General Coordinates Network
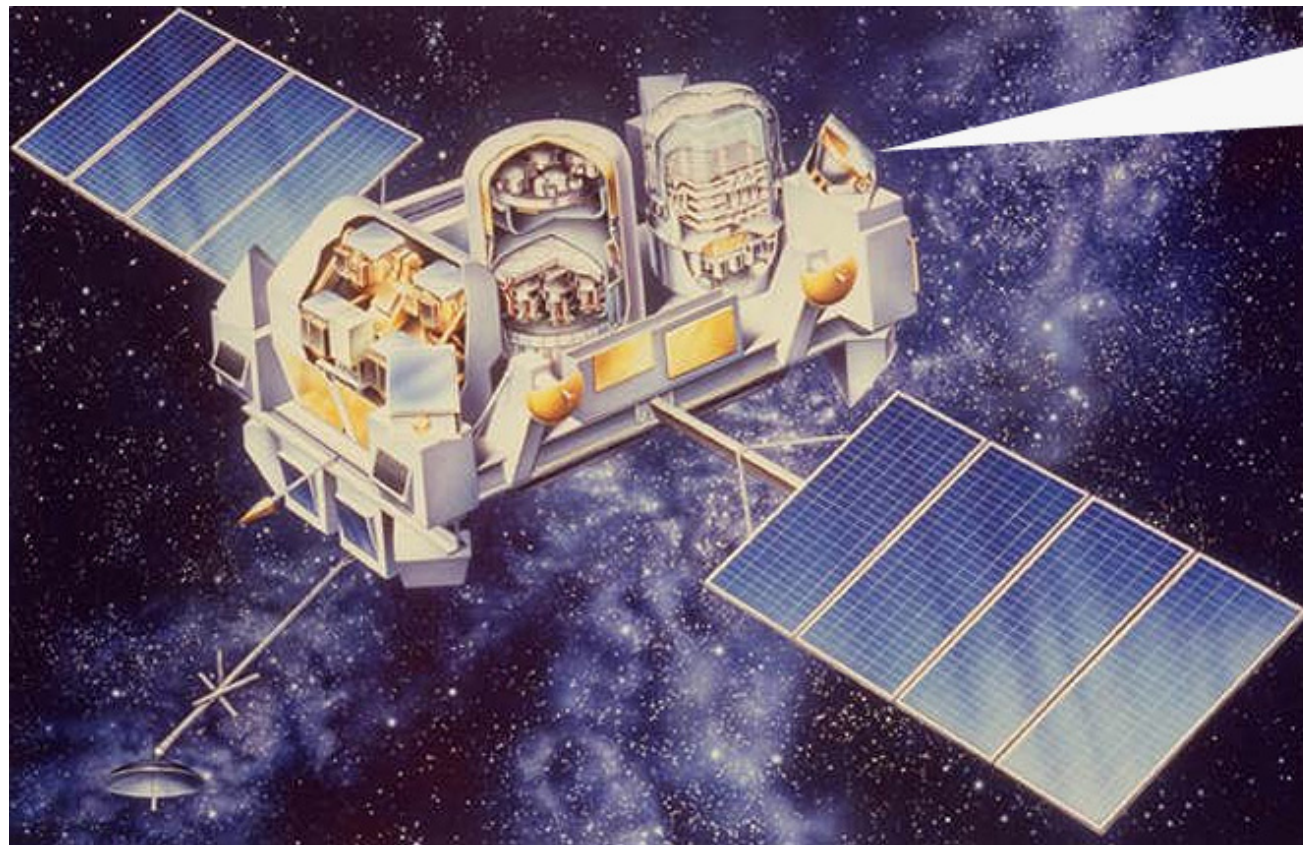
NASA's Next Generation Time-Domain and Multimessenger Alert System

