

The logo for AWS re:Invent features the words "AWS" and "re:Invent" stacked vertically. "AWS" is in a smaller, sans-serif font above "re:Invent", which is in a larger, bold, sans-serif font. The entire logo is white against a dark blue background.

AWS  
re:Invent

ANT 204

# Build Data Engineering Platforms with Amazon EMR

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# Petabyte Scale Data Analytics Platform On AWS



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# Forward-looking statement

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# Salesforce DMP captures data from multiple sources, processes and activates data into different channels



Collect, store & process data  
online behavior, offline purchases



Unify data to single user



Segment into audiences  
“Cereal Moms”

# Salesforce DMP operates at **internet scale**

**~4.3 million  
user match requests**

**~1.6 million  
page views**



**~8.75 million  
data capture events**

**~700,000  
ad impressions**

# Salesforce DMP continues to grow fast



L'ORÉAL

KEURIG



PANDORA



News Corp

hulu



HERSHEY'S



vmware



SONY



jetBlue

January 2017

July 2017

January 2018

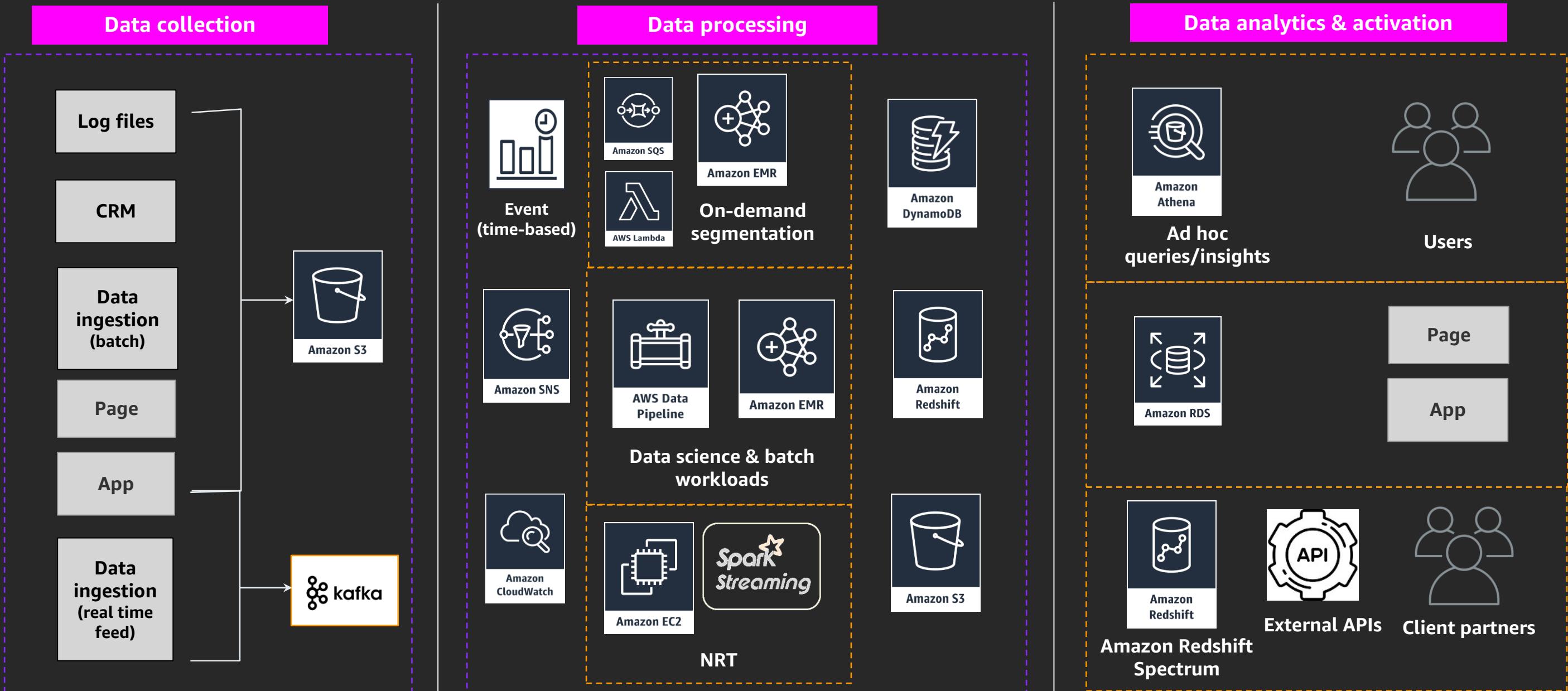
July 2018

40+  
petabytes currently

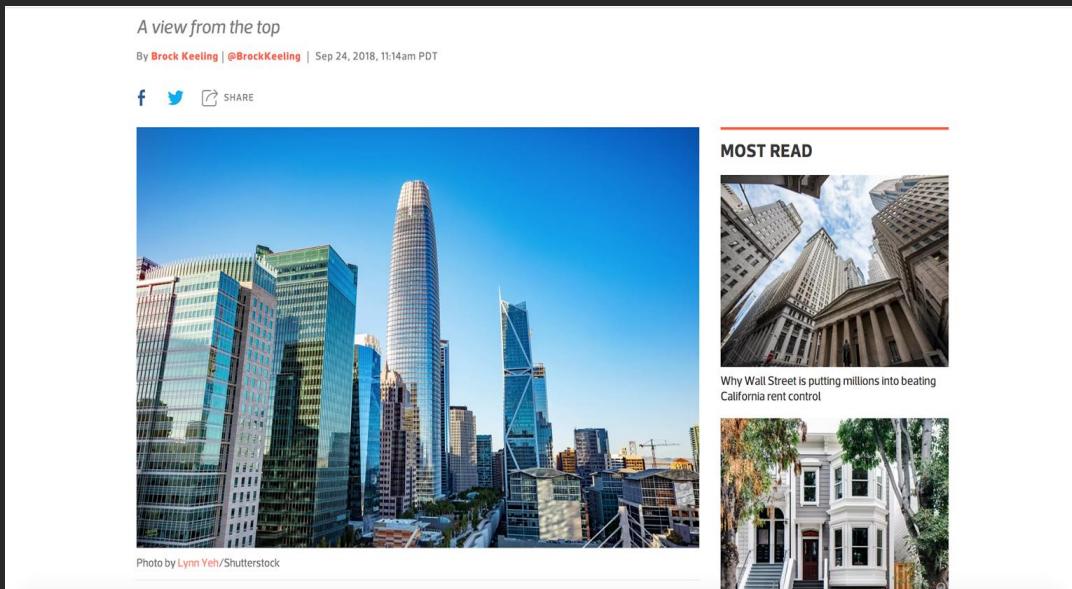
4%  
growth week over week

2x  
by April 2019

# Salesforce DMP supports lambda architecture to perform real time, batch, and on-demand processing



# Using data at scale to produce personalized experiences



Salesforce DMP Segments Insights Activation Manage Internal Pasc-NTO Demo

SEGMENTS / MANAGE SEGMENTS / NEW SEGMENT / CREATE SEGMENT

Build Standard Segment

- Rules
- Details & Activation
- Confirmation

Search Attributes... CRM Mobile App NTO Mobile App NTO Mobile App Version SalesForce Marketing Cloud Audiences Engagements Salesforce Sales Cloud

1st Party

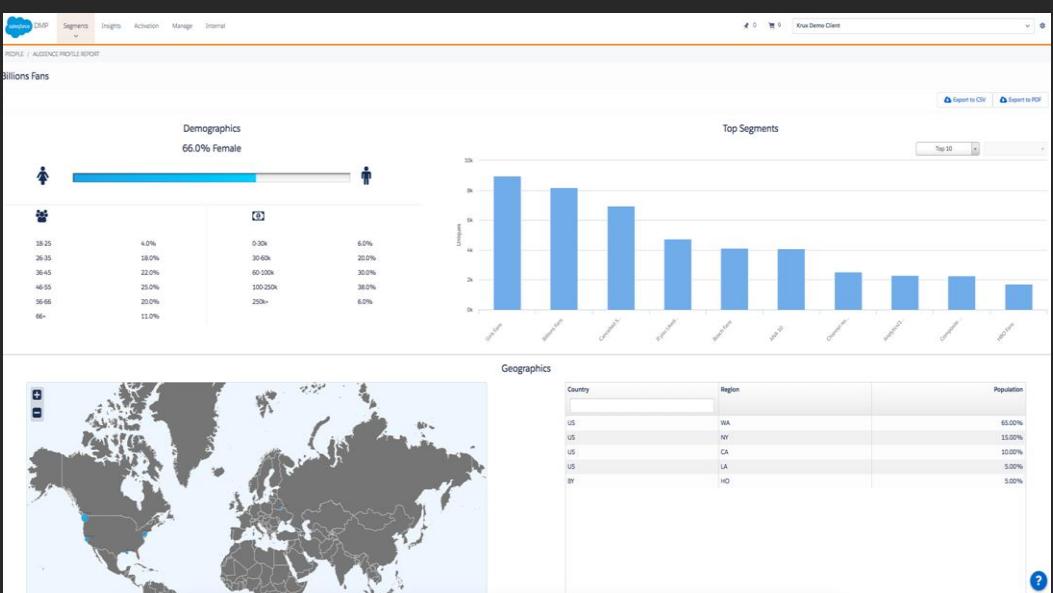
is Search Attribute Values Bulk edit

Attribute Values Add All Remove All

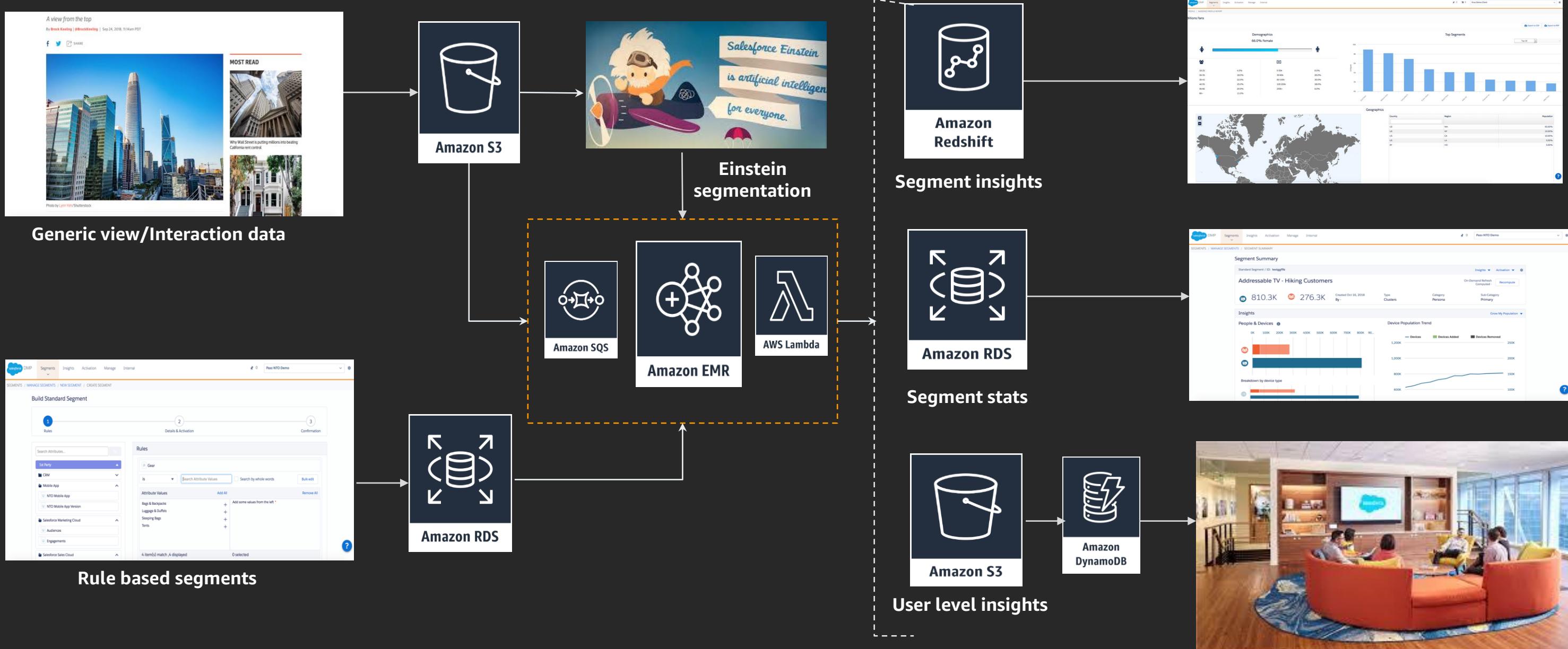
Bags & Backpacks Luggage & Duffels Sleeping Bags Tents

4 item(s) match, 4 displayed 0 selected

This screenshot shows the "Build Standard Segment" interface in the Salesforce DMP. It includes sections for "Rules", "Details & Activation", and "Confirmation". The "Rules" section allows users to define segments based on various attributes like CRM, mobile app usage, and specific product categories like bags and backpacks. The interface is clean and modern, typical of enterprise software.

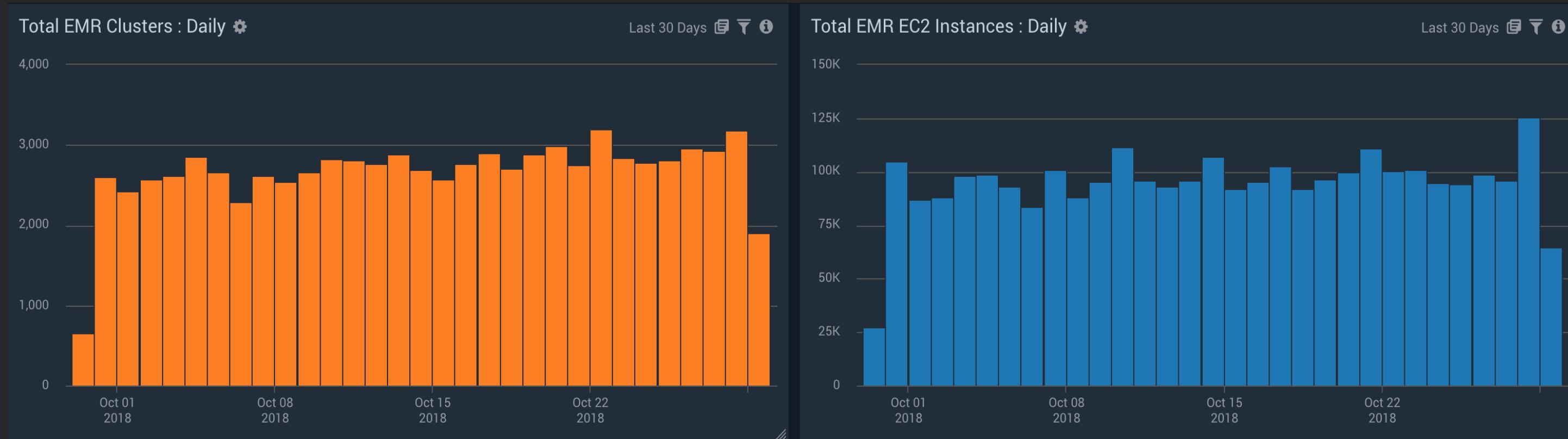


On-demand segmentation allows clients to run data processing jobs via **self-serve UI**



