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

- Operational Data Analytics (ODS)
- Data Warehouse / Business Intelligence
- Event Publishing
- Data Integration
- Audit
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

Typical Uses for this Setup
✔ Continuous Availability
✔ Workload Balancing
✔ Disaster Recovery
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
IMS Log Based Capture Illustration

- IMSA
- IMS Log Capture Agent
- IMS Log Datasets (OLDS & SLDS)
- CDC Store
- Queue(s)
- Apply Engine(s)
- IMSB
- TCP/IP
- 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
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;
```
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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

<table>
<thead>
<tr>
<th>Source Data Store</th>
<th>SQDATA.IMSCDC.QUEUE@MQS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alias</td>
<td>CDCIN</td>
</tr>
<tr>
<td>Start At</td>
<td>0</td>
</tr>
<tr>
<td>Records Selected</td>
<td>0</td>
</tr>
<tr>
<td>Records Read</td>
<td>30166</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Target Data Store</th>
<th>SQDATA.IMSCDC.EXCEPTION.QUEUE@MQS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alias</td>
<td>EXPDS</td>
</tr>
<tr>
<td>Records Inserted</td>
<td>0</td>
</tr>
<tr>
<td>Records Updated</td>
<td>0</td>
</tr>
<tr>
<td>Records Deleted</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Target Data Store</th>
<th>*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alias</td>
<td>IMSTGT</td>
</tr>
<tr>
<td>Records Inserted</td>
<td>5582</td>
</tr>
<tr>
<td>Records Updated</td>
<td>11190</td>
</tr>
<tr>
<td>Records Deleted</td>
<td>389</td>
</tr>
<tr>
<td><strong>Compensated Insert</strong></td>
<td><strong>9915</strong></td>
</tr>
<tr>
<td><strong>Compensated Update</strong></td>
<td><strong>11</strong></td>
</tr>
<tr>
<td><strong>Compensated Delete</strong></td>
<td><strong>13005</strong></td>
</tr>
</tbody>
</table>

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 (DDLT0 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

```
IMSA
  IMS
  Capture Agent(s)

LiveCheck IMS

Apply Engine(s)

LiveCheck Controller

LiveCheck IMS

Control Center

IMSB
  IMS
```
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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

1) Request Data Re-Sync

2) Create Delete/Insert Set & Put in CDC Flow

3) Source Data Applied to Target
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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