

AMOS Conference 2019



PROGRAM

Sunday 15 September

02:00	05:00	ON-SITE REGISTRATION <i>Aulani Ballroom Foyer</i>
06:00	07:30	EMER-GEN™ 2019 Aloha Reception <i>The annual EMER-GEN™, introduced in 2018, is a joint initiative of the AMOS Conference and SGAC. The program is designed especially for young professionals and students (35 and under) enthusiastic about careers in space. Separate registration required.</i>


Monday 16 September

07:30	09:00	EMER-GEN™ Breakfast & Welcome
09:00	11:00	EMER-GEN™ Communication in Multicultural, Generationally Diverse, and Team Settings
11:00	11:15	EMER-GEN™ Break
11:15	12:15	EMER-GEN™ Components of Effective Leadership
12:15	01:00	EMER-GEN™ Lunch
01:00	02:30	EMER-GEN™ Mentor Session
02:00	05:00	ON-SITE REGISTRATION <i>Aulani Ballroom Foyer</i>
02:30	02:45	EMER-GEN™ Break
02:45	04:45	EMER-GEN™ Consensus Building Across Multiple Perspectives
06:00	08:00	EMER-GEN™ Pau Hana Reception

Tuesday 17 September

07:00	08:00	EMER-GEN™ Breakfast
07:00	05:00	ON-SITE REGISTRATION <i>Aulani Ballroom Foyer</i>
08:00	10:00	EMER-GEN™ Critical Thinking Concepts & Tools
08:00	12:00	TECHNICAL SHORT COURSE 1 Conjunction Assessment Risk Analysis <i>Ilima</i> TECHNICAL SHORT COURSE 2 Space Debris Risk Assessment and Mitigation Analysis – Verification of compliance with requirements on space debris mitigation using ESA's DRAMA and MASTER software <i>Vanda</i> TECHNICAL SHORT COURSE 3 Demystifying Machine Learning and Deep Learning Neural Networks <i>Mauna Loa</i>

PROGRAM

		TECHNICAL SHORT COURSE 4 Theory and Application of Multi-objective Optimization using Genetic Algorithm <i>Lokelani III</i>
		TECHNICAL SHORT COURSE 5 SSA Optical Systems Modeling and Simulation <i>Lokelani II</i>
10:00	10:30	EMER-GEN™ Break
10:30	12:30	EMER-GEN™ AGI/STK Short Course
12:30	01:30	EMER-GEN™ Lunch
01:00	05:00	TECHNICAL SHORT COURSE 6 Statistical Orbit Determination for Space Surveillance and Tracking <i>Ilima</i>
		TECHNICAL SHORT COURSE 7 Observing and Characterizing Space Debris <i>Lokelani III</i>
		TECHNICAL SHORT COURSE 8 Deep Learning for Space Situational Awareness <i>Mauna Loa</i>
		TECHNICAL SHORT COURSE 9 Telescopes and Optics for Ground-Based Optical SSA <i>Lokelani II</i>
		TECHNICAL SHORT COURSE 10 How to Get the Most out of Space-Track.org Website and its API <i>Vanda</i>
01:30	04:30	EMER-GEN™ AGI/STK Challenge
04:30	04:45	EMER-GEN™ Break
04:45	06:00	EMER-GEN™ Culminating Session
06:00	07:30	WELCOME RECEPTION <i>Luau Gardens</i> Co-Sponsored by 

Wednesday 18 September

06:00	07:15	BREAKFAST AT LEISURE <i>Luau Gardens</i>
07:30	07:50	CONFERENCE OPENING <i>Aulani Ballroom</i> Leslie Wilkins, President & CEO, Maui Economic Development Board
		CULTURAL INVOCATION Reverend Kealahou Alikea, Keawala'i Congregational Church
		WELCOME & INTRODUCTIONS General William L. Shelton, USAF (Ret.) Chairman, Space Foundation Former Commander, Air Force Space Command

PROGRAM

07:50 08:10 **OPENING KEYNOTE ADDRESS**

Major General John E. Shaw
Deputy Commander, Air Force Space Command

Brigadier General Thomas James
Commander, U.S. Space Command's Joint Task Force Space Defense

08:10 08:30 **KEYNOTE ADDRESS | Hirohisa Mori**
Director, National Space Policy Secretariat, Cabinet Office, Japan

08:30 09:30 **SSA POLICY FORUM | The Future of Launch and On-Orbit Safety**
The year is 2029. The world has a civil and commercial STM system that has developed as a consequence of U.S. and other policies, emerging capabilities, advances in scientific understanding, and rapid expansion of space use by commercial and civil actors. This panel will discuss the future of what launch and on-orbit safety looks like by examining how this system came to be, what challenges it needed to overcome, and what problems are still unresolved.

