AWS re:Invent

DECEMBER 2 – 6, 2024 | LAS VEGAS, NV

DAT426-NEW

Improve resiliency using Amazon MemoryDB Multi-Region

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Customers need multi-Region applications

- 34 regions
- 108 availability zones (AZ)
- Every AWS Region is built for high resilience
- Each AZ is physically separated from other AZs

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Why build multi-Region applications ?

Increase resilience

- Business continuity
- Regulation/compliance

Global applications

- Low regional local latencies

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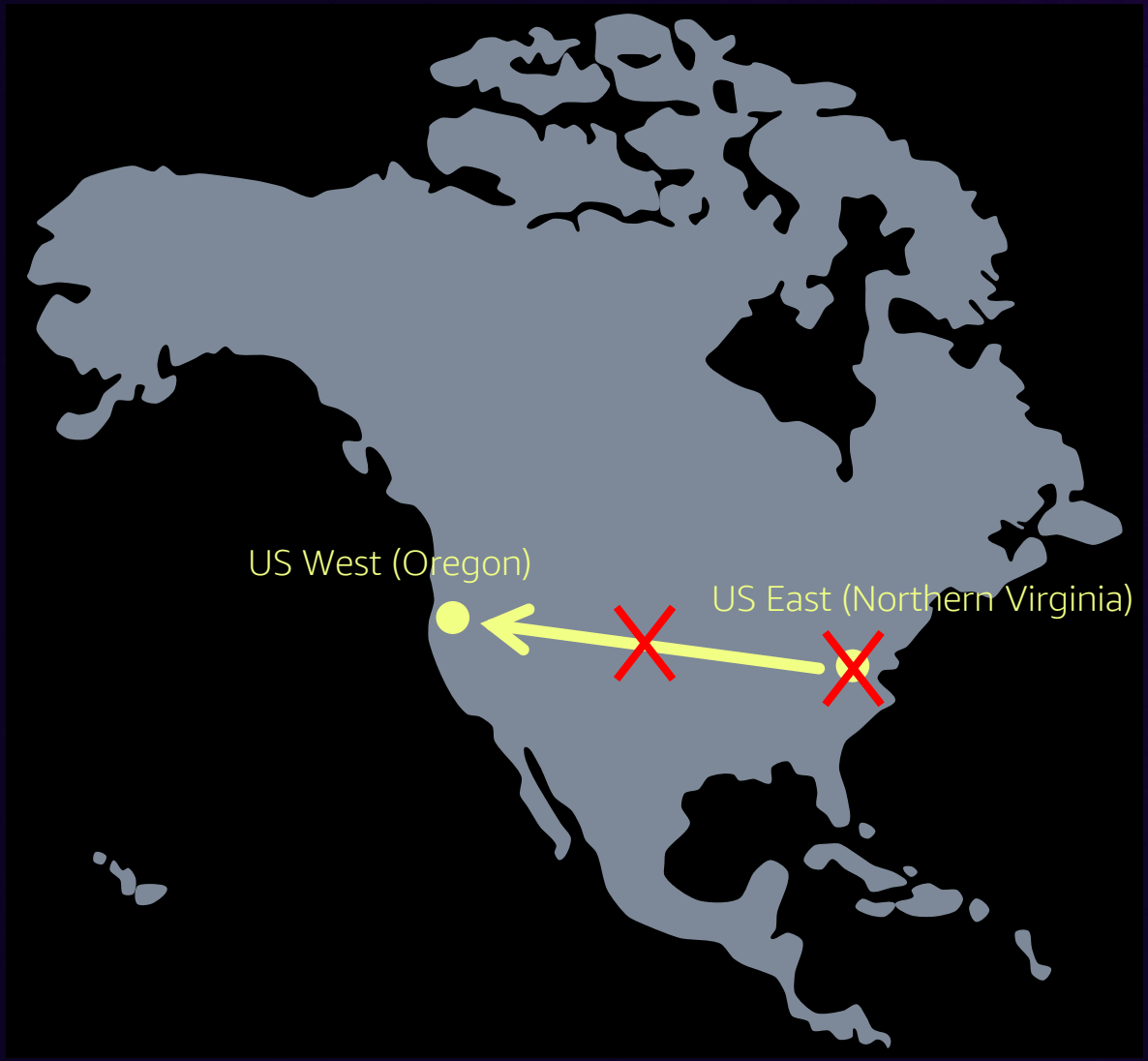
Why build multi-Region applications ?



Increase resilience

- Business continuity
- Regulation/compliance

Critical applications:

- Financial industry
- Health care
- Large enterprises

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Why build multi-Region applications ?

Global applications

- Low regional local latencies
- Global applications like gaming leaderboards
- Global user data like profiles, history, and preferences

Bad customer experience

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Why do you need a multi-Region data layer?

Increase resilience

- Business continuity
- Regulation / compliance

Global applications

- Low regional local latencies

Disaster recovery

- Region failover
- Most applications cannot function without their data
- Even a “standby Region” needs the application’s data

Global data; Local latency

- High latency to fetch data ➔ High application latency
- Local AZ latency: typically < 0.3ms
- Cross-AZ latency: typically < 1ms
- Cross-Region latency: typically < 1s

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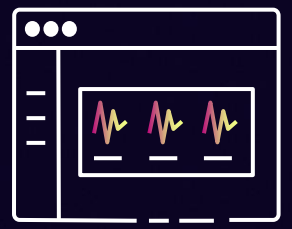
How to build a multi-Region data layer?



Build your own custom solution

Too hard!

Use a multi-Region database

Which one?

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Key considerations for a multi-Region database

Consistency & Durability:

What is your Recovery Point Objective (RPO)?
RPO is the maximum data loss you can tolerate if a Region is unavailable

Synchronous or **asynchronous** cross-Region replication?

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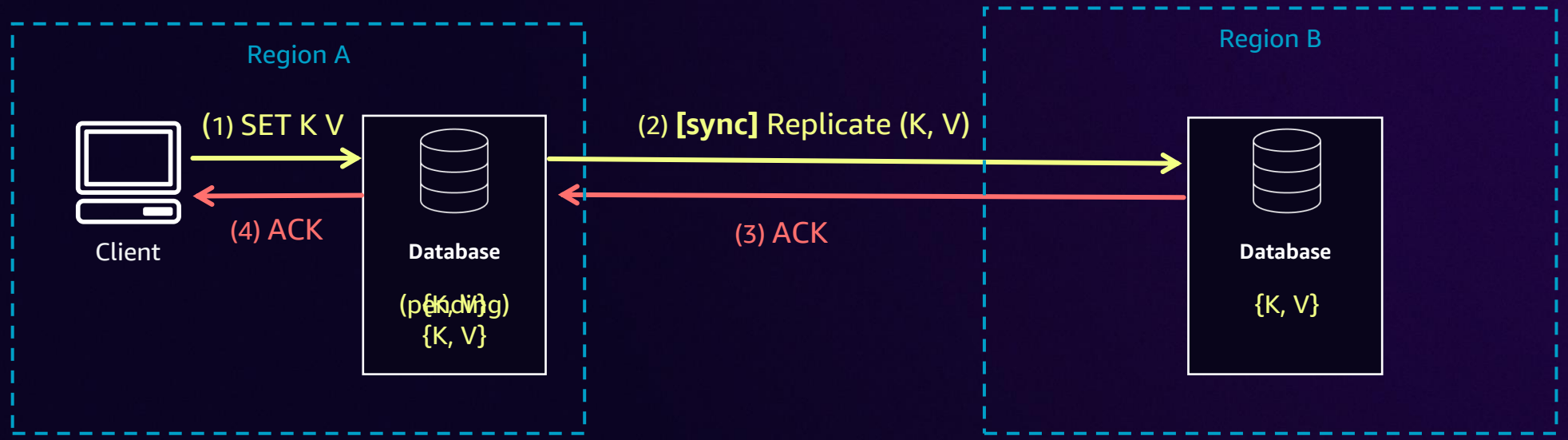
Key considerations for a multi-Region database

Synchronous Cross-Region Replication



The client receives an ACK only after the data is durable in **both** Regions

Strong consistency

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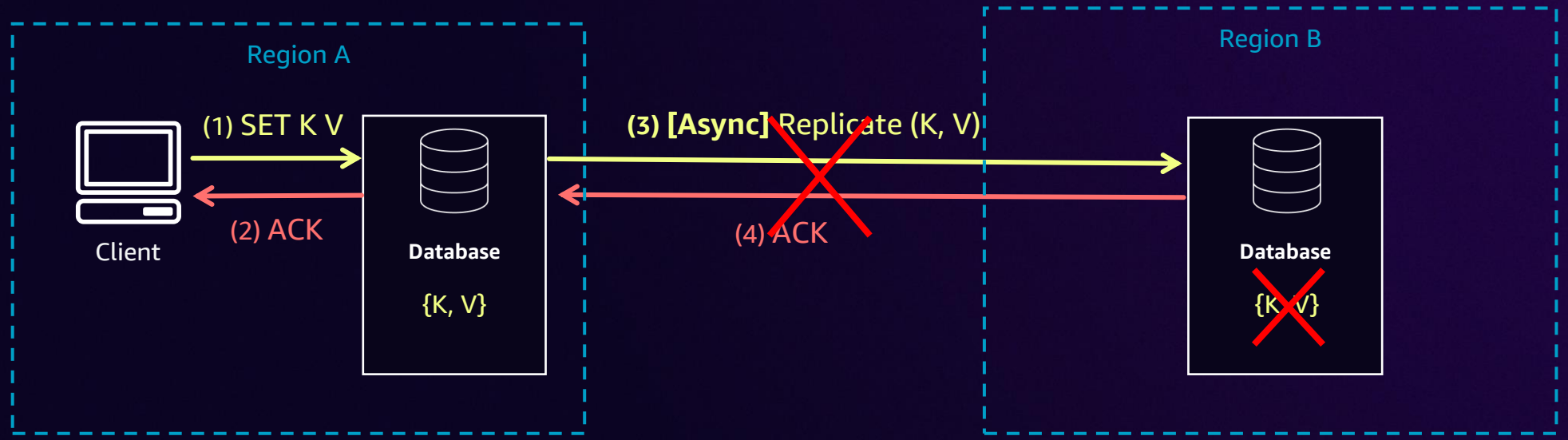
Key considerations for a multi-Region database

Asynchronous Cross-Region Replication



The client receives an ACK after the data is durable in **one** Region

Replication failure ➔ database will retry

Eventual consistency

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Key considerations for a multi-Region database

Synchronous Replication

+ RPO =~ 0 is possible, the client gets an ack only after the data is in ALL Regions

- High write latency, up to **hundreds** of milliseconds

Strong consistency

Asynchronous Replication

- RPO > 0, the client gets an ack after the data is durable in only ONE Region

+ Low write latency, a **few** milliseconds

Usually the replication lag is small (seconds) ➔ **RPO** can be seconds

Eventual consistency

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Key considerations for a multi-Region database

High Availability?

What is your Recovery Time Objective (RTO)?
RTO is the maximum time to restore operations following a Region failure

Active/active or **active/passive** cross-Region replication?

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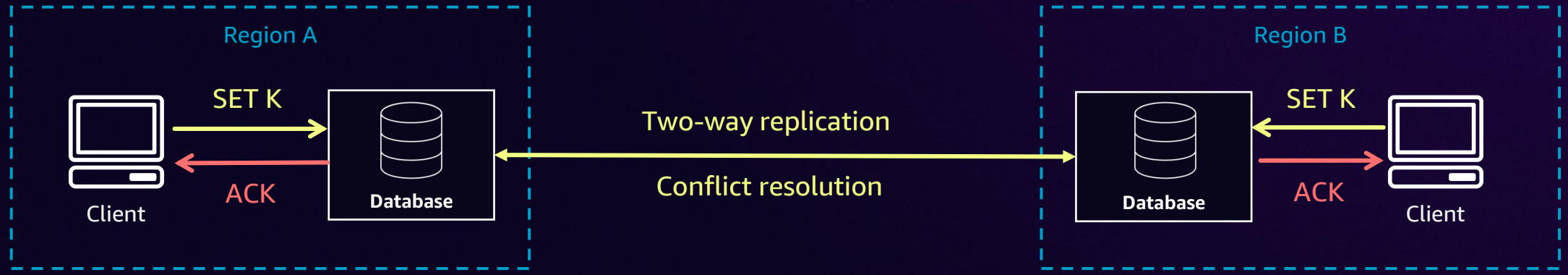
Key considerations for a multi-Region database

Active/Passive Cross-Region Replication, Single-Writer

Active/Active Cross-Region Replication, Multi-Writer



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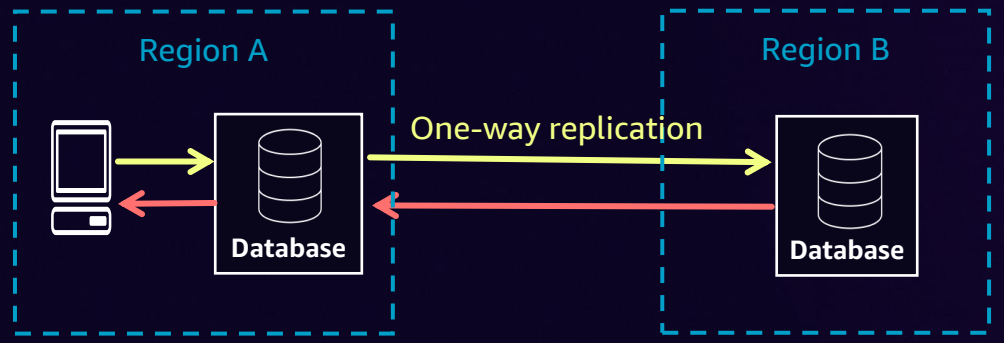
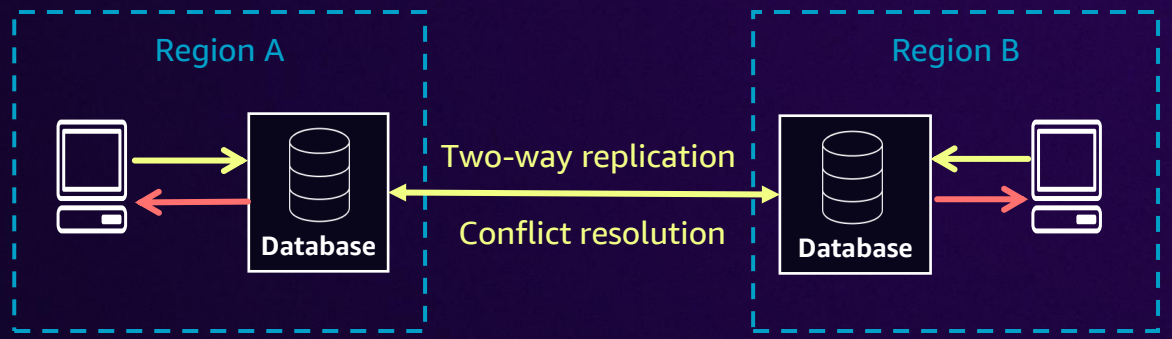
Key considerations for a multi-Region database

Active/Passive Replication, Single-Writer



Active/Active Replication, Multi-writer



Simpler:

+ Easier to build, fewer constraints and limitations
+ No write conflicts

- Harder to build, more constraints and limitations
- Potential write conflicts

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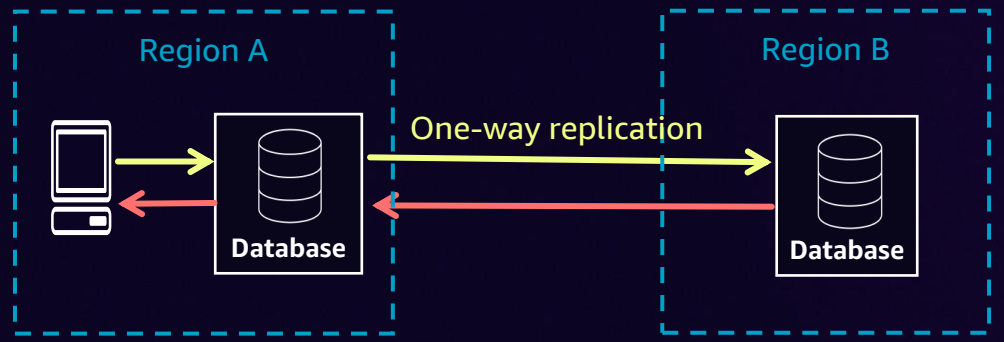
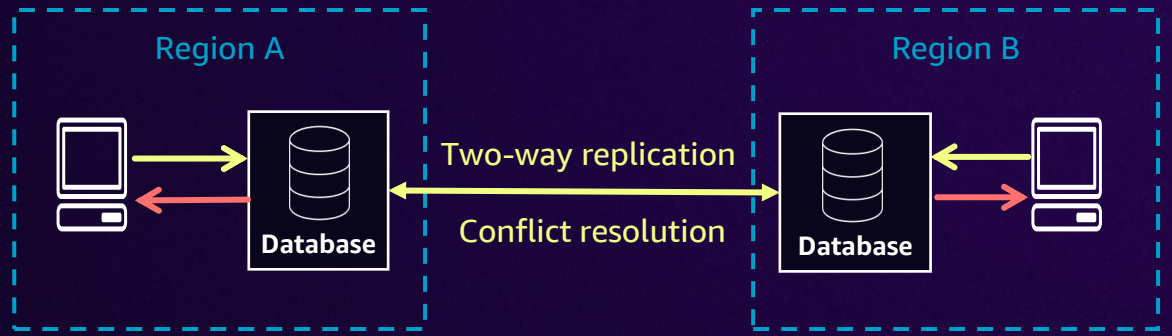
Key considerations for a multi-Region database

