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Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
Federal Grant or Other Identifying Number Assigned by Agency:	1514756
Project Title:	Funding to support Operations and Maintenance of the Monterey Accelerated Research System (MARS)
PD/PI Name:	Craig Dawe, Principal Investigator
Recipient Organization:	Monterey Bay Aquarium Research Institute
Project/Grant Period:	03/15/2015 - 02/29/2020
Reporting Period:	03/01/2018 - 02/28/2019
Submitting Official (if other than PD\PI):	N/A
Submission Date:	N/A
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	N/A

Accomplishments

* What are the major goals of the project?

The goal of MARS Operations and Maintenance is to provide a facility that primarily hosts projects to develop technology for ocean science. Providing this facility for the scientific community makes it challenging to explain MARS O&M science impact. MARS O&M does not do science; we host scientists and technology developers in a very cost effective setting so that they can advance the frontiers of scientific understanding.

In 2018 MARS hosted three projects, an acoustic study renewed from 2016 Sanctuary Soundscape (Formerly Passive Acoustic Sensing) Ryan MBARI/+external collaborators, an engineering test/long term data effort of a new Geodetic Seismic Sensor Module (GSSM) Wilcox/Manalang UW, and Serenity Light on MARS a project utilizing photon detectors to analyze bioluminescence in the ocean, Haddock/Martini MBARI.

Efforts to upgrade the MARS electronics components continue to be a priority to the project team but have been hindered by the results of testing by Teledyne ODI. Currently, ODI has recommended lowering the operating voltage as a result of their testing, the first recommendation was unreasonable.

* What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?

Major Activities:

The major activities of the MARS observatory were to operate and maintain the cabled observatory in safe and efficient manner. As in previous years, MARS suffers from very few outages, most resulting from power interruptions due to local utility failures, Internet Service Provider (ISP) outages and internal network hardware failures and configuration issues.

MARS had a period of down time (4 days) for annual maintenance of the shore power system components. During this maintenance period the cable was utilized by Nate Lindsey from Lawrence Berkeley National Laboratory (Berkeley Lab) to study the seismology of this section of cable using distributed fiber-optic acoustic sensing (DAS) The results of this work have yet to be published but publication is pending. A Seminar "Illuminating the Seafloor with Dark Fiber Seismology and the MARS cable" was presented at MBARI in Oct 2018

The Monterey Ocean Bottom Broadband Seismometer (MOBB) experienced a fault in one of its interconnects and failed. The system was partially recovered with plans to retrieve the remaining cable in 2018. During 2018 multiple attempts to recover the remnants of the MOBB cable were undertaken, all unsuccessful. Another attempt will be conducted in Feb. 2019, this cable is a hazard to navigation of MBARI ROVs and will be collected.

Sanctuary Soundscape Research and Education Project (Ryan MBARI, Jeremy Goldbogen, Dave Cade Hopkins Marine Station, Independent researchers: Marjolaine Caillat, Mark Fischer, Alison Stimpert Moss Landing Marine Laboratories, John Joseph, Tetyana Margolina Naval Postgraduate School, Andrew DeVogelaere, Lisa Uttal NOAA/MBNMS, Simone Baumann-Pickering, Anna Meyer Loebbecke, Jennifer Tricky Scripps, Brandon Southall UCSC). The system continues to work reliably with publications pending for 2019.

Serenity-Light on MARS(LOM) (Haddock/Martini MBARI) deployed photon detectors and environmental instruments (CTD, O2, ADCP) to study bioluminescence at the MARS site. This project is funded by the Haddock lab and is expected to continue as long as the equipment does. Early in the project (July 2017) an increase in ground fault current occurred. Since then the current increased through July of 2018. The system was shutdown in August and all hardware has been recovered. After recovery diagnosis has been conducted on the deployed equipment and the MARS port. The MARS port (4) has a fault on the 375vdc connection, it is not the LOM equipment.

Geodetic Seismic Sensor Module (GSSM) (Wilcox/Manalang UW) was deployed in June of 2017, they expect to remain on the observatory for an indefinite period, hoping to collaborate with other users with similar interests. They hope to get the data being streamed into the IRIS Seismic Data Management System since they think it is of potential use for Northern California seismic studies. Publications from this effort have been presented at Oceans 18 - Kobe, Japan: <https://ieeexplore.ieee.org/document/855917> and AGU Fall meeting in DC: <https://agu.confex.com/agu/fm18/meetingapp.cgi/Paper/354668>

The MARS team provides continuous support to users and prospective users. This is accomplished through consults on design issues particularly on the mechanical side but also with

electrical/electronic and networking configurations. Testing services prior to deployments are supported, ensuring the highest possibility of success.

