

The background features a dark blue gradient with abstract geometric shapes. On the left, a large triangle is formed by a vertical orange line and a diagonal orange line. On the right, a large curved shape in shades of blue and orange sweeps across the frame. The text is positioned in the upper right area.

AWS re:Invent

NOV. 29 – DEC. 3, 2021 | LAS VEGAS, NV

WPS301

Event-driven data processing with AWS Ground Station

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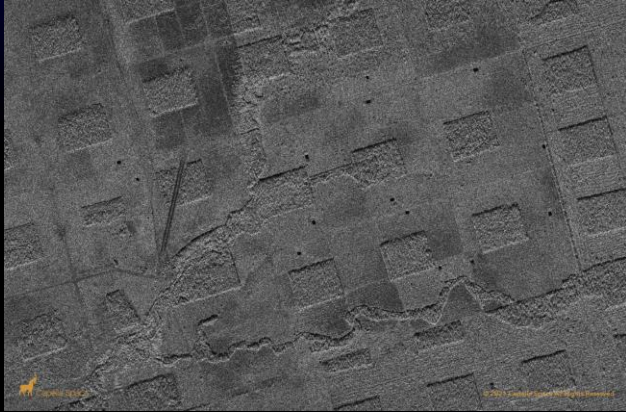
Agenda

- Earth observation data
- Problem set
- How AWS solves
- Workshop – Event-driven architecture for satellite data

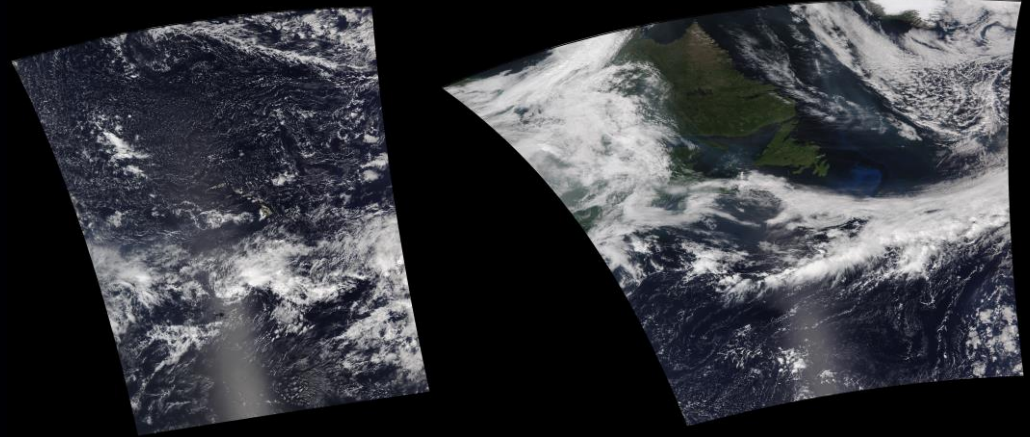
Earth observation (EO) satellite data

- Data about the Earth from remote sensing vehicles (satellites) in various orbits around the planet
- Includes
 - Visual imagery
 - Interpolated imagery (radar, sonar, etc.)
 - Numerical science measurements (temperature, moisture, radiance, chlorophyll)
- Use-cases span scientific research, marketing, national security, logistics operations, property development, financial security, and more

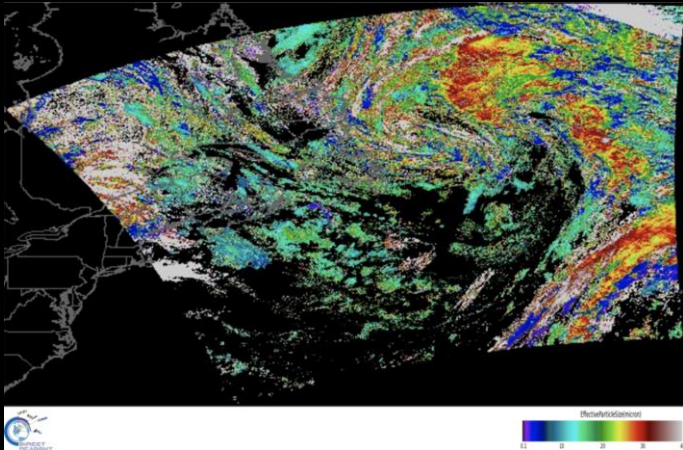
Earth observation satellite data



Capella Space: SAR Imagery Amazon Deforestation, Luna Camba, Santa Cruz, Bolivia¹



JPSS-20: True Color Imagery of Hawaii and Newfoundland [recorded/processed by AWS]

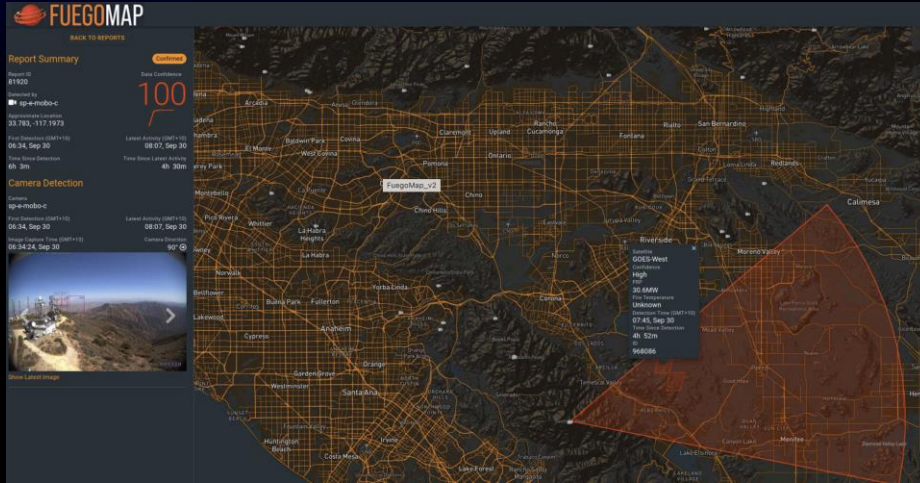


SNPP: Cloud Effective Particle Size, N. Atlantic Ocean²



Sentinel-1 and Sentinel-2: Composite SAR and True Color Imagery from the European Space Agency (ESA)³