Moderated by:
Andrew D'Uva, President | Providence Access Company

Panelists:
Steph Earle, Space Traffic Program Lead | FAA
Walter Everetts, Vice President, Satellite Operations and Ground Development | Iridium
T.S. Kelso, SDC Operations Manager | Center for Space Standards & Innovation; Senior Research Astrodynamist | Analytical Graphics, Inc.
Wasanchai Vongsantivanich, Project Manager | Geo-Informatics and Space Technology Development Agency (GISTDA)

09:30 10:00 EXHIBITS AND COFFEE BREAK | *Exhibit Room* | Sponsored by



09:30 06:30 EXHIBIT HOURS

10:00 10:20 **FEATURED PRESENTATION | *The Space S&T Challenges in Support of Near-peer Conflict*** | *Aulani Ballroom*
Col Eric Felt, Director, Space Vehicles Directorate, Air Force Research Laboratory
Col Timothy Sejba, Director, Advanced Systems & Development Directorate, Air Force Space & Missile Center

10:20 12:00 **SPACE SITUATIONAL AWARENESS**
Co-chaired by **Scott Pierce**, AFRL/RDSMR and **Sergio Restaino**, Naval Research Laboratory

Comparison of Multi-Objective Optimization Algorithms for GEO Space Surveillance Network Architecture Design
Troy Dontigney, Air Force Institute of Technology

PROGRAM

KARI Recent Activities on SSA & STM

Jaedong Seong, Korea Aerospace Research Institute

Automatic, Intelligent SSN Sensor Scheduling using Artificial Intelligence Techniques

Richard Stottler, Stottler Henke Associates, Inc.

Policy and Geopolitical Implications of Launch-on-Demand Capabilities

Liberty Shockley, U.S. Air Force

Optical, Laser and Processing Capabilities of the New Polish Space Situational Awareness Centre

Maciej Konacki, Polish Space Agency

12:00 01:00 LUNCH | *Lokelani Ballroom*

01:00 01:40 **SPACE SITUATIONAL AWARENESS (continued)** | *Aulani Ballroom*

Detection, Tracking, and Characterization of Small, Faint Targets at GEO Distances using the Magdalena Ridge Observatory 2.4-meter Telescope

William Ryan, New Mexico Tech/MRO

Introducing the Space Law Games - Predicting Legal Liability and Fault in Satellite Operations

Ralph Dinsley, Northern Space and Security Ltd/Reflecting Space

01:40 02:40 **NON-RESOLVED OBJECT CHARACTERIZATION**

Co-chaired by **Heather Cowardin**, Jacobs JETS and **John Lambert**, Cornerstone Defense

Space Object Attitude Stability Determined from Radar Cross-Section Statistics

Matthew Stevenson, LeoLabs

Attitude Estimation of Space Objects Using Imaging Observations and Deep Learning

Ryohei Arakawa, Kyushu University

Autonomous Space-Based Shape Estimation Using Range Sensors

Emily Lambert, L3 Harris

02:40 03:00 BREAK AND EXHIBITS | *Exhibit Room*

03:00 03:40 **NON-RESOLVED OBJECT CHARACTERIZATION (continued)** | *Aulani Ballroom*

Satellite Shape Recovery from Light Curves with Noise

Carolyn Frueh, Purdue University

Evaluating Catalog Photometric Uncertainties of Satellites using Bayer Arrays

PROGRAM

T.J. Rodigas, L3Harris Technologies

03:40 05:00

MACHINE LEARNING FOR SSA APPLICATIONS

Co-chaired by **Islam Hussein**, L3Harris Technologies and **Michael Werth**, The Boeing Company

SatNet v2: Generatively-Augmented, Temporally-Aware, Pattern-Based Satellite Detection

Justin Fletcher, AFRL/RDSM

Shape Identification of Space Objects via Light Curve Inversion using Deep Learning Models

Roberto Furfaro, University of Arizona


Automated Resolution Scoring of Ground-Based LEO Observations Using Convolutional Neural Networks

Jacob Lucas, The Boeing Company

Use of AI for Satellite Model Determination from Low Resolution 2D Images

Leon Muratov, Spectral Sciences Inc.

