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**On-Line:**  www.amostech.com
Facebook: AMOScon
Twitter: @amoscon
#AMOS2020     #EMERGEN20

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**Event Date:**  AMOS Conference - Sept 15-18, 2020
EMER-GEN Conference – Sept 12-15, 2020

**Location:**  Online

# FAST FACTS

**Description:** The Advanced Maui Optical and Space Surveillance Technologies (AMOS) Conference is the premier technical conference in the nation devoted to space situational awareness. The cross section of private sector, government, and academic participation helps foster important dialogue and international collaboration. The continued growth in attendance and participating countries at AMOS reflects a growing interest in space sustainability and space commerce initiatives as new actors—national governments, private sector companies, non-governmental entities, and universities—become involved in these activities.

**With the continued uncertainty of holding large gatherings in Hawaii, AMOS has decided that the best, and safest, way forward is to go all-virtual with the 2020 Conference.**

Now in its 21st year, the AMOS Conference attracted over 200 Papers this year with authors from 16 countries which have been reviewed and sorted into oral and poster presentations. Papers are eligible for publication in the 2020 Journal of Astronautical Sciences as well as a Best Paper and Presentation Award. There is also a Student Award for the best manuscript submitted by a student. 30 students submitted abstracts this year.

In addition to the Technical Sessions, the AMOS Conference features Keynote Speakers, Policy Forums and Technical Short Courses. There will also be virtual access to exhibits, posters and networking rooms.

This will also be the third year for the EMER-GEN program, designed especially for young professionals and students (35 and under) enthusiastic about careers in space. The program will be all-virtual with a series of webinars both pre- and post- event.

**Presenter:** This event is presented by the **Maui Economic Development Board,** a 501(c)(3) not-for-profit corporation established in 1982 with a mission to diversify Maui County's economy, building pathways to innovation, jobs and opportunity for our residents. Through partnerships with the public and private sector, MEDB undertakes projects that assists growth industries with navigating and thriving in our county, educates and trains residents for new careers, and engages our community in forums that determine future economic directions.

**Technical Chairs**
Paul Kervin, AFRL/RDSM
Daron Nishimoto, Pacific Defense Solutions – A Centauri Company

**Conference Advisor**
Col L. Kirk Lewis, Ret., Institute for Defense Analyses
Jeanne Skog, Skog Rasmussen LLC

## 2020 SESSION TOPICS AND CHAIRS

**Adaptive Optics & Imaging**
Geoff Andersen, Air Force Office of Scientific Research
Michael Hart, University of Arizona; HartSCI LLC

**Astrodynamics**
T.S. Kelso, Analytical Graphics, Inc
Marek Ziebart, University College London

**Atmospherics/Space Weather**
Thomas Berger, University of Colorado at Boulder
Marcus Holzinger, University of Colorado at Boulder

**Cislunar SSA**
James Frith, Air Force Research Laboratory
Jaime Stearns, Air Force Research Laboratory

**Machine Learning Applications of SSA**
Justin Fletcher, Air Force
Nathan Toner, Centauri

**Non-Resolved Object Characterization**
Tamara Payne, Applied Optimization, Inc.
Emily Lambert, L3 Harris

**Optical Systems & Instrumentation**
Sue Lederer, NASA Johnson Space Center
Darren McKnight, Centauri

**Orbital Debris**
James Blake, University of Warwick
Heather Cowardin, NASA Johnson Space Center

**Space-Based Assets**
Brandon Cesul, Centauri
Elizabeth Cunningham, Air Force

**Space Situational Awareness/Space Domain Awareness**
Moriba Jah, University of Texas at Austin
Danielle Wood, Massachusetts Institute of Technology

## TECHNICAL SHORT COURSES

Short courses provide opportunities for working professionals to upgrade their technical job skills and remain abreast of recent developments in their respective fields of interest. The small size of each class gives you an excellent opportunity for personalized instruction.

This year there will be nine (9) courses, taught by highly regarded industry experts, with five running concurrently in two separate sessions on Tuesday September 15. Topics cover applications for SSA, space policy, space law, conjunction assessment, optical systems, machine learning and more.

### 1. Space Law & The Space Law Games: Legal Liability and Mapping the Future in Orbit

Presented by:
**Ralph Dinsley,** Executive Director, Northern Space and Security Ltd/Reflecting Space
**Christopher Newman,** Professor of Space Law and Policy, Northumbria University

### 2. The Basics of Domain Awareness in Cislunar Space

Presented by:
**Thomas Marshall Eubanks**, Chief Scientist, Space Initiatives Inc
**Paul Blase**, Chief Engineer, Space Initiatives Inc
**Charles Radley**, President and CEO, Space Initiatives Inc

### 3. Collision Avoidance Risk Assessment

Presented by:
**Francois Laporte**, CAESAR Team Leader, CNES
**Lauri Newman**, Senior Engineer, Goddard Space Flight Center – NASA
**Matthew Hejduk**, Chief Engineer, NASA Robotic CARA, Astrorum Consulting LLC

### 4. Demystifying Machine and Deep Learning

Presented by:
**Joseph Coughlin**, Aerospace Corp
**Rohit Mital,** Chief Technologist, KBR Inc.
**Weston Faber,** Research Scientist, L3 Harris

