UNIX Concepts

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presenting a presentation morphed from...

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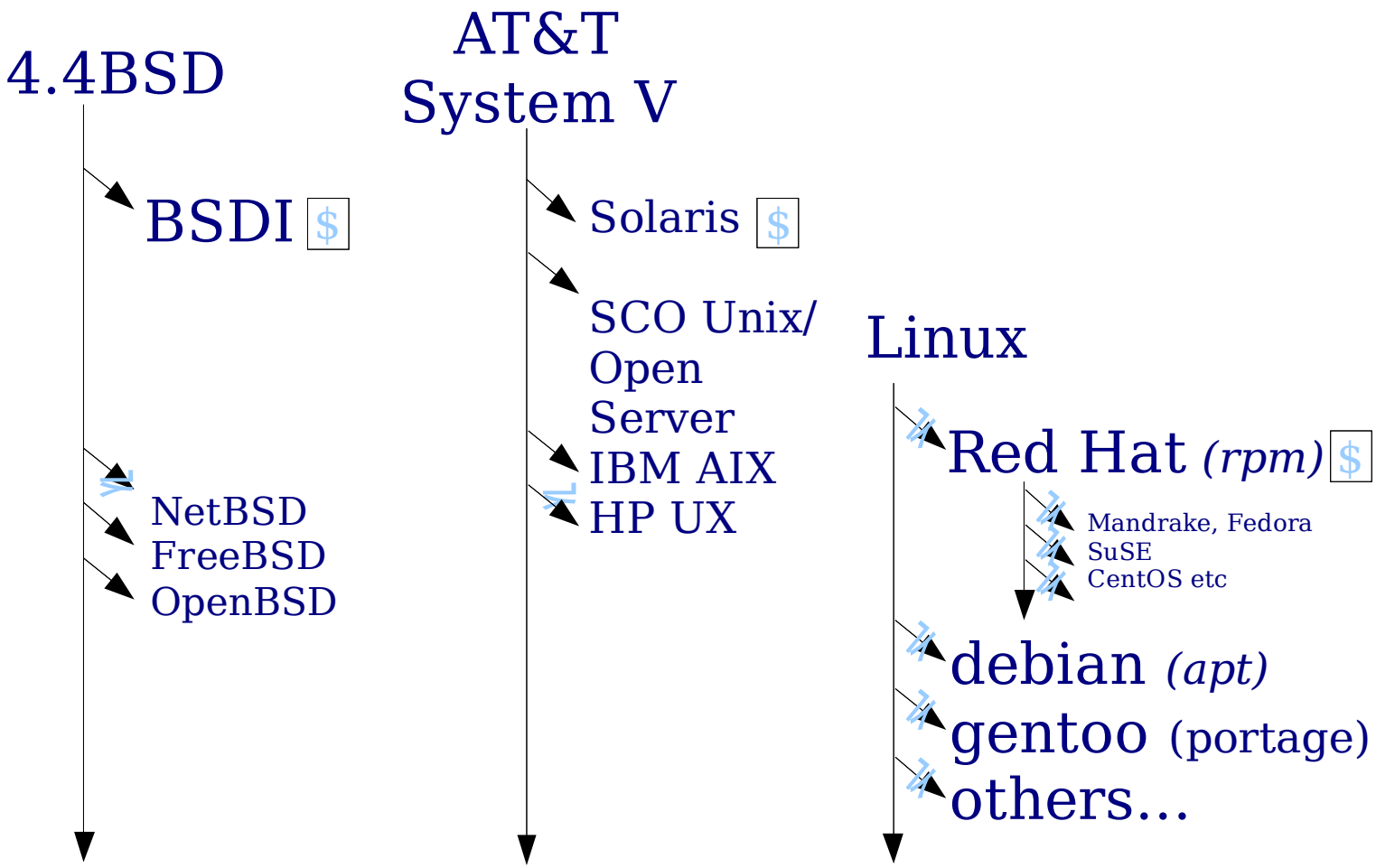
Why use UNIX? Quick Reminder

- Scalability and reliability
  - has been around for many years
  - works well under heavy load
- Flexibility
  - emphasizes small, interchangeable components
- Manageability
  - remote logins rather than GUI
  - scripting
- Security
  - Built in a modular fashion that helps to facilitate securing the OS.

Simplified Unix family tree (Look at the wall, maybe... :-))



Is free software really any good?!

