# Ultra-low Latency Data Collection and Processing for VIIRS, CrIS, and MODIS

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# Introduction

## Direct Broadcast Real-time Network (DbRTN)

- Collect JPSS, MetOp, EOS Level-0 Sounder Data
- 5 Owned & operated stations & 15 Partner stations
- Collected Centrally
- Create L1B and DBNet BUFR products
- As part of WMO DBNet, goal to deliver infrared and microwave sounder products to NWP centers within 30m

## DbRTN Ultra-low Latency (ULL)

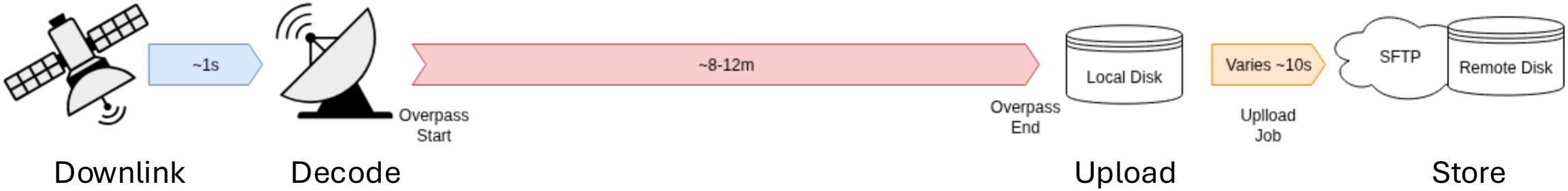
- Produce products in less than 60s of observation
- Provide a single continuous multi-station data stream

# Traditional Operation

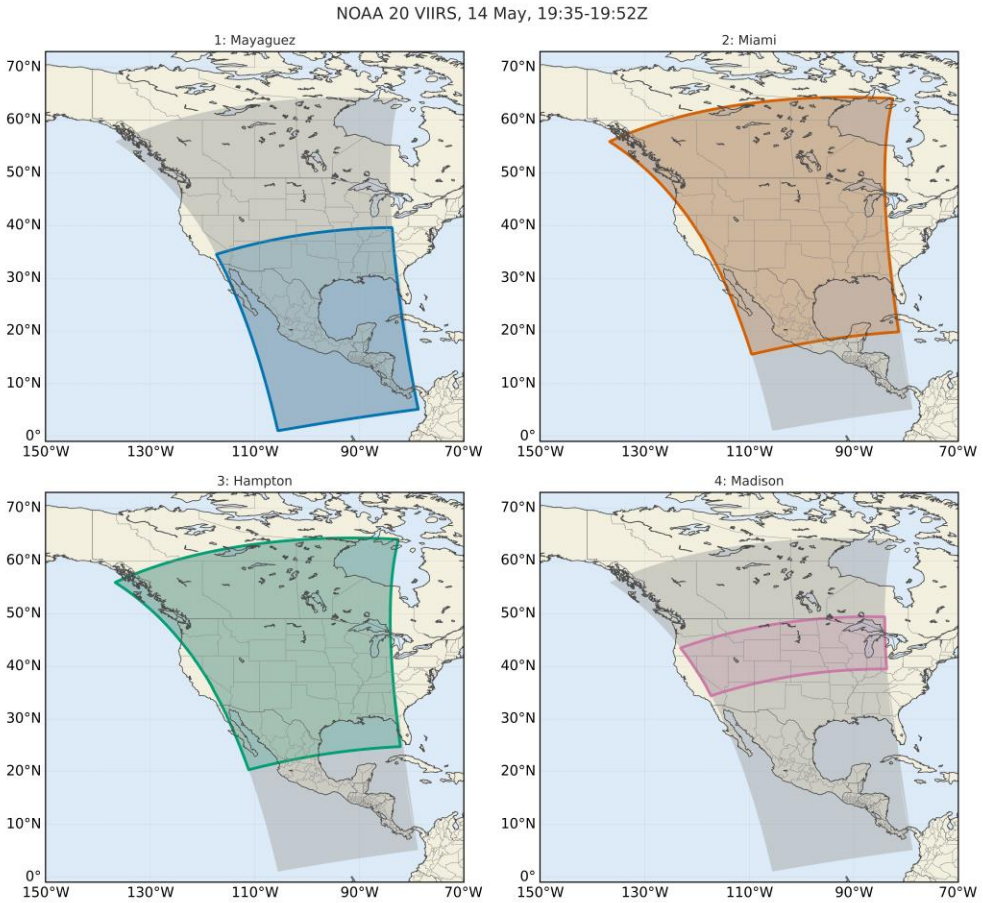
Pipeline

- Hardware demodulator
- Software decoder
- Spool decoded level-0 to disk until overpass ends
- Post-overpass upload task