### 5. Observing and Characterizing Space Debris

Presented by:
**Thomas Schildknecht,** Vice Director, Head Optical Astronomie, Director Zimmerwald Observatory, Astronomisches Institut Universität Bern

### 6.  Space CAMP Intro to DevSecOps

Presented by:
**Samuel Kreimier**, 1st Lt, US Air Force
**Patrick Lorigan**, Space CAMP
**Tory Smith**, 2d Lt, US Air Force
**Rob Slaughter,** Director, Platform One

### 7. Telescopes and Optics for Ground-Based Optical SSA

Presented by:
**Peter Zimmer**, Astronomer, J.T. McGraw and Associates, LLC
**Mark Ackermann**, Optical Lead, J.T. McGraw and Associates, LLC

### 8. Using CelesTrak for SSA

Presented by:
**T.S. Kelso**, SDC Operations Manager, Center for Space Standards & Innovation

### 9. Deep Learning Methods for Space Situational Awareness

Presented by:
**Roberto Furfaro**, Professor, University of Arizona
**Weston Faber**, Senior Research Scientist, L3Harris
**Richard Linares**, Charles Stark Draper Assistant Professor, Massachusetts Institute of Technology

###

**2020**        Po'okela *(working together)*

**Sponsors:**   Boeing

Laulima *(working together)*

| | |
|---|---|
| ExoAnalytic Solutions | Northrop Grumman |
| Kratos | Peraton |
| L3 Harris | |

Lokahi *(collaboration and unity)*

| | |
|---|---|
| AGI | SAIC |
| Ball Aerospace | Secure World Foundation |
| Lockheed Martin | Space Foundation |

Kupa'a *(loyal and committed)*

| | |
|---|---|
| Centauri | General Atomics |
| Charles River Analytics | Numerica Corporation |

Malama *(to care for)*

| | |
|---|---|
| ABB | JHU Applied Physics Lab |
| a.i. solutions | Leolabs |
| Applied Optimization | Northstar Earth & Space |
| Astro Haven | Planewave Instruments |
| Braxton | Seradata |
| DLR Administration | USRA |
| Japan Space Forum | |

## Exhibitors

| | |
|---|---|
| Air Force Office of Scientific Research | Kratos |
| Air Force Research Laboratory | L3 Harris |
| ABB | Leolabs |
| a.i. solutions | Lockheed Martin |
| AGI | Northrop Grumman |
| Applied Optimization | Northstar Earth & Space |
| Astro Haven | Numerica Corporation |
| Ball Aerospace | Peraton |
| Boeing | Planewave Instruments |
| Braxton Technologies | SAIC |
| Centauri | Sandia National Laboratories |
| Charles River Analytics | Secure World Foundation |
| DLR Space Administration | Seradata |
| ExoAnalytic Solutions | Space Foundation |
| General Atomics | USRA |
| JHU Applied Physics Lab | |

# FAQS

**How will the virtual conference experience be for attendees?**

A robust virtual platform will allow attendees to explore the conference venue at their leisure as well as attend the live plenary sessions and participate in Q & A via a chat function. The platform will include virtual exhibit booths, networking rooms and poster halls.  Technical sessions will be on-demand and all presentations will be recorded for later access by those registered unable to attend the live streaming.

In the virtual exhibit booths, attendees can view collateral and videos as well as meet virtually with sponsor representatives. All attendees will receive a small conference care package.

In the poster hall, attendees can view pre-recorded 3 minutes presentations of the posters. Poster presenters will be present for chat Q & A during scheduled Poster Sessions.

**How did the conference come to be on Maui?**

Maui has some of the most diverse and highly capable optical telescopes (AEOS), instrumentation (adaptive optics, spectrometers, photometers, radiometers, etc.) and processing capabilities (MHPCC) centralized into one location on the planet earth.

The AMOS Conference began in 1999 as an AFRL initiative, executed by the Maui Economic Development Board (MEDB). At that time, the focus of the conference was as a users' conference and to promote the Air Force Maui Optical and Supercomputing Site (AMOS) which has provided the U.S. Department of Defense (DoD) with space situational awareness (SSA) capabilities for over 65 years (since 1951).

In 2006, MEDB assumed ownership of the AMOS Conference from the Air Force, and proceeded to build upon early success by evaluating and adding elements to the conference that bring value to the SSA Community. In the 13 years since, MEDB's intent in presenting the AMOS Conference is still to support the Air Force's mission on Maui which, in turn, supports MEDB's mission of economic diversification.

**What are the various activities of the AMOS Conference?**

In order for the AMOS Conference to continue to be of benefit to the Air Force, it must also be of benefit to the SSA Community at large. The conference has expanded from solely Technical Sessions to include exhibition and sponsorship opportunities; SSA Policy sessions that explore international issues; keynotes by

international SSA thought leaders; invited workshops that promote international collaboration and cooperation on SSA topics; and technical short courses.

