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# PHP Scalability and High Availability

## Database Resident Connection Pooling and Fast Application Notification

ORACLE

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# INTRODUCTION

PHP is a popular dynamic programming language for web applications. It comes with extensions providing a wide range of capabilities. The OCI8 extension[1] included in PHP allows applications to connect to Oracle Database. It has support for advanced Oracle Database features, allowing easy and efficient use of SQL and PL/SQL.

This paper describes how PHP's OCI8 extension can use:

- Oracle Database 11*g* Database Resident Connection Pooling (DRCP)
- Oracle Database 10*g*R2 or 11*g* Fast Application Notification (FAN)

The Oracle features are usable separately or together. PHP 5.3 OCI8 has immediate support for them. Older PHP versions can have the OCI8 extension upgraded.

With DRCP, Oracle Database 11*g* has a connection pooling solution usable by PHP's multi-process architecture where Oracle's traditional middle-tier connection pools are not applicable.

Without pooling, PHP's “standard” connections cause frequent creation and destruction costs that can be expensive and crippling to high scalability of the middle tier and database. Also PHP's “persistent” connections remove connection creation and destruction costs but do not achieve optimal connection resource utilization, incurring unnecessary memory overhead in the database. DRCP solves these issues. Database web applications can now be highly scalable.

In addition, PHP OCI8 can exploit advanced Oracle RAC (Oracle's Real Application Clusters) features for high availability and scalability. Without this a database instance or machine failure could cause an application hang until a network timeout occurred and there would be no proactive cleanup of cached connections to failed instances.

The FAN support in OCI8 allows PHP database applications to be resilient.

Whether these features are used together, separately, or even not used at all, PHP’s OCI8 is an efficient and reliable extension for building database applications. The latest extension can be built with PHP 4 and PHP 5, and will compile with Oracle 9*i*R2, 10*g* and 11*g* client libraries. Oracle’s standard cross-version compatibility between database clients and the server is applicable.

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[1] PHP’s OCI8 extension gets its name from Oracle Database’s OCI8 C language API. PHP OCI8 gives PHP scripts a higher abstraction of database functionality than the OCI8 C API.

# CONNECTION POOLING WITH DRCP

## What is Database Resident Connection Pooling?

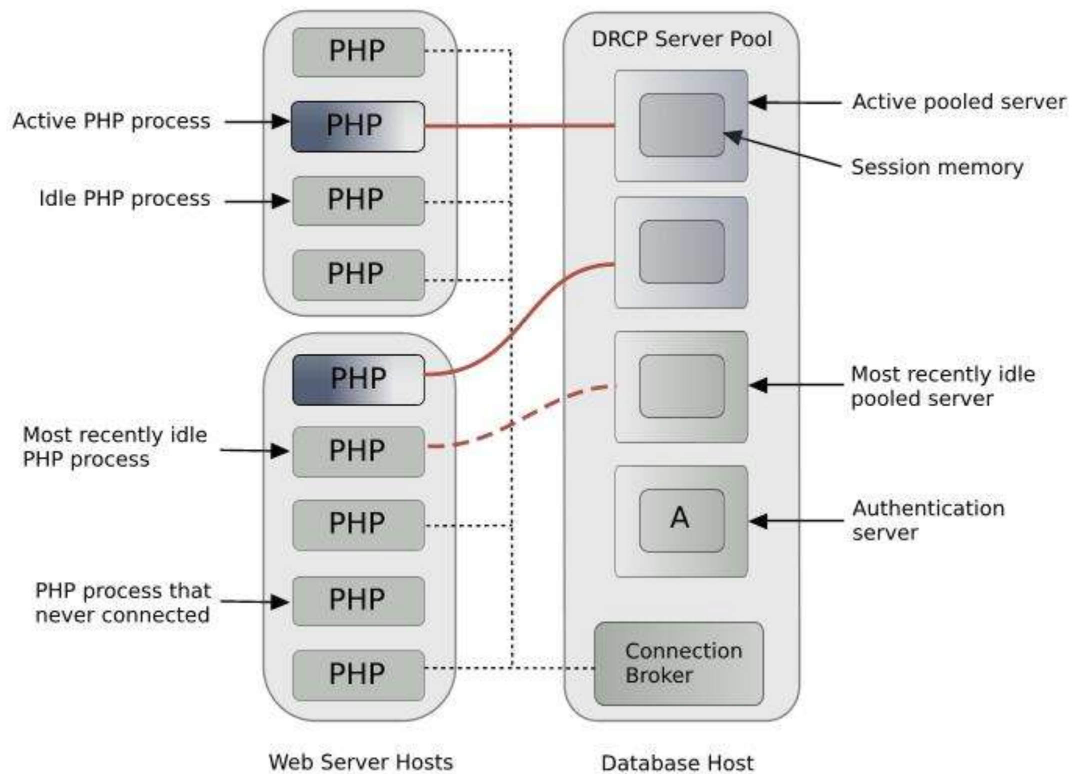
DRCP is a new feature of Oracle Database 11*g* that addresses scalability requirements in environments requiring large numbers of connections with minimal database resource usage. DRCP pools a set of dedicated database server processes (known as *pooled servers*), which can be shared across multiple applications running on the same or several hosts. A connection broker process manages the pooled servers at the database instance level. DRCP is a configurable feature chosen at program runtime, allowing traditional and DRCP-based connection architectures to be in concurrent use.

### How DRCP Works

The architecture of DRCP is shown in Figure 1. A connection broker accepts incoming connection requests from PHP processes (e.g. web server processes handling PHP requests) and assigns each a free server in the pool. Each PHP process that is executing a PHP script communicates with this Oracle server until the connection is released. This happens automatically at the end of the script, or the connection can be explicitly released. When the connection is released, the server process is returned to the pool and the PHP process keeps a link only to the connection broker. Active pooled servers contain the Process Global Area (PGA) and the user session data. Idle servers in the pool retain the user session for reuse by subsequent persistent PHP connections.

When the number of persistent connections is less than the number of pooled servers, a "dedicated optimization" avoids unnecessarily returning servers to the pool when a PHP connection is closed. Instead, the dedicated association between the PHP process and the server is kept in anticipation that the PHP process will quickly become active again. If PHP scripts are executed by numerous web servers, the DRCP pool can grow to its maximum size (albeit typically a relatively small size) even if the rate of incoming user requests is low. Each PHP process, either busy or now idle, will be attached to its own pooled server. When the pool reaches its maximum size, a script that is handled by a PHP process without a pooled server will cause an idle server to be returned to the pool for immediate reuse.

