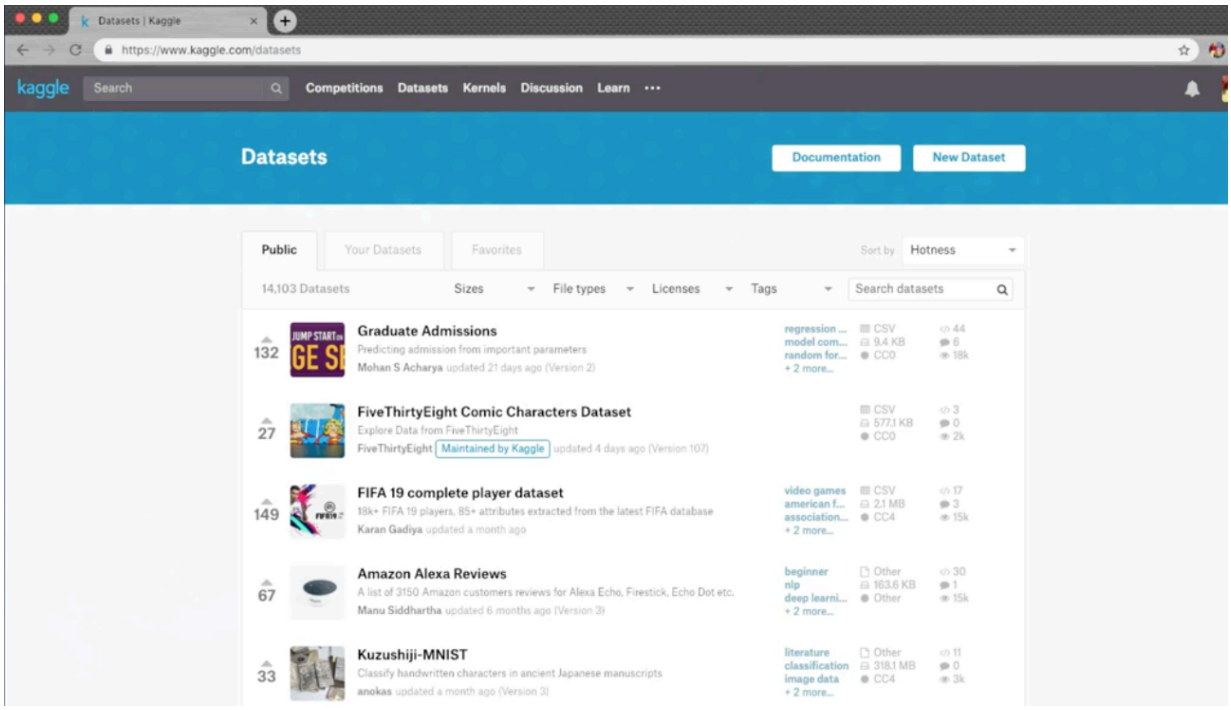
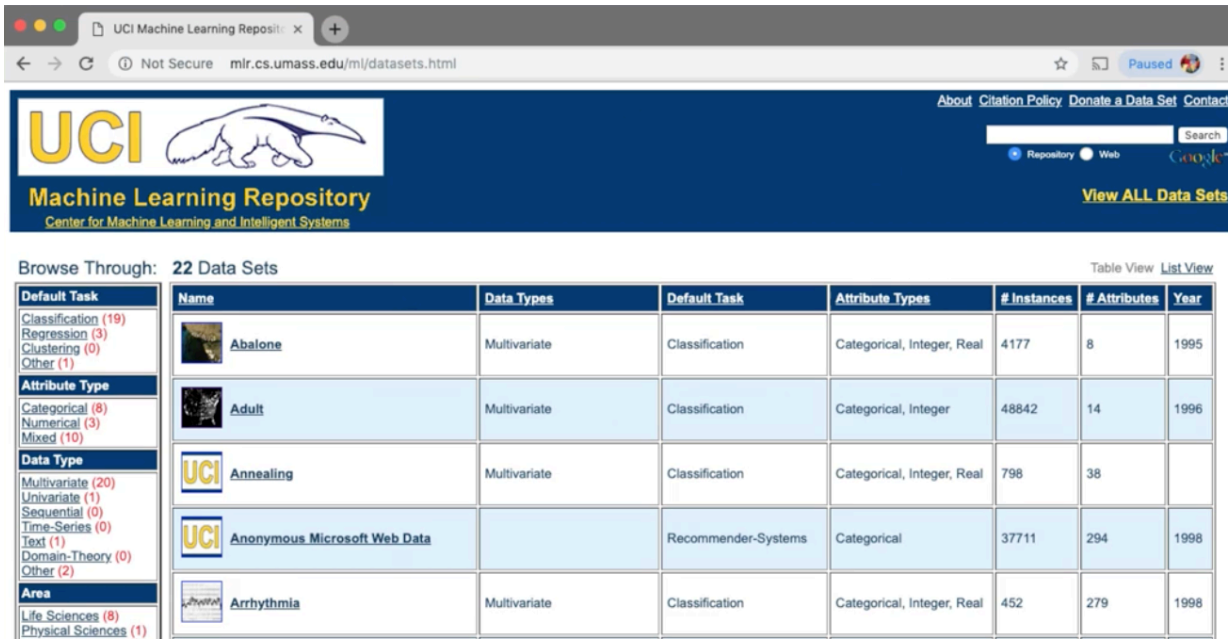
Cloud Guru - 2 - Streaming Data Collection

https://acloud.guru/course/aws-certified-machine-learning-specialty/learn/c756bf92-fc24-f757-1b0d-5072064ea51a/ae135d9e-fd47-7028-b748-677d20da6b23/watch?_ga=2.65864555.490643139.1596727443-133961477.1588770985

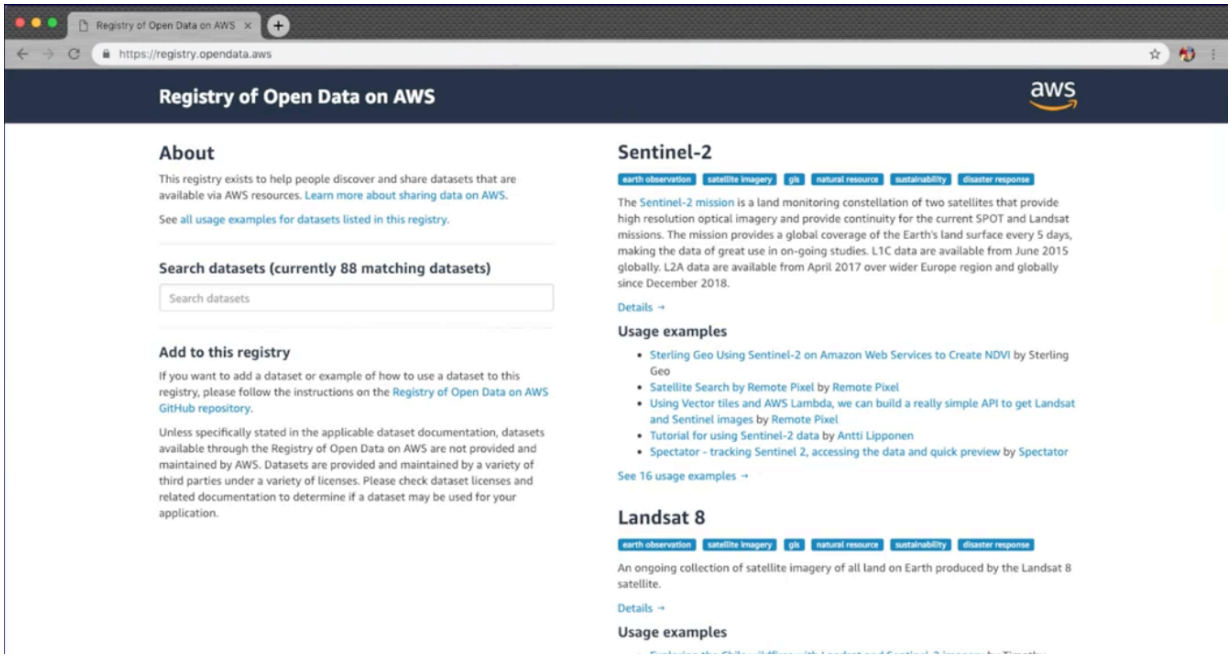
Datasets we can use for ML
Kaggle - online platform that offers datasets and set competitions



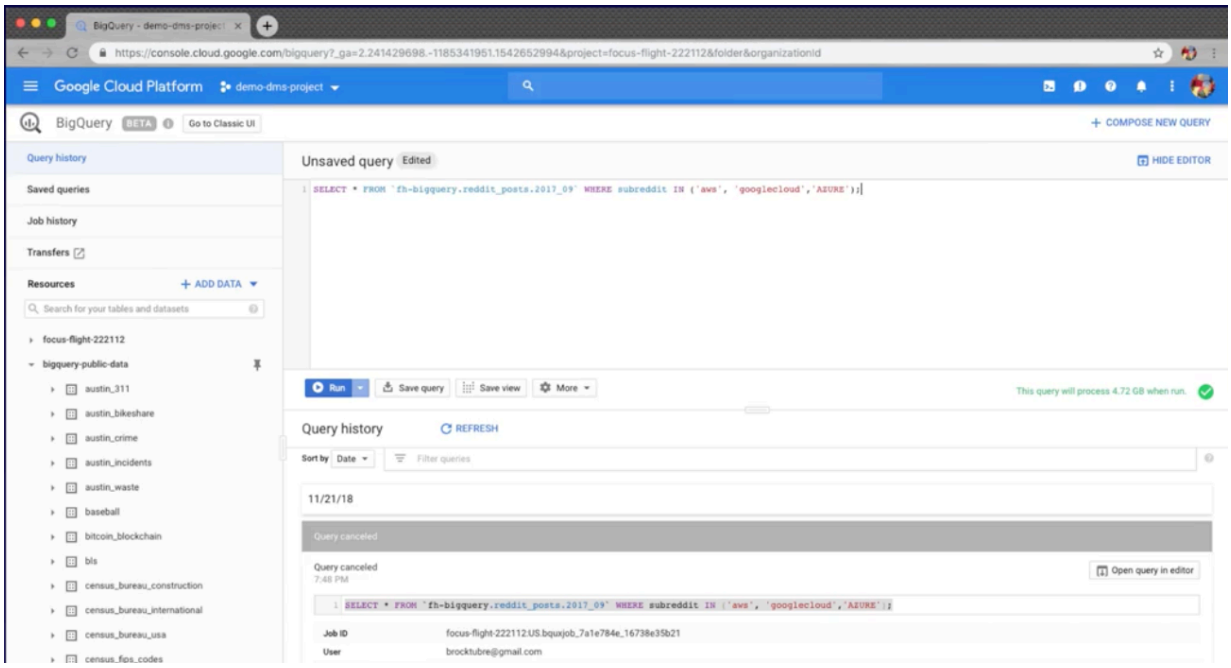
Other website with open source datasets: UCI



