Exchange Server 2007 Performance Comparison of the Dell PowerEdge 2950 and HP Proliant DL385 G2 Servers

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Section 1

Executive Summary

Different applications put different demands on the various components of a server. Depending on the architecture of a given server, the best configuration for a particular application may vary from system to system resulting in advantages in one platform over another for certain applications or workloads.

While the Dell PowerEdge 2950 and the HP Proliant DL385 G2 are both two-socket x86-based servers, they are based on different processor-to-memory interconnect technologies. This difference can result in very different application performance when cost- and energy-efficient one processor configurations are compared. For example, the Dell TechCenter lab ran tests simulating 4000 email users, and determined that running Exchange Server 2007 on the HP DL385 G2 server can cost up to 21% more than on the Dell PowerEdge 2950.

The difference in cost is due to the ability of the Dell PowerEdge 2950 to access all of the server memory banks with only one processor socket populated, while the DL385 G2 must have both sockets populated to access all server memory banks. Running Exchange Server 2007, which is a workload that uses memory and disks more intensively than the processors, illustrates the difference between the servers tested. The performance of Exchange Server 2007 running on the Dell PowerEdge 2950 with only one socket populated was not significantly different than a two-processor configuration, but the DL385 G2 with only one socket populated was only able to support half the number of users it could with two sockets populated.

Section 2

Introduction

Servers based on the Intel x86 instruction set have provided huge gains in performance and price-performance since they were first introduced. It is often assumed that all of these servers will provide the same performance given that they are configured with the same options. Depending on the type of application running and the architecture of the specific server, the performance and price/performance can be quite different.

To illustrate the potential difference between two similar servers running Exchange Server 2007, a Dell PowerEdge 2950 and an HP Proliant DL385 G2 were tested in the Dell Technology Center Lab in April 2007. Both servers were tested with both processor sockets populated, 16 GB of RAM, and the same disk subsystem. Because Exchange is not a processor intensive application, both servers were then tested again with only one processor socket populated. With the Dell PowerEdge 2950, the server could still use all of the eight memory banks. With the HP Proliant DL385 G2 the server could use only half of the memory banks because of the processor to memory architecture. In the HP DL385 G2, the memory banks are divided evenly between each of the processors, with four memory banks directly linked to each of the processors. In the Dell 2950, all eight memory banks are connected to the processors over a shared connection or bus.

If it is possible to run an application with only one processor and still achieve similar performance as with two processors, then not only is the cost of the additional processor saved, but the energy consumed by that second processor is also saved.

While it is possible to configure the DL385 G2 with 16 GB of RAM using four 4GB memory modules with only one processor socket populated and its associated four memory banks, the cost of the memory in this configuration is very expensive because 4GB memory modules must be used. It is more cost effective to populate both processor slots and use the lower cost 2GB memory modules. For this reason, the DL385 G2 with 1 socket populated and 16GB of RAM was not tested.

Exchange Server 2007

The two key factors in providing excellent performance for an Exchange 2007 Mailbox server are memory and disk. All other server aspects are secondary to these.

Microsoft Exchange Server 2007 represents a major upgrade in capabilities and architecture for Microsoft's enterprise messaging solution. This new version of Exchange introduces new server roles and is only available in a 64-bit version for production (32-bit will be available for testing). The new server roles dictate that organizations must take a close look at how to best migrate from existing Exchange deployments to take advantage of the new architecture options. The 64-bit nature of Exchange 2007 allows for customers to no longer have to deal with the 4GB limit of 32-bit applications that applied to previous versions of Exchange. Exchange 2007 can fully address and utilize all 16GB of RAM in the servers compared in this white paper.

The ability of Exchange to address more RAM has allowed for the actual number of Input/Output operations Per Second (IOPS) to disk to decrease because more read operations can be handled by information that is cached in RAM. While this reduces the load on disk to a certain extent, it is still a key resource that must be sized properly for an Exchange 2007 server.

Dell PowerEdge 2950

The Dell PowerEdge 2950 is a two-socket server supporting up to 32 GB of RAM, with 3 expansion slots and up to eight internal disks. The 2950 uses the Intel Xeon 5000, 5100, or 5300 series of processors. These processors use a Front Side Bus (FSB) to connect to memory. All processors must go across the FSB to connect to RAM. See Figure 1 for a simplified view of this processor and memory architecture.