- The people who write it also use it
- Source code is visible to all
  - The quality of their work reflects on the author personally
  - Others can spot errors and make improvements
- What about support?
  - documentation can be good, or not so good
  - mailing lists; search the archives first
  - if you show you've invested time in trying to solve a problem, others will likely help you
  - http://www.catb.org/~esr/faqs/smart-questions.html

Is free software really any good?

- Core Internet services run on free software
  - BIND Domain Name Server
  - Apache web server (secure SSL as well)
  - Sendmail, Postfix, Exim for SMTP/POP/IMAP
  - MySQL and PostgreSQL databases
  - PHP, PERL, Python, Ruby, C languages
- Several very high profile end-user projects
  - Firefox, original Netscape browser
  - OpenOffice
  - Thunderbird
  - Ubuntu

FreeBSD: Why it's Cool

- Uses a single source tree
- FreeBSD project is a non-commercial & independent
- FreeBSD uses the BSD license vs. the *more* restrictive GPL license
- Proven over many years at many sites
- Excellent software package system
- Updating and upgrading FreeBSD is reliable and can be done without a binary install
- FreeBSD has a massive software repository (21788 ports as of May 2010).

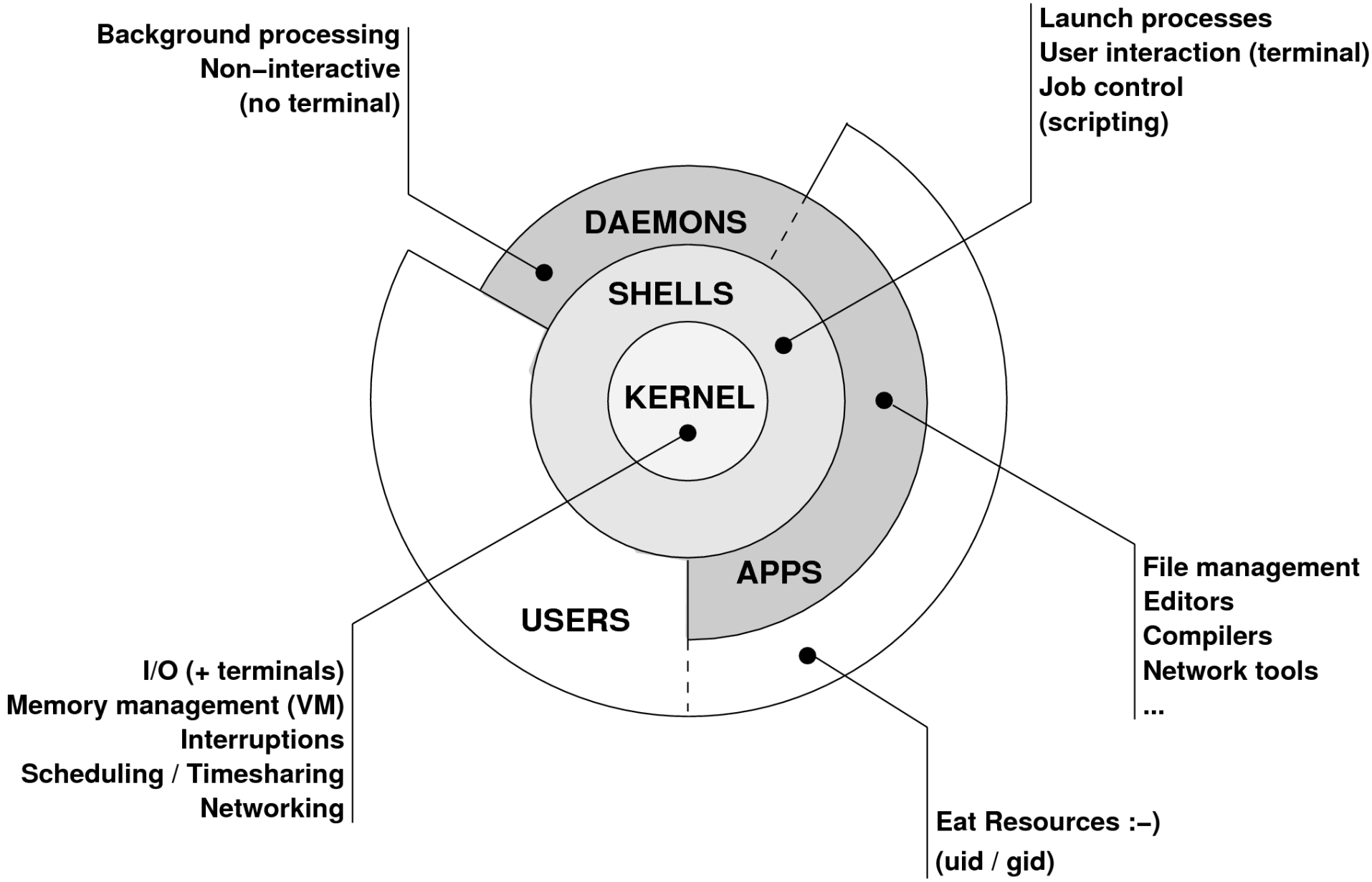
FreeBSD: Why it's Cool

- FreeBSD can run Linux applications, and it can run them as efficiently as Linux in most cases
- Several superior FreeBSD features include:
  - Indexed database file for user passwords
  - Software RAID such as `geom`
  - ZFS file system support
  - A large and experienced community for support
  - Cool, geeky logos ==>

First topics:

- Unix birds-eye overview
- Partitioning
- FreeBSD installation

The UNIX system



Kernel

- The "core" of the operating system
- Device drivers
  - communicate with your hardware
  - block devices, character devices, network devices, pseudo devices
- Filesystems
  - organise block devices into files and directories
  - data structure that allows data on a disk to be organised and accessed by the user
- Memory management
- Timeslicing (multiprocessing)
- Networking stacks - esp. TCP/IP
- Enforces security model

Shell

- Command line interface for executing programs
  - DOS/Windows equivalent: command.com or command.exe
- Choice of similar but slightly different shells
  - **sh**: the "Shell". Standardised in POSIX ($ prompt)
  - **csh**: the "C Shell". Not standard but includes command history (% prompt)
  - **bash**: the "Bourne-Again Shell". Is POSIX standard with command history, up-arrow' and 'down-arrow' recall of previous commands and the use of the TAB key to complete commands. Distributed under GPL (more restrictive than BSD license)

