



The bridge to possible

Starlink Security Advanced

Andrew Benhase, Federal Architect
@CyberSecOps

BRKSEC-2150

CISCO *Live!*

#CiscoLive

Cisco Webex App

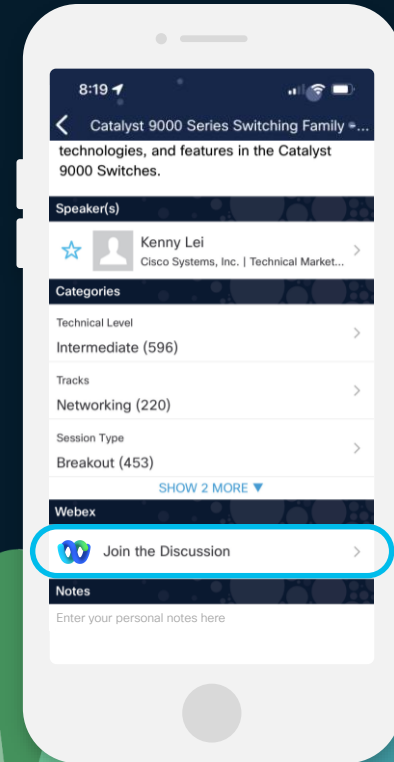
Questions?

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.



Agenda

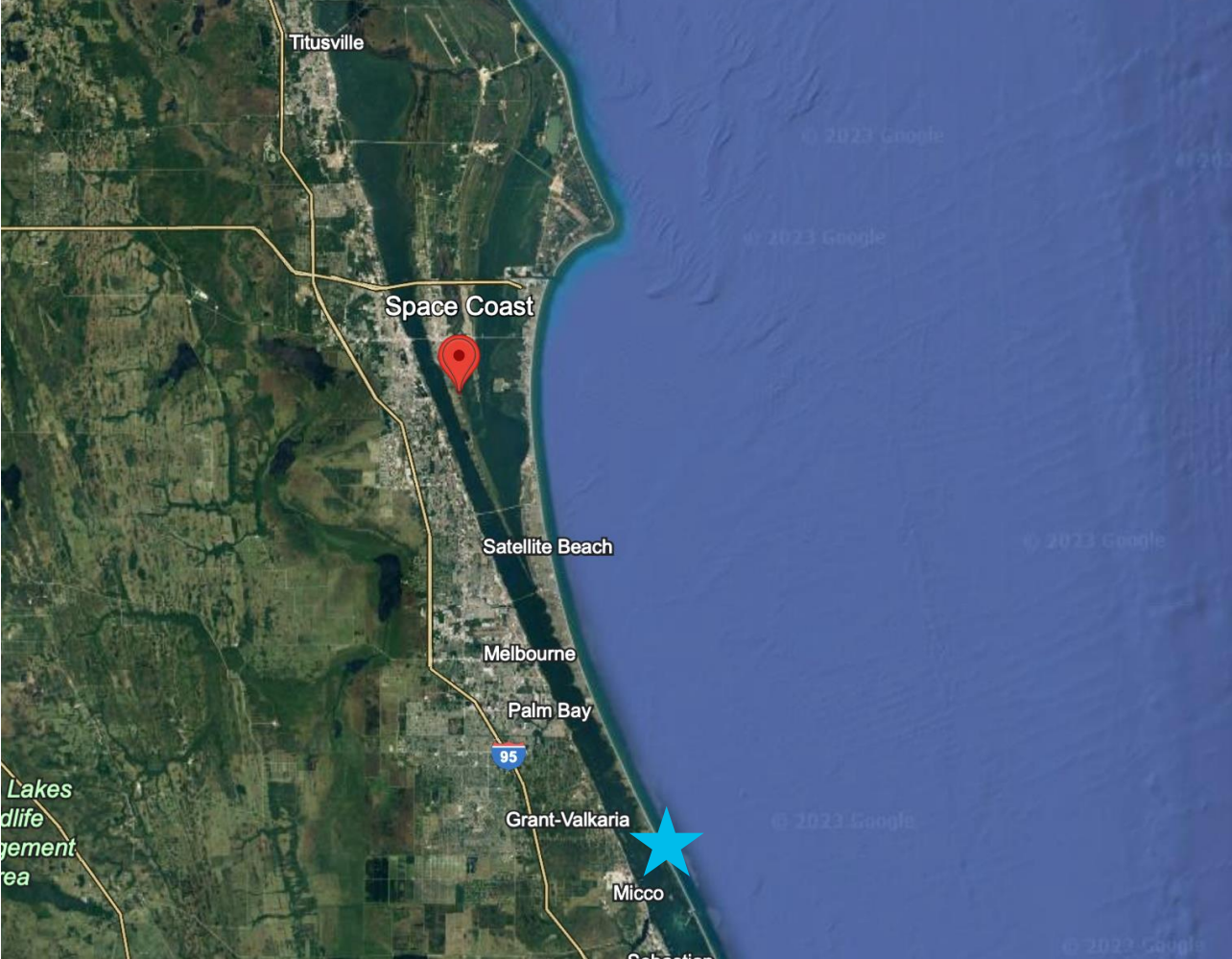
- Catch up on current events
- What is Starlink
- Starlink Security
- Deployment Models
- SDWAN
- Conclusion

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



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







Credit: SpaceX

BRKSEC-2150

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SpaceX Announces a Starship Version Two is in the Works

By Jack Kuhr November 28, 2023

[X](#) [in](#) [f](#) [🔗](#) [✉](#)





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



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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](#)

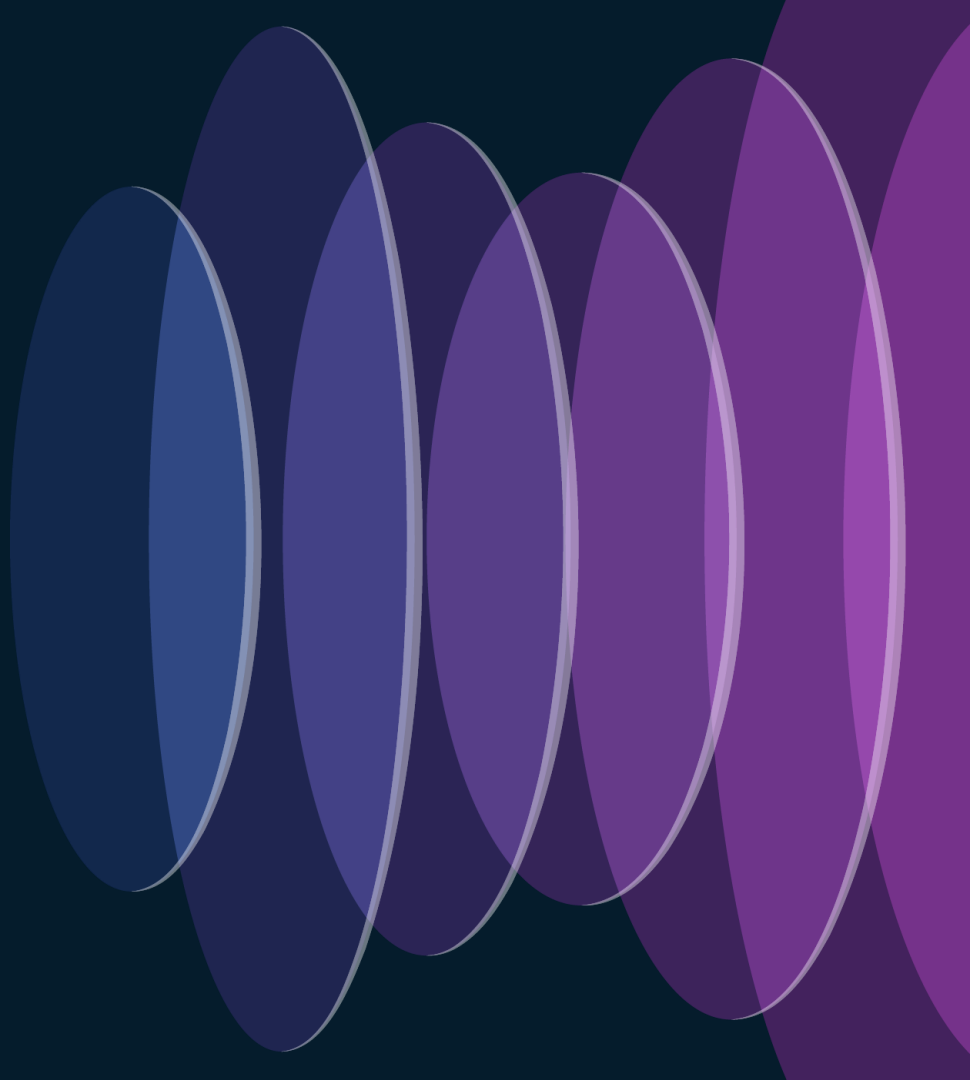




Cats love Starlink



How do you
keep up?



Starlink Federal Room (SL-OSINT)

The screenshot shows the 'Starlink Federal' room interface. At the top, there are tabs for 'Messages', 'People (64)', 'Content', 'Meetings', and 'Apps'. Below the tabs, there is a '+ Add people' button. A list of participants is displayed, each with a profile picture, name, and status. The participants listed are: 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), and Don Rogers (Active 50 minutes ago).

The screenshot shows the 'BRKSEC-2037: Securing Starlink Internet Services' room interface. At the top, there are tabs for 'Messages', 'People (3)', 'Content', 'Meetings', and 'Apps'. Below the tabs, there is a 'Meet' button. A message history is displayed, showing a message from 'CL Amsterdam 2024' that says 'CL Amsterdam 2024 added 2 people to this space.' followed by a blue checkmark. Below this, there is a horizontal line with the word 'Today' in the center. A message from 'You' is partially visible, starting with 'Hey for...'. Below this, there is a message that says 'You pinned a message. 12:43 PM'. A large blue arrow points upwards from the bottom of the message history towards the 'Messages' tab.



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



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

CISCO Live!

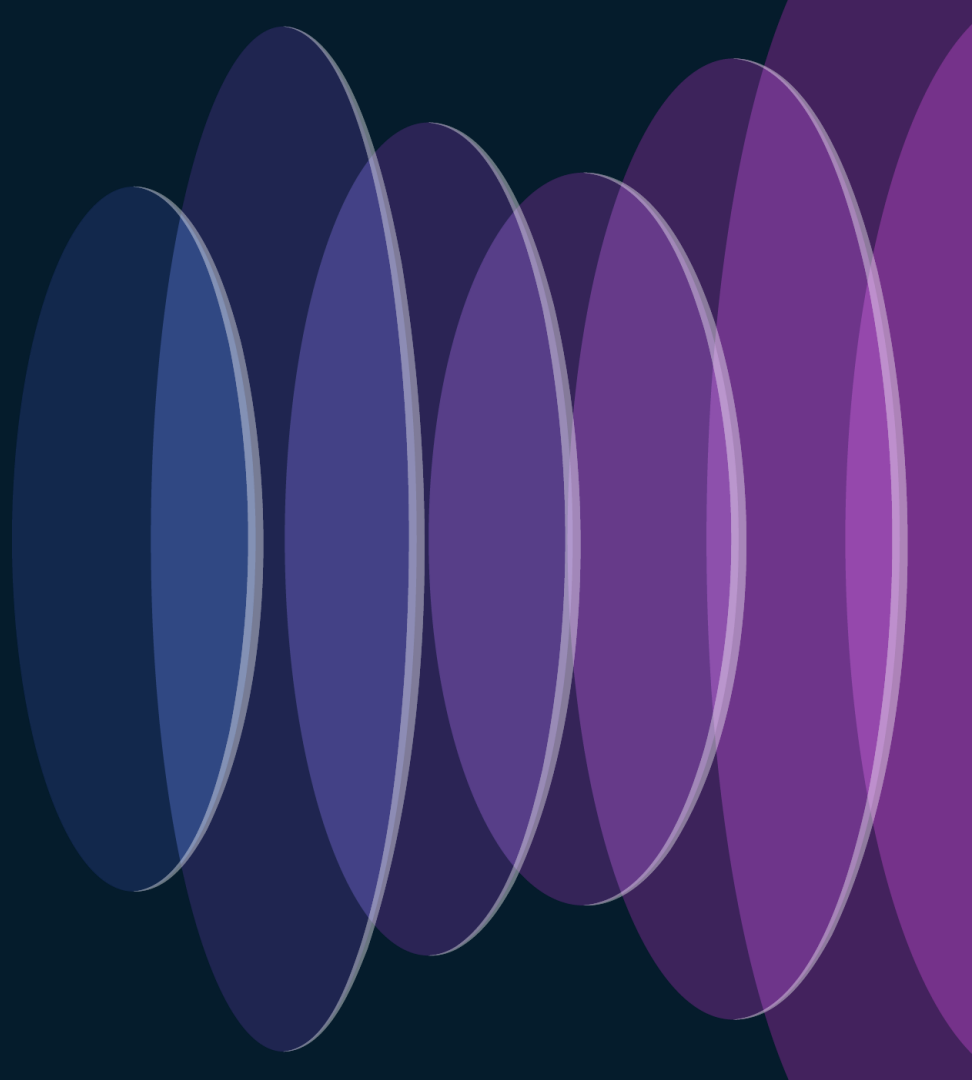
#CiscoLive

BRKSEC-2150

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Whats happening with Kuiper?



First Kuiper Launch



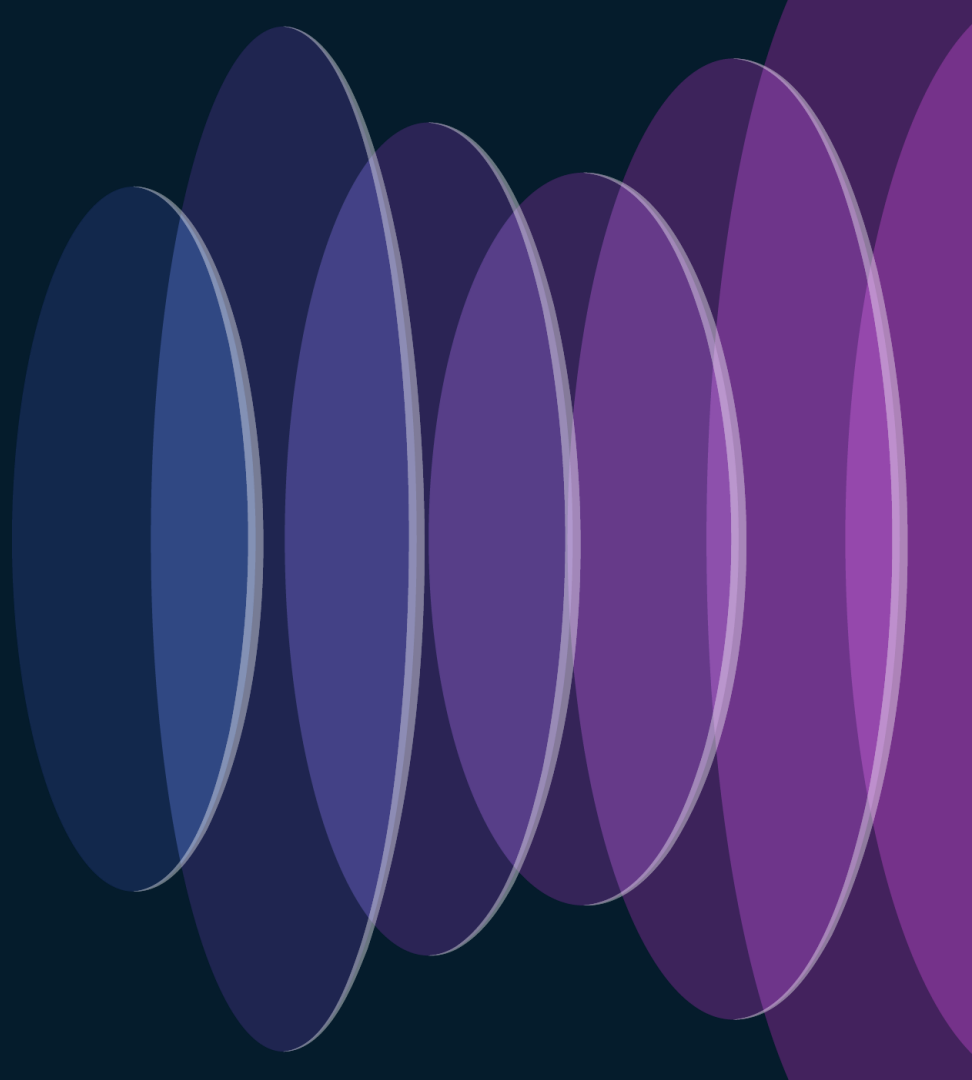
December 2 2023



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

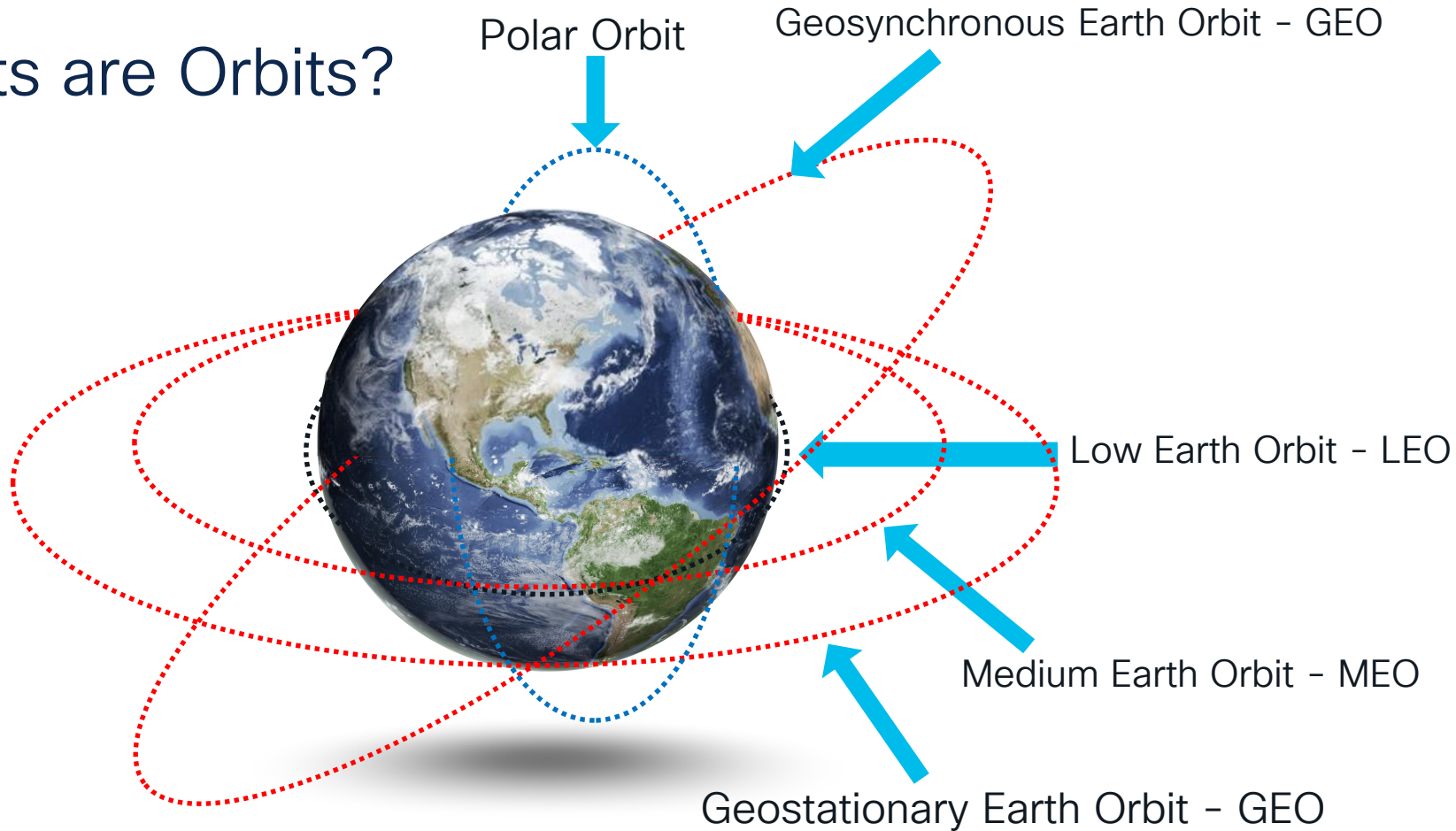


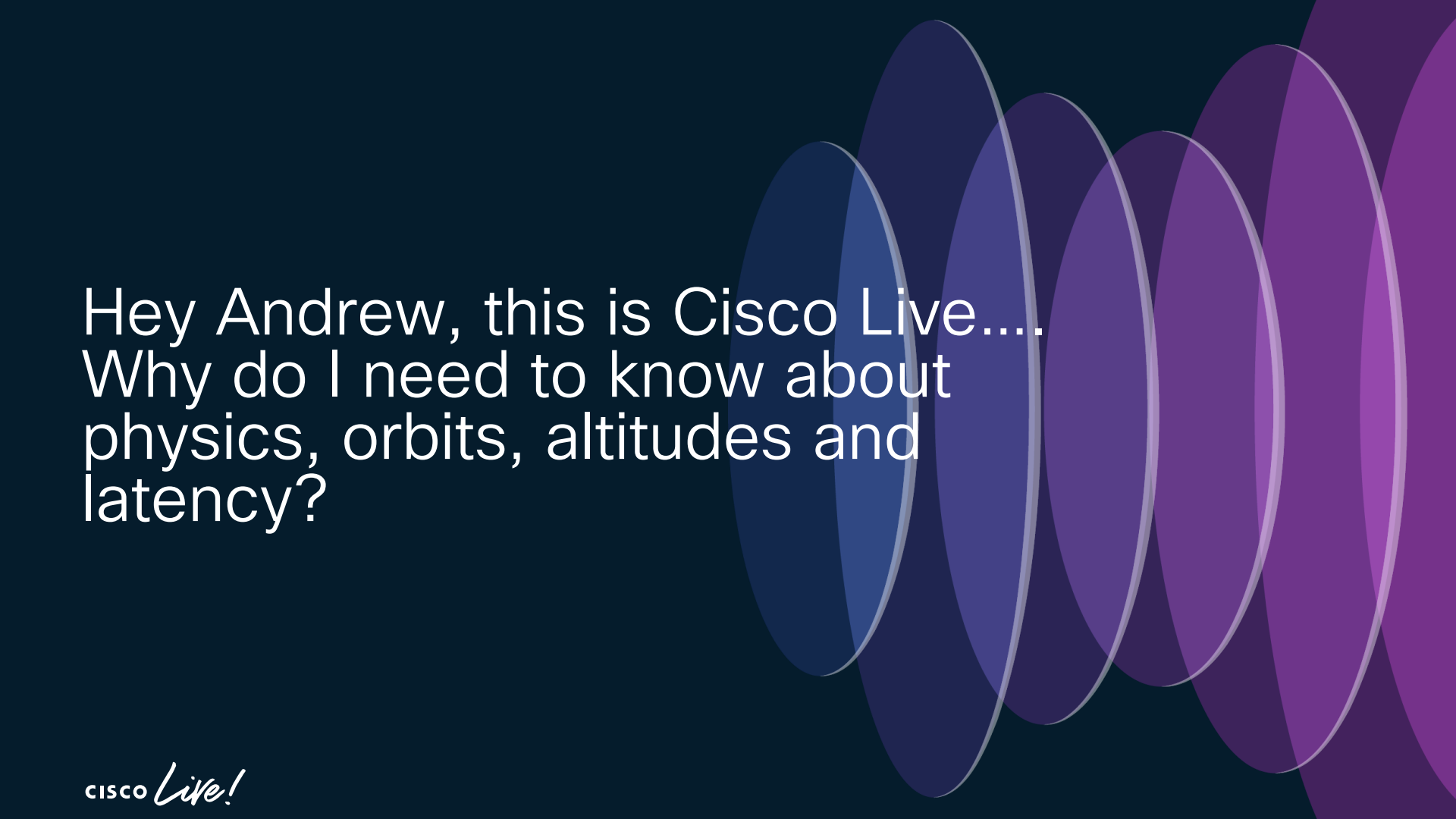
Agenda

- 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

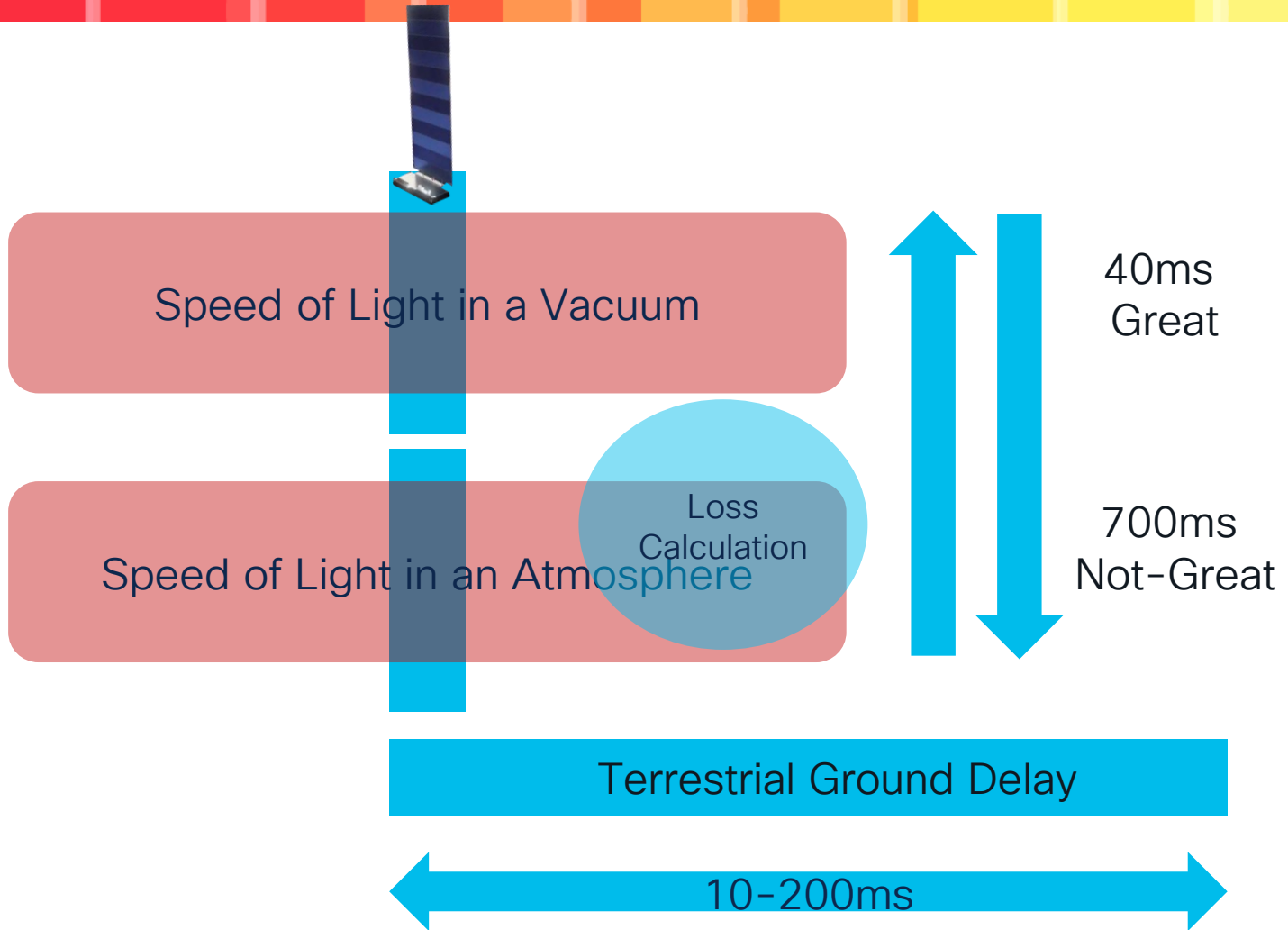
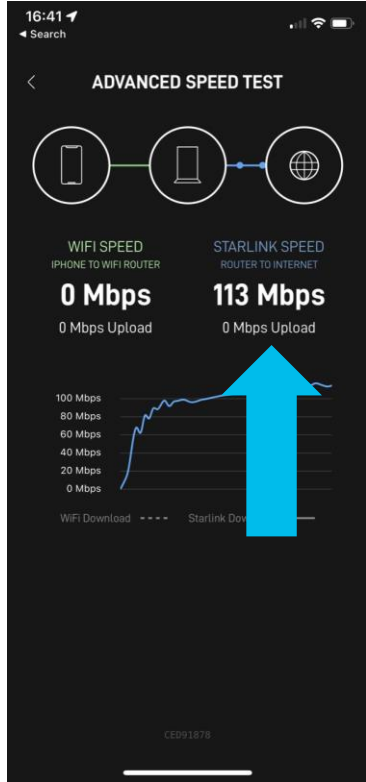
$$c = v\lambda$$

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



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



Happy Network Zone

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



Sad Network Zone

Physics Matters

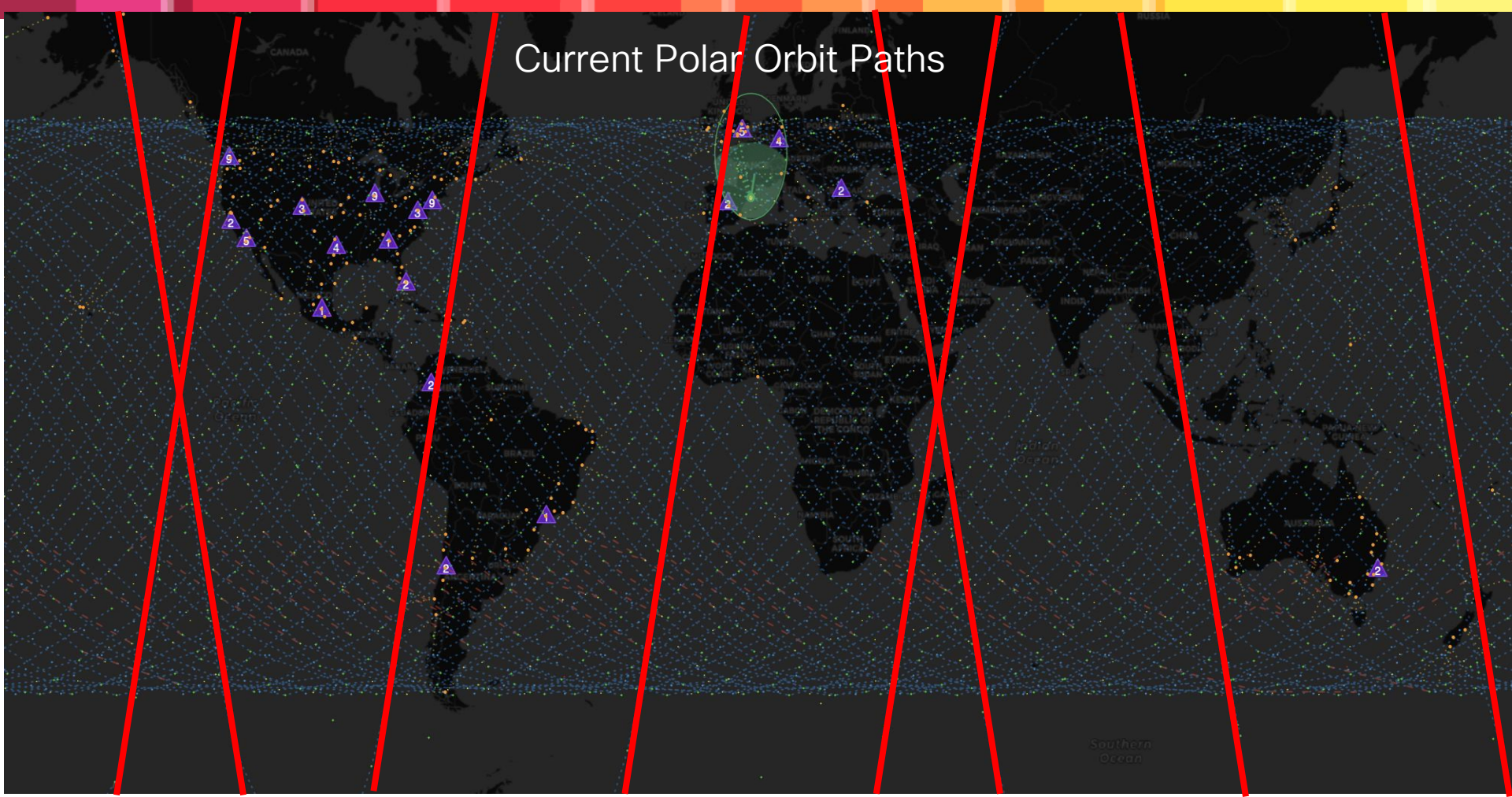
700ms

350ms

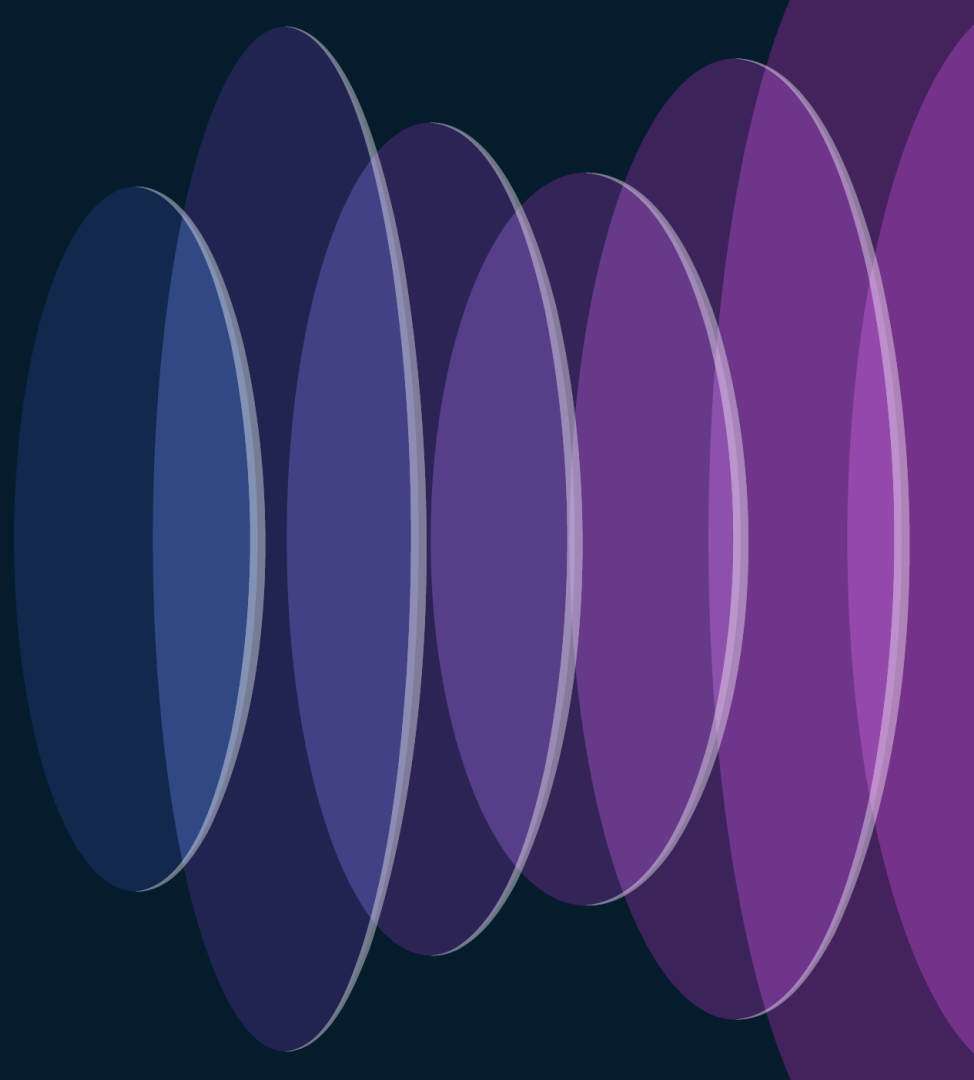
40ms



Current Polar Orbit Paths



What really is Starlink?



