HiSeasNet

Internet for Oceanographic Ships at Sea

HiSeasNet: A Multi-Institution Collaboration

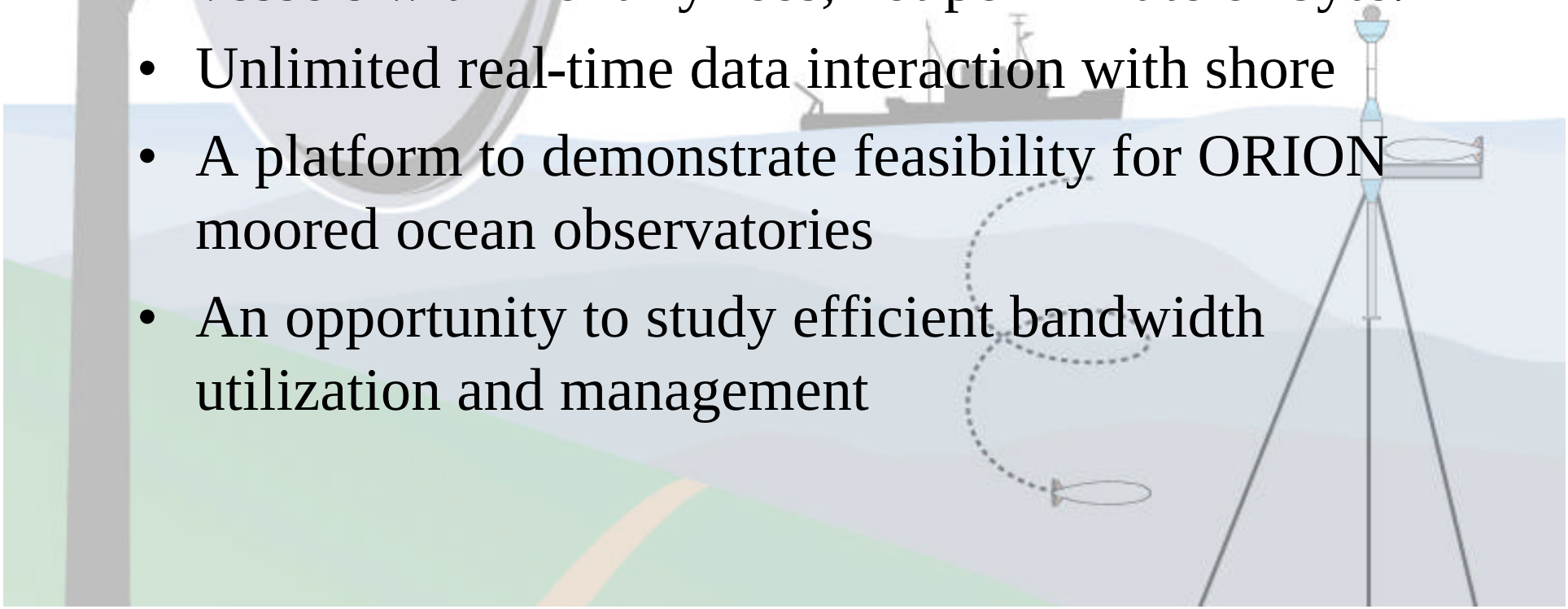
Joint Oceanographic Institutions
On behalf of:
Scripps Institution of Oceanography
The University of Washington
The University of Hawaii
Woods Hole Oceanographic Institution
Lamont-Doherty Earth Observatory
The University of Rhode Island

Funded by the National Science Foundation
the Office of Naval Research
and the State of California

What is *HiSeasNet*?

You might think of it as…

- Dedicated, leased satellite bandwidth to research vessels with monthly fees, not per minute or byte.
- Unlimited real-time data interaction with shore
- A platform to demonstrate feasibility for ORION moored ocean observatories
- An opportunity to study efficient bandwidth utilization and management



What does *HiSeasNet* do?

