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Oracle Streams

Replication Tips and Techniques

Agenda

- Oracle Streams Overview
- Hints and Tips
- Case Studies

Oracle Streams

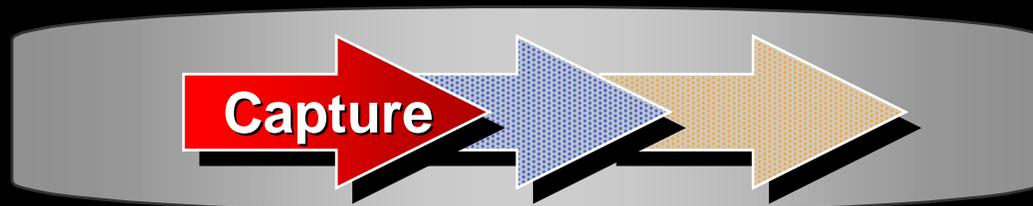
- Simple solution for information sharing
- Provides
 - uniquely flexible replication
 - message queuing
 - data warehouse loading
 - database migration
 - application upgrade
 - event management and notification

Streams Basic Elements



- Capture
- Staging
- Consumption (apply)

Capture



- Low overhead, low latency change capture
 - Changes to the database are written to the online redo log
 - Oracle Streams can extract changes from the log as it is written (hot mining)
 - Local or Downstream capture capability
 - Changes are formatted as a Logical Change Record (LCR), a representation of the change
- Background process
 - Auto restart (instance restart or RAC instance failover)
 - Automatic flow control

Logical Change Record (LCR)

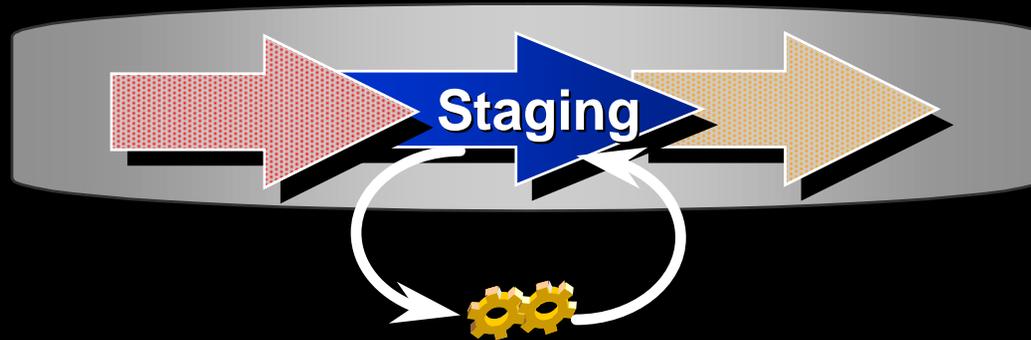
- Database change = LCR
 - DML
 - Row change = LCR
 - Object name, owner, Type of DML, SCN
 - OLD, NEW values
 - Optional attributes: username, session, thread,...
 - DDL
 - Object name, owner, Type of DDL, SCN
 - DDL text
 - Optional attributes: username, session, thread,...
 - LOB and LONG
 - Multiple LCRs per LOB or LONG column
 - Piecewise chunks

Staging



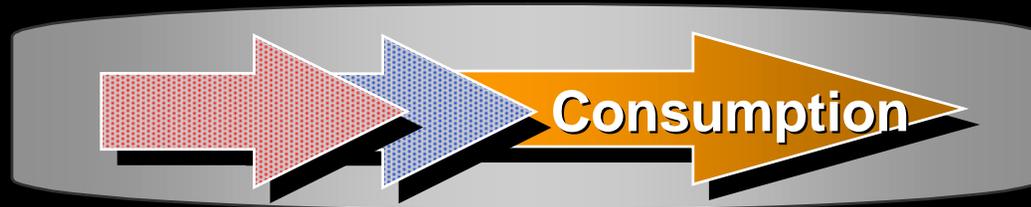
- Streams publishes captured events into a staging area
 - Implemented as ANYDATA queue
 - Streams capture uses buffered ANYDATA queue
 - Streams Pool of SGA
 - Subscribers: other staging areas or processes
 - Messages remain in staging area until consumed by all subscribers
- Propagation between staging areas

