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Oracle GoldenGate 12c: Fundamentals for Oracle

Student Guide

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16 Database Sharding Support, Metadata Encapsulation, Replication Lag Management, Invisible Column Support

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Introduction

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Objectives

After completing this lesson, you should be able to:

- Describe the purpose and need for Oracle GoldenGate
- Identify the supported databases and platforms
- Identify the components of Oracle GoldenGate suite

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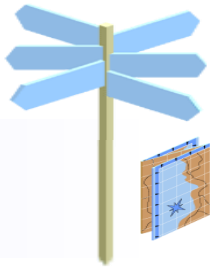
Agenda

- Oracle GoldenGate: Introduction
  - What is it?
  - Why do you need it?
  - When do you use it?
- Technology Overview
- Oracle GoldenGate Technology Suite



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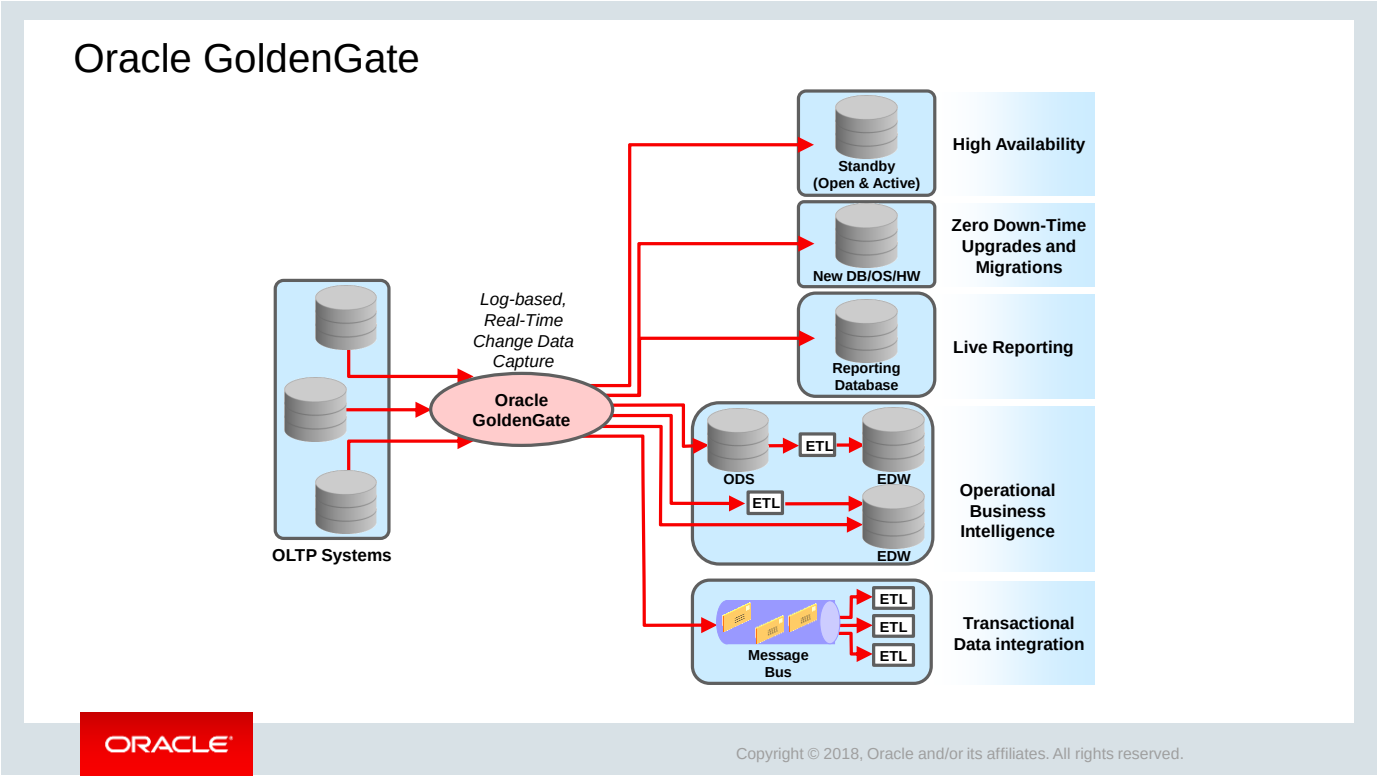

Oracle GoldenGate is an Oracle Fusion Middleware software product that enables you to replicate data across various databases in your enterprise. Oracle GoldenGate moves data with sub-second latency, or in other words, in near real time while maintaining transactional integrity.

The image in the slide shows the different purposes for which you can configure Oracle GoldenGate to meet your enterprise needs. These different purposes are explained in detail in the next few slides.

Oracle GoldenGate is designed to work in a heterogeneous environment and across different operating systems. The supported databases and platforms are listed later in this lesson.

Glossary

- **DB:** database
- **EDW:** Enterprise Data Warehouse
- **ETL:** Extract, Transform, and Load
- **HW:** Hardware (Intel 32-bit, Intel 64-bit, SPARC, and so on)
- **ODS:** Operational Data Store
- **OLTP:** Online Transaction Processing
- **OS:** operating system (Linux, Windows, NonStop, HP-UX and so on)

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Why Do You Need Oracle GoldenGate?

Oracle GoldenGate

- Delivers continuous operations
- Lowers IT costs
- Improves efficiencies
- Reduces risk
- Reduces barriers to sharing data
- Provides extensibility and flexibility

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Oracle GoldenGate can save time and money because it:

- Delivers continuous operations for mission-critical applications to eliminate unplanned and planned down time and related costs
- Lowers IT costs through heterogeneous support for multiple platforms to leverage lower-cost infrastructure for query offloading
- Improves efficiencies through improved performance, scalability of real-time feeds, and data distribution
- Reduces risk by ensuring data integrity and reliability between source and target systems
- Reduces barriers to sharing data because it has no application impact for real-time data acquisition; provides improved visibility and business insight
- Provides extensibility and flexibility by meeting a variety of customer needs and data environments with open and modular architectures

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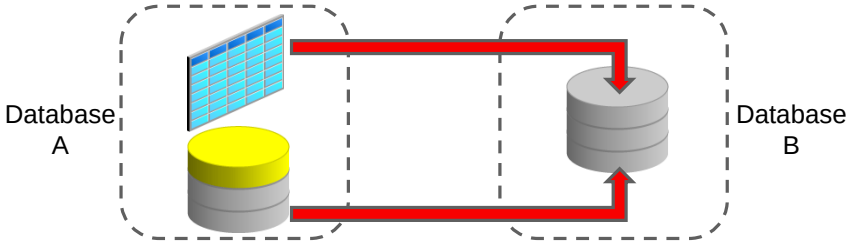
Uses of Oracle GoldenGate

- **Primary use:** Data change capture and delivery from database transaction logs
- **Optional use:** Initial load directly from database tables
  - This is useful for synchronizing heterogeneous databases.
  - Database-specific methods may be preferable for homogeneous configurations.



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One of the main purposes of Oracle GoldenGate is to share data changes from one database with another database. Optionally, you can configure Oracle GoldenGate to perform initial load data migrations.

The exception to the “database-specific” generalization is for Oracle-to-Oracle homogenous environments. In such cases, Oracle GoldenGate is the recommended method of synchronization.

"Transaction logs" in an Oracle Database context are the REDO logs. (Do not confuse these with undo logs.)

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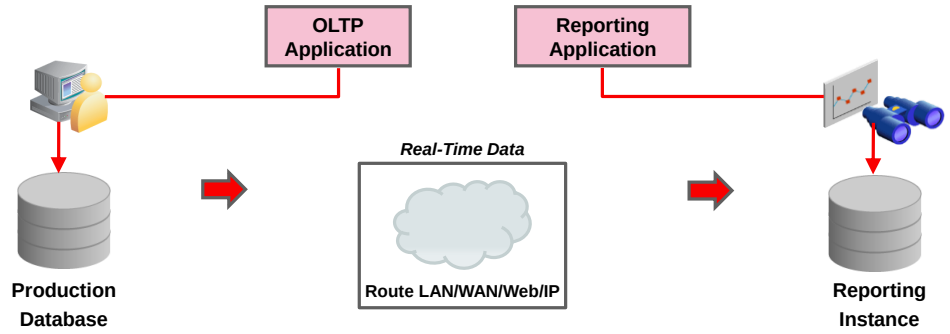
Use Case Example:

Oracle GoldenGate for Operational Reporting



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Operational reporting from a single source system or running queries on the source production system can affect performance. As a result, the best practice is to offload reporting to a lower-cost system.

Oracle GoldenGate enables real-time reporting from a lower-cost system by keeping the reporting database in sync with the OLTP database. Oracle GoldenGate can move just the data that is needed for reporting, and the heterogeneity enables the use of lower-cost systems. The data is moved with sub-second latency and there is no performance degradation for the source system. Transactional integrity is maintained and there is a provision for complete data recoverability.

An example is the offloading from a mainframe to Oracle databases on Linux.

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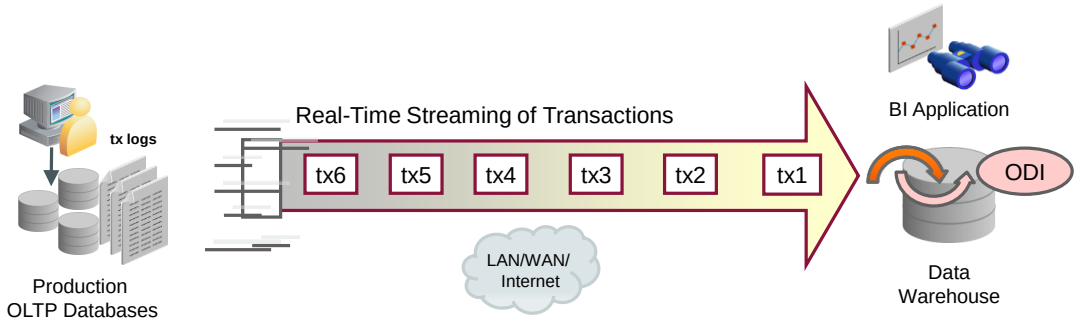
Use Case Example:

Oracle GoldenGate for Real-Time Data Warehousing



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For real-time data warehousing environments, Oracle GoldenGate moves changed data to the data warehouse or operational data store in near real time. Because this is log based, there is minimal impact on the source, there are no batch windows, and it moves the new transactions in a source system in sub-seconds. During the movement phase, each transaction's commit boundaries are maintained to ensure data integrity. ODI performs complex transformations within the database for maximum performance.

The other benefit of this approach is data recoverability in case there is an outage during data movement. This is an important requirement because data latency decreases in feeding the analytical environment. Oracle GoldenGate's files that store the changed data are persistent, so they can be reapplied (if needed) to the target and also to the source system.

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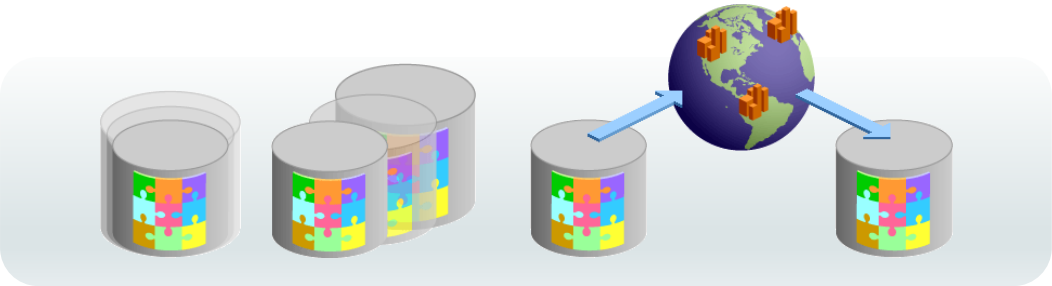
Oracle GoldenGate Use Cases for Oracle Database

- Continuous availability via active-active databases
- Zero–down time upgrades, migrations, and maintenance
- Offloading queries from legacy systems to Oracle databases
- Global Data Synchronization for distributed systems



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Migration and maintenance can take many forms:

- Migrate from non-Oracle databases to Oracle 12*c*.
- Upgrade Oracle Database versions 10*g* or 11*g* to 12*c*.
- Upgrade or migrate the database server or operating system (OS).
- Perform database maintenance.
- Perform application upgrades (Siebel CRM).

GoldenGate 12.3 does not support Oracle 8*i*, 9*i*, or 10g. GoldenGate 11.2 supports Oracle 10.2.0.4.0. Older versions of GoldenGate support Oracle 8*i* and 9*i* but they are no longer on the certification matrix.

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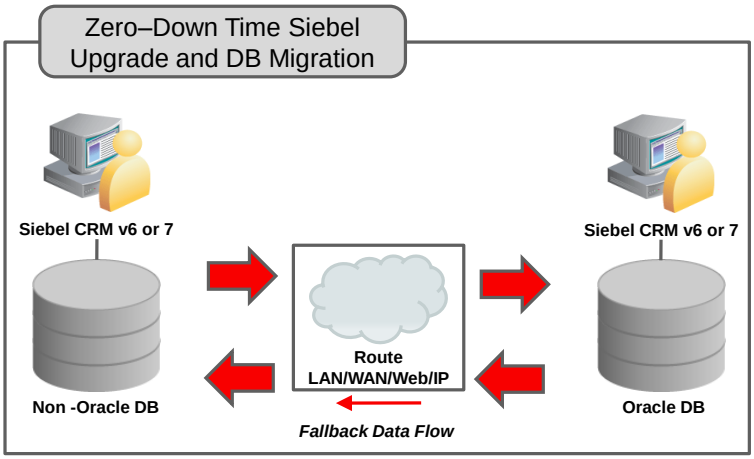
Oracle GoldenGate for Oracle Database

Eliminate Down Time for Migrations and Application Upgrades



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You can use Oracle GoldenGate to:

- Upgrade, migrate, and maintain a database, hardware, an OS, or an application
- Minimize risk with the fallback option
- Improve success with phased user migration

Whenever a database, an application, an OS, or hardware must be upgraded or migrated, Oracle GoldenGate enables zero–down time upgrades by synchronizing the new system with the existing one so that users can immediately switch over as soon as the data is fully synchronized. It also offers a fallback option to go back to the old system if needed for any reason.

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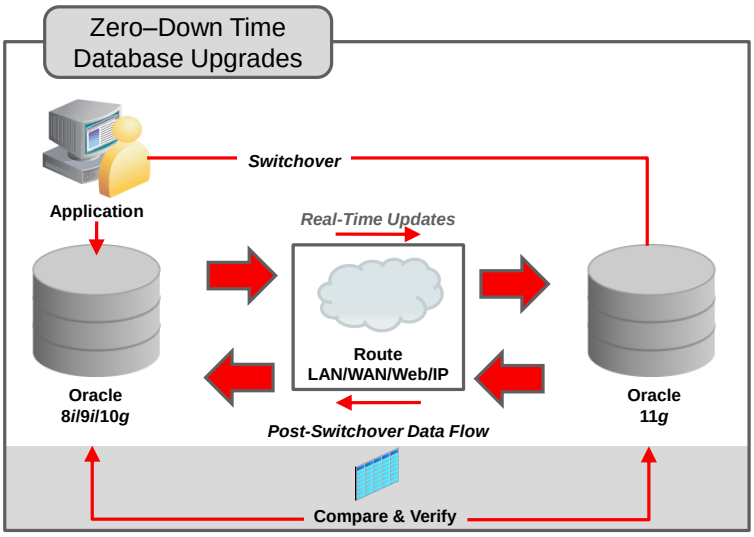
Oracle GoldenGate for Oracle Database

Eliminate Down Time During Oracle Database Upgrades



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You can use Oracle GoldenGate to:

- Upgrade from 10*g* or 11*g* to 12*c* with zero database down time
- Leverage new features of Oracle Database 12*c* without affecting business operations
- Minimize risks by using the fallback option

A key use case in eliminating planned down time is database upgrades. Oracle GoldenGate enables zero database down time for upgrades, supporting upgrades from versions 10*g* and 11*g* to 12*c*. The solution enables zero database down time by synchronizing databases in different versions and enabling immediate switchover. Customers can also use the two database versions concurrently to make the upgrade completely transparent to application users, as well as to validate data consistency.

GoldenGate 12.3 does not support Oracle 8*i*, 9*i*, or 10g. GoldenGate 11.2 supports Oracle 10.2.0.4.0. Older versions of GoldenGate support Oracle 8*i* and 9*i* but they are no longer on the certification matrix.

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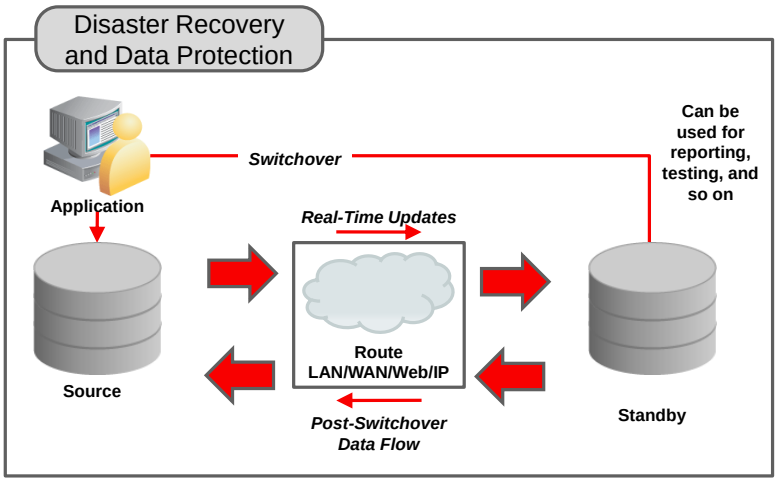
Oracle GoldenGate for Oracle Database

Eliminate Unplanned Down Time with Active Data Guard



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For disaster recovery, Active Data Guard is a viable option for Oracle databases. Oracle GoldenGate supplements it with non-Oracle platforms, active-to-active configurations, and cross-OS or cross-database versions. Oracle GoldenGate can support a physical standby, logical standby, or live standby database system.

Oracle GoldenGate keeps a live standby database system in sync continuously to enable immediate switchover to the standby system when needed. The secondary system is open for read-only as well as write uses. A post-switchover data flow from standby to primary is also provided. Any data that is processed by the standby during the outages is moved to the primary as soon as it is back online.

Oracle GoldenGate can also be used *with* Active Data Guard. For example, Active Data Guard can protect a primary database that Oracle GoldenGate is using for a source. Active Data Guard can also be used to protect a primary database that Oracle GoldenGate is using for a target.

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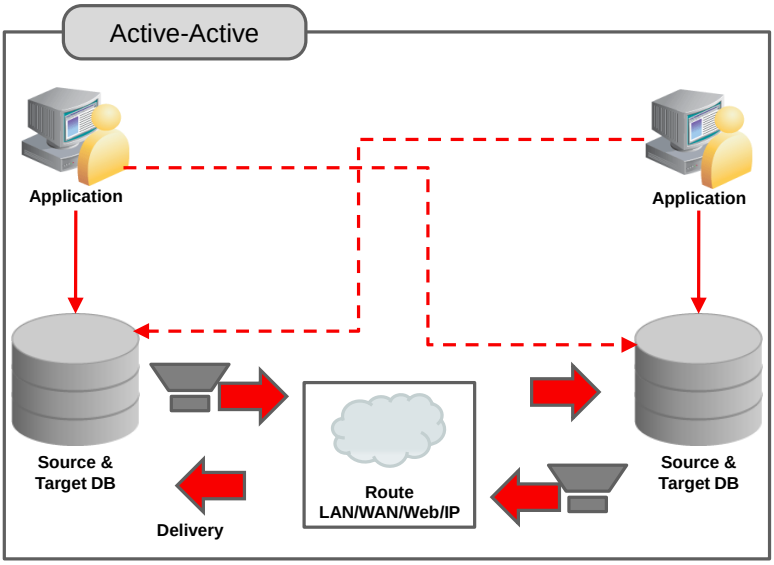
Oracle GoldenGate for Oracle Database

Increase Return on Investment (ROI) on Existing Servers and Synchronize Global Data



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Active-to-active or multimaster database configurations also help to eliminate system performance issues by allowing transaction load distribution between completely parallel systems, which Oracle GoldenGate replicates. Active-to-active configuration also enables continuous system availability because of the ability to work with the remaining databases if one database fails. Data can be filtered to move only certain schemas, tables, or rows.

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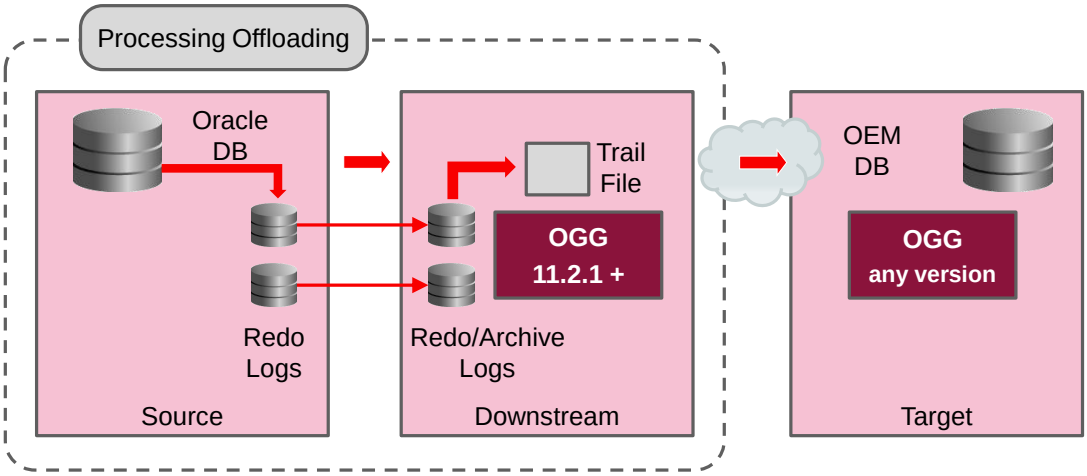
Oracle GoldenGate for Oracle Database

Offload Redo Logs

Capture can be offloaded from the source DB to an intermediate host by copying the redo logs.



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Oracle GoldenGate ("OGG" in the graphic in the slide) version 11, with the plus sign (+) to show offloading, is the *minimum* version; you can have a later version, such as Oracle GoldenGate12*c*. Note that the Oracle GoldenGate and Oracle Database release numbers are not necessarily in sync. That is, you can run Oracle GoldenGate 12.1.2 against Oracle Database 11.2.1.

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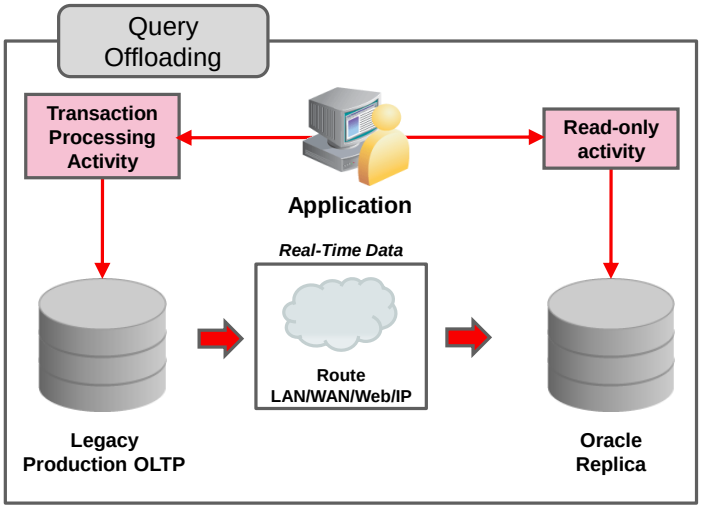
Oracle GoldenGate for Oracle Database

Improve Production System Performance and Lower Costs



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Heterogeneous configurations may include:

- Different OS or database version, or different type of database
- Legacy system query off-load

Active-active environments may also be doing bidirectional replication.

Oracle GoldenGate can also be used to move data from a CPU-bound source machine to a different target machine that is not CPU bound.

To handle semi-availability issues, Oracle GoldenGate offers the approach of offloading queries thus improving the performance of the production systems by assigning expensive queries to a secondary lower-cost platform.

A good example that requires this solution is an airline. Typically, there are many users who query the airline's database but who may not actually confirm a booking. Allowing these users to perform their queries on a different, continuously synchronized database improves production system performance and extends the life cycle of existing OLTP investments.

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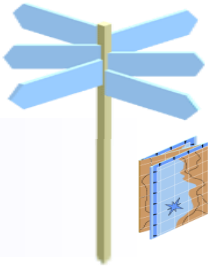
Agenda

- Oracle GoldenGate: Introduction
- Technology Overview
  - Topologies
  - Supported Platforms
  - Supported Databases
- Oracle GoldenGate Technology Suite



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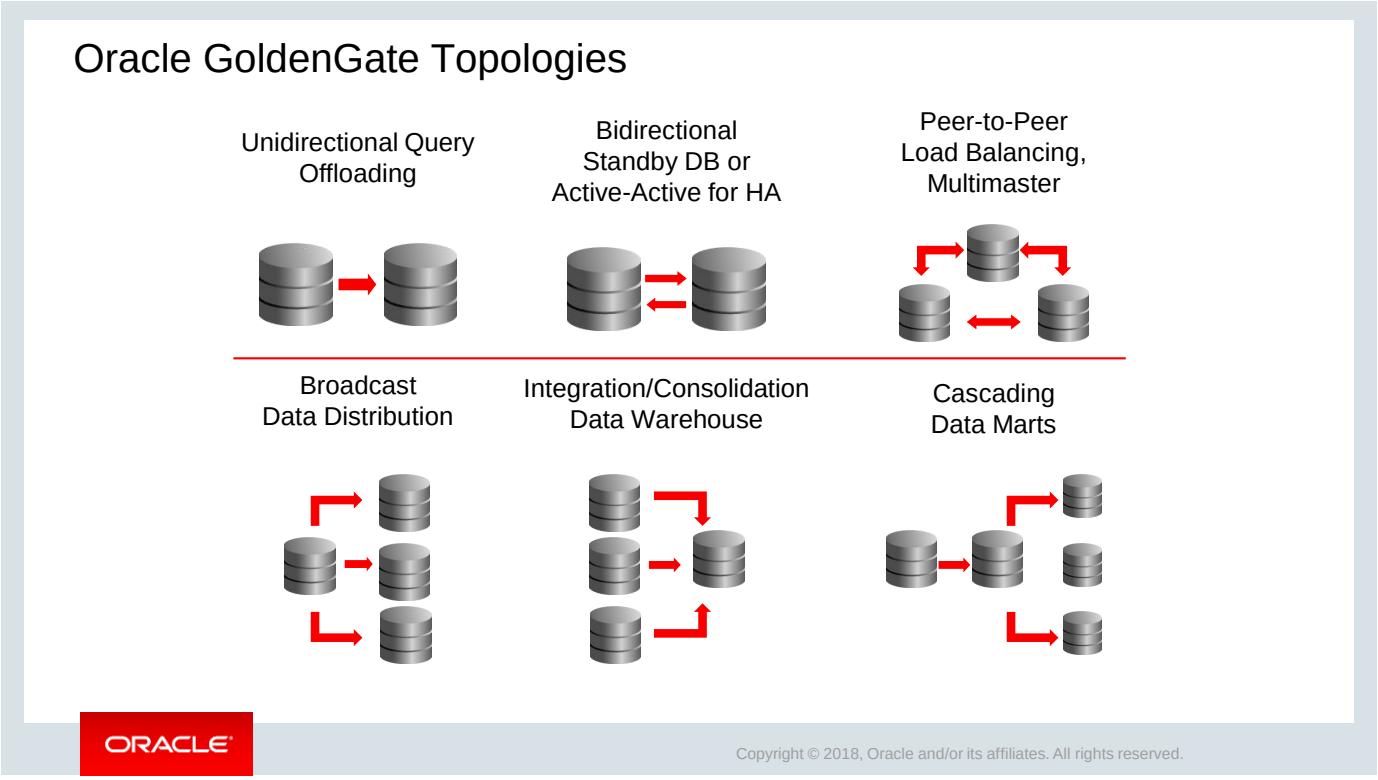

Oracle GoldenGate has a modular architecture that provides the flexibility to extract and replicate selected data records, transactional changes, and changes to data definition language (DDL) across a variety of topologies. With this flexibility, plus the filtering, transformation, and custom processing features of Oracle GoldenGate, you can support several business requirements, including:

- Business continuance and high availability
- Initial load and database migration
- Data integration
- Decision support and data warehousing

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Supported Databases

The following databases are currently certified with GoldenGate 12.3

- Oracle GoldenGate Capture:
  - Oracle
  - MS-SQL
  - My-SQL
  - DB2 for i
  - DB2 z/OS
  - DB2 LUW
- Oracle GoldenGate Delivery:
  - Oracle
  - Teradata (Delivery only)
  - MS SQL Server
  - My-SQL
  - DB2 for i
  - DB2 z/OS
  - DB2 LUW
  - Big Data Products (with the adapter)

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Oracle GoldenGate is ideal for heterogeneous environments—not just to support different versions of the same database or operation system/hardware, but to replicate and integrate data across vendor systems. Oracle GoldenGate supports log-based capture of changed data from nearly all major database vendors.

Replicating and delivering that data are also available to an even wider range of targets, including open source databases, several data warehouse appliances, ETL servers, and Java Message Service (JMS) message queues to support service-oriented architecture (SOA) and event-driven architecture (EDA).

Other systems are supported for delivery when using the Flat File Adapter or the Application Adapter for Java. For example, there is support for delivery to Netezza and Greenplum systems when using the Flat File Adapter.

Not all databases are supported on all versions of Oracle GoldenGate. As always, check the Oracle website (oracle.com) for the latest certification matrix.

The following databases are currently certified with older releases of GoldenGate:

Capture: Oracle, My-SQL, MS SQL Server, Sybase ASE, DB2 for I, DB2 z/OS, DB2 LUW, Enscribe, SQL/MP, SQL/MX, JMS Queues, Informix

Delivery: Oracle, Amazon Aurora PostgreSQL, My-SQL. MS SQL Server, Sybase ASE, Teradata, Enscribe, PostgreSQL (Delivery Only), SQL/MP. SQL/MX, JMS Queues, Informix, TimeTen, DB2 for I, DB2 z/OS, DB2 LUW, Big Data Products (with the adapter), Flat File Products (with the Adapter)

Consult the current certification matrix for details:

http://www.oracle.com/technetwork/middleware/ias/downloads/fusion-certification-100350.html

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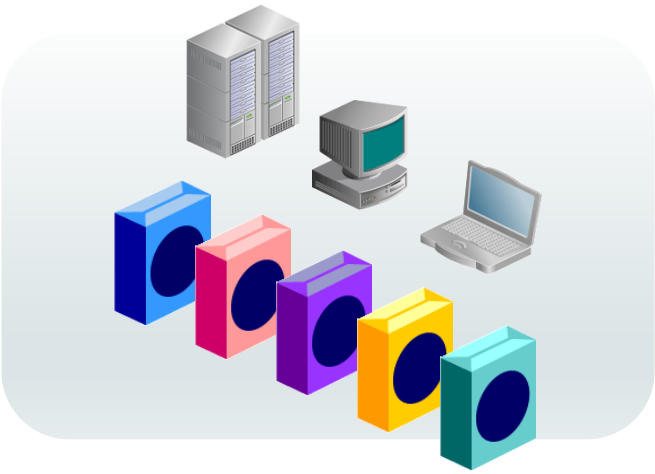
Supported Operating Systems

- Linux
- Windows
- Oracle Solaris
- HP NonStop
- HP-UX
- HP OpenVMS
- IBM AIX
- IBM z/OS
- IBM iSeries
- z/linux



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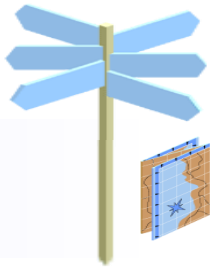
The slide lists all the operating systems that Oracle GoldenGate supports. Not all operating systems are supported on all versions of Oracle GoldenGate. As always, check the Oracle website for the latest certification matrix.

Oracle Internal & Oracle Academy Use Only

Agenda

- Oracle GoldenGate: Introduction
- Technology Overview
- Oracle GoldenGate Technology Suite
  - Oracle Middleware for Business Intelligence
  - Oracle GoldenGate and Oracle Data Integrator
  - Oracle GoldenGate Product Line



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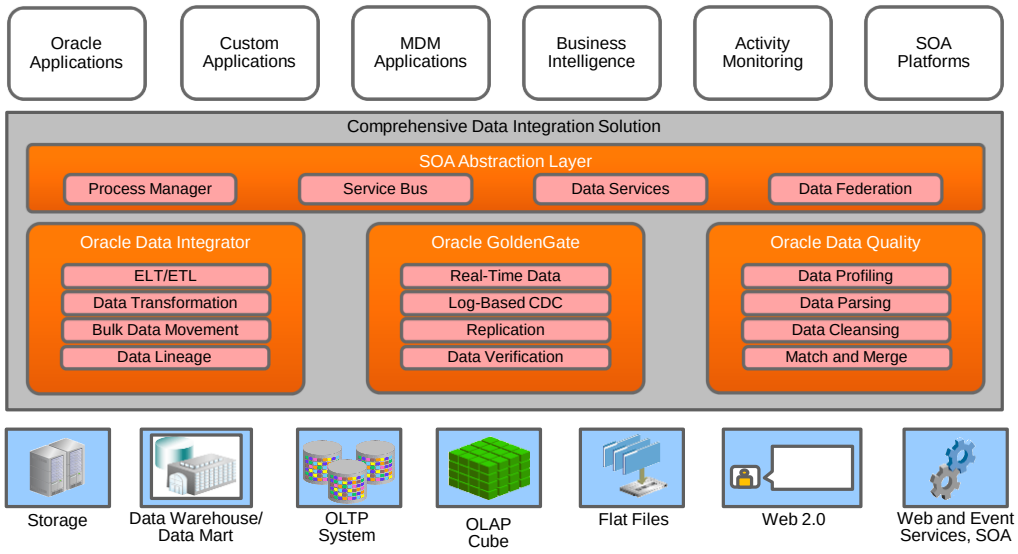
Oracle Middleware for Business Intelligence



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Integrating data and applications throughout the enterprise, and presenting them in a unified view, is a complex task. Not only are there broad disparities in technologies, data structures, and application functionality, but there are also fundamental differences in integration architectures. Some integration needs are data oriented, especially those involving large data volumes. Other integration projects lend themselves to an EDA or a SOA, for asynchronous or synchronous integration.

Oracle offers comprehensive solutions for data integration that help move data in bulk across heterogeneous sources and targets. With the best-in-class extract, load, transform (ELT) technology of Oracle Data Integrator (ODI) EE and best-in-class data cleansing technology (Oracle Data Profiling and Data Quality), these solutions can be integrated together with SOA approaches to build reusable data services. Oracle GoldenGate completes the picture with the addition of real-time change data capture and replication for high availability.

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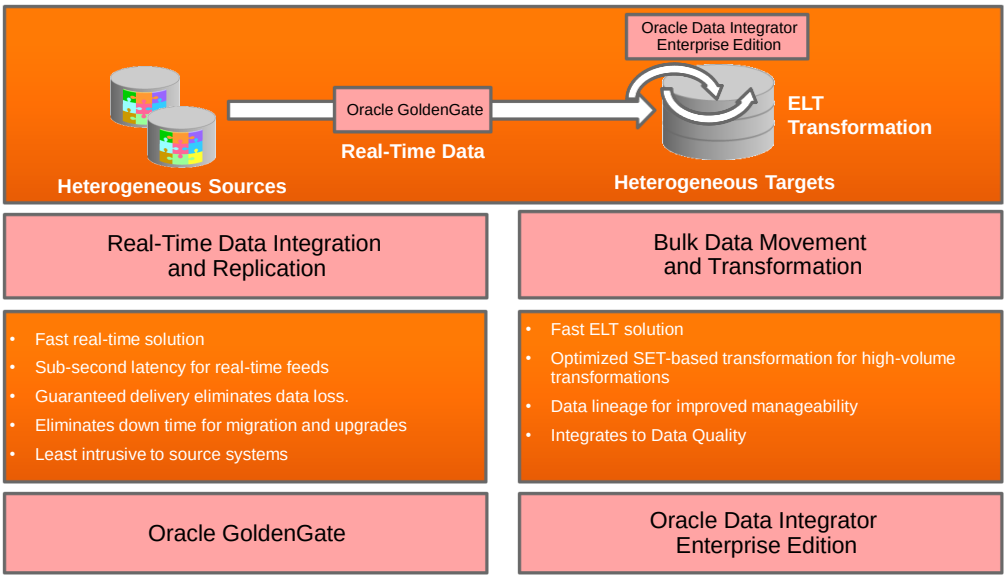
Oracle GoldenGate and Oracle Data Integrator



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Oracle GoldenGate and Oracle Data Integrator EE are combined to deliver real-time data warehousing. This combination brings fast real-time data integration and fast bulk-data transformation. Combining ODI EE with Oracle GoldenGate's real-time low-impact change data capture helps customers use integrated data quality and fast bulk transformations. Oracle GoldenGate feeds the staging area of the data warehouse, and ODI EE performs bulk transformations to feed the user tables in the data warehouse for a low total cost of ownership (TCO) and high-performance Real-Time Data Warehouse (RTDW) solution.

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Oracle GoldenGate Product Line

Oracle GoldenGate Veridata	Oracle GoldenGate Plug-in for EMCC	Oracle GoldenGate Monitor	Oracle GoldenGate for Big Data
Oracle GoldenGate Application Adapters	Oracle GoldenGate for HP NonStop	Oracle GoldenGate Studio	Oracle GoldenGate Director

Oracle GoldenGate Director is not supported with Oracle GoldenGate 12.3.
Oracle recommends you use Oracle GoldenGate Studio instead.

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The Oracle GoldenGate product family includes the following products:

- **Oracle GoldenGate Veridata:** Use Oracle GoldenGate Veridata to produce a comparison report of the data that is being transferred from a source system to a target system to identify and fix discrepancies.
- **Oracle GoldenGate Plug-in for EMCC:** Deploy Oracle GoldenGate Plug-in for EMCC in your cloud control environment to monitor and manage Oracle GoldenGate processes.
- **Oracle GoldenGate Monitor:** Use Oracle GoldenGate Monitor to monitor and manage Oracle GoldenGate processes in real time through a web interface.
- **Oracle GoldenGate for Big Data:** Use Oracle GoldenGate for Big Data to write operation data from Oracle GoldenGate trail records into various Big Data targets (such as, HDFS, HBase, Kafka, Flume, JDBC, Cassandra, and MongoDB).
- **Oracle GoldenGate Application Adapters:** Use Oracle GoldenGate Application Adapters to integrate Java Message Service with Oracle GoldenGate instances.
- **Oracle GoldenGate for HP NonStop:** Use Oracle GoldenGate for HP NonStop to configure and run Oracle GoldenGate on the HP NonStop Guardian platform.
- **Oracle GoldenGate Studio:** Use Oracle GoldenGate Studio to quickly create, modify, validate, deploy, and reuse Oracle GoldenGate designs.
- **Oracle GoldenGate Director:** Use Oracle GoldenGate Director to configure and manage Oracle GoldenGate instances through a graphical web interface from a remote client.

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Quiz

Which three statements are true about Oracle GoldenGate?

a. Oracle GoldenGate is an Oracle Database product that supports other Oracle products.

b. Oracle GoldenGate is a middleware product that does not require an Oracle database.

c. Oracle GoldenGate captures changes from Oracle Redo logs or non-Oracle transaction logs and moves them to another database.

d. Oracle GoldenGate can support high availability.

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Answer: b, c, d

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Quiz

Oracle GoldenGate is a middleware software for business intelligence, and it is designed to support a heterogeneous database environment.

a. True

b. False

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Answer: a

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Quiz

Which three products are part of the Oracle GoldenGate product line?

a. Oracle GoldenGate Veridata
b. Oracle GoldenGate Stadium
c. Oracle GoldenGate Application Adapters
d. Enterprise Manager
e. Oracle Streams
f. Oracle GoldenGate for Big Data

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Answer: a, c, f

These are all separately purchased products.

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Summary

In this lesson, you should have learned how to:

- Describe the purpose and need for Oracle GoldenGate
- Identify the supported databases and platforms
- Identify the components of Oracle GoldenGate suite

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Practice 1 Overview: Verifying the Lab Environment

In this practice, you become familiar with the lab environment that you use for the duration of the class.

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2

Oracle GoldenGate Architecture

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Objectives

After completing this lesson, you should be able to:

- Describe the two Oracle GoldenGate architectures
- Describe the Oracle GoldenGate Classic architecture
- Explain key terms related to Oracle GoldenGate
- Describe the interaction between Oracle GoldenGate and Oracle RDBMS

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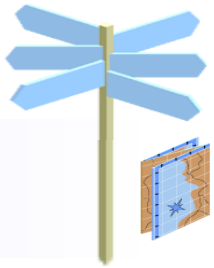
Agenda

- Oracle GoldenGate Architectures
- Classic Architecture
- Extracts
- Initial Loads
- Checkpoints



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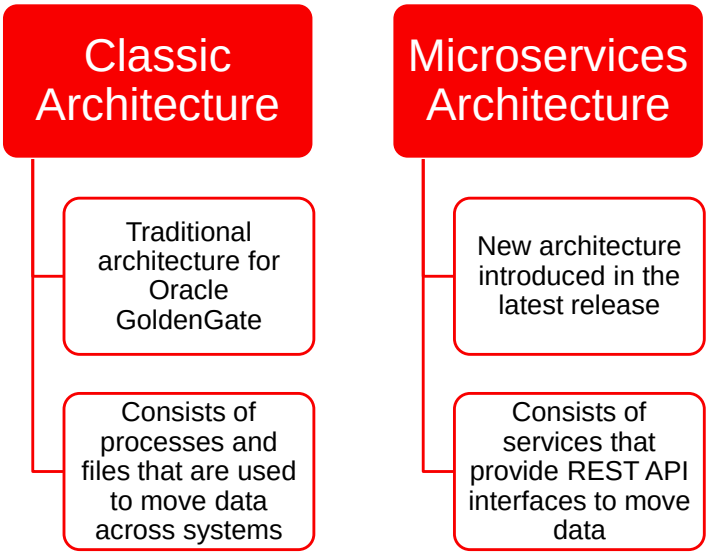
Oracle GoldenGate Architectures



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Oracle GoldenGate has two architectures:

- **Classic Architecture:** Provides the processes and files required to effectively move data across a variety of topologies. These processes and files form the main components of the Classic architecture and was the product design until this release.
- **Microservices Architecture:** Is a new architecture that illustrates server applications running as part of the Oracle GoldenGate environment. It comprises services that provide REST API interfaces for configuration, administration, and monitoring with included HTML5 web applications.

The first set of lessons in this course describe the Classic architecture in detail. The second set of lessons describe the new Microservices architecture.

Both classic extracts and replicats, as well as integrated extracts and replicats are supported with classic architecture. REST is an acronym for Representational State Transfer.

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Classic Versus Microservices Architecture

Use Classic architecture for	Use Microservices architecture for
Static extraction of data records from one database and the loading of those records to another database	Large-scale and cloud deployments with fully secure HTTPS interfaces and Secure WebSockets for streaming data
Continuous extraction and replication of transactional data manipulation language (DML) operations and data definition language (DDL) changes (for supported databases) to keep source and target data consistent	Support system–managed database sharding to deliver fine-grained, multi-master replication where all shards are writable, and each shard can be partially replicated to other shards within a shard group
Extraction from a database and replication to a file outside the database	Simpler management of multiple implementations of Oracle GoldenGate environments and control user access for the different aspects of Oracle GoldenGate setup and monitoring
Capture from heterogeneous database sources	Support for thin and browser-based clients, distributed deployments, remote administration

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The media available for Microservices architecture only supports Oracle at this time.

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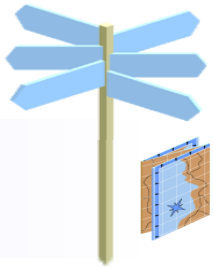
Agenda

- Oracle GoldenGate Architectures
- Classic Architecture
  - Logical Architecture
  - Components
  - Process Groups
  - Files
- Extracts
- Initial Loads
- Checkpoints



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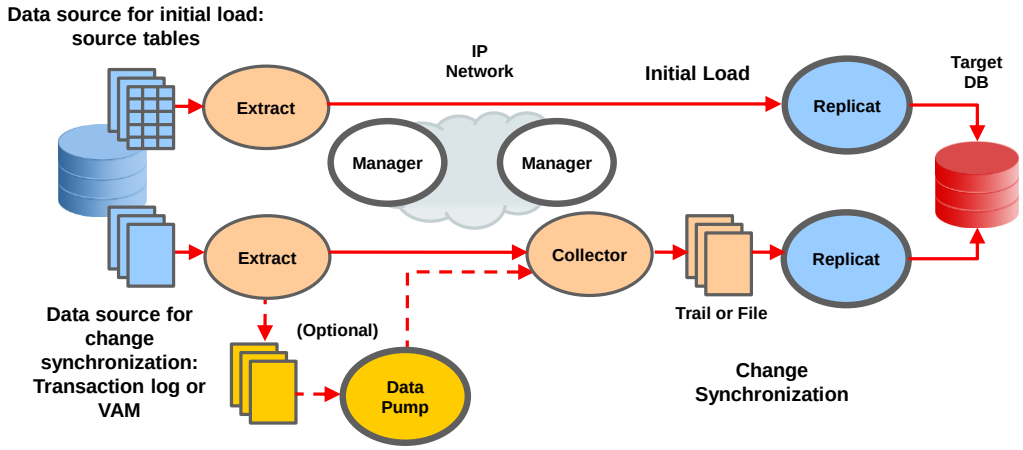
Oracle GoldenGate Classic Logical Architecture



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The diagram in the slide illustrates the logical architecture of Oracle GoldenGate. This is the basic configuration. Variations of this model are recommended depending on business needs.

Vendor Access Module (VAM) is usually used only by non-Oracle databases, such as Teradata.

In Oracle GoldenGate version 11.2.1 and later, all network calls use IPv6-based APIs, which support either IPv4 or IPv6 networks as appropriate.

Each of these components is covered in detail in the following slides and in later lessons in this course.

- **Manager:** Is required to start and stop the other processes, but is not required for the ongoing operation of another process. That is, you can start the Manager, use the Manager to start the Extract, and then stop and restart the Manager (perhaps to pick up new Manager configuration parameters) without affecting the running Extract.
- **Server Collector:** Also known simply as *Collector*
- **Extract:** Also known as *Change Data Capture*
- **Data Pump:** Optional; highly recommended
- **Replicat**
- **Trails or extract files:** Can optionally be compressed and/or encrypted

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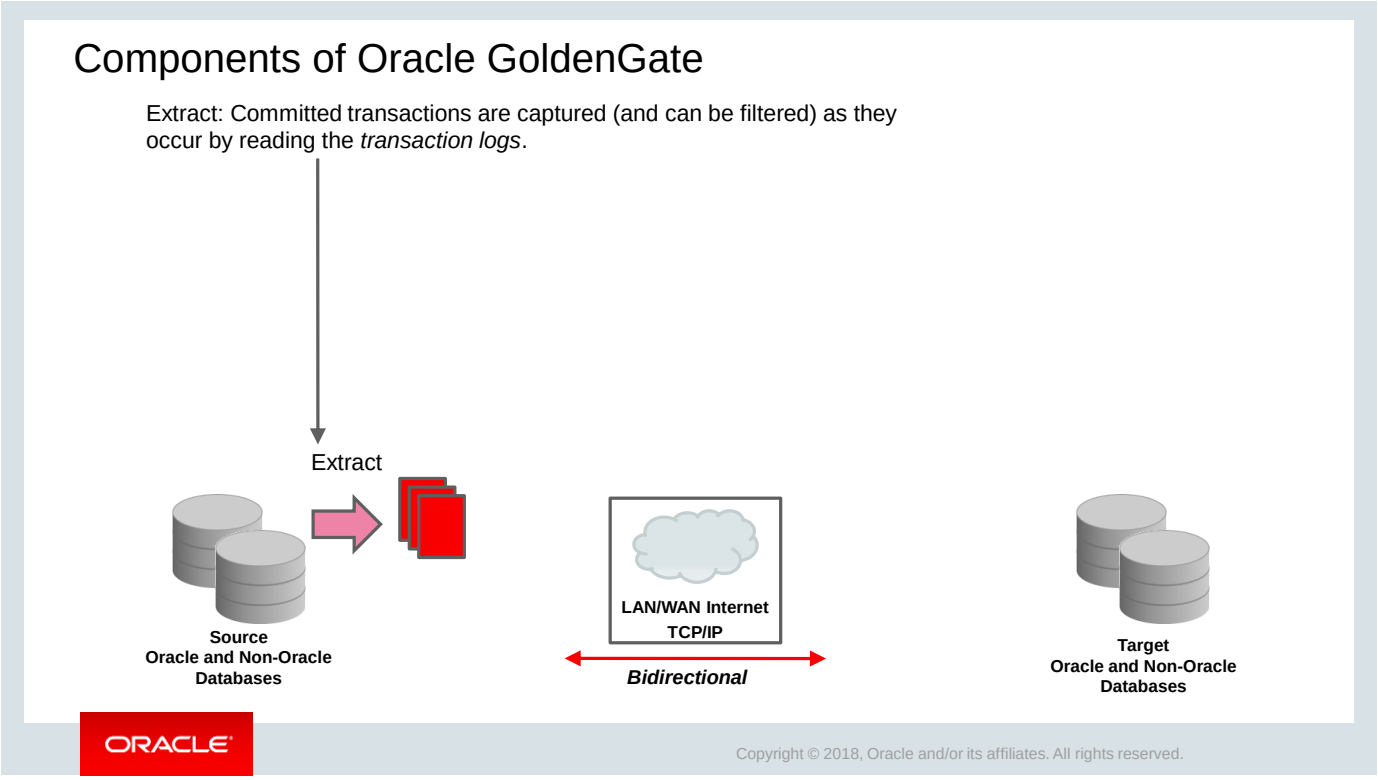

Extract

Oracle GoldenGate can move data between heterogeneous databases for both the source and the target. The software operates at the database level, and the Capture component is typically installed on the source database server outside of the DBMS. Oracle GoldenGate's Extract process reads native transaction logs and captures transactions as soon as they commit, and takes the transactions outside of the database system to be queued. Oracle GoldenGate moves only changed, committed transactional data, allowing it to operate with extremely high performance and very low impact.

Oracle GoldenGate allows filtering at the schema, table, column, or row level. Row-level transformations can be applied either at this capture stage or later when delivering.

Oracle GoldenGate can do a "Classic" Extract for any platform. However, if the platform is Oracle Database of a certain version, it can also do an optional "Integrated" Extract (bypassing the logs) by using direct APIs, which is more efficient. You will learn about Classic Extract and Integrated Extract later in this lesson.

Note: Classic Extract does not work when the source database is Oracle 12*c* configured in multitenant mode.

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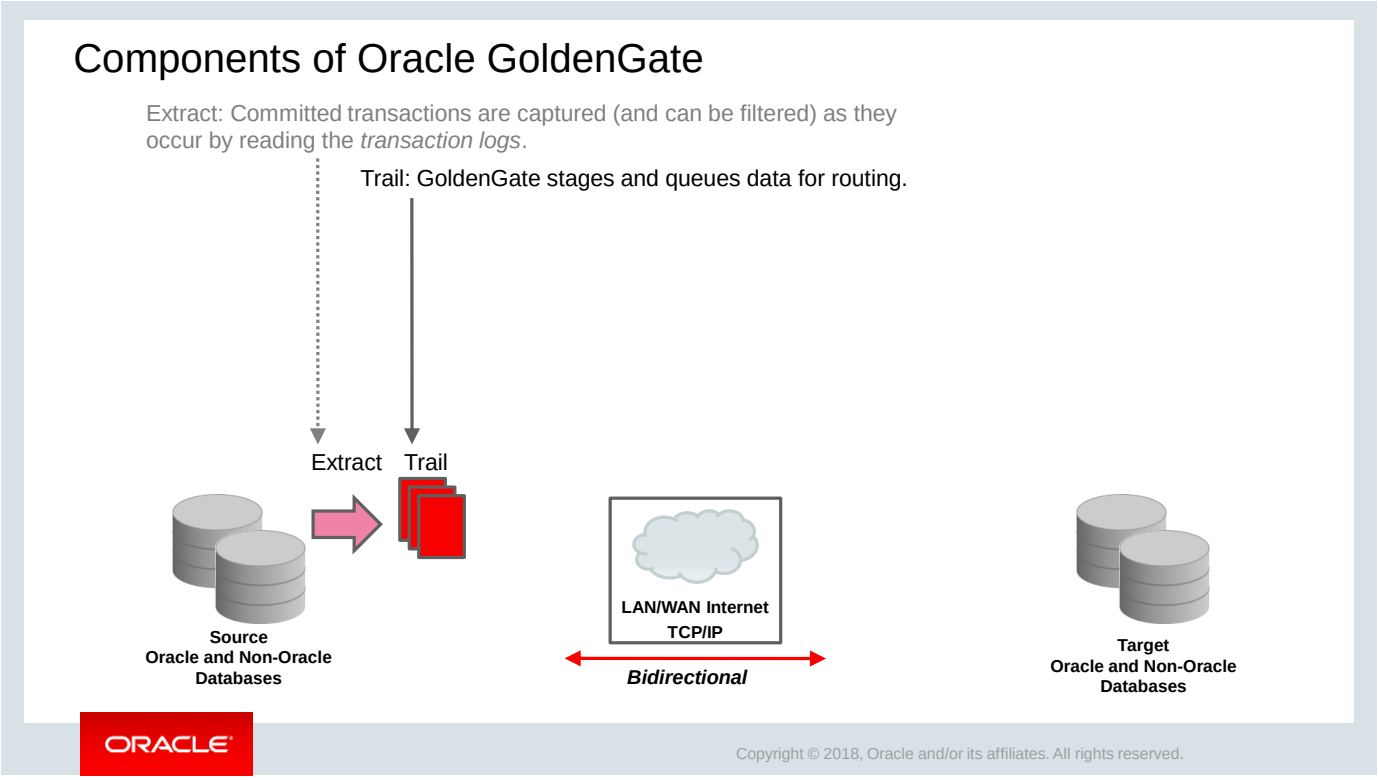

Trail

After the capture, Oracle GoldenGate converts the committed transactions into a canonical (universal) data format in “trail” files. Using source and target trail files, it ensures that data integrity is maintained—even if there is a system error or an outage.

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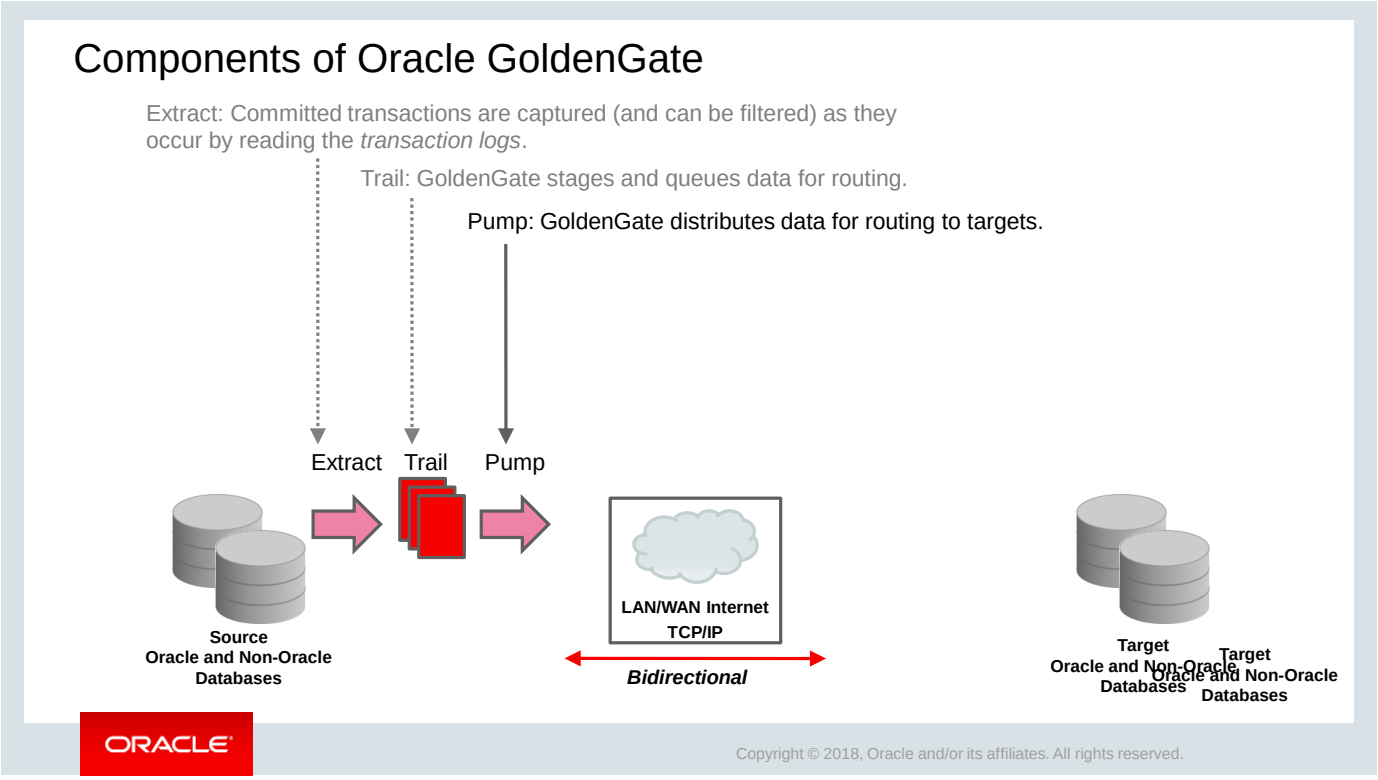

Pump

Another Capture component can be used to pump the data to multiple targets and is used for better recoverability. This configuration enhances the fault tolerance and reliability of the overall GoldenGate environment. If there is a network failure (between the source and the target systems), the Oracle GoldenGate Capture component can continue to capture transactions, because the data can be queued up locally in the trail files on the source, enhancing the recoverability in case of database failures.

Note: This is *not* the database feature called Data Pump.

