

Lecture 15 – Access Control

Stephen Checkoway

University of Illinois at Chicago

CS 487 – Fall 2017

Slides based on Bailey's ECE 422

Authentication vs Authorization

- Authentication — Who goes there?
 - Restrictions on who (or what) can access system
- **Authorization** — Are you allowed to do that?
 - Restrictions on actions of authenticated users
- Authorization is a form of **access control**
- Authorization enforced by
 - Access Control Lists
 - Capabilities

Access Control

- Access control is a collection of methods and components that supports
 - confidentiality
 - integrity
- Goal: allow only authorized **subjects** to access permitted **objects**
- E.g., Least privilege philosophy
 - A subject is granted permissions needed to accomplish required tasks and nothing more

Access Control Designs

- Access control designs define rules for users accessing files or devices
- Three common access control designs
 - Mandatory access control
 - Discretionary access control
 - Role-based access control

Mandatory Access Control (MAC)

- It is a restrictive scheme that does not allow users to define permissions on files, regardless of ownership.
- Instead, security decisions are made by a central policy administrator.
- A common implementation is rule-based access control
 - Subject demonstrates need-to-know in addition to proper security clearance
 - Need-to-know indicates that a subject requires access to object to complete a particular task
- Security-Enhanced Linux (SELinux) incorporates MAC

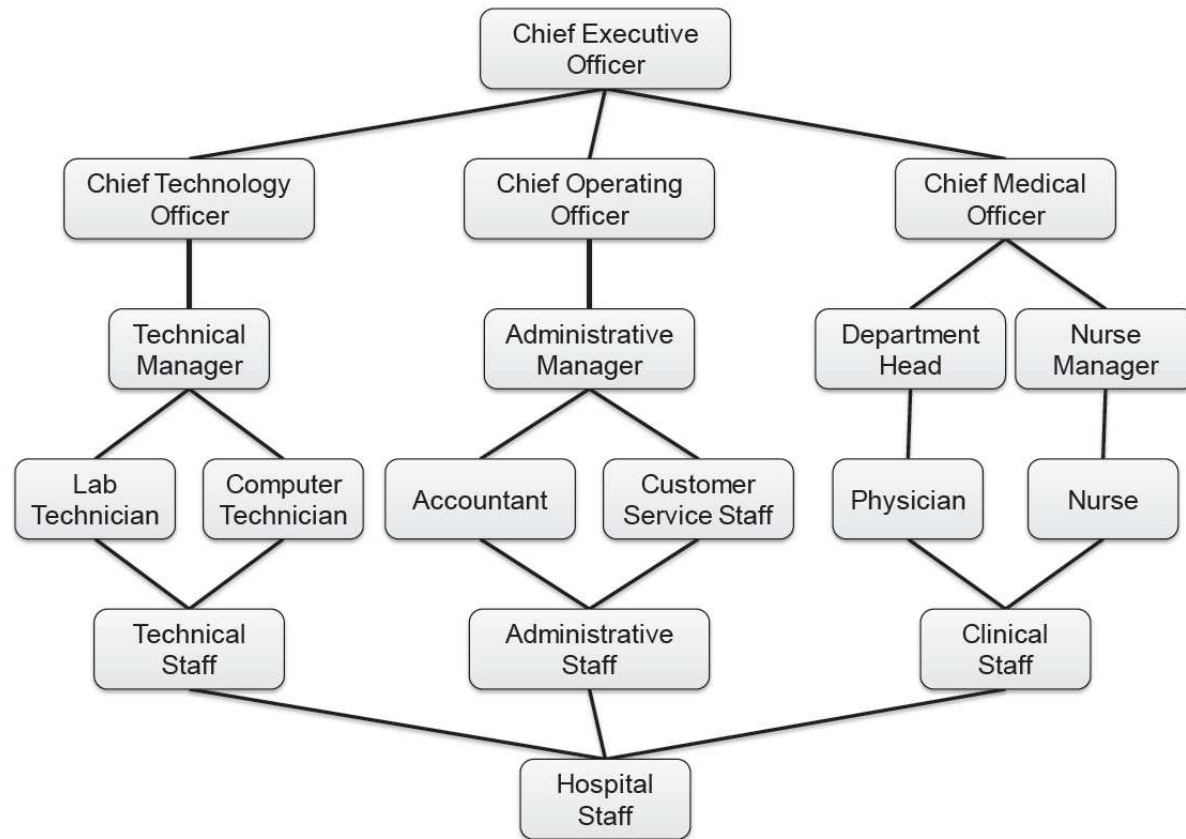
Discretionary Access Control

- Discretionary access control, or DAC, refers to a scheme where users are given the ability to determine the permissions governing access to their own files.
 - DAC typically features the concept of both users and groups
 - In addition, DAC schemes allow users to grant privileges on resources to other users on the same system.
- Most common design in commercial operating systems
 - Generally less secure than mandatory control
 - Generally easier to implement and more flexible