A service of the Astrophysics Science Division at NASA's Goddard Space Flight Center
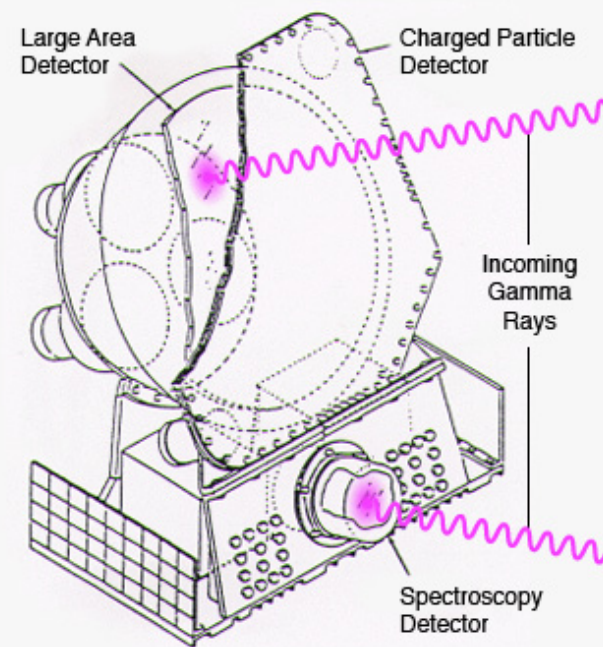
https://gcn.nasa.gov

Gamma-ray Coordinates Network
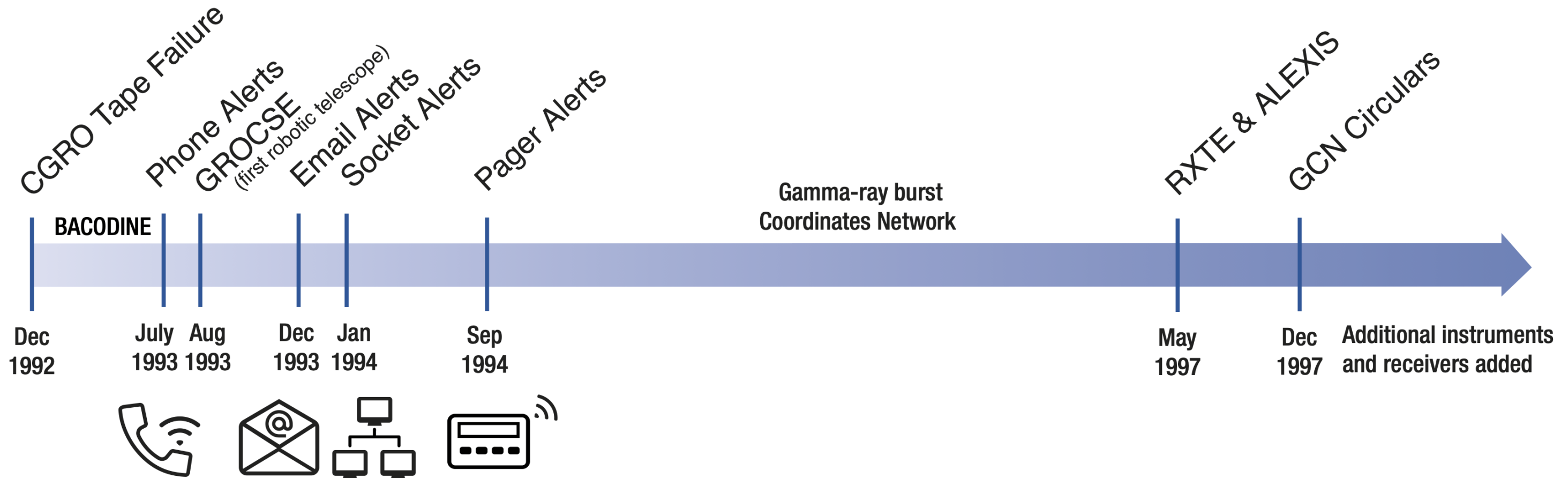
Realtime Alerts Born of Necessity



BATSE Detector Module (1 of 8)

- The Compton Gamma-Ray Observatory's onboard recorder failed in 1992
- The need to downlink events as they occurred created an opportunity for realtime follow-up
- BAtse COordinates DIstribution NEtwork (BACODINE) was built to receive and distribute those alerts worldwide

Early History of GCN

A timeline of the early history of GCN:

- **CGRO Tape Failure** — Dec 1992
- **BACODINE**
- **Phone Alerts** — July 1993
- **GROCSE** (first robotic telescope) — Aug 1993
- **Email Alerts** — Dec 1993
- **Socket Alerts** — Jan 1994
- **Pager Alerts** — Sep 1994
- **Gamma-ray burst Coordinates Network**
- **RXTE & ALEXIS** — May 1997
- **GCN Circulars** — Dec 1997
- Additional instruments and receivers added

- BACODINE provided new alert formats (phone, email, socket, and pager)
- New instruments and transient types led to the Gamma-ray Coordinates Network

GCN Enabled Seminal Breakthroughs in Astrophysics
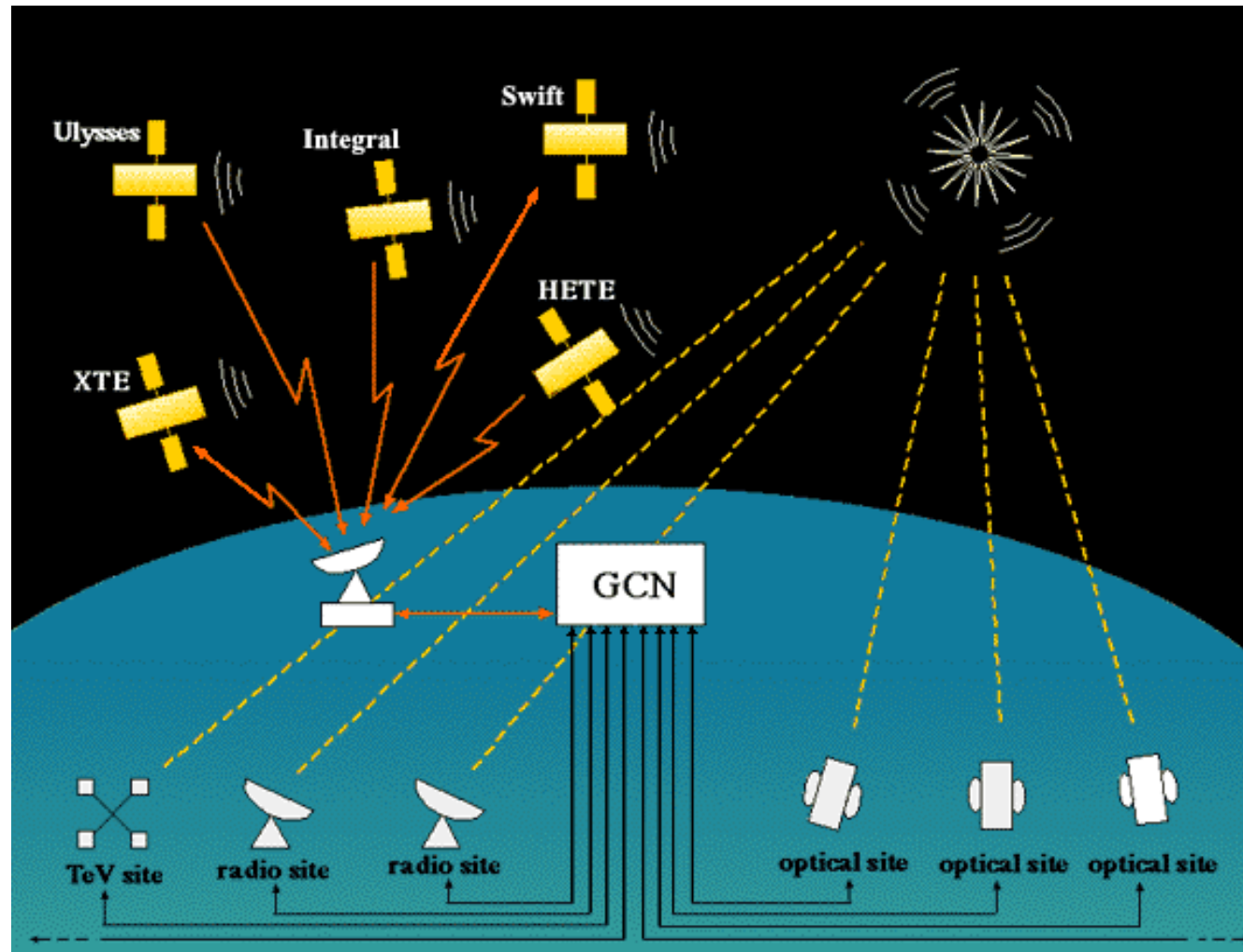
The GCN community enabled worldwide follow-up observations that revealed the nature of gamma-ray bursts:

- Afterglows and redshifts confirmed their distant, extragalactic origin
- Supernova-GRBs established massive stellar deaths as the cause of long GRBs
- Afterglow and host studies established neutron star mergers as the cause of short GRBs

There are two kinds of GCN data products:

GCN NOTICES

```
TITLE:          GCN/FERMI NOTICE
NOTICE_DATE:    Wed 26 Aug 20 22:10:07 UT
NOTICE_TYPE:    Fermi-GBM Flight Position
RECORD_NUM:     45
TRIGGER_NUM:    620172587
GRB_RA:         296.300d {+19h 45m 12s} (J2000),
                296.250d {+19h 45m 00s} (current),
                296.416d {+19h 45m 40s} (1950)
GRB_DEC:        +71.817d {+71d 49' 00"} (J2000),
                +71.868d {+71d 52' 03"} (current),
                +71.693d {+71d 41' 35"} (1950)
GRB_ERROR:      5.50 [deg radius, statistical plus systematic]
GRB_INTEN:      1078 [cnts/sec]
DATA_SIGNIF:    22.80 [sigma]
INTEG_TIME:     1.024 [sec]
GRB_DATE:       19087 TJD;   239 DOY;   20/08/26
GRB_TIME:       79782.72 SOD {22:09:42.72} UT
GRB_PHI:         20.00 [deg]
GRB_THETA:      150.00 [deg]
DATA_TIME_SCALE: 1.0240 [sec]
HARD_RATIO:     0.54
LOC_ALGORITHM:  3 (version number of)
MOST_LIKELY:      93%  GRB
2nd_MOST_LIKELY:   4%  Generic Transient
DETECTORS:      0,0,0, 0,1,1, 0,0,0, 0,0,0, 0,0,
SUN_POSTN:      156.00d {+10h 24m 01s}  +10.00d {+09d 59' 51"}
SUN_DIST:        94.05 [deg]    Sun_angle= -9.3 [hr] (East of Sun)
MOON_POSTN:     258.31d {+17h 13m 14s}  -22.27d {-22d 15' 56"}
MOON_DIST:       97.64 [deg]
MOON_ILLUM:     63 [%]
GAL_COORDS:     103.87, 21.63 [deg] galactic lon,lat of the burst (or transient)
ECL_COORDS:      41.25, 79.40 [deg] ecliptic lon,lat of the burst (or transient)
LC_URL:         http://heasarc.gsfc.nasa.gov/FTP/fermi/data/gbm/triggers/2020/bn200826923/
COMMENTS:       Fermi-GBM Flight-calculated Coordinates.
COMMENTS:       This trigger occurred at longitude,latitude = 209.65,1.28 [deg].
COMMENTS:       The LC_URL file will not be created until ~15 min after the trigger.
```

- By and for machines
- Fixed, predefined format
- Schema specific to each notice type

