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RMOUG Call for Nominations to the Board of Directors

The Rocky Mountain Oracle Users Group continues to be the leading locally organized user group in the country. The success of RMOUG can be attributed to its members, the volunteers who support the activities of the users group, and the Board of Directors who provides direction for the users group. The RMOUG bylaws require the regular election of the Board of Directors. These bylaws (available online at http://rmoug.org/bylaws.htm#membership) outline the makeup and duties of the Board of Directors:

- The range of the number of the Directors shall be an odd number between five and fifteen.
- The management, control, and government of the Corporation (RMOUG) shall be vested in the Board of Directors.
- The Board of Directors shall preserve, protect, and promote the interests of the Corporation and will be responsible for formulating the general policy of the Corporation in accordance with the expressions of the members.

Note: Current general policies for the users group can be found online at http://www.rmoug.org/policies.htm. It is time to begin the process by opening the call for Board Candidates for the fiscal year starting 01-June 2011 and running through 31-May 2012. To run for the Board of Directors, you must:

- Be a RMOUG member in good standing;
- Be able to participate in scheduled Board meetings (approximately 1 per month)
- Be willing and able to uphold the bylaws and policies of the organization
- Have an e-mail address
- You must have actively participated as a volunteer on one or more RMOUG committee(s) or event(s), and have spent at least one year a volunteer-at-large for the board or the RMOUG information systems group,

If you are interested in running for the Board of Directors, please prepare and submit a short campaign statement and biographical sketch. You should outline your reasons for running for the Board of Directors and your qualifications. If you are not a current member of the Board of Directors, you must list the event(s) or committee(s) on which you have participated and the name of a current Board member as a reference. Please limit your statement to approximately one page. Campaign statements must be submitted no later than April 15, 2012 by email to the current RMOUG President at president@rmoug.org. If you have any questions about the process or would like to see a sample statement, please email president@rmoug.org

Tim Gorman, RMOUG President
On the Cover:
Early autumn at Buckskin Pass (elevation 12,462 ft), submitted by Roger Baer. This is a 2-3 hour hike from Maroon Lake between Aspen and Snowmass Wilderness. In the distant view is Snowmass Mountain (elevation 14,092) and Snowmass Lake. About 8 feet away was a family of Rocky Mountain goats, the leader of which is shown here. If you were to look to the left, you would see, Maroon Peak (elevation 14,156) and North Maroon Peak (elevation 14,014) less than 2 miles away. What a “buena vista”.

A special Thank You to Heidi Kuhn, Tim Gorman and Kellyn Pot’vin, without whose continuing help, this publication would not be possible.
Training Days 2012 has concluded, and a huge thanks to everyone who volunteered their time and effort to make it such a success...

- RMOUG Training Days director John Jeunnette, who gave the conference his leadership and provided cohesion throughout the year-long preparation for the conference. John’s confidence and optimism were the anchor for the entire effort, and now that he has delivered an almost-perfect conference, John is retiring from RMOUG as he and his family have moved to New Hampshire. Thank you so much, John! Best wishes and please don’t be a stranger!

- Kathleen, Veronica, Heather, Wendy, Lindsey, and Karen from our conference coordinators, TeamYCC.com. RMOUG and TeamYCC have been working together on the Training Days conference for 15 years now, and they have always done an amazing job making everything perfect for the RMOUG community. RMOUG couldn’t put on one of the most highly-regarded Oracle users group conferences in the world without the wise and wonderful women of TeamYCC.

- RMOUG Past President Peggy King, who did a fantastic job contributing her formidable skills and vast experience to advise and clarify, as well as organize our registration volunteers, our room ambassadors, and our airport greeters.

- The registration volunteers are your friends and colleagues who staff the registration booths and provide assistance during the conference.

- The room ambassadors are the wonderful volunteers who help each speaker get started and help collect speaker evaluation forms.

- The airport greeters are the generous souls who volunteer to meet-n-greet out-of-town speakers as they arrive at the airport and transport them to where they need to go in Denver. RMOUG is known in the worldwide Oracle community for this touch of personal hospitality, and greeters also have the opportunity to privately socialize and chat with the speakers.

- Platinum sponsor DatAvail (www.DatAvail.com), whose generosity and enthusiasm made so much of the conference happen.

- Gold sponsors DBA Knowledge (www.DBAKnow.com), Centroid (www.Centroid.com), and Oracle Corporation (www.Oracle.com), whose generosity sponsored the breakfasts and the cocktail reception during the conference.

- Over 33 Oracle ACE and Oracle ACE Directors who participated in the Topic Tables at lunch on Wednesday, and presented a good portion of the 144 presentations during the conference. I can’t be certain, but there have not been so many Oracle ACEs and Oracle ACE Directors at *any* other conference anywhere in the world, except for Oracle Open World.

- Oracle Tech Network (OTN.oracle.com), whose free “Developer Day” on the Tuesday prior to the conference dovetailed nicely with the Training Days conference. We hope to work with the skilled and accomplished folks from OTN at next year’s Training Days conference.

- ...and where would we be without Ms. Heidi Kuhn? If any one person represents RMOUG and all that is excellent about this organization, then it is surely Heidi, our executive director since Alan Greenspan used the phrase “irrational exuberance” in describing the US economy — that sure seems like a long time ago, doesn’t it? Effective, efficient, pleasant, and endlessly inventive, Heidi keeps this organization running through big projects and small. Thank you, Heidi!

Speaking of next year’s Training Days 2013 conference, it will once again be held at the Colorado Convention Center in downtown Denver, but the dates will be Monday - Wednesday, 11-13 February 2013. Please notice that this is Monday through Wednesday, not Tuesday through Thursday as in previous years. Mostly this shift in dates was simply what was offered by the convention center, but also has the fortunate side-effect of *not* coinciding with Valentine’s Day 2013. Yes friends, RMOUG does love you.

Please put Monday-Wednesday 11-13 February 2013 on your calendar now, and please think about taking the plunge and doing a presentation next year? The “Call For Abstracts” for next year’s conference will begin this coming August, so watch for the upcoming RMOUG email announcements, Facebook postings to the RMOUG group page, the LinkedIn RMOUG group page, and the #RMOUG and #RMOUG13 hashtags on Twitter.

Also, be on the lookout for more varied content from RMOUG over the next year, including more information about MySQL, Enterprise Manager 12c Cloud Control, E-Business Suites, Primavera, Hyperion/OBIEE, SPARC servers, Solaris, and many of the other technologies into which Oracle has expanded.

One final note...

You may have noticed that RMOUG has a new website. Our static HTML-based website has been retired in favor of a more modern one based on Wordpress. Take a look, let us know what you think, and if you’re interested, please use our new application forms to volunteer your creativity and energy at RMOUG! We need new members on the board of directors, we need expertise to help with the new website, and we certainly need people to help us with our award-winning newsletter, our quarterly educational workshops, our DLab “meetups” in association with Regis University, next year’s Training Days conference, and all of the activities RMOUG does.

Please join us! We need your energy and ideas!

Tim
RMOUG Training Days 2012
A Roaring Success!

Training Days 2012, February 14-16, 2012, was one of the best conferences RMOUG has put on. We had over 800 attendees this year at the Colorado Convention Center to

• attend over 160 technical sessions,
• attend one of five RMOUG University Day sessions,
• attend the Oracle Technology Network Developer Day,
• hear a great opening keynote by Cary Millsap,
• learn about the products from over twenty-five companies in the exhibit hall,
• eat breakfast, lunch, and reception fare,
• network with old friends and colleagues,
• meet new friends and colleagues, and
• dance the night away (oops, that was somewhere else...).

Thanks to all our volunteers, speakers, exhibitors, sponsors, and the conference committee for many hours of hard work to pull it all together.

We are already planning for next year so keep space open in your schedules for the middle of February, 2013 to do it all again.

John Jeunnette
2012 Training Days Conference Chair.

John Jeunnette, smiling as always.

Photos by Heidi Kuhn

Many Thanks to our Sponsors!
Apex 4, LDAP And Active Directory
Integrating The Technologies

by Debra Addeo, Douglas County School District

INTRODUCTION
This paper will give a high level overview of LDAP (Lightweight Directory Access Protocol) and Active Directory. Then it will apply these principles to Apex. It will outline a method for an Apex application to use the authorization from Active Directory.

WHAT IS LDAP?
LDAP (Lightweight Directory Access Protocol) is an Internet protocol that programs use to look up information from a server. LDAP is a protocol like FTP (File Transfer Protocol). FTP and LDAP can be used to send information.

As a protocol, LDAP does not define how programs work on either the client or server side. It defines the “language” used for client programs to talk to servers (and servers to servers, too) and access information in a directory also known as an LDAP directory. The client can be any software that can issue the LDAP commands. Using LDAP, data will be retrieved from (or stored in) the correct location within our information directory.

One of the benefits of an LDAP directory is that it can be accessed from almost any computing platform, from any one of the increasing number of readily available, LDAP-aware applications. It's also easy to customize internal applications to add LDAP support.

The LDAP protocol is both cross-platform and standards-based, so applications needn't worry about the type of server hosting the directory. In fact, LDAP is finding much wider industry acceptance because of its status as an Internet standard. Companies are willing to write LDAP integration into their products because they don't have to worry about what's at the other end.

