Low-Latency Alerts Update

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R. De Pietri, S. Ghosh and S. Morisaki

Main Developers

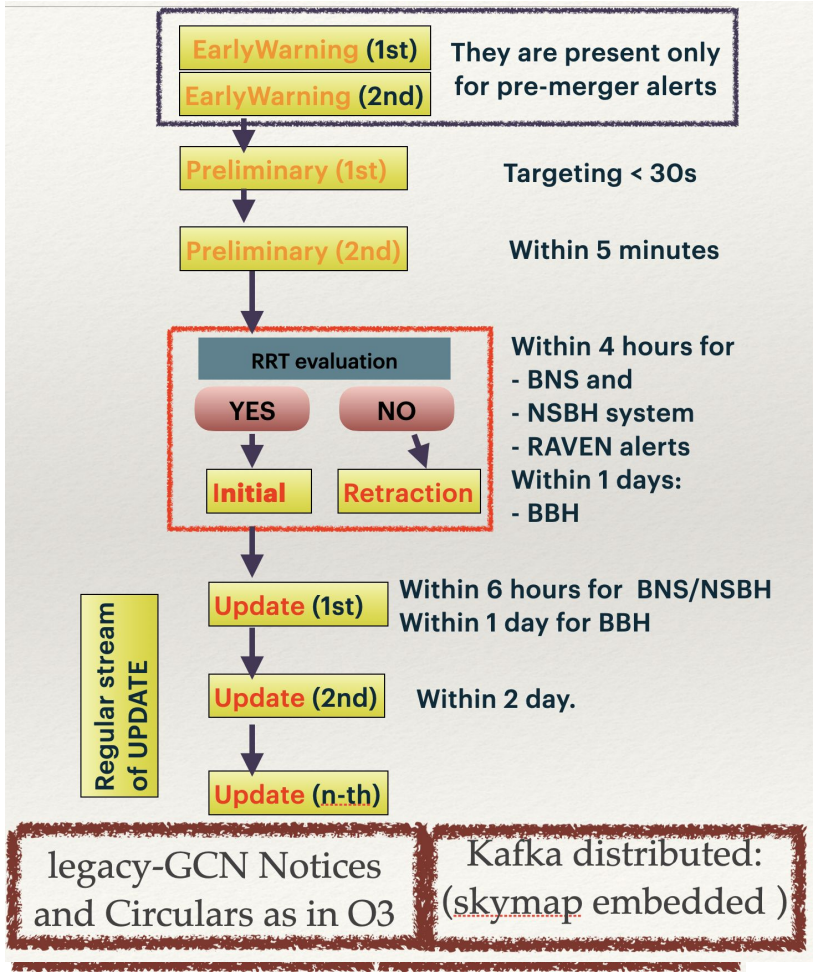
1. Leo Singer
2. Deep Chatterjee
3. Cody Messick
4. Brandon Piotrzkowski
5. Geoffrey Mo

Confirmation from last OpenLVEMs

- **Confirmed timeline of alerts**
- **Mass-gap** moved from **`p_astro`** to source-properties section of GCN
- EM-Bright probabilities (**`HasNS`** and **`HasRemnant`**) will be quantities marginalized over large number of equation of neutron star models (instead of single 2H Equation of State from O3)
- Skymap information will be provided using **“multiorder” MOC** based fits format. Flattened skymap will be available in GraceDB for legacy usage.
- **EarlyWarning** (negative time) alert will be provided
- Coincident alerts (RAVEN+LLAMA) will be publicly distributed
- MULTIPLE DISTRIBUTION CHANNEL for alerts:
  - GCN Notices and Circulars as in O3.
  - Kafka based one with embedded skymap via SCiMMA and GCN

