THE TOLLY GROUP

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Linksys®, A Division of Cisco Network Storage System NSS6100

Four Bay, 1TB Advanced Gigabit Chassis with RAID Competitive Performance Evaluation of Network-Attached Storage Systems

TOLLY Up to Spec CERTIFIED Test Summary

Premise: In networks of all sizes, data backup, consolidation and redundancy provides tangible benefits to end users in terms of data security and availability. Consolidating and backing up data to a network-attached storage system is becoming increasingly affordable and accessible to SMB users. Network administrators need reliability and redundancy to minimize the possibility of end-user downtime.

Linksys, a division of Cisco Systems, Inc., commissioned The Tolly Group to evaluate the performance and features of the NSS6100 network-attached storage appliance against NETGEAR's ReadyNAS™ 1100, and ReadyNAS™ NV+; along with Buffalo Technology (USA), Inc.'s TeraStation PRO™ II appliances.

The Tolly Group examined the NAS appliances' multi-client file server performance using Ziff Davis Media's NetBench 7.0.3 benchmarking test suite. As a baseline to compare against other single-client I/O tests, engineers also evaluated the single client read-and-write mode I/O performance using IOZone benchmark version 3.282. Tests focused on RAID 1, RAID 5 and JBOD configurations, and with on-disk encryption enabled, when supported.

Tests were conducted in December 2007.

Test Highlights

- Achieves highest peak throughput and average response time of the devices tested under the NetBench File Server performance benchmark using up to 32 clients simultaneously
- Sustains high file server performance with near-linear increase in the average response time as the number of clients simultaneously accessing the device ramps up from 1 to 32
- Suffers minimal performance degradation of file server performance even with file encryption enabled in RAID 1 and RAID 5 modes
- Offers users versatile deployment options - RAID 1 and RAID 5, among other RAID modes not tested, like 0, 1+spare, and 10, along with file encryption support (tested under RAID 1 and RAID 5) and JBOD modes

Feature Comparison of Network-Attached Storage Systems Under Test

	Linksys NSS6100	NETGEAR ReadyNAS 1100	NETGEAR ReadyNAS NV+	Buffalo TeraStation Pro II
Advanced Availability Features				
Redundant Power Supply Unit Option	Y	N	N	N
Dual Gigabit Ethenet Ports	Y	Y	N	N
HDD failure detection (SMART support)	Y	Y	Y	N
Failed Drive Locator	Y	N	N	Y
Dual Firmware Images	Y	N	N	N
Advanced NAS Features				
JBOD	Y	N	N	N
RAID 10	Y	N	N	Y
File System Virtualization	Y	N	N	N
Multiple VLANs	Y	N	N	N
On Disk Encryption (AES)	Y	N	N	N

Source: The Tolly Group, December 2007

Figure 1

Executive Summary

Linksys NSS6100 NAS system offers users a strong suite of software functionality, along with high performance, versatile deployment options and data security using on-disk encryption.

