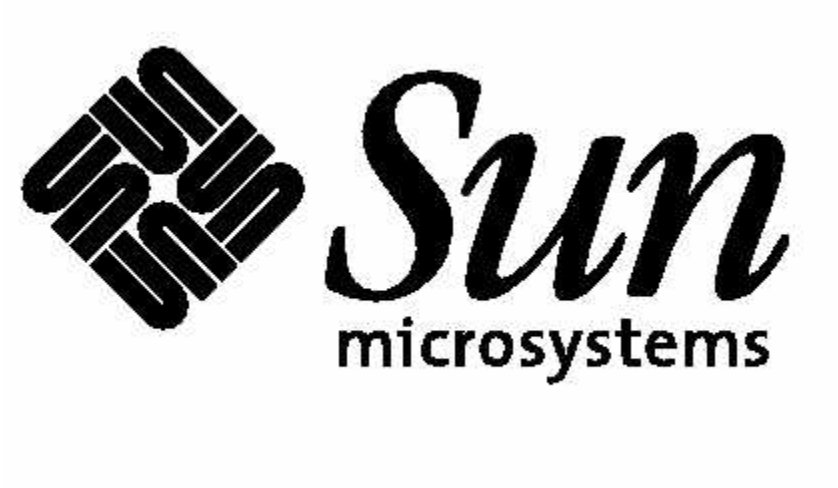

Performance Benchmark Report
UNIX® File System and VERITAS File System 3.5 on Solaris™ 9 Operating System 12/02 Release

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Executive Summary

This benchmark study compares the performance of UNIX® File System (UFS), Sun's integrated and preferred file system for general purpose Solaris™ software installations, and Solaris™ Volume Manager software against VERITAS Foundation Suite 3.5 software (VERITAS File System, VxFS 3.5 on VERITAS Volume Manager, VxVM 3.5).

In most practical scenarios that we tested, Logging UFS outperforms VERITAS Foundation Suite 3.5 by factors of 2-3. Postmark benchmark results show that:

- Logging UFS significantly outperforms VxFS 3.5 in Solaris 9 12/02 release. No special tuning was done on either product.
- The performance stability of Logging UFS and Solaris Volume Manager software is unmatched by VERITAS Foundation Suite 3.5
- The predictable scalability of Logging UFS and Solaris Volume Manager software could not be duplicated by VERITAS Foundation Suite 3.5

This benchmark study also indicates that today's capabilities of UFS and Solaris Volume Manager software satisfy the majority of Solaris customer requirements without incremental cost. Solaris Operating System provides customers with up to $120K savings on the File System and Volume Manager software per server, in addition to annual savings on support cost.

Therefore customers should consider the cost/benefit trade-offs when deciding on the need to stay with UFS and Solaris Volume Manager software which are integrated and tested with Solaris or integrate the complexity of VxFS and VxVM.

Performance Benchmark Result Summary

Benchmark Tests	Logging UFS/Solaris Volume Manager	VERITAS Foundation Suite 3.5 (VxFS/VxVM)
RAID- 0	Generally outperforms VERITAS Foundation Suite 3.5	Performs better at 2 simultaneous Postmarks
RAID- 5	Beats VERITAS Foundation Suite 3.5 beyond 10 Postmark instances	Performs better at fewer Postmark instances
File System on Small Configuration	Beats VxFS at **ALL** workload levels	Not competitive with Logging UFS
File System on Medium Configuration	- Outperforms VxFS at Medium and Large workload levels - Comparable to VxFS at Low workload level	Competitive with Logging UFS **ONLY** at Low workload level
File System on Large Configuration	- Beats VxFS at Medium and Large workload levels - Comparable to VxFS at Low workload level	Competitive with Logging UFS **ONLY** at Low workload level

Test Configuration and Methodology

The Postmark benchmark is designed to measure the performance of file servers for applications such as:

- Electronic Mail
- Netnews
- Web-based Commerce

The design of the Postmark benchmark is covered in detail at:
http://www.netapp.com/tech_library/3022.html

The product sets tested were:

- Solaris 9 Operating System 12/02 Release
- VERITAS Foundation Suite 3.5 (VxFS 3.5 and VxVM 3.5)

No special tuning was done for any of the products. They were configured and used "out of the box". Postmark v1.5 is used.

