GoldenGate for Oracle DBAs
Zero Down-Time Migrations

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14 September, 2018

Unsafe Harbor

- This room is an unsafe harbor
- You can rely on the information in this presentation to help you protect your data, your databases, your organization, and your career
- No one from Oracle has previewed this presentation
- No one from Oracle knows what we are going to say
- No one from Oracle has supplied any of our materials
  (except for slide 15)
- Everything we will present is existing, proven, functionality

Introduction

SPEAKER PROFILE – KEVIN D. SMITH

- **Kevin D. Smith - Master Consultant, Meta7**
- Over twenty-five years of business & technical experience in System Integration across multiple platforms & operating systems
  - Zero downtime migrations of Databases across platform and vendors for Fortune 500 clients
  - Provided GoldenGate expertise since 2007, starting with GoldenGate Expert Services
  - Multiple platform support: HP, SunOS, AIX, and Linux Unix; Windows; MVS, OS/390, z/OS, OS/400
  - Certified GoldenGate Implementation Specialist GoldenGate 8.5, 9, 10g, 11g, 12c, DIPC
  - **Oracle Partner Advisory Council** 2015 - 2018
- PPDL18 - Transformation of PII data on Oracle/Linux, MS SQL Server, & DB2/400 on iSeries(AS/400); others available on request

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Forbes | 2017 AMERICA'S BEST MANAGEMENT CONSULTING FIRMS Powered by Statista

7th straight year CRN Top 50 Providers

THE CHANNEL CO. CRN SOLUTION PROVIDER 500 2017

THE CHANNEL CO. CRN TECH ELITE 250 2017

THE CHANNEL CO. CRN MSP 500 2017

- Sirius acquired Forsythe Nov 1, 2017
- Sirius is a $3.5B consultancy and VAR
- World's largest IBM integrator
- Second largest security integrator in North America
- Our focus areas
  - Silicon up through Data Integration
  - Stability
  - Security
  - Scalability

Daniel Morgan

- Oracle ACE Director
- Educator
  - Wrote Oracle curriculum and primary program instructor at University of Washington
  - Oracle Consultant: Harvard University
  - University Guest Lecturers
    - APAC: University of Canterbury (NZ)
    - EMEA: University of Oslo (Norway)
    - Latin America: Universidad Latina de Panama and Technologico de Costa Rica
- IT Professional
  - First computer: IBM 360/40 in 1969
  - Oracle Database since 1988-9
  - Beta Tester 10g, 11g, 12c, TimesTen, GoldenGate
  - The Morgan behind www.morganslibrary.org
  - Member Oracle Data Integration Solutions Partner Advisory Council
  - Co-Founder International GoldenGate Oracle Users Group
- Director of Applications @ TidalScale

System/370-145 system console

Morgan's Library

www.morganslibrary.org

Morgan's Library

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International Oracle Events 2016-2017 Calendar

Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct

The Library

The library is a spam-free on-line resource with code demos for DBAs and Developers.
If you would like to see new Oracle database functionality added to the library ... just email us.
Oracle Database 12cR2 is is now available in the Cloud. If you are not already working in a 12cR1 CDB database ... you are late to the party and you are losing your competitive edge.

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Presentations Map

Mad Dog Morgan

Training Events and Travels
- OTN APAC, Sydney, Australia - Oct 31
- OTN APAC, Gold Coast, Australia - Nov 02
- OTN APAC, Beijing China - Nov 04-05
- OTN APAC, Shanghai China - Nov 06
- Sangam16, Bangalore, India - Nov 11-12
- NYOUG, New York City - Dec 07

Next Event: Indiana Oracle Users Group

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Morgan

aboard USA-71

ORACLE ACE Director

Library News
- Morgan's Blog
- Morgan's Oracle Podcast
- US Govt. Mil. STIGs (Security Checklists)
- Bryn Llewellyn's PL/SQL White Paper
- Bryn Llewellyn's Editioning White Paper
- Explain Plan White Paper

MEDECINS SANS FRONTIERES DOCTORS WITHOUT BORDERS

Breast Cancer

ACE News

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- ACE Google Map
- ACE Program
- Stanley's Blog

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Morgan In Forbes

ForbesBrandVoice® What is this?

JAN 15, 2018 @ 05:00 AM 20,020

3 Essential DBA Career Priorities For 2018

OracleVoice

Simplify IT, Drive Innovation FULL BIO

Jeff Erickson, Oracle

Many database administrators (DBAs) will go into 2018 wondering if "self-driving" databases will weaken their career prospects. More likely, 2018 will be a year that database technology leaps forward and these valuable data experts take on other, more important responsibilities.

"History is repeating itself," says longtime DBA Dan Morgan, founder of Morgan's Library and principal adviser at tech firm Meta7. Morgan has seen the DBA role evolve amid a long series of technical advances in storage, management, and performance. And each advance asked DBAs to adjust the way they work.

TidalScale

- Founded in 2013
- Cohesive team with deep data center experience
- Focused on revolutionizing the data center
- Available now: on-prem or Cloud deployments
- 22+ patents approved or pending
- Strong portfolio of investors

- Designed, developed and deployed some of the most important and successful systems and services in the history of the computing industry - internet, Ethernet, operating systems, programming languages and microprocessors
- Collectively, we've shipped more than 2 billion licensed products
- We are difference makers who have a reputation for delivering innovative products and accomplishing what many others don’t believe is even possible

Business Case

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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 stand-alone SQL Server to Oracle RAC 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

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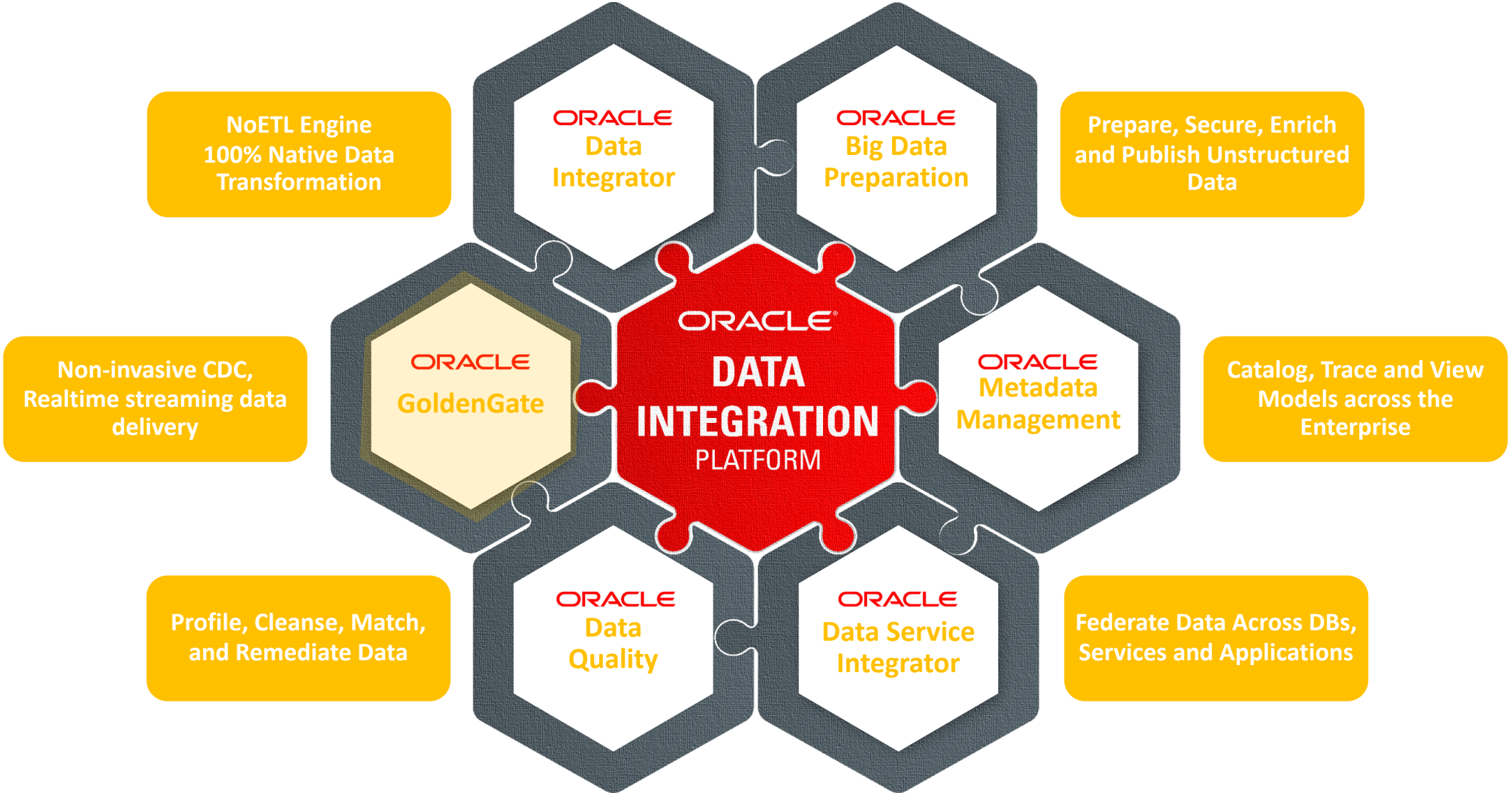
Part of a Family of Data Integration Technologies