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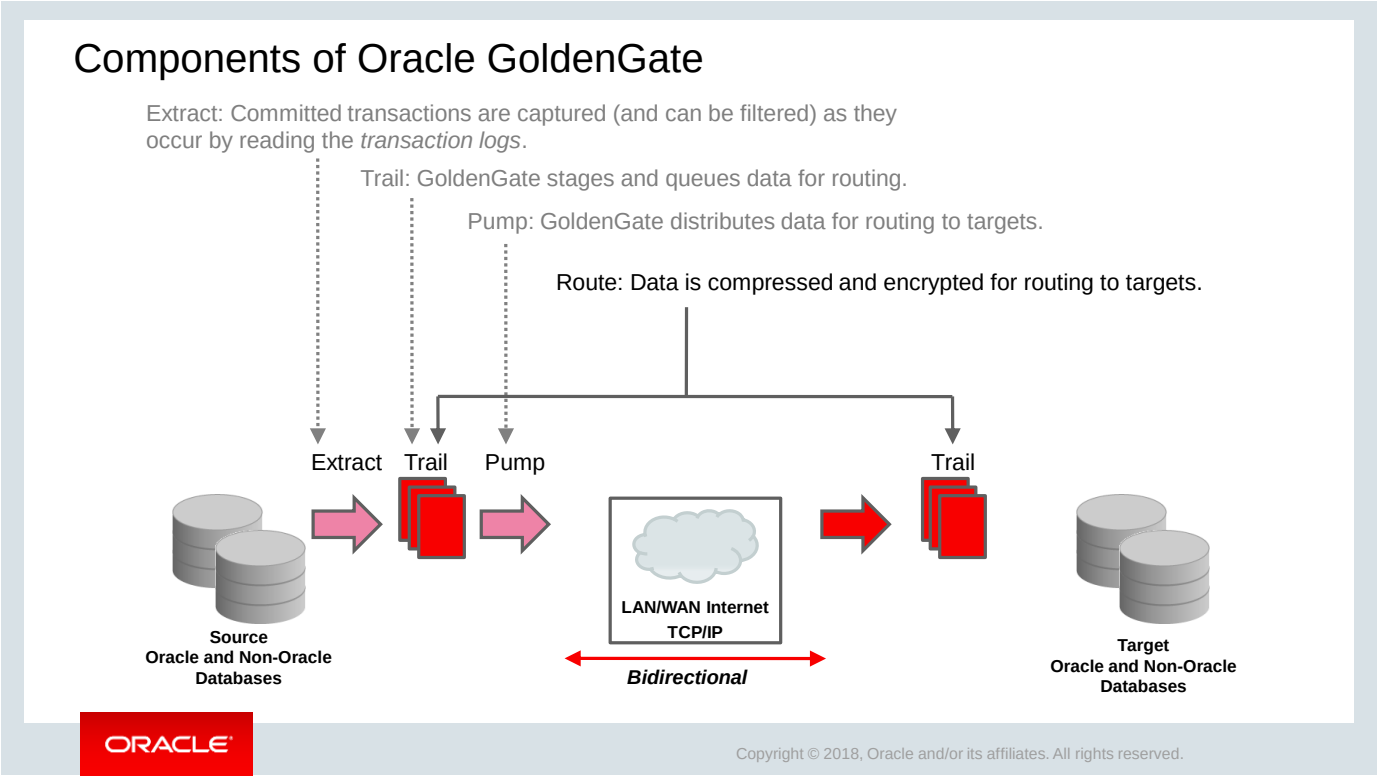

Route

The data is then routed from the trail files via TCP/IP (IPv4 or IPv6) to the target systems. During this routing process, data compression and encryption can be applied and thousands of transactions can be moved per second without distance limitations.

Note: If both Classic and Microservices architectures are used interoperably, encryption and compression cannot be used.

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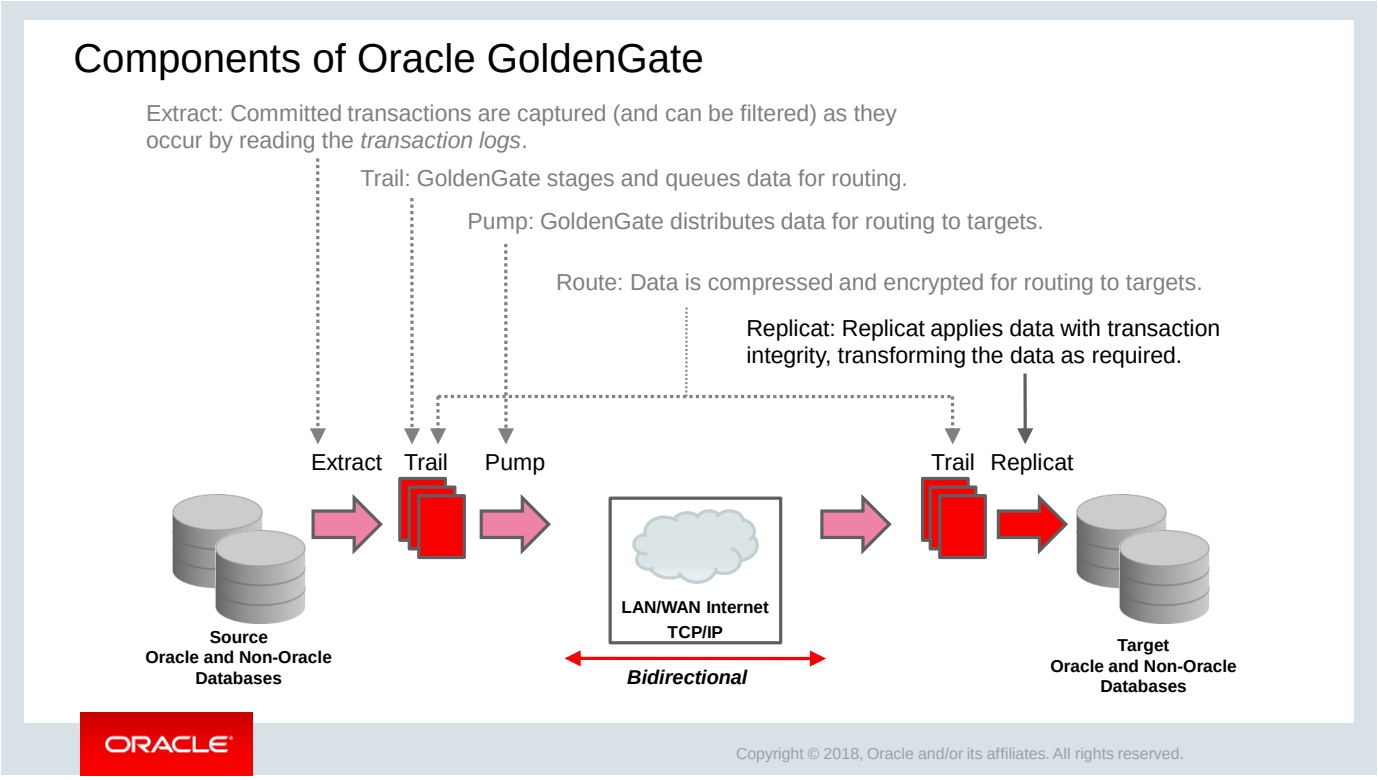

Replicat

The other key component of Oracle GoldenGate is the Replicat (or Delivery) module that is installed on the target database server. Queued transactions that are stored in the trail files are applied to the target by using native SQL calls. If necessary, basic transformations at the row level can be applied at either delivery or capture.

Oracle GoldenGate can do a “Classic” Replicat (delivery) for any supported platform. However, if the platform is Oracle Database of a certain version, it can also do an optional “Integrated” Replicat (bypassing the SQL apply) by using direct APIs, which is more efficient.

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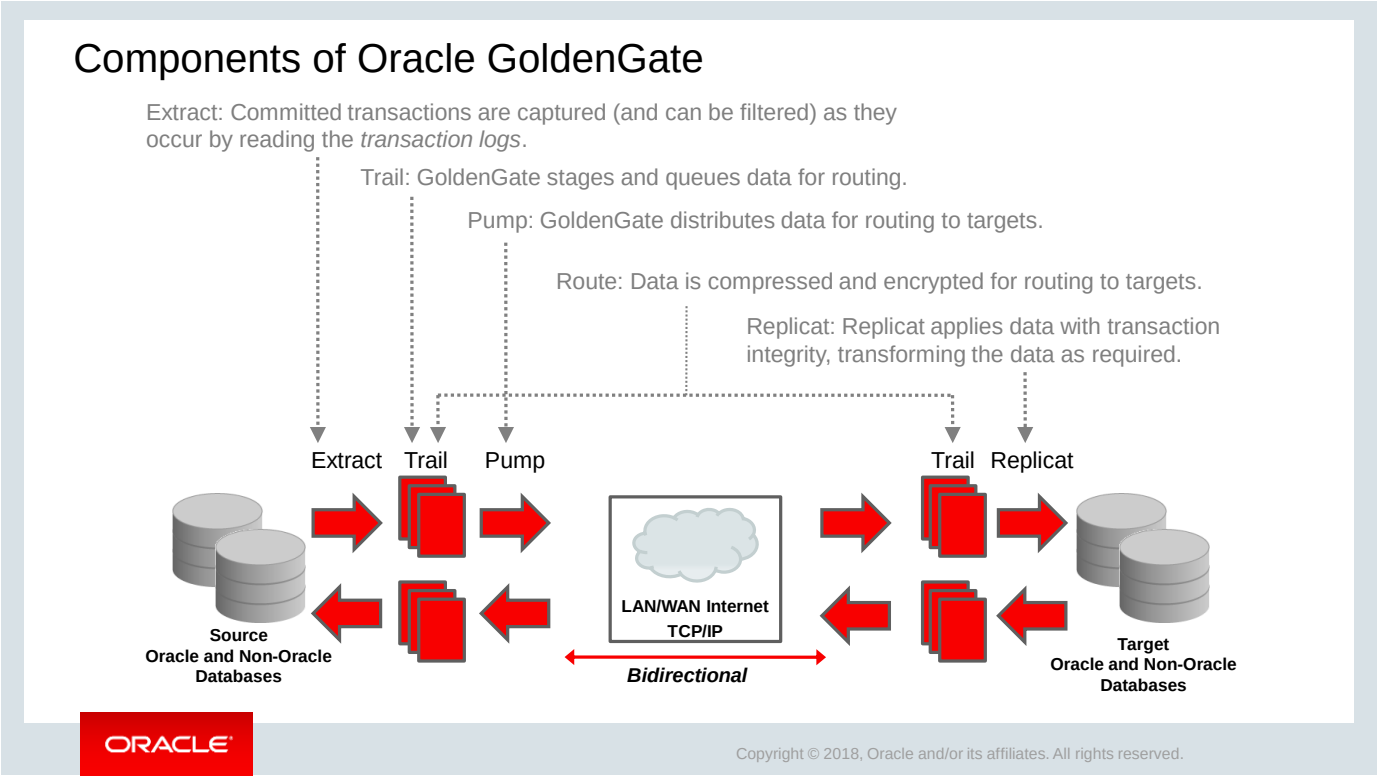

Bidirectional Data Movement

This data movement can also be done bidirectionally. Oracle GoldenGate has built-in loop detection to differentiate between new transactions and data that is replicated.

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Oracle GoldenGate Process Groups

- A process *group* consists of the following:
  - Process (either Extract or Replicat)
  - Parameter file
  - Checkpoint file
  - Any other files associated with the process
- Groups can be defined by using the `Add Extract` and `Add Replicat` commands.
- Each process group must have a unique name.

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To differentiate among multiple Extract or Replicat processes on a system, you define processing groups. For example, to replicate different sets of data in parallel, you create two Replicat groups.

A processing group consists of a process (either Extract or Replicat), its parameter file (`*.prm`), its checkpoint file, and any other files associated with the process, such as Report (`*.rpt`), Discard (`*.dsc`), and Column Definition (`*.def`) ASCII files. For Replicat, a group also includes a checkpoint table (if one is being used). You define groups by using the `Add Extract` and `Add Replicat` commands in the GoldenGate Software Command Interface (GGSCI).

In version 11.2.1 and later, the Oracle GoldenGate GGSCI command interface fully supports up to 5,000 concurrent Extract and Replicat processes for each instance of Oracle GoldenGate Manager.

In version 12.1, the discard file creation is now automatic by default; in earlier versions, you had to define the discard file manually.

In 12*c*, an integrated process causes additional processes to be created in the database.

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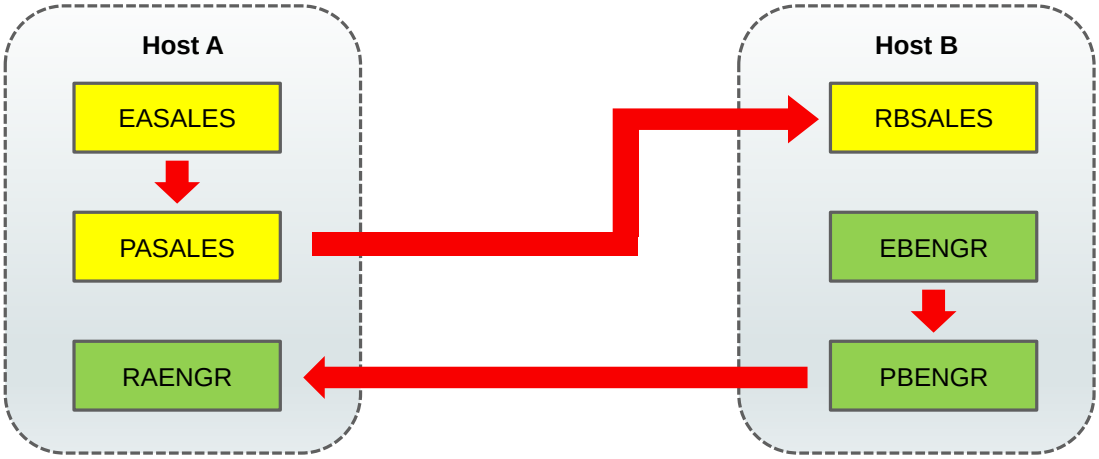
Process-Group Naming Conventions

You can use any convention you choose. Here is an example:



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You can use any OS-supported naming convention you want for the process groups and their associated parameter files (covered in later slides). For example, suppose that you have host A and host B, and you have the engineering and sales departments on both hosts. You may want to use a naming convention such as *PHtask*, where:

P is the process type:

- E=Extract
- P=Pump
- R=Replicat
- I=Initial Load

H is the host:

- A=left, West
- B=right, East

task is the name of the task, department, or schema:

- SALES
- ENGR

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When naming groups, you can use up to eight characters, including non-alphanumeric characters, such as the underscore (_). Any character can be used, as long as the character set of the local operating system supports it and the operating system allows that character to be in a file name. This is because a group is identified by its associated checkpoint file.

The following characters are not allowed in a group name: `{\ / : * ? " < > | }`.

On HP UX, Linux, and Solaris, it is possible to create a file name with a colon (`:`) or an asterisk (`*`), although it is not recommended.

In general, group names are not case-sensitive. For example, `finance`, `Finance`, and `FINANCE` are all considered to be the same. However, in Linux, the group name (and its parameter file name if explicitly defined in the `ADD` command) must be all UPPERCASE or all lowercase. Mixed-case group names and parameter file names will result in errors when starting the process.

Use only one word. Do not use the word `port` as a group name. However, you can use the string `port` as part of the group name. You can include a number in a group name. However, be aware that using a numeric value at the end of a group name (such as `fin10`) can cause duplicate report file names and errors, because the writing process appends a number to the end of the group name when generating a report. You can place a numeric value at the beginning of a group name, such as `10_fin`, `10fin`, and so forth.

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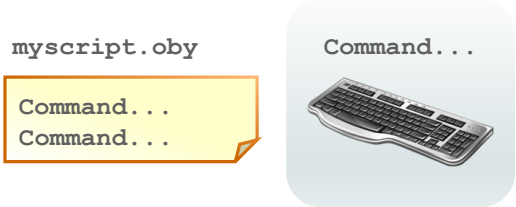
GGSCI

- Processes are added and started using the Oracle GoldenGate Software Command Interface (GGSCI) with the group name.
- The GGSCI is used to issue a complete range of commands that configure, control, and monitor Oracle GoldenGate.
- Commands can be typed or run from a script.
- The script can include OS shell commands.



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GGSCI commands can be collected together in an ASCII text script called an Obey (`.oby`) file. The extension `.oby` is by convention; it can be any extension. You create and maintain these scripts with any text editor, such as Notepad or `gedit` or `vi`.

There are GUI interfaces as well that are part of the Oracle GoldenGate product family.

There is no formal collection of commands to run at startup, but you can create a `startup.oby` file (this name is a convention; you can name the file anything you like) with useful environment and setup commands in it. You would run it first by entering:

```
GGSCI 1> Obey startup.oby
```

Similarly, you may want to make a `shutdown.oby` file with cleanup commands in it. The last command in it would be `Exit`.

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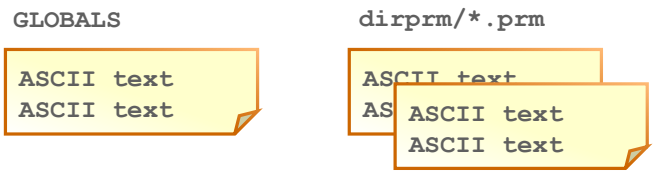
Parameter Files

- Most Oracle GoldenGate functionality is controlled by the use of parameters that are specified in text files.
- Oracle GoldenGate uses two types of parameter files:
  - **`GLOBALS` file:** Stores parameters that relate to the Oracle GoldenGate instance as a whole
  - **Run-time parameter file:** Is coupled with a specific process (such as Extract)
- By default, parameter files are in **`dirprm`** in the Oracle GoldenGate directory.



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The `GLOBALS` file (must be uppercase with no extension) stores parameters that relate to the Oracle GoldenGate instance as a whole. This is in contrast to runtime parameters, which are coupled with a specific process such as Extract. The parameters in the `GLOBALS` file apply to all processes in the Oracle GoldenGate instance, but can be overridden by specific process parameters. After the `GLOBALS` parameters are set, they are rarely changed, and there are far fewer of them than runtime parameters.

A `GLOBALS` parameter file is required only in certain circumstances and, when used, must be created from the command shell before starting any Oracle GoldenGate processes, including GGSCI. The GGSCI program reads the `GLOBALS` file and passes the parameters to processes that need them.

Runtime parameters (extension `.prm`) give you control over the various aspects of Oracle GoldenGate synchronization, such as data selection and mapping, DDL and sequence selection, error resolution, logging, and so on. There can be only one active parameter file for the Manager process or an Extract or Replicat group.

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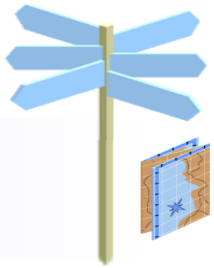
Agenda

- Oracle GoldenGate Architectures
- Classic Architecture
- Extracts
  - Classic
  - Integrated
- Initial Loads
- Checkpoints



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Extract Flavors

Integrated Extract:

- Is an Oracle GoldenGate Extract for Oracle databases
- Is multithreaded
- Relies on Oracle's internal log parsing and processing implementation
- Supports more data types
- Supports downstream topologies
- Is available with OGG version 11.2.1 and later

Classic Extract:

- Is traditional REDO log–based extract for Oracle
- Works for all supported DB platforms and versions
- Does not work in an Oracle multitenant environment
  - Classic Extract is not able to deal with a three-part naming convention for objects.

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The location of the REDO logs is flexible with some of the newest Oracle Database versions. The stated direction is that new features will come out for the Integrated mode, whereas the Classic mode will continue as is. This course assumes the Integrated Extract mode for all practices.

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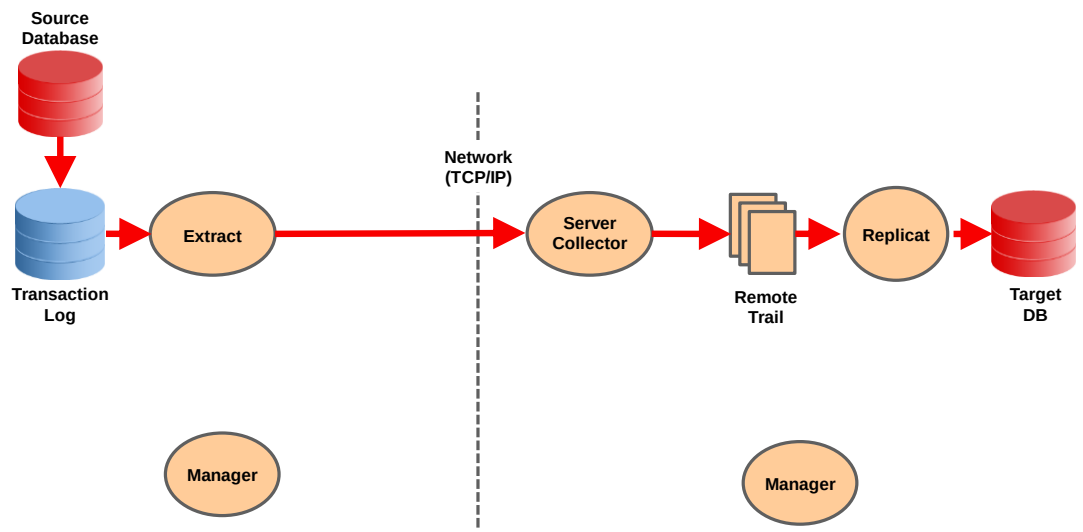
Capture and Delivery Work Flow



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By default, Oracle GoldenGate 10.4 and later have one or more *dynamic* Server Collectors. With a dynamic Server Collector, there is a one-to-one relationship between the Extract and the Server Collector. Earlier releases used a default *static* Server Collector, and there was a many-to-one relationship between the Extracts and the Server Collector.

On the source system:

1. An Extract process captures transactional changes from transaction logs.
2. The Extract process sends data across a TCP/IP network to the target system.

On the target system:

1. A Server Collector process reassembles and writes the data to an Oracle GoldenGate trail.
2. A Replicat process reads the trail and applies it to the target database. (This can be concurrent with data capture or performed later.)

Manager processes on both systems control activities such as starting, monitoring, and restarting processes; allocating data storage; and reporting errors and events.

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Real Application Clusters (RAC)

In an Oracle RAC configuration with Oracle GoldenGate, the Extract (capture) spawns an extract reader thread for every node on the source database. The coordinator thread receives, interprets, and orders redo from all readers. The `THREADS n` option is required in classic capture mode for Oracle RAC to specify the number of redo log threads being used by the cluster. Extract reads and coordinates each thread to maintain transactional consistency. Manual thread maintenance is not required for integrated capture mode.

Only one OGG RAC extract node copy is active at a time; the other nodes are on standby.

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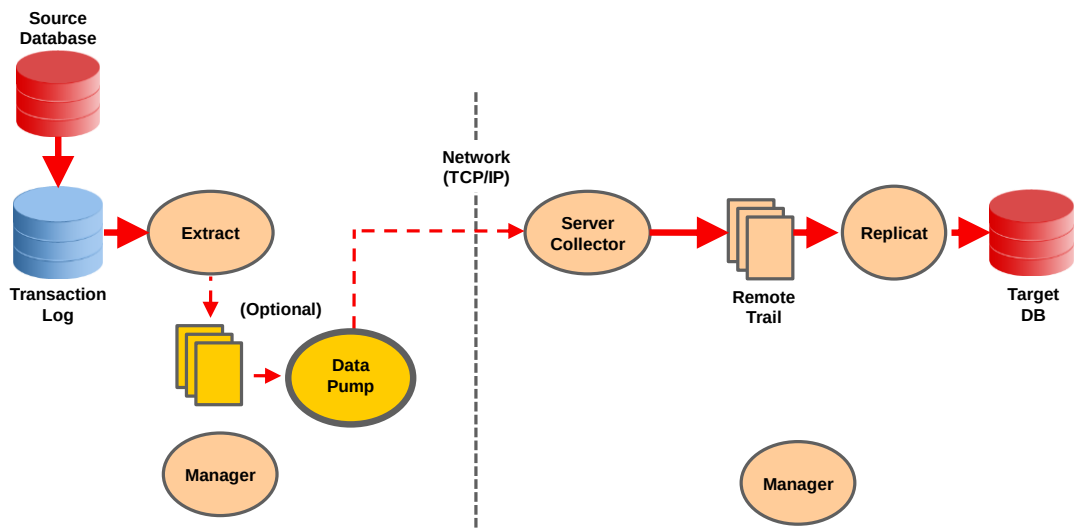
Capture and Delivery Using a Data Pump



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Although the data pump Extract is optional, using one is considered to be a common best practice. The data pump Extract works as follows:

- On the source system:
  1. An Extract process captures transactional changes from the database transaction log.
  2. The Extract process writes the data to a local Oracle GoldenGate trail. (This preserves the captured data if the network or target trail fails.)
  3. A second Extract process (called a *data pump*) sends the data across the network to the target system.
- On the target system:
  1. A Server Collector process reassembles and writes the data to an Oracle GoldenGate trail.
  2. A Replicat process reads the trail and applies it to the target database. (This can be concurrent with data capture or performed later.)

Manager processes on both systems control activities such as starting, monitoring, and restarting processes; allocating data storage; and reporting errors and events.

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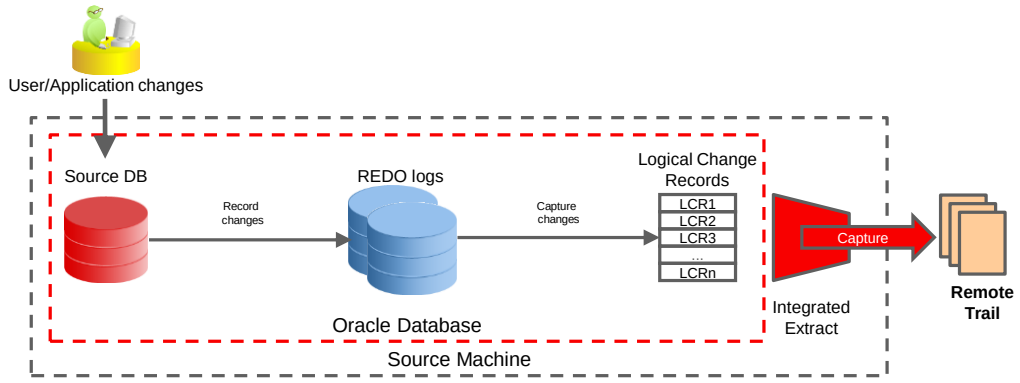
Distributed Topologies for Integrated Extract: Same Machine



Supports:

- Exadata
- Compression
- IOT, XML, LOBs natively

Requires:

- Database 11.2.0.3 or later

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In the typical configuration, Oracle GoldenGate is installed on the same machine or host as Oracle Database. This is similar to the REDO-based Classic Extract configuration. Oracle's REDO parsing and processing system captures the database changes in the form of Logical Change Records (LCRs). Later this LCR data is read by the consumer thread of Integrated Extract and processed by the producer thread of the same Integrated Extract. After processing, the records will be written to trail files.

This real-time configuration is suitable for deployments in which customers do not mind keeping the Oracle GoldenGate Extract process running on the same machine as the Oracle Database instance. This deployment configuration is simple to configure and easy to manage, and it is familiar to existing Oracle GoldenGate customers.

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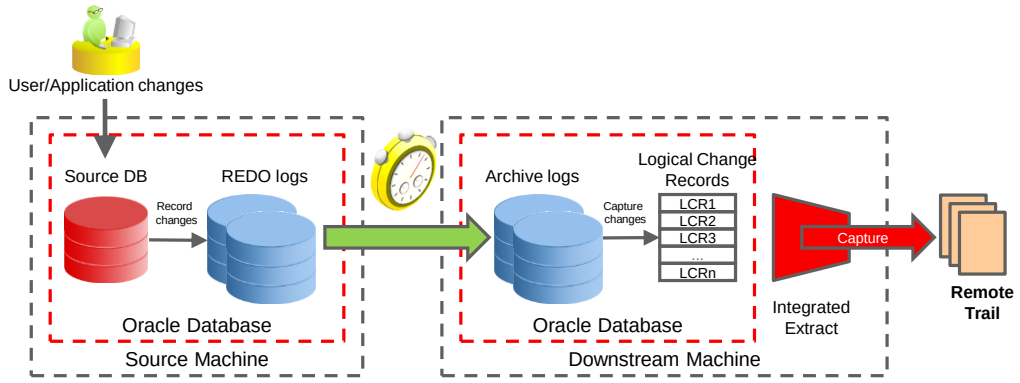
Distributed Topologies for Integrated Extract: Different Machine, Real Time



Source requires:

- Database 10.2 or later
- If not 11.2.0.3, then must run with downstream

Downstream requires:

- Database 11.2.0.3 or later

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While keeping real-time mode in consideration, Integrated Extract supports another configuration called the *downstream* configuration, where the source database instance and Integrated Extract processes are on different machines.

In this deployment configuration, Oracle Database needs to be installed on both the source machine and the downstream machine. The Oracle Database on the downstream machine is used to hold minimal data or metadata specific to the Oracle internal log processing module. From the source machine, change data records from REDO logs are *shipped continuous*ly to the downstream machine as *Standby REDO logs*. These Standby REDO logs are processed by the Oracle internal log processing module and are available as Logical Change Records. Later this LCR data is read by the consumer thread of Integrated Extract and processed by the producer thread of the same Integrated Extract. After processing, the records are written to a trail file.

Note that change data records from the source database will not be persisted in the downstream database. As mentioned earlier, the main purpose of the downstream database is to hold some state-specific data or metadata, which is minimal in nature and is specific to the log processing module. Change data records from the REDO logs of the source database are simply transported or shipped continuously as Standby REDO logs on the downstream machine.

If the source is not Oracle Database version 11.2.0.3, not all new features are available.

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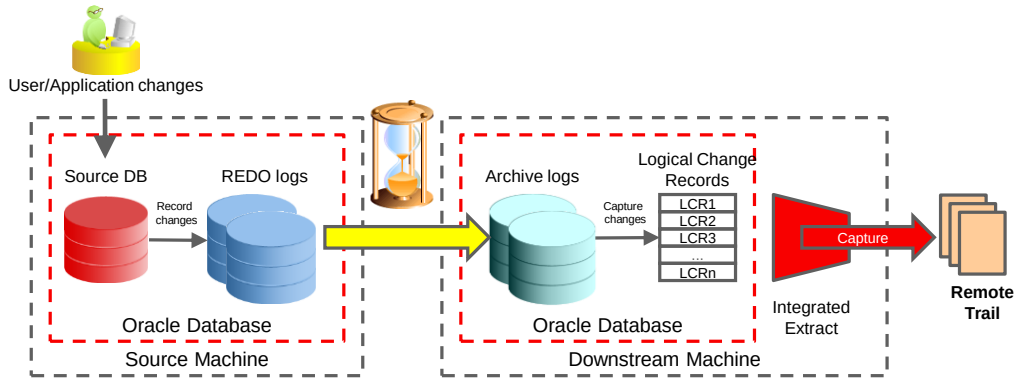
Distributed Topologies for Integrated Extract: Different Machine, Non-Real-Time



Useful for offloading processing overhead

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For non-real-time mode, archive logs can be processed in the configuration shown in this slide.

Only downstream configuration is supported. In this configuration, Oracle Database needs to be installed on both the source machine and the downstream machine. Oracle Database on the downstream machine is used to hold minimal data (or metadata) specific to Oracle internal log processing module.

REDO logs generated on the source machine will be available as archive logs on the downstream machine. This is similar to how you would offload archive log processing using Classic Extract.

Benefits of this configuration:

- Production databases that are sensitive in nature will not be significantly disturbed. No additional software is required to install on the production machine.
- Using a downstream mining database for capture may be desirable to offload the capture overhead and any other overhead from transformation or other processing from the production server.
- The production database version can be independent of the downstream database.

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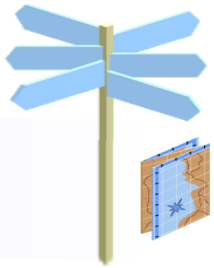
Agenda

- Oracle GoldenGate Architectures
- Classic Architecture
- Extracts
- Initial Loads
  - DB-Specific Methods
  - GoldenGate-Specific Methods
- Checkpoints



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Online Versus Batch Operation

- Capture and delivery can be run either *continuously* (online) or as a *special run* (batch run) to capture changes for a specific period of time.
- The initial load is always a *special run* (batch run).
- An initial load takes a copy of the entire source data set, transforms it if necessary, and applies it to the target tables so that the movement of transaction data begins from a synchronized state.

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You can use Oracle GoldenGate to perform a stand-alone batch load to populate database tables for migration or other purposes. The other method is to load data into database tables as part of an initial synchronization run in preparation for change synchronization with Oracle GoldenGate.

The initial load can be performed from an active source database. Users and applications can access and update data while the load is running. You can also perform an initial load from a quiesced (temporarily inactive) source database if you delay access to the source tables until the target load is completed.

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Running an Initial Load

Oracle GoldenGate can be used to load data in the following ways:

- **Direct load:** Extract sends data directly to Replicat to apply using SQL.
- **Direct bulk load:** Replicat uses the Oracle SQL*Loader API.
- **File to Replicat:** Extract writes to a file that Replicat applies using SQL.
- **File to database utility:** Extract writes to a file formatted for a DB bulk load utility.

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Oracle GoldenGate can be used to load data from the tables of the source database (rather than from the transaction logs) for an initial load. This feature is useful for relatively small tables and for initial loads in a heterogeneous environment. As an alternative, consider using other non-GoldenGate tools for larger databases or tables. For example, a DBA might consider cloning a source database by using the Recovery Manager (RMAN) duplicate features or by using the Oracle Data Pump utility.

The Extract process writes to a trail file and can optionally write to an ASCII, SQL, and XML file by using the `FormatASCII`, `FormatSQL`, and `FormatXML` Extract options, respectively. Do not use `FormatASCII`, `FormatSQL`, or `FormatXML` if the data will be processed by the Replicat process, because Replicat expects the default canonical format.

Note: For more information about Data Pump and the SQL*Loader utility, see the Oracle website:

http://www.oracle.com/technetwork/database/enterprise-edition/index-093639.html

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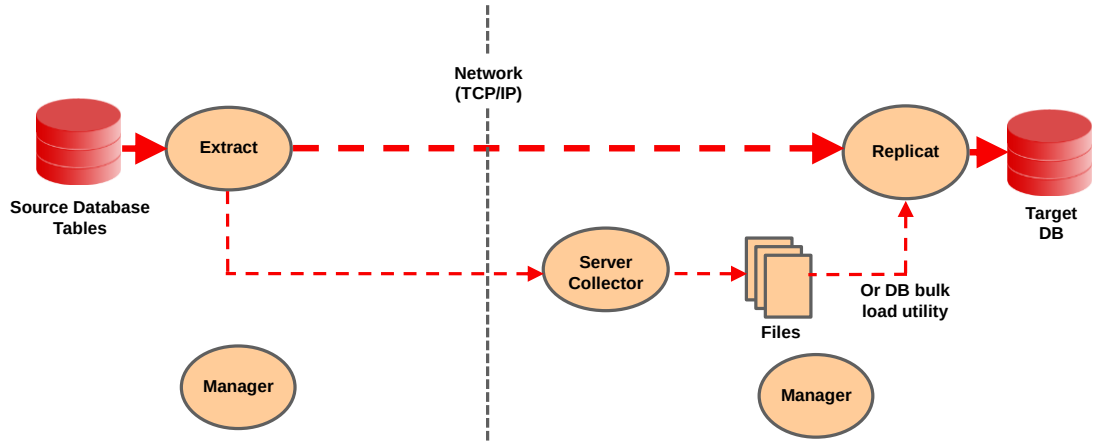
Initial Load Work Flow



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On the source system:

1. An Extract process captures source data directly from tables.
2. The Extract process sends data in large blocks across a TCP/IP network to the target system.

On the target system, one of the following scenarios may occur:

- **Direct load:** Replicat reads the data stream and concurrently applies the data to the target database by using SQL.
- **Direct bulk load (Oracle):** Replicat can apply the data by using the Oracle SQL*Loader API to improve performance.
- **File to Replicat:** Server Collector reassembles and writes the data to Extract files. Replicat applies the data to the target database by using SQL.
- **File to database utility:** Server Collector reassembles and writes the data to files formatted for a bulk loader, which applies the data to the target database.

Manager processes on both systems control activities such as starting, monitoring, and restarting processes; allocating data storage; and reporting errors and events.

This topic is covered in more detail in the lesson titled “Configuring Initial Load.”

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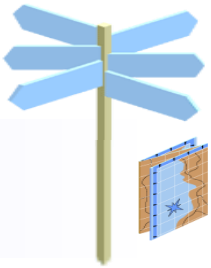
Agenda

- Oracle GoldenGate Architectures
- Classic Architecture
- Extracts
- Initial Loads
- Checkpoints
  - Capture
  - Pump
  - Delivery



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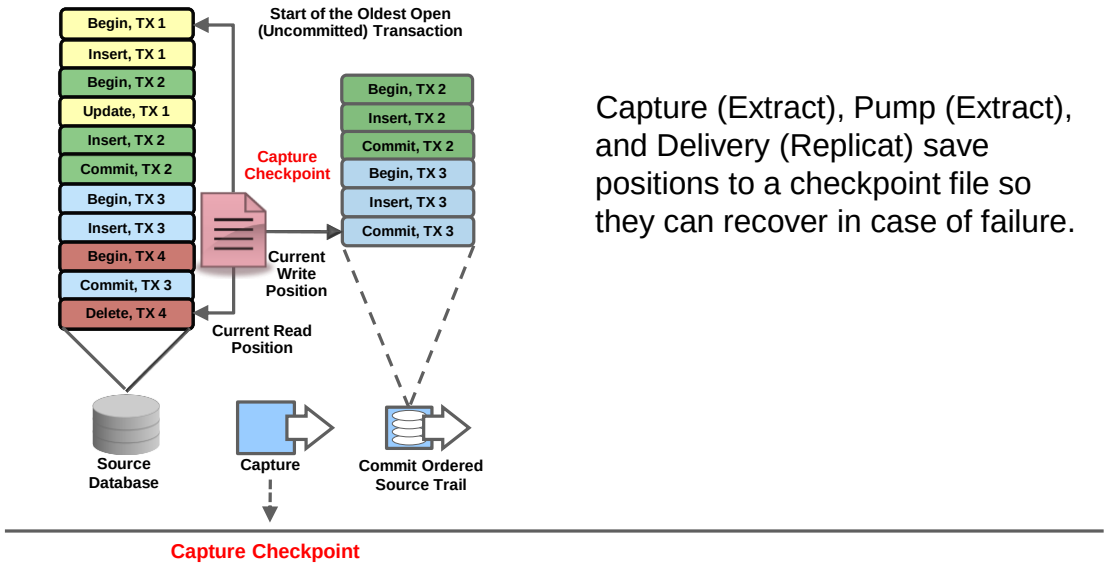
Checkpoints: Capture



Capture (Extract), Pump (Extract), and Delivery (Replicat) save positions to a checkpoint file so they can recover in case of failure.

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Checkpoints are used during online change synchronization to store the current read and write position of a process. Checkpoints ensure that data changes marked for synchronization are extracted, and they prevent redundant extractions. They provide fault tolerance by preventing the loss of data if the system, the network, or an Oracle GoldenGate process needs to be restarted. Capture (Extract), Pump (Extract), and Delivery (Replicat) save positions to a checkpoint file so they can be recovered in case of failure. Extract creates checkpoints for its positions in the data source and in the trail. Replicat creates checkpoints for its position in the trail.

Checkpoint information is maintained in checkpoint files in the `dirchk` subdirectory of the Oracle GoldenGate directory. **Note:** This is not to be confused with the optional checkpoint *table* stored on the database.

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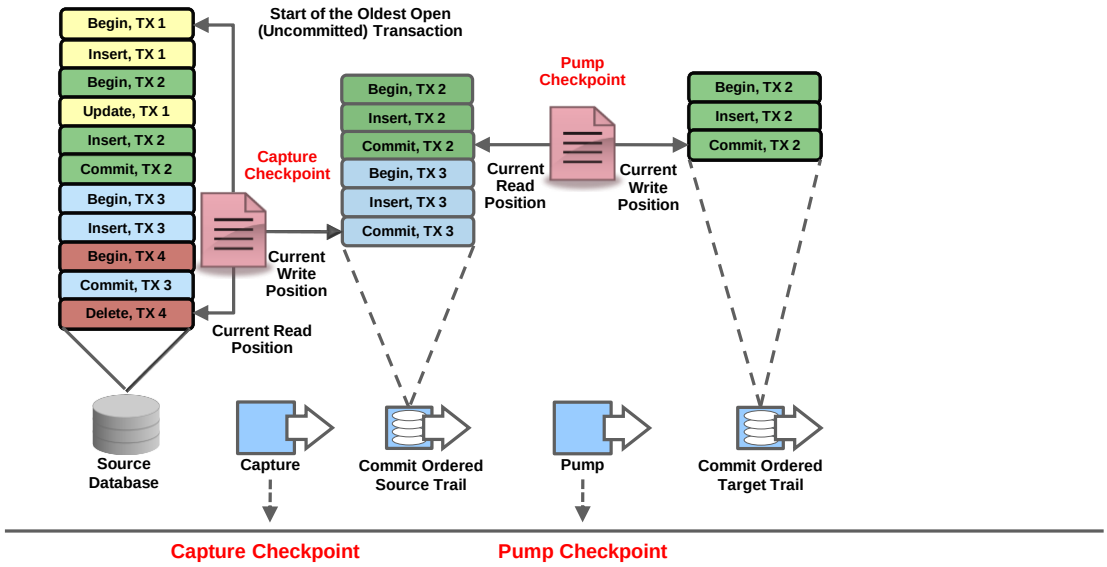
Checkpoints: Pump



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The optional pump checkpoint adds an extra layer of reliability.

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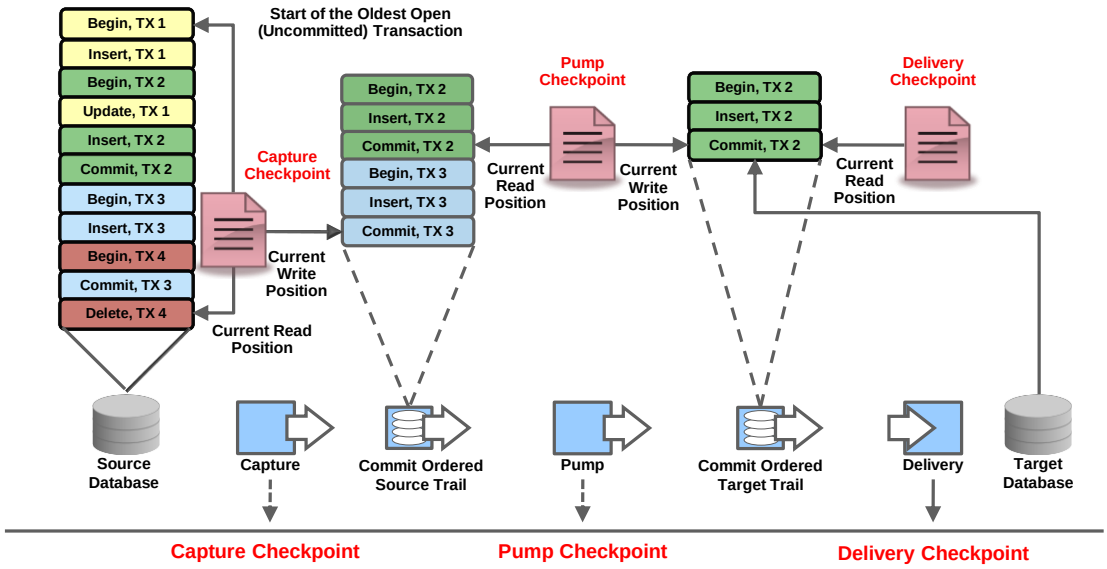
Checkpoints: Delivery



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Checkpoints help Oracle GoldenGate ensure that data is processed at the destination in the same order in which it was committed on the source. Checkpoints also prevent redundant extractions.

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Commit Sequence Number (CSN)

A CSN:

- Is an identifier that Oracle GoldenGate constructs to identify a source transaction
- Uniquely identifies a particular point in time

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A commit sequence number (CSN) is an identifier that Oracle GoldenGate constructs to identify a source transaction for the purpose of maintaining transactional consistency and data integrity.

It uniquely identifies a particular point in time at which a transaction commits to the database. Each kind of database management system generates some kind of unique serial number of its own at the completion of each transaction; this number uniquely identifies that transaction. A CSN captures this same identifying information and represents it internally as a series of bytes, but the CSN is processed in a platform-independent manner.

A comparison of any two CSN numbers, each of which is bound to a transaction-commit record in the same log stream, reliably indicates the order in which the two transactions are completed.

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Discussion Questions

1. How is using Oracle GoldenGate different from simply replicating database operations?
2. What is the purpose of checkpointing?

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1. Log-based change data capture, decoupled from database architecture; real-time, heterogeneous, and transactional
2. Recovery (if an Oracle GoldenGate process, network, or system goes down)

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Quiz

Which of the following statements is true?

a. Oracle GoldenGate checkpoints are stored in an Oracle control file.
b. The **`CKPT`** background process records the Oracle GoldenGate checkpoint.
c. The Oracle GoldenGate checkpoint supports Oracle GoldenGate recovery.
d. There is likely to be only one Oracle GoldenGate checkpoint file.

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Answer: c

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Summary

In this lesson, you should have learned to:

- Describe the two Oracle GoldenGate architectures
- Describe the Oracle GoldenGate Classic architecture
- Explain key terms related to Oracle GoldenGate
- Describe the interaction between Oracle GoldenGate and Oracle RDBMS

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Practice 2 Overview: Oracle GoldenGate Architecture

This practice covers designing a replication solution for a specific business need of a hypothetical company.

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3

Installing Oracle GoldenGate

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Objectives

After completing this lesson, you should be able to:

- Download the required Oracle GoldenGate installable
- Install Oracle GoldenGate Classic architecture on Linux
- Run Oracle GoldenGate commands from the Oracle GoldenGate Software Command Interface (GGSCI)
- Identify the types of GGSCI commands
- Use **`Obey`** files to automate tasks

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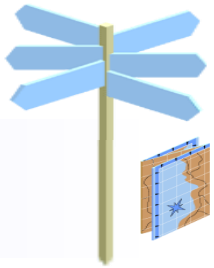
Agenda

- Pre-requisite tasks
  - Software System Requirements
  - Operating System Requirements
  - Download Steps
  - Setting Environment Variables
- Install
- GGSCI



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Software System Requirements

Software	OGG 11.1.1	OGG 11.2.1	OGG 12.1	OGG 12.2	OGG 12.3
RDBMS 11.1	Y	Y	Y		
RDBMS 11.2.0.4	Y	Y	Y	Y	Y
RDBMS 12.1			Y	Y	Y
RDBMS 12.2					Y

Operating system:

Many combinations are certified for database versions and operating systems. Check the documentation for certification requirements.

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Supported platforms for Oracle Databases:

- Oracle GoldenGate version 11.1 (and later) supports DML and DDL on Oracle Database 9.2 and later.

For the latest OS and DB Certification matrix, see:
http://www.oracle.com/technetwork/middleware/data-integration/goldengate-12-3-x-cert-matrix-3424388.xls

or, more generally (including back-level):
http://www.oracle.com/technetwork/middleware/ias/downloads/fusion-certification-100350.html

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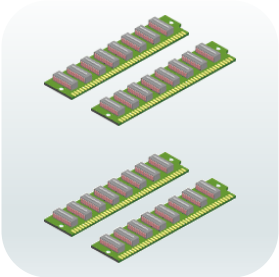
Operating System Requirements

- Memory requirements:
  - RAM required by Oracle GoldenGate depends on the number of concurrent processes running.
  - The amount of memory needed by Extract and Replicat processes varies greatly, from as little as 30 megabytes to as large as a few gigabytes.
  - Swap space must be sufficient for each Oracle GoldenGate Extract and Replicat process.
  - Also allow RAM for Database SGA if Oracle GoldenGate is installed on the same computer as the Oracle RDBMS.
- Disk requirements
- Network requirements



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Supported operating systems for OGG 12*c*:

- **Linux x86-64:** Oracle Linux 6 and 7, Red Hat Enterprise Linux 6 and 7, SUSE Linux Enterprise Server 11 and 12
- **Solaris x86-64:** Versions 10 and 11 – Oracle GoldenGate for Solaris x64 usually lags behind the port to SPARC. Check the supported configuration matrix.
- **SPARC 64-bit:** Versions 10 and 11
- **Windows x64:** Versions 2008 R2 and 2012

The amount of memory that is required for Oracle GoldenGate depends on the number of concurrent processes that are running. At minimum, there is a primary Extract process that captures source data, a secondary Extract data-pump process that transfers data across the network, and one or more Replicat processes that apply the replicated data to the target.

The Oracle GoldenGate GGSCI command interface fully supports up to 5,000 concurrent Extract and Replicat processes per instance of Oracle GoldenGate. An instance of Oracle GoldenGate equates to one Manager process, which is the main controller process. Each Extract and Replicat process needs approximately 25 MB to 55 MB of memory (or more) depending on the size of the transactions and the number of concurrent transactions. In extremely busy systems processing tens of thousands of transactions per second, is not uncommon to observe gigabytes of memory allocated to the Oracle GoldenGate processes.

By default, integrated capture Extract requires 1 GB `Max_SGA_Size` on Oracle Database in `Streams_Pool_Size` *per extract.* That can add up to a lot of memory when your replication relies on many Extract/Replicat processes.

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Operating System Requirements

- Memory requirements
- Disk requirements
  - The distribution kit for the Oracle GoldenGate Classic architecture requires approximately 330 megabytes, and the kit for the Microservices architecture requires approximately 450 megabytes; however, they can be erased after installation.
  - Classic architecture: Approximately 650 megabytes required for the software residing in **OGG_HOME**
  - Microservices architecture: 800 megabytes for the software residing in **OGG_HOME** plus approximately 300 megabytes for each deployment
  - Trail files: You can assign a separate disk for trail files. The default size is 500 MB each, but to optimize space, use the **PurgeOldExtracts** parameter. Allow for at least one gigabyte of disk space for the trail directory.
  - Disk space is also required for the Oracle GoldenGate Bounded Recovery feature. Bounded Recovery is a component of the general Extract checkpointing facility.
- Network requirements

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Assign the following free disk space:

- 2.0 gigabytes depending on the database and platform. This includes space for the compressed download file and space for the uncompressed files, for both Classic and Microservices architecture. You can delete the download file after the installation is complete. 650 megabytes for the working directories and binaries for each instance of Oracle GoldenGate that you are installing on the system (Classic architecture) and 700 megabytes for the software for the Microservices architecture. Each Microservices deployment will take approximately 300 megabytes of disk space.
  - For example, to install two builds of Oracle GoldenGate Classic in two separate directories, allocate 1.3 GB of space.
- Additional disk space on any system that hosts Oracle GoldenGate trails, which are files that contain the working data. The space that is consumed by the trails varies depending on the volume of data that will be processed. A good starting point is 1 GB.
- The bounded recovery mechanism caches long-running open transactions to disk at specific intervals to enable fast recovery upon a restart of Extract.

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Operating System Requirements

- Memory requirements
- Disk requirements
- Network requirements
  - Configure to use TCP/IP.
  - Configure one port for communication between the Manager process and other GoldenGate processes.
  - Configure a range of ports for local Oracle GoldenGate communications.

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For Network TCP/IP requirements:

- Configure the system to use TCP/IP, including DNS. IPv6 is supported by default.
- Configure the network with the host names or IP addresses of all systems that will be hosting Oracle GoldenGate processes and to which Oracle GoldenGate will be connecting. Host names are easier to use.
- Oracle GoldenGate requires the following unreserved and unrestricted TCP/IP ports:
  - One port for communication between the Manager process and other Oracle GoldenGate processes
  - A range of ports for local Oracle GoldenGate communications. This can be the default range starting at port 7840 or a customized range of up to 256 other ports.

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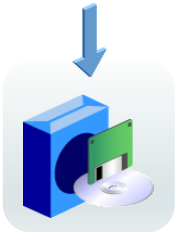
Downloading Oracle GoldenGate

1. Go to Oracle Technology Network:
   http://www.oracle.com/technetwork/middleware/goldengate/downloads/index.html
   Find the Oracle GoldenGate 12*c* (12.x) release that you want to install.
2. Download the appropriate ZIP file for your system.



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Older versions of Oracle GoldenGate are available for older versions of Oracle Database and non-Oracle databases. GoldenGate can also be downloaded from http://edelivery.oracle.com.

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Setting Environment Variables

The following environment variables must be set to point to the correct Oracle RDBMS instance:

- **ORACLE_HOME**
- **ORACLE_SID**
  - The Oracle GoldenGate processes refer to those variables when connecting to the database.

The environment variable **OGG_HOME** must be set when installing the Oracle GoldenGate Microservices architecture, but it is not mandatory for a Classic architecture.

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Optionally, it is helpful to define the `$OGG_HOME` environment variable and place it in `.profile` or `.bashrc` for each session.

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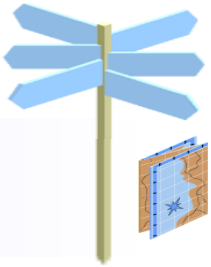
Agenda

- Pre-requisite tasks
- Install
  - Linux
  - OUI (GUI)
  - Windows
  - Directories
- GGSCI



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Installation on UNIX, Linux, or z/OS Systems

1. Extract the OGG **.zip** file to **/tmp** or any other suitable directory.
2. Run the Oracle Universal Installer:

```
[OS prompt] unzip 123012_fbo_ggs_* /tmp
[OS prompt] cd /tmp/fbo_ggs_Linux_x64_shiphome/Disk1
[OS prompt] ./runInstaller
```

3. From the Oracle GoldenGate **OGG_HOME** directory, run the GGSCI program.

```
[OS prompt] cd $OGG_HOME
[OS prompt] ./ggsci
Oracle GoldenGate Command Interpreter for Oracle
Version 12.3.0.1.2 OGGCORE_12.3.0.1.0_PLATFORMS_171208.0005_FBO
Linux, x64, 64bit (optimized), Oracle 12c on Dec  9 2017 00:51:03
Operating system character set identified as UTF-8.
Copyright (C) 1995, 2017, Oracle and/or its affiliates. All rights reserved.
GGSCI (host) 1> Help
```

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To install Oracle GoldenGate, use the `gzip` and `tar` options that are appropriate for your operating system. If you are installing Oracle GoldenGate into a cluster environment, make sure that the Oracle GoldenGate binaries and files are installed on a file system that is available to all cluster nodes.

After installing Oracle GoldenGate, configure the Oracle GoldenGate Manager process within the cluster application (as directed by the vendor's documentation) so that Oracle GoldenGate will fail over properly with the other applications. The Manager process is the master control program for all Oracle GoldenGate operations. An Oracle GoldenGate instance is a single installation of Oracle GoldenGate.

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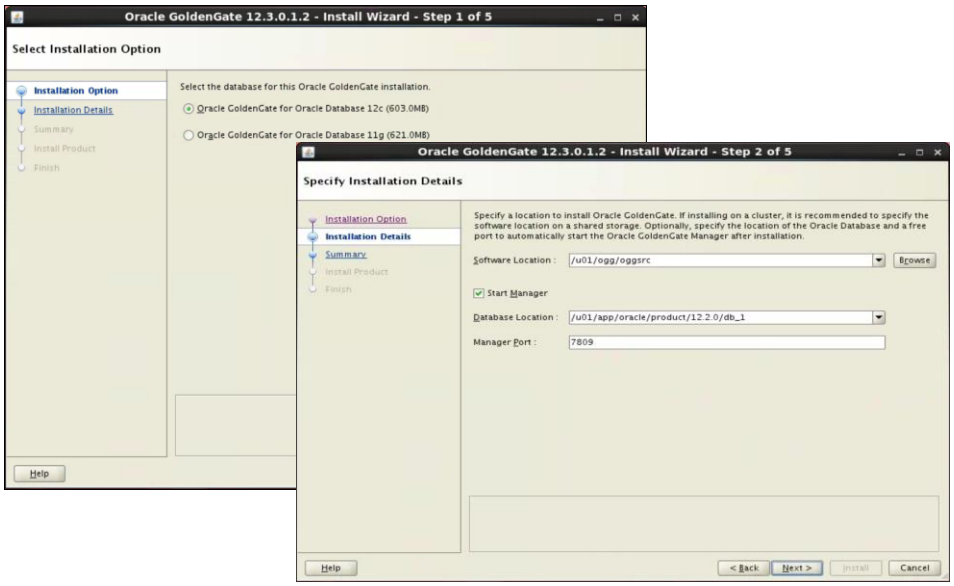
Oracle Universal Installer GUI



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The primary advantage of using Oracle Universal Installer (OUI) is that it registers Oracle GoldenGate with `oraInventory` for later audit purposes.

If you set up the `OGG_HOME` environment variable at a shell level, the installer will pre-fill the "Software Location" field with the directory pointed to by `OGG_HOME`.

Although it is helpful for the Install Wizard to offer to start the Manager, you will probably need to modify the Manager parameter files anyway, and that requires stopping and restarting the Manager. Therefore, there is no reason to start the Manager here, and then have to stop and restart it immediately after the Install Wizard ends. You will need not just one port but a range of ports.

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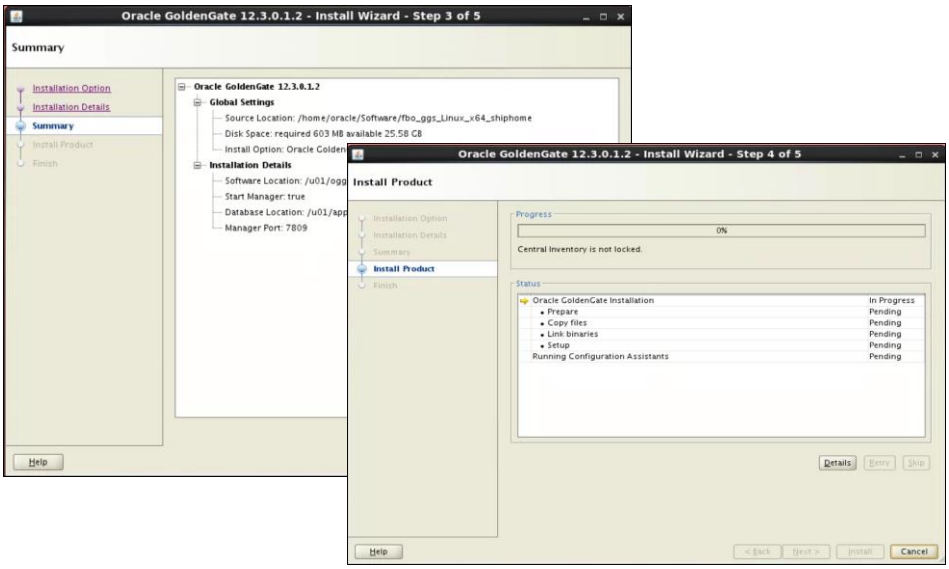
Oracle Universal Installer GUI



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In Step 3 (Summary), you can create and save a response file for making repeated silent installations. The final installation step runs the `Create Subdirs` GGSCI command.

`runInstaller` does not give you the chance to modify, upgrade, or remove any code. The installer is not directly suited for RAC or cluster installation. There are several Tech notes in *My Oracle Support* Knowledge Base (https://support.oracle.com/) on how to do that manually.

The installer creates `$OGG_HOME/deinstall/deinstall.sh` for removing the code and inventory entries. The deinstaller runs in text (not GUI) mode.

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Installation on Windows Systems

- By default, Manager is not installed as a service and can be run by a local or domain account.
  - However, when run this way, Manager will stop when the user logs out.
- When you install Manager as a service, you can operate it independently of user connections, and you can configure it to start manually or at system startup.
- Installing Manager as a service is required on a Windows Cluster, but optional otherwise.
- Run the command shell and change to the new Oracle GoldenGate directory. Use the install utility to `install` Manager as a Windows service. For example:

```
C:\OGG>  Install AddService AddEvents
```

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Do not install Oracle GoldenGate into a folder that contains spaces in its name (for example, “GoldenGate Software”). The application references path names, and the operating system does not support path names that contain spaces, whether they are within quotation marks or not.

The `INSTALL ADDSERVICE ADDEVENTS` command will install event messages into the Windows system registry and will install a Windows Service. Oracle GoldenGate needs only one Manager on each node, but you can install multiple Managers. For example, you can install a "Test" Manager and a "Production" Manager. Multiple Manager processes require multiple installations and unique Windows service names. You may want to create a Windows service for the Manager; otherwise, if the user logs outs, the Manager process stops. You may also want to delete a service. To delete a service, enter `INSTALL DELETESERVICE DELETEEVENTS`.

