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## **Best Practices for Implementing Replication with Oracle Streams in Oracle Database 10g and 11g**

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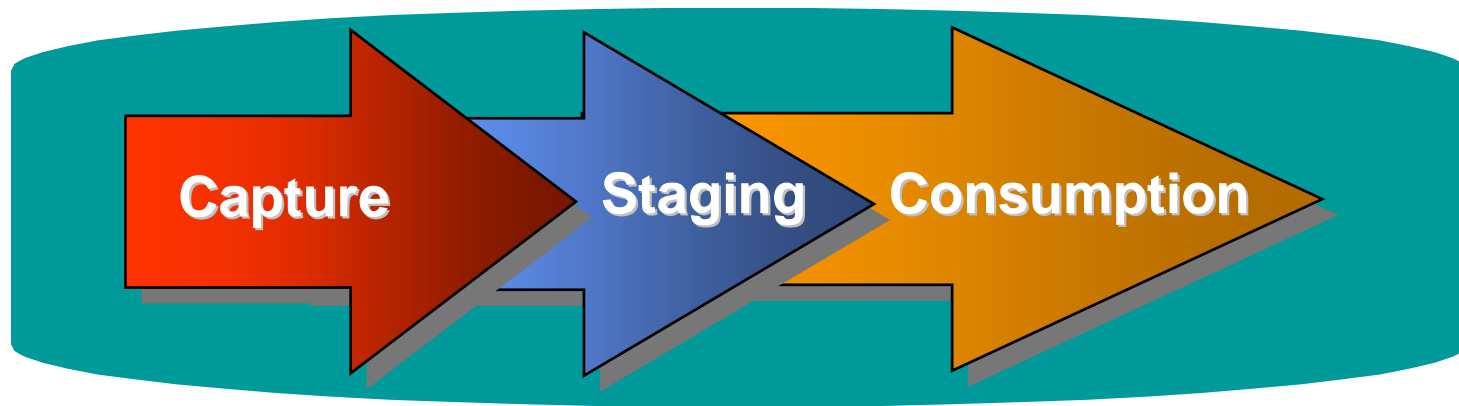
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Database Project Leader  
CERN IT



# What is Oracle Streams?

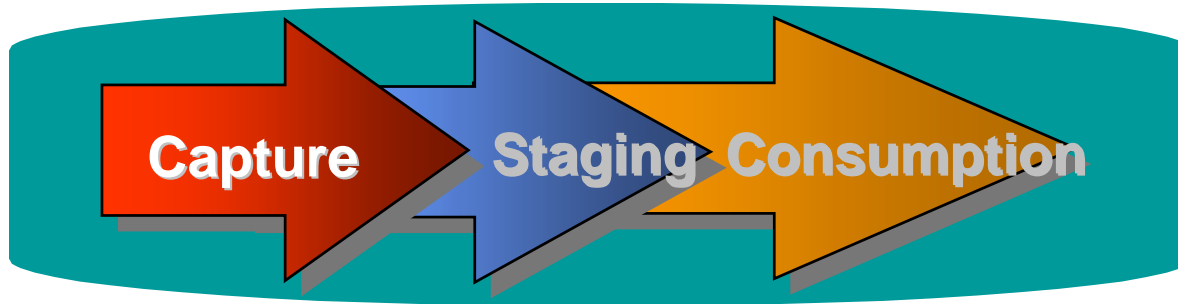
- Simple solution for information sharing
- Provides
  - replication
  - message queuing
  - data warehouse loading and simple ETL
  - database migration
  - application upgrade
  - event management and notification

# Streams: Functional Components



*Asynchronous Information Sharing Infrastructure*

# Capture



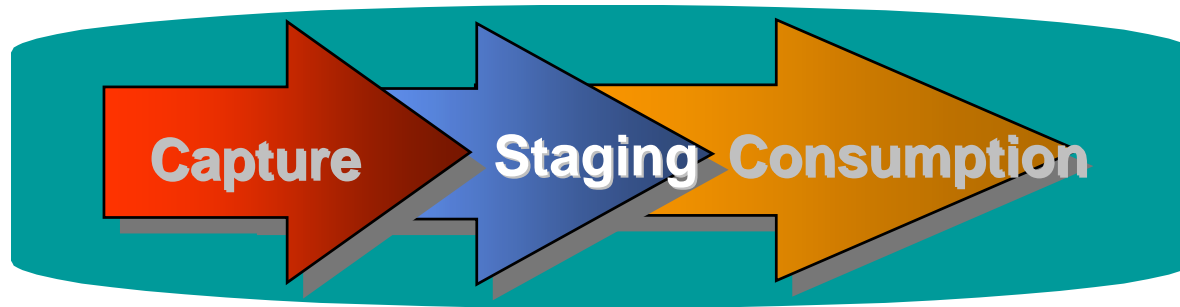
- Low overhead, low latency change capture
  - Multiple modes of capture
    - Asynchronously capture **locally** or at a **downstream** database with Redo-based Capture
      - Oracle Streams extracts changes from the redo as it is written
      - Log Buffer, Online Redo, or Archived log files
    - Sync Capture
      - Capture as **part of executing transaction** and persist to disk
  - Changes are formatted as a Logical Change Record (LCR), a representation of the change