An LDAP directory is particularly useful for storing information that you wish to read from many locations, but update infrequently. For example, all of the following could be stored very efficiently in an LDAP directory:

- The company employee phone book and organizational chart
- External customer contact information
- Infrastructure services information, including NIS maps, email aliases, and so on
- Configuration information for distributed software packages
- Public certificates and security keys

WHAT IS ACTIVE DIRECTORY?
Active Directory (AD) is an implementation of LDAP directory services by Microsoft for use primarily in Windows environments. Its main purpose is to provide central authentication and authorization services for Windows based computers. Active Directory also allows administrators to assign policies, deploy software, and apply critical updates to an organization. Active Directory stores information and settings in a central repository.

Active Directory is a directory service used to store information about the network resources across a domain. A Windows Server domain or Windows NT Domain is a logical group of computers running versions of the Microsoft Windows operating system that share a central directory database.

An Active Directory (AD) structure is a hierarchical framework of objects. The objects fall into three broad categories: resources (e.g. printers), services (e.g. email) and users (user accounts and groups). AD provides information on the objects, organizes the objects, controls access and sets security.

Each object represents a single entity — whether a user, a computer, a printer, or a group — and its attributes. Certain objects can also be containers of other objects. An object is uniquely identified by its name and has a set of attributes — the characteristics and information that the object can contain — defined by a schema, which also determines the kind of objects that can be stored in the AD.

Each attribute object can be used in several different schema class objects. These schema objects exist to allow the schema to be extended or modified when necessary. However, because each schema object is integral to the definition of AD objects, deactivating or changing these objects can have serious consequences because it will fundamentally change the structure of AD itself.

The framework that holds the objects is viewed at a number of levels. At the top of the structure is the forest - the collection of every object, its attributes and rules (attribute syntax) in the AD. The forest holds one or more transitive, trust-linked trees. A tree holds one or more Domain and domain trees, again linked in a transitive trust hierarchy. Domains are identified by their DNS name structure, the namespace.

The objects held within a domain can be grouped into containers called Organization Units (OUs). OUs give a domain a hierarchy, ease its administration, and can give a semblance of the structure of the AD's company in organizational or geographical terms. OUs can contain OUs - indeed, domains are containers in this sense - and can hold multiple nested OUs. Microsoft recommends as few domains as possible in AD and a reliance on OUs to produce structure and improve the implementation of policies and administration. The OU is the common level at which to apply
group policies, which are AD objects themselves called Group Policy Objects (GPOs), although policies can also be applied to domains or sites (see below). The OU is the level at which administrative powers are commonly delegated, but granular delegation can be performed on individual objects or attributes as well.

The actual division of the company’s information infrastructure into a hierarchy of one or more domains and top-level OUs is a key decision. Common models are by business unit, by geographical location, by IT Service, or by object type. These models are also often used in combination. OUs should be structured primarily to facilitate administrative delegation, and secondarily, to facilitate group policy application. Although OUs form an administrative boundary, the only true security boundary is the forest itself and an administrator of any domain in the forest must be trusted across all domains in the forest.

AUTHENTICATION AND AUTHORIZATION

AUTHENTICATION

Authentication is the process of verifying who a person is. This is done with a username and password. Just because someone has the correct username and password it does not mean that they should have full access to your system. This is where authentication comes into play. Active directory or any other method can be used to find out if the password and username are correct.

AUTHORIZATION

Authorization is the finding out if the person with the correct username and password are now authorized to access the application and the data within the application. This can be accomplished many different ways. One can check a group in Active Directory or there could be a simple list in a database table that allows access to the data in the application. An example of this would be where an application would check to see if someone had administrative privileges.

INTEGRATING THE TECHNOLOGIES

WHY WOULD I USE ACTIVE DIRECTORY AND LDAP?

Most database applications are accessed through two or three different methods. The first one would be to have a database account and be able to access the database directly. Using this method the database stores the encrypted password and handles the password expiration. Many web applications use one database username and password that is not available to the user but then contains a table with usernames and passwords. The application needs to keep the passwords secure and handle the password expiration. Also the application would need to know when users are no longer with the company and end permissions.

If a company is currently using Active Directory or any other LDAP based server a database application can then access the username and password on Active Directory for authentication. Using Active Directory the application does not need to keep usernames and passwords or handle the functions that need to be done for password and user maintenance. Depending on the group structure within Active Directory it could be used for the authorization or the exclusion of authorization for an application. The application would be free to concentrate on the other more important functionality.

DBMS_LDAP PACKAGE

Oracle has a package called dbms_ldap that allows the issuing of LDAP commands from the database. Apex uses this package with a wrapper to do the connections to LDAP. This package is shown mostly for troubleshooting problems with the connection from Apex.

This package can be used to verify a username and password. It can also be used to search the tree to see what groups the user is currently in or add, delete or modify a user. This presentation is only going to look at searching the tree for information and verifying passwords for users.

create or replace function chk_ad(in_connect_name IN VARCHAR2 DEFAULT NULL,
in_connect_pw IN VARCHAR2 DEFAULT NULL,
in_search_username IN VARCHAR2 DEFAULT NULL,
in_search_id in VARCHAR2 DEFAULT NULL) RETURN varchar2 IS

my_session DBMS_LDAP.session;
ldap_host VARCHAR2(256);
ldap_port VARCHAR2(256);
ldap_user VARCHAR2(256);
ldap_passwd VARCHAR2(256);

-- The following is the base of the search tree
ldap_base VARCHAR2(256) := 'dc=mycompany,dc=com';

my_attrs DBMS_LDAP.string_collection;
my_message DBMS_LDAP.message;
my_entry DBMS_LDAP.message;
entry_index PLS_INTEGER;
my_dn VARCHAR2(256);
my_attr_name VARCHAR2(256);
my_ber_elmt DBMS_LDAP.ber_element;
attr_index PLS_INTEGER;
i PLS_INTEGER;
my_vals DBMS_LDAP.STRING_COLLECTION;
v_username VARCHAR2(200);

BEGIN
retval := -1;
ldap_host := 'activedirectorymachine';
ldap_port := '389';
ldap_user := in_connect_name;
ldap_passwd := in_connect_pw;

DBMS_OUTPUT.PUT_LINE(RPAD('LDAP Port ',25,' ')) || ': ' || ldap_port);
DBMS_LDAP.USE_EXCEPTION := TRUE;
-- Connect to the server and get a session
my_session := DBMS_LDAP.init(ldap_host,ldap_port);
DBMS_OUTPUT.PUT_LINE (RPAD('LDAP session ',25,' ') || ': ' || RAWTOHEX(SUBSTR(my_session,1,8)) || '(returned from init)');

