Network File Systems

Goals of this lab:

- Understand how clients can use a central file server.
- Get experience with a common server configuration.

Prerequisites: LXB, NET, DNS, NIS, STO
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Complete these exercises before proceeding with the main lab. You should be able to do them using only on-line documentation and man pages.

**Exercise 1: Review and preparation**

Most of this documentation will not be available on marsix or on your systems (until you install the appropriate packages), but they are available on the internet. The man pages for autofs are not very good, and autofs is notoriously finicky. Read the documentation carefully. If you miss a single word in the wrong place you can end up wasting huge amounts of time.

1-1 Review the documentation for the Linux kernel NFS server.
1-2 Review the documentation for the Linux automounter (autofs).
1-3 What is an automount map?
1-4 What is the name of the main configuration file for autofs?
1-5 How can you refer to an automount map in NIS from the main configuration file?
1-6 How do you configure the system so it looks for the main configuration file in NIS instead of looking for a regular file?

**Report:** Nothing to report.

**Exercise 2: Configuration**

2-1 Explain what the automounter is and how it works.
2-2 Explain what an automount map is, and the difference between direct and indirect maps.
2-3 What is the purpose of an automounter? Why not use static network mounts instead?

**Report:** Answers to the questions above.
One of the most important reasons for having a server is to store files on it. By using a central file server, all users in a network can access all files, and services like backup and recovery are far easier to implement on a server than on a diverse set of workstations.

Although it is not required, you should have installed and configured a directory service, such as NIS, before starting this exercise. Otherwise you will have to re-do parts of it.

**Time taken 2005:** 1-9 hours, average 5 hours (no reliable information for 2006)

**Past problems:** NFS itself seems to cause very few problems. The automounter causes more problems. The documentation for the automounter has a lot to do with that, but most of the difficult problems have been caused by not understanding how the automounter works and what its purpose is.

### Part 1: Network File System

There are several network file systems that can be used to implement a file server. Microsoft systems almost always use the SMB protocol (a.k.a. CIFS, the Common Internet File System). In the Unix world there is greater diversity. NFS, Network File System, is one of the most common systems. While it isn’t a marvel of engineering, NFS has been around for a long time and gets the job done. Some users prefer AFS, the Andrew File System, which is technically superior to NFS, but also more complicated. Beyond those there are a multitude of other options.

For this lab you may choose any network file system you want. If you are unsure or lack previous experience with network file systems, use NFS.

Linux supports two different NFS servers: the user space server and the kernel space server. Use the kernel space server for this lab.

**Exercise 3: Configure a file server**

3-1 Set your server up as a file server using NFS (or the network file system of your choice).

3-2 Configure your server to export the `/usr/local` directory to all clients. It must not be possible to access `/usr/local` from any other system. Your server must not treat root users on the client as root on the exported file system.

3-3 Configure your clients to automatically mount `/usr/local` from the server at boot.

**Report:** Automated test cases that demonstrate that your NFS service is working properly.

Due to a quirk in some versions of Linux, you may need to set the fsid option when exporting directories from the server, or the client will ignore all but the first set of mount options (e.g. read-only, read-write) used to mount those directories. For example, imagine that the server has a file system named `/nfs` and exports `/nfs/local` and `/nfs/home`, and the client mounts `/nfs/local` read-only as `/usr/local` and `/nfs/home` read-write as `/home`. Because of this problem in some Linux versions, `/home` will actually be
read-only, and no warnings issued, because the two directories by default have the same file system ID. By explicitly setting distinct file system IDs on the server (using the fsid option), this can be avoided.

Part 2: The automounter

The automounter is a piece of software that mounts remote file systems automatically when they are accessed. The most common use of the automounter is to mount user home directories individually from several disk volumes or file servers, but it is sometimes used for e.g. removable media. In your small network, using an automounter is overkill, but you’re going to do it anyway, for home directories.

This lab (particularly troubleshooting) will be much easier if you understand how the automounter works. Spending some time on learning about the automounter can really pay off.

How the automounter works

The automounter intercepts accesses to the file systems it is configured to mount, and when an access takes place, it mounts the appropriate file system. For example, if you’ve set up the automounter to mount home directories, the automounter will intercept accesses to files in /home/username, and mount the appropriate file system as /home/username on access.

The precise details of how the automounter works depends on the implementation. There are multiple implementations, all with similarities and differences. In Linux, using the kernel automounter (the most common choice), the automounter is controlled using the `autofs` command. However, in most distributions (including Debian), the `autofs` command is run by a /etc/init.d/autofs, which parses configuration files for the automounter. This is similar to how the Solaris automounter works.

