




2016 CODER
ORBITAL DEBRIS
WORKSHOP



UNIVERSITY OF
MARYLAND

November 15-17, 2016
University of Maryland
Samuel Riggs IV Alumni Center
College Park, MD

*Collaboration, research, and education
to address critical issues in orbital debris
policy, mitigation, and remediation.*



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This year, we would like to thank the following sponsors for their generous support for the 2016 CODER Workshop.



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WELCOME

Welcome to the University of Maryland Center for Orbital Debris Education and Research 2016 Workshop to address critical issues in orbital debris policy, mitigation, and remediation.

We hope this year's expanded workshop will connect individuals and research from across academe, industry, and government to foster collaboration and promote the long-term goal of developing policies, laws, and systems that will lead to the effective remediation and control of orbital debris.

Our goal is to promote an open exchange among the science, technology, economic, policy, and law communities, raise awareness, and inform decision makers on state of the art technologies that are currently available to address this growing issue.



PROGRAM

| TUESDAY, NOVEMBER 15, 2016 | | |
|----------------------------|--|---|
| 7:30 a.m. - 8:15 a.m. | Workshop Registration & Check In & Continental Breakfast | |
| 8:15 a.m. | Welcome & Announcements | Raymond Sedwick University of Maryland |
| 8:25 a.m. | Keynote SSA: A look back to look forward | Travis Blake Senior Manager Lockheed Martin ATC |
| 8:55 a.m. | Session 1A Space Situational Awareness | MODERATOR Raymond Sedwick Dir., CODER, Univ. of Maryland |
| 10:35 a.m. | Break | |
| 11:05 a.m. | Session 1B Space Situational Awareness | MODERATOR Marshall Kaplan Assoc. Dir., CODER Univ. of Maryland |
| 12:45 - 1:45 p.m. | Lunch <i>Sponsored by the A. James Clark School of Engineering</i> Guest Speaker: Alvin Alexander , Founder and CEO OrionAST <i>Sustaining Earth's Natural Environment In Orbit</i> | |
| 1:45 p.m. | Keynote Space Weather Effects on Debris Orbits | John Emmert Research Physicist, Naval Research Lab |
| 2:15 p.m. | Session 2A Modeling: Orbital Debris | MODERATOR Roger Thompson Sr. Engineering Specialist, Aerospace Corp. |
| 3:30 p.m. | Break | |
| 4:00 p.m. | Session 2B Modeling: Atmosphere and Space Weather | MODERATOR Surja Sharma Senior Research Scientist, U. of Maryland |
| 5:15 p.m. | Adjourn | |
| 5:15 p.m.-6:45 p.m. | Opening Reception <i>Sponsored by OrionAST</i> | |



Stay connected & share ideas throughout the workshop by tweeting @UMD_CODER or using hashtag #coder16

PROGRAM

WEDNESDAY, NOVEMBER 16, 2016

| | | |
|-----------------------|---|--|
| 7:30 a.m. - 8:15 a.m. | Workshop Registration & Check In & Continental Breakfast <i>Sponsored by the UMD Space Power and Propulsion Lab</i> | |
| 8:15 a.m. | Welcome & Announcements | Raymond Sedwick University of Maryland |
| 8:25 a.m. | Keynote How the U.S. Can Lead in Establishing a Safe Space Environment | Jim Bridenstine U.S. Representative (R-OK) |
| 8:55 a.m. | Session 3A SSA Data Sharing | MODERATOR Theresa Hitchens Sr. Research Scholar CISSM, Univ. of Maryland |
| 10:35 a.m. | Break | |
| 11:05 a.m. | Session 3B Mitigation & Remediation Policies | MODERATOR Owen Brown CTO, Kinsey Technical Services |
| 12:45 - 1:45 p.m. | Lunch <i>Sponsored by the Center for International and Security Studies at Maryland (CISSM)</i> | |
| 1:45 p.m. | Keynote International Collaboration | Audrey M. Schaffer Director for Space Strategy & Plans, Office of the Under Sec. of Defence for Policy |
| 2:15 p.m. | Session 4A International Collaboration Efforts | MODERATOR Victoria Samson Senior Analyst, Secure World Foundation |
| 3:30 p.m. | Break | |
| 4:00 p.m. | Session 4B Re-entry and Debris Removal Liability | MODERATOR Daniel Porras Chairman, Georgetown Space Law Society |
| 5:15 p.m. | Adjourn | |
| 5:15 p.m. - 6:00 p.m. | Reception <i>Sponsored by OrionAST</i> | |
| 6:00 p.m. - 7:30 p.m. | Dinner <i>Sponsored by OrionAST</i> Guest Speaker: Bruce Fredericks , Program Manager Space Fence Radar Development, Lockheed Martin <i>Lockheed Martin Space Fence</i> | |

