

# DEVELOPMENT AND FIELD TRIAL OF OER'S MOBILE TELEPRESENCE UNIT ABOARD THE R/V ROGER REVELLE



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## INTRODUCTION

NOAA's Office of Ocean Exploration and Research (OER) recently designed and built their first Mobile Telepresence Unit (MTU). The MTU is capable of streaming live high-definitions video with audio commentary from any oceanographic research vessel with adequate lab/storage space and appropriate satellite communication system to the OceanExplorer website, YouTube Live and mobile devices. The system was initially developed to support the recently completed 2012 Submarine Ring of Fire Expedition to the NE Lau basin. The MTU allowed scientists and public audiences worldwide to watch live underwater video from a Remotely Operated Vehicle (ROV) and listen to actual observations and reactions from shipboard scientists as they explored extensive hydrothermal features and unique chemosynthetic biological communities.

The cruise was funded by NOAA/OER, NSF, GNS Science (NZ), and Nautilus Minerals (Canada) and included an international team of scientists and engineers. Also onboard were the QUEST-4000 ROV, operated by the MARUM Center for Marine Environmental Sciences, University of Bremen, Germany and OER's Mobile Telepresence Unit. Development and operating costs for the MTU on this cruise funded entirely by OER.

## BACKGROUND

In May 2012 at the request of Chief Scientist Joe Resing, PMEL Oceanographer Sharon Walker contacted Webb Pinner, Telepresence Team Lead for OER's Okeanos Explorer Program, to discuss the possibilities of broadcasting live underwater video from a high definition camera on the German QUEST-4000 ROV to the Internet. In addition to video, the science team wanted to record and embed audio commentary into the live video stream as well as the raw video being recorded by the ROV team's video recording system. Timing was a serious concern because the cruise was scheduled to begin in 15 weeks.

## CORE FUNCTIONALITY REQUIREMENTS:

- Interface with HD Video (HD-SDI signal) from ROV
- Embed Audio into HD Video signal
- Provide ROV Team with video/audio stream for their video recorders
- Support up to 3 headsets for collecting audio content
- Transmit 1 video stream w/ embedded audio to shore