Great use-case(s) of satellite data



Fireball International, now Exci, AWS Case-Study⁴

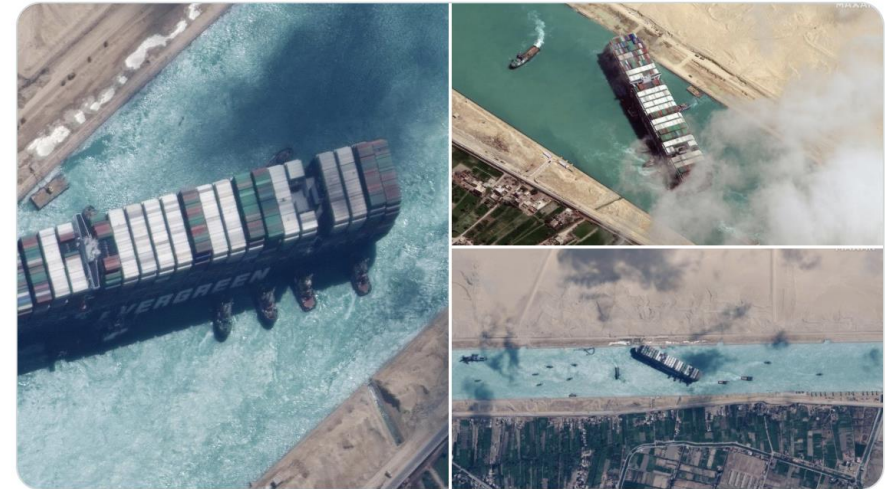


Descartes Labs, AWS Summit⁵



Maxar Technologies
@Maxar

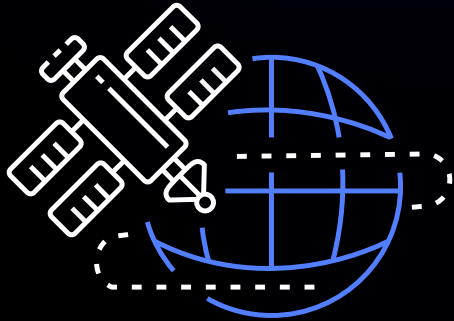
#EVERGIVEN Update: March 29, 2021 #satellite imagery from WV2 was collected at 11:49AM local time followed by a GeoEye-1 collection at 11:52AM. The container ship has been moved away from the eastern bank of the canal, w/ numerous tugboats actively trying to reposition the ship.



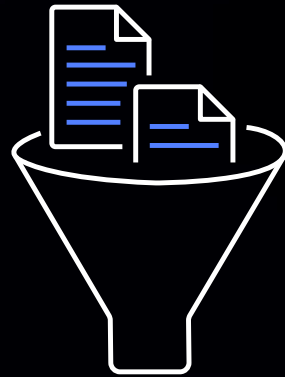
11:05 AM · Mar 29, 2021 · Twitter Web App

