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How DTCC achieves data resiliency with Snowflake and AWS

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About DTCC



Our promise: We deliver resiliency, value, and expertise for our clients. We were built in partnership with the industry to provide stability and efficiency in the global capital markets. With a focus on exceptional service, we promise to advance solutions and next-level innovation.

With over **45 years of experience**, DTCC is the **premier post-trade market infrastructure** for the global financial services industry

From operating facilities and data centers around the world, DTCC, through its subsidiaries, **automates**, **centralizes**, and **standardizes** the processing of financial transactions across the trade lifecycle and **mitigates risk** for **thousands of institutions** worldwide

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We bring economies of SCALE

$2.37 QUADRILLION
securities processed in 2021

FIXED INCOME CLEARING

Processes **$4.5 trillion** per day in U.S. Government Securities and a monthly average of **8.35 trillion** Mortgage-Backed Securities transactions

SETTLEMENT & ASSET SERVICES

Worlds largest depository holds **1.39 million** active U.S issues worth **$87 trillion**

Settles **643 million** U.S. Transactions per year

EQUITIES CLEARING

Clears **202 million** Broker-to-Broker Transactions Per Day Worth **$2.02 trillion** for **50+** Exchanges and Trading Venues

DERIVATIVES REPORTING

Covers all asset classes and processes
16.5 billion messages annually for **8,500+ firms globally**

60+ regulators across the globe have access to our data from across 35 countries

INSTITUTIONAL TRADE PROCESSING

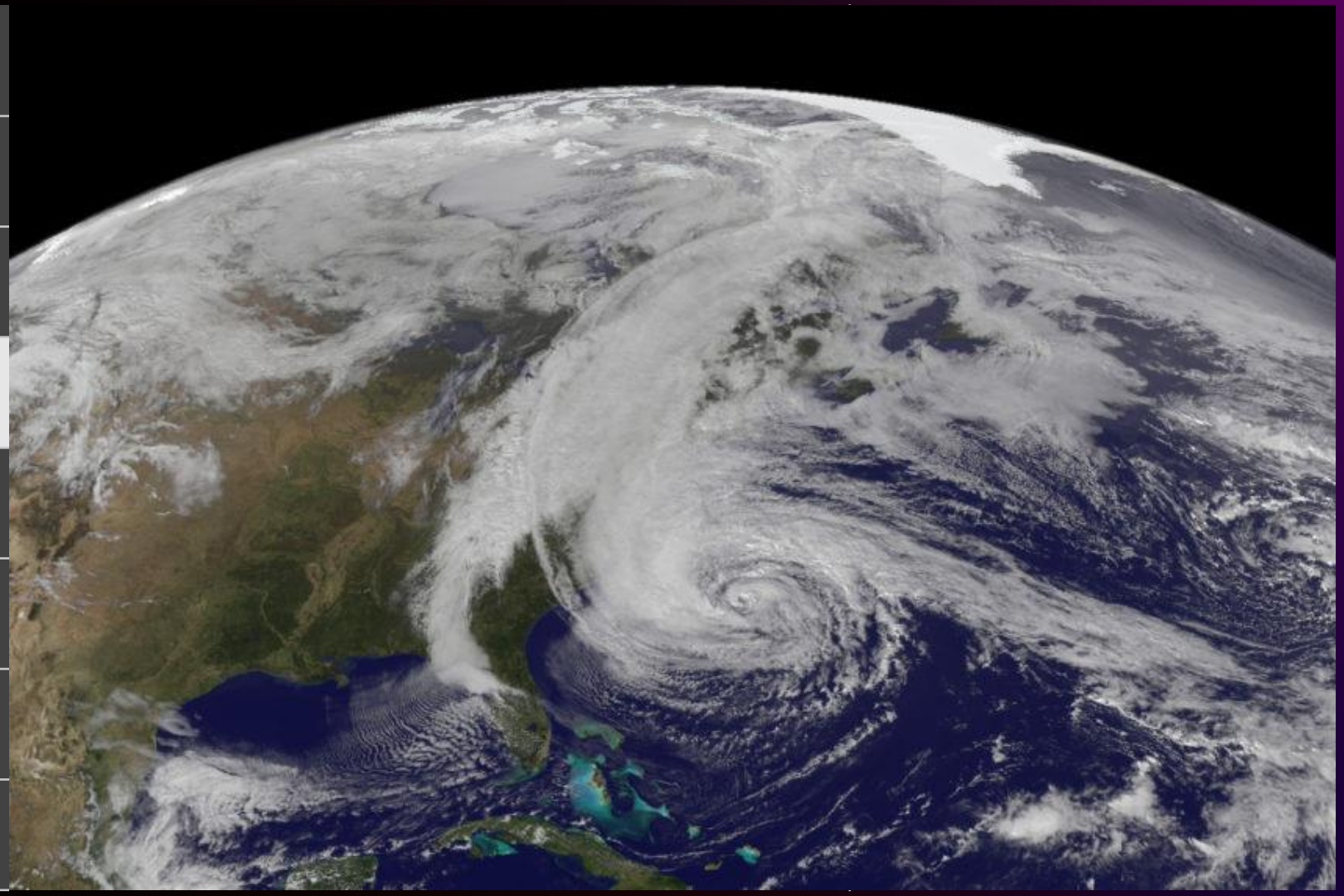
Processes an average of **3.3 million** institutional trades daily

Our unique capabilities and decades of experience deliver a network no other market infrastructure can match –
5,850 CLIENT FIRMS IN 93 COUNTRIES.

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Consequences of real-world disaster events

- Application failure
- Communication failure
- Data center disaster
- Building disaster
- Citywide disaster
- Regional disaster
- National disaster
- Multinational disaster



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DTCC resiliency principles

01	Design for resilient capabilities
02	Regional availability
03	Out-of-region recovery
04	Operational

SNOWFLAKE FEATURES

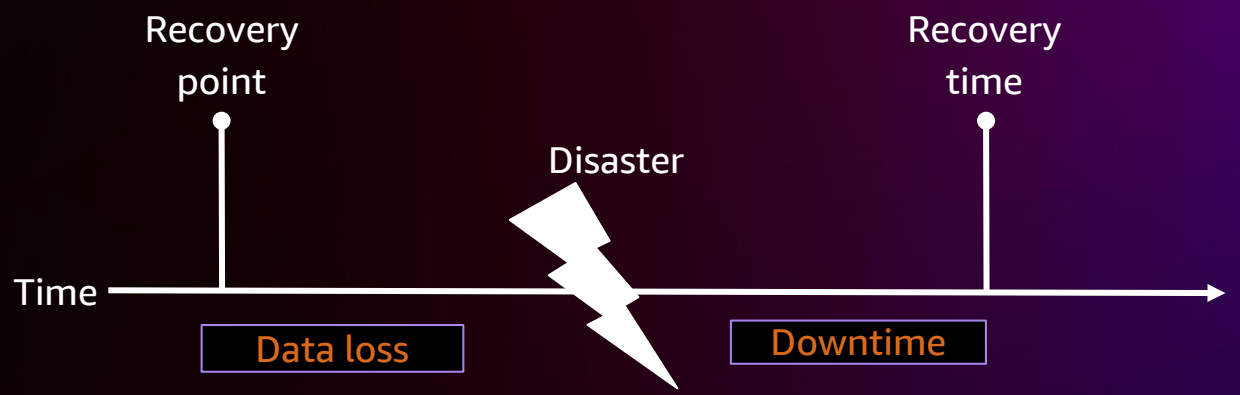
- **No single point of failure**
- **Scalability on demand**
- **Columnar, compressed data storage**
- **Multi-cloud support**
- **Time travel**
- **Fail-safe**
- **Replication and failover**
- **Client redirect**
- **SOC 1 and SOC 2**
- **Durability and availability SLA**

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What do we mean by business continuity?

1. Identify critical applications
2. Analyze business impact
3. Create plan and objectives



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What is Snowflake

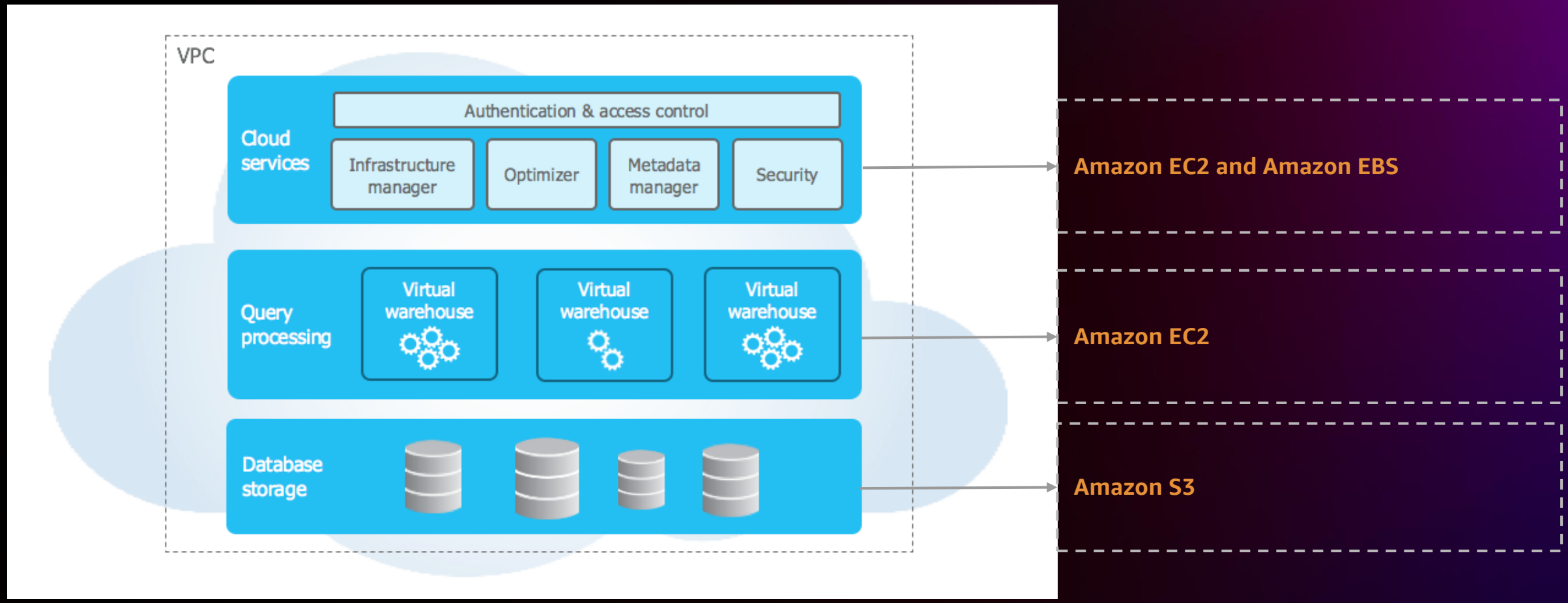
- Data Warehouse built on top of cloud platform
- Allows storage and compute to scale independently
- A true data platform as a service
- Handles infrastructure, optimization, data protection, and availability automatically
- Businesses can focus on using data and not managing it



