ORACLE FUSION MIDDLEWARE 12c GOLDENGATE

An Oracle White Paper
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Zero Downtime Migration to Oracle Exadata using Oracle GoldenGate

Executive Overview

Oracle Exadata Database Machine offers a complete, optimized package of software, servers, and storage, and delivers unbeatable performance and scalability for all your database applications. Many customers are eager to leverage this new powerful system in their business critical environments. As with any system migration or consolidation, a "planned outage" comes along. Business operations, employee productivity and even revenue can be impacted from planned outages when mission-critical systems are involved. In addition, IT teams need to consider the risks involved with such migration efforts, which can disrupt operations for extended periods, cause data loss, and impact customer experience significantly.

IT teams typically complete migration projects over a weekend to minimize disruption on business operations. However, for systems that support global operations or require 24/7availability, limiting these activities to weekends is not a feasible solution. These tight implementation timelines also limit the testing of the new environment, increasing the risk of failure once systems are switched over, and also do not provide a failback option in a worst case scenario.

To capture gains from advanced IT systems like Oracle Exadata sooner than later, businesses seek solutions to migrate with minimized downtime and risk. Oracle GoldenGate offers real-time, heterogeneous database replication capabilities that eliminate downtime from upgrade, migration, and consolidation projects. In addition, it minimizes risks by offering a failback option as well as complete flexibility to test the new environment as long as needed.

In this paper we will review Oracle GoldenGate's capabilities and how it can be used to achieve zero downtime migration and consolidation to Oracle Exadata. We will provide high-level implementation steps for migration with GoldenGate and a customer case study example.

In this paper you will also find a section that describes other use cases where you can leverage GoldenGate and Oracle Data Integration products for your Oracle Exadata implementations, including:

- Data Warehouse Appliance Migration
- Real-Time Data Warehouse Updates
- Bulk Data Loading
- Maximum Availability
- OLTP and SOA Integration

Introduction

IT service continuity is a strategic goal for IT organizations especially when it comes to mission-critical systems. Typically IT teams focus on reducing or eliminating unplanned outages such as system or site level disasters that can have very major impact; but luckily happen infrequently. A more common interruption to IT services is planned outages such as system upgrades, migrations and maintenance. These activities happen more frequently and are typically scheduled for "off business" hours to minimize impact on end users. However for systems that support global operations or need to provide service close to 24/7, the duration of "off business hours" is diminishing or can be non-existent.

For critical system upgrades and migrations that carry significant risks, IT organizations struggle to complete these projects under a big time pressure; many times not testing the systems as well as they would like to. Similarly they delay important upgrade or migration projects because of the business interruption these projects cause and the risks they carry. Consequently, they are not able to improve their IT infrastructure as fast as they should to support business innovation and better compete in the market.

Oracle Exadata Database Machine provides a complete package of servers, storage, networking, and software that is massively scalable, secure, and redundant. Its unique offering makes it a great platform for mission-critical systems that need extreme performance, scalability, and reliability. The new Oracle Database 12c release introduced new multitenant architecture, which simplifies the process of consolidating databases onto the cloud, enabling customers to manage many databases as one - without changing their applications. With Database 12c Oracle Exadata continues to provide the best platform for implementing private database cloud or a sophisticated Database-as-a-Service (DBaaS).

When companies decide to move or consolidate their systems to Oracle Exadata, they face the same challenge: providing IT service continuity for their mission-critical systems, and minimizing risks involved with such major migration effort. Oracle GoldenGate offers real-time data integration and replication capabilities across heterogeneous systems and enables migration to Oracle Exadata without impacting operations and with minimized risks.

Oracle GoldenGate is certified for Oracle Exadata deployments and is a critical component of Oracle Database Maximum Availability Architecture. Oracle GoldenGate 12*c* has been optimized to support new functionality available with Oracle Database 12*c* including the Oracle Multitenant Container Database feature. By eliminating downtime and minimizing risks during critical migration efforts, GoldenGate enables IT organizations to deploy innovative and efficient solutions with greater ease and confidence.

Oracle Exadata Overview

Oracle Exadata Database Machine is an easy to deploy, out-of-the-box solution for hosting the Oracle Database for all applications while delivering the highest levels of performance available.

Oracle Exadata Database Machine is composed of database servers, Oracle Exadata Storage Servers (Exadata), an InfiniBand fabric for storage networking and all the other components required for hosting an Oracle Database. Oracle Exadata Storage Server is a storage product optimized for use with Oracle Database applications and is the storage building block of Oracle Exadata Database Machine. Exadata delivers outstanding I/O and SQL processing performance for online transaction processing (OLTP), data warehousing (DW) and consolidation of mixed workloads. Extreme performance is delivered for all types of database applications by leveraging a massively parallel grid architecture using Oracle Real Application Clusters (Oracle RAC), high-speed InfiniBand connectivity, Exadata intelligent storage, Exadata Smart Flash Cache, , and Hybrid Columnar Compression technology.

