Does Upgrade = Downtime?
Minimal Downtime Strategies for Planned Maintenance

Mike Dietrich – ORACLE Corporation – Upgrade Development Group
Takuya Abe – ORACLE Japan – Sales Consulting
Takashi Ikeda – Fujitsu Hokuriku Systems Ltd. Japan
Introduction

• Who we are???
Introduction

- Mike Dietrich: http://blogs.oracle.com/UPGRADE

Upgrade your Database - NOW!
Ease your Oracle Database upgrades - Best Practices, Workshops, Projects ...
Agenda

- Downtime?
- Different Techniques - Overview
- Different Techniques – The Details
- Practical comparison by Fujitsu Hokuriku
Why Downtime?

• Why do we encounter downtime during a database upgrade?
  • Database is in "UPGRADE" mode
  • The data dictionary will be upgraded
  • The database is protected against changes apart from upgrade
  • ▶ This usually means downtime
  • It applies to:
    • Database release upgrades
      • Example: Upgrade from 10.2.0.3 to 11.2.0.2
    • Patch set upgrades
      • Example: Patch set upgrade from 11.2.0.1 to 11.2.0.2
    • Patches which modify the dictionary
The Goal

• Goal:
  • Reduce the downtime according to your requirements and business needs

• The 3 Magic Upgrade Questions:
  1) Are you changing operating systems?
  2) Will you be moving to new hardware?
  3) How much downtime can you experience?
Agenda

- Downtime?
- Different Techniques - Overview
- Different Techniques – The Details
- Practical comparison by Fujitsu Hokuriku
Change to a **new OS and new HW**

### Overview

- **Possible upgrade/migration downtime**
  - *slow* (strongly dependent on data volume)
  - *fast*

#### Works since Oracle Version

- **Oracle 11.1**
  - Transportable DB
- **Oracle 10.2**
  - expdp/impdp
  - x Transportable TS
- **Oracle 10.1**
- **Oracle 9.2**
- **Oracle 8i**
  - Streams
- **Oracle 8**
  - Golden Gate
- **Oracle 7**
  - COPY
  - CTAS
- **Oracle 6**
  - SQL*Loader
- **Oracle 5**
  - exp/imp
Keep the OS – **Upgrade and change HW**

**Overview**

Possible upgrade/migration time

- **slow** (may or may not depend on data volume)
- **fast**

<table>
<thead>
<tr>
<th>Works since Oracle Version</th>
<th>Upgrade Command Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oracle 11.1</td>
<td>Transient Stby</td>
</tr>
<tr>
<td>Oracle 10.2</td>
<td>Transportable DB</td>
</tr>
<tr>
<td>Oracle 10.1</td>
<td>expdp/impdp</td>
</tr>
<tr>
<td>Oracle 9.2</td>
<td>Logical Stby</td>
</tr>
<tr>
<td>Oracle 8i</td>
<td>Streams</td>
</tr>
<tr>
<td>Oracle 8</td>
<td>Golden Gate</td>
</tr>
<tr>
<td>Oracle 7</td>
<td>COPY CTAS SQL*Loader</td>
</tr>
<tr>
<td>Oracle 6</td>
<td>exp/imp</td>
</tr>
<tr>
<td>Oracle 5</td>
<td></td>
</tr>
</tbody>
</table>
Keep the HW – just upgrade the database

Overview

Possible upgrade/migration time

- slow
- fast

(may or may not depend on data volume)

Oracle 11.1

Oracle 10.2

Oracle 10.1

expdp/impdp

TTS

Streams

Golden Gate

Oracle 9.2

Oracle 8i

Upgrade
DBUA or Command Line

Oracle

COPY

CTAS

SQL"Loader

Oracle 7

exp/imp

Oracle 6

Oracle 5
Agenda

- Downtime?
- Different Techniques - Overview
- Different Techniques – The Details
- Practical comparison by Fujitsu Hokuriku
"Regular" Database Upgrade