# Logical Change Record (LCR)

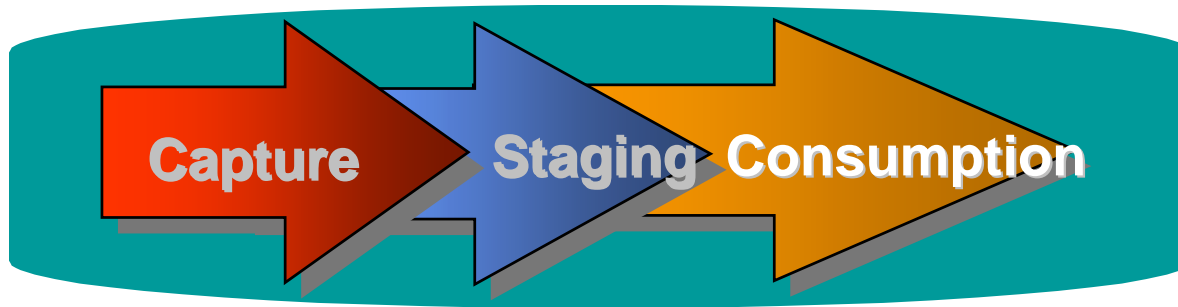
- Database change = LCR
  - DML
    - Row change = LCR
    - Object name, owner, Type of DML, SCN,...
    - OLD, NEW values
    - Optional attributes: username, session, thread,...
  - DDL
    - Object name, owner, Type of DDL, SCN,...
    - DDL text
    - Optional attributes: username, session, thread,...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

# Staging



- Redo-based capture publishes messages into an in-memory staging area
  - Streams Pool of SGA
- Sync Capture stores messages to disk queue
- Subscribers: other staging areas or Streams processes
- Messages remain in staging area until consumed by all subscribers
- Propagation between staging areas is scheduled through a propagation job
  - LCRs propagated from a queue in the local database to a queue in the target database

# Apply



- The default apply engine will directly apply the DML or DDL represented in the LCR
  - Apply to local Oracle table or to non-Oracle table via dbLink
- Automatic conflict detection with optional resolution
  - Unresolved conflicts placed in error queue
  - Transactions can be re-applied or deleted from error queue
- Parallel apply maximizes concurrency
- Customizable apply processing
  - DML, DDL, Pre-commit, and Error handlers modify Apply processing



# 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"');
```

- Rule sets govern capture, staging, and apply
  - Inclusion
  - Negative
- Dynamic rule maintenance
- Tailored Replication API

```
DBMS_STREAMS_ADM.MAINTAIN_*  
  {Tables | Schemas | Global | TTS}  
DBMS_STREAMS_ADM.ADD_*_RULES  
  {Table | Schema | Global | Subset}
```



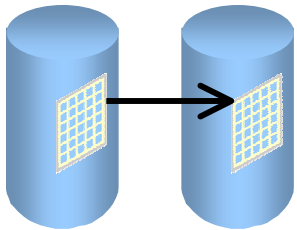
# Simple Configuration

## *Schema Replication*

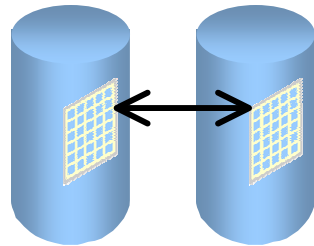
```
BEGIN dbms_streams_adm.MAINTAIN_SCHEMAS(  
    SCHEMA_NAMES          => 'HR,SCOTT',  
    SOURCE_DIRECTORY_OBJECT => null,  
    DESTINATION_DIRECTORY_OBJECT => null,  
    SOURCE_DATABASE       => NULL,  
    DESTINATION_DATABASE   => 'TARGET_global_name',  
    BI_DIRECTIONAL        => TRUE,  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

