RDS - Architecture

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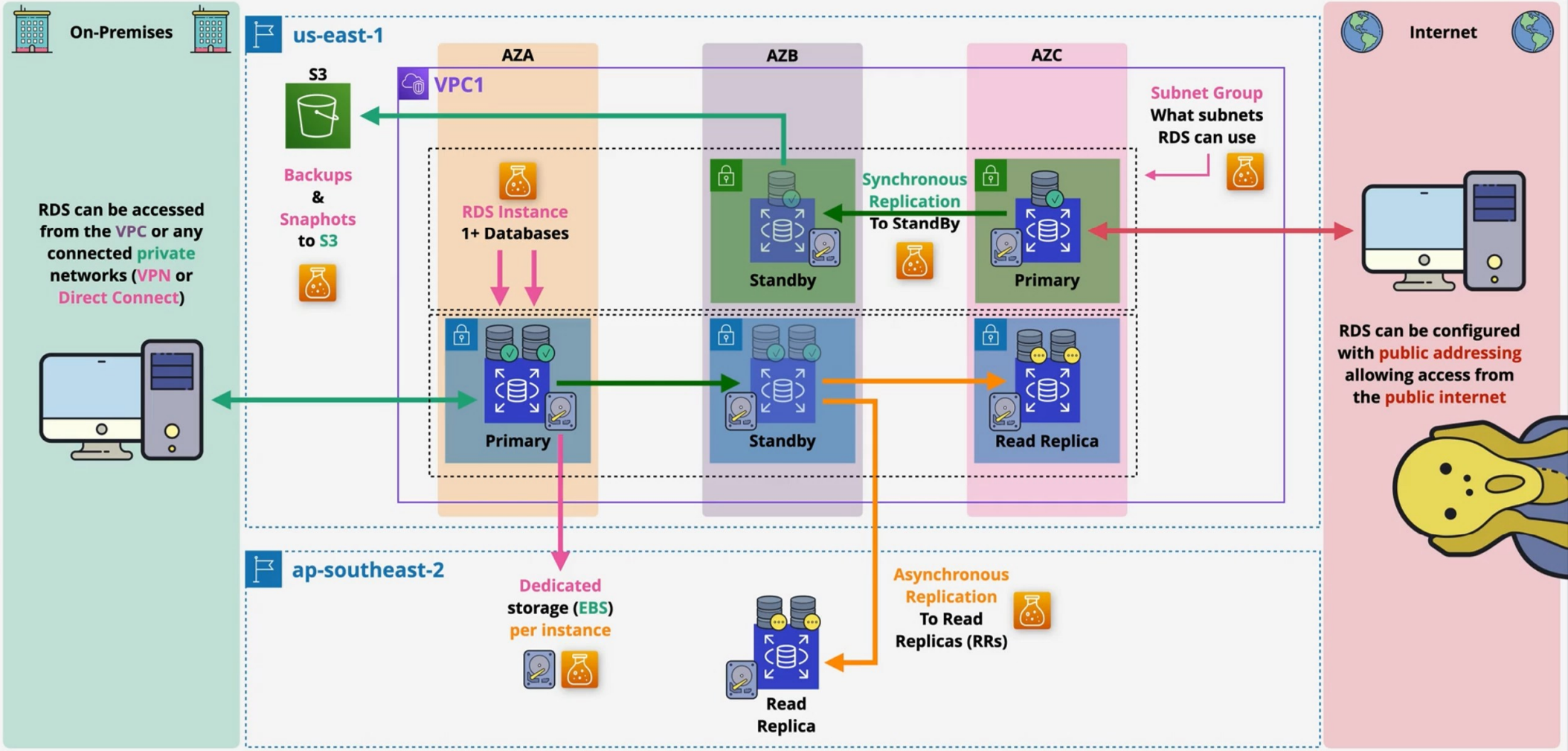
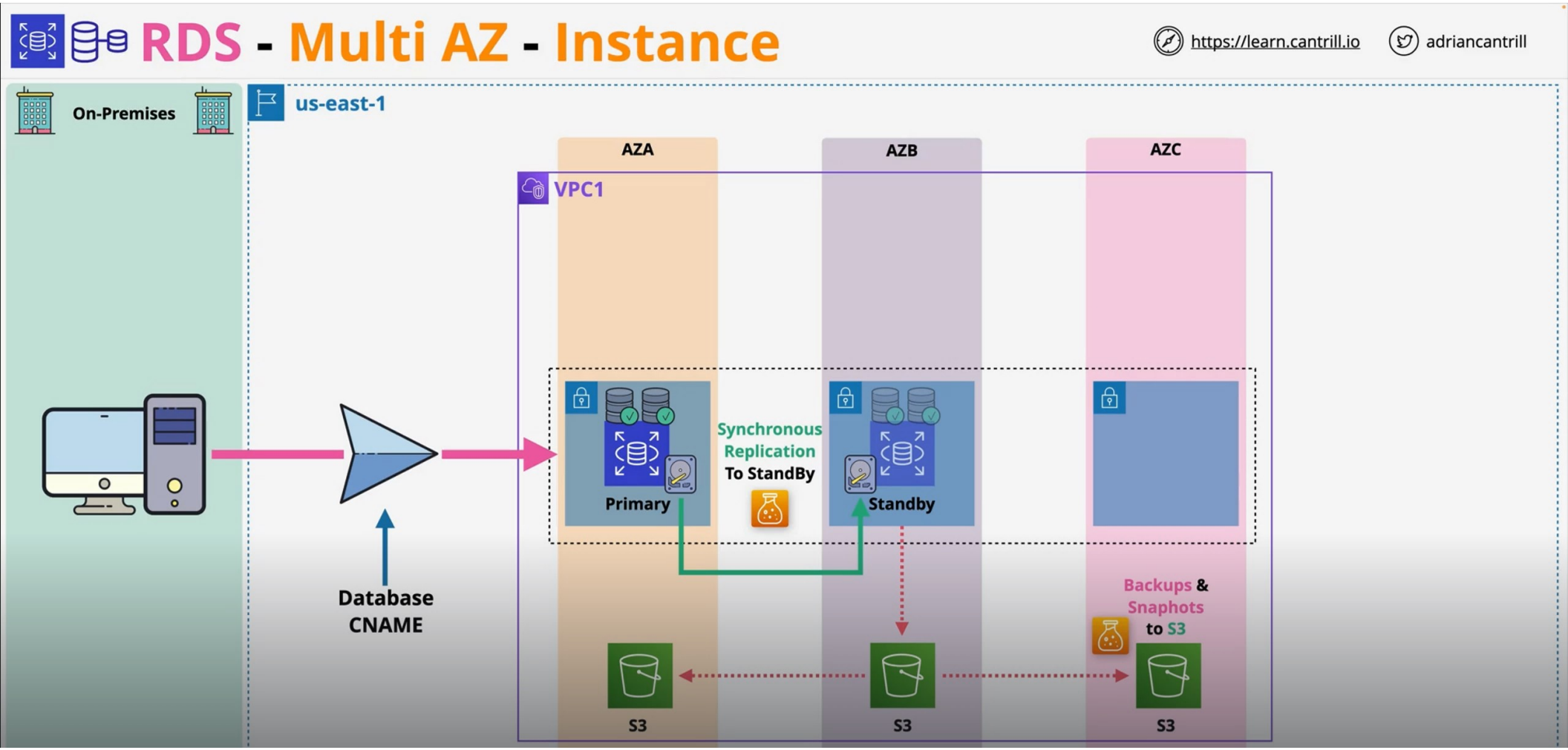


RDS - Costs

- Cost #1 - **Instance Size** & **Type**
- Cost #2 - **Multi AZ** or not
- Cost #3 - **Storage type** & **amount**
- Cost #4 - **Data** Transferred
- Cost #4 - Backups & Snapshots
- Cost #5 - Licensing* (if applicable)

RDS - Multi AZ - Instance

- Data => Primary **AND** Replicated to StandBy = **Committed** (**Synchronous**)
- **Not free tier** ... extra cost for replica
- **ONE** StandBy replica **ONLY**
- .. which **can't be used** for reads or writes
- **60-120** seconds failover
- **Same region only** ... different AZs in the same region
- **Backups** taken from **standby** to **improve performance**
- AZ Outage, Primary Failure, Manual failover, Instance type change and software patching


RDS - Multi AZ - Instance
https://learn.cantrill.io
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On-Premises
us-east-1
AZA
AZB
AZC
VPC1
Primary
Synchronous
Replication
To StandBy
Standby
Database
CNAME
Backups &
Snaphots
to S3
S3
S3
S3

