



IMS Replication For High-Availability

**Presented to the
Virtual IMS User Group**

August 9th, 2011



Agenda

- Introduction
- IMS Replication Basics
- Replication Components
- Conflict Detection / Resolution
- Source to Target Consistency Checking
- Target Re-Materialization
- Q&A
- Wrap Up

About the Speaker



➤ **Scott Quillicy**

- ✓ 28 Years Database Experience
- ✓ Commercial Database Software Development
- ✓ Deployment of Complex Data Replication Solutions

➤ **Founded SQData to Provide Customers with:**

- ✓ An Enterprise Class Replication / CDC Solution
- ✓ A Cost Effective Alternative to More Expensive Solutions
- ✓ The 'Swiss Army Knife' of Data Integration Tools

➤ **Specialization**

- ✓ IMS – the More Complex, the Better
- ✓ Heterogeneous Database Replication
- ✓ Database Performance
- ✓ Best Practices to Avoid Costly Mistakes (SQBP)

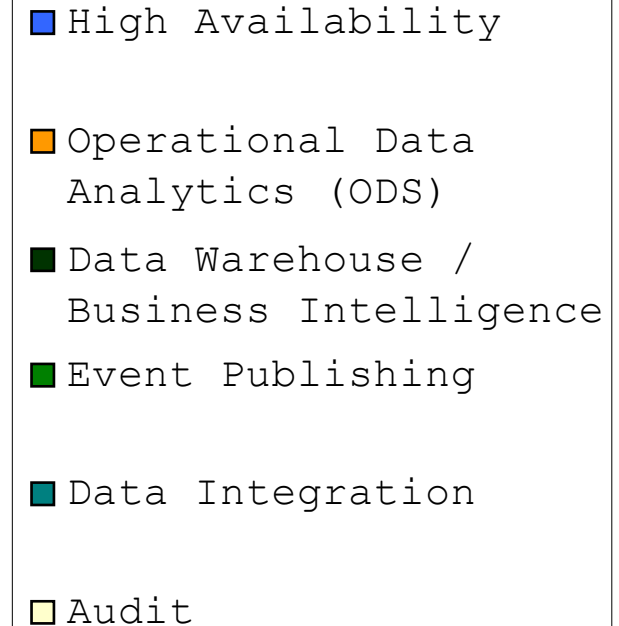
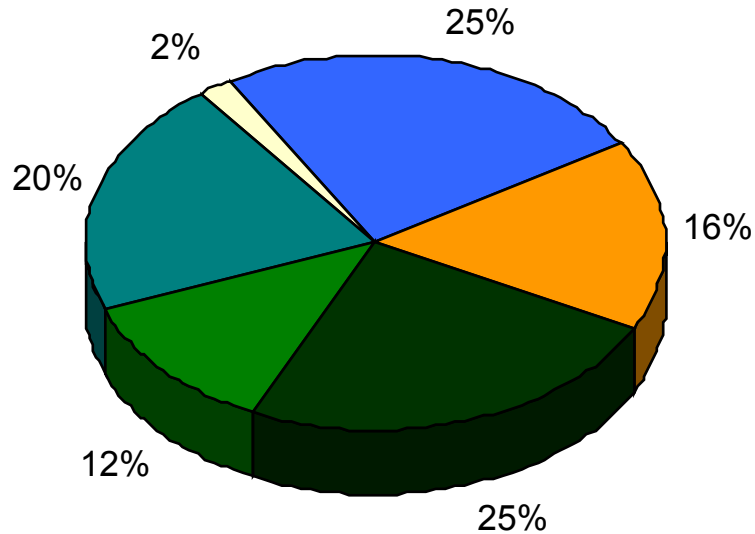
Considerations

- **Replication is a Simple Concept, but Filled with Nuances**
- **Best Practices are the Key to Success**
- **For IMS Replication, there are Few Viable Options**
- **Make Sure You Evaluate All Options**
- **Call if You Run into Trouble**

Terminology

- **CDC**: changed data capture
- **Source**: tables whose changes are being captured
- **Target**: tables that are updated with changed data
- **Capture**: process that captures changed data
- **Apply**: process that updates target datastores
- **Transport**: method of moving data from source to target
- **Latency**: the elapsed time between the source change and target apply
- **Interface**: a unique source to target data flow

What is CDC Being Used For?



High-Availability

- ✓ Minimize Downtime
- ✓ Disaster Recovery
- ✓ Workload Balancing

Replication Best Practices Summary

- **Planning**
 - ✓ Data Movement Requirements
 - ✓ Latency Requirements
 - ✓ Changed Data Volumes
 - ✓ Infrastructure Requirements

- **Minimize the Number of Moving Parts**

- **Have a Recovery Process**

- **Define Conflict / Exception Processing Criteria**

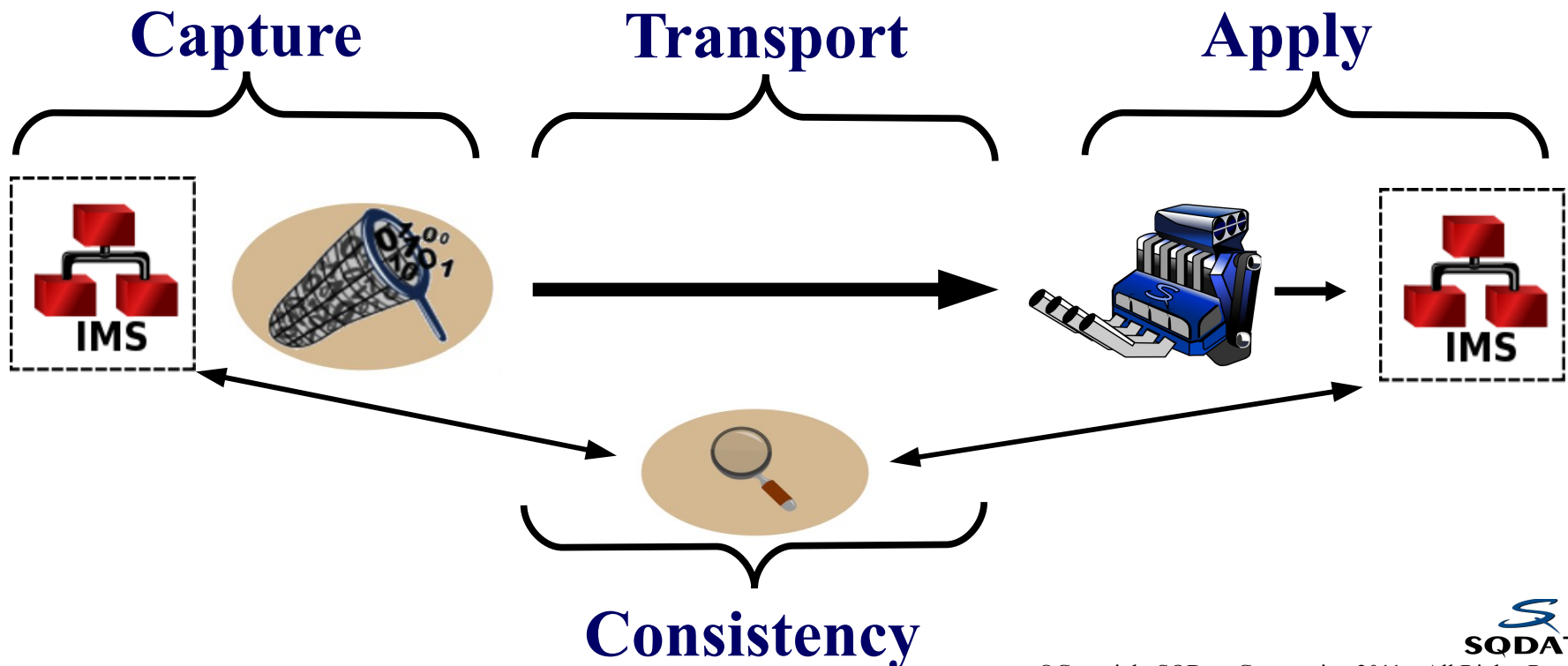
- **Have a Method of Verifying Source / Target Consistency**

