HISEASNET: SERVICES / STARSHIELD UPDATE

RVTEC Cyber Monday Session (2024-10-21)

Thomas Lockwood, HiSeasNet Supervisor, UC San Diego

R/V *Sally Ride*, Anacortes , Washington. *Credit: Jeff Dillon.*

THANK YOU TO OUR COLLABORATORS AND SPONSORS

Scripps researchers recover a BONGO net off the California coast.

HiSeasNet is a satellite communications network established in 2002 and designed specifically to provide continuous Internet connectivity for oceanographic research.

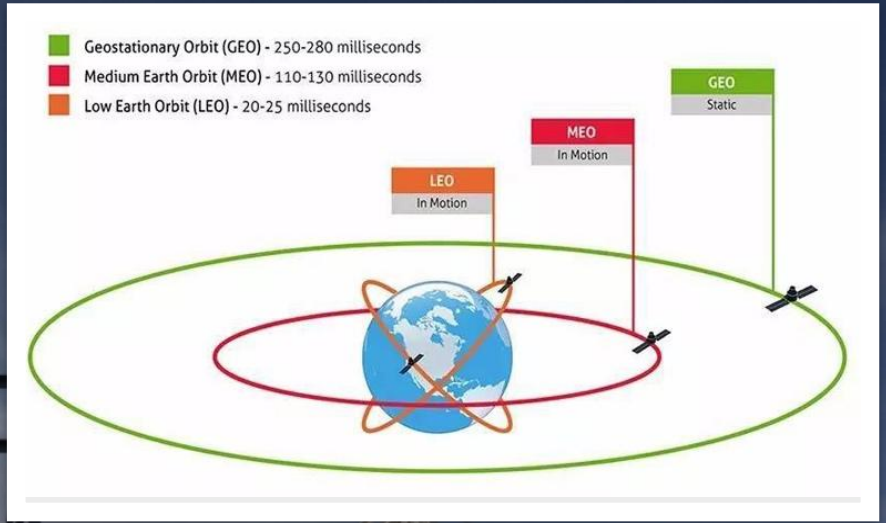
We support research vessels in the US Academic Research Fleet (ARF) as well the United States Antarctic Program (USAP)

Satellite Terms

LEO Low Earth Orbit

MEO Medium Earth Orbit

GEO Geostationary Orbit



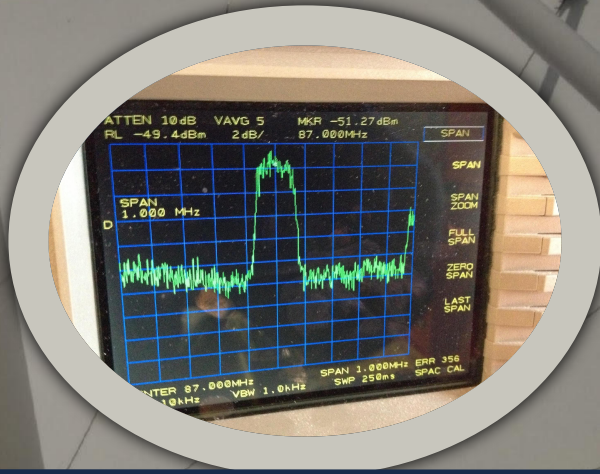
Relevant IEEE Radio frequency/wavelengths

