Landsat in the Cloud

WGISS-49

Kristi Kline, Project Manager
USGS EROS
kkline@usgs.gov

U.S. Department of the Interior
U.S. Geological Survey

Agenda

- Infrastructure and Interfaces
- Storage
- Data Management
- Collection Processing
- Distribution and Access

USGS

Landsat in the Cloud Update

- **Began planning in FY17 for cloud transition with goals to Modernize Processing, Access, and Distribution of Landsat Data**
  - Change from a primary business model of downloads to enabling access to the full archive
  - Enable users to interact with the data in an integrated environment
  - Ensure provenance and data stewardship

USGS

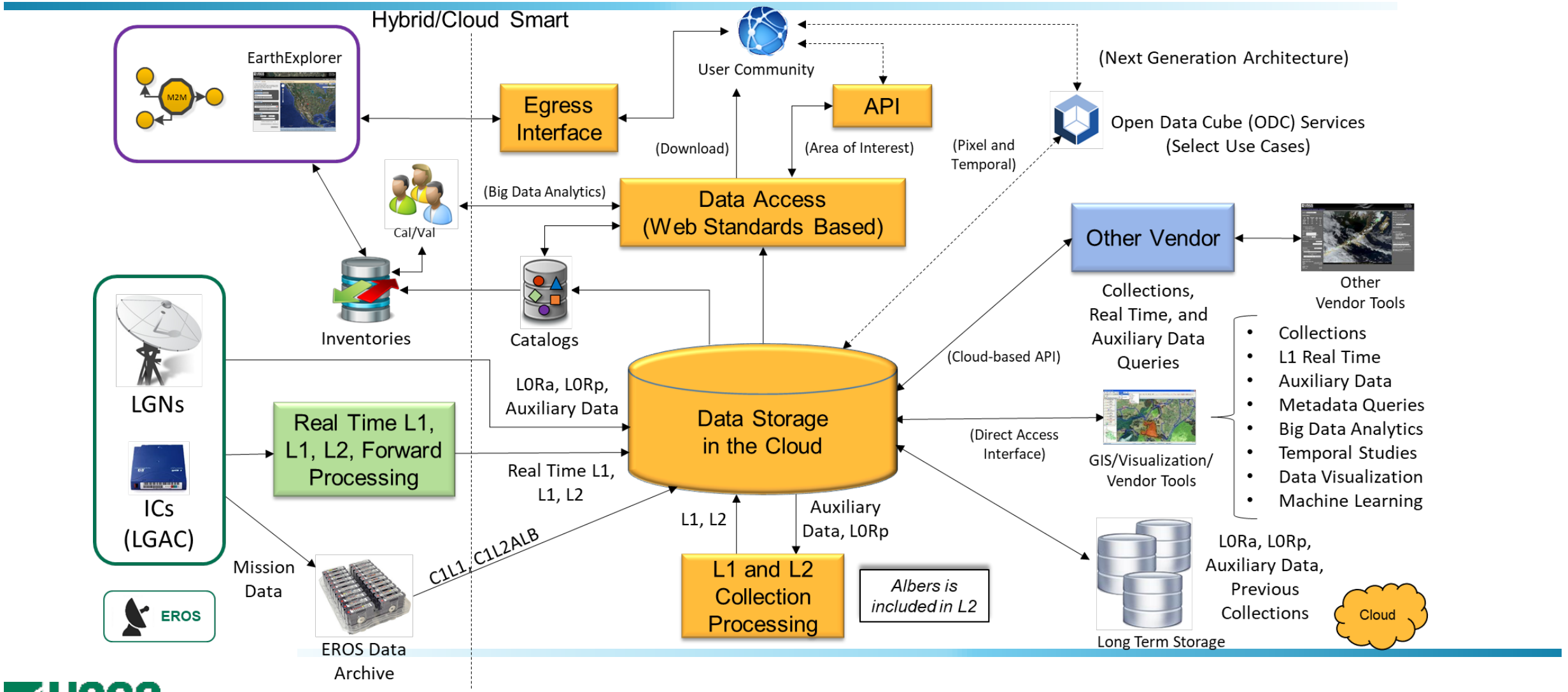
Milestones & Schedule

✔	Project Kick-Off	September 28, 2017
✔	Systems Requirements Review/Preliminary Design Review	April 25, 2019
✔	Critical Design Review	August 15, 2019
✔	Test Readiness Review	April 17, 2020
	Operational Readiness Review	CY Q2 2020
	Release to Public	CY Q3 2020