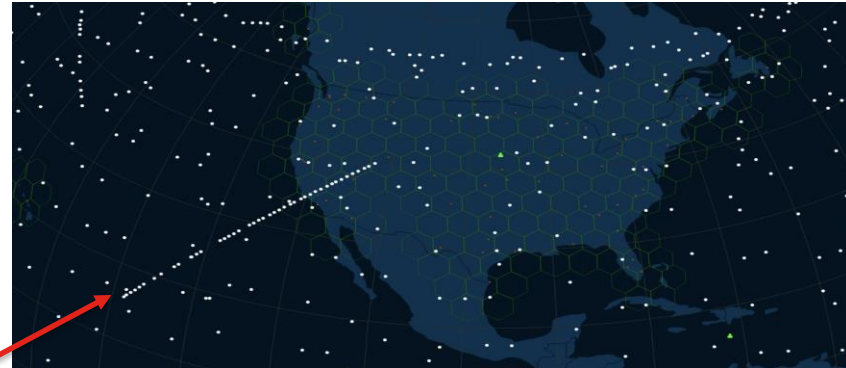
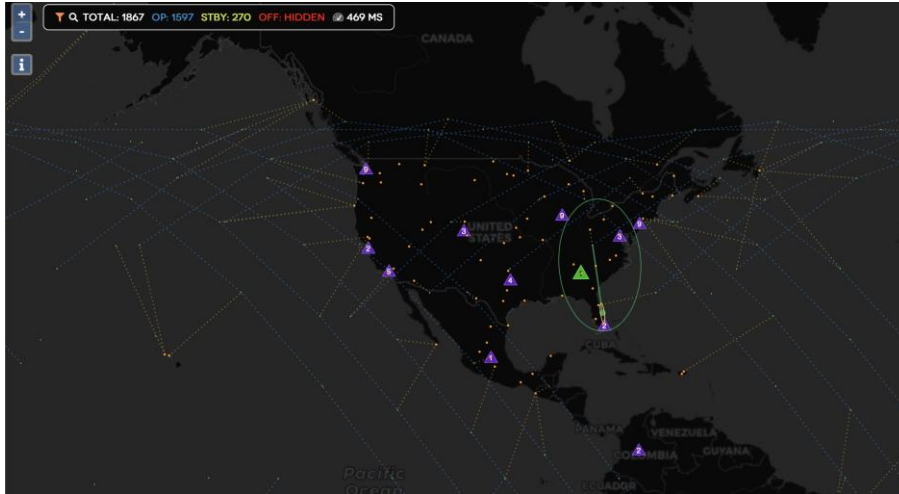
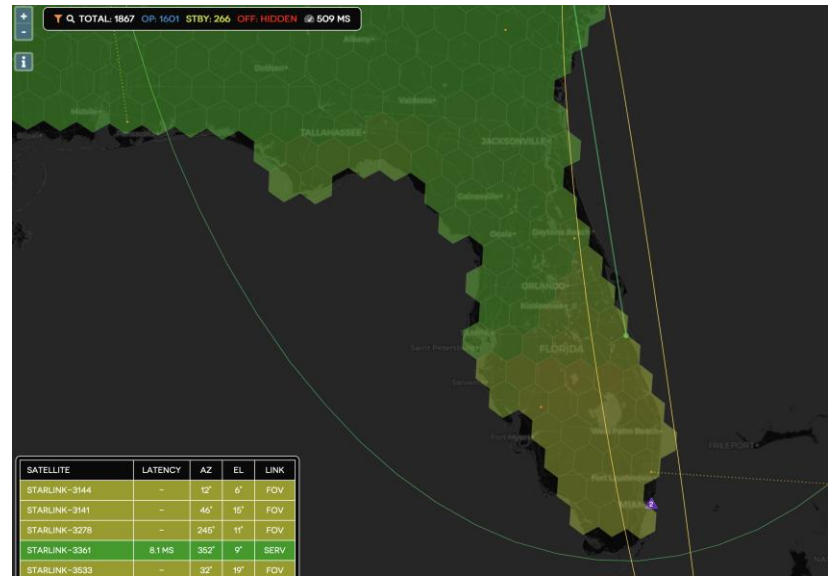
Starlink Australia

- 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*

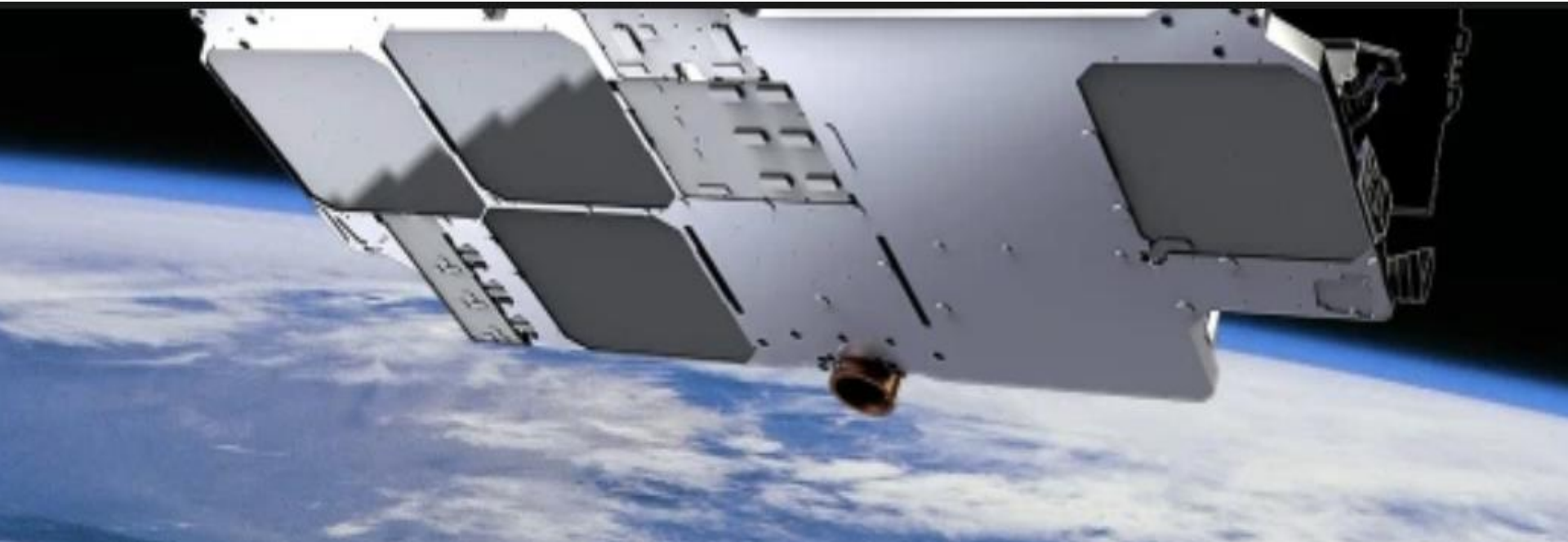


*groups of 53 being launched on a regular basis

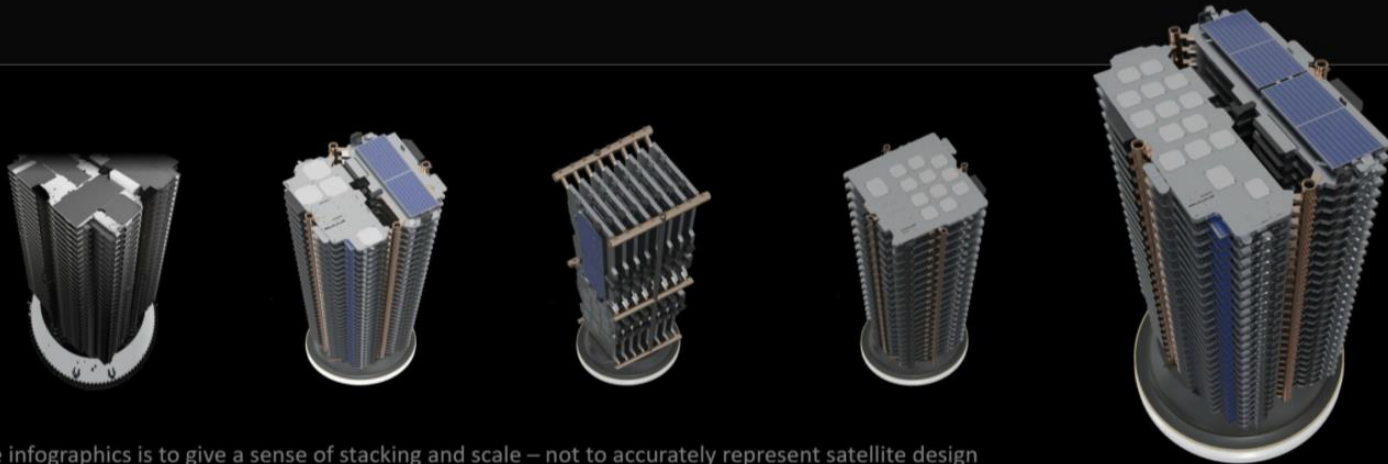
Satellite v1.5

- 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

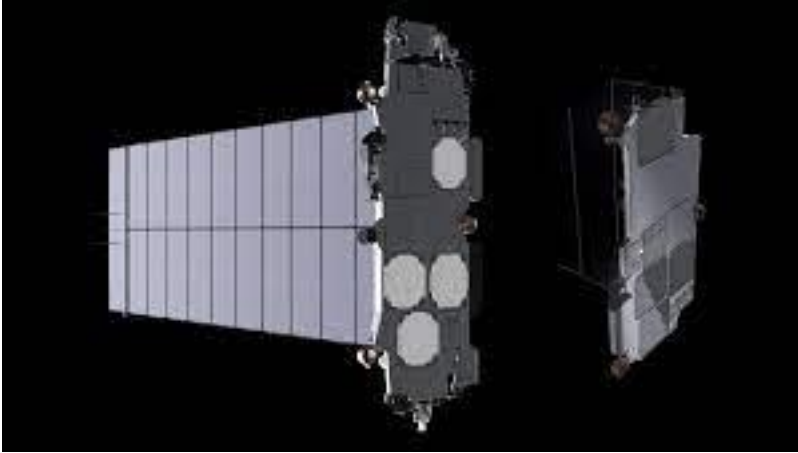


The goal of these infographics is to give a sense of stacking and scale – not to accurately represent satellite design

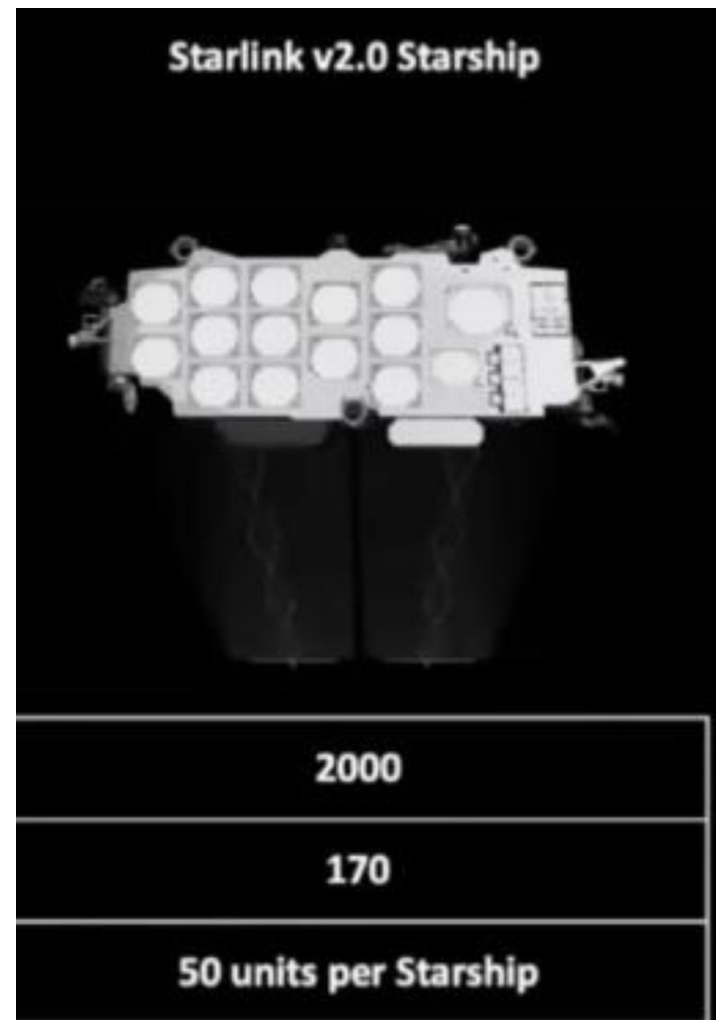
Assumptions

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



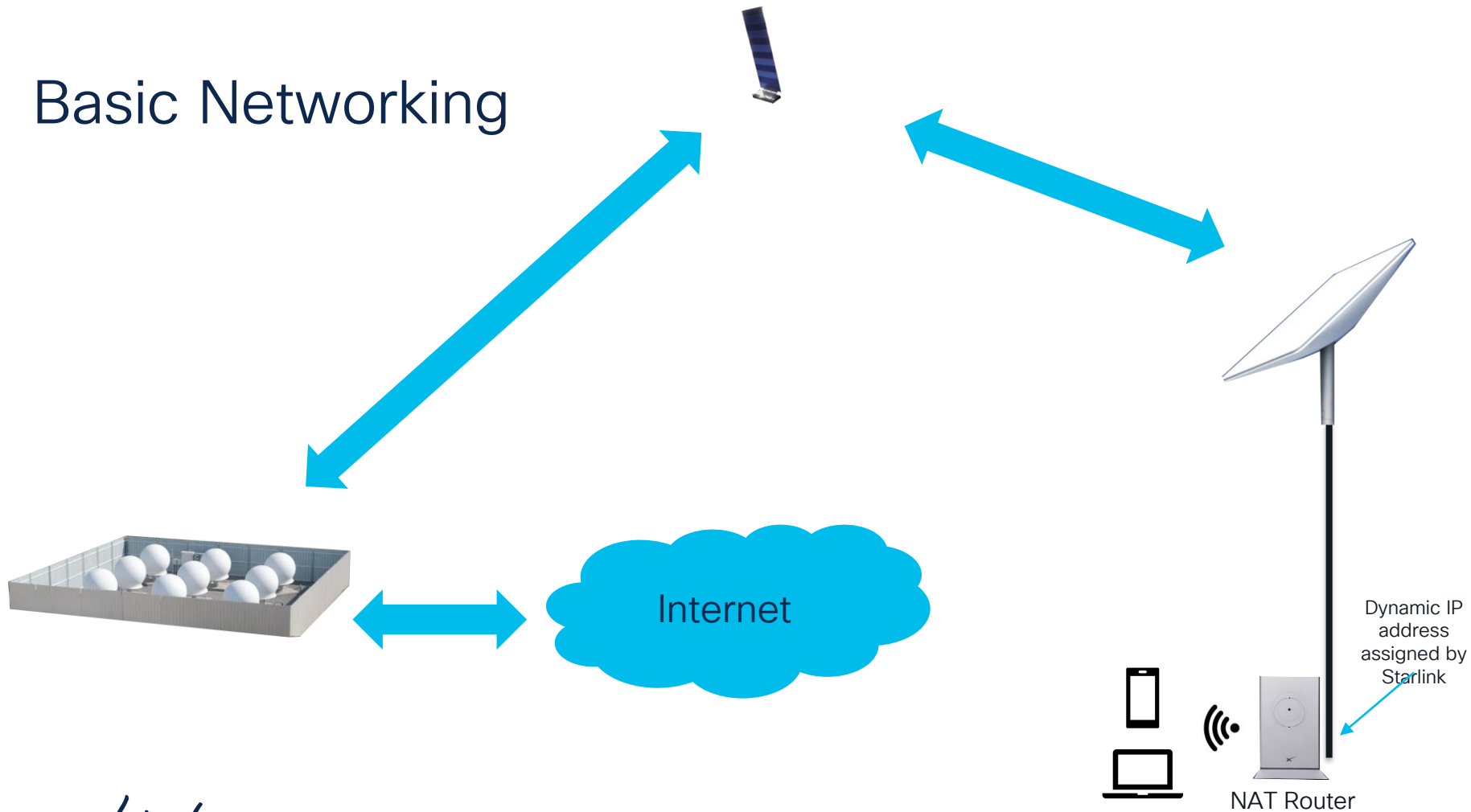
Credit: SpaceX/Starlink

Ground Station

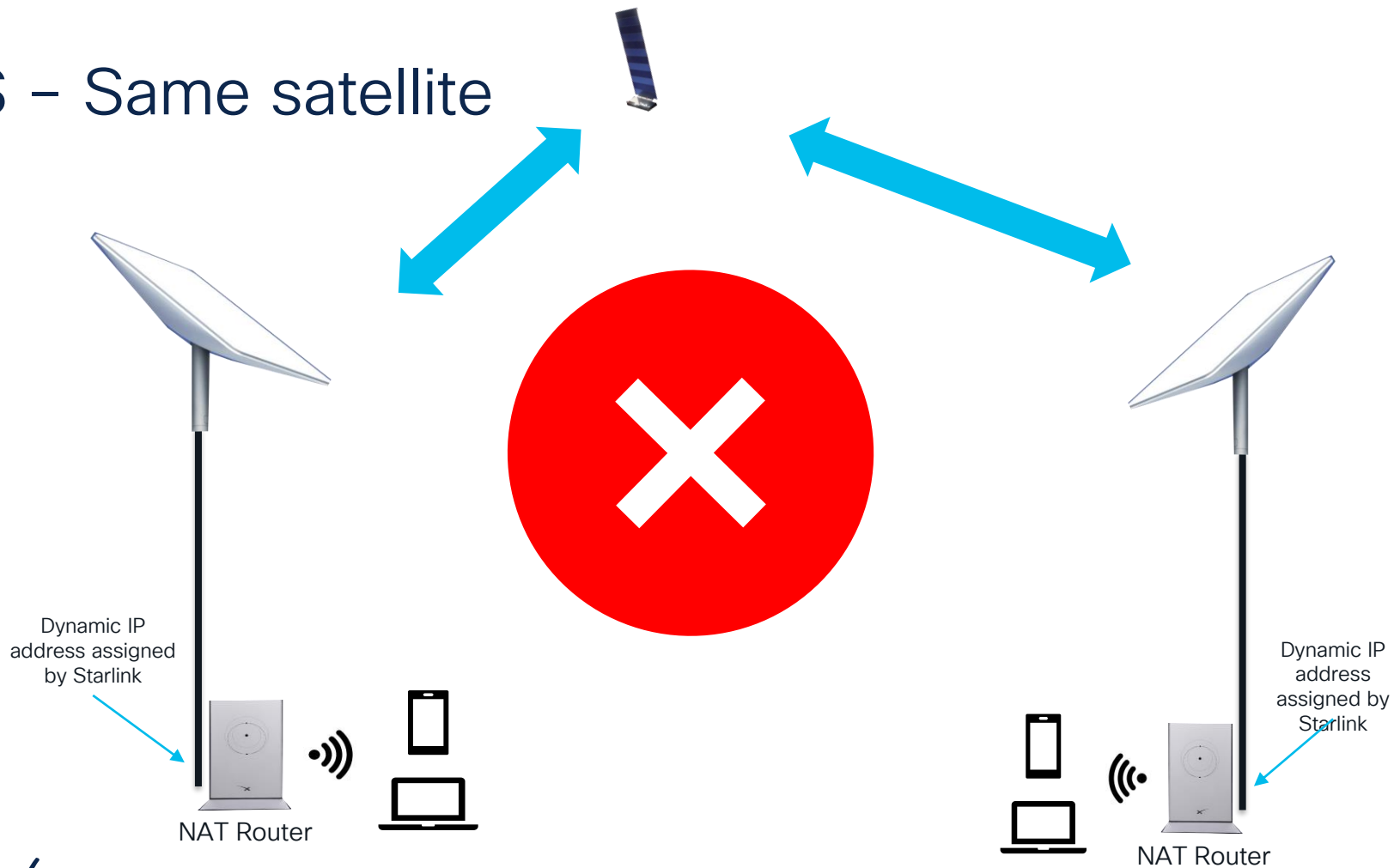
- Each gateway antenna has available a maximum of 4x 500 MHz channels (total 2 GHz) in uplink, and 5x 250 MHz channels (total 1.25 GHz) in downlink
- In this configuration – where 8 antennas are active – would be 10Ghz total active Down and 6Ghz Up per site
- Ground stations are positioned on top of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

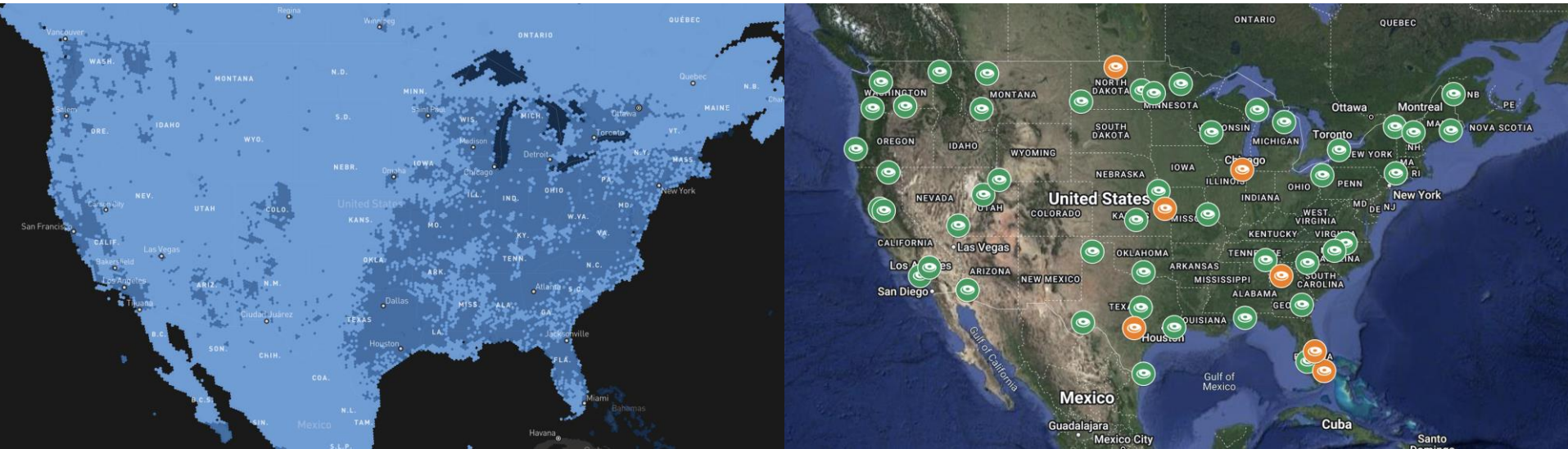


List of Australian Starlink Ground Stations

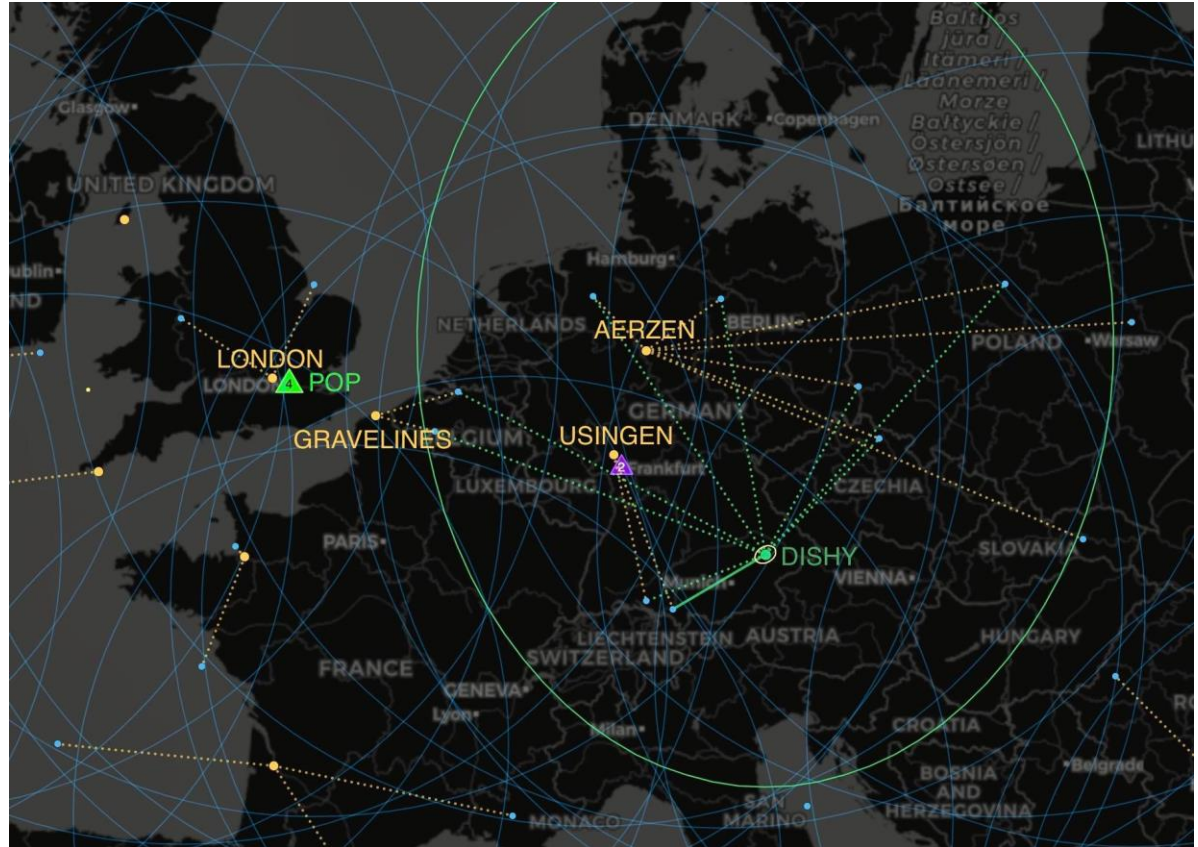
Cataby, WA
Merredin, WA
South West of Coolgardie, WA
Wagin, WA
Ki Ki, SA
Pimba, SA
Broken Hill, NSW
Boorowa, NSW
Calrossie, NSW
Canyonleigh, NSW
Cobargo, NSW
Springbrook Creek, NSW
Tea Gardens, NSW
Ki Ki, SA
Anankie, VIC
Koonwarra, VIC
Torrumbarry, VIC
West of Emerald, QLD
Toonpan, QLD
Warra, QLD
Willows,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



US Gateway Locations



EMEA Gateway Locations

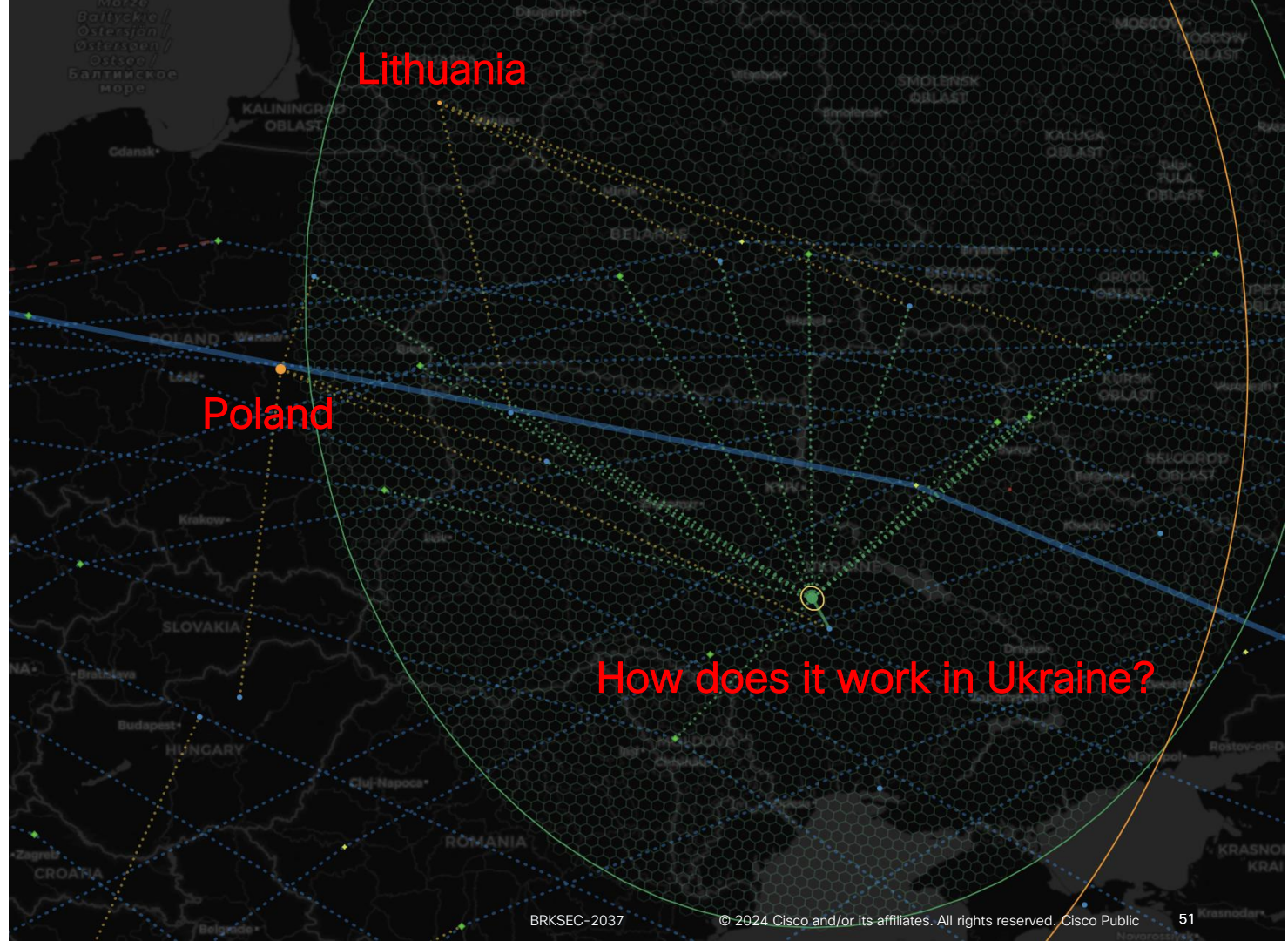


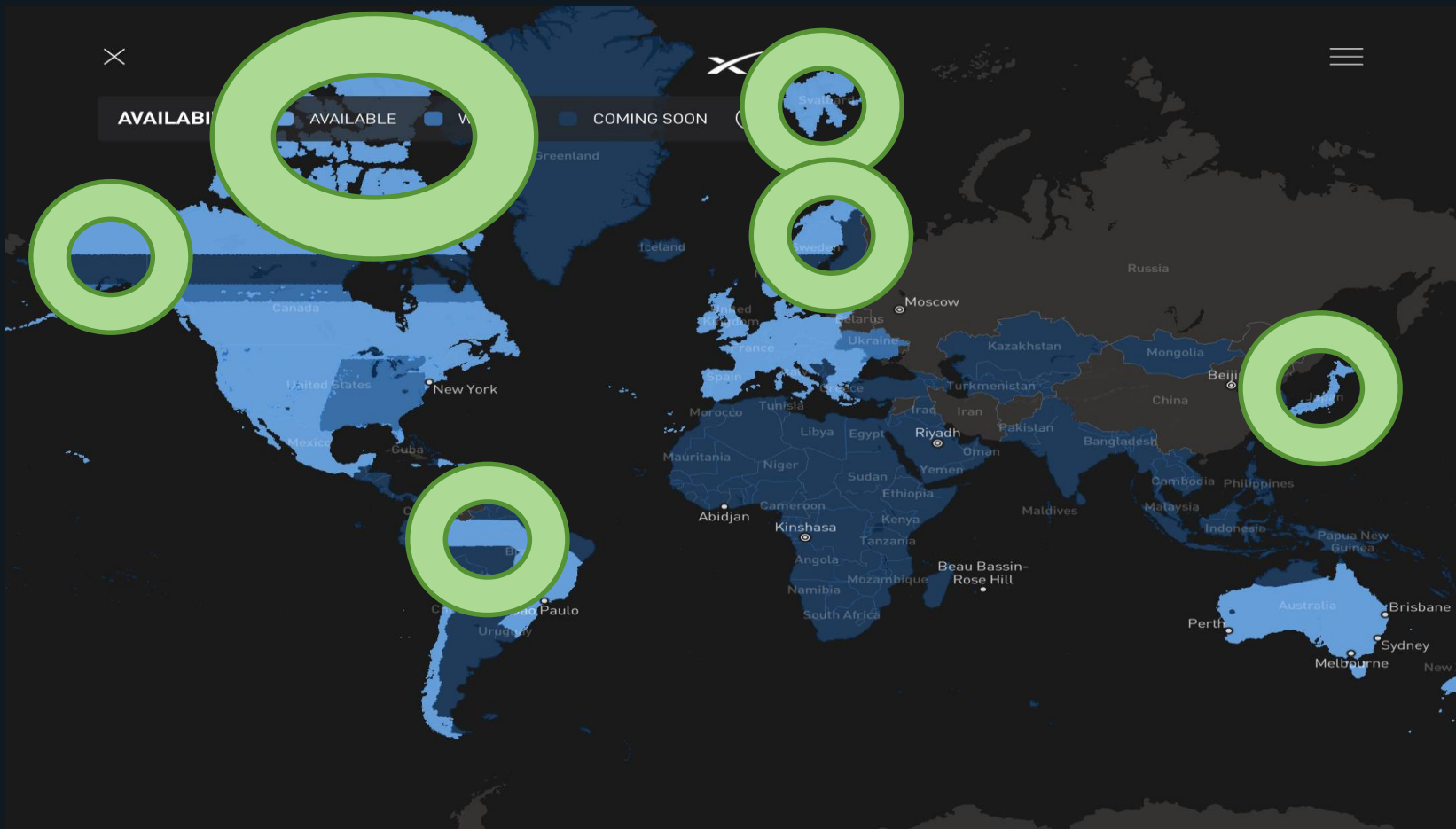
Radio Gateways

Lithuania
Poland

Internet Gateways

Frankfurt
London







STARLINK

RESIDENTIAL

BUSINESS

RV

MARITIME

AVIATION

IOT

AVAILABILITY



AVAILABLE



WAITLIST



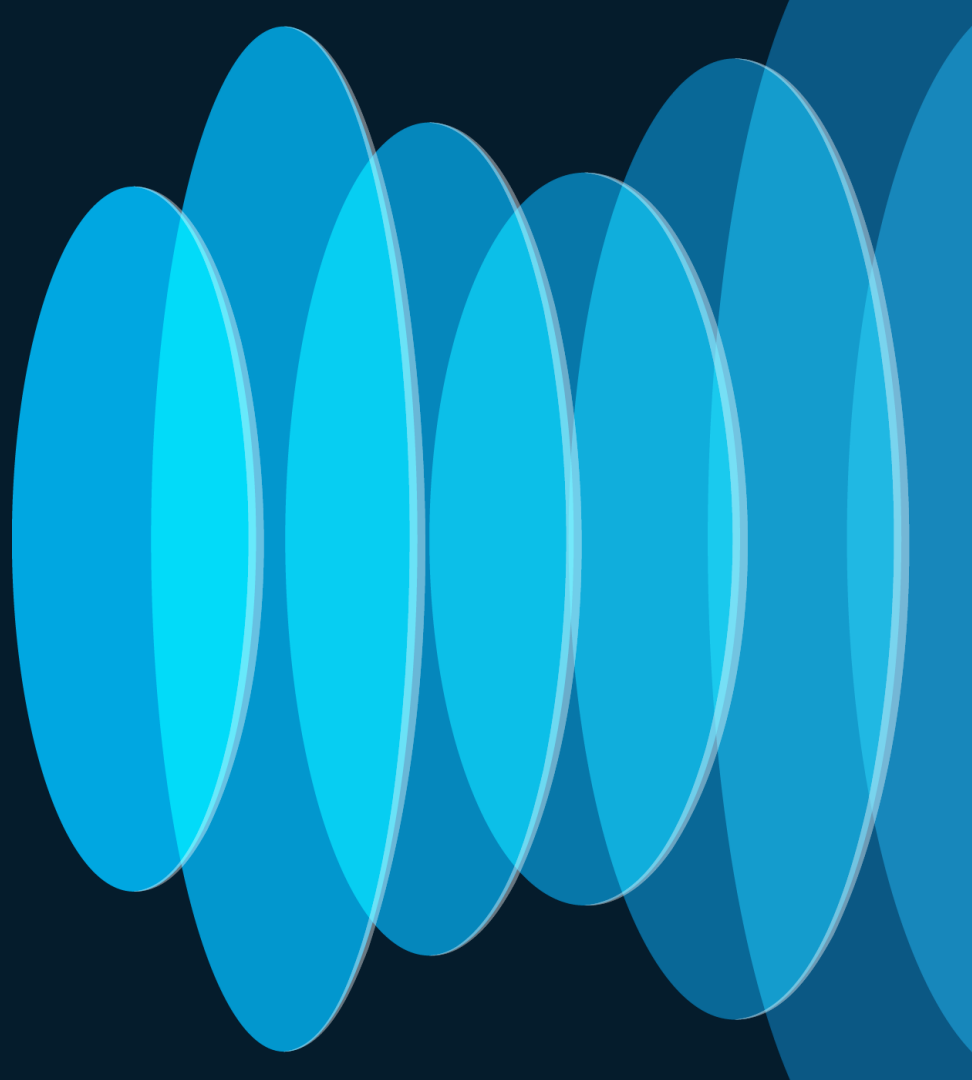
COMING SOON



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

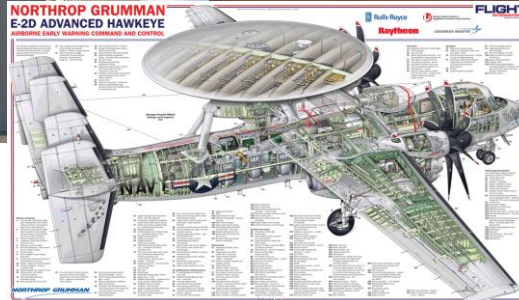
- Space Observation Radar



- AN-SPY-1 Phased Array



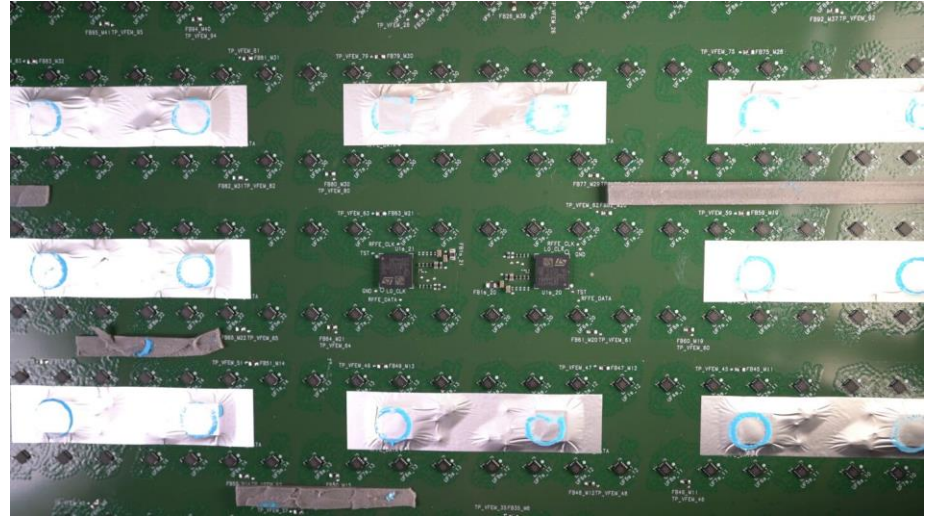
E-3 Sentry
AWACS



E-2D
Early Warning

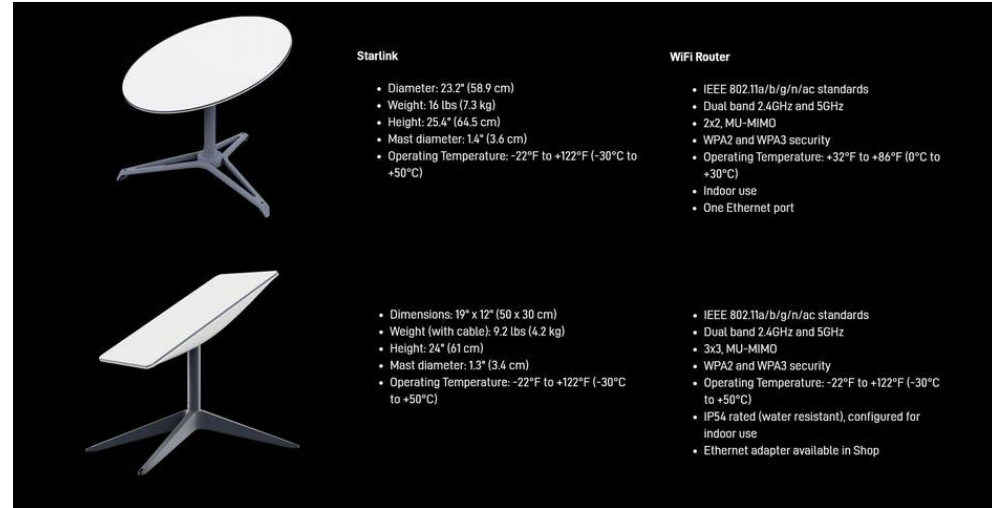
How does Starlink work?

