



NASA CA Operations Devolution: Status Update

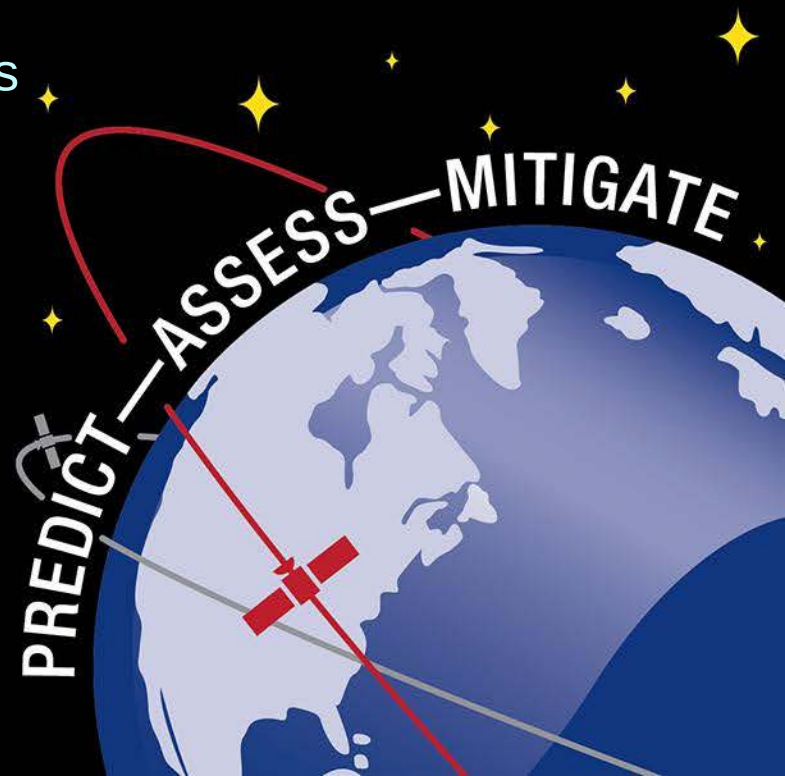
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NASA Conjunction Assessment Risk Analysis

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NASA CARA

www.nasa.gov



Agenda



- Review of Devolution Definition
- Details regarding Devolution Implementation
- Way Ahead



What is Devolution?

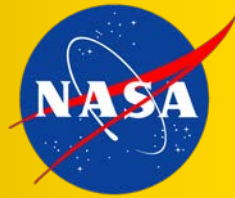
- Devolution is a spreading of CA operations responsibilities to mission FOTs
 - Permits efficiencies in handling the increased workload caused by Space Fence and large constellations
 - Missions given more flexibility in choosing specific approach to CA requirements that resonates best with their particular needs
 - CARA retains Agency oversight through an established NASA Standard
 - Will establish requirements for devolved CA preparations, processing, and operations conduct
- Devolution is a PROPOSED paradigm under consideration by SMD
 - Number of activities required before Agency-level decision can be rendered
 - Agency requirements established via approved CA Standard
 - Operational experience testimony from two separate pilot programs
 - After these activities complete, decision will be made whether devolution is a feasible option for missions
 - CARA is recommending devolution to exist as an option for missions



History of Devolution Guidance

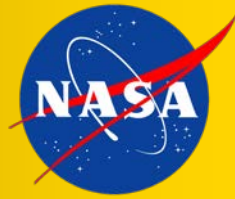
- On Feb 22, 2018, CARA proposed devolution paradigm to Greg Robinson/SMD Deputy Associate Administrator for Programs
 - Received approval to perform pilot program to investigate feasibility of paradigm
- ESMO Program volunteered to be pilot mission
 - Has been performing parallel CA operations for several years using commercial SpaceNav Tool
- On Apr 27, 2018, Sandra Smalley (replaced Greg R) directed a second pilot with a mission that has less experience with autonomous CA
- OCO-2 mission volunteered to be 2nd pilot mission.
 - Activities to start after ESMO pilot parallel operations phase becomes routine