GCN CIRCULARS

```
TITLE:   GCN CIRCULAR
NUMBER:  28298
SUBJECT: GRB 200826B: Fermi GBM detection
DATE:    20/08/27 21:10:30 GMT
FROM:    Christian Malacaria at NASA-MSFC/USRA  <cmalacaria@usra.edu>

C. Malacaria (NASA-MSFC/USRA) and C.Meegan (UAH)
report on behalf of the Fermi GBM Team:

"At 22:09:42.72 UT on 26 August 2020, the Fermi Gamma-Ray Burst Monitor (GBM)
triggered and located GRB 200826B (trigger 620172587 / 200826923).

The on-ground calculated location, using the GBM trigger
data, was reported in GCN 28292.

The GBM light curve shows an exceptionally bright long GRB
with a duration (T90) of about 7.4 s (50-300 keV).
The time-averaged spectrum from T0-0.003 s to T0+ 12.544 s is
best fit by a Band function with Epeak = 410.3 +/- 5.6  keV,
alpha = -0.64 +/- 0.01, and beta = -2.52 +/- 0.04
The event fluence (10-1000 keV) in this time interval is
(1.414 +/- 0.006)E-04 erg/cm^2.
The 1.024-sec peak photon flux measured starting from T0+5.1 s in
the 10-1000 keV band is 110.1 +/- 0.7 ph/s/cm^2.

The spectral analysis results presented above are preliminary;
final results will be published in the GBM GRB Catalog:
https://heasarc.gsfc.nasa.gov/W3Browse/fermi/fermigbrst.html

For Fermi GBM data and info, please visit the official Fermi GBM Support Page:
https://fermi.gsfc.nasa.gov/ssc/data/access/gbm/"
```
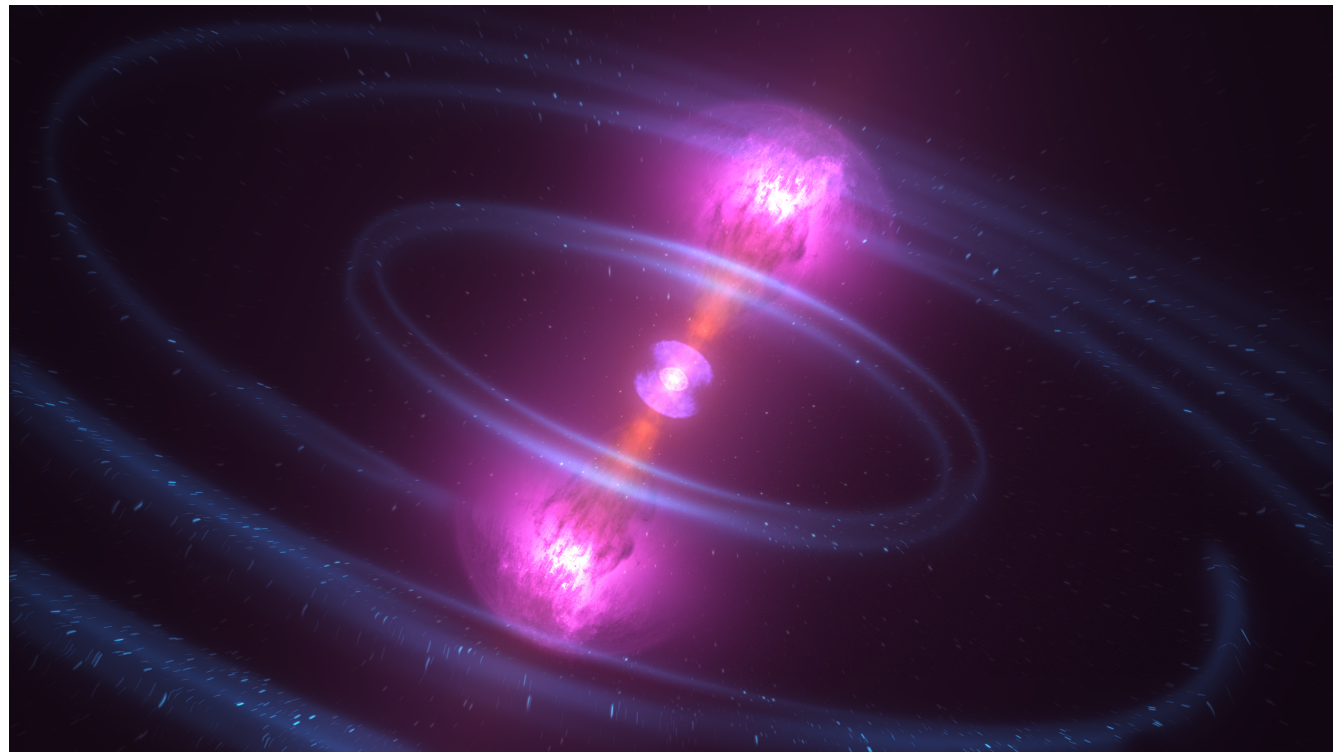
- By and for humans (some automated)
- Freeform text (with established style)
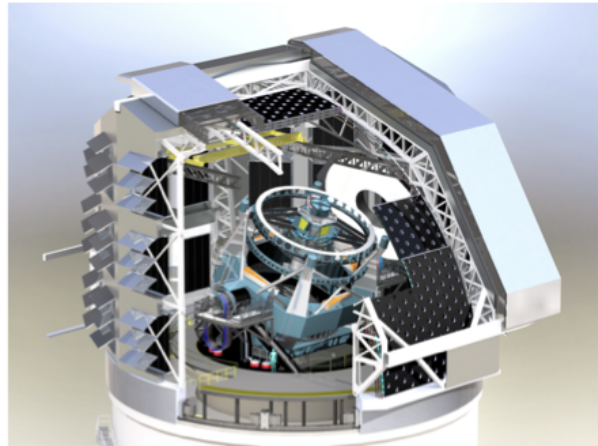- Citable (but not peer-reviewed)

