



The bridge to possible

# Starlink Security Advanced

Andrew Benhase, Federal Architect  
@CyberSecOps

BRKSEC-2150

CISCO *Live!*

#CiscoLive

# Cisco Webex App

## Questions?

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

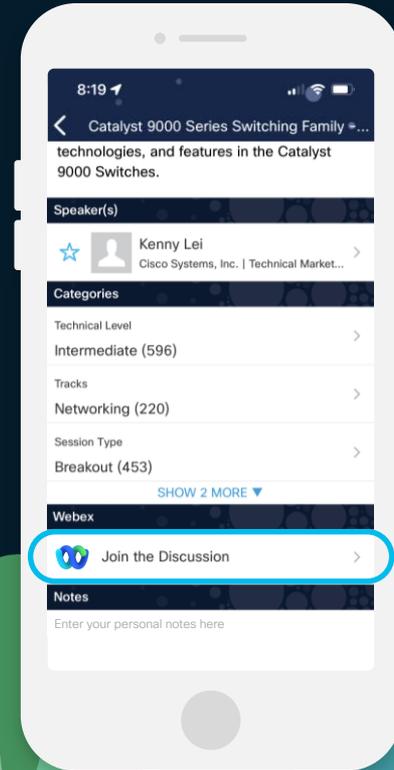
## How

- 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 June 7, 2024.

**CISCO** *Live!*

<https://ciscolive.ciscoevents.com/ciscolivebot/#BRKSEC-2150>



# Agenda

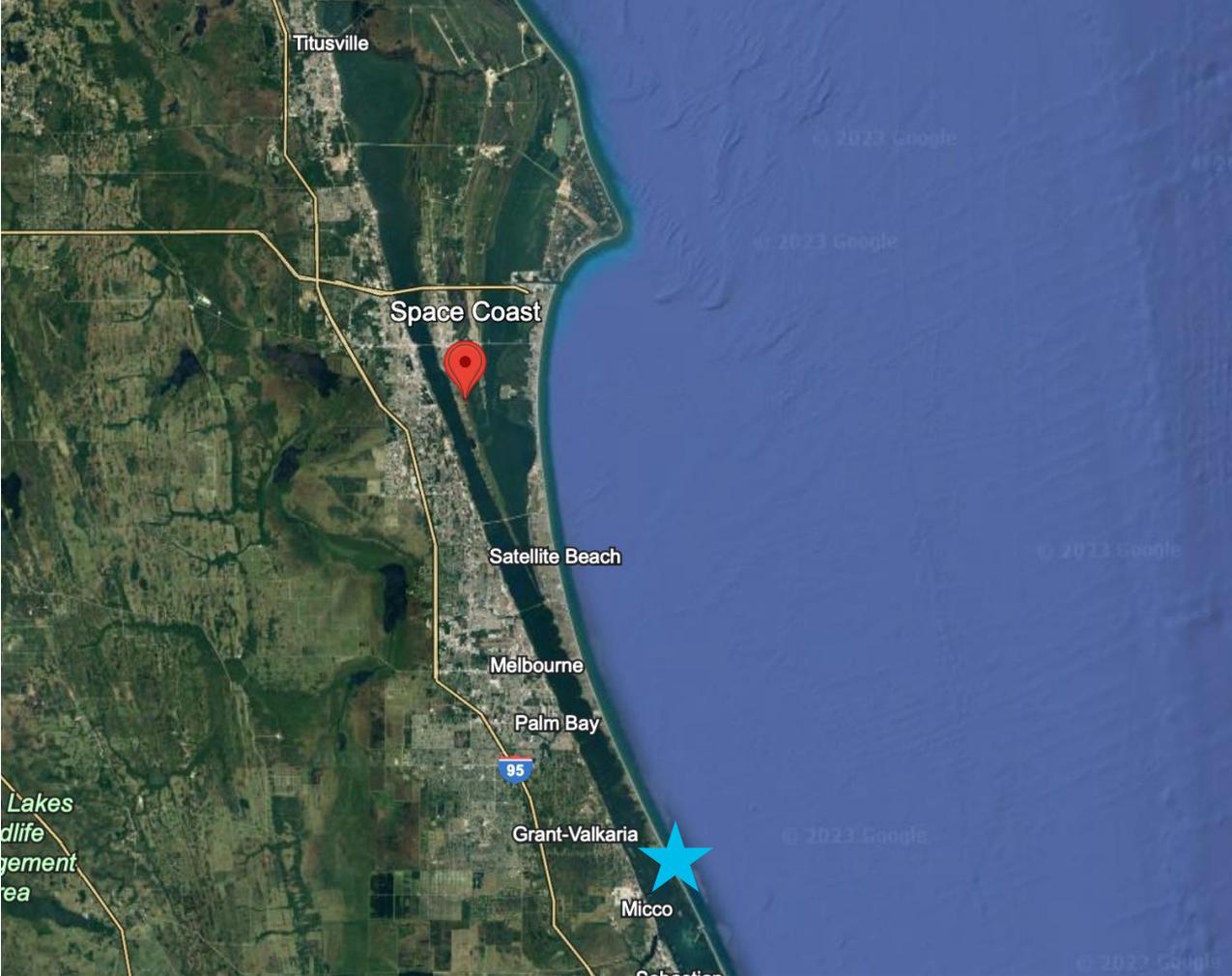
- Catch up on current events
- What is Starlink
- Starlink Security
- Deployment Models
- SDWAN
- Conclusion

# 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](mailto: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)



plane will be better than their  
connection at their house



CISCO *Live!*





Credit: SpaceX

BRKSEC-2150

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# SpaceX Announces a Starship Version Two is in the Works

By Jack Kuhr November 28, 2023





13:07 5G E

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

BRKSEC-2037



# Services Changes – Public IP

## PRIORITY - 1TB

High-speed, priority service for businesses and other high demand users at one location. Includes public IP and priority support. After using Priority data, continue receiving unlimited Standard data.

**\$250.00 /Month (\$174.89 Due Today)**

**ACTIVATE ON PRIORITY - 1TB**

## PRIORITY - 2TB

High-speed, priority service for businesses and other high demand users at one location. Includes public IP and priority support. After using Priority data, continue receiving unlimited Standard data.

**\$500.00 /Month (\$349.79 Due Today)**

**ACTIVATE ON PRIORITY - 2TB**

## PRIORITY - 6TB

High-speed, priority service for businesses and other high demand users at one location. Includes public IP and priority support. After using Priority data, continue receiving unlimited Standard data.

**\$1,500.00 /Month (\$1,049.36 Due Today)**

**ACTIVATE ON PRIORITY - 6TB**

# STARLINK



## You're Invited!

Enjoy an opportunity to experience the next generation Starlink!

The next generation Starlink is slimmer and more portable, with a more elegant design than its predecessor. This Starlink Kit also includes our Gen 3 router with improved range and speeds.

The cost of the Starlink Standard kit is **\$599** + Tax and Shipping.

**EARLY ACCESS SPECIAL OFFER:**  
Enjoy your first month of service on us!\*

[ORDER NOW](#)

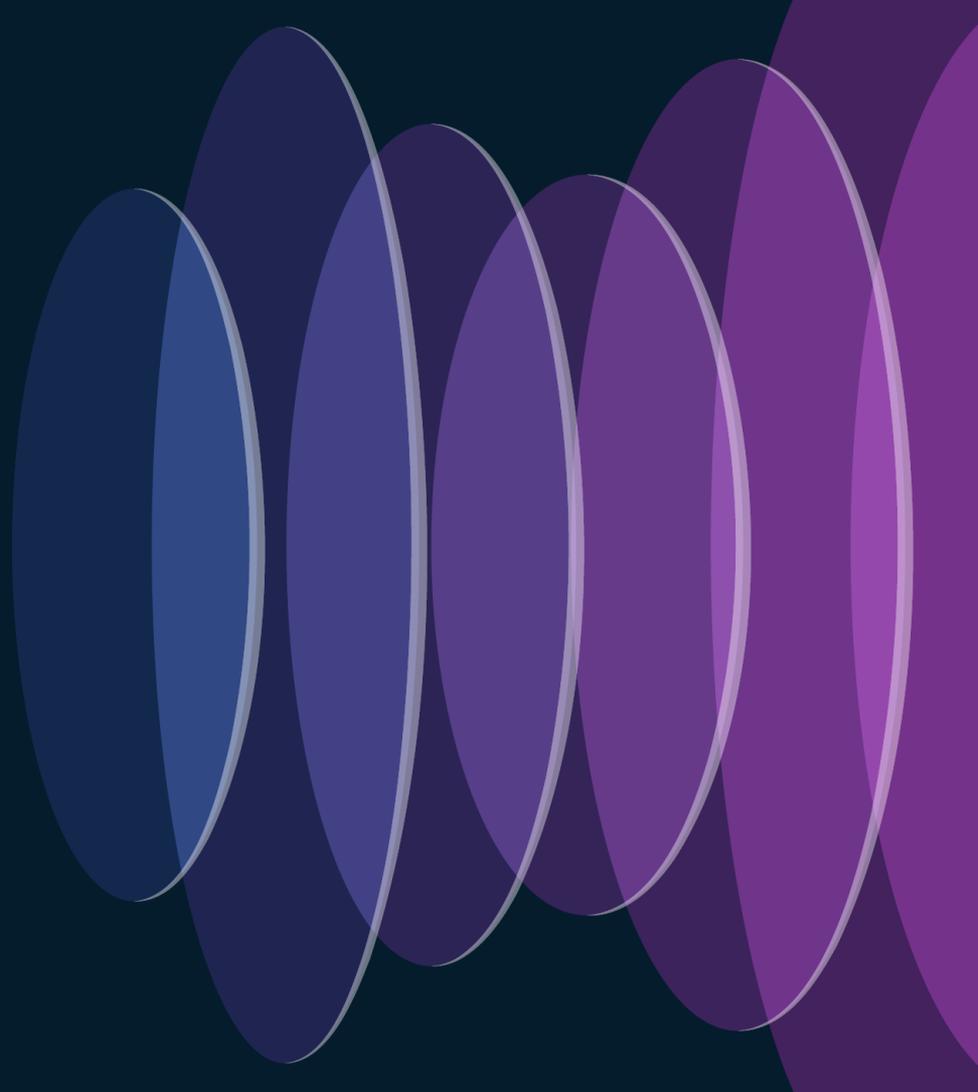




# Cats love Starlink



How do you  
keep up?



# Starlink Federal Room (SL-OSINT)

Starlink Federal

Messages People (64) Content Meetings + Apps

+ Add people

- Andrew Benhase Active
- Adnan Sadiq In a meeting
- Austin McDaniel Active
- Brandon Adkins Out of Office until 5/23/23, 4:00 AM - P...
- Brent Taylor
- Brian Bessette 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
- Don Rogers Active 50 minutes ago

BRKSEC-2037: Securing Starlink Internet Services ☆

Messages People (3) Content Meetings + Apps

CL Amsterdam 2024 added 2 people to this space. 1/23/24, 7:36 PM

Today

You 12:43 PM 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

Joined



r/Starlink

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

Posted by u/Show\_me\_the\_dV 2 months ago



## 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](http://starlink.com)

Created Dec 15, 2008

181k

Members

254

Online

Top 1%

Ranked by Size

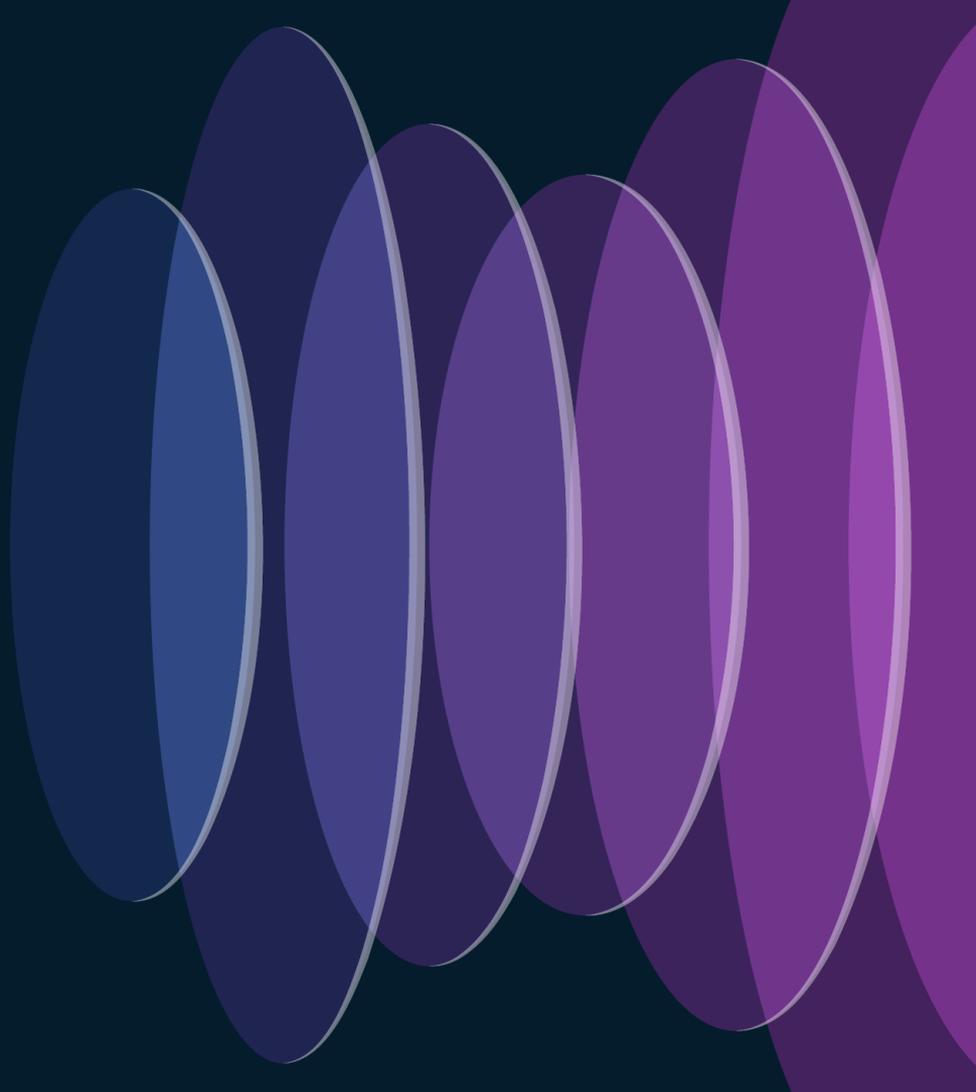
Create Post

PREVIEW



cyber-warrior

Whats happening  
with Kuiper?



# First Kuiper Launch



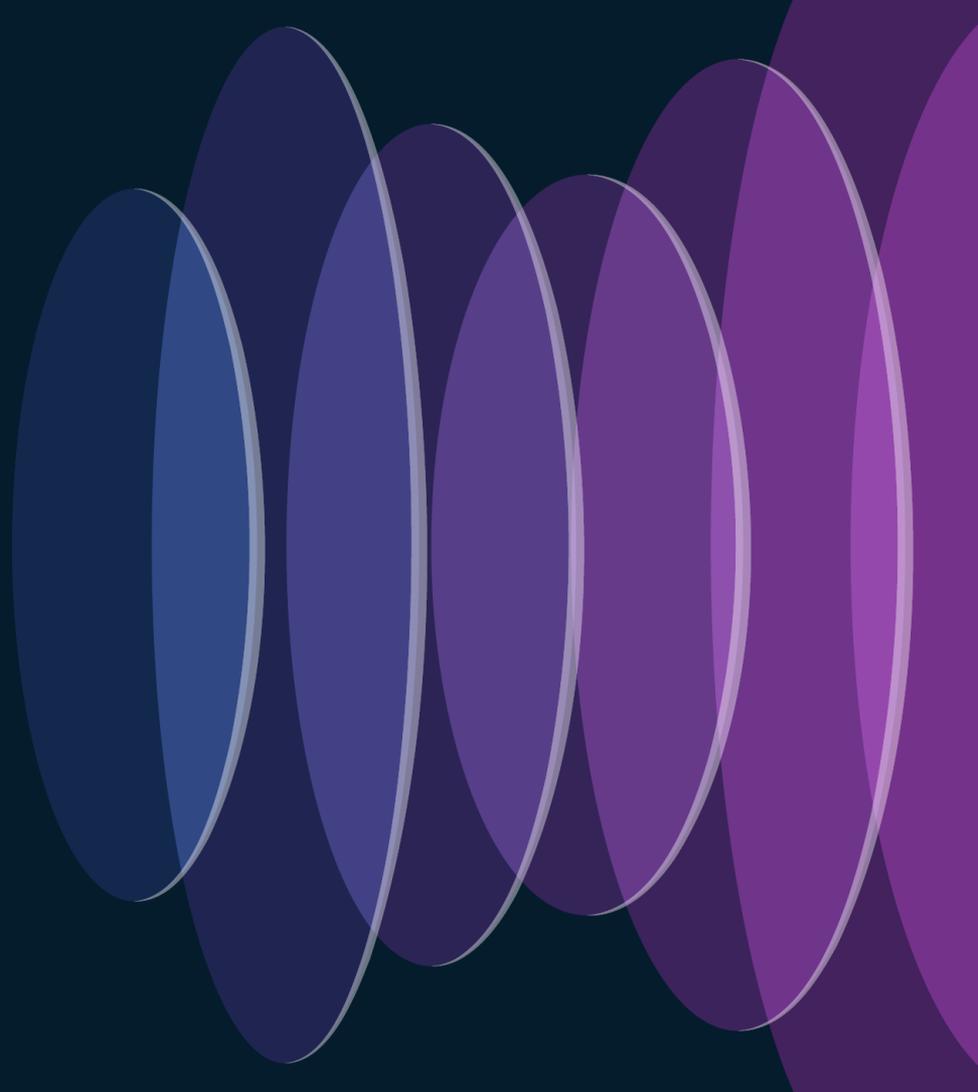
# December 2 2023



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

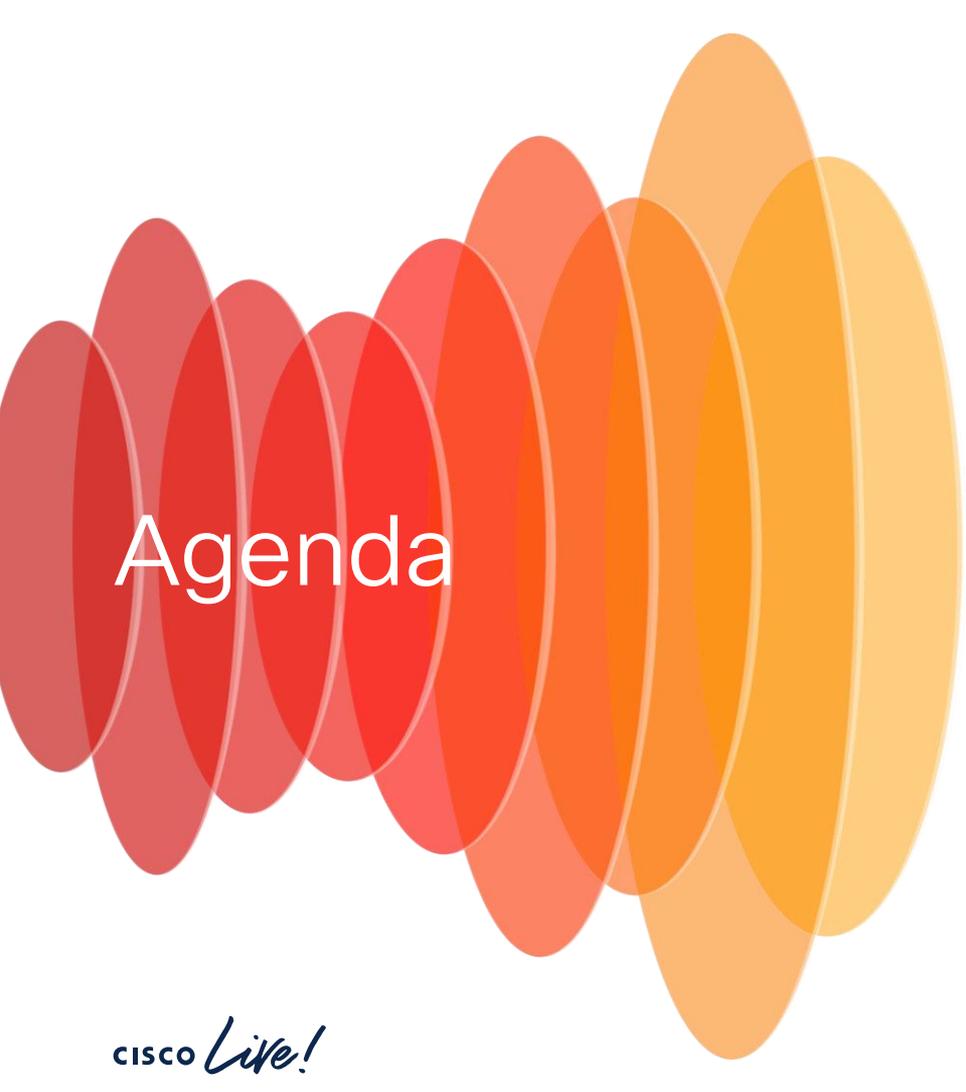
Amazon has signed a contract with SpaceX for three Falcon 9 launches to support deployment plans for Project Kuiper, Amazon's low Earth orbit (LEO) satellite broadband network. Project Kuiper satellites were designed from the start to accommodate multiple launch providers and vehicles, allowing us to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

# Whats happening with OneWeb?



# OneWeb- catering towards Enterprise

- Polar Orbits
- Higher Orbit
- >600 satellites in orbit
- Broad Coverage over Australia
- Focused towards Enterprise Networking

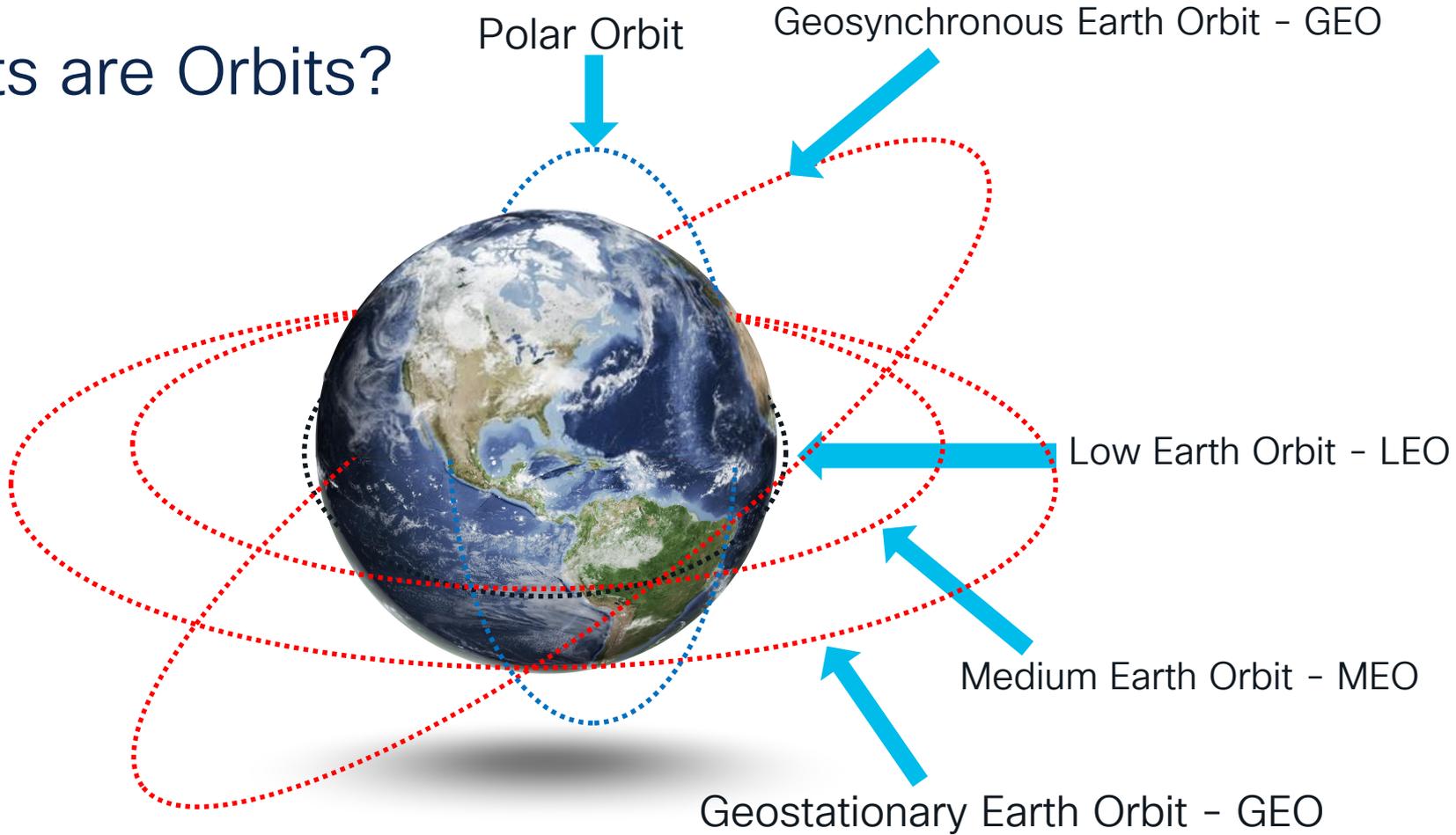


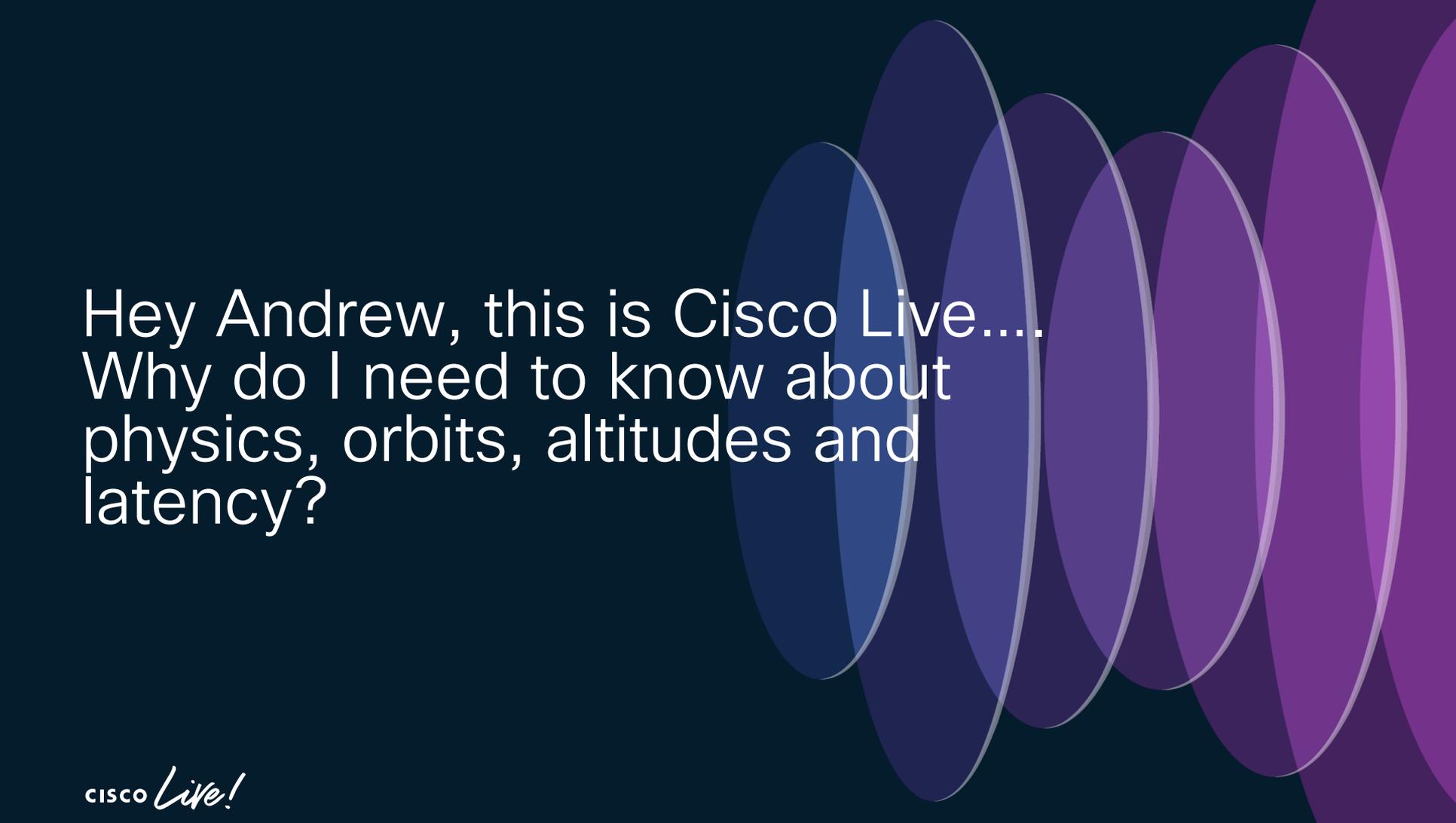
# Agenda

- Orbital Mechanics 101
- What is Starlink today?
- How does Cisco work with Starlink?
- Securing Starlink
- Things you need to know

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

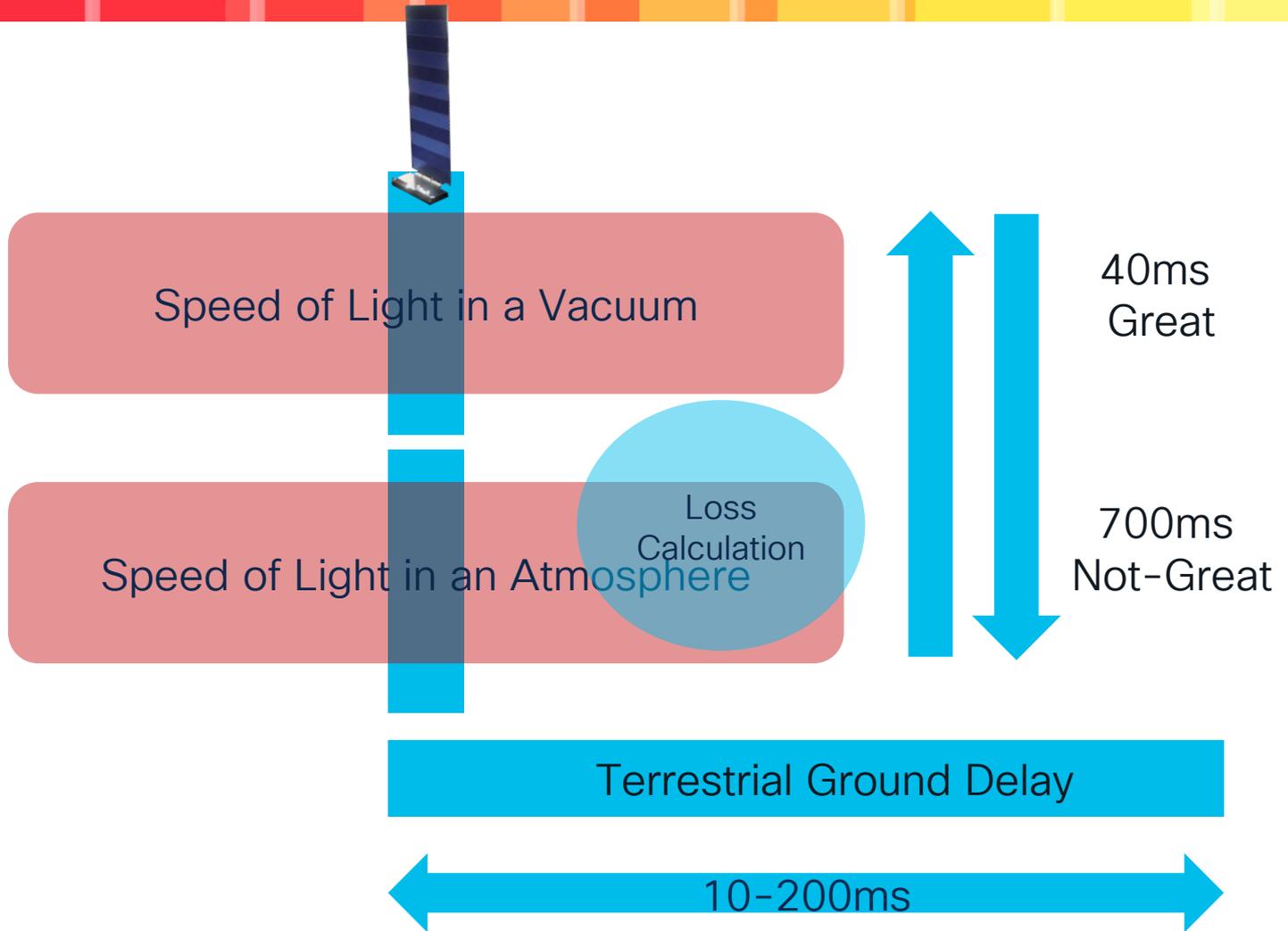
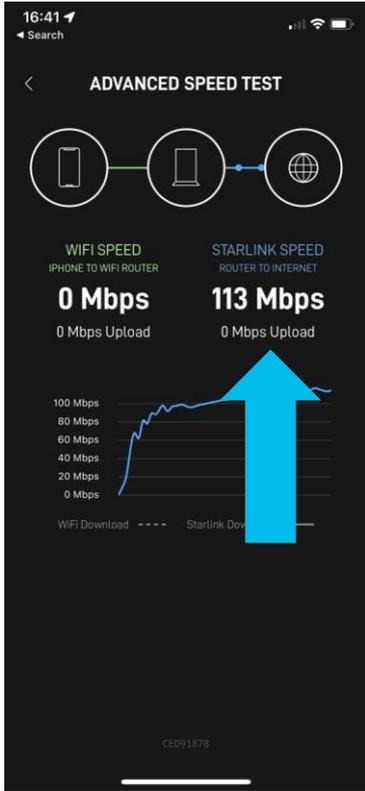
$$c = v\lambda$$

Light (Photons)

Frequency

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



Happy Network Zone

- MEO – 8000 kilometers (5,000 miles)
  - ~RTT 350ms



Sad Network Zone

- GEO – 36,000 kilometers (22,000 miles)
  - ~RTT 725ms



# Physics Matters

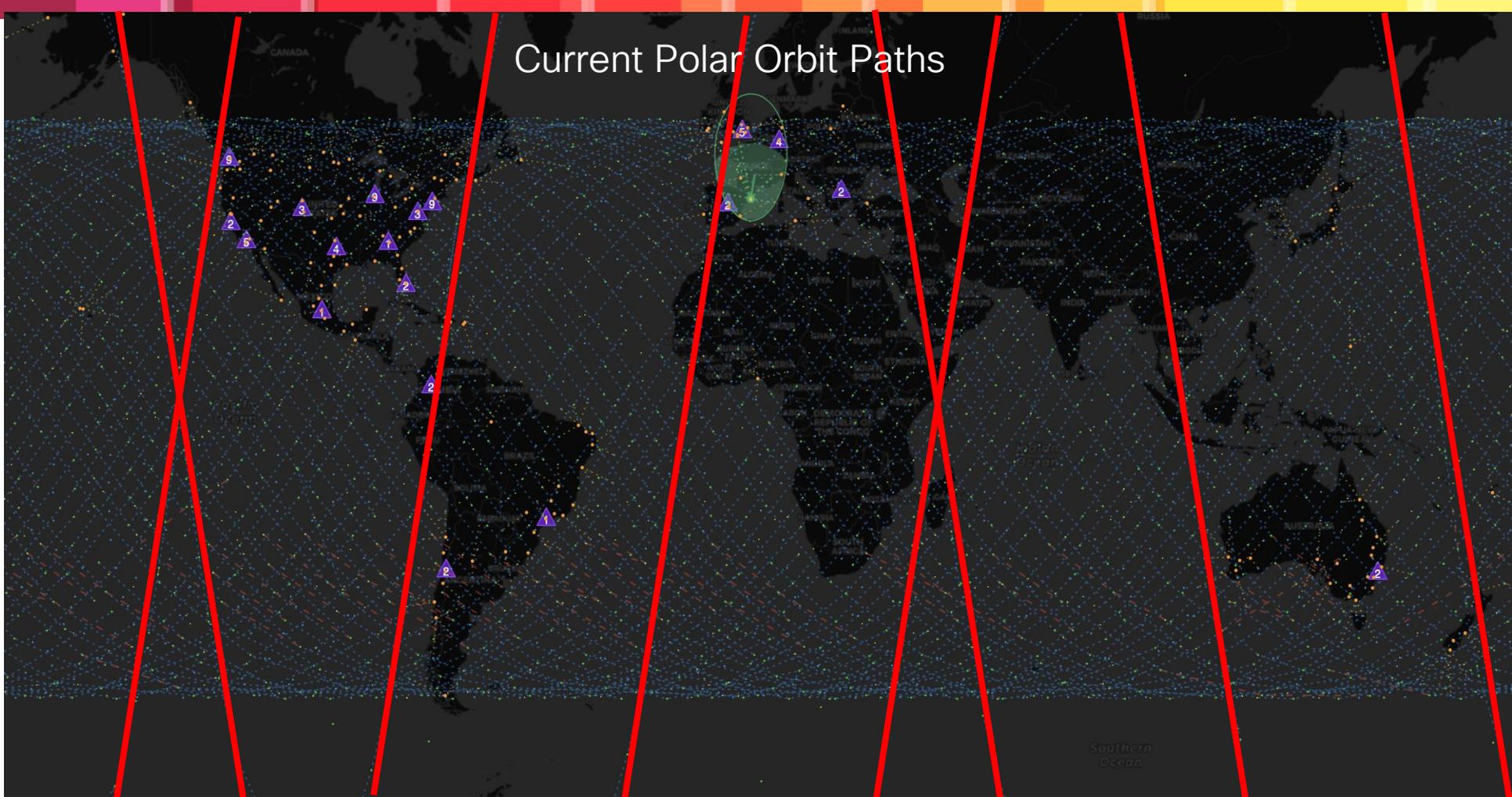
700ms

350ms

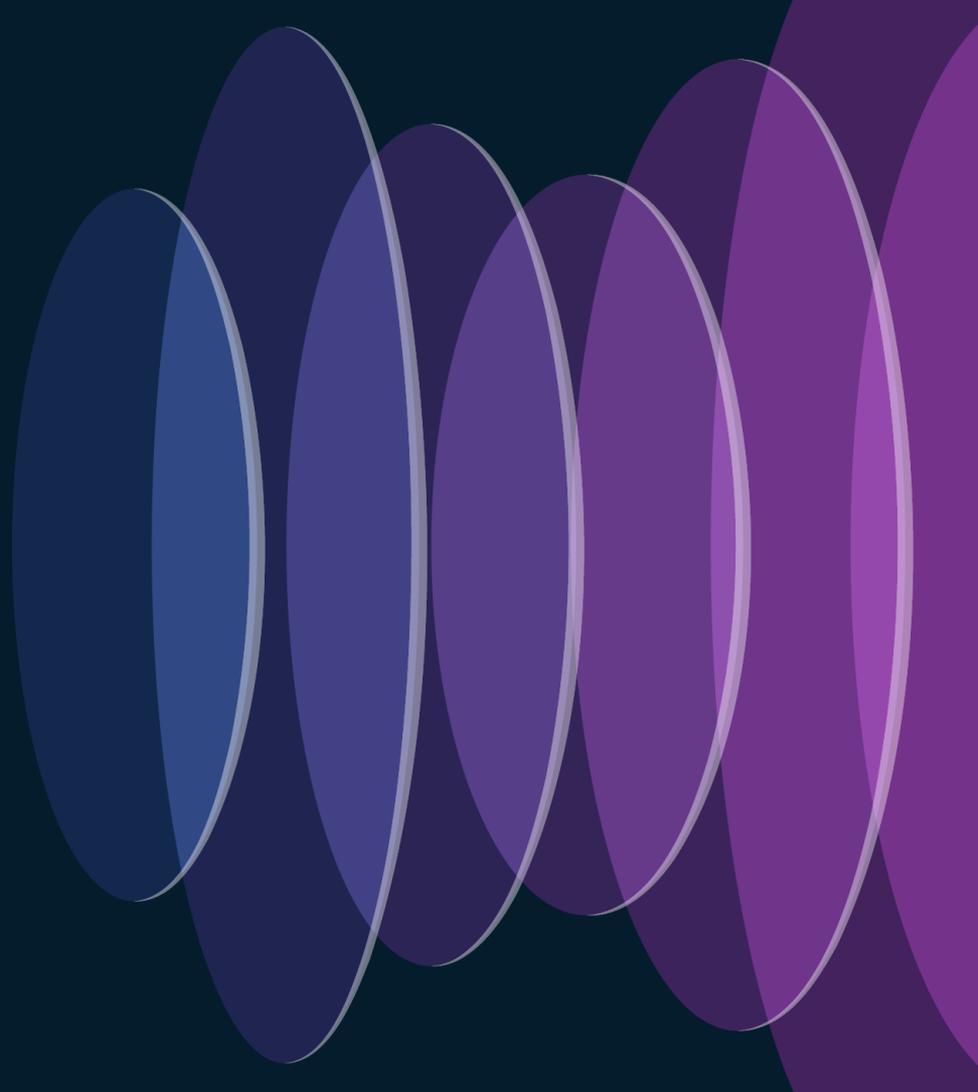
40ms



# Current Polar Orbit Paths



# What really is Starlink?



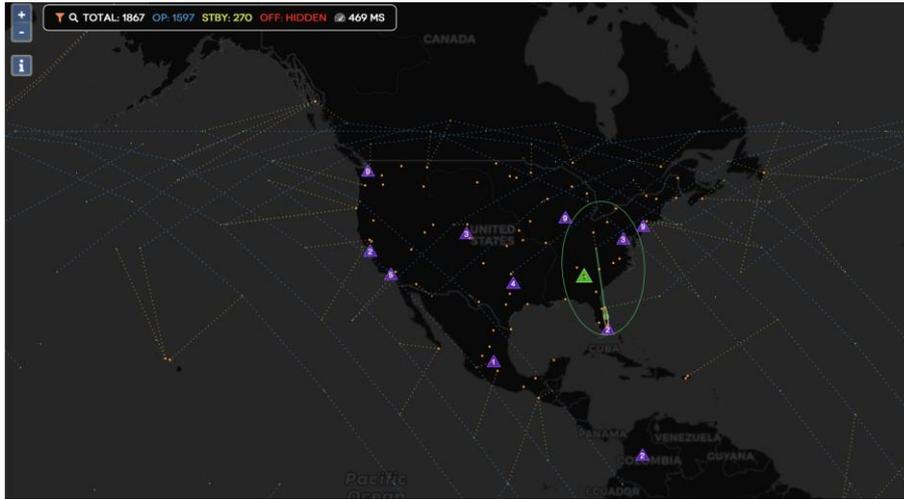
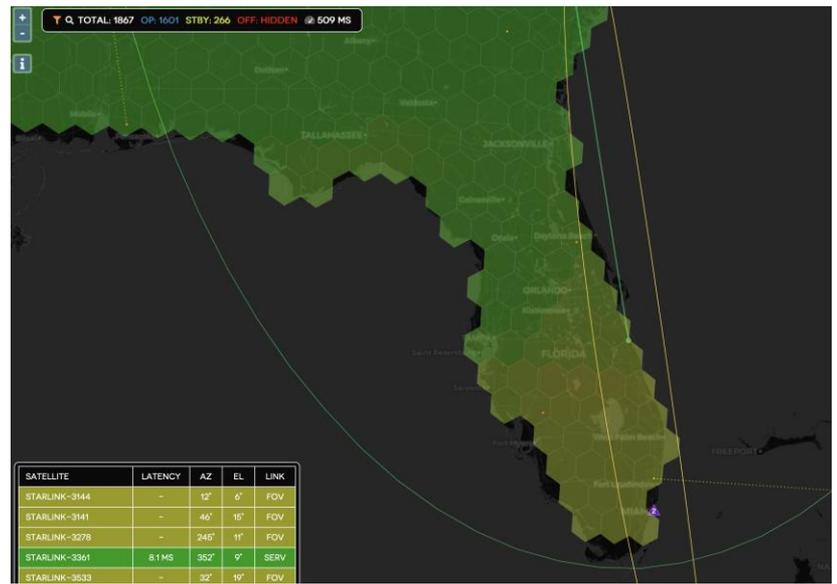
# Starlink Australia

