

# GCN/TAN: Past, Present & Future Serving the Transient Community's Needs

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SANTA BARBARA, CALIFORNIA

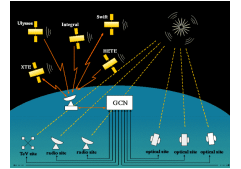


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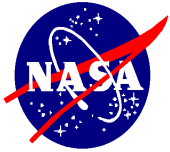


# Basic Functions

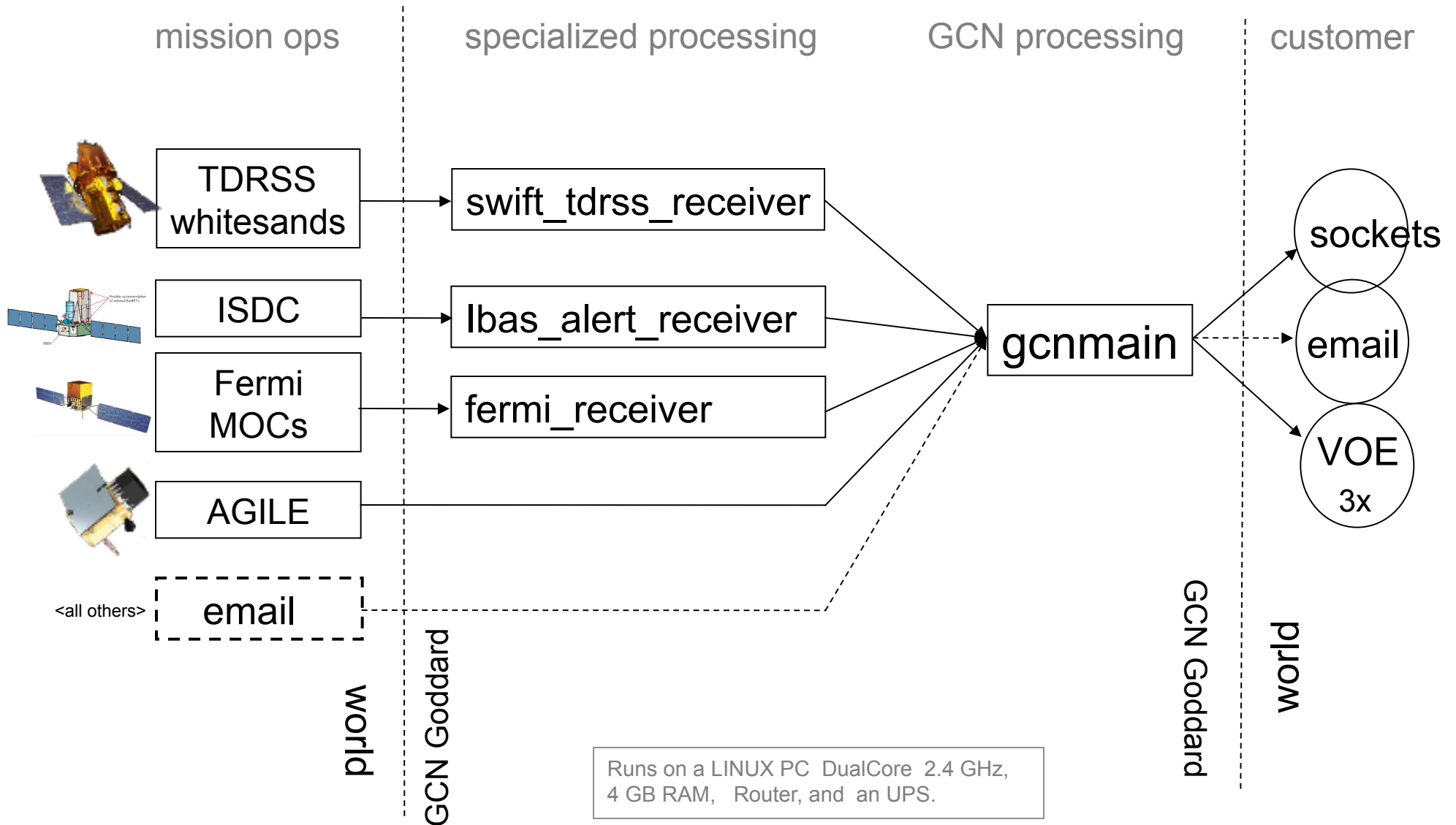
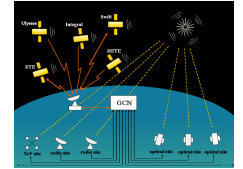