Maxar Technologies, Twitter⁶

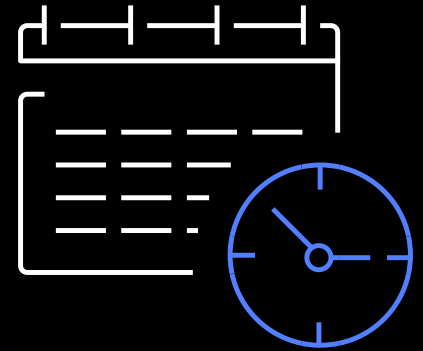
Challenges of using satellite data



Obtaining the data



Storage/processing

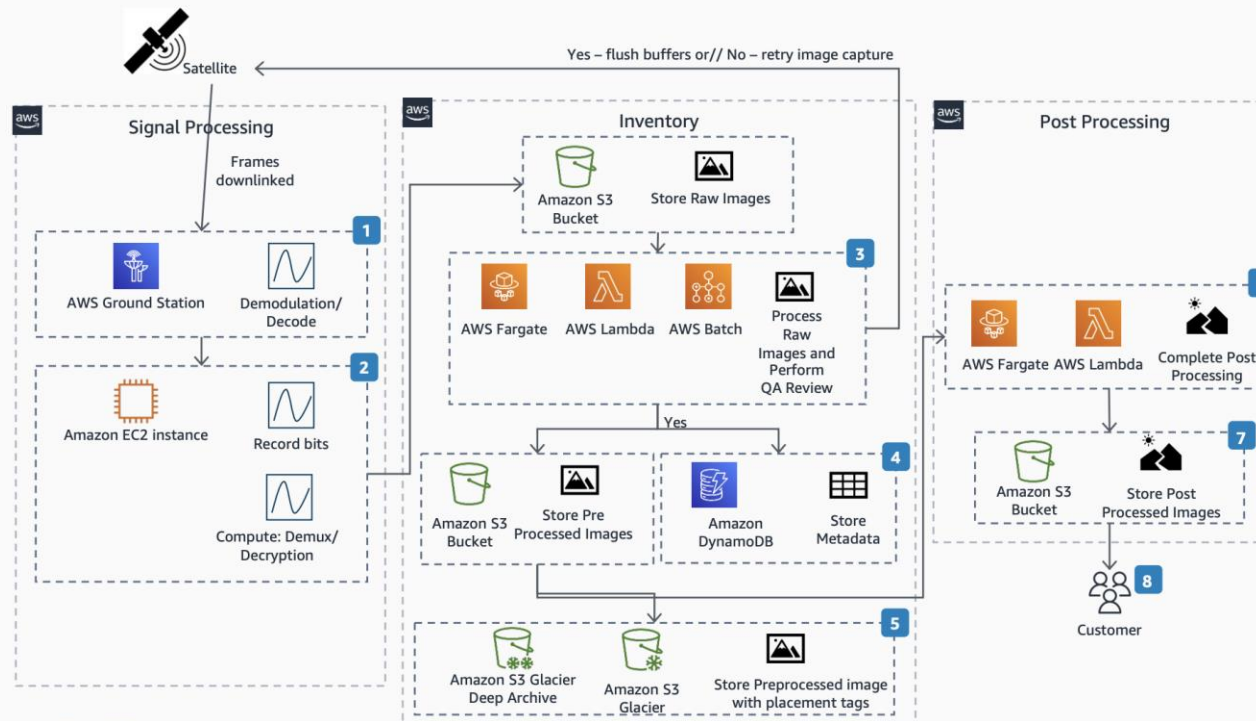


Burst transmissions

How AWS solves

Electro-Optical Imagery Reference Architecture

Process electro-optical imagery on AWS



Reviewed for technical accuracy May 12, 2021
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AWS Reference Architecture

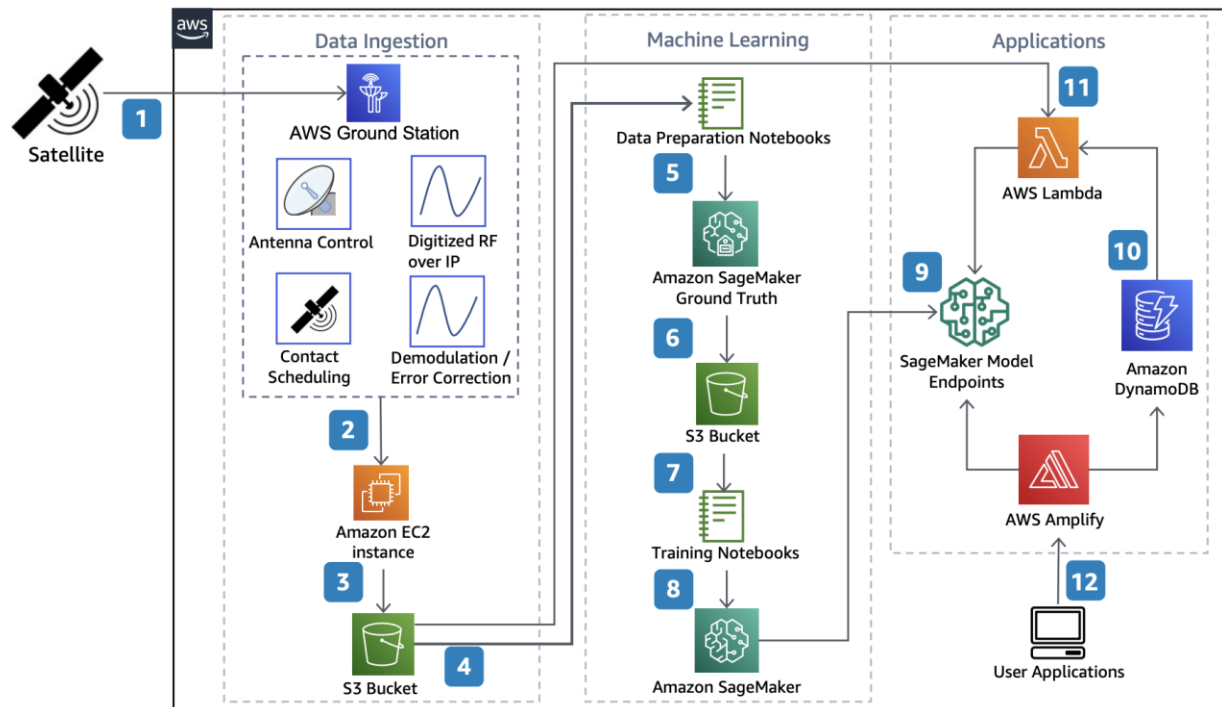
- 1 Demodulate and Decode: Extract baseband waveform from modulated carrier; remove forward error correction
- 2 Convert into raw sensor data: Decommutate signal frames; decrypt data
- 3 Process Raw Images: Process Raw Images and Perform QA Review
 - QA Review: Confirm Images are sufficient for processing
 - AWS Batch: Run multiple jobs in parallel
 - AWS Fargate and AWS Lambda:
 - Sensor Correction: Apply corrections for optical distortions
 - Orthorectify: Sensor perspective
 - Georeference: Apply image to spatial grid and assign known coordinate system
 - Generate Thumbnails: Create post-processed thumbnails for customer purchase
- 4 Store metadata: Store information on latitude/longitude collection, region collection, time and date of retrieval
- 5 Storage: Store preprocessed images in a variety of Amazon S3 services by balancing cost savings and time of retrieval.
- 6 Post Processing and Analysis: Complete imagery processing
 - Feature Extraction: Identify features in images (e.g. ships)
 - Naming/Tagging of Features: Tag features by name/identification system
 - Time Series Creation: Tag images to sort by time
- 7 Storage and Dissemination: Final storage of images and analytics for end customer
- 8 Customer Delivery: Deliver final images to end customers

https://d1.awsstatic.com/architecture-diagrams/ArchitectureDiagrams/electro-optical-imagery-ra.pdf?did=wp_card&trk=wp_card