- 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\*

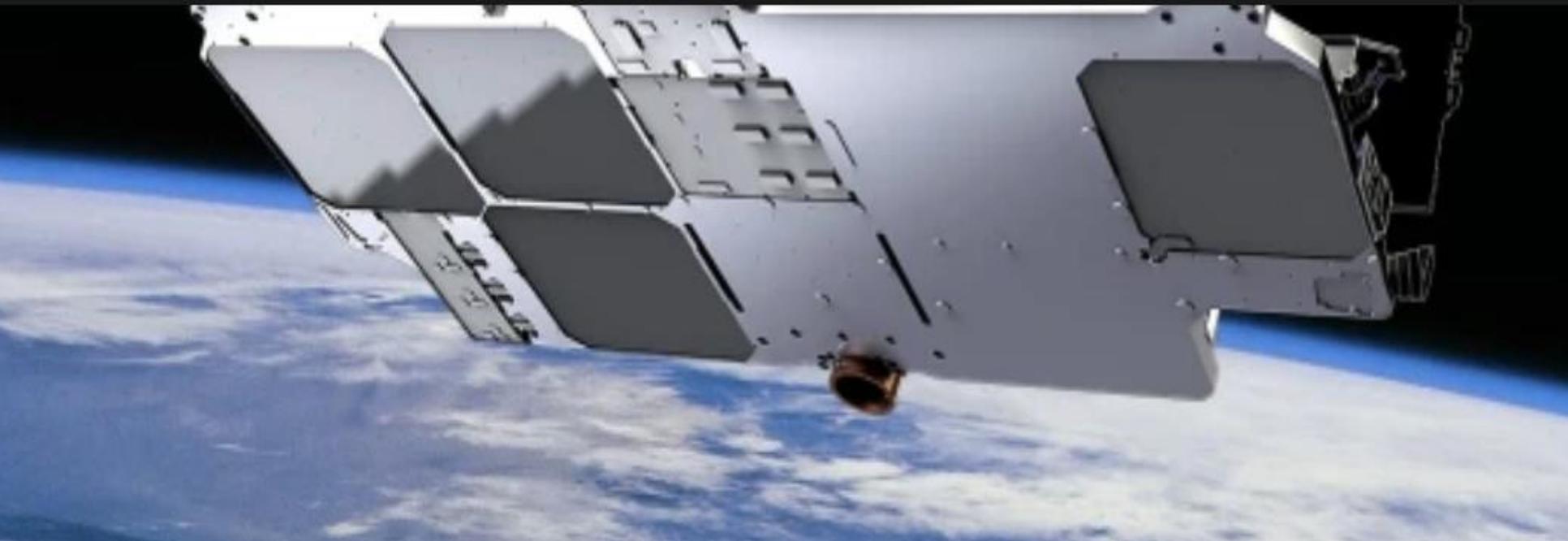


\*groups of 53 being launched on a regular basis

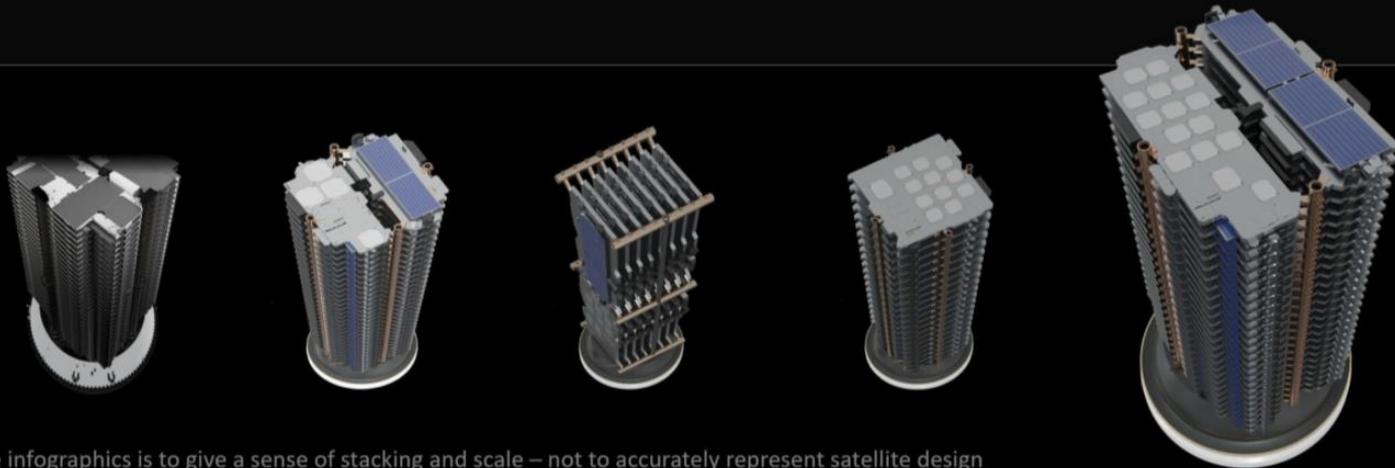
# Satellite v1.5

- 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

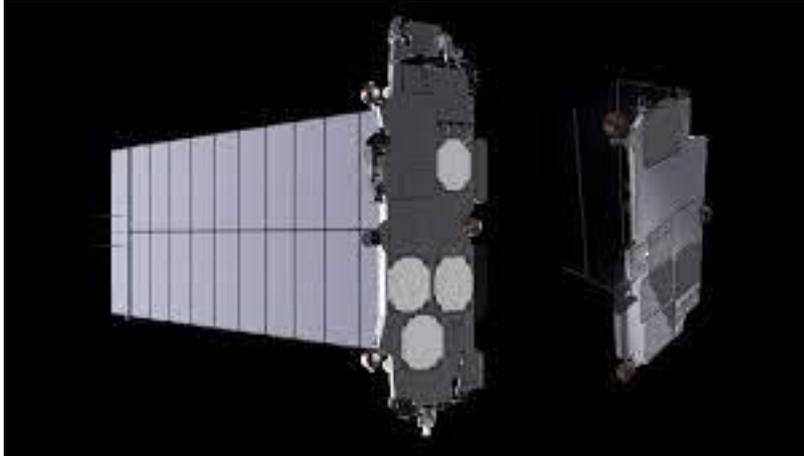


The goal of these infographics is to give a sense of stacking and scale – not to accurately represent satellite design

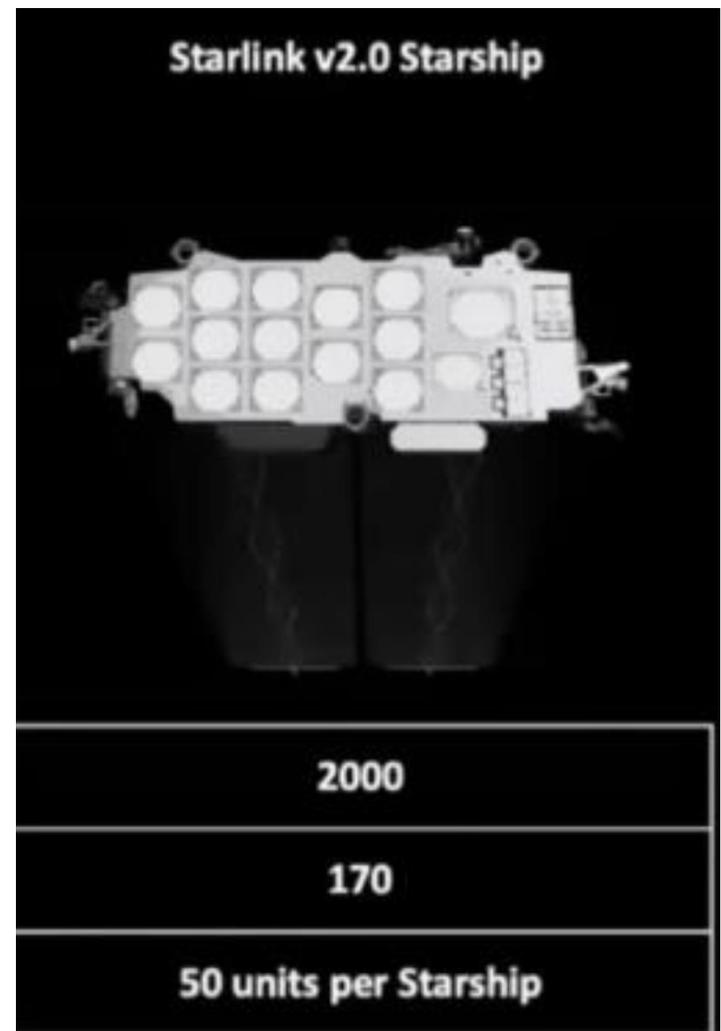
Assumptions

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



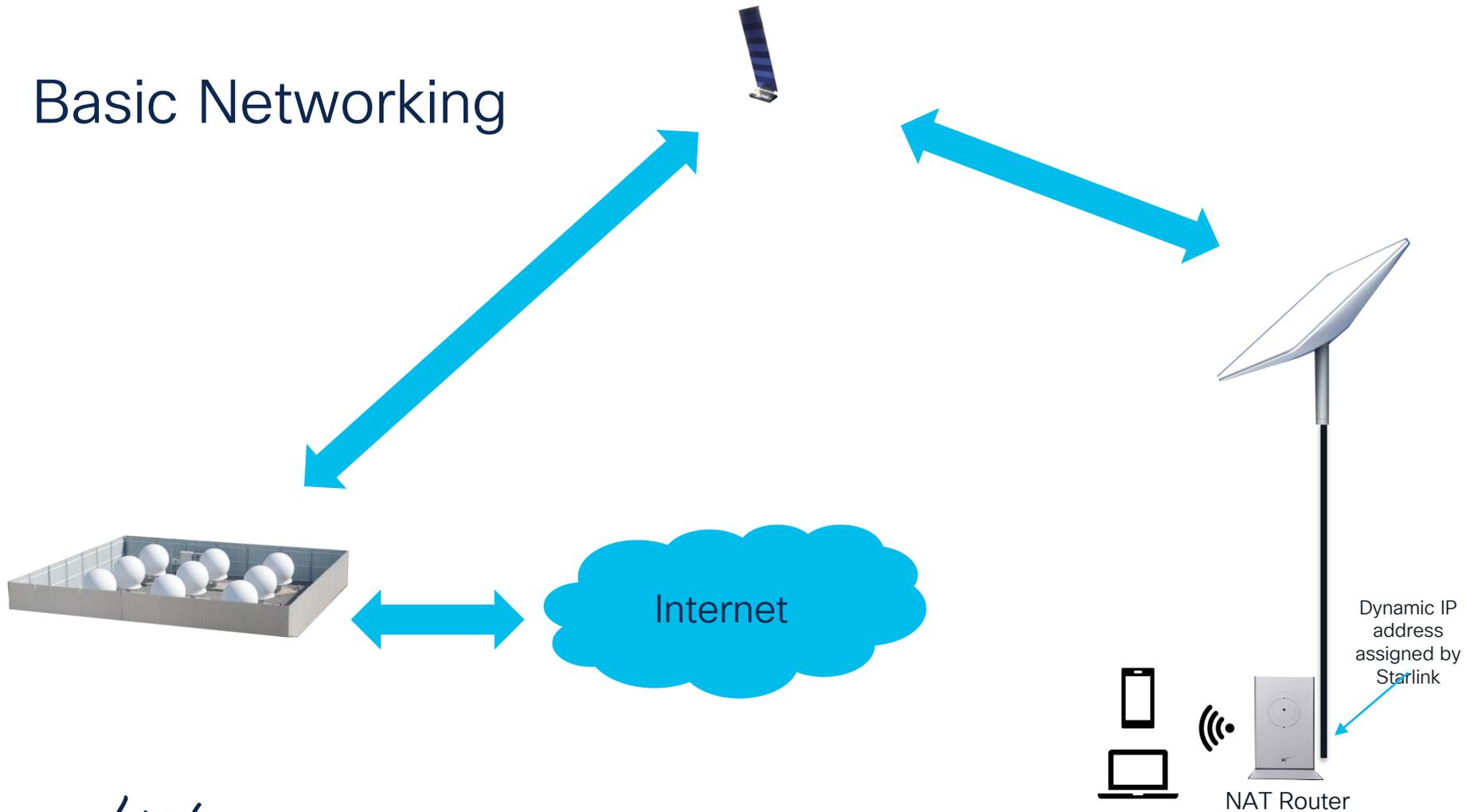
Credit: SpaceX/Starlink

# Ground Station

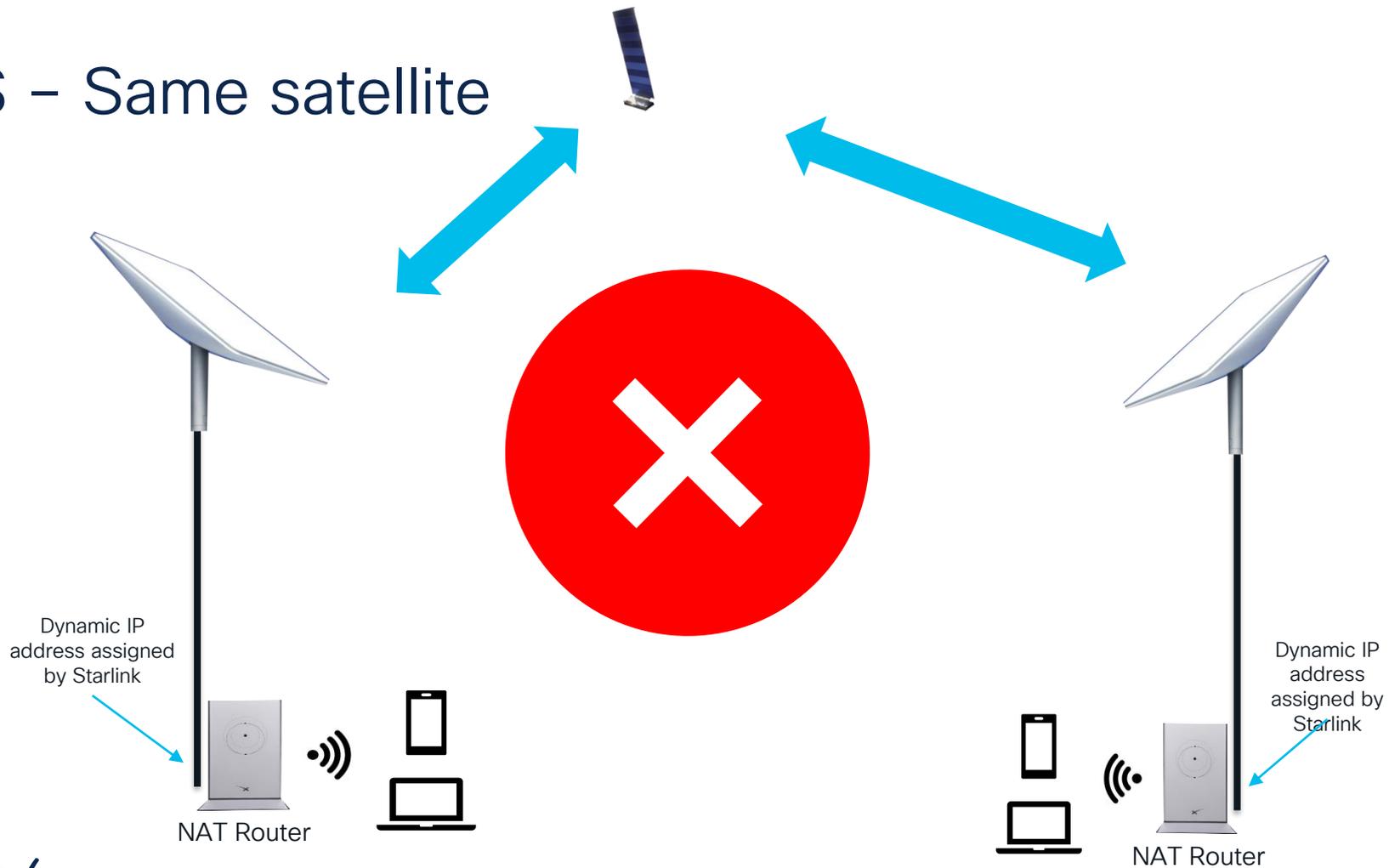
- Each gateway antenna has available a maximum of 4x 500 MHz channels (total 2 GHz) in uplink, and 5x 250 MHz channels (total 1.25 GHz) in downlink
- In this configuration – where 8 antennas are active – would be 10Ghz total active Down and 6Ghz Up per site
- Ground stations are positioned on top of 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

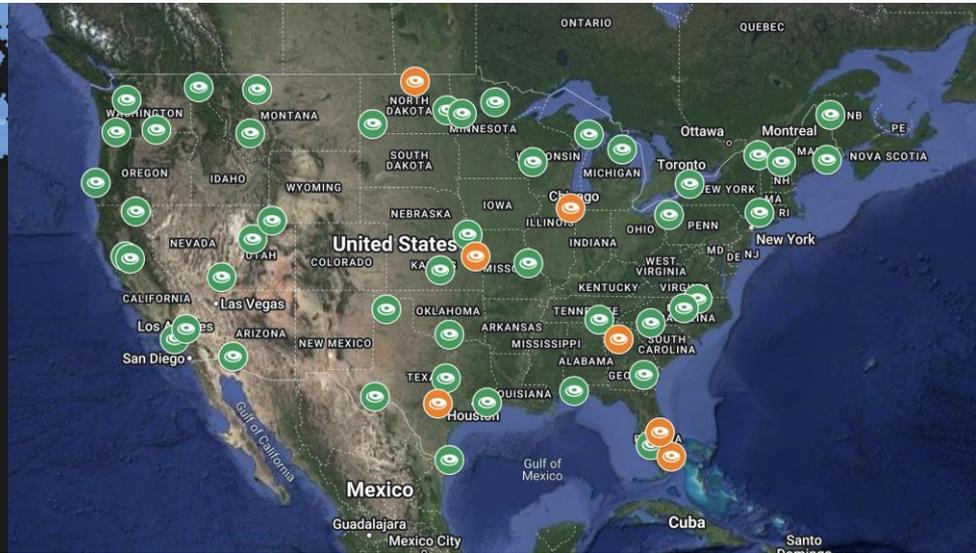
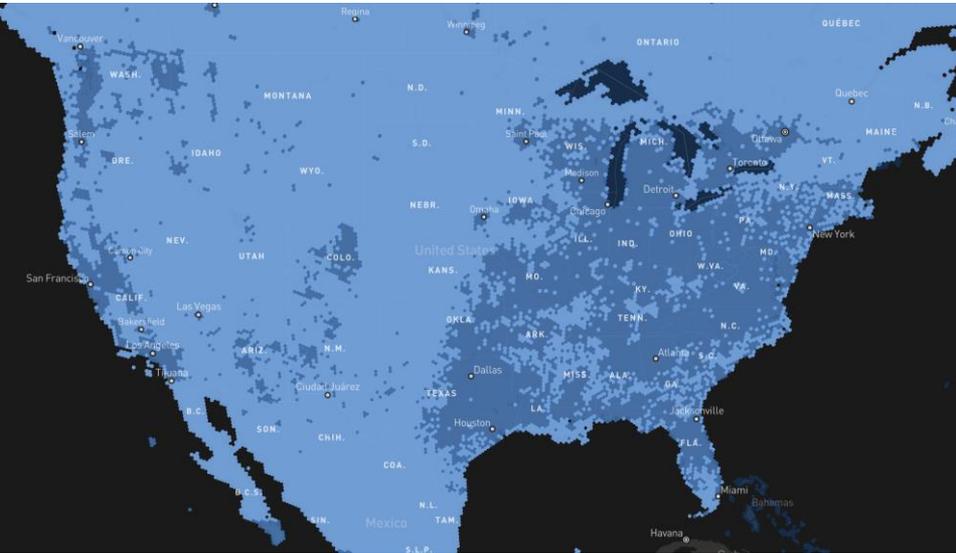


# List of Australian Starlink Ground Stations

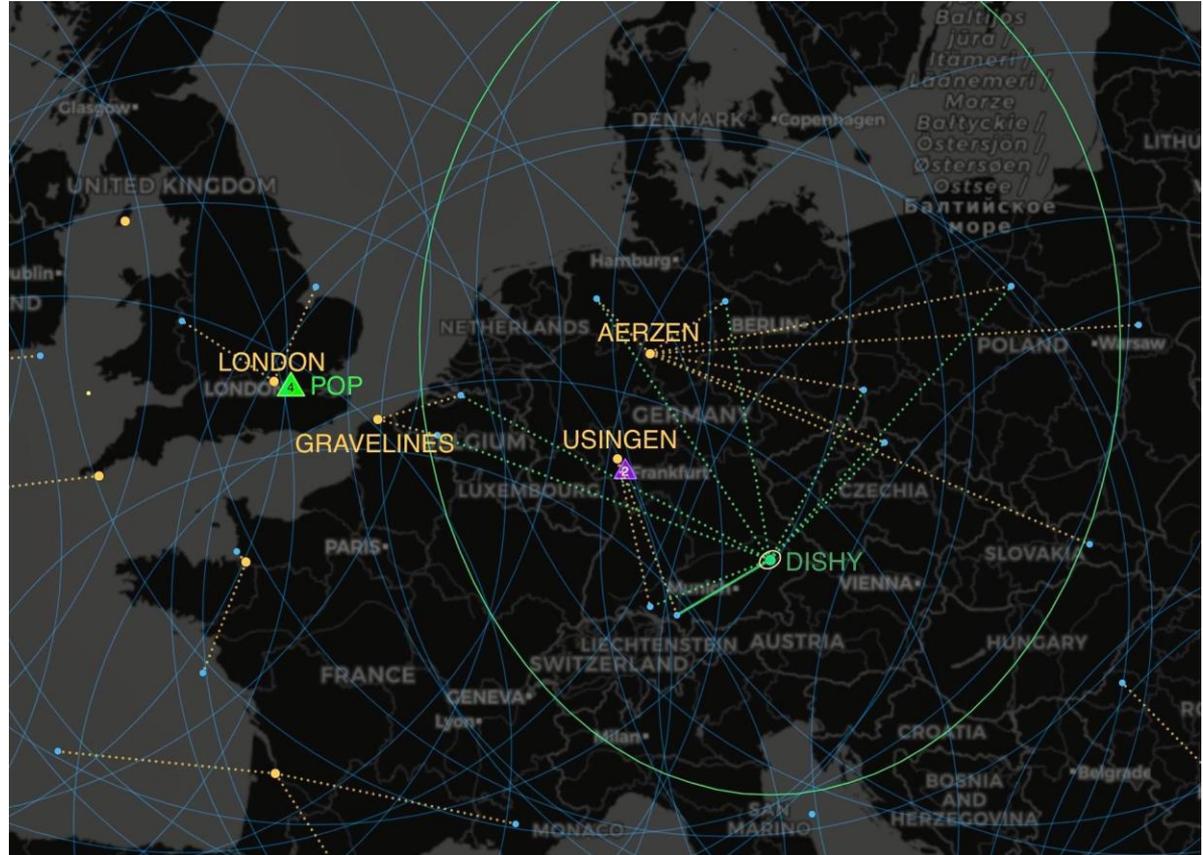
Cataby, WA  
Merredin, WA  
South West of Coolgardia, WA  
Wagin, WA  
Ki Ki, SA  
Pimba, SA  
Broken Hill, NSW  
Boorowa, NSW  
Calrossie, NSW  
Canyonleigh, NSW  
Cobargo, NSW  
Springbrook Creek, NSW  
Tea Gardens, NSW  
Ki Ki, SA  
Anankie, VIC  
Koonwarra, VIC  
Torrumbarry, VIC  
West of Emerald,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



# US Gateway Locations



# EMEA Gateway Locations

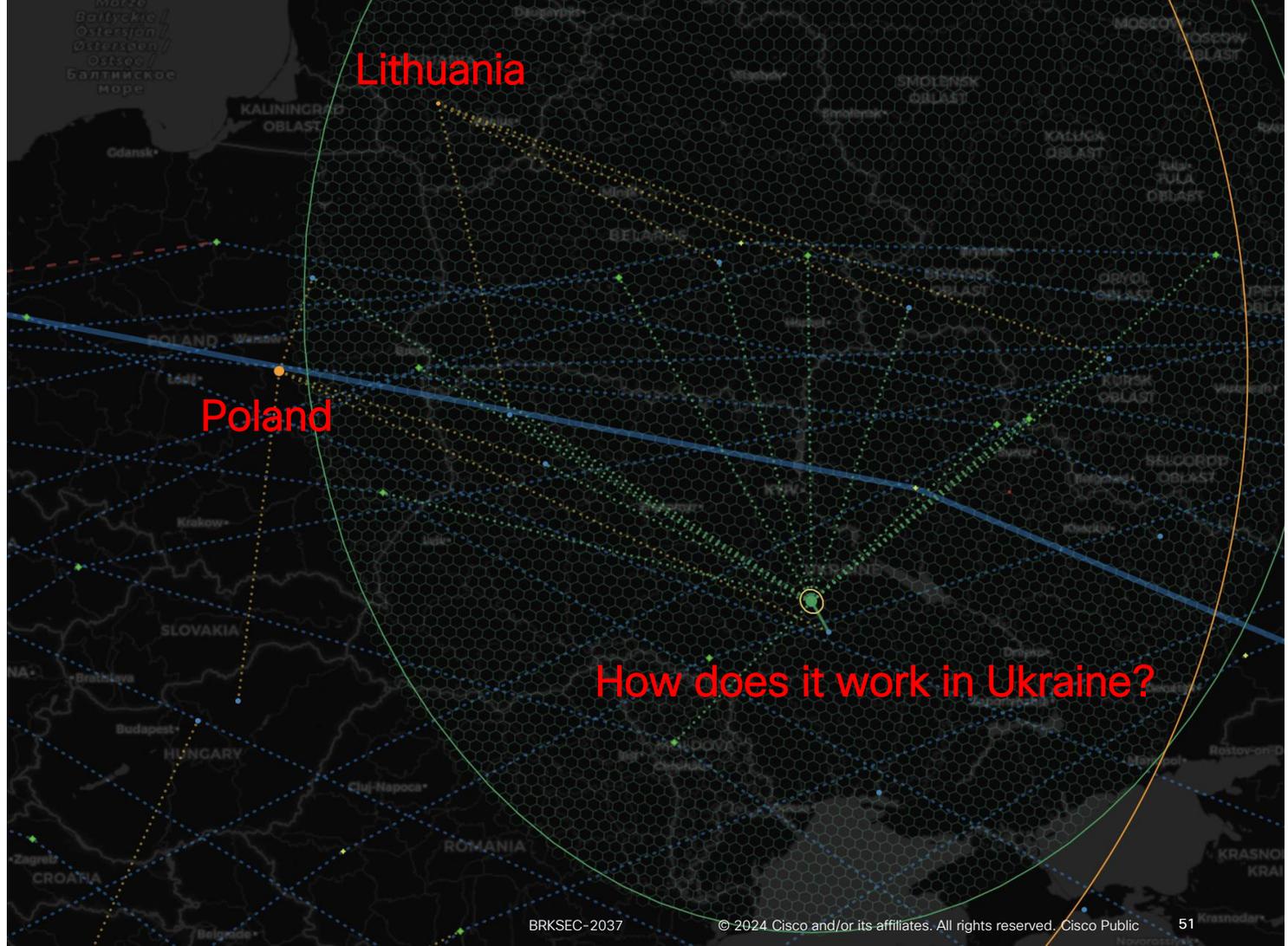


Radio Gateways

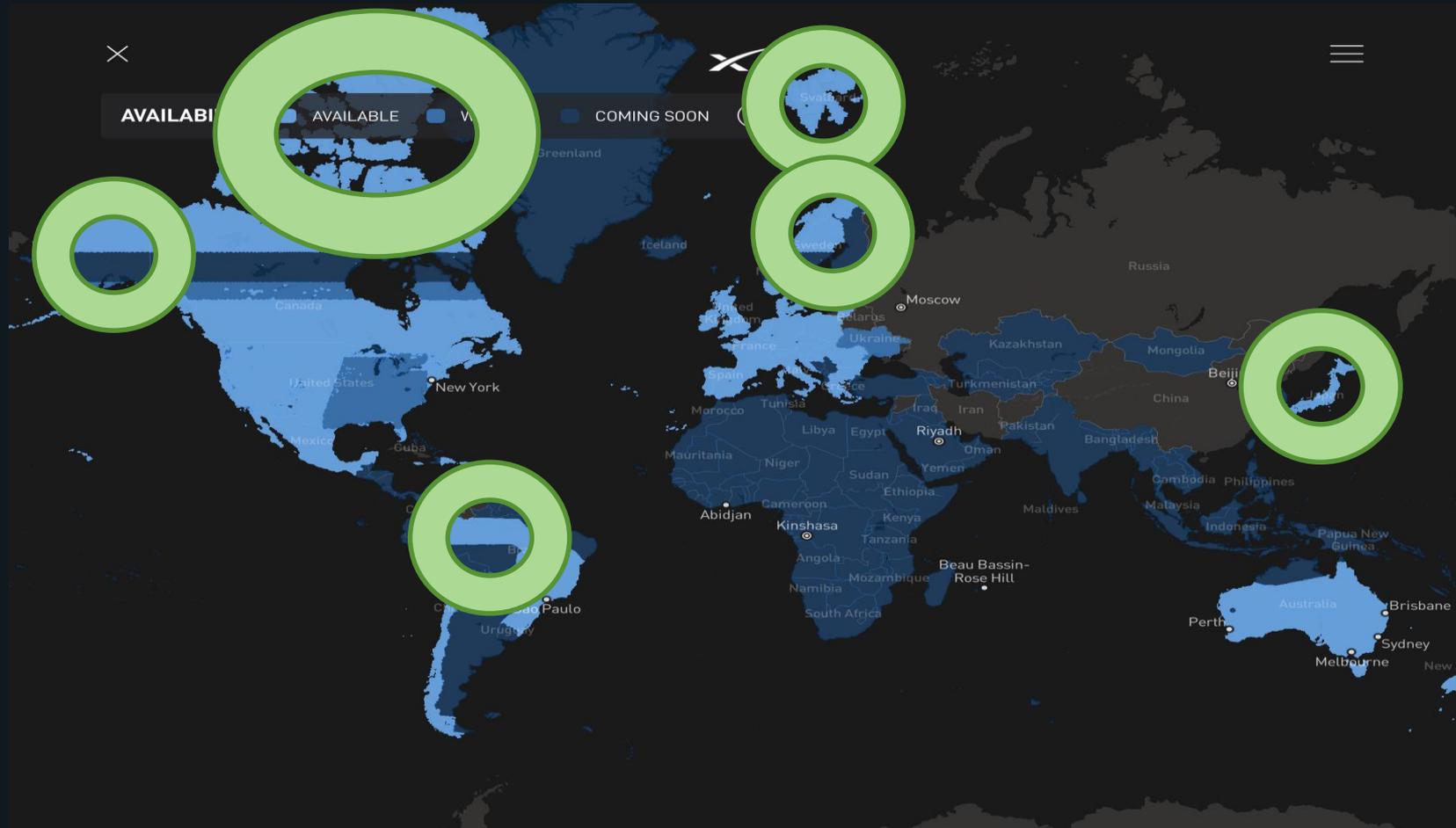
Lithuania  
Poland

Internet Gateways

Frankfurt  
London



How does it work in Ukraine?





# STARLINK

RESIDENTIAL

BUSINESS

RV

MARITIME

AVIATION

IOT

AVAILABILITY



AVAILABLE



WAITLIST



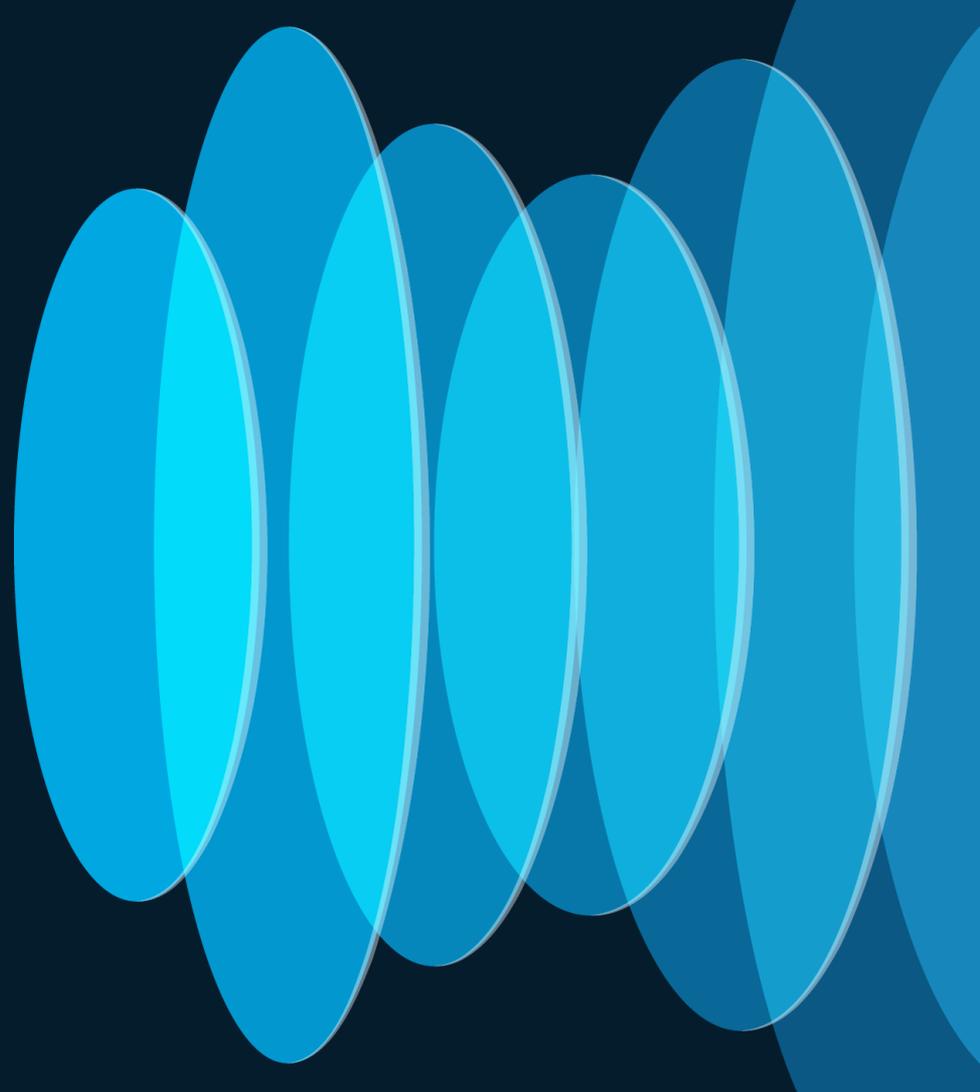
COMING SOON



# Things we know

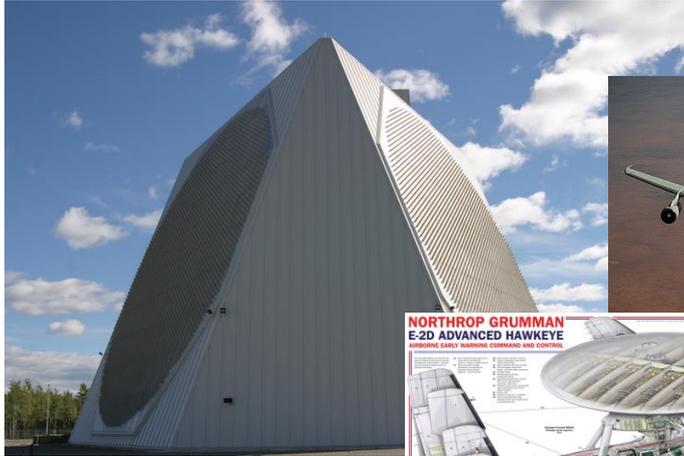
- Dense Orbital shells are extremely robust
- Frequency shifts can be simple software operations
- Receive only satellite arrays are critically important
- Low observability packages are important
- Low cost Software Defined Radios (SDRs) are being used for offensive hunt operations

# Phased Array Antenna



# Examples of Phased Arrays

- Space Observation Radar



- AN-SPY-1 Phased Array



- AEGIS Deployed and Ashore

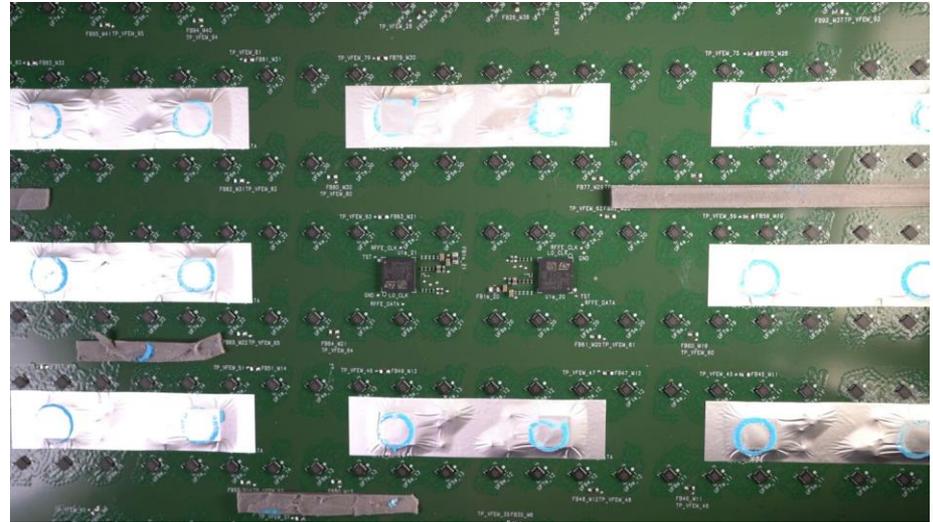
E-3 Sentry  
AWACS



E-2D  
Early Warning

# 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



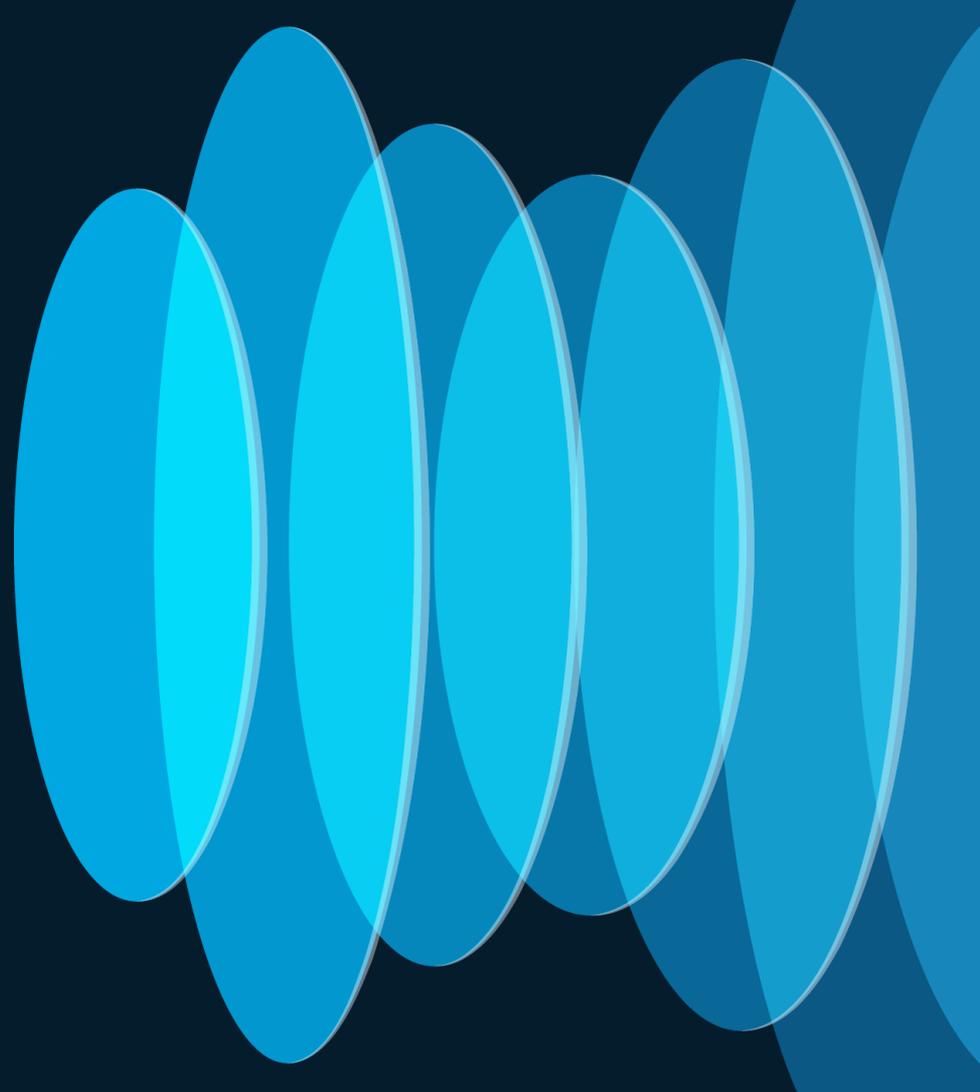
- [12-18 and 26.5-49 GHz bands](#)

