

A Common “Core” alert format?

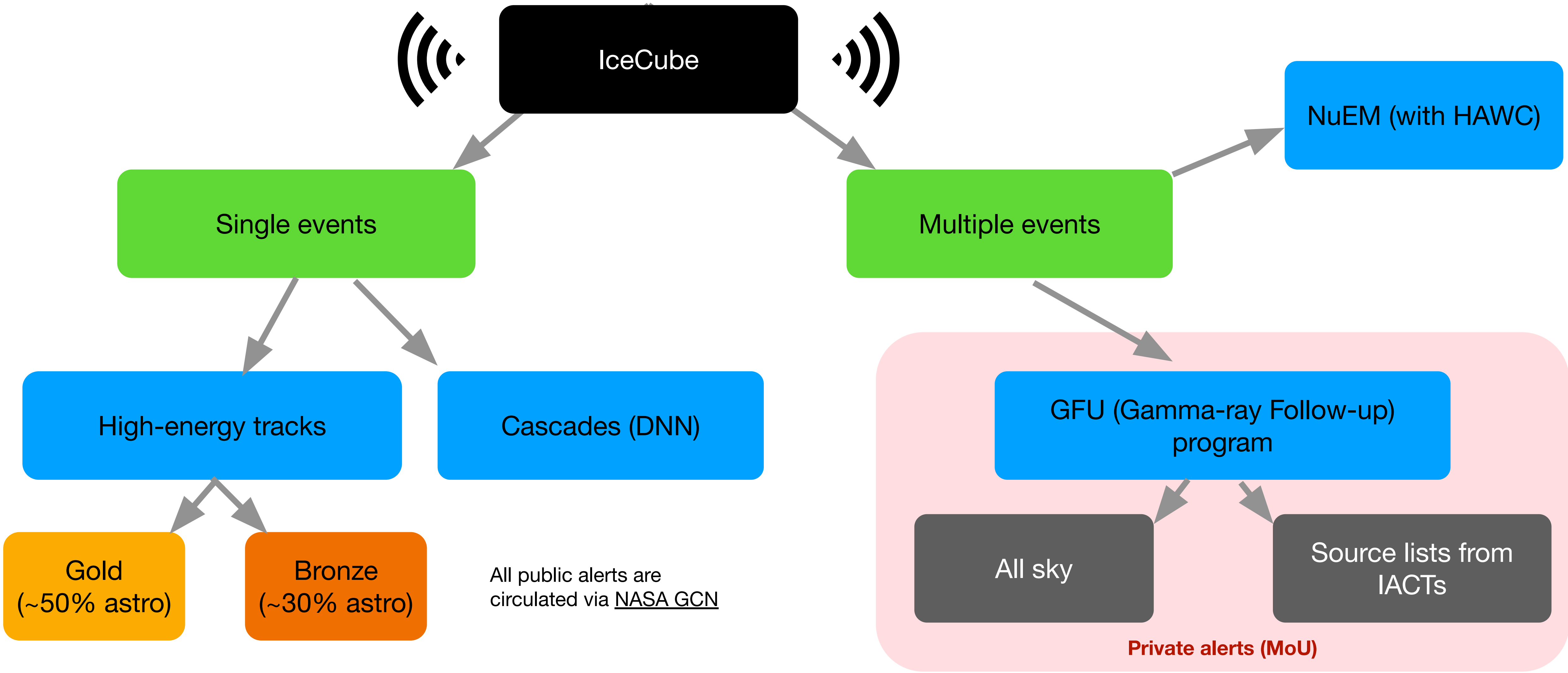
GNN Data Formats WG

Jan 24, 2025 call
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OpenAI “IceCube Data center”

IceCube Generated Alerts



All public alerts are circulated via NASA GCN

Private alerts (MoU)

IceCube Track Alerts: currently there and coming soon

For the IceCube issued alerts, we're working to get these updated with several technical improvements

- Improved event selections and event classifications (increased number of alert from starting events,...)
- Applying new reconstruction tools
 - Cascade and follow-up track reconstructions (rev 1 updates) improved significantly over the past years
- Per-event p-value maps in addition to error boxes.
 - In development in followup reconstruction toolbox

Unfortunately, we can no longer make updates to our “GCN classic alert” stream format

- Nor do we want to; we want to move these to the new [GCN-over-Kafka](#) systems
 - Trivial to copy other Kafka-based brokers such as [SCiMMA](#) as well

Common alert structure?