Active/Passive Replication, Single-Writer



Active/Active Replication, Multi-writer



Simpler:

+ Easier to build, fewer constraints and limitations

+ No write conflicts

- Harder to build, more constraints and limitations

- Potential write conflicts

- Complex to manage outages – requires application side failure detection, complex failover, and disaster recovery

- RTO > 0, minutes or even hours

Better Availability:

+ Easy to manage Region failure – no need application side database failover

+ RTO =~ 0 is possible

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Key considerations for a multi-Region database

- Number of regions supported in a single database
  - For disaster recovery, two Regions are sufficient for many use cases
  - Global applications with global data usually require the data in all the application's Regions

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Other considerations for a multi-Region database

Enterprise security, compliance

The data layer API and simplicity of the solution

Scalability

Performance

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Most complete set of purpose-built databases

RELATIONAL

Amazon RDS

Amazon Aurora

KEY-VALUE

Amazon DynamoDB

DOCUMENT

Amazon DocumentDB

CACHING

Amazon ElastiCache

GRAPH

Amazon Neptune

TIME-SERIES

Amazon Timestream

LEDGER

Amazon QLDB

WIDE COLUMN

Amazon Keyspaces

MEMORY

Amazon MemoryDB

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Overview of Amazon MemoryDB

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Amazon MemoryDB

VALKEY- AND REDIS OSS- COMPATIBLE, IN-MEMORY DATABASE WITH MULTI-AZ DURABILITY

Valkey & Redis OSS compatibility

Intuitive open source APIs and flexible data structures

Ultra-fast performance

Microsecond read and single-digit millisecond write latencies with millions of RPS

Durability and high availability

Multi-AZ transaction log for durability, replicas for high availability with 99.99% SLA

Fully managed

AWS-managed hardware and software setup, configuration, monitoring, and snapshots

High scalability

Up to 500 nodes and 105 TB of in-memory storage per cluster, with 1 replica per shard

Security

Amazon VPC, encryption at rest and in transit, Access Control Lists (ACLs), IAM auth

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Valkey: A community replacement for Redis

Open source, high-performance, key-value data store

Open source

- Built by **existing** Redis OSS contributors
- **Drop-in** replacement for Redis OSS 7.2
- Stewarded by **Linux Foundation**
- **Permissively** licensed (BSD)

Momentum

- **40+** organizations
- **150+** code contributors
- **1000s** of contributions
- **1M+** container pulls

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Valkey: GA on ElastiCache and MemoryDB

Lower prices for Valkey engine

ElastiCache

- 33% lower data storage and ECPUs for serverless
- 20% lower instance price for node-based

MemoryDB

- 80% lower price for data written, with a new 10 TB/month free tier
- 30% lower instance price for node-based

Zero downtime upgrade from Redis OSS with a few clicks

Switch easily from Redis OSS reserved nodes to Valkey

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Amazon MemoryDB

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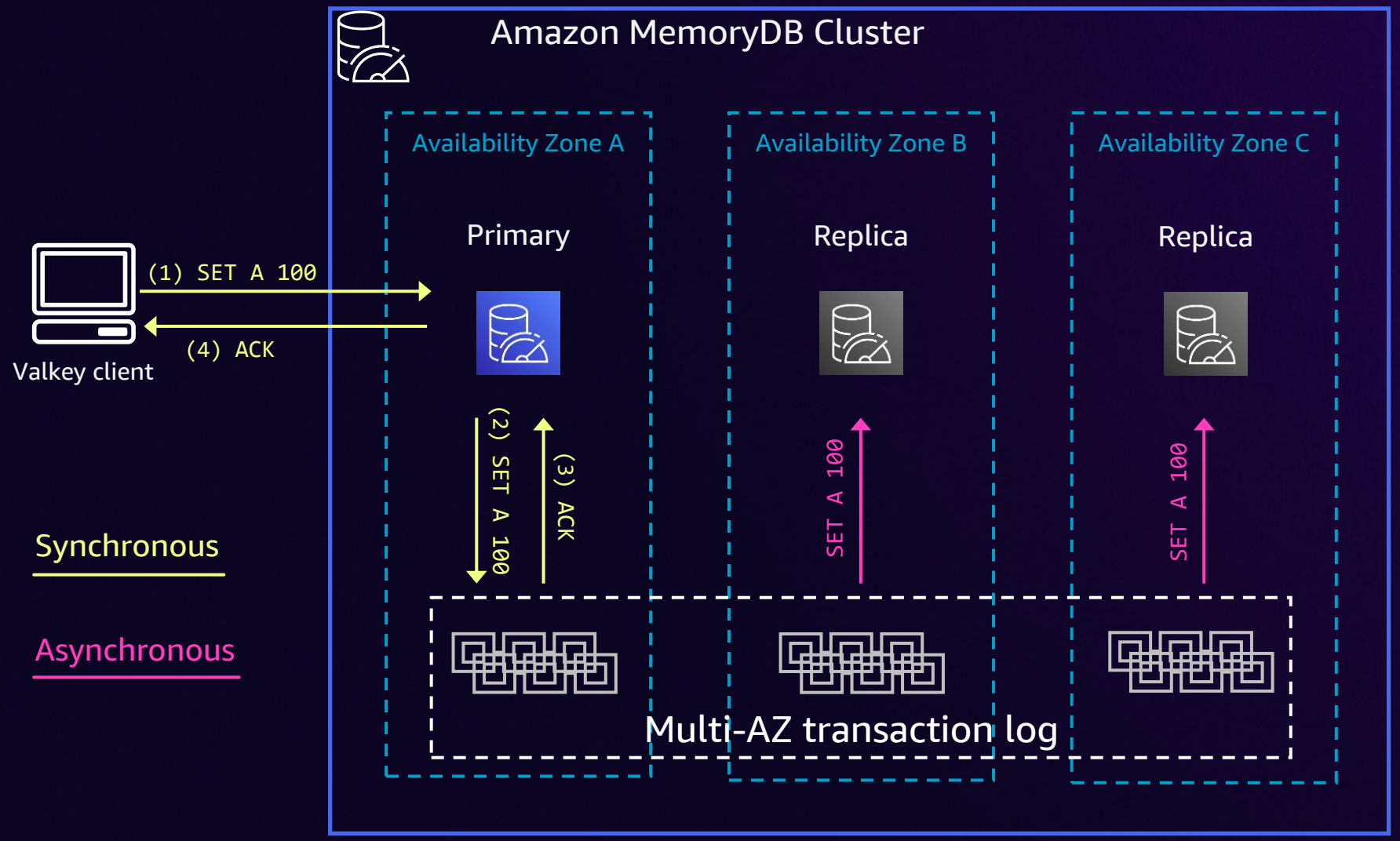
MemoryDB durability



Data is replicated via the transaction log

Acknowledgement sent to client only after transaction is written and replicated across AZs

Data is consumed by replica nodes

Guaranteed delivery of writes to replicas

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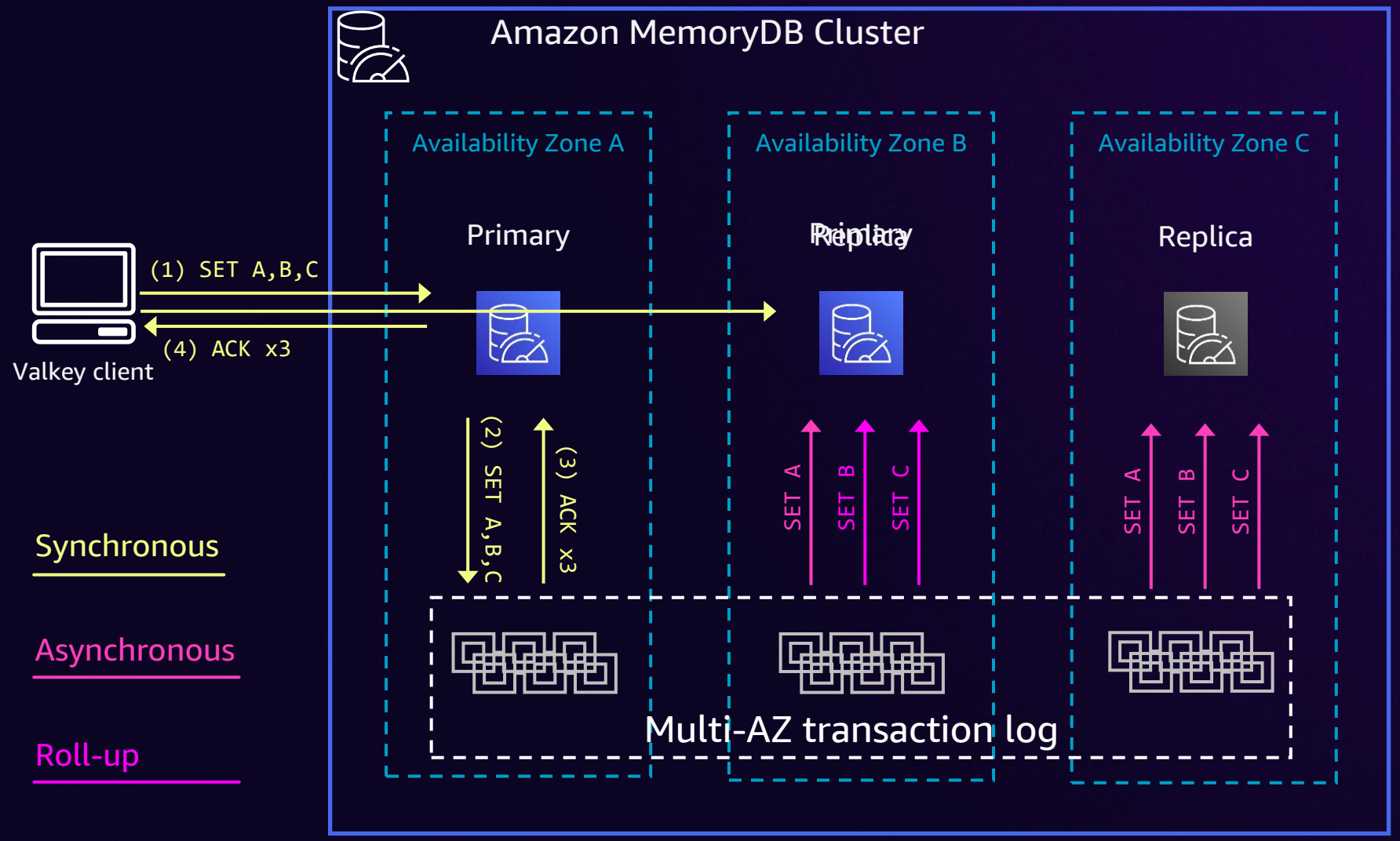
MemoryDB durability – Failover



Replica reads all transactions from the log, then is promoted to primary

Client is now redirected to newly promoted primary for all writes

Replicas continue to consume from log asynchronously

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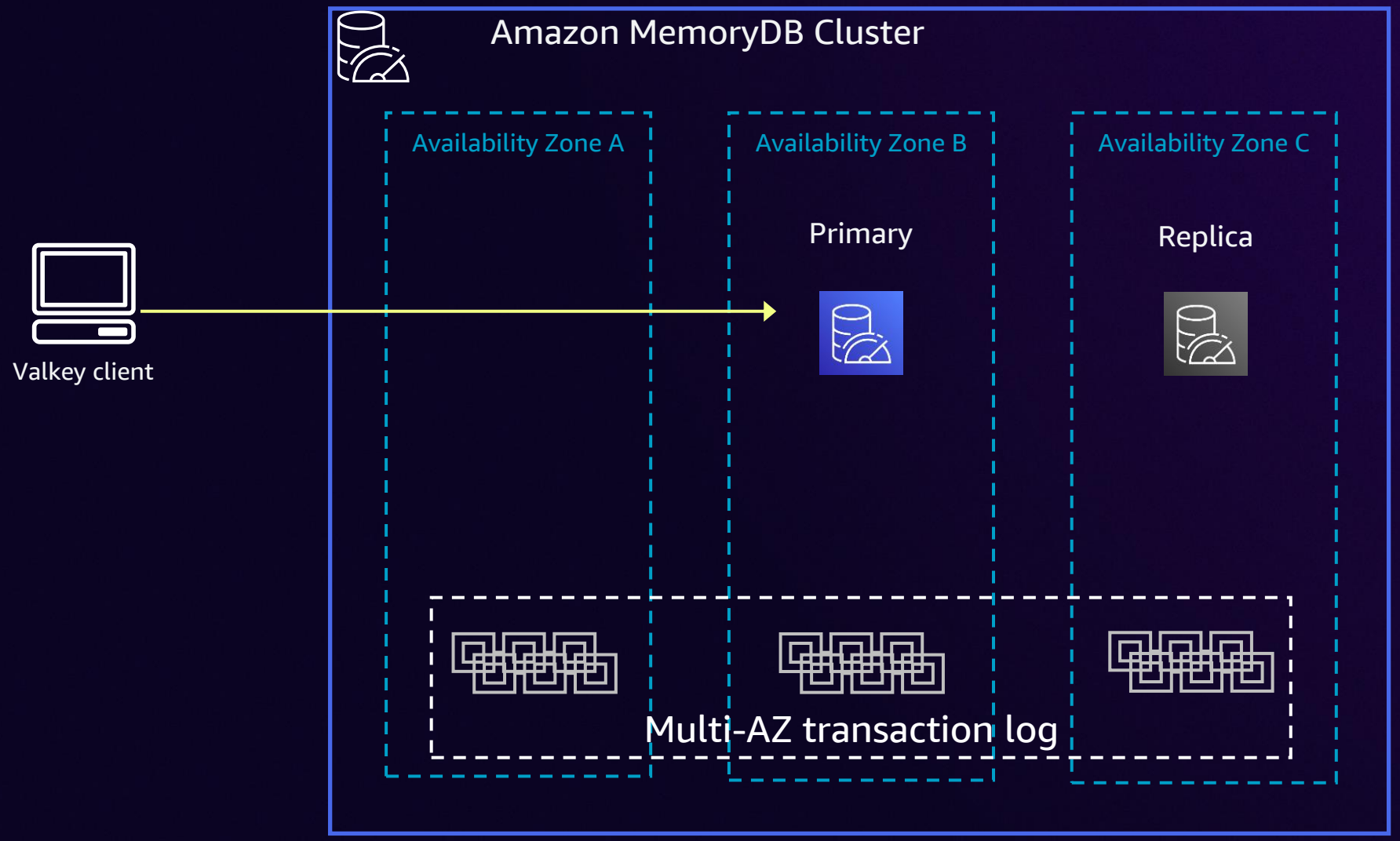
MemoryDB durability – Failover



Fast failover without losing data

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Common use cases

Microservices

Performant datastore, messaging bus

Web and mobile

User data stores, session management, geospatial indexing, chat and message queues

Retail

Customer profiles, inventory tracking, fulfillment

Gaming

Player data stores, session history, leaderboards

Customer 360

Profiles, history, preferences, contacts, likes/dislikes, risk category

Banking and finance

User transactions, fraud detection

Media and entertainment

User data stores, real-time streaming

IoT

Streaming device data, operational insights

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🚀 Amazon MemoryDB Multi-Region

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MemoryDB Multi-Region Active-Active

