

Minor Planet Center

June 2nd 2021:

Planetary Science and Astrobiology Decadal Survey:
Panel on Small Solar System Bodies

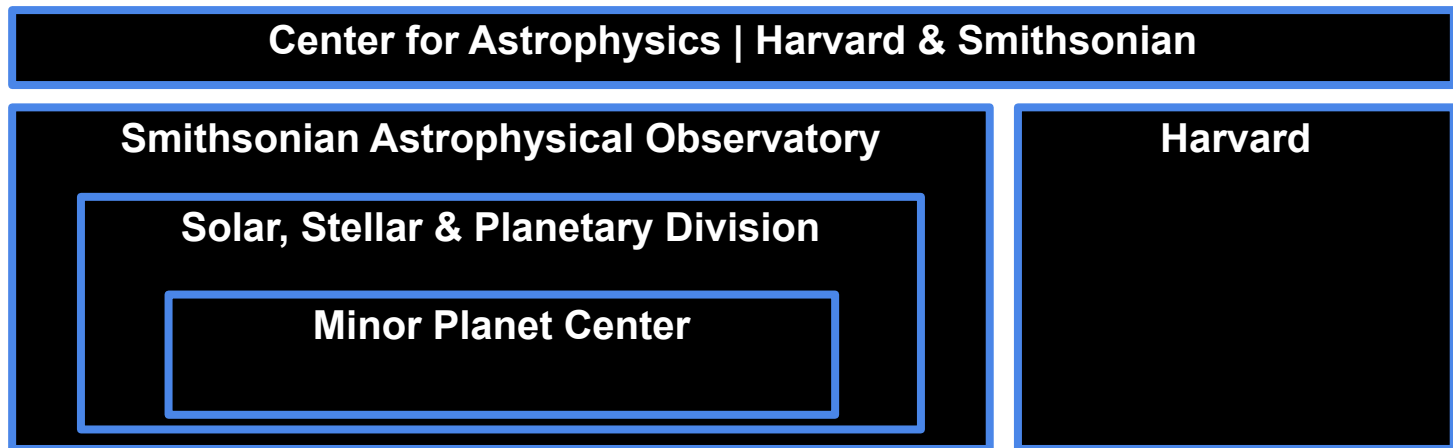
Matthew Payne