- **Have an Operational Monitoring Strategy**

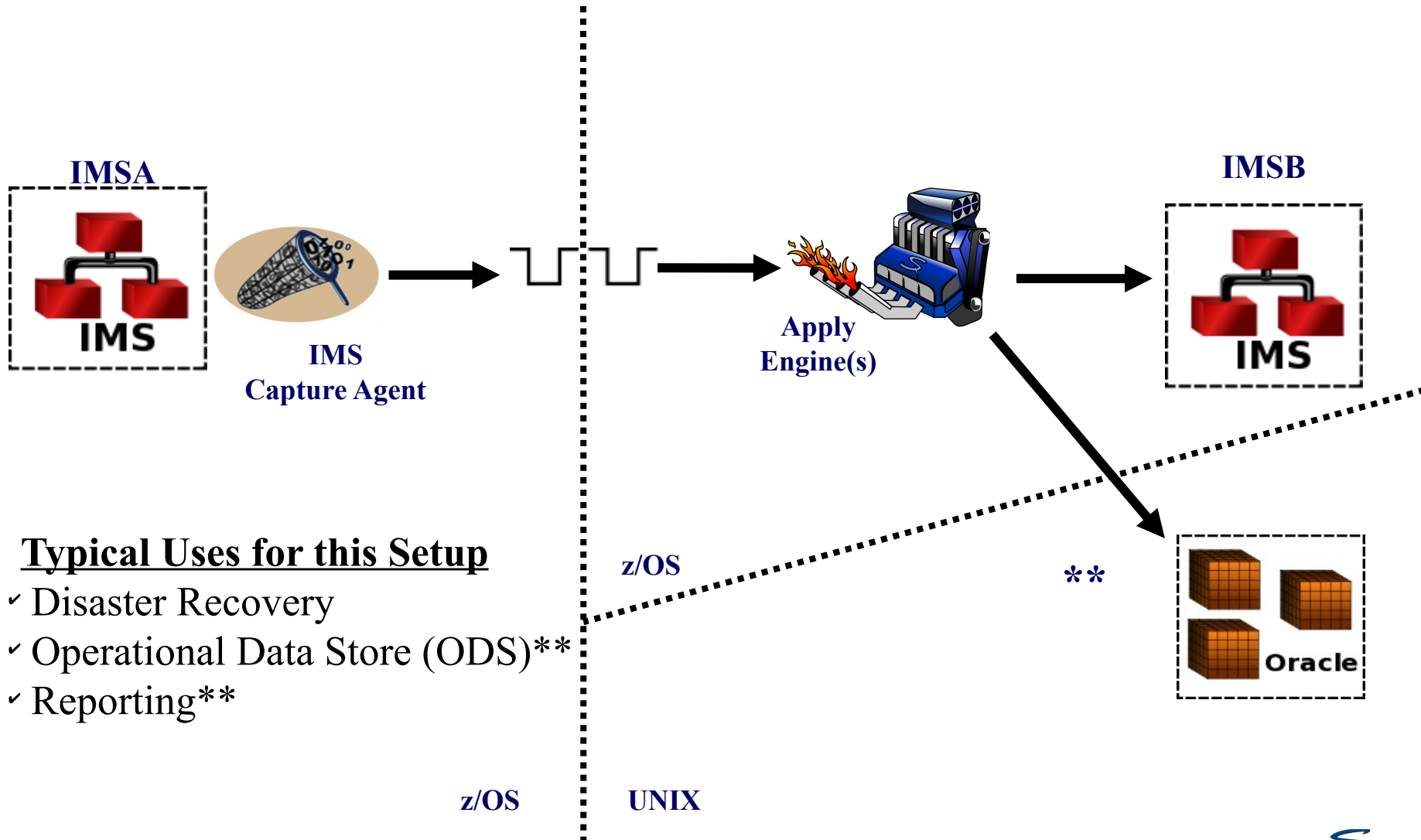
Replication Basics

Four (4) Primary Components

- ✓ Source Capture
- ✓ Data Transport
- ✓ Target Apply
- ✓ Consistency Monitoring