Design for 11 9s Durability

µsec reads
< 10ms *writes*

Multi-Region Active/Active Asynchronous replication

SLA

99.999% SLA

Encryption in-transit and at-rest

Scale horizontally and vertically

Open source rich API: Valkey / Redis OSS compatibility

Compliance

Automatic backups

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Multi-Region architecture

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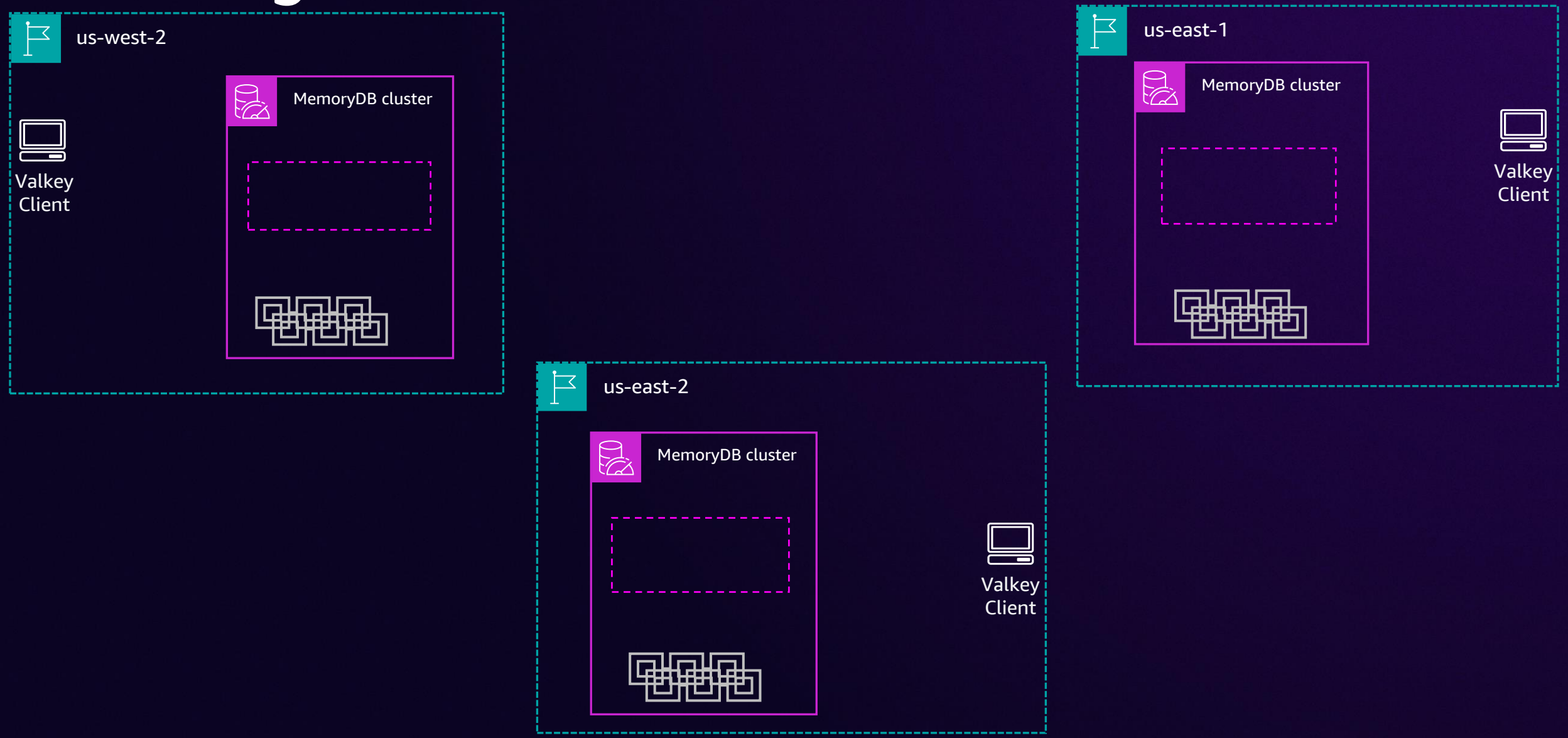
Multi-Region architecture



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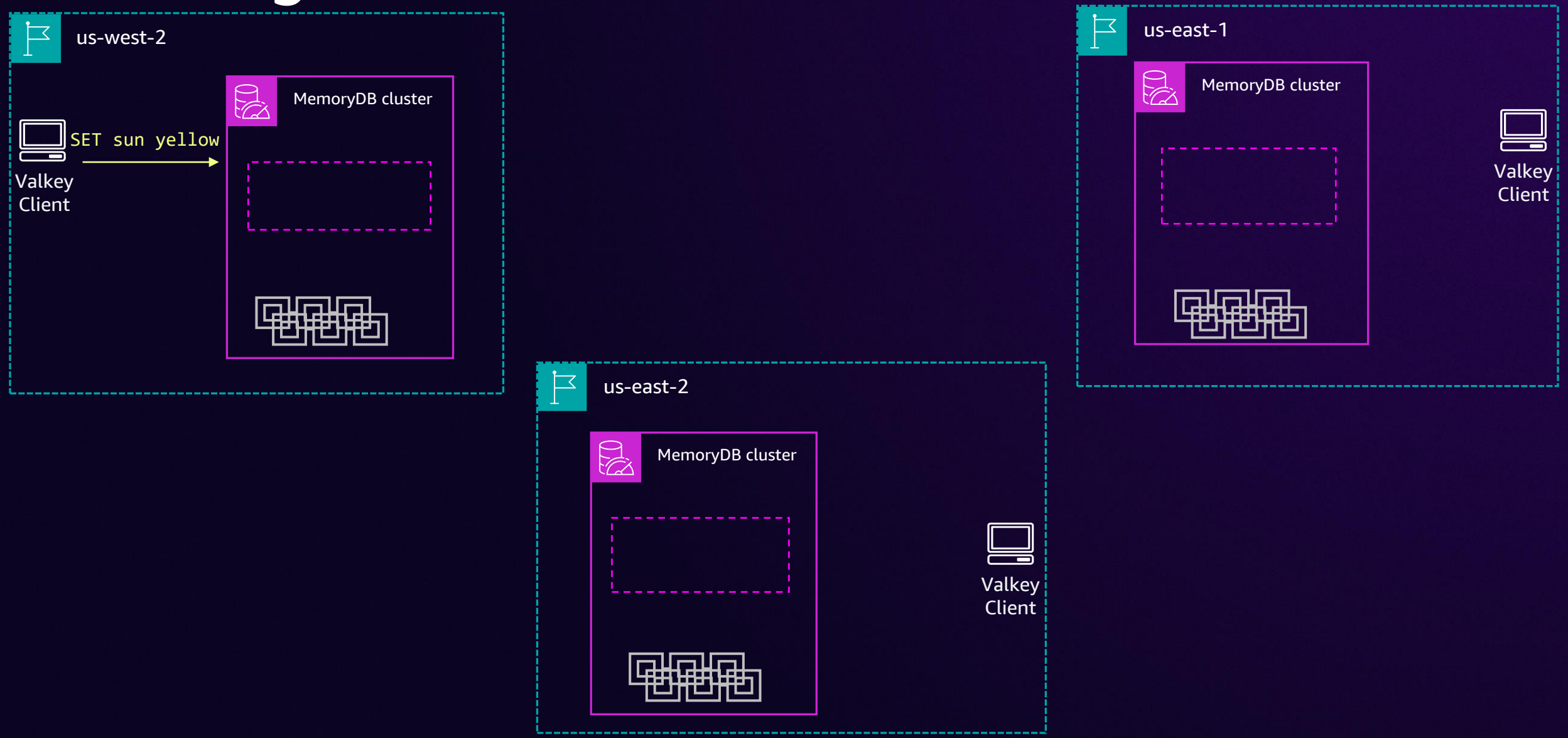

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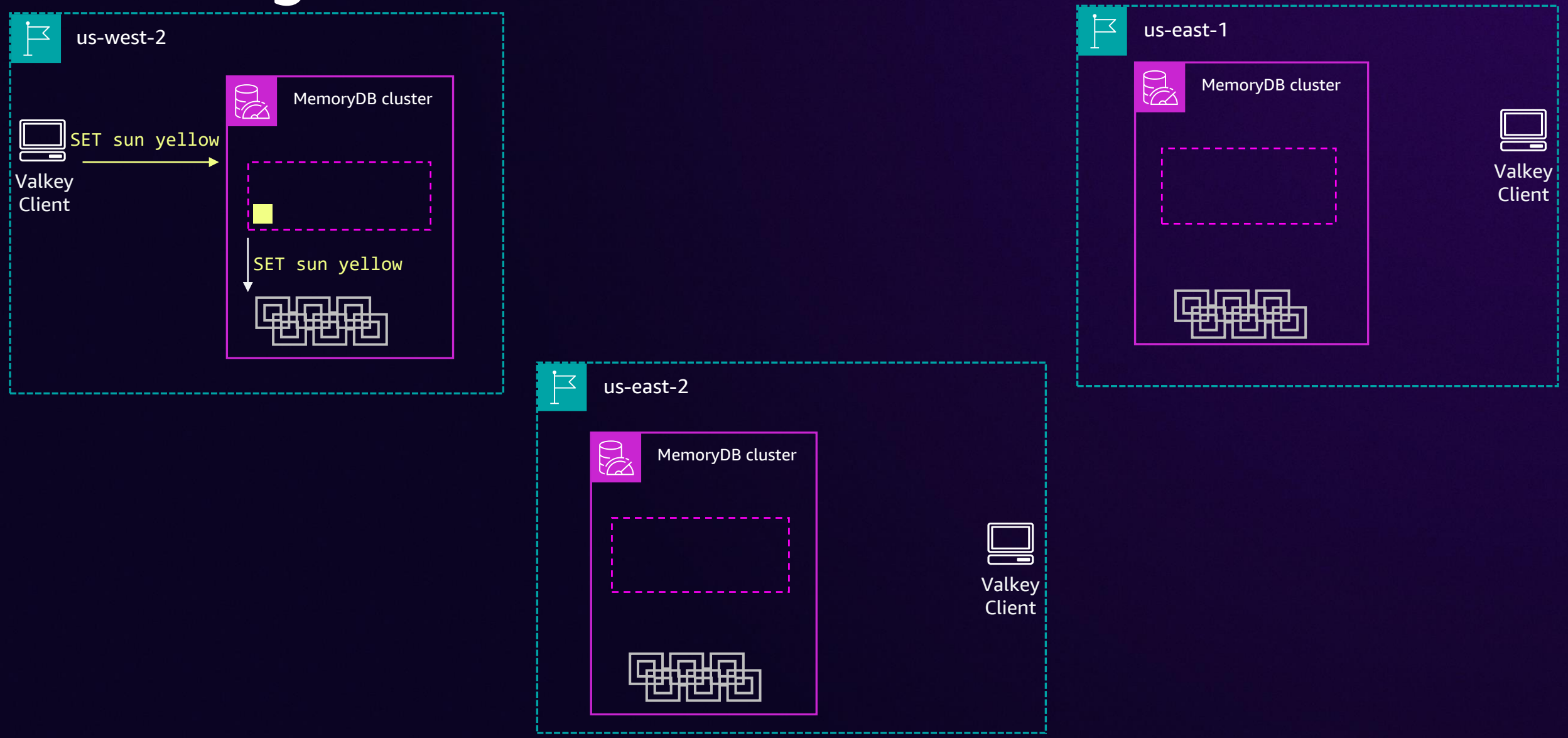

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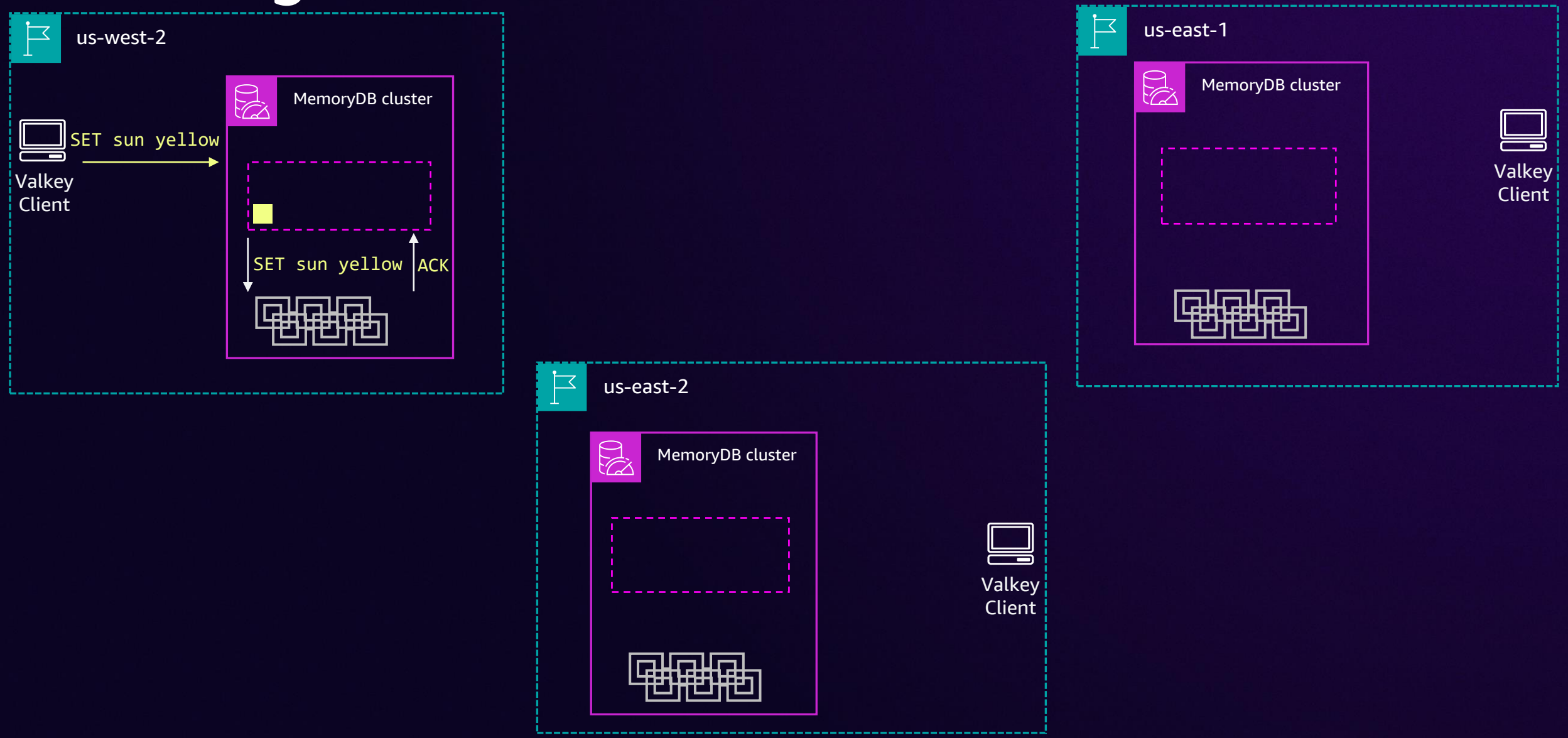

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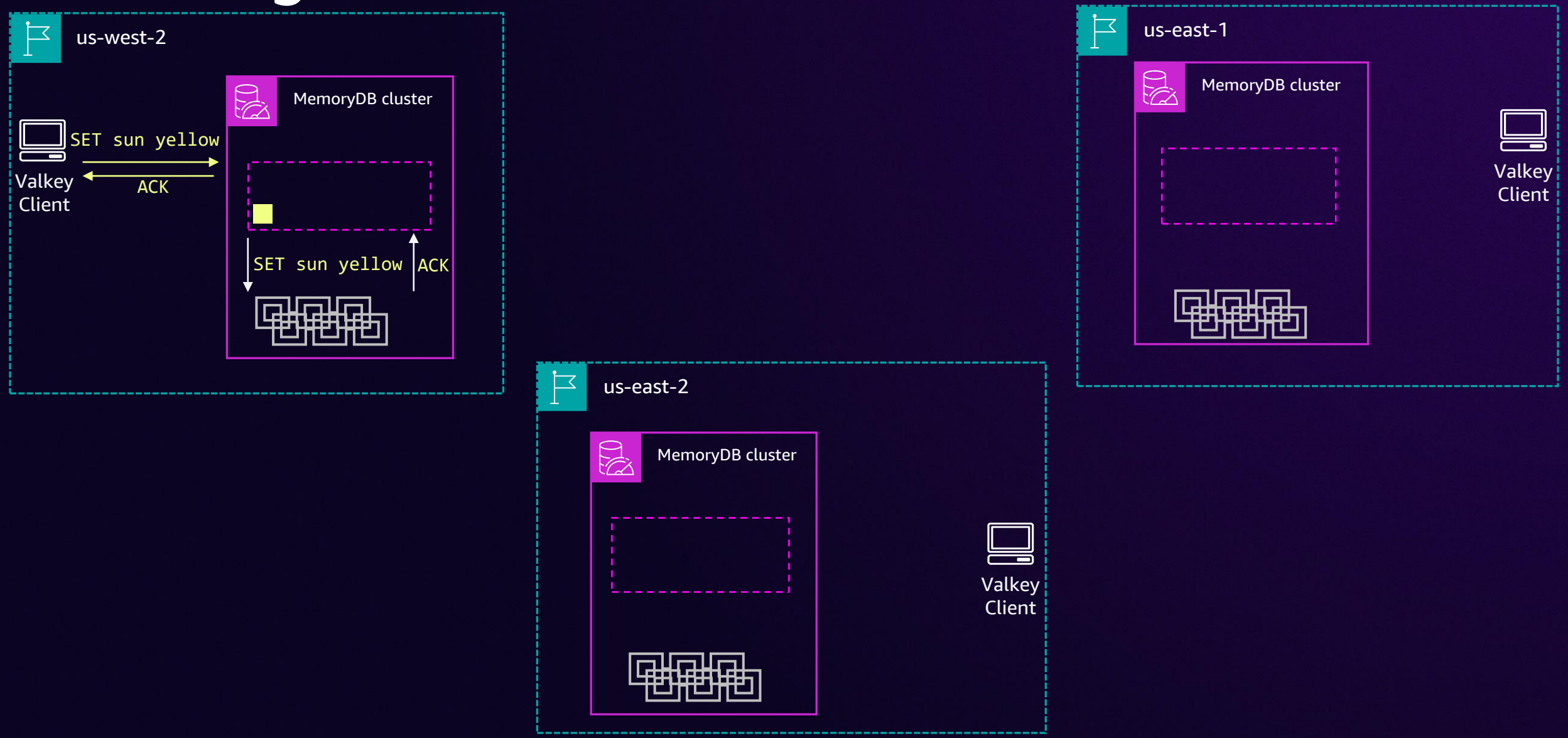