# Ground Terminal

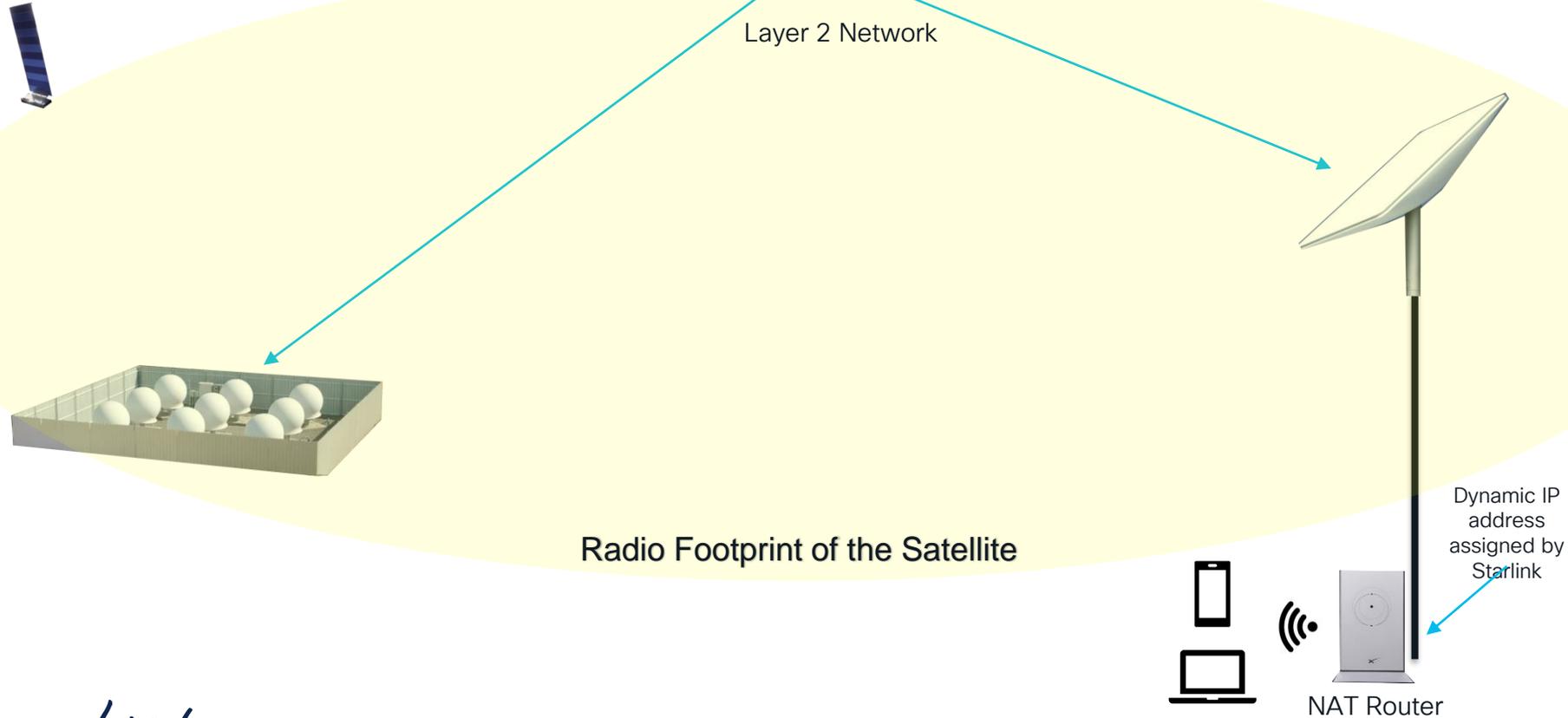
- Phased Array Antenna
- Starlink Router (more on that later)
- Ethernet Cable with proprietary ends



# Basic Networking



# Basic Networking



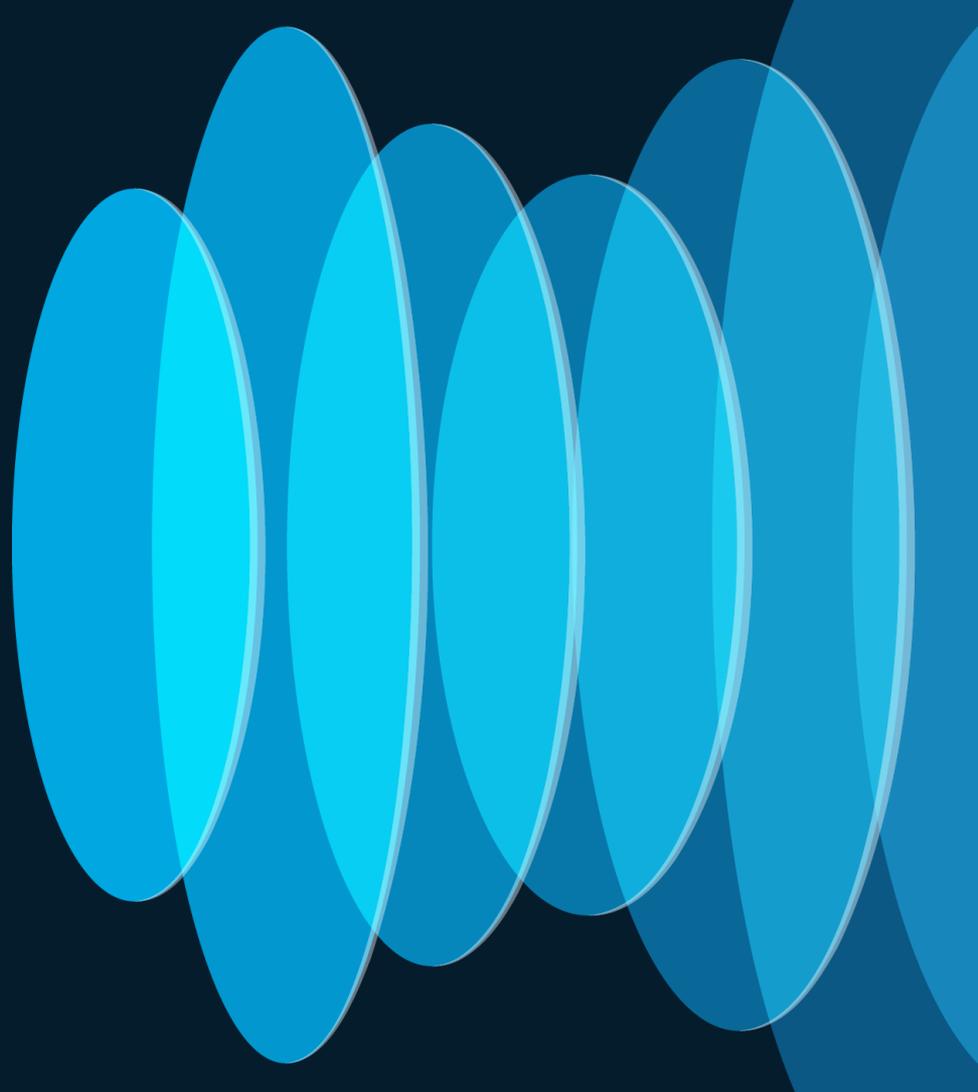
# Starlink Router

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



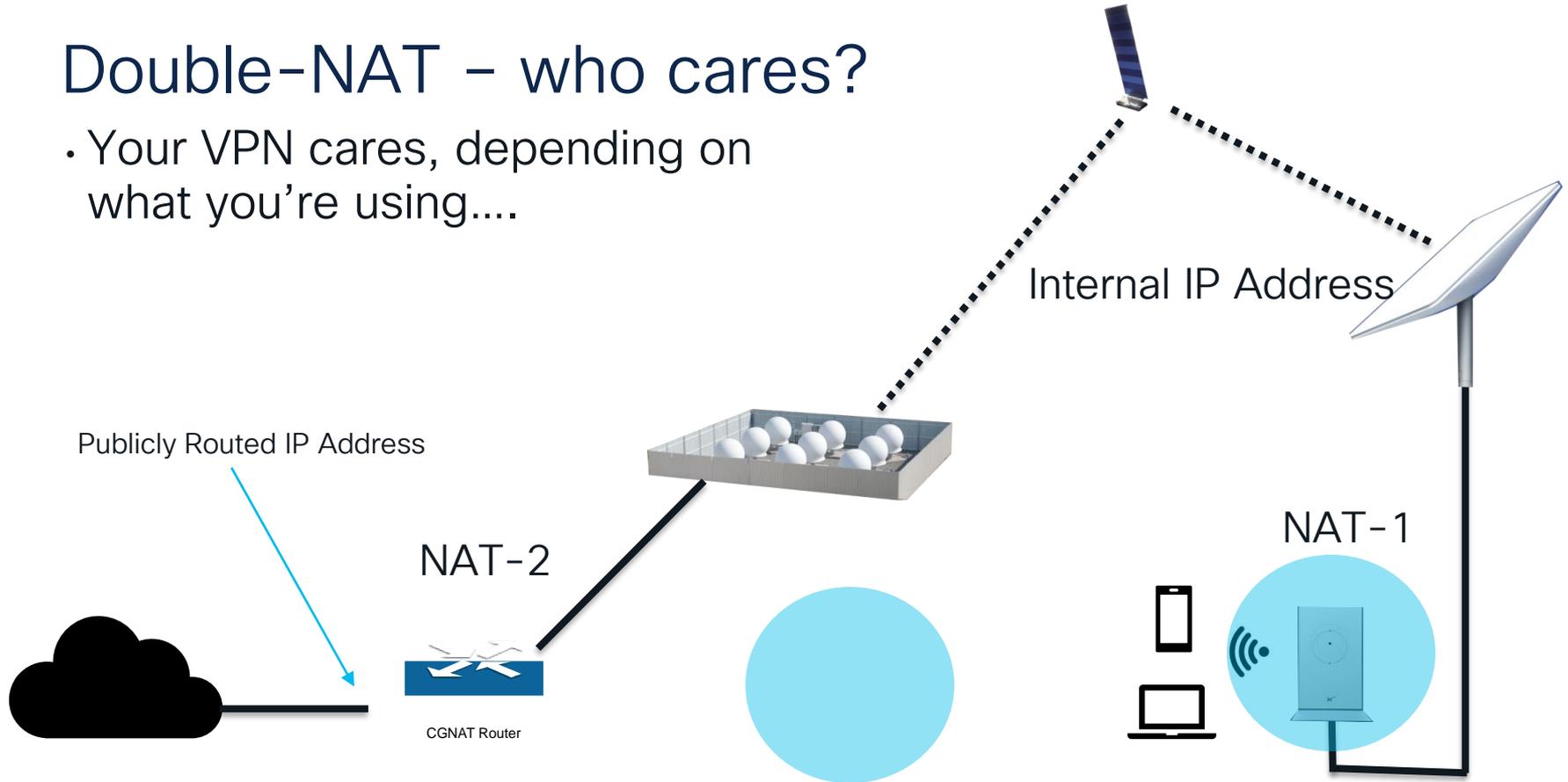


# Double/Triple NAT

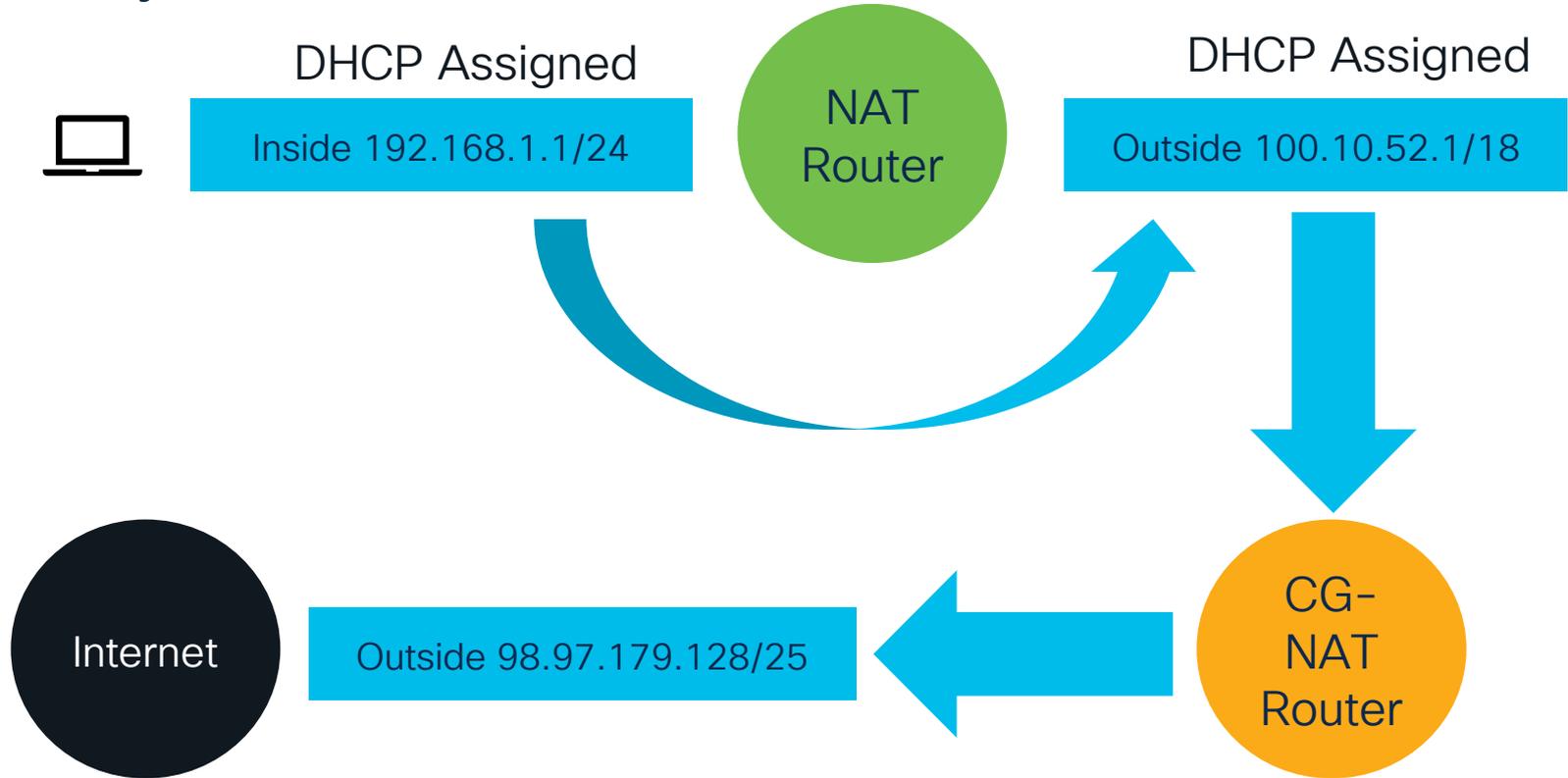


# Double-NAT – who cares?

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



# Why is NAT an issue?

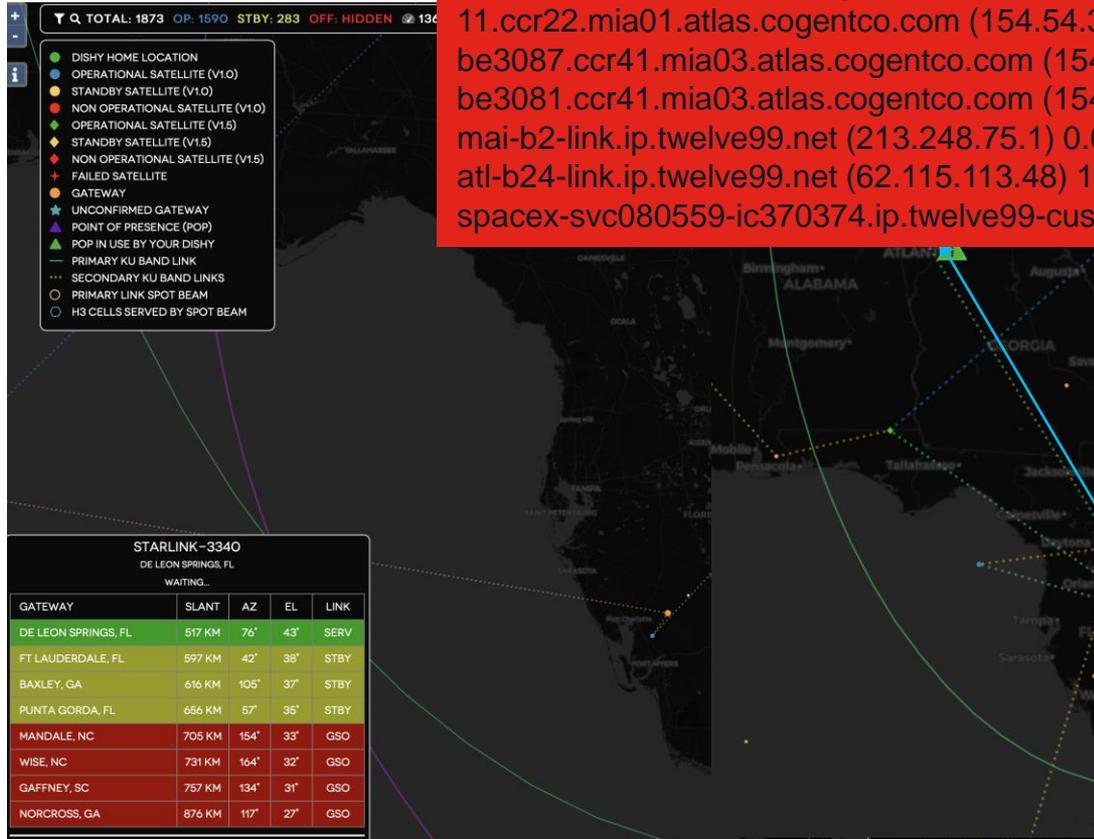


# Things that Fix NAT Problems

- 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 ms



## Summary

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

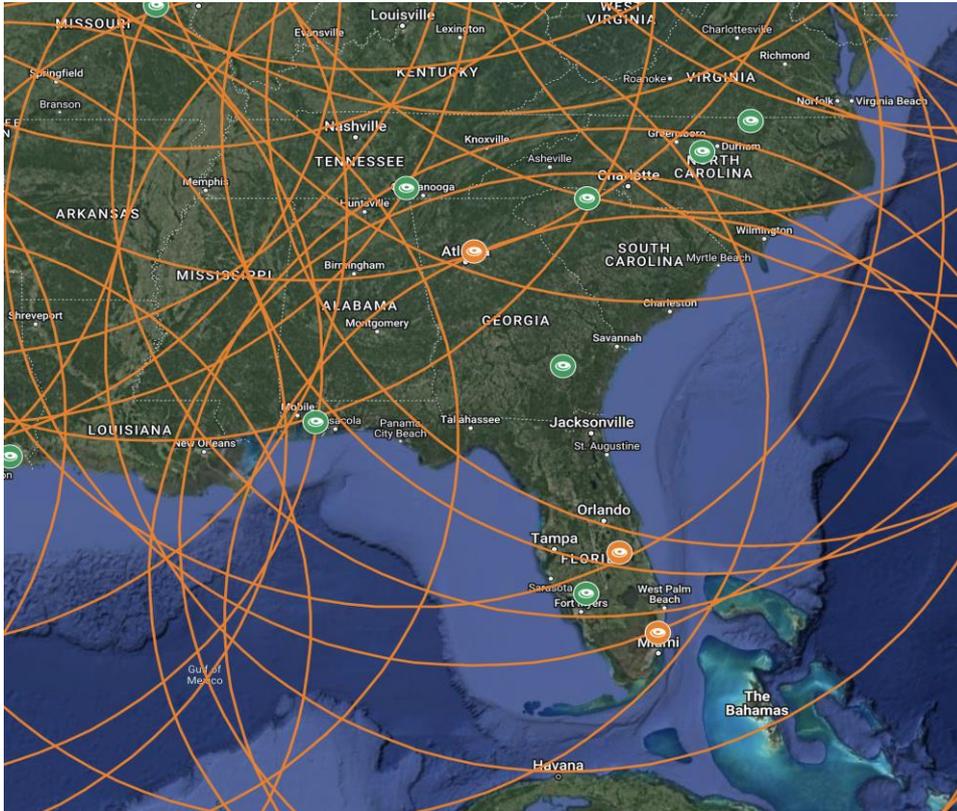
## WHOIS Details

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

# 98.97.179.128/25

AS14593 · Space Exploration Technologies Corporation

## How the network works



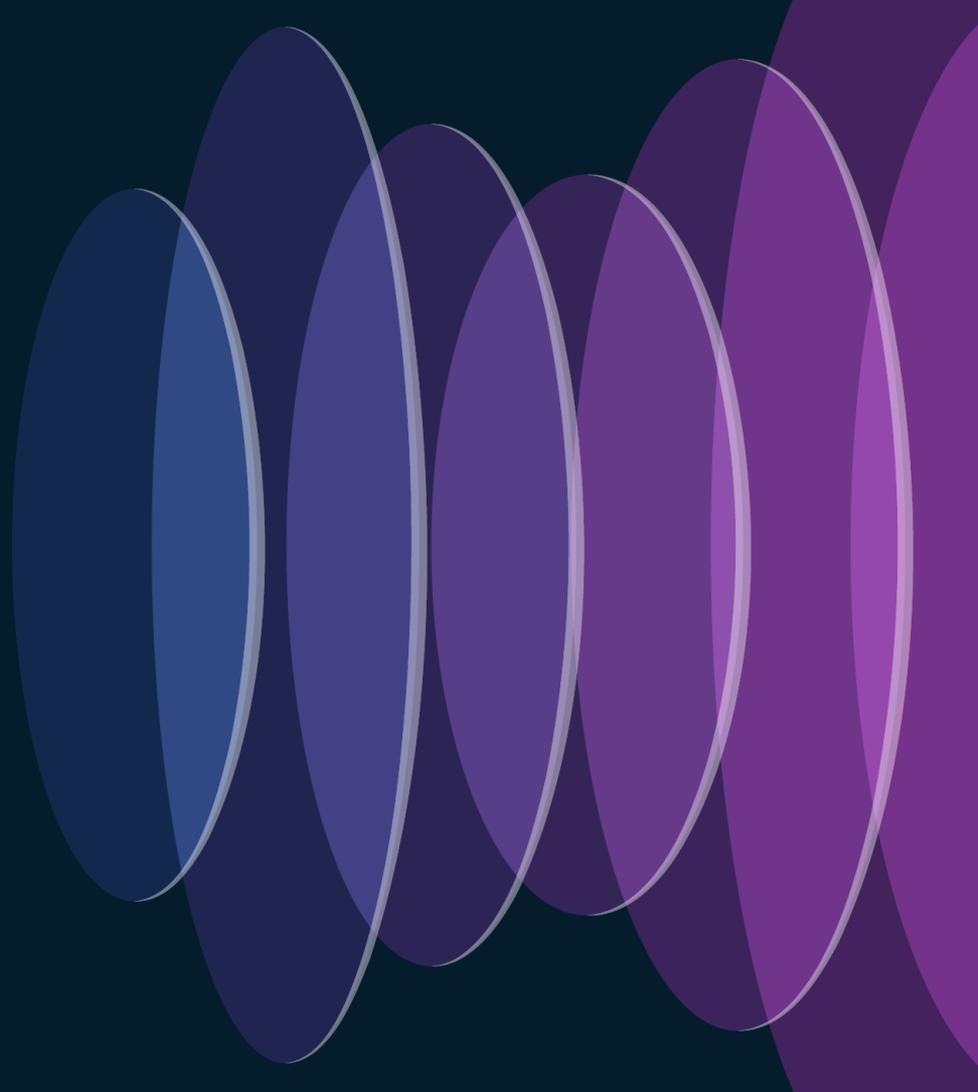
### Summary

Country	 United States
Domain	<a href="https://spacex.com">spacex.com</a>
ASN	<a href="#">AS14593</a>
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

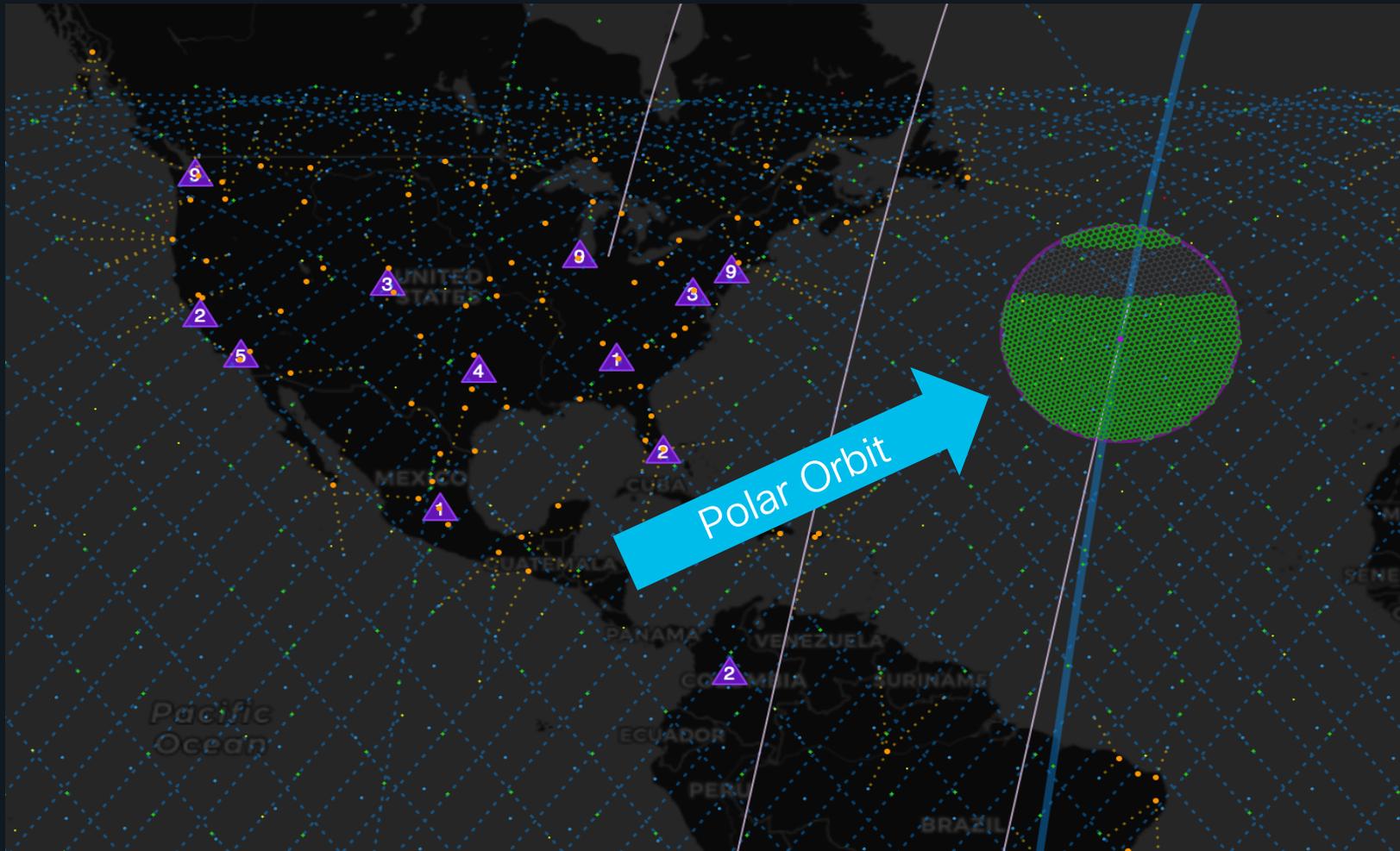
- All Starlink Satellites have “Lasers” – **FALSE**
- All Starlink Satellites can cross communicate to each other – **FALSE**
- Some Starlink Satellites have laser based optics that can point ahead of them to the next satellite – **TRUE**
- On-orbit Satellites can calculate multi-planar ephemeris to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

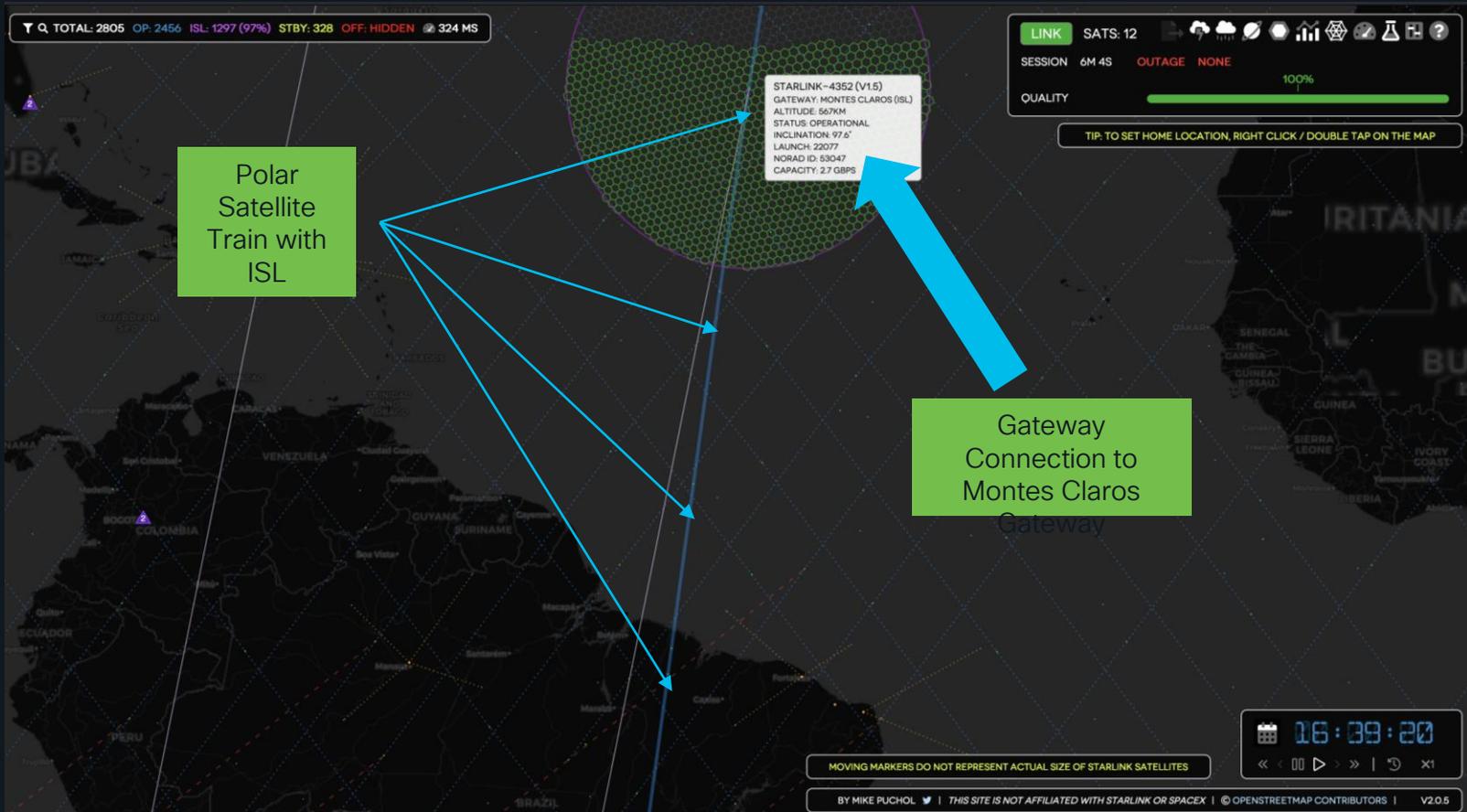
# Polar Orbit Satellites and Free Space Optics

- 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

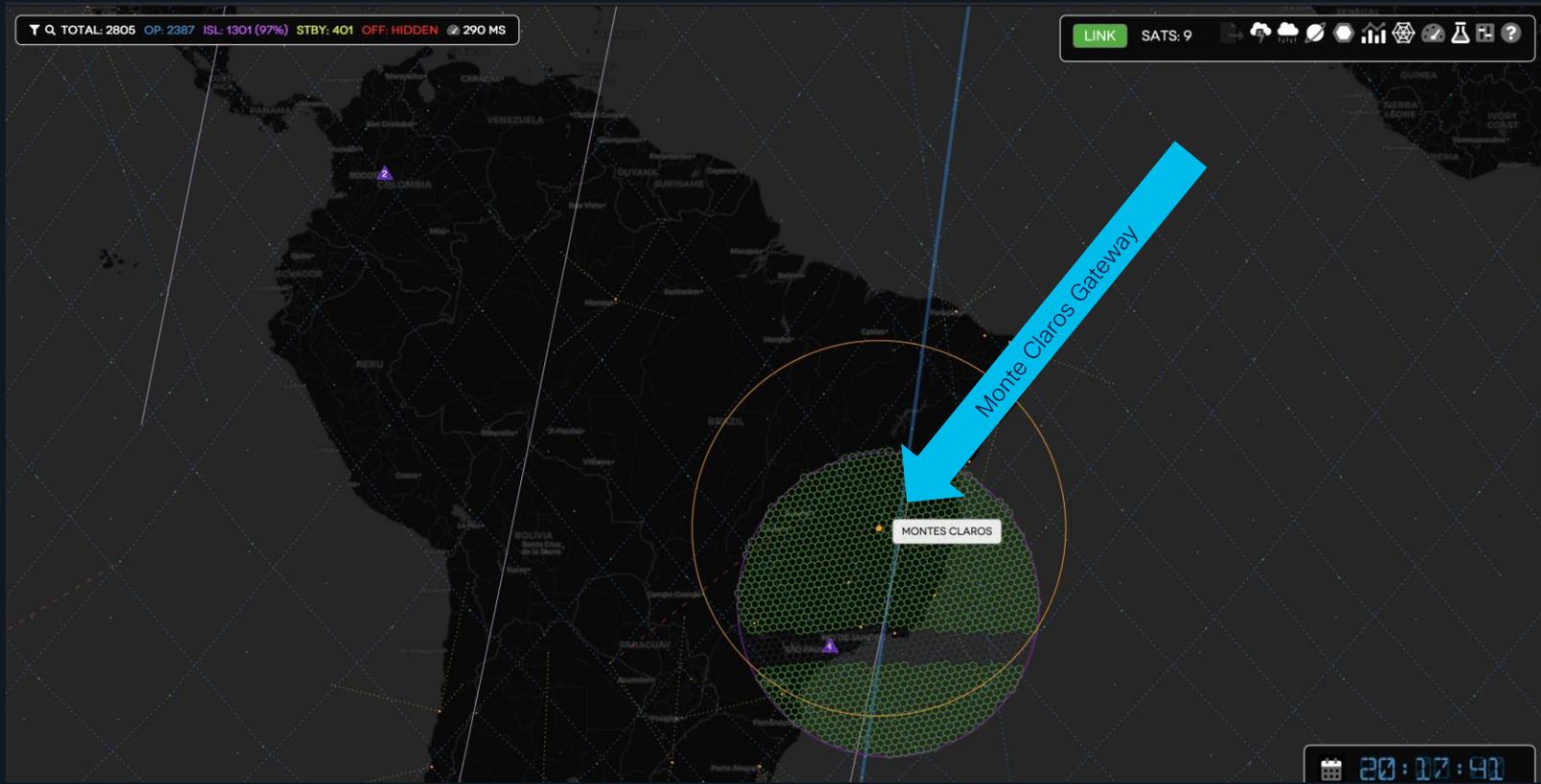




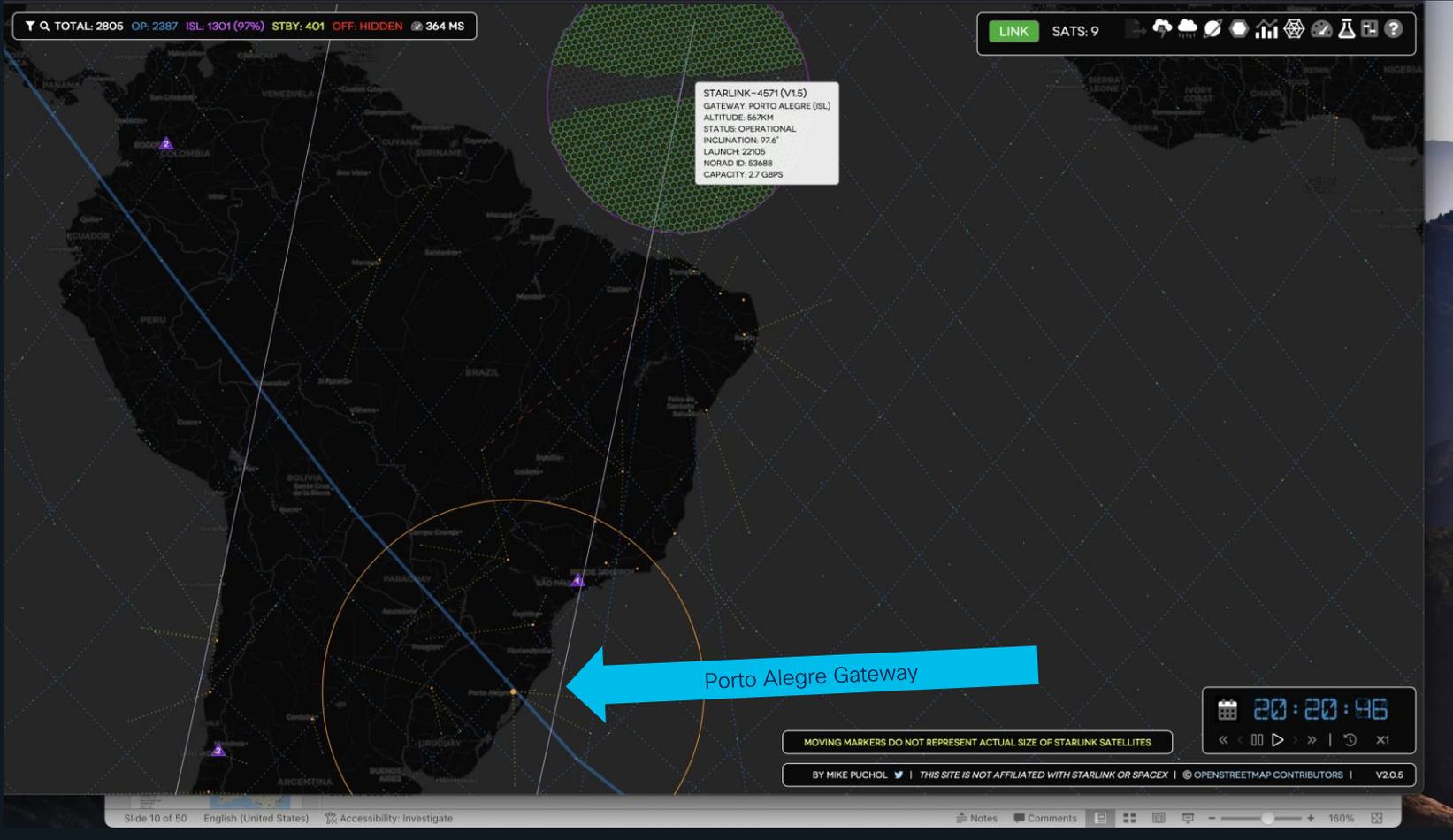


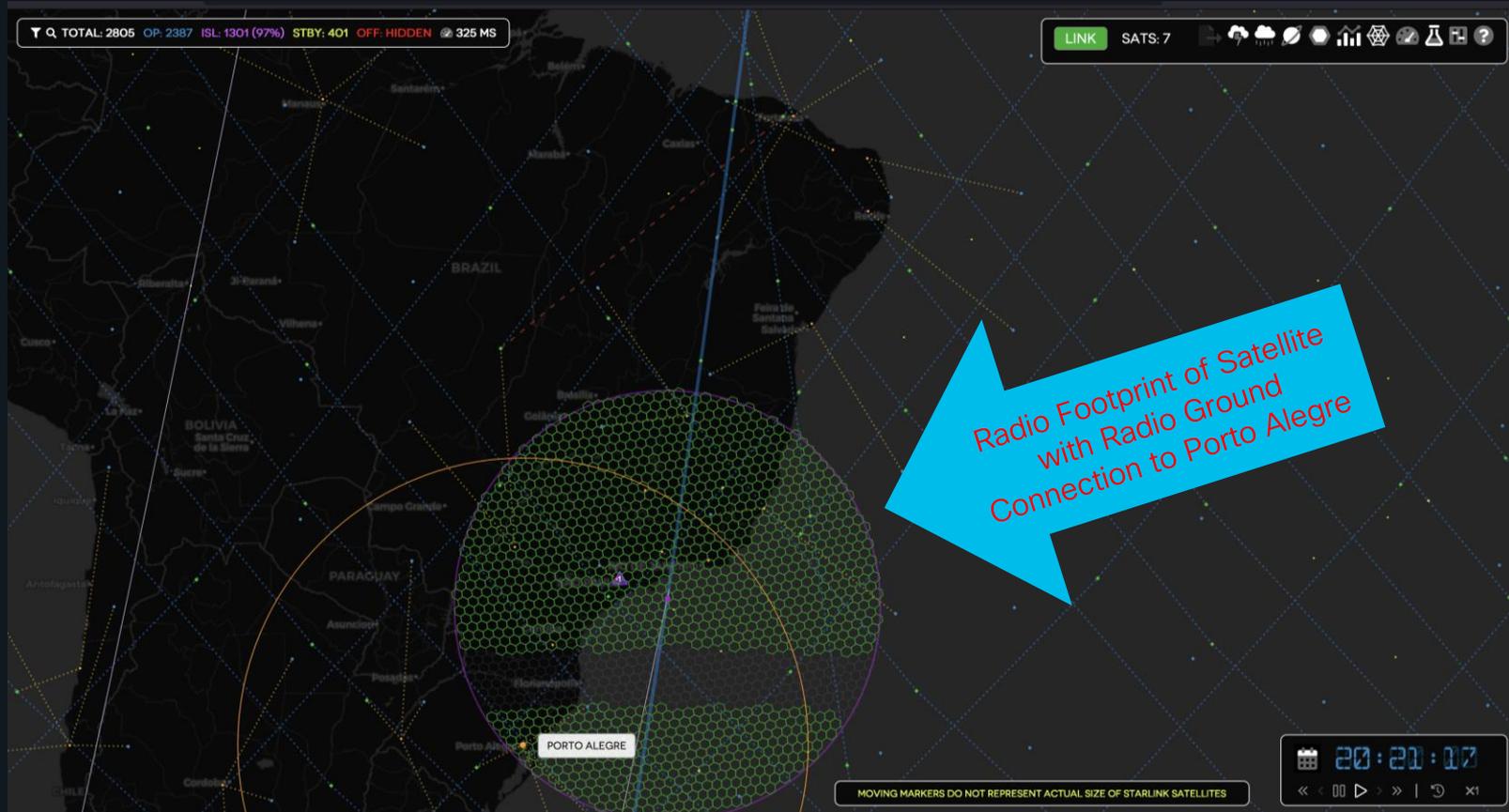
Q TOTAL: 2805 OP: 2387 ISL: 1301 (97%) STBY: 401 OFF: HIDDEN 290 MS