The system under test consisted of a Sun Fire™ 6800 server configured as one domain

comprising 24 x 900 Mhz UltraSPARC® III+ CPUs, 96 Gb RAM. The storage was an 7 x T3+ using a blocksize of 16Kb. The same LUNs were used for both the VERITAS volumes and Solaris software metadevices. These volume manager objects and the filesystems on them were recreated between each iteration of each test.

For this study, the following two different sets of tests were performed. The exact configuration of these tests is included in the *Benchmark Configuration and Raw Data* section.

RAID Performance Benchmarks

Postmark instances ran in parallel in iterations of 1-16. Each iteration ran 3 times and the results were scrutinized. The test was repeated if there were any inconsistencies in the results. An average of the 3 consistent runs were taken as the final result.

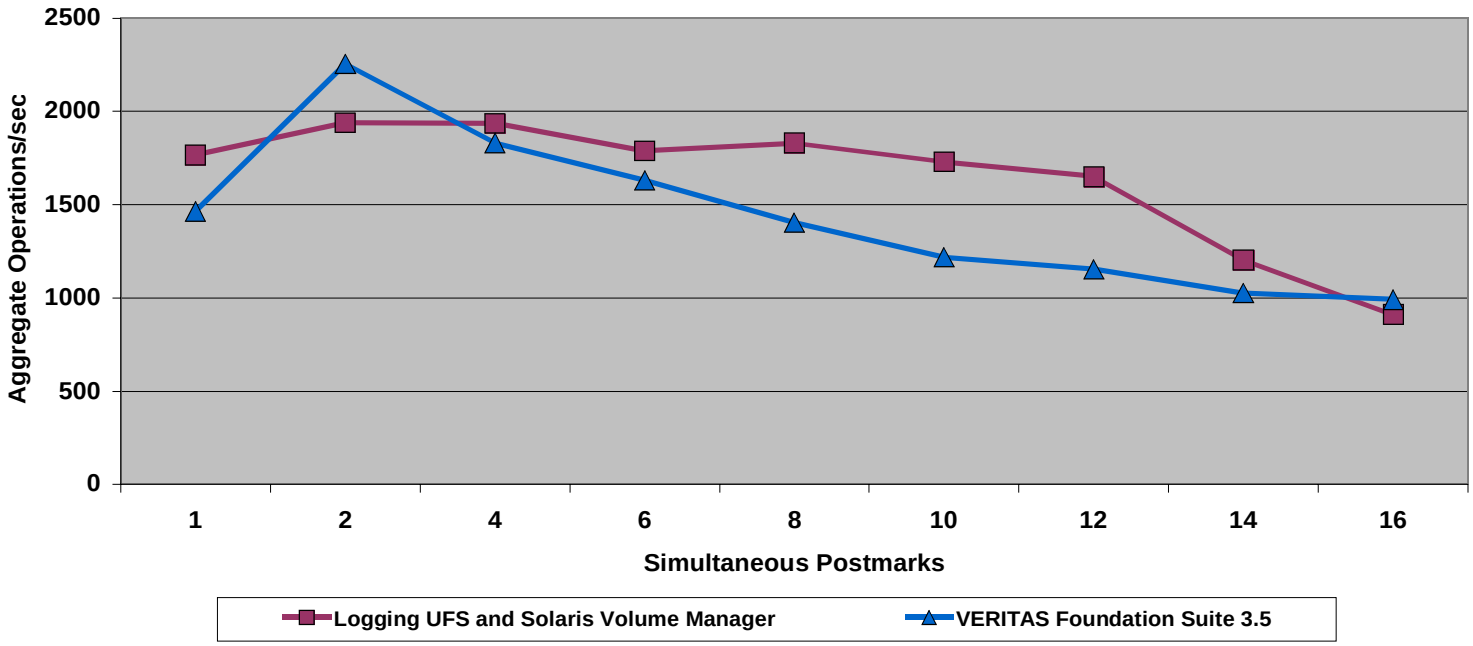
Regardless of the level of concurrency, each Postmark process operated on a distinct file set of 20,000 files across 1,000 directories and performed 20,000 transactions. In other words, as the number of concurrent processes was scaled, the amount of work done by any one process was kept constant.