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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 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?

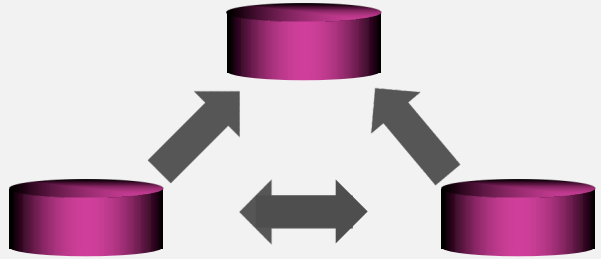
- A software tool that creates a tunnel between two, or more physically separate systems such that they can behave as a single logical system
- Middleware that provides a data communications channel between a source from which transactions will be read and a target to which the transactions will be written
- GoldenGate connections can be homogeneous, for example Oracle Database to Oracle Database, or heterogeneous, for example Teradata to Oracle Database
- Full support for data subsetting and filtering
- Full support for data transformation and enrichment support
- Full support for Data Manipulation Language (DML)
- Full support for Data Definition Language (DDL)
- Unlike Oracle Service Bus ... understands transactions

Logical Replication Architectures

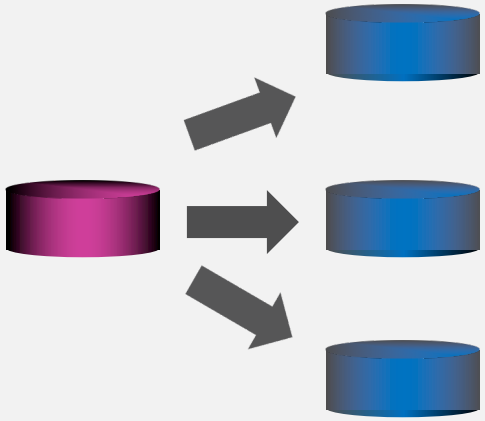
Unidirectional
Reporting Instance

Bi-directional
Active:Active Failover

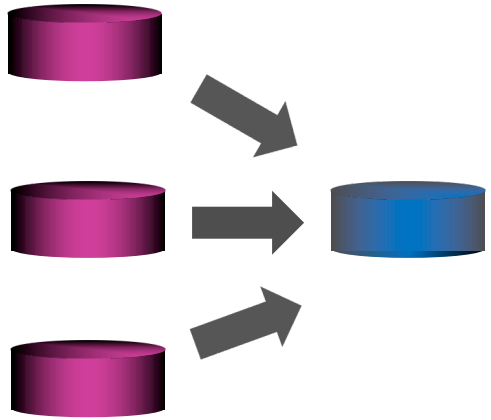
Peer-to-Peer
Load Balancing, High Availability



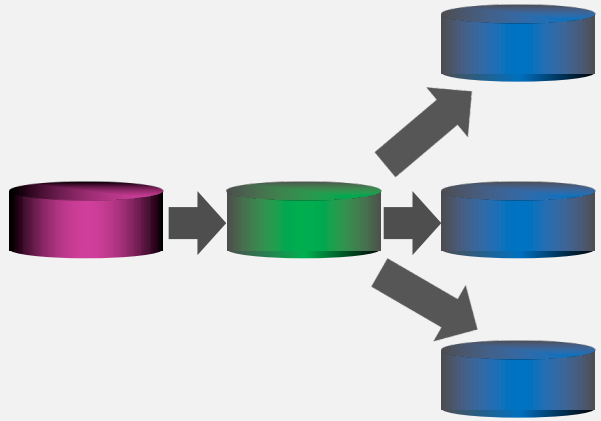
Broadcast
Data Distribution



Consolidation
Data Warehouse/Mart/Store



Cascading
Scaling, Database Tiering



Logical Architecture

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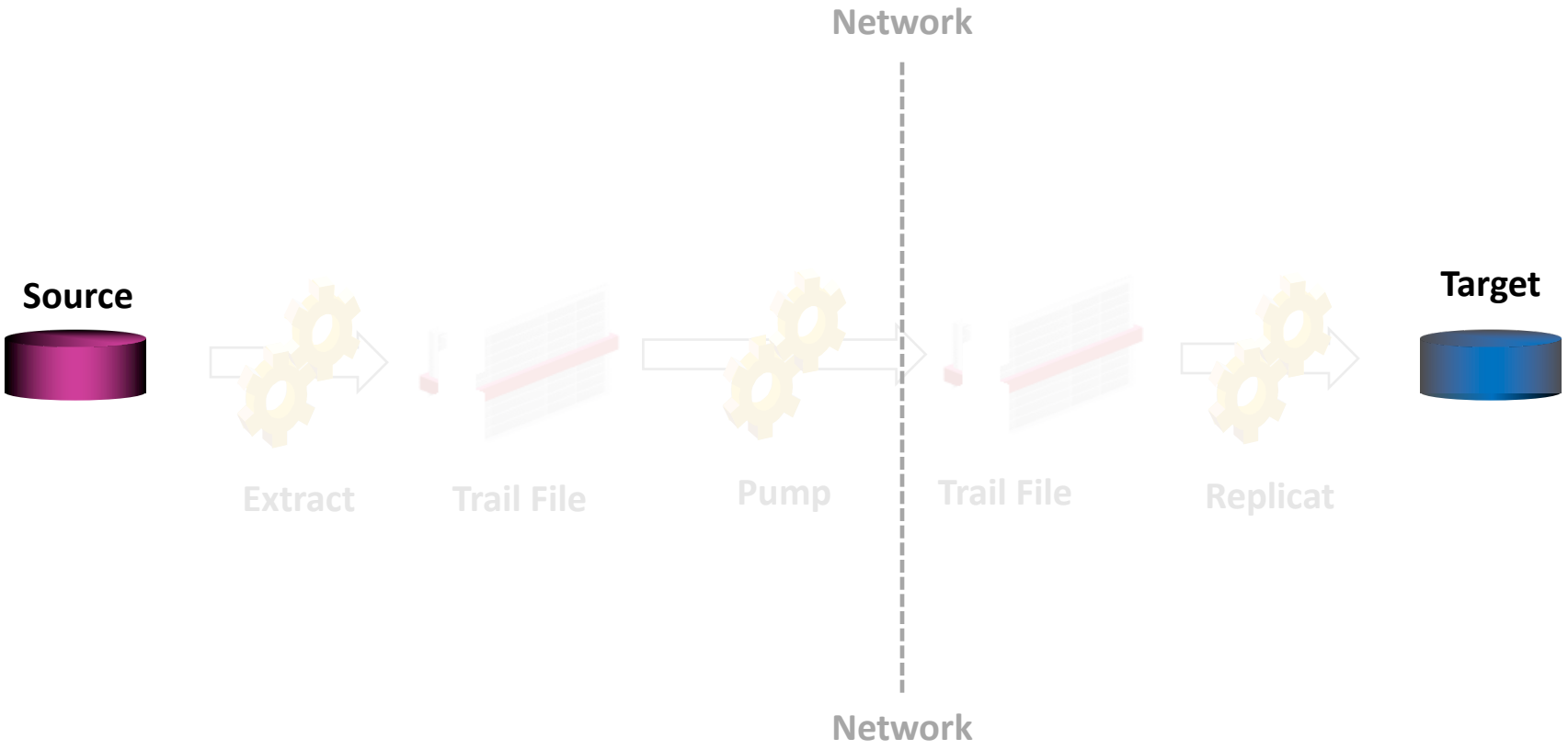
GoldenGate Components