- 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

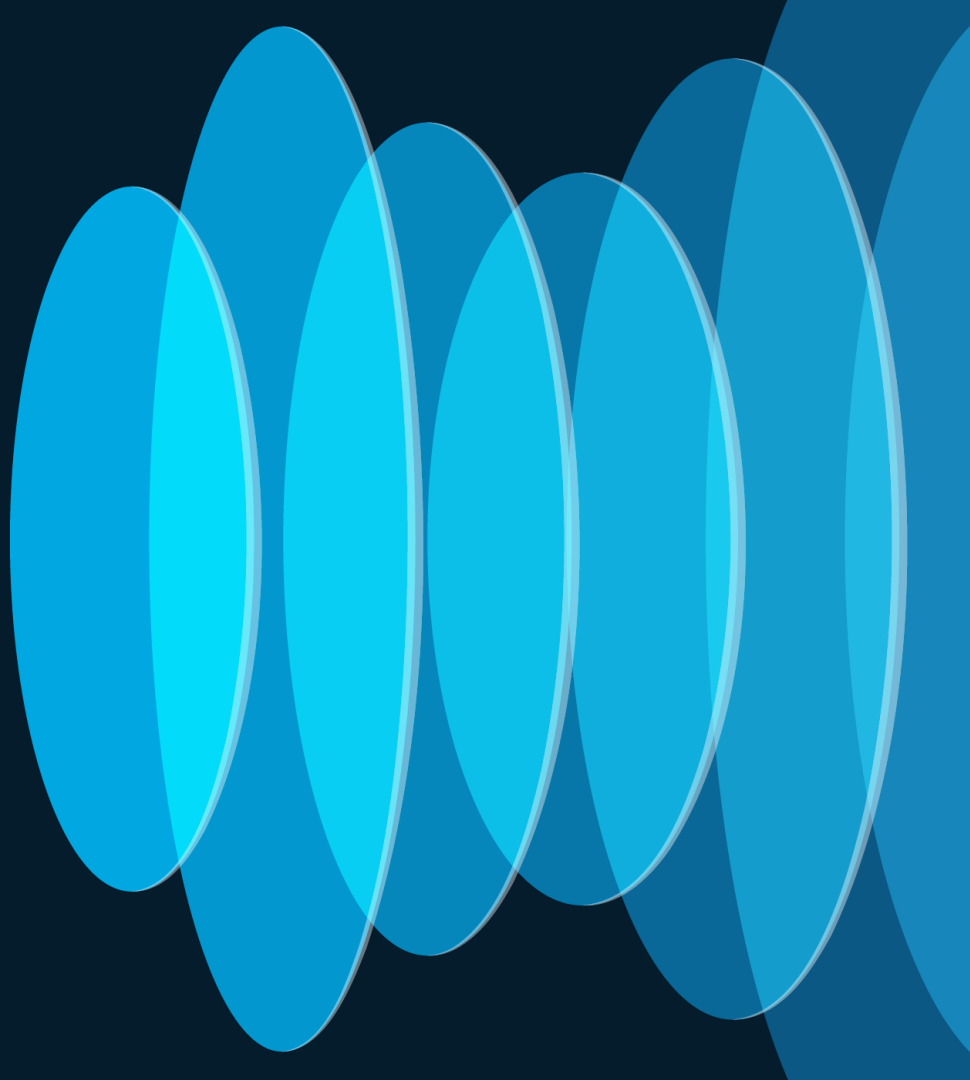


Ground Terminal

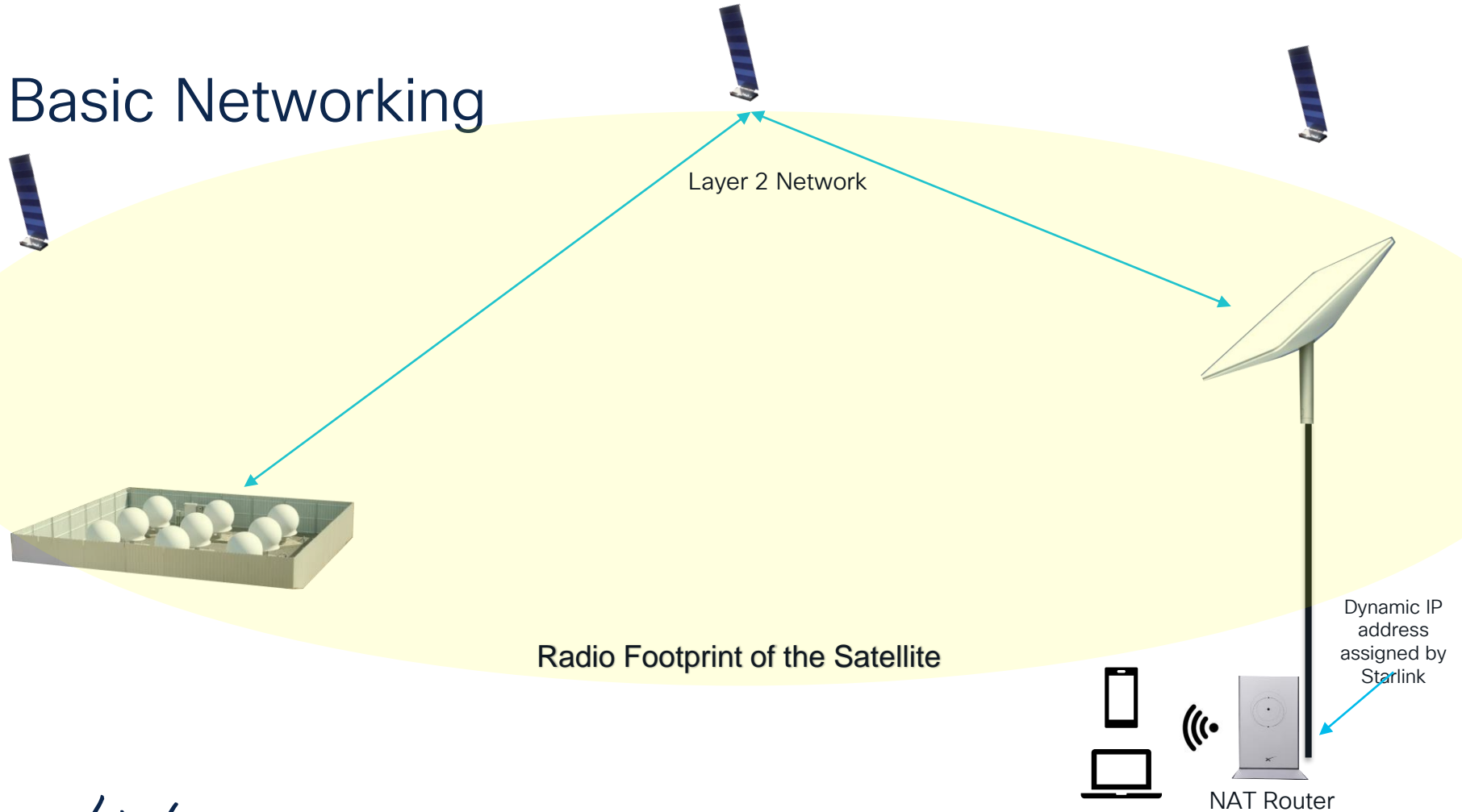
- Phased Array Antenna
- Starlink Router (more on that later)
- Ethernet Cable with proprietary ends



Basic Networking



Basic Networking

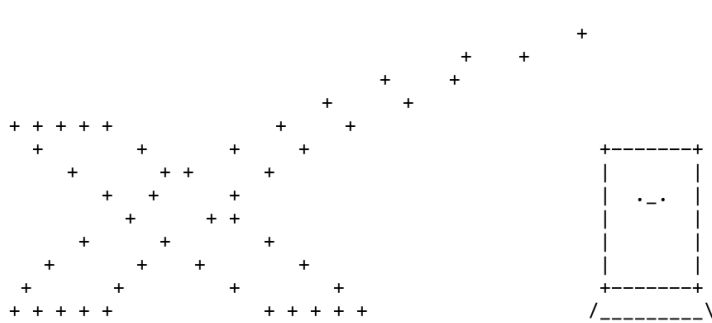


Starlink Router

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



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."

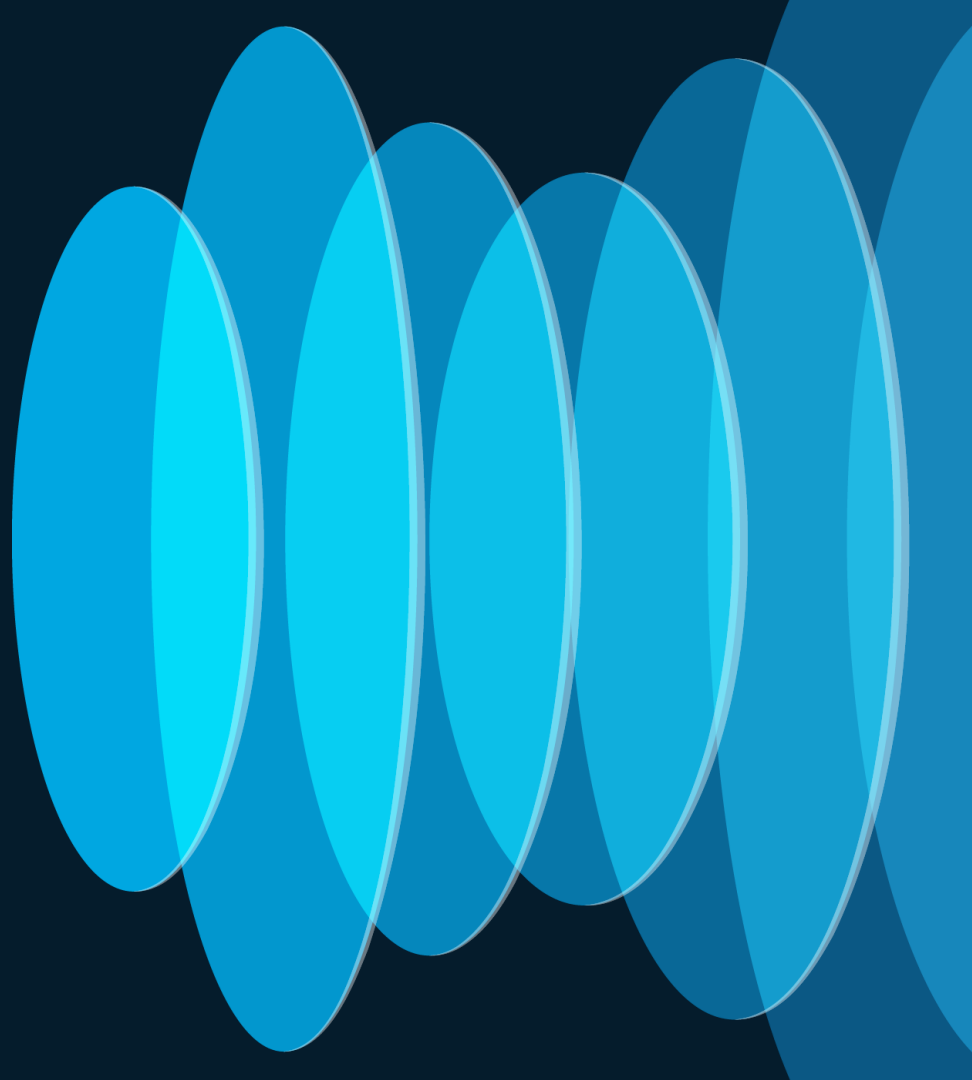
2022.19.0.mr13442

Router-010000000000000001F2F12

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

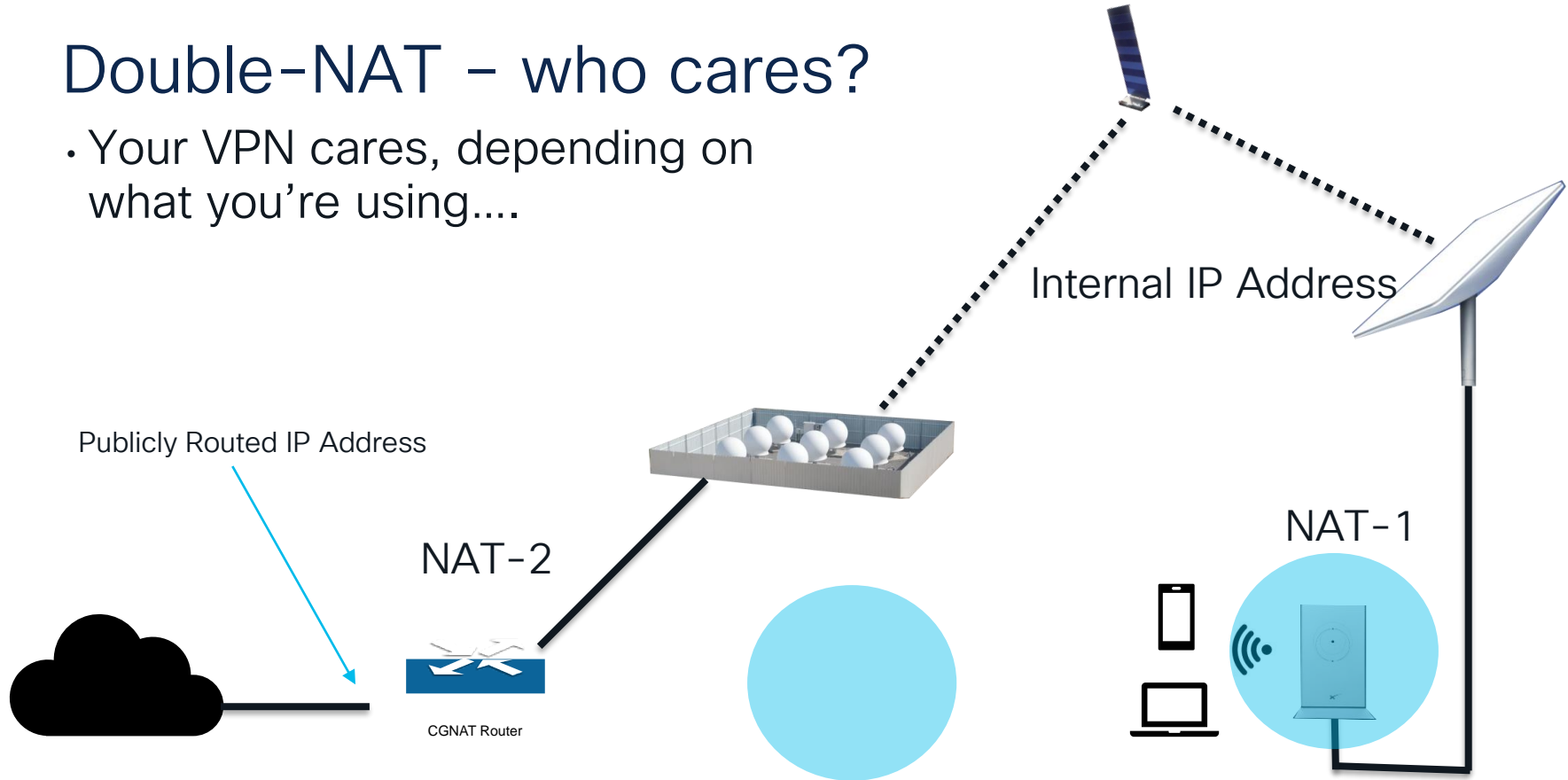
- Nmap scan report for 192.168.1.1
- Host is up (0.0040s latency).
- Not shown: 994 filtered tcp ports (no-response)
- PORT STATE SERVICE
- 22/tcp open ssh
- 53/tcp open domain
- 80/tcp open http
- 9000/tcp open cslistener
- 9001/tcp open tor-orport
- 9002/tcp open dynamid
- Nmap done: 1 IP address (1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

Double/Triple NAT

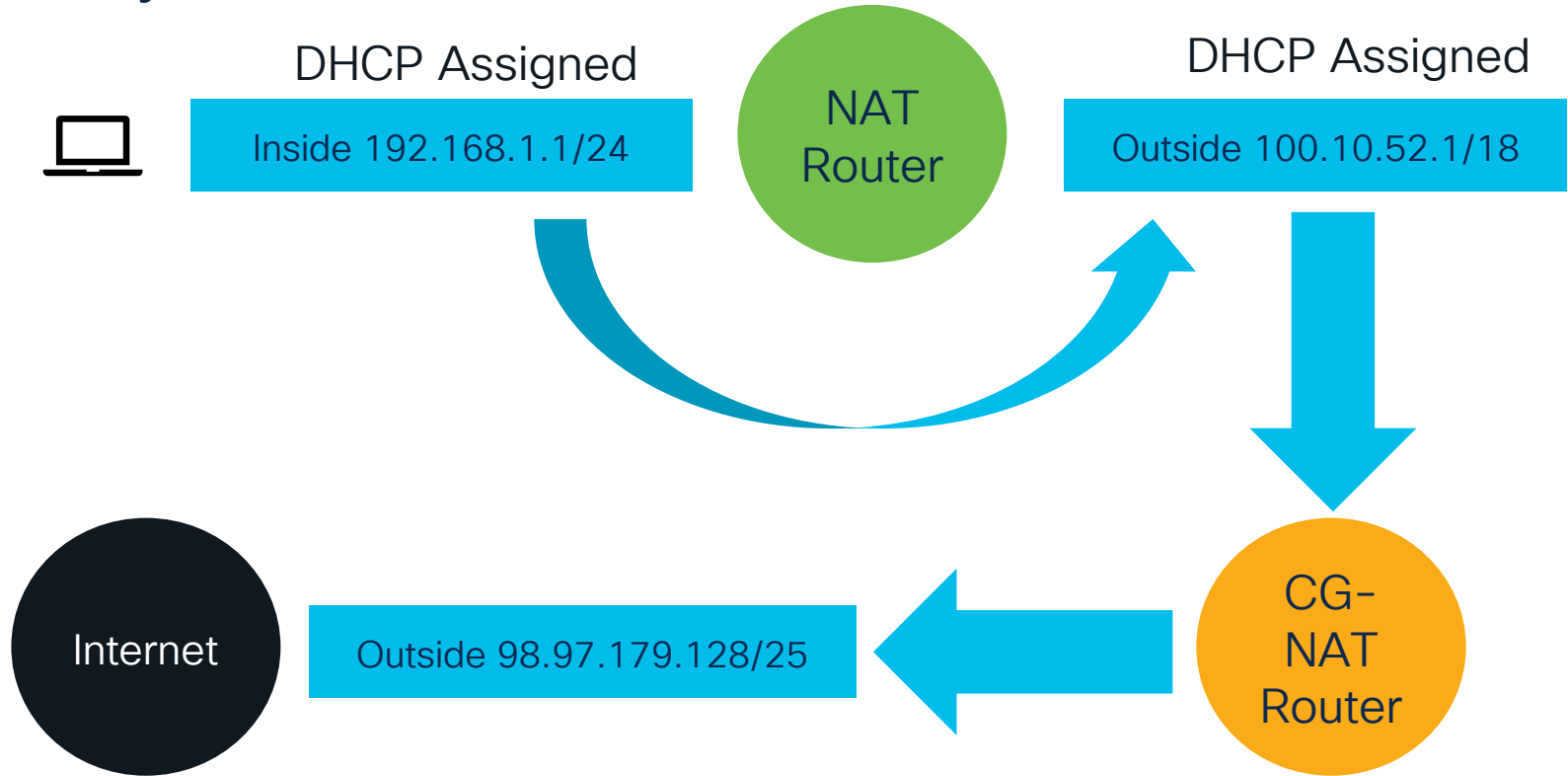


Double-NAT – who cares?

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



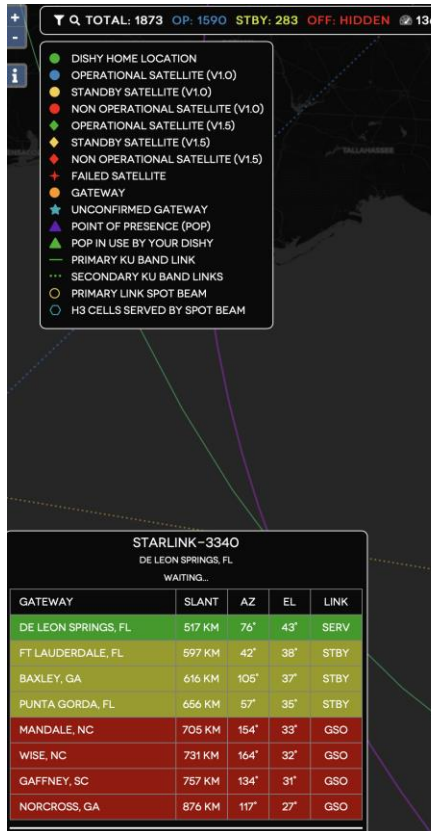
Why is NAT an issue?



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 te0-0-0-5-0-1.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

How the network works

98.97.179.128/25

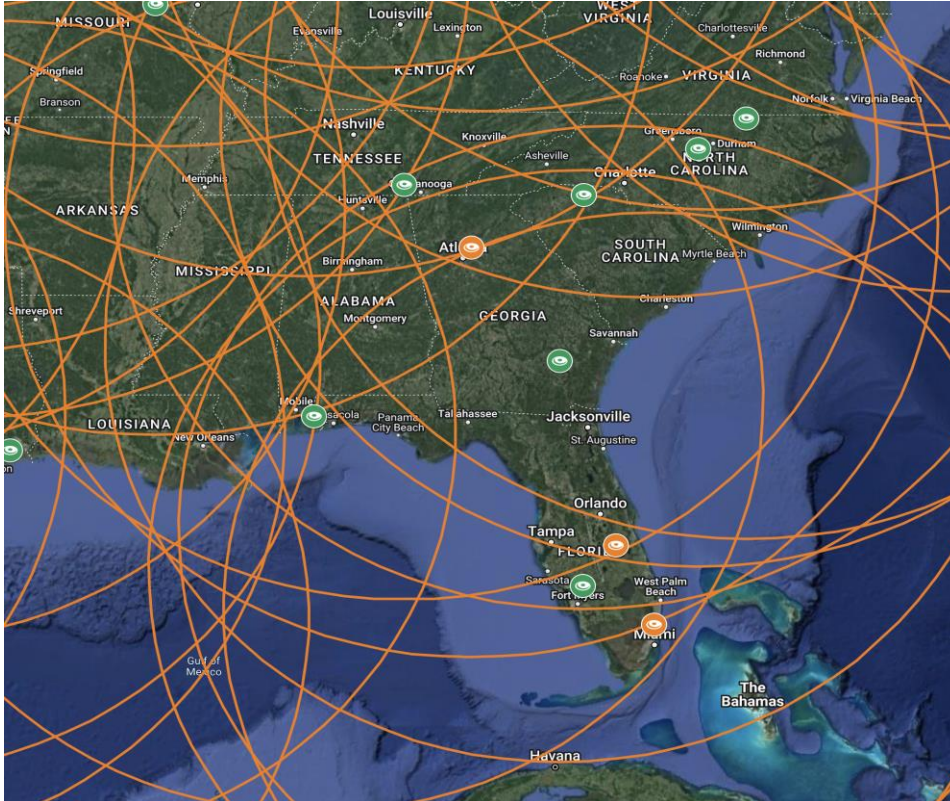
AS14593 · Space Exploration Technologies Corporation

Summary

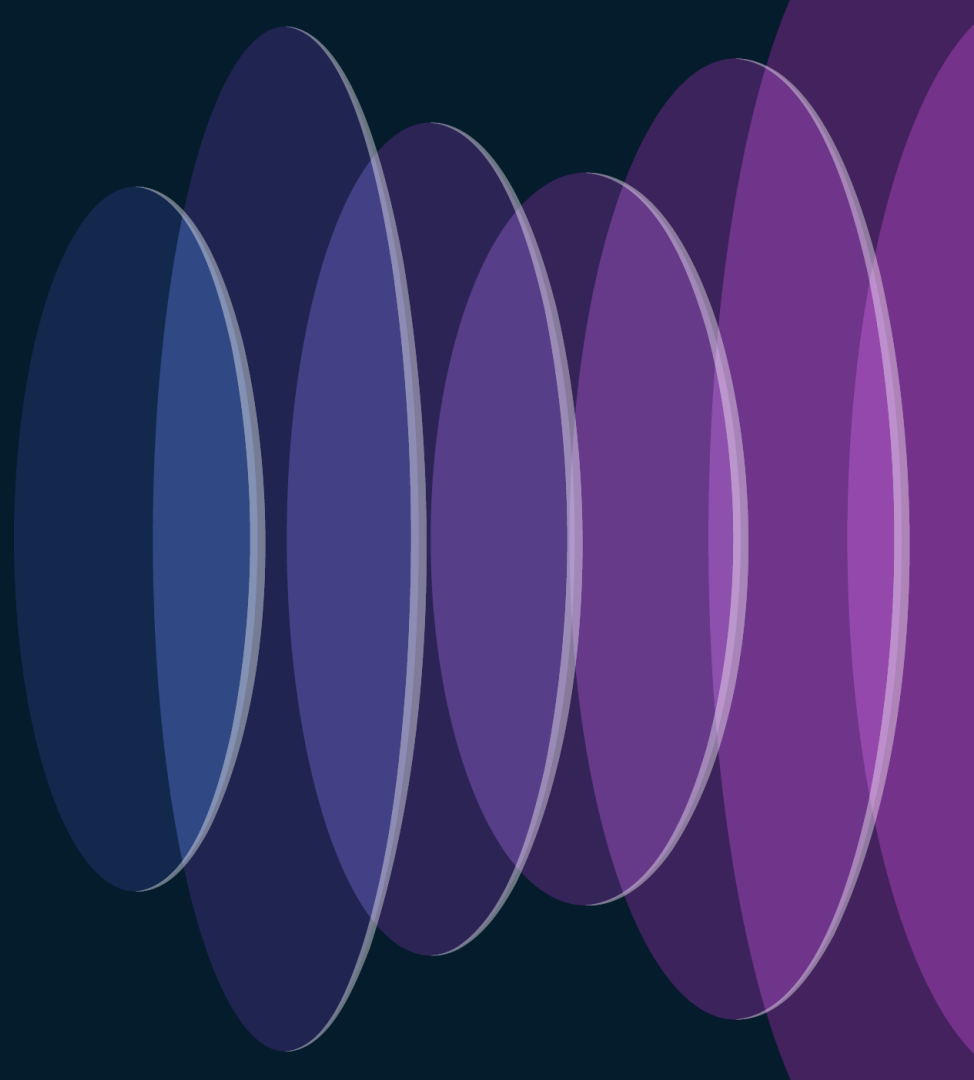
Country	 United States
Domain	spacex.com
ASN	AS14593
Registry	arin
Hosted IPs	128
ID	NET-SUB-98-97-178-0

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”



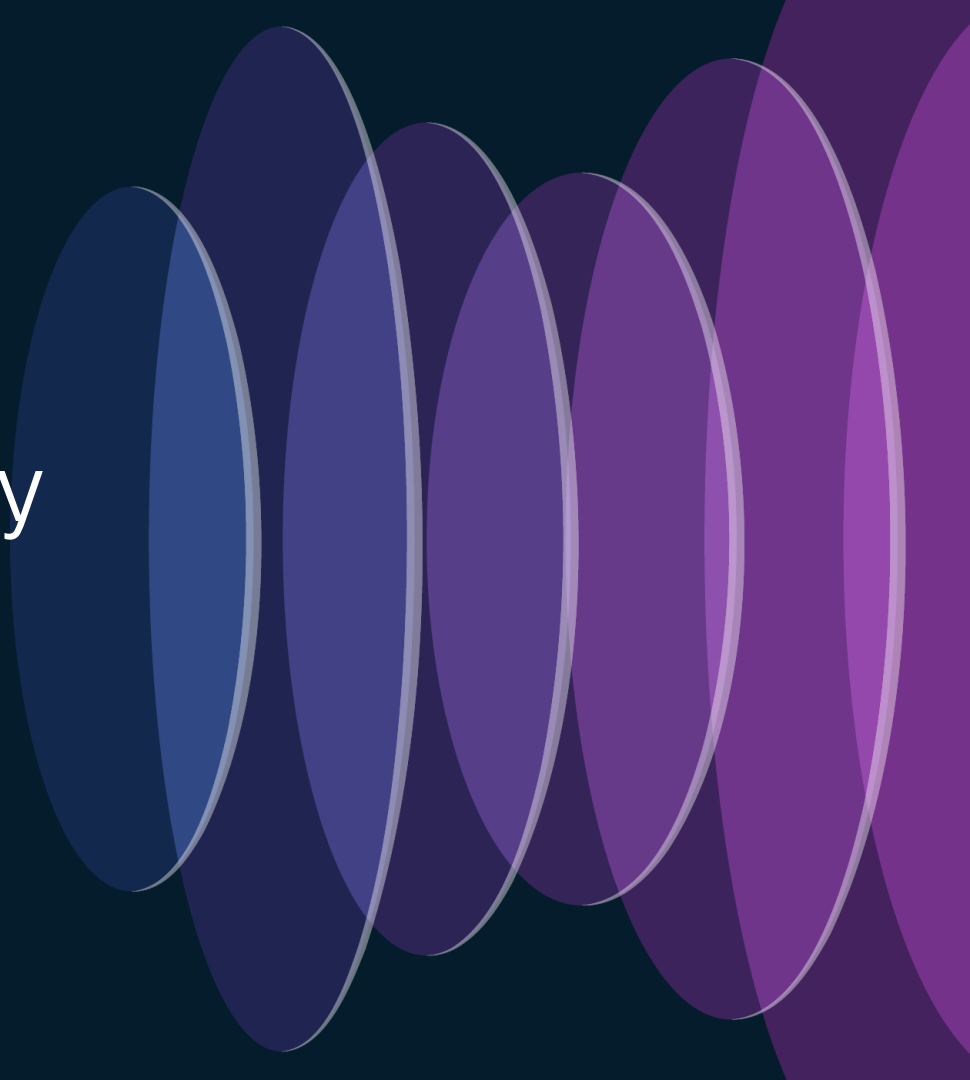
Satellite Truths and Myths

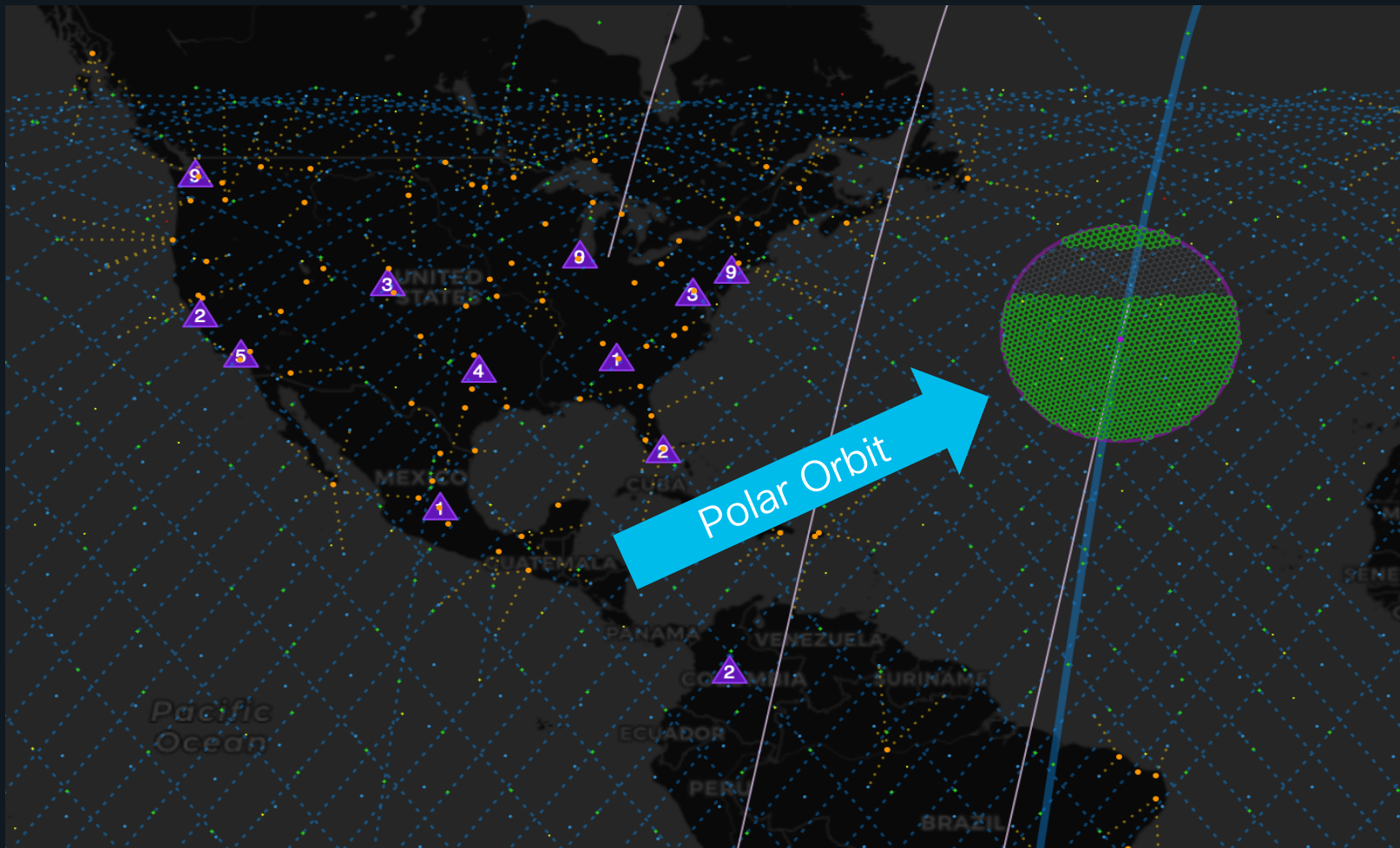
- All Starlink Satellites have “Lasers” – **FALSE**
- All Starlink Satellites can cross communicate to each other – **FALSE**
- Some Starlink Satellites have laser based optics that can point ahead of them to the next satellite – **TRUE**
- On-orbit Satellites can calculate multi-planar ephemeris to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

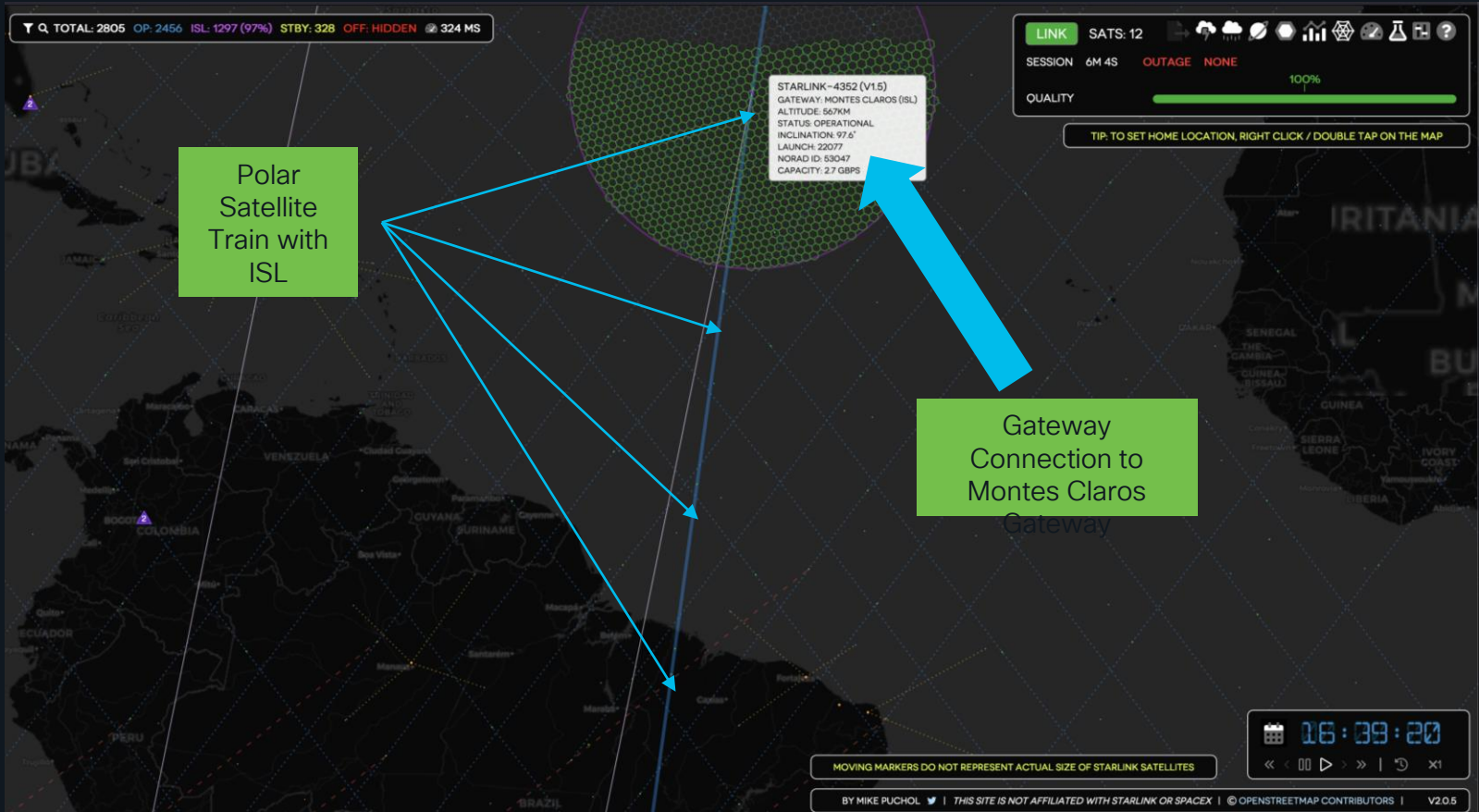
Polar Orbit Satellites and Free Space Optics

