

# Openwall GNU/\*/Linux a security-enhanced OS

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# Why another Linux distro?

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- Aren't major Linux distributions secure?
  - Most care to patch **known** security vulnerabilities which are "**bad enough**", yet do little to prevent vulnerable software from getting into the distribution in the first place
  - There're usually more than just a few pieces of software in a distribution which provide a certain bit of functionality, thereby unnecessarily increasing the risk
    - ▶ The number of vulnerabilities affecting each major distribution that hit Bugtraq is high, and those are only the ones which are "bad enough"

# Why another Linux distro? (cont.)

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- Isn't there already a secure Linux distribution?
- Most choose software based on security track record
  - ▶ A good security track record is no replacement for source code review; unless the software component is very popular, the track record hardly says anything on its **design** and **code quality**
  - ▶ It isn't just the **choice** of software which matters
- There's often an emphasis on kernel modifications
- It's not the security-related bells and whistles which make a system secure

# Openwall GNU/\*/Linux (Owl)

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A security-enhanced server platform based on

- The Linux kernel and its corresponding utilities
- GNU software
- Many BSD-derived components, including those ported to Linux specifically for use in Owl
- Other free software from various authors
- Free software developed by Openwall team members, including specifically for Owl

# Owl: Features

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- A base for installing whatever software is generally available for GNU/\*/Linux systems (including commercial and closed-source)
- Includes a growing set of integrated Internet services
- Includes a complete build environment ("make buildworld")
- Supports multiple architectures (currently x86, SPARC, Alpha)

# Owl: Approach to security

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- Software design and code quality are first priority

- Source code review

- Pieces of code which are typically run with privileges greater than those of a regular user and/or typically process data obtained over a network are audited before the corresponding software component is included; this applies to

- ▶ relevant code paths in many of the system libraries

- ▶ all SUID/SGID programs

- ▶ all daemons and network services

# Owl: Approach to security (cont.)

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- Software modifications in order to
  - apply the least privilege principle
  - introduce privilege separation
- Safe default configuration
- As the project evolves, many of the software components will be replaced with ones of our own

## Owl: Approach to security (cont.)

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- Policy enforcement and integrity checking
- "Strong" cryptography within core OS components
- "Hardening" to reduce likelihood and/or impact of successful real-world attacks on insecure third-party software one might install on the system
- A wide range of security tools available for use "out of the box"



# Owl: Build environment

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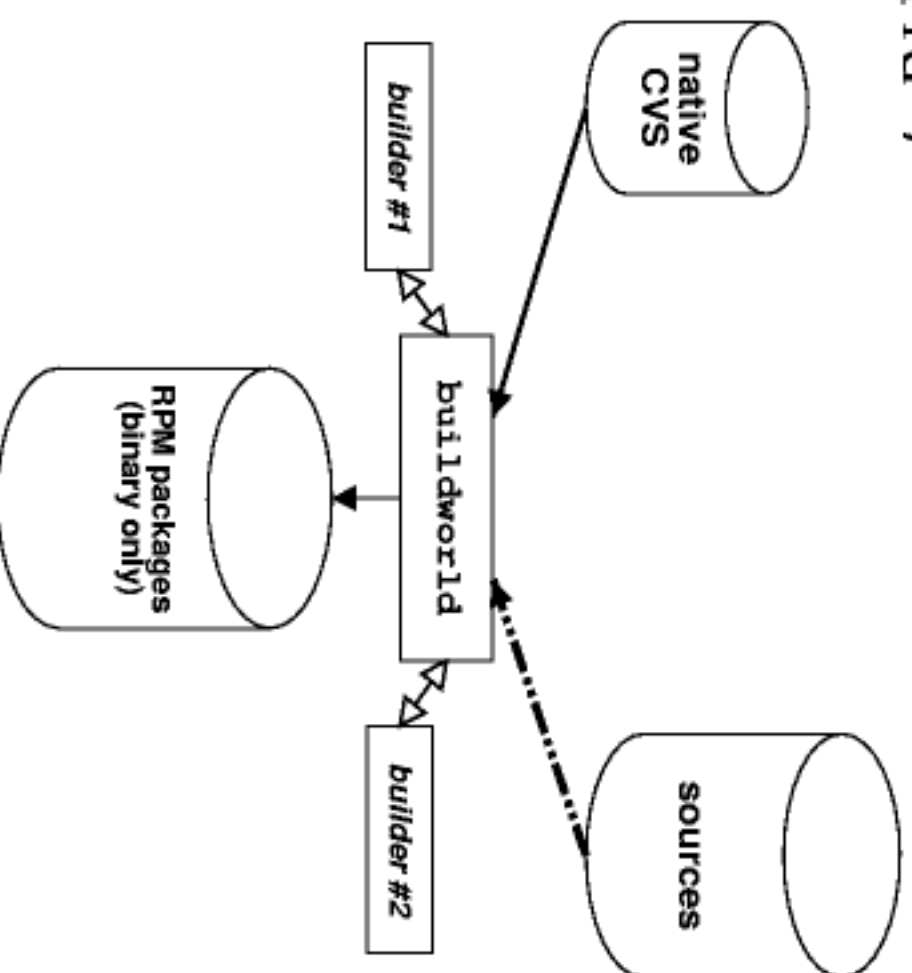
The Owl userland is maintained similarly to \*BSD ports/packages and may be rebuilt with one simple command ("make buildworld")

