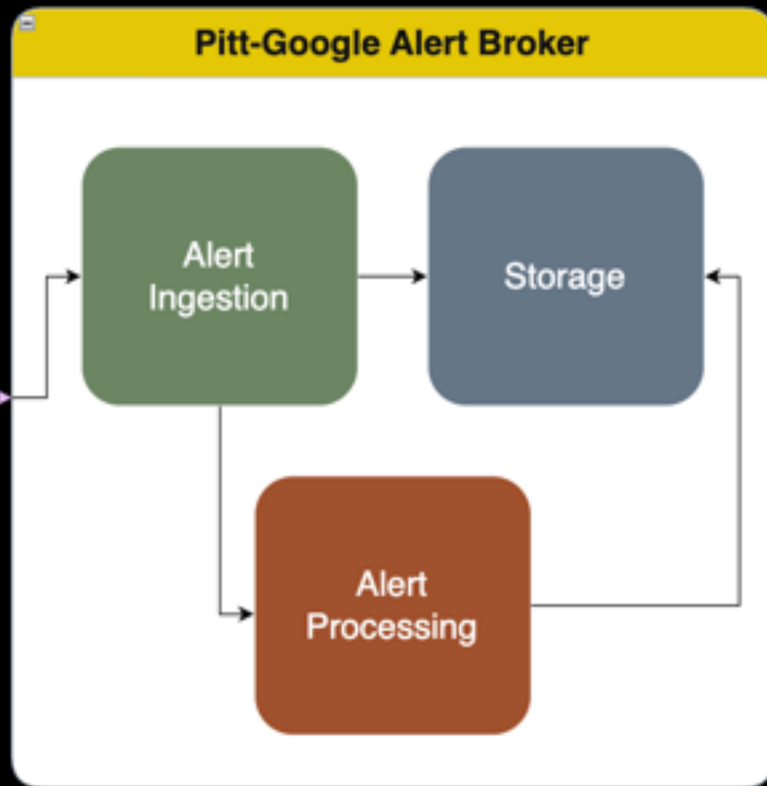


# Pitt-Google Alert Broker: Architecture Overview



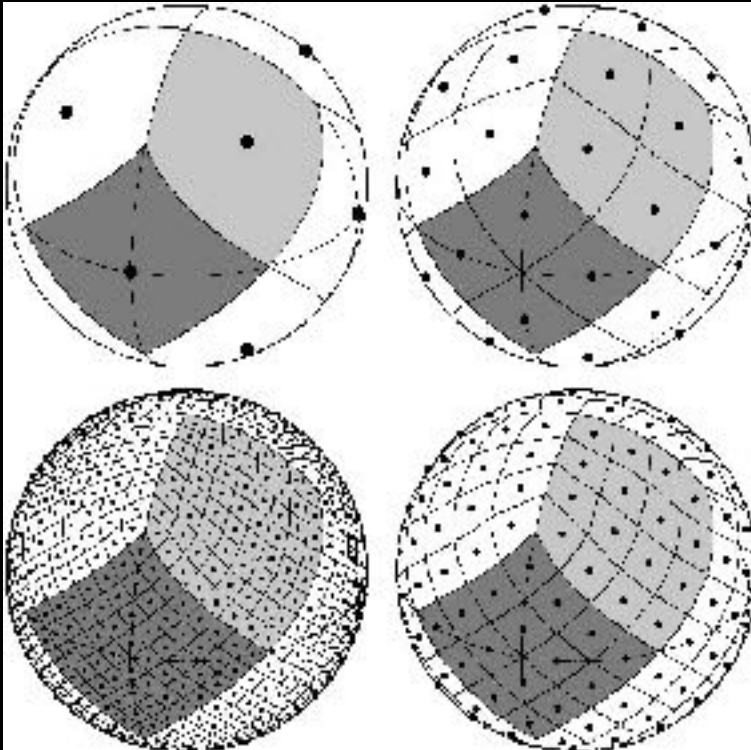
- Our adoption of Google Cloud Services is designed to address the challenges our field currently faces in data access, storage, transport, and processing
  - Pub/Sub
  - Google Cloud Storage buckets
  - BigQuery
  - Cloud Run
- Access to our broker's data products is facilitated by our Python library: `pittgoogle-client`

