



# NASA CA Operations Devolution: Status Update

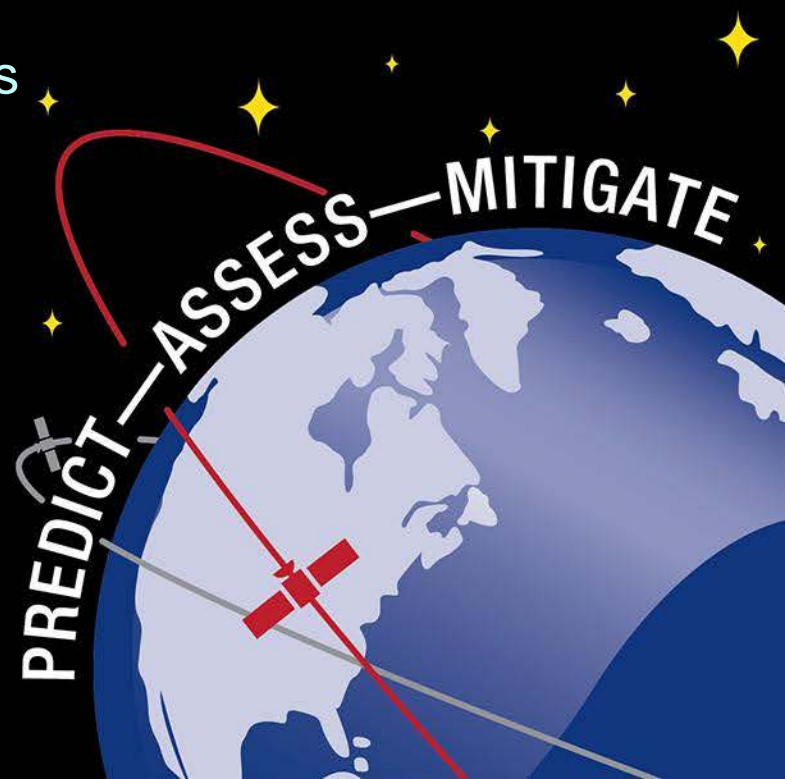
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NASA Conjunction Assessment Risk Analysis

Jan 8, 2019

**NASA CARA**

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# Agenda



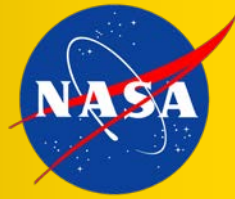
- Review of Devolution Definition
- Details regarding Devolution Implementation
- Way Ahead



# What is Devolution?

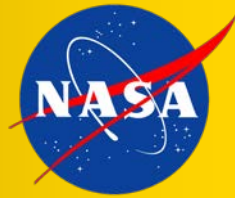
- Devolution is a spreading of CA operations responsibilities to mission FOTs
  - Permits efficiencies in handling the increased workload caused by Space Fence and large constellations
  - Missions given more flexibility in choosing specific approach to CA requirements that resonates best with their 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



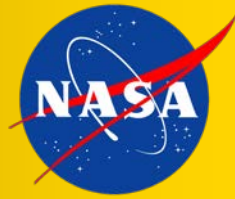
- On Feb 22, 2018, CARA proposed devolution paradigm to Greg Robinson/SMD Deputy Associate Administrator for Programs
  - Received approval to perform pilot program to investigate feasibility of paradigm
- ESMO Program volunteered to be pilot mission
  - Has been performing parallel CA operations for 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 2<sup>nd</sup> pilot mission.
  - Activities to start after ESMO pilot parallel operations phase becomes routine

# Continuity of CARA



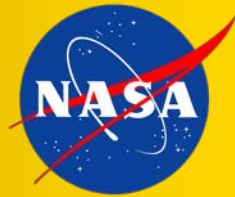
- **CARA IS NOT GOING AWAY!!**
- CARA retains CA SME expertise for Agency support, including:
  - R&D to develop and evaluate new CA algorithms and paradigms
  - 3<sup>rd</sup> party CA tool evaluation
  - Classified CA operations/interactions
  - Liaison to 18 SPCS/CSpOC per NPR 8715.6b
    - Manage 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

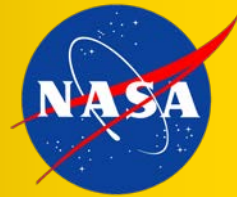


- Orbital Safety Analysts (OSAs) to be retained as essential part of CARA and devolved operations
  - VAFB-resident NASA employees that expedite CA and provide services
  - Have direct access to DoD system and perform many functions
    - *E.g.*, manual orbit determination (OD) solution review, CA product 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)

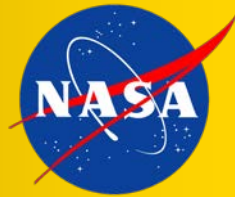


# NPR 8715.6b Update

- 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

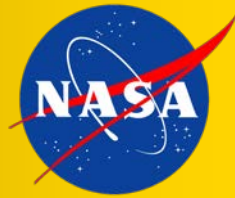


# CA Standard

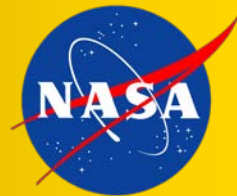


- In order to enable orbit regime protection under devolution, NASA Standard for CA operational conduct is needed
  - Outlines roles and responsibilities, data flow, training requirements, tool validation approaches, risk assessment activities, and reporting requirements
  - Mission pre-launch, launch, 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



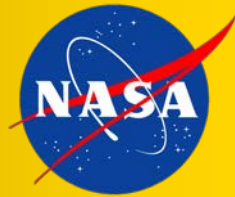
- To facilitate responsible CA, collective wisdom of ten years of CA activities needs to be documented and transitioned to users
- NASA Handbook proper vehicle for this; topics include
  - Introduction to and history of CA
  - Review and technical explanation of major CA methods/algorithms, along with 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

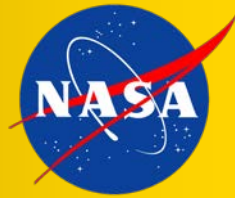
- Updated CARA internal training program to be appropriate to missions
  - Concept- rather than tool-based
  - Distanced-learning paradigms
  - Oral and written exam service available to missions for certification
- Beginner Training Program
  - Material available in SATERN; annual updates planned
- 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



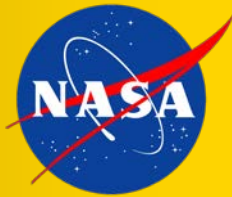
- CARA possesses a number of stand-alone tools that can be helpful to missions performing their own CA
  - Maneuver Trade-Space (MTS) – helpful in selecting maneuvers
  - Sensor Coverage – predicts future SSN tracking opportunities of objects, both theoretically and empirically
  - Monte Carlo Workbench – 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)



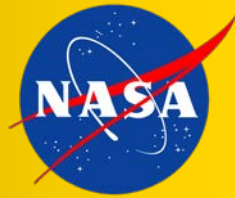
- Method for packaging and distributing established CA algorithms for distribution to missions and industry
  - Allows more rapid development of tools and thus more choices for missions; also seeds better safety of flight for industry
  - Permits benchmarking of non-CARA CA tools
  - Publicly available 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



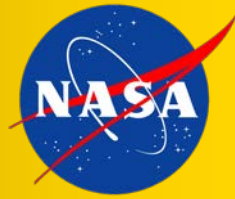
- Each existing on-orbit mission that devolves will need the following documentation:
  - MOU Document between CARA and mission
    - To address how transition of operations will occur
    - To describe the parallel operations phase and the expected fully-devolved end-state
    - Documents success criteria 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