Ex 12 :

Oracle Database 12c Replication – Part 1

Introduction To Oracle Goldengate 12C

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Agenda

1. Introduction To Oracle Goldengate 12C
2. OGG 12C Installation & Configurations & Demos
3. OGG 12C Configuration
4. Configuring GoldenGate for HA
5. Managing GoldenGate
6. OGG 12C Performance & Tuning
7. Oracle GoldenGate 12.2 New Feature and Enhancement
Introduction
To Oracle Goldengate 12C

By David Yitzhak
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Introduction to OGG 12C

- What is OGG.
- Competitor to OGG
- Oracle GG solutions
- Use cases
- OGG Overview
- How Oracle GoldenGate Works
- OGG Solutions (Logical)
- DG or Replication?
- OGG Process Flow
- OGG architecture
- Design Issues
- OGG Prerequisites : Primary Key
- Table Mapping , Data selection & filtering
- Initial data synchronization
- OGG CSN (Commit Sequence Number).
What is OGG?

- Fast, robust, real-time based replication & data integration solution between operational and analytical systems.
- Implements a uniform format to perform data replication
- OGG captures, filters, routes, verifies, transforms, and delivers transactional data across Oracle & heterogeneous environments
- Transaction integrity between source and target systems (read consistency, referential integrity)
- Oracle no longer supports Streams but several key features immigrated to GG 12C.
- Oracle no longer supports Advanced Replication.
### Supported platforms and databases

- Oracle officially support OGG 12c (12.1.2.1.0).
- Full list at Oracle Support website: https://support.oracle.com (formerly Metalink).
- Lists the platforms supported by OGG 11g and 12c.

<table>
<thead>
<tr>
<th>DB</th>
<th>Version</th>
<th>Architecture</th>
<th>OS</th>
<th>Version</th>
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</thead>
<tbody>
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<td>11.2/12.1</td>
<td>64</td>
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<td>Oracle</td>
<td>11.2/12.1</td>
<td>64</td>
<td>Oracle Linux</td>
<td>6</td>
</tr>
</tbody>
</table>
## Supported platforms and databases

Certified non-Oracle databases that support Oracle GoldenGate 12.1:

<table>
<thead>
<tr>
<th>Database</th>
<th>DB Version</th>
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</thead>
<tbody>
<tr>
<td>IBM Infomix</td>
<td>11.5</td>
</tr>
<tr>
<td>IBM Infomix</td>
<td>11.7</td>
</tr>
<tr>
<td>IBM Infomix</td>
<td>12.1</td>
</tr>
<tr>
<td>Microsoft SQL Server</td>
<td>2008</td>
</tr>
<tr>
<td>Microsoft SQL Server</td>
<td>2008R2</td>
</tr>
<tr>
<td>Microsoft SQL Server</td>
<td>2012</td>
</tr>
<tr>
<td>Microsoft SQL Server</td>
<td>2012R2</td>
</tr>
<tr>
<td>Microsoft SQL Server</td>
<td>2014</td>
</tr>
<tr>
<td>MySQL</td>
<td>5.5</td>
</tr>
<tr>
<td>MySQL</td>
<td>5.6</td>
</tr>
</tbody>
</table>
OGG and Data Integration: Over 10K Customers Worldwide.

Competitors: Mainly storage replication solutions with point-in-time data restoration. Examples:

- Attunity
- NetApp Snapmirror
- Dell SharePlex
- Microsoft Sync Framework
- EMC SRDF & EMC RecoverPoint
- IBM InfoSphere data replication
- Hitachi TrueCopy
- Symantec Volume Replicator & File Replicator
## Competitor to OGG