05:00 06:30

EXHIBIT AND POSTER SESSION | Exhibit Room | Co-Sponsored by 

06:30 09:00

20th ANNIVERSARY CELEBRATION DINNER | Pacific Terrace Rooftop
Join us for a special dinner celebration commemorating 20 years of the AMOS Conference. Performance by Na Hoku Hanohano Award-winning group Kapena. Tickets can be purchased at the Hospitality Desk. [View ticket information.](#)

Thursday 19 September

06:00 07:15 BREAKFAST AT LEISURE | Luau Gardens

07:30 08:00 **KEYNOTE ADDRESS** | **Francesca Letizia** | Aulani Ballroom
Space Debris Engineer, Space Debris Office, European Space Agency

08:00 09:00 **SSA POLICY FORUM | Oversight of Satellite Constellations: Licensing and Norms**
The growth in commercial space activities has also sparked a growing number of governments to establish or modernize their existing licensing frameworks to provide oversight of private sector space activities. At the same time, satellite operators are developing norms of behavior and best practices to demonstrate responsible behavior and influence regulations. This panel will discuss recent efforts to modernize licensing frameworks and develop best practices for large constellations and the role for improved space situational awareness.

Moderated by:
Brian Weeden, Director of Program Planning | Secure World Foundation

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Panelists:

David Goldstein, Director of Special Programs, SpaceX

Diane Howard, Chief Counsel for Space Commerce | U.S. Department of Commerce

Chris Kunstadter, Global Head of Space | AXA XL

Agnieszka Lukasczyk, Senior Director for European Affairs | Planet

Michael Nicolls, Founder and Chief Technology Officer | LeoLabs, Inc.

09:00	09:20	COFFEE BREAK Exhibit Room
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09:00	06:00	EXHIBIT HOURS
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09:20	09:30	FEATURED PRESENTATION <i>EMER-GEN™ Briefing</i> Aulani Ballroom
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09:30	11:30	SPACE-BASED ASSETS Co-chaired by Tom Kelecy , L3Harris Technologies and Andy Nicholas , Naval Research Laboratory <i>Cooperative Multi-spacecraft Observation of Incoming Space Threats</i> Jekan Thangavelautham , University of Arizona/SpaceTReX <i>The ELSA-d End-of-life Debris Removal Mission: Mission Design, In-flight Safety, and Preparations for Launch</i> Ron Lopez , Astroscale US <i>Geosynchronous Orbit CubeSat Operating Guidelines to Help the Space Situational Awareness Community</i> Christopher Tamanini , Lockheed Martin <i>Orbit Design of an Autonomous Space-based SSA Swarm: Distributed Deep Learning at the Edge</i> Lorraine Weis , L3Harris Technologies <i>Future On-Orbit Spacecraft Technologies and Associated Challenges for Space Situational Awareness</i> Simon George , DSTL <i>Star Tracker Accuracy Improvement and Optimization for Attitude Measurement in Three-Axis</i> Michael Lichter , Air Force Institute of Technology
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11:30	12:30	LUNCH Lokelani Ballroom
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12:30	01:50	ADAPTIVE OPTICS & IMAGING Aulani Ballroom Co-chaired by Mark Ackermann , Sandia National Labs and Sue Lederer , NASA Johnson Space Center
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PROGRAM

Demonstration of Shift, Scale, and Rotation Invariant Target Recognition Using Polar Mellin Transforms in a Hybrid Opto-Electronic Correlator

