GoldenGate for Oracle DBAs

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Introduction

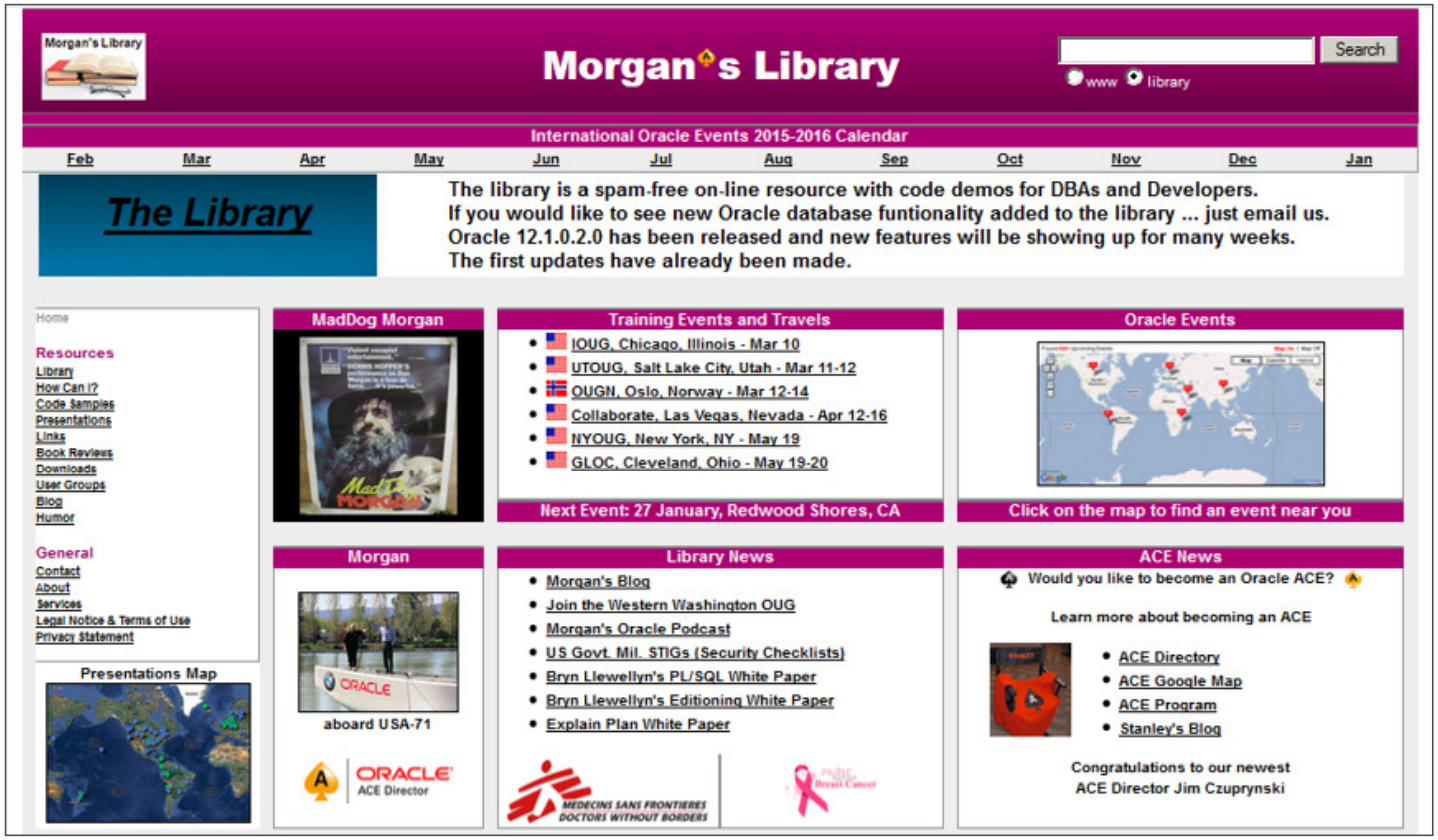
Topics

- Introduction
- New O/S Groups
- New Users with Escalated Privileges
- New Roles
- New System Privs
- New Feature Usage Reports
- Unified Audit Policies

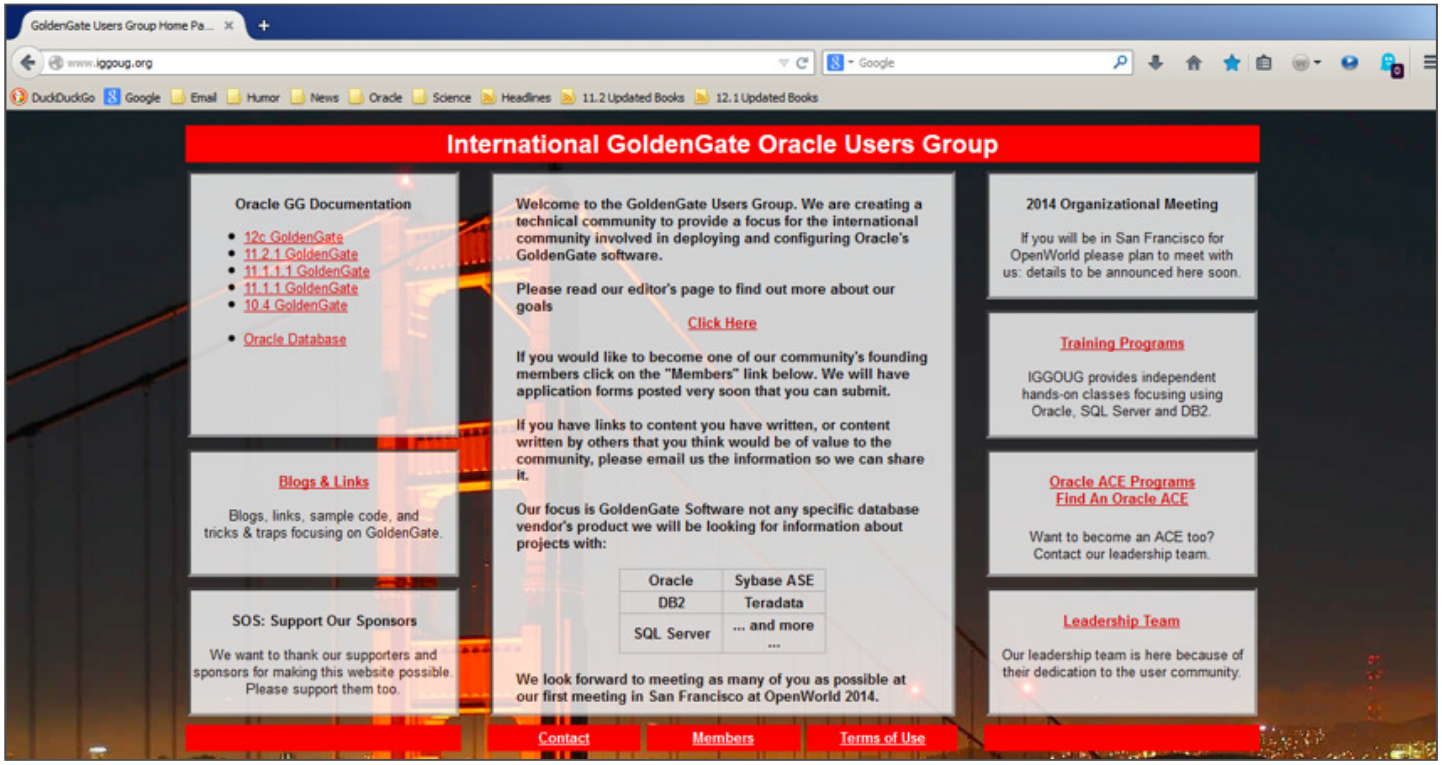
Instructor

- Daniel Morgan
- Oracle ACE Director
- More than 45 years technology experience
  - First computer was an IBM 360/40 mainframe in 1970
  - Fortran IV and Punch Cards
- Curriculum author and primary Oracle instructor at University of Washington
- Guest lecturer on Oracle at Harvard University
- Decades of hands-on SQL, PL/SQL, and DBA experience
- The "Morgan" behind Morgan's Library on the web
  www.morganslibrary.org
- 10g, 11g, and 12c Beta tester
- Co-Founder Intl. GoldenGate Oracle Users Group
- Contact email: dmorgan@forsythe.com

My Websites: Morgan's Library



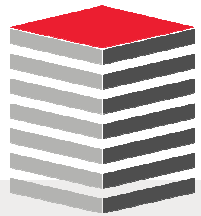
My Websites: International GoldenGate Oracle Users Group



Why Meta7

- The Oracle Only division of Forsythe dedicated to the Oracle Red Stack
  - Highly skilled consultants with extensive experience across multiple industries
  - Reliable on-time and on-budget delivery
  - A professional and agile team of Oracle technical experts
  - New, State of the Art Technology Evaluation Center
  - Secure hosting and Managed Services
  - Flexible financial support