Shell

- Check your shell : # echo $SHELL
- Change your shell: # chsh /usr/local/bin/bash
- Define how your shell behaves in files like:
    - ~/.profile
    - ~/.login
    - ~.bashrc
    - /etc/profile
- The shell interprets commands for the operating system kernel.

User processes

- The programs that you choose to run
- Frequently-used programs tend to have short cryptic names
  - "**ls**" = list files
  - "**cp**" = copy file
  - "**cd**" = change directory
  - "**rm**" = remove (delete) file
- Lots of stuff included in the base system
  - editors, compilers, system admin tools
- Lots more stuff available to install too
  - packages / ports

System processes

- Programs that run in the background; also known as "daemons"

- Examples:
  - cron: executes programs at certain times of day
  - syslogd: takes log messages and writes them to files
  - inetd: accepts incoming TCP/IP connections and starts programs for each one
  - sshd: accepts incoming logins
  - sendmail (other MTA daemon like Exim): accepts incoming mail

Security model

- Numeric IDs
  - user id (uid 0 = "root", the superuser)
  - group ids
  - supplementary groups
- Mapped to names
  - /etc/passwd, /etc/group (plain text files)
  - /etc/pwd.db (fast indexed database)
- Suitable security rules enforced
  - e.g. you cannot kill a process running as a different user, unless you are "root"

Filesystem security

- Each file and directory has three sets of permissions
  - For the file's uid (user)
  - For the file's gid (group)
  - For everyone else (other)
- Each set of permissions has three bits: rwx
  - File: r=read, w=write, x=execute
  - Directory: r=list directory contents, w=create/delete files within this directory, x=enter directory
- Example: **`brian wheel rwxr-x---`**

Filesystem security

- The permission flags are read as follows (left to right)
- **-rw-r--r-- for regular files,**
- **drwxr-xr-x for directories**

Position	**Meaning**
1	directory flag, 'd' if a directory, '-' if a normal file, something else occasionally may appear here for special devices.
2,3,4	read, write, execute permission for User (Owner) of file
5,6,7	read, write, execute permission for Group
8,9,10	read, write, execute permission for Other
Value	Meaning
-	in any position means that flag is not set
r	file is readable by owner, group or other
w	file is writeable. On a directory, write access means you can add or delete files
x	file is executable (only for programs and shell scripts - not useful for data files). Execute permission on a directory means you can list the files in that directory
s	in the place where 'x' would normally go is called the set-UID or set-groupID flag.