Oracle GoldenGate Overview

Oracle GoldenGate is real-time data integration software that provides real-time changed data capture, routing, transformation, and delivery across heterogeneous databases. Its non-intrusive architecture can capture transactions from a source database by reading online transaction logs, transforming the data when needed, and applying those transactions with guaranteed integrity to a target database—all with sub-second latency and with minimal impact on the production users of that database. It supports a variety of use cases including real-time business intelligence, query offloading, zero-downtime upgrades and migrations, disaster recovery, and active-active databases replication for continuous availability and data synchronization across distributed systems (Figure 1).

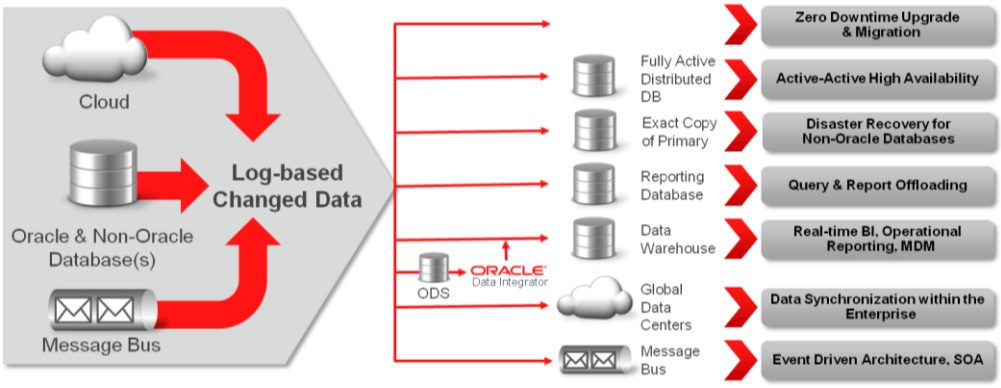

Figure 1. Oracle GoldenGate's real-time, heterogeneous data integration capabilities can be used in multiple solutions across the on-premises and cloud environments

Architecture Overview

The Oracle GoldenGate architecture consists of decoupled modules that can be combined across the enterprise to provide maximum flexibility, availability, and performance (see Figure 2). This architecture facilitates the movement of transactional data in four simple, yet powerful steps.

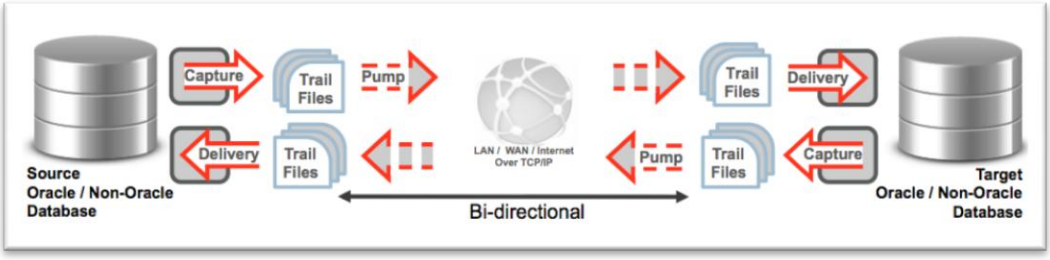

Figure 2. Oracle GoldenGate Architecture

Key Operational Steps

- **Capture.** Oracle GoldenGate captures changed data operations committed in the database transaction logs in a nonintrusive, high-performance, low-overhead implementation.
    - **Route.** Oracle GoldenGate can use a variety of transport protocols, and it can compress and encrypt changed data prior to routing. Transactional data can be delivered via Open Database Connectivity–compliant databases or through a specialized adapter to a JMS message queue or topic.
    - **Transform.** At any point prior to applying the data to the target system, Oracle GoldenGate can be used to execute a number of built-in functions, such as filtering and transformations.
    - **Deliver.** Oracle GoldenGate applies the changed transactional data to one or more targets with only sub-second latency, preserving transactional integrity. While these target systems are typically databases, Oracle GoldenGate can also deliver changed data into JMS-based messaging systems, and other third party products via its Application Adapter product.

Key Components

Oracle GoldenGate consists of four distinct modules and components:

- Oracle GoldenGate Capture
- Oracle GoldenGate Trail Files
- Oracle GoldenGate Delivery
- Oracle GoldenGate Manager

Oracle GoldenGate Capture

The GoldenGate Capture module grabs the result of DML (insert, update, and delete operations) and DDL statements (in Oracle Database and Teradata) executed against a database as they occur, and then routes them for distribution. GoldenGate Capture is a log-based mechanism that extracts change data from the live transaction logs of the source database. This means high performance with minimal impact to the source database.

