CONJUNCTION ASSESSMENT
Session Chair: Lauri Newman, National Aeronautics and Space Administration (NASA)

Scalable Conjunction Processing Using Spatiotemporally Indexed Ephemeris Data ......................... 10
Irene Budianto-Ho, Stellar Science Ltd Co

Probability Forecasting Using Monte Carlo Simulation ................................................................. 20
Matthew Duncan, SpaceNav

Evolution and Implementation of the NASA Robotic Conjunction Assessment Risk Analysis
Concept of Operations .................................................................................................................. 34
Lauri Newman, National Aeronautics and Space Administration (NASA)

JAC Software, Solving Conjunction Assessment Issues ................................................................. 48
Francois Laporte, Centre National d'Etudes Spatiales (CNES)

ORBITAL DEBRIS
Session Chair: Thomas Schildknecht, Astronomical Institute, University of Bern

GEO Belt Survey with WFCAM ........................................................................................................ 57
Rick Kendrick, Lockheed Martin Advanced Technology Center

Improved Space Object Orbit Determination Using CMOS Detectors ........................................... 67
Thomas Schildknecht, Astronomical Institute, University of Bern

High Resolution Radar for NASA and Space Situational Awareness for Observation and Monitoring .... 76
Barry Geldzahler, National Aeronautics and Space Administration (NASA)

Implications of Hierarchies for RSO Characterization, Recognition, and Identification ................... 92
Matthew Wilkins, Applied Defense Solutions

LightForce Photon-Pressure Collision Avoidance: Updated Efficiency Analysis Utilizing a Highly
Parallel Simulation Approach ......................................................................................................... 103
Jan Stupl, SGT

A Deterministic Approach to Active Debris Removal Target Selection ........................................... 117
Aleksander Lidtke, University of Southampton

SPACE SITUATIONAL AWARENESS
Session Chair: Lindsay Millard, DARPA

Joint UK-Australian Space Surveillance Target Tracking, Cueing and Sensor Data Fusion Experiment .... 127
Pat Donnelly, Defence Science Technology Laboratory

Technical Description of Radar and Optical Sensors Contributing to Joint UK-Australian Satellite
Tracking, Data-fusion and Cueing Experiment .............................................................................. 137
Jon Eastment, STFC Chilbolton Observatory

Orbit Determination Analysis for a Joint UK-Australian Space Surveillance Experiment .................. 147
Mark Rutten, Defence Science and Technology Organisation

Proto-Type Development of Optical Wide-field Patrol Network and Test Observation .................. 157
Jang-Hyun Park, Korea Astronomy & Space Science Institute
Multi-phenomenology Observation Network Evaluation Tool (MONET) .................................................. 165
Dan Oltrogge, Analytical Graphics Inc.

Space Situational Awareness of Large Numbers of Payloads from a Single Deployment ..................... 190
Alan Segerman, Naval Research Laboratory

Next Generation Space Surveillance System-of-Systems ................................................................. 200
Bill McShane, Lockheed Martin

ASTRODYNAMICS
Session Chair: Paul Schumacher, Air Force Research Laboratory

Validation of Accuracy and Efficiency of Long-Arc Orbit Propagation Using the Method of
Manufactured Solutions and the Round-Trip-Closure Method ......................................................... 204
Robyn Woollands, Texas A&M University

Terminal Convergence Approximation Modified Chebyshev Picard Iteration for Efficient
Orbit Propagation .............................................................................................................................. 214
Austin Probe, Texas A&M University

Catalog Build-up for Geostationary Orbit Using Simulated Short-arc Tracklets .................................. 224
Jan Siminiski, DLR/GSOC

Simplified Propagation of Uncertainty in the Non-Keplerian Problem .............................................. 231
Inkwon Park, University of Colorado at Boulder

A Comparison of JPDA and Belief Propagation for Data Association in SSA ................................. 250
Mark Rutten, Defence Science and Technology Organisation

Information Theoretic Criteria for Observation-to-Observation Association .................................... 260
Islam Hussein, Applied Defense Solutions

Uncorrelated Track Classification, Characterization, & Prioritization using Admissible Regions
and Bayesian Inference ....................................................................................................................... 275
Marcus Holzinger, Georgia Institute of Technology

An AEGIS-CPHD Filter to Maintain Custody of GEO Space Objects with Limited Tracking Data .......... 304
Steven Gehly, University of Colorado at Boulder

Maneuver Detection and Estimation with Optical Tracklets ............................................................. 314
Keric Hill, Pacific Defense Solutions, Integrity Applications Inc.