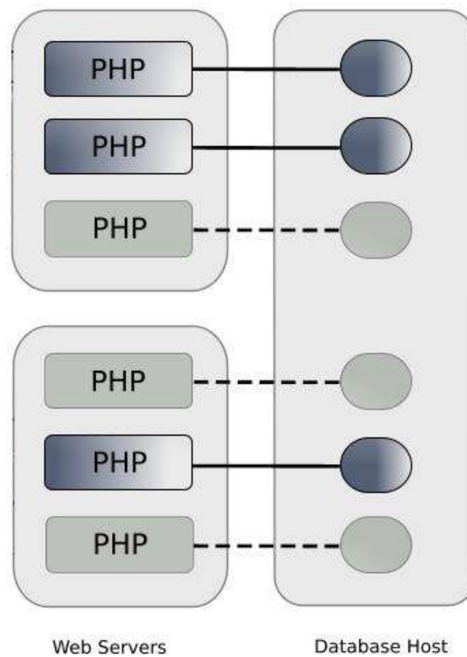
*Figure 1. DRCP Architecture.*




The pool size and number of connection brokers are configurable. There is always at least one connection broker per database instance when DRCP is enabled. Also, at any time, around 5% of the current pooled servers are reserved for authenticating new PHP connections. Authentication is performed when a PHP process establishes a connection to the connection broker. DRCP boosts the scalability of the database and the web server tier because connections to the database are held at minimal cost. Database memory is only used by the pooled servers, and scaling can be explicitly controlled by DRCP tuning options.

Without DRCP, each PHP process creates and destroys database servers when connections are opened and closed. Or alternatively, each process keeps connections open ("persistent connections") even when they are not processing any user scripts. This consumes database resources, shown in Figure 2.

*Figure 2. Without DRCP, idle persistent connections from PHP still consume database resources.*




With the introduction of pooled servers used by DRCP, there are now three types of database server process models that Oracle applications can use: dedicated servers, shared servers and pooled servers.

*Table 1. Differences between dedicated servers, shared servers, and pooled servers for oci_connect() calls.*[2]

| **Dedicated Servers** | **Shared Servers** | **Pooled Servers** |
|---|---|---|
| When the PHP connection is created, a network connection to a dedicated server process and associated session are created | When the PHP connection is created, a network connection to the dispatcher process is established. A session is created in the SGA | When the PHP connection is created, a network connection to the connection broker is established |
| Activity on a connection is handled by the dedicated server | Each action on a connection goes through the dispatcher, which hands the work to a shared server | Activity on a connection wakes the broker, which hands the network connection to a pooled server process. The server then handles subsequent requests directly, just like a dedicated server |

[2] See Table 2 for the differences between connection types.

| Dedicated Servers | Shared Servers | Pooled Servers |
|---|---|---|
| Scripts executing but with idle PHP connections hold a server process and session resources | Scripts executing but with idle PHP connections hold session resources but not a server process | Scripts executing but with idle PHP connections hold a server process and session resources |
| Closing a PHP connection causes the session to be freed and the server process to be terminated | Closing a PHP connection causes the session to be freed | Closing a PHP connection causes the session to be destroyed and the pooled server to be released to the pool. A network connection to the connection broker is retained |
| Memory usage is proportional to the number of server processes and sessions. There is one server and one session for each PHP connection | Memory usage is proportional to the sum of the shared servers and sessions. There is one session for each PHP connection | Memory usage is proportional to the number of pooled server processes and their sessions. There is one session for each pooled server |

Pooled servers in use by PHP are similar in behavior to dedicated servers. After connection, PHP directly communicates with the pooled server for all database operations.

### PHP OCI8 Connections and DRCP

The PHP OCI8 extension has three functions for connecting to a database: `oci_connect()`, `oci_new_connect()`, and `oci_pconnect()`. The implementation of these functions was reworked in OCI8 1.3 and all benefit from using DRCP. Table 2 compares dedicated and pooled servers. Shared servers are similar to dedicated servers with the exception that only the session and not the server is destroyed when a connection is closed.

*Table 2. Behavior of OCI8 connection functions for Dedicated and Pooled Servers.*

| OCI8 Function | Dedicated Servers | Pooled Servers |
|---|---|---|
| `oci_connect()` | Creates a PHP connection to the database using a dedicated server. The connection is cached in the PHP process for reuse by subsequent `oci_connect()` calls in the same script. At the end of the script or with `oci_close()`, the connection is closed and the server process and session are destroyed | Gets a pooled server from the DRCP pool and creates a brand new session. Subsequent `oci_connect()` calls in the same script use the same connection. Upon end of the script or with `oci_close()`, the session is destroyed and the pooled server is available for other PHP connections to use |

| OCI8 Function | Dedicated Servers | Pooled Servers |
|---|---|---|
| `oci_new_connect()` | Similar to `oci_connect()` above, but an independent new PHP connection and server process is created each time this function is called, even within the same script. All PHP connections and the database servers are closed when the script ends or with `oci_close()`. Sessions are destroyed at that time | Similar to `oci_connect()` above, but an independent server in the pool is used and a new session is created each time this function is called in the same script. All sessions are destroyed at the end of the script or with `oci_close()`. The pooled servers are made available for other connections to use |
| `oci_pconnect()` | Creates a persistent PHP connection which is cached in the PHP process. The database connection is not closed at the end of the script. When no script is executing, an idle PHP process still holds the server process and session resource. The server and session are available for reuse by subsequent `oci_pconnect()` calls that pass the same credentials in any script handled by this PHP process | Creates a persistent PHP connection. Calling `oci_close()` releases the connection and returns the server with its session intact to the pool for reuse by other PHP processes. If `oci_close()` is not called, the connection release happens at the end of the script. When no script is executing, an idle PHP process retains only an authenticated network connection to the broker. Subsequent `oci_pconnect() calls` passing the same credentials in scripts handled by this PHP process reuse the existing network connection to quickly get a server and session from the pool |

With DRCP, all three connection functions save on the cost of authentication and benefit from the network connection to the connection broker being maintained, even for connections that are "closed" from PHP's point of view. They also benefit from having pre-spawned server processes in the DRCP pool.