- Upgrade duration is mainly dependent on the number of installed components
  - **Typical upgrade duration:** 15-90 minutes

<table>
<thead>
<tr>
<th></th>
<th>DBUA</th>
<th>Command Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same HW, same OS</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Same HW, different OS</td>
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<td></td>
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<tr>
<td>Different HW, same OS</td>
<td></td>
<td>✗</td>
</tr>
<tr>
<td>Different HW, different OS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Export/Import and Data Pump

• Upgrade duration is mainly dependent on data volume
  • exp/imp will work between Oracle5 and Oracle 11.2
  • expdp/impdp will work starting from Oracle 10.1
  • Faster and more powerful than "old" exp/imp
  • NETWORK_LINK parameter could be very beneficial

<table>
<thead>
<tr>
<th></th>
<th>exp/imp</th>
<th>expdp/impdp</th>
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<tbody>
<tr>
<td>Same HW, same OS</td>
<td>X</td>
<td>X</td>
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</table>
CTAS, COPY command and SQL*Loader

- Upgrade duration is mainly dependent on data volume
- Create-Table-As-Select and COPY work on database links with restrictions
- SQL*Loader requires unload of data
  - Both techniques work since Oracle 7 or earlier – across versions

<table>
<thead>
<tr>
<th></th>
<th>CTAS COPY</th>
<th>SQL Loader</th>
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Transportable Tablespaces

- TTS works since Oracle 8i
  - Cross platform and cross Endianness since Oracle 10g
  - Unplug data tablespaces and plug them into a new db
    - But objects in SYSTEM and SYSAUX have to be transported as well
  - Complexity could be a constraint

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<th>TTS</th>
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<tbody>
<tr>
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<tr>
<td>Same HW, different OS</td>
<td>≥10g</td>
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<tr>
<td>Different HW, same OS</td>
<td>✗</td>
</tr>
<tr>
<td>Different HW, different OS</td>
<td>≥10g</td>
</tr>
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Transportable Database

- TDB works since Oracle 10.2
  - Cross platform, but NOT cross Endianness
  - RMAN automates the platform conversion
    - Database must be switched into READ ONLY mode

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Oracle Streams

- Oracle Streams works since Oracle 9.2
  - Setup a copy of the database, upgrade it and replicate everything to the copy
  - Cross platform and cross Endianness
  - Downstream Capture as fallback
    - But complex to setup and may have performance limitations

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Oracle Golden Gate

- Oracle Golden Gate works since Oracle 8i
  - Similar concept to Oracle Streams
    - Logmining happens outside the database
    - Faster and easier to setup and more datatypes supported

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Logical Standby Database – SQL Apply

- SQL Apply Rolling Upgrade works since Oracle 10.1.0.3
  - Logical Standby database is upgraded first
  - Switchover exchanges roles between primary and standby
  - Then the former production is upgraded
    - Downtime reachable: less than 1 minute
    - For certified combinations see MOS Note: 1085687.1

<table>
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Transient Logical Standby Database

- Recommended beginning with Oracle 11g
  - Start with Physical Standby
  - Convert to Logical Standby, upgrade using SQL Apply
  - Use Flashback Database to return to Physical Standby config.
    - Downtime reachable: less than 1 minute
  - For certified combinations see MOS Note: 1085687.1

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Introduction

• Takuya Abe
  Sales Consulting
  Oracle Japan
Upgrade conditions in Japan

• There are many databases running old versions in Japan

• Why?
  • Basically, they tend to improve their existing databases and not upgrading them
    • Kaizen
  • Each divisions in a company has their own systems with their own policies
    • It’s not easy to standardize or consolidate the systems
  • Afraid of the impact on applications by upgrading database

• It’s difficult to convince customers to upgrade databases
Working with Upgrade Development

- Upgrade Development team members came to Japan last year to promote upgrading databases
  - Provide an upgrade workshop
  - Several meetings with Japanese partner companies
- Good and close relationship between U.S. and Japan
  - Keeping contact and discuss upgrade projects in Japan
  - Task Force Team for upgrading large-scale projects
Collaboration with Partners in Japan