Center for Astrophysics | Harvard & Smithsonian

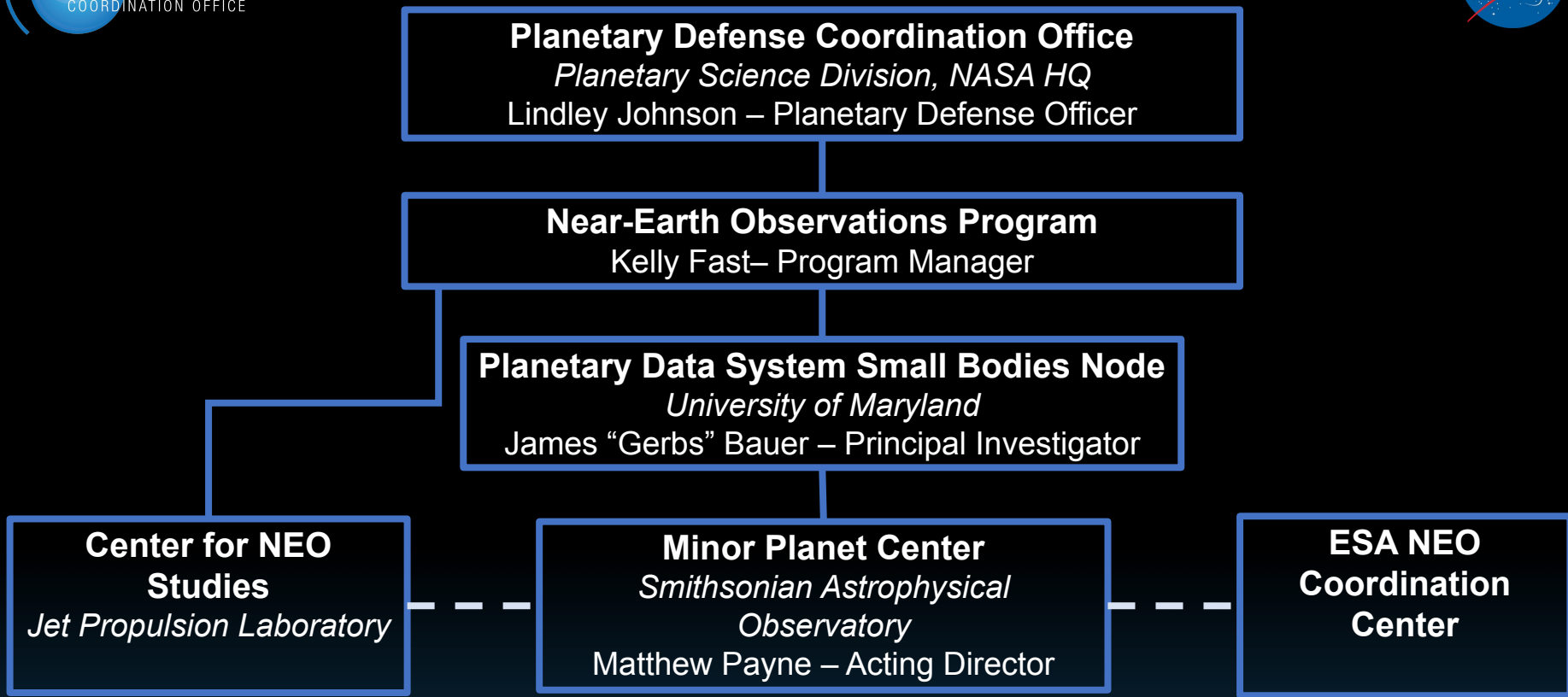
- Organizational Structure and Support
- Roles and Responsibilities
- Data Processing Challenges