- Source & Source Processes
  - Manager
    - Monitors and manages running GoldenGate processes
    - Writes the alert log
    - Performs file maintenance
  - Extract
  - Pump
- Parameter Files
- Trails
  - also referred to as Extract Files, Trail Files, Local and Remote Trail Files
- Target & Target Processes
  - Manager
  - Collector
  - Replicat

Logical Flow (1:4)



Currently Supported Environments

Data and Transaction Sources

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

Data and Transaction Targets

- Amazon S3
- Big Data
  - ALO Framework
  - Apache Flume
  - Apache Hadoop
  - Apache HBase
  - Apache Hive
  - Apache Kafka
  - Apache Spark
  - Apache Storm
  - AVRO
  - Base24 (ATM & POS)
  - HDFS
  - JSON
  - MongoDB
- Cassandra
- EMC Greenplum
- HP Enscribe
- HP SQL/MP
- HP SQL/MX
- IBM DB2 (LUW)
- IBM DB2 (Z/OS)
- IBM DB2 for I (AS/400)
- IBM Informix
- IBM Netezza
- IBM System I
- IBM System Z/OS
- JMS Message Queue
- Microsoft SQL Server
- ODBC Databases
- Oracle Database
- Oracle MySQL
- Oracle NoSQL
- Oracle TimesTen
- Sybase ASE
- Tandem
- Teradata
- Flat Files
- XML Files

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)

- Cloud environments
  - AWS
  - Azure
  - Google
  - IBM
  - Oracle
  - SAP

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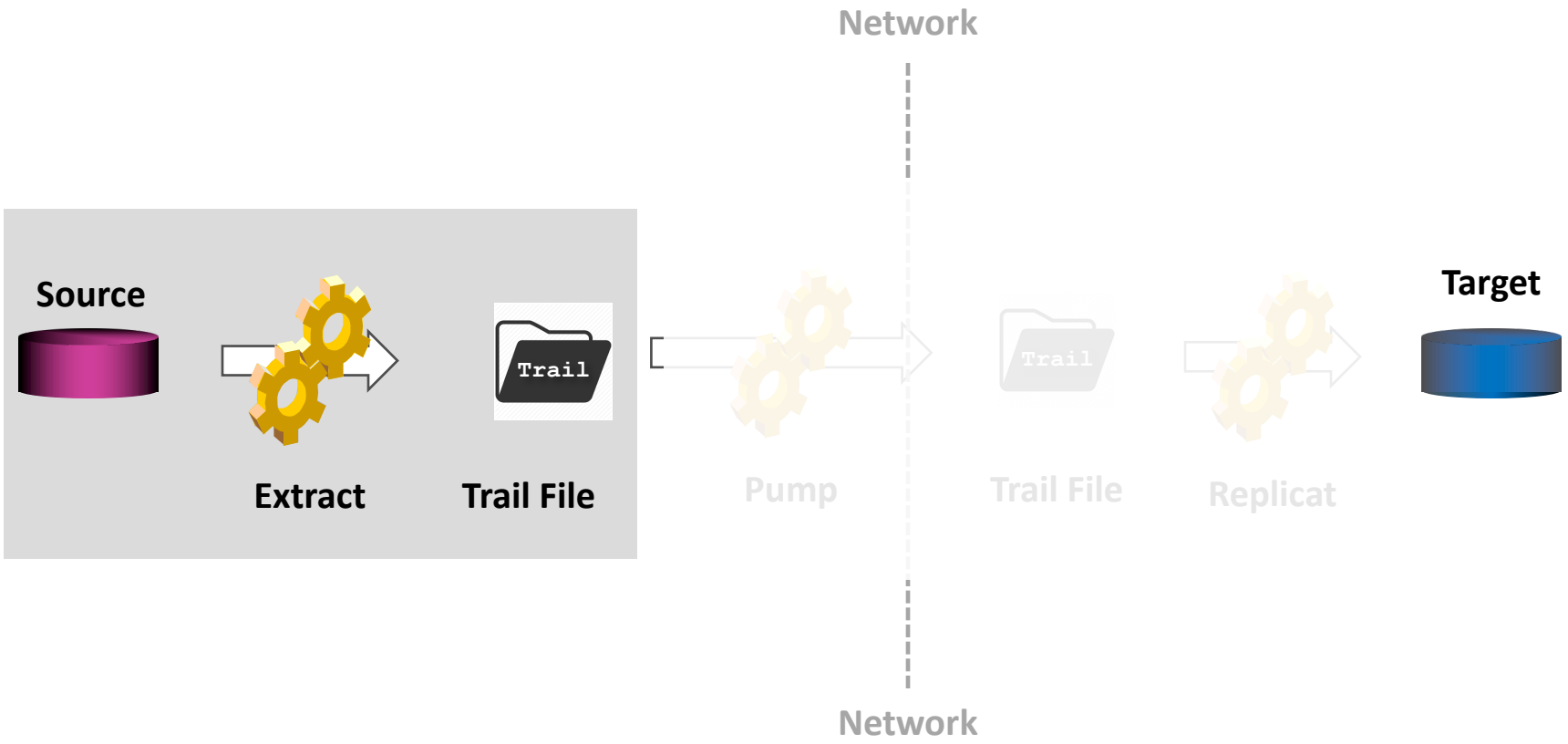
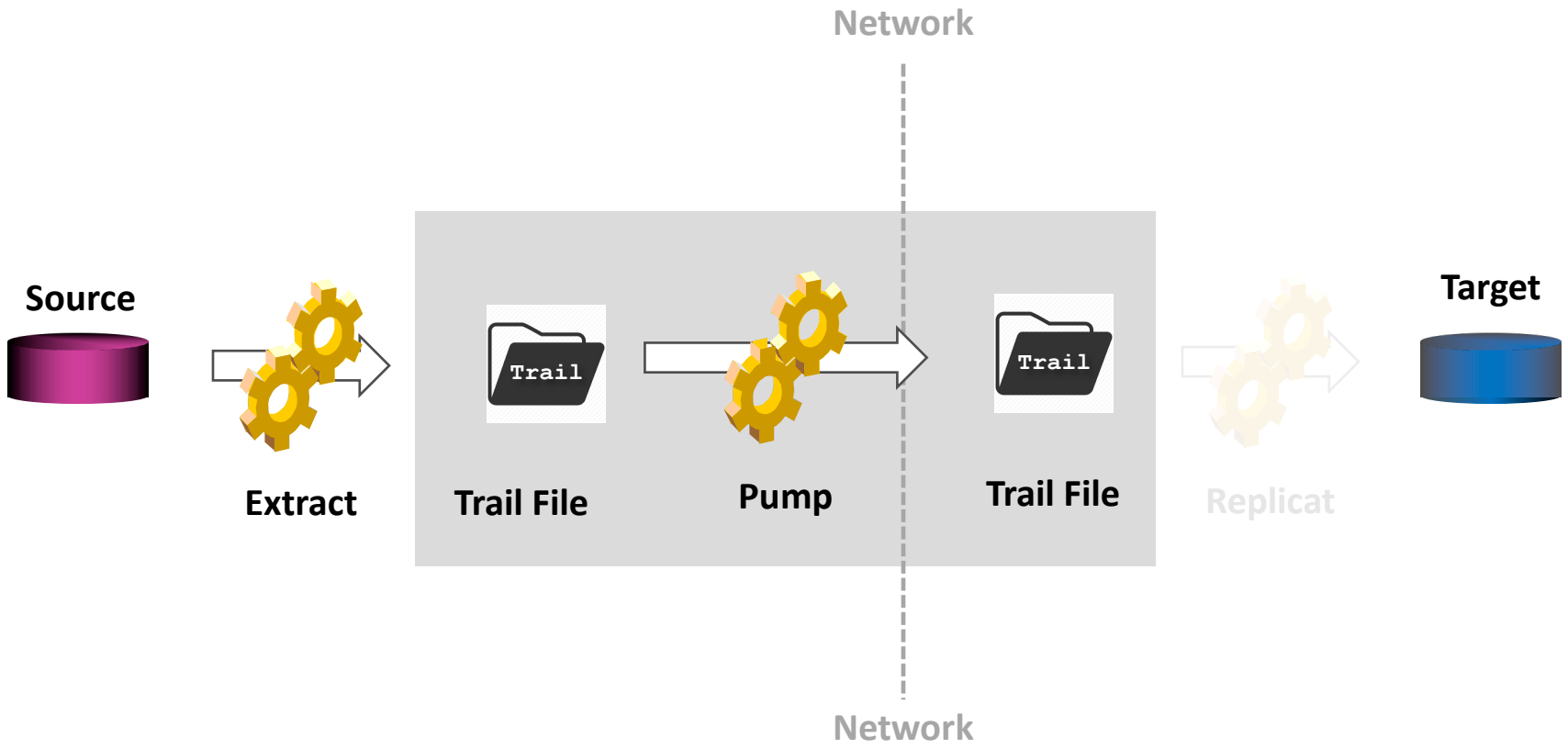
Logical Flow (2:4)