Continuity of CARA



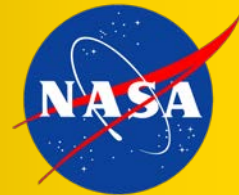
- **CARA IS NOT GOING AWAY!!**
- CARA retains CA SME expertise for Agency support, including:
 - R&D to develop and evaluate new CA algorithms and paradigms
 - 3rd party CA tool evaluation
 - Classified CA operations/interactions
 - Liaison to 18 SPCS/CSpOC per NPR 8715.6b
 - Manage Orbital Safety Analyst staff
 - Review and submit data requests [e.g. Orbital Data Requests (ODRs), Astro Standards]
 - Develop interfaces to DoD software (e.g. 9-digit sat numbers, JMS, etc)
 - Provide Agency SME expertise to improve processes, maintain standards, guide Agency CA policies, and represent the Agency to outside entities for CA/SSA
 - General CA/SSA policy formation support, especially regarding STM initiatives
 - Engagement with external organizations to establish interfaces and exchange of data products, in order to further Agency goals and protection of assets
- **CARA will continue to perform CA operations for non-devolved missions**

Continuity of CARA OSA Functions

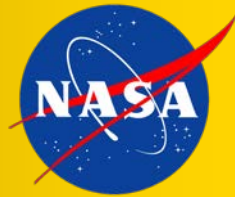


- Orbital Safety Analysts (OSAs) to be retained as essential part of CARA and devolved operations
 - VAFB-resident NASA employees that expedite CA and provide services
 - Have direct access to DoD system and perform many functions
 - *E.g.*, manual orbit determination (OD) solution review, CA product production, classified processing
 - Devolved missions will have direct access to OSAs in support of regular ops CA functions per CARA-provided procedures
- During ESMO pilot, identified many additional important activities performed at CARA that cannot be easily transitioned to missions
 - *E.g.*, manual OD worklist management, OD history profiling, Monte Carlo solution execution, tracking opportunity prediction
- Best way to make such functions available under devolution is to migrate them to the OSAs
 - Special tool suite of such functions being developed
 - Deployment of initial capability in January, with enhancements and updates throughout 2019

Devolution Preparation Activities



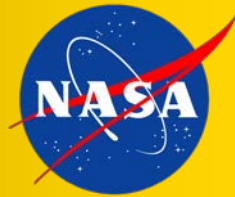
- Preparing for devolution has required CARA to generate many items:
 - Development and approval of Agency requirements: NPR updates, new CA Standard, new CA Handbook
 - Development of CARA CONOPS for devolution
 - CA training for missions
 - Tool certification requirements, including benchmark test cases
 - Transfer of CARA stand-alone CA tools to missions that desire them
 - Placement of essential CA algorithms and test cases into publicly-accessible Software Development Kits (SDKs)



NPR 8715.6b Update

- In order to enable orbit regime protection under devolution, Agency requirements for devolved CA operational conduct are needed
- Initial set of requirements developed, reviewed by ESMO and SSMO, sent to GSFC Code 300 for review
- Draft NPR sent to OSMA 4QFY18
- Decision 12/7/18 by OSMA/OCE *not* to issue a new NPR
 - Will make minor update to NPR 8715.6b to designate the forthcoming CA Standard as mandatory
 - Standard completion required before NPR update

CA Standard

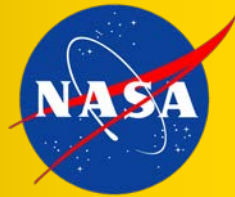


- In order to enable orbit regime protection under devolution, NASA Standard for CA operational conduct is needed
 - Outlines roles and responsibilities, data flow, training requirements, tool validation approaches, risk assessment activities, and reporting requirements
 - Mission pre-launch, launch, and end-of-life activities
 - Provides compliance methods and threshold values
 - Analyses are underway to provide trade space to HQ to choose Agency-level thresholds and risk criteria to be put in Standard
 - Goal is for Standard to be mission- and industry-friendly
- Presently in draft form (with accompanying handbook commentary)
 - Needs to be rewritten based on HQ decision to avoid a new CA NPR; Standard will need to include requirements originally intended for that
- Will be sent to OCE for formal staffing process in early CY19