Since IceCube is redoing and KM3Net is establishing alert structures for the new GCN system, it's a good time to think about our overall alert structure.

Structure is set by the JSON schema used in your alert, built from established GCN “core” schema classes

Namely: Can we find a common set of “core” alert contents that both KM3Net and IceCube can promise to send with each alert?

- Simplify job for downstream consumers if we're including the same information, with the common definitions on what these values mean.
 - Still OK to add detector specific information on TOP of this core structure.

Been working with Vincent Cecchini from KM3Net to develop a common structure.

An updated IceCube Gold and Bronze track GCN-Kafka alerts.

```
{
  "$schema": "https://gcn.nasa.gov/schema/main/gcn/notices/icecube/gold_bronze_track_alerts.schema.json",
  "mission": "IceCube",
  "instrument": "IC86",
  "messenger": "Neutrino",
  "event_name": ["IceCube-230416A"],
  "id": ["137840_57034692_0"],
  "alert_datetime": "2023-04-16T05:42:00.0Z",
  "alert_type": "initial",
  "alert_tense": "current",
  "analysis_pipeline": "IceCube Bronze Track alert",      # Name of alert pipeline
  "alert_topology": "Track",
  "number_of_events": 1,                                # Number of events that generated alert (1 for single event)
  "ra": 345.82,
  "dec": 9.01,                                          # RA/DEC with circular error at 90% containment
  "ra_dec_error": 0.5,
  "containment_probability": 0.9,
  "systematic_included": false,
  "healpix_url": "https://roc.icecube.wisc.edu/public/...",      # Healpix map of per-pixel probability
  "trigger_time": "2023-04-16T05:22:26.150574Z",
  "nu_energy": 127.29,                                  # Estimated Neutrino Energy (TeV)
  "p_astro": 0.34064,                                   # Estimated probability of being astrophysical (was called "signalness")
  "far": 8.029e-8,                                     # False alarm rate (Hz...)
}
```

See my GitHub [PR against gcn-schema](#) for the actual details.

Based on a common core structure shared with KM3Net

```
{
"$schema": "https://gcn.nasa.gov/schema/main/gcn/notices/icecube/gold_bronze_track_alerts.schema.json",
"mission": "IceCube",      "KM3Net"
"instrument": "IC86",      "ARCA021"
"messenger": "Neutrino",
"event_name": ["IceCube-230416A"],  ["KM3-230416A"]
"id": ["137840_57034692_0"],  "_1 for 1st update, _2 for 2nd update.."
"alert_datetime": "2023-04-16T05:42:00.0Z",
"alert_type": "initial",      ["initial", "subsequent", "update", "retraction"]
"alert_tense": "current",     ["current", "archival", "planned", "injection", "commanded", "test"]
"analysis_pipeline": "IceCube Bronze Track alert",  "exceptional_evt_arca"
"alert_topology": "Track",    ["Track", "Shower", "Multiplet"]
"number_of_events": 1,
"ra": 345.82,
"dec": 9.01,
"ra_dec_error": 0.5,
"containment_probability": 0.9,
"systematic_included": false,
"healpix_url": "https://roc.icecube.wisc.edu/public/",  "https://www.km3net.org/about-km3net/open-access/"
"trigger_time": "2023-04-16T05:22:26.150574Z",
"nu_energy": 127.29,         <- IceCube specific value, KM3Net not reporting
"p_astro": 0.34064,         <- GCN core "standard", probability of being astrophysical
"far": 8.029e-8
}
```

black - from core schema

blue - shared neutrino alert schema

red - IceCube specific item

See my GitHub [PR against gcn-schema](#) for the actual details.

A common core discussion items

Other potential items?

- Is the core schema complete? Anything we can both benefit from adding?