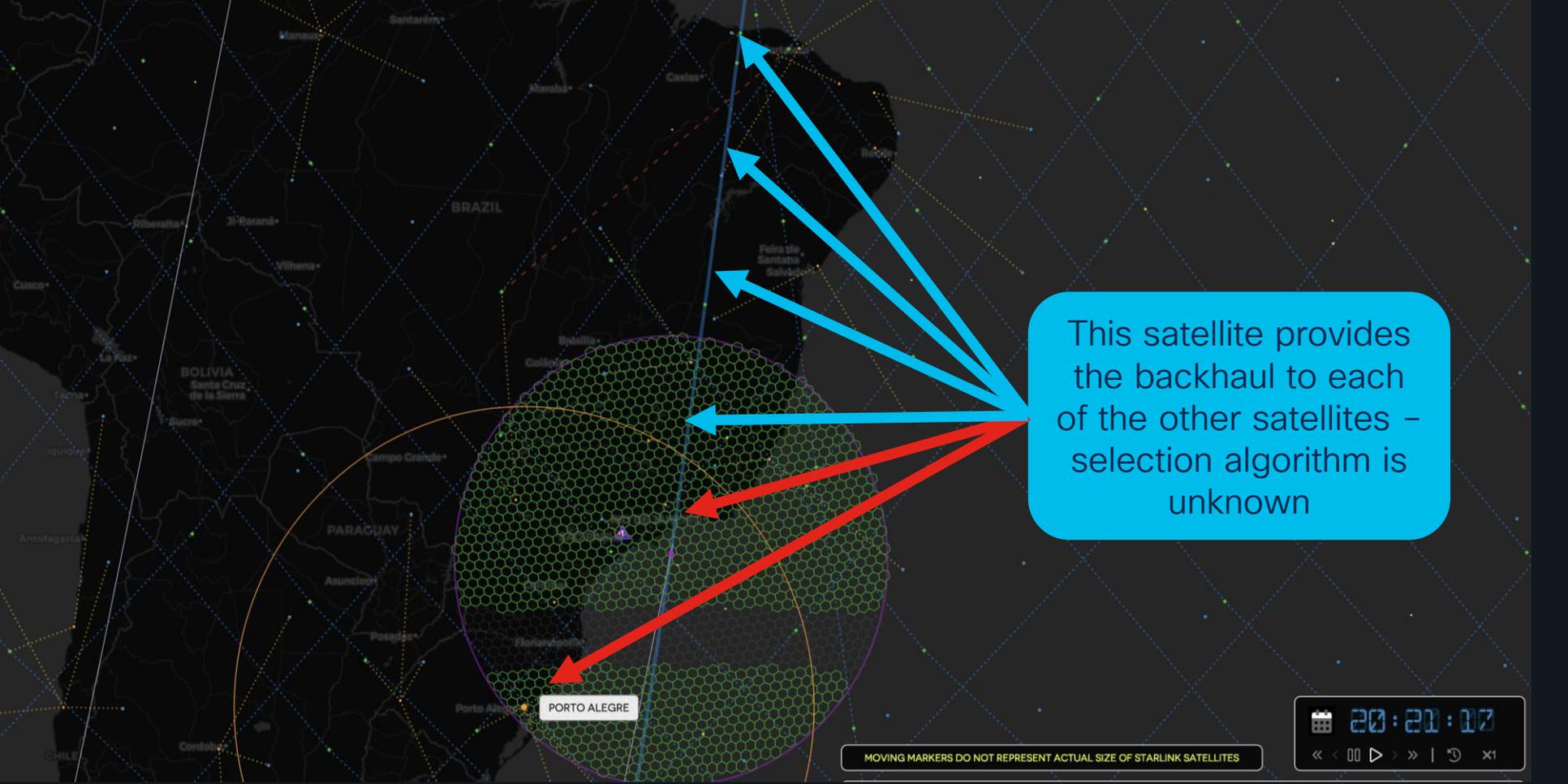
LINK SATS: 9



20:07:40





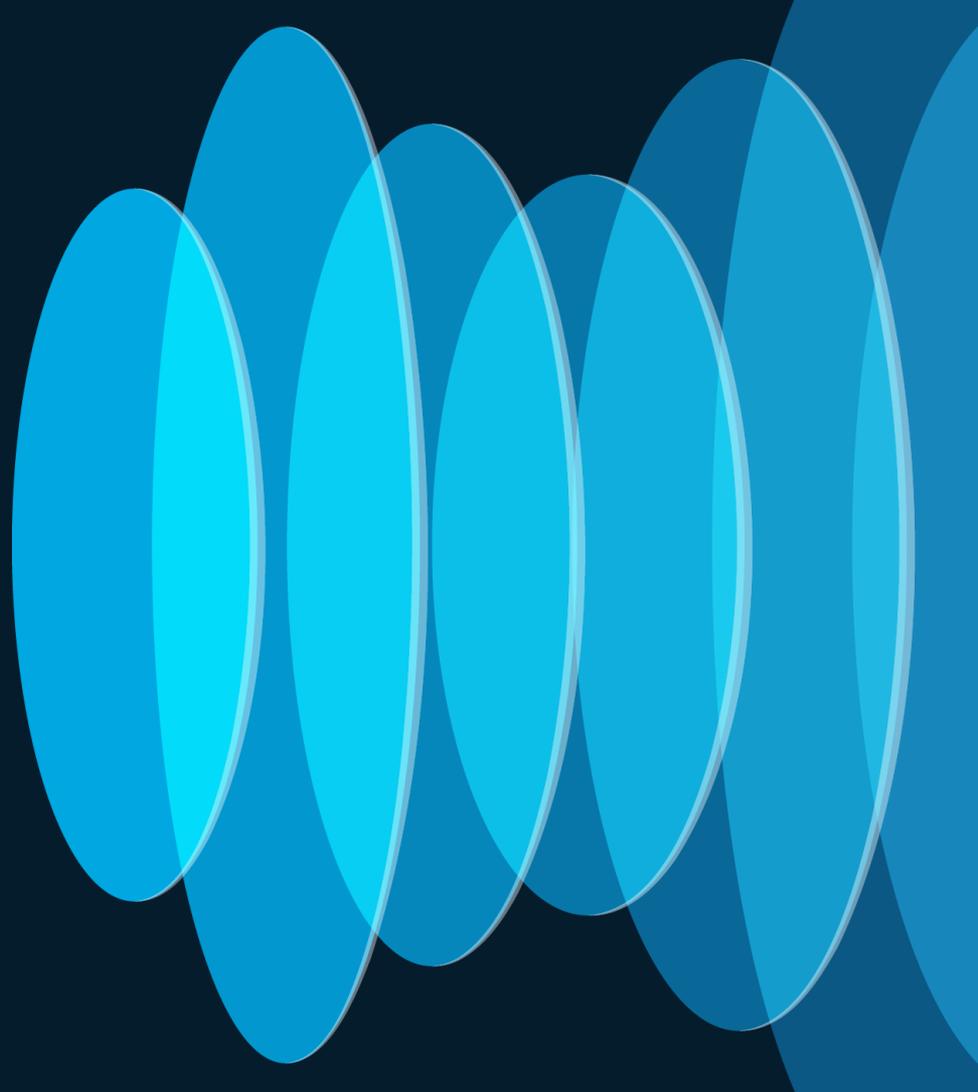


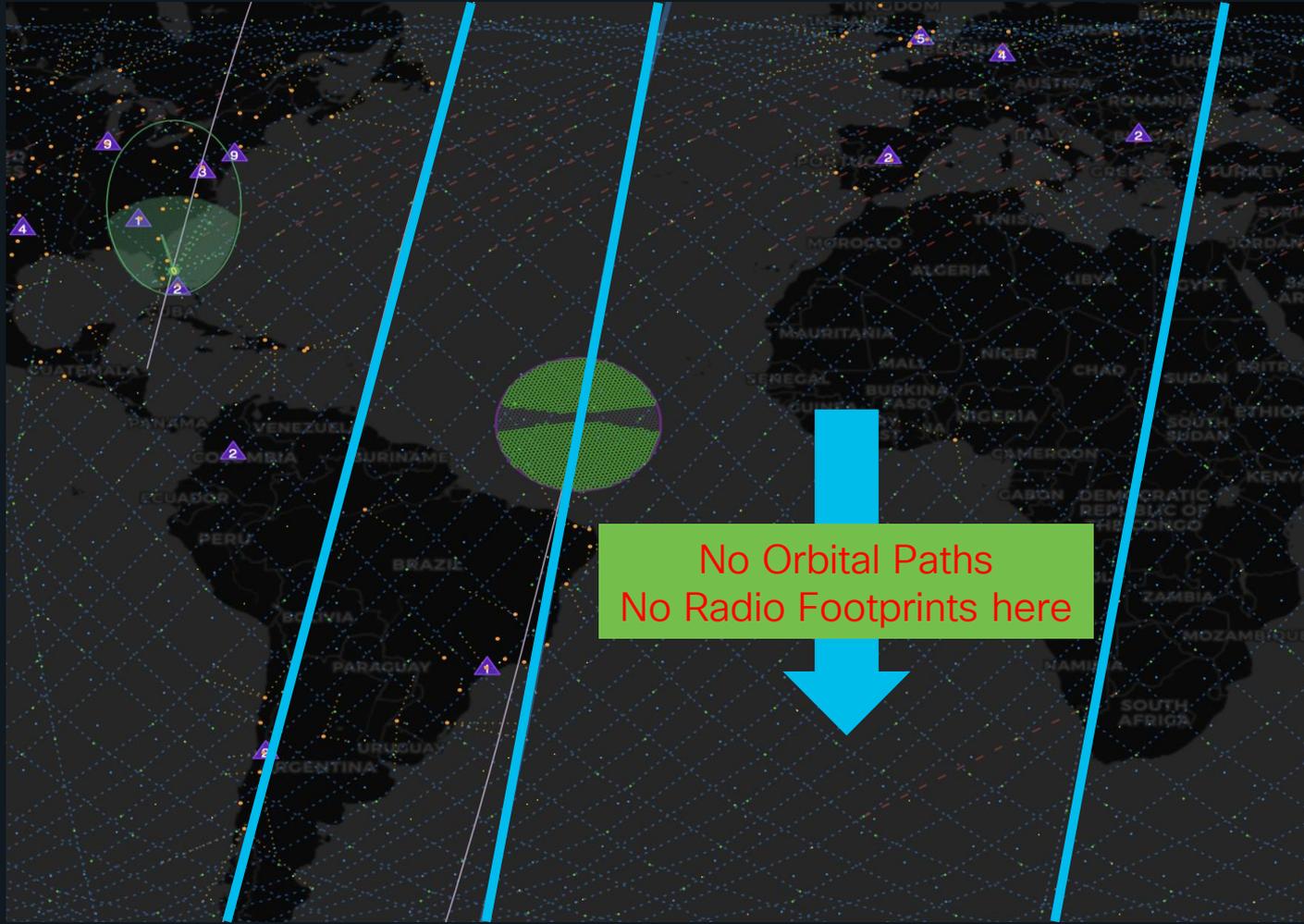
This satellite provides the backhaul to each of the other satellites - selection algorithm is unknown

MOVING MARKERS DO NOT REPRESENT ACTUAL SIZE OF STARLINK SATELLITES

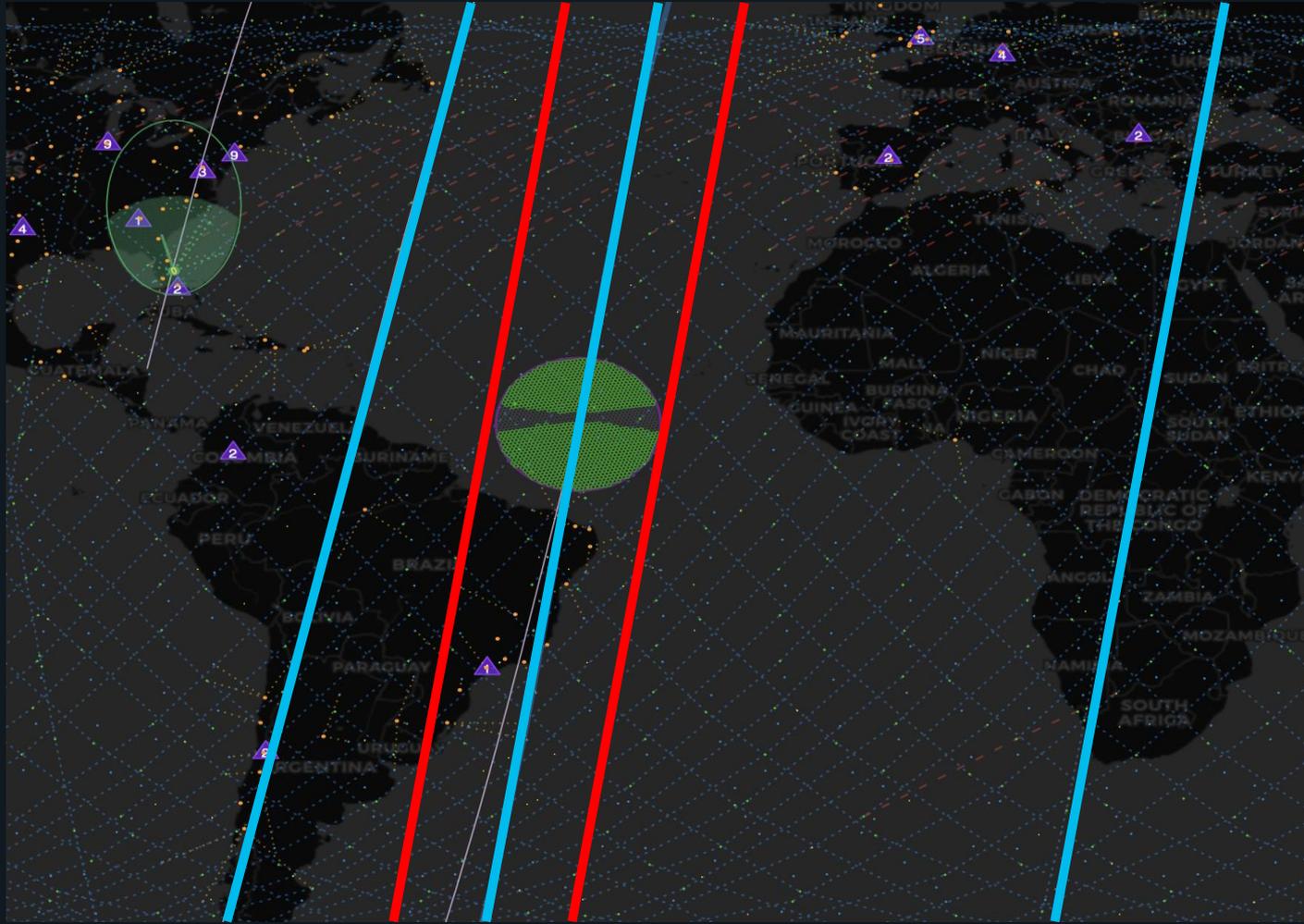
20:20:07  
Navigation icons: back, play, forward, search, refresh, close