The `oci_pconnect()` function reuses sessions, allowing even greater scalability. The non-persistent connection functions create and destroy new sessions each time they are used, allowing less sharing at the cost of reduced performance.

Overall, after a brief warm-up period for the pool, DRCP allows reduced connection times in addition to the reuse benefits of pooling.

### When to use DRCP

DRCP is typically preferred for applications with a large number of connections. Shared servers are useful for a medium number of connections and dedicated sessions are preferred for small numbers of connections. The threshold sizes are relative to the amount of memory available on the database host.

DRCP provides the following advantages:

- It enables resource sharing among multiple client applications and middle-tier application servers.
- It improves scalability of databases and applications by reducing resource usage on the database host.

DRCP can be used if:

- PHP applications mostly use the same database credentials for all connections.
- The applications acquire a database connection, work on it for a relatively short duration, and then release it.
- Connections look identical in terms of session settings, for example date format settings and PL/SQL package state.

These are all typically true for PHP applications.

For persistent PHP connections, dedicated servers can be fastest. There is no broker or dispatcher overhead. The server is always connected and available whenever the PHP process needs it. But as the number of connections increases, the memory cost of keeping connections open quickly reduces efficiency of the database system.

For non-persistent PHP connections, DRCP can be fastest because the use of pooled server processes removes the need for PHP connections to create and destroy processes, and removes the need to re-authenticate for each connect call.

Consider an application in which the memory required for each session is 400 KB. On a 32 bit operating system the memory required for each server process could be 4 MB, and DRCP could use 35 KB per connection (mostly in the connection broker). If the number of pooled servers is configured at 100, the number of shared servers is configured at 100, and the deployed application creates 5000 PHP connections, then the memory used by each type of server is estimated in Table 3.

*Table 3. Example database host memory use for dedicated, shared and pooled servers.*

| | **Dedicated Servers** | **Shared Servers** | **Pooled Servers** |
|---|---|---|---|
| **Database Server Memory** | 5000 * 4 MB | 100 * 4 MB | 100 * 4 MB |
| **Session Memory** | 5000 * 400 KB | 5000 * 400 KB<br>Note: For Shared Servers, session memory is allocated from the SGA | 100 * 400 KB |
| **DRCP Connection Broker Overhead** | | | 5000 * 35 KB |
| **Total Memory** | **21 GB** | **2.3 GB** | **610 MB** |

There is a significant memory saving when using DRCP.

Even if sufficient memory is available to run in dedicated mode, DRCP can still be a viable option if the PHP application needs database connections for only short periods of time. In this case the memory saved by using DRCP can be used towards increasing the SGA, thereby improving overall performance.

Pooling is available when connecting over TCP/IP with user ID/password based database authentication. It is not available using Oracle's bequeath connections.

With Oracle Database 11*g* Release 2, pooled connections can take advantage of Oracle's "Client Result Cache" feature.

### Sharing the Server Pool

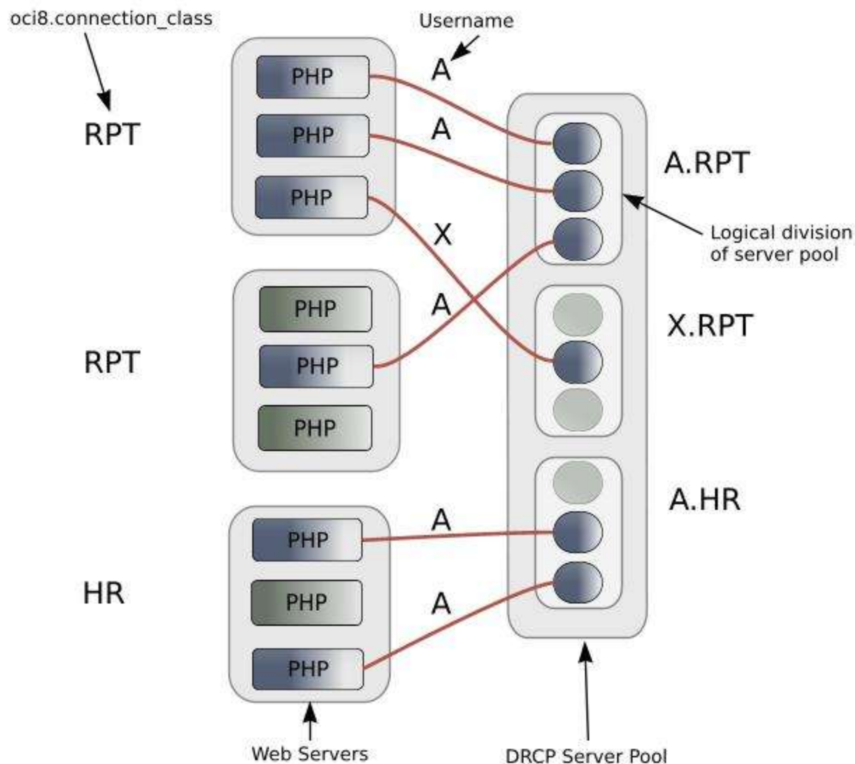
DRCP guarantees that sessions in pooled servers initially used by one database user are only ever reusable by connections with that same user identifier. DRCP also further partitions the pool into logical groups or "connection classes". A connection class is a user-chosen name set in the `php.ini` configuration file.

Session-specific attributes, like the date format or an explicit role, may be re-usable by any connection in a particular application. Subsequent persistent connections will reuse the session and inherit those settings if the user name and connection class are the same as the previous connection.

Applications that need different state in the sessions should use different user names and/or connection classes.

For example, applications in a suite called RPT may be willing to share pooled servers between themselves but not with an application suite called HR. The different connection classes and resulting logical partitioning of the DRCP server pool is shown in Figure 3. Connections with the same user name and connection class from any host will share the same sub-pool of servers.

*Figure 3. The DRCP pool is logically partitioned by user name and connection class.*



If there are no free pooled servers matching a request for a user ID in the specified connection class, and if the pool is already at its maximum size, then an idle server in the pool will be used and a new session created for it. If the server originally belonged to a different connection class, the current session will be destroyed and the server will migrate to the new class and get a newly created session. If there are no pooled servers available, the connection request waits for one to become available. This allows the database to continue without becoming overloaded.

The connection class should be set to the same value for each instance of PHP running the same application where sharing of pooled connections is desired. If no connection class is specified, each web server process will have a unique, system generated class name, limiting sharing of connections to each process.

