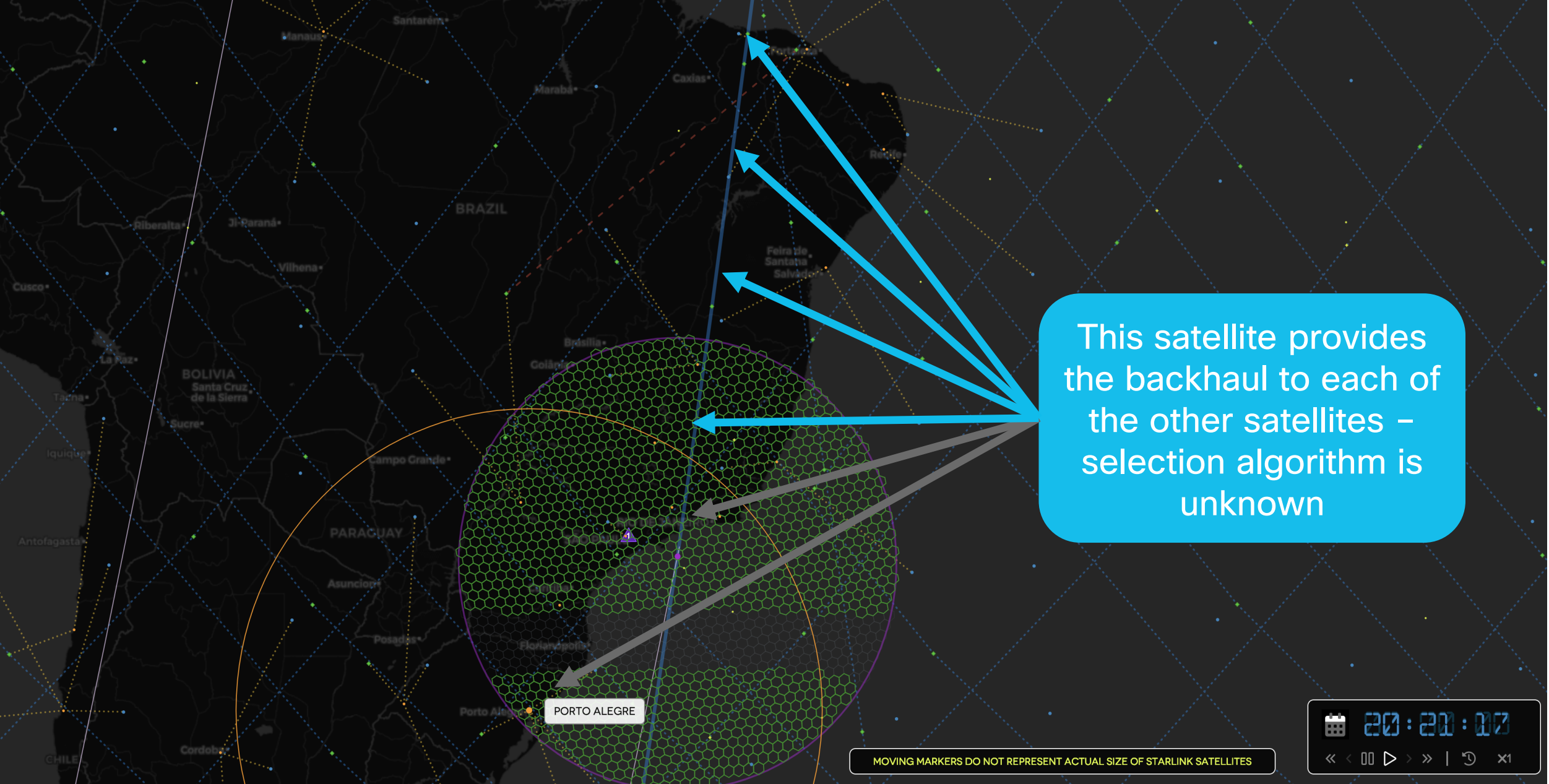




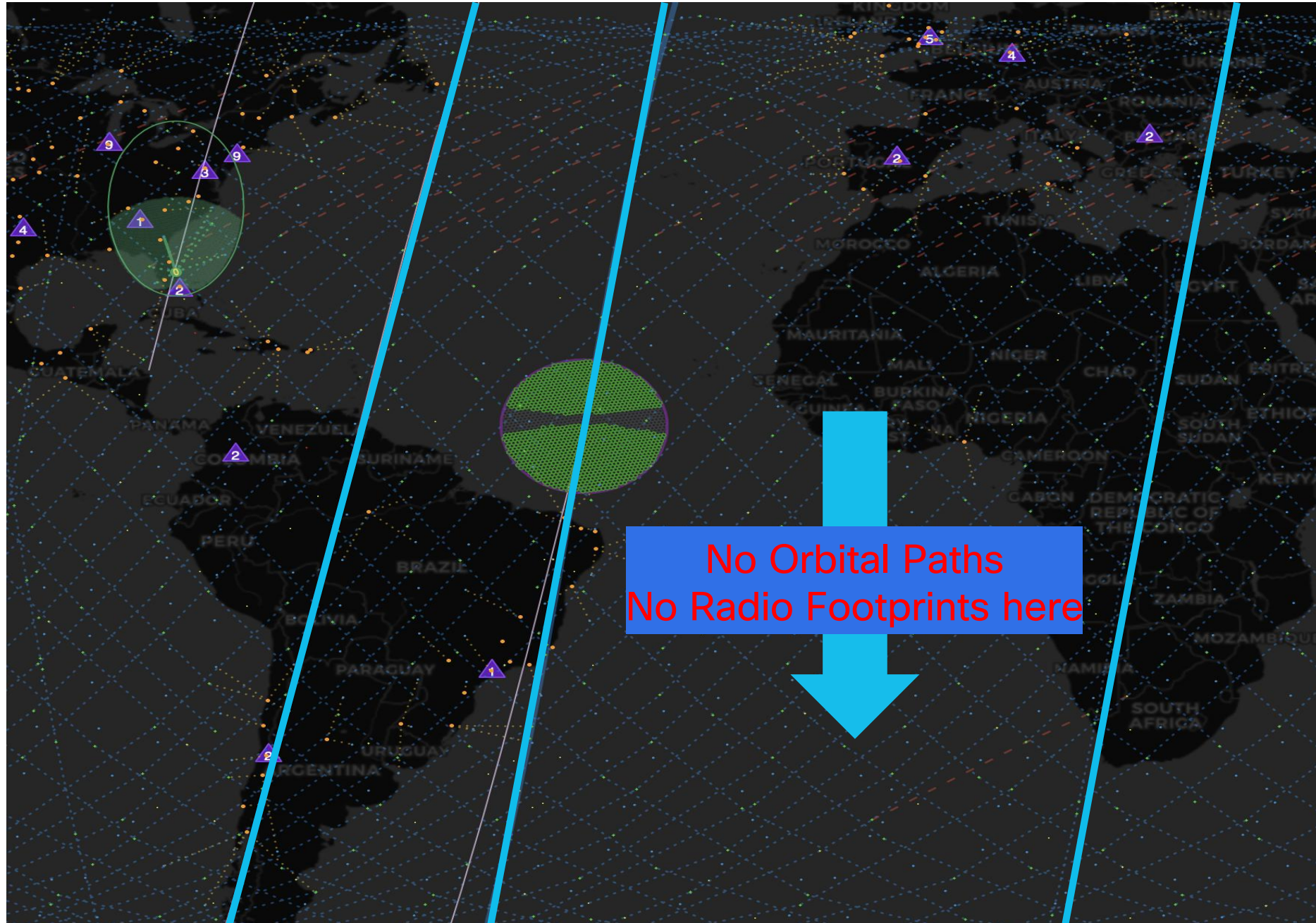


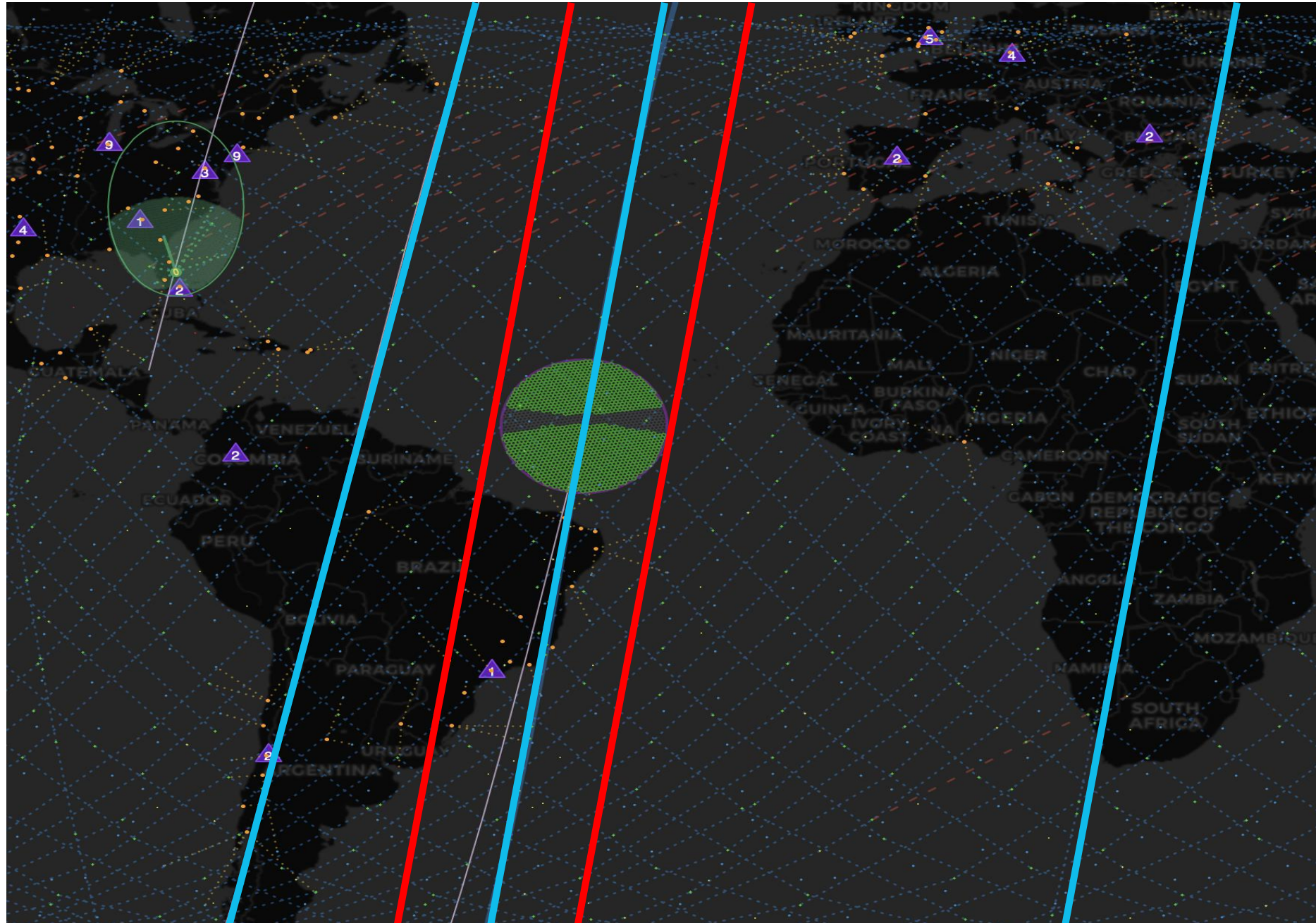


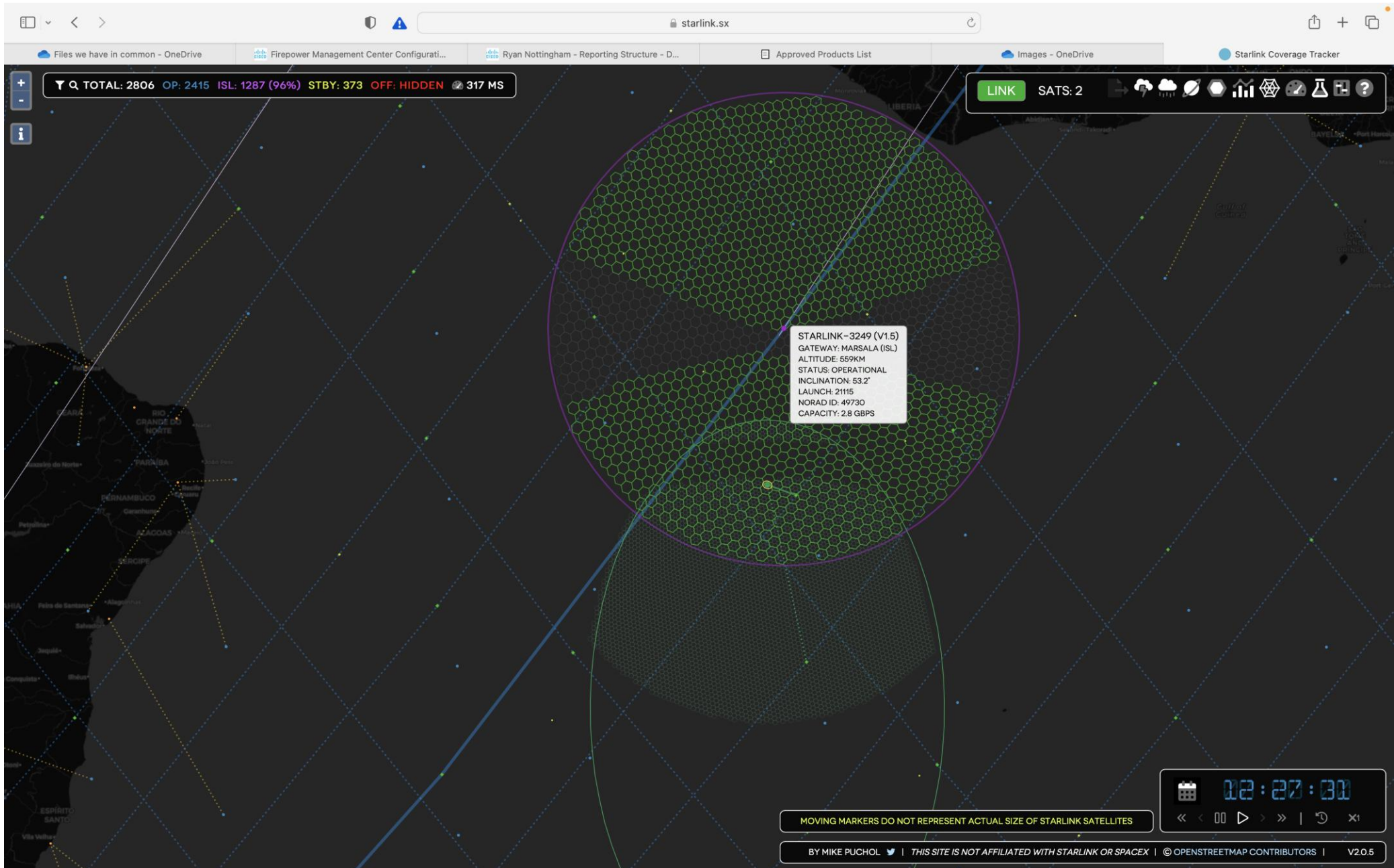




Challenges with Polar Orbits







Enterprise Customer Service Assumptions

Setting Expectations

You like Customer Service

You want a phone number to call

You like an email address for your SE

You have normal Enterprise customer networking and security requirements

You want security transparency over WAN operations

You want to be able to control your path to the Internet

Starlink Security

Sum Total of available Security

<

CONTENT FILTERING

☒

NO FILTERING

☐

MALWARE

Filter known malicious content.

☐

MALWARE AND ADULT CONTENT

Filter known adult or malicious content.

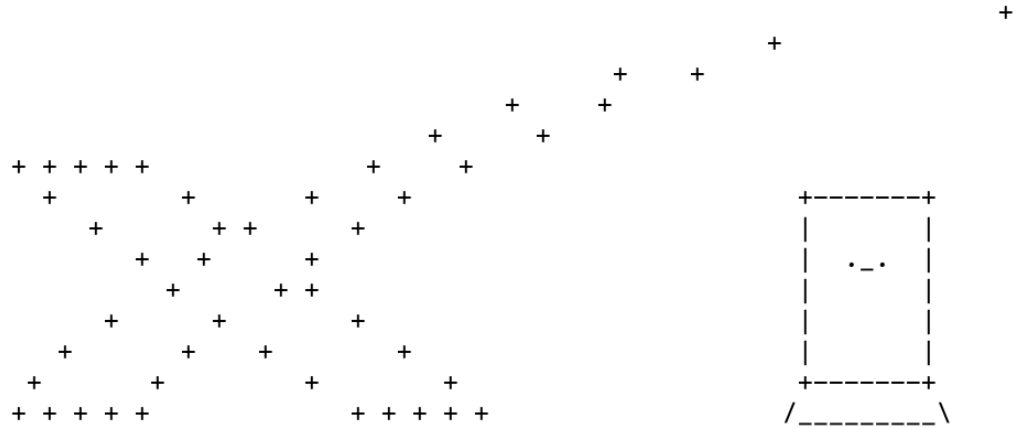
Learn more about content filtering

SAVE

BYOS – Bring Your Own Security

There is “very limited” security other than what you bring yourself

Starlink Router



When I was a kid, I wanted to be a WiFi router more than anything in the world. I stretched my arms out wide, and I hid in the corner. I tried to glue antennas to my head, I had ethernet cables, I had an LED indicator. Everybody knew me and was afraid of me. And one day, my dad said, "Bobby, you're 17. It's time to throw childish things aside," and I said, "OK, Pop." But he didn't really say that. He said, "Stop being a WiFi router and become a Dishy."

2022.19.0.mr13442

Router-01000000000000000000001F2F12

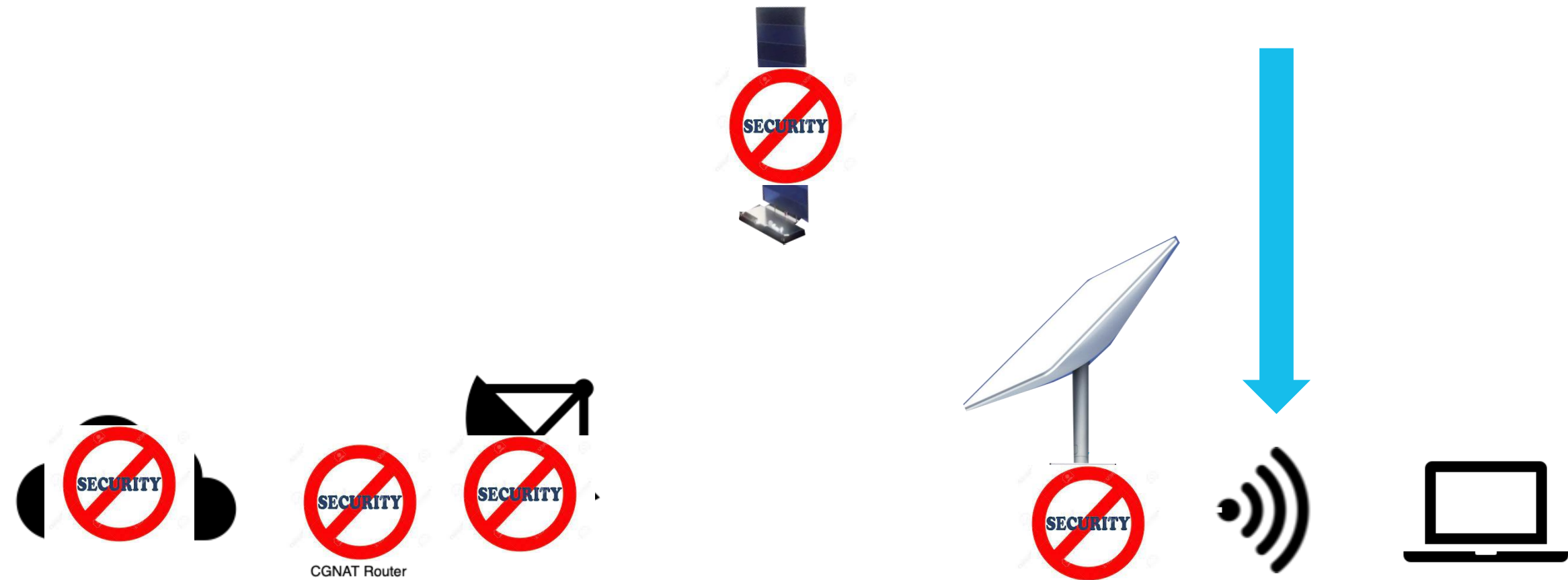
```
abenhase@192.168.1.1: Permission denied (publickey,keyboard-interactive).
abenhase@ABENHASE-M-526H .ssh %
```

- Nmap scan report for 192.168.1.1
- Host is up (0.0040s latency).
- Not shown: 994 filtered tcp ports (no-response)
- PORT STATE SERVICE
- 22/tcp open ssh
- 53/tcp open domain
- 80/tcp open http
- 9000/tcp open cslistener
- 9001/tcp open tor-orport
- 9002/tcp open dynamid
- Nmap done: 1 IP address (1 host up) scanned in 45.68 seconds

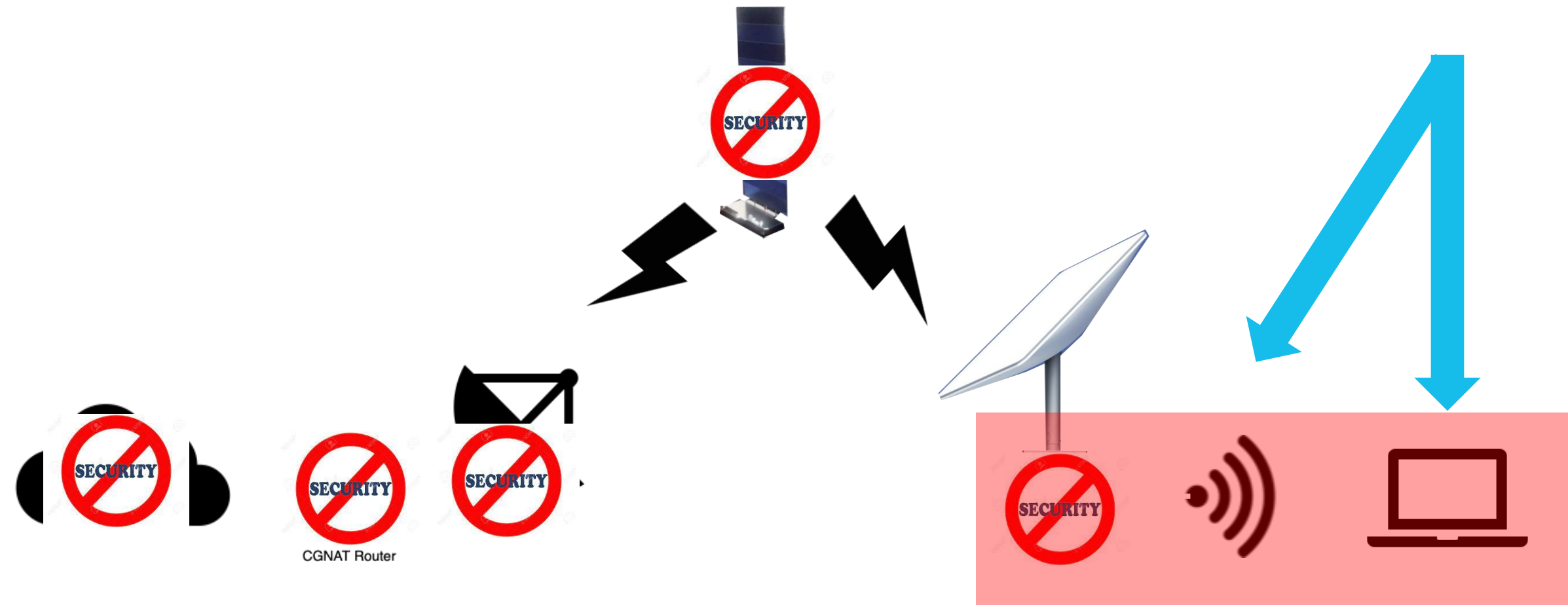
Things we know about Starlink Network

- Carrier Grade NAT (CGNAT) at the Internet Gateway
- IPv4 DHCP is assigned across the network
- IPv6 Prefix Delegation works on some Gateways
- Layer 2 network from terminal to ground to exit point (MPLS)
- Native IPSec will not work (CGNAT) 
- IPSec Encapsulation works – NAT-T (udp4500) 
- TLS VPNs work 
- There is NO local NAT configuration possible on the SL Router