ORACLE Platinum Partner



Travel Log: 2014

Content Density Warning

Take Notes ... Ask Questions

Business Case

GoldenGate Business Cases (1:3)

- Load Distribution
  - The current server infrastructure is not sufficient to handle the demands placed upon it; for example it would save the organization both time and money if analytic queries were run against a separate database performance optimized for those queries
- Upgrading
  - The organization wishes to upgrade from one version of a product to a different version of the same product; for example 11.2.0.3 to 12.1.0.2 with near-zero downtime
- Homogeneous Migration
  - The organization wishes to migrate a database from one hardware platform to another; for example Oracle Database on Solaris to Oracle Database on Linux
- Heterogeneous Migration
  - The organization wishes to migrate from one database product to another; for example from SQL Server to Oracle on an ODA

GoldenGate Business Cases (2:3)

- Data Distribution
  - The organization wishes to make data available at different physical locations without dependency upon the internet; for example the corporate head quarters are in London England but the manufacturing facilities are in Latin America
- Data Consolidation
  - The organization has multiple locations where data is collected and wishes to have a single source that combines them all for management reporting and analysis, for example there are 8,200 retail stores in North America, each with its own on-site database and the corporate headquarters needs to be able to run a single query across data from one region's stores or all stores in all regions
- Data Access Sharing
  - The organization wishes to have two separate locations with equal access to data with the ability to perform DML and DDL, for example the organization considers each office a DR site for the other

GoldenGate Business Cases (3:3)

- Security
  - The organization stores both public and confidential information some of which it does not wish to make vulnerable by making it visible through-out the organization; for example data collection from an
    e-commerce site that processes both orders and credit cards
- Auditing
  - The organization wants a database of suspicious transactions for fraud investigators where the source might be multiple databases, from multiple vendors; for example the organization has both Oracle and DB2 databases and wants a single repository for internal auditors
- Data Transformation
  - The organization wants to load data from OLTP (On-Line Transaction Processing) systems into one or more data warehouses, Operational Data Stores (ODS) or Decision Support Systems (DSS); for example the data warehouse collects data from only specific tables and columns and must load them into cubes

What Is GoldenGate

Part of a Family of Replication Technologies

ORACLE GOLDENGATE	• Real Time Data Replication • Changed Data Capture	• DBMS High Availability • Disaster Tolerance
ORACLE DATA INTEGRATOR ENTERPRISE EDITION	• Heterogeneous E-LT & ETL • High-speed Transformations	• OLAP Data Loading • Data Warehouse Loading
ORACLE DATA INTEGRATION SUITE	• Comprehensive Integration • ELT/ETL for Bulk Data • Service Bus	• Process Orchestration • Human Workflow • Data Grid
ORACLE DATA SERVICE INTEGRATOR	• Data Service Modeling • XQuery Data Federation	• Data Security/Redaction • XA Compliance
ORACLE DATA PROFILING	• Business Data / Metadata • Statistical Analysis	• Time Series Reporting • Integrated Data Quality
ORACLE DATA QUALITY	• Cleansing & Parsing • De-duplication	• High Performance • Integrated w/ODI
ORACLE Metadata Management	• Metadata Harvest • Metadata Catalog • Data Lineage	• Interactive Search • Interactive Browse • Impact Analysis

Other Oracle Database Replication Technologies

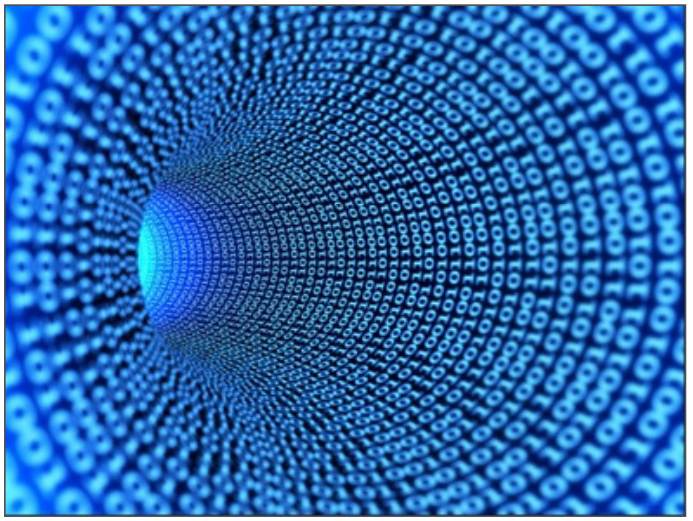
- Data Guard
  - Physical
  - Logical
  - Usable only when the source and the target are identical
    - Operating System and Database Version
- Streams
  - While still supported and used, Streams had a number of issues (which is why Oracle acquired GoldenGate) and is no longer Oracle's strategic replication product, it's on a continue and converge path and will continue to be supported but not extended to support multi-tenant container databases
- Change Data Capture (CDC)
  - A subset of Streams capabilities: Support will continue but capabilities will not be enhanced for multi-tenant container databases
- Materialized View, Database Links, 3rd Party Products

What Makes An Ideal Replication Solution?

- Replication apply time configurable from near-zero to a user defined pre-set delay
- Scalable to handle high transaction volumes
- Minimal footprint and impact to existing systems
- Modular architecture supporting multiple data sources and targets
- Fault tolerant
- Maintains transactional integrity
- Reliable
- Secure
- Stable

What Is GoldenGate?

- A software tool that creates a tunnel between two, or more physically separate systems such that they can behave as a single logical system
- Middleware that provides a data communications channel between a source from which transactions will be read and a target to which the transactions will be written
- GoldenGate connections can be homogeneous, for example Oracle Database to Oracle Database, or heterogeneous, for example Teradata to Oracle Database
- Supports data transformation
- Can replicate DML and DDL

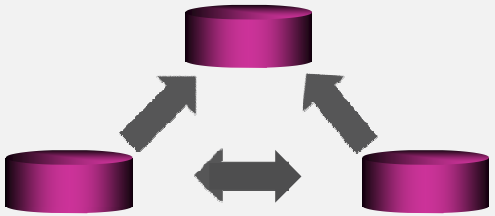


Logical Replication Architectures

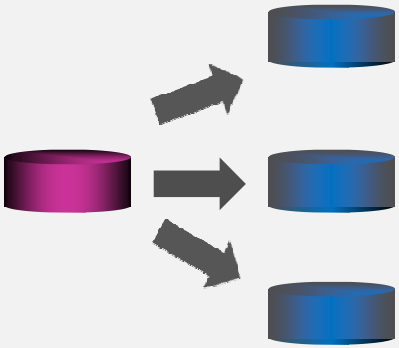
Unidirectional
Reporting Instance

Bi-directional
Active:Active Failover

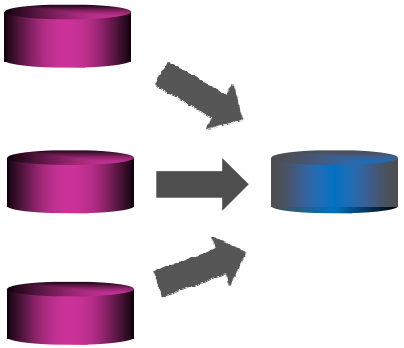
Peer-to-Peer
Load Balancing, High Availability



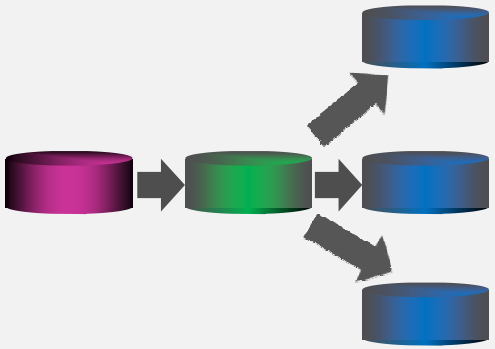
Broadcast
Data Distribution



Consolidation
Data Warehouse/Mart/Store



Cascading
Scaling, Database Tiering



Query Offloading

- Using GoldenGate for offloading queries and reporting tasks reduces the load on the primary system
  - Create a database with either a full set or subset of the data from the original, primary, system and use it as a second target to reduce the connection and I/O load on the primary system
  - The second system can be a single database (replication) or multiple secondary databases (broadcast replication)
  - The secondary databases(s) can be co-located in the same data center as the primary database or be geographically separated
  - A secondary database can be optimized in a number of ways
    - It can be smaller and more efficient with a subset of schemas and objects
    - It can contain indexes not present in the primary system
    - It can eliminate unnecessary indexes and constraints
    - Custom statistics can be created that optimize querying and reporting
    - It can utilize partitioning not present on the source system

Extraction Transformation and Loading (ETL)