RDS - Multi AZ - Cluster

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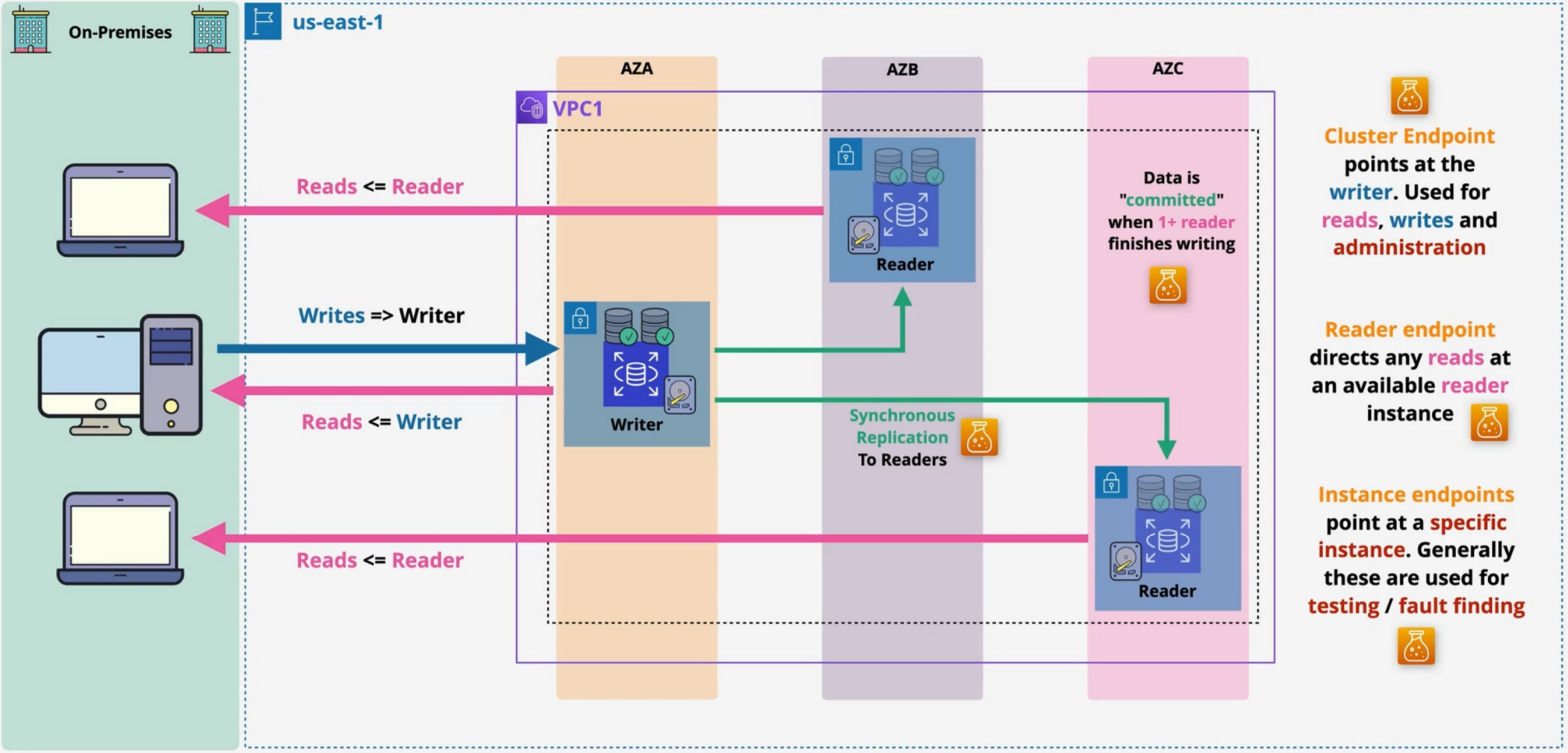

RDS - Multi AZ - Cluster

- **1 Writer** and **2 Reader** DB instances (different AZs)
- .... Much faster hardware, Graviton + local **NVME SSD Storage**
- .... Fast writes to **local storage** => **flushed to EBS**
- .... **Readers** can be used for **reads** ... allowing some **read scaling**
- Replication is via transaction logs ... more efficient
- Failover is faster **~35s** + **transaction log apply**
- Writes are "**committed**" when **1 reader** has confirmed

RDS - Backups - General

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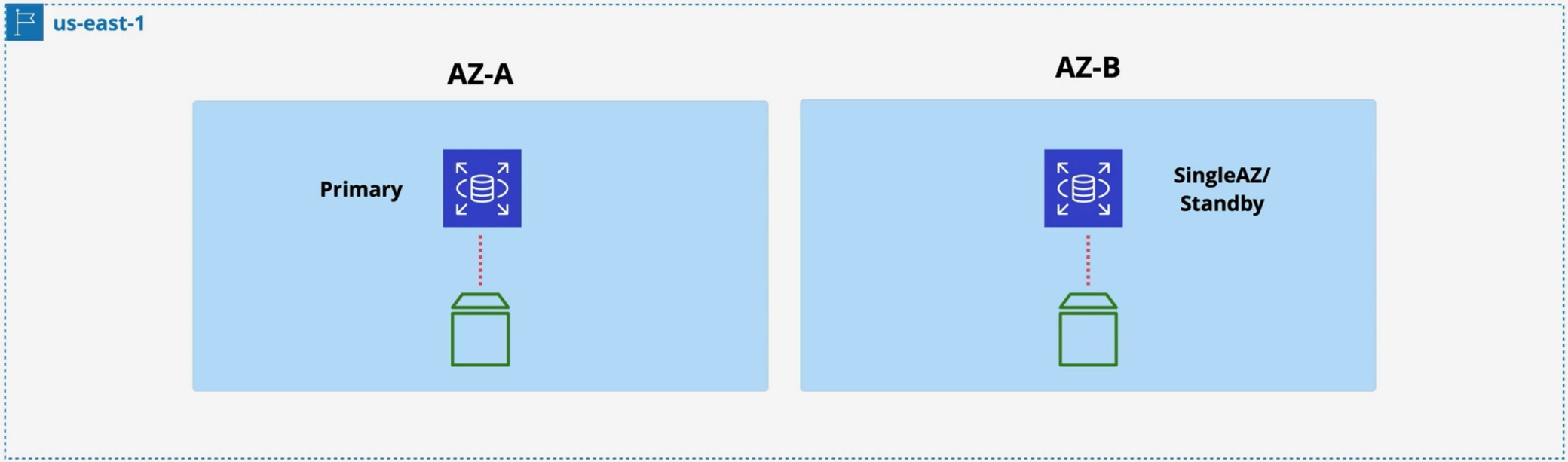

Automated Backups

Snapshots

AWS Managed S3 Buckets

RDS - Backups - General

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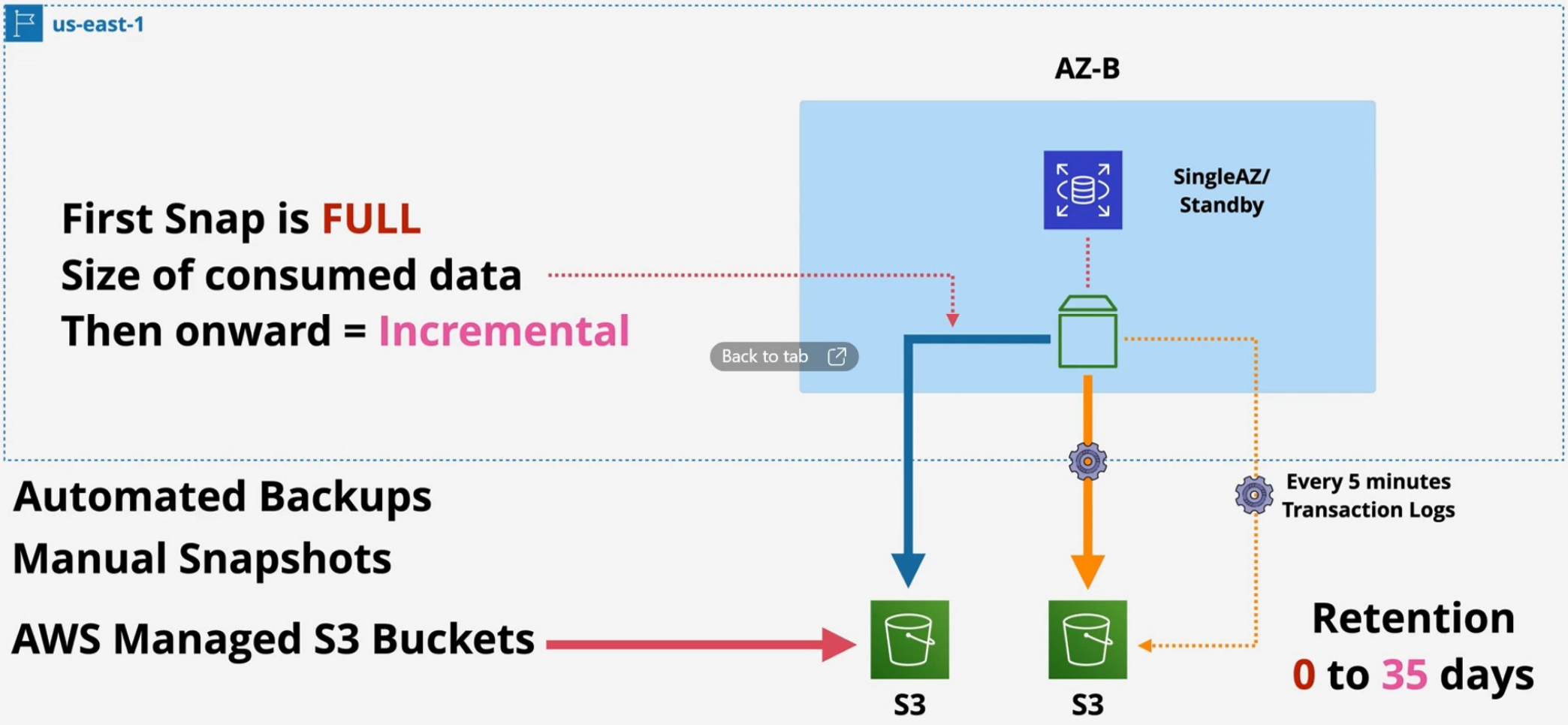

RDS - Backups - Cross-Region

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- RDS can **replicate** backups to **another region**
- .. both **snapshots** and **transaction logs**
- Charges apply for the **cross-region data copy**
- ... and the **storage** in the **destination region**
- **NOT DEFAULT** ..configured within automated backups

Back to tab

RDS - Restores

- Creates a **NEW RDS Instance** - **new address**
- Snapshots = **single point in time**, creation time
- Automated = **any 5 minute point in time**
- Backup is restored and transaction logs are 'replayed' to bring DB to desired point in time (**GOOD RPO**)
- Restores **aren't fast** - Think about **RTO** (***RR's**)