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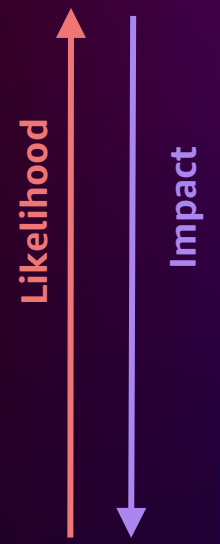
Snowflake architecture and AWS



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Preparing for different types of failures

Types of failures	
Customer error	Accidental data corruption or deletion due to human error
Single instance failure	Virtual machine fails due to hardware or system error
Zone failure	Loss of service availability in a single zone
Region failure	Loss of service availability in multiple zones in a region
Multi-region failure	Loss of service availability in multiple regions of a cloud provider



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Snowflake enables business continuity

POSSIBLE FAILURES AND HOW SNOWFLAKE MITIGATES THEM

Failure	Mitigation
Customer error	**Snowflake features** Time travel Fail-safe
Single instance failure	**Snowflake built-in redundancy** Triple-redundancy for critical services Automatic retries for failed parts of a query
Zone failure	**Snowflake built-in redundancy** Using Availability Zones on AWS
Region failure	**Snowflake features** Cross-region replication Cross-region failover
Multi-region failure	**Snowflake features** Cross-cloud replication Cross-cloud failover

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Snowflake replication at DTCC

Key stats

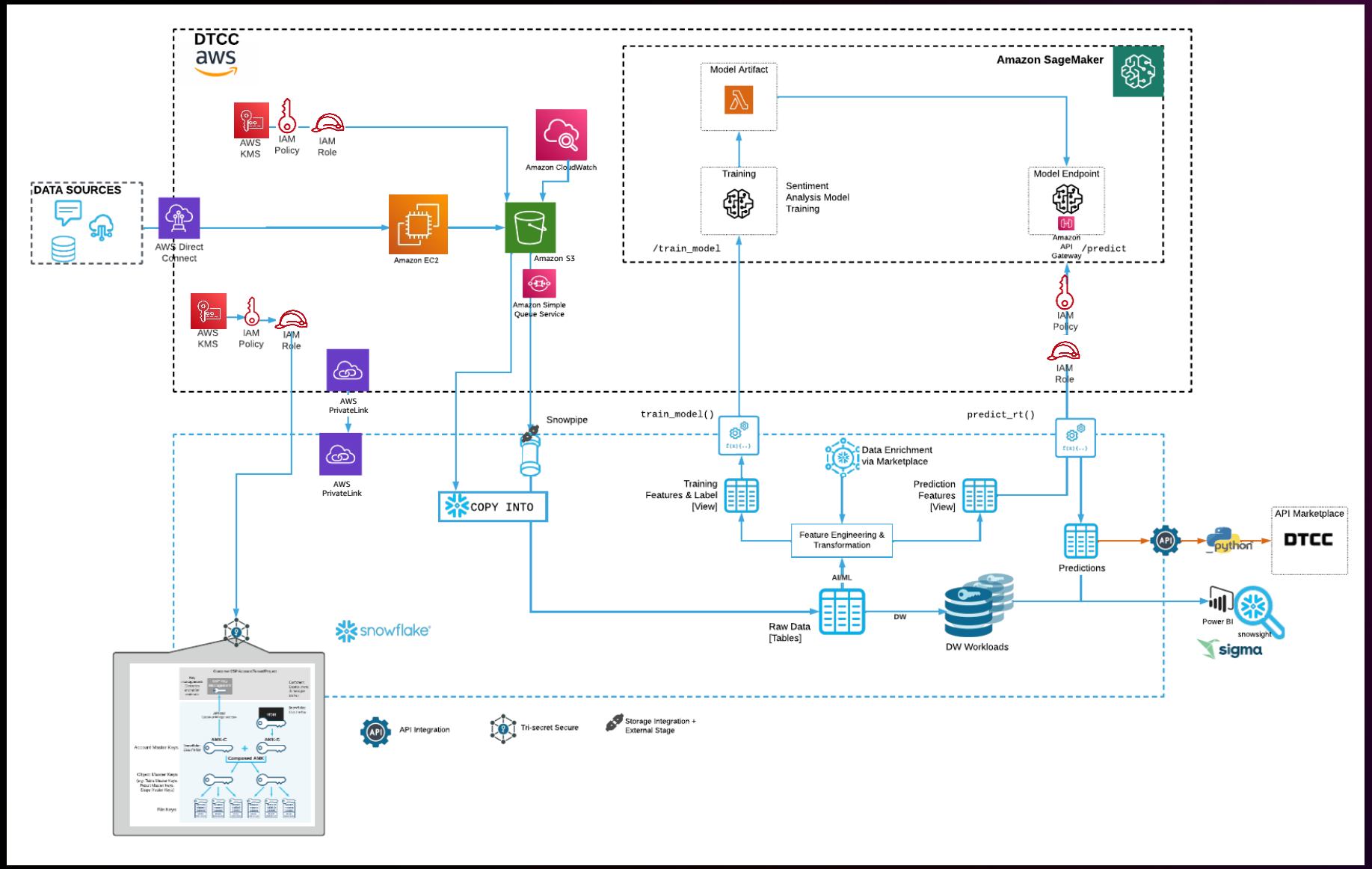
- Live and incident-free since June 2020
- 42 petabytes replicated across regions for over 30 DBs
- 350+ service accounts
- 400+ users
- 1,800 roles
- 300+ warehouses
- 15 applications running on it
- 700,000+ queries per day
- Participated in 15 DR exercises



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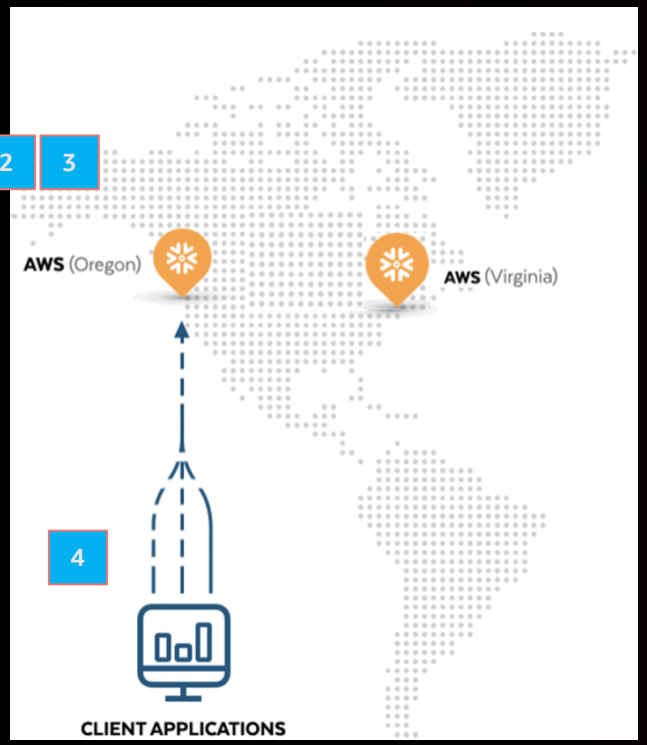
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AWS and Snowflake services used



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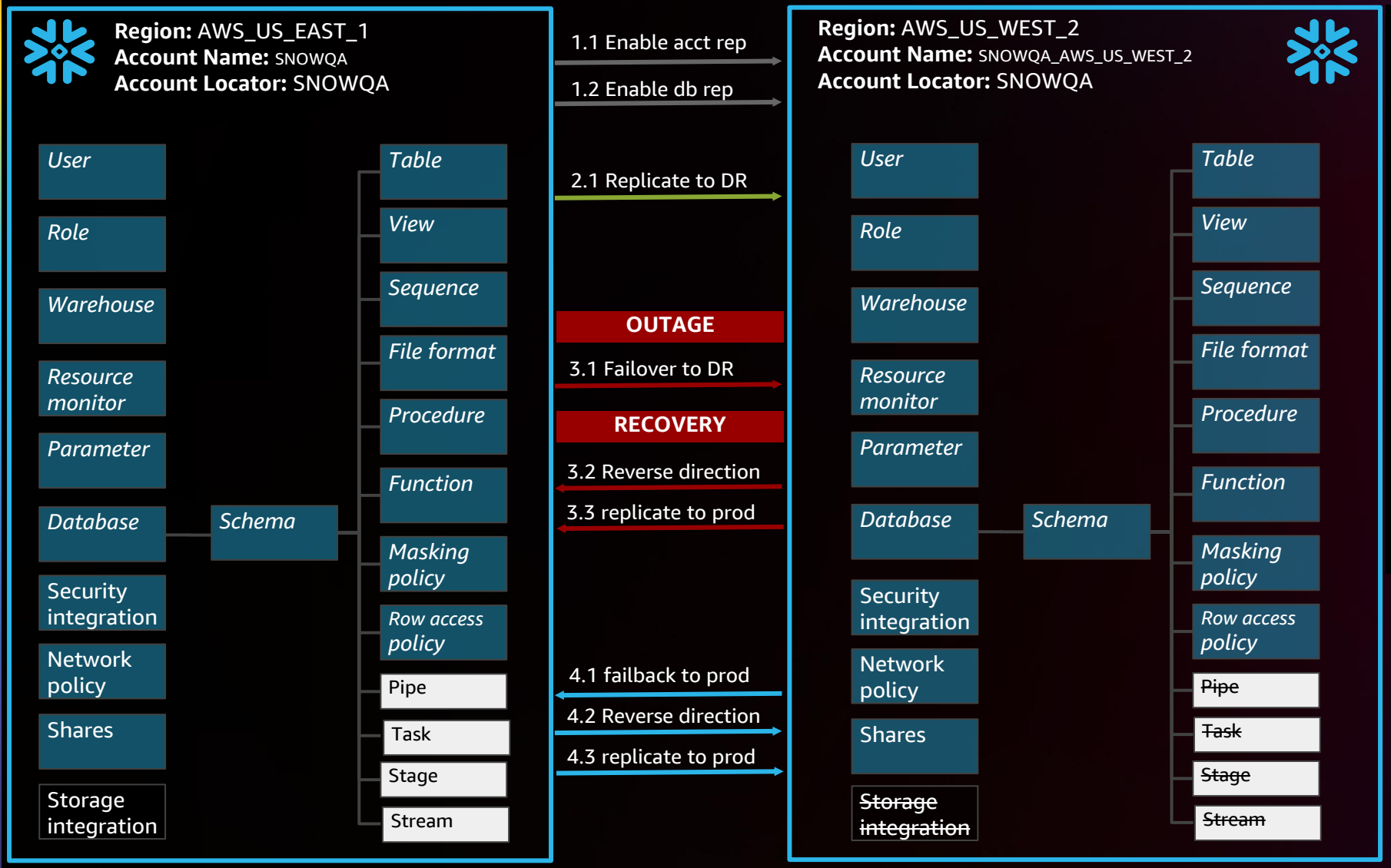
Business continuity