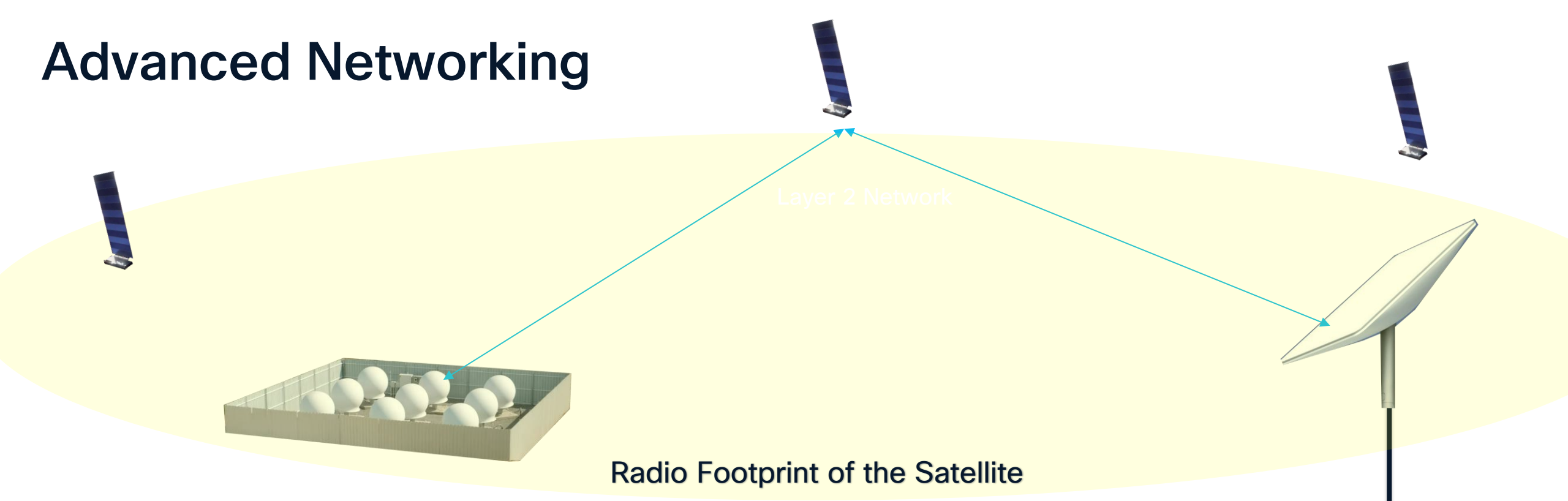
Starlink Security Today



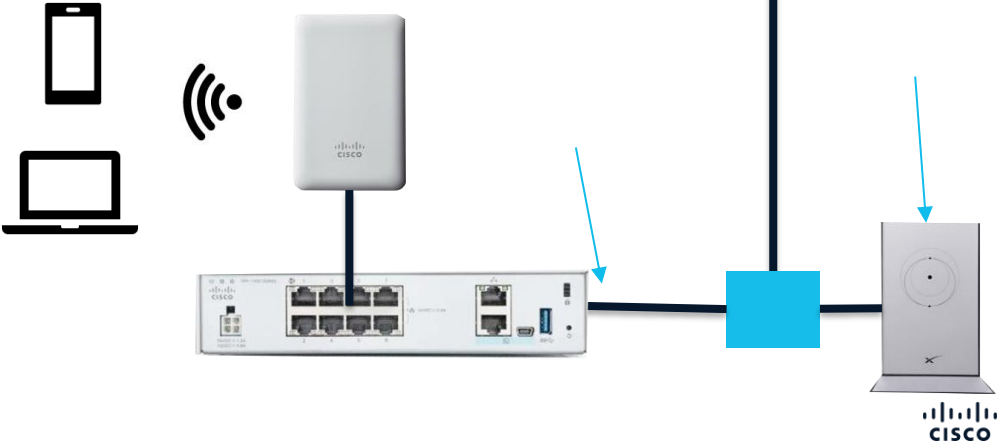
Starlink Security Today



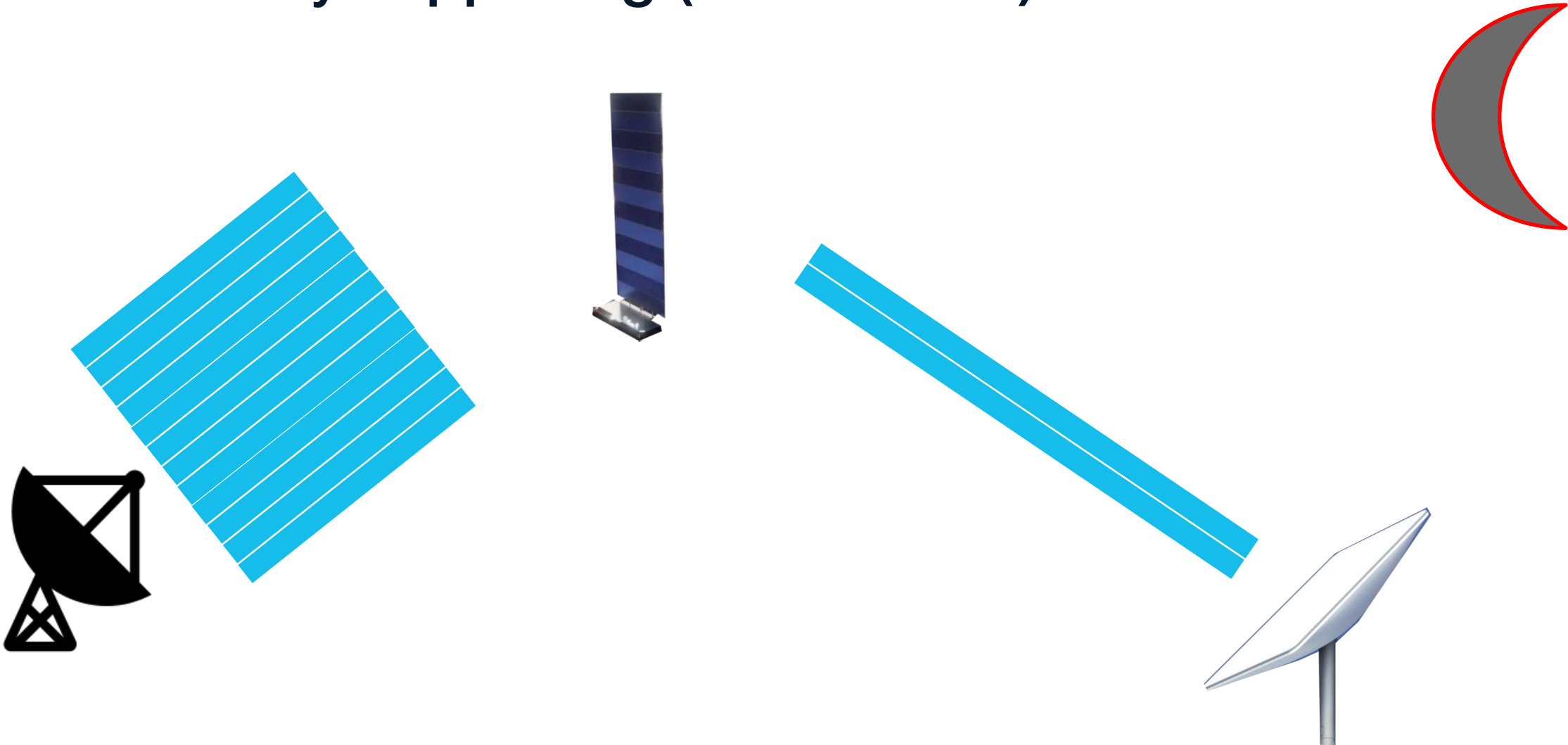
Advanced Networking



SL Router in Bypass Mode:
WIFI Gets disabled
Router is no longer locally accessible
Statistics are stored in SL Cloud
Array connects to SL Cloud and delivers updates



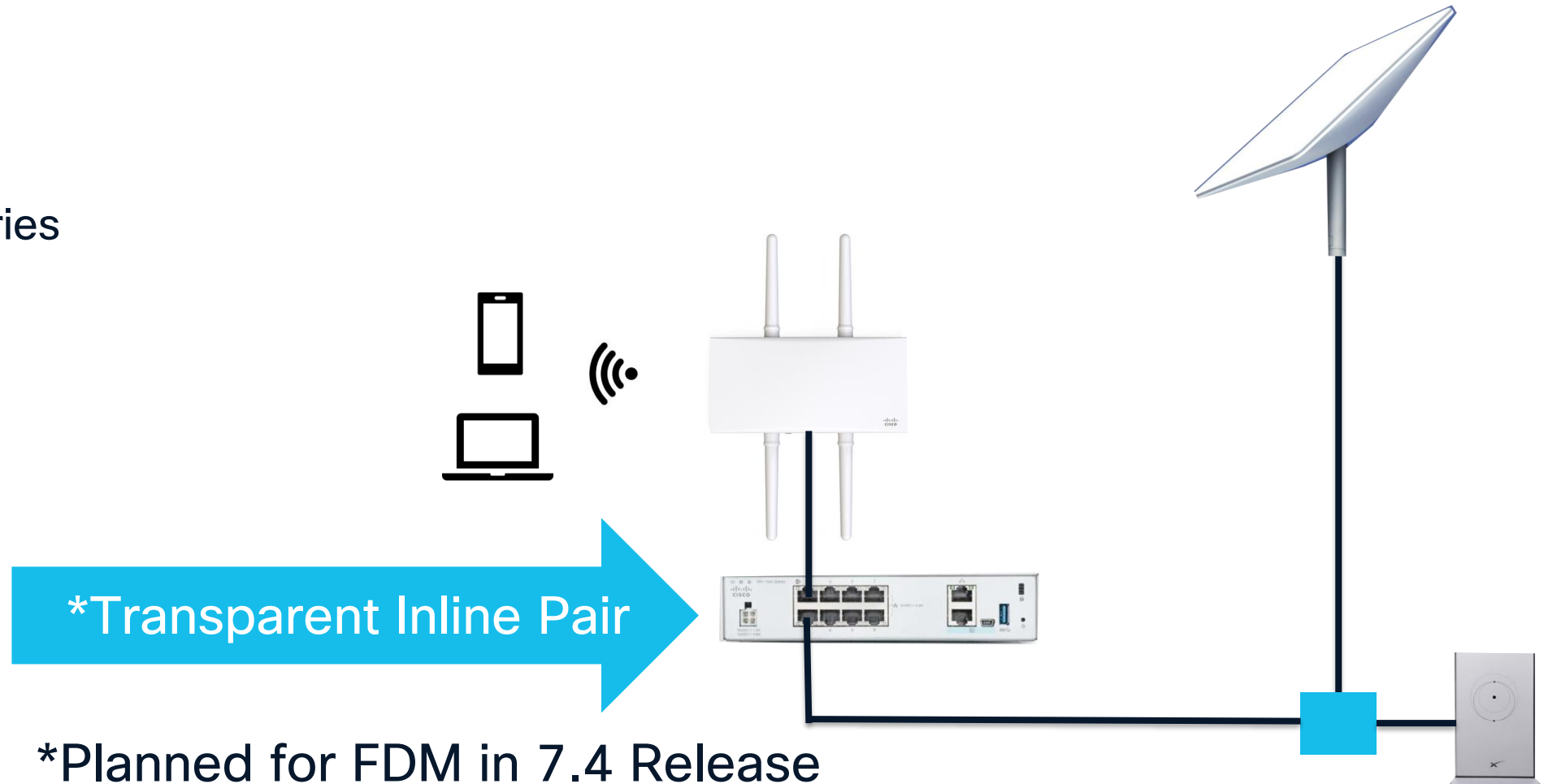
What is really happening (radio nerds)



Cisco Security + Starlink

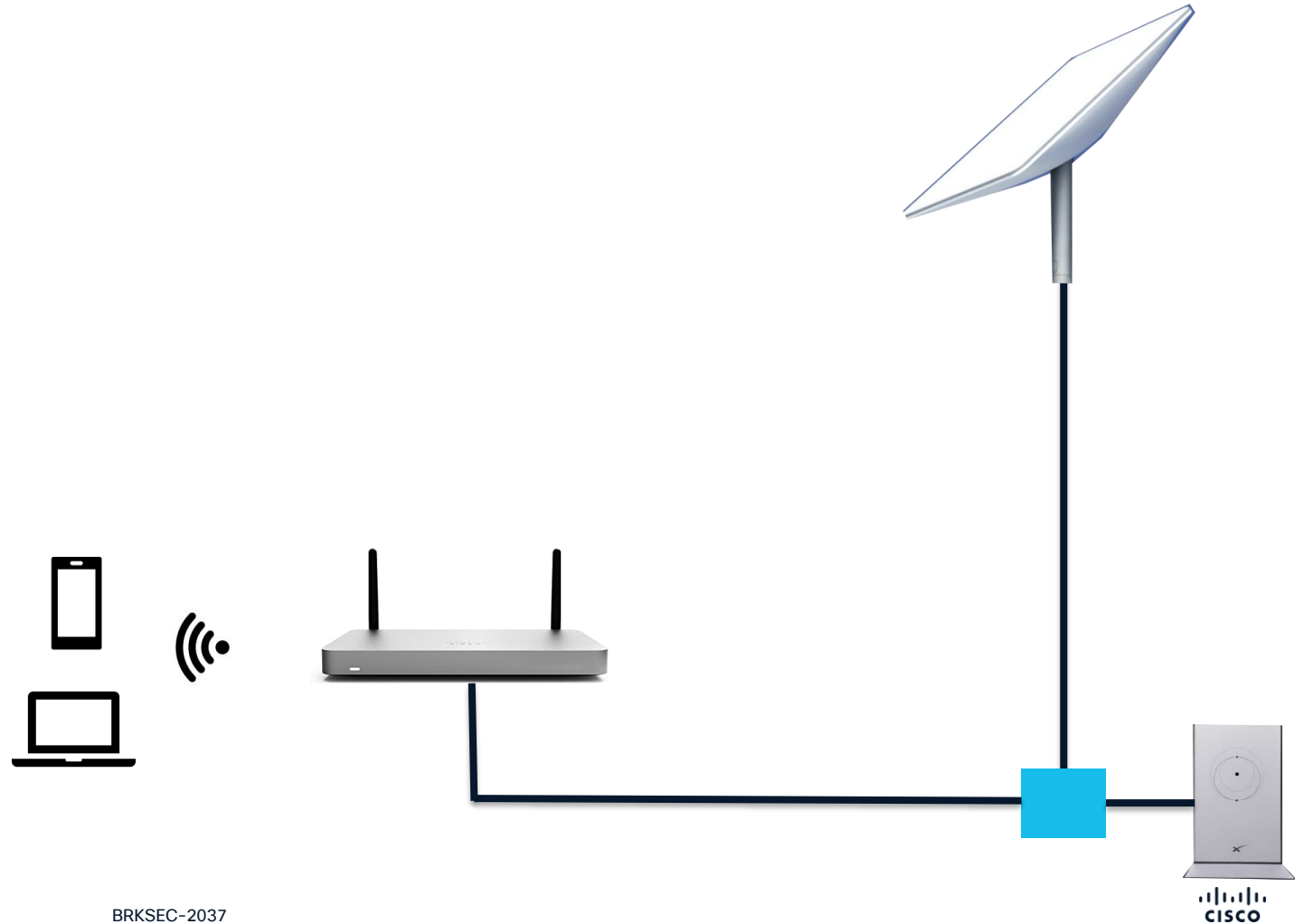
Meraki+Firepower Deployment

- MX Series
- MR Series
- Z3 Series
- Firepower 1010 Series



Meraki MX/MR/Z3 Deployment

- MX Series
- MR Series
- Z3 Series



Native IPv6 Support on MX and MR Platforms

IPv6 Support on MX Security & SD-WAN Platforms [Core Fundamentals]

Last updated: Nov 12, 2022



Note: IPv6 is an ongoing cross-product initiative for Meraki as IPv4 addresses are being exhausted and with more hosts such as IoT devices requiring addressing, IPv6 provides a new structure to accommodate a larger number of hosts.

+ TABLE OF CONTENT

This article describes general information on IPv6 Support on MX Security & SD-WAN Platforms. For more information on compatible devices, please see our [IPv6 Device Compatibility](#) documentation.

Overview

- This document describes the IPv6 functionality and configuration available on the MX Security & SD-WAN Platforms. It will include information such as: supported MX and teleworker models, minimum firmware, and how to configure and use IPv6 on a network.



Note:

- MX cannot currently function in a native IPv6-only environment. It is recommended that dual-stack is implemented in order to leverage IPv6 functionality and management.
- High-availability (HA) and template deployments are not supported at this time.

Minimum Firmware

- MX 17.5+ firmware is required for IPv6 functionality on MX Security & SD-WAN Platforms.

Supported Models

- Z3, Z3C, MX64, MX64W, MX65, MX65W, MX67, MX67W, MX67C, MX68, MX68W, MX68CW, MX75, MX84, MX85, MX95, MX100, MX105, MX250, MX450.
- All current MX/Z models listed on our website [here](#).

Meraki is the simplest security option

cisco Meraki

ORGANIZATION

Cisco Florida ▼

NETWORK

MX95 Firewall ▼

Network-wide

Security & SD-WAN

Insight

Organization

New in Dashboard: New SM features for macOS device deployments - account configurations, provisioning packages, and more.

Account recovery action needed
 You are the only administrator for this organization. If you lose access, you will need to contact support to recover access.
[Add another administrator to ensure you can recover access.](#)

Threat protection

Advanced Malware Protection (AMP)

Mode ⓘ	Enabled ⌵
Allow list URLs ⓘ	There are no URLs on the Allow list. Add a URL to the Allow list
Allow list files	There are no files on the Allow list. Add a file to the Allow list

Threat Grid

Mode	Enabled ⌵
Rate limit	

Intrusion detection and prevention

Mode ⓘ	Detection ⌵
Ruleset ⓘ	Balanced ⌵
Allow list rules ⓘ	There are no IDS rules on the Allow list. Add an IDS rule to Allow list

Summary

Uplink

DHCP

IPv6 Prefixes

Location

Tools

Configuration

General

Public IP

192.168.1.2

customer.atlagax1.pop.starlinkisp.net

WAN 1

Type

IPv4

IPv6

Configured as

Dynamic

Auto (DHCP6)

Status

Active

Active

IP address

192.168.1.164

fd5e:9a9e:c5bd:10::d0b

Gateway

192.168.1.1

fe80::7624:9fff:feaf:2f12

DNS

192.168.1.1

fd5e:9a9e:c5bd:10::d0b

WAN 2

Type

IPv4

IPv6

Configured as

Dynamic

Auto (Stateless)

Status

Not connected

Not connected

Live data

Uplink traffic

600 Kb/s

Total

Download

Historical device data

for the last day

Connectivity to 8.8.8.8

Meraki is the simplest IPv6 Deployment Option

- Takes the downstream Prefix Delegation
- Automatically deploys it to the downstream networks
- Clients will be assigned IPv6 address out of your assigned Prefix

Summary Uplink DHCP **IPv6 Prefixes** Location Tools

Delegated Prefixes

! WAN 2 is not connected. Prefixes assigned to this uplink won't be effective until the uplink becomes active. x

Search by prefix or source name Add new prefixes

No prefix info is available.

NAT Pool

WAN 1: fd5e:9a9e:c5bd:18::/96

VLAN Assignments

Search by prefixes or VLAN name

VLAN ID	VLAN name	Subnet prefix	Origin	Delegated prefix	Prefix status ⓘ
		fd5e:9a9e:c5bd:19::/64	WAN 1	fd5e:9a9e:c5bd:19::/64	Active

Keep it simple, don't overcomplicate things



Actual Working Things

Global Overview

Organization

Cisco Florida

Network

MX95 Firewall

Network-wide

Security & SD-WAN

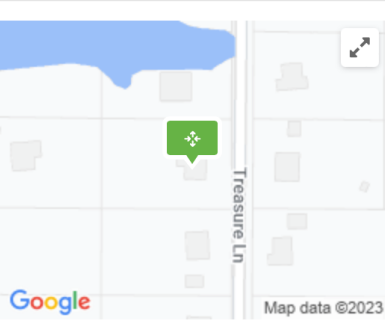
Insight

Organization

[Add another administrator to ensure you can recover access.](#)

● **Starlink-MX95**

MX95 a8:46:9d:3c:b6:d2



ADDRESS
5840 Treasure Lane, Grant, Florida 32949

WARM SPARE

Configure warm spare

WAN 1
98.97.181.203 Active
2605:59c8:6087:3a10::d0b Active

WAN 2

HOSTNAME
grant-florida-rckhqznmqc.dynamic-m.com

SERIAL NUMBER
Q2XN-CRBC-3HG5

TAGS

NOTES

Configuration

General

PUBLIC IP

WAN 1

TYPE

CONFIGURED AS

PREVIOUS STATUS

IP ADDRESS

GATEWAY

DNS

WAN 2

TYPE

CONFIGURED AS

STATUS

Live data

Uplink traffic



peplink

General

Logout

WAN Connection Status

Independent from Priority

Starlink	Connected via Starlink	192.168.1.21
1 Verizon-Cisco	Connected to Verizon LTE-A	100.103.182.178
2 WAN-WIFI	Connected to GigE-Spectrum	192.168.1.108

Priority 1 (Highest)

1 WIFI-WAN 2.4Ghz	Scanning...	(No IP Address)
-------------------	-------------	-----------------

Priority 2

2 T-Mobile	No Device Detected	(No IP Address)
------------	--------------------	-----------------

Priority 3

Drag desired (Priority 3) connections here

Disabled

VLAN WAN 1	Disabled	(No IP Address)
------------	----------	-----------------

LAN Interface

Router IP Address: 192.168.50.1

WI-FI AP

ON Status

2.4 GHz 5 GHz Pepwa (United ...	2.4 GHz 5 GHz Pepwa (United ...	2.4 GHz 5 GHz Pepwa (United ...	2.4 GHz 5 GHz Pepwave-WIFI
---------------------------------	---------------------------------	---------------------------------	----------------------------

SpeedFusion Connect Protect

SFC-ATL	Established
SFC-CHI	Established
SFC-MIA	Established

Data usage allowance: 1003.20 GB (Expiry date: Apr 11, 2024)

GPS

27.919592° N 80.549754° W

© OpenStreetMap contributors.

Device Information

Model: Peplink MAX Transit Duo Pro

WAN Connection Status			?
Independent from Priority			
Starlink	Connected via Starlink	192.168.1.21	
1 Verizon-Cisco	Connected to Verizon LTE-A	100.103.182.178	
2 WAN-WIFI	Connected to GigE-Spectrum	192.168.1.108	

Makes forwarding decision based on API feedback

Priority 1 (Highest)
1 WIFI-WAN 2
Priority 2
2 T-Mobile
Priority 3
Disabled
VLAN WAN 1

IPv6
Enabled

DNS over HTTPS
Enabled

WAN Quality Monitor
Auto

Synergy Controller
Disabled

Starlink
Enabled WAN Connection(s): Starlink

What Is My IP?

My Public IPv4: [98.97.18.37](#)

CG-NAT IP

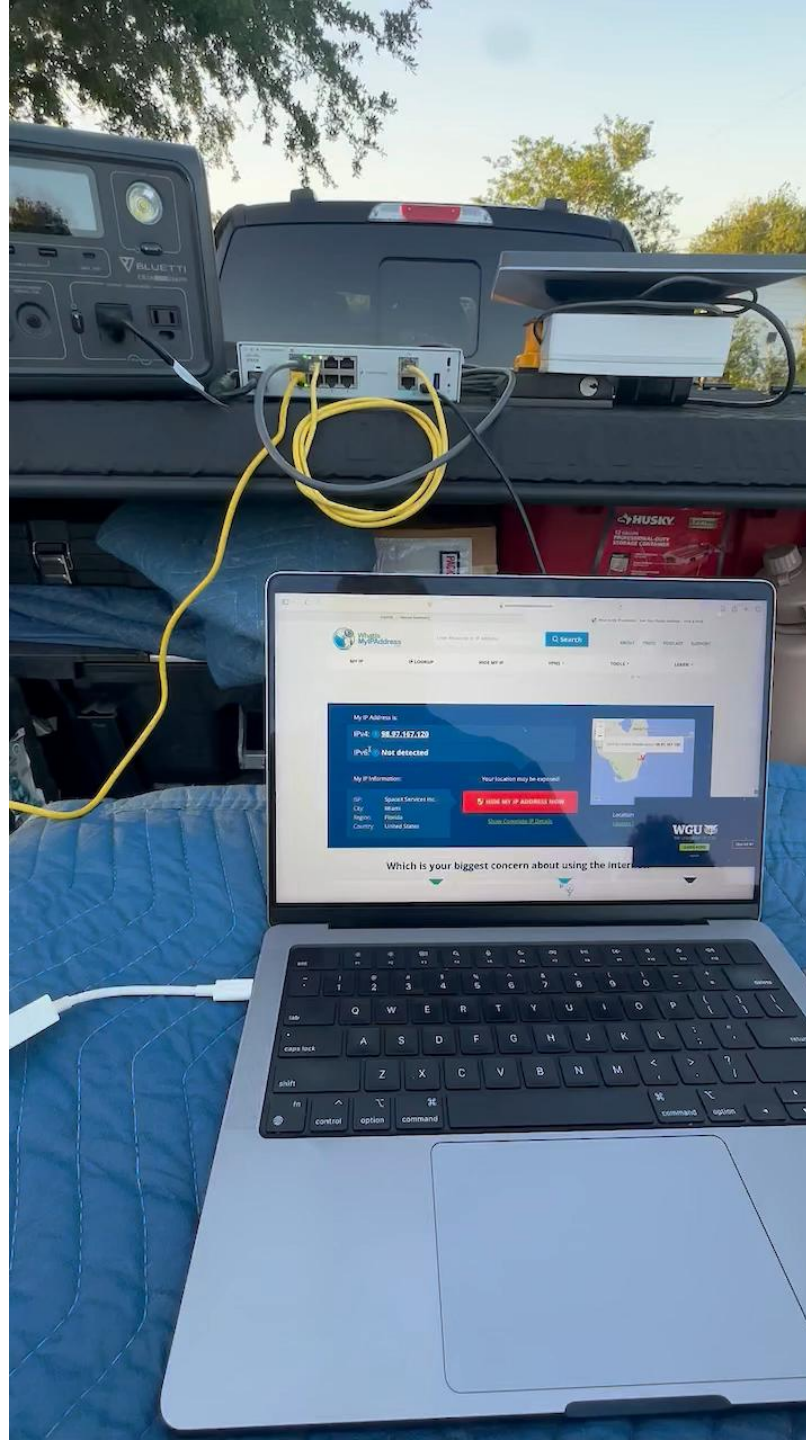
My Public **IPv6**: [2605:59c8:2103:7310:654e:1122:4a82:e20a](#)

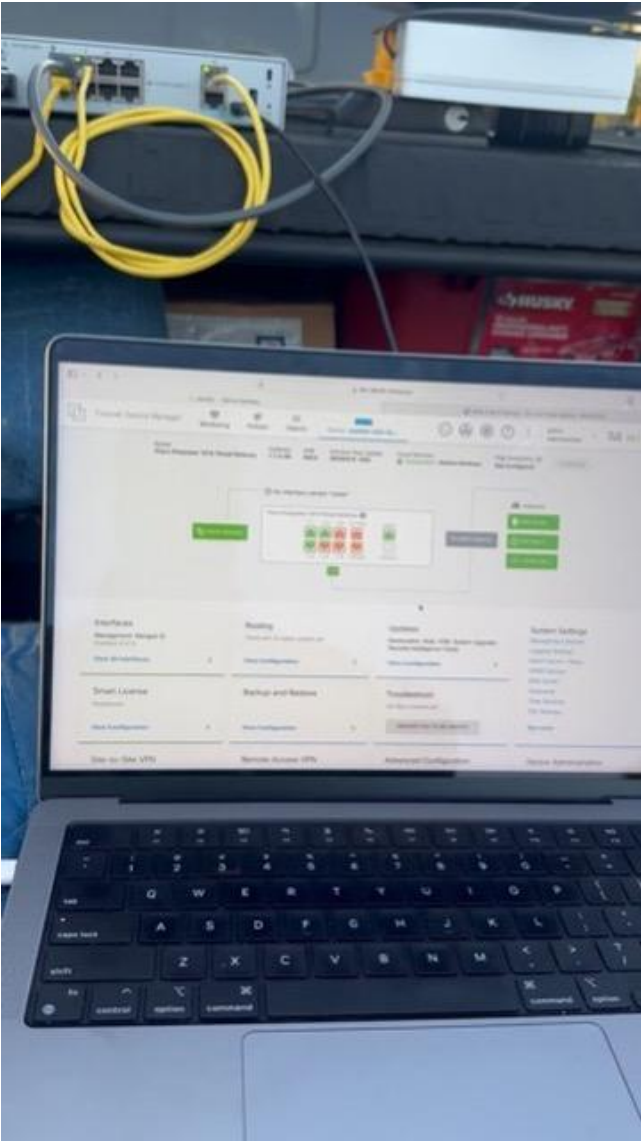
My IP Location: New York City, NY US

My ISP: SpaceX Services Inc.

Actually does API lookups

Small Things working







19:51



Power draw

00580d0e-46017919-183530dd

Starlink

Power draw

22 W

Average

20 W

Current



What is power draw?

Power draw measures the amount of power the Starlink terminal uses. Starlink will use more power while heating to melt snow.