Some build times:

Dual Pentium III, 1.266 GHz, 2 GB	0:30
UltraSparc III, 400 MHz, 256 MB	3:50
Alpha 21164PC, 533 MHz, 128 MB	5:30

(Yes, gcc is this slow on Alpha)

The build times will increase as we add more packages and update to new versions of software already in Owl



# Owl: Developed software

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- Portable
  - pam\_mktemp, pam\_passwdqc, pam\_userpass; popa3d; scanlogd; libnids; John the Ripper
- Semi-portable
  - crypt\_blowfish, tcb (libtcb, libnss\_tcb, pam\_tcb)
- Owl-specific
  - owl-control
    - ▶ intended for Owl only, but now also used by ALT Linux
  - Startup scripts, the build environment, and so on

# Owl: Ported software

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■ Several software components have been ported from OpenBSD (with our usual source code review and modifications)

- `mtree`
  - ▶ and we actually build the initial filesystem hierarchy with `mtree`
- Vixie Cron (`crontab`, `crond`)
  - ▶ with modifications for SGID `crontab(1)`
- `telnet`, `telnetd`
  - ▶ with modifications to introduce privilege separation
- `netcat` (`nc`)
- `mailx`

# Owl: Modified software

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## ■ Essentially all of it

- on average 4 patch files per package
- (the most important) half of the patches originate in Owl

- the other half has been contributed or imported from various other distributions (including \*BSD's)
  - ▶ with appropriate credit given in each patch file name

```
owlbuild:~/native/Owl/packages/tcp_wrappers$ wc -c *.diff
22005 tcp_wrappers_7.6-openbsd-owl-cleanups.diff
4272  tcp_wrappers_7.6-openbsd-owl-ip-options.diff
4088  tcp_wrappers_7.6-owl-Makefile.diff
1866  tcp_wrappers_7.6-owl-safe_finger.diff
4938  tcp_wrappers_7.6-steveg-owl-match.diff
```

# Owl: crontab / crond

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- What privileges does crontab(1) require?
  - Ability to insert jobs into crond(8) spool
- The least privilege principle in the flesh

```
owl!root:/var/spool/cron# ls -ld . joe
drwx-wx--T  root  crontab      1024 Nov  5 14:10 .
-rw-----  joe   crontab      493 Apr  3 2001 joe

owl!root:/usr/bin# ls -l crontab
-rwx--s--x  root  crontab      21116 Nov  5 14:10 crontab
```

- crond(8) must not blindly trust its spool directory (and ours doesn't)