- Unlimited email (attachments and shore accounts included)
- Real-time data transfer (time-lapse images, weather, position)
- Bulk data transfers (maps, images, papers, bathymetry, etc.)
- Web access (equipment manuals, parts ordering, software updates, etc.)
- Voice over IP (VoIP) phone calls
- Video conferencing to shore
- Instant messages, ssh logins, for troubleshooting interaction on shore

What *HiSeasNet* is not

- *HiSeasNet* is **not** *ROADNet*
  - *HiSeasNet* is the hardware and satellite networking infrastructure that enables connectivity at sea
  - *ROADNet* (Real-time Observatories, Applications, and Data management network) is the software real-time virtual network that moves a variety of data
  - On Revelle and Melville, we have machines running *ROADNet* software sending images and MET data to shore when the *HiSeasNet* link is available. Images can go to the web or be stitched into movies.
- *HiSeasNet* equipment is not small
- *HiSeasNet* is fast, but not blazing fast…now.

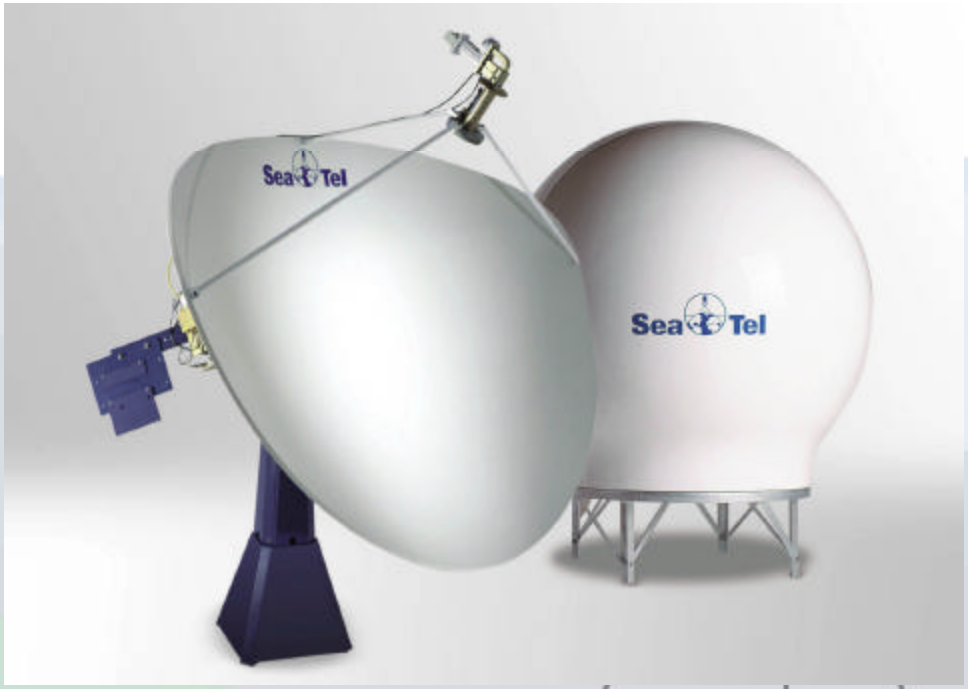
Phase 1, Feb 2002

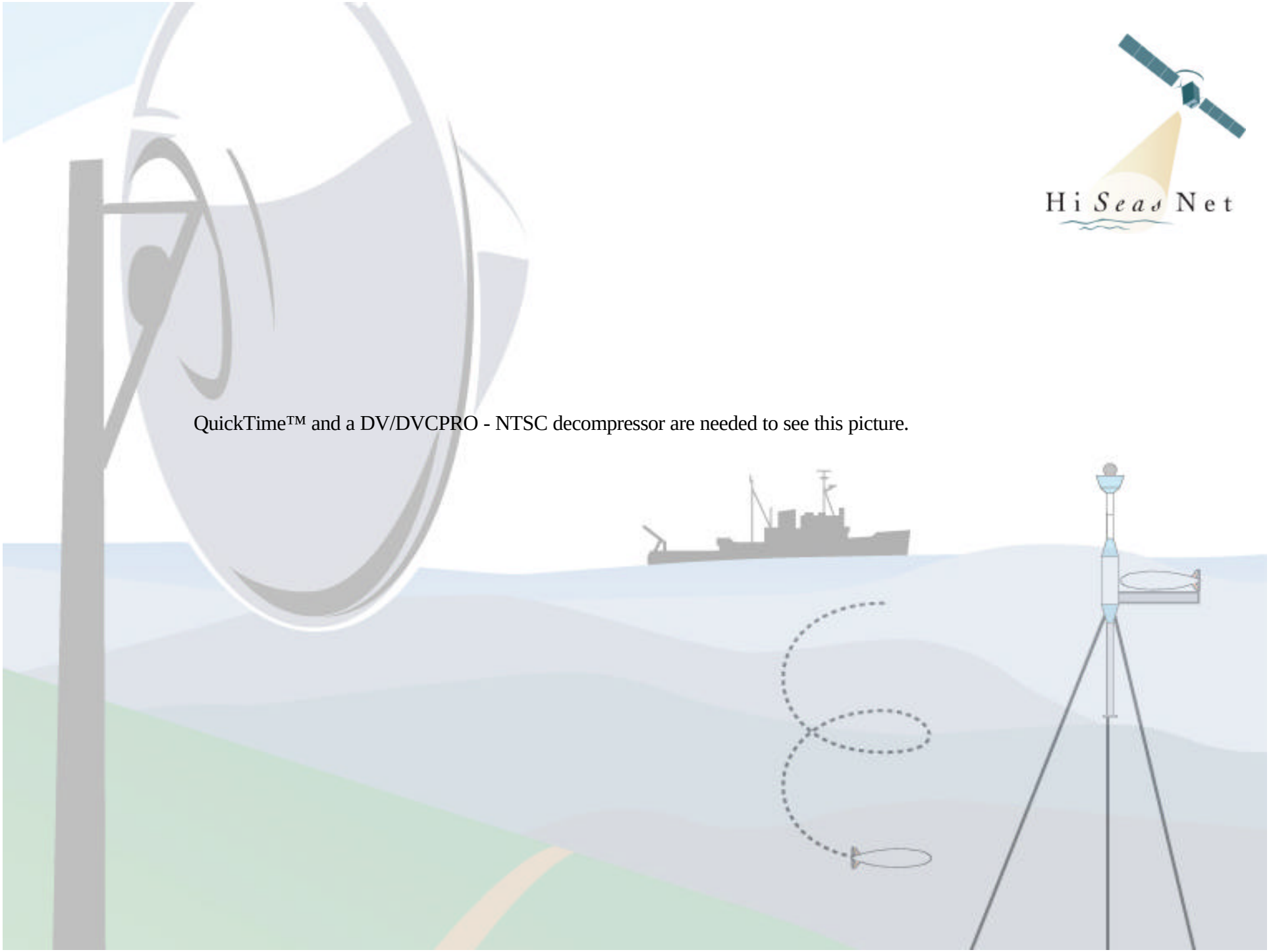
- Installed 2.4m antenna
- Connect via ISP
- Intelsat 701 (180W)
- 32/64K link
- *ROADNet* ORB

R/V Roger Revelle

C-Band System on Research Vessels

- 2.4m SeaTel Model 9797
- Up to 2 Mbps transmission rate depending on power amp
- 3-Axis Stabilization, Pointing to ± 0.1°
  - ±25 roll
  - ±15 pitch
  - Rates to 90°/sec
  - Accelerations to 60°/s^2
- 2U BDU controller unit
- Needs GPS & Gyro feed
- Comtech CDM-550
- Cisco 3620 router
- *ROADNet* ORB (SIO)




HiSeasNet
QuickTime™ and a DV/DVCPRO - NTSC decompressor are needed to see this picture.

Phase 2, Fall 2003

- 2.4 m C-Band antennae installed on:

