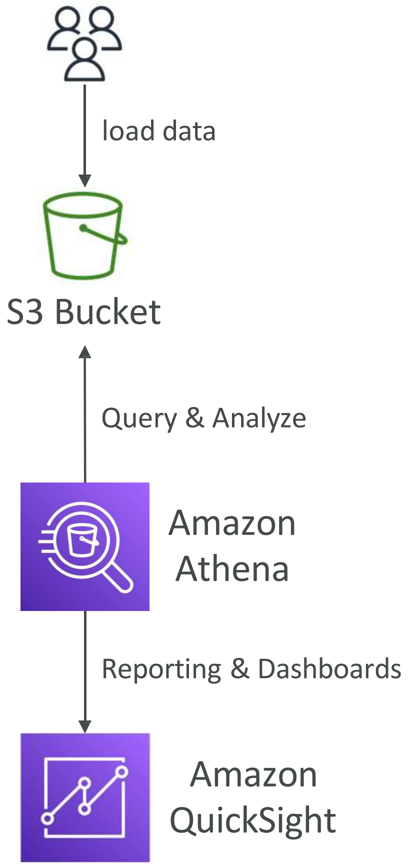
Data & Analytics

Amazon Athena

- Serverless query service to analyze data stored in Amazon S3
- Uses standard SQL language to query the files (built on Presto)
- Supports CSV, JSON, ORC, Avro, and Parquet
- Pricing: $5.00 per TB of data scanned
- Commonly used with Amazon Quicksight for reporting/dashboards

- Use cases: Business intelligence / analytics / reporting, analyze & query VPC Flow Logs, ELB Logs, CloudTrail trails, etc...
- <u>Exam Tip:</u> analyze data in S3 using serverless SQL, use Athena



load data

S3 Bucket

Query & Analyze

Amazon Athena

Reporting & Dashboards

Amazon QuickSight

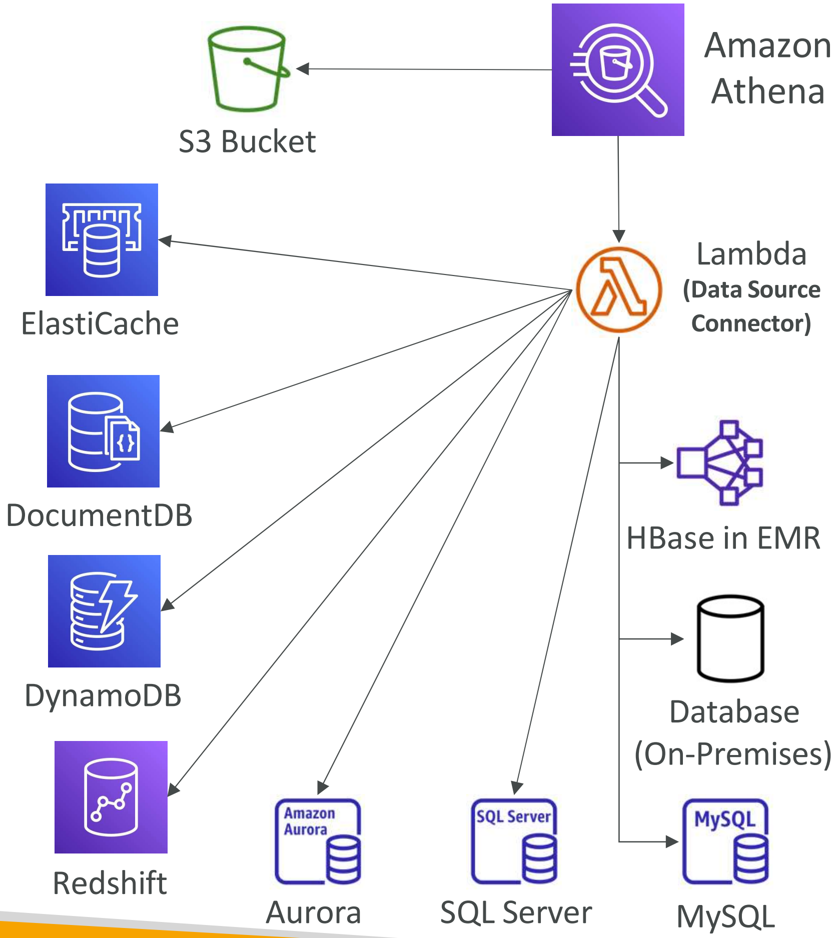
Amazon Athena - Performance Improvement

- Use columnar data for cost-savings (less scan)
  - Apache Parquet or ORC is recommended
  - Huge performance improvement
  - Use Glue to convert your data to Parquet or ORC
- Compress data for smaller retrievals (bzip2, gzip, lz4, snappy, zlip, zstd...)
- Partition datasets in S3 for easy querying on virtual columns
  - s3://yourBucket/pathToTable

    ```
           /<PARTITION_COLUMN_NAME>=<VALUE>
             /<PARTITION_COLUMN_NAME>=<VALUE>
               /<PARTITION_COLUMN_NAME>=<VALUE>
                 /etc...
    ```
  - Example: s3://athena-examples/flight/parquet/year=1991/month=1/day=1/
- Use larger files (> 128 MB) to minimize overhead

Amazon Athena - Federated Query

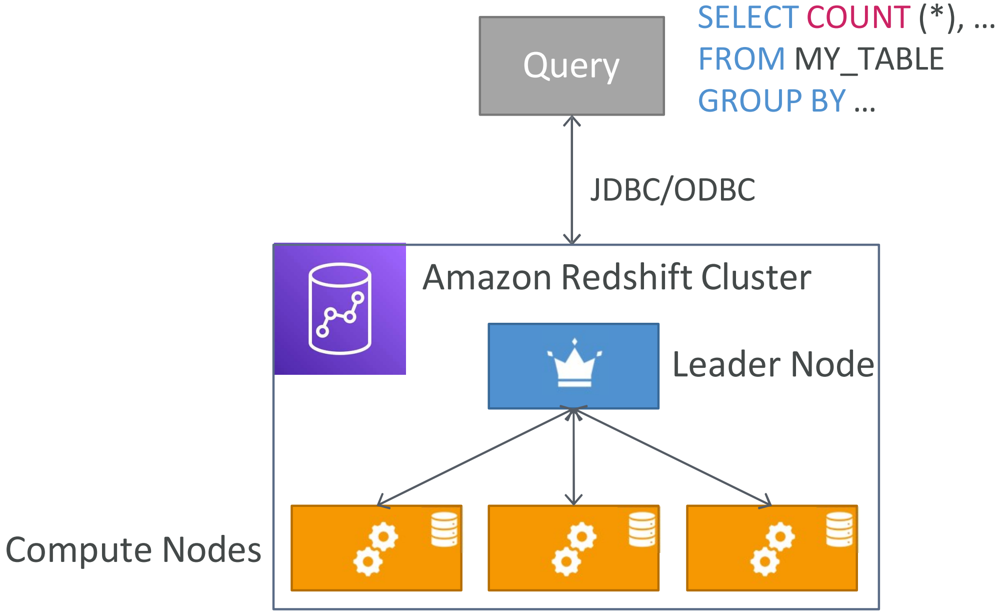
- Allows you to run SQL queries across data stored in relational, non-relational, object, and custom data sources (AWS or on-premises)
- Uses Data Source Connectors that run on AWS Lambda to run Federated Queries (e.g., CloudWatch Logs, DynamoDB, RDS, ...)
- Store the results back in Amazon S3



Redshift Overview

- Redshift is based on PostgreSQL, but it's not used for OLTP
- It's OLAP - online analytical processing (analytics and data warehousing)
- 10x better performance than other data warehouses, scale to PBs of data
- Columnar storage of data (instead of row based) & parallel query engine
- Pay as you go based on the instances provisioned
- Has a SQL interface for performing the queries
- BI tools such as Amazon Quicksight or Tableau integrate with it
- vs Athena: faster queries / joins / aggregations thanks to indexes