**How are presenters selected for the Technical Sessions?**

A Call for Papers is announced at the beginning of the year with submissions closing mid-March. Papers are reviewed and selected by Technical Chairs that have been selected to moderate the specific sessions noted to be in high demand by the submissions.  In 2020 the sessions are: Adaptive Optics and Imaging; Astrodynamics; Atmospherics/Space Weather; CisLunar SSA; Machine Learning Applications of SSA; Non-Resolved Object Characterization; Optical Systems and Instrumentation; Orbital Debris, Space Situational Awareness; and Space-Based Assets.

Papers that are not accepted for an oral presentation may be invited to present a Poster. All presenters, oral or poster, are required to submit a final paper by August 31 in order to present at the AMOS Conference.

**Where are the Technical Papers published?**

Final papers are collated into the Proceedings for the year and available for purchase 8-10 weeks post-Conference.  The Conference also maintains an archive of individual technical papers presented at the AMOS Conference since 2006 which is searchable online as a resource to the SSA technical community https://amostech.com/archives/.

In 2020, relevant papers will be considered for publication in the 2020 Journal of Astronautical Sciences, an archival publication devoted to the sciences and technology of astronautics. Articles are published which present significant new results, important insights, or state of the art surveys in all areas of astrodynamics, celestial mechanics, atmospheric flight mechanics, navigation and guidance, and space related sciences.

**What awards are associated with the AMOS Conference?**

The Space Surveillance Technical Committee of the American Astronautical Society (AAS) and AMOS Conference will present a Student Award for the best manuscript submitted and presented by a student.

All presentations are eligible for an overall Best Paper that will be presented end of the Conference.

**What is the SSA Policy Forum?**

The SSA Policy Forum, coordinated in collaboration with Secure World Foundation, explores international issues related to Space Situational Awareness in a panel format.  Held at the start of each day of the 3-day AMOS Conference, Wednesday to Friday, the sessions are preceded by a relevant keynote presented by an invited SSA thought leader.  Bringing together the developers and implementers of SSA capabilities and the architects of SSA policy provides a forum to interact at a time when the landscape is rapidly changing.

Topics this year are:

**Wed, September 15 |** Extending SSA and Space Activities to Cislunar Space

**Thu, September 19 |** Challenges and Opportunities in Developing Norms of Behavior

**Fri, September 20|** Evolution of Industry Best Practices for Space Sustainability

**Who attends?**

Along with United States representatives from military, contractor, academic and commercial sectors, the number of countries that have attended over the history of AMOS Conference is 28 -- Australia, Austria, Belgium, Brazil, Canada, Chile, China, Czech Republic, Finland, France, Germany, Israel, Italy, Japan, Netherlands, New Zealand, Philippines, Poland, Republic of Korea, Russia, Singapore, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, and the United Kingdom.

A sampling of companies, universities, and government organizations that have attended AMOS are listed at the end of this document.

**What is EMER-GEN and what do you expect to achieve?**

The EMER-GEN program is a joint initiative of the AMOS Conference and the Space Generation Advisory Council (SGAC).  Designed especially for young professionals and students (35 and under) enthusiastic about careers in space, the original 2+ day program has grown to include webinars before and after the main event with a focus on fostering innovation and entrepreneurship among the cohort. Through the whole program, participants will be challenged to solve/hack a problem to create new opportunities for space-based technologies.

With the help of advisers from industry, government, academia and NGOs, the EMER-GEN experience offers the experience offers

➢ Mentoring with renowned space specialists from the public sector (military and civil), private sector, and nongovernmental organizations
➢ Networking with other young professionals

# AMOS CONFERENCE FAQ'S – continued

> ➢ Technical Short Course presented by a specialist in space situational awareness
> ➢ Professional Development sessions to enhance your effectiveness in a global environment

The partnership with the SGAC provides an opportunity to extend the reach of the AMOS Conference and to contribute to the professional development of the upcoming space generation.

42 participants have signed up from 13 countries - Angola, Australia, Canada, Ethiopia, France, Germany, Ghana, India, Japan, Mexico, New Zealand, Nigeria, UK and the USA this year . Scholarships are awarded to Hawaiian residents.

# # #

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**FOR IMMEDIATE RELEASE**

## Virtual EMER-GEN® Program extending its reach

*Kihei, Maui, Hi, August 5, 2020* - The 3rd annual EMER-GEN® program is going virtual and extending itself to a longer schedule and a wider reach.  A joint initiative of the AMOS Conference and the Space Generation Advisory Council (SGAC), EMER-GEN is designed especially for young professionals and students enthusiastic about careers in space.

EMER-GEN has grown to include webinars before and after the main event with a focus on fostering innovation and entrepreneurship among the cohort. The program kicks off August 26 with an introductory webinar and there will be a second webinar one week later before diving into the four-day intensive September 12-15.  The main event overlaps with the annual AMOS Conference which will also be virtual and runs September 15-18.

Through the whole EMER-GEN program, participants will be challenged to solve/hack a problem to create new opportunities for space-based technologies.  Four additional webinars after the main program will provide further mentoring as teams complete the hack-a-thon challenge.