Key differences to Windows

- Unix commands and filenames are CASE-SENSITIVE
- Path separator: {/ for Unix } | { \ for Windows}
- Windows exposes a separate filesystem tree for each device
  - A:\foo.txt, C:\bar.txt, E:\baz.txt
  - device letters may change, and limited to 26
- Unix has a single 'virtual file system' tree (tree structure with a top directory called the root and noted as " / ")
  - /bar.txt, /mnt/floppy/foo.txt, /cdrom/baz.txt
  - administrator choses where each FS is attached
  - Don't need to know disk layout/ partitioning scheme e.g. C:\, D:\

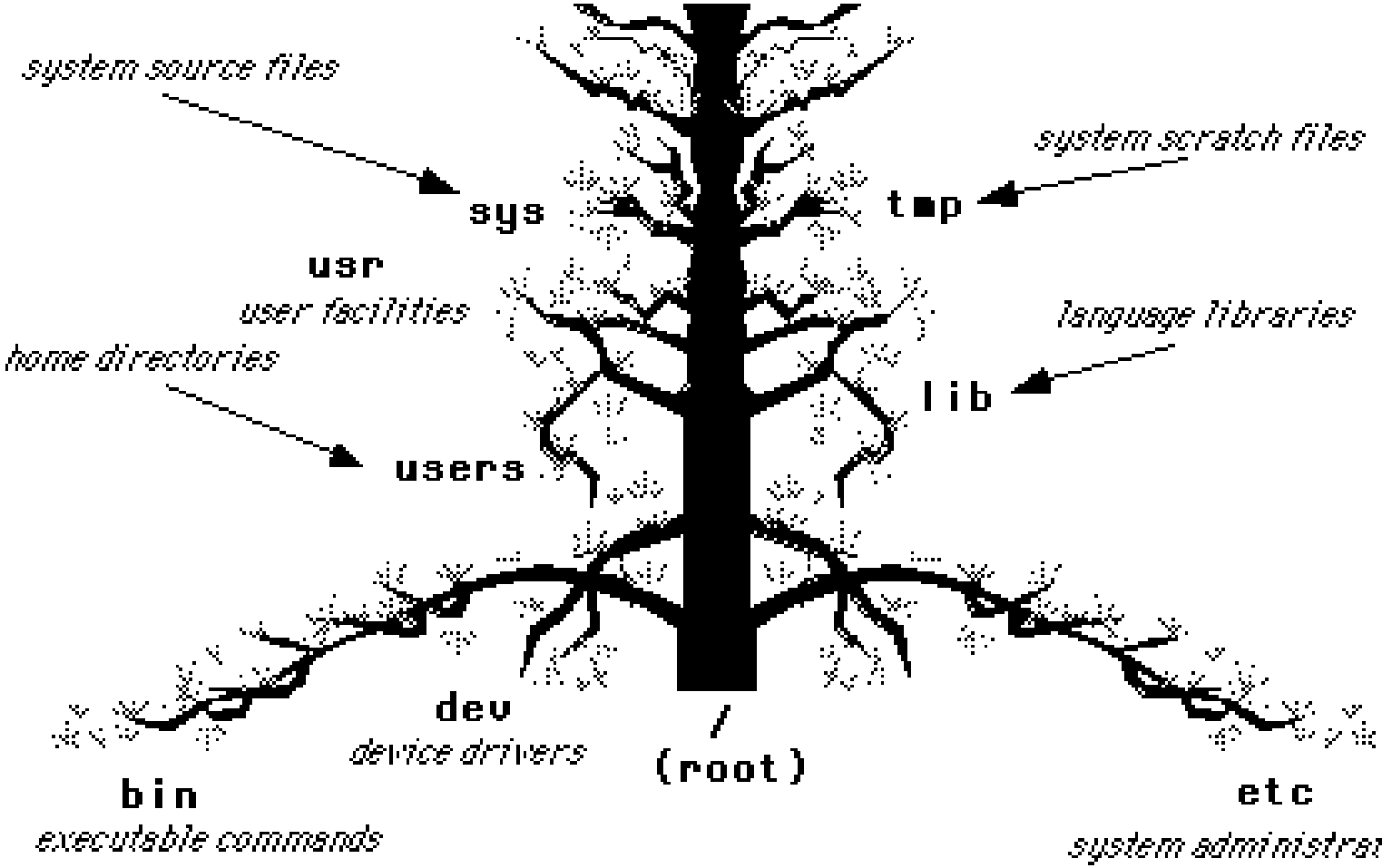
Standard filesystem layout

/bin	essential binaries
/boot	kernel and modules
/dev	device access nodes
/etc	configuration data
/etc/defaults	configuration defaults
/etc/rc.d	startup scripts
/home/*username*	user's data storage
/lib	essential libraries
/sbin	essential sysadmin tools
/stand	recovery tools
/tmp	temporary files
/usr	progs/applications
/var	data files (logs, E-mail messages, status files)

