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I've been paged at 3 AM.

Have you?

Building HA & DR for OpenSearch : the hard way, and the right way.

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Agenda

What we'll cover today

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01

Why HA & DR Matter

Search on the critical path

02

Cluster Fundamentals

Building blocks of resilience

03

Multi-AZ Patterns

In-region high availability

04

Shards & Replicas

Allocation and sizing

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Snapshots & Backup

Point-in-time recovery

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Cross-Cluster Replication

Active replication across clusters

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DR Architecture Patterns

Cross-region strategies

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Automated Failover

Reducing manual intervention

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Monitoring Cluster Health

Detecting issues early

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Real-World Lessons

Best practices from production

Why High Availability & Disaster Recovery Matter for Search

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Search is no longer a 'nice to have' — it's on the critical path

Search powers customer-facing experiences: e-commerce, logs, support, security.
An OpenSearch outage means blind SOCs, broken dashboards, and lost revenue.
Compliance and SLAs increasingly mandate measurable RTO/RPO targets.

$5,600

Per Minute

Average enterprise downtime cost (Gartner)

15min

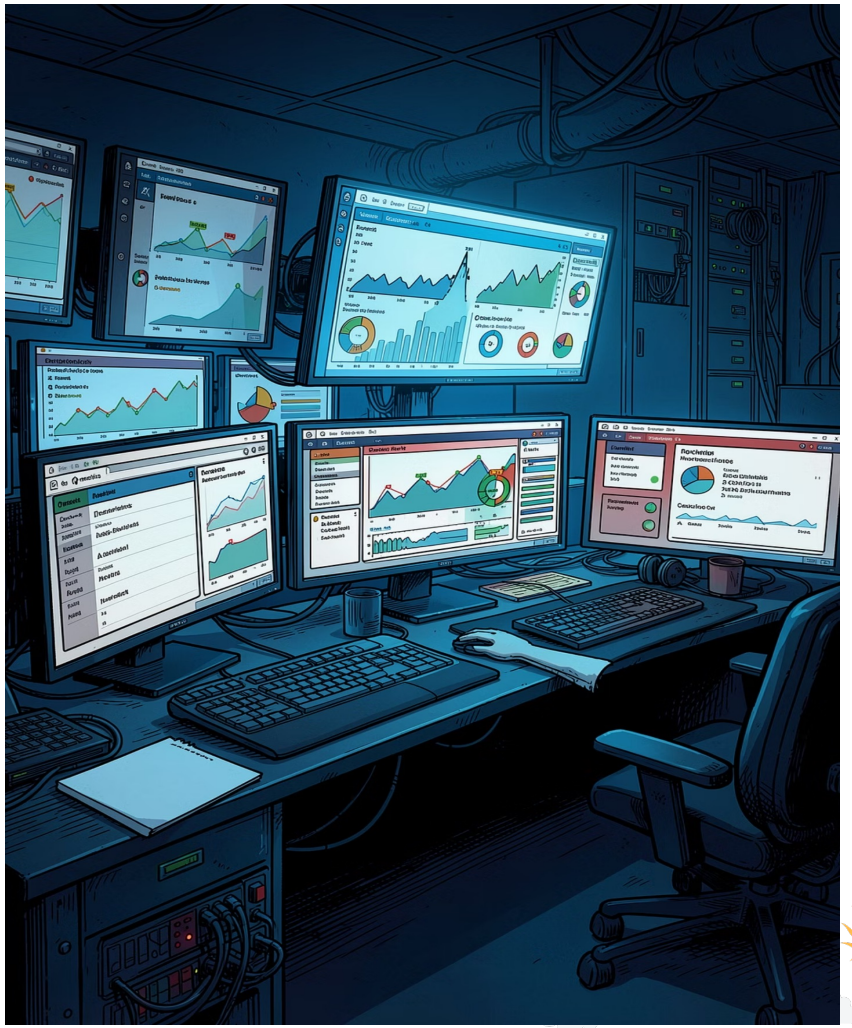
RTO Target

Recovery Time Objective for Tier-1 search workloads

5min

RPO Target

Recovery Point Objective for Tier-1 search workloads



HA vs DR — Two Different Problems

Solved by different mechanisms, often confused

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HIGH AVAILABILITY

Survives node, AZ, or rack failure

- Same region, same logical cluster
- Replicas + dedicated Cluster Managers + AZ awareness
- Recovery is automatic — seconds to minutes
- Goal: zero customer-visible downtime

DISASTER RECOVERY

Survives region-wide outage or data corruption

- Cross-region or cross-cluster
- Snapshots + Cross-Cluster Replication
- Recovery is intentional — minutes to hours
- Goal: bounded data loss, predictable RTO

OpenSearch Cluster Fundamentals

The building blocks every resilient design depends on

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Cluster Manager

Coordinates cluster state — never serves data. Always run dedicated, odd-numbered (3) to avoid split-brain.