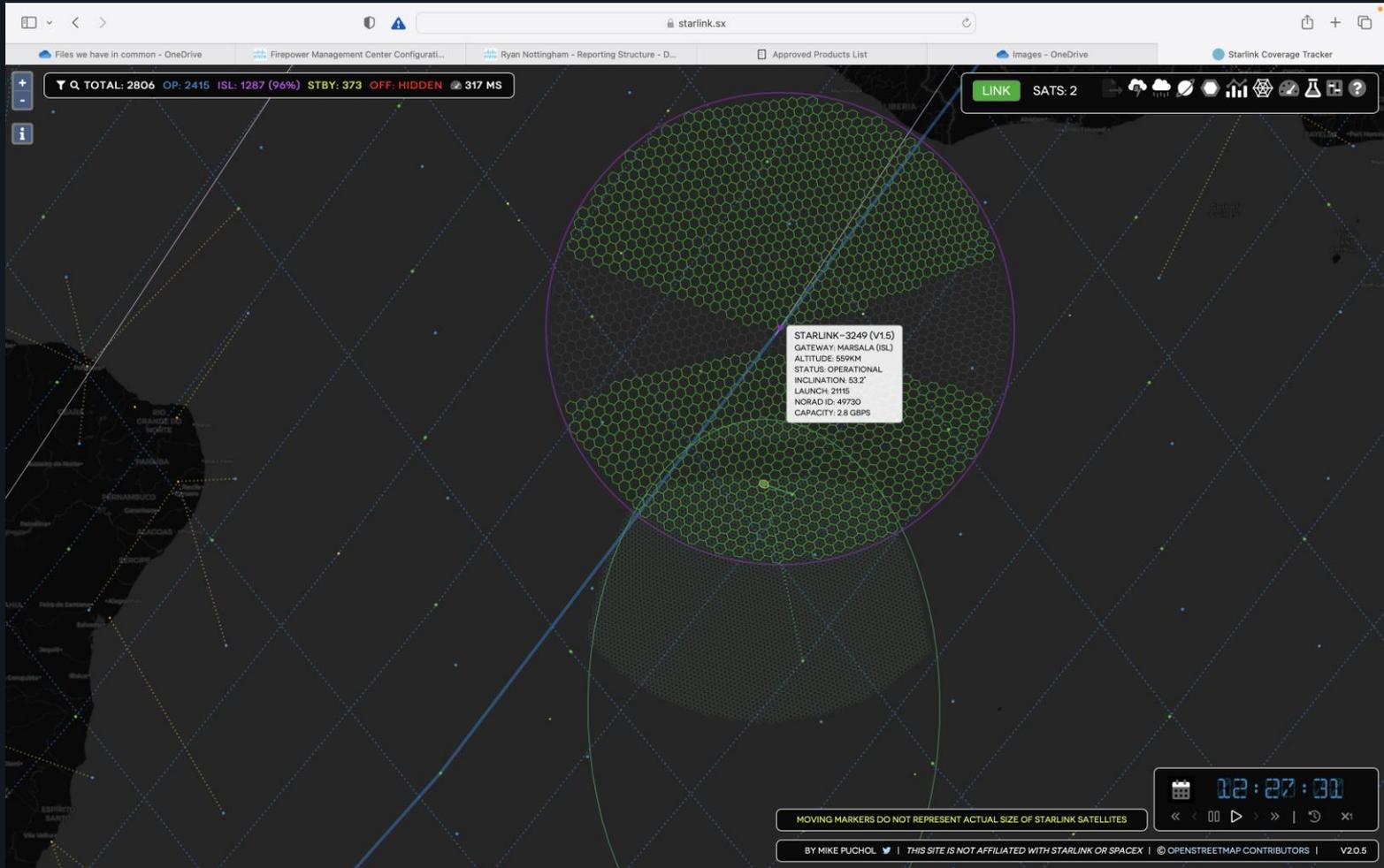
# Challenges with Polar Orbits





No Orbital Paths  
No Radio Footprints here



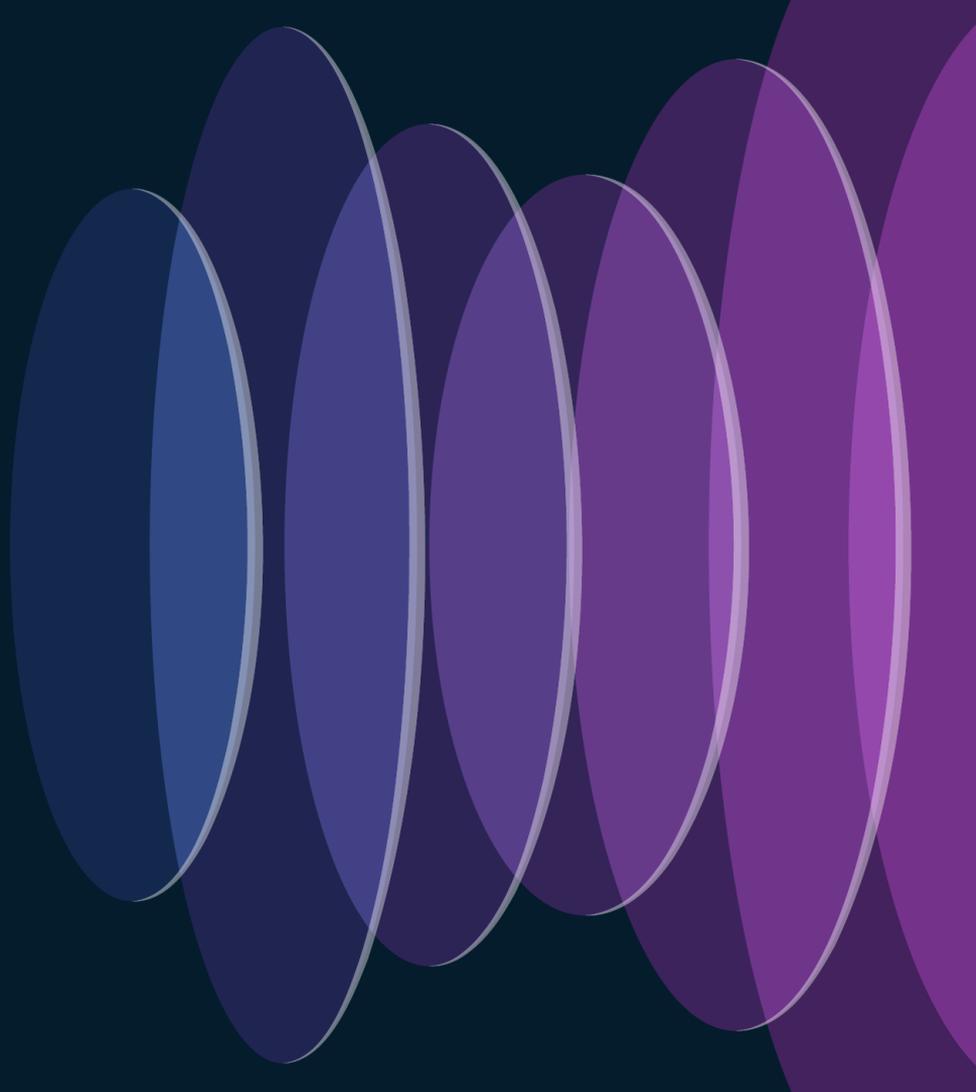


# Enterprise Customer Service Assumptions

# 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](#)

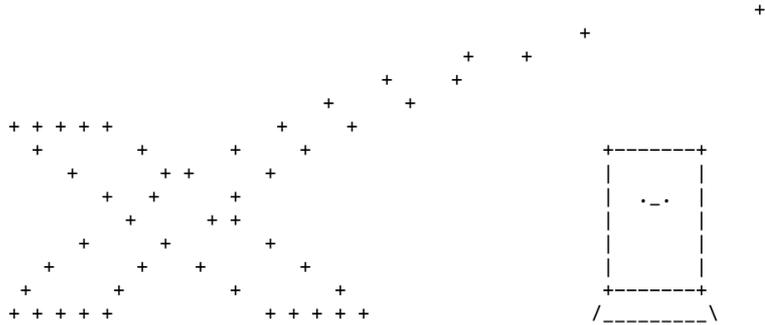
SAVE

# Starlink Security

## 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-010000000000000001F2F12
```

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

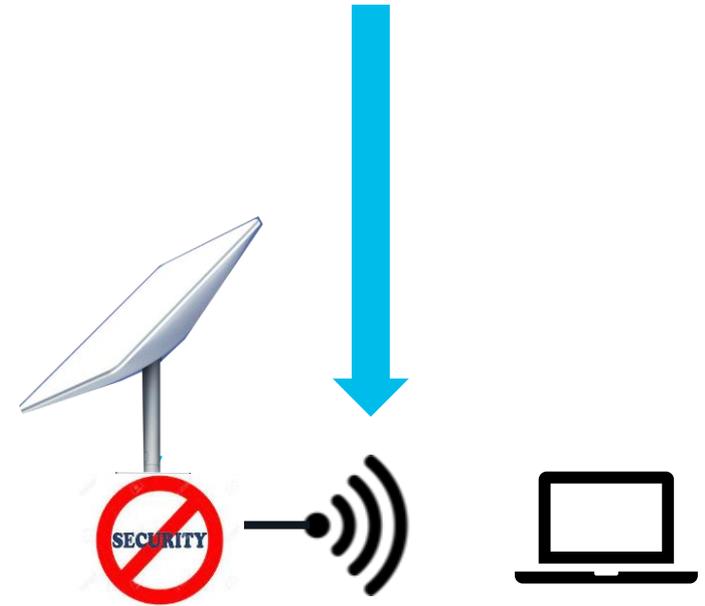
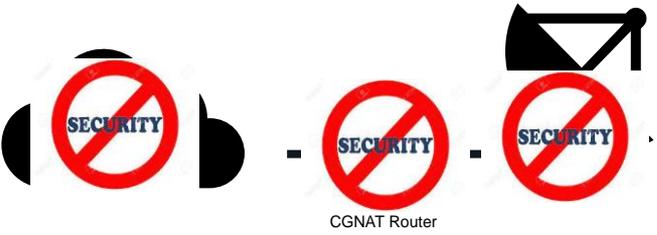
- Nmap scan report for 192.168.1.1
- Host is up (0.0040s latency).
- Not shown: 994 filtered tcp ports (no-response)
- PORT STATE SERVICE
- 22/tcp open ssh
- 53/tcp open domain
- 80/tcp open http
- 9000/tcp open cslistener
- 9001/tcp open tor-orport
- 9002/tcp open dynamid
  
- Nmap done: 1 IP address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

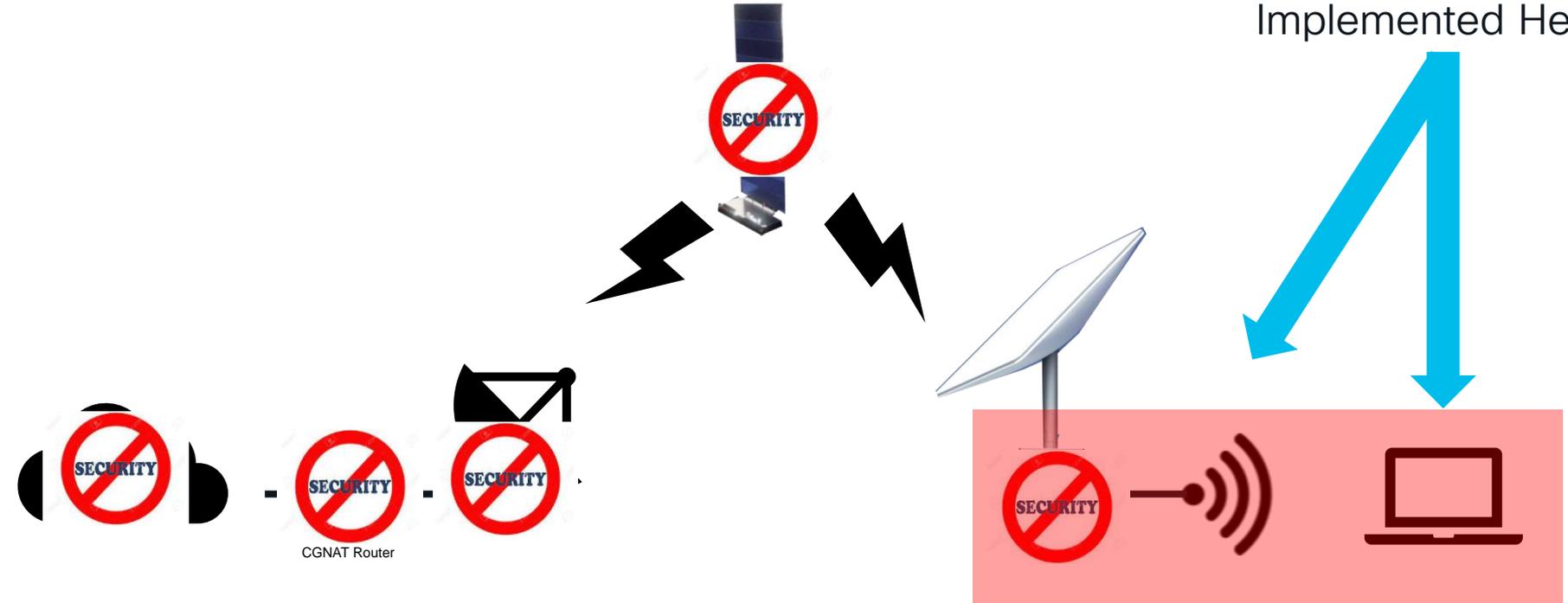
# Starlink Security Today

WPA2 Implemented here

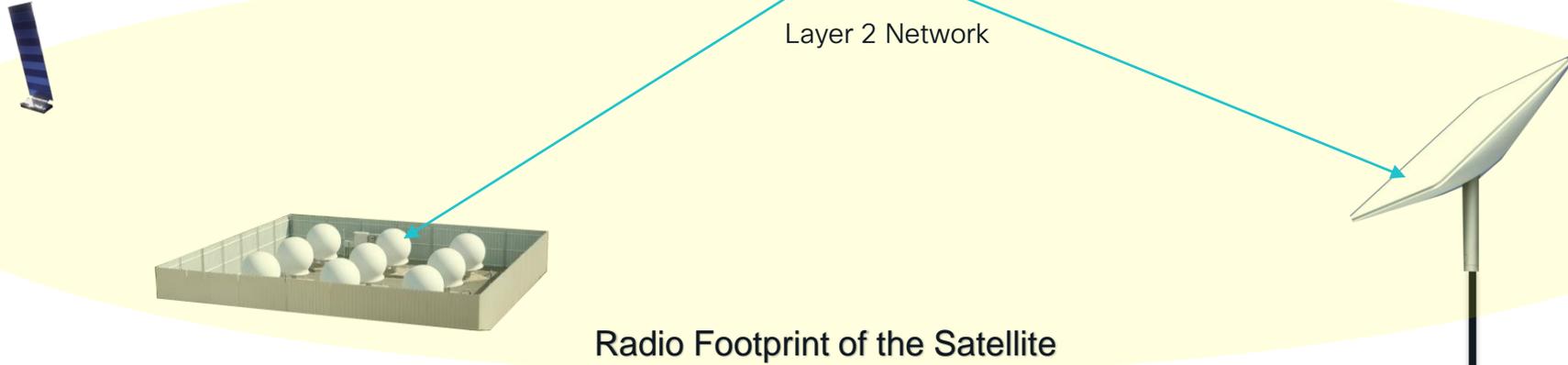


# Starlink Security Today

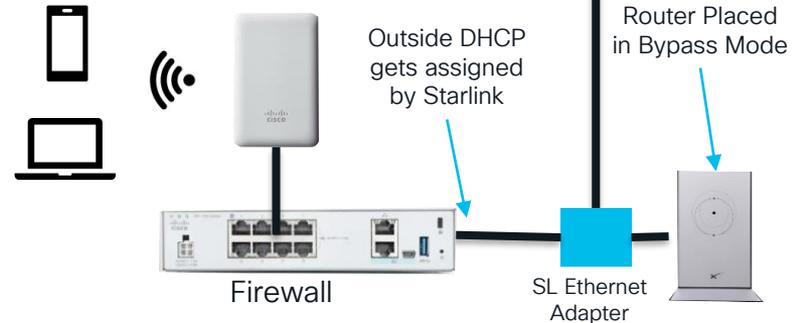
Security Must be Implemented Here



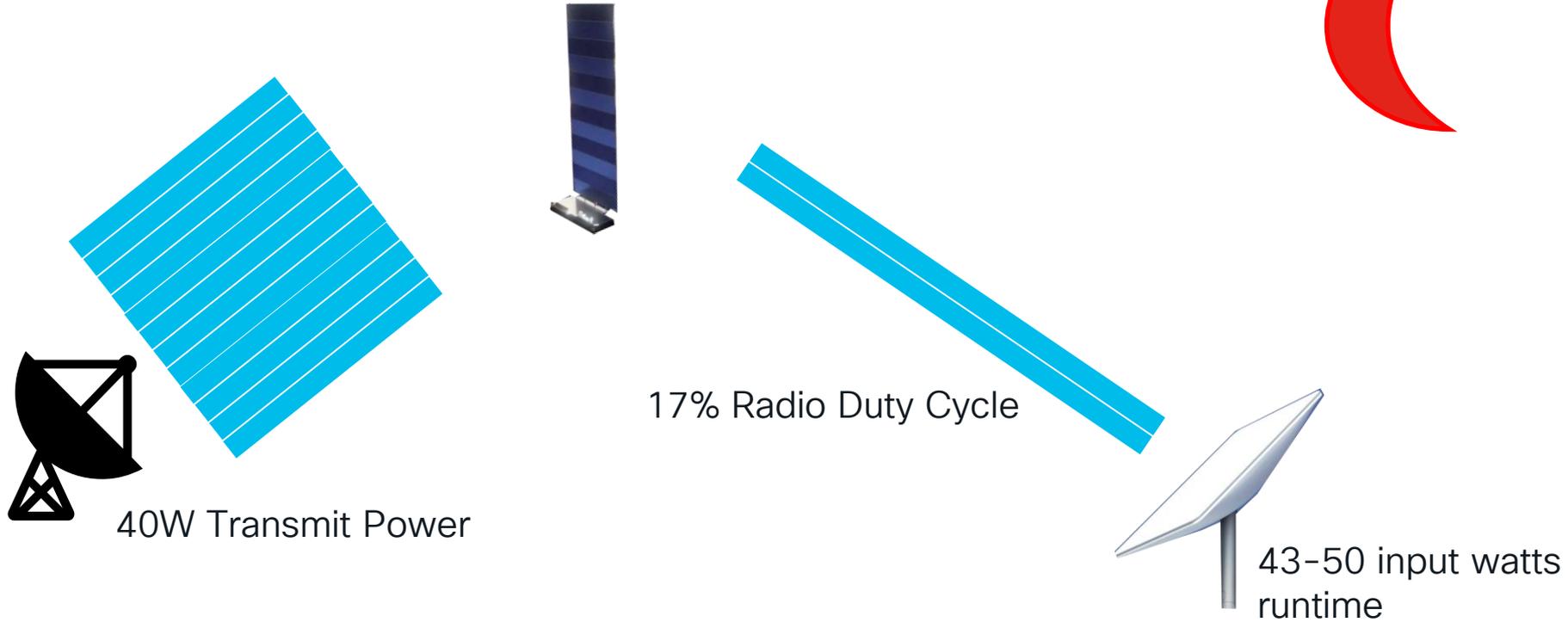
# Advanced Networking



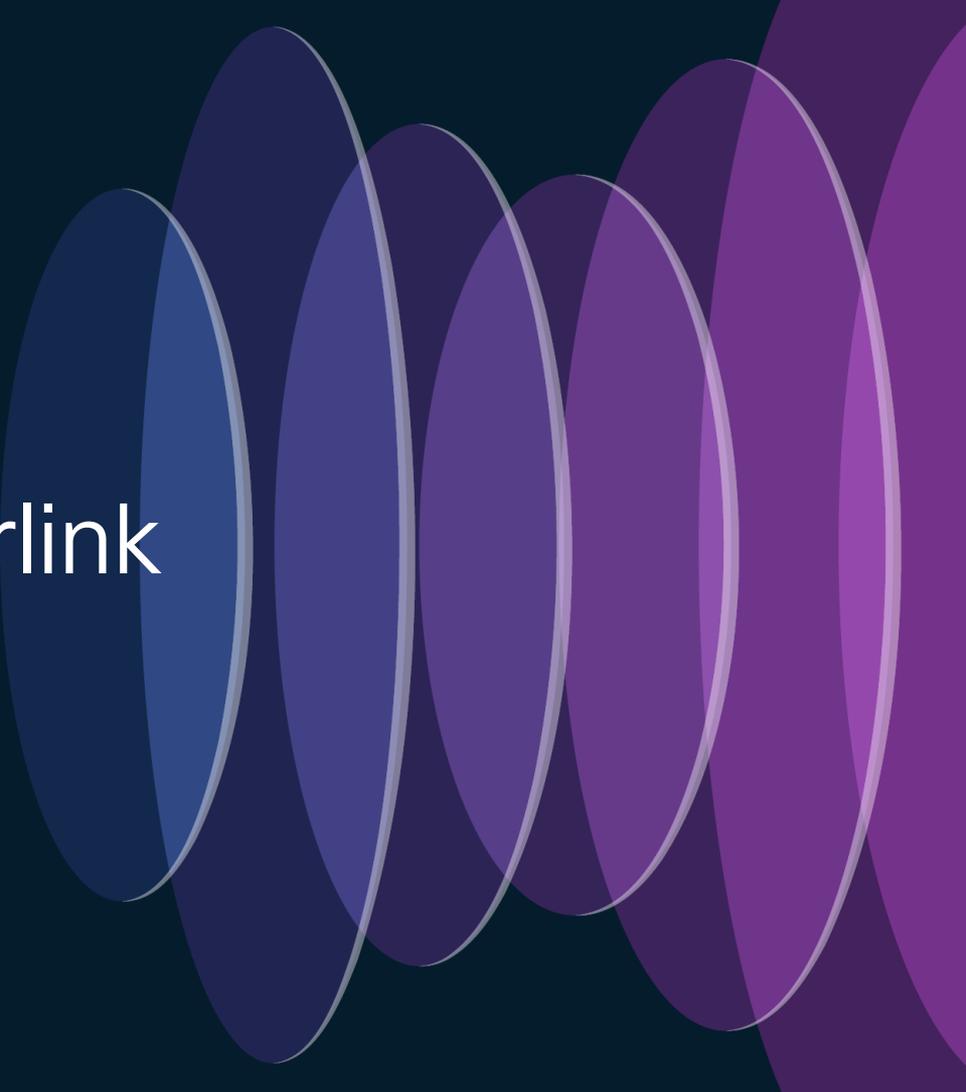
SL Router in Bypass Mode:  
WIFI Gets disabled  
Router is no longer locally accessible  
Statistics are stored in SL Cloud  
Array connects to SL Cloud and delivers updates



# What is really happening (radio nerds)



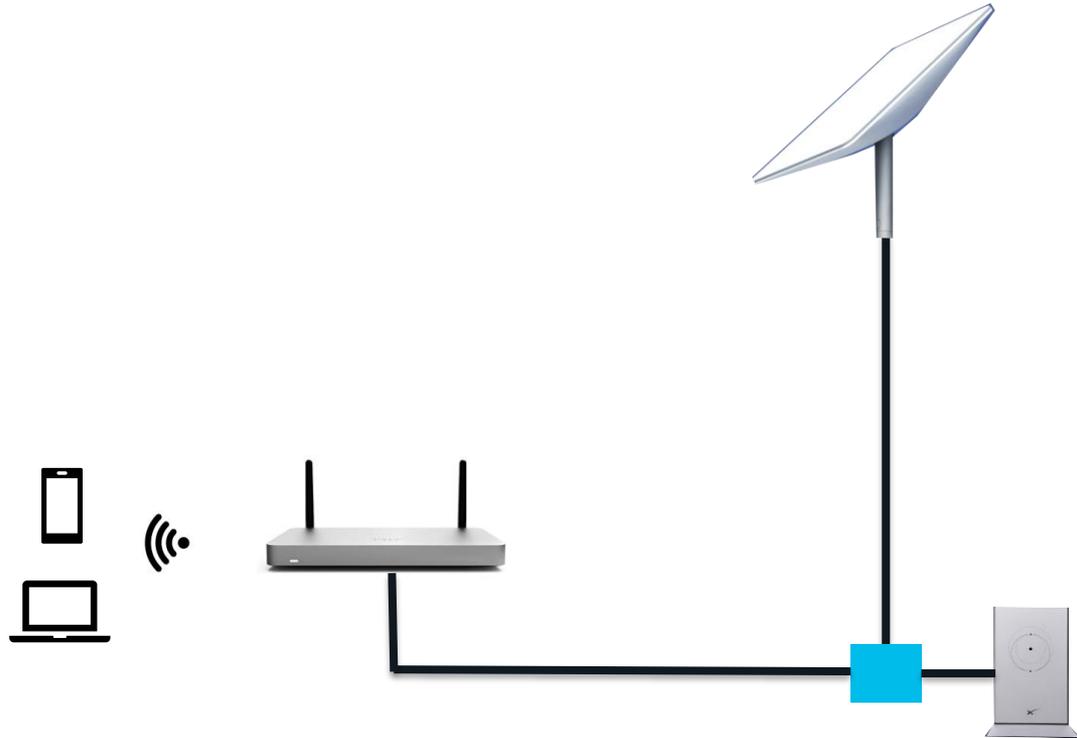
# Cisco Security + Starlink





# Meraki 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

**Meraki**

ORGANIZATION  
Cisco Florida

NETWORK  
MX95 Firewall

Network-wide

Security & SD-WAN

Insight

Organization

Search Dashboard

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

**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: 54.230.132.102  
CUSTOMER: customer@tagax1.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, fe80::7624:9fff:feaf:2f12

#### WAN 2

TYPE	IPv4	IPv6
CONFIGURED AS	Dynamic	Auto (Stateless)
STATUS	Not connected	Not connected

#### Live data

Uplink traffic Total Download

#### Historical device data

for the last day

Connectivity to 8.8.8.8

*CISCO Live!*

# 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

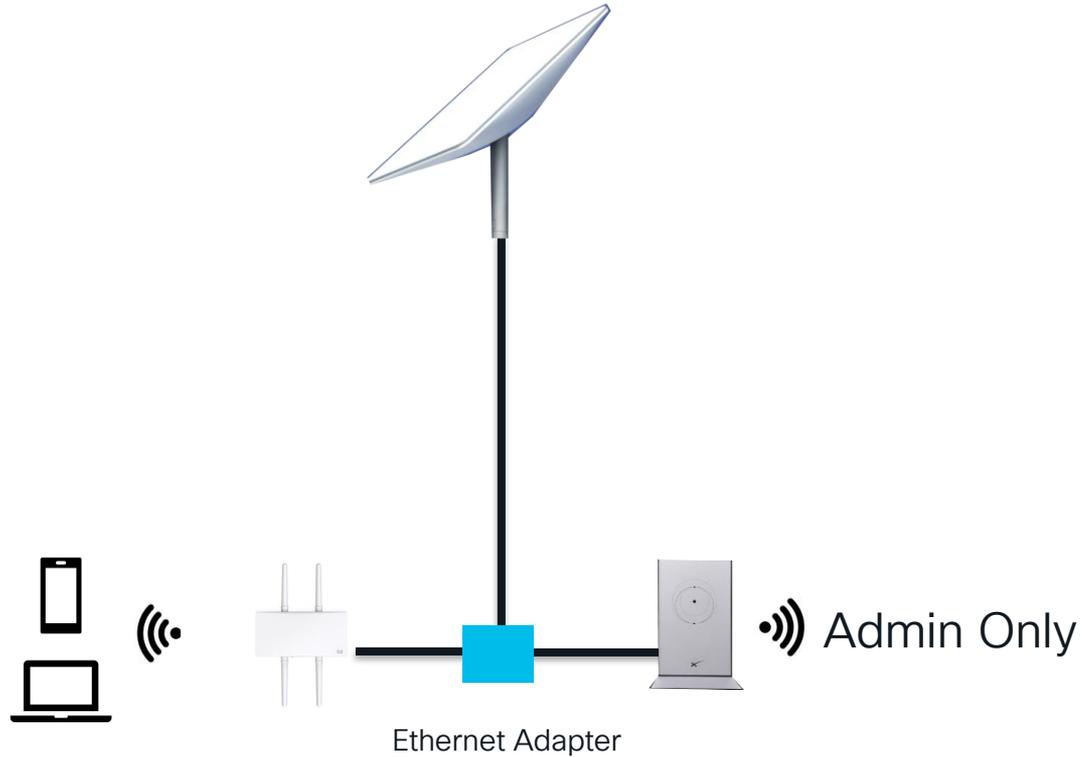
VLAN ID	VLAN name	Subnet prefix	Origin	Delegated prefix	Prefix status
		fd5e:9a9e:c5bd:19::/64	WAN 1	fd5e:9a9e:c5bd:19::/64	Active

1 result

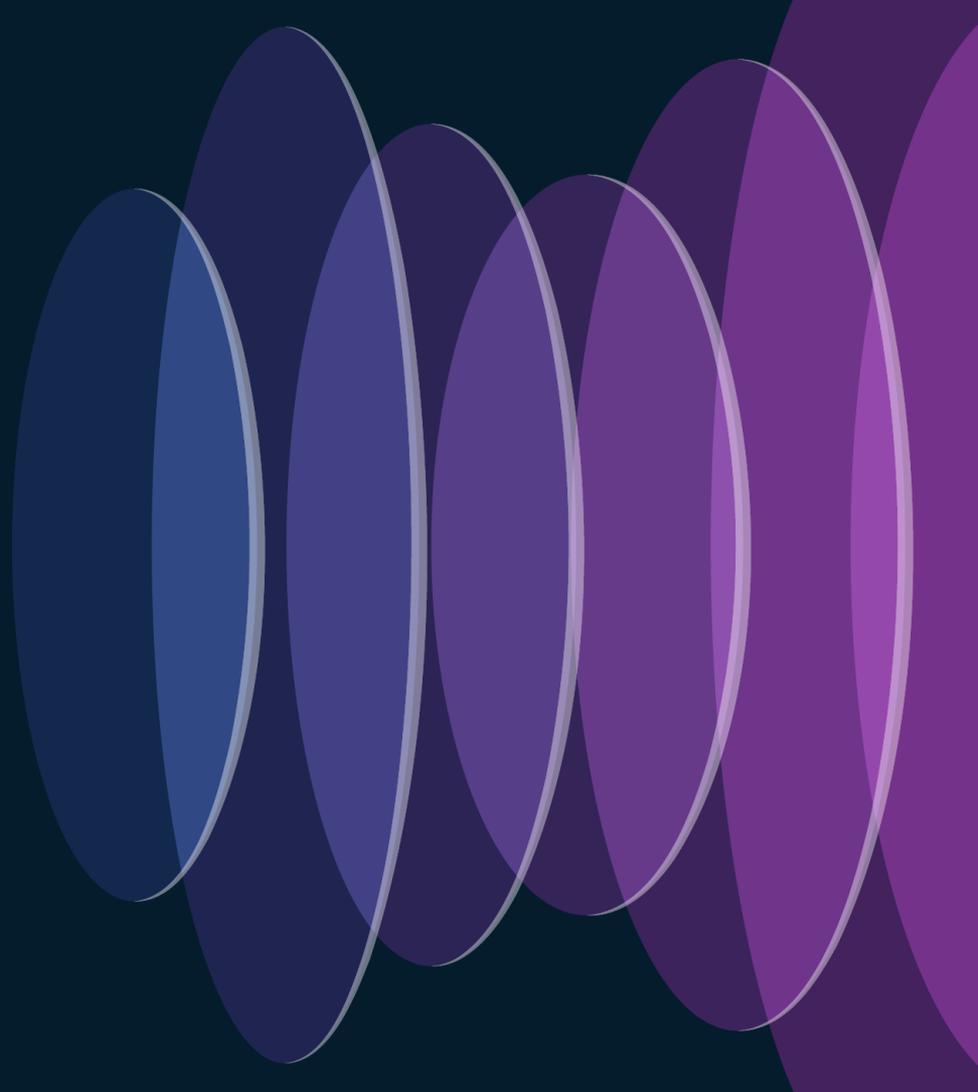
/64 Deployed Network

/96 IPv6 Assigned Interface IP

# Keep it simple, don't overcomplicate things



# Actual Working Things



Global Overview

Organization  
Cisco Florida

Network  
MX95 Firewall

Network-wide

Security & SD-WAN

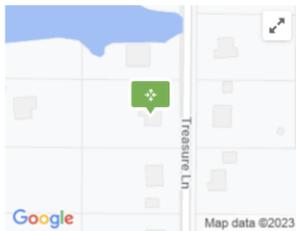
Insight

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



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

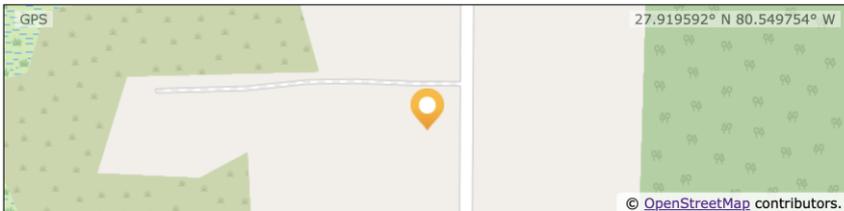
## Wi-Fi AP

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	Pepwa-WIFI
---------------	--------------------	---------------	--------------------	---------------	--------------------	---------------	------------

## SpeedFusion Connect Protect

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

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



## Device Information

Model: Peplink MAX Transit Duo Pro

CISCO Live!

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
<b>IPv6</b>
Enabled
<b>DNS over HTTPS</b>
Enabled
<b>WAN Quality Monitor</b>
Auto

# What Is My IP?

My Public IPv4: [98.97.18.37](#)

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

My IP Location: New York City, NY US

My ISP: SpaceX Services Inc.

CG-NAT IP

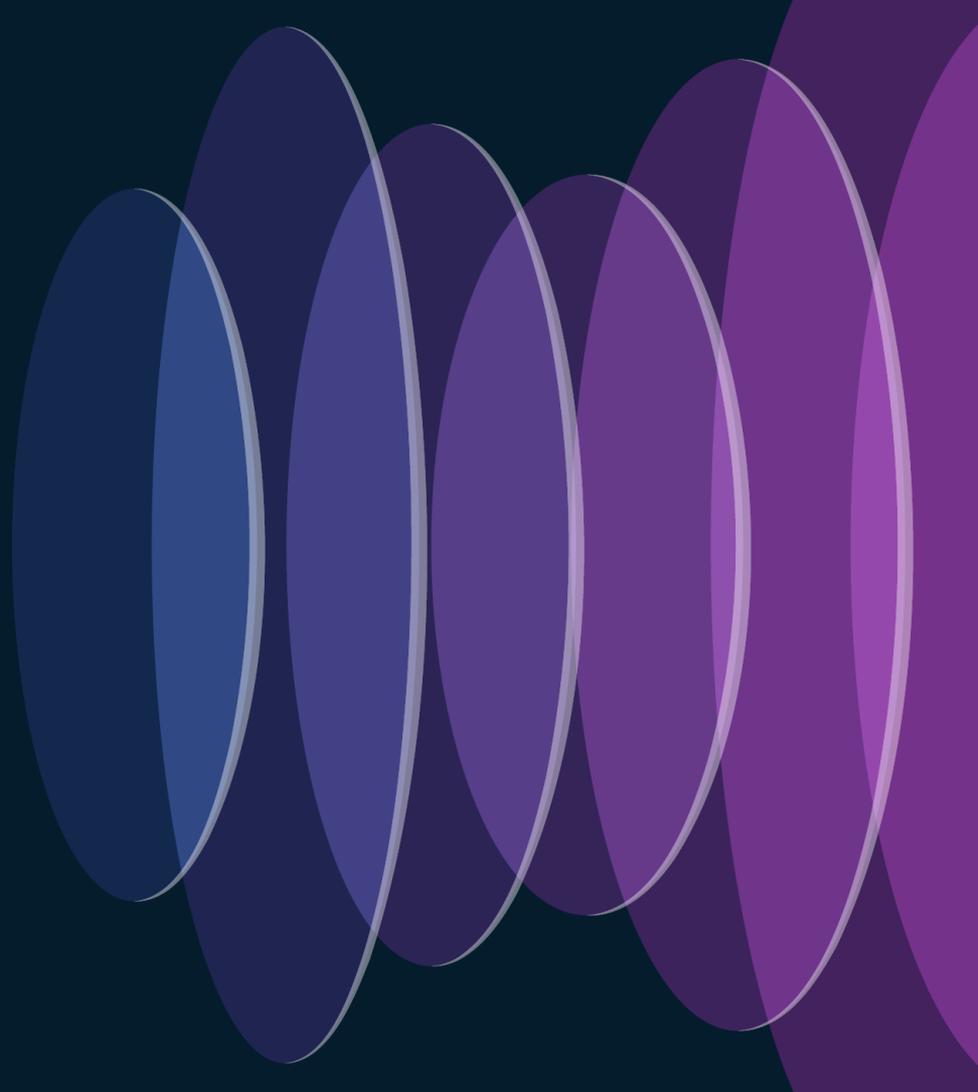
Synergy Controller
Disabled

Starlink
Enabled WAN Connection(s): Starlink

Actually does API lookups



# Deployment Considerations

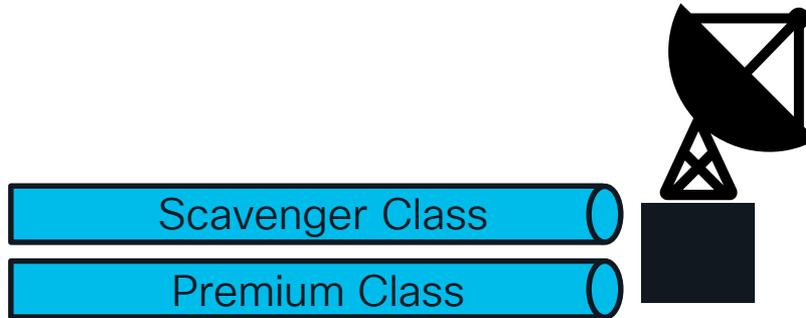
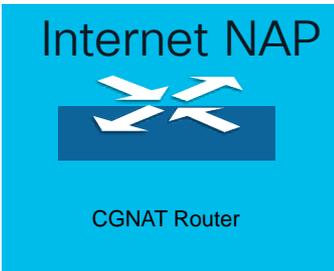


# QoS Observations

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



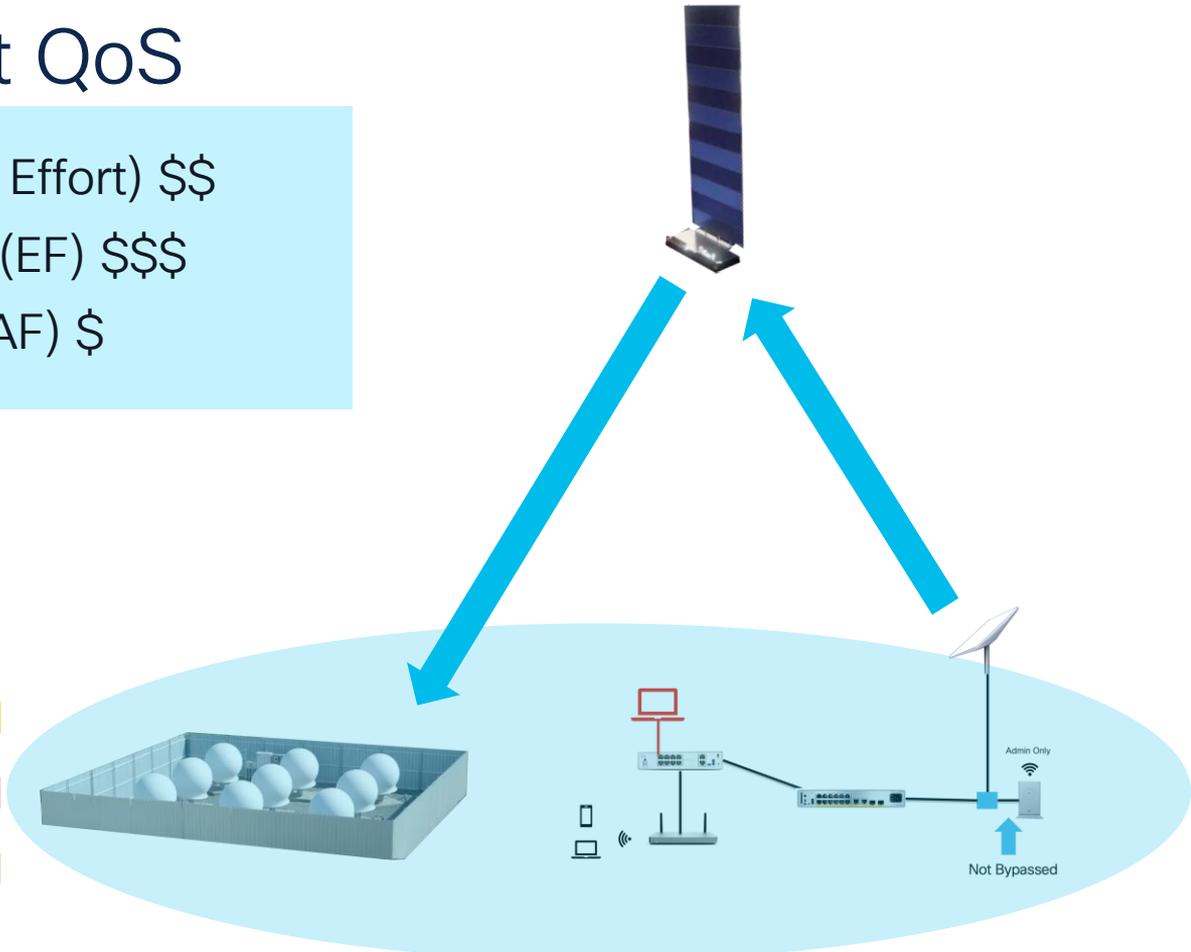
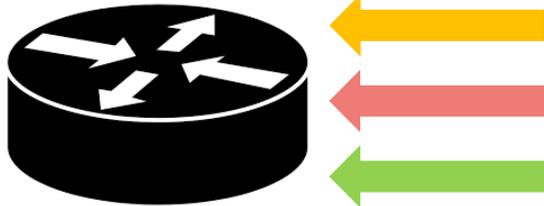
Scavenger class QoS



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

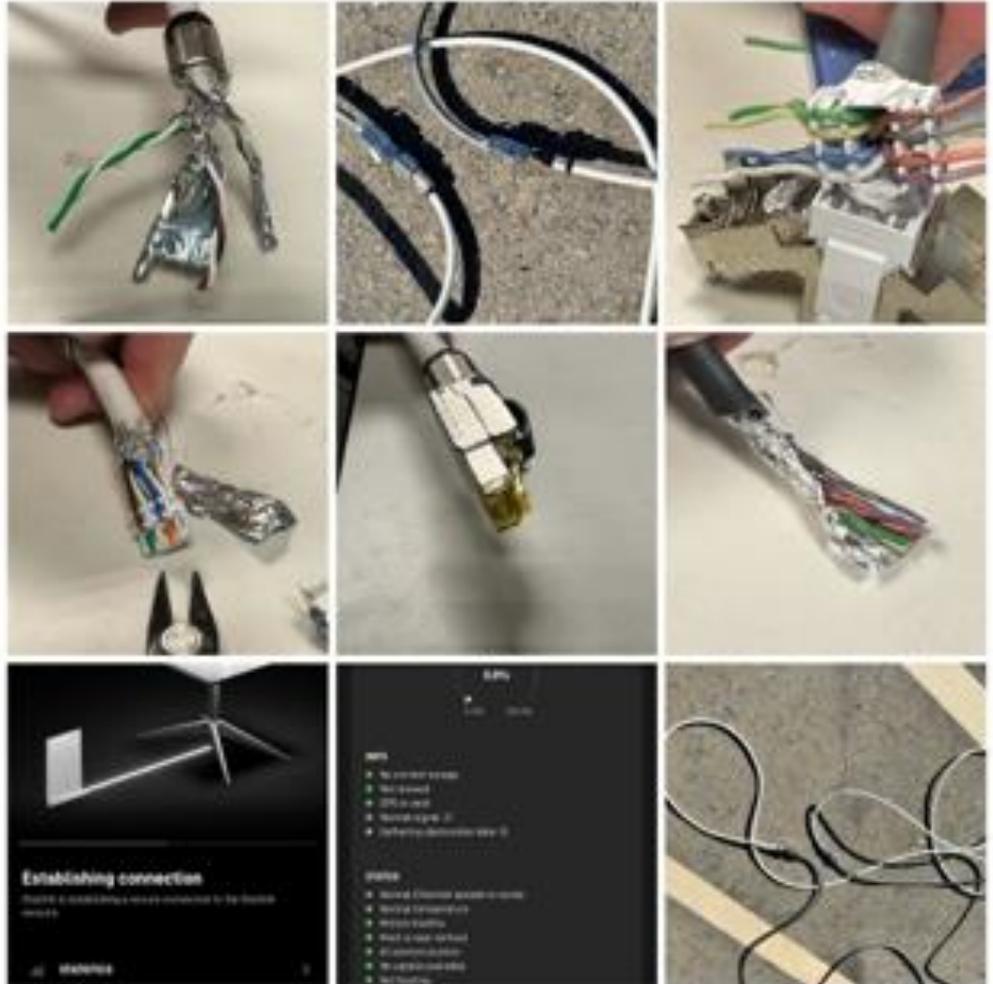
B2 - Purple 8 Brown

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....*



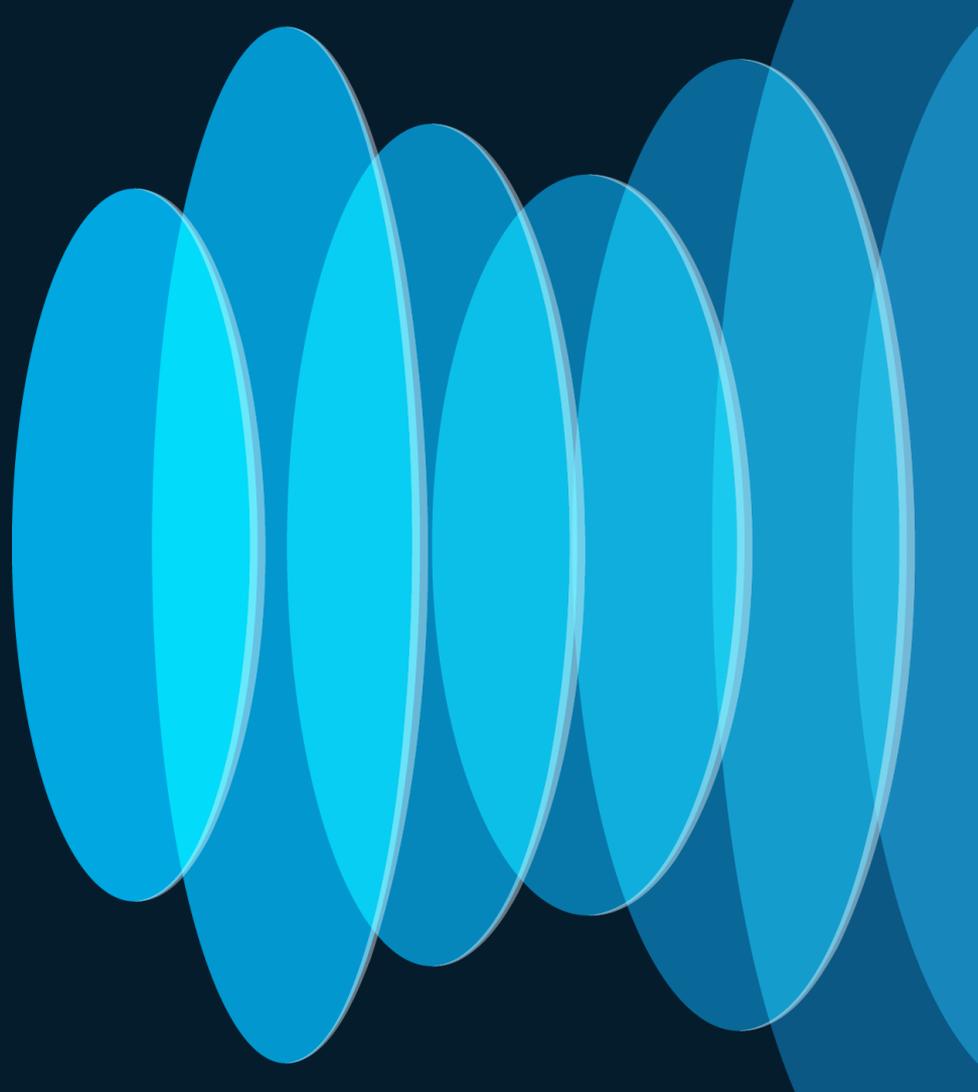
From Colorado - 100% Off Grid

HD Video Broadcast to San Jose





# IR1101 Ruggedized Router



# IR1101 – Starlink 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

AC to DC Power Brick

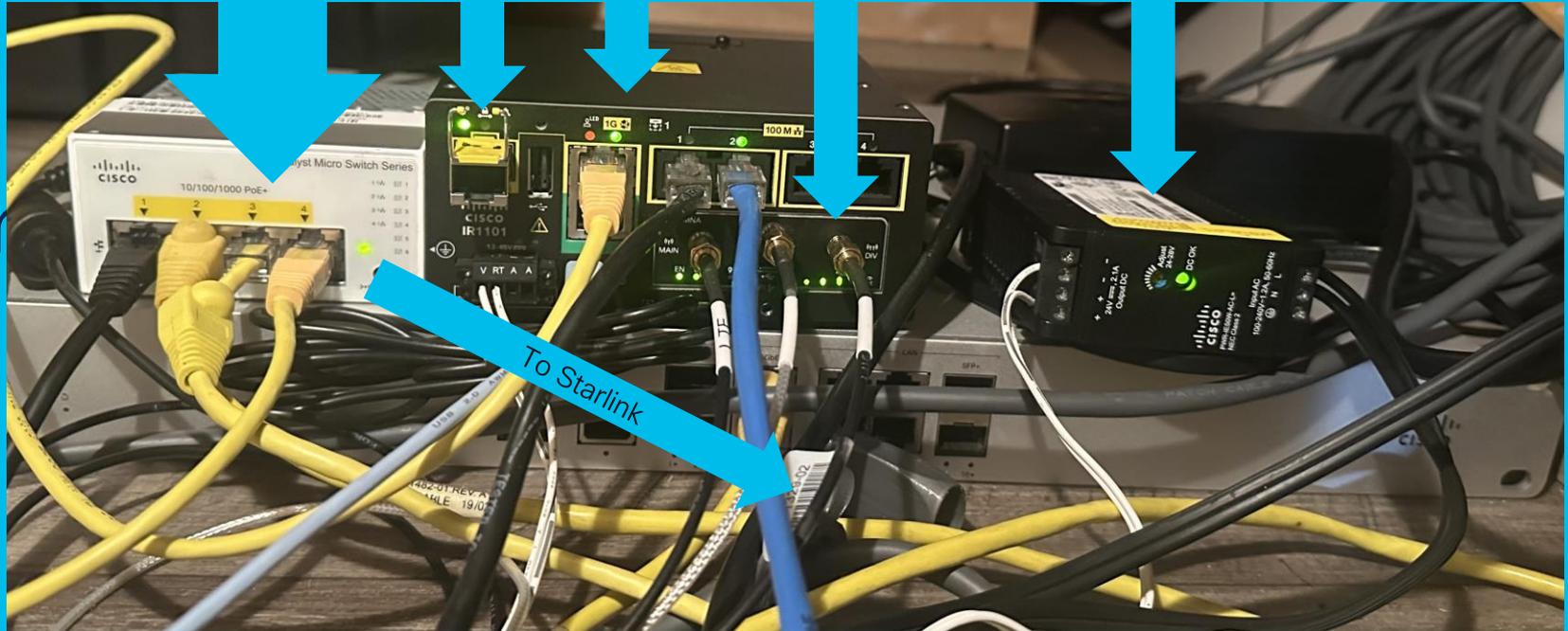
GigE to Catalyst

Pluggable LTE Radio

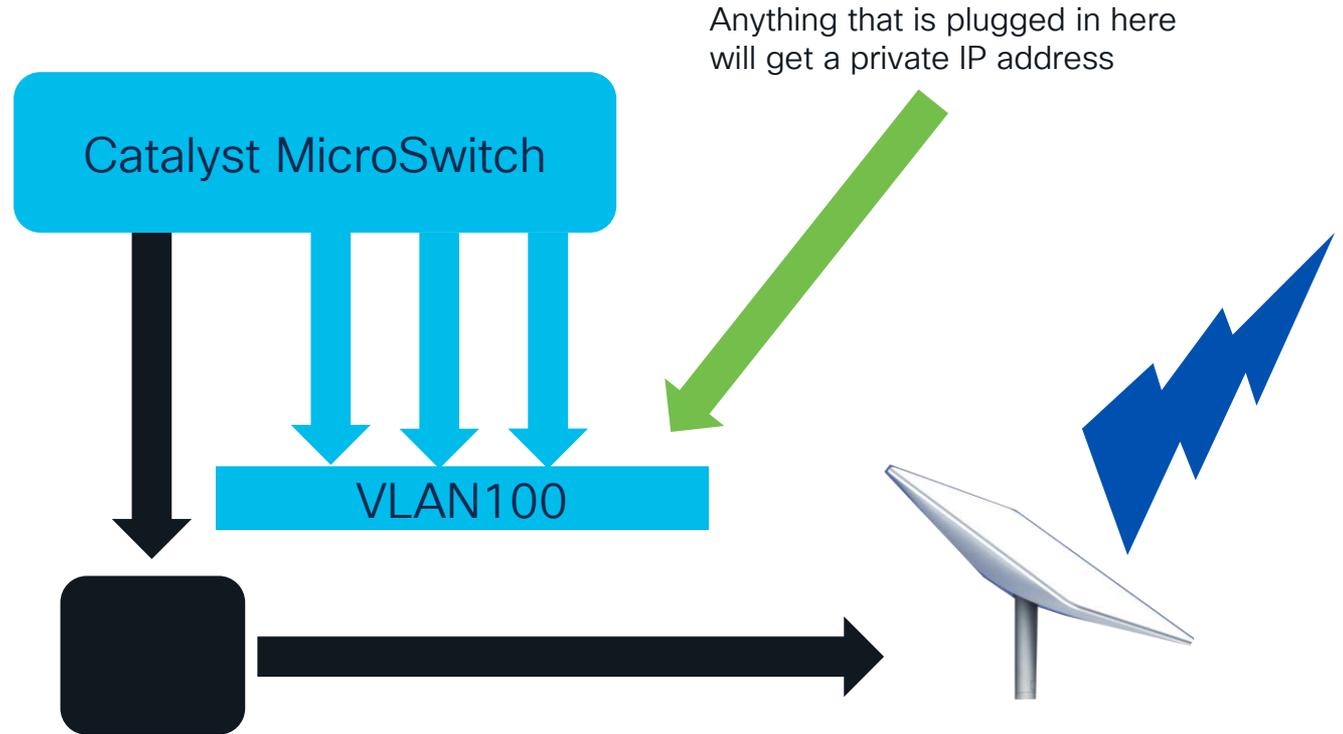
Catalyst Micro Switch  
Single VLAN

SFP

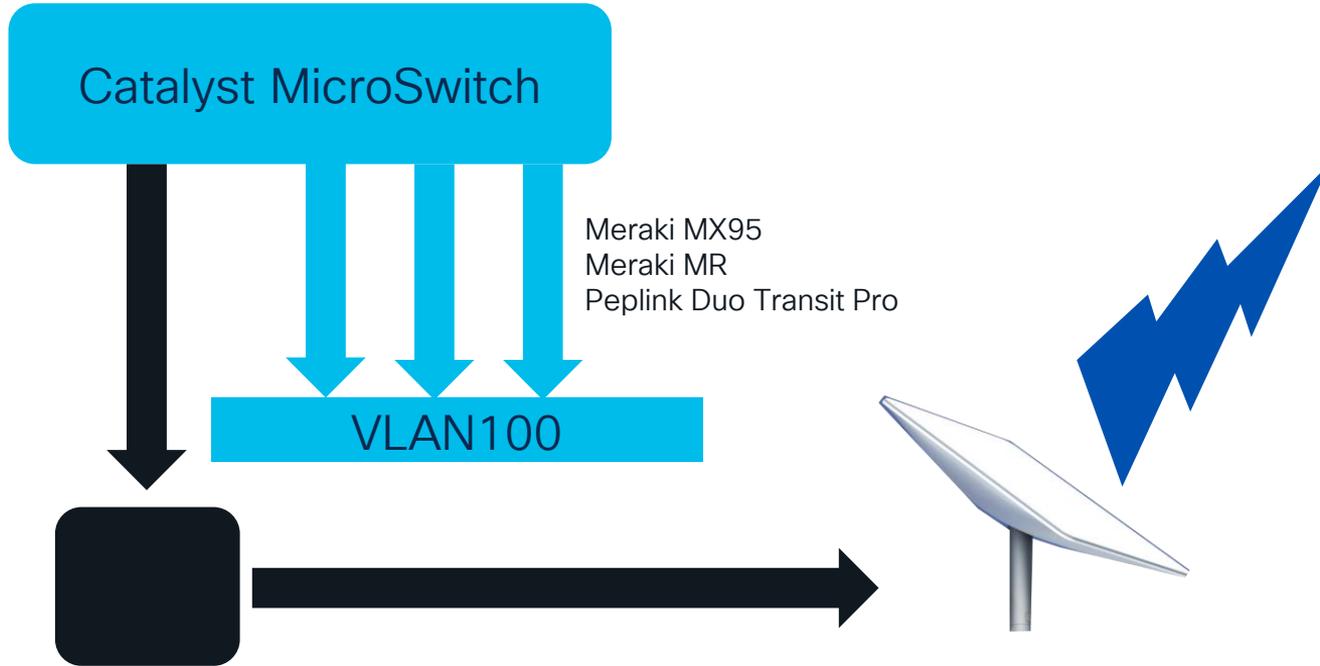
Fire



# How it works



# How it works



# What can I do with an IR1101 to secure SL?

The screenshot shows the Cisco IR1101-K9 configuration interface for DNS Layer Security Integration. The breadcrumb navigation is Configuration > Security > Threat Defense > Cisco DNS Layer Security Integration. The page includes a search bar, navigation menu, and configuration fields for Registration Token, Organization ID, and Allowed Domains. It also features sections for Interfaces (4), LAN Interfaces (4), and WAN Interfaces (2).

Registration Token\*  [Click here to get your Token](#)

Organization ID NONE

Allowed Domains

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

WAN Interfaces (2)

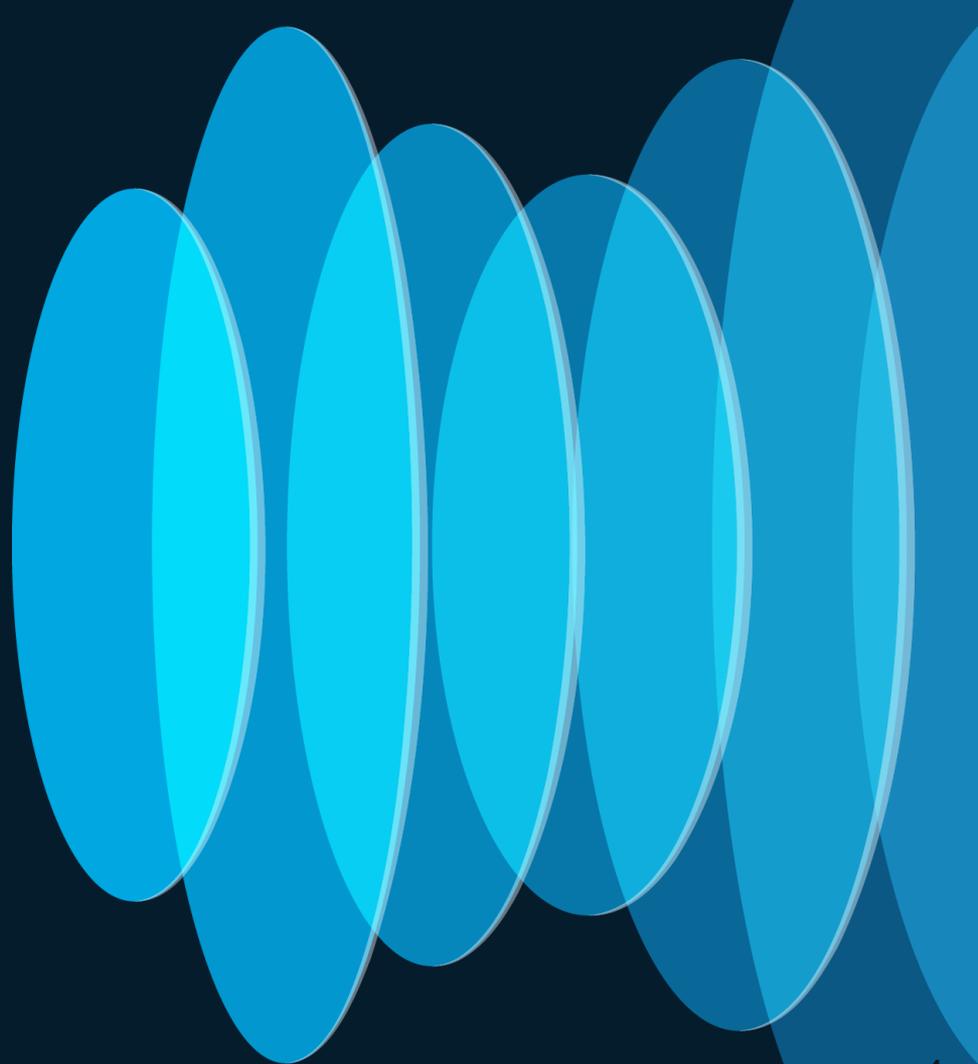
- Cellular0/1/0
- GigabitEthernet0/0/0

Drag and Drop to add/remove LAN & WAN Interfaces

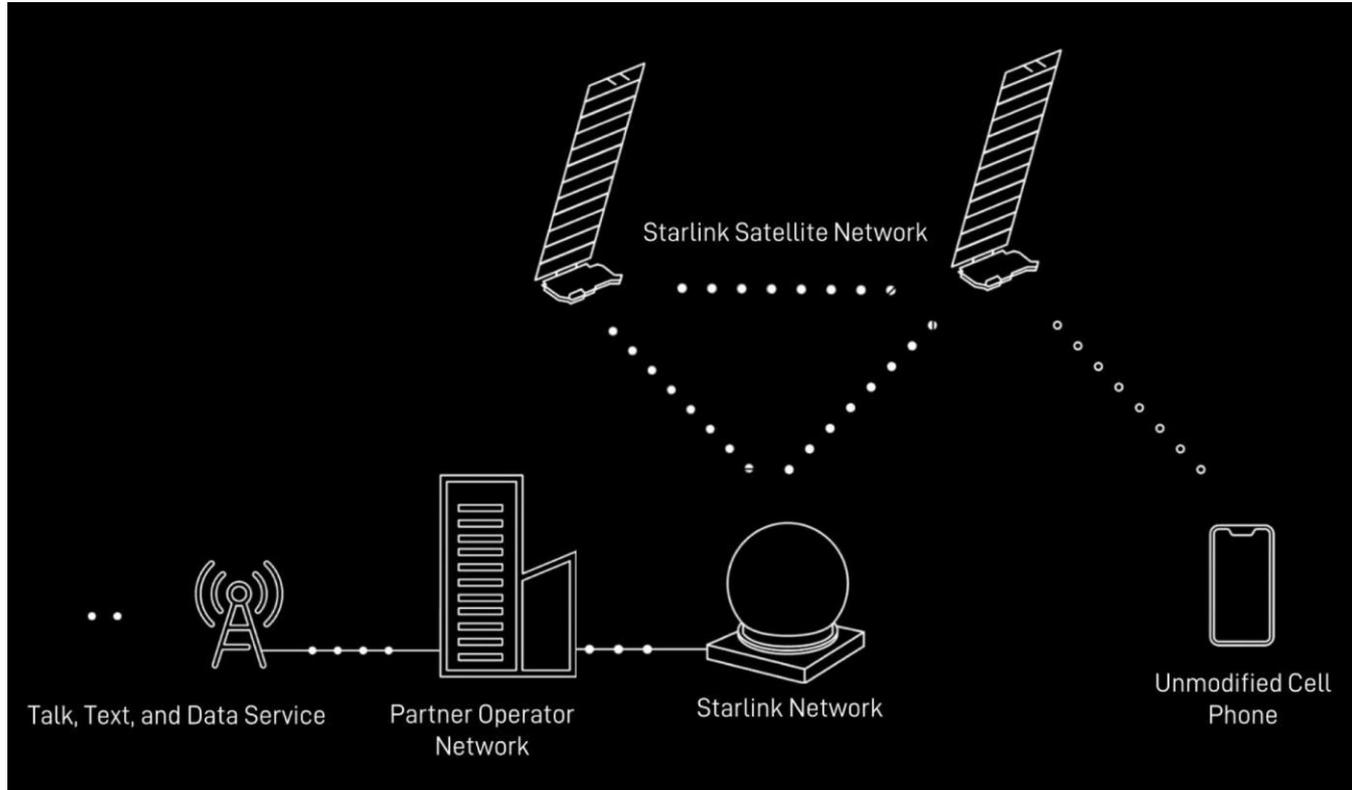
# Cellular Gateway/Starlink

- 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)



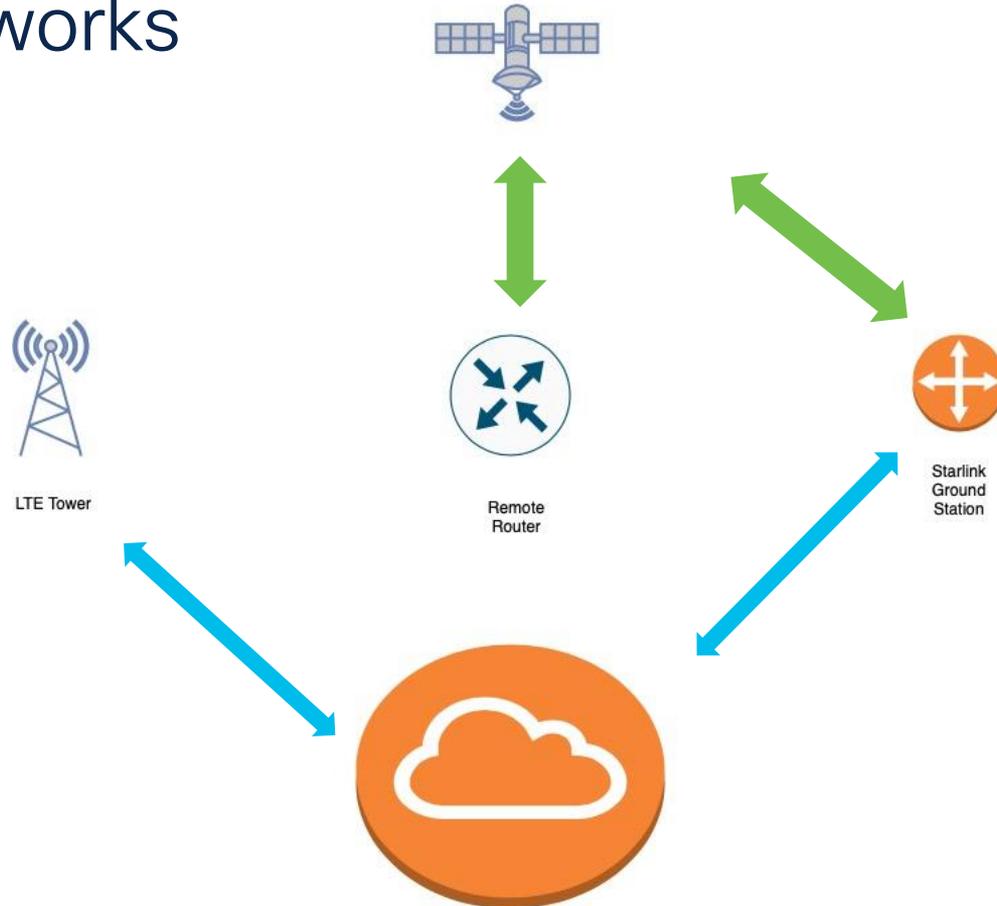
# Direct to Cell



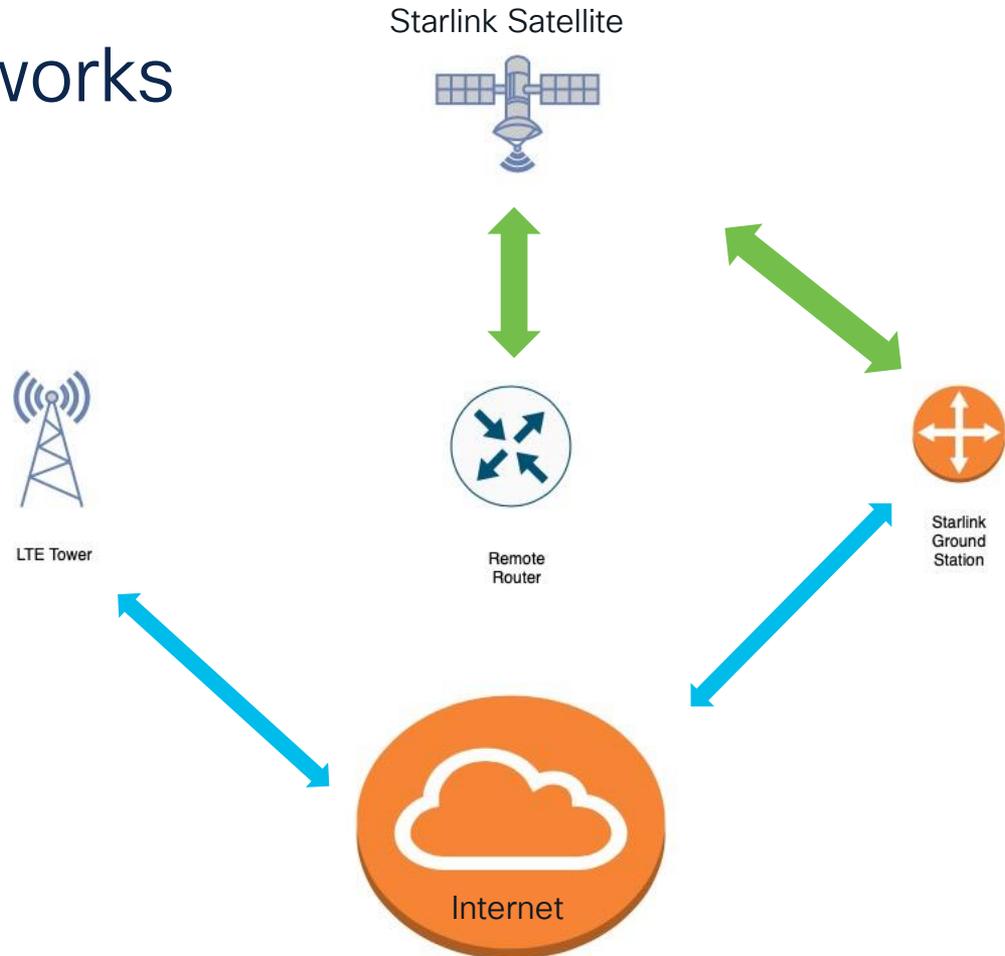
# Starlink - Direct to Cell

- 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