GoldenGate's log-based method runs entirely outside of the database and requires no database queuing tables or schema modifications. As a result, database overhead is significantly reduced compared to trigger-based or native database capture techniques which utilize internal database queuing. The efficiencies of the GoldenGate Capture process are one of the strategic technical differentiators Oracle GoldenGate.

When not all changed data from the source needs to be replicated to the target system—such as for real-time reporting purposes—the Capture module allows users to filter tables and rows based on user-defined criteria and ignores the entries in the transaction log that don't meet the end-user's needs. Users can optionally select and apply transformation rules to specific columns via built-in Oracle GoldenGate functions, user-supplied code, stored procedures, or Oracle Data Integrator Enterprise Edition.

For Oracle Database, GoldenGate offers change data capture from archive logs as well. With Oracle GoldenGate 11*g*R2, Oracle Database users can also take advantage of Integrated Capture, which relies on Oracle's internal log parsing and processing to capture DML transactions. Integrated Capture allows GoldenGate to support all flavors of compression used by Oracle Database and Oracle Exadata. Oracle GoldenGate 12c has been optimized to support new functionality available with Oracle Database 12c. Integrated Capture has been enhanced to provide support for the Oracle Multitenant Container Database feature (CDB). GoldenGate's Integrated Capture process is configured to run at the root container. Oracle GoldenGate customers can mine multiple pluggable databases (PDB) with a single Integrated Capture process and can write changes from multiple PDBs into a single Trail File.

For Microsoft SQL Server; IBM DB2 for LUW, System z and System i (AS/400); Sybase ASE; MySQL; and those running on HP NonStop/Enscribe, SQL/MP, and SQL/MX, changes are captured through direct access to native database transaction logs. For Teradata at the source, custom APIs have been developed to allow Oracle GoldenGate to capture committed transactions with the same efficiencies.

Oracle GoldenGate Trail Files

Oracle GoldenGate's unique queuing mechanism—contain the most recent changed data in a transportable, platform-independent format called the Oracle GoldenGate Universal Data Format, and can be converted to XML and other popular formats for consumption by different applications. The Capture module can create unique as well as overlapping sets of data in each Trail File. Based on the requirements of the implementation, users can store Trail Files on the target system, the source system, or both. Trail Files can be delivered to alternative queue types and application interfaces.

Oracle GoldenGate Delivery

The Delivery module takes any changed transactional data that has been placed in a Trail File and immediately applies it to the target database. Supported target databases include Oracle Database; Microsoft SQL Server; IBM DB2 (LUW), System z, System i, Sybase ASE; those running on HP NonStop/Enscribe, SQL/MP, and SQL/MX, Oracle MySQL, PostgreSQL and Timesten. Through the use of Oracle GoldenGate Application Adapters, Oracle GoldenGate also has the capability to publish changed data to a messaging system in XML or other formats, as well as provide data in flat files for third-party products, such as an ETL system.

The Delivery module applies each database change in the same order as it was committed in the source database to provide data and referential integrity. In addition, it applies changes within the same transaction context as they were on the source system for consistency on the target.As with Capture, users can configure the Delivery module via user-defined criteria to not only specify target tables but also individual rows and columns.

Customers delivering data to an Oracle Database 11*g* Release 11.2.0.4 or Oracle Database 12*c* Release 12.1.0.1 and higher database, can improve performance and provide better scalability and load balancing by using Integrated Delivery feature of GoldenGate 12c. Minimal changes are required to implement this change, which leverages the database parallel apply servers for automatic dependency-aware parallel apply by using a lightweight streaming API. With Integrated Delivery, there is no need to split the delivery process into multiple threads and manage multiple parameter files.

Customers delivering data to non-Oracle databases (or Oracle Database versions before 11.2.0.4) who find it necessary to split their Delivery process into multiple threads can use the Coordinated Delivery feature available with Oracle GoldenGate 12*c* to eliminate the need to manage multiple parameter files. In addition to requiring a single parameter file for multiple Delivery processes, Coordinated Delivery also automatically provides coordination across selected events that require ordering, including DDL, Primary Key updates, EMI and SQLEXEC.