RDS - Read Replicas

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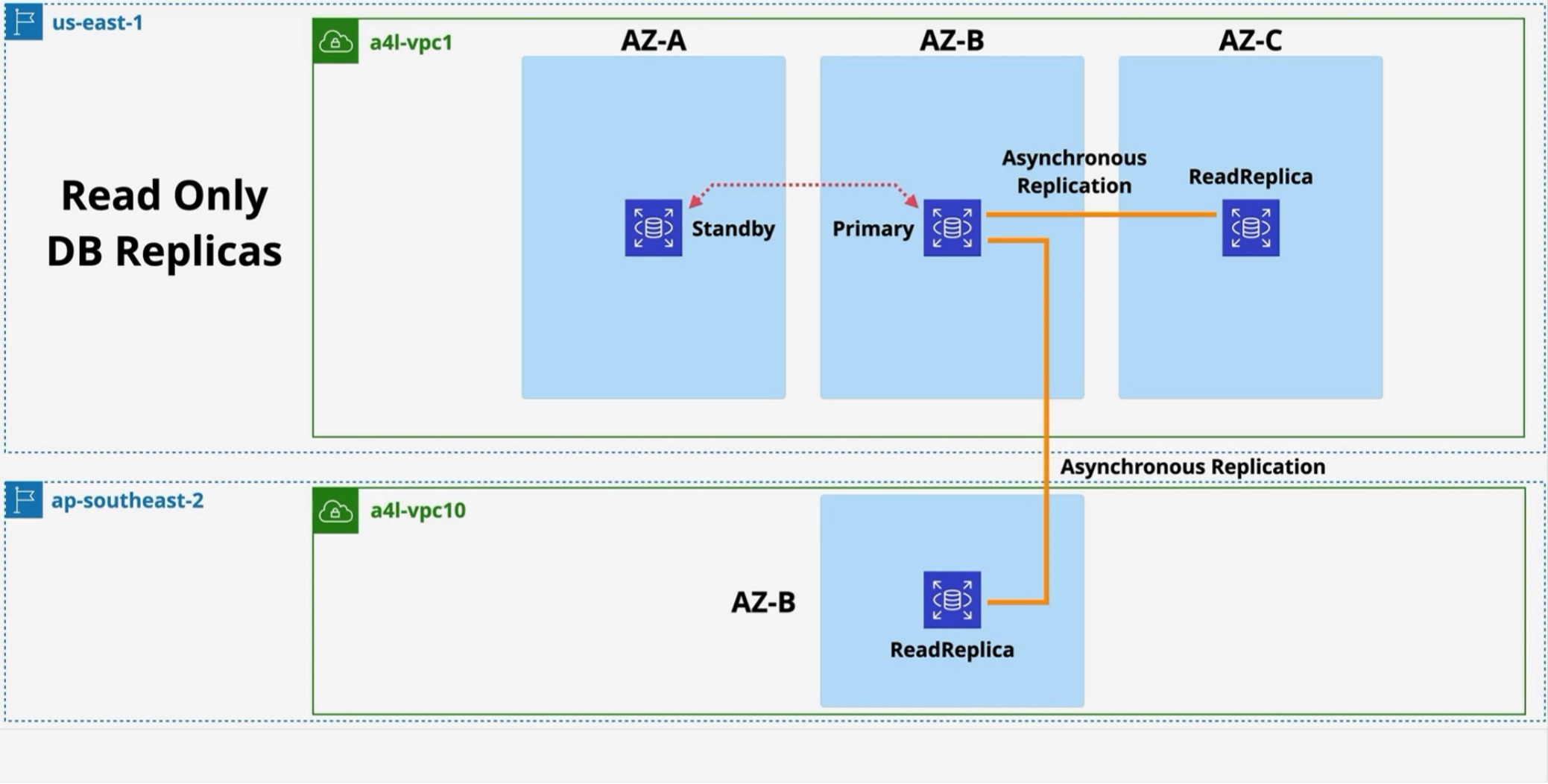
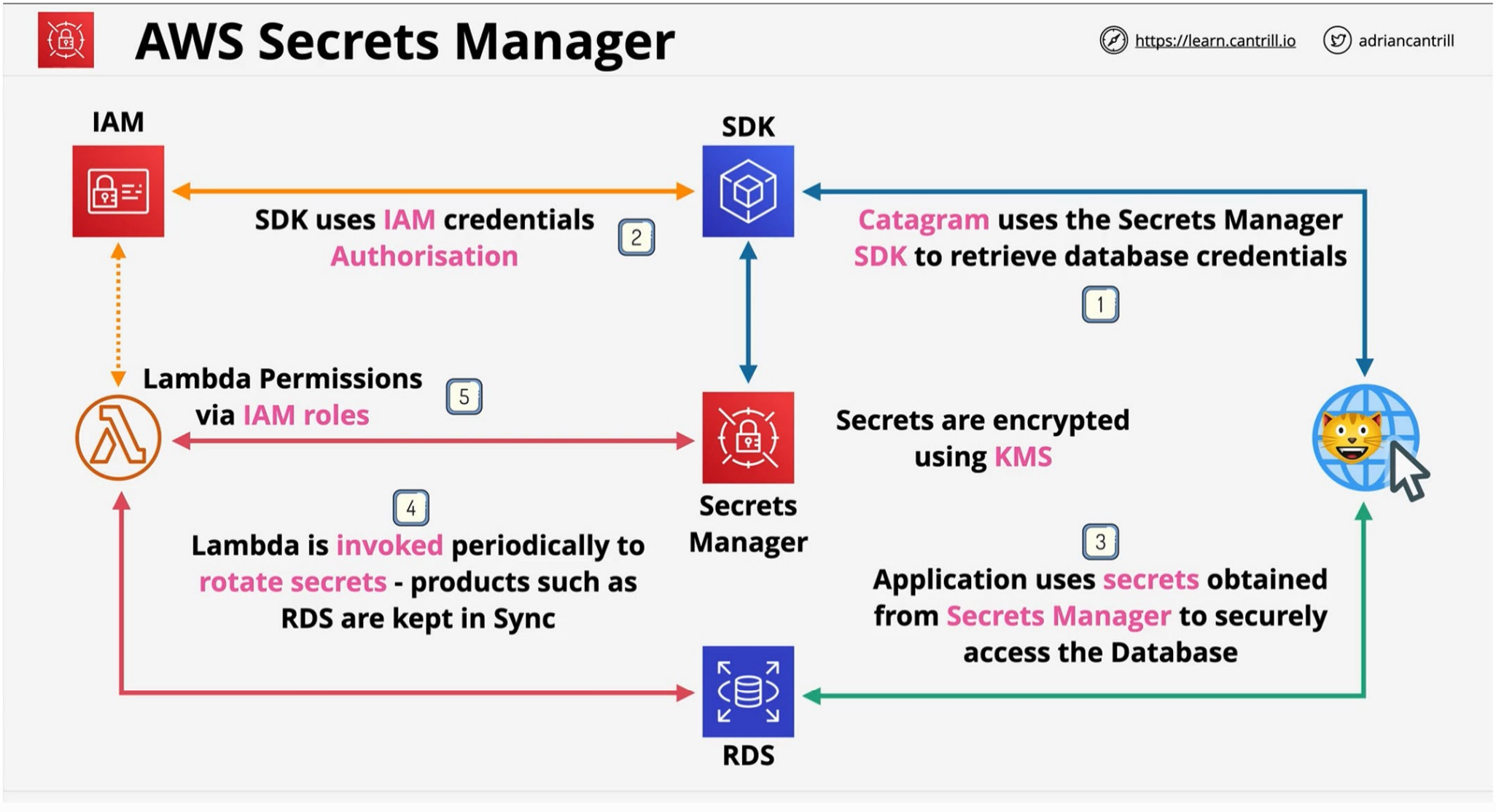


(read) Performance Improvements

- **5x** direct read-replicas per DB instance
- Each providing an **additional instance of read performance**
- Read-Replicas can have read-replicas - **but lag starts to be a problem.**
- **Global** performance improvements

RPO/RTO Improvements

- Snapshots & Backups Improve **RPO**
- **RTO's are a problem**
- RR's offer **nr. 0 RPO**
- RR's can be **promoted quickly** - **low RTO**
- **Failure only** - watch for data corruption
- **Read only - until promoted**
- **Global availability improvements ... global resilience**


AWS Secrets Manager
https://learn.cantrill.io
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IAM
SDK
SDK uses IAM credentials
Authorisation
2
Catagram uses the Secrets Manager
SDK to retrieve database credentials
1
Lambda Permissions
via IAM roles
5
Secrets are encrypted
using KMS
Secrets
Manager
4
Lambda is invoked periodically to
rotate secrets - products such as
RDS are kept in Sync
3
Application uses secrets obtained
from Secrets Manager to securely
access the Database
RDS

AWS Secrets Manager

- It **does share functionality** with Parameter Store
- Designed for **secrets** (.. passwords, API KEYS..)
- Usable via **Console**, **CLI**, **API** or **SDK's** (*integration*)
- Supports **automatic rotation** ... this uses **lambda**
- Directly **integrates** with some AWS products (..**RDS**)

(DMS) & Snowball

- Larger migrations might be multi-TB in size
- ... moving data over networks takes time and consumes capacity
- DMS can utilise snowball ...
- **Step 1** : Use SCT to extract data locally and move to a snowball device
- **Step 2** : Ship the device back to AWS. They load onto an S3 bucket.
- **Step 3** : DMS migrates from S3 into the target store
- **Step 4** : Change Data Capture (CDC) can capture changes, and via S3 intermediary they are also written to the target database

Schema Conversion Tool (SCT)

- SCT is used when converting **one database** engine to **another**.
- .. including **DB** -> **S3** (Migrations using DMS)

- SCT is **not used when migrating between DB's of the same type**
- .. On-premises MySQL -> RDS MySQL
- Works with **OLTP** DB Types (MySQL, MSSQL, Oracle)
- And **OLAP** (Teradata, Oracle, Vertica, Greenplum..)
- e.g. On-Premises **MSSQL** -> RDS **MySQL**
- e.g. On-premises **ORACLE** -> **Aurora**

Database Migration Service (DMS)

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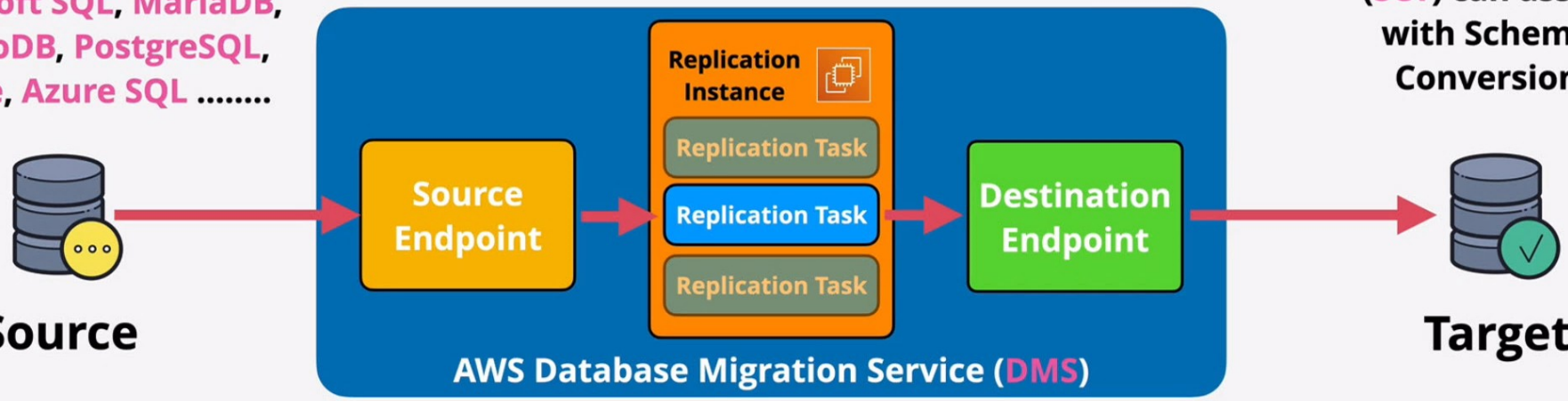
Common DB Support
MySQL, Aurora,
Microsoft SQL, MariaDB,
MongoDB, PostgreSQL,
Oracle, Azure SQL .....