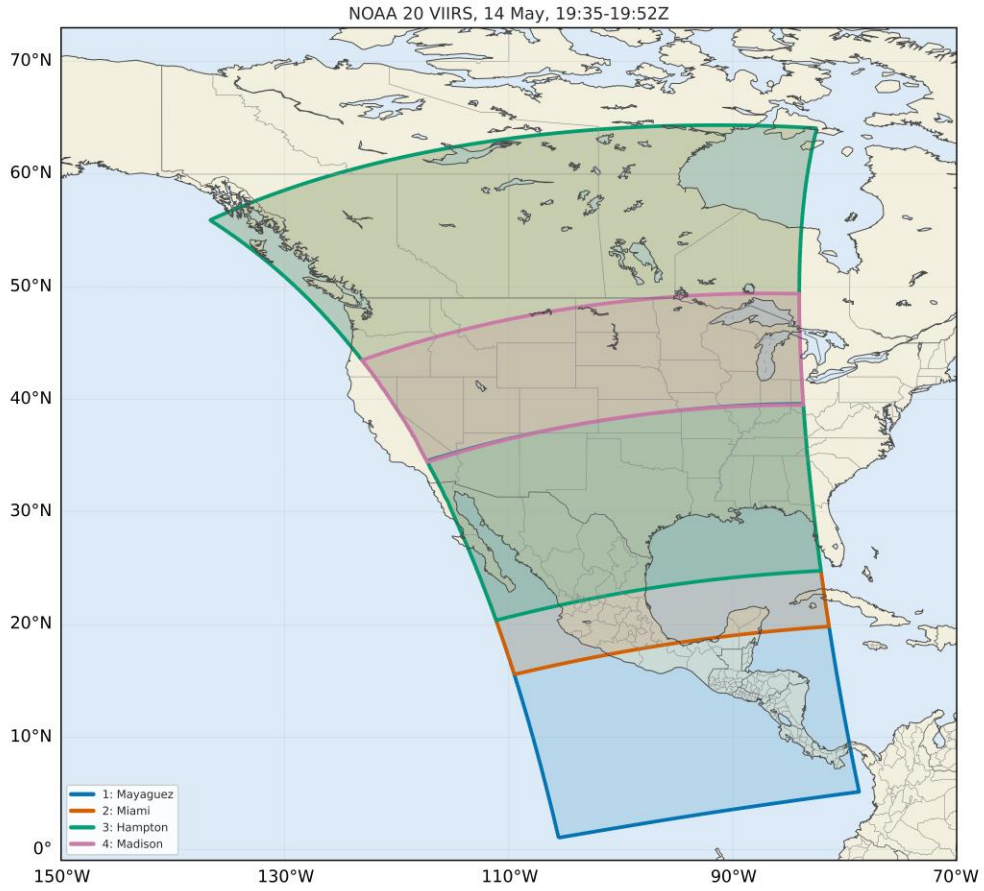
- Latency is dominated by waiting for the overpass to end before uploading.



# Traditional Operation Duplication




Mayaguez, Miami, Hampon, and Madison all receiving NOAA 20 data from May 14




Data in the overlapping region from each station is uploaded and processed independently