The program is developed with the help of the young professionals of the planning committee including two representatives from the SGAC – Quentin Verspieren, Intelligent Space Systems Laboratory, The University of Tokyo; and Michael Barton, a.i. solutions and 2018 and 2019 Cohort.  They are joined by Amber Imai, a member of the 2019 EMER-GEN cohort and an Avionics Engineer with Hawaii Space Flight Laboratory.

"EMER-GEN was one of the best experiences I ever had." said Amber Imai-Hong, Hawaii Space Flight Laboratory. "I got to network with other young professionals and with the mentors as well. It was interesting to work with people from so many different backgrounds in the space industry and learn new things that I am not necessarily familiar with. I want to help expand the space industry in Hawaii so our young professionals can work here."

With a registration deadline extended to August 12, the virtual program has already attracted applications from a diverse range of countries including Angola, Australia, Canada, France, Germany, Ghana, India, Mexico, New Zealand, as well as the United States.

The EMER-GEN program offers professional development with presentations, panel discussions and mentoring with renowned space leaders from the public sector (military and civil), private sector, academia, and NGOs.  Topics to be covered include:

Communication in Multicultural, Generationally Diverse, Sector, and Team Settings
Leadership
Consensus Building
Emerging Nations

Participants will also be exposed to a technical short course which serve to upgrade or expand technical job skills and help remain abreast of recent developments in respective fields of interest.

SGAC is a global non-governmental, non-profit organization and network that aims to represent university students and young space professionals ages 18 to 35 to the United Nations, space agencies, industry, and academia.

The 21st Annual Advanced Maui Optical and Space Surveillance Technologies (AMOS) Conference, a program of the Maui Economic Development Board, is the premier technical conference in the nation devoted to space surveillance. The cross section of military, contractor, and academic participation fuels important dialogue and collaboration on a national and international scale.

For further details on the EMER-GEN program and registration, please go https://EMER-GEN.com.

**Contact:** Sandy Ryan, Conference Director, Maui Economic Development Board
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**FOR IMMEDIATE RELEASE**

## Short Courses livestreamed for 2020 AMOS Conference

*Kihei, Maui, Hi, July 7, 2020* - This year's short courses will be presented virtually during the 2020 AMOS Conference.  The courses, taught by highly regarded industry experts, will be "live" with the ability to interact with the instructor and attendees in real-time. The topics cover applications for SSA, space policy, space law, conjunction assessment, optical systems, machine learning and more.

To make it possible for people from various time-zones to participate in at least one short course, the four-hour courses will start at 6am Hawaii Standard Time (HST) for the first session, and 11:00am HST for the afternoon course.

With five running concurrently in the morning and five in the afternoon, the short courses provide an opportunity to upgrade technical job skills and remain abreast of recent development in fields of interest.  There is a separate registration fee of $50 for each course.

### Space Law & The Space Law Games: Legal Liability and Mapping the Future in Orbit

Presented by:
**Ralph Dinsley,** Executive Director, Northern Space and Security Ltd/Reflecting Space
**Christopher Newman,** Professor of Space Law and Policy, Northumbria University

This half-day course provides participants with an introductory overview of the way in which space exploration is governed on national and international levels using the lens of the Space Law Games. The course examines the overarching international framework for space governance, with a focus on the Outer Space Treaty provisions and related treaties, with a special examination of the Liability Convention. The discussion will then turn to the way in which the Space Law Games have highlighted the difficulties with the current regime in respect of determining fault in orbital operations and discuss the impact that this will have primarily upon activities such as satellite operations, military and commercial uses of space, but also in a broader sense on human spaceflight activity.

The rise of very large constellations and other innovations, such as active debris removal or on-orbit servicing procedures means ever more data from space is required to keep track of the increasing burden placed on the orbital environment. Participants will examine the need for corroborated information which removes as much ambiguity as possible about the position of objects in orbit; crucial to both safe and sustainable satellite operations. The course will discuss and evaluate the considerable barriers that exist to obtaining a more complete picture of this information.

Participants will then discuss the need for both codification of the norms for safe sustainable satellite operations and clarity on protocols for evidence gathering in cases where a collision has resulted in damage to a space asset and fault may be an issue. This discussion will identify that a way in which this could be achieved is by the use of the Space Law Games, which combine military wargaming and legal mooting. In these games,

complex realistic scenarios could highlight some of the key technical, operational and legal issues that might need to be addressed. By identifying the technical and data gaps through a fictional scenario the Space Law Games will help locate possible areas of enhancement in SSA capacity and also gaps in evidential quality data from space. Identifying the wargaming methodology for the simulation, and the need for distinct "games" in different orbits, encompassing future and historic events, is crucial as these will provide the data for the legal phase of the "Space Law Games". Given the total absence of litigation in respect of fault in space, the resulting paper will demonstrate how the Space Law Games will highlight ways to fill the data gap that currently exists in orbital operations support.

At the end of the course, participants will be invited to evaluate legal responses to new developments such as mining, manufacturing and tourism in space and managing environmental issues in space through the lens of liability and the lessons that can be learnt by employing a wargaming approach. They will examine the challenges and opportunities for space governance posed by growing commercial activity of companies in an area where more traditional state and business organizations are facing competition from small and medium size companies.