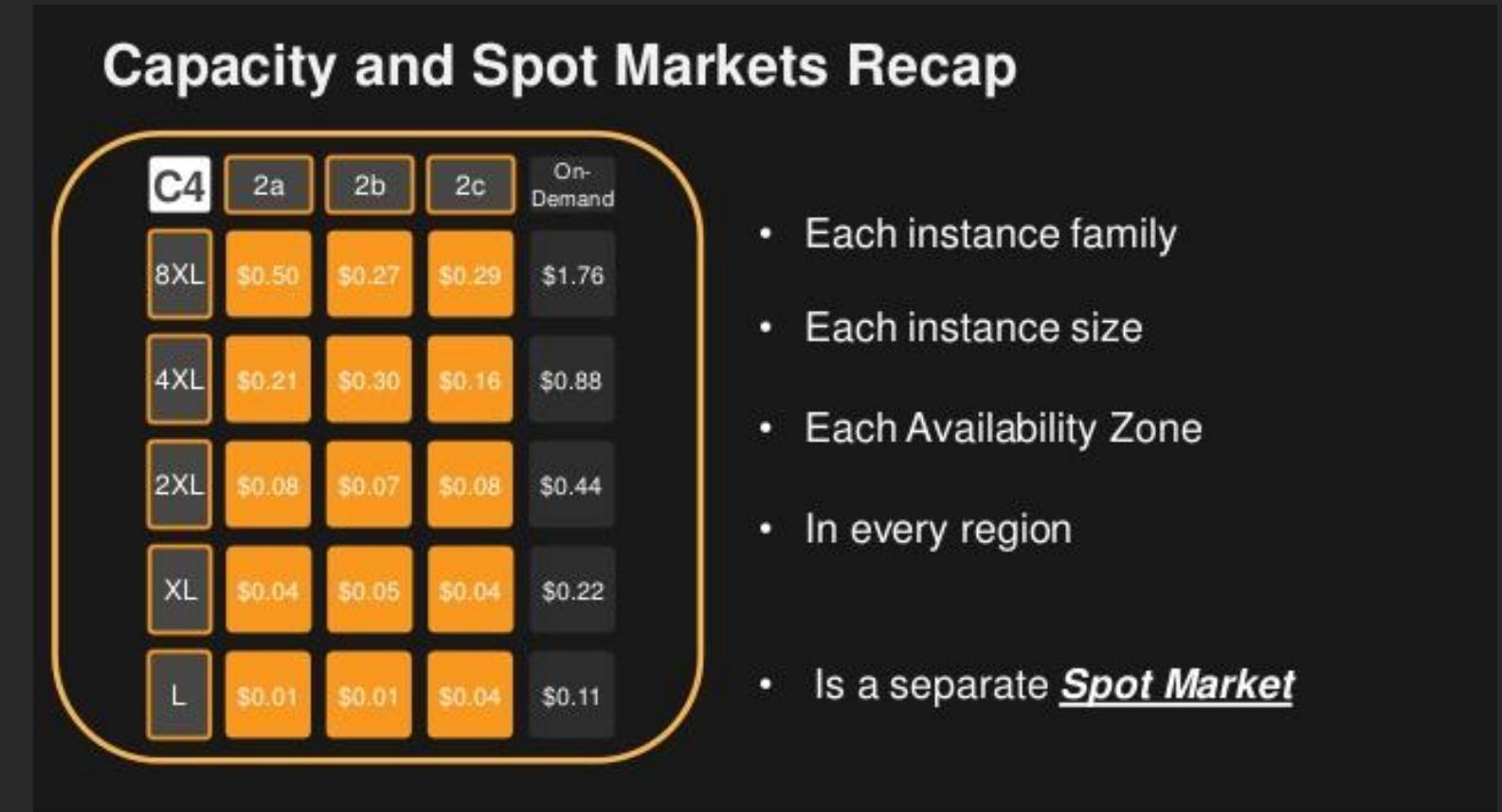
# Daily EMR *scale* that we operate at

- ~3000 EMR clusters running a mix of MapReduce and Spark computation
- ~100,000 Spot Amazon Elastic Compute Cloud (Amazon EC2) nodes running a mix of  $m(3,4,5)$ ,  $c(3,4,5)$ , and  $r(3,4,5)$  instance types
- 0.5% Error rate with 0.1% due to spot interruptions



# Cost-driven workloads on **Spot Instances** provide largest cost savings

- Spot Instances provide up to 90% savings as compared to on-demand instances
- Market where the price of compute changes based on supply and demand
- You'll never pay more than your bid
- Can get terminated at any time



# Spot Instance Fleet provides a mix of instance types with low pricing and high availability in different AZs

Instance fleets						
Filter:	Filter instance groups ...		2 instance groups (all loaded) 			
ID	Status	Node type & name	Fleet instance types	Provisioned capacity	Advanced Spot options	Auto Scaling
if-VR5IOLKNKVMA	Running	MASTER master-on-demand	<b>m5d.xlarge</b> 4 vCore, 16 GiB memory, 150 SSD GB storage EBS Storage: none Maximum Spot price: 100 % of On-demand price Each instance counts as 1 units <b>m3.xlarge</b> 8 vCore, 15 GiB memory, 80 SSD GB storage EBS Storage: none Maximum Spot price: 100 % of On-demand price Each instance counts as 1 units	1 On-demand units 0 Spot units 1 Total units	<b>Defined duration</b> None	Not available for instance fleets
if-2GVT7PZ07UVOK	Running	CORE core-spot	<b>c3.4xlarge</b> 16 vCore, 30 GiB memory, 320 SSD GB storage EBS Storage: none Maximum Spot price: 100 % of On-demand price Each instance counts as 1 units <b>c3.8xlarge</b> 32 vCore, 60 GiB memory, 640 SSD GB storage EBS Storage: none Maximum Spot price: 100 % of On-demand price Each instance counts as 2 units <b>c5d.4xlarge</b> 16 vCore, 32 GiB memory, 400 SSD GB storage EBS Storage: none Maximum Spot price: 100 % of On-demand price Each instance counts as 1 units <b>c5d.9xlarge</b> 36 vCore, 72 GiB memory, 900 SSD GB storage EBS Storage: none Maximum Spot price: 100 % of On-demand price Each instance counts as 2 units	0 On-demand units 24 Spot units 24 Total units <a href="#">Resize</a>	<b>Defined duration</b> None  <b>Provisioning timeout</b> After 60 minutes, Terminate cluster	Not available for instance fleets

# Spot Advisor helps in selecting a mix of instance types low pricing and high availability

The screenshot shows the AWS Spot Advisor interface. At the top, there are filters for vCPU (32), Memory GiB (60, highlighted in blue), Platform (Linux), Availability Zone (us-east-1a), and an 'Amount required' field (50). Below the filters, a note says 'Or inherit values from an instance type'. The main section is titled 'Your recommended fleet'.

**Your recommended fleet**

The selected instance pools will be used interchangeably to fulfill and maintain your specified compute requirements. The actual instance pools and quantities used from this fleet are dynamic to ensure that your capacity is maintained and that your specified fulfillment priority is honored.

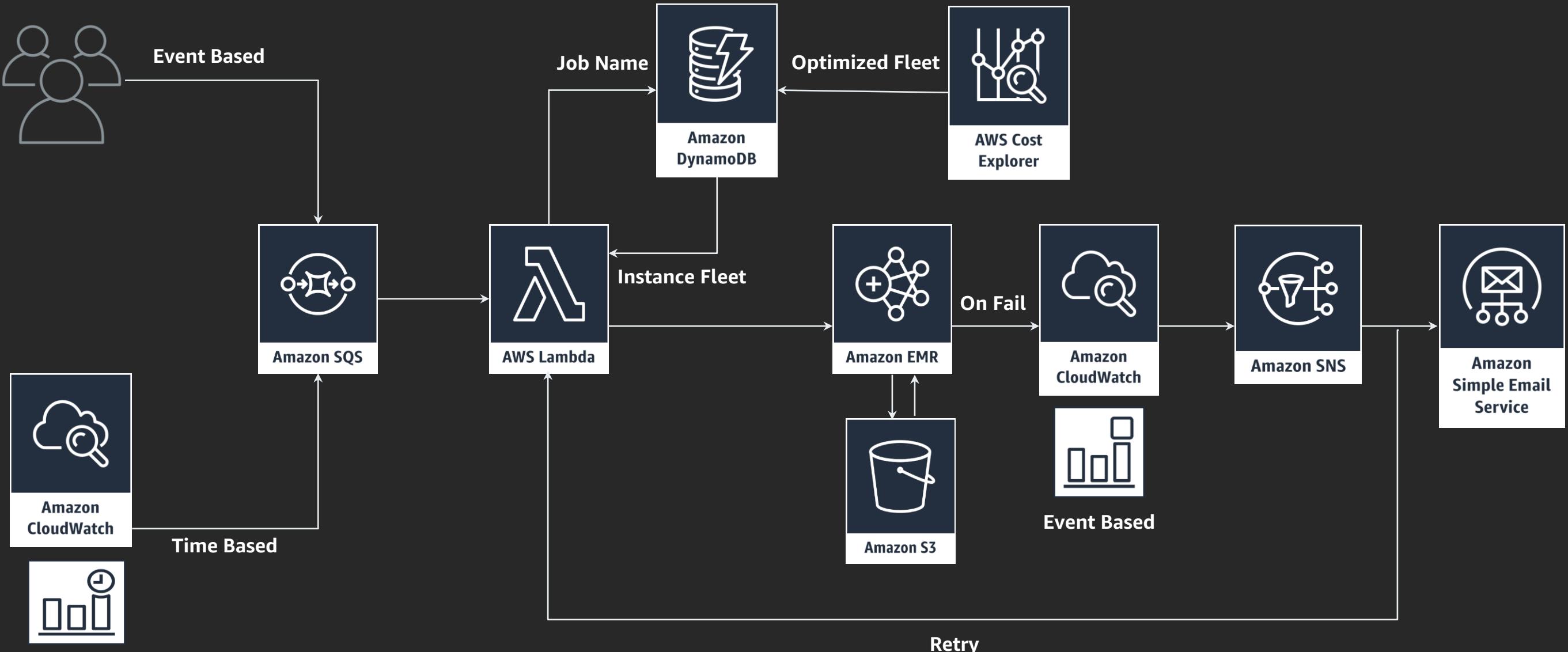
Instance Type	Average Spot price	Interruption likelihood
cc2.8xlarge	\$0.2758/hr	Low
cr1.8xlarge	\$0.35/hr	Low
c3.8xlarge	\$0.4708/hr	Low
c4.8xlarge	\$0.506/hr	Low
h1.8xlarge	\$0.66/hr	Low
i3.8xlarge	\$0.7493/hr	Low
g2.8xlarge	\$0.8546/hr	Low
c5d.9xlarge	\$0.7232/hr	Medium

Total (8 instance pools)  
✓ Strong breadth of instance types to fulfill/maintain your request

Availability Zones  
us-east-1a

Estimated fleet price  
**\$28.686 /hr**  
74% savings

# Event-driven serverless architecture using Instance Fleet



# Key learnings—Compute

- Separate out compute and storage
- Be instance and AZ flexible and design workloads in CPU/memory units
- Choose bigger instances with lower instance count over smaller instances with higher instance count
- Always run *master* node on cheap on-demand instance type
- Attach Amazon Elastic Block Store (Amazon EBS) gp2 volumes over expensive instances with higher instance store capacity
- Fault tolerance

# Key learnings—Storage

- Amazon Simple Storage Service (Amazon S3) data lake
  - Store data in different *file formats* (avro, parquet, csv) based off the use cases
  - *Compress* data using splittable algorithm (LZO, Snappy) to reduce network traffic
  - *Cross-account* access allows data flow between teams with the right controls
  - *Expiration* and *transition* to infrequent access (IA) policies
- EMR File System (EMRFS)
  - Reduce HDFS *replication factor* to 1 (default is 3 for  $\geq 10$  core nodes cluster)
  - Increase YARN *disk utilization threshold* check to 95% (default is 90%)
  - Increase *file max split size* to 256mb

# Key learnings—Monitoring and alerting

- Use custom tags for cost control and accountability
- Build Amazon CloudWatch alerts for billing
- Send real time interactive alerts using event-driven architecture
- Ingest CloudWatch and Amazon EMR logs from Amazon S3 to ELK or some third-party log aggregation tool

# Thank you!

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# Vanguard's Journey to the Data Lake

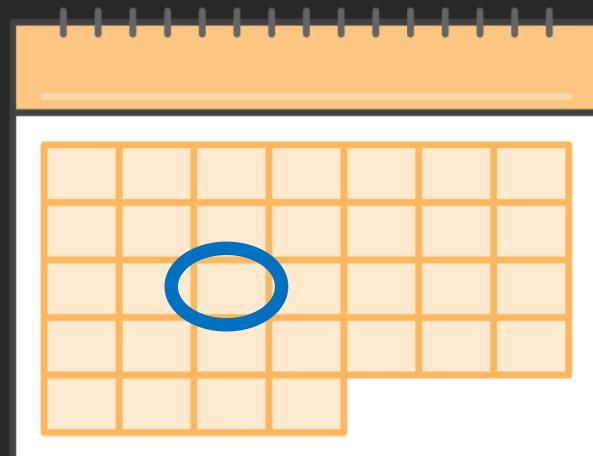
Ritesh B. Shah  
Senior Program Manager  
Vanguard / Chief Technology Office

# Vanguard—Background

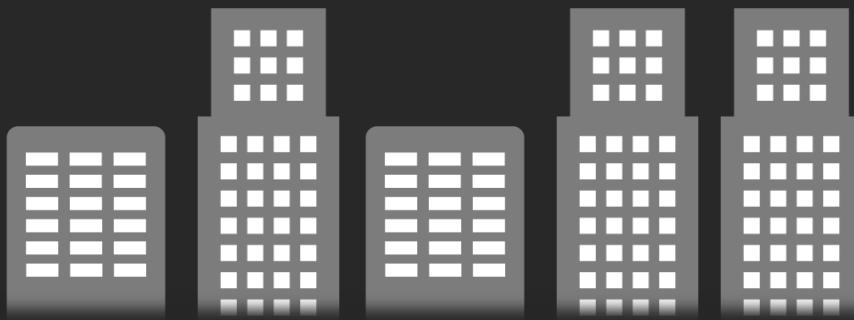
One of the world's largest investment companies, offering a large selection of low-cost mutual funds, ETFs, advice, and related services



Headquartered  
in Malvern, PA



Began Operations—  
May 1, 1975, in  
Valley Forge, PA



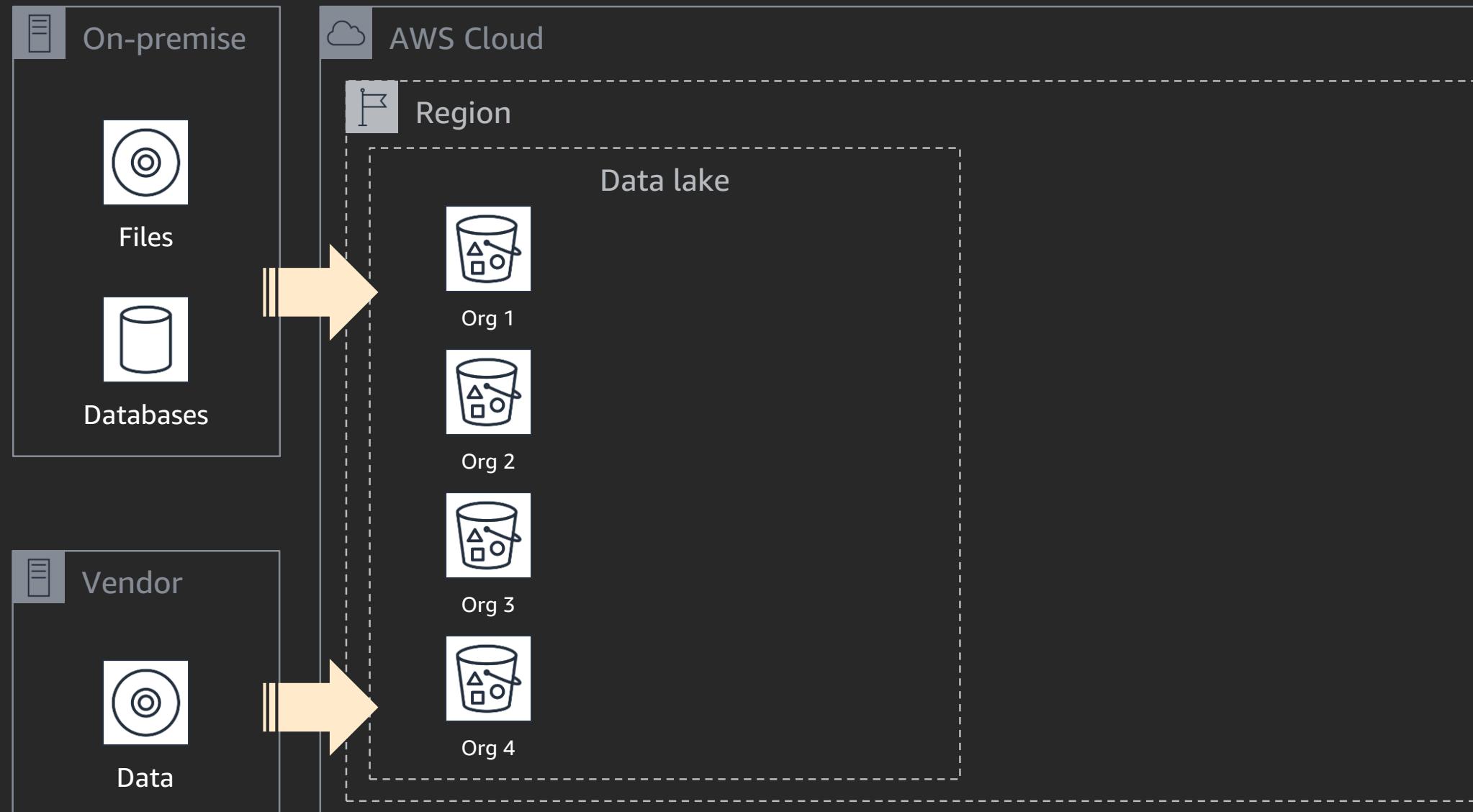
Multiple lines of business:  
Retail, institutional, FAS,  
international, and others