Transformations



- Transformations can be performed
 - as events enter the staging area
 - as events leave the staging area
 - as events propagate between staging areas
- Declarative Transformations
 - Rename schema, table, column
 - Add or delete column
- Custom Transformations
 - User-supplied PL/SQL function

Apply



- The default apply engine will directly apply the DML or DDL represented in the LCR
 - apply to local Oracle table
 - apply via DB Link to non-Oracle table
- Automatic conflict detection with optional resolution
 - unresolved conflicts placed in exception queue
- Parallel apply maximizes concurrency

Customizable Apply



- User-written custom apply procedures
 - DML, DDL, Pre-Commit, Message
- Written in PL/SQL, Java, C, C++
- Uses:
 - full control over apply
 - normalizing or denormalizing data
 - populating related fields or tables

Rule-based Configuration

- Rule is expressed as SQL WHERE clause

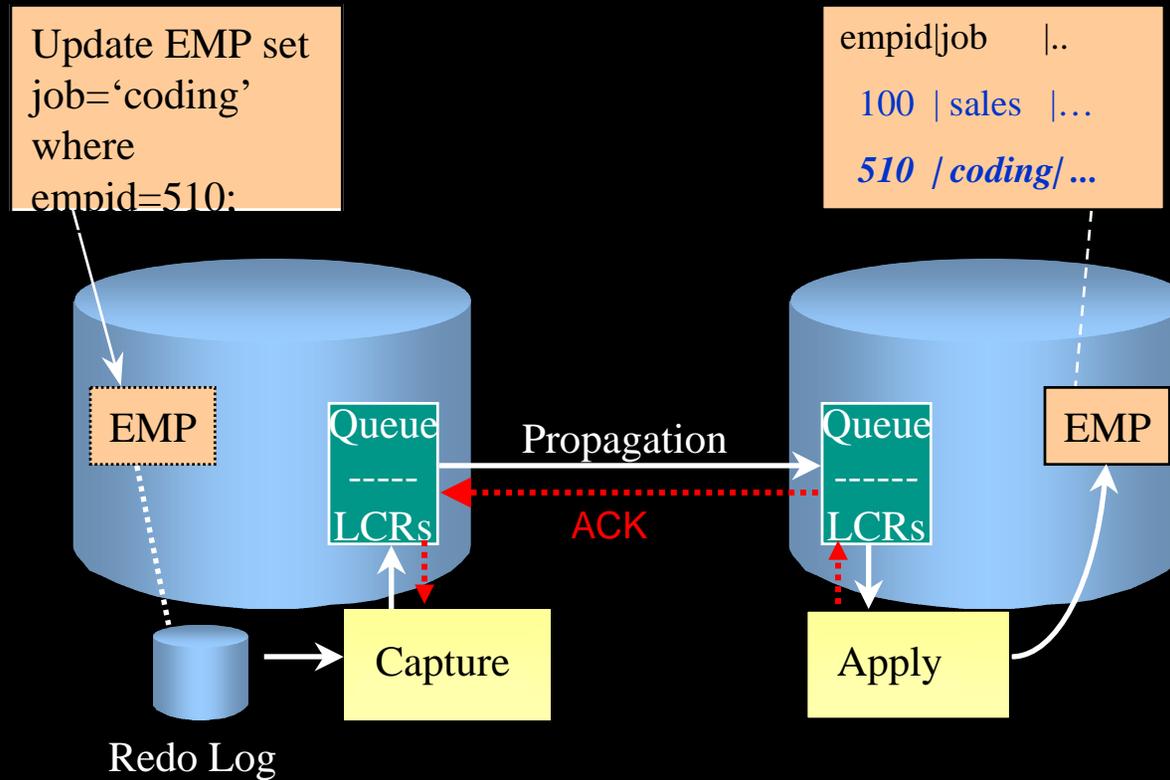
```
dbms_rule_adm.create_rule(  
    rule_name=>'scott.rule1',  
    condition=>':dml.get_object_owner() = "SCOTT" AND  
                :dml.get_object_name()="EMP" and  
                :dml.is_null_tag='y");
```