Redshift Cluster

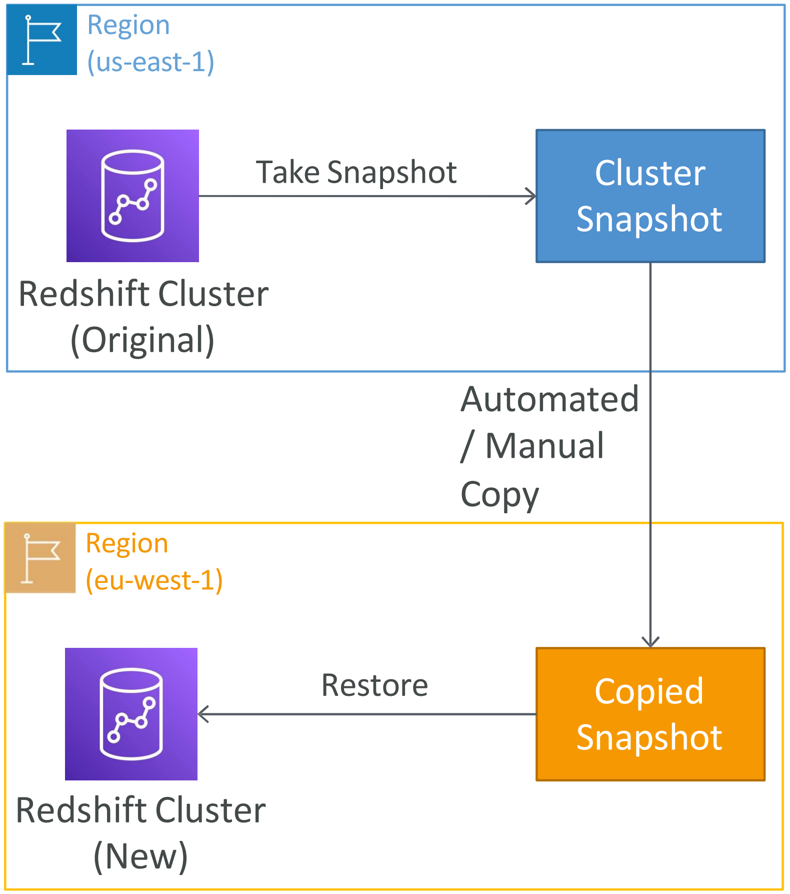


- Leader node: for query planning, results aggregation
- Compute node: for performing the queries, send results to leader
- You provision the node size in advance
- You can used Reserved Instances for cost savings

Redshift - Snapshots & DR

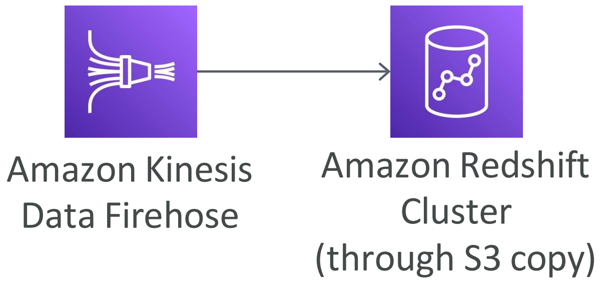
- Redshift has "Multi-AZ" mode for some clusters
- Snapshots are point-in-time backups of a cluster, stored internally in S3
- Snapshots are incremental (only what has changed is saved)
- You can restore a snapshot into a new cluster
- Automated: every 8 hours, every 5 GB, or on a schedule. Set retention between 1 to 35 days
- Manual: snapshot is retained until you delete it

- You can configure Amazon Redshift to automatically copy snapshots (automated or manual) of a cluster to another AWS Region

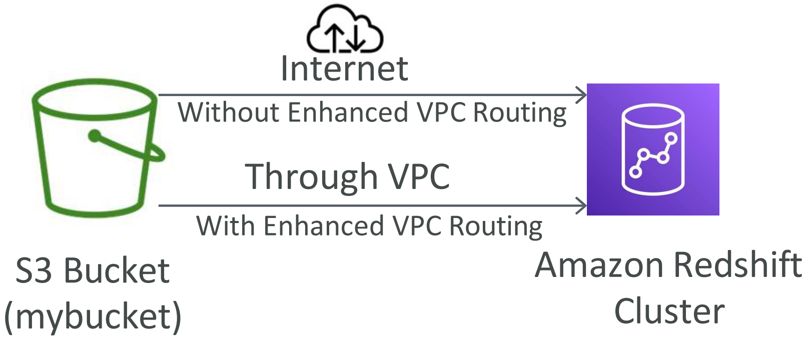


Loading data into Redshift: Large inserts are MUCH better

Amazon Kinesis Data Firehose


Amazon Kinesis Data Firehose
Amazon Redshift Cluster (through S3 copy)

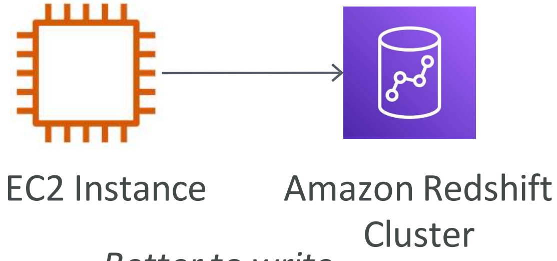
S3 using COPY command



```
copy customer
from 's3://mybucket/mydata'
iam_role 'arn:aws:iam::0123456789012:role/MyRedshiftRole';
```