Ka-band 27-40 GHz
1.11–0.75 cm

Ku-band 12-18 GHz
2.5–1.67 cm

C-band 4-8 GHz
7.5–3.75 cm

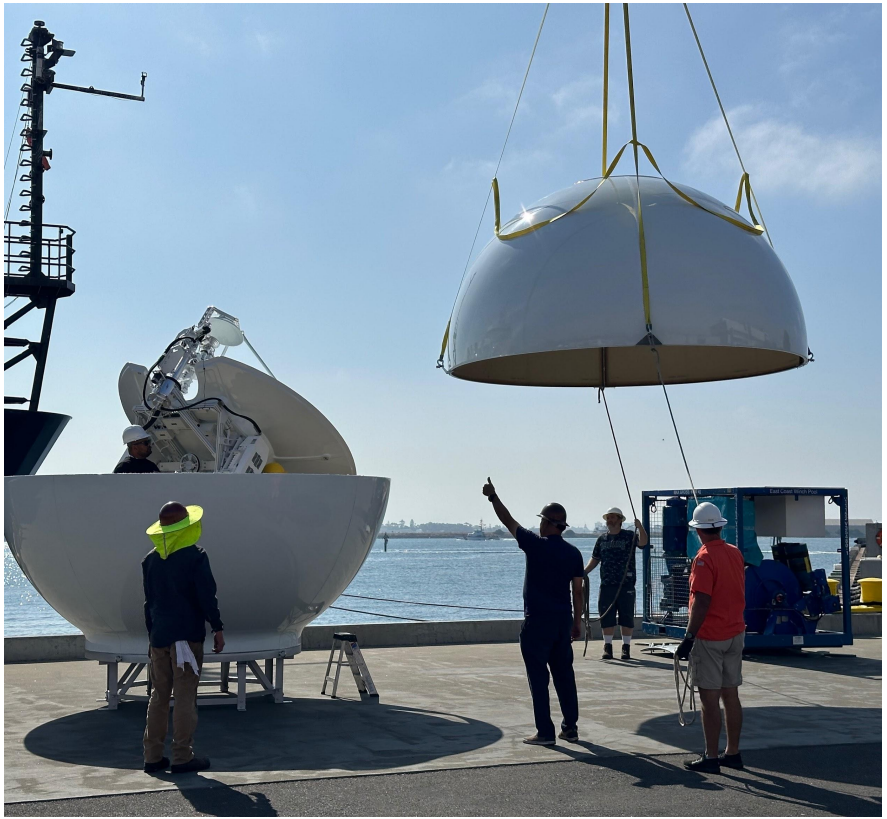
L-band 1-2 GHz
30-15 cm



Current systems

Current GEO system: Sealink Plus

- Sealink is currently GEO only; limited capability at the poles
- Internet, phones
- Mostly capable of ~20Mbps throughput via Ku-band and C-band at global scale
- Intellian v240M-2 antennas, capable of tracking GEO/MEO/LEO
    - Can be purchased/retrofitted with Ka-band, too



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Current GEO system: Fleet Xpress

- GEO only; limited capability at the poles
- Internet, phones
- Dual antenna system, consisting of Global Xpress (Ka-band) and FleetBroadband (L-band, 432 kbps)
- Automatic cutover between Global Xpress and FleetBroadband
- Global Xpress can support speed of 2Mbps (always on) and on special occasions, up to 10Mbps
- Like many commercial operations, we are phasing out this service in favor of diverting funds to Starshield. Current contracts and leases July 2027.

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Current LEO system : Iridium Certus

- LEO, with true global coverage
- Internet, phones
- L-band (1-2 GHz) more reliable for extreme weather, but slow (100-700 kbps)
- Used to satisfy Polar Code requirements as standalone, pooled service for phone/emergency Internet since 2022
- Also used in Sealink Plus as an out-of-band path for as needed "dial-in" remote support of Ku-band /C-band equipment.

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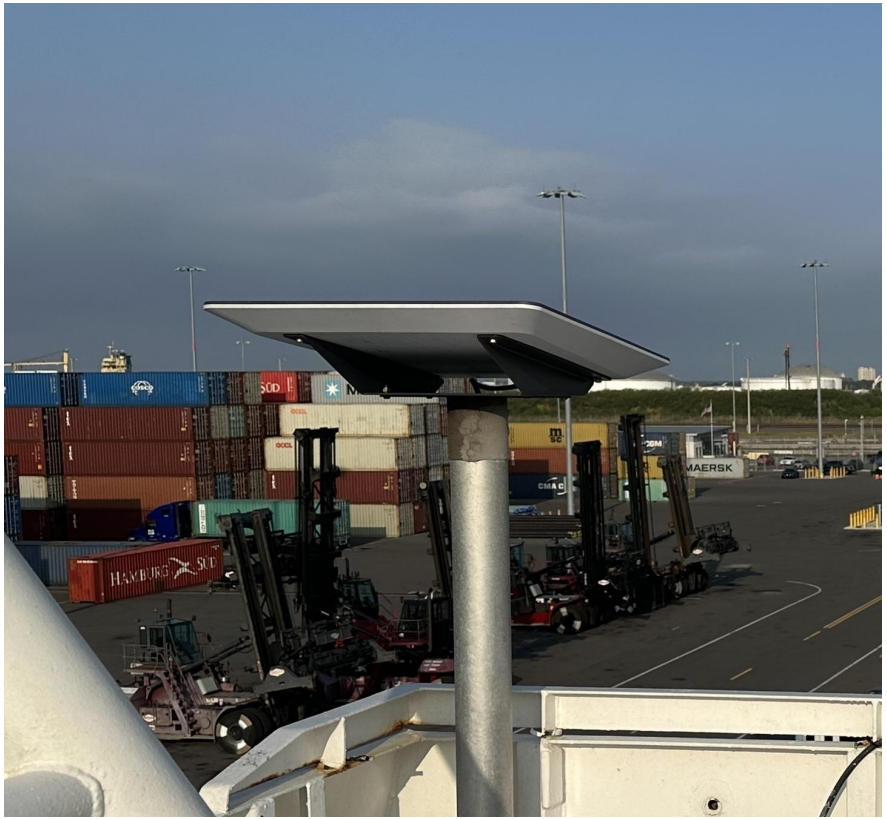
Current LEO system : Starshield