Data Nodes

Hold shards, run search and indexing. Scale independently for throughput.

Coordinating Nodes

Route requests, aggregate results — act as search load balancers for read-heavy workloads.

Ingest Nodes

Pre-process documents before indexing. Isolate heavy parsing workloads from data nodes.

An OpenSearch cluster without a manager node is like Hogwarts without a Headmaster.

Multi-AZ Cluster Topology

The reference architecture for in-region HA

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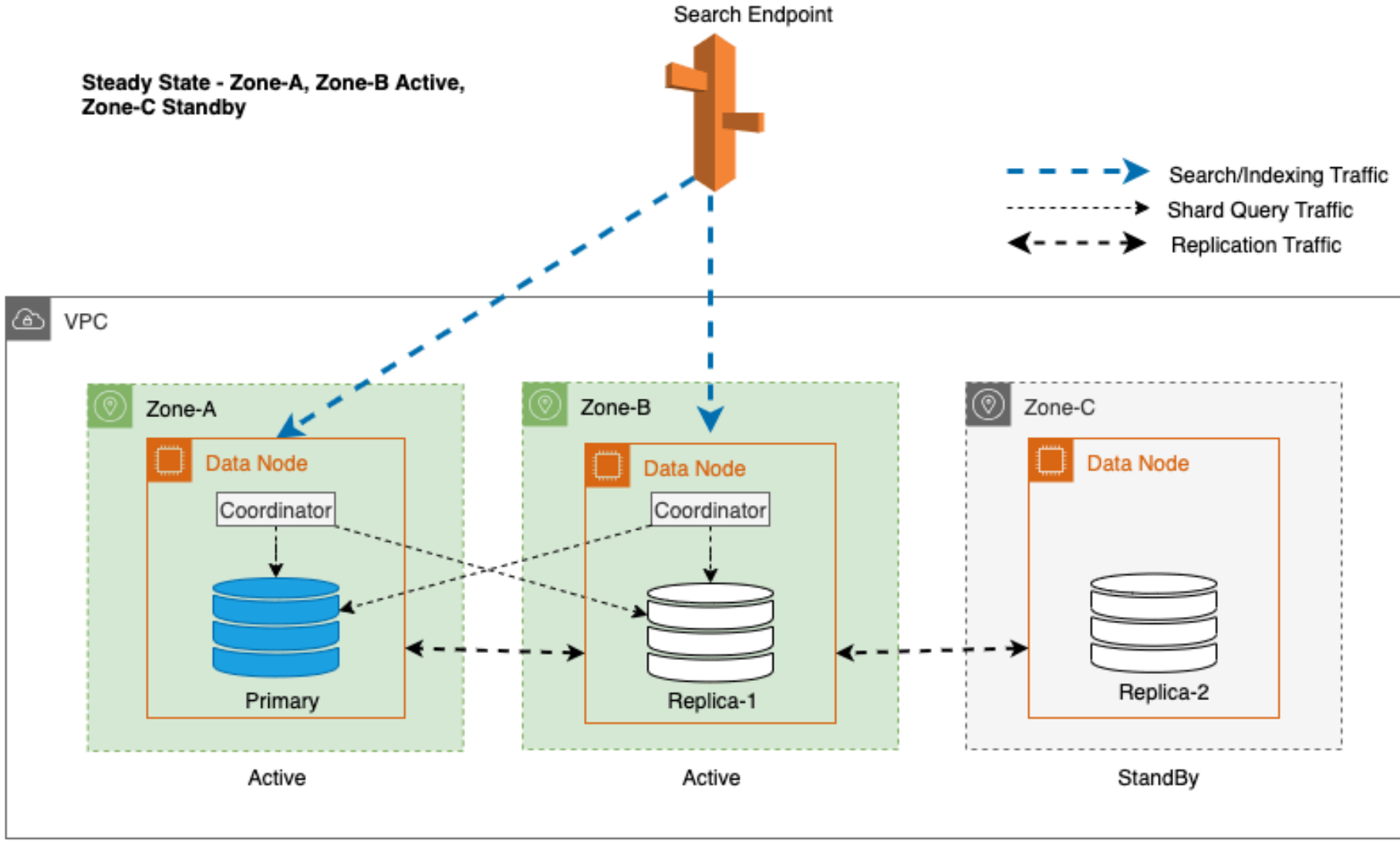
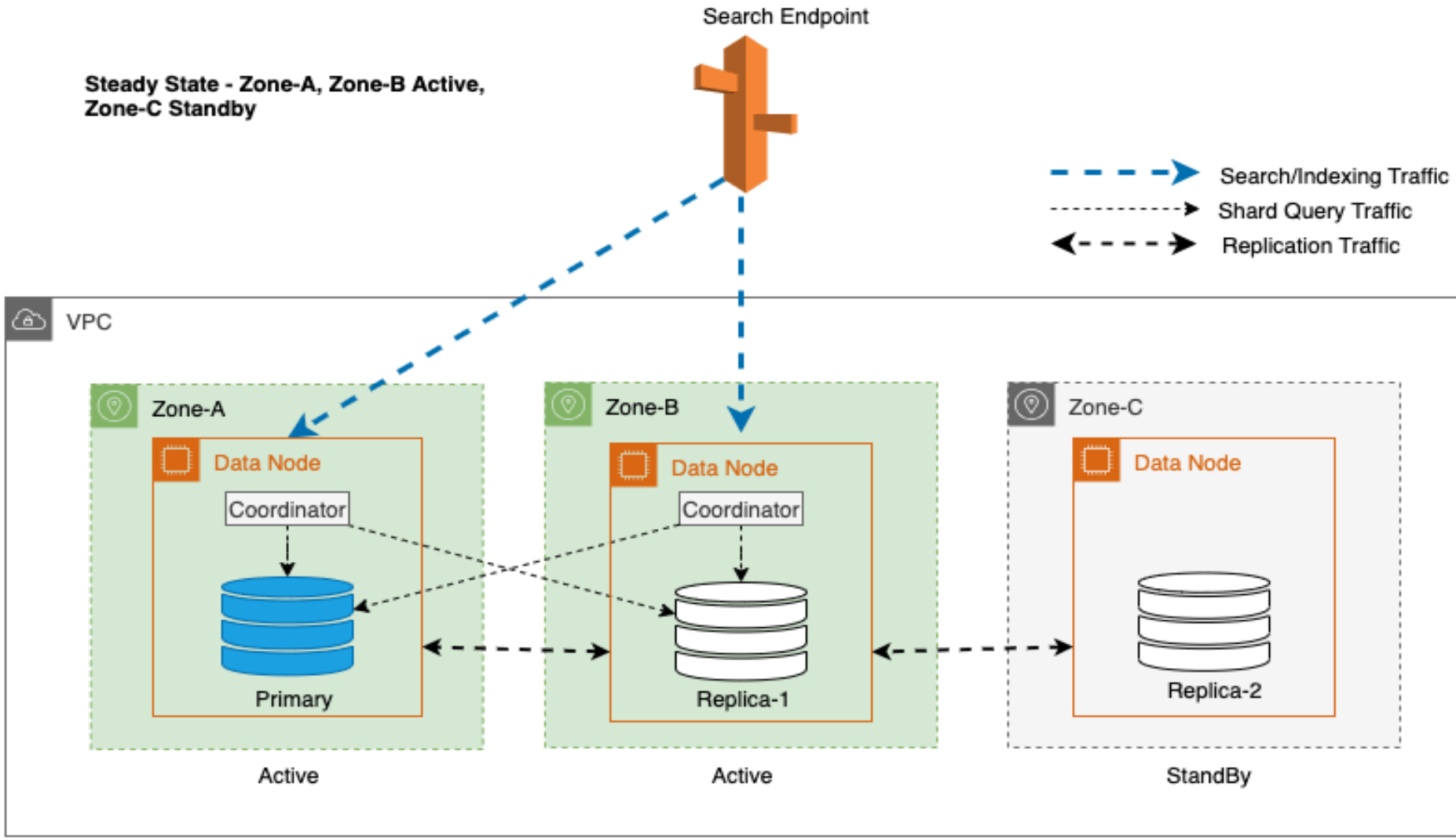
AZ-a	AZ-b	AZ-c
Cluster Manager	Cluster Manager	Cluster Manager
Data node 1	Data node 1	Data node 1
Data node 2	Data node 2	Data node 2
Coordinator	Coordinator	Coordinator