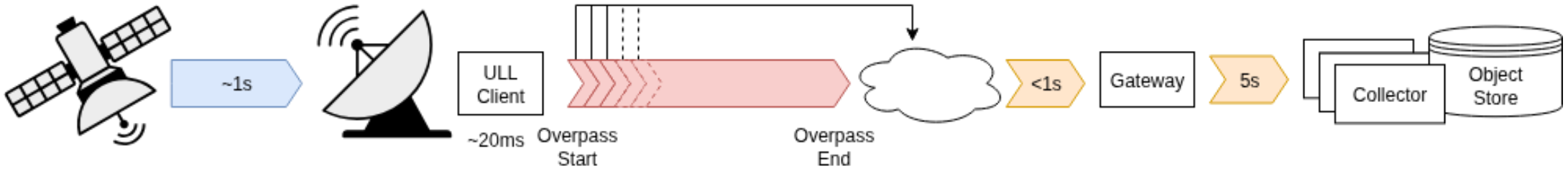
# ULL Operation

**Real-time** pipeline

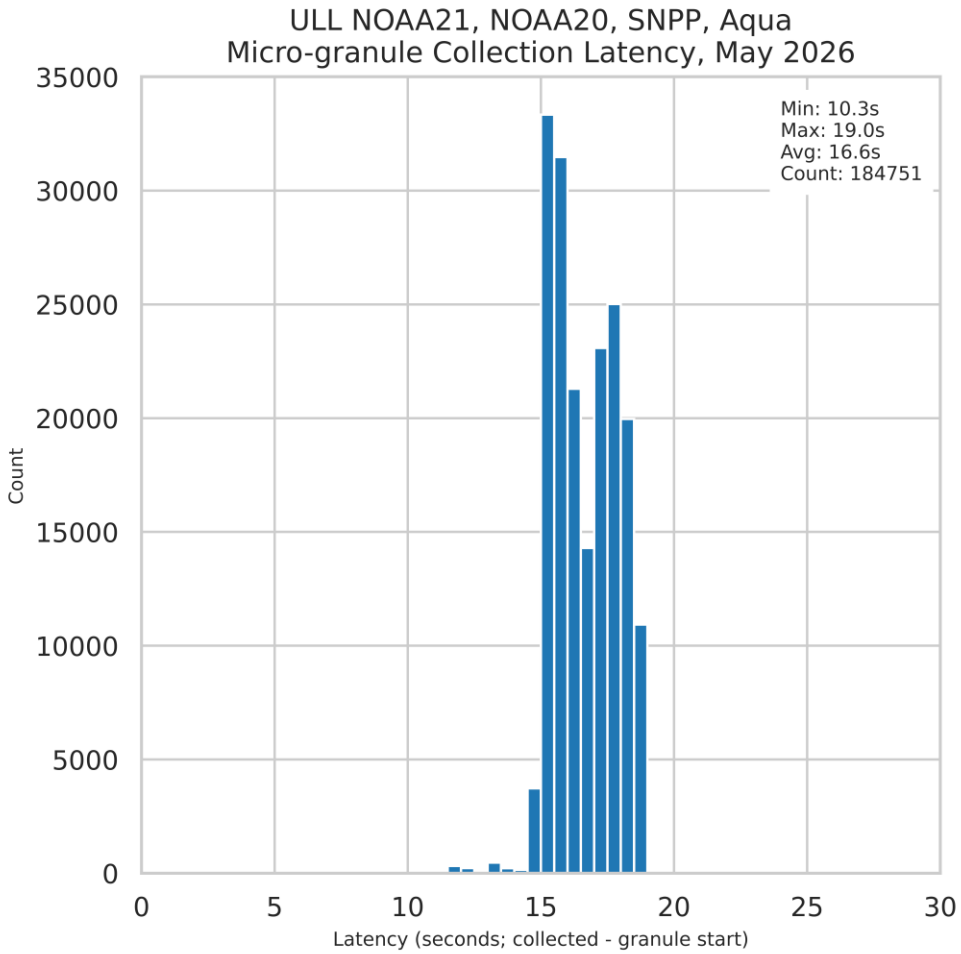
- Hardware demodulator
- Software decoder
- **ULL Client**
  - Filtering
  - Metadata scraping
  - Immediately pushed downstream
    - Does not wait for overpass end
    - Does not write data to disk