<table>
<thead>
<tr>
<th>Replication Feature</th>
<th>Oracle GoldenGate</th>
<th>MySQL Native</th>
<th>Dell Shareplex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master to Master</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Multi-source Master</td>
<td>✓</td>
<td>MySQL 5.7</td>
<td>✓</td>
</tr>
<tr>
<td>Conflict Resolution</td>
<td>Custom SQL code or parameter</td>
<td>No</td>
<td>Custom SQL code</td>
</tr>
<tr>
<td>Heterogeneous</td>
<td>Many DB platforms</td>
<td>No</td>
<td>Oracle or SQL Server</td>
</tr>
<tr>
<td>Point of Replication</td>
<td>After commit</td>
<td>After commit</td>
<td>Before commit</td>
</tr>
<tr>
<td>Data Synchronization</td>
<td>Veridata</td>
<td>3rd party or custom solution</td>
<td>Built-in</td>
</tr>
<tr>
<td>Backward Compatibility</td>
<td>✓</td>
<td>Limited</td>
<td>✓</td>
</tr>
<tr>
<td>Oracle Integration</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>
OGG Solutions

1. Business Continuity
   • Active-Active for Maximum Availability and transactional load distribution between two or more active systems
   • Hot-standby database for failover purposes.
   • Zero downtime upgrades & migrations.

2. Operational BI:
   • Real-time data integration to operational data stores or data warehouses directly or via Extract, Load, and Transform (E-LT) tools
   • Integration support with Oracle Data Integrator that leverages E-LT processes for OLAP and Data Warehouse implementations
   • Replication to data warehouses that eliminates batch or Extract, Load, and Transform processes

3. Reporting or query-offloading purposes BI users or tools (One-Way Replication).
OGG Solutions

4. Transactional Data Integration:
   - Real-time data feeds to messaging systems for business activity & process monitoring and complex event processing
   - OGG can integrate with JMS-based messaging systems to enable Event-Driven Architecture (EDA) and to support Service Oriented Architecture (SOA).

5. Big Data
   - Real-time data consolidation into Big Data targets.
   - Interfaces with standard software components to access to semi-structured data

6. Cloud and On-Premises:
   - Real-time bidirectional data feeds between On-Premises and public Clouds that are both secure and reliable.
Use cases
OGG Overview

- Building blocks: capture process, trail files, data pump, server collector, and apply processes
- Manager process runs on both source and target systems.
- All individual processes are modular: can be easily decoupled or combined for best solution.
- We can configure multiple captures and apply processes to balance the load and enhance the performance.
- Filtering and transformation of data at source by capture process or target by the apply process with parameter files.

GGSCI - GG Software Command Interpreter

- OGG 12c is command-line-driven.
- Provides admins with rich set of commands to create, configure, and monitor all OGG processes
Extract - capture process

• Get committed transactions from the DB transaction logs

• Oracle from the online redo logs or archived redo logs for long-running transactions or to support features like compression.

• Regularly checkpoint it’s read and write position to the trail file to ensure GG can recover its processes without data loss in the case of failure.

• statuses:
  1. STOPPED
  2. STARTING
  3. RUNNING

• From GG 11gR2, can be configured in three different modes:
  1. Classic capture
  2. Integrated capture
  3. Downstream integrated capture
Trail File

- GG converts the captured data into a canonical format written to trail files both on source and target.
- No single point of failure.
- Checkpoint process keeps track of the data being written to the trails on both, the source and target, for fault tolerance.
- Oracle best practice and supports recovery of data for retransmission via a data pump.
- Extract process can send data across a TCP/IP directly from DB redo logs to target server data collector.
- Not recommended because of possible data loss in case of system failure or network problems.
Data pump
• Additional Extract process that sends data in large blocks across a TCP / IP network to the target system.

Server Collector
• Runs on the target system and accepts data from the source (Extract/data pump).
• Reassemble the data and write it to a OGG trail file, (remote trail)
• Decryption of received data when configured.
Replicat - the apply process

- Final step in the data delivery.
- Reads trail file and applies it to the target DB as DML and/or DDL.
- Can be parallel with data capture or performed later.

- Regularly checkpoint its read and write position (usually DB table) to ensure OGG recovers its processes without data loss in case of failure.
- Statuses:
  1. STOPPED
  2. STARTING
  3. RUNNING
  4. ABENDED

- DDL is only supported in unidirectional replication and non-heterogeneous (Oracle to Oracle) environments.