- 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**

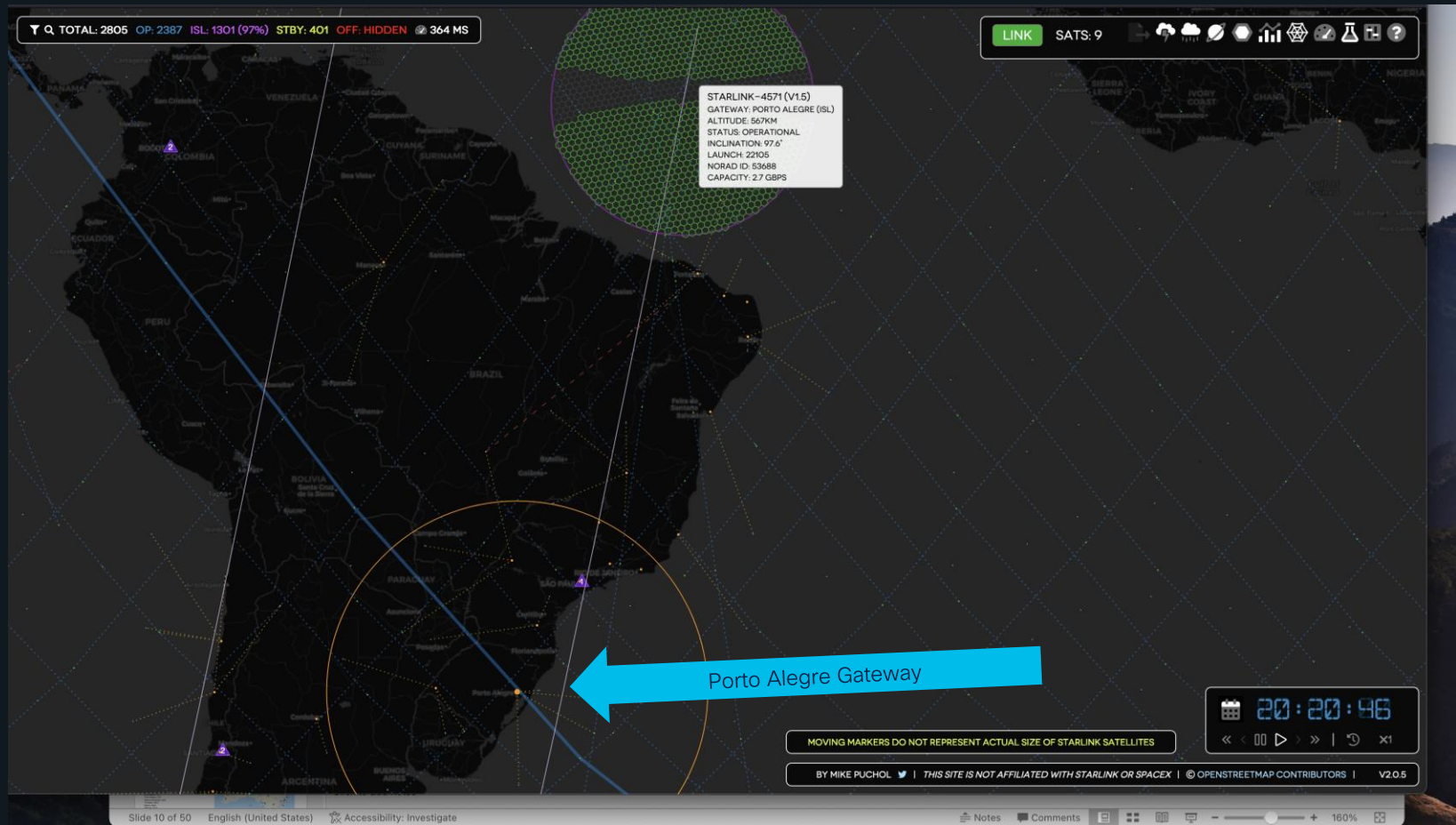
Space Lasers fix my
networking issues

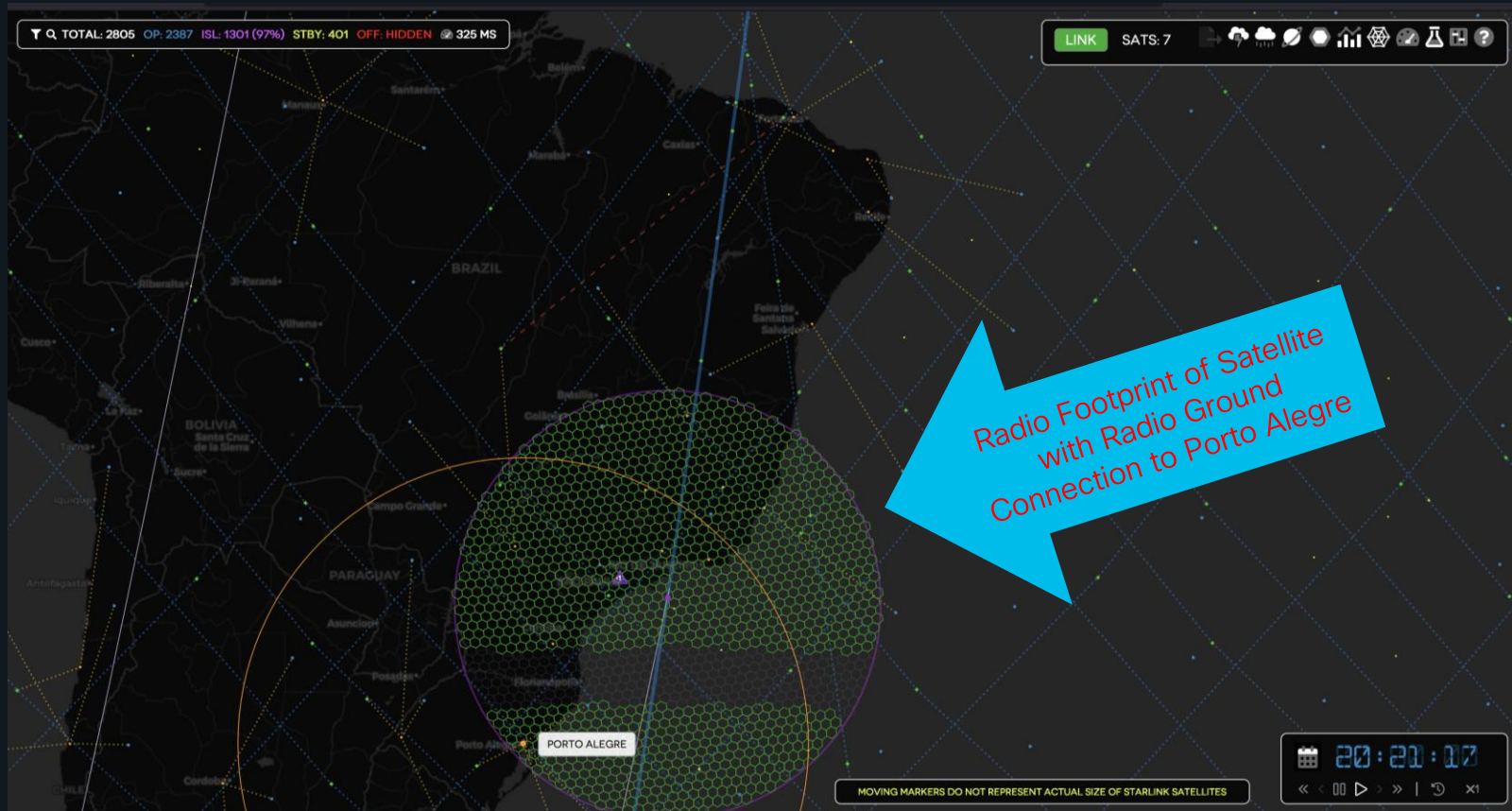


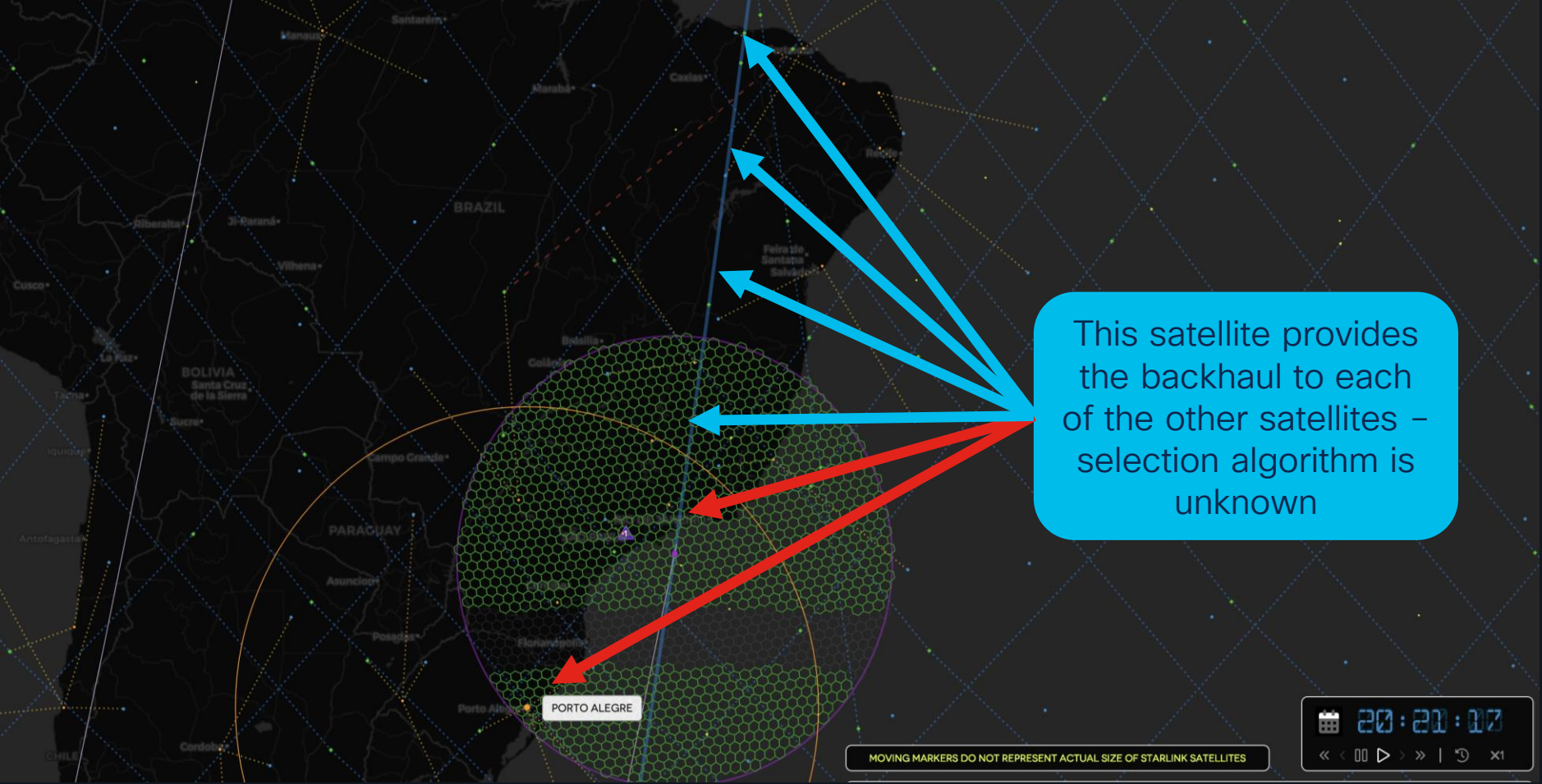




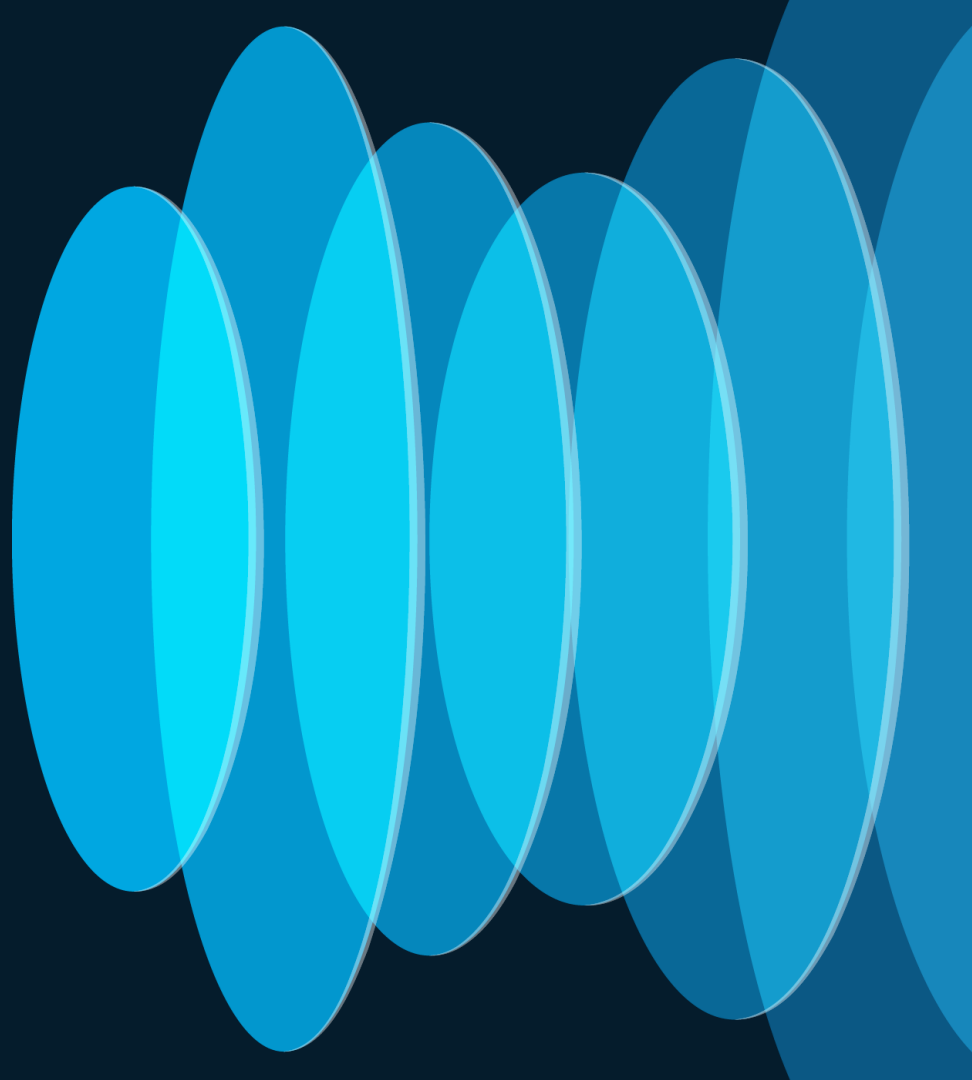


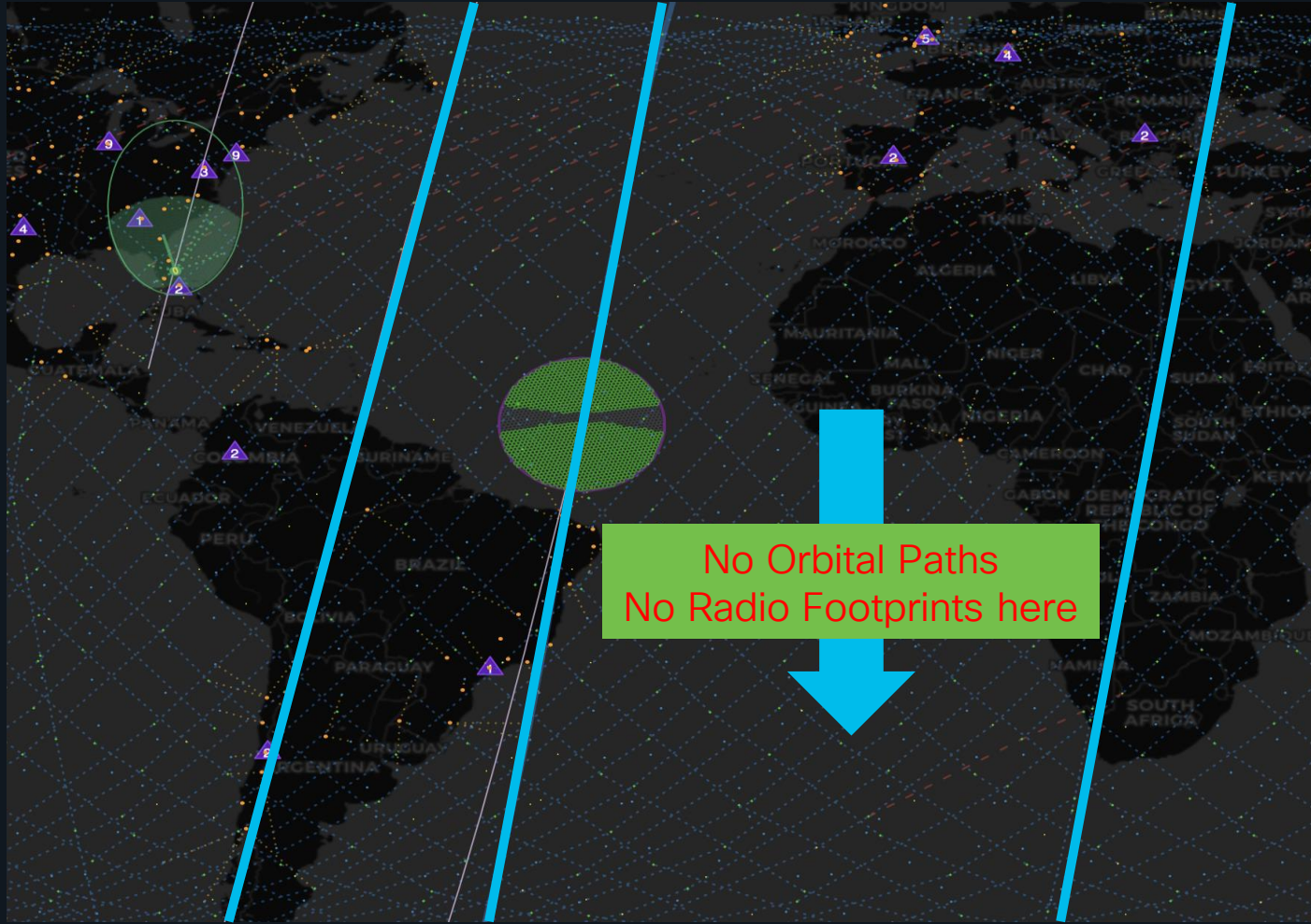


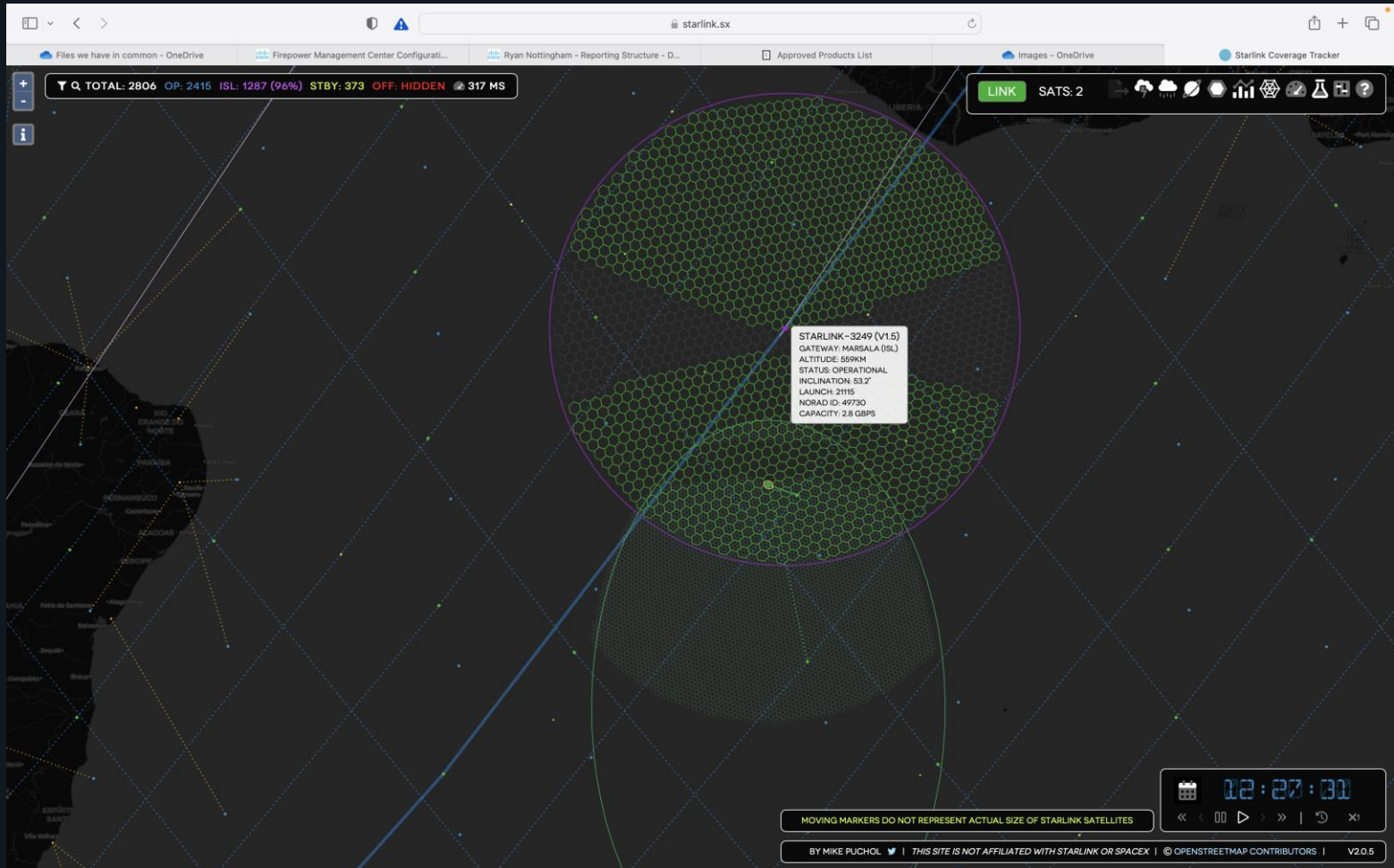




Challenges with Polar Orbits





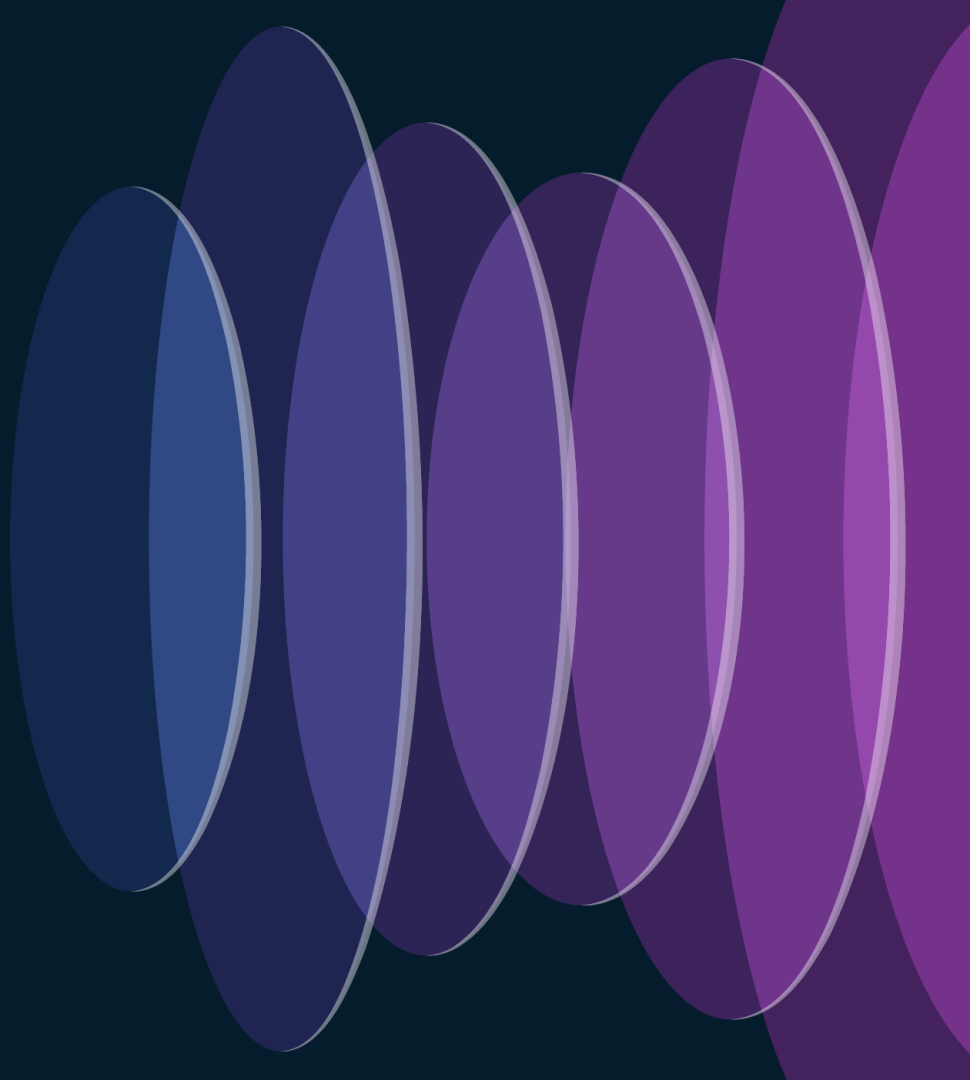


Enterprise Customer Service Assumptions


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.

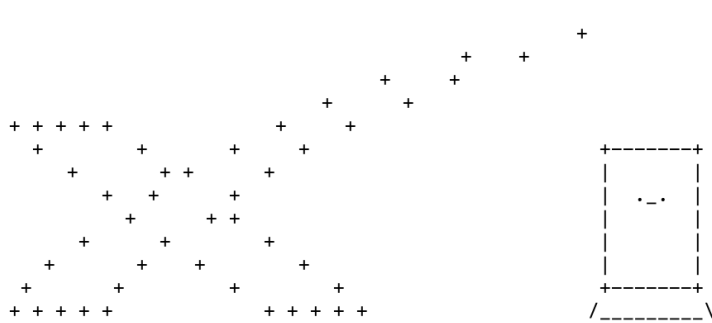
[Learn more about content filtering](#) **SAVE**

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

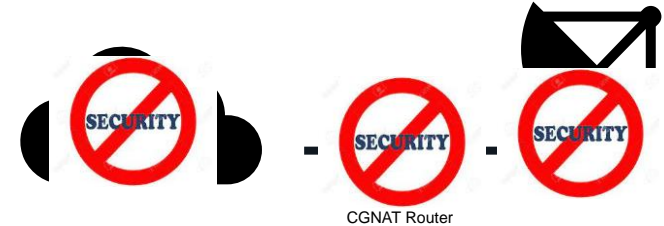
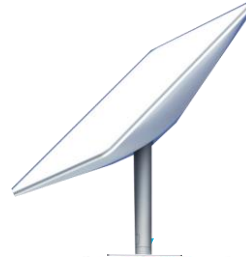
Things we know about Starlink Network

- 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

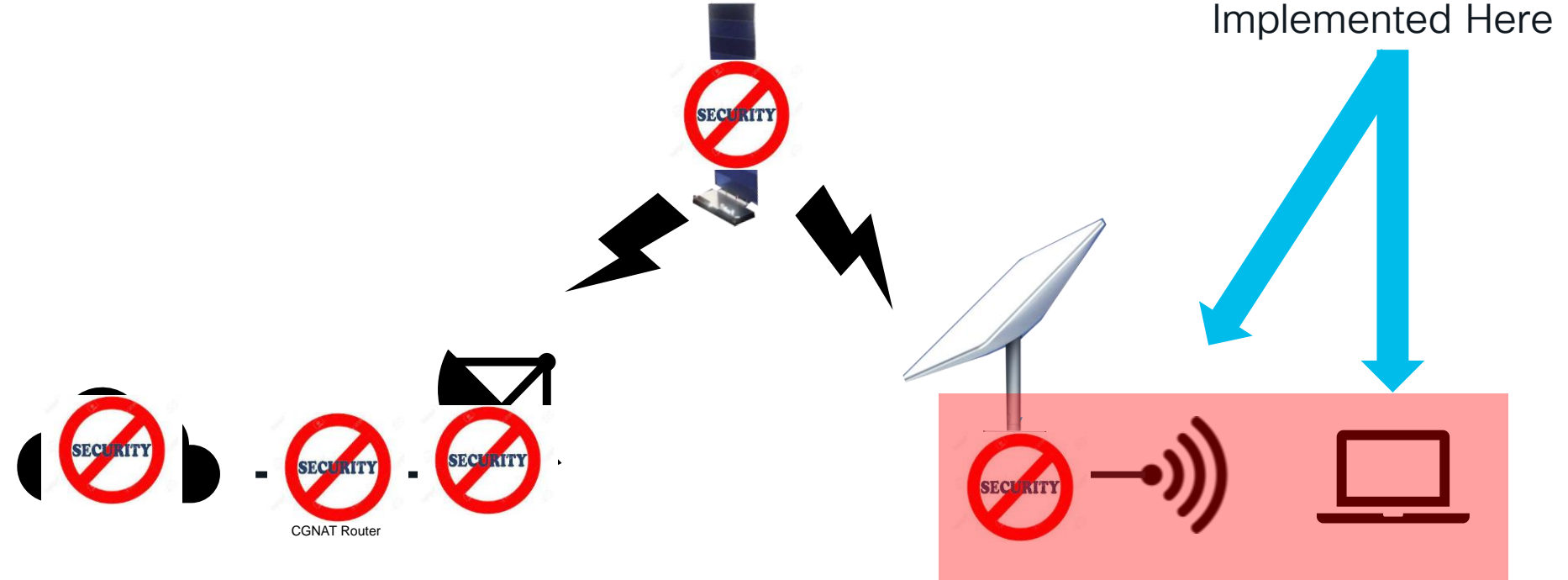


WPA2 Implemented here

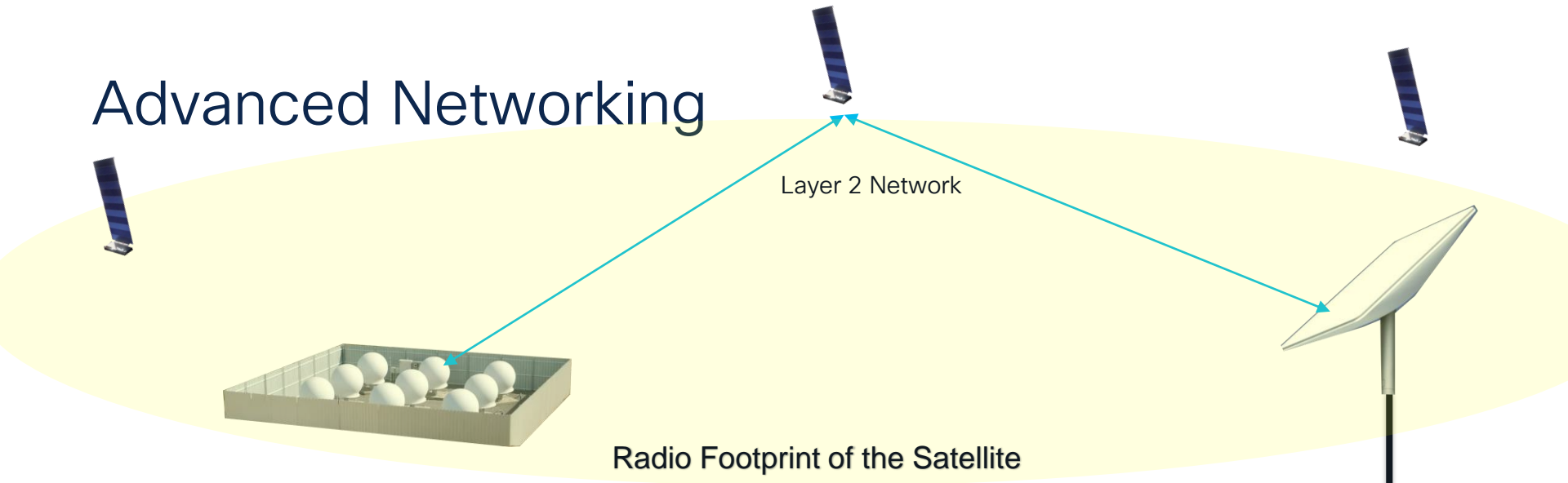


CGNAT Router

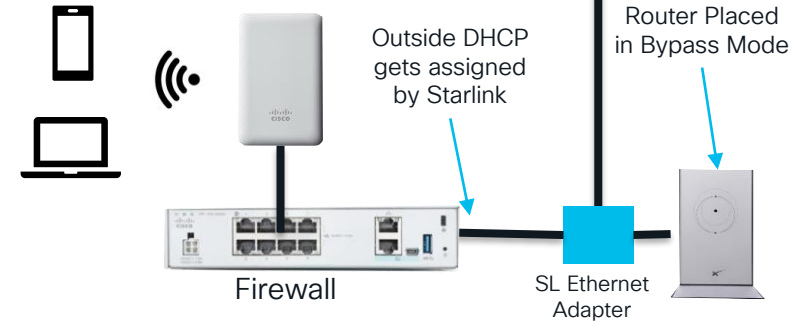
Starlink Security Today



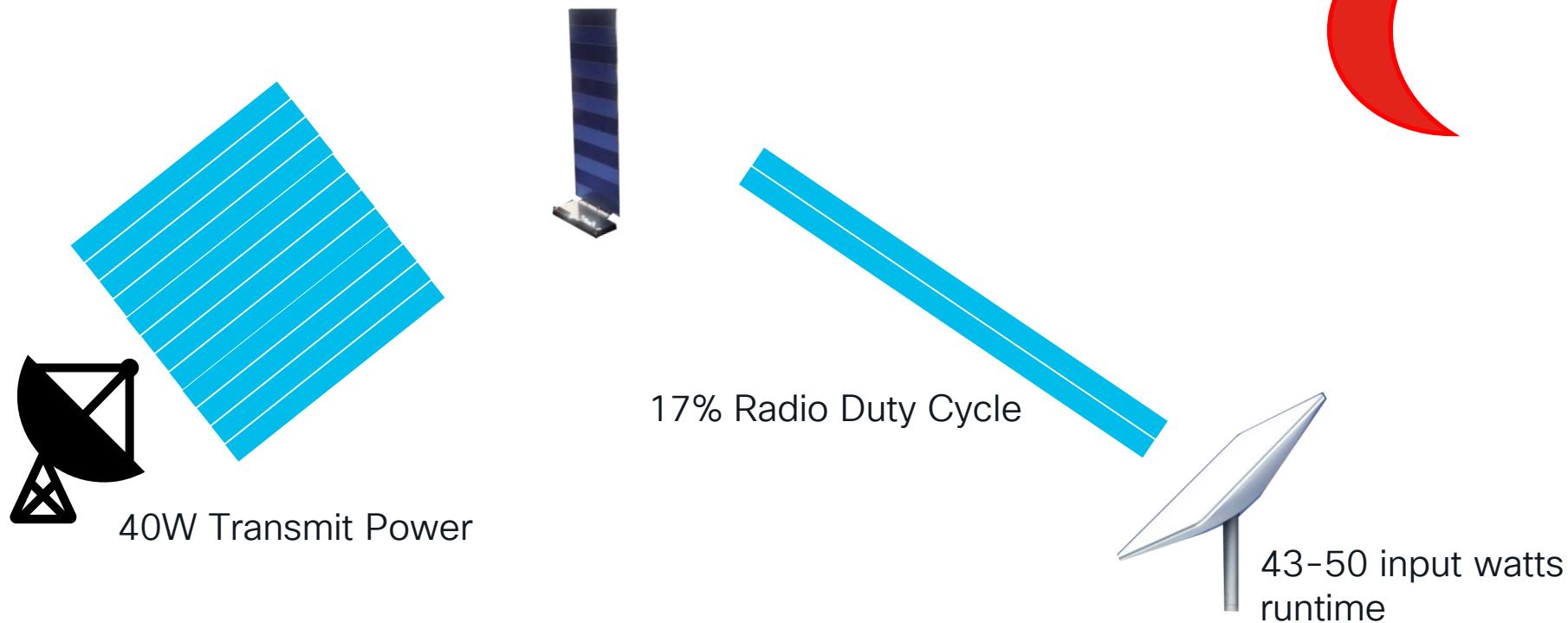
Advanced Networking



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



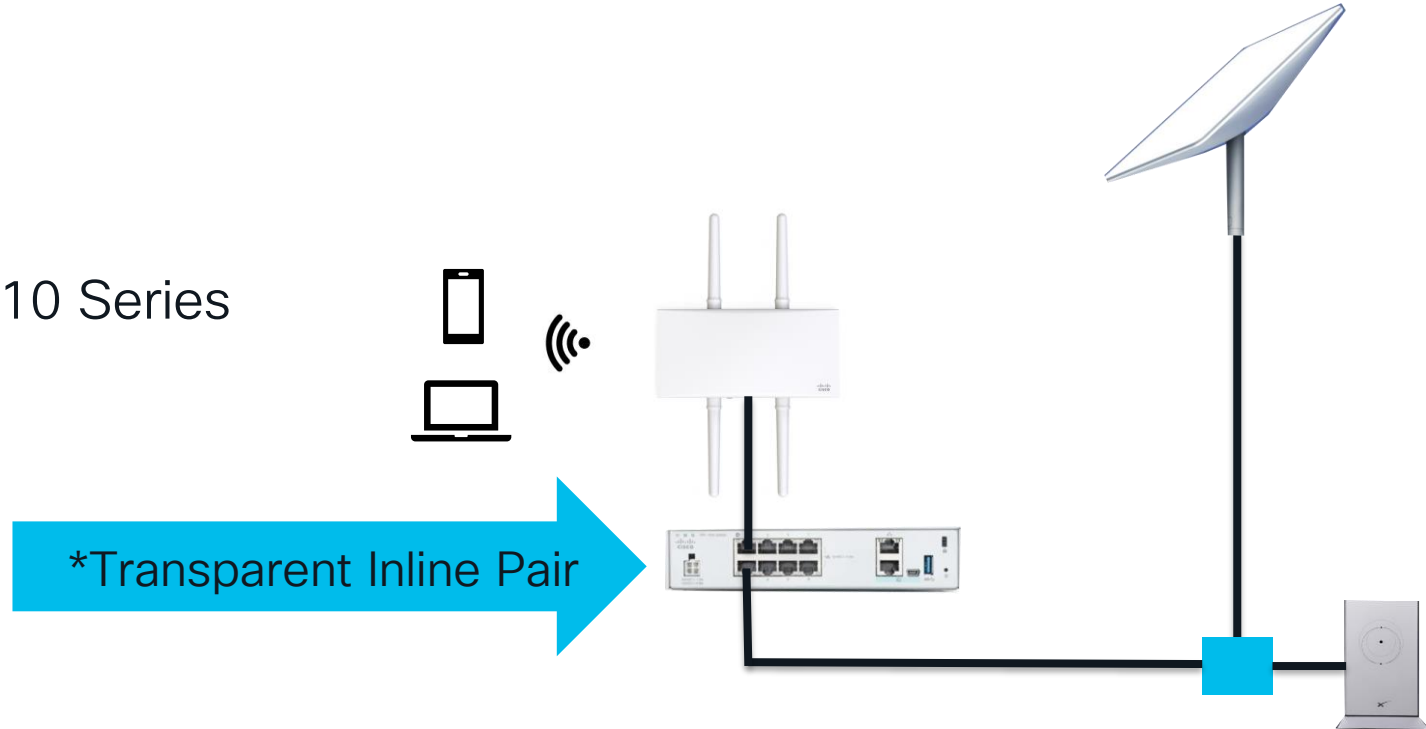
What is really happening (radio nerds)



Cisco Security + Starlink

Meraki+Firepower Deployment

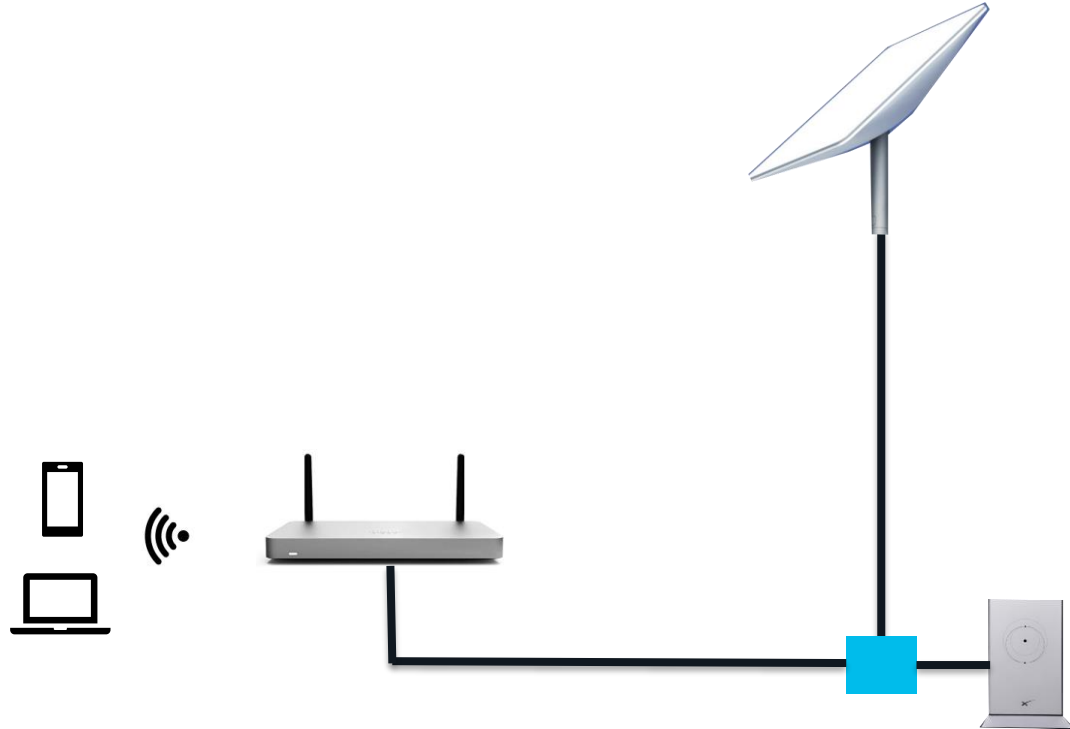
- MX Series
- MR Series
- Z3 Series
- Firepower 1010 Series



*Planned for FDM in 7.4 Release

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.

