SPECsfs2008 User's Guide

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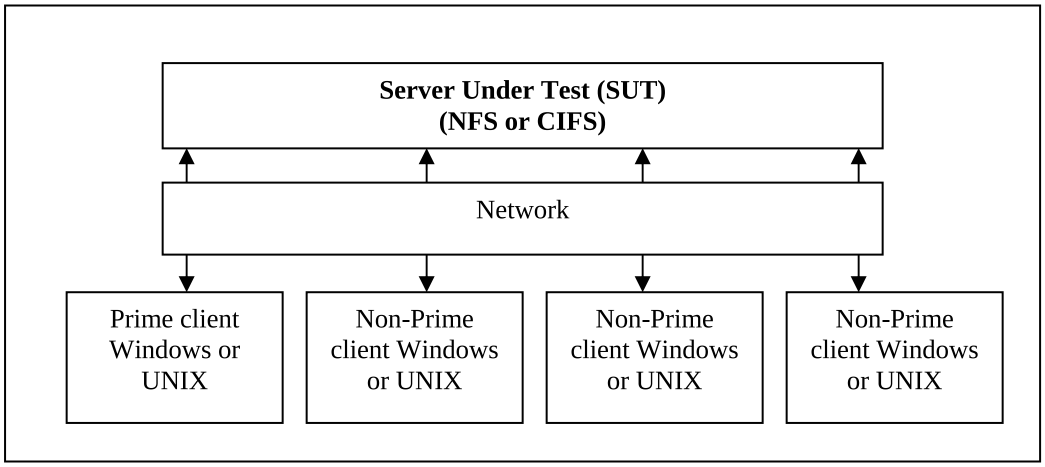
1 Quick Start Guide

The SPECsfs2008 benchmark is used to measure the performance of an NFS or CIFS server. It creates a mixed workload that simulates a typical server environment. The user may use the tool to measure the performance of an NFS or CIFS server and compare the results with other servers that have results published on the SPEC web site.

SPECsfs2008 results summarize the server's capabilities with respect to the number of operations that can be handled per second, as well as the overall latency of the operations. A minimal SPECsfs2008 result will contain ten load points and the results of the server at each of the requested load points. Each load point presents a requested number of operations per second.

The benchmark requires that the user have one or more client systems that can be used to generate load on the server. One of these clients, referred to as the 'prime' client, is used to coordinate all the load-generating clients (the prime client itself is eligible, but not required, to generate load).

Example topology


Server Under Test (SUT)
(NFS or CIFS)
Network
Prime client Windows or UNIX
Non-Prime client Windows or UNIX
Non-Prime client Windows or UNIX
Non-Prime client Windows or UNIX

The minimal configuration consists of one load generating client, and one NFS or CIFS server. The server is often referred to as the SUT (Server Under Test) in the documentation below.

The steps to produce a SPECsfs2008 result are:

- Install SPECsfs2008 on the load generators
- Edit the configuration file on the prime client
- Configure the server for testing
- Start the benchmark

1.1 Prerequisites

- The Java RunTime Environment (jre) release 1.5 or later must be installed on the load generator (client) and Prime Client systems.

- The J2SE(TM) Development Kit release 5.0 or later must be installed on the system(s) where you want to build the java code in the benchmark (not normally required)
- The correct java program must be in the current user's path.
- The test file systems (exported via NFS V3 or as CIFS shares) must have the permissions set correctly in order to allow access and read/write operations by the clients. The test file systems do not need to be mounted or mapped prior to execution of the benchmark.
- There must be network connectivity between the SUT (System Under Test) and clients, and between the clients and the Prime Client. The Prime Client is simply the system on which the benchmark run is started, and could be one of the clients or the SUT.
- The contents of the SPECsfs2008 benchmark CD must be accessible on all the systems where the benchmark will be installed.
- Using these quick start procedures assumes that the pre-compiled C code binaries shipped with the benchmark will be used.

1.2 Installing SPECsfs2008

SPECsfs2008 can be installed on client machines running either a UNIX-based or Windows operating system. Each of these require slightly different configuration and are described separately below.

UNIX client installation and configuration:

- Ensure that DNS is correctly configured.
- Install Java 1.5 or later, and ensure that java is in the user's search path. UNIX versions of Java may be downloaded from http://www.java.com.
- Install SPECsfs2008 benchmark using the following steps:
    - Login to the client (as root)
    - Insert the SPEC CD-ROM and mount the CD-ROM device.
    - cd to the top level CD-ROM directory
    - Enter 'cd spec-sfs2008/manager'
    - Enter 'java SpecInstall "*destination_directory*"' (where "*destination_directory*", enclosed by double-quotes, is where you wish to have the benchmark installed)

Windows client installation and configuration:

- Ensure that Windows Internet Naming Service (WINS) is correctly configured.
- Install Java 1.5 or later, and ensure that java is in the user's search path. Windows versions of Java may be downloaded from http://www.java.com
- Install SPECsfs2008 benchmark
    - Start a command prompt window (DOS type command shell). This can be done using the 'Start' button, choosing 'Run…' and entering 'cmd'.
    - Insert the SFSsfs2008 CD-ROM and enter the drive letter associated with the CD-ROM device (eg. D:) at the command prompt.
    - Enter 'chdir spec-sfs2008\manager'
    - Enter 'java SpecInstall '"*destination_directory*"' (where "*destination_directory*", enclosed by double-quotes, is where you wish to have the benchmark installed)

Note: If one is running SPECsfs2008 on a Windows workstation client. (non-server version of Windows) then one must disable the Windows file server component before using the client to run the SPECsfs2008 benchmark. This is accomplished by using a command window and running:

net stop server

This applies to all non-server versions of Windows (NT, XP, Win2k, and Vista)

1.3 Editing the configuration file on the Prime client

On the Prime client, copy one of the sfs 'rc file' templates (sfs_nfs_rc for NFS, sfs_cifs_rc for CIFS) in the manager directory into a file called sfs_rc. The user must edit the sfs_rc configuration file, and only needs to edit it on one of the clients. The client that contains the edited configuration file must be the Prime client. The user does not need to edit, or even have, a configuration file on the other load generating clients. On the Prime client, edit the values for:

- **LOAD**
  Initial value for requested operations/sec, or a complete list of the data points to be collected by the benchmark. Examples are provided in the sfs_nfs_rc and sfs_cifs_rc template files, which are located in the manager directory.

- **INCR_LOAD**
  Incremental increase in load for successive data points in a run. This parameter is used only if **LOAD** consists of a single (initial) value. To ensure equally spaced points, the value of **LOAD** and **INCR_LOAD** must be equal.

- **NUM_RUNS**
  The number of load points to run and measure (minimum of 10 for a publishable result). This parameter is used only if **INCR_LOAD** is specified.

- **PROCS**
  Number of processes per client. Each client load generator may be able to generate more load if the client has sufficient resources to do so. A general rule of thumb is to have the total requested load be divided across all of the clients, and to have sufficient numbers of clients and processes so as to have the operations/sec per process remain below 250 at the highest load point. It is also recommended to have the operations/sec per process remain above 10 at the lowest load point.

- **CLIENTS**
  List of clients to use in this test. The Prime client, if listed here, may also be used to generate load. If the Prime client is not listed here then it will only coordinate the testing and will not participate in generating load. The client names in this list are hostnames or IP addresses of the clients that will be participating in generating the load.

- **MNT_POINTS**
  List of mount points, or shares, to use in the testing. Each of these mount points must be exported by the server so that they may be mounted by the load generating clients. The value MNT_POINTS can take several different forms:
  - UNIX style: server:/exportfs1 server:/exportfs2 …
  - CIFS style: \\server\exportfs1 \\server\exportfs2 …
  - Use a file that contains the mount points: filename
    The use of a file, and its format, is covered later in this document.

  The number of mount points in the list must be equal to number of processes specified in the PROCS parameter. Note that a mount point may be repeated in the list.

- **FS_PROTOCOL**

The type of server protocol (NFS or CIFS) to test. It may be set to "nfs" or "cifs". Either UNIX or Windows clients can be used to test either NFS or CIFS, however, all clients must be of the same type. ***Note: If this value is set to "nfs" then the MNT_POINTS list must use the UNIX style syntax. If this value is set to "cifs" then the MNT_POINTS list must use the CIFS style syntax.***

When testing a CIFS configuration:

o **USERNAME**	Specify the CIFS user name for accessing the server.
o **PASSWORD**	Specify the CIFS password for accessing the server.
o **DOMAIN**	Specify the CIFS domain for accessing the server.

When testing an NFS configuration from a Windows client:

o **SFS_NFS_USER_ID**	Specify the NFS server user ID to be used.
o **SFS_NFS_GROUP_ID**	Specify the NFS server group ID to be used.

1.4 Configuring the server for testing

- Export or share file systems that will be used for testing (export for UNIX, or enable Shared folders for Windows). The exported name must match the values specified in the MNT_POINTS variable in the SPECsfs2008 configuration file.
- Ensure the exported file systems have read/write permissions.
- Ensure access is permitted for username, password, and domain. (CIFS testing only)

1.5 Starting the benchmark

Note that the SfsManager must be run under the same user id (UID) on the all of the clients, including the prime client.

- Change directories to the *destination_directory* specified during install.
- On the Prime client:
  - Enter 'cd manager'
  - Enter 'java SfsManager –r sfs_config_file –s output_files_suffix –v 2'
    (This performs the server validation)
  - Enter 'java SfsManager –r sfs_config_file –s output_files_suffix'
    (This runs the actual test)

1.6 Monitoring the benchmark execution

- On the Prime client, change directories to the *destination_directory* from the installation step above by entering 'cd result'

The user may now examine the benchmark logs, as well as the results. As the benchmark runs, the results are stored in the files with names like:

sfssum.*	Summary file used in the submission process described later.
sfslog.*	Log file of the current activity.
sfsres.*	Log file of the current activity.

During the run, each client will store its client log file 'sfsc_log' in its local /tmp directory. After all load points are complete, the files from each client are collected into the result directory on prime client and renamed with the client number. The client logs are files with names like: sfsc0001.*

sfsc*.*	The client log files.

1.7 Examining the results after the benchmark execution has completed

The results of the benchmark are summarized in the sfssum.* file in the result directory on the prime client. This may be examined with any text editing software package. This file is the summary file that may be used for the submission process, described later in this document.

2 Introduction

SPECsfs2008 is the latest version of the Standard Performance Evaluation Corporation benchmark that measures file server throughput and response time. It provides a standardized method for comparing performance across different vendor platforms.

This document specifies how SPECsfs2008 is to be run for measuring and publicly reporting performance results, and includes a guide to using the SFS tools. The SPECsfs2008 Run and Reporting Rules (included in a separate companion document on the SPECsfs2008 CD) have been established by the SPEC SFS Subcommittee and approved by the SPEC Open Systems Steering Committee. They ensure that results generated with this suite are meaningful, comparable to other generated results, and are repeatable. Per the SPEC license agreement, all results publicly disclosed must adhere to these Run and Reporting Rules.

SPEC requires that any public use of results from this benchmark follow the SPEC OSG Fair Use Policy. In the case where it appears that these guidelines have not been adhered to, SPEC may investigate and request that the published material be corrected.

The section below describes the changes in SPECsfs2008 compared to the previous version of the benchmark, SFS 3.0.

2.1 What is new in SPECsfs2008

The SPECsfs2008 release of the benchmark includes major workload and functionality changes, as well as clarification of run rules. The code changes compared to earlier SFS versions were NOT performance neutral, therefore **comparing SPECsfs2008 results with SFS 3.0 results is NOT allowed**.