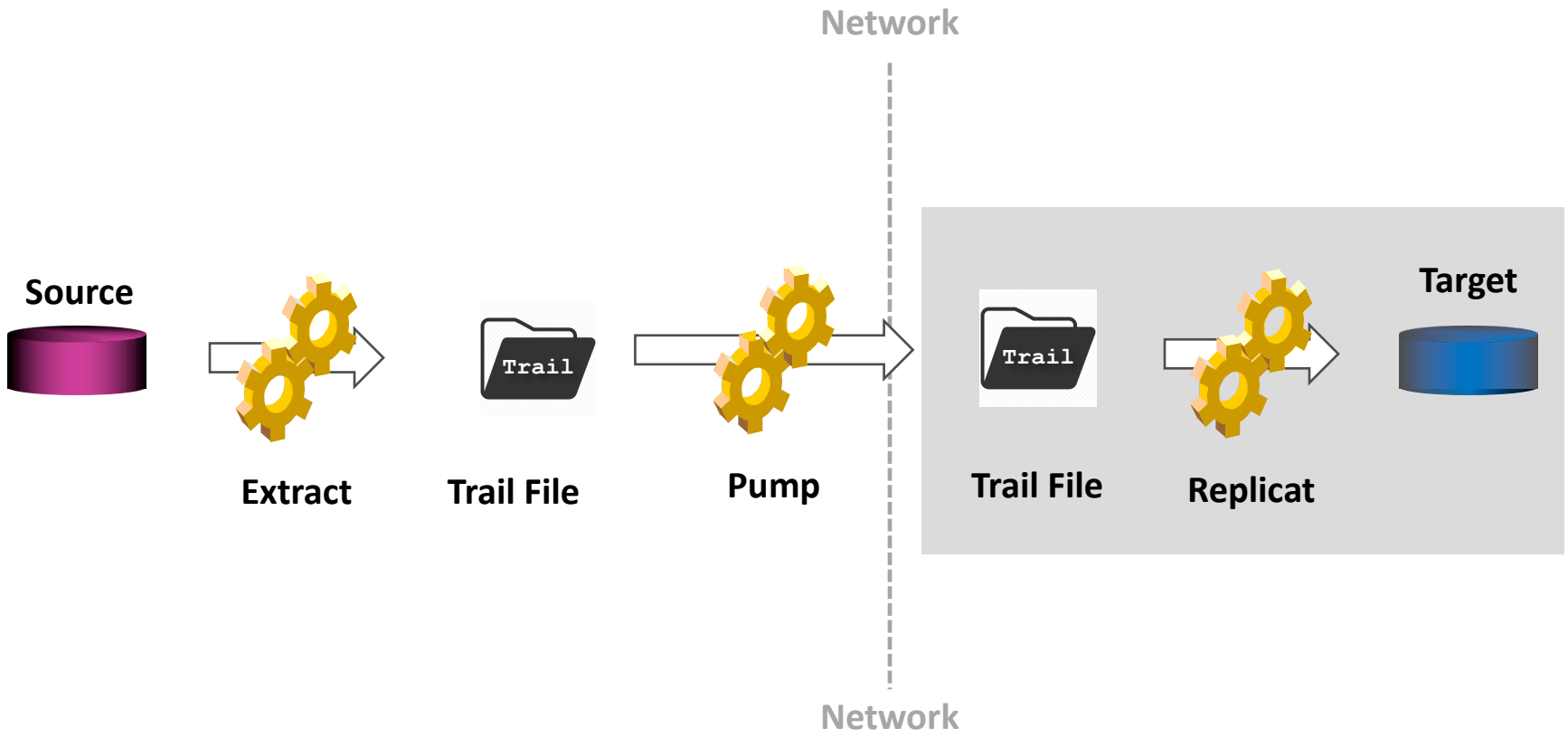
The Extract process captures transactions and writes them to a Local Trail File

Logical Flow (3:4)