- OGG 12c now supports 3 modes:
  1. Classic Replicat
  2. Coordinated Replicat
  3. Integrated Replicat
Manager Process

- Runs on the target system and accepts data from the source (Extract/data pump).
- Reassemble the data and write it to an OGG trail file, (remote trail)
- Decryption of received data when configured.
- Runs on both source and target systems.
- Control activities like starting, stopping, monitoring, and restarting processes; allocating data storage; and reporting errors and events.
- Always exist in any OGG Instance.
- However, there can be only one Manager process per changed data capture (CDC) configuration on the source and target.
- Statuses:
  1. STOPPED
  2. RUNNING
How Oracle GoldenGate Works

Capture: committed transactions are captured (and can be filtered) by reading the transaction logs.

Trail: stages and queues data for routing.

Pump: distributes data for routing to target(s).

Route: data is compressed, encrypted for routing to target(s).

Delivery: applies data with transaction integrity, transforming the data as required.
How Oracle GoldenGate Works

Capture: committed transactions are captured (and can be filtered) by reading the transaction logs.

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Delivery: applies data with transaction integrity, transforming the data as required.

Source Oracle & Non-Oracle Database(s) → Capture → Trail Files → Pump → Trail Files → Route → Delivery → Trail Files → Pump → Trail Files → Delivery → Target Oracle & Non-Oracle Database(s)
How Oracle GoldenGate Works: Checkpoint

Checkpointing

Capture, Pump, and Delivery save positions to a checkpoint file so they can recover in case of failure.
DG or Replication?

**Replication (GoldenGate) Pros**
- Target db open read-write
- Logical multi-master bi-direction replication
- Character set conversions
- Heterogeneous platform support
- Data transformation for ETL
- Rolling DB Upgrades, maint. & migrations.
- Supports more versions & platforms than DG
- Zero downtime application upgrades
- Failover GG components with DB failover
- DDL and DML
- Static extract and load
- GG monitor integrated in OEM 12c

**Replication (GoldenGate) Cons**
- Performance and ease-of-use not as good as DG for protecting a primary db
- No Application continuity
- Supplemental logging
- Directories for trace, checkpoint and other non-DB files must be backed up
- Is replicated DB the same as the primary?
OGG Process Flow

1. Rule: Related Objects (Like FK relationships) and related DDL and DDL should be together in the same process group to ensure data integrity
OGG Process flow: Data delivery with a data pump

<table>
<thead>
<tr>
<th>Start component</th>
<th>End component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extract process</td>
<td>Local trail file</td>
</tr>
<tr>
<td>Local trail file</td>
<td>Data pump</td>
</tr>
<tr>
<td>Data pump</td>
<td>Server collector</td>
</tr>
<tr>
<td>Server collector</td>
<td>Remote trail file</td>
</tr>
<tr>
<td>Remote trail file</td>
<td>Replicat process</td>
</tr>
</tbody>
</table>

Source Database → Extract → Data Pump → Server Collector → Target Database

Source Server

Target Server
OGG Process flow: Data delivery without data pump

<table>
<thead>
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<tr>
<td>Extract process</td>
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<td>Data pump</td>
</tr>
<tr>
<td>Data pump</td>
<td>Server collector</td>
</tr>
<tr>
<td>Server collector</td>
<td>Remote trail file</td>
</tr>
<tr>
<td>Remote trail file</td>
<td>Replicat process</td>
</tr>
</tbody>
</table>

Source Database

Source Server

Manager

Extract

CKPT

Local Trail

Target Server

Manager

Server Collector

Replicat

CKPT

Remote Trail

Target Database
Real Time Data movement with OGG
OGG Solutions (Logical)

**Unidirectional**
- Zero downtime migrations
- Query Offloading/Reporting
- Application integration

**Active-Active (Bidirectional)**
- High Availability
- Active Meshes with CDR

**Hub & Spoke**
- Centralized sharing
- Data distribution

**Consolidation**
- Data Warehouse
- Single Source of Truth
- Mergers & Acquisitions

**Distribution**
- Data dissemination
- Cascade replication
1. One-to-one (source to target)
2. One-to-many (one source to many targets)
3. Many-to-one
4. Cascading
5. Bidirectional (active active)
6. Bidirectional (active passive)
7. Reporting Configuration with a Data Pump on an Intermediary System
8. peer-to-peer Configurations
9. Hub & Spoke Configurations
One-to-one architecture