- Oracle Japan cooperates with many partner companies
  - Fujitsu, NEC, Hitachi, HP, etc
  - NS Solution, CTC, etc
- From our partners perspective, there was not enough information available about database upgrades
- We had tested and created documents about database upgrades with Fujitsu at the Technology Verification Center in Oracle Japan’s office
Oracle GRID Center

Best Practices, Innovative Ideas, from Japan
Performs Key Technical Activities at Oracle Japan

Utilize Various Hardware
Servers, Storages and Network Switches provided by Strategic Partners

Collaborative Verification Testing
Engineers from Partners, Oracle Japan and Oracle Development

Publish Outputs
White Papers

- Oracle Database 11g Release 2 Improving OLTP System Performance Using Database Smart Flash Cache with Fujitsu SPARC Enterprise
- Fujitsu SPARC Enterprise: Migrating from Oracle9i Database to Oracle Database 11g
- Oracle Database ILM Solution based on Fujitsu ETERNUS DX/SPARC Enterprise - Lower storage costs and power consumption for long-term data storage
- Performance verification of Oracle RAC /Oracle BIEE on Fujitsu Blade Server - Validating Scalability by Adding Nodes -
- Verification of Oracle Database 11g for Data Warehousing Using Fujitsu SPARC Enterprise - Performance Improvement Based on Data Segment Compression and ASM Utilization -

- Effective resource utilization by In-Memory Parallel Execution in Oracle Real Application Clusters 11g Release 2
- Oracle Database 11g Release 2 Improving Batch Processing Speed using In-Memory Parallel Execution on Oracle Real Application Clusters
- Performance improvement of the entire Data Warehouse system on NEC Express5800/Scalable HA Server by using Oracle Database 11g Release 2 In-Memory Parallel Query
- Active Data Guard 11g, RMAN Network Duplicate, Snapshot Standby, Apply Performance and Fast-Start Failover w/ Hitachi Ltd.
- Best Practices for Oracle Automatic Storage Management (ASM) on Hitachi Dynamic Provisioning (HDP)
- Data Guard Redo Transport Compression and Proper Network Configuration w/ Hitachi Ltd
  [http://www.hitachi.co.jp/Prod/comp/soft1/oracle/pdf/08-008.pdf](http://www.hitachi.co.jp/Prod/comp/soft1/oracle/pdf/08-008.pdf)
- Data Guard SQL Apply on IBM Power Systems Performance Validation
SOFTWARE. HARDWARE. COMPLETE.
DB Migration for Oracle

September, 2010

Database Solution Div.
Fujitsu Hokuriku Systems Ltd.

Takashi Ikeda
1. About FUJITSU HOKURIKU SYSTEMS (FJH)
2. Concerning Business Downtime
3. GRID Center Co-Evaluation Result Report
4. Cross Platform DB Migration
1. About FUJITSU HOKURIKU SYSTEMS (FJH)
FJH has earned 1st place in Oracle Certified Master AWARD for 3 years running in Japan.

Since 2008, FJH has had the largest number of certified Oracle OCM engineers in Japan.

Oracle OCM is the most advanced Database Administrator certification.

FJH is the Oracle database professional organization within the Fujitsu group.
Introduction

Name : Takashi Ikeda
ORACLE Certified Master (OCM)
  - Oracle9i Database (2004.1 The 1st in JPN)
  - Oracle Database 10g (2008.3)
  - Oracle Database 11g (2010.6)

Work Experience
  Became engaged in Oracle database support.
2004 Provided support for DB tuning and DataGuard (DG) service.
2006 Engaged in construction of Large-scale DB systems.
2007 Successfully led the RAC+DG(logical+DG(physical)system project
2008 Developed the "DB Migration for Oracle” service

Currently providing expertise on DB migration services to Fujitsu customers.
'DB Migration for Oracle'