“Collect all transient information from all sources and distribute it in real-time to all who want it.”

- 3 categories of information distributed (on 3 different timescales):
  - Notices – real-time (or as fast as the mission team’s processing produces them). [1 sec - hours]
  - Circulars – descriptions of follow-up observation results. [min-day]
  - Reports – after the dust settles, all the observations, fully calibrated.
- Distribution Methods: VOEvent servers, the original GCN binary socket protocol, and email-based (in 5 levels of amount of content).
- Filtering Methods: Type, Position Error, Time Delay, Intensity, Significance, Confidence Level, RA,Dec regions, Galactic Coords regions, Ecliptic coords regions, Sun distance, Moon distance, Moon phase, Time-of-day window, Local visible, Local night.
- Other Services: GCN provides demo programs for the 3 types of socket connections to GCN. Download them from the website.

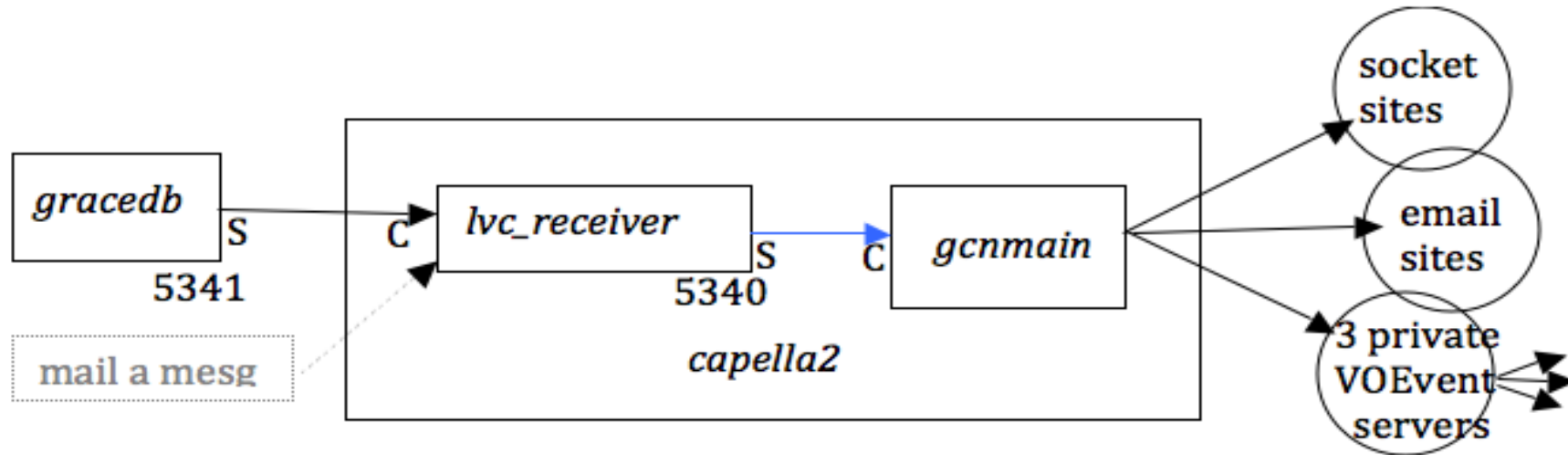
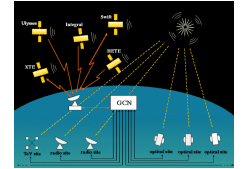