- key benefits:
  - Live reporting
  - Fastest possible recovery and switchover (when the target is synchronized with the source)
  - Backup site that can be used for reporting
  - Supports DDL replication
One-to-Many architecture

Data Distribution Configuration

- Key benefits:
  - Dedicated site for live reporting.
  - Dedicated site to backup data from the source database.
  - Offers the fastest possible recovery and switchover when using a dedicated backup site. It minimizes logical data corruption, as the backup database is separate from the read-write OLAP database.
Many-to-One architecture

Data Warehousing Configuration

- key benefits:
  ✓ Consolidation-scenario is common in all industries

Important Points:
Conflict Handling
Data needs to be available on the central database and cannot become lost or corrupted.
Cascading Reporting Configuration

- data replication at $n$ sites originating from a single source
- Loop detection
Active-Active Configuration

- key benefits:
  - High availability
  - Transaction load distribution
  - Performance and scalability
Reporting Configuration with a Data Pump on an Intermediary System

- key point:
  ✓ source and target systems are in different networks and there is no direct connection between them (Cloud and on premise).
  ✓ Form of cascaded replication.
  ✓ Performing data filtering and conversion if the character sets on all systems are identical. If character sets differ configure Replicat to perform the conversion and transformation on the target.
peer-to-peer Configurations

- One extract capture process at each DB site.
- \(<n-1>\) extract pump processes that points to the other DB.
- \(<n-1>\) Replicat processes at each DB site that applies the DML-changes from each of the other \(<n-1>\) sites.
Hub & Spoke Configurations

- DML changes from the hub itself will be routed to all spokes.
- DML changes from a spoke will be routed and applied at the hub and forwarded to all other spokes except of the spoke, where the DML change was originally initiated using (tag functionality).
- DML changes are bi-directionally replicated.
- It works with the classic integrated Extract and not with integrated Extract (tag functionality) - In our labs
Design Issues

• Configuration Comparison

• Good schema design.
  
  • Example: complex cascading referential constraints -> impossible to divide tables for extract, OGG to spent more CPU time on processing.

• What to replicate? If you need to replicate everything, ADG may be a better solution.

• Network: Maximum accepted latency
OGG Prerequisites: Primary Key

• Ensure each source and target table has a primary key
  ✓ If PK does not exist on source table, OGG will unique
    identifier by concatenating all the table columns together ->
    not efficient
  ✓ If the primary key does not exist on the target table, you may
    receive in OGG error log:

    WARNING OGG-00869 No unique key is defined for table
    'TARGET_TABLE_NAME'. All viable columns will be used to
    represent the key, but may not guarantee uniqueness. KEYCOLS
    may be used to define the key.

• Recommended to put PK on target tables - very important to
  UPDATE and DELETE operations.
Table Mapping, Data selection & filtering

- **TABLE/MAP**
  - Specifies source and target objects to replicate. Used in Extract and MAP in Replicat parameter files.

- **WHERE**
  - Enables basic data filtering in TABLE or MAP parameter (like in SQL)

- **FILTER**
  - Complex data filtering. Used a TABLE or MAP parameter.

- **COLS/COLSEXCEPT**
  - Allows columns to be mapped or excluded with a TABLE or MAP parameter.
Initial data synchronization

- Data synchronization between source and target - the load is being applied users can update the source:
  1. A database load utility such as import/export or Oracle data pump.
  2. An Extract process to write data to files in ASCII format. Replicat then applies the files to the target tables.
  3. An Extract process to write data to files in ASCII format. SQL*Loader (direct load) can be used to load the data into the target tables.
  4. An Extract process that communicates directly with the Replicat process across a TCP/IP network without using a collector process or files.

