Oracle Rdb LogMiner and JCC LogMiner Loader

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Oracle Rdb Engineering

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Why Data Replication is Important

Information access is increasingly important; disks are increasingly cheap

- Ad hoc, reporting access interferes with OLTP
- Access to information needs to be continuous, but
  - Databases must sometimes be restructured
  - Databases must sometimes be isolated
  - Databases and systems sometimes fail
- Information must be protected from disaster
- Oracle Rdb is not always the right database management system

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Replication Method	Type	Year
Journal Backup/Restore Method	Journal	~1980
Replication Option for Rdb	Table	~1985
Hot Standby	Journal	~1995
LogMiner/Loader	Journal	2000-2
Application Based	Table	
Shadowing/Mirroring	Disk	~1990

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CLM/LML

- Transactional
  - One or many source transactions = one target transaction
- Event driven or scheduled (Static LogMiner)
- Excellent performance on source database
  - Uses journals, not tables
  - Takes advantage of hardware disk cache; no database hot spot
- Excellent performance on target database
  - Multiple load threads now supported
- Multiple target databases supported

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CLM/LML (Cont.)

- No Geographic Limit
- Low network overhead
- Write your own loader if you like
- Lots of flexibility
  - Logical data model
  - Physical implementation
  - Supports Rdb, Oracle, Tuxedo targets; more possible
  - Read/write access to target possible (be careful)

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What is the Rdb LogMiner?

- Public access to AIJ file contents
  - Oracle does not publish internal AIJ format
  - Command line interface
  - Use AIJ contents without performing recovery
- Extract changed table information from AIJ backup files
- Offers very high performance, low overhead
- Extracts changes to file, mailbox, pipe or your callable routine

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What Rdb LogMiner Does

- The Rdb LogMiner reads the AIJs to produce a stream of database changes.
- The LogMiner can run in either of two modes.
  - Static
    - Runs on backup copies of AIJ files (must start with quiet point)
    - Can process AIJs on the same or a different machine.
  - Continuous
    - "Near Real Time" (needs to wait for the commit on the source).
    - Runs on a machine where the database is open.

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How Rdb LogMiner Works

- Most information is already in the journal
  - Additional information stored - ignored by recovery
  - System relations used to retrieve metadata
- Capturing changes from AIJ means minimal impact to production database
  - Single, quick metadata retrieval
  - AIJ size will grow
  - Content of deleted rows is now written to the AIJ
  - CLM process usually reads cached data just written to the AIJ

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What Isn't Rdb LogMiner?

- Not a Data Loader
  - The data extracted from AIJ backup files can have several targets: file, mailbox, pipe, callback
  - None of them are a database

- Data not in the source table format
  - Additional information is added to the record by LogMiner

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Extract Operation

- All specified tables extracted at once (one pass through AIJs)
- Multiple output streams are possible
  - One output stream per table or multiple tables delivered to one output stream
  - Skip some tables
- One or more input AIJ files (processed sequentially)
- Output record order within transaction not predictable
- Only committed transactions are output
  - Output in transaction commit sequence order

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What Does LogMiner Output?