# GCN/TAN Diagram





# LVC in GCN Diagram

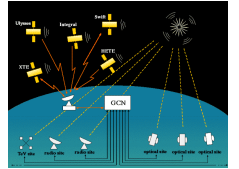


- Status: Basic capabilities were completed March 2014;
- Available in all the regular GCN formats and delivery protocols;
- End2end testing (Feb-May 2015) from *gracedb* to several test recipients of Prelim/Initial/Update Notices from playback of old/sim LVC data (25K notices to date);
- Remaining work:
  - (a) tweaking minor things (e.g. param labels & writing the web pages),
  - (b) setting up the *sites.cfg* entries.





# LVC Specifics (1 of 2)



- LVC Triggers are candidate events from low-latency searches for transients in the gravitational wave data from the LIGO and Virgo observatories.
- Private Phase Operations: Initially there will be a “private” phase of distribution (starting this Fall). Only those people/projects that have signed an MOU with LVC will be allowed to receive Notices and Circulars. Private phase requires an *lvc\_enabled* flag in the GCN config\_file entry (and no anonymous connections on the special VOEvent servers). This private phase will last until there have been 4 confirmed detections.
- Public Phase: Then the distribution will switch to a full “public” distribution phase. Anyone can receive LVC-based Notices and Circulars.

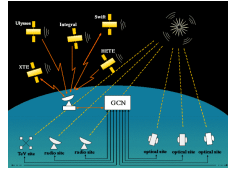


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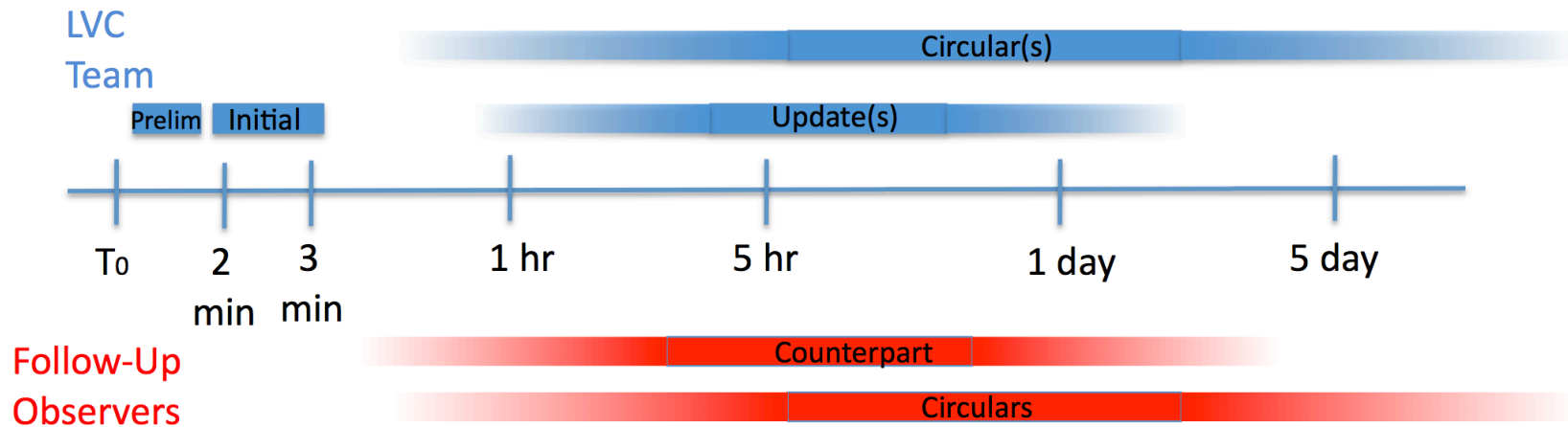




# LVC Specifics (2of2)



- Notice Types: There are 5 LVC-based Notice types defined:
  - Preliminary: Timestamp and parameter values (skymap not yet available).
  - Initial: Location probability skymap now available (T+2-3 min).
  - Updated: Updated skymap (using deeper analysis methods; T+hrs-days).
  - Test: Used for end2end testing.
  - Counterpart: Follow-up observers submit detections of potential candidates.
- Retractions available on all types.