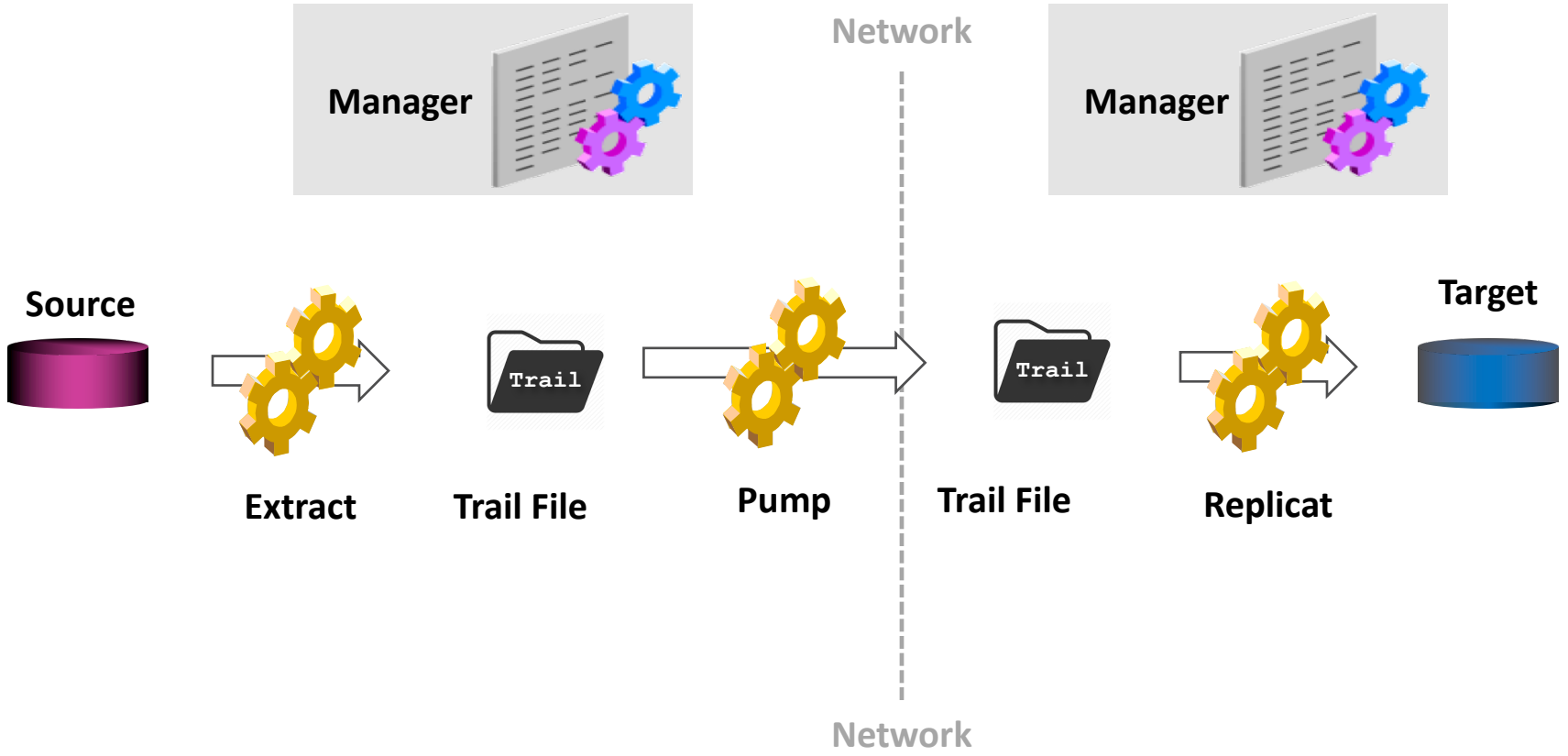
The Pump process routes and copies the trail file from the Local directory to the Remote location(s)

Logical Flow (4:4)



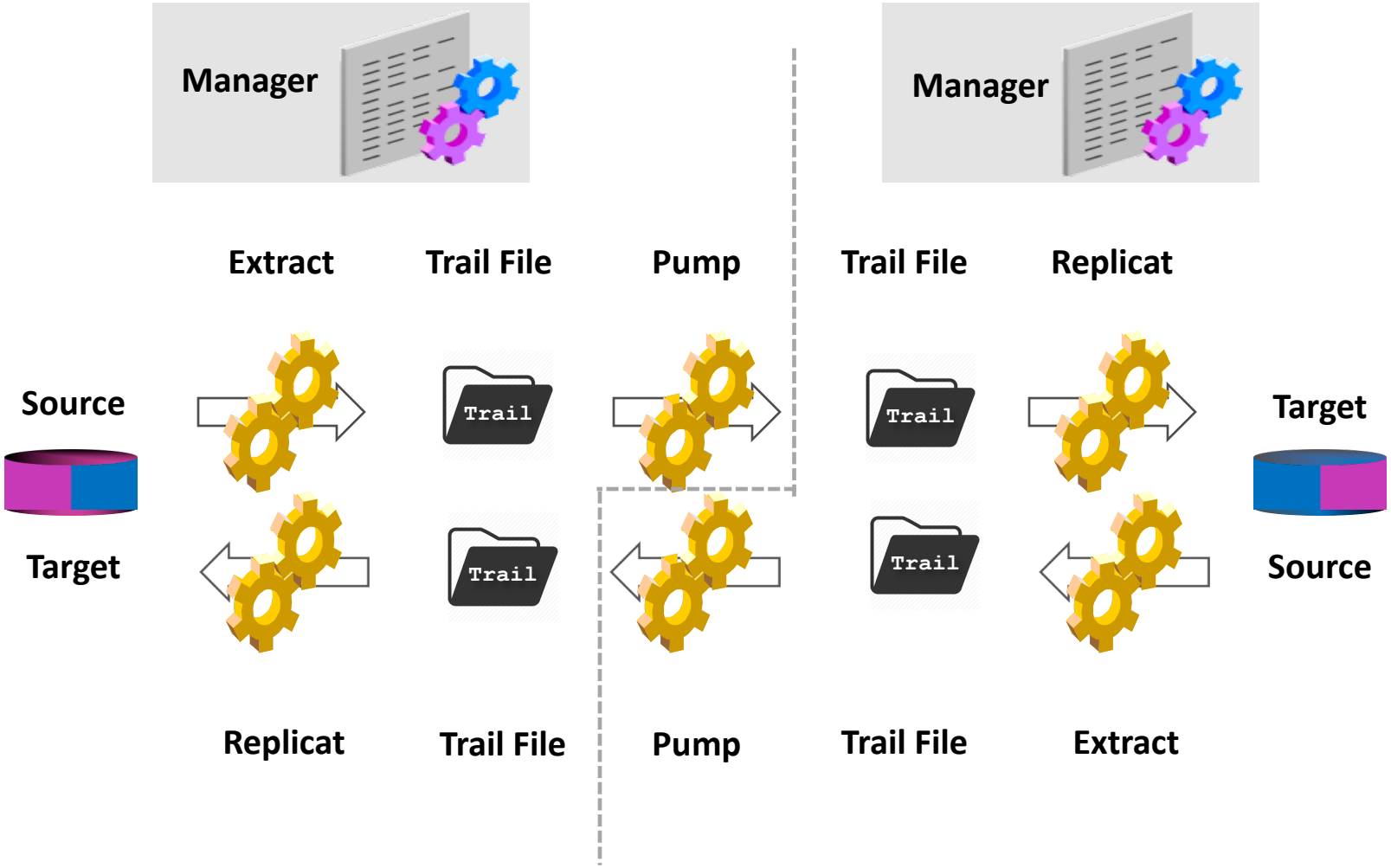
The Replicat process reads the Remote Trail File and Applies transactions