EC2 Instance

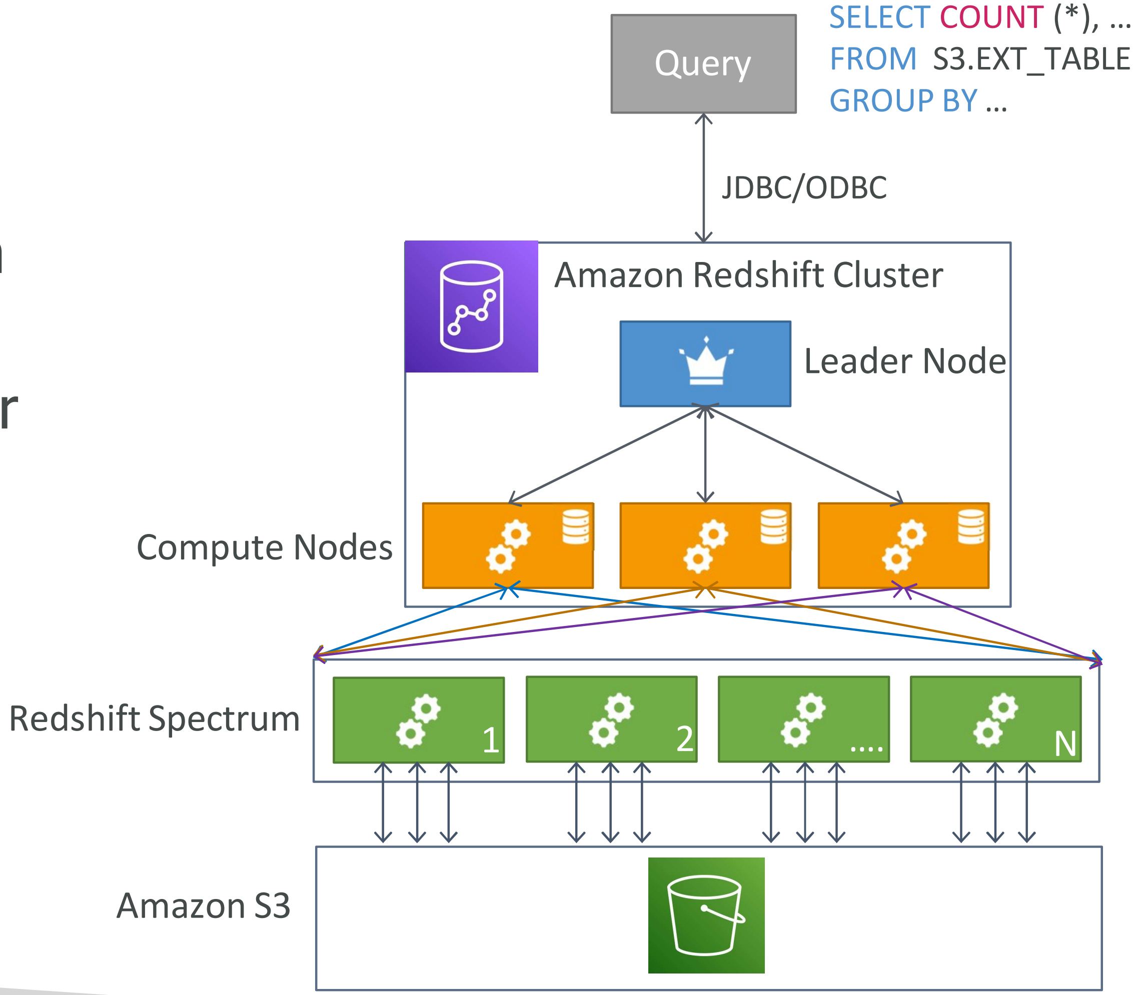
JDBC driver



Better to write Data in batches

Redshift Spectrum

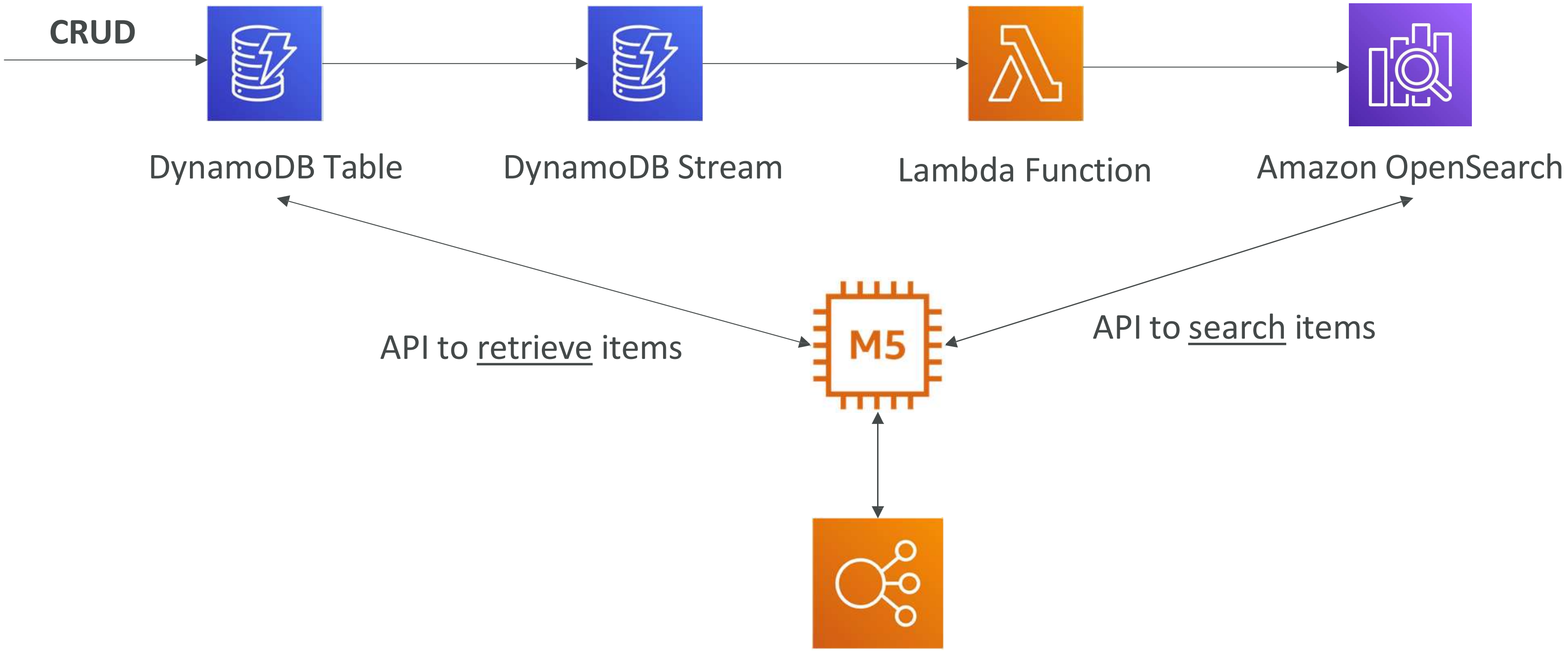
- Query data that is already in S3 without loading it
- Must have a Redshift cluster available to start the query
- The query is then submitted to thousands of Redshift Spectrum nodes



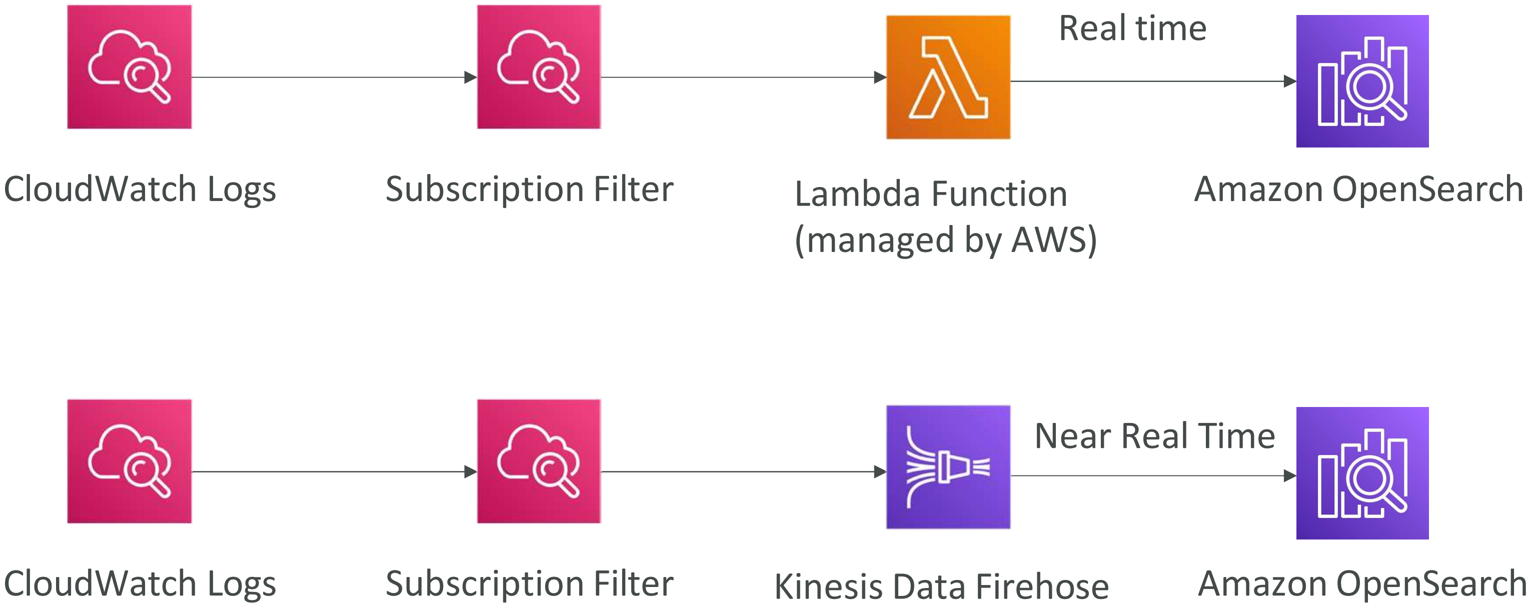
Amazon OpenSearch Service

- *Amazon OpenSearch is successor to Amazon ElasticSearch*
- In DynamoDB, queries only exist by primary key or indexes…
- With OpenSearch, you can search any field, even partially matches
- It's common to use OpenSearch as a complement to another database
- Two modes: managed cluster or serverless cluster
- Does *not* natively support SQL (can be enabled via a plugin)
- Ingestion from Kinesis Data Firehose, AWS IoT, and CloudWatch Logs
- Security through Cognito & IAM, KMS encryption, TLS
- Comes with OpenSearch Dashboards (visualization)

OpenSearch patterns DynamoDB



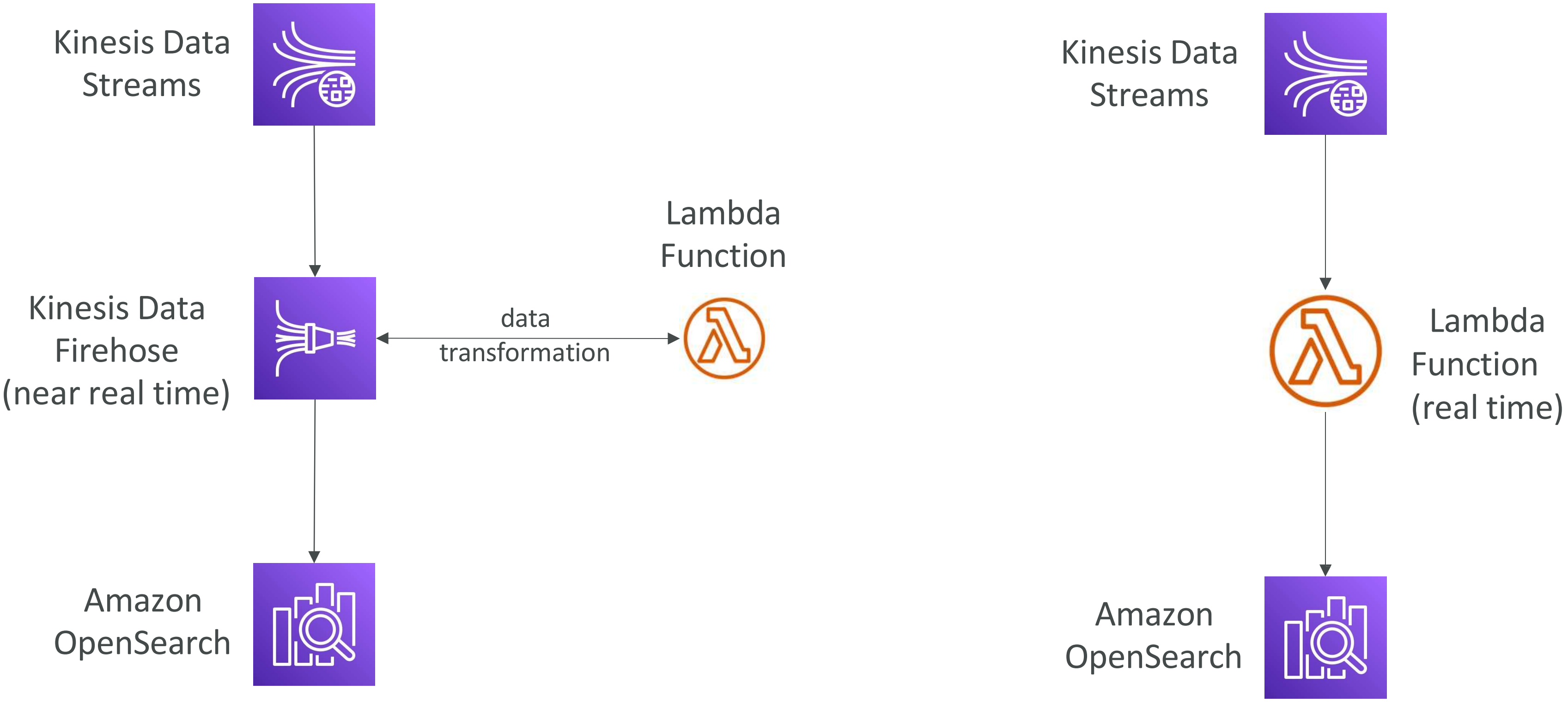
OpenSearch patterns CloudWatch Logs



CloudWatch Logs → Subscription Filter → Lambda Function (managed by AWS) → Real time → Amazon OpenSearch