R/V Thomas Thompson

R/V Melville

Phase 2 - San Diego Earth Station

7 m *HiSeasNet* Earth Station Antenna

San Diego Supercomputer Center

- 3 Comtech Modems
- Cisco 2611 router with 2 WIC-2T cards
- UPS

General experiences so far…

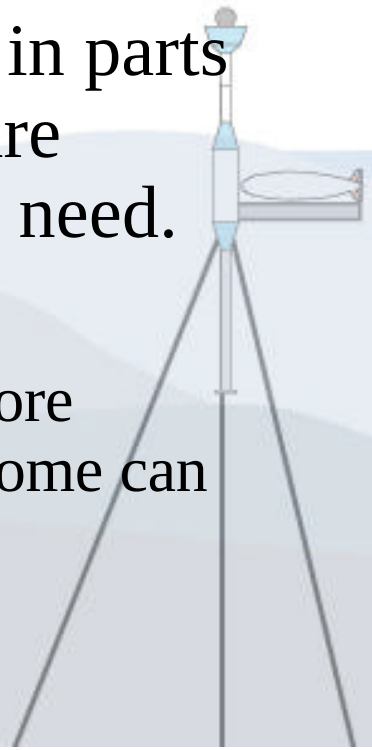
- The technology is incredibly flexible…its all just IP packets
- It has changed the way crew and science do work and respond to problems
  - Images, phone calls, instant messages, OS/software patches, virus signature updates, etc. are all in easy reach
  - Faster response, more eyes on a problem, better reliability of solutions, fewer mistakes.
- People are not so far out of touch
- With only a little imagination, we can use the link enough to make high jitter, congestion, and delay.

Current Phase 2 Setup

- Earth station uses 7m Vertex dish pointed at Intelsat 701 (180°W)
- Earth station sends 96Kbps link with all ship traffic (Revelle, Melville, Thompson)
  - **Not** split into 32K chunks
  - Allows for a ship to get more bandwidth if other ships are offline, automatically, with a fair queue
  - When all online, all ships compete for bandwidth
  - Changes to one ship may affect all of them
- Each ship has a dedicated 96Kbps link back **to** shore

Equipment experiences

- Comtech modems are solid.
- Cisco routers can be tricky to configure, but solid operationally.
- SeaTel antennas fail sometimes. Usually in parts that we have spares for on the ship. We are learning about what additional spares we need.
- Troubleshooting can be a challenge.
  - More experiences on the ships makes for more successful problem solving. Inmarsat calls home can sometimes help as needed.



VoIP experiences

- Revelle and Melville using Nuera F200SIP units tied to UCSD PBX. Call setup is SIP, not H.323.
- Using E-CELP 4.8k vocoder, calls are about 10kbps including overhead
- Started out okay. Quality degraded with congestion. Better with some more control over shore-to-ship RTP packets. Still reports of shaky connections sometimes.
- Will improve with bigger outbound carrier (more ships)
- New, smaller, cheaper equipment in trials

Videoconference experiences

- Started in 2003 with VoIP for audio and streaming wireless web camera for video. Serious audio/video timing offset.
- In April of 2004, SIO purchased portable Tandberg 2500 video conference units for Revelle and shore. Equipment is H.323 based.
- Have done excellent video conferences to K12 classrooms using ~90Kbps of the 96Kbps ship-to-shore link.
- Tricky (politically and technically) to get through firewalls and NAT boxes sometimes.
- Instant messaging makes a great back channel.

Policy/People experiences

- **This is the hardest part**
- Who gets priority for equipment use?
- What traffic is allowed? To how many workstations?
- How do we share a carrier fairly with other ships?
- Firewalls, viruses, worms, etc.
- With no user restrictions, pipe is easily clogged
- With lots of restrictions, we don’t provide a good service and good things don’t happen

General SIO rules/policy

- Science has the highest priority for the link. Personal use comes later. Personal calls are requested to be reasonable (~15 mins).
- Web access is restricted to a couple of public workstations and goes through a proxy.
- All computers currently have access to outside POP/IMAP mail. We encourage spam/virus scanned ship email accounts.
- OS updates are constantly downloaded to SIO computers only.
- Network virus scanning is done on SIO boxes.
- Ship uses public addresses, firewall on the ship