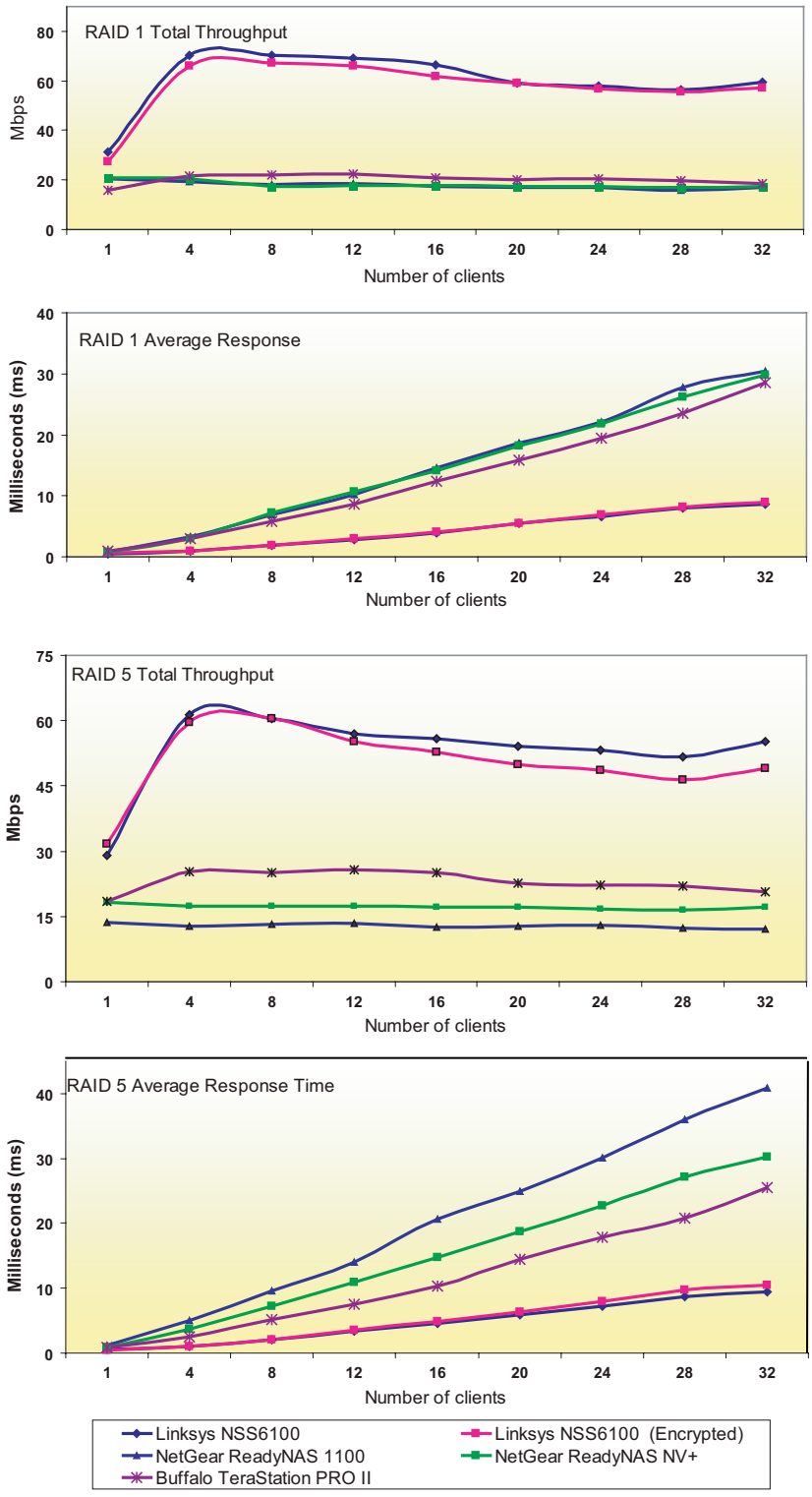
Tolly Group engineers compared the Linksys NSS6100 against NETGEAR's ReadyNAS NV+ and ReadyNAS 1100, and Buffalo Technology (USA)'s TeraStation PRO II. All devices were configured with up to 2 Terabytes (TB) of total storage capacity under RAID 1, RAID 5 and JBOD (Just a Bunch of Disks, meaning all the disks appear as one logical disk - supported only on the NSS6100) modes.

The Linksys NSS6100 offered the highest throughput and best overall average response time of the devices under test (DUTs) using the NetBench File Server benchmark, under RAID 1 and RAID 5 modes.

As shown in Figure 2, the NSS6100 not only provided better performance than the other DUTs, but also maintained the performance with increasing number of clients accessing it simultaneously. Performance of the NSS6100 suffered only slightly when on-disk encryption was enabled, all the while out-performing other DUTs operating without disk encryption.