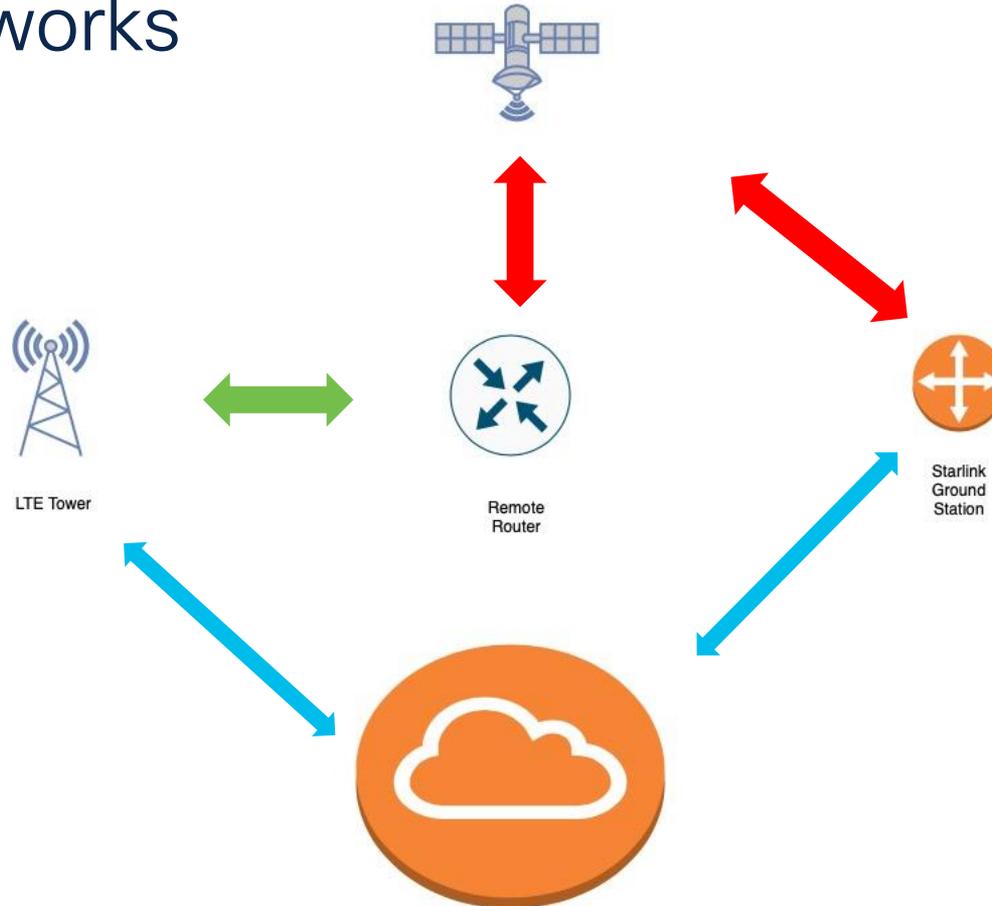
# How this works

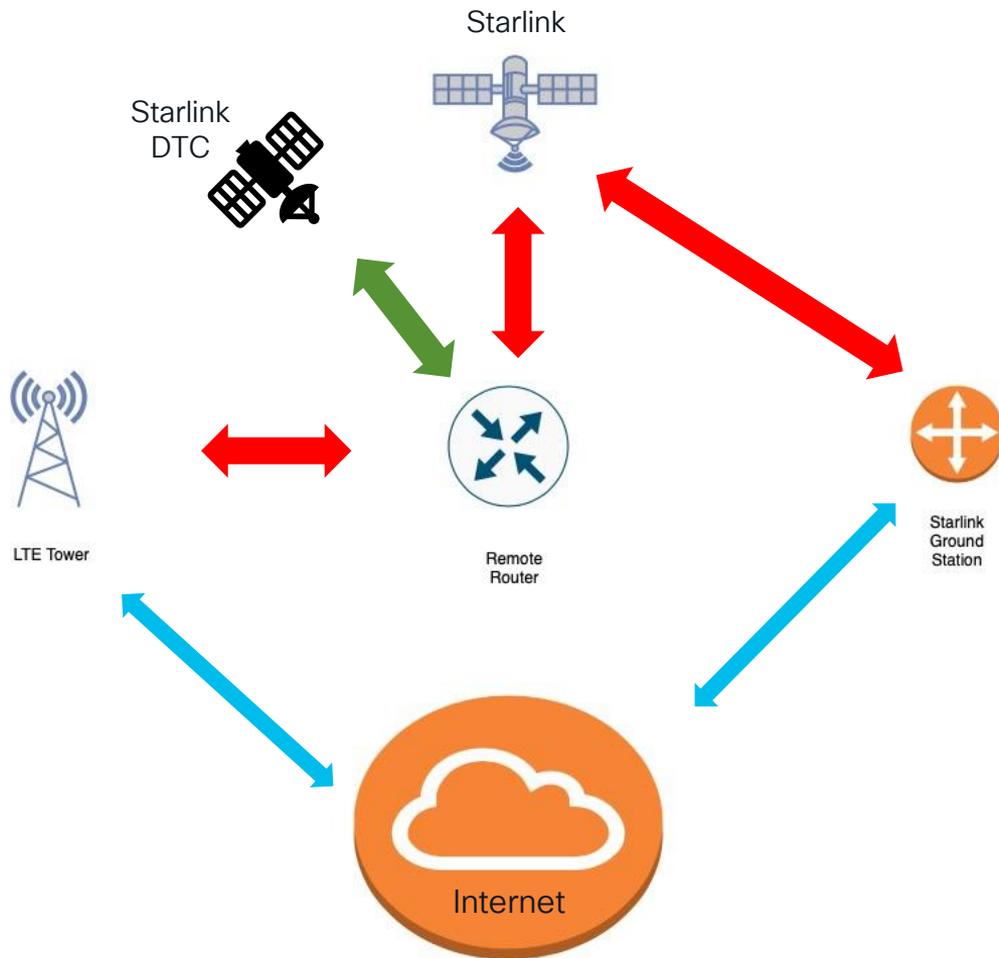


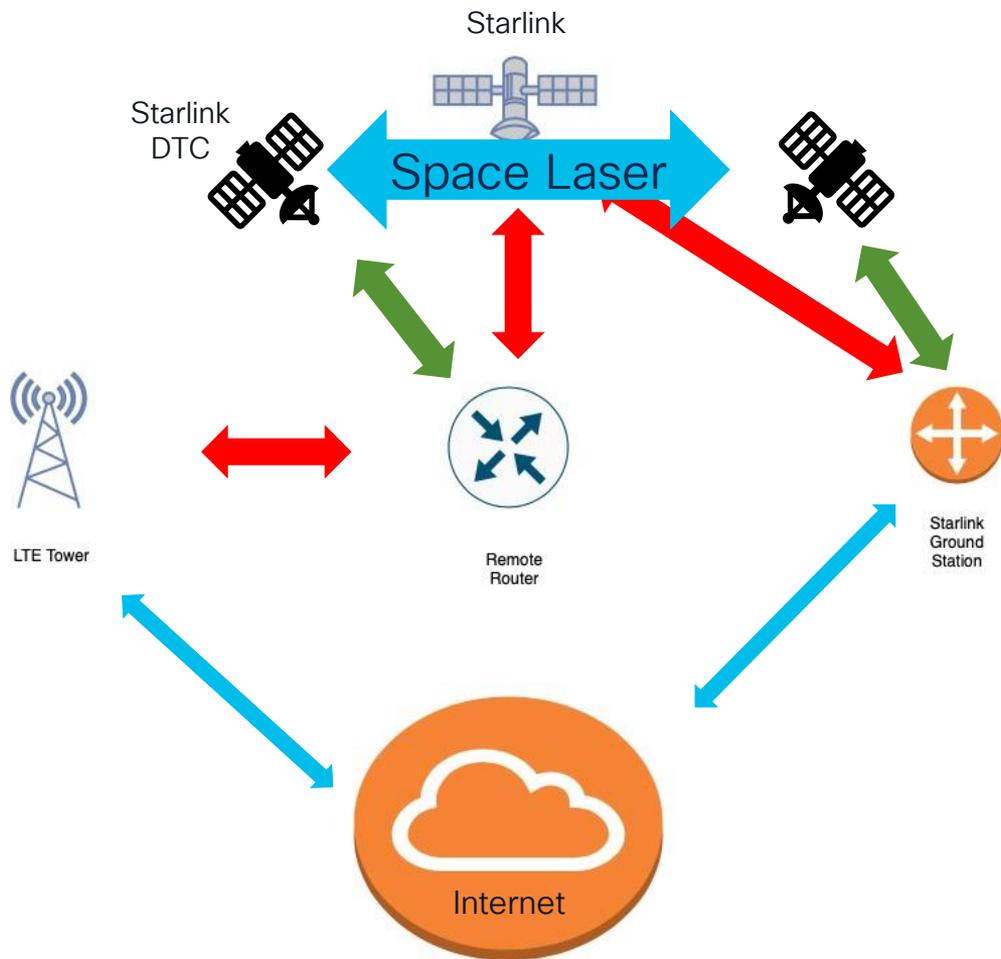
# How this works



# How this works







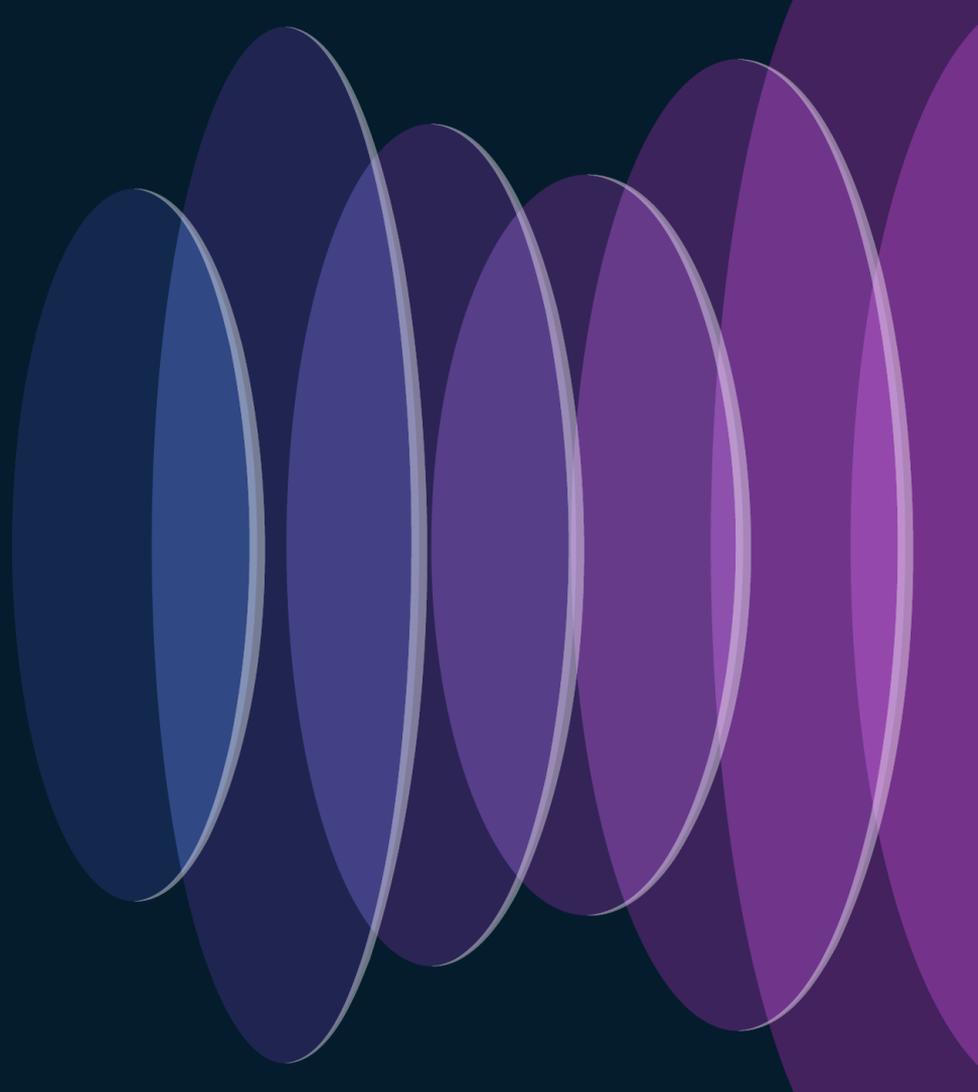
# Remote Sensor Package Details

- 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



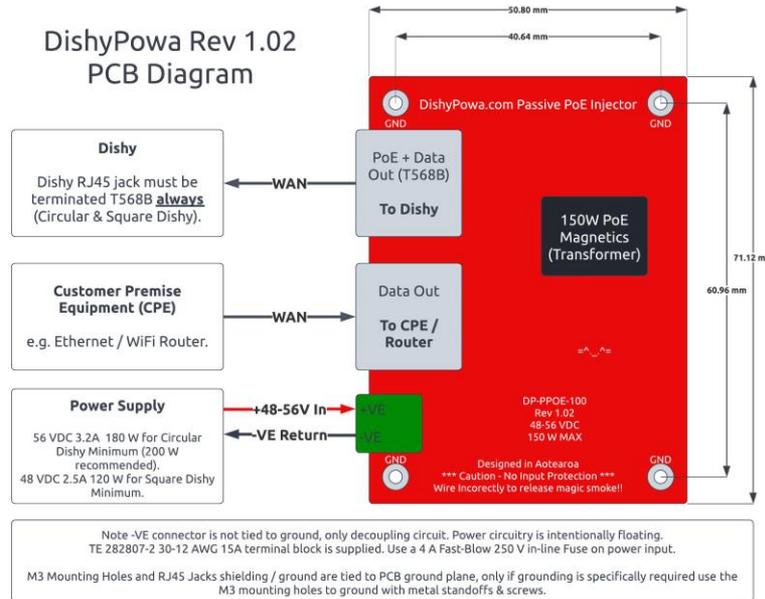


# Disclaimer

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

\$17.99

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

\$299.99

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

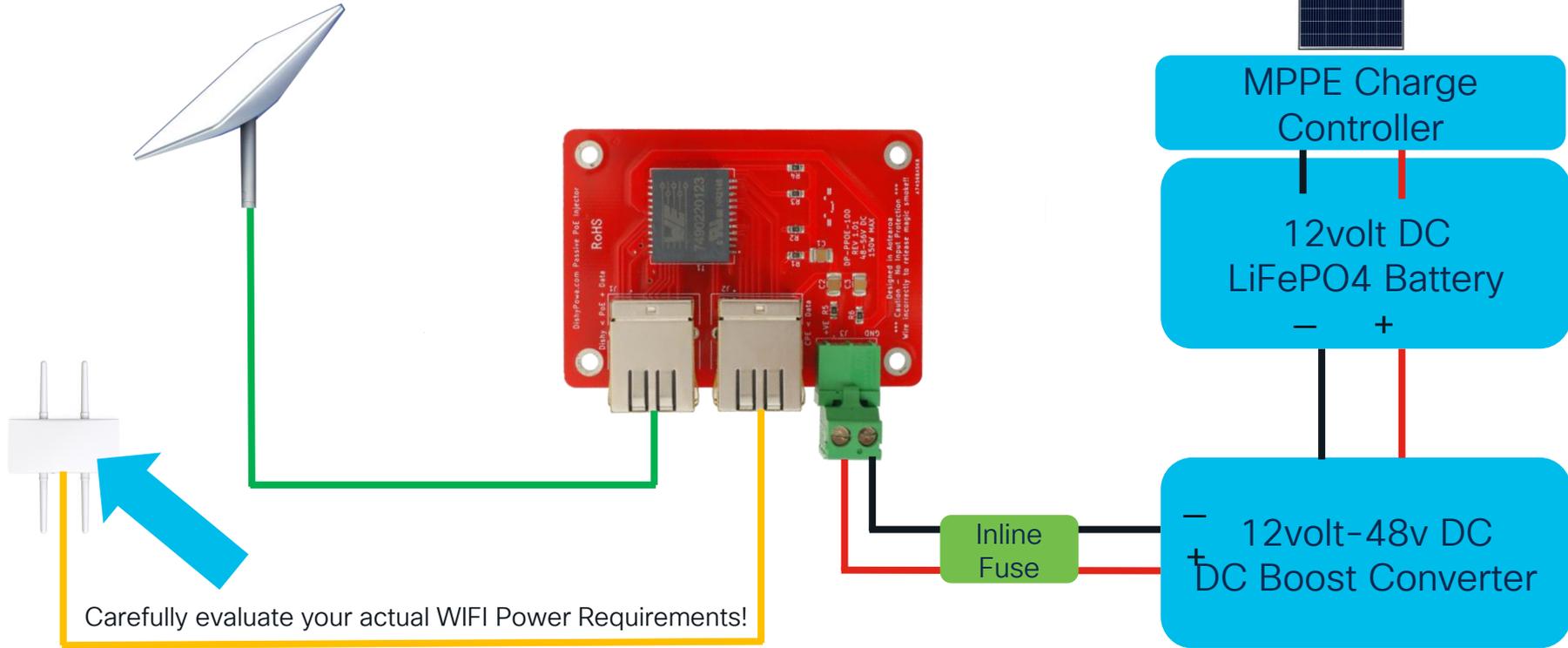
Size: 12V100Ah

12V50Ah \$179.98	12V100Ah <b>\$299.99</b>
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



100-200w Panel

MPPE Charge Controller

12v DC LiFePO4 Battery

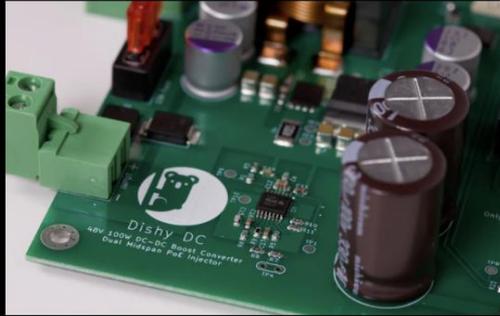
12v-48v DC DC Boost Converter

Carefully evaluate your actual WIFI Power Requirements!

Minimum 120watts

# Dishy Dualie Products

Filter: Availability ▾



Dishy Dualie DC Power Supply

\$148.00 AUD



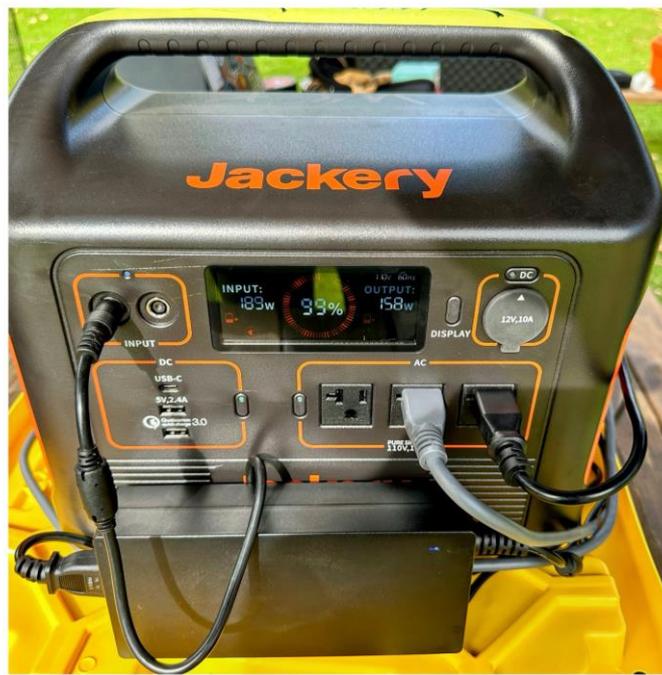
Dishy Dualie DC Enclosure

\$68.00 AUD

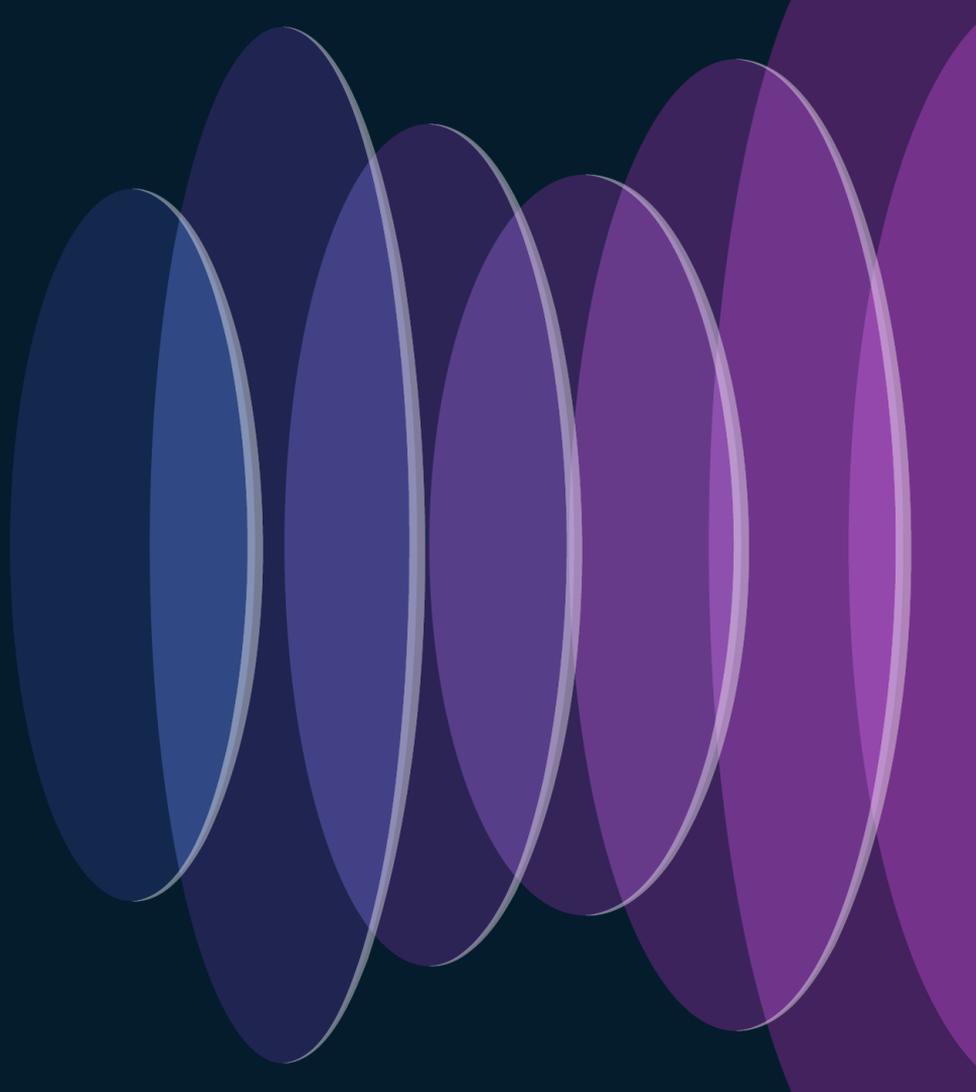
# Cisco Crisis Response Deployment to Maui

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

*cisco Live!*



# SOLAR POWER (last year)





### ADVANCED SPEED TEST



WIFI SPEED  
IPHONE TO WIFI ROUTER

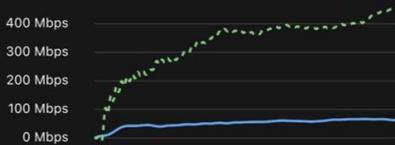
# 499 Mbps

388 Mbps Upload

STARLINK SPEED  
ROUTER TO INTERNET

# 64 Mbps

4.4 Mbps Upload



400 Mbps  
300 Mbps  
200 Mbps  
100 Mbps  
0 Mbps

WiFi Download - - - Starlink Download —

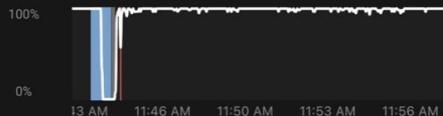
9F8E4566

### 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 ⓘ

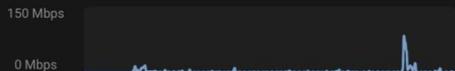
#### LATENCY ⓘ

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.

#### UPTIME ⓘ

#### OUTAGES

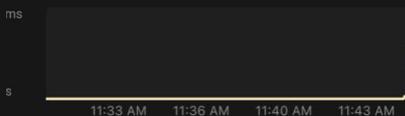


Last 2 minutes:

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

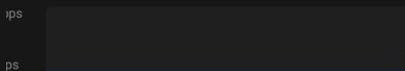
#### LATENCY ⓘ

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



#### THROUGHPUT ⓘ

#### SPEED TEST



EB3A2226002144201

Power off



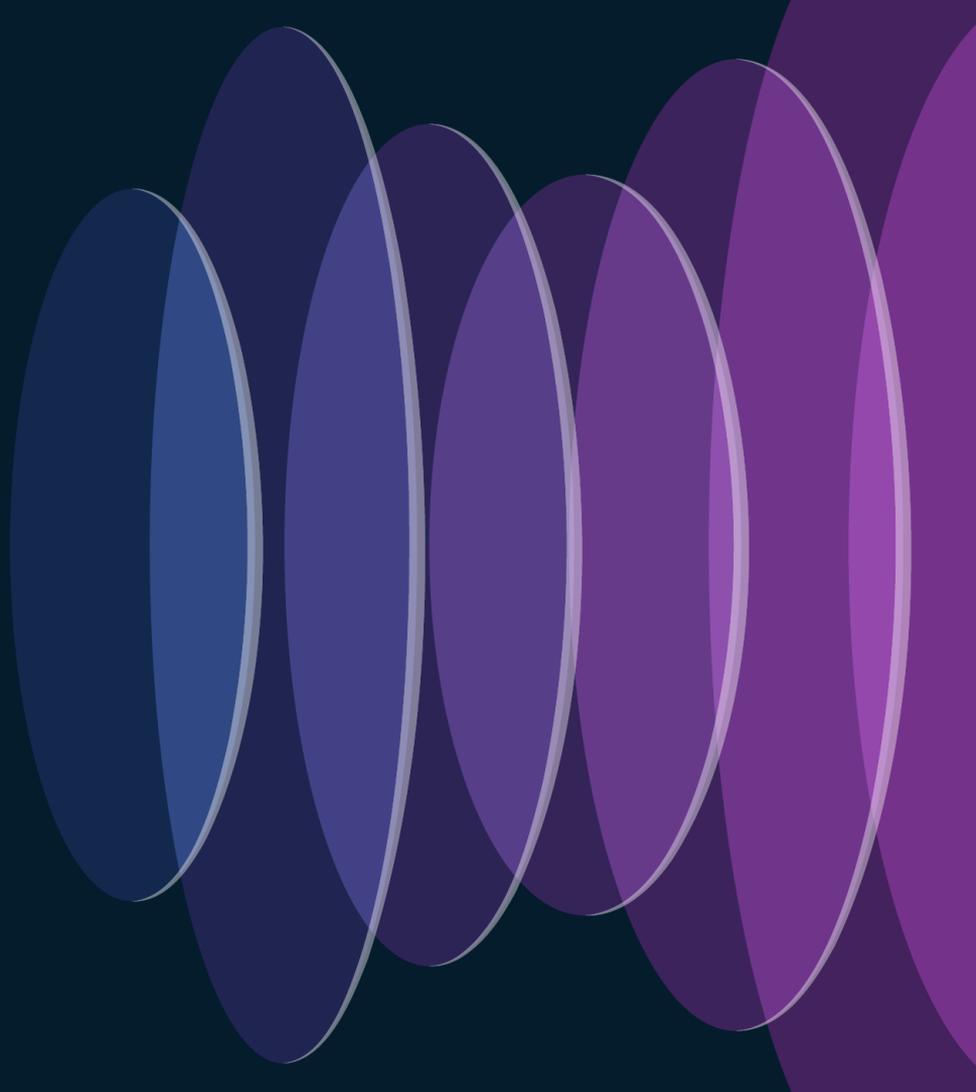
72%

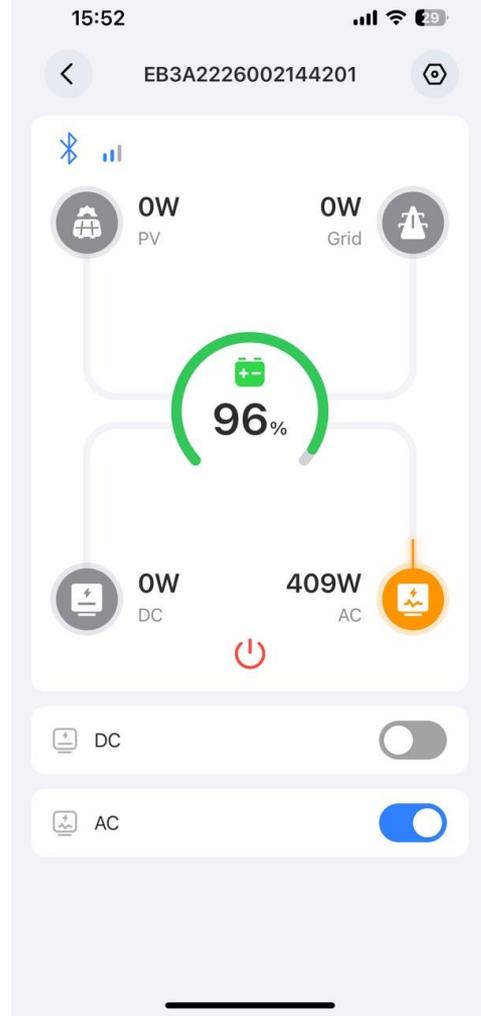


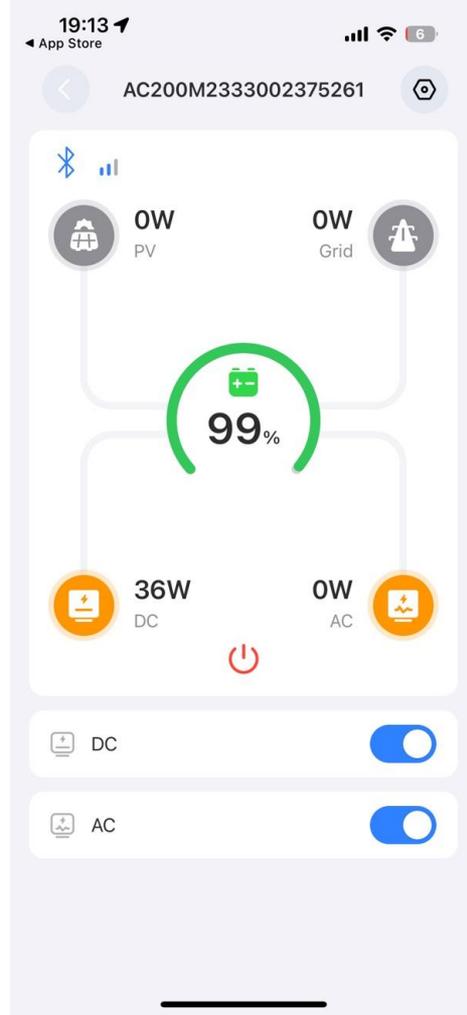
DC

AC

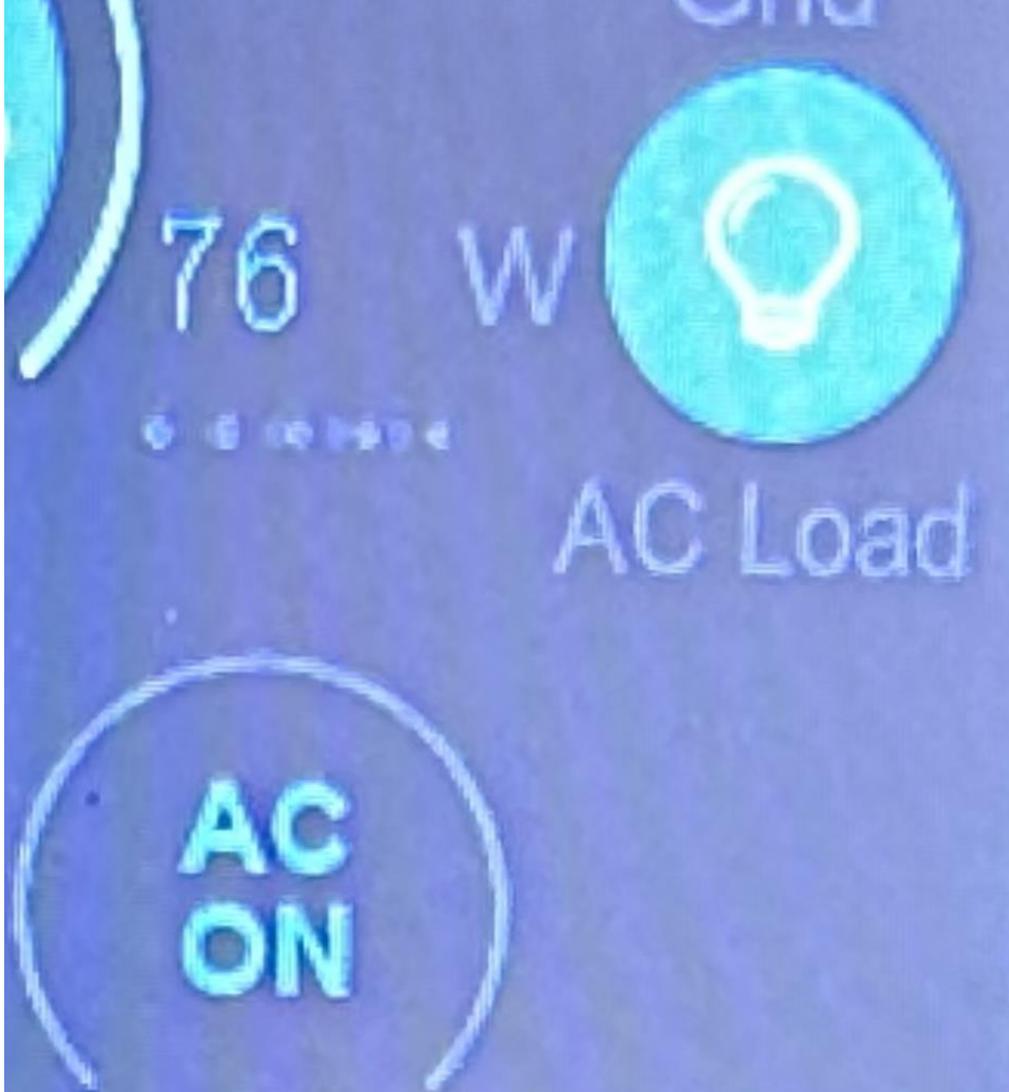
# SOLAR POWER (this year)











# 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

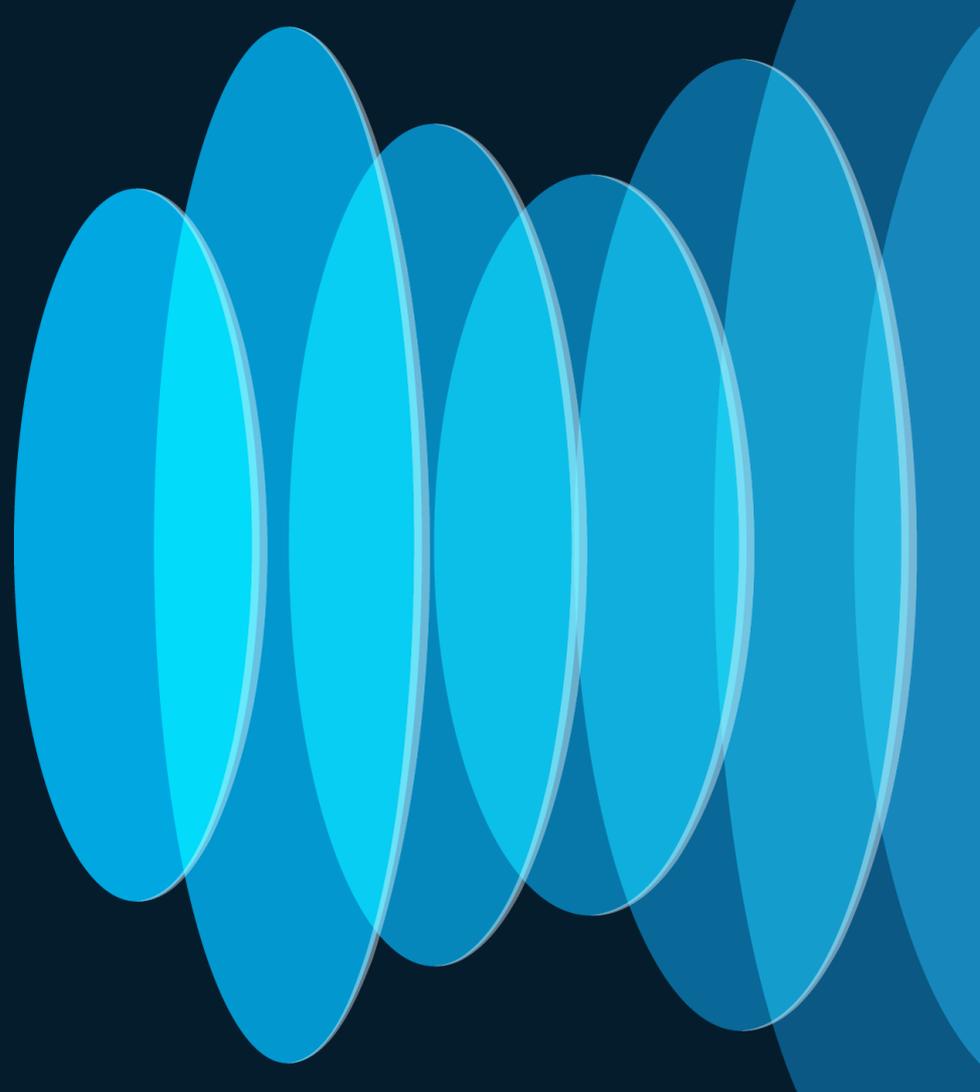
4

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.utermin.release',
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':
currently_obstructed': False, 'seconds_obstructed': None, 'obstruction_duration': None, 'obstruction_interval': None, 'direction_azimuth': 1.722228288650512
ise_floor': True}
status: {'id': 'ut01000000-00000000-0008d16e', 'hardware_version': 'rev3_proto2', 'software_version': 'f562e306-0cd5-44c2-9058-9ab6800c4b50.utermin.release',
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':
currently_obstructed': False, 'seconds_obstructed': None, 'obstruction_duration': None, 'obstruction_interval': None, 'direction_azimuth': 1.747515082359314
e_floor': True}
status: {'id': 'ut01000000-00000000-0008d16e', 'hardware_version': 'rev3_proto2', 'software_version': 'f562e306-0cd5-44c2-9058-9ab6800c4b50.utermin.release',
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':
currently_obstructed': False, 'seconds_obstructed': None, 'obstruction_duration': None, 'obstruction_interval': None, 'direction_azimuth': 1.886579871177673
se_floor': True}
status: {'id': 'ut01000000-00000000-0008d16e', 'hardware_version': 'rev3_proto2', 'software_version': 'f562e306-0cd5-44c2-9058-9ab6800c4b50.utermin.release',
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':
'currently_obstructed': False, 'seconds_obstructed': None, 'obstruction_duration': None, 'obstruction_interval': None, 'direction_azimuth': 1.84504163265228
ise_floor': True}
status: {'id': 'ut01000000-00000000-0008d16e', 'hardware_version': 'rev3_proto2', 'software_version': 'f562e306-0cd5-44c2-9058-9ab6800c4b50.utermin.release',
to_first_nonempty_slot': 0.0, 'pop_ping_drop_rate': 0.0, 'downlink_throughput_bps': 2781602.25, 'uplink_throughput_bps': 454972.9375, 'pop_ping_latency_ms':
'currently_obstructed': False, 'seconds_obstructed': None, 'obstruction_duration': None, 'obstruction_interval': None, 'direction_azimuth': 1.78820550441741
oise_floor': True}
status: {'id': 'ut01000000-00000000-0008d16e', 'hardware_version': 'rev3_proto2', 'software_version': 'f562e306-0cd5-44c2-9058-9ab6800c4b50.utermin.release',
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':
'currently_obstructed': False, 'seconds_obstructed': None, 'obstruction_duration': None, 'obstruction_interval': None, 'direction_azimuth': 2.0890917778015
oise_floor': True}
status: {'id': 'ut01000000-00000000-0008d16e', 'hardware_version': 'rev3_proto2', 'software_version': 'f562e306-0cd5-44c2-9058-9ab6800c4b50.utermin.release',
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':
bstructed': False, 'seconds_obstructed': None, 'obstruction_duration': None, 'obstruction_interval': None, 'direction_azimuth': 2.058941125869751, 'directio
rue)}
status: {'id': 'ut01000000-00000000-0008d16e', 'hardware_version': 'rev3_proto2', 'software_version': 'f562e306-0cd5-44c2-9058-9ab6800c4b50.utermin.release',
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'
'currently_obstructed': False, 'seconds_obstructed': None, 'obstruction_duration': None, 'obstruction_interval': None, 'direction_azimuth': 2.2009549140930
oise_floor': True}
status: {'id': 'ut01000000-00000000-0008d16e', 'hardware_version': 'rev3_proto2', 'software_version': 'f562e306-0cd5-44c2-9058-9ab6800c4b50.utermin.release',
to_first_nonempty_slot': 0.0, 'pop_ping_drop_rate': 0.0, 'downlink_throughput_bps': 2885577.0, 'uplink_throughput_bps': 485163.53125, 'pop_ping_latency_ms':
```