Replication instance performs the migration between Source and Destination endpoints which store connection information for source and target databases

Schema Conversion Tool (SCT) can assist with Schema Conversion



Jobs can be Full load (one off migration of all data), Full Load + CDC (Change data capture) for ongoing replication which captures changes or CDC Only (if you want to use an alternative method to transfer the bulk DB data ... such as native tooling)

Database Migration Service (DMS)

- A managed database migration service
- Runs using a **replication instance**
- **Source** and **Destination Endpoints** point at ...
- **Source** and **Target** Databases
- **One endpoint MUST be on AWS**

RDS - Proxy - Key Facts

- **Fully Managed** DB **Proxy** for **RDS**/**Aurora**
- ... **auto scaling**, **highly available** by default
- Provides **connection pooling** - reduces DB Load
- ONLY **accessible** from **a VPC**
- Accessed via **Proxy Endpoint** - no app changes
- Can enforce **SSL**/**TLS**
- Can **reduce failover time** by **over 60%**
- **Abstracts failure** away from your applications

RDS - Proxy - When?

- **Too many connections** errors...
- DB Instances using T2/T3 (i.e **smaller**/**burst**) **instances**
- **AWS Lambda** ... **time saved**/connection **reuse** & **IAM Auth**
- Long running connections (SAAS apps) - low latency
- Where **resilience** to database failure is a priority...
- ... RDS proxy can **reduce the time for failover**
- ... and make it **transparent to the application**

RDS - Proxy - Architecture

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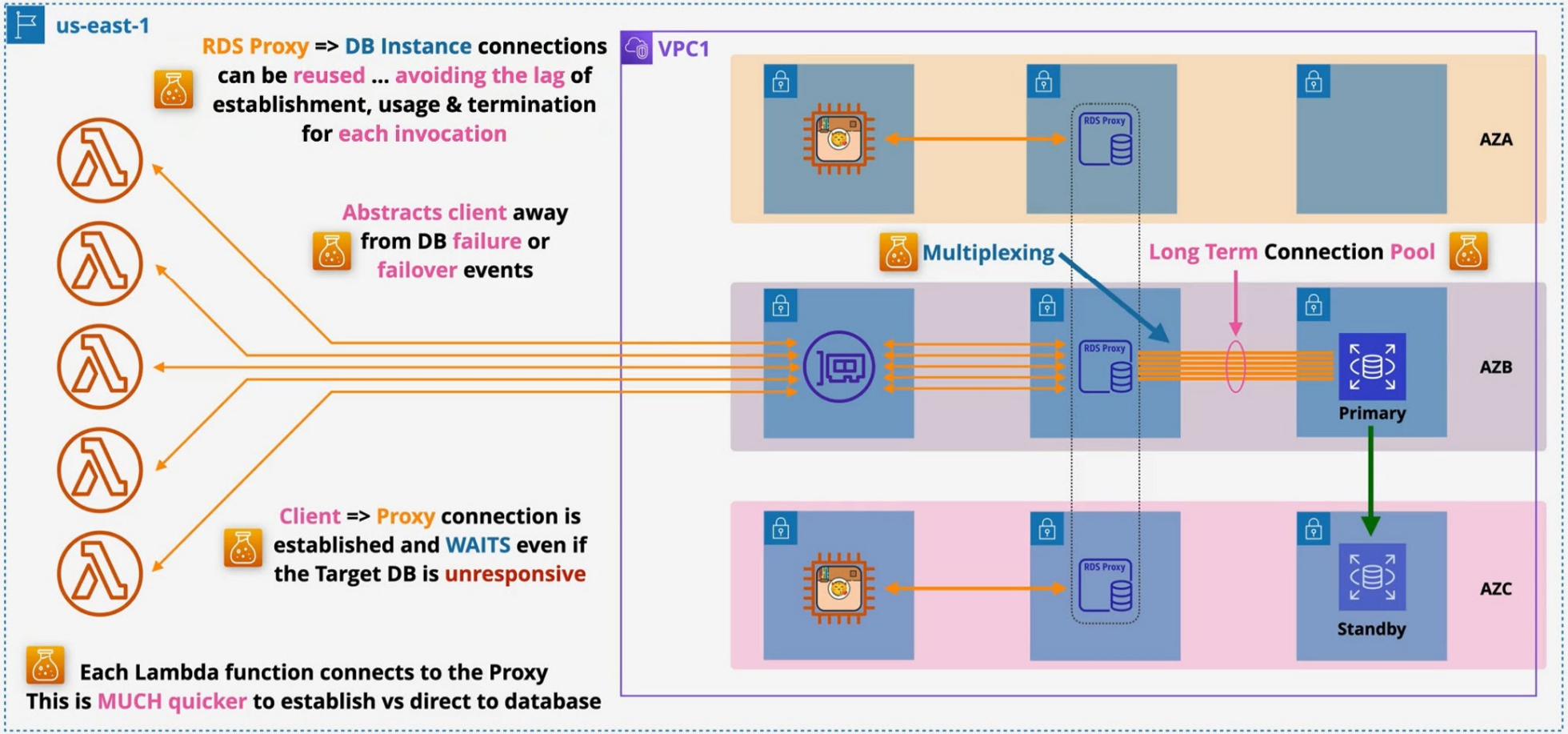

RDS - Proxy - Why?

- **Opening** and **Closing** Connections **consume resources**
- .....It takes **time** .. which creates **latency**
- With serverless .. **every lambda** opens and closes ?
- Handling **failure** of Database instances is **hard** ...
- .. doing it within your application **adds risks**
- DB **Proxies** help ... **managing** them is not trivial (**scaling**/**resilience**)
- Application(s) => Proxy (connection pooling) => Database

Aurora Multi-Master

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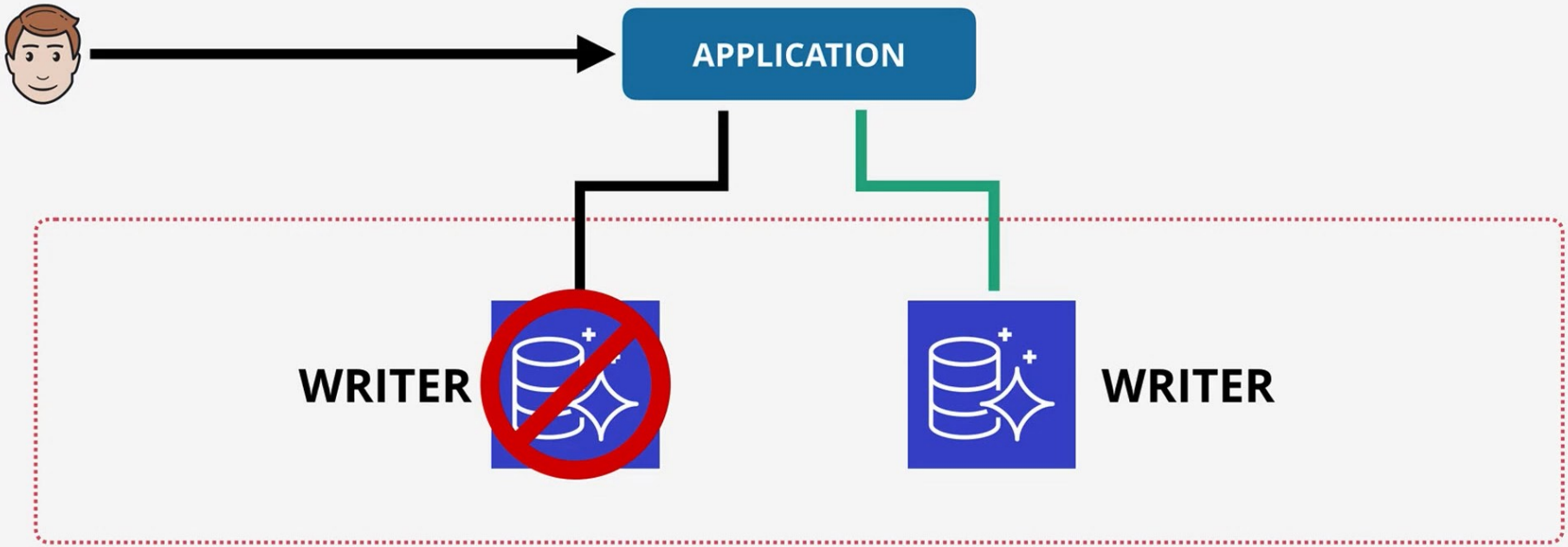