In 2018 discussions and planning continued with the Quest Institute(MBARI project 881129.00), the Naval Post Graduate School (NPS)(MBARI project 901502), the Deep Sea Connect (DSC) Project (MBARI project 901802) and the Benoit-Bird lab (MBARI project 901700). The Quest, NPS and DSC projects were scheduled for deployment in 2018. Quest Institute's "Ocean Discovery Deep ROV" was connected to MARS on Oct 15 but immediately went into fault before power could be applied. The system was recovered and diagnosed with many issues that did not present during pre-deployment testing. The issues are being addressed by vendors and the Quest Group. Deployment has been rescheduled for May 2019. The NPS deployment originally scheduled for Sept 2018 has been delayed due to delivery issue from the vendor till Jan 30 2019. Pre-deployment testing is complete and the sytem is deployed on MARS (Jan 30,2019). DSC is struggling with delivery issues from the vendor and is expected to deploy later in 2019. Benoit-Bird has deployed the DIEMOS (John Horne UW) for Sam Urmy (MBARI Post Doc) In January 2019 for acoustic biological studies.

Additional outreach is ongoing with consultations conducted with The Monterey Bay Aquarium (MBA). This project will consist of a camera system deployed on a whale fall to observe and document the predation and colonization of a whale carcass over time. The imagery will be used for public outreach and display. An additional science component will be conducted by Dr. Shanna Gofreddi of Oxidental College. This project is a joint effort between MBA and MBARI.

The University of Washington Applied Physics Lab (UW APL) met with MARS and MBARI staff for two days to discuss the testing of a "resident AUV and dock" on the MARS observatory. This system is destine for the Ocean Observatory Initiative Regional Scaled Network.

Another researcher from UW APL is working to test a hydrophone array on MARS. Discussions and planning are ongoing.

MARS is also represented at the annual MBARI Open House conducting public outreach, informing the public about the capabilities and information coming from the local ocean observatory.

Specific Objectives:

The primary objective of 2018 was to complete the "Mini node". This work is ongoing with completion expected first Qtr 2019. In Mar 2018 a network consultant was contracted to develop a clone of the MARS network communications system utilizing the new components purchased for the MARS upgrade. This was completed and tested against known qualified instruments previously deployed on the MARS system. Evaluation of the High Voltage Nautilus connector has been completed by the vendor, the results were inconclusive however, a recommendation to lower the operating voltage was suggested by ODI. Initially 300-600 VDC was recommended, this level of input is not practical on the end of a 52km cable. The ODI engineering team agreed that 1500vdc would be acceptable. This has several ramifications to the project; the overall power delivered to the node would be reduced to three (3) kilowatts from 7.5 Kilowatts and a new power supply would need to be procured and installed. The later has both financial and resource impacts.

Significant Results:

The development of the Mininode to act as an interim way to continue operations while refurbishment of the primary node is a viable but an impractical solution based on the current and projected user base. Seven of the eight science ports will be in use by the end of 2019.

There at least three inquiries for deployment and testing on the node. If the node were to fail it would be possible to deploy the mininode once completed however, some form of arbitration would be needed to decide what efforts would remain connected and those that would be recovered. Recovery of the node electronics and power supply remain a risky operation even with the reduced voltage recommendations.

Key outcomes or Other achievements:

A new data transport system has been designed, procured, tested and ready to be deployed in a completed mininode or in a refurbished main node.

Mininode electronics is in the testing and final assembly stage and will soon be ready for deployment if required. This electronic package will support upgraded timing protocol IEEE 1588/Precision Time Protocol.

Evaluation of the HV connector has been completed with a recommendation to reduce the input voltage. This has a number of impacts on the project, power, rework of the current supply and user base. These issues will be addressed in the renewal process for 2020.

The power utility failures experienced by the local community affect the MARS observatory. Under current loading the UPS holds the system up for approximately 2.5 hours, as additional equipment is added this will decrease likely resulting in more frequent shutdowns of the system. To that end, The Observatory has purchased a back up generator sized to run the system in the event of a power outage. This will be installed during the first quarter 2019.

*** What opportunities for training and professional development has the project provided?**

Nothing to report.