# Docker Tools Repository

The screenshot shows the Docker Desktop interface. The top navigation bar includes 'Docker Desktop', 'Upgrade plan', a search bar, and the user profile 'abenhase'. The left sidebar contains navigation options: Containers, Images, Volumes, Dev Environments (BETA), Extensions (BETA), and Add Extensions. The main content area is titled 'Images' and includes a 'Give feedback' link. Below the title, there is a description: 'An image is a read-only template with instructions for creating a Docker container. [Learn more](#)'. There are two tabs: 'LOCAL' (selected) and 'REMOTE REPOSITORIES'. A progress bar shows '5.09 GB / 7.27 GB in use' and '26 images'. A search bar contains the text 'star'. Below the search bar is a table of Docker images with columns for NAME, TAG, STATUS, CREATED, SIZE, and ACTIONS. The table lists several images, including 'sponsianus/starlink-grpc-tools' and 'ghcr.io/sparky8512/starlink-grpc-tools'. The bottom status bar shows 'RAM 0.25GB', 'CPU 0.37%', 'Connected to Hub', and 'v4.14.1'.

**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

Search: star

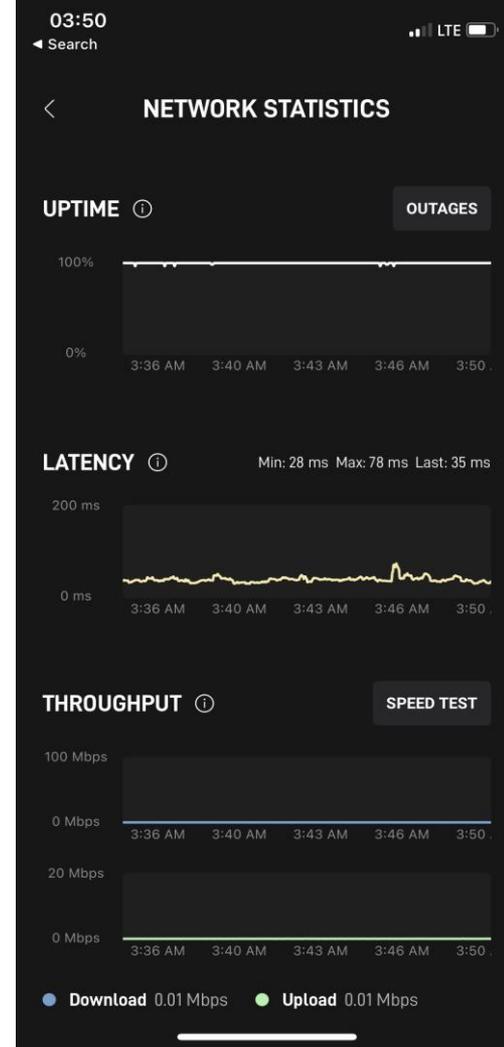
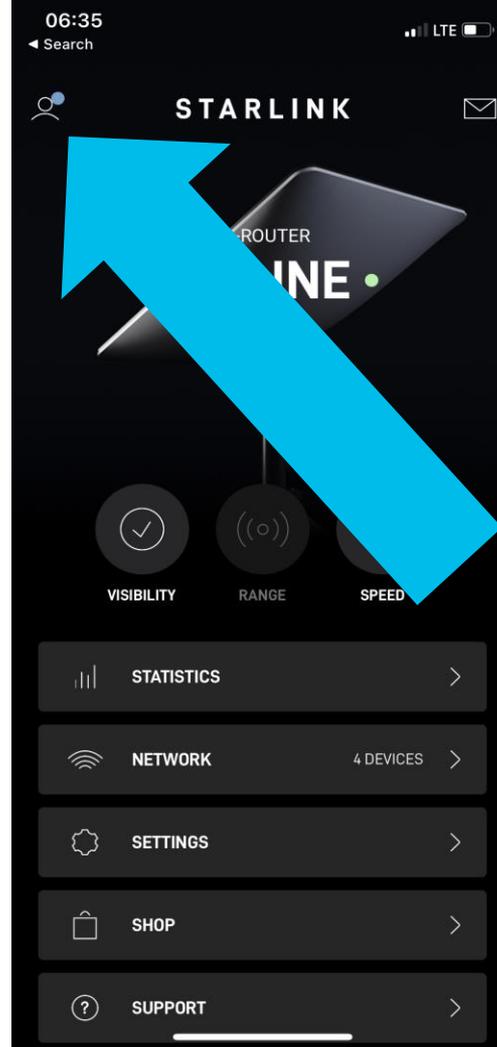
NAME	TAG	STATUS	CREATED	SIZE	ACTIONS
sponsianus/starlink-grpc-tools 330f096f73b1	latest	In use	8 days ago	961.64 MB	▶ ⋮ 🗑️
ghcr.io/sparky8512/starlink-grpc-tools 3221e3c4730e	latest	In use	26 days ago	960.32 MB	▶ ⋮ 🗑️
sponsianus/starlink-grpc-tools 9385172f655f	<none>	In use (dangling)	2 months ago	960.93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

Showing 8 items

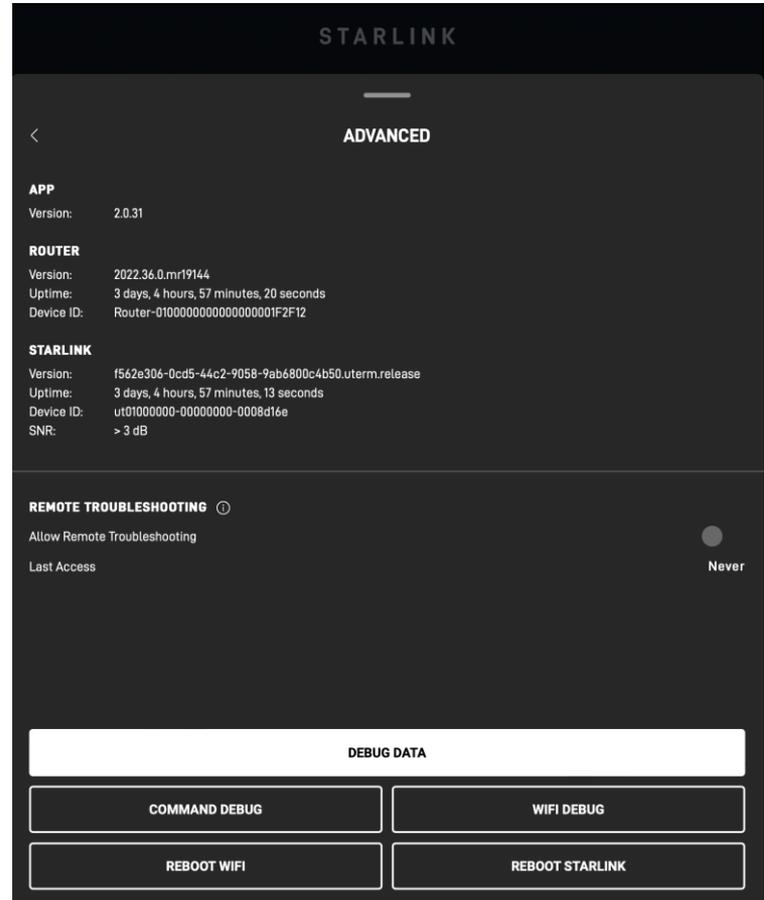
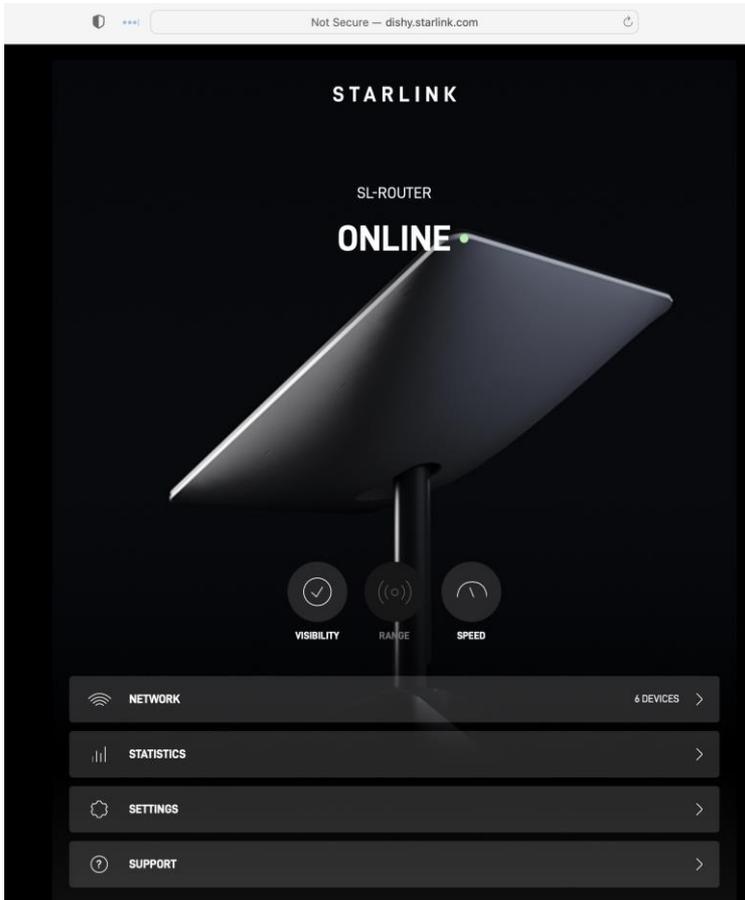
RAM 0.25GB CPU 0.37% Connected to Hub v4.14.1

# 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"
```

```
. • "isDev": false,  
  . • "bootcount": 129,  
  . • "antiRollbackVersion": 0,  
  . • "isHitl": false  
  . • },  
  . • "installPending": false,  
  . • "isHeating": false,  
  . • "powerSupplyThermalThrottle": false  
  . • },  
  . • "gpsStats": {
```

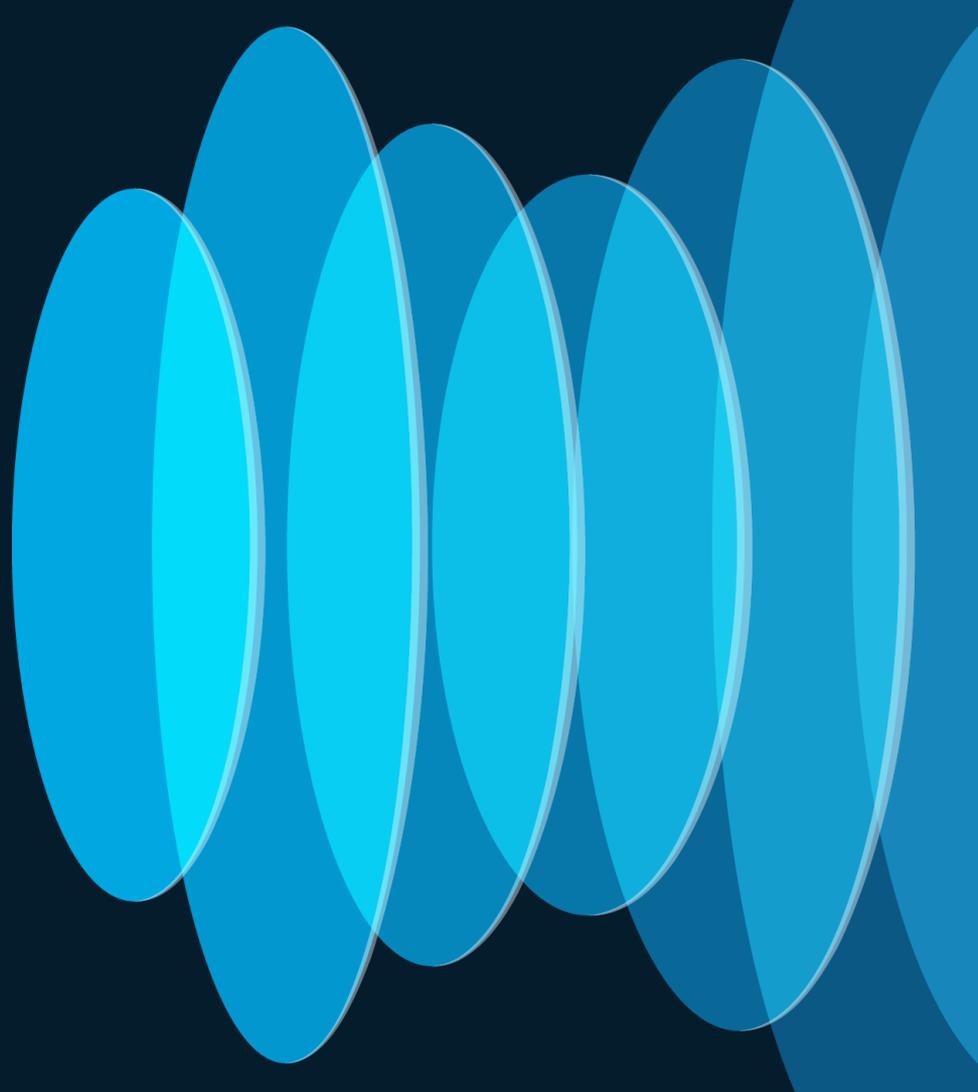
```
"gpsStats": {  
  "gpsValid": true,  
  "gpsSats": 16,
```

# 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

 1/1 healthy

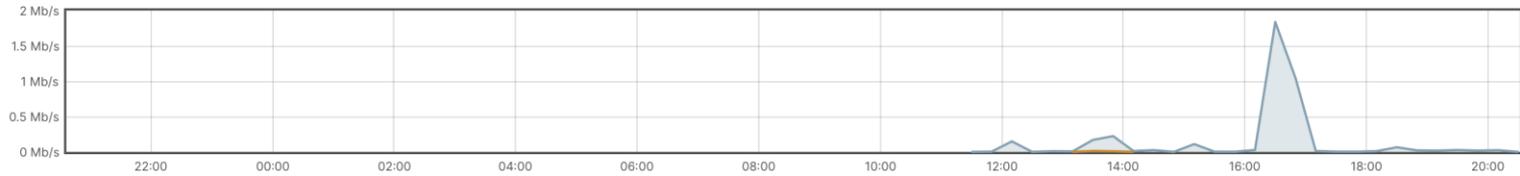
WAN APPLIANCES

 1/1 healthy

## Clients

all ▾ for the last day ▾

573 MB (↓ 528.9 MB, ↑ 44.1 MB)



Policy ▾

Search... ▾

6 clients

Add client

<input type="checkbox"/>	Status	Description	Last seen ▲	Usage	Client type, OS	IPv4 address	IPv6 address
<input type="checkbox"/>	📶	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
<input type="checkbox"/>	📶	ABENHASE-M-526H	Nov 30 14:02	53.2 MB	Other	192.168.50.181	fd11:1f5a:8f9a:16:cc9:3f77:d78a:c6a4
<input type="checkbox"/>	📶	Blink-Mini	Nov 30 14:02	100 KB	Other	192.168.50.4	
<input type="checkbox"/>	📶	Blink-Mini	Nov 30 14:02	95 KB	Other	192.168.50.3	
<input type="checkbox"/>	📶	10:56:ca:84:bb:e0	Nov 30 16:45	9 KB	Other	192.168.50.1	
<input type="checkbox"/>	📶	ABENHASE-M-C02F	Nov 30 20:36	5171 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 1key

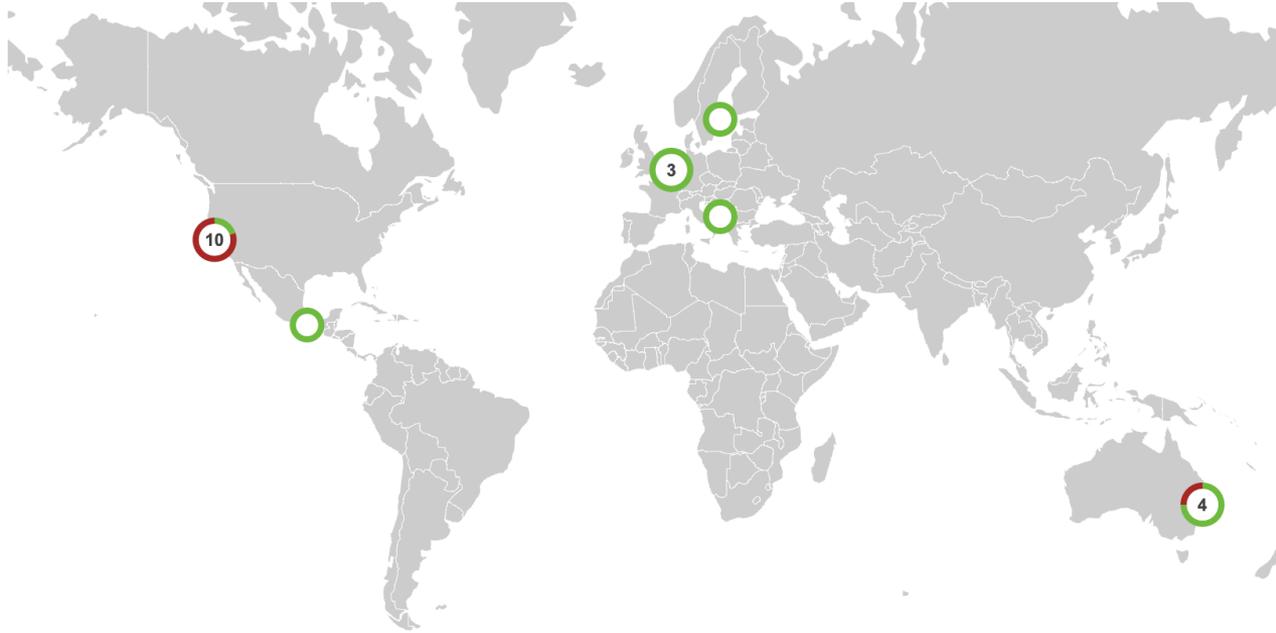
WAN health Last 2 hours View old version

0 Offline ✖ 0 Poor performance ! 0 High usage ! 2 Online ✓

Search 4 Status ISPs Uplinks [Reset all](#) 16 Results [Download](#)

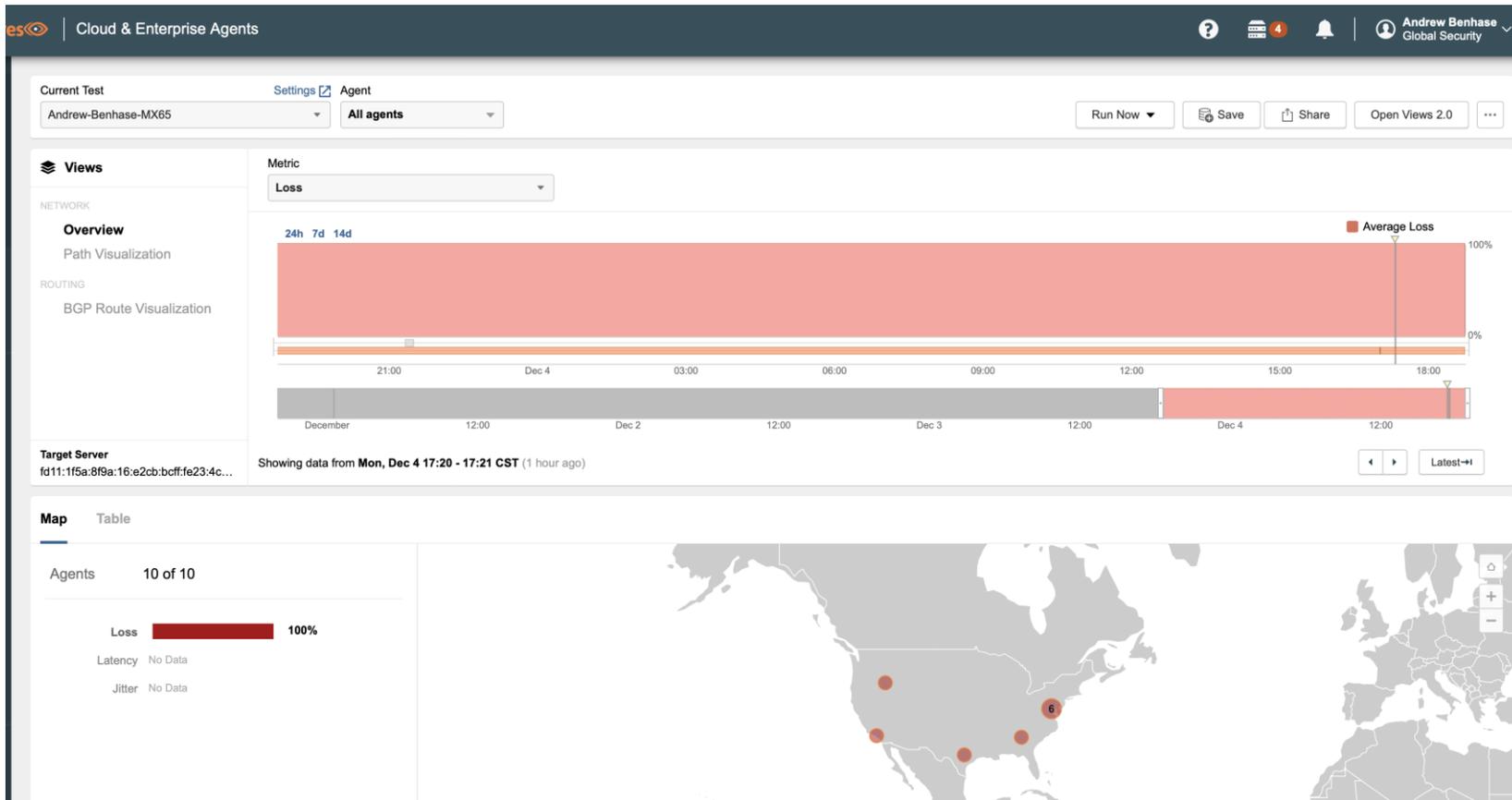
Status	Network	Type	ISP	Availability	Downtime	Total usage	Average throughput	Speed test <span>Beta</span>	Loss	
✓	<a href="#">MX95 Firewall</a>	WAN 1	starlinkisp.net	<div style="width: 100%; height: 10px; background-color: green;"></div>	0 s	↓ 64.49 MB, ↑ 30.97 MB	↓ 70.95 Kbps, ↑ 34.07 Kbps	<a href="#">Run speed test</a>	0.29%	
✓	<a href="#">Remote_Office</a>	WAN 1	starlinkisp.net	<div style="width: 100%; height: 10px; background-color: green;"></div>	3.4 mins	↓ 2.80 MB, ↑ 3.51 MB	↓ 3.06 Kbps, ↑ 3.83 Kbps	<a href="#">Run speed test</a>	0.48%	

Rows per page 10 < 1 >



Agent based Reporting for Thousand Eyes running Starlink across the Globe

# Agent to ICMP IPv6 not working



# IPv6 PD Renew Every 5 Minutes

## Event log

Client:  Before:   (EST)

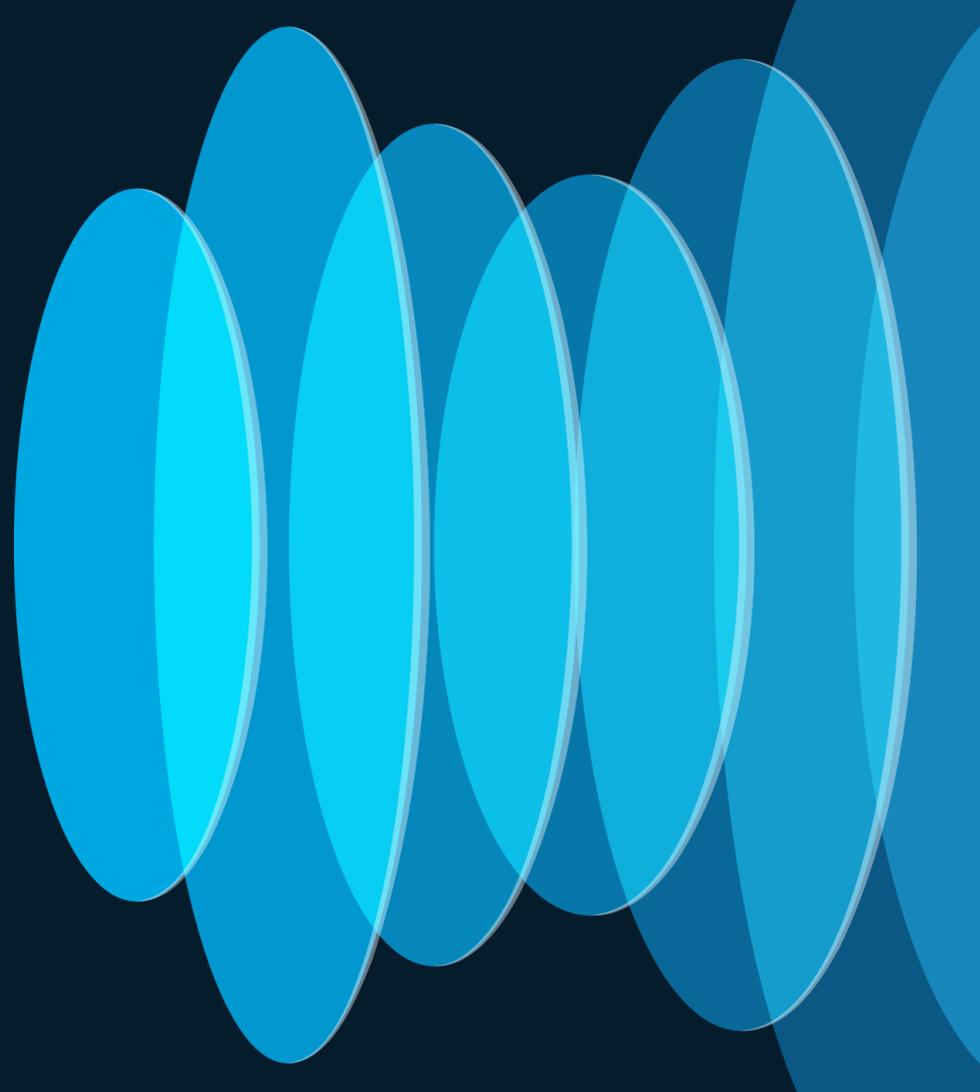
Event type include:  Event type ignore:

[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 <a href="#">more »</a>
Nov 30 21:48:52		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 600, ValidLifetime: 1200 <a href="#">more »</a>
Nov 30 21:43:53		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 599, ValidLifetime: 1199 <a href="#">more »</a>
Nov 30 21:43:53		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 599, ValidLifetime: 1199 <a href="#">more »</a>
Nov 30 21:38:54		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 598, ValidLifetime: 1198 <a href="#">more »</a>
Nov 30 21:38:54		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 598, ValidLifetime: 1198 <a href="#">more »</a>
Nov 30 21:33:55		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 597, ValidLifetime: 1197 <a href="#">more »</a>
Nov 30 21:33:55		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 597, ValidLifetime: 1197 <a href="#">more »</a>
Nov 30 21:28:57		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 595, ValidLifetime: 1195 <a href="#">more »</a>
Nov 30 21:28:57		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 595, ValidLifetime: 1195 <a href="#">more »</a>
Nov 30 21:24:01		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 590, ValidLifetime: 1190 <a href="#">more »</a>
Nov 30 21:24:01		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 590, ValidLifetime: 1190 <a href="#">more »</a>
Nov 30 21:19:11		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 581, ValidLifetime: 1181 <a href="#">more »</a>
Nov 30 21:19:11		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 581, ValidLifetime: 1181 <a href="#">more »</a>
Nov 30 21:14:30		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 562, ValidLifetime: 1162 <a href="#">more »</a>
Nov 30 21:14:30		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 562, ValidLifetime: 1162 <a href="#">more »</a>
Nov 30 21:10:06		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 526, ValidLifetime: 1126 <a href="#">more »</a>
Nov 30 21:10:06		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 526, ValidLifetime: 1126 <a href="#">more »</a>
Nov 30 21:06:21		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 449, ValidLifetime: 1049 <a href="#">more »</a>
Nov 30 21:06:21		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 449, ValidLifetime: 1049 <a href="#">more »</a>
Nov 30 21:03:51		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 300, ValidLifetime: 900 <a href="#">more »</a>
Nov 30 21:03:51		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 300, ValidLifetime: 900 <a href="#">more »</a>
Nov 30 20:58:52		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 599, ValidLifetime: 1199 <a href="#">more »</a>
Nov 30 20:58:52		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 599, ValidLifetime: 1199 <a href="#">more »</a>
Nov 30 20:53:52		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 599, ValidLifetime: 1199 <a href="#">more »</a>
Nov 30 20:53:52		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 599, ValidLifetime: 1199 <a href="#">more »</a>
Nov 30 20:48:51		DHCPv6	DHCPv6-NA Renew successful	Address: 2605:59c8:6087:3a10::d0b, PreferredLifetime: 600, ValidLifetime: 1200 <a href="#">more »</a>
Nov 30 20:48:51		DHCPv6	DHCPv6-PD Renew successful	Prefix: 2605:59c8:6087:3a14::/62, PreferredLifetime: 600, ValidLifetime: 1200 <a href="#">more »</a>

# SDWAN



CISCO *Live!*

## Devices



Devices

Certificates

Licensing

## FILTERED BY

Reachable · Up x

## SUMMARY

 Health

 Reachable

 Up

 Down

 Control Status

 Cloud Provider

Device Group All

Devices (5)

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
<a href="#">IR1833-tom</a>	IR1833	<a href="#">SITE_206202</a>	172.16.20.1	<span style="color: green;">✔</span>	<span style="color: green;">↑</span>	2 / 2	6 / 6	1 / 1	Dec 04, 2023 07:08 AM	<div style="width: 33.93%;"></div> 33.93%	...
<a href="#">StarlinkPOC-1121X</a>	C1121X-8P	<a href="#">SITE_303303</a>	172.16.250.200	<span style="color: green;">✔</span>	<span style="color: green;">↑</span>	2 / 2	6 / 6	1 / 1	Nov 15, 2023 06:43 AM	<div style="width: 6.24%;"></div> 6.24%	...
<a href="#">Starlink-WASH-8300-1</a>	C8300-1N1S-4T2X	<a href="#">SITE_303302</a>	172.16.250.199	<span style="color: orange;">⚠</span>	<span style="color: green;">↑</span>	2 / 2	5 / 6	1 / 1	Dec 02, 2023 04:30 AM	<div style="width: 11.97%;"></div> 11.97%	...
<a href="#">C8300-RTP6-SL-1</a>	C8300-1N1S-6T	<a href="#">SITE_206250</a>	172.16.1.1	<span style="color: orange;">⚠</span>	<span style="color: green;">↑</span>	4 / 4	6 / 8	2 / 2	Nov 16, 2023 08:23 AM	<div style="width: 8.22%;"></div> 8.22%	...
<a href="#">C8300-RTP6-SL-2</a>	C8300-1N1S-6T	<a href="#">SITE_206250</a>	172.16.1.2	<span style="color: orange;">⚠</span>	<span style="color: green;">↑</span>	2 / 4	3 / 4	1 / 2	Nov 15, 2023 04:26 AM	<div style="width: 8.25%;"></div> 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

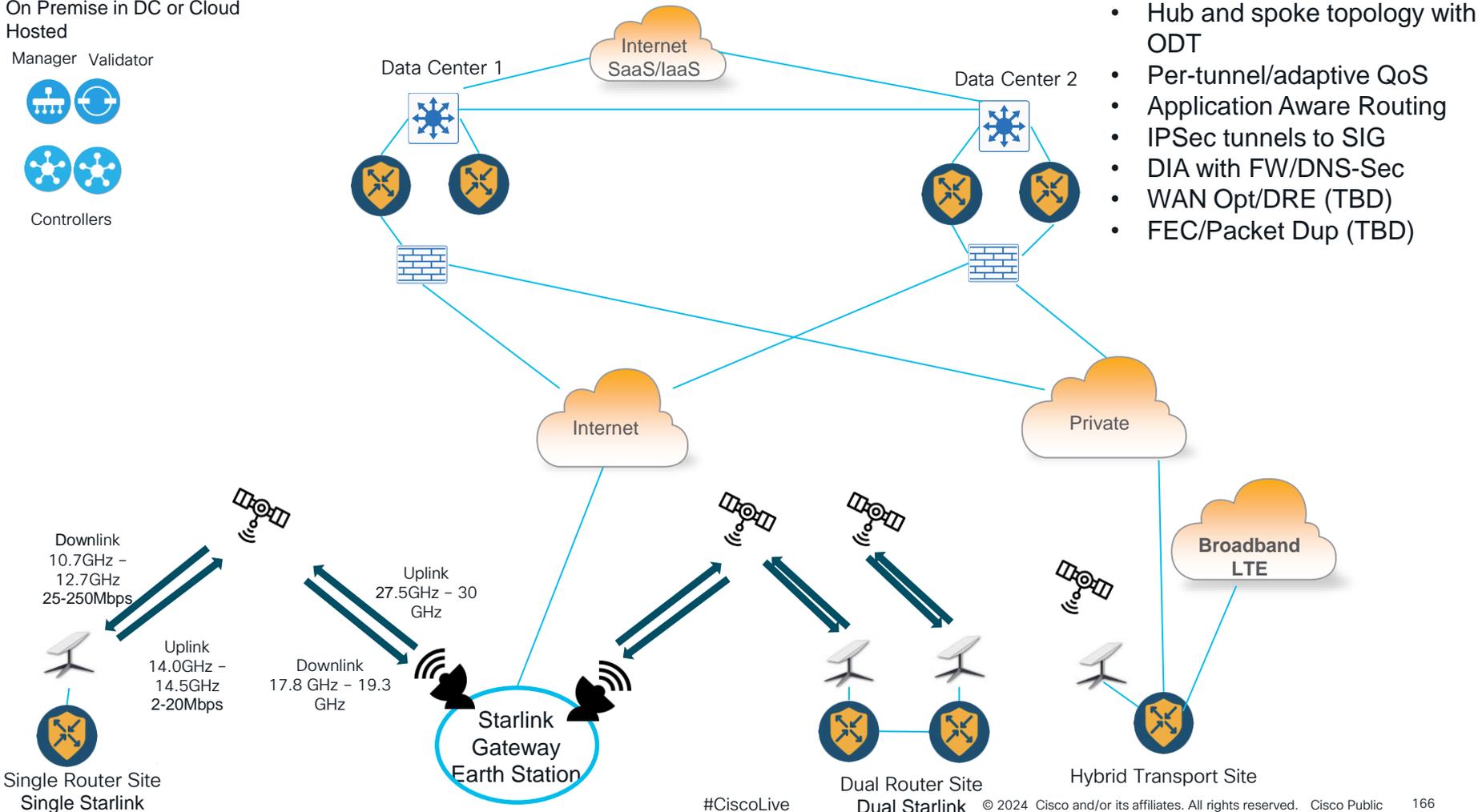
Catalyst SD-WAN Controllers  
On Premise in DC or Cloud  
Hosted

Manager Validator



Controllers

# Starlink Reference Architecture



## 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	<a href="#">Add Tag</a> ▼	No	Unmanaged
C8300-1N1S-4T2X-FLM272112RA	SITE_206202	C8300-TOM-SL	<a href="#">Add Tag</a> ▼	Yes	Template Starlink-8300-1N1S-4T2X-Tom-Zs
C8300-1N1S-4T2X-FLM272112R8	SITE_303302	Starlink-WASH-8300-1	<a href="#">Add Tag</a> ▼	Yes	Template Starlink-8300-1N1S-4T2X-Tom-Zs
ISR1100-6G-FGL2347L5EX	-	-	<a href="#">Add Tag</a> ▼	No	Unmanaged
C8500L-8S4X-FLX26030880	SITE_300	Router	<a href="#">Add Tag</a> ▼	Yes	Template 8500L-RTP6-Hub1
C1101-4PLTEP-FGL2321113A	-	-	<a href="#">Add Tag</a> ▼	No	Unmanaged
C1101-4PLTEPWB-FGL232613MD	-	-	<a href="#">Add Tag</a> ▼	No	Unmanaged
IR1833-K9-FCW2711Y52G	SITE_206202	IR1833-tom	<a href="#">Add Tag</a> ▼	No	Unmanaged
C8300-1N1S-6T-FLM272112HR	SITE_206250	C8300-RTP6-SL-1	<a href="#">Add Tag</a> ▼	Yes	Template Starlink-8300-1N1S-6T-TLOCEXT
C8300-1N1S-6T-FLM272112J0	SITE_206250	C8300-RTP6-SL-2	<a href="#">Add Tag</a> ▼	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.

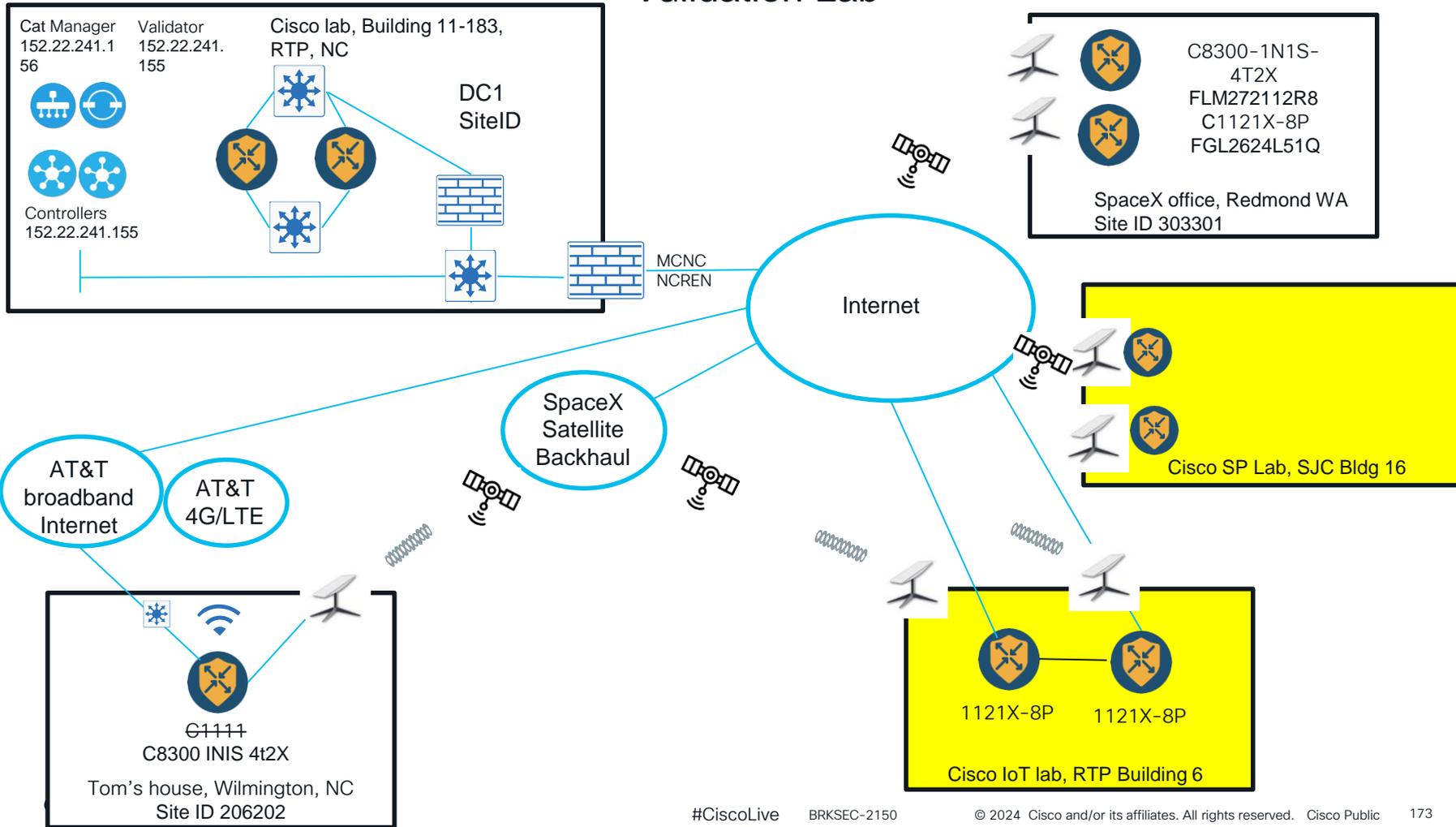
OMP Hello tuning: Reduce Hello-interval to further optimize bandwidth