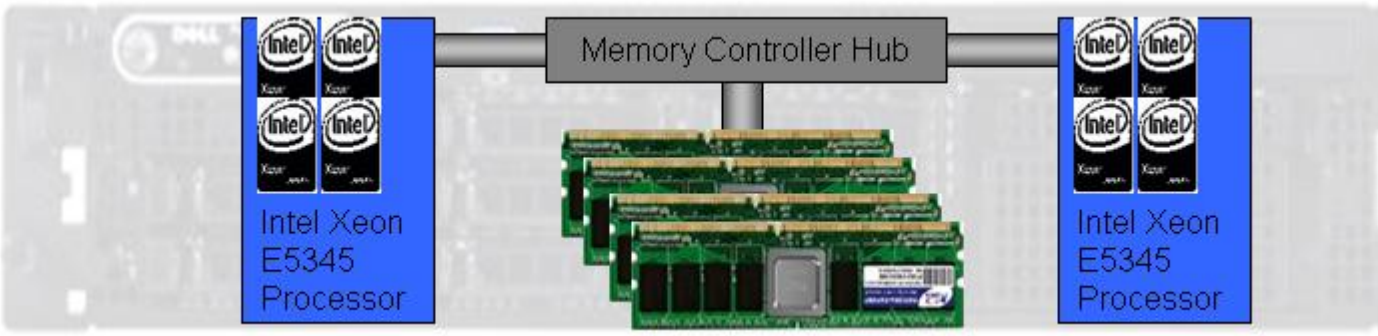

Figure 1 Simplified processor and memory architecture in Dell PowerEdge 2950.

HP Proliant DL385 G2

The HP Proliant DL385 G2 server is a two-socket server that supports up to 32GB of RAM, with 4 expansion slots, and up to eight internal disks. The DL385 G2 uses the Opteron 2000 series of processors. These are dual-core processors that utilize the Direct Connect Architecture with HyperTransport to directly link processors to memory. This means that each processor has a direct link to RAM, and if a processor needs to access RAM that is linked to a different processor, the high-speed HyperTransport link between processors is used. A simplified diagram of this architecture is shown in Figure 2.

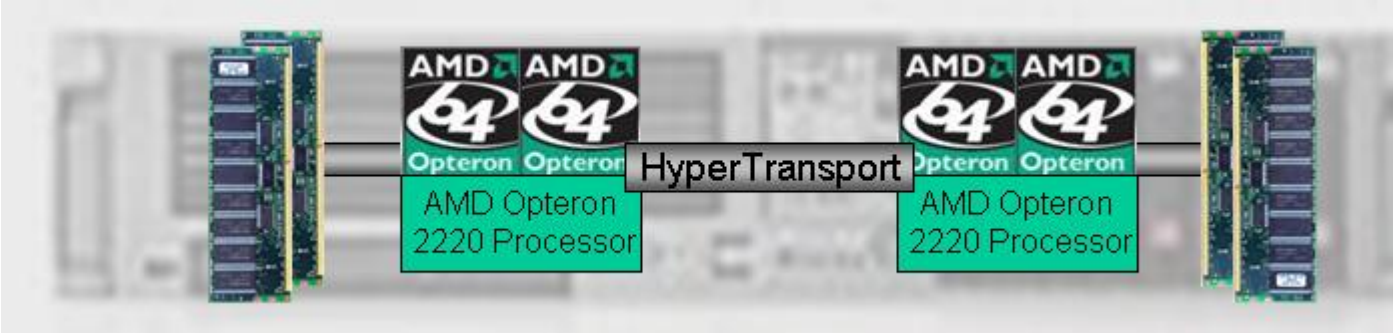

Figure 2 Simplified processor and memory architecture in HP Proliant DL385 G2.

Section 3

Test Configuration

The documentation of the complete test configuration for this comparison has been organized into the areas of server hardware, SAN storage, Exchange Server, and the test program - LoadGen. In all configuration options, every attempt was made to ensure that the test would allow for the PowerEdge 2950 and ProLiant DL385 G2 servers to be compared with all configuration options set up equally.

Server Hardware

The servers compared in this paper are both two-socket rack based systems that have been configured with the most powerful processors available for their respective platforms within their standard processor types. Both servers also have a higher speed processor available at a higher cost that consumes more power, and has been classified as high-performance. Exchange is not an extremely processor intensive application, so the additional cost and power consumption of the processors offered at the highest end were viewed to outweigh the performance gained from faster processor speed, and were not used in the testing.