- Data from user tables
  - Inserts and modifies
    - 'Final' record content per transaction
  - Deletes
    - Record content just prior to delete
- Only Committed transactions
  - Rolled-back transactions ignored
- Final form of row returned
  - Row modified many times in the same transaction results in a single modify output record
  - Transaction that inserts and deletes a row in one transaction results in only a delete record being extracted
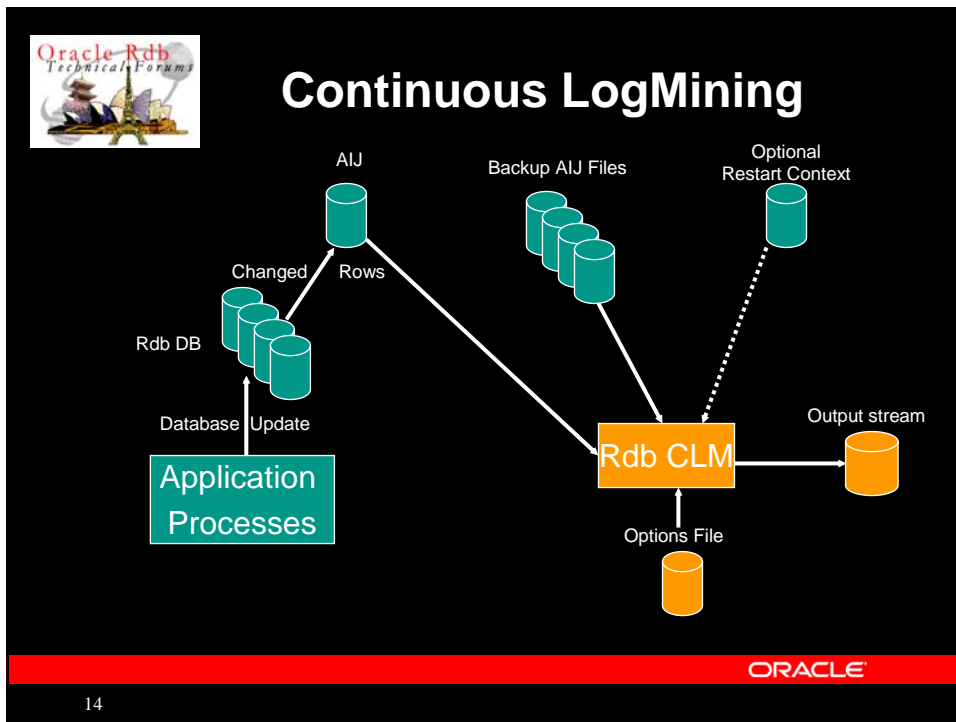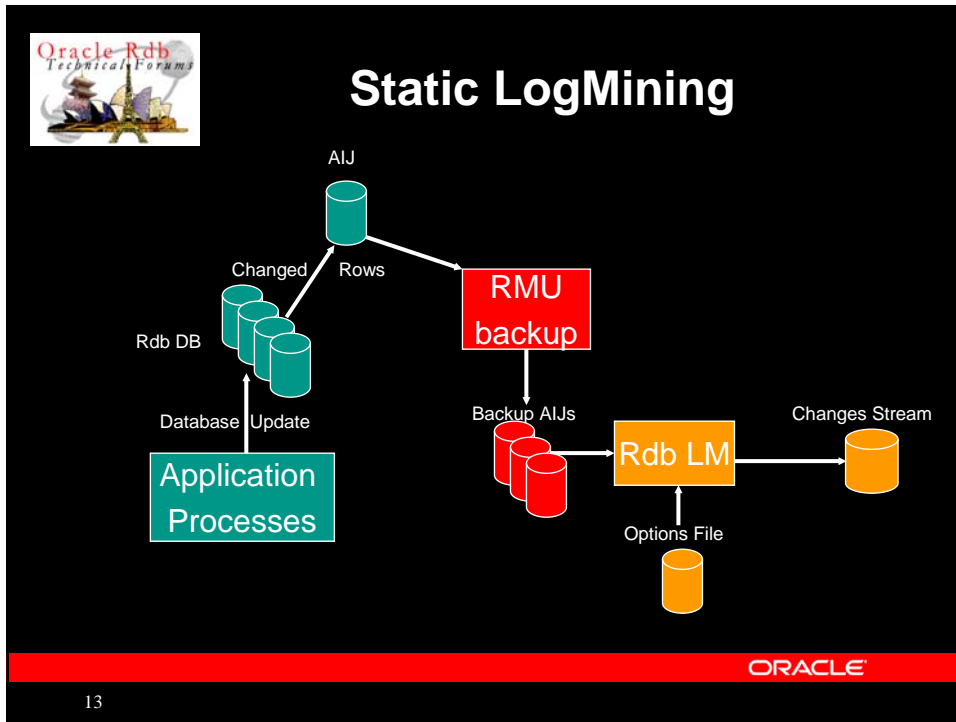
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What Does LogMiner Output?