# Agenda

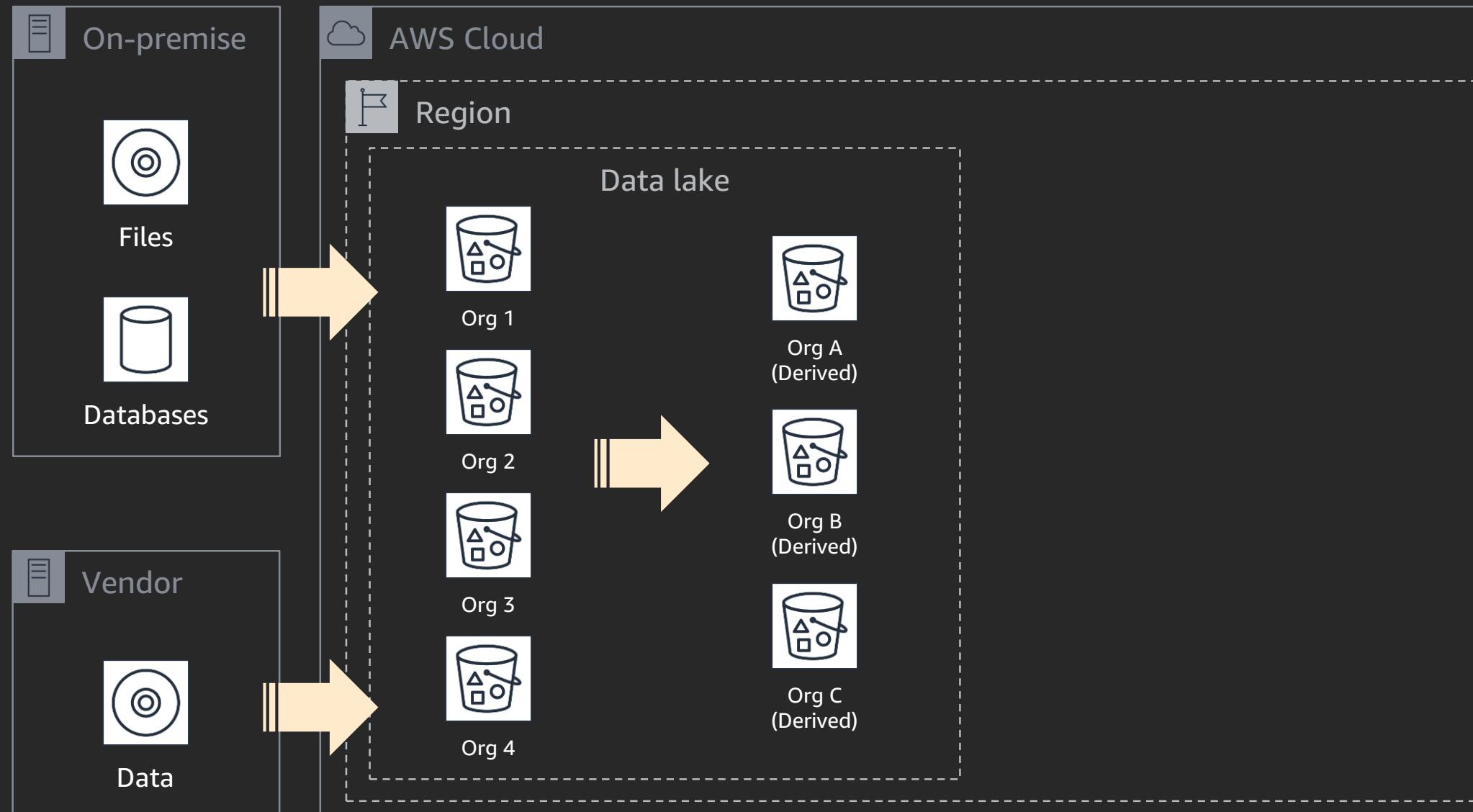
- Vanguard's data lake, data pipelines, and analytics environment
  - 2017 – 2018: State of the union
  - Lessons learned
  - Metrics for 2017 – 2018 : Reason to change
  - 2018 – 2019 : Implementation in progress & future state

# 2017-2018: State of the union

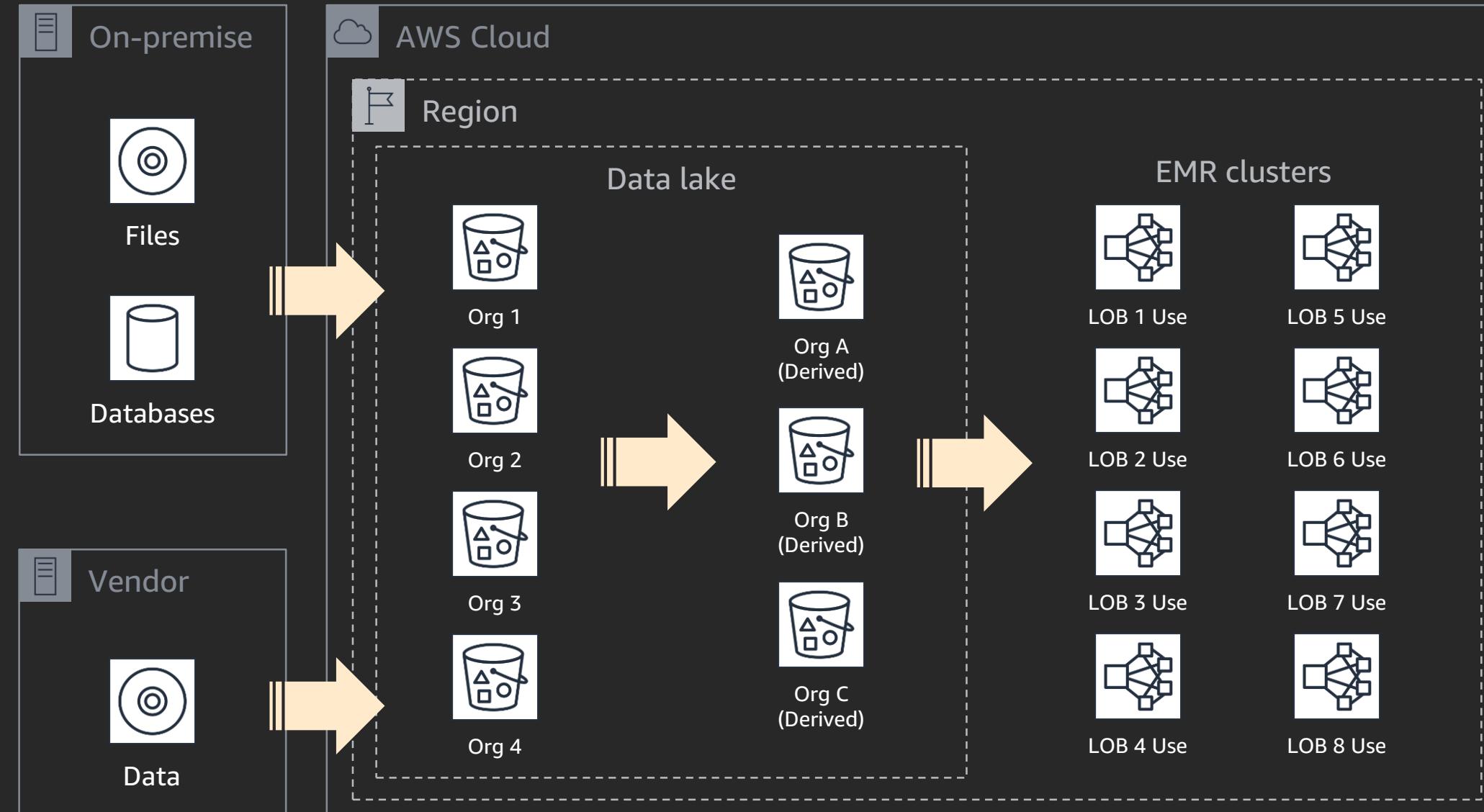
# Data lake at Vanguard



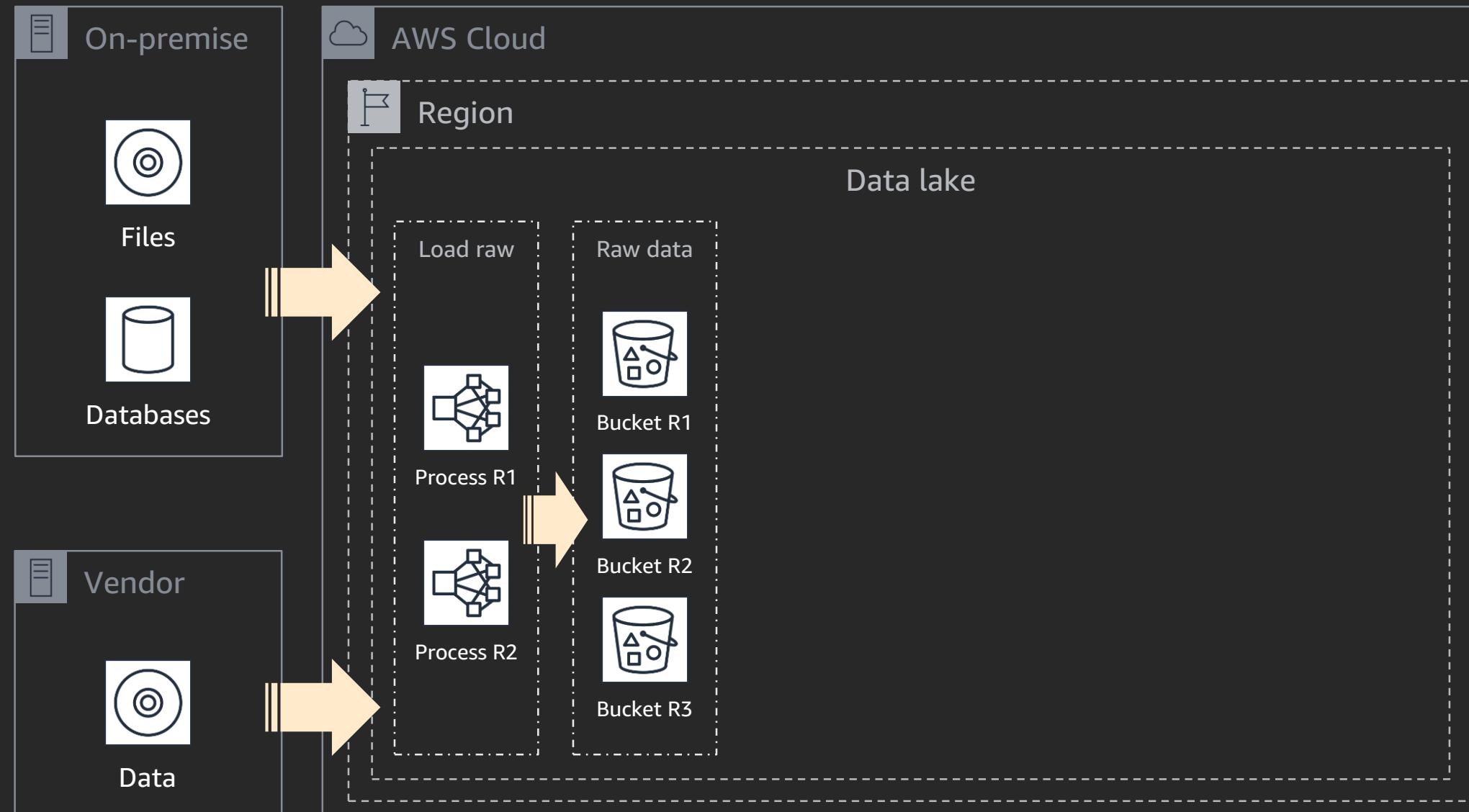
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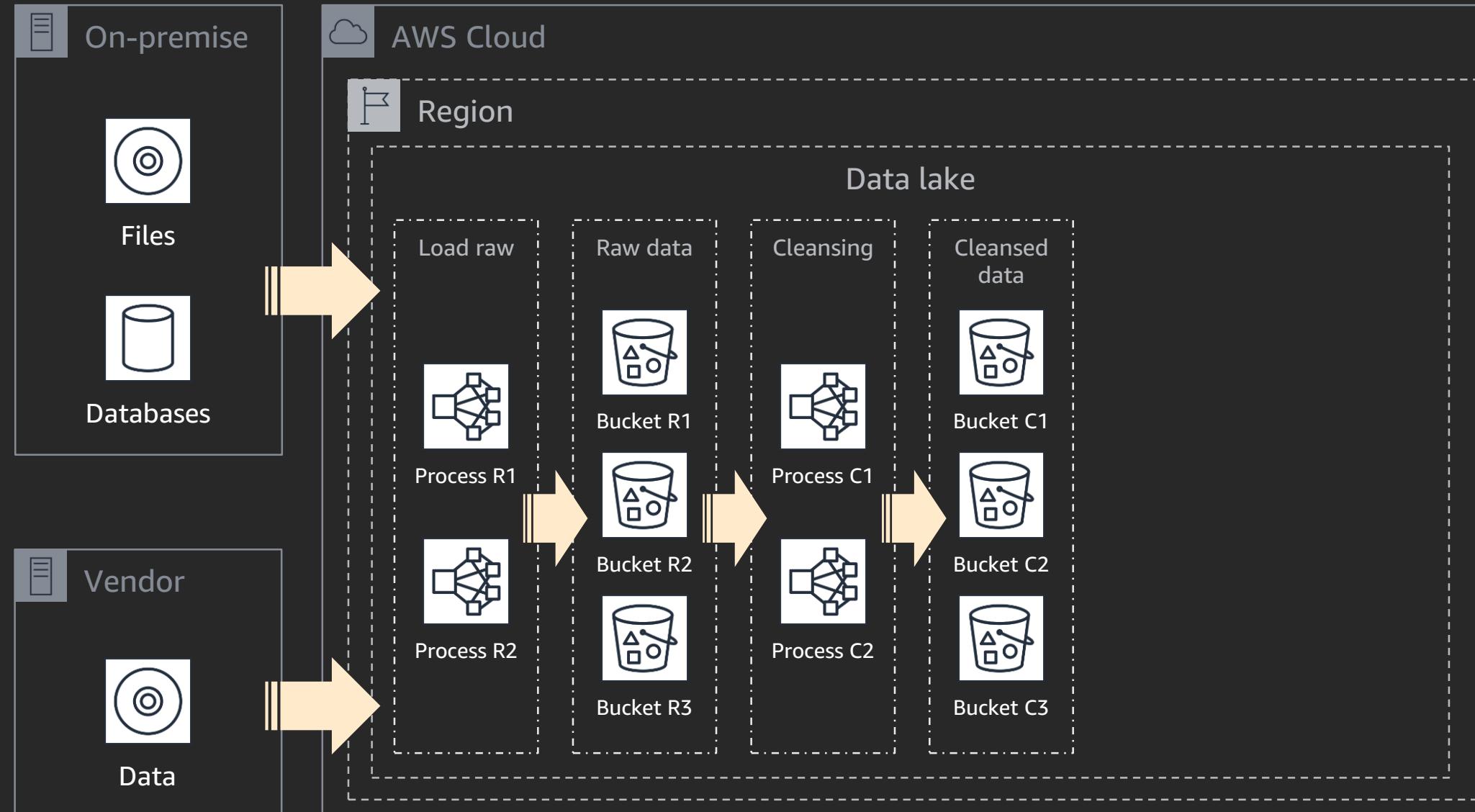
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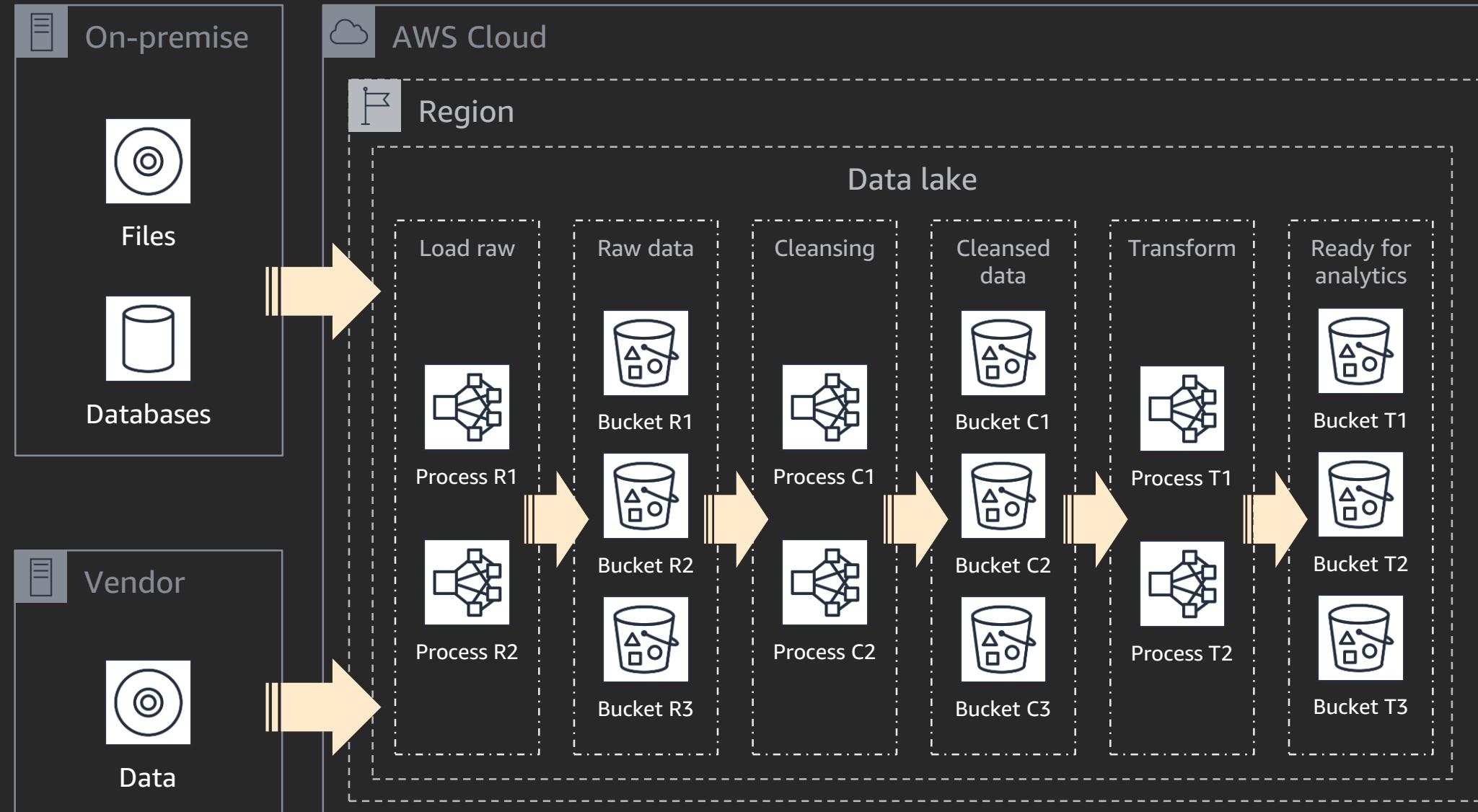
# Typical "internals" of data lake at Vanguard