MPC: Overview

- Granted authority for operation by the International Astronomical Union (IAU).
 - *1978: Smithsonian Astrophysical Observatory*



- Granted authority for operation by the International Astronomical Union (IAU).
- Sub-node of the Small Bodies Node (SBN) of the NASA Planetary Data System at U. Maryland.
- Funded 100% by NASA through a Cooperative Agreement via a sub-award from U. Maryland.
 - *SBN is responsible for oversight of the sub-award.*
- Evaluated in 2021 Senior Review as part of NASA Planetary Data System/Small Bodies Node.



MPC: Overview

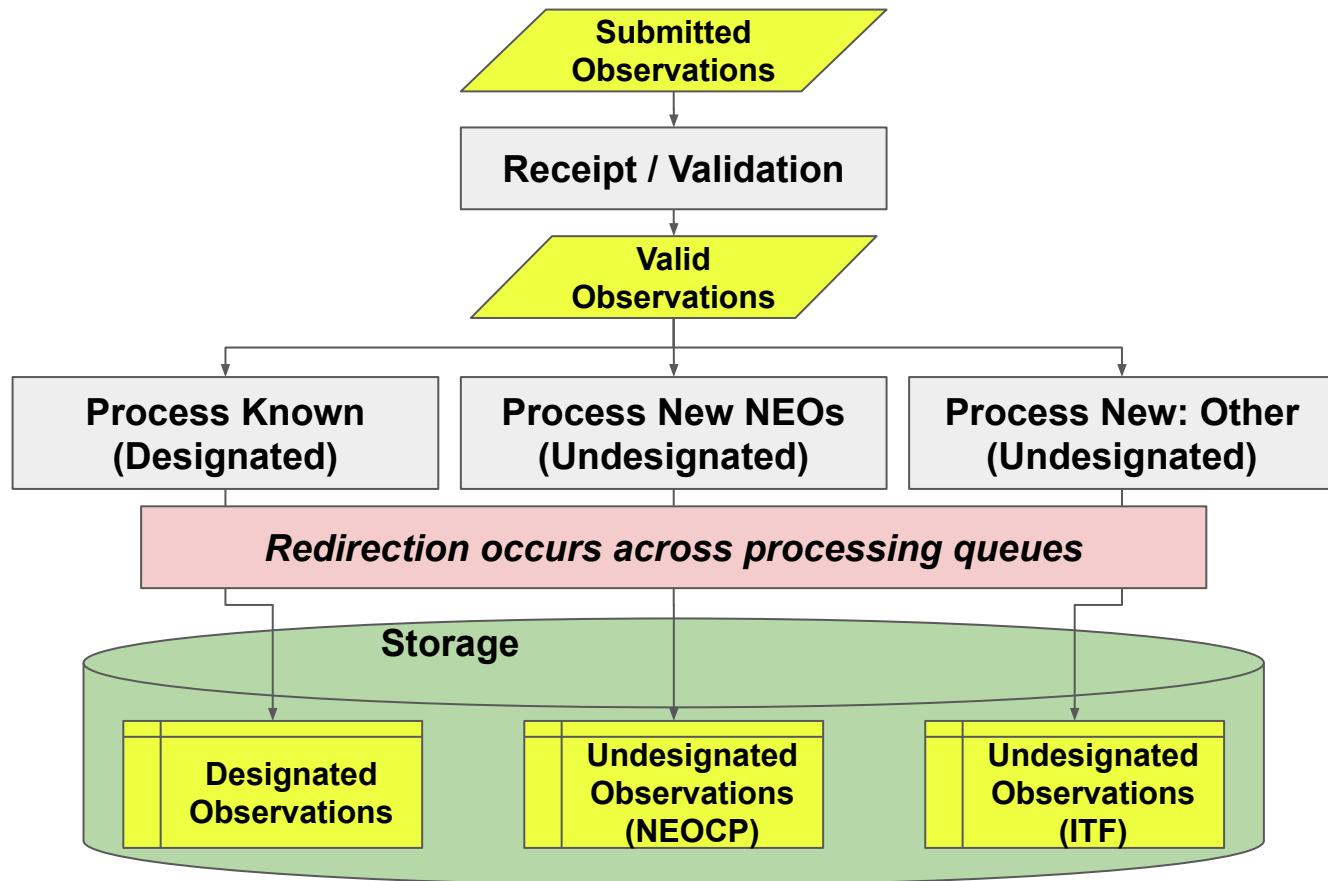


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<i>Name</i>	<i>FTE</i>	<i>Role</i>
<i>Matthew Payne</i>	1.00	Acting Dir.
<i>Mike Rudenko</i>	1.00	Software & Sys-Admin; Comets;
<i>Dave Bell</i>	1.00	Software & DB-Dev; NEOCP; ADES
<i>Paresh Prema</i>	1.00	Software & Web-Dev; Identifications;
<i>Margaret Pan</i>	1.00	Pipeline Migration; Orbit-Fitting
<i>Federica Spoto</i>	1.00	Pipeline Migration; Orbit Fitting
<i>Peter Veres</i>	1.00	NEOCP Operations; Identifications; Pipeline Automation
<i>Rosemary Pike</i>	0.42	TNOs;
<i>Mike Alexandersen</i>	0.5	<i>MPC Fellow</i> ; Nat. Satellites; Chebyshev-Ephemeris
<i>Michael Lackner</i>	1.00	<i>Contractor</i> : Database Migration
<i>Tyler Linder</i>	0.1	<i>Contractor</i> : AWS Migration

MPC: Simplified Process Flow

- Top-level validation of format and basic physical plausibility
- Submitted labels & designation *guide* process-path
 - Redirection occurs
- Orbit-fitting of “known”
- Attempt “linking” of unknown/unattributed
- Suspected NEOs → NEOCP for follow-up