-- Bind to the server to authenticate the user. If all you need to do is to check the user then code could be finished after the bind.
```
retval := DBMS_LDAP.simple_bind_s(my_session, ldap_user, ldap_passwd);
DBMS_OUTPUT.PUT_LINE(RPAD('simple_bind_s Returns ','25,' ') || ': ' || TO_CHAR(retval));

-- If you need to search for attributes about the user then the code continues.
-- If the attribute is set to * then all attributes are retrieved. This is helpful in the case where you do not know the attribute name and need to find it.
--my_attrs(1) := '*';
-- Multiple attributes can be retrieved in one search
my_attrs(1) := 'uidNumber';
my_attrs(2) := 'userPrincipalName';

-- Perform the search. Finding the principal name may be part trial and error because one may or may not need the mycompany.com. It just depends on how AD is setup.
retval := DBMS_LDAP.search_s(my_session, ldap_base, DBMS_LDAP.SCOPE_SUBTREE,

'(userPrincipalName='||in_search_username||'@mycompany.com)',
my_attrs, 0,
my_message);
DBMS_OUTPUT.PUT_LINE(RPAD('> search_s Returns ','25,' ') || ': ' || TO_CHAR(retval));
DBMS_OUTPUT.PUT_LINE(RPAD('LDAP message  ',25,')  || ': ' || RAWTOHEX(SUBSTR(my_message,1,8)) || '(returned from search_s)');

-- count the number of entries returned.
retval := DBMS_LDAP.count_entries(my_session, my_message);
DBMS_OUTPUT.PUT_LINE(RPAD('> Number of Entries ','25,' ') || ': ' || TO_CHAR(retval));
DBMS_OUTPUT.PUT_LINE('+++++++++++++++++++++++++');

-- get the first entry.
my_entry := DBMS_LDAP.first_entry(my_session, my_message);
entry_index := 1;
END IF;

-- Loop through each of the entries one by one.
while my_entry IS NOT NULL loop

-- print the current entry.
my_dn := DBMS_LDAP.get_dn(my_session, my_entry);
DBMS_OUTPUT.PUT_LINE('  dn: ' || my_dn);
my_attr_name := DBMS_LDAP.first_attribute(my_session,my_entry,
my_ber_elmt);
attr_index := 1;
while my_attr_name IS NOT NULL loop
my_vals :=DBMS_LDAP.get_values (my_session,
my_entry,
my_attr_name);
if my_vals.COUNT > 0 then
FOR i in my_vals.FIRST..my_vals.LAST loop
DBMS_OUTPUT.PUT_LINE('           ' || my_attr_name|| to_char(i) || ' : ' ||
SUBSTR(my_vals(i),1,200));
END if;
my_attr_name := DBMS_LDAP.next_attribute(my_session,my_entry,
my_ber_elmt);
attr_index := attr_index+1;
end loop;
my_entry := DBMS_LDAP.next_entry(my_session,
my_entry);
end loop;
end loop;
```

```
-- Release the bind.
retval := dbms_ldap.unbind_s(my_session);
return v_username;
end;

AD can be indexed just like a database table. If there are speed issues with the above commands then ask the administrator to index the item that is being searched. It can make a large difference in the speed of the above commands.

**ADDING ACTIVE DIRECTORY TO APEX**

Open the application and go to shared components:

You will need to create an authentication scheme. Click on the create button and the next wizard will appear:

Choose based on a pre-configured scheme from the gallery.

Enter the name and the Scheme Type as LDAP Directory. Enter the LDAP information for the production instance. If the / does not work try the @ with the myco.com.

Once create is pressed this becomes the current authentication scheme. To change the current authentication scheme edit the authentication scheme using the pencil next to the list. The one that is current has the word current next to the name. It may be a bit difficult to see if there are multiple ones listed.

Then press the Make Current Scheme button.

You can now run the application using the user name and password from active directory.

**AUTHORIZATION**

Click on the Authorization Schemes to configure. (See figure on next page)

Authorization could be as simple as using a query from a table in the database or a PL/SQL function as shown below. It could be as complex as using the procedure from above to check the groups in Active Directory.
CONCLUSION

Active Directory (or any other LDAP based Directory) and LDAP can be used to handle the authorization and authentication for an application. This allows the application builder to handle application specific issues and not worry about the username and password functions that need to be performed by an application.

Debra Addeo works for Douglas County School District. She currently administers and develops the Identity Management system for the school district. The applications are based on Oracle’s fusion middleware software. She has over 20 years of experience with Oracle technologies solving business problems for many organizations both in the public and private sector. Her experience includes development, database administrator and application server administrator. Debra volunteers for RMOUG Training Days and is a former board member. She has also presented at RMOUG and IOUG.

Present Our DBLabs

Back in December of 2009, RMOUG and Regis University teamed up to start offering hands-on lab sessions on various topics. These events are open to the public (you do not have to be an RMOUG member), and they are a great way to learn new skills, get some hands-on experience in a lab environment, and network with other users and members! The meetings happen in one of the computer labs on the Regis campus in Denver, so each person gets their own workstation where they can do the labs. They are typically held on a weeknight evening, with food and drinks provided, so you can just show up, have some dinner, learn some new skills and meet new people!

Past topics have included OEM, Oracle on Linux, RMAN, Oracle database security, and Oracle automatic SQL tuning features. And we’ve had some well-known RMOUG “masters” as presenters, including Darl Kuhn and Tim Gorman. Future topics being planned include MySQL, OEM11g and more. And we are always open to new presenters and topics. So if you’d be interested in running a future lab session, feel free to contact Brad Blake at SigsDir@rmoug.org.

To stay up-to-date and informed on upcoming sessions, be sure to join the group here:

http://www.meetup.com/RMOUGLabs/

Also, be sure to “friend” us on Facebook to get updates on the labs, as well as other RMOUG events:

http://www.facebook.com/RMOUG

You can also follow us on Twitter @RMOUG_ORG

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Training Days Remembered

John King enjoys reuniting with old friends at the Presenter and Volunteer Reception

Kevin Courtney with Nathan Roseman and Don Seiler

Don Seiler, Pythian

Brad Blake and Joe Boncha chat during the break

Kris Rice and friends enjoying the reception

Gathering in the Main Ballroom

Pete Sharman, Oracle Corporation

.....continued on page 21
Putting On The Flash!
Using Oracle Smart Flash Cache

by Michael Ault, Oracle Guru, TMS, Inc.

Introduction
Deep in the throes of rewriting the Oracle and SSD book, I am currently working with Oracle11gR2 and its flash cache feature on Oracle Linux. For the book, we are repeating the TPC-C tests with the newer TMS hardware and upgraded servers. To achieve the optimal results the various memory areas of the Oracle database kernel need to be adjusted, once they are set, then the automatic memory management processes can be used to provide peaking load coverage. Figure 1 shows the Oracle memory areas and their relationships.

Of concern are the floor settings for:
- DB_CACHE_SIZE
- SHARED_POOL_SIZE
- LARGE_POOL_SIZE
- DB_KEEP_CACHE_SIZE
- DB_RECYCLE_CACHE_SIZE
- DB_FLASH_CACHE_FILE
- DB_FLASH_CACHE_SIZE

Of lesser concern since they will be application use specific are:
- JAVA_POOL_SIZE
- STREAMS_POOL_SIZE

Test Configuration:
In this test I used the following equipment configuration:
1. HP Proliant DL380 G6 with 4 Xeon 5540 CPUs for a total of 16-2.53 GHz processors and 72 GB or core memory
1. TMS, Inc RamSan-70 450gb PCI-e Flash Card, Read latency 0.070 ms, Write Latency 0.030ms, 300,000-1,200,00 IOPS

1. TMS, Inc RamSan-440 128 GB DDR based appliance (used for swap area), Read/Write latency 0.016ms latency (plus the latency of the interface), 600,000 IOPS
1. TMS, Inc. RamSan-630 5 TB Flash based appliance, Read Latency 0.250 ms, Write latency 0.080 ms, 1,000,000 IOPS
1. DotHill 24-300gb 10K RPM disk array, 3-5ms latency, 6000 IOPS

All storage equipment is direct attached to the host using 4gb fibre-channel or Infiniband with the exception of the RS-70 which is inserted into the host’s PCI-e bus. Figure 2 shows the hardware setup.

Test protocols:
In the tests I checked the following combinations:
1. DB_CACHE_SIZE, LARGE_POOL_SIZE and SHARED_POOL_SIZE only
2. DB_CACHE_SIZE, LARGE_POOL_SIZE, DB_KEEP_CACHE_SIZE, DB_RECYCLE_CACHE_SIZE and SHARED_POOL_SIZE
3. DB_CACHE_SIZE, LARGE_POOL_SIZE, DB_FLASH_CACHE_FILE, DB_FLASH_CACHE_SIZE and SHARED_POOL_SIZE

The database tested was Oracle11.2.0.2 with the appropriate patches for flash cache. Note that there are two types of flash cache in Oracle11g:
1. DB FLASH CACHE – This is an L2 type cache available on Oracle Linux and Solaris based systems in the Enterprise release of Oracle11g, no special hardware (other than a flash card or other SSD) is required.
2. Smart FLASH CACHE – This is identical to a SAN based DDR or Flash cache except it is optimized for Oracle and is only available with Exadata Storage cell technology and the Exadata Database systems.

For the purpose of this paper, we will only consider DB FLASH CACHE since it only requires Oracle Linux or Solaris and Oracle11gR2. Note that there is a work-around to use the DB FLASH CACHE on RedHat (and probably by extension other Linux implementations) but the work-around is not supported and should not be used in a production environment.

Test Environment

The test environment consists of a HP Proliant 8 Core – 16-2.53 GHz CPU server with 72 gigabytes of memory. The server has both fibre-channel and Infiniband dual connections to the RamSan-630 which has 5 terabytes of available storage. The RamSan-630 has an 80 gigabyte log-lun configured. A log-lun is a storage intensive area configured for optimal write bandwidth strictly for use with redo-logs. For these tests a 10 gigabyte redo log was found to be optimal in size. Oracle ASM is used to manage the standard and log luns.

As far as the RamSan-630, all luns were aligned on sector boundaries. A RamSan-70 PCIe card was also installed in the server for use as a flash cache and was configured for optimized Oracle IO (512 byte block size).

The database was manually created based on the TPC-C schema with a 3000 warehouse size factor. Partitioning and table clusters and parallel query were used to optimize access. The schema of the TPC-C database is shown in Figure 3.

The transaction control was accomplished using the Quest-Benchmark Factory software tool. Table 1 shows the row counts for a 3000 warehouse TPC-C schema.

<table>
<thead>
<tr>
<th>Table Name</th>
<th>Row Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>C_WAREHOUSE</td>
<td>3,000</td>
</tr>
<tr>
<td>C_DISTRICT</td>
<td>30,000</td>
</tr>
<tr>
<td>C_CUSTOMER</td>
<td>90,000,000</td>
</tr>
<tr>
<td>C_HISTORY</td>
<td>90,000,000</td>
</tr>
<tr>
<td>C_NEW_ORDER</td>
<td>27,000,000</td>
</tr>
<tr>
<td>C_ORDER</td>
<td>90,000,000</td>
</tr>
<tr>
<td>C_ORDER_LINE</td>
<td>900,093,356</td>
</tr>
<tr>
<td>C_ITEM</td>
<td>100,000</td>
</tr>
<tr>
<td>C_STOCK</td>
<td>300,000,000</td>
</tr>
</tbody>
</table>

Other Factors