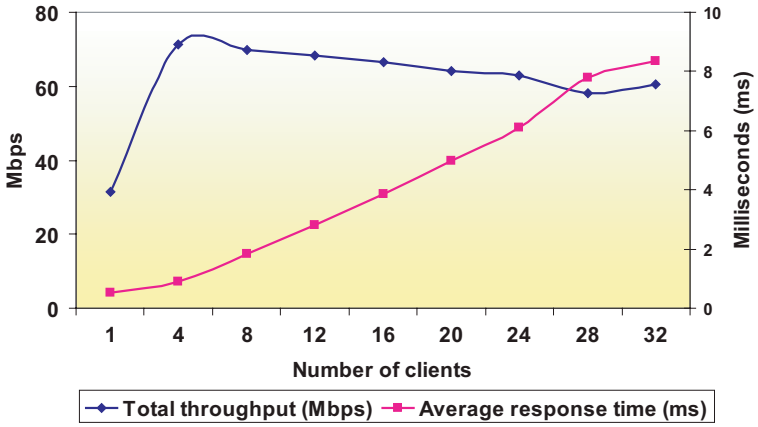
The NSS6100 also offered similar performance under JBOD mode. (JBOD mode was

File Server Performance Comparison
as Reported by Ziff Davis Media NetBench 7.0.3



Source: The Tolly Group, December 2007

Figure 2



Source: The Tolly Group, December 2007 *Figure 3*

only available on the Linksys NSS6100.)

The NetBench benchmark is indicative of real-world performance of the NAS device/file server where it is typically accessed by multiple users simultaneously.

As a baseline to compare the NSS6100 performance against other published performance benchmarks, engineers also ran the popular IOZone single-client file-server benchmark using read-and-write scenarios using a 64KB record size under a RAID 1 configuration. The NSS6100 provided superior write performance for file sizes up to 64MB, compared to other DUTs. But the NSS6100 was outperformed by the other DUTs in read performance. (See Figure 4 for performance charts from these tests.)

The NSS6100 NAS offered a convenient Web browser-based management interface, with hot-swappable disks and an intelligent chassis that stores the Linux operating system for better reliability in case of drive failures.

The ability to manage disk quotas dynamically, along with the option of securing the disk contents using AES 256-bit encryption and volume locking provides a robust and highly secure storage.

The NSS6100 also distinguishes itself from the other devices tested by offering dual Gigabit Ethernet (GbE) NICs featuring support for Active Backup (failover support) and IEEE 802.3ad link aggregation, along with advanced functionality like VLAN support, and security policies based on IP/MAC address filters.

The NSS6100 delivers a strong suite of features and performance aimed at SMB networks.

Results

NetBench File Server Performance Benchmark

Tolly Group engineers used Ziff Davis Media's NetBench 7.0.3 File Server Benchmark test suite to compare the file server performance of the DUTs.

Test results show that the NSS6100 demonstrated supe-

Linksys
A Division of Cisco Systems, Inc.

NSS 6100

Competitive Performance Evaluation of NAS Systems

TOLLY Up to Spec CERTIFIED

Product Specifications

Vendor-supplied information not necessarily verified by The Tolly Group

Linksys NSS6100

- 1U 19" rack mount design
- Support for up to four internal SATA drives with hot swap capability
- Preconfigured with four 250GB (unformatted capacity) 7200 RPM high-duty cycle SATA drives
- Two 10/100/1000 Mbps Auto MDI/X Ethernet ports, and (2) AUX ports (support USB flash disk for configuration backup)
- (1) UPS-USB port (APC Smart UPS only)
- Only 53W power consumption with four 250GB SATA drives (will vary depending on hard drives)
- Supports RAID 0 (Striping), RAID 1(Mirroring), RAID 5 (Striped Set with Parity), RAID 10 (Stripe of Mirrors), Just a Bunch of Disks (JBOD)
- Intelligent SATA HDD Spin-up/Spin-down
- File sharing for Microsoft Windows, MAC OS X, and Unix via SMB/CIFS,NFS, FTP
- Journaling File System
- Supports "Virtualization" of RAID sets across multiple boxes (requires at least one NSS6000 Series NAS)
- Advanced security features: On-disk AES256 file encryption, VLAN,Access Control Lists, network filtering,
- High-availability features: Optional external redundant power supply, Snapshots, scheduled backup, hot RAID spare, redundant LAN ports, integrated SMART monitoring for Predictive Hard Drive failure notification