- ETL is the name we give to a three-step process
  - Extract (capture) data from a source
  - Transform the data if necessary
  - Load the data into a target system
- Numerous transformation options are available
  - Value substitutions can be performed ("Yes" changed to "T" true)
  - Character sets can be changed
  - Columns and/or rows can be dropped
  - Nulls can be replaced with default values
  - Strings can be concatenated or parsed
  - Functions can be applied to perform mathematical operations
  - Denormalized data can be normalized

Load Distribution

- Load Distribution allows the load of database operations to be distributed among several systems
  - Active Data Guard might be a better option if no transformation is being done
  - GoldenGate is ideal where transformation is required
  - The load can be distributed both locally within the data center or to remote locations
  - If using an Oracle 12c database connectivity can be configured using Global Data Services (GDS)

Auditing

- Auditing is an important part of database operations
- Often custom audit tables are created
- These audit tables can be replicated via GoldenGate to local or remote audit tables
- Data can be subsetted
- Data can be masked
- Depending on your needs, initial replication may not be required
  - For example: Monthly, Quarterly or Yearly Audit tables

Data Warehouse or Decision Support System

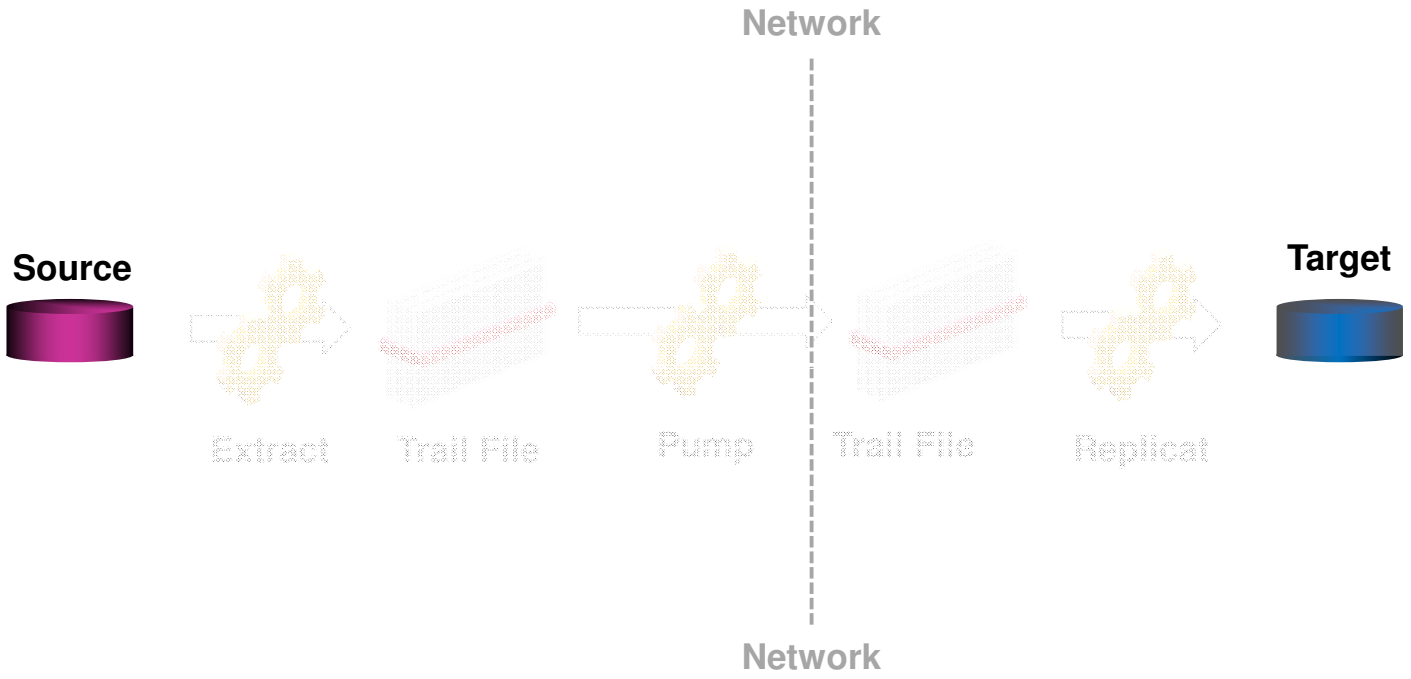
- GoldenGate can be used to loading Data Warehouse, Decision Support Systems and schemaless Big Data from OLTP
- GoldenGate has transformed data loading
  - Batch, trickle and real-time loading are supported
  - GoldenGate can be integrated with Oracle Data Integrator (ODI) in a configuration where ODI's Journaling Knowledge Module (JKM) is used to generate GoldenGate parameter file mappings saving manual work and reducing the errors

Logical Architecture

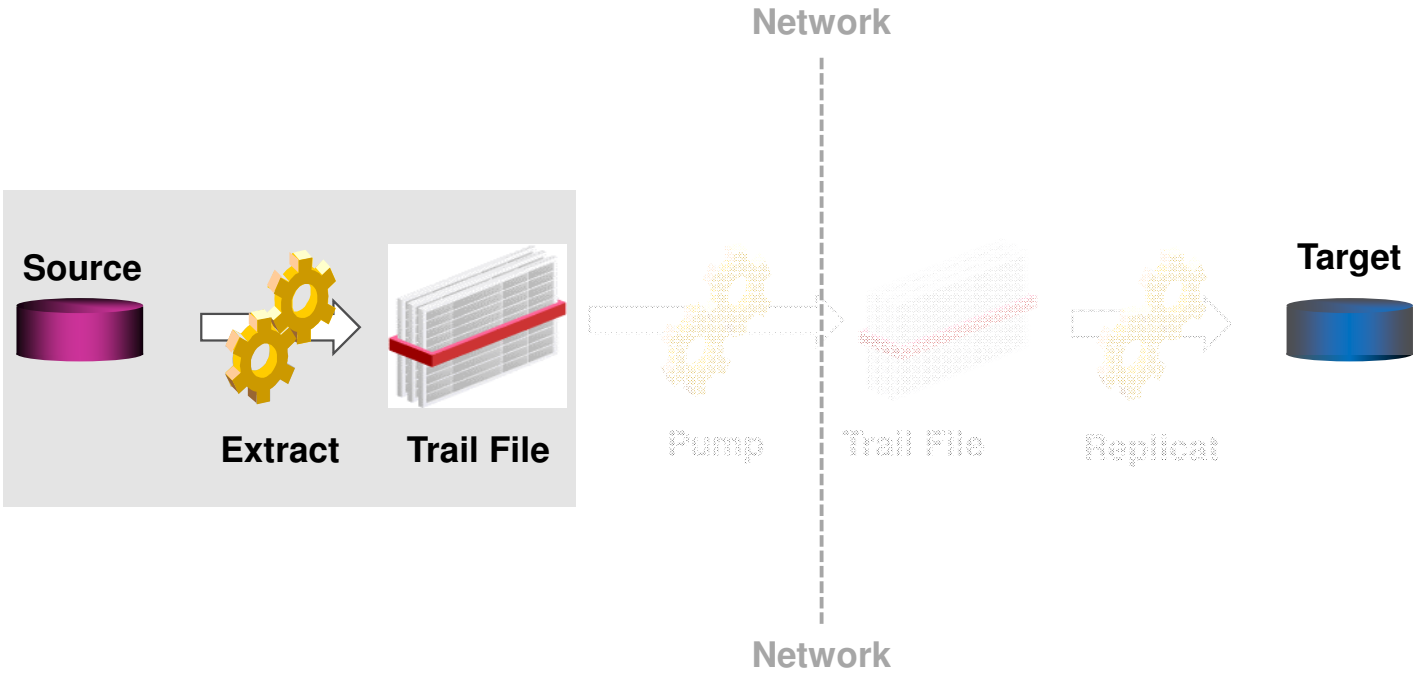
Components

- Source
- Processes
  - Manager
  - Extract
  - Pump
  - Replicat
  - Collector
- Trails
  - also known as Extract Files, Trail Files, Local or Remote Trail Files
- Target