One factor that dramatically affects the processing of Oracle queries is the setting of the OPTIMIZER_MODE initialization parameter. By default this parameter is set to ALL_ROWS which will attempt to optimize the SQL statements to return all rows form the queries in the minimum amount of time. ALL_ROWS will choose full scan options such as sort-merge-join and hash-join over paths that return initial rows the fastest such as a nested-loop. Since the TPC-C benchmark is an online transaction processing (OLTP) most queries will return very few rows, so one of the settings of the FIRST_ROWS_(n) value for the OPTIMIZER_MODE should be utilized.

The (n) settings are 1, 10, 100 and 1000. Varying the FIRST_ROWS setting from 100 down to 1 changed the tpmC results from 126492 up to 160298, nearly a 27% improvement. From ALL_ROWS to a setting of FIRST_ROWS_1 the performance improved from 119729 to 160298 tpmC. This shows that OPTIMIZER_MODE must be set correctly to get the best performance for your system. In this case the TPC-C is a pure OLTP system so a FIRST_ROWS_1 Setting makes sense. Figure 4 shows the effects of switching the OPTIMIZER_MODE settings.

In the test we used rapid loading techniques to reload table data after testing utilizing direct loads from external tables, in order to facilitate this the FILESYSTEMIO_SETTINGS parameter was set to NONE. In order to utilize the log lun feature of the RamSan effectively the un-documented parameter “_DISK_SECTOR_SIZE_OVERRIDE” was set to TRUE and the logs created using the BLOCKSIZE parameter set to 4096. The other non-standard initialization parameters were:

- CURSOR_SHARING=FORCE
- DB_WRITER_PROCESSES=8
- SORT_AREA_SIZE=17000000

Combination 1: DB_CACHE_SIZE, LARGE_POOL_SIZE and SHARED_POOL_SIZE only

This combination utilizes no advanced features of the Oracle kernel, not even the keep and recycle pools which have been available for several releases. In tests prior to the full fledged test series it was determined that the window number of users from 20-40 produced the highest transactions per second so the tests will be limited to a maximum of 50 users with a 5 user increment. Figure 5 shows the results of the DB_CACHE_SIZE changes on performance.
This test shows that increasing the cache size increased the TPS, as expected. In addition the user level at which the TPS peaked also increased, from 20 users at 14 GB to 35 users at 40 GB.

**Combination 2: DB_CACHE_SIZE, LARGE_POOL_SIZE, SHARED_POOL_SIZE, DB_KEEP_POOL_SIZE and DB_RECYCLE_POOL_SIZE**

What happens if we add in KEEP and RECYCLE areas? To refresh memories, the KEEP area is a memory cache used to store object blocks that you don’t want to have aged out of the cache. The RECYCLE area is a cache area designed to hold frequently changing or blocks that you don’t want to keep.

In order to effectively use the keep and recycle pool areas, database objects such as tables, indexes and clusters must be assigned to the appropriate pool. The default, understandably, is the DB_CACHE_SIZE controlled (SGA_*, MEMORY_* controlled) pool. For these tests the following objects where assigned as shown:

- Cluster: CUSTCLUSTER – RECYCLE
  - Contains: C_CUSTOMER table
- Cluster: DISTCLUSTER – DEFAULT
  - Contains: C_DISTRICT table
- Table: C_HISTORY – RECYCLE (This table is partitioned)
- Cluster: ITEMCLUSTER – KEEP
  - Contains: C_ITEM
- Cluster: NORDCLUSTER_QUEUE - DEFAULT
  - Contains: C_NEW_ORDER table
- Table: C_ORDER – DEFAULT
- Table: C_ORDER_LINE – DEFAULT
- Cluster: STOKCLUSTER – KEEP
  - Contains: C_STOCK table
- Cluster: WARECLUSTER – DEFAULT
  - Contains: C_WAREHOUSE table

These assignments were made based on how the table was used and if it is frequently changed. Using the cache advisors in the AWR reports from test runs the sizes of the special caches were optimized. Tests were run with the caches turned on and turned off to determine what affects the caches had on performance. With the caches turned off the memory they utilized was returned to the default cache. Using a maximum allocation of 40 gb for Oracle cache areas the basic settings for the memory areas were:

**NO_K_R_40:**
- DB_CACHE_SIZE=40gb
- DB_KEEP_CACHE_SIZE=0gb
- DB_RECYCLE_CACHE_SIZE=0gb

**WITH_K_R:**
- DB_CACHE_SIZE=30gb
- DB_KEEP_CACHE_SIZE=4gb
- DB_RECYCLE_CACHE_SIZE=5gb

**WITH_K_R_2: (As advised by the cache advisors)**
- DB_CACHE_SIZE=30gb
- DB_KEEP_CACHE_SIZE=7gb
- DB_RECYCLE_CACHE_SIZE=3gb

Figure 6 shows the effects of use of the keep and recycle pools on performance.

**Combination 3: DB_CACHE_SIZE, LARGE_POOL_SIZE, DB_FLASH_CACHE_FILE, DB_FLASH_CACHE_SIZE and SHARED_POOL_SIZE**

In this final test series we will compare the best result from the memory only, Keep and Recycle and first rows tests with the best result with a flash cache set. Tests were completed comparing using a slightly faster server mounted PCIe flash cache to a flash based san so the results will not be as dramatic as when testing server mounted PCIe flash cache against disk based storage.

The flash cache was sized at the suggested 2X the database cache size (90 gb) and then a run with the flash cache set to zero was run. Note that for the first run appropriate tables and indexes were assigned to be kept in the flash cache, other tables where set to default. Figure 7 shows the results from use of the Smart Flash Cache with Flash as storage.

At least for our testing with the database on a RamSan630 SSD and the flash cache being placed on a RamSan70 PCIe card,
As you can see from reviewing the graph, the Flash cache definitely helped performance at all levels of our user range. It also showed that with the same hardware the sustained performance increase could be extrapolated to a larger number of users so in the case of using flash cache with disks, yes, performance is gained.

While running this test I had indication that over 160 gigabytes of data blocks were cached in the flash cache. Figure 10 shows the SQL script used to determine flash usage for a single user and Figure 11 shows an example of its output during test runs.

### Disk with Flash Cache

Since the test with a flash utility against an internal PCIe Flash card proved inconclusive we decided to have the lab hook up some disks and re-run the tests using a disk array containing 24-10k 300gb disks for the tables and indexes. The DB_CACHE_SIZE was increased to 50gb and the DB_FLASH_CACHE_SIZE was set to 300gb. Figure 9 shows the results for a disk array with and without a 300gb flash cache.

![Figure 9: Disk versus Disk plus Flash Cache Performance](image)

**Figure 9:** Disk versus Disk plus Flash Cache Performance

In reviewing Figure 12 you should first note it is a logarithmic plot, which means that for each change on the left axis there is a factor of 10 change. This figure shows that using pure flash far outperforms even the best we can expect from a combination of flash and disk. In this case by nearly a factor of 7. The peak performance we obtained from our disk combined with a Flash cache was 1024 TPS, while the peak we obtained in our flash tests (see next
section) was over 7000 TPS. Even in previous testing with larger disk arrays, the peak performance I obtained from disk arrays was only in the 2000 TPS range, again showing that SSD technology is superior to any equivalent disk array.

A Final Test

In creating the TPC-C schema I used a schema model based on a successful TPC-C run on an HP platform from the http://www.tpc.org/ website. In this schema, several of the tables were created as single-table or multi-table clusters. I noticed during reloads that the single-table clusters took longer to finish loading than did the non-clustered tables of a similar size. I decided for a final test to check to see if the clustering was having a positive or negative effect on the performance of the database. In the final test I replaced all clustered tables with table-primary key index table combinations and used the configuration that gave the best previous performance (no flash cache, no keep and recycle pools and maximized db cache, with FIRST_ROWS_(n) set to 1). The results are shown in Figure 13.

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>FLASH_BLOCKS</th>
<th>CACHE_BLOCKS</th>
<th>TOTAL_CACHED_BLOCKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPCC.C_CUSTOMER_I1</td>
<td>15249</td>
<td>0</td>
<td>15249</td>
</tr>
<tr>
<td>TPCC.C_STOCK_I1</td>
<td>15863</td>
<td>0</td>
<td>15863</td>
</tr>
<tr>
<td>TPCC.C_NEW_ORDER_I1</td>
<td>15875</td>
<td>18108</td>
<td>33983</td>
</tr>
<tr>
<td>TPCC.C_ORDER_I1</td>
<td>37838</td>
<td>6308</td>
<td>44146</td>
</tr>
<tr>
<td>TPCC.WARECLUSTER</td>
<td>63562</td>
<td>650</td>
<td>64012</td>
</tr>
<tr>
<td>TPCC.DISTCLUSTER</td>
<td>59511</td>
<td>4504</td>
<td>64015</td>
</tr>
<tr>
<td>TPCC.NORDCLUSTER_QUE</td>
<td>45764</td>
<td>56100</td>
<td>101864</td>
</tr>
<tr>
<td>TPCC.ORDR_UK</td>
<td>94404</td>
<td>40801</td>
<td>135205</td>
</tr>
<tr>
<td>TPCC.C_ORDER</td>
<td>123514</td>
<td>67081</td>
<td>190595</td>
</tr>
<tr>
<td>TPCC.C_CUSTOMER_I2</td>
<td>202994</td>
<td>51896</td>
<td>254890</td>
</tr>
<tr>
<td>TPCC.C_ORDER_LINE_I1</td>
<td>38383</td>
<td>26284</td>
<td>410117</td>
</tr>
<tr>
<td>TPCC.C_ORDER_LINE</td>
<td>873325</td>
<td>64108</td>
<td>937433</td>
</tr>
<tr>
<td>TPCC.ORDL_UK</td>
<td>1073711</td>
<td>38760</td>
<td>1112471</td>
</tr>
<tr>
<td>TPCC.CUSTCLUSTER</td>
<td>1940874</td>
<td>124103</td>
<td>2064977</td>
</tr>
<tr>
<td>TPCC.STOKCLUSTER</td>
<td>5508278</td>
<td>3055117</td>
<td>8563395</td>
</tr>
</tbody>
</table>

Figure 11: Example of Using Flash Cache

Figure 12: The Affect of Removing Table Clusters

Surprisingly removing the clusters increased performance from a peak of 6435 up to a peak value of 7065, nearly a 10% increase in performance. This corresponds to a non-audited tpmC value of 197,378,310, this would be equivalent to a result from around a 200 disk drive based system. From my research I find generally a 1K of tpmC per physical disk drive depending on the amount of cache and the speed and type of disk used.

It appears that the SSD reduces latency to the point where disk access time saving features such as table clustering may actually incur more overhead in processing than is saved from the supposed reduction in IO from their use.

Summary

In this set of tests we have been attempting to optimize Oracle performance on SSD primarily through memory adjustment and secondarily through other adjustments in physical structure of the database. We tested techniques such as increasing cache size, utilizing the keep and recycle pools and utilizing the new Oracle11g flash cache.

In my tests I found that it appears that the overhead in utilizing many of the features such as keep and recycle pools and using flash cache was not justified when using the RamSan630 SSD as the database data source. In addition I found that physical features such as clustering may also be less than effective when utilizing super-low latency SSD storage.

When using the RamSan630 SSD as primary database storage it appears to be more efficient to use large db cache size, no keep and recycle pools and only utilize flash cache if the latency of the flash cache is far less than the latency provided by the SSD storage. In addition, features designed to optimize the retrieval of data from disk based storage such as clustering, may not be as effective as standard table-index structures when using SSD.

