Technical White Paper

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64-Bit Versus 32-Bit eDirectory™ Comparison Evaluation

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Introduction

Novell® eDirectory™ is the most widely used identity foundation for managing internal and Web-based relationships among user identities, corporate assets and security policies. Novell eDirectory is a standards-compliant, cross-platform, highly scalable, fault tolerant, and high-performance directory services solution.

This white paper compares the performance of the 64-bit eDirectory 8.8 SP5 running on a 64-bit SUSE® Linux Enterprise Server (SLES) 11 (x86_64) operating system with the 32-bit eDirectory 8.8 SP5 running on a 32-bit SLES 11 (i586) operating system.

Executive Summary

Caching the database inside of the Novell eDirectory database block cache yields better performance than caching at the file system. Performance of both the 32-bit eDirectory and the 64-bit eDirectory is found to be similar on a smaller database that can be fully cached. The maximum database cache in 32-bit eDirectory cannot exceed 3 GB. However, 64-bit eDirectory does not have this limitation. Hence it performs much better for larger databases. The 32-bit eDirectory also suffers from increased disk access for larger databases. In addition, the 64-bit eDirectory gives the capability to deploy more Novell Identity Manager drivers by configuring a large Java* heap size.

64-Bit Architecture

The availability of low-cost memory and the desire to have more memory for certain performance-intensive applications compelled hardware vendors to seriously consider the 64-bit processor architecture. The key advantages of the 64-bit architecture include:

- Increased virtual address space up to 2^{64} bytes, equivalent to 17.2 billion gigabytes when compared to the 4 GB memory in 32-bit.
- Double precision (64-bit) integer support.
- Additional registers. For example, for the x86-64 (also called AMD64 or x64) instruction set:
  - Sixteen 64-bit general purpose registers are available for applications and device drivers in comparison to the four 32-bit general purpose registers.
  - Sixteen 128-bit XMM registers are available for enhanced multimedia performance and to double the register space of any current SSE/SSE2 implementation.

Some of the types of applications that benefit from the 64-bit architecture are:

- Applications that require more than 4 GB memory, such as applications with large datasets.
- Server applications and data warehouse applications managing a large number of concurrent users or application threads.
- Security applications that require real-time encryption and decryption.
- Applications that require large and high-powered database performance for decision support, searching, and indexing.

Goals

The goal of this white paper is to compare the performance of the 64-bit Novell eDirectory 8.8 SP5 running on a 64-bit SLES 11 (x86_64) operating system to the 32-bit eDirectory 8.8 SP5 running on a 32-bit SLES 11 (i586) operating system. Three databases of varying sizes are identified as:

- Database with 100,000 objects. This can be fully cached on both 32-bit and 64-bit eDirectory.
- Database with 1,000,000 objects. This can almost be cached on 64-bit eDirectory.
- Database with 3,000,000 objects. The hardware configurations are chosen so that it cannot be fully cached on 64-bit eDirectory. This means that the data cannot be cached on both the versions.

Some commonly used directory operations are identified and used to generate workloads. Then, the performance is measured by varying the eDirectory database cache size for each of these configurations. The

performance numbers on very large database caches as high as 10 GB are studied.

This white paper does not intend to cover the following:

- It does not identify the precise amount of database cache tuning to get the maximum performance. It only studies the performance effects for different cache sizes.
- It does not identify the precise amount of RAM given for a database size.
- Replication performance. Tests are carried out in a single-server, single-partition tree.
- File system comparison. Tests are carried out on an ext3 file system. The tests do not intend to compare any disk drives or disk configurations. The same disk configuration is used on all the servers.