**ULL Infrastructure**

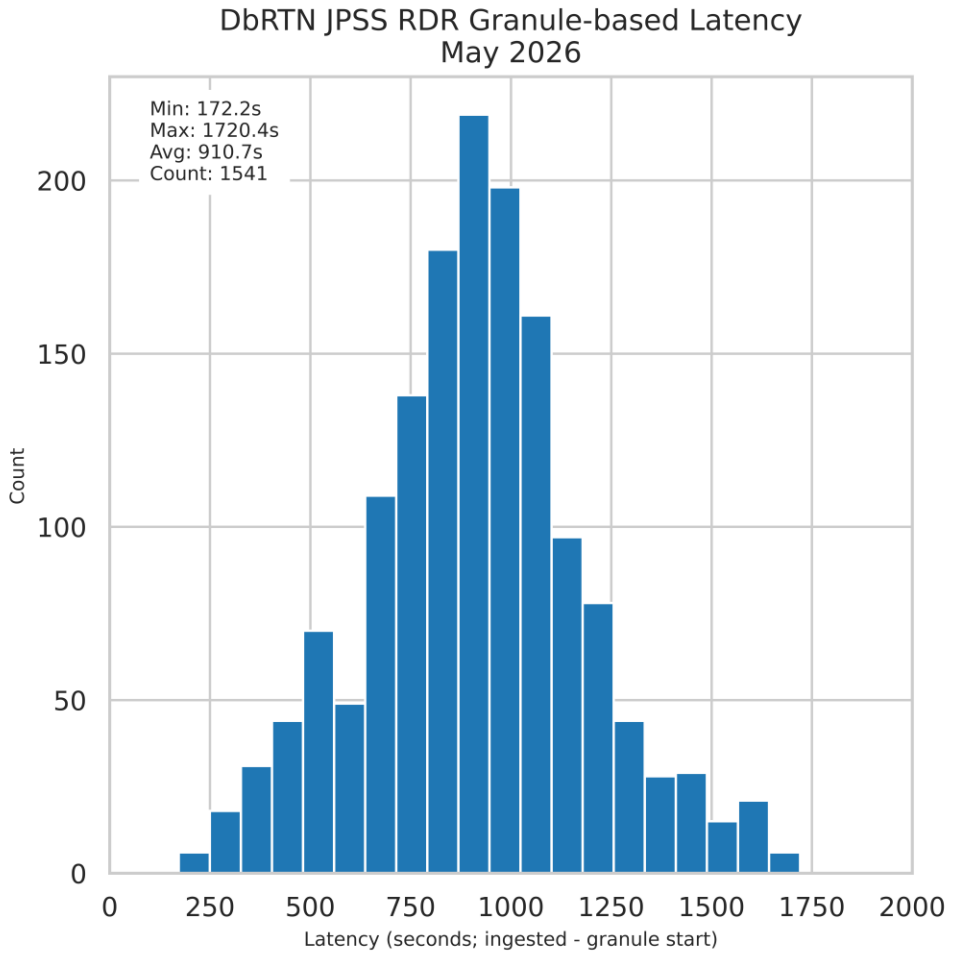
- Gateway Receiver
  - Deduplication/merge
  - Streaming
- Collectors
  - Creates Micro-granules (5 seconds)
  - Per-product
- Submitters
  - Collects micro-granules inputs
  - Per-algorithm



# ULL Operation




ULL Latency: ~17s (**~50x reduction**)