CloudWatch Logs → Subscription Filter → Kinesis Data Firehose → Near Real Time → Amazon OpenSearch

OpenSearch patterns
Kinesis Data Streams & Kinesis Data Firehose



Amazon EMR

- EMR stands for “Elastic MapReduce”
- EMR helps creating Hadoop clusters (Big Data) to analyze and process vast amount of data
- The clusters can be made of hundreds of EC2 instances
- EMR comes bundled with Apache Spark, HBase, Presto, Flink…
- EMR takes care of all the provisioning and configuration
- Auto-scaling and integrated with Spot instances

- Use cases: data processing, machine learning, web indexing, big data…

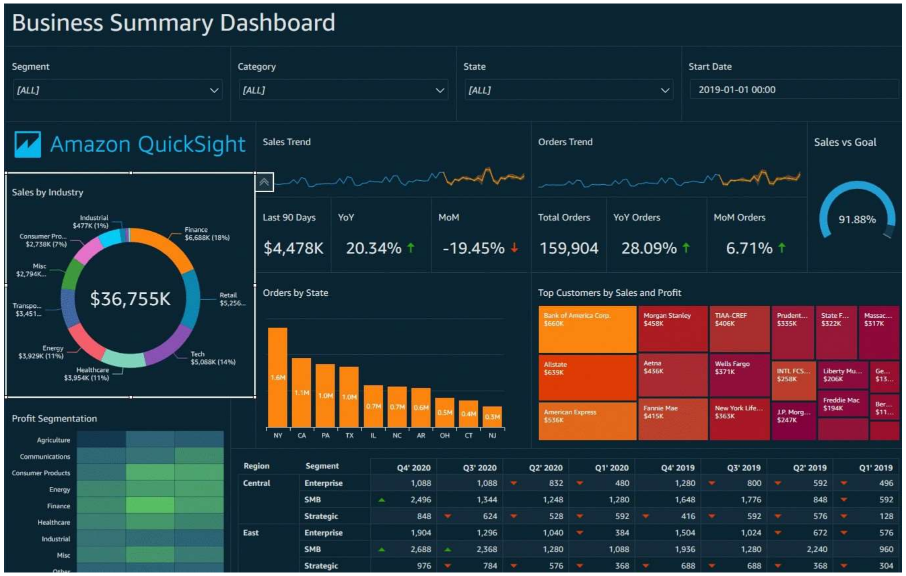
Amazon EMR – Node types & purchasing

- Master Node: Manage the cluster, coordinate, manage health – long running
- Core Node: Run tasks and store data – long running
- Task Node (optional): Just to run tasks – usually Spot
- Purchasing options:
  - On-demand: reliable, predictable, won't be terminated
  - Reserved (min 1 year): cost savings (EMR will automatically use if available)
  - Spot Instances: cheaper, can be terminated, less reliable

- Can have long-running cluster, or transient (temporary) cluster

Amazon QuickSight

- Serverless machine learning-powered business intelligence service to create interactive dashboards
- Fast, automatically scalable, embeddable, with per-session pricing
- Use cases:
  - Business analytics
  - Building visualizations
  - Perform ad-hoc analysis
  - Get business insights using data
- Integrated with RDS, Aurora, Athena, Redshift, S3…
- In-memory computation using SPICE engine if data is imported into QuickSight
- Enterprise edition: Possibility to setup Column-Level security (CLS)



Business Summary Dashboard

Segment: [ALL]

Category: [ALL]

State: [ALL]

Start Date: 2019-01-01 00:00

Last 90 Days: $4,478K

YoY: 20.34% ↑

MoM: -19.45% ↓

Total Orders: 159,904

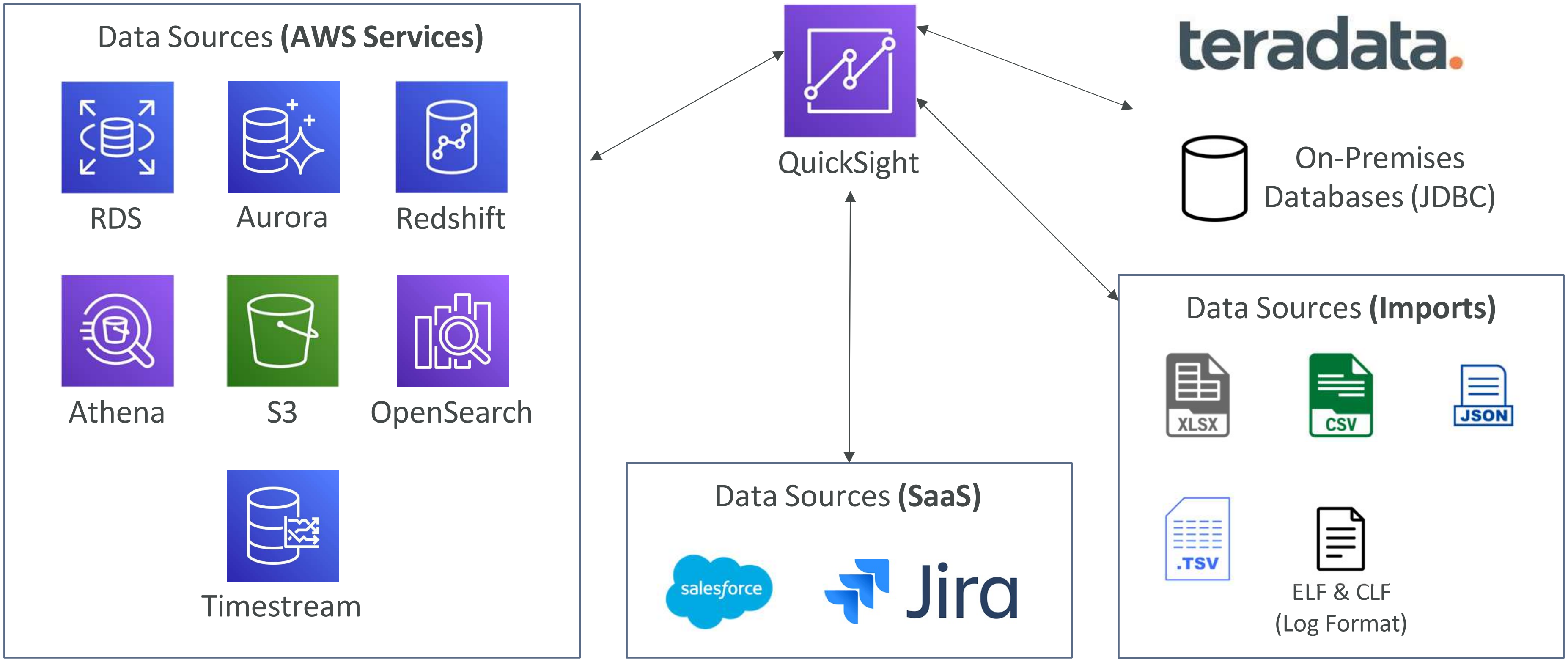
YoY Orders: 28.09% ↑

MoM Orders: 6.71% ↑

Region	Segment	Q4' 2020	Q3' 2020	Q2' 2020	Q1' 2020	Q4' 2019	Q3' 2019	Q2' 2019	Q1' 2019
Central	Enterprise	1,088	1,088	▼ 832	▼ 480	1,280	▼ 800	▼ 592	▼ 496
	SMB	▲ 2,496	1,344	1,248	1,280	1,648	1,776	848	▼ 592
	Strategic	848	▼ 624	▼ 528	▼ 592	▼ 416	▼ 592	▼ 576	▼ 128
East	Enterprise	1,904	1,296	1,040	▼ 384	1,504	1,024	▼ 672	▼ 576
	SMB	▲ 2,688	▲ 2,368	1,280	1,088	1,936	1,280	2,240	960
	Strategic	976	▼ 784	▼ 576	▼ 368	▼ 688	▼ 688	▼ 368	▼ 304

