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Time Domain and Multi-Messenger Astrophysics General Observer Facility Implementation Study Terms of Reference

Goddard Space Flight Center
Greenbelt, Maryland

National Aeronautics and
Space Administration

Time Domain and Multi-Messenger Astrophysics General Observer Facility Implementation Study Terms of Reference Signature/Approval Page

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1 BACKGROUND

Driven by the exciting firsts of 2017 – the first coincidence of a gravitational wave (GW) event, GW170817, with a short gamma-ray burst (GRB) and the first strong indication of an association between an astrophysical neutrino, IceCube-170922, and an active galactic nucleus (AGN), TXS 0506+056, the new capabilities encompassed by Time Domain and Multi-Messenger Astrophysics (TDAMM) were called out by the Astro 2020 Decadal Survey[1] as the highest-priority sustaining activity in space for the coming decade. Much time domain and multi-messenger science can only be performed using space-based assets, thus creating a unique opportunity for NASA contributions. The Decadal Survey recognized that to "advance this science, it is essential to maintain and expand space-based time-domain and follow up facilities in space." For NASA to meet the vision outlined in the Astro2020 report it must invest in the infrastructure needed to enable multi-messenger and time domain astronomy discoveries.

As was recognized by Astro2020, a "suite of space-based electromagnetic capabilities [is] required to study transient and time-variable phenomena." Numerous currently operating facilities that contribute to time-domain science are working to improve how they serve the time-domain astronomy community and expand how they can work collaboratively with other space and ground-based observatories. However, up until this point these collaborations between facilities have been bilateral and coordination has generally been on an ad-hoc basis. This can lead to a failure to capture rare and exciting scientific opportunities arising from transients whose brightness fades on time scales of seconds to days, depending on the facilities required to observe them. In 2019, NASA commissioned a Gravitational-Wave Electromagnetic (GW-EM) Task Force to assess the status[2] of community resources. The study found that the extent to which observatories collaborate is inconsistent, is not especially well coordinated, and does not currently serve the science community as well as it could. A Guest Observer Facility that coordinates multi-facility time-domain observation, supports astronomers' needs for data access and analysis across NASA missions, and streamlines the relevant proposal process would better serve NASA and the science community.

A recent workshop[3] on the scientific opportunities afforded by TDAMM was held in Annapolis, MD, August 22-24, with nearly 200 attendees in person and robust participation by another 150 attendees online. The workshop demonstrated the level of excitement in the community for opportunities to coordinate across instruments and wavelengths and across space and ground. A session on TDAMM infrastructure – communications systems, data archives – showed that dedicated consideration of how to robustly ensure we have the capabilities to respond rapidly to rare but vital transient events is needed and new structures may need to be built to enable broad access to these capabilities for the entire astrophysical community.

General Observer Facilities (GOFs) exist to support the science community in using NASA's space-based observatories. GOFs implement community engagement, science prioritization and proposal selection processes. Additionally, GOFs provide organizational, financial and technical

[1] https://www.nationalacademies.org/our-work/decadal-survey-on-astronomy-and-astrophysics-2020-astro2020
[2] http://1https/pcos.gsfc.nasa.gov/gw-em-taskforce/gw-em-taskforce.php
[3] https://pcos.gsfc.nasa.gov/TDAMM/

resources to improve the effectiveness and efficiency of scientific investigations involving NASA observatories. Although existing GOFs support some joint observation programs, NASA's GOFs have been primarily organized to support investigations involving single observatories. Furthermore, rare and time-sensitive TDAMM science cases involving multiple observatories require a greater degree of collaboration and coordination than can be achieved by existing GOFs.

2 PURPOSE & SCOPE

In accordance with the recommendations of the Senior Review and the approved PPBE24 submission, the purpose of this study is to investigate and develop architecture concepts, top-level requirements, schedule, cost estimates and implementation strategies to realize a TDAMM GOF.

The study shall consider the organizational, programmatic and technical issues needed to:

1. Define and sustain TDAMM community engagement, science proposal and award process(es),
2. Interface with participating missions and infrastructure systems to coordinate and execute TDAMM observations, and
3. Interface with existing archives to provide a readily available registry of all TDAMM-related astronomical events.

Execution of the study scope is decomposed into three sequential phases. Phase 1 is focused on planning the implementation of TDAMM GOF initial operating capabilities for NASA assets. The subsequent phases will examine the needs and possible coordination mechanisms between the TDAMM GOF and other United States domestic (non-NASA) assets (Phase 2) and international space or ground-based assets (Phase 3).