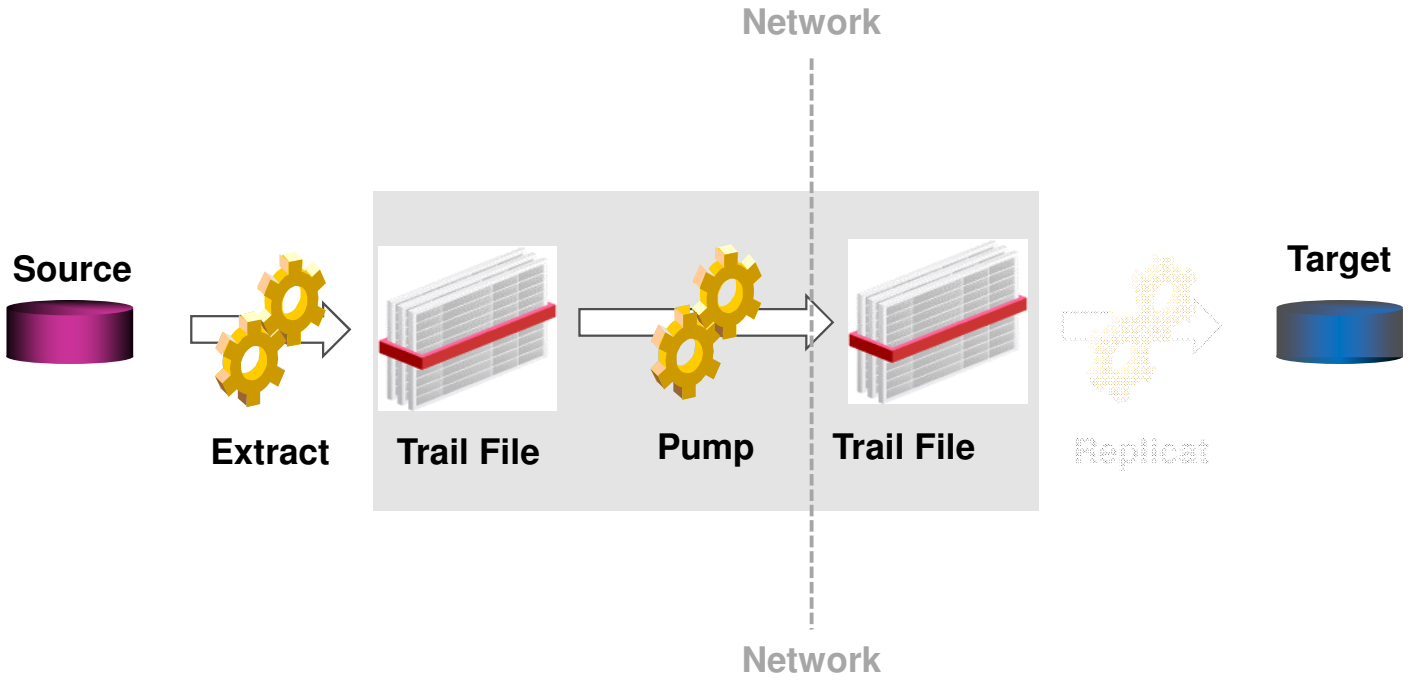
Logical Flow (1:4)



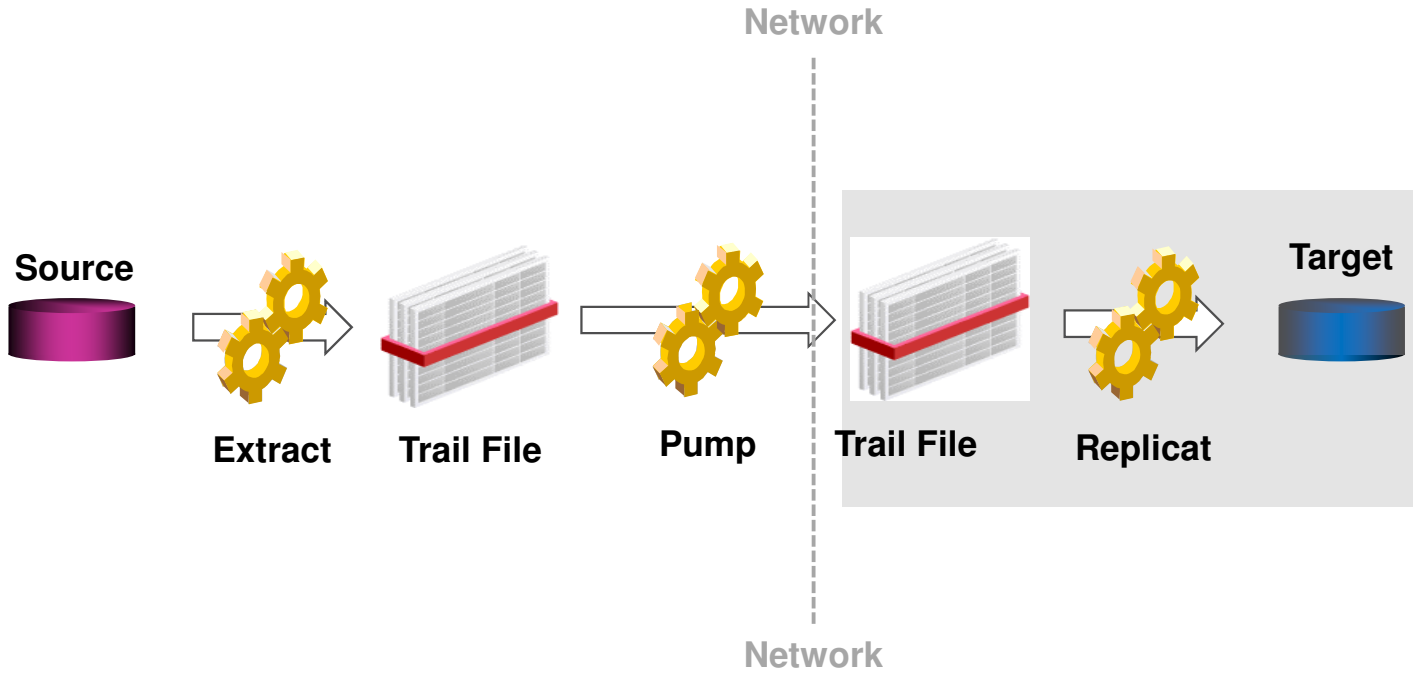
Logical Flow (2:4)



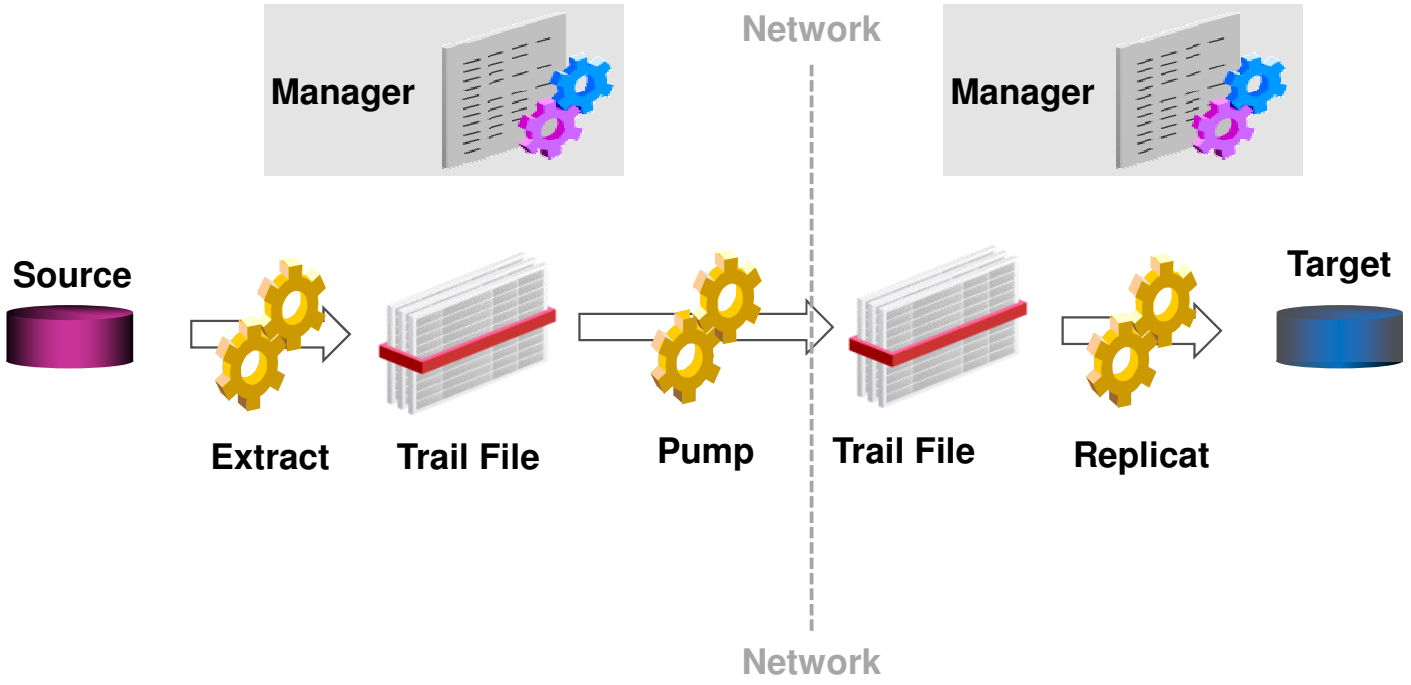
Logical Flow (3:4)



Logical Flow (4:4)

