Security Fundamentals and Practice FreeBSD

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Network Startup Resource Center

FreeBSD vs. Linux

Security models are almost identical, but actual implementation is a bit different.

We include some FreeBSD-specific steps and tips here...

Core security concepts

Set the stage… In the end you want to:

- Maintain confidentiality.
- Keep data safe from intruders.
- **Integrity:** protect from loss or change.
- **Authentication**

  Is this person who they claim to be?
  Is this person allowed access?

- **Availability**

  Are our systems up and running?

Maintain confidentiality

To do this you need to have:

- Correct user and file permissions.
- Strong passwords.
- Trust in your users.
- Use of good cryptographic methods.

Keep data safe from intruders

Requires some effort:

- Keep people out who don't belong:
  - Trust your users.
  - Strong passwords.
  - Limit services you run.
  - Protect the services you do run.
- Encrypt data as needed.
- Backup data in case of intrusion or corruption.
- Remember physical security.

Integrity

Protect your data against loss or change.

- *Backup your data.*
- Consider revision control.
- Intrusion detection systems (IDS).

In the end is your data unchanged by others? How can you tell?

Authentication

How do you ensure?:

- Someone accessing your system is who they claim to be?
  - Trusted users.
  - Strong passwords.
  - Public/Private keys.
- The person is allowed access?
  - Maintain accounts properly.
  - Correct user/group/file permissions.
  - Scan and watch for SUID and SGID.

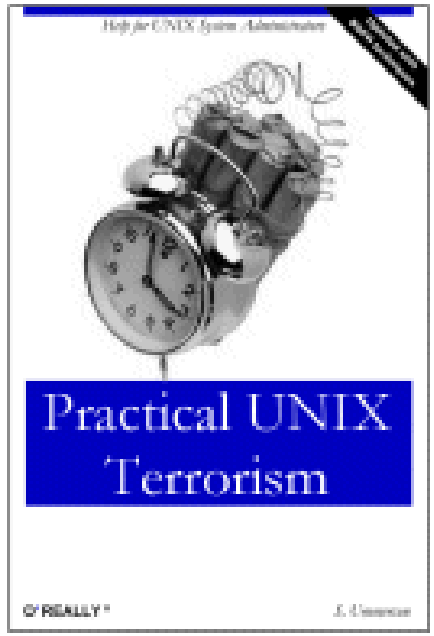
Availability

Make sure your server and services are up and detect attacks like Denial of Service (DoS).

- Log what your services do and install log "watching" software.
- Setup notifications if there are problems.
- Scan for network attacks like spoofing (ARP), syn packet dumping, general packet source address spoofing, brute force attacks (dictionary password crack attempts).

Steps to take

- Run only the services you plan on using.
- Use only the services that are necessary.
- Stay up-to-date and patch services as needed.
- Use secure passwords and force your users to use them.
- Consider if you need quotas.
- Restrict root access to services.
- Restrict access to services via tcpwrappers if appropriate.



Steps to take cont.

- Restrict access to your box using IP firewall services (ipfw, ipf base system).
- Buffer overflow attacks. Be aware of them.
- Log events and understand your logs.
- Install intrusion detection software.
- Back up your server's data!
- Think about physical security.
- Test your security model.
- Don't forget about your clients.

A few resources

The FreeBSD Handbook:

- /usr/share/doc/en/books/handbook/index.html
- Chapter 14: Security

Class reference book:

- *Mastering FreeBSD and OpenBSD Security*
- http://www.oreilly.com/catalog/mfreeopenbsd/

Security repository with references and examples:

- http://nsrc.org/security/

Reduce the number of services

What is being started at system startup?

- `grep YES /etc/defaults/rc.donf`
- `grep YES /etc/rc.conf`
- `ls /usr/local/etc/rc.d`
- `/etc/inetd.conf`

Delete services you are not using.

- Change "YES" entries in rc.conf to "NO"
- Remove /usr/local/etc/rc.d start scripts.
- Comment out services in /etc/inetd.conf if inetd is running.

Reduce number of services cont.

To see what is running you could use:

- `lsof -i (if installed)`
- `netstat -an -f inet`
- `ps -auxw | more`
- `Sockstat -4`
- `fstat (with grep, read man page)`

Know what each and every item is.

Simplify – remove any and all services you are not using.

Use cryptographic methods to access services

- POP/IMAP with SSL only.
- Consider TLS-Enabled SMTP.
- Remove Telnet replace with SSH.
- Remove FTP replace with SCP or SFTP.
- Anonymous FTP is OK, but be careful if you allow user uploads.
- Require HTTPS (HTTP over SSL) for sensitive information.