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

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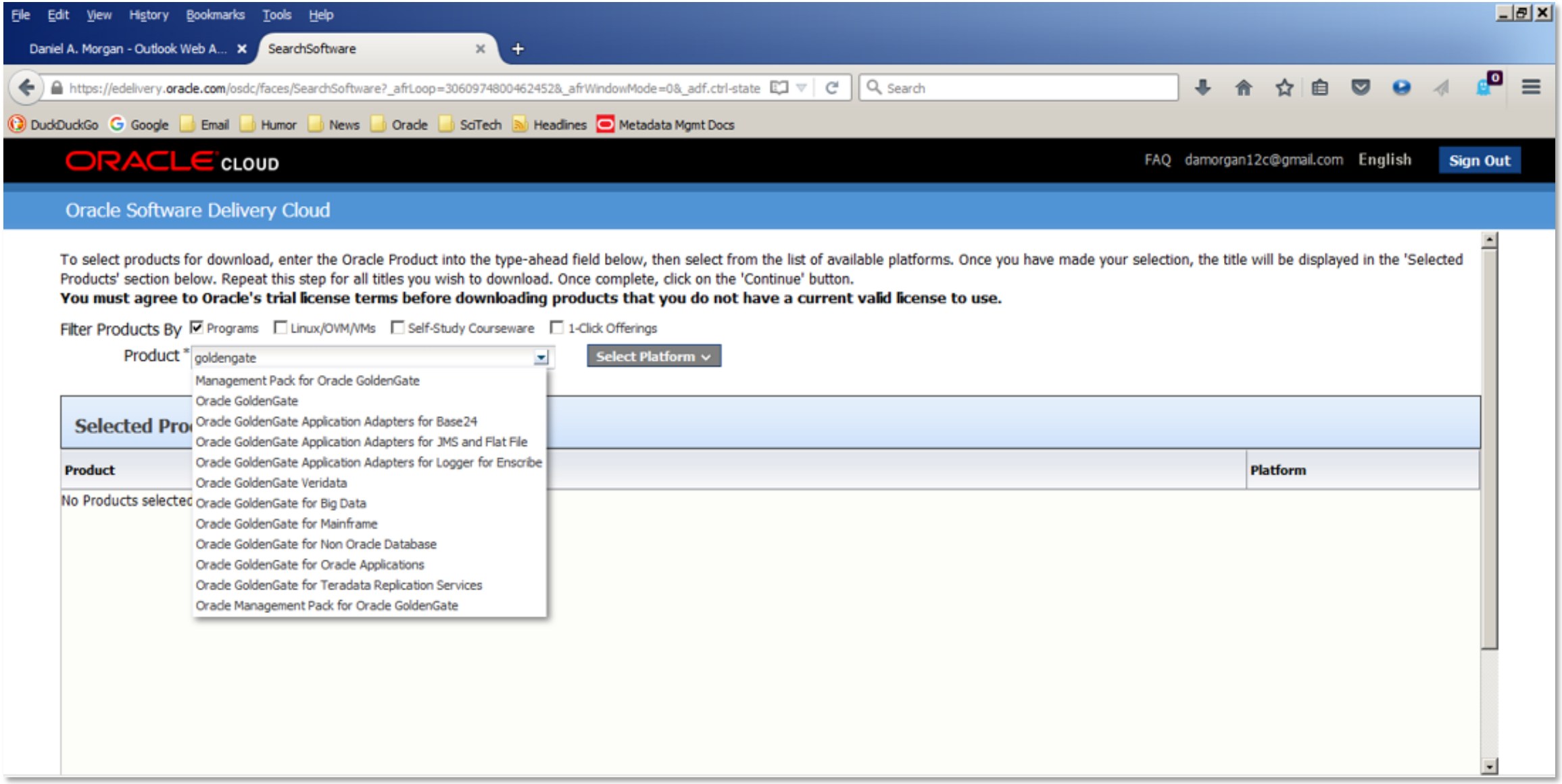
eDelivery.oracle.com



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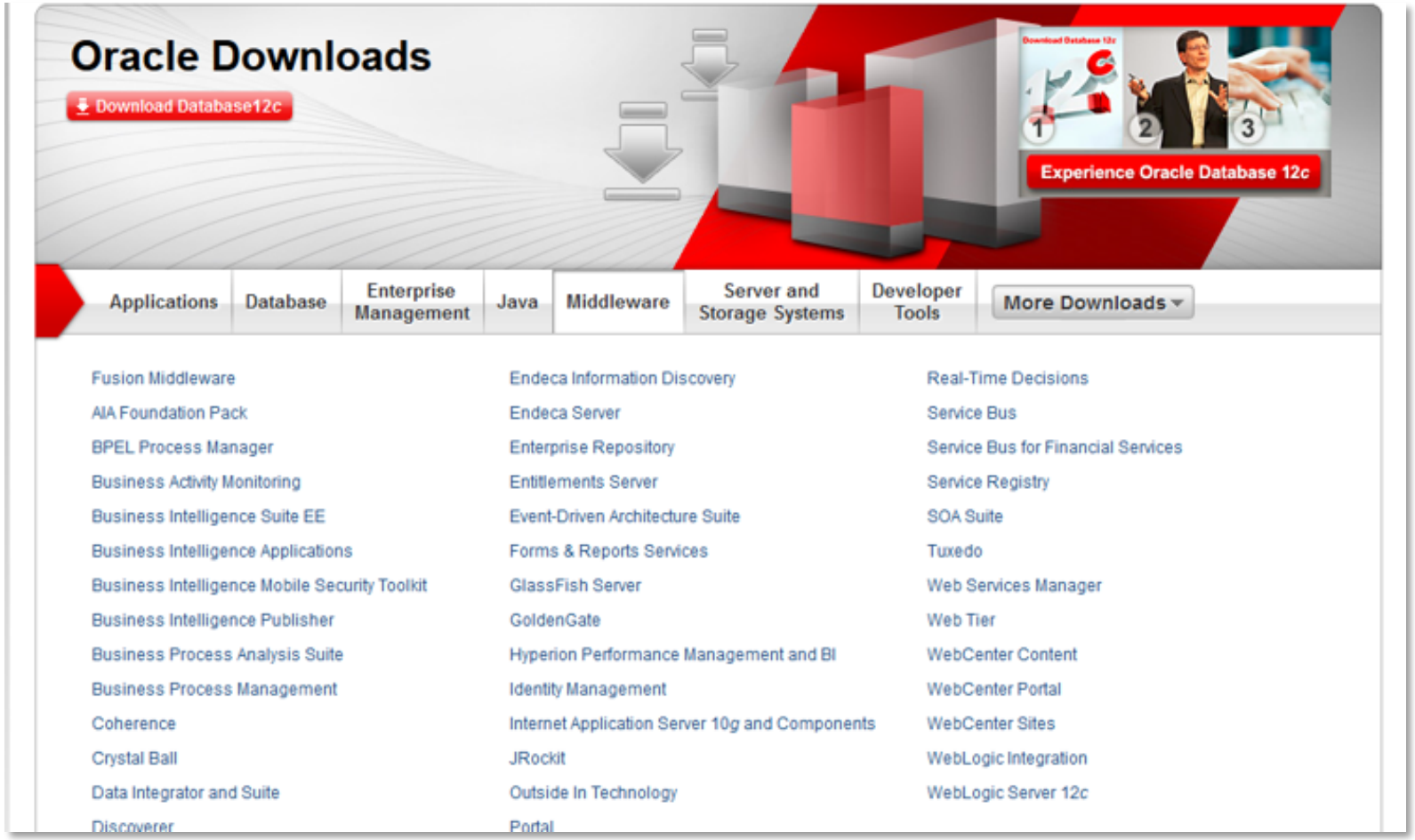
Download