Our 3 services for a successful DB migration

<table>
<thead>
<tr>
<th>Proposal</th>
<th>Requirements Definition</th>
<th>Fundamental design</th>
<th>Detailed design</th>
<th>Implementation</th>
<th>Unit Test</th>
<th>Integration Test</th>
<th>System Test</th>
<th>Migration</th>
<th>Operation</th>
</tr>
</thead>
</table>

**Migration Assessment**

We provide the following as the assessment (evaluation report).
- The best DB Migration method for the project
- Projected time necessary for migration
- Migration risk (Compatibility, priority)

**Hearing/data collection**
**Requirement/data analysis**
**Assessment report**

**Oracle Japan co-development**

**Migration Solution**

Migration using pre-verified high-quality method/procedure/tools
- Migration to Oracle11g environment
- Migration with DB configuration change
- Migration with platform change

**Assessment report**
**Select pattern and customize**
**Apply adequate migration**

**Oracle Japan co-evaluation**

**Migration Consulting**

Technology consulting for entire DB Migration project (Planning/Design/Construction/Test)
Offering expertise of ORACLE Certified MASTER holder.
Positioning of ‘DB Migration for Oracle’

- Solutions for new environment migration

DB migration for Oracle
- DB Migration assessment
- DB Migration solution
- DB Migration consulting

- The Services are specialized for DB Migration.
- DB migration knowhow is systematized.

Reduced customer/systems engineer works for DB migration

→ Specialized migration services are provided.
   Customers does not need to acquire special skills for migration.

→ Customers/systems engineers can focus on new base/operation system testing
2. Concerning Business Downtime during DB Migration
Challenges in DB Migration

In HW replacement and server integration projects, DB Migration is necessary and it is very important. It is key to leading a successful project.

Customer requirements
- Shorten business downtime as much as possible.
- Minimize risk during DB migration.
- Identify risks early

Systems Engineer's Challenges
- Identify the best method of DB Migration.
- Achieving required business downtime.
- Limited time to examine DB Migration procedure.
- Lack of knowledge in system replacement projects.
Customer’s Concern

There is a big concern of DB migration project.

- Business Downtime

  - How long will it take to complete a large DB Migration? (Terabyte-scale)
  - Downtime needs to be minimized (a few hours if possible).
  - Downtime is critical success factor when planning and determining stages.
Business Downtime

- **DB size is getting larger (TB scale ~).**
- **Required downtime is getting shorter ( ~ a few hours).**

- Servers are often replaced at the same time as DB upgrade.
- Physical reallocation of data is necessary in the DB migration.
- With large-scale DB (TB scale), data migration time is key.

How to transfer data to new hardware in shortest time?

The key to migration.
3. GRID Center evaluation result report
FJH-ORACLE Japan co-evaluation
Purpose of testing

- The 1TB-size DB can be migrated and upgraded within 2 hours?

Evaluate and verify methods for migrating large-scale database in a short time (a few hours).

FUJITSU and ORACLE established the effective methods for large-scale DB migration.

- Target: Migration from Oracle9i to Oracle11g
- Use only standard functions provided by Oracle Database Software, use no additional middleware.
Summary of the evaluation

- Achieved migration speed of 65 minutes from 9i to 11g DB Migration.
- Verified migration methods for terabyte-scale DB

<table>
<thead>
<tr>
<th>No.</th>
<th>Migration method</th>
<th>Migrated objects(size)</th>
<th>time</th>
<th>notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DataGuard (physical)+ transportable tablespace</td>
<td>datafiles (1.2TB) + archived log</td>
<td>1h 5m</td>
<td>-nologging operations are not available - need self-contained tablespace</td>
</tr>
<tr>
<td>2</td>
<td>DataGuard (physical)+ Upgrade script</td>
<td>datafiles (1.2TB) + archived log</td>
<td>1h 25m</td>
<td>-nologging operations are not available</td>
</tr>
<tr>
<td>3</td>
<td>DB Link + direct load(delta)</td>
<td>recently data (60GB)</td>
<td>2h 5m</td>
<td>Data size should be minimized by selecting data.</td>
</tr>
<tr>
<td>4</td>
<td>DB Link + direct load(entire)</td>
<td>all data (660GB)</td>
<td>22h 13m</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>File copy + Upgrade script</td>
<td>datafiles (1.2TB)</td>
<td>31h 2m</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Export/Import</td>
<td>all data (660GB)</td>
<td>33h 12m</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Solaris Containers STDBY+UPGRADE(8.1.7)</td>
<td>datafiles (1.2TB) + archived log</td>
<td>2h 15m (estimated)</td>
<td>-nologging operations are not available</td>
</tr>
</tbody>
</table>