**SC2 | The Basics of Domain Awareness in Cislunar Space**

Presented by:
**Thomas Marshall Eubanks**, Chief Scientist, Space Initiatives Inc
**Paul Blase**, Chief Engineer, Space Initiatives Inc
**Charles Radley**, President and CEO, Space Initiatives Inc

It is clear that there will be an increasing demand for means to keep track of activities on and near the Moon, to protect and manage the increasing traffic to that body. The Moon is of course close to the Earth, but in many ways cislunar space and the near-Earth space environments are different domains and in many cases it will not be easy or even possible to apply the techniques used for near-Earth space domain analysis to the Moon. This will inevitably lead to the development of new techniques for domain management in this new arena of activity. This short course will focus on the differences between the near-Earth and the Cislunar space domains, and on the tools and techniques for domain awareness and domain management in this new focus for our Nation's scientific and commercial activities. The intent is to give a grounding and common technical vocabulary for work in this new area.

The Moon is of course easily visible in the night sky, but the multiple operating environments in cislunar space have many features that are not encountered in low or medium Earth orbit. The cislunar orbital environment is much more varied and complicated that a Low Earth Orbit (LEO), the radiation and low frequency radio environments are different and time variable, and the infrastructure available in LEO is generally either severely degraded or not available at the Moon. This short course will describe the relevant physics of the cislunar domain – which, in effect, extends from orbits just about the terrestrial Geostationary belt all the way to the lunar surface and then out well beyond the Moon, and which supports an incredibly wide variety of orbital behaviors and orbital techniques

This course will provide knowledge of both the astrodynamics of the Moon and the astrodynamics of cislunar spacecraft, including our knowledge of the rotation and orbit of

the Moon (important for surface sensors), the Weak Stability Boundary (WSB) techniques that provide a highway for slow cargo to the Moon, the difficulties of Low Lunar Orbits (LLO) and the Halo orbits about the Earth-Moon Lagrange points that will feature in both Human spaceflight and Cislunar monitoring and communications networks. Terrestrial GPS suffers from a very bad Geometrical Dilution of Precision (GDOP) at the Moon, and the various means proposed for navigation in cislunar space will be described. Proposed and possible techniques for domain awareness on both the near and far sides of the Moon will be described in some detail. Finally, the Moon has a very complex and poorly understood radio environment at wavelengths much longer than one meter, and we will describe how this might be used in future domain monitoring.

## SC3 | Collision Avoidance Risk Assessment

Presented by:
**Francois Laporte**, CAESAR Team Leader, CNES
**Lauri Newman**, Senior Engineer, Goddard Space Flight Center – NASA
**Matthew Hejduk**, Chief Engineer, NASA Robotic CARA, Astrorum Consulting LLC

The threat of on-orbit collisions has become an increasing concern to the spacefaring community, both as an increasing mission risk due to a more congested space environment and through wider community awareness of the problem. The operational practice of conjunction assessment in response to this risk has also become more commonplace, evolving from simply predicting close approaches between orbiting objects to sophisticated systems and processes for managing on-orbit collision risk. This short course, organized and taught by industry leaders and subject matter experts in the field, is designed to educate beginners to intermediate-level practitioners on the fundamentals of conjunction assessment

This course provides a three-part overview of Conjunction Assessment. The first part is an extended background theory section that includes all the theoretical components which are needed in order to perform conjunction analysis and associated risk assessment. Topics include relevant astrodynamics basics, orbit determination methodologies, space domain awareness basic concepts, satellite conjunction assessment theory, quantified limitations of the two-dimensional probability of collision calculation, Monte Carlo analysis, cross-correlation between satellite covariances, and collision consequence assessments.

The second part of the course contains a treatment of modern conjunction risk assessment practices. The presenters share their operational experience and lessons learned, including some historical collision and close approach prediction statistics. Topics in this section include using and interpreting satellite probabilities of collision, designing and evaluating collision risk mitigation maneuvers, and understanding and processing the various relevant conjunction assessment data products, including those provided by the 18th Space Control Squadron.

Altogether over 190 satellites are supported by either the NASA Conjunction Assessment Risk Analysis (CARA) or the CNES Conjunction Assessment and Evaluation Service: Alerts and Recommendations (CAESAR), two instances of Middle Man. For both Middle Man examples, operations methods are presented and feedback is discussed. Both organization's processes regularly evolve in order either to follow 18th Space Control Squadron upgrades or to improve analysis according to operational experience acquired during the past years.

The third and final section of the course contains a treatment of emerging technical and policy challenges for conjunction assessment activities. The space environment has been rapidly evolving, and is expected to continue to do so in the coming years.

These changes include:

- many companies are proposing very large constellations
- cubesats are making space accessible to non-traditional space operators
- regulation and best practices are evolving
- efforts continue to define an architechture for a consolidated governmental or international Space Traffic Management (STM) entity
- the incipient deployment of the Air Force's Space Fence radar is expected to greatly increase the number of catalouged space objects

This course not only demonstrates that Collision Avoidance is a 2-step process (close approach detection followed by risk evaluation to enable making a sound collision avoidance decision) but also leads to the conclusion that the complicated topic leads to the need for an experienced Middle Man role to provide expert advice to spacecraft operators. This course is presented jointly between Centre National d'Etudes Spatiales (the French Space Agency) and the NASA Conjunction Assessment Risk Analysis team.