```
sdwan
```

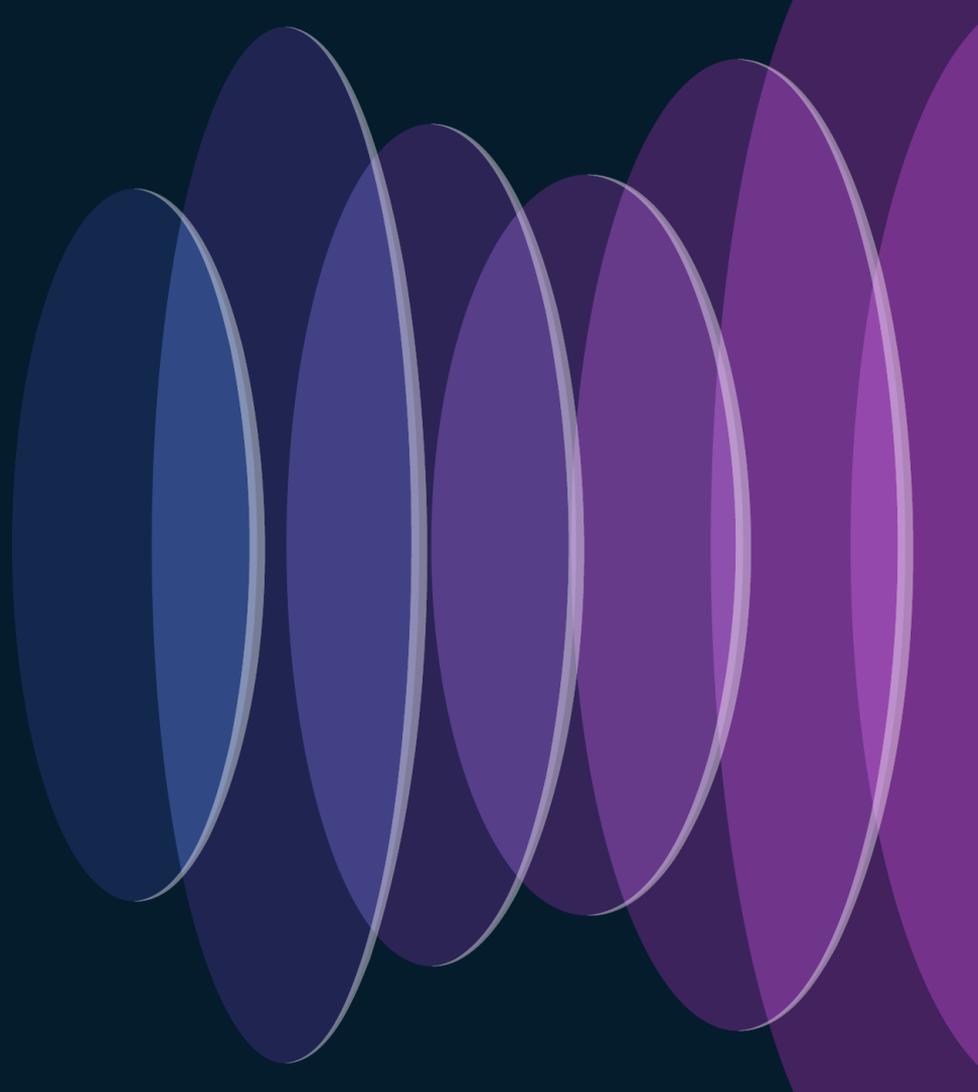
```
interface GigabitEthernet 0/1/0
Description connected to Starlink
tunnel-interface
encapsulation ipsec weight 1
no border
color
no last-resort-circuit
```

```
low-bandwidth-link
hello-interval 6000
hello-tolerance 600
vmanage-connection-preference 1
```

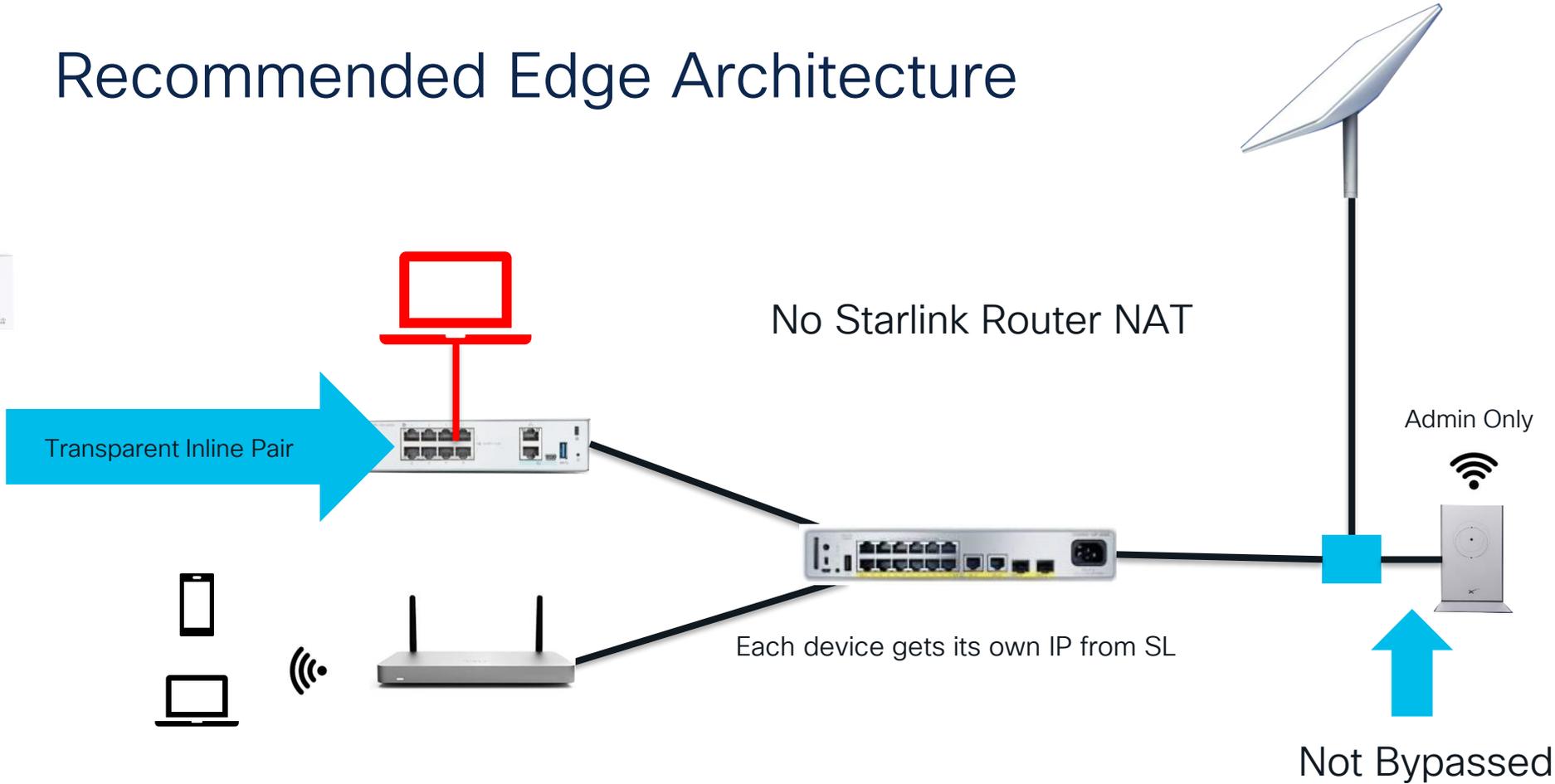
# Validation Lab



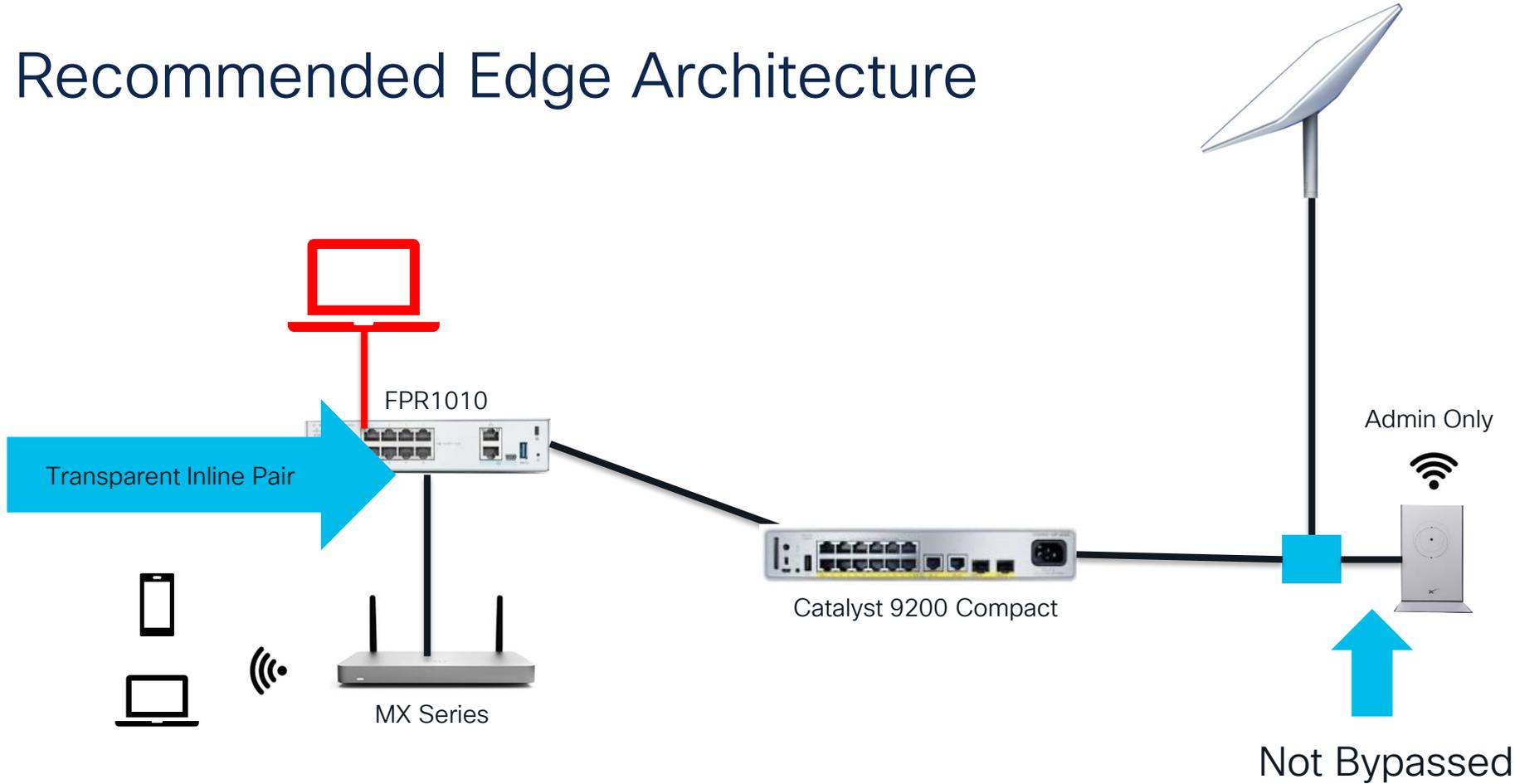
# Ground/Space Architectures



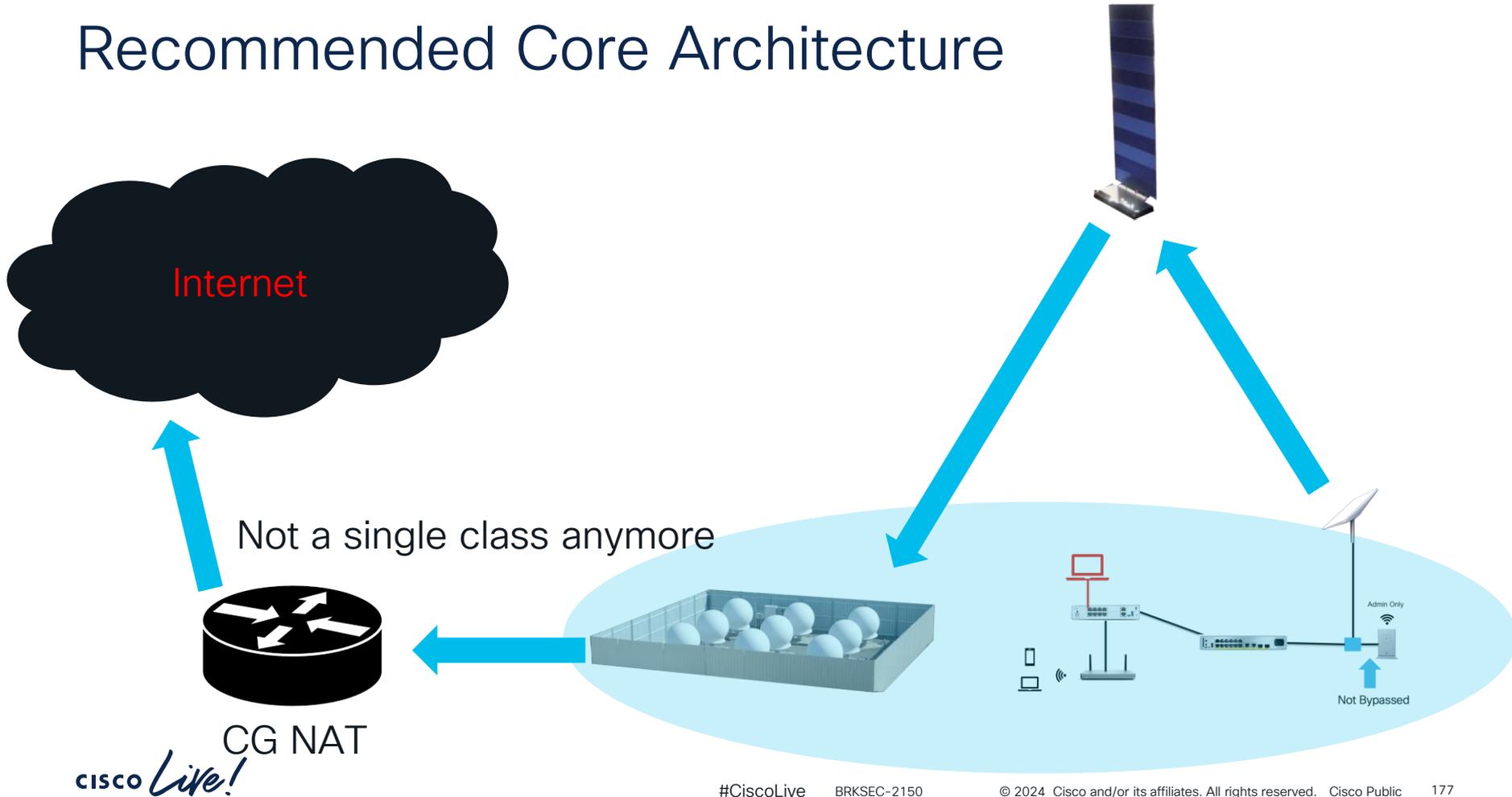
# Recommended Edge Architecture



# Recommended Edge Architecture

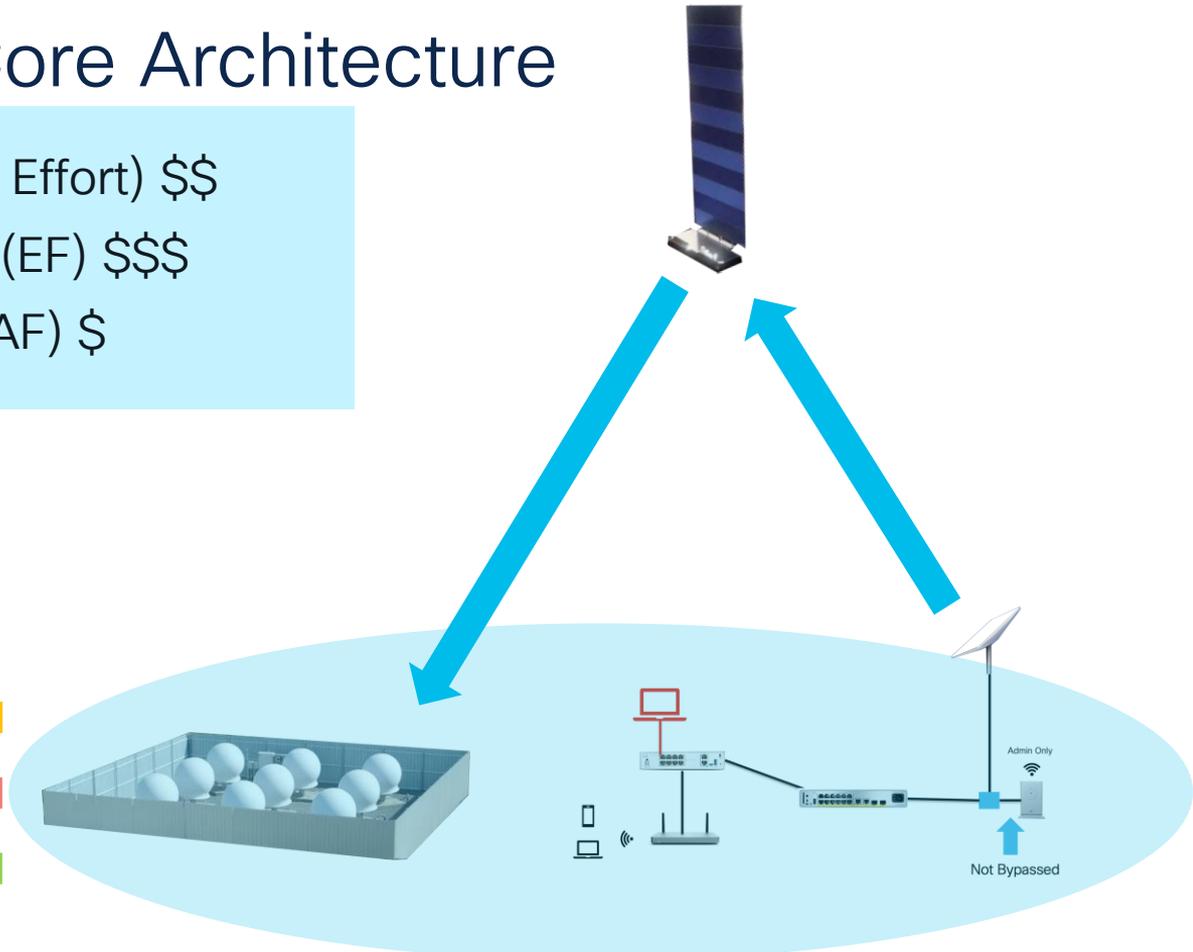
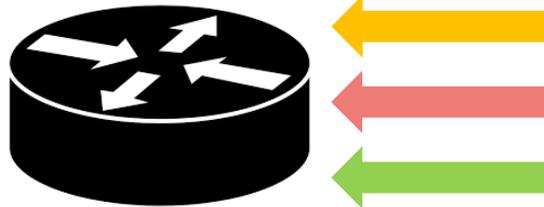


# Recommended Core Architecture

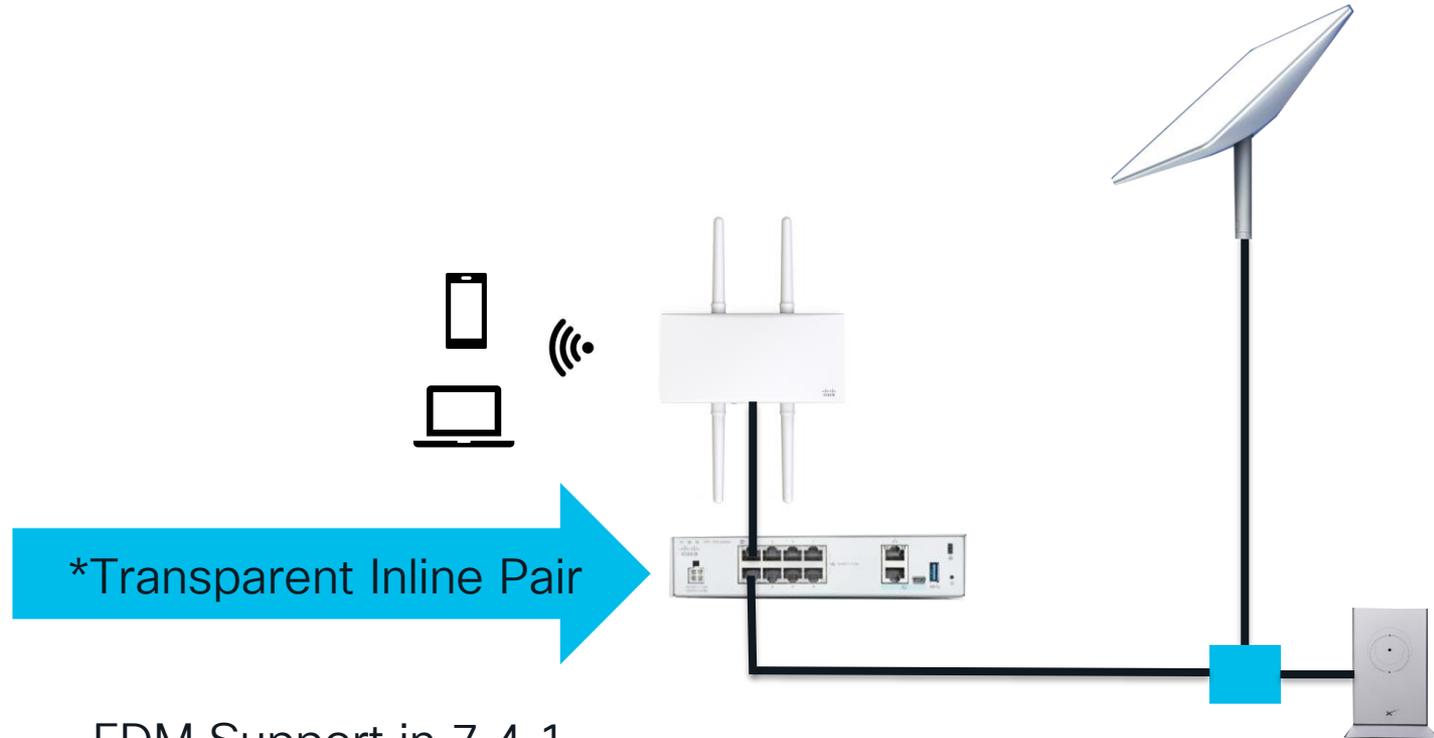


# Recommended Core Architecture

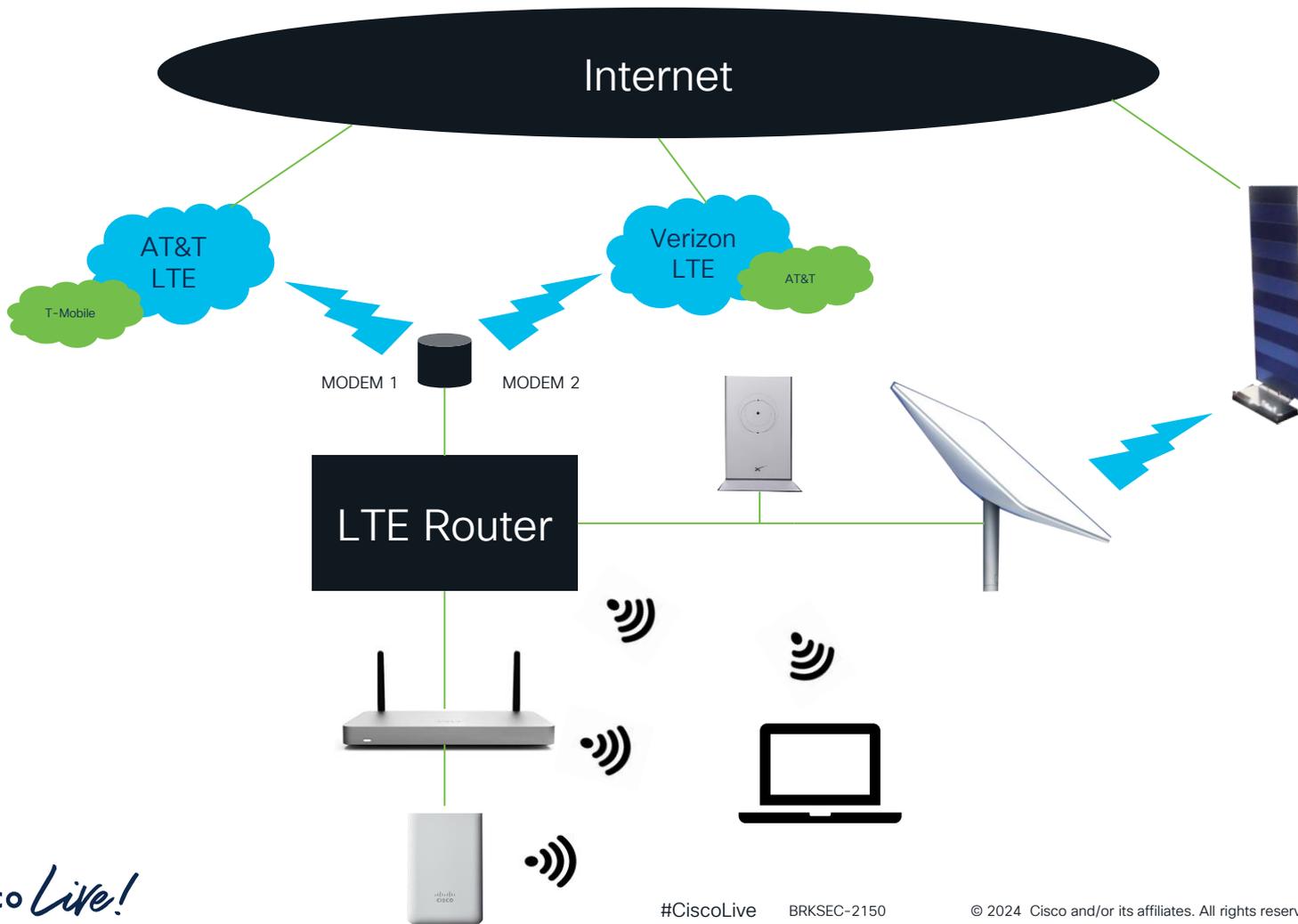
- ← Mobile (Best Effort) \$\$
- ← Priority Data (EF) \$\$\$
- ← Residential (AF) \$



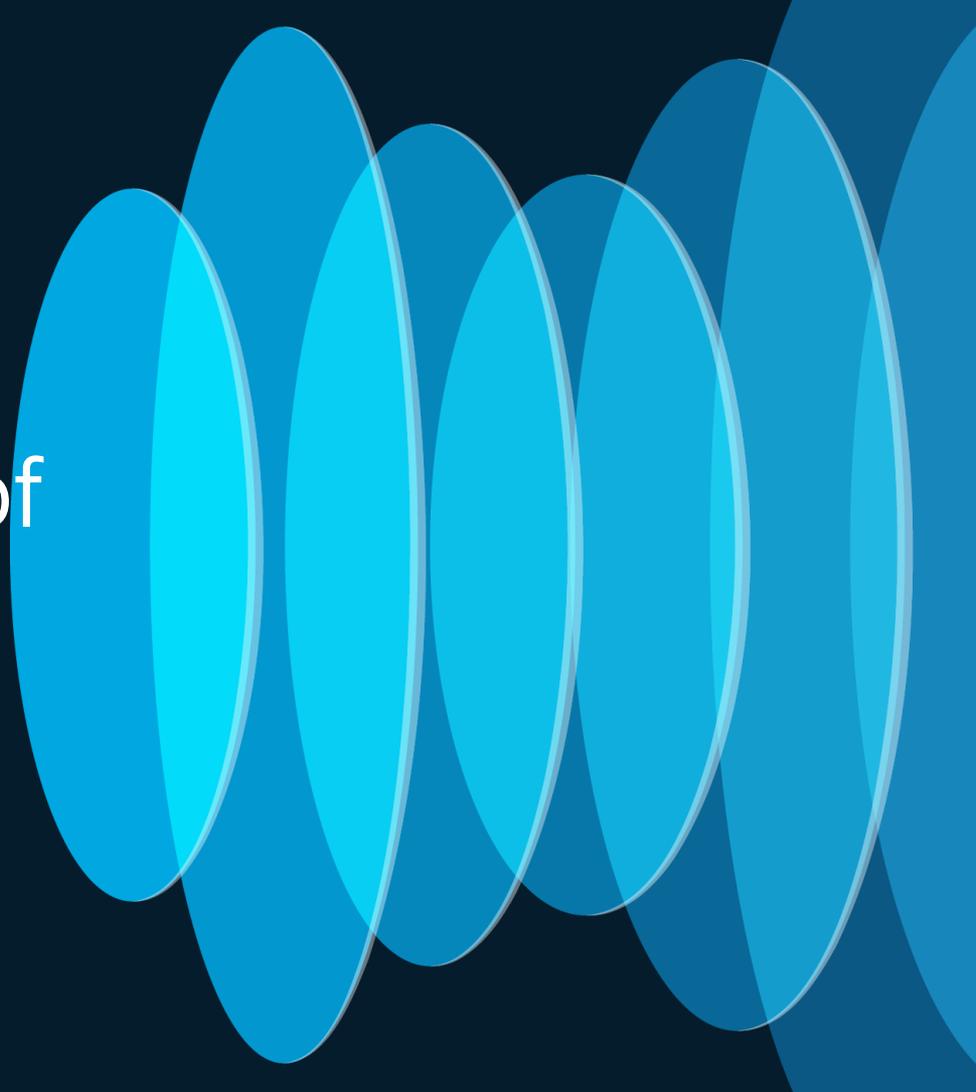
# Recommended Architecture

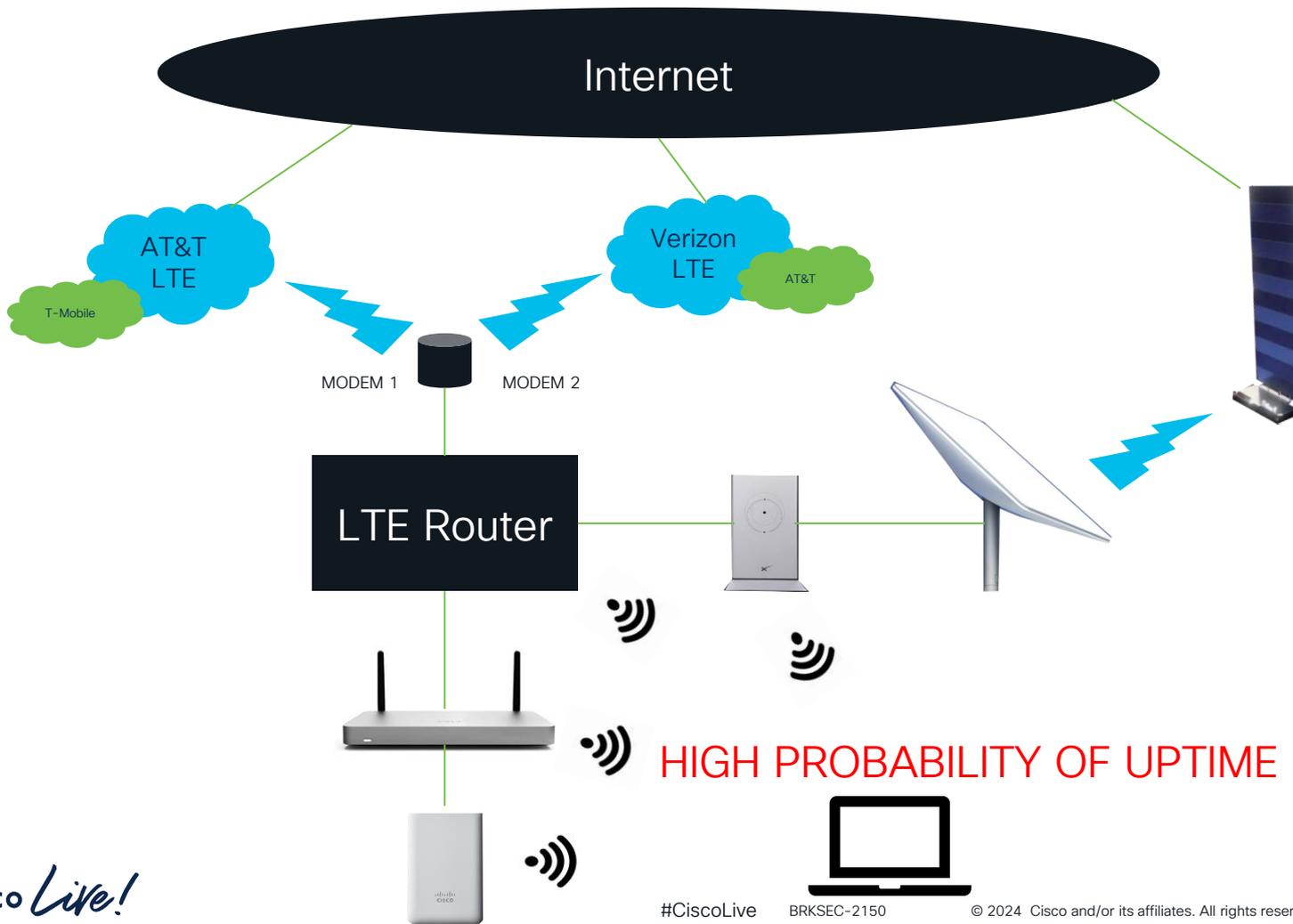


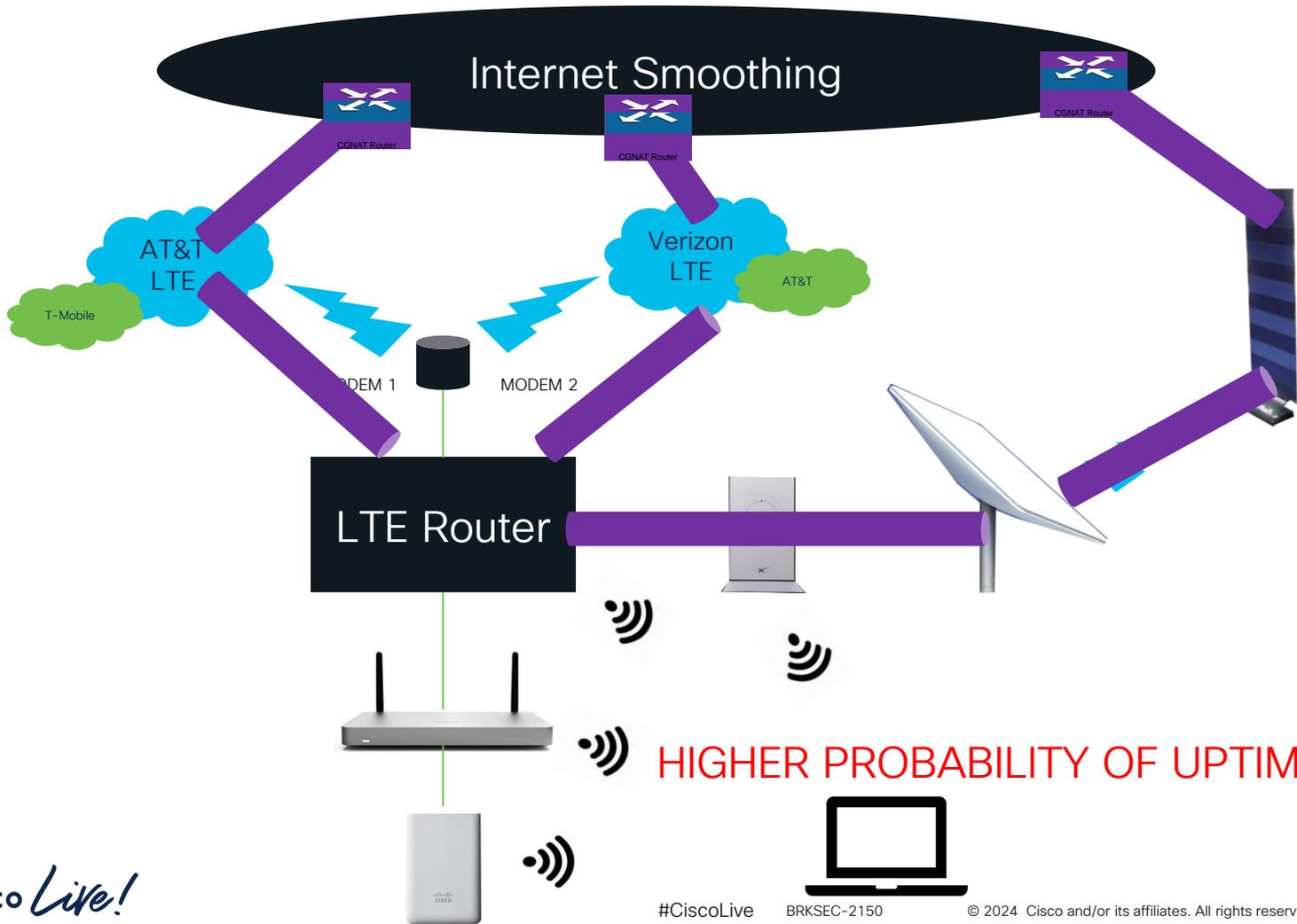
FDM Support in 7.4.1



# Highest Probability of Network Uptime



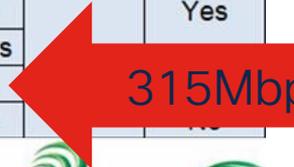




# LTE Cat 7/14 or 5G Cat 20 Modem?

- Great question – do you think you can compare on a consistent basis?
- If not, I would opt for LTE based
- With WAN Smoothing technology, the performance impacts are largely minimized

Downlink			Uplink			
DL UE Categor	Max data rate in Mbps	DL MIMO	DL UE Categor	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	
6	~300 Mbps		5	~75 Mbps		
7	~300 Mbps	2 or 4	7	~100 Mbps	No	
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	No	Yes
15	~800 Mbps	2 or 4	18	~210 Mbps		
16	~1050 Mbps		19	~13500 Mbps		
17	~25000 Mbps	8	20	~315 Mbps		
18	~1200 Mbps	2, 4 or 8	21	~300 Mbps	No	
19	~1600 Mbps					
20	~2000 Mbps					
21	~1400 Mbps	2 or 4				



# When Starlink goes down for 20 minutes





# Please Fill Out The Survey!



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---



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Contact me at: [abenhase@cisco.com](mailto:abenhase@cisco.com)



The bridge to possible

# Thank you

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# Bonus Material: Local Launch Pictures from Melbourne (Florida)