How to enforce good passwords

By default FreeBSD allows for completely insecure passwords. Test this using `passwd` as a user.

You can use cracklib with Pluggable Authentication Modules (PAM).

Cracklib keeps a user from creating trivial passwords.

You can find cracklib here:

- /usr/ports/security/cracklib

You should enable it here:

- /etc/pam.d/passwd

Requires installing cracklib and uncommenting one line in /etc/pam.d/passwd.

Cracklib

From "`locate cracklib`" under FreeBSD 5.4 after installation :

```
/usr/local/libdata/cracklib
  /usr/local/libdata/cracklib/pw_dict.hwm
  /usr/local/libdata/cracklib/pw_dict.pwd
  /usr/local/libdata/cracklib/pw_dict.pwi
  /usr/local/man/man3/cracklib.3.gz
  /var/db/pkg/cracklib-2.7_2
  /var/db/pkg/cracklib-2.7_2/+COMMENT
  /var/db/pkg/cracklib-2.7_2/+CONTENTS
  /var/db/pkg/cracklib-2.7_2/+DESC
  /var/db/pkg/cracklib-2.7_2/+MTREE_DIRS
```

As you can see cracklib is installed, a cracklib dictionary, and the PAM cracklib shared library.

You can install via "`pkg_add -r cracklib`" or by compiling in */usr/ports/security/cracklib*

More cracklib

Taken directly from the cracklib README file:

4) it's MIND-NUMBINGLY THOROUGH!

(is this beginning to read like a B-movie flyer, or what?)

CrackLib makes literally hundreds of tests to determine whether you've chosen a bad password.

It tries to generate words from your username and gecos entry to tries to match them against what you've chosen.

It checks for simplistic patterns.

It then tries to reverse-engineer your password into a dictionary word, and searches for it in your dictionary. *(> million entries!)*

- after all that, it's PROBABLY a safe(-ish) password. 8-)

Other password checkers

Some tools you could run against /etc/master.passwd after password generation for more thorough testing.

- John the Ripper: http://www.openwall.com/john/
- Crack: http://www.crypticide.org/users/alecm
- FreeBSD's built-in PAM module pam_passwdqc.

You would create a cron entry to run a process against some/all user passwords once every certain period. “Cracked” passwords would generate an email warning to the user asking them to change their password or be disabled.

Extra: more ways to control users

Look in to /etc/login.conf if you wish to define login classes for your users to control their access to resources.

FreeBSD Handbook section 13.7

/usr/share/doc/en/books/handbook/users-limiting.html

Consider file system quotas.

FreeBSD Handbook section 16.14

/usr/share/doc/en/books/handbook/quotas.html

Back up your server's data!

Pretty hard to stress this more. If your security is compromised what will you do without a backup? How many here do this?

A few basic items to consider are:

- What needs to be backed up.
- How often do you need to backup?
- Where will your backup media be in case of disaster (fire, flood, earthquake, theft)?
- What happens in case of total loss?
- What tools will you use? Tar, Arkeia, cpio, dump, dd, rsync with ssh?

Tools to use for backups

- **Arkeia**: commercial product:
  - http://www.arkeia.com/
  - http://nsrc/security/#backups
- **dd**: convert and copy a file.
  - `man dd`
  - `dd if=/dev/ad0 of=/dev/fd0/bootsector.bin bs=512 count=1`

Backs up a boot sector to a floppy.

  - `dd if=/dev/fd0/bootsector.bin of=/dev/ad0 bs=512 count=1`

Recovers from floppy to ad0. Be *very* careful doing this!

Tools to use for backups cont.

- **cpio**: copy files to and from archives:
  - cpitool: http://www.nickb.org/utils/
  - `man cpio`
- **dump**: ext2/ext3/ufs filesystem backup.
  - `man dump`
- **rsync:** remote copy.
  - `man rsync` (not installed by default)
- **tar**: read
  - `man tar`

A few practical backup tricks

You can use ssh and tar together to quickly backup parts of your server. For instance, to backup all /home directories to another server as a single image:

- `root@machine1# tar xzvf - /home/ | \`
  `ssh machine2 "cat > machine1-homes.tgz"`

Or, you can use rsync over ssh if you wish to keep directories synchronized between two locations. FreeBSD uses ssh by default with rsync:

- `rsync -av . remote:/home/docs`

rsync with ssh and ssh keys

Later today we'll discuss ssh and the use of ssh keys to connect to a remote machine without passwords and use encryption.