	Recovery point Near-zero data loss	Recovery time Instant recovery
1	Database replication	Database failover
2	Account replication	Account Failover
3	Pipeline replication	Pipeline failover
4	Client redirect	

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Disaster recovery flow



1. DR setup
    1. Enable account replication
    2. Enable DB replication & failover
2. Pre-failover
    1. Replicate to DR
3. Failover
    1. Failover to DR
    2. Reverse direction (DR to prod)
    3. Replicate to prod
4. Failback
    1. Failback to prod
    2. Reverse direction (prod to DR)
    3. Replicate to DR

Replicated | Not replicated

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Account replication and failover groups



```
create failover group MY_FAILOVER_GROUP

      object_types = ALL
      #                    ( USERS
          , ROLES
          , ONWAREHOUSES
          , RESOURCE MONITORS
          , DATABASES
          , NETWORK POLICIES
          , INTEGRATIONS
          , SHARES )

      allowed_databases = ALL
      #  ( DB1, DB2, ... )


      allowed_accounts = DTCC.SNOWPROD_AWS_US_WEST_2



            replication_schedule = 10 MIN
;
```

WHAT
to replicate

WHERE
to replicate it

WHEN
to replicate

BENEFITS

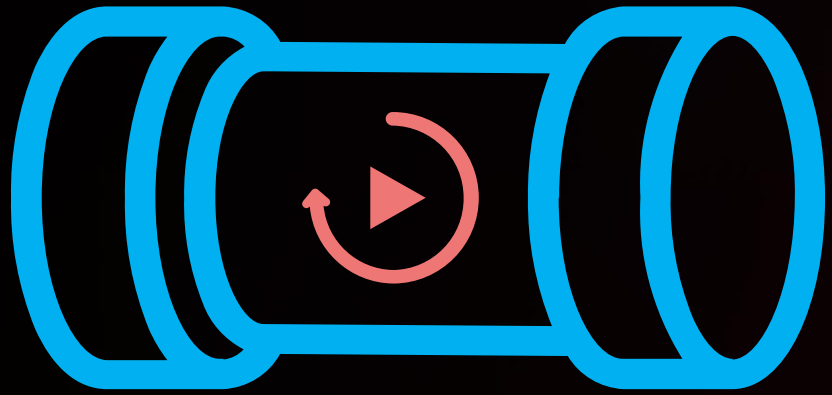
- Account object replication
- Point-in-time consistency
- Centralized governance
- Flexibility
- Cost effective
- Ease of use

Requires business-critical edition

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Pipeline replication

Coming soon . . .



Replay pipelines from last replication point to fully recover data in idempotent way (i.e., deduplicating data)

BENEFITS

- **Pipeline object replication**

  External stages
  Storage integrations
  Pipes

- **Idempotent loads after failover**

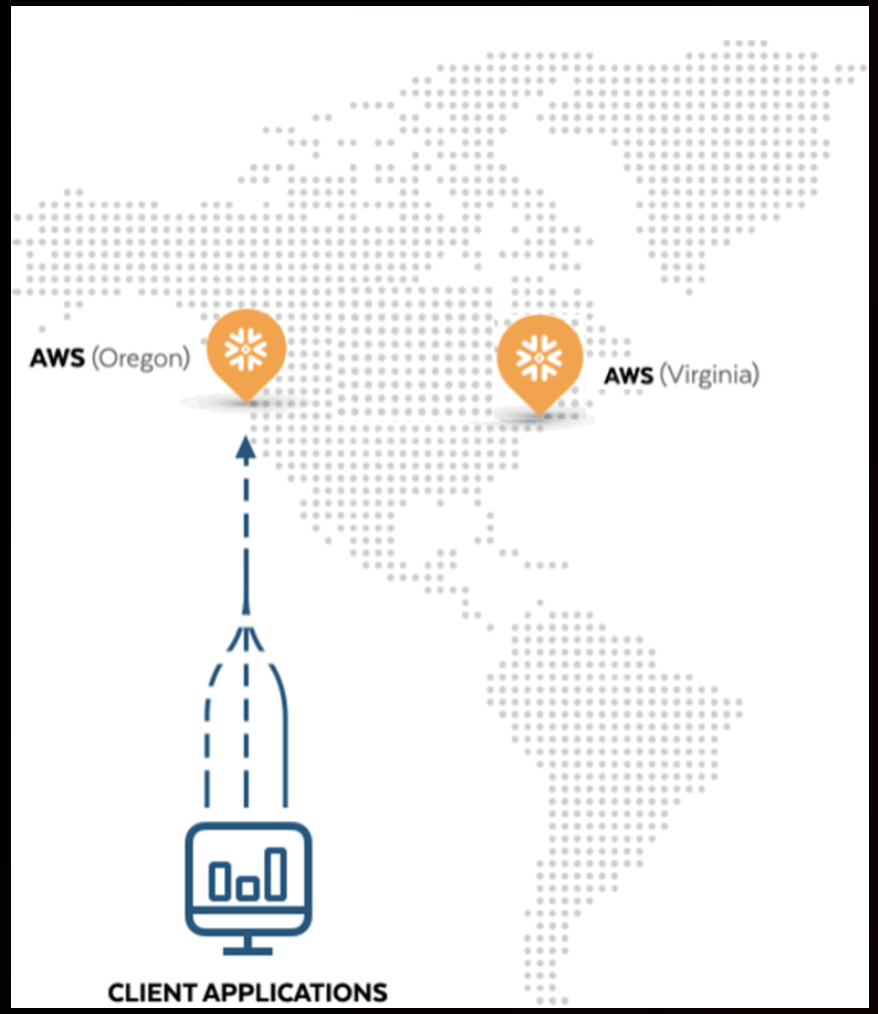
  History of copy and Snowpipe loads is replicated and prevents duplicate loads

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Client redirect

REDIRECT CLIENT CONNECTIONS TO THE SECONDARY REGION WITH A SINGLE SERVER-SIDE COMMAND



BENEFITS

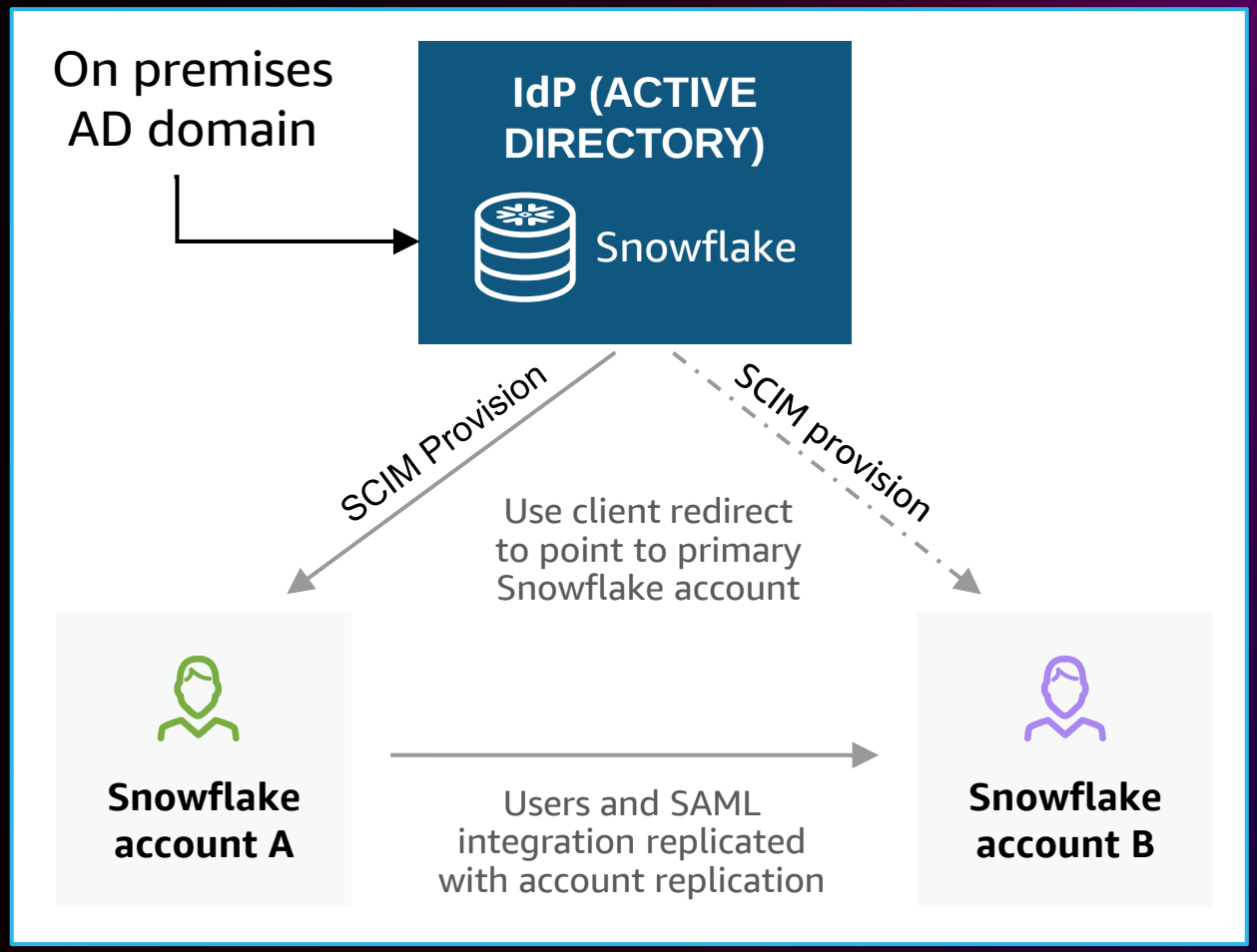
- **New connection URL**
  Can be failed over across regions and clouds
- **Supports all clients**
  SnowSQL, Python, JDBC, ODBC, Go, Node.js, .NET, Snowflake UI
- **Redirects instantly**
  Connections redirect within 30–45 seconds
- **Supports PrivateLink**
  - Private connections routed via customer's DNS
  - Customer creates & updates CNAME