# Data Products Served by Pitt-Google



Survey	Brokered data products
Legacy Survey of Space & Time (LSST)	<ul style="list-style-type: none"> <li>• Alert streams (Pub/Sub)</li> <li>• Value-added streams (Pub/Sub)</li> <li>• Original alerts in avro format (Cloud Storage bucket)</li> <li>• Alert table and value-added tables (BigQuery)</li> </ul>
Zwicky Transient Facility (ZTF)	<ul style="list-style-type: none"> <li>• Alert streams (Pub/Sub)</li> <li>• Value-added streams (Pub/Sub)</li> <li>• Original alerts in avro format (Cloud Storage bucket)</li> <li>• Alert table and value-added tables (BigQuery)</li> </ul>
LIGO/Virgo/KAGRA (LVK)	<ul style="list-style-type: none"> <li>• Alert streams (Pub/Sub)</li> <li>• Original alerts in JSON format (Cloud Storage bucket)</li> <li>• Alert table (BigQuery)</li> </ul>
Gaia	<ul style="list-style-type: none"> <li>• Gaia Data Release 3 tables (BigQuery)</li> </ul>

# Hierarchical Equal Area isoLatitude Pixelation (HEALPix)



Various resolutions of a sphere hierarchically tessellated into curvilinear quadrilaterals. The spheres are partitioned, respectively, into 12, 48, 192, and 768 pixels (clockwise from upper-left to bottom-left). Credit: [HEALPix](#)

## Three essential properties:

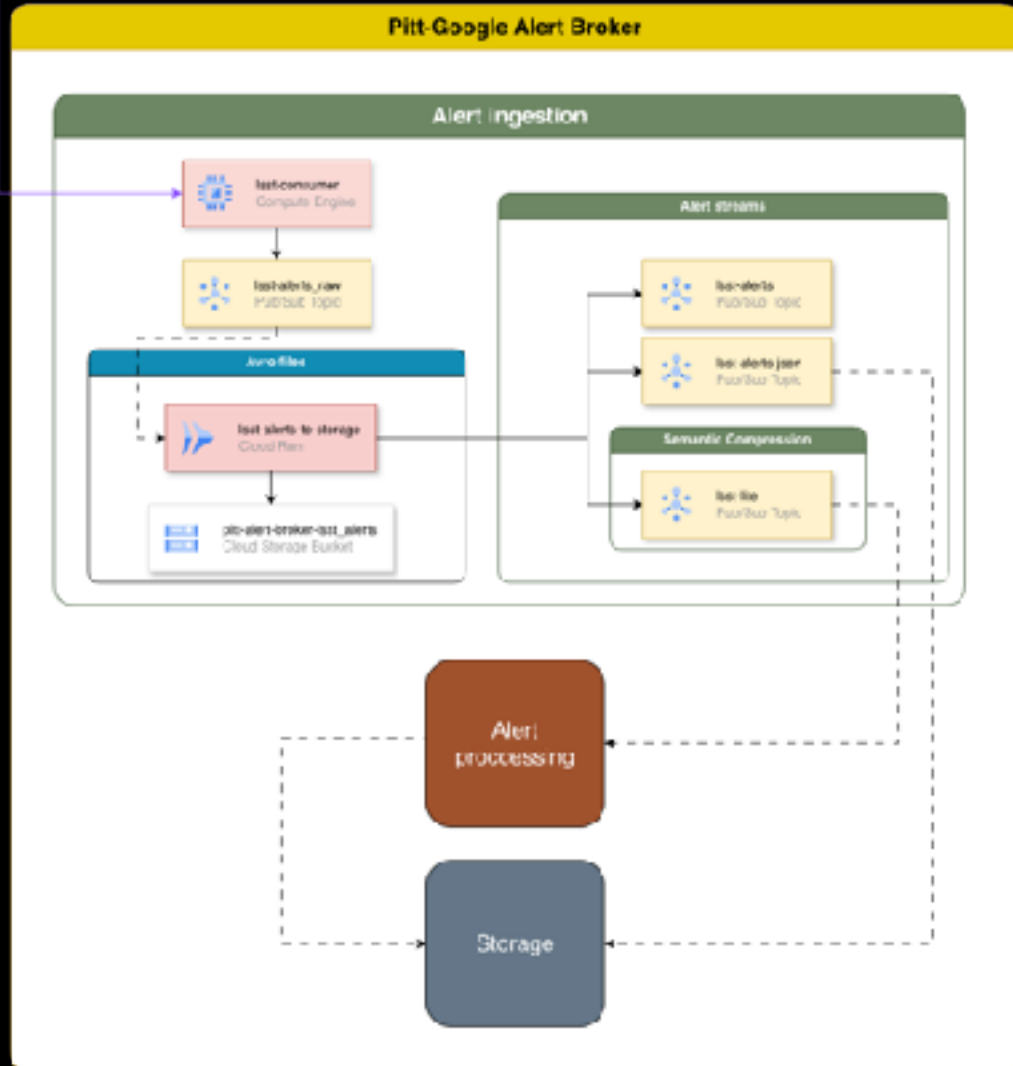
- The sphere is tessellated into curvilinear quadrilaterals
- Areas of all pixels at a given resolution are identical
- Pixels are distributed on lines of constant latitude

