RVTEC 2023
HiSeasNet - Evolution of Satellite Connectivity for the US Academic Research Fleet
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Extra Special Thanks

- NSF and ONR have supported our vision for reliable, resilient, always-on, high performance Internet service as an enabler of research and ship operations for years. Support during the COVID-19 pandemic was critical to the growth and success of our project, and for improving conditions on vessels

- Since 2022, ONR and NSF have funded a project to demonstrate the productivity that can occur with constant broadband bandwidth capability on deep-ocean research vessels

Observed broadband benefits

1. Network stability (versus expansion model)
2. Concurrent Zoom sessions possible, allowing ops and science to consult experts concurrently
3. More possible to ship data from ship to shore in real-time or near-real time
4. Less planning needed for science support logistics
5. Possible to consider use of modern IT tools which depend on cloud
6. Ship's Crew increasingly able to leverage 21st century workflow solutions EG charts, parts shopping, HR, time reporting – many tools that have "gone digital"

Agenda

- Introduction/Refresher
- Service Catalog
- Roadmap, 2024-2028
- Status Report of systems

HiSeasNet Introduction/Refresher

Since 2002, HiSeasNet is a project that provides Internet support to US-based oceanographic research vessels. We support coastal, regional, intermediate ocean class, global class and ice-capable vessels

We are passionate about high-performance, high-availability networking to remote environments, leveraging economies of scale

Internet-based reliance has crept into most aspects of our daily professional (and personal) lives such that it is now challenging to plan for seagoing research without it. We aim to make the mechanisms of what it takes to provide the presence of Internet at sea as invisible as possible to the vessels we support

"Any ocean, any time, anywhere"

HiSeasNet Service Catalog

- Procurement at scale (equipment, leases, airtime)
- Monitor industry, allow ARF fleet to get best-available services
- Monitoring and support of Internet, from ship's router onward
- VoIP phones
- Satellite ground station (2002-2020, decommission 2023-2024)
- Commercial contract management of Internet (2020-present)
  - Marlink Sealink
  - Inmarsat Fleet Xpress
  - SpaceX Starshield
  - Iridium CERTUS
  - Cellular (under evaluation)
- Link expansions (more throughput)
- Extra support for Telepresence
- ARF Firewall Project support
- Real-time systems, leveraging high throughput
  - Marlink BridgeLink (ShipOps)
 - Siemens EcoMain (ShipOps)
  - Ocean Data Tools (Science)

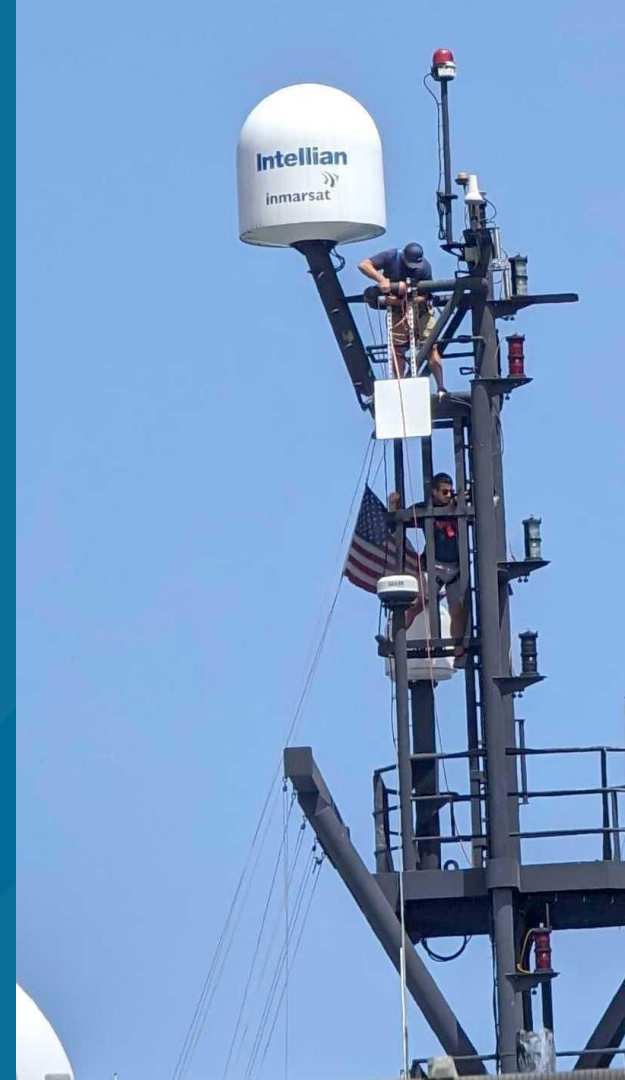# HiSeasNet Roadmap, 2024-2028
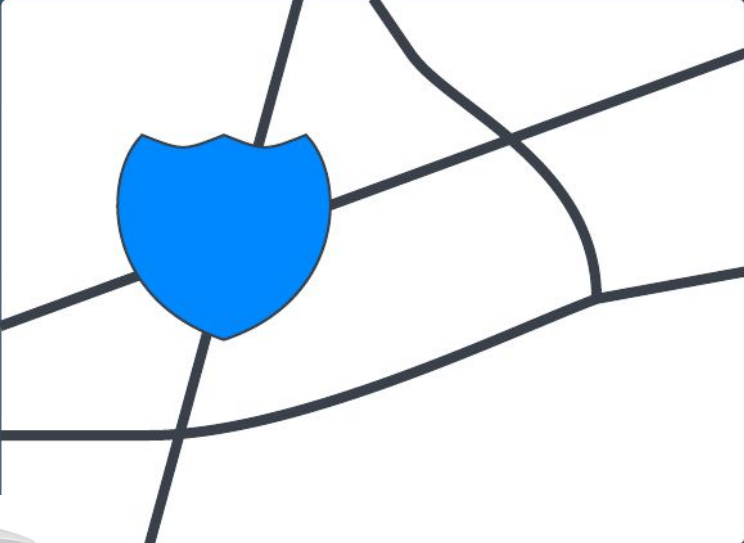
HiSeasNet Roadmap, 2024