Role-Based Access Control

- The role-based access control (RBAC) model can be viewed as an evolution of the notion of group-based permissions in file systems.
- An RBAC system is defined with respect to an organization, such as company, a set of resources, such as documents, print services, and network services, and a set of users, such as employees, suppliers, and customers
- Uses a subject's role or task to grant or deny object access

Visualizing Role Hierarchy



Example of Implementing Policy

Filesystem Access Control

Access Control Entries and Lists

- An Access Control List (ACL) for a resource (e.g., a file or folder) is a list of zero or more Access Control Entries (ACEs)
- An ACE refers specifies that a certain set of accesses (e.g., read, execute and write) to the resources is allowed or denied for a user or group
- Examples of ACEs for folder “CS 487 Grades”
 - Professor; Read; Allow
 - Students; Read; Allow
 - Professor; Write; Allow
 - Students; Write; Deny

Linux File System

- Tree of directories (folders)
- Each directory has links to zero or more files or directories
- **Hard link**
 - From a directory to a file
 - The same file can have hard links from multiple directories, each with its own filename, but all sharing owner, group, and permissions
 - File deleted when no more hard links to it
- **Symbolic link (symlink)**
 - From a directory to a target file or directory
 - Stores path to target, which is traversed for each access
 - The same file or directory can have multiple symlinks to it
 - Removal of symlink does not affect target
 - Removal of target invalidates (but not removes) symlinks to it
 - Analogue of Windows shortcut or Mac OS alias

Unix Permissions

- Standard for all UNIXes
- Every file is owned by a user and has an associated group
- Permissions often displayed in compact 10-character notation
- To see permissions, use `ls -l`

```
jk@sphere:~/test$ ls -l
total 0
-rw-r----- 1 jk ugrad 0 2005-10-13 07:18 file1
-rwxrwxrwx 1 jk ugrad 0 2005-10-13 07:18 file2
```

Permissions Examples (Regular Files)

-rw-r--r--	read/write for owner, read-only for everyone else
-rw-r-----	read/write for owner, read-only for group, forbidden to others
-rwx-----	read/write/execute for owner, forbidden to everyone else
-r--r--r--	read-only to everyone, including owner
-rwxrwxrwx	read/write/execute to everyone

Permissions for Directories

- Permissions bits interpreted differently for directories
- *Read* bit allows listing names of files in directory, but not their properties like size and permissions
- *Write* bit allows creating and deleting files within the directory
- *Execute* bit allows entering the directory and getting properties of files in the directory
- Lines for directories in `ls -l` output begin with `d`, as below:

```
jk@sphere:~/test$ ls -l
```

```
Total 4
```

```
drwxr-xr-x  2 jk ugrad 4096 2005-10-13 07:37 dir1
```

```
-rw-r--r--  1 jk ugrad   0 2005-10-13 07:18 file1
```

Permissions Examples (Directories)

drwxr-xr-x	all can enter and list the directory, only owner can add/delete files
drwxrwx---	full access to owner and group, forbidden to others
drwx--x---	full access to owner, group can access known filenames in directory, forbidden to others
-rwxrwxrwx	full access to everyone

Special Permission Bits

- Three other permission bits exist
 - Set-user-ID (“suid” or “setuid”) bit
 - Set-group-ID (“sgid” or “setgid”) bit
 - Sticky bit

Set-user-ID

- Set-user-ID (“suid” or “setuid”) bit
 - On executable files, causes the program to run as file owner regardless of who runs it
 - Ignored for everything else
 - In 10-character display, replaces the 4th character (x or -) with s (or S if not also executable)
 - rwsr-xr-x: setuid, executable by all
 - rwxr-xr-x: executable by all, but not setuid
 - rwSr--r--: setuid, but not executable - not useful

Root

- “root” account is a super-user account, like Administrator on Windows
- Multiple roots possible
- File permissions do not restrict root
- This is *dangerous*, but necessary, and OK with good practices

Becoming Root

- `su`
 - Changes home directory, PATH, and shell to that of root, but doesn't touch most of environment and doesn't run login scripts
- `su -`
 - Logs in as root just as if root had done so normally
- `sudo <command>`
 - Run just one command as root
- `sudo -s`
 - Runs a shell as root
- `su [-] <user>`
 - Become another non-root user
 - Root not required to enter password

Changing Permissions

- Permissions are changed with **chmod** or through a GUI
- Only the file owner or root can change permissions
- If a user owns a file, the user can use **chgrp** to set its group to any group of which the user is a member
- root can change file ownership with **chown** (and can optionally change group in the same command)
- **chown**, **chmod**, and **chgrp** can take the -R option to recurse through subdirectories

Examples of Changing Permissions

<code>chown -R root dir1</code>	Changes ownership of dir1 and everything within it to root
<code>chmod g+w,o-rwx file1 file2</code>	Adds group write permission to file1 and file2, denying all access to others
<code>chmod -R g=rwX dir1</code>	Adds group read/write permission to dir1 and everything within it, and group execute permission on files or directories where someone has execute permission
<code>chgrp testgrp file1</code>	Sets file1's group to testgrp, if the user is a member of that group
<code>chmod u+s file1</code>	Sets the setuid bit on file1. (Doesn't change execute bit.)