AWS also allows for Open Data

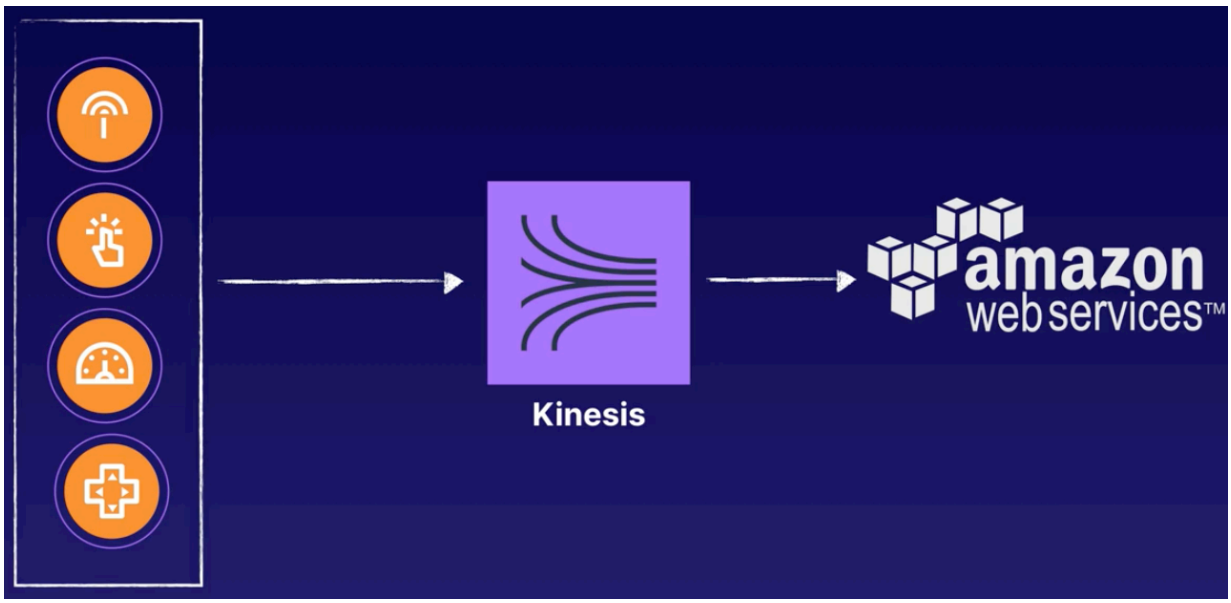


Same with Google Big Queries

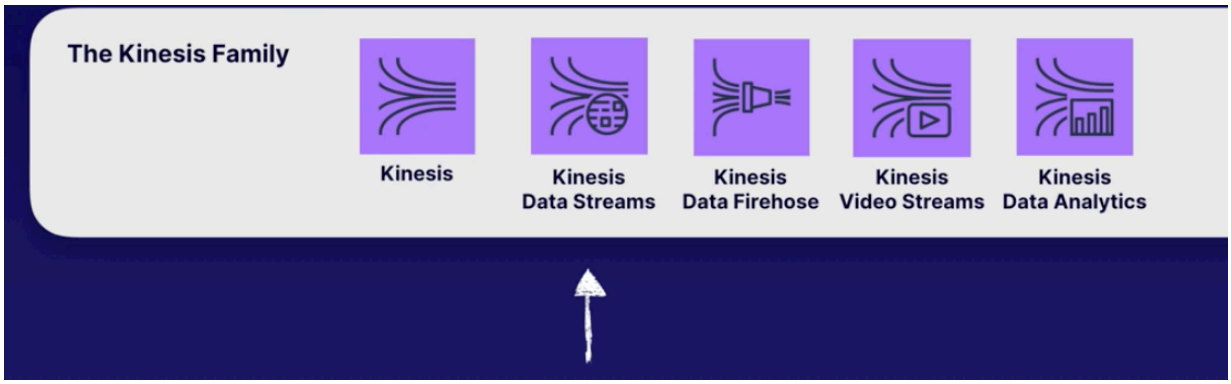


Example of Streaming data: sensor, industrial equipments, financial stock market, real estate websites to make real time recommendations, click stream data for recommendation, online gaming company about game player interaction and feedback back to platform...

How to handle streaming data? Via a family of tools: Kinesis



Kinesis Data Streams

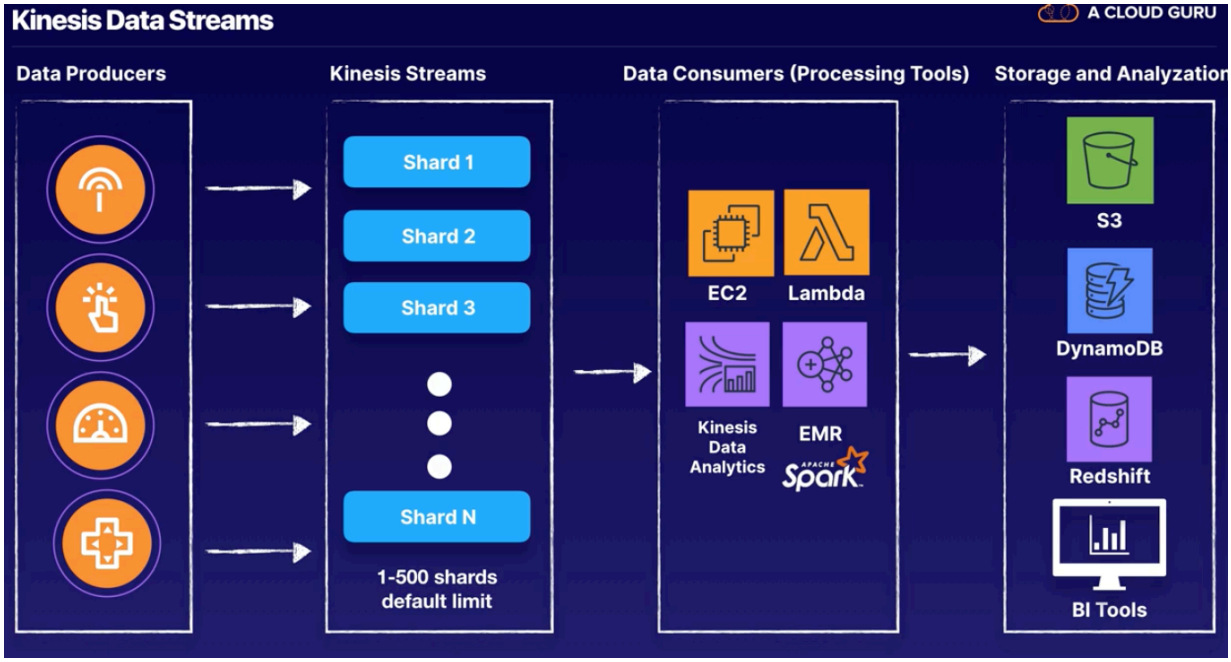


Kinesis Data Streams get data from data producers: typically have JSON data as payload, or any type of data into a data blob
Data producers can be application log files, social media streams, real time user interaction from video games, IoT devices, click stream, user interaction for online website/app,...

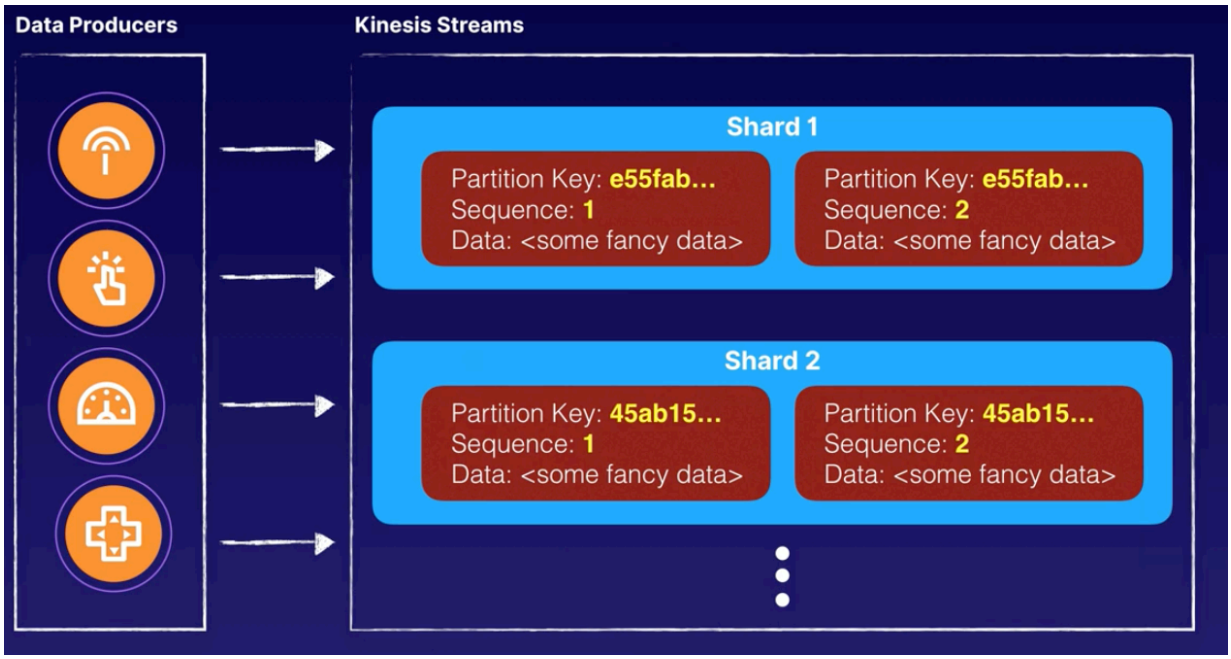
Once data is produced, we use Kinesis Data Streams to transfer/load/stream that data into AWS
It leverages Shards - a container that holds the data that we want to send to AWS

Once data is contained within a star, we use data consumers to process or analyze that data => EC2 instances, lambda function with real time ETL process,
We can also use Kinesis Data Analytics to run real time SQL queries on our streaming data.
Or we can use streaming data to an EMR cluster and process it with Spark.