- Complete SpaceX Starshield installs (50% complete)
- Move Starshield from pilot phase to production phase
  - Migrate Starshield from direct-from-vendor to reseller
  - Evaluate add-on services offered by resellers
- Reduction or removal of Fleet Xpress
  - Global sales for Fleet Xpress have fallen precipitously
  - Our contracts expire in 2027, but we can also pay a cancellation fee
  - Reduce plans to lowest possible once Starshield is onboard
  - Suspend plans in September 2024
  - Consider removal and contract cancellation where it makes sense. EG avoid re-investment into failed equipment
- Add or replace FleetBroadband with Iridium CERTUS
  - Need L-band for emergencies
  - LEO, no moving parts
  - VoIP
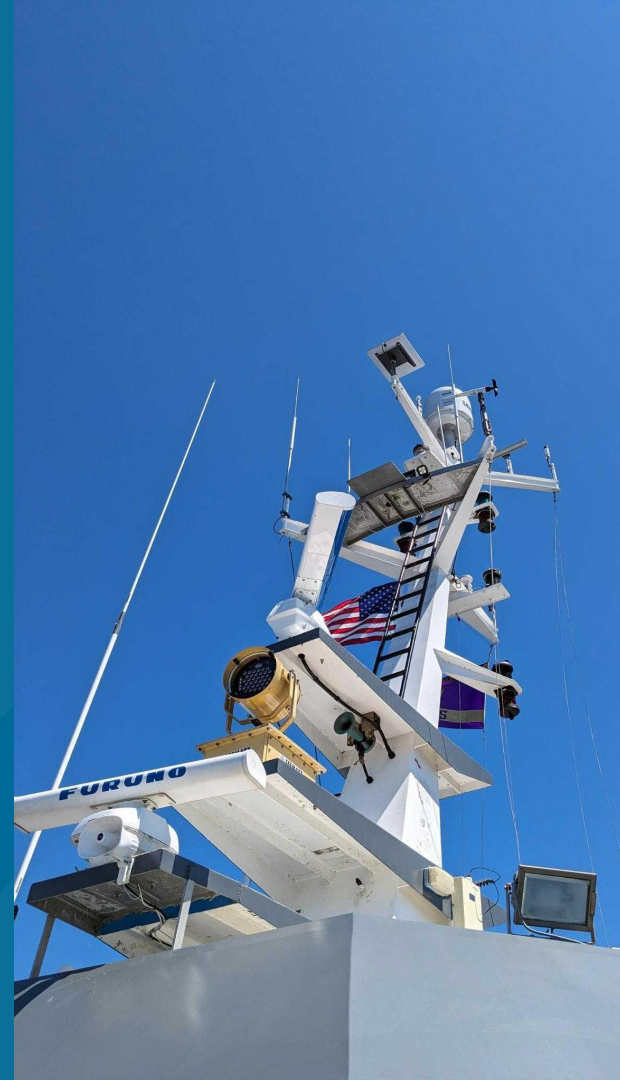
HiSeasNet Roadmap, 2025

