



ACROSS

ENABLING TIME DOMAIN AND MULTI-MESSENGER ASTROPHYSICS



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Background

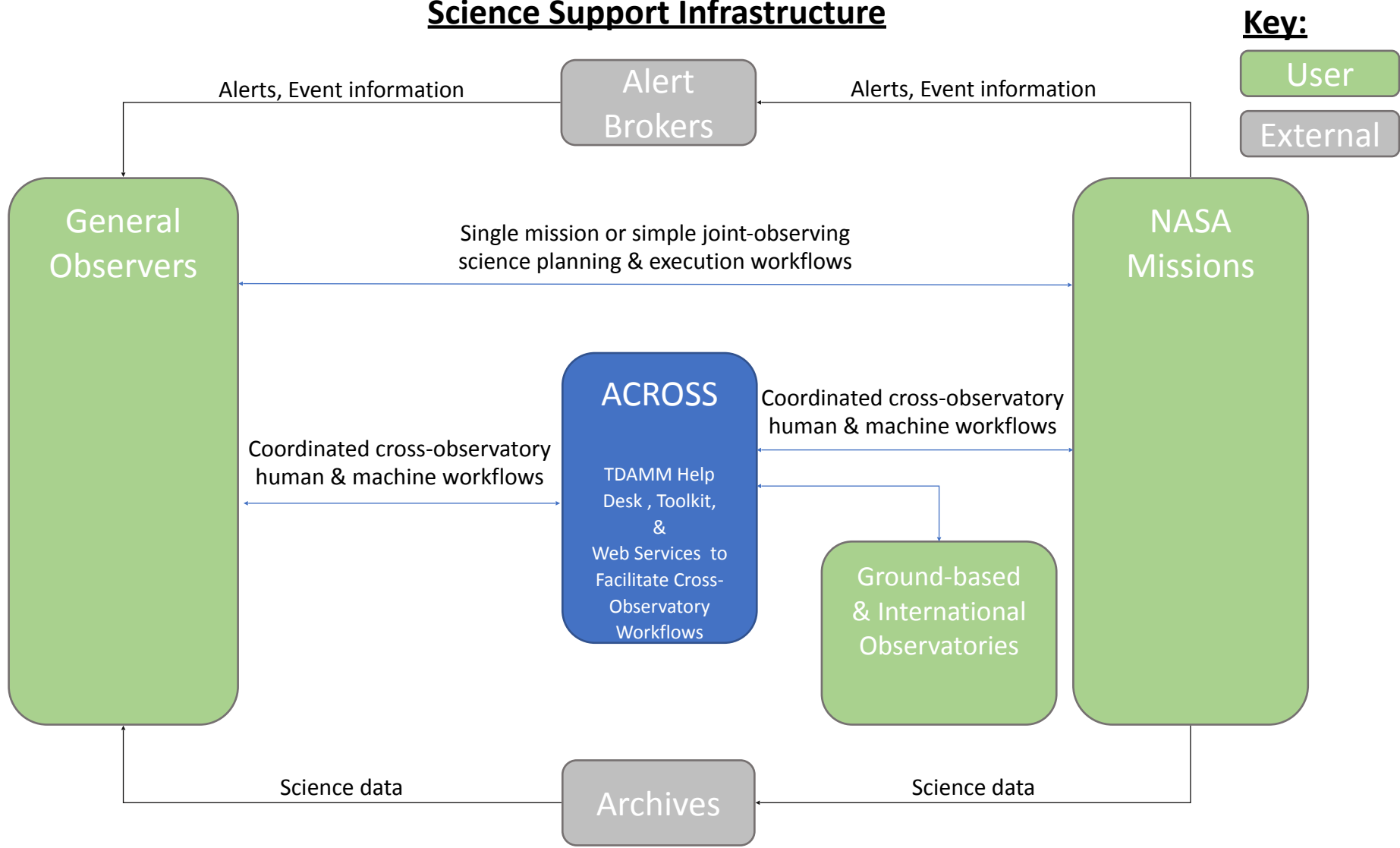
- **The PhysCOS Time-Domain and Multi-Messenger (TDAMM) Initiative responds to a top priority of the Astro2020 decadal report recommendation and has been tasked with:**
 1. Organizing or supporting **TDAMM workshops**,
 2. Conducting a three-year **TDAMM Study** investigating policy, processes and technical coordination mechanisms to enable TDAMM science, and
 3. Recommending one or more potential implementations for enabling TDAMM science support.
- **The Astrophysics Cross-Observatory Science Support (ACROSS) pilot project is an outcome of the first year of the TDAMM study, which identified needs for:**
 1. Software & data systems to facilitate TDAMM science workflows,
 2. TDAMM help desk to provide expertise & facilitate coordination, and
 3. TDAMM community grant program to incentivize scientific innovation.