Image if in /etc/periodic/daily/ you set up a cron script to do the following:

- `rsync -a /var/www/html/ \`
  `backup.machine:/var/www/html/`

This recursively copies your root web documents to a backup machine using rsync via ssh. Note no “v” (verbose) option was used.

If you use the “--delete” option in rsync, then files removed on your local machine would be removed on the remote machine as well when you run this.

Log events and understand your logs

This is time consuming – even with the many tools that are available.

You need to go through each service running and decide if you want to log events from this service. This has already been partially done for you in /etc/syslog.conf under FreeBSD.

Ideally logs should be created or saved off your server. A cracker will alter your logs to cover their tracks.

Networking monitoring/logging

A few useful network monitoring tools:

- **Nagios**: monitors services running on hosts on your network as well as resources. Can monitor you of events via email, pager, etc. Find this at http://www.nagios.org/.
- **nmap**: network exploration tool and security scanner can identify machines and services on your network. Find this at http://www.insecure.org/nmap/.
- **ntop**: from http://www.ntop.org/ gives full featured protocol analysis of who's talking to whom on your network. Includes graphical reports and web interface.
- **httptop**: can give you real time monitoring of your web traffic. Find this from http://examples.oreilly.com/.

Caveat: these tools can get you in trouble. Be sure you have permission to run them.

Patching your software

- As needed download patches for the services you run. You should be notified of these via the mailing lists mentioned.
- For your OS the vendor will often provide specific patches or update installers.
- For FreeBSD the FreeBSD project will provide port updates or new packages.
- Or, use cvsup and ports. If software is a port and it is patched, then a simple "`make`" in /usr/ports/category/package/ may do the trick.

Where to find some security mailing lists

General security mailing lists:

- BugTraq: http://www.securityfocus.com/
- CERT: http://www.cert.org/
- Rootshell: http://www.rootshell.com/

For Apache, Bind, Exim and SSH:

- http://www.apache.org/
- http://www.isc.org/ *(Bind)*
- http://www.exim.org/
- http://www.openssh.org/

FreeBSD Security Notifications Mailing List:

- http://lists.freebsd.org/mailman/listinfo/freebsd-security-notifications

Think about physical security

All the security in the world does nothing against a disgruntled employee, server sitting out in the open, people who copy keys, and so on.

Backups: where do you physically keep your them? Who has access to them. Are they separate from your server?

Logs: are they on a separate and physically secure log server? Printed to a separate printer?

Bootloader password and encrypted files: what happens if someone walks off with your machine?! Or, how about just the hard drive(s)?

Physical access = total access

Consider if some services should run under the inetd tcpwrapper

- Access control for services is done in /etc/hosts.allow (hosts.deny is deprecated).
- /etc/inetd.conf determines what services will run under the inetd wrapper.
- Enable /etc/inetd in /etc/rc.conf with:
  - inetd_enable="YES"
- What does inetd provide? ==>

What does inetd provide?

- The inetd daemon (service) listens for network packets for each service started in /etc/inetd.conf.
- inetd saves on memory and resources as a service is only started if a packet arrives for it, but it's better not to use inetd for a loaded service like http.
- You can control how packets arrive or don't arrive on a service-by-service basis in a detailed manner using inetd.

inetd vs. ipfw

- Note: FreeBSD doesn't use xinetd.
- ipfw permits full control over packets arriving for a service or server.
- ipfw provides a more complete ruleset that you can apply to a service, including more fine-grained control over icmp and udp packets.
- ipfw is part of the kernel, thus it is more efficient.
- inetd has (imho) an easier syntax to understand.
- inetd can send messages for rejected items.

More inetd information

If you are interested in all the parameters you can specify on a service-by-service basis in both /etc/inetd.conf and /etc/hosts.allow, and when you start the inetd daemon, then see:

- man inetd
- man hosts_access
- man hosts_options

Automated logging

To configure what is logged read “man syslog.conf” for full details on how this file is formatted.

FreeBSD sends a daily summary of events and system status generated by cron to root by default.

Consider using a central logging server. You can use /etc/syslog.conf to send events to another server via your network.

Yet more logging...

A few useful tools to monitor activity:

- **Swatch**: Simple WATCHer is available from http://swatch.sourceforge.net/ or in the port collection in /usr/ports/security/swatch. Will watch for "trigger" events in your logs and notify you immediately.
- **syslog and periodic:** see "`man syslog`" and "`man periodic`" to understand how daily log and system activity summaries are generated in FreeBSD.
- See http://nsrc.org/security/#logging for some more tools.