The most significant areas of change in SPECsfs2008 include:

- An updated NFSv3 workload, based on recent data collected by SFS committee members from thousands of real NFS servers operating at customer sites.
- The addition of a general-purpose CIFS fileserver workload, also developed using data collected from thousands of real CIFS servers.
- Removal of support for the NFSv2 and support for the UDP transport.
- Support for Windows and MacOSX clients (for generating either NFS or CIFS workloads).
- A new java-based SFS manager test harness.
- A new XML based reporting and submission framework.
- Simplified and better organized documentation.
- Significant improvements to benchmark stability and error handling.

2.2 SPECsfs2008 Benchmark Overview

The SPECsfs2008 benchmark is used to test the performance capacity of NFS and CIFS fileservers. Performance is measured in both in terms of throughput (the number of operations the server can serve) as well as the response time (time required to complete individual operations).

In a typical SFS test configuration, a series of load generating clients are directed through a network at file systems shared or exported from the 'server under test' or SUT. Clients are directed by the SFS manager program to execute a series of ten or more tests at increasing, equally spaced 'load points'. A load point represents a throughput level (number of operations) for the workload the SFS clients will present to the server. At the end of each load point, the clients will report how much throughput was actually achieved, as well as the average response time for all requests presented to the server during the measurement interval. The benchmark reporting tools can be used after the full run is complete to present the peak achieved throughput as well as calculate an 'overall response time' metric, which is meant to reflect the results of average response time measurements across the series of load points (essentially it is the area under the throughput vs. average response time curve).

At the start of each load point each client will start a specified number of load generating processes. Each process will mount the exported or shared file systems, create a directory structure, and fill it with a series of files of various sizes. The number of files the load generating process creates is determined by and increases proportionally with the number of operations per second specified for the given load point.

When all load generating processes have completed the initialization of the fileset (known as the 'INIT' phase of the benchmark), they will begin to request from the server a series of NFS or CIFS operations based on the workload parameters established by the benchmark. The load generators will spend 300 seconds running in WARMUP mode, where no official measurements are recorded. After the WARMUP phase is completed, the benchmark will start a 300 second measurement phase, where the actual measurement of throughput and response time for the load point is collected.

Upon successful completion of the 300 second measurement period, statistics from all load generators on all clients are collected and centralized by the SFS manager program, which will report and record the overall results of the test. If the test completes without violating any benchmark rules, the summary report produced by the SFS manager may be used to produce an SFS submission which can be sent to SPEC for review and publication.

In the following subsections, some additional specifics regarding the NFS and CIFS workloads are provided.

2.2.1 NFS Workload

The NFS workload in SPECsfs2008 is intended for servers which can serve the NFS version 3 protocol over the TCP transport. Support for NFS version 2 and the UDP transport are no longer officially supported by the benchmark.

In many ways, the workload in SPECsfs2008 is similar to the workload presented by SFS 3.0. However, there are a number of changes that significantly alter the effect the workload is likely to have on the server under test. These changes were mainly driven by the need to adapt the original benchmark to changes that have occurred in real NFS server configurations, file sets, and workload patterns in the years since the last benchmark was released. Here is a list of the most significant changes made to the NFS workload for SPECsfs2008.

- ✓ The percentage of each NFS operation has been adjusted to better reflect more recent data collected on real NFS servers. A table later in this section summarizes the adjustments.
- ✓ The maximum file size was increased from 1 Megabyte to 32 Megabytes.
- ✓ The total file set size created for a given load point has been increased from 10 Megabytes per SFS op/s to 120 Megabytes per SFS op/s
- ✓ The percentage of files in the file set accessed during the test was increased from 10 percent to 30 percent.
- ✓ The maximum logical transfer size was increased from 135 Kilobytes, to 256 Kilobytes.
- ✓ The NFS block (physical transfer) size was previously fixed at 8 Kilobytes. It is now automatically negotiated with the server.

- ✓ COMMIT operations are no longer issued if the server returns the STABLE bit on the write operations. When a server returns an UNSTABLE response to a write operation, a COMMIT may be issued after a number of WRITE operations are issued. Previously, the benchmark would issue a COMMIT after every logical write operation was completed, regardless of whether or not the operation was STABLE. This was determined to not reflect the behavior observed by real client/server interactions.

The shift in NFS operations is outlined in the table below comparing the NFS operation mix in SFS 3.0 and SPECsfs2008. Note that the percentage of READ and WRITE operations in SPECsfs2008 are now expressed as 'logical' operations. This is because the number of physical IOs required to complete the logical read or write may vary depending on the transfer size negotiated between the SFS client and the server under test. Also note that COMMITs are no longer included in the op mix and are not counted as completed operations in the benchmark result. When required due to UNSTABLE write responses from the server, COMMITs will be issued and the time required to complete the COMMIT will be included in the response time measurement for the logical write which required it. In effect, COMMIT operations are 'overhead' for which no credit is given in situations when they are required by the nature of the server response.

NFS Version 3 Operation	SPECsfs2008	SPEC SFS 3.0
LOOKUP	24%	27%
READ	18%	18%
WRITE	10%	9%
GETATTR	26%	11%
READLINK	1%	7%
READDIR	1%	2%
CREATE	1%	1%
REMOVE	1%	1%
FSSTAT	1%	1%
SETATTR	4%	1%
READDIRPLUS	2%	9%
ACCESS	11%	7%
COMMIT	NA	5%

2.2.2 CIFS Workload

The CIFS workload in SPECsfs2008 shares the file set attributes with the NFS workload. However, the operations applied to the server under test are, of course, quite different. As with NFS, a study of thousands of CIFS servers deployed at customer sites was used to determine a target operation mix. CIFS, however, is a 'stateful' protocol, which implies that operations must be delivered in valid sequences. For example, a file must be opened before certain operations can be issued to the server, and closed after those operations are completed. Clearly, delivering operations in a random succession, as is done with the 'stateless' NFS workload, would not work.

To overcome the more restrictive requirements of CIFS, as well as to improve the realism of the CIFS workload, an operation generation technique utilizing a Hidden Markov Model (HMM) was developed for SPECsfs2008. Real CIFS traces collected from active CIFS servers were used to train the model, and the resulting CIFS workload reflects the valid operation sequences exhibited in the original traces.
The operation mix produced by the SPECsfs2008 CIFS workload is captured in the table below.

CIFS Operations	SPECsfs2008
ECHO	0.5%

LOCKING_ANDX	1.1%
NT_TRANSACT_QUERY_SECURITY_DESC	1.6%
READ_ANDX	20.5%
TRANS2_QUERY_FS_INFORMATION	1.6%
TRANS2_QUERY_FILE_INFORMATION	12.9%
TRANS2_QUERY_PATH_INFORMATION	21.5%
TRANS2_SET_FILE_INFORMATION	3.2%
TRANS2_FIND_FIRST2	8.6%
WRITE_ANDX	8.6%
NT_CREATE_ANDX	9.7%
CLOSE	9.7%
FLUSH	0.5%

2.2.3 Comparing the NFS and CIFS Workloads

While there are some similarities, especially with respect to the file sets each workload operations on, **the NFS and CIFS workloads are not comparable and no conclusions about the ability of a given SUT to perform NFS versus CIFS operations should be made by comparing the NFS and CIFS results for that SUT.** For example, if the CIFS results for an SUT are 20% higher than the NFS results for the same SUT, it should not be inferred that the SUT is 'better' at delivering CIFS operations than NFS operations. The workloads are very different and no attempt was made to normalize the NFS and CIFS workloads. The only valid comparisons that can be made are between published results for different SUTs operating against the same SPECsfs2008 workload, either NFS or CIFS.

3 Installing and Configuring the Benchmark Environment

This section provides information on hardware/software configuration requirements for the load generators and the file servers (CIFS and NFS). It also includes installation instructions for the benchmark on the load generators for each of the supported operating systems.

3.1 Setting up the System Under Test (SUT)

There are several things you must set up on your ***server*** before you can successfully execute a benchmark run.

1. Configure enough disk space. SPECsfs2008 needs 120 MB of disk space for each NFS or CIFS ops/sec you will be generating, with space for 10% growth during a typical benchmark run (10 measured load levels, 5 minutes per measured load). You may mount your test disks anywhere in your server's file space that is convenient for you. The maximum NFS or CIFS ops/sec a server can process is often limited by the number of independent disk drives configured on the server. In the past, a disk drive could generally sustain on the order of 100-200 NFS or CIFS ops/sec. This was only a rule of thumb, and this value will change as new technologies become available. However, you will need to ensure you have sufficient disks configured to sustain the load you intend to measure.
2. Initialize and mount all file systems. According to the Run and Reporting Rules, you must completely initialize all file systems you will be measuring before every benchmark run. On UNIX systems, this is accomplished with the "newfs" command. On a Windows system the "FORMAT" utility may be used. Just deleting all files on the test disks is not sufficient because there can be lingering effects of the old files (e.g. the size of directory files, location of inodes on the disk) which affect the performance of the server. The only way to ensure a repeatable measurement is to re-initialize all data structures on the disks between benchmark runs. However, if you are not planning on disclosing the result, you do not need to perform this step.
3. Export or share all file systems to all clients. This gives the clients permission to mount, read, and write to your test disks. The benchmark program will fail without this permission.
4. Verify that all RPC services work. The benchmark programs use port mapping, mount, and NFS services, or Microsoft name services, and file sharing, provided by the server. The benchmark will fail if these services do not work for all clients on all networks. If your client systems have NFS client software installed, one easy way to do this is to attempt mounting one or more of the server's exported file systems on the client. On a Windows client one may try mapping the shares to ensure that the services are correctly configured on the CIFS server.
5. NFS servers generally allow you to tune the number of resources to handle TCP requests. When benchmarking using the TCP protocol, TCP support is of course required, and you must also make sure that UDP support is at least minimally configured or the benchmark will fail to initialize.
6. Ensure your server is idle. Any other work being performed by your server is likely to perturb the measured throughput and response time. The only safe way to make a repeatable measurement is to stop all non-benchmark related processing on your server during the benchmark run.
7. Ensure that your test network is idle. Any extra traffic on your network will make it difficult to reproduce your results, and will probably make your server look slower. The easiest thing to do is to have a separate, isolated network between the clients and the server during the test. Results obtained on production networks may not be reproducible. Furthermore, the benchmark may fail to correctly converge to the requested load rate and behave erratically due to varying ambient load on the network.

At this point, your server should be ready for a benchmark measurement. You must now set up a few things on your client systems so they can run the benchmark programs.

3.2 Setting up the Load Generators

Running the SfsManager requires that the Java Runtime Environment (JRE) release 5.0 or later be loaded on the system. You can get the JRE package from www.java.com.

1. On UNIX systems, create "spec" user. SPECsfs2008 benchmark runs should be done as a non-root user.
2. The SPECsfs2008 programs must be installed on clients.