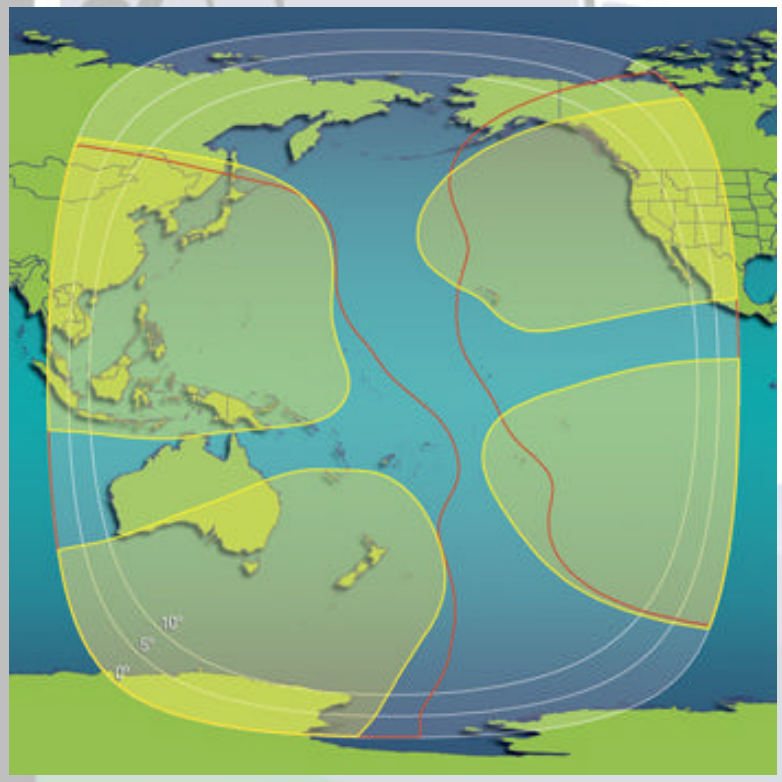
Earth Station Experiences

- We route non-SIO ship traffic back to the home institution via secure router tunnels.
  - Allows ship addresses to appear and be advertised as on the home institution's campus
  - Puts maximal network control in home institution hands
- Earth station can put some priority on VoIP or videoconference packets
- Shifting carriers and bandwidth limits requires coordination among ships, but is possible.
- Maintenance may affect multiple ships
- Earth station generally runs itself

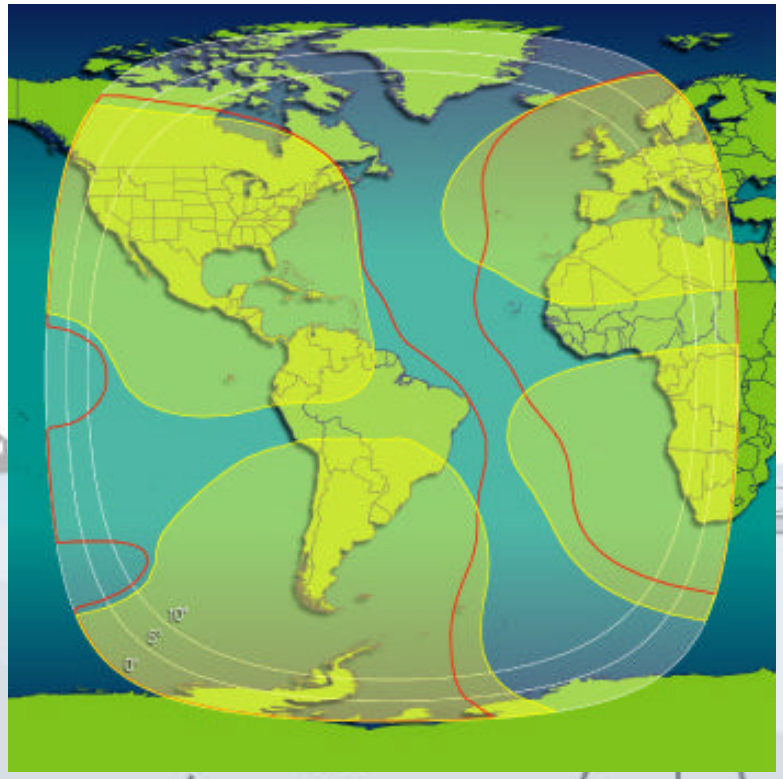
Phase 3

- 2.4m C-Band antennae for the *R/V Kilo Moana*, *R/V Knorr*, *R/V Atlantis*, and *R/V Ewing*'s replacement
- 1.2m Ku-Band antennae installed on *R/V Endeavor* (16 watt) and *R/V New Horizon* (4 watt).
- Second 7m earth station antenna for C-band service on the Intelsat Atlantic satellite
- 3.8m antenna at earth station for service on domestic Ku-band satellite