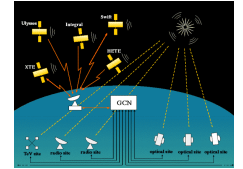


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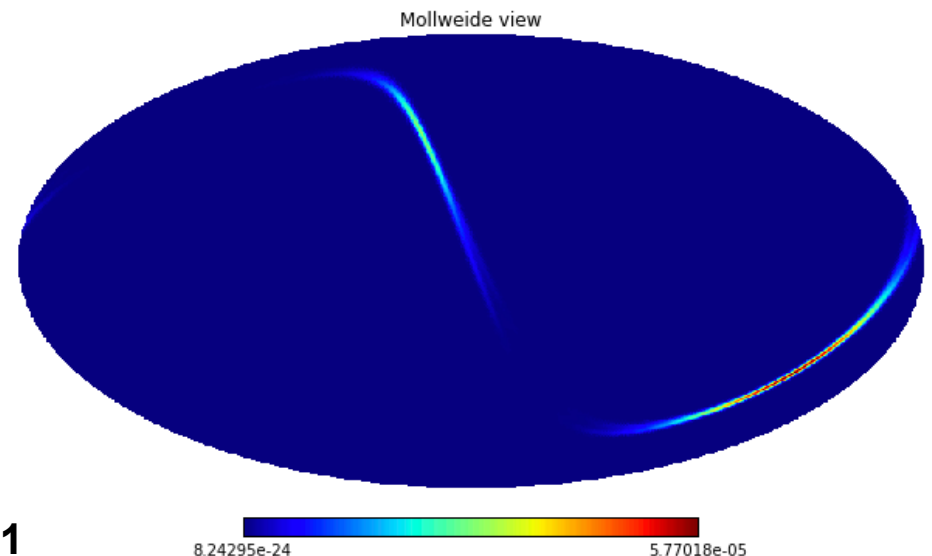
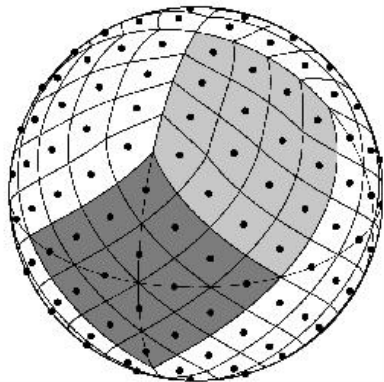