ACTION	"M" or "D"
TABLE_NAME	table name string
RECORD_ID	relation ID
RECORD_LEN	length of data record
NBV_LEN	null bit vector count
LDBK	logical DbKey
START_TAD	date/time of transaction start
COMMIT_TAD	date/time of transaction commit
TSN	transaction sequence number
RECORD_VER	metadata version of record
RECORD data	record contents
RECORD_NBV	null bit indicator array (1 bit per field)

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Static LogMining

Continuous LogMining

Enabling LogMiner

- Requires offline access

```
$ RMU/SET LOGMINER/ENABLE MY_DB
    or
$ RMU/SET LOGMINER/ENABLE/CONTINUOUS MY_DB
```

- Requires AIJ to be enabled
- Continuous LogMiner requires circular AIJ
- Backup database and AIJ after enabling

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LogMiner Options File

- One file per table or the same file for multiple tables
- Options file example:

```
table=account                   ,output=account_output_file.dat
table=account_audit             ,output=audit_output_file.dat
table=account_batch_processing  ,output=account_output_file.dat
table=account_contract          ,output=account_output_file.dat
```

- Output types:
  - File
  - Mailbox
  - Pipe
  - Callback routine

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Examples (Static LogMiner)

```
$ RMU/UNLOAD/AFTER_SOURCE.RDB SOURCE.AIJBCK -
   /TABLE=(NAME=CUST,OUTPUT=CUST.DAT, -
        RECORD-DEFINITION = RDB-LM-RPT-CUST.RRD)

$ RMU/LOAD TARGET.RDB RDB-LM-RPT-CUST CUST.DAT -
   /RECORD-DEFINITION = FILE = RDB-LM-RPT-CUST.RRD -
   /COMMIT_EVERY = 1000
```

- Or Replace the table qualifier with an Options file

```
$ TYPE TABLES.OPTIONS
TABLE=MYTBL, OUTPUT=MYTBL.DAT
TABLE=SALES, OUTPUT=SALES.DAT
$ RMU/UNLOAD/AFTER_SOURCE.RDB SOURCE.AIJBCK -
        /OPTIONS = FILE = TABLES.OPTIONS
```

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Examples (Continuous LogMiner)

- This example demonstrates unloading three tables (EMPLOYEES, SALES,and CUSTOMERS) to a single mailbox.

- In order to include transaction commit information, the /Include=Action=Commit qualifier is specified:

```
$ DEFINE MBX$ LOADER_MBX:X
$ RMU /UNLOAD /AFTER_JOURNAL /CONTINUOUS MFP.RDB –
        /INCLUDE = ACTION = COMMIT -
        /TABLE = (NAME = EMPLOYEES, OUTPUT = MBX$:) -
        /TABLE = (NAME = SALES, OUTPUT = MBX$:) -
        /TABLE = (NAME = CUSTOMERS, OUTPUT = MBX$:)
```

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Limitations

- Segmented strings, computed by field, temporary tables not captured
- Optimized AIJ files cannot be used
- Truncate or Drop table not captured
- Tables using vertical record partitioning (VRP)
- Changes to a table when the table definition has changed within an after-image journal file.
- Do not use the OpenVMS Alpha High Performance Sort/Merge utility

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Loading

What do you do with the resulting data?