### Additional Functionality:

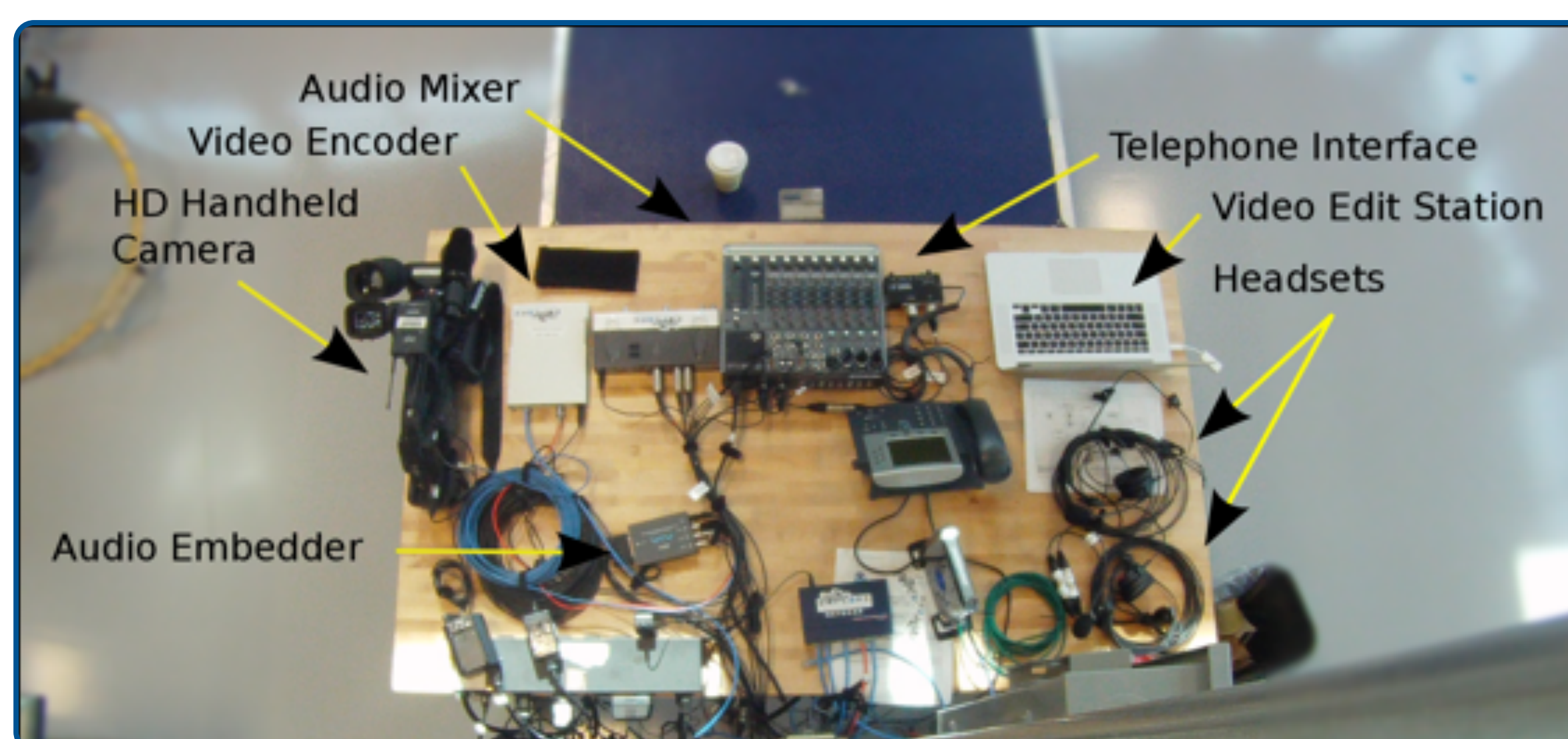
- HD Handheld Camera for capturing topside activities
- Wireless Mic and Lighting for conducting interviews.
- POV Cameras
- Video Editing Capability

## DESIGN AND DEVELOPMENT

The R/V Roger Revelle was equipped with a 2.4m SeaTel 9797 satellite antenna. During normal deployments the vessel operates with a 96kbps Internet connection. This project would require the existing antenna, satellite modem and amplifier to support a 1.5Mbps outbound data pipe, representing a 1600% increase. Steve Foley from HiSeasNet concluded that the existing equipment on the R/V Roger Revelle would be able to support the higher bandwidth.

The next challenge was solving how to disseminate the live video over the Internet. For this OER leveraged their existing partnership with the ISC. Once the video reached the HiSeasNet Earth station at USCD, it would be sent via network to the ISC in Rhode Island. The ISC would ingest, convert and upload a properly formatted video stream to streaming servers at the ISC's Content Distribution Network (CDN). The CDN would provide the required services and bandwidth to support an almost unlimited number of Internet viewers, including those tuning in via mobile devices (Android and iOS devices).