Oracle GoldenGate Manager

To give users control over Oracle GoldenGate processes, the Manager module provides a command-line interface to perform a variety of administrative, housekeeping, and reporting activities, including

- Setting parameters to configure and fine-tune Oracle GoldenGate processes
- Starting, stopping, and monitoring the Capture and Delivery modules
- Critical, informational event, and threshold reporting
- Resource management
- Trail File management
- Consolidation and communication for Oracle GoldenGate Management Pack (i.e. Oracle GoldenGate Monitor)

The Manager module executes requests on demand as well as unattended. For example, it can be used to restart Oracle GoldenGate components, monitor latency. The command-line interface enables to perform a variety of administrative, housekeeping, and reporting. The module also automatically recycles Trail File data when no longer needed, providing insurance against inadvertent disk-full conditions and offering an alternative to error-prone manual housekeeping procedures. Starting with version 11g, Oracle GoldenGate offers increased transaction tracing flexibility to easily identify bottlenecks and tune the Oracle GoldenGate implementation for optimum performance.

For enhanced management of Oracle GoldenGate processes and solutions and integration with Oracle Enterprise Manager, customers should consider adding the Management Pack for Oracle GoldenGate.

Management Pack for Oracle GoldenGate

Management Pack for Oracle GoldenGate is a centralized, server-based graphical enterprise application that offers an intuitive way to define, configure, manage, and report Oracle GoldenGate processes. The application centralizes configuration, management, monitoring, and reporting for Capture and Delivery processes running across multiple hosts, and provides real-time feedback on configuration and status changes—problems are instantly highlighted for corrective action.

Management Pack for Oracle GoldenGate minimizes human error and enables the rapid production of multi-server solutions from a central location to improve productivity and responsiveness, lower costs, and increase return on investment. The Management Pack for Oracle GoldenGate license includes a plug-in for Oracle Enterprise Manager, as well as a monitoring component, Oracle GoldenGate Monitor that provides an end-to-end view of all your Oracle GoldenGate implementations. GoldenGate Monitor can integrate with your existing alerting infrastructure with its sophisticated alerts based on SNMP, email and command line integration (CLI) for third-party call outs.

Oracle GoldenGate Veridata

Oracle GoldenGate Veridata is a high-speed, low-impact data comparison solution that identifies and reports data discrepancies between two databases, without interrupting those systems or the business processes they support. A standalone product, Oracle GoldenGate Veridata does not depend on the presence of Oracle GoldenGate's core components.

Using this application, companies can audit and verify large volumes of data shared across different business applications with absolute certainty. Oracle GoldenGate Veridata reduces the amount of time and the number of resources required to compare data, minimizes the impact of human errors, and accelerates the discovery of potential problems for rapid resolution.

Oracle GoldenGate Veridata supports cross-database comparison between Oracle, SQL Server, Teradata, HP Enscribe, and HP SQL/MP databases.

You can find more detailed information on Oracle GoldenGate's architecture, key features, differentiators, and solutions in another Oracle white paper: Oracle GoldenGate 12c: Real-Time Access to Real-Time Information.

Zero Downtime Migration to Oracle Exadata Using Oracle GoldenGate

Solution Benefits

With its low-impact, real-time change data capture, distribution and delivery capabilities Oracle GoldenGate synchronizes the new Exadata environment with the production environment to enable:

- Continuous business operations on the production environment while the migration is in progress
- Immediate switchover to the Exadata system without database downtime
- Ability to test the new environment thoroughly without time pressure

In addition, with its bidirectional replication capabilities, Oracle GoldenGate:

- Minimizes risk by offering a failback option
- Eliminates downtime completely by enabling a phased migration in an Active-Active database replication configuration where both new and old systems support the transaction processing

Solution Overview

After the user creates the target Exadata system, from the initial load point onwards GoldenGate captures new transactions (only changed data) in the production environment. (see Figure 3) Once the target system is ready to be synchronized, GoldenGate delivers change data to Exadata, and continues to keep the systems in synch with only sub-second latency. While the migration is taking place, the old system stays open for transactions and GoldenGate moves new transactions to the target system in real time. This is fundamentally different than the traditional migration methods where you need to stop the production database in order to keep the target environment in synch after the initial copy. This approach minimizes downtime required for the migration/upgrade down to a duration that is needed for application switchover only.

For failback, Oracle GoldenGate can be set up to capture the transactions taking place in the new Exadata environment and deliver to old production environment, to keep the old system in synch. This allows switching back to the old system with minimal or no data loss in the event that the new production system has any issues.