- LEO, Ku-band, Internet only
- Starlink Maritime became available in July 2022, Conducted pilot testing on ARF ship in fall of 2022
- Starshield announced by SpaceX December 2022, Deployed fleet-wide May 2023 through August 2024 on ARF & USAP vessels
- Speeds of "350 Mbit/s" (best effort) advertised; Typically seeing closer to 100-250Mbps shore to ship and 6-30Mbps ship to shore.
- 5TB per month or Unlimited plans available; pay per GB for usage over 5TB is option. Usage is ionally pushing against 5TB/mo on globals.



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Current LEO system : Starshield, the “fine print” of Starlink Service

Limited Warranty, Disclaimers, Remedies and Liabilities.

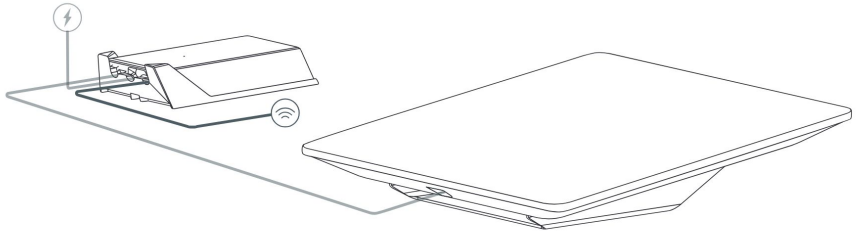
- **LIMITATIONS OF LIABILITY**. STARLINK WILL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, CONSEQUENTIAL, OR INDIRECT DAMAGES, LOSS OF GOODWILL OR BUSINESS PROFITS, LOST REVENUE, WORK STOPPAGE, LOSS OR CORRUPTION OF DATA, COMPUTER FAILURE, DATA SECURITY BREACH, MALFUNCTION OR ANY LOSSES OR DAMAGES RESULTING FROM THE KIT INSTALLATION, REPAIR, REMOVAL, OR OTHER ASSOCIATED SERVICES. STARLINK’S LIABILITY UNDER THIS AGREEMENT FOR ANY INDIVIDUAL CLAIM OR ALL CLAIMS IN THE AGGREGATE WILL NOT EXCEED THE TOTAL AMOUNT PAID BY YOU TO STARLINK UNDER THIS AGREEMENT OVER THE SIX MONTHS PROCEEDING THE CLAIM GIVING RISE TO THE LIABILITY. THE LIMITATIONS SET FORTH IN THIS SECTION WILL APPLY TO ANY CLAIMS OR DAMAGES ARISING OUT OF OR RELATED TO THE AGREEMENT, SERVICES OR STARLINK KIT, INCLUDING ANY EXEMPLARY OR PUNITIVE DAMAGES, REGARDLESS OF WHETHER STARLINK WAS INFORMED OR WAS AWARE OF THE POSSIBILITY OF SUCH LOSS OR DAMAGE AND REGARDLESS OF WHETHER CLAIMS ARE ASSERTED BASED ON CONTRACT, STATUTE, TORT, STRICT LIABILITY, NEGLIGENCE, OR OTHER LEGAL OR EQUITABLE CLAIM OR THEORY PROVIDED, EXCEPT IF AND TO THE EXTENT THAT ANY LIMITATION VIOLATES APPLICABLE MANDATORY LAW THAT THE PARTIES CANNOT DEROGATE FROM BY WAY OF CONTRACT.