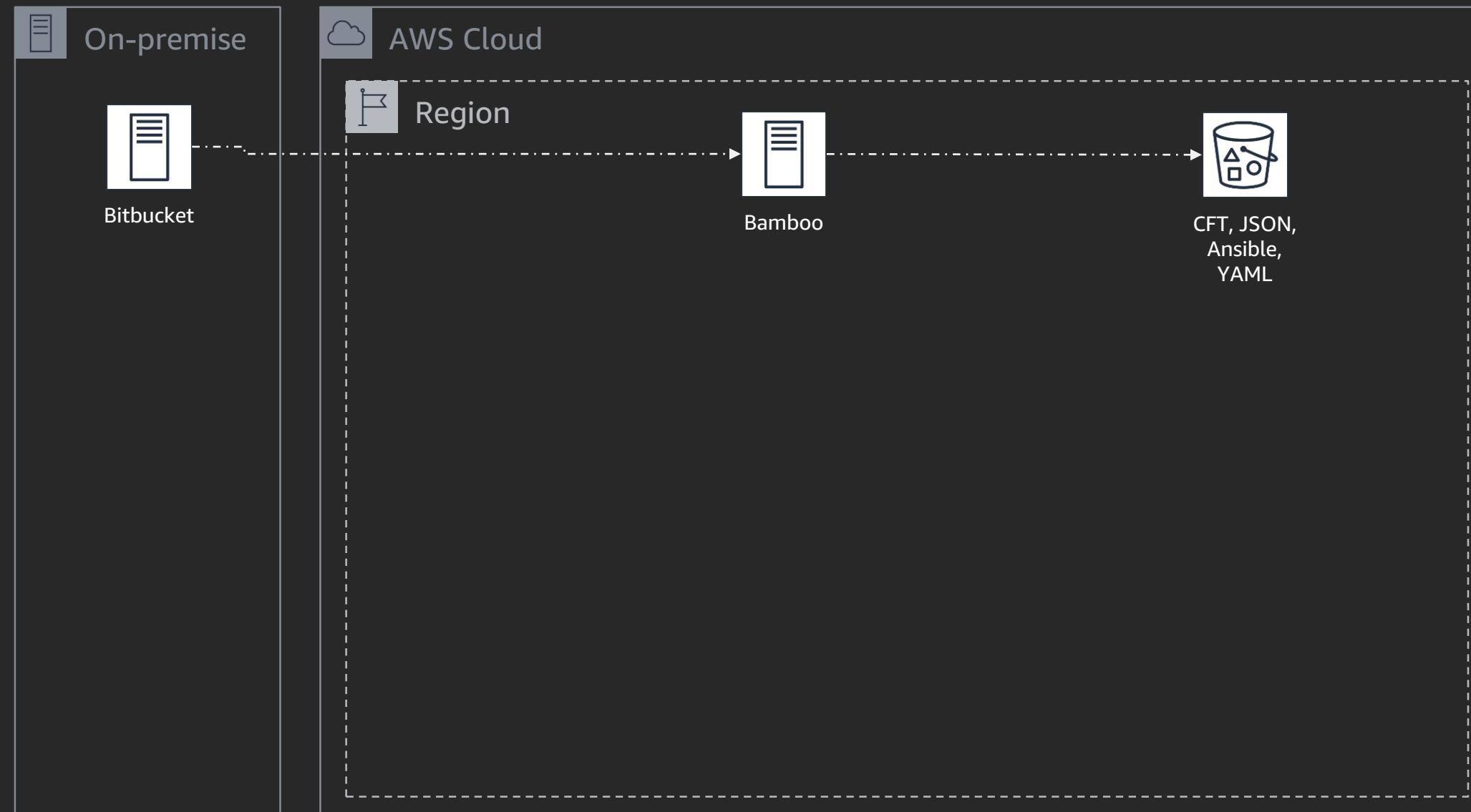
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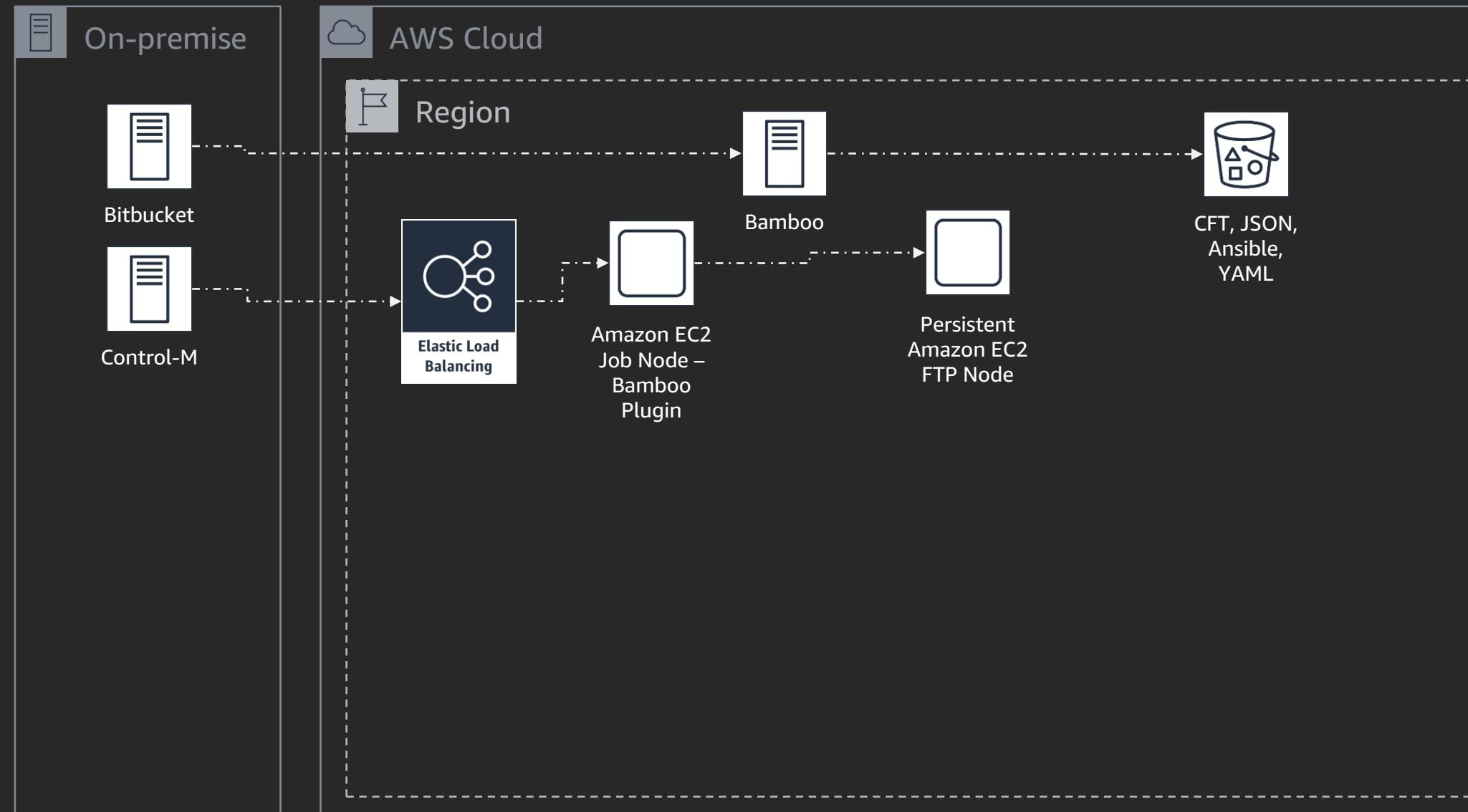
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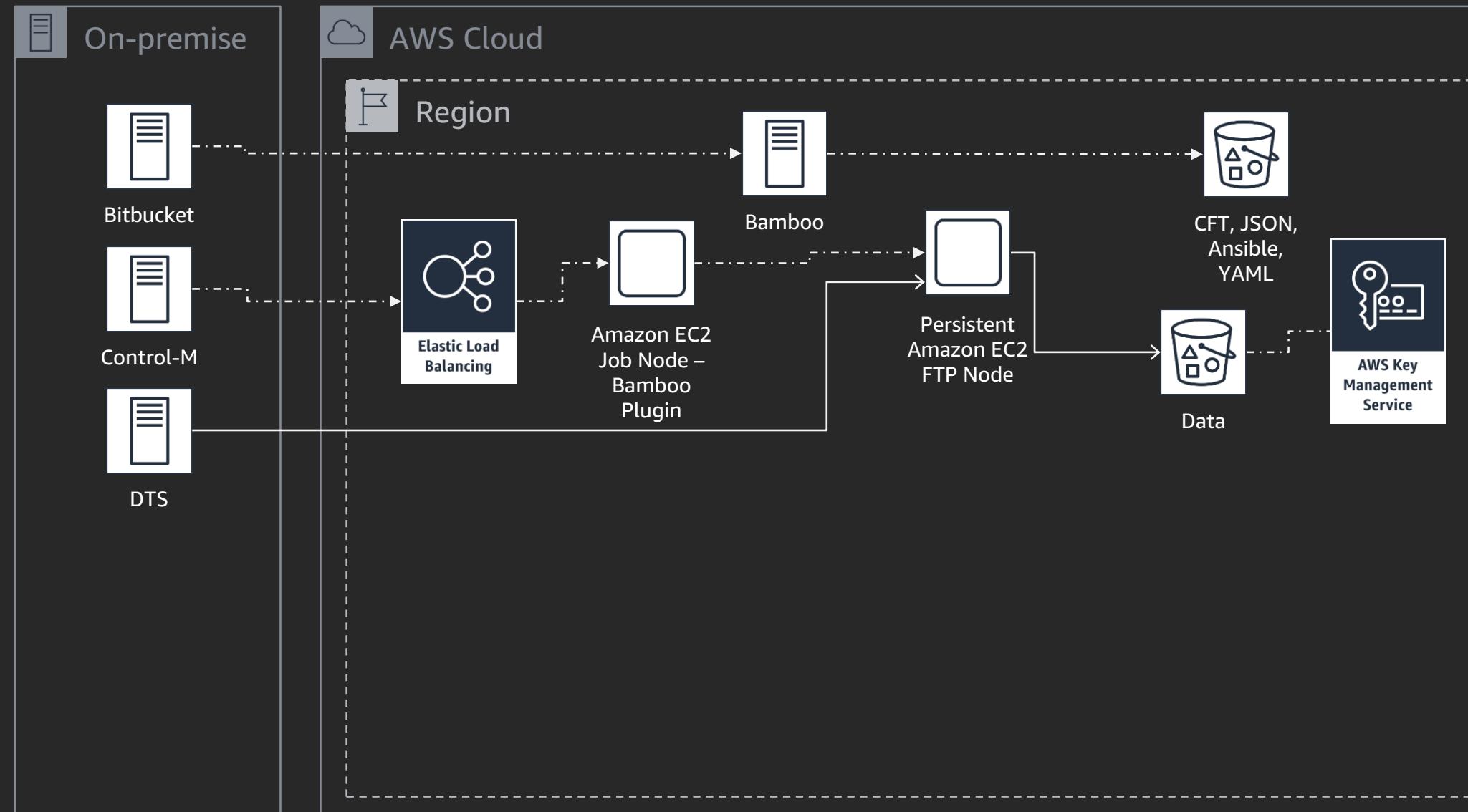
# Conceptual diagram—Data pipelines workload