Spread shards across all 3 AZs | Replicas guarantee an AZ-loss survivable copy

Multi-AZ Architecture Patterns




Steady State - Zone-A, Zone-B Active, Zone-C Standby
Search Endpoint
Search/Indexing Traffic
Shard Query Traffic
Replication Traffic
VPC
Zone-A
Data Node
Coordinator
Primary
Active
Zone-B
Data Node
Coordinator
Replica-1
Active
Zone-C
Data Node
Replica-2
StandBy

Shard Allocation Awareness

Telling OpenSearch about your failure domains

Configuration Steps

- Tag every node with its zone attribute (e.g., node.attr.zone=az-a)
- Set cluster.routing.allocation.awareness.attributes: zone
- Forced awareness prevents shards from collapsing into one zone if others fail
- Combine with shard_balance_threshold to prevent hotspotting
- Validate with _cat/shards — primary and replica should never share a zone

opensearch.yml

```
node.attr.zone: az-a

cluster.routing.allocation.awareness
.attributes: zone

cluster.routing.allocation.awareness
.force.zone.values:
 az-a,az-b,az-c
```

Primaries, Replicas, and Sizing

How many shards? How many copies?

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- 1 primary + 1 replica = minimum for HA (2 copies)
- 1 primary + 2 replicas = strong reads, faster recovery, 3x storage
- Target shard size: 10–50 GB for most workloads
- Avoid oversharding — each shard adds Lucene overhead
- Use the index template to enforce defaults across new indices
- number_of_replicas can be tuned online; number_of_primaries cannot

Quick math

1 TB index

→ 30 GB shards = 34 primaries

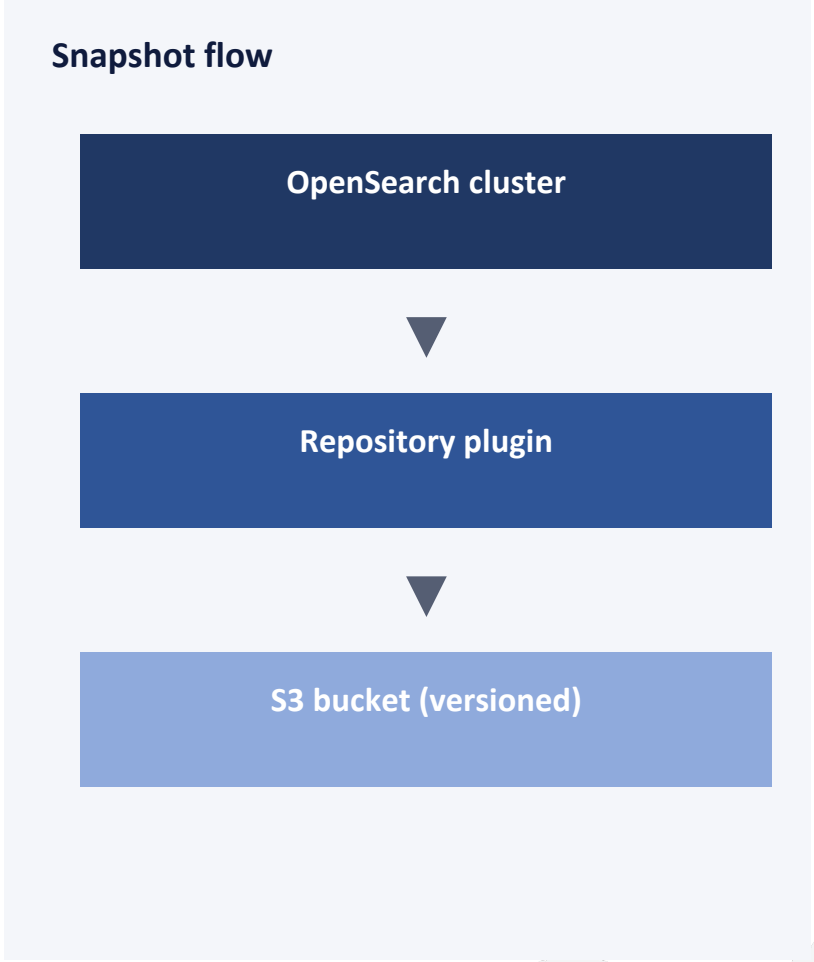
→ 1 replica = 2 TB on disk

→ Spread across ≥ 3 data nodes

Snapshots — Your Last Line of Defense

Incremental, point-in-time backups to durable object storage

- Snapshots are incremental and stored in a snapshot repository
- Common backends: S3, Azure Blob, GCS, shared FS, HDFS
- Use a separate bucket/prefix per cluster — never share writers
- Snapshot Management (SM) policy automates schedule + retention
- Always test restores — an untested backup is a hope, not a strategy