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Oracle GoldenGate Directories

Directory	Contents
dirchk	Oracle GoldenGate checkpoint files
dircrd	* Credential Store for users and passwords
dirdat	Oracle GoldenGate trail and Extract files
dirdef	Column definitions produced by **defgen** to translate heterogeneous data
dirjar	Java executables to support OGG Monitor and other services
dirpcs	Process status files
dirprm	Parameter files
dirrpt	Process report files
dirsql	SQL scripts
dirtmp	Temp storage for transactions that exceed allocated memory
dirwlt	* Wallet for masterkey; works with `dircrd`
dirwww	* Web artifacts for Monitoring

A few other directories are not shown. * New with 12*c*

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Some key directories:

- **dirchk:** Contains the checkpoint files created by Extract and Replicat processes, which store current read and write positions to support data accuracy and fault tolerance. These files are written in internal Oracle GoldenGate format and should not be modified. The file name format is *<group_name><sequence_number>.<ext>*, where *<sequence_number>* is a sequential number appended to aged files and *<ext>* is either `cpe` for Extract checkpoint files or `cpr` for Replicat checkpoint files. Examples include `ext1.cpe` and `rep1.cpr`.
- **dircrd:** The default credential store location for encrypted user IDs and passwords. You can change this location.
- **dirdat:** The default location for Oracle GoldenGate trail files and Extract files created by Extract processes to store records of extracted data for further processing, either by the Replicat process or another application or utility. `dirdat` is written in internal GoldenGate format and should not be modified.

  The file name format is a user-defined two-character prefix followed by either a six-digit sequence number (used by trail files; for example, `rt000001`) or the user-defined name of the associated Extract process group (used by extract files; for example, `finance`).
- Other directories include diretc, healthcheck, srvm, diagnostics, crypto, and logging.

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- **dirdef:** The default location for data definition files created by the `defgen` utility to contain source or target data definitions used in a heterogeneous synchronization environment. These files are written in plain text ASCII format.

  The file name format is a user-defined name specified in the `defgen` parameter file (for example, `defs.dat`). These files can be edited to add definitions for newly created tables. If you are unsure how to edit a definitions file, contact technical support.
- **dirjar:** Contains the Java executable files that support Oracle GoldenGate Monitor
- **dirpcs:** The default location for status files. The file name format is `<group>.<ext>`, where `<group>` is the name of the group and `<ext>` is an extension of `pce` (Extract), `pcr` (Replicat), or `pcm` (Manager).

  These files are created only while a process is running. The file shows the program name, the process name, the port, and process ID that is running. Do not edit these files. Examples include `mgr.pcm` and `ext.pce`.
- **dirprm:** The default location for Oracle GoldenGate parameter files created by Oracle GoldenGate users to store run-time parameters for Oracle GoldenGate process groups or utilities. These files are written in plain text ASCII format.

  The file name format is `<group_name/user-defined_name>.prm` or `mgr.prm`. These files can be edited to change Oracle GoldenGate parameter values. They can be edited directly from a text editor, such as `gedit` or Notepad, or by using the `EDIT PARAMS` command in GGSCI. Examples include `defgen.prm` and `finance.prm`.
- **dirrpt:** The default location for process report files created by Extract, Replicat, and Manager processes to report statistical information about a processing run. These files are written in plain text ASCII format.

  The file name format is `<group_name><seq_num>.rpt`, where `<seq_num>` is a sequential number appended to aged files. Do not edit these files. Examples include `fin2.rpt` and `mgr4.rpt`.
- **dirsql:** The default location for SQL scripts
- **dirtmp:** The default location for storing large transactions when the size exceeds the allocated memory size. Do not edit these files.
- **dirwlt:** The default Oracle Wallet location for the masterkey; you can change this location. Existing GUI Wallet utilities that come with other products, such as the Oracle Database "Oracle Wallet Manager" (`owm`), do not work on this version of the Wallet.
- **dirwww:** Artifacts for Oracle Monitoring software; separately licensed
- **jagent** and **jdk:** Used for Java bits of the Monitor facility

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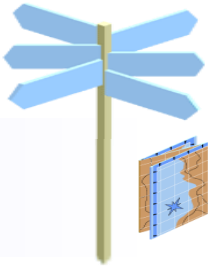
Agenda

- Pre-requisite tasks
- Install
- GGSCI
  - Keyboard
  - `Obey` files
  - New commands



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GGSCI Command Interface

- GGSCI is the command interface that executes Oracle GoldenGate commands.
- Start GGSCI from the Oracle GoldenGate installation directory:

```
[OS prompt] cd <GoldenGate_install_location>
[OS prompt] ./ggsci
```

- For the help Summary page:

```
GGSCI> Help
```

- For help on a specific command:

```
GGSCI> Help <command> <object>
GGSCI> Help Add Extract
```

- To re-execute a command:

```
GGSCI> !
```

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The Golden Gate Software Command Interface (GGSCI) provides online help for all commands. The following is an example of the information that is returned when you enter `HELP Status Extract`. Use `Status Extract` to determine whether or not Extract groups are running.

Syntax

```
Status Extract <group_name>
[, Tasks]
[, AllProcesses]
```

- *<group_name>* is the name of a group or a wildcard (`*`) to specify multiple groups.
- `AllProcesses` displays the status of all Extract processes, including tasks.
- `Tasks` displays the status of all Extract tasks.

Examples

- `Status Extract finance`
- `Status Extract fin*`

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GGSCI Commands

	Manager	Extract	Replicat	ER	ExtTrail	RmtTrail	TranData	Checkpoint Table	Trace Table
Add		X	X		X	X	X	X	X
Alter		X	X		X	X			
Cleanup		X	X					X	
Delete		X	X	X	X	X	X	X	X
Info	X	X	X	X	X	X	X	X	X
Kill		X	X	X					
Lag		X	X	X					
Refresh	X								
Send	X	X	X	X					
Start	X	X	X	X					
Stats		X	X	X					
Status	X	X	X	X					
Stop	X	X	X	X					

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Objects

- **`Manager`, `Extract`, `Replicat`:** Oracle GoldenGate processes
- **`ER`:** Multiple Extract and Replicat processes
- **`ExtTrail`:** Local Extract trail
- **`RmtTrail`:** Remote trail
- **`TranData`:** Enables supplemental logging of primary keys and/or indexes for a schema or table in the transaction logs. Also, use `SchemaTranData` for all the present and future tables in a schema.
- **`CheckpointTable`:** Checkpoint table (on target database)
- **`TraceTable`:** Oracle trace table (on target database)

Commands

- **`Add`:** Creates an object or enables `TranData` or `SchemaTranData` capture
- **`Alter`:** Changes the attributes of an object
- **`Cleanup`:** Deletes the run history of a process or removes records from a checkpoint table

The examples in the slides are a subset of commands. There are other commands such as 'create' and other components such as 'wallet', 'credentialstore' and 'heartbeatable table'.

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- **`Delete`:** Deletes an object or disables `TranData` or `SchemaTranData` capture
- **`Info`:** Displays information about an object (status, and so on)
- **`Kill`:** Forces a process to stop (no restart)
- **`Lag`:** Displays the lag between when a record is processed by the process and the source record time stamp
- **`Refresh`:** Refreshes Manager parameters (except port number) without stopping Manager
- **`Send`:** Sends commands to a running process
- **`Start`:** Starts a process
- **`Stats`:** Displays statistics for one or more processes
- **`Status`:** Indicates whether a process is running
- **`Stop`:** Stops a process gracefully

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GGSCI Commands

	Commands
Parameters	`Set Editor`, `Edit Params`, `View Params`
Database	`DBLogin`, `MiningDBLogin`, `Encrypt Password`, `List Tables`
DDL	`DumpDDL [SHOW]`
Miscellaneous	`!command`, `Create Subdirs`, `FC`, `Help`, `History`, `Info All`, `Obey`, `Shell`, `Show`, `Versions`, `View GGSevt`, `View Report`

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Parameter Commands

- **`Set Editor`:** Changes the default text editor for the current GGSCI session from Notepad (Windows) or `vi` (Linux) to any ASCII editor
- **`Edit Params`:** Edits a parameter file with an implied extension of `.prm`
- **`View Params`:** Displays the contents of a parameter file with an implied extension of `.prm`

Database Commands

- **`DBLogin`** and **`MiningDBLogin`:** Establish a database connection through GGSCI to a local or remote database
- **`Encrypt Password`**: Encrypts a database login password in a parameter file
- **`List Tables`:** Lists all tables in the database that match a wildcard string (asterisks and question marks)

DDL Commands

- **`DumpDDL`:** Saves the Oracle GoldenGate DDL history table to file
- **`Show`:** Displays the DDL information in standard output format

Miscellaneous Commands

- **`!`*`command`*:** Executes a previous GGSCI command without modification
- **`Create Subdirs`:** Creates default directories within the Oracle GoldenGate home directory
- **`FC`:** Edits a previously issued GGSCI command
- **`Help`:** Displays information about a GGSCI command
- **`History`:** Lists the most recent GGSCI commands issued
- **`Info All`:** Displays the status and lag for all Oracle GoldenGate online processes on a system (`Info All AllProcesses` also displays tasks.)
- **`Obey`:** Runs a file containing a list of GGSCI commands
- **`Shell`:** Runs shell commands from within GGSCI
- **`Show`:** Displays the Oracle GoldenGate environment
- **`Versions`:** Displays OS and database versions
- **`View GGSEvt`:** Displays the Oracle GoldenGate event/error log
- **`View Report`:** Displays a process report for Extract or Replicat

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GGSCI Examples

- Start a Manager process:

```
GGSCI> Start Mgr
```

- Add an Extract group:

```
GGSCI> Add Extract myext, Integrated TranLog, Begin Now
```

- Add a local trail:

```
GGSCI> Add ExtTrail /ggs/dirdat/lt, Extract myext
```

- Start an Extract group:

```
GGSCI> Start Extract myext
```

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In this example, a primary extract named `myext` extracts database changes from the transaction logs starting with records generated at the time the group was created. The changes will be written to a local trail (`lt`). The extract is then started. When an extract is started, it creates a new trail file rather than appending to an existing trail file.

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Obey Files

- **Obey** files are used to automate a series of frequently used GGSCI commands.
- Create and save a text file that contains the commands, with one command per line:
  [OS prompt] **more myscript.oby**

```
Start Mgr
Add Extract myext, Integrated TranLog, Begin Now
Add ExtTrail ./dirdat/lt, Extract myext
Start Extract myext
```

- Then use the GGSCI **Obey** command to run the file:

```
GGSCI> Obey myscript.oby
```

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`Obey` can also appear in an Extract or Replicat parameter file for nesting other parameters. For nesting parameters, the file extension is `.prm` rather than `.oby`. The `Obey` command does not look for a specific file extension. If a file extension is part of the name, it must be used as in the following example:

```
GGSCI> Obey myfilename.oby
```

The `AllowNested` command enables the use of nested `Obey` files. A nested `Obey` file contains another `Obey` file. An attempt to run a nested `Obey` file in the default mode of `NoAllowNested` causes an error. The maximum number of nested files is 16 levels deep.

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Running Oracle GoldenGate from the OS Shell

- You can also start Oracle GoldenGate processes from the OS command shell when running a batch job or initial load, as in the following example:

```
Shell> cd <GoldenGate_install_location>
Shell> ./extract paramfile <filepath> reportfile
       <filepath> [-p <port>]
Shell> ./replicat paramfile <filepath> reportfile
       <filepath>
```

- This is especially useful in scheduling Oracle GoldenGate batch jobs to run during off-peak hours using a command-line capable scheduler.

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Manager must be running when you issue the following commands:

- *<filepath>* specifies the fully qualified name of the parameter and report files.
- `paramfile` can be abbreviated to `pf`.
- `reportfile` can be abbreviated to `rf`.

When you run Extract and Replicat from the command line, you do not get any feedback to `stdout`; you must look in `reportfile` to see the results.

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Discussion Questions

1. Where can you find the Oracle GoldenGate software for downloading?
2. What is GGSCI?
3. Where can you view Oracle GoldenGate command syntax?
4. What is an **`Obey`** file? Why would you use it?

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GoldenGate Commands: Discussion Points

1. OTN
2. Oracle GoldenGate Software Command Interface, which is a text-based prompt
3. In the help or in the *Reference Guide* (online or downloaded)
4. An ASCII text file containing a sequence of Oracle GoldenGate commands or parameters. You use it for easy reuse of common command sequences (similar to a script).

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Summary

In this lesson, you should have learned how to:

- Download the required Oracle GoldenGate installable
- Install Oracle GoldenGate Classic architecture on Linux
- Run Oracle GoldenGate commands from the Oracle GoldenGate Software Command Interface (GGSCI)
- Identify the types of GGSCI commands
- Use **`Obey`** files to automate tasks

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Practice 3 Overview: Installing Oracle GoldenGate

This practice covers the following topics:

- Installing Oracle GoldenGate Classic architecture
- Using the GGSCI command-line interface
- Writing and running an **`OBEY`** file

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4

Preparing the Environment and Configuring Integrated Extract

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Objectives

After completing this lesson, you should be able to:

- Describe the high-level configuration steps for Oracle GoldenGate
- Prepare the environment for configuration
- Configure data capture

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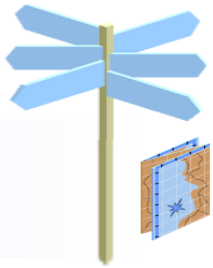
Agenda

- Configuration Overview
- Preparing the Environment
  - Enabling Oracle GoldenGate in the Database
  - Enabling Supplemental Logging
  - Defining Roles and Permissions
  - Starting the Manager
- Configuring Data Capture



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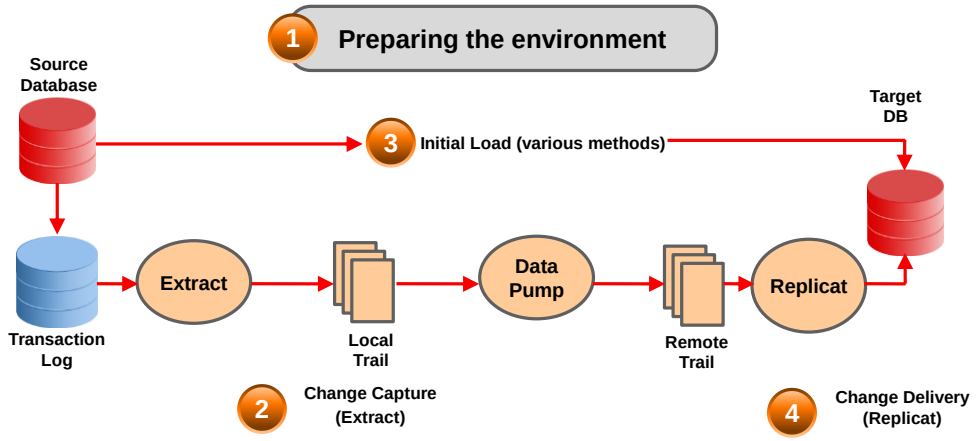
Configuring Oracle GoldenGate: Overview



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Oracle GoldenGate can be deployed quickly and easily in four steps. This lesson covers the first two steps; the remaining steps are covered in subsequent lessons.

1. Prepare the environment.
   - Install the Oracle GoldenGate software on source and target.
   - Set up a GoldenGate database user.
   - Enable supplemental logging.
   - For a heterogeneous source and/or target, generate source definitions so Replicat can process trail data.
2. Configure and start change capture to GoldenGate trail files (Extract processes: primary and data pump).
3. Perform initial load to synchronize databases by database-specific or Oracle GoldenGate methods. The timing of the initial load can happen at several places: before or after Step 2. If you have an initially empty table, the initial load step can be skipped altogether.
4. Configure and start change delivery (Replicat process).

For the purposes of teaching, these steps are presented in a different order.

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Configuring Oracle GoldenGate

Oracle GoldenGate can be deployed in four steps:

1. Preparing the environment:
   a) Decide NLS and mixed-case object name issues.
   b) Set up a database user to access Oracle GoldenGate.
   c) Enable supplemental logging.
   d) Start the Manager process.
   e) If you are using a heterogeneous source and/or target, create source definitions.
2. Change capture (Extract)
3. Initial load
4. Change delivery (Replicat)

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The installation of Oracle GoldenGate includes all of the components required to run and manage Oracle GoldenGate processing and Oracle GoldenGate utilities. The Manager process must be running on each system before Extract or Replicat can be started, and must remain running while those processes are running so that resource management functions are performed.

The source definitions file contains the definitions of the source tables and is required on the target system in heterogeneous configurations. Replicat refers to the file when transforming data from the source to the target.

To reconstruct an update operation, Oracle GoldenGate needs more information than the transaction logs provide by default. Adding supplemental log data forces the log writer to also include the primary keys to logs instead of just the columns that have changed.

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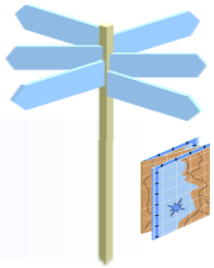
Agenda

- Configuration Overview
- Preparing the Environment
  - Enabling Oracle GoldenGate in the Database
  - Enabling Supplemental Logging
  - Defining Roles and Permissions
  - Starting the Manager
- Configuring Data Capture



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Step 1: Preparing the Environment
Enabling Oracle GoldenGate in the Database

```
ENABLE_GOLDENGATE_REPLICATION=true
```

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You set the `ENABLE_GOLDENGATE_REPLICATION` initialization parameter to `TRUE` to allow Oracle GoldenGate to use RDBMS services. This parameter controls the supplemental logging feature that is required to support data replication.

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Preparing the Environment
Enabling Supplemental Logging

You can set supplemental logging in three levels:

- Database level

```
SQL> ALTER DATABASE ADD SUPPLEMENTAL LOG DATA;
SQL> ALTER DATABASE FORCE LOGGING;
```

- Schema level

```
GGSCI> ADD SCHEMATRANDATA schema [ALLCOLS|NOSCHEDULINGCOLS]
```

- Table level

```
GGSCI> ADD TRANDATA [container.]schema.table[ALLCOLS|NOSCHEDULINGCOLS]
```

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Oracle GoldenGate uses the Oracle Database redo logs to replicate the data. By default, the redo logs contain only those column values that change. The redo logs don't contain all the data that is required to convert the logged changes to SQL statements. When you enable supplemental logging, you allow the database to add extra information to the log files. This information enables the logged changes to be converted to SQL statements without having to fetch more information from the database for each change.

Oracle recommends setting your source Oracle Database to forced logging mode. This ensures that no data in the source Extract configuration is missed.

In addition, you set one of the following three logging levels when using Oracle GoldenGate:

- **Database-level supplemental logging:** Enables logging to add row-chaining information to the redo logs. You can verify the current values in the Oracle Database for forced logging and database-level logging by issuing the following SQL command:

  ```
  SQL> SELECT supplemental_log_data_min, force_logging FROM
  v$database;
  ```

- **Schema-level supplemental logging:** Enables logging to add primary key and optionally unique keys and foreign keys of all tables in a schema
- **Table-level supplemental logging:** Enables logging to add primary key and optionally unique keys and foreign keys of a table

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Consider a schema named `myschema` with tables `A`, `B`, and `C`, and run the following command:

```
GGSCI> Add TranData myschema.*
```

The result is that it adds the transaction data of the three tables. Later, you create another table `myschema.D`, but now that table is not added to the `TranData` list because `Add` has already happened and the wildcard was already resolved.

Alternatively, suppose that you have another schema named `yourschema` and it has tables `E`, `F`, and, `G`. You run the following command:

```
GGSCI> Add SchemaTranData yourschema
```

It adds the three tables just like `Trandata` would. Later, you create another table `myschema.H`, and that table and all future tables for `yourschema` are automatically added to the `TranData` list.

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Preparing the Environment
Defining Roles and Permissions

User Privilege	Extract (Source)	Replicate (Target)
CREATE SESSION, ALTER SESSION	x	x
RESOURCE	x	x
CONNECT	x	x
ALTER ANY TABLE	x	
ALTER SYSTEM	x	
DBA	x	x
INSERT, UPDATE, DELETE ON *<target tables>*		x
LOCK ANY TABLE		x
SELECT ANY TRANSACTION	x	

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Database Access

Although not required, Oracle GoldenGate recommends creating a user specifically for the Oracle GoldenGate application, with all of the privileges listed in the slide. To ensure that processing can be monitored accurately, do not permit other users or processes to operate as the Oracle GoldenGate user.

In general, the following permissions are necessary for the Oracle GoldenGate user:

- On the source system, the user must have permissions to read the data dictionary or catalog tables.
- On the source system, the user must have permissions to select data against the tables.
- On the target system, the user must have the same permissions as the Oracle GoldenGate user on the source system plus additional privileges to perform DML on the target tables.

In addition, execute the following command in SQL*Plus as `SYSDBA`:

```
EXEC DBMS_GOLDENGATE_AUTH.GRANT_ADMIN_PRIVILEGE('GGUSER');
```

In this syntax, *`GGUSER`* is the database user ID that is used in GGSCI `DBLogin` commands. You can grant fewer privileges, but the default is both capture and apply, Integrated, and Classic.

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Preparing the Environment
Starting the Manager

To configure and start the manager:

- Create the parameter file by using GGSCI commands:

```
GGSCI> Edit Params Mgr
```

- Start the Manager by using GGSCI:

```
GGSCI> Start Manager
```

- Determine which port the Manager is using:

```
GGSCI> Info Mgr
```

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Manager is a controller process that must be running on each system before Extract or Replicat can be started. The Manager provides a command-line interface to perform a variety of tasks:

- Starting, stopping, and monitoring Oracle GoldenGate processes
- Setting the parameters that configure Oracle GoldenGate processes
- Error and lag reporting
- Resource management
- Trail file management

You must start the Manager before most other configuration tasks are performed in GGSCI. GGSCI commands and parameter keywords are not case-sensitive. Putting `Start Mgr` (and some other useful commands) in a `startup.oby` file is a good practice.

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Preparing the Environment: Sample Manager Parameter File

```
-- Created by Joe Admin on 10/11/2013
Port 7809
DynamicPortList 8001, 8002, 9500-9520

PurgeOldExtracts /ggs/dirdat/aa*, UseCheckpoints
PurgeOldExtracts /ggs/dirdat/bb*, UseCheckpoints, &
  MinKeepDays 5

Autostart ER *
AutoRestart Extract *, WaitMinutes 2, Retries 5

LagReportHours 1
LagInfoMinutes 3
LagCriticalMinutes 5
```

Comment

Line continuation character

ER = Extract and Replicat

Wildcard names

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You enter the Manager parameters in the `dirprm/mgr.prm` file in the Oracle GoldenGate installation directory. A `mgr.prm` file must exist; otherwise, you get an error when you try to start the Manager. A `mgr.prm` file is created by Oracle Universal Installer (OUI). On a multi-host environment, it is recommended that you make all Manager ports unique; on a single host environment, it is *required* that you make all Manager ports unique.

Manager reports critical and informational events to the `ggserr.log` file in the Oracle GoldenGate installation directory.

The sample parameter file shown in the slide has the Manager listening on port 7809. Ports 8001 and 8002, and those ports in the range 9500 through 9520, will be assigned to the dynamic processes started by the Manager. It is not smart enough to test or skip busy ports.

The Manager process will also recycle Oracle GoldenGate trails that match the file name of `/ggs/dirdat/aa*` and `/ggs/dirdat/bb*`. The Manager process can be configured to delete trail files after all processing by any Extracts and Replicats has completed (which is determined by the `UseCheckpoints` option). However, `bb*` trails will not be purged until there has been no activity for five days.

The Manager will automatically start any Extract and Replicat process at startup and will attempt to restart any Extract process that ABENDs after waiting two minutes, but only up to five attempts.

The Manager will report lag information every hour, but only for processes that have three and five minutes of latency. The message will be flagged *informational* for lags of three minutes and *critical* for any process that has a lag greater than five minutes. Oracle GoldenGate Monitor can be set to watch for lag values that exceed any user-specified threshold, and then to send either an email to a group of users and/or an SNMP trap to a target.

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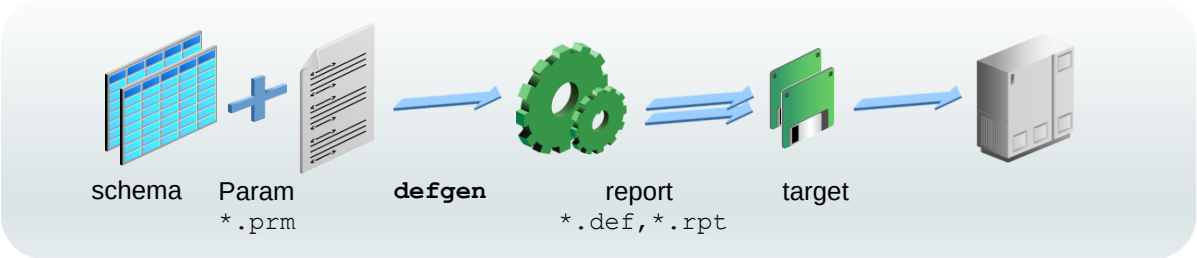
Preparing the Environment
Generating a Source Definitions File

- **defgen** is initiated from the command prompt:

```
defgen paramfile <paramfile> [ reportfile <reportfile> ]
```

- Definitions are saved to the file that is specified in the parameter file. This file must be transferred to the target system as a text file.



Since the introduction of database metadata information in the trail files (OGG 12.2), the need to run the **defgen** utility has been significantly reduced.

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When capturing, transforming, and delivering data across disparate systems and databases, Oracle GoldenGate must understand both the source and target layouts. Understanding column names and data types is instrumental to Oracle GoldenGate's data synchronization functions.

You use the `defgen` utility program to produce a file containing a definition of the layouts of the source files and tables. The output definitions are saved in an edit file and transferred to all target systems in text format. Replicat and Collector read the definitions at process startup and use the information to interpret the data from Oracle GoldenGate trails.

When transformation services are required on the source system, Extract can use a definition file containing the target layouts rather than source layouts.

Note: The user should never modify the `defgen` output.

Character Set Configuration (Optional)

Use the `CharSet` parameter to generate the definitions file in the specified character set:

```
DefsFile ./dirdef/source.def, Purge, CharSet UTF-8
```

Add the `UpdateCS` option:

```
defgen ./dirdef/source.def UpdateCS ISO-8859-1
```

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Sample `defgen` Output

```
*+- Defgen version 2.0, Encoding UTF-8
*
* Definitions created/modified  2013-04-13 11:36
*
*  Field descriptions for each column entry:
*
*     1    Name
*     2    Data Type
*     3    External Length
*     4    Fetch Offset
*     5    Scale
*     6    Level
*     7    Null
*     8    Bump if Odd
*     9    Internal Length
*    10    Binary Length
*    11    Table Length
*    12    Most Significant DT
*    13    Least Significant DT
*    14    High Precision
*    15    Low Precision
*    16    Elementary Item
*    17    Occurs
*    18    Key Column
*    19    Sub Data Type
*
Database type: ORACLE
Character set ID: UTF-8
National character set ID: UTF-16
Locale: neutral
Case sensitivity: 14 14 14 14 14 14 14 14 14 14 14 14 11 14 14 14
*
Definition for table WEST.ACCOUNT
Record length: 58
Syskey: 0
Columns: 2
ACCOUNT_NUMBER   134     11        0  0  0 1 0      8      8      8 0 0 0 0
1    0 1 3
ACCOUNT_BALANCE   64     40       12  2  0 1 0     40     40     40 0 0 0 0
1    0 0 3
End of definition
*
Definition for table WEST.BRANCH
Record length: 24
Syskey: 0
Columns: 2
BRANCH_NUMBER  134     11        0  0  0 1 0      8      8      8 0 0 0 0 1
0 1 3
BRANCH_ZIP     134      8       12  0  0 1 0      8      8      8 0 0 0 0 1
0 0 3
End of definition
```

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Quiz

`Add TranData` enables supplemental logging of key values in the transaction logs whenever a row change occurs.

a. True

b. False

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Answer: a

If you need additional columns replicated other than just the key columns, you can specify them by using the `Cols` attribute.

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Quiz

Users of both Extract and Replicat require the DBA role for the database.

a. True

b. False

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Answer: b

Although the DBA role will certainly work for Extract and Replicat, you do not require quite that much privilege.

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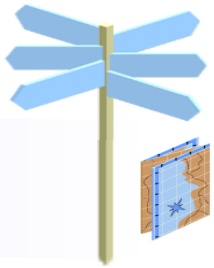
Agenda

- Configuration Overview
- Preparing the Environment
- Configuring Data Capture
  - Extract Overview
  - Configuring Extract
  - Accessing Logs on Oracle ASM
  - Oracle GoldenGate Tasks
  - Add Extract Group
  - Edit Extract Parameters
  - Extract Use of Archived Transaction Logs
  - Add Trails



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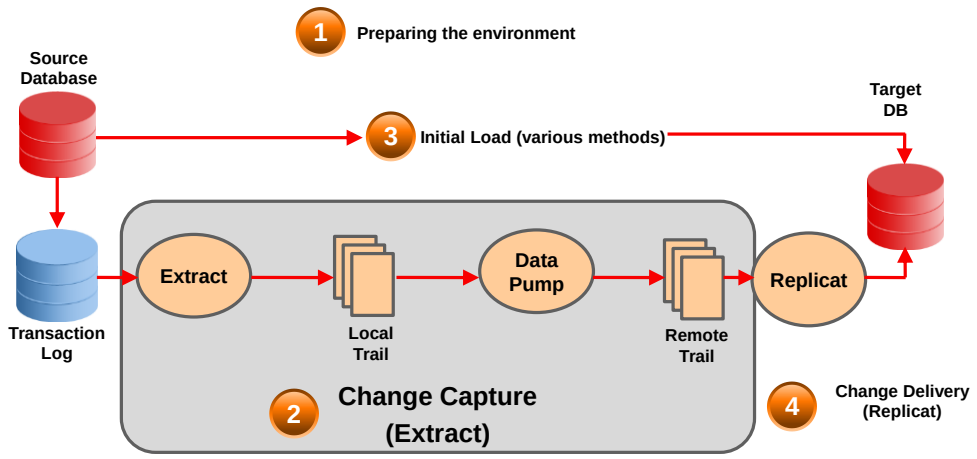
Step 2: Change Capture



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Recall the steps for configuring Oracle GoldenGate:

1. Prepare the environment
2. Change capture (Extract)
3. Initial load
4. Change delivery (Replicat)

The graphic in this slide represents a high-level overview of Step 2: “Change capture.” The data pump is optional but recommended as a best practice.

Disclaimer: Normally, you would make sure that the target tables are ready to receive the *new* transactions. If both source and target are empty tables, there is nothing additional to do.

If you choose to use a homogeneous database-specific utility to do the initial table copy, there is nothing for Oracle GoldenGate to do. If you want to do the initial table load with Oracle GoldenGate, you normally do a one-time initial load. Because initial load is done only once, and even then optionally, it will be presented *after* the ongoing capture and delivery. This is not the normal sequence that you would run in a production shop, but it makes the teaching and understanding easier.

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Extract: Overview

- A primary Extract can be configured to:
  - Capture changed data from database logs or archive logs
  - Capture changed data from JMS
  - Capture data directly from source tables for initial data load
  - Send the data to be written to a local or remote trail or file
- A secondary Extract, called a *data pump*, can be configured to distribute data from local trails to remote systems.

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Extract captures all the changes that are made to objects that you configure for synchronization. Extract stores the changes until it receives commit records or rollbacks for the transactions that contain them. When a rollback is received, Extract discards the data for that transaction. When a commit is received, Extract sends the data for that transaction to the trail for propagation to the target system. All the log records for a transaction are written to the trail as a sequentially organized transaction unit. This design ensures both speed and data integrity.

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Data Pump: Overview

- An Extract data pump can write to one or multiple remote trails and/or servers (not to be confused with Oracle Data Pump).
- A data pump:
  - Reads the local trail
  - Manipulates the data or passes it through without change
  - Sends the data to one or more targets
- A data pump is useful:
  - As a safeguard against network and target failures
  - To break complex data filtering and transformation into phases
  - To consolidate data from many sources
  - To synchronize one source with multiple targets

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For most business cases, it is a best practice to use a data pump. Some reasons for using a data pump include the following:

- **Protection against network and target failures:** In a basic GoldenGate configuration, with only a trail on the target system, there is no space on the source system to store the data that Extract continuously extracts into memory. If the network or the target system becomes unavailable, the primary Extract could run out of memory and ABEND. However, with a trail and data pump on the source system, captured data can be moved to disk, preventing the ABEND. When connectivity is restored, the data pump extracts the data from the source trail and sends it to the target systems.
- **Breaking down complex data filtering and transformation phases:** You can configure a data pump to perform the first transformation either on the source system or on the target system, and then use another data pump or the Replicat group to perform the second transformation.
- **Consolidating data from many sources to a central target:** You can store extracted data on each source system and use data pumps on each system to send the data to a trail on the target system. Dividing the storage load between the source and target systems reduces the need for massive amounts of space on the target system to accommodate data arriving from multiple sources.
- **Synchronizing one source with multiple targets:** When sending data to multiple target systems, you can configure data pumps on the source system for each one. If network connectivity to any of the targets fails, data can still be sent to the other targets.

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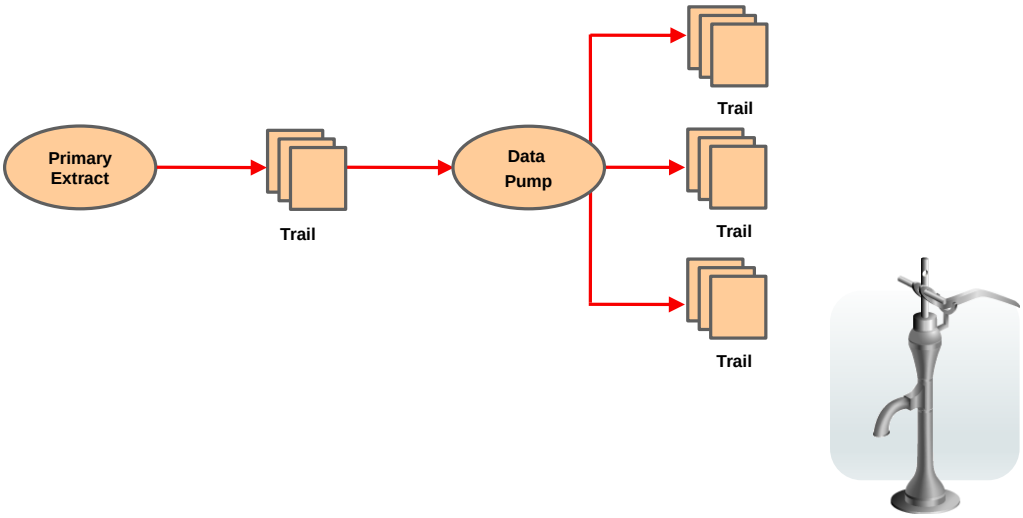
Data Pumps: One-to-Many Trails



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A data pump can be set up to duplicate or selectively route the data to multiple trails. However, if the trails are on multiple target systems and the communication to one of the systems goes down, the Extract may exhaust its retries and shut down, causing the updates to all targets to stop.

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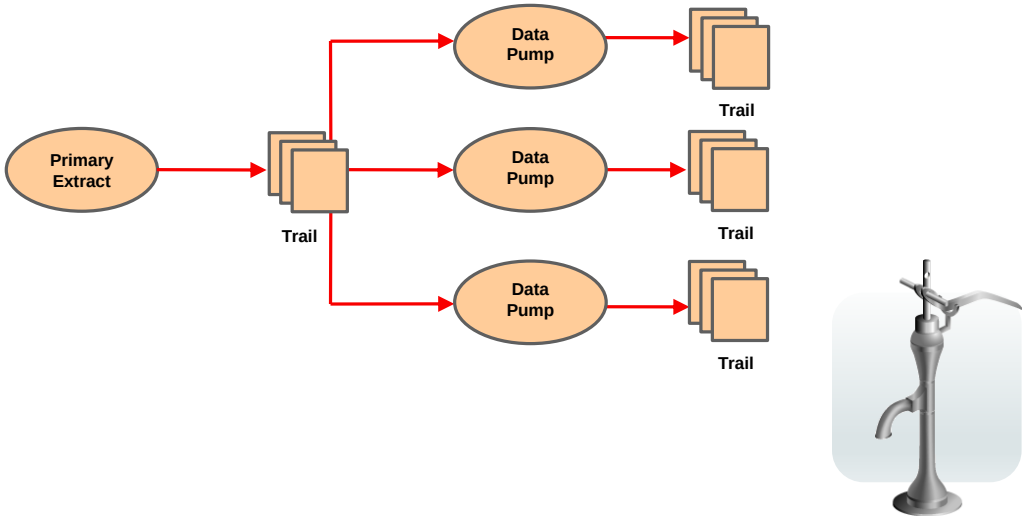
Data Pumps: One-to-Many Target Systems



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Oracle GoldenGate supports synchronization of a source database to any number of target systems. For this configuration, Oracle Corporation recommends using data pump Extract groups to ensure that if network connectivity to any of the targets fails, data can still be sent to the other targets.

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Configuring Extract

On the source system:

1. Add a primary Extract. This Extract reads from the transaction logs located on the source and has an associated parameter file.
2. (Optional) Add a local trail and a data pump Extract that reads from the transaction logs located on the source and has an associated parameter file.
3. Add a remote trail.
4. Start the Extract processes.

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To configure Extract to capture changes from transaction logs:

1a. Set up a parameter file for Extract with the GGSCI `Edit Param` command.

1b. Set up an initial Extract checkpoint in the logs with the GGSCI `Add Extract` command.

- Alternatively, the Extract can be registered using the `LogRetention` option, which enables an Extract group in Classic Capture mode to work with Oracle Recovery Manager (RMAN) to retain the logs that Extract needs for recovery.

2. (Optional) Create a local trail by using the GGSCI `Add ExtTrail` command and a data pump Extract (and parameter file) reading from the local trail.

3. Set up a remote trail by using the GGSCI `Add RmtTrail` command.

4a. Start the Server Collector process on the target system, or let the Manager start the Server Collector dynamically.

4b. Start Extract by using the GGSCI `Start Extract` command, as shown in the following example:

```
GGSCI> Start Extract finance
```

GGSCI sends this request to the Manager process, which in turn starts Extract. Manager monitors the Extract process and restarts it, when appropriate, if it goes down.

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Add Extract Command

- For a regular, passive, or data pump Extract, use the GGSCI **Add Extract** command. (This automatically creates a checkpoint.)

```
GGSCI> Add Extract <group_name>
       , <data_source_options>
       , <starting_point>
       [, <processing options>]
```

- For an alias Extract:

```
GGSCI> Add Extract <group_name>
       , RmtHost {<host_name> | <IP address>}
       , {MgrPort <port>} | {Port <port>}
       [, RmtName <name>]
       [, Desc "<description>"]
```

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The Passive Alias Extract is covered in more detail later in this lesson.

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Add Extract: Examples

```
GGSCI 1>  DBLogin UserIDAlias oggadmin

GGSCI 1> Register Extract finance database
Extract FINANCE successfully registered with database at SCN 1905933.
GGSCI 3> Add Extract finance, Integrated TranLog, Begin Now
EXTRACT added.

GGSCI 4> Add Extract atms, TranLog, Begin 2013-01-31 08:00
EXTRACT added.

GGSCI 5> Add Extract pump, ExtTrailSource c:\ggs\dirdat\lt
EXTRACT added.

GGSCI 6> Add Extract load, SourceIsTable
EXTRACT added.

GGSCI 7> Info All
```

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All of these examples presume that a `DBLogin` has already been done.

1. Create an Extract group named `finance` that extracts database changes in an integrated manner. Start extracting with records generated at the time that you add the Extract group.
2. Create an Extract group named `atms` that extracts database changes from the transaction logs. Start extracting with records generated at 8:00 AM on January 31, 2013.
3. Create a data pump Extract group named `pump` that reads from the Oracle GoldenGate Windows trail `c:\ggs\dirdat\lt`.
4. Create an initial-load Extract named `load`.
5. After you create all of these Extracts, it is customary to enter `Info All` to see if they are all present. They should be `Status=STOPPED` at this point.

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Editing Extract Parameters

- To edit a parameter file for an online Extract group, issue the following command:

```
GGSCI> Edit Params <group name>
```

- Then modify the following parameters in the file:

```
--Some Comment Goes Here.
Extract extwest
ExtTrail ./dirdat/ew
UserIDAlias oggadmin
TranLogOptions ExcludeUser ogguser
Table WEST.*;
Table SALES.INVENTORY;
```

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In Linux, the default GGSCI editor opens `vi`. You can change that by entering:

```
GGSCI> Set Editor gedit
```

Or, you can choose any other editor. That editor choice stays in effect only for that session. If you exit GGSCI and restart it, you must enter the `set editor` command again.

The example in the slide shows a primary local Extract. A companion data pump is not shown.

The example uses UserIDAlias providing an alias for credentials, which are stored in an Oracle Wallet and not stored in clear in the parameter files (as it was customary in older Oracle GoldenGate releases). See the lesson titled “Additional Transformation and Configuration Options” for additional information about other uses of the Wallet for encryption.

The `$ORACLE_SID` variable needs to be set somewhere. It could be set in the Extract parameter file, in the alias, in the `.bashrc` profile, or by using `oraenv`. There is no harm in setting it twice. `ORACLE_SID` can also be set in the parameter file, for example:

```
SETENV (ORACLE_SID='orcl')
```

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User ID and Password Aliases (New with 12*c*)

- Oracle Wallet:
  - Contains user IDs and passwords
  - Is used in Extracts, ASM, and so on

```
GGSCI> Create Wallet
GGSCI> Add CredentialStore
GGSCI> Alter CredentialStore Add User oggadmin Password
  Welcome1 Alias oggalias
GGSCI> Info CredentialStore
GGSCI> DBLogin UserIDAlias oggalias
```

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The `Info` command lists the user IDs and aliases, but not the passwords.

The following are the additional commands that are not shown in the slide:

```
GGSCI>Alter CredentialStore Replace User userid …
GGSCI> Alter CredentialStore Delete User userid …
```

Optionally, you can add "`Domain mydom`" at the end of each of the `Alter` commands to maintain multiple groups of credentials in the same wallet. As another option, *`userid`* can include an Oracle SID in the form of `@mysid` as a suffix.

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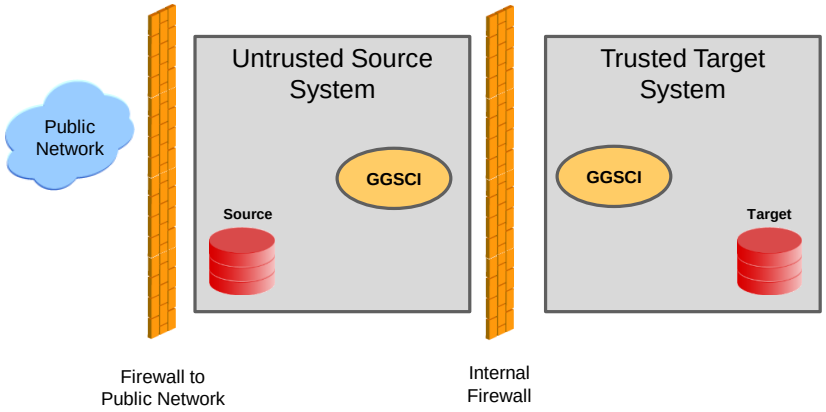
Passive Alias Extract



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When a target system resides inside a trusted intranet zone, initiating connections from the source system (the standard Oracle GoldenGate method) may violate security policies if the source system is in a less-trusted zone. It also may violate security policies if a system in a less-trusted zone contains information about the ports or IP address of a system in the trusted zone, such as that normally found in an Oracle GoldenGate Extract parameter file. In this kind of intranet configuration, you can use a passive-alias Extract configuration.
Connections are initiated from the target system inside the trusted zone by an alias Extract group, which acts as an alias for a regular Extract group on the source system, known in this case as the passive Extract. After a connection between the two systems is established, data is processed and transferred across the network by the passive Extract group in the usual way.

Unlike a Primary Extract group, the alias Extract group on the trusted target does not perform any data processing activities. Its sole purpose is to initiate and terminate connections to the less-trusted source. In this capacity, the alias Extract group does not use a parameter file nor does it write processing checkpoints. A checkpoint file is created for this group, but it is used only to determine whether the passive Extract group is running or not and to record information required for the remote connection.

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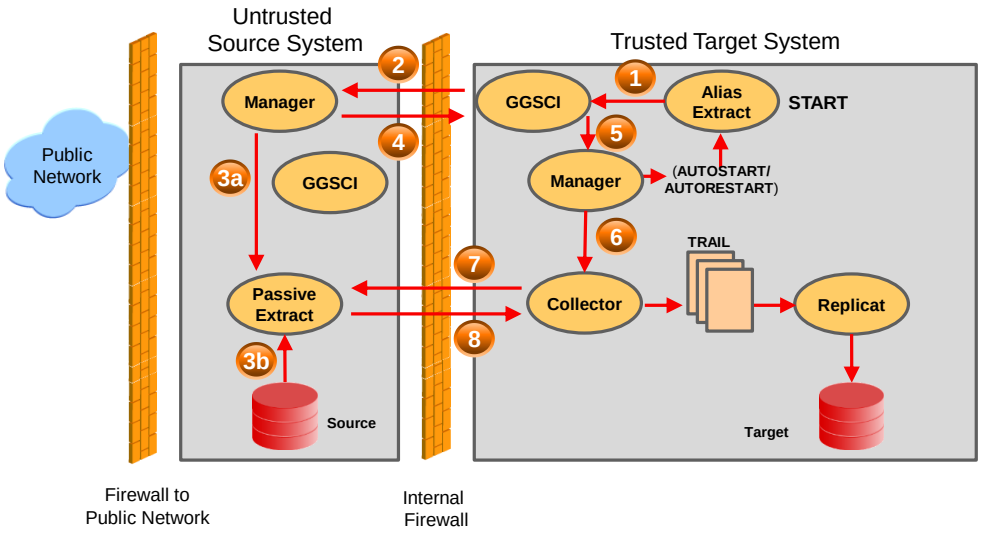
Passive Alias Extract



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1. An Oracle GoldenGate user starts the alias Extract on the trusted system, or an `Autostart` or `AutoRestart` parameter causes it to start.
2. GGSCI on the trusted system sends a message to the Manager on the less-trusted system to start the associated passive Extract. The host name or IP address and port number of the Manager on the trusted system are sent to the less-trusted system.
3. On the less-trusted system, the Manager finds an open port (according to rules in the `DynamicPortList` Manager parameter) and starts the passive Extract, which listens on the specified port.
4. The Manager on the less-trusted system returns that port to GGSCI on the trusted system.
5. GGSCI on the trusted system sends a request to the Manager on that system to start a Collector process on that system.
6. The target Manager starts the Collector process and passes it the port number where Extract is listening on the less-trusted system.
7. Collector on the trusted system opens a connection to the passive Extract on the less-trusted system.
8. Data is sent across the network from the passive Extract to the Collector on the target and is written to the trail in the usual manner for processing by Replicat.

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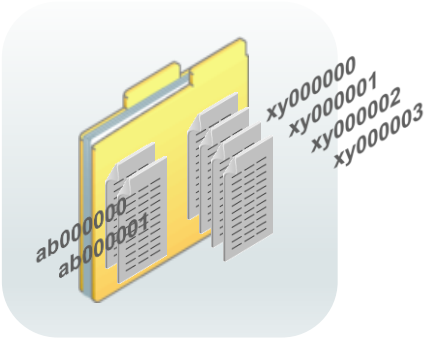
Overview of Trails

- Trails are used in Oracle GoldenGate to support the continuous extraction and replication of database changes.
- A trail can exist on the source or target system, or on an intermediary system.
- Only one primary Extract process writes to a trail.
- Processes that read the trail include:
  - Data pump Extract
  - Replicat



./dirdat

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Trails are stored in the `dirdat` subdirectory of the Oracle GoldenGate directory. When created, all file names in a particular trail begin with the same two characters. Then, as additional files are needed, each name is appended with a unique nine-digit sequence number.

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Adding a Local or Remote Trail

- Add a local or remote trail with the GGSCI command:

```
GGSCI> Add ExtTrail | RmtTrail <trail_name>
  , Extract <group_name>
 [, Megabytes <n>]
```

- If you are using a data pump:
  - The primary Extract needs a local trail (`ExtTrail`)
  - The data pump Extract needs a remote trail (`RmtTrail`)

```
GGSCI> Add ExtTrail /u01/app/ogg/dirdat/aa,
   Extract finance, Megabytes 10
GGSCI> Add RmtTrail /u01/app/ogg/dirdat/bb,
   Extract parts, Megabytes 5
```

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On the local system, a trail is known as an *Extract trail* (or *local trail*). On a remote system, it is known as a *remote trail*. The primary Extract writes to a local trail. The data pump Extract sends changes to a remote trail. The default trail file size is 500 MB. In this example, the `parts` Extract file is set to 5 MB.

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Starting the Extract

- Start an Extract process with the GGSCI command:

```
GGSCI> Start Extract <group_name>

GGSCI> Info Extract <group_name>
```

- If the output trail is remote, this normally triggers the target Manager process to start a Server Collector process with default parameters.

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You will not know if the `Start` fails until you run the `INFO ALL` command. You should look for a `Status` of `RUNNING`.

It is possible for users to start a Server Collector statically and modify the parameters, but this option is rarely used.

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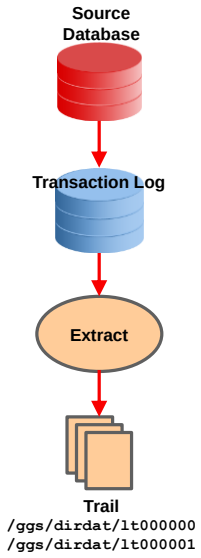
Primary Extract Configuration for Oracle




```
GGSCI> Edit Params finance
```

```
Extract finance
UserIDAlias oggalias
ExtTrail /ggs/dirdat/lt
Table SALES.ORDERS;
Table SALES.INVENTORY;
```

```
GGSCI> DbLogin UserIDAlias oggadmin
GGSCI> Register Extract finance database
GGSCI> Add Extract finance, Integrated TranLog, Begin Now
GGSCI> Add ExtTrail /ggs/dirdat/lt, Extract finance
GGSCI> Start Extract finance
```

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The primary Extract makes a local Extract trail (`lt`). Although you could locate the local Extract trail file anywhere, by convention it is usually located in the Oracle GoldenGate installation directory. If you are following the convention, the path is simply `./dirdat` to indicate relative to the installation directory.

Make sure that you are logged in to the database before trying to register a new Extract.

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Data Definition Language (DDL) Replication

By default, DDL replication is disabled on the source database (Extract side) but is enabled on the target Database (Replicat side).

To enable and manage DDL replication, you can use the **DDL** parameter, specified in the parameter file for the Extract.

- **DDL** can be used in conjunction with filter options.
  - **DDL Include All**
    - It will transmit all DDL operation to the Replicat.
  - **DDL Include All, Exclude ObjName myschema.***
    - It will exclude from replication all objects created in the **myschema** schema.
- Only one **DDL** parameter can be used in a parameter file.
  - You can, however, combine multiple inclusion and exclusion options to filter the **DDL** to the required level.
  - When combined, multiple filter option specifications are linked logically as AND statements.

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The 'All' keyword in 'DDL Include All' refers to the scope of the DDL and means 'Mapped', 'Unmapped'. and 'Other'.

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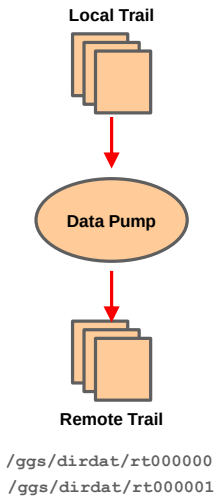
Data Pump Configuration for Oracle




```
GGSCI> Edit Params mypump
```

```
Extract mypump
Passthru
RmtHost <target>, MgrPort <port>
RmtTrail ./dirdat/rt
Table SALES.ORDERS;
Table SALES.INVENTORY;
```

```
GGSCI> Add Extract mypump, ExtTrailSource ./dirdat/lt
GGSCI> Add RmtTrail ./dirdat/rt, Extract mypump
GGSCI> Start Extract mypump
GGSCI> Info Extract mypump
```

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The `Passthru` parameter is used on a data pump if you do not need to perform any data transformations or user exit processing. Add the data pump Extract with a local trail (`lt`) as the source, and add the remote trail (`rt`) as the destination.

Notice that no `UserID` login is needed in `Passthru` mode.

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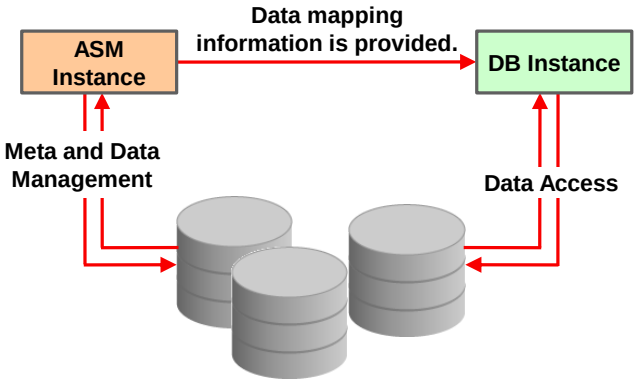
Automatic Storage Management (ASM)

Automatic Storage Management (ASM) enables a disk group to be designated for Oracle database files, control files, and backup files.



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ASM enables a disk group to be designated as storage for Oracle database files, control files, and backup files. A disk group consists of multiple disk drives and is managed as a unit by ASM. Any file stored in a disk group is automatically striped over all the disk drives in the group. ASM provides clustering capabilities and is available not only for a single SMP machine, but across multiple nodes of Oracle Real Application Clusters. To generate maximum performance, ASM automatically and dynamically distributes I/O loads among all the disk drives, even if the data usage pattern is rapidly changing.

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Ensuring ASM Connectivity

To connect Oracle GoldenGate to an ASM instance:

```
TranLogOptions
    ASMUser SYS@<ASM_instance>, ASMPassword <password> ...
Or
TranLogOptions
    ASMUserAlias <alias>
```

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To ensure that Oracle GoldenGate can connect to an ASM instance, verify the following:

- A user with `SYSDBA` privileges in the ASM instance must be used.
- Confirm that the ASM instance is listed in the `tnsnames.ora` file.
- Confirm that the Oracle listener is listening for new connections to the ASM instance.
- Use the `TranLogOptions` parameter with the `ASMUser` and `ASMPassword` options for ASM (or ASMUserAlias).

ASMUser and ASMUserAlias are used only by a classic extract.

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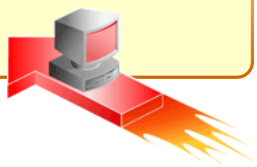
ASM and **DBLogReader**

- For Classic Extract only
- Causes newer API to be used
- Potential performance improvements

```
TranLogOptions
...
    DBLogReader, DBLogReaderBufSize nnn ...
```



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You may use the `DBLogReader` option with Oracle Database to cause Extract to use a newer ASM API that is available as of Oracle Database 10.2.0.5 and later 10*g* R2 versions, and with Oracle Database 11.2.0.2 and later 11*g* R2 and 12*c* versions (but not in Oracle Database 11*g* R1 versions).

This API uses the database server to access the redo and archive logs. The database must contain the libraries that contain the API modules and must be running.

When used, `DBLogReader` enables Extract to use a read size of up to 4 MB. This is controlled with the `DBLogReaderBufSize` option. The maximum read size when using the default OCI buffer is 28672 bytes. The size is controlled by the `ASMBufSize` option.

A larger buffer may improve the performance of Extract when the redo rate is high.
When using `DBLogReader`, do not use the `ASMUser` and `ASMPassword` options of `TranLogOptions`. The API uses the username and password that are specified with the `UserID` parameter.

More information about ASM can be found in the Oracle Database 11*g* and 12*c* documentation at http://www.oracle.com/technetwork/products/cloud-storage/index.html.

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Discussion Questions

1. What does Extract do?
2. Where does Extract capture transactional changes?
3. What parameters tell Extract where to send data?
4. What commands are used to create and start an Extract group?
5. What command option is used to set the maximum size of an Oracle GoldenGate trail file before it rolls to the next file?

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Answers

1. Extract captures incremental changes from database transaction logs. It can also save source data from the tables themselves or other Oracle GoldenGate trails. It writes the captured data to Oracle GoldenGate trails or files.
2. From transaction logs (or archive logs) (except for Teradata)
3. `ExtTrail`, `ExtFile`

   `RmtHost` with `RmtTrail`, `RmtFile`, or `RmtTask`
4. `Edit Params`

   `Add Extract`

   `Add {ExtTrail | RmtTrail |ExtFile | RmtFile}`

   `Start Extract`
5. The `Megabytes <megabytes>` option in the `Add ExtTrail` or `Add RmtTrail` command

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Discussion Questions

6. What is a data pump?
7. What is the advantage of using a data pump?
8. Why might you use multiple data pumps for one source trail?
9. What parameter is used to identify the remote target system?
10. What other parameter is commonly used on data pumps?

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Answers

6. A secondary Extract process that reads from a local trail and distributes that data to a remote system
7. Allows a local trail on the source system, which is useful for recovery if the network or target system fails
8. To send to multiple target systems (so if one goes down, they do not all go down); to separate out different tables; for parallel processing (faster)
9. `RmtHost` is used to identify the name or IP address of the remote system and the port that is being used.
10. The `PASSTHRU` parameter is used on a data pump (unless you need to perform data transformation or user exit processing).

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Summary

In this lesson, you should have learned how to:

- Describe the high-level configuration steps
- Prepare the environment for configuration
- Configure data capture

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Practice 4 Overview: Preparing the Environment and Configuring Classic Extract

This practice covers the following topics:

- Preparing your environment
- Creating the `GLOBALS` parameter file
- Configuring and starting Oracle GoldenGate Manager
- Using the `TranData` option
- Setting up the Extract and `ExtTrail`
- Setting up an Extract data pump and the remote trail
- Starting the two Extracts

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5

Configuring Initial Load

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Objectives

After completing this lesson, you should be able to:

- Explain when to perform an initial load
- List the Oracle GoldenGate initial load methods
- Configure an initial load by using Oracle GoldenGate

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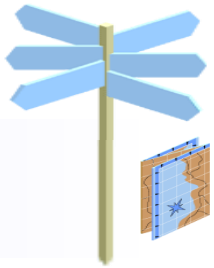
Agenda

- Initial Load Overview
  - Advantages
  - Limitations
  - Prerequisites
  - Methods
- Configuring Initial Load



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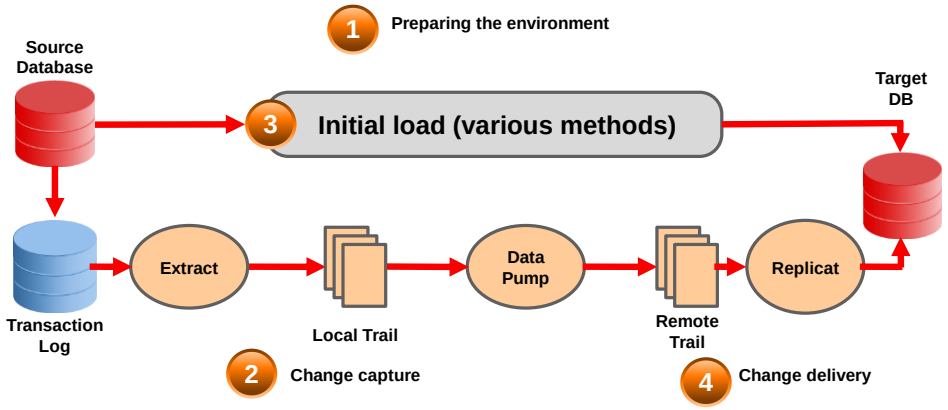
Step 3: Initial Load



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You have already prepared the environment and configured change capture. The next step is to configure the initial load. The target table exists but may be empty. You need to do DML (`INSERT`), but not DDL (`CREATE`). These `INSERT`s are reading not from the change logs, but from the original source table itself.