# LVC Notice Content



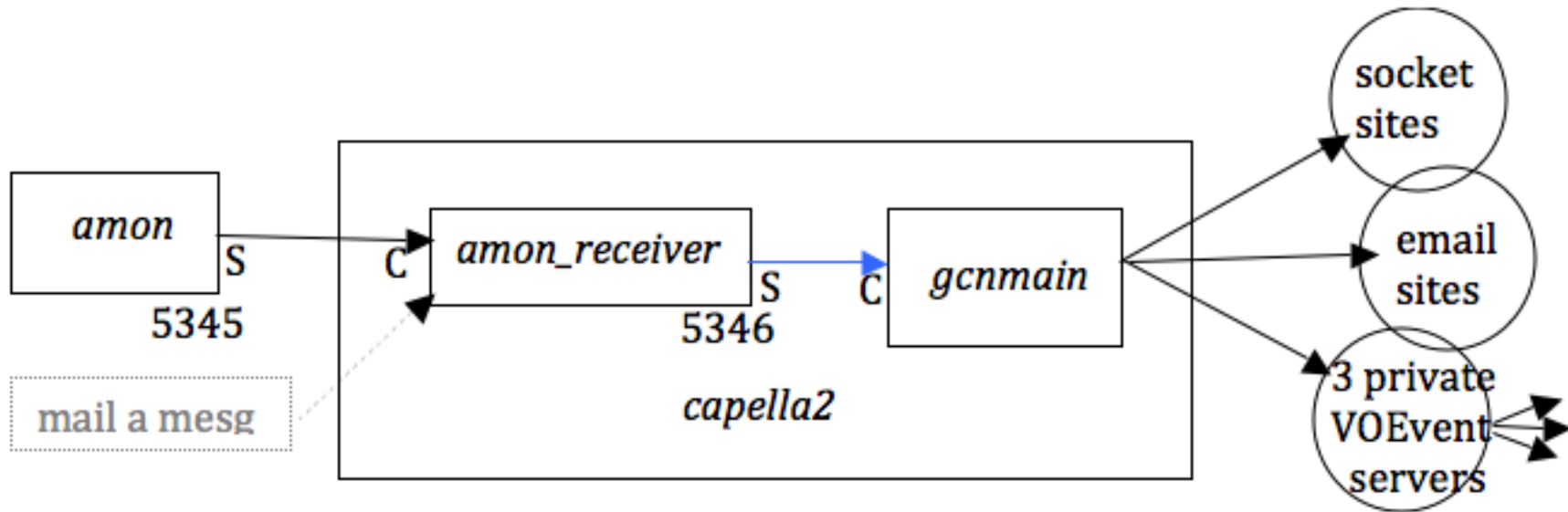
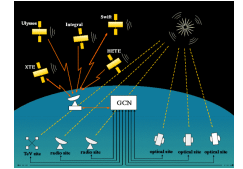
- Triggrr\_ID\_number (and a prefix letter: 'G', 'M', & 'T'),
- Trigger\_date\_time,
- Group (CBC or Burst) and Pipeline (gstlal-svd, gstlal-iir, mbta),
- Search (lo-mass, hi-mass),
- False Alarm Rate,
- Chirp\_mass/Eta/Max\_distance or Fluence/Peak\_freq/Duration,
- Which observatories contributed to the detections & localization,
- URLs to the location probability sky\_maps,
  - HEALPIX FITS format.
- Plus the usual GCN-provided fields.



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# AMON in GCN Diagram



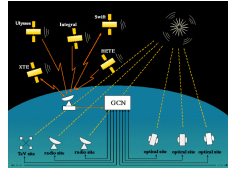
- Status: Basic capabilities were completed end of April 2015;
- End2end testing from *amon* to GCN (soon).







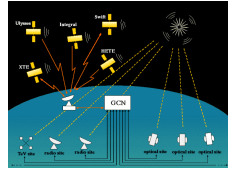
# Classes of Source Objects



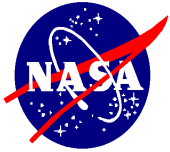
- GRBs (LVC, AMON, Swift, Fermi, INTEGRAL, AGILE, MAXI, KONUS, Suzaku)
- Transients (Swift-BAT, Fermi-GBM/-LAT, MAXI Unknowns)
- Gravitational Lensing events (MOA)
- In the past (no longer available):
  - MILAGRO g-ray & cosmic ray air shower events.
  - ALEXIS extreme UV events.
- In the testing phase:
  - Gravity wave (binary mergers) (aLIGO/Virgo Eng & Sci runs 2015-->)
  - AMON (coincidences between anything)
- Future (hopefully these will happen – Let's talk):
  - Neutrinos (supernova, SNEWS)
  - Optical Transients (e.g. iPTF, MASTER, PESSTO, ...).