To note we can have multiple consumers consume these shards and do multiple processes/analysis/...



A **shard** is made up of a couple of parts:
- unique **partition key** per shard
- **sequence** / associated with a shard.

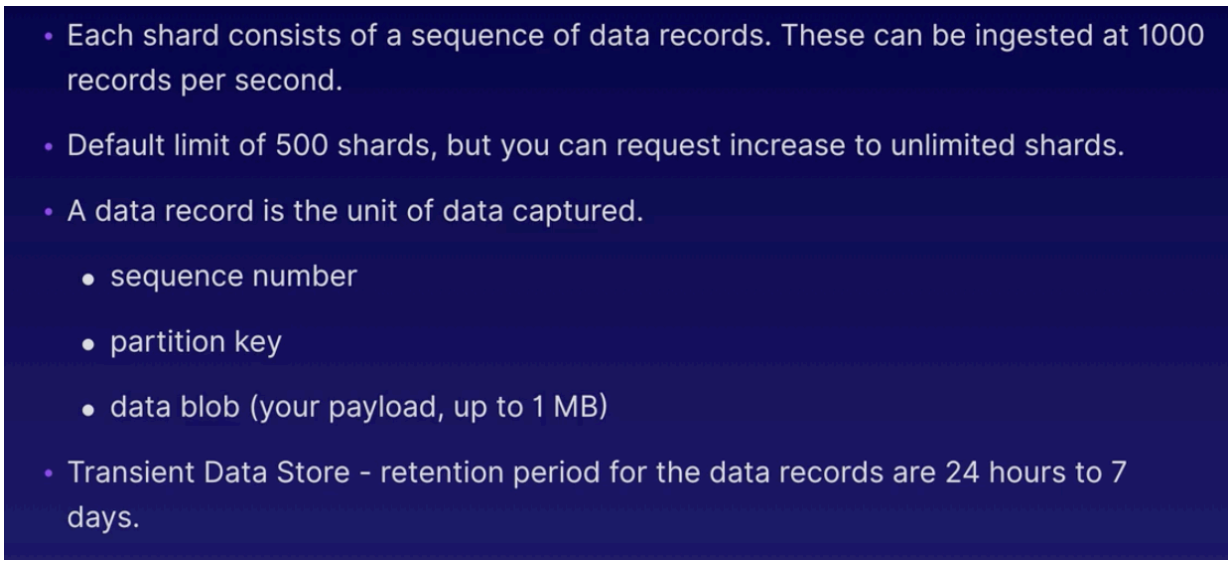


The more requests we make and the larger the payload will determine the # of shards

Analogy for Kinesis Data Stream shard/partition key => train

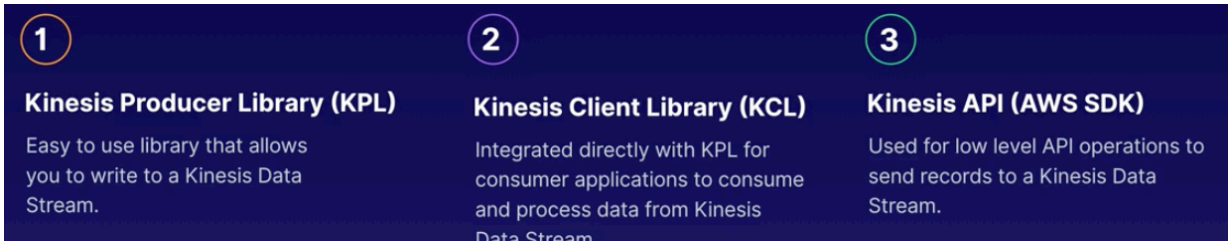
The train ID is the **partition** key
Each car on the train is the **sequence** #
The passengers in each car is the **data**

Each shard consists of data records. Default limit of shards is 500 but can go beyond,. Data can be ingested at 1000 records / second
Transient data store - data held for 24 hours by default but can go up to 7 days



Interacting with Kinesis Data Streams via:
- KPL: Kinesis Producer Library to write. Can install it onto EC2 instance or in our

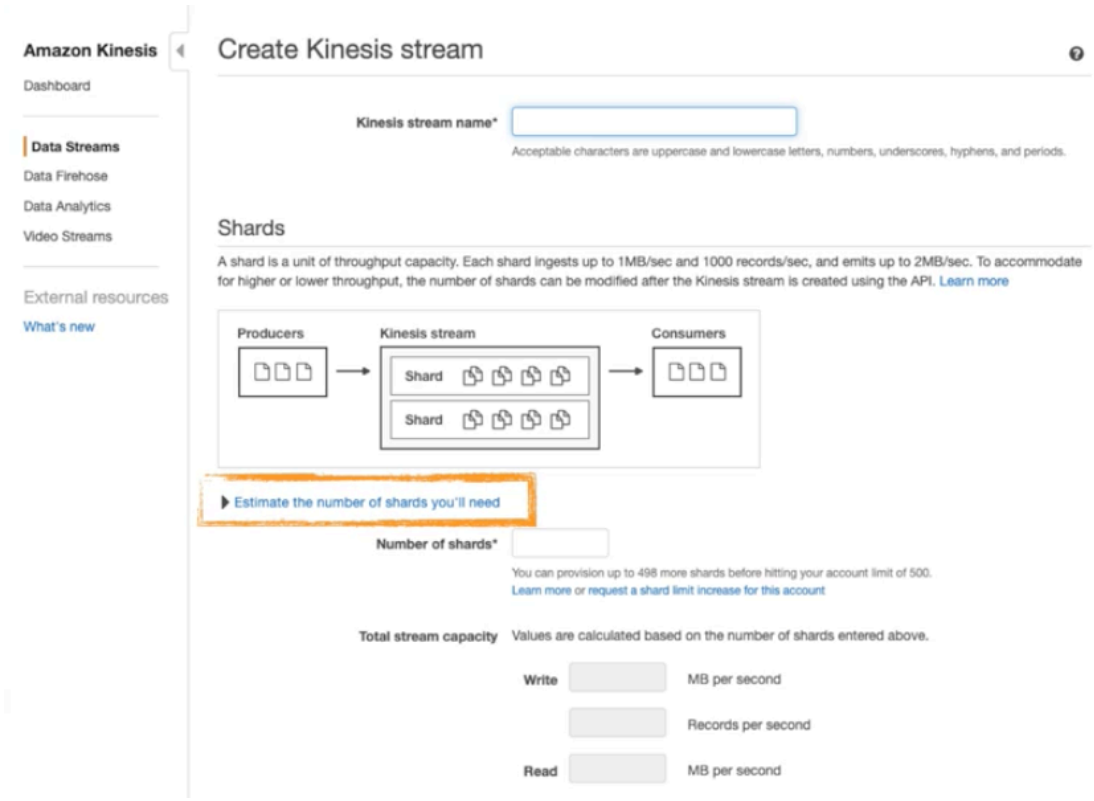
Java app. Handles automatically retries, aggregate of records for optimization
 - KCL: Kinesis Client Library: to interact with KPL to consume and process the data
 - Kinesis API (SDK): more for low level interactions



Kinesis Producer Library (KPL)	• Provides a layer of abstraction specifically for ingesting data • Automatic and configurable retry mechanism • Additional processing delay can occur for higher packing efficiencies and better performance • Java wrapper
Kinesis API	• Low-level API calls (`PutRecords` and `GetRecords`) • Stream creations, resharding, and putting and getting records are manually handled • No delays in processing • Any AWS SDK

If need data stream immediately avail within ms => use Kinesis API
If app is written in other language than Java => use Kinesis API

Console

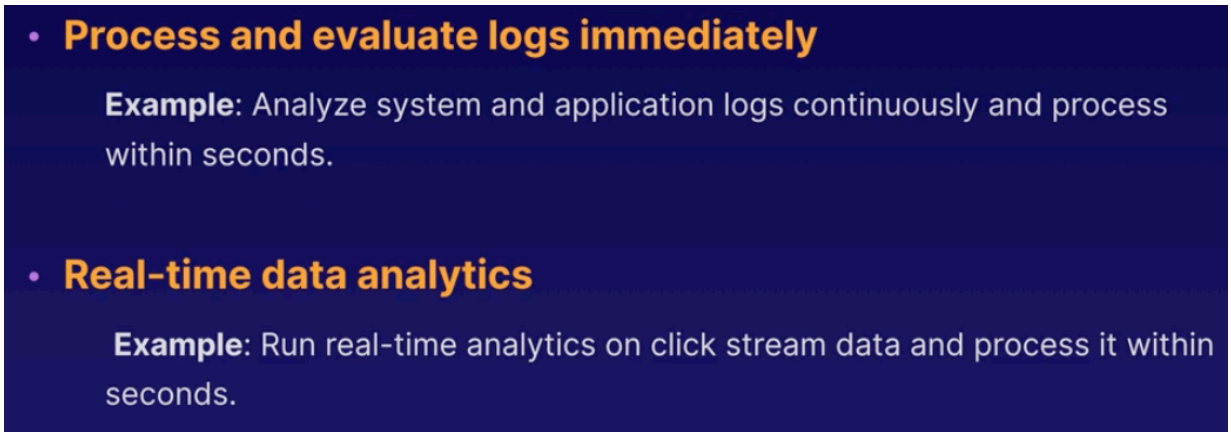


A shard is a init of throughput capacity Each shard inlet up to 1 Mb/sec and 1000 records/sec, and emits up to 2 Mb / sec.
To accommodate for higher/lower throughput, adjust shard #

