Security Mechanisms and Policies

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- Mechanism and Policy
- setuid
- How to Regulate Access
- The K.I.S.S. Principle

Subjects and Objects

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Practical guideline: If it is (or should be) in code, it's a mechanism. If it is (or should be) in a config file, it's a policy.

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Negative example: Unix. The Superuser always gets access.

This part of the policy is hardcoded into most Unix kernels, and becomes a de facto part of the mechanism.

That makes root omnipotent on a Unix system and that's why it is such an exposed account.

Access Control Matrix

View of access control mechanisms as matrix: row contains active objects (users, processes, etc.), columns contain passive objects (files etc.), matrix entry says what active object may do with passive object.

	passwd	httpd.conf	ls	Objects
root	r/w	r/w	r/w/x	
neuhaus	r	r	r/x	Capability
zeller	r	r/w	r/x	
cleve	r	r/w	r/x	
Subjects		ACL		

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Solution 3: Store mostly columns, compute some rows: hodgepodge :-)

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Crude example: passwords (no fine-grained control)

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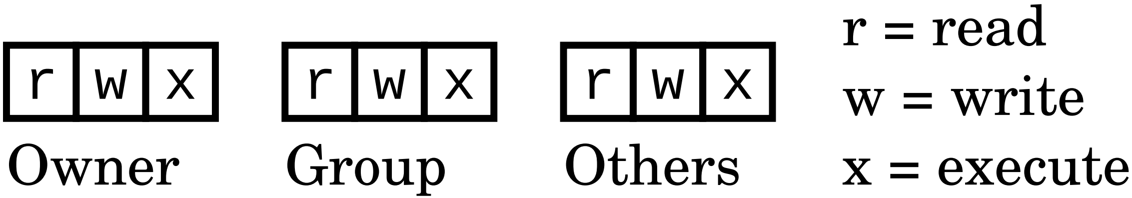
Crude example: Unix permission bits (see below)

The Unix File Access Model

Unix file objects have an owner and a goup. They also have nine bits associated with them (actually, there are twelve bits, we'll talk about the remaining three bits later).



Meaning of Bits

The first group of three bits tell what the *owner* of the object may do with it.

The second group of three bits tell what *group* members may do with it.

The third group of three bits tell what all *others* may do with it.

Within a group, bit 0 means "execute permission" (on directories: can change to this directory)

Bit 1 means "write permission" (on directories: can create new files, delete files)

Bit 2 means "read permission" (on directories: can read directory contents)

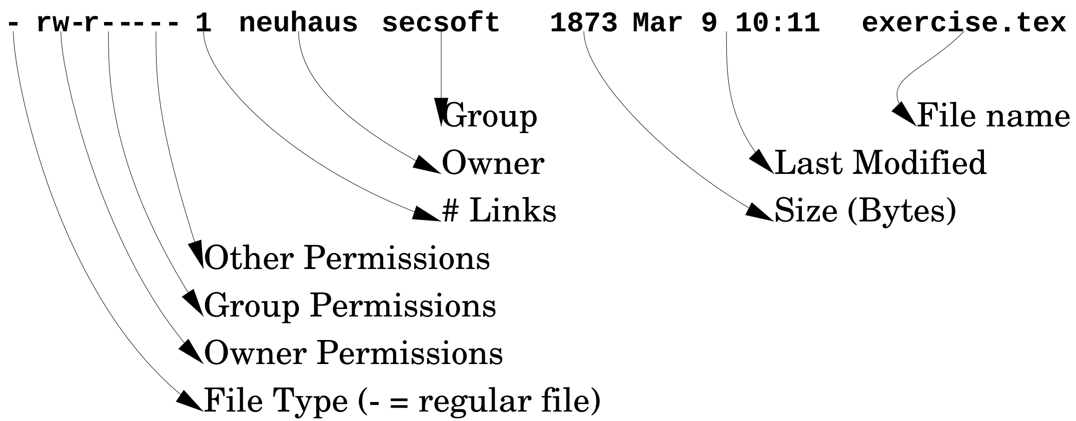
Access Control

When a file is opened (removed, renamed, executed, attributes changed), the process requesting the operation makes a *system call*.

The operating system examines the *effective user ID* (euid) and *effective group ID* (egid) of the process making the call.

It also looks at the file's (or directory's) *attributes* and thereby decides whether to perform the operation or not.