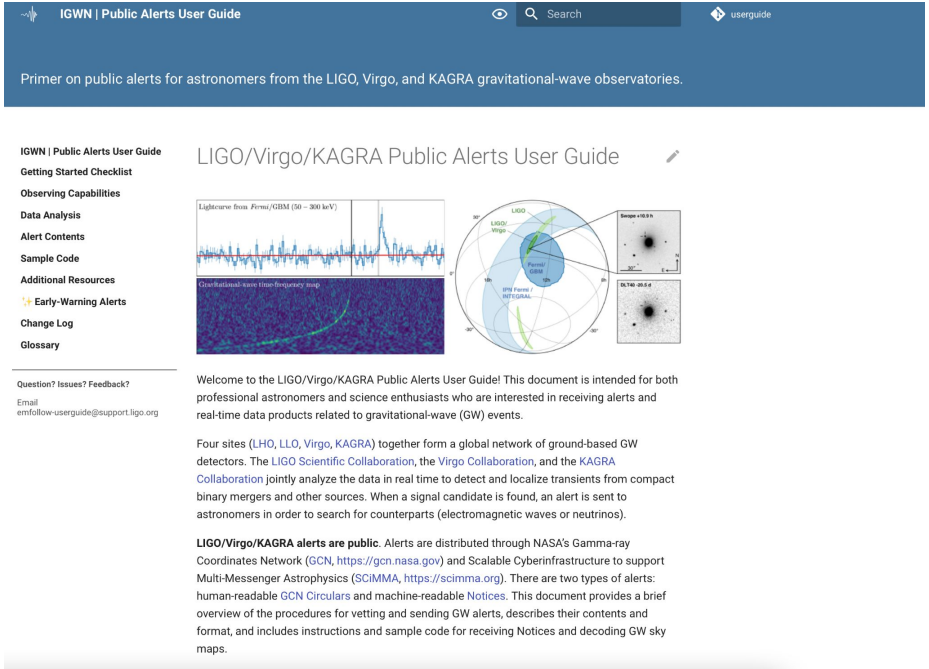
Alert system: Public alert

- (1st) **EarlyWarning** (fully automatic)
- (2nd) **EarlyWarning** (fully automatic) possible second alert as new localization are available.
- (1st) **Preliminary** (fully automatic) alert (targeting < 30s).
- (2nd) **Preliminary** alert (fully automatic) after search is completed by all the pipelines with updated localization (targeting < 3 minutes).
- A (**3rd…n-th**) Preliminary will be published in case of improved localization before Rapid Response Team (RRT) validation.



The Public Userguide

- Updated observational capabilities
- Alert content update - Mass-gap moved to source properties
- Receiving of GCN alerts - Three avenues to getting alerts
- Early warning capabilities



Observation capability updated

- The event rate (a bit optimistic) are based on the best possible sensitivity curve, and the change in SNR threshold from 12 to 8.

- Final and more realistic numbers will be updated once engineering run is performed and representative sensitivity curve are available

Annual number of public alerts

(log-normal merger rate uncertainty × Poisson counting uncertainty)

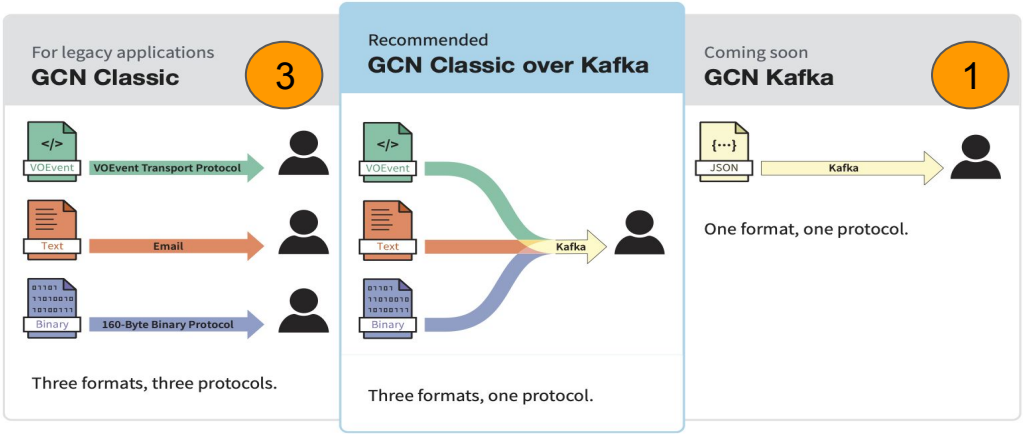
O4	HKLV	36^{+49}_{-22}	6^{+11}_{-5}	260^{+330}_{-150}
O5	HKLV	180^{+220}_{-100}	31^{+42}_{-20}	870^{+1100}_{-480}
		BNS	NSBH	BBH

Receiving of GCN alerts

Instructions on receiving of alerts are now available on the Userguide:

Users need to use one of the following:

1. GCN-kafka for connecting to GCN to receive JSON-serialized notices over Kafka
2. hop-client to receive Avro-serialized notices over Kafka from SCiMMA.
3. Classic GCN format (like in O3)



Kafka Notices via GCN with embedded sky-map using JSON

Kafka Notices via SCiMMA with embedded sky-map using Avro

A quick walkthrough

Parameter Estimation Updates

Shifting from LALInference to Bilby

RapidPE-RIFT starts to run on MDC triggers, documentation currently under progress

Details on automation of PE results are under discussion

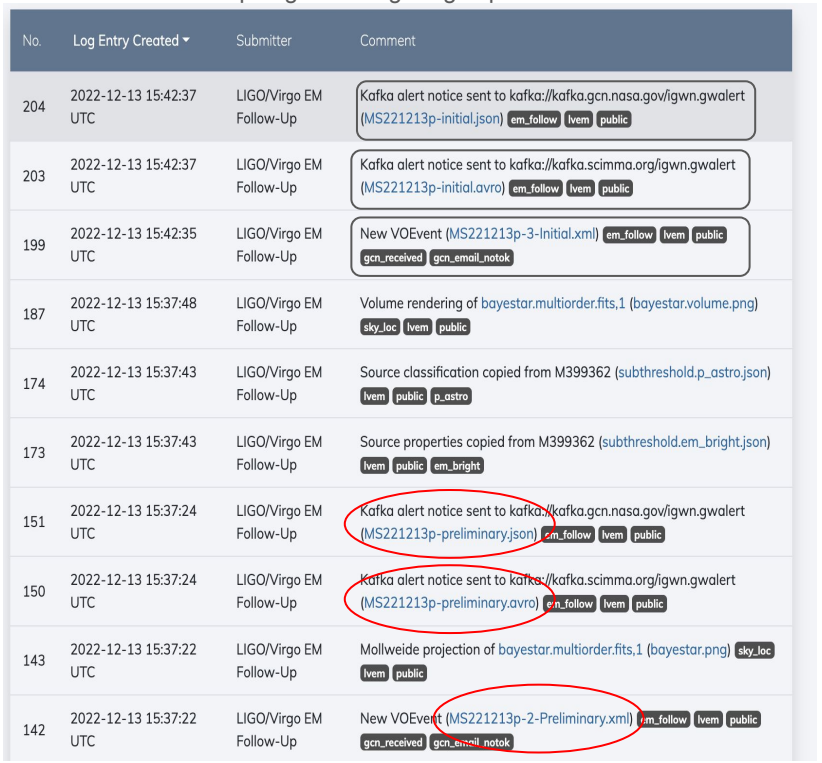
Updates on a future call

Summary

- kafka (avro/json) packets finalized.
- User Guide has been published **December 15th 2002**.
- Now operational the distribution of public alerts using kafka transport (using SCiMMA and the upcoming GCN Kafka infrastructure):

  - **SCiMMA:**
    `kafka://kafka.scimma.org/igwn.gwalert`
  - **GCN Kafka:**
    `subscribing to igwn.gwalert`

