OS Security

Authentication

Radboud University Nijmegen, The Netherlands

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What does an OS do?

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Examples of shared resources

- Memory
- Input and Output (I/O) including
  - Files on the harddrive
  - Network
- Computation cycles on the processor(s)
- Peripheral hardware (keyboard, screen, . . .)

What does that mean for security?

- Operating system needs to decide whether processes are allowed to perform certain operations
- Obvious security disasters:
  - One process reading the memory of another process
  - A process reading a “secret” file
  - A process preventing other processes from operating
  - One process reading (keyboard) input meant for another process

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- Typically perform *user authentication* as a login procedure
- Start a shell mapped to the logged-in user
- A shell is (basically) an interface to run other programs
- All programs run from this shell are mapped to the logged-in user

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- Worst-case of authentication going wrong: *impersonation*
  - Authenticating as somebody else lets you perform all operations that this user is allowed to do
  - Authenticating as anybody else lets you perform arbitrary operations

User authentication

- Can authenticate through
  - *something you know* (typically a password)
  - *something you have* (typically a card or token)
  - *something you are* (biometrics)
- Multi-factor authentication combines two (or more) means of authentication

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- **Security nightmare:** an attacker who gets `root` access

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- `init`, `getty` and `login` all run as root
- `login` prompts for username and password
  - Bad password: `login` exits, `init` starts new `getty`
  - Good password: `login` changes to new user and executes a shell

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- **Eavesdropping attacks** (key logging, acoustic attacks): physical security

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- Linux uses the file `/etc/passwd` to store user login information
- Each line has 7 fields, separated by ':', e.g.:

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- 6. field: Home directory
- 7. field: Login program (set to `/bin/false` or `/usr/sbin/nologin` for users that are not allowed to log in)

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- Use '`*`' or '`!`' in the password field to lock the password
- Locking a password is different from using `/bin/false` as login program
- There may be other means to authenticate than the password

Password hashing algorithms

- Traditionally Linux used `crypt` for password hashing
- Truncate the password to 8 characters, 7 bits each
- Encrypt the all-zero string with modified DES with this 56-bit key
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- Maybe better algorithm in the future, see https://password-hashing.net/

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  7. Concatenate the two ciphertexts to obtain the LM hash

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- No salt, rainbow tables are feasible
- Passwords shorter than 8 characters produce hash ending in `0xAAD3B435B51404EE`
- Cracking LM hashes is fairly easy, there are even online services, e.g., http://rainbowtables.it64.com/

NT hashes

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- Today, Windows uses multiple different approaches for passwords

NT hashes

http://www.hotforsecurity.com/blog/windows-8-stores-logon-passwords-in-plain-text-3914.html

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- **Replay attack:** device-dependent, use challenge-response

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- Keystroking, timing of keystrokes

Pluggable authentication modules

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  - Graphical login (GDM, LightDM)
  - Screen locks (screensaver)
  - su and sudo (more next lecture)

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- This is handled by Pluggable Authentication Modules (PAM)
- Add a new module (e.g., for fingerprint authentication), directly available to all PAM enabled programs

