

## CONNECTING SUBSEA CABLES AND SATELLITES FOR GLOBAL OCEANS HEALTH MONITORING

### **The MIT Flagship Project K2D: *Knowledge and Data from the Deep to Space***

#### Abstract:

This session is aimed at discussing the development of an unprecedented oceans monitoring system at the global scale. By taking advantage of the worldwide existing infrastructure of submarine communications cables, the novel monitoring system will be based on basic environmental variables as a standard. Additionally, it will develop a persistent and widespread presence of underwater autonomous vehicles, monitoring stations and other relevant sensors. Coupled with space systems, information and other essential variables, the data retrieved is intended to allow the mapping and monitoring of natural and human activities as well as earth systems vital variables which are critical for sustainability, prosperity and environmental equilibrium in the Atlantic and other areas of the planet.

Within the context of the MIT Portugal flagship project under development named K2D – Knowledge and Data from the Deep to Space, the first insights and proposed concepts will be presented. By addressing the current state of knowledge on Ocean environmental monitoring and health, the panellists will address the main challenges posed to the implementation of global environmental monitoring systems for Oceans, and their relation to both subsea cables and space systems.

#### **AGENDA (UTC time):**

##### **11h30 Opening**

- Opening of the Side Event, chaired by [Eduardo Pereira](#) and [Douglas Hart](#).
- [Sergio Fernandes](#): 'From Land to Ocean'; MIT Flagship project K2D – Knowledge and Data from the Deep to Space

##### **11h40 – Session 1: Oceans Environmental Monitoring and new perspectives with Smart Submarine Cables, Eduardo Pereira**

- [Aníbal Matos](#): *Persistent AUV operations in open ocean*
- [António Silva, Sérgio M. Jesus](#): *Deep sea acoustics for environmental monitoring, communications and localization*
- [Filipe Costa](#): *Potential of DNA-based approaches for ocean biomonitoring*
- [Laura González García](#): *Ocean acoustics to improve cetacean monitoring*

##### **12h20 – Session 2: Connecting Smart Submarine Cables and Space Systems for Oceans Health Monitoring, challenges and opportunities, Douglas Hart**

- [Douglas Hart](#): *Subsea Power for Extended Autonomy*
- [John J Leonard](#): *Cooperative Localization and Navigation for Ocean Sensing Networks*
- [Olivier L de Weck](#): *Connecting Oceans with Space Systems*
- [Pierre F. J Lermusiaux](#): *Optimal Path Planning and Ocean Monitoring*

##### **13h00 – Closing**

## Panellists:

### *Douglas Hart, MIT TATA Center*



**Title: Subsea Power for Extended Autonomy**

#### Short bio:

Douglas Hart is a Professor of Mechanical Engineering and head of the Controls, Instrumentation, and Robotics division of the Mechanical Engineering Department, and a principal investigator and former head of the Hatsopoulos Fluids Laboratory at the Massachusetts Institute of Technology, MIT. He serves on the department's governing board and is the faculty lead for the MIT/Skoltech entrepreneurship program, co-director of the MIT Portugal Program, a faculty member of the MIT Martin Trust Center for Entrepreneurship, and serves on the advisory committee for the Department of Mechanical Engineering at the California Institute of Technology, Caltech. Doug is an inventor, cofounder, and board member of several venture funded medical device companies. He worked as a research engineer for Electromagnetic Launch Research, Inc. (now Kaman Electromagnetics Corp. a subsidiary of Kaman Corp.) on satellite propulsion and electromagnetic acceleration technology and as a senior systems engineer for Northrop Corp. (now Northrop Grumman Corp.) on unmanned drones before joining the faculty at M.I.T.. Doug teaches and conducts research in the areas of ocean robotics, design, and instrumentation. His research group is known for the development of a highly energy dense hydrogen storage technology based on a unique aluminum fuel developed in his laboratory and for the development of a now commercial aluminum battery technology that does not require oxygen to operate.