	HP Proliant DL385 G2	Dell PowerEdge 2950
Operating System	Microsoft Windows Server 2003 R2 Enterprise x64 Edition	Microsoft Windows Server 2003 R2 Enterprise x64 Edition
CPU	2 x 2.8 GHz Dual-core AMD Opteron 2220 with 2MB Cache	2 x 2.33 GHz Quad-Core Intel Xeon E5345 with 8MB Cache
Memory	16 GB (8 x 2 GB DDR2 DIMMs)	16 GB (8 x 2 GB FB DIMMs)
Internal Disks	2 x 146 GB 10K RPM SAS	2 x 146 GB 10K RPM SAS
NICs	2x 10/100/1000 Mb/s (Internal)	2x 10/100/1000 Mb/s (Internal)
Disk Controller	SmartArray E200	PERC 5/i
Fiber Channel HBA	Qlogic QLE 2462 - dual port FC2 PCI-Express	QLogic QLE 2462 – dual port FC4 PCI-Express
Remote Management	HP insight Lights Out (iLO) Advanced Pack	Dell Remote Access Card, 5th Generation
Service	3-Year HP Care Pack w/ 7x24, 4 Hour Response, Onsite Service	3-Year Silver Support w/ 7x24 , 4 Hour Response, Onsite[1] Service
Hardware Price (without HBAs)	$14,181	$12,955
Source	http://www.hp.com 4/20/2007	http://www.dell.com 4/20/2007

Table 1: Comparison of Configuration and Hardware Pricing of HP Proliant DL385 G2 server vs the Dell PowerEdge 2950 server as of 4/20/07.

The Dell PowerEdge 2950 was configured with two 2.33 GHz quad-core Intel Xeon E5345 processors. Each processor has 8 MB of L2 cache. The HP Proliant DL385G2 was configured with two AMD Opteron 2220 dual-core 2.8 GHz processors with a 2MB cache. Both systems were installed with 16 GB of RAM, 2 internal disks, and remote access capabilities. Detailed system configurations are shown in Table 1.

The system configuration for each server was modified only slightly for the second round of testing. One processor was removed from the Dell PowerEdge 2950. One processor and the 8 GB of RAM that was connected to that processor were removed from the HP Proliant DL385 G2.

Although it would be possible to use 4GB memory modules to get the DL385 G2 up to 16GB of RAM with only a single processor socket populated, the cost would be much higher than the cost of a second processor and 8GB worth of 2GB memory modules.

List prices of the two systems are shown in Table 1. Pricing of the configurations did not include the SAN hardware or software.

SAN Storage

Storage for both the Dell and HP servers was provided by a Storage Area Network (SAN)-attached Dell/EMC CX3-80 fibre channel storage array. Each server was attached to the SAN via a dual-port QLogic 2462 Host Bus Adapter.

Each server was assigned to a set of storage logical units (LUNs) that used the same number and type of disk drives. The EMC compatibility matrix (available at http://www.emc.com/interoperability/index.jsp), which includes both the Dell PowerEdge 2950 and HP ProLiant DL385 G2, was consulted to ensure that the proper versions of drivers and firmware were utilized on both servers. The 9.1.4.15 version of the QLogic 2462 driver for Windows and PowerPath® 4.5.0 for Windows was installed on both servers. PowerPath provides load-balancing and failover for the dual connections from the HBA to the storage. The storage components used for both servers in the test are shown in Table 2.

Controller	1 Dell/EMC CX3-80
Disk Enclosures	4 Dell/EMC DAE3P
Disks	30 x 73 GB/ 15K RPM
LUNs	2 10-Disk RAID 1/0 LUNs for Mailbox Databases 2 2-Disk RAID 1 LUNs for Logs 1 5-Disk RAID 5 LUN for mailbox database backup 1 HotSpare Disk
Software	Navisphere® Manager Access Logix™ PowerPath

Table 2: Dell/EMC Storage

Exchange Server 2007 Setup

Both servers were installed with Windows Server 2003 x64 Enterprise Edition and Exchange Server 2007 Enterprise Edition on a RAID 1 logical disk setup on the internal drives. The Mailbox, Client Access, and Hub Transport Exchange server roles were installed on both the 2950 and DL385G2 servers. In a standard production environment, these roles would be split out onto separate servers. In order to keep the test environment as simple as possible and to keep the focus of the test on the two individual servers, all of these required roles were installed on both servers. The mailbox role is the primary function that was stressed in this test.