Cross-Cluster Replication

Continuous, low-latency replication between clusters

- Leader-follower model: writes go to leader, replicate to follower(s)
- Follower indices are read-only until failover is invoked
- Replicates per-index — pick what's worth the bandwidth
- RPO measured in seconds, not hours like snapshots
- Pairs perfectly with a warm DR region or a read-scaled secondary
- Stop replication on the follower to make it writable for failover

Active-Passive vs Active-Active

Different DR postures, different complexity bills

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Active-Passive

- One region serves all traffic
- Standby is read-only via CCR
- Simple, well-supported
- Failover is a deliberate decision
- RTO: minutes • RPO: seconds

Active-Active (read)

- Both regions serve reads
- Writes still go to one leader
- Lower latency for global users
- Requires routing logic
- RTO: seconds • RPO: seconds

DR Architecture Patterns — Cost vs RTO

Pilot light, warm standby, hot standby

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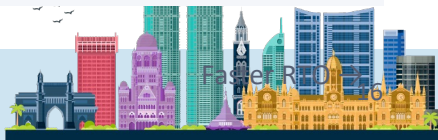
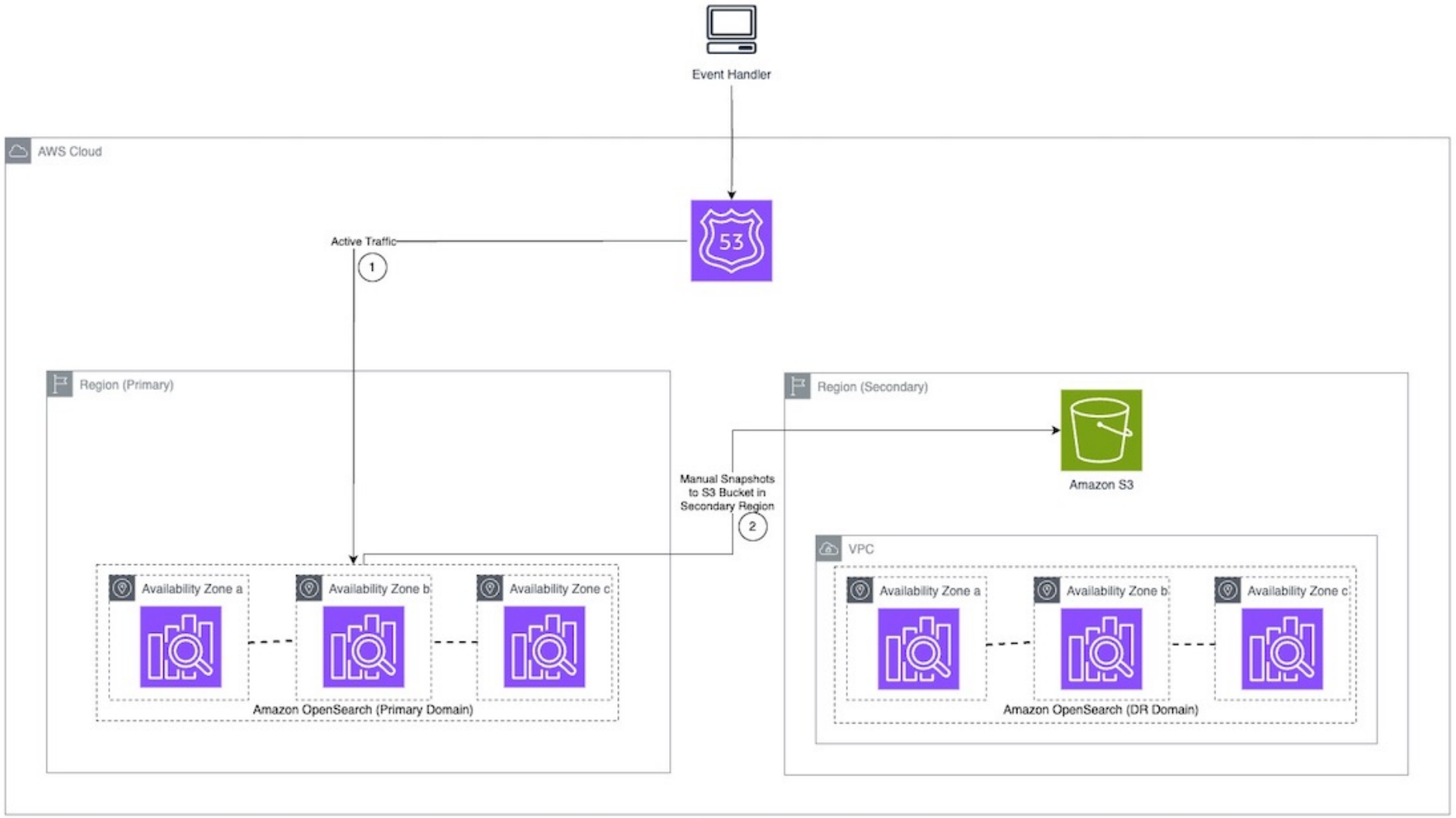
Backup & Restore	Pilot Light	Warm Standby	Hot / Active-Active
RTO: hours **RPO: minutes-hours**	**RTO: < 1 hour** **RPO: minutes**	**RTO: < 15 min** **RPO: seconds**	**RTO: seconds** **RPO: seconds**
• Snapshots only • No standby cluster running • Provision + restore on demand • Cheapest • Acceptable for tier-3	• Tiny standby cluster idle • Snapshots replicated cross-region • Scale up + restore on failover • Low steady-state cost • Common for tier-2	• Right-sized standby running • CCR keeps follower fresh • Promote + scale up traffic • Moderate cost • Tier-1 default	• Both regions serve traffic • Symmetric capacity • DNS or service mesh routing • Highest cost • Tier-0 / global apps