# Example Configurations using MAINTAIN\_SCHEMAS

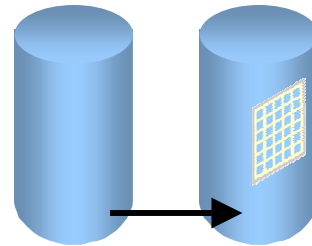
Reporting



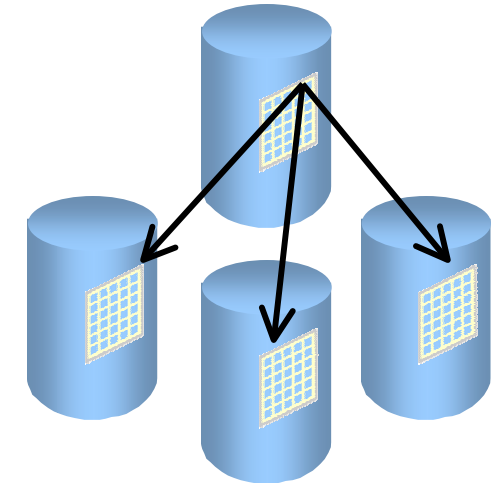
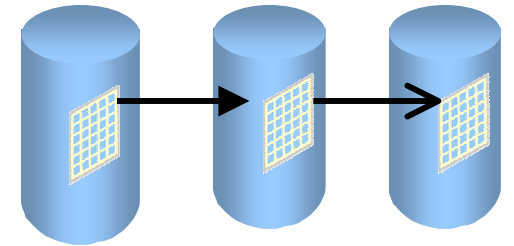
Updatable