https://aws.amazon.com/quicksight/

QuickSight Integrations



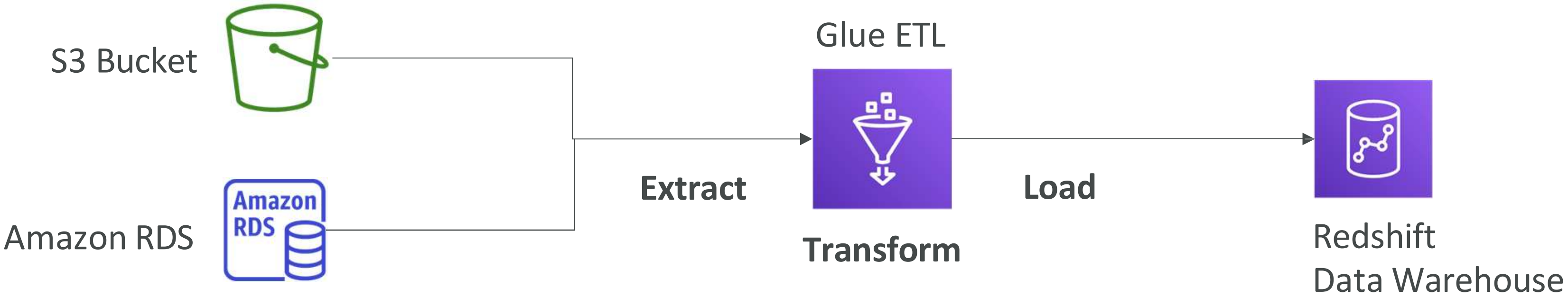
QuickSight - Dashboard & Analysis

- Define Users (standard versions) and Groups (enterprise version)
  - These users & groups only exist within QuickSight, not IAM !!
- A *dashboard…*
  - is a read-only snapshot of an analysis that you can share
  - preserves the configuration of the analysis (filtering, parameters, controls, sort)

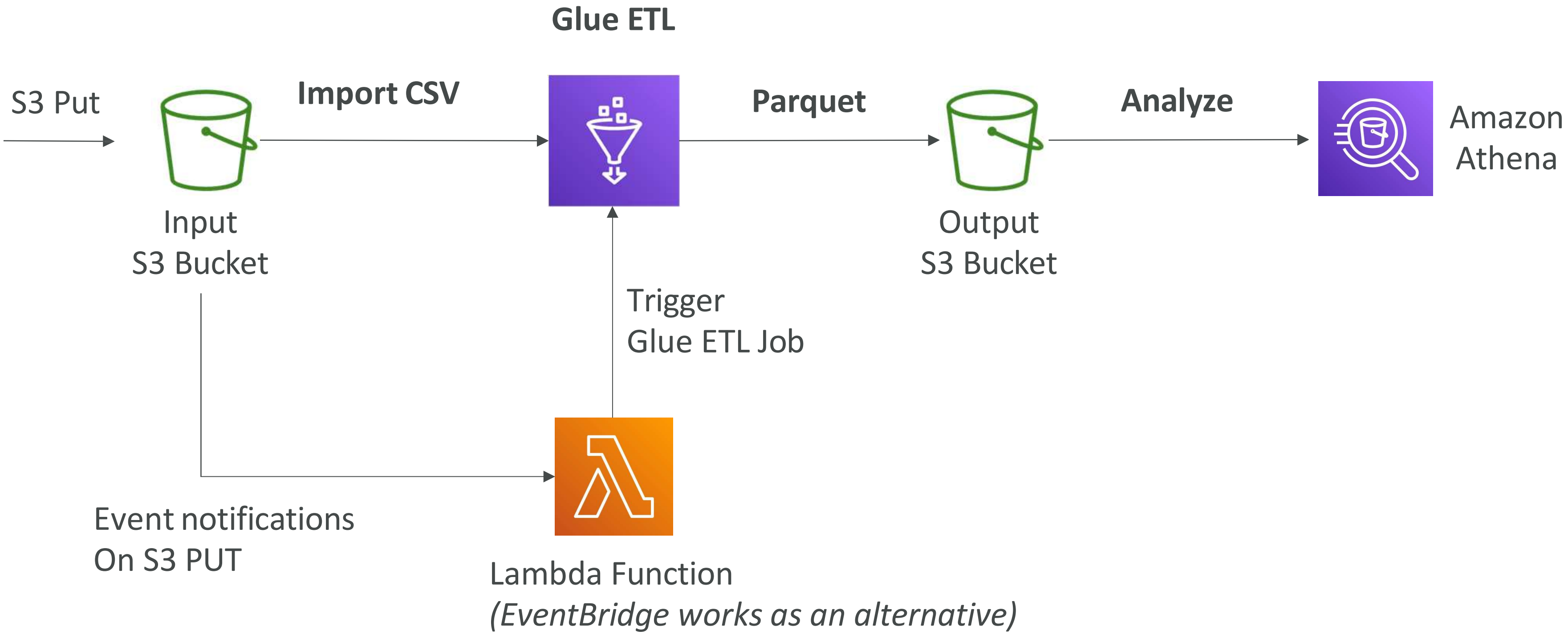
- You can share the analysis or the dashboard with Users or Groups
- To share a dashboard, you must first publish it
- Users who see the dashboard can also see the underlying data

AWS Glue

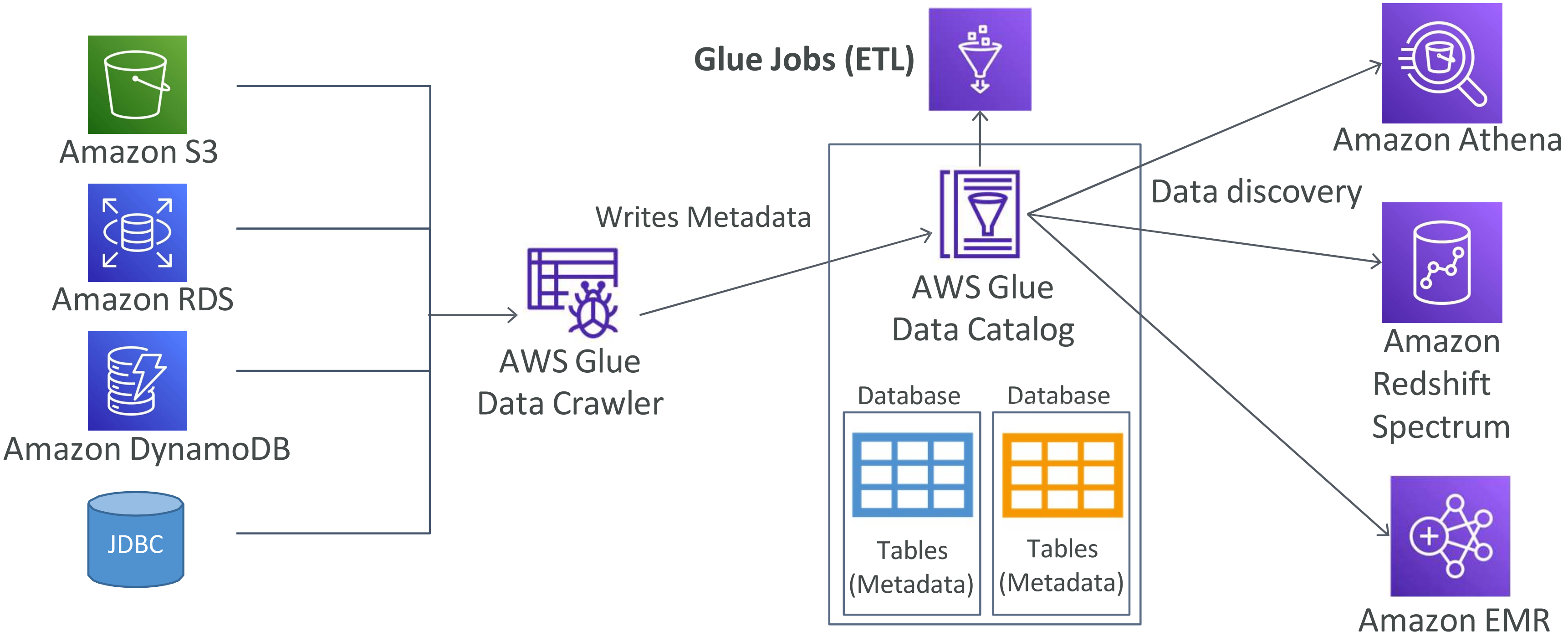
- Managed extract, transform, and load (ETL) service
- Useful to prepare and transform data for analytics
- Fully serverless service