Following a 6 year Navy enlistment in the Nuclear Navy riding submarines, Mike began working with computers in 1980 programming in Basic and Fortran IV on the PDP-11 architecture in the nuclear industry. During Mike’s nuclear years he worked with PDP, IBM-PC, Osborne and later VAX-VMS and HP architectures and with the Informix and Ingres databases. Following the downturn in the nuclear industry Mike began working with Oracle as the only DBA at the Iuka, Mississippi based Advanced Solid Rocket Motor (ASRM) project for NASA in 1990. Since 1990 Mike has worked with a variety of industries both as in house and consulting talent. Mike is currently the Oracle Guru for Texas Memory Systems. Mike is an Oracle ACE and a member of the advisory board on the IOUG Virtualization SIG.

Mike has published nearly two-dozen Oracle related books including the 7.0, 8.0, 8i and 9i versions of his Oracle Administration and Management title with Wiley, the Oracle8 Black Book and Oracle DBA OCP ExamCram series (for versions 8 and 8i) with Coriolis and multiple titles including Oracle9i RAC and Oracle10g Grid and RAC with Rampant Technical Press. Mike has written articles for Oracle, Select, DBMS, Oracle Internals and several other database related magazines. Mike is also a frequently high-rated presenter at local, regional and international Oracle conferences such as GOUSERS, SEOUG, RMOUG, NYOUG, NCOUG, IOUG, GOW, ODTUG, UKOUG and EOUG.
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Preventing The Seven User Behaviors

That Most Impact Data Warehousing Performance

by Kevin Courtney

What Users Don’t Know Can Hurt Performance

If you manage the data warehouse, you know that user behavior can really rob your system of performance. They may try to connect all types of applications and tools to the data warehouse; some are authorized, others are not. Some perform very efficiently and others, in the hands of misguided or untrained users, behave badly, consuming a disproportionately high level of CPU or server memory and slowing overall system performance.

Last week at one of our customer sites, we witnessed a helpdesk call from a VP who tried to create and download a mailing list of customers using Microsoft® Word through an ODBC connection after reading an article in PC Magazine. With help, she was successful at connecting to the corporate data warehouse and accessing two large fact tables to get the names and addresses. Unfortunately, she did not fully understand the part of the article that explained how to properly join tables together or how to limit the data returned by using a “WHERE” clause. Furthermore, she used a “SELECT*” in order to be efficient with her keystrokes, rather than typing out all the data names. As you can imagine, during this process, she created a Cartesian product between the fact tables that ran for hours, generating a massive results set that consumed all of the free file space and ultimately requiring recycling the database engine.

This is just one example of the visible artifacts of the dangerous world of data warehouse management. Like floating icebergs, the vast majorities of these user behaviors are submerged below the waterline, and are not visible to the data warehouse manager. Even if you navigate through these dangerous waters, there are often more ugly events and perilous activities waiting to torpedo your service-level agreements.

What Users Don’t Know Can Hurt You

Over the years, we have seen all sorts of these events and have developed a list of the seven most disruptive and harmful user behaviors that you should watch out for. We also talk about how you can easily identify and prevent these behaviors from degrading performance and service levels, driving up support costs, and frustrating your end users.

1. The Dynamically Executed Query That Ran 80,000 Times

In many organizations, Microsoft Access is used as a general-purpose tool to retrieve data for desktop analysis or to extract data to populate a downstream analytic application. From time to time, we discover SQL that was inadvertently written to execute dynamically. The “developers” generally don’t realize the impact dynamic execution can have on the data warehouse. We do.

Dynamic execution causes the same query to repeatedly execute until manually stopped. This usually means that execution occurs all day long. In some cases, the execution count can reach 80,000 to 90,000 queries. This high execution count needlessly crushes performance for all the other users competing for the scarce database resources. In addition, the query returns the same results all 80,000 times because typically the data is refreshed just once a day, overnight.

The lesson here is to specify limits to dynamic execution code, and to be aware of any programs that really have to use it. You will want to monitor those.

2. The Query That Just Won’t Finish

Sometimes we observe complex queries generated by business intelligence (BI) platforms like SAP BusinessObjects or IBM Cognos that literally run for hours, until the BI platform governor cancels the query. It often works like this: a national accounts sales manager needs information for a critical sales call on a major client. Since the sales manager is not aware that his huge complex query was cut off because it timed out after an hour, he launches his query repeatedly, every couple of hours. In exasperation, he calls the CIO, the VP of Sales, and the Help Desk to complain about how the system is a failure. A Chinese fire drill ensues, resulting in a highly paid systems analyst sitting and watching the database process the request at off-hours. Since the off-hours processing load is lower, his report finishes prior to cancellation, but the stage is set for “round two” next week.

Preventing huge queries from running during normal business hours can solve this. These big queries should be monitored and analyzed to determine if they are of real business value or just the result of sloppy query construction. Sloppy queries can be addressed at the application or user level. Legitimate, very large queries can be scheduled to run during off-hours.

3. The Biggest Query Known to Man

Certain, BI tools generate exceedingly long lists of values using the classic “IN <LIST>” clause. The longest IN LIST we have seen expanded a single SQL statement to almost 1,000,000 bytes. The SQL statement was rather simple, but the list contained almost 125,000 entries. We were amazed at how slowly it ran, but were even more amazed that it ran at all.

Establishing a process that identifies these long IN LIST queries and actively controls them before they hit the database can address this issue. It is also helpful to be able to identify the particular users launching these types of requests and communicate more efficient query methods to them.
Like floating icebergs, the vast majority of these user behaviors are submerged below the waterline, and are not visible to the data warehouse manager.

helped them understand the impact of their work and let them choose another time to pull their data sets. Or, the data warehouse refresh cycle might need to be rescheduled.

5. Users Who Build Rogue Data Marts

Data marts are legitimate and effective data constructs and are indispensible in many organizations, delivering information with speed and agility. However, when they are built and managed “off the radar screen,” real problems can arise. We have seen many tools, like Microsoft Access and Quest’s Toad, used for unauthorized, uncontrolled, and highly inefficient data mart activities.

Security and compliance departments usually have a problem with 500GB of sensitive customer data downloaded onto a server or desktop located “somewhere out there” for later analysis.

Data warehouse managers usually uncover these rogue data marts when they detect a performance problem due to large volumes of data movement consuming database and network resources. In general, rogue data marts are very inefficient, disruptive, and in violation of compliance policies. Red flags should go up when we see a query selecting all data elements on all rows from a very large fact table. More flags should start waving when we observe a series of similar requests for each of the dimensions that support it. In some sites, we’ve seen this kind of job stream executed every weekday morning starting at around 9:00 a.m. After the dust settles, we hear all sorts of reasons why the rogue data mart was critical like, “...we couldn’t trust the numbers from the data warehouse,” or “...we need this data when we need it and can’t wait.”

Once uncovered, most organizations will want to incorporate rogue data marts into more efficient, manageable, and compliant processes with appropriate oversight and controls.

6. Data That Will Not Go Away

Many times, we have discovered large volumes of data in the data warehouse standing idle and unused for months and even years. In a large pharmaceutical company, this happened when marketing conducted a bake-off between syndicated industry databases. Many terabytes of syndicated data was loaded into the data warehouse to complete the data vendor evaluation and selection. Two years after the project was finished, the data — no longer of value to anyone — sat in the data warehouse with no apparent owner and no one willing to take charge of its removal.

We also see old subject areas from earlier data warehouse versions still maintained in current production data warehouses. Sometimes these subject areas will not go away because there is a rumor that an old Sybase PowerBuilder application has never been migrated. The rumor never seems to identify who uses the old application or why they can’t get their information from the new environment, so the data sits and sits, increasing disk space requirements, data handling costs, and server resource waste.

Identifying owners before loading large volumes of data can help with housekeeping later on. Or you can set automatic expiration dates with the project owner when the data is originally loaded.

7. The Authorized User Who Breaches Data Security Policies

A data security breach strikes fear in the hearts of data warehouse managers. It’s is a great way to get a company lined up for a lawsuit and on the front page of the Wall Street Journal. Ninety-nine percent of ad-hoc queries to the data warehouse are appropriate and used in the normal course of business. Those unlikely queries that breach policy, and we did not anticipate are the ones that can land our companies and us in trouble.

Good policies and procedures can eliminate many, but not all of these problems. So you still need a solution that addresses that last 1%.

Ensuring Safety and Performance in Data Warehouses

Data Warehouse Visibility and Protection

The first step is to get full visibility into the unforeseen events that are happening in and around your data warehouse. The solution must be agile enough to identify dangerous queries prior to execution, and must be strong enough to enforce policies to actually prevent SQL issues from hurting overall data warehouse performance and knocking out your SLAs.