## SC4 | Demystifying Machine and Deep Learning

Presented by:
**Joseph Coughlin**, Aerospace Corp
**Rohit Mital,** Chief Technologist, KBR Inc.
**Weston Faber,** Research Scientist, L3 Harris

Operators and analysts are being overwhelmed with the amount of data available from both existing and new classes of sensors. When multiple sensors are combined in a network, the magnitude of the data becomes too great to analyze by conventional means. Machine Learning has been proposed as a solution to "big data" problems which will enable analysts to evaluate and determine courses of action based on information. A lot of misinformation surrounds Machine Learning and its potential to solve SDA problems. This short course builds upon the course given last year by further delving into Machine Learning and especially Deep Learning techniques to solve potential problems of interest to AMOS participants. This course presents an overview of current technologies and software and hardware architectures but especially the crucial details on Machine Learning algorithms for aspiring or current users so that they can utilize Machine Learning and Deep Learning techniques in their exploitation of existing data. A key aspect of this course is the discussion of how and when Machine Learning is applicable. An overview of emerging technologies in Machine Learning and Artificial Intelligence, such as Explainable AI and Reinforcement Learning, will also be presented. Although many of the cases presented deal with the exploitation of optical data, the techniques can be applied to other data types as well.

## SC5 | Observing and Characterizing Space Debris

Presented by:
**Thomas Schildknecht,** Vice Director, Head Optical Astronomie, Director Zimmerwald Observatory, Astronomisches Institut Universität Bern

The proliferation of space debris and the increased probability of collisions and interference raise concerns about the long-term sustainability of space activities, particularly in the low-Earth orbit and geostationary orbit environments. During recent years governments, space agencies and civilian research organizations increased their efforts to build space object catalogues and to investigate the space debris population in different orbit regions. Understanding the nature and the sources of debris is a prerequisite to provide the scientific foundation for a sustainable use of near-Earth space.

This course will provide a general introduction to the space debris problem, give an overview on the current space debris research activities to detect and characterize space debris, followed by a presentation of the efforts to model the future space debris population and the international efforts to protect and remediate the space environment. Particular focus will be put on optical techniques to detect, track and characterize space objects including small-size debris. The techniques will be illustrated with examples from the long-standing observation programs of the Astronomical Institute of the University of Bern (AIUB).

### SC6 | Space CAMP Intro to DevSecOps

Presented by:
**Samuel Kreimier**, 1st Lt, US Air Force
**Patrick Lorigan**, Space CAMP
**Tory Smith**, 2d Lt, US Air Force
**Rob Slaughter,** Director, Platform One

Located in Colorado Springs, CO, Space CAMP is a software factory focused on the continuous development and deployment of Space C2 mission applications to the warfighter. Space CAMP is a joint program between organizations including SMC, AFRL, the 14th AF Combat Development Division, AFWERX, Naval Information Warfare Center Pacific, and USAFCENT that leverages Platform One (the DoD Executive agent for DevSecOps) for CI/CD. Space CAMP has built upon the processes proven out by Kessel Run with some additions: avoid vendor-lock by building an open platform (Kubernetes/Istio), embrace DevSecOps principles outlined by the DoD CIO and AF CSO, consider microservice/service mesh architectures early and often, leverage event-driven behavior across the entire portfolio, and build a network of like-minded software shops for collaboration. By embracing the eXtreme programming (XP) flavor of agile software development, Space CAMP is able to continually produce quality code that can adapt to rapid changes and meet the high level of security standards necessary for maintaining a Continuous-ATO. The pillars of XP include paired programming, test driven development, continuous integration/continuous delivery, and small iterations. Additionally, the applications developed at Space CAMP follow user-centered design, a process through which designers continuously engage with users and employ a mixture of investigative and generative methods and tools to develop an understanding of user needs. This whole process results in recurring capability delivery to the operations floor.

### SC7 | The Dynamic Co-Evolution of Space Policy and Technology: Historical Overview and Lessons for Assessing Future Trends

Presented by:
Nancy Hayden, Principle Systems Research Analyst, Sandia National Laboratories

David Cox, Chief Architect, Sandia National Laboratories
Mallory Stewart, Principle Member Technical Staff, Sandia National Laboratories