*** How have the results been disseminated to communities of interest?**

MBARI maintains a public web site available to science and the public at large that allows access to much of the work conducted on MARS past and present. (<http://www.mbari.org/at-sea/cabled-observatory/>)

Currently the Soundscape and Research Education project publishes the data online along with information about the project. (<http://www.mbari.org/technology/solving-challenges/persistent-presence/mars-hydrophone/>) The project also disseminates data and information through its collaborators NPS, Stanford/Hopkins, UCSD/Scripps, NOAA Exploration Center, MBNMS). Recorded marine mammal vocalizations have been ported to a mobile playback system used in public outreach, local schools, Monterey Bay Aquarium.

GSSM has presented at Oceans 18 - Kobe, Japan: <https://ieeexplore.ieee.org/document/8559178> AGU Fall meeting in DC: <https://agu.confex.com/agu/fm18/meetingapp.cgi/Paper/354668>

Light on MARS participated in the MBARI Open house in 2018 educating the public about the project and its goals.

External users of MARS are under no obligation to disseminate their data.

*** What do you plan to do during the next reporting period to accomplish the goals?**

Completion of the Mininode in preparation for a system upgrade or failure.

Installation of a back up generator to reduce the shutdowns of the system.

March 2019 annual maintenance will be conducted to service (shore station) hardware and verify the seawater ground system.

Continue consultations with prospective users to aid/guide in the sdeployment of equipment on the MARS observatory

Re-test the Quest Institute system prior to deployment in May 2019.

Test the Deepsea Connect system prior to deployment

Continue the program of daily weekly and annual maintenance to ensure reliable operation of the MARS observatory

Products

Books

Book Chapters

Inventions

Journals or Juried Conference Papers

Licenses

Other Conference Presentations / Papers

Nathaniel J. Lindsey, Craig Dawe, Veronica Rodriguez-Tribaldos, Satish Maurya, Tushar Mittal, Douglas S. Dreger, Charlie Paull, Jonathan B. Ajo-Franklin (2018). *Illuminating the Seafloor with Dark Fiber Seismology and the MARS cable Abstract: see attached NateLindseyABs.doc*. MBARI Seminar Series. Moss Landing Ca. USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Other Products

Other Publications

Patents

Technologies or Techniques

Thesis/Dissertations

Websites

Geodetic and Seismic Sensor Module (GSSM)

<https://www.mbari.org/at-sea/cabled-observatory/mars-science-experiments/geodetic-and-seismic-sensor-module-gssm/>

Project description of the platform along with operational details

Hydrophone for passive acoustic monitoring

<https://www.mbari.org/technology/solving-challenges/persistent-presence/mars-hydrophone/>

Human and natural sounds generated in the ocean, project description and goals

Light on MARS

<https://www.mbari.org/at-sea/cabled-observatory/mars-science-experiments/light-on-mars-serenity/>

Describing the use of Photomultipliers to investigate bioluminescence in the ocean

MARS A new Way of Doing Oceanography

<https://www.mbari.org/at-sea/cabled-observatory/>

An overview of the MARS Observatory showing past and current connected projects along with details of the system and connection information for researchers. There are links for fisherman providing charts and local notice to mariners and a hot line for possible entangle issues.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
NateLindseyDAS_Abtract.pdf	abstract and images of work done during MARS Maintenance down time	Craig Dawe	01/30/2019

Participants/Organizations

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Dawe, Craig	PD/PI	4
Allen, Mandy	Other Professional	1
Heller, Kenneth	Technician	2

Name	Most Senior Project Role	Nearest Person Month Worked
Thompson, Duane	Technician	3

Full details of individuals who have worked on the project:

Craig Dawe**Email:** dacr@mbari.org**Most Senior Project Role:** PD/PI**Nearest Person Month Worked:** 4

Contribution to the Project: Project management, reporting and day to day operations/maintenance, technical support to users during trials and testing

Funding Support: David and Lucille Packard Foundation/MBARI National Science Foundation NSF award #1514756 45/55% split with MBARI

International Collaboration: No

International Travel: No

Mandy Allen**Email:** mandy@mbari.org**Most Senior Project Role:** Other Professional**Nearest Person Month Worked:** 1

Contribution to the Project: Responsible for meeting national and local permitting requirements for the MARS observatory and any experiments to be deployed on it.

