Directory Structure Re-organization in IRIX 5.x

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This note discusses the re-organization of the directory structure in IRIX 5.x. The intent of this reorganization is make the /usr directory tree capable of being shared as read-only file system. This better supports diskless and dataless workstations. Most system-owned files and directories are moved transparently by using a symbolic link from the old location to the new location.

Executive Summary

IRIX 5.0.1 and IRIX 5.1 will continue the efforts to re-organize the directory structure which started in IRIX 5.0. This reorganization is beneficial for several reasons:

- it will allow a shared /usr to be mounted read only on diskless and semi-diskless workstations. This /usr will be common across all SGI processor and graphics architectures.
- it is in conformance with System V Release 4 practices, as well as those followed by most other manufacturers

The plan is to make this transition as transparent and painless as is possible. To do this, files and directories will be moved around as appropriate, and symbolic links will be placed in the old locations of critical files and directories to point to the files in their new locations.

Application developers, both within and outside of SGI, will want to be aware of these changes, primarily to ensure that files they place in /usr will be read only. Existing applications will continue to run without change on most workstations. On configurations where a read-only /usr is used, these applications will continue to run by moving read--write files from /usr in /var (or other writable location) and installing a symbolic link from /usr to /var.

Introduction

The system directory tree in IRIX 5.0.1 and beyond has been restructured to facilitate sharing of files in a network environment. The goal of this restructuring is to make /usr capable of being mounted read-only, and shared among diskless or dataless client systems. This new directory layout is similar to those in System V Release 4 and other industry standard systems. It was the intent of the implementation to be essentially transparent to most applications. Where files or directory trees have been relocated, symbolic links have been placed in the old location on /usr pointing to the new location on /var. (The only exceptions to this are that symbolic link have not been placed in /usr/sysgen, /usr/man and /usr/catman). The movement of writable system files from /usr to /var occurs transparently and automatically as the IRIX operating system is installed.

Files have been grouped into the following main types:

- private files (administrative, configurations, logs, etc.)
- architecture dependent files
- application architecture dependent files
- CPU board dependent files
- graphics and audio architecture dependent files
- architecture independent files (documents, data, manual pages)

Each of the major subtrees has different characteristics and requirements. The following is a brief discussion of them.

/	Machine specific files and files required to boot the system. The / (root) file system is not intended to be shared in this scheme, partly from the requirements in the boot mechanisms.
/usr	Application architecture dependent files to be shared by machines of similar architecture. All MIPS1 machine can share the same /usr. (To allow all systems to use the same binaries for commands and utilities, the standard system commands are built as MIPS1 for all systems, including the R4000 systems.) These files are not writable.
/usr/share	Sharable, architecture independent files.
/usr/gfx	Graphics architecture related files. All files which are dependent upon the system's graphics hardware complement will reside in this tree.
/var	Files private to a machine, such as machine specific administrative, configuration and log files. The file system may also be used for user directories.
/usr/people	Files private to users of the system/network. Normally in SVR4 systems, this is /home. For IRIX, the decision has been made to not move home directories because doing so would cause unnecessary grief.

/usr/diag	All diagnostics for <cpu-arch, graphics, audio> hardware suite. No writable files.
/usr/cpu	CPU architecture- or CPU board-dependent files.
/usr/cpu/sysgen	Shareable files to reconfigure/boot a system. These are dependent on CPUBOARD.
/usr/cpu/sysgen/<cpu-arch>	boot objects needed to boot a system, e.g. IP6boot
/usr/cpu/root	Tools needed to configure the IRIX kernel.
/usr/sysgen	Symbolic link to /var/sysgen. This permits different clients sharing the same /usr file system to have individual kernel configurations.

/usr Changes

A shared /usr file system requires several modifications.

- All system modifiable files move to /var, a system private tree. This includes the local administrative, configuration and log files, NIS databases, and other system managed files.
- Files that depend on the machine's hardware become symbolic links to fixed names in machine architecture specific tree which is always mounted at a fixed place. libgl is a special case, which requires an addition level of indirection, as explained below.
- All configuration files in /usr/etc move to /etc. resolv.conf, statd.d, so that a system can be booted with the appropriate configurations.
- /usr/local can not be used as a tree local to the machine unless it is a mount point for a machine private area. No application may have writable files or machine specific configuration files in /usr. /usr/local may be used for non-writable files that would be common to all the clients mounting the shared /usr.

Much of this transition is already manifest in changes made to system utilities in SVR4. IRIX 5.x has incorporated much of these changes into its system utilities.

Moving system modifiable files to /var requires /var to be mounted in when the system is in single user mode. This requires changes in rc scripts. Also some of the scripts make directories whose names have now changed

/var

Variable files (ones which may be written) which formerly resided in /usr will migrate to the /var tree in the new scheme. Where all the files in a directory subtree are potentially variable, the entire subtree is moved, and the symbolic link in /usr points to the relocated subtree in /var, e.g. /usr/adm is moved to /var/adm, with the symlink at /usr/adm.