Selim Shahrar, Northwestern University

High Resolution and High Contrast Imaging of Faint Objects Near Satellites

Douglas Hope, Georgia State University

Satellite and Debris Characterisation with Adaptive Optics Imaging

Michael Copeland, Australian National University

Multi-Frame Blind Deconvolution Accelerated with Graphical Processing Units (GPUs)

Michael Werth, The Boeing Company

01:50 02:30

OPTICAL SYSTEMS & INSTRUMENTATION

Co-chaired by **Greg Cohen**, Western Sydney University and **Carolyn Frueh**, Purdue University

Sensor Network for Global Monitoring of Spacecraft Situational Awareness

Mark Werremeyer, Raytheon

Daylight Imaging of LEO Satellites Using COTS Hardware

Nathan Estell, University of Michigan

02:30 02:50

BREAK | *Exhibit Room*

02:50 04:30

OPTICAL SYSTEMS & INSTRUMENTATION (continued) | Aulani Ballroom

Spectral Performance Optimization of Small Telescopes for Space Object Detection

Gregory Badura, Georgia Tech Research Institute

Ground-based Daytime Modeling and Observations in SWIR for Satellite Custody

Grant Thomas, Air Force Institute of Technology

Atmospheric Characterization of the Space Environment: Unique Observations from Haleakala

Randall Alliss, Northrop Grumman

Interaction of VLF and ELF Waves and Impact on Energetic Electrons in a Radiation Belt

Vladimir Sotnikov, Air Force Research Laboratory

Optical Sensor Model and its Effects on the Design of Sensor Networks and Tracking

John McGraw, J. T. McGraw and Associates

PROGRAM

04:30 06:00 **EXHIBIT AND POSTER SESSION** | *Exhibit Room* | Co-sponsored by



08:00 10:00 **CELESTIAL VIEWING SOCIAL**
Pacific Rooftop Terrace | Sponsored by



Friday 20 September

06:00 07:15 **BREAKFAST AT LEISURE** | *Luau Gardens*

07:30 08:00 **KEYNOTE ADDRESS** | **Kevin O'Connell** | *Aulani Ballroom*
Director of the Office of Space Commerce, U.S. Department of Commerce

08:00 09:00 **SSA POLICY FORUM | SSA Data Sharing and Open Data Repositories**
The growing number of space actors and activities is driving increased demand for better quality SSA data and products. This in turn is creating interest in pooling different sources of data together in ways that are openly accessible to many different users. This panel will discuss the value of such open data repositories, what characteristics are essential for their success, and what challenges will need to be overcome in creating them and building trust with users.

Moderated by:

Victoria Samson, *Washington Office Director* | *Secure World Foundation*

Panelists:

Pascal Faucher, Chairman, European Space Surveillance and Tracking; Defense and Security | CNES

Diana McKissock, SSA Sharing & Spaceflight Safety Lead | 18th Space Control Squadron, U.S. Air Force

Mark Mulholland, U.S. Department of Commerce

Rogel Mari Sese, Program Leader | Philippines National Space Development Program; President | Regulus SpaceTech

09:00 09:20 **EXHIBITS AND COFFEE BREAK** | *Exhibit Room*

09:00 02:00 **EXHIBIT HOURS**

09:20 11:20 **ASTRODYNAMICS** | *Aulani Ballroom*
Co-chaired by **Keric Hill**, Pacific Defense Solutions, A Centauri Company and **Laura Pirovano**, University of Surrey

Object Detection Methods for Optical Survey Measurements

Alejandro Pastor, GMV

On-Orbit Observations of Conjuncting Space Objects Prior to the Time of Closest Approach

Lauchie Scott, Defence R&D Canada

PROGRAM

Physics-based Approach to Density Estimation and Prediction using Orbital Debris Tracking Data

Shaylah Mutschler, University of Colorado Boulder

An Australian Conjunction Assessment Service

James Bennett, EOS Space Systems

Statistical Covariance Realism Assessment of LeoLabs' Orbit Determination System

Inkwan Park, LeoLabs, Inc.