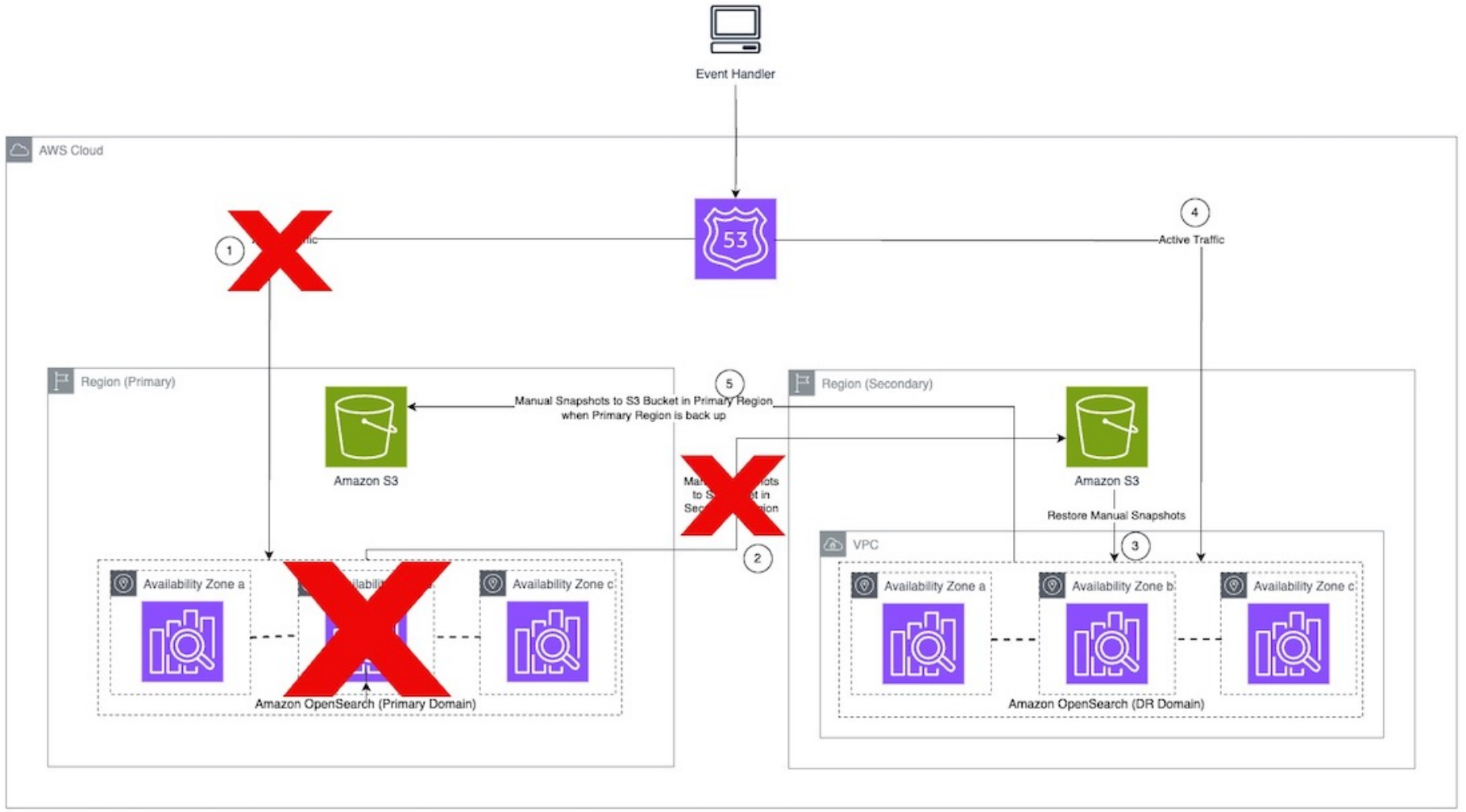
← Lower cost