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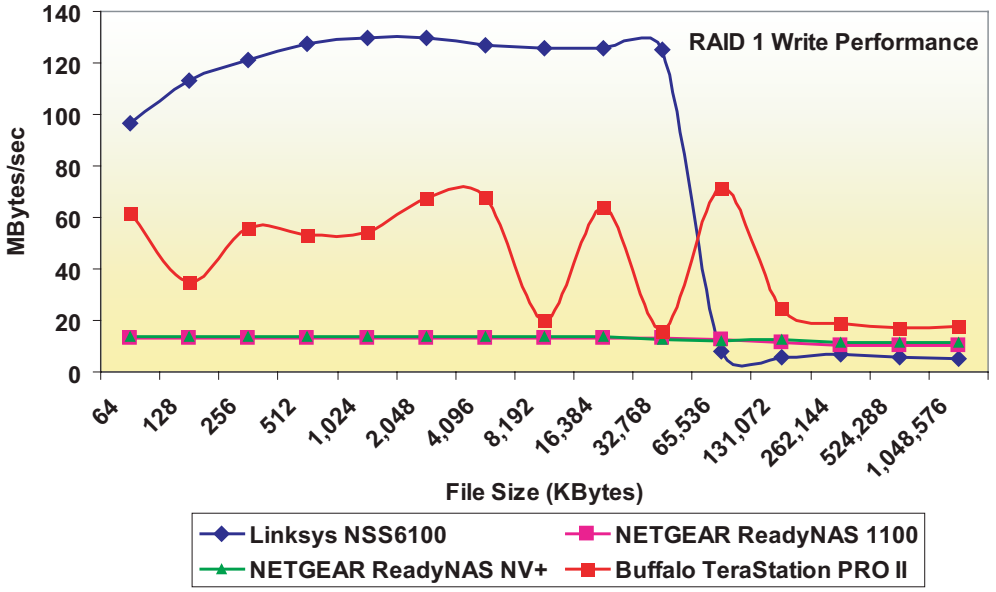
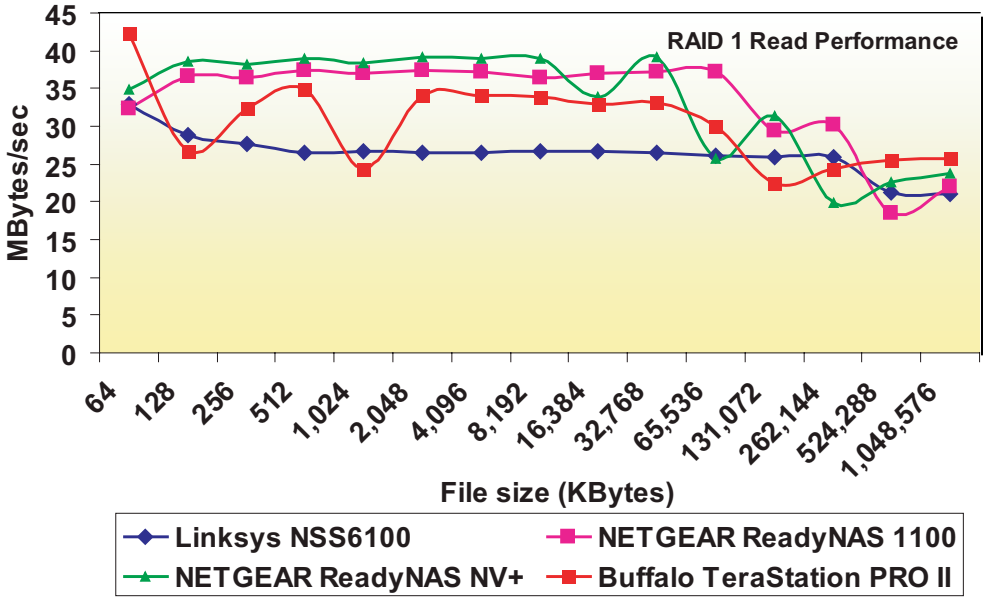
rior file server performance (throughput and average response time) than the NETGEAR and Buffalo devices tested while serving up to 32 clients simultaneously under RAID 1, RAID 5 and JBOD configurations. (See Figures 2 and 3 for performance charts.) Even with file-system encryption enabled, the NSS6100 suffered less than 15% performance degradation compared to unencrypted operation, all while handily surpassing the performance of the NETGEAR and