Example (1)



PID 123 has euid `zeller` and egid `secsoft` ⇒ access granted

Process 234 has euid `cleve` and egid `users` ⇒ access denied

Process 345 has euid `neuhaus` ⇒ access granted

Process 1 has euid `root` ⇒ access granted

Numerical Modes

Since there are groups of three bits each, we can express a mode in base 8:

Mode	Binary	Octal
`rw-r--r--`	110100100	644
`rw-------`	110000000	600
`rwxr-xr-x`	111101101	755
`rwxrwx---`	111111000	770
`--x--x--x`	001001001	111

Additional Bits (1): Sticky

Bit No. 10: Sticky bit. On regular files mostly without semantics; on directories: only owner can delete file, regardless of mode (used for temp directories)

Letter: `t` (if other x bit set) or `T` (if other x bit not set)

`/tmp` has mode 1777, `/tmp/strange` has mode 1770.

```
drwxrwxrwt  9 root    root   16384 Mar  9 13:01 /tmp
drwxrwx--T  2 neuhaus users   4096 Mar  9 13:39 /tmp/strange
```

Additional Bits (2): Setgid

Bit No. 11: Set group ID bit. On regular non-executable files, has mandatory file locking enabled (but don't count on it). On regular executable files, executes file with effective group id changed to group. On directories: Files created in that directory get group ID from directory, not from creating process.

Letter: s (if group x bit also set) or S (if group x bit not set)

```
-rwxr-sr-x  1 root    tty   9112 Jan 27  2002 /usr/bin/wall
drwxrwsr-x  8 zeller  www   4096 Jan 20 10:51 /home/www/edu/sopra
-rw---S---  1 neuhaus users    0 Mar  9 13:05 /tmp/lockme
```

Additional Bits (3): Setuid

Bit No. 12: Set user ID bit. On regular non-executable files without meaning. On regular executable files, this executes file with effective user id changed to owner of file, not owner of creating process. On directories semantics are unclear.