- If data synchronization is not required then best practice are:
  - Data: Target table should be empty to avoid errors (Empty schema).
  - Constraints: Disable foreign key constraints and check constraints which slow loading process. Enable them after load completes.
  - Indexes: Remove indexes from the target tables (apart from primary keys). Recreate indexes after the load completes.
OGG CSN (Commit Sequence Number).

- Oracle DB uses **System Change Number (SCN)** to keep track of transactions.
  - Every commit, a new SCN is generated. The data changes, including primary key and SCN, are written to DB online redo logs for crash recovery (committed transactions are committed uncommitted transactions are rolled back).

- OGG read extract data and SCN as a series of bytes.

- Replicat process replays data in SCN order while applying data changes to the target database.

- In OGG docs SCN is called **CSN**.
OGG 12C new features

- Integrated capture
- Integrated Replicat
- Installation & Upgrade to OGG 12C
- Multitenant database replication
- Coordinated Delivery
- Enhanced event-based processing
- Enhanced security: Credential Store/Oracle Wallet
- Conflict Detection and Resolution (CDR)
- Dynamic Rollback
- Streams to Oracle GoldenGate Conversion Utility
## OGG 12c Enhancements: Integration Advantages

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefits</th>
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<tbody>
<tr>
<td>Extreme Performance with Auto Parallelization</td>
<td>Automatically de/allocate apply threads</td>
</tr>
<tr>
<td>Bidirectional with Conflict Detection/Resolution</td>
<td>Built-in conflict management routines and handlers</td>
</tr>
<tr>
<td>Enterprise Manager Integration and SNMP Alerts</td>
<td>Monitor and manage entire stack from one location</td>
</tr>
<tr>
<td>Data Guard, Clusterware and RMAN Integration</td>
<td>World Class Enterprise Availability</td>
</tr>
<tr>
<td>High speed Remote Cloud Capture</td>
<td>Insanely fast zero footprint remote capture</td>
</tr>
<tr>
<td>Complete DDL Support</td>
<td>HA is incomplete without it</td>
</tr>
<tr>
<td>Complete Encryption and Compression Support</td>
<td>Security and efficiency matter more than ever</td>
</tr>
<tr>
<td>Streams Migration Utility</td>
<td>Free utility handles advanced configurations</td>
</tr>
<tr>
<td>Edition Based Redefinition (EBR) Support</td>
<td>Support online application upgrades using EBR</td>
</tr>
<tr>
<td>UDT, IOT, Spatial, Global Temporary Tables</td>
<td>Replicate all of your application data</td>
</tr>
<tr>
<td>Dynamic RAC Node Allocation Support</td>
<td>Automatic awareness of RAC node modifications</td>
</tr>
<tr>
<td>Trigger Suppression, Constraint Deferral, Invisible Column</td>
<td>No need to modify your application to replicate it</td>
</tr>
<tr>
<td>Parallel DML, Distributed Transactions</td>
<td>Take advantage of the Oracle DB parallelization features</td>
</tr>
<tr>
<td>More...</td>
<td></td>
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</tbody>
</table>
OGG 12.1 Review

Optimized for Oracle Database 12c
Multitenant and Cloud-based Real-Time Replication

Integrated Delivery for the Oracle Database
Leveraging lightweight Streaming API built Exclusively for Oracle GoldenGate

Coordinated Delivery for All Databases
Orchestrates the High-Speed Apply Processes & Simplifies Setup and Management

Improved Ease of Use
Automatic Discard File, Enhanced Debugging, and Schema Wildcarding

Expanded Heterogeneity
12c Brings Support for New Databases and Enhancements to Existing Supported Platforms

Enhanced High Availability
Integration with Data Guard FSFO for Automated & Transparent failover of Components

Tighter Security
Integration with the Oracle Credential Store and Oracle Wallet for encrypted user details

Expanded Oracle Application and Technology Support
Active/Active ATG, Low Downtime E-Business Suite Migrations and Coherence Integration
OGG 12.1 Patchset Review

Optimized for Oracle Database
Support for Edition Based Redefinition, support for AnyData, and UDT’s, CTAS with DML. Capture from ADG (Classic)

Integrated Delivery Enhancements
Dependency aware Batching, Support for Streams DML/DDL Handlers, Error Queue Support

Integrated Extract
Use TAG based filtering for Active/Active, Share mining dictionary for multiple captures

Enhanced Cloud Support
SOCKS V5 support for secure transport of data between cloud and on-premise

Stream to GoldenGate Conversion Utility
Tools on MOS for easier migration from Streams to GoldenGate.