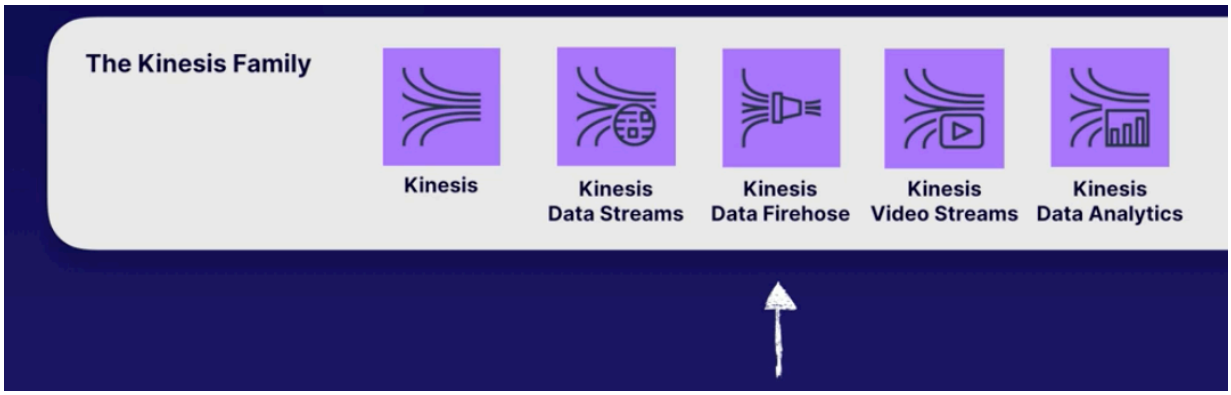
When to use Kinesis Data Streams?

If data is important, data retention is built in Kinesis and we can hold onto it for 24 hours (and up to 7 days). Can allow us to reprocess data in a stream

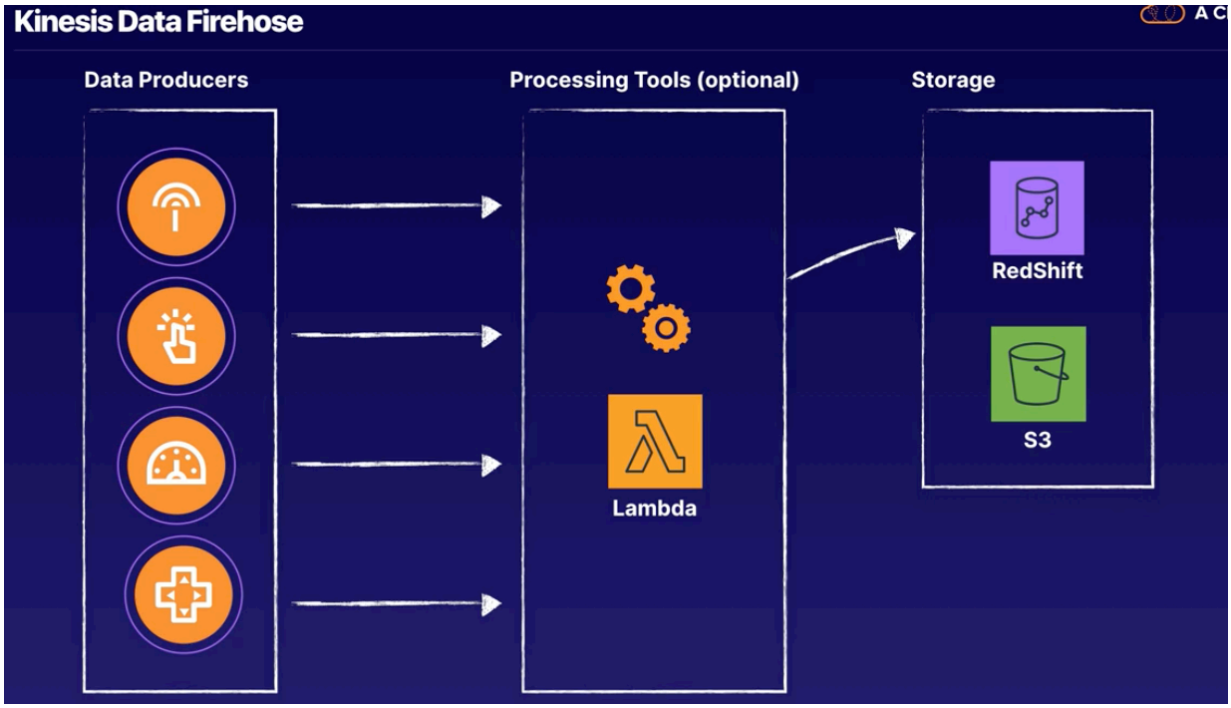
Good options for Kinesis Data Streams:



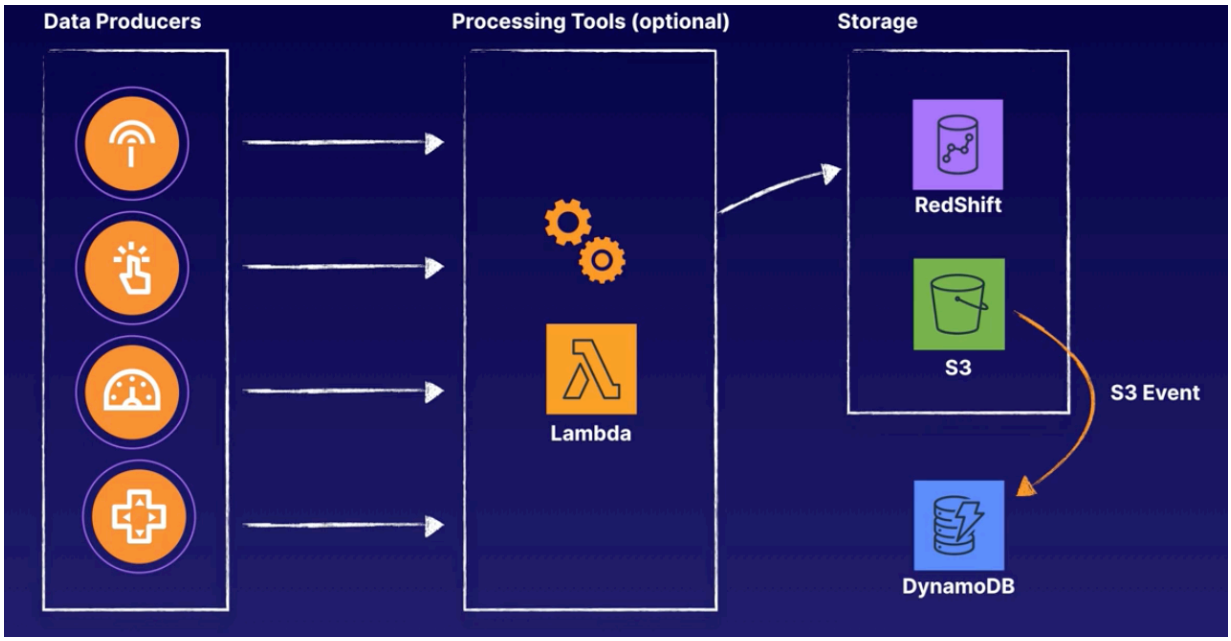
Kinesis Firehose:
Easily streams data



No longer have to worry about shards (as with Kinesis Data Streams)
We can preprocess the data with Lambda, optionally, before we land the data in S3, Redshift, splunk and Amazon Elastic Serach
We could also stream from Data Firehose to storage directly



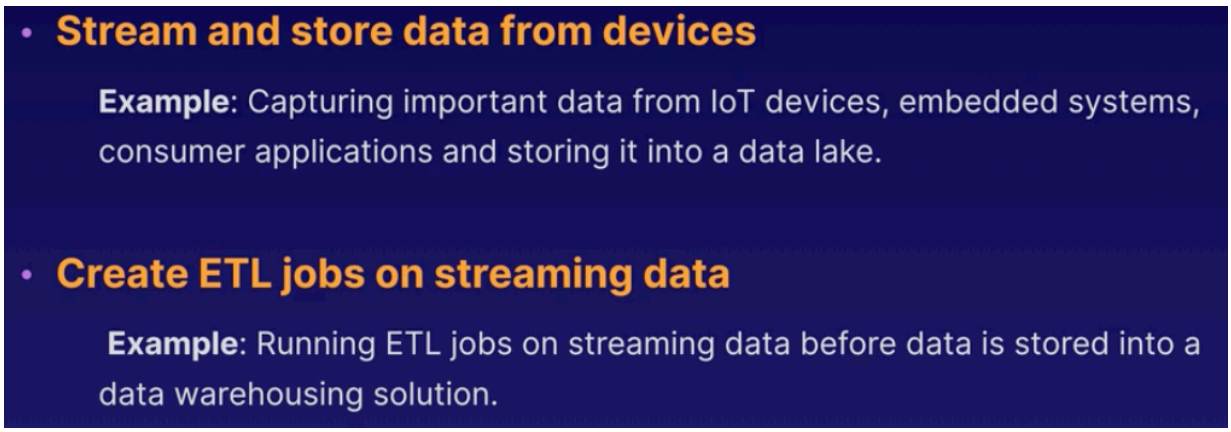
We can also use S3 event to push data to Dynamo DB



Difference between Kinesis Data Streams and Data Firehose:
- Streams needs shards and has data retention (24 hours default, up to 7 days)
- Firehose: no need to worry about shards. Used for streaming straight the data to repository like S3 (or with light processing with lambda). However no data retention. If we lose some data, not the end of the world

When to use Kinesis Data Firehose?