Letter: s (if user x bit also set) or S (if user x bit not set)

```
-rwsr-xr-x  1 root    root  23176 Apr  7  2002 /bin/su
-rwS------  1 neuhaus users     0 Mar  9 13:25 /tmp/testme
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This privilege elevation (and sometimes demotion) is handled by the kernel.

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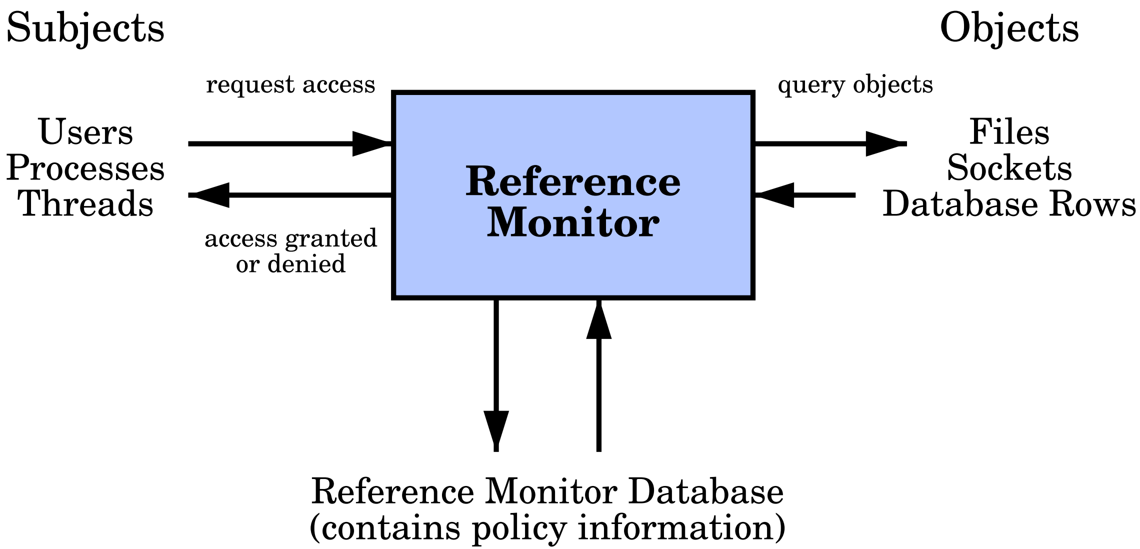
Windows NT (and, by extension, XP and 2003) have real ACLs, where every object has a list of subjects and its permissions

Reference Monitors

The reference monitor is that piece of software that performs the access decision.



It implements the mechanism.

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- which files the user can access (C)

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- The *-Property (“Star Property”): a subject may write only objects that are at its own security level, or higher (“no write down”)

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That's too oldfashioned? OK: a Word macro virus steals your sensitive data and uses Outlook express to send it over the Internet.

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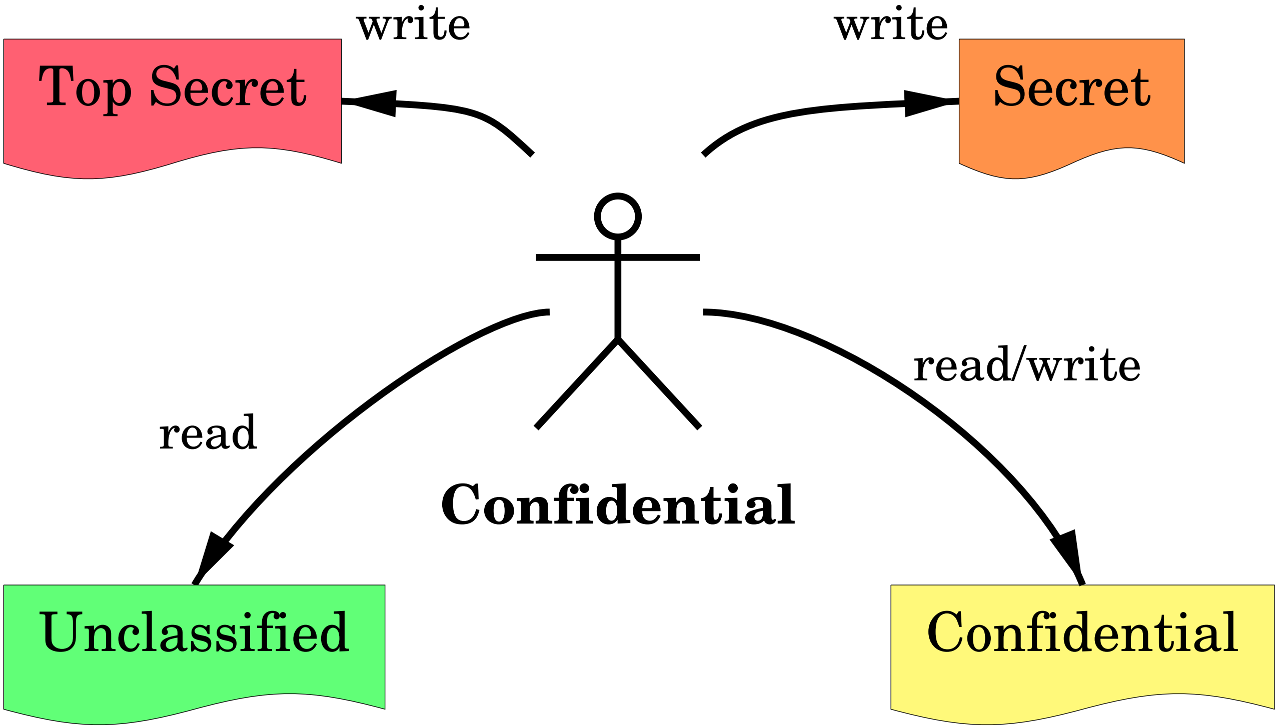

Top Secret
write
write
Secret
read
read/write
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Unclassified