PAM design

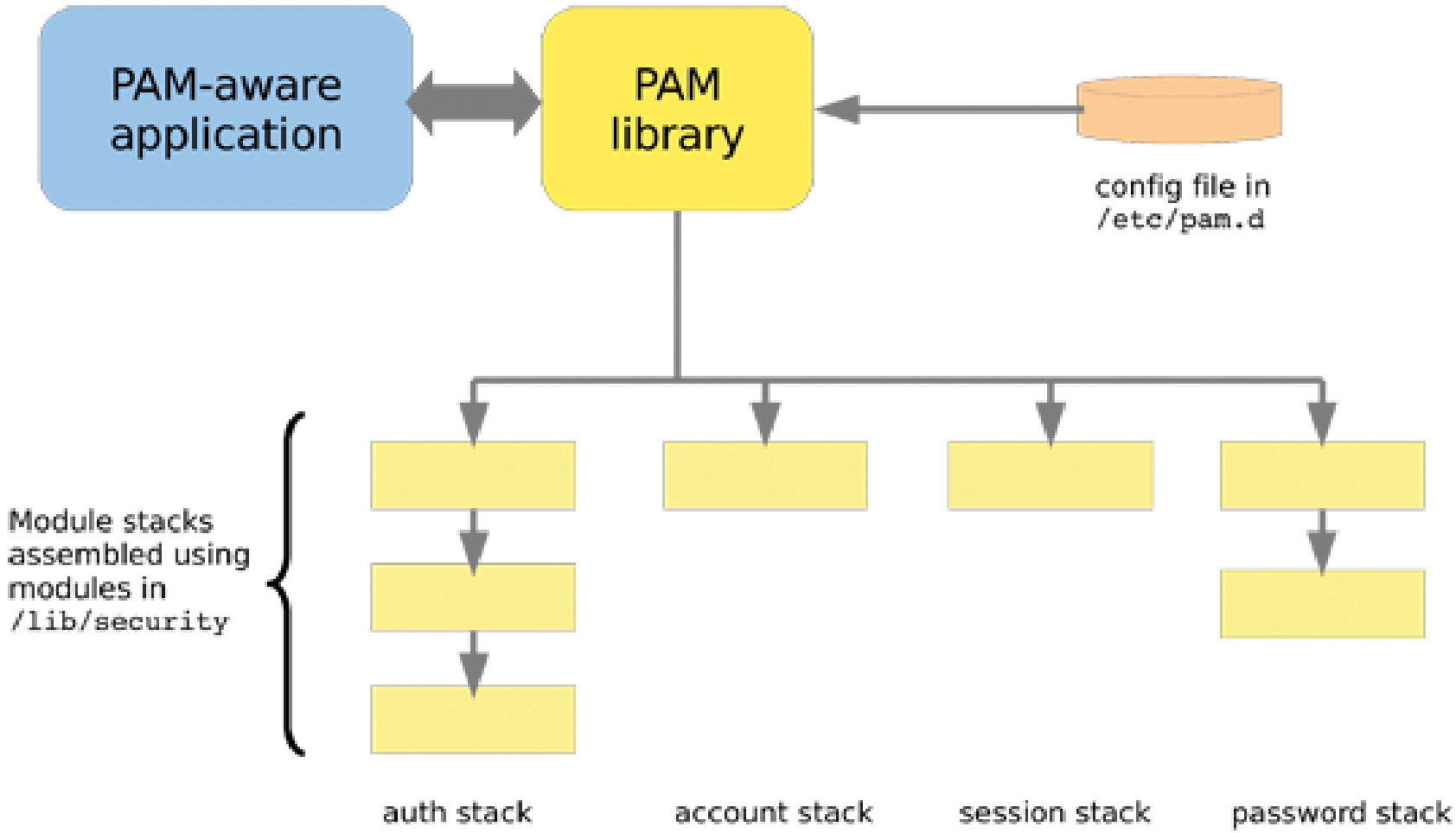


Image from http://www.tuxradar.com/content/how-pam-works

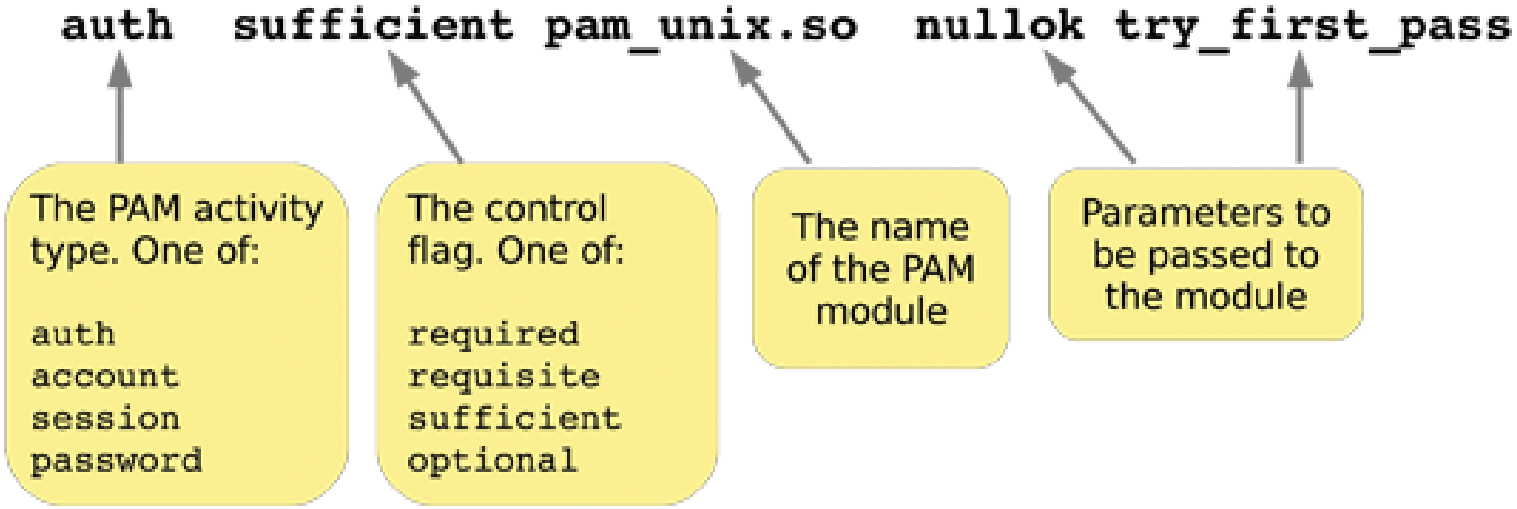
PAM activities

PAM knows 4 different authentication-related *activities*:

- **auth:** The activity of user authentication; typically by password, but can also use tokens, fingerprints etc.
- **account:** After a user is identified, decide whether he is allowed to log in. For example, can restrict login times.
- **session:** Allocates resources, for example mount home directory, set resource usage limits, print greeting message with information.
- **password:** Update the user's credentials (typically the password)

PAM configuration syntax

Configuration for program `progname` is in `/etc/pam.d/progname`



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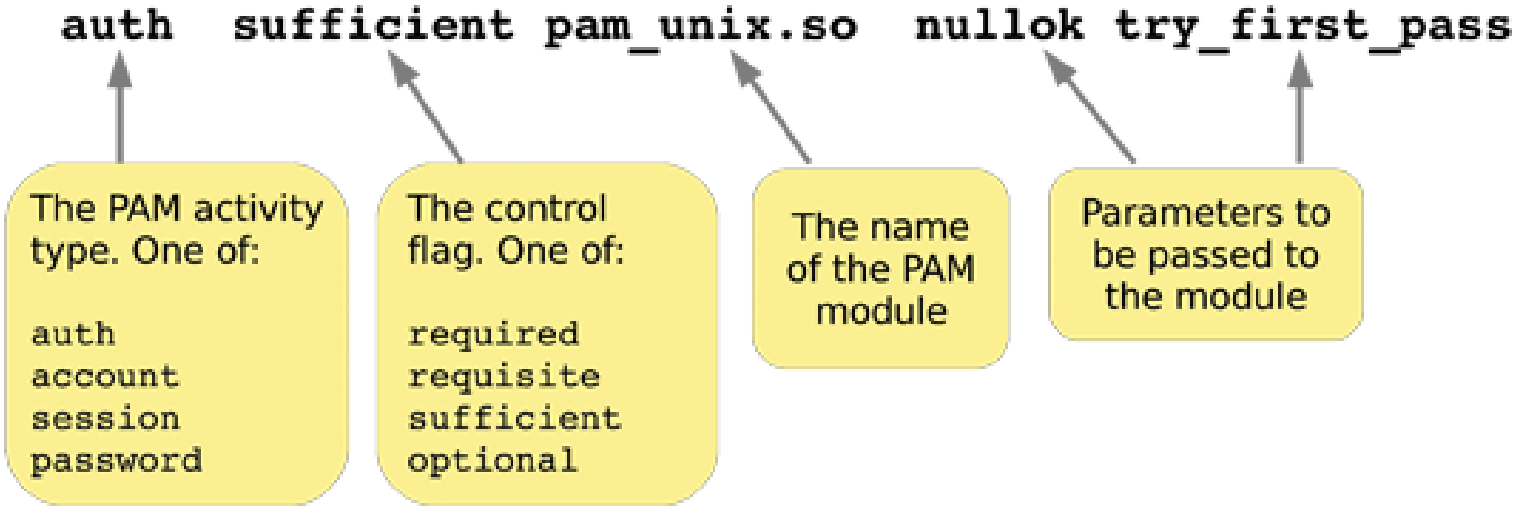

PAM control flags

- **requisite:** if module fails, immediately return failure and stop
- **required:** if module fails, return failure but continue
- **sufficient:** if module passes, return pass and stop
- **optional:** pass/fail result is ignored

Image source: http://www.tuxradar.com/content/how-pam-works

Examples of PAM modules

Name	Activities	Description
`pam_unix`	auth, session, password	Standard UNIX authentication through `/etc/shadow` passwords
`pam_permit`	auth, account, session, password	Always returns true
`pam_deny`	auth, account, session, password	Always returns false
`pam_rootok`	auth	Returns true iff you're root
`pam_warn`	auth, account, session, password	Write a log message to the system log
`pam_cracklib`	password	Perform checks of the password strength

Some PAM config examples

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```

- Enforce passwords with at least 10 characters and at least 2 special characters, use SHA-512 for password hash (`/etc/pam.d/passwd`):

```
password    required    pam_cracklib.so minlen=10 ocredit=-2
password    required    pam_unix.so      sha512
```

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- Also more complex ways, e.g., challenge-response
- Possible disadvantage of central login server: single point of failure

NTLM and "pass the hash"

- Microsoft's LM and NTLM network authentication can send hash from the client, server compares hashes
- Attacker only needs to obtain the password *hash*
- The whole point of storing password hashes is gone
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- Conveniently automated in `metasploit`
- Almost any larger Windows network still has NTLM somewhere

NIS

- Network Information Service (NIS) invented by Sun
- Centrally administer users and hosts
- Server sends hash to the client, client compares
- Essentially, the advantage of `/etc/shadow` is lost
- NIS is still in use today, but not very common anymore

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- Even better: integrate LDAP with Kerberos

Kerberos

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- More in the lecture "Cryptography" next semester