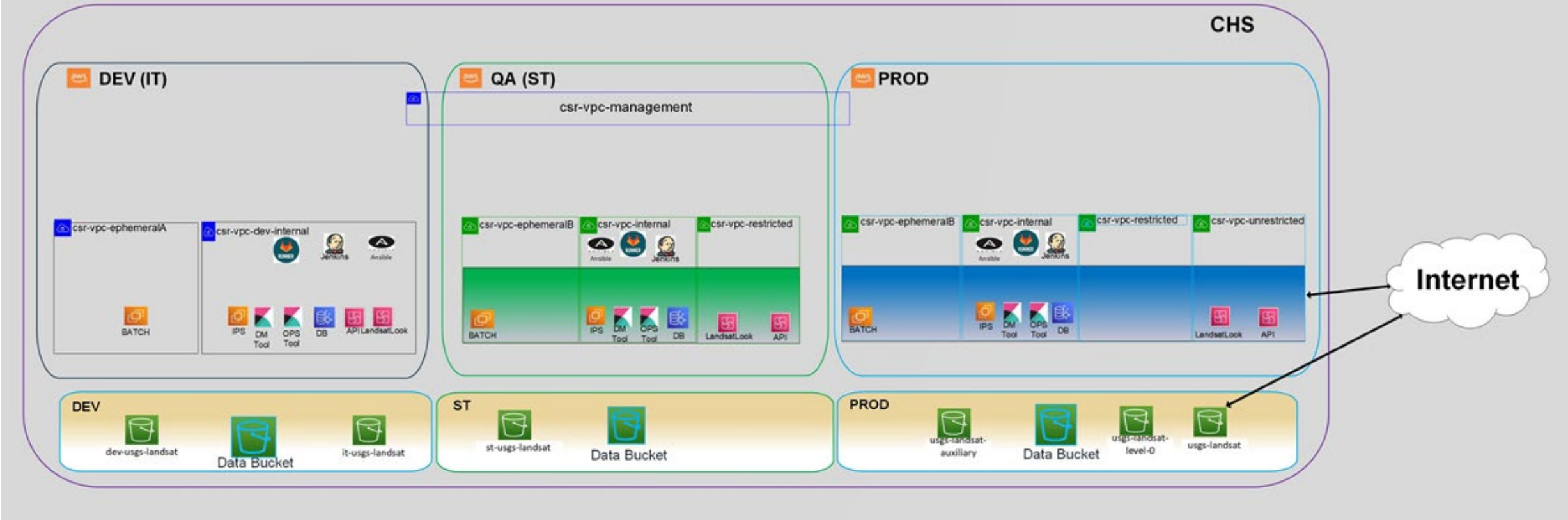
USGS

Infrastructure and Interfaces

LPIP Operational View

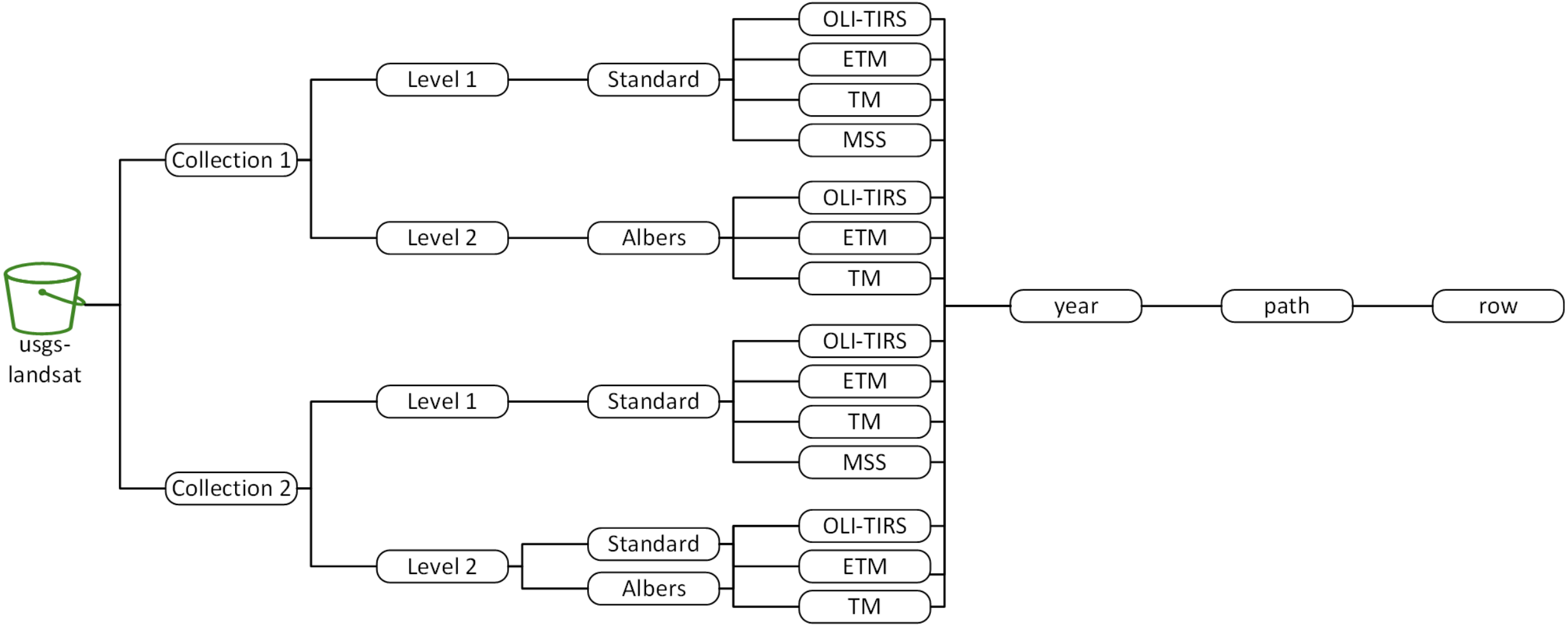


Overall Cloud Environment



Storage

usgs-landsat Bucket Layout



Validation and Verification

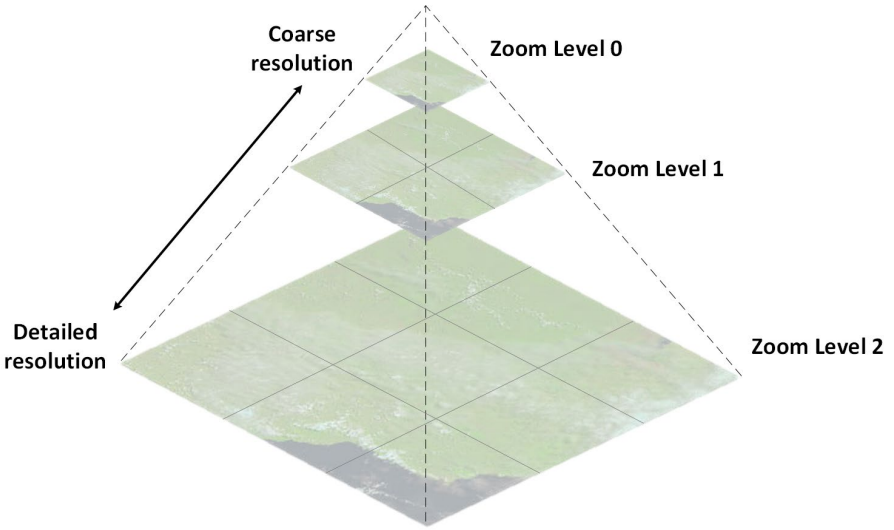
- To assure the data integrity, a SHA-512 is generated for all files prior to transfer
- When transfer is complete, an AWS Lambda process generates a “Cloud” SHA-512
- Local database tracks both local and cloud-generated SHA values for verification
- Values are also written as metadata on all objects in the cloud for future internal and external transfer validation
- Any discrepancies are double-checked before re-submitting the transfer
- One SHA on-premises takes ~57 seconds