## Facilitates:

- Spatial alert filtering and queries



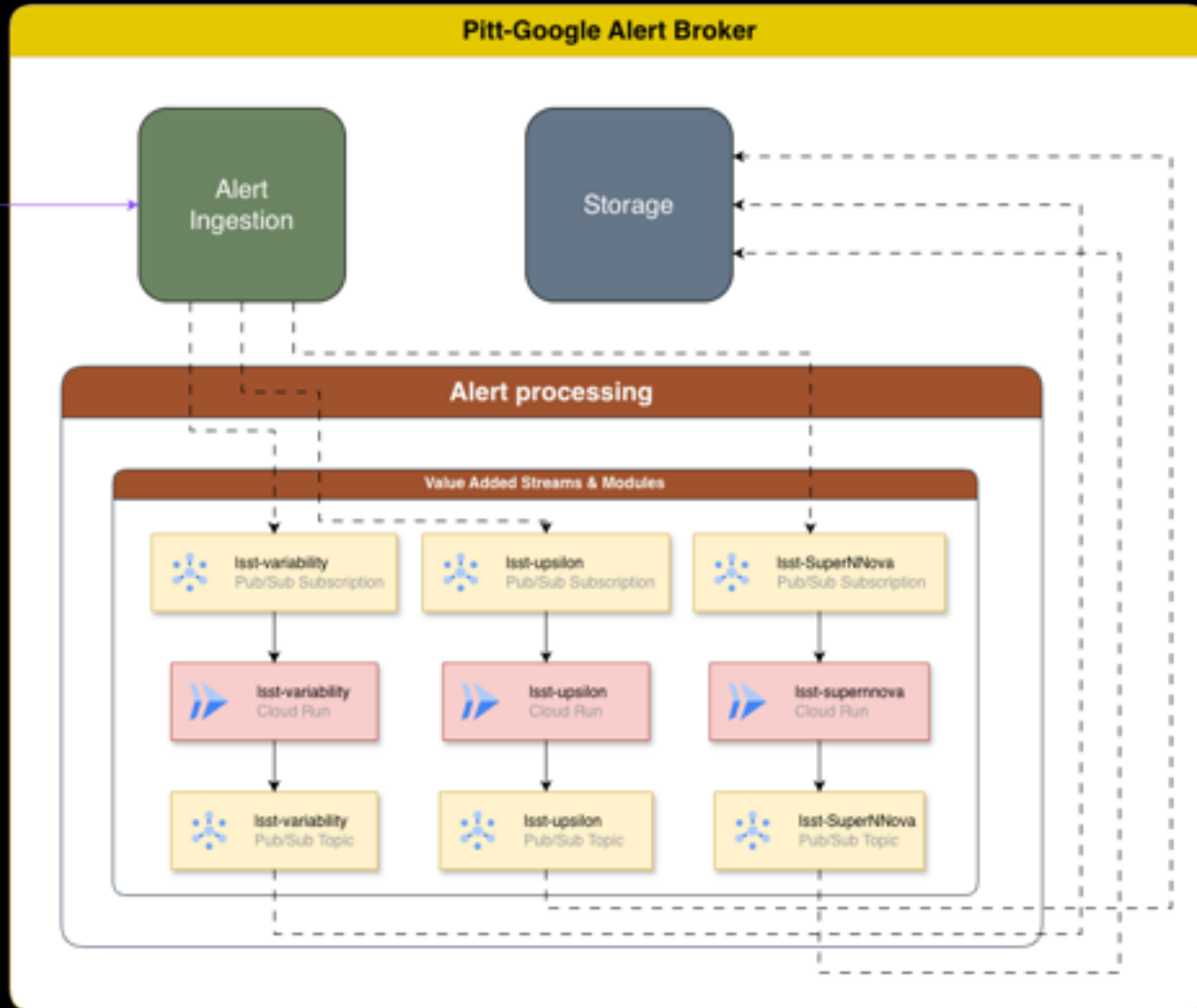
# Pub/Sub



- **Publisher -> subscriber model**
  - Supports user-defined filters
  - Subscriptions can be made private
- **Alert streams:**
  - lsst-alerts
  - lsst-alerts-json
  - lsst-lite
  - lsst-loop
- **Value-added streams:**
  - lsst-variability
  - lsst-upsilon
  - lsst-supernnova