Aurora Single-Master

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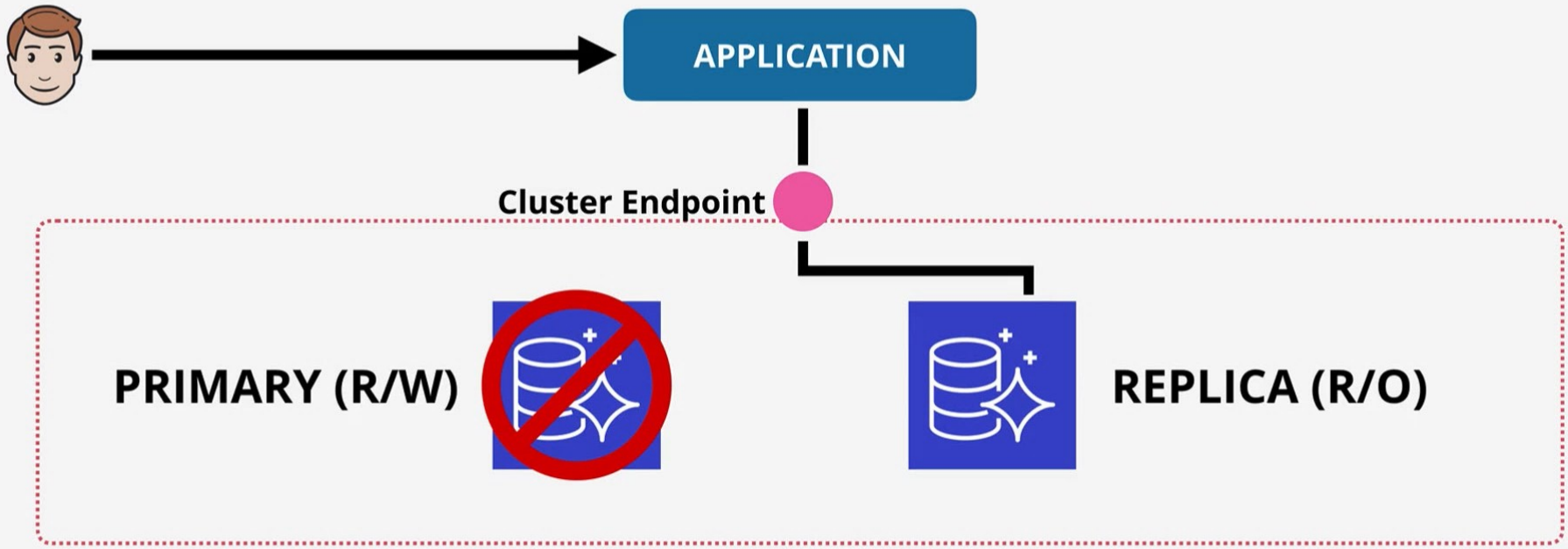
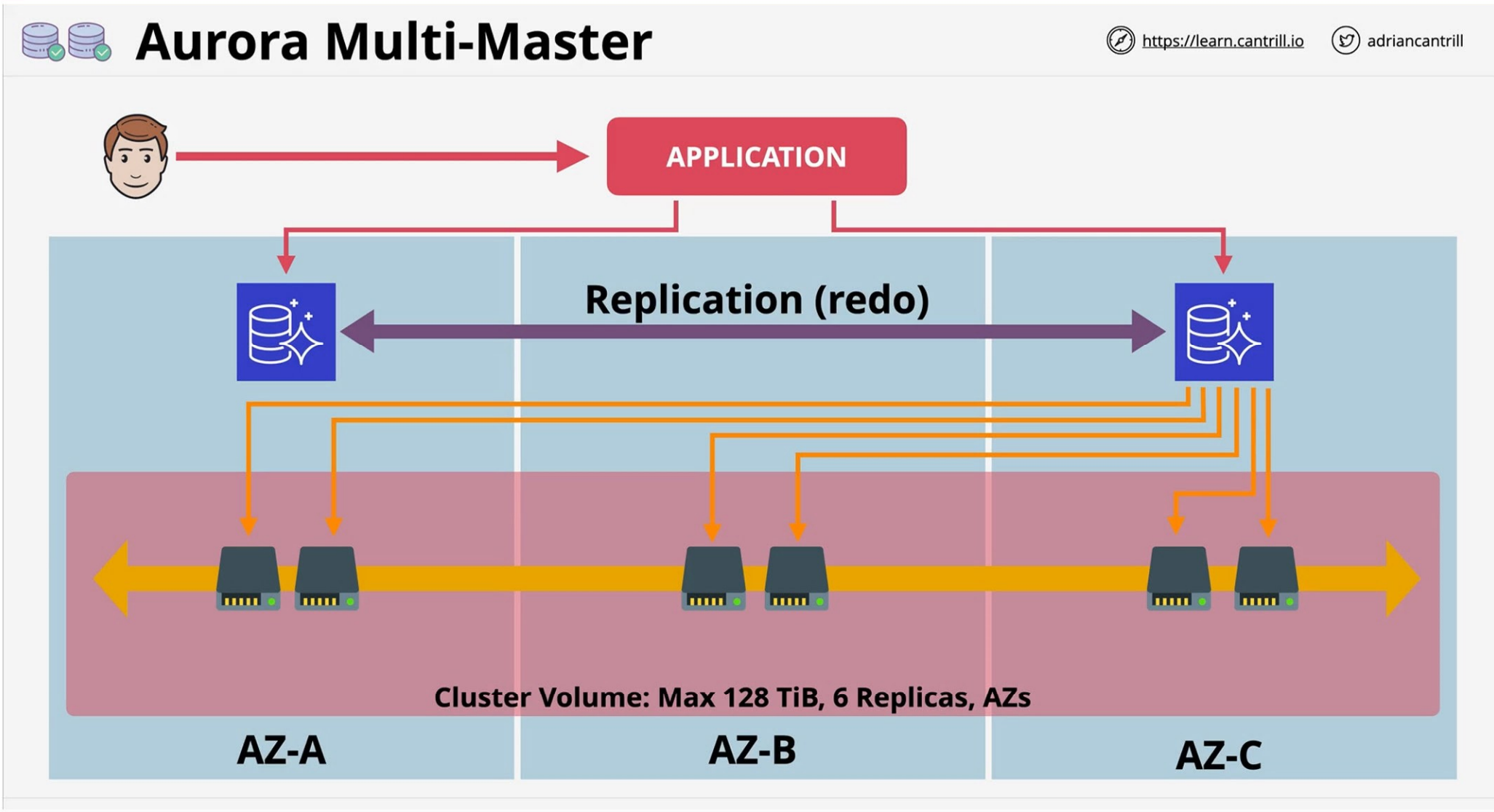


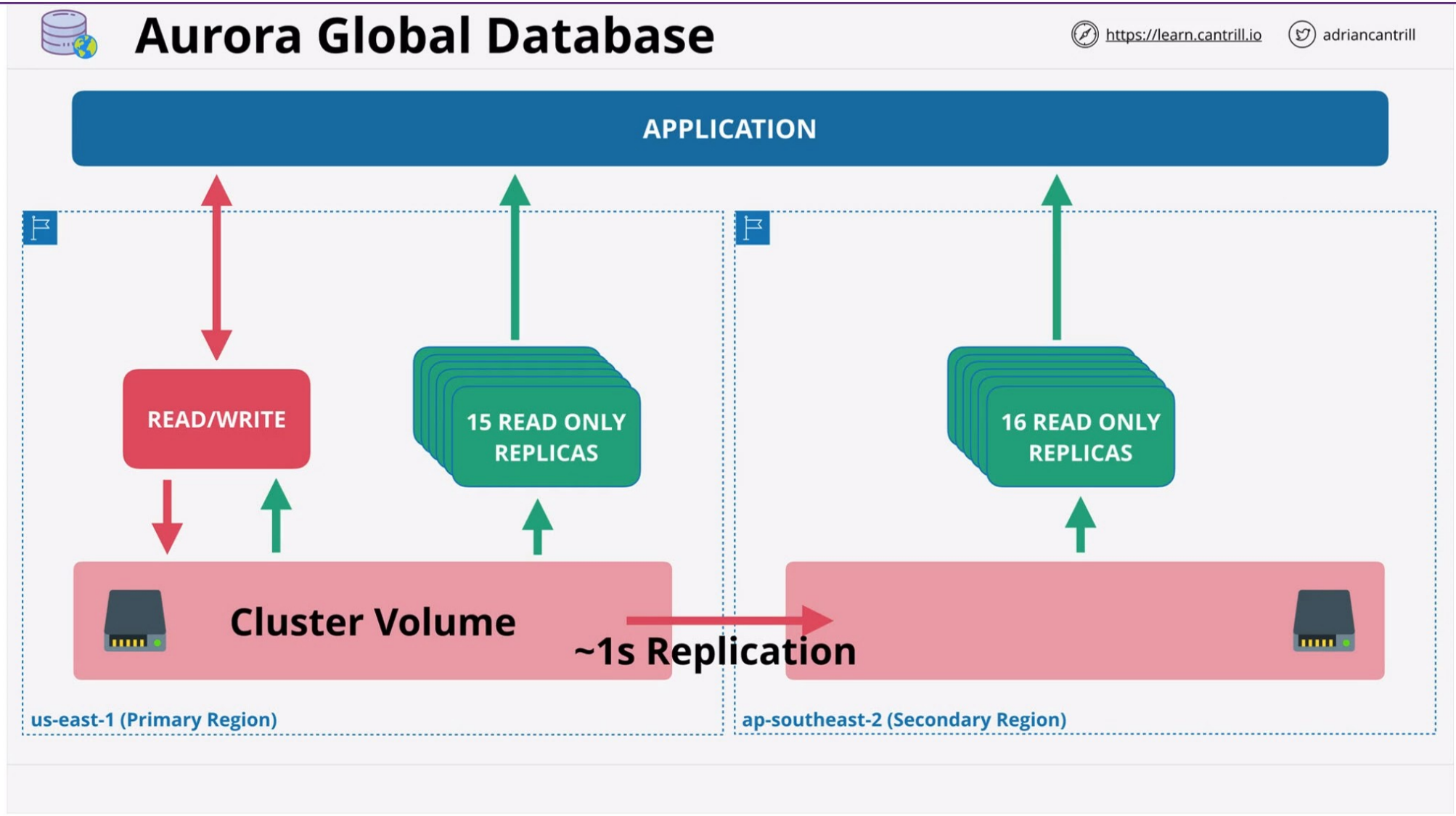

Aurora Multi-Master
https://learn.cantrill.io
adriancantrill
APPLICATION
Replication (redo)
Cluster Volume: Max 128 TiB, 6 Replicas, AZs
AZ-A
AZ-B
AZ-C

Aurora Multi-Master

- Default Aurora mode is **Single-Master**
- **One R/W** and **0+ Read Only** Replicas
- Cluster Endpoint is used to write, read endpoint is used for load balanced reads
- Failover takes time - replica promoted to R/W
- In Multi-Master mode **all instances are R/W**