19:51



Statistics

00580d0e-46017919-183530dd

Ping success

97.80 %

last 15 minutes

Latency

29 ms

median, last 15 minutes

Power draw

22 W

average, last 15 minutes

Throughput

0 Mbps

download

Outages

2 outages >2s in the last 15 minutes

Bigger Things working



FLAT HIGH PERFORMANCE KIT (NO ROUTER)



SN: KITP00350021 PN: 02541705-501/D



 **ZICTA**

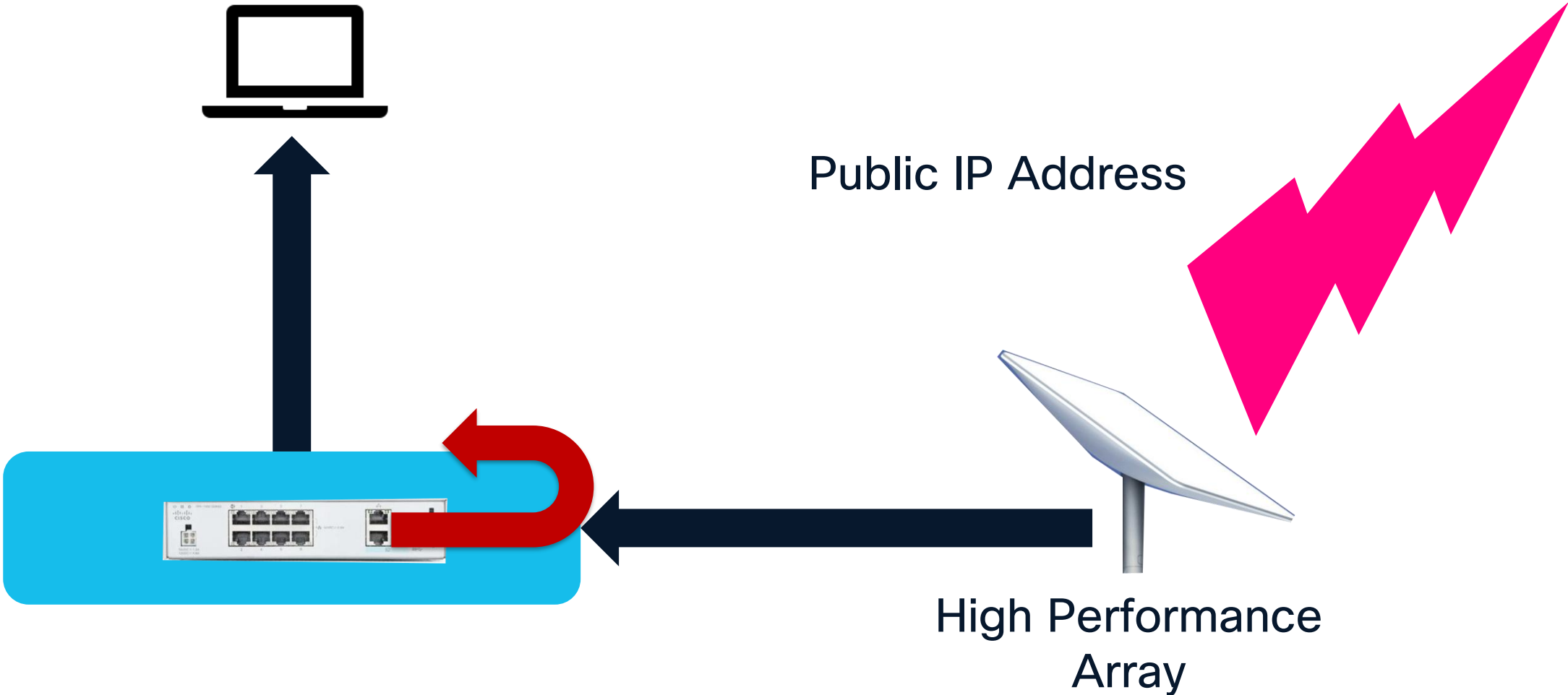
STLXX01073

Qty: 1

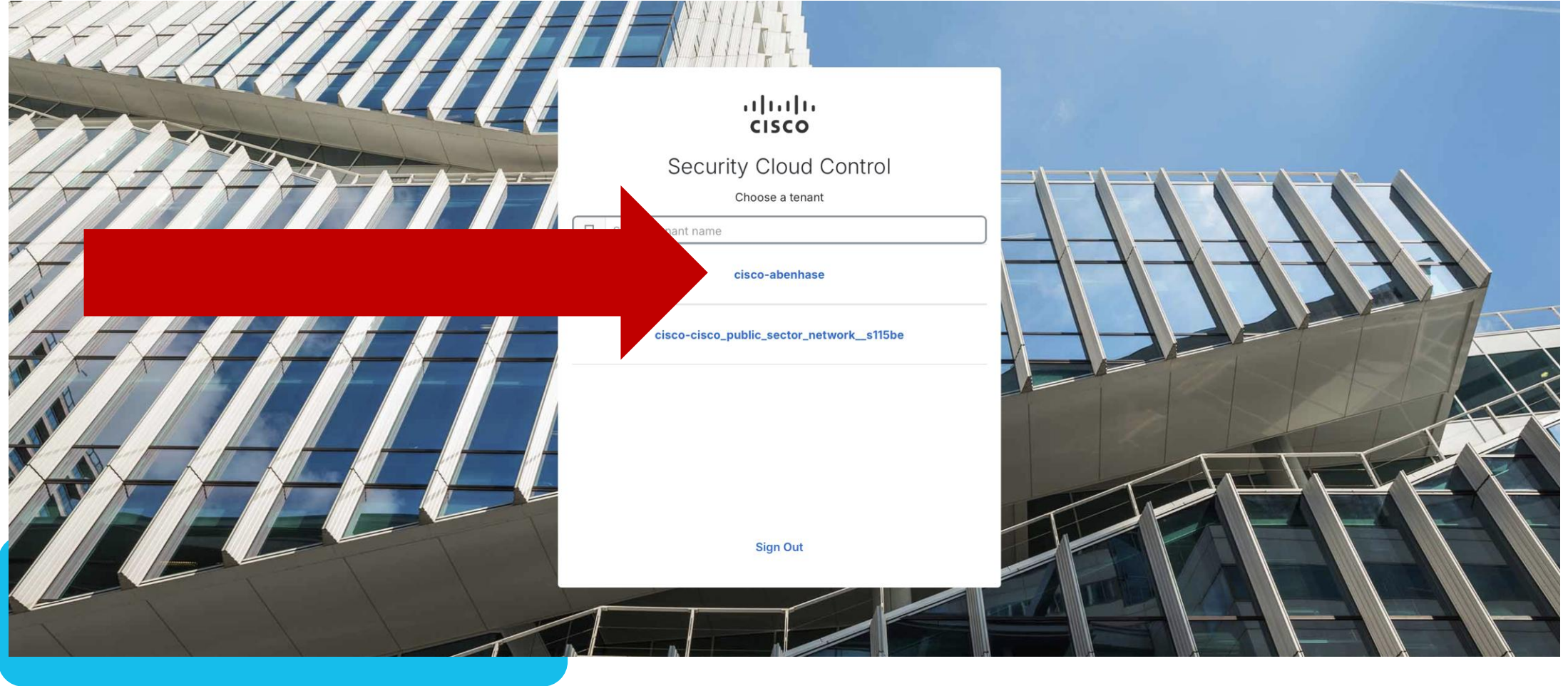
INTERNET KIT, STARLINK MOBILITY
(TYPE B)



High Performance Networking



High Performance Networking



Internet Firewall Management

Security Cloud Control

Type 'Ctrl' + '/' to search

cisco-abenhase

abenhase@cisco.com

Dashboard

Multicloud Defense

Monitor

Insights & Reports

Events & Logs

Manage

Policies

Objects

Security Devices

Secure Connections

Administration

Event Logging

Historical

Live

Search by event fields and values or use one of the sample searches

Search

Storage Utilization

UTC Time

Local Time

All times shown in Local (EDT)

Views

View 2

Date/Time	Device Type	Event Type	Sensor ID / Hostname	Initiator IP	Responder IP	Responder Port	Protocol	Action	Policy	Device	Reason
⌚ Waiting for matching events after 17:25:13.											
Jun 8, 2025, 17:25:08	FTD	Connection	firepower	135.129.118.152	173.243.0.154		icmp	Allow	Starlink-HS-Policy	Florid...	
<div><div><div>ClientAppDetectorID</div><div>ClientApplication</div><div>ClientApplicationID</div><div>ClientApplicationProductivityIndex</div><div>ClientApplicationRiskIndex</div><div>ConnectionDuration</div><div>ConnectionID</div><div>ConnectorID</div><div>Device</div><div>DeviceIP</div><div>DeviceType</div><div>DeviceUUID</div></div><div><div>0</div><div>ICMP client</div><div>2000003501</div><div>3</div><div>3</div><div>0</div><div>41890</div><div>4249b8ee-4c0c-4f12-8bd5-76b2bdb3db5e</div><div>Florida-StarlinkHS-1010</div><div>172.16.0.56</div><div>FTD</div><div>682a33dc-1957-11f0-bfe2-e81fb1761c16</div></div></div> <div><div><div>FirewallRule</div><div>FirewallRuleList</div><div>FirstPacketSecond</div><div>Hostname</div><div>ICMP_Code</div><div>ICMP_CodeID</div><div>ICMP_Type</div><div>ICMP_TypeID</div><div>IngressInterface</div><div>IngressZone</div><div>InitiatorBytes</div></div><div><div>Inside-to-Outside</div><div>Inside-to-Outside;Monitor</div><div>Jan 21, 1970, 01:56:57</div><div>firepower</div><div>No Code</div><div>0</div><div>Echo Request</div><div>8</div><div>Inside</div><div>Inside</div><div>42</div></div></div> <div><div><div>LastPacketSecond</div><div>NAP_Policy</div><div>NetmapID</div><div>PrefilterPolicy</div><div>Protocol</div><div>ResponderBytes</div><div>ResponderBytesDropped</div><div>ResponderIP</div><div>ResponderPackets</div><div>ResponderPacketsDropped</div><div>Timestamp</div></div><div><div>Jan 21, 1970, 01:56:57</div><div>Balanced Security and Connectivity</div><div>1</div><div>Starlink-Prefilter</div><div>icmp</div><div>42</div><div>0</div><div>173.243.0.154</div><div>1</div><div>0</div><div>Jun 8, 2025, 17:25:08</div></div></div>											

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BRKSEC-2037

CISCO

Cisco Confidential

Firepower Management Center...on the Internet

Security Cloud Control

Q Type 'Ctrl' + '/' to search



Dashboard

Multicloud Defense

Monitor

Insights & Reports >

Events & Logs >

Manage

Policies >

Objects

Security Devices

Secure Connections >

Administration

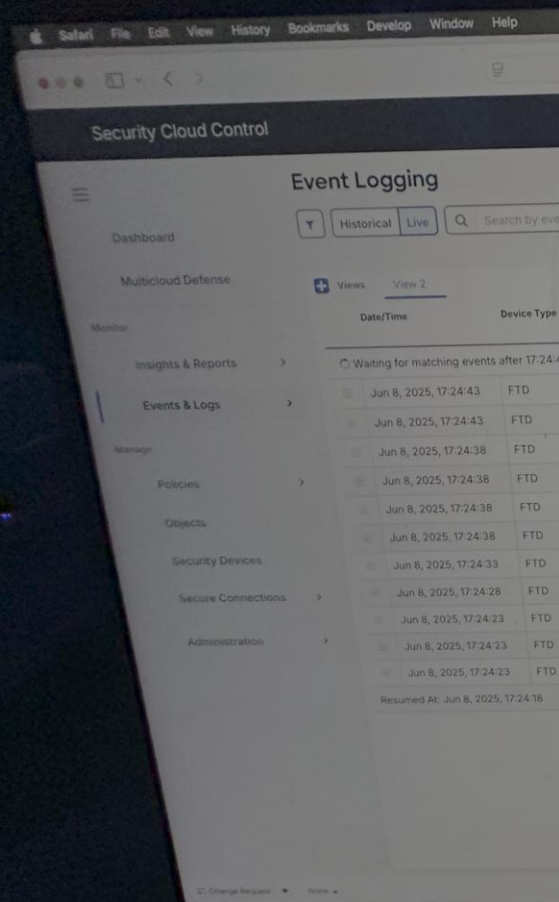
Objects

8

Q Search for objects by name, IP, or port number

Displaying 33 of 33 objects

☐	Name	Devices	Type	
☐	Any IPv4	1	Network Object	-
☐	Any IPv6	1	Network Object	-
☐	Cisco Adaptive Security Virtual Appliance -ASAv- -BYOL-9-16-1-AutogenByAWSMP-	1	Cloud Security Group	-
☐	Cisco Catalyst 8000V Edge Software - BYOL-17.07.01a-AutogenByAWSMP--1	1	Cloud Security Group	-
☐	Cisco Catalyst 8000V for SD-WAN & Routing-17.06.06-AutogenByAWSMP--1	1	Cloud Security Group	-
☐	Cisco Secure Firewall ASA Virtual - BYOL-9.20.2.2-AutogenByAWSMP--1	1	Cloud Security Group	-
☐	Cisco Secure Firewall Threat Defense Virtual - BYOL-7.4.1-172-AutogenByAWSMP--1	1	Cloud Security Group	-



You can also edit and watch
your firewall logs and edit policy
at 32,000 feet over Texas....

For your Firewall connected to a
Satellite Terminal back in Florida

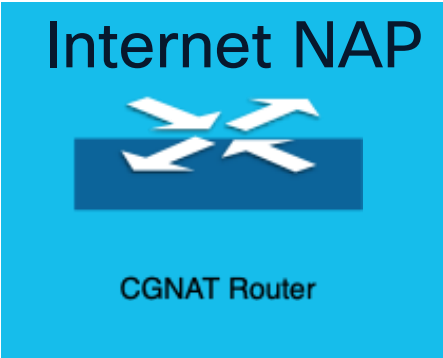
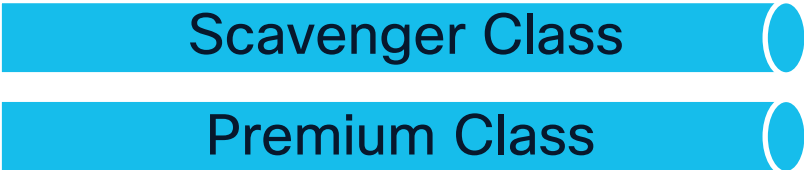
Deployment Considerations

QoS Observations

- Terminals (arrays) are statically linked to what we believe to be MPLS VPNs with static exits to the Internet



Scavenger class QoS

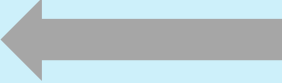


Residential QoS

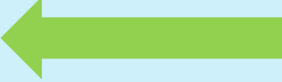
Observed Current QoS



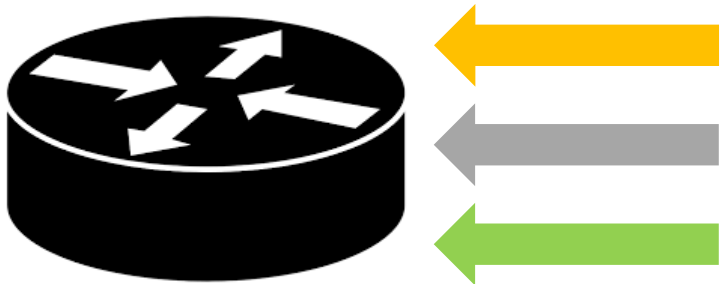
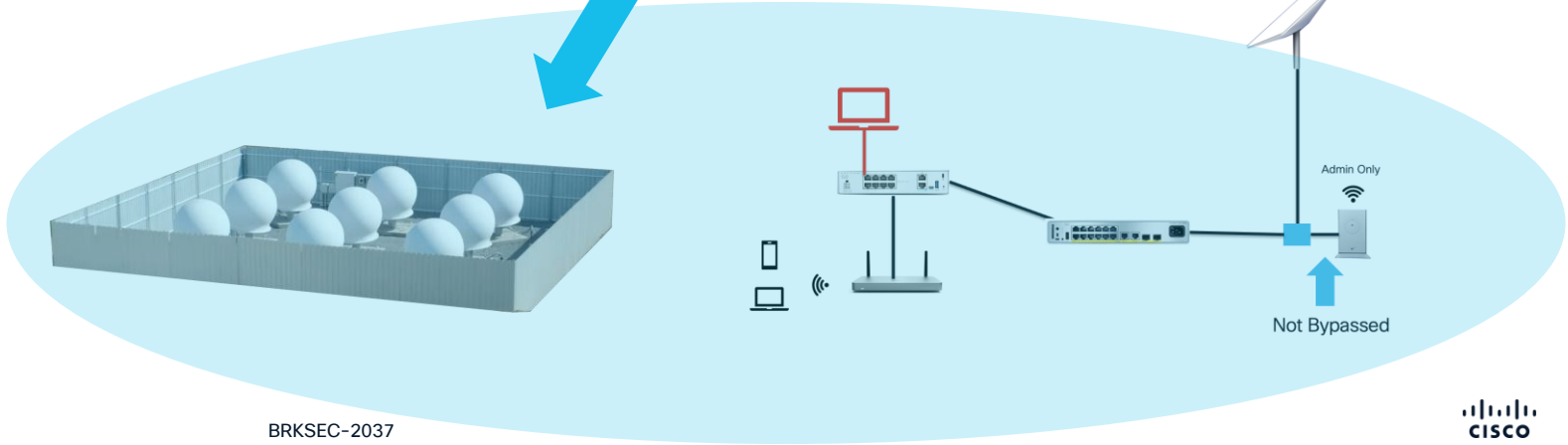
Mobile (Best Effort) \$\$



Priority Data (EF) \$\$\$



Residential (AF) \$



Deployment Considerations

- You will probably want a 150 foot cable
- You can make a 300+ foot cable easily by inserting Ethernet in the middle
 - Use High Quality watertight connectors



Decisions

Service for this order is only guaranteed at this location.
\$110/mo for service and \$599 for hardware.

HARDWARE ⓘ

STANDARD \$599	HIGH PERF. \$2,500
----------------	--------------------

- “High Performance” is simply double the array
- They have a single GigE output – but have doubled the transceivers
- They are clearly creating a Service Class for High Performance users and doing traffic engineering to support it

High Performance Terminal Considerations

HP Wires are 22AWG!

HP pin / Pot / Dish Wire Color / RJ-45 pin &
Color using 568B standard

A1 + Green 1 Orange/White

A2 + Yellow 2 Orange

A3 + Blue 3 Green/White

A4 + White 6 Green

B1 - Orange 7 Brown/White

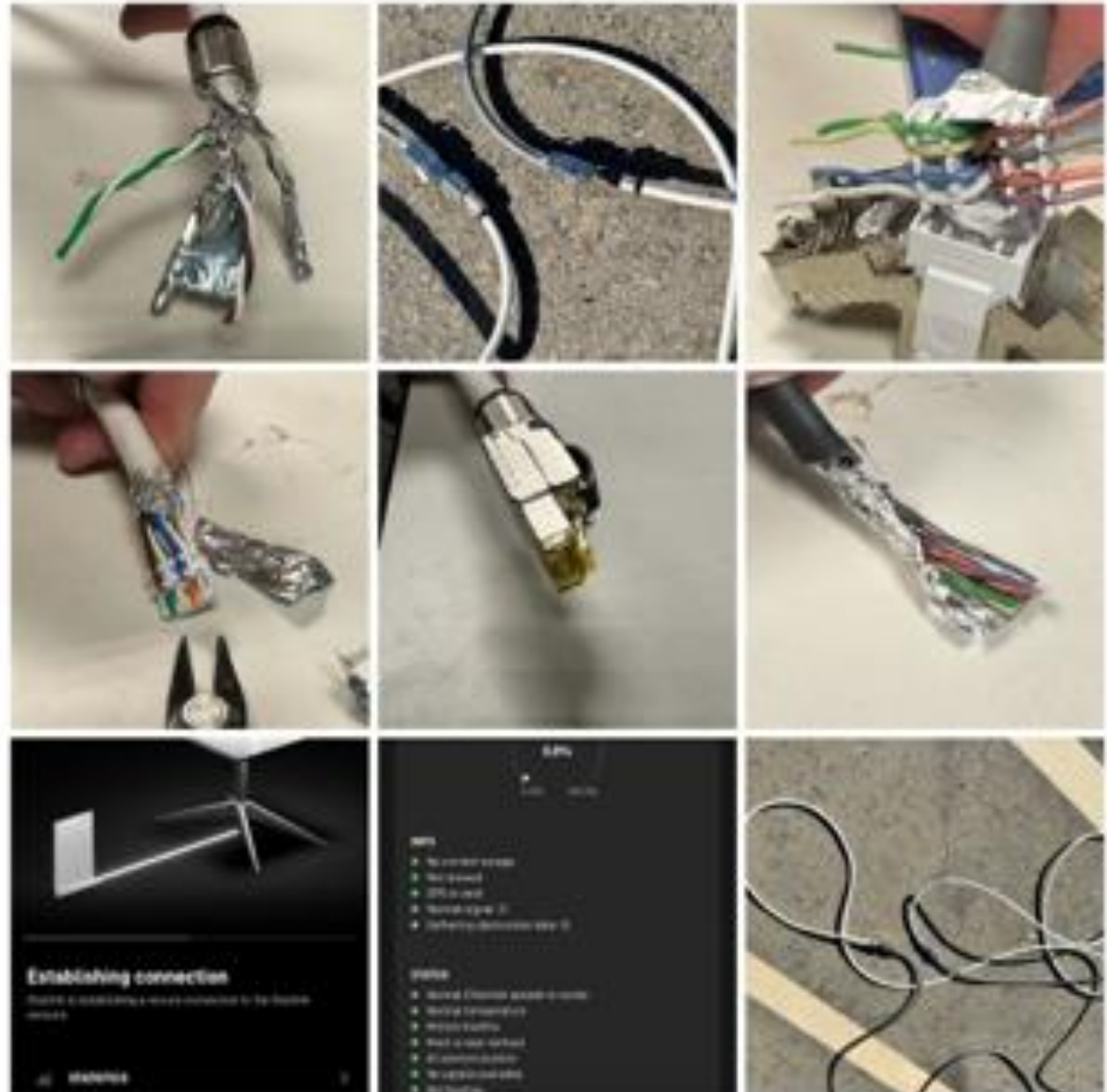
B2 - Purple 8 Brown

B3 - Brown 5 Blue/White

B4 - Gray 4 Blue

B5 × Shield / Shell

**CAT8 22AWG STP
RJ45**



**I had a recent important meeting to attend but
it conflicted with PTO....**



From Colorado – 100% Off Grid

HD Video Broadcast to San Jose

IR1101 Ruggedized Router



IR1101 – Starlink Security Integration

- Ruggedized Router meant for harsh conditions
- Pluggable LTE – including Multi-SIM
- New LTE P-LTEA7-NA= capable of support T-Mobile waveform for Starlink Direct to Cell frequencies