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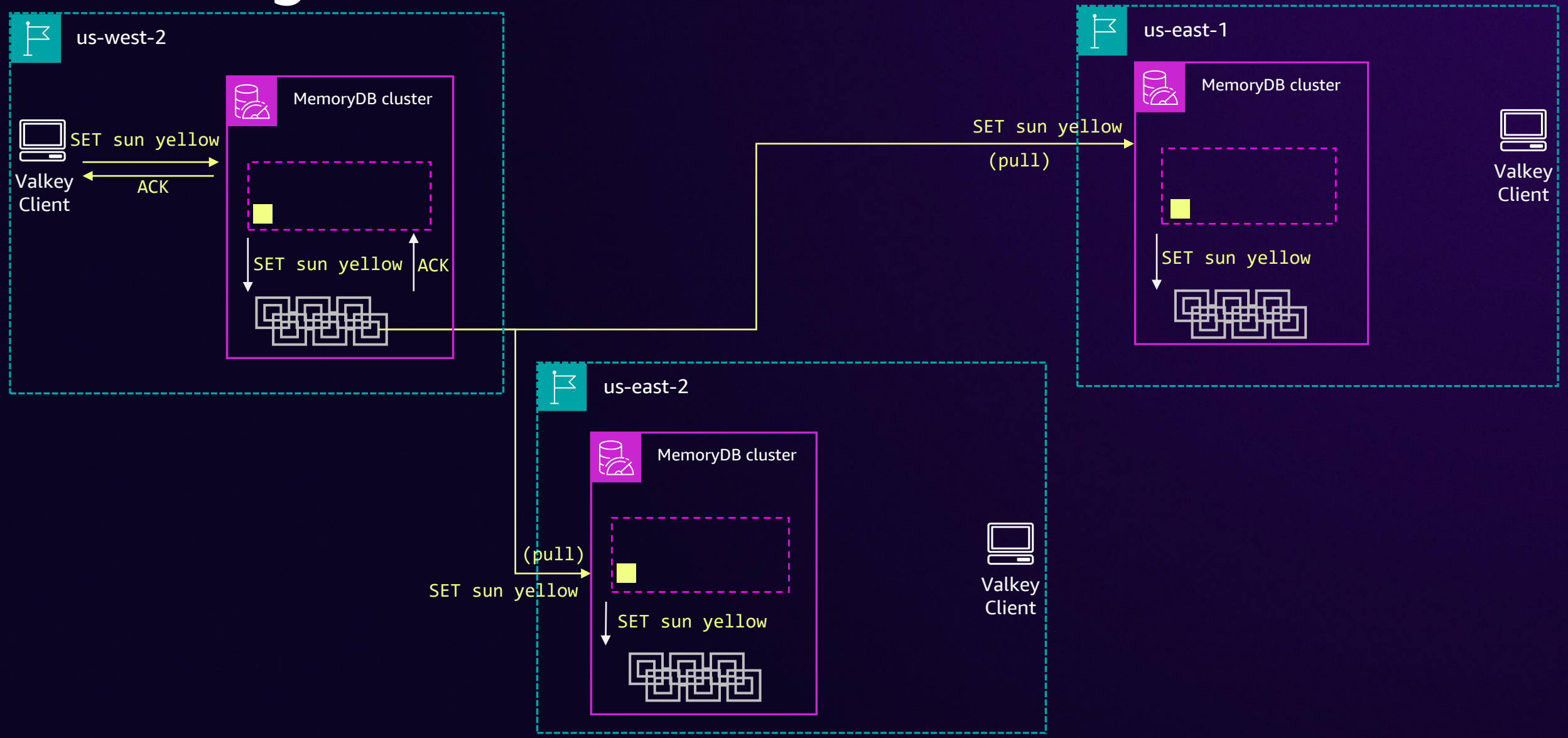

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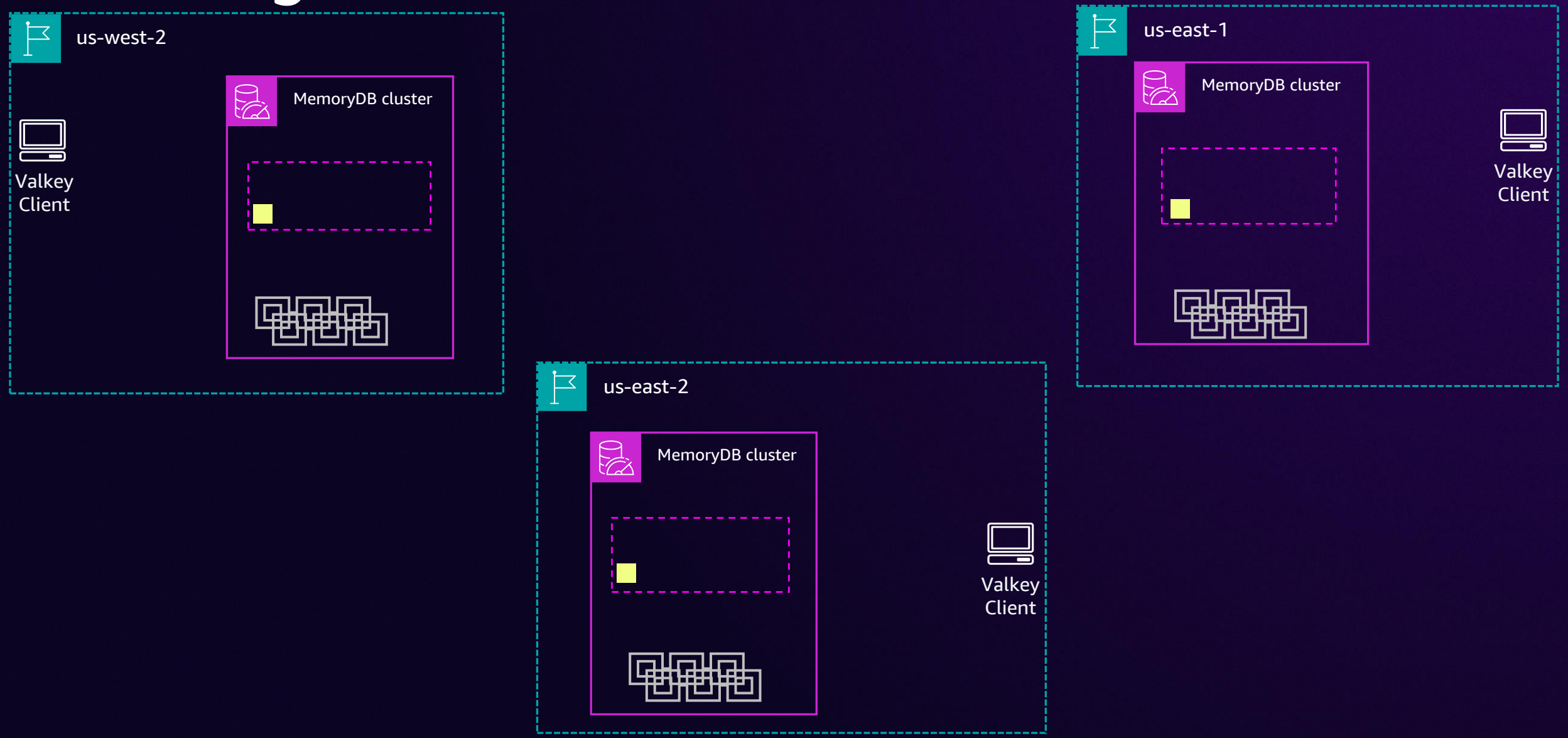

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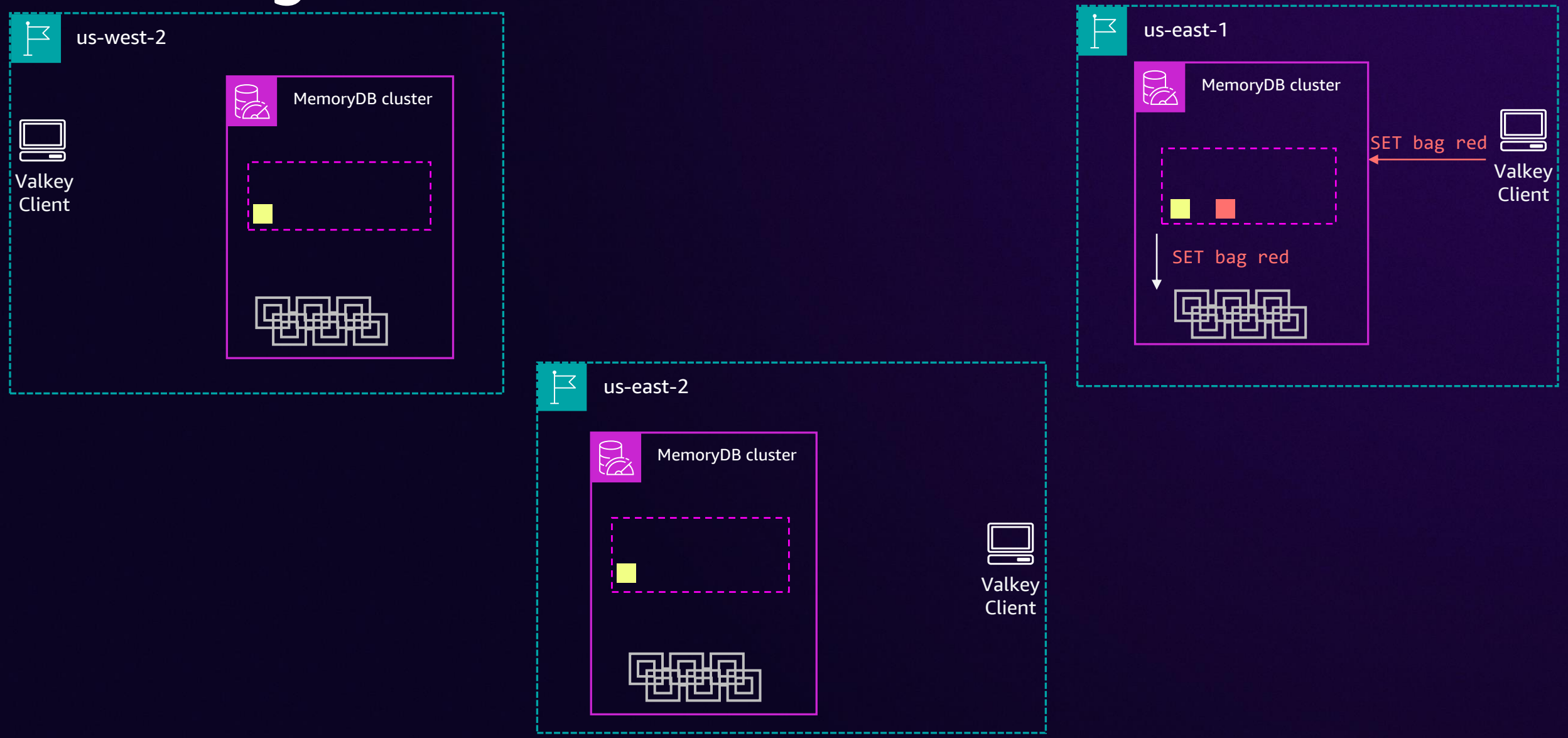

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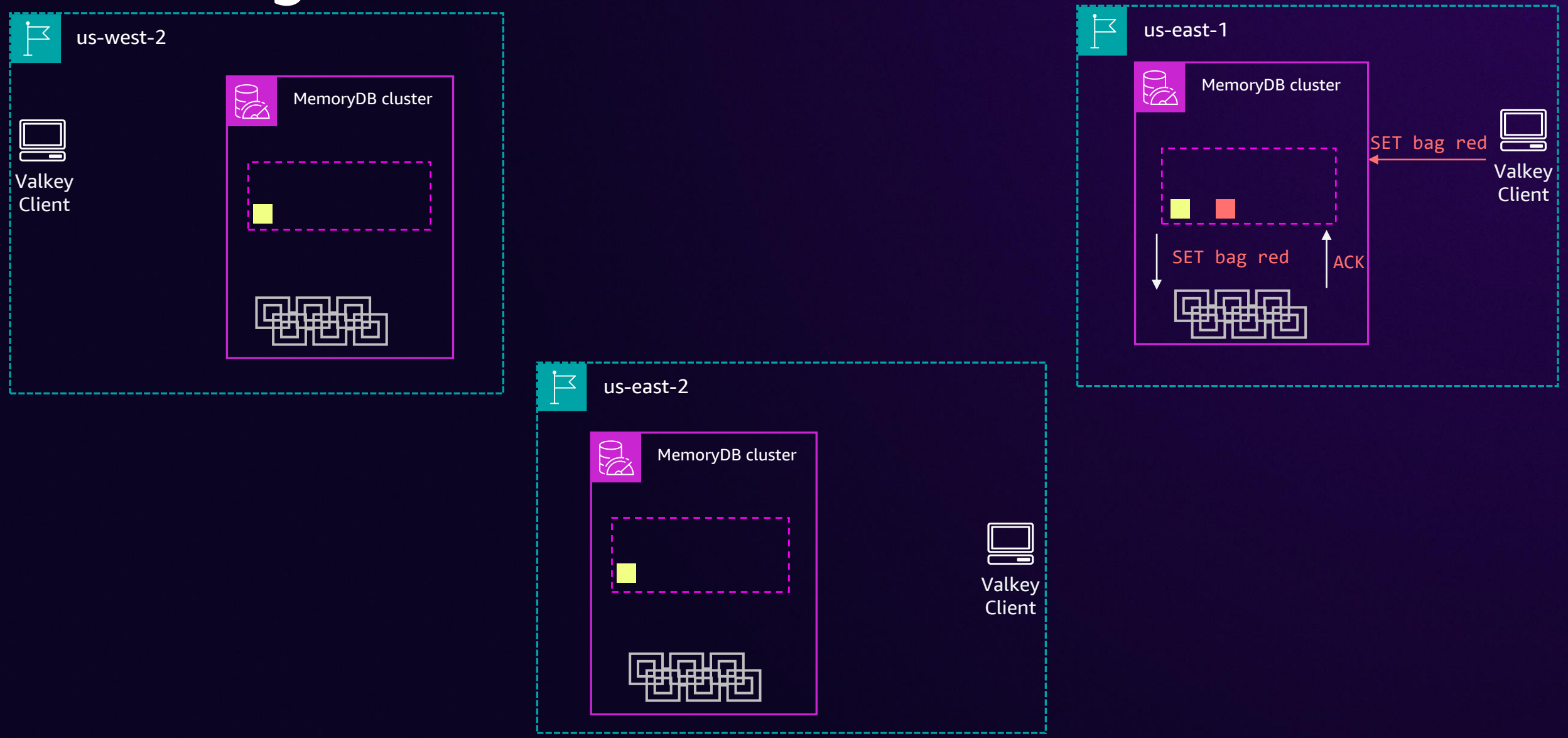