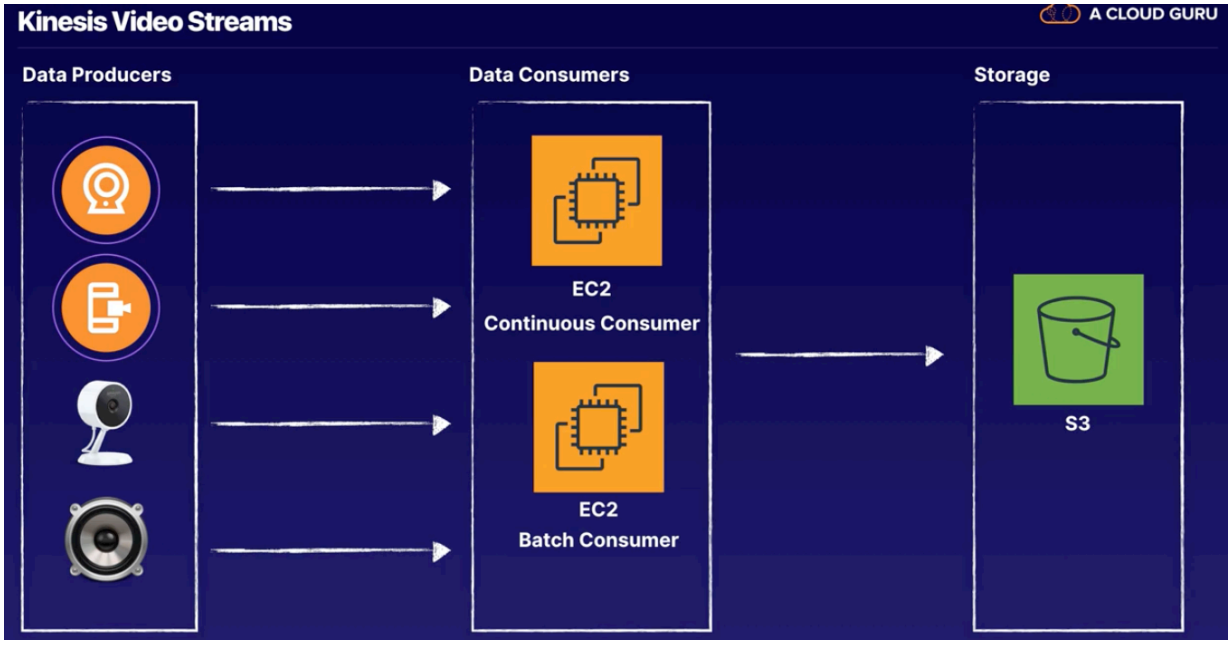
Use cases for Data Firehose:



Kinesis Video Stream

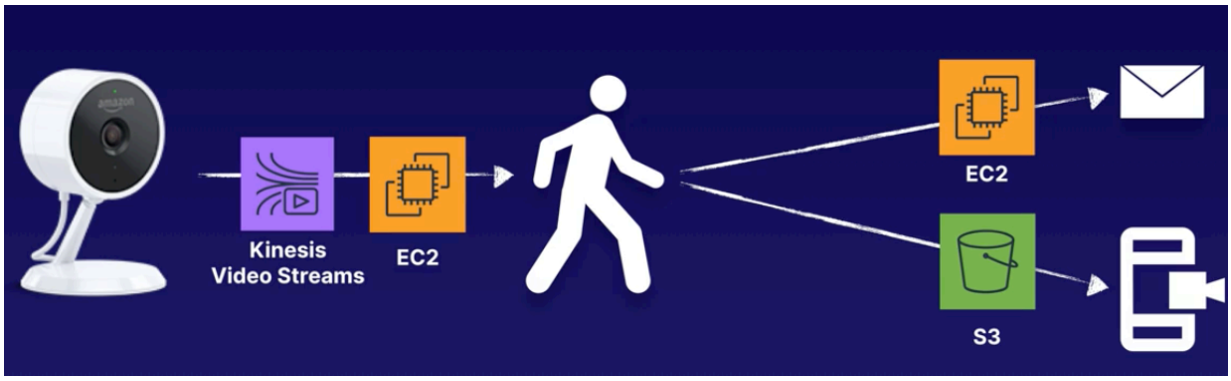
To build real time processing application on Video data or Audio files
Data producers: web cams, security cameras, audio feeds, radar data,...

Can consume that data in real time or in batch

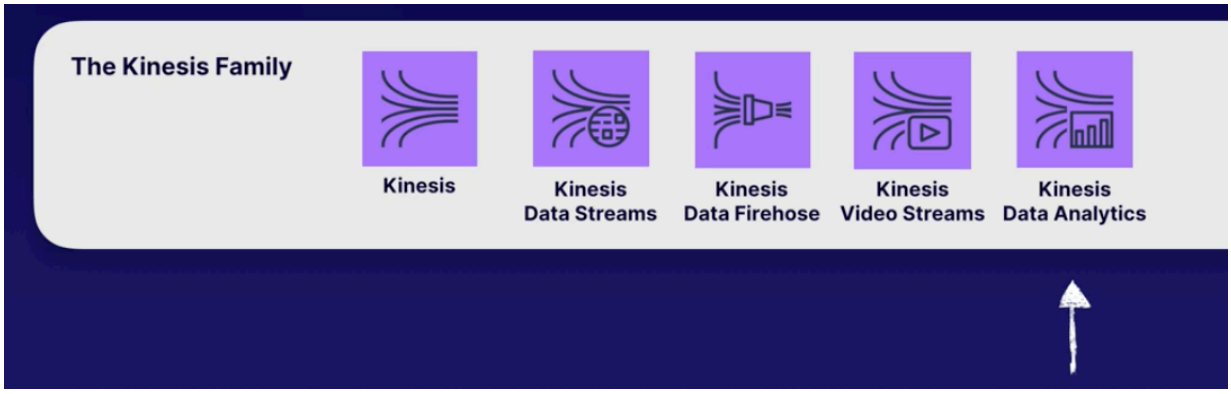


When to use Kinesis Video Streams?

Amazon Cloud Cam example:
Can detect people, dogs barking,...

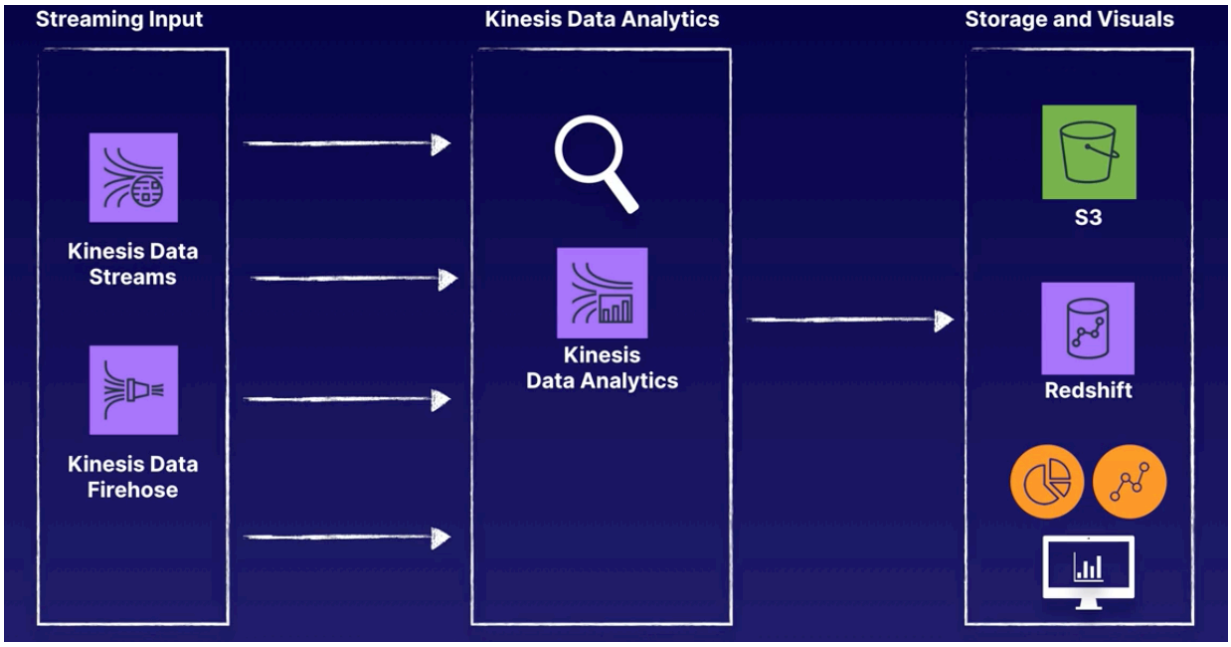


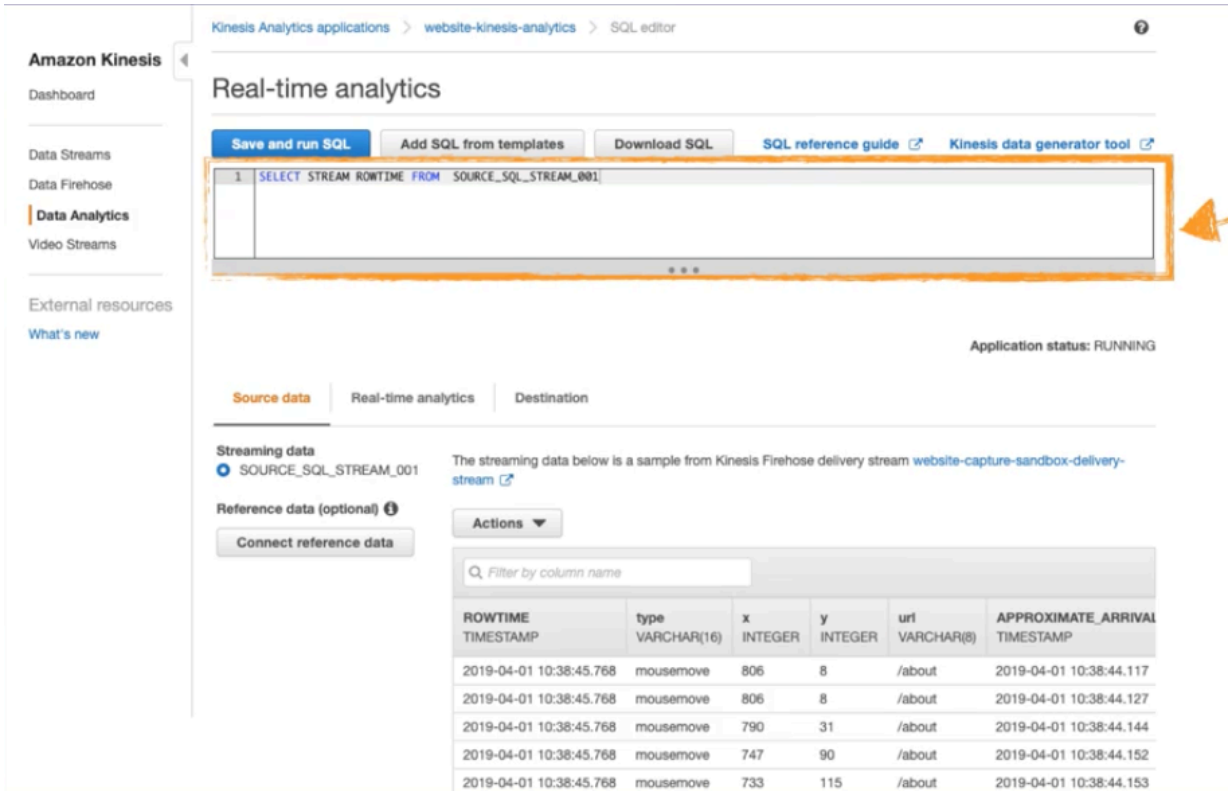
Kinesis Data Analytics



Last service in Kinesis family: Kinesis Data analytics
Pretty powerful tool to continuously read and process streaming data in real time, using SQL queries to process incoming dat and prod output data from that.

