SCIMMA: Real-time Orchestration of Multi-Messenger Astrophysical Observations

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SCIMMA

The goal of SCIMMA is to enable discovery of some of the most rare and exotic astrophysical events such as kilonovae. Our team is developing the cyberinfrastructure to support real-time alerts and analysis from heterogeneous data streams by global teams.

Hopskotch at the heart of an *ecosystem*

Exchange of data is at heart of MMA, and the nascent field needs low-latency, identity and access management (IAM) and the ability to deal with bursts of data, with a stable archive. Hopskotch [1] is the SCIMMA Kafka-based pub-sub system that:

1. Consumes & can post to GCNs [2], TNS [3], etc
2. Is accessible via *hop-client* python (https://github.com/scimma/hop-client) library, with tutorials & documentation (https://hop-client.rtfd.io)
3. Provides high-uptime, low-latency, and scaling for high-throughput via AWS cloud
4. Archives messages + soon provides DOIs and integration with a science-platform https://explore.archive.scimma.org/
5. Is used by LIGO-Virgo-Kagra gravitational wave observatories for igwn-alert, both internal communication and external alerts
6. Can be extended with new front-ends and interactions e.g. HERMES, Treasure Map, TOMs, to serve more users

Engagements Case Study: SNEWS

SCIMMA worked with SNEWS [5] to implement new internal messaging system ("SNEWS 2.0") for their detector network, based on Hopskotch:

1. Integrated SNEWS and SCIMMA software engineers into a min-Scrum for 2 months
2. Produced working SNEWS 2.0 system with Hopskotch
3. Runs with entirely distributed components (via remote installations and cloud servers)
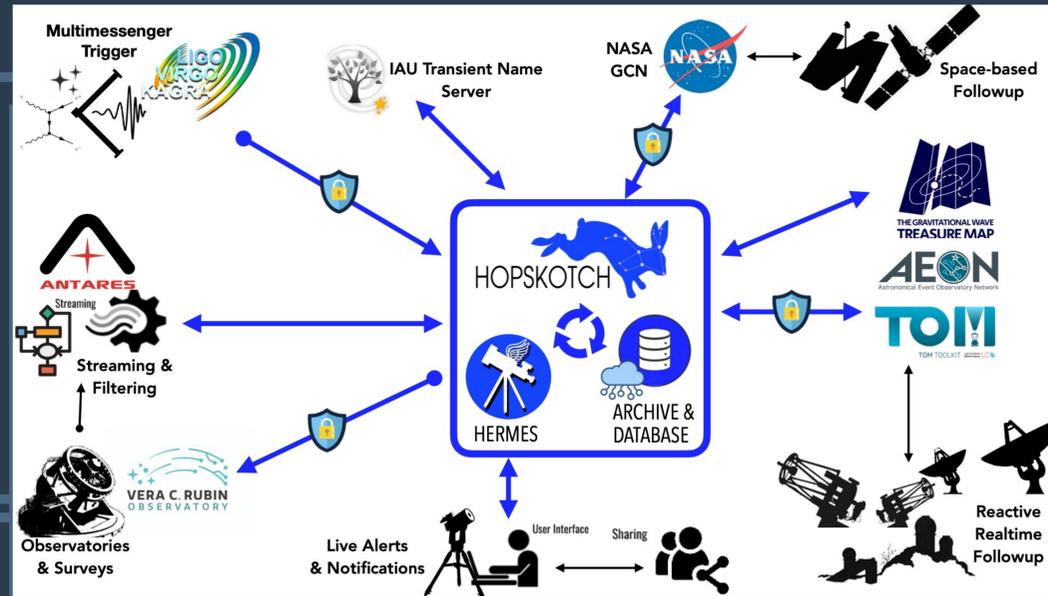

Fig. 1: The SCIMMA ecosystem (Above) connects experiments & surveys with users and teams, providing real-time alerts, archiving analysis services, and connections to follow-up facilities

Case Study: Target and Observation Managers (TOMS) and the Treasure Map

SCIMMA is working with other groups to build an ecosystem for MMA
• an open-source TOM Toolkit has been released by LCO [5].
• SCIMMA contributing alerts support for MMA search and follow-up to enable groups to coordinate, schedule and annotate observations
• once formed, collaborations will be able to instantiate and tailor the TOMS stack and integrate it with the SCIMMA IAM system
• HERMES allows smaller groups to report observations in real-time to Treasure Map[6]/TNS/GCN with a single web-interface.

Fig 2. (Below) The HERMES GUI allows users to submit messages, as well as browse the archive of all sent messages, providing human- and machine-readable versions. Integrating this user-reported follow-up is critical for identifying the EM counterparts of GW events and coordinating followup with Treasure Map (Right)

HERMES

Hopskotch is designed with features for large surveys and experiments in mind. The Hopskotch Enabled Real-time Message Exchange Service (HERMES, https://hermes.lco.global/) is built on Hopskotch, and provides a simple web-based GUI to allow small teams or individuals to report MMA observations.

1. HERMES webform converts uploaded data into a form that is both human-readable and machine-parseable
2. Data validation for all fields prevents issues with freeform text as on e.g. NASA/GCN
3. Submit to IAU's Transient Name Server, NASA GCN, Treasure Map etc with a single click from one end point
4. Large messages including image or spectroscopic data, store payload in archive with URL retrieval.

References

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