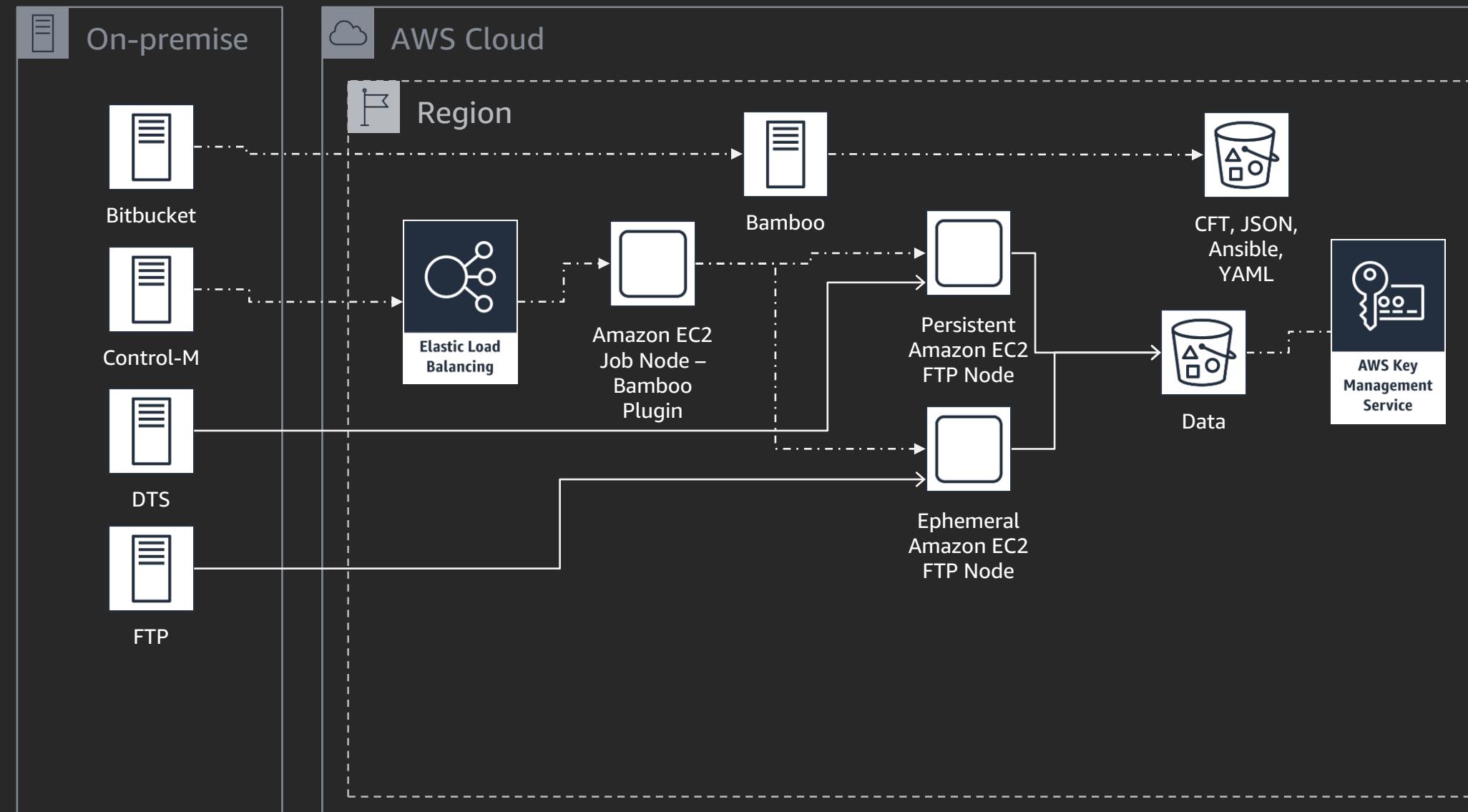
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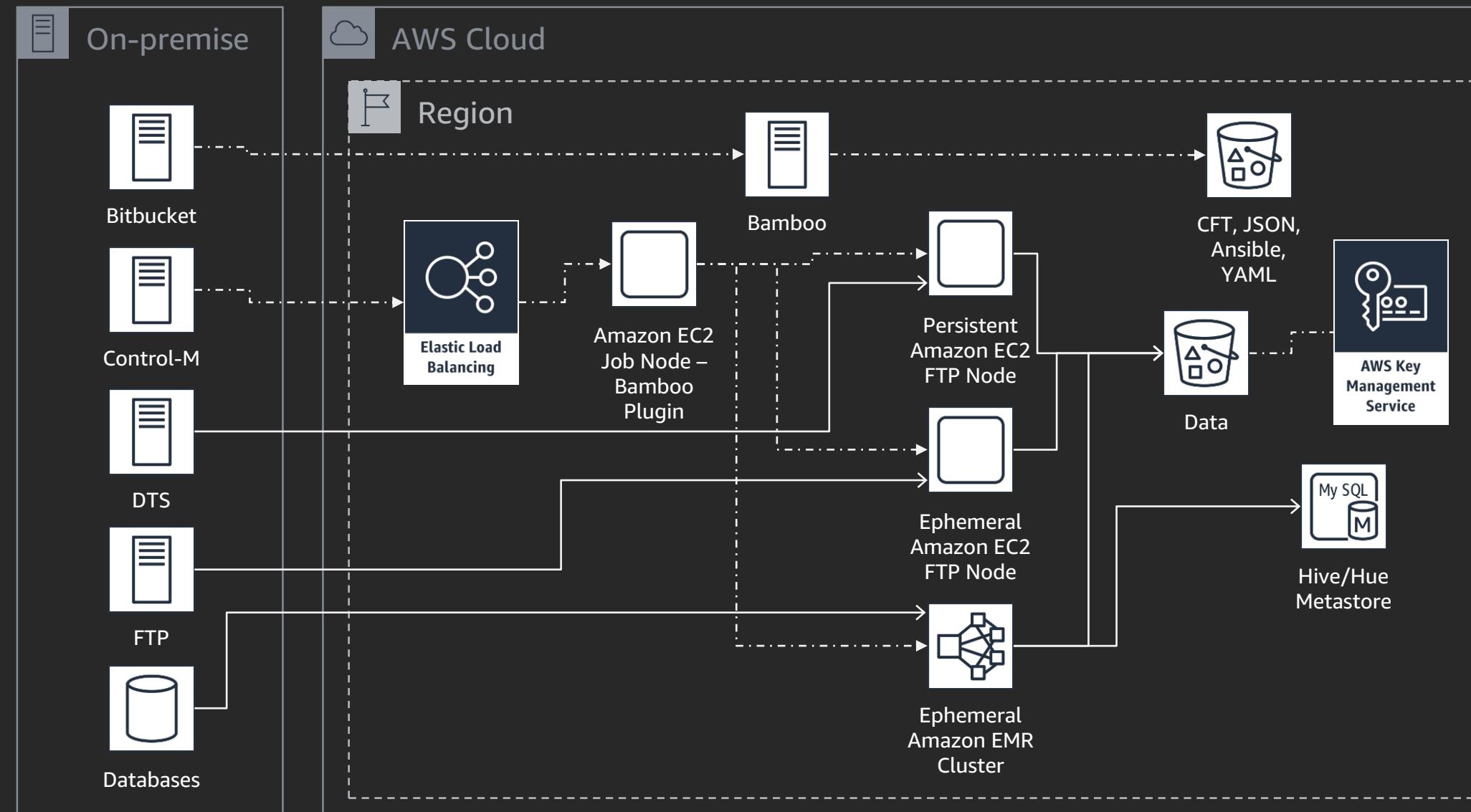
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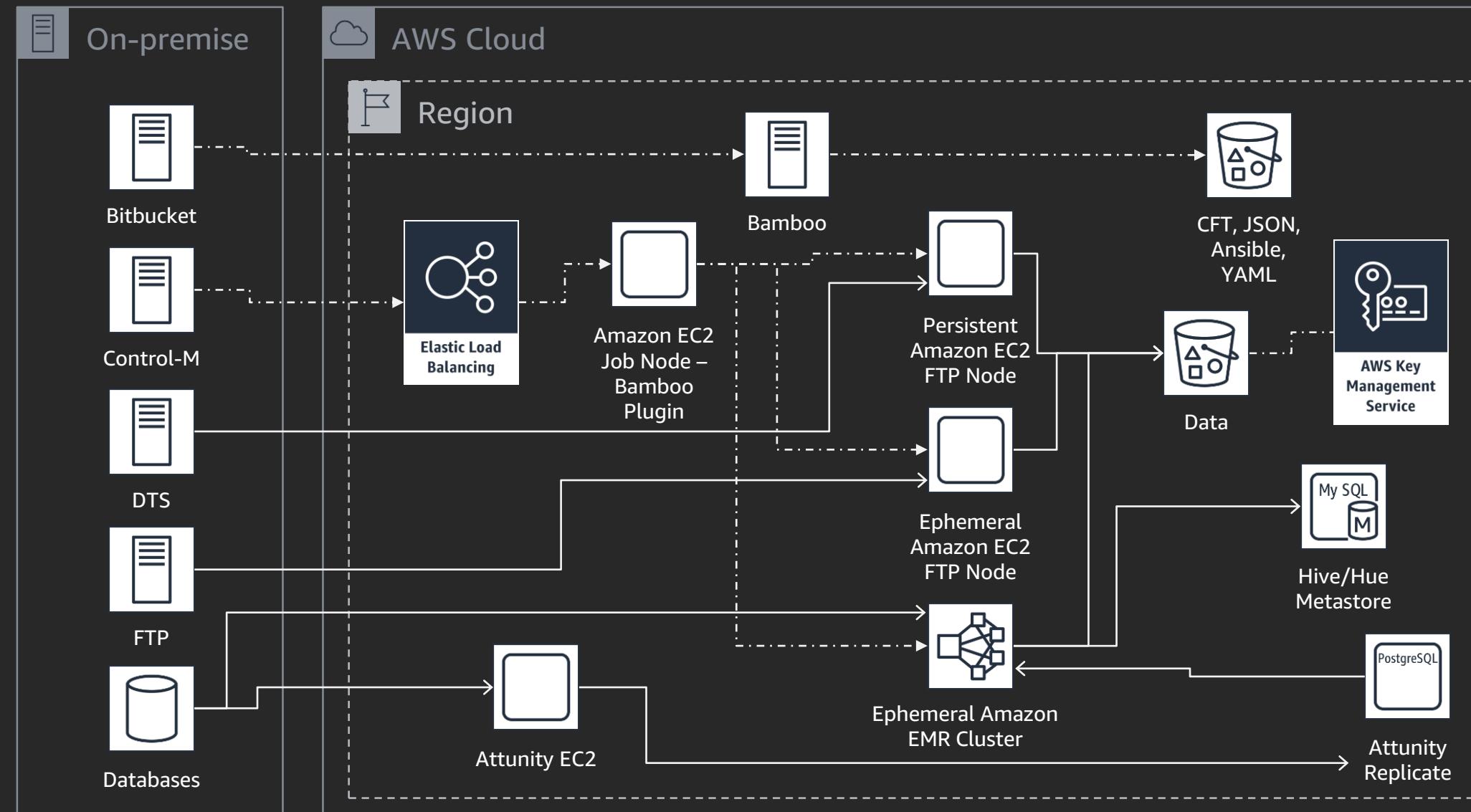
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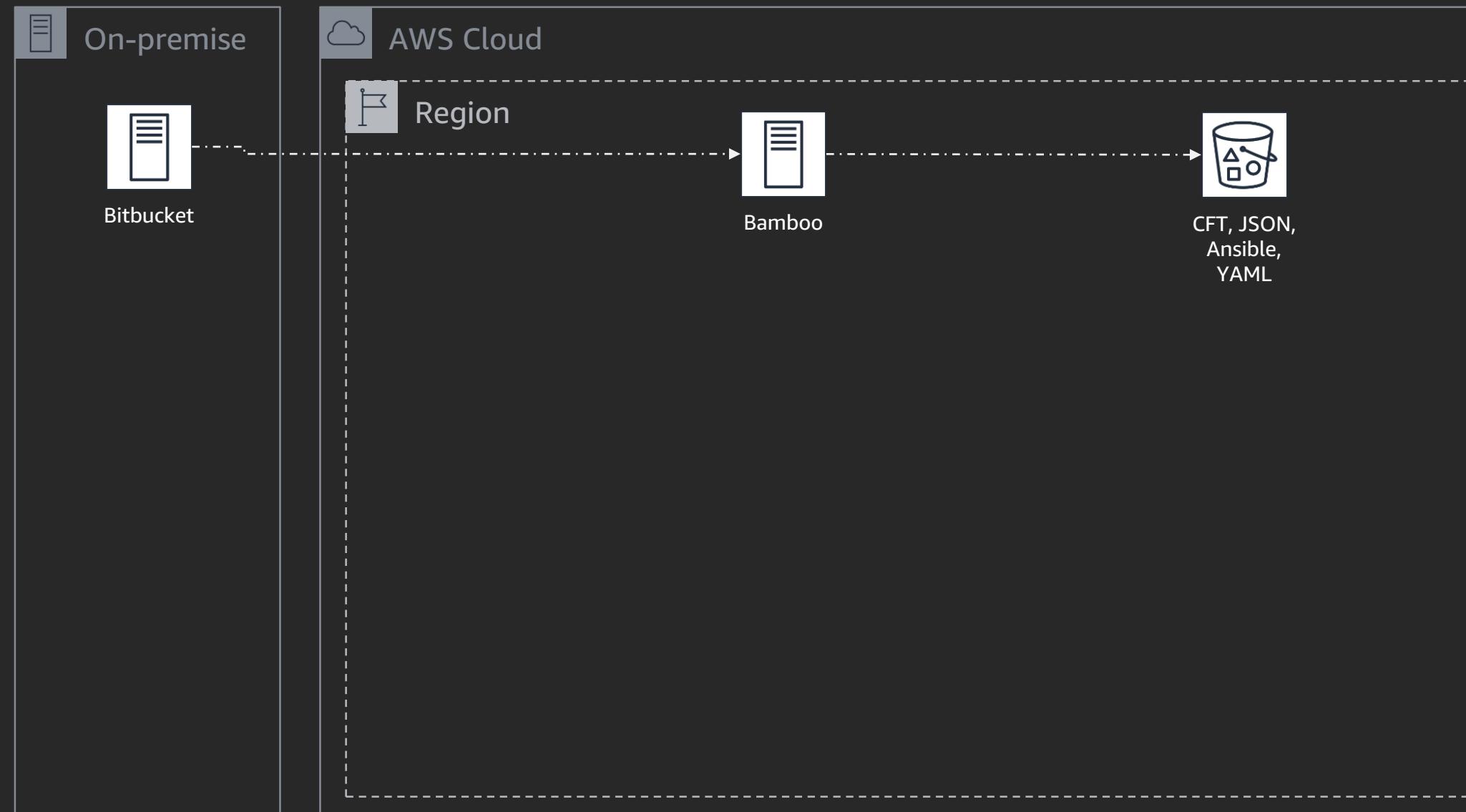
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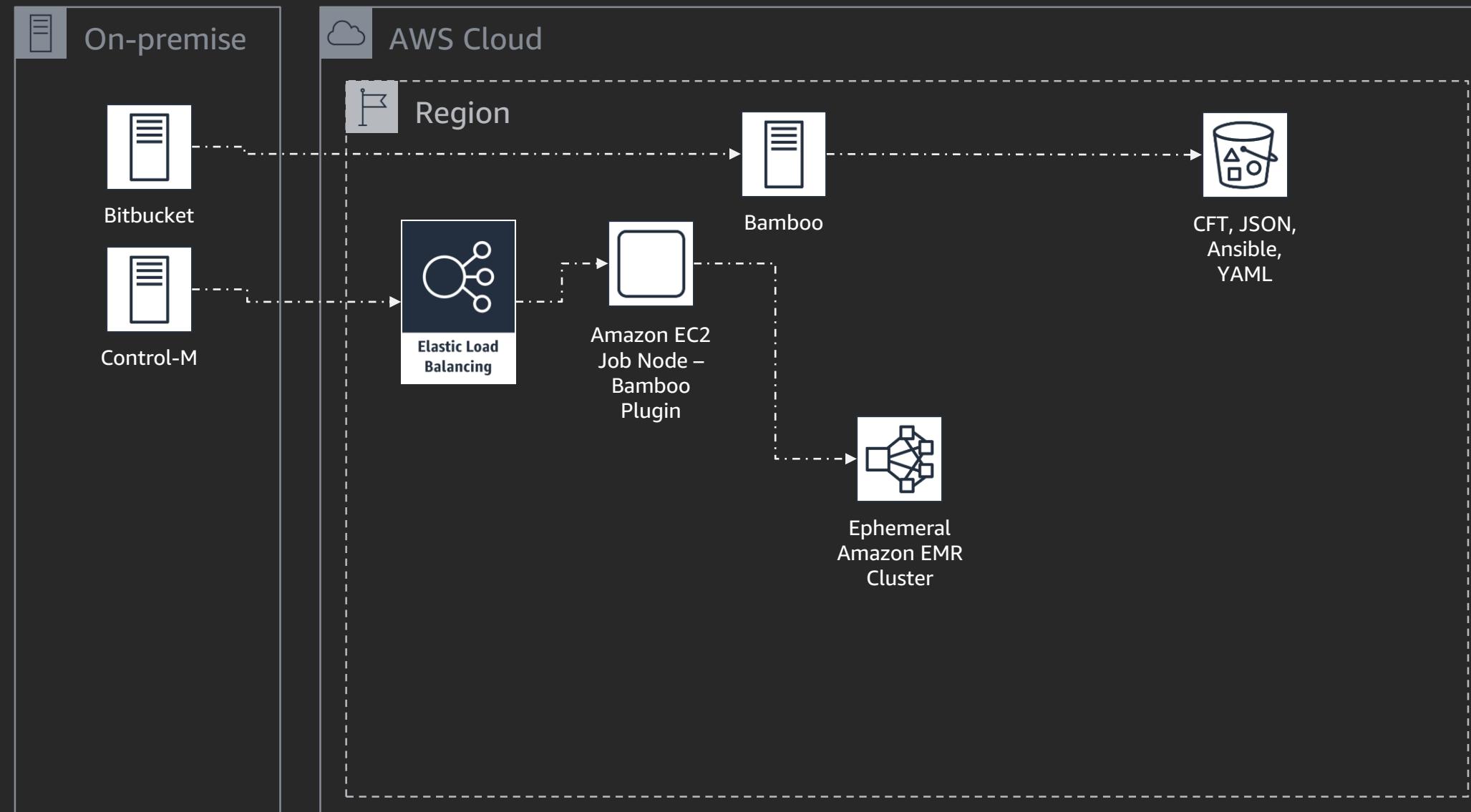
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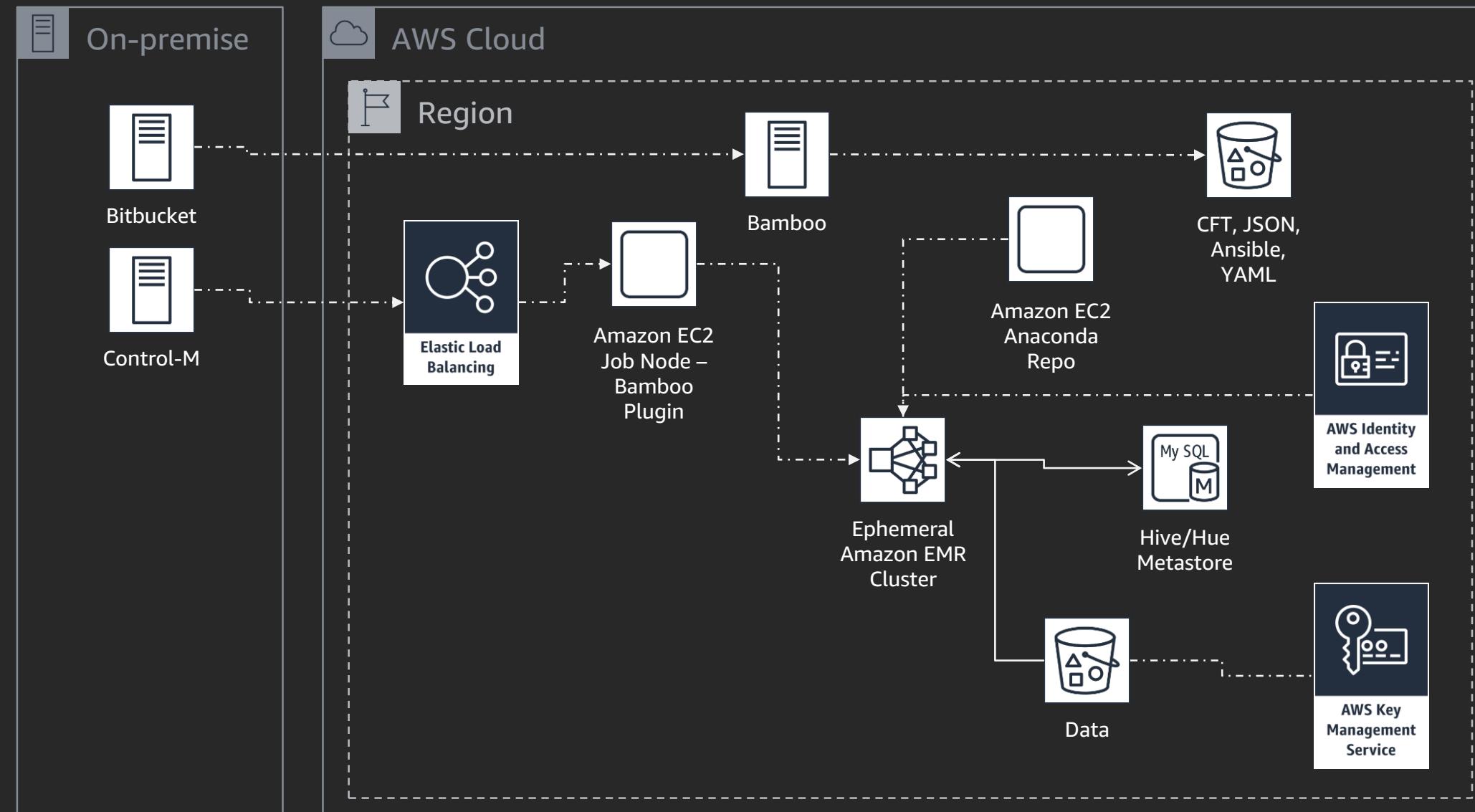
# Conceptual diagram—Analytics workload