RAID 1 File Server Performance Benchmark
as Reported by IOZone 3.282





Note: The I/O throughput shown above is for performing the write and read I/O operations using files varying in size from 64 KB to 1GB using a record size of 64KB.

Source: The Tolly Group, December 2007

Figure 4

Buffalo devices without encryption. (Only Linksys NSS6100 was capable of on-disk encryption.)

The Linksys NSS6100 also outperformed the NETGEAR and Buffalo devices tested, by delivering superior scaling of file server performance in terms of total throughput and average response time, with the number of clients accessing the device increased from 1 to 32.

IOZone File Server Performance Benchmark

The popular IOZone performance benchmark was used to provide a baseline to compare the single-client performance of the DUTs.

Tolly Group tests under RAID 1 configuration, using a 64KB record size show that the Linksys NSS6100 demonstrated very high file write performance for file sizes up to 65,536KB (64MB), followed by the Buffalo TeraStation PRO II and then the two NETGEAR ReadyNAS appliances.

For the read mode, however, the NSS6100 was outperformed by the

Devices Under Test

Linksys NSS6100	
Machine Type	NSS6100
Memory	512 MB
Disk	4 - Western Digital WD2500YS WD Caviar RE16 250 GB
Network Adapter(s)	Dual copper Gigabit Ethernet ports
RAID Level Supported	0, 1, 5, 10, JBOD, 5+Spare (RAID 5 Configured for NetBench Test)
Firmware	Release Version 1.12.1

NETGEAR ReadyNAS 1100	
Machine Type	ReadyNAS 1100
Memory	512 MB
Disk	4 - Seagate ST3500630NS 500GB SATA
Network Adapter(s)	Dual copper Gigabit Ethernet ports
RAID Level Supported	0, 1, 5, X-RAID (RAID5 is default)
Firmware	RAIDiator™ v3.01c1-p6 [1.00a140]

NETGEAR ReadyNAS NV+	
Machine Type	ReadyNAS NV+
Memory	512 MB
Disk	4 – Western Digital WD2500YS WD Caviar RE16 250 GB
Network Adapter(s)	One 10/100/1000 Copper Gigabit Ethernet port
RAID Level Supported	0, 1, 5, X-RAID (RAID5 is default when 4 disks installed)
Firmware	RAIDiator™ v3.01c1-p6 [1.00a034]

Buffalo TeraStation PRO II	
Machine Type	Buffalo TeraStation PRO II
Disk	4 – Sam Sung SP2504C 250GB 7,200 RPM SATA
Network Adapter(s)	One 10/100/1000 Copper Gigabit Ethernet port
RAID Level Supported	0, 1, 5, 10 (RAID5 is default from manufacturer)
Firmware	1.20

Source: The Tolly Group, December 2007

Figure 5

other DUTs. See Figure 4 for detailed charts of the performance test results.

Test Setup & Methodology

All the devices tested were equipped with up to 1TB of total hard disk storage (although the NETGEAR ReadyNAS 1100 had 2TB), and ran the latest publicly available firmware and software.

Each device was configured with up to four 250GB or 500GB hard disks, and 512MB of RAM. See Figure 6 for more hardware details. The devices were tested with their factory default configurations (except the Buffalo TeraStation PRO II) to ensure engineers measured the out-of-the-box performance of each device. The logging feature on the Buffalo TeraStation PRO II was disabled as it was determined to result in up to 70% higher performance.

NetBench File Server Performance Benchmark

The NetBench File Server Performance Benchmark simulated up to 32 Windows PC 32-bit clients simultaneously accessing the NAS device and measured the throughput and average response time while the NAS handled I/O requests from the Windows clients.