How AWS solves

Run Machine Learning Algorithms with Satellite Data

Use AWS Ground Station to ingest satellite imagery, and use Amazon SageMaker to label image data, train a machine learning model, and deploy inferences to customer applications.



Reviewed for technical accuracy May 24, 2021

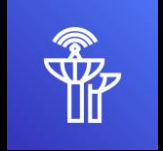
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AWS Reference Architecture

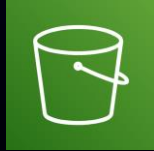
- 1 Satellite sends data and imagery to the **AWS Ground Station** antenna.
- 2 **AWS Ground Station** delivers baseband or digitized RF-over-IP data to an **Amazon EC2** instance.
- 3 The **Amazon EC2** instance receives and processes the data, and then stores the data in an **Amazon S3** bucket.
- 4 A Jupyter Notebook ingests data from the **Amazon S3** bucket to prepare the data for training.
- 5 **Amazon SageMaker Ground Truth** labels the images.
- 6 The labeled images are stored in the **Amazon S3** bucket.
- 7 The Jupyter Notebook hosts the training algorithm and code.
- 8 **Amazon SageMaker** runs the training algorithm on the data and trains the machine learning (ML) model.
- 9 **Amazon SageMaker** deploys the ML models to an endpoint.
- 10 The SageMaker ML model processes image data and stores the generated inferences and metadata in **Amazon DynamoDB**.
- 11 Image data received into **Amazon S3** automatically triggers an **AWS Lambda** function to run machine learning services on the image data.
- 12 Applications interact with **AWS Amplify** to access the ML algorithm and database.

https://d1.awsstatic.com/architecture-diagrams/ArchitectureDiagrams/run-machine-learning-algorithms-with-satellite-data-ra.pdf?did=wp_card&trk=wp_card

Simplified architecture



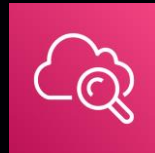
AWS Ground Station



Amazon Simple Storage Service (S3)



Amazon EventBridge



Amazon CloudWatch



AWS Step Functions



AWS Lambda



AWS Batch



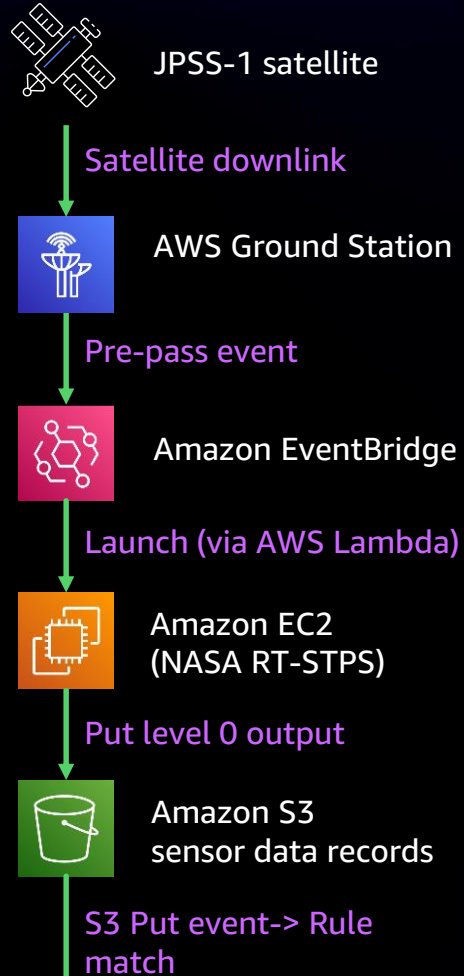
Amazon Elastic Compute Cloud (EC2)