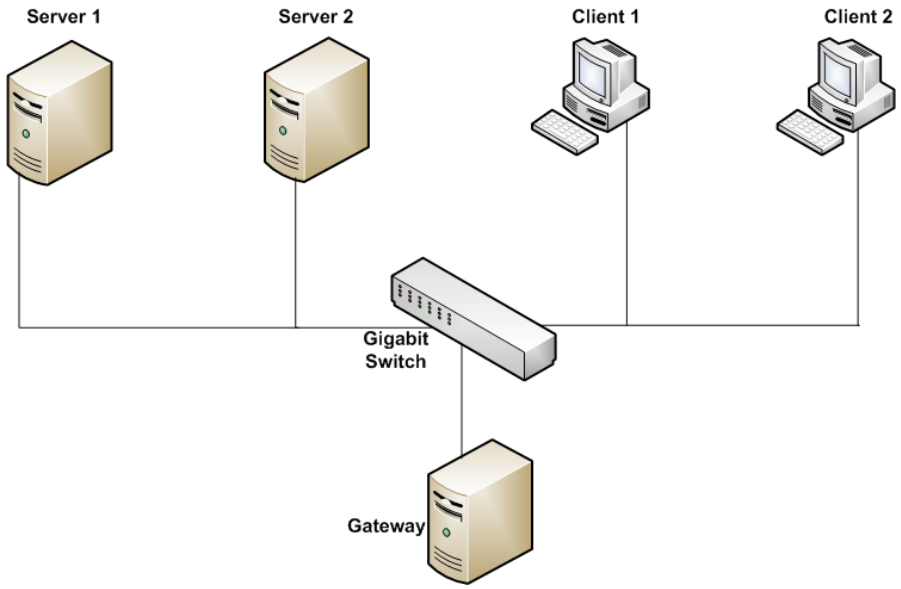
Test Methodology

The same 64-bit hardware is used for both the 32-bit and 64-bit eDirectory to minimize the differences in the environment as much as possible. The 32-bit SLES 11 (i586) is used to host 32-bit eDirectory and 64-bit SLES 11 (x86_64) is used to host 64-bit eDirectory. Same file system (ext3) is used on both the systems. 64-bit operating systems are deployed with more RAM (16 GB) than 32-bit operating systems (4GB). This is done such that the tests bring out the influences of RAM on performance.

The disk subsystem is the most common bottleneck and influences the performance in a major way. Therefore, it is critical to make sure that disk behaves at the same performance levels across the tests. The database format does not change between 32-bit and 64-bit eDirectory, so the same disk is used in both the environments. The eDirectory database generated is held on the disk at the same location until the tests are executed.

The testing is done on an isolated network with 1 Gbps bandwidth. Figure 1 illustrates the test setup. The Gateway (GW) server is used as a router in this private network.

Figure 1: Test Setup



Server Configuration

Table 1: Server Specifications

Components	Server 1	Server 2
Server	Hewlett-Packard* (HP) Proliant* DL 585	HP Proliant DL 585
Processor	Eight processors Dual-Core AMD* Opteron* Processor 8212 (1 GHz)	Eight processors Dual-Core AMD Opteron Processor 8212 (1 GHz)
Hard drive	Single RAID-0 disk containing: ● Two 146.8 GB, 10K-rpm drives ● 63 GB, partition holding the root file system ● 7.8 GB, swap partition ● 136 GB, ext3 partition where the eDirectory database is hosted	Single RAID-0 disk containing: ● Two 146.8 GB, 10K-rpm drives ● 63 GB, partition holding the root file system ● 7.8 GB, swap partition ● 136 GB, ext3 partition where the eDirectory database is hosted
RAM	4 GB	16 GB
Operating system	32-bit SLES 11 (i586)	64-bit SLES 11 (x86_64)

Client Configuration

Two clients, Client 1 and Client 2 are used. The Search and Modify test cases run exclusively on Client 1. The Bind test cases run exclusively on Client 2.

Table 2: Client Specifications

Components	Client 1	Client 2
Model	HP Proliant DL 385	Dell* Optiplex* 755
Processor	Four processors Dual-Core AMD Opteron (tm) Processor 2214 HE (1 GHz)	One processor Intel* Pentium* 4 processor
RAM	8 GB	2 GB
Operating System	64-bit SLES 11 (x86_64)	32-bit SLES 11 (i586)

Database Configuration

The following table lists the various database sizes that are used in the tests.

Table 3: eDirectory database Size

Test	Number of Users	Size
1	100,000	~650 MB
2	1,000,000	~4 GB
3	3,000,000	~7.1 GB