Engineers selected the NetBench Enterprise Disk Mix test "ent_dm" for a 60-client test bed. Using 28 physical client PCs, 32 simultaneous clients were simulated, using up to two engines per PC. The test steadily increases the load on a file server by increasing the number of NetBench clients participating in the test.

The test collected nine data points and each data point was considered a single test from the suite test.

All the client PCs and the controller PC were rebooted prior to each test.

Configuration of PC Clients Used

Client PCs (28 Total)	
Machine Type	Cisco MCS 7800 Series (Based on HP 320 Model)
Host Processor	2 Intel Xeon 2.13GHz processors
Memory	2.0 GB RAM
Disk	Single 160 GB SATA Disk
Network Adapter(s)	Dual copper Gigabit Ethernet ports (Only Primary is used)
OS	Microsoft Windows® XP Professional (Service Pack 2)
NetBench Controller PC	
Machine Type	Cisco MCS 7800 Series (Based Hon P 320 Model)
Host Processor	2 Intel Xeon 2.13GHz processors
Memory	2.0 GB RAM
Disk	Single 160 GB SATA Disk
Network Adapter(s)	Dual copper Gigabit Ethernet ports (Only Primary is used)
OS	Microsoft Windows® XP Professional (Service Pack 2)
IOzone Controller PC	
Machine Type	Cisco MCS 7800 Series (Based on HP 320 Model)
Host Processor	2 Intel Xeon 2.13GHz processors
Memory	2.0 GB RAM
Disk	Single 160 GB SATA Disk
Network Adapter(s)	Dual copper Gigabit Ethernet ports (Only Primary is used)
OS	Microsoft Windows® XP Professional (Service Pack 2)

Source: The Tolly Group, December 2007

Figure 6

Then, the NAS device was configured for the desired RAID level (RAID 1 or RAID 5), or JBOD mode of operation. A file-share volume was created on the NAS, and then mapped on to each client PC. The NetBench test then performed various file I/O tasks and reported the throughput and average response time.

Each NAS device was left at its factory default configuration, except for configuring the desired RAID level, creating the required file shares and volumes and user profiles to govern access the NAS.

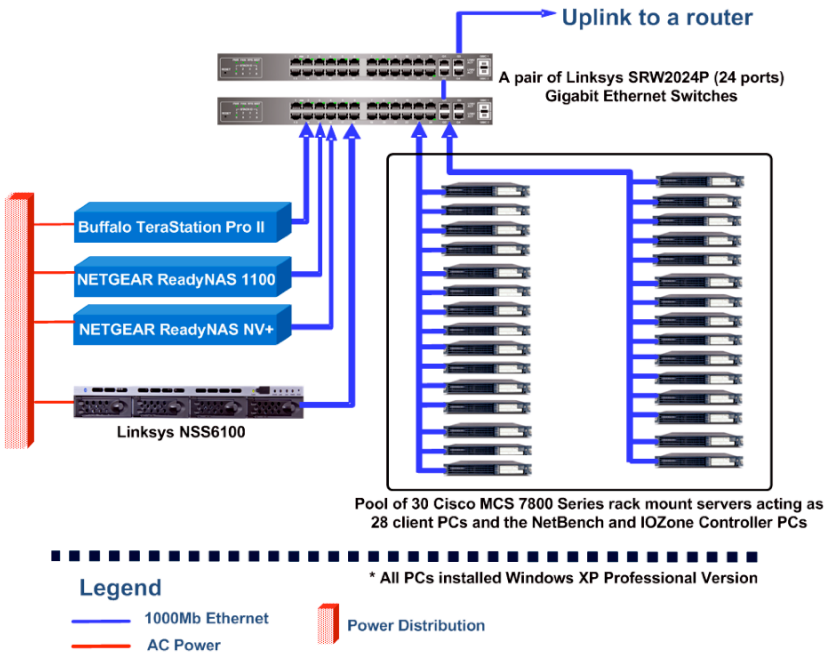
IOZone File System Performance Benchmark

This test shows the read and write performance of the NAS devices under test being accessed by a single client. This test utilized one controller PC that runs the scripts to access the NAS and perform the various I/O operations. The scripts utilized files ranging from 64KB to 1GB and attempted the various file I/O operations for a record size of 64KB.