This benchmark is showcased in various seminars and proposals. The response from customers is very positive. Implemented in projects for Manufacturing, Securities and Power companies in Japan. Successful in eliminating customer concerns about business downtime.
Evaluation Environment

DB server (source)
FUJITSU PRIMEPOWER 250
(SPARC64V 1.1GHz x 2CPU)
Solaris 9
Oracle9i R2 EE

DB server (target)
FUJITSU SPARC Enterprise M4000
(SPARC64VII 2.4GHz x 4CPU(16CORE))
Solaris 10
Oracle11g EE

100Mbps LAN

DB size 1TB
ETERNUS 4000 M500
RAID5 (7+1)x3
146GB(15000rpm)

DB size 1TB
ETERNUS 4000 M500
RAID5 (7+1)x3
146GB(15000rpm)
Database Structure

- 1TB of user tablespace

526GB in USER01 tablespace

User 1: 407GB
- 254GB
- 153GB

User 3: 120G
- 76GB
- 43GB

526GB in USER02 tablespace

User 2: 407GB
- 254GB
- 153GB

User 4: 120G
- 76GB
- 43GB

\[ \text{table size} + \text{Index size} = 660\text{GB} + 392\text{GB} = 1052\text{GB} + \alpha \approx 1.2\text{TB} \]

*: SYSTEM/SYSAUX, etc.
Export/Import

Over 33 hours

Step 1) 16 hours, 53 minutes for Exporting 660GB
Step 2) 10 hours for Importing 660GB
3) 6 hours, 19 minutes for creating index

Total duration: 33 hours and 12 minutes

Exporting to NFS speed is 11.1MB/s.
(Near limit of 100Mbps line)

- Transfer time depends on amount of data.

Reference: Local output: 4 hours and 43 minutes
File transfer: 16 hours and 46 minutes
File Copy + Upgrade Script

Over 31 hours

Step 1) 30 hours and 12 minutes for 1.2 TB copy
Step 2) 50 minutes for executing upgrade

Total duration: 31 hours and 02 minutes

Copying to new HW speed is 11.2MB/s. (Near limit of 100Mbps line)

- Migration method is simple but it takes time.
- It depends on the data file size.
DB link + Direct Load Insert (Entire)

Over 22 hours

Step 1) 15 hours and 54 minutes
   *Direct load (table: 660GB)
Step 2) 6 hours and 19 minutes
   *Index build

Total duration: 22 hours and 13 minutes

Loading to new HW speed is 11.2MB/s.
(Near limit of 100Mbps line)

Time depends on the amount of real data.
DB link + Direct Load Insert (Delta)

2 hours

Step 1) 1 hour 27 minutes
   *load data (60GB)

Step 2) 38 minutes
   *build index (36GB)

Total duration: 2 hours 5 minutes

Loading to new HW speed is 11.2MB/s. (Near limit of 100Mbps line)

- Scope of load is limited to the latest part.
- Depends on amount of the latest data.
DataGuard + Upgrade Script

1.5 hours

Step 3) 35 minutes
*failover + α

Step 4) 50 minutes
*execute upgrade

Total duration: 1 hour 25 minutes

- Time reduction using DataGuard
- Depends on components and numbers of objects for Upgrade
DataGuard + Transportable Tablespace