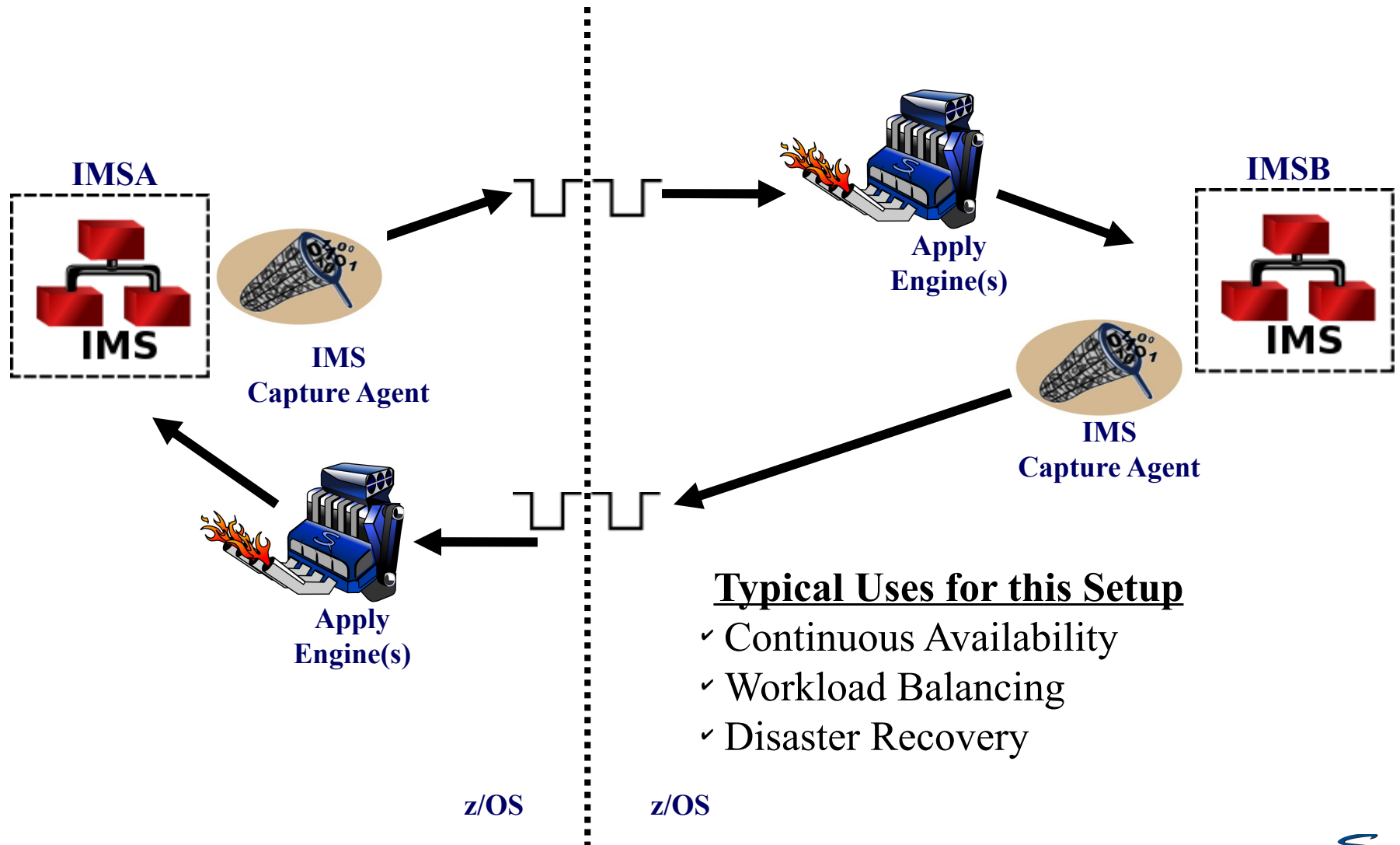
Active / Passive Replication



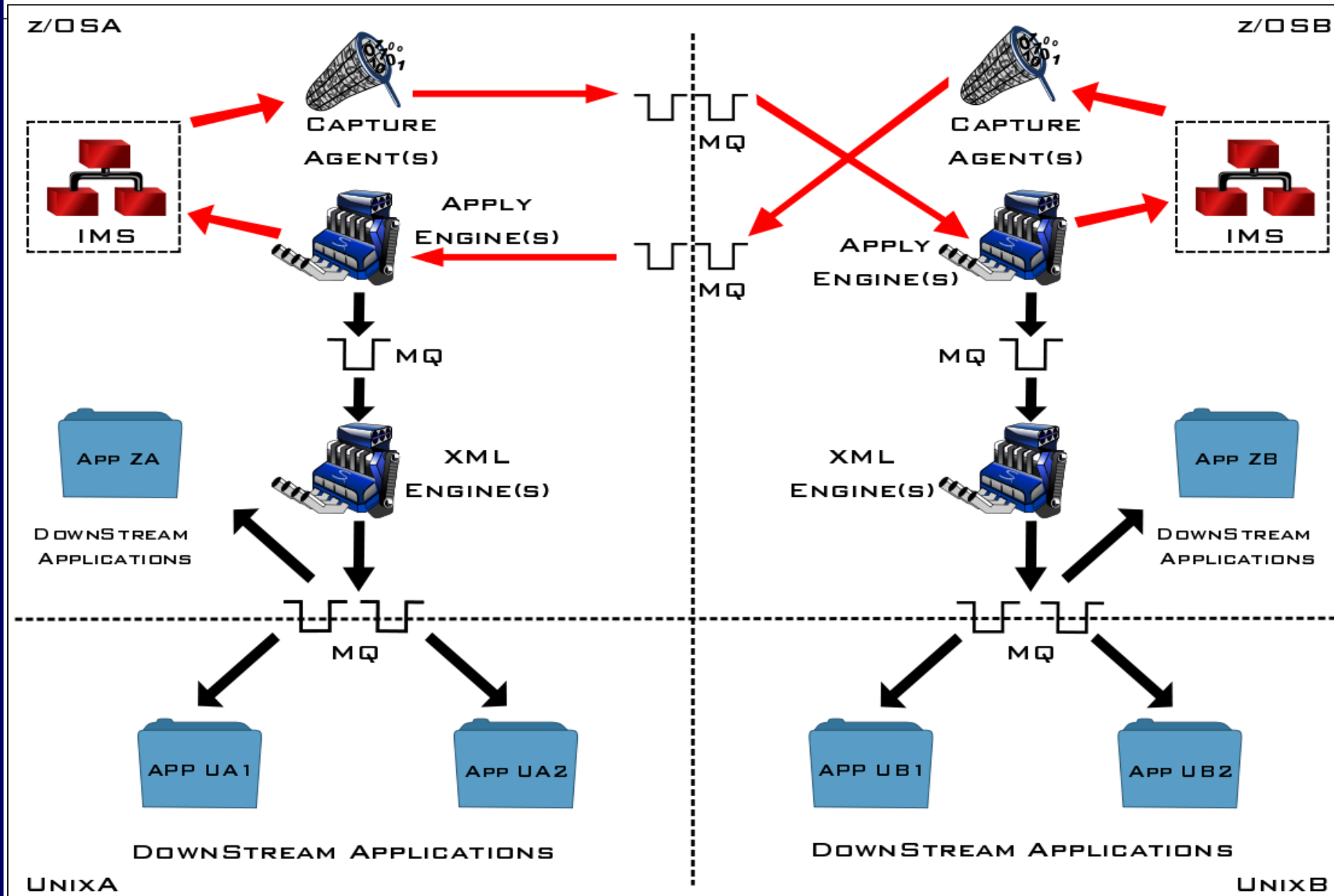
Typical Uses for this Setup

- ✓ Disaster Recovery
- ✓ Operational Data Store (ODS)**
- ✓ Reporting**

Active / Active Replication



Active / Active Replication with a Twist



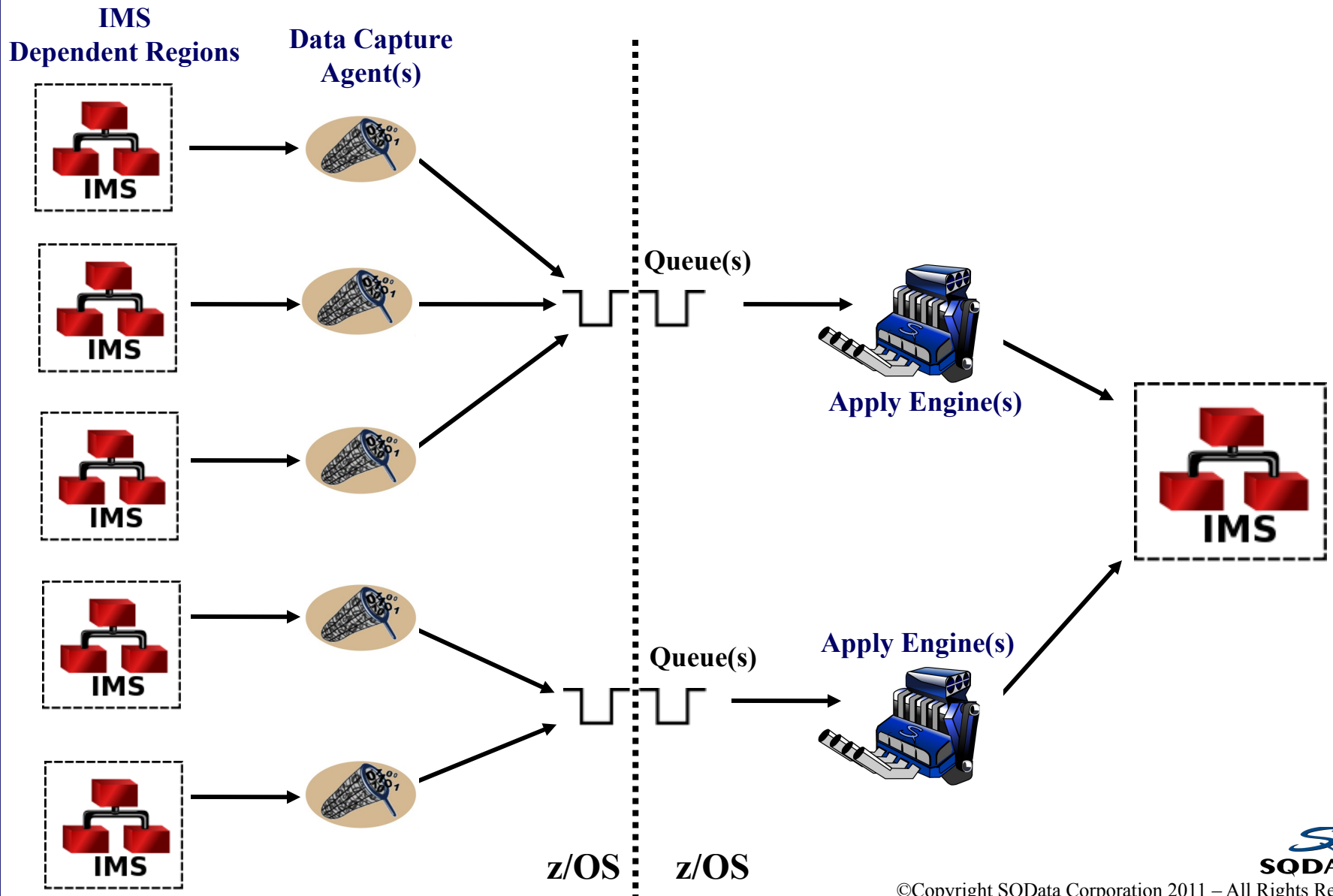
IMS Data Capture Methods

- **Two (2) Primary Methods of Capture**
 - ✓ Data Capture Exit Routines
 - ✓ Log Based

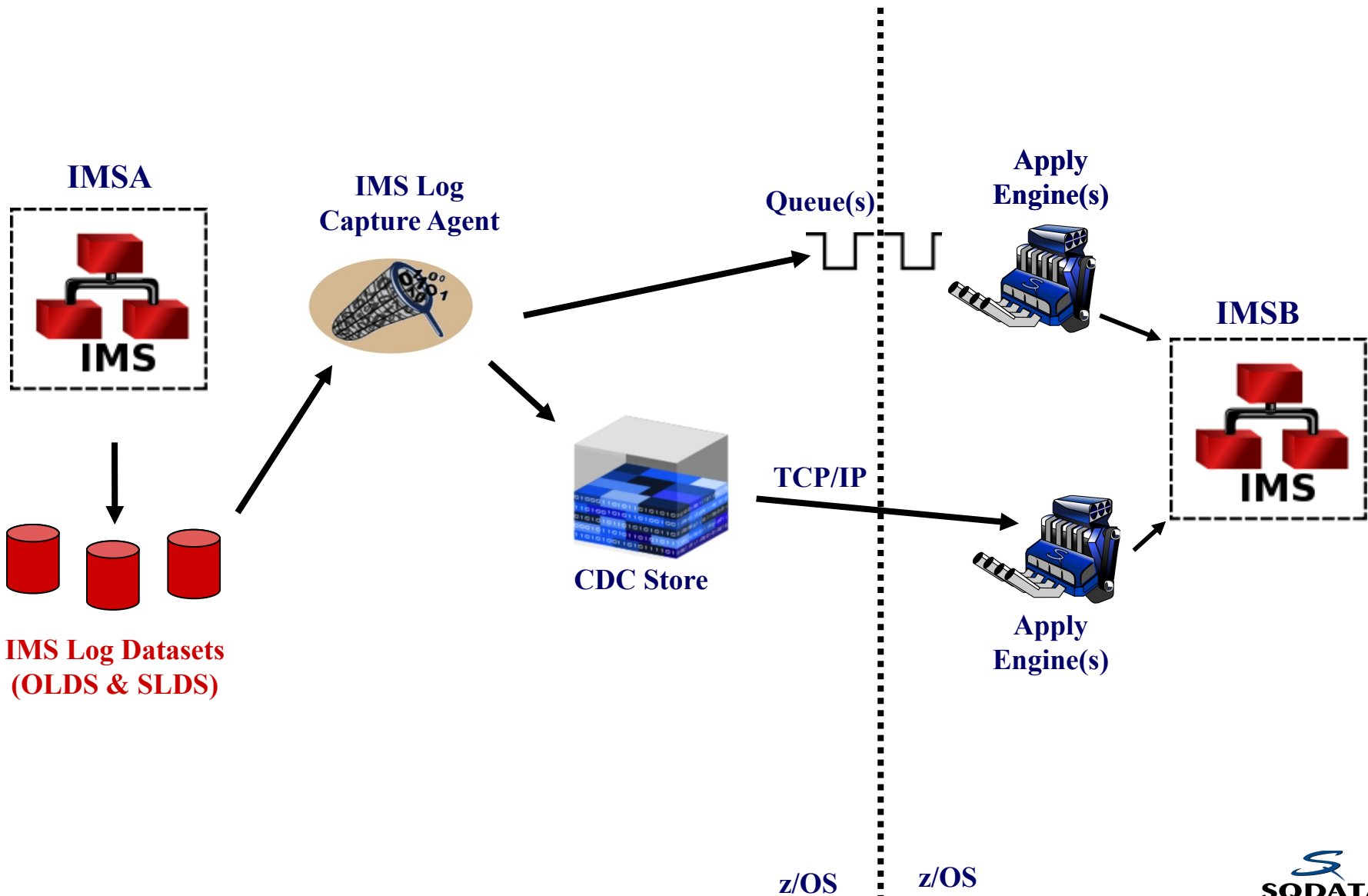
- **Database Exit Routines**
 - ✓ Near-Real-Time
 - ✓ Scalability → Capture / Apply by FP Area, HALDB Partition, PSB, Database
 - ✓ Can Use MQ for Persistent Storage and Transport
 - ✓ Do Not Require x'99' Log Records
 - ✓ Executes in Dependent Region as Part of Transaction

- **Log Based**
 - ✓ Near-Real-Time or Asynchronous
 - ✓ Requires x'99' Log Records
 - ✓ Allows for Recapture from SLDS
 - ✓ Scalability → Single Capture Point...Apply by PSB
 - ✓ Executes in Control Region or in Separate Address Space