CA Handbook



- To facilitate responsible CA, collective wisdom of ten years of CA activities needs to be documented and transitioned to users
- NASA Handbook proper vehicle for this; topics include
 - Introduction to and history of CA
 - Review and technical explanation of major CA methods/algorithms, along with operational lessons learned and cautions
 - Treatment of advanced concepts
- Draft version of Handbook planned for MAR 19
- Plan is to circulate publicly to broader industry to help new and established actors improve safety of flight



CA Training for Missions

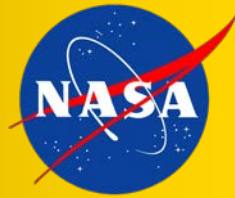
- Updated CARA internal training program to be appropriate to missions
 - Concept- rather than tool-based
 - Distanced-learning paradigms
 - Oral and written exam service available to missions for certification
- Beginner Training Program
 - Material available in SATERN; annual updates planned
- Advanced Training Program
 - Offered as part of past bi-monthly Users' Forum meetings
 - Material will be available in SATERN soon
- Under devolution, use of CARA training program by missions is not expected to be mandatory but is offered as an option



CARA Tools to Missions

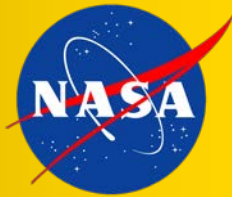
- CARA possesses a number of stand-alone tools that can be helpful to missions performing their own CA
 - Maneuver Trade-Space (MTS) – helpful in selecting maneuvers
 - Sensor Coverage – predicts future SSN tracking opportunities of objects, both theoretically and empirically
 - Monte Carlo Workbench – performs Monte Carlo Pc calculation (from TCA) in equinoctial space, along with covariance repair
 - Pc Uncertainty – produces PDF of Pc values to compare against threshold, modeling covariance and HBR uncertainty
- Presently being packaged and made available for circulation
- Effort underway to move CARA to GovCloud environment
 - Possible deployment mechanism for difficult-to-circulate but potentially desirable services, such as Brute Force Monte Carlo

CA Software Development Kits (SDKs)



- Method for packaging and distributing established CA algorithms for distribution to missions and industry
 - Allows more rapid development of tools and thus more choices for missions; also seeds better safety of flight for industry
 - Permits benchmarking of non-CARA CA tools
 - Publicly available kits contain a reference conference paper, relevant test and validation cases, and MATLAB source code for main algorithm with simple driver
- Planned SDKs include 2-D Pc, OD Quality, Monte Carlo from TCA (equinoctial conversions), collision consequence, single-covariance Pc, and Pc Uncertainty
 - Other functions seen as too basic to require SDK
 - Routine updates envisioned for bug fixes and enhancements
- Public release paperwork in process; difficult to determine when will be approved
 - Legal approval is last remaining step – ETA unknown

Devolution Governing Documentation



- Each existing on-orbit mission that devolves will need the following documentation:
 - MOU Document between CARA and mission
 - To address how transition of operations will occur
 - To describe the parallel operations phase and the expected fully-devolved end-state
 - Documents success criteria for parallel operations phase
 - Parallel Operations Plan
 - Documents any differences between parallel operations and devolved nominal operations
 - Mission CA CONOPS (written in response to CA Standard; template being developed as part of ESMO pilot)
 - Tool Certification Plan and tool testing/validation report
 - Mission CA Personnel Training and Certification Plan

Schedule



- ESMO Pilot
 - Weekly status meetings
 - TRR planned for January
 - Parallel Operations to last about 6 months
 - ORR briefing to CMAB
 - Goal: permission to continue operating in devolved state until HQ finalizes requirements documentation and approves devolution as an acceptable option
- OCO-2 pilot
 - Begin work on documentation after ESMO parallel operations becomes routine

Way Ahead



- Feel free to send additional comments via email to CARA or your HQ PE
- Missions interested in using a devolution paradigm can contact CARA to be put on a waiting list assuming use of devolution is approved
- **Missions not desiring to use devolution are not required to do so**
- Economies of scale can be realized if missions participate as groups
 - Gets more missions into a devolved status in the fastest way possible
 - Cheaper for all if use same tools/procedures
 - Negotiations are needed but take time, so may be beneficial to initiate discussions now
- CARA will need to limit number of missions/groups of similar missions that can be devolved at a time due to limited resources
 - Prioritization can be accomplished by SMD