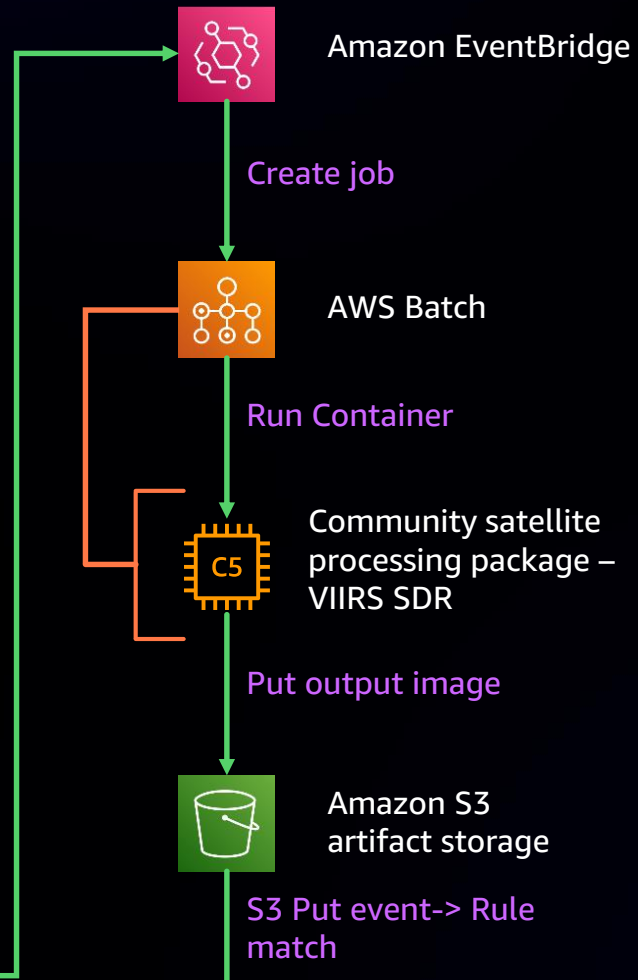
Amazon SageMaker

Data flow/sequence

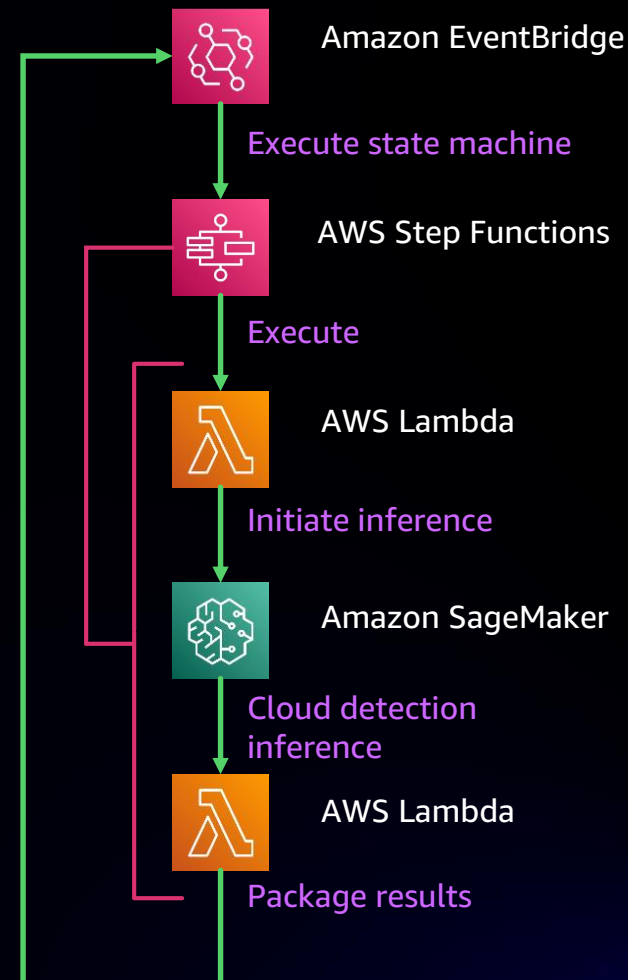
Downlink



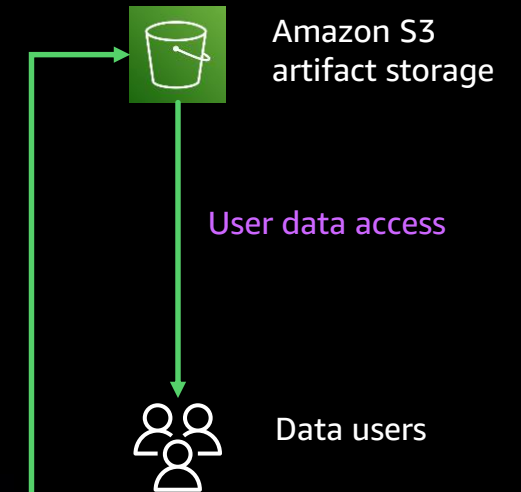