Phase 3 Planned C-Band Coverage



INTELSAT
701@180°W



INTELSAT
707@307°E

Examples of Ku-Band Coverage

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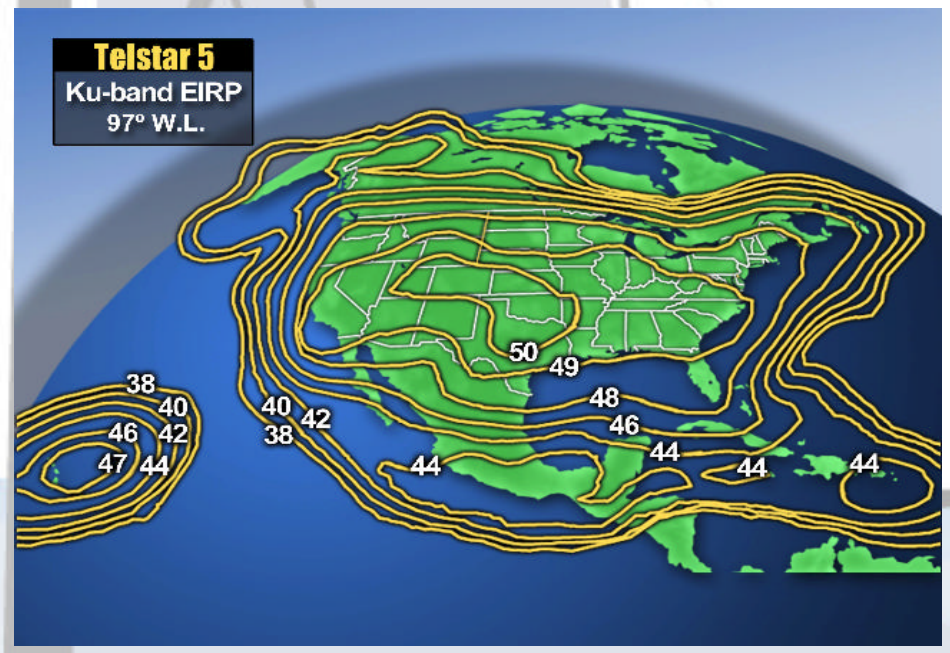