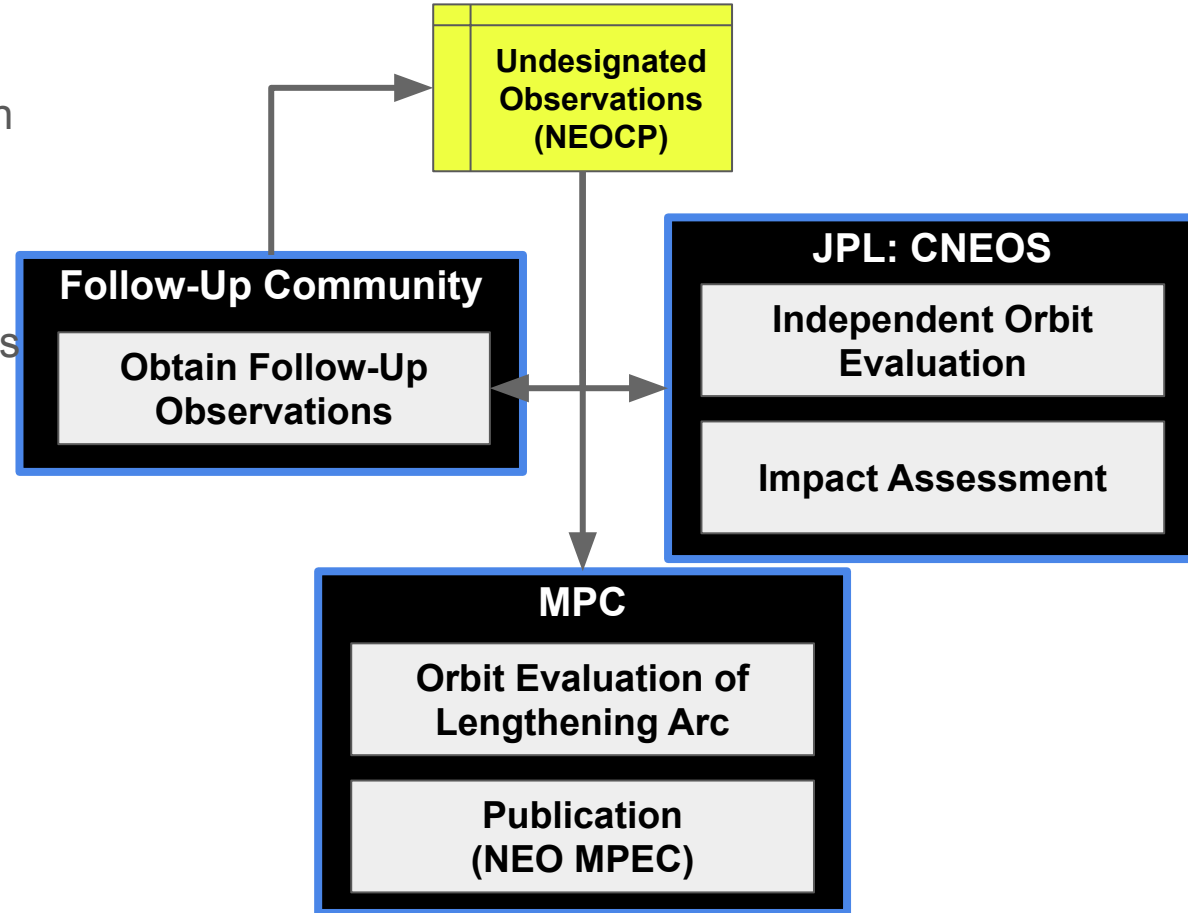


MPC: Planetary Defence (NEOCP)