Data Management

11

Cloud Optimized GeoTIFF Format

- **Conducted trade study on cloud formats, which resulted in the selection of Cloud Optimized GeoTIFFs (COGs)**
- **An enhanced GeoTIFF with tiling and overviews**
  - Uses internal tiling instead of lines to speed access and support better remote reading
  - Downsampled overviews are generated when lower resolution data is acceptable
  - No changes to the underlying pixels
  - Stored in an unbundled format
  - Data is internally compressed
  - Enables HTTP Get Range requests
- **Using Rasterio (GDAL library wrapper)**
  - Setting Block Sizes - GeoTIFF = 256; Overview = 128
  - Creating Overviews (2, 4, 8, 16, 32, 64)
  - Compression – Internal,Deflate



USGS

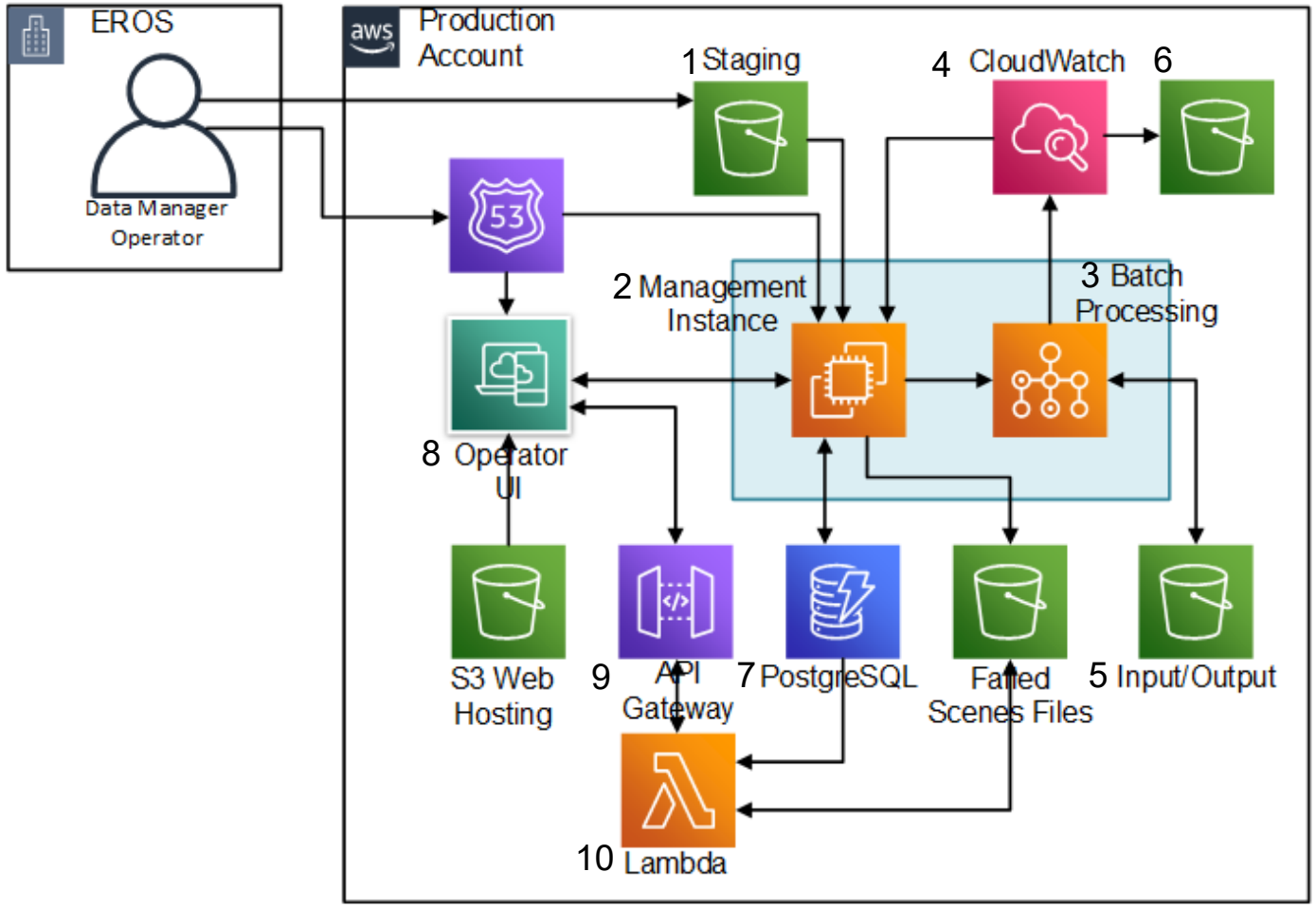
SpatioTemporal Asset Catalog (STAC)

- **New collaborative standard for managing access metadata**
  - Open-source, headed by Planet Labs, freely available on GitHub, working on Landsat extension
  - Flexibility to support many types of geospatial data (satellite, drone, radar, etc.)
  - Allows for interoperability between satellite metadata (e.g. Landsat 8 + Sentinel 2)
  - Lives alongside product-level metadata (MTL, XML)
- **Exposes data in a common, machine-readable JSON format for both end users and internal processes**
- **Includes direct links to S3 objects**
- **Can be exploited through Jupyter Notebooks by end users to read data directly from the cloud without downloading**
- **Gaining wide adoption by the remote sensing community**
  - i.e., Government, International, Commercial, Academic