PROGRAM

| THURSDAY, NOVEMBER 17, 2016 | | |
|-----------------------------|--|---|
| 7:30 a.m. - 8:15 a.m. | Workshop Registration & Check In & Continental Breakfast <i>Sponsored by the UMD Space Systems Laboratory</i> | |
| 8:15 a.m. | Welcome & Announcements | Raymond Sedwick University of Maryland |
| 8:25 a.m. | Keynote Cooperation, Collaboration, and Good Space Stewardship | Walt Everetts VP of Satellite Ops and Ground Dev, Iridium |
| 8:55 a.m. | Session 5A Mitigation and Large Satellite Constellations | MODERATOR Walt Everetts VP of Satellite Ops and Ground Dev, Iridium |
| 10:35 a.m. | Break | |
| 11:05 a.m. | Session 5B Mitigation Technologies | MODERATOR Scott Hull NASA Goddard Space Flight Center |
| 12:45 - 1:45 p.m. | Lunch <i>Sponsored by the University of Maryland Department of Aerospace Engineering</i> | |
| 1:45 p.m. | Keynote Satellite Servicing Technology and Debris Remediation | Charles Bacon Chief Cooperative Servicing Engineer, NASA GSFC SSO |
| 2:15 p.m. | Session 6A Remediation Technologies and Architectures | MODERATOR David Barnhart USC Dept. of Astronautical Engineering/ISI |
| 3:30 p.m. | Break | |
| 4:00 p.m. | Session 6B Remediation Technologies and Architectures | MODERATOR David Barnhart USC Dept. of Astronautical Engineering/ISI |
| 5:15 p.m. | Closing Remarks | Marshall Kaplan Assoc. Dir., CODER Univ. of Maryland |
| 5:30 p.m. | Adjourn | |



Stay connected & share ideas throughout the workshop by tweeting @UMD_CODER or using hashtag #coder16

KEYNOTES

➤ TUESDAY, NOVEMBER 15

SPACE SITUATIONAL AWARENESS



TRAVIS F. BLAKE, PH.D.

**Senior Manager
Advanced Technology Center
Lockheed Martin
Space Systems Company**

Dr. Travis Blake is the Space Domain Awareness Senior Manager at the Advanced Technology Center (ATC)

at Lockheed Martin Space Systems Company (SSC). The ATC develops and transitions technology discriminators for SSC lines of business in civil and military space, strategic missile defense systems, special programs, and commercial space. Dr. Blake provides management and oversight for ATC's internal research and development (R&D) investments and contract R&D programs for all aspects of Space Battle Management/Command, Control, and Communications (SpBMC3). Dr. Blake leads far-reaching architecture studies, utility assessments, and technology demonstrations that create next-generation mission capabilities to support evolving customer needs. Dr. Blake's R&D portfolio spans the full-spectrum of SpBMC3, including space domain awareness, sensor management, data validation, characterization algorithms and behavior analysis, decision support tools, and predictive assessments. His current R&D efforts are focusing on accurate space domain modeling for architecture analysis, wargaming, and course-of-action evaluation. A retired Air Force Lieutenant Colonel, Dr. Blake was a Distinguished AFROTC graduate and held leadership positions in space launch, intelligence, R&D, and policy. He authored numerous national intelligence documents and while as a SAF/OR and DARPA Program Manager, he developed novel space technologies and led the Space Domain Awareness portfolio. He completed his career at the Office of Science and Technology Policy within the Executive Office of the President where he developed empowering policies for all aspects of air, space, and near-space technologies including aviation security, Planetary Defense, and hypersonics. Dr. Blake holds a Ph.D. in Electro-Optics from the Air Force Institute of Technology, where he also received a Masters in Electrical Engineering, and continues to serve on student advisory committees. A graduate from the Georgia Institute of Technology (with Honors), Dr. Blake is also the LMSSC Focused School Advisor for the Institute where he works with the faculty and staff to prepare the engineering and science students to meet the challenges of tomorrow.