High-Level Architecture: Future-State Context Diagram



Science Support Infrastructure





High-Level Architecture: Future State Context Diagram

Science Support Infrastructure

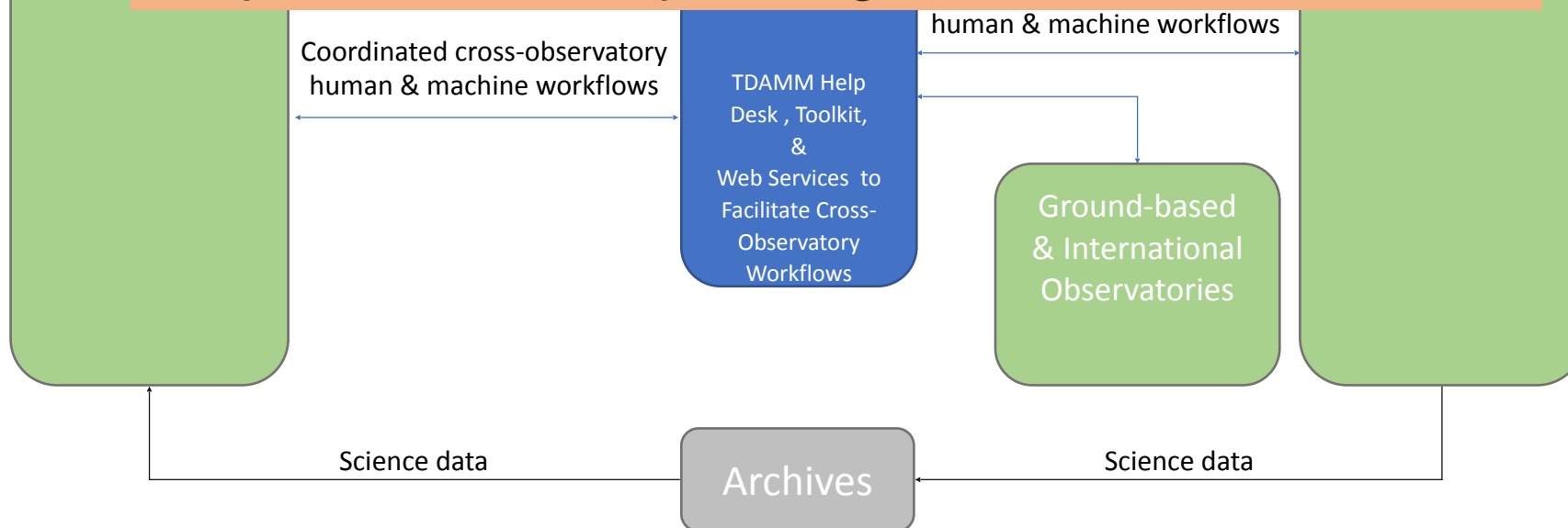
Key:

User

External

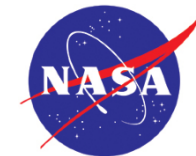
Observatory Workflow Status Data Feeds

- Live feed of NASA observatory status parameters relevant for TDAMM science planning & execution (e.g. observing plans).
- API access to easily incorporate into Observer and Operations Team planning & execution tools.