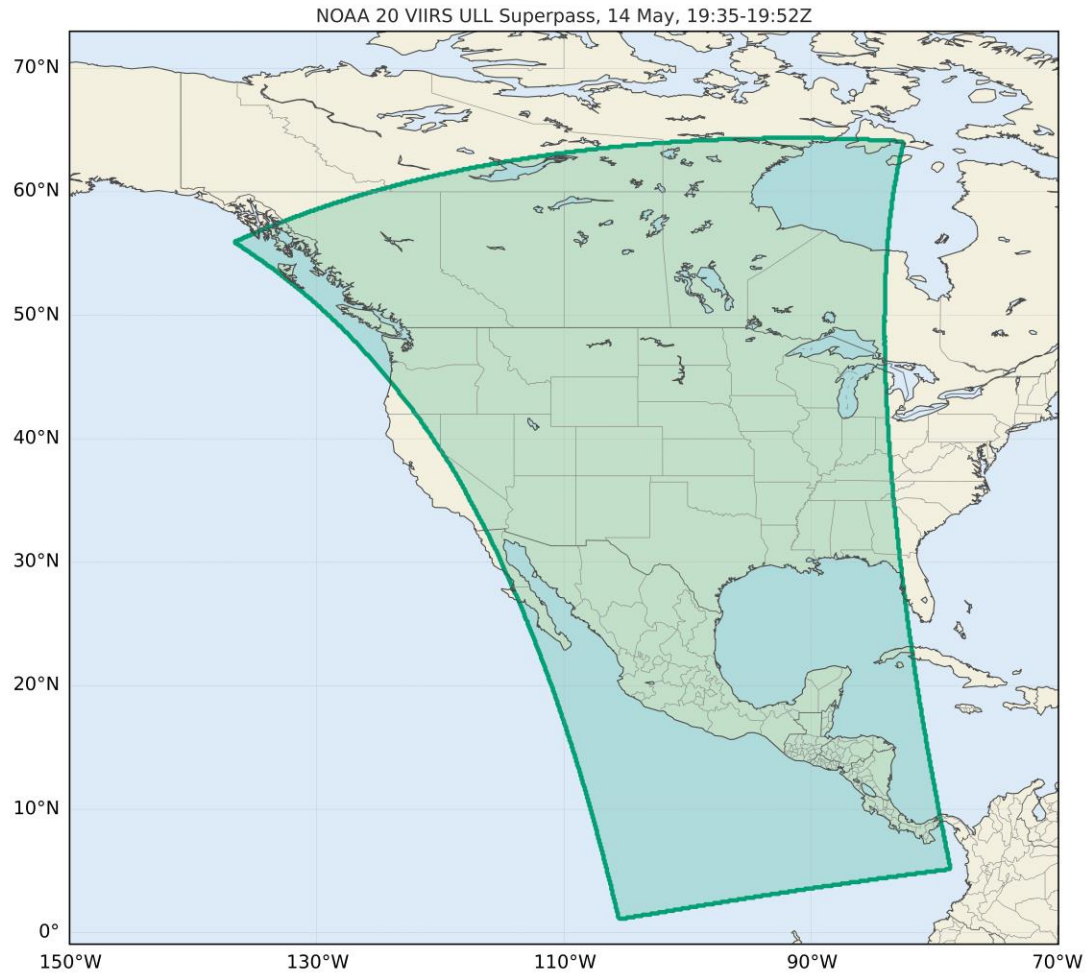



DbRTN RDR Latency: ~15m10s

# ULL Operation

Superpass

- A deduplicated, merged, multi-station overpass
- Data provided by the spacecraft will only be processed once