Process imagery



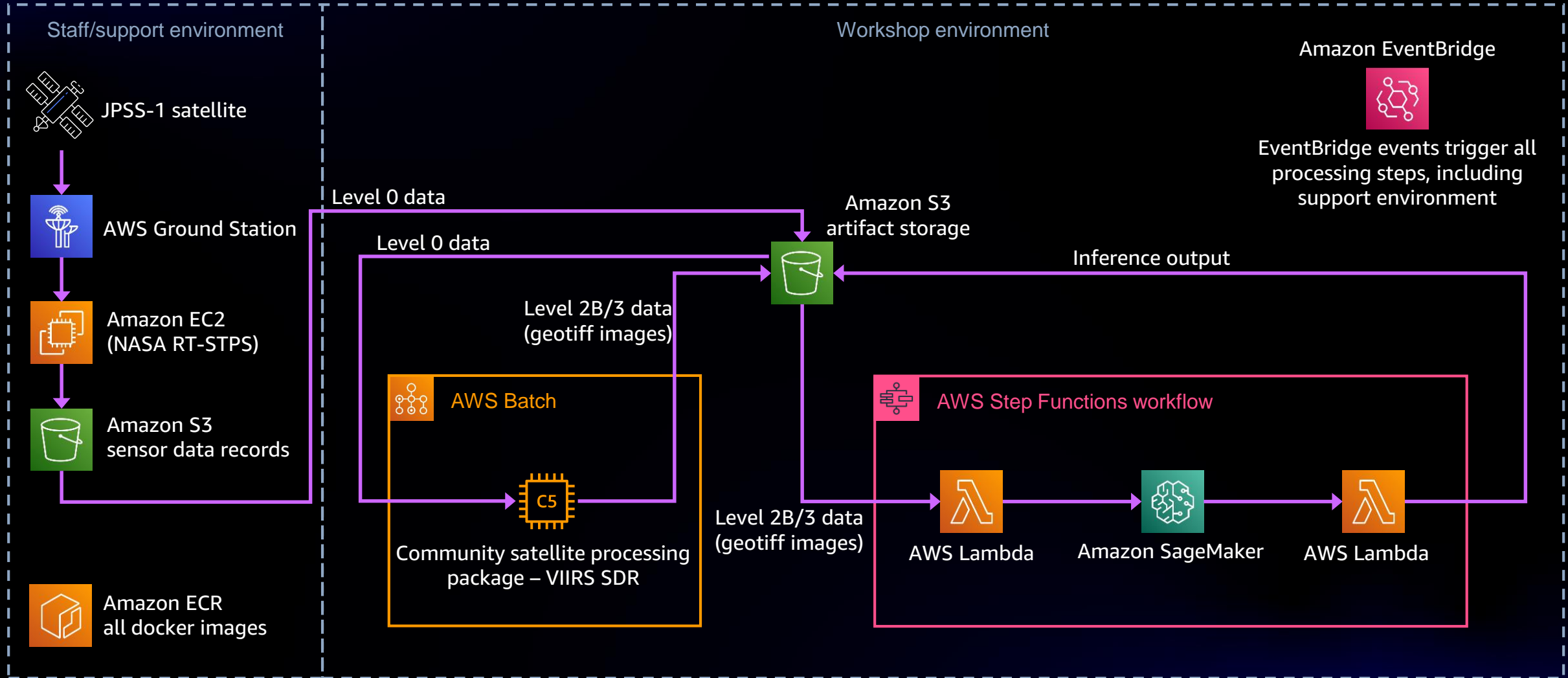
ML inference



Publish



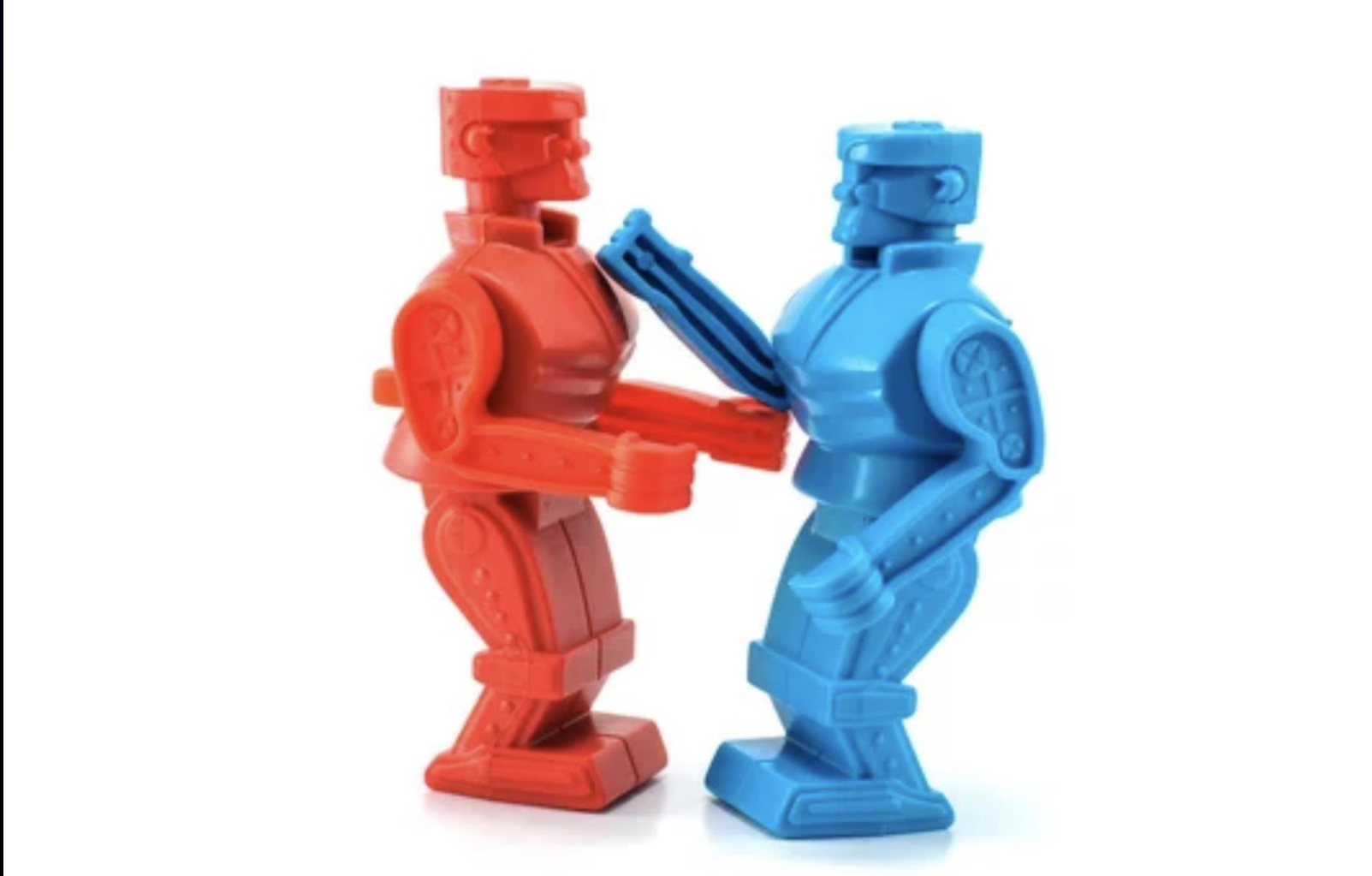
Workshop architecture diagram



Why this architecture?