https://gracedb.ligo.org/superevents/MS221213o/view/



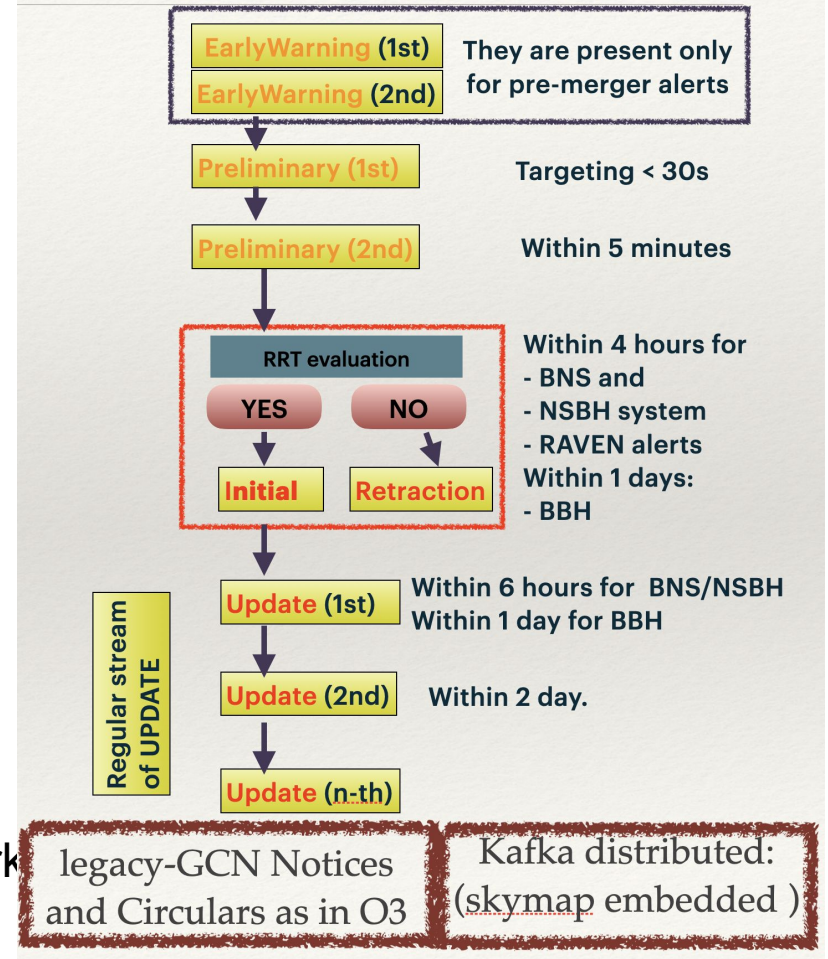
No.	Log Entry Created	Submitter	Comment
204	2022-12-13 15:42:37 UTC	LIGO/Virgo EM Follow-Up	Kafka alert notice sent to kafka://kafka.gcn.nasa.gov/igwn.gwalert (MS221213p-initial.json) em_follow lvem public
203	2022-12-13 15:42:37 UTC	LIGO/Virgo EM Follow-Up	Kafka alert notice sent to kafka://kafka.scimma.org/igwn.gwalert (MS221213p-initial.avro) em_follow lvem public
199	2022-12-13 15:42:35 UTC	LIGO/Virgo EM Follow-Up	New VOEvent (MS221213p-3-Initial.xml) em_follow lvem public gcn_received gcn_email_notok
187	2022-12-13 15:37:48 UTC	LIGO/Virgo EM Follow-Up	Volume rendering of bayestar.multiorder.fits,1 (bayestar.volume.png) sky_loc lvem public
174	2022-12-13 15:37:43 UTC	LIGO/Virgo EM Follow-Up	Source classification copied from M399362 (subthreshold.p_astro.json) lvem public p_astro
173	2022-12-13 15:37:43 UTC	LIGO/Virgo EM Follow-Up	Source properties copied from M399362 (subthreshold.em_bright.json) lvem public em_bright
151	2022-12-13 15:37:24 UTC	LIGO/Virgo EM Follow-Up	Kafka alert notice sent to kafka://kafka.gcn.nasa.gov/igwn.gwalert (MS221213p-preliminary.json) em_follow lvem public
150	2022-12-13 15:37:24 UTC	LIGO/Virgo EM Follow-Up	Kafka alert notice sent to kafka://kafka.scimma.org/igwn.gwalert (MS221213p-preliminary.avro) em_follow lvem public
143	2022-12-13 15:37:22 UTC	LIGO/Virgo EM Follow-Up	Mollweide projection of bayestar.multiorder.fits,1 (bayestar.png) sky_loc lvem public
142	2022-12-13 15:37:22 UTC	LIGO/Virgo EM Follow-Up	New VOEvent (MS221213p-2-Preliminary.xml) em_follow lvem public gcn_received gcn_email_notok

We encourage users to use the hourly MDC events on GraceDB to test their listeners. Search `MDC` in the search bar of gracedb.