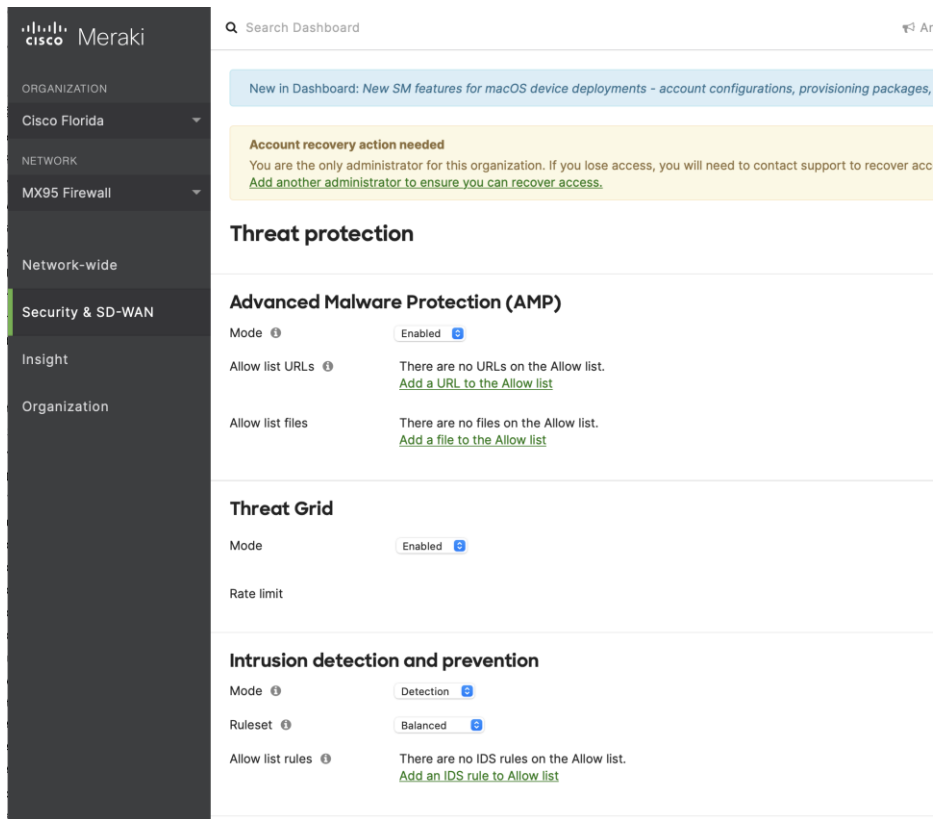
Minimum Firmware

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

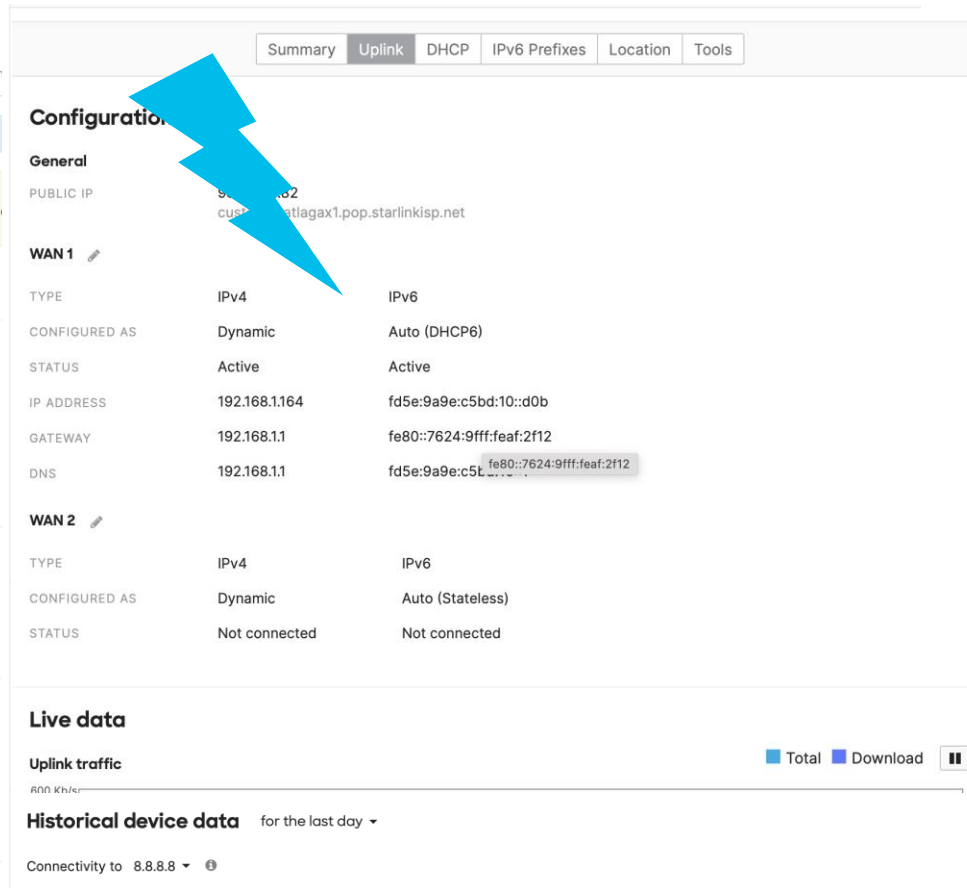
Supported Models

- 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



The screenshot shows the Cisco Meraki dashboard interface. On the left is a dark sidebar with navigation links: ORGANIZATION, Cisco Florida, NETWORK, MX95 Firewall, Network-wide, Security & SD-WAN (highlighted), Insight, and Organization. The main content area has a search bar and a notification banner about new SM features for macOS. Below this is a yellow alert box titled "Account recovery action needed" stating that the user is the only administrator and providing a link to add another administrator. The "Threat protection" section is expanded, showing "Advanced Malware Protection (AMP)" with "Mode" set to "Enabled". It lists "Allow list URLs" and "Allow list files", both currently empty. Below this is the "Threat Grid" section, also with "Mode" set to "Enabled" and a "Rate limit" field. The "Intrusion detection and prevention" section shows "Mode" set to "Detection" and "Ruleset" set to "Balanced". It also lists "Allow list rules", which are currently empty.



The screenshot shows the "Configuration" section of the Cisco Meraki dashboard. At the top are tabs for Summary, Uplink, DHCP, IPv6 Prefixes, Location, and Tools. The "Uplink" tab is selected. A large blue lightning bolt graphic points to the "WAN 1" configuration. The "General" section shows "PUBLIC IP" as "Static" and "WAN 1" configuration. The "WAN 1" table shows the following details:

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

Below this is the "WAN 2" configuration, which is "Not connected". The "Live data" section shows "Uplink traffic" with "Total" and "Download" buttons. The "Historical device data" section shows "Connectivity to 8.8.8.8" for the last day.

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

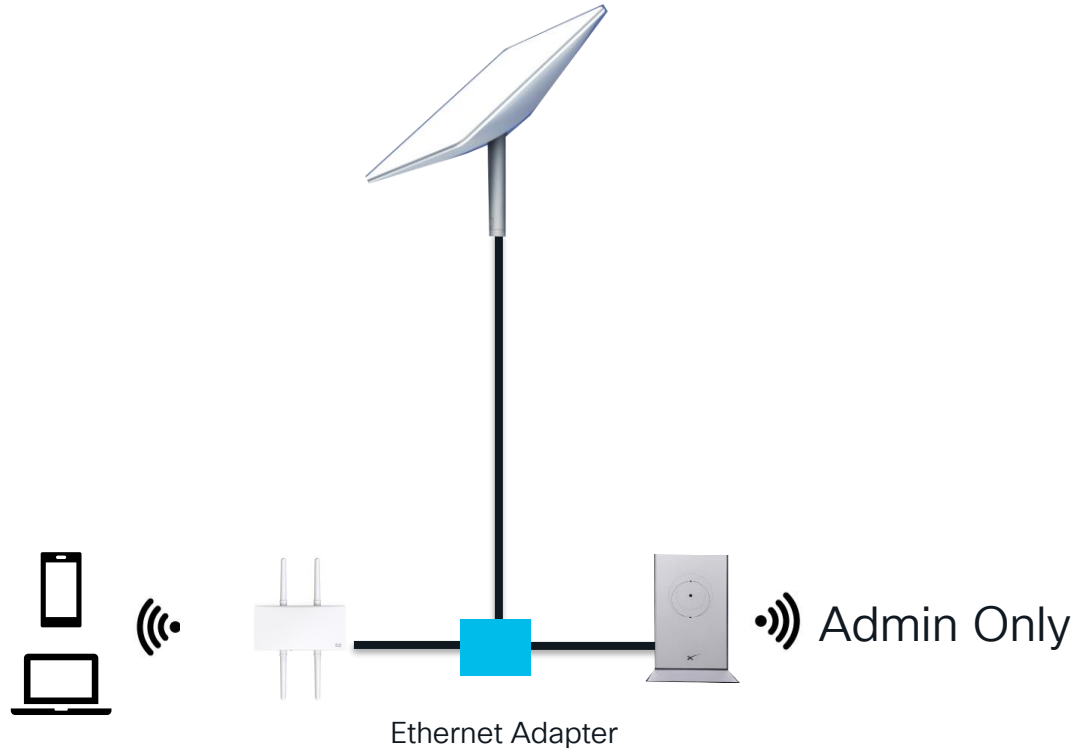
VLAN Assignments

Search by prefixes or VLAN name

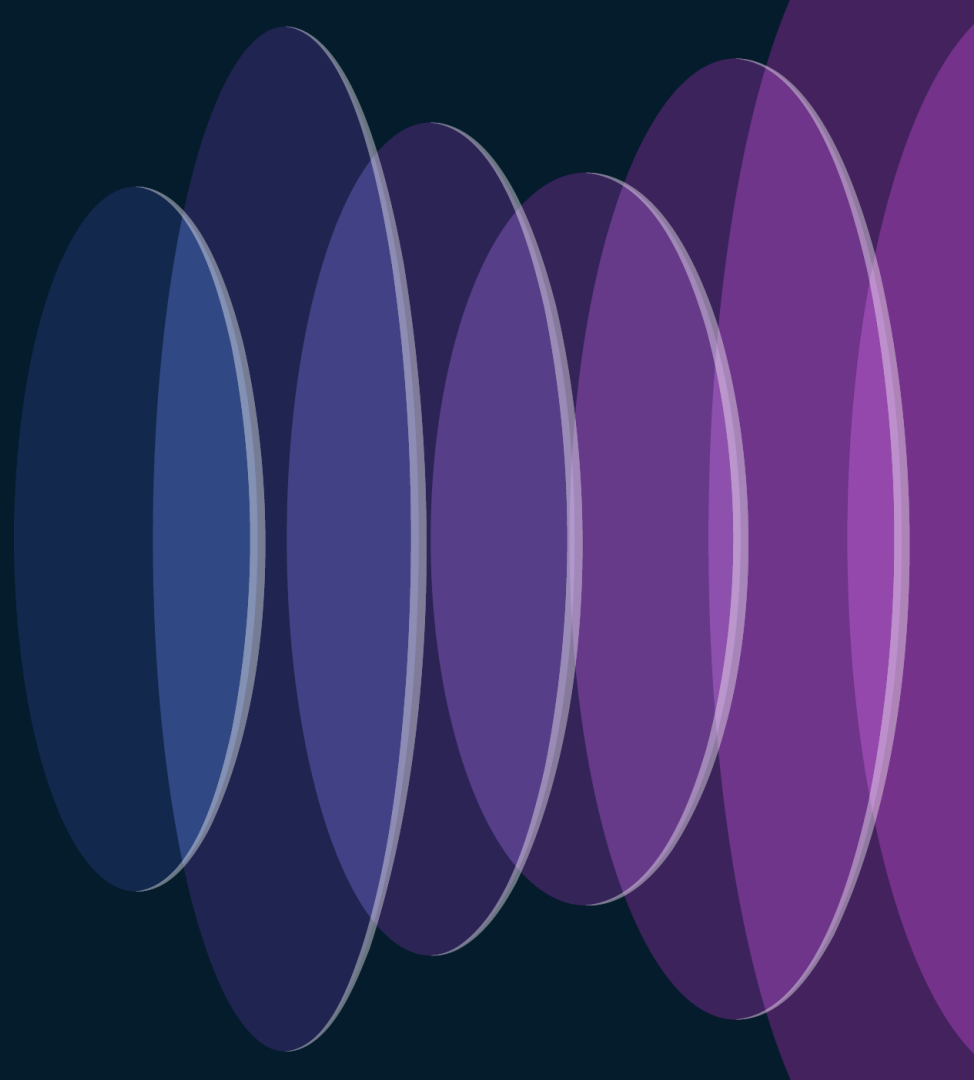
VLAN ID	VLAN name	Subnet prefix	Origin	Delegated prefix	Prefix status ⓘ
		fd5e:9a9e:c5bd:19::/64	WAN 1	fd5e:9a9e:c5bd:19::/64	Active

1 result

Keep it simple, don't overcomplicate things



Actual Working Things



Global Overview

Organization

Cisco Florida

Network

MX95 Firewall

Network-wide

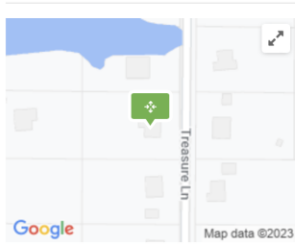
Security & SD-WAN

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	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 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)

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 LITE-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

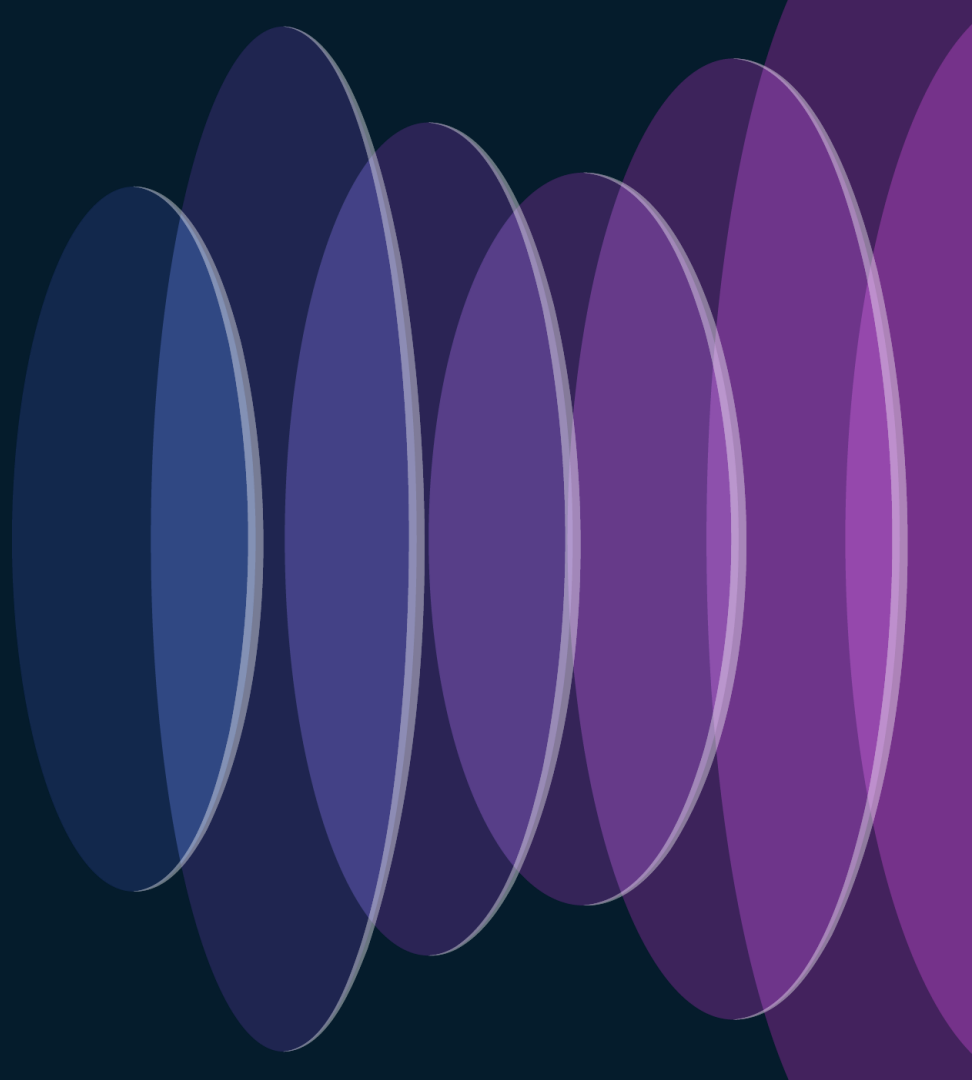
My Public IPv6: [2605:59c8:2103:7310:654e:1122:4a82:e20a](#)

My IP Location: New York City, NY US

My ISP: SpaceX Services Inc.

Actually does API lookups

Deployment Considerations

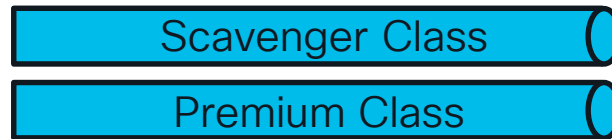
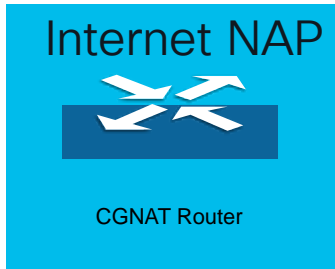


QoS Observations

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



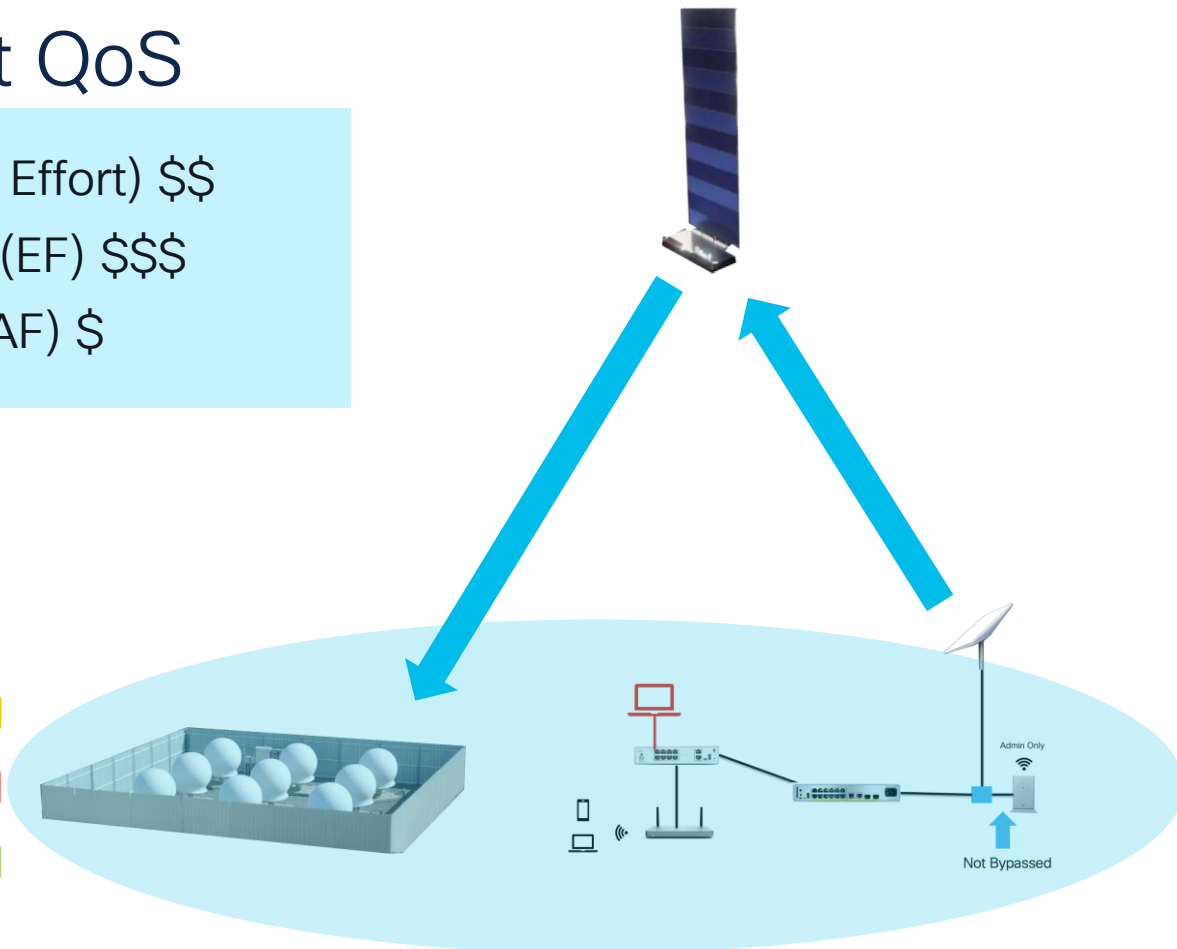
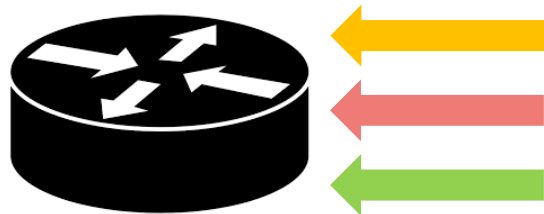
Scavenger class QoS



Residential QoS

Observed Current QoS

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

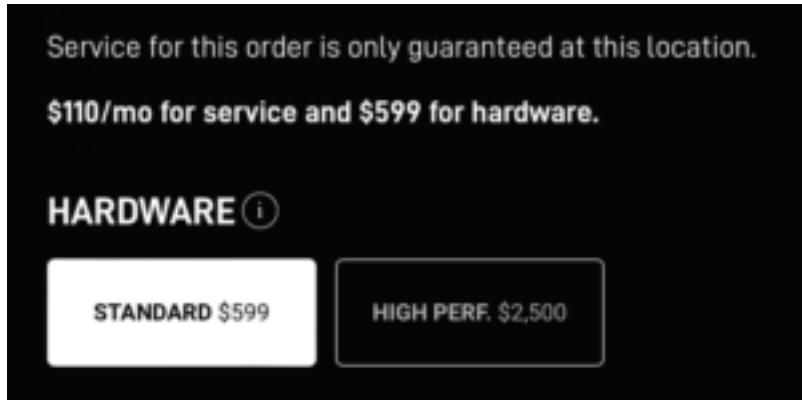


Deployment Considerations

- 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



- “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

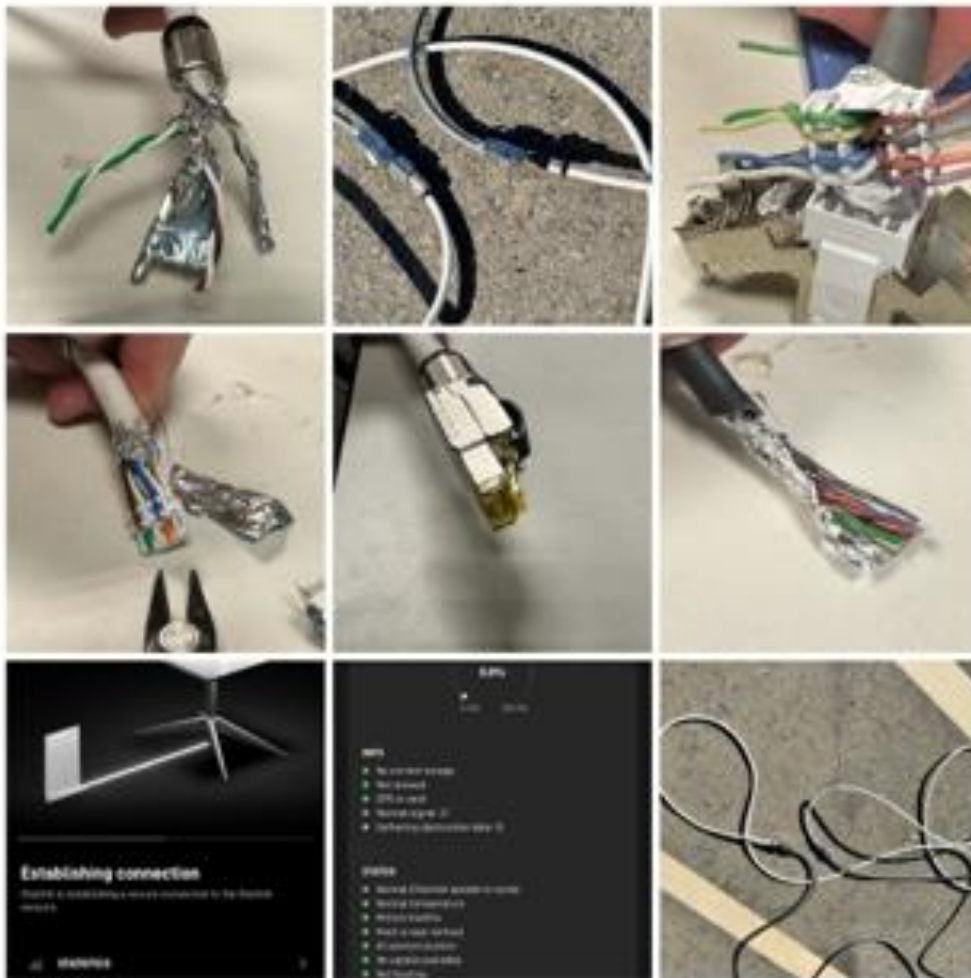
B2 - Purple 8 Brown

B3 - Brown 5 Blue/White

B4 - Gray 4 Blue

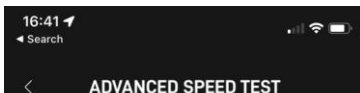
B5 × Shield / Shell

CAT8 22AWG STP RJ45





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

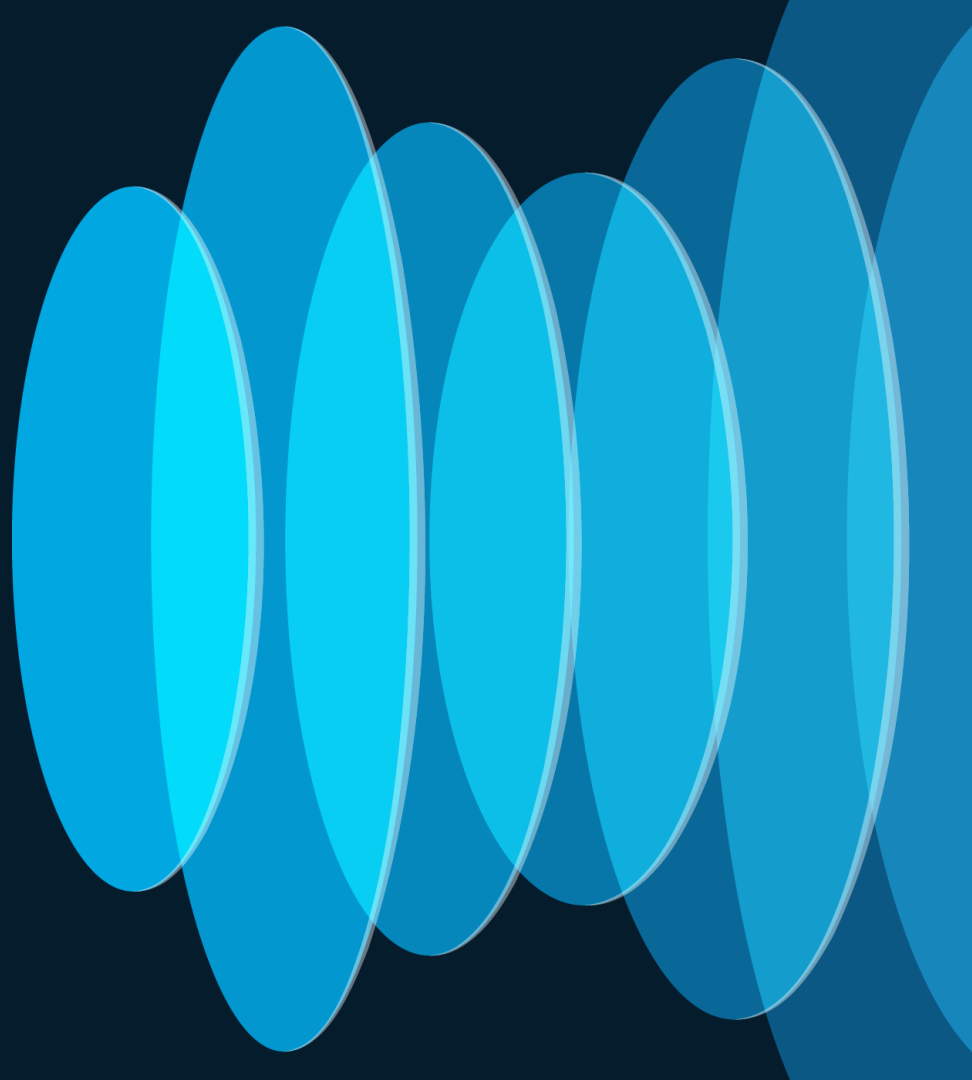


From Colorado – 100% Off Grid

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

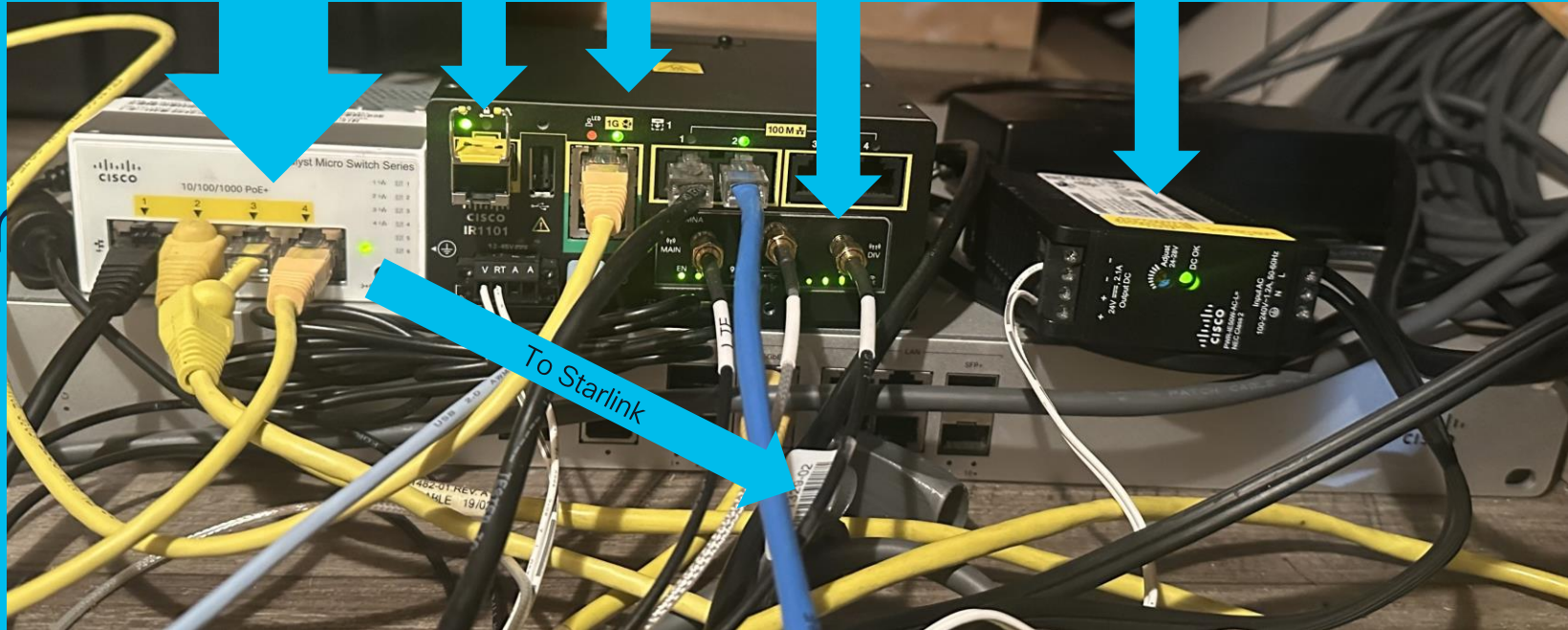
GigE to Catalyst

Pluggable LTE Radio

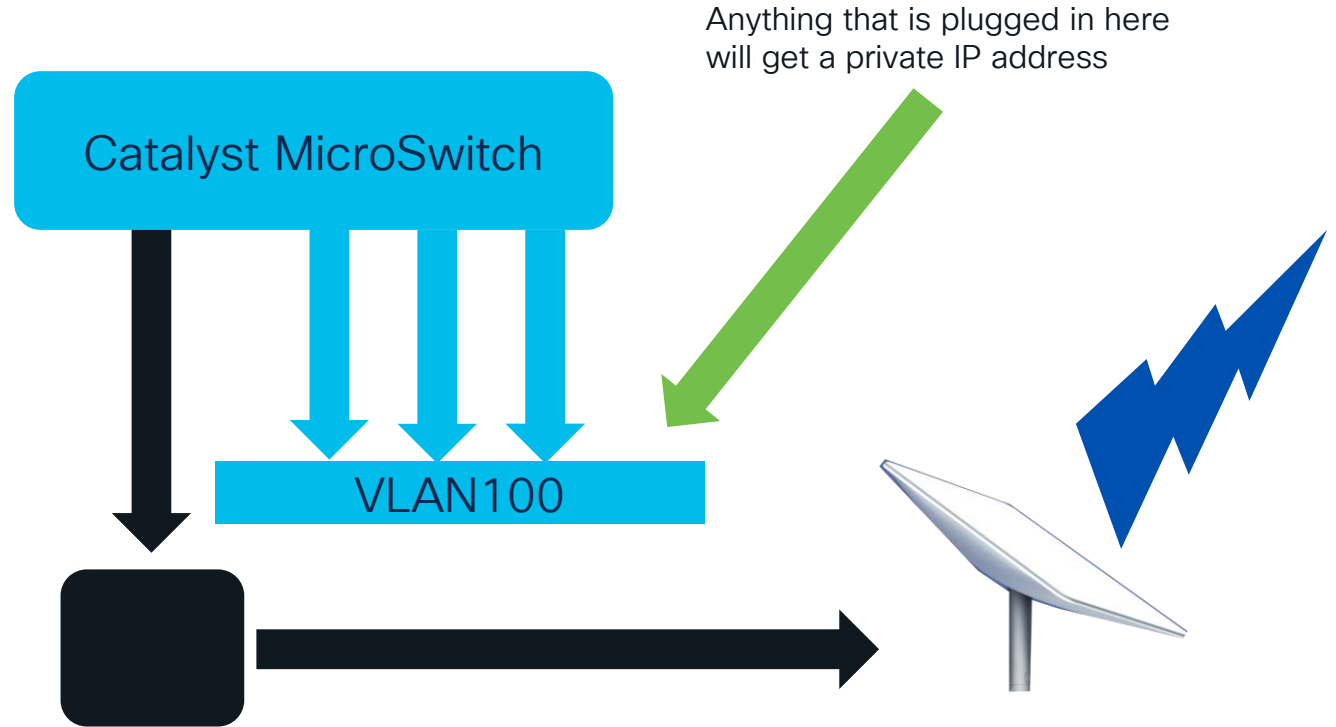
Catalyst Micro Switch
Single VLAN

SFP

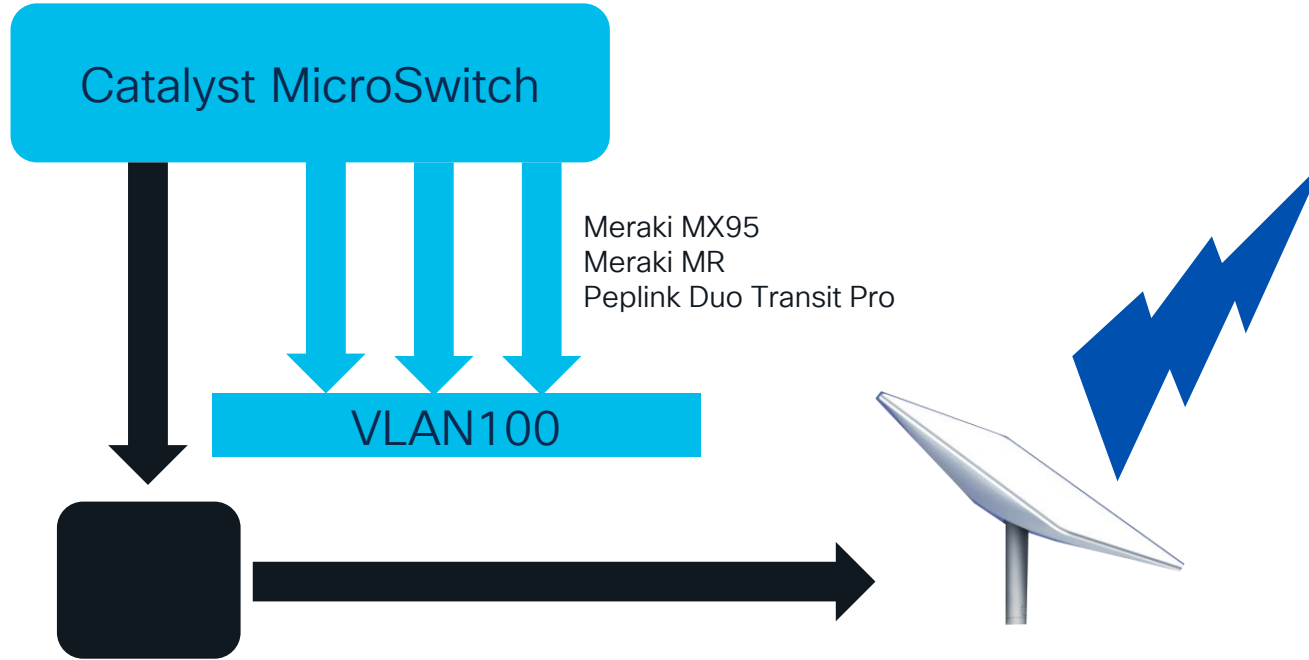
Fire



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. The top navigation bar includes a back arrow, the Cisco logo, the device name 'Cisco IR1101-K9' with version '17.14.1a', and a 'Welcome abenhase' message. The main navigation menu on the left lists: Dashboard, Monitoring, Configuration (highlighted), Administration, Licensing, and Troubleshooting. The breadcrumb trail is 'Configuration > Security > Threat Defense > Cisco DNS Layer Security Integration'. The right side of the page has 'Apply' and 'Unconfigure DNS Layer Security' buttons. The configuration fields are: 'Registration Token*' with value '7105a672ff204fd986355a880ea22ee' and a link 'Click here to get your Token'; 'Organization ID' with value 'NONE'; 'Allowed Domains' with value 'cisco.com'; and a checked checkbox for 'Enable DNS packets encryption'. Below these are three panels: 'Interfaces (4)' with a search bar and a list of Cellular0/1/1, Async0/2/0, Vlan1, and Vlan100; 'LAN Interfaces (4)' with a list of FastEthernet0/0/1 through 0/4, each with a dropdown menu (all set to 'inside'); and 'WAN Interfaces (2)' with a list of Cellular0/1/0 and GigabitEthernet0/0/0. A 'Drag and Drop to add/remove LAN & WAN Interfaces' instruction with a curved arrow points from the main Interfaces list to the LAN and WAN interface lists.