High-Level Architecture: Future State Context Diagram



Science Support Infrastructure

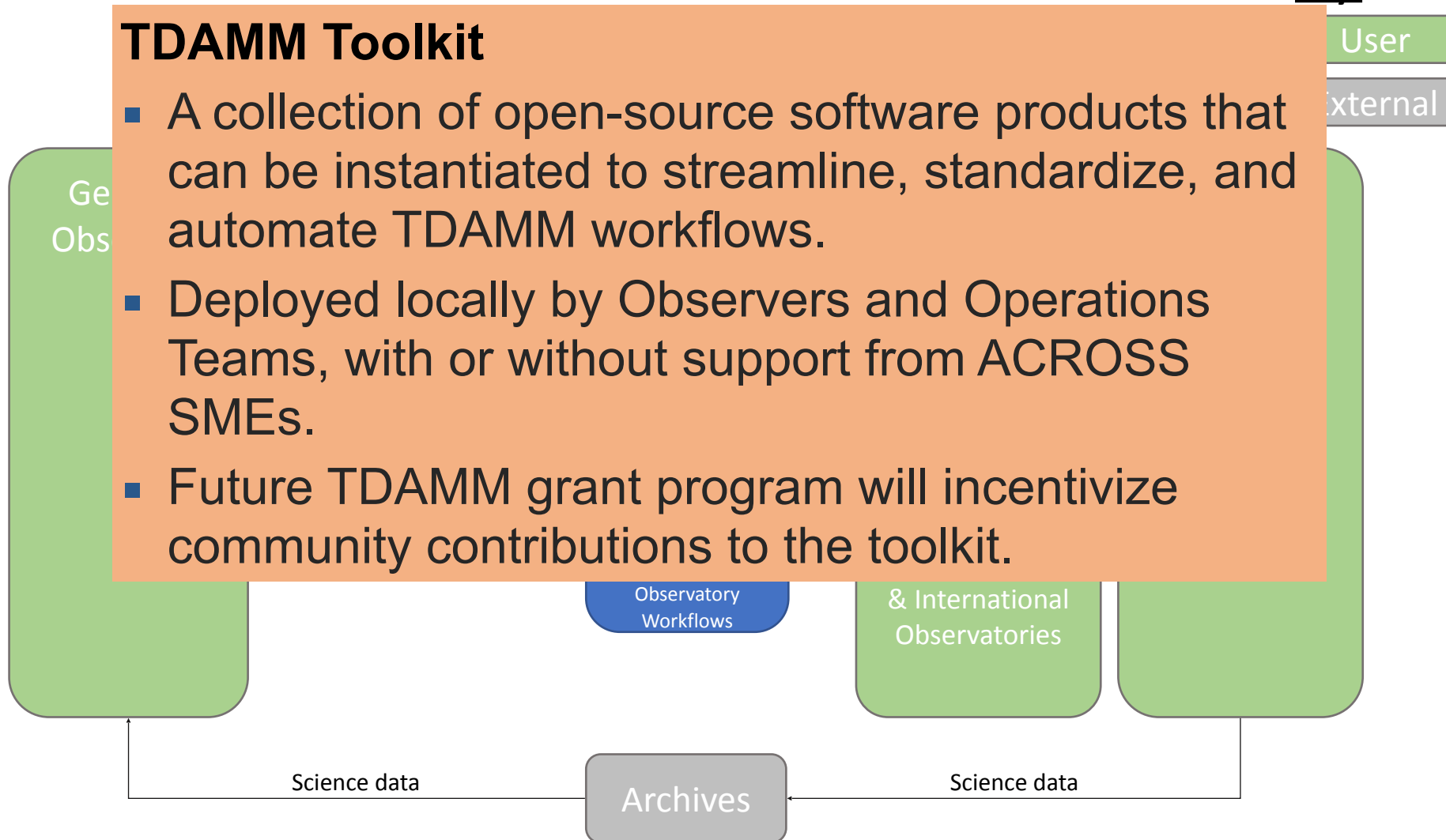
Key:

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TDAMM Toolkit

- A collection of open-source software products that can be instantiated to streamline, standardize, and automate TDAMM workflows.
- Deployed locally by Observers and Operations Teams, with or without support from ACROSS SMEs.
- Future TDAMM grant program will incentivize community contributions to the toolkit.