If DRCP is used but session sharing is not desirable under any condition, use `oci_connect()` or `oci_new_connect()` which recreate the session each time.

Although session data may be reused by subsequent persistent connections, transactions do not span connections across scripts. Uncommitted data will be rolled back at the end of a PHP script.

## Using DRCP in PHP

Using DRCP with PHP applications involves the following steps:

1) Configuring and enabling the pool
2) Configuring PHP
3) Deploying the application

PHP applications deployed as Apache modules, FastCGI, CGI and standalone applications can benefit from DRCP. PHP applications deployed as Apache modules or with FastCGI gain most, since they remain connected to the connection broker over multiple script executions and can also take advantage of other optimizations, such as statement caching.

### Configuring and Enabling the Pool

Every instance of Oracle Database 11*g* uses a single, default connection pool. User defined pools are currently not supported. The default pool can be configured and administered by a DBA using the `DBMS_CONNECTION_POOL` package:

```
SQL> execute dbms_connection_pool.configure_pool(
            pool_name => 'SYS_DEFAULT_CONNECTION_POOL',
            minsize                 => 4,
            maxsize                 => 40,
            incrsize                => 2,
            session_cached_cursors  => 20,
            inactivity_timeout      => 300,
            max_think_time          => 600,
            max_use_session         => 500000,
            max_lifetime_session    => 86400);
```

Alternatively the method dbms_connection_pool.alter_param() can be used to set a single parameter:

```
SQL> execute dbms_connection_pool.alter_param(
            pool_name => 'SYS_DEFAULT_CONNECTION_POOL',
            param_name  => 'MAX_THINK_TIME',
            param_value => '1200');
```

There is a dbms_connection_pool.restore_defaults() procedure to reset all values.

When DRCP is used with RAC, each database instance has its own connection broker and pool of servers. Each pool has the identical configuration. For example all pools will start with minsize server processes. A single dbms_connection_pool command will alter the pool of each instance at the same time.

The pool needs to be started before connection requests begin. The command below does this by bringing up the broker, which registers with the database listener:

```
SQL> execute dbms_connection_pool.start_pool();
```

Once enabled this way, the pool automatically restarts when the instance restarts, unless explicitly stopped with the command:

```
SQL> execute dbms_connection_pool.stop_pool();
```

The DRCP configuration options are described in Table 4.

*Table 4. DRCP Configuration Options.*

| DRCP Option | Description |
|---|---|
| pool_name | The pool to be configured. Currently the only supported name is the default value SYS_DEFAULT_CONNECTION_POOL |
| minsize | Minimum number of pooled servers in the pool. The default is 4 |
| maxsize | Maximum number of pooled servers in the pool. If this limit is reached and all the pooled servers are busy, then connection requests wait until a server becomes free. The default is 40 |
| incrsize | The number of pooled servers is increased by this value when servers are unavailable for PHP connections and if the pool is not yet at its maximum size. The default is 2 |
| session_cached_cursors | Indicates to turn on SESSION_CACHED_CURSORS for all connections in the pool. This value is typically set to the size of the working set of frequently used statements. The cache uses cursor resources on the server. The default is 20. Note: there is also an init.ora parameter for setting the value for the whole database instance. The pool option allows a DRCP-based application to override the instance setting. |

| DRCP Option | Description |
| --- | --- |
| `inactivity_timeout` | Time to live for an idle server in the pool. If a server remains idle in the pool for this time, it is killed. This parameter helps to shrink the pool when it is not used to its maximum capacity. The default is 300 seconds |
| `max_think_time` | Maximum time of inactivity the PHP script is allowed after connecting. If the script does not issue a database call for this amount of time, the pooled server may be returned to the pool for reuse. The PHP script will get an `ORA` error if it later tries to use the connection. The default is 120 seconds |
| `max_use_session` | Maximum number of times a server can be taken and released to the pool before it is flagged for restarting. The default is 500000 |
| `max_lifetime_session` | Time to live for a pooled server before it is restarted. The default is 86400 seconds |
| `num_cbrok` | The number of connection brokers that are created to handle connection requests. This can only be set with `alter_param()`. The default is 1 |
| `maxconn_cbrok` | The maximum number of connections that each connection broker can handle. Set the per-process file descriptor limit of the operating system sufficiently high so that it supports the number of connections specified. This can only be set with `alter_param()`. The default is 40000 |

Note: the parameters have been described here relative to their use in PHP but it is worth remembering that the DRCP pool is usable concurrently by other applications, including those using Perl's DBD::Oracle and Python's cx_Oracle extensions.

In general, if pool parameters are changed, the pool should be restarted, otherwise server processes will continue to use old settings.

The `inactivity_timeout` setting terminates idle pooled servers, helping optimize database resources. To avoid pooled servers permanently being held onto by a dead web server process or a selfish PHP script, the `max_think_time` parameter can be set. The parameters `num_cbrok` and `maxconn_cbrok` can be used to distribute the persistent connections from the clients across multiple brokers. This may be needed in cases where the operating system per-process descriptor limit is small.

Some customers have found that having several connection brokers improves performance.

The `max_use_session` and `max_lifetime_session` parameters help protect against any unforeseen problems affecting server processes. The default values will be suitable for most users.

Users of Oracle 11.1.0.6 must apply the database patch for bug 6474441 to avoid query errors. It also enables LOGON trigger support. The bug is fixed in the Oracle 11.1.0.7 patch set and in Oracle 11.2.

### Configuring PHP for DRCP

PHP must be built with the OCI8 1.3 or later extension. PHP 5.3 contains OCI8 1.4. For PHP 5.2 and older versions of PHP, download the latest release of OCI8 from PECL, extract it and use it to replace the existing `ext/oci8` directory in PHP. Rebuild the `configure` script. Then configure, build and install PHP as normal. Alternatively use the `pecl install` command to automatically download and install OCI8 as a shared module.

The OCI8 1.4 extension can be used with Oracle client libraries version 9.2 and higher, however DRCP functionality is only available when PHP is linked with Oracle 11*g* client libraries and connects to Oracle Database 11*g*.

Once installed, use PHP's `phpinfo()` function to verify that OCI8 has been loaded.

Before using DRCP, the new `php.ini` parameter `oci8.connection_class` should be set to specify the connection class used by all the requests for pooled servers by the PHP application.

```
oci8.connection_class = MYPHPAPP
```

The parameter can be set in `php.ini`, `.htaccess` or `httpd.conf` files. It can also be set and retrieved programmatically using the PHP functions `ini_set()` and `ini_get()`.