- Rule sets govern capture, staging, and apply
 - Inclusion
 - Negative

- Tailored Replication API

```
DBMS_STREAMS_ADM.MAINTAIN_*  
DBMS_STREAMS_ADM.ADD_*_RULES,  
DBMS_STREAMS_ADM.ADD_SUBSET_RULES  
{Table | Schema | Global}
```

Streams Capture and Apply



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Software Updates

10.2

- OEM: Look for Streams on MAINTENANCE page of Enterprise Manager.

10.1.0.4 patch set

- Apply patch for bug 4291110 (ORA-25228)
- OEM support in “classic OEM”
 - Client CD: Administrator Install

Watch OTN Streams website for custom software

- <http://otn.oracle.com/products/dataint/content.html>

General Configuration Tips

- Configure separate Tablespace for Streams queues
 - Use separate queue table for each queue
- Use separate queues for
 - Capture
 - Apply (separate queue for each source database)
- Reduce job queue interval to 1 second
- For WANs: Increase SDU (sqlnet.ora, tnsnames.ora, listener.ora)

Simple Configuration (10gR2)

```
BEGIN dbms_streams_adm.MAINTAIN_SCHEMAS(  
    SCHEMA_NAMES          => 'HR,SCOTT',  
    SOURCE_DIRECTORY_OBJECT => null,  
    DESTINATION_DIRECTORY_OBJECT => null,  
    SOURCE_DATABASE       => NULL,  
    DESTINATION_DATABASE  => 'TARGET',  
    PERFORM_ACTIONS      => TRUE,  
    BI_DIRECTIONAL       => FALSE,  
    INSTANTIATION        =>  
        DBMS_STREAMS_ADM.INSTANTIATION_SCHEMA_NETWORK  
    SCRIPT_DIRECTORY_OBJECT => 'SCRIPT_DIR',  
    SCRIPT_NAME          => 'generated_schemas_script.sql',  
);  
END;
```

/

Rule Tips

- Spelling counts!
- Make sure that the `source_database_name` is correctly specified.
 - At source site: *SELECT global_name FROM GLOBAL_NAME;*
- Eliminate duplicate or overlapping rules in a rule set.
- Ensure that rules do not allow objects with unsupported data types
- Avoid complex rules
 - LIKE
 - Functions
 - NOT (9.2)

Rule Management Tips

- Having no rule set defined is NOT the same as an empty rule set.
- Use DBMS_STREAMS_ADM package to create replication rules
- Use same package to create or remove rules
 - DBMS_STREAMS_ADM
 - DBMS_RULE_ADM

Operational Tips

- Replicating DDL?
 - Avoid replicating system-generated constraint/index names
 - Modify manual hotbackup scripts to set an apply tag .
 - Ex:

```
dbms_stream.set_tag('DONOTREPLICATE'  
)
```
- Removing Archive log files from disk?
 - Do not remove log files that may be needed for capture restart.
 - REQUIRED_CHECKPOINT_SCN
 - RMAN (10.1.0.4+) manages logs properly
- Implement “heartbeat” table
 - Update periodically.