Data Capture Exit Illustration



IMS Log Based Capture Illustration



z/OS

z/OS



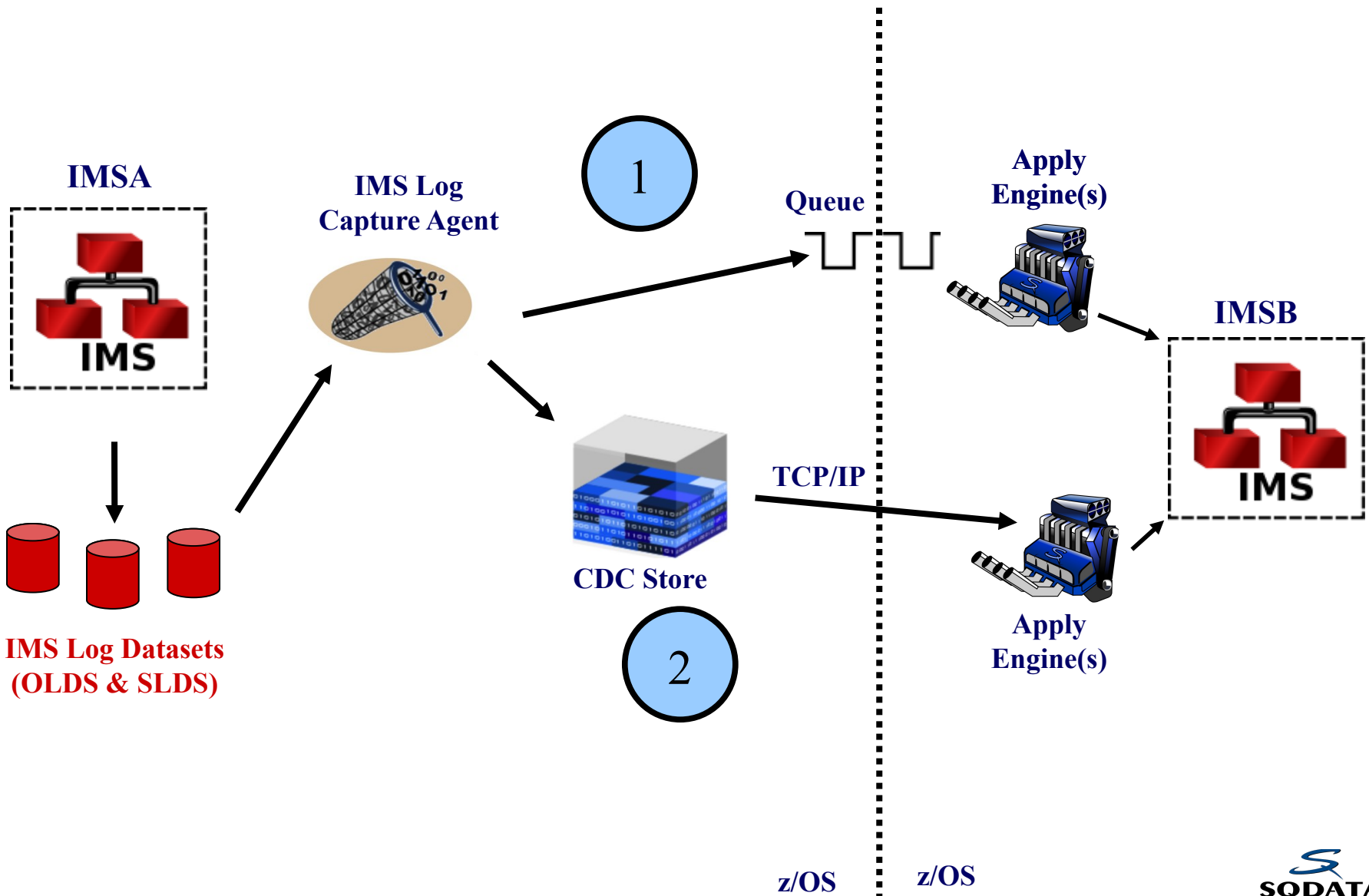
Data Transport Methods

- **Two (2) Primary Methods of Transport**
 - ✓ Queue Based (i.e. MQ, Tibco)
 - ✓ Native TCP/IP

- **Queue Based**
 - ✓ Handles Persistent Storage in Addition to Transport
 - ✓ Resilient
 - ✓ Can Handle High Data Volume on a Continuous Basis
 - ✓ Operates Independently of Capture and Apply

- **Native TCP/IP**
 - ✓ Transport Typically Faster than Queue Based
 - ✓ Can Handle High Data Volume on a Continuous Basis
 - ✓ Requires Separate Storage for CDC Data
 - ✓ Resiliency Must be Built In to CDC Storage
 - ✓ Operation not Always Independent