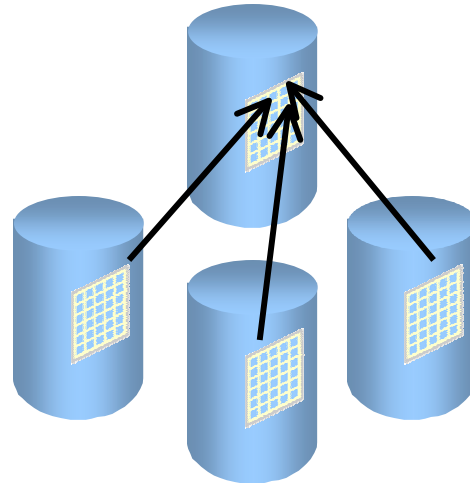
Offload Prod



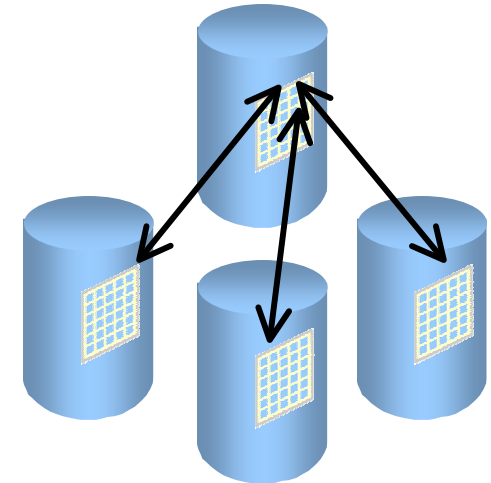
Cascade



Disseminate

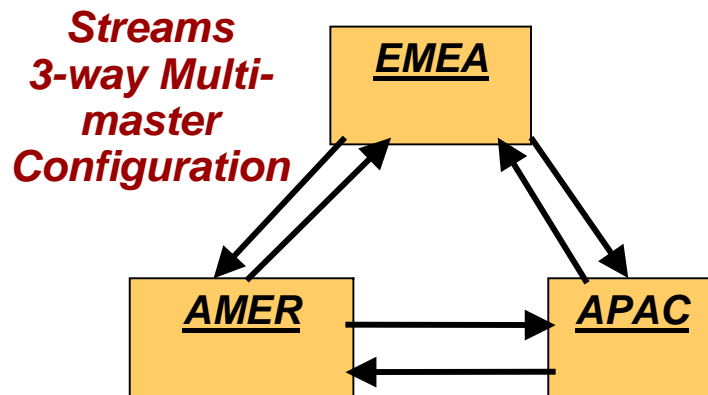


Consolidate



Bidirectional

# N-way Multimaster Replication



## Each Database

3 queues: 1 for each process

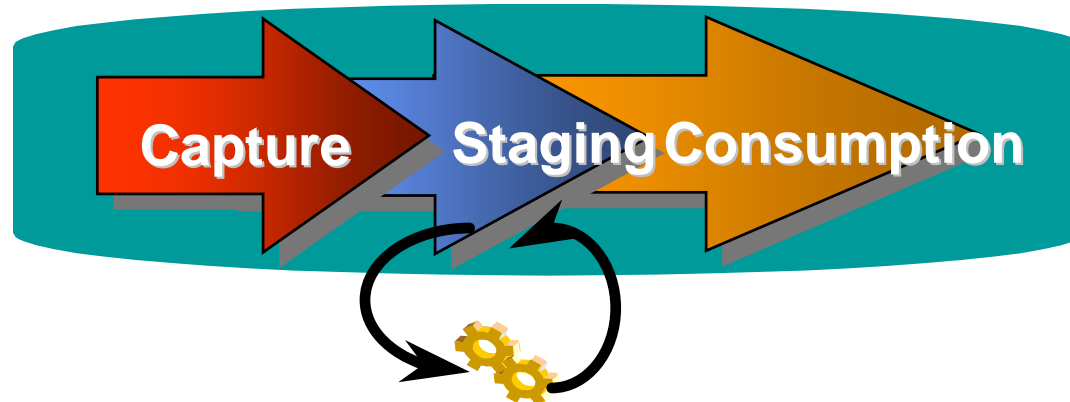
1 capture (local changes)

2 apply processes

- changes from each of the other source databases

- Real-time data replication useful to provide site autonomy and balancing usage
- Geographically distinct locations, frequently across WAN
- Consistent data available at each database
- Updates at each database shared directly with each of the other databases
- Automatic conflict detection, customizable conflict resolution

# Rule-based 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



# Declarative Transformations

```
BEGIN
```

```
  DBMS_STREAMS_ADM.RENAME_SCHEMA(  
    rule_name => 'STRMADMIN.HR51',  
    from_schema_name => 'HR',  
    to_schema_name => 'HR_REPL',  
    operation => 'ADD');
```

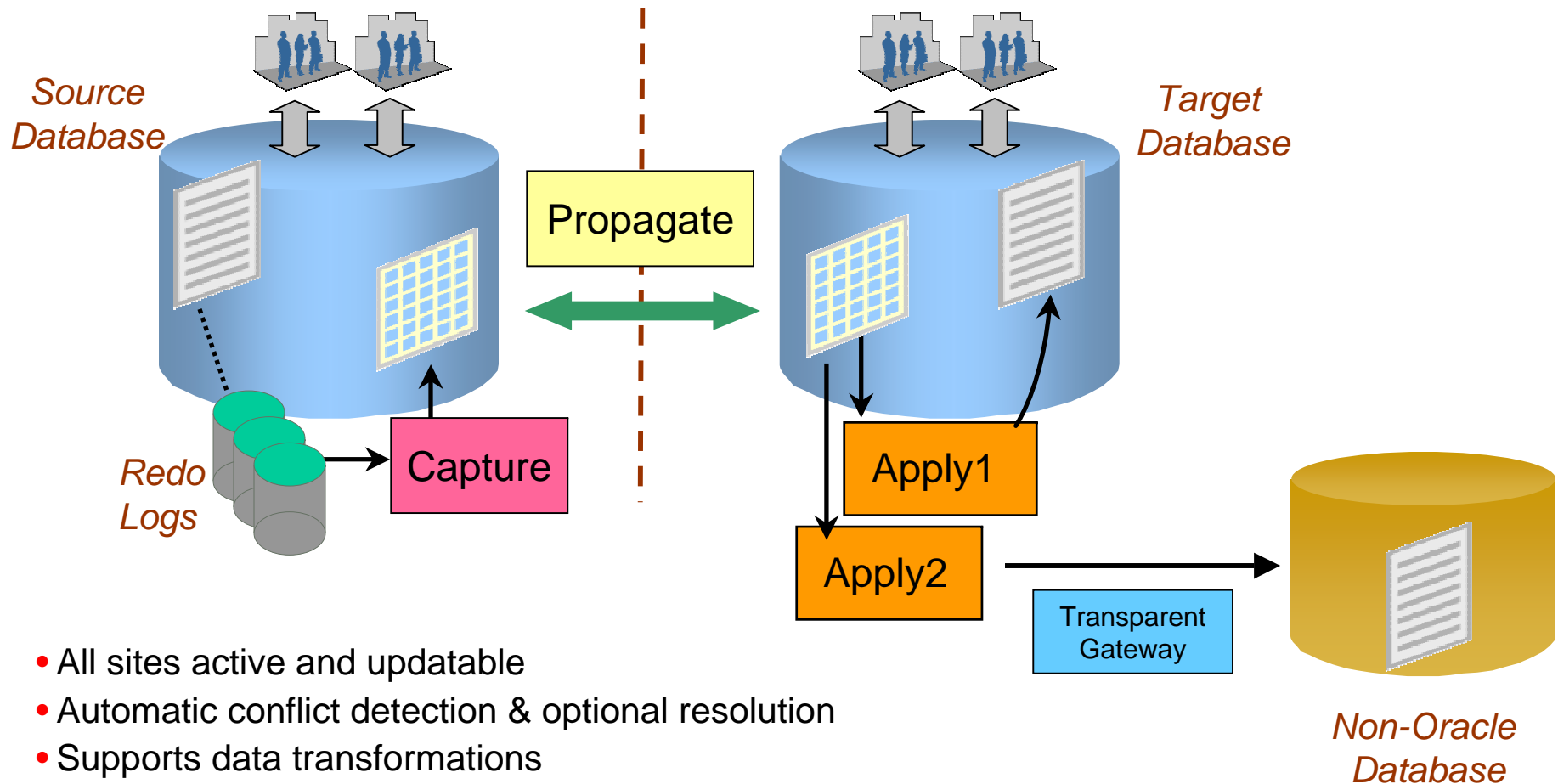
```
END;
```

```
/
```

```
SELECT rule_owner||'.'||rule_name  
       rule,transform_type,from_schema_name,to_schema_name from  
       DBA_STREAMS_TRANSFORMATIONS;
```