High-Level Architecture: Future State Context Diagram

Science Support Infrastructure

Key:

User

External

TDAMM Web Services

- Accessed through our portal
- Organizes and displays status data feeds
- Services are cloud-hosted, with human and machine interfaces, and provide:
 1. Science Situational Awareness Multi-observatory follow-up planning & feasibility analysis tools (REST API + VO Interfaces).
 2. Follow-up hub for, e.g., ToO requests
 3. Follow-up decision support & recommendations

Ge
Obs

Science data

Archives

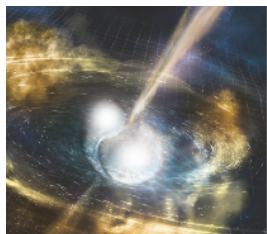
Science data



ACROSS: Key Progress So Far

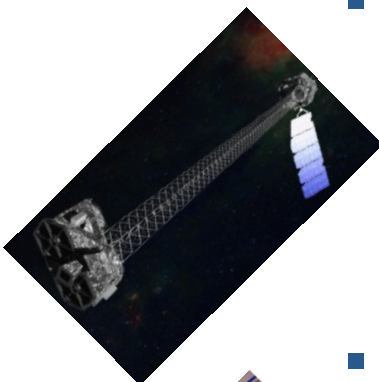
- **Pre-coordinated gravitational-wave follow-up plans among current NASA X-ray missions and XMM-Newton during the LVK O4 runs.**

Established an O4-follow-up Slack channel for rapid science team coordination.
Demonstrates a value-added function provided by an ACROSS TDAMM Help Desk.



- **Established interfaces to receive NuSTAR near-future/recent-past observing plans**

Fills a gap in science situational awareness for both observers and science teams.
Serves as a pathfinder for how ACROSS manages and implements value-added interfaces with current NASA mission science teams and systems.



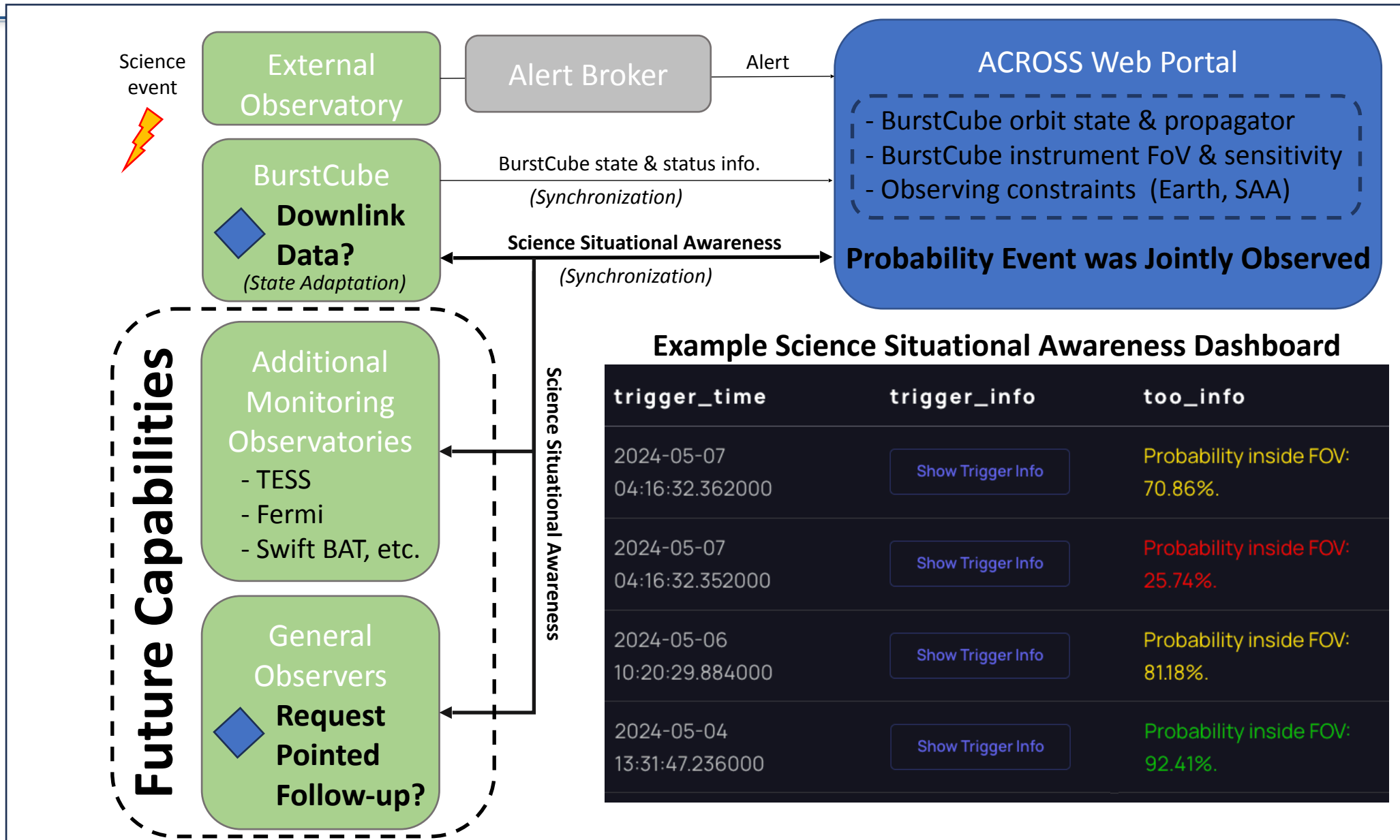
- **Developed a Minimum Viable Product TDAMM web service for BurstCube**