SPACE SYSTEMS
Session Chair: Pat Patterson, Space Dynamics Laboratory

The Case for GEO Hosted SSA Payloads .............................................................................................. 324
Carol Welsch, Orbital Sciences Corp.

Concepts for an Enhanced CubeSat GEO Space Situational Awareness Architecture ...................... 333
Keith Morris, Lockheed Martin Space Systems Company

Flexible Next-Generation Space-Based SSA Payload ........................................................................ 343
Alan Scott, COM DEV International

The Near Earth Object Surveillance Satellite: Mission Status and CCD Evolution
After 18 Months On-orbit ..................................................................................................................... 351
Brad Wallace, Defence Research and Development Canada
NON-RESOLVED OBJECT CHARACTERIZATION
Session Chair: Matt Hejduk, a.i. solutions

Interpretation of Spectrometric Measurements of Active Geostationary Satellites .......................... 360
Donald Bedard, Royal Military College of Canada

Bi-static Optical Observations of GEO Objects ............................................................................. 376
Patrick Seitzer, University of Michigan Astronomy

Optical Characterization of Deep-Space Object Rotation States ......................................................... 384
Doyle Hall, Boeing

Effects of Optical and Geometrical Properties on YORP Effect for Inactive Satellites ..................... 394
Antonella Albuja, University of Colorado, Boulder

Propagation of Bayesian Belief for Near-real Time Statistical Assessment of Geosynchronous Satellite Status Based on Non-Resolved Photometry Data .................................................. 403
Anil Chaudhary, Applied Optimization, Inc.

Comparison of Unscented Kalman Filter and Unscented Schmidt Kalman Filter in Estimating Attitude and Associated Uncertainty of Geosynchronous Satellite ........................................ 440
Charles Wetterer, Integrity Applications Incorporated-PDS

ADAPTIVE OPTICS AND IMAGING
Session Chair: Charles Matson, Air Force Office of Scientific Research

A Wavefront Sensor to Detect Dim Objects ..................................................................................... 450
Mala Mateen, Air Force Research Laboratory

Gemini Planet Imager First Light: Advancing High Contrast Adaptive Optics ................................. 457
S. Mark Ammons, Lawrence Livermore National Laboratory

Research into a Single-aperture Light Field Camera System to Obtain Passive Ground-based 3D Imagery of LEO Objects ......................................................................................... 465
Kenneth Bechis, Northrop Grumman Information Systems

Optimal Dictionaries for Sparse Solutions of Multi-frame Blind Deconvolution ............................. 474
Bobby Hunt, Integrity Applications Inc.-PDS

Demonstration of Uncued Optical Surveillance of LEO ..................................................................... 482
Peter Zimmer, J.T. McGraw & Assoc., LLC

The Navy Precision Optical Interferometer for SSA: A Progress Report ......................................... 497
Sergio Restaino, US Naval Research Laboratory

DAYLIGHT IMAGING
Session Chair: Stacie Williams, Air Force Research Laboratory

The Daniel K. Inouye Solar Telescope: A Project Update ................................................................. 501
Thomas Rimmle, National Solar Observatory

Inertially-Aided Image Stabilization ................................................................................................. 511
Steve Griffin, Boeing

Daylight Imaging of SSA Targets Through Distributed Volume Non-Kolmogorov and Anisotropic Deep Turbulence at Low Elevation Angles ........................................................................ 516
Jeremy Bos, Air Force Research Laboratory

Automating Image Enhancement Optimization Using Image Quality Metrics ................................ 524
David Gerwe, Boeing Phantomworks Adv. Network and Space Systems
SPACe WEAthern

Session Chair: Randall Alliss, Northrop Grumman

Automated Recognition of Type III Solar Radio Bursts Using Mathematical Morphology ........................................ 529
James Jones, Northrop Grumman

Propagation of Forecast Errors from the Sun to LEO Trajectories: How Does Drag Uncertainty Affect Conjunction Frequency? ................................................................. 536
John Emmert, Naval Research Laboratory

LSP Simulation and Analytical Results on Electromagnetic Wave Scattering on Coherent Density Structures ........................................................................................................ 546
Vladimir Sotnikov, Air Force Research Laboratory

Numerical Simulations of Optical Turbulence Using an Advanced Atmospheric Prediction Model: Implications for Adaptive Optics Design ................................................................. 547
Randall Alliss, Northrop Grumman Corporation