3 ASSUMPTIONS

The study will operate under the following assumptions:

Operational Schedule – Initial staffing of the GOF beginning FY24, Phase 1 (NASA assets) operations beginning FY26, and, to the extent warranted by the study, Phase 2 (other US assets) coordinated operations beginning FY27, Phase 3 (international assets) coordinated operations beginning mid FY28.

Budget – An initial budget for the Phase 1 study was approved as an overguide in PPBE24. The study milestones are aligned to provide recommendations for Phase 2 and 3 of the study and for the TDAMM GOF implementation.

International Partnerships –The scope of concerns associated with establishing and sustaining international partnerships will be addressed in Phase 3 of the study.

Data Policy – To the maximum extent practical, all data acquired under the purview of the TDAMM GOF call for proposals will become available to the public immediately, in accordance with NASA's accessibility and inclusion objectives.

4 COMPOSITION OF THE STUDY TEAM

In addition to the study scientist and study manager, the Physics of the Cosmos Program Office shall provide expertise and support in systems engineering, technology development, program management and financial management. A diverse set of study contributors shall provide inputs to the study team. Contributors with subject matter expertise including but not limited to the following areas shall be identified:

- Time domain and multi-messenger astrophysics, including mission guest observer facility operations and science user support functions
- Ground/space communications networks, particularly for time-sensitive data flows
- Science ground segment / data center / archive operations
- Science Program / Project management

The team may consult with additional subject matter experts as needed.

5 STUDY CONDUCT

The study manager is responsible for ensuring that study activities and work products are consistent with NASA program management, systems engineering and Lean Six Sigma procedures and methods, as appropriate or required.

Phase 1 of the study will execute the following tasks.

Task	Definition	Activities	Completion Milestone
1	Establish a study team.	a) Preliminary scope definition and refinement meetings with program and headquarters stakeholders, as needed. b) Initiation of weekly team meetings and collaboration tools setup.	Terms of Reference Signed and Validated
2	Execute study scope.	a) Weekly and as-needed status and feedback meetings with study team, program, and headquarters stakeholders. b) Preparation of draft study report materials.	Draft Study Report Delivery
3	Conduct peer review.	a) As-needed meetings with program and headquarters stakeholders to select and establish an independent review team. b) Conduct peer review.	Review Team Findings Delivery
4	Finalize Study Report.	a) Address review team findings. b) Prepare final report materials.	Final Phase 1 Report Delivery

6 STUDY DELIVERABLES

The study shall deliver a report and supporting materials with the following content:

1. A set of top-level requirements and architecture concept models for a TDAMM GOF.
2. Processes for TDAMM community engagement, proposal solicitations and awards.
3. A motivating set of TDAMM science cases and an analysis of the associated agreements, tools, process flows and interfaces necessary to support those cases.
4. One or more implementation strategies for the Phase 1 TDAMM GOF to achieve an initial operating capability by FY26.
5. A best-value recommendation for a particular implementation strategy if more than one option is evaluated.

7 SCHEDULE

This study will commence in late fiscal year 2022 with a team kickoff planned for October. The goal is to provide draft findings in sufficient time to inform PPBE25 in Spring 2023 and be ready to begin implementing the GOF in FY24.

Consistent with the PPBE24 submittal, the planned study schedule is as follows:

- Team selected and oriented no later than 14 October 2022
- Preliminary findings to be completed by 31 January 2023
- PPBE25 budget request submitted by 1 April 2023
- Draft study report delivered by 30 June 2023
- Study Review Team findings delivered by 31 July 2023
- Final recommendation of plans for GOF implementation delivered to NASA by 31 August 2023

If necessary, any revisions to this schedule will be negotiated with program and headquarters stakeholders.

8 SUNSET

The Phase 1 study team will be disbanded following delivery of the final study report and closeout of associated actions, if any. Study teams shall be formed to address the scope of subsequent phases according to the tasks detailed in Section 5. The Terms of Reference shall be updated as needed throughout the three sequential phases of the study.

9 APPENDIX A Abbreviations and Acronyms

AGN	Active Galactic Nucleus
GOF	General Observer Facility
GRB	Gamma-ray Burst
GW	Gravitational Wave
GW-EM	Gravitational-Wave Electromagnetic
TDAMM	Time Domain and Multi-Messenger Astrophysics