SDWAN Capable

802.1AE MACSEC on LAN

IPSec on WAN

Runs full IOS-XE – 17.15

What works

AC to DC Power Brick

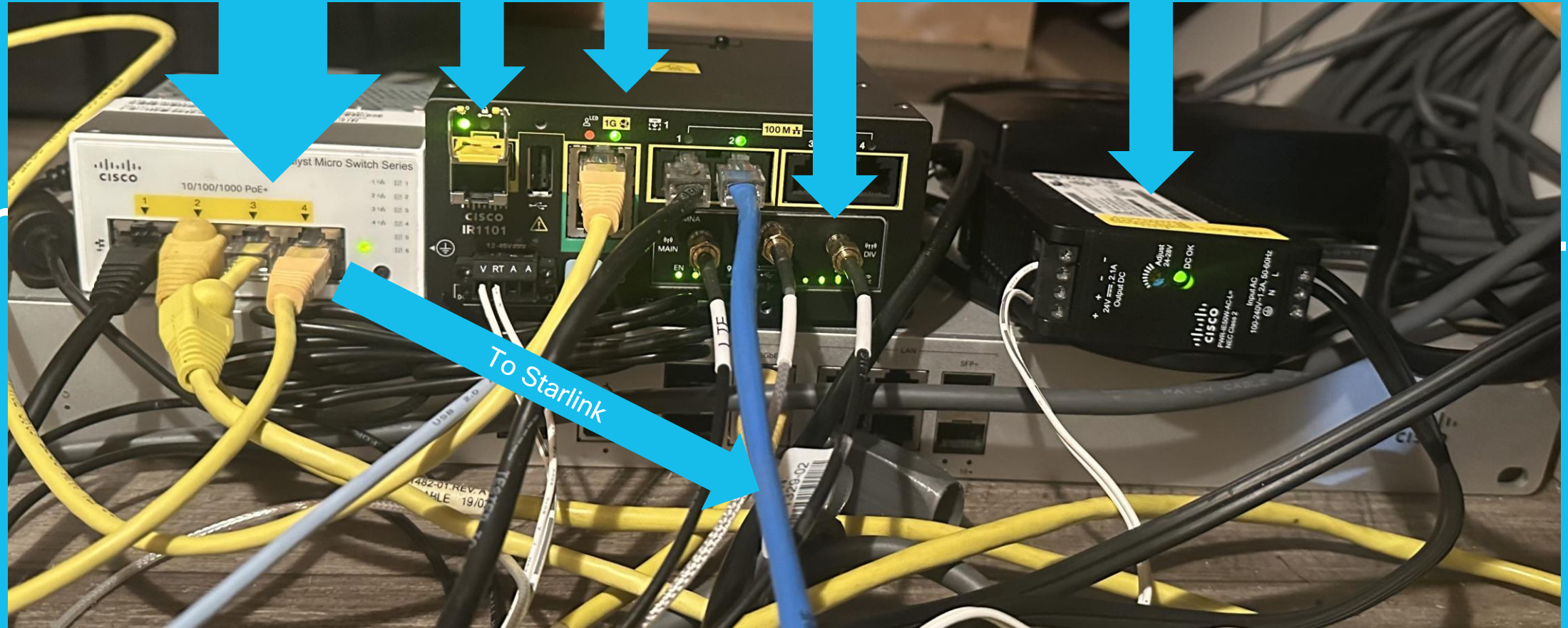
GigE to Catalyst

Catalyst Micro Switch
Single VLAN

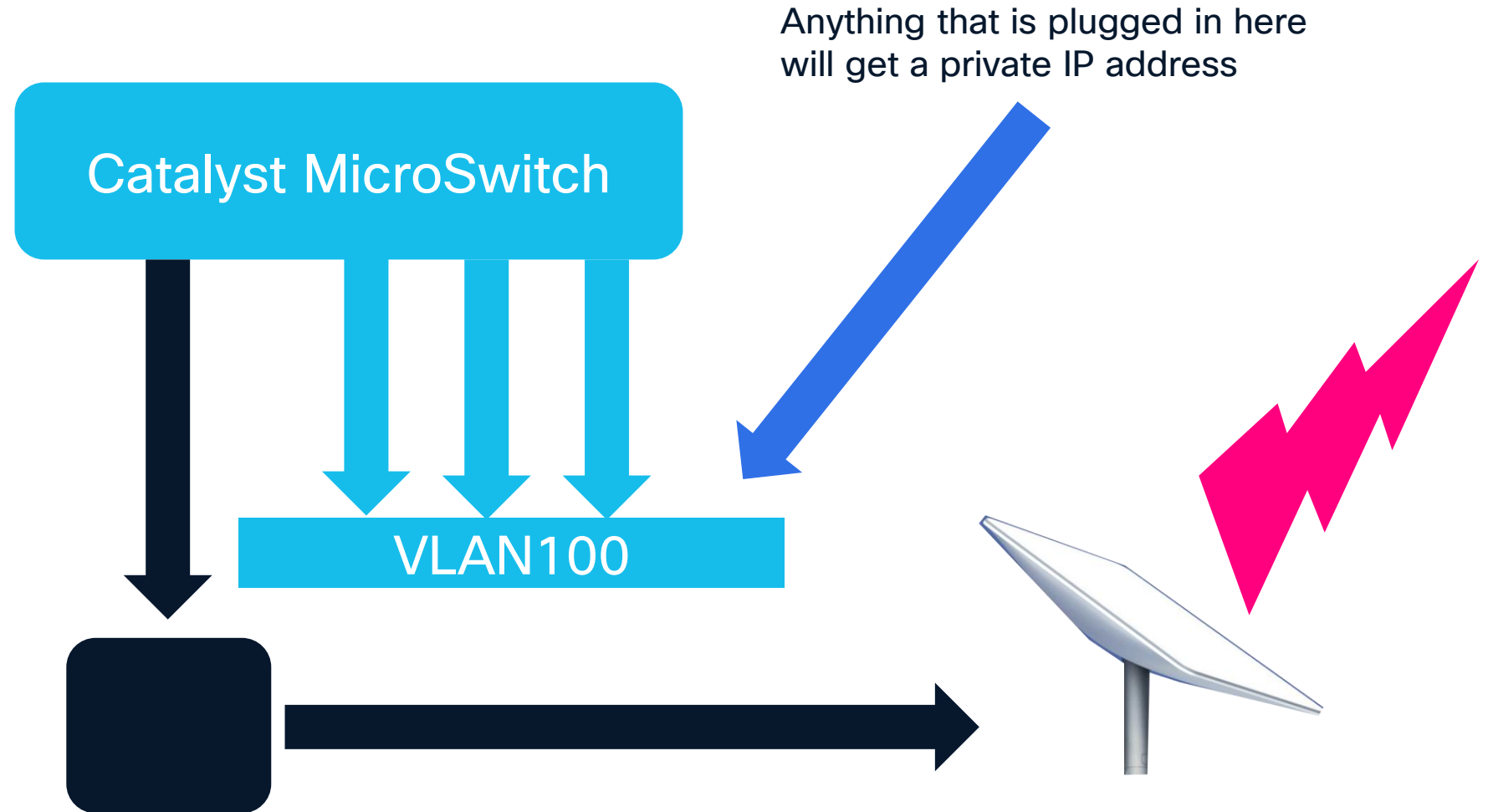
Pluggable LTE Radio

SFP

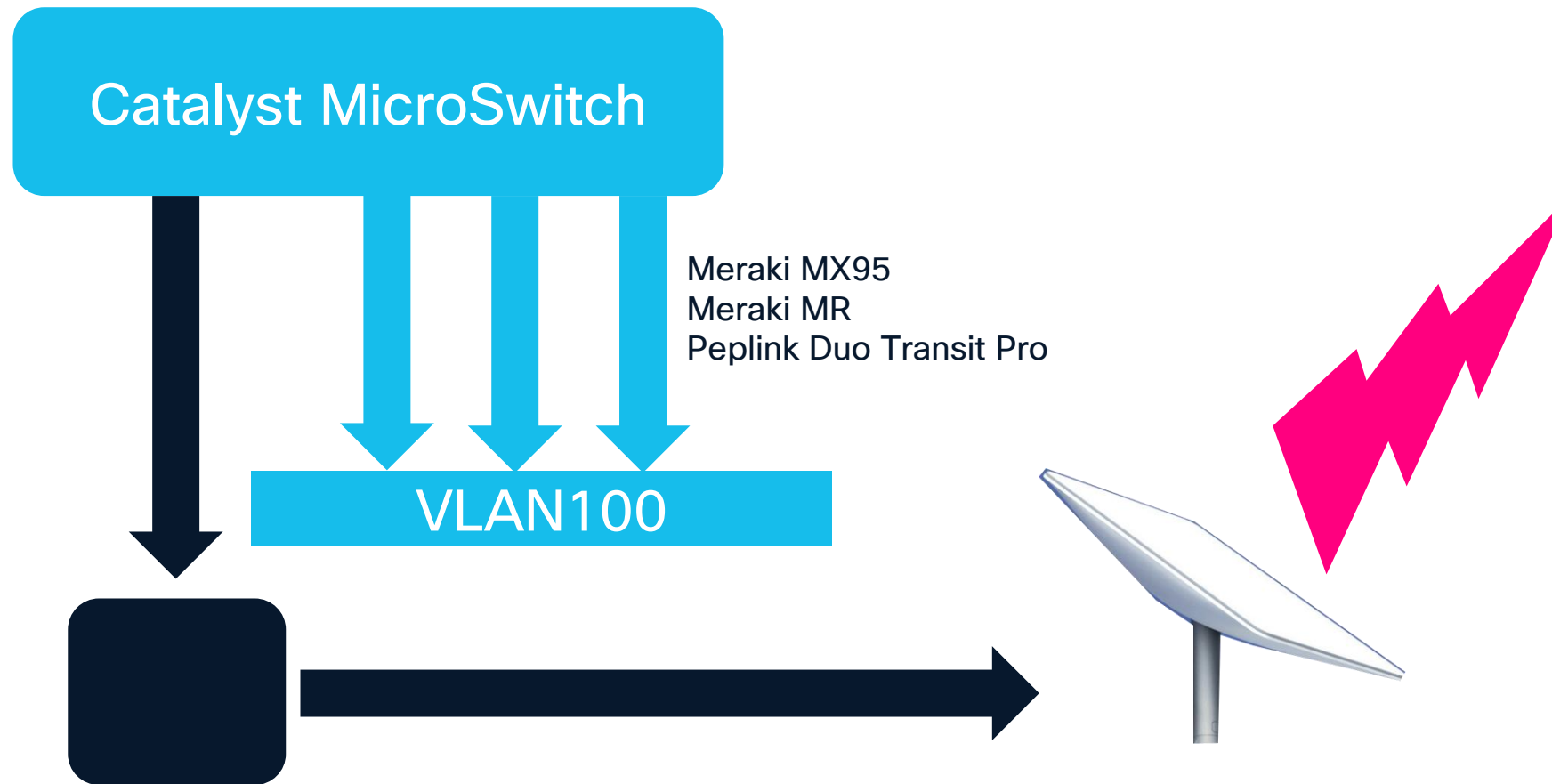
Fire



How it works



How it works



What can I do with an IR1101 to secure SL?

 Cisco

IR1101-K9

17.14.1a

Welcome *abenhase*



Search Menu Items

Dashboard

Monitoring

Configuration

Administration

Licensing

Troubleshooting

Configuration

Security

Threat Defense

Cisco DNS Layer Security Integration

Apply

Unconfigure DNS Layer Security

Registration Token*

7105a672ff204f0d986355a880ea22ee

[Click here to get your Token](#)

Organization ID

NONE

Allowed Domains

cisco.com

☒ Enable DNS packets encryption

Interfaces (4)

Cellular0/1/1

Async0/2/0

Vlan1

Vlan100

LAN Interfaces (4)

FastEthernet0/0/1

FastEthernet0/0/2

FastEthernet0/0/3

FastEthernet0/0/4

inside1

inside2

inside3

inside4

WAN Interfaces (2)

Cellular0/1/0

GigabitEthernet0/0/0

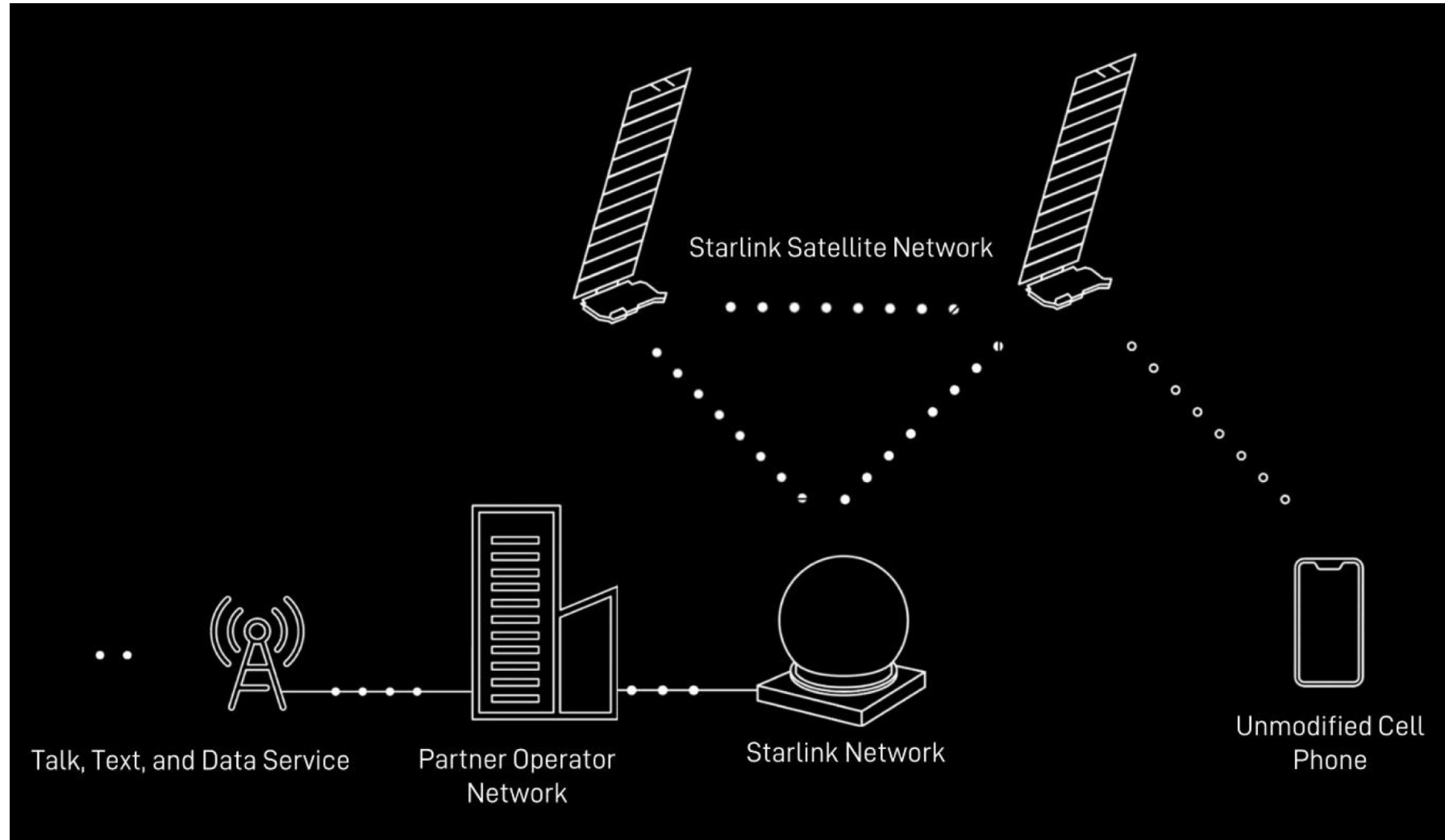
Drag and Drop to add/remove LAN & WAN Interfaces

Cellular Gateway/Starlink

- Starlink can be primary link using phased array
- LTE model can be secondary backup in the event that primary waveform fails
- LTE failover to cellular network if primary path fails

Starlink Direct to Cell (DTC)

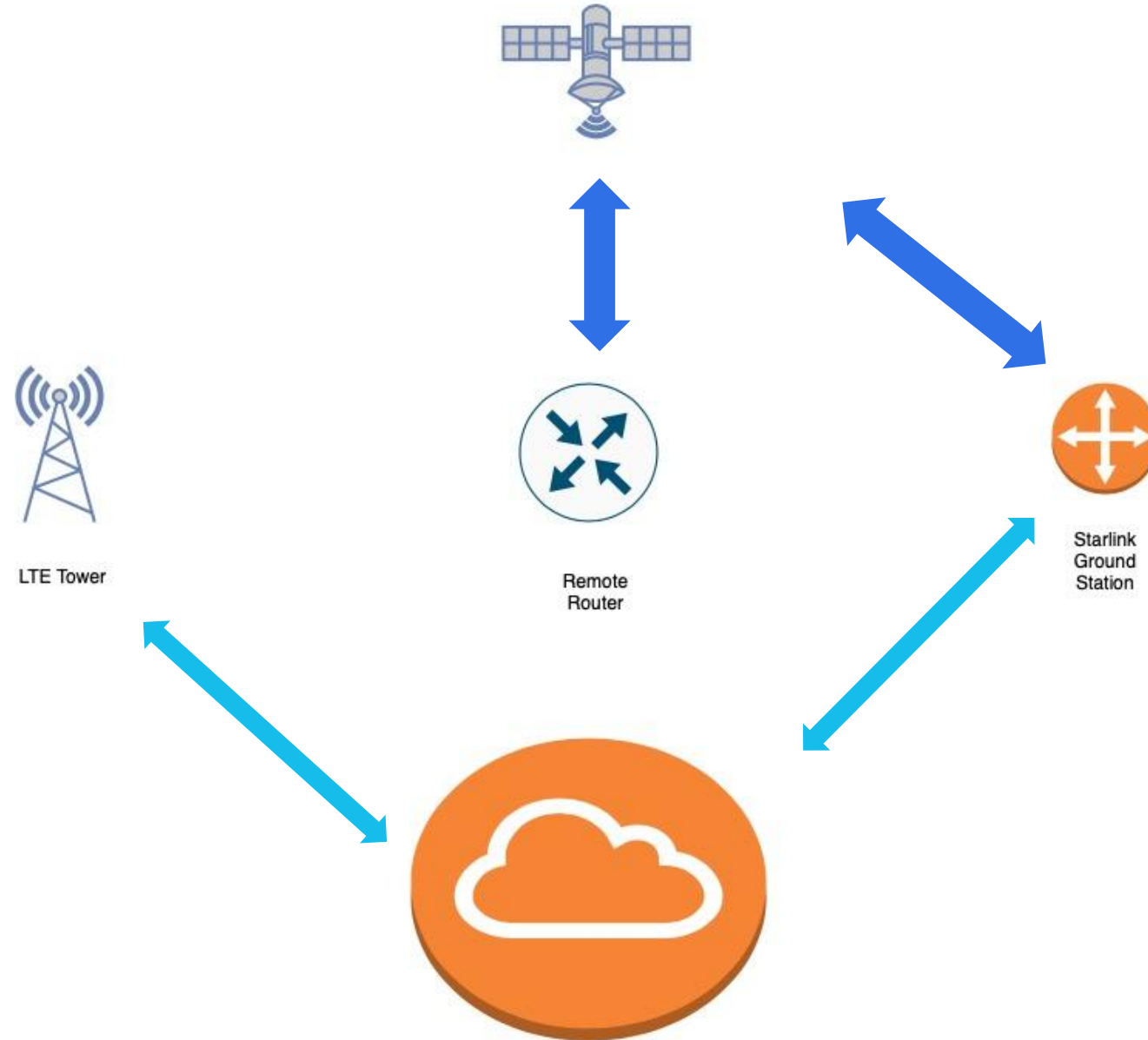
Direct to Cell



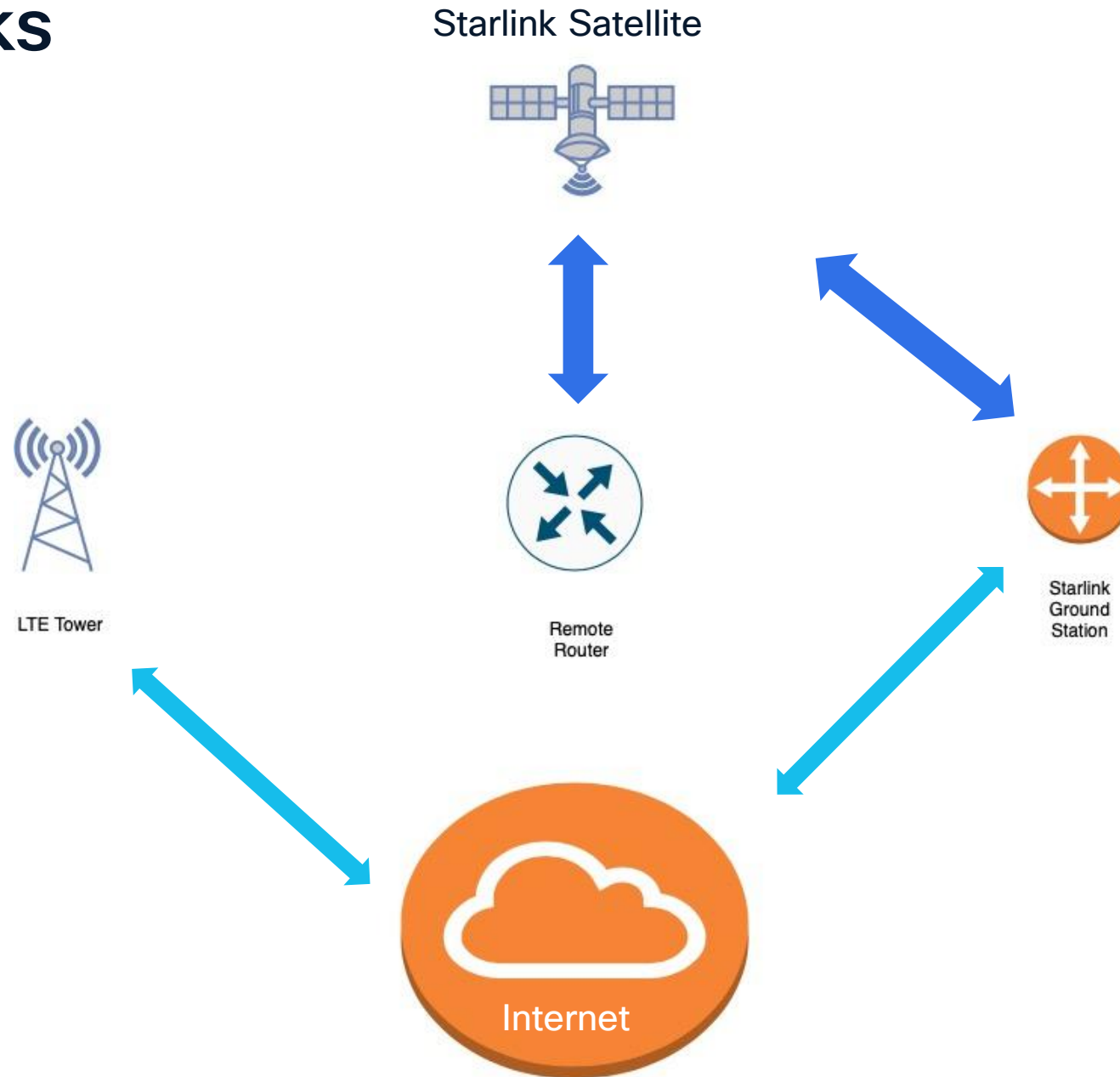
Starlink – Direct to Cell

- Contract with T-Mobile to provide capability in CY2025
- Operates at 1.6Ghz to 2.7Ghz
- No Phased Array required!!!
- ~38 satellites in orbit currently
- New satellites are being launched each week
- Starlink v2 MINI Only capability
- Starship will be a critical enabler

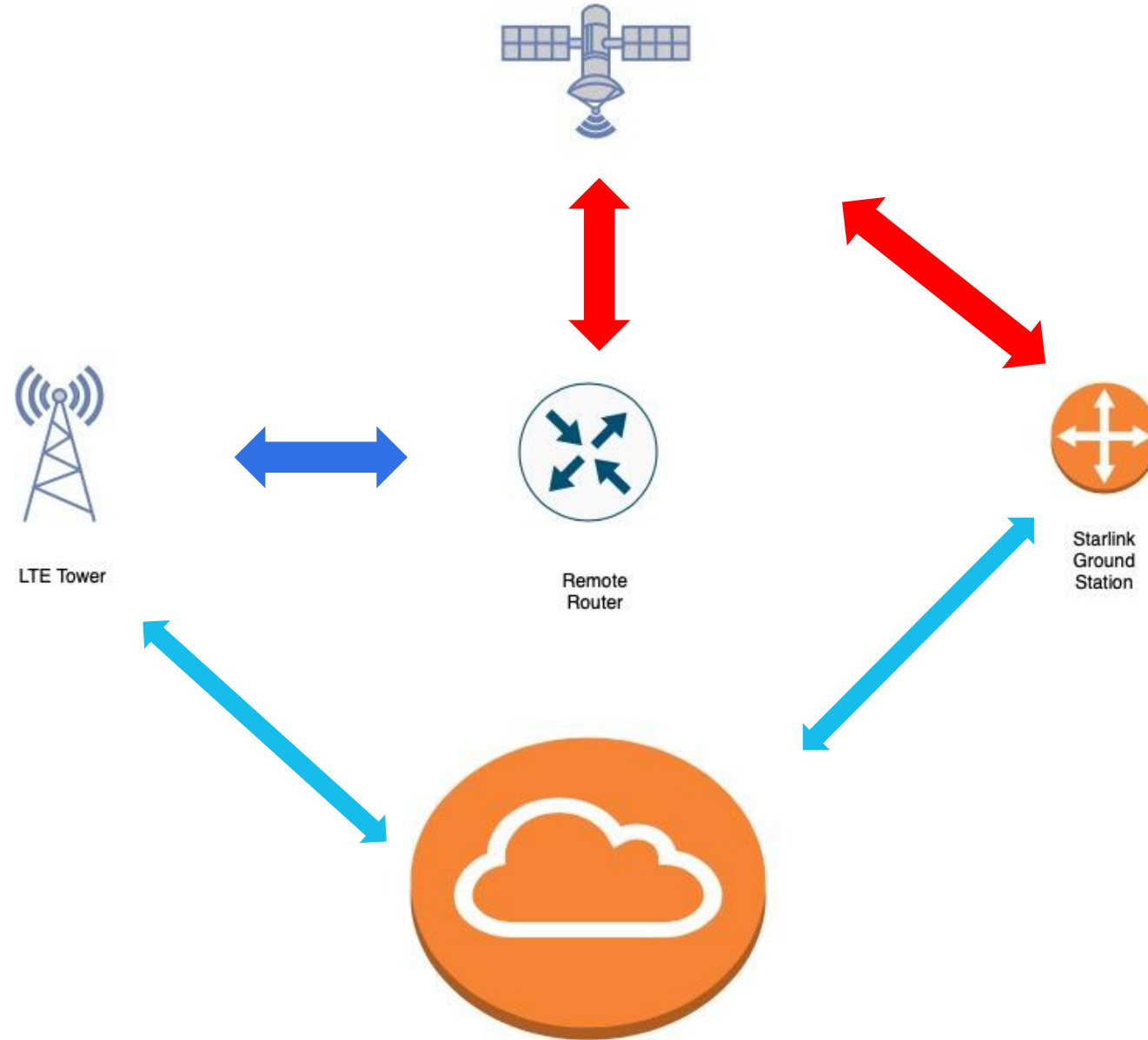
How this works

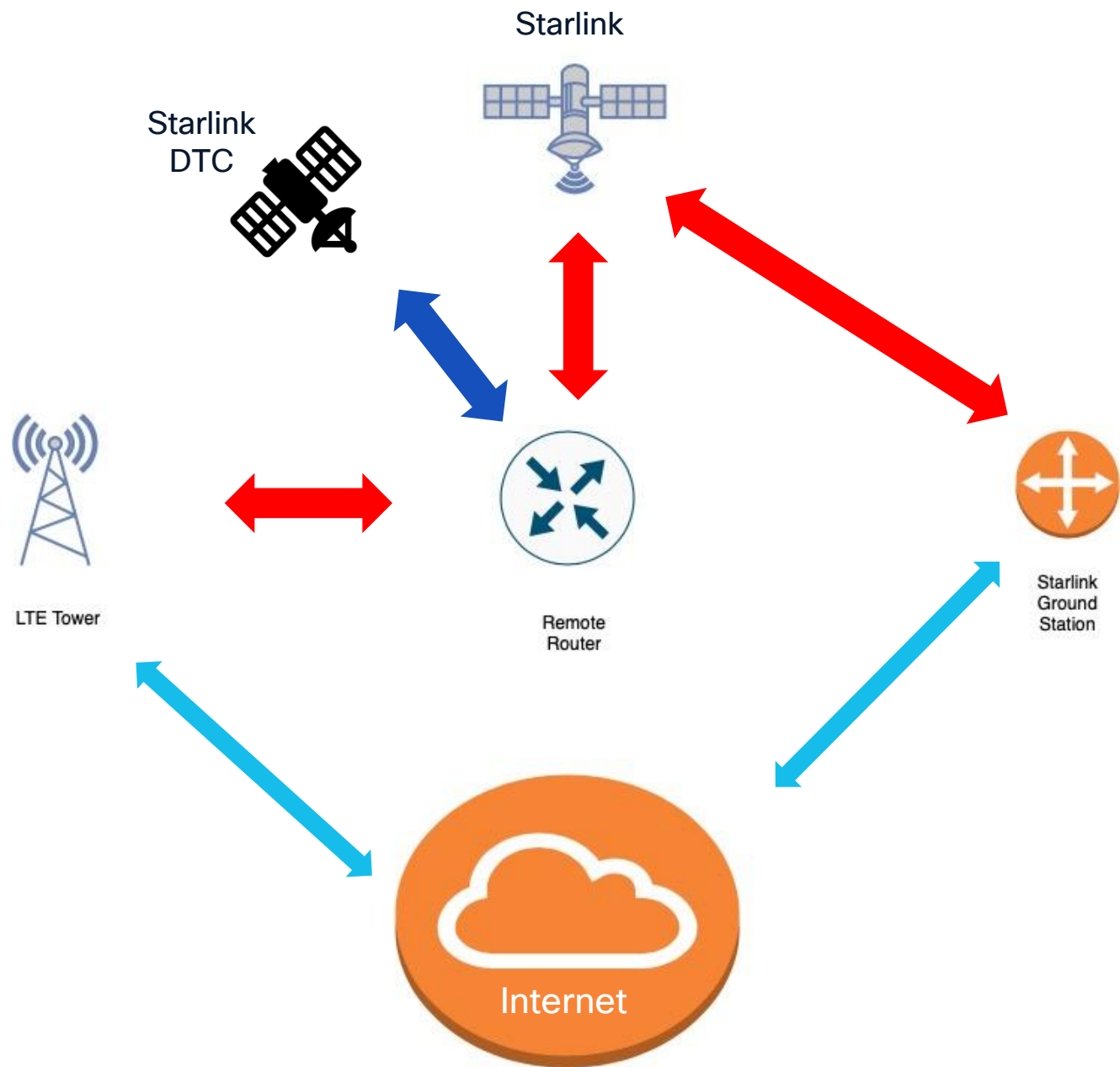


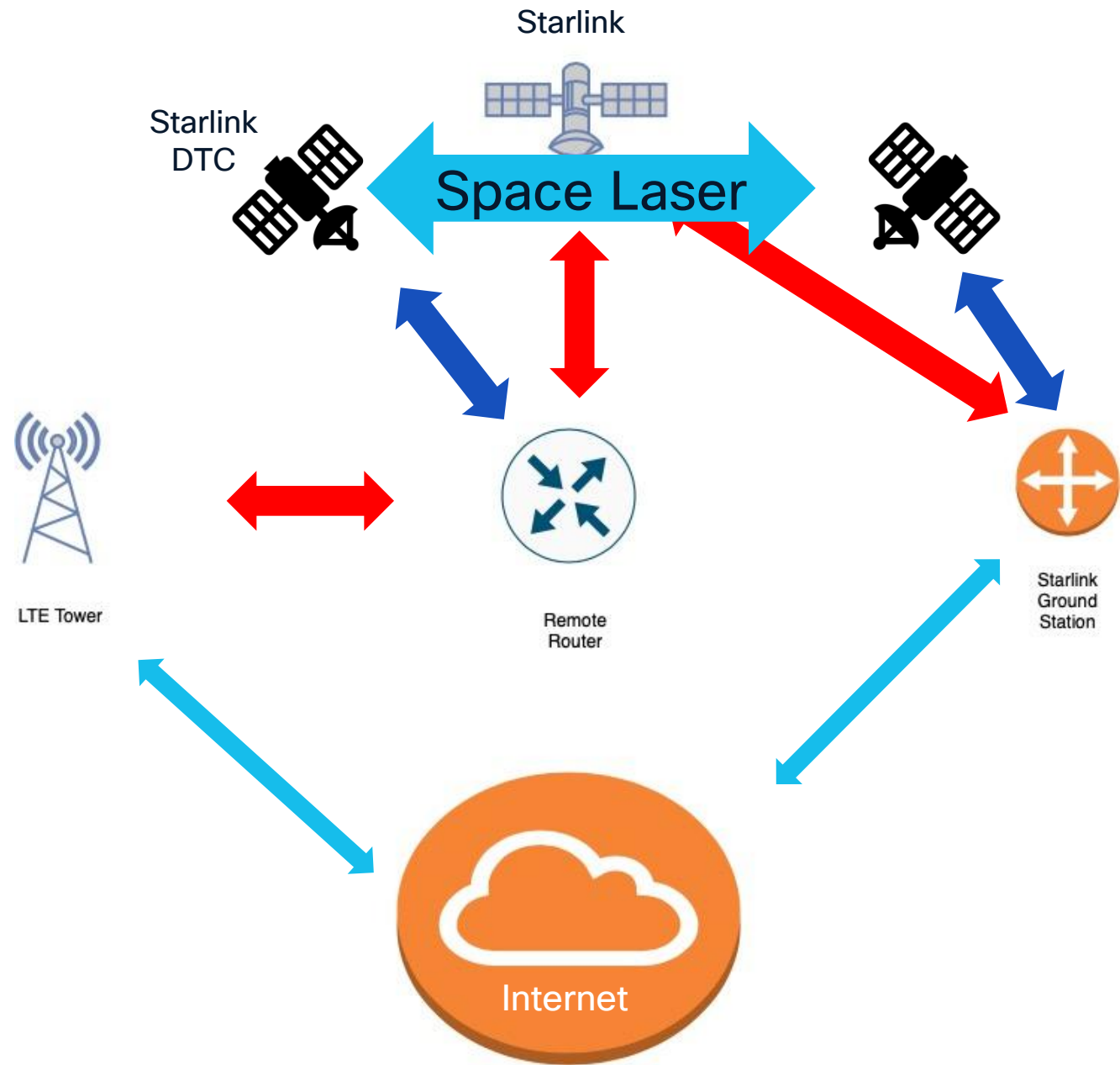
How this works



How this works







Remote Sensor Package Details

- Low power Router+Radio combination
- Man portable
- **Requires no external phased array!**
- **Low bandwidth use cases – sub 7mbps**
- **Remote Sensor packages are a huge use case**
- **With LiFEPO4 battery, 30w solar array and a scheduled power on, you could collect, upload and run indefinitely**