ENVIRONMENTAL MODELING



JOHN EMMERT

**Research Physicist
Naval Research Laboratory**

Dr. John Emmert is a research physicist in the Geospace Science and Technology Branch within the Space Science Division at the Naval Research Laboratory.

Dr. Emmert's research focuses on the climate and dynamics of the thermosphere, using a variety of extensive geophysical databases and models. He has developed a 45-year database of thermospheric densities derived from orbital tracking of 5,000 space objects in low Earth orbit. He has employed this data set for continuing studies of long-term upper atmospheric climate change, for analysis of the thermospheric response to solar activity variations, and for validation of thermospheric densities inferred from far-ultraviolet remote sensing. He has also studied extensively the effect of geospace storms on global thermospheric dynamics and has developed a global empirical model of geomagnetic storm effects on thermospheric winds. Dr. Emmert received a B.S. in astronomy from the University of Arizona and a Ph.D. in physics from Utah State University.

POLICY

**JIM BRIDENSTINE**

**United States Representative
(R) Oklahoma, 1st District**

Congressman Jim Bridenstine was elected in 2012 to represent Oklahoma's First Congressional District. He serves on the House Armed Services Committee and the

Science, Space and Technology Committee, where he was selected to serve as Chairman of the House Environment Subcommittee.

Bridenstine began his Naval aviation career flying the E-2C Hawkeye off the USS Abraham Lincoln aircraft carrier. It was there that he flew combat missions in Iraq and Afghanistan and gathered most of his 1,900 flight hours and 333 carrier-arrested landings. While on active duty, he transitioned to the F-18 Hornet and flew at the Naval Strike and Air Warfare Center, the parent command to TOPGUN. After leaving active duty, Bridenstine returned to Tulsa to be the Executive Director of the Tulsa Air and Space Museum & Planetarium. Bridenstine's background includes a triple major at Rice University, a MBA from Cornell University, 9 years active duty in the United States Navy, and business experience in real estate, ranching, aerospace, and defense contracting. Bridenstine was promoted to the rank of Lieutenant Commander in the U.S. Navy Reserve in 2010 flying missions in Central and South America in support of America's war on drugs and most recently transitioned to the 137th Air Refueling Wing of the Oklahoma Air National Guard, where he will fly with an MC-12 squadron stationed at Will Rogers World Airport in Oklahoma City.

POLICY

**AUDREY M. SCHAFFER**

**Director for Space
Strategy and Plans
Office of the Under Secretary
of Defense for Policy**

Audrey Schaffer is currently the Director for Space Strategy and Plans in the Office of the Under

Secretary of Defense for Policy in the U.S. Department of Defense. In that role, she manages a team of military officers and civil servants responsible for policy and strategy initiatives to enhance space security. Her team develops DoD policy guidance; represents the DoD in U.S. Government interagency policy deliberations; negotiates multilateral diplomatic space security agreements; manages bilateral relationships with strategic international partners; and oversees strategic communications initiatives. Ms. Schaffer has been with the Office of the Secretary of Defense since 2010. She has served in a variety of capacities within the Space Policy office, including as the Deputy Director of Space Policy Engagement, where she was involved in a variety of international military and government space cooperation initiatives. Ms. Schaffer was also detailed to the Bureau of Arms Control, Verification and Compliance within the Department of State, where she established and led the Bureau's first cyber strategic stability policy team and cross-Bureau cyber working group. Prior to joining the Office of the Secretary of Defense, Ms. Schaffer was an Air Force Presidential Management Fellow (PMF), working in Washington, D.C. and Los Angeles, California.