- Purchase a tool that does the work for you
  - JCC LogMiner Loader
- Write your own code
  - This requires understanding of all the unusual things that happen in the process. (see JCC LML documentation at http://www.jcc.com/)
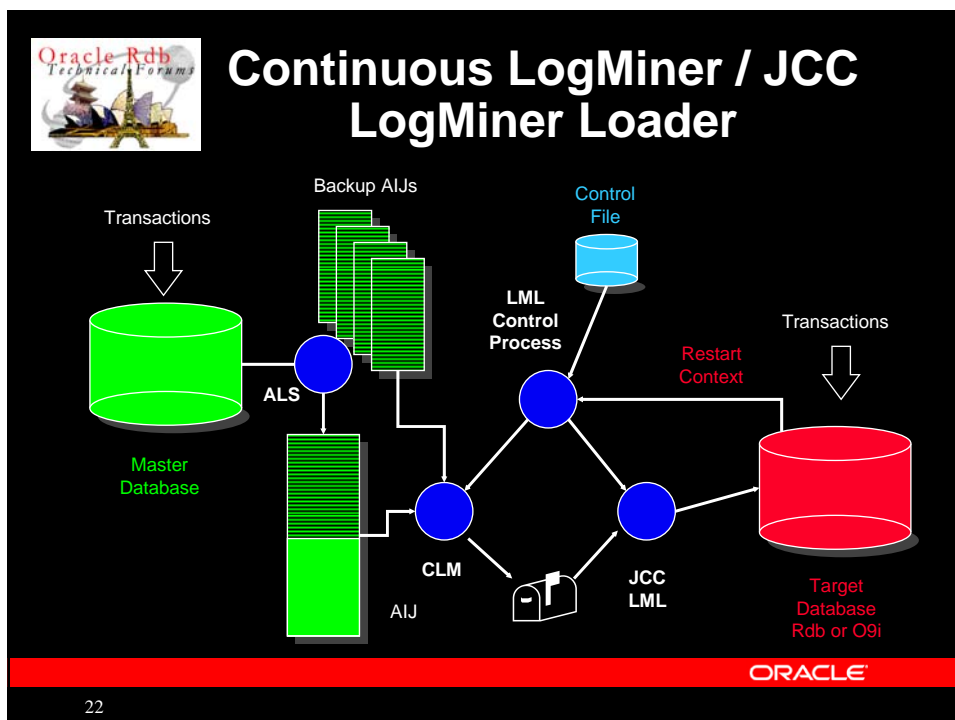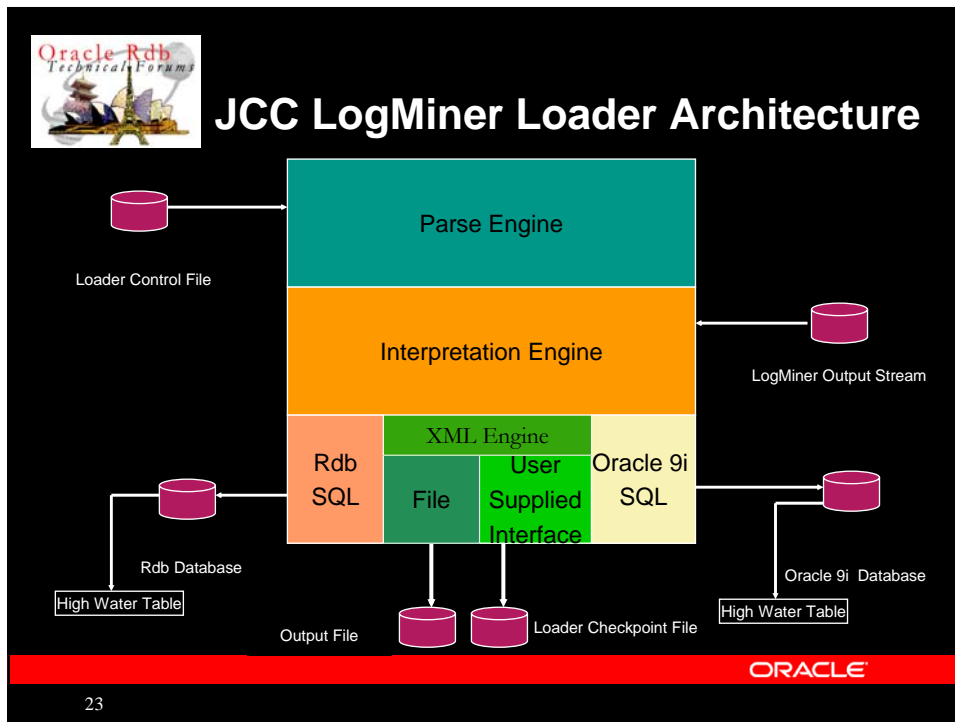
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JCC LogMiner Loader Overview

- The Loader
  - Reads the binary files or output stream produced by the Rdb LogMiner and records the changes in a target data store
  - Reads a control file that specifies actions for the session

- The target data store may be one of the following:
  - Rdb database.
  - Oracle 9i database.
  - User-supplied API (XML document per source transaction.)
  - Disk file.

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Continuous LogMiner / JCC LogMiner Loader

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LogMiner Loader Control File

- Control file controls all characteristics of replication
- Most database definitions will be long and complex.
  - LML Automatically generates the metadata portion of the Loader control file with supplied utility.
    - "Guesses" primary keys.
  - Must regenerate when the database metadata is changed.