User Objects

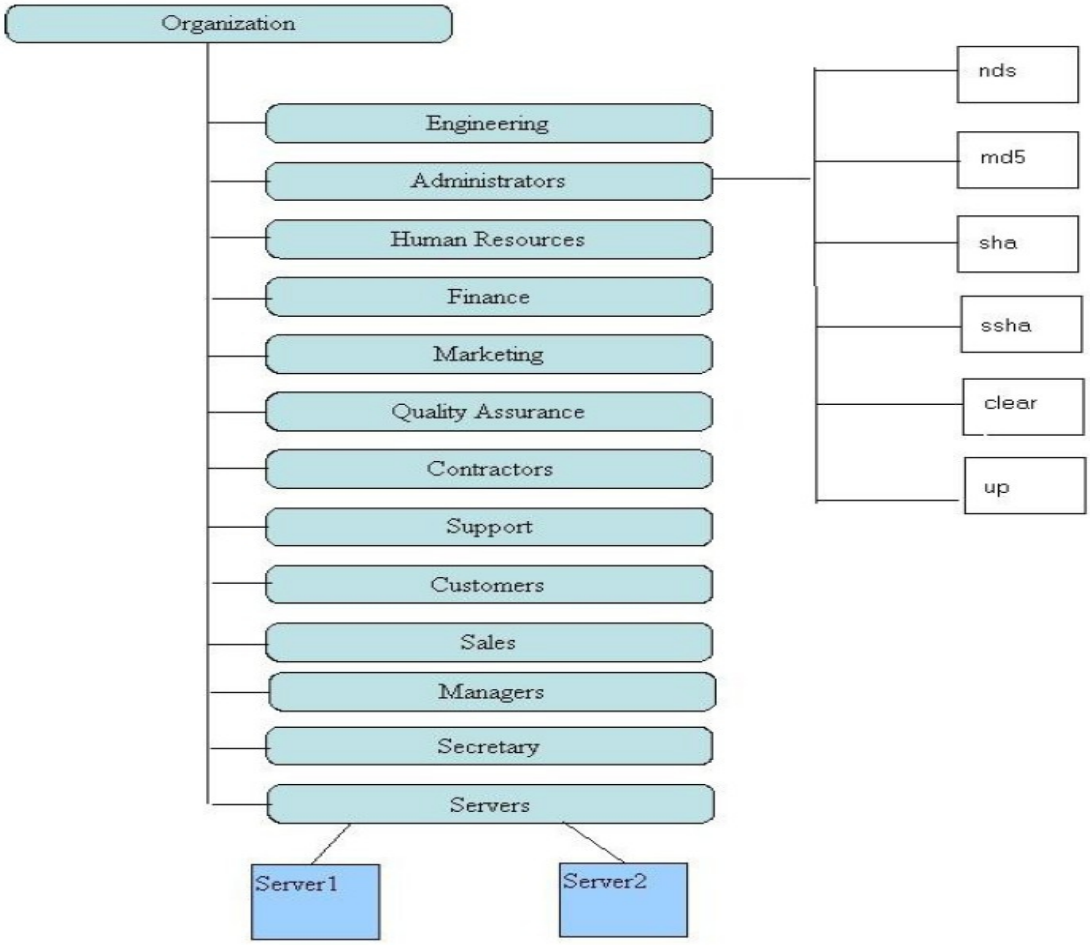
This section provides information about the attributes used for the user objects that are used in these tests.

dn: cn=joe,ou=finance,o=organization
changetype: add
objectclass: inetorgPerson
objectclass: novellPerson
facsimileTelephoneNumber: 800-001-0000
employeeNumber: 8000
telephoneNumber: 800-001-0002
mobile: 800-001-0003
title: Performer
novellCostCentre: 800
sn: surname
givenName: joe
displayName: joel
mail: joe@joe.com
novellPreferedName: joe
preferedLanguage: english
employeeType: star
initials: A B
novellTeamCode: EAGLE
novellStatus: Active
businessCategory: Accountant
ou: ou=finance,o=organization
co: England
uid: uname
manager: cn=jack,ou=managers,o=organization
secretary: cn=jill,ou=secretary,o=organization
admin: cn=hill, ou=managers,o=organization
hr: cn=pale,ou=secretary,o=organization
helpdeskengineer: cn=water,ou=managers,o=organization

Tree Structure

Figure 2 illustrates the tree structure that is used for testing.

Figure 2: Directory Tree Structure



Tests Conducted

This section provides more information about the actual tests conducted.

The following table lists the LDAP operations performed on the servers for each test.

Table 4: LDAP Operations

LDAP Operation Name	*Description*
Base Search	Returns one attribute, which is the common name (CN) of a user using a filter (objectClass=*).
Subtree Search	A one-level search that returns the CN of a distinct user, using a filter (CN=$UserName) where $UserName is the distinct name of the user.
Modify an Attribute	Modifies an attribute on distinct user objects (in this case, the Title attribute).
Bind with NDS password	Simulates a Bind with the NDS password.
Bind with NMAS Login (UP)	Simulates a Bind with the NMAS Login, using the Universal Password policy.

The Search and Modify operations workloads are generated by using the DirectoryMark tool (http://www.mindcraft.com/directorymark/). However, the Bind operation workload is generated from an internal test suite. Multiple instances of these suites are introduced as necessary. In all cases, it was ensured that the clients and the servers do not run into more than 90 percent processor utilization.

The following table provides the details about the number of simultaneous LDAP connections maintained for the various test cases.