As a PMF, she rotated through assignments related to space policy, strategy, acquisition, and engagement, including the Policy and Plans Division of the Air Force Directorate of Space Acquisition, the Commander's Action Group of Air Force Space Command's Space and Missile Systems Center, and the Commercial Policy and Strategy Branch of the National Security Space Office. Ms. Schaffer holds a B.S. in Aerospace Engineering from the Massachusetts Institute of Technology and a M.A. in International Science and Technology Policy from the George Washington University.

KEYNOTES

➤ THURSDAY, NOVEMBER 15

MITIGATION TECHNOLOGIES



WALT EVERETTS

**VP, Satellite Operations and Ground Development
Iridium Satellite, LLC**

Walt Everetts is Vice President, Satellite Operations and Ground Development for Iridium, where he is responsible for overseeing and monitoring the Iridium network operations and deployment of upgrades to support future system enhancements.

Walt started his career working within the aerospace industry with specific responsibilities in commercial communication satellite integration, testing and launch. In 1996, he joined the satellite communications division at Motorola as the manufacturing manager responsible for the delivery and deployment of the Iridium program spacecraft constellation. After completion of today's Iridium network, Walt left the Iridium project but remained at Motorola in a new product program management position, where he was assigned to projects in more than 40 different countries and a multitude of different product lines in the telecommunication industry. His primary responsibilities included developing repeatable processes that were used in initial field trials and deployment of new product services offerings.

Walt heeded the irresistible call of Iridium again in February 2008 as the Space Systems Operations Director. He graduated with a Bachelor of Science in Aerospace Engineering from the Pennsylvania State University.

REMEDICATION TECHNOLOGIES



CHARLES BACON

**Chief Cooperative Servicing Engineer, NASA GSFC SSO
OrbitalATK**

Mr. Charles Bacon has served as an expert in the field of satellite servicing for almost 10 years. Since 2009, he has provided mission systems design engineering support for the Satellite Servicing Capabilities Office (SSCO) at NASA's Goddard Space Flight in Greenbelt, Maryland.

Currently Mr. Bacon supports NASA's Restore-L mission, a groundbreaking venture that will refuel Landsat 7 to demonstrate a core suite of NASA-developed servicing technologies. In parallel with his role on Restore-L, Mr. Bacon also serves as the chief engineer for NASA's cooperative servicing effort. In this role, he works with diverse entities to identify stakeholder needs, and guides the maturation of new technologies that enhance the serviceability and resiliency of future government and commercial missions. Prior to these efforts, Mr. Bacon served as a systems and operations engineer on SSCO's multi-phased Robotic Refueling Mission (RRM). Mr. Bacon also served as a leader in the design, development and testing of astronaut tools for the 2009 Hubble Space Telescope Servicing Mission Four.

Mr. Bacon graduated in 2005 from the University of Maryland, College Park with a Bachelor of Science in Aerospace Engineering. In 2011, he was awarded the Space Flight Awareness Honoree Award by NASA for his work on the RRM servicing demonstrations.

GUEST SPEAKERS

➤ LUNCH SPEAKER
TUESDAY, NOVEMBER 15

➤ DINNER SPEAKER
WEDNESDAY, NOVEMBER 16

ENHANCED SPACE SITUATIONAL AWARENESS



ALVIN ALEXANDER

**President and CEO
Orion Applied Science and
Technology**

Alvin Alexander, is a combat veteran with over 23 years of service in the United States Army. In 2013, he founded Orion Applied Science & Technology, LLC for the purpose of becoming the industry leader of on-orbit, risk mitigation services, with an emphasis on orbital asset protection and recovery.