File System Performance Benchmarks

The performances of UFS and VxFS 3.5 were tested while the system workload and the system configuration were modified to closely model customer environments.

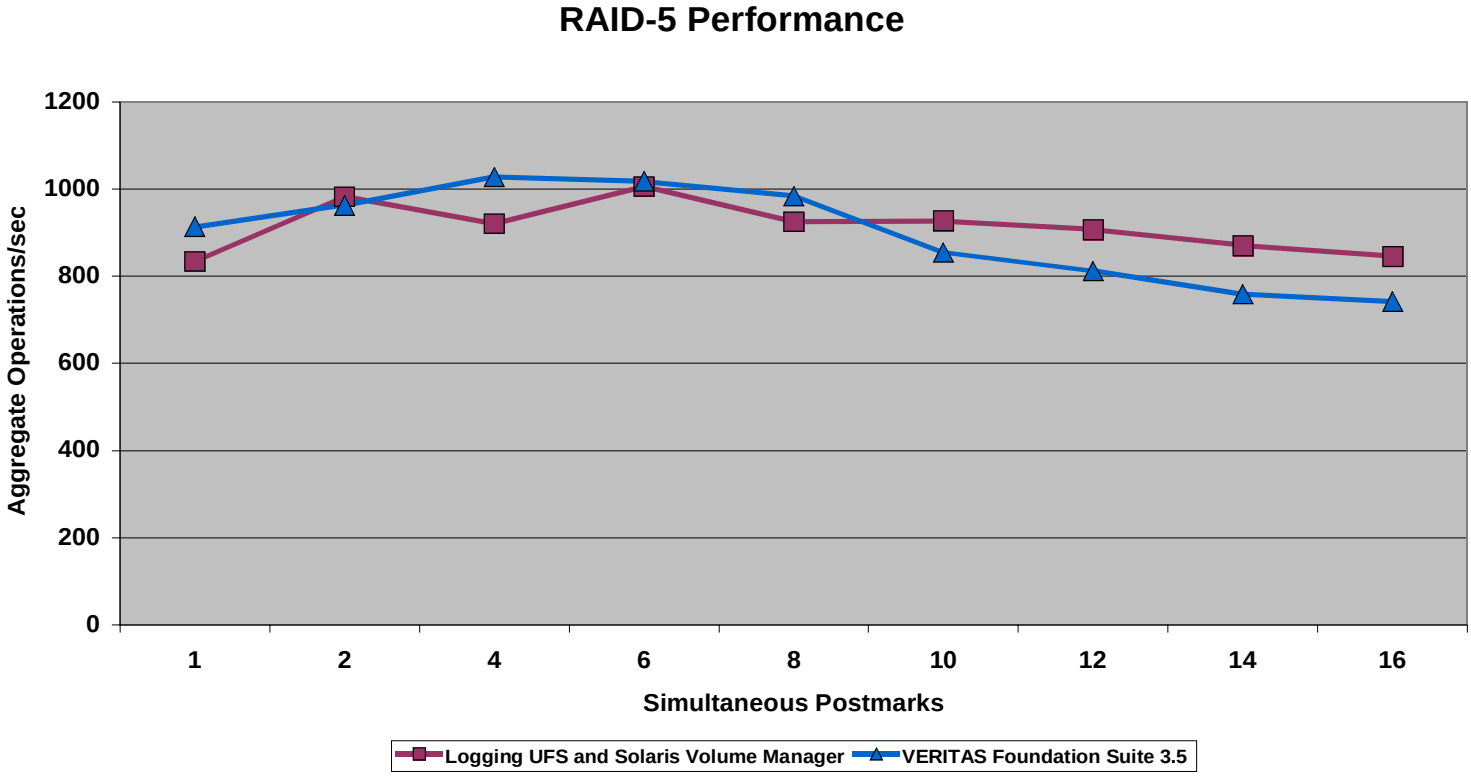
Results

RAID-0 Performance



Conclusions:

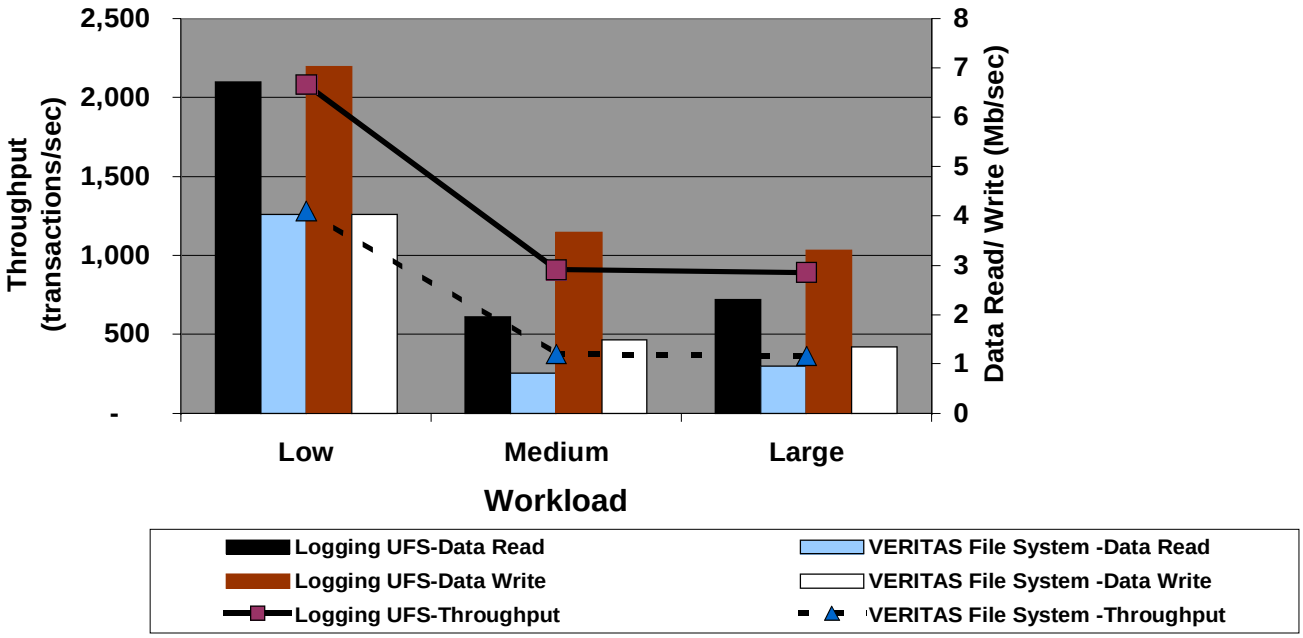
- The performance of Logging UFS and Solaris Volume Manager software generally exceeds that of VERITAS Foundation Suite 3.5
- At 16 simultaneous Postmarks, the two products are very comparable.
- Between 8 to 12 simultaneous Postmarks, Logging UFS/Solaris Volume Manager software consistently outperform VERITAS Foundation Suite 3.5 by 30- 40%.



Conclusions:

- On software RAID-5, Logging UFS and Solaris Volume Manager software scale better than VERITAS Foundation Suite 3.5 when the number of simultaneous Postmark instances increase in number.
- Between 14 to 16 simultaneous Postmarks, Logging UFS and Solaris Volume Manager software together are approximately 14% faster than VERITAS Foundation Suite 3.5

File System Performance Benchmark Using Solaris 9 Operating System-12/02 Release on Small Configuration