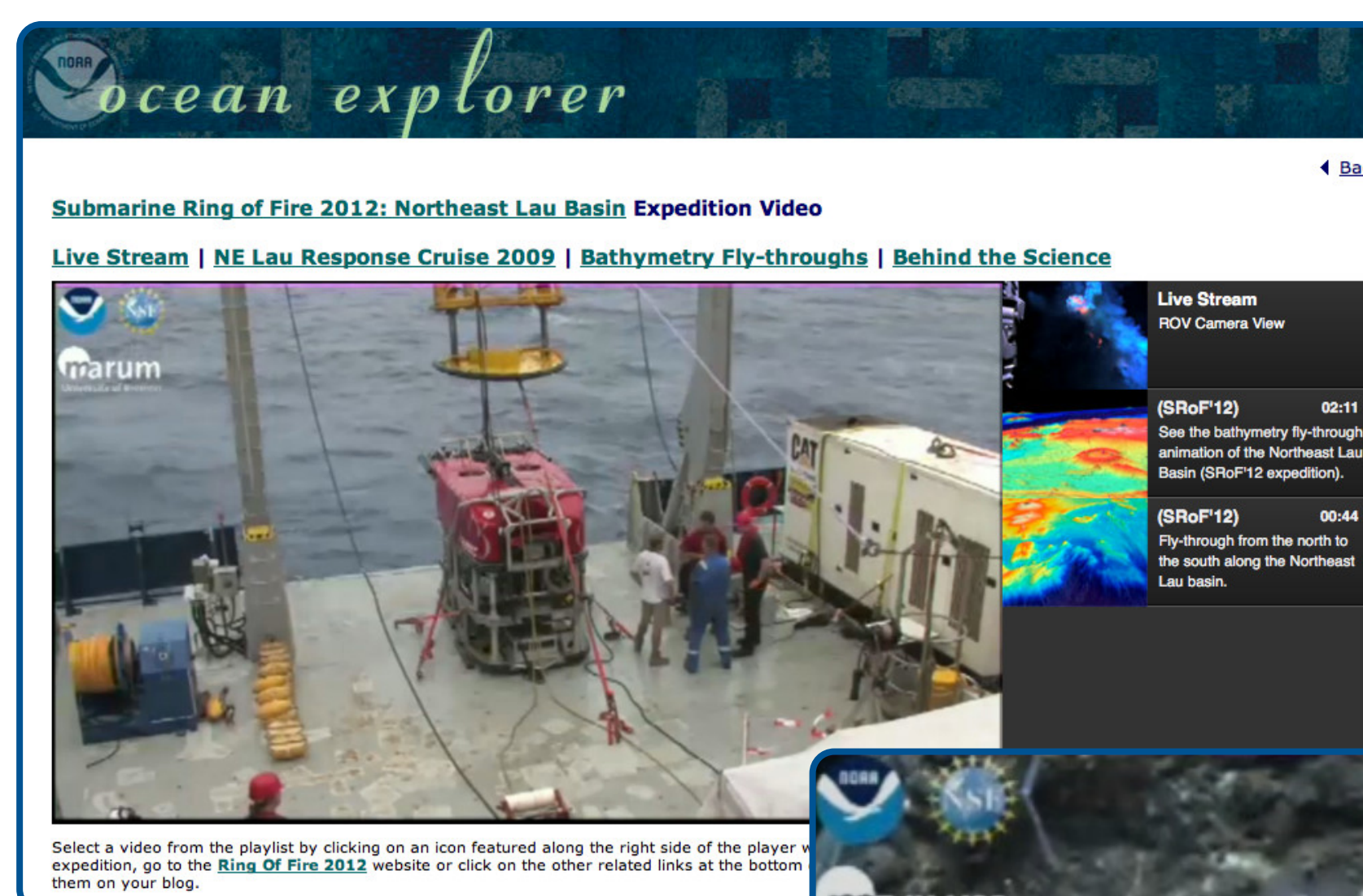
A team at PMEL procured all necessary equipment for the MTU. Roland Brian, a broadcast engineering contractor previously used aboard the NOAA Ship Okeanos Explorer was brought in to assist in the buildout. The MTU was assembled in the NOAA Port Office in Davisville Rhode Island 3 weeks prior to the cruise.