Requires business-critical edition

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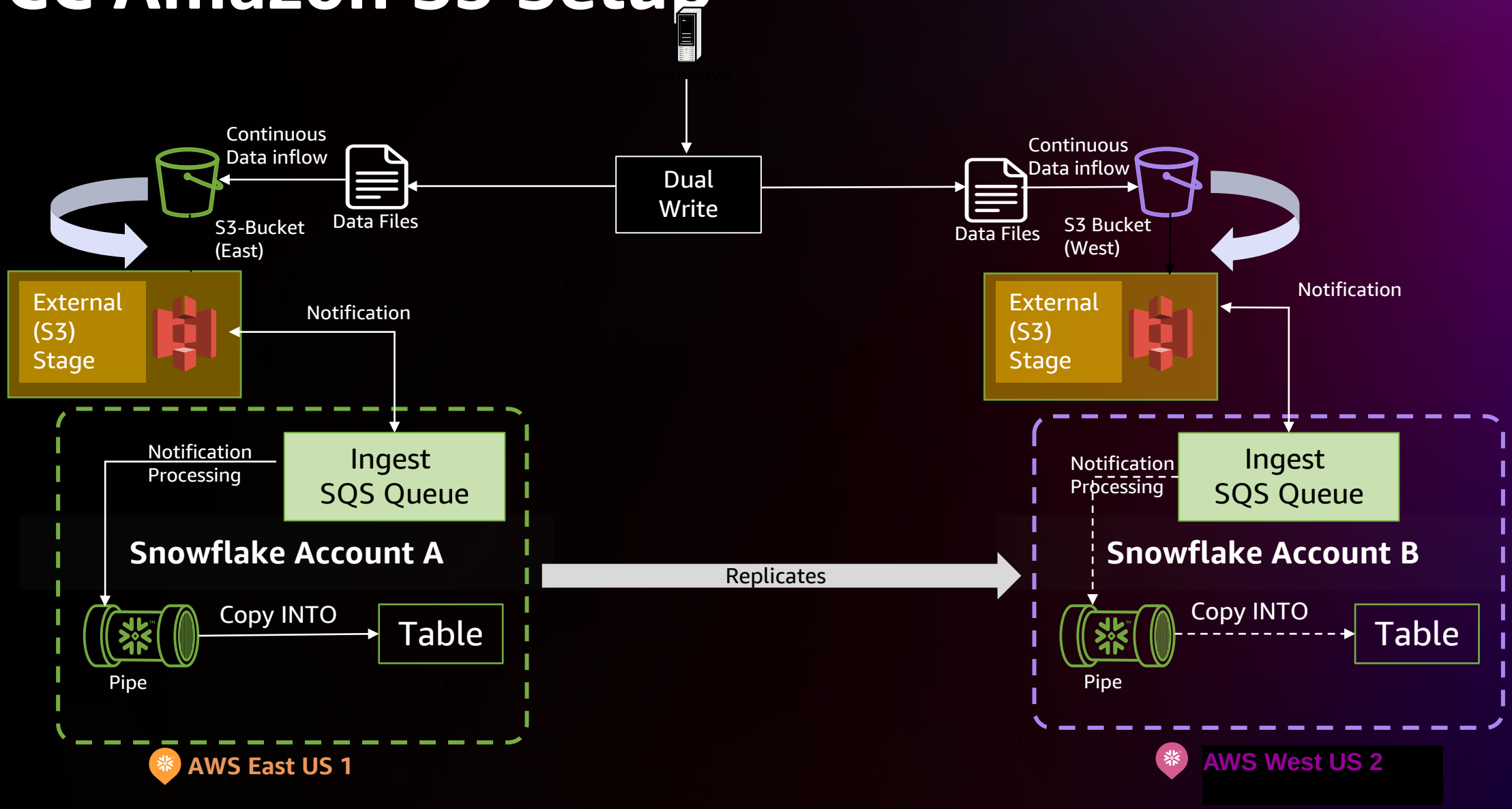
Seamless identity and user authentication

- **Password**
- **Password with multi-factor authentication**
- Multi-factor authentication
- Key pair
- **Federated Authentication and SSO**
- Snowflake OAuth
- External OAuth



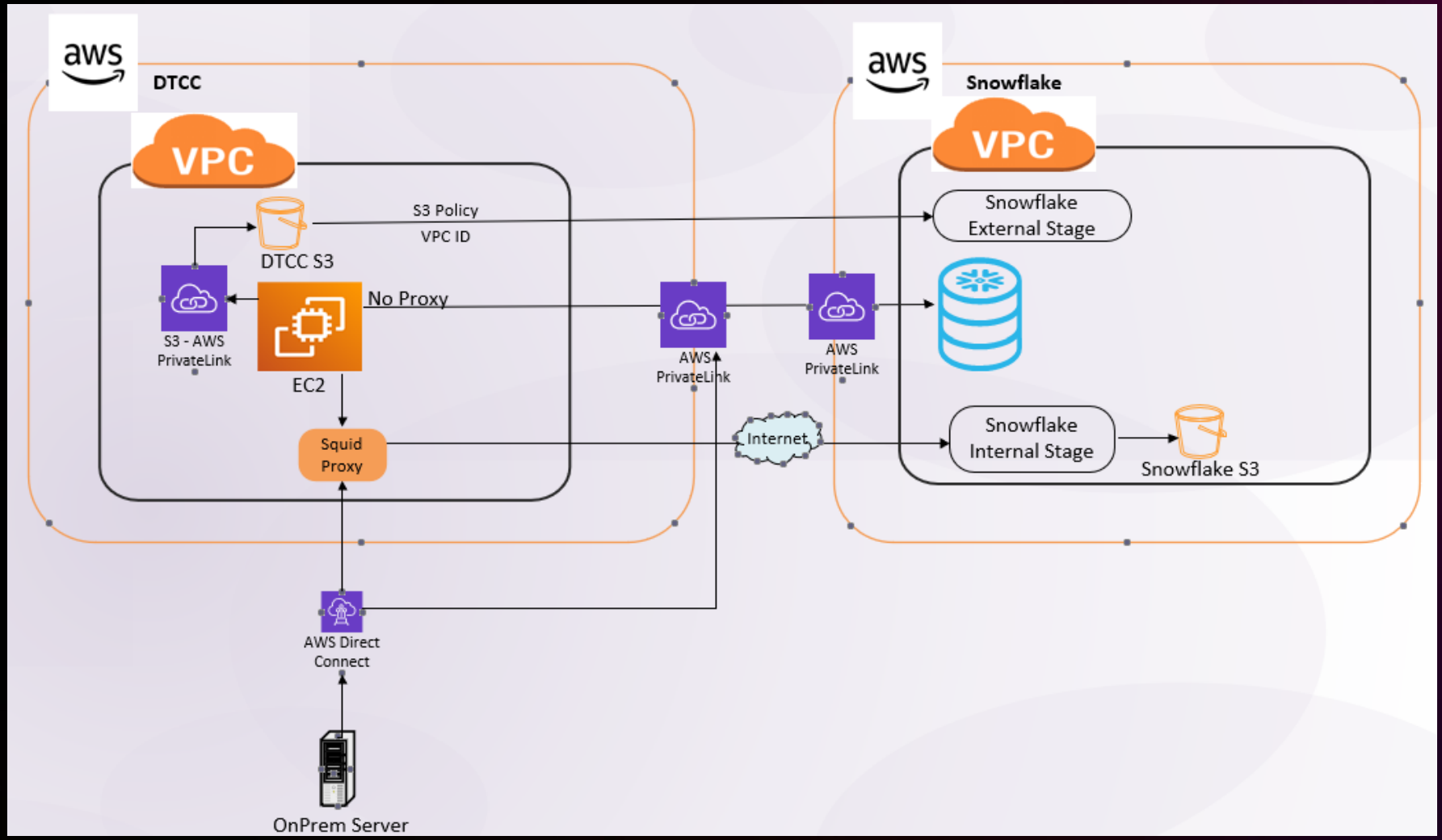
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DTCC Amazon S3 Setup