Note: This initial load could have been done as Step 2 or 3. Because the practice uses a new set of tables, it is okay to do this after the lesson titled “Configuring Replicat.”

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Initial Load: Advantages of Oracle GoldenGate Methods

- Work across heterogeneous database types and platforms
- Do not require application down time
- Read directly from source tables without locking tables
- Fetch data in arrays to speed performance
- Use parallel processing with `Where` clauses or the `@Range` function
- Distribute data over multiple network controllers
- Include flexible load alternatives, such as native bulk-load utilities
- Enable change delivery to handle collisions with initial load

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Initial load is a data migration process that is performed only once. The advantages of using the initial load process are listed in the slide.

You start change synchronization first during the initial load process. Change synchronization keeps track of ongoing transactional changes while the load is being applied. Coordinated Apply can often be used in place of `@RANGE`.

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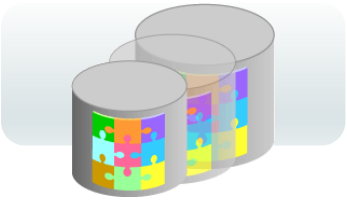
Initial Load: Resource Limitations

- How close are your systems?
- How large are your tables?
- What are the outage time constraints?
- How much disk space do you have to store changes?



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Suppose you are tracking something with a large amount of historical data. If your tables are huge (for example, in the terabyte range), even if the ongoing changes are small, the initial load can be challenging.

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Prerequisites for Initial Load

- Disable DDL processing.
- Prepare target tables.
- Configure the Manager process.
- Create a data definitions file (if the source and target databases have dissimilar definitions).
- Create change-synchronization groups (for capture and replication transactional changes during the initial load).
- Share parameters between process groups.

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Proper prerequisite planning results in a smooth initial load.

Do not use initial load `SpecialRun` or `ExtFile` with the `Integrated` or `Coordinated` Replicat options.

The steps to prepare for initial load are listed in the slide. You prepare the target tables with:

- `ALTER TABLE … DROP UNUSED COLUMNS;`
  GoldenGate supports unused columns, but avoid them before an initial load. There is no reason to drag around unused data.
- `ALTER TABLE … READ ONLY;`
  (Optional) Place the table in read-only mode (if practical) until the initial load is complete. However, this is not required.

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Initial Load: Oracle GoldenGate Methods

GoldenGate Method	Extract writes to	Load Method
File to Replicat	Trail (canonical format)	Replicat via SQL
File to database utility	Formatted text file	Database utility
Direct load	Replicat (directly)	Replicat via SQL
Direct bulk load	Replicat (directly)	Replicat via SQL*Loader API

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In an initial load, all the data is selected directly from the source tables rather than the transaction log. Therefore, in an initial load, data values for all columns (including virtual columns) are written to the trail or sent to the target, depending on the method that is being used.

Another method that can be used for Oracle Database is Oracle Data Pump.

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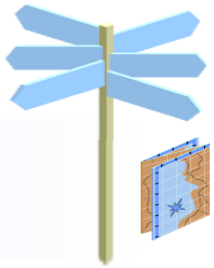
Agenda

- Initial Load Overview
- Configuring Initial Load



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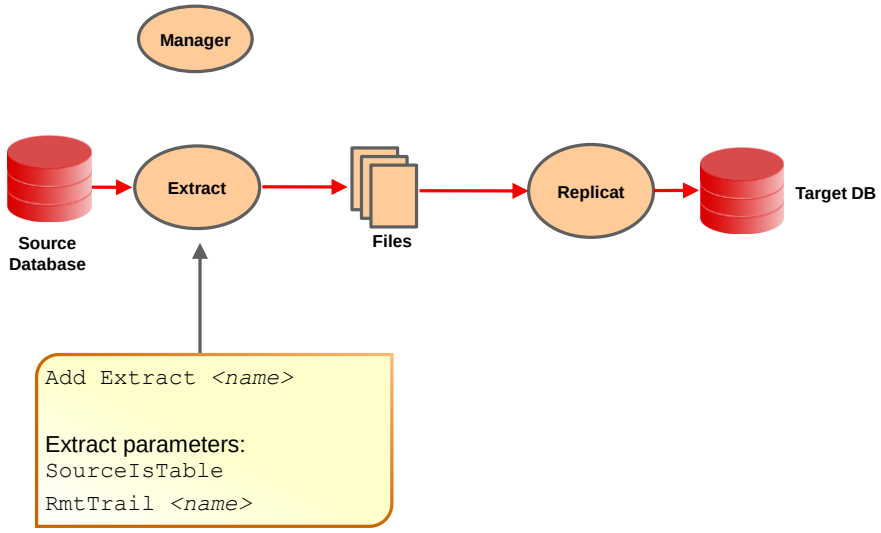
Initial Load: File to Replicat



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To use Replicat to establish the target data, you use an initial load Extract to extract source records from the source tables and write them to an extract file in canonical format. From the file, an initial load Replicat loads the data by using the database interface. During the load, the change-synchronization groups extract and replicate incremental changes, which are then reconciled with the results of the load.

During the load, the records are applied to the target database one record at a time, so this method is considerably slower than any of the other initial load methods. This method permits data transformation to be done on either the source or the target system. The “file to Replicat” method supports the extraction of `LONG` and `LOB` data.

Extract Parameters

`SourceIsTable` instructs Extract to read the source tables directly rather than from the transaction log. To format the output for processing by Replicat, use `RmtTrail` or `RmtFile`. You can use Replicat to perform additional data transformation before loading the data.

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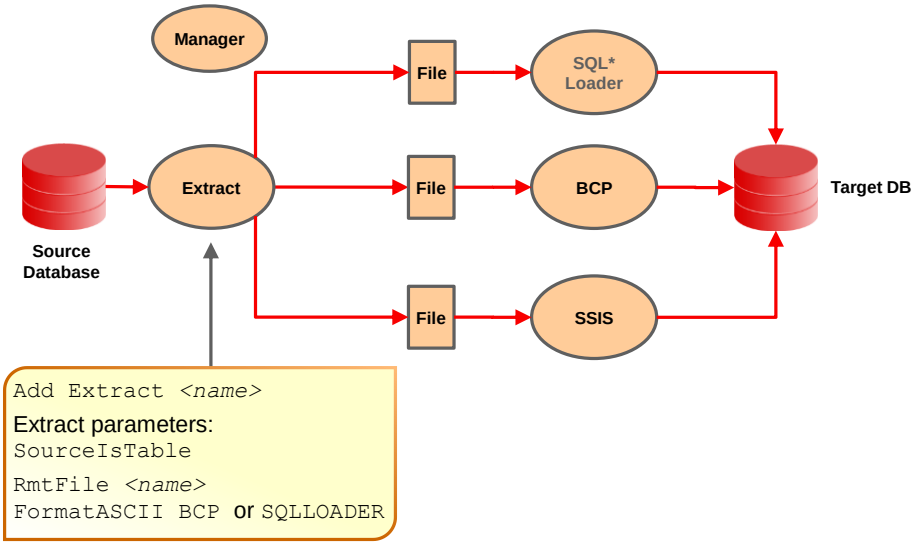
Initial Load: File to Database Utility



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To use a database bulk-load utility, use an initial load Extract to extract source records from the source tables and write them to an extract file in plain text ASCII format. The file can be read by Oracle SQL*Loader, Microsoft BCP, DTS, or SQL Server Integration Services (`SSIS`) utility, or IBM Load Utility (`LOADUTIL`). During the load, the change synchronization groups extract and replicate incremental changes, which are then reconciled with the results of the load. As part of the load procedure, Oracle GoldenGate uses the initial load Replicat to create run and control files required by the database utility.

Any data transformation must be performed by the initial load Extract on the source system, because the control files are generated dynamically and cannot be preconfigured with transformation rules.

Extract Parameters

`SourceIsTable` instructs Extract to read the source tables directly rather than the transaction log.

Oracle GoldenGate checkpoints are not maintained when `SpecialRun` is used. To format the output for native bulk utilities (such as SSIS, BCP, or SQL*Loader), use `RmtFile` or `RmtTrail` and `FormatASCII` with appropriate options, such as `BCP` or `SQLLOADER`.

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Replicat Parameters

Replicat uses the `GenLoadFiles` parameter when using the file-to-database-utility initial load method to generate run and control files that are compatible with:

- Oracle SQL*Loader
- Microsoft BCP, DTS, or SQL Server Integration Services (SSIS) utility
- IBM Load Utility (`LOADUTIL`)

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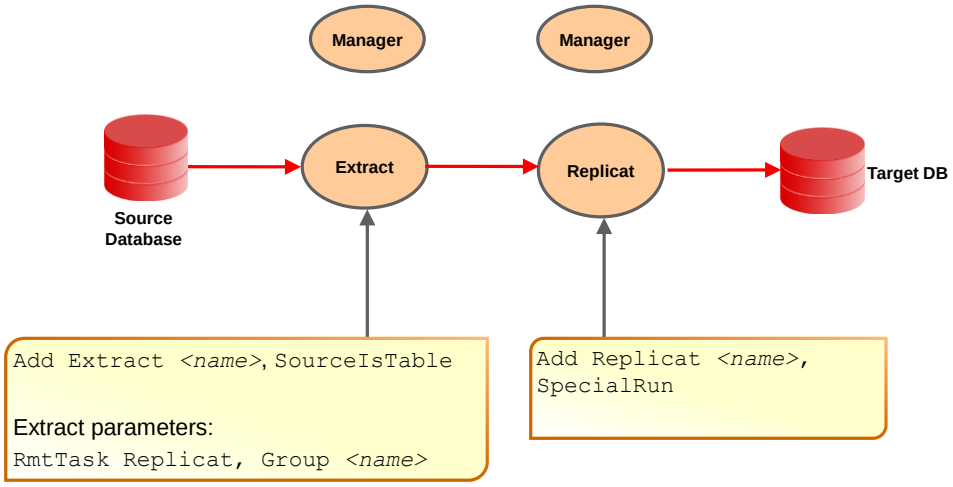
Initial Load: Direct Load



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To use an Oracle GoldenGate direct load, you run an Oracle GoldenGate initial load Extract to extract the source records and send them directly to an initial load Replicat *task.* A task is started dynamically by the Manager process and does not require the use of a Collector process or file. The initial load Replicat task delivers the load in large blocks to the target database. Transformation and mapping can be done by Extract, Replicat, or both. During the load, the change-synchronization groups extract and replicate incremental changes, which are then reconciled with the results of the load.

The direct load method does not support tables that have columns that contain `LOB`s, `LONG`s, user-defined types (UDT), or any other large data type that is greater than 4 KB in size. Transformation can be done with Extract or Replicat.

Extract Parameters

For this example, `RmtTask` (instead of `RmtFile` in the Queue Data method) is used. `RmtTask` instructs the Manager process on the target system to start a Replicat process with a group name specified in the `Group` clause.

If the initial load is from a compressed table, there are some additional constraints:

- The Extract must be Integrated (instead of Classic).
- You need to specify the `InsertAppend` command to cause the `Append` hint for the target table.

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Execution

When you add Extract and Replicat:

- `SourceIsTable` instructs Extract to read the source tables directly rather than the transaction log. `SpecialRun` on Replicat specifies a one-time batch processing where checkpoints are not maintained.
- The initial data load is then started using the GGSCI command `Start Extract`. The Replicat process is automatically started by the Manager process. The port used by the Replicat process can be controlled by using the `DynamicPortList` Manager parameter.

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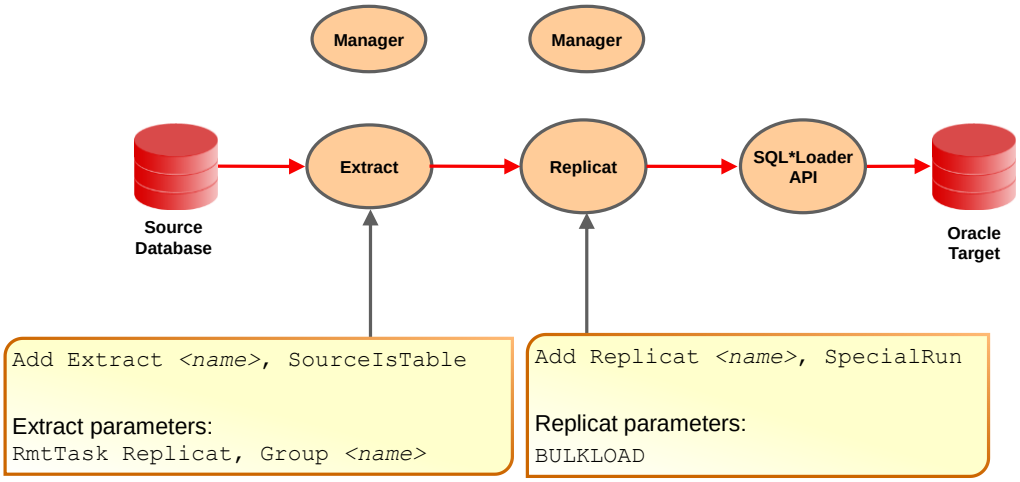
Initial Load: Direct Bulk Load (to Oracle)



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To use the Oracle SQL*Loader utility to establish the target data, you run an Oracle GoldenGate initial load Extract to extract the source records and send them directly to an initial load Replicat task.

A task is a process that is started dynamically by the Manager process and does not require the use of a Collector process or file. The initial load Replicat task interfaces with the API of SQL*Loader to load data as a direct-path bulk load.

Data mapping and transformation can be done by either the initial load Extract or initial load Replicat, or by both. During the load, the change-synchronization groups extract and replicate incremental changes, which are then reconciled with the results of the load.

The direct bulk load method is the fastest method using Oracle GoldenGate for initial data load. It sends data in large blocks to the Replicat process, which communicates directly with SQL*Loader through an API.

Replicat Parameters

The `BULKLOAD` parameter distinguishes the direct bulk load method from the direct load method.

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Discussion Questions

1. What are the Oracle GoldenGate methods for initial load?
2. Which Oracle GoldenGate command arguments specify that Extract and Replicat run as batch tasks (for example, for initial load)?

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Answers

1. File to Replicat: Extract writes to a file for Replicat to load via SQL.
   File to database utility: Extract writes to ASCII files formatted for database utilities to load.
   Direct load: Extract writes directly to Replicat, which loads via SQL.
   Direct bulk load: (Oracle only) Extract writes directly to Replicat, which loads through the SQL*Loader API.
2. `Add Extract` with `SourceIsTable`
   `Add Replicat` with `SpecialRun`

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Summary

In this lesson, you should have learned how to:

- Describe Oracle GoldenGate initial load methods
- Explain the advantages of Oracle GoldenGate methods
- Configure an initial load by using Oracle GoldenGate

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Practice 5 Overview: Configuring Initial Load

This practice covers the following topics:

- Setting up the initial load by using the “file to Replicat” method
- Setting up the initial data load by using the “bulk load” method
- Putting it all together

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6

Configuring Replicat

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Objectives

After completing this lesson, you should be able to:

- Explain what the Replicat process does
- Add, configure, and start a Replicat process
- Configure Replicat to handle collisions between changes and the initial load data

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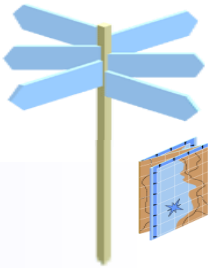
Agenda

- Replicat Overview
  - Overview
  - Classic
  - Integrated
  - Coordinated
  - Parallel
- Replicat Tasks
- Initial Load
- Troubleshooting



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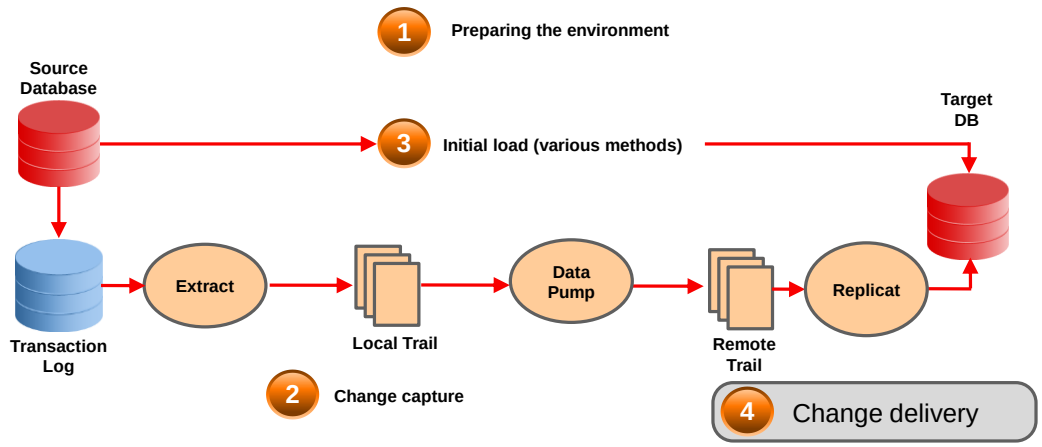
Step 4: Change Delivery (Replicat)



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Step 4 in the GoldenGate configuration process is change delivery. After the initial table data is loaded, you are ready to deliver just the changes.

Disclaimer

Normally, you would make sure that the target tables are ready to receive the *new* transactions. If both source and target are empty tables, there is nothing more to do.

If you choose to use a homogeneous database-specific utility to do the initial table copy (for example SQL*Loader or RMAN `DUPLICATE`), then there may be nothing for Oracle GoldenGate to do. If you want to do the initial table load with Oracle GoldenGate, you would normally do a one-time initial load. Because that initial load is done only once, and even then optionally, it will be presented *after* the ongoing capture and delivery. This is not the normal sequence that you would run in a production shop, but it makes the teaching and understanding easier.

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Replicat: Overview

- The Replicat process runs on the target system.
- Multiple Replicat processes can be used with multiple Extract processes in parallel to increase throughput.
- Replicat can:
  - Read data out of Oracle GoldenGate trails
  - Perform data filtering by table, row, or operation
  - Perform data transformation
  - Perform database operations just as your application performed them

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Oracle GoldenGate trails are temporary queues for the Replicat process. Each record header in the trail provides information about the database change record. Replicat reads these trail files sequentially and then processes `INSERT`s, `UPDATE`s, and `DELETE`s that meet your criteria. Alternatively, you can filter out the rows that you do not want to deliver, as well as perform data transformation before applying the data.

Replicat supports a high volume of data-replication activity. As a result, network activity is block based, not record-at-a-time. Replicat uses native calls to the database for optimal performance. You can configure multiple Replicat processes for increased throughput.

When replicating, Replicat preserves the boundaries of each transaction so that the target database has the same degree of integrity as the source. Small transactions can be grouped into larger transactions to improve performance. Replicat uses a checkpointing scheme, so changes are processed exactly once. After a graceful stop or a failure, processing can be restarted without repetition or loss of continuity.

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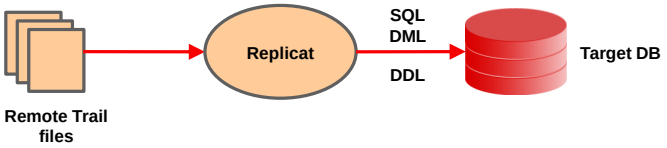
Nonintegrated or “Classic” Replicat

- Trail files contain OGG canonical format statements.
- Data applied through “normal” SQL-type channels
- Available for any supported platform, multiple vendors
- Heterogeneous, that is, source and target could be almost any database



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The universal trail files are used to construct SQL DML and/or DDL statements customized to the target database vendor syntax. The SQL statements then apply the data. The target database often is not aware that the data is coming from Oracle GoldenGate; it appears to be regular plain old SQL commands as if a user typed them in.

DDL replication, if enabled, is supported on either an Oracle or a Teradata environment.

This mode is available on almost every OEM platform (including Oracle) and every version (with some rare exceptions). You can start a Replicat in Classic and then later convert it to Integrated if the platform permits it.

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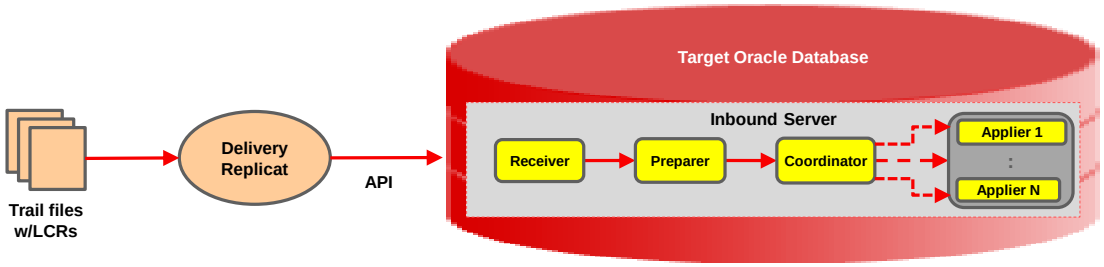
“Integrated” Replicat a.k.a. “Integrated Delivery”

- Trail files contain data in either canonical or LCR format.
- Data applied through API, very efficient, bypasses overhead
- Available for only latest Oracle Database platforms
- Source can be anything, but target must be Oracle Database.
- Source can be Classic or Integrated.
- Integrated Replicat does not need a checkpoint or a trace table for its operations.



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- Logical Change Records (LCRs) are created by Integrated Extract, whereas canonical is created by Classic Extract.
- Integrated Replicat uses Lightweight Streaming API from the Replicat process to an Inbound Server, and converts canonical to LCR format if needed:
  - **Receiver:** Reads trails in LCR format
  - **Preparer (Reader):** Computes the dependencies between the transactions (primary key, unique indexes, foreign key), grouping transactions and sorting in dependency order
  - **Coordinator:** Coordinates transactions; maintains the order between applier processes
  - **Appliers:** Performs changes for assigned transactions, including conflict detection and error handling
- There are several new database `sysdba` tables and views named `V$GG_APPLY_*` and `DBA_APPLY_*`.
- Integrated Replicat is supported only on Oracle Database versions 11.2.0.4 and later.
- Integrated Replicat does not support GGSCI parameters such as `BULKLOAD`, `GENLOADFILES`, `RMTTASK`, and `SPECIALRUN`; they cause an abort. There is limited functionality for `SHOWSYNTAX`, which does not abort but does not show interactive commands either.

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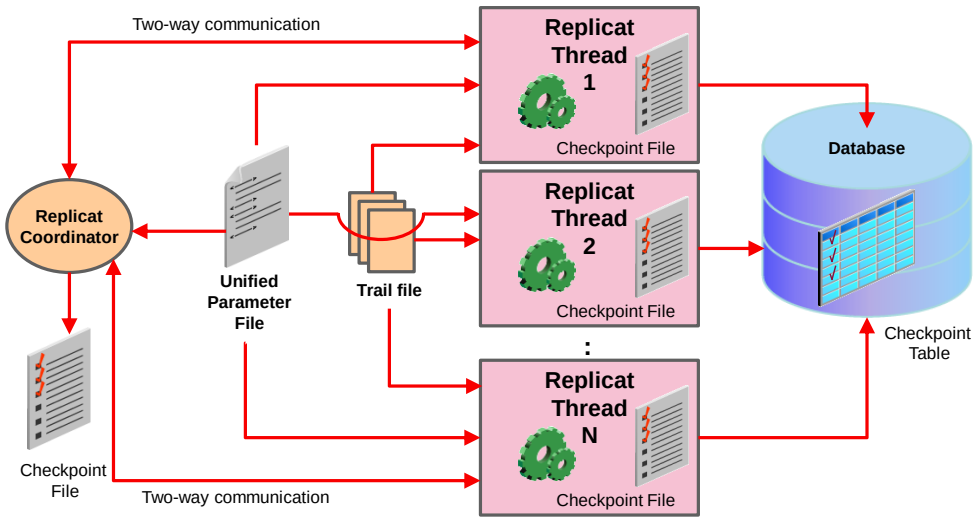
Coordinated Replicat



Note that the group name of a coordinated Replicat can contain only five characters.

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Coordinated Replicat is also known as *coordinated apply*. This is independent of Integrated Replicat, and it works on most versions and most vendors' databases. The main feature is that all of the Replicat threads can apply in parallel, though there may be cases where a full barrier synchronization (serialization) is desirable.

- **Coordinator:** It is responsible for thread creation and shutdown, dependency coordination, and statistics aggregation.
- **Multiple checkpoints:** If there are *n* threads, there are *n* + 1 checkpoint files, one for each thread and a coordinator's checkpoint file, plus the checkpoint *table* in the database.
- **Single parameter file:** This greatly simplifies configuration, maintenance, and use.
- **Single trail file:** You do not need to figure out how to split up the work. The Replicat coordinator process does that.

By default, the coordinated Replicat sets up a maximum of 25 threads (there are actually 26, including one coordinator thread plus 25 Replicat threads), but you can increase or decrease this maximum.

Examples of coordinated apply are shown in the lesson titled "Data Selection and Filtering."

Do not use initial load `SpecialRun` or `ExtFile` with `Coordinated` Replicat options.

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Parallel Replicat

Parallel replicat is a new variant of Replicat that applies transactions in parallel to improve performance.

- It takes into account dependencies between transactions, similar to Integrated Replicat.
  - The dependency computation, parallelism of the mapping, and apply are performed outside the database so it can be off-loaded to another server.
  - Transaction integrity is maintained in this process.
- Parallel Replicat supports the parallel apply of large transactions by splitting a large transaction into chunks and applying them in parallel.
- Parallel Replicat supports all databases using the non-integrated option.
  - It supports only replicating data from trails with full metadata.

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Parallel Replicat is a new feature of GoldenGate 12.3.

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Components of Parallel Replicat

- **Mapper:** Operates in parallel to read the trail, maps trail records, converts the mapped records to the Integrated Replicat LCR format, and sends the LCRs to Merger for further processing
- **Master processes:** Have two threads:
  - Collater
  - Scheduler
- **Collater:** Receives mapped transactions from the Mappers and puts them back into trail order for dependency calculation
- **Scheduler:** Calculates dependencies between transactions, groups transactions into independent batches, and sends the batches to the Appliers to be applied to the target database
- **Appliers:** Reorder records within a batch for array execution

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One Mapper maps one set of transactions, whereas the next Mapper maps the next set of transactions. The trail information is split and the trail file is untouched because it orders trail information in order.

Appliers apply batches to the target database and perform error handling. They also track applied transactions in checkpoint tables.

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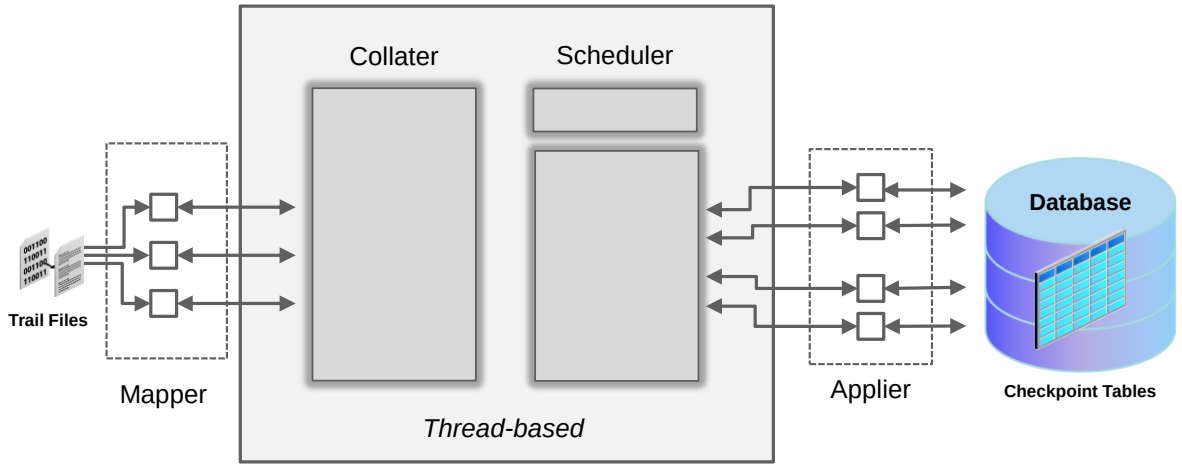
Parallel Replication Architecture



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The Mappers read the trail file and map records, and forward the mapped records to the Master. The batches are sent to the Appliers where they are applied to the target database.

The Master process consists of two separate threads, Collater and Scheduler.

The Collater is responsible for managing and communicating with the Mappers, along with receiving the mapped transactions and reordering them into a single in-order stream.

The Scheduler is responsible for managing and communicating with the Appliers, along with reading transactions from the Collater, batching them, and scheduling them to Appliers.

The Scheduler controller communicates with the Scheduler to gather any necessary information (such as, the current low watermark position). The Scheduler controller is required for CDB mode for Oracle Database because it is responsible for aggregating information pertaining to the different target PDBs and reporting a unified picture.

The Scheduler controller is created for simplicity and uniformity of implementation, even when not in CDB mode. Every process reads the parameter file and shares a single checkpoint file.

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Parallel Replicat Control Parameters

Parameter	Description
MAP_PARALLELISM	Configures the number of mappers. This controls the number of threads used to read the trail file. The minimum value is `1`, maximum value is `100` and the default value is `2`.
APPLY_PARALLELISM	Configures the number of appliers. This controls the number of connections in the target database used to apply the changes. The default value is `four`.
MIN_APPLY_PARALLELISM **MAX_APPLY_PARALLELISM**	The Apply parallelism is auto-tuned. You can set a minimum and maximum value to define the ranges in which the Replicat automatically adjusts its parallelism. There are no defaults. Do not use with `APPLY_PARALLELISM` at the same time.
SPLIT_TRANS_REC	Specifies that large transactions should be broken into pieces of specified size and applied in parallel. Dependencies between pieces are still honored. This is disabled by default.
CHUNK_SIZE	Controls how large a transaction must be for parallel Replicat to consider it as large. When parallel Replicat encounters a transaction larger than this size, it will serialize it, resulting in decreased performance.

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Example of a parameter file for a Parallel Replicat:

```
replicat parrep
useridalias oggadmin
MAP_PARALLELISM 3
MIN_APPLY_PARALLELISM 2
MAX_APPLY_PARALLELISM 10
SPLIT_TRANS_RECS 1000
map *.*, target *.*;
```

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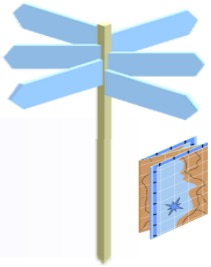
Agenda

- Replicat
- Replicat Tasks
  - Adding Checkpoints
  - Using Checkpoints
- Initial Load
- Troubleshooting



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Change Delivery Tasks

On the target system:

1. Create a checkpoint table in the target database (best practice):

```
GGSCI> DBLogin UserIDAlias oggadmin
GGSCI> Add  CheckpointTable
GGSCI> Info CheckpointTable
```

2. Create a parameter file for Replicat:

```
GGSCI> Edit Params
```

3. Create a Replicat group:

```
GGSCI> Add Replicat <params>
```

4. Start the Replicat process:

```
GGSCI> Start Replicat
```

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Replicat reads the Oracle GoldenGate trail and applies changes to the target database. Like Extract, Replicat uses checkpoints to store the current read and write position and is added and started using the processing group name.

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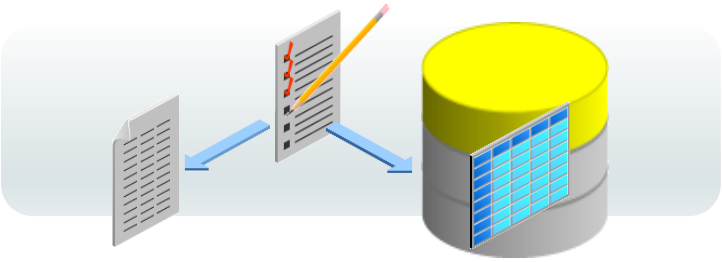
CheckpointTable

You can provide checkpoint instructions by:

- Specifying a default checkpoint table in the **GLOBALS** file
- Using **CheckpointTable** or **NoDBCheckpoint** in the **Add Replicat** command to override the default
- Using file system or database for storing the checkpoint table



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Replicat maintains checkpoints that provide a known position in the trail from which to start after an expected or unexpected shutdown. By default, a record of these checkpoints is maintained in a trail file on disk in the Oracle GoldenGate directory. Optionally, the checkpoint record can also be maintained in a checkpoint table in the target database.

Using database checkpointing is recommended because it enables the checkpoint to be included within Replicat's transaction, which improves recovery in certain situations. The checkpoint table remains small because rows are deleted when no longer needed, and it does not affect database performance. It can reside in a schema of your choice, but Oracle Corporation recommends using one that is dedicated to Oracle GoldenGate.

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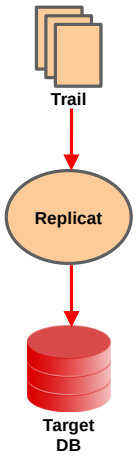
Sample Configuration




```
GGSCI> DBLogin UserIDAlias oggadmin
GGSCI> Add CheckpointTable mycheckpt
GGSCI> Edit Params repord
```

```
-- Some Comment here.
Replicat repord
UserIDAlias oggadmin
DiscardFile ./dirrpt/REPORD.dsc, Append
Map SALES.ORDERS, Target USSALES.USORDERS;
Map SALES.INVENTORY, Target USSALES.USINVENTORY;
```

```
GGSCI> Add Replicat repord, Integrated ExtTrail ./dirdat/rt
GGSCI> Start Replicat repord
```

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In this example, `DBLogin UserIDAlias` logs the user in to the database to add the checkpoint table. Note that `DBLogin` and `UserIDAlias` in the Replicat might be different.

For the Replicat parameters, `UserIDAlias` provides the credentials to access the database.

`DiscardFile` creates a log file to receive records that cannot be processed. `MAP` establishes the relationship between the source table and the target table. `Add Replicat` names the Replicat group `REPORD` and establishes a local trail (`ExtTrail`) with the two-character identifier `rt` residing in the `dirdat` directory.

As always, the `Map` statements end with a semicolon; the other statements do not.

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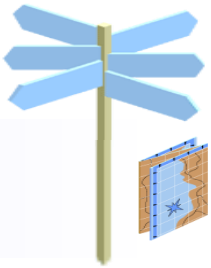
Agenda

- Replicat
- Replicat Tasks
- Initial Load
  - Avoiding Collisions with Initial Load
  - Handling Collisions with Initial Load
- Troubleshooting



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Avoiding Collisions with Initial Load

- If the source database remains active during an initial load, you must either avoid or handle any collisions when updating the target with interim changes.
- If you can back up, restore, or clone the database at a point in time, you can avoid collisions by starting Replicat to read trail records from a specific transaction commit sequence number (CSN):

```
GGSCI> Start Replicat <group> AtCSN | AfterCSN <csn>
```

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During the initial load, updates may occur to the source during the load process. To avoid these collisions, perform the following steps:

1. Use a standby copy of the source database for the initial load.
2. After the initial load completes, note the highest CSN number of the standby database. The CSN varies by database. (For example, for Oracle Database, it is the system change number [SCN].)
3. Start Replicat to read from the next CSN:

```
Start Replicat <group> AtCSN <csn> | AfterCSN <csn> | SkipTransaction
```

- **AtCSN *<csn>*** causes Replicat to skip transactions in the trail until it finds a transaction that contains the specified CSN. *<csn>* must be in the format that is native to the database.
- **AfterCSN *<csn>*** causes Replicat to skip transactions in the trail until it finds the first transaction after the one that contains the specified CSN.
- **SkipTransaction** causes Replicat to skip the first transaction in the trail after startup. All operations in that first transaction are excluded.

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Handling Collisions with Initial Load

- If you cannot avoid collisions, you must *handle* them.
- The Replicat **`HandleCollisions`** parameter can be used.
  - When Replicat encounters a duplicate-record error on an insert, it writes the change record over the initial data load record.
  - When Replicat encounters a missing-record error for an update or delete, the change record is discarded.
- After all of the change data generated during the load has been replicated, turn off **`HandleCollisions`**:

```
GGSCI> Send Replicat <group> NoHandleCollisions
GGSCI> Edit Param <group>
```

Temporary

Permanently remove parameter

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`HandleCollisions` processing requires that each target table have a primary key or unique index. If you cannot create a temporary primary key or unique index through your application, use the `KeyCols` argument of the `Table` or `Map` parameter to designate columns as a substitute key. Otherwise, the source database must be quiesced for the initial load.

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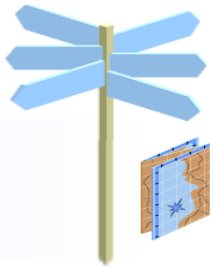
Agenda

- Replicat
- Checkpoint
- Initial Load
- Troubleshooting
  - GGSCI Process Information
  - Report Files
  - Log Files



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After everything is started, the `Info All` process status (see the next slide) ideally changes from `STOPPED` to `RUNNING`. However, you may see the status change from `STOPPED` to `ABEND`. If the process fails to start, this section discusses some troubleshooting techniques.

For additional details, see the follow-on course *Oracle GoldenGate 11g Troubleshooting and Tuning.*

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Obtaining Process Information Through GGSCI

GGSCI>

- **Info {Extract | Replicat} <group> [Detail]**
- **Info Manager**
- **Info All**
- **Stats {Extract | Replicat} <group>**
- **Status {Extract | Replicat} <group>**
- **Status Manager**
- **Lag {Extract | Replicat} <group>**

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The primary way to view processing information is through GGSCI (as shown in preceding lessons). The slide shows the key commands to view process information.

- **Info {Extract | Replicat} *<group>* [Detail]:** Run status, checkpoints, approximate lag, and environmental information
- **Info Manager | Mgr:** Run status and port number
- **Info All:** Info output for all Oracle GoldenGate processes on the system
- **Stats {Extract | Replicat} *<group>*:** Statistics for operations processed
- **Status {Extract | Replicat} *<group>*:** Run status (starting, running, stopped, and abended)
- **Status Manager | Mgr:** Run status
- **Lag {Extract | Replicat} *<group>*:** Latency between last record processed and time stamp in the data source

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Obtaining Process Information Through GGSCI

GGSCI>

- **Info {ExtTrail | RmtTrail} <*path_name*>**
- **Send Manager**
- **Send {Extract | Replicat}**
- **View Report <group>**
- **View GGSEvt**
- **<*command*> ER <*wildcard*>**

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The slide shows the additional commands to view process information:

- **Info {ExtTrail | RmtTrail} <*path_name*>:** Name of the associated process, position of the last data processed, and maximum file size
- **Send Manager:** Run status, information about child processes, port information, and trail purge settings
- **Send {Extract | Replicat}:** Depending on the process, information about memory pool, lag, TCP stats, long-running transactions, process status, recovery progress, and so on
- **View Report <*group*>:** Contents of the process report
- **View GGSEvt:** Contents of the Oracle GoldenGate error log
- **<*command*> ER <*wildcard*>:** Information dependent on the `<command>` type:
  - Info
  - Lag
  - Send
  - Stats
  - Status

  `<wildcard>` is either `*` or `?`.

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Process Report Files

- Process reports (depending on the process) enable you to view the following:
  - Parameters in use
  - Table and column mapping
  - Database information
  - Runtime messages and errors
  - Runtime statistics for the number of operations processed
- These reports can be viewed with:
  - `GGSCI>` View Report
  - Any text editor
  - Oracle Management Pack for Oracle GoldenGate

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Every Extract, Replicat, and Manager process generates a report file at the end of each run. The report can help you diagnose problems that occurred during the run, such as invalid mapping syntax, SQL errors, and connection errors.

To view a process report, use any of the following:

- A standard shell command for viewing a text file, such as `more`, `less`, or `cat`
- Oracle Management Pack for Oracle GoldenGate (Oracle GoldenGate Director and/or Oracle GoldenGate Monitor)
- The `View Report` command in GGSCI:

```
View Report {<group> | <file_name> | Mgr}
```

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Sample Extract Process Report

```
************************************************************************
**            Running with the following parameters                   **
************************************************************************
2017-04-10 12:58:48  INFO    OGG-03035  Operating system character set identified as UTF-8.
Locale: en_US, LC_ALL:.
-- WEST
Extract pwconf
RmtHost easthost, MgrPort 15001, Compress
RmtTrail ./dirdat/pf
Passthru
Table west.*;
-- cannot use GetBeforeCols on the data pump above with Passthru...

2017-04-10 12:58:53  INFO    OGG-01226  Socket buffer size set to 27985 (flush size 27985).

************************************************************************
**                      Run Time Messages                             **
************************************************************************
Opened trail file ./dirdat/wf000000 at 2017-04-10 12:58:53
Wildcard TABLE resolved (entry west.*):
  Table "WEST"."PRODUCTS";
PASSTHRU mapping resolved for source table WEST.PRODUCTS
```

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Because this is for the `pwconf` process group, the report is in `dirrpt/pwconf.rpt`.
The normal report is much longer than is shown in the slide. The `pwconf.prm` parameter file for this process is included in the report.

To view the report, you can use the following within GGSCI:

`GGSCI>` **View Report *groupname***

Alternatively, you can view the file by using any editor.

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Discard Files

```
Oracle GoldenGate Delivery for Oracle process started, group RWCONF discard file opened:
2017-04-10 12:43:13
ORA-20017: asta0009 6144935
ORA-06512: at "LON.STARTASTA0009_INSERT", line 31
ORA-04088: error during execution of trigger 'LON.STARTASTA0009_INSERT'
Operation failed at seqno 45 rba 12483311
Problem replicating PRODTAB.ASTA0009 to ASTA0009
Error occurred with insert record (target format)...
*
A_TIMESTAMP = 2017-05-15 13:18:32
RELA_PERSON_NR = 3618047
RELA_BEZART = 1
RELA_BEZCODE = 01
RELA_AZ_BAFL = 2819220
RELA_STEMPEL = 0
AKTION = I
OK = 1.0000
NOTOK = -1.0000
*
```

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Discard files are used to capture information about the Oracle GoldenGate operations that have failed.

The Discard file reports information such as:

- The database error message
- The sequence number of the data source or trail file
- The relative byte address of the record in the data source or trail file
- The details of the discarded operation, such as the column values of a DML statement or the text of a DDL statement

A Discard file can be used for both Extract and Replicat.

To use a Discard file, include the `DiscardFile` parameter in the Extract or Replicat parameter file. Parameters are covered in the lesson titled “Oracle GoldenGate Parameters.” Starting with OGG 12.1.2, `DiscardFile` is the default.

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Using the `ggserr.log` Error Log

```
2017-04-06 11:10:02  INFO    OGG-00987  Oracle GoldenGate Command Interpreter for Oracle:  GGSCI
command (oracle): edit param mgr.
2017-04-06 11:11:00  INFO    OGG-00987  Oracle GoldenGate Command Interpreter for Oracle:  GGSCI
command (oracle): start mgr.
2017-04-06 11:11:01  INFO    OGG-00983  Oracle GoldenGate Manager for Oracle, mgr.prm:  Manager
started (port 15000).
2017-04-06 11:57:24  INFO    OGG-00987  Oracle GoldenGate Command Interpreter for Oracle:  GGSCI
command (oracle): add trandata west.account.
2017-04-06 11:59:25  INFO    OGG-00987  Oracle GoldenGate Command Interpreter for Oracle:  GGSCI
command (oracle): add schematrandata hr.
2017-04-06 11:59:25  INFO    OGG-01788  Oracle GoldenGate Command Interpreter for Oracle:
SCHEMATRANDATA has been added on schema hr.
2017-04-06 11:59:45  ERROR   OGG-01780  Oracle GoldenGate Command Interpreter for Oracle:
Missing/Invalid argument(s) on ADD/INFO/DELETE SCHEMATRANDATA command.
2017-04-06 12:00:03  ERROR   OGG-01780  Oracle GoldenGate Command Interpreter for Oracle:
Missing/Invalid argument(s) on ADD/INFO/DELETE SCHEMATRANDATA command.
2017-04-06 12:00:09  INFO    OGG-01786  Oracle GoldenGate Command Interpreter for Oracle:  Schema
level supplemental logging is disabled on schema GGUSER.
2017-04-06 12:00:09  INFO    OGG-01[illegible]  Oracle GoldenGate Command Interpreter for Oracle:  Schema
level supplemental logging is disabled [illegible] schema WEST.
2017-04-06 12:00:09  INFO    OGG-0178[illegible]  [illegible] GoldenGate Command Interpreter for Oracle:  Schema
level supplemental logging is disable[illegible]
```

ERROR vs INFO

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You can use the Oracle GoldenGate error log to view the following:

- A history of GGSCI commands
- The Oracle GoldenGate processes that started and stopped
- The processing that was performed
- The errors that occurred
- Informational and warning messages

Because the error log shows events as they occurred in sequence, it is a good tool for detecting the cause (or causes) of an error. For example, you might discover that someone stopped a process or a process failed to make a TCP/IP or database connection.

To view the error log, use any of the following:

- A standard shell command to view the `ggserr.log` file in the root Oracle GoldenGate directory
- Oracle Management Pack for Oracle GoldenGate (Oracle GoldenGate Director and/or Oracle GoldenGate Monitor)
- The `View GGSEVT` command in GGSCI
- An external table

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Using the System Logs

- Oracle GoldenGate writes errors that are generated at the level of the operating system:
  - Event Viewer on Windows
  - **`syslog`** on UNIX and Linux
- Use the **`SYSLOG`** parameter to control the types of messages that Oracle GoldenGate sends to the system logs on a Windows or UNIX system.
- By using the **`SYSLOG`** parameter, messages can be filtered to:
  - Include all Oracle GoldenGate messages
  - Suppress all Oracle GoldenGate messages
  - Include information, warning, or error messages, or any combination of these types

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Oracle GoldenGate writes errors that are generated at the level of the operating system to the Event Viewer in Windows or to `syslog` in UNIX and Linux. Oracle GoldenGate events are basically in the same format in the UNIX, Linux, and Windows system logs. The Oracle GoldenGate errors that appear in the system logs also appear in the Oracle GoldenGate error log.

You can use `SYSLOG` as a `GLOBALS` parameter, a Manager parameter, or both. When present in the `GLOBALS` parameter file, `SYSLOG` controls message filtering for all Oracle GoldenGate processes on the system. When present in the Manager parameter file, `SYSLOG` controls message filtering only for the Manager process. If `SYSLOG` is used in both the `GLOBALS` and Manager parameter files, the Manager setting overrides the `GLOBALS` setting for the Manager process. This enables you to use separate settings for Manager and all the other Oracle GoldenGate processes.

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Discussion Questions

1. What does Replicat do?
2. What commands are used to create and start a Replicat group?
3. Which GGSCI command creates an Oracle GoldenGate checkpoint table on the target database?
4. What is the purpose of **`DiscardFile`**?
5. Which parameter manages conflicts between initial load and change replication? Where is it specified?

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Answers

1. Replicat reads change data from Oracle GoldenGate trails and applies it to a target database by using SQL commands.
2. `Edit Params`
   `Add Replicat`
   `Start Replicat`
3. `Add CheckpointTable` (must be logged in to the database)
4. `DiscardFile` identifies operations that could not be processed by Replicat.
5. `HandleCollisions`, which is specified in the Replicat parameter file for change delivery. Turn it off after initial load data is processed.

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Quiz

Which of the following tools would you use to determine whether all Oracle GoldenGate processes are up and running?

a. `tcperrs`

b. `CMDSEC`

c. GGSCI

d. Process report

e. Oracle GoldenGate Monitor

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Answer: c, d, e

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Quiz

Which files are used to capture information about the Oracle GoldenGate operations that have failed?

a. Discard files

b. Purge trail files

c. `tcperrs` files

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Answer: a

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Summary

In this lesson, you should have learned how to:

- Explain what the Replicat process does
- Add, configure, and start a Replicat process
- Configure Replicat to handle collisions between changes and the initial load data
- Troubleshoot a started solution

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Practice 6 Overview: Configuring Change Delivery

This practice covers the following topics:

- Setting up the checkpoint table on the target system
- Setting up Replicat delivery
- Generating DML data
- Starting Oracle GoldenGate processes
- Stopping processes and checking statistics

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7

Managing Extract Trails and Files

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Objectives

After completing this lesson, you should be able to:

- Describe and contrast Extract trails and files
- Describe the formats that Extract trails and files can have
- View Extract trails and files by using **`logdump`**
- Describe the **`reverse`** utility

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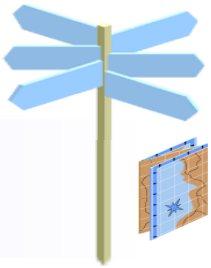
Agenda

- Trail Format
  - Local and Remote
  - Cleanup
  - Record Header Area
  - Record Data Area
- Alternative Trail Formats
- `logdump`
- `reverse`



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Extract Trails and Files: Overview

- Extract writes data to any of the following:
  - Local trail (**`ExtTrail`**) on the local system
  - Local file (**`ExtFile`**) on the local system
  - Remote trail (**`RmtTrail`**) on a remote system
  - Remote file (**`RmtFile`**) on a remote system
- Extract trails and files are unstructured, with variable length records.
  - I/O is performed using large block writes.
- Extract writes checkpoints for trails during change capture:
  - This guarantees that no data is lost during restart.
  - Multiple Replicat processes may process the same trail.
- Extract does not write checkpoints for files.

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Oracle GoldenGate trails support the continuous extraction and replication of database changes and store them temporarily on disk. A trail can exist on the source or target system, or on an intermediary system, depending on how you configure Oracle GoldenGate. A trail can reside on any platform that Oracle GoldenGate supports.

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Extract Trails and Files Distribution

- Extract can write to:
  - Local trails, and then distribute over IP with a data pump to remote trails
  - Multiple trails:
    - For distribution to multiple systems/disk storage devices
    - For parallel processing by downstream processes
- Trails and files can be transported online using TCP/IP or sent in batch using any file transfer method.

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When transporting trails via TCP/IP, a Server Collector process on the target platform collects, writes, and checkpoints blocks of records in one or more extract files.

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Extract Trails and Files Contents

- Each record in the trail contains an operation that has been committed in the source database.
- Committed transactional order is preserved.
- Operations in a transaction are grouped together in the order in which they were applied.
- By default, only the primary key and changed columns are recorded.
- Flags indicate the first and last records in each transaction.
- Starting from Oracle GoldenGate release 12.2, the trail files also contain metadata information about database objects being replicated.

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You can examine the contents of trail files directly by using the `logdump` utility if you need to troubleshoot. `logdump` is covered later in this lesson.

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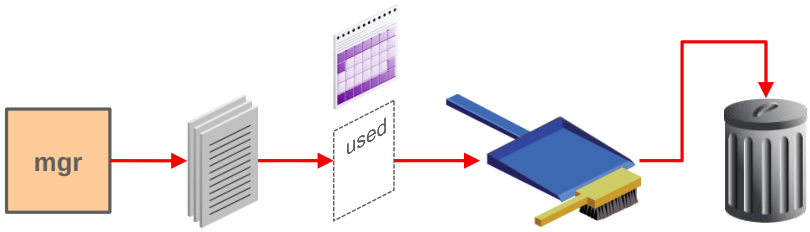
Extract Trails and Files Cleanup

Trail files can be purged after they are consumed:

- The temporary storage requirement is small if processes keep pace.
- Configure the Manager to purge used trail data (best practice).



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You can configure more than one Replicat to process a trail. After all of the data has been consumed, Replicat can then purge the data by using the `MinKeepDays` parameter. As long as Replicat remains current, your temporary storage requirements for trails can be very low.
If multiple Replicat processes are configured against a single trail, you can instruct the Manager to purge the data in the trail as soon as all checkpoints have been resolved. As long as replication processes keep pace, temporary storage requirements can be kept quite low.

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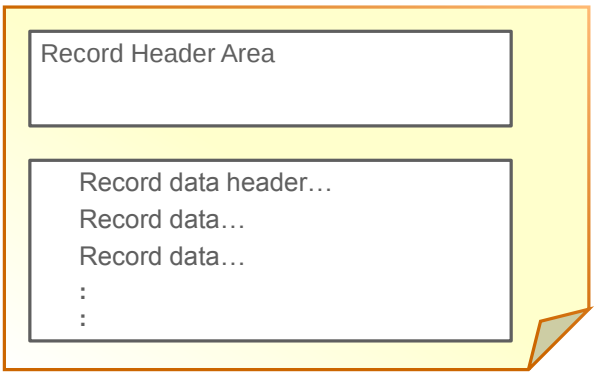
Trail Format

- By default, trails are formatted in canonical format, allowing them to be exchanged rapidly and accurately among heterogeneous databases.
- Each trail file contains the following:
  - Record header area
  - Record data area



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Oracle GoldenGate Trails

Trail files are unstructured files containing variable length records. They are unstructured and written in large blocks for best performance. Trail files contain:

- **Record header area:** Stored at the beginning of the file and contains information about the trail file itself
- **Record data area:** Contains a header area as well as a data area

Checkpoints

Both Extract and Replicat maintain checkpoints into the trails. Checkpoints provide persistent processing whenever a failure occurs. Each process resumes where the last checkpoint was saved, guaranteeing that no data is lost. One Extract can write to one or many trails. Each trail can then be processed by one or many Replicat processes.

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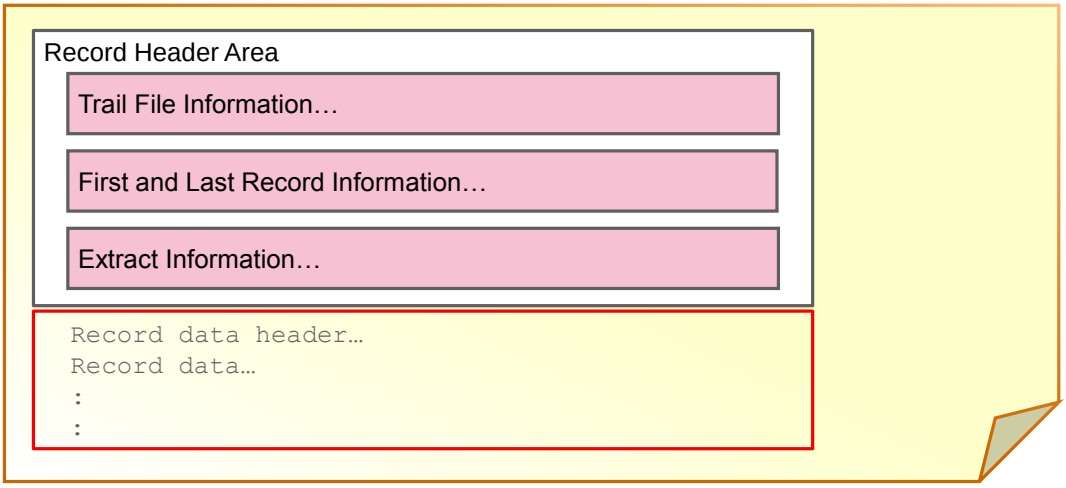
Record Header Area

Trail file:



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Each trail file has a record header area that contains:

- Trail File Information
  - Compatibility level
  - Character set (globalization function with version 11.2.1 and later)
  - Creation time
  - File sequence number
  - File size
- First and Last Record Information
  - Time stamp
  - Commit Sequence Number (CSN)
- Extract Information
  - Oracle GoldenGate version
  - Group name
  - Host name and Hardware type
  - OS type and version
  - DB type, version, and character set

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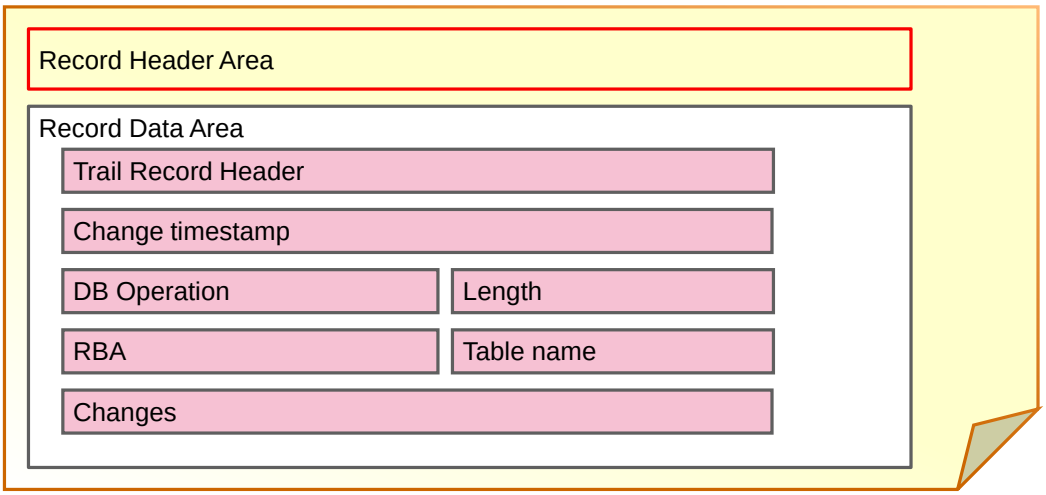
Record Data Area

Trail file:



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The trail file header and the data area of the Oracle GoldenGate trail record contain:

- Trail record header
- The time that the change was written to the Oracle GoldenGate file
- The type of database operation (Insert, Update, Delete)
- The length of the record
- The relative byte address within the trail file
- The table name
- The data changes in hex format
- Optional user token area

The contents of the record header and data areas are discussed (with an example) in the section "Viewing Trail Records" later in this lesson.

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Setting the Compatibility Level

- The ***<major>.<minor>*** setting identifies the trail file format version numbers used by Oracle GoldenGate.
- This allows customers to use different versions of Oracle GoldenGate Extract, trail files, and Replicat together.
- The compatibility level is set in the Extract **ExtFile**, **ExtTrail**, **RmtFile**, or **RmtTrail** parameter:

```
:
RmtTrail ./dirdat/ex, Format Release 12.3
:
```

- The input and output trails of a data pump must have the same compatibility level.

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It is recommended that all instances of Oracle GoldenGate be the same version to take advantage of the new functionality. However, this is not required.

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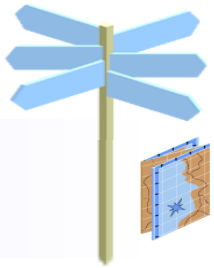
Agenda

- Trail Format
- Alternative Trail Formats
  - Logical Change Records (LCRs)
  - Text (ASCII and UTF)
  - SQL
  - XML
- `logdump`
- `reverse`



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Alternative Trail Formats

- Instead of the default canonical format, alternative formats can be used to output data.
- This is beneficial if database load utilities or other programs are used that require different input.
- These alternative formats include:
  - Logical Change Records (LCRs)
  - **`FormatASCII`**
  - **`FormatSQL`**
  - **`FormatXML`**

  Obsolete in OGG 12.3. Now:

  ```
  OutputFormat  TEXT
  OutputFormat  SQL
  OutputFormat  XML
  ```
- The new 12.3 syntax is more powerful and expressive. Each major format (Text, SQL, and XML) can now have multiple options that further specify various output subvariants, as well as requesting the output to follow ISO and UTF standards.

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The benefits of each alternative format are discussed in the next few slides.

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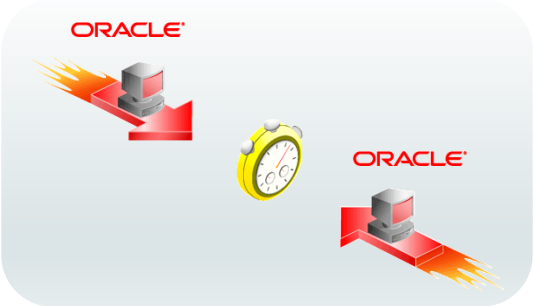
Logical Change Records (LCRs)

- Instead of applying SQL-type statements (slower), LCRs enable the APIs to interact with Oracle Database directly (faster).
- However, LCRs are:
  - Oracle-to-Oracle only
  - Integrated Capture only
  - 11*g* and later only



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The integrated mode (and, therefore, the LCR trail) is the platform to which new features will be added. New features may or may not be added to the Classic Capture mode, which produces the canonical trails for Oracle and non-Oracle databases. The specific 11*g* version depends on the topology, not all 11*g* versions are supported in all topologies.