Table 5: Test Cases and Connections Used

Test Case	*Number of Concurrent LDAP Connections*
Base search	5000
Subtree search	5000
Modify of an attribute	200
Binds with users having up password	100
Binds with users having NDS password	100

While the tests run for a fixed interval of time, they also operate on unique objects in the Novell eDirectory database. Thus, every attempt is made to generate a random workload. Although the number of connections appear the same throughout the tests, the total number of connections spawned can vary based on the response time of the server and the size of the eDirectory database. For the Search and Modify tests, Binds are performed at fixed points in the tests. Login updates are also enabled. This means that the nature of the tests vary based on the eDirectory database size. The location of the eDirectory database on the disk changes with different eDirectory databases. Therefore, the results obtained for a given eDirectory database size cannot be compared with results obtained against other eDirectory database sizes.

The database entry cache-to-block ratios are set at 70:30. Typically, such a setting is used in a read-intensive deployment. When the database cache is increased on a system with less RAM, the entry cache begins to eat up the space originally consumed by file system cache. This also means that the database block cache is always short of caching the three million database fully on all the tests. This ratio is maintained for all the tests.

The number of operations per second is measured and used for comparison. Each test is run three times for a duration of four minutes. Whenever the database block cache cannot hold the complete DIB, the tests always result in database block cache faults. This 4-minute duration is good enough to ensure that such faults happen. The first iteration is typically the priming phase where the cache is warmed up. The best of the subsequent runs is used for comparison.

Test Results

Database with 100,000 Objects

In this scenario, eDirectory database is so small that it is always cached in the file system cache. As the database cache increases, the block cache hit ratios improve and result in a very small improvement in performance. Both the versions perform equivalently. The margin of error in tests can be considered as 10 percent.

The following table and the subsequent graphs (Figure 3, Figure 4, and Figure 5) illustrate the performance data. The values are in transactions per second (TPS).

Table 6: Performance Results with One Hundred Thousand Users

Test Case	*Cache for 32-Bit (GB)*					*Cache for 64-Bit (GB)*							
	0.5	**1**	**1.5**	**2**	**2.5**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**10**
Base Search	8676	8712	8678	8732	8882	8816	8856	8963	8900	9160	9120	9423	9236
Subtree search	7677	7813	7842	7765	7912	7923	7956	8048	7878	7986	7947	8014	8028
Modification of indexed attribute	712	720	740	801	786	745	849	873	846	797	888	876	840
Bind with NDS password	19167	19167	19167	20000	21250	18518	18867	18518	18867	18867	20408	18518	19230
Bind with NMAS login (UP)	936	932	928	932	930	959	957	963	963	963	959	968	957