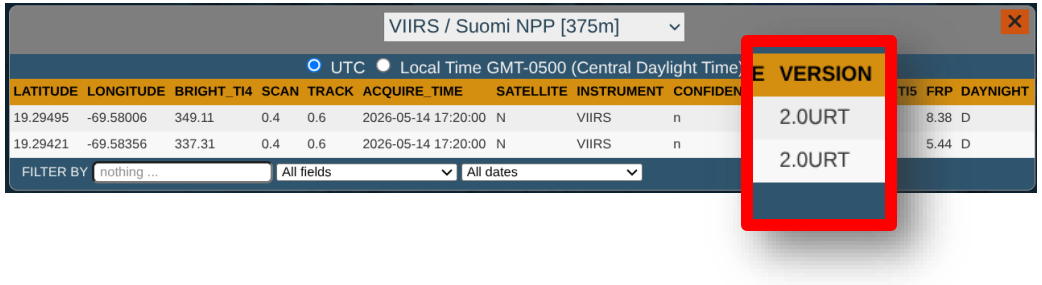


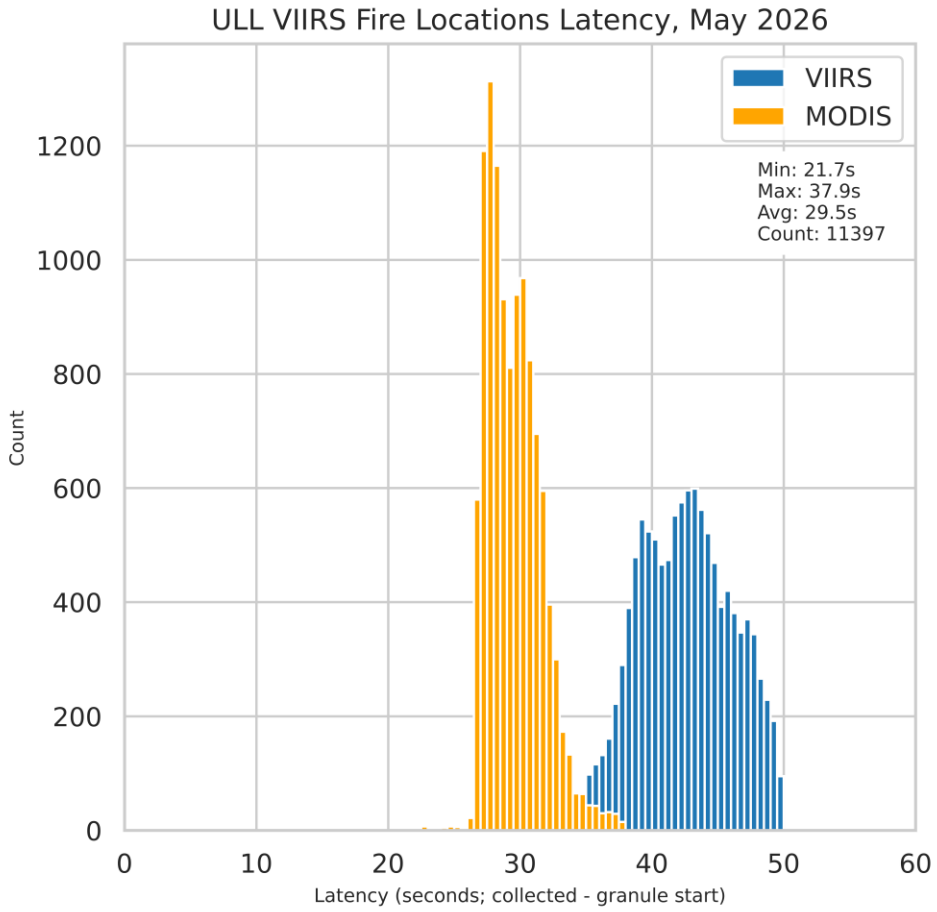

Merged Superpass of May 14 overpass from Mayaguez, Miami, Hampton, and Madison

# ULL Products

## VIIRS/MODIS Fire Locations (NASA FIRMS)

- Within 60s of observation
- Micro-granule processing
  - 2-3 scans due to scan duration
- NASA VIIRS L1 / VFire375
  - NOAA 21, NOAA 20, SNPP
- NASA MODIS L1 / MOD14
  - Aqua



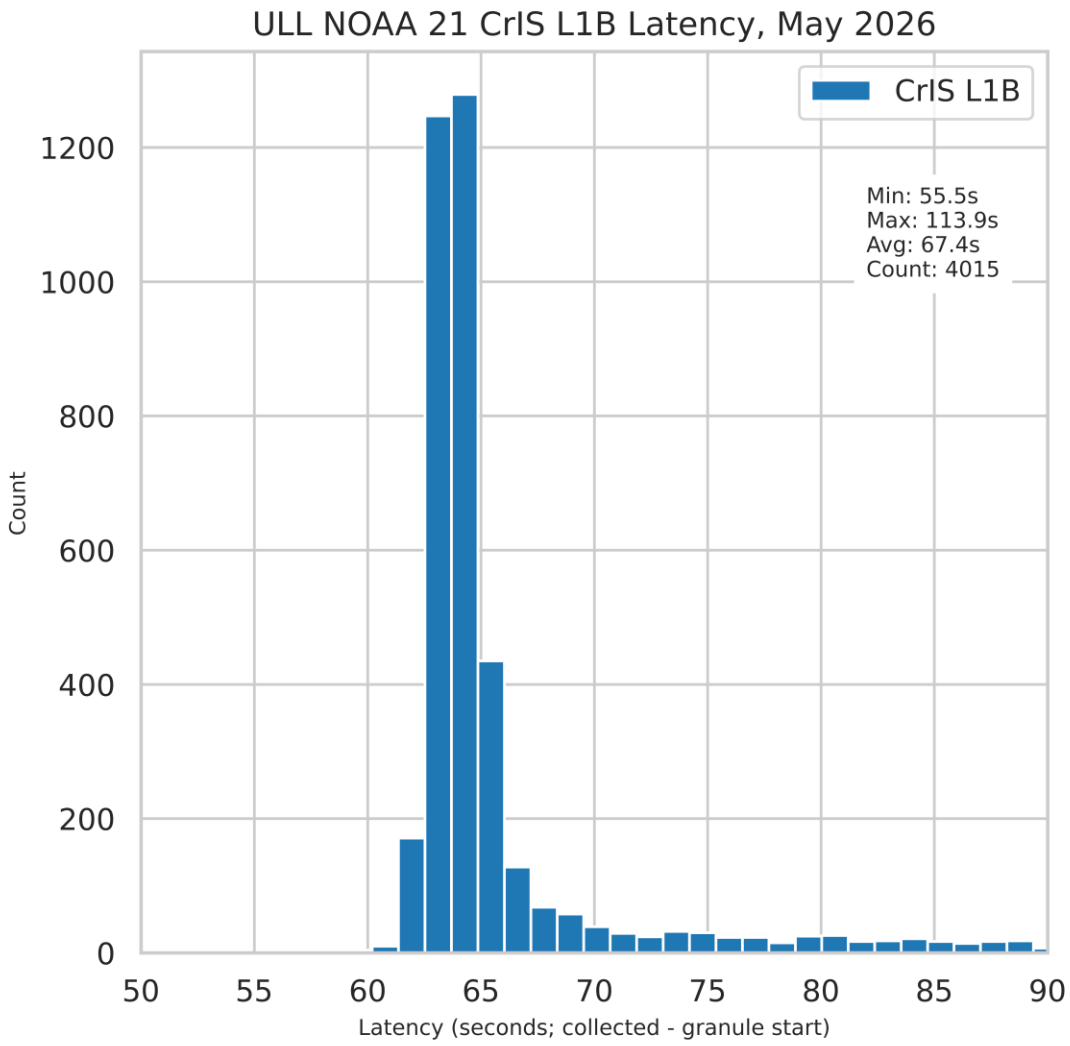

Goal: 60s

**Actual: ~30s**

# ULL Products

## NASA CrIS Level-1

- Collaboration with CrIS L1 Team
- Scan-based processing
  - Single scan (8s) per job
- Only NOAA 21
  - Single scan calibration
  - Original developed to handle eclipse exit artifact
- Latest version v4.0.0