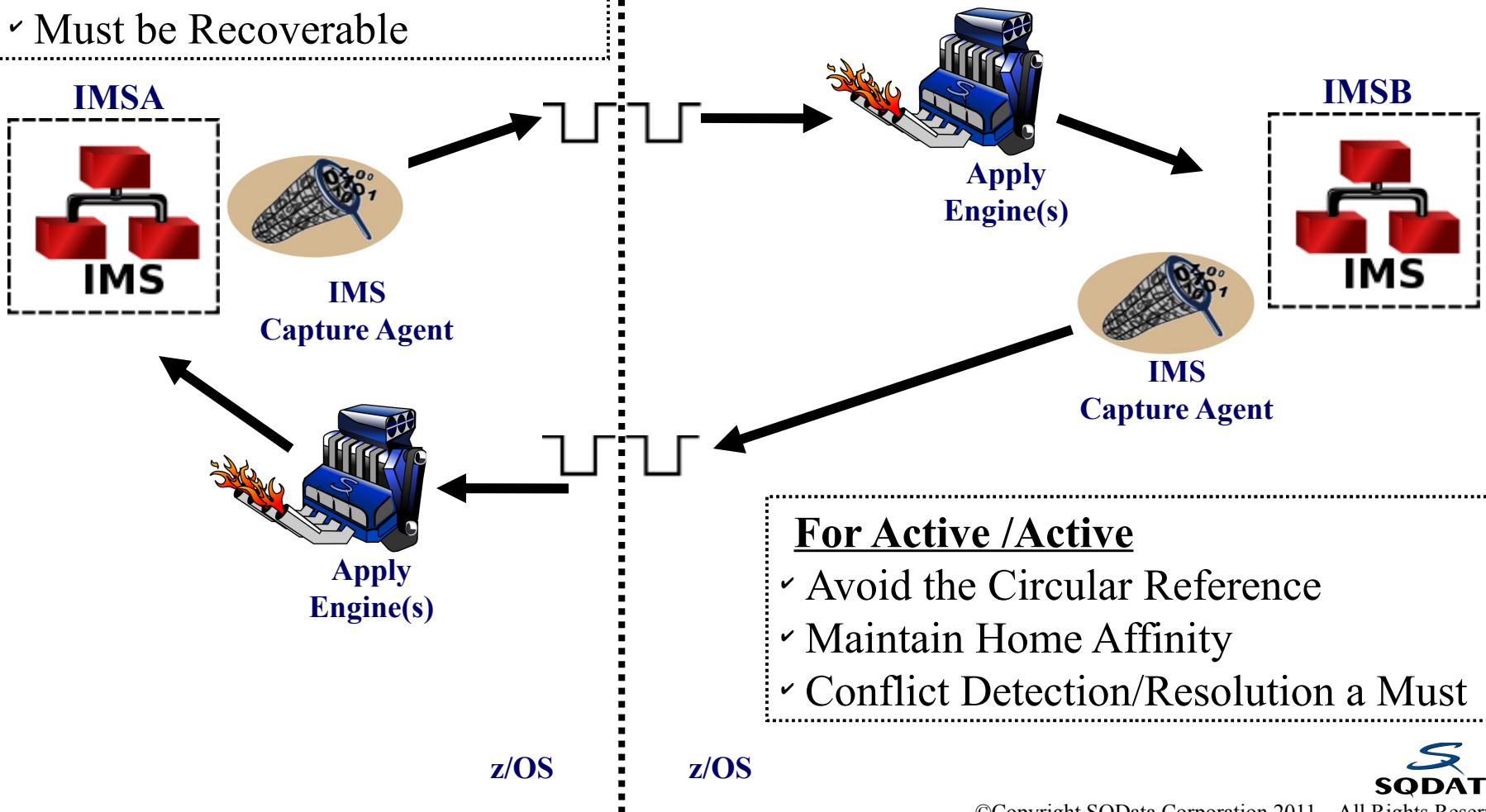
Data Transport Illustration



Target Apply Process

Basic Rules

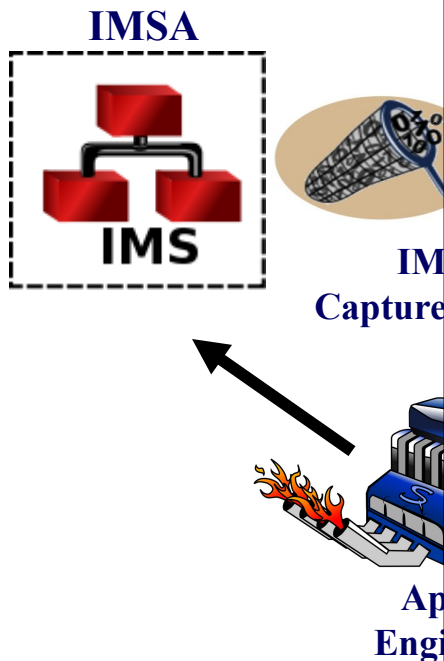
- ✓ Data Must be Applied in Order
- ✓ Must be Able to Keep Up
- ✓ Must be Recoverable



For Active /Active

- ✓ Avoid the Circular Reference
- ✓ Maintain Home Affinity
- ✓ Conflict Detection/Resolution a Must

Sample Target Apply Script (SQData)



```

JOBNAME IMSREP;
COMMIT EVERY 1;

-----
--          IMS DATABASE DESCRIPTIONS
-----
DESCRIPTION IMSDBD DD:DBDSRC (IMSDB01) AS IMSDB01;

-----
--          SOURCE DATASTORE
-----
DATASTORE SQDATA.IMSCDC.QUEUE@MQS
          OF IMSCDC
          AS CDCIN
          DESCRIBED BY IMSDB01;

-----
--          TARGET DATASTORE (S)
-----
DATASTORE * OF IMSDB
          AS IMSTGT
          DESCRIBED BY IMSDB01
          COMPENSATE WITH WARNING;

-----
--          MAIN SELECT
-----
PROCESS INTO IMSTGT
SELECT
{
  REPLICATE (IMSTGT)
}
FROM CDCIN;
    
```



z/OS

z/OS

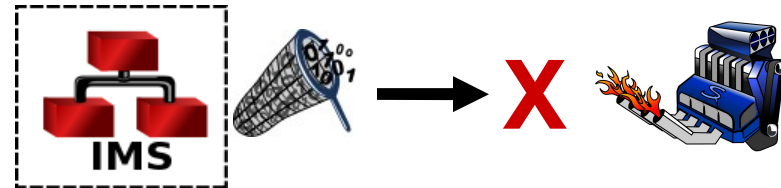
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Exception Processing

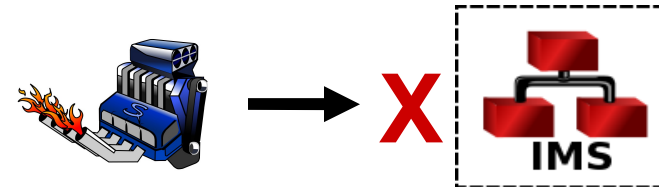
➤ Source Exceptions

- ✓ Invalid Data in Source Change Record
- ✓ Not Common for Relational CDC



➤ Target Exceptions

- ✓ Issue with Target Datastore (i.e. Unavailable)
- ✓ Conflicts
- ✓ Application Specific Logical Errors



➤ Replication Tool Should Allow for Continued Operation

- ✓ Include the Ability to Provide Notification of Exceptions
- ✓ Save Exception Records to a Separate Datastore

** Some Exceptions Should Force Replication Shutdown **

Conflict Detection and Resolution

➤ Conflicts Indicate a Probable Out-of-Sync Condition

➤ Replication Conflicts

- ✓ Insert Segment that Already Exists in Target
- ✓ Update Segment that Does Not Exist in Target
- ✓ Update Segment where Before Image does not Match Current Target Image
- ✓ Delete for Segment that Does Not Exist in Target
- ✓ Any Operation for Child Segment that has No Parent

➤ Conflicts that Can be Compensated

- | | | |
|---|---|------------------|
| ✓ Insert for Segment that Already Exists | → | Turn into Update |
| ✓ Update for Segment that Does Not Exist | → | Turn into Insert |
| ✓ Deletes for Segment that Does Not Exist | → | Ignore |

➤ SQBP – Conflict Detection Should be Tied into Consistency Checking

Conflict Reporting

➤ SQData Engine Runtime Report if Compensation Occurs

- ✓ Compensated Insert: Inserts that were Turned into Updates
- ✓ Compensated Update: Updates that were Turned into Inserts
- ✓ Compensated Delete: Deletes that were Ignored

```
Source Data Store.....: SQDATA.IMSCDC.QUEUE@MQS
  Alias.....: CDCIN
  Start At.....: 0
  Records Selected.....: 0
  Records Read.....: 30166
Target Data Store.....: SQDATA.IMSCDC.EXCEPTION.QUEUE@MQS
  Alias.....: EXPDS
  Records Inserted.....: 0
  Records Updated.....: 0
  Records Deleted.....: 0
Target Data Store.....: *
  Alias.....: IMSTGT
  Records Inserted.....: 5582
  Records Updated.....: 11190
  Records Deleted.....: 389
  Compensated Insert.....: 9915
  Compensated Update.....: 11
  Compensated Delete.....: 13005
```

17.55.17 SQD0041I 00 0 21 Processing completed with return code 0



Conflict Resolution Options

➤ Detect and Compensate

- ✓ COMPENSATE Keyword on Target Datastore
- ✓ Compensate where Allowed
- ✓ Write Non-Allowed Compensations to Exception Datastore