   To install the SPECsfs2008 programs:

   On all the clients:

   Login as "root"

   Enter 'cd cdrom_directory/manager'

   Enter 'java SpecInstall "destination_directory"'

3. On UNIX systems, ensure sfsnfs3 is setUID root, if necessary. Some NFS servers only accept mount requests if sent from a reserved UDP or TCP port, and only the root user can send packets from reserved ports. Since SPECsfs2008 generally is run as a non-root user, the sfsnfs3 program must be set to execute with an effective UID of root.
4. To get the benchmark to use a reserved port, you must include a **-DRESVPORT** option in your compile command. This is easiest to accomplish by editing the Makefile section in which compiler options for the specific operating system used on your client systems. The build process will then make the client use a reserved port and will arrange to run the benchmark programs as root. However, you may want to verify this works the first time you try it.
5. Configure and verify network connectivity between all clients and server. Clients must be able to send IP packets to each other and to the server. How you configure this is system-specific and is not described in this document. Two easy ways to verify network connectivity are to use a "ping" program or the netperf benchmark *(http://www.netperf.org)*.
6. Before starting the benchmark, ensure that the prime client can execute commands on the remote clients using ssh with no password challenges. Refer to Appendix B for an example of how to do this.
7. If clients have NFS client code, verify they can mount and access server file systems. This is another good way to verify your network is properly configured. You should unmount the server's test file systems before running the benchmark. If configuring SPECsfs2008 to test CIFS, one can test that the clients can map the shares. You should un-map the shares before running the benchmark.
8. The Prime Client must have sufficient file space in the SPECsfs2008 file tree to hold the result and log files for a run. Each run generates a log file of 10 to 100 kilobytes, plus a result file of 10 to 100 kilobytes. Each client also generates a log file of one to 10 kilobytes.

*** IMPORTANT *** -- If Windows Firewall is turned on; each program will need to be added to the exceptions list. Either open the Windows Firewall control panel and add the applications manually, or wait for the pop-up to appear after the first execution of each application. Other locally-based firewall applications may require a similar allowance.

3.2.1 Configuring SFS2008 Windows Clients for Auto-Startup

The following are the steps to follow to configure Windows clients in order to allow the Prime Client to communicate with them directly and remotely start the SfsManager process when a benchmark run is started.

Granting DCOM Remote Launch permissions:

1. Click Start, click Run, type DCOMCNFG, and then click OK.

2. In the Component Services dialog box, expand Component Services, expand Computers.

3. Right mouse click on My Computer and select properties.

The My Computer dialog box appears.

4. In the My Computer dialog box, click the COM Security tab.

5. Under Launch and Activate Permissions, click Edit Limits.

6. In the Launch Permission dialog box, follow these steps if your name or your group does not appear in the Groups or user names list:
   a. In the Launch Permission dialog box, click Add.
   b. In the Select Users, Computers, or Groups dialog box, add your name and the group in the Enter the object names to select box, and then click OK.

7. In the Launch Permission dialog box, select your user and group in the Group or user names box. In the Allow column under Permissions for User, select Remote Launch, and then click OK.

3.3 Configuring the Required Benchmark Parameters

Once you have the clients and server configured, you must set some parameters for the benchmark itself, which you do in a file called the "rc file". The actual name of the file is a prefix picked by you, and the suffix "_rc". The default versions shipped with the benchmark are delivered as "sfs_nfs_rc" and "sfs_cifs_rc" in the benchmark source directory. One may use any text editor to modify parameters in the rc files. Please note that any variable which is a list of values must have its value enclosed in double quotes.

There are several parameters you must set, and several others you may change to suit your needs while performing a disclosable run. There are also many other parameters you may change which change the benchmark behavior, but lead to an undisclosable run (for example, turning on debug logging). See the SPECsfs2008 Run Rules for the classification of all the parameters.

The parameters you must set are:

1. **MNT_POINTS**: This parameter specifies the names of the file systems the clients will use when testing the server. It can take two forms.
   The first form is a list of host:path pairs specifying the file systems this particular client will be using. For example, if the server is named "testsys" and has three test mount points named "/test1", "/test2", and "/test3", the list would be "testsys:/test1 testsys:/test2 testsys:/test3", for an NFS configuration, and \\testsys\test1 \\testsys\test2 \\testsys\test3 for a CIFS configuration. You must be very careful when specifying the mount point to comply with the uniform access rule (see below). The second form is simply the name of a file containing a list of mount points for each client. The format of the file is:

   For an NFS configuration:
   ```
   client_name server:path server:path...
   client_name server:path server:path...
   ```

   For a CIFS configuration:
   ```
   client_name \\server\path \\server\path…
   client_name \\server\path \\server\path…
   ```

   And so on, one line for each client system. This file gets stored in the "manager" directory, the same place as the rc file.

   NOTE: The mount points file must be stripped of carriage-return line-feeds. For example, on Linux vi, use the ":set filemode=unix" option when editing this file.

2. **LOAD**, **INCR_LOAD**, and **NUM_RUNS**: These parameters specify the aggregate load the clients will generate. You can specify the load points two ways:

   • You can explicitly specify a list of load levels in LOAD. So, if you want to test a load of 100, 300, and 700 NFSops, you would set LOAD to "100 300 700".
   • If you want to test a set of evenly spaced load points, set all three parameters. Set LOAD to the lowest load level, set INCR_LOAD the amount you would like to increase the load for each measured run, and set NUM_RUNS to the number of times you would like to increment the load. This is the easiest way to configure a disclosable run.

   For example, if you would like to measure 10 evenly spaced points ending at 2000 NFSops, you would set LOAD to 200, INCR_LOAD to 200, and NUM_RUNS to 10. If CLIENTS is 4 and NUM_PROCS is 8, note that due to rounding that occurs within the benchmark code, this will result in load points of 192 384 576 800 992 1184 1376 1600 1792 1984.
3. **CLIENTS**: This is the names of all the client systems you will use to load your server. If you will be generating load with the prime client, include it on this list.
4. **NUM_PROCS**: This is the number of load generating processes ("procs") you want to run on each client system. As you add procs, you can have more operation requests outstanding at any given time, and you can use more file systems on the server, all of which tends to increase the load your server can process (until either the disks or the processors run out of capacity).
   There is a relationship between the value of PROCS, CLIENTS and MNT_POINTS. The number of mount points specified in MNT_POINTS must equal the value of PROCS, or equal the value of PROCS times the number of clients in CLIENTS. In the first case, each mount point will be accessed by one proc on each client. In the second case, each listed mount point will be accessed by exactly one proc on one client. The first PROC mount points will be used by the first client, the second PROC mount points by the second client, and so forth.
   You may specify the same mount point multiple times in MNT_POINTS. This allows you to have more than one process accessing a given file system on the server, without having all clients loading that file system. If a file system traverses multiple disks, (Example RAID Level 0, 1 …), then care must be taken to conform to the uniform access rule.

5. **FS_PROTOCOL**: Set this to NFS or CIFS, which are the only supported protocols.
6. **USERNAME**: Set this to the user account name for the CIFS share. (CIFS testing only)
7. **PASSWORD**: Set this to the user's password for the CIFS share. (CIFS testing only)
8. **DOMAIN**: Set this to the correct CIFS domain. (CIFS testing only)

There are many other parameters you can modify in the rc file, but generally none are necessary. They allow you to change the NFS operation mix, change run duration parameters, or turn on debugging information.

3.3.1 Other Variables in the RC File

As mentioned above, there are many more parameters you can set in the RC file. Here is the list and what they do:

1. **TCP**: Leave it unset, or set it to 1 or "on" to use TCP to communicate between the clients and the server. UDP is not supported.
2. **BIOD_MAX_READS** and **BIOD_MAX_WRITES**: SPECsfs2008 emulates the read-ahead and write-behind behavior of NFS block I/O daemons. These allow a client to have multiple read and write requests outstanding at a given time. BIOD_MAX_READS and BIOD_MAX_WRITES configure how many read or write operations SPECsfs will transmit before stopping and waiting for replies. You can set these to any value from 0 to 32, inclusive. (NFS testing only)
3. **SFS_DIR** and **WORK_DIR**: These are the directory names containing the SPECsfs2008 programs (**SFS_DIR**), the RC file, and logging and output files (**WORK_DIR**). If you configure your clients with the same path for these directories on all clients, you should not need to fool with this. One easy way to accomplish this is to export the SFS directory tree from the prime client and NFS mount it, or for CIFS map the share, at the same place on all clients.
4. **PRIME_MON_SCRIPT** and **PRIME_MON_ARGS**: This is the name (and argument list) of a program which SPECsfs will start running during the measurement phase of the benchmark. This is often used to start some performance measurement program while the benchmark is running so you can figure out what is going on and tune your system.
   Look at the script "sfs_ext_mon" in the SPECsfs2008 source directory for an example of a monitor script.
5. **WARMUP_TIME** and **RUNTIME**: These set the duration of the warmup period and the actual measurement period of the benchmark.
6. **INIT_TIMEOUT**: The maximum time (in seconds) that the benchmark will run during the working set initialization phase for a single data point before timing out. This value may be increased as needed, e.g., when using a slow I/O subsystem, in order to keep the benchmark from timing out during initialization.
7. **BLOCK_SIZE**: The maximum block (RPC) size which the load generators will use for network communication with the NFS server. If this value is not set, the load generators will auto-negotiate the block size with the server based on the server's advertised preferred size. (NFS testing only)
8. **MIXFILE**: This specifies the name of a file in WORK_DIR which describes the operation mix to be executed by the benchmark. ***This capability is only available for NFS testing configurations.*** Look in the file sfs_c_man.c near the function setmix() for a description of the mix file format. The easiest to use format is as follows:

   ```
   SFS MIXFILE VERSION 2
           opname xx%
           opname yy%
           # comment
           opname xx%
   ```

The first line must be the exact string "SFS MIXFILE VERSION 2" and nothing else. The subsequent lines are either comments (denoted with a hash character in the first column) or the name of an operation and it's percentage in the mix (one to three digits, followed by a percent character). The operation names are: null, getattr, setattr, root, lookup, readlink, read, wrcache, write, create, remove, rename, link, symlink, mkdir, rmdir, readdir, fsstat, access, commit, fsinfo, mknod, pathconf, and readdirplus. The total percentages must add up to 100 percent.

9. **ACCESS_PCNT**: This sets the percentage of the files created on the server which will be accessed for I/O operations (i.e. will be read or written).
10. **DEBUG**: This turns on debugging messages to help you understand why the benchmark is not working. The syntax is a list of comma-separated values or ranges, turning on debugging flags. A range is specified as a low value, a hyphen, and a high value (e.g. "3-5" turns on flags 3, 4, and 5), so the value "3,4,8-10" turns on flags 3, 4, 8, 9, and 10.
    To truly understand what gets reported with each debugging flag, you need to read the source code. The messages are terse, cryptic, and not meaningful without really understanding what the code is trying to do. Note the child debugging information will only be generated by one child process, the first child on the first client system.

Table 3**.** Available values for the DEBUG flags:

Value	Name of flag	Comment
1	**DEBUG_NEW_CODE**	**Obsolete and unused**
2	**DEBUG_PARENT_GENERAL**	**Information about the parent process running on each client system.**
3	**DEBUG_PARENT_SIGNAL**	**Information about signals between the parent process and child processes**
4	**DEBUG_CHILD_ERROR**	**Information about failed NFS or CIFS operations**
5	**DEBUG_CHILD_SIGNAL**	**Information about signals received by the child processes**
6	**DEBUG_CHILD_XPOINT**	**Every 10 seconds, the benchmark checks it's progress versus how well it's supposed to be doing (for example, verifying it is hitting the intended operation rate). This option gives you information about each checkpoint**
7	**DEBUG_CHILD_GENERAL**	**Information about the child in general**
8	**DEBUG_CHILD_OPS**	**Information about operation starts, stops, and failures**
9	**DEBUG_CHILD_FILES**	**Information about what files the child is accessing**
10	**DEBUG_CHILD_RPC**	**Information about the actual RPCs generated and completed by the child**
11	**DEBUG_CHILD_TIMING**	**Information about the amount of time a child process spends sleeping to pace itself**
12	**DEBUG_CHILD_SETUP**	**Information about the files, directories, and mix percentages used by a child process**
13	**DEBUG_CHILD_FIT**	**Information about the child's algorithm to find files of the appropriate size for a given operation**

4 Running the Benchmark and Interpreting Results

This section contains information on the SFS benchmark directory structure, running the benchmark, and interpreting the benchmark metrics output generated in the summary results file.