Specific Tips for 10gR2

- Enable Auto tuning of Streams Pool
 - Sga_target>0, streams_pool_size=0
- Use MAINTAIN_* procedures to configure
- Propagation
 - Use queue_to_queue parameter
- APPLY:
 - Enable apply parallelism
- CAPTURE:
 - Alter the retention time for capture checkpoints as needed
 - Reduce the capture checkpoint frequency

Specific Tips for 10gR1

- Size the streams pool for change volume/activity
- Monitor Source Alert log
- Metalink article [298877.1](#) for Streams 10gR1 recommendations

Specific Tips for 9iR2

- Increase `shared_pool_size` `init.ora` parameter
- Move the Logminer tables from `SYSTEM` tablespace
- Implement Manual Flow control: Metalink 259609.1
- Monitor Source Alert log
- Metalink article [297273.1](#) for Streams 9iR2 recommendations

Monitoring

Message Number columns = SCN for source DML,DDL

- CAPTURE_MESSAGE_NUMBER, ENQUEUE_MESSAGE_NUMBER
DEQUEUE_MESSAGE_NUMBER, APPLIED_MESSAGE_NUMBER
- Timestamp columns are associated with SOURCE DML/DDL SCN
- **STRMMON utility**
 - Available from Metalink [290605.1](#)
 - Line output of streams rates or detail (-long) output
- **Enterprise Manager**
- **AWR statistics for Streams (10gR2)**
 - DBA_HIST_STREAMS_* views
 - {[capture](#) , [apply_sum](#), [pool_advice](#) }

Troubleshooting Tips

- Determine the scope of the problem
 - One site?
 - Multiple sites?
- Identify the problem
 - Streams processes enabled
 - Propagation job functioning
 - Check Queue size at each DB
 - Use healthcheck and STRMMON
- Apply not making changes?
 - Check DBA_APPLY_ERROR for errors
 - Check trace files , alert logs
 - Check rules at this site
 - Make sure COMMIT was performed for transaction



Troubleshooting Apply

- Failed LCR= Message_number column of DBA_APPLY_ERROR
- Print LCR script in Streams Documentation
 - “Displaying Detailed Information about Apply Errors”
- Typical Errors:
 - **ORA-26687** no instantiation scn set
 - Set Instantiation SCN
 - Exp/Imp with appropriate clauses
 - DBMS_APPLY_ADM.SET_TABLE_INSTANTIATION_SCN
 - **ORA-01031** insufficient privilege
 - Explicitly grant privileges to apply user
 - **MISSING Streams data dictionary information!**
 - DBMS_CAPTURE_ADM.PREPARE_TABLE_INSTANTIATION
 - LCRs ignored, warning logged in alert log and trace file

Troubleshooting ORA-1403

- If UPDATE or DELETE
 - Compare LCR “old” values with existing column value
 - Expand date/timestamp columns to compare old and existing columns
- If DELETE and <9.2.0.6:
 - possible DELETE CASCADE issue, use dml handler to resolve
- If Parallelism>1: Check supplemental logging at source