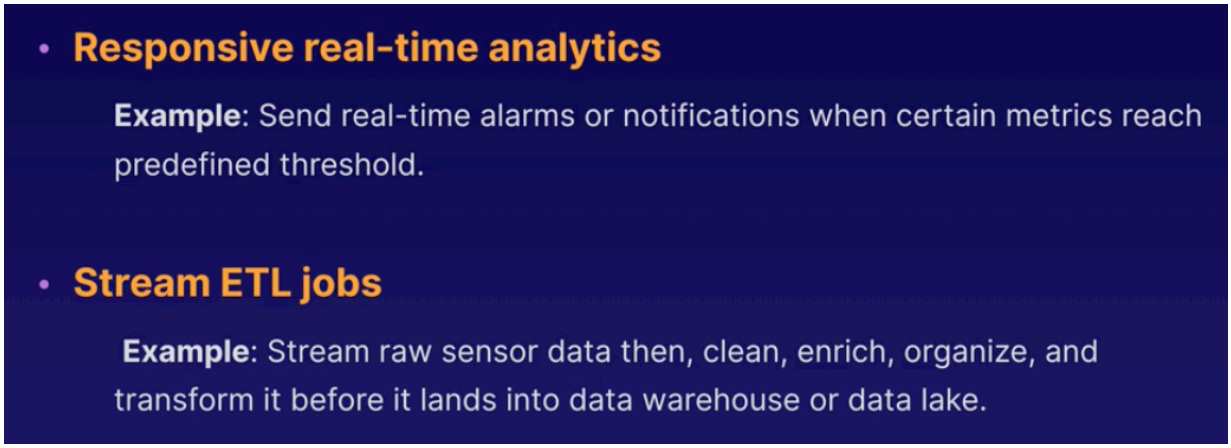
It gets streaming data from Kinesis Data streams of Firehose, then run real time SQL queries and output to S3 or Redshift or other visual/BI tools
=> can run complex queries (change data type/column names, complex joins, aggregate,...) in real time and store in S3 for ML process down the road
Allows us to do pre-processing.





When to use Kinesis Dat Analytics?
When we need to run SQL queries on real time data
Can be useful for monitoring too

Use Cases for Kinesis Data Analytics:

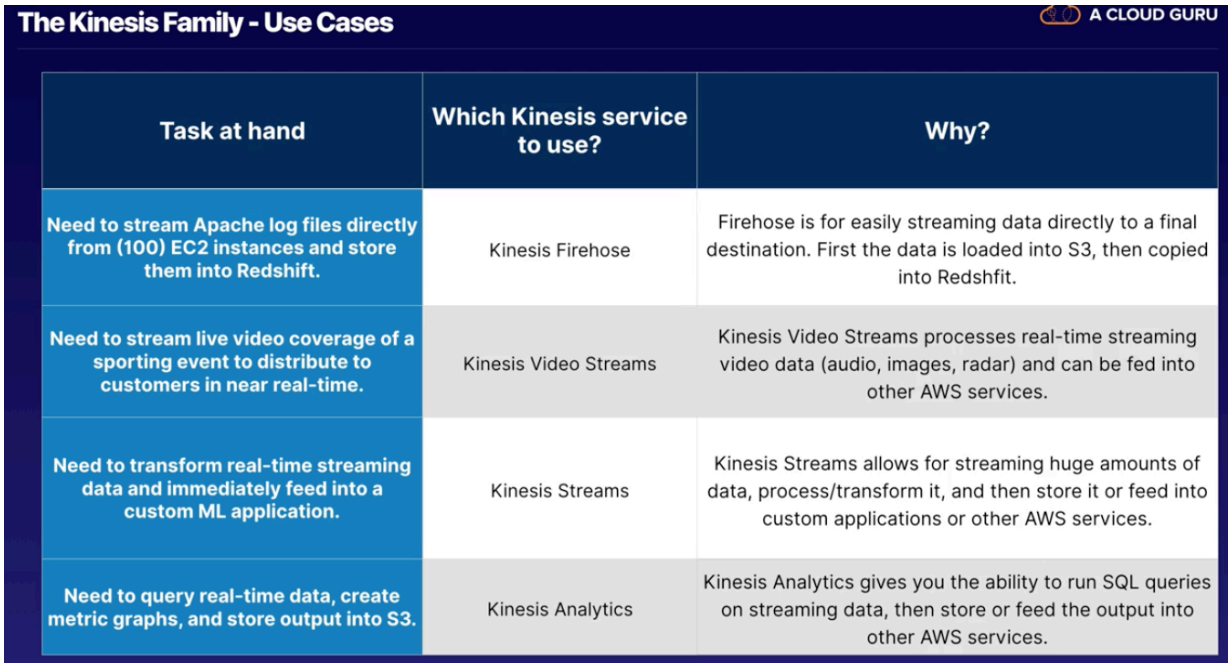


Kinesis Family - Use Cases

At exam, we may be asked what Kinesis service to use for a streaming data. Make sure to remember Kinesis Firehose does not have data retention and does not have shards as opposed to Kinesis Data Streams, that uses shards and offers data retention (default 24h, up to 7 days). Kinesis Firehose mainly used to directly output streaming data into some datastore like S3

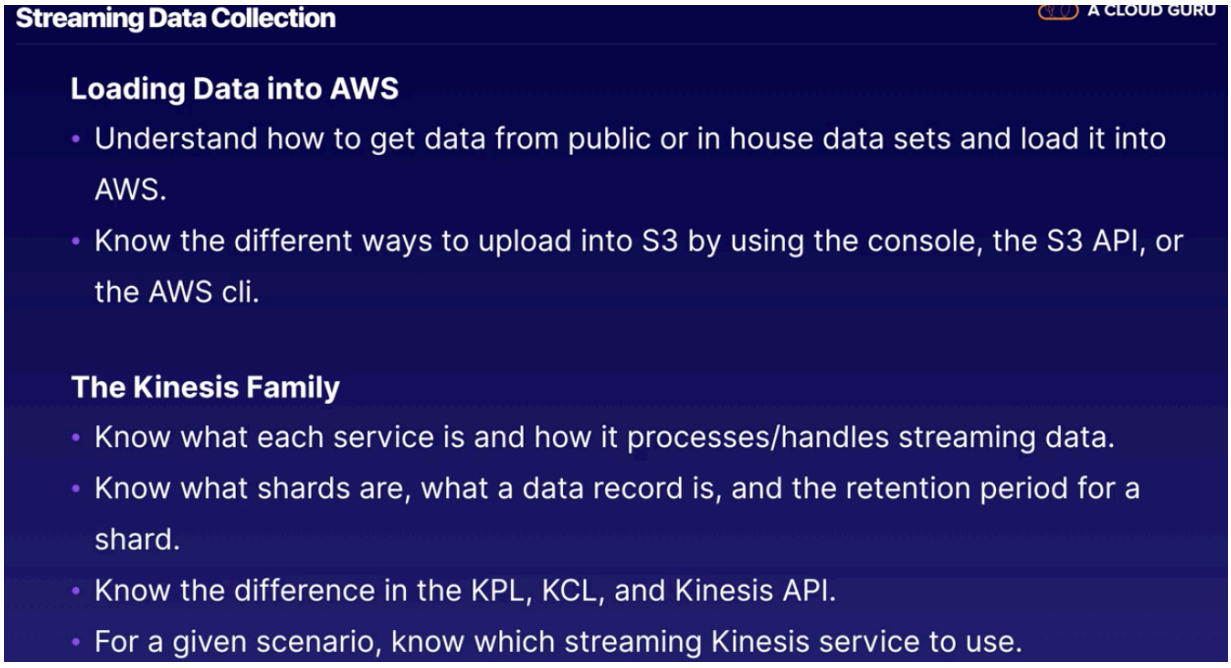
1/ Since there is no preprocessing on this data, we can use Kinesis Firehose to easily stream it to final destination. Once data is in S3, we can copy it over to Redshift.
2/ Since we get video data, we will use Kinesis Video Streams
3/ Since we need some real time transform, we will use Kinesis Data Streams. It allows us to stream hue amount of data, transform it and feed it to other services

(lambda-> S3, custom apps,...)
4/ To create metric graphs, we will run live SQL queries on the streaming data and hence use Kinesis Data Analytics



Task at hand	Which Kinesis service to use?	Why?
Need to stream Apache log files directly from (100) EC2 instances and store them into Redshift.	Kinesis Firehose	Firehose is for easily streaming data directly to a final destination. First the data is loaded into S3, then copied into Redshfit.
Need to stream live video coverage of a sporting event to distribute to customers in near real-time.	Kinesis Video Streams	Kinesis Video Streams processes real-time streaming video data (audio, images, radar) and can be fed into other AWS services.
Need to transform real-time streaming data and immediately feed into a custom ML application.	Kinesis Streams	Kinesis Streams allows for streaming huge amounts of data, process/transform it, and then store it or feed into custom applications or other AWS services.
Need to query real-time data, create metric graphs, and store output into S3.	Kinesis Analytics	Kinesis Analytics gives you the ability to run SQL queries on streaming data, then store or feed the output into other AWS services.