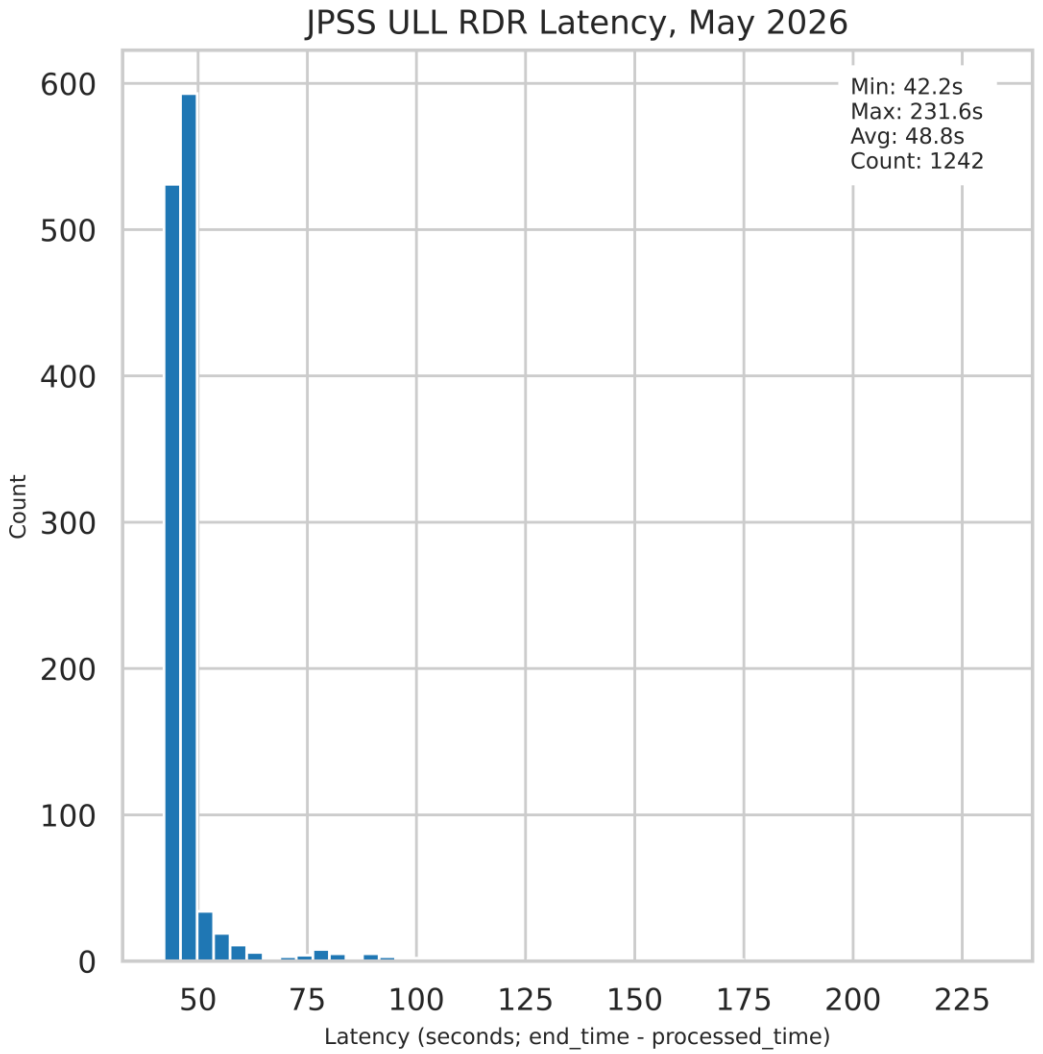


# ULL Products

JPSS RDRs

- CrIS (operational)
- VIIRS (local testing)
- Native Granulation
  - ~32s CrIS
  - ~85s VIIRS

RDR Tool



# ULL Products

HSRTV Dual-regression CAPE

- CrIS L1B v4
- Currently in local testing
- Runtime in testing ~15s
  - Expected overall latency ~1m30s

NASA CrIS Rare Event Detection (RED)

- CrIS L1 v4
- Further collaboration with the CrIS L1 Team

# ULL Architecture

- Streams Level-0 (Space Packet)*
- Designed for Cloud environment
  - Distributed
  - Event-driven
  - Containerized
  - Automatic Deployment/Updates