4.1 SFS Benchmark Directory Structure

The following is a quick overview of the benchmark's directory structure. Please note that the variable "$SPEC" used below represents the full path to the install_directory, where the benchmark is installed.

1. $SPEC
   The directory contains the SFS benchmark Makefile. The SFS benchmark uses the UNIX "Makefile" structure to build tools, compile the benchmark source into executables, and to clean directories of all executables. However, note that pre-built binaries for several operating systems, and therefore compilation should not be required in most cases.
2. $SPEC/bin
   The benchmark binaries for the specific environment being used are located in the "$SPEC/bin" directory if the user has built the binaries using the Makefile provided..
3. $SPEC/binaries
   The benchmark pre-built binaries for various operating systems are located in subdirectories under the "$SPEC/binaries" directory.
4. $SPEC/documents
   The benchmark documentation is located under the "$SPEC/documents" directory.
5. $SPEC/manager
   Both the SFS default and user modified _rc files are located in the "$SPEC/manager" directory. These files contain the parameter values to be used by the SFS Manager (SfsManager) for benchmark execution. The SfsManager is also located in this directory.
6. $SPEC/redistributable_sources
   Source code which is being used within the benchmark under the terms of the GNU Lesser General Public License is located under the "$SPEC/redistributable_sources" directory.
7. $SPEC/result
   The benchmark log and results files created during a benchmark run are located in the "$SPEC/result" directory.
8. $SPEC/src
   The benchmark source code is located under the "$SPEC/src" directory.
9. $SPEC/submit_tools
   The tools for generating a benchmark result submission file which can submitted for SPEC review are located under "$SPEC/submit_tools".

4.2 Pre-Compiled SFS Benchmark Binaries

Included in this benchmark release are pre-compiled versions of the benchmark for various operating systems at various levels. If it becomes necessary for the user to compile a version of the benchmark source for testing, a generic UNIX makefile is provided in the benchmark top level directory ($SPEC). This top level makefile will determine the target during its execution, and build the appropriate executables for the target system.
The makefile may be modified or supplemented in a performance neutral fashion to facilitate the compilation and execution of the benchmark on operating systems not included within the benchmark distribution.

The Visual Studio workspace files are also provided should one need to rebuild the Windows executables. The workspace files are located in the src/win32 subdirectory. Building SPECsfs2008 can be done with Visual Studio 2005.

The following is a list of the vendors and their respective operating system levels for which the benchmark workloads have been pre-compiled and included with the benchmark distribution.

NFS workload:

IBM Corporation	
	AIX 5.3 TL05
FreeBSD	
	FreeBSD 5.4
Sun Microsystems, Inc.	
	Solaris10
Redhat Inc.	
	RHEL3 and RHEL4
Apple Computer Corporation	
	Mac OSX (Tiger, and Leopard)
Microsoft Corporation	
	Windows XP, and Vista

CIFS workload:

FreeBSD	
	FreeBSD 5.4
Sun Microsystems, Inc.	
	Solaris10
Redhat Inc.	
	RHEL3 and RHEL4
Apple Computer Corporation	
	Mac OSX (Tiger, and Leopard)
Microsoft Corporation	
	Windows XP, and Vista

4.3 Using the SFS Manager

This section briefly describes the usage of the Java-based Manager provided with the SPEC System File Server (SFS) SPECsfs2008 suite. The manager is used to run the benchmark. The results obtained from multiple data points within a run are also collected in a form amenable for ease of use with other result formatting tools.

This section does not cover the complete Client-Server environment setup in detail. It touches only the portions currently handled by the manager. For information on how to set up and run the SFS suite the reader is advised to refer to the section on configuring the SFS environment above.

A new Java-based manager program exists to handle the execution of the SPECsfs2008 benchmark. The manager replaces the shell scripts that had been used by previous versions of the benchmark. The new manager was implemented to allow the same manager to run on Windows and UNIX clients and to eliminate the need for using rsh, and rcp. The manager uses Remote Method Invocation (RMI) to communicate between the clients. Java requires a security policy to be defined when using RMI. The manager comes with a default security policy in the manager/java.policy file that allows anybody to send messages to any SPECsfs2008 client and to execute commands on the SPECsfs2008 client. If you wish to tighten up the security then you can edit the policy file. You can get more information on how to do this by looking up Java security documentation in the Java Runtime Environment that you are using.

4.3.1 Example of SUT Validation

```
C:\Documents and Settings\Administrator\Desktop\spec\manager>java SfsManager -r
sfs_rc -s junk -v 2
     @(#)COPYRIGHT   2008    06/01/12

     Copyright (c) 1992-2008 Standard Performance Evaluation Corporation
     All rights reserved.

          Standard Performance Evaluation Corporation (SPEC)
          6585 Merchant Place, Suite 100
          Warrenton, VA 20187

     SPEC System File Server 2008 Release

     This product contains benchmarks acquired from several sources who
     understand and agree with SPEC's goal of creating fair and objective
     benchmarks to measure computer performance.

     This copyright notice is placed here only to protect SPEC in the
     event the source is misused in any manner that is contrary to the
     spirit, the goals and the intent of SPEC.

     The source code is provided to the user or company under the license
     agreement for the SPEC Benchmark Suite for this product.

     This product includes cryptographic software written by
     Eric Young (eay@cryptsoft.com)

  Operating System Architecture: x86
  Operating System Name: Windows 2003

>> Prior to running SFS for valid publication data, all targeted
>> file systems on the server are required to be cleaned (ex. newfs).


     >>>>> STARTED SFS VALIDATION ON Sat Jan 20 12:40:13 MST 2007 <<<<<

Executing SFS protocol Validation ...
Starting SFS protocol validation on client (c1)
   sfsCIFS -V 2 -o CIFSpass -u Administrator –G MYGROUP -Q \\sut\export
SFS protocol validation completed successfully.
See ../result/sfsval.junk for results.
```

4.3.2 Example of a Benchmark Run

```
C:\Documents and Settings\Administrator\Desktop\spec\manager>java SfsManager -r
sfs_rc -s junk
        @(#)COPYRIGHT   2008    08/01/12

        Copyright (c) 1992-2008 Standard Performance Evaluation Corporation
        All rights reserved.

                Standard Performance Evaluation Corporation (SPEC)
                6585 Merchant Place, Suite 100
                Warrenton, VA 20187

        SPEC System File Server 2008 Release

        This product contains benchmarks acquired from several sources who
        understand and agree with SPEC's goal of creating fair and objective
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        event the source is misused in any manner that is contrary to the
        spirit, the goals and the intent of SPEC.

        The source code is provided to the user or company under the license
        agreement for the SPEC Benchmark Suite for this product.

        This product includes cryptographic software written by
        Eric Young (eay@cryptsoft.com)

  Operating System Architecture: x86
  Operating System Name: Windows 2003

>> Prior to running SFS for valid publication data, all targeted
>> file systems on the server are required to be cleaned (ex. newfs).


        The Results from this run will be stored in
        ../result/sfssum.junk

        >>>>> STARTED SFS RUNS ON Sat Jan 20 12:48:42 MST 2007 <<<<<

    Sat Jan 20 12:48:42 MST 2007
     Executing run 1 of 10 ... done
    Sat Jan 20 12:59:42 MST 2007
     Executing run 2 of 10 ...  done
    Sat Jan 20 13:10:42 MST 2007
     Executing run 3 of 10 ...  done
    Sat Jan 20 13:21:42 MST 2007
     Executing run 4 of 10 ...  done
    Sat Jan 20 13:32:42 MST 2007
  Executing run 5 of 10 ...  done
Sat Jan 20 13:43:42 MST 2007
  Executing run 6 of 10 ...  done
Sat Jan 20 13:54:42 MST 2007
  Executing run 7 of 10 ...  done
Sat Jan 20 14:05:42 MST 2007
  Executing run 8 of 10 ...  done
Sat Jan 20 14:16:42 MST 2075
   Executing run 9 of 10 ...  done
Sat Jan 20 14:27:42 MST 2007
   Executing run 10 of 10 ...  done
```

Reminder: The benchmark "run" may take many hours to complete depending upon how many data points were requested. Also, some failures may take more than an hour to manifest.

Note: If one is running SPECsfs2008 on a Windows Workstation client. (non-server version of Windows) then one must disable the Windows file server component before using the client to run the SPECsfs2008 benchmark. This is accomplished by using a command window and running:

```
net stop server
```

This applies to all non-server versions of Windows. (NT, XP, Win2k, and Vista)

4.4 Interpreting the Benchmark Results

Here is sample output from an sfssum file for a full SFS run:

```
 320     321     1.5     96187  299 CIFS T 4   37764720   4 10  2  2 2008
 640     640     1.8    192114  300 CIFS T 4   75529440   4 10  2  2 2008
 960     962     2.1    288236  299 CIFS T 4  117478440   4 10  2  2 2008
1280    1283     2.3    384644  299 CIFS T 4  155221920   4 10  2  2 2008
1600    1605     2.5    480411  299 CIFS T 4  192986640   4 10  2  2 2008
1920    1924     3.1    576595  299 CIFS T 4  234935648   4 10  2  2 2008
2240    2241     4.0    672385  300 CIFS T 4  272679104   4 10  2  2 2008
2560    2571     5.8    768874  299 CIFS T 4  314628128   4 10  2  2 2008
2880    2894     8.9    865936  299 CIFS T 4  352392832   4 10  2  2 2008
3200    3011    11.3    901761  299 CIFS T 4  390136320   4 10  2  2 2008
```

The column definitions are as follows:

1. Aggregate requested load (ops/sec)
2. Achieved SFS throughput (ops/sec). Note that the throughput achieved by the server may not necessarily match the requested load
3. Average response time per SFS operation (msec/op)
4. Total logical SFS operations completed
5. Test time. Duration of the run at the requested load. Note that the actual duration may be off by a second relative to the requested run time, e.g., 300 secs in this case. This is OK
6. File server protocol. Either CIFS or NFS3
7. Network protocol. This will always be "T", for TCP
8. IP version. Should always be "4" since IPv6 is not supported at this time
9. Total file set size created (KB)
10. Number of load generators
11. Number processes per load generator
12. Maximum number of outstanding reads (BIOD_MAX_READS). This only applies to NFS testing, but the value shows up in CIFS sfssum files as well

13. Maximum number of outstanding reads (BIOD_MAX_WRITES). This only applies to NFS testing, but the value shows up in CIFS sfssum files as well
14. SFS version. Should be "2008" for SPECsfs2008