- Oracle Technology Network: Middleware



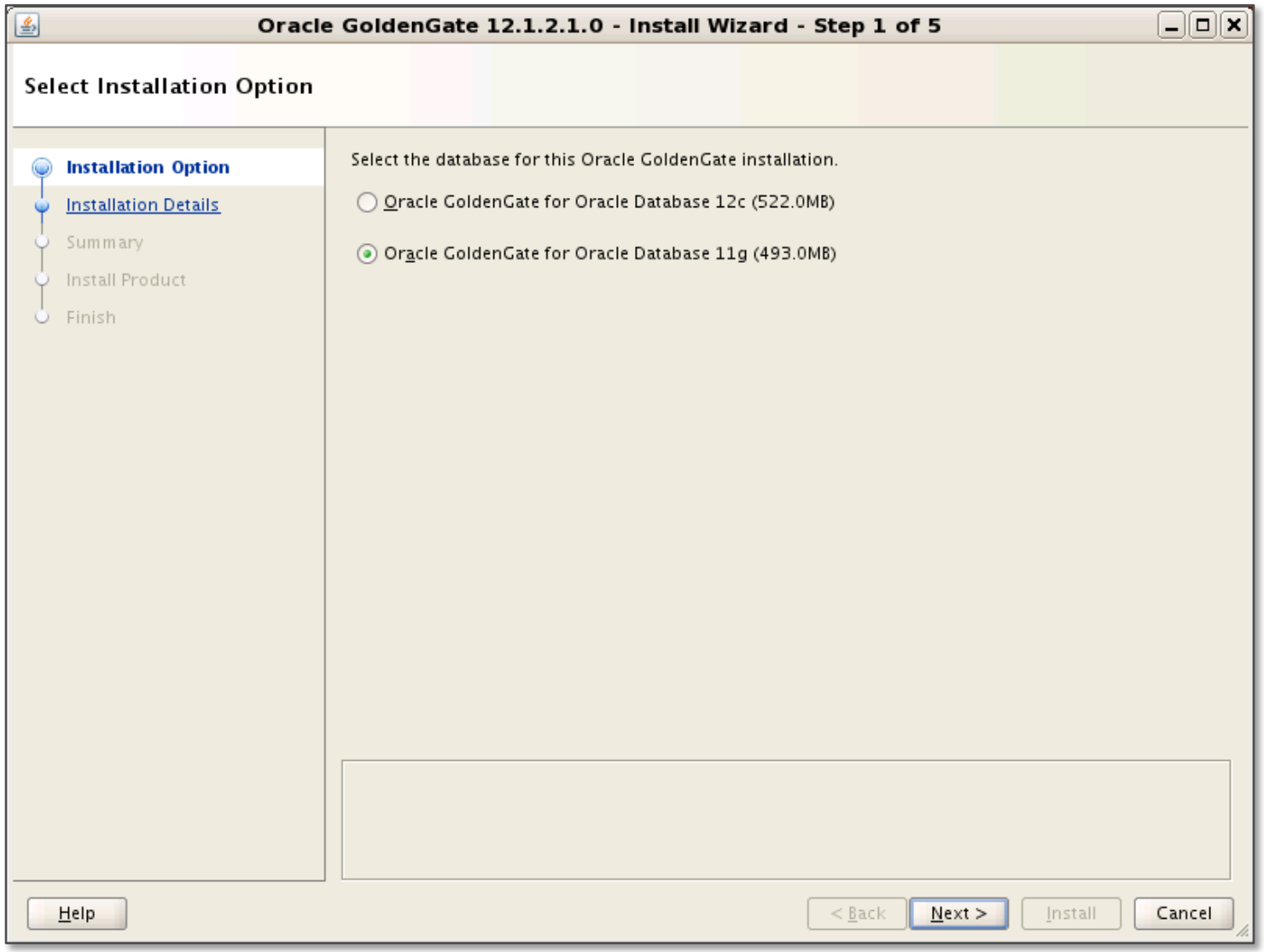
Installation (1:2)

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

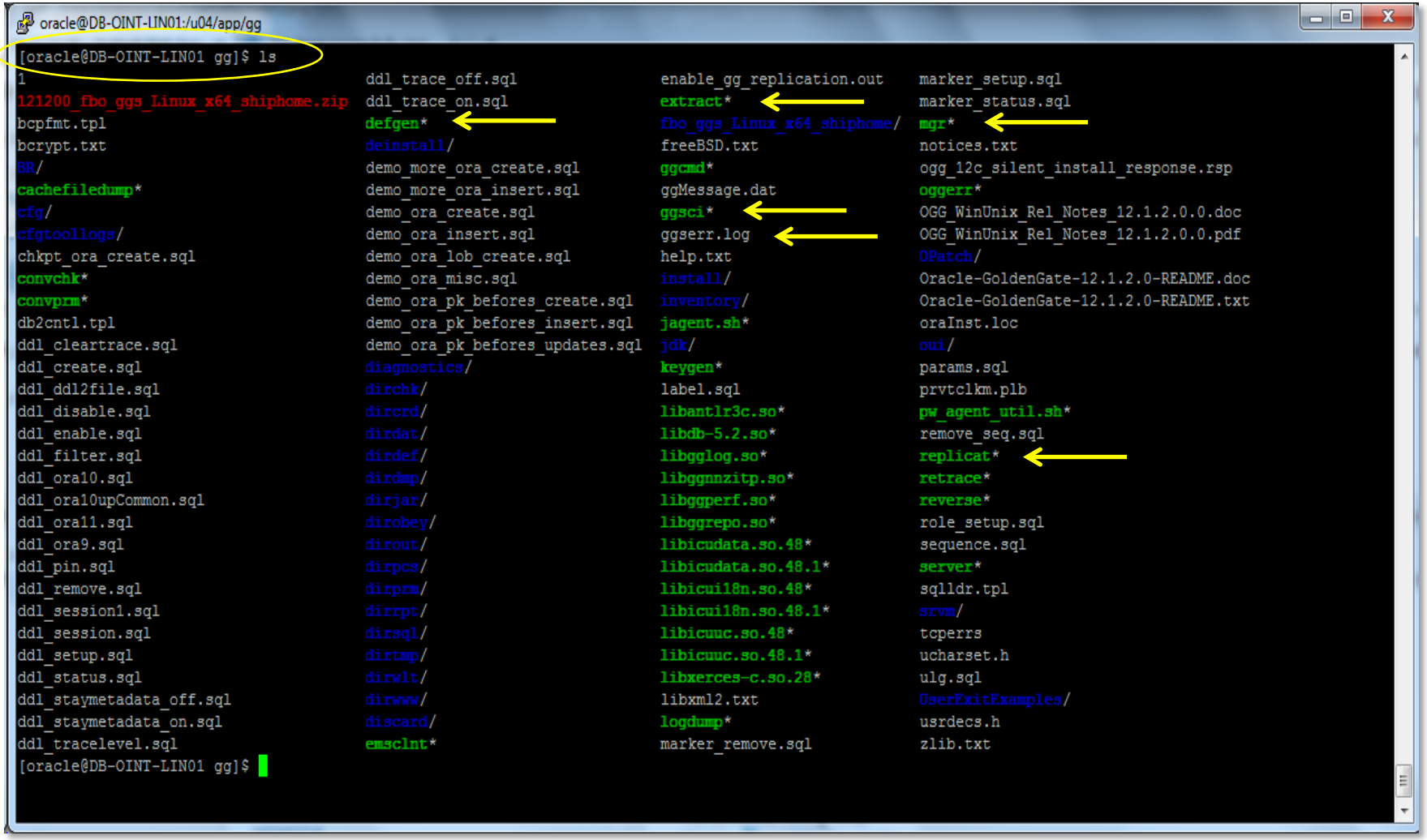
```
[oracle@gg00a Disk1]$ ls
install  response  runInstaller  stage
[oracle@gg00a Disk1]$ ./runInstaller
Starting Oracle Universal Installer...

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)



Directory Structure from the GGHOME directory



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
- Some of the more important minor parameter files are
  - CMDSEC (command security)
  - ENCKEYS (encryption keys)
  - TCPERRS (Posix-based TCP/IP network error handling)
  - The Collector process does not have an editable parameter file

GLOBALS Parameter File