Both the PowerEdge 2950 and Proliant DL385 G2 joined the same Windows domain, meaning that the domain controller and DNS server were the same for both systems. The domain controller for this environment was a 32-bit Windows Server 2003 virtual machine running on a Dell PowerEdge 1855 blade server. All systems were connected to the same gigabit Ethernet switch and were in the same subnet.

Preparing for Exchange Server 2007 installation requires that all prerequisite software and patches be installed. This included the common files for IIS and the world wide web (www) service, .Net Framework 2.0, Microsoft Management Console 3.0, Windows PowerShell, a MDAPS.DLL update, and a TCP/IP update.

With all of the prerequisites installed, the installation of Exchange was straightforward and can be done from either a GUI or the Exchange Management Shell. To simplify installation of the Exchange servers the Exchange Management shell was used with the following command:

```
Setup /mode:install /roles:ca,mb,ht /on:TechCenter
```

After completing the setup of Exchange, eight storage groups, each with a single mailbox database, were set up on the SAN based LUNs. Four storage groups were placed on each of the ten disk RAID 1/0 mailbox database LUNs. The logs for the storage groups were also split across two RAID 1 LUNs. A screenshot of the Exchange 2007 Management Console after the storage groups were created is shown in Figure 3.

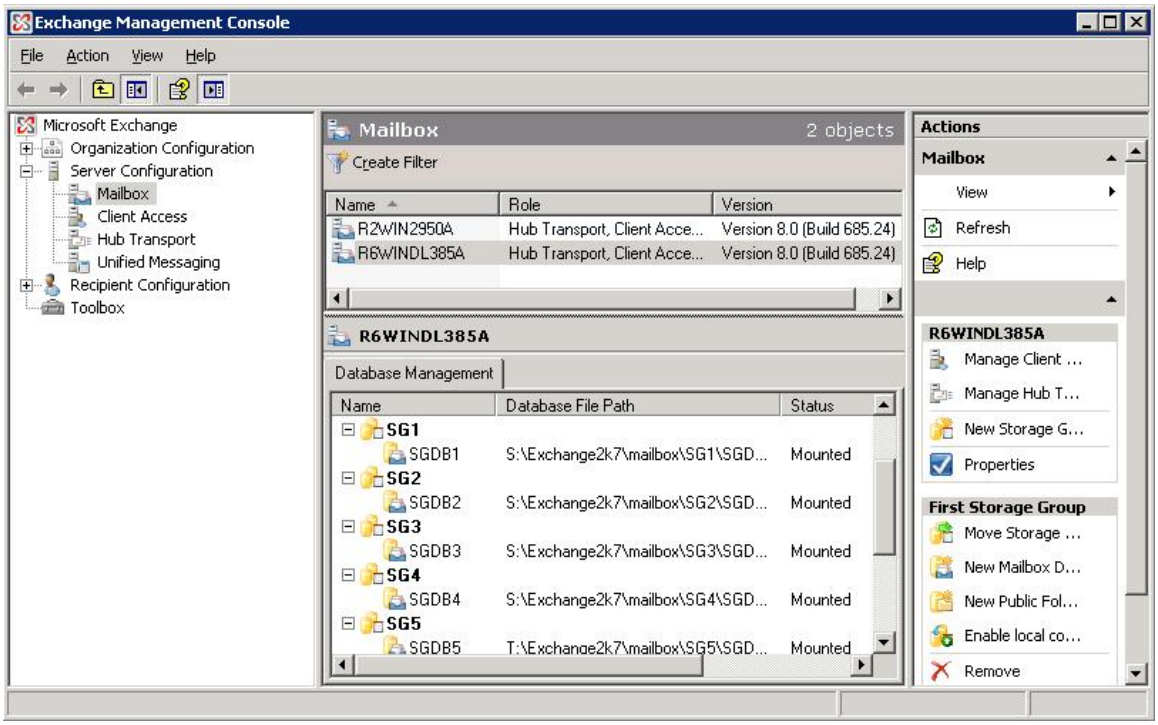

Figure 3 Exchange Management Console

Exchange Load Generator Testing Tool

With previous versions of Exchange Server, Microsoft provided a load simulation tool called LoadSim that was widely used to model and test servers. With Exchange 2007, Microsoft has replaced LoadSim with a new tool called Exchange Load Generator (LoadGen), which is similar in function but promises to provide more realistic sizing.