Below is sample output for one load point from an sfslog file. The columns in the table are self-explanatory. The table contains useful information which can tell you, for instance, which types of operations are most costly in terms of processing time on your server:

```
SFS Aggregate Results for 4 Client(s), Tue Jan 22 02:41:36 2008
CIFS Protocol

---------------------------------------------------------------------------------------------------------
CIFS                              Target Actual CIFS Op CIFS Op   CIFS   Mean     Std Dev  Std Error Pcnt
Op                                CIFS   CIFS   Logical Physical  Op     Response Response of Mean,  of
Type                              Mix    Mix    Success Success   Error  Time     Time     95% Conf  Total
                                  Pcnt   Pcnt   Count   Count     Count  Msec/Op  Msec/Op  +-Msec/Op Time
---------------------------------------------------------------------------------------------------------
ECHO                               0.5%   0.5%     4482     4482      0      0.62     0.98      0.03  0.0%
LOCKING_ANDX                       1.1%   1.1%     9811     9811      0      0.93     2.12      0.03  0.1%
NT_TRANSACT_QUERY_SECURITY_DES     1.6%   1.6%    14435    14435      0      1.34     1.54      0.02  0.2%
READ_ANDX                         20.5%  20.5%   184659   199307      0     39.71    74.05      0.04 72.2%
TRANS2_QUERY_FS_INFORMATION        1.6%   1.6%    14309    14309      0      2.77     2.68      0.03  0.4%
TRANS2_QUERY_FILE_INFORMATION     12.9%  12.9%   115989   115989      0      0.63     0.99      0.01  0.7%
TRANS2_QUERY_PATH_INFORMATION     21.5%  21.4%   193547   193547      0      0.65     1.20      0.00  1.2%
TRANS2_SET_FILE_INFORMATION        3.2%   3.2%    29140    29140      0      0.64     1.84      0.02  0.2%
TRANS2_FIND_FIRST2                 8.6%   8.6%    77822    77822      0      0.74     2.20      0.01  0.6%
WRITE_ANDX                         8.6%   8.6%    77679    83248      0     14.13    42.83      0.05 10.8%
NT_CREATE_ANDX                     9.7%   9.7%    87712    87712      0     14.98    50.84      0.05 12.9%
CLOSE                              9.7%   9.7%    87713    87713      0      0.73     1.15      0.01  0.6%
FLUSH                              0.5%   0.5%     4463     4463      0      0.59     0.92      0.03  0.0%
---------------------------------------------------------------------------------------------------------

        ---------------------------------------------
        |  SPEC SFS 2008 AGGREGATE RESULTS SUMMARY  |
        ---------------------------------------------
SFS CIFS THROUGHPUT:    3011 Ops/Sec   AVG. RESPONSE TIME:    11.3 Msec/Op
TCP PROTOCOL (IPv4)
CIFS MIXFILE: [ SFS default ]
AGGREGATE REQUESTED LOAD: 3200 Ops/Sec
TOTAL LOGICAL CIFS OPERATIONS:  901761         TEST TIME: 299 Sec
TOTAL PHYSICAL CIFS OPERATIONS: 921978
PHYSICAL CIFS IO THROUGHPUT: 3083 Ops/sec
NUMBER OF SFS CLIENTS: 4
TOTAL FILE SET SIZE CREATED: 380992.5 MB
TOTAL FILE SET SIZE ACCESSED: 114310.2 - 116088.6 MB  (100.00% to 101.56% of Base)

------------------------------------------------------------------------
```

5 Submission and Review Process

The SPECsfs2008 benchmark release includes tools for generating benchmark results in a format that can be submitted by email to the SFS results processing facility at SPEC, which will automatically process these results and distribute them to the SFS subcommittee for review. This section describes how you can use these tools to generate a file for each result that you wish to submit to SPEC. It also describes the review process that occurs once the results are submitted. At this point, it is expected that you have become familiar with the SPECsfs2008 Run and Reporting Rules.

5.1 Creating Reports

Once a benchmark run is completed, the configuration file, results file and additional information are combined into a submission file that is used for submitting runs to SPEC for review using the **`subedit`** command. Descriptions of the fields that need to be filled out in the submission file are included in Appendix A in the SPECsfs2008 Run and Reporting Rules. This same submission file can be use to generate reports in the form presented on the SPEC web site using the **`specreport`** command. Each command is documented below.

Running the SPEC SFS submit tools requires that the Java RunTime Environment (jre) release 1.5 or later be loaded on the system. You can get jre packages from www.java.com. The following examples assume that the correct java program is in the current users path.

There are two components to the submit tools:

* subedit - Create an XML submission file to be used to generate a report, optionally bundle all submit files into a ZIP for submission.

* specreport - Create the HTML and/or text reports from the submission files.

5.1.1 Creating the Submission File

To run subedit:

```
cd $SPEC/submit_tools
perl subedit.pl -o submitFile [-i sourceFile] resultFile
```

```
NAME
     subedit.pl - SPEC SFS submission file editor

SYNOPSIS
     subedit.pl -o submitFile [-i defaultsFile] resultFile rcFile
     subedit.pl -b -o submitFile -i defaultsFile resultFile rcFile
     subedit.pl -z -o submitZipFile -i defaultsFile resultFile rcFile
     subedit.pl -v -i submitFile
     subedit.pl -n -o nonCompliantSubmitFile -i submitFile

DESCRIPTION
     Produces an XML-based submission file by allowing you to
     interactively walk through the "tree" of the file, prompting for
     field values. Two input files are required: resultFile (the file
     created by a benchmark run whose name begins with 'sfssum_') and
     rcFile (the benchmark configuration file). You can optionally
     supply a previously generated submission file to provide default
     field values. Note that the resultFile and rcFile are not required
     for validation (-v) or non-compliant (-n) mode.

OPTIONS
     -o submitFile - Names the output file.

     -b (batch) - Instead of prompting for input, merges the
                  information from the three files into the output.
                  This is equivalent to coming up in interactive mode
                  and taking all defaults. If -b is specified, then a
                  file containing default values must be specified via
                  -i.

     -z (zip) - Like batch mode, but produces a zip file for submission
                with all necessary files in the zip file specified with
                -o

     -v (validate) - Only validates the contents of the XML submission
                     file specified with -i, reporting missing or
                     invalid nodes.

     -n (non-compliant) - Marks the XML submission file specified with
-i
                          as non-compliant and stores the XML
submission
                          marked as non-compliant in the XML file
                          specified with -o

     -i defaultsFile - The name of a previously generated output file
                       that is used as a template for the editing
session.

     resultFile - The result file from the SPEC SFS run associated
                  with this submission. The name of the file generated
                  by SPEC SFS begins with "sfssum".

     rcFile - The configuration file for the SPEC SFS run associated
              with this submission.

Subedit Editor Interface
  The prompt displays the current location in the XML document (as if
  it were a tree with nodes separated by '.'), the current value
  stored in the node at the current location (if any), and is
  terminated with a ':'.

  There are three types of actions that can be performed in the
  subedit interface: commands, queries, and data entry.

  Subedit Navigation Commands:
    * .u# - Go up # levels in the tree. If # is omitted, 1 is assumed.
    * .d  - Go to the first child of the current node, or the next
            logical node in the document if the current node has no
            children (as determined by breadth first search). This is
            the same as pressing 'enter' at a blank prompt.

    * .n  - Go to the next sibling of the current node, if one exists.

    * .p  - Go to the previous sibling of the current node, if one
            exists.

    * .#  - Go to the #th child of this node (note: get a numbered list
            of children with ?c).

  Subedit List Manipulation Commands:
    * .a  - Add a new, blank, list item to the end of the list. This
            command only works from the node which contains all the
            list items.

    * .r# - Remove child node # from a list (for list use ?c). This
            command only works from the node which contains all the
            list items. Does not allow removal of the last node from a
            list if there is only one item in the list.

  Subedit Logical Commands:
    * .q  - Quit the program. You will be prompted for confirmation if
            the document is invalid or has not been saved.

    * .s  - Save the document - can also be used to bundle all
            submission materials into a ZIP file. See note below.

    * .v  - Validate the document. This will indicate whether document
            is valid or not, and will prompt whether or not to display
a
            list of invalid nodes. The list of invalid nodes is simply
a
            list of paths from root to invalid nodes separated by line
            returns,
            e.g. 'specSFS4_0Info.productInfo.productAndVendor.vendor'

  Subedit Queries:
    * ?c - Show children of the current node. Produces a numbered
           list, which is helpful for use with .# command. Nodes that
           are invalid, or have invalid descendents, are prefixed by
           '*'. Items in lists have a few fields summarized in the list
           to help more easily identify the contents of the list items.

    * ?d - Show documentation for the current node. This describes
           what information should be put into the current node and
           what constitutes a valid entry for the field, if there are
           any restrictions.

    * ?  - Generic help: lists subedit commands and queries.

  Subedit Data Entry:
    * Entering text that is neither a command, nor query, and pressing
```

```
      'enter' will cause that text to be stored in the current node,
      replacing existing data and move to the next node.

    * Simply pressing 'enter' will keep the current data in the node
      and move to the next node, as if '.d' was entered.

    * Entering a '.' then pressing 'enter' will enter multiline input
      mode, where input will be continually accepted until a line with
      a single '.' is encountered. This replaces existing data in the
      node and moves to the next node.

  Subedit Interface Notes:
    * Save a ZIP file containing all files for this submission:
      .s file.zip

    * Save a snapshot of the document currently being edited to
      another XML file:
      .s file.xml
```

5.1.2 Creating the Submission Reports

To run specreport, enter the following:

```
 cd $SPEC/submit_tools
 perl specreport.pl -o reportFile submitFile
```

```
NAME
     specreport.pl - SPEC SFS report generator

SYNOPSIS
     specreport.pl [-h] [-r] [-f {html|text|summary}] -o reportFile
submitFile

DESCRIPTION
     Translates an XML submission file into a human-readable report in
     either HTML or text format.

OPTIONS
     -h - Print usage information and terminate

     -r - Generate a report for SPEC reviewers. -f summary causes this
to be
          ignored

     -f - Generate either an HTML (default), text, or a summary of
key,value
          pairs

     -o reportFile - Filename for the report to be generated

     submitFile - Path and filename of XML submission file from which
                  to generate the report
```

5.1.3 Submit Tools Example Files

```
* sfssum.example - a sample benchmark NFS run sfssum output file

* sfssum.cifs.example - a sample benchmark CIFS run sfssum output file

* example_rc - sample NFS configuration file to correspond with
        sfssum.example

* example_cifs_rc - sample CIFS configuration file to correspond with
          sfssum.cifs.example

* example.xml - a sample NFS submission file containing default
        values but no results - subedit must be used to add
        result information before this is a valid submission
        file

* example.cifs.xml - a sample CIFS submission file containing
          default values but no results - subedit must be
          used to add result information before this is a
          valid submission file

* example.txt -  a sample text NFS submission report created by
         specreport

* example.cifs.txt - a sample text CIFS submission report created by
          specreport

* example_review.txt - a sample text NFS submission report created by
           specreport for SPEC reviewers.

* example.html - a sample HTML NFS submission report created by
         specreport

* example.cifs.html - a sample HTML CIFS submission report created by
          specreport

* example_review.html - a sample HTML NFS submission report created by
           specreport for reviewers at SPEC.

* example.png - the results chart created by specreport for the HTML
        NFS submission report example

* example.cifs.png - the results chart created by specreport for the
          HTML CIFS submission report example

* example_review.png - the results chart created by specreport for
           the HTML NFS submission report example for
```

```
                    the SPEC reviewers.

  * example_config.jpg - the config diagram referenced by the
                    example.xml file and the sample HTML
                    submission reports
```