1 hour

Step 3) 35 minutes
  *failover + α

Step 4,5) 30 minutes
  *executing TTS

Total duration: 1 hour 5 minutes

- Time reduction using DataGuard.
- Depends on components and numbers of objects for Upgrade

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Solaris Containers use STDBY+Upgrade

<Older Oracle version case>

About 2.3 hours (estimated)

- Step 3) 35 minutes * failover + α
- Step 4) 50 minutes * upgrade to 10g
- Step 5) 50 minutes * upgrade to 11g

Total duration: 2 hour 15 minutes

- Solaris8 Containers is useful for upgrading. (e.g. Sol8 on Sol10 + Oracle 8.1.7)
- Copy DB made using Standby DB.
- 2 Phase upgrade by SQL script
# Results of the co-evaluation

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<td>6</td>
<td>Export/Import</td>
<td>all data (660GB)</td>
<td>33h 12m</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Solaris Containers STDBY+UPGRADE(8.1.7)</td>
<td>datafiles (1.2TB) + archived log</td>
<td>2h 15m (estimated)</td>
<td>-nologging operations are not available</td>
</tr>
</tbody>
</table>

- No elimination of fragmentations → DataGuard is effective (1, 2, 7)
- Need to eliminate fragmentations → DB Link+direct load(delta) is effective (3)
4. Cross Platform DB Migration
Oracle GoldenGate
Cross Platform DB Migration

How to migrate large-scale DB in short time?

- Using DataGuard is effective
  - Basically need same platform

- DB Link+Direct load can be used for cross platform
  - Migration time depends on the amount of data

Is there rapid migration method in case of cross platform?

Oracle GoldenGate is very effective
# DataGuard Certified Matrix

<table>
<thead>
<tr>
<th>No</th>
<th>Source</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Solaris[tm] OE (64-bit) Solaris Operating System (SPARC) (64-bit)</td>
<td>OK</td>
</tr>
<tr>
<td>2</td>
<td>HP-UX (64-bit) HP-UX PA-RISC</td>
<td>NG</td>
</tr>
<tr>
<td>3</td>
<td>HP-UX IA (64-bit) HP-UX Itanium</td>
<td>NG</td>
</tr>
<tr>
<td>4</td>
<td>Linux (32-bit) Linux x86</td>
<td>NG</td>
</tr>
<tr>
<td>5</td>
<td>Linux IA (64-bit) Linux Itanium</td>
<td>NG</td>
</tr>
<tr>
<td>6</td>
<td>Linux 64-bit for AMD Linux x86-64</td>
<td>NG</td>
</tr>
<tr>
<td>7</td>
<td>Microsoft Windows 64-bit for AMD Microsoft Windows (x86-64)</td>
<td>NG</td>
</tr>
</tbody>
</table>

*e.g. If migrating to Solaris(SPARC), Oracle GoldenGate is very useful*
Migration Using Oracle GoldenGate (GG)

1) OLTP Users
   Start GG capture
   Oracle 9i
   Oracle 11g

2) OLTP Users
   Initial copy/load
   Oracle 9i
   Oracle 11g

3) OLTP Users
   Apply (Replicat)
   Oracle 9i
   Oracle 11g

4) OLTP Users
   Test New DB
   Oracle 9i
   Oracle 11g

5) OLTP Users
   Configure switch-back
   Oracle 9i
   Oracle 11g

6) OLTP Users
   Switch to New DB
   Oracle 9i
   Oracle 11g
Migration Using GoldenGate Evaluation

**a few minutes** for switching to New DB

GoldenGate on SPARC Enterprise is validated and it is now available.
Reduced Business Downtime

FUJITSU and ORACLE established the effective methods for large-scale DB migration.

<table>
<thead>
<tr>
<th>Methods</th>
<th>Same Platform Migration</th>
<th>Cross Platform Migration</th>
<th>A Few Minutes Migration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Guard</td>
<td>OK</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>DB Link + Direct Load</td>
<td>OK</td>
<td>OK</td>
<td>--</td>
</tr>
<tr>
<td>GoldenGate</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
</tbody>
</table>
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