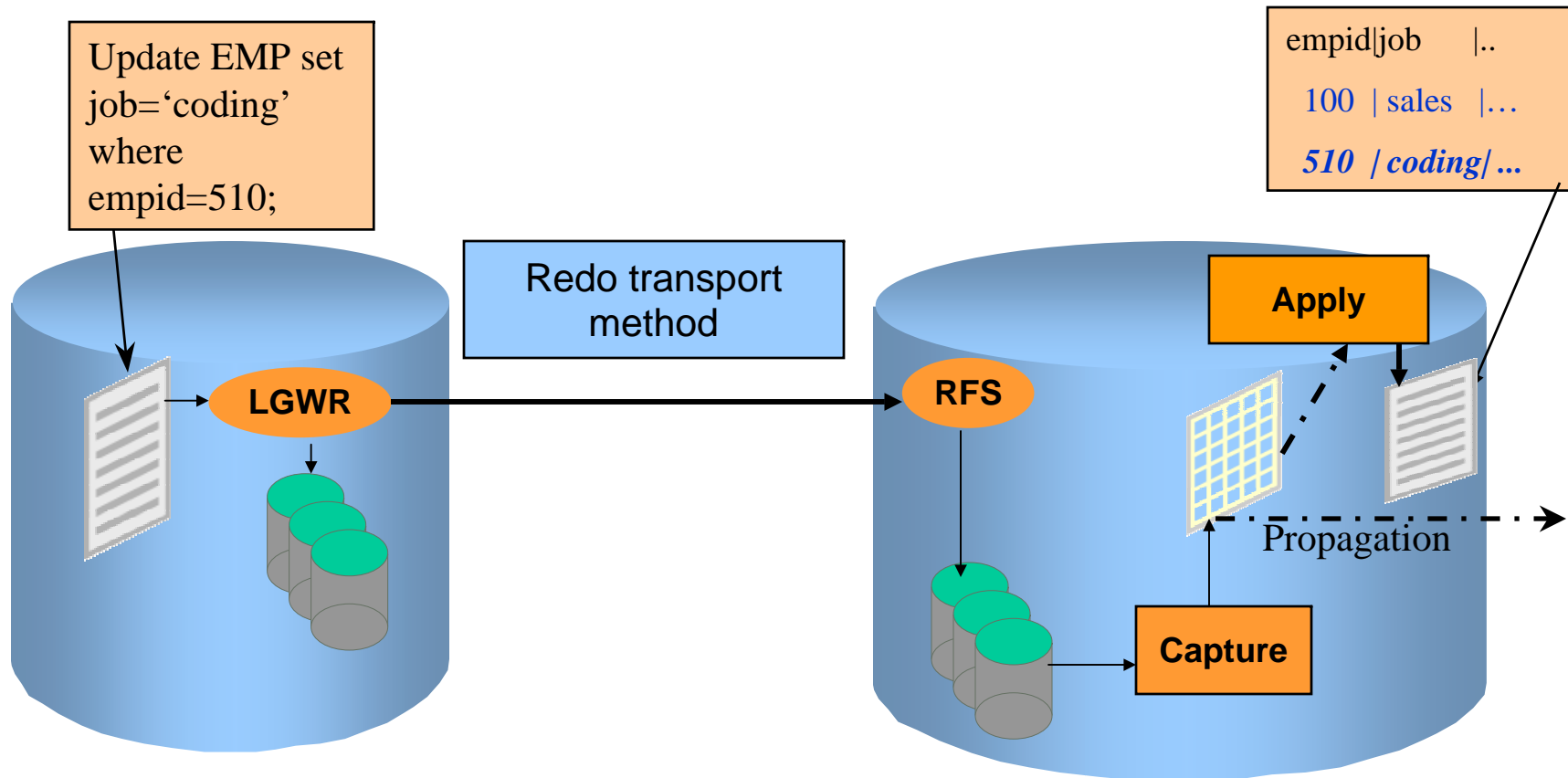
RULE	TYPE	FROM	TO
-----	-----	-----	-----
STRMADMIN.HR51	DECLARATIVE TRANSFORMATION	HR	HR_REPL