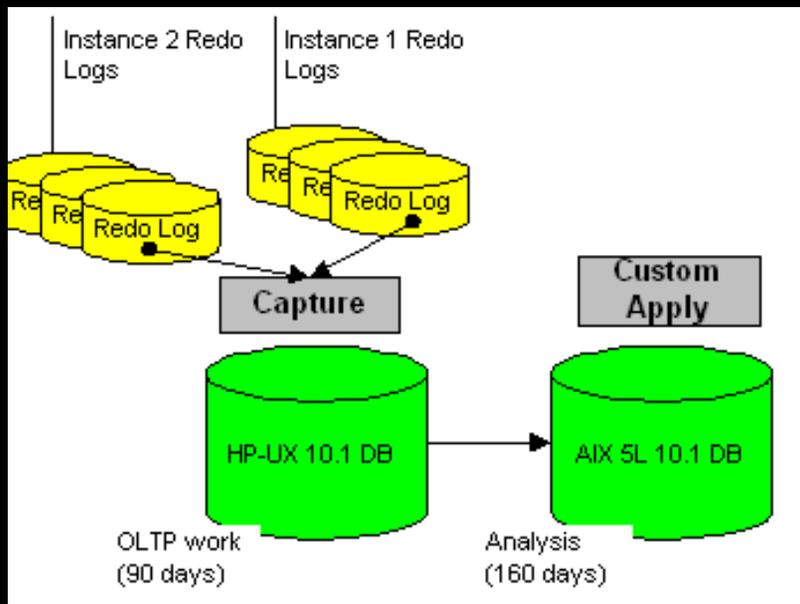
Streams and RAC

- Queue ownership by instance
 - Streams processes run only on owning instance
- Oracle9i
 - No hot mining for RAC
 - Streams restart after failure not automatic
- Oracle10gR1
 - Hot mining
 - Primary and secondary owning instance
 - Failover of Streams processes automatic
- Oracle 10gR2
 - Automatic service for queue propagation
 - Automatic redo notification on instance shutdown

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- Case Studies

Case Study #1: 10g RAC->10g



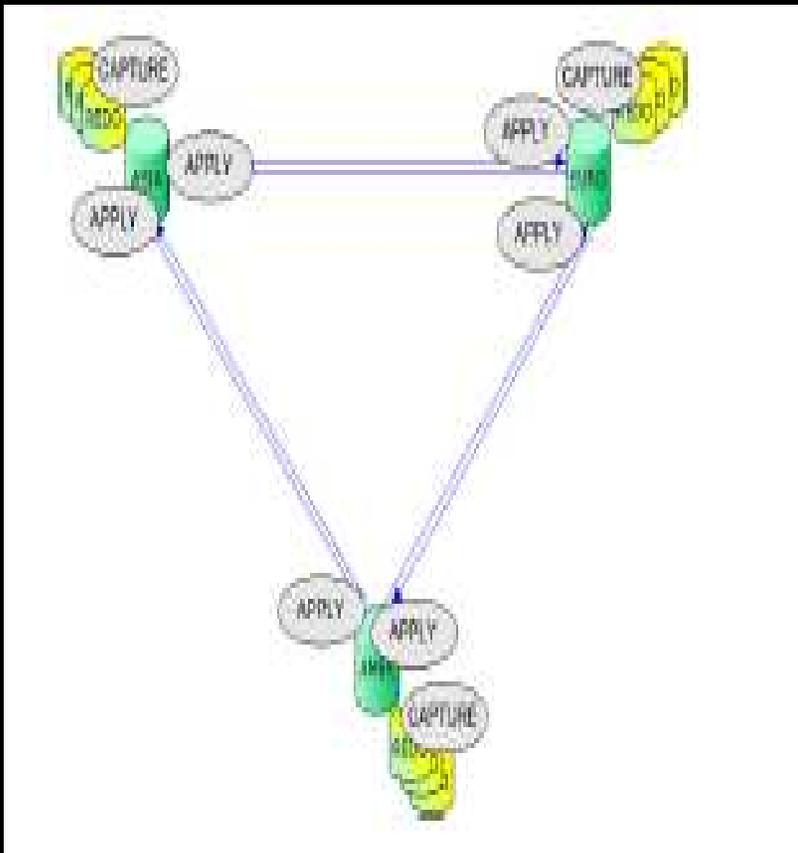
- Large manufacturing factory
 - Offload reporting
 - Constant workload (manufacturing 24/7)
 - Customized apply: track all transactions
- Phase 1: 9.2
- Phase 2: 10.1 (final)

Lessons Learned #1

- Implement Streams Best Practices
 - Separate queues, streams_pool, RAC
 - Purge checkpointing metadata (first_scn move)
 - Reduce checkpoint frequency
 - Apply: DISABLE_ON_ERROR=N
- PARALLELISM=8
- Custom apply impacts throughput
- Extensive testing=>Successful Deployment
 - Written test plan with production workload and scenarios
 - Separate dev and test environments
 - Online Redefinition to maintain 24x7 schedule
 - Massive periodic purging required special handling