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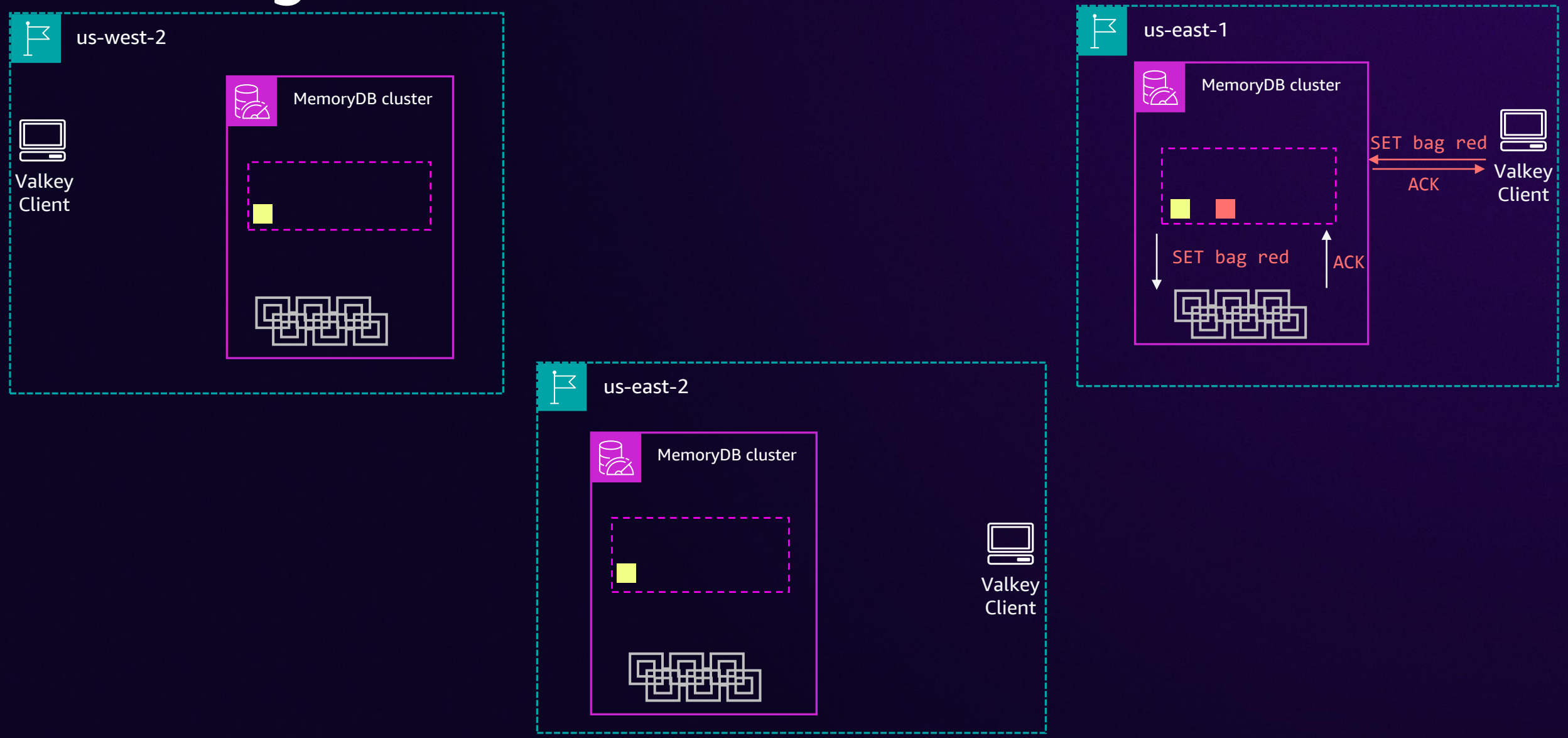

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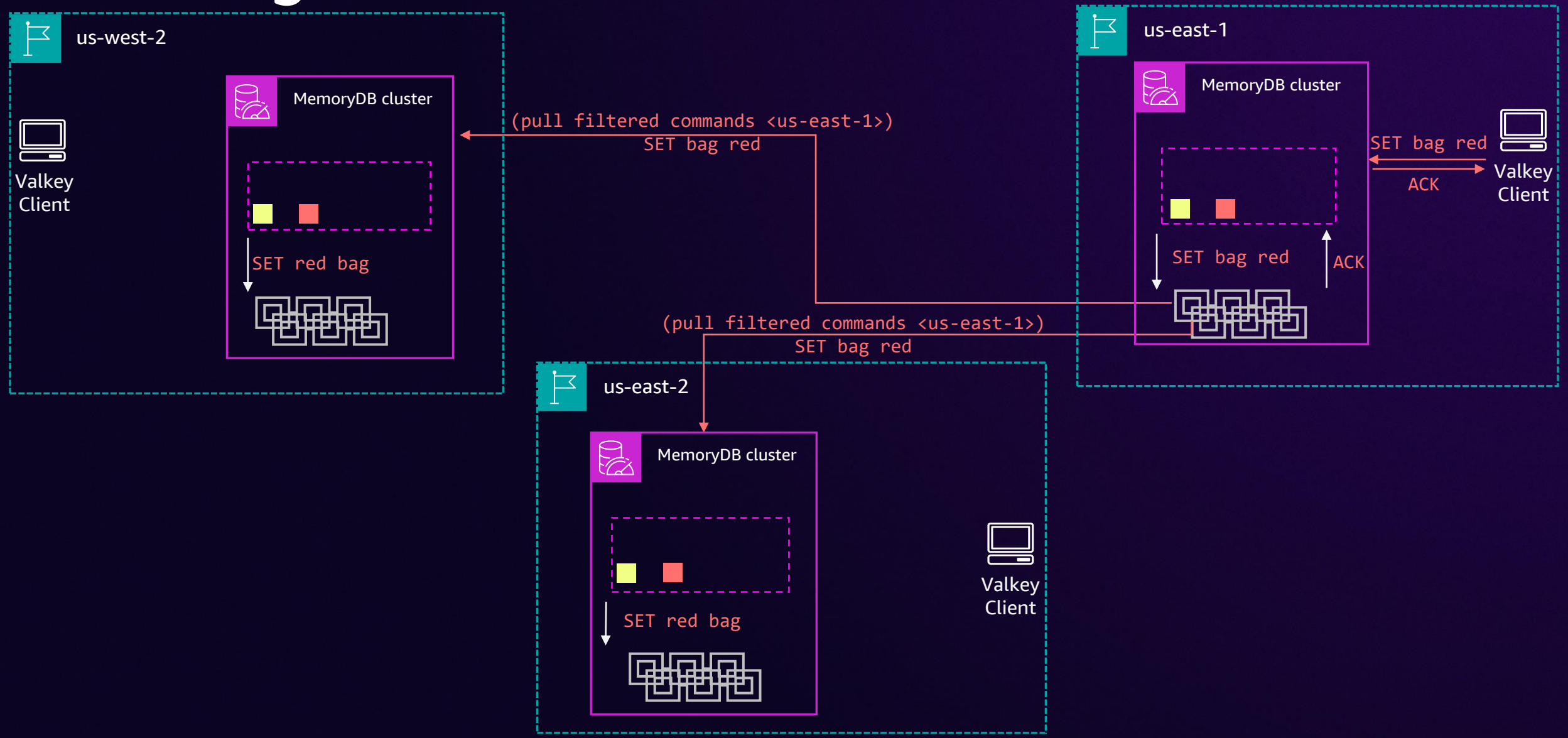

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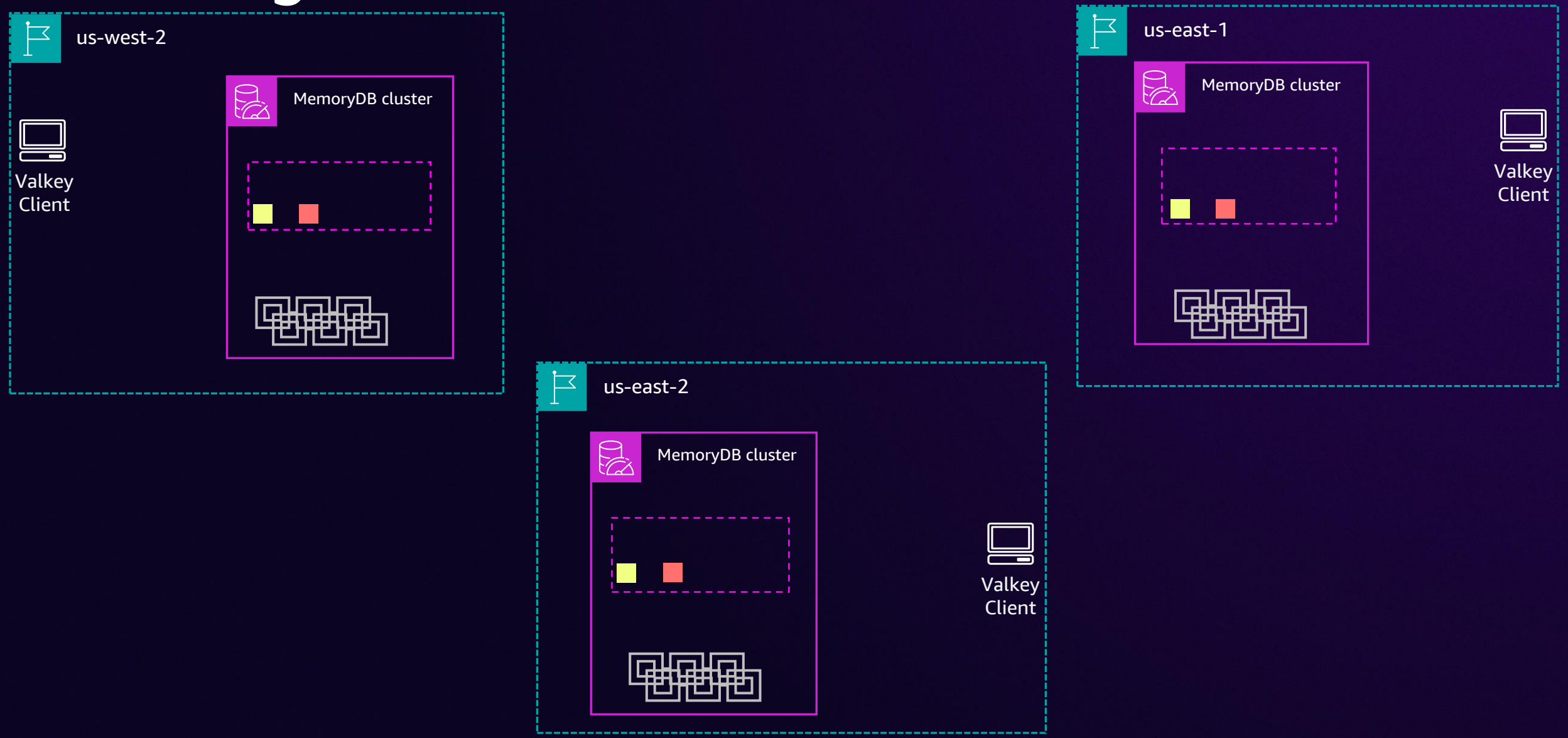

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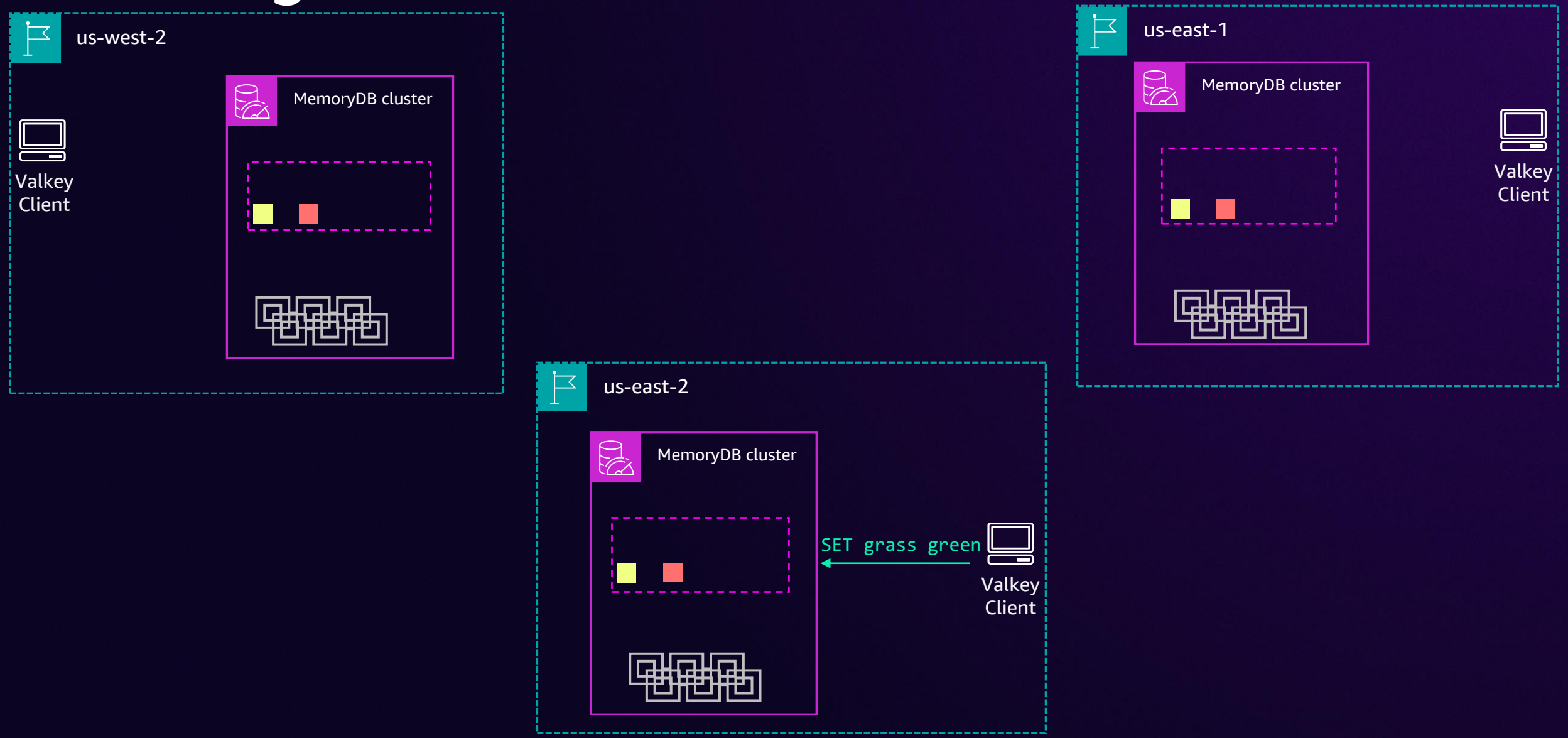

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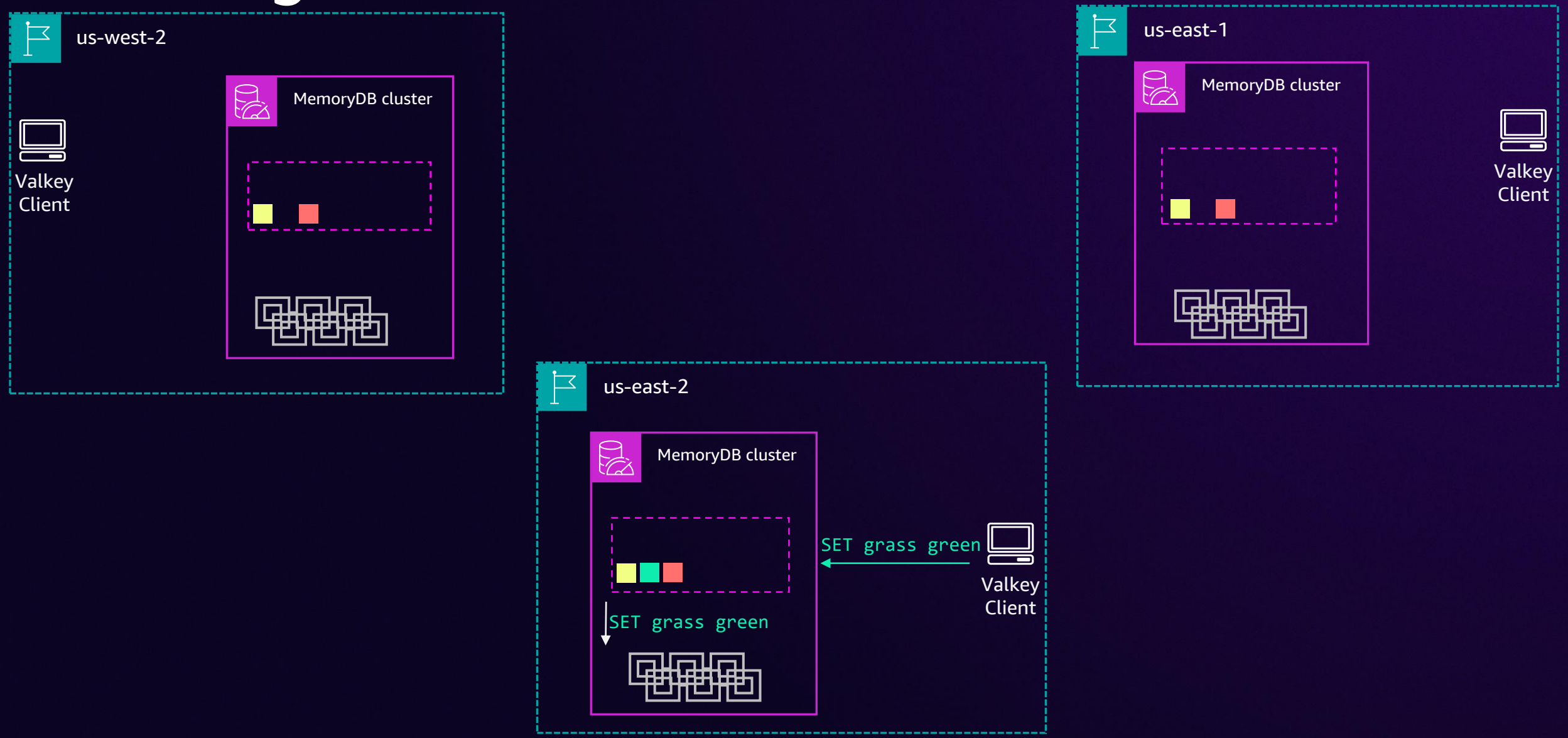