AWS Glue - Convert data into Parquet format



Glue Data Catalog: catalog of datasets



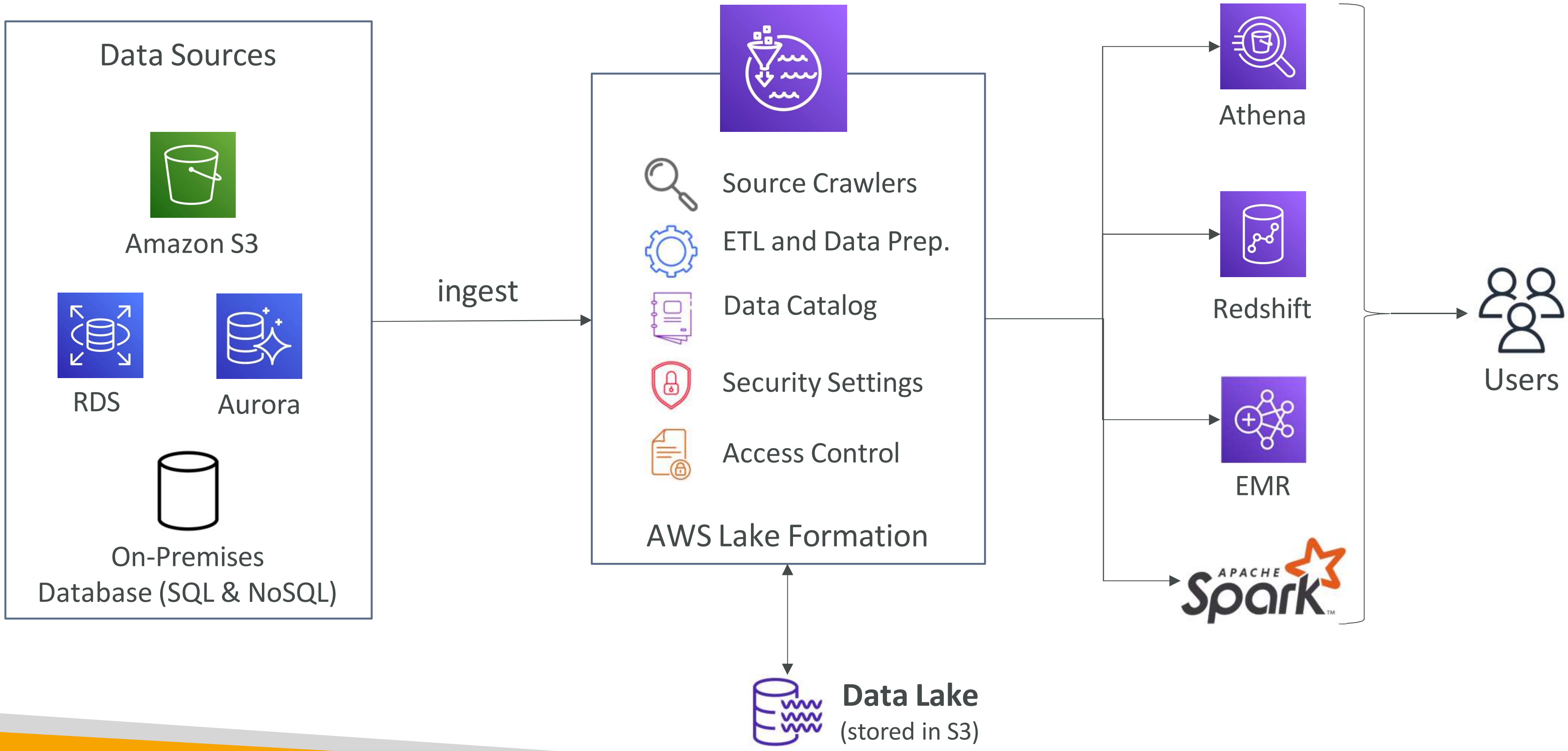
Glue - things to know at a high-level

- Glue Job Bookmarks: prevent re-processing old data
- Glue Elastic Views:
  - Combine and replicate data across multiple data stores using SQL
  - No custom code, Glue monitors for changes in the source data, serverless
  - Leverages a "virtual table" (materialized view)
- Glue DataBrew: clean and normalize data using pre-built transformation
- Glue Studio: new GUI to create, run and monitor ETL jobs in Glue
- Glue Streaming ETL (built on Apache Spark Structured Streaming): compatible with Kinesis Data Streaming, Kafka, MSK (managed Kafka)

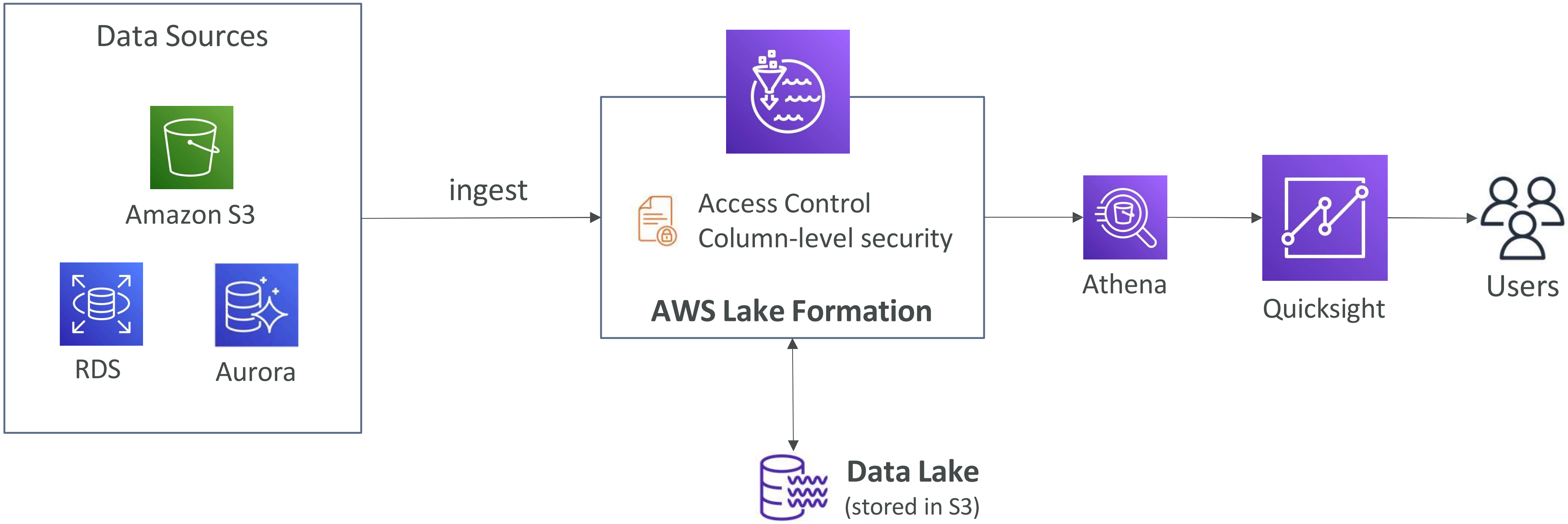
AWS Lake Formation

- Data lake = central place to have all your data for analytics purposes
- Fully managed service that makes it easy to setup a data lake in days
- Discover, cleanse, transform, and ingest data into your Data Lake
- It automates many complex manual steps (collecting, cleansing, moving, cataloging data, …) and de-duplicate (using ML Transforms)
- Combine structured and unstructured data in the data lake
- Out-of-the-box source blueprints: S3, RDS, Relational & NoSQL DB…
- Fine-grained Access Control for your applications (row and column-level)
- Built on top of AWS Glue