The OCI8 extension has several legacy `php.ini` configuration parameters for tuning persistent connections. These were mainly used to limit idle resource usage. With DRCP, the parameters still have an effect but it may be easier to use the DRCP pool configuration options.

*Table 5. Existing php.ini parameters for persistent connections.*

| **php.ini Parameter** | **Behavior with DRCP** |
|---|---|
| `oci8.persistent_timeout` | At the timeout of an idle PHP connection, PHP will close the Oracle connection to the broker. |
| `oci8.max_persistent` | The maximum number of unique persistent connections that each PHP process will maintain to the broker. When the limit is reached a new persistent connection behaves like `oci_connect()` and releases the connection at the end of the script. Note: the DRCP `maxsize` setting will still be enforced by the database independently from `oci8.max_persistent` |
| `oci8.ping_interval` | From OCI8 1.3 onwards, `oci8.ping_interval` is also used for non-persistent connections when DRCP is used. |

With `oci8.ping_interval` the existing recommendation to set it to -1 thereby disabling pinging, and to use appropriate error checking still holds true. Also, the use of FAN (see later) reduces the chance of idle connections becoming unusable.

Web servers and the network should benefit from `oci8.statement_cache_size` being set. For best performance it should generally be larger than the size of the working set of SQL statements. To tune it,

monitor general web server load and the Oracle AWR "bytes sent via SQL*Net to client" values. The latter statistic should benefit from not shipping statement meta-data to PHP. Adjust the statement cache size to your satisfaction.

Once you are happy with the statement cache size, then tune the DRCP pool `session_cached_cursors` value. Monitor AWR reports with the goal to make the "session cursor cache hits" close to the number of soft parses. Soft parses can be calculated from "parse count (total)" minus "parse count (hard)".

### Application Deployment for DRCP

PHP applications must specify the server type POOLED in the connect string to use DRCP. Using Oracle's Easy Connect syntax, the PHP call to connect to the `sales` database on `myhost` would look like:

```
$c = oci_pconnect('myuser', 'mypassword', 'myhost/sales:POOLED');
```

or if PHP uses an Oracle Network alias that looks like:

```
$c = oci_pconnect('myuser', 'mypassword', 'salespool');
```

then only the Oracle Network configuration file `tnsnames.ora` needs to be modified:

```
salespool=(DESCRIPTION=(ADDRESS=(PROTOCOL=tcp)
        (HOST=myhost.dom.com)
        (PORT=1521))(CONNECT_DATA=(SERVICE_NAME=sales)
        (SERVER=POOLED)))
```

If these changes are made and the database is not actually configured for DRCP, connections will not succeed and an error will be returned to PHP.

#### Closing Connections

PHP scripts that do not currently use `oci_close()` should be examined to see if they can use it to explicitly return connections to the pool, allowing maximum use of pooled servers:

```
// 1. Do some database operations
$conn = oci_pconnect('myuser', 'mypassword', 'myhost/sales:POOLED');
. . .
oci_commit($conn);
oci_close($conn);  // Release the connection to the DRCP pool


// 2. Do lots of non-database work
. . .

// 3. Do some more database operations
$conn = oci_pconnect('myuser', 'mypassword', 'myhost/sales:POOLED');
. . .
oci_commit($conn);
oci_close($conn);
```

Prior to OCI8 1.3, closing `oci_connect()` and `oci_new_connect()` connections had an effect but closing an `oci_pconnect()` connection was a no-op. Now, with the latest version of the extension, `oci_close()` on a persistent connection rolls back any uncommitted transaction. Also the extension will do a rollback when all PHP variables referencing a persistent connection go out of scope, for example if the connection was opened in a function and the function has now finished. For DRCP, in addition to the rollback, the connection is also released; a subsequent `oci_pconnect()` may get a different connection. For DRCP, the benefit is that scripts taking advantage of persistent connections can explicitly return a server to the pool when non-database processing occurs, allowing other concurrent scripts to make use of the pooled server.

With pooled servers, the recommendation is to release the connection when the script does a significant amount of processing that is not database related. Explicitly control commits and rollbacks so there is no unexpectedly open transaction when the close or end-of-scope occurs. Scripts coded like this can use `oci_close()` to take advantage of DRCP but still be portable to older versions of the OCI8 extension.

If behavior where `oci_close()` is a no-op for all connection types is needed, set the existing `php.ini` parameter `oci8.old_oci_close_semantics` to `On`.

#### Transactions Across Re-connection

Scripts should avoid re-opening connections if there are incomplete transactions:

```
// 1. Do some database operations
$conn = oci_pconnect('myuser','mypassword','salespool');

// Start a transaction
$s = oci_parse($conn, 'insert into mytab values (1)');
$r = oci_execute($s, OCI_NO_AUTO_COMMIT); // no commit

. . .

// BAD: no commit or rollback done

// 2. Continue database operations on same credentials
$conn = oci_pconnect('myuser','mypassword','salespool');

$s = oci_parse($conn, 'insert into mytab values (2)');
$r = oci_execute($s, OCI_NO_AUTO_COMMIT); // no commit

// Rollback or commit both 1 & 2
if (!$r)
  oci_rollback($conn);
else
  oci_commit($conn);
```

If there was a node or network failure just prior to point 2, the first transaction could be lost. The second connection command may return a new, valid connection if a ping (see `oci8.ping_interval`) occurs to validate the connection, and the script might not be aware of a problem.

The script should do an explicit commit or rollback before the second connect, or simply continue to use the original connection and do appropriate error handling.

### LOGON and LOGOFF Triggers with DRCP

LOGON triggers are useful for setting session attributes needed by each PHP connection. For example a trigger could be used to execute an ALTER SESSION statement to set a date format. The LOGON trigger will execute when `oci_pconnect()` first creates the session, and the session will be reused by subsequent persistent connections. Scripts save time by no longer always executing code to set the date format.

The suggested practice is to use LOGON triggers only for setting session attributes and not for executing per PHP-connection logic such as custom logon auditing. This recommendation is also true for persistent connections with dedicated or shared servers.

Database actions that must be performed exactly once per OCI8 connection call should be explicitly executed in the PHP script.

From Oracle 11*g*R2 onwards, LOGOFF triggers fire for pooled servers when sessions are terminated. For `oci_connect()` and `oci_new_connect()` connections this is with `oci_close()` or at the end of the script. For `oci_pconnect()` connections, it can happen when the pooled server process naturally terminates or its session needs to be recreated.