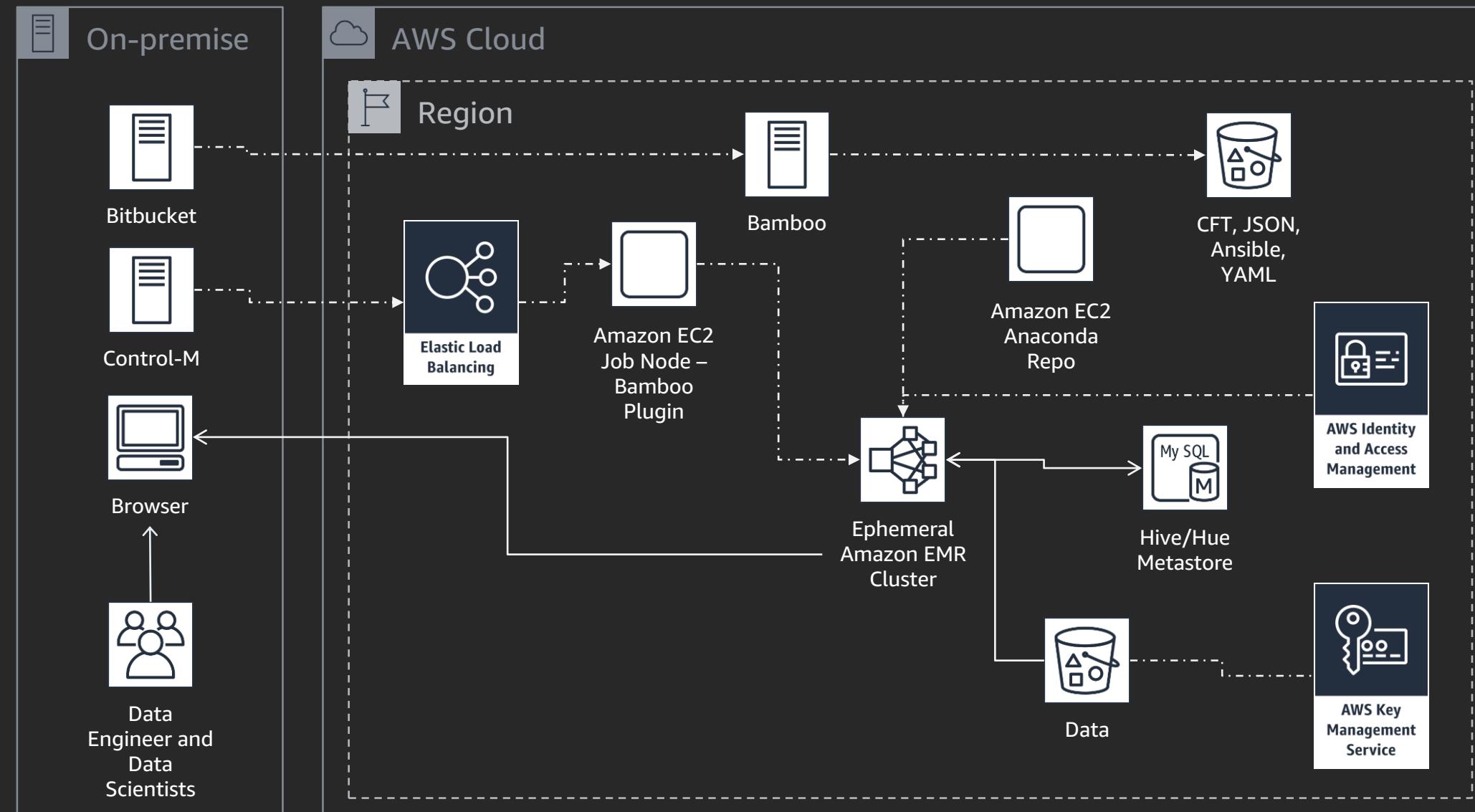
# Conceptual diagram—Analytics workload



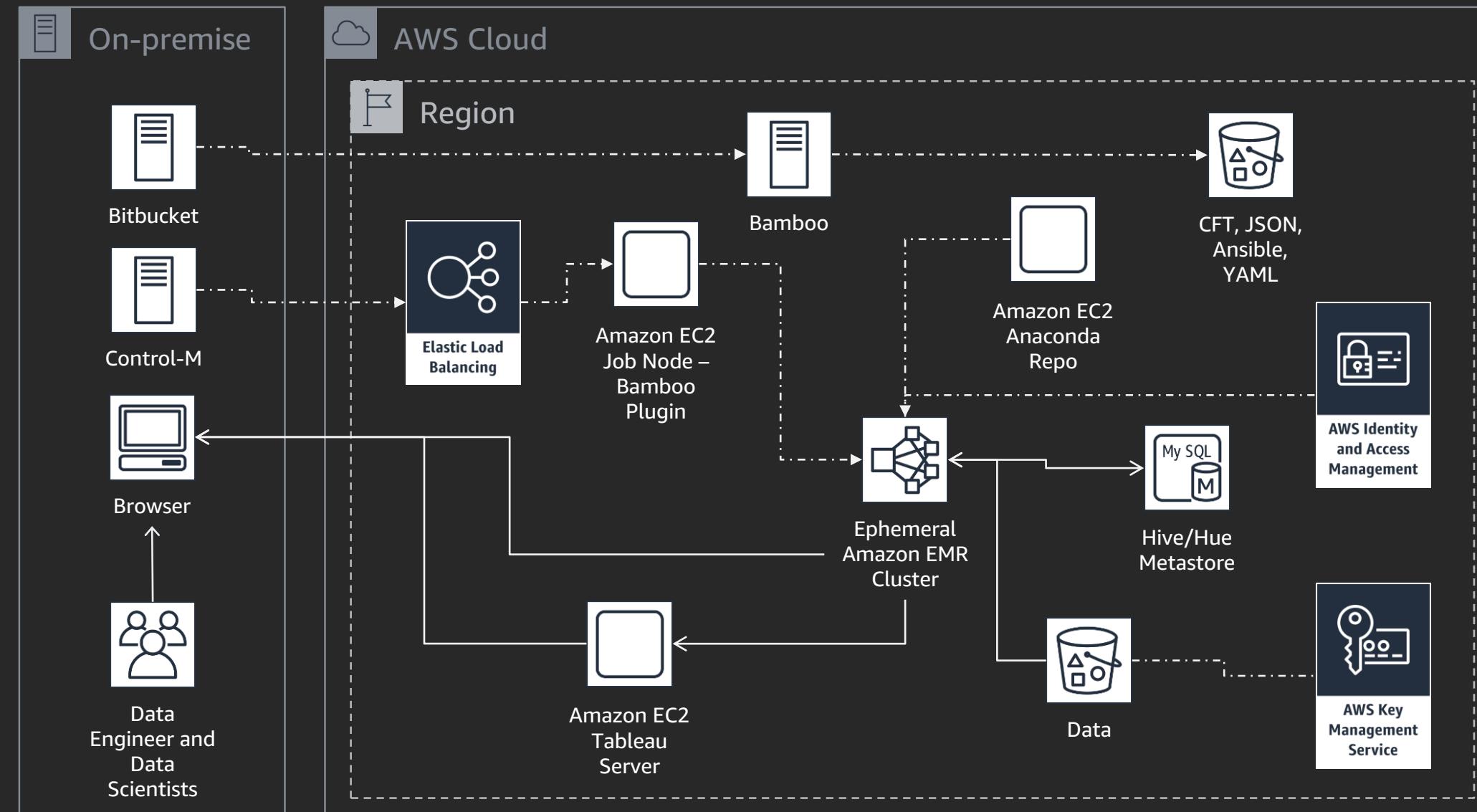
# Conceptual diagram—Analytics workload



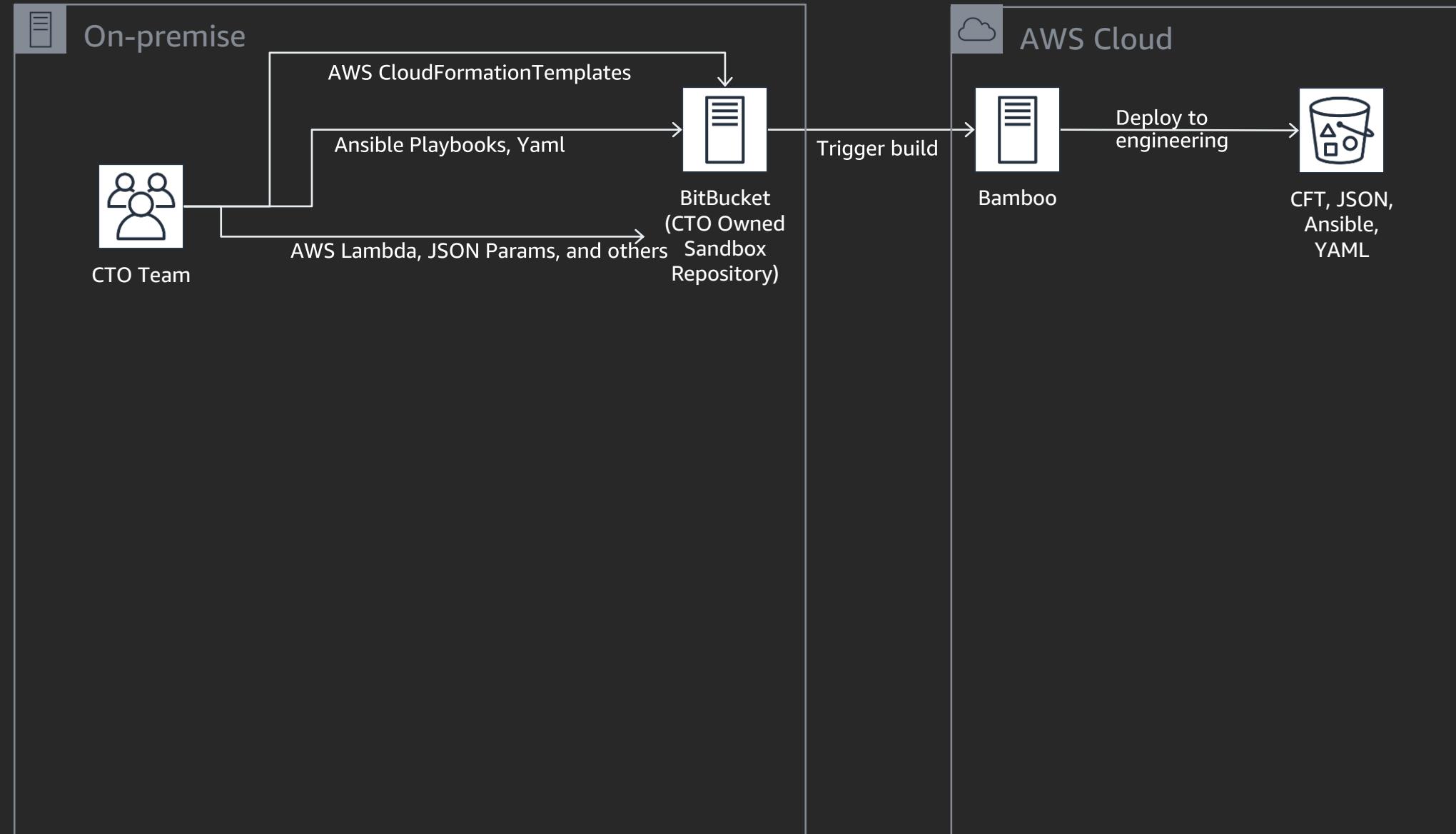
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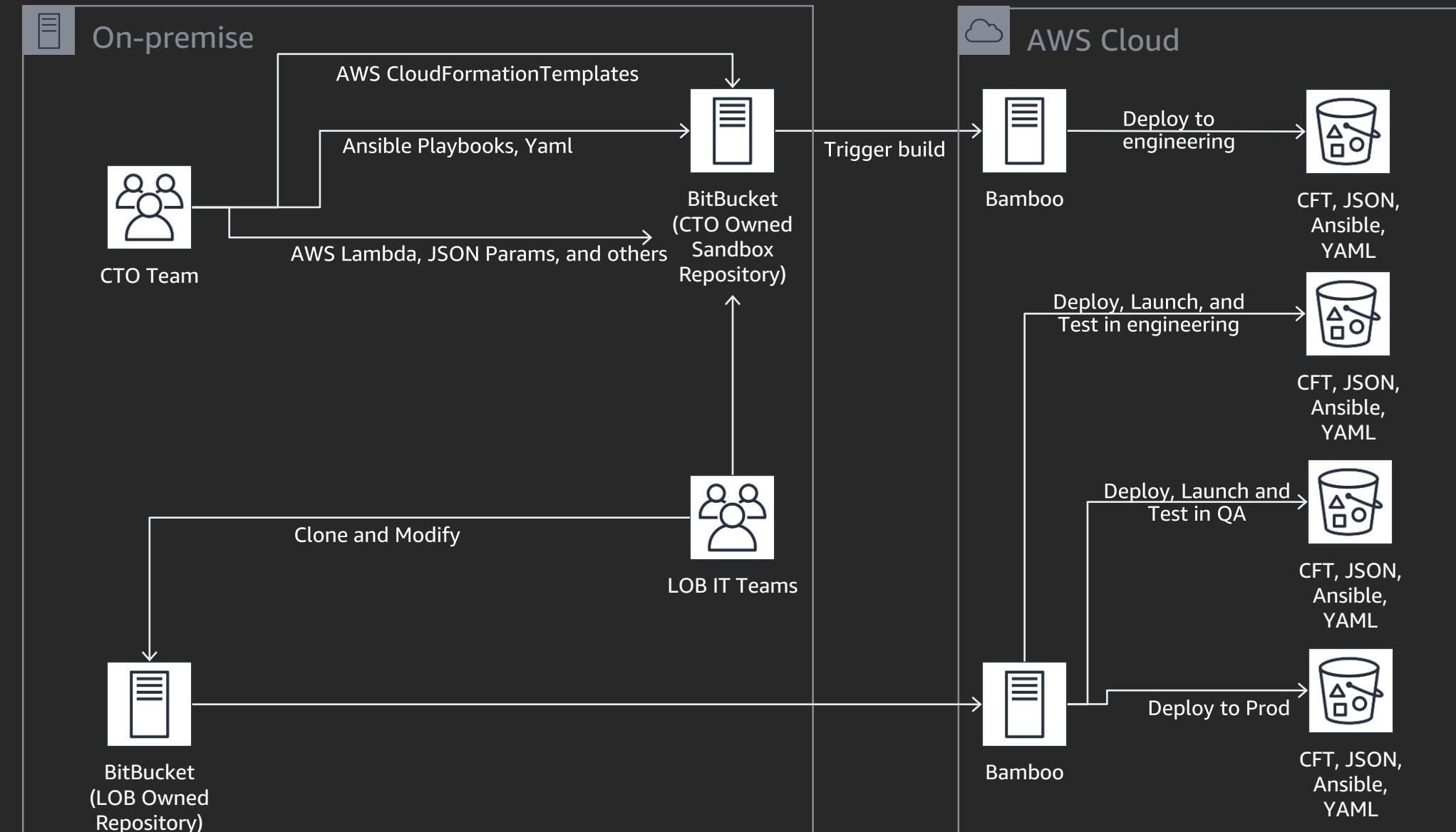
# Conceptual diagram—Analytics workload



# Conceptual diagram—Amazon EMR cluster deployment



# Conceptual diagram—Amazon EMR cluster deployment



# Lessons learned

# Four major areas of non-functional requirements

## Authentication

- **Integration with Active Directory or RadiantLogic**

## Authorization

- **Full automation** of required process
- **AWS Identity and Access Management (IAM)** preferred
- **Least privileged access** model

## Auditing

- What access **can** be provisioned
- What access **is** provisioned
- What access provisioned is **used**

## Encryption

- Using **Vanguard managed keys**
- **At rest**
- **In-flight**

# Lessons learned

## Hive & Presto

- Presto would perform anonymous bind with AD
  - ✓ AWS provided a patch and committed back to open source
- Auditing gaps in Presto due to missing integration with EMRFS
  - ✓ Partnered with AWS to develop this integration which is rolled out in Amazon EMR 5.12
- Authorization implemented using Hive SQL Auth
  - ✓ Built custom automation process to load authorizations

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## Jupyter & Spark

- Livy (for Spark) has no authentication and does not have SSL support
- Anaconda Repo integration is not simple
  - ✓ Built custom solution to install packages on all nodes
- Spark-Hive integration not available as Spark calls to Hive Metastore bypass Hive SQL authorizations
- Auditing requires customizations
  - ✓ EMRFS auditing for Spark
  - ✓ Enabled LinuxContainerExecutor and AWS\_EXECUTION\_ENV for Python

# Lessons learned

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## Hue & Oozie

- Hue File Browser uploads to Amazon S3 not supported for KMS-CMK
- Hue allows execution of Oozie actions as Yarn user. Plus gaps in auditing.
  - ✓ Enabled LinuxContainerExecutor to block yarn users access and AWS\_EXECUTION\_ENV for auditing
- Oozie Hive local action can bypass Hive SQL authorization
  - ✓ Disabled this action
- Oozie Hive2 does not support "service id"
  - ✓ Customized Beeline script to resolve

