Delivering Oracle Compatibility

A White Paper by EnterpriseDB

www.EnterpriseDB.com

EnterpriseDB™

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Executive Summary

Enterprises running Oracle® are generally interested in alternative databases for at least three reasons. First, these enterprises are experiencing budget constraints and need to lower their database Total Cost of Ownership (TCO). Second, they are trying to gain greater licensing flexibility to become more agile within the company and in the larger market. Finally, they are actively pursuing vendors who will provide superior technical support and a richer customer experience. And, subsequently, enterprises are looking for a solution that will complement their existing infrastructure and skills.

The traditional database vendors have been unable to provide the combination of all three benefits. While Microsoft SQL Server™ and IBM DB2™ may provide the flexibility and rich customer experience, they cannot significantly reduce TCO. Open source databases, on the other hand, can provide the TCO benefits and the flexibility. However, these open source databases either lack the enterprise-class features that today's mission critical applications require or they are not equipped to provide the enterprise-class support required by these organizations. Finally, none of the databases mentioned above provide the database compatibility and interoperability that complements their existing applications and staff. The fear of the costs of changing databases, including costs related to application re-coding and personnel re-training, outweigh the expected savings and, therefore, these enterprises remain paralyzed and locked into Oracle.

To meet the needs of these enterprises, EnterpriseDB has substantially enhanced PostgreSQL, the world's most advanced open source database, to create EnterpriseDB Advanced Server™. EnterpriseDB Advanced Server is an enterprise-class relational database management system (RDBMS) that is suitable for high-volume, mission-critical applications. EnterpriseDB's enhancements to PostgreSQL fall primarily in two categories: performance and Oracle compatibility.

The most distinguishing feature of EnterpriseDB Advanced Server is its ability to run applications written for Oracle databases without change to the applications' code. EnterpriseDB's compatibility with Oracle makes it easy for enterprises with existing Oracle investments to enjoy the benefits of open source databases. The ability to run existing Oracle applications on EnterpriseDB eliminates the costly, time-consuming, and risky re-coding typically required to migrate applications from Oracle to any other database. In addition, an enterprise's Oracle DBA and database developer skill sets are completely re-usable in an EnterpriseDB environment, eliminating the need for costly re-training or re-hiring.

At the Enterprise Performance Center near Oxford, England, EnterpriseDB database performance specialists have tuned the performance of EnterpriseDB Advanced Server to enable it to run up to 50% faster than native PostgreSQL. The result is a highly scalable database solution with unmatched cost-effectiveness. In fact, after moving their existing Oracle applications to EnterpriseDB, many customers cite performance equal to or faster than the same application running against Oracle.

EnterpriseDB has augmented PostgreSQL in eight critical areas to create an enterprise-class database that can

replace or supplement the Oracle databases in an enterprise's IT infrastructure:

- **Oracle SQL Compatibility.** EnterpriseDB Advanced Server executes Oracle-specific SQL syntax.
- **PL/SQL Compatibility.** EnterpriseDB Advanced Server executes PL/SQL, Oracle's unique language for triggers, stored procedures, packages, and functions.
- **Data Dictionary Views.** EnterpriseDB provides the most common Oracle catalog views.
- **Programming Flexibility and Drivers.** EnterpriseDB supports the most common programming languages used to create database applications for Oracle including compatibility and interoperability with the Oracle Call Interface (OCI)™.
- **Migration Tools.** EnterpriseDB provides a suite of automated tools to move Oracle data, packages, triggers, stored procedures, and functions to EnterpriseDB in one simple step.
- **Replication.** EnterpriseDB Replication Server can replicate Oracle databases in near real-time to: improve database performance, run reporting and as the foundation for other applications at a small fraction of Oracle's cost.
- **Enterprise-Class Reliability and Scalability.** EnterpriseDB Advanced Server is a suitable replacement for Oracle in high-volume, mission-critical applications.
- **Oracle-Like Tools.** EnterpriseDB Advanced Server includes a robust set of integrated tools that will be familiar to professional Oracle DBAs and developers.