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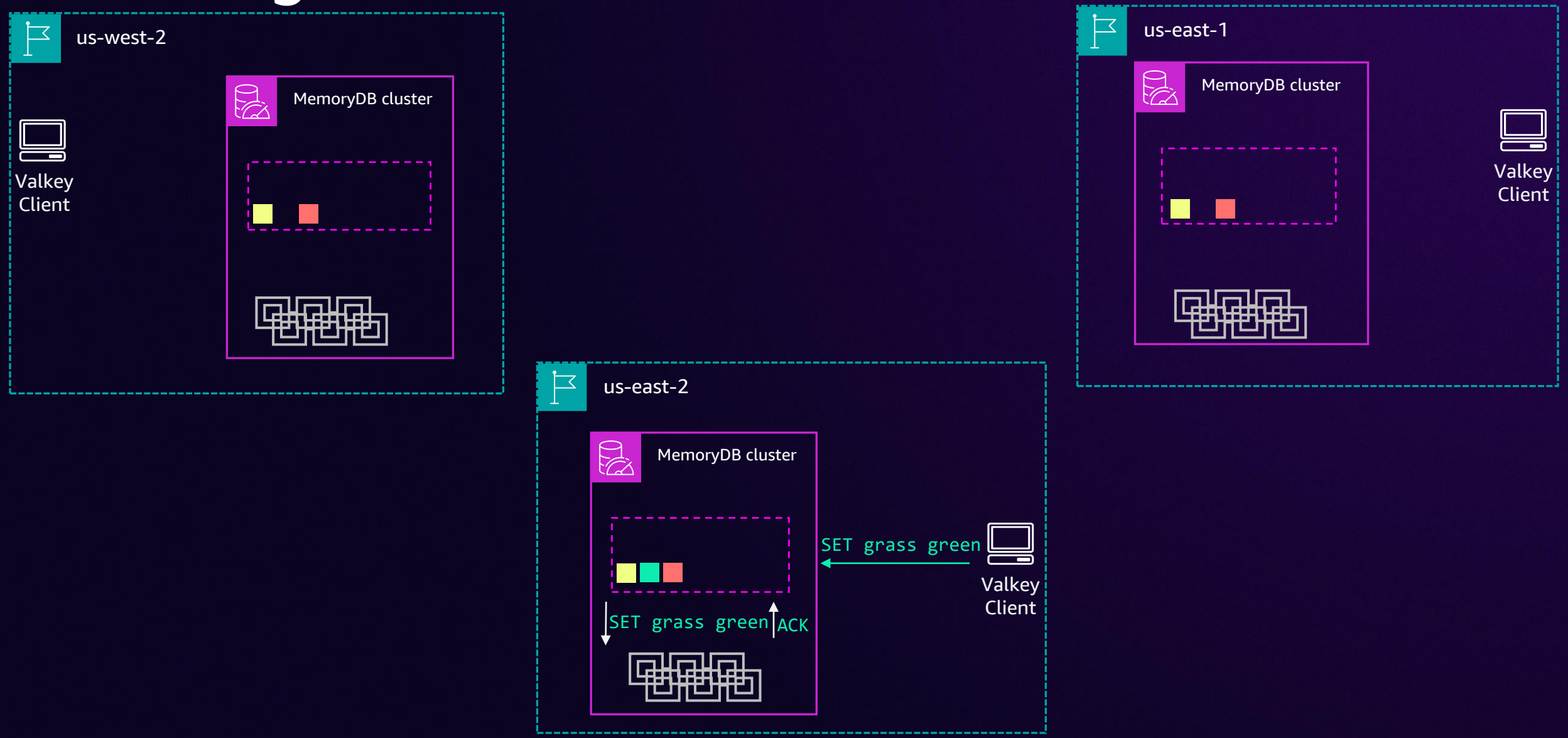

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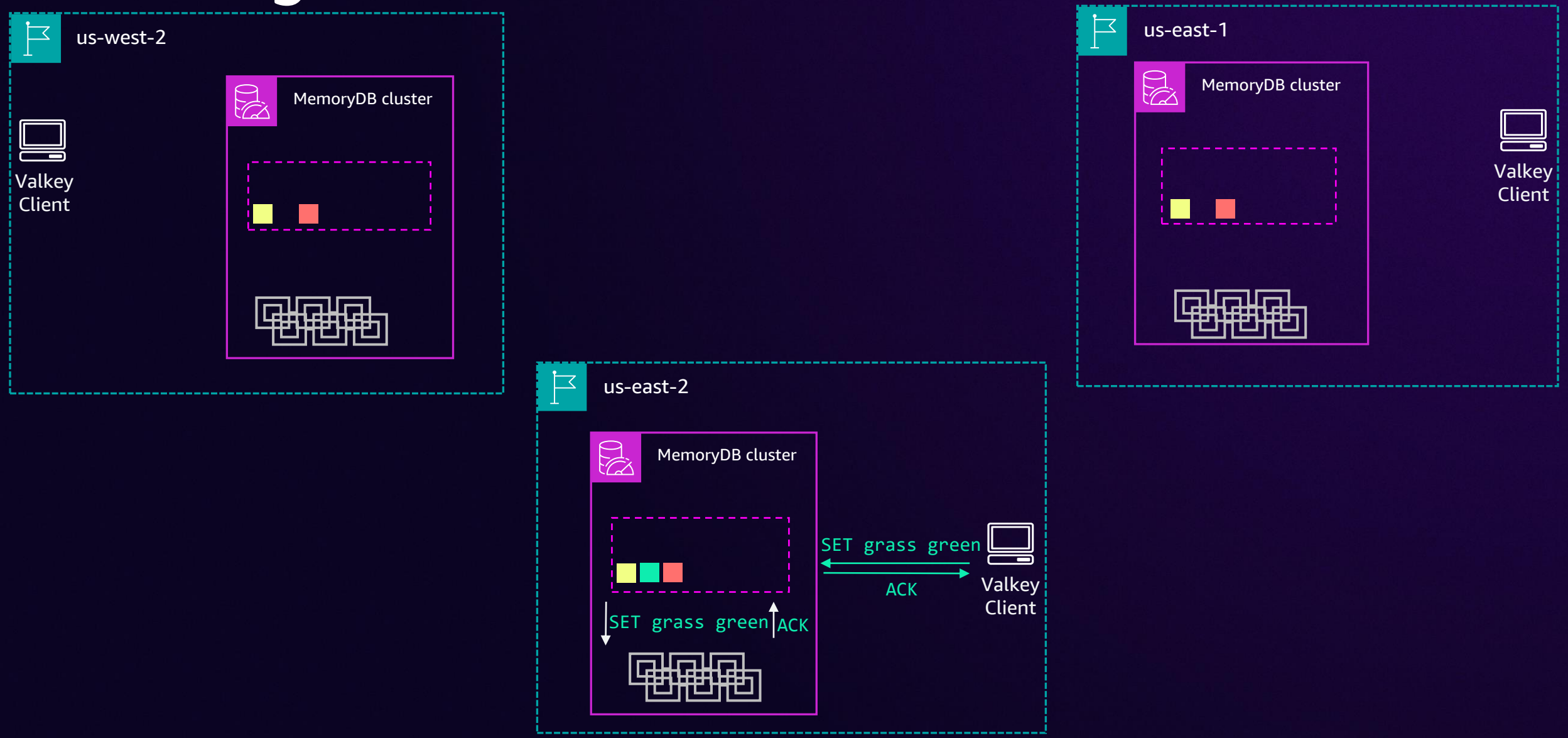

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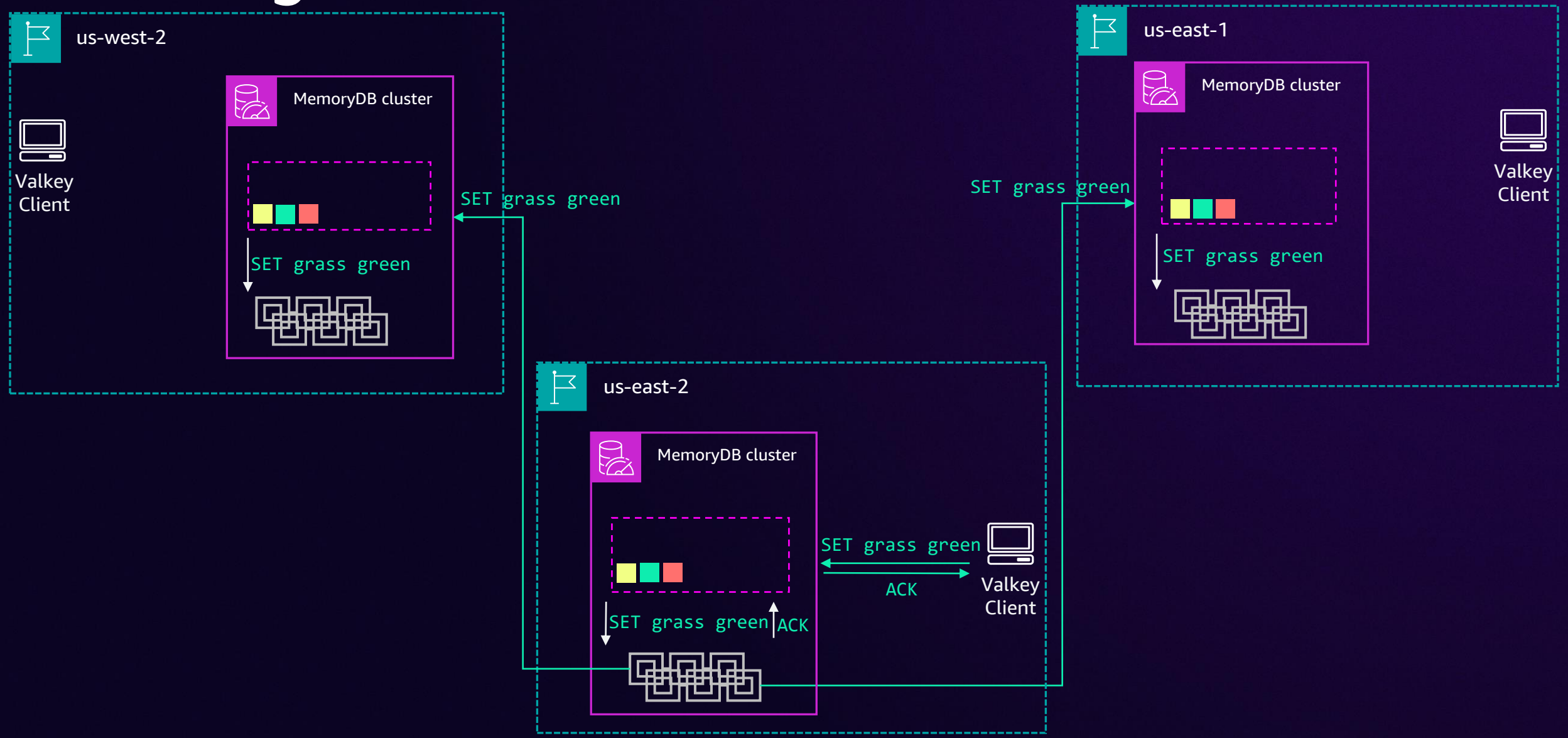

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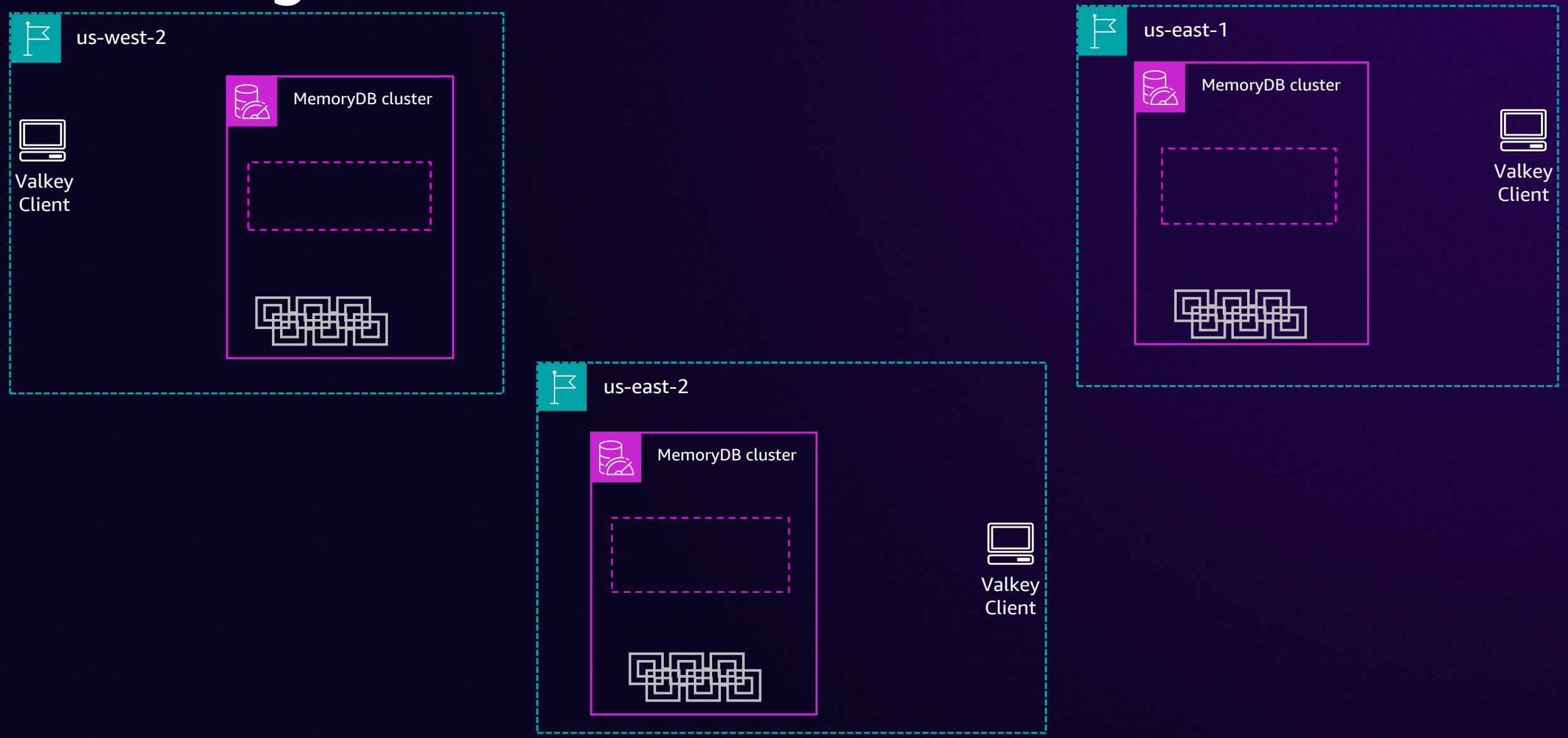

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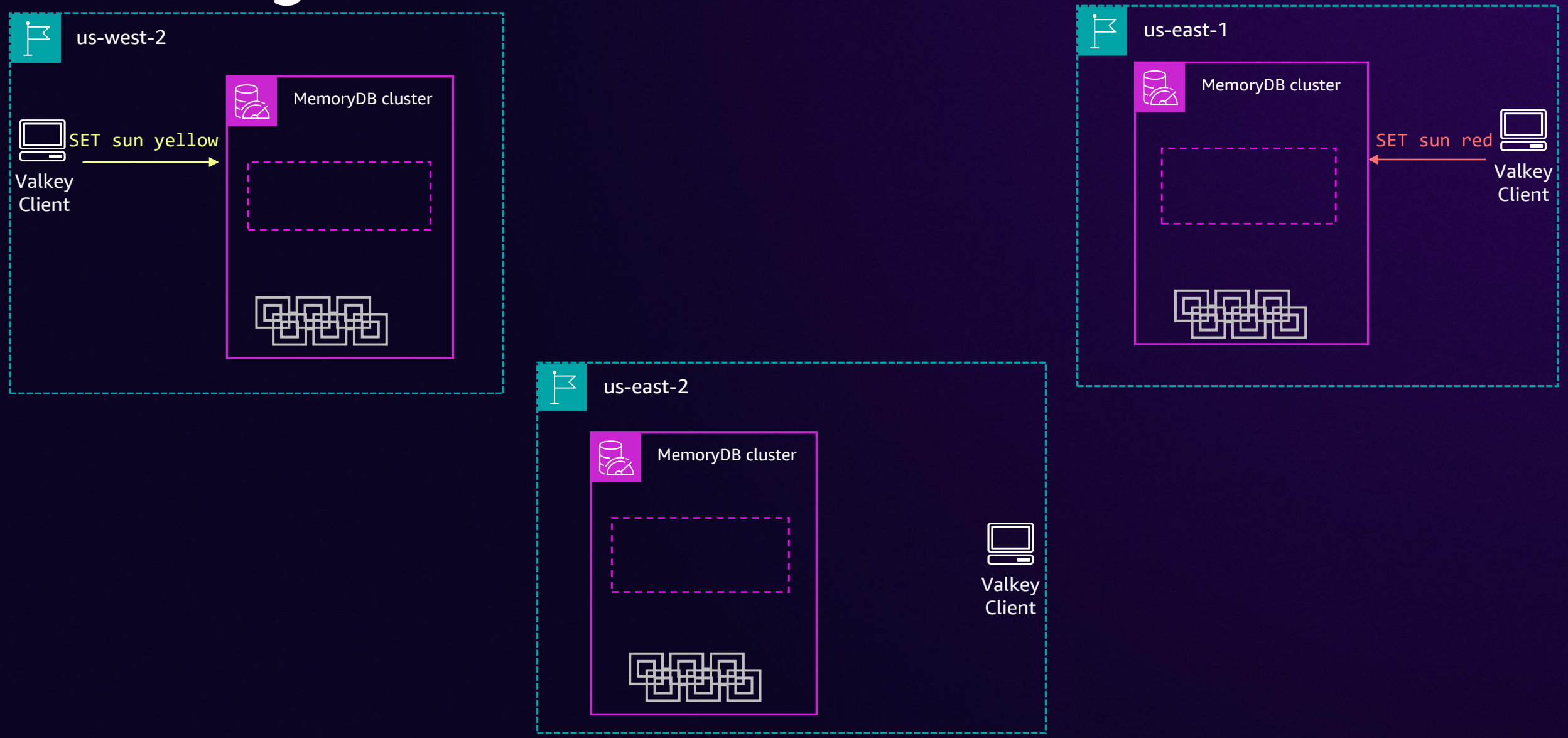