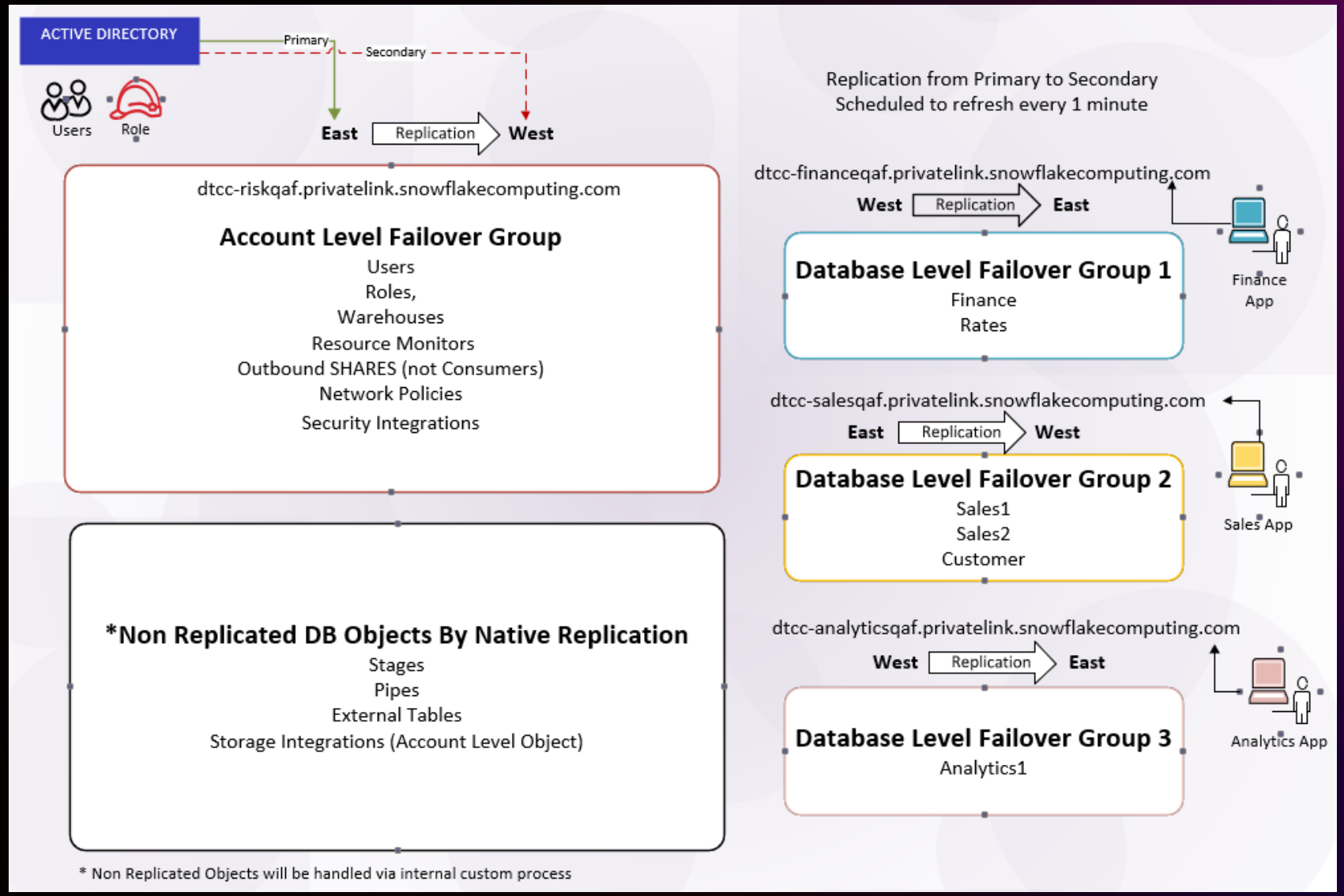
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AWS PrivateLink connectivity from on premises to cloud



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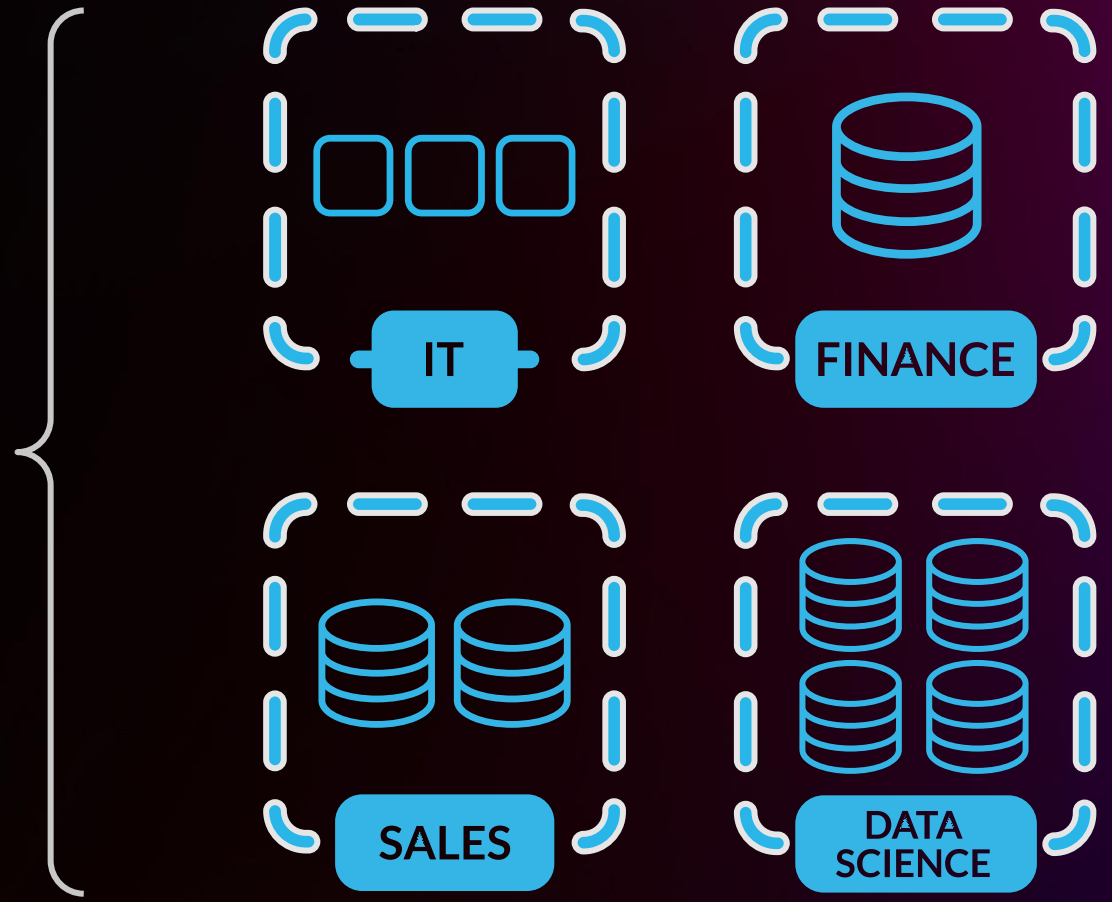
App Rotation Model in Snowflake (sample use case)



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Flexibility for different failover scenarios

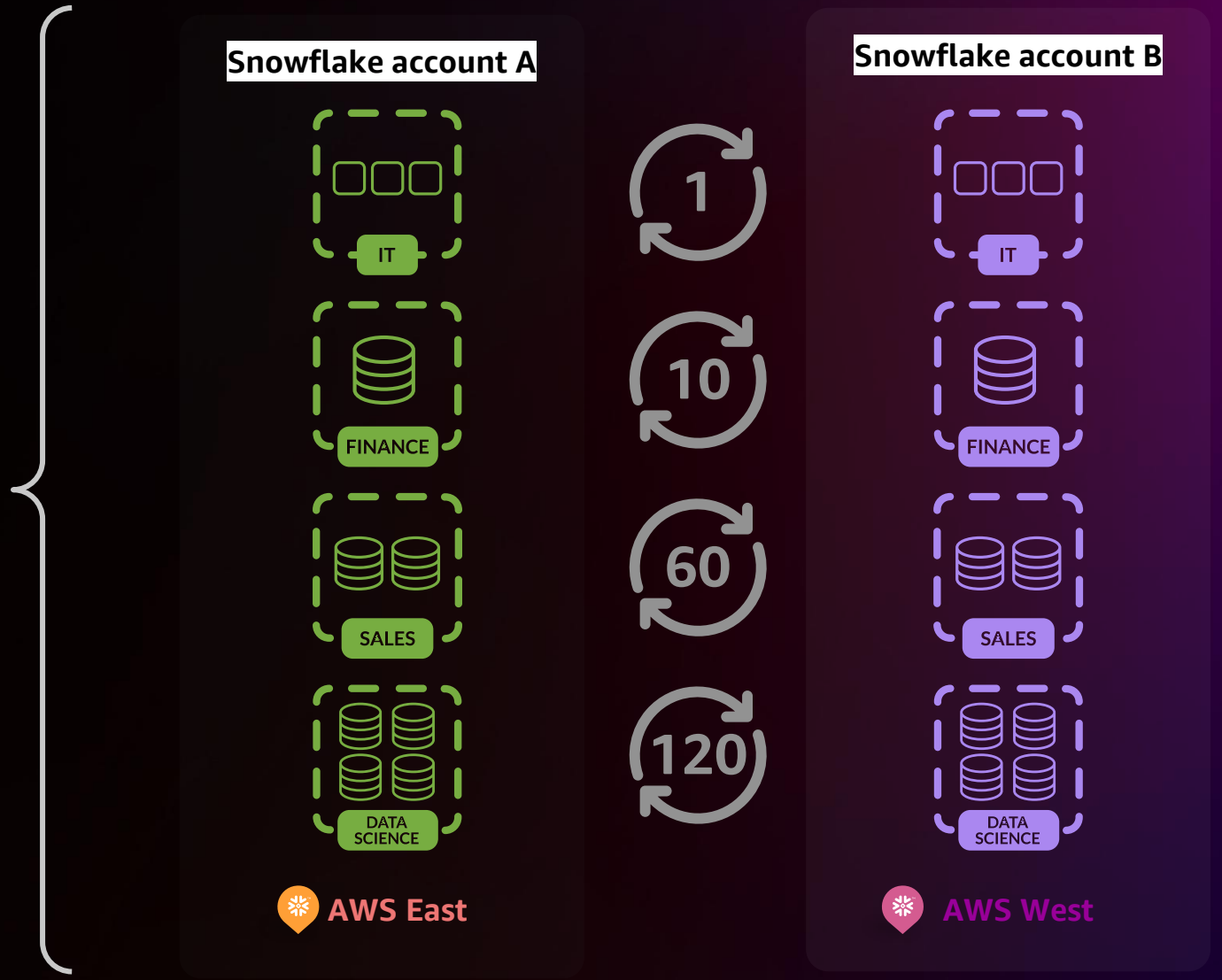
Or you can create multiple groups for flexibility