### *John J Leonard, MIT CSAIL*



**Title: Cooperative Localization and Navigation for Ocean Sensing Networks**

#### Short bio:

John J. Leonard is Samuel C. Collins Professor of Mechanical and Ocean Engineering in the MIT Department of Mechanical Engineering. He is also a member of the MIT Computer Science and

Artificial Intelligence Laboratory (CSAIL). His research addresses the problems of navigation and mapping for autonomous mobile robots and underwater vehicles. He holds the degrees of B.S.E.E. in Electrical Engineering and Science from the University of Pennsylvania (1987) and D.Phil. in Engineering Science from the University of Oxford (1994). He is the recipient of an NSF Career Award (1998) and the King-Sun Fu Memorial Best Transactions on Robotics Paper Award (2006). He is an IEEE Fellow (2014). Professor Leonard is also a Technical Advisor at Toyota Research Institute, where he has been working to improve vehicle safety using autonomous driving technologies.

*Olivier L de Weck, MIT AeroAstro*



Title: **Connecting Oceans with Space Systems**

Short bio:

Olivier de Weck is Professor of Aeronautics and Astronautics and Engineering Systems at MIT where he teaches Technology Roadmapping, Satellite Engineering and Systems Engineering as well as Multidisciplinary Design Optimization. He has authored over 400 publications (12 best paper awards since 2004) and is a Fellow of INCOSE, Associate Fellow of AIAA and Senior Member of IEEE. He and his group worked with NASA's Office of Emerging Space to develop new Commercial Space Technology Roadmaps in 2018 and he is a former Senior Vice President of Technology Planning and Roadmapping at Airbus where he was responsible for roadmapping a \$1 billion R&D portfolio for the world's largest aircraft manufacturer. His passion is to improve life on our home planet Earth through research and education while paving the way for humanity's future off-world settlements.

*Pierre F. J Lermusiaux, MIT Mechanical Engineering*



Title: **Optimal Path Planning and Ocean Monitoring**

Short bio:

**Dr. Lermusiaux** is Professor of Mechanical Engineering and Ocean Science and Engineering at MIT, and, since July 2018, Associate Department Head for Research and Operations in Mechanical

Engineering. He received a Fulbright Foundation Fellowship (1992), the Wallace Prize at Harvard (1993), the Ogilvie Young Investigator Lecture in Ocean Eng. at MIT (1998), and the MIT Doherty Chair in Ocean Utilization (2009-2011). In 2010, the School of Eng. at MIT awarded him with the Ruth and Joel Spira Award for Distinguished Teaching. He has made outstanding contributions in data assimilation, as well as in ocean modeling and uncertainty predictions. His research thrusts include understanding and modeling complex physical and interdisciplinary oceanic dynamics and processes. With his group, he creates, develops and utilizes new mathematical models and computational methods for ocean predictions and dynamical diagnostics, for optimization and control of autonomous ocean systems, for uncertainty quantification and prediction, and for data assimilation and data-model comparisons. He has participated in many national and international sea exercises. He has served on numerous committees and organized major meetings. He is associate editor of three journals, and has more than hundred fifty refereed publications.

*Eduardo Pereira, IB-S/ISISE – University of Minho*



Short bio:

**Eduardo Pereira holds** a PhD in Civil Engineering from the University of Minho and the Technical University of Denmark. As an Assistant Professor at the University of Minho and a member of IB-S and ISISE, he has been involved in the development of remote sensing and monitoring techniques for structures and multiscale natural and humanized systems. He was the coordinator from ISISE of the Structured Project NEXT-SEA (Monitoring and Management of Coastal Ecosystems in a Scenario of Global Change), and a member of the OMARE project (development of spatial information systems, decision support and management of coastal systems in Marine Protected Areas (MPAs), as well as ecosystems restoration). He is also collaborating with the GOAP (Global Ocean Accounting Platform) created in the context of the statistical division of ESCAP - United Nations for next generation sustainable development models for the Oceans, Oceans Accounting. Currently he is coordinating the *K2D* project.