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Sample of Control File

```
!
LOADERNAME~DEMO
LOGGING~STATISTICS~COMMIT,RUNTIME,TIMER
!
! Table name, max version, what to do with table
TABLE~ACCOUNT_STATUS_CODE_TABLE~3~Replicate
!
PRIMARY KEY~ACCOUNT_STATUS_CODE_TABLE~ACCOUNT_STATUS_CODE~1~4~0~14~0
COLUMN~ACCOUNT_STATUS_CODE_TABLE~OLD_ACCOUNT_STATUS_CODE~2~1~0~14~0
COLUMN~ACCOUNT_STATUS_CODE_TABLE~CODE_TEXT~3~20~0~14~0
COLUMN~ACCOUNT_STATUS_CODE_TABLE~CURRENTLY_USED_FLAG~4~1~0~14~0
!
TABLE~ADDRESS_TYPE~3~Replicate
PRIMARY KEY~ADDRESS_TYPE~ADDRESS_TYPE_CODE~1~4~0~14~0
COLUMN~ADDRESS_TYPE~CODE_TEXT~2~20~0~14~0
COLUMN~ADDRESS_TYPE~USER_SELECTABLE_FLAG~3~1~0~14~0
```

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Identifying Rows in Target Database

- The Loader can
  - Replicate rows to a target database
  - Write change records for audit or other purposes
- Replication produces tables exactly like the source table
  - Insert
  - Update
  - Delete
- Requires a primary key that does not change
  - Target database may be very different from the source database
- For tables without keys, the Loader can materialize a pseudo-key column, originating_dbkey
  - Guaranteed to be unique.
  - DBKeys can be reused so source table reorganization is more complicated.

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Checkpoints

- The loader applies its changes in transactions
- The Loader retains restart context in the target database.
  - Requires a new table
  - The TSN of the last transaction committed
  - The AERCP
- For non-database output the Loader writes to a special checkpoint file
- Multiple source database transactions may be grouped in a single target database transaction
  - Checkpoints still work correctly

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Near Real Time

- The LogMiner does not emit any records for a transaction until it finds a commit record
- All records for that transaction are emitted in a single group
- Therefore the LogMiner and Loader will always be "behind" the activities in the production database

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The CLML Control Program

- Reads the target database or local checkpoint file to obtain restart information
- Creates a sub-process to run the Loader
- Creates a sub-process to run the continuous LogMiner
- Monitors the health of the two sub-processes
- Acts as a logging sink for the log files for the two sub processes (uses more mailboxes for this)
- Sends out operator alerts if something goes wrong
- Listens for shutdown request
- Drains mailbox during shutdown

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Example Running Static Logloader

```
$ define jcc_logminer_loader_input <unload file>
$ define jcc_logminer_loader_init <control file name>
$ define jcc_logminer_loader_db <target database file name>
$ jcc_logminer_loader [-c] [-override overide_type] –
   [-sequence seq_opt] –
   [-i input_name [-it input_type]] –
   [-o output_name] [-ot output_type] –
   ["-I" initialization_file_name]
```

Can also be defined in control file by:
output~rdb~synch~target_db~record

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Running Continuous Loader

```
$ DEFINE JCC_ADD_CLM_SHARED_READ TRUE
$ DEFINE JCC_LOGMINER_LOADER_HW_RESPONSE CREATE|QUIT
$ DEFINE JCC_AIJ_backup_spec <directory name>
$ DEFINE JCC_ADD_CLM_LOG TRUE
$ DEFINE JCC_ADD_CLM_TRACE TRUE
$ DEFINE JCC_ADD_CLM_DEBUG TRUE
$ @jcc_tool_com:jcc_run_clm_lml.com <source database> –
  <LogMiner options file> –
  <LogMiner Loader control file> –
  [<restart override tag> <LogMiner restart context> –
   <Loader sequence number>]
```

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Shutting down Continuous Loader

- In general, you should not terminate Loader or LogMiner jobs manually.