➤ Detect and Compensate with Warning

- ✓ COMPENSATE WITH WARNING Keyword on Target Datastore
- ✓ Compensate where Allowed and Issue Message for each Occurrence
- ✓ Write Non-Allowed Compensations to Exception Datastore

➤ Detect - No Compensate - Continue Running

- ✓ Exception Datastore Specified for Target Datastore
- ✓ Write Conflicts to Exception Datastore (DDLTO Format)

➤ Detect – No Compensate - Stop

- ✓ No Exception Datastore Specified for Target Datastore
- ✓ Stops the Apply Engine

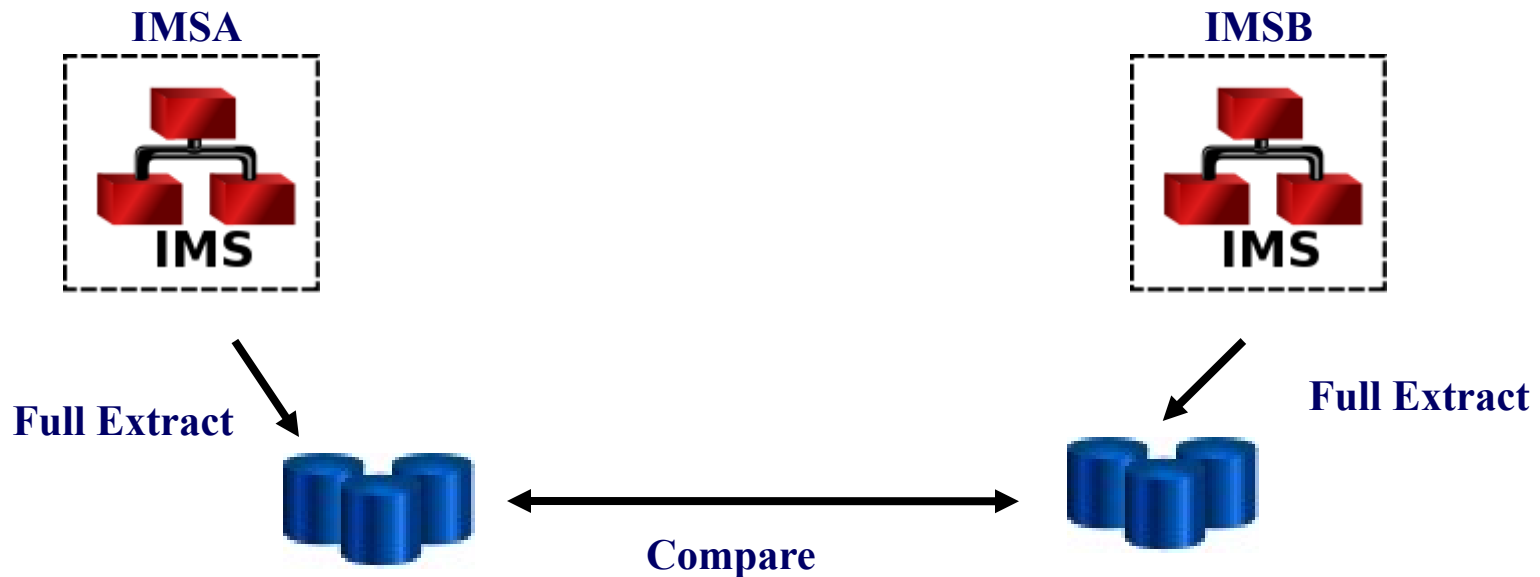
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Verifying Source / Target Consistency

➤ Classic Method #1: Requires Source/Target to be Read-Only

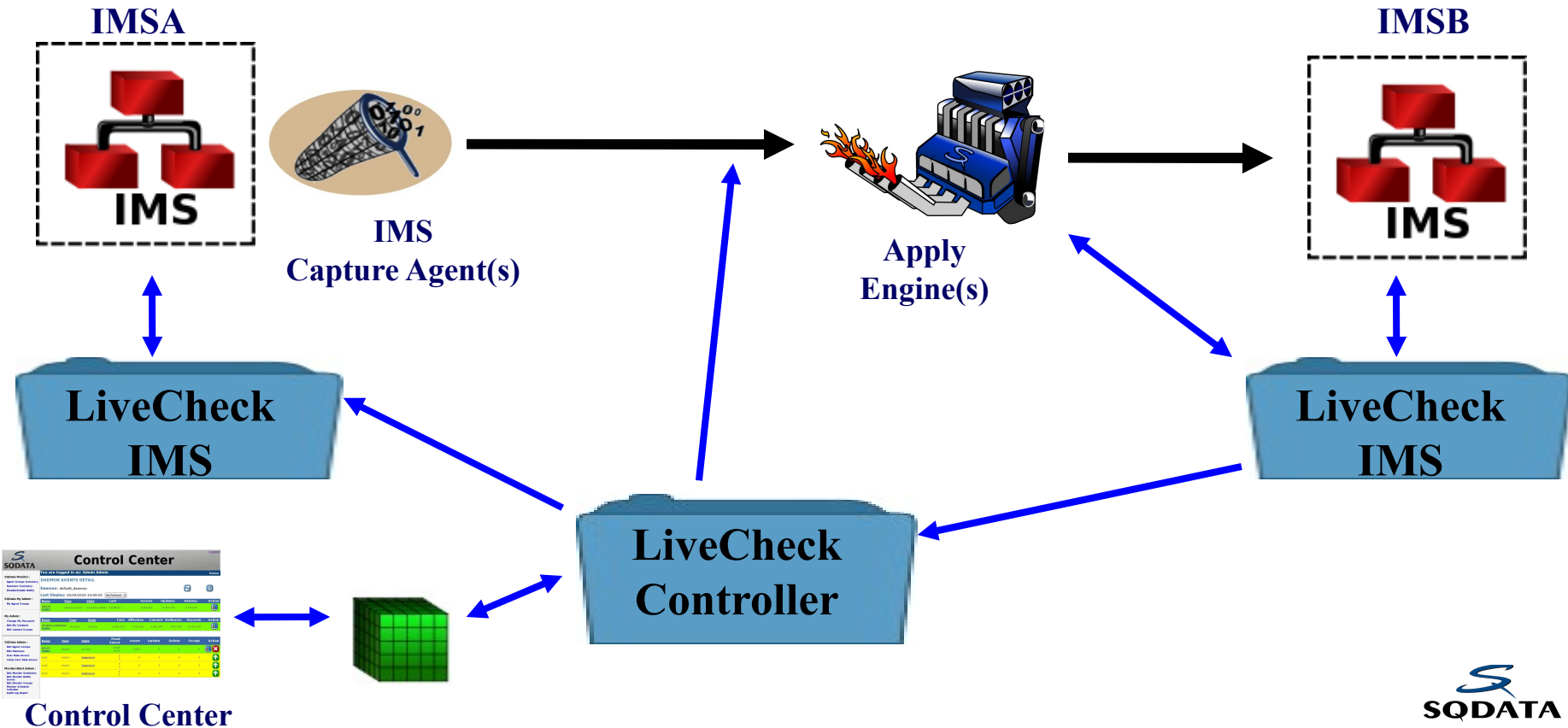
- ✓ Unload Source
- ✓ Unload Target
- ✓ Transmit Source Unload to Target (or Vice-Versa), if Required
- ✓ Compare Source Unload to Target Unload
- ✓ NOT Practical for Fast Moving Databases



Verifying Source / Target Consistency...