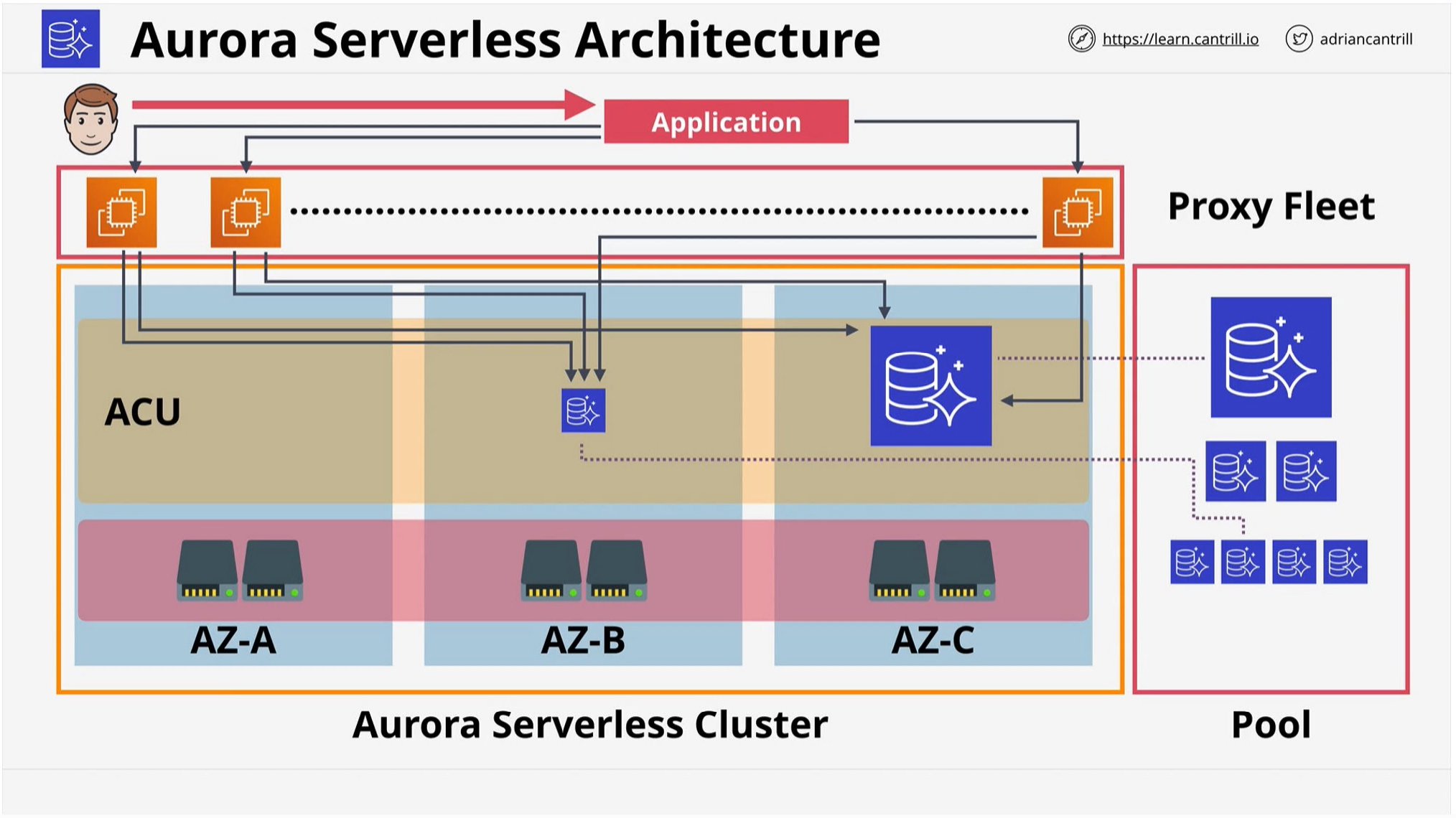
Aurora Global Database

- **Cross-Region DR and BC**
- **Global Read Scaling - low latency performance improvements**
- **~1s or less** replication between regions
- **No impact** on DB performance
- Secondary regions can have **16 replicas**
- .. Can be promoted to R/W
- Currently MAX 5 secondary regions...


Aurora Global Database
https://learn.cantrill.io
adriancantrill
APPLICATION
READ/WRITE
15 READ ONLY REPLICAS
16 READ ONLY REPLICAS
Cluster Volume
~1s Replication
us-east-1 (Primary Region)
ap-southeast-2 (Secondary Region)

Aurora Serverless - Use Cases

- **Infrequently** used applications
- **New** applications
- **Variable** workloads
- **Unpredictable** workloads
- **Development** and **test** databases
- **Multi-tenant** applications


Aurora Serverless Architecture
https://learn.cantrill.io
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Application
Proxy Fleet
ACU
AZ-A
AZ-B
AZ-C
Aurora Serverless Cluster
Pool

Aurora Serverless Concepts

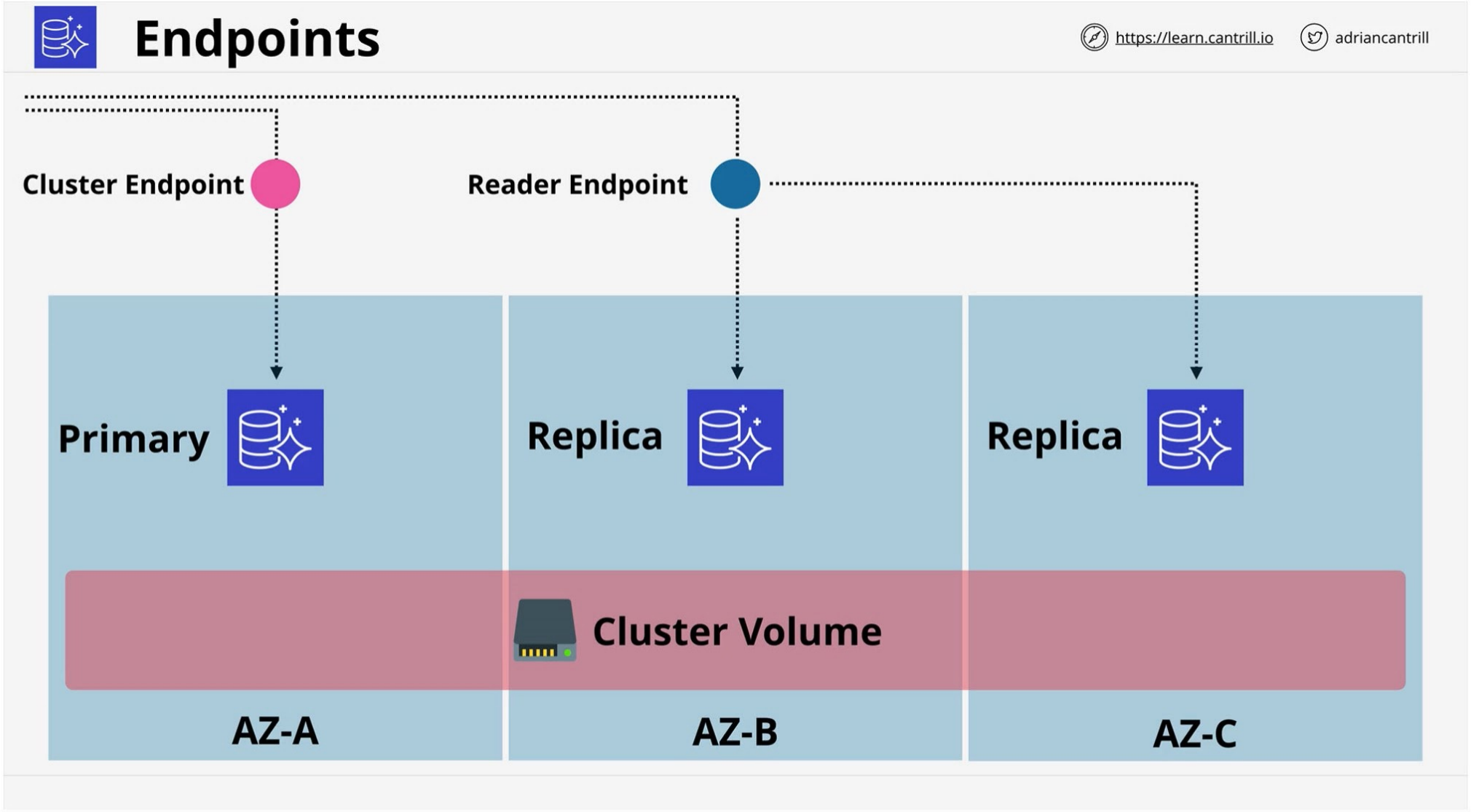
- Scalable - **ACU** - Aurora Capacity Units
- Aurora Serverless cluster has a **MIN & MAX ACU**
- Cluster adjusts based on load
- Can go to **0** and be **paused**
- Consumption billing per-second basis
- Same resilience as Aurora (6 copies across AZs)

Aurora Restore, Clone & Backtrack

- Backups in Aurora work in the same way as RDS
- Restores create a **new cluster**
- Backtrack can be used which allow **in-place rewinds** to a previous point in time
- Fast clones make a new database MUCH faster than copying all the data - **copy-on-write**

Cost

- **No free-tier option**
- Aurora doesn't support Micro Instances
- Beyond RDS singleAZ (micro) Aurora offers better value
- Compute - hourly charge, per second, 10 minute minimum
- Storage - GB-Month consumed, IO cost per request
- 100% DB Size in backups are included


Endpoints
https://learn.cantrill.io
adriancantrill
Cluster Endpoint
Reader Endpoint
Primary
Replica
Replica
Cluster Volume
AZ-A
AZ-B
AZ-C

Aurora Storage Architecture

- All SSD Based - **high IOPS**, **low latency**
- Storage is billed based on **what's used**
- **High water mark** - billed for the most used
- Storage which is freed up can be re-used
- Replicas can be added and removed without requiring storage provisioning.