The Changing Scientific Landscape

GCN is constantly evolving to serve new transients, messengers, and observatories:

- Gravitational wave events (GW150914, GW170817)
- High-energy neutrinos (IC170922A)
- Tidal disruption events (Swift J1644+57)
- Magnetar giant flares (200415A)

The Changing Technological Landscape

Rubin Observatory/NSF/AURA

- Internet standards have led to new, better ways to serialize astronomy data (VOEvent, JSON, Avro, etc.)
- Encryption is necessary on the modern Internet (e.g. https)
- Industry has developed general time-series databases and streaming frameworks
- The Vera C. Rubin Observatory will use Apache Kafka to distribute transient alerts as its primary data product
- Several experiments are following suit

Introducing the new GCN
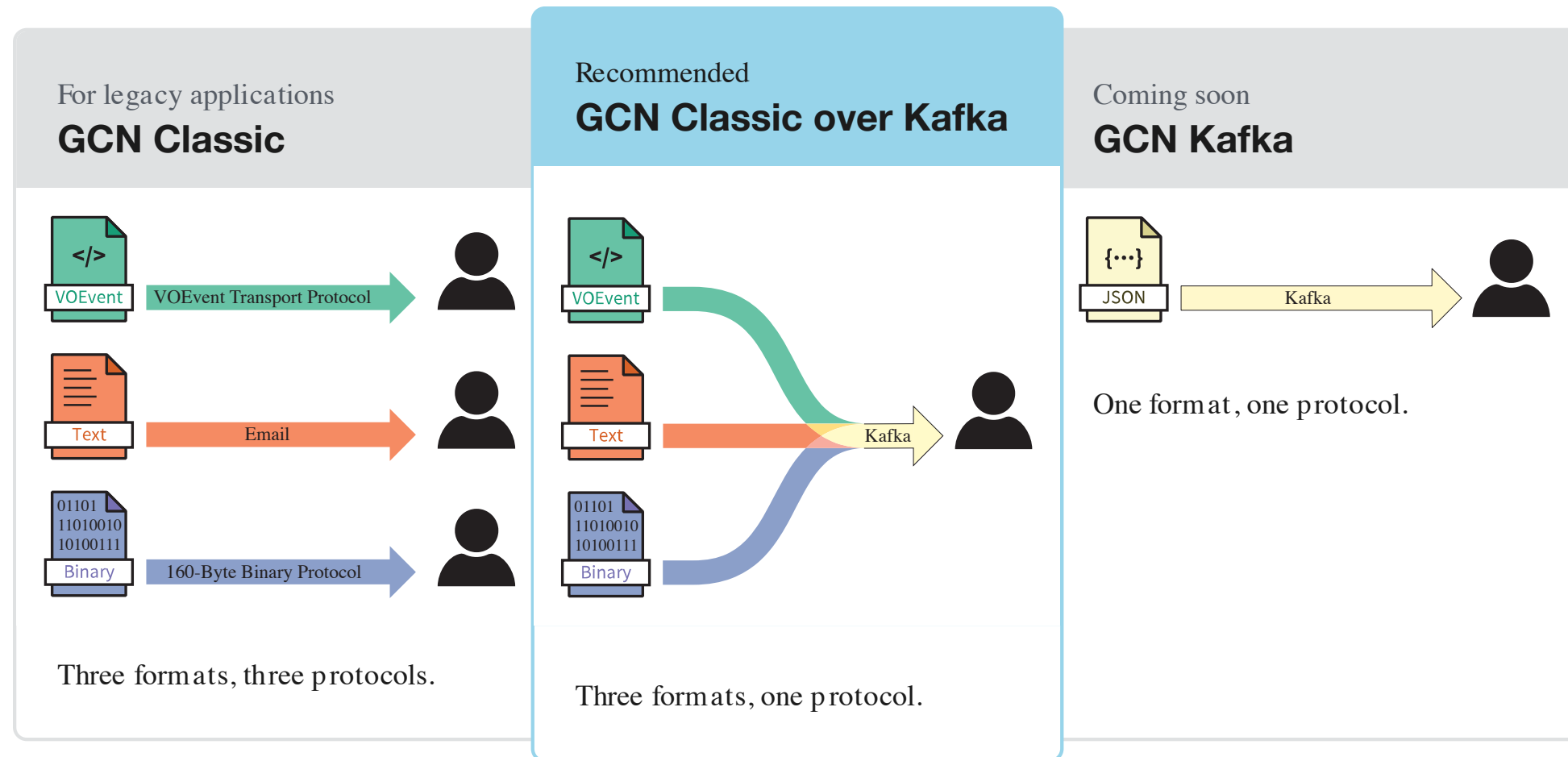
The New GCN is built on Kafka