**We are rapidly approaching a time when there
will be no place on Earth that will be without
Internet access.**

Austere Deployment Options



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From Starlink community on **Reddit**



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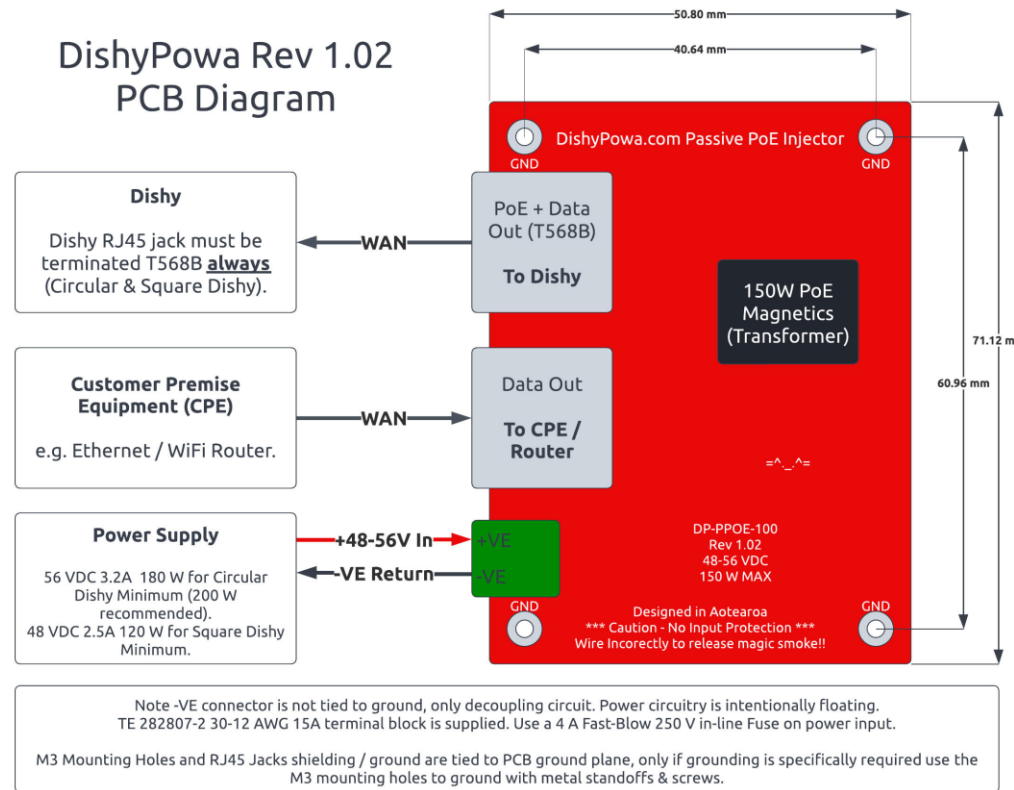


Disclaimer

I make 100% zero guarantees or warranty
you won't damage something....

Ditching the Starlink Router

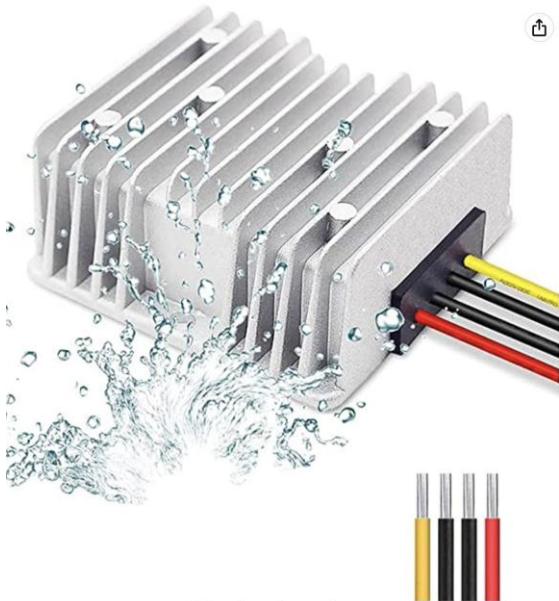
- <https://dishypowa.com>
- 48-56V DC passive PoE injector
- Allows you to remove Starlink Router entirely
- Connect up BYOS options
- Needs 48v DC Power



Credit: dishypowa.com



Parts Needed



Roll over image to zoom in



DC 12V Step Up to 48V Boost Converter
3A 144W DC Voltage Regulator Power
Converter Adapter Waterproof Module
Transformer for Golf Cart Club Car LED
Light

Brand: Protooma
★★★★★ 26 ratings | 4 answered questions

\$17⁹⁹

FREE Returns

Get 40% off eligible products sold and shipped by Amazon
when you pay with Discover rewards. Max discount \$50.
Activation required. Limited-time offer, see terms.

Color: 12V to 48V 3A



Brand Protooma
Model Name Boost Converter
Color 12V to 48V 3A
Item Dimensions 2 x 2 x 0.8 inches
LxWxH
Input Voltage 12 Volts

About this item

- Input Voltage:DC 12V nominal; Voltage Range: 9-20V(12V);
Output Voltage: DC 48V 3A 144W; Maximum Efficiency:≥95%;
Ripple Wave: 50mV; Starting delay time:≤2s.
- Protection: Built in over-load, over-current, over-temperature and



LiTime 12V 100Ah Lithium
LiFePO4 Battery, Built-in 100A
BMS, 4000-15000 Cycles, 10-
year Lifetime, Perfect for RV,
Solar, Backup Power, Off Grid
Application, Boat, Trolling
motor.

Brand: Litime
6 answered questions

\$299⁹⁹

Pay \$25.00/month for 12 months, interest-free
upon approval for the Amazon Prime Rewards Visa
Card

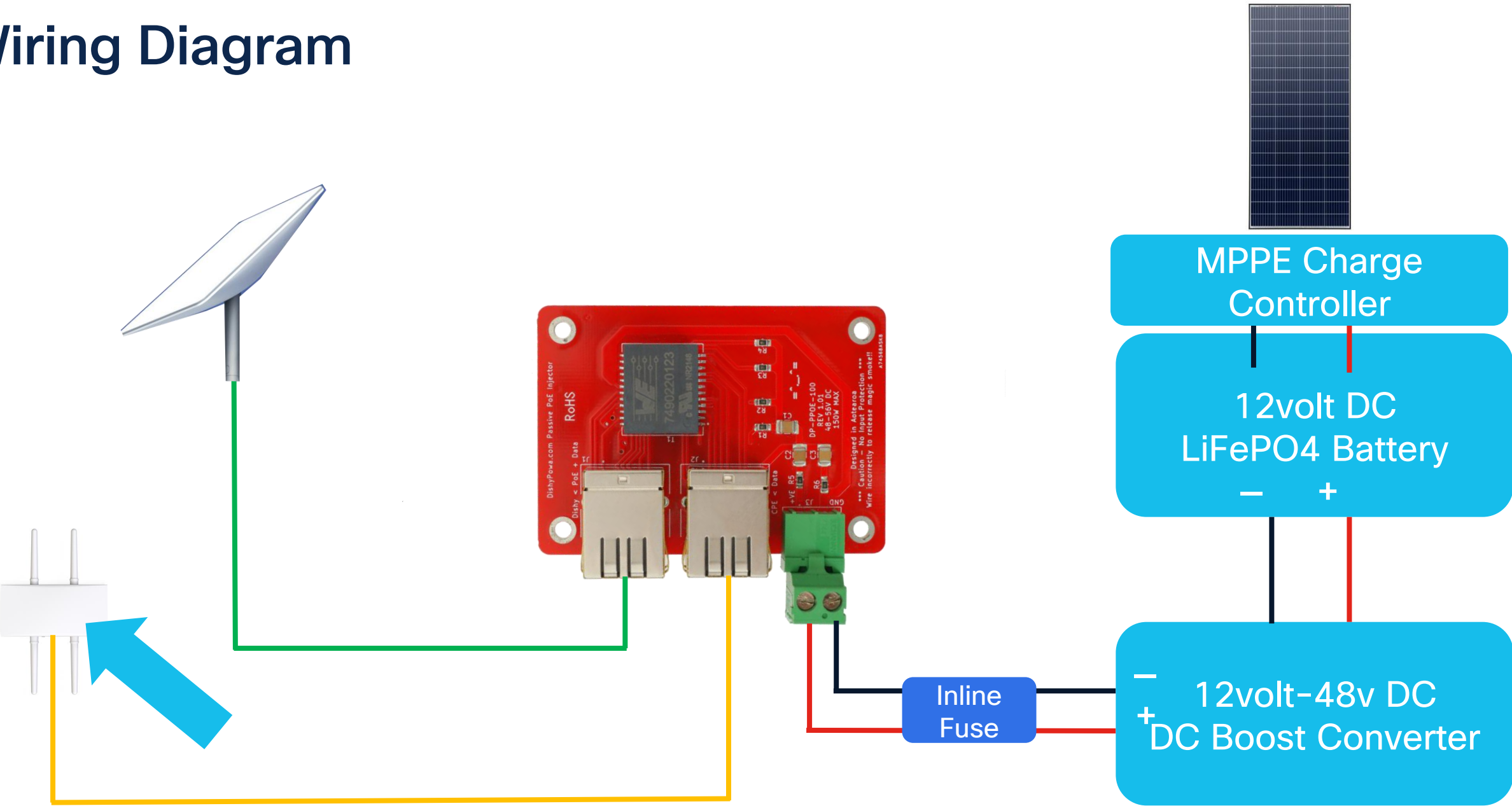
Size: 12V100Ah

12V50Ah \$179.98	12V100Ah \$299.99
12V100Ah Smart \$479.99	12V200Ah \$599.99
12V300Ah \$999.99	24V100Ah \$649.99
48V100Ah \$1,699.98	



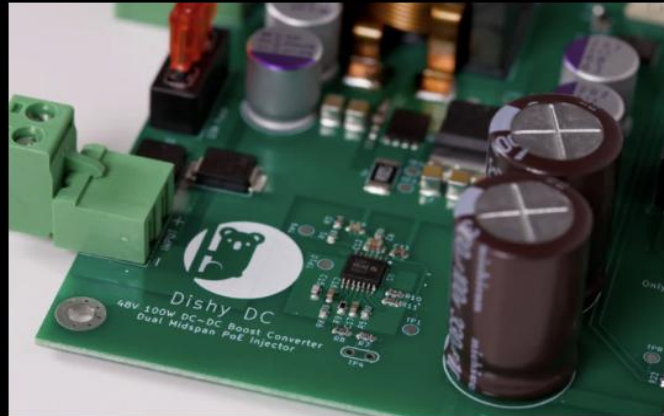
Roll over image to zoom in

Wiring Diagram



Dishy Dualie Products

Filter: Availability ▾



Dishy Dualie DC Power Supply
\$148.00 AUD



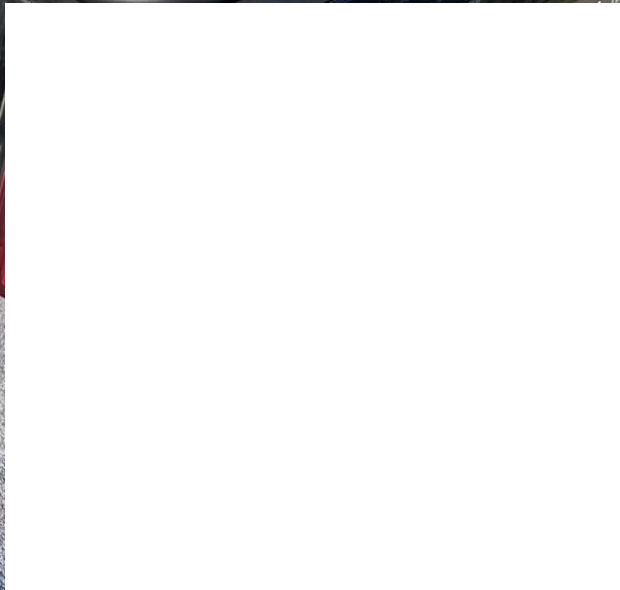
Dishy Dualie DC Enclosure
\$68.00 AUD

Cisco Crisis Response Deployment to Maui

- Requested to support Maui First Responders with Internet access
- Cisco Employees dispatched with High Performance Terminals
- Setup instant Internet access



SOLAR POWER
(last year)



12:00



11:58
Search



1:45
ch



11:46
Search



ADVANCED SPEED TEST



WIFI SPEED

IPHONE TO WIFI ROUTER

499 Mbps

388 Mbps Upload

STARLINK SPEED

ROUTER TO INTERNET

64 Mbps

4.4 Mbps Upload



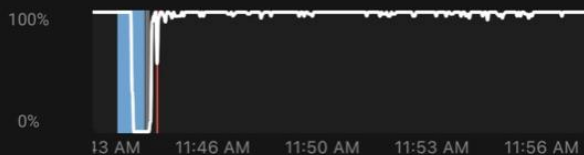
WiFi Download - - - - Starlink Download —

NETWORK STATISTICS

Your Starlink just powered on. Network performance should stabilize after about 15 minutes.

UPTIME ⓘ

OUTAGES



Last 14 minutes:

- Possibly Obstructed 3s ⓘ
- Network Issue 8s ⓘ

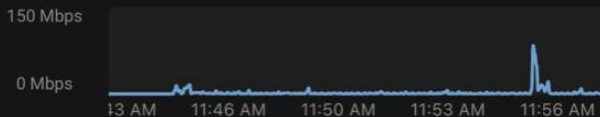
LATENCY ⓘ

Min: 0 ms Max: 1383 ms Last: 40 ms



THROUGHPUT ⓘ

SPEED TEST

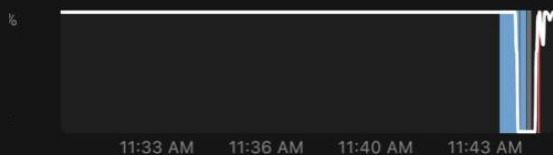


NETWORK STATISTICS

Your Starlink just powered on. Network performance should stabilize after about 15 minutes.

IME ⓘ

OUTAGES

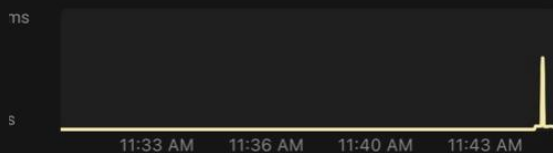


2 minutes:

- Possibly Obstructed 3s ⓘ
- Network Issue 8s ⓘ

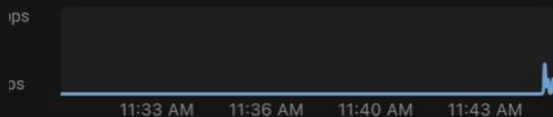
ENCY ⓘ

Min: 0 ms Max: 1383 ms Last: 38 ms



OUGHPUT ⓘ

SPEED TEST



EB3A2226002144201



Power off



72%



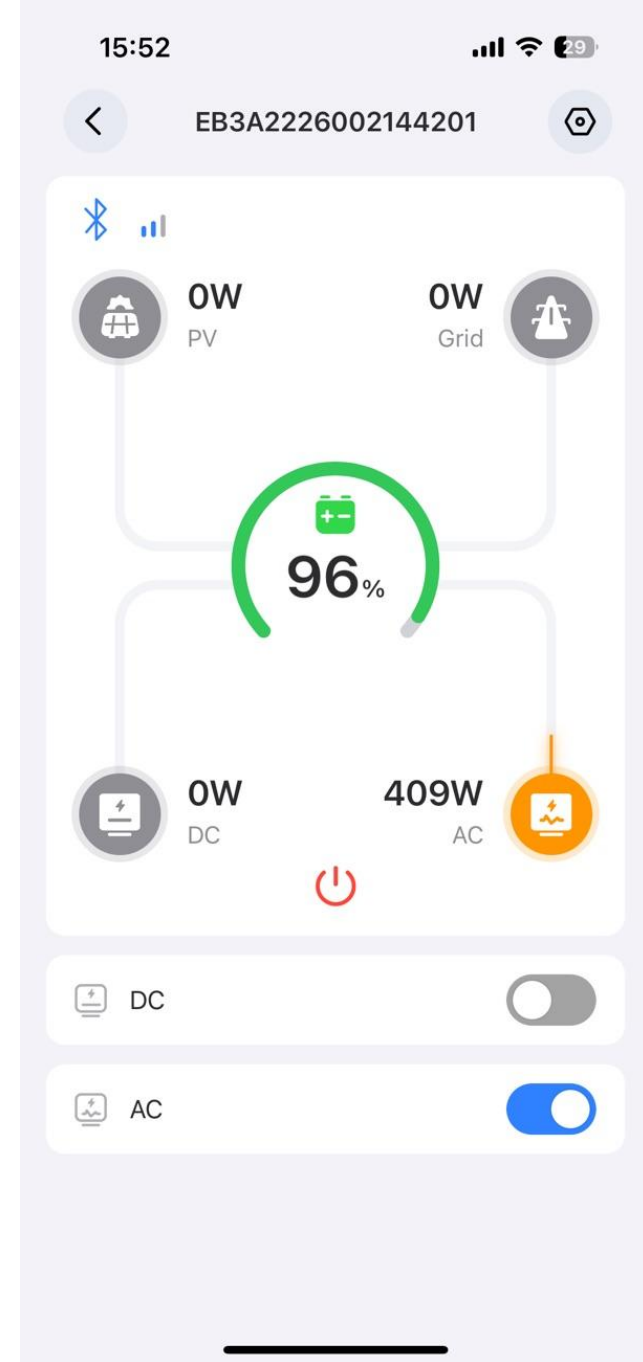
DC

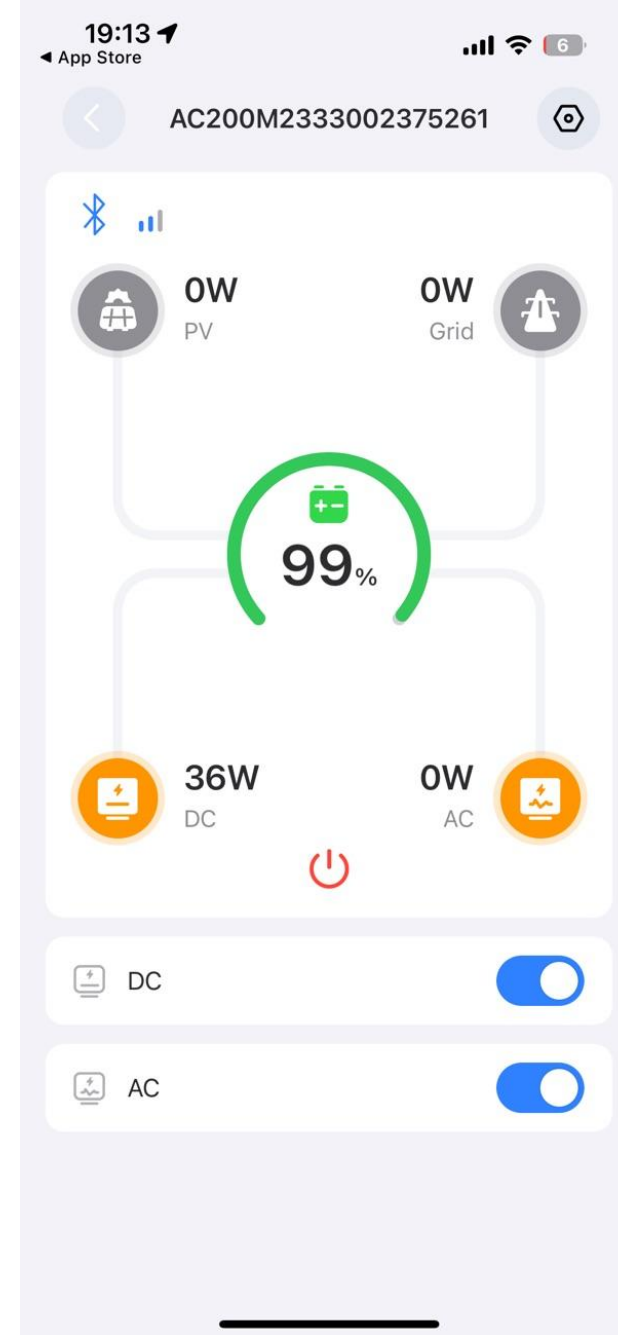


AC



SOLAR POWER
(this year)







Power/Solar Conclusions (from last year)

1

You will need more stored power than you think

2

You will need more solar power than you think

3

You will have to trial 24hr operation to be sure it works

4

You will have to account for lack of full solar cycles

Updated Solar Guidance

- Minimum 1000Wh between solar cycles
- Gen 2 dish consumes between 43-50watts consistently
- 200watts of solar panel will reliably recharge 800Wh in 4-5 hours of direct sun
- 24 hour remote operation is completely achievable

Debugging

Debugging at the CLI

```
[abenhase@ABENHASE-M-526H starlink-grpc-tools-main % python3 poll_history.py | grep software_version
status: {'id': 'ut01000000-00000000-0008d16e', 'hardware_version': 'rev3_proto2', 'software_version': 'f562e306-0cd5-44c2-9058-9ab6800c4b50.utm.release', 'state': 'CONNECTED', 'uptime': 356145, 'snr': None, 'seconds_to_first_nonempty_slot': 0.0, 'pop_ping_drop_rate': 0.0, 'downlink_throughput_bps': 1429922.125, 'uplink_throughput_bps': 270549.375, 'pop_ping_latency_ms': 41.14285659790039, 'alerts': 0, 'fraction_obstructed': 0.0, 'currently_obstructed': False, 'seconds_obstructed': None, 'obstruction_duration': None, 'obstruction_interval': None, 'direction_azimuth': 1.7222282886505127, 'direction_elevation': 58.981868743896484, 'is_snr_above_noise_floor': True}
status: {'id': 'ut01000000-00000000-0008d16e', 'hardware_version': 'rev3_proto2', 'software_version': 'f562e306-0cd5-44c2-9058-9ab6800c4b50.utm.release', 'state': 'CONNECTED', 'uptime': 356149, 'snr': None, 'seconds_to_first_nonempty_slot': 0.0, 'pop_ping_drop_rate': 0.0, 'downlink_throughput_bps': 2350362.25, 'uplink_throughput_bps': 232783.875, 'pop_ping_latency_ms': 40.238094329833984, 'alerts': 0, 'fraction_obstructed': 0.0, 'currently_obstructed': False, 'seconds_obstructed': None, 'obstruction_duration': None, 'obstruction_interval': None, 'direction_azimuth': 1.747515082359314, 'direction_elevation': 58.87015151977539, 'is_snr_above_noise_floor': True}
status: {'id': 'ut01000000-00000000-0008d16e', 'hardware_version': 'rev3_proto2', 'software_version': 'f562e306-0cd5-44c2-9058-9ab6800c4b50.utm.release', 'state': 'CONNECTED', 'uptime': 356153, 'snr': None, 'seconds_to_first_nonempty_slot': 0.0, 'pop_ping_drop_rate': 0.0, 'downlink_throughput_bps': 6270954.0, 'uplink_throughput_bps': 481732.59375, 'pop_ping_latency_ms': 36.28571319580078, 'alerts': 0, 'fraction_obstructed': 0.0, 'currently_obstructed': False, 'seconds_obstructed': None, 'obstruction_duration': None, 'obstruction_interval': None, 'direction_azimuth': 1.8865798711776733, 'direction_elevation': 58.91215133666992, 'is_snr_above_noise_floor': True}
status: {'id': 'ut01000000-00000000-0008d16e', 'hardware_version': 'rev3_proto2', 'software_version': 'f562e306-0cd5-44c2-9058-9ab6800c4b50.utm.release', 'state': 'CONNECTED', 'uptime': 356159, 'snr': None, 'seconds_to_first_nonempty_slot': 0.0, 'pop_ping_drop_rate': 0.0, 'downlink_throughput_bps': 836696.5625, 'uplink_throughput_bps': 155541.5625, 'pop_ping_latency_ms': 34.54999923706055, 'alerts': 0, 'fraction_obstructed': 0.0, 'currently_obstructed': False, 'seconds_obstructed': None, 'obstruction_duration': None, 'obstruction_interval': None, 'direction_azimuth': 1.8450416326522827, 'direction_elevation': 58.79641342163086, 'is_snr_above_noise_floor': True}
status: {'id': 'ut01000000-00000000-0008d16e', 'hardware_version': 'rev3_proto2', 'software_version': 'f562e306-0cd5-44c2-9058-9ab6800c4b50.utm.release', 'state': 'CONNECTED', 'uptime': 356163, 'snr': None, 'seconds_to_first_nonempty_slot': 0.0, 'pop_ping_drop_rate': 0.0, 'downlink_throughput_bps': 2781402.25, 'uplink_throughput_bps': 454972.9375, 'pop_ping_latency_ms': 37.238094329833984, 'alerts': 0, 'fraction_obstructed': 0.0, 'currently_obstructed': False, 'seconds_obstructed': None, 'obstruction_duration': None, 'obstruction_interval': None, 'direction_azimuth': 1.7882055044174194, 'direction_elevation': 58.803531646728516, 'is_snr_above_noise_floor': True}
status: {'id': 'ut01000000-00000000-0008d16e', 'hardware_version': 'rev3_proto2', 'software_version': 'f562e306-0cd5-44c2-9058-9ab6800c4b50.utm.release', 'state': 'CONNECTED', 'uptime': 356168, 'snr': None, 'seconds_to_first_nonempty_slot': 0.0, 'pop_ping_drop_rate': 0.0, 'downlink_throughput_bps': 2786863.25, 'uplink_throughput_bps': 344620.78125, 'pop_ping_latency_ms': 41.400001525878906, 'alerts': 0, 'fraction_obstructed': 0.0, 'currently_obstructed': False, 'seconds_obstructed': None, 'obstruction_duration': None, 'obstruction_interval': None, 'direction_azimuth': 2.0890917778015137, 'direction_elevation': 58.88453674316406, 'is_snr_above_noise_floor': True}
status: {'id': 'ut01000000-00000000-0008d16e', 'hardware_version': 'rev3_proto2', 'software_version': 'f562e306-0cd5-44c2-9058-9ab6800c4b50.utm.release', 'state': 'CONNECTED', 'uptime': 356174, 'snr': None, 'seconds_to_first_nonempty_slot': 0.0, 'pop_ping_drop_rate': 0.0, 'downlink_throughput_bps': 822544.9375, 'uplink_throughput_bps': 182125.0625, 'pop_ping_latency_ms': 41.25, 'alerts': 0, 'fraction_obstructed': 0.0, 'currently_obstructed': False, 'seconds_obstructed': None, 'obstruction_duration': None, 'obstruction_interval': None, 'direction_azimuth': 2.058941125869751, 'direction_elevation': 58.94309616088867, 'is_snr_above_noise_floor': True}
status: {'id': 'ut01000000-00000000-0008d16e', 'hardware_version': 'rev3_proto2', 'software_version': 'f562e306-0cd5-44c2-9058-9ab6800c4b50.utm.release', 'state': 'CONNECTED', 'uptime': 356178, 'snr': None, 'seconds_to_first_nonempty_slot': 0.0, 'pop_ping_drop_rate': 0.0, 'downlink_throughput_bps': 3287621.25, 'uplink_throughput_bps': 224588.203125, 'pop_ping_latency_ms': 40.47618865966797, 'alerts': 0, 'fraction_obstructed': 0.0, 'currently_obstructed': False, 'seconds_obstructed': None, 'obstruction_duration': None, 'obstruction_interval': None, 'direction_azimuth': 2.2009549140930176, 'direction_elevation': 58.91402816772461, 'is_snr_above_noise_floor': True}
status: {'id': 'ut01000000-00000000-0008d16e', 'hardware_version': 'rev3_proto2', 'software_version': 'f562e306-0cd5-44c2-9058-9ab6800c4b50.utm.release', 'state': 'CONNECTED', 'uptime': 356182, 'snr': None, 'seconds_to_first_nonempty_slot': 0.0, 'pop_ping_drop_rate': 0.0, 'downlink_throughput_bps': 9985874.0, 'uplink_throughput_bps': 485163.53125, 'pop_ping_latency_ms': 39.66666793823242, 'alerts': 0, 'fraction_obstructed': 0.0, 'currently_obstructed': False, 'seconds_obstructed': None, 'obstruction_duration': None, 'obstruction_interval': None, 'direction_azimuth': 2.16888861477005, 'direction_elevation': 58.8737555550073, 'is_snr_above_noise_floor': True}
```