Aurora Storage Architecture

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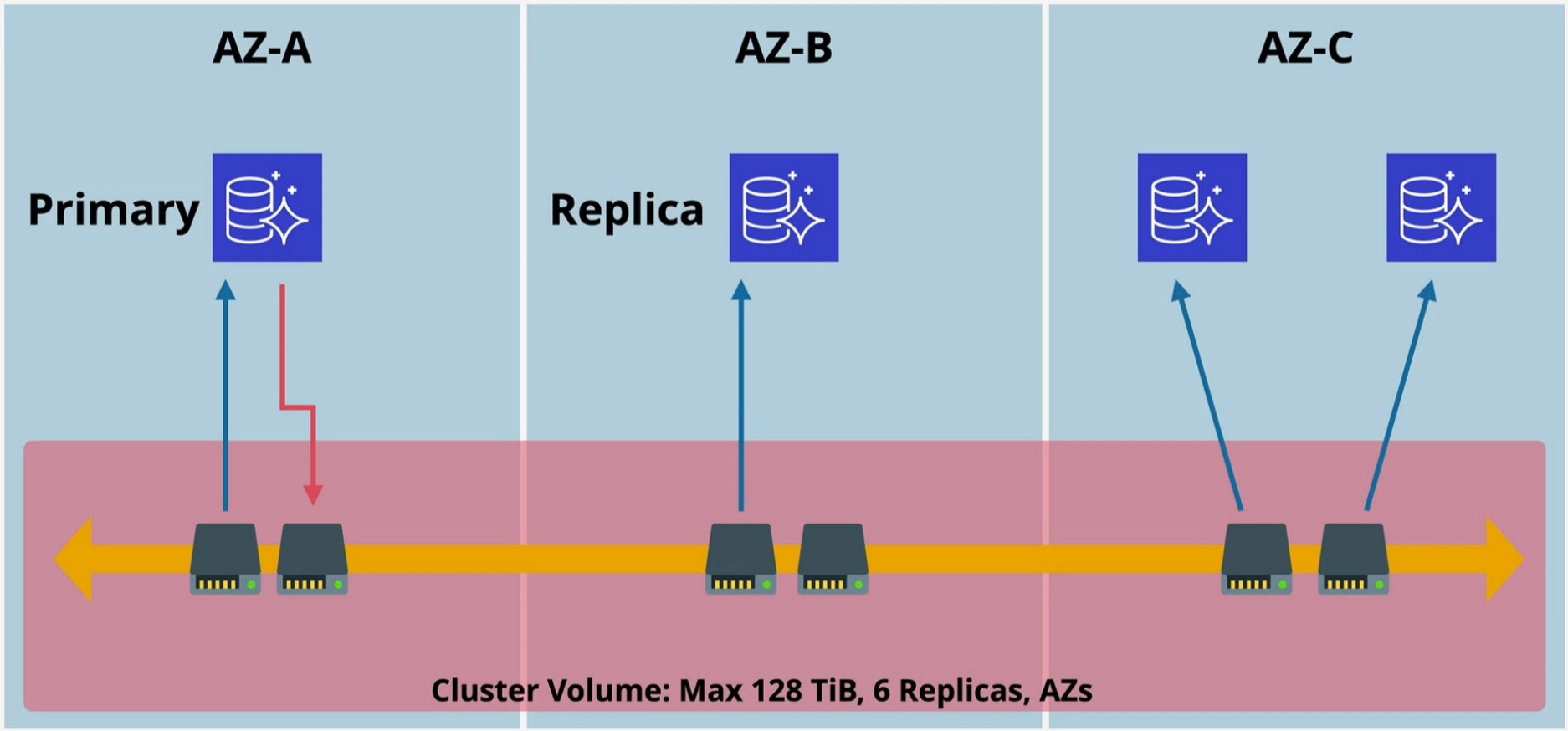

Aurora Key Differences

- Aurora architecture is **VERY** different from RDS...
- ...Uses a "**Cluster**"
- A single **primary** instance + **0** or more **replicas**
- No local storage - uses **cluster volume**
- Faster provisioning & improved availability & performance

Amazon RDS IAM Authentication

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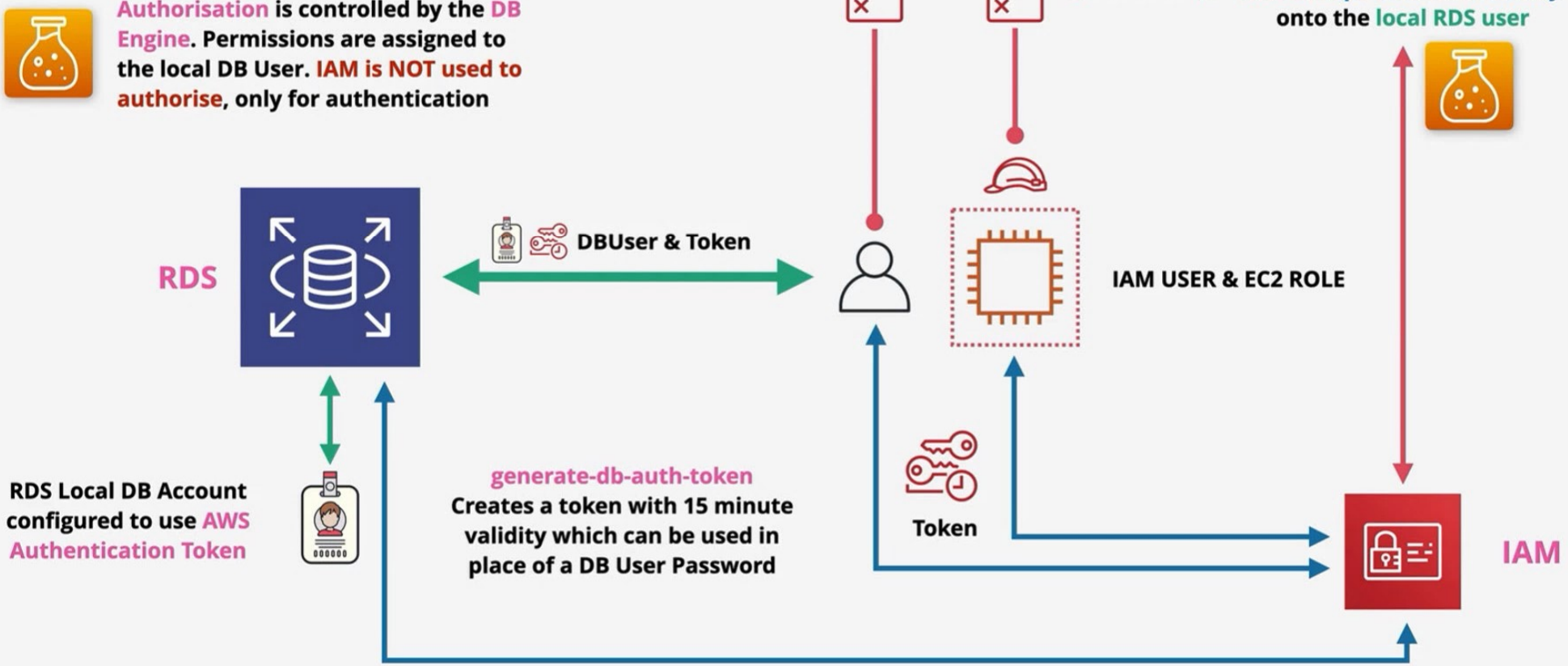

Amazon RDS KMS Encryption & TDE

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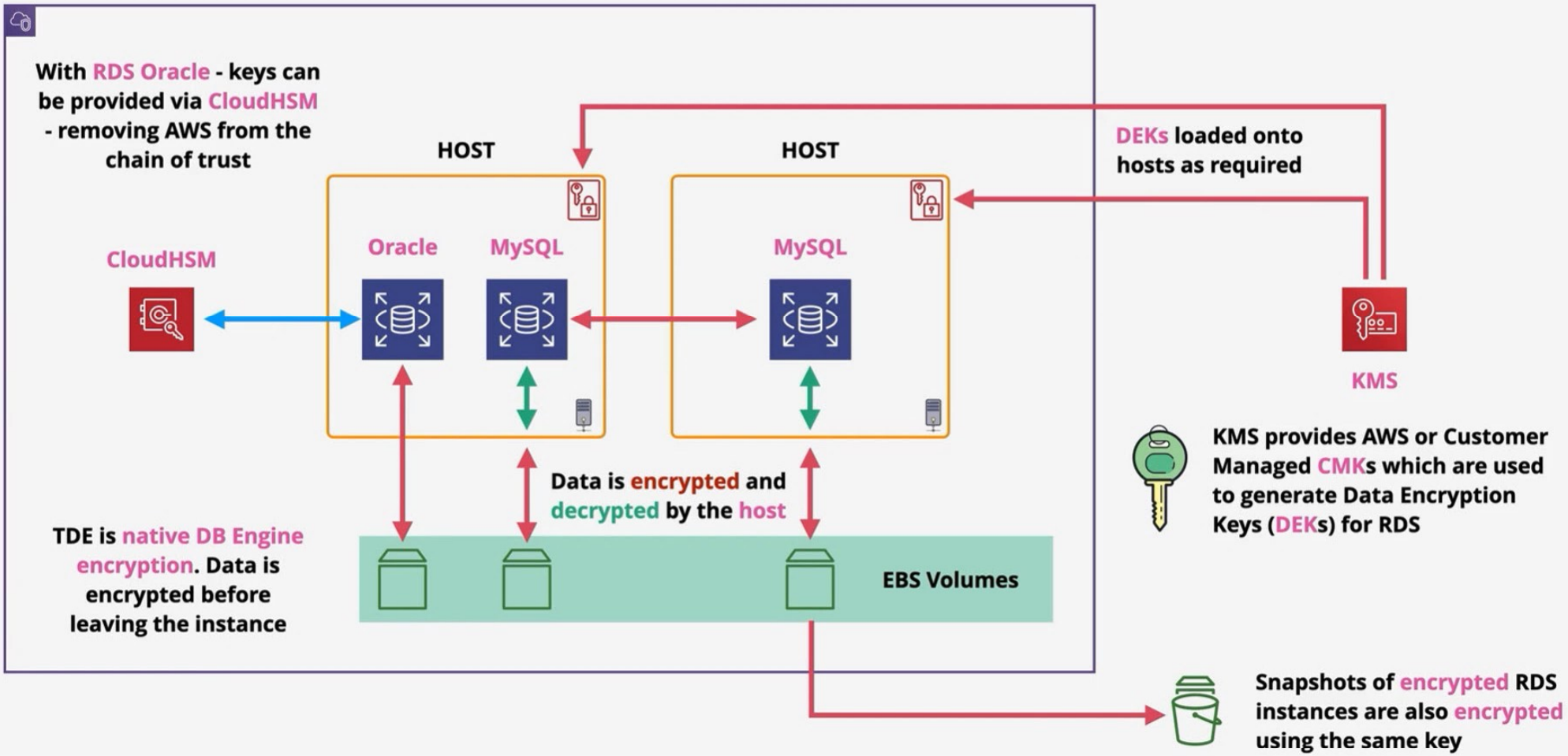