# Streams Replication



- All sites active and updatable
- Automatic conflict detection & optional resolution
- Supports data transformations
- Flexible configurations – n-way, hub & spoke, ...
- Database platform / release / schema structure can differ
- Provides HA for custom apps where update conflicts can be avoided or managed

# Downstream Capture





# Streams Enhancements

- Documentation: 2Day+ Data Replication & Integration
- Source and Target data compare & converge
- Streams Performance Advisor
- Split/Merge of Streams for Hub & Spoke replication
  - Maintains high performance for all replicas
  - Automated, fast “catch-up” for unavailable replica
- Cross-database LCR tracking
  - Trace Streams messages from start to finish in single view
- Performance optimizations
- Streams Synchronous Capture
  - Available in all Editions of Oracle Database 11g
  - Efficient internal mechanism to immediately capture change



# ***Streams Replication Best Practices***

***Ref. Chap 15 - “Best Practices for Streams Replication Databases”,  
Oracle Streams Replication Administrator’s Guide 11g .***

***Ref. Chap 14 - “Best Practices for Streams Replication Databases”,  
Oracle Streams Replication Administrator’s Guide 10g Release 2 (10.2) .***



# General Configuration Tips

- Separate queue for each capture and apply, also for each source database
- init.ora:
  - `_job_queue_interval=1` (set at the source site, indicates scan rate interval (seconds) of job queue) (**10g recommendation**)
  - `streams_pool_size=200M` (set at source and destination, ref. to `V$STREAMS_POOL_ADVICE`)
- For WANs: (SQL\*NET parameters)
  - Increase SDU (sqlnet.ora, tnsnames.ora, listener.ora)
  - Increase send\_buf\_size, recv\_buf\_size
  - For downstream capture, refer to MAA best practice paper: *Oracle Database 10g Release 2 Best Practices: Data Guard Redo Transport & Network Configuration*



# Rule Tips

- Spelling counts!
- source\_database\_name = GLOBAL\_NAME of source
  - Must be correctly specified for each process
- Eliminate duplicate or overlapping rules in a rule set
- Use the negative rule set (available with 10g and above)
  - Ensure that rules do not allow objects with unsupported data types
- Avoid complex rules
  - LIKE
  - Functions
  - NOT (9.2)



# Streams Process Parameters

## Capture (DBMS\_CAPTURE\_ADM package)

- Set retention time for capture checkpoints as needed  
Alter\_capture( 'captureName', checkpoint\_retention\_time=>7)  
(checkpoint\_retention\_time available in 10.2 and above)

## Propagation (DBMS\_PROPAGATION\_ADM package)

- Use queue\_to\_queue parameter (set to TRUE)
  - Source and target must be 10.2 or above

## Apply (DBMS\_APPLY\_ADM package)

- Set\_parameter('applyName','parallelism','4') (as needed)
- Set\_parameter('applyName','disable\_on\_error','N')



# 10g Additional Recommendations

## Capture (DBMS\_CAPTURE\_ADM package)

- Reduce the capture checkpoint frequency parameter

Set\_parameter('captureName','\_checkpoint\_frequency','1000')

## Apply (DBMS\_APPLY\_ADM package)

- Set\_parameter('applyName','\_hash\_table\_size','1000000')



# Apply Performance Tips

- **ALTER TABLE SYS.STREAMS\$\_APPLY\_PROGRESS  
INITRANS 16 PCTFREE 10;**
  - **INITRANS** should match the apply parallelism
- Batch Processing
  - Frequent commits (transaction size < 1000 LCRs)
  - Consider procedural replication – replication of a PL/SQL procedure call, rather than the DML generated by the PL/SQL procedure – sample code available