SENSEr PROCEssING

Session Chair: Paul Sydney, IAI-PDS

Improvements in Space Surveillance Processing for Wide Field of View Optical Sensors .................. 558
Paul Sydney, Integrity Applications Incorporated-PDS

Ground Optical Signal Processing Architecture for Contributing SSA Space Based Sensor Data .......... 568
Darin Koblick, Millennium Space Systems

Serendipitous Acquisition of Space Situational Awareness from Astronomical and Survey Sensors (SASSAARFESS) .................................................................................................................................. 580
Mark Bolden, Pennsylvania State University

Faint Debris Detection by Particle Based Track-Before-Detect Method ......................................................... 587
Masahiko Uetsuhara, The Institute of Statistical Mathematics

Track-Before-Detect Algorithm for Faint Moving Objects based on Random Sampling and Consensus 597
Phan Dao, Air Force Research Laboratory

Image Stacking Techniques for GEO Satellites ................................................................................................. 607
Grant Privett, Defence Science and Technology Laboratory

Measuring Close Binary Stars with Speckle Interferometry ............................................................................. 615
Keith Knox, Air Force Research Laboratory

POSTER PRESENTATIONS

SSA Modeling and Simulation with DIRSIG ........................................................................................................ 626
David Bennett, Lockheed Martin Advanced Technology Center

An Analysis of Debris Orbit Prediction Accuracy from Short-arc Orbit Determination Using Optical and Laser Tracking Data .................................................................................. 633
James Bennett, RMIT University / EOS Space Systems

Optical Survey of the Tumble Rates of Retired GEO Satellites ........................................................................ 642
Christopher Binz, Naval Research Laboratory

GEODSS Overview ............................................................................................................................................. 660
Robert Bruck, BAE Systems
The Falcon Telescope Network ......................................................... 669
   Francis Chun, Air Force Academy, Department of Physics

Rotation Rates of Inactive Satellites Near Geosynchronous Earth Orbit ........................................ 675
   Rita Cognion, Oceanit

Determining Satellite Rotation Rates for Unresolved Targets Using Temporal Variations in Spectral Signatures ........................................ 684
   Joseph Coughlin, Stinger Ghaffarian Technologies (SGT)

NASA’s Optical Measurement Program 2014 H ........................................ 697
   Heather Cowardin, Jacobs

Measuring Geosynchronous Satellites from Stellar Appulses with AO ........................................ 707
   Jack Drummond, Air Force Research Laboratory

Computer Vision Techniques Applied to Space Object Detect, Track, ID, Characterize .................... 714
   Brien Flewelling, Air Force Research Laboratory

Use of Hierarchical Mixtures of Experts to Detect Resident Space Object Attitude .......................... 724
   David Gaylor, University of Arizona

Compliant Baffle for Large Telescope Daylight Imaging .................................................. 734
   Steven Griffin, Boeing

SOFIA Cycle 2 Science Status and Targets of Opportunity .................................................. 739
   Helen Hall, University Space Research Association

Quantitative Measurements of the Daytime Near Infrared Sky Brightness at the AEOS 3.6 m Telescope .................................................. 745
   Michael Hart, Hart Scientific Consulting International, LLC

A New Approach to Computing Information in Measurements of Non-resolved Space Objects by the Falcon Telescope Network .................................................. 753
   Douglas Hope, United States Air Force Academy

Probabilistic Admissible Region for Short-Arc Angles-Only Observations ......................................... 761
   Islam Hussein, Applied Defense Solutions

Collision Avoidance: Coordination of Predicted Conjunctions between NASA Satellites and Satellites of other Countries ........................................ 771
   Angelita Kelly, National Aeronautics and Space Administration

Spacecraft Orbit Anomaly Representation Using Thrust-Fourier-Coefficients with Orbit Determination Toolbox .................................................. 779
   Hyun Chul Ko, University of Colorado Boulder

NASA’s Newest Orbital Debris Ground-based Telescope Assets: MCAT and UKIRT ......................... 789
   Susan Lederer, National Aeronautics and Space Administration

Characterization of Inactive Rocket Bodies via Non-Resolved Photometric Data ............................ 798
   Richard Linares, Los Alamos National Lab

An Adaptive, Agile, Reconfigurable Photonic System for Handling Analog Signals ......................... 813
   Charles Middleton, Harris Corporation

Relative Cost and Performance Comparison of GEO Space Situational Awareness Architectures ........ 821
   Keith Morris, Lockheed Martin Space Systems Company