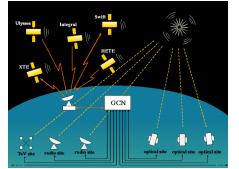
# Categories of Notifications



- Positions (Swift, INTEGRAL, Fermi, MAXI, MOA, Counterparts)
  - The fundamental data product. Follow-up observers know where to look.
- Lightcurves (Swift, KONUS, INTEGRAL, Suzaku)
  - Visual inspection aids in determining the identity of the event (noise vs astrophysical, and what type of astrophysical).
  - Enables the IPN team to perfect their lightcurve cross-correlation calculations: peak match-up.
- Images and Spectra (Swift)
  - Images can be used as a finding chart, bright stars, noise vs astrophysical.
- Pointing Directions (Swift, Fermi, INTEGRAL)
  - These let (robotic) observers follow the location of the mission so they can take truly simultaneous data on the expectation there will be a trigger.
- Sub-threshold triggers (Swift, INTEGRAL)
  - Allows cross-mission temporal/spatial correlations on these low confidence-level triggers. (eg. AMON, others)
- Monitoring for Flares from Known Sources (Swift-BAT, Fermi-LAT, MAXI Knowns)
  - These all-sky missions accumulate lightcurves of known sources and scan these LCs for outbursts/flares/etc (above a certain flux of significance threshold) and GCN distributes these events.



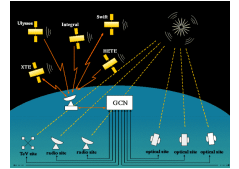
# VOEvents



- Are available from 3 separate brokers; redundancy and both versions of VOEvents (port 8099):
  - Atlantic.net 209.208.78.170 Ver 1.1
  - Linode.com 50.116.49.68 Ver 1.1
  - eApps.com 68.169.57.253 Ver 2.0
- Also 3 LVC brokers (port 8096) Ver 2.0
- Q: Any reason to continue to support Ver 1.1 ?
- All **91** active Notice Types are available in VOEvent format.
- Can get the filtering if you sign up (same config file).
- You can also get VOEvents by:
  - GCN-protocol voevent socket method.
  - In emails as an attachment or in the body of email.



# Value Added

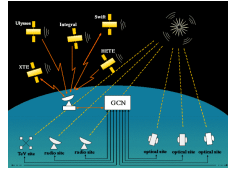


The information supplied by each mission-instrument is enhanced with value-added information. This information appears in COMMENT fields in the email Notices (and as flag bits in the binary socket packet form). All is in VOEvents.

- Cross-mission Spatial/Temporal Correlations (<100sec and/or <20 arcmin) with other events (since June 2012).
- Search results from SIMBAD and NED (in a separate Notice).
- Spatial correlations with ~400 known hard x-ray/g-ray sources (<20 arcmin).
- Spatial correlations with the 4875 closest near-by galaxies (< each\_gal\_size).
- Confidence level on correctness of the identification.
- Information to help follow-up observers make decisions to observe or not:
  - Sun hour\_angle distance & sky\_angle distance,
  - Moon illumination percentage and sky\_angle distance,
  - Bright stars (<6.5 mag) within 12 arcmin (9054 stars in the catalog),
  - Positions in also Galactic and Ecliptic coordinates.



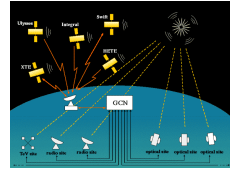
# Extra Services



- Distribution of special mission-internal messages to the team members:
  - Warnings, errors, other special conditions
- Special alert to special recipients when any source triggers from pre-defined lists of sources:
  - SFXTs, binary pulsars, etc.
- Test Notices for all the position notice types.
- When the spacecraft decides to slew to the newly triggered source (Swift & Fermi).
- You can receive a time-of-day-day-of-week email-based notice from GCN/TAN to monitor the connectivity and time delay between GCN/TAN and yourself.
- All Notices are archived on mission-based web pages.
- All the Circulars & Reports are archived on web pages. The Circulars are also bundled up in a tar-file with a link on the archive page. You can pull this file and mine the Circulars for whatever your needs are.