Configuration > Security > Threat Defense > Cisco DNS Layer Security Integration

Apply Unconfigure DNS Layer Security

Registration Token* 7105a672ff204fd986355a880ea22ee [Click here to get your Token](#)

Organization ID NONE

Allowed Domains cisco.com

☒ Enable DNS packets encryption

Interfaces (4) Search

- Cellular0/1/1
- Async0/2/0
- Vlan1
- Vlan100

LAN Interfaces (4)

- FastEthernet0/0/1 inside1
- FastEthernet0/0/2 inside2
- FastEthernet0/0/3 inside3
- FastEthernet0/0/4 inside4

WAN Interfaces (2)

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

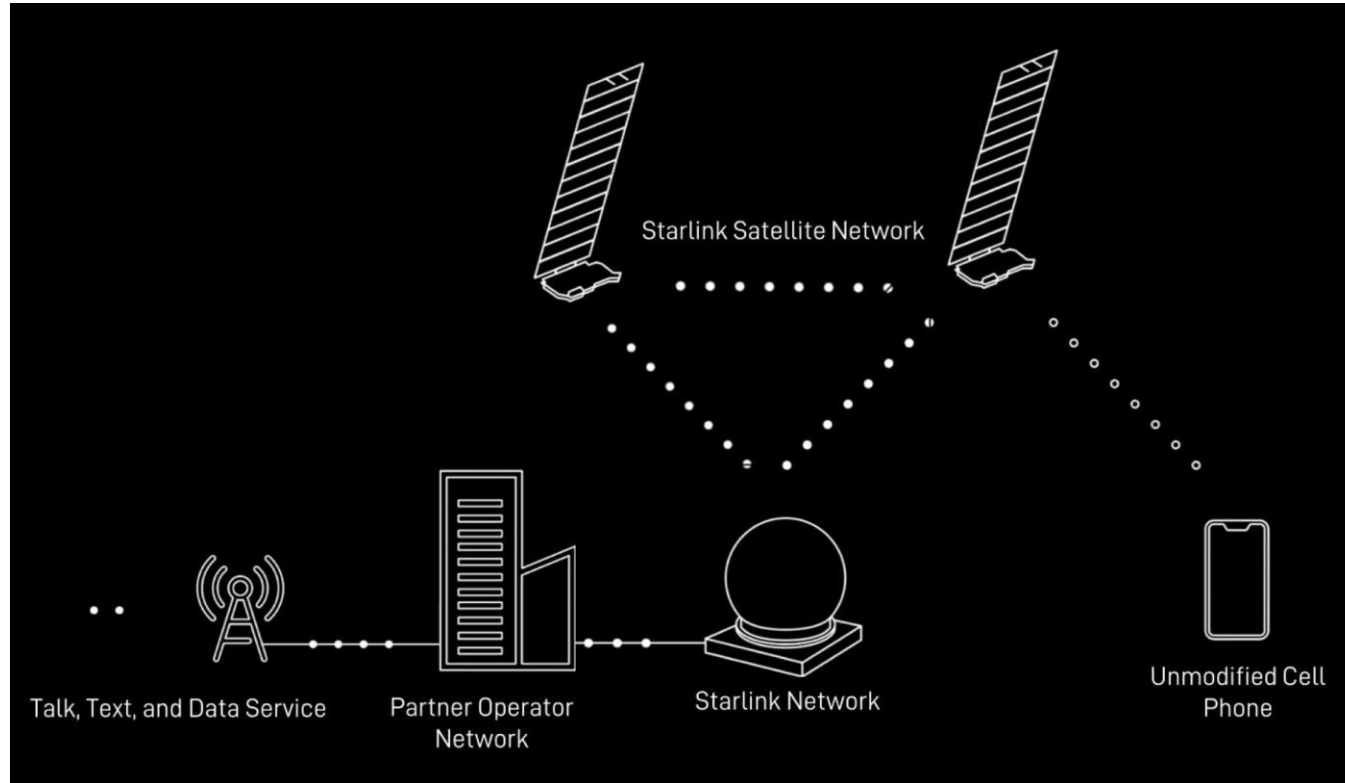
Drag and Drop to add/remove LAN & WAN Interfaces

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)

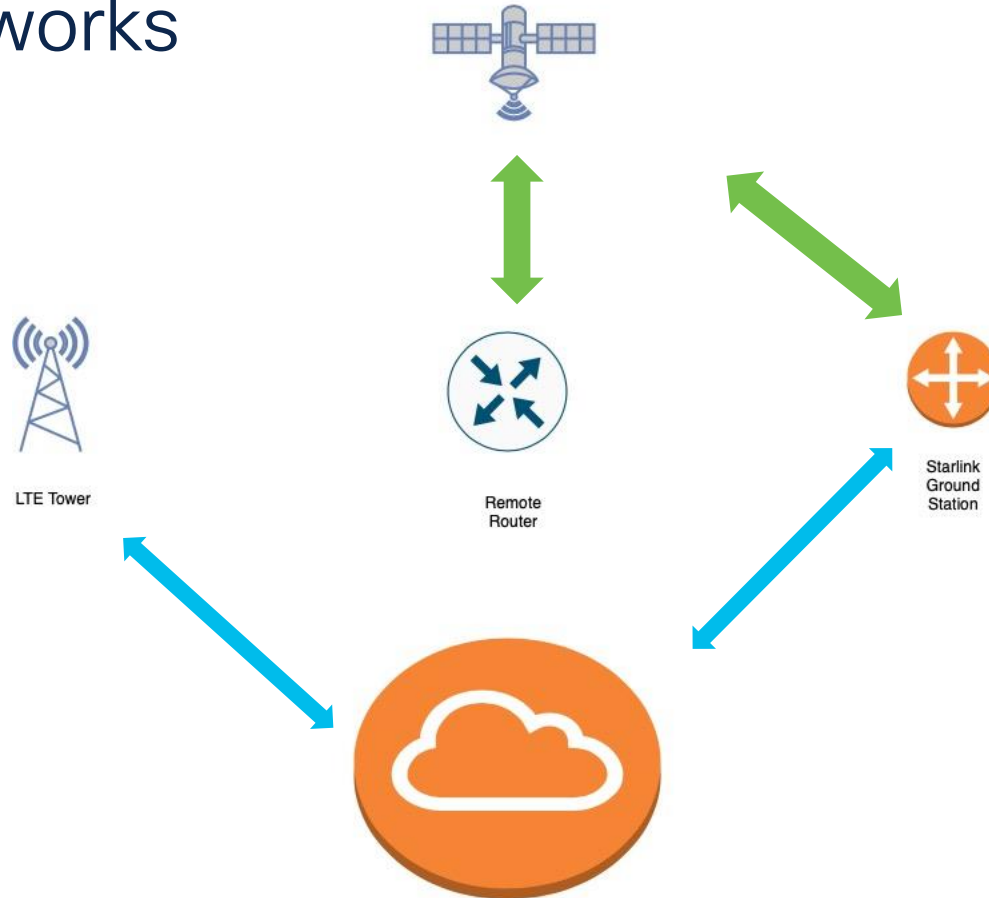
Direct to Cell



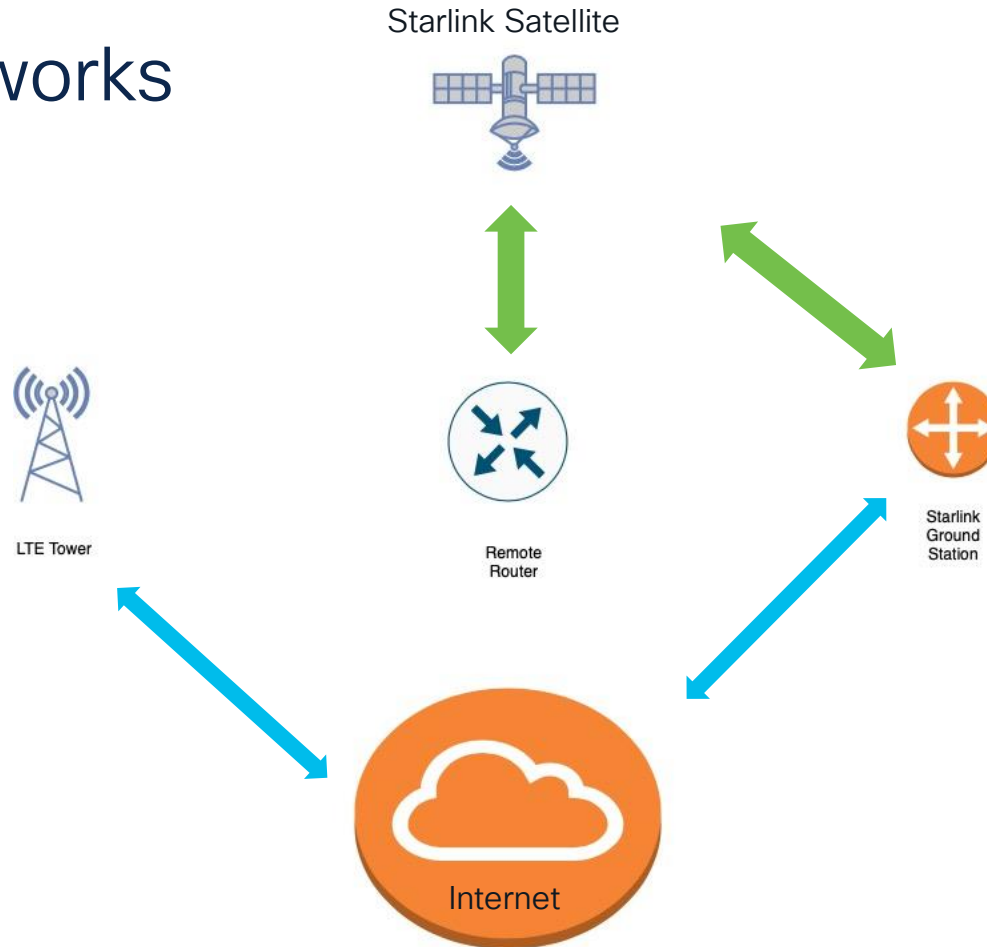
Starlink – Direct to Cell

- 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

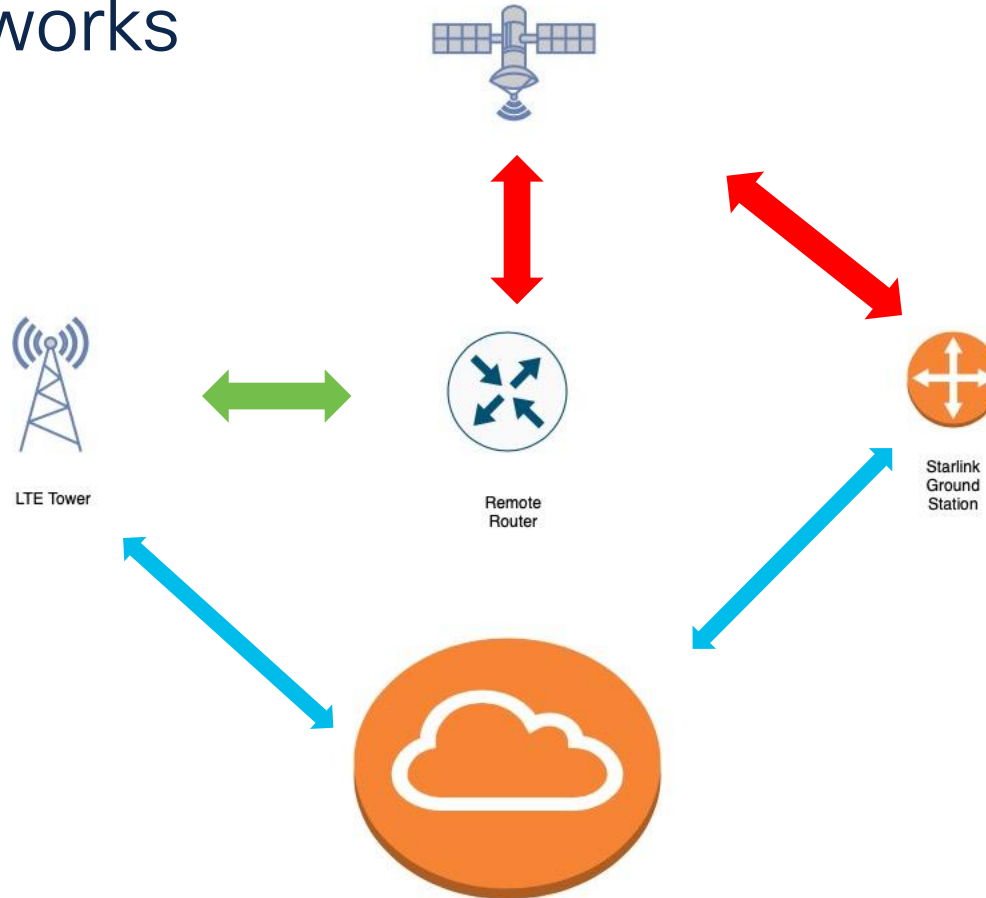
How this works

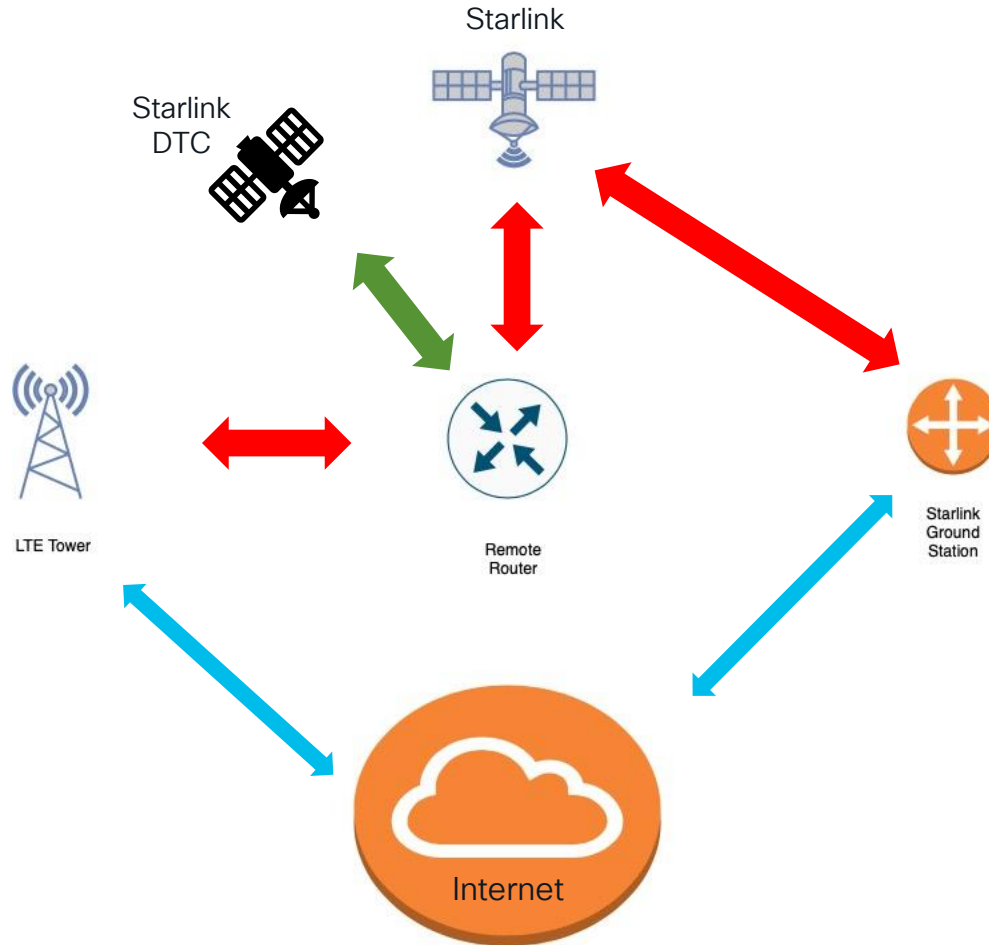


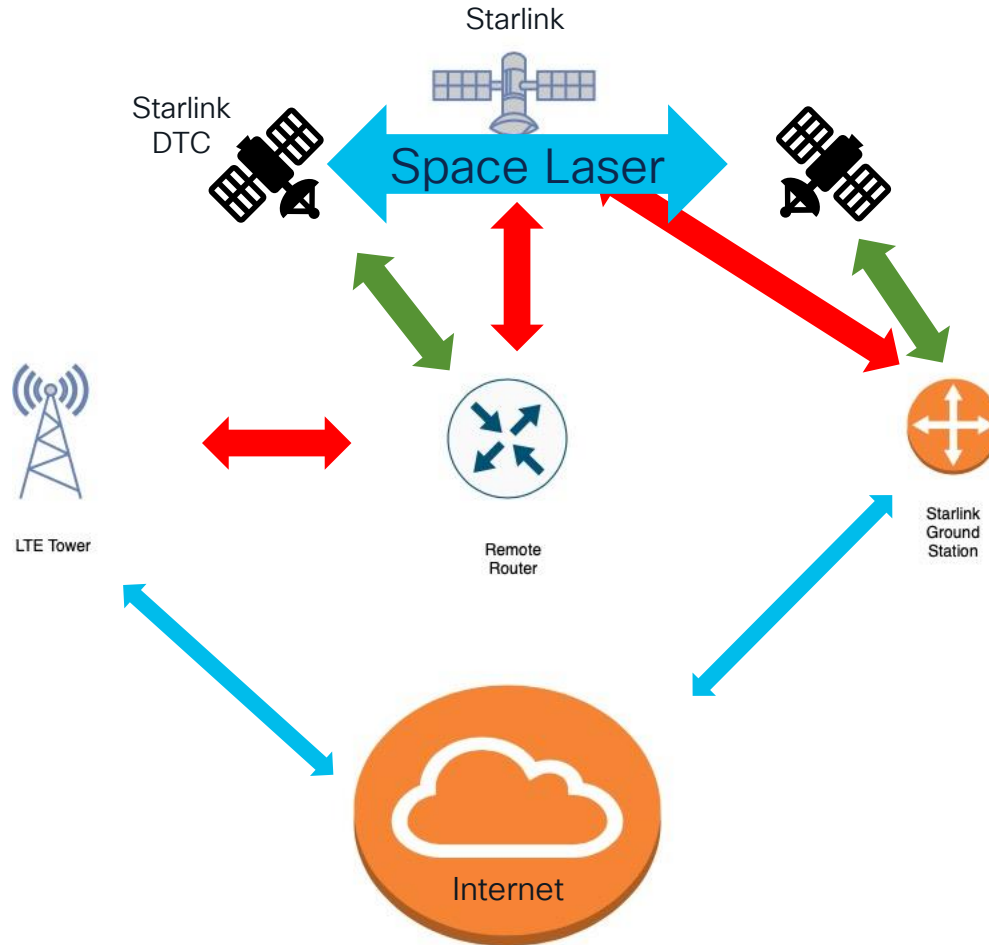
How this works



How this works







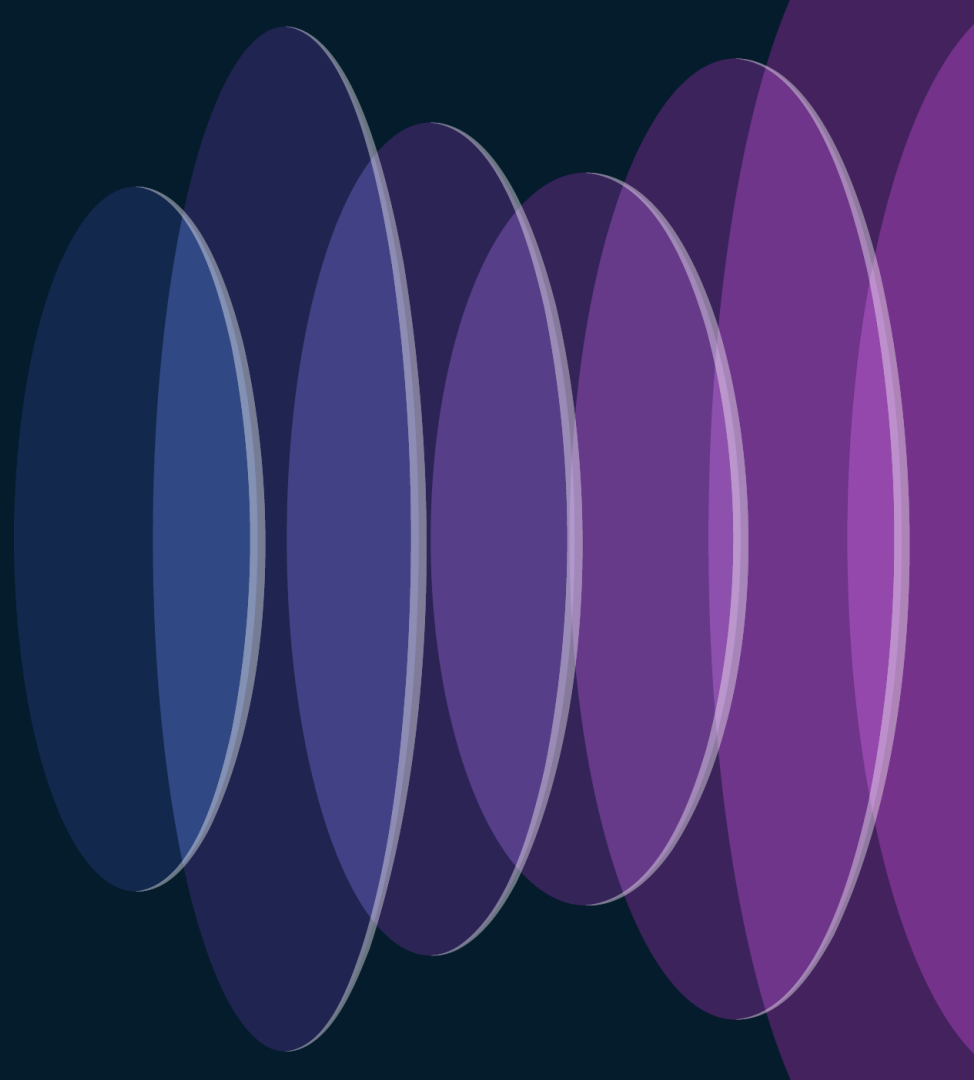
Remote Sensor Package Details

- 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



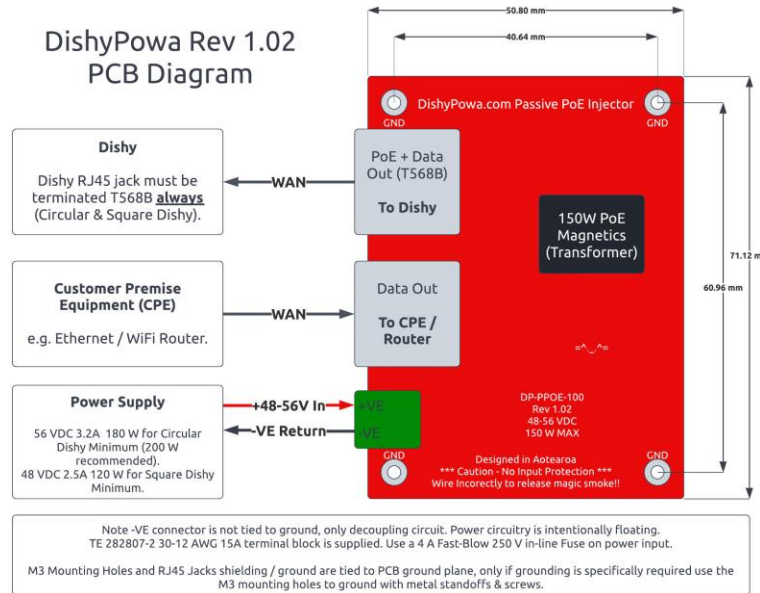


Disclaimer

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: 9-30V(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

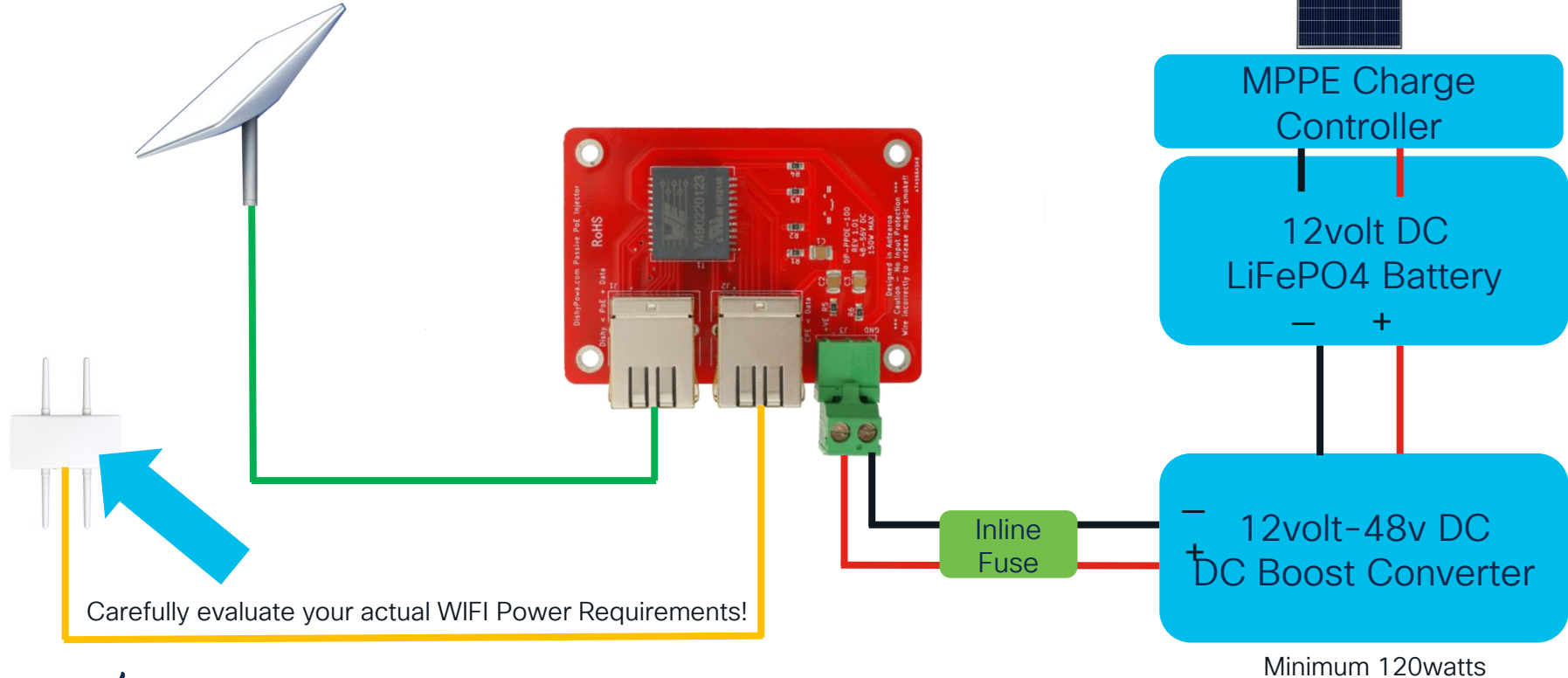
12V50Ah \$179.98	12V100Ah \$299.99
12V100Ah Smart \$479.99	12V200Ah \$599.99
12V300Ah \$999.99	24V100Ah \$649.99
48V100Ah \$1,699.98	



Roll over image to zoom in

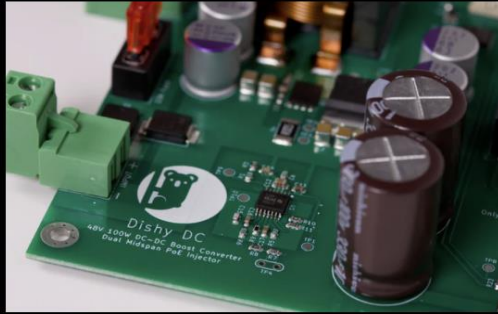
cisco Live!

Wiring Diagram



Dishy Dualie Products

Filter: Availability ▾



Dishy Dualie DC Power Supply
\$148.00 AUD

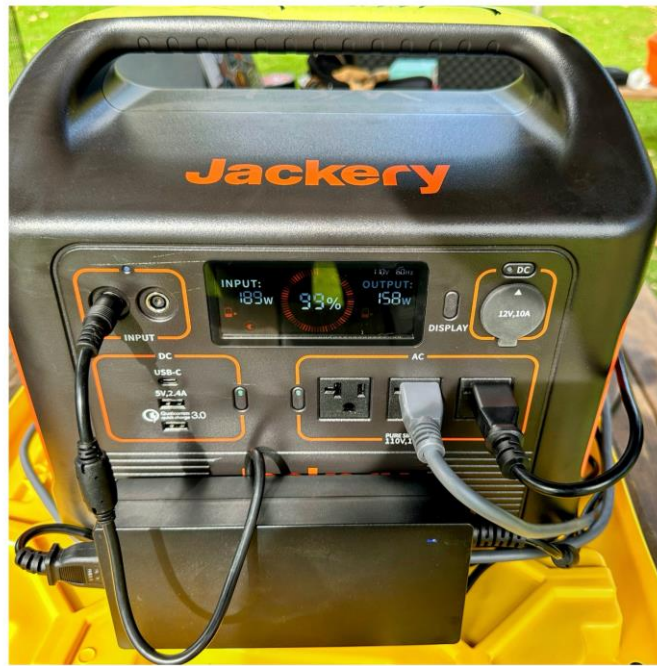


Dishy Dualie DC Enclosure
\$68.00 AUD

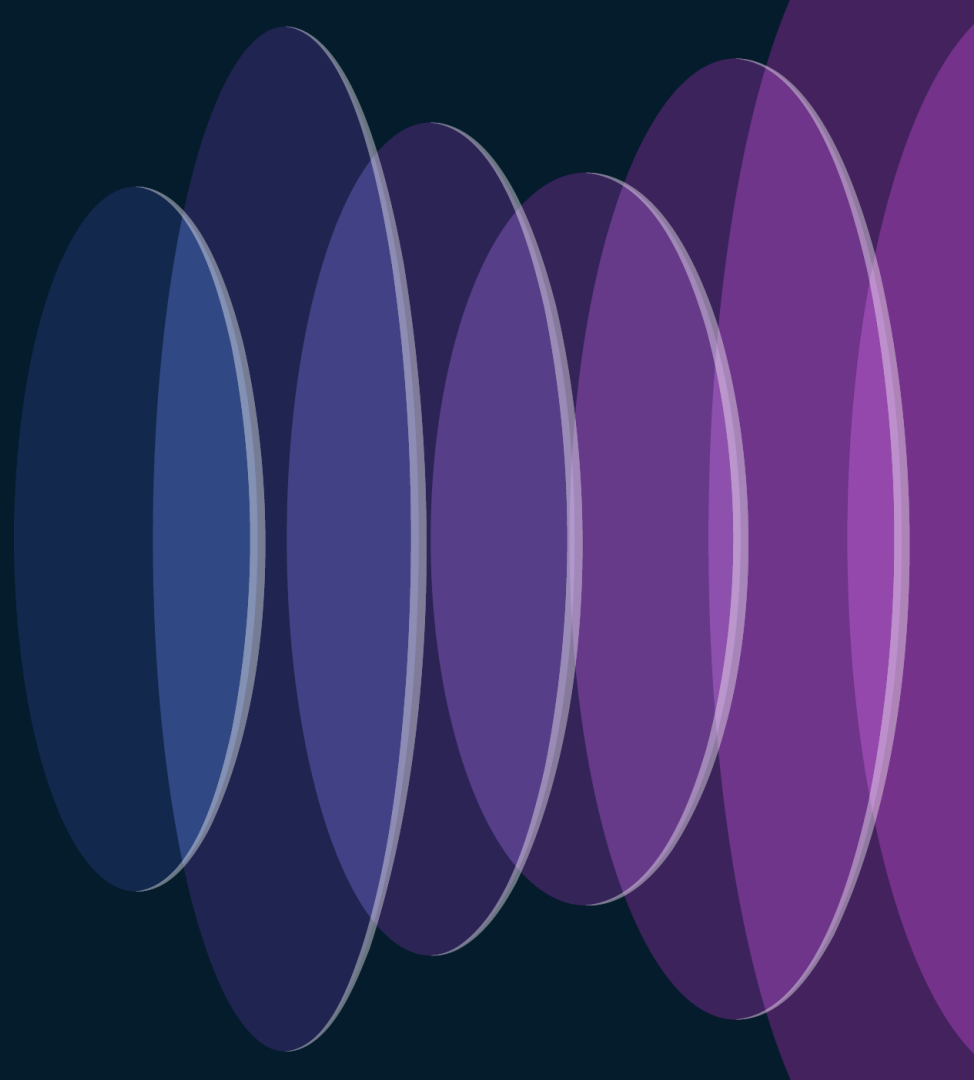
Cisco Crisis Response Deployment to Maui

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

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



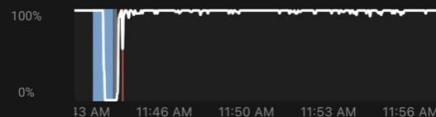
9F8E4566

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 ⓘ

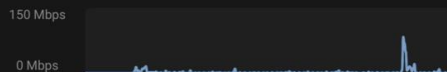
LATENCY ⓘ

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.