With a strong background in systems engineering, he has supported a number of acquisition programs where he advised senior program managers and key leaders as to best practices for system development. Alvin maintains a broad experience base of advance sensor phenomenology's, and applications. Also, he is a Master of Science Candidate at Johns Hopkins University, Whiting School of Engineering, and possesses a Bachelors of Arts in Aviation, from The Ohio State University.

LOCKHEED MARTIN SPACE FENCE



BRUCE FREDERICKS

**Program Manager, Space Fence
Radar Development
Lockheed Martin, Rotary &
Mission Systems (RMS)**

Bruce Fredericks is responsible for leading the radar development of the Space Fence System. This includes a massive effort to complete final development (Software, Firmware and Integration & Test) while manufacturing and procuring all the components required to build the system. The Space Fence radar will be installed and operated on Kwajalein; a small island located within the Marshall Islands atoll in the Pacific Ocean.

Bruce started his career with RCA in 1983 working as a digital designer and signal processing systems engineer. Over his career, Bruce has worked extensively on every stage of system life cycle; from concept definition through fielding. This includes a stint as the New Business Capture Manager for sales of naval combat systems internationally as well as being the technical lead on a newly formed team to aid programs across Lockheed Martin during the startup phase immediately after contract award. The Space Fence radar will be the first (and largest) element level digital beamforming (DBF) radar fielded when it becomes operational late in 2018. It will also be one of the most easily maintained systems Lockheed Martin has produced. Bruce holds a Master of Science in Electrical Engineering from Drexel University.

SESSIONS

SESSION 1A > *Space Situational Awareness*



MODERATOR
RAY SEDWICK
Director
Center for Orbital Debris Education and Research



TOM JOHNSON
Vice President, Engineering
Analytical Graphics, Inc. and Research



JIM MORRISSEY
Director, Western Operations
Omitron, Inc



LAURI NEWMAN
NASA Robotic Conjunction
Assessment Manager, NASA
GSCF Robotic Systems
Protection Program/Code 590



ROBERT ROVETTO
Ontologist

SESSION 1B > *Space Situational Awareness*



MODERATOR
MARSHALL KAPLAN
Assoc. Director
Center for Orbital Debris Education and Research



DON GREIMAN
Vice President, Schafer Commercial
Space Situational Awareness



ROGER THOMPSON
Senior Engineering Specialist, Mission
Analysis and Operations Department
The Aerospace Corporation



CHRISTOPHER SIMPSON
Doctoral Candidate
University of Alabama



RYAN SHEPPERD
Astronautical Engineer
Deputy Head of Orbital Analysis
for Iridium Program, Boeing

SESSION 2A ➤ *Environmental Modeling: Orbital Debris*



MODERATOR
ROGER THOMPSON
*Senior Engineering Specialist
The Aerospace Corporation*



MARK MATNEY
*Modeling Lead, NASA Orbital
Debris Program Office*



JOEL SLOTTEN
*Space Systems Engineer
Navistel, LLC*



GLENN PETERSON
*Senior Engineering Specialist
The Aerospace Corporation*

SESSION 2B ➤ *Environmental Modeling: Atmosphere and Space Weather*



MODERATOR
SURJA SHARMA
*Senior Research Scientist
University of Maryland Astronomy Department*



TIM FULLER-ROWELL
*CIRES Senior Research Scientist
NOAA Space Weather
Prediction Center*



DELORES KNIPP
*Research Professor
Colorado Center for
Astrodynamics Research*



MARCIN PILINSKI
*Deputy Director, Space
Systems Division
ASTRA, LLC*

SESSIONS

SESSION 3A ▶ *Space Situational Awareness Data Sharing*



MODERATOR
THERESA HITCHENS
*Senior Research Scholar
Center for International and Security Studies at Maryland (CISSM)*



ANDREW D'UVA
*President
Providence Access Company*



COL. SCOTT TRINRUD
*Division Chief of Doctrine and Policy
Plans and Policy Directorate
USSTRATCOM*