USGS

Collection Processing

Cloud Image Processing System Design



1.Staging
- Temp area for input scene list

2.Management Instance
- Populates db with input scenes
- Job scanner provides job status
- Interface to OUI for Batch processing

3.Batch Processing
- Manage jobs running on EC2

4.CloudWatch
- Logging and system metrics

5.S3
- Output products, logs, characterization, inventory metadata

6.Logs
- CloudWatch and archived to S3

7.PostgreSQL
- Holds the input scene list
- Records job status

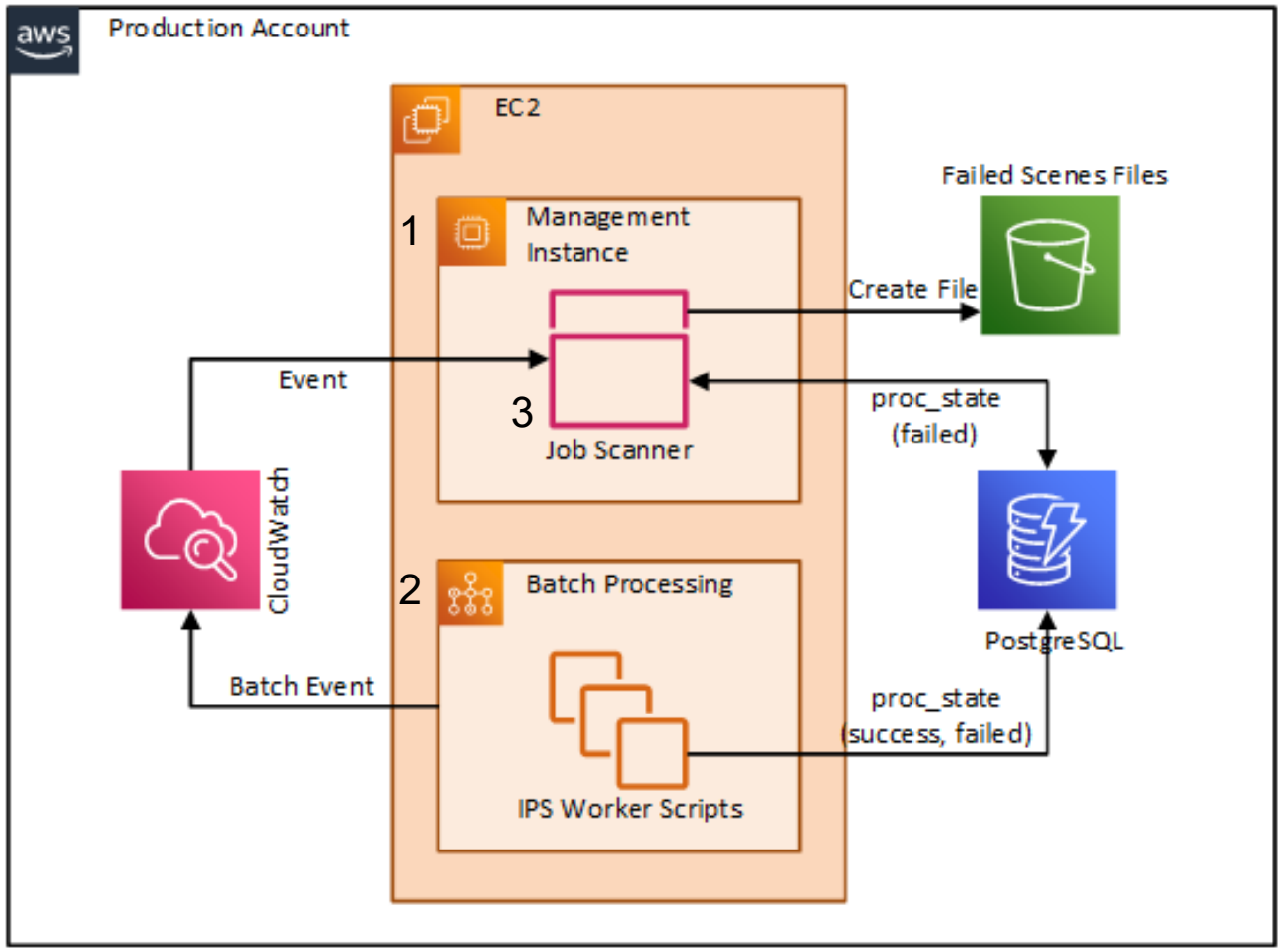
8.Operator User Interface

9.API Gateway
- Interface to Lambda functions

10.Lambda Functions

10. Triggering of job scanner

Processing Status Updates



1. **Submission process**
   - Updates status to Submitted
2. **Batch worker**
   - Updates status at end of job
   - Success and Failed
3. **Job scanner**
   - Use cases where worker script is not able to update (loss of instance)
   - Updates reason for failure
   - Creates failure files for job array runs