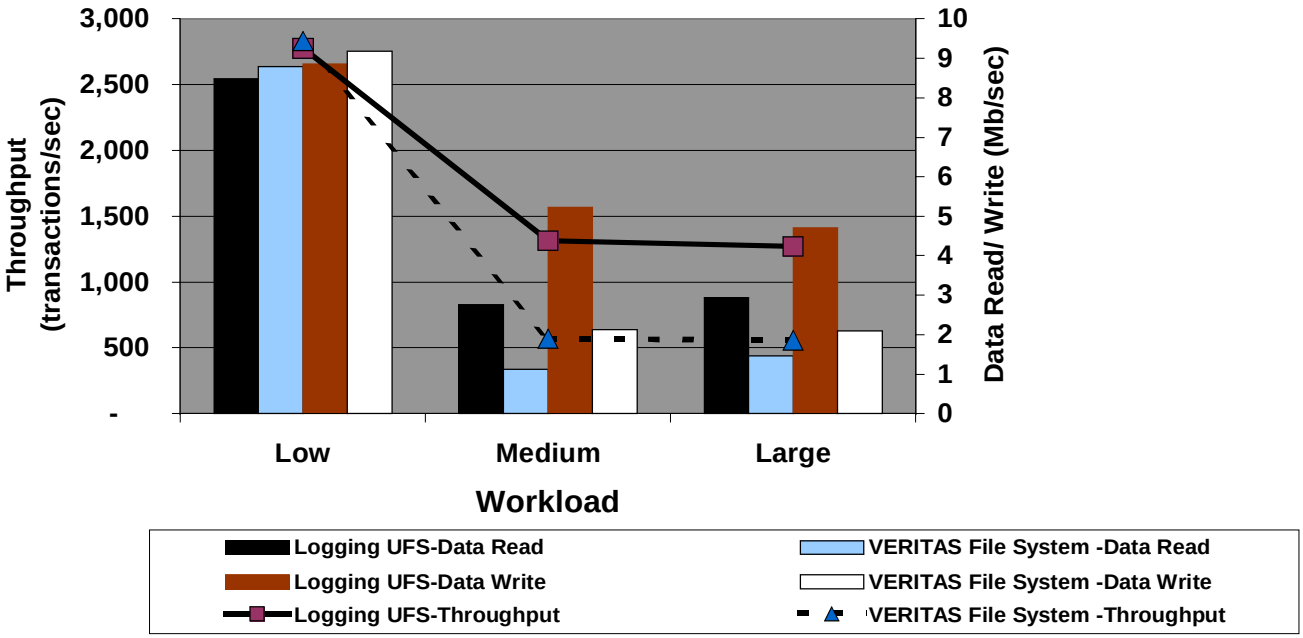


The system under test consisted of a Sun Blade™ 2000 workstation; 2 x 750 Mhz UltraSPARC® III processor, 1 Gb RAM. The storage was an A5200 populated with 9 Gb Seagate ST19171FC disks.

Conclusions:

- Logging UFS beats the performance of VERITAS File System (VxFS) at **ALL** workload levels
- At Low workload, Logging UFS is 62% faster than VxFS
- At Medium and Large workloads, Logging UFS is 142% (more than 2 times) faster than VxFS

File System Performance Benchmark Using Solaris 9 Operating System-12/02 Release on Medium Configuration