# Cloud Run

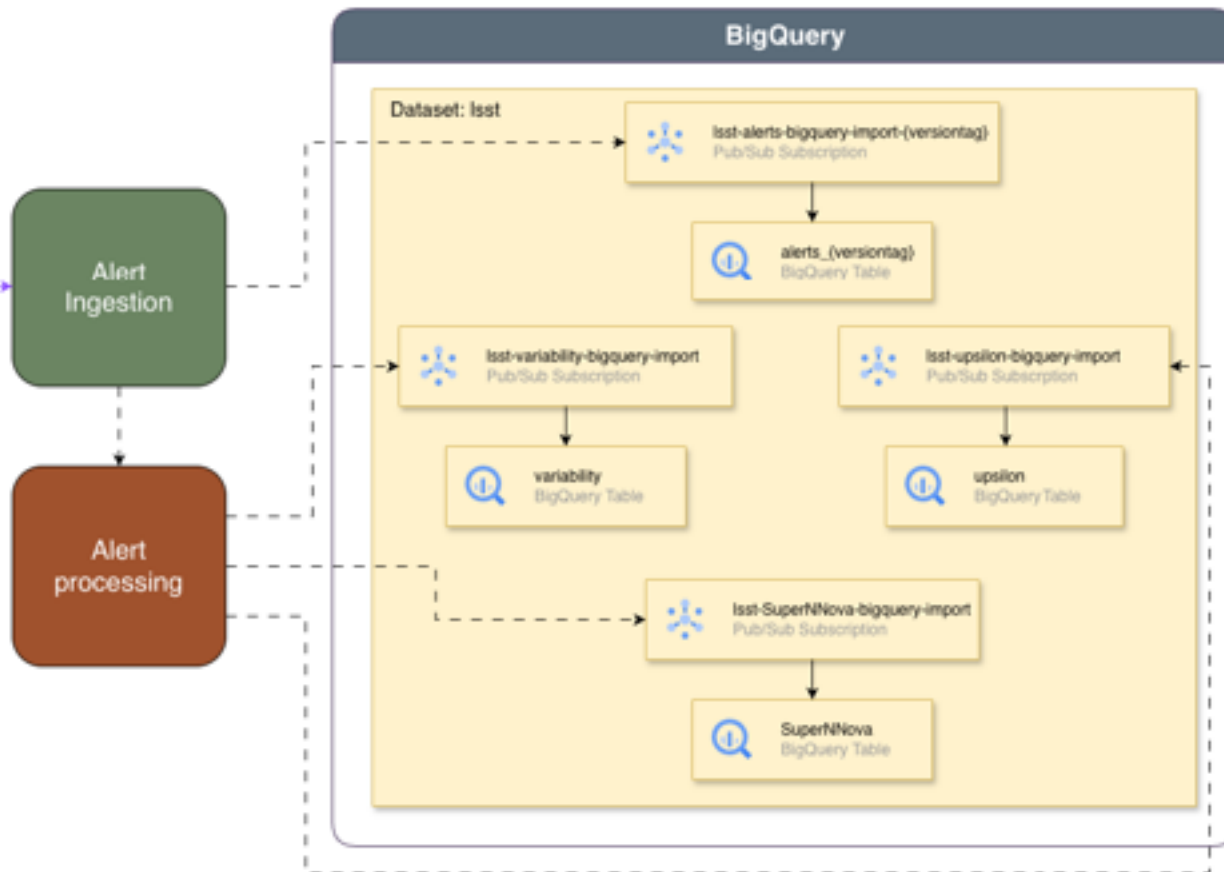


- Applications (i.e., Python code) are containerized and deployed as a Cloud Run service (e.g., lsst-upsilon, lsst-supernova)
- Cloud Run service
  - Responds to HTTP requests sent to a unique and stable endpoint
  - Rapidly and automatically scales out the number of instances to handle all incoming requests

# BigQuery



## Pitt-Google Alert Broker



- **Tables:**
  - `alerts_{versiontag}`
  - `supernnova`
  - `upsilon`
  - `variability`
- **Cloud-based data warehouse**
- **Optimized for analytical queries**
  - **Data can be accessed via the Google Cloud Console or through the `pittgoogle-client` using SQL queries**

# Alerts (v10.0) table

## Not clustered; Not partitioned

diaSourceId	observation_reason	healpix9	healpix19	healpix29	kafkaPublishTimestamp
170028510883610	ddf_cosmos	1749339	1835048118767	1923429858321150000	2026-02-27
170028510883619	ddf_cosmos	1750024	1835027918044	1924224341945890000	2026-02-28
170028511145754	ddf_cosmos	1749366	1835073640408	1924201253188560000	2026-02-28