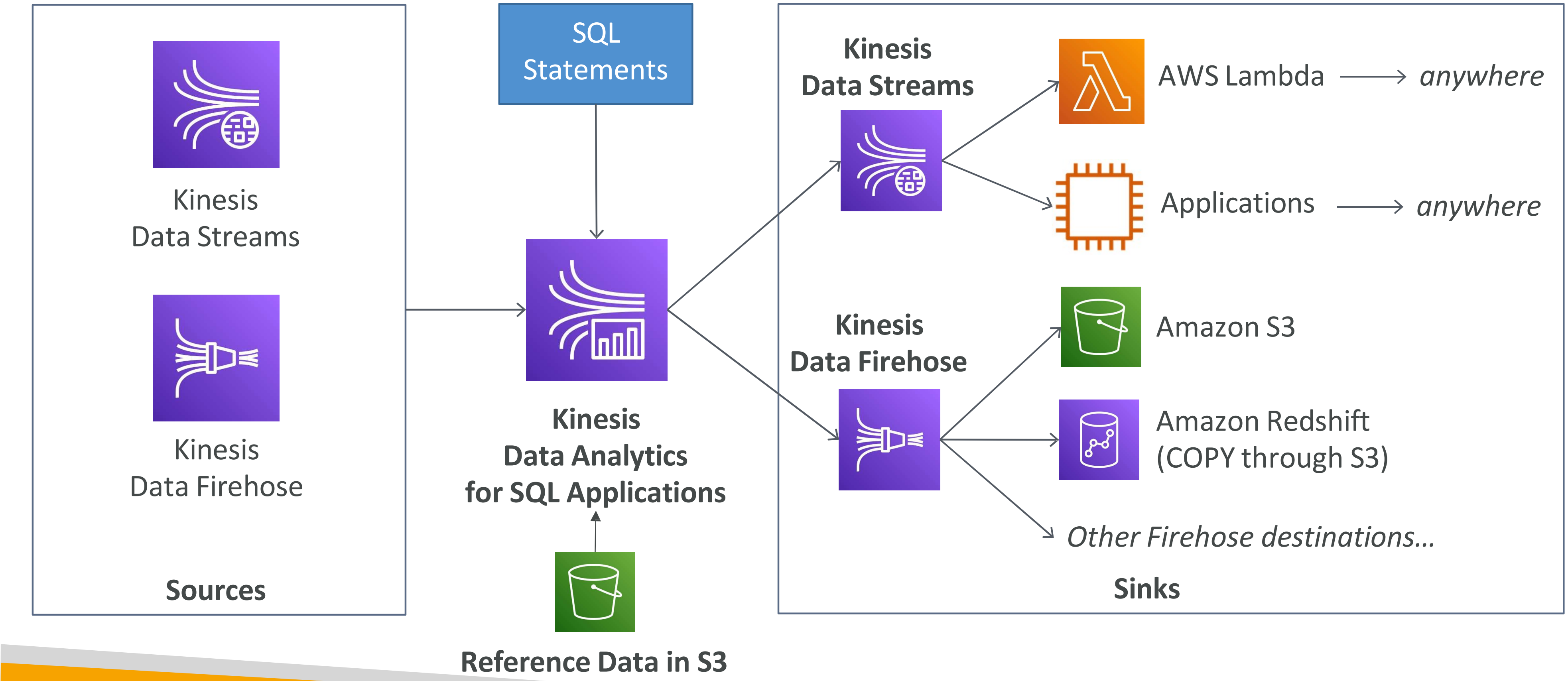
AWS Lake Formation



AWS Lake Formation
Centralized Permissions Example



Kinesis Data Analytics for SQL applications

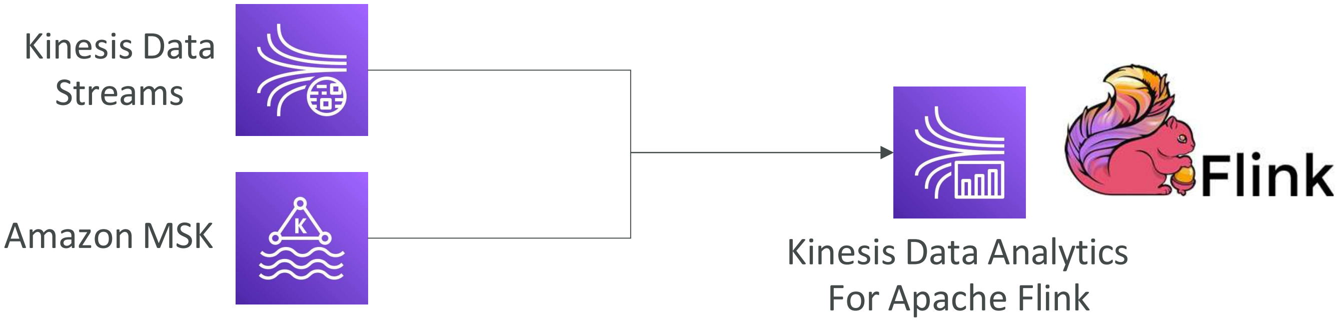


Kinesis Data Analytics (SQL application)

- Real-time analytics on Kinesis Data Streams & Firehose using SQL
- Add reference data from Amazon S3 to enrich streaming data
- Fully managed, no servers to provision
- Automatic scaling
- Pay for actual consumption rate
- Output:
  - Kinesis Data Streams: create streams out of the real-time analytics queries
  - Kinesis Data Firehose: send analytics query results to destinations
- Use cases:
  - Time-series analytics
  - Real-time dashboards
  - Real-time metrics

Kinesis Data Analytics for Apache Flink

- Use Flink (Java, Scala or SQL) to process and analyze streaming data

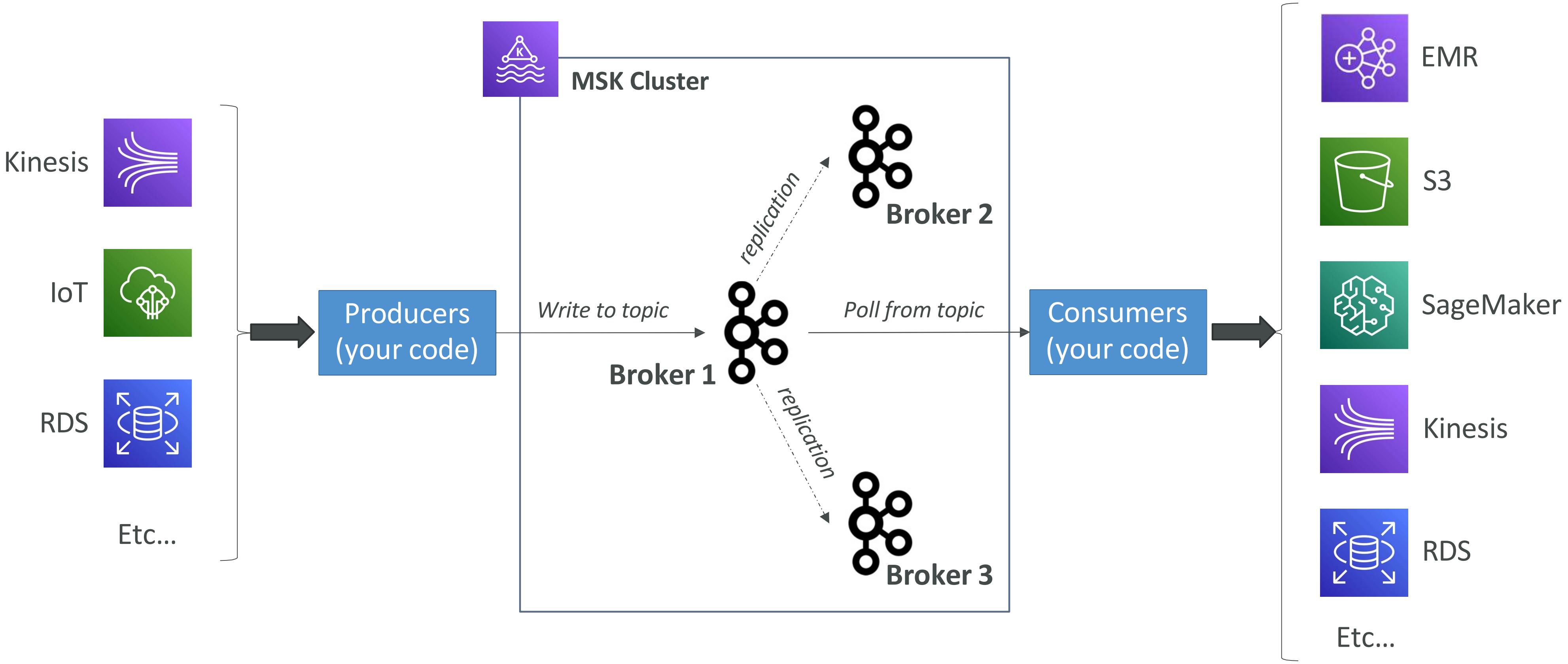


- Run any Apache Flink application on a managed cluster on AWS
  - provisioning compute resources, parallel computation, automatic scaling
  - application backups (implemented as checkpoints and snapshots)
  - Use any Apache Flink programming features
  - Flink does not read from Firehose (use Kinesis Analytics for SQL instead)

Amazon Managed Streaming for Apache Kafka (Amazon MSK)

- Alternative to Amazon Kinesis
- Fully managed Apache Kafka on AWS
  - Allow you to create, update, delete clusters
  - MSK creates & manages Kafka brokers nodes & Zookeeper nodes for you
  - Deploy the MSK cluster in your VPC, multi-AZ (up to 3 for HA)
  - Automatic recovery from common Apache Kafka failures
  - Data is stored on EBS volumes for as long as you want
- MSK Serverless
  - Run Apache Kafka on MSK without managing the capacity
  - MSK automatically provisions resources and scales compute & storage