5.1.4 Submit Tools Example Scenarios

5.1.4.1 Scenario 1:

```
An XML submission file with configuration details already exists and
you
want to generate a submission file for an SFS2008 run without editing
any of the information contained within.

Scenario 1 Prerequisites:
 * The RC file used for the SFS2008 run (referred to as example_rc)
 * The sfssum file generated by the SFS2008 run (referred to as
   sfssum.example)
 * The XML submission file containing configuration details for the
   SFS2008 run (referred to as example.xml)
 * Any JPEG configuration diagrams referenced by the XML submission
file
   containing configuration details (example.xml) (for this example,
   it is assumed there is one named example_config.jpg)
```

5.1.4.1.1 Scenario 1, Example 1:

```
Generate XML submission file (sub.xml) only

 * Step 1: Move all files mentioned in prerequisites section to the
           submit_tools directory.

 * Step 2: From the submit_tools directory, run the command:
           perl subedit.pl -b -o sub.xml -i example.xml \
                sfssum.example example_rc

 * Step 3: subedit should produce the following output:
           Document is valid
           Saved sub.xml

 * Step 4: Verify that the file sub.xml was created in the
           submit_tools directory.
```

5.1.4.1.2 Scenario 1, Example 2:

```
Generate a ZIP file (sub.zip) of all submission-related materials for
submission to SPEC

 * Step 1: Move all files mentioned in prerequisites section to the
```

```
           submit_tools directory.

 * Step 2: From the submit_tools directory, run the command:
           perl subedit.pl -z -o sub.zip -i example.xml \
                sfssum.example example_rc

 * Step 3: subedit should produce the following output:
           Document is valid
           Saved sub.zip

 * Step 4: Verify that the file sub.zip was created in the
           submit_tools directory.
```

5.1.4.2 Scenario 2:

You want to generate an XML submission file, or ZIP submission file for submission to SPEC, for an SFS2008 run and do not have an existing XML submission file with configuration details for the run.

```
Scenario 2 Prerequisites:
 * The RC file used for the SFS2008 run (referred to as example_rc)
 * The sfssum file generated by the SFS2008 run (referred to as
   sfssum.example)
 * Any JPEG configuration diagrams to be included in the submission
```

Scenario 2, Example 1:
Generate the XML submission file (sub.xml) only

```
 * Step 1: Move all files mentioned in the prerequisites section to
           the submit_tools directory.

 * Step 2: From the submit_tools directory, run the command:
           perl subedit.pl -o sub.xml sfssum.example example_rc

 * Step 3: subedit will enter into interactive editing mode and
           display the following prompt:
           .specSFS4_0Info
           :

           The first line of the prompt indicates your position within
           the XML 'tree' of the submission file, with each node
           separated by a period (.). The second line of the prompt,
           which begins with a colon (:), is where you enter subedit
           commands to edit, browse, and enter information into the
           document.

 * Step 4: Using the subedit commands (see "Subedit Editor Interface"
           above), step through the document and fill in all relevant
           information. There are a couple helpful "query" commands
           that provide information to help you fill in information
           correctly and know your position in the document. For
           general help, enter a ? and press the "enter" key.

           For example, ?c will list all immediate children of the
           node you are currently at in the document. From the prompt
           in step 3, type the following, and then press the enter
           key:
           ?c

 * Step 5: Subedit should output the following:
           1. *productInfo
           2. *testInfo
           3. results
           4. otherReportNotes
           5. resultCompliance
           6. *submissionInfo
           :

           If the child node name is preceded by "*" it means either
           it or one of its descendents is either empty or contains
           invalid data.

 * Step 6: To get started filling in the report, fill in the vendor
           name field by pressing the "enter" key at the prompt in
           step 5 three times until the prompt looks like:
           .specSFS4_0Info.productInfo.vendorAndProduct.vendor
           :

 * Step 7: To get a description of what to fill in for this field,
           enter the following command and press the "enter" key:
           ?d

 * Step 8: Subedit should output the following:
           The name of the SPEC licensee who is publishing this report.
           ----------
           Type: String
           Value must not be empty, and cannot be multi-line
           ----------
           :

 * Step 9: Now, to fill in a value for the field, simply type in the
           desired vendor name at the prompt and press "enter".

 * Step 10: Subedit should output the following:
            .specSFS4_0Info.productInfo.vendorAndProduct.productName
            :

            This indicates that subedit has saved the value you
            entered for the vendor field and has automatically
            advanced to the next field, "productName"

 * Step 11: Continue filling in information until complete

 * Step 12: To save the XML file, enter the following command and press
            the "enter" key:
            .s

 * Step 13: Subedit should display the following:
            Saved sub.xml
            You should then be returned to the subedit prompt, and may
            quit by entering the following command and pressing the
            "enter" key:
            .q

            If you see the following prompt:
            This document is not valid! Really save (y/n)?

            Then there are still empty fields in the document. You
            must fill in all fields as necessary so that the document
            is valid before submitting your result to SPEC.
```

5.1.4.2.1 Scenario 2, Example 2:

Generate the ZIP (sub.zip) file of all submission materials for submission to SPEC.

NOTE: For a more detailed walkthrough of editing the document, see Scenario 2, Example 1 above.

```
 * Step 1: Move all files mentioned in the prerequisites section to
           the submit_tools directory.

 * Step 2: From the submit_tools directory, run the command:
           perl subedit.pl -o sub.xml sfssum.example example_rc

           NOTE: Using this procedure, sub.xml will not be generated,
           though it can be easily generated by issuing a ".s" command
           without any arguments. (See Step 5)

 * Step 3: subedit will enter into interactive editing mode and
           display the following prompt:
           .specSFS4_0Info
           :

 * Step 4: Using the subedit commands (see "Subedit Editor Interface"
           above), step through the document and fill in all relevant
           information until complete.

 * Step 5: To save the ZIP file, enter the following command and press
           the "enter" key:
           .s sub.zip

 * Step 6: Subedit should display the following:
           Saved sub.zip

           You should then be returned to the subedit prompt, and may
           quit by entering the following command and pressing the
           "enter" key:
           .q

           If you see the following prompt:
           This document is not valid! Really save (y/n)?
           Then there are still empty fields in the document. You must
           fill in all fields as necessary so that the document is
           valid before submitting your result to SPEC.
```

5.1.4.3 Scenario 3:

You want to generate an XML submission file, or ZIP submission file for submission to SPEC, for an SFS2008 run and have an existing XML submission file with configuration details for the run that you wish to edit.

```
Scenario 3 Prerequisites:
 * The RC file used for the SFS2008 run (referred to as example_rc)
 * The sfssum file generated by the SFS2008 run (referred to as
   sfssum.example)
 * The XML submission file containing configuration details for the
   run that you wish to edit (referred to as example.xml)
 * Any JPEG configuration diagrams to be included in the submission
```

5.1.4.3.1 Scenario 3, Example 1:

Generate the XML submission file (sub.xml) only

```
 * Step 1: Move all files mentioned in the prerequisites section to
           the submit_tools directory.

 * Step 2: From the submit_tools directory, run the command:
           perl subedit.pl -i example.xml -o sub.xml \
                sfssum.example example_rc

 * Step 3: subedit will enter into interactive editing mode and
           display the following prompt:
           .specSFS4_0Info
           :

           The first line of the prompt indicates your position within
           the XML 'tree' of the submission file, with each node
           separated by a period (.). The second line of the prompt,
           which begins with a colon (:), is where you enter subedit
           commands to edit, browse, and enter information into the
           document.

 * Step 4: Using the subedit commands (see "Subedit Editor Interface"
           above), step through the document and fill in all relevant
           information. There are a couple helpful "query" commands
           that provide information to help you fill in information
           correctly and know your position in the document. For
           general help, enter a ? and press the "enter" key.

           For example, ?c will list all immediate children of the
           node you are currently at in the document. From the prompt
           in step 3, type the following, and then press the enter
           key:
```

```
           ?c

 * Step 5: Subedit should output the following:
           1. *productInfo
           2. testInfo
           3. results
           4. otherReportNotes
           5. resultCompliance
           6. submissionInfo
           :

           If the child node name is preceded by "*" it means either
           it or one of its descendents is either empty or contains
           invalid data.

 * Step 6: To get started filling in the report, fill in the vendor
           name field by pressing the "enter" key at the prompt in
           step 5 three times until the prompt looks like:
           .specSFS4_0Info.productInfo.vendorAndProduct.vendor
                   Acme Servers
           :

           Note that the prompt now displays the current value of the
           node on a separate line, indented, before the ":"
           prompt. (Your existing value may not be "Acme Servers".)
           This line will be omitted if the node does not contain a
value.

 * Step 7: To get a description of what to fill in for this field,
           enter the following command and press the "enter" key:
           ?d

 * Step 8: Subedit should output the following:
           The name of the SPEC licensee who is publishing this report.
           ----------
           Type: String
           Value must not be empty, and cannot be multi-line
           ----------
           :

 * Step 9: Now, to fill in a value for the field, simply type in the
           desired vendor name at the prompt and press "enter".

 * Step 10: Subedit should output the following:
            .specSFS4_0Info.productInfo.vendorAndProduct.productName
            :

            This indicates that subedit has saved the value you
            entered for the vendor field and has automatically
            advanced to the next field, "productName", which contains
            no value yet.

 * Step 11: Continue filling in information until complete

 * Step 12: To save the XML file, enter the following command and press
```

```
            the "enter" key:
            .s

 * Step 13: Subedit should display the following:
            Saved sub.xml

            You should then be returned to the subedit prompt, and may
            quit by entering the following command and pressing the
            "enter" key:
            .q

            If you see the following prompt:
            This document is not valid! Really save (y/n)?

            Then there are still empty fields in the document. You
            must fill in all fields as necessary so that the document
            is valid before submitting your result to SPEC.
```

5.1.4.3.2 Scenario 3, Example 2:

```
Generate the ZIP (sub.zip) file of all submission materials for
submission to SPEC.

NOTE: For a more detailed walkthrough of editing the document, see
Scenario 3, Example 1 above.

 * Step 1: Move all files mentioned in the prerequisites section to
           the submit_tools directory.

 * Step 2: From the submit_tools directory, run the command:
           perl subedit.pl -i example.xml -o sub.xml \
                sfssum.example example_rc

           NOTE: Using this procedure, sub.xml will not be generated,
           though it can be easily generated by issuing a ".s" command
           without any arguments. (See Step 5)

 * Step 3: subedit will enter into interactive editing mode and
           display the following prompt:
           .specSFS4_0Info
           :

 * Step 4: Using the subedit commands (see "Subedit Editor Interface"
           above), step through the document and fill in all relevant
           information until complete.

 * Step 5: To save the ZIP file, enter the following command and press
           the "enter" key:
           .s sub.zip

 * Step 6: Subedit should display the following:
           Saved sub.zip

           You should then be returned to the subedit prompt, and may
           quit by entering the following command and pressing the
           "enter" key:
           .q

           If you see the following prompt:
           This document is not valid! Really save (y/n)?

           Then there are still empty fields in the document. You must
           fill in all fields as necessary so that the document is
           valid before submitting your result to SPEC.
```

5.1.4.4 Scenario 4:

```
You want to generate a text or HTML report, as would appear on the
SPEC website, for your SFS2008 result.

Scenario 4 Prerequisites:
 * The XML submission file for your run, as generated by subedit
   (referred to as example.xml). (See Scenarios 1, 2, and 3.)
 * Any JPEG configuration diagrams to be included in the submission
   that are referenced in your XML submission file.
```