Each of these eight areas is discussed in greater detail below. This white paper is not a technical reference, but it is intended to provide database administrators (DBAs) and developers with an understanding of the depth of EnterpriseDB Advanced Server's compatibility with Oracle. Complete EnterpriseDB documentation and free downloads of EnterpriseDB Advanced Server are available at www.enterprisedb.com.

Introducing EnterpriseDB Advanced Server

EnterpriseDB is a stable, secure, and scalable enterprise-class relational database management system (RDBMS) that is built on the open source PostgreSQL database and compatible with many Oracle applications. While priced for open source environments and deployments, EnterpriseDB is a proprietary, reliable RDBMS suitable for high-volume, mission-critical enterprise use.

The EnterpriseDB product family consists of a comprehensive relational database management system suite that includes all the elements of an enterprise-class software solution. The EnterpriseDB product family consists of:

- **EnterpriseDB Advanced Server.** Based on the well-tested and industry-accepted PostgreSQL database, EnterpriseDB Database Server delivers solid Oracle compatibility, stability, and scalability.
- **DBA Management Server.** A single web-based interface for monitoring and administering EnterpriseDB databases.
- **Developer Studio.** A utility that enables developers and DBAs to manage EnterpriseDB and Oracle databases.
- **Migration Toolset.** An automated tool that moves Oracle schema, data, packages, functions, and procedures to EnterpriseDB.
- **EnterpriseDB Replication Server.** Replicates Oracle and EnterpriseDB database across the enterprise in near real-time to meet a wide array of business challenges.
- **EnterpriseDB Connectors.** Enable EnterpriseDB to be used with all the most popular programming languages and platforms.

SQL Compatibility

A fundamental building block of EnterpriseDB's Oracle database compatibility is its ability to recognize and appropriately execute database queries expressed in Oracle's SQL language. In addition, EnterpriseDB supports the same data types, functions, and variables as Oracle and fixes incompatibilities between Oracle's and PostgreSQL's treatment of column aliasing, public synonyms, sequences, and the DUAL table.

Oracle-Compatible Data Types

While the International Standards Organization defines a set of standard SQL data types, Oracle has extended the set to provide additional flexibility and functionality for developers. All Oracle data types have been mapped to those native in PostgreSQL to provide Oracle compatibility.

NOTE: *Because Oracle has had to maintain backward binary data type compatibility for so long, most data type mappings in EnterpriseDB provide additional options and flexibility.*

Data Type	Oracle Compatible	Additional Functionality
CHAR	x	See Note 1
VARCHAR	x	See Note 2
VARCHAR2	x	See Note 2
NUMBER	x	See Note 3
BLOB	x	
CLOB	x	
DATE	x	

Note 1: *In Oracle, the CHAR data type has an upper limit of 2000 bytes or characters, while the maximum size of CHAR in EnterpriseDB is 1GB (the actual number of characters which can be stored is based solely on database character set encoding).*

Note 2: *In Oracle, the VARCHAR and VARCHAR2 data types have an upper limit of 4000 bytes or characters, while the maximum size of these data types in EnterpriseDB is 1GB (the actual number of characters which can be stored is based solely on database character set encoding).*

Note 3: *In Oracle, the NUMBER data type is limited to 38 digits of precision, while the EnterpriseDB NUMBER implementation provides up to 1000 digits of precision.*

Oracle-Compatible Functions and Variables

EnterpriseDB supports the following SQL-callable functions and variables, which are popular with Oracle developers and DBAs:

Function/Variable Name	Oracle Compatible
TO_CHAR	x
TO_DATE	x
SYSDATE	x
ADD_MONTHS	x
CEIL	x
CHR	x
CONCAT	x
DECODE	x
FLOOR	x
GREATEST	x
INITCAP	x
INSTR	x
LAST_DAY	x
LENGTH	x
LOWER	x
LPAD	x
LTRIM	x