Docker Tools Repository

Containers

Images

Volumes

Dev Environments BETA

Extensions BETA

Add Extensions

Docker Desktop

Upgrade plan

Search 🔍

🔧

⚙️

abenhase

👤

Images [Give feedback](#)

An image is a read-only template with instructions for creating a Docker container. [Learn more](#)

LOCAL

REMOTE REPOSITORIES

5.09 GB / 7.27 GB in use

26 images

Last refresh: 6 days ago

🔍 star

☰

⋮

☐	NAME	TAG	STATUS	CREATED	SIZE	ACTIONS
☐	sponsianus/starlink-grpc-tools 330f096f73b1	latest	In use	8 days ago	961.64 MB	▶ ⋮ 🗑️
☐	ghcr.io/sparky8512/starlink-grpc-tools 3221e3c4730e	latest	In use	26 days ago	960.32 MB	▶ ⋮ 🗑️
☐	sponsianus/starlink-grpc-tools 9385172f655f	<none>	In use (dangliir)	2 months ago	960.93 MB	▶ ⋮ 🗑️
☐	sysdigdan/starlink_exporter 5cf69d174bdb	latest	In use	7 months ago	13.63 MB	▶ ⋮ 🗑️
☐	ghcr.io/sparky8512/starlink-grpc-tools a90c66134558	<none>	In use (dangliir)	11 months ago	955.73 MB	▶ ⋮ 🗑️
☐	dbryanjohnson/starlink-monitor	latest	In use	12 months ago	305.88 MB	▶ ⋮ 🗑️

Showing 8 items

RAM 0.25GB

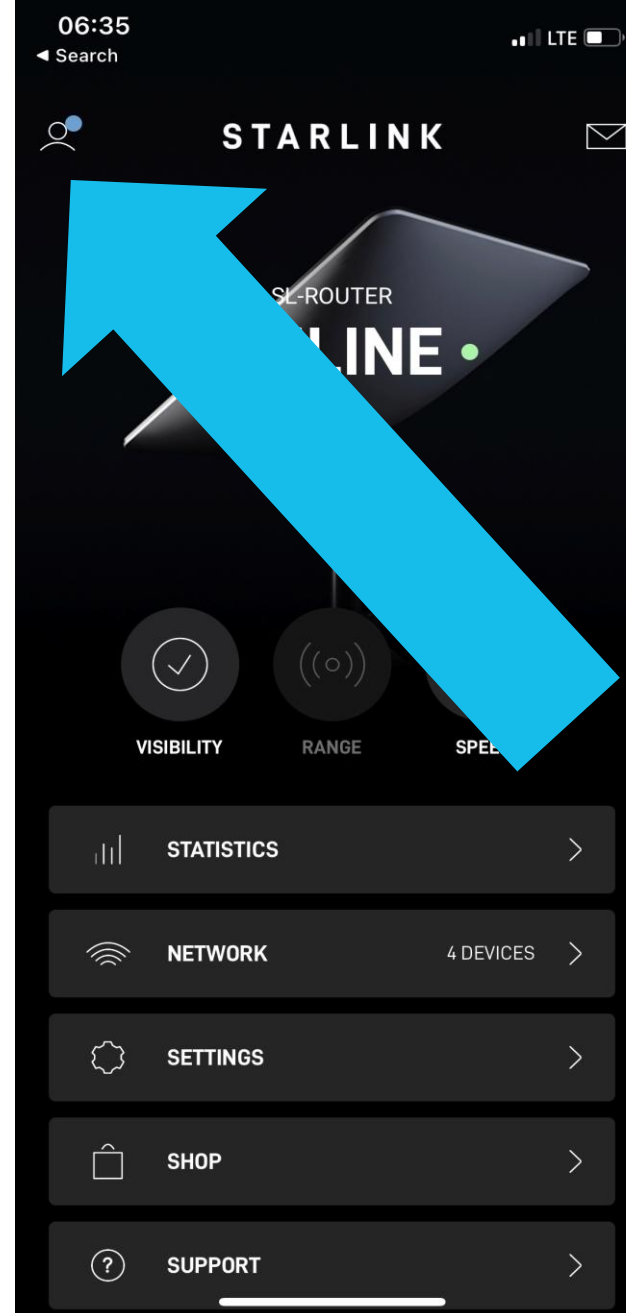
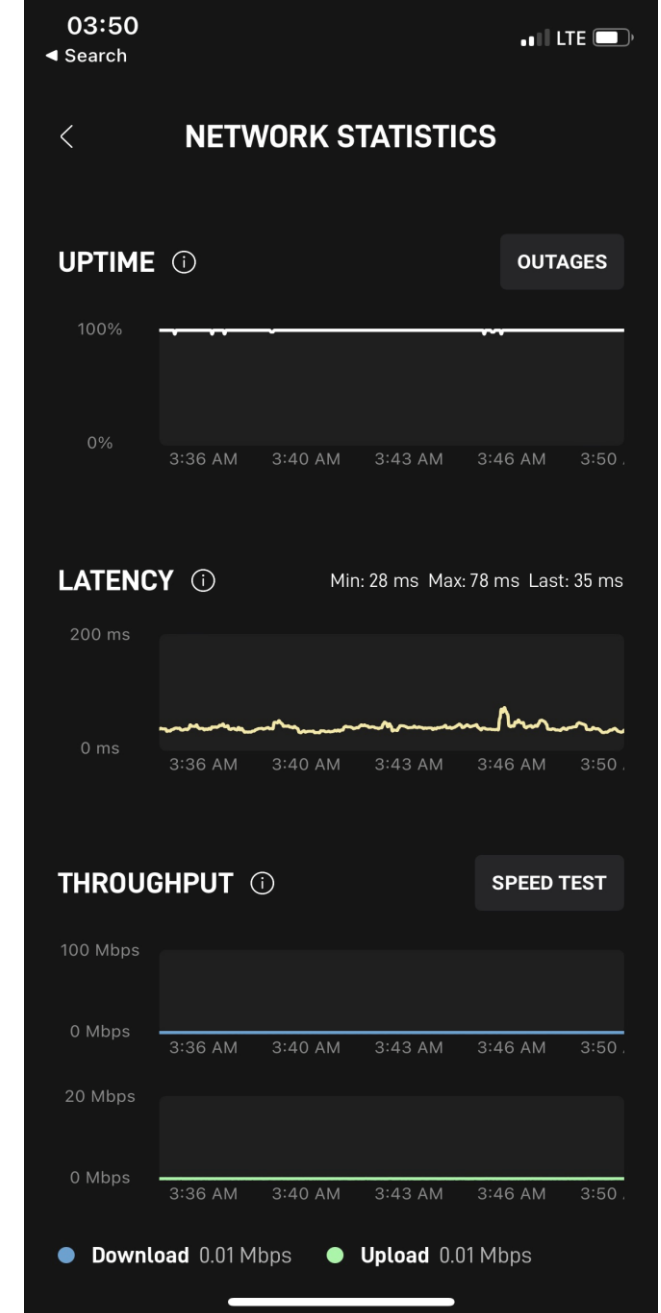
CPU 0.37%

🔌 Connected to Hub

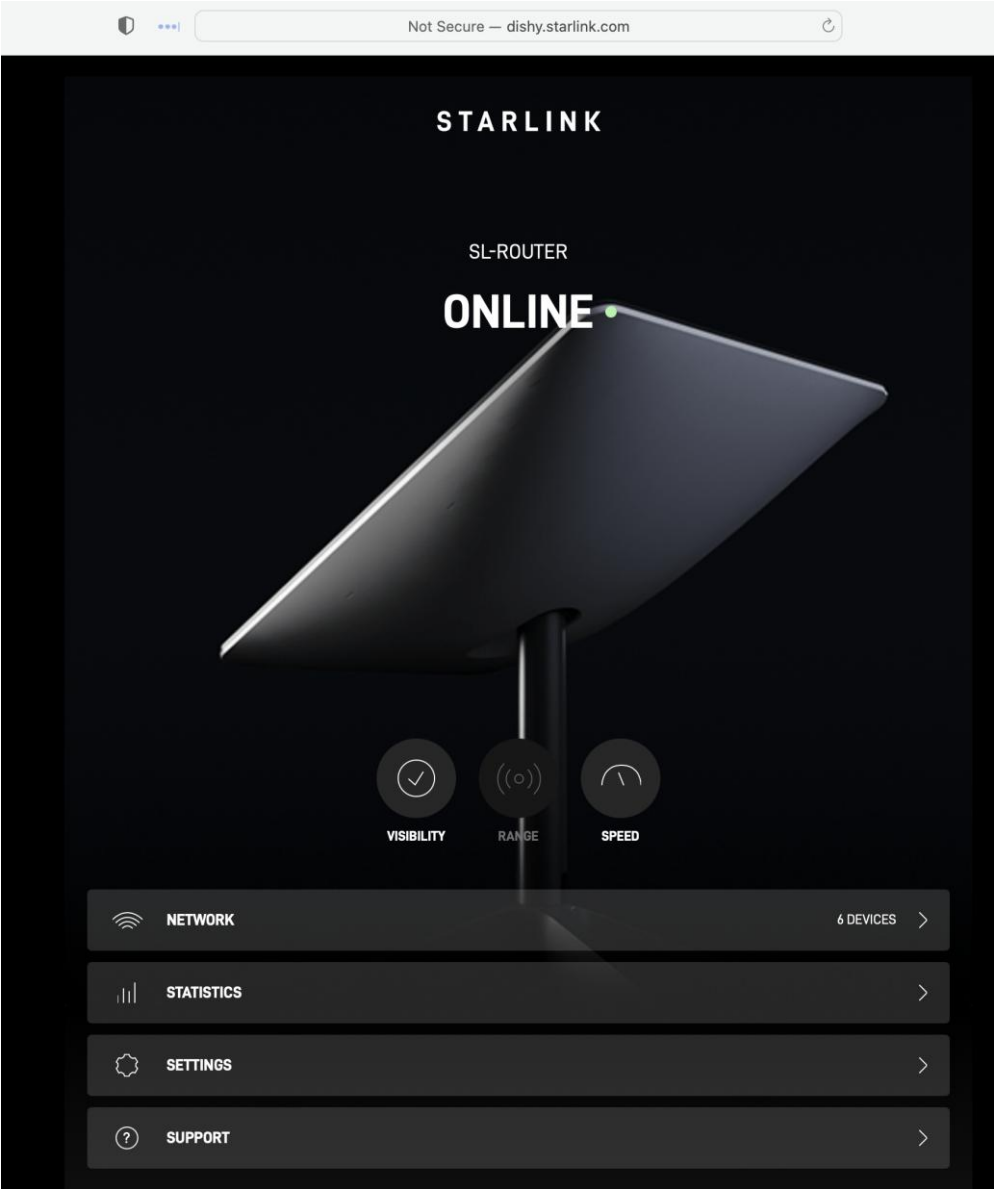
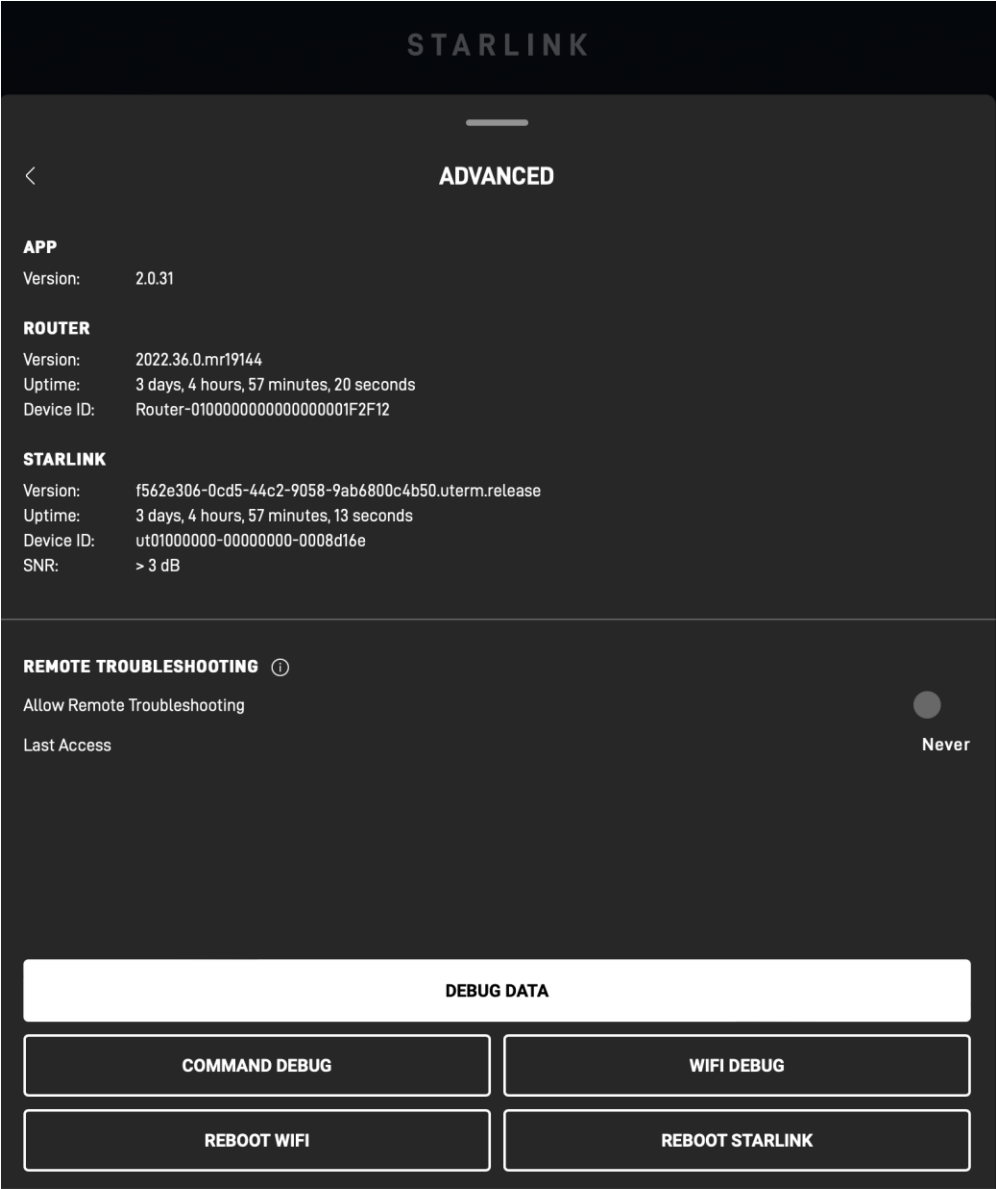
v4.14.1

Remote Connections

- Performance Data is stored in the Starlink Cloud
- Allows remote access to data statistics from your local network without being there



http://dishy.starlink.com



Starlink Debug

- "dish": {
 - "reachable": true,
 - "service": "dish",
 - "cloud": false,
 - "features": {
 - "stowRequested": true,
 - "unstow": true
 - },
 - "timestamp": 1666895243,
 - "deviceInfo": {
 - "id": "ut01000000-00000000-0008d16e",
 -

```
"auth": {  
  "accessToken": "<len=848>",  
  "refreshToken": "<len=66>",  
  "accessTokenExpirationDate": "2022-10-  
27T18:39:21Z",  
  "idToken": "<len=723>",  
  "tokenType": "Bearer"
```

- "antiRollbackVersion": 0, "isHeating": false,
- "isHitl": false
- "powerSupplyThermalThrottle": false
- },
- "deviceState": {
- "uptimeS": 122693
- "gpsStats": {
- "gpsValid": true,
- "gpsSats": 16,

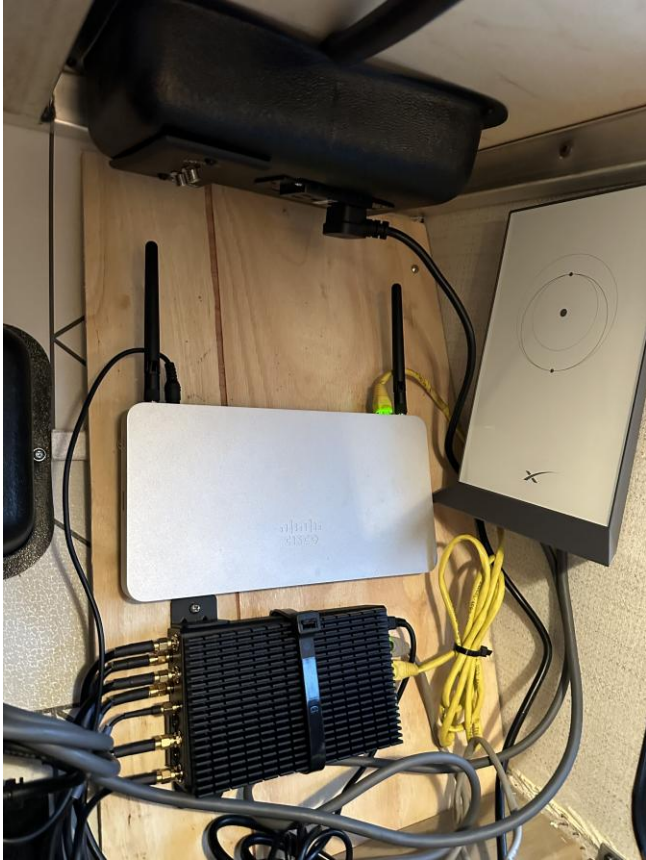
```
"gpsStats": {  
  "gpsValid": true,  
  "gpsSats": 16,
```

Should you leave your SL Router WIFI Enabled?

- The short answer is yes – primarily for local debug reasons
- Just don't use it for actual production users
 - It is not secured
 - It is not configurable
 - It is not a Firewall
 - It is a very poor performing Access Point

BYOS – Bring Your Own Security

What do you have running?



What is running now?

- Meraki MX95 (IPv4 and IPv6)
- Meraki MX65 (IPv4 and IPv6)
- Peplink MAX Transit Duo Pro (IPv4)
- Cisco

Meraki Starlink

Health

UPLINKS



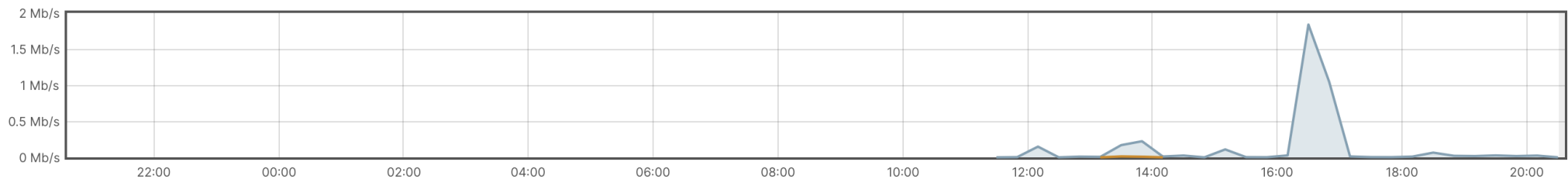
WAN APPLIANCES



Clients

all for the last day

573 MB (↓ 528.9 MB, ↑ 44.1 MB)



Policy	Search...	6 clients						Add client
☐	Status	Description	Last seen ▲	Usage	Client type, OS	IPv4 address	IPv6 address	
☐		027092e3-8692-42c2-a0bc-4302f88fe1c3	Nov 30 13:51	3.2 MB	Other	192.168.128.102	2605:59c8:6087:3a10:842e:e72:4cdb:2d87	
☐		ABENHASE-M-526H	Nov 30 14:02	53.2 MB	Other	192.168.50.181	fd11:1f5a:8f9a:16:cc9:3f77:d78a:c6a4	
☐		Blink-Mini	Nov 30 14:02	100 KB	Other	192.168.50.4		
☐		Blink-Mini	Nov 30 14:02	95 KB	Other	192.168.50.3		
☐		10:56:ca:84:bb:e0	Nov 30 16:45	9 KB	Other	192.168.50.1		
☐		ABENHASE-M-C02F	Nov 30 20:36	517.1 MB	Other	192.168.128.99	fd11:1f5a:8f9a:15:1cc8:8925:33c8:21fc	

Threat protection

Changes saved. ✕

Advanced Malware Protection (AMP)

- Mode ⓘ

Enabled ▾
- Allow list URLs ⓘ

There are no URLs on the Allow list.
[Add a URL to the Allow list](#)
- Allow list files

There are no files on the Allow list.
[Add a file to the Allow list](#)

Intrusion detection and prevention

- Mode ⓘ

Detection ▾
- Ruleset ⓘ

Balanced ▾
- Allow list rules ⓘ

There are no IDS rules on the Allow list.
[Add an IDS rule to Allow list](#)

Trusted Traffic Exclusions

To increase network performance, select traffic categories and IP addresses or subnets to bypass when AMP or IDS/IPS is enabled.

Trusted Applications ⓘ



Streaming & entertainment

Amazon Video, Google Services, Hulu, Netflix, Pandora Radio,...

[View all](#)



Software updates

Adobe Updates, Apple Updates, Google Updates, Microsoft ...

[View all](#)



Collaboration

Cisco Collaboration, MS Teams, RTP, SCCP, SIP, Skinny Call ...

[View all](#)



Online storage

Box, Dropbox, Google Workspace, Microsoft OneDrive, iCloud

[View all](#)



Business critical applications

AWS, Atlassian, Azure, Concur, Google Workspace, Jira, Log...

[View all](#)

WAN Health using 1keye

WAN health

Last 2 hours

View old version

0 Offline

0 Poor performance

0 High usage

2 Online

Search

4 Status

ISPs

Uplinks

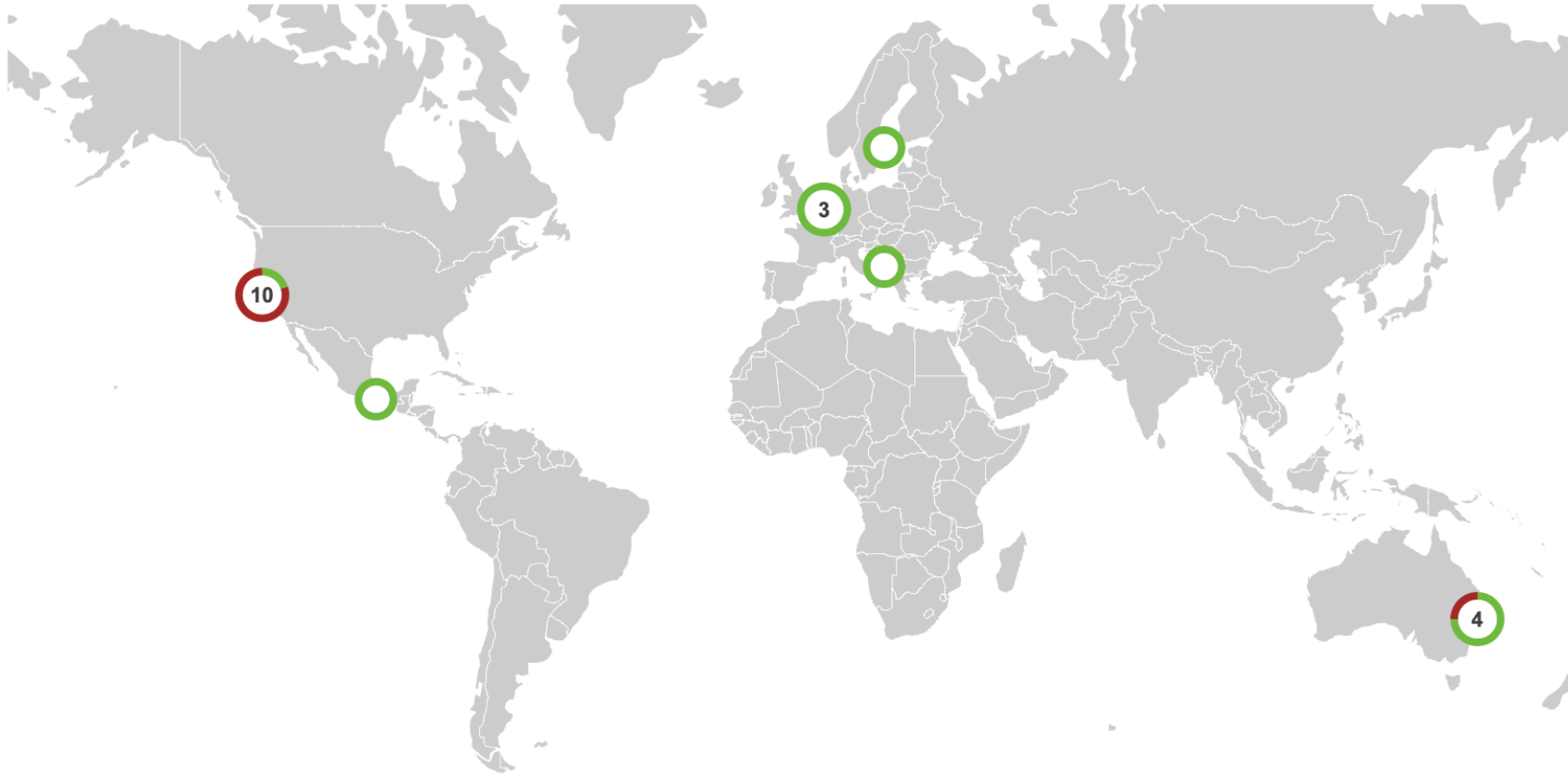
Reset all

16 Results

Download

Status	Network	Type	ISP	Availability	Downtime	Total usage	Average throughput	Speed test	Beta	Loss	
	MX95 Firewall	WAN 1	starlinkisp.net		0 s	↓ 64.49 MB, ↑ 30.97 MB	↓ 70.95 Kbps, ↑ 34.07 Kbps	Run speed test		0.29%	
	Remote_Office	WAN 1	starlinkisp.net		3.4 mins	↓ 2.80 MB, ↑ 3.51 MB	↓ 3.06 Kbps, ↑ 3.83 Kbps	Run speed test		0.48%	

Rows per page 10 < 1 >



Agent based Reporting for Thousand Eyes running Starlink across the Globe

Current Test

[Settings](#)

Agent

Andrew-Benhase-MX65

All agents

Run Now

Save

Share

Open Views 2.0

...