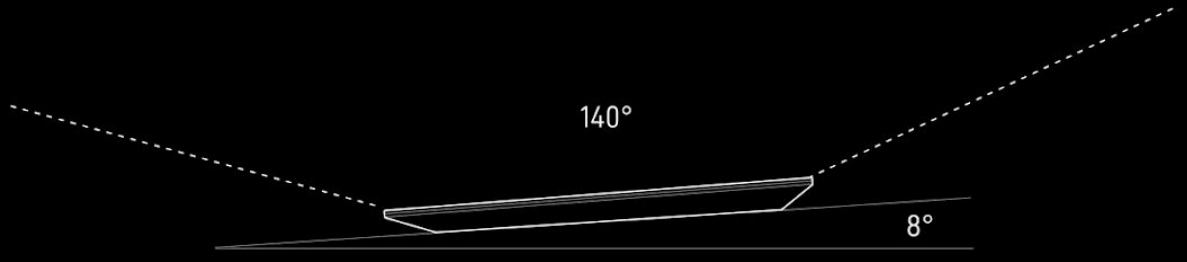
- **ASSUMPTION OF RISK**. YOU AGREE THAT THE SERVICES ARE ENTERTAINMENT SERVICES AND ARE NOT SUITED OR INTENDED AS A VESSEL-CRITICAL, MISSION-CRITICAL OR SAFETY-OF-LIFE SERVICE. YOUR USE OF [illegible]E STARLINK KIT, AND SUCH USE BY ANYONE USING YOUR ACCOUNT, IS AT YOUR SOLE

Current LEO system : Starshield, the High Performance Hardware

Flat High Performance Starshield Terminal Specifications

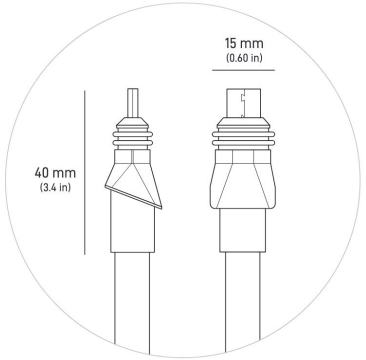
- https://www.starlink.com/specifications?spec=3
- Electronic Phased Array Antenna with 140° field of view
- Operating Temperature: -30°C to 50°C (-22°F to 122°F);
- built in heater capable of melting 3” snow per hour
- Wind Rating: Survivable: 280 kph+ (174 mph+)
- Antenna weight: 5.9 kg / 13 lbs (without Cable or Angled Wedge Mount)

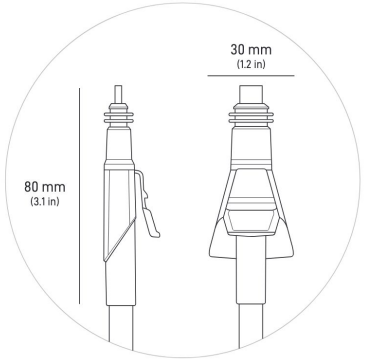


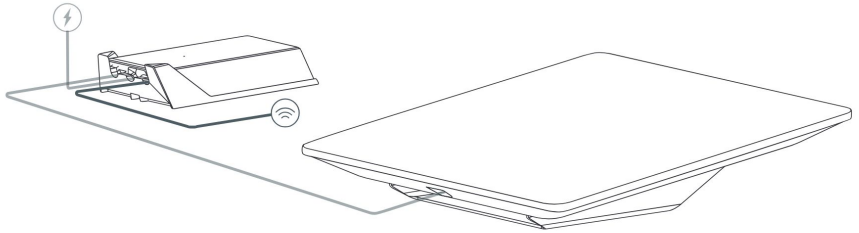


Current LEO system : Starshield, Starlink Antenna Cable

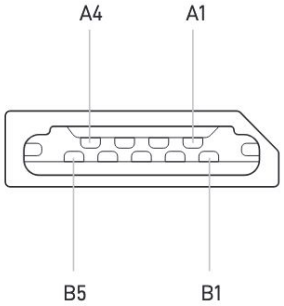
- Terminal is Ethernet device using Starlink Power Supply as a PoE injector.