LEAST	x
MONTHS_BETWEEN	x
NEXT_DAY	x
NVL	x
NVL2	x
REPLACE	x
ROUND	x
RPAD	x
RTRIM	x
SUBSTR	x
SYSTIMESTAMP	x
TO_NUMBER	x
TRUNC	x
UPPER	x
USER	x

Oracle-Compatible Column Aliasing

Column aliasing is a SQL feature commonly used by both Oracle developers and report writers. Because PostgreSQL has long required the keyword “AS” when assigning column aliases in a select-list and Oracle does not, PostgreSQL has had incompatibilities with many SQL statements written for Oracle. EnterpriseDB Advanced Server has removed the requirement of the “AS” keyword, allowing Oracle SQL queries to run without error.

Oracle-Compatible Public Synonyms

EnterpriseDB supports PUBLIC SYNONYMS, alternate database-wide names for objects such as tables, views, and sequences.

Oracle-Compatible Sequences

While PostgreSQL implements sequences, it uses the functions CURRVAL(seq_name) and NEXTVAL(seq_name) to perform manipulations. This is incompatible with Oracle’s seq_name.CURRVAL and seq_name.NEXTVAL. To remedy this incompatibility, EnterpriseDB has extended PostgreSQL to support Oracle-compatible sequence manipulation syntax while keeping the current syntactical benefits of PostgreSQL.

With the exception of the ORDER clause, the CREATE SEQUENCE syntax used for defining sequences in Oracle will also work in EnterpriseDB Advanced Server. For example:

```
CREATE SEQUENCE empno_seq START WITH 1 INCREMENT BY 1;
```

An example of EnterpriseDB’s added benefits is the use of Oracle-compatible sequence manipulation syntax within the DEFAULT clause of a table definition for auto-numbering. By taking advantage of this feature, the need to manually create a BEFORE UPDATE trigger for auto-numbering (as is required by Oracle) has been eliminated.

For example:

```
CREATE TABLE emp (
        empno     NUMBER(10) NOT NULL
                  DEFAULT empno_seq.NEXTVAL,
        ename     VARCHAR2(32) NOT NULL
        ...
        PRIMARY KEY (empno));
```

The DUAL Table

As Oracle has always required a FROM clause to be present in SELECT statements, they created a table named DUAL which contains a single column named DUMMY and has been populated with a single row of value x. EnterpriseDB Advanced Server includes this table for SQL-statement compatibility with Oracle.

ROWNUM

ROWNUM is a pseudo column and it is called in many applications. ROWNUM numbers the records in a result set. The first record that meets the where criteria in a select statement is given ROWNUM=1, and every subsequent record meeting that same criteria increases ROWNUM. EnterpriseDB Advanced Server supports ROWNUM.

PL/SQL Compatibility

EnterpriseDB Advanced Server includes a procedural language called EnterpriseDB SPL that closely matches Oracle's PL/SQL procedural language. Like PL/SQL, SPL is a highly productive, block-structured procedural programming language for writing custom procedures, functions, and triggers. The close similarity between EnterpriseDB's SPL and Oracle's PL/SQL also enables EnterpriseDB to support Oracle-style packages of procedures, functions and variables.

Block Structure

As in PL/SQL, SPL procedures, functions, and triggers have the same block structure. A block consists of up to three sections - an optional declaration section, a mandatory executable section, and an optional exception section. Minimally, a block has an executable section that consists of one or more procedural statements within the keywords BEGIN and END.

Oracle Built-In Packages

EnterpriseDB supports the most used packages that are built into the Oracle database. A package is a construct for building reusable code and employing object-oriented design techniques. A package is a collection of related database objects identified by a common package name in the database. These database objects include procedures, functions, and variables. Oracle has built-in packages which are often called by existing applications and used by developers to simplify programming.