LCRs are not an option for non-Oracle databases, such as IBM DB2, Microsoft SQL Server, and so on, and also do not apply to non-flagship Oracle databases, such as MySQL or TimesTen.

Use of Integrated Replicat will convert canonical format to LCR format at the target using the Lightweight Streaming API.

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OutputFormat Text

- Output is in external ASCII format.
- **OutputFormat Text** is required by the file-to-database-utility initial-load method.
- The **OutputFormat Text** statement must be before the extract files or trails statements that are listed in the parameter file.
- **OutputFormat Text** can format data for popular database load utilities:
  - **OutputFormat Text BCP**: Formats the output for compatibility with SQL Server's Bulk Copy Program and other bulk load utilities
  - **OutputFormat Text SQLLOADER**: Produces a fixed-length text formatted file that is compatible with the Oracle SQL*Loader utility or the IBM load utility
- Data output in text format cannot be processed by Oracle GoldenGate Replicat because Replicat expects the default canonical format.

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Use the `FormatASCII` parameter to output data in external ASCII format instead of the default Oracle GoldenGate canonical format. Using `FormatASCII`, you can format output that is compatible with most database load utilities and other programs that require ASCII input.

Using the `FormatASCII, BCP` option provides output that is compatible with SQL Server's BCP, DTS, or SQL Server Integration Services (SSIS) bulk-load utility. The `FormatASCII, SQLLOADER` option produces a fixed-length, ASCII-formatted file that is compatible with the Oracle SQL*Loader utility or the IBM Load Utility program.

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`OutputFormat Text` Sample Output

Example 1. **`OUTPUTFORMAT TEXT`** without options produces:

```
I,A,AMER.WEST.ACCOUNT,ACCOUNT_NUMBER,1,ACCOUNT_BALANCE,'914.18'
I,A,AMER.WEST.ACCOUNT,ACCOUNT_NUMBER,2,ACCOUNT_BALANCE,'2072.65'
I,A,AMER.WEST.ACCOUNT,ACCOUNT_NUMBER,3,ACCOUNT_BALANCE,'7767.49'
```

Example 2. **`OUTPUTFORMAT TEXT , NONAMES, DELIMITER '|'`** produces:

```
I|A|AMER.WEST.ACCOUNT|1|'914.18'
I|A|AMER.WEST.ACCOUNT|2|'2072.65'
I|A|AMER.WEST.ACCOUNT|3|'7767.49'
```

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In Example 1:

- The transaction begins (B)
- A record is added (I)
- A record is updated (V)
- The transaction commits (C)

Note that Example 2 returns column names for the `CUSTNAME` and `BALANCE` columns because the record is a compressed update and `PLACEHOLDERS` was not used.

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OutputFormat SQL

- Output is in external SQL DML format.
- **OutputFormat SQL** generates SQL statements (**INSERT**, **UPDATE**, and **DELETE**) that can be applied to both SQL and Enscribe tables.
- The Encoding option allows to further specify the SQL output:
  - **Oracle:** Formats records for compatibility with Oracle Databases by converting date and time columns to a format accepted by SQL*Plus
  - **SQLLOADER**: Produces a fixed-length text formatted file that is compatible with the Oracle SQL*Loader utility or the IBM load utility program
- Data output in SQL format cannot be processed by Oracle GoldenGate Replicat because Replicat expects the default canonical format.

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Every record in a transaction is contained between the begin and commit indicators. Each combination of commit time stamp and relative byte address (RBA) is unique. The output can be customized with optional arguments.

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`OutputFormat SQL` Sample Output

```
INSERT INTO AMER.WEST.ACCOUNT (ACCOUNT_NUMBER,ACCOUNT_BALANCE) VALUES
     (1,'914.18');
INSERT INTO AMER.WEST.ACCOUNT (ACCOUNT_NUMBER,ACCOUNT_BALANCE) VALUES
     (2,'2072.65');
INSERT INTO AMER.WEST.ACCOUNT (ACCOUNT_NUMBER,ACCOUNT_BALANCE) VALUES
     (3,'7767.49');
INSERT INTO AMER.WEST.ACCOUNT (ACCOUNT_NUMBER,ACCOUNT_BALANCE) VALUES
     (4,'7945.73');
INSERT INTO AMER.WEST.ACCOUNT (ACCOUNT_NUMBER,ACCOUNT_BALANCE) VALUES
     (5,'3856.77');
INSERT INTO AMER.WEST.ACCOUNT (ACCOUNT_NUMBER,ACCOUNT_BALANCE) VALUES
     (6,'238.56');
INSERT INTO AMER.WEST.ACCOUNT (ACCOUNT_NUMBER,ACCOUNT_BALANCE) VALUES
     (7,'8567.07');
```

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This SQL format is not compact, but it is very portable. The `FormatSql` parameter can be used to monitor what is being captured. It can also be used to create a SQL script that can be used in SQL*Plus. For example, a SQL script can be created to apply missed transactions in a recovery.

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OutputFormat XML

- **OutputFormat XML** generates SQL statements (**INSERT**, **UPDATE**, **DELETE**) that can be applied to SQL tables by utilities other than Oracle GoldenGate Replicat.
- XML stored as CLOB or BLOB is output up to 4000 bytes. To include larger XML stored as BLOB or CLOB, use the **ENCODING** option.
  - XML stored as CLOB is always output in a CDATA section regardless of its size. This is to avoid the overhead of converting reserved characters such as <, >, and & to the appropriate XML representation.
- Binary data including BLOB are encoded as Base64, which represents binary data in an ASCII string format and allows output to XML.

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The XML, the database object names, such as table and column names, and CHAR and VARCHAR data are written in the default character set of the operating system unless the ENCODING option is used to output in UTF-8.

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`OutputFormat XML` Sample Output

```
<?xml version="1.0" encoding="UTF-8"?>
<OracleGoldenGateFormatXML>
  <dbupdate table="AMER.WEST.ACCOUNT" type="insert">
    <columns>
      <column name="ACCOUNT_NUMBER" key="true">1</column>
      <column name="ACCOUNT_BALANCE">914.18</column>
    </columns>
  </dbupdate>
  <dbupdate table="AMER.WEST.ACCOUNT" type="insert">
    <columns>
      <column name="ACCOUNT_NUMBER" key="true">2</column>
      <column name="ACCOUNT_BALANCE">2072.65</column>
    </columns>
  </dbupdate>
</OracleGoldenGateFormatXML>
```

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This XML format is not very compact, but it is very portable.

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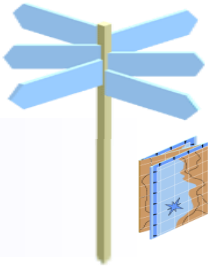
Agenda

- Trail Format
- Alternative Trail Formats
- **`logdump`**
  - Opening
  - Viewing
  - Filtering
- `reverse`



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logdump Utility

- The **logdump** utility enables you to:
  - Display or search for information that is stored in Oracle GoldenGate trails or extract files
  - Save a portion of an Oracle GoldenGate trail to a separate trail file
- To start **logdump** from the Oracle GoldenGate installation directory:

```
[OS prompt] ./logdump
```

- To access help:

```
[OS prompt] Logdump 1> help
```

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`logdump` provides access to Oracle GoldenGate trails, which are unstructured files with a variable record length. Each record in the trail contains a header (known as the GGS Header, unless the `NoHeaders` Extract parameter was used), an optional user token area, and the data area.

For more information about the `logdump` utility, see the *Oracle GoldenGate Troubleshooting and Tuning Guide.*

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Opening a Trail

```
Logdump> open dirdat/rt000000000
Current LogTrail is /ggs/dirdat/rt000000000
```

Response/confirmation

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The syntax to open a trail is:

`Open <file_name>`

In this syntax, `<file_name>` is either the relative name or a fully qualified name of the file, including the file sequence number. `logdump` reads one trail file at a time.

The log sequence number is made of 9 digits after the trail file name, for a total of 11 characters for each trail file name.

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Setting Up a View

- To view the trail file header:

```
Logdump 1> fileheader on
```

- To view the record header with data:

```
Logdump 2> ghdr on
```

- To add column information:

```
Logdump 3> detail on
```

- To add hex and ASCII data values to the column list:

```
Logdump 4> detail data
```

- To control how much record data is displayed:

```
Logdump 5> reclen 280
```

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fileheader `[on | off | detail]` controls whether or not the trail file header is displayed.

ghdr `[on | off]` controls whether or not the record header is displayed with each record. Each record contains a header that includes information about the transaction environment. Without arguments, `ghdr` displays the status of header display (ON or OFF).

detail `{on | off | data}`

- `DETAIL ON` displays a list of columns that includes the column ID, length, and value in hex and ASCII.
- `DATA` adds hex and ASCII data values to the column list.
- `DETAIL OFF` turns off detailed display.

Usertoken: By default, the name of the token and its length are displayed. Use the `USERTOKEN DETAIL` option to show the actual token data. User tokens are discussed in the lesson titled "Additional Transformation and Configuration Options."

reclen controls how much of the record data is displayed. You can use `reclen` to control the amount of scrolling that must be done when records are large, while still showing enough data to evaluate the record. Data beyond the specified length is truncated.

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Viewing the Trail File Header

```
Logdump 14662 > fileheader detail
Logdump 14663 > pos 0
Reading forward from RBA 0
Logdump 14664 > n

TokenID x46 'F' Record Header    Info x00  Length  587
TokenID x30 '0' TrailInfo        Info x00  Length  303
TokenID x31 '1' MachineInfo      Info x00  Length  103
TokenID x32 '2' DatabaseInfo     Info x00  Length   88
TokenID x33 '3' ProducerInfo     Info x00  Length   85
TokenID x34 '4' ContinunityInfo  Info x00  Length    4
TokenID x5a 'Z' Record Trailer   Info x00  Length  587
2008/07/18 13:40:26.034.631 FileHeader           Len   587 RBA 0
Name: *FileHeader*
 3000 012f 3000 0008 660d 0a71 3100 0006 0001 3200 | 0../0...f..q1.....2.
 0008 0000 0016 3300 000c 02f1 7834 eac7 7f3f 3400 | ......3.....x4...?4.
 0037 0031 7572 693a 7465 6c6c 7572 6961 6e3a 3a68 | .7.1uri:tellurian::h
 6f6d 653a 6d63 6361 7267 6172 3a67 6773 3a67 6773 | ome:mccargar:ggs:ggs
 4f72 6163 6c65 3a73 6f75 7263 6536 0000 1700 112e | Oracle:source6......
 2f64 6972 6461 742f 6572 3030 3030 3030 3700 0005 | /dirdat/er0000007...
 0138 0000 0800 01e2 4039 0000 0c00 0000 0000 001d | .8......@9..........
GroupID x30 '0' TrailInfo        Info x00  Length  303
 3000 012f 3000 0008 660d 0a71 3100 0006 0001 3200 | 0../0...f..q1.....2.
 etc.
```

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If the file header `[on|detail]` option is used, the file header data is displayed.

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Viewing Trail Records

- To go to the first record and to move from one record to another in sequence:

```
Logdump 6 > pos 0
Logdump 7 > next
```

Or just type **n**.

- To position at an approximate starting point and locate the next good header record:

```
Logdump 8 > pos <approximate RBA>
Logdump 9 > scanforheader
```

Or just type **sfh**.

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position | pos [*<RBA>* | 0 | FIRST]: You can position on the first record using `0` or `FIRST` or on a relative byte address.

scanforheader | sfh [prev]: Use `scanforheader` to go to the next record header. Adding the `prev` option will display the previous header. Before using this command, use the `ghdr on` command to show record headers.

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Viewing Canonical Trail Records

```
Logdump 10 > next

Hdr-Ind    :     E  (x45)     Partition  :     .  (x04)
UndoFlag   :     .  (x00)     BeforeAfter:     A  (x41)
RecLength  :    26  (x001a)   IO Time    : 2013/11/08 15:20:06.000.000
IOType     :     5  (x05)     OrigNode   :   255  (xff)
TransInd   :     .  (x03)     FormatType :     R  (x52)
SyskeyLen  :     0  (x00)     Incomplete :     .  (x00)
AuditRBA   :        86        AuditPos   : 20450320
Continued  :     N  (x00)     RecCount   :     1  (x01)

2013/11/08 15:20:06.000.000 Insert               Len    26 RBA 1479
Name: WEST.ACCOUNT
After  Image:                                              Partition 4   G  s
 0000 000a 0000 0000 0000 0000 07d7 0001 0008 0000 | ....................
 0004 3730 3030                                   | ..7000
Column     0 (x0000), Len    10 (x000a)
 0000 0000 0000 0000 07d7                         | ...  .....
Column     1 (x0001), Len     8 (x0008)
 0000 0004 3730 3030                              | .    000
```

Record header contains transaction information. Below header is data area.

I/O type

Operation type and the time that the record was written

Length of the record and its RBA position in the trail file

Source table name

Image type: Could be a Before or After image

Record data, in ASCII

Columns information

Record data, in hex

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Oracle GoldenGate trail files are unstructured. The Oracle GoldenGate record header provides metadata of the data contained in the record and includes the following information:

- The operation type, such as an insert, an update, or a delete
- The transaction indicator (`TransInd`): `00` beginning, `01` middle, `02` end, or `03` whole of transaction
- The before or after indicator for updates
- Transaction information, such as the transaction group and commit time stamp
- The time that the change was written to the Oracle GoldenGate file
- The type of database operation
- The length of the record
- The relative byte address within the Oracle GoldenGate file
- The table name

The change data is shown in hex and ASCII format. If before images are configured to be captured (for example, to enable a procedure to compare before values in the `WHERE` clause), a before image also would appear in the record. The format varies slightly in different GoldenGate versions.

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Counting Records in the Trail

```
Logdump> count

LogTrail /ggs/dirdat/rt000000 has 4828 records
Total Data Bytes            334802
  Avg Bytes/Record              69
Delete                         900
Insert                        3902
FieldComp                       26
Before Images                  900
After Images                  3928

Average of 25 Transactions
    Bytes/Trans .....      22661
    Records/Trans ...        193
    Files/Trans .....          8
```

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The basic output, without options, shows the following:

- The RBA where the count began
- The number of records in the file
- The total data bytes and average bytes per record
- Information about the operation types
- Information about the transactions

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Counting Records in the Trail

```
TCUSTMER
   Total Data Bytes            10562
     Avg Bytes/Record             55
     Delete                      300
    Insert                      1578
    FieldComp                     12
    Before Images                300
    After Images                1590

TCUSTORD
   Total Data Bytes           229178
   Avg Bytes/Record               78
                        Delete                      600
                        Insert                     2324
                        Field Comp                   14
                        Before Images               600
                        After Images               2338
```

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Syntax:

```
COUNT
[, DETAIL]
[, END[TIME] <time_string>]
[, FILE <specification>]
[, INT[ERVAL] <minutes>]
[, LOG] <wildcard>]
[, START[TIME] <time_string>]
```

`COUNT` options enable you to:

- Show table detail without using the `DETAIL` command first
- Set a start and end time for the count
- Filter the count for a table, data file, trail file, or extract file
- Specify a time interval for counts

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Filtering by a File Name

```
Logdump 7 > filter include filename TCUST*
Logdump 8 > filter match all
Logdump 9 > n ____________________________________________________________________
    Hdr-Ind    :     E  (x45)     Partition  :     .  (x00)
    UndoFlag   :     .  (x00)     BeforeAfter:     A  (x41)
    RecLength  :    56  (x0038)   IO Time    : 2002/04/30 15:56:40.814
    IOType     :     5  (x05)     OrigNode   :   108  (x6c)
    TransInd   :     .  (x01)     FormatType :     F  (x46)
    SyskeyLen  :     0  (x00)     Incomplete :     .  (x00)
    AuditRBA   : 105974056

    2002/04/30 15:56:40.814  Insert     Len   56   Log RBA 1230
    File: TCUSTMER                 Partition 0
    After  Image:
     3220 2020 4A61 6D65 7320 2020 2020 4A6F 686E 736F   | 2 James Johnso
     6E20 2020 2020 2020 2020 2020 2020 4368 6F75 6472   | n Choudr
     616E 7420 2020 2020 2020 2020 2020 4C41             | LA

    Filtering suppressed      18 records
```

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Use the `Filter` option to filter the display based on one or more criteria. `Filename` specifies a SQL table, NonStop data file, or group of files. An asterisk (`*`) wildcard can be used to specify multiple tables. You can string multiple `Filter` commands together, separating each one with a semicolon, as in the following example:

```
Filter INCLUDE FILENAME fin.act*; Filter RECTYPE 5; Filter MATCH ALL
```

To avoid unexpected results, avoid stringing filter options together with one `Filter` command. For example, the following would be *incorrect*:

```
Filter INCLUDE FILENAME fin.act*; RECTYPE 5; MATCH ALL
```

Without arguments, `Filter` displays the current filter status (ON or OFF) and any filter criteria that are in effect.

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Locating a Hex Data Value

```
Logdump 27 > filter inc hex /68656C20/
Logdump 28 > pos 0
Current position set to RBA
Logdump 29 > n _____________________________________________________________
   Hdr-Ind    :     E  (x45)     Partition  :     .  (x00)
   UndoFlag   :     .  (x00)     BeforeAfter:     B  (x42)
   RecLength  :    56  (x0038)   IO Time    : 2002/04/30 16:22:14.205
   IOType     :     3  (x03)     OrigNode   :   108  (x6c)
   TransInd   :     .  (x01)     FormatType :     F  (x46)
   SyskeyLen  :     0  (x00)     Incomplete :     .  (x00)
   AuditRBA   : 109406324

   2002/04/30 16:22:14.205  Delete                  Len   56   Log RBA 64424
   File: TCUSTMER                  Partition 0
   Before Image:
    3620 2020 4A61 6D65 7320 2020 2020 4A6F 686E 736F | 6   James Johnso
    6E20 2020 2020 2020 2020 2020 2020 4574 6865 6C20 | n   Ethel
    2020 2020 2020 2020 2020 2020 2020 4C41           |     LA
   Filtering suppressed    545 records
```

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The example in the slide includes a hex range.

The `Filter` command can `INCLUDE | EXCLUDE` the following options:

`AUDITRBA <rba> [<comparison operator>]`

`CLEAR {<filter_spec> | ALL}`

`ENDTIME <time_string>`

`FILENAME <name> [, <name>]`

`HEX <hex_string> [<byte_range>] [, ...]`

`INT16 <16-bit_integer> | INT32 <32-bit_integer>`

`IOTYPE <operation type> [, <operation type>]`

`MATCH {ANY | ALL}`

`DISABLE | OFF`

`ENABLE | ON`

`CSN | LogCSN`

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```
PROCESS <process_name>
RBA <byte address> [<comparison operator>] [...]
RECLEN <length> [<comparison operator>]
RECTYPE {<type_number> | <type_name>}
SHOW
STARTTIME <time_string>
STRING [BOTH] [B],<text> [<column_range>]
[[B],<text> [<column_range>]] [...]
SYSKEY <system key> [<comparison operator>] [...]
TRANSIND <indicator> [<comparison operator>]
TYPE <type>
UNDOFLAG <type> [<comparison operator>]
```

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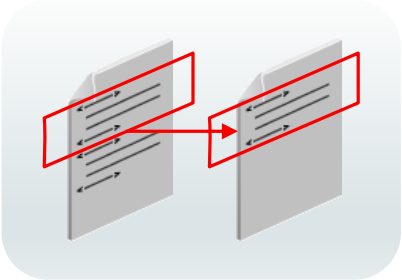
Saving Records to a New Trail

To save the 10 records from the current position in the file, issue the following command:

```
Logdump> save newtrail 10 records
```



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Use `Save` to write a subset of the records to a new trail or an extract file. By saving a subset to a new file, you can work with a smaller file. Saving to another file also enables you to extract valid records that can be processed by Oracle GoldenGate, while excluding records that may be causing errors.

`Save` options enable you to overwrite an existing file, save a specified number of records or bytes, suppress comments, use the old or new trail format, set the transaction indicator (first, middle, end, only), and clean out an existing file before writing new data to it.

Syntax:

```
Save <file_name> [!] {<n> records | <n> bytes}[NoComment]
[OldFormat | NewFormat]
[TRANSIND <indicator>]
[Truncate]
```

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Keeping a Log of Your Session

- To start and stop the logging of a `logdump` session, use the **`Log`** option:

```
Logdump> Log to MySession.txt
```

- When enabled, logging remains in effect for all sessions of Logdump until it is disabled with the `Log Stop` command:

```
Logdump> Log Stop
```

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Use `Log` to start and stop the logging of `logdump` sessions. When enabled, logging remains in effect for all sessions of `logdump` until it is disabled with the `Log STOP` command. Without arguments, `Log` displays the status of logging (ON or OFF). An alias for `Log` is `Out`.

Syntax :

`Log {<file_name> | Stop}`

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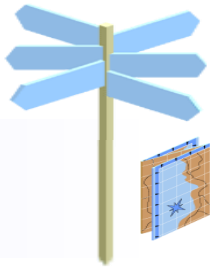
Agenda

- Trail Format
- Alternative Trail Formats
- `logdump`
- **`reverse`**
  - Overview
  - Parameters



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`reverse` Utility: Overview

The `reverse` utility:

- Reorders operations within Oracle GoldenGate trails in reverse sequence
- Provides the ability to selectively back out of certain operations (such as corrupt data or accidental delete operations) while keeping the rest of the application alive
- Is used to restore a database to a specific point in time, providing the ability to back out all operations during regression testing to restore the original test baseline
- Is an OS command rather than a `GGSCI` command

The `reverse` utility has been deprecated in Oracle GoldenGate release 12.3. Oracle recommends using other options for point-in-time recovery, such as the Oracle Flashback facility.

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The `reverse` utility uses before images to undo database changes for specified tables, records, and time periods. It enables you to perform a selective backout, unlike other methods that require restoring the entire database. An alternative to using the `reverse` utility is an Oracle Flashback table feature.

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Discussion Questions

1. What is a trail?
2. In what formats are Extract trails and files written?
3. Which Oracle GoldenGate utility enables you to view trail contents?

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Answers

1. A trail is a series of files on disk where Oracle GoldenGate stores data for further processing.
2. Oracle GoldenGate trail format (canonical), LCR, Text (ASCII or UTF), SQL, XML
3. `logdump`

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Summary

In this lesson, you should have learned how to:

- Describe and contrast Extract trails and files
- Describe the formats that Extract trails and files can have
- View Extract trails and files by using `logdump`
- Describe the `reverse` utility

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Practice 7 Overview: Using Extract Trails and Files

This practice covers using the `logdump` utility.

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8

Oracle GoldenGate Parameters

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Objectives

After completing this lesson, you should be able to:

- Edit parameter files
- Compare `GLOBALS` parameters with process parameters
- Describe commonly used parameters for:
  - `GLOBALS`
  - Manager
  - Extract
  - Replicat
  - Both Extract and Replicat

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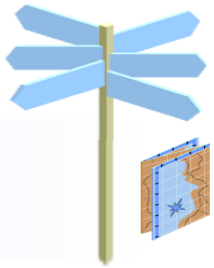
Agenda

- GLOBALS
  - Overview
  - Examples
- Manager
- Extract
- Replicat



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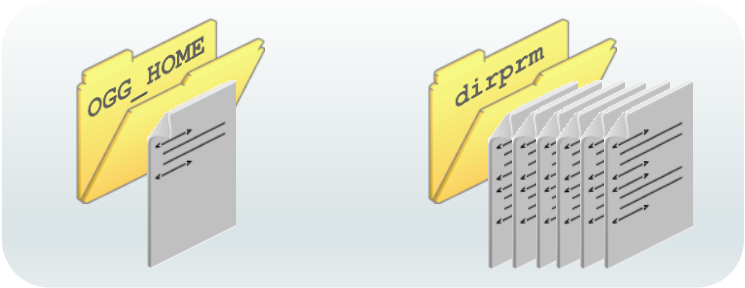
Oracle GoldenGate Parameter Files

There are two types of parameter files:

- **`GLOBALS` file (one):** Stores parameters that relate to the Oracle GoldenGate instance as a whole
- **Runtime parameter files (many):** Are coupled with a specific process (such as Extract or Replicat)



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Most Oracle GoldenGate functionality is controlled by means of parameters specified in parameter files. A parameter file is an ASCII file that is read by an associated process. Oracle GoldenGate uses two types of parameter files:

- A `GLOBALS` file, which cannot have any extension (Beware of text editors that try to append `.txt` to the file name after creation.) There is at most one `GLOBALS` file per instance.
- Runtime parameter files, which have an extension of `.prm`. Examples include:
  - Extract (both primary and data pump)
  - Replicat
  - Manager

There can be many (hundreds or more) parameter files per instance.

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Using Parameter Files

- To create a parameter file in GGSCI, use the `EDIT PARAM` option.
- The `GLOBALS` parameter file is identified by its file path:

```
GGSCI> Edit Param ./GLOBALS
```

- Manager and utility parameter files are identified by keywords:

```
GGSCI> Edit Param mgr
GGSCI> Edit Param defgen
```

- Extract and Replicat parameter files are identified by the process group name:

```
GGSCI> Edit Param <group_name>
```

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Before editing, set your default editor to whatever you prefer:

```
GGSCI> Set Editor notepad
GGSCI> Set Editor vi
GGSCI> Set Editor gedit
```

`Notepad` is the default editor for Windows; `vi` is the default for Linux. Whatever you set is valid only for that session; it is not retained after `exit` and there is no way to permanently change the defaults.

You can edit any of the files outside GGSCI as well. You can create the `GLOBALS` file manually by using any text editor. Make sure that the file name is in uppercase and has no extension. (Editors usually append `.txt` to the file name, which will break the process.)

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GLOBALS Versus Process Parameters

- **GLOBALS** parameters apply to all processes.
  - These are set when Manager starts.
  - They reside in ***<OGG_HOME>*/GLOBALS**.
- Process parameters apply to a specific process (Manager, Extract, Server Collector, Replicat, and utilities).
  - These are set when the process starts.
  - They override **GLOBALS** settings.
  - By default, they reside in the **dirprm** directory in files named ***<processname>*.prm**.
  - Most apply to all the tables that are processed, but some can be specified at the table level.

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Parameters manage all Oracle GoldenGate components and utilities, enabling you to customize your data management environment to suit your needs.

Processwide Parameters

These apply to all the tables that are specified in the parameter file for the process. These parameters can appear anywhere in the parameter file, and each should be listed only once in the file. If they are listed more than once, only the last instance of the parameter is active. All other instances are ignored.

Table-Specific Parameters

These control processing for the tables that are specified with a `Table` or `Map` statement. Table-specific parameters enable you to designate one set of processing rules for some tables, while designating other rules for other tables. Table-specific parameters take effect in the order in which each parameter is listed in the parameter file. There are two implementations for file-specific parameters:

- Toggling the parameter on and off for one or more `Table` or `Map` statements
- Adding the parameter within a `Map` statement so that it applies only to that table or file

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GLOBALS Parameters

- **GLOBALS** parameters:
  - Control things that are common to all processes in an Oracle GoldenGate instance
  - Can be overridden by parameters at the process level
- Exit GGSCI for new parameters to take effect.
- After the **GLOBALS** parameters are set, they are rarely changed.
- Some of the most common parameters include:
  - **MgrServName ggsmanager1:** Defines a unique Manager service name on Windows
  - **CheckPointTable oggadmin.ggschkpt:** Defines the default table name used for the Replicat checkpoint table

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CheckPointTable: Defines the table name used for Replicat's checkpoint table. You can use any `schema.name`; the name shown is only by convention.

MgrServName: Is valid only for Windows. It defines the name of the Manager service that is used for starting or stopping the Manager process. This service name is also used when you run the `INSTALL` utility to add the Windows service.

Parameters for Oracle DDL Replication

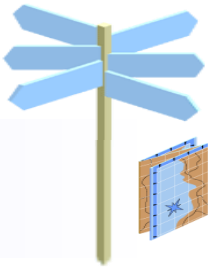
- **GGSchema:** Specifies the name of the schema that contains the database objects that support DDL synchronization for Oracle
- **DDLTable:** Specifies a nondefault name for the DDL history table that supports DDL synchronization for Oracle
- **MarkerTable:** Specifies a nondefault name for the DDL marker table that supports DDL synchronization for Oracle

After you add or change any `GLOBALS` parameters, you must exit GGSCI for the new parameters to take effect.

Oracle Internal & Oracle Academy Use Only

Agenda

- GLOBALS
- Manager
  - Overview
  - Examples
- Extract
- Replicat



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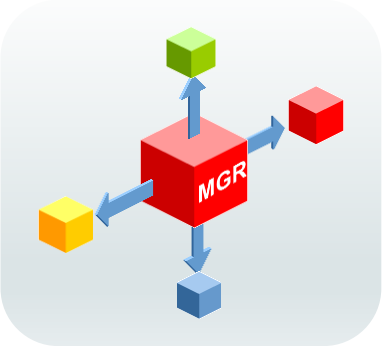
Manager Parameters: Overview

- The Manager is the Oracle GoldenGate parent process.
- The Manager controls other Oracle GoldenGate processes, resources, user interface, and reporting of thresholds and errors.



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You always need to specify unique ports* for each Manager process. The remaining default parameter settings usually suffice. The Manager is not required for the operation of Oracle GoldenGate replication; it is required only for starting, stopping, and changing processes. This allows you to alter and bounce the Manager settings without service disruption.

* **Note:** Actually, a combination of IP address and port makes the Manager unique. So, 10.0.0.**1**:7000 and 10.0.0.**2**:7000 are considered unique, but it is a good practice to keep the ports themselves dedicated and unique.

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Sample Manager Parameter File

```
-- Some Comment with leading double-dashes.
-- Created by Joe Admin on 10/11/2017.
Port 7809
DynamicPortList 9001-9100
Autostart ER *
AutoRestart Extract *, WaitMinutes 2, Retries 5
LagReportHours 1
LagInfoMinutes 3
LagCriticalMinutes 5
PurgeOldExtracts ./dirdat/rt*, UseCheckpoints
```

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- **`--`**: If you copy and paste text into parameter files, beware of editors that try to turn a double-minus into two en dashes (different character) or one big em dash.
- **`Port`**: Establishes the TCP/IP port number on which Manager listens for requests
- **`DynamicPortList`**: Specifies the ports that Manager can dynamically allocate
- **`Autostart`**: Specifies the processes that are to be automatically started when Manager starts
- **`AutoRestart`**: Specifies the processes to be restarted after abnormal termination
- **`LagReportHours`**: Sets the interval, in hours, at which Manager checks the lag for Extract and Replicat processing. Alternatively, this can be set in minutes.
- **`LagInfoMinutes`**: Specifies the interval at which Extract and Replicat will send an informational message to the event log. Alternatively, this can be set in seconds or hours.
- **`LagCriticalMinutes`**: Specifies the interval at which Extract and Replicat will send a critical message to the event log. Alternatively, this can be set in seconds or hours.
- **`PurgeOldExtracts`**: Purges the Oracle GoldenGate trails that are no longer needed, based on option settings

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Manager Parameter Categories

Category	Parameter Summary
General	Allows comments in the parameter file; filters messages that are written to the system logs
Port Management	Establishes the TCP/IP port; specifies a time to wait before assigning a port number
Process Management	Determines the processes and how long after a failure they are restarted
Event Management	Reports processes that stop abnormally; determines the information that is reported to the error log
Database Login	Provides login information
Maintenance	Maintains trails, including trail data that is no longer needed

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For a complete list of Manager parameters and definitions, see the *Oracle GoldenGate Windows and UNIX Reference Guide 12c*.

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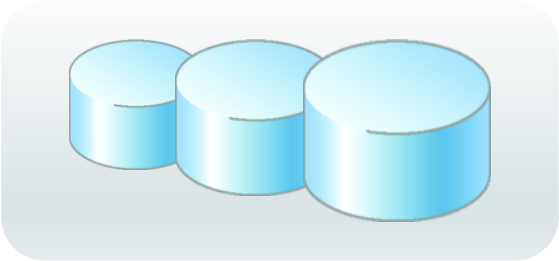
Managing Trail Files

- Use the **`PurgeOldExtracts`** parameter in the Manager parameter file to purge trail files when Oracle GoldenGate has finished processing them.
- The Manager parameter (rather than the Extract or Replicat version of **`PurgeOldExtracts`**) is preferred because it enables the trail files to be managed in a more centralized fashion.



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Trail files, if not managed properly, can consume a significant amount of disk space.

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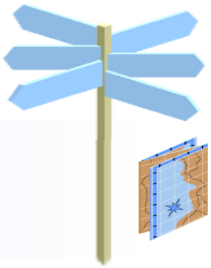
Agenda

- GLOBALS
- Manager
- Extract
  - Overview
  - Examples
- Replicat



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Extract Parameter: Overview

Extract parameters specify the following:

- Group name (associated with a checkpoint file)
- Where to send data:
  - Local system
  - Multiple remote systems
  - One-to-many Oracle GoldenGate trails
- What is being captured:
  - Which tables
  - Which rows and columns
  - Which operations
- Which column mapping to apply
- Which data transformations to apply

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The Extract process captures either full data records or transactional data changes depending on configuration parameters, and then sends the data to a target system to be applied to target tables or processed further by another process such as a load utility.

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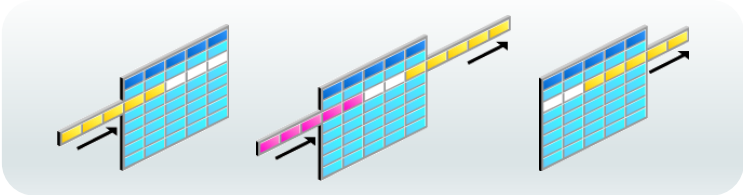
Extract Parameter Defaults

Extract parameters can be modified or can assume a default value. For insert, update, and delete operations, data can be captured with certain specifications:

- Send data without transformation
- Buffer transactions, either/or
  - Until a block is full
  - Until time elapses
- Based on average transaction volumes



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For insert, update, and delete operations, data can be captured with the following specifications:

- Committed data only
- Full image for inserts
- Only primary key and changed columns for updates
- Only primary key for deletes
- Only after-image of update

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Sample Extract Parameter File

You can use either of the following commands:

- `[OS prompt] more dirprm/somename.prm`
- `GGSCI> View Params somename`

```
-- Created by Joe Admin on 10/11/2017.
Extract somename
-- UserIDAlias oggalias
RmtHost mytarget.example.com, MgrPort 7909
RmtTrail ./dirdat/rt
Passthru
Table SALES.ORDERS;
Table SALES.INVENTORY;
```

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This particular Extract shows a data pump because it has a remote trail. There is another Extract that writes to a local trail.

- **`UserID`** and **`Password`** or **`UserIDAlias`** supply database credentials. (`SourceDB` is not required for Oracle.)
- If running with **`Passthru`**, the **`UserID`** lines are not required for data pumps, only for primary extracts.
- **`RmtHost`** specifies the target system; the `MgrPort` option specifies the port where Manager is running.
- **`RmtTrail`** specifies the Oracle GoldenGate path and trail file prefix on the target system. The system will append 000000000, 000000001, 000000002, and so on to the file name prefix.
- **`Table`** specifies a source table for which activity will be extracted.

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Extract Parameter Categories

Category	Parameter Summary
General	Verifies parameter file syntax and retrieves variables that were set by other parameters
Processing Method	Determines when a processing run begins and ends
Database Login	Provides login information
Selecting and Mapping Data	Determines the information that is extracted and the format
Routing Data	Provides the location where data is written
Formatting Data	Formats data in a format other than the default Oracle GoldenGate format

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For a complete list of Extract parameters and definitions, see the *Oracle GoldenGate Windows and UNIX Reference Guide 12c,* section 2.1.3 and following.

General: `RecoveryOptions`, `SourceDB`, `TCPSourceTimer`, `UpdateRecordFormat`, `Obey`, `SetEnv`

Processing Method: `DBOptions`, `Extract`, `GetApplOps`, `GetReplicates`, `Passthru`, `RmtTask`, `SourceIsTable`, `VAM`

Database Login: `UserID`, `UserIDAlias`

Selecting and Mapping Data: `CompressDeletes`, `CompressUpdates`, `FetchOptions`, `LocalSupCols`, `Sequence`, `Table`, `Map`, `TableExclude`, `TargetDefs`, `TrailCharASCII`

Routing Data: `ExtFile`, `ExtTrail`, `RmtFile`, `RmtHost`, `RmtTrail`

Formatting Data: `OutputFormat Text, OutputFormat SQL, OutputFormat XM`, `NoHeaders`

There are other parameters that are not shown here. Not all parameters are supported in all environments.

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Extract Parameter Categories

Category	Parameter Summary
Custom Processing	Determines whether to invoke a user exit routine or a macro
Reporting	Displays what information is included in statistical displays
Error Handling	Contains records that cannot be processed and error handling for DDL extraction
Tuning	Controls how long data is buffered before writing to a trail; controls memory allocations
Maintenance	Specifies how often trail files are created or purged
Security	Indicates whether data encryption is enabled in a trail or file

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The Extract's behavior can be influenced by many of the documented parameters. Some of these parameters can be used only in the Extract parameter file, whereas others can be used in the Extract, Replicat, or Manager parameter file. These parameters are categorized based on what they can do. The categories include General, Processing Method, Database Login, Selection and Mapping, Formatting, Custom Processing, Reporting, Tuning, Maintenance, and Security. Although you may never memorize all the parameters, you should become familiar with these categories and know where to look in the documentation for more details.

Custom Processing: `CUserExit`, `Include`, `Macro`, `SQLExec`

Reporting: `CmdTrace`, `List`, `Report`, `StatOptions`, `ReportCount`, `Trace`

Error Handling: `DDLError`, `DiscardFile`

Tuning: `BR`, `CacheMgr`, `FlushSecs`, `ThreadOptions`, `AllocFiles`, `CheckpointSecs`, `DBOptions`, `EOFDelay`, `NumFiles`

Maintenance: `DiscardRollover`, `PurgeOldExtracts`, `ReportRollover`, `Rollover`

Security: `EncryptTrail`, `DecryptTrail`

There are other parameters that are not shown here. Not all parameters are supported in all environments.

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Extract Example: **`Table`** Parameter

- Use the `Table` parameter in an Extract parameter file to specify objects for extraction.
- Some of the `Table` options do the following:
  - Select and filter records.
  - Select and map columns.
  - Transform data.
  - Designate key columns.
  - Define user tokens.
  - Trim trailing spaces.
  - Pass a parameter to a user exit.
  - Execute stored procedures and queries.

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There must be a `Table` statement for each source table from which you will be extracting data. Use wildcards (asterisks and question marks) to specify multiple tables with one `Table` statement, as in the following examples:

```
Table acct*;
Table myschema.acct*;
Table plug?.my*.acct*;
```

Version 12*c* supports table name wildcarding even in three-part names for container (pluggable) databases.

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Extract Example: **TranLogOptions** Parameter

- Use the **TranLogOptions** parameter to control database-specific aspects of log-based extraction.
- Several options control the archive log.
  - To specify an alternative log format:

```
TranLogOptions AltArchivedLogFormat log_%t_%s_%r.arc
```

  - To specify an alternative archive log location:

```
TranLogOptions AltArchiveLogDest /oradata/archive/log2
```

  - To cause Extract to read from the archived logs exclusively:

```
TranLogOptions ArchivedLogOnly
```

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Many of the `TranLogOptions` parameters are vendor specific.

Use the `TranLogOptions` parameter to control aspects of the way that Extract interacts with transaction logs. You can use multiple `TranLogOptions` statements in the same parameter file or you can specify multiple options within the same `TranLogOptions` statement.
For example, `ArchivedLogOnly` causes Extract to read from Oracle archived logs exclusively, without querying or validating the logs from system views such as `v$log` and `v$archived_log`. This is called “Archived Log Only” mode (ALO). ALO mode can be used to support a physical or logical standby database. For requirements and more information, see the *Oracle GoldenGate Oracle Installation and Setup Guide*. By default, Extract does not use Archived Log Only mode even if the database that it connects to is a physical standby database.

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Extract Example: **`TranLogOptions`** Parameter

Additionally, there are options for loop prevention.

- To specify the name of the Replicat database user so that those transactions are not captured by Extract:

```
TranLogOptions ExcludeUser ggsrep
```

- To specify the transaction name of the Replicat database user so that those transactions are not captured by Extract:

```
TranLogOptions ExcludeTrans "ggs_repl"
```

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Loop prevention is an advanced topic covered in the *Oracle GoldenGate 12c: Advanced Configuration for Oracle Classic Architecture* and *Oracle GoldenGate 12c: Advanced Configuration for Oracle Microservices Architecture* courses.

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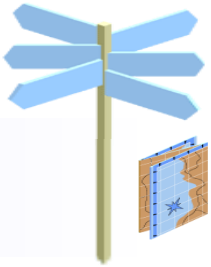
Agenda

- GLOBALS
- Manager
- Extract
- Replicat
  - Overview
  - Examples
  - Options common to both Replicat and Extract



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Replicat Parameters: Overview

Replicat parameters specify the following:

- A group name that is also associated with a checkpoint file
- A list of source-to-target relationships:
  - Optional row-level selection criteria
  - Optional column mapping facilities
  - Optional transformation services
  - Optional stored procedure or SQL query execution
- Error handling
- Various optional parameter settings

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The Replicat process runs on the target system, reads the extracted data, and replicates it to the target tables. Replicat reads extract and log files sequentially, and processes the inserts, updates, and deletes specified by selection parameters. Replicat reads extracted data in blocks to maximize throughput.

Optionally, you can filter the rows that you do not want to deliver, as well as perform data transformation before replicating the data. Parameters control the way Replicat processes—how it maps data, uses functions, and handles errors. You can configure multiple Replicat processes for increased throughput and identify each by a different group name.

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Replicat Parameter Defaults

Replicat parameters can be modified or can assume a default value:

- Apply all insert, update, or delete operations.
- Smart transactional grouping is possible.
  - 1,000 source operations are grouped into a single target transaction.
- Process `ABEND`s on any operational failure:
  - Rollback of transactions to the last good checkpoint
  - Optional error handling
  - Optional mapping to secondary table for exceptions

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Replicat supports a high volume of data replication activity. As a result, network activity is block based rather than one record at a time. The SQL operations that are used to replicate operations are compiled once and executed many times, resulting in virtually the same performance as precompiled operations.

Replicat preserves the boundaries of each transaction while processing, but small transactions can be grouped into larger transactions to improve performance. Like Extract, Replicat uses checkpoints so that processing can be restarted without repetition or loss of continuity after a graceful stop or a failure.

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Sample Replicat Parameter File

```
-- Created by Joe Admin on 10/11/2017.
Replicat salesrpt
SetEnv (ORACLE_SID = 'orcl')
UserID ggsuser@myorcl, Password ggspass
-- UserIDAlias oggalias
DiscardFile ./dirrpt/SALESRPT.dsc, Append
Map HR.STUDENT, Target HR.STUDENT
       Where (STUDENT_NUMBER < 400000);
Map HR.CODES, Target HR.CODES;
Map SALES.ORDERS, Target SALES.ORDERS,
      Where (STATE = 'CA' AND OFFICE = 'LA');
```

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- **`Replicat`** names the group that links the process, checkpoints, and log files together.
- Indicate the SID in either the Set Environment or the User ID (probably, not both).
- **`UserID`** and **`Password`** provide the credentials to access the database.
- **`DiscardFile`** identifies the file to receive records that cannot be processed for any reason. Records will be appended or the file will be purged at the beginning of the run, depending on the options. Starting with version 12.1.2, creation of the discard file is the default and does not need to be specified. If you do not specify this parameter, the file name will be the process name. If it is a Coordinated Replicat, the file name will be the process name plus the thread ID. If the file already exists, you must specify `Append` or `Purge`, else you will get an error. See also `DiscardRollover`. By default, the discard file rolls over for each new process start. Rolled file names are the process name plus a one-digit sequence number starting with 0 (similar to the reports).
- **`Map`** links the source tables to the target tables and applies mapping, selection, error handling, and data transformation, depending on options. Because the `Map` statements are terminated with a semi-colon, they may span multiple lines in the parameter text file without any special continuation characters.

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Replicat Parameter Categories

Category	Parameter Summary
General	Verifies parameter file syntax and retrieves variables that were set by other parameters
Processing Method	Determines when a processing run begins and ends
Database Login	Provides login information
Selecting, Converting, and Mapping Data	Specifies the information that is replicated and the format
Routing Data	Defines the name of the Extract file or trail that contains the data to be replicated

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For a complete list of Replicat parameters and definitions, see the *Oracle GoldenGate Windows and UNIX Reference Guide 12c.*

General: `TargetDB`, `HaveUDFWithinChar`, `Obey`, `SetEnv`

Processing Method: `Begin`, `BulkLoad`, `End`, `GenLoadFiles`, `Replicat`, `SpecialRun`

Database Login: `UserID`, `UserIDAlias`

Selecting, Converting, and Mapping Data: `AllowNoUpdates`, `ApplyNoUpdates`, `AssumetargetDefs`, `InsertAllRecords`, `InsertDeletes`, `InsertMissingUpdates`, `InsertUpdates`, `Table`, `Map`, `MapExclude`, `SourceCharSet`, `SourceTimeZone`, `SpacesToNull`, `UpdateDeletes`, `UseDedicatedCoordinationThread`

Routing Data: `ExtFile`, `ExtTrail`

There are other parameters that are not shown. Not all parameters are supported in all environments.

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Replicat Parameter Categories

Category	Parameter Summary
Custom Processing	Determines whether to invoke a user exit routine or a macro
Reporting	Displays the information that is included in statistical displays and the number of records processed
Error Handling	Determines how Replicat manages errors for duplicate or missing records
Tuning	Controls the parameters for how fast Replicat can process data and memory allocations
Maintenance	Specifies how often discard files are created or obsolete trail files are purged
Security	Indicates whether to decrypt data in a trail or an extract file

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Custom Processing: `CUserExit`, `Include`, `Macro`, `MacroChar`, `SQLExec`

Reporting: `CmdTrace`, `List`, `Report`, `StatOptions`, `ReportCount`, `Trace`, `WarnRate`

Error Handling: `DDLError`, `DiscardFile`, `HandleCollisions`, `HandleTPKUpdates`, `OverrideDups`, `RestartCollisions`, `RepError`, `ShowSyntax`

Tuning: `BatchSQL`, `CoordStatInterval`, `CoordTimer`, `DeferApplyInterval`, `GroupTransOps`, `InsertAppend`, `MaxDiscardRecs`, `MaxSQLStatements`, `MaxTransOps`, `NumFiles`, `TransactionTimeout`

Maintenance: `DiscardRollover`, `PurgeOldExtracts`, `ReportRollover`

Security: `EncryptTrail`, `DecryptTrail`

There are other parameters that are not shown. Not all parameters are supported in all environments.

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Replicat Example: **Map** Parameter

- The **Map** parameter establishes a relationship between one source and one target table.
- Using the **Map** parameter, particular subsets of data can be replicated to the target table.
- **Map** also enables users to map certain fields or columns from the source record to the start record format (“column mapping”).

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The `Map` parameter establishes a relationship between one source and one target table. Insert, update, and delete records originating in the source table are replicated in the target table. The first *<table spec>* is the source table. With `Map`, you can replicate particular subsets of data to the target table [for example, `Where (STATE = "CA")`]. In addition, `Map` enables the user to map certain fields or columns from the source record to the target record format (“column mapping”). You can also include a `Filter` command with built-in functions to evaluate data for more complex filtering criteria.

The syntax for the `Map` parameter includes the following:

- **Map** *<table spec>* specifies the source object.
- **Target** *<table spec>* specifies the target object.
- **Def** *<definitions template>* specifies a source-definitions template.
- **TargetDef** *<definitions template>* specifies a target-definitions template.
- **ColMap** maps records between different source and target columns.
- **EventActions** (*<action>*) triggers an action based on a record that satisfies a specified filter criterion or (if there is no filter condition) on every record.

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- **ExceptionsOnly** specifies error handling within an exceptions `Map` statement.
- **ExitParam** passes a parameter in the form of a literal string to a user exit.
- **Filter** selects records based on a numeric operator. `Filter` provides more flexibility than `Where`.
- **HandleCollisions** | **NoHandleCollisions** reconciles the results of changes made to the target table by an initial load process with those applied by a change-synchronization group.
- **InsertAllRecordS** applies all row changes as inserts.
- **InsertAppend** | **NoInsertAppend** controls whether or not Replicat uses an Oracle `APPEND` hint for `INSERT` statements.
- **KeyCols** designates columns that uniquely identify rows.
- **RepError** controls how Replicat responds to errors when executing the `Map` statement.
- **SQLExec** executes stored procedures and queries.
- **TrimSpaces** | **NoTrimSpaces** controls whether trailing spaces are trimmed or not when mapping `CHAR` to `VARCHAR` columns.
- **Where** selects records based on conditional operators.
- `;` terminates the `Map` statement and is required.

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DBOptions

DBOptions is used:

- For Extract or Replicat
- After **TargetDB**, **SourceDB**, or **UserID**

Some options are valid for:

- Oracle only
- OEM only
- Multiple vendors

Example:

```
Replicat ename
UserIDAlias oggalias
DBOptions DeferRefConst SuppressTriggers
:
```

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`DBOptions` is a parameter for Extract and Replicat that is placed after the `TargetDB` or `SOURCEDB` parameter statement and/or the `UserID` statement to specify database options. Some of the two dozen options are:

- **[SuppressTriggers | NoSuppressTriggers]:** For Oracle databases to disable triggers on the target database
- **[DeferRefConst]**: To defer deferrable constraints
- **[FetchBatchSize <*num_recs*>]:** To change the fetch array size the same way you do in SQL*Plus in Oracle
- **[LimitRows | NoLimitRows]:** To prevent multiple rows from being updated or deleted by the same Replicat SQL statement when the target table does not have a primary or unique key
- **[SPThread | NoSPThread]:** To create a separate database connection thread for stored procedures

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Discussion Questions

1. What are some typical Manager parameters?
2. What are some typical Extract parameters?
3. What are some typical Replicat parameters?
4. Where are Oracle GoldenGate parameters documented?

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Answers

1. `Port`, `DynamicPortList`, `Autostart`, `AutoRestart`, `Lag` parameters, `PurgeOldExtracts`, and so on. These can be found in the section titled "Manager Parameter Categories."
2. `Extract` with group name, database login parameters; `ExtTrail` or `RmtHost` and `RmtTrail`; `Table`, and so on. These can be found in the section titled "Extract Parameter Categories."
3. `Replicat` with group name, database login parameters; `SourceDefs` or `AssumeTargetDefs`, `DiscardFile`, `Map`, and so on. These can be found in the section titled "Replicat Parameter Categories."
4. *Oracle GoldenGate Windows and UNIX Reference Guide 12c*

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Summary

In this lesson, you should have learned how to:

- Edit parameter files
- Compare **GLOBALS** parameters with process parameters
- Describe commonly used parameters for **GLOBALS**, Manager, Extract, and Replicat

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Practice 8 Overview: Modifying Parameters

This practice covers modifying the following:

- Source Manager parameters
- Target Manager parameters
- Extract parameters on the source database

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9

Data Selection and Filtering

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Objectives

After completing this lesson, you should be able to:

- Select and filter data for replication
- Map columns between different schemas
- Use built-in functions
- Use `SQLEXEC` to interact directly with a database

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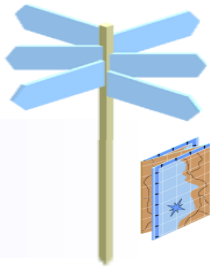
Agenda

- Overview
  - Mapping and Manipulation
  - Definition Files
  - Data Selection
- `Where`
- `Filter`
- Mapping
- `SQLEXEC`



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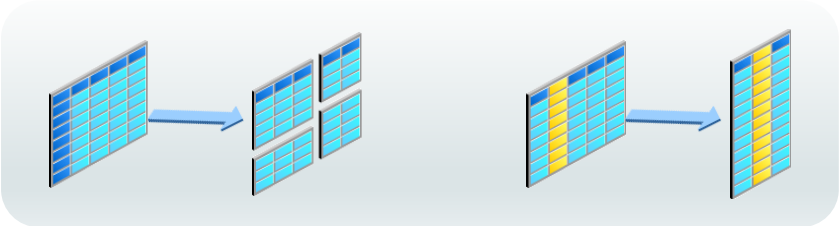
Data Mapping and Manipulation: Overview

All data selection, mapping, and manipulation is done by using options of the `Table` (Extract) and `Map` (Replicat) parameters.



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Data can be integrated between different source and target tables by:

- Selecting records and columns
- Selecting and converting operations
- Mapping dissimilar columns
- Using transaction history
- Testing and transforming data
- Using tokens

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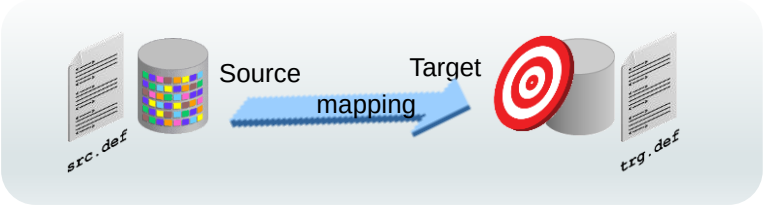
Types of Definition Files

- Configuring column mapping or transformation on the target system requires a *source-definitions* file in releases prior to GoldenGate 12.2, and can optionally use a *source-definitions* file in GoldenGate 12.2 and higher.
- Configuring column mapping or transformation on the source system requires a *target-definitions* file.
- Configuring column mapping or transformation on an intermediary system that contains neither a source database nor a target database requires a *source-definitions* file and a *target-definitions* file on that system.



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- If you are configuring Oracle GoldenGate to perform column mapping or transformation on the target system, then a *source-definitions file* is required in GoldenGate releases prior to 12.2. The source-definitions file is optional using GoldenGate 12.2 and higher. The source-definitions file contains the definitions of the source tables. You transfer this file to the target system. Replicat refers to these definitions, plus the queried target definitions, to perform the conversions.
- If you are configuring Oracle GoldenGate to perform column mapping or transformation on the source system, then a *target-definitions file* is required. The target-definitions file contains the definitions of the target tables. You transfer the file to the source system.
  A primary Extract or a data pump refers to these definitions, plus the queried source definitions, to perform the conversions.
- If you are configuring Oracle GoldenGate to perform column mapping or transformation on an intermediary system that contains *neither* a source database nor a target database, then you must provide both a *source-definitions file* and *a target-definitions file* on that system.

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Data Selection: Overview

Oracle GoldenGate provides the ability to select or filter data based on a variety of levels and conditions:

Parameter/Clause		Selects
Table or Map		Table
	Where	Rows
	Filter	Operations
Table	Cols | ColsExcept	Columns

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Table Selection

The `Map` (Replicat) or `Table` (Extract) parameter is used to select a table:

```
Map sales.tcustord, Target sales.tord;
```

ROWS Selection

The following `Where` option can be used with `Map` or `Table` to select rows for the "`AUTO`" product type:

```
Where (PRODUCT_TYPE = "AUTO");
```

OPERATIONS Selection

The following can be used with `Map` or `Table` to select rows with amounts greater than zero only for update and delete operations:

```
Filter (ON UPDATE, ON DELETE, amount > 0);
```

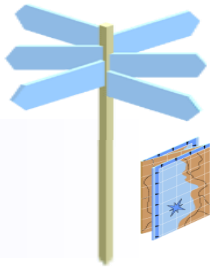
COLUMNS Selection

The `Cols` and `ColsEXCEPT` options of the `Table` parameter enable selection of columns. Use `Cols` to select columns for extraction and use `ColsEXCEPT` to select all columns except those designated by `ColsEXCEPT`. Here is an example:

```
Table sales.tcustord, Target sales.tord, ColsEXCEPT (facility_number);
```

Agenda

- Overview
- **`Where`**
  - Overview
  - Compared to **`Filter`**
  - Compared to SQL **`WHERE`**
  - Examples
- **`Filter`**
- Mapping
- **`SQLEXEC`**



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Data Selection: `Where` Clause

- The `Where ()` clause is the simplest form of selection.
- The `Where ()` clause appears on either the `Map` or the `Table` parameter and must be enclosed in parentheses.
- You cannot use the `Where ()` clause to:
  - Perform arithmetic operations
  - Refer to trail header and user token values
- Use the `Filter` clause for more complex selections with built-in functions.

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The Oracle GoldenGate `Where` clause (shown in mixed case) is similar but *not* identical to the SQL `WHERE` clause (shown in *uppercase*). In particular, certain operations that are permitted in the SQL `WHERE` clause are not permitted in the GoldenGate `Where` clause, such as math.
If you need a full SQL query including `WHERE`, see the section about `SQLEXEC` later in this lesson.

Examples of using the `Where ()` clause:

```
Map SALES.TCUSTORD, Target SALES.TORD,
Where (product_amount > 10000);
Map SALES.TCUSTORD, Target SALES.TORD,
Where (product_type = "AUTO");
```

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Data Selection: `Where` Clause

You can use `Where` to perform an evaluation for:

Element Description	Example
Columns	`PRODUCT_AMT, LAST_NAME`
Comparison operators	`=, <>, >, <, >=, <=`
Numeric values	`-123, 5500.123`
Literal strings	`"AUTO", "Ca"`
Field tests	`@NULL, @PRESENT, @ABSENT`
Conjunctive operators	`AND, OR`

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Arithmetic operators and floating-point data types are not supported by `Where`.

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Data Selection: **Where** Clause Examples

Returns:

- Only rows where the **STATE** column has a value of **CA**

```
Where (STATE = "CA");
```

- Only rows where the **AMOUNT** column has a value of **NULL** (Note that if **AMOUNT** is not part of the update, the result is false.)

```
Where (AMOUNT = @NULL);
```

- Only rows where **AMOUNT** is a part of the operation and has a value that is not **NULL**

```
Where (AMOUNT = @PRESENT AND AMOUNT <> @NULL);
```

- Only rows where the account identifier is greater than **CORP-ABC**

```
Where (ACCOUNT_ID > "CORP-ABC");
```

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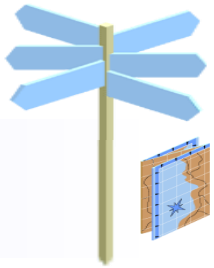
Agenda

- Overview
- **Where**
- **Filter**
  - Overview
  - Compared to **Where**
  - Examples
- Mapping
- **SQLEXEC**



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Data Selection: **`Filter`** Clause

- The **`Filter`** clause:
  - Provides complex evaluations to include or exclude data selection
  - Appears on either the **`Map`** or the **`Table`** parameter and must be enclosed in parentheses
- With **`Filter`**, you can:
  - Deploy other Oracle GoldenGate built-in functions
  - Use multiple **`Filter`**s on one statement
    - If any filter fails, the entire `filter` clause fails.
  - Include multiple option clauses (for example, on insert or update)
  - Raise a user-defined error for exception processing

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When multiple filters are specified for a given `Table` or `Map` entry, the filters are executed until one fails or until all are passed. Failure of any filter results in a failure for all filters.

Filters can be qualified with operation type so that you can specify different filters for inserts, updates, and deletes.

The `Filter RAISEERROR` option creates a user-defined error number if the `Filter` clause is true. In the following example, error 9999 is generated when the `BEFORE` time stamp is earlier than the `CHECK` time stamp. This also selects only update operations.