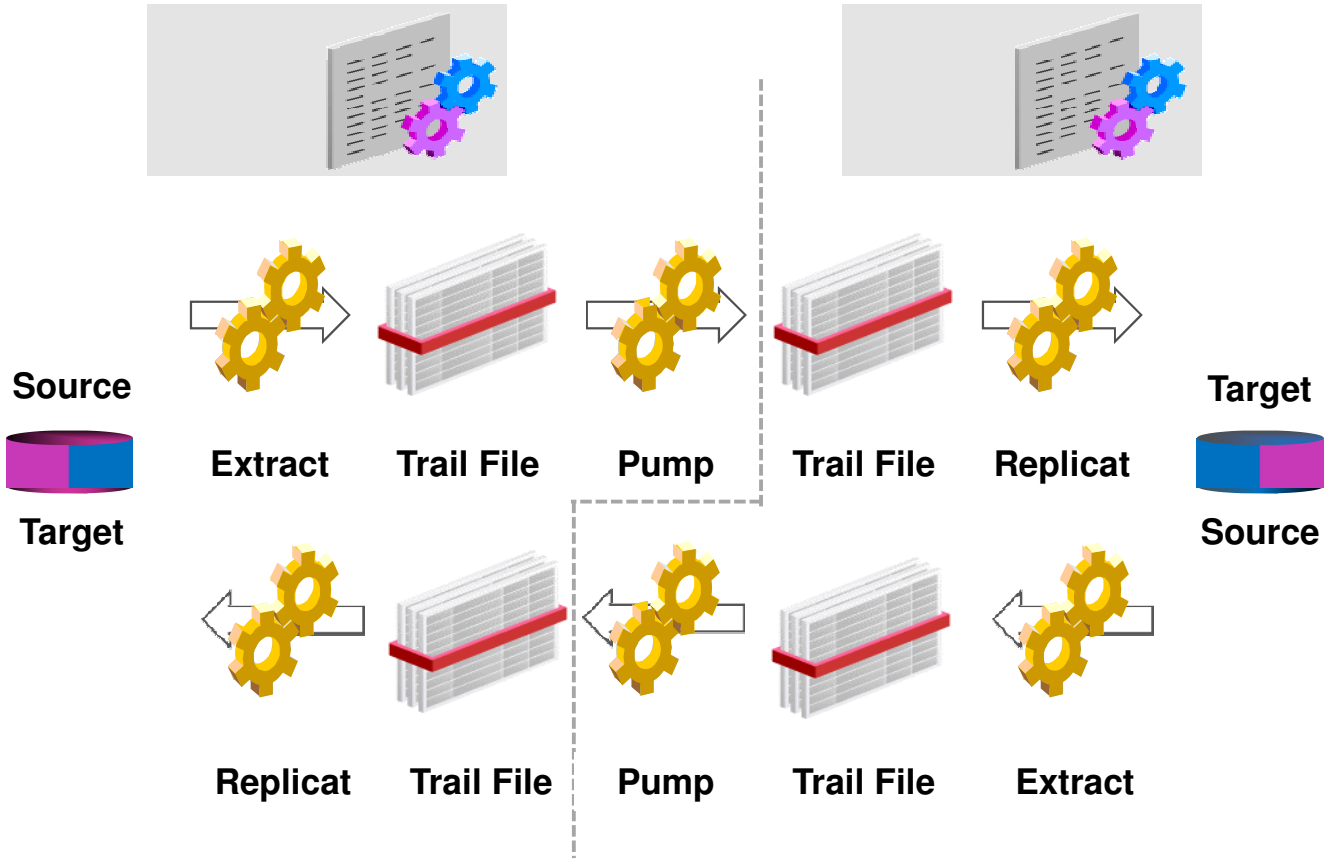


Complete Logical Flow with Managers



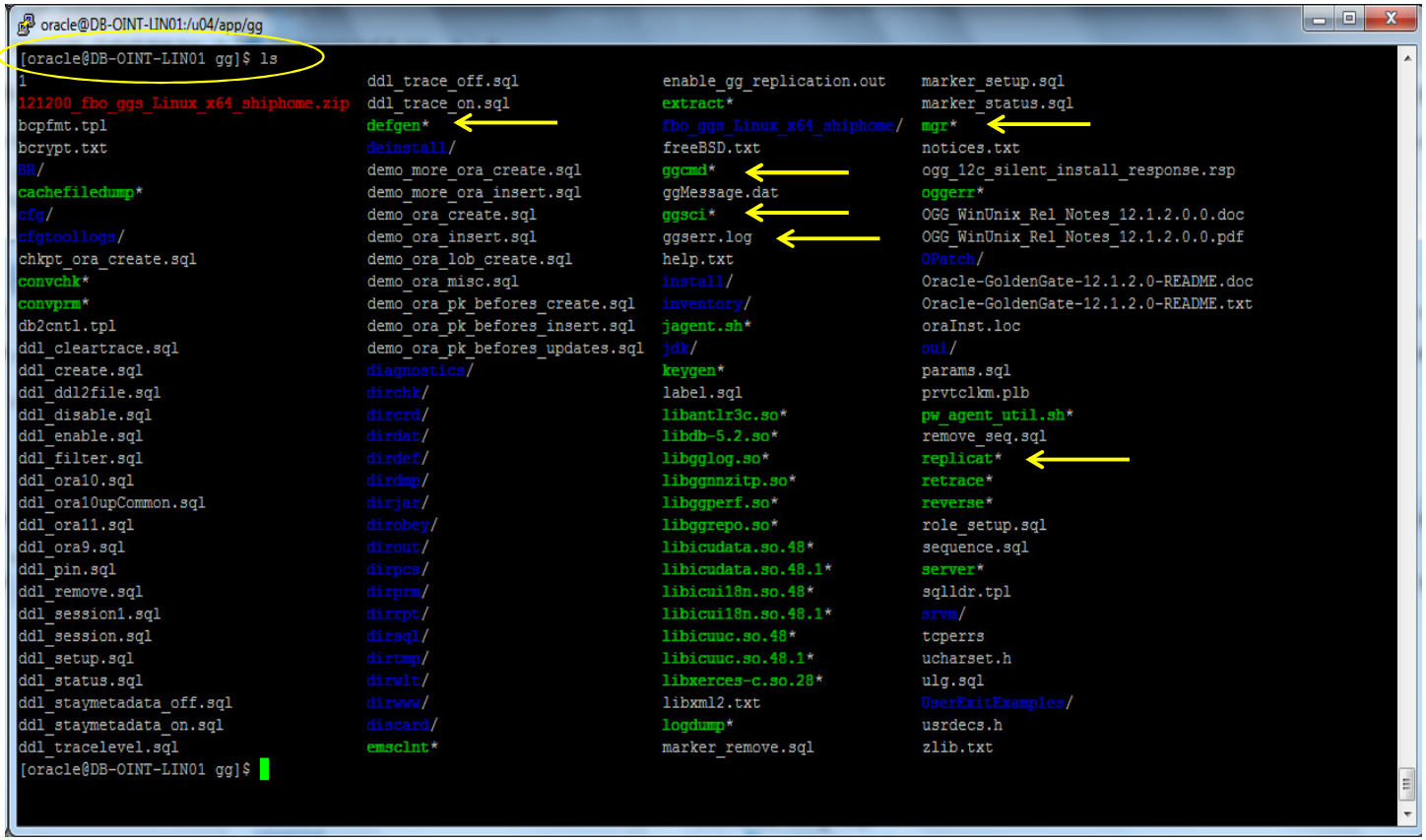
The Pump process communicates with the Target's Manager and requests a Collector process to transfer the trail file

Logical Flow: Bi-directional



Physical Architecture and Installation

Directory Structure from the GGHOME directory



Supported Source Databases

- HP SQL/MP
- HP SQL/MX
- IBM DB2
- IBM DB2 for I (AS/400)
- IBM Informix
- JMS message queues
- Microsoft SQL Server
- Oracle Database
- Oracle MySQL
- Oracle TimesTen
- Sybase ASE
- Tandem
- Teradata