Figure 3: Performance Data with One Hundred Thousand Users

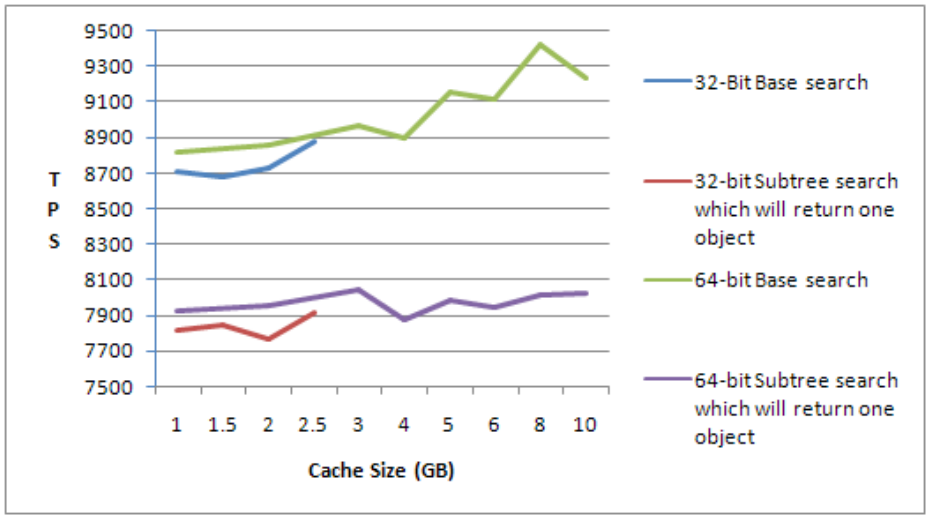


Figure 4: Performance Data with One Hundred Thousand Users

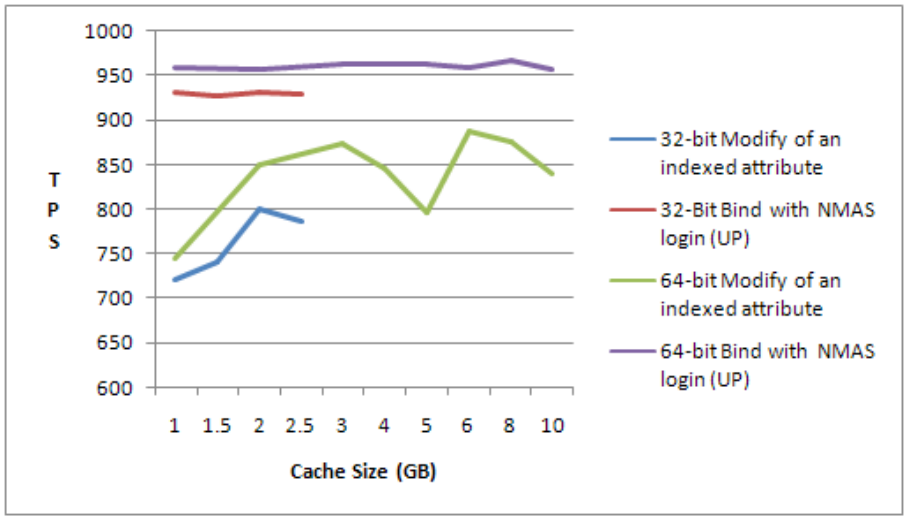
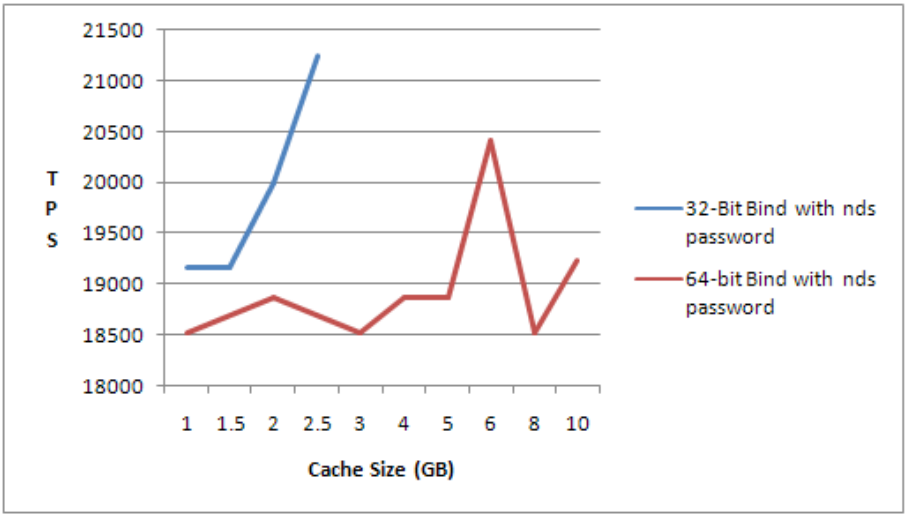


Figure 5: Performance Data with One Hundred Thousand Users



Database with 1,000,000 Objects

An attempt is made to pollute the file system with other files, then the eDirectory database is copied. This is to see how disk seek times can impact the directory performance.

This eDirectory database is large enough to be cached on the 32-bit eDirectory. As the database cache increases, the disk utilization increases. This is because the database entry cache begins to eat up on the space consumed by the file system cache. Therefore, the 32-bit eDirectory numbers begin to slide as the database cache increases.

This eDirectory database can be cached completely on the 64-bit eDirectory. At any time, the sum of the file system cache holding the eDirectory database and the database block cache is enough to hold the entire database in memory. As the database cache increases, the hit ratios on the database block cache also increase. This results in an improved performance for 64-bit eDirectory.

The following table and the subsequent graphs (Figure 6, Figure 7, and Figure 8) illustrate the difference in performance. The values are in transactions per second (TPS).

Table 7: Performance Results

Test Case	*Cache for 32-Bit (GB)*					*Cache for 64-Bit (GB)*							
	0.5	**1**	**1.5**	**2**	**2.5**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**10**
Base Search	8161	5841	5296	3544	2267	8298	8239	8336	8244	8379	8940	9120	11575
Subtree search	4250	5335	4748	3345	1962	7386	7168	7520	7605	7976	7892	7521	10282
Modification of indexed attribute	566	632	651	693	621	733	751	681	754	779	688	614	789
Bind with NDS password	10416	10869	11494	10752	11111	11764	11764	11627	12658	11111	11764	11627	12048
Bind with NMAS login (UP)	795	824	818	824	819	892	856	877	882	892	888	840	894

