Design, Build and Test of the VOEvent network for the SVOM Chinese Ground Segment

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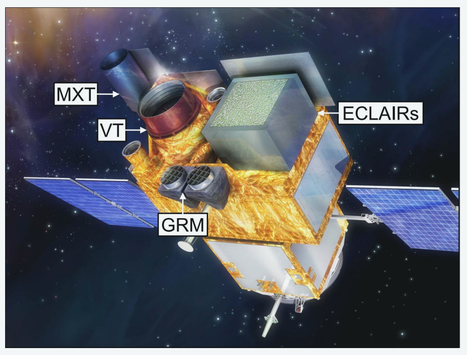
The SVOM mission

The Space-based multi-band astronomical Variable Object Monitor (SVOM) is a collaborative project between China and France dedicated to the detection, localization and study of ~60 Gamma Ray Bursts (GRBs) per year and other high-energy transient phenomena. SVOM is planned to be launched in 2021, with a life of 3-5 years.



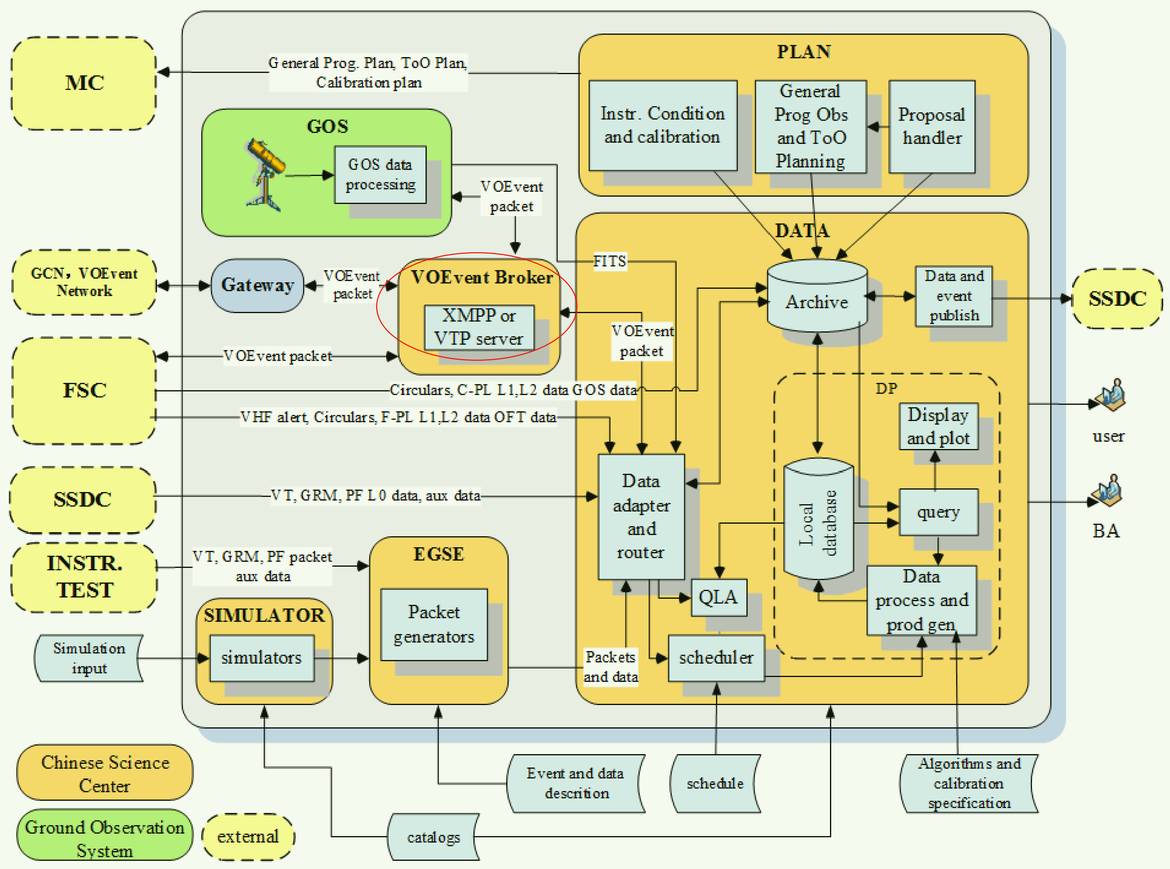
Payloads

- X-/gamma-ray camera(Eclairs)
- Gamma-Ray Monitor(GRM)
- X-ray Imager for Afterglow Observation(MXT)
- Visible Telescope(VT)