Teleran’s Automated Management Software Protects Your Data Warehouse

Teleran is the market leader in the field of Dynamic Data Warehouse Management, which looks at the entire data warehouse ecosystem: all the users, all the queries, and all the applications in the context of the database. Teleran iSight™ provides a powerful tracking and data collection module that tracks every SQL event in a lightweight, non-intrusive manner. Its flexible architecture allows it to be positioned mid-tier on the network, operating in a packet capture mode, or sitting in front of the database listener port.

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iGuard™ completes the loop, taking the results from iSight to formulate data-usage policies that prevent performance-robbing transactions from ever reaching the database engine. iGuard materially reduces system resource costs over time, forestalling and eliminating the need for hardware upgrades. It is also a true enabler of business intelligence self-service as it guides users away from wasteful, unwanted, inefficient, or incorrect queries using customizable user messages that explain their error and guides them to more effective and efficient queries. All of this is automated, so the data warehouse and BI support teams do not have to be involved in monitoring and managing the users and their interactions with the data warehouse, automatically saving labor and lowering support costs.

**A Better Return on Investment**

The performance issues in your data warehouse, data mart, or ODS could be due to poor queries, dormant data, or the realities of self-service environments. The common fact is that, if they are not addressed, they can upset your whole world. Teleran’s proven data warehouse management solutions address these common user problems in an easy-to-understand, easy-to-implement way. They also identify quantifiable returns on investment so you can build a comprehensive business case to show how automating the management of your data warehouse can reduce costs while improving the service levels and increasing the value of your data warehouse.

Kevin Courtney is Vice President of Business Solutions of Teleran Technologies. He brings over 30 years of senior and executive information technology experience in business management, technology strategy, design and deployment, program and project management, product development and marketing.

At Teleran, his focus is on the development of customer-oriented analysis and Business Intelligence analytic solutions based upon customer usage of enterprise data warehouses, data marts, and operational data stores. He is also focused on managing the overall business relationship with these Fortune 1000 customers and prospective customers.

Prior to Teleran, Courtney was Vice President of Business Intelligence and Data Warehousing at Highpoint Solutions, where he was responsible for managing the Business Intelligence and Data Warehousing Practice, serving customers such as Pfizer Pharmaceuticals, Verizon, NASD, and Dartmouth College.

Courtney’s entrepreneurial career includes founding CoreMedia Systems, an innovative software company focused on providing decision support and business intelligence solutions to the advertising and media industries. As CEO, Courtney led CoreMedia’s rapid expansion. The firm was named to Inc. 500’s list of fastest growing privately held companies in America.

Courtney holds a BS in Applied Mathematics and Statistics and Economics from Stony Brook University and an MS in Operations Research and Statistics from the School of Management at Rensselaer Polytechnic Institute.
The Stan Yellott Scholarship Fund

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To provide members with the ability to help their peers maximize their knowledge and skills working with products in information technology and in particular Oracle products.

To provide a consolidated channel of communication, conveying needs, concerns, and suggestions, for members of the organization, to Oracle Corporation and other vendor corporations involved with Oracle related technology.

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Database Cloning Options In 11G

by John Darrah, DBAK

Introduction

The first publicly available relational database was released in June of 1976. It is quite likely that the first request for a database clone was made before July of that year. Database clones have become as integral to IT operations as backups. Cloning environments is an essential component to most development projects, reporting environments, QA and environment management, and IT operations. However, as important as database clones are, the expense both in labor and infrastructure means that most companies must compromise on the number and frequency of cloned environments. These compromises can lead to uncomfortable situations such as code being tested against data that is hopelessly out of date, production OLTP databases being bogged down by operational reporting, and new code developed against irrelevant data.

This paper will give an overview of some of the newer database cloning technologies available in Oracle 11g. This paper and presentation will provide an overview of these technologies and provide suggestions on where and where not to use the particular technology. This paper and its associated presentation is not intended to be an exhaustive deep dive of each technology mentioned since, in most cases, a simple Google search will yield 10 to 20 really good papers or blog entries specific to each topic. The goal of this paper is instead to make people aware of these features, point out any licensing implications, and provide examples of use cases.

Types of Clones

A database clone can come in many forms and implement an array of database, storage, server, and SAN fabric technologies. Even though there are likely over 50 distinct methods and technologies to clone a database, the high level types of database clones generally fall into one of two categories. For the purposes of the use cases described in this paper, database clones will be broken into three general types:

- Full Copy Clones
- Delta Clones
- Code Clones

Full Copy Clones

A full copy clone is a byte for byte copy of a source database. This is by far the most common type of database cloning technique used due to the fact that it requires no special software or hardware beyond what is in the database itself. They have the advantage that they can leverage existing backups to create the clone copy serving to validate database backups in addition to creating the clone. This type of clone has three big drawbacks:

First, full copies can be time consuming to create. Second, they require at least as much disk as is used on the source database. Third, they can impact performance on the source database if the data window requires copying data from the live database instead of a backup. To mitigate two of the three problems above, software companies came up with clever ways to quickly identify changed blocks on the source that were needed to refresh the clone; EMC’s Business Continuous Volumes are one example.

Some examples of Oracle Full Copy Clones include:
- RMAN Duplicate
- Physical Standby Database
- Delta Clones

A delta clone involves an offline copy or read only set of database datafiles sometimes referred to as a snapshot and one or more clone instances that use the snapshot as a baseline. When writes are made to the clone databases, the database block is copied to a new location and pointers or bitmaps are used to determine which version of the database datafile, base or delta block should be considered part of the clone database. Delta clones differ from full copy clones in that only the changed blocks within the files need to be stored and the unchanged blocks can all be retrieved from the base copy of the data. Probably the best known delta clone technology in use for Oracle databases today are NetApp snapshots.

The advantage for environments that are read mostly is that several clones can use the same baseline and only store their changes. This can provide a huge space savings over the full copy approach. Because each delta clone begins its life as an identical copy of the base files that back it, they take a small fraction of the time to create as do full copy clones. While delta clones have space and creation time advantages over full copy clones, there are some important caveats to consider when using delta clones. First, if the application is write intensive, the area required to hold the deltas between the clone and the baseline can grow to be as large as the baseline itself. This is not a problem in and of itself but it can cause unplanned outages to the environment if the filesystem holding the changed blocks is not big enough to accommodate the changes. Second, delta clones by design introduce a layer of indirection on reads and writes to the cloned database. Filesystem pointers or bitmaps within files must be traversed/inspected to determine whether to retrieve the base block or the changed block. Depending on the type of environment, the overhead can be negligible but the overhead should be considered. Delta clones are ideally suited for

1 Code clones are a new concept Oracle introduced with their Edition Based Redefinition feature. They do not easily fit into either of the existing categories of clones and it could be argued that they are not, in fact, clones at all. I decided to include them because the technology is an ideal way to stretch some types of development, test, and QA environments so they can be used by multiple groups of users.

2 The exception being TEMP and UNDO may not need to be as large although depending on the requirement these tablespaces may actually need to be larger on the clone than the source.
read intensive environments that do not have extremely high performance requirements.

An example of an Oracle database technology that provides a delta clone is the dNFS clonedb feature available as of 11.2.0.2 (more on that later).

**Code Clones**

A code clone is a made up term to shoehorn the idea of Edition Based Redefinition into this paper. While Edition Based Redefinition is not marketed as a cloning technology, it can, in certain situations allow the same environment to be stretched across different groups of consumers - which is a key reason databases are cloned in the first place.

**Business Drivers for Database Clones**

There are many business reasons why it is often necessary to clone a database. Generally business drivers to clone environments fall into one of the categories below.

**Reporting Environments**

OLTP and reporting applications tend to have different usage characteristics. OLTP applications generally run short, efficient queries and small DML operations. Reporting queries on the other hand tend to be longer in duration, run in parallel, and often have large batch oriented DML/DDL operations to store intermediate report results; I’m guessing this is not news to anyone reading this paper. OLTP and reporting workloads running against the same database can have a negative impact on both the reporting and OLTP response times.