It is not possible to depend on triggers for tracking PHP OCI8 connect calls. The caching, pooling, timing out and recreation of sessions and connections with or without DRCP or the new extension can distort any record. With pooled servers, LOGON triggers can fire at authentication and when the session is created, in effect firing twice for the initial connection.

### Changing Passwords with DRCP Connections

In general, PHP applications that change passwords should avoid using `oci_pconnect()`. This call will use the old password to match an open connection in PHP's persistent connection cache without requiring re-authentication to the database with the new password. This can cause confusion over which password to connect with. With DRCP there is a further limitation - connections cannot be used to change passwords programmatically. PHP scripts that use `oci_password_change()` should continue to use dedicated or shared servers.

## Monitoring DRCP

Data dictionary views are available to monitor the performance of DRCP. Database administrators can check statistics such as the number of busy and free servers, and the number of hits and misses in the pool against the total number of requests from clients. The views are:

```
DBA_CPOOL_INFO
V$PROCESS
V$SESSION
V$CPOOL_STATS
V$CPOOL_CC_STATS
V$CPOOL_CONN_INFO
```

For RAC, there are GV$CPOOL_STATS, GV$CPOOL_CC_STATS and GV$CPOOL_CONN_INFO views corresponding to the instance-level views. These record DRCP statistics across clustered instances. If a database instance in a cluster is shut down, the statistics for that instance are purged from the GV$ views.

The DRCP statistics are reset each time the pool is started.

### DBA_CPOOL_INFO View

DBA_CPOOL_INFO displays configuration information about all DRCP pools in the database. The columns are equivalent to the dbms_connection_pool.configure_pool() settings described in Table 4, with the addition of a STATUS column. The status is ACTIVE if the pool has been started and INACTIVE otherwise. Note the pool name column is called CONNECTION_POOL.

This example checks whether the pool has been started and finds the maximum number of pooled servers:

```
SQL> select connection_pool, status, maxsize
     from dba_cpool_info;

CONNECTION_POOL              STATUS              MAXSIZE
---------------------------- ---------------- ----------
SYS_DEFAULT_CONNECTION_POOL  ACTIVE                   40
```

In Oracle 11*g*R2, DBA_CPOOL_INFO adds NUM_CBROK and MAXCONN_CBROK columns, equivalent to the pool configuration options of the same names. In Oracle 11*g*R*1* the number of configured brokers per instance can be found from the V$PROCESS view, for example on Linux:

```
SQL> select program
     from v$process
     where program like 'oracle%(N%)';

PROGRAM
------------------------------------------------
oracle@localhost (N001)
```

### V$PROCESS and V$SESSION Views

The V$SESSION view will show information about the currently active DRCP sessions. It can also be joined with V$PROCESS via V$SESSION.PADDR = V$PROCESS.ADDR to correlate the views.

### V$CPOOL_STATS View

V$CPOOL_STATS displays information about the DRCP statistics for an instance.

*Table 6. V$CPOOL_STATS View.*

| Column | Description |
|---|---|
| POOL_NAME | Name of the Database Resident Connection Pool |
| NUM_OPEN_SERVERS | Total number of busy and free servers in the pool (including the authentication servers) |
| NUM_BUSY_SERVERS | Total number of busy servers in the pool (not including the authentication servers) |
| NUM_AUTH_SERVERS | Number of authentication servers in the pool |
| NUM_REQUESTS | Number of client requests |
| NUM_HITS | Total number of times client requests found matching pooled servers and sessions in the pool |
| NUM_MISSES | Total number of times client requests could not find a matching pooled server and session in the pool |
| NUM_WAITS | Total number of client requests that had to wait due to non-availability of free pooled servers |
| WAIT_TIME | Reserved for future use |
| CLIENT_REQ_TIMEOUTS | Reserved for future use |
| NUM_AUTHENTICATIONS | Total number of authentications of clients done by the pool |
| NUM_PURGED | Total number of sessions purged by the pool |
| HISTORIC_MAX | Maximum size that the pool has ever reached. With PHP this is likely to reach the maximum pool size value. |

The V$CPOOL_STATS view can be used to assess how efficient the pool settings are. The example query below shows an application using the pool effectively. The low number of misses indicates that servers and sessions were reused. The wait count shows just over 1% of requests had to wait for a pooled server to become available:

```
SQL> select num_requests, num_hits, num_misses, num_waits
     from v$cpool_stats;

NUM_REQUESTS   NUM_HITS NUM_MISSES  NUM_WAITS
------------ ---------- ---------- ----------
      100031      99993         38       1054
```

If oci8.connection_class is set (allowing pooled servers and sessions to be reused) then NUM_MISSES is low. If the pool maxsize is too small for the connection load then NUM_WAITS is high:

```
NUM_REQUESTS   NUM_HITS NUM_MISSES  NUM_WAITS
------------ ---------- ---------- ----------
       50352      50348          4      50149
```

Tune the pool size by monitoring the NUM_WAITS trend. If the value is high then increase the number of pooled servers.

If the connection class is left unset, the sharing of pooled servers is restricted to within each web server process. Even if the pool size is large, session sharing is limited causing poor utilization of pooled servers and contention for them:

```
NUM_REQUESTS   NUM_HITS NUM_MISSES  NUM_WAITS
------------ ---------- ---------- ----------
       64152      17941      46211      15118
```

### V$CPOOL_CC_STATS View

V$CPOOL_CC_STATS displays information about the connection class level statistics for the pool per instance. The columns are similar to those of V$CPOOL_STATS described in Table 6, with a CCLASS_NAME column giving the name of the connection sub-pool the results are for:

```
SQL> select cclass_name, num_requests, num_hits, num_misses
     from v$cpool_cc_stats;

CCLASS_NAME          NUM_REQUESTS   NUM_HITS NUM_MISSES
-------------------- ------------ ---------- ----------
HR.MYPHPAPP                100031      99993         38
SCOTT.SHARED                   10          0         10
HR.OCI:SP:SdjxIx1Ufz            1          0          1
```

For PHP, the CCLASS_NAME value is composed of the value of the user name and of the oci8.connection_class value used by the connecting PHP processes. This view shows an application known as MYPHPAPP using the pool effectively.