Supported Target Databases

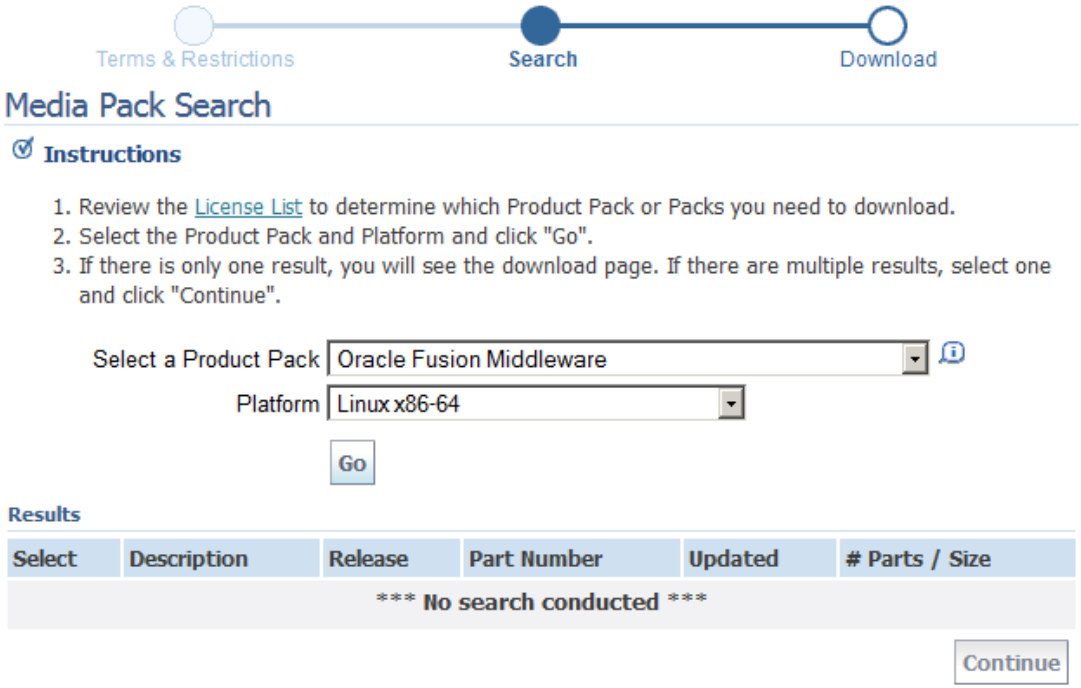
- EMC Greenplum
- Hadoop
- HP SQL/MP
- HP SQL/MX
- IBM DB2 (LUW)
- IBM Informix
- IBM Netezza
- IBM System I (AS/400)
- IBM System z (mainframe)
- JMS Message Queue
- Microsoft SQL Server
- ODBC Databases
- Oracle Database
- Oracle MySQL
- Oracle TimesTen
- Sybase ASE
- Tandem
- Teradata
- Flat Files
- XML Files

Supported Operating Systems

- HPUX IA64
- HP NonStop Itanium
- IBM AIX
- IBM z/OS
- IBM iSeries
- Linux x86-64
- Oracle Solaris Sparc
- Oracle Solaris x86-64
- Windows x86-64
- z/Linux (IBM mainframe)

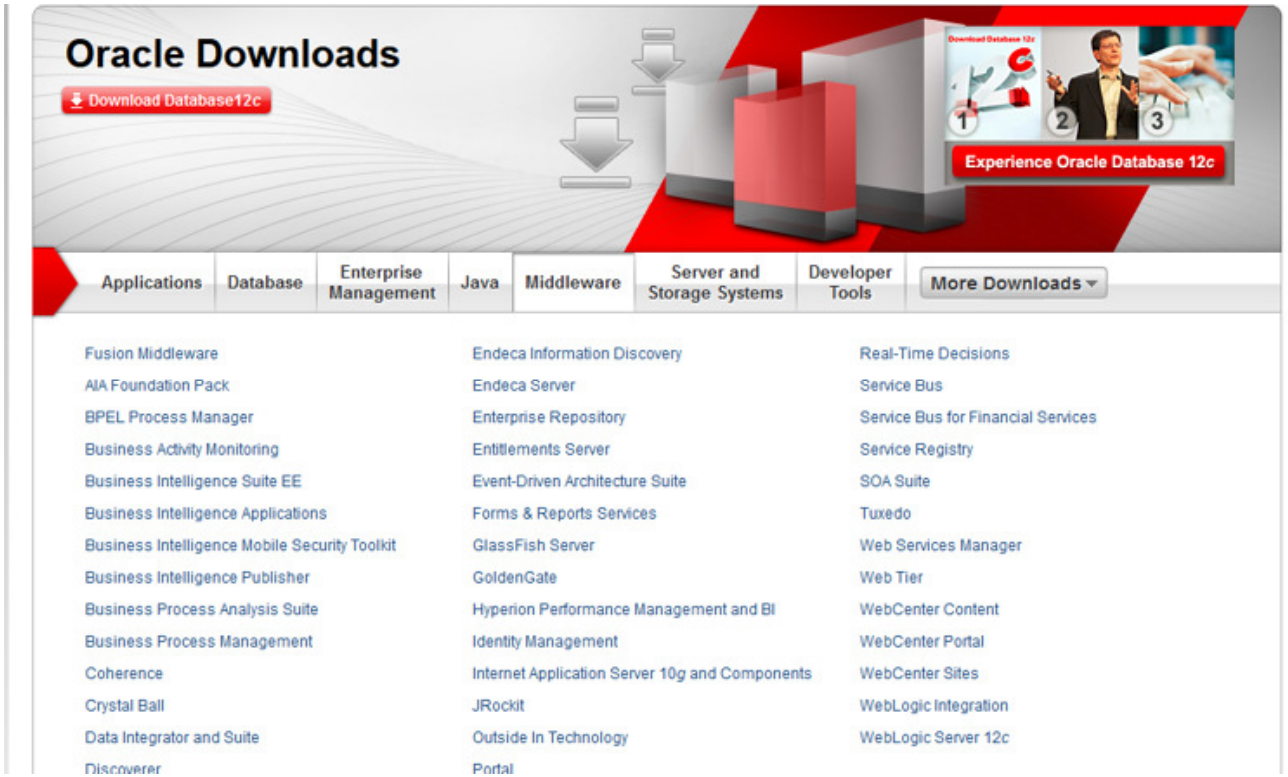
Download

- eDelivery: Oracle Fusion Middleware



Download

- Oracle Technology Network: Middleware



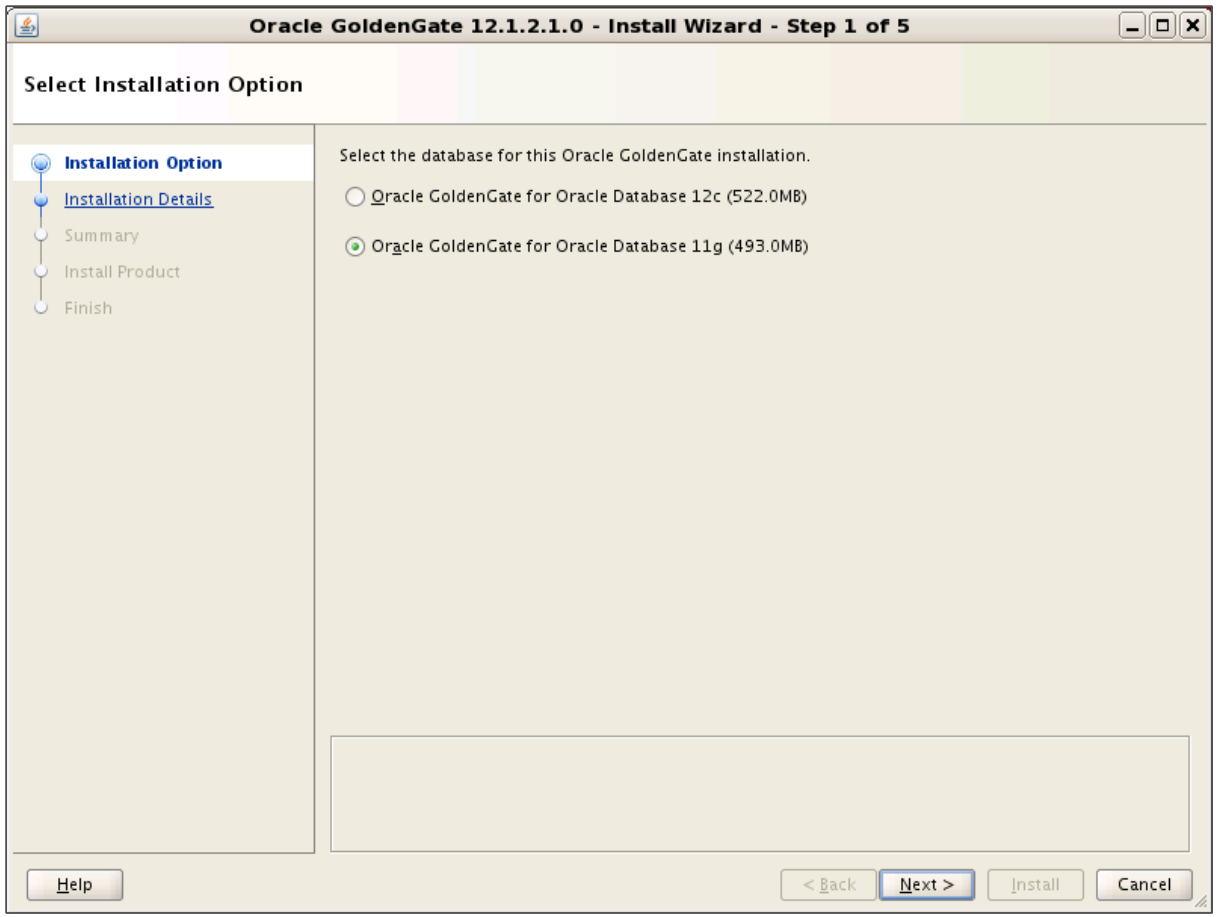
Installation (1:2)