Ground facilities

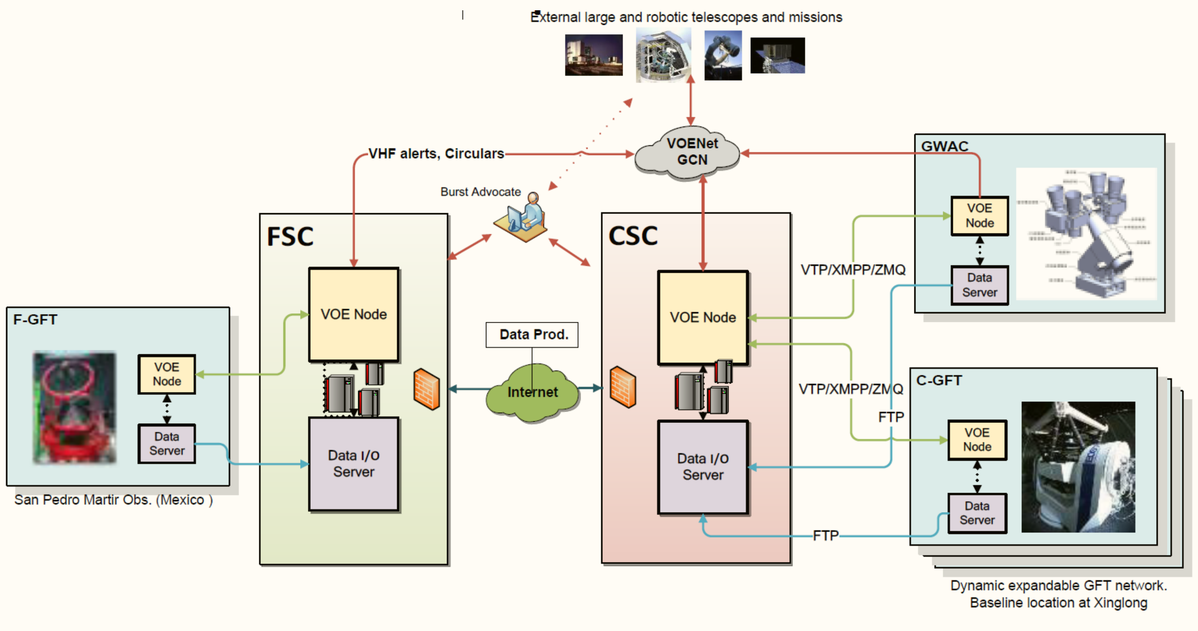
- Chinese ground follow-up telescope (C-GFT)
- French ground follow-up telescope (F-GFT)
- Ground Wide Angle Cameras (GWAC)

SVOM CSC architecture



SVOM Chinese Science Center (CSC) is being designed to offer guaranteed follow-up capabilities, quick reaction time, a flexible architecture for science teams who are grouped to act as Burst Advocates. This unconventional science center is to meet the formal requirements of not only the SVOM observation programs bur also the need of the community as time-domain astronomy enters a rapidly expanding period.
The diagram above shows the technical scheme of the SVOM Chinese science application system. It contains a lot of modules and have complicate logistics, note is the ground alert distribution subsystem showing within the red circle, that is the VOEvent broker, which is an interface between Data reduction subsystem and the global VOEvent network and French Science Center.

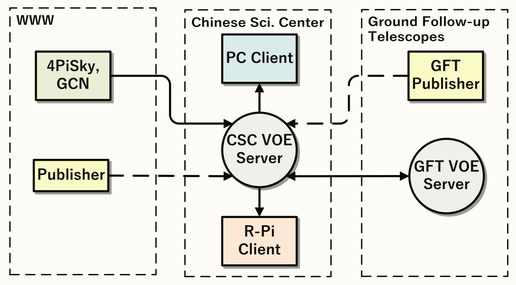
VOE and data interfaces involving GFTs



CSC and FSC play equipotent role in the architecture, having VOE/data link with their GFTs, respectively. Burst Advocates use a software platform to process data with the support of FSC or CSC. Both SCs, GWAC and BA have connection with global VOEventNet/external robotic telescopes. Our potential GFTs include a 1.2m telescope in Changchun, a 1m telescope in Xinjiang, as well as LCOGT. We welcome more telescopes to be involved.

Prototype network based on VTP

Our prototype VOEvent network is based on *Comet*, an open source software implementation of VTP. Comet provides a mechanism for fast and reliable VOEvent distribution. Scalable and flexible due to the tree topology and the software consistence.

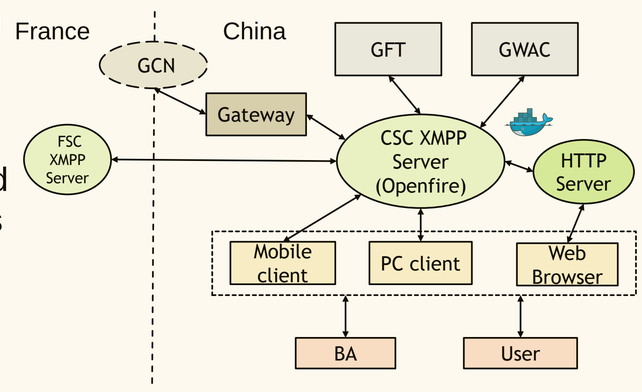


Raspberry Pi is a low cost, credit-card sized computer based on ARM. It provides enough performance to serve as brokers or filters in the network to select events for different science cases. We also use Docker container for fast distribution.