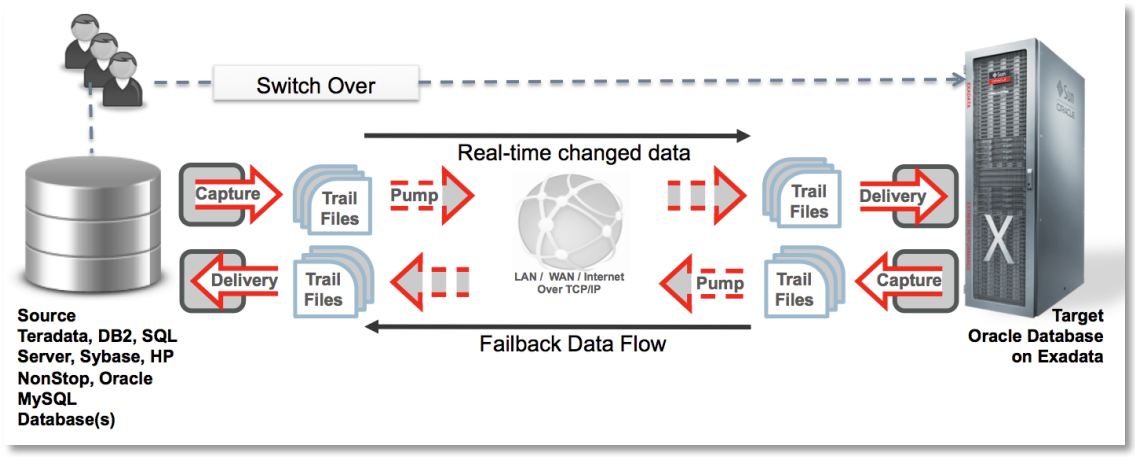

Figure 3. Oracle GoldenGate synchronizes old production systems with the new Exadata system to enable migration or consolidation without database downtime

Implementation Steps

High-level migration steps using Oracle GoldenGate include:

Step 1. Starting the Oracle GoldenGate Capture process on the source production system

Step 2. Setting up the target Oracle Exadata environment using a source database backup.

Step 3. Synchronizing the standby database with the production database.

Step 4. Testing Exadata in active/live mode.

Step 5. Verifying data consistency using Oracle GoldenGate Veridata

Step 6. Switching over the application to the target Exadata system

Step 7. Setting up failback data flow from new primary Exadata system to old production system

Starting the Oracle GoldenGate Capture on the Source System

To avoid data loss during instantiation, the first step is to start capturing changed data from the source system. Oracle GoldenGate Capture process should be installed and start capturing new transactions before the production database copy is made for setting up the target system. Any open transactions that were ongoing when GoldenGate Capture started should close before starting a production database backup. GoldenGate Trail Files store change data until the target system is ready for synchronization.

Instantiation – Setting Up the Target Oracle Exadata Environment

When performing a migration, users need to also choose the method by which the target database is instantiated. This step itself includes 2 sub-steps:

Sub-Step 1. Creating the target database structure

Sub-Step 2. Data load to target database

The methods to choose from also differ based on the source system.

Source System: Oracle Database

For creating the target database structure customer can use Oracle RMAN. Oracle RMAN is a database tool that manages the process of making backups and managing the process of restoring and recovering from them. It is also used for the conversion of endian systems during a cross-platform CONVERT and can load data to the target systems. It can perform online and offline backups and migrates data to Oracle ASM, making it a great fit for Oracle Exadata implementations.

For data loading there are multiple options when source system is Oracle Database, one such as option is Oracle Data Pump. Oracle Data Pump is a feature of Oracle Database and enables very fast bulk data and metadata movement between Oracle databases. After laying out the database structure, Data Pump Export and Import utilities (expdp and impdp) can create internal objects such as tables, indexes and triggers. Oracle Data Pump's Export and Import utilities, as well as RMAN, can be used for loading the target environment.

Typically customers chose Oracle RMAN to clone their production Oracle Database and leverage expdp and impdp to load the database when the source system is an Oracle Database.

One of the challenges in creating a target database for real-time replication is to make sure that no "collisions" (applying data that has been already been "applied" by virtue of copying data after the same change data has been captured) or data loss will occur when applying the change data after the initial instantiation of the target database. Oracle GoldenGate has introduced a new functionality to apply the change data to the target at the appropriate CSN (Commit Sequence Number) where no collisions will occur. To learn more about Oracle GoldenGate best practices for instantiation from an Oracle Source Database please review the following white paper.
Oracle GoldenGate Best Practices: Instantiation from an Oracle Source Database (My Oracle Support Knowledge Document ID 1276058.1)

Source System: Non-Oracle Database

When source production systems are non-Oracle databases— such as Teradata, DB2, Sybase, or SQL Server— creating target database needs a different approach.

As a better alternative to manually setting up the target system, customers can use Oracle SQL Developer Migration feature, which creates the database objects from non-Oracle Databases such as SQL Server, DB2 etc. and performs the initial load into Exadata. This approach works well when the target database needs to have a similar structure to the production environment and does not need data transformations. You can learn more about use Oracle SQL Developer Migration via the following link: http://www.oracle.com/technetwork/database/migration/migrationdatasheet-21-128240.pdf

Oracle GoldenGate provides initial data load capabilities between heterogeneous systems as well.