- **AWS Ground Station** enables customers to **transfer satellite data** from their satellites to AWS cloud in near real time
- **AWS-managed compute** solves **performance data processing** – The processing software available to us is monolithic; Amazon EC2 C5 instances provided the memory and core count to enable timely processing of our data; using AWS Batch means we don't have to scale it ourselves
- **Event-driven workflow** efficiently handles our **bursting workload** – AWS Batch, AWS Step Functions and AWS Lambda all enable us to scale up when we need to process imagery, and scale back down when we don't

Architecture trade-offs

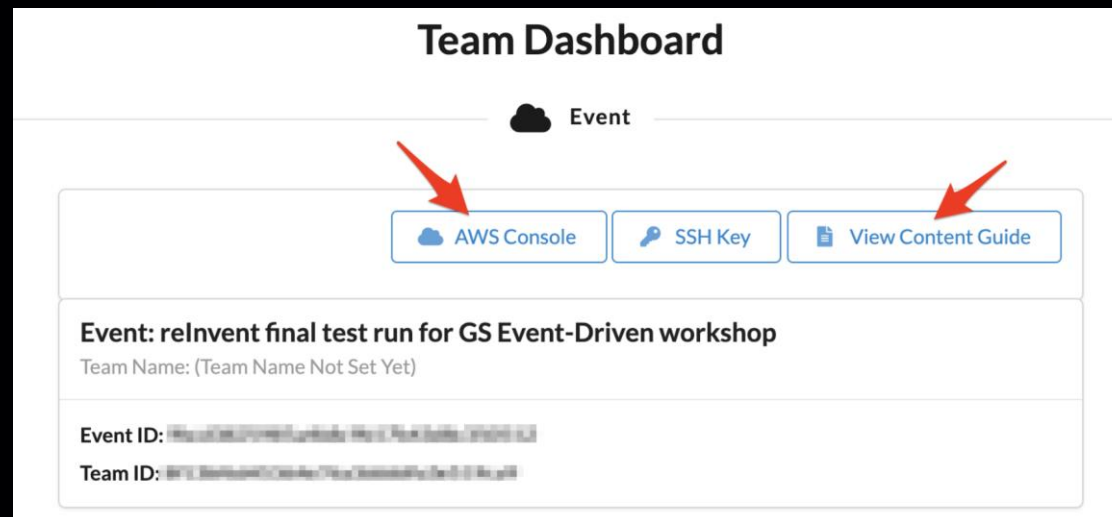


Goals of workshop

- Learn how AWS can help the challenges associated with EO data
- Obtain hands-on experience deploying an event-driven image processing architecture
- Use AI/ML to automate cloud detection
- Obtain your own satellite imagery product
- Work hard; have fun; make history

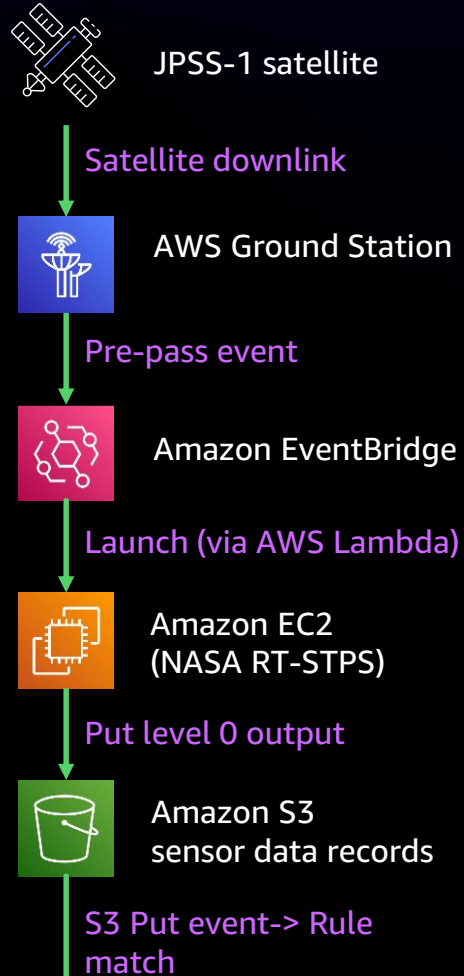
Next steps

- Log in to Event Engine at the following:
<https://dashboard.eventengine.run/> Event hash: 1219-18d1e71184-7c
- Obtain emailed one-time password
- Click **View Content Guide**