- Uses the Oracle Universal Installer (OUI) used by the database

```
[oracle@gg00a Disk1]$ ls
install  response  runInstaller  stage
[oracle@gg00a Disk1]$ ./runInstaller
Starting Oracle Universal Installer...

Checking Temp space: must be greater than 120 MB    Actual 4028 MB    Passed
Checking swap space: must be greater than 150 MB    Actual 2047 MB    Passed
Checking monitor: must be configured to display at least 256 colors.    Actual 65536    Passed
Preparing to launch Oracle Universal Installer from /tmp/OraInstall2015-01-25_01-54-05PM. Please
 wait ...[oracle@gg00a Disk1]$ ./runInstaller
Starting Oracle Universal Installer...
```

Installation (2:2)



GGSCI

- GoldenGate Software Command Interface

```
GGSCI (gg00a) 1> info mgr

Manager is running (IP port gg19a.7809, Process ID 14259).

GGSCI (gg19a) 2> info all

Program     Status      Group       Lag at Chkpt  Time
Since Chkpt

MANAGER     RUNNING
EXTRACT     RUNNING     E1SH        00:00:12      00:00:03
EXTRACT     RUNNING     P1SH        00:00:01      00:00:05

GGSCI (gg00a) 4> info extract e1sh

EXTRACT    E1SH      Last Started 2015-08-14 15:21
Status RUNNING
Checkpoint Lag       00:00:08 (updated 00:00:11 ago)
Process ID           21465
Log Read Checkpoint  Oracle Integrated Redo Logs
                     2015-08-14 12:17:54
                     SCN 0.14674261 (14674261)

GGSCI (gg00a) 5> info extract p1sh

EXTRACT    P1SH      Last Started 2015-08-14 26:15
Status RUNNING
Checkpoint Lag       00:00:00 (updated 00:00:00 ago)
Process ID           21496
Log Read Checkpoint  File dirdat/la000001
                     First Record  RBA 2307
```

Configuration

GoldenGate Configuration

- Configuration is performed using parameter files very similar in concept and editing to the database initSID.ora
- GG parameter files are ASCII text ... they are not compiled
- The major parameter files are:
  - GLOBALS
  - manager (mgr.prm)
  - extract
  - pump
  - replicat
- The minor parameter files are:
  - CMDSEC (command security)
  - ENCKEYS (encryption keys)
  - TCPERRS (Posix-based TCP/IP network error handling)

GLOBALS Parameter File

```
------------------------------------------------------------------
-- Sample GLOBALS File - Author: Daniel Morgan Date: 14-AUG-2015
------------------------------------------------------------------
CredentialStore /home/oracle/ggcredentials
AllowInvisibleIndexKeys
CharSet UTF-8
GGSchema ggadmin
MaxGroups 256
OutputFileUMask 022
Syslog ALL
```

Manager Parameter File

```
------------------------------------------------------------
 -- Sample Manager - Author: Daniel Morgan Date: 14-AUG-2015
------------------------------------------------------------
UserIDAlias ggadm
AutoStart ER *
AutoRestart Extract *, WaitMinutes 5, Retries 10
CheckMinutes 15
DownCritical
DownReportMinutes 2
DynamicPortList 9500, 9800-9899
LagCriticalSeconds 60
LagInfoMinutes 3
LagReportMinutes 30
Port 7809
PurgeDDLHistory MinKeepDays 2, MaxKeepDays 7, FrequencyMinutes 60
PurgeMarkerHistory MinKeepDays 2, MaxKeepDays 7, FrequencyMinutes 60
PurgeOldExtracts ./dirdat/*, UseCheckPoints, MinKeepDays 7,
  FrequencyMinutes 60
PurgeOldTasks EXTRACT *, After 3 DAYS
StartupValidationDelayCSecs 100
SysLog ALL
UpReportMinutes 60
```

Capture/Extract Parameter File

```
------------------------------------------------------------
 -- Sample Extract - Author: Daniel Morgan Date: 14-AUG-2015
------------------------------------------------------------
EXTRACT E1SH
SETENV (NLS_LANG = AMERICAN_AMERICA.AL32UTF8)
SETENV (ORACLE_HOME=/app/oracle/product/11.2.0.3)
USERIDALIAS ggadm

TranLogOptions IntegratedParams(max_sga_size 2048, parallelism 4)
TranLogOptions User ggadmin
EXTTRAIL dirdat/la
LogAllSupCols
UpdateRecordFormat COMPACT

StatOptions ReportFetch
WarnLongTrans 1h, CheckInterval 2m
ReportCount Every 30 Minutes, Rate
Report At 01:01
ReportRollover At 01:02 On SUNDAY
DiscardFile dirrpt/E1SH.dsc, Append
DiscardRollover at 01:03 On Sunday

TABLE SH.*;
```

Pump Parameter File

```
------------------------------------------------------------
 -- Sample Pump - Author: Daniel Morgan Date: 14-AUG-2015
------------------------------------------------------------
EXTRACT P1SH
SETENV (NLS_LANG = AMERICAN_AMERICA.AL32UTF8)
SETENV (ORACLE_HOME=/app/oracle/product/11.2.0.3)
USERIDALIAS ggadm

PASSTHRU
RMTHOST GG00B, MGRPORT 7809
RMTTRAIL /dirdat/ra

StatOptions ReportFetch
WarnLongTrans 1h, CheckInterval 2m
ReportCount Every 30 Minutes, Rate
Report at 01:00
ReportRollover at 01:15 on SUNDAY

TABLE SH.*;
```

Coordinated Deliver/Replicat Parameter File

```
------------------------------------------------------------
 -- Sample Delivery - Author: Daniel Morgan Date: 14-AUG-2015
------------------------------------------------------------
REPLICAT R1SH
SETENV (NLS_LANG = AMERICAN_AMERICA.AL32UTF8)
SETENV (ORACLE_HOME=/app/oracle/product/12.1.0.2)
USERIDALIAS ggadm

ASSUMETARGETDEFS
map sh.sales, target sh.sales, ThreadRange (1-2);
map sh.sales_arch, target sh.sales_arch, Thread (3);
map sh.events, target sh.events, Coordinated, ThreadRange (4-6);
map sh.transfers, target sh.transfers;

StatOptions ReportFetch
ReportCount Every 20 Minutes, Rate
Report At 01:01
ReportRollover at 01:02 On SUNDAY

DiscardFile dirrpt/r1sh.dsc, Purge
DiscardRollover At 01:03 On Sunday
```

Integrated Deliver/Replicat Parameter File

```
------------------------------------------------------------
 -- Sample Delivery - Author: Daniel Morgan Date: 14-AUG-2015
------------------------------------------------------------
REPLICAT R1SH
SETENV (NLS_LANG = AMERICAN_AMERICA.AL32UTF8)
SETENV (ORACLE_HOME=/app/oracle/product/12.1.0.2)
USERIDALIAS ggadm

ASSUMETARGETDEFS
DBOPTIONS INTEGRATEDPARAMS(parallelism 6)
REPERROR (1403,DISCARD)

StatOptions ReportFetch
ReportCount Every 20 Minutes, Rate
Report At 01:01
ReportRollover at 01:02 On SUNDAY

DiscardFile ./dirrpt/REP1HR.dsc, Append, MEGABYTES 100
DiscardRollover At 01:03 On Sunday

MAP sh.sales, Target sh.sales_archive WHERE (CUST_ID > 101000)
```

Database Preparation

Database Preparation Steps

- GoldenGate Home Directory
- Archivelog Mode
- Force Logging
- Supplemental Logging
- GG Admin Schema
- Roles and System Privileges

GoldenGate Home Directory

- A separate GoldenGate instance must be created for every Oracle instance on a server, or in a VM, you wish to replicate
- One GoldenGate instance connects to only one Oracle Database instance
- Create a directory under ORACLE_BASE/product to hold the GoldenGate application files
- If one ORACLE_BASE services multiple Oracle homes then perform multiple GG installs and be sure you name the directories so that you know which directory corresponds with which Oracle home
- A GoldenGate installation requires less than 250MB of disk
- The trail files can consume substantial space and should be on a separate mount point(s) with very fast disk

Archive Log Mode and Force Logging

- Simply put ... transactions that do not get written into the redo logs do not get replicated
- A danger to data integrity is any object created or modified using NOLOGGING

```
SQL> conn / as sysdba

SQL> shutdown immediate;

SQL> startup nomount;

SQL> ALTER DATABASE ARCHIVELOG MODE;

SQL> alter database mount;

SQL> ALTER DATABASE FORCE LOGGING;

SQL> alter database open;
```