# Handling Errors

- Error queue stores information about transactions that could not be successfully applied
  - Created automatically when queue created
  - Only contains information about local errors
  - Contains all LCRs for each error transaction
- **DBMS\_APPLY\_ADM.EXECUTE\_ERROR( )** has optional error handler capability
- Apply Error Management
  - **MESSAGE\_NUMBER** column in **DBA\_APPLY\_ERROR**
  - Ref. scripts in Manual “*Oracle Streams Concepts and Administration*”, “*Monitoring Streams Apply Processes*”, and Section – “*Displaying Detailed Information About Apply Errors*”  
[Chap 22 in 10.2, Chap 27 in 11g ]



# Operational Tips

- Streams processes restart automatically, if enabled before database shutdown
- Automatic flow control between capture process and targets
  - Rate controlled by fastest subscriber (target)
- Replicating DDL?
  - Avoid replicating system-generated constraint/index names
  - Modify manual hotbackup scripts to set an apply tag
    - Eg: `dbms_streams.set_tag('99')`
- Removing archived log files from disk ?
  - Do not remove log files that may be needed for capture restart
    - Minimum `REQUIRED_CHECKPOINT_SCN`
    - Configure the source database to store archived redo log files in a location other than the flash recovery area – applies to downstream database also



# Active/Active Considerations

- Potential for updates to same row at same time in multiple locations
  - Avoid conflicts, as much as possible
  - Implement conflict resolution methods to automate error handling
- If replicating DDL, perform DDL from single database
- Manage keys generated from sequences



# Streams Monitoring

- Views
- STRMMON – MetaLink Note:290605.1 – *Oracle Streams STRMMON Monitoring Utility*
- UTLSPADV – 11g STRMMON replacement
  - Package in `$ORACLE_HOME/rdbms/admin` directory
- Healthcheck – MetaLink Note:273674.1 – *Configuration Report and Health Check Script*
- Alert Log –
  - Look out for messages from the Capture process, logged when Capture sees at least 1 large or long-running transaction in its active transaction workload

# Enterprise Manager 11g Database Control

The screenshot shows the Oracle Enterprise Manager 11g Database Control interface within a Windows Internet Explorer browser window. The browser title is "Oracle Enterprise Manager (SYSTEM) - Database Instance: database". The address bar shows the URL "http://stadq11.us.oracle.com:7724/em/console/database/instance/sitemap?event=dot". The page header includes "ORACLE Enterprise Manager 11g Database Control" and "Logged in As SYSTEM". The main navigation tabs are "Home", "Performance", "Availability", "Server", "Schema", "Data Movement", and "Software and Support". The "Data Movement" tab is selected, showing sub-sections: "Move Row Data", "Move Database Files", "Streams" (highlighted with a yellow box), and "Advanced Replication". The "Streams" section contains links for "Setup" and "Management". A "Related Links" section at the bottom lists various monitoring and configuration links. The footer contains copyright information and a link to "About Oracle Enterprise Manager".

# Enterprise Manager 10g Grid Control

The screenshot displays the Oracle Enterprise Manager 10g Grid Control interface within a Microsoft Internet Explorer browser window. The page title is "Oracle Enterprise Manager (SYSMAN) - Streams - Microsoft Internet Explorer". The browser's menu bar includes File, Edit, View, Favorites, Tools, and Help. The Oracle logo and "Enterprise Manager 10g Grid Control" are visible at the top left. Navigation tabs include Home, Targets (selected), Deployments, Alerts, Policies, Jobs, and Reports. A breadcrumb trail shows "Hosts | Databases | Web Applications | Services | Systems | Groups | All Targets". The current page is "Streams", with sub-tabs for Overview (selected), Capture, Propagation, Apply, and Messaging. The page is refreshed on May 10, 2005, at 1:58:02 PM PDT. A "View Data" button and a "Manual Refresh" dropdown are present. The main content area is divided into four sections: Capture, Propagation, Apply, and Messaging, each with a table of metrics and status indicators. An "Overview" sidebar on the right provides a detailed description of Oracle Streams.

Section	Metric	Value	Status
Capture	Capture Processes	1	
	Capture Processes Having Errors	0	✓
	Propagation Jobs	1	
Propagation	Propagation Errors	0	✓
	Apply Processes	1	
Apply	Apply Processes Having Errors	0	✓
	Queue Tables	15	
Messaging	Queues	31	
	Total Propagation Errors	0	✓

**Overview**  
Oracle Streams enables information sharing. Oracle Streams can share database changes and other information in a stream, which can propagate events within a database or from one database to another. The specified information is routed to specified destinations. The result is a feature that provides greater functionality and flexibility than traditional solutions for capturing and managing information, and sharing the information with other databases and applications.