USGS

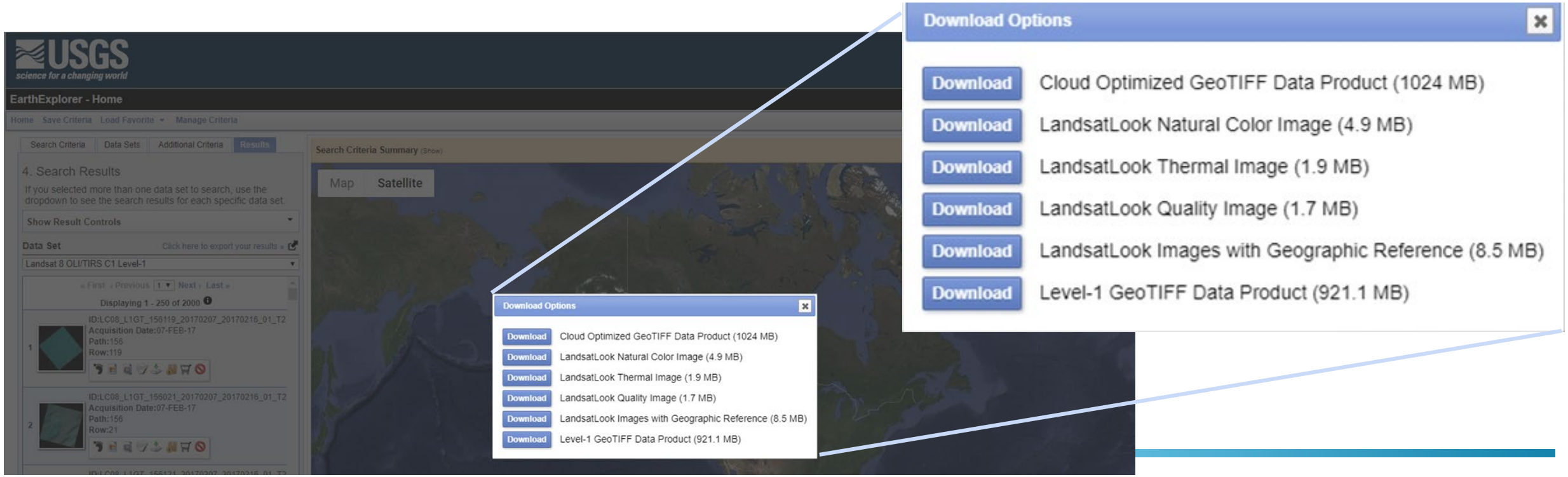
Distribution and Access

Cloud Smart Design w/On-Premises Systems

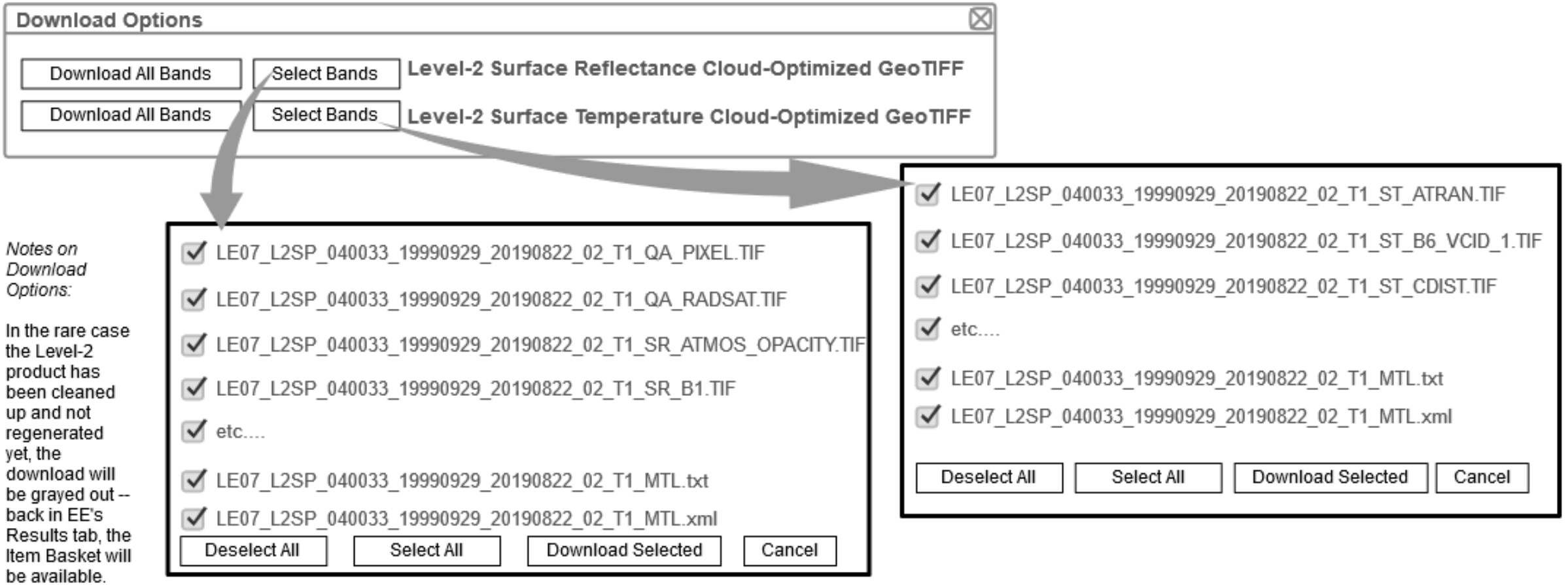
- **EarthExplorer (EE)**
  - EE data delivery through Cloud will enable band subsetting to users
  - The EROS Registration System (ERS) will work with **Cognito** to authenticate users accessing data in the cloud
  - Download metrics will be captured and integrated with the metrics system
- **Machine-2-Machine (M2M)**
  - The M2M API is a RESTful JSON-based Service that provides data access, distribution and ordering
  - All requests are logged and provide a standard response that can be scripted by users to implement their own data discovery and download based on their needs

Cloud Integration with EarthExplorer

- **EarthExplorer will be configured to point to cloud data store locations**
  - Familiar interface
  - A new download option will be displayed
  - The download option will take users to a STAC Browser Page, where users will be able to select individual bands