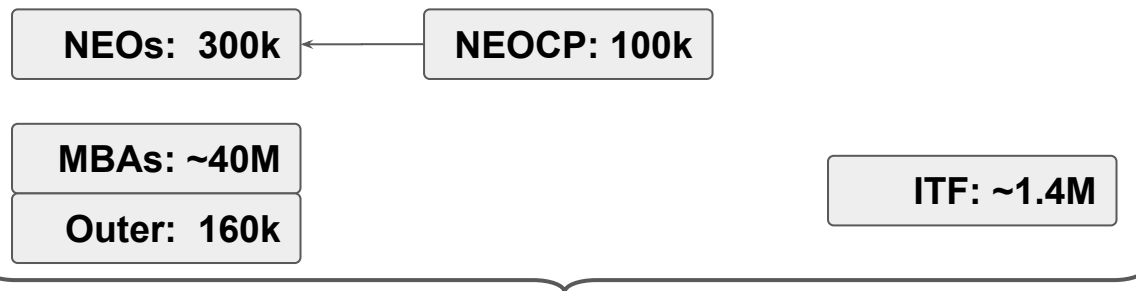
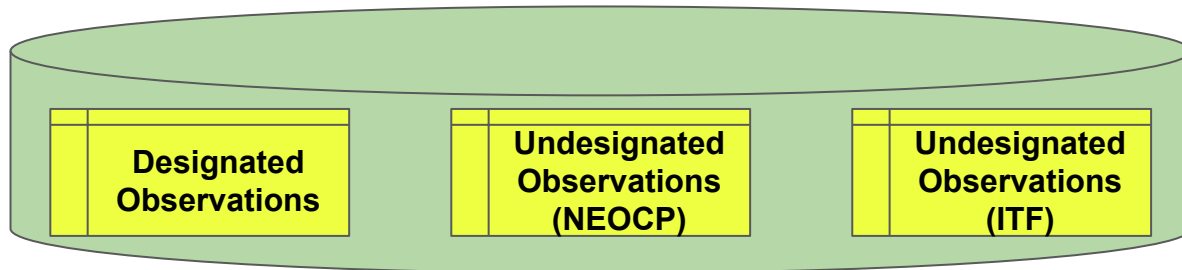
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- NEO Confirmation Page
- Facilitate follow-up & confirmation of new NEOs
- Surveys & Follow-up community submit observations of suspected NEOs
- MPC filters the observations
- Post new-NEO observations to NEO Confirmation Page
- Onto JPL & CNEOS team
- New NEOs are published once orbits are confirmed



MPC: Indicative Statistics

- Observations submitted during 2020
 - 50M
- Total observational data archive through 2020
 - 300M



Active Observations:	42M
Rejected / Remeasured / Duplicates:	8M
Total Submitted Observations:	50M

MPC: Obligations/Requirements



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Planetary Defence Related

- Process and update the NEOCP in near-real time:
 - *Mid 2000s: IAU request to allow orbit computers access to NEOCP data*
- Identify close approaches and possible impacts and alert PDCO, JPL, Pisa:
 - *2008 TC3: suggestion from L. Johnson*
- Identify artificial objects and remove from the NEOCP:
 - *Initially self-motivated, then emphasized by L. Johnson*

General

- Collect Minor-Planet and Comet Observations
 - *IAU Mandate*
- Designate New Discoveries & Issue New Numberings
 - *IAU Mandate*
- Designate Comets
 - *2015: from CBAT*
- Timely Comet MPECs (weekly)
 - *Early/mid 2000s request by Yeomans*
- Communications of service outages
- Interface Change requirements

MPC: Accreted Responsibilities

Planetary Defence Related

- Identify, post, publish NEO Observations daily (< 24 hours from receipt) via DOU or NEOCP:
 - *1997 XF11: put in place to allow other orbit computers to compute impact probabilities*
- Timely NEO MPECs (< 3 days from discovery):
 - *1993: IAU circulars too slow*

General

- Publish orbits in “Daily Orbit Updates”, and observations and orbits weekly/monthly
 - *MPCs (1947+) or MPS (1997+), MPO (2000+)*
- Identify main-belt asteroids in incoming batches and update orbits for known objects
- Accept and publish identifications from outside orbit computers.