When the target Exadata needs to have a different structure, e.g. needs to be designed as a data warehouse, Oracle SQL Developer Data Modeler tool should be used to create the data warehouse schema. For more information on Oracle SQL Developer Data Modeler please review its user guide:

SQL Developer Data Modeler User Guide

For loading the target Exadata system with a different structure, Oracle Data Integrator would be the best solution as it can move data between heterogeneous systems, and provides high performance bulk data movement and transformation capabilities. Oracle Data Integrator (ODI) uses extract, load, transform (E-LT) architecture and runs natively on Oracle Exadata. After loading the data, ODI performs set-based transformations within Exadata without adding any additional hardware. Oracle ODI supports many Exadata best practices out-of-the-box including built-in support for external tables on DBFS for extremely fast parallel flat file loading, as well as support for many advanced Oracle database features such as complex incremental loading strategies which fully exploit the Exadata Smart Scan and Flash Cache technology. You can learn more about Oracle Data Integrator and download via the following link: http://www.oracle.com/technetwork/middleware/data-integrator/overview/index.html

Configuring Oracle GoldenGate for Oracle Exadata

To enable incremental data load to Oracle Exadata, Oracle GoldenGate needs to be configured for Oracle Exadata target environment. There are specific requirements for GoldenGate Trail Files, checkpoint and binary location. In this paper we will not cover these requirements and configuration steps as there is a very specific white paper written for this purpose by the Oracle Maximum Availability Architecture team. Please review the white paper: Oracle GoldenGate on Exadata Database Machine to learn best practices for configuring Oracle GoldenGate to work with Oracle Exadata Database Machine and Exadata storage.

The white paper describes the following configuration steps in great detail:

Step 1. Set Up DBFS on Oracle Exadata Database Machine

Step 2. Configure GoldenGate and Database Parameters

Step 3. Install Oracle GoldenGate

Step 4. Set Up Checkpoint Files and Trail Files in DBFS

Step 5. Set Up Discard and Page Files on the Local File System

Step 6. Configure Replicat Commit Behavior

Step 7. Configure Autostart of Extract, Data Pump and Replicat Processes

Step 8. Oracle Clusterware Configuration

Real-Time Data Synchronization with Oracle GoldenGate

As mentioned above, Oracle GoldenGate's main benefit is to provide incremental data synchronization for the new Exadata environment in real time to eliminate downtime during migration. For this purpose, it needs to be configured to capture changed data from the active production database. The Capture module can be set to start propagating transactions against an existing target database from a given point. DML and, optionally, data dictionary language (DDL) changes are captured from the transaction logs. GoldenGate Capture module should be set to capture all transactions that have a commit time stamp higher than the quiesce point where the production database was cloned.

The Oracle GoldenGate Trail Files describe DML operations (inserts, updates, and deletes) along with transactional context as captured from the source database. Trail Files are persisted to disk and minimize the risk of data loss or corruption, in the event of an outage at the source or target sites.

The Oracle GoldenGate Delivery process runs on the target system and reads the captured data from the Trail Files and applies the new transactions that were committed at the source since the initial load started. The Capture and Delivery modules continue to run, ensuring that all ongoing data changes at the source move in real time to the target. Thousands of transactions can be continuously moved between these databases at sub-second speed.

Oracle GoldenGate provides top-notch reliability and ease-of-use during replication. GoldenGate 12c is integrated with Data Guard Fast-Start Failover (FSFO) and provides automated and transparent failover of Oracle GoldenGate components with the failover/switchover of the primary database so the replication can continue without any manual intervention. In the instance of a failover/switchover, Oracle GoldenGate processes are started on the standby during the role transition, and this approach insures that no data is lost during the failover/switchover.

GoldenGate's Downstream Capture mode is able to utilize the Data Guard redo log transport mechanism to process transactions off-source. There is no chance of data loss when using the Data Guard Redo log transport mechanism to ship redo logs to a downstream / remote machine where GoldenGate Capture processes are installed.

Test the New Exadata Environment

Because GoldenGate allows the production system to be operational throughout the migration period and feeds new transactions to the target system when it is ready, IT teams have the full flexibility to test the target environment with production data, until they are absolutely comfortable with the switchover. Leveraging live, production data in the new environment also improves testing quality.

Verify Data Consistency using Oracle GoldenGate Veridata

During testing and before switchover, Oracle GoldenGate Veridata product can perform live database comparison to make sure data is completely in synch to give additional assurances before switchover. GoldenGate Veridata provides high speed comparison while databases are live, processing transactions. It provides a detailed report on any data inconsistency issues to isolate them for testing

and troubleshooting. After switchover, GoldenGate Veridata can to determine if a failback is needed, in case of any risky data anomalies.