Consider if you need to use quotas

FreeBSD Handbook section 16.14 and Chap. 8:

- /usr/share/doc/en/books/handbook/quotas.html
- /usr/share/doc/en/books/handbook/kernelconfig.html

- Do you trust your users?
- What happens if /tmp or /usr (/usr/home) fills?
- Are you using anonymous ftp?
- Are these on separate disks or partitions?
- If not, you might want quotas.

Practical quota tips ==>

Practical quota tips

General Steps to Activate:

- Recompile kernel with "`options QUOTA`" in your kernel configuration file.
- Enable quotas in /etc/rc.conf with:

```
enable_quotas="YES"
```

- Enable group and/or user quotas in /etc/fstab:

```
/dev/da1s2g    /home    ufs rw,userquota,groupquota 1 2
```

- Use edquota to update the quota.user and quota.group files in the root directory of each quota-enabled file system.
- Commands include quota, quotaon/quotaoff, quotacheck, edquota.

Restrict root access to a minimal set of services

Check for files with setuid/setgid bits running as root. If you don't need these files, or users don't need to run them, then remove this bit (chmod 000)

Consider running a service in a “sandboxed” environment using chroot.

Consider running a service under a different userid if possible.

Practical restriction tips ==>

Practical root restriction tips

To find all files with setuid or setgid bits set on a machine you can do:

- `find / -perm +6000 -type f -exec ls -ld {} \; > setuid.txt &`

You'll have a file listing all setuid/setgid files (but not scripts) on your machine.

You can turn off setuid or setgid bits by doing either:

```
chmod 0nnn filename
chmod 0000 filename
```

Be aware of what your changes imply. FreeBSD 5.4 ships preconfigured with many setuid & setgid files and warns if additional files are set.

Practical root restriction tips cont.

- Use `chroot` to run services with their own root directory – i.e. in a “sandbox” or “jail”.
- You can use the FreeBSD `jail` facility.
- Several services already run “sandboxed” by default, including ntalk, comsat, and finger
- The named service has configuration options in /etc/defaults/rc.conf.
- See FreeBSD Handbook 14.3.2 for more details.

How apache runs as user “apache”

Taken directly from */etc/httpd/conf/httpd.conf*:

```
# If you wish httpd to run as a different user or group, you
# must run httpd as root initially and it will switch.
#
# User/Group: The name (or #number) of the user/group to run
# httpd as. . On SCO (ODT 3) use "User nouser" and "Group
# nogroup". . On HPUX you may not be able to use shared
memory
# as nobody, and the suggested workaround is to create a user
# www and use that user.
# NOTE that some kernels refuse to setgid(Group) or semctl
# (IPC_SET) when the value of (unsigned)Group is above 60000;
# don't use Group #-1 on these systems!
#

User apache
Group apache
```

Buffer overflow attacks

A Cracker pushes more data on to a services buffer than space provides. They can “break out” of the program space and execute arbitrary commands on your system with the privileges of the compromised service.

Many security patches deal with newly discovered buffer overflow holes.

The Linux world has several solutions for this, but also has more problems with this issue.

Configure and use an IDS

- Intrusion Detection System = IDS
- Network Intrusion Detection System = NIDS
- And, System Integrity Checking is a generic term for this.

An IDS monitors network traffic and warns if suspicious behavior is detected.

A System Integrity Checker looks for changes to files that are not expected and warns you of these.

For a list of many tools see http://nsrc.org/#integrity

Snort intrusion detection system

Snort from http://www.snort.org/ is a very popular tool to detect unexpected network events using a known set of rules and patterns. This is a signature-based IDS. We will be using Snort tomorrow.

Additional Snort add-ons include:

- **ACID**: Anaylsis Console for Intrusion Databases. Web front-end to IDS alert database(s). Good for large site. From http://acidlab.sourceforge.net/.
- **Sguil**: Snort GUID for Lamerz. Complex system to analyze possible IDS events with tools such as ethereal and TcpFlow as well as Snort. From http://sguil.sourceforge.net/.
- **Snort_inline**: from http://snort-inline.sf.net/. Detect intrusions and react to them.
- **SnortSam**: from http://www.snortsam.net/ to update firewalls on the fly to deal with attacks.

Restrict access to your box using IP firewall services (ipfw)

FreeBSD 5.4 ships with no less than three “ready-to-go” firewall solutions. These are:

1.) IPFIREWALL: or *ipfw*. Version 2, or ipfw2, comes with FreeBSD 5.4. Sample (outdated) ruleset in /etc/rc.firewall if installed.

2.) IPFILTER: or *ipf* (the “Handbook's pick”).

3.) Packet Filter Firewall: or *pf* from the OpenBSD project.

Detailed discussion can be found in:

- /usr/share/doc/en/books/handbook/firewalls.html

Firewalling cont.