ABOVE: LAYOUT OF THE MTU EQUIPMENT PRIOR TO PACKING



RIGHT: FOOTPRINT OF OER'S MOBILE TELEPRESENCE UNIT JUST PRIOR TO PICKUP FOR AIR SHIPMENT TO FIJI. WEIGHT: ~325 LBS



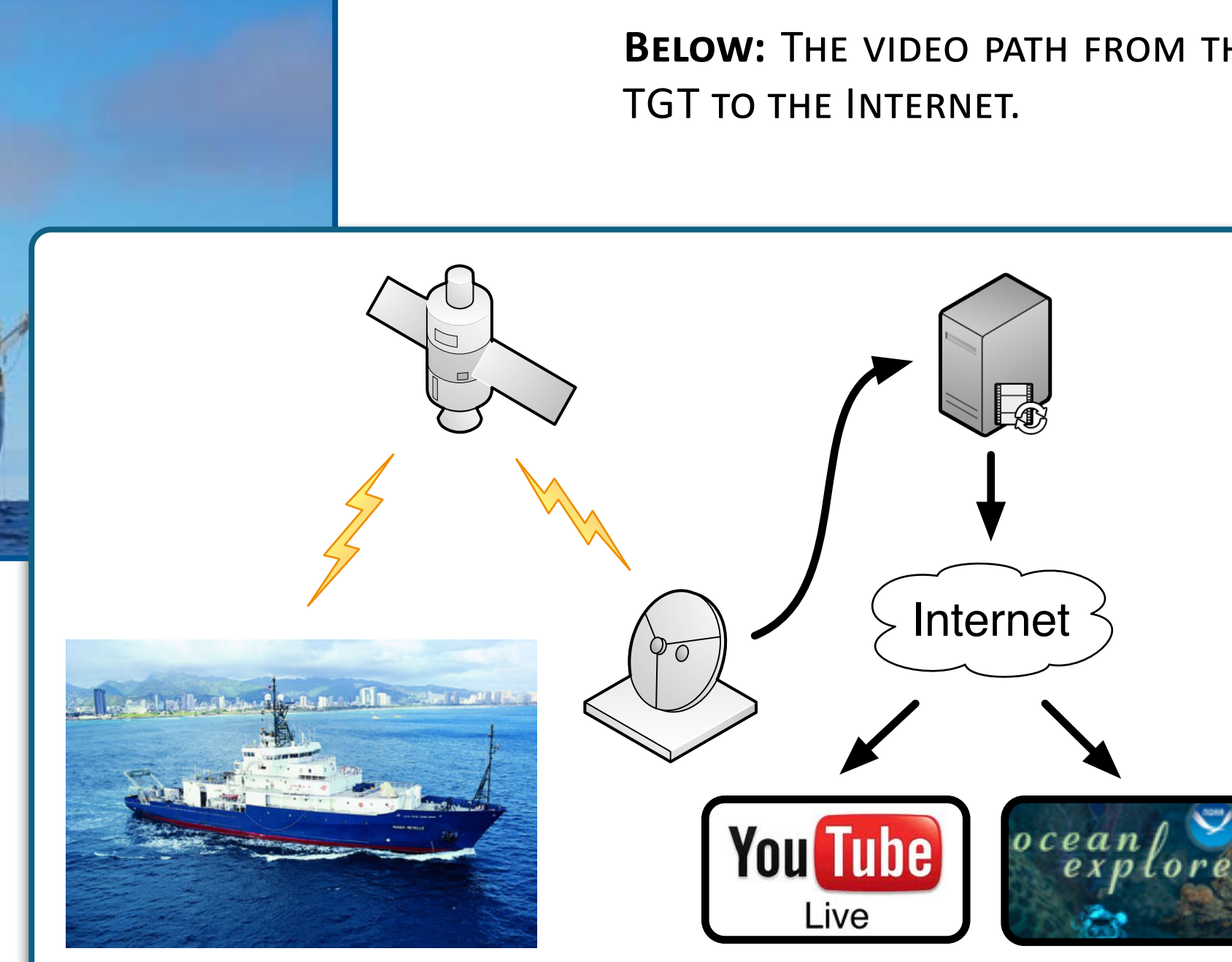
LEFT: LIVE VIDEO OF THE QUEST 4000 ROV BEING LAUNCHED OFF THE ROGER REVELLE AS VIEWED FROM THE NOAA OCEANEXPLORER WEBSITE



RIGHT: FRAME CAPTURE OF THE LIVE VIDEO FROM THE QUEST 4000 ROV WORKING AT DEPTH; TAKEN FROM NOAA OCEANEXPLORER WEBSITE.