# Owl: `syslogd` architecture

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- Initialization as root
  - Bind a socket to `/dev/log`
  - Process `/etc/syslog.conf`, open appropriate log files
  - Drop to user/group `syslogd`
- Normal operation as user `syslogd`
  - Read from `/dev/log`, write to the log files
- In order to be able to reopen the log files on SIGHUP, they must be made writable to user or group `syslogd` when rotated

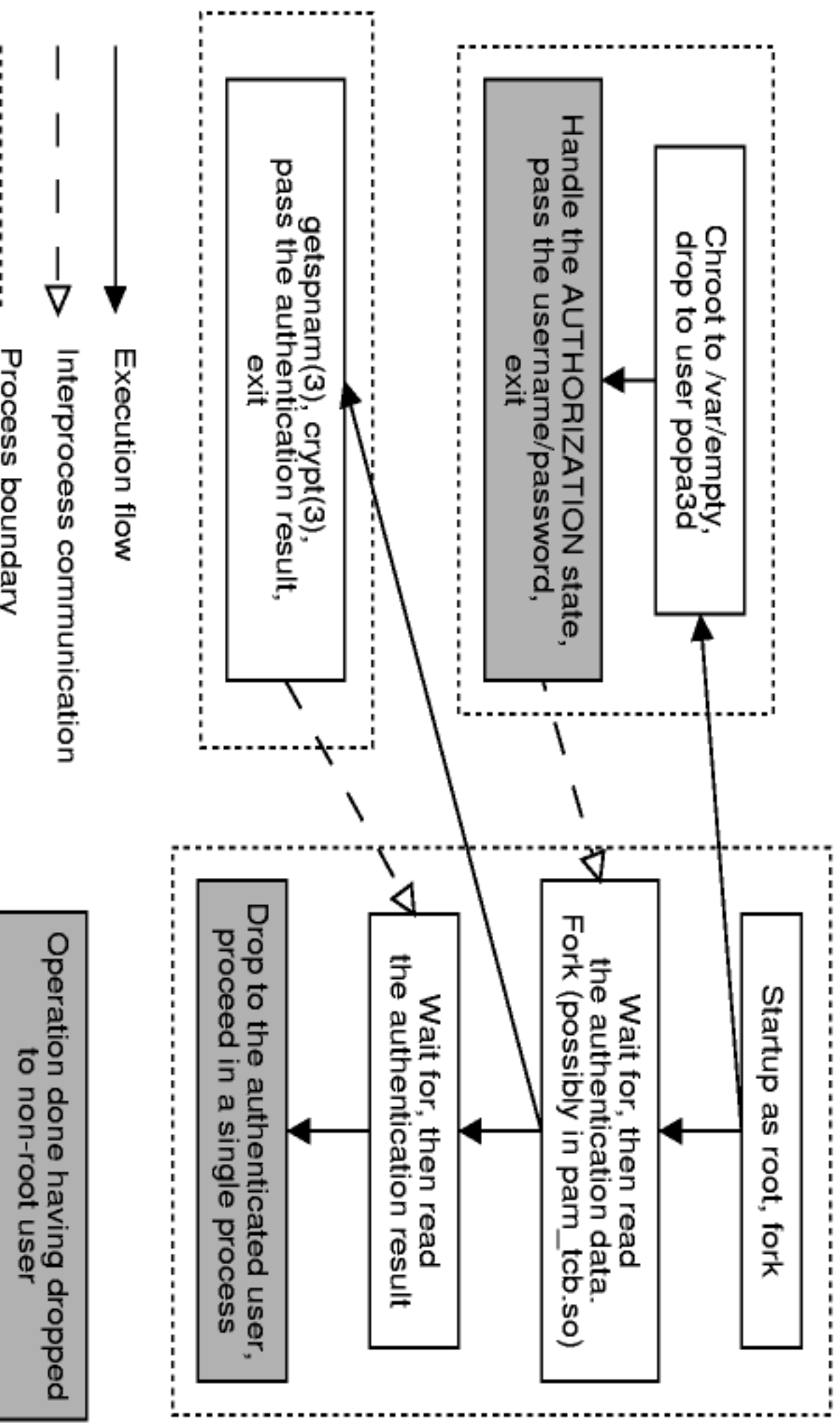
# Owl: klogd architecture

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- Initialization as root