Space Object Tracking using a Jump Markov System based Delta-GLMB filter for Space Situational Awareness

Martin Adams, Universidad de Chile

09:30	12:30	<p>SPACE EXPLORATION STUDENT SESSION The AMOS Conference welcomes 150 Maui middle school students and 25 STEM teachers to visit exhibit booths for hands-on STEM demonstrations.</p>
11:20	12:20	LUNCH <i>Lokelani Ballroom</i>
12:20	01:40	<p>ASTRODYNAMICS (continued) <i>Aulani Ballroom</i></p> <p><i>Dynamic Calibration of Multiple Data Types</i> Thomas Kelecy, L3Harris Technologies</p> <p><i>Aliasing of Unmodeled Gravity Effects in Estimates of Non-gravitational Coefficients</i> Vishal Ray, CU Boulder</p> <p><i>Multi-Fidelity Orbit Uncertainty Propagation with Systematic Errors</i> Enrico Zucchelli, University of Texas at Austin</p> <p><i>Data Association for Too-short Arc Scenarios with Initial and Boundary Value Formulations</i> Laura Pirovano, University of Surrey</p>
01:40	02:00	BREAK <i>Exhibit Room</i>
02:00	02:20	<p>FEATURED PRESENTATION <i>Space Enterprise Acquisition</i> <i>Aulani Ballroom</i> Col Russell Teehan, Portfolio Architect, Air Force Space and Missiles System Center</p>
02:20	03:40	<p>ORBITAL DEBRIS Co-chaired by Darren McKnight, Centauri and Thomas Schildknecht, University of Bern</p> <p><i>Optical Measurements of Faint LEO RSOs: CubeSats and Fengyun 1C Debris</i></p>

PROGRAM

Peter Zimmer, JTMA

BVRI Photometry to Space Debris Objects at the Astronomical and Geophysical Observatory in Modra

Jiri Silhai, Comenius University

ESA Optical Surveys to Characterize Recent Fragmentation Events in GEO and HEO

Thomas Schildknecht, Astronomisches Institut Universität Bern

Space Environment Management – A Common Sense Framework for Controlling Orbital Debris Risk

Darren McKnight, Centauri


03:40 04:00

CONFERENCE CLOSING & AWARDS CEREMONY

In collaboration with the Space Surveillance Technical Committee of the [American Astronautical Society](#) (AAS), the AMOS Conference recognizes outstanding efforts in the field of Space Situational Awareness by presenting the second annual AMOS Conference Best Paper and Student Awards.

Completed feedback forms will also be collected at this time for the iPad Mini 4 drawing.

04:00 05:00

PAU HANA RECEPTION | *Aulani Foyer* | Co-sponsored by  **L3HARRIS**

Poster Presentations

Sodium Guidestar Signal Levels Measured at AMOS

Michael Abercrombie, The Boeing Company

Multi-Frame Blind Deconvolution of Closely Spaced Dim Stellar Objects

Ronald Aung, USAF

Optical Imaging of Faint Geosynchronous Debris with the Isaac Newton Telescope

James Blake, University of Warwick

Characterizing LEO Objects using Simultaneous Multi-Color Optical Array

Tanner Campbell, University of Arizona

Precision Optical Light Curves of LEO and GEO Objects

Paul Chote, University of Warwick

Experimentally Derived Bidirectional Reflectance Distribution Function Data in Support of the Orbital Debris Program Office

Heather Cowardin, JACOBS

PROGRAM

Machine Learning for RSO Maneuver Classification and Orbital Pattern Prediction

Michael Czajkowski, Lockheed Martin Advanced Technology Laboratories

Machine Classification and Sub-classification Pipeline for GEO Light Curves

Phan Dao, AFRL

ARGUS: A UK Citizen Science Study in Support of the Surveillance of Space

Joshua Davis, Defence Science and Technology Laboratory

Correlation-based Shack-Hartmann Wavefront Sensing with Extended Source Beacon

Takao Endo, Mitsubishi Electric Corporation

CREAM - ESA's Proposal for Collision Risk Estimation and Automated Mitigation

Tim Flohrer, ESA/ESOC Space Debris Office

*Survey Design for Small Autonomous Ground-Based Telescopes To Detect Uncontrolled/Debris
GEO Objects*

David Geller, Utah State University

Image Restoration in Daylight using Closed Loop Sodium Guide Star

Michael Hart, Hart Scientific Consulting LLC

Search-Based Vs. Task-Based Space Surveillance for Ground-Based Telescopes

Fred Hertwig, U.S. Air Force

Determining Multi-Frame Blind Deconvolutions Resolvability using Deep Learning

Trent Kyono, The Boeing Company

NASA's Orbital Debris Optical Program: MCAT Updated and Upgraded

Sue Lederer, NASA Johnson Space Center Orbital Debris Program Office

A Virtual Assistant for Space Situational Awareness

Jeremy Ludwig, Stottler Henke Associates, Inc.