➤ SQData LiveCheck™

- ✓ Intended for High-Volume, 24x7 Setups
- ✓ Checks Source Target Integrity during Active Replication

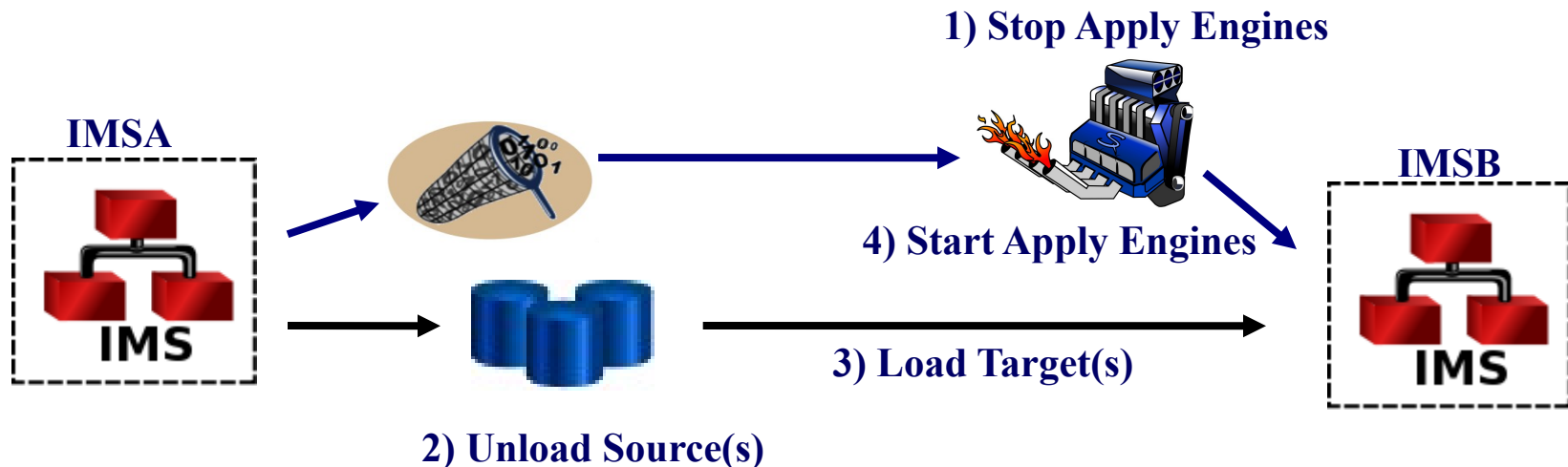


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Data Synchronization / Materialization

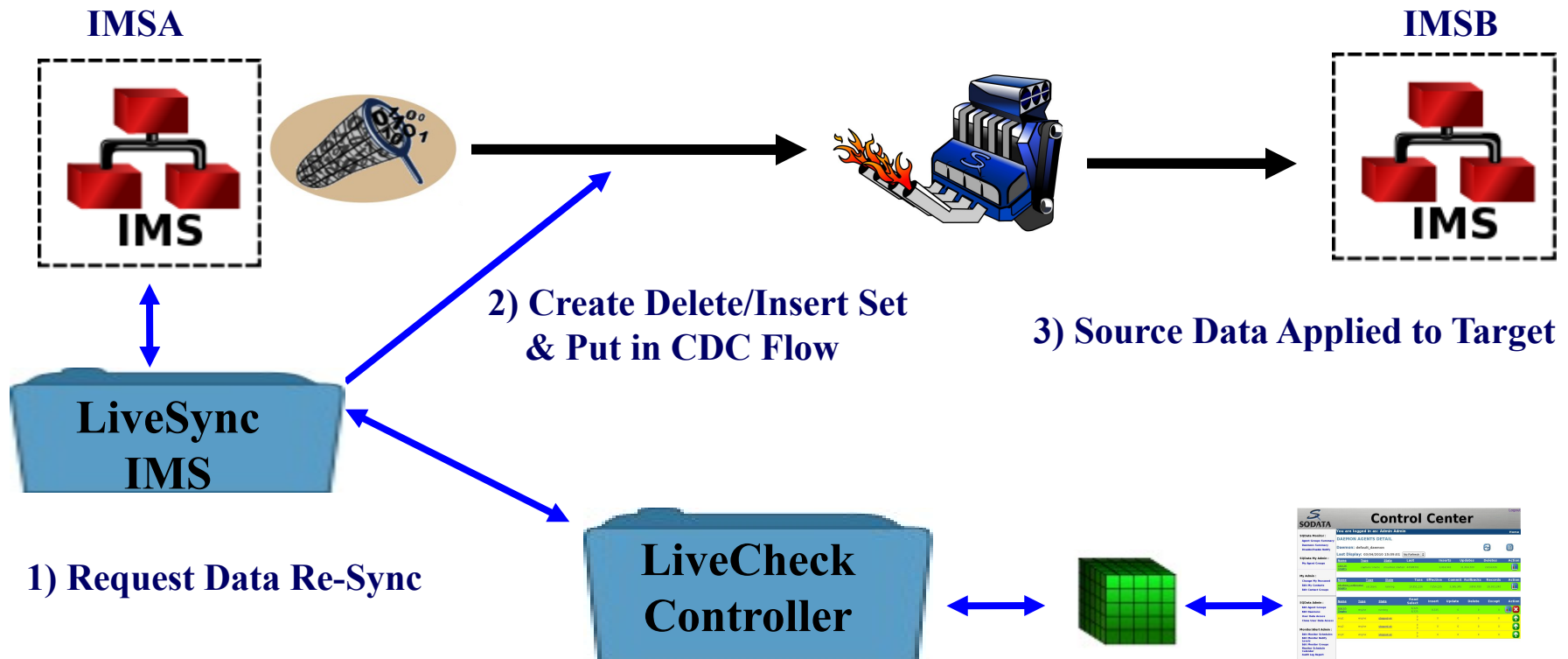
- **SQBP - Have a Refresh / Recovery Process**
- **Needs to be Done Against Active Source Databases**
- **Method #1: Full Loads or Partial Loads**
 - 1) Stop Apply Engine(s)
 - 2) Unload / Copy Source
 - 3) Load Target
 - 4) Start Apply Engine(s)



Data Synchronization / Materialization...

➤ SQData LiveSync

- ✓ Compliments SQData LiveCheck
- ✓ Intended for High-Volume, 24x7 Setups
- ✓ Re-Synchronizes Individual Segments



Summary

- **Replication is a Simple Concept, but Filled with Nuances**
- **Best Practices are the Key to Success**
- **For IMS Replication, there are Few Viable Options**
- **Make Sure You Evaluate All Options**
- **Call if You Run into Trouble**

Questions?



Where to Find Additional Information

- **Email Requests: squillicy@sqdata.com**
- **SQData Website: www.sqdata.com**
- **Phone Requests: 866-252-3575**



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