  - Open `/proc/kmsg` and `/dev/log`, retain the open fd's
  - Open `/dev/kmem` and `System.map`, read relevant data, close them
  - Chroot to `/var/empty`
  - Drop to user `klogd`
- Normal operation as user `klogd`, in the chrooted environment
  - Read from the `/proc/kmsg` fd, format the message, and write it to the `/dev/log` fd

# Owl: popa3d architecture

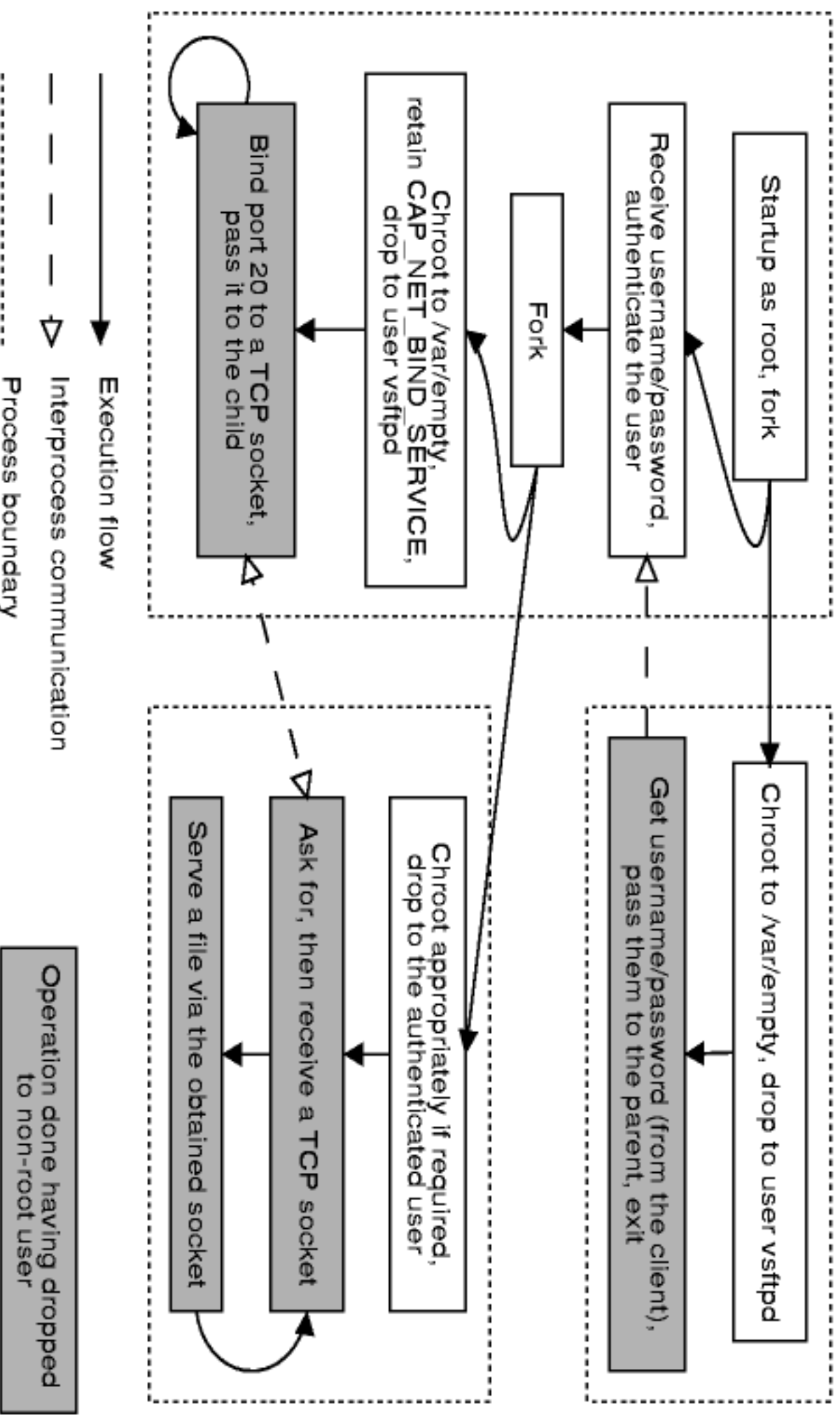
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# Owl: vsftpd architecture