Extra slides

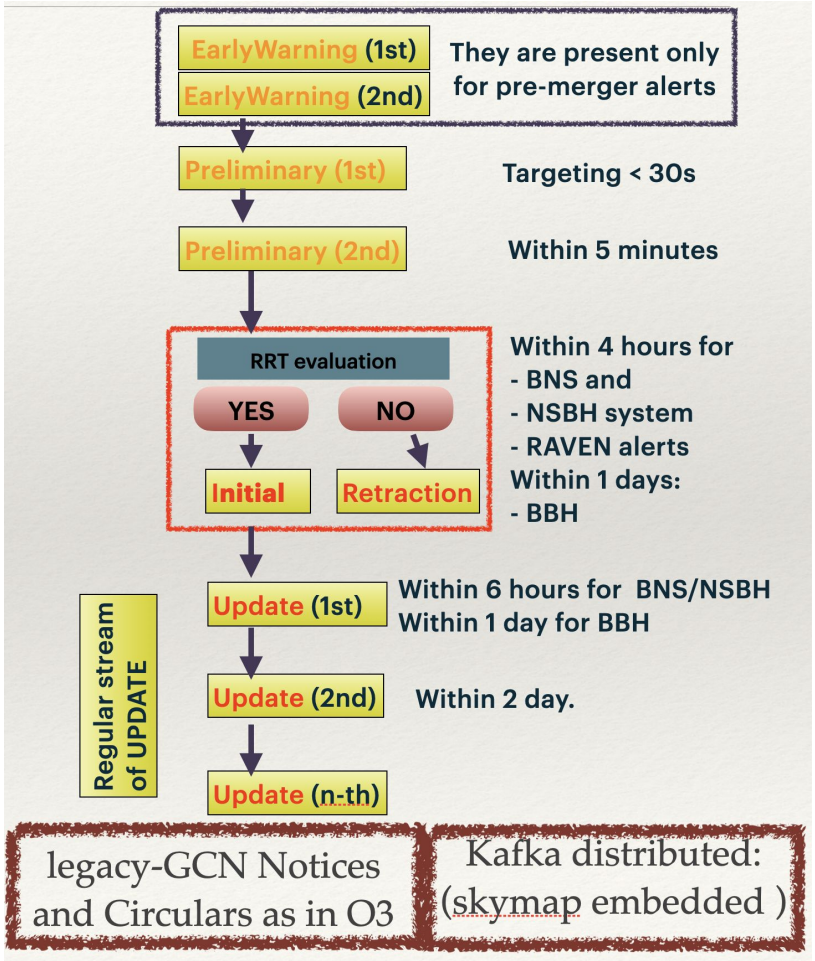
Alert system: Public alert

- FAR threshold (Trial factor will be applied)
  - 1/(2 months) (CBC)
  - To be discussed if lower FAR may be considered for CBC Early Warning.
  - 1/(1 year) (Burst)
- Multiple distribution channels for alerts
  - **GCN** (classic)-notices and circulars (as in O3)
  - **Kafka-based** alerts with embedded skymap via SCiMMA and GCN network



Alert system: Public alert

- RRT meeting and a human/rapid-PE evaluation typically within 4 hours for BNS or 1 day for vanilla BBH.
- An **Initial**/**Update** or **Retraction** alert will be sent. An Initial/Update alert can contain improved localization and source classification.
- Update alerts will be sent when improved PE results are available.



Avro schema for public alerts (Final !)

```
{  "name": "Alert",
   "namespace": "igwn.alerts.v1_0",
   "type": "record",
   "doc": "Alert schema v1.0.",
   "fields": [
      {"name": "author", "type": "string"},
      {"name": "alert_type", "type": "igwn.alerts.v1_0.AlertType",
                  "doc": "The type of alert; the possible values are EARLY_WARNING, PRELIMINARY, INITIAL, UPDATE,
RETRACTION."},
      {"name": "time_created", "type": "string", "doc": "The time the superevent was created in ISO 8601 format."},
      {"name": "superevent_id", "type": "string", "doc": "The GraceDB superevent ID."},
      {"name": "is_public", "type": "boolean", "doc": "Whether or not the event is public."},
      {"name": "is_injection", "type": "boolean", "doc": "Whether or not the event corresponds to an injected signal."},
      {"name": "event", "type": ["null", "igwn.alerts.v1_0.EventInfo"],
                  "doc": "Information about the event, if any."},
      {"name": "external_coinc", "type": ["null", "igwn.alerts.v1_0.ExternalCoincInfo"],
                  "doc": "Information about the coincidence with an non-GW event, if any."},
      {"name": "urls", "type": {"type": "map", "values": "string", "default": {}}, "doc": "URLs relevant to the event, if any."}
   ]
}
```

```
{   "name": "AlertType",
    "namespace": "igwn.alerts.v1_0",
    "type": "enum",
    "doc": "The type of alert.",
    "symbols": ["EARLY_WARNING", "PRELIMINARY", "INITIAL", "UPDATE", "RETRACTION"]
}
```

To be published in the O4 User Guide (Early November).
First draft will be published at the next openLVEM.