TIME ⓘ

OUTAGES

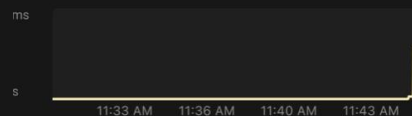


2 minutes:

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

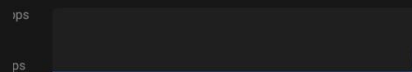
ENCY ⓘ

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



THROUGHPUT ⓘ

SPEED TEST



EB3A2226002144201



Power off



72%



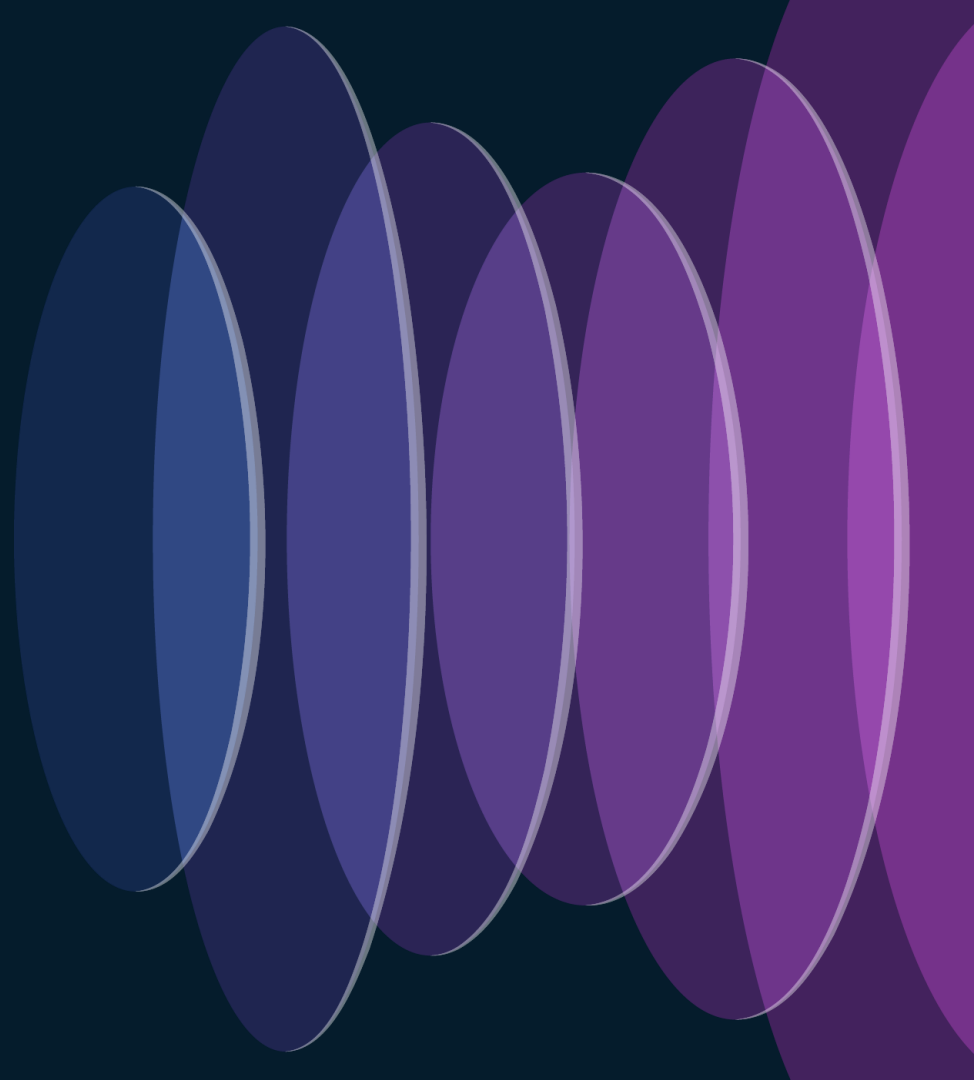
DC

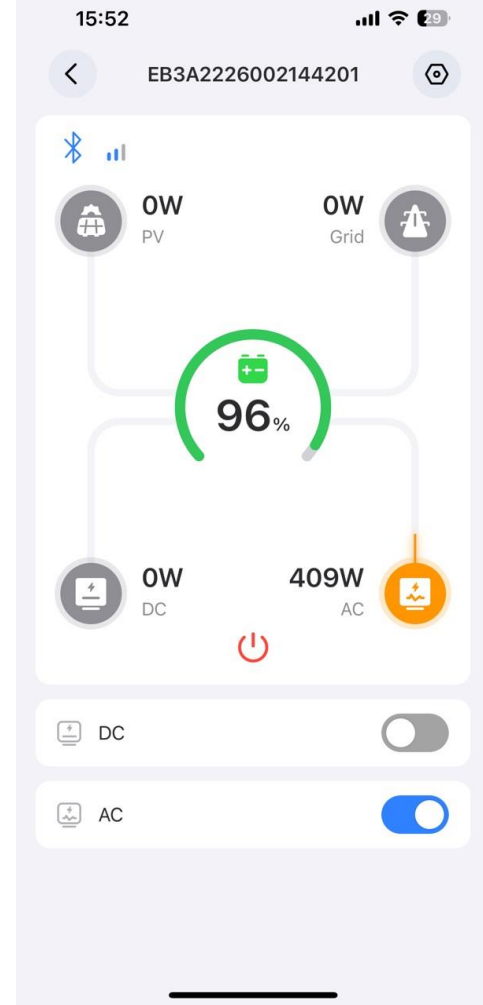


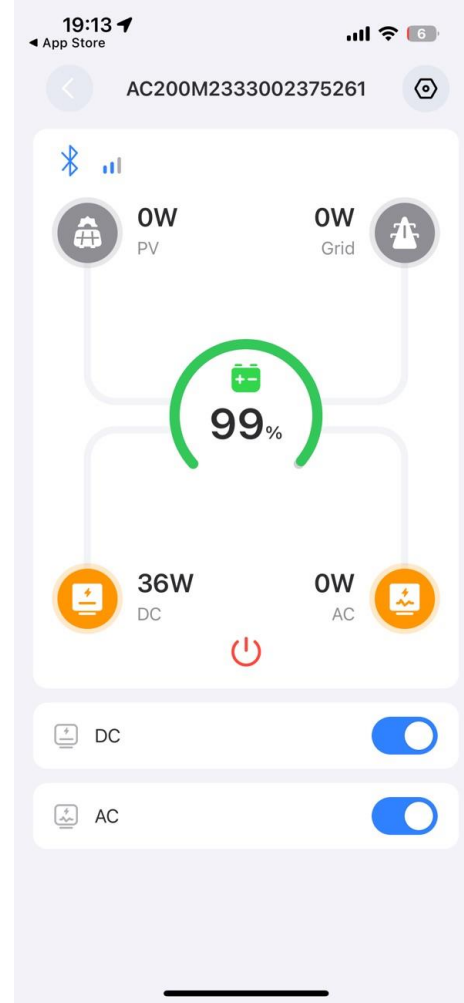
AC



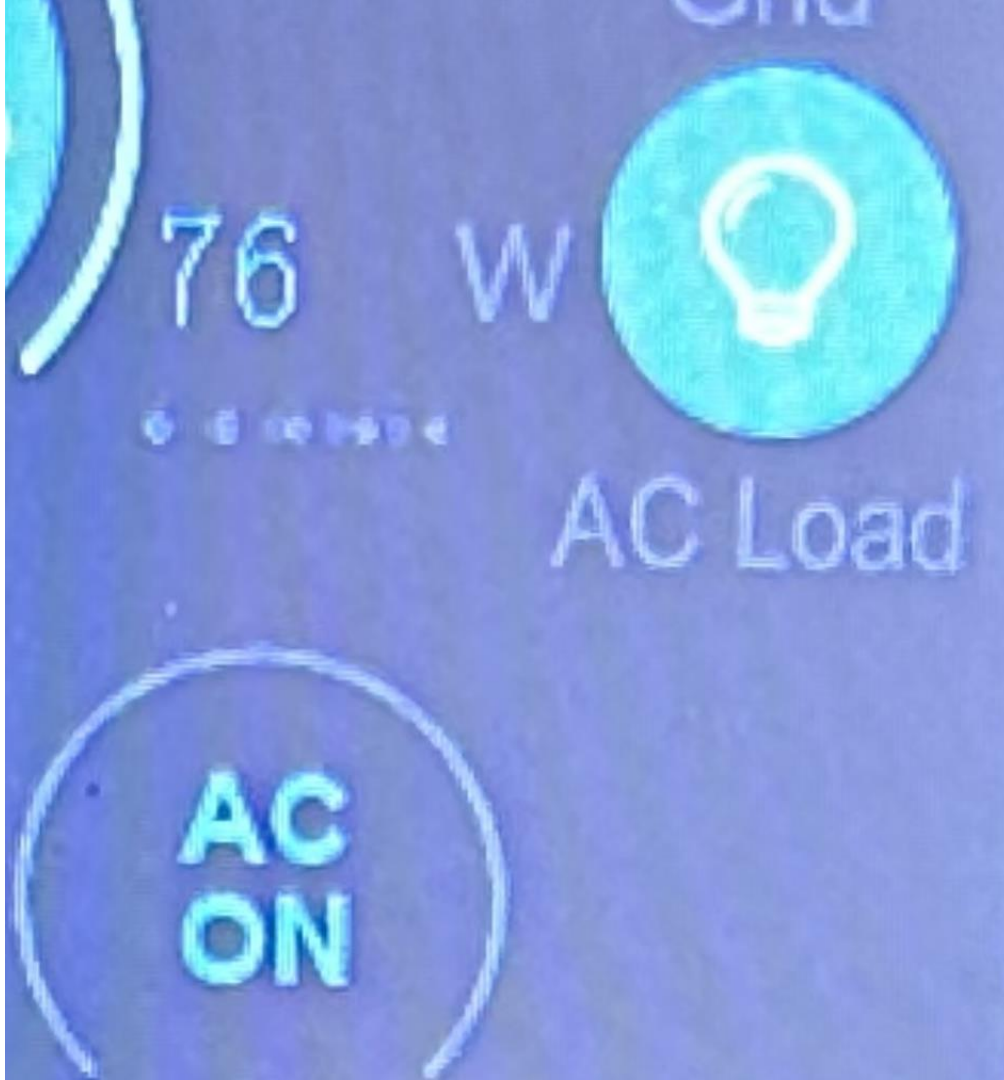
SOLAR POWER (this year)











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

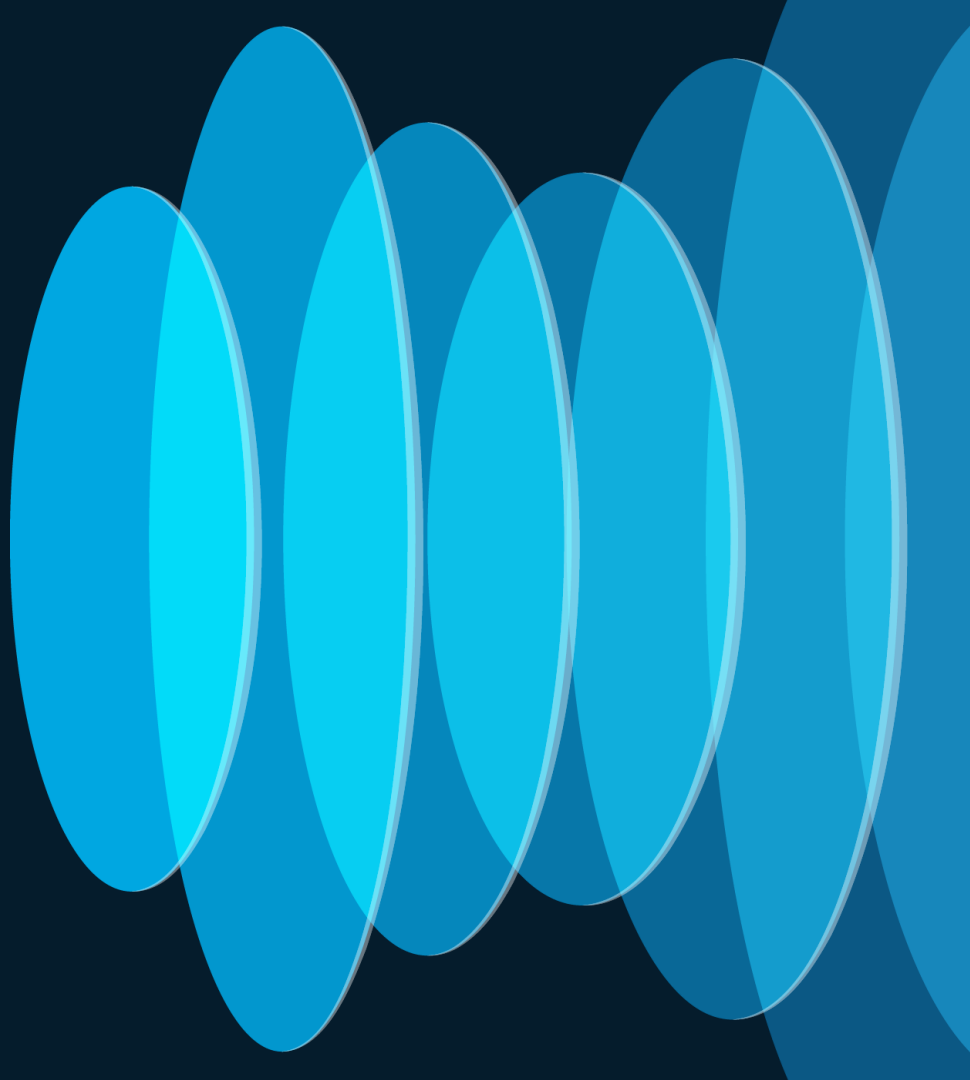
4

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.utm.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.utm.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.utm.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.utm.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.utm.release',
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':
'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.utm.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.utm.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.utm.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.utm.release',
to_first_nonempty_slot': 0.0, 'pop_ping_drop_rate': 0.0, 'downlink_throughput_bps': 885557.0, 'uplink_throughput_bps': 485163.53125, 'pop_ping_latency_ms':
```


Docker Tools Repository

The screenshot shows the Docker Desktop application window. The top bar includes 'Docker Desktop', an 'Upgrade plan' button, a search bar, a '96K' badge, and user settings for 'abenhase'. The left sidebar contains navigation options: Containers, Images, Volumes, Dev Environments (with a 'BETA' badge), Extensions (with a 'BETA' badge), and 'Add Extensions'. The main area is titled 'Images' with a 'Give feedback' link. Below the title 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 'Last refresh: 6 days ago' indicator is present. A search bar contains the text 'star'. Below this is a table of images with columns: NAME, TAG, STATUS, CREATED, SIZE, and ACTIONS. The table lists six 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 the version '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

star

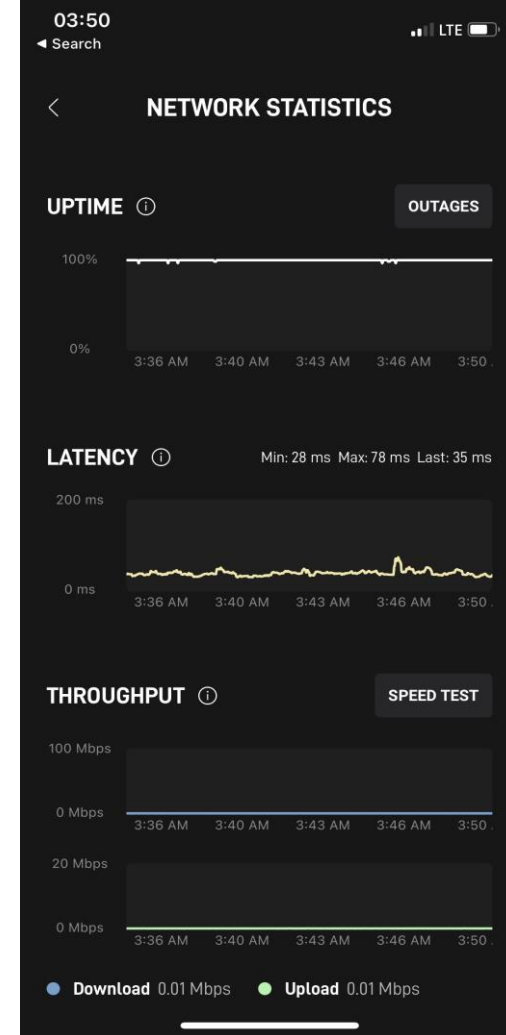
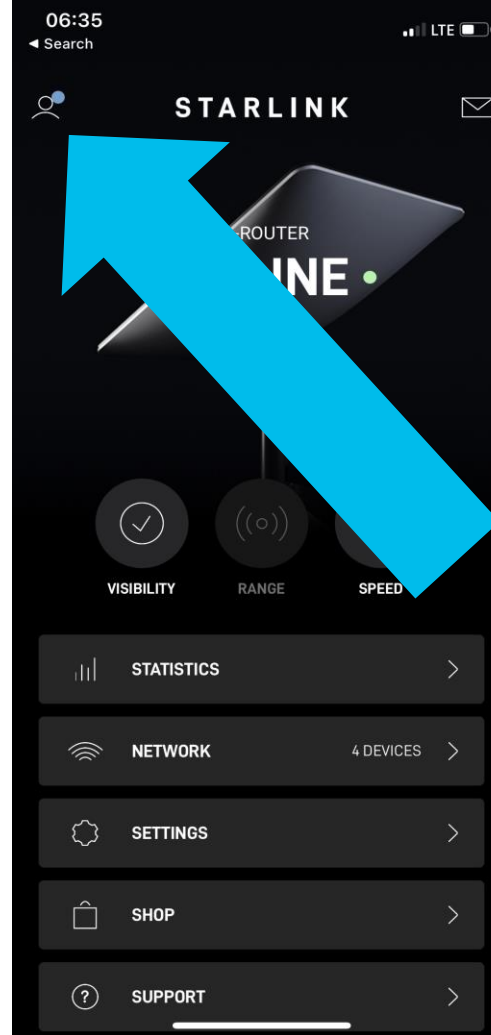
NAME	TAG	STATUS	CREATED	SIZE	ACTIONS
sponsianus/starlink-grpc-tools 330f096f73b1	latest	In use	8 days ago	961.64 MB	▶ ⋮ 🗑️
ghcr.io/sparky8512/starlink-grpc-tools 3221e3c4730e	latest	In use	26 days ago	960.32 MB	▶ ⋮ 🗑️
sponsianus/starlink-grpc-tools 9385172f655f	<none>	In use (danglir)	2 months ago	960.93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

Showing 8 items

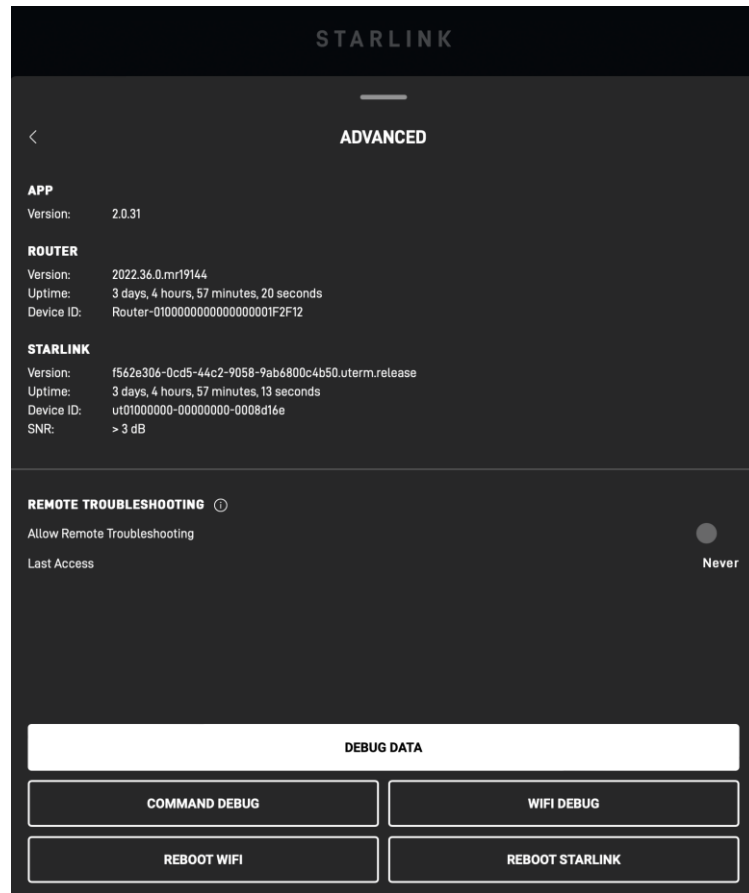
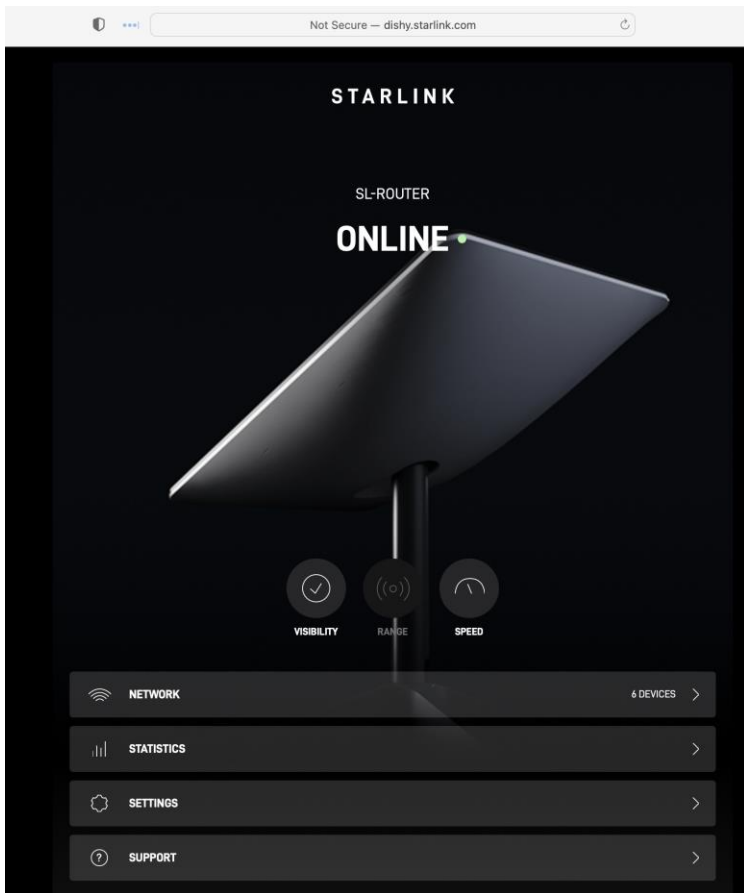
RAM 0.25GB CPU 0.37% Connected to Hub v4.14.1

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": {
```

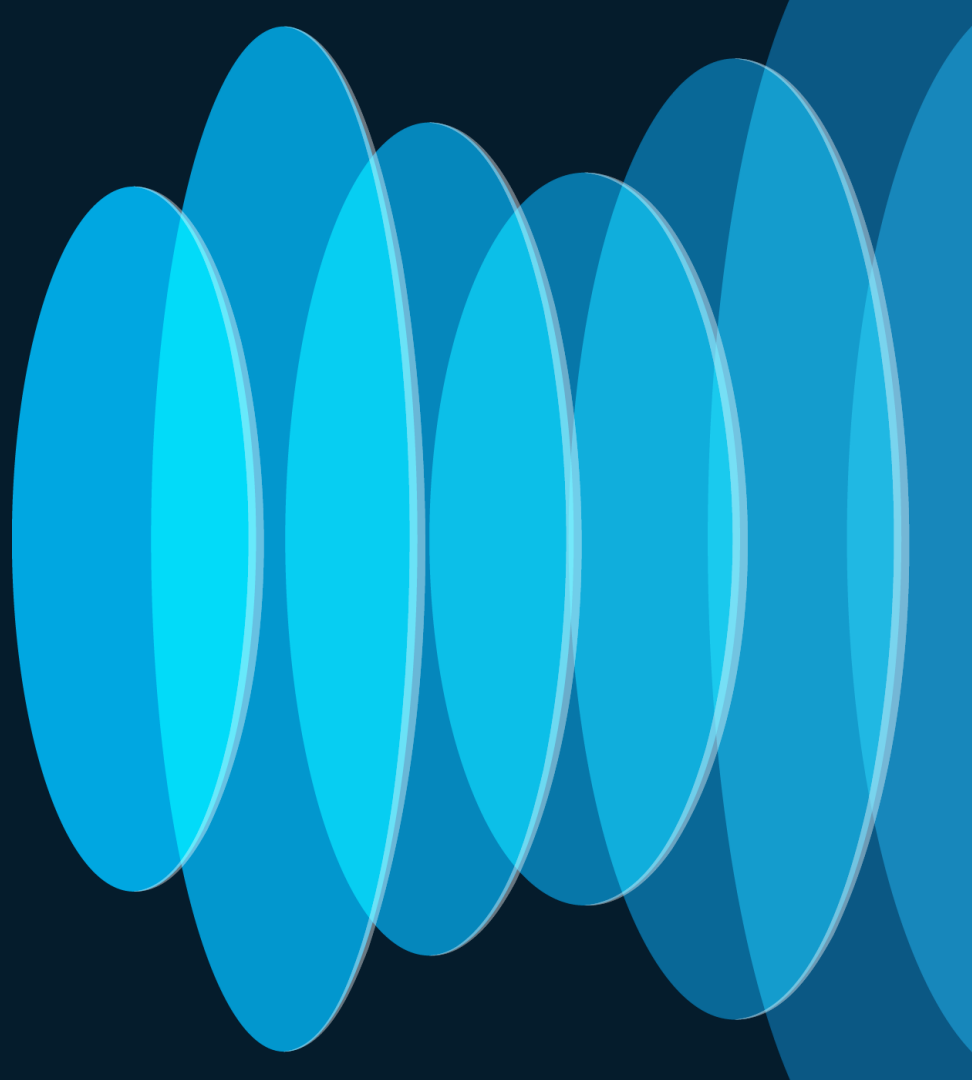
```
"gpsStats": {  
  "gpsValid": true,  
  "gpsSats": 16,
```

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

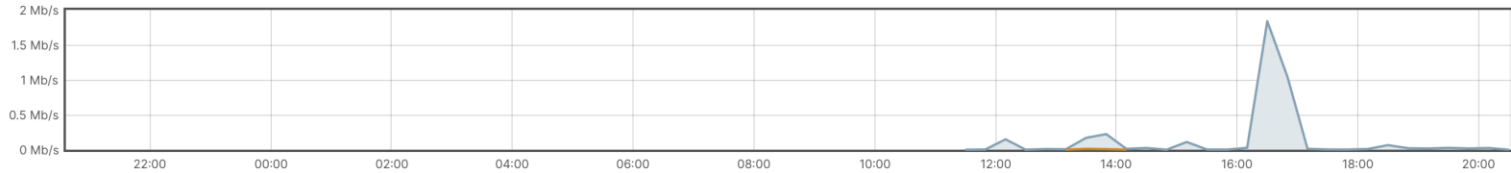


1/1 healthy

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	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](#)

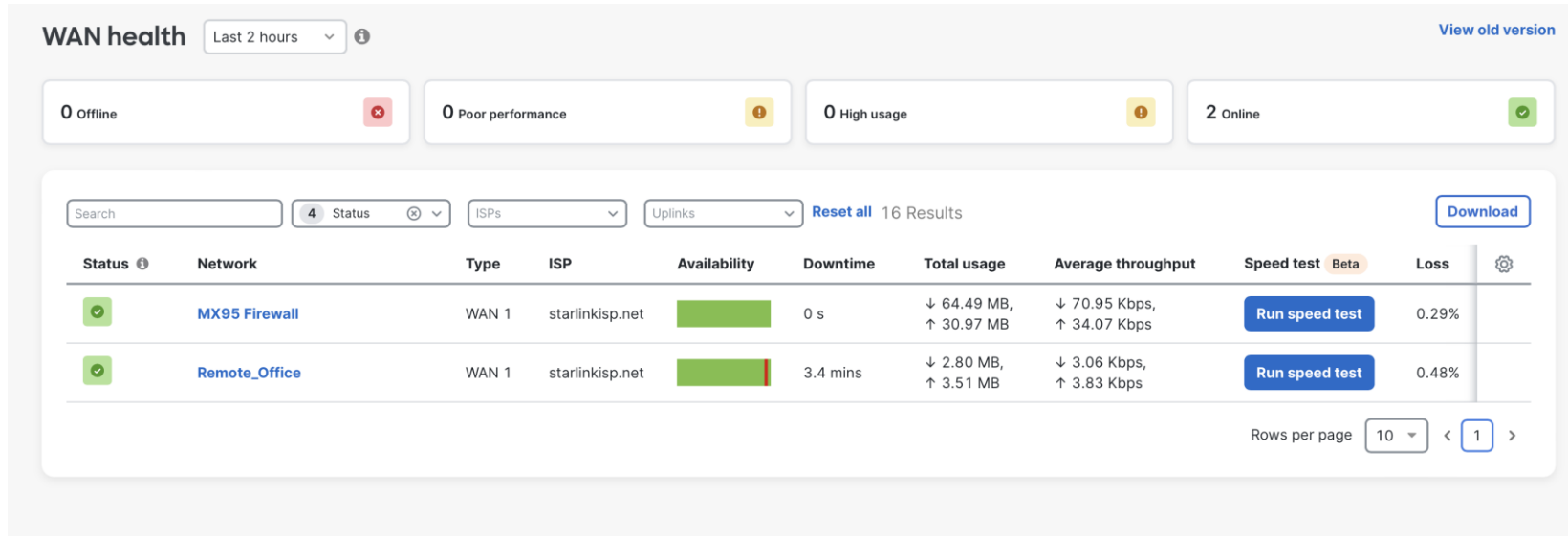


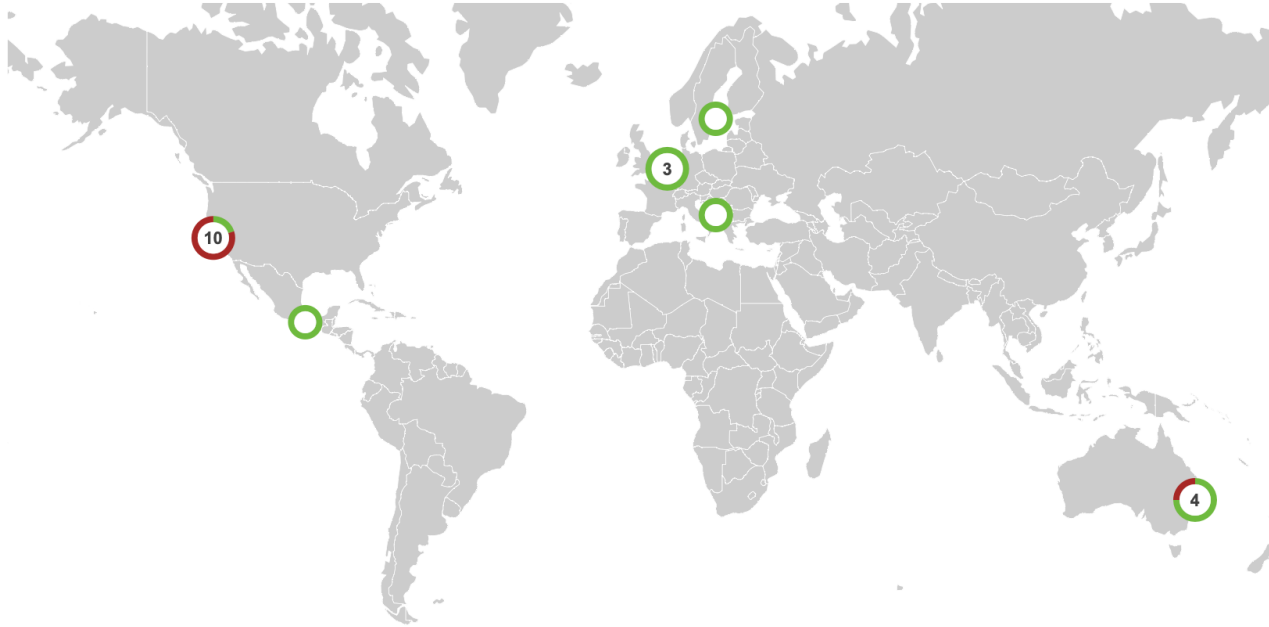
Business critical applications

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

[View all](#)

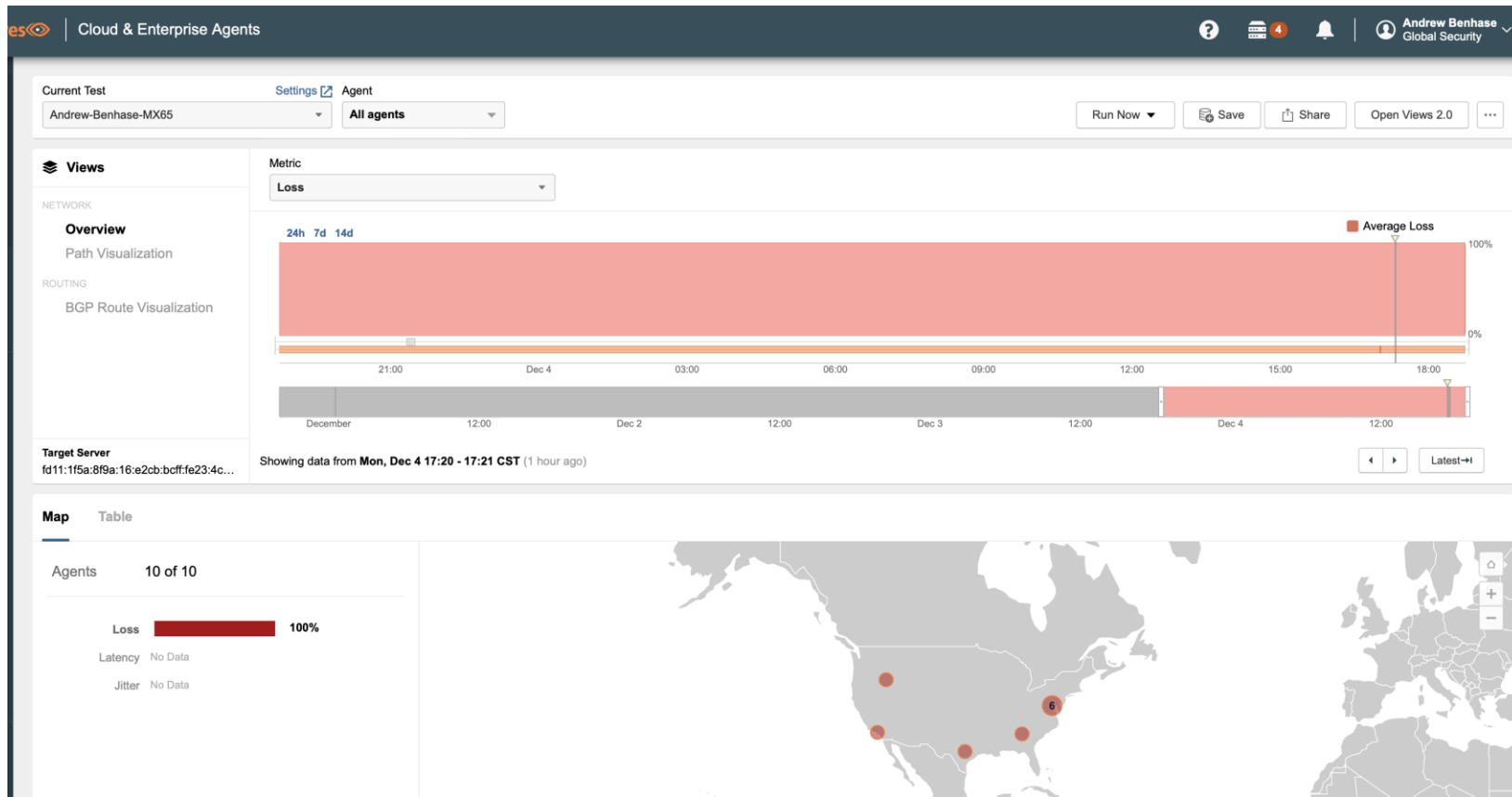
WAN Health using 1keye





Agent based Reporting for Thousand Eyes running Starlink across the Globe

Agent to ICMP IPv6 not working

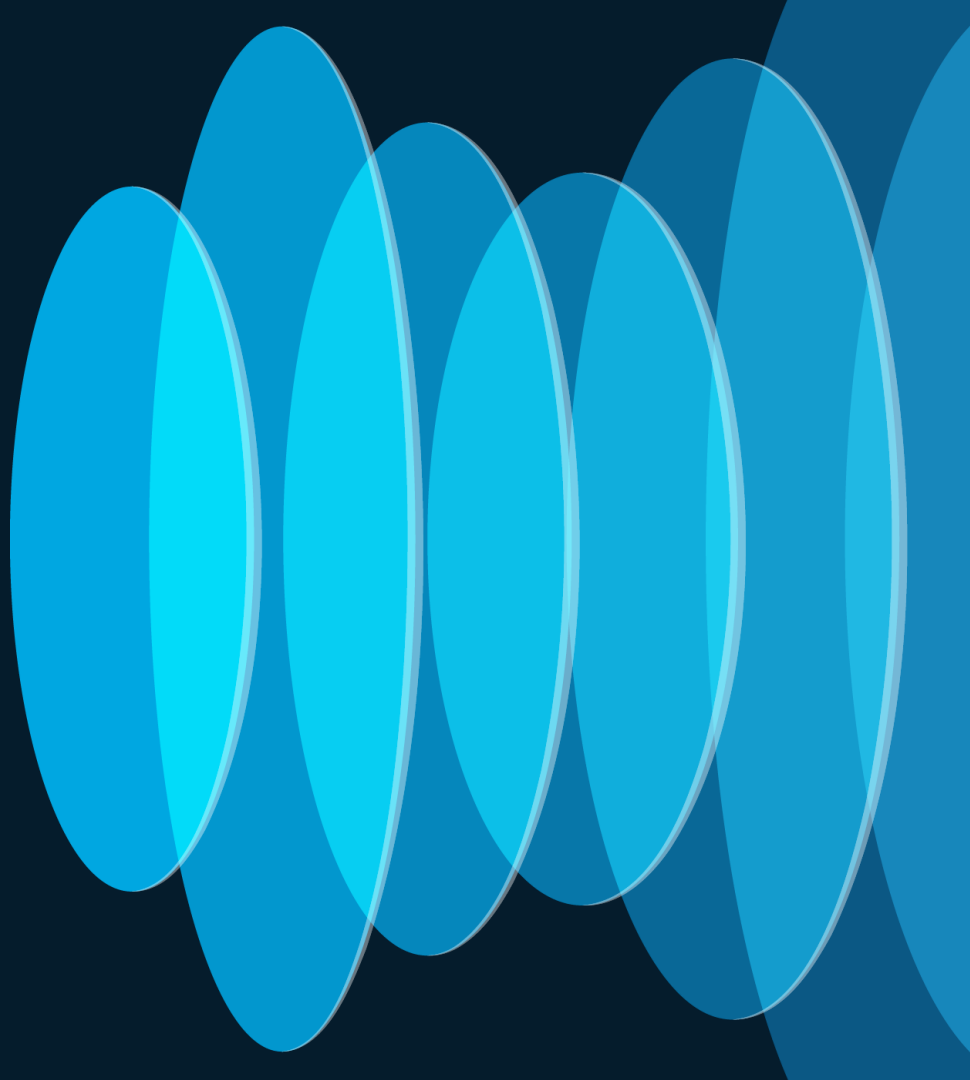


IPv6 PD Renew Every 5 Minutes

Event log

<div>Client: <input type="text" value="Any"/> Before: <input type="text" value="11/30/2023"/> <input type="text" value="21:49"/> (EST)</div> <div>Event type include: <input type="text" value="All"/> Event type ignore: <input type="text" value="None"/></div> <div><input type="button" value="Search"/> Reset filters</div>				
<div>Download as <input type="button" value="v"/> newer older</div>				
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

SDWAN



Devices



Devices

Certificates

Licensing

FILTERED BY

Reachable · Up x

SUMMARY

> Health

▼ Reachable

☒ Up☐ Down













> Control Status

> Cloud Provider

Device Group All

Devices (5)

[Export](#) 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	<div><div></div></div> 33.93%	...
StarlinkPOC-1121X	C1121X-8P	SITE_303303	172.16.250.200			2 / 2	6 / 6	1 / 1	Nov 15, 2023 06:43 AM	<div><div></div></div> 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	<div><div></div></div> 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	<div><div></div></div> 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	<div><div></div></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

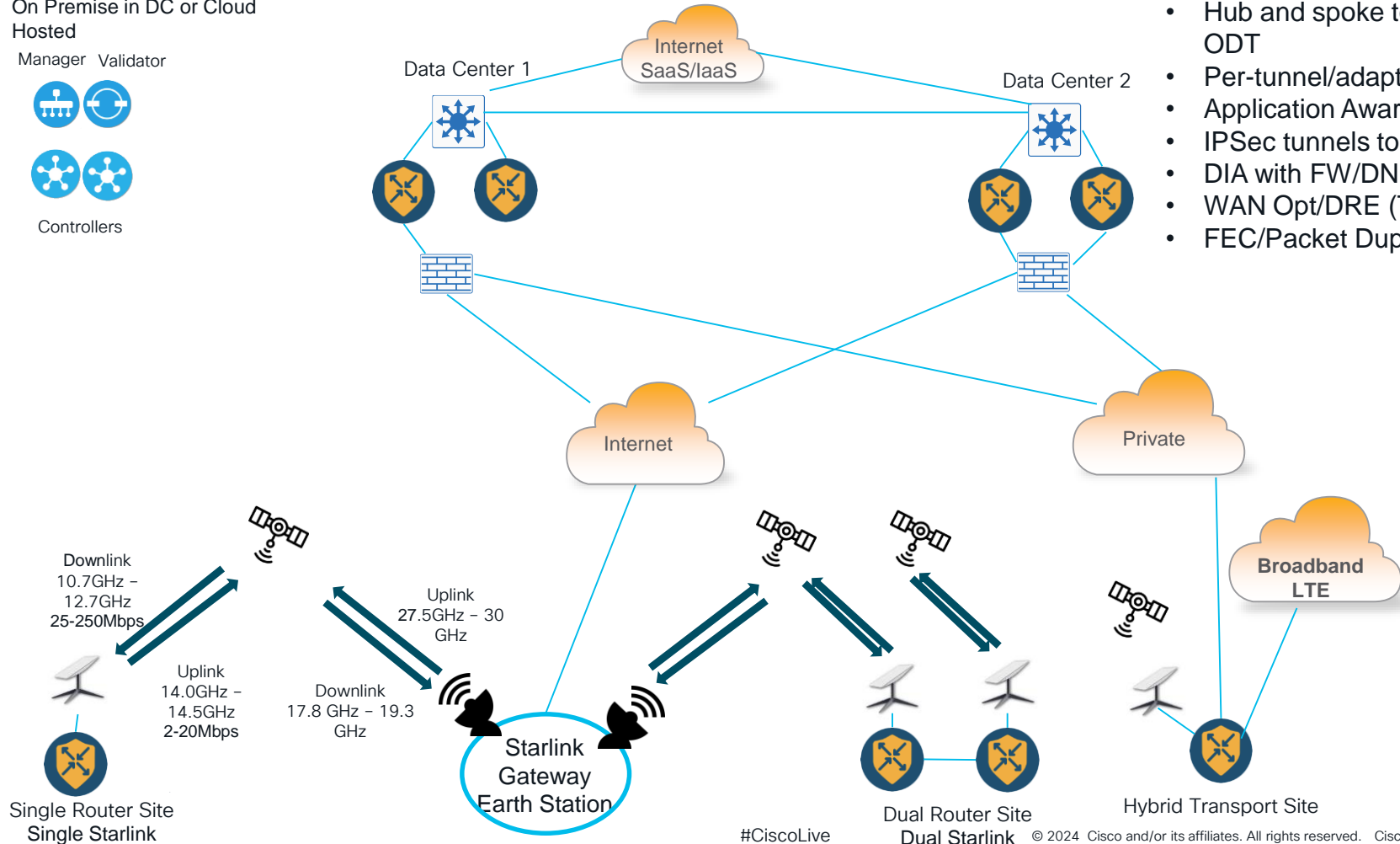
Manager Validator



Controllers

Starlink Reference Architecture

- 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)



Cisco Catalyst SD-WAN

Select Resource Group

Configuration • Devices

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
C1101-4PLTEPWB-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.