Prototype network based on XMPP

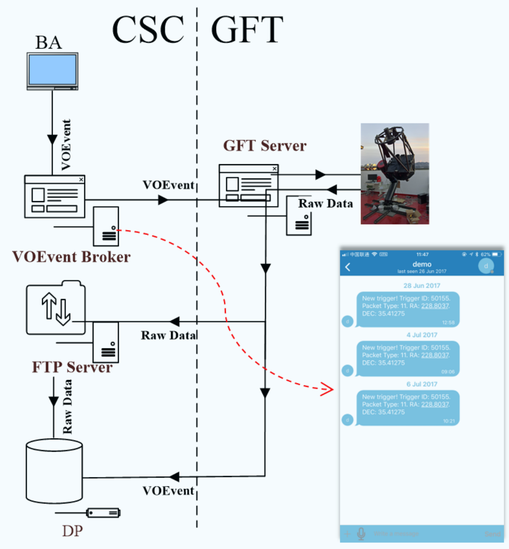
Compared with VTP, there are various alternatives cross-platform clients based on XMPP, even on mobile devices. Besides, the payload on a XMPP network is not limited to VOEvents, but also can be in other formats like text messages and pictures. Given these advantages, we carefully design the network structure to satisfy various use cases of different roles.

We use *Openfire Docker container* on the server side of the prototype network, which is an instant messaging and group chat server based on XMPP. Openfire is designed to be a centralized system that serves many clients. It not only forward VOEvents to telescopes such as GFT and GWAC, but also handles interactions between a variety of cross-platform clients, as well as web browsers through an HTTP server. BAs (burst advocates) and users can chat in natural language and sharing information between each other. BA also has the privilege to send VOEvents to telescopes.

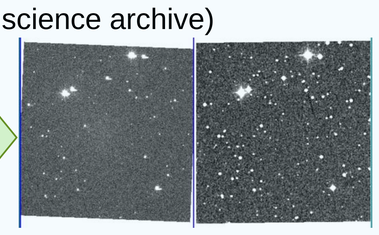


An automatically observation flow

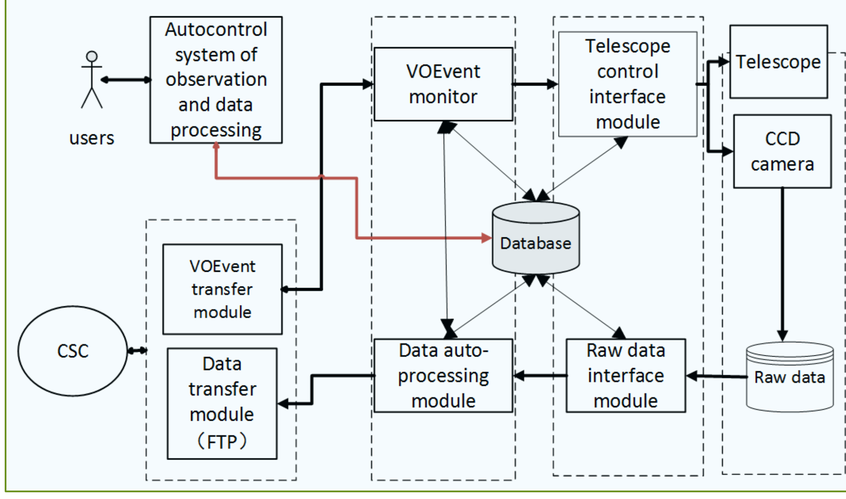
- A trigger is produced and sent from CSC to GFT & BA (through XMPP to mobile clients)
- GFT parse out the trigger information and followed by follow-up observations.
- When each exposure completed, GFT uploads all observational data to the FTP server of CSC, sends a VOEvent right after the transmission to notify CSC the data upload status, so that CSC can retrieve data from the FTP server and archive them into SSA (SVOM science archive) immediately.



- *Left: image produced by GFT*
- *Right: image retrieved from SDSS*



Auto-observation and data reduction framework of GFT



For the interface to CSC, VOEvent module handles the alert messaging with CSC, while data transfer module uploads data products, data file checksum, and processing log to its FTP server for CSC to download and archive.

Future work

- Connect to Swift GS; receive alert about gravitational wave; do follow-up observations and data reduction; send back results
- Test VOEvent messaging & datalink between China and France
- Polish the software interface between VTP and XMPP (collaborate with FSC)

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