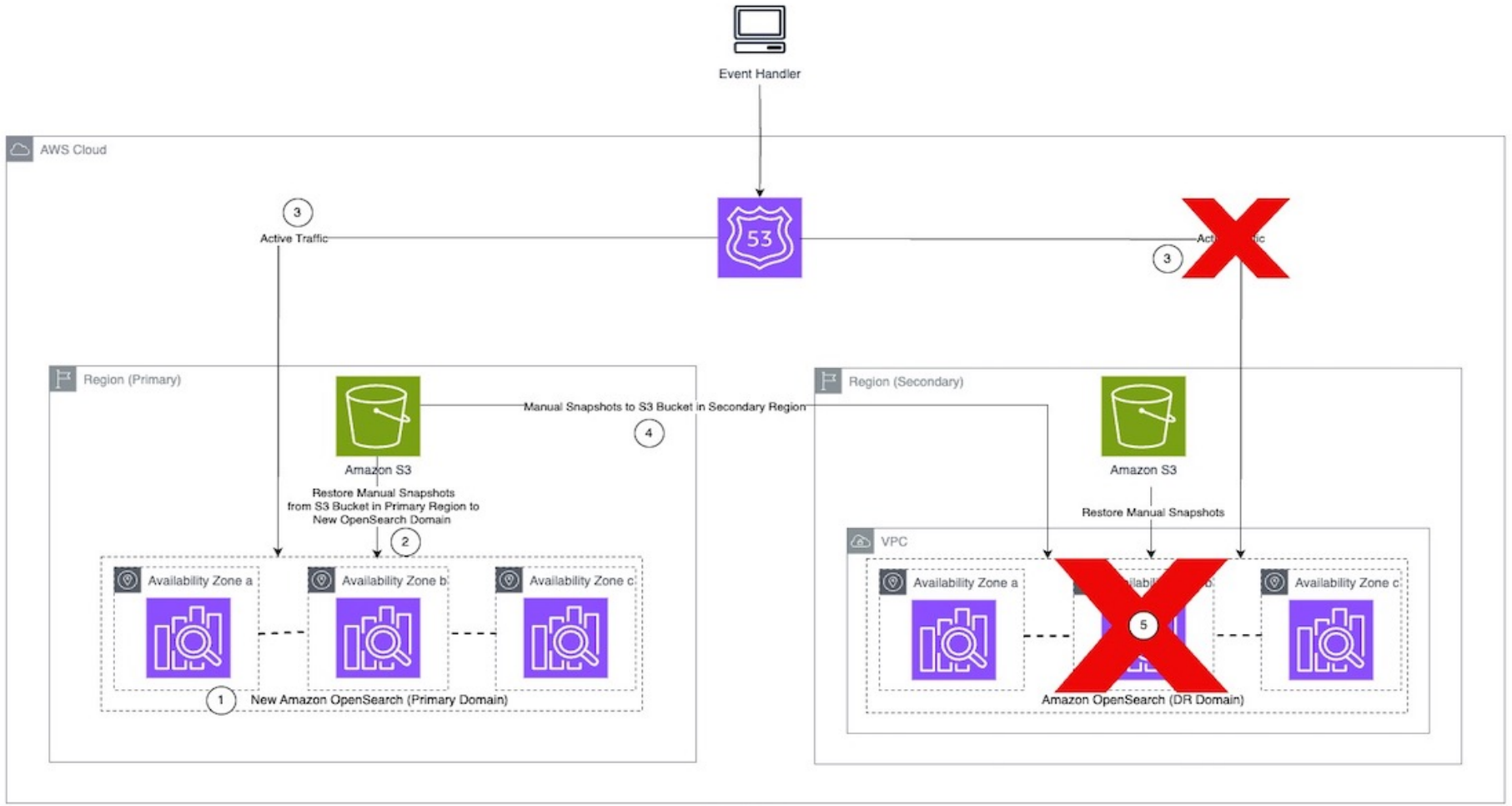
Snapshot based recovery : Reference Architecture