Single Band Download from EarthExplorer

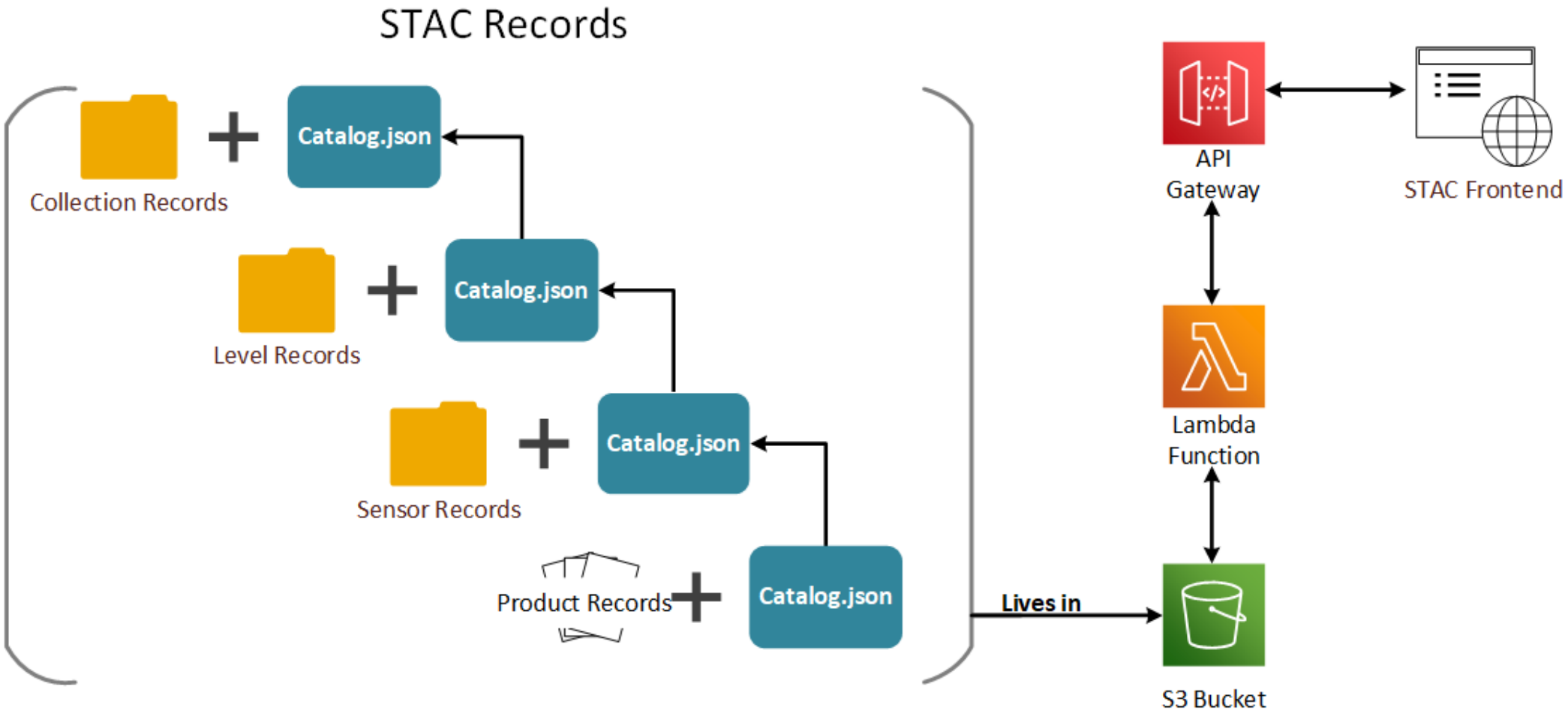


Notes on Download Options:

In the rare case the Level-2 product has been cleaned up and not regenerated yet, the download will be grayed out -- back in EE's Results tab, the Item Basket will be available.