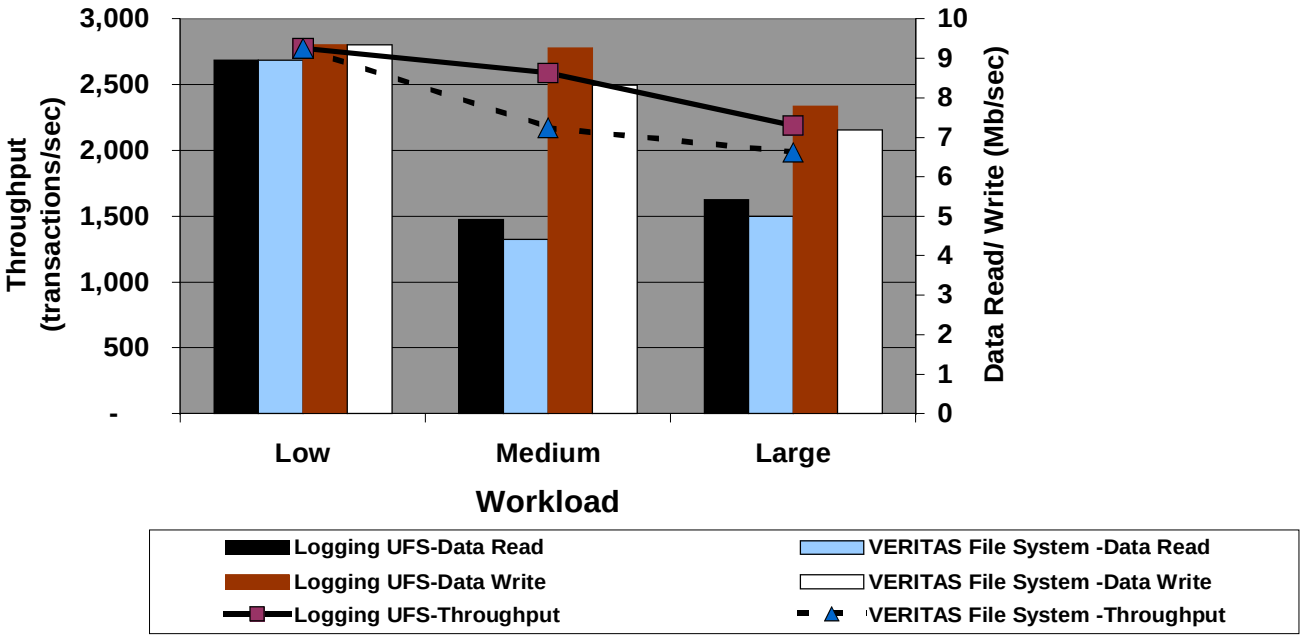


The system under test consisted of a Sun Fire™ V880 server; 8 x 900 Mhz UltraSPARC® III+ processor, 16 Gb RAM. The storage was internal to the Sun Fire™ V880 server; Seagate ST373472 Gb disks. Volumes/Metadevices were configured similar to the small configuration but over two disks.

Conclusions:

- Logging UFS and VERITAS File System (VxFS) are comparable at Low workload level.
- A very steep performance degradation occurs in VxFS as the workload increases from Low to Medium. Compared to a 53% decline in performance for Logging UFS, there is a 80% performance decline for VxFS.

File System Performance Benchmark Using Solaris 9 Operating System-12/02 Release on Large Configuration



The system under test consisted of a Sun Fire™ 6800 server configured as one domain comprising 24 x 900 Mhz UltraSPARC® III+ processor, 96 Gb RAM. The storage was an 7 x T3+.

Conclusions:

- Logging UFS and VERITAS File System (VxFS) are comparable at Low level of workload.
- Again, steeper performance degradation in VxFS (22%) compared to Logging UFS (7%) as the workload increases from Low to Medium.
- Infact Logging UFS at a Large workload outperforms VxFS at Medium workload.

Benchmark Configuration & Raw Data

Solaris 9 Operating System 12/02 Release with Logging UNIX® File System

For RAID-0:

Volumes/Metadevices were configured as follows:

vxassist -g rootdg make vol01 43142m layout=stripe ncol=5

metainit d0 1 3 <list of 3 disks>

Raw Data:

Solaris 9 12/02 RAID-0

Postmarks	Logging UFS and Solaris Volume Manager (Aggregate Ops/Sec)	VERITAS Foundation Suite 3.5 (Aggregate Ops/Sec)	UFS over VxFS (Aggregate Ops/Sec)
1	1767	1465	302
2	1939	2255	-316
4	1936	1831	105
6	1789	1630	159
8	1831	1405	426
10	1731	1219	512
12	1650	1154	496
14	1204	1028	176
16	912	991	-79

Solaris 9 Operating System 12/02 Release with Logging UNIX File System

For RAID 5:

Volumes/Metadevices were configured as follows:

metainit d0 -r <list of 7 disks>

vxassist -b -g rootdg -o ordered make testvol 50g layout=raid5 nlog=0 <list of 7 disks>