Autonomous Satellite Fingerprinting using Machine Learning

Simon Melia, Roke Manor Research Ltd

An Open Source Long Term Archiving and Trending Solution for SSA

Ryan Melton, Ball Aerospace

Commercial SSA Capability in Japan

Daiki Mori, NEC Corporation

*Examining the Effects of On-Orbit Aging of SL-12 Rocket Bodies using Visible Band Spectra with the
MMT Telescope and 5-Color Photometry with the UKIRT/WFCAM*

Eric Pearce, University of Arizona Steward Observatory

PROGRAM

Satellite Tracking and Characterization Using Signal Data

Tatum Poole, Lockheed Martin

Observations and Design of a New Neuromorphic Event-based All-Sky Camera and Fixed Region Imaging System

Nicholas Ralph, Western Sydney University

Blockchain Enabled Space Traffic Awareness (BESTA)

Harvey Reed, The MITRE Corporation

Assessing and Minimizing Collisions in Satellite Mega-Constellations

Nathan Reiland, The University of Arizona

Network Performance Analysis of Laser-optical Tracking for Space Situational Awareness in the Lower Earth Orbit

Wolfgang Riede, DLR

Panoptes-1AB and Solaris-5 Unique Wide Field Telescopes with sCmos Cameras

Beata Rogowska, Nicolaus Copernicus Astronomical Center

Modeling Energy Dissipation and Deformation in a Tumbling Defunct Satellite Using a Finite Element Method

Ryotaro Sakamoto, University of Colorado Boulder

Application Development with High Definition SSA Information

Takao Sato, NEC Aerospace Systems, Ltd.

Phasing an Optical Interferometer using the Radio Emission from the Target

Henrique Schmitt, Naval Research Laboratory

Daytime GEO Tracking with Aquila: Approach and Results from a New Ground-Based SWIR Small Telescope System

Jeffrey Shaddix, Numerica Corporation

Design & Development of an Optimized Sensor Scheduling & Tasking Programme for Tracking Space Objects

David Shteinman, Industrial Sciences Group

Large Format Cross Strip Readout Image Sensors for High Temporal Resolution Astronomy and Remote Sensing

Oswald Siegmund, University of California

Development of the Slovak 70-cm Optical Passive System Dedicated to Space Debris Tracking on LEO to GEO Orbits

Jiri Silha, Comenius University, Faculty of Mathematics, Physics and Informatics

PROGRAM

Remote Manoeuvre of Space Debris using Photon Pressure for Active Collision Avoidance

Craig Smith, EOS Space Systems

Dragster: An Assimilative Tool for Satellite Drag Specification

Eric Sutton, University of Colorado / SWx TREC

Conditionally Augmented Temporal Anomaly Reasoner And Convolutional Tracking System

Dwight Temple, ExoAnalytic Solutions

Building Small-Satellites to Live Through the Kessler Effect

Jekan Thangavelautham, Univ. of Arizona, SpaceTReX

Fast Covariance Propagation for Two-Line Element Sets

Blair Thompson, 319 Combat Training Squadron

A Testbed to Evaluate New Approaches for STM

Kevin Toner, MITRE FFRDC

Streak Detection in Wide Field of View Images using Convolutional Neural Networks (CNNs)

Luis Varela, New Mexico State University

Ultrafast Wide Field Telescope for Space Debris Detection and Tracking

Dietmar Weinzinger, ASA Astrosysteme GmbH

Test Phase of OWL-Net : Global Network of Robotic Telescopes (2017-2018)

Hong-Suh Yim, Korea Astronomy and Space Science Institute

A Robust Vision-based Algorithm for Detecting and Classifying Small Orbital Debris Using On-board Optical Cameras

Yasin Zamani, University of Utah