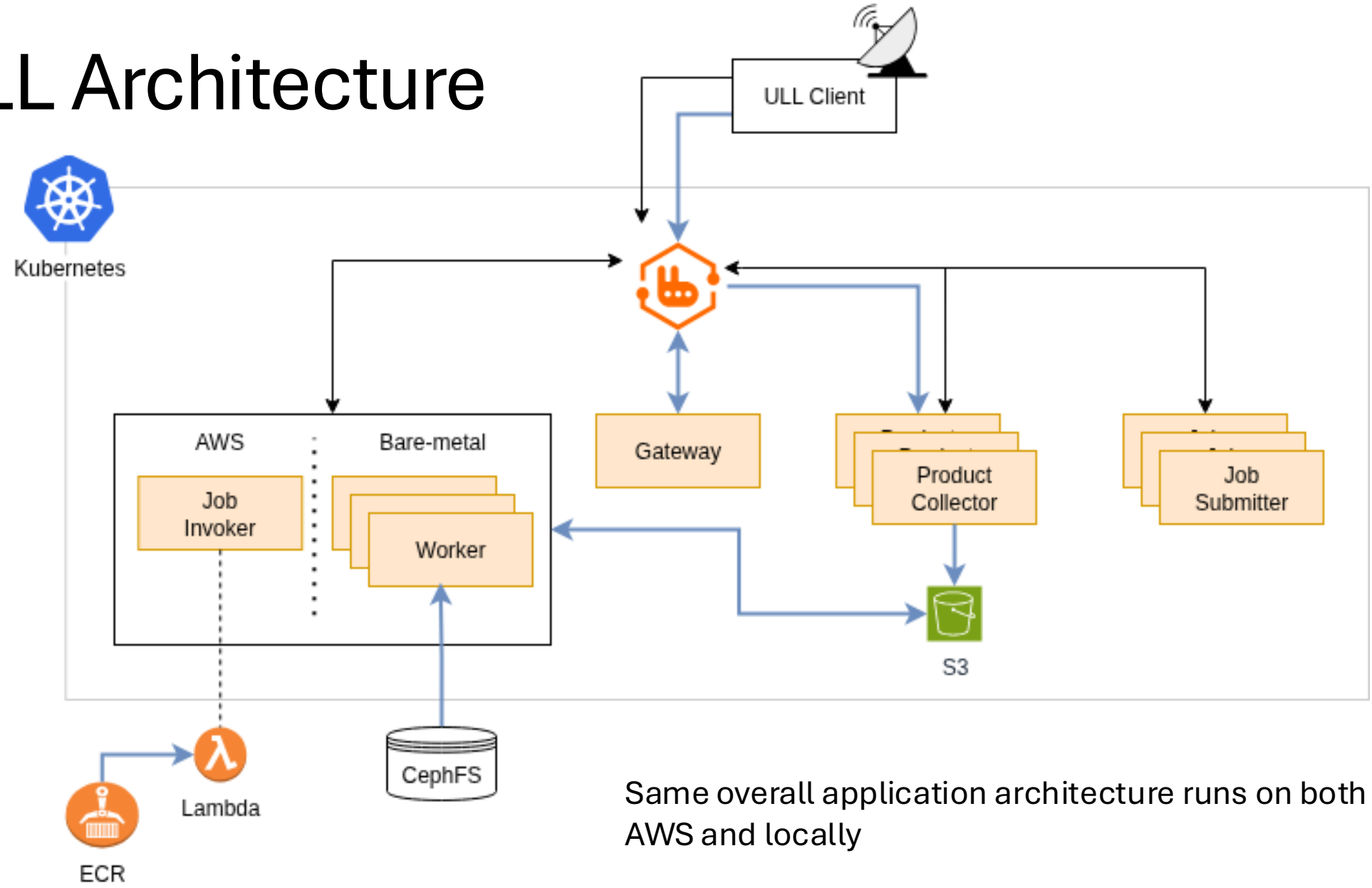
SSEC

- Bare-metal Kubernetes
- Static science workers
- CephFS for science software
- Ceph Object Gateway (S3) for products

AWS

- Elastic Kubernetes Service
- Lambda jobs
- Containers for science software
- S3 for products

# ULL Architecture




Same overall application architecture runs on both AWS and locally

# ULL Looking Forward

Frame-based delivery, by request

- Only deliver data requested
- Smaller, more consistent payload size

Decouple collection and processing

- ULL is a system for collecting Level-0 data as quickly as possible
- External processing capabilities would subscribe to ULL data

Expansion

- ATMS, OMPS, other spacecraft data?
- More stations

# Questions?

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