Supplemental Logging

- Supplemental logging is essential for the following situations
  - Tables without primary keys
  - Tables without unique constraints
  - Tables without unique indexes
  - Transactions that may alter one or more rows but the SQL does not alter the columns corresponding to the unique identifier or use it to define the columns to be updated

```
SQL> conn / as sysdba

SQL> ALTER DATABASE ADD SUPPLEMENTAL LOG DATA;

SQL> alter system switch logfile;
```

- The GoldenGate administrator will issue commands from within GoldenGate using the syntax SCHEMATRANDATA or TRANDATA that will enhance supplemental logging

GoldenGate Administration Schema

- On the both source and target databases a GoldenGate administration schema must be created
- The most common name for this schema is GGADMIN
- The Oracle docs recommend giving this user privileges far in excess of what is actually required
  - If operational security is important to you do not follow Oracle's recommendations
  - For example Oracle recommends giving the GG administrator the privilege of flashing back a database
  - Giving anyone other than a senior DBA the flashback database privilege is **totally irresponsible** (and you can tell Oracle I said so)

Database Roles and System Privileges (1:3)

- GoldenGate capabilities, as of GoldenGate version 12.1 are integrated into the database and require the following

```
SQL> conn / as sysdba

SQL> ALTER SYSTEM SET enable_goldengate_replication=TRUE SID=* SCOPE=spfile;
-- restart the database

-- on the source only
SQL> exec dbms_goldengate_auth.grant_admin_privilege('GGADMIN', 'CAPTURE', TRUE);

-- on the target only
SQL> exec dbms_goldengate_auth.grant_admin_privilege('GGADMIN', 'APPLY', TRUE);

-- if Transparent Data Encryption is in use in database version 12.1 or above
SQL> GRANT execute ON dbms_internal_clkm TO ggadmin;
```

- Some versions of GoldenGate with an Oracle Database may require running scripts that create tables, sequences, triggers, and roles that are granted to the GoldenGate administrator schema

Database Roles and System Privileges (2:3)

- Source System Privileges
  - CREATE SESSION
  - CREATE TABLE
  - SELECT ANY DICTIONARY
  - SELECT ANY TABLE
  - SELECT ANY TRANSACTION

Database Roles and System Privileges (3:3)

- Target System Privileges
  - CREATE SESSION
  - CREATE TABLE
  - SELECT ANY DICTIONARY
  - INSERT ANY TABLE (if DML inserts will be replicated)
  - UPDATE ANY TABLE (if DML updates will be replicated)
  - DELETE ANY TABLE (if DML deletes will be replicated)
  - ALTER ANY <object_type> (for DDL replication is enabled)
  - CREATE ANY <object_type> (if DDL replication is enabled)
  - DROP ANY <object_type> (if DDL replication is enabled)

Subsetting, Transformation & Mapping

Subsetting

- Subsetting consists of starting with a full data set, the primary host server database and replicating a selected set of qualified transactions
- For example the subset might consist of
  - Only insert and update statements: Not deletes
  - Only invoice data (header and detail) but not look-up tables
  - Only columns that do not contain PII (Personally Identifiable Information)
  - Only rows that are modified by a person whose title is District Manager or Assistant District Manager

@RANGE Filtering

- You can use the **@RANGE** function in the filter clause to divide the processing workload among multiple processes, using separate **MAP** statements, to improve performance
  - Syntax:

```
@RANGE (range, total_ranges [, column] [, column]
[, ...])
```

- For example, the following splits the replication workload into two ranges (between two Replicat processes or two threads of a coordinated Replicat) based on the ID column of the source EMPLOYEES table
  - One Replicat parameter file will include the first MAP statement

```
MAP HR.EMPLOYEE, TARGET HR.EMPLOYEE, FILTER (@RANGE (1, 2, PID));
```

  - Second Replicat parameter file will include the second MAP statement

```
MAP HR.EMPLOYEE, TARGET HR.EMPLOYEE, FILTER (@RANGE (2, 2, PID));
```

WHERE Clause Filtering (1:2)

- The syntax for **WHERE** is identical in the **TABLE** and **MAP** statements
- Each **WHERE** clause must be enclosed within parentheses
- Literals must be enclosed within single quotes
- Permissible **WHERE** operators
  - Column names (i.e. LAST_NAME, SALARY, ID)
  - Numeric values (i.e. 4096, -545, 3187.775)
  - Literal strings (i.e. 'FL', 'Fred', 'Auto')
  - Built-in column tests (i.e. @NULL, @PRESENT, @ABSENT)
  - Boolean Comparison operators (i.e. =, <>, >, <, >=, <=)
  - Conjunctive operators (i.e. **AND**, **OR**)
  - Grouping parentheses (Use open and close parentheses ( ) for logical grouping of multiple elements)

WHERE Clause Filtering (2:2)

- TABLE Syntax
  `TABLE <table_name>, WHERE (<where_clause>);`
- TABLE Example

```
Table HR.EMPLOYEE, Where FIRST_NAME = @PRESENT;
Table HR.EMPLOYEE, Where (EMPLOYEE_ID < 100);
```

- MAP Syntax
  `MAP <source_table>, TARGET <target_table>,`
  `WHERE (<where_clause>);`
- MAP example

```
Map HR.EMPLOYEE, Target HR.EMPLOYEE_DATA,
Where SALARY > 50000 And ACTIVE_EMPLOYEE = 'YES';
```

Transformation

- Basic Transforms
  - A commonly seen transformation is converting <first_name><space><last_name> into the equivalent <last_name><comma><space><first_name> for example
    "Daniel Morgan" becomes "Morgan, Daniel"
- Data Masking Transforms
  - Also referred to as "Data Masking"
  - A technology that transforms most often sensitive information by changing its form
  - A commonly seen example of a data masking transform is converting a social security number (`678-91-2345`) into a masked (`****-**-2345`)

```
MAP HR.EMPLOYEE, Target HR.STAFF, COLMAP (USEDEFAULTS,
WAGES = @COMPUTE(SALARY * 12),
FULL_NAME = @STRCAT(LAST_NAME, ", ",FIRST_NAME));
```

Schema, Table, and Column Mapping

- COLMAP - Table-level Column Mapping
  - Valid for both TABLE and MAP
  - Map individual source columns to target columns that have different names
  - Specify default column mapping when an explicit column mapping is not needed
  - Provide instructions for selecting, mapping, translating, and moving data from a source column into a target column
  - Syntax

```
COLMAP ([USEDEFAULTS, ]
target_column = source_expression)
```

  - Examples

```
Map SH.SALES, Target SH.SALES, ColMap (USEDEFAULTS);

Map SH.SALES, Target SH.SALES_REMAP, ColMap (PROD_ID = PROD#, AMOUNT_SOLD = INV_QUANT);
```

Troubleshooting and Debugging

DBA Considerations

- The most common problems are network stability issues
- The second most common problems are caused by DBAs and Developers making schema changes that create collisions
  - For example inserting rows into the target that will later cause a failure when an identical key is replicated from the source
- The third most common issues relate to adding and altering tables creating supplemental logging failures
- Help your GoldenGate admin identify processing -intensive tables so they can be replicated using separate processes
- There are special considerations for ASM and RAC dependent upon GoldenGate and Database version ... do your research
- Bidirectional replication is hard ... not because of the database and not because of GoldenGate but because of application designs not capable of supporting it

Security

Credential Store

- Deploy GoldenGate version 12.1 with a Credential Store to hold login userid and passwords to protect the database

```
[oracle@gg00a gghome_1]$ cd dircrd
[oracle@gg00a dircrd]$ ggsci

Oracle GoldenGate Command Interpreter for Oracle
Version 12.1.2.1.0 OGGCORE_12.1.2.1.0_PLATFORMS_140727.2135.1_FBO
Linux, x64, 64bit (optimized), Oracle 11g on Aug  7 2014 09:14:25
Operating system character set identified as UTF-8.

Copyright (C) 1995, 2014, Oracle and/or its affiliates. All rights reserved.

GGSCI (gg00a) 1> ADD CREDENTIALSTORE

Credential store created in ./dircrd/.

GGSCI (gg00a) 1> exit

[oracle@gg00a dircrd]$ ls -l
total 4
-rw-r----- 1 oracle oinstall 324 May  9 12:06 cwallet.sso

GGSCI (gg00a) 1> ALTER CREDENTIALSTORE ADD USER ggadmin PASSWORD ora123 ALIAS ggadm

Credential store in ./dircrd/ altered.

GGSCI (gg00a) 1> dblogin useridalias ggadm
Successfully logged into database.
```

Wrap-Up

Conclusion

- In my opinion GoldenGate is the best homogeneous and heterogeneous replication tool on the market
- Very small cpu, memory, and storage footprint
- Capable of solid security lockdown
- Robust capabilities for subsetting and transformation
- Substantial tools for troubleshooting and debugging
- Substantial capabilities for performance tuning
- Easy to patch
- Easy to upgrade
- Stable

```
*
ERROR at line 1:
ORA-00028: your session has been killed
```

Thank You

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