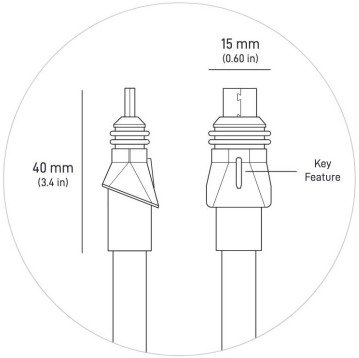


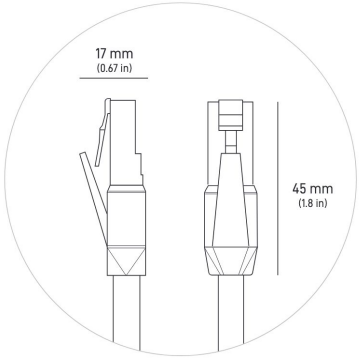
End	Pin	Wire Color	Pin	End
	A1	Green	A1	
	A2	Yellow	A2	
	A3	Blue	A3	
	A4	White	A4	
Dish	B1	Orange	B1	Power Supply
	B2	Purple	B2	
	B3	Brown	B3	
	B4	Gray	B4	
	B5	Shield / Shell	B5	

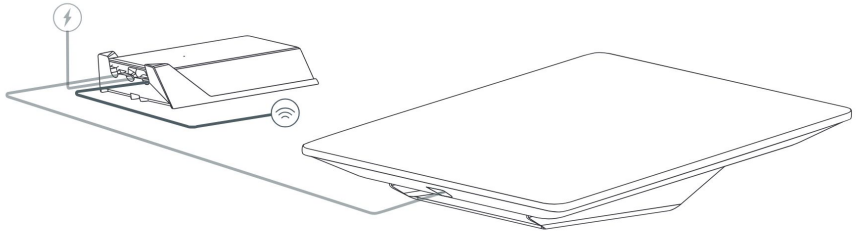


Current LEO system : Starshield, Starlink Ethernet Cable

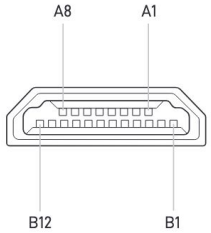
- Terminal is Ethernet device using Starlink Power Supply as a PoE injector.





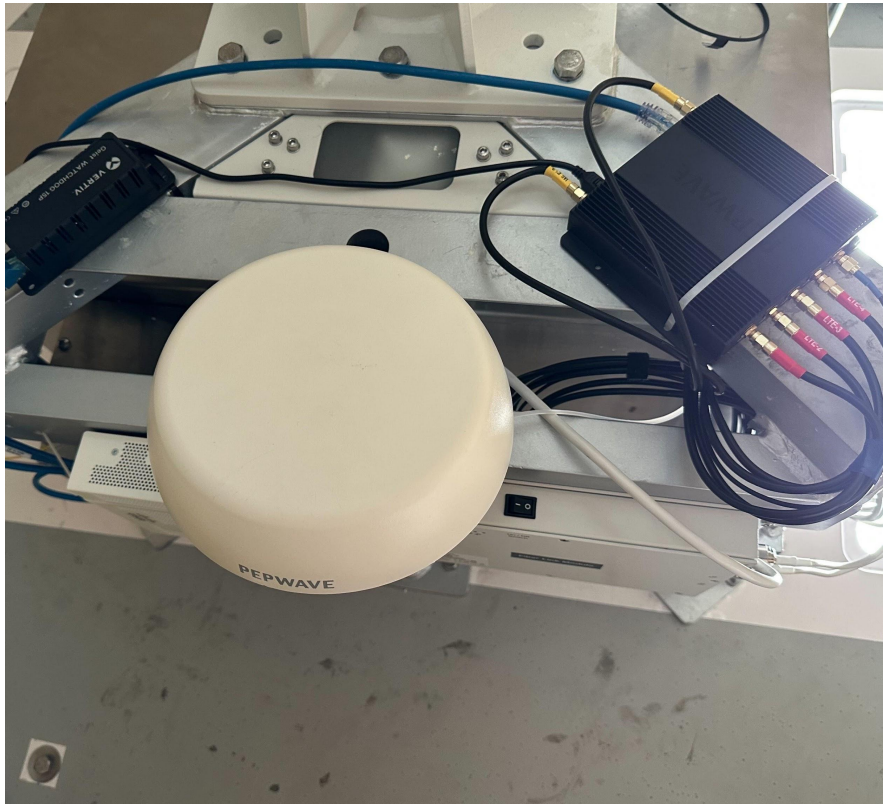


End	Pin	Ethernet Pin	Wire Color	Pin	End
	A1, A2	B+	Orange White	A1, A2	
	A3, A4	B-	Orange	A3, A4	
	A5, A6	A+	Green White	A5, A6	
	A7, A8	A-	Green	A7, A8	
	B1, B2	--	N / C	B1, B2	
	B3, B4	--	N / C	B3, B4	
RJ45	B5	D+	Brown White	B5	Power Supply
	B6	D-	Brown	B6	
	B7	C-	Blue White	B7	
	B8	C+	Blue	B8	
	B9, B10	--	N / C	B9, B10	
	B11, B12	--	N / C	B11, B12	
	Shield Can		Drain Wire	Shell	