# Metrics for 2017 – 2018: Reason to change

# Some important metrics



# Reason to change

Increased demand for analytics

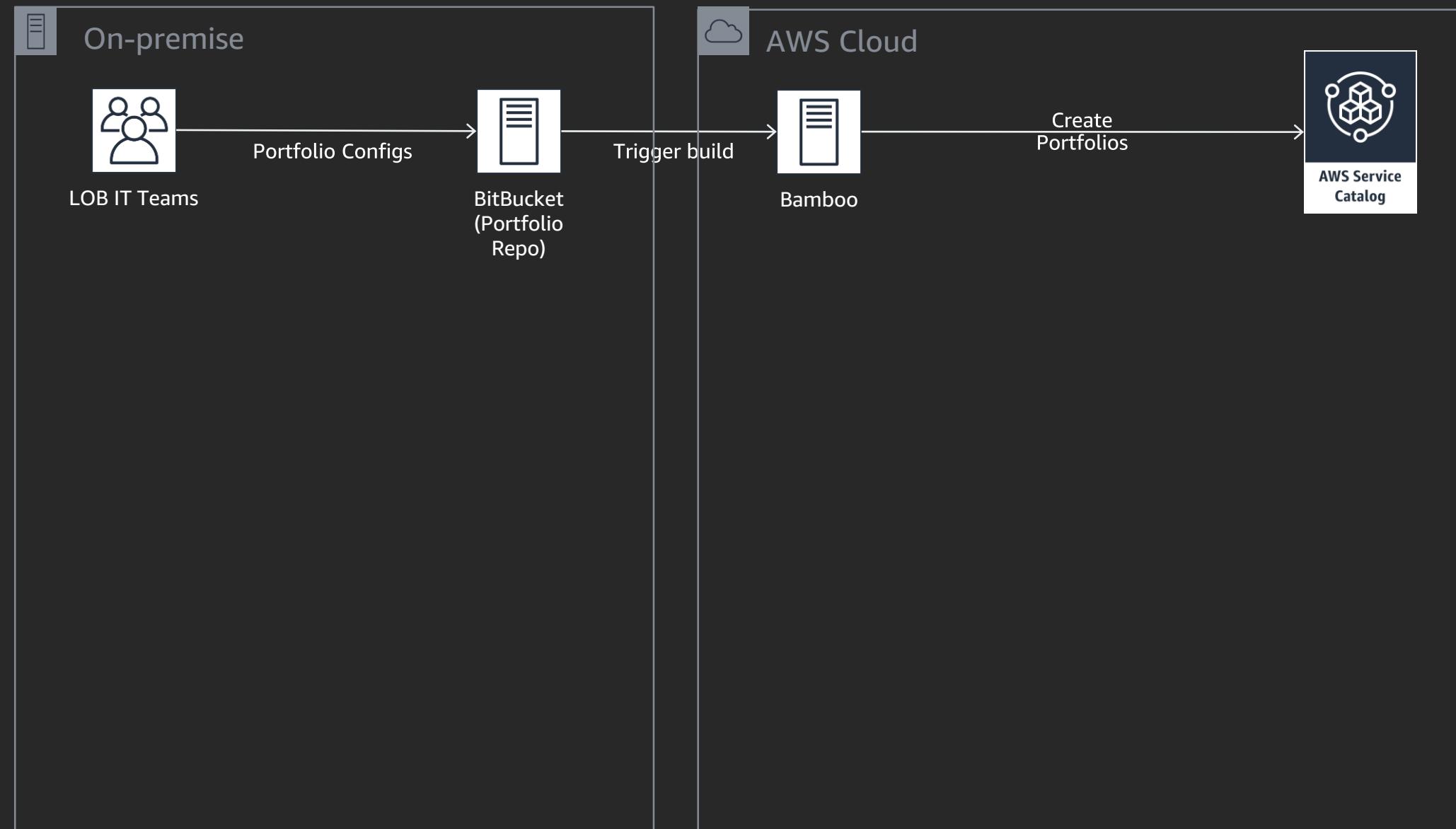
Faster enablement of compute

Operational resiliency with lowered cost

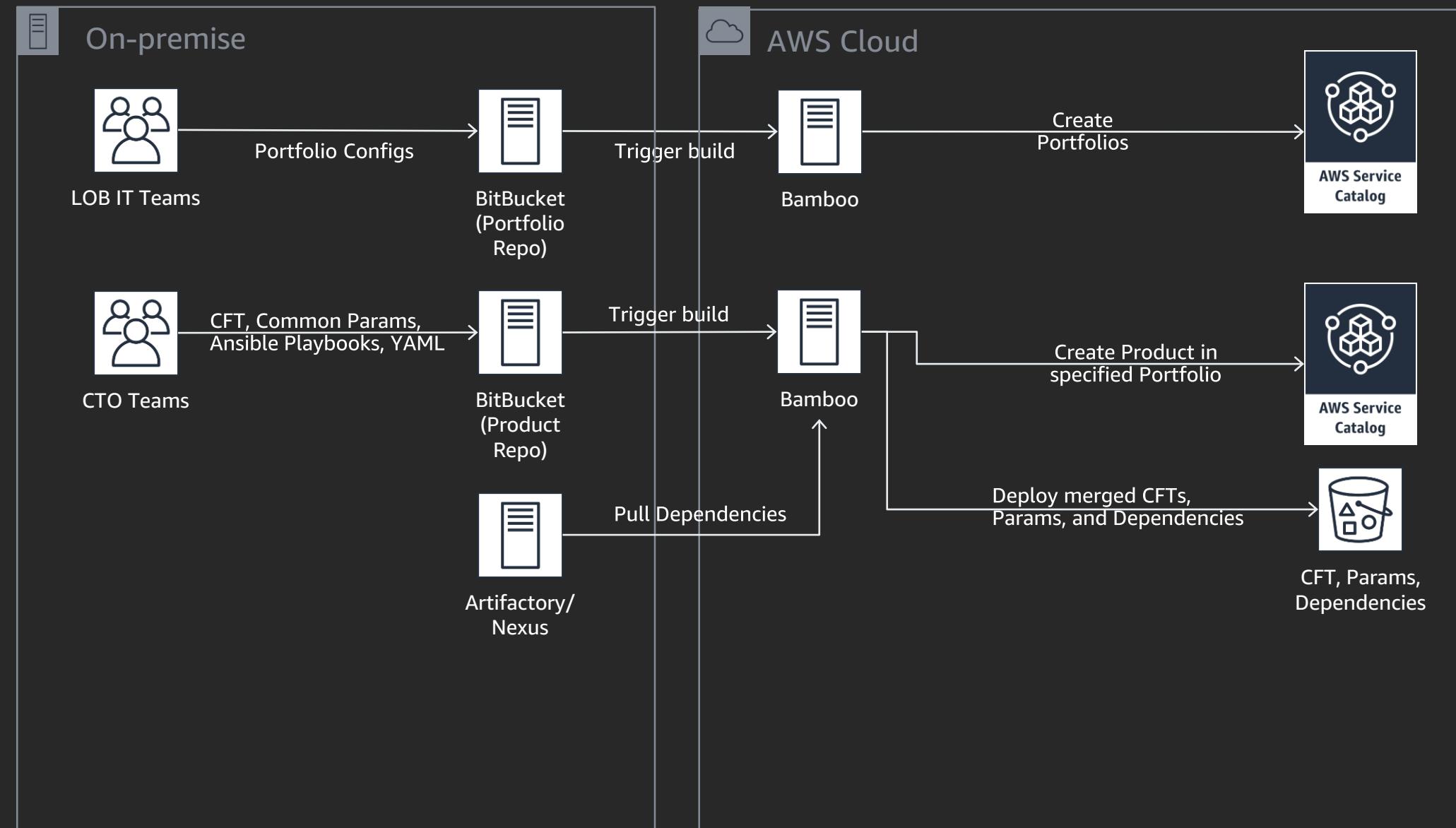
Self-management of compute

# 2018 – 2019: Implementation in progress & future state

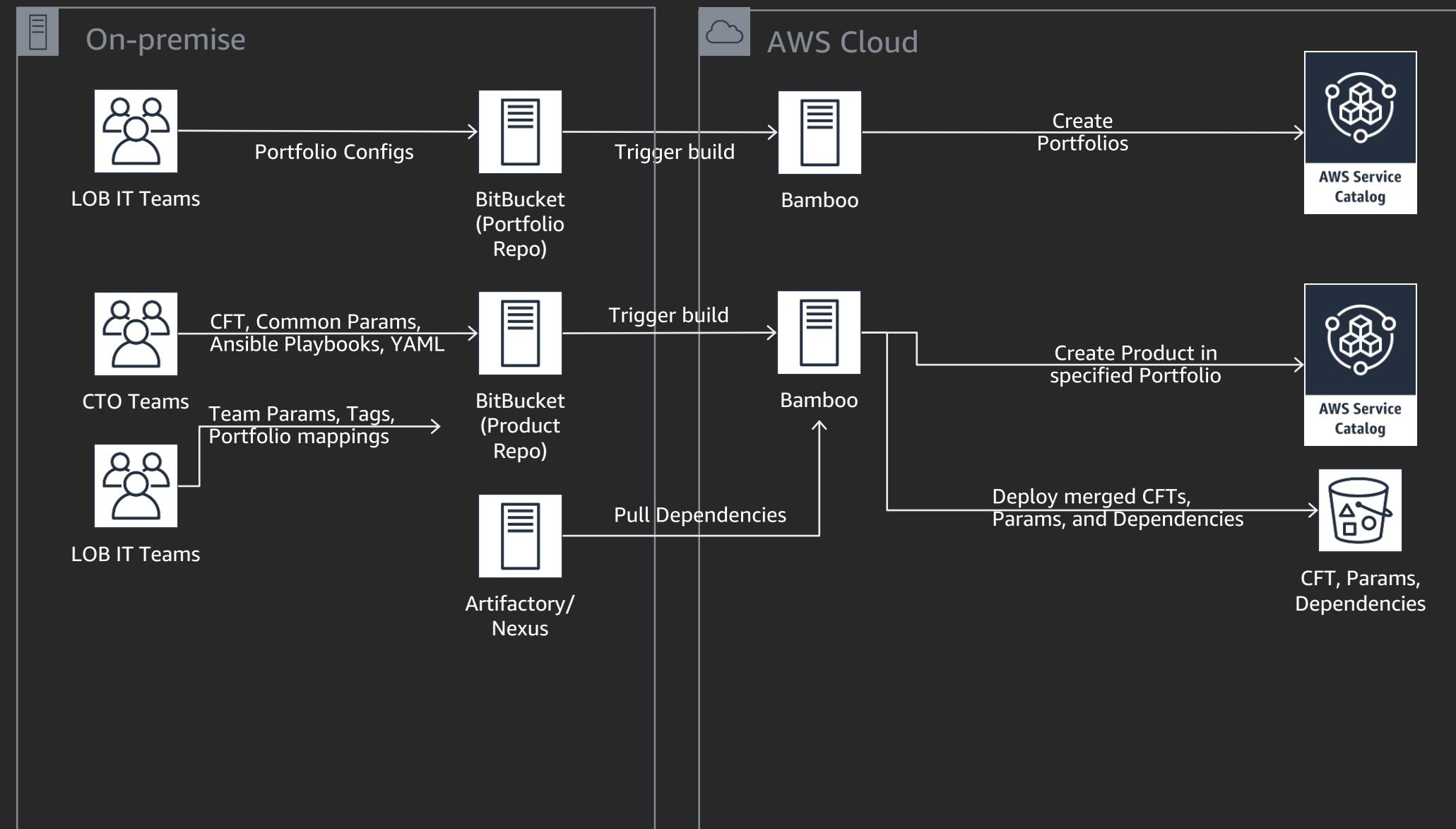
# Conceptual diagram—Amazon EMR cluster deployment



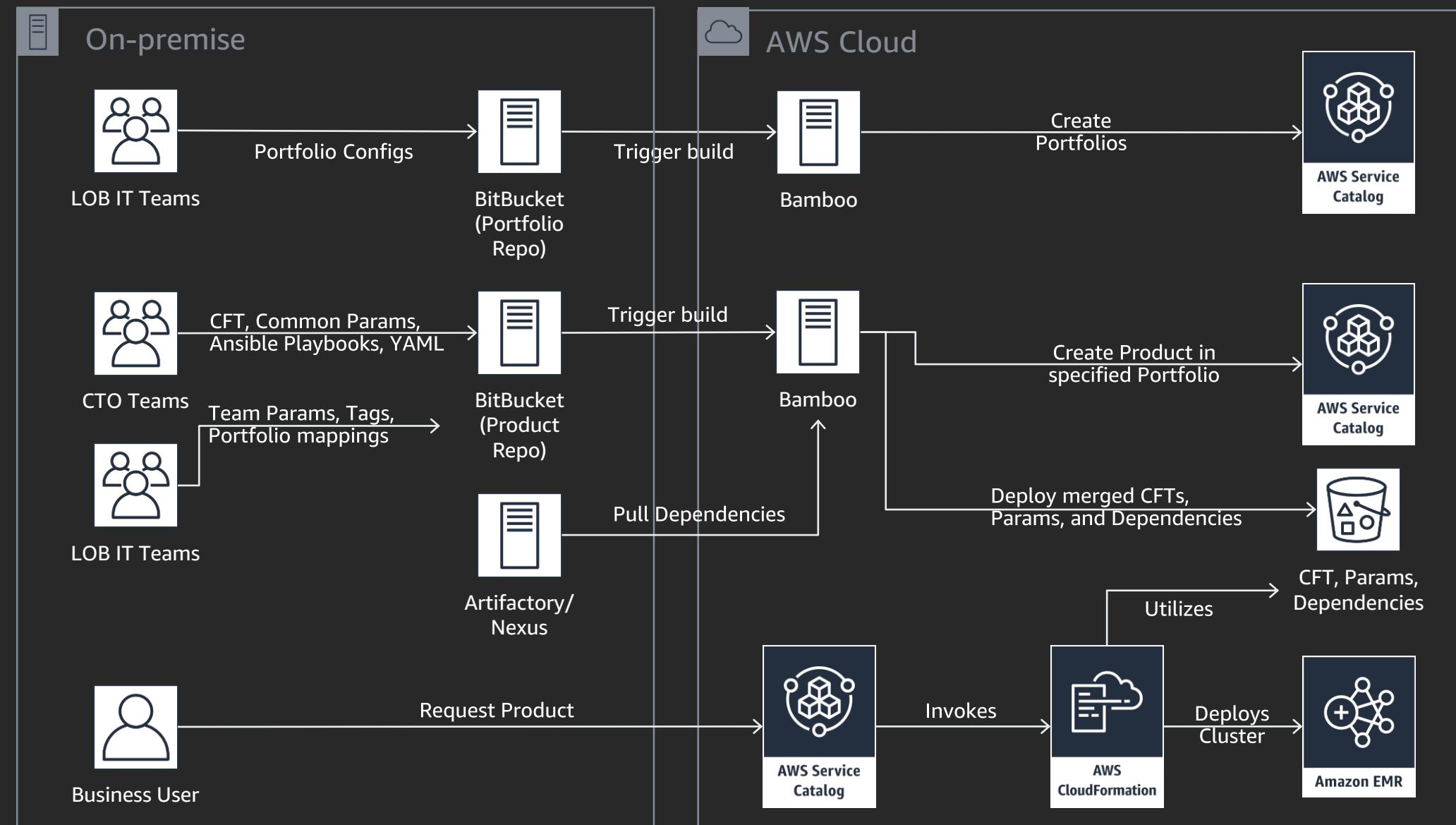
# Conceptual diagram—Amazon EMR cluster deployment



# Conceptual diagram—Amazon EMR cluster deployment



# Conceptual diagram—Amazon EMR cluster deployment



# Benefits of updated cluster deployment architecture

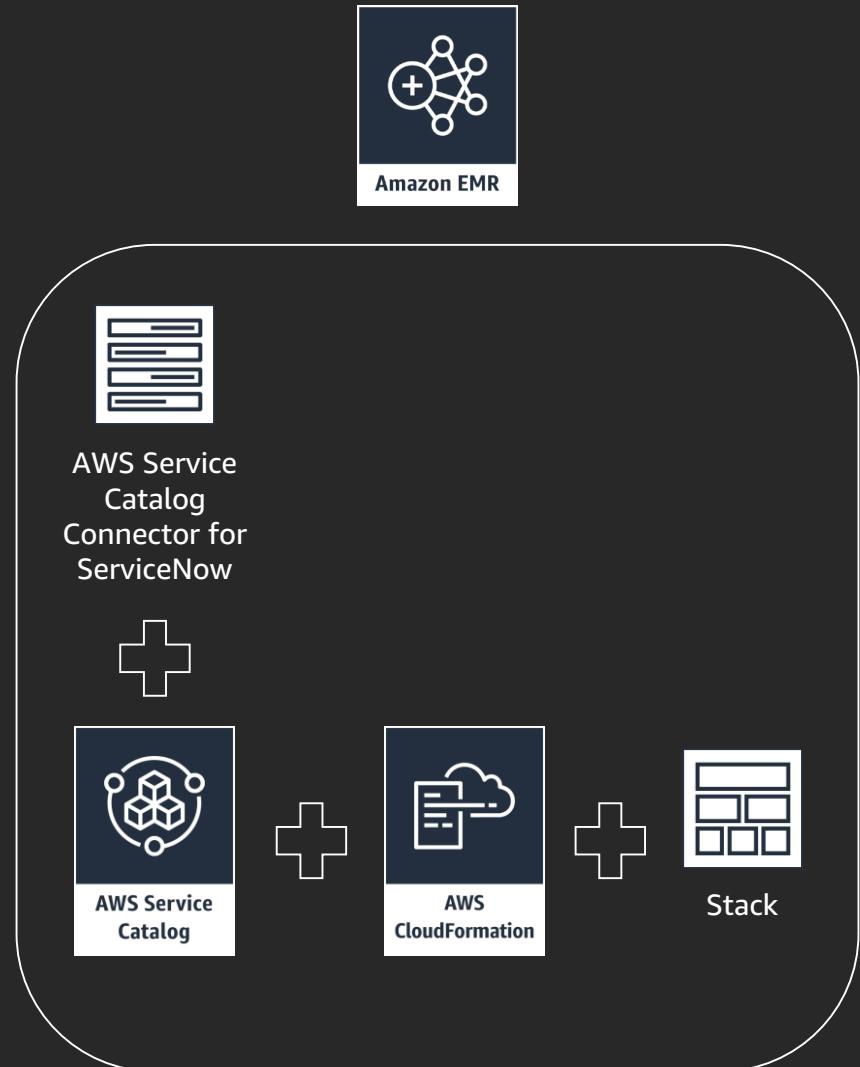