```
Filter (ON UPDATE, BEFORE.TIMESTAMP < CHECK.TIMESTAMP, RAISEERROR 9999);
```

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Data Selection: `Filter` Clause Examples

- The following example includes rows where the price multiplied by the amount exceeds 10,000:

```
Filter ((PRODUCT_PRICE * PRODUCT_AMOUNT) > 10000);
```

- The following example includes rows containing the string `"JOE"`:

```
Filter (@StrFind(NAME, "JOE") > 0);
```

- The following example executes the `Filter` clause for both updates and deletes, but not inserts:

```
Filter (ON UPDATE, ON DELETE, @Compute
(PRODUCT_PRICE * PRODUCT_AMOUNT) > 10000);
```

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The `Filter` clause can be used to perform arithmetic operations and to call Oracle GoldenGate functions.

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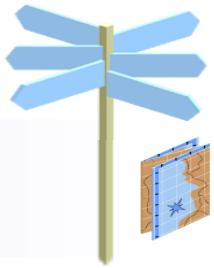
Agenda

- Overview
- `Where`
- `Filter`
- Mapping
  - Column Mapping
  - @ Functions
    - Tests
    - Strings
    - Numbers
- `SQLEXEC`



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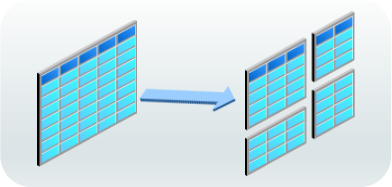
Column Mapping: Overview

- Oracle GoldenGate provides the capability to map columns from one table to another.
- Data can be transformed between dissimilar database tables.
  - Use `ColMap` to map target columns from your source columns.
- Oracle GoldenGate automatically matches source to target column names with `UseDefaults`.
- Mapping can be applied when either extracting or replicating data.



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Extract and Replicat provide the capability to transform data between two dissimilarly structured database tables or files. These features are implemented with the `ColMap` clause in the `Table` and `Map` parameters.

Data Type Conversions

Numeric fields are converted from one type and scale to match the type and scale of the target. If the scale of the source is larger than that of the target, the number is truncated on the right. If the target scale is larger than the source, the number is padded with zeros.

Varchar and character fields can accept other character, varchar, group, and datetime fields, or string literals enclosed in quotation marks. If the target character field is smaller than that of the source, the character field is truncated on the right.

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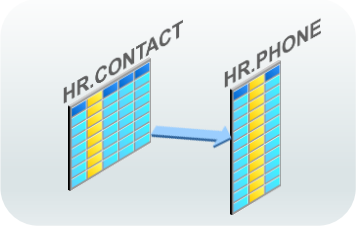
Column Mapping: Example

```
:
Map HR.CONTACT, Target HR.PHONE,
  ColMap (USEDEFAULTS,
  NAME = CUST_NAME,
  PHONE_NUMBER = @StrCat( '(', AREA_CODE, ')',
         PH_PREFIX, '-', PH_NUMBER ) );
```



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The example in the slide does the following:

- Moves the `HR.CONTACT CUST_NAME` column value to the `HR.PHONE NAME` column
- Concatenates `HR.CONTACT AREA_CODE`, `PH_PREFIX`, and `PH_NUMBER` with quote and hyphen literals to derive the `PHONE_NUMBER` column value
- Automatically maps other `HR.CONTACT` columns to the `HR.PHONE` columns that have the same name

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Column Mapping: Building History

This example uses special values to build a history of operations data:

```
:
InsertAllRecords
Map SALES.ACCOUNT, Target REPORT.ACCTHISTORY,
  ColMap (USEDEFAULTS,
  TRAN_TIME = @GetEnv('GGHEADER', 'COMMITTIMESTAMP'),
  OP_TYPE = @GetEnv('GGHEADER', 'OPTYPE'),
  BEFORE_AFTER_IND =
  @GetEnv('GGHEADER', 'BEFOREAFTERINDICATOR'),
  );
```

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`InsertAllRecords` causes Replicat to insert every change operation performed on a record as a new record in the database. The initial insert and subsequent updates and deletes are maintained as point-in-time snapshots.

- `ColMap` uses the `@GetEnv` function to get historical data from the GoldenGate trail header.
- `TRAN_TIME` picks up the commit time stamp for the date of the transaction.
- `OP_TYPE` indicates whether it is an insert, an update, or a delete operation.
- `BEFORE_AFTER_IND` indicates whether it is storing a “before” or an “after” image.

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Data Transformation Using Functions

- Oracle GoldenGate provides the capability to transform columns by using a set of built-in functions.
- Transformation functions can be applied for either Extract or Replicat.
- You can use additional functions by calling your own logic through user exits.
- Functions are identified with the @ prefix.

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Using column conversion functions, you can:

- Perform string and number conversion
- Extract portions of strings or concatenate columns
- Compare strings or numbers
- Perform a variety of date mappings
- Use single or nested `IF` statements to evaluate numbers, strings, and other column values to determine the appropriate value and format for target columns

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Functions: Performing Tests on Column Values

@Function	Description
Case	Enables a user to select a value depending on a series of value tests
Eval	Enables a user to select a value depending on a series of independent tests
If	Selects one of two values depending on whether a conditional statement returns `TRUE` or `FALSE`
ColStat	Tests whether a column value is missing, `NULL`, or invalid
ColTest	Tests whether a column value is present, missing, `NULL`, or invalid
ValOneOf	Returns `TRUE` if a column contains one of a list of values

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The functions listed in the slide select a value based on tests against the current value.

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@IF Function

***Variable* = @IF(*condition, true_val, false_val*)**

- This function can be used with other Oracle GoldenGate functions to begin a conditional argument that tests for one or more exception conditions.
- Examples of **@IF** functions:
  - The following returns an amount only if the **AMT** column is greater than zero. Otherwise, it returns zero.

```
AMOUNT_COL = @IF (AMT > 0, AMT, 0)
```

  - The following returns **WEST** if the **STATE** column is **CA**, **AZ**, or **NV**. Otherwise, it returns **EAST**.

```
REGION = @IF (@VALONEOF (STATE, 'CA', 'AZ',
      'NV'), 'WEST', 'EAST')
```

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The @IF function is used to return one of two values based on a condition.

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Functions: Working with Dates

@Function	Description
`Date`	Returns a date from a variety of sources in a variety of output formats
`DateDiff`	Returns the difference between two dates or times
`DateNow`	Returns the current date and time

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The functions listed in the slide return dates in various formats and calculate the difference between two dates.

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@Date Function

- The **@Date** function is used to return dates and times in a variety of formats to the target column based on the format passed into the source column.
- Examples of **@Date** functions:
  - The following converts year, month, and day columns to a date:

```
date_col = @Date ('YYYY-MM-DD', 'YY',
      date1_yy, 'MM', date1_mm, 'DD', date1_dd)
```

  - The following converts a numeric column that is stored as YYYMMDDHHMISS to a Julian time stamp:

```
julian_ts_col = @Date ('JTS', 'YYYYMMDDHHMISS',
       numeric_date))
```

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The `@Date` function is used to return dates and times in a variety of formats to the target column based on the format passed into the source column. `@Date` converts virtually any type of input to a valid SQL date. `@Date` can also be used to extract portions of a date column or to compute a numeric timestamp column based on a date.

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Functions: Working with Strings and Numbers

@Function	Description
Compute	Returns the result of an arithmetic expression
NumBin	Converts a binary string into a number
NumStr	Converts a string into a number
StrCat	Concatenates two or more strings
StrCmp	Compares two strings to determine whether they are equal, or whether the first is less or greater than the second
StrEq	Tests to see whether two strings are equal; returns `1` for equal and `0` if not equal
StrExt	Extracts selected characters from a string
StrFind	Finds the occurrence of a string within a string
StrLen	Returns the length of a string

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These functions convert, compare, extract, trim, and otherwise manipulate strings and numbers.

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Functions: Working with Strings and Numbers

@Function	Description
StrLTrim	Trims the leading spaces in a column
StrNCat	Concatenates one or more strings up to a specified number of characters per string
StrNCmp	Compares two strings up to a certain number of characters
StrNum	Converts a number into a string, with justification and zero-fill options
StrRTrim	Trims the trailing spaces in a column
StrSub	Substitutes one string for another within a column
StrTrim	Trims both leading and trailing spaces in a column
StrUp	Changes a string to uppercase

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@StrCat Function

- The **@StrCat** function is used to concatenate one or more strings or string (character) columns.
- **@StrCat** function examples:
  - The following concatenates the **LASTNAME** and **FIRSTNAME** columns, separated by a semicolon:

```
NAME = @StrCat (LASTNAME, ';' ,FIRSTNAME)
```

  - The following concatenates a country code, area code, and local phone number into an international phone number with hyphens between the components:

```
INTL_PHONE = @StrCat (COUNTRY_CODE, '-',
                      AREA_CODE, '-',
                      LOCAL_PHONE)
```

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The last example in the slide assumes that the phone “number” is made up of strings.

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`@StrExt` Function

- The `@StrExt` function is used to extract a portion of a string.
- Example
  - Using three `@StrExt` functions to extract a phone number into three different columns:

```
AREA_CODE = @StrExt (PHONE, 1, 3),
PREFIX    = @StrExt (PHONE, 4, 6),
PHONE_NO  = @StrExt (PHONE, 7, 10)
```

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The previous example assembled a phone number. This example breaks a compound phone number into its parts.

Note: This is a *string* Extract, which is not related to a *database* Extract.

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Other Functions

@Function	Description
Binary	Keeps source data in its original binary format in the target when the source column is defined as character
BinToHex	Converts a binary string to a hexadecimal string
GetEnv	Returns information about the GoldenGate environment, trail file header, trail record header, last replicated operation, and lag; can retrieve the commit time stamp in local time or GMT
GetVal	Extracts parameters from a stored procedure as input to a `Filter` or `ColMap` clause
HexToBin	Converts a hexadecimal string to a binary string
Range	Divides a workload into multiple groups of data, while ensuring that the same row is always sent to the same process. `Range` uses a hash against primary key or user-defined columns.
Token	Maps environmental values that are stored in the user token area to the target column

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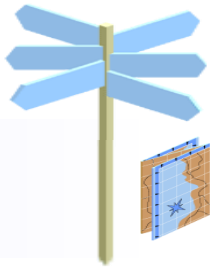
Agenda

- Overview
- **Where**
- **Filter**
- Mapping
- **SQLEXEC**
  - Overview
  - With Procedures
  - With SQL Query
  - Standalone



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SQLEXEC: Overview

- The **SQLEXEC** parameter extends Oracle GoldenGate capabilities by enabling Extract and Replicat to communicate with the database through SQL queries or stored procedures.
- **SQLEXEC** also extends data integration beyond what can be done with Oracle GoldenGate functions.

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The SQLEXEC option enables both Extract and Replicat to communicate with the user's database via SQL queries or stored procedures. SQLEXEC can be used to interface with a virtually unlimited set of functionality supported by the underlying database.

Stored Procedure Capabilities

Stored procedures extend the functionality of popular databases such as Oracle Database, DB2, SQL Server, Sybase, and Teradata. Users write stored procedures to perform custom logic, typically involving the database in some way, by using languages such as Oracle's PL/SQL and Microsoft's Transact-SQL.

Extract and Replicat enable stored procedure capabilities to be leveraged for Oracle Database, SQL Server, and DB2. Combining industry-standard stored procedure languages with extraction and replication functions brings a familiar, powerful interface to virtually unlimited functionality.

Stored procedures can also be used as an alternative method for inserting data into the database, aggregating data, denormalizing or normalizing data, or any other function that requires database operations as input. Extract and Replicat can support stored procedures that only accept input, or procedures that produce output as well. Output parameters can be captured and used in subsequent map and filter operations.

SQL Query Capabilities

In addition to stored procedures, Extract and Replicat can execute specified database queries that either return results (SELECT statements) or update the database (INSERT, UPDATE, and DELETE statements).

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SQLEXEC: Basic Functionality

- Execute a stored procedure or SQL query by using the **SQLEXEC** clause of the **Table** or **Map** parameter.
- (Optional) Extract output parameters from the stored procedure or SQL query as input to a **Filter** or **ColMap** clause by using the **@GETVAL** function.
- Use **SQLEXEC** at the root level (without input/output parameters) to call a stored procedure, run a SQL query, or issue a database command.

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Before you define the `SQLEXEC` clause, a database logon must be established. This is done via the `SourceDB` or `UserID` parameter for Extract and the `TargetDB` or `UserID` parameter for Replicat.

When you use `SQLEXEC`, you must supply a mapping between one or more input parameters and source columns or column functions. When you supply at least one `SQLEXEC` entry for a given Replicat `Map` entry, a target table is not required.

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SQLEXEC: DBMS and Data Type Support

- **SQLEXEC** is available for the following databases:

  Oracle Database
  SQL Server
  Teradata
  Sybase
  DB2

- The stored procedure interface supports the following data types for input and output parameters:

Oracle	DB2	SQL Server/Sybase/Teradata
CHAR VARCHAR2 DATE All numeric types LOBs up to 200 bytes	CHAR VARCHAR2 DATE All numeric types BLOB data types	CHAR VARCHAR DATETIME All numeric types

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The stored procedure interface for Oracle Database currently supports the following input and output parameter types:

- CHAR
- VARCHAR2
- DATE
- All available numeric data types
- LOB data types (BLOB and CLOB) where the length is less than 200 bytes
- The ANSI equivalents of the preceding types

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The stored procedure interface for SQL Server currently supports the following input and output parameter types:

- `CHAR`
- `VARCHAR`
- `DATETIME`
- All available numeric data types
- Image and text data types where the length is less than 200 bytes

`TIMESTAMP` parameter types are not supported natively, but you can specify other data types for parameters and convert the data to the `TIMESTAMP` format within the stored procedure.

The stored procedure interface for DB2 currently supports the following input and output parameter types:

- `CHAR`
- `VARCHAR`
- `DATE`
- All available numeric data types
- `BLOB` data types

The stored procedure interface for Sybase currently supports all data types except `TEXT`, `IMAGE`, and `UDT`.

The stored procedure interface for Teradata version 12 and later supports all data types that are supported by Oracle GoldenGate.

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SQLEXEC: Usage with a **LOOKUP** Stored Procedure

The following example uses **SQLEXEC** to run a stored procedure named **lookup** that performs a query to return a description based on a code:

```
CREATE OR REPLACE PROCEDURE lookup
  (code_param IN  VARCHAR2,
   desc_param OUT VARCHAR2)
BEGIN
  SELECT desc_col INTO desc_param
  FROM lookup_table
  WHERE code_col = code_param;
END;
```

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Mapping can be augmented with a simple database lookup procedure in Extract or Replicat. The example in the slide illustrates the stored procedure to perform a table lookup.

Note: This is a regular SQL `WHERE` instead of an Oracle GoldenGate `Where` (as shown earlier in this lesson). For this reason, this `WHERE` can perform complex math.

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SQLEXEC: Usage with a LOOKUP Stored Procedure

Content of the **Map** statement:

- Data is mapped from the **ACCOUNT** table to the **NEWACCT** table.
- When processing any rows from **ACCOUNT**, Extract performs the **LOOKUP** stored procedure before executing the column map.
- Values returned in **desc_param** are mapped to the **newacct_val** column by using the **@GETVAL** function:

```
Map HR.ACCOUNT, Target HR.NEWACCT, &
SQLEXEC (SPNAME lookup,
         PARAMS (code_param = account_code)), &
ColMap  (USEDEFAULTS, newacct_id = account_id,
         newacct_val = @GETVAL(lookup.desc_param));
```

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The example in the slide illustrates how a stored procedure can be used for mapping in a Replicat parameter file.

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SQLEXEC: Usage with a SQL Query

For an Oracle database, the following example performs a SQL query directly to return the description. **@GETVAL** is used to retrieve the return parameter:

```
:
Map HR.ACCOUNT, Target HR.NEWACCT, &
   SQLEXEC (id lookup, &
     QUERY ' SELECT desc_param FROM lookup_table
     WHERE code_col = :code_param ', &
   PARAMS (code_param = account_code)), &
   ColMap (USEDEFAULTS, newacct_id = account_id,
    newacct_val = @GETVAL(lookup.desc_param));
```

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The example parameter file entries illustrate a mapping using a simple SQL query to look up the account description.

Note: The ampersand (&) is used as a continuation character in Oracle GoldenGate parameter files. It must be placed at the end of each line of a parameter statement that spans multiple lines. Most examples in the documentation show the ampersand in its proper place; however, some examples of multiline statements may omit the ampersand to meet the space constraints of the publication format.

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SQLEXEC: Usage in a **Table** or **Map** Statement

- When used within a **Table** or **Map** statement, **SQLEXEC** can pass and accept parameters.
- It can be used for procedures and queries, but not for database commands.
- To execute a procedure in a **Table** or **Map** statement:

```
SQLEXEC (SPNAME <sp_name>,
[ID <logical_name,]
{PARAMS <param_spec> | NOPARAMS})
```

- To execute a query in a **Table** or **Map** statement:

```
SQLEXEC (ID <logical_name>, QUERY ' <sql_query> ',
{PARAMS <param_spec> | NOPARAMS})
```

Note the spaces.

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Note: Spaces are required within the `'` single straight quotation marks `'` around `<sql_query>`. Although, you may get `SQLEXEC` to work without the spaces, it is recommended that you include spaces within the quotes.

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SQLEXEC: Usage as a Stand-Alone Statement

- When **SQLEXEC** is used as a stand-alone parameter statement in the Extract or Replicat parameter file, it can execute a stored procedure, query, or database command.
- For these situations, **SQLEXEC** does not need to be tied to a specific table, and it can be used to perform general SQL operations.

Parameter Syntax	Purpose
`SQLEXEC "exec <procedure name>()"`	Executes a stored procedure
`SQLEXEC "<sql query>"`	Executes a query
`SQLEXEC "<database command>"`	Executes a database command

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When `SQLEXEC` is used as a stand-alone parameter statement in the Extract or Replicat parameter file, it can execute a stored procedure, query, or database command. As such, it need not be tied to any specific table, and can be used to perform general SQL operations.

For example, if the Oracle GoldenGate database user account is configured to time out when idle, you could use `SQLEXEC` to execute a query at a defined interval, so that Oracle GoldenGate does not appear idle.

As another example, you could use `SQLEXEC` to issue an essential database command (for example, to disable target triggers). A stand-alone `SQLEXEC` statement cannot accept input parameters or return output parameters.

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Quiz

SQLEXEC can communicate only via a SQL query.

a. True

b. False

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Answer: b

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Quiz

What is required to configure column mapping or transformation on the target system?

a. Source-definitions file
b. Target-definitions file
c. Both a source-definitions file and a target-definitions file
d. Neither, because transformations never occur on the target
e. With Oracle GoldenGate 12.3, you do not need a source definitions file.

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Answer: e

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Summary

In this lesson, you should have learned how to:

- Select and filter data for replication
- Map columns between different schemas
- Use built-in @ functions
- Use **`SQLEXEC`** to interact directly with a database

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Practice 9 Overview: Data Selection and Filtering

This practice covers:

- Configuring filters in Extract and Replicat groups
- Mapping different column and table names between source and target
- Invoking stored procedures from Replicat processes

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10

Additional Transformation and Configuration Options

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Objectives

After completing this lesson, you should be able to:

- Create and invoke macros
- Set and retrieve user tokens
- Run user exits in Oracle GoldenGate processes
- Compress data across the network
- Encrypt messages, trails, and passwords
- Automatically trigger actions based on event records

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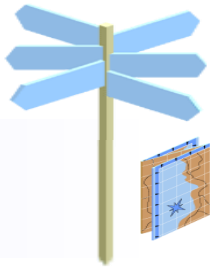
Agenda

- Macros
  - Creating
  - Invoking
  - Parameters
  - Tracing
- Tokens
- User Exits
- Compression
- Encryption
- Event Actions



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Macros: Overview

- Macros make coding easier and more efficient.
- You can use macros in the following ways:
  - Write once and use many times.
  - Consolidate multiple statements.
  - Eliminate the need for redundant column specifications.
  - Invoke other macros.
  - Create macro libraries and share across parameter files.

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Macros make it easier and more efficient to build parameters (not related to your individual parameter *files*, but commands that can be used across all parameter files).

By using Oracle GoldenGate macros in parameter files, you can easily configure and reuse parameters, commands, and functions. The slide describes how to use macros for a variety of operations to enable the easier and more efficient building of parameters.

Oracle GoldenGate macros work with the following parameter files:

- Manager
- Extract
- Replicat
- `GLOBALS`

Note: Do not use macros to manipulate data for tables that are being processed by a data pump Extract in `Passthru` mode.

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Creating Macros

- Macros can be defined in any parameter file or library.
- Macro and parameter names must begin with a macro character. (The default is the pound [#] character.)
- Macro statements include the following:
  - Macro name
  - Optional parameter list
  - Macro body

```
Macro #<macro_name>
Params (#<param1>, #<param2>, …)
BEGIN
<macro_body>
End;
```

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- ***<macro_name>*** is the name of the macro. `<macro_name>` must begin with the `#` character, as in `#macro1`. If the `#` macro character is used elsewhere in the parameter file, such as in a table name, you can change it to something else with the `MacroCHAR` parameter. Macro names are not case-sensitive.
- **`Params`** `(<p1>,<p2>...)` describes each of the parameters to the macro. Names must begin with the macro character, as in `#param1`. When the macro is invoked, it must include a value for each parameter named in the `Params` statement. Parameter names are optional and not case-sensitive. `BEGIN` indicates the beginning of the body of the macro and must be specified before the macro body.
- ***<macro_body>*** represents one or more statements to be used as parameter file input. It can include simple parameter statements, such as `Col1 = Col2`; more complex statements that include parameters, such as `Col1 = #val2`; or invocations of other macros, such as `#colmap(Col1, #sourcecol)`.
- **`End;`** ends the macro definition.

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Invoking a Macro

1. Define a macro:

```
:
Macro #make_date
Params (#year, #month, #day)
BEGIN
 @DATE("YYYY-MM-DD", "CC", @IF(#year < 50, 20, 19),
 "YY", #year, "MM", #month, "DD", #day)
End;
```

2. Invoke the macro:

```
Map SALES.ACCT, Target REPORT.ACCOUNT,
ColMap
( TargetCol1 = SourceCol1,
  Order_Date = #make_date(Order_YR,Order_MO,Order_DAY),
  Ship_Date  = #make_date(Ship_YR,Ship_MO,Ship_DAY)
 );
```

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The example in the slide demonstrates defining a macro named `#make_date` and calling the macro two different times, with each instance sending a different set of source column values to determine the target column values. The steps are as follows:

1. Define the macro, either inline within a single Extract/Replicat `.prm` file or in a library to be included (covered later in this lesson).
2. To invoke the macro, place an invocation statement in the parameter file wherever you want the macro to occur. Use of a macro library would allow you to invoke it from several different parameter files.

Note that the order and ship dates are determined as the result of calling the `make_date` routine to populate the target columns.

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Reusing Parameter Sets

1. Define a macro:

```
Macro #option_defaults
       Begin
       GetInserts
       GetUpdates
       GetDeletes
       InsertDeletes
       End;
```

2. Invoke the macro:

```
#option_defaults ()
IgnoreUpdates
Map SALES.SRCTAB, Target SALES.TARGTAB;
#option_defaults ()
Map SALES.SRCTAB2, Target SALES.TARGTAB2;
```

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Another use of macros is to create a set of frequently used commands. For example, `GETINSERTS`, `GETUPDATES`, `GETDELETES`, and `INSERTDELETES` may be referenced as a macro within multiple `Map` statements (as shown in the slide).

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Reusing Parameter Sets

3. The macro expands to the following:

```
GetInserts
GetUpdates
GetDeletes
InsertDeletes
IgnoreUpdates
Map SALES.SRCTAB, Target SALES.TARGTAB;
GetInserts
GetUpdates
GetDeletes
InsertDeletes
Map SALES.SRCTAB2, Target SALES.TARGTAB2;
```

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Note that the macro's result is altered by the `IgnoreUpdates` parameter for the first `Map` statement.

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Creating Macro Libraries

- You can create a macro library that contains one or more macros.
- By using a macro library, you can define a macro once and then use it in many parameter files.
- In this parameter file, use the **`Include`** command at the beginning of the parameter file:

```
Include /ggs/dirprm/mdatelib.mac
Replicat rep
AssumeTargetDefs
UserIDAlias myoggalias
Map FIN.ACCT_TAB, Target FIN.ACCOUNT;
```

- Macros listing can be toggled by using the **`List`** and **`NoList`** parameters.

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To use a macro library, use the `Include` parameter at the beginning of a parameter file. The syntax is:

`Include <macro_name>`

If the library should include both Extract and Replicat macros, you are responsible for maintaining a copy on both the source and target `/dirprm` directories.

Use the `List` and `NoList` parameters to toggle between showing and hiding the output of libraries. Because of this, `NoList` can be used to reduce the size of the report and the space needed to store the reports.

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Tracing Macro Expansion

- Trace macro expansion with the **`CmdTrace`** parameter.
- Options for the **`CmdTrace`** parameter include **`ON`**, **`OFF`** (default value), and **`Detail`**.
- For this example, tracing is enabled before **`#testmac`** is invoked, and then it is disabled after the macro's execution:

```
Replicat rep
Macro #testmac
BEGIN
Col1 = Col2,
Col3 = Col4,
End;
...
CmdTrace ON
Map TEST.TABLE1, Target TEST.TABLE2,
ColMap (#testmac);
CmdTrace OFF
```

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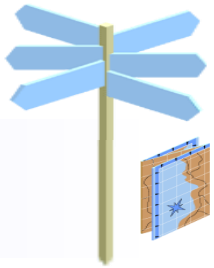
The macro processor enables tracing of macro expansion for debugging purposes via the `CmdTrace` command. When `CmdTrace` is enabled, the macro processor displays macro expansion steps in the process's report file.

The `ON` option enables tracing, `OFF` disables it, and `DETAIL` produces additional details.

Oracle Internal & Oracle Academy Use Only

Agenda

- Macros
- Tokens
  - Overview
  - Environmental Variables
  - `logdump`
- User Exits
- Compression
- Encryption
- Event Actions



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User Tokens: Overview

- Set token values through a **`Table TOKENS`** clause and **`@GETENV`** functions.
  Example (set for each transaction):

```
Table SALES.PRODUCT,
TOKENS (TKN1 = @GETENV('GGENVIRONMENT','OSUSERNAME'),
TKN2 = @GETENV('GGHEADER','COMMITTIMESTAMP') );
```

- Use token values to populate target columns through a **`Map ColMap`** clause and **`@TOKEN`** functions.
  Example:

```
Map SALES.PRODUCT, Target SALES.PRODUCT_HISTORY,
ColMap (USEDEFAULTS,
  OSUSER    = @TOKEN('TKN1'),
  TRANSTIME = @TOKEN('TKN2') );
```

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User tokens are environment values that are captured and stored in the trail record for replication to target columns or other purposes.

User tokens differ from a macro in the sense that a macro is a set of functions, whereas a user token is a set of variables (or data). To set a token, use the `TOKENS` option of the Extract `Table` parameter to define a user token and associate it with data. Tokens enable you to extract and store data within the user token area of a trail record header. You can set tokens to values returned by the `@GETENV` function (for example, values from the GoldenGate header or environment).

You can use token data in column maps, stored procedures called by `SQLEXEC`, or macros. For example, use the `@TOKEN` function in the `ColMap` clause of a Replicat `Map` statement to map a token to a target column. If you have both a token and a macro and they are the same, they are both executed. Mapping statements take precedence over tokens. Tokens consist of supplemental data that you can use.

The quotation marks around the tokens must be `'`straight single`'` quotation marks. This is a change from previous versions of Oracle GoldenGate.

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Environmental Values Available to `@GETENV`

Source	Option	Returns values for/from

General	`'LAG'`
	`'LASTERR'`
	`'JULIANTIMESTAMP'`
	`'RECSOUTPUT'`
		Lag (in unit specified)
		Last failed operation
		Julian time stamp
		Number of records written to trail

GoldenGate	`'GGENVIRONMENT'`
	`'GGFILEHEADER'`
	`'GGHEADER'`
	`'RECORD'`
		GoldenGate environment
		Trail file header
		Trail record header
		Trail record location

Database	`'DBENVIRONMENT'` `'TRANSACTION'`	Database environment Source transaction
Operating System	`'OSVARIABLE'`	OS environmental variable

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For a detailed list of all parameters and their options, see the *Oracle GoldenGate Windows and UNIX Reference Guide 12c.*

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User Tokens Display

Values are stored in the Oracle GoldenGate record header by using a **TOKENS** clause and **@GETENV** functions:

```
Extract extdemo
Table SALES.PRODUCT, TOKENS (
(Token name) TKN-OSUSER = @GETENV ('GGENVIRONMENT',
'OSUSERNAME'),
TKN-DOMAIN      = @GETENV ('GGENVIRONMENT', 'DOMAINNAME'),
TKN-COMMIT-TS   = @GETENV ('GGHEADER', 'COMMITTIMESTAMP'),
TKN-BA-IND      = @GETENV ('GGHEADER',
'BEFOREAFTERINDICATOR'),
TKN-TABLE       = @GETENV ('GGHEADER', 'TABLENAME'),
TKN-OP-TYPE     = @GETENV ('GGHEADER', 'OPTYPE'),
TKN-LENGTH      = @GETENV ('GGHEADER', 'RECORDLENGTH'),
TKN-DB-VER      = @GETENV ('DBENVIRONMENT', 'DBVERSION')
);
```

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The example in the slide shows how to store details in the Oracle GoldenGate trail header. Using the `TOKENS` clause of the `Table` parameter, the user defines a token identifier (for example, `TKN-OSUSER`) and specifies the environment category and value by using the `@GETENV` function.

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Using User Tokens

```
Map SALES.ORDER, Target REPORT.ORDER_HISTORY,
   ColMap (USEDEFAULTS,
   TKN_NUMRECS = @TOKEN ('TKN-NUMRECS');

Map SALES.CUSTOMER, Target REPORT.CUSTOMER_HISTORY,
   ColMap (USEDEFAULTS,
   TRAN_TIME     = @TOKEN ('TKN-COMMIT-TS'),
   OP_TYPE       = @TOKEN ('TKN-OP-TYPE'),
   BEFORE_AFTER_IND    = @TOKEN ('TKN-BA-IND'),
   TKN_ROWID     = @TOKEN ('TKN-ROWID'));
```

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Tokens are retrieved through a `Map ColMap` clause and `@TOKEN` functions.

The example in the slide demonstrates how to retrieve values that have been stored as tokens in the GoldenGate trail header. Using the `@TOKEN` function on the `Map` parameter, specify the token identifier (for example, `TKN-GROUP-NAME`) value to use for the target column specification.

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Viewing User Tokens in Logdump

```
logdump 2> UserToken On
logdump 3> UserToken Detail
logdump 4> Next
User tokens:
   TKN-HOST                      : jemhadar
   TKN-GROUP            : EXTORA
   TKN-BA_IND                    : AFTER
   TKN-COMMIT_TS                 : 2003-03-24 17:08:59.000000
   TKN-POS                       : 3604496
   TKN-RBA                       : 4058
   TKN-TABLE            : SOURCE.CUSTOMER
   TKN-OPTYPE                    : INSERT
   TKN-LENGTH                    : 57
   TKN-TRAN_IND                  : BEGIN
   TKN-LAG_SEC                   : 1
   TKN-LAG_MIN                   : 0
   TKN-LAG_MSEC                  : 1229
   TKN-NUMRECS                   : 8
   TKN-DBNAME                    : ORA901
   TKN-DB_USER                   : GGOODRIC
   TKN-DB_VER                    : 9.0.1.0.0
   TKN-INAME            : ora901
   TKN-ROWID            : AAABBAAABAAAB0BAAF
```

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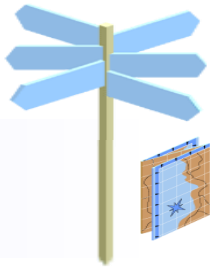
After environment values are stored in the trail header, `Logdump` can display them when the `UserTOKEN ON` option is used. The `UserTOKEN DETAIL` option provides additional information.

Oracle Internal & Oracle Academy Use Only

Agenda

- Macros
- Tokens
- User Exits
  - Overview
  - Implementing
  - Parameters
  - Samples
- Compression
- Encryption
- Event Actions



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User Exits: Overview

User exits:

- Are custom logic written by the customer in C or C++
- Are invoked at different points in Extract or Replicat processing (through the `CUserExit` parameter)
- Enable you to extend or customize the functionality of data movement and integration beyond what is supported through mapping, functions, or `SQLEXEC`
- Can perform an unlimited number of functions

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At different points during Extract and Replicat processing, routines can be created in C and invoked to perform an unlimited number of functions. You can employ user exits as an alternative to, or in conjunction with, the column-conversion functions that are available in GoldenGate. User exits can be a better alternative to the built-in functions because, with a user exit, data is processed once (when extracted) rather than twice (extracted and then read again to perform the transformation).

User exits cannot be used for tables that are being processed by a data pump Extract in `Passthru` mode.

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Uses for User Exits

User exits can be used to:

- Perform arithmetic operations or data transformations beyond those possible with GoldenGate built-in functions
- Perform additional table lookups or clean up invalid data
- Respond to events in custom ways (for example, by sending a formatted email message or paging a supervisor based on some field value)
- Accumulate totals and gather statistics
- Perform conflict detection or custom handling of errors or discards
- Enable Oracle GoldenGate for Flat File

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The gathering of statistics and the sending of event emails based on thresholds are best done by using Oracle GoldenGate Monitor, which is part of the Oracle Management Pack for Oracle GoldenGate.

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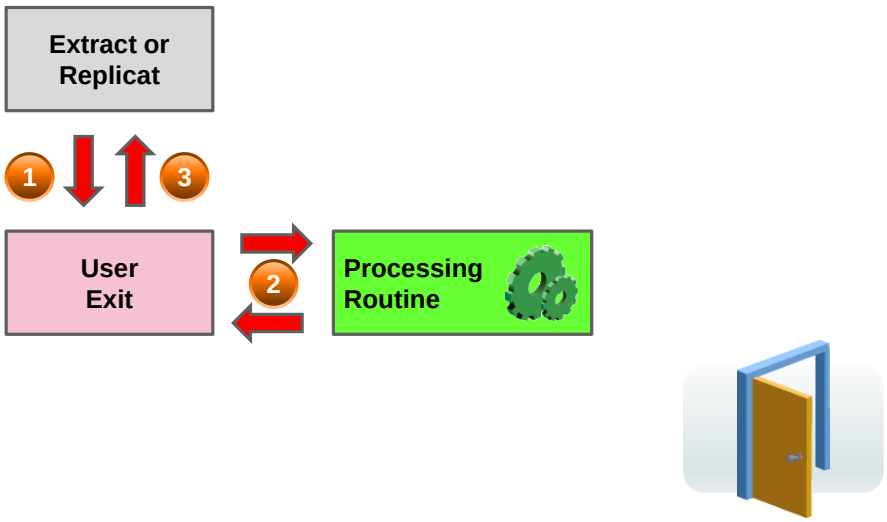
User Exits: High-Level Processing Logic



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A user exit:

1. Accepts different events and information from Extract or Replicat
2. Passes the information to an appropriate paragraph or a routine for processing
3. Returns a response and information to the caller

In C, create either a shared object (UNIX systems) or a DLL (Windows), and create or export a routine to be called from Extract or Replicat. This routine is the communication point between Oracle GoldenGate and your routines.

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Implementing User Exits

- Windows: Create a DLL in C, and create a routine to be called from Extract or Replicat.
- UNIX: Create a shared object in C, and create a routine to be called from Extract or Replicat.
- The routine must accept the following parameters:

```
Exit_Call_Type
Exit_Call_Result
Exit_Params
```

- In the source for the DLL or shared object, include the `usrdecs.h` file (in the GoldenGate installation directory).
- Call the `ERCallback` function from the shared object to retrieve record and application context information.

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To implement user exits on Windows, perform the following steps:

1. **On Windows systems:** Create a user exit DLL in C and export a routine to be called from Extract or Replicat.
   On UNIX systems: Create a shared object in C, and create a routine to be called from Extract or Replicat. This routine is the communication point between Extract or Replicat and your routines.

   You can define the name of the routine, but it must accept the user exit parameters:

```
Exit_Call_Type
Exit_Call_Result
Exit_Params
```

2. In the source for the DLL or shared object include the `usrdecs.h` file. This file contains type definitions, return status values, callback function codes, and other definitions.
3. Include callback routines in the user exit when applicable. Callback routines retrieve record and application context information and modify the contents of data records.

Extract and Replicat export an `ERCallback` function to be called from the user exit routine. The user exit must explicitly load the callback function at run time by using appropriate Windows or UNIX API calls.

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User Exit Parameters

- `Exit_Call_Type`
- `Exit_Call_Result`
- `Exit_Params`
- `Exit_Call_Begin_Trans`
- `Exit_Call_End_Trans`
- `Exit_Call_Abort_Trans`
- `ERCallback`

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- **`Exit_Call_Type`:** During processing, indicates when the Extract or Replicat process calls the user exit: at start processing, stop processing, begin transaction, end transaction, process record, process marker, discard record, fatal error, or call result
- **`Exit_Call_Result`:** Provides a response to the routine: OK, ignore, stop, ABEND, or skip record
- **`Exit_Params`:** Supplies information to the routine: calling program path and name, function parameter, or "more records" indicator
- **`Exit_Call_Begin_Trans`:** Is called just before the start of a Replicat transaction or just before the begin record of a transaction is read by data pump
- **`Exit_Call_End_Trans`:** Is called just after the last record in a Replicat transaction or just after an end record of a transaction is read by data pump
- **`Exit_Call_Abort_Trans`:** Is called when Replicat or data pump reads a Restart Abend record from the trail
- **`ERCallback`:** Implements a callback routine. Callback routines retrieve record and Oracle GoldenGate context information and modify the contents of data records.

For a detailed list of all parameters and their options, see the *Oracle GoldenGate Windows and UNIX Reference Guide 12c.*

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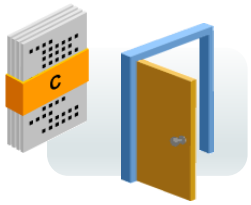
Sample User Exits

- Sample user exit files are located in ***<OGG_HOME>*/UserExitExamples**.
- Each directory contains the **.c** file as well as **makefiles** and a **readme.txt** file.
- You will also need ***<OGG_HOME>*/demo*.sql** to create sample tables.



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- **exitdemo.c** shows how to initialize the user exit, issue callbacks at given exit points, and modify data. The demo is not specific to any database type.
- **exitdemo_passthru.c** shows how the `PASSTHRU` option of the `CUserExit` parameter can be used in an Extract data pump.
- **exitdemo_more_recs.c** shows an example of how to use the same input record multiple times to generate several target records.
- **exitdemo_lob.c** shows an example of how to get read access to LOB data.
- **exitdemo_pk_befores.c** shows how to access the before and after image portions of a primary key update record, as well as the before images of regular updates (non-key updates). It also shows how to get target row values with `SQLEXEC` in the Replicat parameter file as a means for conflict detection. The resulting fetched values from the target row are mapped to the target record when the target record enters the user exit.

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Calling User Exits

- You can call a user exit from Extract or Replicat by using the `CUserExit` parameter.
- Example parameter file syntax on UNIX systems:

```
CUserExit eruserexit.so MyUserExit
```

- Example parameter file syntax on Windows systems:

```
CUserExit eruserexit.dll MyUserExit
```

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To call a user exit, include the `CUserExit` parameter in your Extract or Replicat parameter file. This parameter accepts the name of the shared object or DLL and the name of the exported routine that is to be called from Extract or Replicat. You can specify the full path of the shared object or DLL or let the operating system's standard search strategy locate the shared object. The parameter also accepts options to:

- Use a user exit with a data pump that is operating in `Passthru` mode
- Get before images for update operations
- Supply a startup string, such as a startup parameter

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Quiz

User _____ are a set of variables.

a. Macros
b. Tokens
c. Exits
d. Procedures

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Answer: b

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Quiz

User exits can be used for tables that are being processed by a data pump Extract in **`Passthru`** mode.

a. True

b. False

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Answer: b

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Agenda

- Macros
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- User Exits
- Compression
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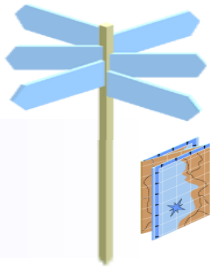

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Compression Options

- Oracle GoldenGate provides optional data compression when sending data over TCP/IP.
- Automatic decompression is performed by the Server Collector on a remote system.
- The compression threshold enables the user to set the minimum block size to compress.
- Oracle GoldenGate uses zlib compression. More information can be found at www.zlib.net.

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Compression can be initiated in either the Extract or Data Pump.

Compression ratios depend on the type of data being compressed. Some data is already precompressed (such as JPEGs).

This TCP compression in transit is unrelated to storage compression within the database itself.

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Example of Compression

- Compression is specified on the Extract or Pump **RmtHost** parameter:

```
RmtHost <host> | <ip address>, MgrPort <port>
[, Compress ]
[, CompressThreshold <bytesize> ]
```

  - **Compress** specifies that outgoing blocks of captured changes are compressed.
  - **CompressThreshold** sets the minimum byte size for which compression occurs (the default is 1000 bytes).
- Example:

```
RmtHost newyork, MgrPort 7809, Compress, CompressThreshold 750
```

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The destination Server Collector decompresses the data stream before writing it to the remote file or remote trail. This typically results in compression ratios of at least 4:1 (and sometimes much better). However, compression can require significant CPU resources.

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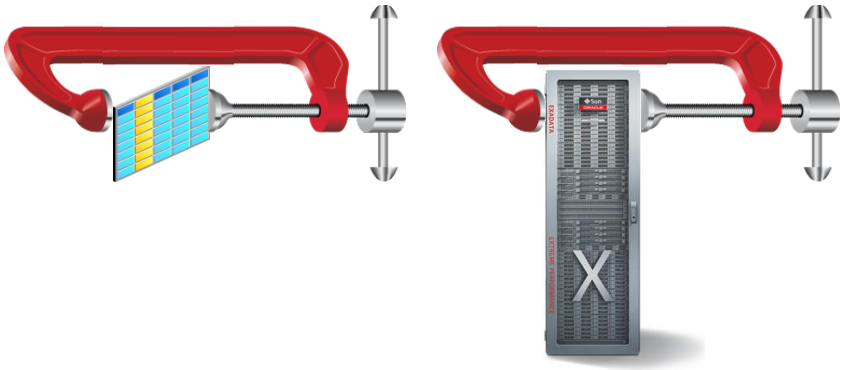
Compression and Exadata

- EHCC
- `InsertAppend` in Replicat



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Oracle GoldenGate supports Oracle Exadata Database Machine as follows:

- Oracle GoldenGate can capture from Exadata in either classic capture or integrated capture mode, but to capture from **E**xadata with **H**ybrid **C**olumnar **C**ompression (EHCC), Extract must be in integrated capture mode, and the source database compatibility must be set to 11.2 or later.
- Oracle GoldenGate can replicate data from any supported database to Exadata. In general, the configuration of Oracle GoldenGate to operate with Exadata is the same as any other Oracle GoldenGate configuration.

Replicating to Exadata with EHCC Enabled

To ensure successful delivery of insert operations to Oracle Exadata with EHCC, use the `InsertAppend` parameter in the Replicat parameter file. This causes Replicat to use an `Append` hint for inserts so that they remain compressed. Without this hint, the record is inserted uncompressed.

Oracle Internal & Oracle Academy Use Only

Agenda

- Macros
- Tokens
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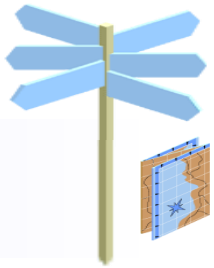
- Compression
- Encryption
  - Overview
  - Message
  - File
  - Password
- Event Actions



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Encryption: Overview

Encrypting and decrypting data can be done by using the following methods:

- Message encryption
  - Messages that are sent over TCP/IP are encrypted.
  - FIPS (AES) and/or Blowfish is used.
  - The data is automatically decrypted by Server Collector before saving the data to the trail.
- Trail or extract file encryption
  - Oracle GoldenGate uses 256-key byte substitution.
  - Only the record data is encrypted in a trail or extract file.
  - The data is decrypted by a downstream data pump or Replicat.
- The Encrypted Database password is generated by using:
  - A default key
  - A user-defined key

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The Federal Information Processing Standards (FIPS) standardization was developed by the United States Federal Government. These standards encompass existing security standards such as Data Encryption Standard (DES) and Advanced Encryption Standard (AES).

AES is a symmetric-key encryption standard that is used by governments and other organizations that require a high degree of data security. AES supports the following ciphers:

- AES128
- AES192
- AES 256

FIPS-supported encryption was added to Oracle GoldenGate with version 11.2.1.0.0.

Blowfish is a symmetric 64-bit block cipher from CounterPane Internet Security. Blowfish is not FIPS-compliant and, therefore, not recommended except for backward compatibility. The master key and wallet method is the preferred method on platforms that support it. It is not supported for the iSeries, z/OS, and NonStop platforms.

`ENCKEYS` method is valid for all Oracle GoldenGate-supported databases and platforms. Blowfish must be used on the iSeries, z/OS, and NonStop platforms.

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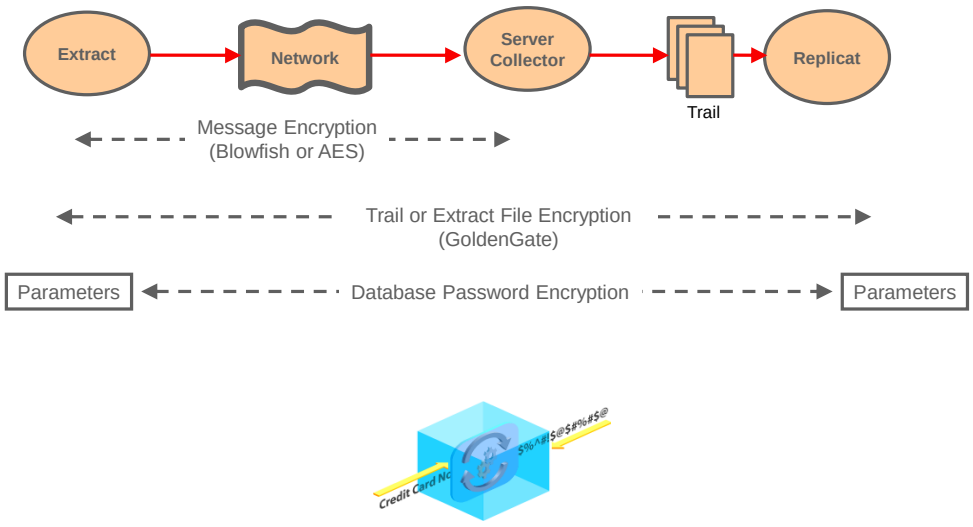
Encryption: Overview



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Encryption can be at several levels:

- **Message:** The transmission across the TCP/IP network is encrypted.
- **File:** The contents of the trail or extract files are encrypted end to end.
- **Database Password:** The contents of the database can be encrypted.

The keys are stored in either flat file `ENCKEYS` (which works on all platforms) or Oracle Wallet (which works on only some platforms). Each type of encryption is shown in the following slides.

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Message Encryption

1. Run the Oracle GoldenGate `keygen` utility to generate random hex keys:

```
[OS prompt] ./keygen <key_length> <number_of_keys>
```

2. Enter your key names and values in an ASCII text file named **ENCKEYS** (uppercase, no file extension) in the Oracle GoldenGate installation directory:

```
##Key name    Key value
 superkey     0x420E61BE7002D63560929CCA17A4E1FB
 secretkey    0x027742185BBF232D7C664A5E1A76B040
```

3. Copy the **ENCKEYS** file to the source and target Oracle GoldenGate installation directories.

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The `keygen` utility and `ENCKEYS` are needed only if you do not use the wallet (covered later in this lesson).

<key_length> can be up to 256 bits. Example syntax:

```
[OS prompt]$ ./keygen 128 4
0xA100BF1FDAFE440C0D410901341B7D58
0x28677E0C59BA41177B0F5B23B8C11335
0xAECD3D79D8753E22E9DDAC453C68AA11
0x3534FD6557313B2D57ACFE67BF0E416E
```

If you prefer to use a literal key instead of using `keygen`, enter the literal key in quotation marks as the key value in an `ENCKEYS` file:

```
##Key name          Key value
mykey               "DailyKey "
```

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Message Encryption

4. In the Extract parameter files, use the **RmtHost Encrypt** and **KeyName** parameters:

```
RmtHost <process>, Port <port>,
 Encrypt <encrypt_type>, KeyName <keyname>
```

Example:

```
RmtHost west, Port 7809,
  Encrypt AES256, KeyName superkey
```

5. Configure a static Server Collector and start it manually with the **Encrypt** and **KeyName** parameters:

```
server -p <port> -Encrypt <encrypt_type>
 -KeyName <keyname>
```

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For the remote host `RmtHost`, use either `MgrPort` if you use a dynamic collector (the typical way to do things) or `Port` if you use a static collector, as shown in the slide.

<encrypt_type> can be:

- `AES128`
- `AES192`
- `AES256`
- `BLOWFISH` (avoid using except for backward compatibility)

The `ENCKEYS` file contains one or many keys, one of which you named `superkey`. If you omit the `KeyName` clause, it defaults to the master key in the wallet (covered later in this lesson).

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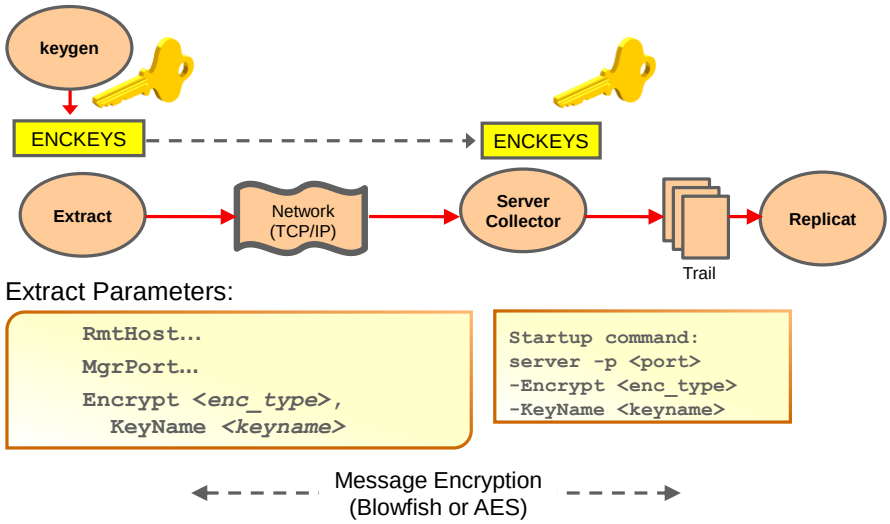
Options: Message Encryption



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Now the messages go back and forth encrypted.

`<enc_type>` can be any of the following encryption types:

- `AES128`
- `AES192`
- `AES256`
- `BLOWFISH` (avoid using except for backward compatibility)

If you omit the `KeyName` clause, it defaults to the master key in the wallet (covered later in this lesson).

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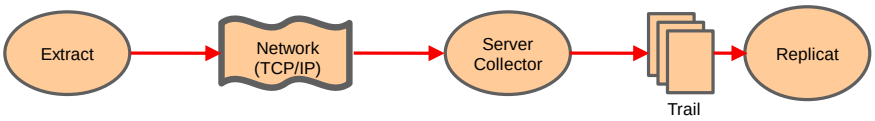
Trail or Extract File Encryption



Extract Parameters:

```
EncryptTrail <AESxxx> KeyName
<table statements>
```

Replicat Parameters:

```
DecryptTrail <AESxxx> KeyName
<map statements>
```

Trail or Extract File Encryption

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Only the data records are encrypted in the trail.

Set `EncryptTrail` before the tables that you want to be encrypted, and start `NoEncryptTrail` before the other tables.

Downstream data pumps can also decrypt the trail for transformation and pass it on either encrypted or decrypted.

<AESxxx> can be any of the following encryption types:

- `AES128`
- `AES192`
- `AES256`

The `KeyName` *<keyname>* refers to a key name in the `ENCKEYS` file.

If you omit the AES specification, Oracle GoldenGate defaults to using the 256-key byte substitution, which is very weak. If you omit the `KeyName` clause, it defaults to the master key in the wallet (covered later in this lesson).

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Trail Encryption with Wallet

- Oracle Wallet
  - Contains master keys
  - Is used in encryption for trail or TCP/IP
  - Creates keys used with AES
- Common commands:

```
GGSCI> Open Wallet
GGSCI> Add MasterKey {mykey}
GGSCI> Renew MasterKey {mykey}
GGSCI> Info MasterKey { ALL | mykey }
```

- Rare commands:

```
GGSCI> Delete MasterKey ALL
GGSCI> Purge Wallet
```

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There are at least two wallets in Oracle GoldenGate. The wallet that holds Oracle Database user IDs and passwords for Extract parameter files is stored in the credential store file `dircrd/cwallet.sso`. The wallet file in `dirwlt/cwallet.sso` holds the master keys used with trail or TCP/IP encryption, not with database users. After you create a master key, you only need to add one line:`EncryptTrail <enc_type>` in the Pump (or Extract if there is no Pump), and nothing in the Replicat:

```
Extract mypump
EncryptTrail AES256
-- the matching decrypt in the replicat is automatic and is not
specified.
RmtHost targethost, MgrPort 15001, Compress
RmtTrail ./dirdat/pe
Passthru
Table MYSCHEMA.*;
```

Similar to `ENCKEYS`, the master keys' wallet created on the source host must be either stored on a centrally available disk or copied to all GoldenGate target hosts.

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Password Encryption: Method 1

1. Generate an encrypted password with an Oracle GoldenGate default key code:
   Example:

```
GGSCI> Encrypt Password <password> EncryptKey Default
```

```
GGSCI> Encrypt Password mypswd EncryptKey Default
No key specified, using default key...
Encrypted password:  AACAAAAAAAAAAAOARAQIDGEEXAFAQJ
```

2. Paste the encrypted password in the Extract or Replicat `Password` parameter, as in the following example:

```
:
SourceDB mysource, USERID joe, Password
 AACAAAAAAAAAAAOARAQIDGEEXAFAQJ, EncryptKey DEFAULT
 :
```

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There are three ways to encrypt passwords:

- **Method 1:** As shown in the slide, use an Oracle-supplied default key and no `ENCKEYS` file. This method is repeatable and, therefore, susceptible to a reverse dictionary crack, so it is not recommended. Notice that there is also no encryption type specified, so it defaults to AES128.
- **Method 2:** A user-defined custom key using the `ENCKEYS` file (less susceptible) is shown in the next slide.
- **Method 3:** Oracle Wallet (new with Oracle GoldenGate 12*c*)

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Password Encryption: Method 2

1. Generate an encrypted password with a cipher strength (***encrypt_type***) and user-defined key:

```
GGSCI> Encrypt Password <password> <encrypt_type> EncryptKey <keyname>
```

2. Enter the key name and value in the **ENCKEYS** file.
3. Paste the encrypted password in the Extract or Replicat **Password** parameter.

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1. *<encrypt_type>*: Specify AES128, AES192, AES256, or Blowfish. If you do not specify anything, the default is to use Blowfish, which is the weakest of the four encryption types.
   <keyname>: Comes from the ENCKEYS file
   Example of generating an encrypted password with a user-defined key:

```
GGSCI> Encrypt Password MyPass AES256 EncryptKey drkey
Encrypted password:  AACAAAAAAAAAAAIAJFGBNEYGTGSBSHVB
```

2. Example of key name and value from ENCKEYS:

```
##Key name     Key value
drkey          0x11DF0E2C2BC20EB335CB98F05471A737
```

3. Example of pasted encrypted password:

```
SourceDB mysource, UserID joe, Password
AACAAAAAAAAAAAIAJFGBNEYGTGSBSHVB, EncryptKey drkey
```

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Password Encryption: Method 3

This method is only for Oracle Database passwords. It is not for TCP/IP encryption or for trail encryption.

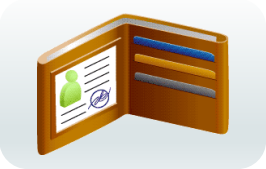
```
GGSCI> Create Wallet
GGSCI> Add CredentialStore
GGSCI> Alter CredentialStore Add User ogguser@mysid Password mypswd Alias oggadmin
GGSCI> Info CredentialStore
```

In Extract or Replicat **.prm** files, replace all occurrences of:

```
UserID ogguser@mysid, Password mypswd
```

With:

```
UserIDAlias oggadmin
```



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If available, this is the preferred method of password encryption.

Note that this is a different wallet from the one used for trails and TCP/IP encryption.

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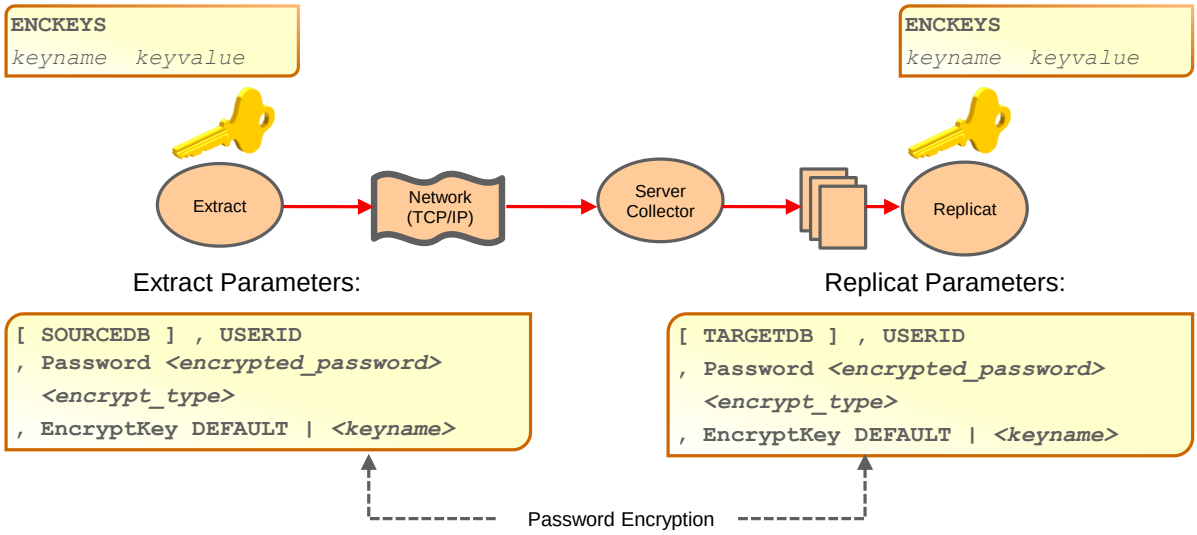
Summary of Password Encryption



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There are two ways to create the password; either way involves copying and pasting the encrypted value into the parameter files on both the source and the target.

Note that there is no comma between the password and its type.

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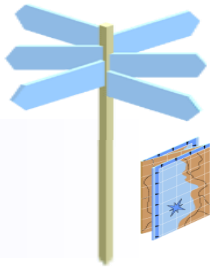
Agenda

- Macros
- Tokens
- User Exits
- Compression
- Encryption
- Event Actions
  - Rules
  - Heartbeat
  - Automated Actions



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Event Marker System

- Oracle GoldenGate provides an event marker system that enables Oracle GoldenGate processes to take a defined action based on an event record in the transaction log or in the trail (depending on the data source of the process).
- The event record is one of the following:
  - A record in a data table that satisfies a specific filter condition for which you want an action to occur
  - A record that you write to a dedicated event table when you want an action to occur

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You can use the event marker system to customize Oracle GoldenGate processing based on database events.

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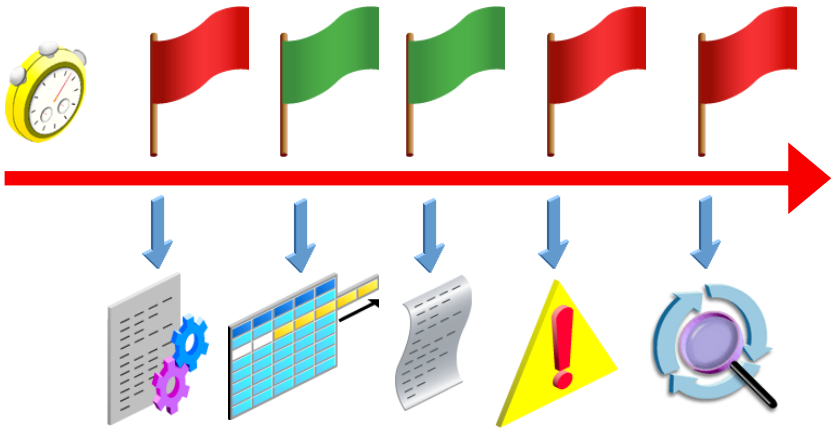
Uses for Event Actions



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Examples of actions that you might take after detecting an event record:

- Start or stop a GoldenGate process (there are several flavors of “stop”: graceful, abort, and so on).
- Ignore or discard the current record.
- Log an informational or warning message to the report file, Oracle GoldenGate error log, and system event log.
- Generate a report file.
- Roll over the trail file.
- Run a shell command in the OS (for example, to switch an application, start batch processes, or start end-of-day reporting).
- Activate tracing.
- Write a checkpoint before or after writing the record to the trail.

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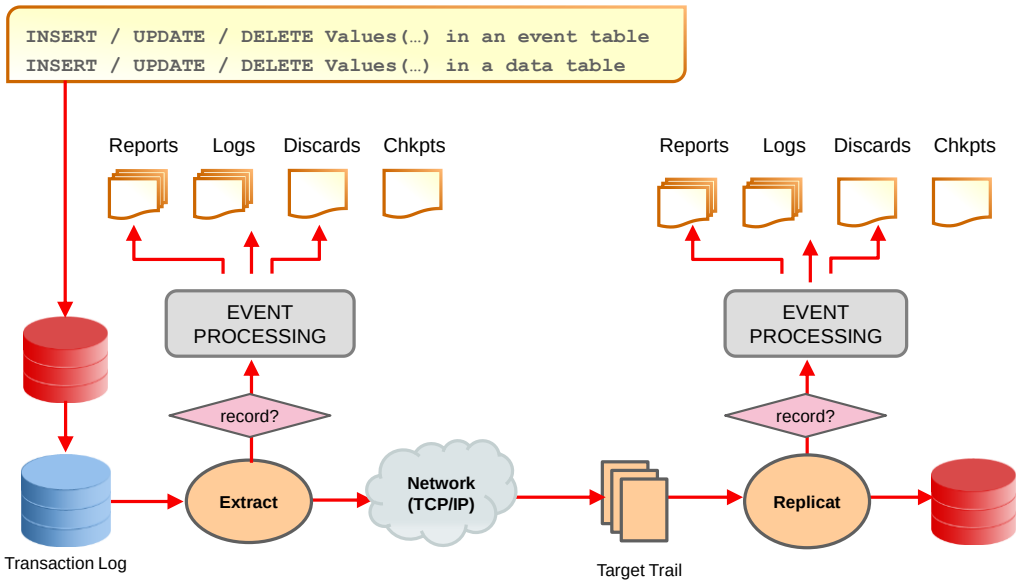
Event Actions Flowchart



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The event can trigger in an Extract or a Replicat. One transaction can contain many rows, and several of those rows could each trigger multiple events.

Events can trigger:

- Reports
- Writing to a log
- Discard of records
- Writing a checkpoint

New with version 11.2 is the ability to trigger from a DDL event as well as a DML event.

Similar to database triggers, the amount of overhead from excessive events should be monitored.

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EventActions Order

Before	Process the Record…	After
Trace	…unless you specified either Ignore or Discard	Report
Log		Suspend
Checkpoint Before		Abort
Ignore		Checkpoint After
Discard		ForceStop
Shell		Stop
Rollover		

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Many (but not all) `EventActions` options can be combined. You probably will need to combine two or more actions to achieve your goals.

The entire `EventActions` statement is parsed first, and only then are the specified options executed according to which one takes precedence over the other. In the table in the slide, the actions in the Before column occur before the record is written to the trail or applied to the target (depending on the process, Extract or Replicat). Actions that are listed in the After column are executed after the record is processed. If you do not want to process the record at all but only perform the actions, specify `Ignore` or `Discard` in addition to the other actions.

It is possible that a single transaction contains two or more records that trigger an event action. In such a case, there could be multiple executions of certain `EventActions`. For example, if two qualifying records trigger two successive `Rollover` actions, it causes Extract to roll over the trail twice, leaving one of the two files essentially empty.

`Trace` has several modifiers: `Transaction`, `DDL`, and `Purge` or `Append`.

The `Checkpoint` option has three modifiers: `Before` and `After` (listed in the slide) and `Both`. `Checkpoint` cannot be combined with `Abort`.

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Implementing Event Actions: Examples

- Use a separate event table to manage events.
  Whenever a record is written to the event table, the trail file is rolled over:

```
Table MYSOURCE.EVENT_TABLE, EventActions (Rollover);
```

- Use data values to trigger events.
  Any record where **`account_no = 100`** is discarded and a log message is written:

```
Map MYSOURCE.ACCOUNT, Target MYTARGET.ACCOUNT,
Filter (account_no = 100), EventActions (Discard, Log);
```

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Oracle GoldenGate supports actions based on the event record condition.

There are two ways to configure event actions. Perform either of the following steps:

- Add the `EventActions` option to a `Table` or `Map` statement.
- In the same `Table` or `Map` statement where you specified the event record, include the `EventActions` parameter.

New with version 11.2 is the ability for Oracle GoldenGate to pass values to an external shell script as a result of an action. The syntax is:

```
EventActions Shell
(
  "<command>",
  VAR <variable> = {<column_name> | <expression>}
  [, ...][, ...]
)
```

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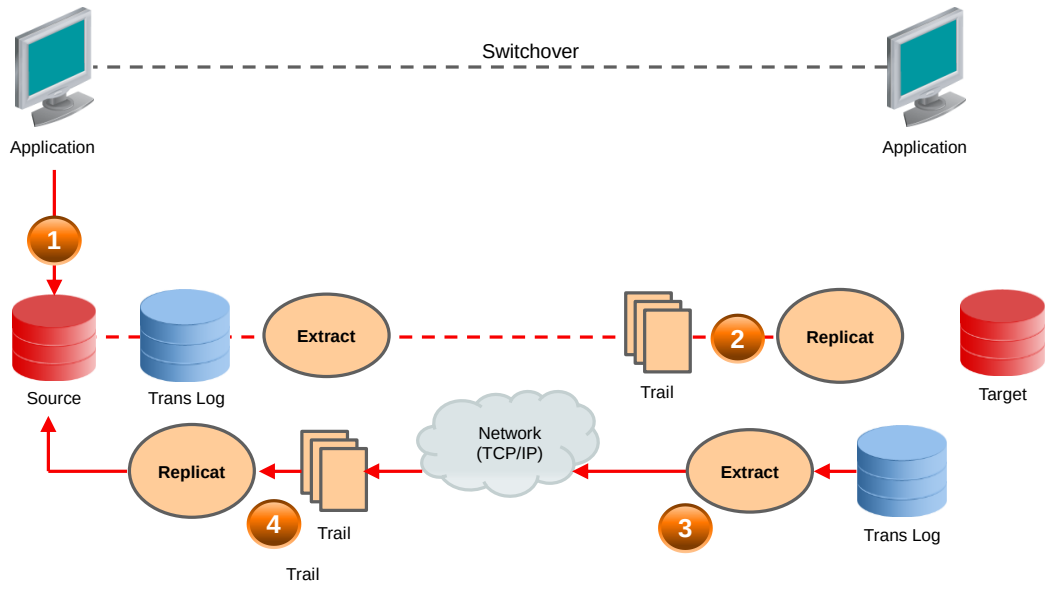
Event Actions: Automated Switchover Example



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1. The user writes an event record at the planned outage point. This is read by Extract through the transaction log.
2. When Replicat reads the event record, it triggers an event action (runs a custom script to switch the application to the target database).
3. The Extract on the target, which is already configured and running, starts capturing transactions.

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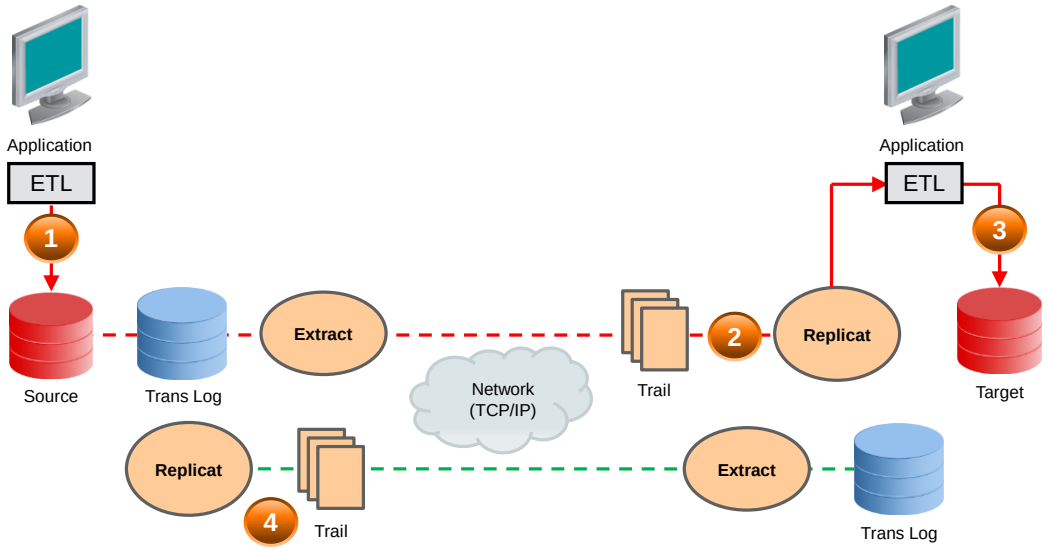
Event Actions: Automated Synchronization Example



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1. When a batch load is starting, the ETL process writes an event record. Extract reads the record and performs a checkpoint before and after the record.
2. When Replicat reads the event record, it requests the second ETL process to start at the right point.
3. The ETL performs checkpoints before and after the record.
4. When the second ETL process is completed, it generates an event record that is read by Extract on the target. When Replicat on the source receives the event record, it triggers a custom script to start the application based on the status of the batch process on the source.

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Quiz

Key names and values can be stored in:

a. **GLOBALS**

b. **ENCKEYS**

c. **SourceDefs**

d. **DefsFile**

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Answer: b

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Quiz

Only the **`EncryptTrail`** extract parameter should be set to encrypt and decrypt the records in the trail file.

a. True

b. False

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Answer: b

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Summary

In this lesson, you should have learned how to:

- Create and invoke macros
- Set and retrieve user tokens
- Run user exits in Oracle GoldenGate processes
- Compress data across the network
- Encrypt messages, trails, and passwords
- Automatically trigger actions based on event records

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Practice 10 Overview: Data Transformation and Configuration Options

This practice covers triggering an end-of-day job (database backup) via an EVENTACTIONS command.

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11

Installing Oracle GoldenGate Microservices Architecture

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Objectives

After completing this lesson, you should be able to:

- Identify and describe the various components of the Oracle GoldenGate Microservices Architecture
- List the operating system prerequisites needed for a Microservices Architecture installation
- Perform an Oracle GoldenGate Microservice Architecture installation and verify its successful completion

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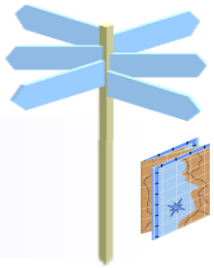
Agenda

- Discuss the major components of the Services Architecture
- Verify operating system requirements and prepare the computer
- Perform the software installation



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The Oracle GoldenGate Microservices Architecture

The Microservices Architecture (MA) for Oracle GoldenGate is a new REST API Microservices-based architecture that allows for the:

- Installation
- Configuration
- Monitoring
- Managing

of the Oracle GoldenGate services using a web-based UI.

Administrators can use MA to deploy, monitor, manage, and perform Extract and Replicat operations on trail data within an MA implementation.

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REST is an acronym for Representational State Transfer. The GoldenGate REST APIs are documents at the following link:

https://docs.oracle.com/goldengate/c1230/gg-winux/OGGRA/toc.htm

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Microservices Architecture: Main Components

The MA consists of five main components (servers or services:)

- Service Manager
  - It acts as a watchdog for other services available with Microservices Architecture.
- Administration Server
  - It supervises, administers, manages, and monitors processes operating within an Oracle GoldenGate deployment.
- Distribution Server
  - It functions as a networked data distribution agent in support of conveying and processing data and commands in a distributed networked deployment.
- Receiver Server
  - It is the central control service that handles all incoming trail files.
- Performance Metrics Server
  - It uses the metrics service to collect and store instance deployment performance results.

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Microservices Architecture: Additional Components

The MA also includes two additional components:

- The Admin client
  - Is a command-line utility (similar to the classic GGSCI utility). It uses the REST API published by the Microservices Architecture (MA) Servers to accomplish control and configuration tasks in an Oracle GoldenGate MA deployment.
- MA Security, Authentication, and Authorization Model/Services
  - A combination of services that declare and define how communication security (Confidentiality and Integrity) and Authorization (Authentication and Permissions) are configured and implemented within MA deployments. Together they implement the security model that governs all MA deployments.

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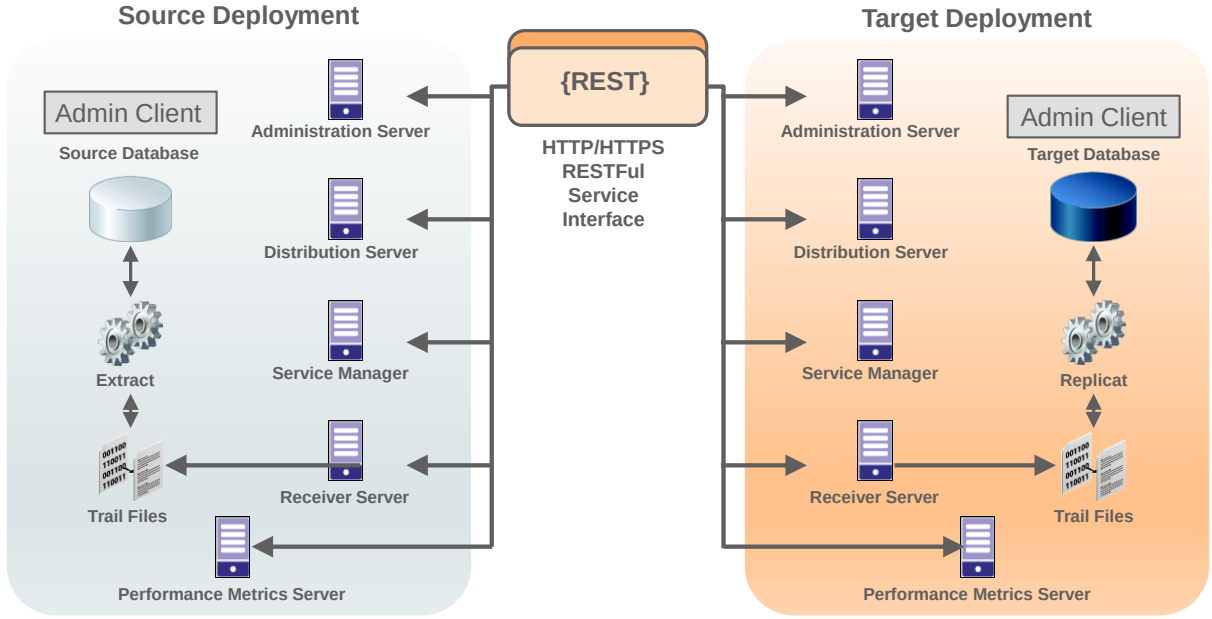
Microservices Architecture: a Pictorial Representation



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Microservices Architecture: Service Manager

A Service Manager allows administrators to create and manage one or multiple Oracle GoldenGate deployments on a local host.

- Service Manager is usually run as a system service and maintains inventory and configuration information about your deployments and allows administrators to maintain multiple local deployments.
- Using the Service Manager, administrators can start and stop instances and query deployments and the other services.
- The web-based UI client application connects to the Service Manager in order to interact with the MA infrastructure.
- The Admin Client command-line shell also connects to the Service Manager, which dispatches the commands entered in the shell to the appropriate MA servers.

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MA Security, Authentication, and Authorization

The MA security and authorization model declares and defines how communication security—*Confidentiality* and *Integrity*—and Authorization—*Authentication* and *Permissions*—are configured and implemented.

- Security and authorization configurations and services are common to all MA-based servers.
- These servers:

authenticate	**Access To**	**command and control**
authorize		**monitoring**
secure		**data conveyance**
		information service interfaces

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Microservices Architecture Authentication

The goal of the authenticated identity design is to establish identity authentication between:

- Users
- An MA service or application
- An MA server

The authentication design relies on the validity of either a certificate or a user credential (username/passphrase pair).

- Oracle recommends the use of security certificates for production deployments.

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Types of Certificates Used for Authentication

There are three types of certificates in an MA deployment.

- Application Certificate.
  - Is a certificate issued to a specific application.
    - The Application Certificate is stored by the application. Oracle GoldenGate client applications store the Application Certificate in an application Oracle Wallet designated by the Application configuration.
- User Certificate.
  - Is a certificate issued to a specific user.
    - The User Certificate is stored in a user Oracle Wallet. The default location of the user Oracle Wallet is under the user's home directory.
- Server Certificate.
  - Is a certificate issued to a specific MA server.
    - The Server Certificate is stored by the MA server in the server's Oracle Wallet. The default location of the server Oracle Wallet is under the server's installation directory.

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The distribution server uses the user certificate.

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Secure and Unsecure Deployments

You can opt to configure an unsecure MA deployment if you wish to do so.

If you opt for a secure deployment instead, as Oracle recommends, you can use the **`orapki`** utility to create and manage Oracle wallets and security certificates.

- Development and test MA environments can use self-signed certificates.
  - MA environments secured through self-signed certificates have the drawback that browsers used to interact with the MA servers will throw a security exception, as the root entity will not be recognized.
- Production deployments should use security certificates purchased from reputable Internet security companies.

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Security certificates can be purchased from DigiCert.

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Agenda

- Discuss the major components of the Services Architecture
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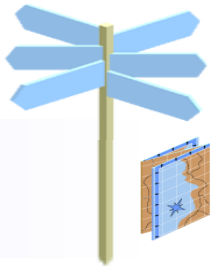

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OS Requirements: Memory

The crucial component while considering memory requirements for an Oracle GoldenGate MA installation is the temporary storage of RAM to disk, which is commonly known as swapping or paging.

- Excessive swapping to disk causes performance issues for the Extract process in particular, because it must store data from each open transaction until a commit record is received.
- For production systems Oracle recommends a minimum of 512 gigabytes for the swap partition/file, particularly if Oracle GoldenGate is installed on the same computer where the Oracle RDBMS resides.

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RAM and swap usage are controlled by the operating system, not the Oracle GoldenGate processes.

The Oracle GoldenGate cache manager takes advantage of the memory management functions of the operating system.

In most cases, users need not change the default Oracle GoldenGate memory management configuration.

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OS Requirements: Disk

- The distribution kit file is approximately 1 gigabyte in size (can be erased after the installation).
- The Oracle GoldenGate MA directory with executables and required components takes approximately 1.6 gigabytes of space on disk.
- Allow for an additional 1 GB of disk space on any system that hosts the Oracle GoldenGate trail files.
- Oracle GoldenGate maintains the transaction data that it swaps to disk a subdirectory of the Oracle GoldenGate installation directory. This directory may fill up quickly if there is a large transaction volume with large transaction sizes.
  - In production systems, in order to prevent I/O contention and possible disk-related failures, Oracle recommends dedicating a disk to this directory.

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Transaction data that is swapped to disk goes by default to the dirtmp subdirectory of the Oracle GoldenGate installation directory.

The directory location can be assigned with the CACHEDIRECTORY option of the CACHEMGR parameter.

In each parameter file, only one entry for CACHEMGR is allowed, but the CACHEDIRECTORY subparameter can occur multiple times (up to a maximum of 100), so multiple swap directories can be used.

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OS Requirements: Network

- The fastest network possible (10 gigabits preferred) should be used and redundancies installed at all points of failure.
- The system where MA is to be deployed should be configured to use both TCP/IP and UDP services, including DNS.
- Oracle GoldenGate supports both IPv4 and IPv6, and the two protocols can be used together.
- Oracle GoldenGate requires some unreserved and unrestricted TCP/IP ports, the number of which depends on the number and types of processes in the configuration.
- Firewalls must be configured to accept connections through the Oracle ports assigned to each server/service of the MA deployment.

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OS Requirements: Privileges

- For Linux/Unix installations, the user who installs Oracle GoldenGate must have read and write privileges on the Oracle GoldenGate installation directory.
- The Oracle GoldenGate Extract and Replicat processes and MA components part of MA deployments must operate as an operating system user that has privileges to:
  - read,
  - write,
  - and delete files and subdirectories in the Oracle GoldenGate directory.
- The **`oggca.sh`** process, the utility used to create and manage MA deployments, requires privileges to control the other Oracle GoldenGate processes.
- Sensitive information might be available to anyone who runs an Oracle GoldenGate process. Extract and Replicat processes should be run by OS users solely dedicated to Oracle GoldenGate. Common users SHOULD NOT have access to MA replication servers or services.

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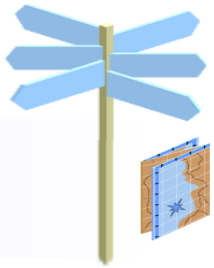
Agenda

- Discuss the major components of the Services Architecture
- Verify operating system requirements and prepare the computer
- Perform the software installation



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Oracle GoldenGate 12.3 MA Software Bundle

Installing the Oracle GoldenGate 12.3 MA software occurs in two phases:

- You install the software in the **`$OGG_HOME`** directory using the Oracle GoldenGate installer.
- Upon successful software installation, you run the **`oggca.sh`** utility to configure the Service Manager and the other MA servers.

The software installation through the Oracle GoldenGate installer is a simple, five-step procedure that requires two inputs from the administrator:

- You must choose between the Oracle RDBMS release (11*g* or 12*c*).
- You must provide the installation destination (**`$OGG_HOME`**).

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Configuring MA servers/services using **oggca**.

After the Oracle GoldenGate MA software is successfully installed, you launch the shell script **oggca.sh** to configure the Service Manager and the other MA servers.

- The **oggca.sh** utility allows you to configure the Service Manager.
  - Oracle recommends installing the Service Manager as a system service/daemon so that the entire MA architecture is started when the computer boots up.
  - Service Manager is the watchdog process that takes care of starting the other MA services (Administration Server, Distribution Server, Receiver Server and, if configured, the Performance Metrics Server.)
- The **oggca.sh** utility also allows you to configure the first deployment while configuring the Service Manager.

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If the `$OGG_HOME/bin` directory is included in your `$PATH` variable, you can launch `oggca.sh` from any directory your current default is.

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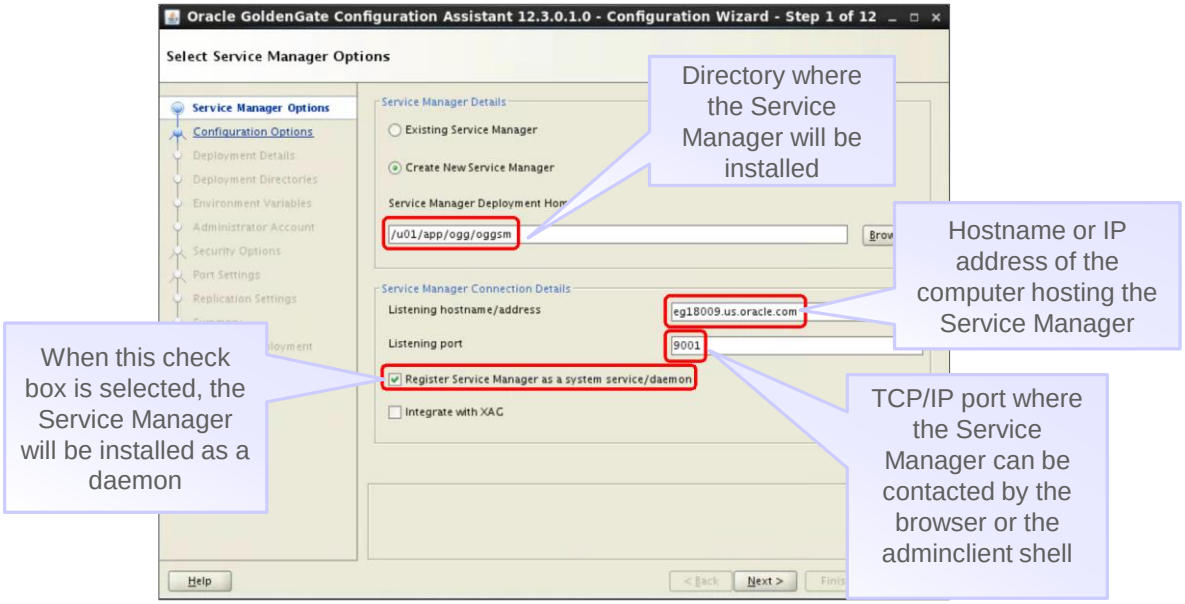
`oggca.sh`: Step One



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GoldenGate can be managed by the XAG bundled agent, which is a component of the Oracle Clusterware.

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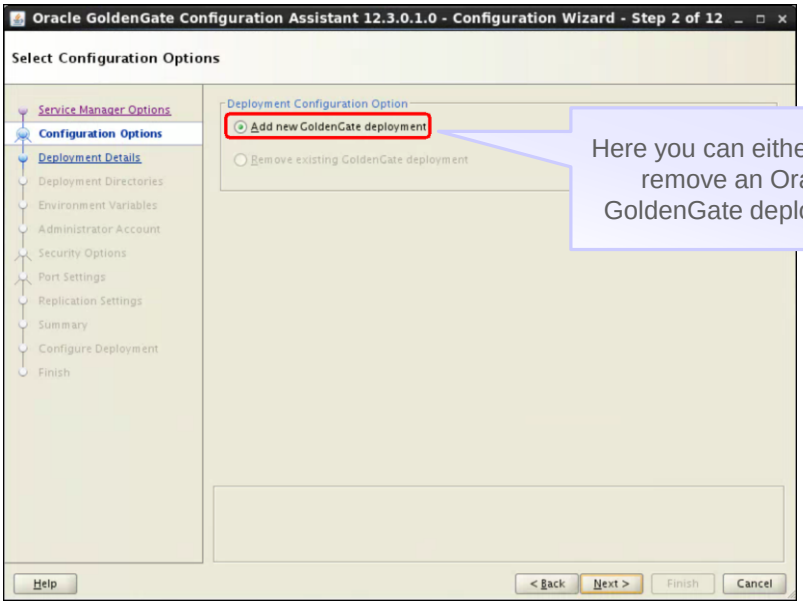
`oggca.sh`: Step Two



Here you can either add or remove an Oracle GoldenGate deployment

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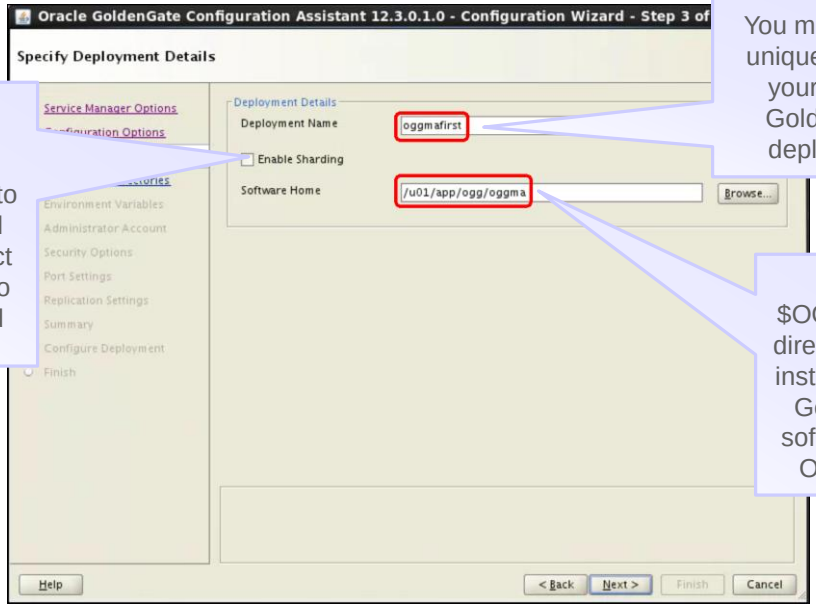
`oggca.sh`: Step Three



The MA architecture supports replicating from/to Oracle sharded instances. Select this check box to enable sharded replication

You must give a unique name to your Oracle GoldenGate deployment

This is $OGG_HOME, the directory where you installed the Oracle GoldenGate MA software using the Oracle installer

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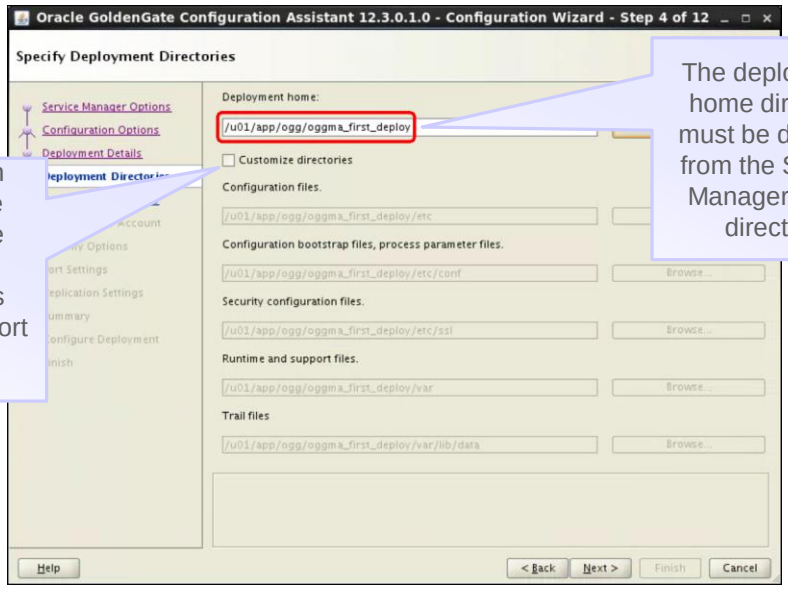
`oggca.sh`: Step Four



Here, you can customize the location of the various subdirectories needed to support the MA architecture

The deployment home directory must be different from the Service Manager home directory

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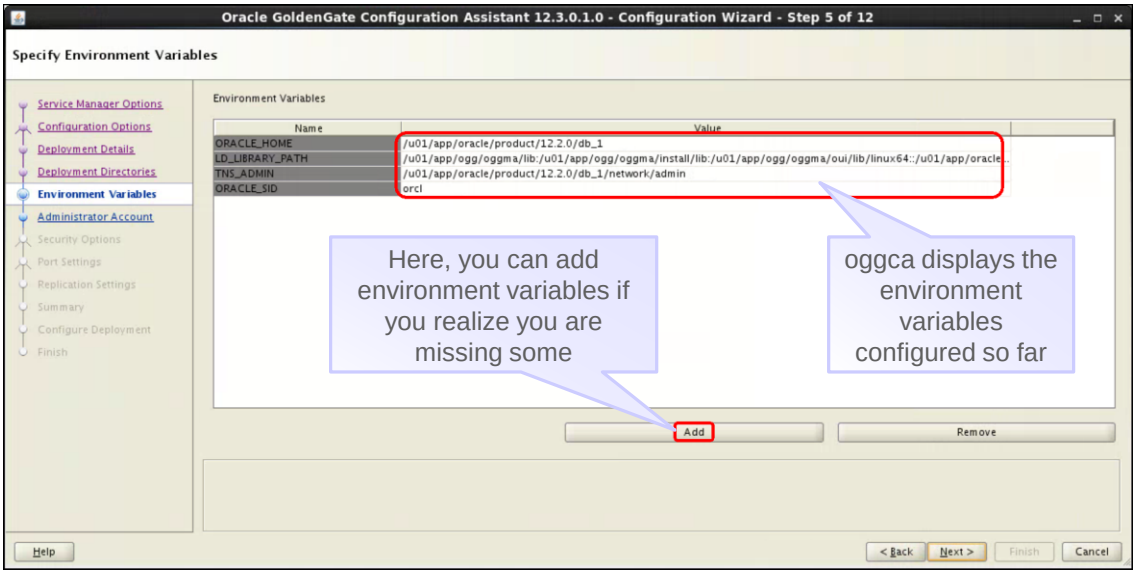
`oggca.sh`: Step Five



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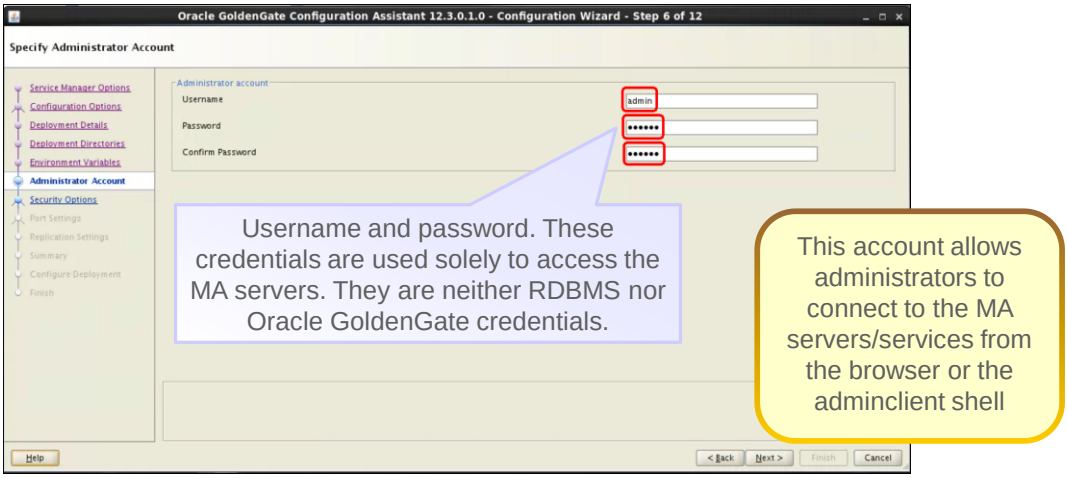
`oggca.sh`: Step Six

In step six you provide the credentials for the MA Administration Account.



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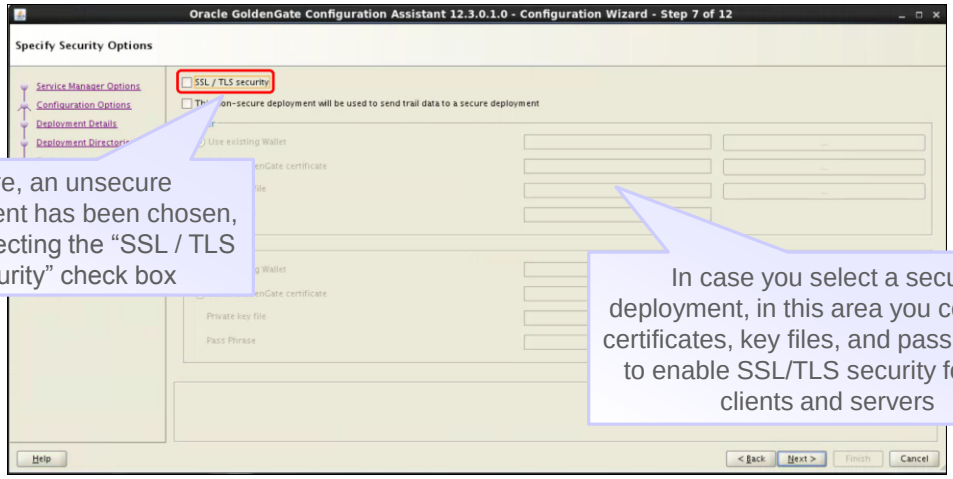
`oggca.sh`: Step Seven

In step seven you choose between secure and unsecure deployments.



Here, an unsecure deployment has been chosen, by unselecting the "SSL / TLS security" check box

In case you select a secure deployment, in this area you configure certificates, key files, and pass phrases to enable SSL/TLS security for both clients and servers

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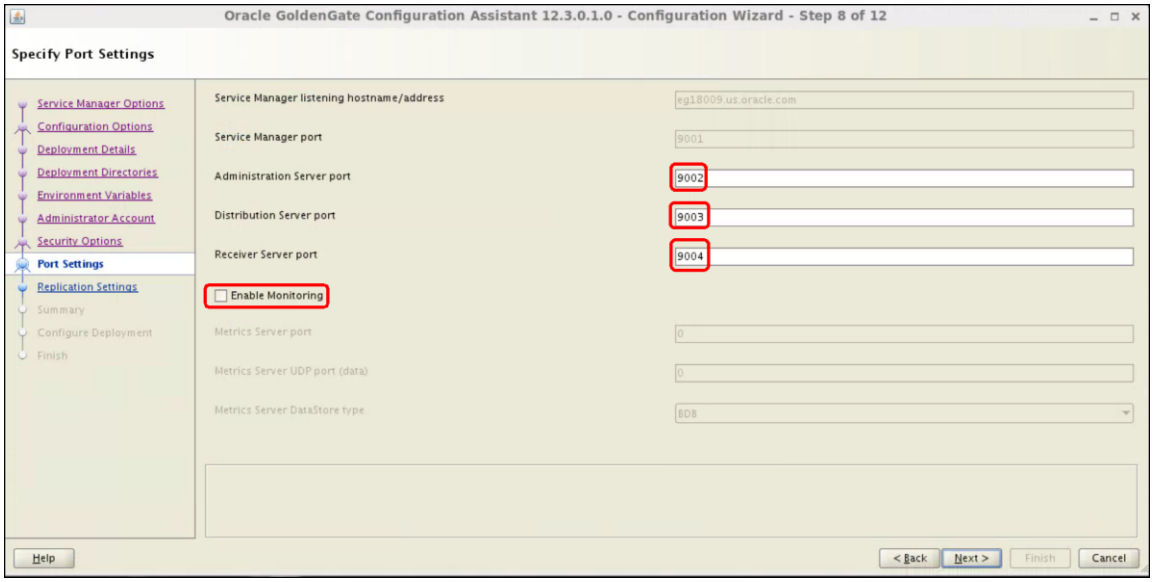
`oggca.sh`: Step Eight



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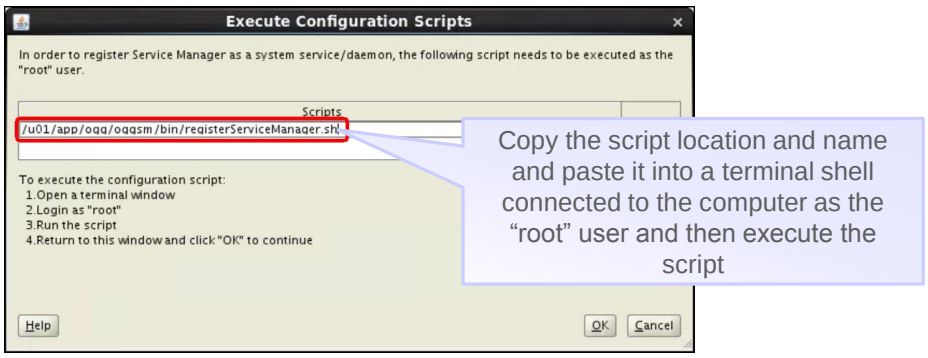
`oggca.sh`: Step Nine

This step must be performed with “root” privileges. Only an administrator can configure a service or daemon process to start at computer boot.



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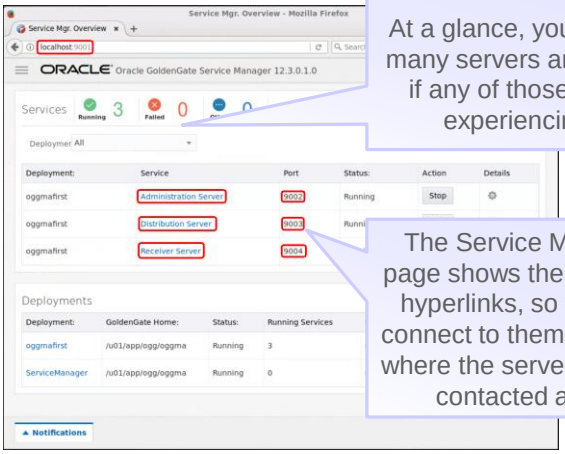
Verifying Deployment Configuration Using Your Browser

After you run the **`oggca.sh`** script to completion, enter the computer name and the port where the Service Manager is listening to in your browser:

The Service Manager overview page gives you a visual oversight of your MA installation



At a glance, you can see how many servers are running and if any of those servers are experiencing issues

The Service Manager overview page shows the various servers as hyperlinks, so you can click and connect to them. The port numbers where the server processes can be contacted are also shown

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Verifying Deployment Configuration Using **adminclient**

You can launch the Admin Client utility and connect to the newly provisioned deployment.