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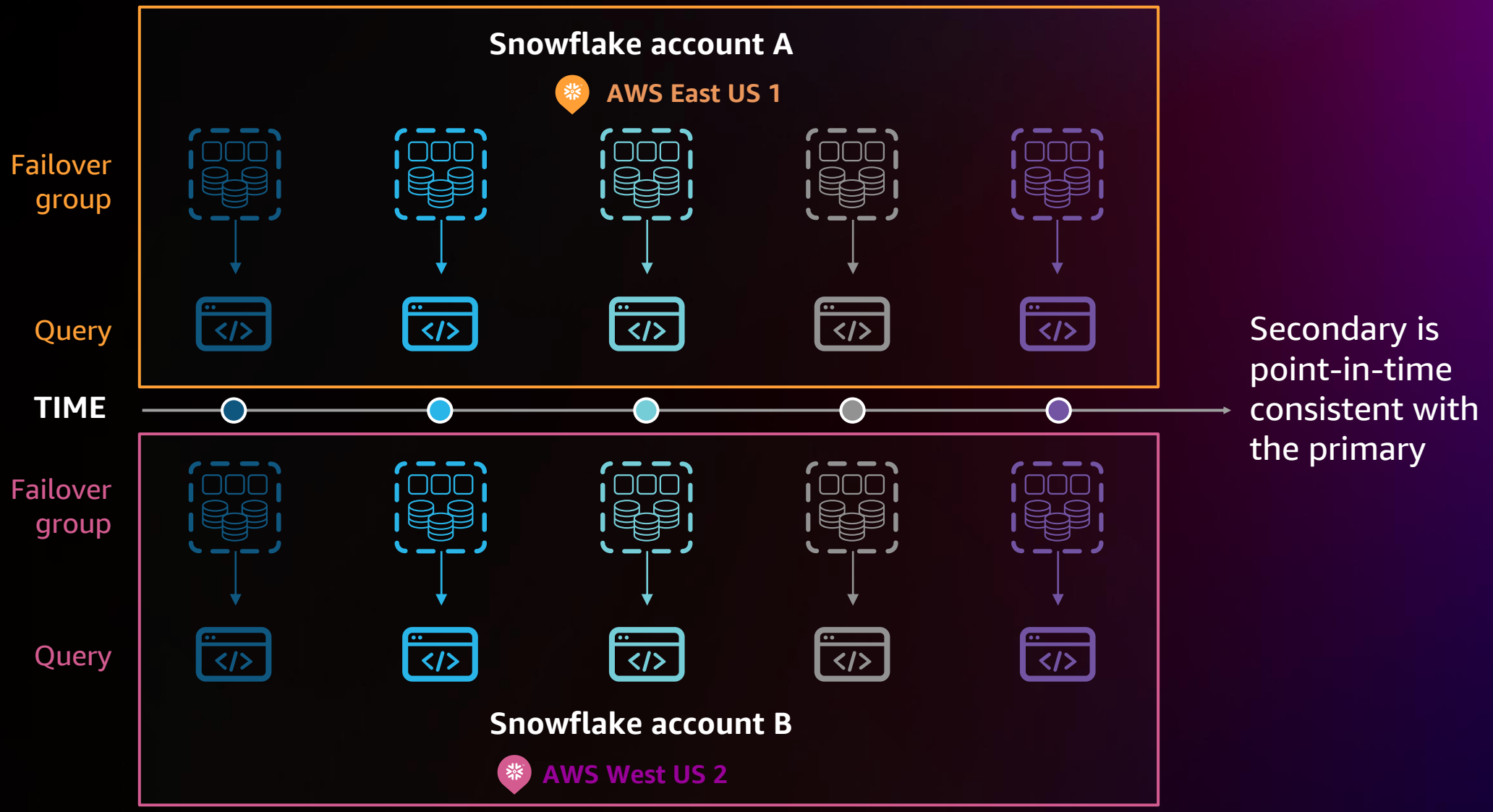
Flexible for different failover scenarios

You choose the replication schedule for each failover group based on the tier of application



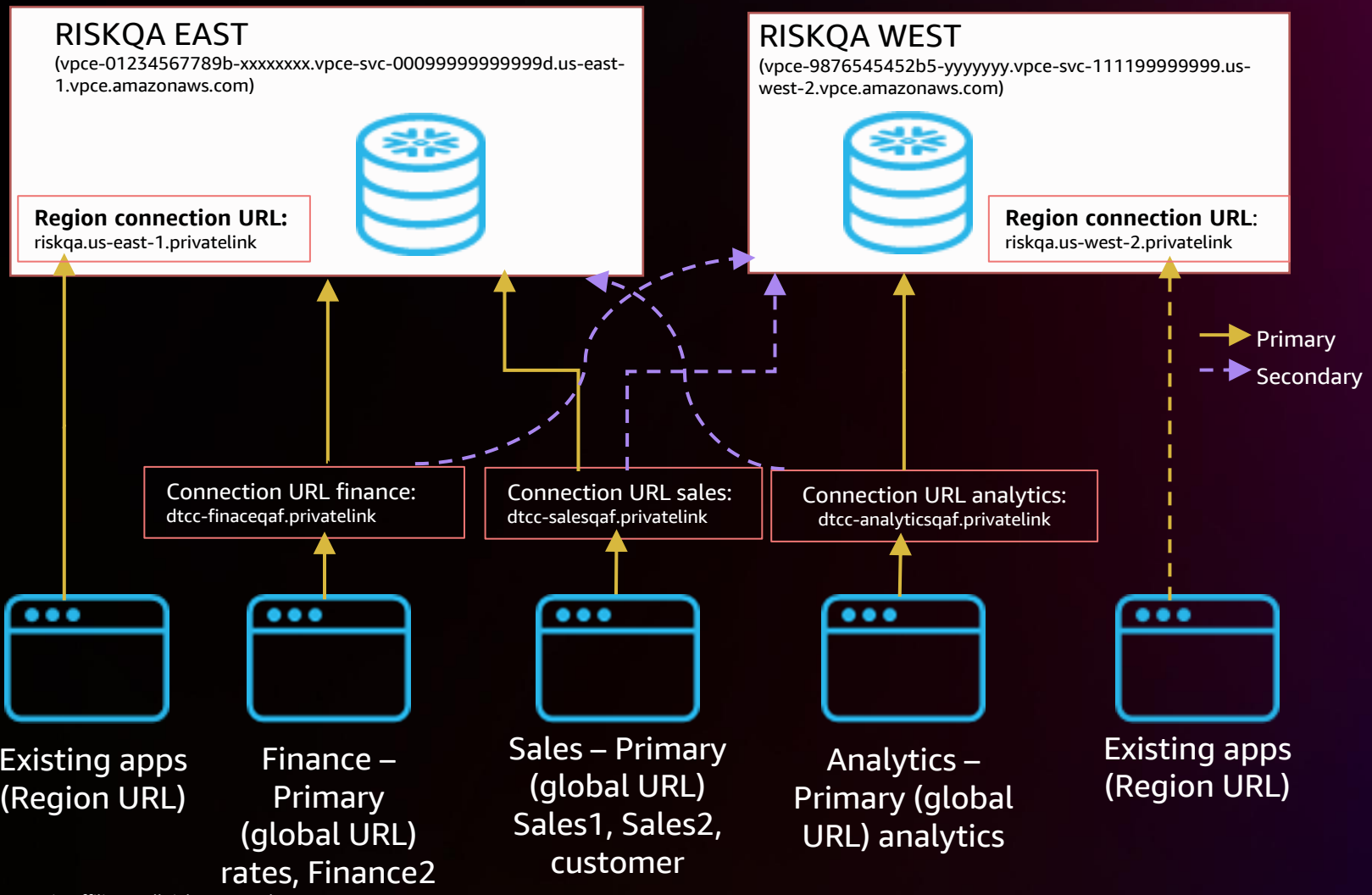
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Point-in-time consistency



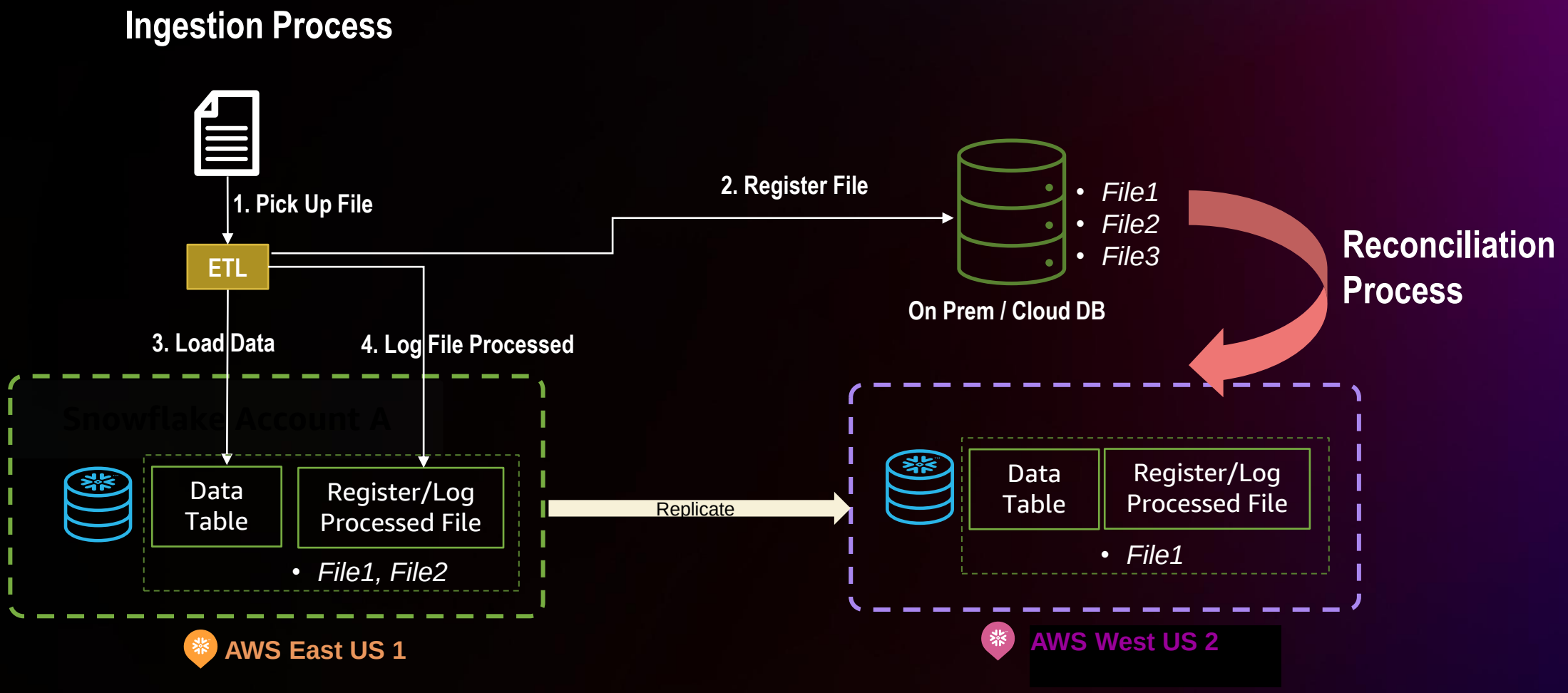
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Connection global URL for application rotation/client redirect