- A capture process is an Oracle background process that scans the database redo log to capture DML and DDL changes made to database objects. It formats these changes into events called logical change records (LCRs) and enqueues them into a queue.
- Propagations send events from one queue to another, and these queues can be in the same database or in different databases.
- An apply process is an Oracle background process that dequeues events from a queue and applies each event directly to a database object or sends events to apply handlers for custom processing.
- Oracle Streams Messaging, also called as Oracle Streams Advanced Queuing, provides database-integrated message queuing functionality.



## Source Site: Heartbeat

- Implement periodic Job to update “heartbeat” table
  - 2 columns: Dbname, timestamp
  - Configure Streams capture/apply for “heartbeat” table
  - Configure Conflict Resolution OVERWRITE or Latest Timestamp
- Generates activity in Database
- Quick status for DBA



# Periodic Maintenance

- **DBMS\_CAPTURE\_ADM.BUILD()**
- **DBMS\_CAPTURE\_ADM.  
PREPARE\_GLOBAL\_INSTANTIATION()**
  - Default prepare enables supplemental logging
  - To avoid supplemental logging configuration, use 'NONE' instead of default 'KEYS'



# Streams Summary

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



# CERN Case Study





# Resources

- Collateral, best practices, sample code:  
<http://otn.oracle.com/products/dataint/>
- MetaLink Note [418755.1](#) – 10.2 Streams Recommendations

# Database HA Sessions From Oracle Development

## Monday, Nov 12

•S291483 - The Fastest and the Most Cost-Effective Backup for Oracle Database: What's New in Oracle Secure Backup 10.2, 11:00 am - 12:00 pm, Moscone South 304

•S291492 - Oracle Database 11g: Next-Generation High Availability, 12:30 - 1:30 pm, Moscone South 103

•S291923 - Implementing Oracle Maximum Availability Architecture (MAA) at Allstate Insurance Using Oracle 10g RAC, ASM, Oracle Data Guard and Oracle Grid Control, 3:15 - 4:15 pm, Moscone South 304

•S291484 - Oracle Database 11g Data Repair Technologies: Comprehensive, Intelligent Recovery, 4:45 - 5:45 pm, Moscone South 304

## Tuesday, Nov 13

•S290710 - Maximum Availability Architecture Best Practices: Oracle E-Business Suite 12, 12:15 - 1:15 pm, Marriott Salon 10 & 11

## Wednesday, Nov 14

•S291915 - What's New in Oracle Data Guard 11g: Revolutionizing Data Protection and Availability, 9:45 - 10:45 am, Moscone South 304

# Database HA Sessions From Oracle Development

## Wednesday, Nov 14

- S291487 - Backup and Recovery Best Practices for Very Large Databases (VLDB), 11:15 am - 12:15 pm, Moscone South 304
- S291920 - Oracle Active Data Guard: How to Utilize Your Standby Databases for Production Workload - What They Didn't Print in the Manuals, 3:00 - 4:00 pm, Moscone South 304
- S291917 - Oracle Data Guard Tips and Tricks: Direct From Oracle Development, 4:30 - 5:30 pm, Moscone South 102

## Thursday, Nov 15

- S291495 - Oracle Streams Replication and Advanced Queuing (AQ): What's New in Oracle Database 11g, 8:30 - 9:30 am, Moscone South 304
- S291499 - Best Practices for Implementing Replication with Oracle Streams in Oracle Database 10g and 11g, 10:00 - 11:00 am, Moscone South 304
- S291525 - Maximum Availability Architecture (MAA) Best Practices: Online Patching, Rolling Upgrades and Planned Maintenance with Minimal Downtime with Oracle Database, 11:30 am - 12:30 pm, Moscone South 104
- S290542 - Maximum Availability Architecture (MAA) Best Practices for Siebel 8.0, 2:30 pm - 3:30 pm, Marriott Salon 10 & 11



# Database HA Demos From Oracle Development

**Monday, Nov 12 – Thursday, Nov 15**  
**Oracle DEMOgrounds, Moscone West**

Oracle Active Data Guard

Oracle Streams: Replication and Advanced Queuing

Oracle Secure Backup

Recovery Manager (RMAN) and Flashback Technologies

Maximum Availability Architecture




# Q & A

QUESTIONS  
ANSWERS



## For More Information

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