```
[oracle@hostname ~]$ adminclient
Oracle GoldenGate Administration Client for Oracle
Version 12.3.0.1.0 OGGCORE_12.3.0.1.0_PLATFORMS_170721.0154
Copyright (C) 1995, 2017, Oracle and/or its affiliates. All rights reserved.
Linux, x64, 64bit (optimized) on Jul 21 2017 07:16:02
Operating system character set identified as UTF-8.
OGG (not connected) 1> connect https://localhost:9001 as admin
Password for 'admin' at 'https://eg18009.us.oracle.com:9001': ******
Using default deployment '<deployment>'
```

After you connect to the Service Manager, you can enter the "**INFO ALL**" command to show the status of the MA servers.

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Discussion Questions

1. What are the five main components of an Oracle GoldenGate MA implementation?
2. Can you use the **`oggca.sh`** utility to just configure the Service Manager, without configuring a deployment at the same time?
3. What is **`adminclient`**?

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1. Service Manager, Administration Server, Distribution Server, and Receiver Server.
2. No. The oggca.sh utility must configure the Service Manager and at least one deployment to complete successfully.
3. The Admin Client is a command-line utility (similar to the classic GGSCI utility). It uses the REST API published by the Microservices Architecture Servers to accomplish control and configuration tasks in an Oracle GoldenGate deployment.

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Summary

In this lesson, you should have learned how to:

- Identify and describe the various components of the Oracle GoldenGate Microservices Architecture
- List the operating system prerequisites needed for a Microservices Architecture installation
- Perform an Oracle GoldenGate Microservice Architecture installation and verify its successful completion

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Practice 11: Overview

This practice covers the following topics:

- 11-1: Installing the Oracle GoldenGate Microservices Architecture software
- 11-2: Using **`oggca.sh`** to configure the Service Manager and a deployment
- 11-3: Verifying the successful installation and configuration of the MA implementation

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12

Oracle GoldenGate Microservices Architecture—Administration Server

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Objectives

After completing this lesson, you should be able to:

- Describe roles and functions of the MA Administration Server.
- Use the Administration Server embedded web application to create Extract and Replicat groups.
- Access the Extract/Replicat process parameters, statistics, checkpoints, and reports using the Administration Server embedded web application.

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MA Administration Server Overview

An Oracle GoldenGate MA Administration Server provides the following services:

- Supervision
- Administration
- Management
- Monitoring

of processes operating within an Oracle GoldenGate MA deployment for both active and inactive processes.

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Administration Server – Functionality

You use the Administration Server to:

- Create and manage Extract and Replicat processes.
- Register and unregister Extract and Replicat Processes.
- Manage parameter files.
- Review process information, statistics, reports, and status including LAG and checkpoints.
- Retrieve reports and discard files.
- Manage credential stores and encryption keys.
- Add and remove users who can interact with the Administration Server.

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The Administration Server is also used to manage:

1. Auto-start tasks
2. Auto-restart tasks
3. Checkpoint tables
4. Supplemental logging in the source database

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The REST API

The key feature of the Administration Server is the REST API Service Interface.

- The REST API can be accessed from any HTTP or HTTPS client.
- It is routinely accessed by the Microservices Architecture service interfaces.
- Perl and Python scripts can also interface with the REST API, allowing third-party client applications to easily interact with the Administration Server for ad-hoc tasks.
- The Admin Client can be used to make REST API calls to communicate directly with the Administration Server.

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Using these APIs, a single RESTful service call could be used to create, update the parameter file, register, and start an integrated extract.

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Embedded Web Server

The Administration Server includes an embedded web application.

- You can use the embedded web application to connect from any web browser.
- The embedded web application does not require any client software installation.
- You interact with the Administration Server using your browser. The TCP/IP port used by the Administration Server is set up during deployment configuration through the **`oggca.sh`** utility.

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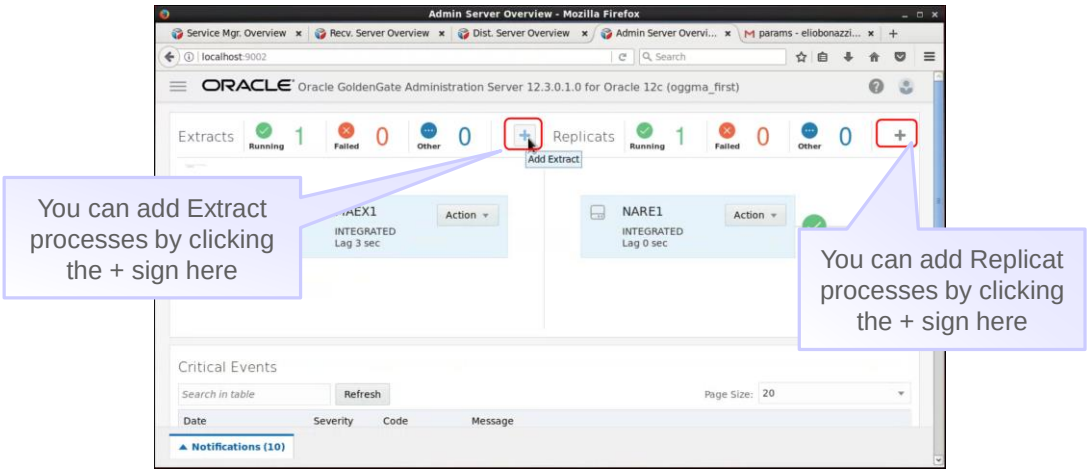
Web Page Overview

The main page displayed by the Administration Server web application shows, at a glance, the Extract and Replicat processes currently configured.



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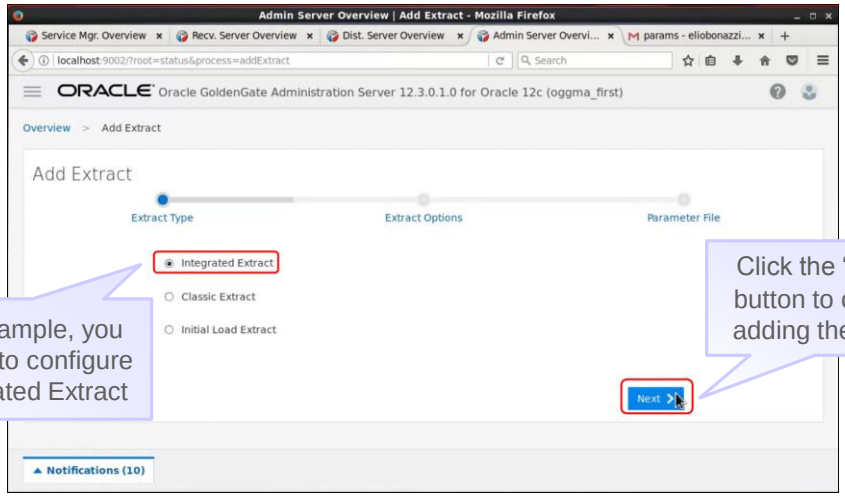
Add Extract

The Add Extract page allows you to configure the Extract type (Integrated, Classic, Initial load).



In this example, you are going to configure an Integrated Extract

Click the "**Next>**" button to continue adding the Extract

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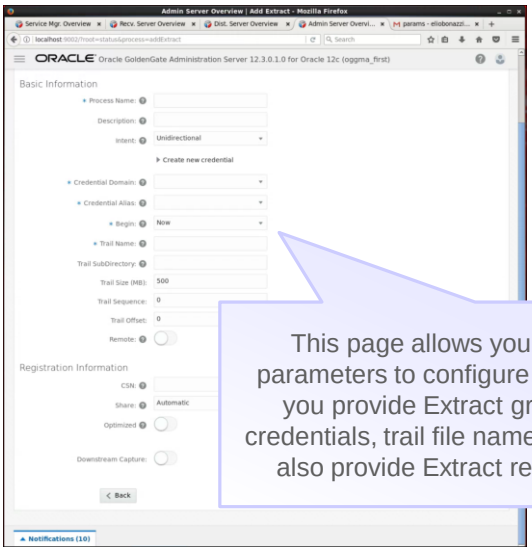
Extract Options



This page allows you to enter all required parameters to configure an Extract group. Here you provide Extract group name, database credentials, trail file name, location, and size. You also provide Extract registration parameters

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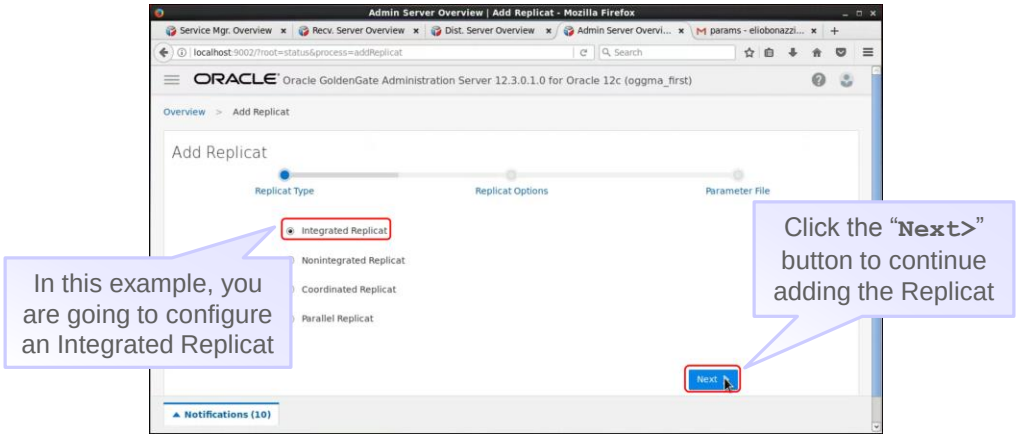
Add Replicat

The Add Replicat functionality allows you to configure the Replicat type (Integrated, Nonintegrated, Coordinated, and Parallel).



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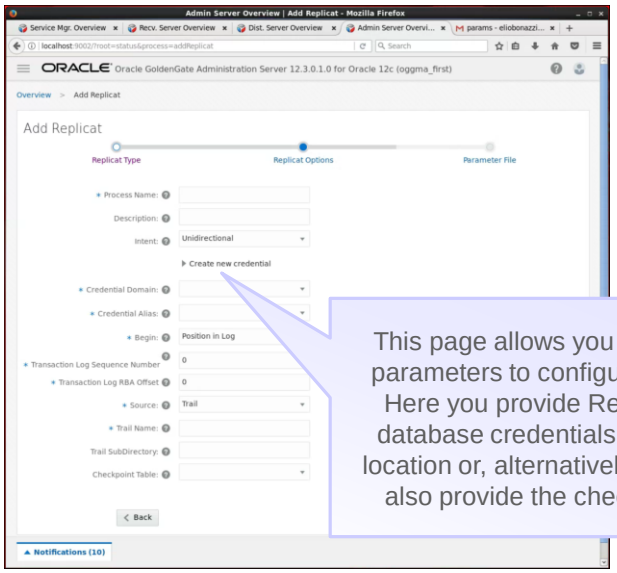
Replicat Options



This page allows you to enter all required parameters to configure a Replicat group. Here you provide Replicat group name, database credentials, trail file name, and location or, alternatively, file name. You can also provide the checkpoint table name

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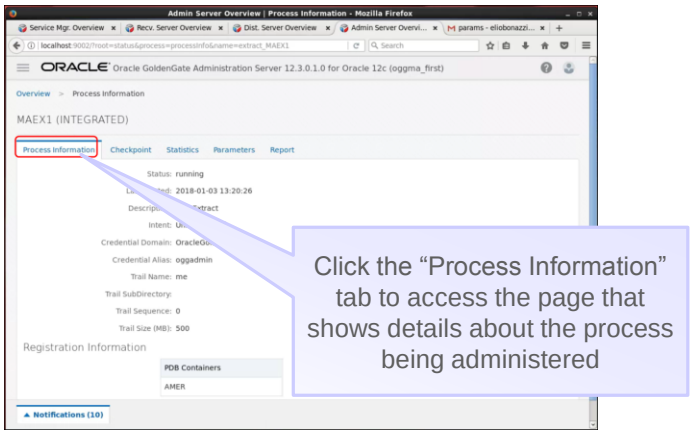
Extract/Replicat Process Overview

The Administration Server web application allows you to manage Extract and Replicat processes in great detail. You can access checkpoint information, statistics, parameters, and process reports.



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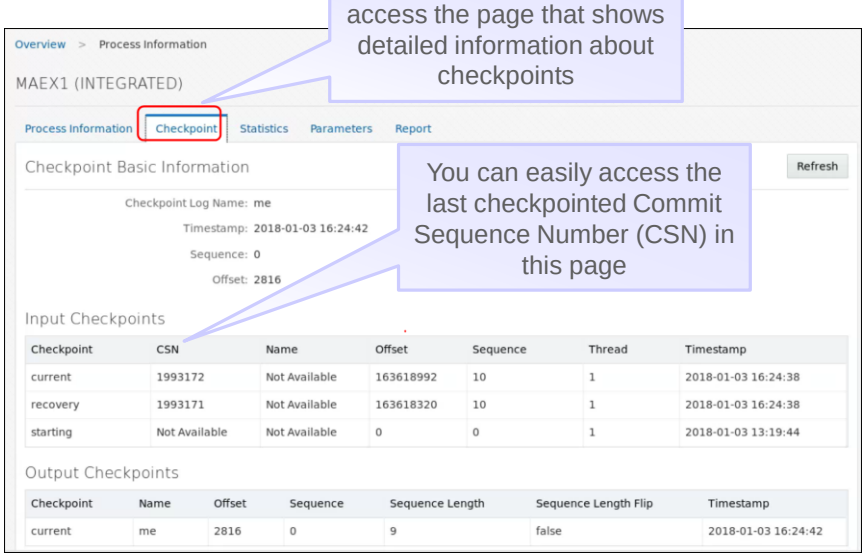
Checkpoint Information

Click the “Checkpoint” tab to access the page that shows detailed information about checkpoints



You can easily access the last checkpointed Commit Sequence Number (CSN) in this page

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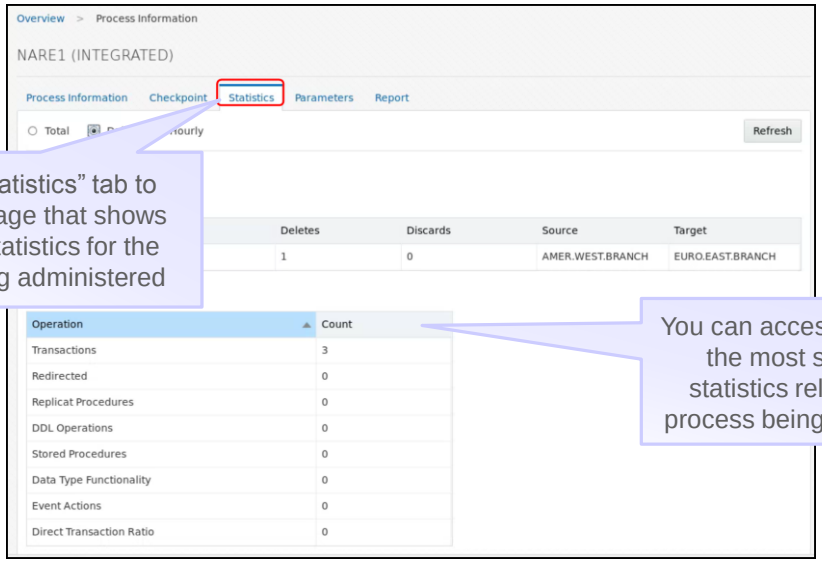
Extract/Replicat Statistics



Click the "Statistics" tab to access the page that shows replication statistics for the process being administered

You can access at a glance the most significant statistics related to the process being investigated

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The slide shows a replicat named NARE. The practice will provide instructions to create a replicat named MARE1.

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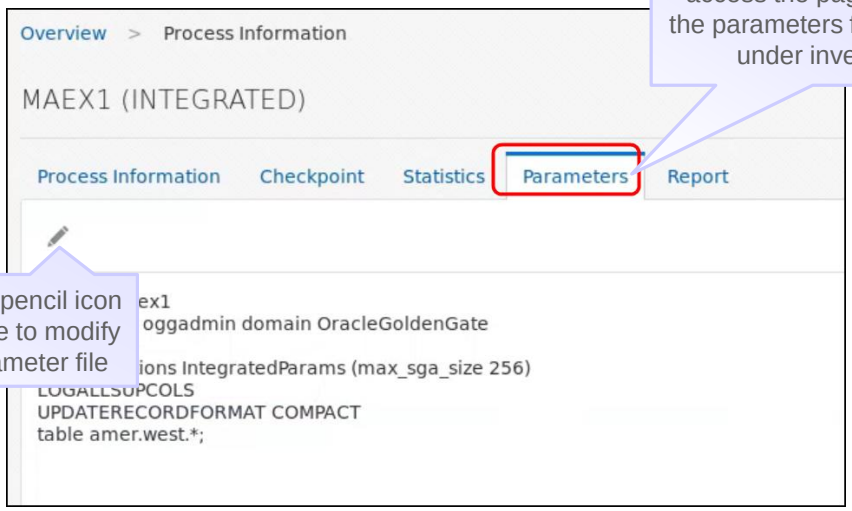
Process Parameters



Click the "Parameters" tab to access the page that shows the parameters for the process under investigation

Click the pencil icon to be able to modify the parameter file

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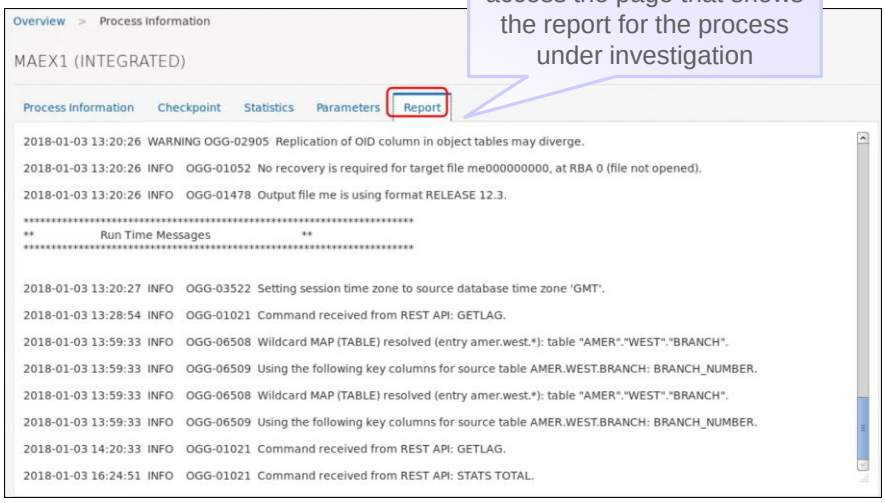
Process Reports

Click the “Report” tab to access the page that shows the report for the process under investigation



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Quiz

You need the Admin Client command-line utility in order to modify process parameters after you successfully configure and start the process using the Administration Server GUI interface.

a. True

b. False

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Answer: b

Extract and Replicat parameters can be changed using the Administration Server GUI.

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Summary

In this lesson, you should have learned how to:

- Describe roles and functions of the MA Administration Server.
- Use the Administration Server embedded web application to create Extract and Replicat groups.
- Access the Extract/Replicat process parameters, statistics, checkpoints, and reports using the Administration Server embedded web application.

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Practice 12: Overview

This practice covers the following topics:

- 12-1: Adding an Extract group by using the Administration Server web application
- 12-2: Adding a Replicat group by using the Administration Server web application

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13

Oracle GoldenGate Microservices Architecture – Distribution Server

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Objectives

After completing this lesson, you should be able to:

- Describe roles and functions of the MA Distribution Server.
- Use the Distribution Server embedded web application to create, start, and stop paths.
- Access the data path parameters, statistics, SCN/RBA positions in trail files, and data filters using the Distribution Server embedded web application.

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MA Distribution Server Overview

A Distribution Server is a process that functions as a networked data distribution agent.
It is responsible for:

- Conveying and processing of data
- Dispatching commands

in a distributed networked deployment.

A Distribution Server is able to concurrently handle:

- multiple commands
- multiple data streams

from multiple source trail files to target trail files, all at once.

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Data Pump Replacement

A Distribution Server replaces the classic multiple source-side data pumps with a single instance service.

- It distributes one or more trails to one or more destinations.
- It provides lightweight data and object filtering.
  - Unlike data pump processing, a Distribution Server cannot perform data content transformation.
- A Distribution Server can dispatch trail files to one or more Receiver Servers in a Multiservices deployment. It is also capable of inter-operating with the Classic architecture, delivering trail files to classic architecture collectors.

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Multiple Protocols

A Distribution Server supports multiple communication protocols:

- Oracle GoldenGate protocol (**`ogg`**).
  - Used for communication between the Distribution Server and the Collector in a non-services-based (classic) target. Supported for inter-operability with OGG classic.
- WebSockets for HTTP/HTTPS-based streaming (**`ws`** or **`wss`**)
  - This protocol is supported over plain HTTP (ws) or HTTPS relying on SSL/TLS security (wss).
- UDT
  - A UDP-based data transfer protocol for high-speed wide area networks.
- Proxy support for cloud environments.
  - CKS5 for any network protocol.
  - TTP for HTTP-type protocols only, including WebSocket.

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Distribution Server Functionality

You connect to a Distribution Server to:

- Create and manage paths
- Stop and start paths
- Reposition reading offsets in trail files
- Assign content filters to paths

A path, within an MA deployment, is a channel that connects source trail files to target trail files. In a fully MA context, a path is established between a Distribution Server and a Receiver Server. In a mixed classic/MA environment, a path can connect MA servers with classic architecture processes, such as collectors.

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Embedded Web Server

The Distribution Server includes an embedded web application.

- You can use the embedded web application to connect directly from any web browser.
- The embedded web application does not require any client software installation.
- You interact with the Distribution Server using your browser. The TCP/IP port used by the Distribution Server is set up during deployment configuration through the **`oggca.sh`** utility.

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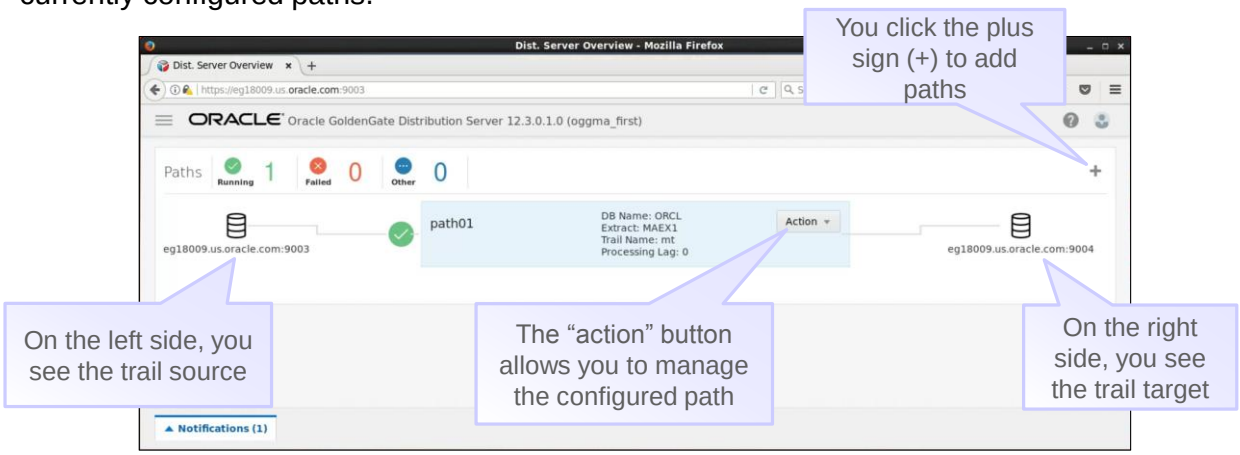
Web Page Overview

The main page displayed by the Distribution Server web application shows, at a glance, the currently configured paths.



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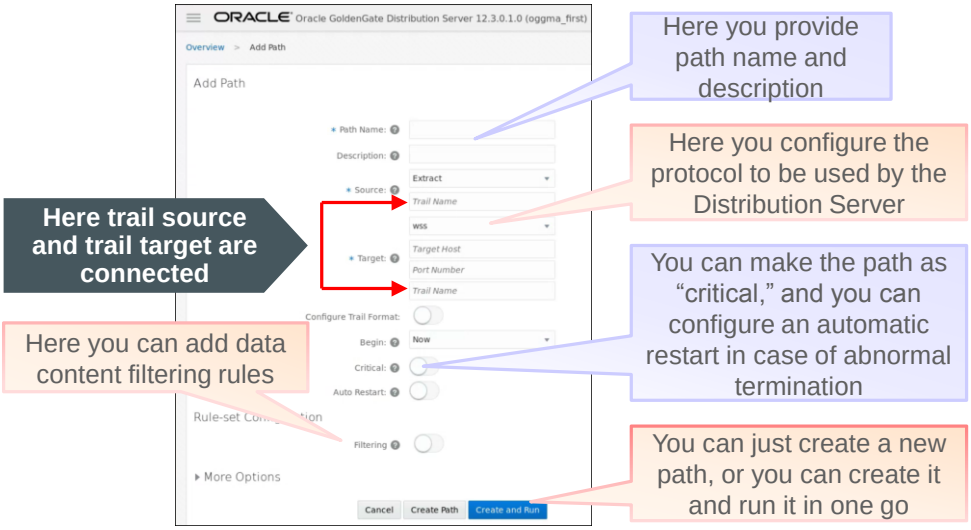
Add Path

The Add Path page allows you to create and configure a new path.



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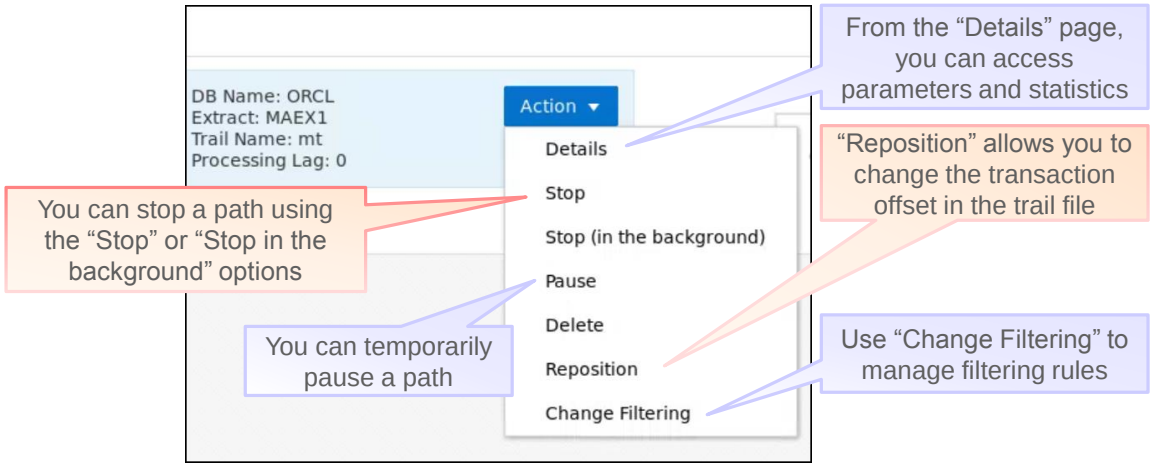
Path Management

The “Action” button in the path box allows you to manage a path.



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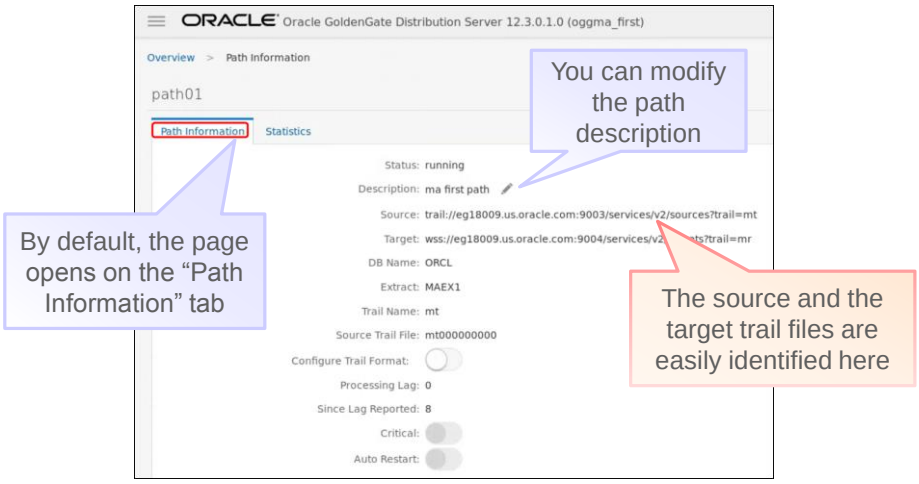
Path Information Page

The “Details” option from the “Action” button displays the Path Information page.



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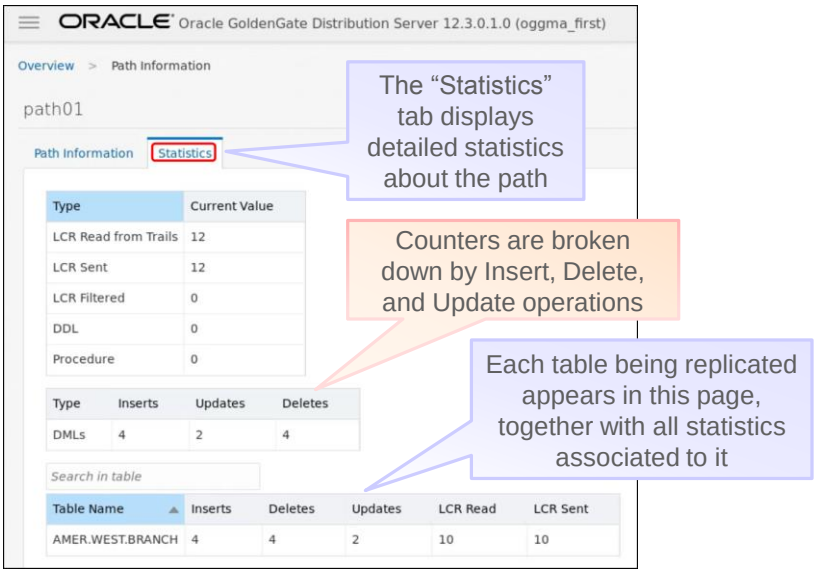
Path Statistics



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Quiz

Using the built-in lightweight filtering facility, the Distribution Server allows you to operate simple transformations while dispatching trail files to the Receiver Server.

a. True

b. False

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Answer: b, false

No transformation can be performed when using the Distribution Server.

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Summary

In this lesson, you should have learned how to:

- Describe roles and functions of the MA Distribution Server
- Use the Distribution Server embedded web application to create, start and stop paths
- Access the data path parameters, statistics, SCN/RBA positions in trail files, and data filters using the Distribution Server embedded web application

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Practice 13: Overview

This practice covers the following topics:

- 13-1: Creating a data path by using the Distribution Server
- 13-2: Generating database activity and verifying that replication occurs
- 13-3: Adding filtering options to an existing path

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Option: You can include a brief summary

Creating a Data Path Using the Distribution Server of the practice here. Do not merely repeat the information in the slide.

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14

Oracle GoldenGate Microservices Architecture—Receiver Server and Performance Metrics Server

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Objectives

After completing this lesson, you should be able to:

- Describe role and functionality of an MA Receiver Server
- Describe role and functionality of an MA Performance Metrics Server

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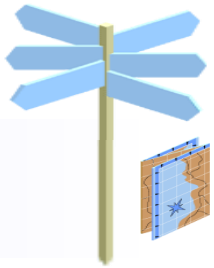
Agenda

- The Receiver Server
- The Performance Metrics Server



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The Receiver Server: Overview

A Receiver Server is the central control service that handles all incoming trail files.

- It interoperates with the Distribution Server.
  - It receives the trail files sent over the network by the Distribution Server.
- It provides compatibility with the classic architecture pump for remote classic deployments.

A Receiver Server replaces multiple discrete target-side collectors with a single instance service.

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Receiver Server Functionality

You connect to a Receiver Server when you must:

- Monitor data path events.
- Query the status for incoming paths.
- View the statistics of the incoming paths.
- Diagnose and troubleshoot path issues.

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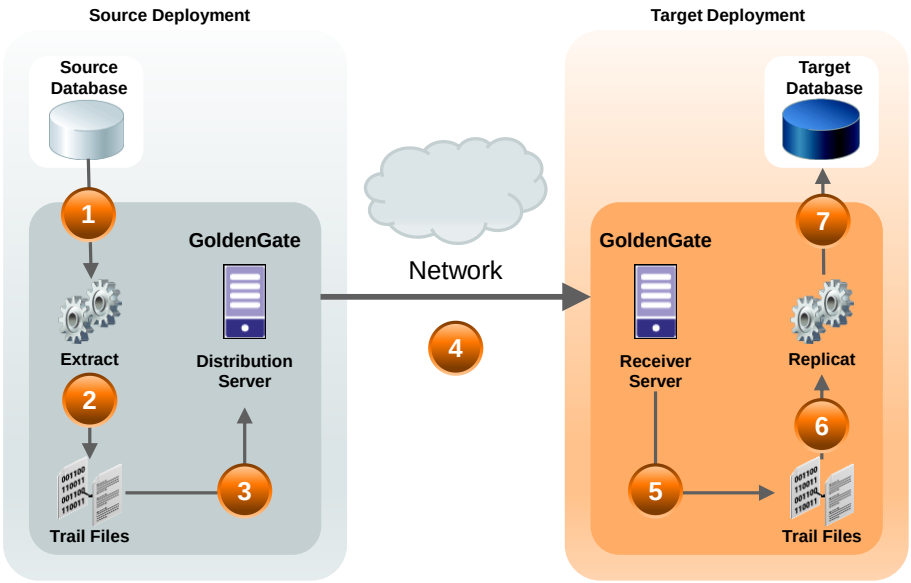
Receiver Server Interaction with a Distribution Server



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The seven steps for a data path in the Oracle GoldenGate MA environment:

1. Data is captured from the source database
2. The Extract process stores the captured data in trail files
3. The Distribution Server accesses the trail files
4. The Distribution Server ships the trail files over the network to the Receiver Server
5. The Receiver Server saves to disk the trail files that it receives from the Distribution Server
6. The Replicat process reads the trail files that are made available by the Receiver Server
7. The Replicat process applies all committed changes to the target database

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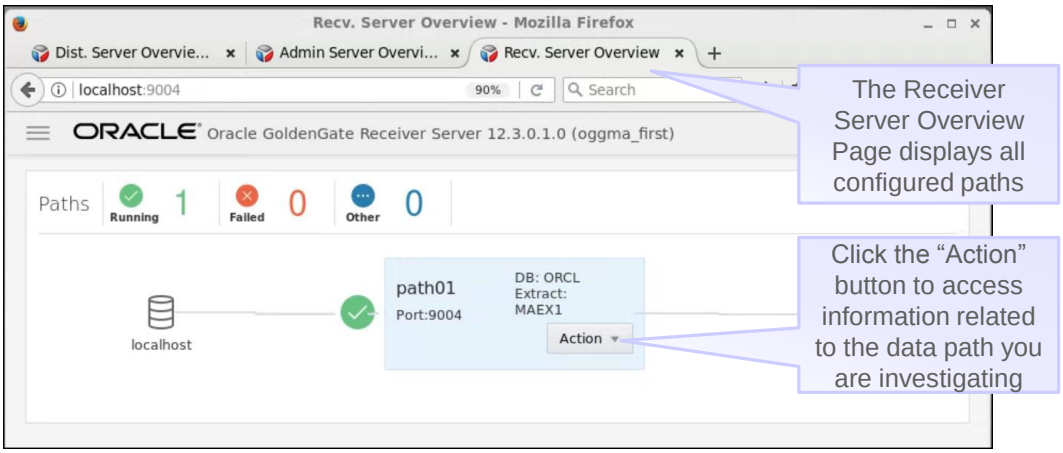
Receiver Server Web GUI

The Receiver Server offers a GUI application that can be accessed using your browser.



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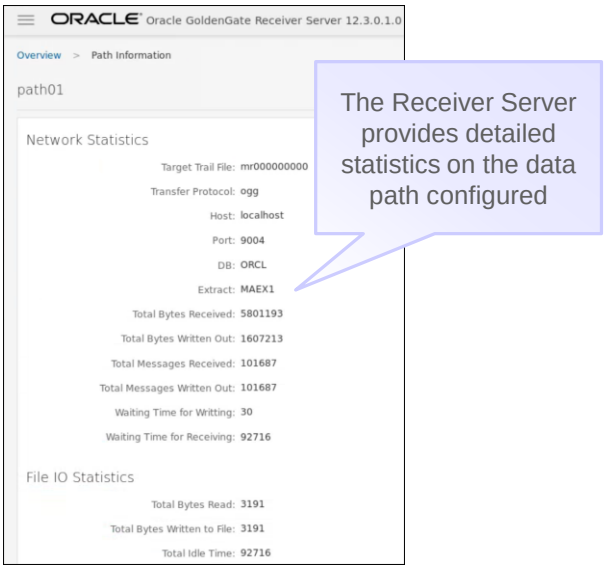
Receiver Server: Path Information



The Receiver Server provides detailed statistics on the data path configured

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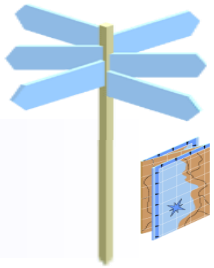
Agenda

- The Receiver Server
- The Performance Metrics Server



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Performance Metrics Server: Overview

The Performance Metrics Server collects and stores metrics sent by all Oracle GoldenGate processes.

- Performance metrics and counters received by the Performance Metrics Server are stored in a local storage engine—either Oracle Berkeley DB or the Lightning Memory-Mapped Database (LMDB).
- All the server components of the Services Architecture can be monitored at drill-down levels to allow trend monitoring and statistical analysis of data.
- The Performance Metrics Server offers these detailed views with graphical representations of statistical data in real time.

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Performance Metrics Server Functionality

You connect to a Performance Metrics Server and use its services to:

- Query for various metrics and receive responses in the services JSON format or the classic XML format.
- Monitor system resource utilization.
- View active process status.
- View error logs.
- Integrate third-party metrics tools.

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Metrics and Counters by MA Component: 1

Performance Report Type	Available for MA Component
Process Performance	Service Manager Administration Server Distribution Server Performance Metrics Server Receiver Server Extracts Replicats
Thread Performance	Service Manager Administration Server Distribution Server Performance Metrics Server Receiver Server Extracts Replicats
Server Statistics	Distribution Server Performance Metrics Server

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Metrics and Counters by MA Component: 2

Performance Report Type	Available for MA Component
Status and Configuration	Service Manager Administration Server Distribution Server Performance Metrics Server Receiver Server Extracts Replicats
Trail Files	Extracts and Replicats
Database Statistics	Extracts and Replicats
Cache Statistics	Extracts
Queue Statistics	Extracts
Procedure Statistics	Extracts and Replicats

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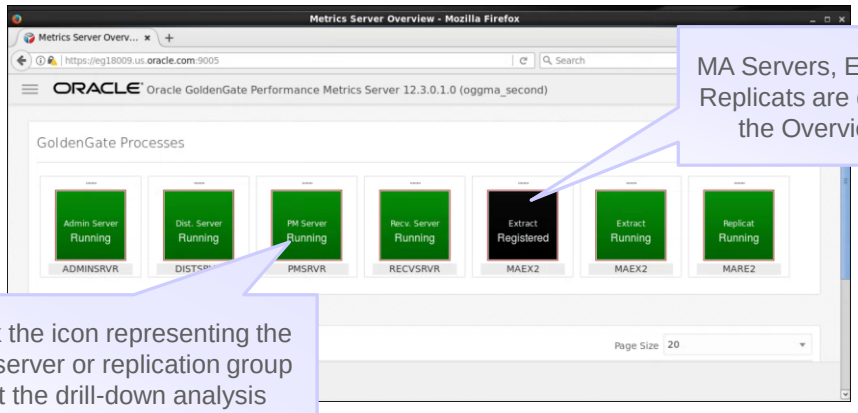
Metrics Server Overview Page

The Overview page shows at a glance all MA components that you can access and drill-down looking for metrics and counters.



MA Servers, Extracts, and Replicats are displayed in the Overview page

You click the icon representing the specific server or replication group to start the drill-down analysis

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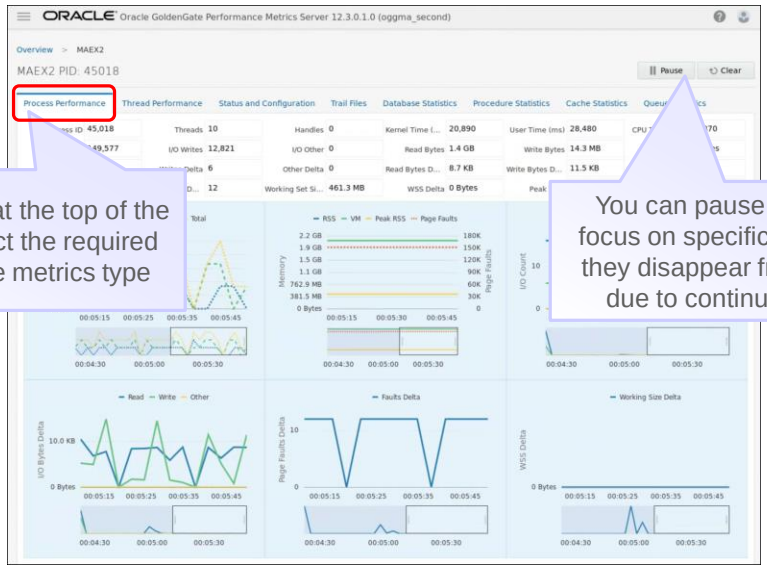
Extract Group: Process Performance Analysis



Click the tab at the top of the page to select the required performance metrics type

You can pause the display to focus on specific metrics before they disappear from the screen due to continuous scrolling

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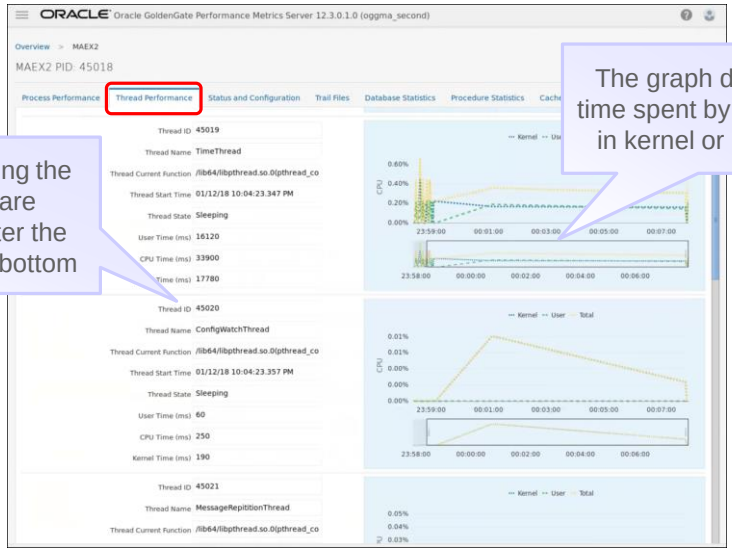
Extract Group: Thread Performance Analysis



Threads comprising the Extract group are displayed one after the other, from top to bottom

The graph displays the time spent by each thread in kernel or user mode

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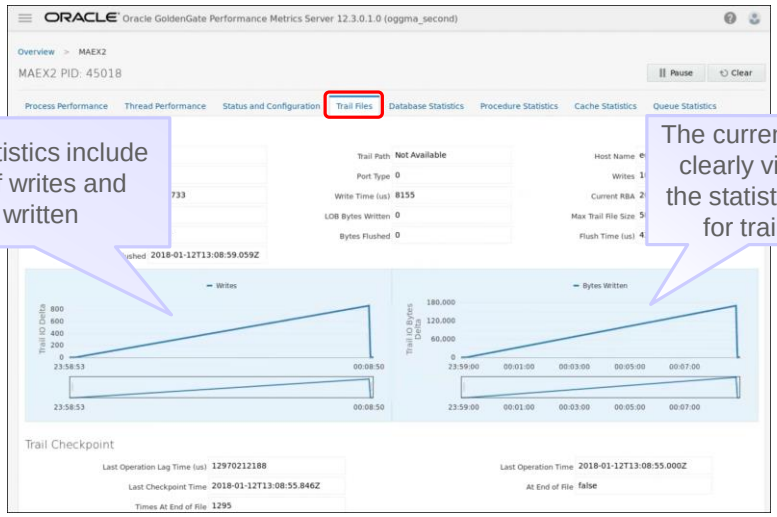
Extract Group: Trail File Analysis



Trail file statistics include number of writes and bytes written

The current RBA is clearly visible in the statistics page for trail files

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RBA is the 6-byte relative byte address of the commit record within the transaction log.

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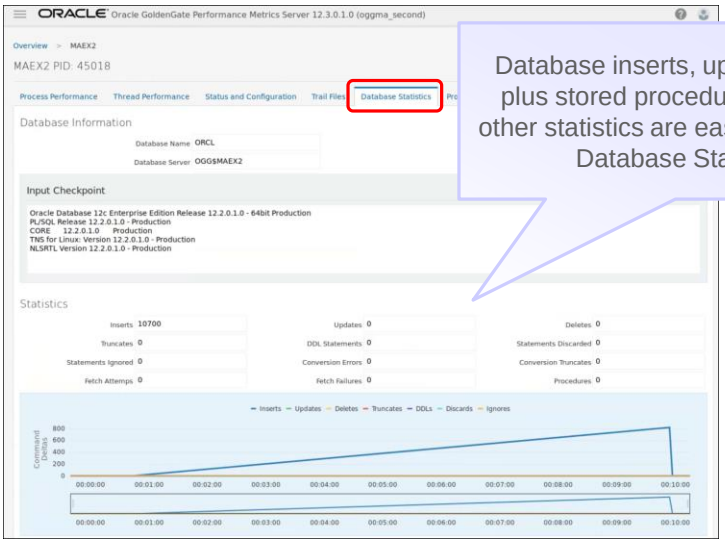
Extract Group: Database Statistics



Database inserts, updates, and deletes plus stored procedure invocations and other statistics are easily accessible in the Database Statistics page

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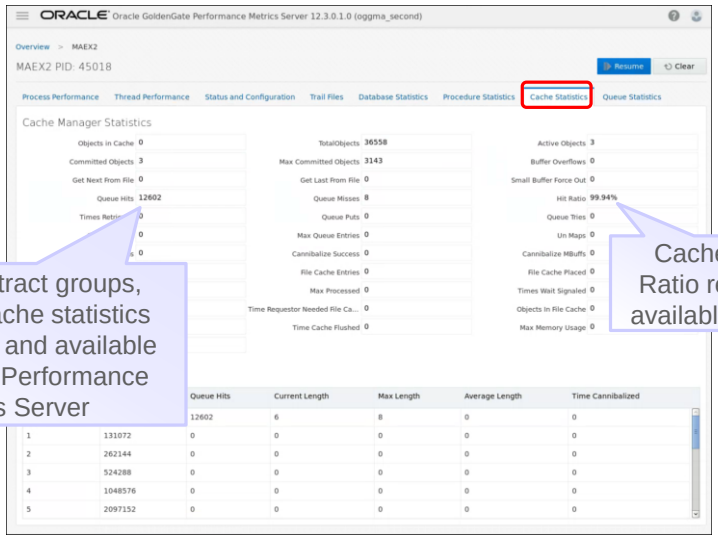
Extract Group: Cache Statistics



Only for Extract groups, database cache statistics are exposed and available through the Performance Metrics Server

Cache Hit Ratio readily available here

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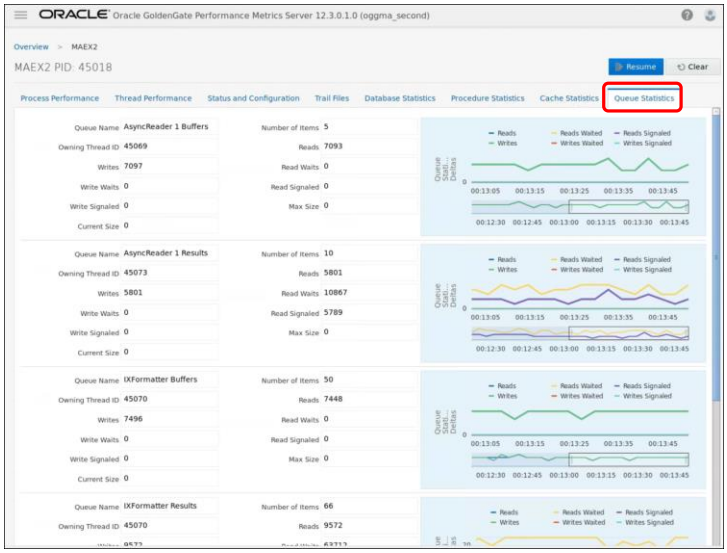
Extract Group: Queue Statistics



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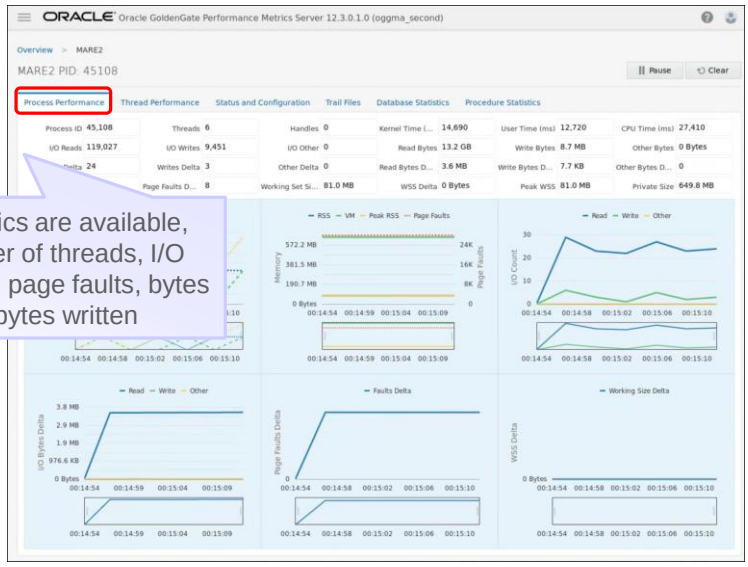
Replicat Group: Process Performance Analysis



Detailed statistics are available, such as number of threads, I/O reads, I/O writes, page faults, bytes read, and bytes written

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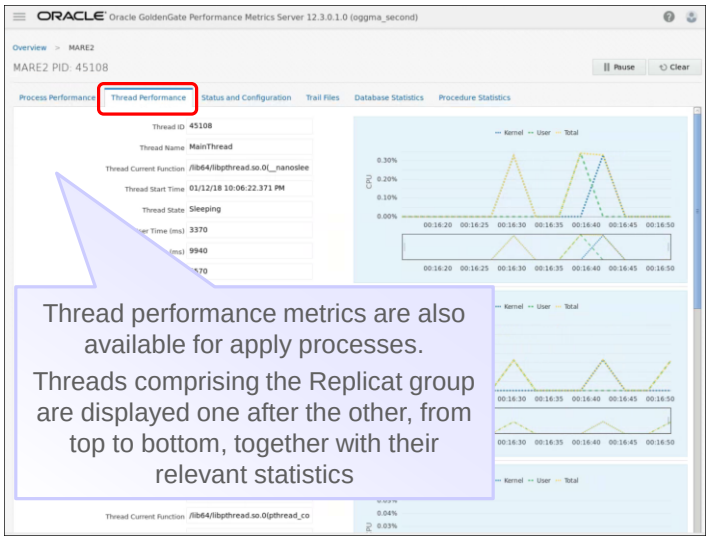
Replicat Group: Thread Performance Analysis



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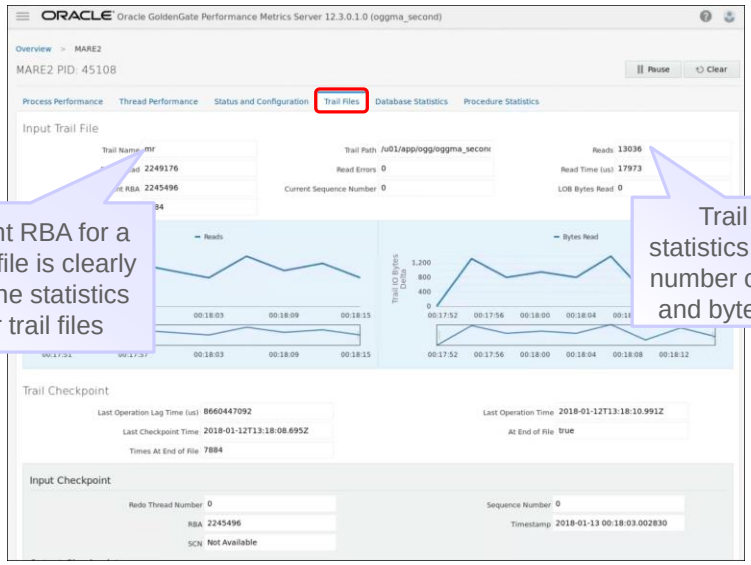
Replicat Group: Trail File Analysis



The current RBA for a target trail file is clearly visible in the statistics page for trail files

Trail file statistics include number of reads and bytes read

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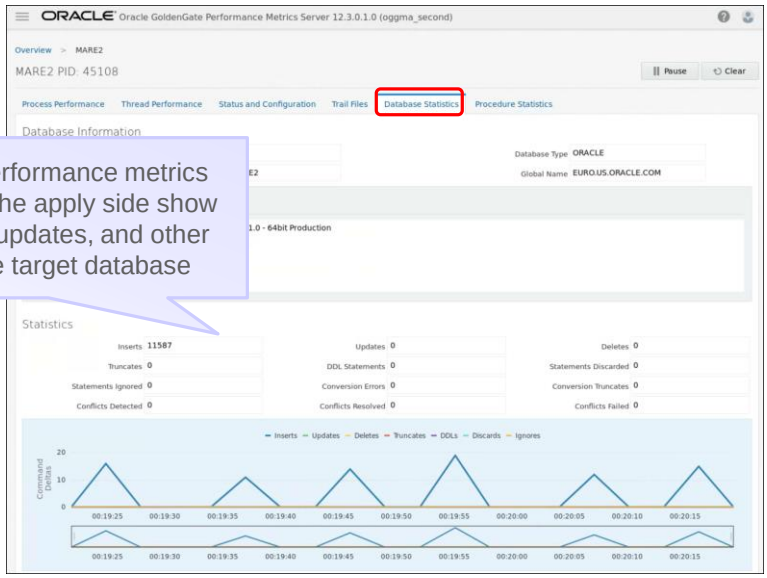
Replicat Group: Database Statistics



The database performance metrics and counters on the apply side show inserts, deletes, updates, and other statistics for the target database

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Quiz

You can connect to the Receiver Server to manage, that is, start and stop, the configured data paths.

a. True

b. False

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Answer: b

You can only administer the data paths by connecting to the Distribution Server.

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Quiz

The cache and queue statistic drill-downs are available for both Extract and Replicat groups.

a. True

b. False

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Answer: b

Cache and queue drill-downs are only available for Extract groups.

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Summary

In this lesson, you should have learned how to:

- Describe role and functionality of an MA Receiver Server
- Describe role and functionality of an MA Performance Metrics Server

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Practice 14: Overview

This practice covers the following topics:

- Practice 14-1: Accessing the Receiver Server to display path statistics
- Practice 14-2: Stopping data capture and applying by using the Admin Server
- Practice 14-3: Stopping the data path **`path01`** by using the Distribution Server
- Practice 14-4: Uploading a stored procedure to the Oracle RDBMS to generate database activity
- Practice 14-5: Removing the **`oggma_first`** deployment by using **`oggca.sh`**
- Practice 14-6: Configuring your second deployment by using **`oggca.sh`**
- Practice 14-7: Exploring the second deployment and creating an Extract group, a Replicat group, and a path
- Practice 14-8: Causing database activity and monitoring through the Performance Metrics Server

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MA Admin Client

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Objectives

After completing this lesson, you should be able to:

- Use the Admin Client to connect to an MA deployment.
- Perform common administrative tasks using the Admin Client.

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MA Admin Client Overview

The Admin Client is a command-line utility that uses the REST API published by the Microservices Architecture Servers to accomplish control and configuration tasks in one or more Oracle GoldenGate MA deployments.

- Admin Client is similar to GGSCI, sharing a lot of the syntax.

Admin Client is used by MA administrators as an interactive shell to execute commands in an MA environment.

- It is not used by MA servers.

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The admin client does not support the following commands:

```
-dblogin userid
-edit param
-info mgr
-info mgr detail
-add extract <group>, exttrailsource
```

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Admin Client Common Use

You use the Admin Client to:

- Create Extract and Replicat groups
- Start and stop Extract and Replicat groups
- Start and stop MA servers
- Request statistics on running MA processes
- View and modify parameter files
- View reports

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Admin Client and GGSCI: Similarities and Differences

While Admin Client and GGSCI share a common purpose and syntax, there are differences:

Admin Client	GGSCI
Connects to any MA deployment	Connects to a local deployment
Requires HTTP or HTTPS access	Requires local machine access, typically SSH
Application logic executed remotely	Application logic executed locally
Uses MA security	Uses operating system security
Authenticated and authorized for each operation	Authenticated and authorized once
Requires a CONNECT command	No special connect semantics
Supports **`USERIDALIAS`** only	Supports **`USERID`**, **`PASSWORD`**, and **`USERIDALIAS`**
Encrypted communications using SSL	Non-secure communications

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Admin Client: MA Specific Syntax

Compared to **GGSCI**, Admin Client introduces new syntax to support MA components and concepts. Admin Client supports:

- Connecting to an MA deployment.
  - New commands are: **CONNECT**, **DISCONNECT**
- Managing MA servers.
  - New commands are: **START SERVICE**, **RESTART SERVICE**, **STOP SERVICE**, **START DEPLOYMENT**, **STOP DEPLOYMENT**, **STATUS DEPLOYMENT**, **STATUS SERVICE**, **HEALTH DEPLOYMENT**, **RESTART DEPLOYMENT**
- Managing Distribution Paths.
  - New commands are: **ADD DISTPATH**, **START DISTPATH**, **ALTER DISTPATH**, **RESTART DISTPATH**, **STOP DISTPATH**
- Requesting path statistics.
  - New command is: **STATS DISTPATH**

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Admin Client Environment Variables

Admin Client needs at least three environment variables to be set in order to work.

- **OGG_HOME**
  - The Oracle GoldenGate home that is created on a host computer is the directory that you choose to install the product. This read-only directory contains binary, executable, and library files for the product. Example: **/u01/app/ogg/oggma**
- **OGG_VAR_HOME**
  - The location in which each deployment logging and reporting processing artifact is stored. Example: **/u01/app/ogg/test_deployment/var**
- **OGG_ETC_HOME**
  - The location in which each deployment configuration file is stored including parameter files. Example: **/u01/app/ogg/test_deployment/etc**

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Admin Client: Syntax Help

The **HELP** command is your best friend when using Admin Client.

- **HELP** with no qualifiers displays a list of all available top-level commands.
- **HELP** followed by a specific sub-command gives you an explanation on how to use the syntax, with examples.
  - Example: **HELP START EXTRACT**

```
START EXTRACT

Syntax:
| START EXTRACT <group-name-wildcard> [ ATCSN <csn> |
    AFTERCSN <csn> ]

Use RESTART EXTRACT to stop then start an Extract group.
…Many Omitted Lines…
```

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There is also a HELP SHOWSYNTAX <command> command, useful to find out how a specific command can be used with its options and sub-commands.

You can also use HELP <command-wildcard> to select similar commands.

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Admin Client Example

```
[oracle@eg18009 ~]$ adminclient
Oracle GoldenGate Administration Client for Oracle
Version 12.3.0.1.0 OGGCORE_12.3.0.1.0_PLATFORMS_170721.0154
Copyright (C) 1995, 2017, Oracle and/or its affiliates. All rights reserved.
Operating system character set identified as UTF-8.
OGG (not connected) 1> connect https://eg18009.us.oracle.com:9001 as admin password ******
Using default deployment 'oggma_second'
OGG (https://eg18009.us.oracle.com:9001 oggma_second) 2> health deployment oggma_second
... Many Omitted Lines...
Deployment: oggma_second
    Service: distsrvr
     Status: running
    Started: 2018-01-14T00:54:50.707Z
     Health: OK
  Resources: Name                              Type        Health
             -------------------------------   ----------  --------------
             path02                            distPath    OK (Disabled)
OGG (https://eg18009.us.oracle.com:9001 oggma_second) 3>
```

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Quiz

Using **adminclient**, you can add a data pump Extract by using the "**ADD EXTRACT <ext name>, EXTTRAILSOURCE <trail file>**" syntax.

a. True

b. False

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Answer: b

The Distribution Server is used in MA deployment transfer trail files between source and target environments. The **EXTTRAILSOURCE** sub-command is not implemented for **adminclient**.

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Quiz

Using **`adminclient`**, you can connect to the database issuing the **`DBLOGIN USERIDALIAS`** command before you connect to the MA deployment.

a. True

b. False

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Answer: b

Connecting to a database using DBLOGIN USERIDALIAS before connecting to a service manager causes the error: "ERROR: No connection to services. Use CONNECT command."

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Summary

In this lesson, you should have learned how to:

- Use the Admin Client to connect to an MA deployment
- Perform common administrative tasks using the Admin Client

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Practice 15: Overview

This practice covers the following topics:

- 15-1: Setting up the environment and launching **`adminclient`**.
- 15-2: Stopping the Extract group **`MAEX2`**, modifying its parameters, and restarting it.
- 15-3: Performing database activity and accessing path statistics.

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Option: You can include a brief summary of the practice here. Do not merely repeat the information in the slide.

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Database Sharding Support, Metadata Encapsulation, Replication Lag Management, Invisible Column Support

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Objectives

After completing this lesson, you should be able to:

- Describe database sharding concepts and GoldenGate MA support for it
- List metadata encapsulation features and advantages
- Implement a lag management policy
- Handle replication of invisible columns

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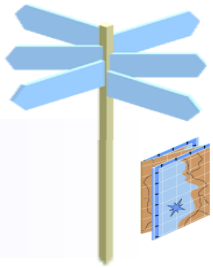
Agenda

- MA Support for Database Sharding
- Metadata Encapsulation
- Replication Lag Management
- Invisible Column Support



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Database Sharding Overview

Sharding is a data tier architecture in which data is horizontally partitioned across independent databases.

- Each database is hosted on dedicated server with its own local resources—CPU, memory, flash, or disk.
- Each database in such a configuration is called a *shard*. All the shards together make up a single logical database, which is referred to as a *sharded database* (SDB).

Horizontal partitioning involves splitting a database table across shards so that each shard contains the table with the same columns but a different subset of rows. A table split up in this manner is also known as a *sharded table*.

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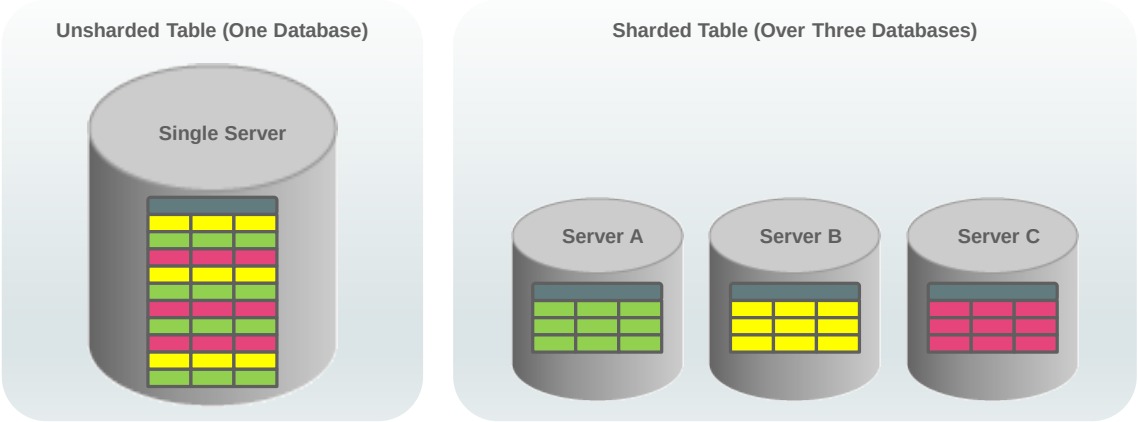
Unsharded Table vs. Sharded Table (Three Databases)

Horizontal Partitioning of a table across three shards.

The sharding key determines the placement of data in shards.



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Sharding in Details

Sharding is based on a shared-nothing hardware infrastructure that eliminates single points of failure because shards do not share physical resources such as:

- CPU
- memory
- storage devices

Shards are also loosely coupled in terms of software.

- Shards do not run clusterware.
- Shards can be placed on premises, in a cloud, or in a hybrid on-premises and cloud configuration.

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From the perspective of a database administrator, a sharded database (SDB) consists of multiple databases that can be managed either collectively or individually.

From the perspective of the application, however, an SDB looks like a single database:

the number of shards and distribution of data across those shards are completely transparent to database applications.

Sharding is intended for custom OLTP applications that are suitable for a sharded database architecture.

Applications that use sharding must have a well-defined data model and data distribution strategy (consistent hash, range, list, or composite) that primarily accesses data using a sharding key.

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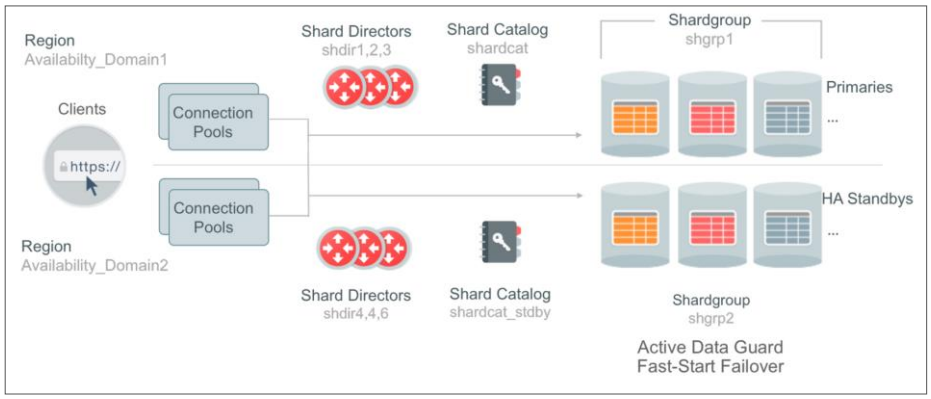
Oracle Sharding: Typical Deployment

The diagram shows a typical complex shard deployment, where collection of shards (shardgroups) are configured for fault tolerance and high availability using Oracle Data Guard.



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A sharded database is a collection of shards. Shards can all be placed in one region (datacenter(s)) or can be placed in different regions. A region in the context of Oracle Sharding represents a datacenter or multiple datacenters that are in close network proximity.

Shards are replicated for High Availability (HA) and Disaster Recovery (DR) with Oracle replication technologies such as Active Data Guard. For HA, the standby shards can be placed in the same region where the primary shards are placed. For DR, the standby shards are located in another region.

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Oracle GoldenGate MA Support for Sharded Databases

Oracle GoldenGate 12.3 MA provides complete support for a sharded Oracle Database.

- Data replication is enabled across all sharded database topologies.
- Sharding is only available with Oracle Database 12.2.0.1 or later, over a secure MA deployment.
- All the functionality of a sharded database is supported by the Microservices Architecture.

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Oracle GoldenGate Sharding Advantages

- Horizontally partitioned data and workload across numerous discrete Oracle databases that do not share hardware or software.
- Automatic partitioning and replication, elastic scaling, rebalancing, and data-dependent routing for single-shard and cross-shard queries.
- Active replication within and across shardgroups.
- Flexible Deployment, which could have single shardgroup for high availability and multiple shardgroups with varying replication factors.
  - Different shardgroups can have different replication factors.
  - Different number of shards.
  - Different hardware platforms and OS versions.
  - Different database versions and patch sets.

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Oracle GoldenGate Sharding

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Oracle GoldenGate Shard Configuration

Oracle GoldenGate 12.3 MA can configure shards in two ways:

- Add shards: An existing single instance database is converted into a shard.
  - The instance must not contain any user data and should be an empty database.
- Create shards: It sets up a new database at run time.
  - These commands are issued from the Global Data Services Control Utility (**`GDSCTL`**) shell interface.

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In order to use the sharding configuration, the Oracle Database Global Service Manager software must be installed as a requirement. The GDSCTL utility is part of the Oracle Database Global Service Manager software.

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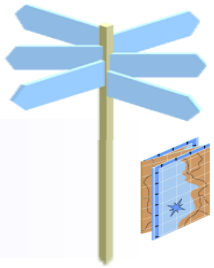

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Metadata Encapsulation: Overview

In older releases of Oracle GoldenGate (up to 12.2.0.1.0), the trail files did not contain metadata information about objects being replicated.

- If the source table structure was identical to the target table structure, the **ASSUMETARGETDEFS** keyword was used on the apply side to instruct the Replicat process to take the first value from the trail record and write it to the first field of the target table, the second value to the second field, etc.
- If source and target tables had a different structure, the **DEFGEN** utility was used to store the static column mappings, and the **SOURCEDEFS** parameter was used by the Replicat to point to the file generated by **DEFGEN**.

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The drawback of using the DEFGEN utility was the increased volume of manual work: whenever the source table structure changed, the DEF file had to be regenerated to avoid losing data consistency.

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Metadata in Trail Files

In recent releases, GoldenGate automatically transfers metadata definitions in trail files.

- Metadata definitions are also re-transferred in case of table structure changes.
  - Definitions will only be re-transferred after DML on the table.
  - Definitions will also be re-transferred after a switch to a new trail file.

Oracle GoldenGate introduces two special new record types to support metadata encapsulation:

- Database Definition Record (DDR)
  - It carries information about the database, such as vendor, character set id, locale, and time zone.
- Table Definition Record (TDR)
  - It carries information about the table, such as table name, record length, number of columns, and column names.

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Support for Metadata Encapsulation in **`logdump`**

The **`logdump`** utility has been enhanced with the introduction of the **`SCANFORMETADATA`** command.

- **`SCANFORMETADATA`**, abbreviated as **`SFMD`**, is used to find and display metadata information.
- A few options are available to further qualify the **`SCANFORMETADATA`** command.
  - DDR—look for a database definition record.
  - TDR—look for a table definition record.
  - NEXT—find the next metadata record.
  - INDEX—position the pointer to a specific offset in the trail file.

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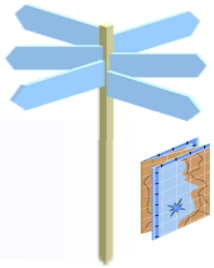

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Replication Lag Analysis

To assess the performance of your Oracle GoldenGate replication, you need a mechanism that captures lag statistics across source and target databases.

- Prior to the 12.2.0.1.0 release, such a mechanism, based on heartbeat tables, was not officially supported by Oracle Corporation. An Oracle Support document (Doc ID 1299679.1) described an implementation of heartbeat tables proposed by the Oracle GoldenGate A-Team. However, no official support was provided.
- With Oracle GoldenGate 12.2.0.1.0, lag management based on heartbeat tables is officially supported. The **`GGSCI`** utility has been enhanced with new commands that explicitly deal with heartbeat tables. Within an MA deployment, the Administration Server offers support for heartbeat table configuration in the database configuration section.

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Heartbeat Mechanism

The heartbeat-based mechanism works by replicating a heartbeat transaction across all data capture—data apply.

- Each Extract, Data Pump, and Replicat configured in GoldenGate carry timestamps that are recorded in heartbeat tables, which must be created on both source and target environments.
- The database scheduler updates a record in one heartbeat table at predefined intervals (default one minute.)
- The heartbeat tables are stored in the Oracle GoldenGate administrative account and are not defined or mentioned in the Extract/Replicat parameter files.
- As part of the replication lag setup, the Oracle RDBMS exposes heartbeat and heartbeat history views, which can be queried and graphed for analysis.

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Heartbeat Lag Management Setup—**GGSCI**

Setting up replication lag management in **GGSCI** for a classic Oracle GoldenGate configuration is performed in three simple steps.

1. Make sure the Oracle GoldenGate administration schema is specified in the **GLOBALS** file.
   - If you change **GLOBALS**, you must restart the manager process.
2. In **GGSCI**, use **DBLOGIN** to connect to the source administration schema on the source database.
3. Enter the **ADD HEARTBEATTABLE** command.

- Repeat the same steps for the target environment.

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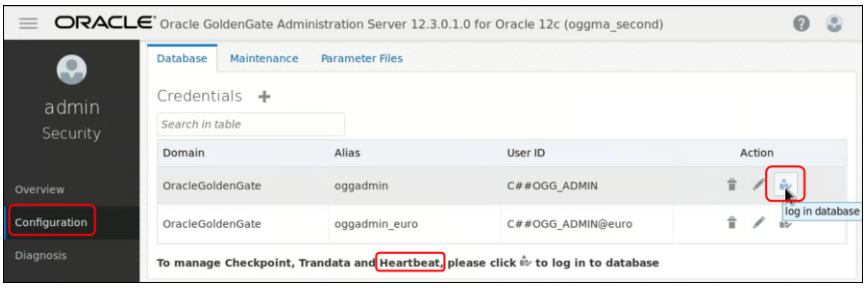
Heartbeat Lag Management Setup: MA Deployment

In the Administration Server, click the "**`Application Navigation`**" icon and then select "**`Configuration.`**"

- Under the "Action" column, click the icon that allows for database connection.



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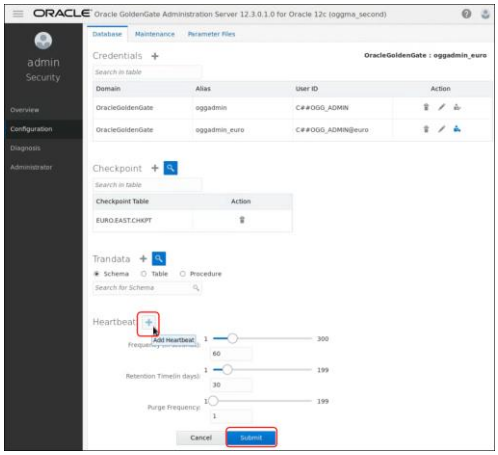
MA Deployment: Heartbeat Management

Click the plus sign (+) beside "**`Heartbeat`**" and expand the fields below. You can configure:

- Heartbeat Frequency (in seconds)
- Retention Time (in days)
- Purge Frequency (in days)
- Click "**`Submit`**" to create the heartbeat objects



The objects created by Oracle GoldenGate heartbeat facility include tables, views, and jobs for the scheduler running inside the Oracle RDBMS.

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Accessing Heartbeat Statistics

In the Oracle GoldenGate administration schema for the target environment, you find two views:

1. **GG_LAG**
2. **GG_LAG_HISTORY**

You can periodically query those views to find out about the performance of your replication paths. Columns such as:

1. **HEARTBEAT_RECEIVED_TS**
2. **INCOMING_LAG**
3. **INCOMING_PATH**

in **GG_LAG_HISTORY** will allow you to keep the lag in your replication environment under control.

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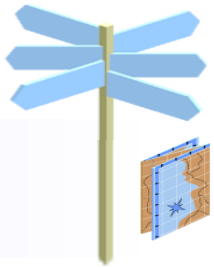

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Invisible Columns in the Oracle RDBMS

In the Oracle Database 12*c*, table columns can be defined as invisible either during their creation with the **`CREATE TABLE`** command or by modifying their status via the **`ALTER TABLE`** statement.

- Columns configured as invisible will not appear in:
  - **`SELECT * FROM`** in SQL instructions.
  - The **`DESCRIBE`** statement when used in either SQL*PLUS or via Oracle Call Interface (OCI).
  - **`%ROWTYPE`** attribute in PL/SQL variable declarations.
- From the table indexes standpoint, invisible columns are still available for indexing, and such indexes are available to the optimizer during the access path selection.

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A SQL*PLUS session can be set to display invisible columns by setting the new switch COLINVISIBLE to ON as follows:

```
SQL> SET COLINVISIBLE ON
```

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Oracle GoldenGate Support for Invisible Columns

Oracle GoldenGate release 12.2 introduced support for invisible columns.

- When Data Definition Language (DDL) replication is enabled, invisible and virtual columns created in the source environment are replicated in the target environment.
- Subsequent variations to the status of invisible columns (that is, modifying an invisible to make it visible) are also propagated to the target.

It is possible to exclude invisible columns from replication using the Integrated Extract parameter **EXCLUDEHIDDENCOLUMNS**, for example:

```
tranlogoptions integratedparams (EXCLUDEHIDDENCOLUMNS)
```

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The EXCLUDEHIDDENCOLUMNS parameter disables all Oracle hidden columns, including automatic CDR-created timestamp columns.

The parameter is valid only for integrated extract(IE), and it does not have any effect for Classic Extract because CE can't mine hidden columns.

The parameter is available from ogg v12.3.0.1.0 and 12.2.0.2.0 onward.

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Quiz

In an Oracle RDBMS sharding architecture, the shardgroups checkpoint their data on a shared disk to ensure data integrity.

a. True

b. False

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Answer: b

A sharded database is based on a shared-nothing architecture.

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Quiz

Which components have been made redundant by the recent Oracle GoldenGate releases (12.2 onward)?

a. Extract
b. Replicat
c. ASSUMETARGETDEFS
d. DEFGEN

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Answer: c, d

Clearly, Extract and Replicat are still crucial components of the Oracle GoldenGate replication solution, while thanks to metadata encapsulation, ASSUMETARGETDEFS and DEFGEN are not needed any more.

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Summary

In this lesson, you should have learned how to:

- Describe database sharding concepts and GoldenGate MA support for it
- List metadata encapsulation features and advantages
- Implement a lag management policy
- Handle replication of invisible columns

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Practice 16: Overview

This practice covers the following topics:

- 16-1: Using logdump to identify DDR and TDR records in trail files
- 16-2: Configuring replication lag and checking lag statistics
- 16-3: Replicating invisible columns

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