Switchover

Once the target Exadata system is tested thoroughly to handle production workload, and data in synchronized with the existing operational systems, applications can be pointed to the new Exadata environment. Any downtime related to application switchover would be the total downtime experienced by end users.

Oracle GoldenGate provides advance features such as Event Marker Infrastructure to automatically trigger a script to kick-off the switchover process based on database events captured, such as a specific marker written at the source production database. When the Delivery process receives this marker through GoldenGate's replication process, it triggers the script that notifies the application to switch over to the target Exadata system. A previously configured GoldenGate Capture process can at that time automatically start capturing new transactions taking place in the new Exadata system for failback purposes.

Failback Data Flow

For failback configuration, users need to install Oracle GoldenGate Capture process on the new production system running on Oracle Exadata, and Oracle GoldenGate Delivery process on the old production system to keep the old environment in synch with the Exadata system. This synchronization enables the old system to take over operations immediately and without data loss in case there are issues in the new environment. This feature minimizes risks involved with such major migration projects.

With Integrated Capture, available since version 11*g* Release 2, Oracle GoldenGate supports all flavors of compression used by Oracle Database and Oracle Exadata, including support for Exadata Hybrid Columnar Compression (EHCC), OLTP, and Segment compression. This capability enables failback data flow for compressed and non-compressed tables. Integrated Capture also adds distributed transaction support for XA (distributed) and PDML (parallel DML) transactions on Oracle RAC.

Active-Active Database Synchronization for Phased Migration

GoldenGate provides bidirectional replication to support Active-Active database synchronization, and enables both old and new system to run in parallel supporting transaction processing. This configuration enables phased migration for users and applications to the new environment and eliminates downtime completely. Many GoldenGate migration customers choose this approach for their mission-critical systems, rather than a Big Bang migration strategy. It allows them to test the new environment completely with production data load, before retiring the old system. For implementations with heavy reliance on nightly batch-jobs or extensive integration with backend

systems, using GoldenGate in a bi-directional replication enables these systems to be switched over at the same time or gradually in a phased manner to avoid business interruptions.

Oracle GoldenGate provides robust and automated conflict management features to handle possible data collision issues in Active-Active database configuration. You can learn more about the new capabilities please read the white paper: Best Practices for Conflict Detection and Resolution in Active-Active Replication Environments Using Oracle GoldenGate . Oracle GoldenGate's Active-Active synchronization solution supports compressed tables.

Other GoldenGate and Data Integration Solutions for Exadata

Oracle's data integration solutions, including Oracle GoldenGate, Oracle Data Integrator, and Oracle Enterprise Data Quality, are optimized to run on, interoperate with and integrate to the Oracle Exadata Database Machine. In addition to enabling to migrate to Oracle Exadata without interrupting business operations, Oracle's data integration solutions help businesses benefit from their investment in the Oracle Exadata Database Machine by addressing multiple data integration needs:

Real-time Data Warehouse Updates— Oracle GoldenGate enables low-impact, real-time data integration for Oracle Exadata data warehouses and operational data stores (ODS) from heterogeneous source systems. Log-based, non-invasive data capture minimizes overhead on source systems, and removes batch window dependency for extracting data. In addition it provides timely data for the data warehouse/ODS to improve business insight. Oracle GoldenGate is tightly integrated with Oracle Data Integrator to provide a complete end-to-end data integration solution for Oracle Exadata data warehouses.

Data Warehouse Bulk Loading—Oracle Data Integrator's runs natively on the Oracle Exadata Database Machine and offer the most efficient data integration offering for Exadata with its ELT architecture. Unlike other ETL solutions, Oracle Data Integrator Enterprise Edition allows every transformation to occur on the Oracle Exadata Database Machine, without adding any additional hardware. With this architecture data never leaves the Exadata server, and Oracle Data Integrator Enterprise Edition scales along with the Exadata server.

Data Warehouse Appliance Migration— Oracle GoldenGate and Oracle Data Integrator can easily and efficiently propagate data incrementally or in bulk from data warehouse appliances, such as Teradata and Netezza, to the Oracle Exadata Database Machine. Oracle GoldenGate provides the only real-time change data capture solution for Teradata and can offer zero downtime migration from Teradata to Oracle Exadata.

Maximum Availability—Oracle Active Data Guard and Oracle GoldenGate are key components of the maximum availability architecture for the Oracle Exadata Database Machine offering disaster recovery and query offloading. Oracle GoldenGate's zero downtime migration, upgrade and consolidation solution and continuous availability offering with Active-Active database synchronization are critical offering for maximizing availability for Oracle Exadata systems.