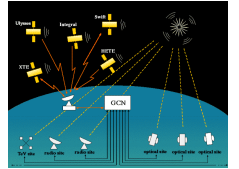
# Recent Additions



- VOEvent format & brokers Mar 2012
- IPN Raw Lightcurves Aug 2012
- Swift-BAT Subthreshold Notices May 2012
- VOEvent (true) servers Mar 2012
- Suzaku Lightcurves Nov 2013
- Fermi-LAT Offline Position Feb 2014
- Fermi-GBM Location Map & Lightcurve Apr 2014
- Future Additions:
  - SNEWS (SN, neutrino)
  - AMON (coincidences between anything)
  - LIGO-VIRGO (binary mergers, gw) (Eng & Sci runs 2015-->)
  - CALET (launch 2016(?))
  - SVOM (launch 2021)



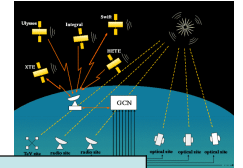
# Statistics



- System livetime (for the last 6 years):
  - 99.7% old GCN/TAN (last 6 years)
  - 99.5% Atlantic.net (last 4 years)
  - 99.4% Linode “
  - 99.7% eApps “
- Notices:
  - There are 550+ Notice “site” recipients (~700 people involved).
    - 107 socket-based (~65 routinely connected).
    - 420 email-based (full-format, cellphone, etc).
    - 3/6/11 VOEvent server anonymous connections
  - 2,800 Transient Notices/yr; 45,000 Pnt/yr; 10,500 Test/Yr; 1e6 Subthreshold/yr
- Circulars:
  - There are 1022 Circulars recipients.
  - 17,763 have been distributed (as of Apr 27<sup>th</sup>).
- Reports:
  - There are about 1010 recipients.
  - 481 have been distributed (as of Apr 27<sup>th</sup>).



# Active GRB Notice Types

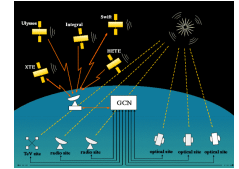


NAME	RATE [/yr]	ERROR	COMMENT
Swift_BAT_QL	90	3'	RA,Dec only; 3 sec before the BAT_Pos
Swift_BAT_Pos	90	3'	BAT Position (initial trigger for Swift NFIs).
Swift_BAT_Slew_Pos	4	4'	Off-line analysis to find burst during Swift slews.
Swift_BAT_Lightcurve	90	3'	Light curve
Swift_FOM	90	3'	What is the Figure-of-Merit for this trigger.
Swift_Slew	90	3'	Will the s/c slewing (or not) to this trigger.
Swift_XRT_Pos	80	5"	XRT Position.
Swift_XRT_Pos_Nack	10	n/a	XRT did not find a real-time position.
Swift_XRT_Image	90	n/a	XRT Image used to find the position.
Swift_UVOT_SrcList	90	n/a	UVOT Sources within an 8x8' image.
Swift_UVOT_Image	90	n/a	UVOT image, 2.2x2.2' sub-region.
Swift_UVOT_Pos	35	1"	UVOT Position.
Fermi_GBM_Alert	260	n/a	GBM had a trigger, timestamp only.
Fermi_GBM_Flt_Pos	260	10-20°	GBM on-board location & type assessment.
Fermi_GBM_Gnd_Pos	260	4-13°	GBM automated, ground determination.
Fermi_GBM_Final_Pos	25	3-6°	GBM humans-in-the-loop analysis.
Fermi_LAT_Pos_Update	10	<30'	LAT on-board location.
Fermi_LAT_Pos_Gnd	1	30-60'	LAT automated ground trigger search.
AGILE_Wakeup/Gnd/Refined	10	30/3/3'	3 levels of AGILE analysis.
INTEGRAL Weak/Wake/Refine/Offline	12	< 4'	4 levels of INTEGRAL analysis.
MAXI_Unknown	12	30-60'	MAXI unknown source triggers (mostly GRBs).