*Sergio Fernandes, DSTelecom*



**Title: DStelecom - From Land to Ocean**

**Short bio:**

As of 2018, Sergio is acting as the CTO of the company. He initially joined DST Telecomunicações in 2009 as an Engineer. He was previously working as Director of Engineering and Network Planning of DST Telecomunicações, and was responsible for Network Engineering, Network Operations Center, Network Inventory and Project Development. Prior to joining DST Telecomunicações, Sergio worked in the Network Optimization department at Radiomovel and was responsible for the North BSC and all the associated BTS; he also worked in the Network Quality department of Radiomovel, where he was responsible for the network benchmark analysis.

*Aníbal Matos, University of Porto*



**Title: Persistent AUV operations in open ocean**

**Short bio:**

**Aníbal Matos (PhD ECE, 2001)** is associated professor at the School of Engineering of Porto University (FEUP). He is a senior researcher at the INESC TEC Centre of Robotics and Autonomous System, being coordinator of this Centre since 2015. His research activities address navigation and control of autonomous robots in challenging environments. He has published more than 100 papers in international journals and conferences, and he has also a strong involvement in research projects, both national and international, being the coordinator of several of them. The vast majority of these projects are related either to foundations of marine robotics (navigation, perception, or control) or to the application of marine robotics (ocean observation, environmental monitoring, underwater inspection and maintenance). He is currently the coordinator of the INTENDU project, co-funded by H2020 program within the scope of the MarTera ERANET and the co-coordinator of the H2020 ATLANTIS project.

*António Silva, CINTAL – University of Algarve*



Title: **Deep sea acoustics for environmental monitoring, communications and localization**

Short bio:

**António Silva** is Assistant Professor at the University of Algarve with an experience record on sea trial and project management of over 10 years, with emphasis on underwater communications, having participated on FP7 project UAN and now OceanTech and 2DeepScape. His research interests are focussed in the areas of on underwater acoustic signal processing, ocean acoustics, ocean properties inversion, ocean noise assessment and underwater communications

*Sérgio M. Jesus, CINTAL – University of Algarve*



Short bio:

**Sérgio M. Jesus** is a full professor at the University of Algarve and SiPLAB Coordinator, with over 30 years of experience in underwater acoustic signal processing. He has worked for 7 years at the NATO Undersea Research Centre (former SACLANTCEN) in La Spezia, Italy, and since 1992 has an academic position at the Electronic Engineering Department at the University of Algarve, Faro, Portugal. He has lead over 15 scientific projects both at the national and European level and participated in two international initiatives: the High Frequency Initiative (HFI) and the Acoustic Oceanographic Buoy (AOB) joint research project involving several teams from Europe and from the USA.

*Filipe Costa, IB-S/CBMA - University of Minho*



Title: **Potential of DNA-based approaches for ocean biomonitoring**

Short bio:

**Filipe Costa** is a marine ecologist and Associate Professor at the University of Minho, Portugal, where he leads a research group on Molecular Ecology, Biodiversity and DNA barcoding (ME-Barcode) within the Centre for Molecular and Environmental Biology (CBMA) and the Institute of Science and Innovation for Bio-sustainability (IB-S). Before joining the UMinho in 2008, he completed postdoctoral research at Texas Tech University (USA), University of Guelph (Canada) and was granted a Marie-Curie Fellowship at Bangor University (UK). Filipe's main research interests dwell around the themes of molecular biodiversity and evolution, with a strong focus on the employment of DNA barcodes to investigate and monitor marine biodiversity. He has worked extensively in the development of reference libraries of DNA barcodes for marine invertebrates and fish from Europe, contributing to expose considerable hidden and cryptic diversity, and to reveal unforeseen evolutionary mechanisms.

*Laura González García, University of the Azores*



Title: **Ocean acoustics to improve cetacean monitoring**

Short bio:

**Laura González García** holds a PhD in Marine Science Technology and Management from the University of Vigo (Spain). With extensive experience working with cetaceans in the Azores, both in the field and behind the screen, and with a sound background in oceanography and remote sensing environmental variables, she has focused her research on cetacean ecology, habitat, and distribution, working mainly with opportunistic whale watching data. At the moment, she works as a post-doc researcher at the University of the Azores reinforcing the importance of opportunistic data for long-term cetacean monitoring purposes. Furthermore, she supervises several MSc. and Bachelor students on their work with cetaceans, and actively participates on cetacean research networks in the North Atlantic.