Figure 6: Performance Data with One Million Users

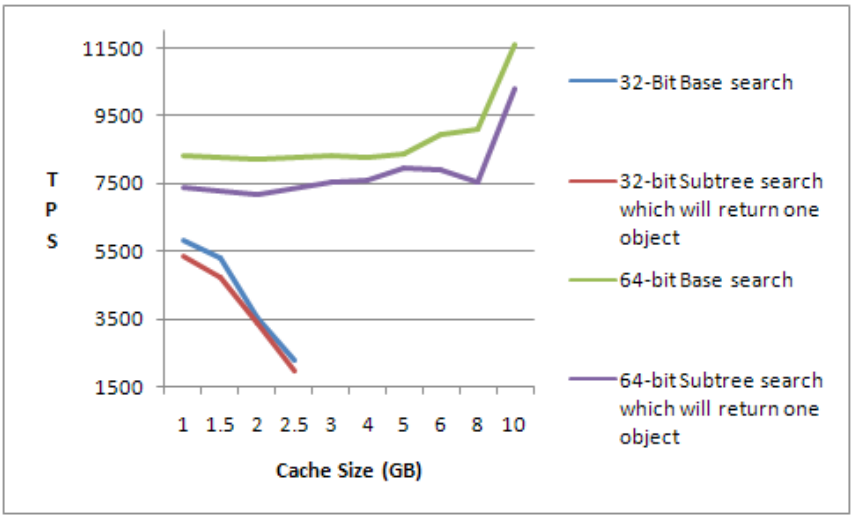


Figure 7: Performance Data with One Million Users

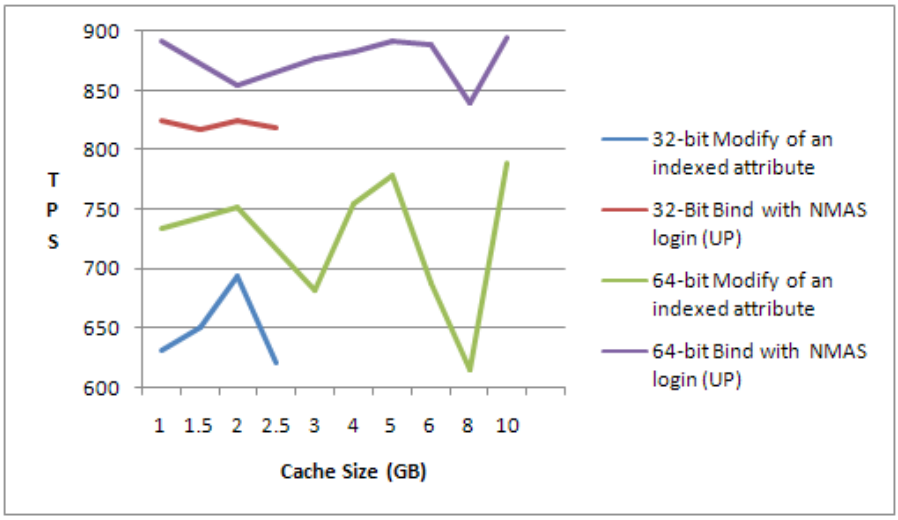
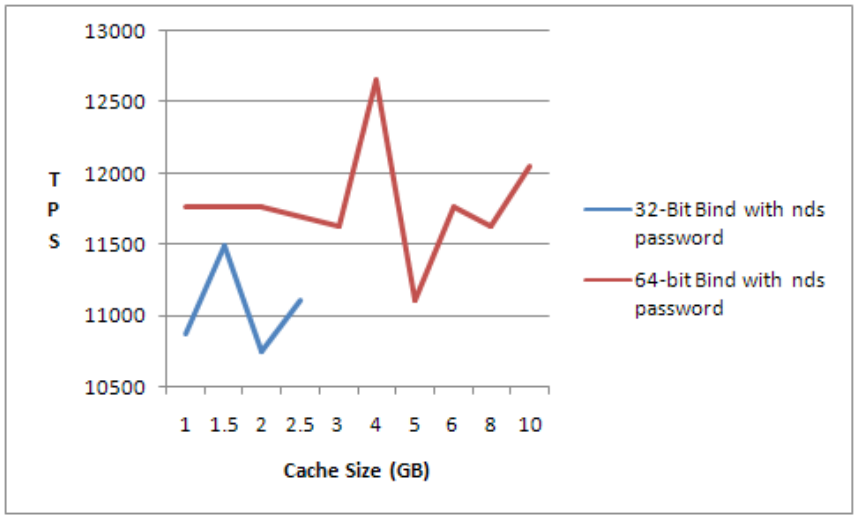


Figure 8: Performance Data with One Million Users



Database with 3,000,000 Objects

This eDirectory database is very large to be cached on the 32-bit eDirectory. As the database cache increases, the disk utilization increases because the database entry cache begins to eat up on the space consumed by file system cache. Therefore, the 32-bit eDirectory numbers begin to slide as the database cache increases.