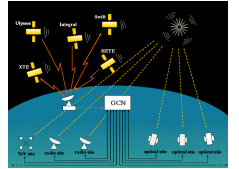
# Active Non-GRB Notice Types



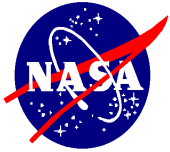
CLASS & NAME	RATE [/yr]	ERROR	COMMENT
<b>MONITORS:</b>			Flares from known sources that are routinely monitored.
Swift-BAT_Monitor	90	0	Well known sources, so loc error is usually small (~1").
Fermi-LAT_Monitor	2	0	Well known sources, so loc error is usually small (~1").
MAXI_Known	90	0-60"	Well known sources, so loc error is usually small (~1").
<b>TRANSIENTS:</b>			Hard X-ray transients.
Swift-BAT_Trans	20	3'	Does not include noise events.
MAXI_Unknown	12	30-60"	Did not match a previously identified source.
<b>MISC:</b>			Grab bag.
MOA	360	1"	Gravitational micro-lensing event.
SIMBAD_NED	~150	n/a	Other sources within a search radius.
Spacecraft Slewing (Swift, Fermi)	120	n/a	Is/did the s/c slew to the new trigger?
Lighcurves (Swift,KONUS,INTEGRAL)	100, 200, 270	n/a	Temporal-only's, and useful for durations.
<b>POINTING DIRECTION:</b>			Follow along (be on target before/during T0).
Swift	27,000	n/a	Every 5-30 min
Fermi	9,000	n/a	Every hour.
INTEGRAL	100's	n/a	Episodic.
AGILE	9,000	n/a	Every hour.
<b>TEST:</b>			Provide practice notices; exercise your system.
Swift-BAT, Fermi-GBM/-LAT	3000 , 3000	n/a	
INTEGRAL-all, AGILE	1500 , 3000	n/a	



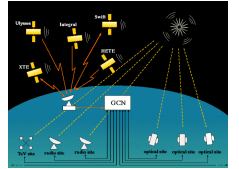
# Looking for New Contributors:



- GCN/TAN is always looking for new Notice Types to add (SN, CV, OT, whatever). Let GCN/TAN distribute your timely data to others in the world so that they can
  - (a) make timely follow-up observations of your targets, or
  - (b) do spatial/temporal cross-correlations with their data.
- GCN/TAN is not just GRBs; it is all transient phenomenon. (optical, particles, etc)
- Ground-based as well as space-based. All wave bands and all particles.
- It's easy – I do most of the work. If needed I'll make a new importing protocol for you.
- Current methods of importing contributions into GCN/TAN:
  - Socket method for the short time-delay &/or high volume contributions.
  - Email method for the longer time-delay and low volume contributions.
  - VOEvents.
- By any of these methods, your identification/credit is maintained in the VOEvent.
- GCN/TAN can/does run sub-networks. If you want to maintain privacy of your data, then GCN/TAN can limit the distribution to only those recipients you specify.
  - Why do I do this? Because:
    - Many of your current customers are GCN customers, and they would prefer not to have to maintain/manage more than one connection.
    - Eventually you may go public, and then the infrastructure is already in place.



# Asking/Looking for More New



## Looking for New Features and Functions:

- Please suggest new features, functionality or services that you would like to see implemented within the GCN/TAN.
  - GCN/TAN is always trying to broaden the net as wide as possible, to maximize the number and scope of participation.

## Looking for New Customers/Recipients:

- Ground-based as well as space-based.
- Anybody, any institution, any country can receive Notices/Circulars/Reports.
  - By any distribution method (VOEvent brokers, or original-GCN methods)

## Contact information & GCN URLs:

- [scott@milkyway.gsfc.nasa.gov](mailto:scott@milkyway.gsfc.nasa.gov) or 301-286-3106
- <http://gcn.gsfc.nasa.gov/gcn/> Top-level page
- <http://gcn.gsfc.nasa.gov/gcn/invitation.html> Introduction to signing up as a customer.