The Joint Space Operations Center (JSpOC) Mission System (JMS) and the Advanced Research, Collaboration, and Application Development Environment (ARCADE) ........................................ 832
   Jeremy Murray-Krezan, AFRL

Fast Tomographic Reconstruction of Atmospheric Turbulence from Micro-lens Imagery ............ 844
   James Nagy, Emory University
Fusion of Telescopic and Doppler Radar Data ................................................................. 853  
Mirko Navara, Czech Technical University in Prague, Faculty of Electrical Engineering  

SpinSat Mission Preliminary Results ................................................................. 862  
Andrew Nicholas, Naval Research Laboratory  

Optical Observation, Image-processing, and Detection of Space Debris in Geosynchronous Earth Orbit ................................................................. 868  
Hiroshi Oda, Japan Aerospace Exploration Agency (JAXA)  

Parametric Characterization of SGP4 Theory and TLE Positional Accuracy ................................................................. 876  
Dan Oltrogge, Analytical Graphics, Inc.  

Data Reduction Algorithm for Optical Wide Field Patrol (OWL) ................................................................. 894  
Sun-youp Park, Korea Astronomy & Space Science Institute (KASI)  

A Community Format for Electro-Optical Space Situational Awareness (EOSSA) Data Products ................................................................. 900  
Tamara Payne, Applied Optimization Inc.  

Identifying On-Orbit Test Targets for Space Fence Operational Testing ................................................................. 908  
Daniel Pechkis, Institute for Defense Analyses  

Doublet Pulse Coherent Laser Radar for Orbital Debris Tracking of Resident Space Objects ................................................................. 917  
Narasimha Prasad, NASA Langley Research Center  

Development and Analysis of a Waffle Constrained Reconstructor (WCR) for Fried Geometry Adaptive Optics Systems ................................................................. 927  
Robert Praus, MZA Associates Corporation  

Simulation of Telescope Detectivity for Geo Survey and Tracking ................................................................. 935  
Pascal Richard, CNES  

Clients of SSA Net-Ready Data ................................................................. 943  
David Richmond, Lockheed Martin  

Diagnostic Comparisons of Near-Earth Object Identification using Slit Spectroscopy and Slitless Grating Methods ................................................................. 954  
Eileen Ryan, New Mexico Institute of Mining and Technology  

On LEO Debris Orbit Prediction Performance Using Tracking Data from a Single Station ................................................................. 962  
Jizhang Sang, Wuhan University  

Manyscale Computing for Sensor Processing in Support of Space Situational Awareness ................................................................. 963  
Mark Schmalz, University of Florida  

Practical Issues Related to the Interferometric Imaging of Geosats ................................................................. 964  
Henrique Schmitt, Naval Research Laboratory  

Using a Smartphone Camera for Nanosatellite Attitude Determination ................................................................. 973  
Rogan Shimmin, SGT  

Optical and UV Sensing Sealed Tube Microchannel Plate Imaging Detectors with High Time Resolution ................................................................. 986  
Oswald Siegmund, University of California, Space Sciences Lab  

A Short Evaluation of Triangulated Range from Multiple Angles-Only Sites ................................................................. 996  
Zach Slatton, 614 AOC//SSD  

Interchange and Flow Velocity Shear Instabilities in the Presence of Finite Larmor Radius Effects ................................................................. 1006  
Vladimir Sotnikov, Air Force Research Laboratory  

Follow-up Observatory for Low Earth Orbit Objects with a Detection Algorithm Using Streaks ................................................................. 1007  
Makoto Tagawa, Kyushu University
Joint Processing of Visible and Long-Wave Infrared Imagery .......................................................... 1012
  Daniel Thompson, Boeing

Exploiting the Magnetic Origin of Solar Activity in Forecasting Thermospheric Density Variations .......... 1019
  Harry Warren, Naval Research Laboratory

Recent Developments in Advanced Automated Post-Processing at AMOS ........................................ 1028
  Michael Werth, Boeing

Comparison of Radiation Pressure Perturbations on Rocket Bodies and Debris at Geosynchronous Earth Orbit ................................................................. 1034
  Charles Wetterer, Integrity Applications Incorporated-PDS

AMORE: Applied Momentum for Orbital Refuse Elimination ......................................................... 1044
  Mark Wolfson, Lockheed Martin

Emerging Technologies: Small Satellite and Associated TPED .................................................... 1050
  Robert Zitz, Leidos

APPENDIX

Conference Program ......................................................................................................................... 1052

List of Participants .......................................................................................................................... 1068