Views

NETWORK

Overview

Path Visualization

ROUTING

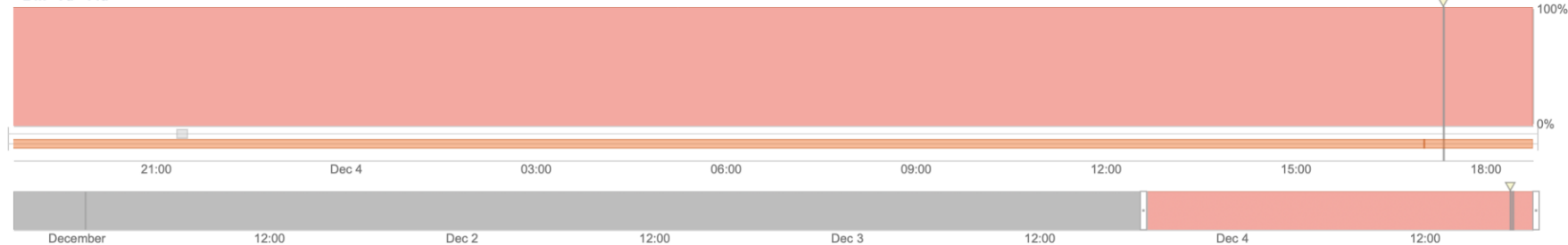
BGP Route Visualization

Metric

Loss

24h 7d 14d

Average Loss



Map

Table

Agents

10 of 10

Loss 100%

Latency No Data

Jitter No Data



IPv6 PD Renew Every 5 Minutes

Event log

Client: Any

Before: 11/30/2023 21:49 (EST)

Event type include: All

Event type ignore: None

Search

Reset filters

Download as ▾

« newer older »

Time (EST) ▾	Client	Category	Event type	Details
Nov 30 21:48:52		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 600, ValidLifetime: 1200 more »
Nov 30 21:48:52		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 600, ValidLifetime: 1200 more »
Nov 30 21:43:53		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 599, ValidLifetime: 1199 more »
Nov 30 21:43:53		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 599, ValidLifetime: 1199 more »
Nov 30 21:38:54		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 598, ValidLifetime: 1198 more »
Nov 30 21:38:54		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 598, ValidLifetime: 1198 more »
Nov 30 21:33:55		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 597, ValidLifetime: 1197 more »
Nov 30 21:33:55		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 597, ValidLifetime: 1197 more »
Nov 30 21:28:57		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 595, ValidLifetime: 1195 more »
Nov 30 21:28:57		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 595, ValidLifetime: 1195 more »
Nov 30 21:24:01		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 590, ValidLifetime: 1190 more »
Nov 30 21:24:01		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 590, ValidLifetime: 1190 more »
Nov 30 21:19:11		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 581, ValidLifetime: 1181 more »
Nov 30 21:19:11		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 581, ValidLifetime: 1181 more »
Nov 30 21:14:30		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 562, ValidLifetime: 1162 more »
Nov 30 21:14:30		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 562, ValidLifetime: 1162 more »
Nov 30 21:10:06		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 526, ValidLifetime: 1126 more »
Nov 30 21:10:06		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 526, ValidLifetime: 1126 more »
Nov 30 21:06:21		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 449, ValidLifetime: 1049 more »
Nov 30 21:06:21		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 449, ValidLifetime: 1049 more »
Nov 30 21:03:51		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 300, ValidLifetime: 900 more »
Nov 30 21:03:51		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 300, ValidLifetime: 900 more »
Nov 30 20:58:52		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 599, ValidLifetime: 1199 more »
Nov 30 20:58:52		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 599, ValidLifetime: 1199 more »
Nov 30 20:53:52		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 599, ValidLifetime: 1199 more »
Nov 30 20:53:52		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 599, ValidLifetime: 1199 more »
Nov 30 20:48:51		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 600, ValidLifetime: 1200 more »
Nov 30 20:48:51		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 600, ValidLifetime: 1200 more »

SD-WAN

Devices

Devices

Certificates

Licensing

FILTERED BY

Reachable · Up

SUMMARY

- > Health
- > Reachable
- Up
- Down
- > Control Status
- > Cloud Provider

Device GroupAll

Devices (5)

Export

Search Table

As of: Dec 06, 2023 01:04 PM

Hostname	Device Model	Site Name	System IP	Health	Reachability	vSmart Control	BFD	TLOC	Up Since	CPU Load	Action
IR1833-tom	IR1833	SITE_206202	172.16.20.1			2 / 2	6 / 6	1 / 1	Dec 04, 2023 07:08 AM	33.93%	
StarlinkPOC-1121X	C1121X-8P	SITE_303303	172.16.250.200			2 / 2	6 / 6	1 / 1	Nov 15, 2023 06:43 AM	6.24%	
Starlink-WASH-8300-1	C8300-1N1S-4T2X	SITE_303302	172.16.250.199			2 / 2	5 / 6	1 / 1	Dec 02, 2023 04:30 AM	11.97%	
C8300-RTP6-SL-1	C8300-1N1S-6T	SITE_206250	172.16.1.1			4 / 4	6 / 8	2 / 2	Nov 16, 2023 08:23 AM	8.22%	
C8300-RTP6-SL-2	C8300-1N1S-6T	SITE_206250	172.16.1.2			2 / 4	3 / 4	1 / 2	Nov 15, 2023 04:26 AM	8.25%	

Things we know

- CG-NAT is a reality for all Residential and Mobile Plans
- High Performance Array is allocated a public IP address
- This is NOT a static IP address!
 - DHCP 5 minute renewal

Catalyst SD-WAN Controllers
On Premise in DC or Cloud
Hosted

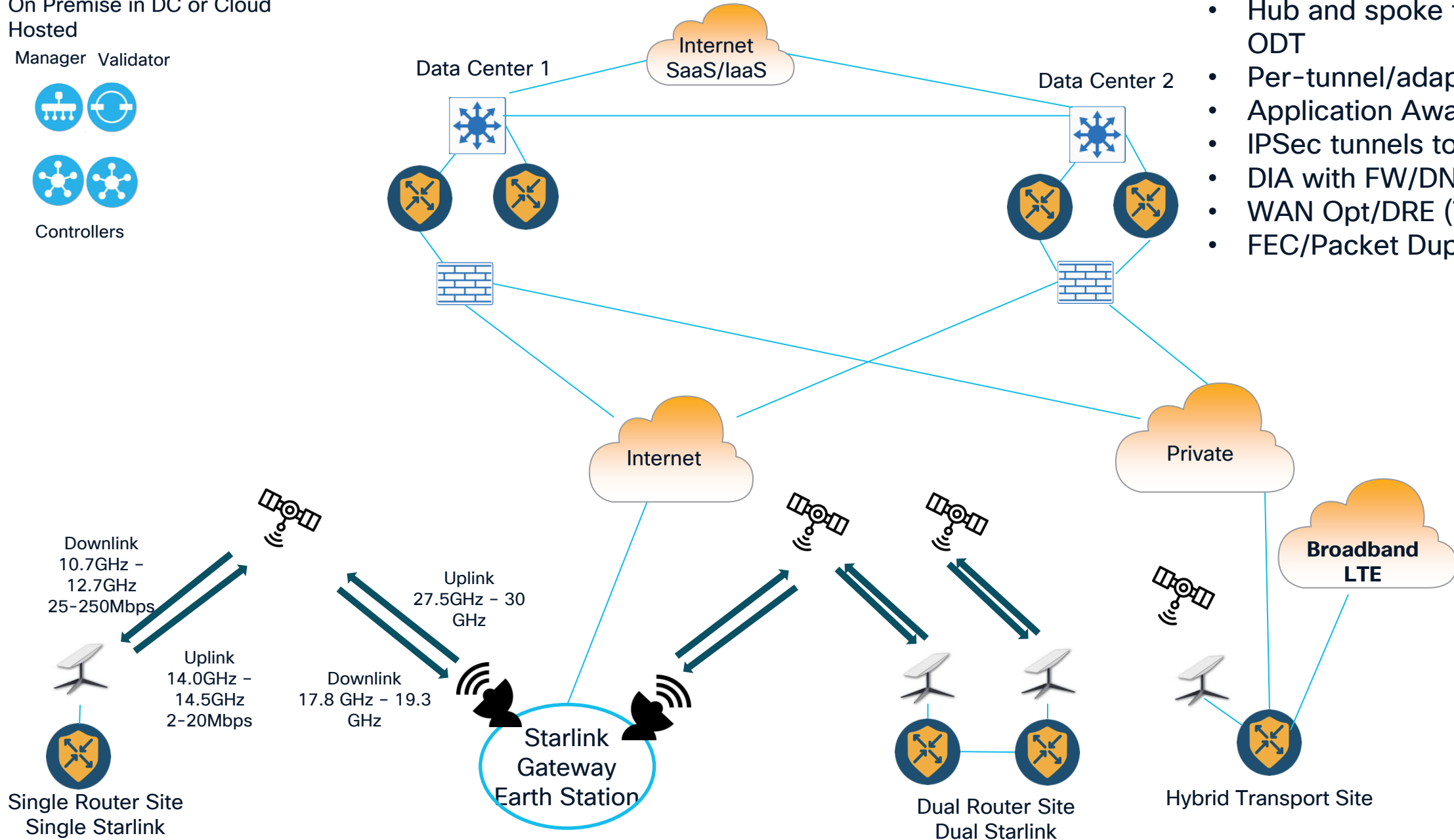
Manager Validator



Controllers

Starlink Reference Architecture

- SD-WAN version 17.x
- Hub and spoke topology with ODT
- Per-tunnel/adaptive QoS
- Application Aware Routing
- IPSec tunnels to SIG
- DIA with FW/DNS-Sec
- WAN Opt/DRE (TBD)
- FEC/Packet Dup (TBD)



WAN Edge List

WAN Edge List (10)

Search Table

Upload WAN Edge List

Export Bootstrap Configuration

Sync Smart Account

Add PAYG WAN Edges

Chassis Number	Site Name	Hostname	Tags	Config Locked	Managed By ⓘ
C1121X-8P-FGL2624L51Q	SITE_303303	StarlinkPOC-1121X	Add Tag ▾	No	Unmanaged
C8300-1N1S-4T2X-FLM272112RA	SITE_206202	C8300-TOM-SL	Add Tag ▾	Yes	Template Starlink-8300-1N1S-4T2X-Tom-Zs
C8300-1N1S-4T2X-FLM272112R8	SITE_303302	Starlink-WASH-8300-1	Add Tag ▾	Yes	Template Starlink-8300-1N1S-4T2X-Tom-Zs
ISR1100-6G-FGL2347L5EX	-	-	Add Tag ▾	No	Unmanaged
C8500L-8S4X-FLX26030880	SITE_300	Router	Add Tag ▾	Yes	Template 8500L-RTP6-Hub1
C1101-4PLTEP-FGL2321113A	-	-	Add Tag ▾	No	Unmanaged
C1101-4PLTEPW-B-FGL232613MD	-	-	Add Tag ▾	No	Unmanaged
IR1833-K9-FCW2711Y52G	SITE_206202	IR1833-tom	Add Tag ▾	No	Unmanaged
C8300-1N1S-6T-FLM272112HR	SITE_206250	C8300-RTP6-SL-1	Add Tag ▾	Yes	Template Starlink-8300-1N1S-6T-TLOCEXT
C8300-1N1S-6T-FLM272112J0	SITE_206250	C8300-RTP6-SL-2	Add Tag ▾	Yes	Template Starlink-8300-1N1S-6T-TLOCEXT

Running Configuration

Host: C8300-RTP6-SL-1(169.254.12.83)

Site ID: 206250

Device Model: C8300-1N1S-6T

```
system
gps-location latitude 35.89
gps-location longitude -78.0
device-groups STARLINK1
system-ip 172.16.1.1
overlay-id 1
site-id 206250
port-offset 0
control-session-pps 300
admin-tech-on-failure
sp-organization-name "mt-vmanage-demo - 627179"
organization-name "mt-vmanage-demo - 627179-spacex"
port-hop
track-transport
track-default-gateway
```


SD-WAN Configuration

```
interface GigabitEthernet0/0/0
  description Ethernet to Starlink LEO satellite
  no shutdown
  arp timeout 1200
  ip address dhcp client-id GigabitEthernet0/0/0
  no ip redirects
  ip tcp adjust-mss 1360
  ip dhcp client default-router distance 1
  ip mtu 1500
  ip nat outside
  load-interval 30
  mtu 1500
  negotiation auto
```

```
interface Tunnel100201
  no shutdown
  ip unnumbered GigabitEthernet0/0/0
  no ip clear-dont-fragment
  ip mtu 1400
  tunnel source GigabitEthernet0/0/0
  tunnel destination dynamic
  tunnel mode ipsec ipv4
  tunnel protection ipsec profile if-ipsec201-ipsec-profile
  tunnel vrf multiplexing
  tunnel route-via GigabitEthernet0/0/0 mandatory
exit
interface Tunnel100202
  no shutdown
  ip unnumbered GigabitEthernet0/0/0
  no ip clear-dont-fragment
  ip mtu 1400
  tunnel source GigabitEthernet0/0/0
  tunnel destination dynamic
  tunnel mode ipsec ipv4
  tunnel protection ipsec profile if-ipsec202-ipsec-profile
  tunnel vrf multiplexing
  tunnel route-via GigabitEthernet0/0/0 mandatory
exit
```

Crypto Configuration

```
crypto ikev2 policy policy1-global
proposal p1-global
!
crypto ikev2 profile if-ipsec201-ikev2-profile
no config-exchange request
dpd 60 10 on-demand
dynamic
lifetime 14400
!
crypto ikev2 profile if-ipsec202-ikev2-profile
no config-exchange request
dpd 60 10 on-demand
dynamic
lifetime 14400
!
crypto ikev2 proposal p1-global
encryption aes-cbc-128 aes-cbc-256
group 14 15 16 19 20 21
integrity sha1 sha256 sha384 sha512
```

```
crypto ipsec transform-set if-ipsec201-ikev2-transform esp-null esp-
sha-hmac
mode tunnel
!
crypto ipsec transform-set if-ipsec202-ikev2-transform esp-null esp-
sha-hmac
mode tunnel
!
crypto ipsec profile if-ipsec201-ipsec-profile
set ikev2-profile if-ipsec201-ikev2-profile
set transform-set if-ipsec201-ikev2-transform
set security-association lifetime kilobytes disable
set security-association lifetime seconds 3600
set security-association replay window-size 1024
!
crypto ipsec profile if-ipsec202-ipsec-profile
set ikev2-profile if-ipsec202-ikev2-profile
set transform-set if-ipsec202-ikev2-transform
set security-association lifetime kilobytes disable
set security-association lifetime seconds 3600
set security-association replay window-size 1024
```

Design optimizations for LEO Satellite Transport

Reducing SD-WAN control plane traffic on Satellite links

Problems

LEO satellite have low transmit speeds (2-20 Mbps up) relative to download speeds of 25-220 Mbps down). SD-WAN control traffic can consume a high proportion of this bandwidth in heavily meshed topologies with default timers. This includes:

- BFD probes over each IPsec tunnel (2.2 Kbps per SD-WAN tunnel)
- OMP hellos and updates to/from Catalyst controllers (up to 80 Kbps)
- Statistics upload to the Catalyst Manager (up to 1.2 Mbps)

Control traffic is automatically mapped to Q0 on the WAN edge, ~~which can contend with user realtime traffic also~~ in Q0 resulting in drops and instability

Solutions

- Dynamic OnDemand tunnel design (reduces # of BFD sessions)
 - BFD low bandwidth link
 - Last-resort-circuit in cases where Starlink is for backup
 - vManage connection preference 1
 - Administration Settings for Statistics – disable some, all or vAnalytics only?
 - QoS design with Adaptive QoS and 2-level policer / Split LLQ
-

Tunnel Optimizations for low bandwidth links

Low bandwidth link: Reduces BFD overhead by 50% per tunnel

Last-Resort-Circuit: No tunnel or traffic unless all other transports down

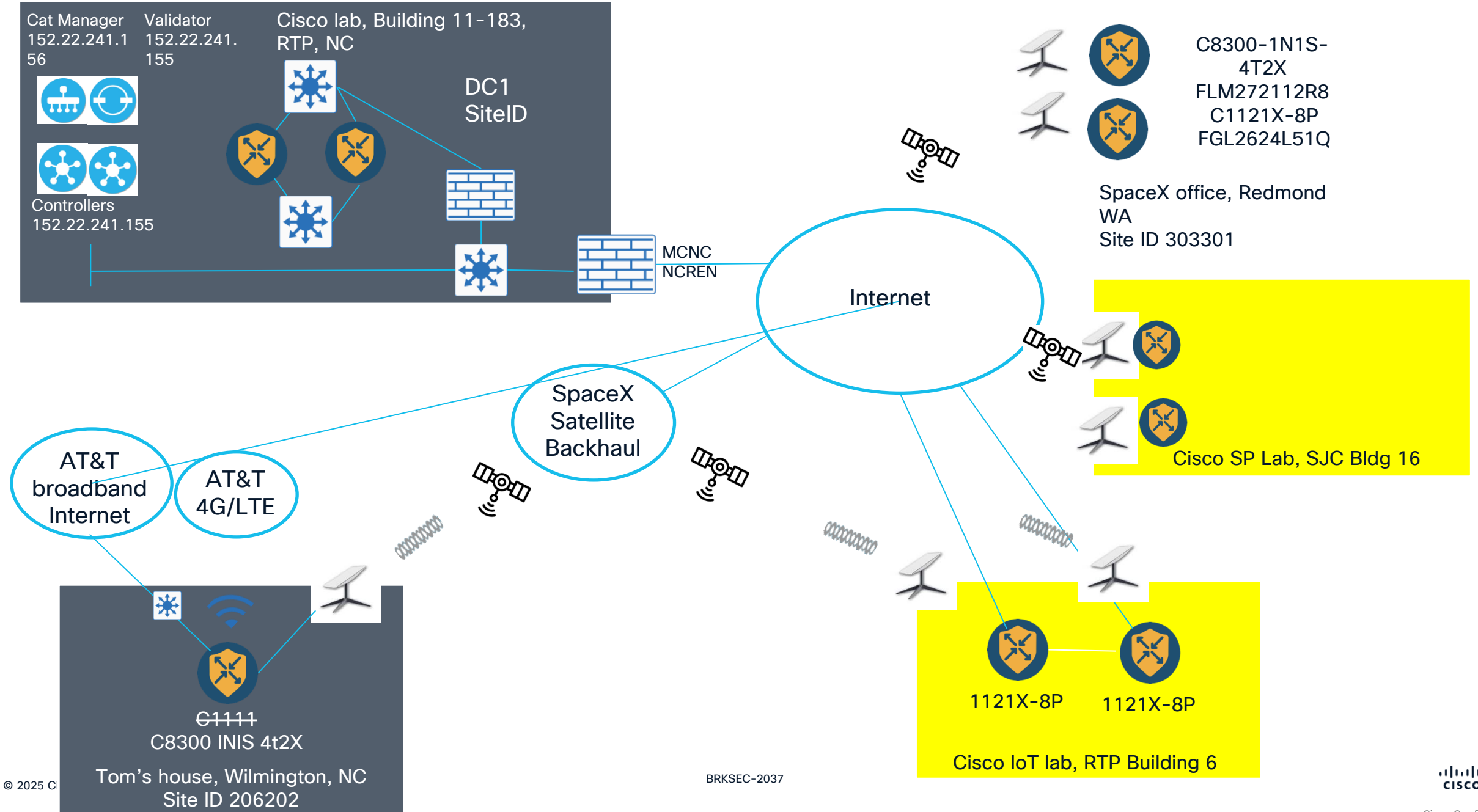
vManage connection preference 1: Prefer terrestrial (if available) over Satellite for vManage control connections to reduce overhead of statistics publishing.

OMP Hello tuning: Reduce Hello-interval to further optimize bandwidth

```
sdwan

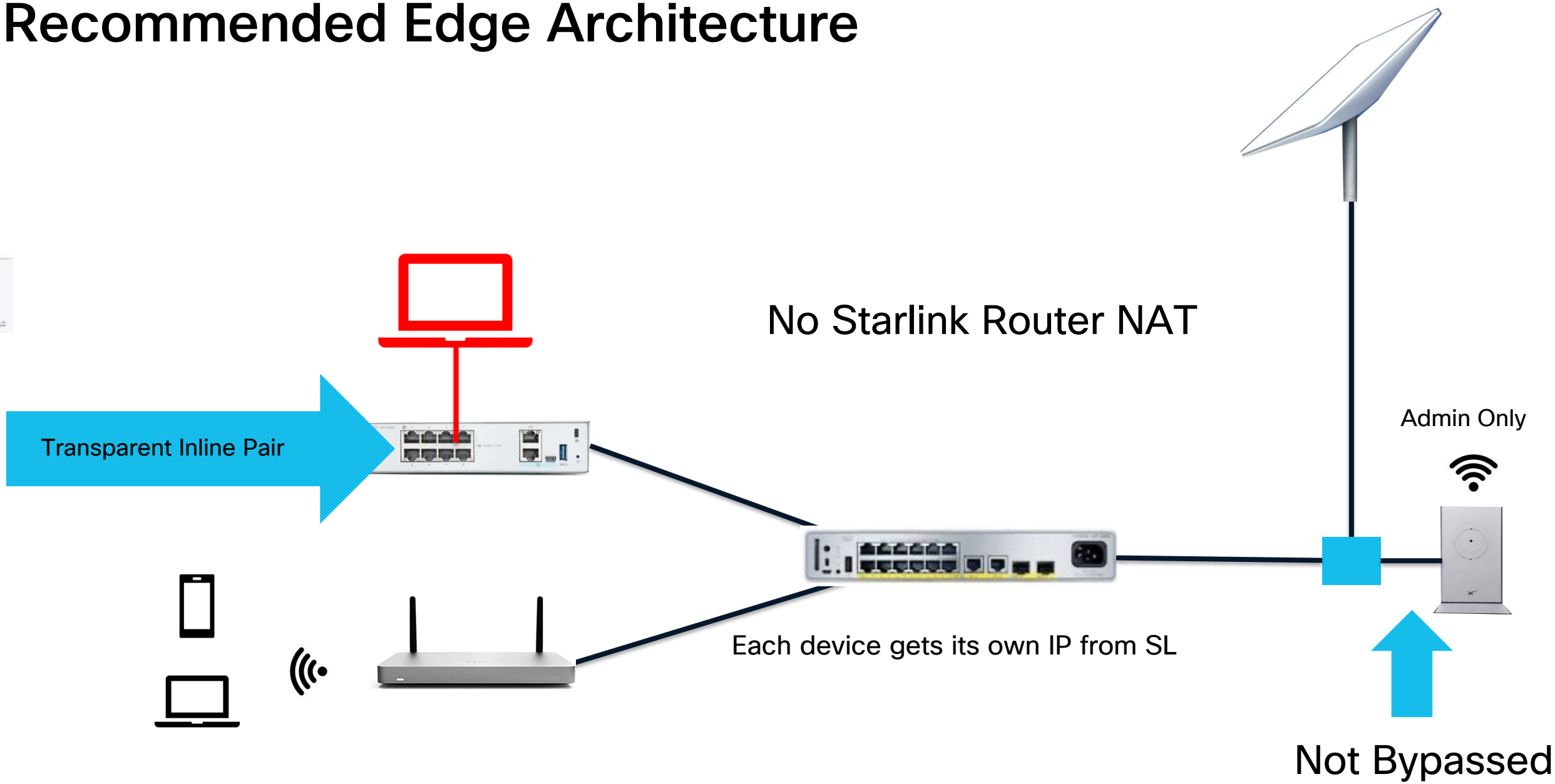
interface GigabitEthernet 0/1/0
Description connected to Starlink
 tunnel-interface
 encapsulation ipsec weight 1
 no border
 color
 no last-resort-circuit
 low-bandwidth-link
 hello-interval          6000
 hello-tolerance         600
 vmanage-connection-preference 1
```