LoadGen simulates a number of MAPI (Mail Application Program Interface) clients accessing their email on Exchange servers. The configuration of LoadGen is controlled with an XML file that specifies all the attributes that the simulated clients will have. Included with LoadGen are profiles for medium, heavy, MMB3 and MMB4 workloads. The MMB3 and MMB4 workloads are for Microsoft's benchmark for Exchange 2003 and 2007 respectively. For the testing in this server comparison the heavy workload profile was used with approximately a 100MB mailbox size per user.

The server configurations were sized to host approximately 4000 users. This is based on the size of the mailbox databases, amount of disks, and amount of RAM in the systems. Some initial testing was done, varying the number of users, which confirmed that the disk subsystem and servers were correctly sized for this configuration.

In order to reach 4000 users, each of the eight storage groups were configured with 500 users using the LoadGen configuration tool. Figure 4 is a screen shot of the LoadGen console showing the number of users configured for each storage group. Once the users were configured in LoadGen, it then created the needed Exchange users on the servers. Once the user creation was completed and the LoadGen profile was specified, LoadGen initialized the test environment by pre-populating all the mailboxes. This process took about eight hours to complete.

Following this, Exchange indexed all of the mailboxes, which took several more hours to complete. After this completed the systems were ready for testing.

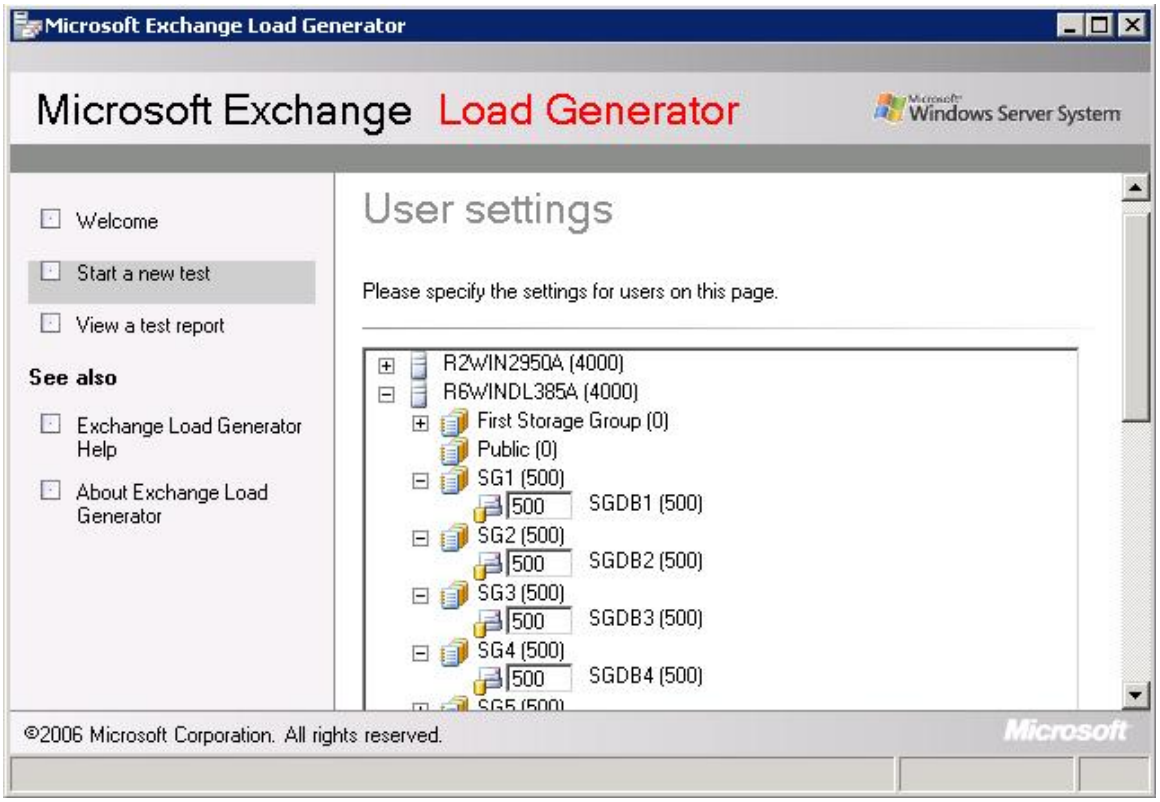

Figure 4 Microsoft Exchange LoadGen Console

Because of the lengthy process of getting a LoadGen test initialized, it is a good idea to make a backup of the mailbox databases after the initialization completes. It takes about an hour to back up or restore the 4000 user environment configured for this test, which is much shorter than the 10 or more hours to initialize and index.