**Simplified  
and faster  
deployment  
of clusters**

**Increased  
operational  
resiliency**

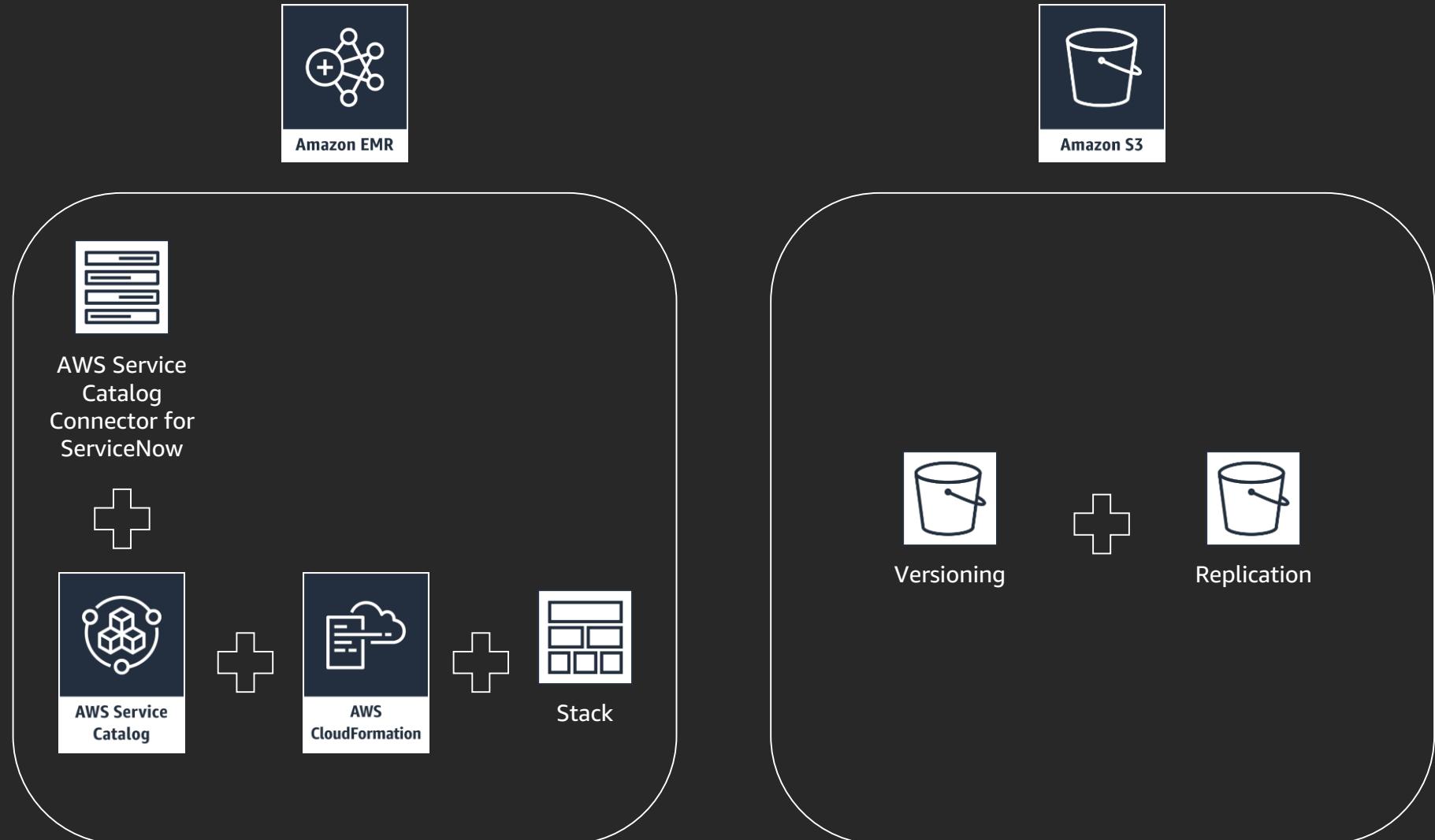
**Flexibility**  
for business  
to manage  
clusters

**Easier  
integration  
with ITIL  
products**

# Operational resiliency with multi-region HA



# Operational resiliency with multi-region HA



# Operational resiliency with multi-region HA



# Thank you!

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[ritesh\\_shah@vanguard.com](mailto:ritesh_shah@vanguard.com)



Please complete the session  
survey in the mobile app.