The GRB Coordinates Network (GCN): A Status Report

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Abstract. A review of the GRB Coordinates Network (GCN) will be given. The GCN has recently replaced the BATSE Coordinates Distribution Network (BACODINE), maintaining all of BACODINE's original capabilities and services, but also providing new sources of GRB location information. These are: (1) source locations using the MSFC LOCBURST algorithm, (2) the Rossi-XTE detections (PCA and ASM), (3) the Interplanetary Network (IPN) locations, and (4) CGRO-COMPTEL locations. These new sources of locations are available for distribution in the minutes-to-hours-to-days time delay ranges, and they also have increasingly and significantly reduced error boxes, thus providing a broad range of time delays and error box sizes to fit within the observing capabilities of a broad range of follow-up instruments in the radio, optical, and TeV gamma-ray bands. Extreme-UV transients from ALEXIS are also now distributed. For all sources of location information, all the distribution methods are available (Internet Socket, E-mail, Alpha-numeric and Numeric Pagers, and Phone/modem) and several filters. Sites can choose which sources to receive and what filters to be applied. The GCN web site has been expanded to include a globally inclusive table of locations, light-curves, and fluence information which is automatically updated in real-time.

INTRODUCTION

The original BATSE Coordinates Distribution Network (BACODINE) was set up in 1993 to distribute the locations of GRBs detected by CGRO-BATSE

[1]. It has since grown to include GRB locations detected by other spacecraft. And as such, the name has been changed to the GRB Coordinates Network (GCN) to reflect this generalization of the system. All the original capabilities of the BACODINE system have been carried over into the new GCN system. In addition there have also been several enhancements related to the BATSE-derived GRB detections. This combined and enhanced GCN system provides a wide range of error box sizes (tens of square arcmin to tens of square degrees) over a range of delay times after the burst (seconds to minutes to hours to a few days). The addition of GRB sources with error box sizes that are much smaller than the original BATSE-based locations of the BACODINE system means that telescopes with small FOVs can participate.

By combining all sources of GRB information into a single central disemination point, the GCN system provides a one-stop shopping facility for people wishing to make follow-up observations. They need maintain only one interface and handle one protocol and format.

SOURCES OF GRB LOCATIONS

There are currently nine different types of location information for GRBs available in real- or near real-time. They span a range of delay times after the start of the burst and they span a range of sizes of error boxes. Each type has its own separate dis/enable flag in the GCN "sites.cfg" file controlling the distribution of that type to each site. If sites want different filtering (ALL, VISIBLE, NIGHT, custom, etc.) for the different notice types, they can have multiple entries in the "sites.cfg" file. The comparison is shown in Table 1, and the sources are described in more detail below.

TABLE 1. Sources of GRB locations within GCN.

SOURCE	TIME DELAY	ERROR BOX SIZE	RATE	COMMENTS
Original	5 sec	6-20° dia	1/day	Dedicated, automated, wide FOV
Final	37 sec	6-18° dia	1/day	Dedicated, automated, wide FOV
Light Curve	5 min	n/a	1/day	Useful for burst assessment
MAXBC	10 min	5-20° dia	1/day	Fast response, wide FOV
LOCBURST	15-35 min	4-8° dia	10/month	Medium response, medium FOV
COMPTEL	20-30 min	3-5° dia	5/year	Medium response, medium FOV
RXTE-ASM	1-2 hr	4′x15-150′	8/year	Small FOV telescopes
RXTE-PCA	2-5 hr	6′-40′ dia	6/year	Small FOV telescopes
IPN	0.5-3 day	4′x4-8°	2/month	Small FOV with tiling
MSFC Admin	1-3 day	4-20° dia	1/day	Final location and classification

The various types and sources of GRB locations are listed in order of increasing delay time after the onset of the burst. The first four are BATSE-derived locations. The BATSE-Original and BATSE-MAXBC notices were part of the original BACODINE system. Recently added to the list of BATSE-derived location notices are the BATSE-Final and BATSE-LOCBURST Notices. While the location in the Original Notice is based on the first one or two seconds of the burst light curve, the Final Notice integrates the light curve for up to 32 seconds. A fluence and peak intensity are reported in the notice. These two parameters for the burst are useful for assessing the importance of the burst when making plans for follow-up observations. As with the Original Notices, the Final Notices have trigger type identification (GRB, solar flare, electron precipitation, etc.) which is 98% accurate.

While the emphasis on the BATSE-Original Notice was speed (the minimum time delay from the start of the burst to the location coordinates being delivered to the burst follow-up observer is 5.5 sec), a new BATSE-based notice has been added, BATSE-LOCBURST, which trades off some time delay for a much reduced location error box size. The GCN system captures the raw telemetry from CGRO-BATSE and automatically ftp's it to the BATSE team in Huntsville where there are people on call to analyse the incoming data for bright GRBs. This semi-automated process takes 15-35 minutes and is described in detail in Kippen et al. 1997. These locations are sent back to the GCN system where an automatic daemon detects the incoming locations, reads them into the program, reformats the messages into the standard GCN format, and then distributes them to all GCN sites requesting this source of GRB information by any of the standard distribution methods.

The same capturing and processing is done for the CGRO-COMPTEL telemetry data. The COMPTEL team at UNH processes the burst and if the burst is bright enough, then a location can be calculated and sent back to GCN, which imports these notices and distributes them to all GCN sites requesting this source of information.