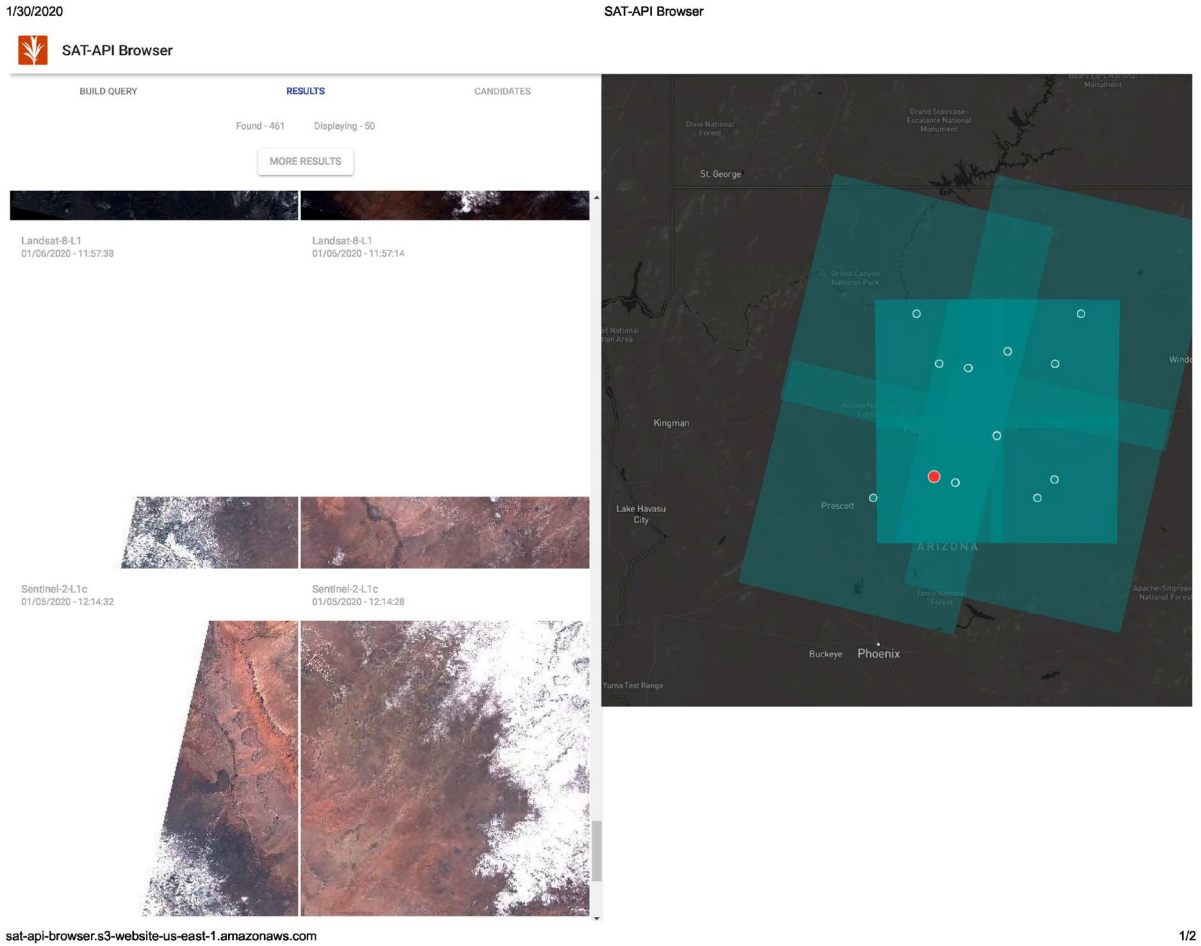
USGS

STAC Browser



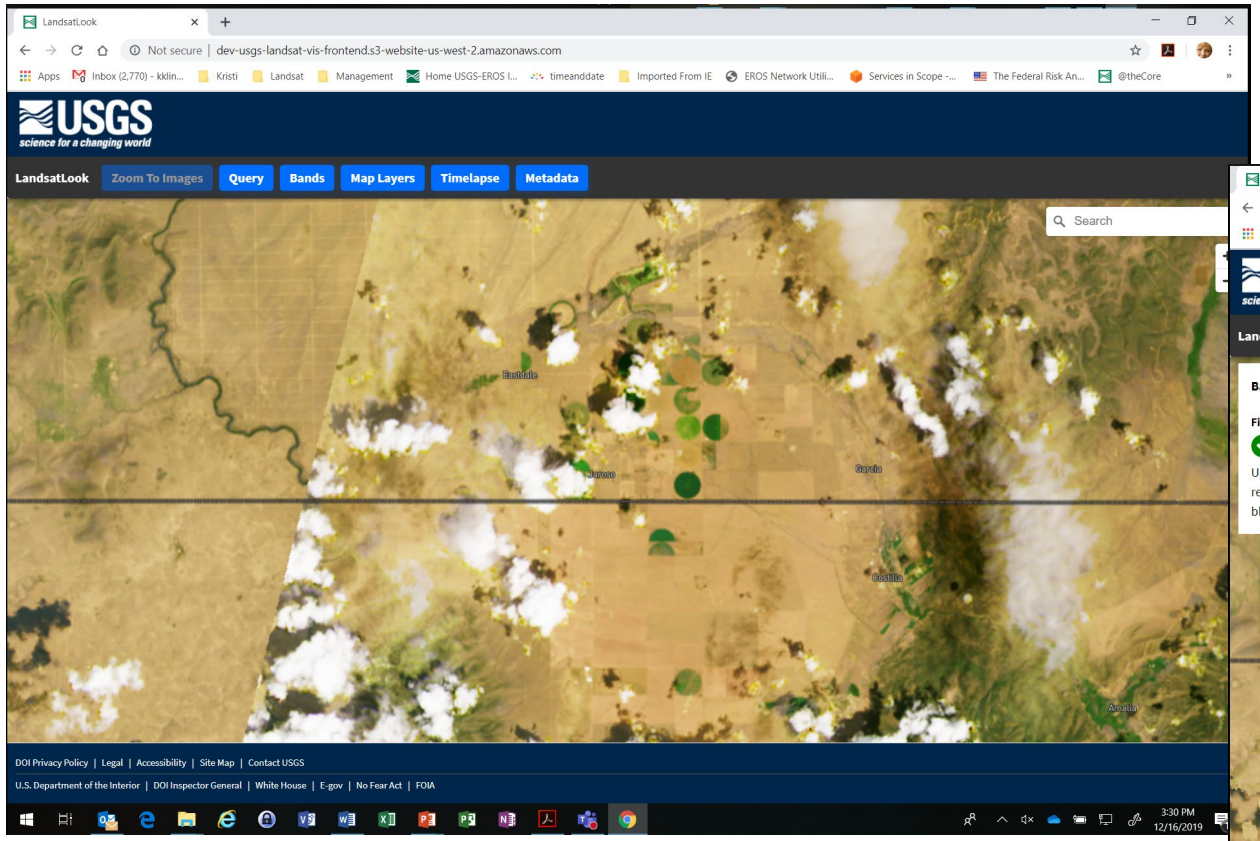
Sat-api Browser Demo

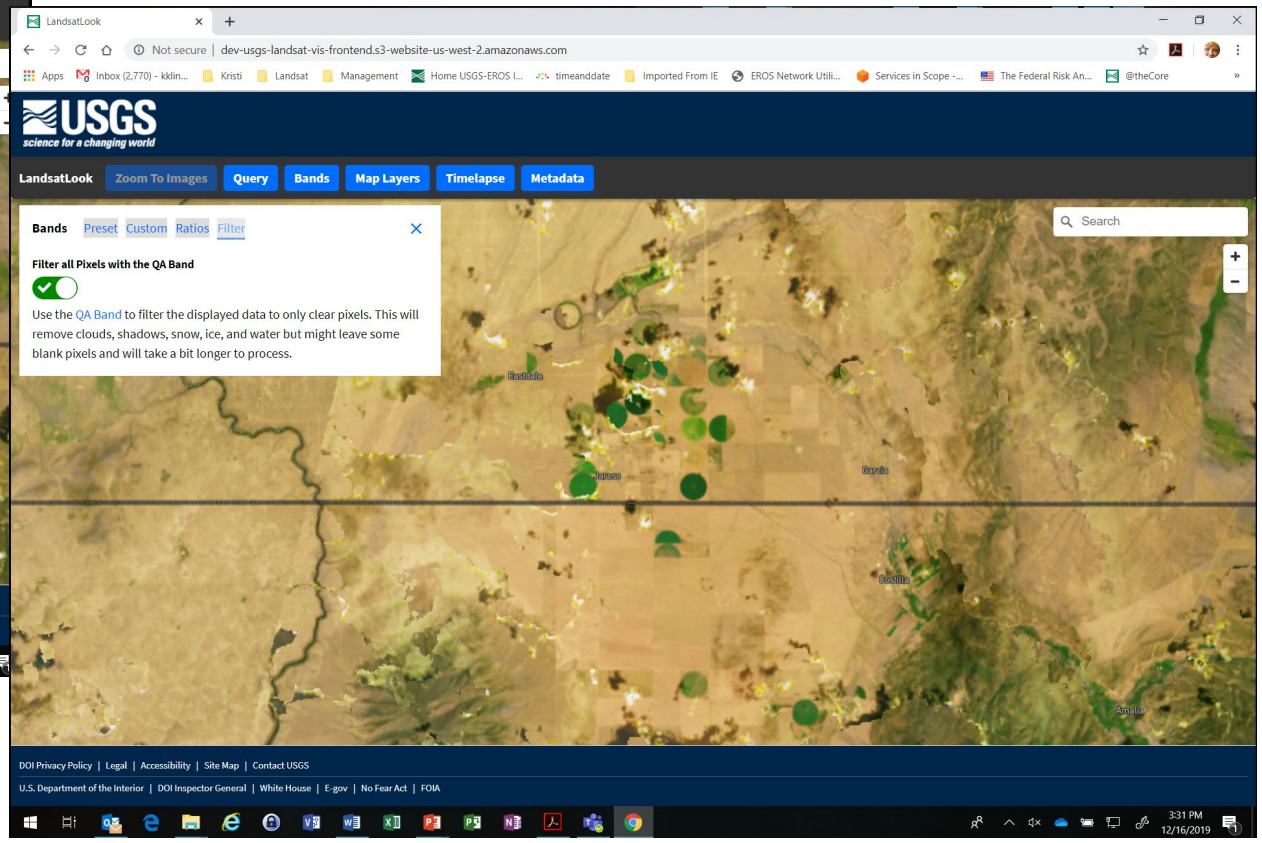
- http://sat-api-browser.s3-website-us-east-1.amazonaws.com/



USGS

New LandsatLook Tool



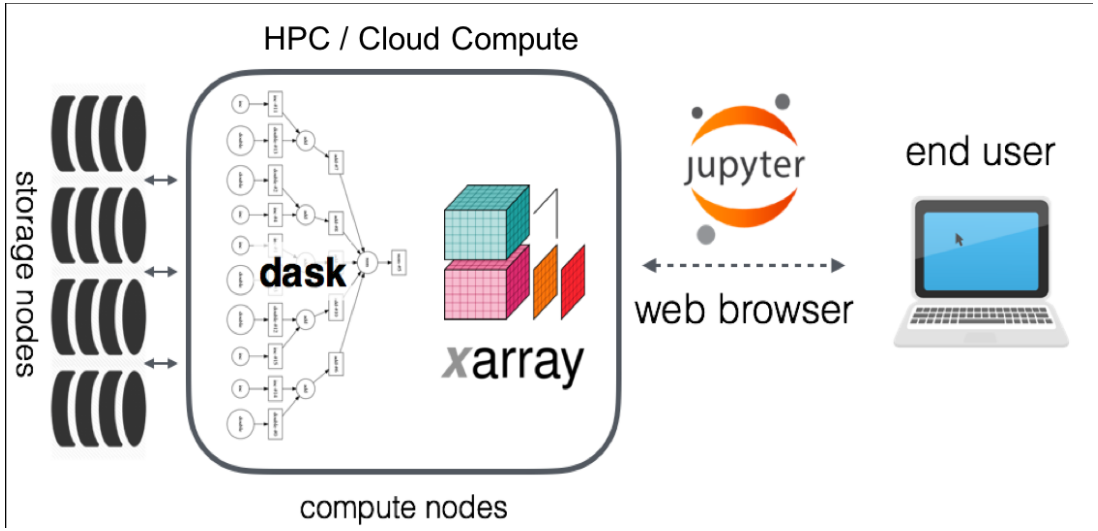


USGS

Pangeo

INTERCHANGEABLE PIECES IN PANGEO (PICK 1 OR MORE FROM EACH ROW)

Data Models	xarray	Iris	pandas
N-D Arrays	NumPy	DASK	
Processing Mode	Interactive jupyter	Batch	Serverless
Compute Platform	HPC	aws	Google Cloud Platform
Foundation	python™		



USGS

Egress Filter Design Details – Limiting Costs

- **Design limits users based on system threshold parameter**
  - Starting value determined – PB/time period
  - Value is stored in Secrets Manager
  - WonderShaper is a Linux tool that limits bandwidth per EC2
  - Adjust any time during a time period
- **Auto-scaling cluster with Nginx and WonderShaper configured to limit bandwidth**
  - Nginx provides limiting by IP and total number of connections
  - WonderShaper will monitor and limit network bandwidth
    - Max Kb/s download rate is configurable based on the System_threshold parameter defined by the USGS

Egress Use Cases

1. **Traditional User**
   - A. Occasional user
     - i. Uses EarthExplorer or LandsatLook
     - ii. Non-regular interaction
     - iii. Lower volume
     - iv. Rate limited
   - B. Persistent User
     - i. Some scripting using M2M
     - ii. Using scripting or tools on a more frequent basis
     - iii. Higher volume
     - iv. Rate limited
2. **Non US-Oregon-West User**
   - A. AWS account outside US-Oregon-West
   - B. Higher volume
   - C. Rate limited
3. **Direct Access User (Oregon West)**
   - A. AWS Account in Oregon West
   - B. Higher volume
   - C. Direct read access to the data
   - **D. NOT** rate limited
4. **Rogue Actor**
   - A. DDoS – Stopped from gaining access
   - B. Logged for further action