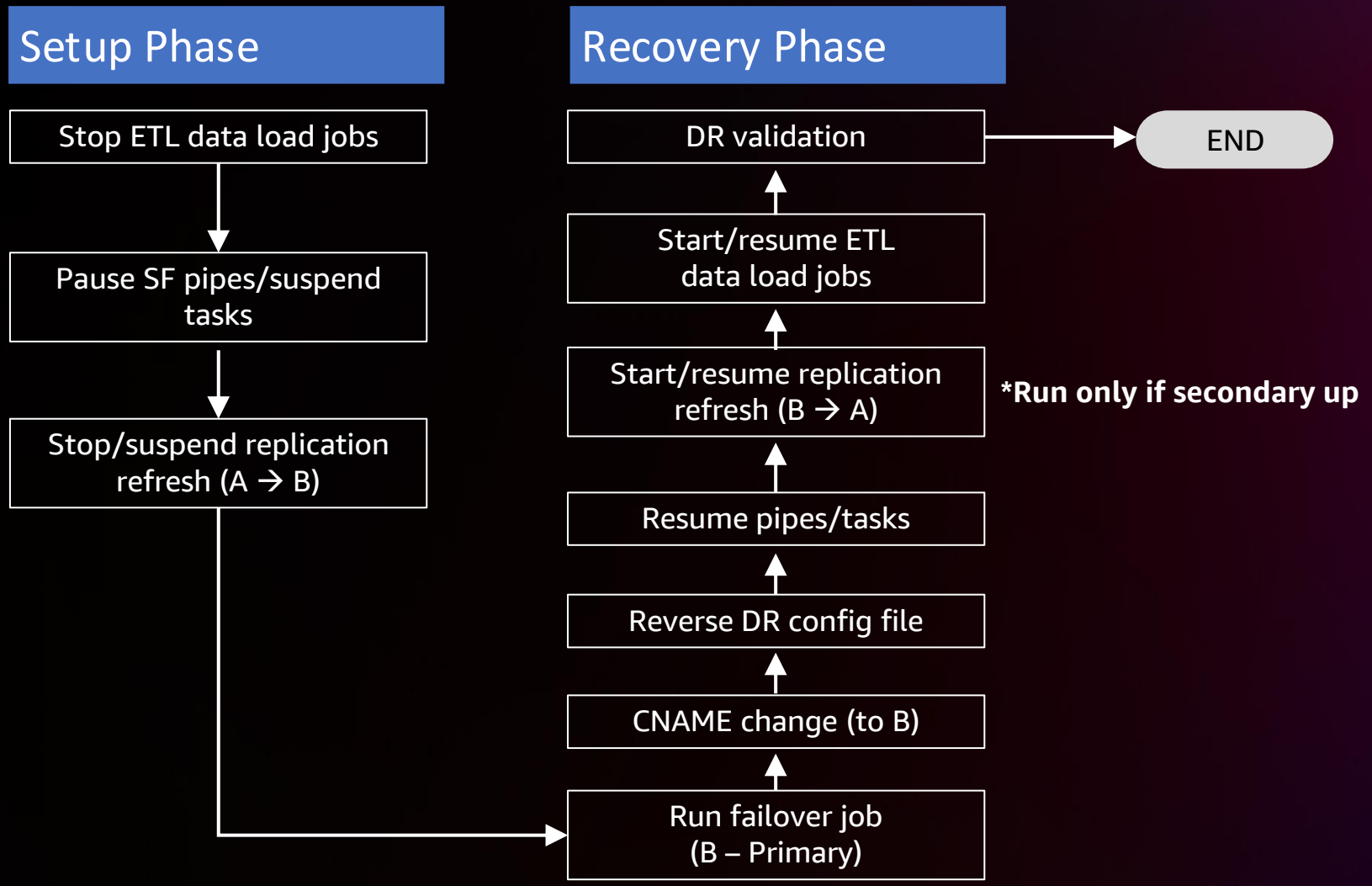
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Replay missed data loads after DR



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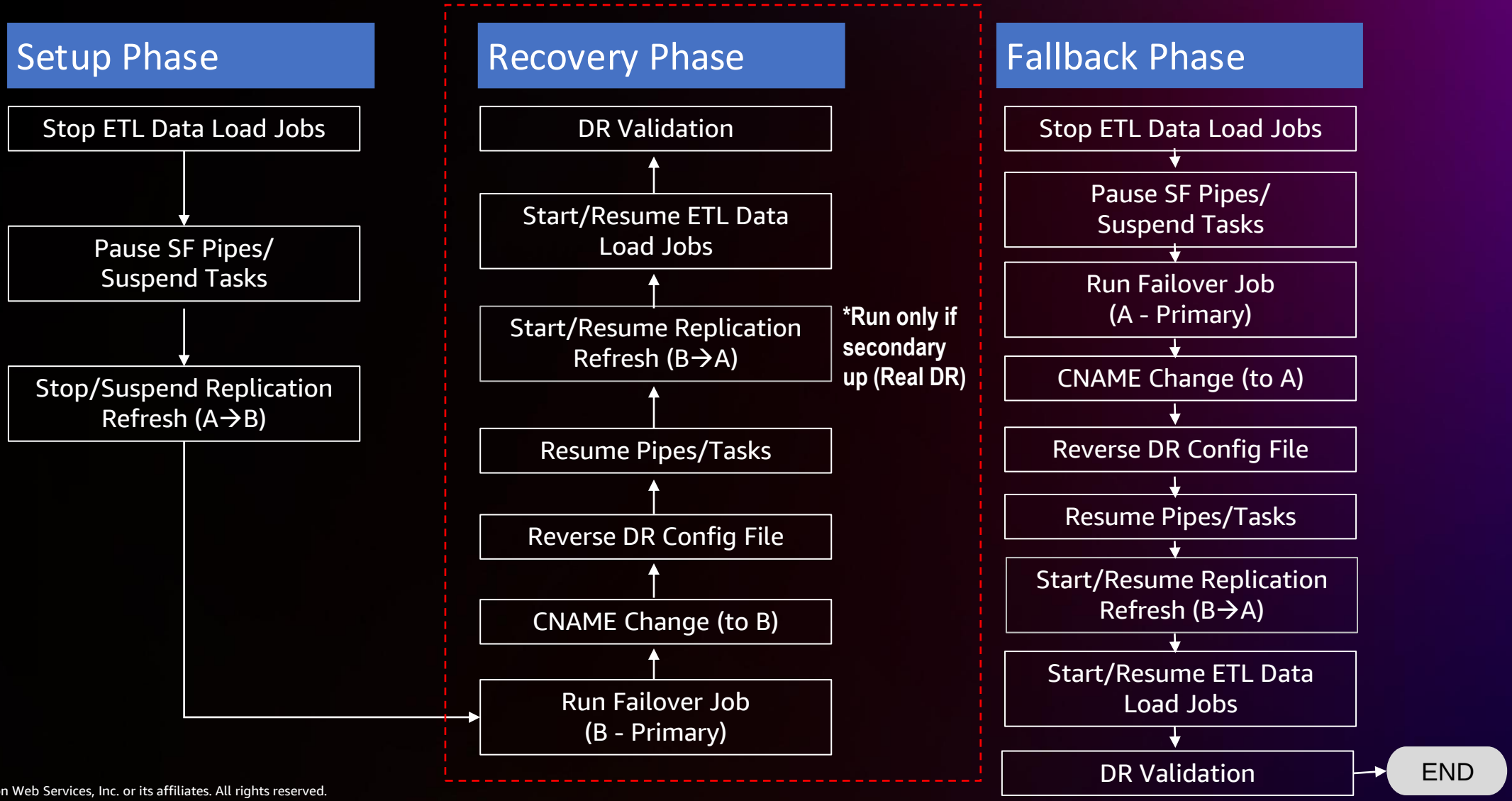
App rotation for extended runs – Process flow



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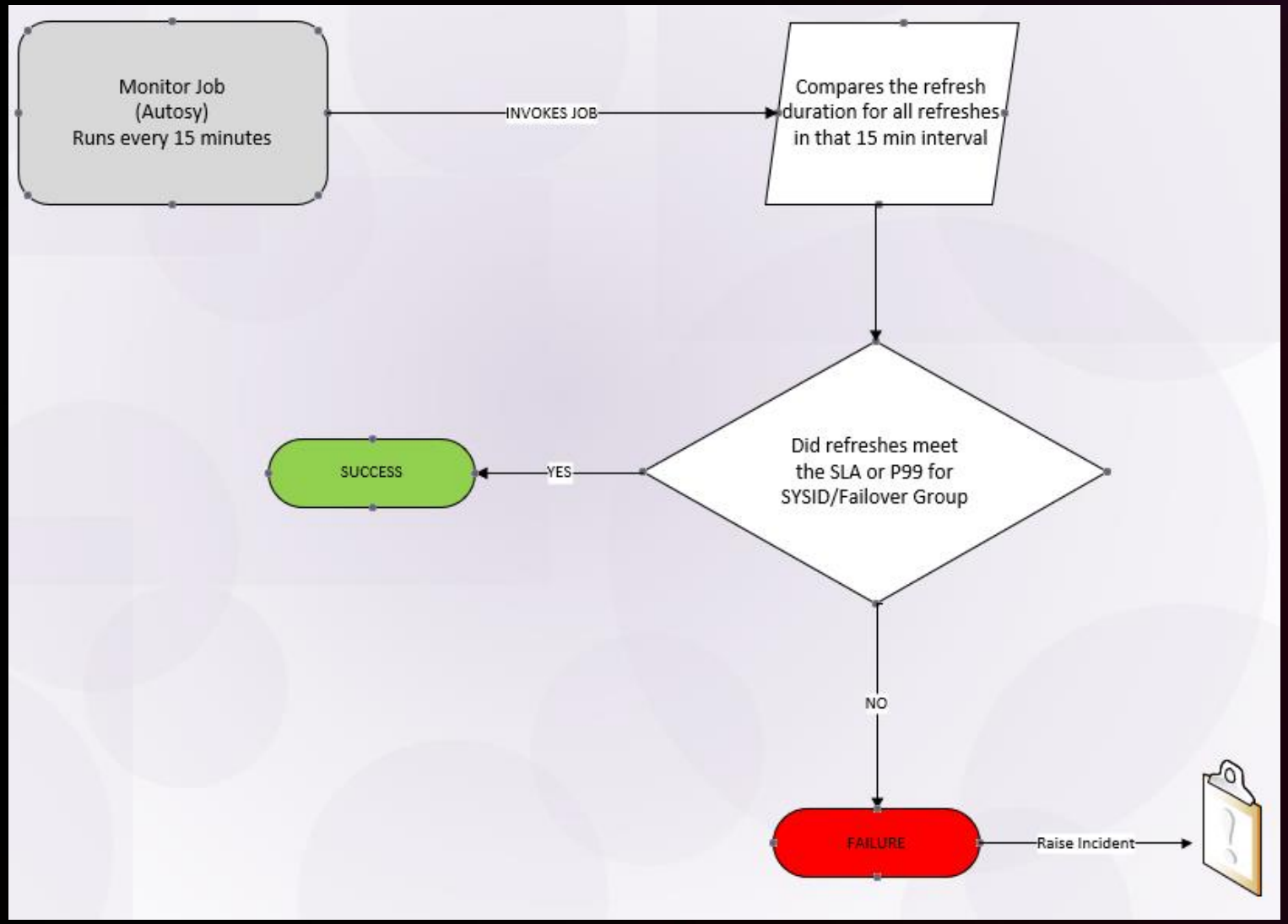
Planned DR exercise – Process flow