Standard filesystem layout (cont)

/usr	
/usr/bin	binaries
/usr/lib	libraries
/usr/libexec	daemons
/usr/sbin	sysadmin binaries
/usr/share	documents
/usr/src	source code
/usr/local/...	3rd party applications
/usr/X11R6/...	graphical applications
/var	
/var/log	log files
/var/mail	mailboxes
/var/run	process status
/var/spool	queue data files
/var/tmp	temporary files

Standard filesystem layout (cont)



Src: ei.cs.vt.edu

Directories (branches) contains either files or subdirectories (branches of branches). Directories are analogous to DOS subdirectories.

File system is normally viewed as inverted (upside down) tree.

* highest level directory = root '/'
* user's current dir is the "working directory" by default => /usr/home/username

Why like this?

- It's good practice to keep /usr and /var in separate file systems in separate partitions
  - So if /var fills up, the rest of the system is unaffected
  - So if /usr or /var is corrupted, you can still boot up the system and repair it
- That's why we have a small number of essential tools in /bin, /sbin; the rest go in /usr/bin and /usr/sbin
- Third-party packages are separate again
  - /usr/local/bin, /usr/local/sbin, /usr/local/etc ...

A note about devices

- e.g. /dev/ad0 = the first ad (ATAPI/IDE disk)
- In FreeBSD, entries for each device under /dev are created dynamically
  - e.g. when you plug in a new USB device
- Some "devices" don't correspond to any hardware (pseudo-devices)
  - e.g. /dev/null is the "bit bucket"; send your data here for it to be thrown away
  - /dev/cdrom is a link to /dev/acd0

Any questions?

?

Some reminders about PC architecture

- When your computer turns on, it starts a bootup sequence in the BIOS
- The BIOS locates a suitable boot source (e.g. floppy, harddrive, CD-ROM, network)
- The very first block is the MBR (Master Boot Record)
- The BIOS loads and runs the code in the MBR, which continues the bootup sequence

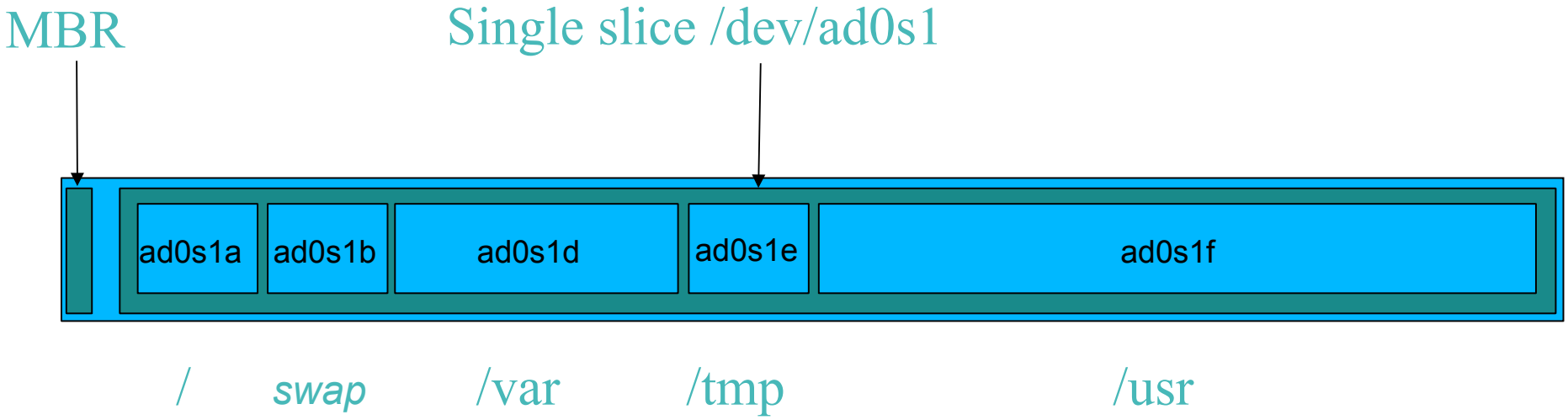
Partitioning

- The MBR contains a table allowing the disk to be divided into (up to) four partitions
- Beyond that, you can nominate one partition as an "extended partition" and then further subdivide it into "logical partitions"
- FreeBSD has its own partitioning system, because Unix predates the PC
- FreeBSD recognises MBR partitions, but calls them "slices" to avoid ambiguity