Other considerations:

- Same notice schema for all alerts?
 - In IceCube - I think we can do this for our single alert events (tracks and showers alert searches)
 - Considering a potentially different format for multiplet alerts - but still a work in progress.
 - GFU time dependent catalog and all-sky point source searches
 - Dedicate follow-ups of higher rate alerts (currently LVK only) already get dedicated alert notice format.
- Move away from “always send a GCN Circular”?
 - Just use to highlight very interesting alerts (high p_{astro} , interesting correlations?)
 - Some discussions about doing this in Icecube (no conclusion yet)
 - Already doing this for LVK alerts due to high rate.

Moving forward

Good coordination toward a “common” neutrino telescope schema into GCN

- Strong, well established base of neutrino telescope specific values with common definitions.
- Each collaboration can build onto this with per-detector specific information
- [PR review](#) started with GCN organization
- Mission specific documentation needed for GCN website

Once in place IceCube plans to:

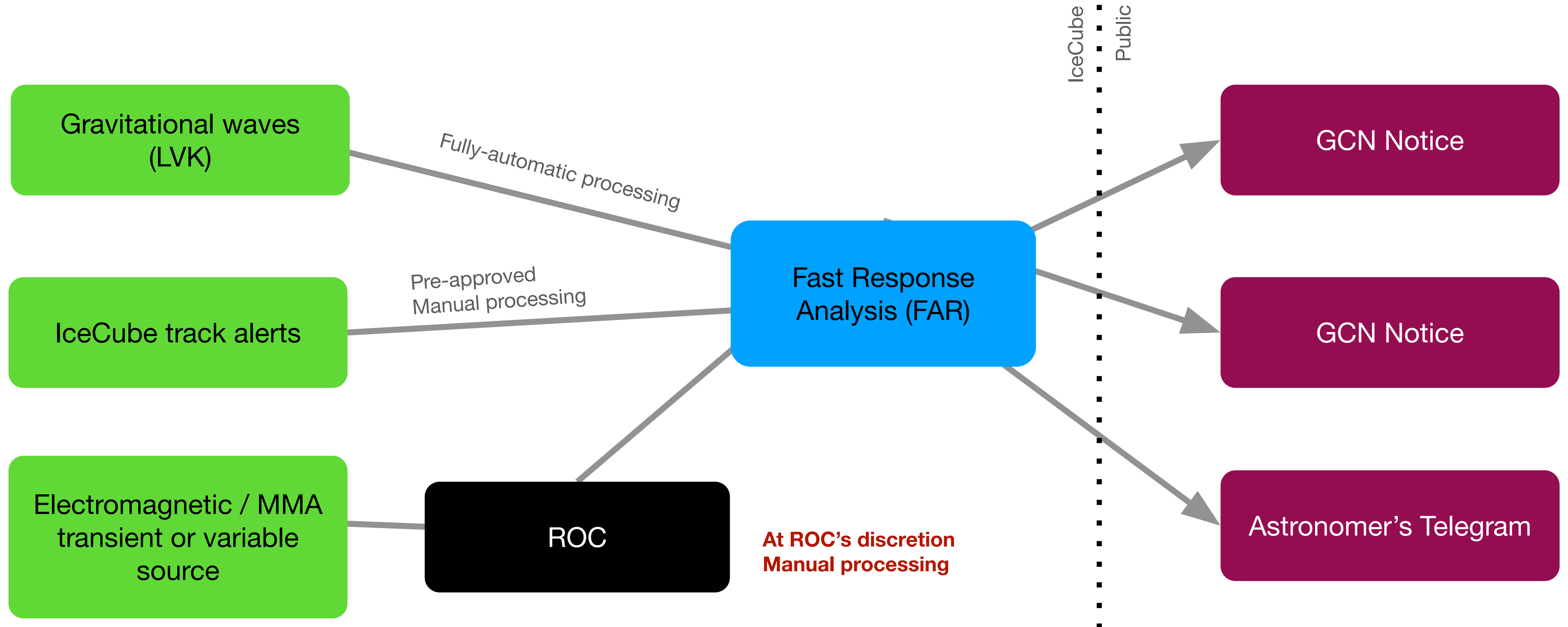
- Start sending copies of track alerts on GCN Kafka (initial and updates)
- Move our Cascade alerts as well!
- Retire AMON-based alert sender to GCN classic at a later time

Welcome discussion!



Extras...

IceCube responses to external triggers



IceCube responses to external triggers

Only LVK Notices sent to [New GCN](#)