5.1.4.4.1 Scenario 4, Example 1:

```
Generate the HTML report (example.html).

 * Step 1: Move all files mentioned in the prerequisites section to
           the submit_tools directory.

 * Step 2: From the submit_tools directory, run the command:
           perl specreport.pl -f html -o example.html example.xml

 * Step 3: Specreport should output the following:
           Creating example.html

 * Step 4: Verify that example.html and example.png (the chart of the
           SFS2008 results) were created in the submit_tools
           directory.

 * Step 5: The example.html file may be opened in a browser and
           viewed.
```

5.1.4.4.2 Scenario 4, Example 2:

```
Generate the text report (example.txt).

 * Step 1: Move all files mentioned in the prerequisites section to
           the submit_tools directory.

           NOTE: The config diagrams are only necessary when
           generating HTML reports

 * Step 2: From the submit_tools directory, run the command:
```

```
          perl specreport.pl -f text -o example.txt example.xml

 * Step 3: Specreport should output the following:
          Creating example.txt

 * Step 4: Verify that example.txt was created in the submit_tools
          directory.

 * Step 5: The example.txt file may now be opened in a text editor and
          viewed.
```

5.1.5 Translation of Free-Form Fields

A number of the full disclosure fields described above say that their content contains "free-form" information. When providing that information (typically with the `subedit` command) you are allowed to supply fragements of source that conform to a subset of the HTML language. The `specreport` command inserts this text literally into the appropriate place when generating an HTML output. When the `-t` (text output) option is supplied, the HTML-fragment is interpreted in the following manner:

HTML Tag	**Meaning**
<p>	Paragraph break – insert a blank line and start the remaining text at the current indent level.
<br>	Line break – start a new line.
<blockquote> .. </blockquote>	Increase the indent level by four spaces until the corresponding end tag is encountered.
<ul> .. </ul>	Unordered list – start a new line and indent four spaces until the </ul> is encountered. Lists can be nested.
<li>	Start a new list item by un-indenting two spaces and inserting "* " or some other character if at a nested level greater than one.
<pre> .. </pre>	Copy contained text preserving line breaks.
all other tags	Are ignored, but removed. Thus, for example, some text can be in a particular font in the HTML rendering, but the font change will have no effect in the text rendering.

All tag attributes are ignored. All tags not in the above table are removed (and ignored).

Additionally the text processor converts the following text sequences:

Input	**Translation**
`&lt;`	`<`
`&gt;`	`>`
`&quot;`	`"`
`&amp;`	`&`

For example, the following supplied in a bomItem description that produces some underlined bold text in the html version and preserves the text while ignoring the other font directives:

```
Disk drive that contains <b><u>many</u></b> interesting
features including the fact that it holds bits of
information.
```

Might be rendered in HTML as:

Configuration Bill of Materials

No	Qty	Vendor	Model/Name	Description
…				
…	…	…	…	Disk drive that contains **<u>many</u>** interesting features including the fact that they hold bits of information.
…				

and in text as:

```
Configuration Bill of Materials

No  Qty Vendor     Model/  Description
                   Name
…
…   …   …          …       Disk drive that contains many
                           interesting features including
                           the fact that they hold bits of
                           information.
…
```

Note that the submitter is responsible for a reasonable presentation in both the HTML format and the text format of the report. It is suggested that if you take advantage of this feature that you use the `specreport` command to generate the report in both forms and inspect the generated reports.

5.2 Submitting Results

Once you have generated a submission file as described in the Creating Reports section above, you may submit your run for review by the SFS committee by emailing the ZIP file to `subsfs2008@spec.org`. Upon receipt, the SPEC results processing facility will parse the submission file and validate the formats. If the check passes, an email reply is returned to the sender including a submission number assigned to the result. This submission number is used to track the result during the review and publishing process. If there are any formatting errors, the parser will respond with a failure message indicating where in the file the parsing failed. You may then either correct the error and resubmit or contact the SPEC office for further assistance.

Every results submission goes through a minimum two-week review process, starting on a scheduled SPEC SFS sub-committee conference call. During the review, members of the committee may contact the submitter and request additional information or clarification of the submission. Once the result has been reviewed and accepted by the committee, it is displayed on the SPEC web site at http://www.spec.org/.

6 FAQ

6.1 SPECsfs2008 Benchmark Press Release

Question 1: What is SPECsfs2008 and how does this benchmark compare to other network file system (NFS/CIFS) benchmarks?
Answer : SPECsfs2008 is the latest version of the Standard Performance Evaluation Corp.'s benchmark that measures CIFS and NFS file server throughput and response time. It differs from other file server benchmarks in that it provides a standardized method for comparing performance across different vendor platforms. The benchmark was written to be client-independent and vendor-neutral. Results are validated through peer review before publication on SPEC's public Web site <http:// www.spec.org/sfs2008/>

Question 2: Does this benchmark replace the SPEC SFS 3.0 suite?
Answer : Yes. Now that SPECsfs2008 is available, SFS 3.0 licenses are no longer being sold. Results from SFS 3.0 will no longer be accepted by SPEC for publication.

Question 3: Can SPECsfs2008 results be compared to SFS 3.0 results?
Answer : No. Although the benchmarks are similar in many ways, they cannot be compared, since SPECsfs2008 uses a different file selection algorithm, its results can only be compared with other SPECsfs2008 results.

Question 4: What improvements have been made to SPECsfs2008?
Answer : In addition to general code improvements, SPECsfs2008 includes major enhancements:

1. A workload to test servers accessible via the CIFS protocol.
2. Support for Windows and Mac OSX clients.
3. Enhancements to the NFS workload.
4. Removal of dependency on UNIX specific commands, such as rsh and rcp.
5. A more flexible reporting form which allows for a wider array of modern system configurations to be accurately detailed.

Question 5: How was the SPECsfs2008 workload determined?
Answer : The SPECsfs2008 NFS and CIFS workloads are based primarily on data collected from tens of thousands of fileservers from member companies, deployed by customers in a variety of file-serving application environments. The bulk of the data was collected by mining databases that hold the data received via automatic reporting systems embedded in products from member companies. To provide further information, NFS/CIFS packet trace data was collected from a number of customer and member company internal systems. The resulting workload in SPECsfs2008 more accurately represents a composite of the workloads seen in current fileserving environments.

Question 6: What is the metric for SPECsfs2008?
Answer : SPECsfs2008 has two performance measurement metrics: SPECsfs2008_nfs for NFS, and SPECsfs2008_CIFS for CIFS. Both metrics include a throughput measure (in

operations per second) and an overall response time measure (the average response time per operation).

Question 7: Are the metrics for SPECsfs2008 different than the metric for SFS 3.0?
Answer : Yes. SPECsfs2008 maintains similar metrics that were used in SFS 3.0, but it also now provides metrics for CIFS. It provides overall response time and peak throughput. The larger the peak throughput the better. The lower the overall response time the better. The overall response time is an indicator of how quickly the system under test responds to NFS, or CIFS, operations over the entire range of the tested load. In real-world situations, servers are not run continuously at peak throughput, so peak response time provides only minimal information. The overall response time is a measure of how the system will respond under an average load. Mathematically, the value is derived by calculating the area under the curve divided by the peak throughput.

Question 8: How widespread are NFS and CIFS?
Answer : NFS has been shipping on systems for more than sixteen years and is available for most systems. CIFS is the dominant remote file system protocol for all Windows systems.

Question 9: What is the correlation between the TPC (Transaction Processing Council) and SPEC (Storage Performance Council) benchmarks, including SPECsfs2008?
Answer : There is no correlation; the benchmarks present very different workloads on the systems under test and measure different aspects of system performance .

Question 10: Is SPECsfs2008 a CPU-intensive or I/O-intensive benchmark?
Answer : SPECsfs2008 is a system-level benchmark that heavily exercises CPU, mass storage and network components. The greatest emphasis is on I/O, especially as it relates to operating and file system software. To obtain the best performance for a system running SPECsfs2008, the vendor will typically add additional hardware -- such as memory, disk controllers, disks, network controllers and buffer cache – as needed in order to help alleviate I/O bottlenecks and to ensure that server CPUs are used fully.

Question 11: For what computing environment is SPECsfs2008 designed?
Answer : The benchmark was developed for load-generating clients running in the UNIX or Windows. But since the load-generating clients execute the benchmark code, SPECsfs2008 can be used to evaluate the performance of any CIFS and NFS file server, regardless of the underlying environment.

Question 12: Can users measure NFS performance for workloads other than the one provided within SPECsfs2008?
Answer : Yes, users can measure their own workloads by making changes to the SPECsfs2008 benchmark mix parameters to reflect the new measurements. The SPECsfs2008 User's Guide details how this can be done. Workloads created by users cannot, however, be compared with SPECsfs2008 results, nor can they be published in any form, as specified within the SPECsfs2008 license.

Question 13: To what extent is the server's measured performance within SPECsfs2008 affected by the client's performance?
Answer : SPEC has written SPECsfs2008 to minimize the effect of client performance on SPECsfs2008 results.

Question 14: How does SPEC validate numbers that it publishes?
Answer : Results published on the SPEC Web site have been reviewed by SPEC members for compliance with the SPECsfs2008 run and disclosure rules, but there is no monitoring

beyond that compliance check. The vendors that performed the tests and submitted the performance numbers have sole responsibility for the results. SPEC is not responsible for any measurement or publication errors.

Question 15: Are the reported SPECsfs2008 configurations typical of systems sold by vendors?
Answer : Yes and no. They are similar to large server configurations, but the workload is heavier than that found on smaller server configurations. SPEC has learned from experience that today's heavy workload is tomorrow's light workload. For some vendors, the configurations are typical of what they see in real customer environments, particularly those incorporating high-end servers. For other vendors, SPECsfs2008 configurations might not be typical.

Question 16: Do the SPECsfs2008 run and disclosure rules allow results for a clustered server?
Answer : Yes, cluster configurations are allowed as long as they conform strictly to the even distribution of all resources as defined by the SPECsfs2008 run and disclosure rules.

Question 17: Why do so few published results approach SPEC's response-time threshold cutoff of 20 milliseconds?
Answer : It is important to understand first that SPECsfs2008 run rules do not require that the throughput curve be carried out to 20 ms; they only state that the results cannot be reported for a response time higher than 20 ms. There are several reasons why results do not approach the threshold cutoff. Optimally configured servers often will achieve their maximum throughput at response times lower than the cutoff. Additionally, some vendors emphasize maximum throughput while others concentrate on fast response time. It does not indicate a problem with the results if the curve is not carried out to 20 ms, and those reviewing results should not try to predict what the throughput curve might be past the reported point.

Question 18: Why was the response-time threshold reduced from 40 ms for SFS 3.0 to 20 ms for SPECsfs2008 ?
Answer : The lower response-time threshold reflects advances in server technologies since the release of SFS 3.0.

Question 19: What resources are needed to run the SPECsfs2008 benchmark?
Answer : In addition to a server, a test bed includes several clients and an appropriate number of networks. Ideally, the server should have enough memory, disks and network hardware to saturate the CPU. The test bed requires at least one network. A minimum of 256 MB of memory is required for each client, although in most cases 512 MB is needed. To facilitate accuracy of reported vendor results, SPECsfs2008 includes an entire NFS, and CIFS implementation. Examples of typical load-generating configurations can be found on the SPEC Web site: < http://www.spec.org/sfs2008/>.