- GCN Classic provides three formats over *three custom protocols*
- GCN Classic over Kafka provides all three formats over *one standard protocol*: Apache Kafka

Why switch to the new GCN?

	GCN Classic	GCN Classic over Kafka
Self-service	**NO.** Users need to contact administrator in order to make account and subscription changes	**YES.** Manage your own account and subscription settings through the web site
Open standards	**NO.** Notices are sent using three custom protocols	**YES.** Notices are sent using one standard protocol, Apache Kafka
Open source	**NO.** Custom software needed to receive notices	**YES.** Receive notices using open-source software
Highly available	**NO.** Notices are broadcast by a single server	**YES.** Notices are broadcast by a cluster of highly-available Kafka brokers in the cloud
Secure	**NO.** Notices are sent as plaintext	**YES.** Notices are protected with SSL/TLS

New GCN web site

at https://gcn.nasa.gov
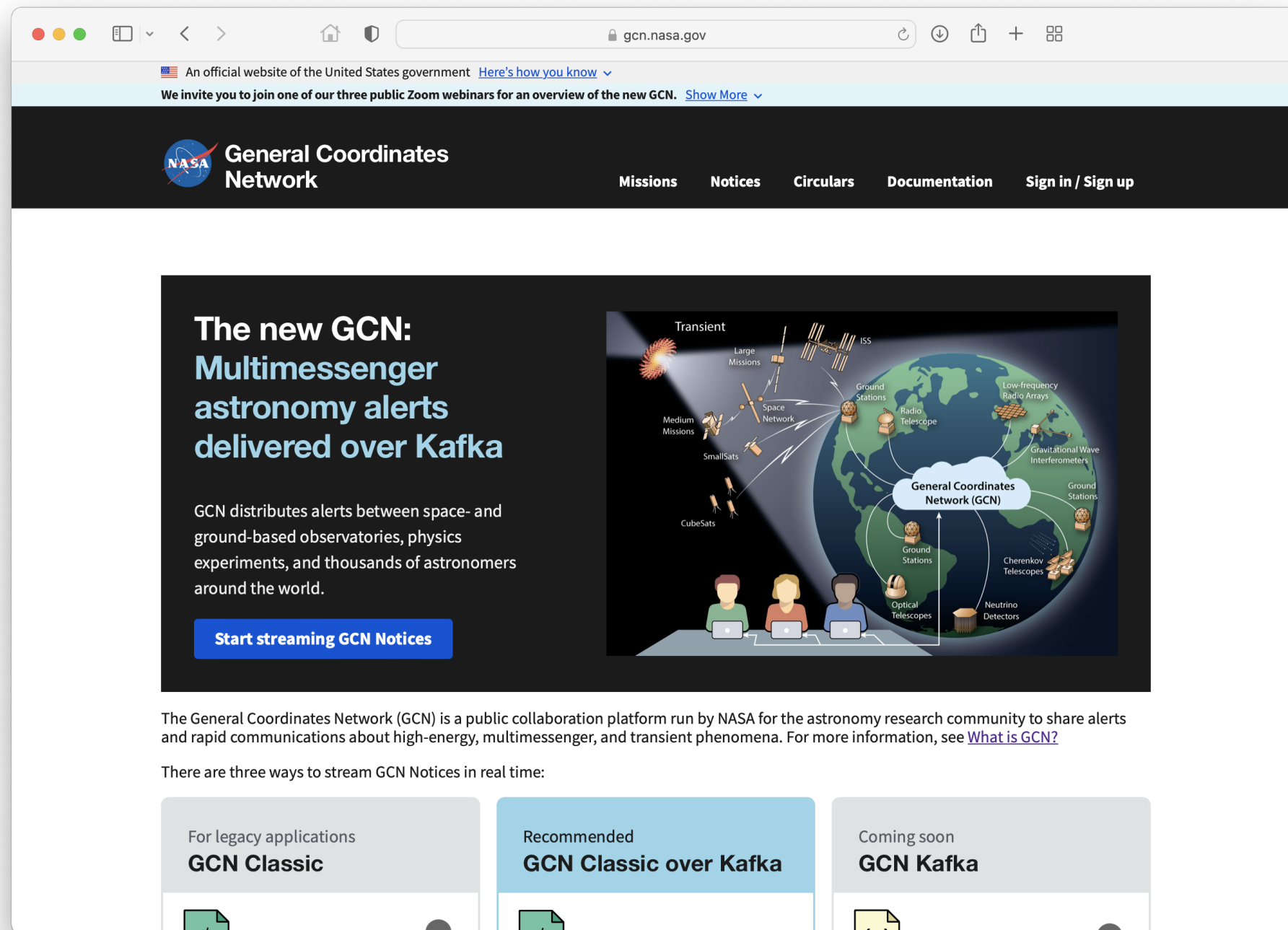
- Updated look and feel
- More accessible, based on US Web Design System
- Single sign on with:
  - email and password
  - Google
  - Facebook
  - LaunchPad (for NASA employees and affiliates)

✨New!✨ Self-service email alerts

Email is still the most popular way to receive GCN Notices.

- Previously, users had to contact Scott Barthelmy to create or modify their subscriptions manually.
- Now, you can manage your email subscriptions yourself through our new web site.