Case Study #2

10g RAC<->10gRAC

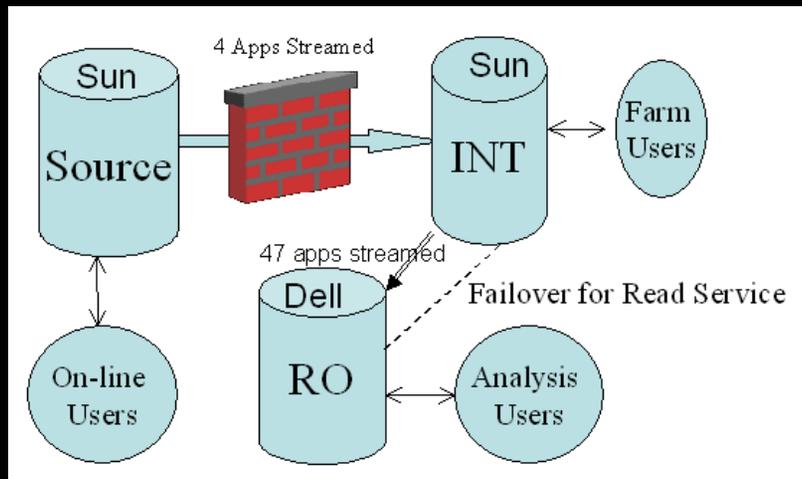


- Large investment bank:
 - Linux 10g RAC (2node) databases:
 - Geographically distinct regions (WAN)
 - Follow the sun workload
 - Customized Streams to convert LOBs to XMLType

Lessons Learned #2

- Implement Streams Best Practices
 - No PK on many tables, use SET_KEY_COLUMN
 - If error occurs, stop immediately
 - **DISABLE_ON_ERROR=Y**
 - Implement Conflict resolution
- LOB handling
 - Lob chunk LCRs written to temporary table
 - Construct SQL to insert LOB into XMLType
- Monitoring is key
 - Monitor environment regularly, especially propagation jobs
 - Archive log management:
 - **Required_checkpoint_scn**

Case Study #3 9.2



- National Scientific Laboratory:
 - 9.2
 - Replicas outside firewall
 - DML & DDL
 - Intermediate site apply forwarding
 - Replace Materialized Views

Lessons Learned #3

- Implement Streams Best Practices
 - Flow control, sizing of shared_pool
 - DDL replication considerations
- Monitoring:
 - OEM, web
 - Large or Long transactions
 - Log statistics periodically
- Testing => key to success
 - Application assumptions
 - Planned environment

Available Sample Code

- Automatic Correction
 - Update from source, but no row at target
 - Insert from source, but row exists at target
- Procedural Replication
 - Replicate invocation of procedure rather than DML
- Auditing DML/DDL activity
 - Store LCRs to separate table for auditing
- Conflict Resolution for tables with LOBs

Extending Streams

- Asynchronous After-commit TRIGGERS
 - Asynchronously fire triggers after transaction commit
- Using Streams with Materialized Views
 - Asynchronous After-commit Refresh of Materialized Views
 - Maintaining a middle-tier cache query
 - Maintaining a Materialized View

Streams Summary

- Features:
 - Log-based Change Capture
 - Customizable Apply Engine
 - Schema Evolution
 - Transformations
 - Heterogeneous Support
- Versatile:
 - Replicate Data
 - Consolidate Information
 - Provide High Availability during database migration, upgrade
 - Extend Database

More on Streams....

- Visit Oracle Streams booth in Exhibit Hall, Booth A26
- Learn about Oracle Streams Advanced Queuing in room 302 South, Monday at 4:30 pm
- Look for Sample Code for Streams on OTN
- Bookmark OTN page for Streams and other Oracle Information Integration features:
<http://otn.oracle.com/products/dataint/>

A large, stylized 'Q&A' logo is centered in the background. The 'Q' is a large, dark grey, sans-serif letter. The ampersand is a vibrant red, cursive-style symbol. The 'A' is a large, dark grey, sans-serif letter. The text 'QUESTIONS' and 'ANSWERS' is overlaid on the logo in white, bold, sans-serif capital letters.

QUESTIONS
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