- Refresh of Sealink systems installed in 2020
- Starshield non-commercial constellation could be online
- Pilot of OneWeb (possible follow-on from 2024, depending on readiness)
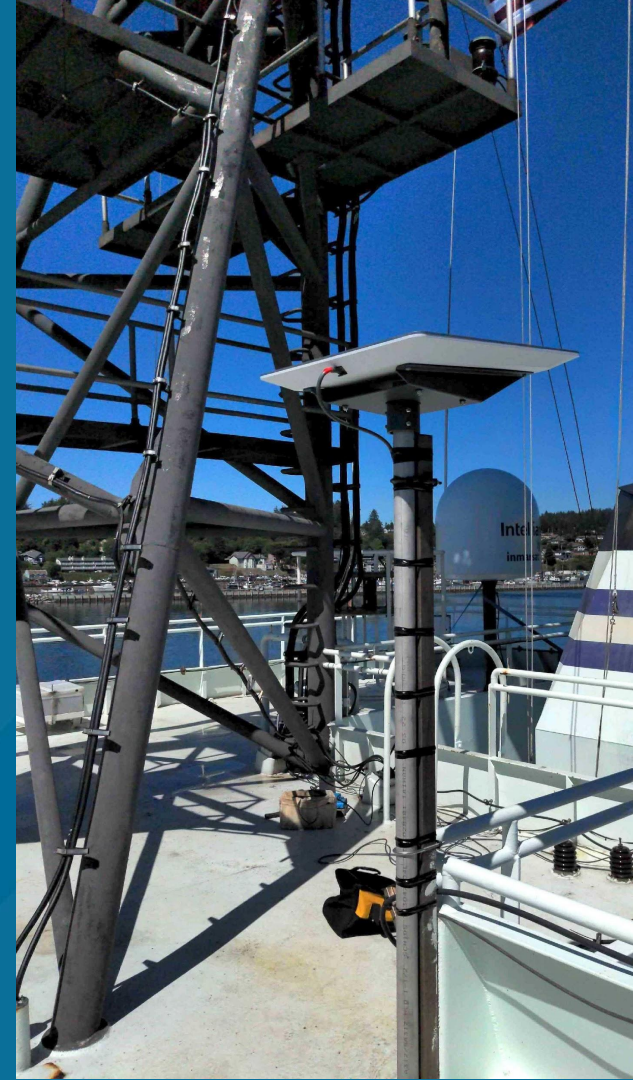- Evaluate refreshment of Sealink systems installed in 2020

HiSeasNet Roadmap, 2026

- New systems potentially on market
  - Amazon Kuiper
  - O3B mPower
- Evaluate refreshment of Sealink systems installed in 2021

UC San Diego

HiSeasNet Roadmap, 2027

- End of Fleet Xpress contracts, remove existing systems
- Evaluate refreshment of Sealink systems installed in 2022

HiSeasNet Roadmap, 2028

- Starshield equipment refresh
- ARF Firewall Project hardware refresh

Current State of fleet systems

Sealink

1. Stable, likely to become secondary link for most use
2. Proven tech; will be needed to mitigate risk for some years
3. "Big" bandwidth may get reduced in order to divert funds for more Starshield
4. Still needed for "safety net"
5. Still needed for low-jitter
6. More capable for ship->shore than Starshield

Fleet Xpress

- Stable, but likely on the way out due to performance and budget limitations
- Will divert funds from this system to other systems
- Less likely to reinvest into systems that break
- We generally aim to keep systems available and on ship until 2027 to mitigate risk

Standalone Iridium CERTUS

1. In progress (~40% deployed)
2. LEO, no moving parts
3. Needed for emergency comms (L-band)
4. Needed for VoIP when/if Starshield is primary
5. For high-latitude work, can get one with a heater
6. Global coverage; has helped ships accomplish polar code comms plans