The autofs script can be used to control the automounter. Running /etc/init.d/autofs stop will stop the automounter and /etc/init.d/autofs status will show the current status of the automounter (including any mount points it is controlling).

The autofs script parses a so-called master map, which lists other automounter maps to load. Each automounter map describes how file systems below a certain mountpoint (an existing directory, specified in the master map) are to be mounted.

Note that the automounter “owns” any directory specified as a mount point in the master map. Any files or directories already in that directory will be hidden as long as the automounter is running. For example, if the /home directory contains local home directories for users, and you then start the automounter with /home as its mountpoint, then the local home directories will become inaccessible.

Automount maps, including the master map, can be stored in several different ways. By the time you complete this lab, you are expected to have all configuration in NIS (or LDAP, if that’s what you’re using). The location (NIS, LDAP, local file) of the master map can be specified in nsswitch.conf or /etc/default/autofs (depending on Debian version) and the location of all other maps can be specified in the master map.

Exercise 4: Preparations

4-1 If you have not completed the storage lab, do so now.

4-2 Create two new users, but move one user’s home directory to /home2/USERNAME and the other user’s home directory to /home1/USERNAME (you will probably have to create the /home1 and /home2 directories first). Ensure that no home directories remain in /home. Do not change the home directory location in the user database.

4-3 Configure your NFS server to export /home1 and /home2 with the appropriate permissions to your clients (and only your clients).

Report: Automated test cases that show that /home1 and /home2 are being exported with appropriate permissions.

The use of /home1 and /home2 is fairly typical in larger systems, where the home directories of all users won’t fit on a single disk. This is also the type of situation in which the automounter is really useful.
Furthermore, it is easier to test the automounter in this configuration than it is when the server has all home directories in /home.

In the version of Debian we are using, nis may start after autofs, which is a problem if you keep your automount maps in nis (which you are supposed to do). In order to fix this, you need to reorder the boot sequence. The boot sequence for the default run level (2) is determined by the lexicographic order of the links in /etc/rc2.d. The link names are formatted as "S priority service". For example, cron starts at priority 89, so its link is named S89cron. The default for portmap is 18, and the default for autofs and nis is 19. You need to change the priority for portmap to 17 and the priority for nis to 18. That way, portmap will start before nis, which starts before autofs. The update-rc.d command can be used to accomplish this:

```
update-rc.d -f service remove
update-rc.d service defaults
```

Depending on the version of Debian you are using, some unexpected configuration may be required. In particular, some versions of Debian default to NFS version 4 in the automounter, even when the server does not support it. We recommend that you explicitly configure the automount maps so the automounter uses NFS version 3 by adding "-vers=3" between the key and the path in the automount maps.

Exercise 5: Configure the automounter

5-1 Install an automounter on the clients and on the server. The autofs package is recommended, but you may try amd or some other automounter if you prefer. Note the warning above.

5-2 Configure the automounter so it mounts /home/USERNAME from the user’s real home directory (on the NFS server). Make /home an indirect mount point – that is, the automounter will automatically mount subdirectories of /home, but not /home itself. You will probably need one line per user in the configuration file.

5-3 Verify that all users can log on to the client and that the correct home directories are mounted.

Report: Automated test cases that show that the automounter is working properly.

Note that the only automounter configuration that may reside in local files on the client are configuration files that are guaranteed to never change when new automounts are added or old ones removed. In other words, the master map and any map it references must be stored in the directory service. If you have a single local configuration file, you probably have too many. If you have more than one, you definitely have too many.

As a troubleshooting help, you may want to try running `sh -x /etc/init.d/autofs restart` to restart the automounter after reconfiguring it. The `/etc/init.d/autofs` script is responsible for reading the automount maps (configuration), and by using `sh -x` to invoke it, all commands that are used to read the configuration will be printed. You will be able to see exactly which files and NIS maps are consulted, and what automount commands are run.
Complete this feedback form individually at the end of the lab and hand it to the lab assistant when you finish. Your feedback is essential for improving the labs. Each student should hand in a feedback form. Do not cooperate on completing the form.

You do not need to put your name on the feedback form. Your feedback will be evaluated the same way regardless of whether your name is on it or not. Your name is valuable to us in case you have made and comments in the last section that need clarifications or otherwise warrant a follow-up.

For each section, please rate the following (range 1 to 5 in all cases).

- **Difficulty**: Rate the degree of difficulty (1=too easy, 5=too difficult)
- **Learning**: Rate your learning experience (1=learned nothing, 5=learned a lot).
- **Interest**: Rate your interest level after completing the part (1=no interest, 5=high interest).
- **Time**: How long did the part take to complete (in minutes)?

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