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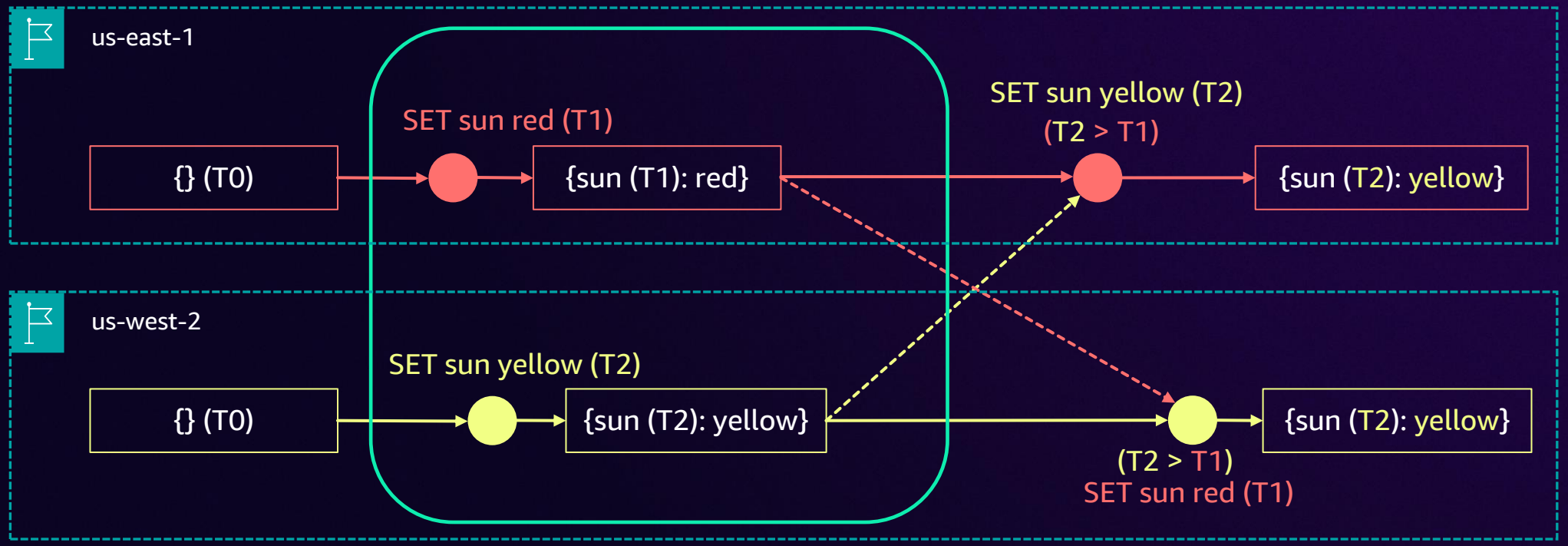
What if there are conflicts?



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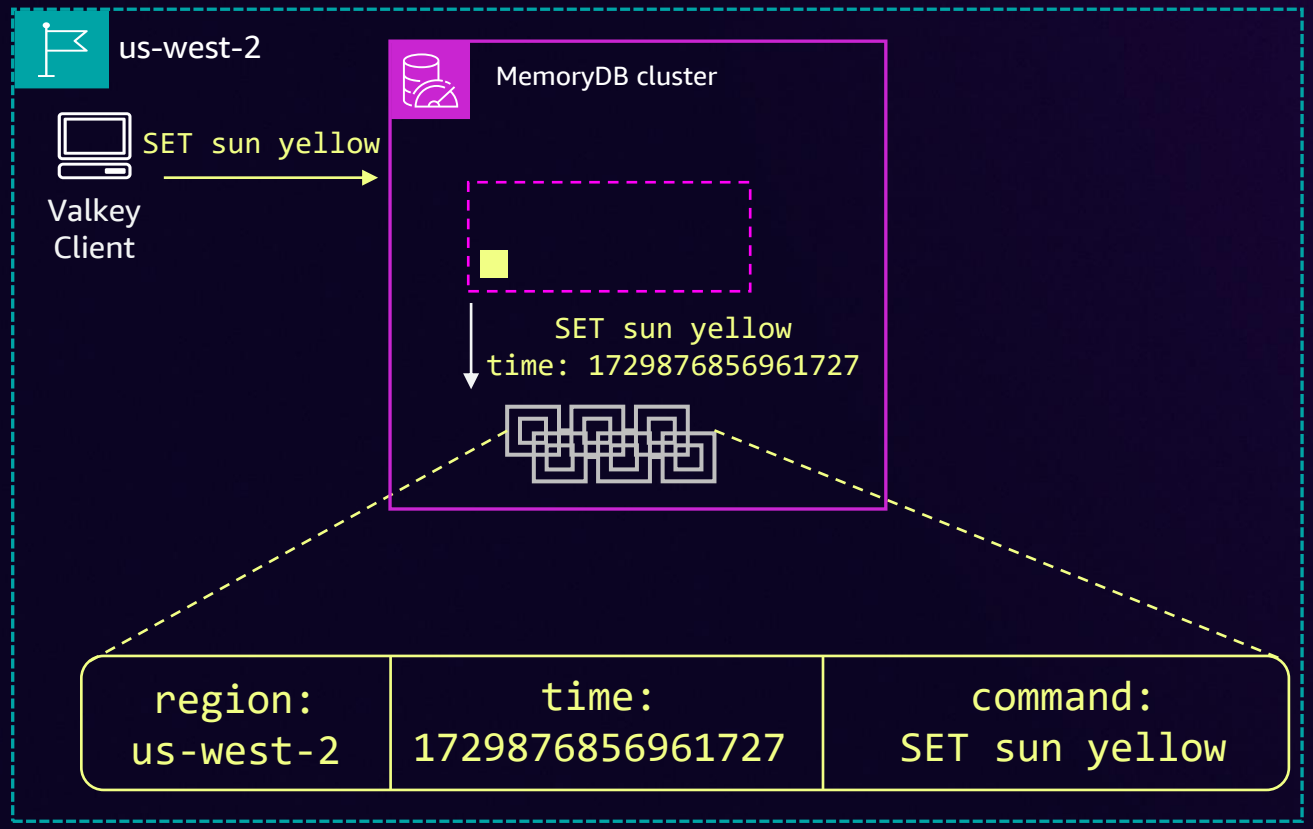
Conflict resolution strategy – Last writer wins



Key	Value	Region	Timestamp
sun	yellow	us-west-2	1729876856961727

Commands are labeled with µs timestamps and the Region of origin

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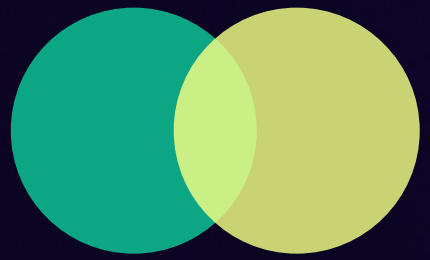
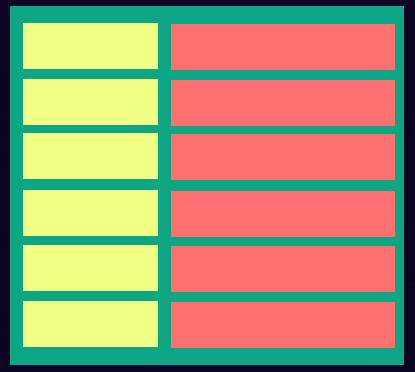
Valkey is more than a key-value store



Sets/Sorted sets: Leaderboard, count unique items



Hashmaps: Session stores

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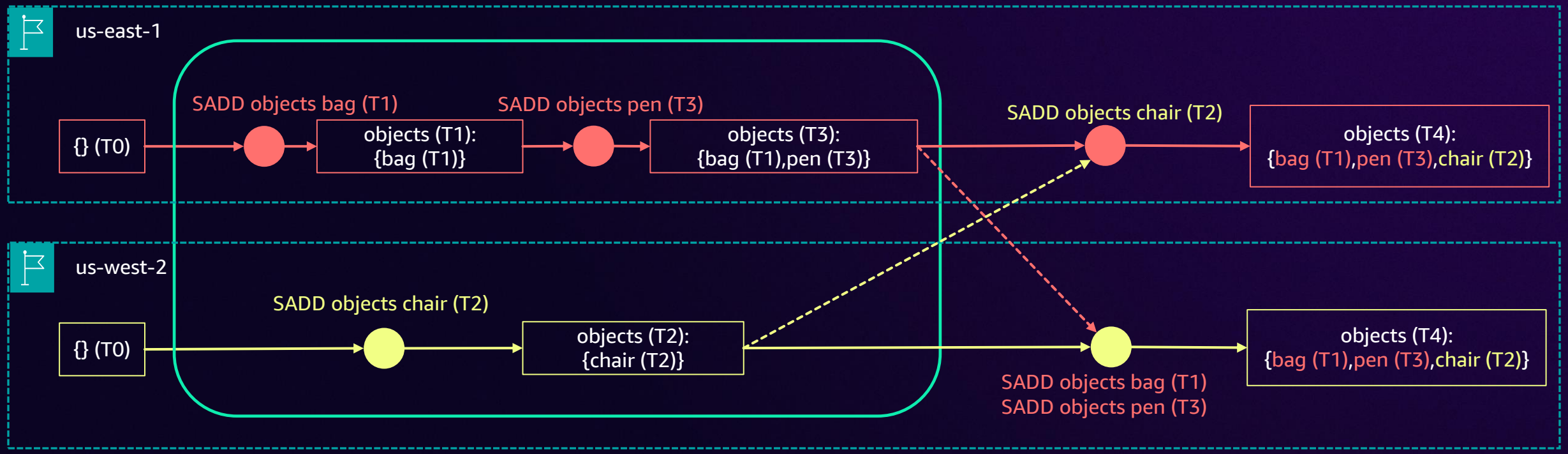
Is “last writer wins” sufficient?



SADD: Valkey command to add an element into a set

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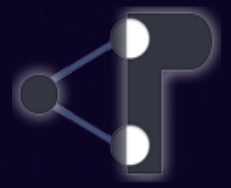
CRDT – Conflict-free replicated data type

Allow multiple Regions to write concurrently even on the same key

Writes are propagated asynchronously with the original timestamps (µs)

Concurrent writes are merged in a consistent way

LWW – timestamps are tracked at the key and subkey level



Analyzed with formal modeling technique using the P language

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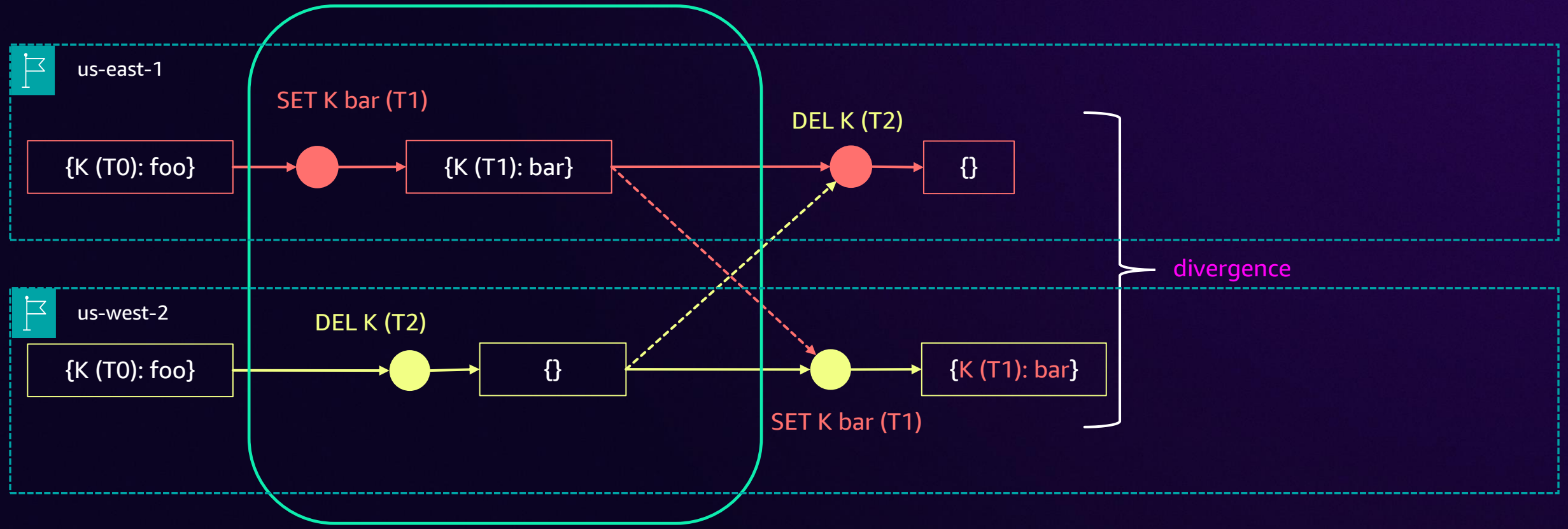
The delete problem



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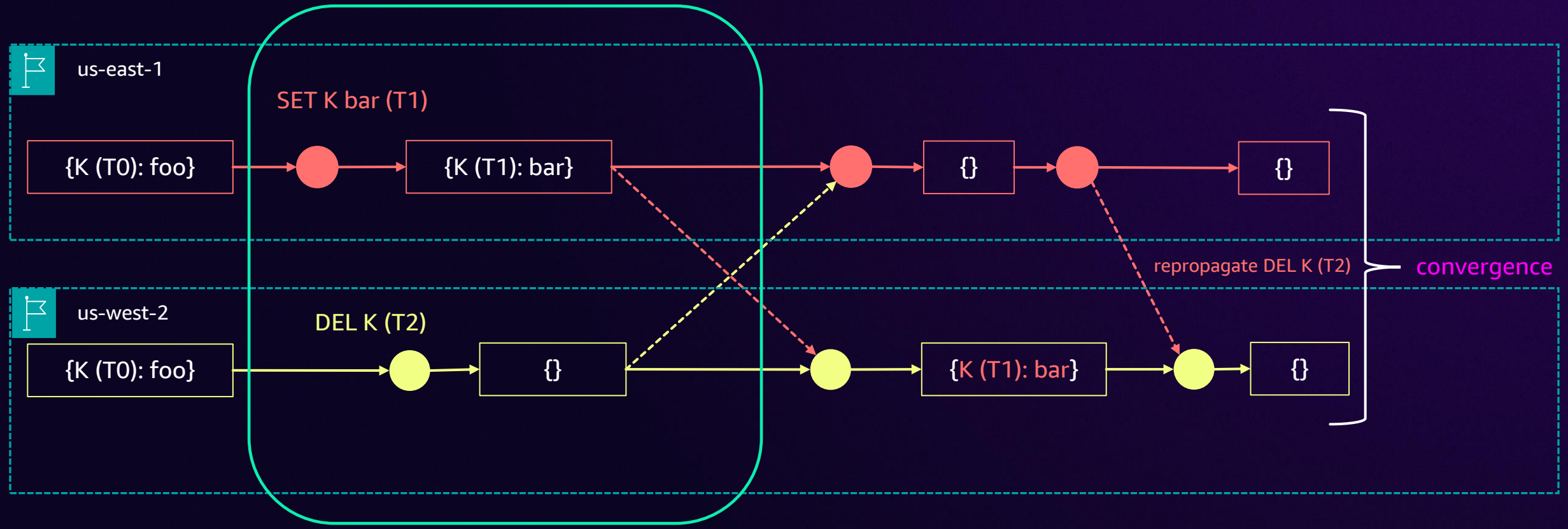
The delete problem