In the event of a disaster



Primary region becomes available



Reference Architecture — Multi-Region Warm Standby

End-to-end view of a tier-1 OpenSearch DR setup

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Clients → Global DNS / Health-checked endpoint (Route 53 / CloudFlare / NS1)

REGION A — Primary (active)

- **Ingest pipelines**
- **Application reads/writes**
- **OpenSearch cluster (3 AZs)**
  - 3 CM • 6 data • 3 coord
  - Allocation awareness ON • 1+ replica per index
- **Snapshot repo: s3://prod-snapshots-region-a**
- **Metrics → Prometheus / OpenSearch Dashboards**

CCR ⇒

S3 CRR ⇒

REGION B — DR (warm standby)

- **Ingest (parallel)**
- **Read-only (until failover)**
- **Follower cluster (3 AZs)**
  - Right-sized • CCR follower indices
  - Auto-scaling group ready to scale on promote
- **Snapshot repo: s3://prod-snapshots-region-b**
- **Same observability stack — pre-wired**

Monitoring Cluster Health

What to watch, before something goes wrong

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Cluster status

GREEN / YELLOW / RED — page on RED, escalate on YELLOW > 5m

Search latency p99

Watch tail latency, not averages

JVM heap

< 75% used; sustained > 85% = imminent GC pressure

Disk watermark

Stay under low watermark (85%); high (90%) blocks writes

Pending tasks

> 50 sustained = cluster manager bottleneck

Snapshot success rate

100% expected; one failure = page

Indexing latency p99

Track per index; correlate with merge & refresh activity

Replication lag

Per-index follower lag in seconds; alert > 60s sustained

Lessons Learnt

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The Silent Snapshot Failure : Real story: 6 months of 'green' backups, none restorable

What happened

- IAM role rotated; snapshot writes silently 403'd
- Repository status check missing from monitoring
- Discovered during a real incident requiring a restore
- Restored from a 7-month-old snapshot — multi-day data loss

Fix

- Page on snapshot failure events explicitly
- Quarterly restore drill — no exceptions
- Repository health check in synthetic monitoring
- Object Lock + bucket policies that survive role rotation
- Snapshot age SLO: 'newest snapshot < N minutes old'

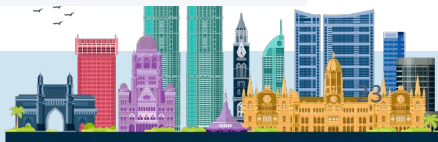
The Single-AZ Cluster That Wasn’t Multi-AZ in name only

What happened

- Cluster ran across 3 AZs — but no allocation awareness
- All replicas of one hot index ended up in AZ-a
- AZ-a outage took the index offline despite multi-AZ topology
- 30 minutes of search errors before traffic shifted

Fix

- Set node.attr.zone on every node
- Enable forced awareness with all 3 zone values
- Validate post-deploy: _cat/shards | grep <index>
- Add a synthetic 'zone diversity' test to CI
- Game-day: simulate AZ loss and watch behavior



The Failover That Failed Open : Auto-promoted, but with stale data

What happened

- Network partition between regions tripped auto-failover
- CCR follower was 4 minutes behind
- Promoted follower; primary recovered moments later
- Result: split-brain writes, manual reconciliation

Fix

- Region failover requires human approval — always
- Replication-lag gate before promotion
- Fence the old leader before flipping DNS
- Idempotent ingest pipelines so replays are safe
- Quarterly fail-back drill, not just fail-over

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Thank you!

Questions, war stories, and follow-ups welcome.


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