The last line of the example output shows a system generated class name for an application that did not explicitly set oci8.connection_class. Pooling would not be effectively used in this case. Such an entry could be an indication that a php.ini file is mis-configured.

For programs like SQL*Plus that were not built using Oracle's session pooling APIs, the class name will be SHARED. The example shows that ten such connections were made as the user SCOTT. Although these programs share the same connection class, new sessions are created for each connection, keeping each cleanly isolated from any unwanted session changes. This is similar to using PHP's oci_connect() with DRCP pooled servers.

### V$CPOOL_CONN_INFO View

This view gives insight into client processes that are connected to the connection broker, making it easier to monitor and trace applications that are currently using pooled servers or are idle.

This view was introduced in Oracle 11*g*R2.

*Table 7: V$CPOOL_CONN_INFO View.*

| Column | Description |
|---|---|
| `CMON_ADDR` | Address of the connection broker |
| `SESSION_ADDR` | Address of the session associated with the connection. NULL if there is no active session. Can be joined with `V$SESSION.SADDR` |
| `CONNECTION_ADDR` | Address of the connection |
| `USERNAME` | Name of the user associated with the connection |
| `PROXY_USER` | Name of the proxy user |
| `CCLASS_NAME` | Connection class associated with the connection |
| `PURITY` | Will be `SELF` for `oci_pconnect()` calls or `NEW` otherwise |
| `TAG` | Not set by PHP |
| `SERVICE` | TNS service name for the connection |
| `PROCESS_ID` | Process ID of the PHP or Apache process |
| `PROGRAM` | Program name of the PHP or Apache process |
| `MACHINE` | Machine name where PHP is running |
| `TERMINAL` | Terminal identifier of the PHP process that created the connection |
| `CONNECTION_MODE` | Reserved for internal use |
| `CONNECTION_STATUS` | Status of the connection: `NONE`, `CONNECTING`, `ACTIVE`, `WAITING`, `IDLE` |

## DRCP SCALABILITY BENCHMARK

DRCP performance was measured using the PHP OCI8 1.3.2 Beta extension. The impressive results are shown below.

The test consisted of Apache servers concurrently executing PHP scripts that connected to a single database instance and performed queries. The PHP application included a call to `oci_pconnect()` (i.e. requesting a pooled server), execution of a SELECT statement, and a call to `oci_close()`. After completing the database operations, each script slept for one second (simulating the "think time" of a user).

The workload was generated using Apache's `ab` benchmark tool to send requests to the Apache servers to execute the PHP scripts. At steady state, each Apache server had 20 persistent connections to the database. Three Intel P4/Xeon machines running 32bit Enterprise Linux were used to host the Apache servers and to run `ab`.

A single database instance was hosted on a dual CPU Intel P4/Xeon 3.00GHz computer with 2GB RAM. The operating system was 32bit Enterprise Linux. The operating system file descriptor limit was set at 35000. Oracle 11*g* Release 1 (patched for bug 6474441) was used for the client and database software. The DRCP pool was configured with one connection broker and 100 pooled servers. DRCP's `MAXCONN_CBROK` parameter was 35000. The CPU and memory utilizations were captured using the `vmstat` command. The throughput was captured using Oracle AWR reporting.

The results show throughput scaled linearly as the number of incoming connections grew and that the memory required for the connections was minimal, again proportionate to the number of connections. Very large numbers of connections can easily be supported by commodity hardware.

*Figure 4. Throughput and CPU Usage with DRCP.*

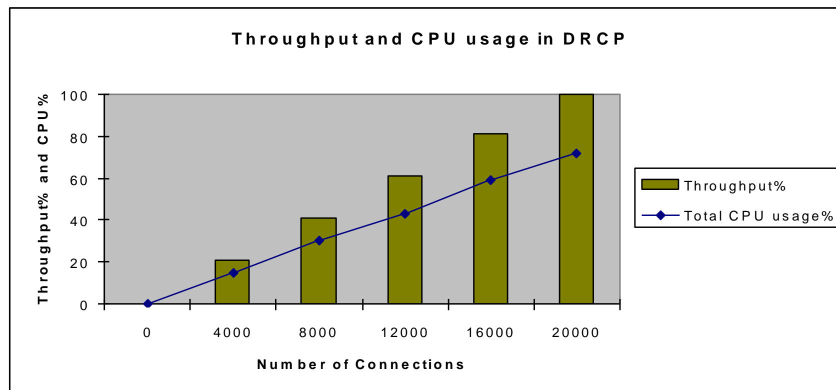
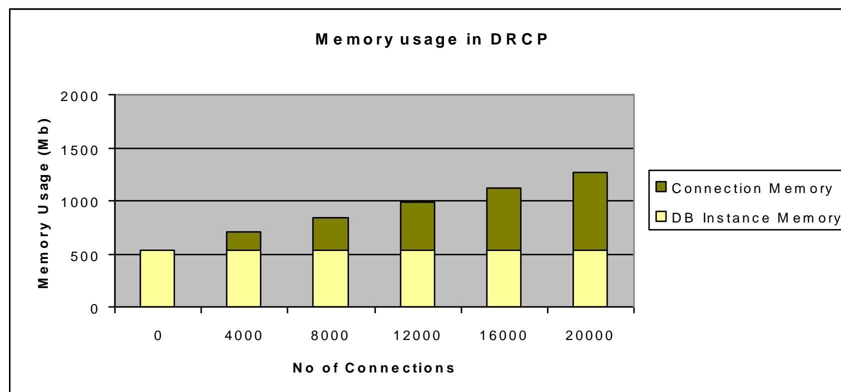



*Figure 5. Memory Utilization with DRCP.*



# HIGH AVAILABILITY WITH FAN AND RAC

Clients that run in high availability configurations such as with Oracle RAC or Data Guard Physical Stand-By can take advantage of Fast Application Notification (FAN) events to allow applications to respond quickly to database node failures. FAN support in PHP may be used with or without DRCP – the two features are independent.

Without FAN, when a database instance or machine node fails unexpectedly, PHP applications may be blocked waiting for a database response until a TCP timeout expires. Errors are therefore delayed, sometimes up to several minutes, by which time the application may have exceeded PHP's maximum allowed execution time.

By leveraging FAN events, PHP applications are quickly notified of failures that affect their established database connections. Connections to a failed database instance are proactively terminated without waiting for a potentially lengthy TCP timeout. This allows PHP scripts to recover quickly from a node or network failure. The application can reconnect and continue processing without the user being aware of a problem.