ABOVE: THE 274' R/V ROGER REVELLE EQUIPPED WITH A SEATEL 9797 2.4M ANTENNA (IN RADOME).



BELOW: THE VIDEO PATH FROM THE TGT TO THE INTERNET.

OER extended the core functionality of the MTU by provided additional equipment borrowed from the NOAA Ship Okeanos Explorer. The loaned equipment included an HD handheld camera, tripod, 4 GoPro point-of-view (POV) cameras with various mounting options, camera lights, a HD video recorder with 6TB of video storage, and a video edit station.

### DESIGN CHALLENGES:

- Sufficient satellite connectivity using existing Equipment
- Dissemination of Video over Internet
- Equipment Procurement
- Personnel Hiring
- Equipment Delivery Leadtimes
- System Delivery Timeline

## THE CRUISE BEGINS

The MTU was loaded onto the R/V Roger Revelle on Friday, September 7th, 2012. Roland installed the equipment, ran the necessary cabling, and trained the science party on the use of the headsets. The team from HiSeasNet, lead by Steve Foley, successfully increased the outbound bandwidth on the vessel by 1600%. Shortly thereafter, the first live images of the ship's main lab reached the ISC in Rhode Island. Within an hour the stream was redirected to the ISC's CDN and was being viewed on the OceanExplorer website and YouTube Live.

The vessel departed Suva, Fiji on Sunday, September 9th, 2012. As the days progressed the daily operations fell into a steady rhythm: at 0800 ship local time the ROV team launched the vehicle. At 2000 ship local time the ROV was recovered. Video of each ROV launch and recovery was captured by the MTU's handheld camera and streamed live to the Internet. Once the ROV was in the water, the video stream switched to the ROV's HD camera.

Throughout the dive Roland recorded a subset of the underwater footage using the MTU's video recorder. Each night the MTU would stream the raw underwater highlights from the previous ROV dive. This model insured there was live or otherwise interesting video streamed to the Internet 24 hours a day. In addition to streaming raw video, the ship also hosted a live outreach event with the San Francisco Exploratorium.

## CONCLUSION OF THE CRUISE

Many agree that the outreach success of live streaming video from this research cruise was well worth the investment. The MTU demonstrated that this capability is well within the reach of the ocean science community, even on short notice and on vessels operating on the far side of the world.

The MTU is currently being shipped back to the United States. As part of the arrangement for this project, the MTU is the property of OER and will be managed by the Okeanos Explorer Program. The system will reside at the Port Office for the NOAA Ship Okeanos Explorer in Davisville Rhode Island. As demonstrated during this cruise, the Mobile Telepresence Unit is a portable system. In addition to physical space and satellite communication system requirements, use of the MTU requires a single bunk for a supporting broadcast engineer.

It is the hope of OER that the ocean science community will request to use the MTU on future cruises. As usage increases and budgets allow, OER plans to further develop the MTU and increase its capabilities. The cost model for use of the system and the ancillary expenses are still being discussed but it is the hope of OER that the ocean science community will ask to use the MTU again on future oceanographic expeditions.

### MTU Ship Requirements:

- 30 sqft of Counter Space for Equipment
- 120 ft<sup>3</sup> of Storage Space for Equipment
- 1.5Mbps of Bandwidth
- 1 Bunk for Support Personnel

### SUMMARY OF COSTS

INCREASED BANDWIDTH	\$12,390
EQUIPMENT	\$20,167
PERSONNEL/TRAVEL	\$37,800
SHIPPING	\$ 1,800
TOTAL	\$72,157