- For predetermined shutdown, use the procedure supplied with the JCC LogMiner Loader kit:

```
$ @JCC_TOOL_COM:JCC_CLML_SHUTDOWN.COM –
  <loadername>
```

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Obtaining Evaluation Licenses

- 90-day evaluation licenses are available
- Fill out form on JCC web page
- Distribution kit and documentation are available on the JCC FTP site:
  - ftp://ftp.jcc.com/outgoing/JCCLogLoader/
  - Requires license key to run
- Questions/information on Loader:
  - jeff@jcc.com

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Customer Experience # 1

- U. S. Car Rental Business
- The internet really did change everything:
  - Web based travel sites replaced human travel agents
  - Far more rate requests
  - Far more rate changes
- Little capital available because of terror attack fears

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Customer Experience # 1

- Database with normal transaction rate of 500 TPS.
  - About 2% of them update transactions.
- Loader database used for read only transactions in ACMS application.
- Target database is Rdb database.
- Maintains synchronization with one loader thread within a few (0-5) seconds.
  - Required commit interval of 50 because of bursts of do-nothing read-write transactions on night time batch runs.
- Average transaction duration reduced by 50%
- Solution is highly scalable

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Customer Experience # 1

• Solution:
  – Replicate rate data to copy database
  – Retain master database for rate updates and reservations
  – Use Row Cache in both databases for speed (< 0.02 sec trans time)
  – Target databases never more than 5 seconds behind

Rate Changes, Reservations

Rate Inquiries
Rate Inquiries
Rate Inquiries

CLM

JCC
LML
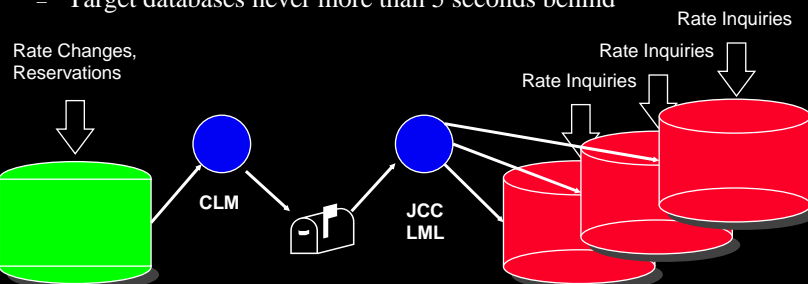
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Customer Experience #2

• Huge, multi database OLTP system
• Customer desires single Operational Data Store
• Source databases generate up to 5,000 change records per second during batch processing
• Replication target is Oracle 9i RAC database
• CLM-LML replication to target never falls more than 5 minutes behind
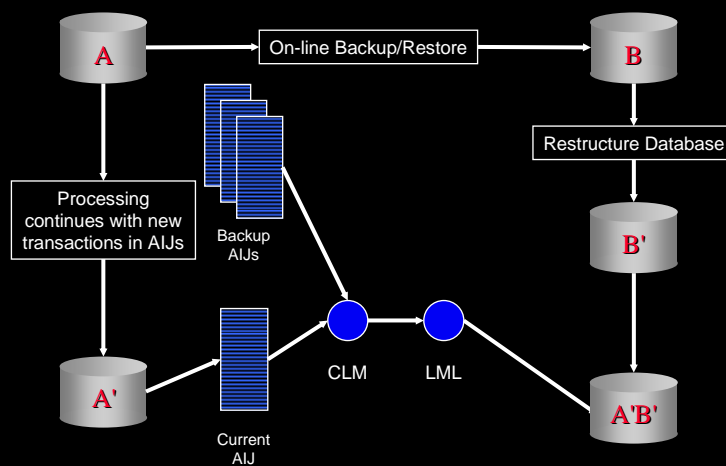
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Customer Experience #3

- Reorganize critical on-line 50Gb database in near-on-line mode
- Requirement: less than 1 hour downtime
  - Export/Import timed at 20 hours
  - Unload/Reload timed at 12 hours
- Solution:
  - Reorganize off line.
  - Apply AIJ iteratively to catch up.
  - One last AIJ application with database down.
  - Minimal down time.
- Database now has architecture to support growth.
- Jobs run in ½ of the time.

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Customer Experience #3

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Other Uses:

- Populate a reporting database
- Consolidate information from multiple systems to deliver information on the web
- Security audit changes to a table
- Populate a data warehouse
- Recover accidentally deleted records
- ….

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COMMENTS ?

Q U E S T I O N S

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www.oracle.com/rdb

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