170028510872076	ddf_cosmos	1750062	1835027918044	1924200221537570000	2026-02-28
170028510741528	ddf_cosmos	1750062	1835080260705	1924214147087010000	2026-02-26
170028510871027	ddf_cosmos	1749339	1835048118767	1923418514677430000	2026-02-27
170028510871024	ddf_cosmos	1750024	1835080675559	1924182437838870000	2026-02-27
170028510466803	ddf_cosmos	1750062	1835031718236	1923429858321150000	2026-02-25
170028510871029	ddf_cosmos	1749366	1834315471488	1924223879459800000	2026-02-27
170028510872072	ddf_cosmos	1749366	1835074182299	1924208688231980000	2026-02-28
170028510738381	ddf_cosmos	1750024	1835080675559	1924214496117610000	2026-02-26
170028510468899	ddf_cosmos	1749366	1835073640408	1924214496117610000	2026-02-25
170028510871029	ddf_cosmos	1749339	1835073640408	1923418514677430000	2026-02-26
170028510738382	ddf_cosmos	1750024	1834343478227	1924215218628000000	2026-02-26
170028500543079	ddf_cosmos	1750062	1835073611341	1924214093461090000	2026-02-25
170028510484627	ddf_cosmos	1749339	1835027918044	1924215218628000000	2026-02-25