# Traditional password shadowing

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- Password hashes and aging information of all users are stored in a single file
  - passwd(1) possesses the privilege to alter **all** entries in the shadow file
    - ▶ The traditional filesystem layout forces passwd(1) to be SUID root
  - chage(1) possesses the privilege to read **all** entries in the shadow file
- A passwd process compromise is fatal
- The problem cannot be fixed by assigning a dedicated user for `/etc/shadow` accesses

## **Owl: tcb - the alternative to shadow**

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- Each user is assigned a separate shadow file
- Each user is the owner of their shadow file
- Access to shadow files is group-restricted to allow for password policy enforcement
- The move to tcb is transparent for existing applications which rely on interfaces such as `getspnam(3)` (and thus on NSS) or PAM; no modifications to application sources are needed

# Owl: tcb: Filesystem layout

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```
owl!root::~# ls -ld /etc/tcb/
drwx---x----   root   shadow  1024 Nov 27 12:14 /etc/tcb/

owl!root::~# ls -l /etc/tcb/
drwx---s----   root   auth    1024 Nov 27 12:14 root
drwx---s----   joe    auth    1024 Nov 27 12:14 joe

owl!root::~# ls -l /etc/tcb/joe/
-rw-r-----   joe    auth    84 Nov 27 12:14 shadow

owl!root::~# cat /etc/tcb/joe/shadow
joe::$2a$08$ghnh1Q5K6kE24bY9xqQa5uSXwG2Y04051bj.yfLkP8BVFBusqLwxi:
11320:0:999999:7:::
```

- The per-user directories are also used as scratch space for temporary and lock files which are needed during password change

# Owl: tcb: Required privileges

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- `passwd(1)` is made SGID shadow
- `chage(1)` is SGID shadow
  - A possible compromise would only let one bypass password policy enforcement for their own account
- **Group auth** may be used to grant a process read access to all password hashes should the need arise
- No real need for any SUID binaries on the entire system

# Owl: tcb: Components

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- libtcb, the auxiliary library used by almost all of the tcb suite
  - Provides functions for locking and accessing tcb shadow files safely
- libnss\_tcb, the NSS module
  - Provides `getspnam(3)` and related functions
  - When running as root, the `/etc/tcb/*`/**shadow** files are accessed with the proper effective credentials and treated as untrusted input

## Owl: tcb: Components (cont.)

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- pam\_tcb, the PAM module
  - Provides functionality for all four PAM management groups
  - Supports `/etc/passwd`, `/etc/shadow`, `/etc/tcb/` directory structure, NIS, and NIS+ for password changes
  - Supports arbitrary password hashing methods
  - Optional forking to keep address space clean
- Backwards compatible with Linux-PAM `pam_unix` and `pam_pwdb` but offers additional functionality and better code quality



# Owl: tcb: Components (cont.)

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## ■ tcb\_convert and tcb\_unconvert

- Easy conversion between `/etc/tcb/*` and traditional `/etc/shadow` databases

## ■ The shadow suite utilities

- Non-trivial patching has been applied to the sources of most shadow suite utilities
- The invocation syntax remained unchanged
- A setting in `/etc/login.defs` specifies whether the utilities should adhere to the tcb scheme

# Owl: Further information

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- The Openwall GNU/\*/Linux homepage is

<http://www.openwall.com/Owl/>

- Any questions?