Exploring the Ocean and in Real-Time With HiSeasNet

Foley, S. (sfoley@ucsd.edu), Berger, J. (berger@ucsd.edu), Orcutt, J. (jorcutt@ucsd.edu), and Vernon, F. L. (fvernon@ucsd.edu)

Cecil H. and Ida M. Green Institute of Geophysics and Planetary Physics
Scripps Institution of Oceanography, UCSD MC-0225 9500 Gilman Drive, La Jolla, CA 92030-0225

www.hiseasnet.net

HiSeasNet, the IP communications network providing full-period Internet access for the U.S. academic ocean research fleet, is an enabling technology that is changing the way oceanography is done in the 21st century. With the operation of a system on RV Marcus Langseth in the summer of 2007, all but two of the Universities National Oceanographic Laboratories System (UNOLS) fleet of large/medium and intermediate ocean vessels are now equipped with HiSeasNet capability. Installation on RV Walton Smith continues in service on other Regional class UNOLS vessels. Installation on more Intermediate Regional class vessels are planned for 2008.

Current status

The HiSeasNet teleport is in San Diego, CA and is operated by Scripps Institution of Oceanography. The satellite hub has two pairs of 7m-C-band antennas (AOR and POR) and a 3.8m Ku-band antenna for downlink. The 3.8 meter antenna operates on two beams of the SatMex satellite for coverage in both the northeast and northwest US coast, as well as the Gulf of Mexico and west coast of South America. Additional Indian Ocean operations for RV Revelle were supported for most of 2007 through a teleport in Germany.

Science uses of HiSeasNet

- Remote Science: Due to changing schedules a PI was unable to sail on the RV Knorr to direct a multi-beam bathymetry, magnetic, and gravity survey. The chief scientist directed the cruise from shore through the Internet. The data were later telemeasured to shore for analysis by the “virtual” scientific team both at Woods Hole and in Paris. (EOS 86.37, 13 Sept 2006).
- Oceanography: The ROADNet project (roadnet.ucsd.edu) is continuously transferring streams of low bandwidth data from SIO vessels in real-time. The data are currently GPS position, gyro and weather data and ship camera images, but could be expanded to include any type of data. When the location of a satellite is obstructed or corrupted, buffers on the ship start filling to transmit the spoofed data when the link is available again.
- Streaming Video: The Research Channel (a cable channel like C-SPAN but with the emphasis on research, science, education, etc.) broadcast a live HDTV feed from a deep-sea, high temperature venting system associated with an active underwater volcano off the Washington-British Columbia coastlines. Images from the seafloor robot JASON were transmitted to the RV Thompson through an electro-optical tether. An on-board engineering-production crew delivered a live HD program using both broadcast and Internet. The program was transmitted via a modified HiSeasNet system to the University of Washington in Seattle. The resulting HD stream was mixed in real-time with live two-way discussion and HD imagery from participants, field-based researchers working in the field with students, underwriters, and scientists, and teachers. The amplifiers needed for transfer at 19Mbps for HD communications were purchased by Scripps and are available for use on other projects.
- Videoconference: Many HiSeasNet vessels have hosted real-time videoconferencing using a variety of gear ranging from laptops with SighCam and iChat software to Tandberg 2500 professional video conferencing gear. This has enabled outreach to classrooms on shore, presentations to the public, and collaborations at sea. (See EDDAITS talk, “In the Footsteps of Roger Revelle: Seagoing Oceanography for Middle School Science”)
- Field Collaboration: HiSeasNet ships can more easily communicate and share data in real-time during multi-vessel operations/projects such as 2006 and PLUSNET. Coupled with the SWAP project, even non-HiSeasNet ships can share data in real-time.

Technical advantages to science

- Budget: HiSeasNet bandwidth is purchased in long-term leases paid monthly, not by the minute or byte. Unlike Inmarsat ISDN or MPDS connections, the communications costs off the simulated, easily computed, and never exceed the contract lo.
- Home Network: Network routing through the teleport makes the ship a part of an institution’s own campus network. Using IP routing with Generic Routing Encapsulation (GRE) and IPsec tunnels between teleport and oceanographic institutions, ships have access to and are protected by campus firewalls and other facilities automatically.
- Real-time: Data can be exchanged in real-time between ship and shore. No need to batch or delay communications to shore. Problems requiring help from shore can be resolved quickly, and results can be shared immediately with the other ships.
- Burstable: Bandwidth is shared among ships automatically and fairly on a satellite to increase fleet efficiency. When one ship is offline or not transferring much data, the shared bandwidth is immediately distributed to the other ships.
- Flexible: With generic IP connectivity at sea, anything goes. This might include: Real-time display of ship data on shore Email and web access (grant submissions, collaborations, etc.) Videoconferencing, Voice over IP (VoIP), and shared whiteboard collaboration Large file transfers (FTP, P2P, e-mail, full consortia, etc.) Access to shore systems (SSH, VPNs, license key servers, etc.) Synchronization of data (patches, configurations, firmware, keys) between ship and shore.

Future work

- User Community: We intend to encourage and develop a stronger user community so that shipboard techie and scientists can more easily help the shipboard techie and scientist on shore. Over the 3-week period of use of the ROADNet project.
- Improved Training: The HiSeasNet equipment can be tricky to operate especially on small vessels with limited technical staff. We plan to develop a training program for shipboard techie to work more effectively and efficiently with the HiSeasNet gear.
- Better Ku-band footprints: The Ku-band coverage area is based on a terrestrial-aimed satellite with limited coastal coverage. There may be some more satellites coming online soon that would allow for better ocean or coastal coverage.
- Long-term data collection: With experience connecting the HOOPE seismic site on South Georgia Island, along with new data acquisition through the ROADNet project on some ships, the technology can readily be used in for longer-term data collection as in the Ocean Observatories Initiative.

Conclusions

- The network successfully moves a variety of data to and from the ship, enabling new approaches to scientific programs, outreach, and ship operations.
- Despite seemingly low bandwidth, there is still a lot of time spent when the links to shore are not fully up. With unstepped ship-to-shore bandwidth, the network is ready to carry even more data to shore in real-time.
- With outreach being even more of a focus, there exists great potential for more educational opportunities...even beyond telepresence.
- The network has already changed the way science is done at sea, but new improvements are yet to come.

Acknowledgements

The HiSeasNet fleet includes ships operated by Scripps Institution of Oceanography, University of Washington, University of Hawaii, Woods Hole Oceanographic Institution, Lamont-Doherty Earth Observatory, University of Rhode Island, Oregon State Oceanographic Institution, the Louisiana Universities Marine Consortium, Moss Landing Marine Labs, and University of Miami.

SIO operates the HiSeasNet hub, manages shipboard installations, maintains a spares depot, manages front-line tech support, and organizes maintenance visits to ships twice a year.

CommSystems of San Diego (www.comm-systems.com) is the principal subcontractor for HiSeasNet, providing system integration, installation, and maintenance services for both the hub and the shipboard systems.