MPC: Future Requirements



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Planetary Defence Related

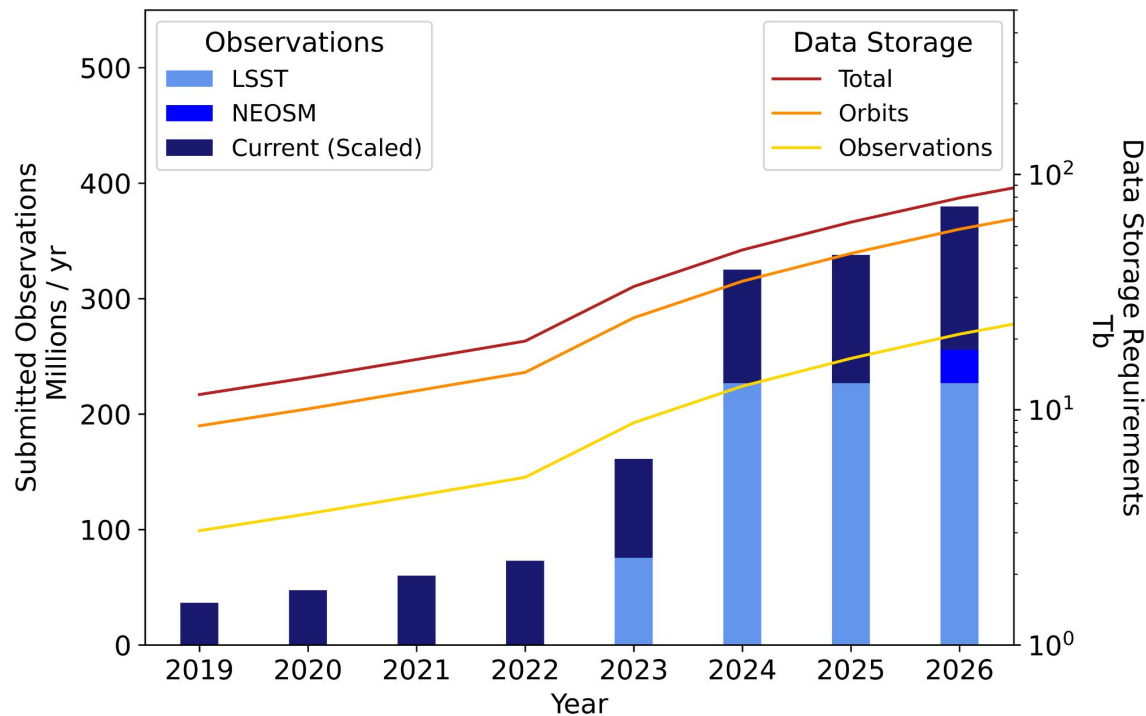
- MOU with VRO:LSST
 - *Turn around data in ~12 hrs*
 - *Perform orbit-fits, for both known and newly-discovered objects.*
 - *Includes all new NEOs*
- Likely updated MOU with NEOSM
 - *More detailed specification of requirements in line with VRO*
- Likely MOU with JPL

General

- Improved, Flexible Access to Data
 - Replicate DB
 - Provide API Access

MPC: Data Forecasts

- Linear Growth from current surveys:
 - 50M obs in 2020
- LSST Operations:
 - Late 2023
 - 2024: 225M obs/yr
- NEOSM Operations:
 - 2025 / 2026
 - ~30M obs/yr
- Nightly Variations drive Processing Requirements



MPC: Challenges & Opportunities



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Challenges

Increased Submission Volumes

Increased Resubmission Volumes
(Accidental: Open Archives)
(Deliberate: Remeasurements)

Growing Volume of Unattributed Survey Tracklets

Solutions

Restructure pipeline queues:

- Baseline processing on local servers
- Peak load processing using AWS.

Automated handling of all duplicates & near-duplicates

- Observations
- Tracklets

Heliocentric -Linking algorithm:

- Development, refinement & deployment
- Highly efficient

Opportunities

- Simplified pipeline structure & operation
- Reduced dependency on “labelling” by submitter
- Significant reduction in average FTE “touches” per submission
- Homogeneous processing of all submitted data
- Homogeneous, validated data products

MPC: Challenges & Opportunities



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Challenges

Inefficient Ephemeris & Attribution Software

Responding to Evolving Community Requirements

Solutions

New Algorithmic and Data-Storage Solutions

- Orbital representation using Chebyshev Polynomials

Incorporating Community Feedback

- User Group
- System Review Panel
- Data Challenge Week

Opportunities

- Significantly faster *attribution* services (mpchecker, etc)
- Accelerated development schedules
- Access to gifted community members (incl. Contractual work)

- Proposal due June 7th:
 - MPC sub-award within SBN proposal
 - Budget period 2022 - 2026
- Requested modest increase in supported MPC FTE:
 - +1.5
- Propose to:
 - Continue operations, satisfying all current requirements and future MOUs
 - Continue significant development of pipeline and infrastructure:
 - Database Centered Operations
 - Robust Pipeline with Local & Cloud Components
 - Staged deployment ahead of key deadlines (LSST & NEOSM)

MPC: Development Schedule



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