The Proportional Counter Array (PCA) instument on RXTE has recently started making ToO follow-up observations on bright BATSE-detected bursts [3]. As with the BATSE-LOCBURST and COMPTEL locations, the GCN system imports and distributes the locations based on these PCA detections. The typical location uncertainties of 6-40$'$ put them within the capabilities of traditional narrow-FOV telescopes. And they are available at 2-5 hours time delay, which is useful for ToO's by observers already at the telescope. To provide the follow-up community with a heads-up service for potential RXTE-PCA detections, RXTE-PCA ALERT notices are issued about 1-2 hours before the location notices. The All Sky Monitor (ASM) instrument on RXTE has also begun a program to automatically detect GRBs that occur in their FOV, produce rapid locations (1-2 hr), and have them distributed through the GCN system [4].

Included in Table 1 are the BATSE Light Curve notices which are available through the GCN web page, see below, and soon to be available by the e-mail method. These are useful for assessments of the importance of the burst by potential observers planning their follow-up observations. GCN also distributes the coordinates of extreme-UV transients detected by ALEXIS [4].

In the future, GCN intends to incorporate into the network every source of GRB location information that becomes available. As new spacecraft and instruments come on-line, arrangements will be made to add them to the list of sources. In particular arrangments have already been made to distribute HETE2 positions.

DISTRIBUTION METHODS

Within the last year the Short Pager (SPager), Subject-only and Web Page distribution methods have been added. The full list of distribution methods is shown in Table 2 as a function of GRB Source type and Notice type – an X indicates availability. The Internet Socket, E-mail, Pager, and the two Phone methods are discussed in [1] and [4]. The Short Pager and Subject-only methods were added as brief and briefer versions of the alpha-numeric Pager method. A few sites needed these truncated versions to match their locally available telecommunications company's capabilities. The time-delay to the end user is typically less than 30 sec for the e-mail delivery time to the telecommunications company plus 1-3 minutes for the pager/cell-phone transmitter queueing time. There are two pages within the GCN web site which contain all the location and light curve information about the BATSE-detected and RXTE-detected GRBs and which are automatically updated in real-time (less than a minute after GCN distributes each notice). The BATSE GRB Light Curves come in three forms: (1) a text table of count rates versus time in the four DISCLA energy bands, (2) a postscript version and (3) a JPEG version of the plots of the same DISCLA rates (the JPEG version is soon to be available).

TABLE 2. GCN Distribution Methods by Source type.

Source/Notice Type	Socket	Email	Pager	SPager	Subject only	Ded/Dialed Phone	WebPage
Original	X	X	X	X	X	X	X
Final	X	X	X	X	X	X	X
MAXBC	X	X	X	X	X	X	X
LOCBURST	X	X	X	X	X	X	X
Text LC		X					X
Postscript LC		X					X
JPEG LC							soon
RXTE-PCA	X	X	X	X	X	X	X
RXTE-ASM	X	X	X	X	X	X	X
COMPTEL	X	X	X	X	X	X	X
IPN	X	X	X	X	X	X	X
ALEXIS	X	X	X	X	X	X	X

AVAILABLE FILTERS

There is a wide range of filters available to sites wishing to customize the quantity and quality of the notices they receive. These filters are independent of the distribution method through which they receive the notices. The primary filter function is to select the sources of GRB information. Each Source Type listed in Table 1 has a dis/enable flag in each entry in the GCN "sites.cfg" file. And then sites can elect to apply the ALL, VISIBLE, or NIGHT filtering functions. The ALL filter has been available for about a year. The VISIBLE and NIGHT filters restrict notice delivery to only those RA,Dec locations which are above the site's local horizon and during nighttime, respectively. Since the non-BATSE-based sources of GRB locations have intrinsic delays of hours, the instantenous observability restrictions of VISIBLE and NIGHT are not as important for them. Custom filter functions have been constructed to meet the needs of some sites (e.g. declination bands, sun angle bands, etc.). Finally, an intensity threshold can be applied (BATSE-based notices only) to eliminate the weaker bursts.

MISCELLANEOUS

The GCN web site (URL: http://gcn.gsfc.nasa.gov/gcn) has been greatly improved since its original release. In addition to the real-time updated pages of GRB locations and related information, the descriptive and technical sections have been expanded and updated. The reader is referred to these web pages for all the current information and the latest developments and improvments in the GCN system.

In the near future the GCN system will implement a capability to accept e-mail messages from researchers in the GRB community and automatically distribute them to all those wishing to receive this new type of messages. By relaxing the highly formated style requirements of the messages that are imported from the other non-BATSE sources (RXTE, COMPTEL, etc.), burst follow-up researchers can submit, and have distributed, prose-style messages describing observations that have been made, results, and plans for future observations. This additional timely and automated dissemination of information among the follow-up community will facilitate the optimum use of limited resources.

REFERENCES

1. Barthelmy, S.D., et al.; in "Proc. 3rd Huntsville Worshop", v384, p 580, 1996.
2. Kippen, R. M., et al.; these proceedings.
3. Takeshima, T., et al.; these proceedings.
4. The GCN Web Pages URL: http://gcn.gsfc.nasa.gov/gcn.