Developing a disaster recovery runbook that can be run by the level 1 team



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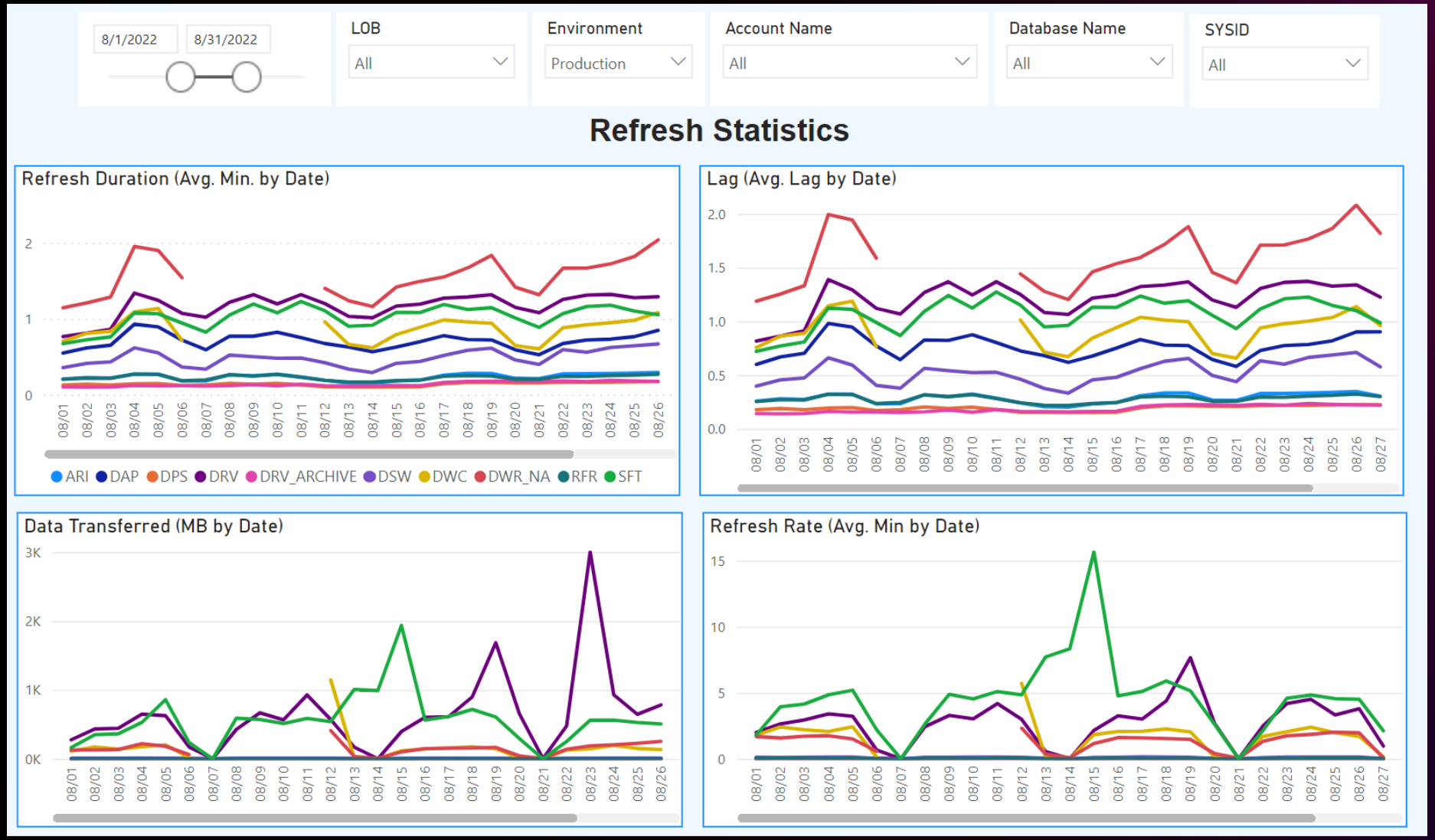
Monitor data refresh duration and lags



- Refresh Durations
- Refresh Lags
- P99 for SLA
- Refresh Failures

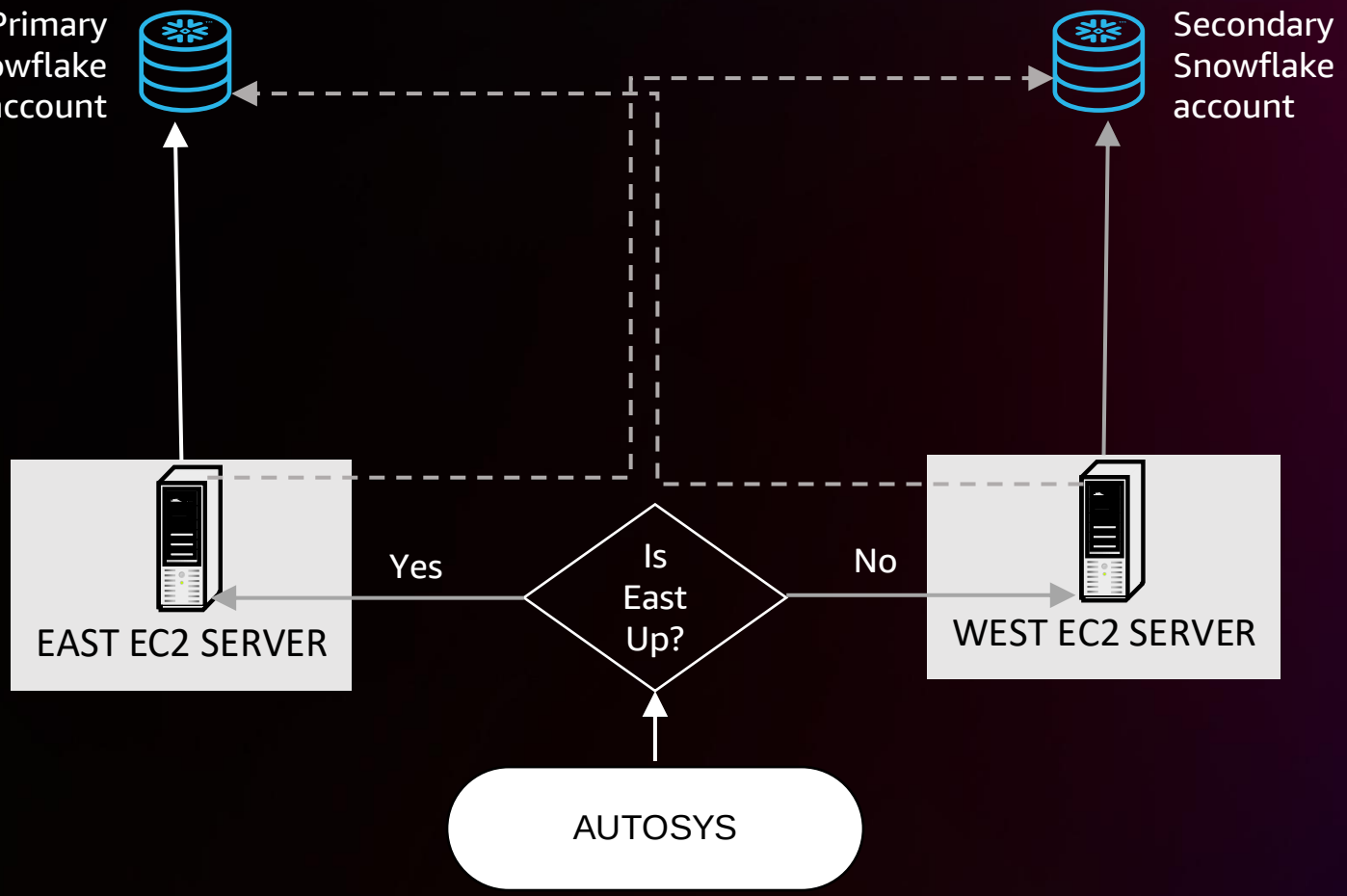
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Monitor replication



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Replication orchestration



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One code base deployed globally



Develop code once and deploy across the globe

Simplicity of design leads to cost savings

Centralized execution and management of replication

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Benefits of Snowflake replication and failover for DTCC



Consistency

Automated syncing across primary and secondary accounts and cloud providers removed operational burden of manual migration tasks



Speed

Completed in less than 3 days as replication was easy to set up, configure, and carry out



Savings

~30% cost savings over unloading and transferring data ourselves with optimized transfer in Snowflake replication



Collaboration

Partnership with Snowflake team to access and use a feature in private preview

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Key takeaways

Plan — Understand your company assets and prepare for many types of disasters

Test — Put your plan to the test

Automate — Add automation and training

Measure — Create benchmarks on timing, cost, and more – Keep improving!

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Questions?

And feedback?

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Thank you!

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