Column Level Character Support
Enable minimal downtime when cleaning up character data to be Unicode compliant using DMU
Conflict Detection and Resolution (CDR)

• In earlier versions CDR was not readily available out of the box— we have to programmatically resolve any data conflict in the replication process.

• In OGG 12c version, the feature has emerged from Oracle streams as an easily configurable option through Extract and Replicat parameters.
Installation & Upgrade

Installation:

• OGG 12C installation use Oracle Universal Installer (OUI) : interactive or silent mode.

• OUI reads the Oracle Inventory on server allow you:
  • Discover existing installations (Oracle Homes)
  • install, d-einstall, or clone software products

Upgrading to GG 12c from 11g R2:

• Backup the GG home

• Use OUI to perform fresh installation.

• Restarting GG manager & Replication, ensure extract process begins from the stopping point.
Dynamic Rollback

- Selective data back out of applied transactions.
- Operates at table and record-level and supports point-in-time recovery.
- Eliminates the need for a full database restore because: data corruption, deletions by mistake, or removing of test data.
Streams to OGG Conversion Utility

- Streams is now deprecated (as of Oracle 12c)
- MOS 1912338.1 Oracle Streams to Oracle GoldenGate Conversion
- Designed to help existing Streams users convert their replication into Oracle GoldenGate replication. The streams2ogg tool will generate the appropriate GG 12c configuration files allowing for an easier way to migrate the Streams implementation into a GG implementation.
- This tool will help
  - Eliminate manual conversion errors
  - Minimize the GG learning curve for Streams customers
  - Implement GG best practices
OGG Capture Configuration Option

Capture = Extract
Integrated Capture
Integrated Extract

Classic Capture
- Redo Logs + Archive Logs
- Archive Logs Only

Integrated Capture
- Upstream Capture
- Downstream Capture
**Downstream capture**

- Integrated Extract runs on different database – typically on different machines.

- A **real-time downstream capture** process Uses Oracle Data Guard's log transportation mechanism, which writes changed data to standby redo logs.

- Real-time mine configuration that falls back to archive log mining when the apply process cannot keep up.

- Real-time mine process is re-enabled automatically when the data throughput decreases.
Downstream capture

- Real Time Downstream Mode
Downstream capture

- Downstream Archive log Mode

Source Server

Primary Database

Online Redo Logs

Standby Database

Archive Redo Logs

Logical Change Records

Capture

Integrated Extract

Trail File
Oracle Management Pack

- Oracle Management Pack for Oracle GoldenGate Update

CON9716- OOW2015

- 3 products, Each requires additional license:
  - Oracle Enterprise Manager 12c Plug-In
  - OGG Monitor
  - OGG Director

Oracle Enterprise Manager 12c Plug-In

- The OGG Plug for OEM 12c Cloud Control: allowing starting, stopping, monitoring, and alerting of GoldenGate processes.
- Create user defined metric in OEM 12c Cloud Control that provides the necessary monitoring and alerting without the additional license cost.
OGG Monitor

- Standalone product dedicated to managing, monitoring, and alerting on OOG components
- Should replace the aging OGG Director product
- Graphically provides a real-time view of your OGG Enterprise, allowing control over Extract and Replicat processes as well as the ability to edit parameter files.
- 12C release supports Single Sign On (SSO), drill-down functionality and some support for monitoring OGG instances running with non-Oracle databases.
OGG Director

- A standalone product that provides basic management, monitoring, and alerting on legacy OGG deployments
- Centralized monitoring and configuration (wraps GGSCI)
- A multi-tier client server application that enables the configuration and management of GG environment from a remote client which includes a web browser based client.
- Still supported by Oracle for monitoring and administration functionality of legacy OGG implementations.