The space security policy landscape of the U.S. and many space-faring nations are in a state of flux, evolving at both the strategic and operational levels to adapt to the realities of the changing space environment and rapid technological advancements. This course will provide an overview of the current space security policy landscape and teach participants how to study its evolution in the context of the historical interplay between space policy and technology, and the important analytic questions that reveal the dynamics between the two. Historical considerations include the geopolitical, commercial, and technical contexts, as well as international norms and treaties. Within these contexts, participants will explore the roles of technical, budgetary, and environmental constraints; and the interrelations between military, commercial and scientific drivers through past and present case studies. In so doing, participants will gain an understanding of space policy-technology dynamics, and how to apply this understanding to assess (i) the potential impacts of evolving space security policy on technical research and development needs for current and future space operations; and (ii) how technical research and development advancements might shape future directions and implementation of space security policy. They will also gain an appreciation for the role of language, and of safety and security frameworks in shaping common understanding of drivers for technical developments, norms, and standards, with an emphasis on applications for Space Domain Awareness, Space Traffic Management, and Space Control. The space security policy landscape of the U.S. and many space-faring nations are in a state of flux, evolving at both the strategic and operational levels to adapt to the realities of the changing space environment and rapid technological advancements. This course will provide an overview of the current space security policy landscape and teach participants how to study its evolution in the context of the historical interplay between space policy and technology, and the important analytic questions that reveal the dynamics between the two. Historical considerations include the geopolitical, commercial, and technical contexts, as well as international norms and treaties. Within these contexts, participants will explore the roles of technical, budgetary, and environmental constraints; and the interrelations between military, commercial and scientific drivers through past and present case studies. In so doing, participants will gain an understanding of space policy-technology dynamics, and how to apply this understanding to assess (i) the potential impacts of evolving space security policy on technical research and development needs for current and future space operations; and (ii) how technical research and development advancements might shape future directions and implementation of space security policy. They will also gain an appreciation for the role of language, and of safety and security frameworks in shaping common understanding of drivers for technical developments, norms, and standards, with an emphasis on applications for Space Domain Awareness, Space Traffic Management, and Space Control.

### SC8 | Telescopes and Optics for Ground-Based Optical SSA
Presented by:
Peter Zimmer, Astronomer, J.T. McGraw and Associates, LLC
Mark Ackermann, Optical Lead, J.T. McGraw and Associates, LLC

This course will provide those new to the SSA community (as well as those seeking a refresher) an introductory-level understanding of the tools and techniques used for detecting and tracking earth-orbiting satellites with ground-based optical instruments.

The course begins with an overview of optical telescopes and includes a discussion of many of the key terms and buzzwords one might encounter when reading about ground-based optical telescopes. From there, the course presents an overview of how these components are assembled into a sensor package for night time optical SSA and can be optimized to suit various mission goals.  This includes a discussion of satellite visual magnitudes, terminator viewing, sensitivity, search rate and related topics.  Finally, the course presents a brief look at the challenges and differences of optical systems for daytime optical SSA.

## SC9 | Using CelesTrak for SSA

Presented by:
T.S. Kelso, SDC Operations Manager, Center for Space Standards & Innovation

CelesTrak was the first site to offer SSA data to the public digitally, starting back in 1985. Over the past 35 years, it has built a reputation for quality and reliability that draws millions of unique users every month. SSA data is available from a wide variety of sources for use by everyone from satellite operators to amateur observers. CelesTrak also began providing the first conjunction advisory service via SOCRATES, staring in 2004. And CelesTrak regularly works with satellite operators, such as SpaceX, to produce SSA products for users that may not be otherwise available.

Today, CelesTrak's goal is to shorten the time from question to answer for a wide range of SSA issues. Interactive tables make it easy to query for information on satellites and launches. Our new Orbit, Pass, and Conjunction Visualization features allow users to quickly and easily visualize what is going on in Earth orbit, regardless of operating system or platform, via a simple, intuitive web interface.

This course will start by reviewing the different types of data available on CelesTrak and then diving into how to most effectively use the site to find the information you need. We will review our Orbit, Pass, and Conjunction Visualization features in depth, to ensure attendees are familiar with the core capabilities and can see how it can be applied to a variety of analysis, research, and educational questions. Students are encouraged to bring an Internet-connected device so that they can follow along (there is no need to pre-install software or create a user account).

## SC10 | Deep Learning Methods for Space Situational Awareness

Presented by:
Roberto Furfaro, Professor, University of Arizona
Weston Faber, Senior Research Scientist, L3Harris
Richard Linares, Charles Stark Draper Assistant Professor, Massachusetts Institute of Technology

Over the past decade, the field of machine learning has experienced incredible improvements in the applicability and accuracy of its techniques.  More importantly, due to availability of data and advancements in computing hardware (e.g. GPUs), deep learning has gained huge popularity due to its success in many field (e.g. image processing and classification, speech recognition, computer vision, robotics). These advances present huge opportunities for the SSA community as it faces ever increasing scope, sensing modalities, and data volumes. This short course will provide and introduction of deep learning and associated applications to SSA. The first portion of the course will cover a broad overview of deep learning methods with an emphasis on those areas that seem most

directly relevant to SSA. The second portion of the course will examine a set of case studies of the techniques being to real SSA problems, including code examples in Python (Tensorflow, Keras)

**Contact:** Sandy Ryan, Conference Director, Maui Economic Development Board
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**FOR IMMEDIATE RELEASE**

## 2020 AMOS Conference is going all-virtual

*Kihei, Maui, Hi, July 1, 2020* - With the continued uncertainty of holding large gatherings in Hawaii, AMOS has decided that the best, and safest, way forward is to go all-virtual with the 2020 Conference.

We are forging exciting new territory, as are so many conferences and meetings, and our team is developing a robust digital experience for our presenters, participants, sponsors, and exhibitors.

Registration will open next week with the rates updated to reflect the virtual experience. The early bird ticket is now $295 with special rates for government, military, international, presenters and students.