OLTP system and SOA Integration—Oracle GoldenGate can capture database events from Oracle Exadata non-invasively and with high performance and scalability to distribute data in real time to other OLTP systems as well as SOA messaging bus to support event-driven architecture. Oracle Data Integrator integrates with Oracle SOA Suite and provides reusable data services for SOA deployments. ODI can use the data stored in Oracle Exadata to create high performance data services that are reusable for all SOA integrations. In addition, ODI can complement a SOA infrastructure by providing as web services data integration processes running directly on Oracle Exadata.

Zero Downtime Migration- Customer Examples

Many Oracle Exadata customers, in different industries and sizes, have trusted Oracle GoldenGate to support their critical migration to their new Exadata environment. Below are two examples from many leading companies.

Brown Brothers Harriman

Brown Brothers Harriman (BBH) is a custodian bank, which hold assets and perform transactions for large investment firms. The firm decided to migrate BBH's custodian accounting platform to Oracle Exadata to ensure applications runs more efficiently while their custody-related accounting business at BBH was growing more than 30 percent per year.

BBH leadership decided to move ahead as their ROI analysis supported their decision: by retiring hardware and support contracts, saving on storage, and other improvements, BBH's team determined that Oracle Exadata would deliver positive ROI over five years. The company chose Oracle GoldenGate to perform the migration within 90 days to ensure the least impact on their operations.

BBH team used Oracle Real Application Testing and Oracle GoldenGate to replicate data from the existing Oracle9i production database to the new Oracle Database 11*g* test database. During this migration the team chose not to copy everything from the old environment. Instead they created all the objects and data in Oracle Database 11g. Thus, total 15-terabyte database had to be mapped and validated during the migration. The team also used Oracle GoldenGate to replicate from the test database to a separate backup Oracle9*i* database for failback, to be used only if the final cutover was unsuccessful. This failback plan helped minimize the risk for their business.

After weeks of testing and dry runs, the actual switchover took place over a weekend, the accounting platform and several smaller applications were all migrated to Oracle Exadata. According to the BBH team "This project worked perfectly, as planned, to the minute and BBH's customers did not experience any disruption in service."

The new platform brought significant improvements to BBH's accounting operations. Reports that formerly took hours, can be completed in 15 or 20 minutes. This speed improves the productivity further when the accounting team needs to run year-end, quarter-end, and semiannual reports for all offerings.

"Oracle Exadata Database Machine gives us the performance and scalability that we need to provide increasingly sophisticated analytics to our customers. Oracle GoldenGate was essential to a successful migration—enabling us to transition without impact for customers."

— **Tarang Patel,** Director, Database Administration and Operation, e-Dialog

E-Dialog

e-Dialog, part of GSI Commerce Inc., provides integrated digital marketing solutions to businesses worldwide. Its technology and services give marketers direct access to timely customer insight that drives targeted consumer dialogs. e-Dialog helps marketers transform conversations into conversions.

The company faced the challenge of supporting 50% year-over-year increase in message volume. The IT team had to ensure extreme performance of its multichannel marketing and campaign analytics services as message volume increased. Furthermore, they needed to ensure absolute business continuity when they chose to migrate to a new data infrastructure on Oracle Exadata.

EDialog selected Oracle Exadata Database Machine as the foundation for a new data infrastructure. Before this decision the team demonstrated the cost effectiveness of migrating to Oracle Exadata by eliminating the need for additional storage, processing, and clustering software. As a result of Exadata implementation, EDialog improved processing performance and scalability to enable increasingly sophisticated marketing services and analytics for its clients.

For the migration, EDialog used Oracle GoldenGate to move more than 12 terabytes of data from the heterogeneous legacy environment to Oracle Exadata without impact, ensuring business continuity. Oracle GoldenGate helped the team at EDialog to complete completed the migration in phases over six months using Oracle GoldenGate's bidirectional replication capabilities that allowed e-Dialog to run the legacy system along with Exadata concurrently.

For more customer stories on Oracle GoldenGate for Oracle Exadata, please visit the following link and read the Oracle Magazine article that features additional customer implementations.

Conclusion

Oracle GoldenGate is real-time data integration and replication software product that enables migration to Oracle Exadata without impacting operations and with minimized risks.

For migrations, it enables:

- Continuous business operations and switchover to the Exadata system without database downtime
- Ability to test the new environment thoroughly without time pressure
- Minimized risk by offering a failback and phased migration options

Oracle GoldenGate is certified for Oracle Exadata deployments and has been proven in many customer implementations. By removing one of the major barriers in migrating to modern, efficient systems, Oracle GoldenGate helps Oracle Exadata customers to reap the benefits without unnecessary delay and with greater ease.

After migration, Oracle GoldenGate can be used to provide continuous availability for Oracle Exadata and integrate timely information across heterogeneous systems to enable improved business operations.

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Zero Downtme Migration to Oracle Exadata Using Oracle GoldenGate
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