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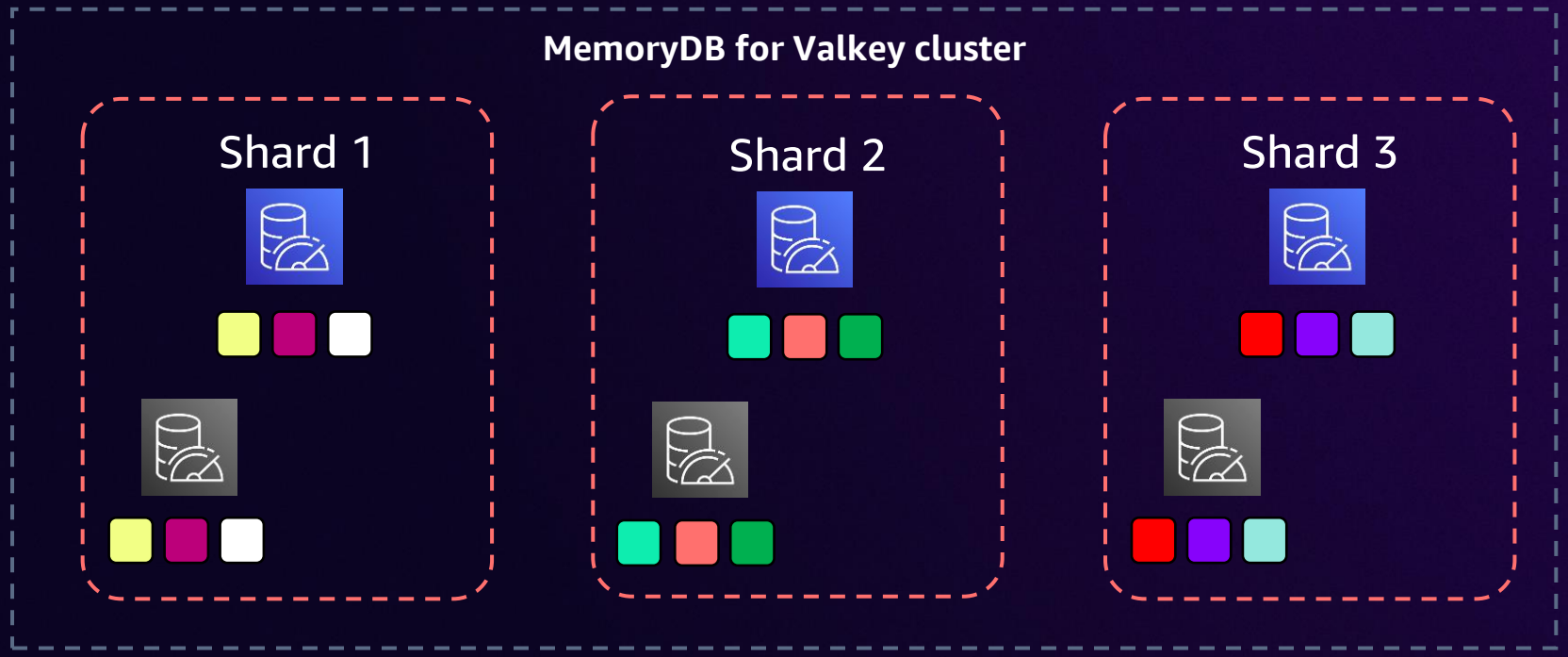
Flexible scaling



Primary node

Replica node

Slot, a group of data items

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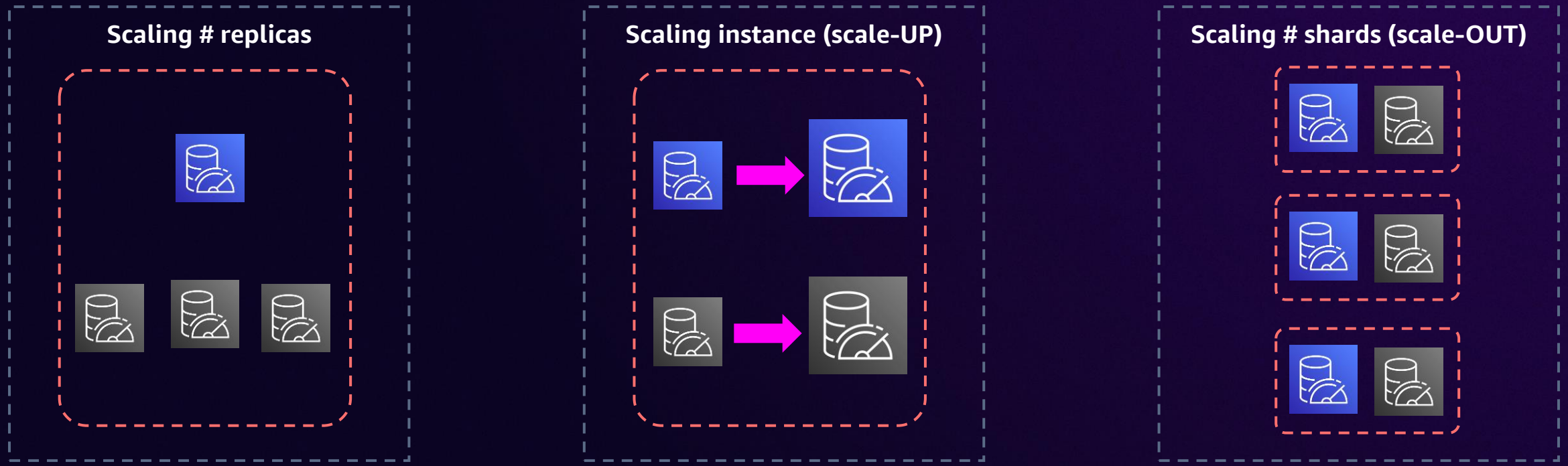
Scaling options



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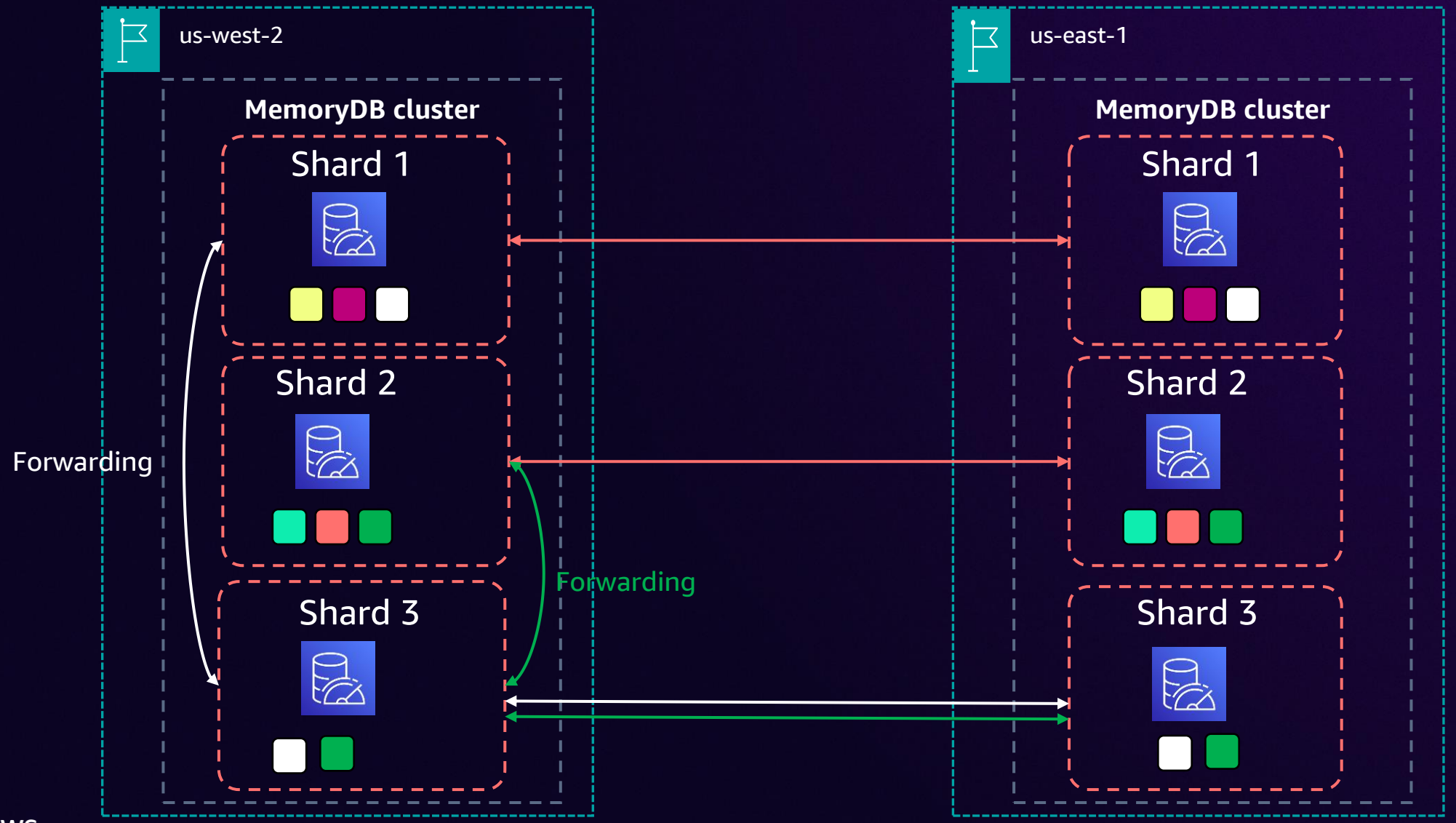
Horizontal scaling MemoryDB Multi-Region



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Example – Multi-Region session store

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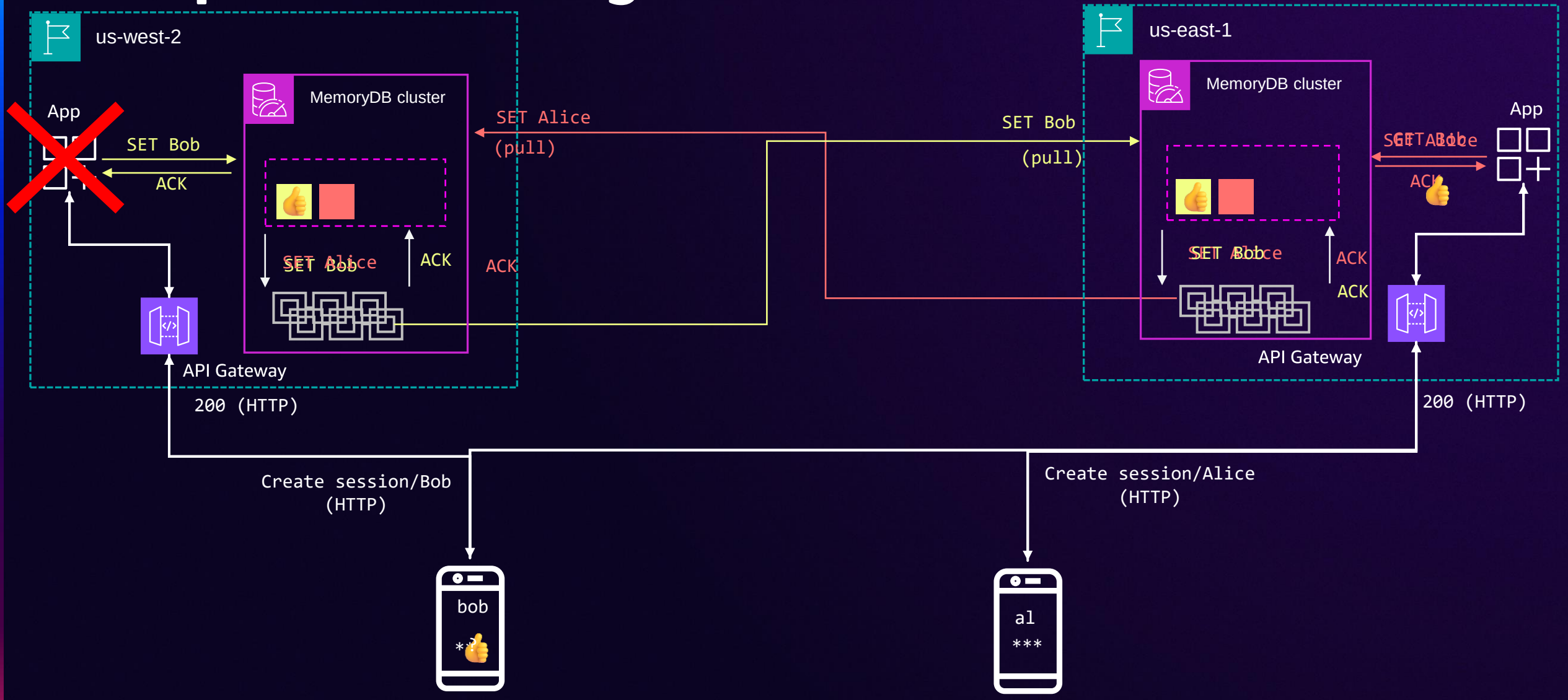
Example – Multi-Region session store



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Getting started

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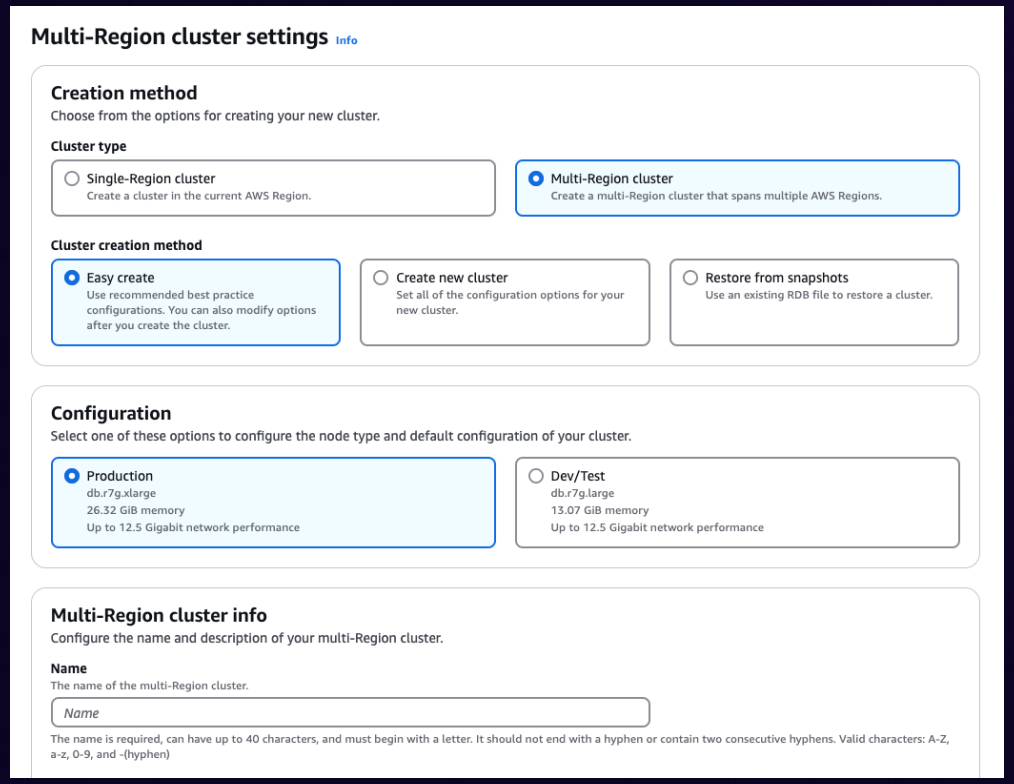
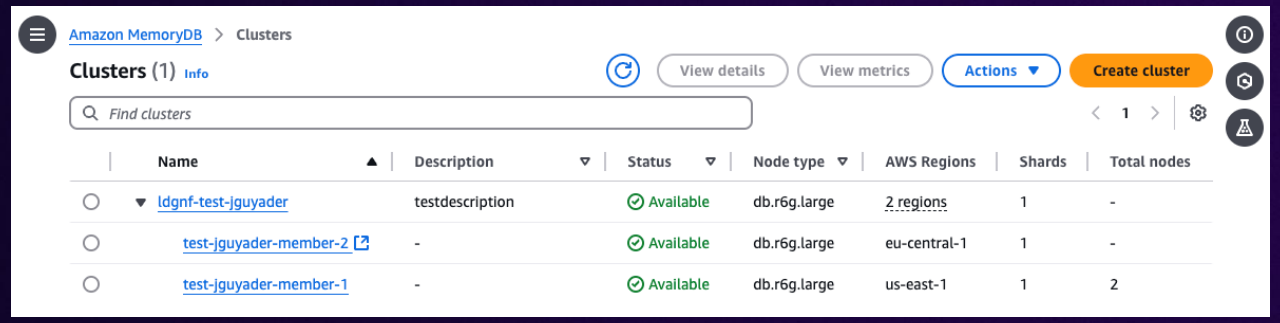
Getting started





- MemoryDB Multi-Region cluster is available today in 12 Regions
- More Regions coming soon

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Thank you!

Please complete the session survey in the mobile app

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