From the Handbook:

The configuration of the IPFW software is done through the ipfw(8) utility. The syntax for this command looks quite complicated, but it is relatively simple once you understand its structure.

There are currently four different command categories used by the utility: **addition/deletion**, **listing**, **flushing**, and **clearing**. Addition/deletion is used to build the rules that control how packets are accepted, rejected, and logged. Listing is used to examine the contents of your rule set (otherwise known as the chain) and packet counters (accounting). Flushing is used to remove all entries from the chain. Clearing is used to zero out one or more accounting entries.

Firewalling cont.

To use ipfw you should place ipfw rulesets in /etc/rc.conf.

Logging is recommended when you first build your ipfw ruleset to help debug what you are doing.

A couple of example ipfw rules:

```
ipfw add deny tcp from evil.doers.org to nice.people.org 22

ipfw add deny log tcp from evil.crackers.org/24 to nice.people.org
```

We explain these on the next page ==>

Firewalling cont.

This command will deny all packets from the host evil.doers.org to the ssh port of the host nice.people.org:

```
ipfw add deny tcp from evil.doers.org to nice.people.org 22
```

The next example denies and logs any TCP traffic from the entire crackers.org network (a class C) to the nice.people.org machine (any port).

```
ipfw add deny log tcp from evil.crackers.org/24 to nice.people.org
```

Firewalling cont.

Before starting:

- Read FreeBSD Handbook on ipfw and/or firewalls
- Read "`man ifpw`" - "`man ipf`" - "`man pf`"
- See pf's comprehensive user guide here:
  - http://www.openbsd.org/faq/pf/

- Setting up a useful and functioning ruleset can be quite complex.
- The FreeBSD Handbook's firewall discussion is *excellent* and you should use this.

Test your security model

Connect to your machine(s) externally and see if your model works!

Run some security scanning software against your machine.

A common tool is `nmap`.

Another tool is Nessus, which we'll use next.

See:

- http://www.insecure.org/nmap/
- http://www.nessus.org/.

Test your security model: nmap

Warning! Don't run nmap against machines or networks without giving prior notice!

Now try scanning your neighbor's box:

- `nmap 202.62.122.`*`nnn`*
- `nmap -O 202.62.122.`*`nnn`*
- `nmap -sS -O -p 1-1024 -v \`
  `202.62.122.`*`nnn`*

Read the `nmap` man pages to figure out what's going on, and a decent `nmap` discussion:

`http://linuxgazette.tolix.org/issue56/flechtner.html`

Don't forget about your clients

Make sure that your users must connect to your servers in such ways as to help ensure the integrity of their data and their user accounts.

Insist on software clients that use encryption like SSH vs. Telnet, SCP/SFTP vs. FTP, POP/IMAP over SSL.

Human clients running their OS'es... Dealing with Windows security issues such as viruses, Windows Updates, worms, spyware, etc...

Virus scanning software to defang email on your server?

Scripts as well – can rename files like .exe, .pif, .com, .scr, .vbs, .bat to fn.ft.*txt*.

Social issues. Security is inconvenient. For instance, Windows *still* does not ship with SSH – This is painful.

Later we'll look at Windows XP and 2000 practical security tips.

Some resources

CERT (Coordinated Emergency Response Team)

- http://www.cert.org/ and http://www.us-cert.gov/cas/index.html

Nice List of Security Resources for Linux/UNIX

- http://www.yolinux.com/TUTORIALS/LinuxSecurityTools.html

nmap: Network exploration tool and security scanner

- http://www.insecure.org/nmap/

O'Reilly Books

- http://www.oreilly.com/

SANS Computer Security and Mailing Lists

- http://www.sans.org/ and http://www.sans.org/newsletters/risk/

Security Documents from nsrc.org

- http://nsrc.org/security/ and http://nsrc.org/freebsd-tips.html

And, don't forget your own local help at http://www.sanog.org/!

More resources

The FreeBSD Handbook Security Section

- http://www.freebsd.org/doc/en_US.ISO8859-1/books/handbook/security.html

FreeBSD Website “intrusion detection” Software

- http://www.freebsd.org/cgi/ports.cgi?query=intrusion+detection&stype=all

FreeBSD Security Notifications Mailing List

- http://lists.freebsd.org/mailman/listinfo/freebsd-security-notifications

Nessus Security Auditing Package

- http://nessus.org/

Conclusion

More security means less convenience, but a security breach can be the least convenient moment of all.

There is always a tradeoff between how much security you put in place and what services you are providing.

Your users may grumble, but they'll really grumble if their data is compromised – Remind them of this :-)