Registration will include access to all plenary sessions (Keynotes, Policy Forum and Technical Sessions), the virtual Exhibit Hall, Poster Hall, and networking opportunities. You will be able to attend in real-time or access recordings at a convenient time for you.

We look forward to sharing further details with you in coming weeks.

EMER-GEN 2020

The EMER-GEN Program will also be virtual in 2020.  This year, the program is extended with webinars before and after the main September program. Registration details coming soon. Learn more about EMER-GEN at http://www.emer-gen.com

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**FOR IMMEDIATE RELEASE**

## 2020 AMOS Conference Opening Registration in June

*Kihei, Maui, Hi, May 15, 2020* - Registration for the 21st Advanced Maui Optical and Space Surveillance Technologies (AMOS) Conference will open first week of June.  The premier technical conference in the nation devoted to space situational awareness, presented by Maui Economic Development Board (MEDB), is to be held September 15-18, 2020 at the Wailea Beach Resort.

The COVID-19 pandemic has created challenges for the hosting of live conferences and MEDB is monitoring the situation and conditions which may affect how the conference proceeds. With travel restrictions in place for organizations and countries, the team is exploring the opportunity to include virtual presentations and livestreaming for those unable to attend in person.

"The health and well-being of participants is our highest priority while maintaining the important dialogue, the networking opportunities and the Aloha Spirit the AMOS Conference is known for." said Sandy Ryan, Conference Director of Maui Economic Development Board.

The AMOS Conference features keynote speakers, policy forums, technical sessions, exhibits and networking events. The Policy Forums held each morning are coordinated in collaboration with Secure World Foundation, and explore international issues related to Space Situational Awareness. Bringing together the developers and implementers of SSA capabilities and the architects of SSA policy provides a forum to interact at a time when the landscape is rapidly changing.

The call for papers once again attracted record-breaking numbers of submissions and over 150 abstract authors were recently notified of the acceptance to present their papers at AMOS 2020 either orally during the technical sessions or as a poster. This year's technical sessions introduce the new topic of Cis-lunar SSA while Atmospherics/Space Weather makes a return to the line-up. Topics are selected according to the number and quality of submissions. Other topics to be presented will be Adaptive Optics & Imaging; Astrodynamics; Machine Learning Applications of SSA; Non-Resolved Object Characterization; Optical Systems & Instrumentation; Orbital Debris; Space-Based Assets and Space Situational Awareness.

Ten technical short courses will also run on Tuesday, September 15 with topics to be announced later this month.  Short courses are an optional addition to the program for attendees to upgrade technical skills and remain abreast of recent development in fields of interest.

**3rd Annual EMER-GEN**

Registration for the 3rd annual EMER-GEN Program, a joint initiative of the AMOS Conference and the Space Generation Advisory Council (SGAC) will also open in June. The program for young professionals and students 18 to 35 years old is expanding this year to include webinars before and after the main event with a focus on fostering innovation and entrepreneurship among the cohort. Through the whole program, participants will be challenged to solve/hack a problem to create new opportunities for space-based technologies.

The 2020 EMER-GEN Planning Committee welcomes two representatives from the Space Generation Advisory Council — Quentin Verspieren, Intelligent Space Systems Laboratory, The University of Tokyo; and Michael Barton, a.i. solutions and 2018 and 2019 Cohort. They are joined by Amber Imai, a member of the 2019 EMER-GEN cohort and an Avionics Engineer with Hawaii Space Flight Laboratory.

"The young professionals on the planning committee provide invaluable input to deliver a program relevant to the needs of their peers," said Sandy Ryan. "We are really lucky this year to have representation of diverse perspectives – international, local Hawaiian and U.S. Industry."

The EMER-GEN program precedes the AMOS Conference, September 13 -15, and will again feature the popular mentoring sessions with renowned space specialists, along with professional development sessions designed to enhance the young professionals' effectiveness in a global environment.

The annual AMOS Conference and EMER-GEN Program provide the opportunity to stay on the cutting edge of industry trends while networking and cross-sharing knowledge within the SSA community.  For further details on registration for AMOS go to https://amostech.com/registration and for EMER–GEN 2020, please visit https://amostech.com/emer-gen.

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**FOR IMMEDIATE RELEASE**

**2020 AMOS Conference response to COVID-19**

*Kihei, Maui, Hi, March 27, 2020* - The AMOS Conference team has been monitoring the COVID-19 on a state, national and global level, with specific interest on how it impacts the AMOS community. In these challenging times, we extend our thoughts and best wishes for your health and well-being.

With the AMOS Conference six (6) months away we are proceeding as planned while continuing to monitor the appropriate resources and advisories of any impact by COVID-19. While the team is working remotely from home we remain focused and available for you via email or phone.

**RECORD NUMBER OF ABSTRACTS**

We received a record number of abstracts for the 2020 AMOS Conference including 54 International from 15 countries (25% of total) and 30 from Students (the highest number to-date).

The student submissions will be considered for the Best Student Paper Award which provides travel assistance and conference registration. Students wishing to apply for this award must submit their completed manuscript and co-author statement by June 26, 2020.

For registration details go to https://amostech.com/registration