This eDirectory database can be cached completely inside the 64-bit eDirectory database. The amount of memory required to cache the complete database in the block cache is nearly the size of the database on the disk (7.1 GB).The amount of memory required to cache the complete database in the entry cache is two to four times the database size on the disk. In this case, the entry cache is slightly greater than two times the size of the block cache. The cache ratios in all the tests are set to 70:30. Therefore, to cache the complete eDirectory database requires approximately 22 GB of database cache. However, the system has only 16 GB of RAM. If the

tests are run with a larger database cache so that the sum of the file system cache holding the database and database block cache is less than the size of the database, the numbers would dip. However, tests are run up to 10 GB of cache.

These tests are run without polluting the disk in any way, unlike the 1,000,000 object tests.

The tests reveal significant improvement in the performance of 64-bit eDirectory. For example, a comparison of the best numbers for the Base Search test shows 64-bit eDirectory performing approximately 35 percent better than the 32-bit eDirectory.

The following table and the subsequent graphs (Figure 9, Figure 10, and Figure 11) illustrate the difference in performance. The values are in transactions per second (TPS).

Table 8: Performance Data with Three Million Users

Test Case	***Cache for 32-Bit (GB)***					***Cache for 64-Bit (GB)***							
	0.5	**1**	**1.5**	**2**	**2.5**	**1**	**2**	**3**	**4**	**5**	**6**	**8**	**10**
Base Search	5354	6985	5562	4184	3777	8664	9046	9193	8900	9148	9133	9370	9293
Subtree search	6142	6712	5763	4981	2538	7824	7833	7971	7746	7990	7890	7672	7829
Modification of indexed attribute	716	742	738	744	781	772	847	814	829	780	836	741	843
Bind with NDS password	18181	17543	17241	17543	18181	19230	18518	18867	18518	19230	19230	18181	19607
Bind with NMAS login (UP)	866	905	898	905	909	943	948	930	943	934	934	941	932