Raw Data:

Solaris 9 12/02 RAID-5

Postmarks	Logging UFS and Solaris Volume Manager (Aggregate Ops/Sec)	VERITAS Foundation Suite 3.5 (Aggregate Ops/Sec)	UFS over VxFS (Aggregate Ops/Sec)
1	834	914	-80
2	982	963	19
4	920	1028	-108
6	1006	1018	-12
8	925	984	-59
10	927	854	73
12	907	812	95
14	870	759	111
16	845	742	103

Solaris 9 Operating System 12/02 Release Variation By Size of Platform

Volumes/Metadevices were configured as follows:

vxassist -g rootdg make vol01 43142m layout=stripe ncol=5

metainit d10 1 5 <list of 5 disks> -i 64k

Small Configuration

The system under test consisted of a Sun Blade™ 2000 workstation; 2 x 750 Mhz UltraSPARC® III processor, 1 Gb RAM. The storage was an A5200 populated with 9 Gb Seagate ST19171FC disks.

Raw Data:

Workload	**Logging UFS**	**VxFS**	**Which Wins?**
Low (1000 files/50,000 txns)			
txns/sec	2083	1282	Logging UFS
data read	6.71 Mb/s	4.03 Mb/s	Logging UFS
data write	7.02 Mb/s	4.03 Mb/s	Logging UFS
Medium (20,000 files/50,000 txns)			
txns/sec	909	375	Logging UFS
data read	1.95 Mb/s	0.81 Mb/s	Logging UFS
data write	3.67 Mb/s	1.49 Mb/s	Logging UFS
Large (20,000 files/100,000 txns)			
txns/sec	892	364	Logging UFS
data read	2.3 Mb/s	0.95 Mb/s	Logging UFS
data write	3.3 Mb/s	1.35 Mb/s	Logging UFS

Medium Configuration:

The system under test consisted of a Sun Fire™ V880 server; 8 x 900 Mhz UltraSPARC® III+ processor, 16 Gb RAM. The storage was internal to the Sun Fire™ V880 server; Seagate ST3734 72 Gb disks. Volumes/Metadevices were configured similar to the above but over two disks.

Raw Data:

Workload	**Logging UFS**	**VxFS**	**Which Wins?**
Low (1000 files/50,000 txns)			
txns/sec	2777	2831	VxFS
data read	8.48 Mb/s	8.79 Mb/s	VxFS
data write	8.86 Mb/s	9.18 Mb/s	VxFS
Medium (20,000 files/50,000 txns)			
txns/sec	1315	569	Logging UFS
data read	2.77 Mb/s	1.13 Mb/s	Logging UFS
data write	5.23 Mb/s	2.13 Mb/s	Logging UFS
Large (20,000 files/100,000 txns)			
txns/sec	1271	558	Logging UFS
data read	2.94 Mb/s	1.46 Mb/s	Logging UFS
data write	4.7 Mb/s	2.1 Mb/s	Logging UFS

Solaris 9 Operating System 12/02 Release : Variation By Size of Platform (contd.)

Large Configuration:

The system under test consisted of a Sun Fire™ 6800 server configured as one domain comprising 24 x 900 Mhz UltraSPARC® III+ processor, 96 Gb RAM. The storage was an 7 x T3+.

Raw Data:

Workload	**Logging UFS**	**VxFS**	**Which Wins?**
Low (1000 files/50,000 txns)			
txns/sec	2777	2777	TIE
data read	8.95 Mb/s	8.95 Mb/s	TIE
data write	9.35 Mb/s	9.35 Mb/s	TIE
Medium (20,000 files/50,000 txns)			
txns/sec	2587	2173	Logging UFS
data read	4.91 Mb/s	4.41 Mb/s	Logging UFS
data write	9.26 Mb/s	8.32 Mb/s	Logging UFS
Large (20,000 files/100,000 txns)			
txns/sec	2190	1986	Logging UFS
data read	5.42 Mb/s	5 Mb/s	Logging UFS
data write	7.79 Mb/s	7.19 Mb/s	Logging UFS