Current near-shore systems: Cellular Modems

- Useful as an in-port Internet offload (to avoid in-port use of Starlink/Starshield) when 5G is available
- Most successful test setup so far:
  - T-Mobile for truly unlimited domestic coverage
  - AT&T for $10/day foreign port coverage
  - Cellular modem that can toggle between SIMs
  - Ignore 4G and lower
- Tests of installing this system inside Sealink domes have gone well. 2.4 Meter antennas already have built in filters for 5G cellular emissions w close to C-Band frequency spectrum.
- Modem is able to use WiFi-as-WAN, too



Future(?) systems

Future LEO systems of interest: Starlink (fully deployed constellation)

- Orbit ~550km Currently deployed: ~6000 satellites; SpaceX has requested licenses for 12,000 (possibly 42,000)
- Speeds of "350 Mbit/s" (best effort)
- Requires purchase of a fixed flat maritime-grade user terminal for seagoing (similar to Starshield)
- Initially, limited intra-satellite comms; Gen 1.5 and Gen 2 launches have allowed for ISL
- As ISL options grow, the speed of the constellation is expected to increase. Number of Starlink ground-stations has also been increasing.
- Areas with limited to no ground stations currently include Africa, Middle-East, India and mainland Asia.
- Constellation coverage over polar regions is currently limited but will improve with full deployment.

Future LEO systems of interest: Starshield (fully deployed)

- Announced December 2022; DOD hand off starts in July 2024.
- Enhanced encryption and other security features
- Unlike Starlink, which is a commercial service, Starshield satellites and ground stations would be owned and controlled by the U.S. government
- Currently, Starshield uses encrypted-in-transit data on Starlink's commercial service, but enjoys better speeds and better coverage than the commercial service.
- Plans between 2023-2033 to have the military manage their own constellation of satellites
- Declared a "legitimate military target in the future" by some non-US nations. Satellites include additional imagery and thermal sensors to detect ICBM launches.
- How Starshield's dedicated constellation of satellites interacts with Starlink commercial (if at all), in the future, is unclear

Future LEO systems of interest: OneWeb

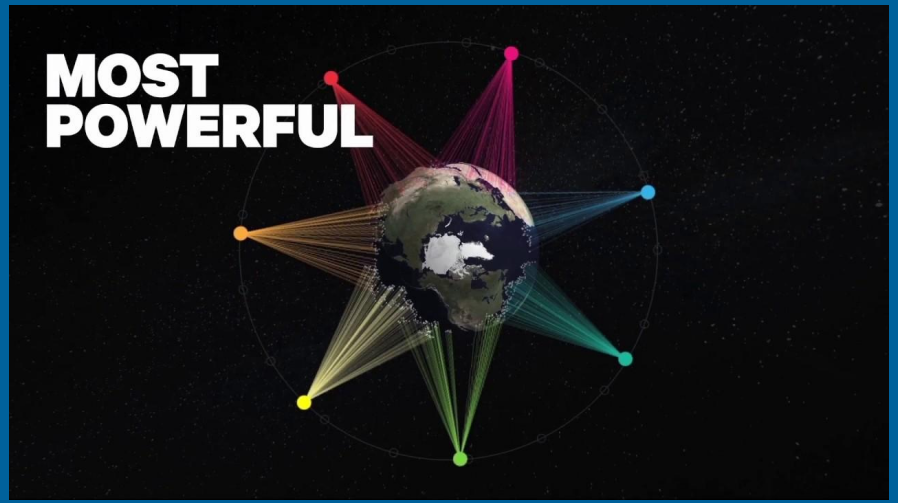
- Polar orbit ~1200km with 634 OneWeb operational satellites now in orbit, constellation is complete and fully operational down to 35 degrees latitude with Gen1 satellites.
- Expected CIR speeds up to 195Mbps (downlink) and 32 Mbps (uplink)
- In Sep 2023, Intellian and OneWeb introduced an active electronically scanned array (AESA) panel solution for OneWeb (replacing dual stabilized dome solution) as of Oct 2024 these panels have not been commercially released. Current commercially available Intellian solution is dual 70CM domes; Kymeta Peregrine flat panel systems are commercially available along with milspec varients. Original HSN plan was to retrofit dual Intellian GX100NX domes with Ku BUCs once certified for OneWeb use but the new phased array antenna solution would be simpler.
- Deep sea connectivity will be a challenge till intersatellite links are introduced. Gen1 satellites have to be in range of a ground station to provide service. Initial Gen2 test satellites with intrasatellite links ut have yet to be deployed at scale.