- **Note**: to cancel legacy email subscriptions on the old web site, contact us.

What's staying the same?

GCN Classic is not going away any time soon. The following are still fully supported:

- GCN Notices legacy delivery mechanisms (email, socket)
- GCN Circulars submission and delivery via email
- The old GCN Classic web site, https://gcn.gsfc.nasa.gov
- The live archives of GCN Notices and GCN Circulars on the old web site

However, starting later this year new features and notice types will only be available on the new web site and GCN Kafka.

What's next for GCN?

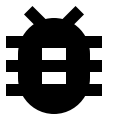# We're planning lots of enhancements in the near future:

- Modernization of GCN Circulars
  - Self-service subscription management
  - Self-service submitter registration using peer endorsement system
  - Correct handling of Unicode
  - Contextual parsing of links
  - Automatically minted DOIs and BiBTeX entries
  - Link ORCIDs to GCN Circulars
- Unified schema and alert format for GCN Kafka
- Integrated, searchable database of Notices and Circulars (GCN Viewer)
- Interoperability with other transient Kafka brokers (e.g. SCiMMA)
- Alerts from new missions and facilities

Thanks for listening!

Web site: https://gcn.nasa.gov

This presentation: https://nasa-gcn.github.io/gcn-presentation/

? Questions or comments? Contact GCN directly

🐞 Have you found a bug in GCN? Open an issue

** Want to contribute code to GCN?** Get involved on GitHub