Validation Lab

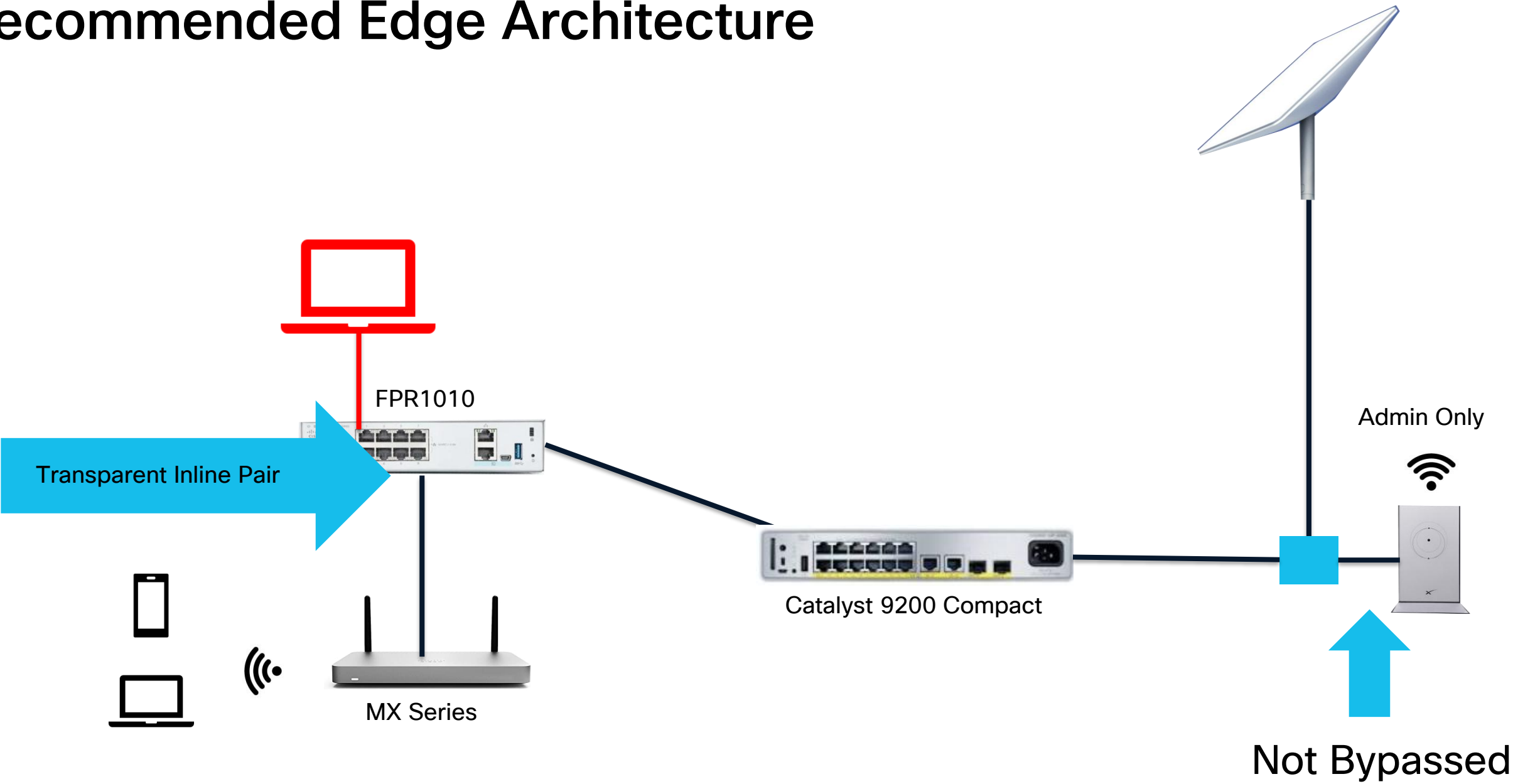


Ground/Space Architectures

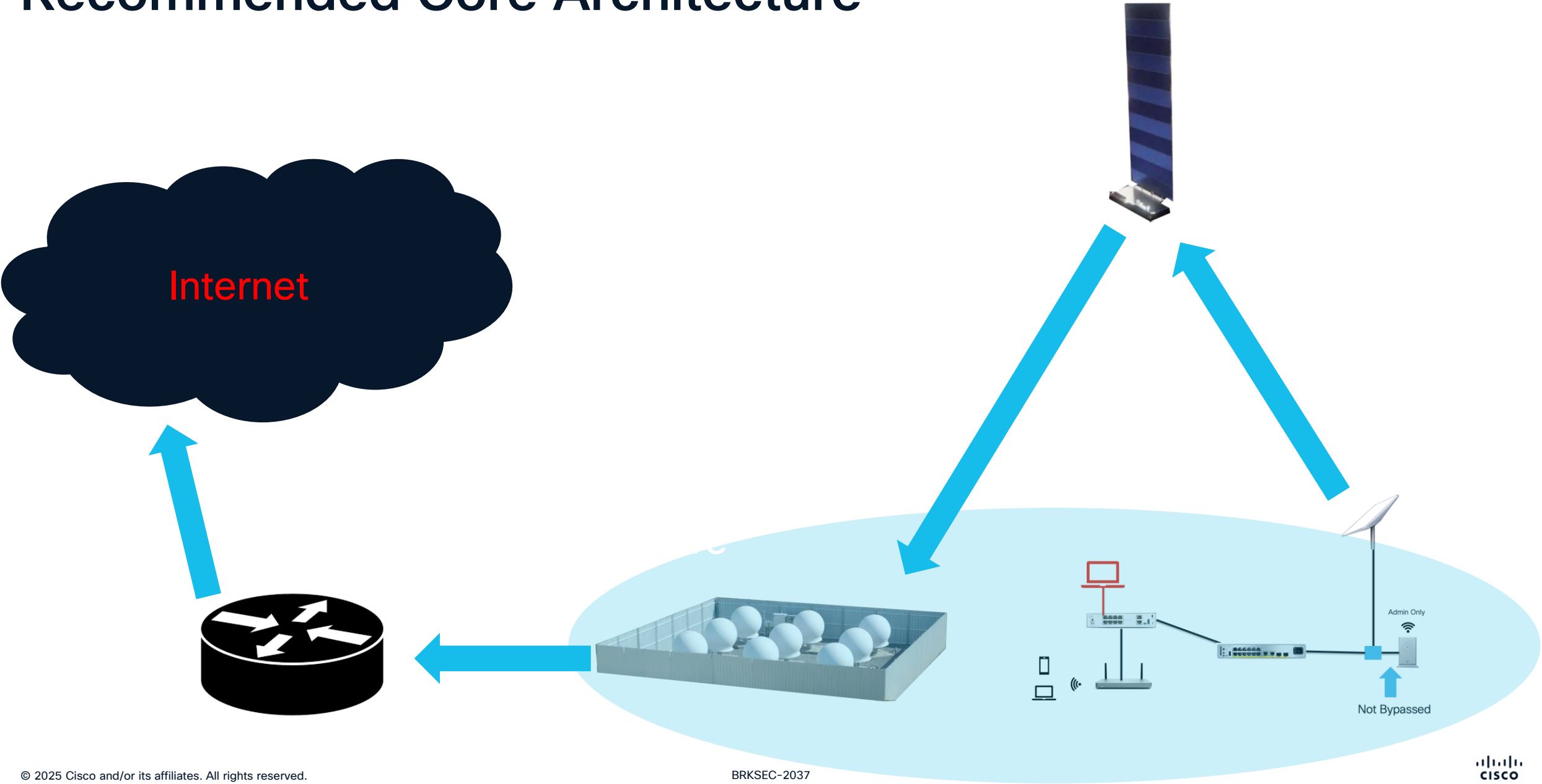
Recommended Edge Architecture



Recommended Edge Architecture



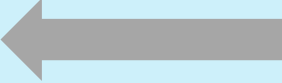
Recommended Core Architecture



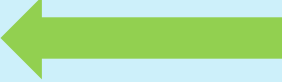
Recommended Core Architecture



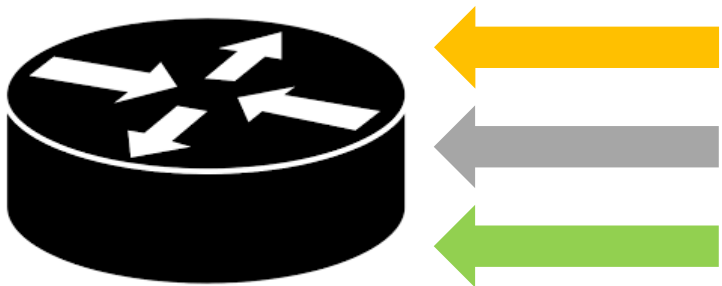
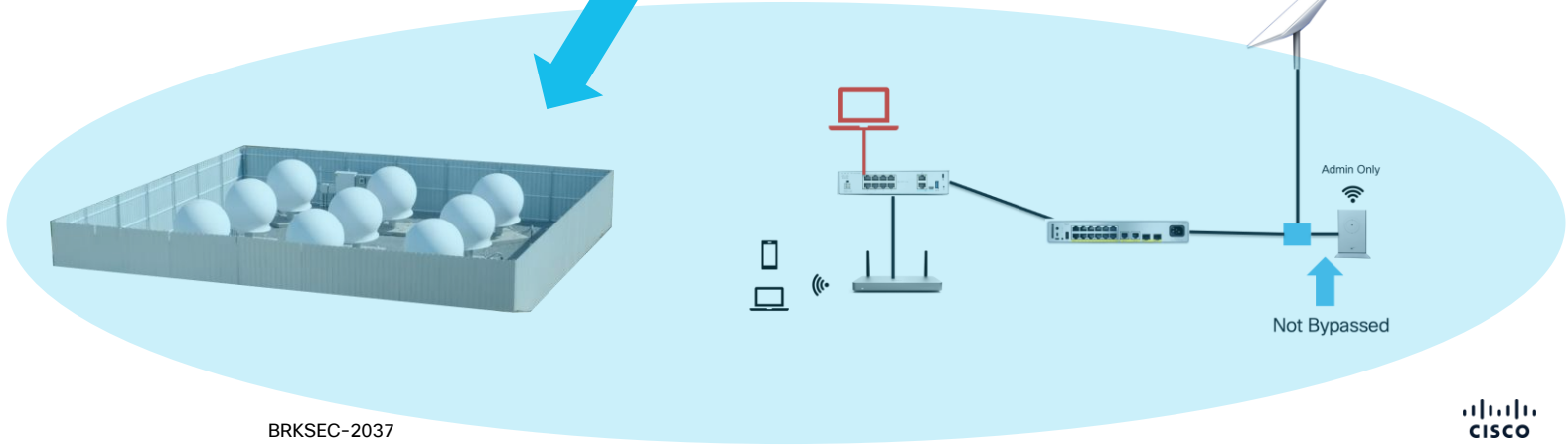
Mobile (Best Effort) \$\$



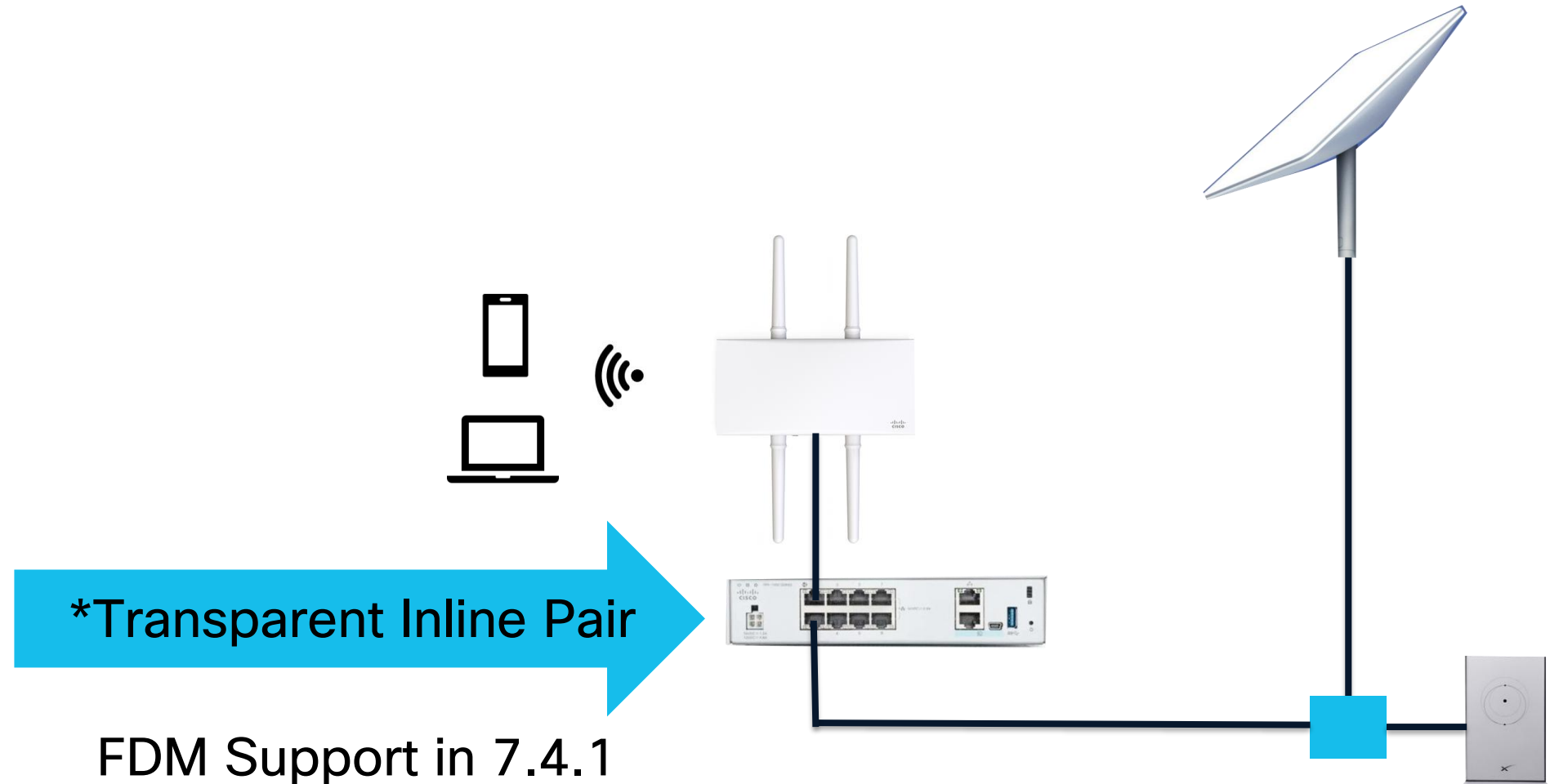
Priority Data (EF) \$\$\$

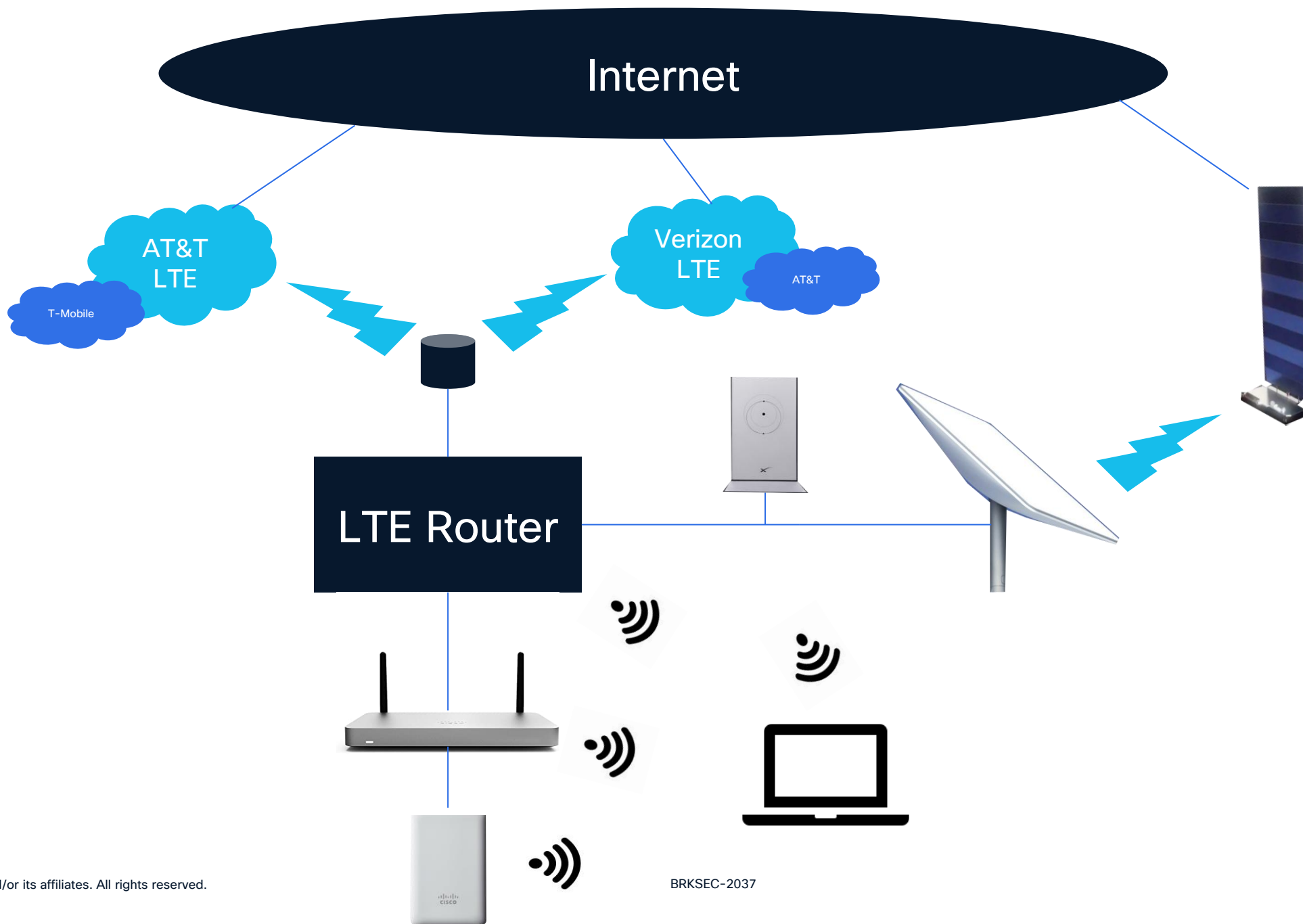


Residential (AF) \$

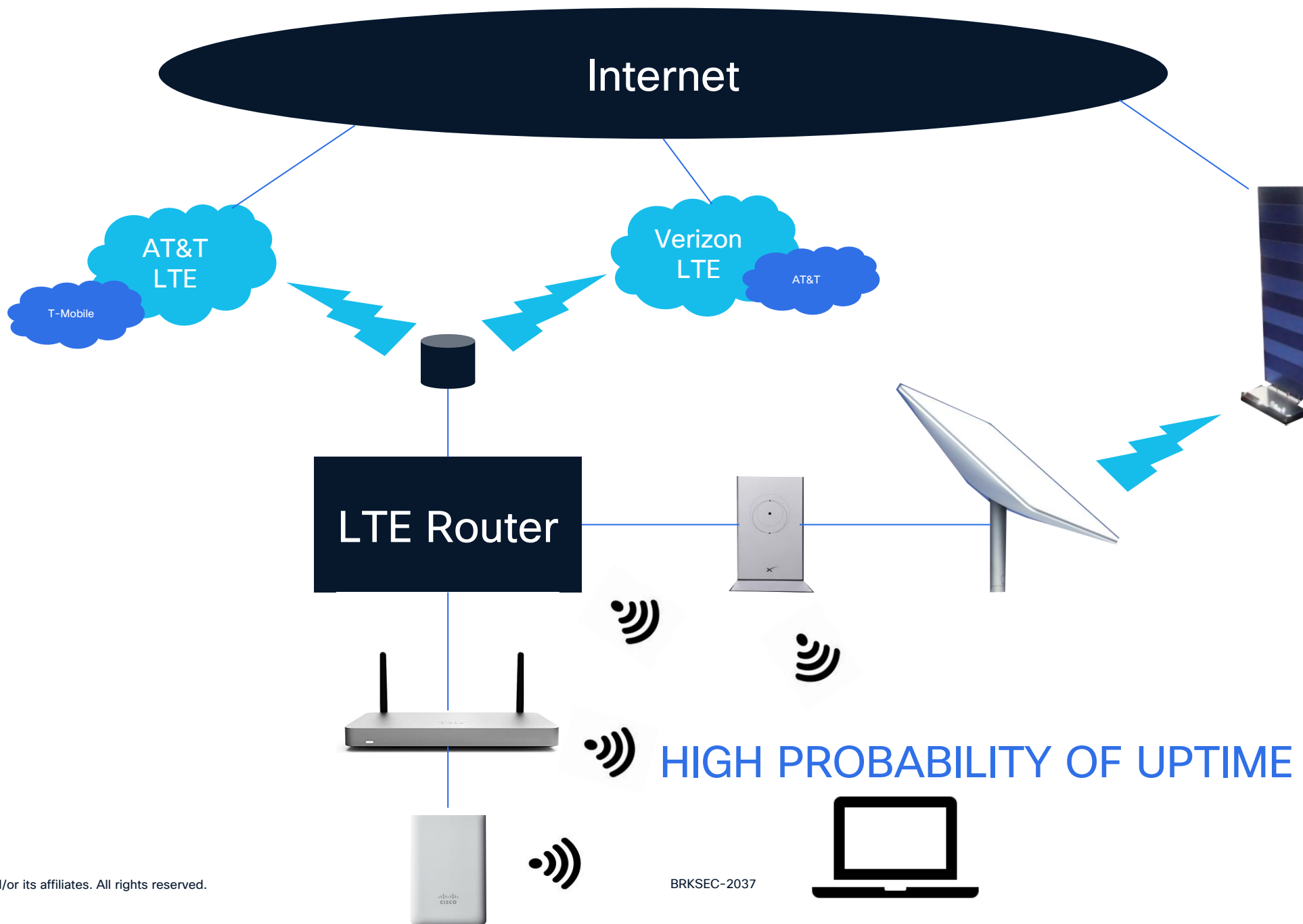


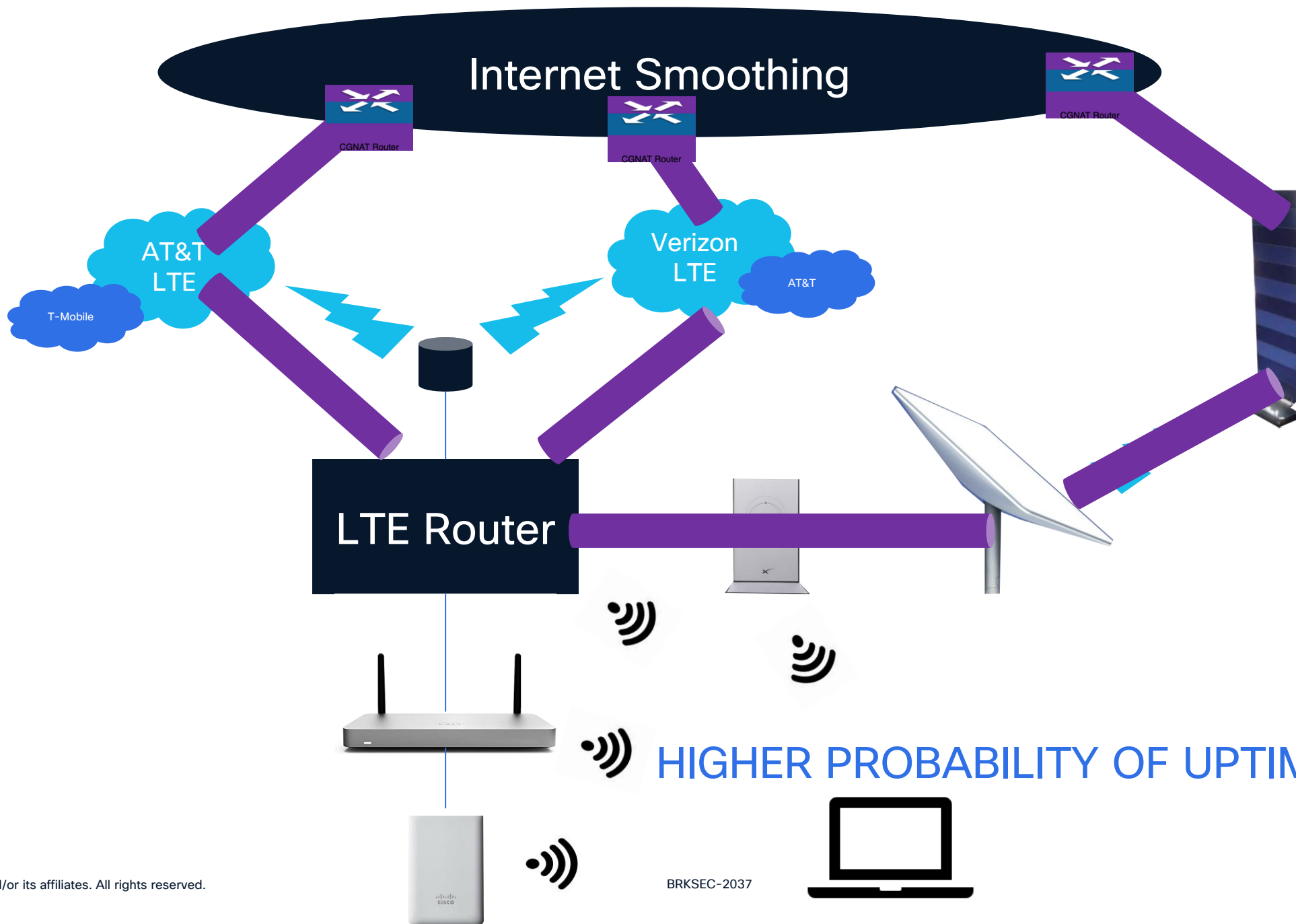
Recommended Architecture





Highest Probability of Network Uptime

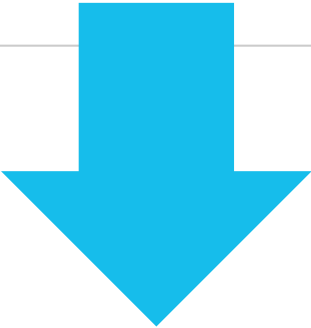




PRO TIP: Get MintMobile SIM Unlimited: \$20

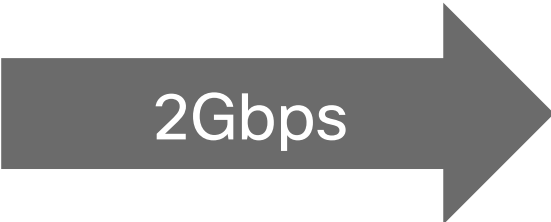
UNLIMITED

\$30/mo \$90 upfront payment required	\$35/mo \$210 upfront payment required	Limited Time Offer \$20/mo \$30/mo \$240 upfront payment required
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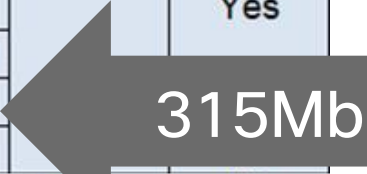
LTE Cat 7/14 or 5G Cat 20 Modem?

- Great question – do you think you’ll be close to a 5G network on a consistent basis?
- If not, I would opt for LTE based cellular modems x 2
- With WAN Smoothing technologies, over multiple interfaces, outage impacts are largely minimized



Downlink			Uplink				
DL UE Gatorgor	Max data rate in Mbps	DL MIMO	DL UE Gatorgor	Max data rate in Mbps	64QAM Support	256QAM Support	
M1	~1 Mbps	1	M1	~3 Mbps	No	No	
M2	~ 4 Mbps		M2	~7 Mbps			
0	~1 Mbps		0	~0 Mbps			
1bits	~10 Mbps		1bits	~5 Mbps			
4	~150 Mbps	2	3	~50 Mbps	Yes		Yes
6	~300 Mbps	2 or 4	5	~75 Mbps	No		
7	~300 Mbps		7	~100 Mbps			
9	~450 Mbps		8	~1500 Mbps			
10	~450 Mbps		13	~150 Mbps			
11	~600 Mbps		14	~9500 Mbps			
12	~600 Mbps		15	~220 Mbps			
13	~390 Mbps		16	~100 Mbps			
14	~3900 Mbps	8	17	~2100 Mbps	Yes		
15	~800 Mbps	2 or 4	18	~210 Mbps			
16	~1050 Mbps		19	~13500 Mbps			
17	~25000 Mbps	8	20	~315 Mbps		315M	
18	~1200 Mbps	2,4 or 8	21	~300 Mbps			
19	~1600 Mbps						
20	~2000 Mbps						
21	~1400 Mbps	2 or 4					





When Starlink goes down for 20 minutes





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