## Alerts (v10.0) table Clustered by healpix9; Not partitioned

diaSourceId	observation_reason	healpix9	healpix19	healpix29	kafkaPublishTimestamp
170028510738382	ddf_cosmos	1750024	1834343478227	1924215218628000000	2026-02-26
170028510738381	ddf_cosmos	1750024	1835080675559	1924214496117610000	2026-02-26
170028510871024	ddf_cosmos	1750024	1835080675559	1924182437838870000	2026-02-27
170028510883619	ddf_cosmos	1750024	1835027918044	1924224341945890000	2026-02-28
170028500543079	ddf_cosmos	1750062	1835073611341	1924214093461090000	2026-02-25
170028510466803	ddf_cosmos	1750062	1835031718236	1923429858321150000	2026-02-25
170028510741528	ddf_cosmos	1750062	1835080260705	1924214147087010000	2026-02-26
170028510872076	ddf_cosmos	1750062	1835027918044	1924200221537570000	2026-02-28
170028510468899	ddf_cosmos	1749366	1835073640408	1924214496117610000	2026-02-25
170028510871029	ddf_cosmos	1749366	1834315471488	1924223879459800000	2026-02-27
170028510872072	ddf_cosmos	1749366	1835074182299	1924208688231980000	2026-02-28
170028511145754	ddf_cosmos	1749366	1835073640408	1924201253188560000	2026-02-28
170028510484627	ddf_cosmos	1749339	1835027918044	1924215218628000000	2026-02-25
170028510871029	ddf_cosmos	1749339	1835073640408	1923418514677430000	2026-02-26
170028510871027	ddf_cosmos	1749339	1835048118767	1923418514677430000	2026-02-27
170028510883610	ddf_cosmos	1749339	1835048118767	1923429858321150000	2026-02-27

# Alerts (v10.0) table

## Clustered by healpix9; Partitioned by

Partition:  
2026-02-25  
Cluster:  
healpix9

diaSourceId	observation_reason	healpix9	healpix19	healpix29	kafkaPublishTimestamp
170028500543079	ddf_cosmos	1750062	1835073611341	1924214093461090000	2026-02-25
170028510466803	ddf_cosmos	1750062	1835031718236	1923429858321150000	2026-02-25
170028510468899	ddf_cosmos	1749366	1835073640408	1924214496117610000	2026-02-25
170028510484627	ddf_cosmos	1749339	1835027918044	1924215218628000000	2026-02-25

Partition:  
2026-02-26  
Cluster:  
healpix9

diaSourceId	observation_reason	healpix9	healpix19	healpix29	kafkaPublishTimestamp
170028510738382	ddf_cosmos	1750024	1834343478227	1924215218628000000	2026-02-26
170028510738381	ddf_cosmos	1750024	1835080675559	1924214496117610000	2026-02-26
170028510741528	ddf_cosmos	1750062	1835080260705	1924214147087010000	2026-02-26
170028510871029	ddf_cosmos	1749339	1835073640408	1923418514677430000	2026-02-26

Partition:  
2026-02-27  
Cluster:  
healpix9

diaSourceId	observation_reason	healpix9	healpix19	healpix29	kafkaPublishTimestamp
170028510871024	ddf_cosmos	1750024	1835080675559	1924182437338870000	2026-02-27
170028510871029	ddf_cosmos	1749366	1834315471488	1924223879459800000	2026-02-27
170028510871027	ddf_cosmos	1749339	1835048118767	1923418514677430000	2026-02-27
170028510883610	ddf_cosmos	1749339	1835048118767	1923429858321150000	2026-02-27

Partition:  
2026-02-28  
Cluster:  
healpix9

diaSourceId	observation_reason	healpix9	healpix19	healpix29	kafkaPublishTimestamp
170028510883619	ddf_cosmos	1750024	1835027918044	1924224341945890000	2026-02-28
170028510872076	ddf_cosmos	1750062	1835027918044	1924200221537570000	2026-02-28
170028510872072	ddf_cosmos	1749366	1835074182299	1924208688231980000	2026-02-28
170028511145754	ddf_cosmos	1749366	1835073640408	1924201253188560000	2026-02-28



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The Ohio State University



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Google



**Ross Thomson**  
Software Engineer  
Google



**Joseph Pingnot**  
Software Engineer  
Google