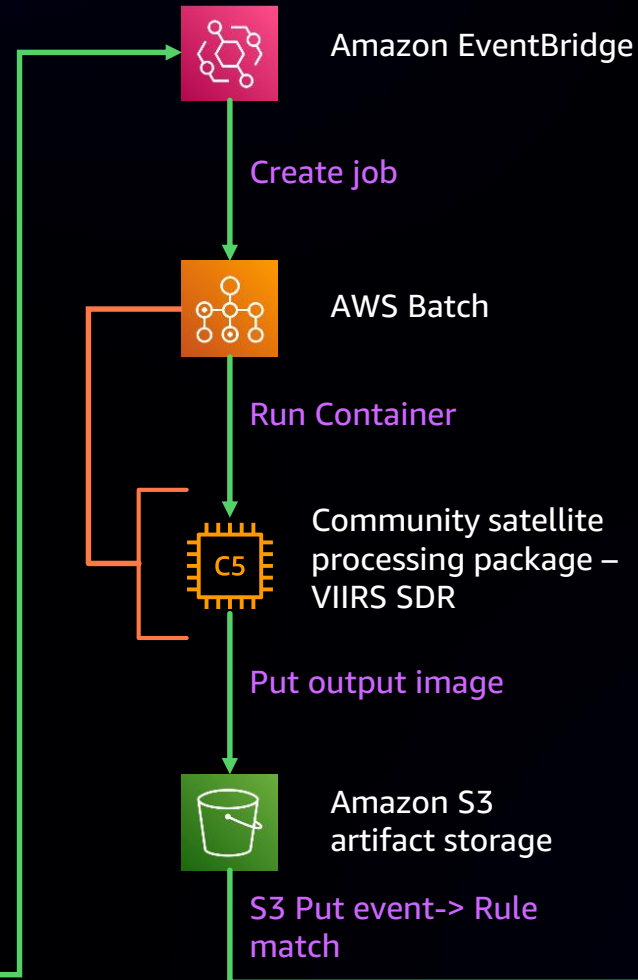


Reminder: Data flow/sequence

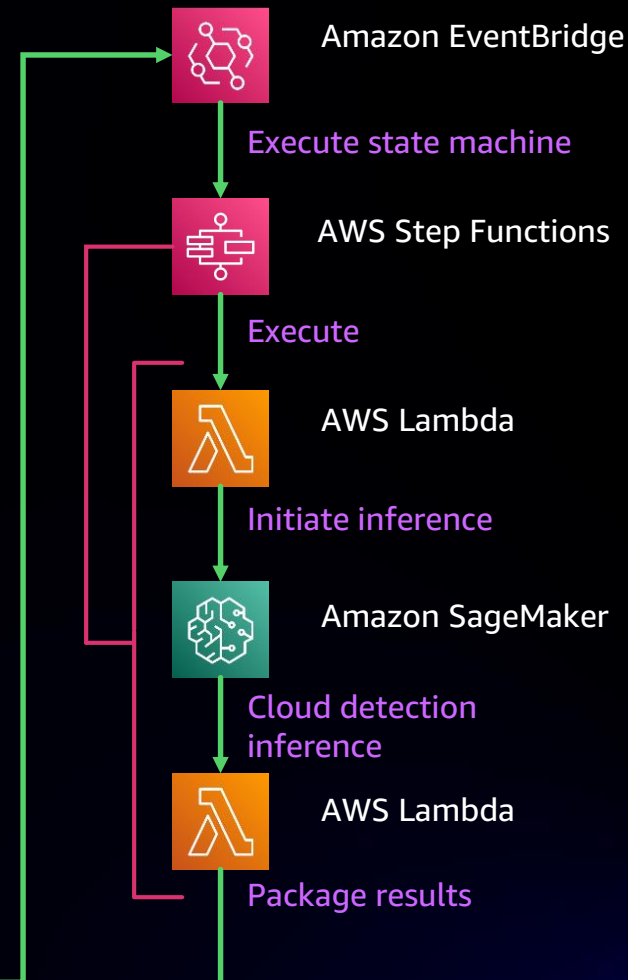
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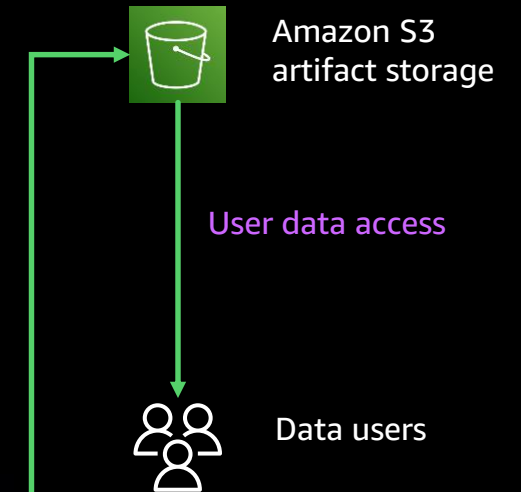
Process imagery



ML inference



Publish



Sources

- (1) Capella Space, "Capella Space Opens its SAR Data to the Public," 14 September 2021, <https://www.capellaspace.com/capella-space-opens-its-sar-data-to-the-public/>; accessed 10 Oct 2021
- (2) Direct Readout Laboratory, "Recent Data Products," 21 October 2021, <https://directreadout.sci.gsfc.nasa.gov/?id=dspContent&cid=159>; accessed 21 October 2021
- (3) Space.com, "Integrating diverse satellite images sharpens our picture of activity on Earth (op-ed)," 23 Mar 2021; <https://www.space.com/satellite-imagery-advance-expert-voices>; accessed 20 Oct 2021
- (4) AWS Case-Study, "Fireball International Shortens Wildfire Detection to 3 Minutes Using AWS," 2021; <https://aws.amazon.com/solutions/case-studies/fireball-international-case-study/>; accessed 20 Oct 2021
- (5) Descartes Labs, 2021 AWS DC Summit, "Addressing planetary problems with satellite data"; 28 September 2021; <https://www.youtube.com/watch?v=DCJ36R8mGSc>; accessed 28 Nov 2021
- (6) Maxar Technologies [@Maxar], Twitter, 29 Mar 2021, <https://twitter.com/maxar/status/1376551006125879297?lang=en>; accessed 10 Oct 2021

Thank you!

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