Question 20: What is the estimated time needed to set up and run SPECsfs2008?
Answer : Hardware setup and software installation time depend on the size of the server and the complexity of the test beds. Many servers require large and complex test beds. The SPECsfs2008 software installs relatively quickly. A SPECsfs2008 submission from a vendor includes at least 10 data points, with each data point taking from 30 to 90 minutes to complete.

Question 21: What shared resources does SPECsfs2008 use that might limit performance?
Answer : Shared resources that might limit performance include CPU, memory, disk controllers, disks, network controllers, network concentrators, network switches, clients, etc.

Question 22: SPEC's CPU2006 benchmark defines compiler optimization flags that can be used in testing. Does SPECsfs2008 set tuning parameters?
Answer : When submitting results for SPEC review, vendors are required to supply a description of all server tuning parameters within the disclosure section of the reporting page.

Question 23: Can a RAM disk be used within a SPECsfs2008 configuration?
Answer : SPEC enforces strict storage rules for stability. Generally, RAM disks do not meet these rules, since they often cannot survive cascading failure-recovery requirements unless an uninterruptible power supply (UPS) with long survival times is used.

Question 24: How will the choice of networks affect SPECsfs2008 results?
Answer : Different link types and even different implementations of the same link type might affect the measured performance -- for better or worse -- of a particular server. Consequently, the results measured by clients in these situations might vary as well.

Question 25: Is SPECsfs2008 scalable with respect to CPU, cache, memory, disks, controllers and faster transport media?
Answer : Yes, like SFS 3.0, the new benchmark is scalable as users migrate to faster technologies.

Question 26: What is the price of a SPECsfs2008 license and when will it be available?
Answer : SPECsfs2008 is available now on CD-ROM for $1600.
Contact the SPEC office:

Standard Performance Evaluation Corporation (SPEC)
6585 Merchant Place, Suite 100
Warrenton, VA 20187, USA
Phone: 540-349-7878
Fax: 540-349-5992
E-Mail: info@spec.org

Question 27: How much is an upgrade from SFS 3.0 to SPECsfs2008?
Answer : The SPECsfs2008 benchmark is a major new release. The upgrade is $700 for those who purchased SFS 3.0 licenses within 90 days prior to the SPECsfs2008 release. Any purchases after that will be at the full price. Upgrades are available through the SPEC office.

Question 28: Can users get help in understanding how to run SPECsfs2008?
Answer : The majority of questions should be answered in the SPECsfs2008 User's Guide. There is also useful information on the SPEC Web site: < http://www.spec.org/sfs2008/>.

6.2 Running and troubleshooting the benchmark

Question 29: Do I need to measure NFS and CIFS?
Answer : No. NFS and CIFS are separate workloads and you only need to measure and disclose the ones you want.

Question 30: How do I get started running the SPECsfs2008 benchmark?
Answer : Please read the SPECsfs2008 User's Guide in its entirety.

Question 31: I am running into problems setting up and running the benchmark. What can I do?
Answer : The most common problem is usually that file server file systems are not being correctly mounted on the clients. Most of the problems relating to the SPECsfs2008 benchmark

can be resolved by referring to appropriate sections of the User's Guide, including this FAQ.

Question 32: I have read the SPECsfs2008 User's Guide. But I am still running into problems. What can I do next?
Answer : Looking at the sfslog.* and sfscxxx.* files can give you an idea as to what may have gone wrong. In addition, you can check the Troubleshooting SPECsfs2008 web page on the SPEC website. And, as a last resort, you can contact SPEC at support@spec.org. It is assumed that such calls/emails are from people who have read the SPECsfs2008 User's Guide completely, and have met all the prerequisites for setting up and running the benchmark.

Question 33: How does one abort a run?
Answer : The benchmark can be aborted by simply stopping the SfsManager. This will kill all SFS related processes on all clients and on the prime client. The processes are sfscifs, sfsnfs3, sfs_syncd and sfs_prime.

Question 34: For a valid run, which parameters are required to be unchanged?
Answer : Information is provided in the SFS2008 Run and Reporting Rules and in the sfs_nfs_rc, and sfs_cifs_rc files, and this is enforced by the benchmark. If invalid parameter values are selected, the benchmark reports an invalid run.

Question 35: Is there a quick way to debug a testbed?
Answer : Read the SPECsfs2008 User's Guide, ping the server from the client, try mounting the server file systems or shares from the client using the client's real CIFS or NFS implementation, ping from the prime client to the other clients and vice versa, run the benchmark with one client and one file system.

Question 36: When I specify 1000 NFS ops/sec in the sfs_nfs_rc, the results report only 996 NFS ops/sec requested, why is it less?
Answer : The sfs_nfs_rc file specifies the total number of NFS ops/sec across all of the clients used. Because the benchmark only allows specifying an even number of NFS ops/sec, the actual requested ops/ sec may be less due to rounding down. For example, 1000 NFS ops/sec requested over 6 clients will result in each client generating 166 NFS ops/sec for an aggregate of 996 NFS ops/sec.

Question 37: The number of operations/second that I achieve is often slightly higher or slightly lower than the requested load. Is this a problem?
Answer : No, the benchmark generates operations using random selection and dynamic feedback to pace correctly. This will result in small difference from the actual requested load.

6.3 Tuning the Server

Question 38: What are a reasonable set of parameters for running the benchmark?
Answer : Study existing results' pages with configuration information similar to your system configuration.

Question 39: When I request loads of 1000, 1300, 1600 NFSops, I get 938, 1278, and 1298 NFSops, respectively. Why do I not get the requested load?
Answer : This may happen when one has reached the server limit for a particular configuration. One needs to determine the bottleneck, and possibly tune and/or enhance the server configuration.

Question 40: How do I increase the performance of our server?
Answer : One may need to add, as necessary, one or more of the following: processors, memory, disks, controllers, etc.

6.4 Submission of Results

Question 41: We have a valid set of results. How do we submit these results to SPEC?
Answer : See the Submission and Review Process section. The new submission tool documentation is in that section.

7 Bibliography

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8 Trademarks

9 Appendix A – Building SFS Benchmark Components

9.1 Building SFS for UNIX

Note that it is a requirement that you have a GNU-compatible build environment (e.g., a 'gmake' compatible 'make') in order to build SFS on a UNIX system.

To build SFS, you need to simply:
- *cd* to the top-level spec directory ($SPEC)
- Type *make*

The executables and other necessary files are copied onto the $SPEC/bin directory as part of the build process. The root password may be required in order to set the setuid bit on the executables.

9.2 Building SFS for Windows

SPECsfs2008 for WIN32 was developed using Microsoft Visual Studio 2005. Other versions of the development environment may work for building the benchmarks, but these have not been tested.

9.2.1 Update Visual Studio Libraries/Includes

If not already installed, download and install the Microsoft Platform SDK for Windows XP SP2 update. Visit http://www.microsoft.com/msdownload/platformsdk/sdkupdate/ for information/download links. [*NOTE: The SDK appears to have been recently updated and is now named Microsoft Windows Server 2003 SP1 Platform SDK. The above link should redirect to the correct page.*] Only the core SDK needs to be installed (other SDK components may be installed as desired). Read the README file included, and make sure to register PSDK directories with Visual Studio.

This update includes some implementations for sockets that allow porting to use some of the already included functions and types in SFS.

9.2.2 Open the Visual Studio workspace files

Obtain the SPECsfs2008 source base and place it in a convenient location on the system to be used for building. In the *benchspec\162.nfsv2\src* directory of the sourcebase is a *win32* folder. This contains all the project files and the WIN32 specific source files for building SFS for WIN32. Open the *src\win32\SFS_WIN32\SFS_WIN32.dsw* workspace file using Visual Studio. This workspace contains the project files for each of the executables plus the rpc and CIFS libraries.

9.2.3 Build the individual project files

If you are familiar with building projects in Visual Studio, you may build the projects as you are accustomed to doing and skip this section.

To build all the projects at once, from the *Build* menu select *Batch Build*. With all projects and configurations selected ,click *Build* or *Rebuild All* and the build process will begin. Debug versions will be built in *bin\win32\Debug*. Debug browse information files will be built in *bin\win32\Browse*. These are useful for finding references between source files (e.g. find where [variable] is declared or [function] is defined). Release versions will be built in *bin\win32*.

To build the individual projects, from the *Project* menu select a project under the *Select Active Project* submenu. The selected project will appear in bold in the workspace window. From the *Build* menu, select *Rebuild All* to force a rebuild of all modules in that project, or select *Build [project name]* to build only those modules that have changed or are missing.

Paths and directories within the project settings are all relative to the project file locations, so building the benchmark files should be possible regardless of where the sourcebase is placed on the system.

9.2.4 Debugging with Visual Studio

Visual Studio may be used to debug one or more of the SFS benchmark executables. For executing either the SFS client or prime client applications, the runtime parameters must be set. From the *Project* menu select *Settings*. For the application and build of interest, enter the command line parameters in the *Program arguments* box of the *Debug* tab.

9.3 Building the SFS Manager

You must load the J2SE™ Development Kit release 5.0 or later on the system where you want to build the Manager. Update the paths in the build script if needed and then build the java code by entering the following:

```
cd $SPEC
cd manager
build
```

Distribute the built java code to the 'manager' directory on all the clients.

Note that the manager uses the following algorithm for finding the executables to be used by the benchmark:

1) It uses the binary path argument specified on the command line.
2) If no binary path argument was specified then it looks in the bin directory.
3) If the executables where not found in the bin directory then it will look in the binaries directory using the OS name followed by the abbreviation for the processor architecture. Here are some examples: win32-x86 linux-x86 linux-ppc solaris2-x86 solaris2-sparc.

9.4 Building the Result Submission Tools

The submission tools and associated files are located in the `submit_tools` subdirectory under the `<install_dir>` directory.

To build the SPEC SFS submit tools, you must load the J2SE(TM) Development Kit release 5.0 or later on the system where you want to build the java code. Update paths in the build script if needed.

To build the submit tools, enter the following:

```
cd $SPEC/submit_tools
```

```
make
```

Mac OS X Note:
Under Mac OS X, you must install the expat and XML-Parser libraries.
These are located under $SPEC/redistributable_sources as

```
  * expat-2.0.0.tar.gz
  * XML-Parser-2.34.tar.gz
```

10 Appendix B – Setting up password-less ssh

Here is a sample script that can be used to set up password-less ssh on Linux clients.

```
# Define the hosts to be involved in the trust here
# DO NOT include the host you are running, it is added by default

hosts="s2 s3 s4 s5 s6"

echo ""
echo ""
echo "This script will generate SSH keys for the specified machines,"
echo " and set up password-less authentication between them."
echo " You will be prompted for passwords several times during this
process."
echo ""

# Get current user
user=`who -m | awk {'print $1'}`
echo "Trust will be configured for user $user"
echo ""
echo "If this is not correct, stop and login as the appropriate user"
echo -n "(RETURN to continue, CTRL-C to exit) "

read continue

# Configure keys on current host
cd $HOME
ssh-keygen -t rsa
cat .ssh/id_rsa.pub >> .ssh/authorized_keys
chmod 700 .ssh
chmod 600 .ssh/*

for host in $hosts
do
   ssh $user@$host 'ssh-keygen -t rsa'
   ssh $user@$host 'cat .ssh/id_rsa.pub' | cat - >>
~/.ssh/authorized_keys
done

for host in $hosts
do
   scp .ssh/authorized_keys $host:.ssh
   ssh $user@$host 'chmod 700 .ssh ; chmod 600 .ssh/*'
done

exit
```