Packages

In addition to the built-in packages, EnterpriseDB also supports Oracle-style custom packages.

As in Oracle, an EnterpriseDB package consists of two main components:

- **Package Specification.** This is the public interface containing the public procedures, functions, and variables that can be referenced outside the package by other programs and applications.
- **Package Body.** This contains the implementation logic of procedures and functions declared in the package specification as well as the declaration and logic of private variables, procedures, and functions that cannot be accessed by other programs and applications external to the package.

Procedures

Procedures in EnterpriseDB SPL work as they do in Oracle PL/SQL. Procedures are programs that are invoked or called as an individual program statement. When called, procedures may optionally receive values from the caller in the form of input parameters and optionally return values to the caller in the form of output parameters. A procedure is stored in the database by executing a script containing the procedure definition on an EnterpriseDB Database Server. Then, the procedure may be invoked from another program.

Functions

Functions in EnterpriseDB SPL work as they do in Oracle PL/SQL. Functions are programs that are invoked as expressions. When evaluated, a function returns a value that is substituted in the expression in which the function is embedded. Functions may optionally take values from the calling program in the form of input parameters. In addition to a function's returning a value, it may optionally return additional values to the caller in the form of output parameters. The use of output parameters in functions, however, is not an encouraged programming practice. A function can be used anywhere that an expression can appear within a statement.

Triggers

Triggers in EnterpriseDB SPL work as they do in Oracle PL/SQL. A trigger is a block of code that is given a name, associated with a table, and stored in the database. When certain events occur on the table, the code block is executed. The trigger is said to be "fired" when the code block is executed.

Like Oracle, EnterpriseDB supports both row-level and statement-level triggers. A row-level trigger fires once for each row that is affected by a triggering event. In contrast, a statement-level trigger fires once per triggering statement, regardless of the number of rows affected by the triggering event.

As in Oracle, trigger code blocks may be executed by EnterpriseDB Advanced Server before or after the triggering statement in the case of statement-level triggers and before or after each row is affected in the case of row-level triggers.

Hierarchical Queries

EnterpriseDB Advanced Server supports hierarchical queries as in Oracle. Hierarchical queries allow for querying parent/child relationships within a single table. EnterpriseDB supports the most used operators for hierarchical queries.

Anonymous Blocks

A block of procedural code can simply be executed in EnterpriseDB as in Oracle. A code block of this type is called an anonymous block. An anonymous block is unnamed and is not stored in the database. Once the block has been executed and erased from the application buffer, it cannot be re-executed unless the block code is re-entered into the application. Anonymous blocks are useful for quick, one-time programs, such as testing programs.

Data Dictionary Views

EnterpriseDB Advanced Server provides views into its data dictionary that resemble the most commonly used views into Oracle's data dictionary. These views allow database administrators and developers familiar with Oracle to look up dictionary information quickly without having to relearn a new data dictionary format.

ALL and USER Views

By providing Oracle-compatible ALL and USER catalog views, developers and DBAs can quickly and easily access database metadata through a familiar interface that requires no additional training to use.

View Name
ALL_OBJECTS
ALL_SOURCE
ALL_SYNONYMS
ALL_TABLES
ALL_TAB_COLUMNS
ALL_USERS
ALL_VIEWS
ALL_VIEW_COLUMNS
DBA_ROLES
DBA_ROLE_PRIVS
USER_OBJECTS
USER_SOURCE
ADD_MONTHS
USER_SYNONYMS
USER_TABLES
USER_TAB_COLUMNS
USER_VIEWS
USER_VIEW_COLUMNS

Programming Flexibility and Drivers

EnterpriseDB Advanced Server supports the most popular programming languages used to develop Oracle database applications.

In addition to the publicly available database connectors listed below, EnterpriseDB Advanced Server also provides interoperability and compatibility with the Oracle Call Interface (OCI). EnterpriseDB Advanced Server includes the Open Client Library (OCL) enabling applications based on OCI to run unchanged.