The system used as the LoadGen server, to generate load against the two systems being tested, was another PowerEdge 2950 server with the same configuration as the Exchange server 2950 that was detailed earlier in Table 1. It was also installed with Windows Server 2003 x64 Enterprise Edition, joined to the same domain, installed with all the prerequisites for Exchange 2007, and the Exchange Server 2007 management server role. LoadGen requires the Exchange Server 2007 management role as a prerequisite, which means that all of the Exchange prerequisites are also required.

Section 4

Results

LoadGen reports results in terms of average latency for a range of typical operations performed by email users. Examples are logon, send mail, create contact, browse calendar, and request meeting. In order to determine the relative performance of the systems tested, the best performing system was used as the standard and all others were compared to it in terms of percentage slower average latency. Each category that LoadGen reported average latency for was compared to calculate the relative difference. The relative differences were then averaged to come up with a single number. Table 3 summarizes the results.

	PowerEdge 2950	PowerEdge 2950	Proliant DL385 G2	Proliant DL385 G2	Proliant DL385 G2	Proliant DL385 G2
Processors / Cores	2 / 8	1 / 4	2 / 4	1 / 2	1 / 2	1 / 2
RAM	16GB	16GB	16GB	8GB	8GB	8GB
LoadGen Heavy Users	4000	4000	4000	4000	3000	2000
Average CPU Utilization %	11%	12 %	11 %	23 %	21 %	15 %
Average % Longer Latency	Best Performing	3%	8%	109%	36%	7%
Server HW and OS Price	$12,955	$11,706	$14,181	$11,030	$11,030	$11,030
Server Cost Per User	$3.24	$2.93	$3.55	$2.76 (Perf. Not on Par)	$3.68 (Perf. Not on Par)	$5.51

Table 3 Results of PowerEdge 2950 and DL385 G2 comparison testing with Exchange 2007.

The testing results show that the system configurations with 16GB of RAM were able to provide similar performance in supporting 4000 heavy LoadGen users (all within 10% of the best performing configuration). When a processor was removed from the PowerEdge 2950, only a 3% increase in latency was found. When a processor was removed from the Proliant DL385 G2, and half of the RAM due to the processor and memory architecture of this server, the result was over a 100% increase in latency. In order to get the performance of this server back to within 10%, the number of users had to be reduced by half. The PowerEdge 2950 was able to host twice the number of users as the DL385 G2 when both servers were populated with one processor.

An easy way to determine the best configuration is to calculate the cost per user. The Exchange user licensing, SAN storage costs, and network infrastructure

costs are not included because they are the same for both systems. This cost is the price for the hardware and OS as priced from the respective company websites. This cost per user calculation shows that the HP Proliant DL385 G2 when configured with two processors and 16GB of RAM costs 21% more than the Dell PowerEdge 2950 server when configured with one processor and 16GB of RAM to support the same 4000 Exchange 2007 users.

Section 5

Conclusions

The architecture of the Dell PowerEdge 2950 makes it a better platform for running Exchange Server 2007 than the HP ProLiant DL385 G2. Although both systems are similar in many ways, the specific performance requirements of Exchange Server 2007 are much more heavily dependent on RAM than processor. A single processor socket on the Dell PowerEdge 2950 is able to utilize all the memory banks in the server, but an HP Proliant DL385 G2 must have both processors in the system to use all memory banks. This difference causes the DL385 G2 to be 21% more expensive than the 2950 to support the same 4000 Exchange users while maintaining similar performance. The DL385 G2 was only able to support half the users with a reduced configuration, meaning that it was not able to provide the cost and power savings that the 2950 was able to provide.

Section 8

Acknowledgements

The author would like to thank Casey Birch, Suman Singh, and Clint Espinoza for the valuable Exchange guidance and discussions.