```
------------------------------------------------------------------
-- Sample GLOBALS File - Author: Daniel Morgan Date: 14-JUN-2018
------------------------------------------------------------------
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-JUN-2018
------------------------------------------------------------
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-JUN-2018
------------------------------------------------------------
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.*;
```

Capture/Extract Parameter File

```
------------------------------------------------------------
 -- Sample Extract - Author: Daniel Morgan Date: 14-JUN-2018
------------------------------------------------------------
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
LogAllSu
UpdateRe

StatOpti
WarnLong
ReportCo
Report A
ReportRo
DiscardF
DiscardR

TABLE SH.
```

What is the implication for most Oracle databases?

- Long running transactions require a larger SGA
- If your server doesn't have sufficient memory to support that larger SGA GoldenGate can have a significant impact on Buffer Cache, PGA, Result Cache, and other memory structures as you try to manually tune around the limitation
- Software Defined Servers allow you to allocate the memory required to optimize both GoldenGate and the database

Pump Parameter File

```
------------------------------------------------------------
 -- Sample Pump - Author: Daniel Morgan Date: 14-JUN-2018
------------------------------------------------------------
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-JUN-2018
------------------------------------------------------------
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-JUN-2018
------------------------------------------------------------
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

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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 the admin 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 the 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

```
Container Databases Notes
-- the GG admin user must be a common user
SQL> exec dbms_goldengate_auth.grant_admin_privilege('C##GGATE', '*', TRUE, CONTAINER=>'ALL');
```

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 & Mapping

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Subsetting

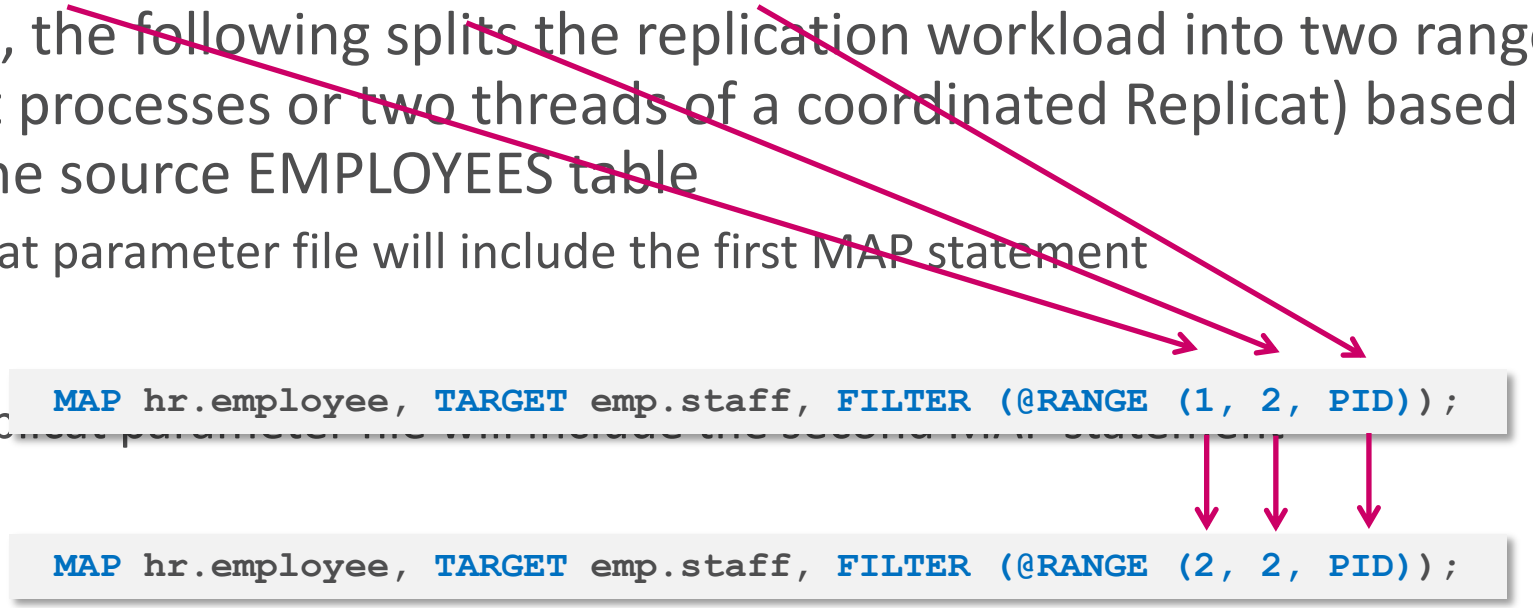
- Subsetting consists of starting with a full data set, the primary host server database and replicating a selected set of qualified transactions
- For example the subset might consist of
  - Only insert and update statements: Not deletes
  - Only invoice data (header and detail) but not look-up tables
  - 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
  - Second Replicat parameter file will include the second MAP statement



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**)
  - Use 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_flag = 'Y';
```

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 = invoiced_quantity);
```

Data Transformation & Enrichment

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Data 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));
```

Data Enrichment

- Data enrichment is the process by which GoldenGate can be used to add new columns to the data stream using either
  - Default values
  - Dynamic values

```
MAP hr.employee, TARGET hr.staff, COLMAP (USEDEFAULTS,
wages = @COMPUTE(salary * 12),
full_name = @STRCAT(last_name, ", ",first_name),
source_system_id = 'EBS',
target_commit_timestamp = SYSDATE);
```

Troubleshooting and Debugging

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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

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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.
```

Zero Downtime Migration

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ZDT Basics (1:2)

- The problem with most database migration attempts is that they require an outage
  - RMAN backup
    - A backup is taken and must be restored
    - Transactions during the time after the backup completes and before the new database is instantiated are not in the new database
    - This forces an outage as the database has no way to identify all transactions not included in the backup
  - Physical Data Guard
    - No matter the technology something must capture transactions while the standby is being built
    - If that "something" is the archived redo logs they require the database be in recovery mode while they are applied
    - Then the standby must be closed and opened as a read-write database

ZDT Basics (2:2)

- With GoldenGate the technique is straight forward
  - GoldenGate capture is enabled as of a System Change Number prior to beginning either an RMAN backup or a DataPump export
  - The backup or export is used to create the new database
  - Delivery using the GoldenGate Replicat process, is started as of the SCN one higher than the last SCN captured by the backup or export
  - When the Replicat has caught up so that the backlog is less than 2 seconds all new transactions are directed to the new database
  - When the final transaction from the old database has been replicated, 1 to 2 seconds later, the old database can be shutdown
  - End users, and client applications, experience zero downtime
- ZDT Issues with GoldenGate
  - Some non-scalar data types

Wrap-Up

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Conclusion

- In our opinion GoldenGate is
- The best homogeneous and heterogeneous replication tool on the market
- Robust capabilities for data enrichment, transformation
- Substantial toolset for troubleshooting and debugging
- Very small cpu, memory, and storage footprint
- Substantial capabilities for performance tuning
- Robust capabilities for subsetting and filtering
- Capable of solid security lockdown
- Easy to upgrade and patch
- Stable and Secure
- And the only tool that enables both homogeneous and heterogeneous zero downtime database migrations
- You can enhance database and GoldenGate performance of long running transactions by enlarging the SGA with Software Defined Server

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- Easy to upgrade
- Easy to patch
- Secure
- Stable
- And the only tool that enables both homogeneous and heterogeneous zero downtime database migrations

```
SELECT more_information
FROM experience
WHERE tool = 'GoldenGate'
AND topic = 'Zero Downtime';
*
ERROR at line 1:
ORA-00028: your session has been killed
```

Thank You
For Sharing Your Day With Us

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