Programming Language	Supported Drivers
C	x
C++	x
JDBC	x
ODBC	x
Perl	x
PHP	x
Ruby	x
.NET	x

Transfer Tools

EnterpriseDB provides advanced, easy-to-use tools that automate the transfer of an entire Oracle database environment to EnterpriseDB. These graphical tools allow users to browse Oracle and EnterpriseDB databases and automatically migrate:

- Data
- Schema
- Stored Procedures
- Functions
- Triggers
- Views
- Sequences
- Packages
- Constraints
- Indexes

Once the data and business logic have been transferred, EnterpriseDB Advanced Server is ready to run an enterprise's existing Oracle applications. For customers looking to standardize on Oracle-based technology, EnterpriseDB Advanced Server also provides browsing and one-click migration of the data and schema for Microsoft SQL Server™, MySQL™, and Sybase™.

Database Replication

EnterpriseDB Replication Server replicates data in Oracle and EnterpriseDB databases across an enterprise in near real-time to meet a wide array of business challenges. Data can be replicated across distant geographies, complex enterprise data infrastructures, and heterogeneous operating platforms, including Linux, Solaris, Windows, and HP-UX.

EnterpriseDB Replication Server enables enterprises to:

- Run reporting and other applications in Oracle environments at a fraction of Oracle's cost
- Ensure availability and seamless disaster recovery of critical database services
- Speed performance of Oracle and EnterpriseDB databases
- Transfer data across heterogeneous data sources while ensuring transactional integrity
- Migrate to updated or upgraded versions of EnterpriseDB Advanced Server with virtually no database downtime or risk to data

Enterprise-Class Reliability and Scalability

Oracle databases are routinely used for high-volume, mission-critical applications. As EnterpriseDB has inherited the legendary reliability of the open source PostgreSQL database and significantly enhanced the performance of PostgreSQL, even these applications may be safely transferred to EnterpriseDB. EnterpriseDB has added the following features to PostgreSQL to enhance its reliability and scalability:

Point in Time Recovery (PITR)

EnterpriseDB continuously maintains a Write Ahead Log (WAL), which, similar to Oracle REDO logs, contains every change made to the database's data files. In the event of a crash, EnterpriseDB can replay these changes in the form of roll-forward database recovery. As a result, EnterpriseDB can perform the following types of PITR:

- **Recovery to the point in time of a backup.** EnterpriseDB can recover all WAL changes up to the last committed transaction found in the backup logs.
- **Recovery to an arbitrary point in time.** EnterpriseDB can recover the WAL changes up to an arbitrary point in time from the last backup, as defined by a transaction identifier or timestamp.
- **Log-shipping and Disaster Recovery.** By transferring WAL files to remote systems, EnterpriseDB can be brought back up and running in the event of a hardware crash or disaster situation.

Performance

A database that is suitable for enterprise applications must be highly scalable: Simply put, it needs to be really fast, both in high-volume transactional environments and when working with massive amounts of data. EnterpriseDB has made significant enhancements to PostgreSQL to accommodate high-volume enterprise environments.

Performance enhancements include:

- **Online Transaction Processing (OLTP).** In addition to supporting row-level locking and table partitioning EnterpriseDB contains several internal optimizations for scalability in high-volume OLTP environments.
- **Dynamic Tuning.** By analyzing the hardware it's running on, EnterpriseDB can determine its own configuration settings, reducing the need for both initial and ongoing tuning.
- **Bulk Loading.** When moving large amounts of data from mainframes or other databases into EnterpriseDB, the time it takes to insert hundreds, thousands, or millions of rows is essential. EnterpriseDB bulk loads are up to 12% faster than PostgreSQL's bulk loads.

Oracle-Like Tools

EnterpriseDB Advanced Server includes a robust set of integrated tools that enable developers and database administrators to create, deploy, monitor and tune EnterpriseDB databases and applications. These tools have a look, feel, and operation that will be immediately familiar to Oracle DBAs and developers, enabling them to work comfortably with the tools with no additional training. A comprehensive set of tools is provided to facilitate the professional management of an EnterpriseDB database environment.