New systems with large system disks will be configured to have /var be a separately mounted file system. To minimize the impact on the installed base, existing systems will have /var be a symbolic link to usr/var.

In a standard IRIX 5.0.1 environment, the following files and directories are located in /var. In almost all cases, a symbolic link pointing to the /var entry has been left in the original location.

/var/X11	system specific X11 files which were formerly locate in /usr/X11
/var/adm	administrative logs and accounting files formerly in /usr/adm
/var/arch	Architecture dependent private files.
/var/arch/libgl	Indirect links for libgl*. This is discussed below.
/var/arch/include	Indirect links for feed.h
/var/config	system specific kernel configuration information formerly in /usr/config
/var/cron	system specific cron logs and control files
/var/lib	system specific writable files from /usr/lib
/var/mail	mail directory
/var/ncs, /var/netls	system specific writable files for the software licensing system
/var/opt	install area for optional products (SVR4 standard name)
/var/preserve	vi/ex saved file area formerly /usr/preserve
/var/sadm	SVR4 system administration work area
/var/saf	SVR4 networking work area
/var/spool	spooling area, formerly /usr/spool
/var/sysgen	Machine specific/private files needed to configure a specific system. The building of a new kernel will use the boot and toolroot directories in /usr/cpu/sysgen and will have private system, mtune and master.d files in /var/sysgen.
/var/tmp	temporary area, formerly /usr/tmp
/var/tmp_rex	temporary mount point used by rexd, formerly /usr/tmp_rex
/var/yp	NIS configuration and database files

Other Changes

/etc

Executables in /etc/ have been moved to /usr/etc and /sbin, so they can be shared.

/etc/utmp and similar files have moved to /var/adm/utmp.

System specific networking configuration files which were located in /usr/etc, have moved to /etc. (resolv.conf, snmpd.auth, inetd.conf, etc.)

CPU-architecture dependencies

The commands and utilities on all SGI systems are built as MIPS1 (R2000/R3000) binaries, so that they are common for all systems. These binaries can be shared among all systems, including R4000 systems. There are a handful of CPUBOARD dependent files and graphics-architecture specific files, the stand alones and diagnostics. They will be located on the / file system as they are in current IRIX systems.

Graphics-architecture dependencies

Some of the graphics support files (/usr/lib/libgl* and /usr/include/feed.h) must reside at a fixed name in the file system. This requires a second level of name indirection in the /var area to point back to the actual graphics file in the shared /usr area. That is, on /usr the symbolic link points to a fixed name in /var, and the name in /var is a symbolic link to the actual, uniquely named file in the shared /usr.

The rest of graphics dependent files have unique names across different graphics and cpu architectures, and can all reside on the shared /usr.

This makes it possible to store all the graphics dependent files in a single tree which then can be shared by all graphics architectures. This part of the tree looks like:

/usr/gfx microcode,start,stop,init etc.

/usr/gfx/libgl/<gfx+cpu arch>/libgl*libgl files for a specific CPU/GFX combination.

/usr/gfx/include/<gfx+cpu arch>/feed.h all graphics specific include files will be included with all architectures. Special links will be made for feed.h which depends on graphics arch.

Other files and directories

The Network Information Service (NIS) databases and runtime files located in /usr/etc/yp will be relocated to /var/yp.

/usr/etc/boot is used to keep software and data configuration files for diskless support. The diskless client installation software will be changed to use the new directory /var/boot.

The installed software history database maintained by inst in /usr/lib/inst moves to /var/inst.

The sendmail configuration file, sendmail.cf is moved to /etc with the other networking configuration files.

Application Considerations

Private files (machine/user specific, log, lock files) should not be made in shared /usr. All configuration and other writable files should reside on /var or some partition other than /usr like /opt. The impact on applications code varies. In most cases, this change has already been made for other system architectures and can be replicated for SGI systems. Applications may store sharable files, e.g. executables, read-only files, in the usual places in /usr.

Other Information

This file is available in postscript form in the RCS tree as ".../irix/cmd/diskless/dir-reorg.ps".

Raghav Sharma wrote the original proposal which explained how to tailor the SVR4 directory hierarchy to IRIX. He performed a great majority of the engineering work; but many were involved with the conversion, including Sunita Das, Wei Hu, Bill Kawakami, Mark Minihan, Michael Nishimoto, and Adam Sweeney. Jay McCauley took the original proposal and wrote this document. Subsequent modifications have been made by Michael Nishimoto.

For a discussion of the diskless architecture, please see "Diskless Architecture". It is available in postscript format as ".../irix/cmd/diskless/diskless-arch.ps". Installation of diskless workstations is described in "Diskless Workstation Administration Guide", document number 007-0855-030.