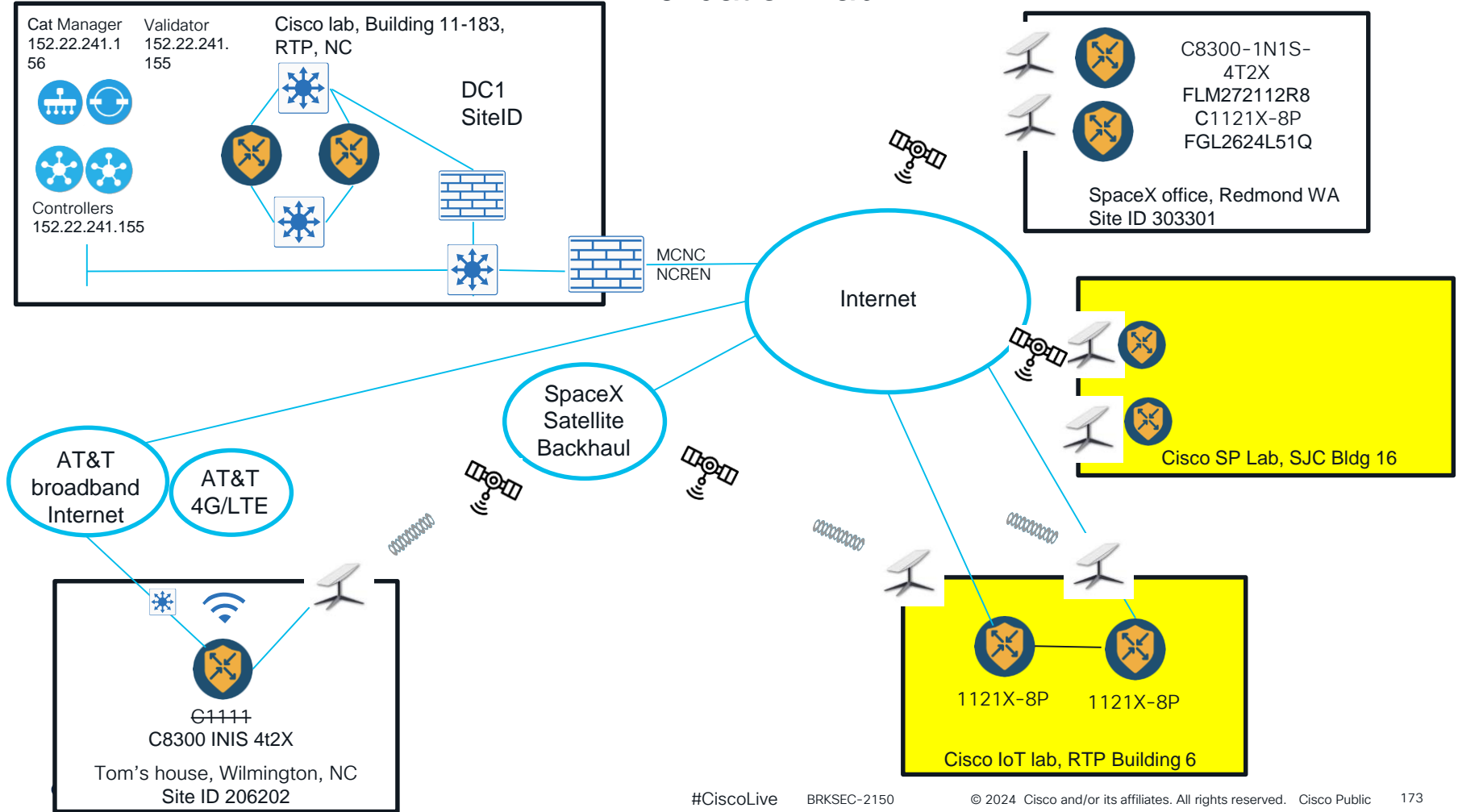
OMP Hello tuning: Reduce Hello-interval to further optimize bandwidth

```
sdwan
```

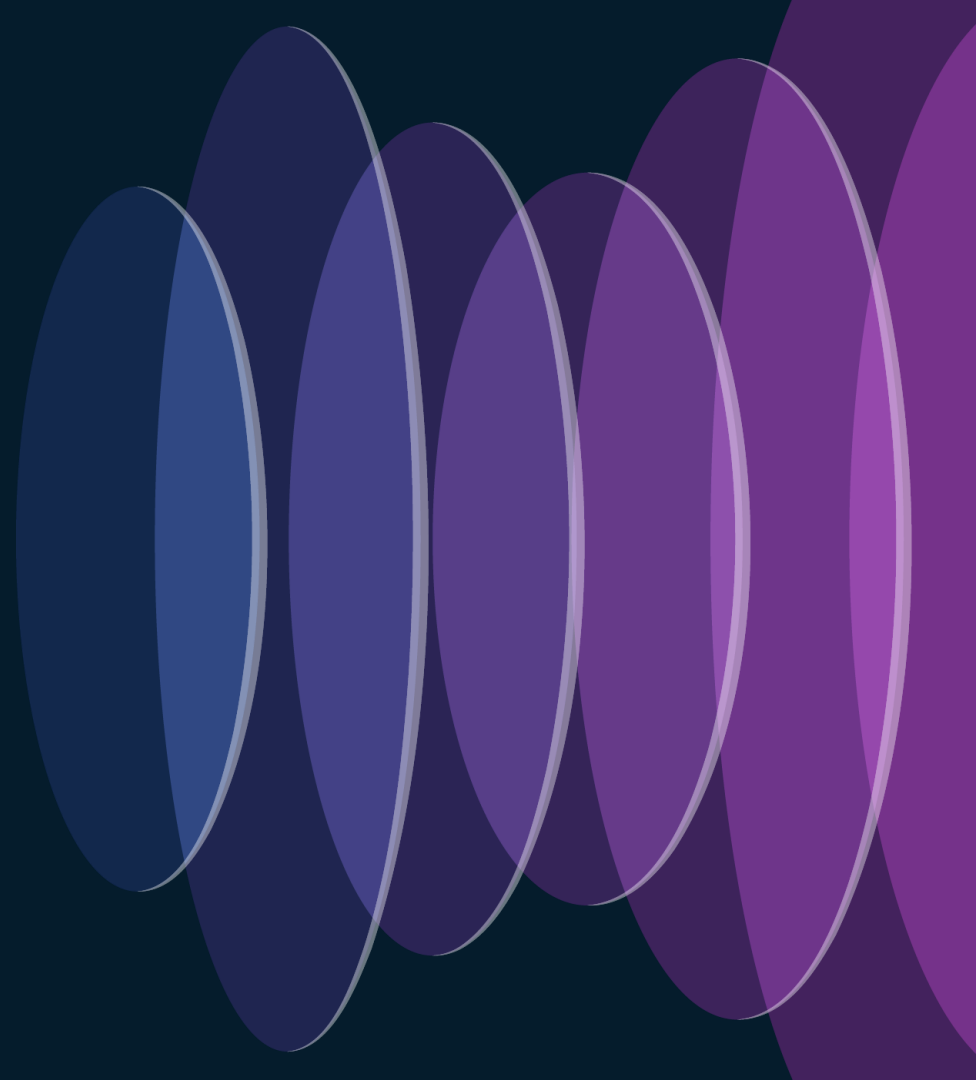
```
interface GigabitEthernet 0/1/0
Description connected to Starlink
tunnel-interface
encapsulation ipsec weight 1
no border
color
no last-resort-circuit
```

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

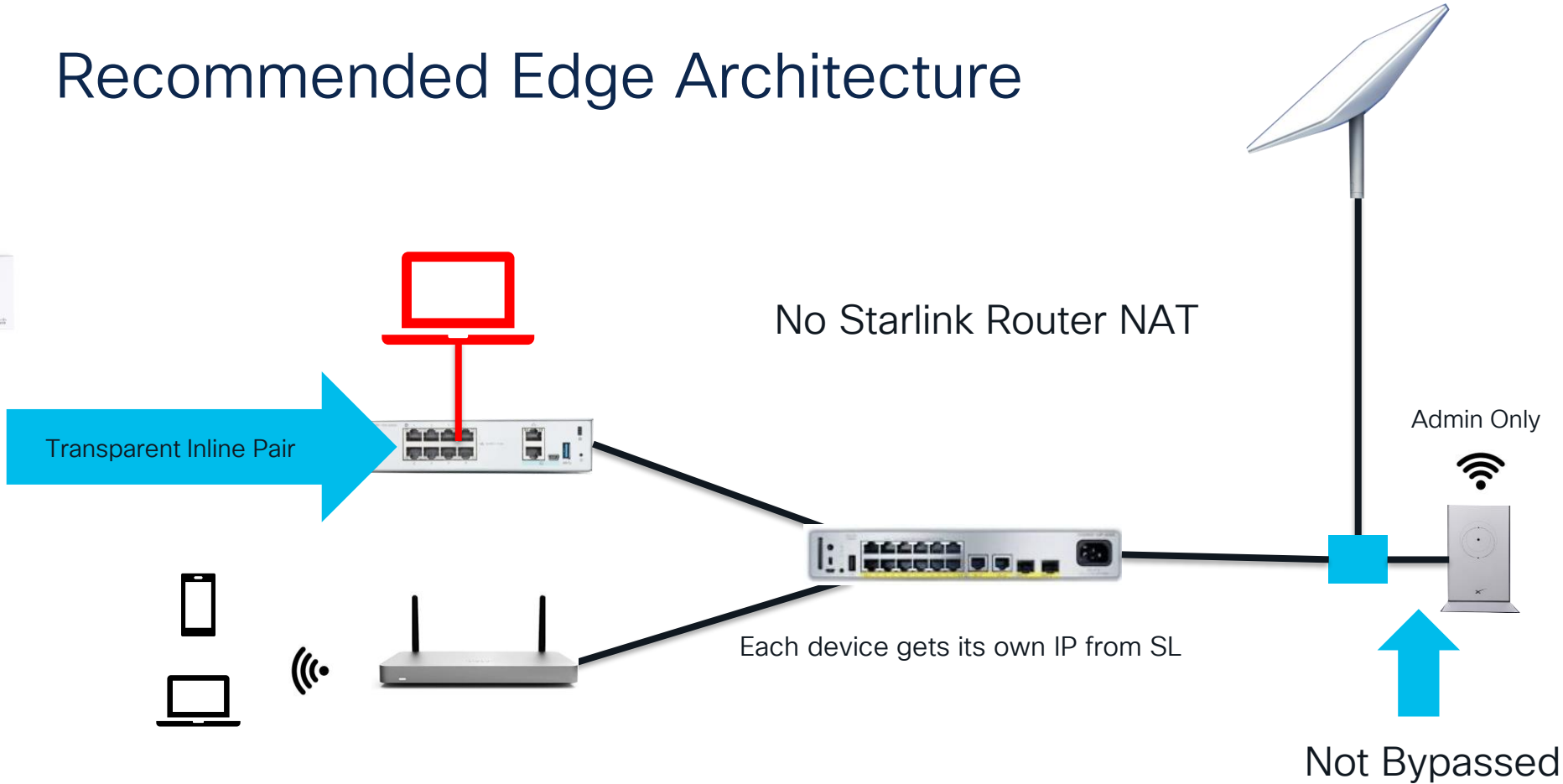
Validation Lab



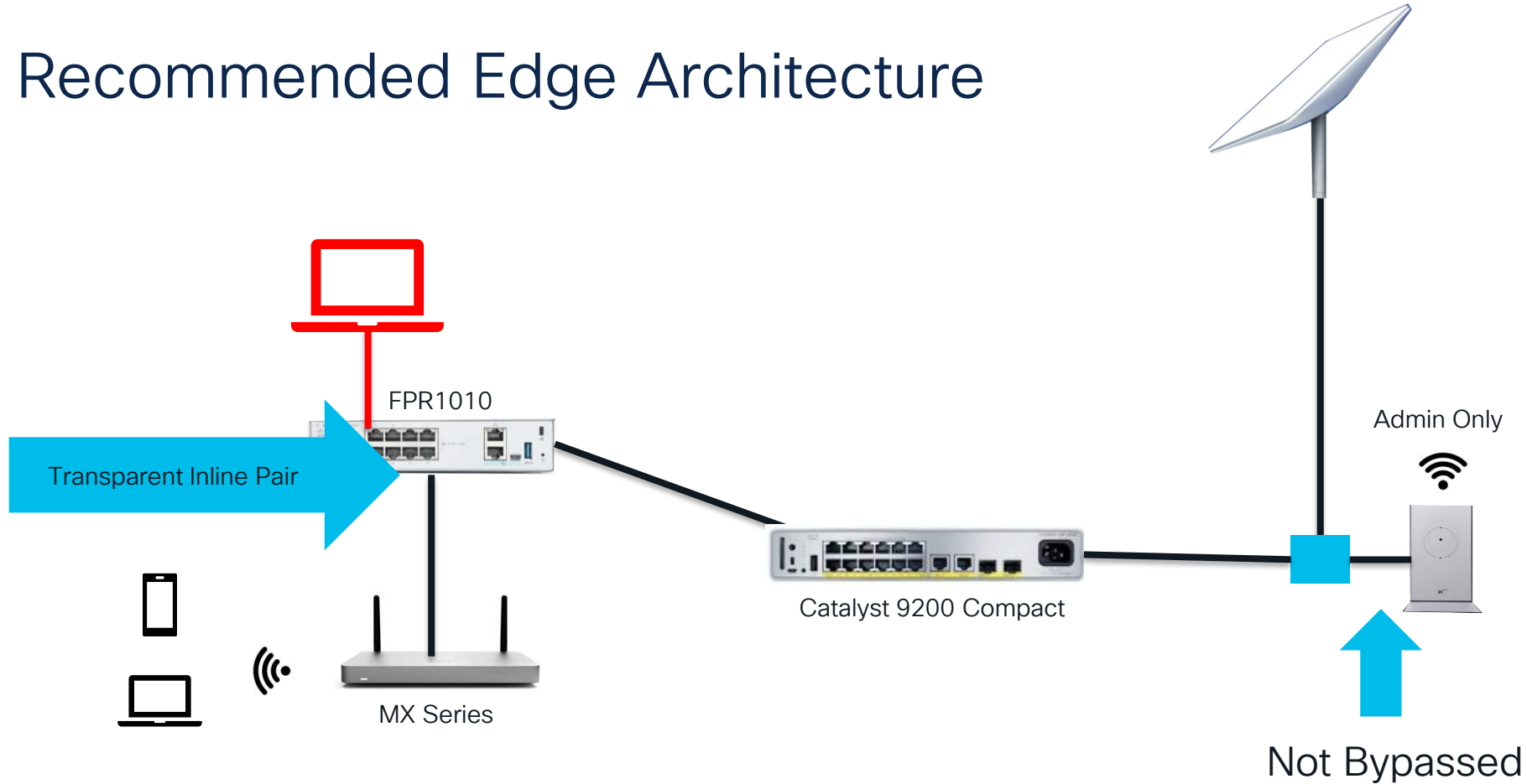
Ground/Space Architectures



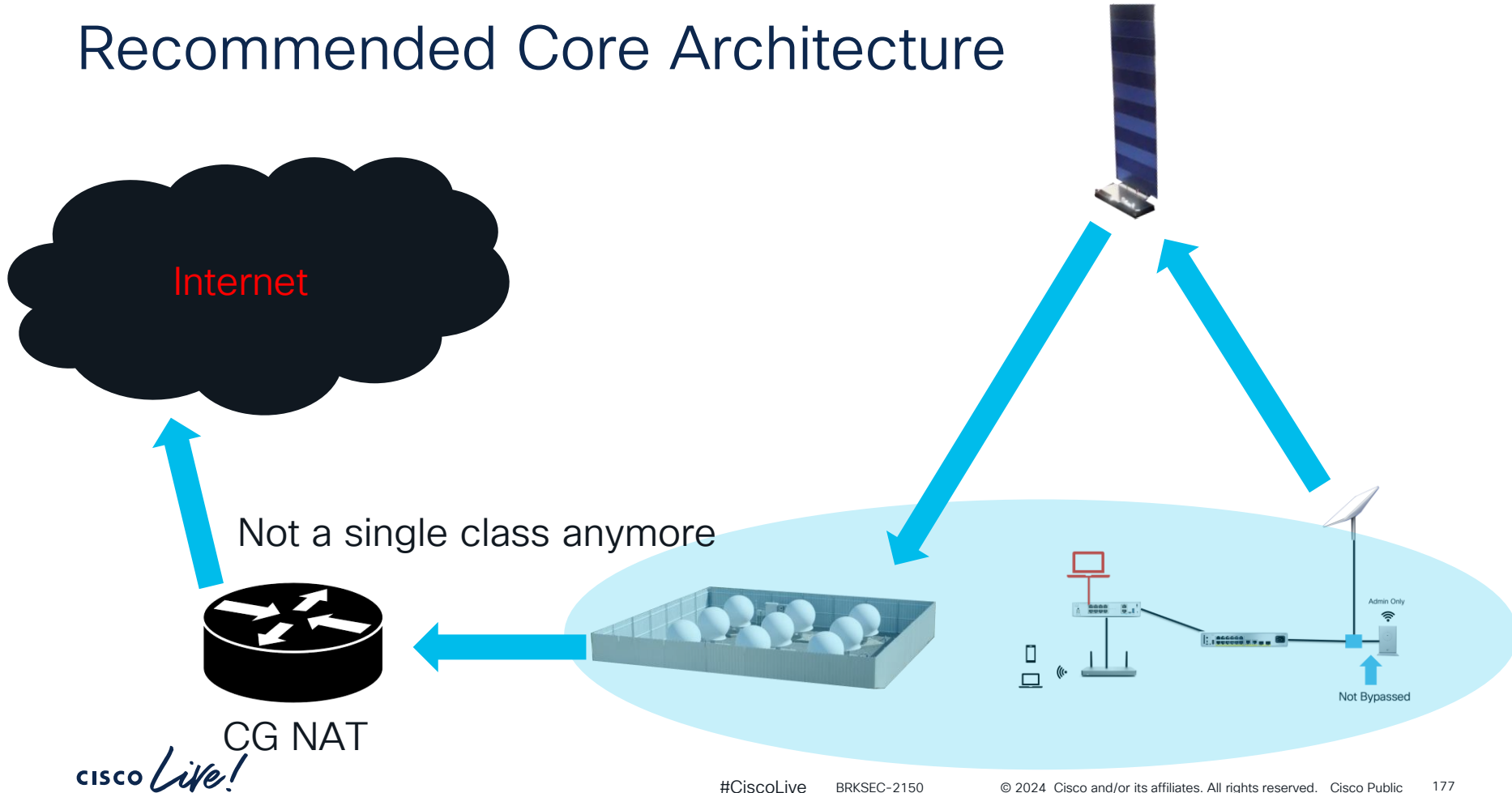
Recommended Edge Architecture



Recommended Edge Architecture

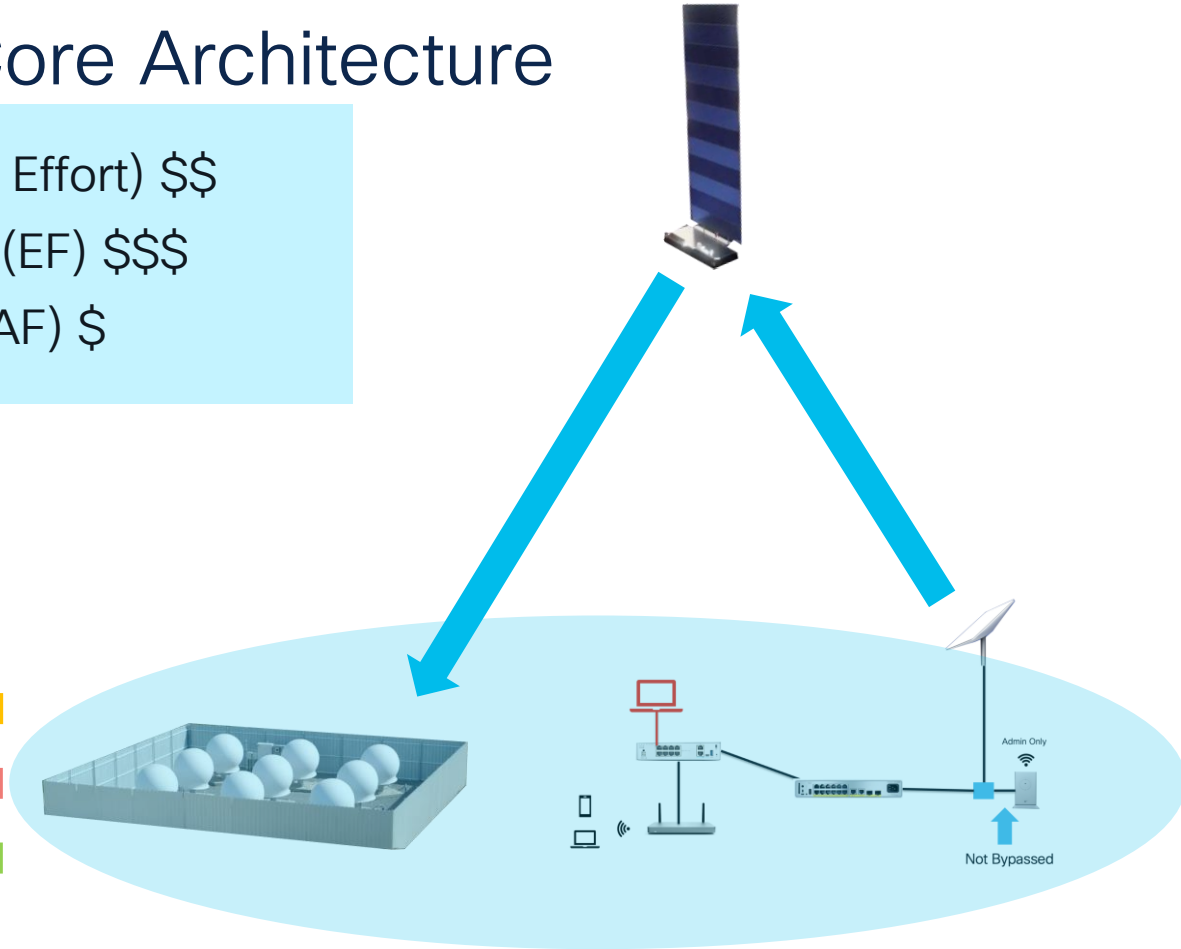
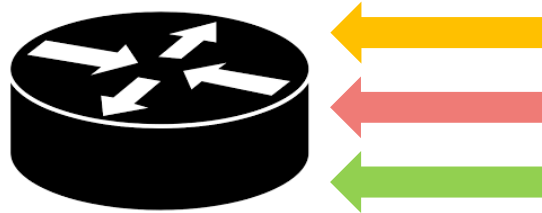


Recommended Core Architecture

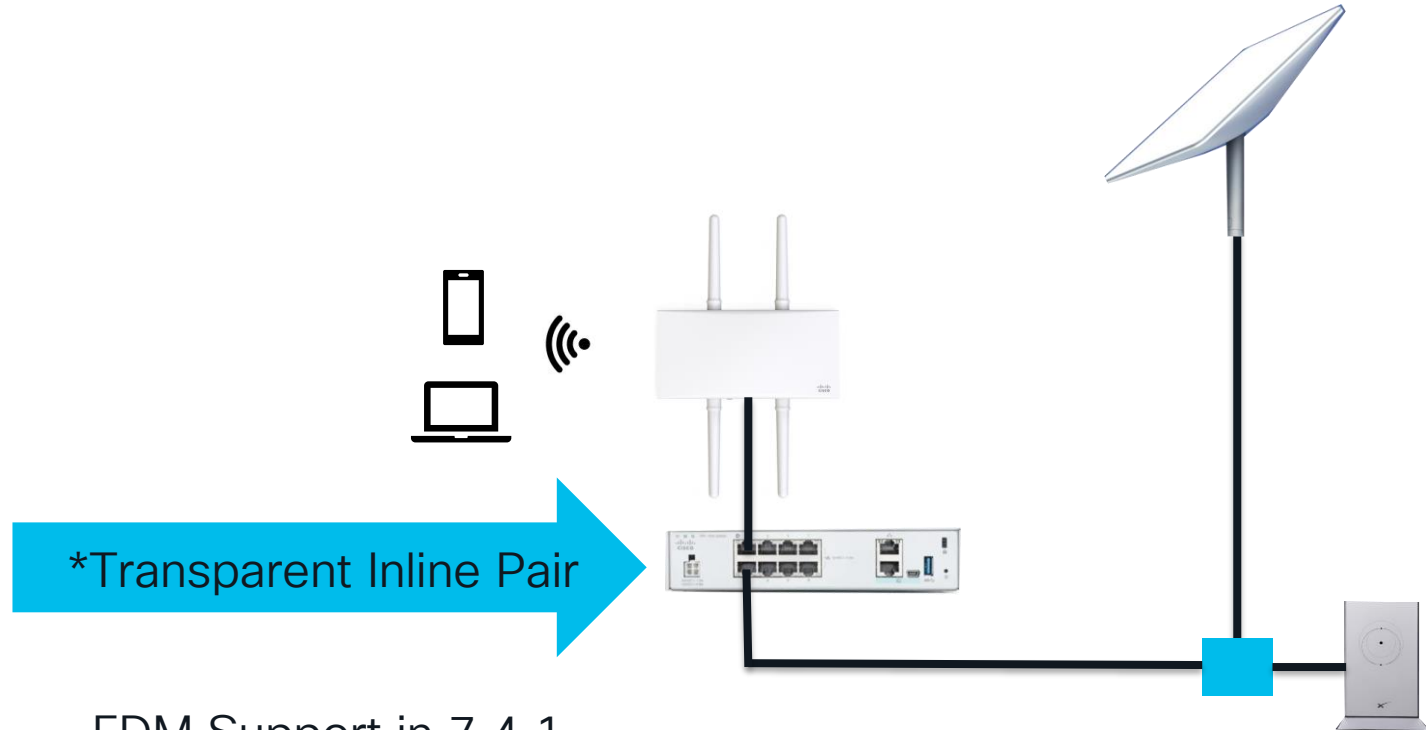


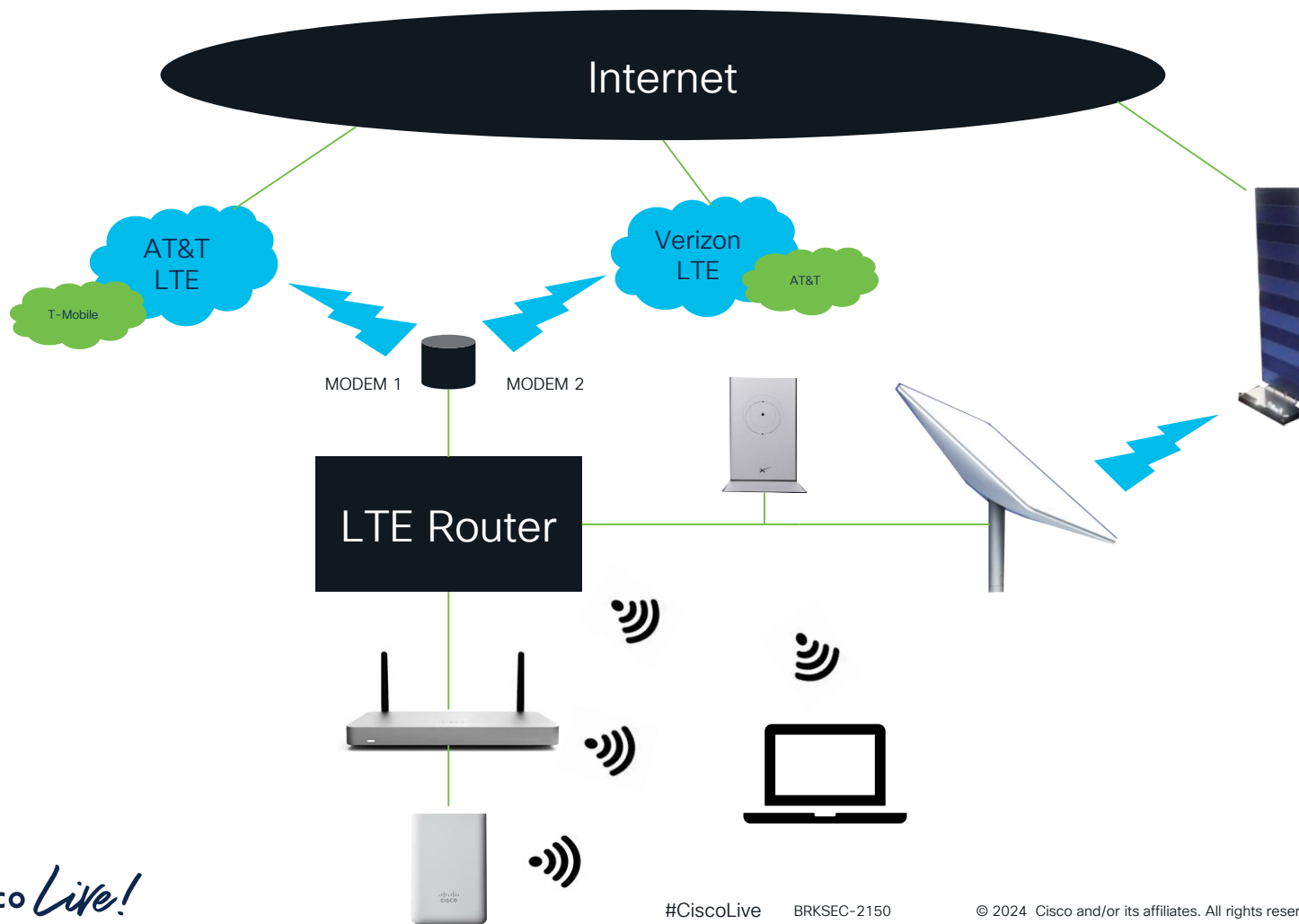
Recommended Core Architecture

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

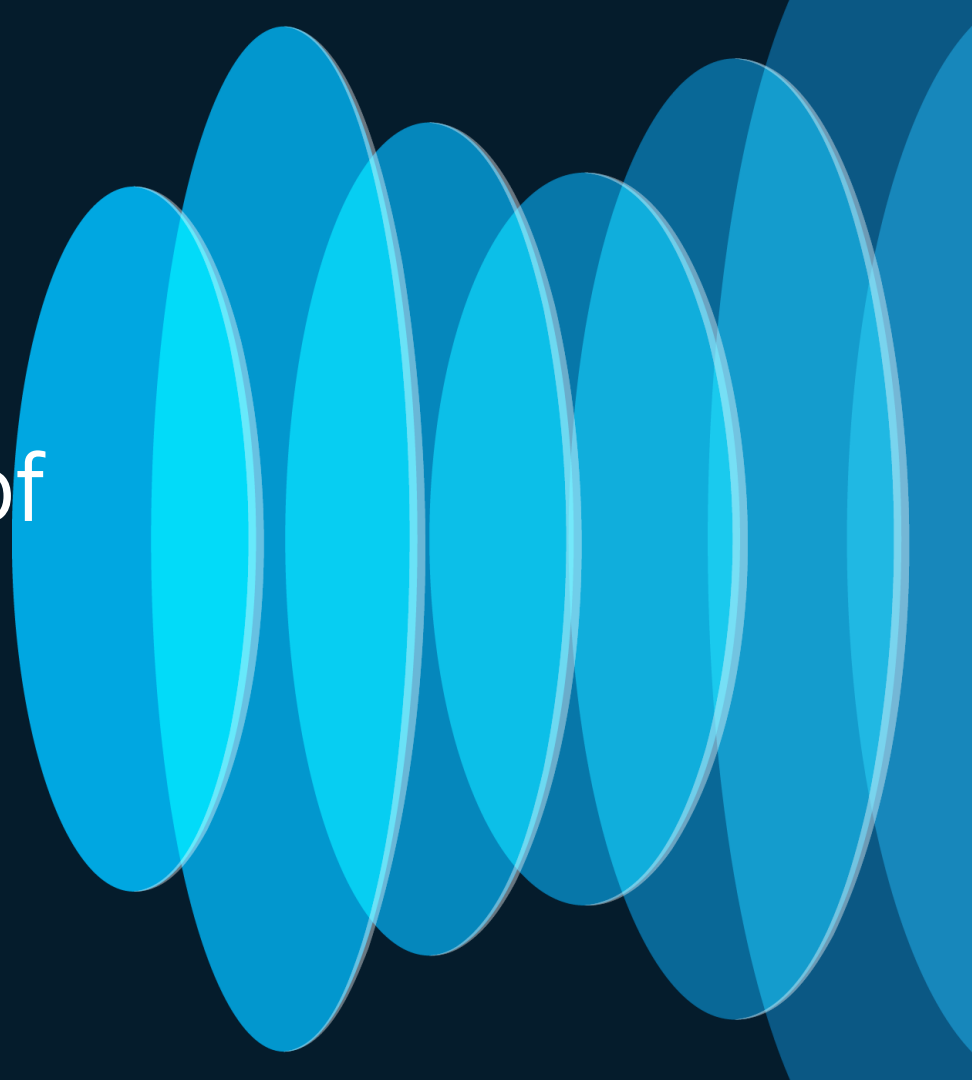


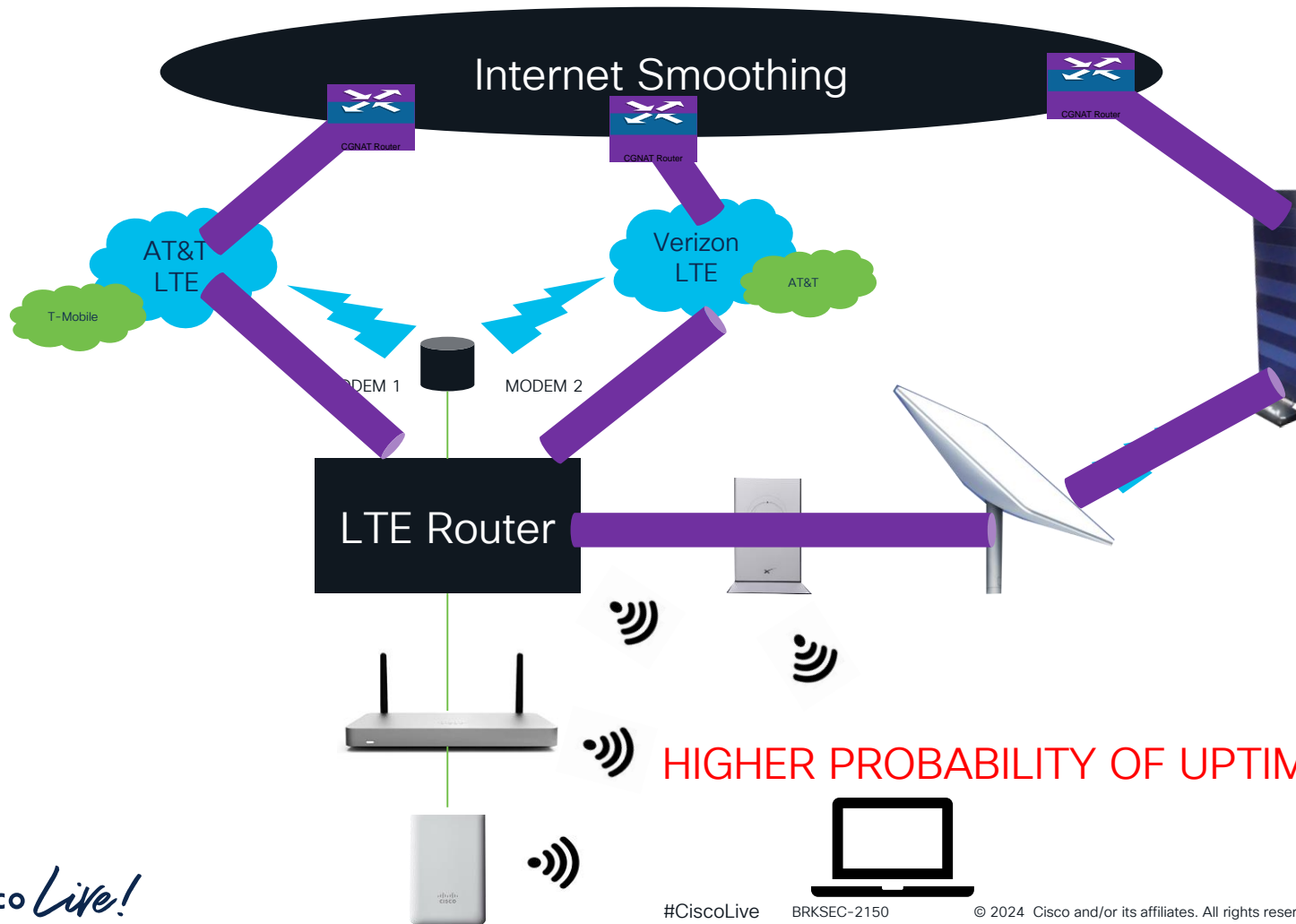
Recommended Architecture





Highest Probability of Network Uptime







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

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

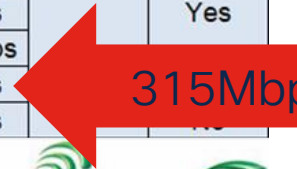
Downlink			Uplink				
DL UE Categor	Max data rate in Mbps	DL MIMO	DL UE Categor	Max data rate in Mbps	64QAM Support	256QAM Support	
M1	~1 Mbps	1	M1	~3 Mbps	No	No	
M2	~ 4 Mbps		M2	~7 Mbps			
0	~1 Mbps		0	~0 Mbps			
1bits	~10 Mbps		1bits	~5 Mbps			
4	~150 Mbps	2	3	~50 Mbps	Yes		No
6	~300 Mbps	2 or 4	5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



315Mbps



lte **lte** **lte** **5G**



When Starlink goes down for 20 minutes





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The bridge to possible

Thank you

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Bonus Material: Local Launch Pictures from Melbourne (Florida)