Funding Support: David and Lucile Packard Foundation

International Collaboration: No

International Travel: No

Kenneth Heller**Email:** kheller@mbari.org**Most Senior Project Role:** Technician**Nearest Person Month Worked:** 2

Contribution to the Project: Day to day operations and repairs as required, User instrument testing

Funding Support: NSF award #1514756

International Collaboration: No

International Travel: No

Duane Thompson**Email:** drt@mbari.org**Most Senior Project Role:** Technician**Nearest Person Month Worked:** 3

Contribution to the Project: Day to day operations and repairs as required, User instrument testing

Funding Support: NSF award #1514756

International Collaboration: No

International Travel: No

What other organizations have been involved as partners?

Name	Type of Partner Organization	Location
The David and Lucile Packard Foundation	Other Nonprofits	Palo Alto, California

Full details of organizations that have been involved as partners:**The David and Lucile Packard Foundation****Organization Type:** Other Nonprofits**Organization Location:** Palo Alto, California**Partner's Contribution to the Project:**

Financial support

Facilities

Collaborative Research

More Detail on Partner and Contribution: The David and Lucile Packard Foundation provide funding for Stephen Etchemendy, Mandy Allen and other support personnel through the Monterey Bay Aquarium Research Institute (MBARI).**What other collaborators or contacts have been involved?**

MBARI

- Bird, Larry EENG-Mechanical Eng-Mfg
McGill, Paul RENG-Electrical Engineer
Thompson, Ford RE Machinist
Jose Rosal Technician
Thomas Marion Technician
Richard Schramm Eng Software Engineer
Teledyne Marine Systems
- Sean Brennan/Steven Gloor

Impacts**What is the impact on the development of the principal discipline(s) of the project?**

MARS continues to provide a cost effective platform for testing of instruments destined for the OOI Cabled Array. Versatile schedules, year round access to the node with transit/deployment/recovery capable of being completed in a single day provides increased confidence of a deployment on the larger array.

New users including the NPS, Quest Institute, MBA and UW APL have turned in to long term residents on the system. To maintain availability to platforms for testing it may require creating a breakout port to accomodate lower power and lower data bandwidth experiments similar to the Deepsea Connect project where one port has three physical connections.

What is the impact on other disciplines?

Nothing to report.

What is the impact on the development of human resources?

Nothing to report.

What is the impact on physical resources that form infrastructure?

Addition of a back-up generator to the system should reduce the down time and more importantly reduce the number of restarts for the system. This issue has been indicated as a possible source of degradation.

What is the impact on institutional resources that form infrastructure?

Nothing to report.

What is the impact on information resources that form infrastructure?

Nothing to report.

What is the impact on technology transfer?

Nothing to report.

What is the impact on society beyond science and technology?

MARS/MBARI and project outreach inform the general population about the this vast resource by providing a view into the goings on in the ocean through demonstration presentation and education to the local communities. A knowledgeable society is better able to make decisions about how to manage the oceans well into the future.

Changes/Problems

Changes in approach and reason for change

The evaluation of the Teledyne ODI High Voltage connector and its delivery had significant impact on the 2018 plans to recover and refurbish the MARS main electronics and power supply. The recommendation to reduce the applied voltage to a maximum of 1500vdc will result in a repowering of the Node. A commercial enterprise, Schaefer Power offers a solution that was used in the VENUS system for ONC at approximately \$120k. Because there is still a good deal of risk associated with disconnecting and re-connecting the HV plug and the current user base is so high, it is recommended that planning and procurement move forward to make the upgrade but the deployment wait until the userbase drops or the current deployed node has major issues and needs to be recovered to continue operating.

Actual or Anticipated problems or delays and actions or plans to resolve them

Two ports on the MARS node exhibit issues, one has a ground fault on the 375 vdc channel the other has a failure of the 48vdc completely. Both faults can be isolated so the ports can be used but have lost some of their functionality

Changes that have a significant impact on expenditures

If the path to Node refurbishment is to be completed with a new power scheme there will be some additional expenses to build a power supply however, they should fall within the current working budget of the project.

If the Teledyne-ODI HV connector does not meet specifications and fails, this would necessitate a cables ship repair. The cables ship repair to recover the entire node would be an expensive operation, but the system would be inoperable until such time as a repair was completed.

Actual or Anticipated problems or delays and actions or plans to resolve them

Nothing to report.

Changes that have a significant impact on expenditures

Nothing to report.

Significant changes in use or care of human subjects

Nothing to report.

Significant changes in use or care of vertebrate animals

Nothing to report.

Significant changes in use or care of biohazards

Nothing to report.