FreeBSD partitions

- Partitions (usually) sit within a slice
- Partitions called a,b,c,d,e,f,g,h
- CANNOT use 'c'
  - for historical reasons, partition 'c' refers to the entire slice
- By convention, 'a' is root partition and 'b' is swap partition
- 'swap' is optional, but used to extend capacity of your system RAM

Simple partitioning: /dev/ad0



/ (root partition)	ad0s1a	512MB
swap partition	ad0s1b	~ 2 x RAM
/var	ad0s1d	256MB (+)
/tmp	ad0s1e	256MB
/usr	ad0s1f	rest of disk

* Clearly an old, teeny, tiny disk :-)

'Auto' partition does this:

- Small root partition
  - this will contain everything not in another partition
  - /boot for kernel, /bin, /sbin etc.
- A *swap partition* for virtual memory
- Small /tmp partition
  - so users creating temporary files can't fill up your root partition
- Small /var partition
- Rest of disk is /usr
  - Home directories are /usr/home/<username>

Issues

- /var may not be big enough
- /usr contains the OS, 3rd party software, and your own important data
  - If you reinstall from scratch and erase /usr, you will lose your own data
- /tmp could overwhelm "/"
- /usr/home can fill up /usr, some sites mount (separate out) /usr/home as well.

Core directory refresher

- / *(/boot, /bin, /sbin, /etc, maybe /tmp)*
- /var *(Log files, spool, maybe user mail)*
- /usr *(Installed software and home dirs)*
- Swap *(Virtual memory)*
- /tmp *(May reside under "/")*

d

Don't confuse the the "root account" (/root) with the "root" partition.

Notes...

- Slicing/partition is just a logical division
- If your hard drive dies, most likely *everything* will be lost
- If you want data integrity, then you need to set up mirroring with a separate drive
  - Remember, "`rm -rf`" on a mirror works very well
- If you want proper data security then you need to backup. RAID *does not* secure your data (RAID vs. Water... Who wins?).

Summary: block devices

- IDE (ATAPI) disk drives
  - /dev/ad0
  - /dev/ad1 ...etc
- SCSI or SCSI-like disks (e.g. USB flash, SATA)
  - /dev/da0
  - /dev/da1 ...etc
- IDE (ATAPI) CD-ROM
  - /dev/acd0 ...etc
- Traditional floppy drive
  - /dev/fd0

Summary

- Slices
  - /dev/ad0s1
  - /dev/ad0s2
  - /dev/ad0s3
  - /dev/ad0s4
- Defined in MBR
- What PC heads call "partitions"

- BSD Partitions
  - /dev/ad0s1a
  - /dev/ad0s1b
  - /dev/ad0s1d ...etc
  - /dev/ad0s2a
  - /dev/ad0s2b
  - /dev/ad0s2d ...etc
- Conventions:
  - 'a' is /
  - 'b' is swap
  - 'c' cannot be used

Any questions?

Installing Software in FreeBSD

- Several different methods
  - ports
  - packages
  - source
  - binary
- We will go in to detail on these methods later in the workshop.

How Does FreeBSD Start?

- The *BIOS* loads and runs the *MBR*
  - The *MBR* is not part of FreeBSD
- A series of "bootstrap" programs are loaded
  - see "`man boot`"
    - `/boot.config` parameters for the boot blocks (optional)
    - `/boot/boot1` first stage bootstrap file
    - `/boot/boot2` second stage bootstrap file
    - `/boot/loader` third stage bootstrap
- Kernel is loaded, and perhaps some modules
  - controlled by `/boot/loader.conf`

How Does FreeBSD Start?

- The root filesystem is mounted
  - "root" = "/" or something like "ad0s1a"
- `/sbin/init` is run and executes the main startup script `/etc/rc`
- This in turn runs other scripts `/etc/rc.d/*`
  - /etc/rc.conf is used to decide whether a service is started or not and to specify options.

Finding more information

- Our reference handout
  - a roadmap!
- man pages
  - esp. when you know the name of the command
- www.freebsd.org
  - handbook, searchable website / mail archives
- "Absolute FreeBSD" (O'Reilly)
- comp.unix.shell FAQ
  - http://www.faqs.org/faqs/ \
    by-newsgroup/comp/comp.unix.shell.html
- STFW (Search The Friendly Web) - GIYF...