The IOZone command line used for the test was similar to:

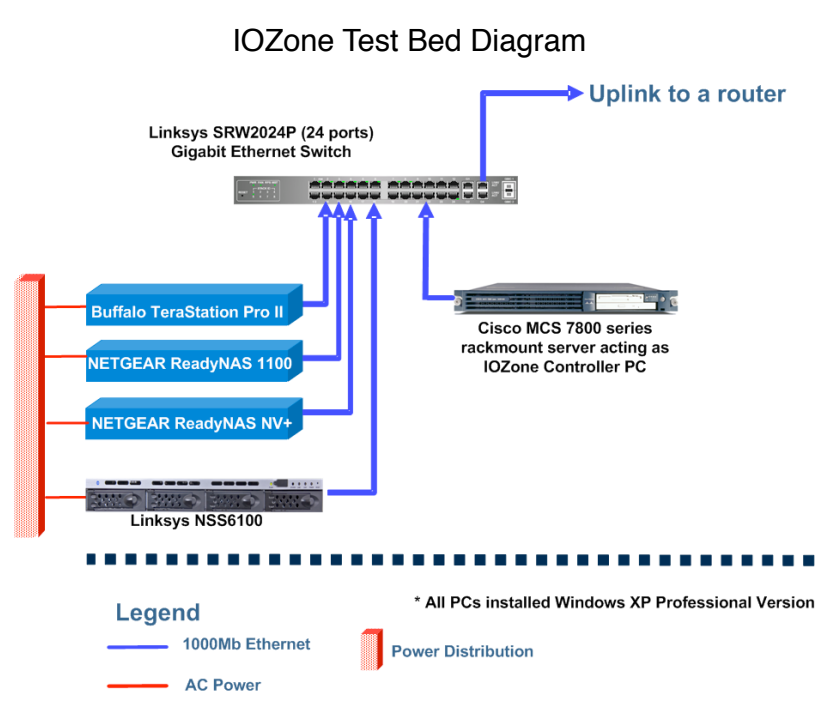
"iozone -Rab [results file name] -i 0 -i 1 -+u -f [path to directory on the NAS device under test] -q 64k -n 64k -g 1G -z"

This command line runs the test in full automatic mode and creates an Excel file of the results from read and write tests using a record size of 64KB and a maximum file size of 1GB. The reported test results were obtained from the I/O numbers for all file sizes corresponding to the 64KB record size.



Source: The Tolly Group, December 2007

Figure 7



Source: The Tolly Group, December 2007

Figure 8

Fair Testing Charter™
Interaction with Competitors

NETGEAR and Buffalo Technology (USA), Inc. were invited to participate in the tests in accordance with The Tolly Group's Fair Testing Charter (See http://www.tolly.com/FTC.aspx).

NETGEAR and Buffalo representatives were sent the test plan and methodology, and invited to make suggestions to configure their devices properly.

Representatives at Buffalo did not convey any reservations about the test methodology, and also did not provide any comments critiquing the results for the company's device at the completion of testing.

NETGEAR representatives did not respond with comments on the test plan in time for the testing. At the end of the testing, the test results for the NETGEAR devices were shared with the vendor to review and comment.

NETGEAR recommended to enable all performance-tuning options available (thereby deviating from the factory default configuration on the received devices), which the company claimed would provide better performance.

NETGEAR also claimed that its proprietary X-RAID (Expandable RAID) mode would yield higher performance. The Tolly Group confined the test to standard RAID modes.

Test Tool Summary

Vendor	Product	Web URL:
Public Domain	IOZone 3.282	http://www.iozone.org
Ziff Davis Media	NetBench 7.0.3 Performance Benchmark	http://www.lionbridge.com

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