Apache Kafka at a high level



Kinesis Data Streams vs. Amazon MSK

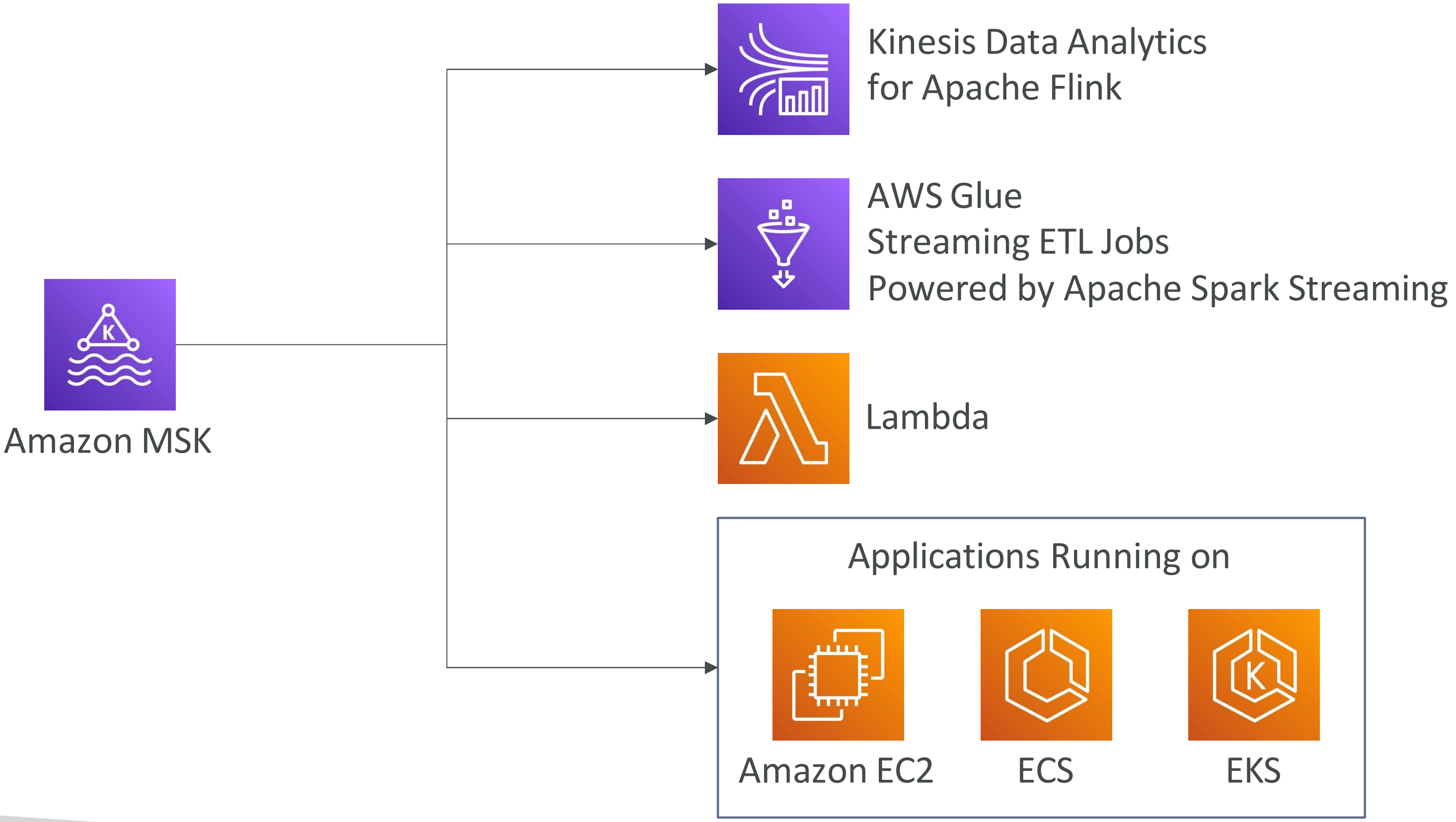
Kinesis Data Streams

- 1 MB message size limit
- Data Streams with Shards
- Shard Splitting & Merging
- TLS In-flight encryption
- KMS at-rest encryption

Amazon MSK

- 1MB default, configure for higher (ex: 10MB)
- Kafka Topics with Partitions
- Can only add partitions to a topic
- PLAINTEXT or TLS In-flight Encryption
- KMS at-rest encryption

Amazon MSK Consumers



Amazon MSK

Kinesis Data Analytics
for Apache Flink

AWS Glue
Streaming ETL Jobs
Powered by Apache Spark Streaming

Lambda

Applications Running on

Amazon EC2

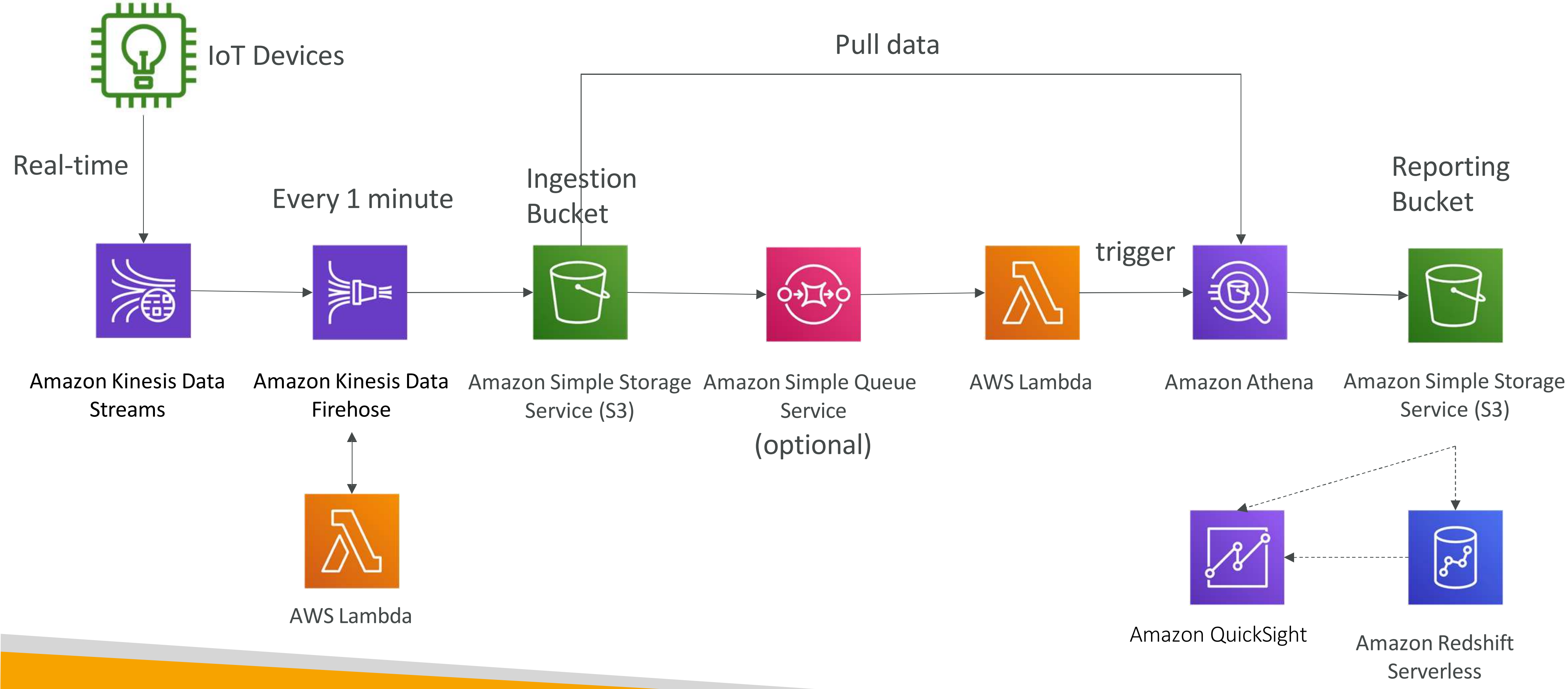
ECS

EKS

Big Data Ingestion Pipeline

- We want the ingestion pipeline to be fully serverless
- We want to collect data in real time
- We want to transform the data
- We want to query the transformed data using SQL
- The reports created using the queries should be in S3
- We want to load that data into a warehouse and create dashboards

Big Data Ingestion Pipeline


IoT Devices
Real-time
Every 1 minute
Ingestion Bucket
Pull data
Reporting Bucket
trigger
Amazon Kinesis Data Streams
Amazon Kinesis Data Firehose
Amazon Simple Storage Service (S3)
Amazon Simple Queue Service
(optional)
AWS Lambda
Amazon Athena
Amazon Simple Storage Service (S3)
AWS Lambda
Amazon QuickSight
Amazon Redshift Serverless

Big Data Ingestion Pipeline discussion

- IoT Core allows you to harvest data from IoT devices
- Kinesis is great for real-time data collection
- Firehose helps with data delivery to S3 in near real-time (1 minute)
- Lambda can help Firehose with data transformations
- Amazon S3 can trigger notifications to SQS
- Lambda can subscribe to SQS (we could have connecter S3 to Lambda)
- Athena is a serverless SQL service and results are stored in S3
- The reporting bucket contains analyzed data and can be used by reporting tool such as AWS QuickSight, Redshift, etc…