Exam Tips with Streaming Data



Additional contents:

1 - Real Time Machine Learning using Amazon Kinesis (AWS Summit 2018): https://www.youtube.com/watch?v=M8jVTI0wHFM
2 - White Paper- Streaming Data Solutions on AWS with Amazon Kinesis (July 2017): https://d0.awsstatic.com/whitepapers/whitepaper-streaming-data-solutions-on-aws-with-amazon-kinesis.pdf

Data engineers, data analysts, and big data developers are looking to evolve their analytics from batch to real-time so their companies can learn about what their customers, applications, and products are doing right now and react promptly. This whitepaper discusses the evolution of analytics from batch to real-time. It describes how services such as Amazon Kinesis Streams, Amazon Kinesis Firehose, and Amazon Kinesis Analytics can be used to implement realtime applications, and provides common design patterns using these services.
Toll Use Case

Figure 1: New solution using Amazon Kinesis Firehose

Amazon Kinesis Firehose Amazon Kinesis Firehose is the easiest way to load streaming data into AWS. It can capture, transform, and load streaming data into Amazon Kinesis Analytics, Amazon S3, Amazon Redshift, and Amazon Elasticsearch Service, enabling near real-time analytics with existing business intelligence tools and dashboards that you're already using today. It's a fully managed service that automatically scales to match the throughput of your data and requires no ongoing administration. It can also batch, compress, and encrypt the data before loading it, minimizing the amount of storage used at the destination and increasing security.

Sending Data to an Amazon Kinesis Firehose Delivery Stream To send data to your delivery stream, there are several options. AWS offers SDKs for many popular programming languages, each of which provides APIs for Kinesis Firehose. AWS has also created a utility to help send data to your delivery stream.

Using the API

The Kinesis Firehose API offers two operations for sending data to your delivery stream. PutRecord sends one data record within one call. PutRecordBatch can send multiple data records within one call.

More info at: https://docs.aws.amazon.com/firehose/latest/dev/writing-with-sdk.html

Using the Amazon Kinesis Agent

The Amazon Kinesis Agent is a stand-alone **Java** software application that offers an easy way to collect and send data to Kinesis Streams and Kinesis Firehose. The agent continuously monitors a set of files and sends new data to your stream. The agent handles file rotation, checkpointing, and retry upon failures. It delivers all of your data in a reliable, timely, and simple manner. It also emits Amazon CloudWatch metrics to help you better monitor and troubleshoot the streaming process.

Data Transformation

In some scenarios, you might want to transform or enhance your streaming data before it is delivered to its destination.

For example, data producers might send unstructured text in each data record, and you need to transform it to JSON before delivering it to Amazon Elasticsearch Service. To enable streaming data transformations, Kinesis Firehose uses an AWS **Lambda** function that you create to transform your data.

Data Transformation Flow When you enable Kinesis Firehose data transformation, Kinesis Firehose buffers incoming data up to 3 MB or the buffering size you specified for the delivery stream, whichever is smaller. Kinesis Firehose then invokes the specified Lambda function with each buffered batch asynchronously. The transformed data is sent from Lambda to Kinesis Firehose for buffering. Transformed data is delivered to the destination when the specified buffering size or buffering interval is reached, whichever happens first

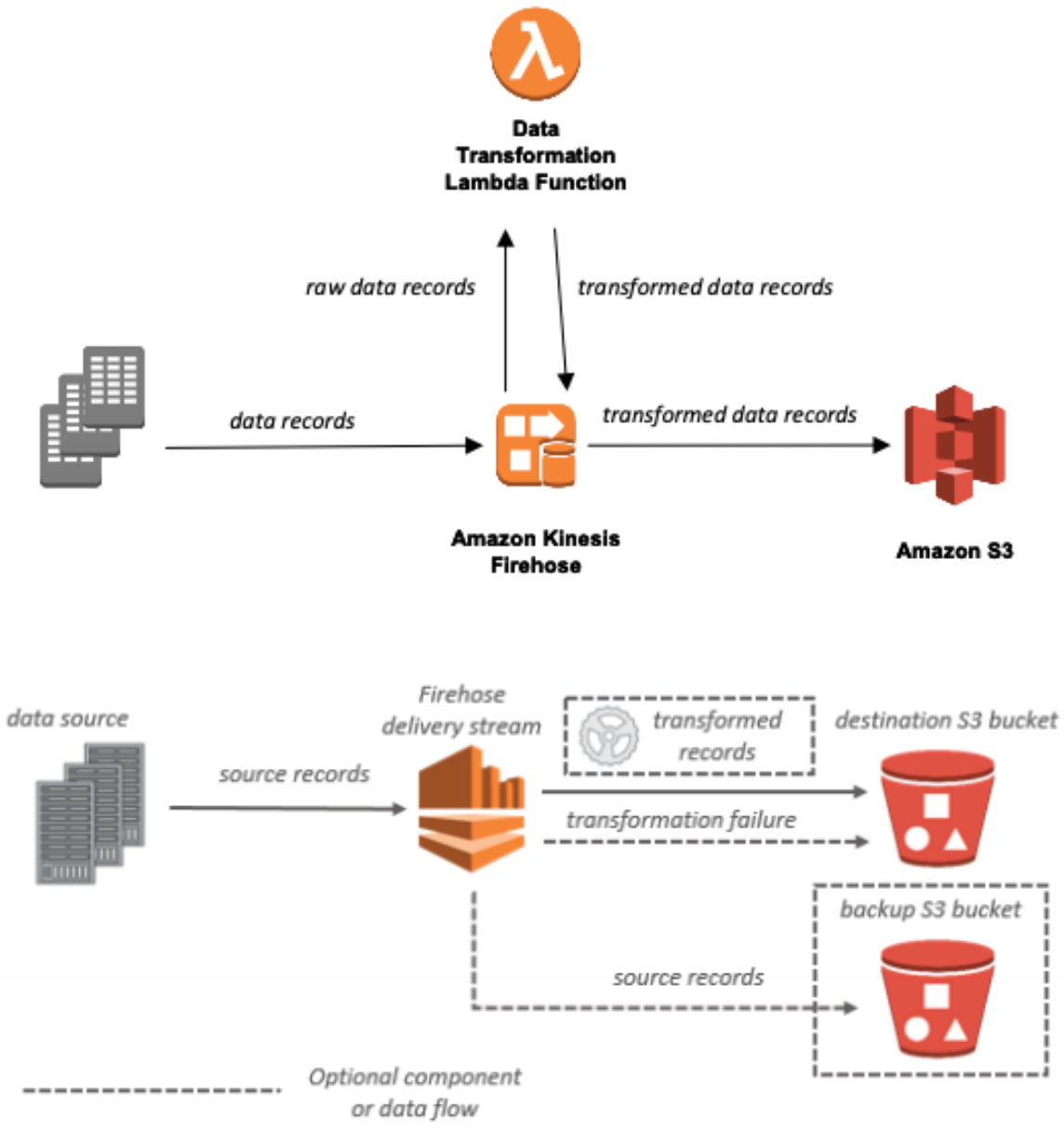


Figure 3: Data flow from Kinesis Firehose to S3 buckets

Amazon Redshift

Amazon Redshift is a fast, fully managed data warehouse that makes it simple and cost-effective to analyze all your data using standard SQL and your existing business intelligence (BI) tools.7 It allows you to run complex analytic queries against petabytes of structured data using sophisticated query optimization, columnar storage on high-performance local disks, and massively parallel query execution. Most results come back in seconds.

For data delivery to Amazon Redshift, Kinesis Firehose first delivers incoming data

to your S3 bucket in the format described earlier. Kinesis Firehose then issues an Amazon Redshift COPY command to load the data from your S3 bucket to your Amazon Redshift cluster

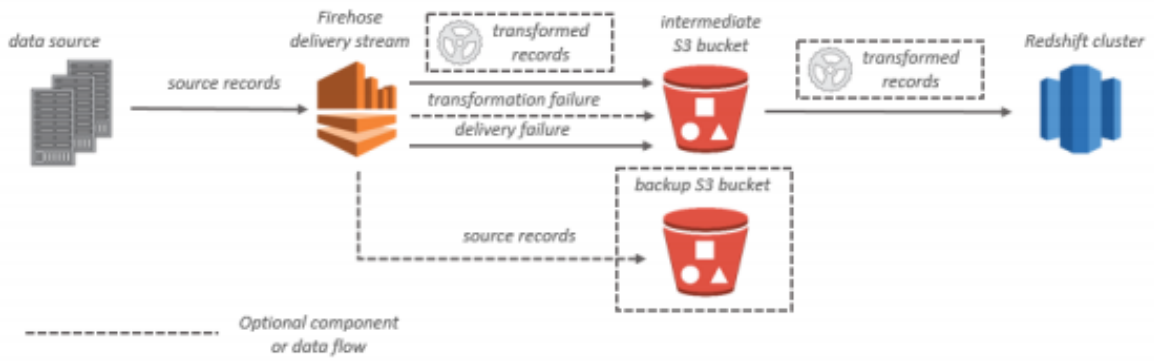


Figure 4: Data flow from Kinesis Firehose to Amazon Redshift

Amazon Elasticsearch Service

Amazon Elasticsearch Service (Amazon ES) is a fully managed service that delivers the Elasticsearch easy-to-use APIs and real-time capabilities along with the availability, scalability, and security required by production workloads.8 Amazon ES makes it easy to deploy, operate, and scale Elasticsearch for log analytics, full text search, application monitoring, and more.

For data delivery to Amazon ES, Kinesis Firehose buffers incoming records based on the buffering configuration of your delivery stream and then generates an Elasticsearch bulk request to index multiple records to your Elasticsearch cluster. You need to make sure that your record is UTF-8 encoded and flattened to a single-line JSON object before you send it to Kinesis Firehose.