Future LEO systems of interest: Amazon Kuiper

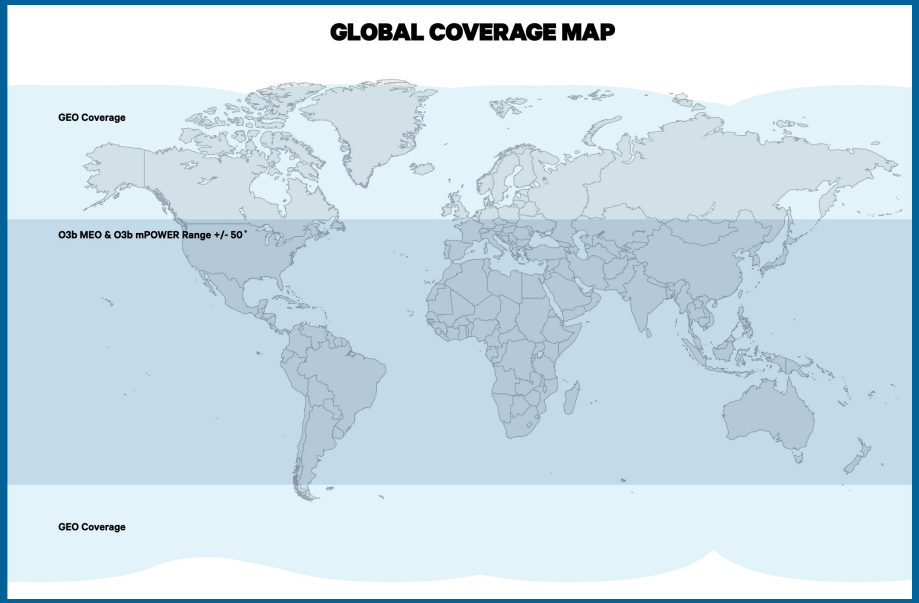
- Planned to consist of 3,236 satellites
- FCC license requires a 50% deployed, operational constellation by July 2026
- First 2 prototype satellites launched on October 6, 2023
- Plan on "Rolling out commercial service in 2025"
- Phase 1 of deployment will be 578 satellites
- A total of five phases of constellation development are planned
- Operate at 590 km, 610 km, and 630 km orbital altitude
- Ka-band phased-array antenna ~30 cm (12 in) in width
- Expected to support "up to 400 megabits per second"

Future MEO systems of interest: O3B mPower

- 8,000 km orbit with 6 Medium Earth Orbit satellites
- MEO, 8000 km orbit
- ~10x more capable than LEO offerings. EG, Gigabit or more to a single ship
- Requires 3 or more pointed 2.4m antennae (radomes)
- Focuses on high-uptime capability, high performance (at a premium) with redundant equipment (ConOps)
- Limited to latitudes 50° N and 50° S (which covers 96% of the global population). They have a polar orbit defined, but no announced plans
- SES Cruise mPOWERED + Starlink service claims to combine the best features of LEO and MEO orbits to provide high-speed, secure connectivity at up to 3 Gbps anywhere in the world