Figure 9: Performance Data with Three Million Users

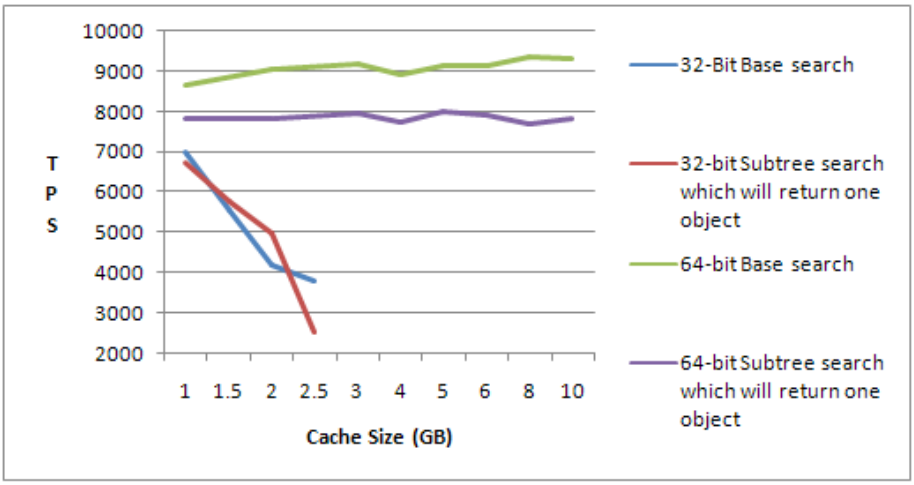


Figure 10: Performance Data with Three Million Users

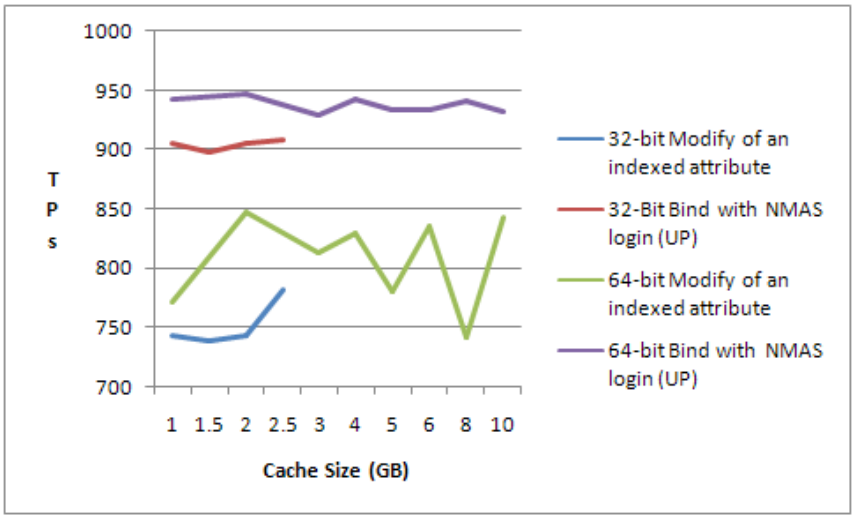
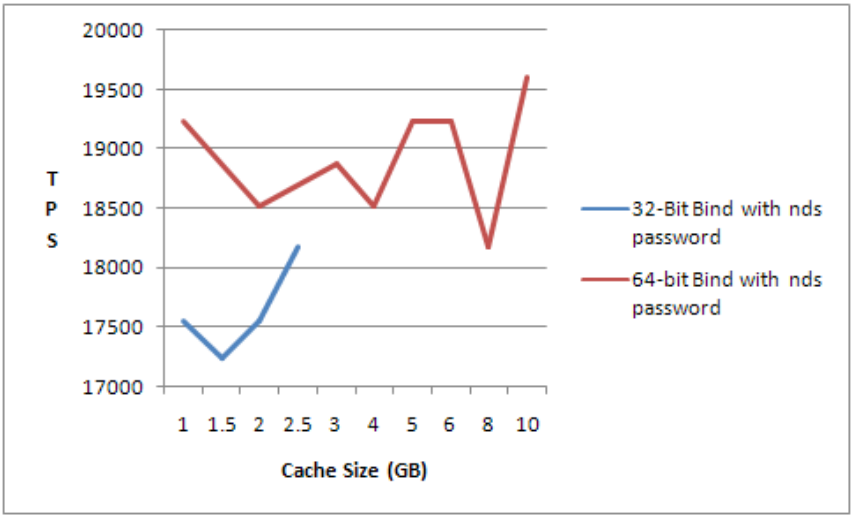


Figure 11: Performance Data with Three Million Users

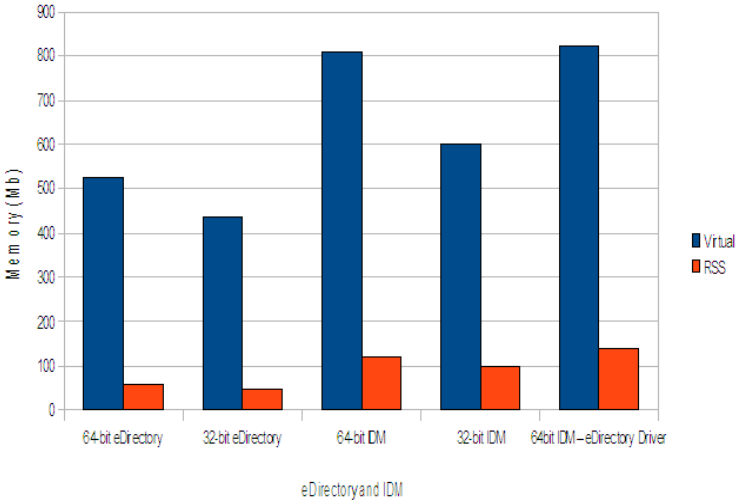


Memory Footprint Comparison

One of the downsides of the 64-bit binary is the increased memory footprint. For example, each pointer reference is eight bytes in a 64-bit deployment versus four bytes in a 32-bit deployment.

Figure 12 shows the average memory usage of Novell eDirectory and Novell Identity Manager. These values are taken after configuring eDirectory and Identity Manager instances that have only default configuration data. As seen, the 64-bit deployment consumes 22 percent more memory than that of a 32-bit deployment.

Figure 12: Process Memory Footprint



The increase in memory footprint can cause a decrease in the processor cache efficiency. This is because of the high number of cache misses caused by the increase in working set size. It is recommended to use systems with larger L2/L3 caches for optimal performance of 64-bit eDirectory.

Conclusion

From a Novell eDirectory perspective, the results for both the 64-bit eDirectory and 32-bit eDirectory are similar when the database is completely cached by using the eDirectory database cache and the file system cache. However, this is possible only for smaller database. It is not possible to cache databases larger than 2 GB to 3 GB on a 32-bit eDirectory. The performance gains from using a 64-bit version with sufficient RAM are quite high for larger databases.

Terminology

- TPS – Transactions Per Second
- OPS – Operations Per Second
- RSS – Resident Set Size