EnterpriseDB Developer Studio

Developer Studio is an enterprise-class, cross-platform tool that includes:

- **PL/SQL Debugger.** EnterpriseDB's Procedural Language Debugger facilitates the development and analysis of stored procedures, functions, and triggers in applications written for Oracle and EnterpriseDB databases. The Procedural Language Debugger uniquely allows users to monitor and step through stored procedures and functions as they are called from applications.
- **Oracle Database Browser.** The Browser enables a user to browse Oracle databases at the same time as browsing EnterpriseDB and PostgreSQL databases.
- **EnterpriseDB Migration Toolset.** The Database Transfer Toolkit provides one-click transfer of all tables, views, packages, constraints, triggers, procedures, functions, views, sequences, indexes, and data stored in an Oracle database to EnterpriseDB Advanced Server.

Embedded SQL Pre-Compiler (ECPG)

Embedded SQL is a method of combining the computing power of a high-level language, such as C or C++, with the database manipulation capabilities of SQL by allowing the execution of SQL statements from within an application program.

In EnterpriseDB, an embedded SQL program is compiled in two steps. The first step is to use ECPG, the embedded SQL pre-compiler for EnterpriseDB, to translate the SQL statements embedded in the program into appropriate calls to the database driver library. The output of ECPG is C or C++ code with all the application portions intact. This C or C++ code can then be compiled using a standard C or C++ compiler.

EnterpriseDB Network

- The EnterpriseDB Network provides customers with the confidence that their EnterpriseDB product suite contains the most up-to-date components available.
- **Product Updates**. EnterpriseDB Network subscribers automatically receive real-time notification and delivery of product releases, updates and patches. This not only saves DBAs the time and effort to search for updates, but also eliminates potential problems before they occur. All delivered software can be installed with only a few clicks, saving even more time and effort.

EnterpriseDB DBA Management Server

The EnterpriseDB DBA Management Server provides powerful database monitoring, profiling, reporting, and querying capabilities that enable DBAs and developers to analyze, manage, and tune multiple EnterpriseDB and PostgreSQL databases from a single Web interface. The tool includes the ability to monitor overall database performance, the ability to monitor database queries for speed and efficiency, and integration with the EnterpriseDB Network.

Conclusion

EnterpriseDB has included many features in EnterpriseDB Advanced Server that enable it to run most applications written for Oracle databases unchanged. These include the ability to execute Oracle's SQL and PL/SQL languages, the most common Oracle data dictionary views, an extensive suite of programming language drivers and connectors including the Oracle Call Interface (OCI), automated data and business logic transfer tools, an Oracle database replication server, enterprise-class reliability and scalability, and a robust set of integrated tools with a look, feel, and operation immediately familiar to Oracle professionals.

Downloading EnterpriseDB

More information and free downloads of EnterpriseDB Advanced Server are available on the EnterpriseDB website: **http://www.enterprisedb.com/**

About EnterpriseDB

EnterpriseDB develops and supports EnterpriseDB Advanced Server, the world's leading Oracle-compatible relational database management system (RDBMS). EnterpriseDB Advanced Server runs most applications written for Oracle unchanged at a fraction of Oracle's cost. Built on PostgreSQL, the world's most advanced open source database, EnterpriseDB Advanced Server has the reliability and scalability necessary for high-volume, mission-critical enterprise use. EnterpriseDB has offices throughout the world, including North America, Europe, and Asia. The company also provides PostgreSQL support and is the world's leading provider of enterprise-class, PostgreSQL-based products and services. EnterpriseDB was founded in March 2004, and is headquartered in Iselin, N.J. For more information about EnterpriseDB and free downloads of EnterpriseDB Advanced Server, please contact +1-732-331-1300 or visit www.enterprisedb.com.

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