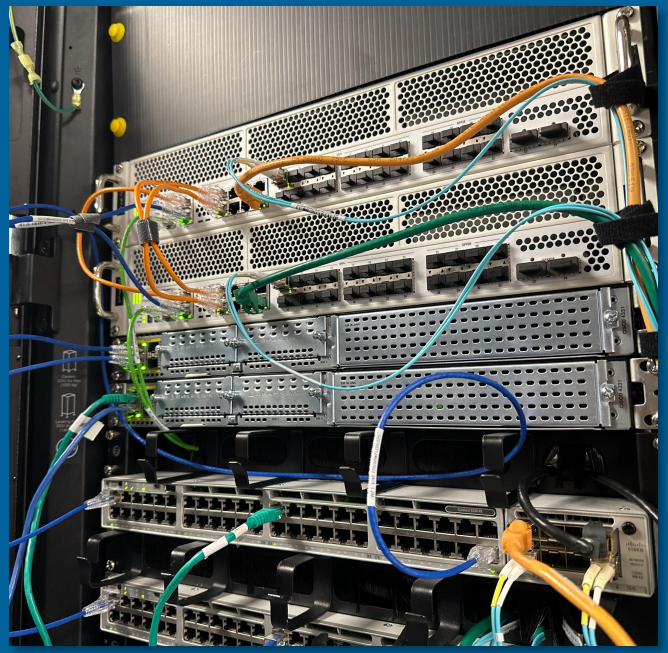
O3B mPower contrived example



Other Projects

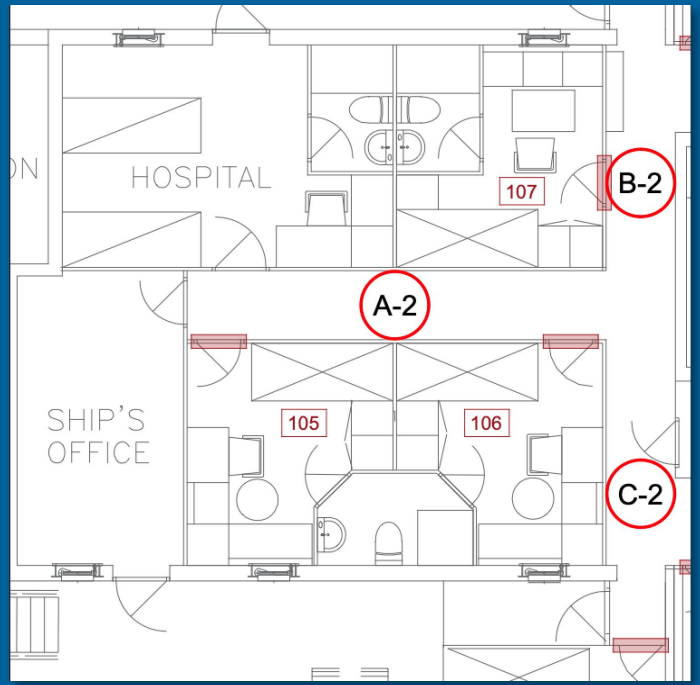
Other Projects: ARF-Firewall-Team

- Working with SatNAG, OmniSOC on fleetwide deployment of Fortigate Firewalls and Analyzers (opt-in)
- Hosting West-Coast hub for:
  - FortiGate routing
  - FortiAnalyzer traffic analysis collection
  - FortiManager device manager
- Purchasing and distribution of equipment
- Will check on state-of-health of equipment during annual satcoms inspections, per-ship
- For questions to all team stakeholders, there is an UNOLS email address specific to this project



Other projects: Safer Seas Act cameras

- Required by law as of Nov 2023
- UNOLS asked USCG about compliance requirements soon after
- Local Coast Guard is the decider; several global ships have been told to comply
- HiSeasNet is managing the group purchase with Digigone and coordinating installations – will be able to advise of bandwidth considerations, too
- Will conduct annual state-of-health checks on the equipment
- UNOLS Office is coordinating other aspects of the Safer Seas Act (EG signage, Title IX office interface, etc)
- OmniSOC is handling cybersecurity review
- For questions to all stakeholders, there is an UNOLS email address specific to this project



Milestones

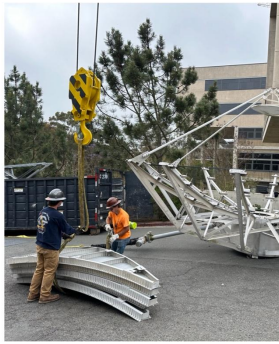
Milestone: Farewell to the HiSeasNet Ground Station

2002 Pacific Ocean Relay

2004 Atlantic Ocean Relay, Ku

2020 All links shut down

2024 All equipment removed



Milestone: Welcome to the ARF Firewall West Coast colocation facility!

2023 Test install at HSN bunker

2024 Move down to SDSC Datacenter, upgrade to 20Gbps

2020 Kilo Moana, Revelle

2021 Langseth, Sikuliaq, Atlantis

2022 Atlantic Explorer

2023 Thompson

2024 Armstrong, Ride

Milestone: fleetwide Intellian v240M/v150NX conversions for non-retiring vessels


HiSeasNet
Thank you!
Questions?
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