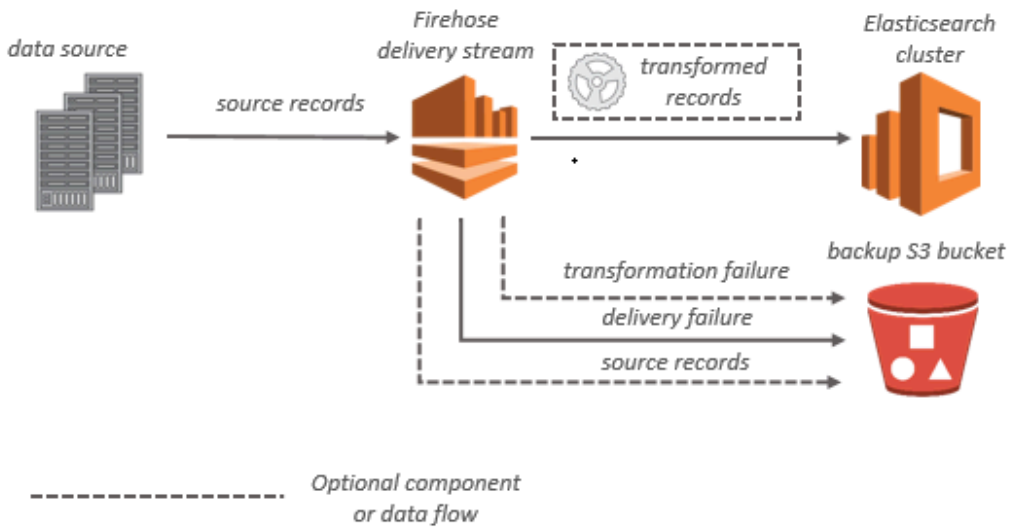


Figure 5: Data delivery from Kinesis Firehose to Amazon ES cluster

Running Analytics

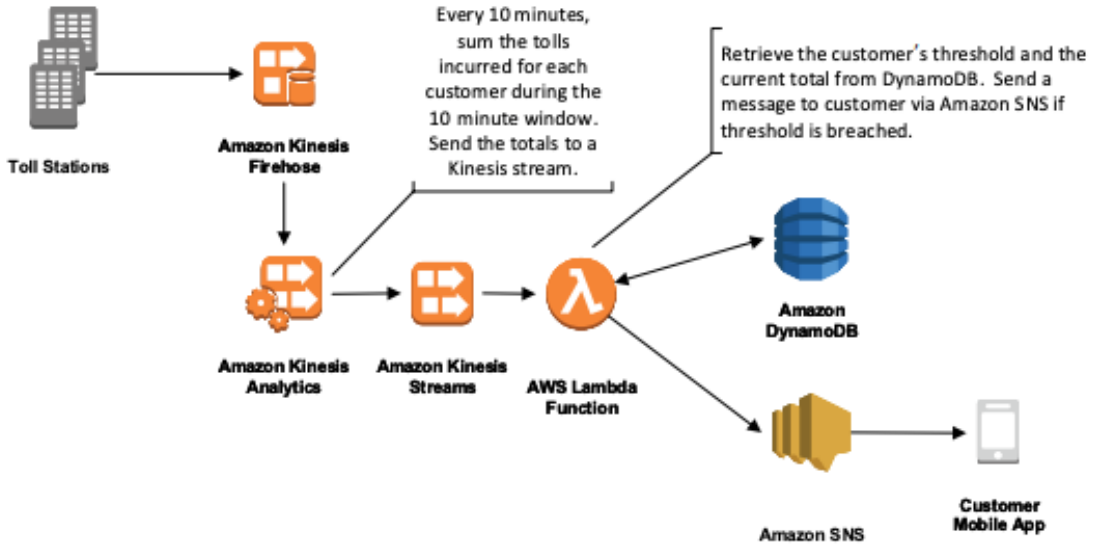


Figure 6: Architecture for billing threshold alerts and notifications

Amazon Kinesis Analytics

With Kinesis Analytics, you can process and analyze streaming data using SQL. The service enables you to quickly author and run powerful SQL code against streaming sources to perform time series analytics, feed real-time dashboards, and create real-time metrics.

Amazon Kinesis Streams

Amazon Kinesis Streams enables you to build custom, real-time applications using popular stream processing frameworks and load streaming data into any data store. You can configure hundreds of thousands of data producers to continuously put data into a Kinesis stream, for example, data from website clickstreams, application logs, IoT sensors, and social media feeds. Within less than a second, the data will be available for your application to read and process from the stream

Sending Data to Amazon Kinesis Streams

There are several mechanisms to send data to your stream. AWS offers SDKs for many popular programming languages, each of which provides APIs for Kinesis Streams. AWS has also created several utilities to help send data to your stream. Let's review each of the approaches you can use and why you might choose each. Amazon Kinesis Agent The Amazon Kinesis Agent was discussed earlier as a tool that can be used to send data to Kinesis Firehose. The same tool can be used to send data to Kinesis Streams. For details on installing and configuring the Kinesis agent, see Writing to Amazon Kinesis Firehose Using Amazon Kinesis Agent: https://docs.aws.amazon.com/firehose/latest/dev/writing-with-agents.html

Amazon Kinesis Producer Library (KPL)

The KPL simplifies producer application development, allowing developers to achieve high write throughput to one or more Kinesis streams. The KPL is an easy-to-use, highly configurable library that you install on your hosts that generate the data that you wish to stream to Kinesis Streams. It acts as an intermediary between your producer application code and the Kinesis Streams API actions. Because the KPL buffers your records before they're sent to a Kinesis stream, the KPL can incur an additional processing delay

Amazon Kinesis API

After a stream is created, you can add your data records to it. A record is a data structure that contains the data to be processed in the form of a data blob. After you store the data in the record, Kinesis Streams does not inspect, interpret, or change the data in any way. There are two different operations in the Kinesis Streams API that add data to a stream: PutRecords and PutRecord. The PutRecords operation sends multiple records to your stream per HTTP request, and the singular PutRecord operation sends records to your stream one at a time (a separate HTTP request is required for each record). You should prefer using PutRecords for most applications because it will achieve higher throughput per data producer. Because the APIs are exposed in all AWS SDKs, using the API to write records provides the most flexible solution to send data to a Kinesis stream.

Processing Data in Amazon Kinesis Streams

Using Amazon Kinesis Analytics

Earlier, we discussed how Kinesis Analytics can be used to analyze streaming data using standard SQL. Kinesis Analytics can read the data from your Kinesis stream, and process it using the SQL you provid

Using the Amazon Kinesis Client Library (KCL)

You can develop a consumer application for Kinesis Streams using the KCL. Although you can use the Kinesis Streams API to get data from an Amazon Kinesis stream, we recommend using the design patterns and code for consumer applications provided by the KCL. The KCL helps you consume and process data from a Kinesis stream. This type of application is also referred to as a consumer. The KCL takes care of many of the complex tasks associated with distributed computing, such as load balancing across multiple instances, responding to instance failures, checkpointing processed records, and reacting to resharding. The KCL enables you to focus on writing record-processing logic. The KCL is a Java library; support for languages other than Java is provided using a multi-language interface.

Using AWS Lambda

AWS Lambda is a compute service that lets you run code without provisioning or managing servers.16 AWS Lambda executes your code only when needed and scales automatically. With AWS Lambda, you can run code with zero administration. AWS Lambda runs your code on a high-availability compute infrastructure and performs all of the administration of the compute resources, including server and operating system maintenance, capacity provisioning and automatic scaling, and code monitoring and logging. All you need to do is supply your code in one of the languages that AWS Lambda supports. You can subscribe Lambda functions to automatically read batches of records off your Kinesis stream and process them if records are detected on the stream. Amazon Web Services – Streaming Data Solutions on AWS with Amazon Kinesis Page 21 AWS Lambda then polls the stream periodically (once per second) for new records. When it detects new records, it invokes your Lambda function by passing the new records as a parameter. If no new records are detected, your Lambda function is not invoked.

Using the API

For most use cases, you should use the KCL or AWS Lambda to retrieve and process data from a stream. However, if you prefer to write your own consumer application from scratch, there are several methods that enable this. The Kinesis Streams API provides the GetShardIterator and GetRecords methods to retrieve data from a stream.

Choosing the Best Consumer Model for Your Application
How do you know which consumer model is best for your use case? Each approach has its own set of tradeoffs and you'll need to decide what's important to you. Here is some general guidance to help you choose the correct consumer model.
In most cases, consider starting with **AWS Lambda**. Its ease of use and the simple deployment model will enable you to quickly build a data consumer. The tradeoff to using AWS Lambda is that each invocation of your Lambda function should be considered stateless. That is, you can't easily use results from previous invocations of your function (e.g., earlier batches of records from your stream). Also consider that the maximum execution time for a single Lambda function is 5 minutes. If a single batch of records takes longer than 5 minutes to process, AWS Lambda might not be the best consumer for your use case.

If you decide that you can't use AWS Lambda, consider building your own processing application with the **KCL**. Because you deploy KCL applications to EC2 instances within your AWS account, you have a lot of flexibility and control in the local data persistence and state requirements for your data.

Your third option is to build your own application using the **APIs** directly. This gives you the most control and flexibility, but you also need to build your own logic to handle common consumer application features like checkpointing, scaling, and failover.

Here is more info from AWS console:

Kinesis Data Streams

Collect and store data streams
Collect gigabytes of data per second and make it available for processing and analyzing in real time.

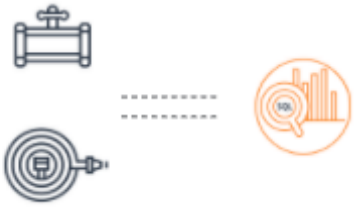
Create data stream

Kinesis Data Firehose

Process and deliver data streams
Prepare and load real-time data streams into data stores and analytics tools.

Create delivery stream

Kinesis Data Analytics



Analyze streaming data
Get actionable insights from streaming data in real time.

Create application

Benefits and features

Kinesis Data Streams

Real-time data capture
Ingest and store data streams from hundreds of thousands of data sources:

- Log and event data collection
- IoT device data capture
- Mobile data collection
- Gaming data feed

Kinesis Data Firehose

Load real-time data
Load streaming data into data lakes, data stores, and analytics tools for:

- Log and event analytics
- IoT data analytics
- Clickstream analytics
- Security monitoring

Kinesis Data Analytics

Get insights in real time
Analyze streaming data and gain actionable insights in real time:

- Real-time streaming ETL
- Real-time log analytics
- Ad tech and digital marketing analytics
- Real-time IoT device monitoring