Starshield

- ## On its way to becoming preferred primary when available
  - Less latency
  - High burst capacity
  - Observed ~20Mbps average at mid-latitudes
  - Higher performance at high latitudes
- ## Starshield, not Starlink
  - Higher tier on network
  - Less geofencing
  - Future compatibility with dedicated Starshield constellation of satellites
  - Unlimited plans available, but $$$$
- ## 5TB/mo quota
  - Taking queues from Cellular industry
- ## Challenges
  - ~10:1 downlink:uplink not well-suited for some cruises EG ROV
  - SpaceX terms and conditions very dynamic – will take some years to stabilize
  - Very High latitude coverage currently sparse
  - Gen 1.5 -> Gen 2 satellite changes will make taming 5TB/mo more difficult over time w/o QoS
  - Some relief may be possible via resellers absorbing risk
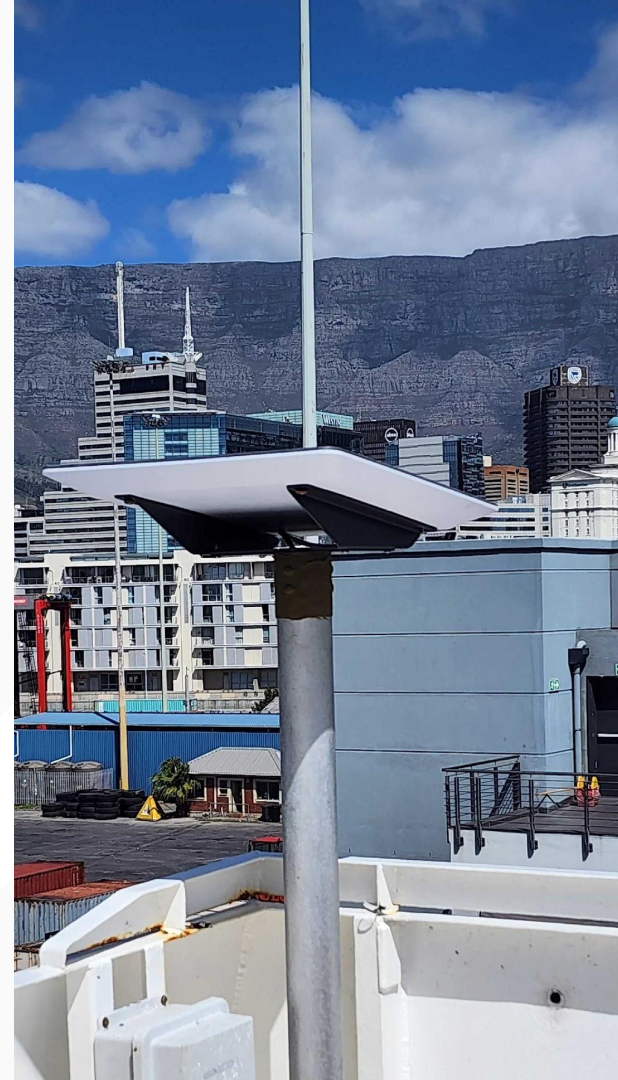
In-fleet Starshield Deployment Status: 50%

Completed (in order, Jun-Sep 2023)

1. R/V Rachel Carson
2. R/V Robert Gordon Sproul
3. R/V Sally Ride
4. R/V Sikuliaq portside
5. R/V Sikuliaq starboard
6. R/V Thomas G. Thompson portside
7. R/V Thomas G. Thompson starboard
8. R/V Neil Armstrong
9. R/V Marcus G. Langseth
10. R/V Roger Revelle portside

Pending (alphabetical order, devices on order)

1. R/V Atlantic Explorer
2. R/V Atlantis portside
3. R/V Atlantis starboard
4. R/V Blue Heron
5. R/V Endeavor
6. R/V F.G. Walton Smith
7. R/V Kilo Moana
8. R/V Pelican
9. R/V Roger Revelle starboard
10. R/V Savannah

Starshield Installation Factors

1. Recommend bolt-on installations. As we get to know this system and our fleet's needed, permanent homes can be found, if needed
2. Low-Earth Orbit – looking at 140° of sky and multiple satellites 800km away (more like cellular towers) – but obstruction needs to be <1%
3. Global Vessels get 2 antennas when needed
   - Largely due to other redundant systems causing notable obstruction
   - Allows us to experiment with multi-antenna options during pilot phase in an affordable way
   - Some benefit in avoiding 5TB overages for more densely populated ships
4. Other Vessels: 1 antenna
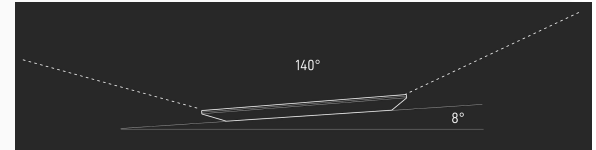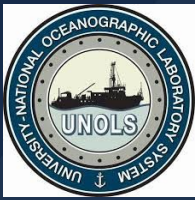
Thank You! Questions?

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