JEFF ROWILSON
*VP, Government Affairs
SES Government Solutions*



NANCY GALLAGHER
*Interim Director, Center for
International & Security Studies
at Maryland (CISSM)*

SESSION 3B ▶ *Mitigation & Remediation Policies*



MODERATOR
OWEN BROWN
Chief Technology Officer, KTSi



KARL KENSINGER
*Deputy Chief, Satellite Division
FCC International Bureau*



TODD MASTER
Program Manager, DARPA TTO



BRIAN WEEDEN
*Technical Advisor
Secure World Foundation*



MAUREEN MCLAUGHLIN
*Vice President for Public Policy
Iridium*

SESSIONS

SESSION 4A > *International Collaboration Efforts*



MODERATOR
VICTORIA SAMSON
Secure World Foundation



RICHARD BUENNEKE
*Deputy Director of Space Policy
U.S. Department of State*



JEAN-LUC BALD
*First Secretary Space
European Commission
Delegation to the U.S.*



HIRO IWAMOTO
*Director of JAXA
Washington DC office*

SESSION 4B > *Re-entry and Debris Removal Liability*



MODERATOR
DANIEL PORRAS
Associate, LMI Advisors



PAMELA MEREDITH
*Chair, Space Law Practice Group
Zuckert Scoutt Rasenberger*



DAVID KOPLOW
*Professor of Law
Georgetown Law*



BRIAN ISRAEL
*Attorney-Adviser
U.S. Department of State*

SESSIONS

SESSION 5A ► *Mitigation and Satellite Constellations*



MODERATOR

WALT EVERETTS

VP, Satellite Operations and Ground Development, Iridium



DOUG ENGELHARDT

*Technical Fellow
Manager of Navigation Systems
DigitalGlobe*



RICH LESHNER

*Director of Government Affairs
Planet Labs*



ALVIN ALEXANDER

*President and CEO
Orion Applied Science and Technology*



TIM MACLAY

*Director, Mission Systems Engineering
OneWeb*

SESSION 5B ► *Mitigation Technologies*



MODERATOR

SCOTT HULL

*Orbital Debris Services Group Leader
NASA GSFC*



JEFFREY SLOSTAD

*Chief Operating Officer
Tethers Unlimited, Inc.*



LUCA ROSSETTINI

*CEO
D-ORBIT srl*



JOSEPH A. CARROLL

*President
Tether Applications, Inc.*

SESSIONS

SESSION 6A > Remediation



MODERATOR
DAVID BARNHART
Director
USC Space Technology and Systems Group



GYSILA DANIELLE BENTO DA SILVA
Security Coordinator
COBRUF



MATTHEW MARCUS
Doctoral Candidate
University of Maryland
Department of Aerospace Engineering



ERIC SMITH
Doctoral Candidate
University of Maryland
Department of Aerospace Engineering

SESSION 6B > Remediation



MODERATOR
DAVID BARNHART
Director
USC Space Technology and Systems Group



MARSHALL KAPLAN
Associate Director, CODER
University of Maryland



KIM AARON
Chief Engineer
Global Aerospace Corporation



AURELIEN PISSELOUP
Space Logistics & On-orbit Services
Airbus Space & Defense

CODER CONSORTIUM

The CODER Consortium is a group of corporate and government partners that provide financial support to the center through an annual membership fee. In return for this support, members of the consortium receive the following benefits:

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- Priority consideration for partnering on major R&D proposals
- Opportunity to influence the direction of CODER research
- Opportunity to monitor ongoing research projects
- Opportunity to submit research proposals for CODER research agenda
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- Free attendance for Member employees to technical review meetings
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COOPERATIVE PROGRAMS

- Participation in cooperative programs with the University
- Assistance with recruiting CODER graduates, or general assistance with recruiting University of Maryland students
- Representation on the Advisory Board**

**Each Full Member may appoint one voting member to the Advisory Board

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