Also, all inactive network connections cached in PHP to the connection broker in case of DRCP, and persistent connections to the server processes or dispatcher in case of dedicated or shared server connections on the failed instances, are automatically cleaned up.

A subsequent PHP connection call will create a new connection to a surviving RAC node, activated stand-by database, or even the restarted single-instance database.

## Configuring FAN Events in the Database

To get the benefit of high availability, the database service to which applications connect must be enabled to post FAN events. For example, to enable events on the service `SALES` in an Oracle 11*g*R2 database `SALESDB`:

```
$ srvctl modify service -d SALESDB -s SALES -q TRUE
```

The `-q` option indicates that AQ high availability events should be enabled.

## Configuring PHP for FAN

With the enhanced OCI8 extension, a `php.ini` configuration parameter `oci8.events` allows PHP to be notified of FAN events:

```
oci8.events = On
```

FAN support is only available when PHP is linked with Oracle 10*g*R2 or 11*g* libraries and connecting to Oracle Database 10*g*R2 or 11*g*. Review the patches for Oracle bugs 7143299 (fixed in Oracle 11.2.0.1) and 8670389 (fixed in 11.2.0.2) to improve login times in various conditions when using `oci8.events`.

## Application Deployment for FAN

The error codes returned to PHP will generally be the same as without FAN enabled, so application error handling can remain unchanged.

Alternatively, applications can be enhanced to reconnect and retry actions, taking advantage of the higher level of service given by FAN.

As an example, the code below does some work (perhaps a series of update statements). If there is a connection failure, it reconnects, checks the transaction state and retries the work. The OCI8 extension will detect the connection failure and be able reconnect on request, but the user script must also determine that work failed, why it failed, and be able to continue that work. The example code detects connections errors so it can identify whether to continue or retry work. It is generally important not to redo operations that already committed updated data.

Typical errors returned after an instance failure are “ORA-12153: TNS:not connected” or “ORA-03113: end-of-file on communication channel”. Other connection related errors are shown in the example, but errors including standard database errors may be returned, depending on timing.

```
function isConnectionError($err)
{
  switch($err) {
    case   378: /* buffer pool param incorrect */
    case   602: /* core dump */
    case   603: /* fatal error */
    case   609: /* attach failed */
    case  1012: /* not logged in */
    case  1033: /* init or shutdown in progress */
    case  1043: /* Oracle not available */
    case  1089: /* immediate shutdown in progress */
    case  1090: /* shutdown in progress */
    case  1092: /* instance terminated */
    case  3113: /* disconnect */
    case  3114: /* not connected */
    case  3122: /* closing window */
    case  3135: /* lost contact */
    case 12153: /* TNS: not connected */
    case 27146: /* fatal or instance terminated */
    case 28511: /* Lost RPC */
    return true;
  }
  return false;
}

$conn = doConnect();
$err = doSomeWork($conn);
if (isConnectionError($err)) {
  // reconnect, find what was committed, and retry
  $conn = doConnect();
  $err = checkApplicationStateAndContinueWork($conn);
}
if ($err) {
  // end the application
  handleError($err);
}
```

## RAC Connection Load Balancing with PHP

PHP OCI8 onwards will automatically balance connections across RAC instances with Oracle's Connection Load Balancing (CLB) to use resources efficiently. The balancing happens at the first connect for each set of credentials in a PHP process. The same RAC instance will then be used for the life of the PHP process.

It is recommended to use FAN and CLB together.

No PHP script changes are needed to use CLB. The connection balancing is handled transparently by the Oracle Net listener. To enable CLB, the database service must be modified to send load events to the listener. In Oracle 11gR2 use the `-j SHORT` or `-j LONG` options to `srvctl`. For example:

```
$ srvctl modify service -d SALESDB -s SALES -j LONG
```

*Table 8. CLB goal parameter values.*

| Parameter Value | Parameter Description |
|---|---|
| `SHORT` | Use for the connection load balancing method in applications that have short-lived connections such as created by `oci_connect()` in quick scripts. This uses CPU-based statistics to distribute connections. |
| `LONG` | Use for applications that have long-lived connections such as created by `oci_pconnect()`. This uses a simple session-based metric to distribute connections. |

# CONCLUSION

The PHP OCI8 extension has been enhanced to take advantage of Oracle Database Resident Connection Pooling, and of Fast Application Notification. These features can be used together or separately. DRCP allows PHP applications to use a connection pool in the database that is shared across web servers. Applications can establish connections quickly and will use minimal database resources for large numbers of connections. FAN support allows PHP applications to quickly detect database instance or hardware failures without blocking on a TCP timeout. Applications can use another RAC node or an activated standby database to continue database processing, minimizing user exposure to the failure.

# MORE INFORMATION

For information about PHP and the OCI8 extension see:

- The PHP Developer Center on Oracle Technology Network
  http://otn.oracle.com/php
- The Underground PHP and Oracle Manual
  http://www.oracle.com/technetwork/topics/php/underground-php-oracle-manual-098250.html
- PHP OCI8 extension
  http://pecl.php.net/package/oci8
  Refer to the Changelog for up-to-date information. The OCI8 extension is also included in the full PHP source code.

For information on DRCP see:

- Oracle Database Concepts
  http://download.oracle.com/docs/cd/E11882_01/server.112/e16508/toc.htm
- Oracle Database Administrator's Guide
  http://download.oracle.com/docs/cd/E11882_01/server.112/e17120/toc.htm
- Oracle Call Interface Programmer's Guide
  http://download.oracle.com/docs/cd/E11882_01/appdev.112/e10646/toc.htm
- Oracle Database PL/SQL Packages and Types Reference
  http://download.oracle.com/docs/cd/E11882_01/appdev.112/e16760/toc.htm
- Database Resident Connection Pooling (DRCP) Oracle Database 11*g* Technical White Paper
  http://www.oracle.com/technetwork/articles/oracledrcp11g-1-133381.pdf

For information on FAN and RAC see:

Oracle Real Application Clusters Administration and Deployment Guide
http://download.oracle.com/docs/cd/E11882_01/rac.112/e16795/toc.htm

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Oracle Corporation
World Headquarters
500 Oracle Parkway
Redwood Shores, CA 94065
U.S.A.

Worldwide Inquiries:
Phone: +1.650.506.7000
Fax: +1.650.506.7200

oracle.com

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Hardware and Software, Engineered to Work Together