It is fairly common for certain reports to require real-time or near real-time data in order to be useful. In other cases, reporting environments require a cutoff of the prior day’s data so report results are consistent throughout the day. Many reporting environments go a step further and denormalize data or otherwise transform it for easier faster access. This last case of reporting environments refers to data marts or data warehouses and is a much larger topic than can be covered in this paper. When this paper refers to reporting environments it is referring to ODS type reporting environments where the data contained in the reporting environment has not been transformed to a new table structure.

**Development Environments**

Developers need databases. Most IT departments have a constant tug of war between developers and operations. The developers complain about how the size or freshness of the data in their development environments make it difficult or impossible to write and unit test their code effectively. The operations staff retort that they have neither the disk space nor the time available to produce and refresh as many environments as the developers want. If the developers win the tug of war, the operations staff is saddled with an endless cycle of database refreshes and a ballooning storage budget. If the operations staff wins, the developers end up not being able to adequately unit test their code, in effect killing those testing activities further down the development lifecycle to quality assurance.

**Testing (QA / UAT / Performance) Environments**

Testing environments are similar to full size Development environments with the added wrinkle that they may need performance characteristics similar to production and may need to be as up to date as possible in terms of data so as many variables as possible are eliminated or otherwise accounted for when testing commences.

**New Cloning features in 11g (Full Copy)**

There are two new features as of Oracle 11g that can help create full copy clone; Active Data Guard and Snapshot standby.

**Active Data Guard - What it is**

Active Data Guard is a licensable option for Oracle Enterprise Edition Database. It provides several features to help leverage a physical standby database for reporting and backups. The two most noteworthy features (in my opinion) of Active Data Guard are Active Standby Database and Fast Incremental Backups of the physical standby database. These two features can be used to create near real-time reporting environments and quickly refresh environments cloned from the physical standby.

**How It Works**

Active Standby Database extends Oracle’s standard Consistent Read Technology allowing recovery to continue while the database is open in a read only state. The data in the physical standby database remains as up to date as the redo log data applied. Active Standby Database allows queries to error or be redirected back to the primary if the data lag between primary and standby falls outside a defined threshold.

Block Change Tracking works functionally the same as it does when configured on the primary database. When blocks within the database are changed, a bit is flipped in the block change tracking file that corresponds to the section within the datafile containing the block. When an RMAN backup takes place, the bitmap is inspected to quickly identify the blocks that have changed since the prior incremental backup. This can greatly reduce the time needed for incremental backups, particularly if only a small subset of the database has actually changed.

**Use Cases**

Active Standby Database is an excellent solution for an operational reporting environment. Combined with the Block Change Tracking (BCT) feature of Active Data Guard, Active Data Guard can be further leveraged to quickly refresh more static environments that were cloned from the standby database.

**Caveats**

Active Data Guard is a separate licensed feature. While everything needed to utilize Active Data Guard is included as part of the 11g rdbms binaries it must be licensed in order to remain compliant with Oracle’s SLEUA.

If the primary purpose of the standby database is DR, it is important to make sure the report load does not become so intense as to slow down the rate of recovery and jeopardize Recovery Point or Recovery Time objectives.

**Snapshot Standby - What it is**

Snapshot Standby Database allows a physical standby database to be opened read write and then flashed back and converted into a physical standby database. The technology to do this has existed since 10g but in 11g the whole process is automated through DGMGRL or Enterprise Manager Grid Control (which uses DGMGRL).
How It Works

To create a snapshot standby, DGMGRL first creates a guaranteed restore point of the physical standby database and then opens the database read write changing its role from PHYSICAL STANDBY to SNAPSHOT STANDBY. While the database is open read write, archive logs are still shipped to the standby host but they are not applied until the database is converted back to a physical standby database. To convert the database from a Snapshot Standby back to a Physical Standby, the database is flashed back to the guaranteed restore point created after recovery was stopped and prior to the database being opened, and finally, the database is converted to a Physical Standby database and recovery is resumed.

Use Cases

Snapshot Standby Database can be used for many types of clones including reporting databases where the report tool requires read write access to the database, QA environments, performance test environments, and full sized development environments.

Caveats

The biggest caveat to be considered with snapshot standby is the impact of stopping recovery on the Physical Standby Database. If the standby is used as a DR environment, stopping recovery could impact disaster recovery SLAs. Both the time to flush the database back and the time required to recover through the logs that were shipped but not applied depends on the rate of change on both the primary and the Snapshot Standby. It could be minutes or hours depending on these two factors to re-instantiate the Physical Standby.

Snapshot Standby Database should not be used if doing so jeopardizes the uptime SLAs of the primary environment.

New Cloning Features in 11g (Delta Copy)

CloneDB feature (11.2.0.2 and greater)

In the 11.2.0.2 patch set, Oracle quietly released a feature that leverages Oracle’s Direct NFS client to create clones from a backup copy of an Oracle database. There is almost no Oracle documentation on this feature save a single Note on MOS (Note: 1210656.1, Clone your dNFS Production Database for Testing).

What it is

Clonedb is an entirely new way to create cloned databases within Oracle. It requires that dNFS, Oracle’s NFS client, be configured and running on any servers that plan to take advantage of the feature by creating a cloned database. It also requires that a backup or read only copy of the source database’s datafiles is visible, either via NFS or directly, to any server that will create a clone of the source. The key difference between clonedb and the other cloning methods mentioned above is that several separate cloned instances can be created using the same base datafiles. Additionally, the clones themselves take up virtually no disk space when first created.

How It Works

The Metalink note referenced above contains a perl script which in turn creates two sql scripts which when run create the cloned database instance. The SQL scripts do two things. The first script creates a new controlfile with the database name of the cloned database. The second script executes a procedure called dbms_dnfs.clonedb_renamefile to change the name of the datafiles referenced in the controlfile from the source file name to new files that reside in a dNFS filesystem mount.

BEGIN
  dbms_dnfs.clonedb_renamefile('/u01/backups/users.dbf','/mnt/nfs/test01.dbf');
END;

The clone files are created as sparse files, which can be a little confusing since commands like “ls” will report the size of the original file, whereas “du” will report the actual space used on disk:

$ ls -hl ora_data_TEST25.dbf
-rw-r----- 1 oracle dba 1011M Jan 18 12:48 ora_data_TEST25.dbf
$ du -h ora_data_TEST25.dbf
80M  ora_data_TEST25.dbf

As DML operations occur the file will grow until it is equal to, or if the file is set to autoextend, bigger than the original. The clone files contain a bitmap that shows which blocks have been modified and which should be retrieved from the base files. dNFS then presents a merged view of the data back to the user. From a user perspective the database is a complete read write physical copy.

Use Cases

This type of clone could be used for any of the business cases listed above - the sweet spot being full-sized development environments and Release Management environments to test any DDL / DML scripts needed for a given code release. If the cloned environments will only ever change 10% of the data there could be roughly 10 cloned environments taking the same amount of space as a two source environments (one copy of the source and 10 delta copies). The Metalink note above mentions using RMAN backups as the base set of files for the clone. While this is fine, it is not a requirement. The only requirement is that the base set of files not change and the needed archivelogs be available if media recovery is needed.

Caveats

Clonedb is a new feature that is not well documented. It is very likely Oracle will document and possibly enhance this feature in an upcoming release of Oracle but for now, test it thoroughly before introducing it into any critical business processes such as a release cycle. Remember that all of the databases that are cloned off of a set of base datafiles share those files when reading data that they have not changed in the cloned environment. This means the disk on which the base datafiles sit can easily become a bottleneck if the number of IO requests coming from the clones exceeds what the disk can handle. Finally, even with no disk bottleneck there will be some performance overhead incurred when using this technology. Kevin Closson found a 15 – 20% response time difference when using the cloned database verses a normal database; your mileage may vary.

**New Cloning features (Code Clone)**

**Edition Based Redefinition**

Edition Based Redefinition or EBR is not technically a database cloning technology but I include it in this paper and associated presentation for two reasons.

First, I personally think EBR is one of the most important new features to be introduced in 11g for making developers more productive, QA more effective, and production environments more available. Better development and QA as well as better production availability are some of the key reasons businesses clone databases to begin with.

Secondly, for certain types of environments where the table structure is fairly static, EBR is the ideal way to “clone” copies of views, PL/SQL stored procedures, Triggers, and types - allowing several development releases to take place concurrently in the same database.

**What it is**

EBR introduces a new concept to the namespace hierarchy for objects in Oracle databases. Up until 11g most database objects followed the following hierarchy:

```
-->Schema Name
-->Object Name
```

Meaning a schema could not have two objects with the same name existing at the same time. EBR adds a new wrinkle to this concept by adding version, referred to as edition, to the object hierarchy:

```
-->Schema Name
-->Object Name
-->Object Edition
```

The object edition allows for multiple versions of the object to exist in the same schema at the same time. The database is assigned a default edition, but different schemas, database services, and sessions use different editions present in the database. When a session uses an edition it sees the objects built in that edition and inherits the objects from the default or prior edition. This means the same schema can hold objects from the code release currently in production, a prod fix line, and one or more development lines of code at the same time.

**How It Works**

As stated above EBR works by providing a new level to the object hierarchy, the EDITION, thereby allowing multiple versions of the object to exist at the same time. Not all database objects are Editionable.

<table>
<thead>
<tr>
<th>Editable Objects</th>
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<td>SYNONYM</td>
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<tr>
<td>VIEW</td>
<td></td>
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</tbody>
</table>

4 There are some exceptions namely constraints and indexes but you get the idea.

There are two new object types introduced in 11g as part of EBR; EDITIONING VIEWS and CROSSSECTION TRIGGERS. Both of these object types attempt to compensate for the fact that TABLES and MATERIALIZED VIEWS are not editonable. Editioning views act similarly to tables in that they can have standard DML triggers normally allowed only on tables, and selecting from them should not affect the query execution plan. Editioning Views are used when a different edition needs to add additional columns or otherwise change the structure of the table. The view is placed on top of the table in a particular edition so that the table appears as it should for that edition. Crossedition triggers are used to propagate changes forward and backwards between editions in the database. They are meant to be temporary while the schema is being updated from one version to another.

**Use Cases**

There are many good use cases for EBR outside of the context of database cloning but those will not be addressed in this paper. A good example of where EBR can be used to “clone” a development environment would be an application where PL/SQL stored procedures and /or views are used to provide a data access layer to a client application. Many IT environments have multiple releases running concurrently that address specific projects or different areas of functionality. The result of multiple environments can quickly lead to development environment sprawl in order to keep one project from stepping on another project. With EBR, EDITIONS can be used to segregate projects so a Prod-fix code line can coexist with one or more project lines. This approach becomes more difficult (but not impossible) if many table modifications accompany the release.

**Caveats**

EBR is not true cloning. The tables and underlying data are shared between editions. Editioning views can mitigate data sharing issues somewhat but EBR is probably not the best approach to stretch development environments if massive mutually exclusive data changes are required for each development environment, or if large scale structural schema reorganizations are the norm in development releases.

**Conclusion**

With each release of the database, Oracle continues to provide new features that can be leveraged to clone databases. Each method has its own strengths and weaknesses which should be considered before deciding which method to use. I hope this paper and presentation give a good high level overview of some of the newer cloning features available in 11g.

John Darrah has been working on Oracle systems since 1996 and as an Oracle DBA / Developer since 1996. John has built a reputation for solving difficult to diagnose technical problems by combining methodical, data based analysis techniques with a thorough understanding of Oracle and operating system internals. John has been a presenter at several Oracle related conferences including Oracle Open World and RMOUG. John lives in Lafayette Colorado with his wife and son. When not working John enjoys skiing and mountaineering.
By the time you read this I will have presented at my fourth consecutive RMOUG Training Days. I love RMOUG and think that outside of my own conference in UK, this is one of my favourite regional conferences. I love the atmosphere of the Conference Center. Some I go to are simply too big, and even more I love the way everyone volunteers to make it run so smoothly. Volunteers are the lifefood of all user groups.

I am President of UKOUG (UK Oracle User Group) which like RMOUG has a geographical scope. We ‘Serve the Oracle Community’ of the UK and Ireland. I was recently asked by new members of our Members’ Council to explain the relationship between Oracle and user groups and thought I would share it with you.

We value our Independence; all Oracle user groups are INDEPENDENT of Oracle. None are run by the vendor and consequently there is no single user group model. User groups are broadly scoped by product, geography or industry, or a combination.

It is difficult to visualize the global Oracle user group network. With Oracle’s acquisition strategy the number of user groups is ever growing. As of January 2012 there are approximately 400 Java user groups, and 450 traditional user groups.

So it is not surprising that globally Oracle cannot interact successfully with this number of user groups. To combat this they have set up an umbrella hierarchy. It is run by Global Customer Programs (GCP), and the advantage of this structure is the coming together of user group leaders who can then share best practice, and is effectively a user group for user group leaders.

Global Customer Programs is led by Jeb DeSteel, SVP & Chief Customer Officer of Oracle, and is responsible for all customer interaction initiatives, Advisory Boards, CIO groups, Reference Programs, Surveys, and user groups etc. The GCP user group structure is a Global Umbrella, IOUC – International Oracle user group Community managed by Mary Lou Dopart and there are then regional umbrella organisations, EOUC, AFOUC, LAOUC & NAOUC covering EMEA, Asia Pacific, Latin America and North America. UKOUG sits as part of the EOUC.

The International Oracle usergroup Community holds a summit each January in Oracle HQ and then additionally for each regional group. For us EOUC has their own leaders’ summit at least once a year. At the summits, especially the Global Summit, Oracle executives share their plans and thoughts for the next year with the leaders. These sessions are invaluable in understanding what is behind the marketing.

At this year’s summit I attended on behalf of UKOUG and for RMOUG Carolyn Fryc, your Vice President and Programs Director, attended. The first morning is in our regional groups, so I am not sure what Carolyn got up to, but the EOUC sessions were excellent and attended by 25 groups from our region.

A few statistics illustrate the size of the summit. There were 151 attendees from around the world. More than half were from outside North America. Fifty-three had never attended before and this was an increase of 20% on last year. In addition, there were over 30 Oracle executives and product managers who came to talk with these leaders. Whilst Oracle host and organised the summit, expenses are met by the individual user groups.

The next two days there were 75 formal sessions where Oracle told us what they are up to in a much less marketing mode than at Oracle Open World. There are very few slides and lots of questions. user group members look to their organizations for information and comment, which can only be provided when Oracle shares like this. Some of these were also talks on upcoming campaigns so that we can be engaged with Oracle by working with our local Oracle liaisons rather than in competition. Look out for the Customer Experience CRM campaigns; I was very impressed with that.

Another area that works really well is the un-conference sessions, where user groups debate hot topics and learn from each other. I led two of these sessions, the first on how to attract young people to user groups and I was really pleased to be joined by the President of the Columbian user group as I think the Latin American groups have a great rapport with the universities.

My second un-conference was around getting the right balance of speakers between Oracle, end users, ACE program and new speakers. What surprised me is that even some user group leaders did not understand the ACE program; so let me explain a little:

The Oracle ACE Program is run by OTN (Oracle Technology Network) and not GCP. It is a program to recognise expertise and contribution within the Oracle Community. It is not limited to usergroup members however there is an obvious overlap.

The program has two levels; those designated ACE are being recognised. The higher level of ACE Director is not only for extreme contribution but also requires a commitment to keep learning through briefings and attendance at certain events, and continued sharing through presenting.

ACE Directors can apply for funding for travel and accommodation for some events where they present. This enables emerging usergroups to have access to some of the best presenters around; but obviously there are budgets, a requirement that a speaker requesting funding has at least two presentations and where appropriate request usergroups run their in-country events in an arranged timeframe so that speakers can take part in several in

About The IOUC

by Debra Lilley

Debra & Carolyn at RMOUG Training Days
Global events such as Open World, sign up for Oracle or Profit Magazine, register for an Oracle University Course, or simply complete your online profile this is the option you will be presented with.

UKOUG and RMOUG are big user groups, bigger than some of those recognized in the hierarchy above and I know we have argued we should have direct representation; however, where would it stop? We are a regional Usergroup and are represented here by the EOUC. You are represented by your affiliation to IOUG. AT IOUC Summits any user group can attend and influence directly, which both UKOUG & RMOUG does.

The IOUC www.iouc.org has a number of Committees where Usergroups work together to achieve things with Oracle they can influence better as a global force.

The IOUC has appointed 2 spokespeople who represent the IOUC with Oracle Executives; these are currently Stan Jakubik (HEUG) and Carolyn Hayden-Garner (OHUG)

Currently there are four committees.
• Support Committee – led by Pat Dues (OAUG)
• Product Development Committee – led by Floyd Teter (OAUG)
• Localizations – led by Wolfgang Scherer (DOAG) and Daniel Strassberg (QUEST/APOUC)
• Contracts – led by John Matelski (IOUG) and Sue Shaw (QUEST)

I was leader of the Product Development Committee until this latest summit when I handed it over to Floyd Teter. I started the committee over six years ago when Oracle first announced Fusion Applications. They said they wanted user group input but could not logistically speak to all, so asked that we create one channel. I am very proud of what we have achieved. Throughout the entire period we have had quarterly Q&A sessions with development and these sessions formed the basis of the Q&A now found on www.oracle.com. We have advised Oracle on what users want, and arranged to verify both functionality and user experience by introducing the Oracle User Experience team to the power of mobile labs at user groups. We advised on how members are receiving messages and working with them to help educate their customers, our members. Five years ago when asked to address Oracle marketing on the messaging it was George Trujillo from Denver and long time volunteer with RMOUG that explained to the technology and we then started working with both the Fusion Middleware and Application Technology teams to help get those messages across and how you can prepare for the applications by adopting the technology ahead of time.

We have delivered sessions at several Oracle Open Worlds and Collaborate. I was honoured on behalf of user groups worldwide to introduce Steve Miranda SVP Oracle Development when he gave the first demonstration for the completed product at OOW 2010. It was very rewarding to hear Steve thank all of the invaluable input that we were able to provide.

We have created a number of online tools to help which you can find on the Product Development Committee page of www.iouc.org and our latest tool “Your Path to Understanding Fusion Applications” gives you a number of resources, presentations, video and webcasts to help educate you depending on your job role. I demonstrated this at the recent Training Days.

So yes user groups are independent of Oracle; but it is very important that we work together, not to deliver a joint marketing message, but to ensure that you have influence on the vendor and their product, and also a consistent, easy to understand stream of education from well informed leaders.

User groups are about sharing, networking and getting the most from your Oracle Investment, something both UKOUG and RMOUG do well.

Thank you for allowing me to present at Training Days and for sharing this article. Hope to see you next year.
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**RMOUG Events Calendar**

3/18/12  Newsletter  Spring Issue of SQL>Update Mailing
3/20/12  Board  March Meeting, Location TBD
4/12/12  TCOUG  Twin Cities Oracle Users Group, Eden Prairie, MN
4/15/12  Newsletter  Summer Issue of SQL>Update Call for Articles and Photos
4/18/12  NYOUG  New York Oracle Users Group Training Days 2012, NYC
4/22-26/12  Collaborate  Collaborate 2012 Conference in Las Vegas, NV http://www.ioug.org
4/24/12  Board  April Meeting, Location TBD
5/15/12  Newsletter  Summer Issue of SQL>Update Article/Photo Deadline
5/18/12  QEW  RMOUG Quarterly Education Workshop - Oracle Corp, Broomfield
          MySQL Special Interest Group Debut
5/18/12  Board  May Meeting, QEW
6/15/12  Newsletter  Summer Issue of SQL>Update Mailing
6/19/12  Board  June Meeting, Location TBD
9/30-10/5/12  OOW  Oracle Open World, San Francisco, CA

*Please note dates are subject to change. For the most current events calendar visit our website at www.rmoug.org.*

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Join us for our next Quarterly Education Workshop in May. The location will be announced via email or please check our web site. RMOUG hosts quarterly workshops in May, August and November of each year with the fourth and largest educational event being Training Days in February. Learn about the newest technologies, gain more insight into Oracle techniques and enjoy the camaraderie of meeting with other Oracle professionals.

If you or your organization are interested in partnering with RMOUG to host an upcoming meeting, or to submit an abstract for presentation, please contact

Carolyn Fryc, Programs Director at ProgramsDir@rmoug.org

Watch RMOUG’s Web Page for May Training Topics  www.rmoug.org