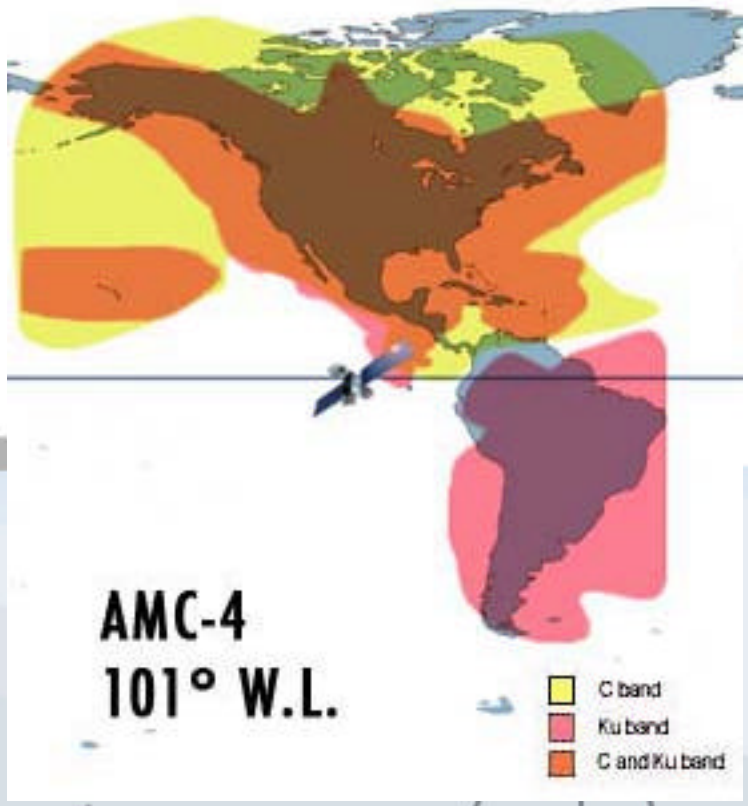

Ku-Band System on Research Vessels

- Spot coverage, higher bandwidth, smaller antennae but smaller beams
- 1.2m SeaTel antenna Model 4996T
- Up to 5 Mbps transmission rate depending on power
- 8 watts from shore, 4 watts on New Horizon unit, 16 watts on Endeavor
- 3-Axis Stabilization, Pointing to ± 0.2°
  - ±25 roll
  - ±15 pitch
- BDU controller unit
- Needs GPS & Gyro feed
- Comtech CDM-550 modem
- Cisco 2611 router
- Separate carriers per ship
- *ROADNet* ORB

The UNOLS Fleet

SHIP	OPERATING INSTITUTION	LENGTH (ft)
	LARGE / GLOBAL	
MELVILLE	Scripps Institution of Oceanography	279
KNORR	Woods Hole Oceanographic Institution	279
THOMAS G. THOMPSON	University of Washington	274
ROGER REVELLE	Scripps Institution of Oceanography	274
ATLANTIS	Woods Hole Oceanographic Institution	274
MAURICE EWING	Lamont-Doherty Earth Observatory	239
RONALD H. BROWN*	NOAA*	274
	INTERMEDIATE / OCEAN	
SEWARD JOHNSON	Harbor Branch Oceanographic Institution	204
KILO MOANA	University of Hawaii	185
WECOMA	Oregon State University	185
ENDEAVOR	University of Rhode Island	184
GYRE	Texas A&M University	182
OCEANUS	Woods Hole Oceanographic Institution	177
NEW HORIZON	Scripps Institution of Oceanography	170
SEWARD JOHNSON II	Harbor Branch Oceanographic Institution	168
	REGIONAL	
POINT SUR	Moss Landing Marine Laboratories	135
CAPE HATTERAS	Duke University/UNC	135
ALPHA HELIX	University of Alaska	133
ROBERT GORDON SPROUL	Scripps Institution of Oceanography	125
CAPE HENLOPEN	University of Delaware	120
WEATHERBIRD II	Bermuda Biological Station for Research	115
PELICAN	Louisiana Universities Marine Consortium	105
LONGHORN	University of Texas	105

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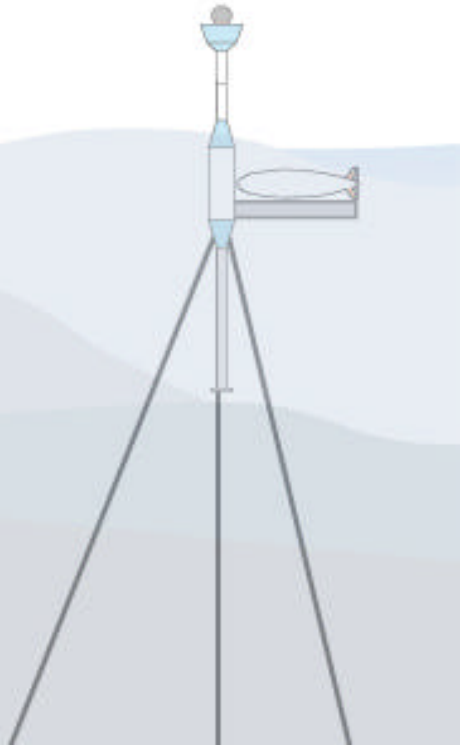
Green - Operational