Supports reprioritization and downlinking of priority science event data.
Serves as a pathfinder for how ACROSS manages and implements value-added interfaces with in-development mission science teams and systems.





Example workflows for complex science cases



Example Science Situational Awareness Dashboard

trigger_time	trigger_info	too_info
2024-05-07 04:16:32.362000	Show Trigger Info	Probability inside FOV: 70.86%.
2024-05-07 04:16:32.352000	Show Trigger Info	Probability inside FOV: 25.74%.
2024-05-06 10:20:29.884000	Show Trigger Info	Probability inside FOV: 81.18%.
2024-05-04 13:31:47.236000	Show Trigger Info	Probability inside FOV: 92.41%.



ACROSS: Next Steps

- **Complete the NASA open-source software release authorization process.**
 - Intent of ACROSS is to make all code available on GitHub, encouraging user involvement in development, and enhancing code reuse opportunities.
- **Acquire a permanent web domain name.**

Will enable publishing our web portal at a convenient, easy-to-remember location (we know what this will be, but can't tell you yet! Red tape!)
- **Incorporate state/status data streams from NASA missions.**
 - NuSTAR, Swift, NICER, IXPE and TESS all in immediate roadmap. Missions supporting VO protocols will be automatically included.
- **Continue developing ACROSS API and web portal.**

API provides direct access to available data streams for integration into observer or mission workflows.

Web portal will provide state/status visualization and central clearinghouse for information.



Study Year 2: Coordinating with U.S. Ground Assets



- **Objectives:**

- **Assess the landscape of infrastructure efforts among the ground-based community.**

- **Understand what information from the NASA fleet needs to be exposed to the ground-based community and vice versa.**

- **Discuss what tools, platforms, or services can be shared or co-developed between NASA and the ground-based community.**

- **Tasks & Status:**

- **Participated in the NOIRLab-hosted Windows on the Universe: Establishing the Infrastructure for a Collaborative Multi-messenger Ecosystem workshop and white paper.**

- **Using the white paper recommendations to inform the TDAMM GO Program design.**

- **Meeting with developers of widely used ground observatory software infrastructure tools (TOM Toolkit, SkyPortal, YSE PSE, AEON) to understand workflows, options for interfacing ACROSS data streams and web services.**

- **Meeting with observers to survey user experience of coordinating observing campaigns between ground and space assets.**

- **Holding monthly meetings with the ACROSS Advisory Group to provide status and receive feedback.**



Summary

- **The Astrophysics Cross Observatory Science Support (ACROSS) pilot project was developed as a result of the 1st year of the TDAMM study.**
- **ACROSS's objective is to partner with observers and science teams to provide services and infrastructure that enable the full potential of time domain and multi-messenger (TDAMM) science.**
- **The study continues, to understand how this coordination can extend to ground-based and international observatories.**
- **What we're developing:**
 - TDAMM Toolkit & API sharing observatory state and status information, observing plans, observability constraints, and target of opportunity (ToO) request pages.
 - Web Portal: links to tools, ToO requests, funding opportunities, conferences, and Events of Interest pages.
 - TDAMM Research Announcement: Initial call targeted for 2026, subject to availability of funds.
 - Community support: help desk, documentation, tutorials, and workshops.



Feedback welcome! We want to make ACROSS as useful as possible!