Amazon RDS Security

- RDS **MSSQL** and RDS **Oracle** Support **TDE**

- .. **Transparent Data Encryption**
- Encryption handled **within the DB engine**
- RDS **Oracle** supports integration with **CloudHSM**

- Much stronger key controls (even from AWS)

Amazon RDS Security

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- SSL/TLS (in transit) is available for RDS, can be mandatory
- RDS supports EBS volume encryption - KMS
- Handled by HOST/EBS
- AWS or Customer Managed CMK generates data keys.
- Data keys used for encryption operations
- Storage, Logs, Snapshots & replicas are encrypted
- .....encryption can't be removed

RPO/RTO Improvements

- Snapshots & Backups Improve **RPO**
- **RTO's are a problem**
- RR's offer **nr. 0 RPO**
- RR's can be **promoted quickly** - **low RTO**
- **Failure only** - watch for data corruption
- **Read only - until promoted**
- **Global availability improvements ... global resilience**

(read) Performance Improvements

- **5x** direct read-replicas per DB instance
- Each providing an **additional instance of read performance**
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RDS - Read Replicas

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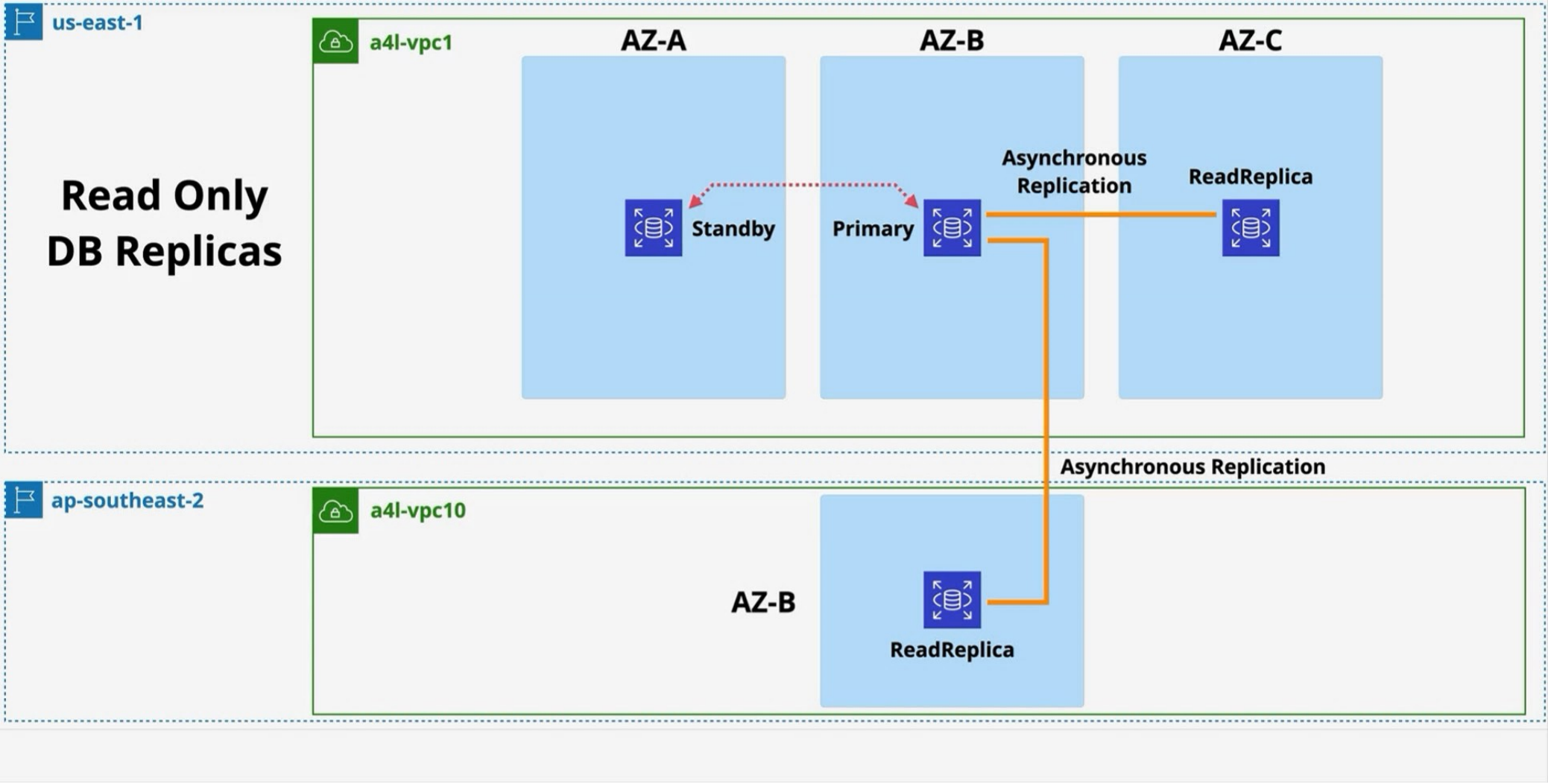

RDS - Restores

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- Snapshots = **single point in time**, creation time
- Automated = **any 5 minute point in time**
- Backup is restored and transaction logs are 'replayed' to bring DB to desired point in time (**GOOD RPO**)
- Restores **aren't fast** - Think about **RTO** (***RR's**)

RDS - Backups - Cross-Region

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Back to tab

RDS - Backups - General

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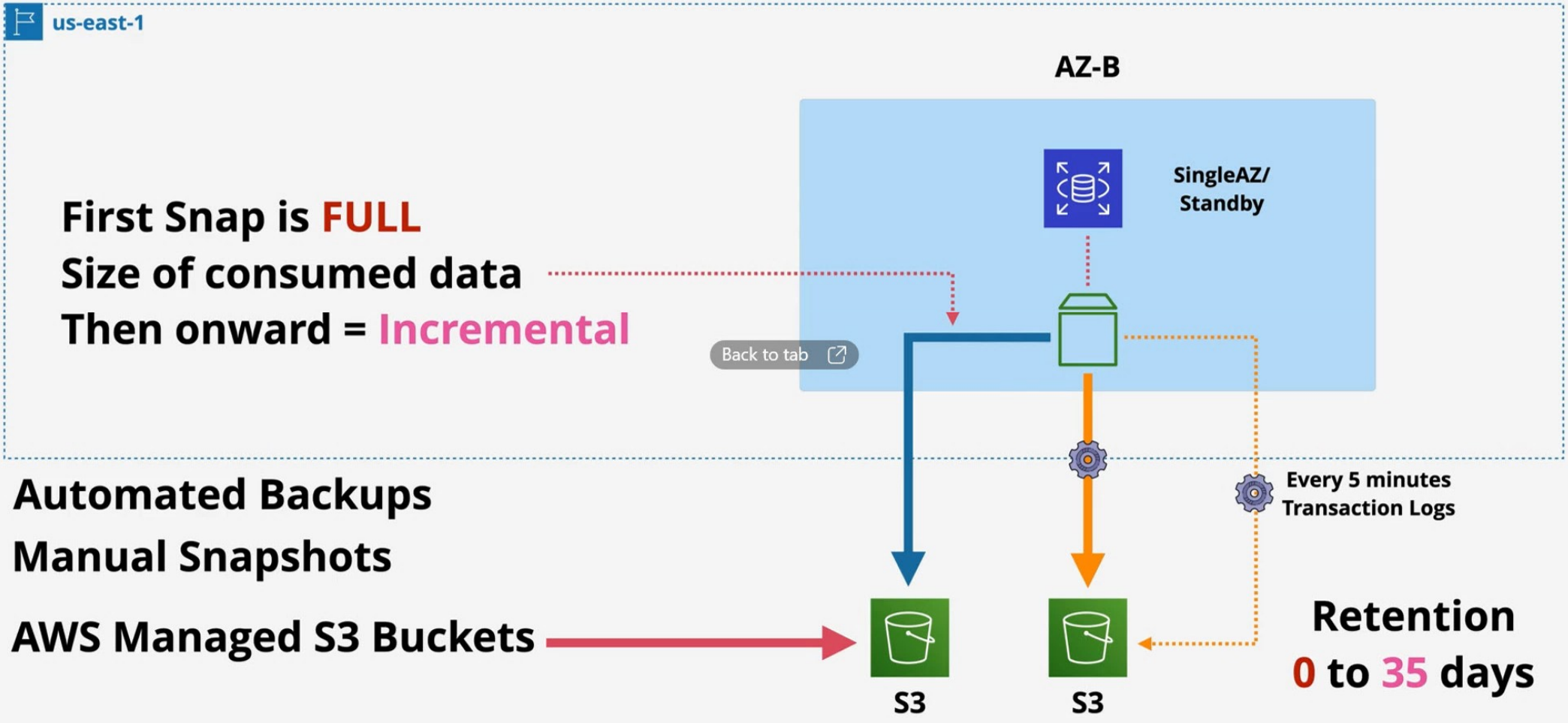

RDS - Backups - General

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Automated Backups

Snapshots

AWS Managed S3 Buckets

Why might you do it...

- Access to the DB Instance **OS**
- **Advanced DB Option tuning** ... (DBROOT)
- ... Vendor demands..
- **DB or DB Version AWS don't provide..**
- Specific **OS/DB Combination** AWS don't provide
- Architecture AWS don't provide (replication/resilience)
- Decision makers who '**just want it**'

Why you shouldn't really..

- **Admin overhead** - managing EC2 and DBHost
- **Backup** / DR Management
- EC2 is **single AZ**
- **Features** - some of AWS DB products are amazing
- EC2 is **ON** or **OFF** - no serverless, no easy scaling
- **Replication** - skills, setup time, monitoring & effectiveness
- **Performance**....AWS invest time into optimisation & features

and implement it on EC2,