Yellow - Phase 3



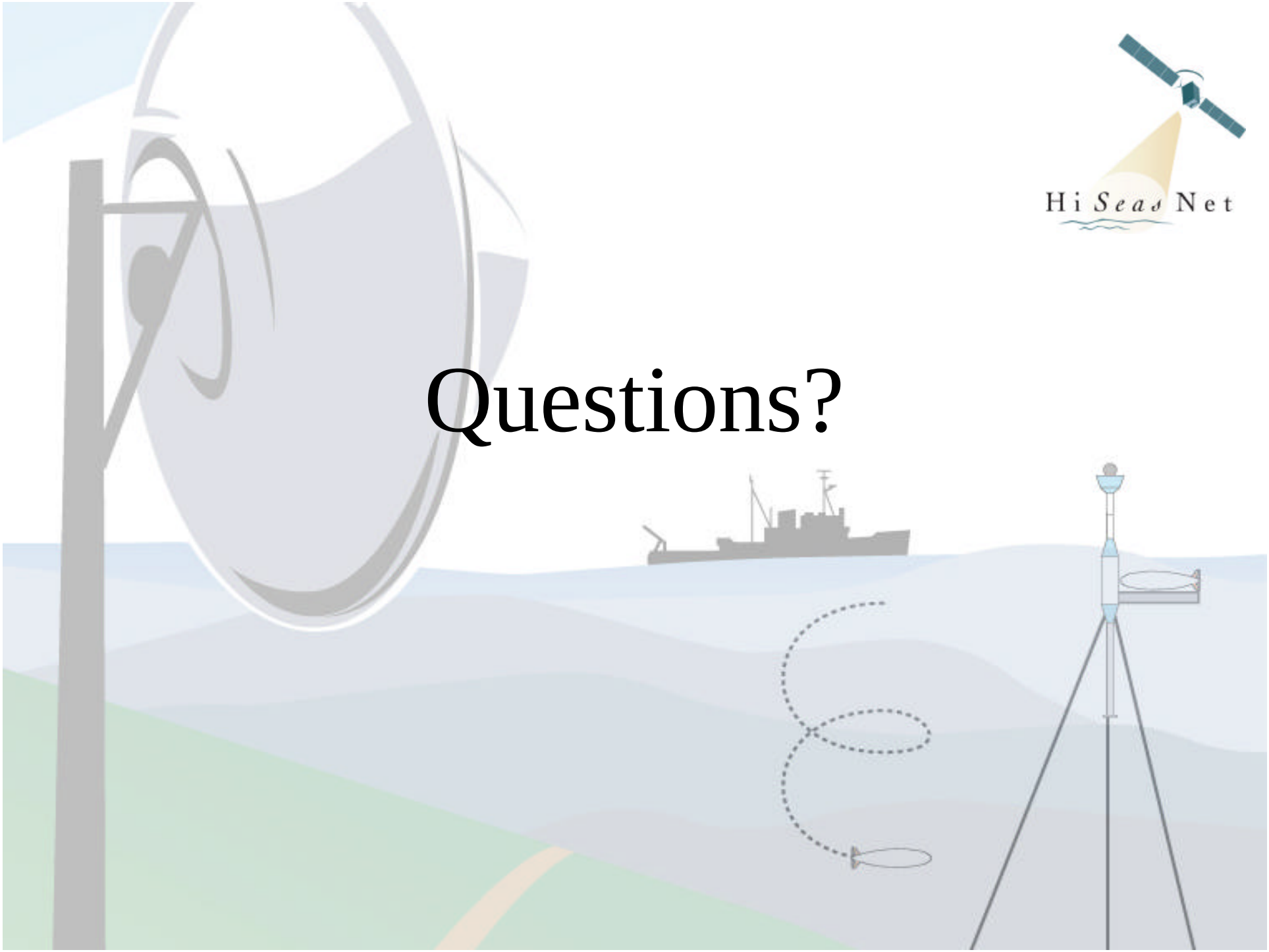
Rough Phase 3 Schedule

- Mid November - Hub installation (7m and 3.8m)
- Late November - R/V New Horizon - San Diego
- First week Jan - R/V Atlantis - San Diego
- Late Jan - R/V Endeavor - Naragansett
- March 1-15 - R/V Knorr - shipyard USA
- Mid March - R/V Kilo Moana - Brisbane, Australia
- TBD - Ewing replacement

Satellite Lease Costs

- Current C-band setup is 96Kbps ship-to-shore and 32Kbps per ship in shared shore-to-ship (ie 3 ships = 96Kbps)
- Current C-band setup is about 300KHz of satellite bandwidth per ship (Currently rounded up to 1MHz)

- $2000/month for C-Band satellite lease
- $1000/month for Ku-Band satellite lease
- $180K for 2.4m C-band ship's system
- $100K for 1.2m Ku-band ship's system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Questions?

Jason H2O J-Box video from Jason real-time images

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