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- A user at level n can see messages at level $m < n$, but can't reply to them

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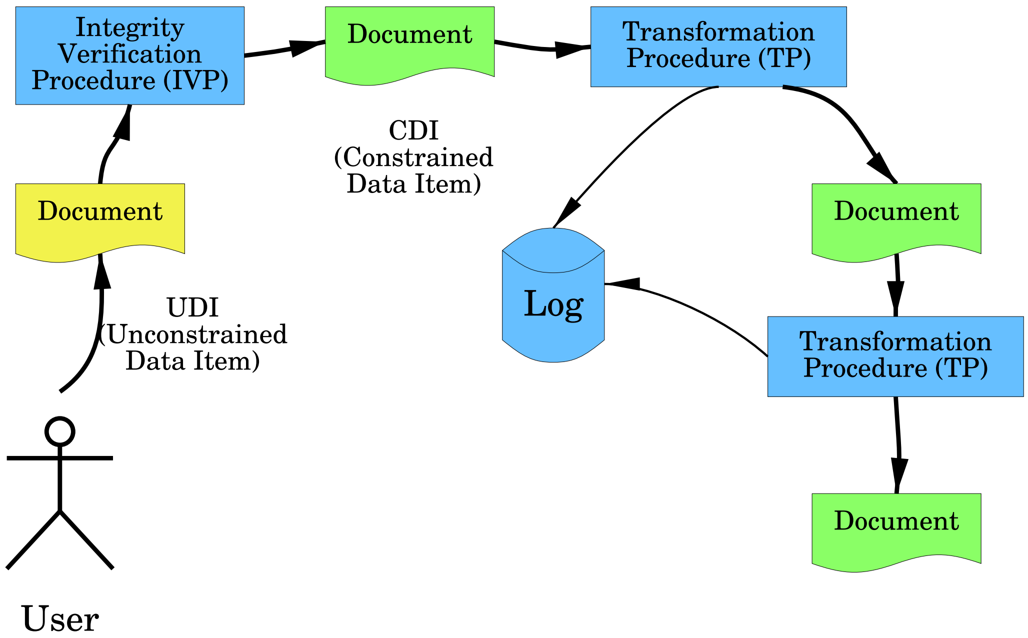
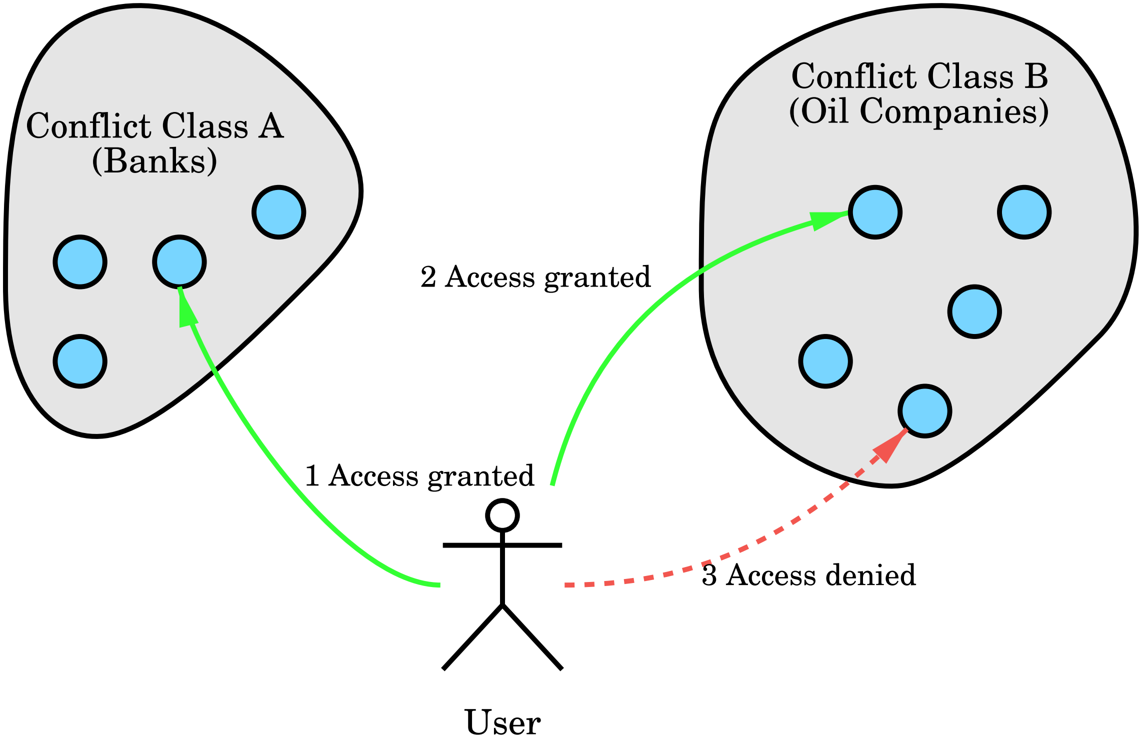


Chinese Wall Model



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Practical problems abound; see exercises.

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Solution: Apply policy models only to small and specific parts of the entire system. *Don't look for a silver bullet!*

Implementation of Mechanisms

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Design goals:

- Must run on many architectures (VAX, IBM mainframes, embedded systems);
- Must support crypto hardware
- Must support many good crypto algorithms under a single unified interface
- Must present a *secure interface* to the user, one that is impossible to use in an insecure manner.

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- It's well documented (comes with 300+ page user manual and tutorial; design and implementation are described in Gutmann's 300+ page Ph.D. thesis)

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Access to objects is mediated through a trusted *security kernel* that forms (part of) the *trusted computing base*

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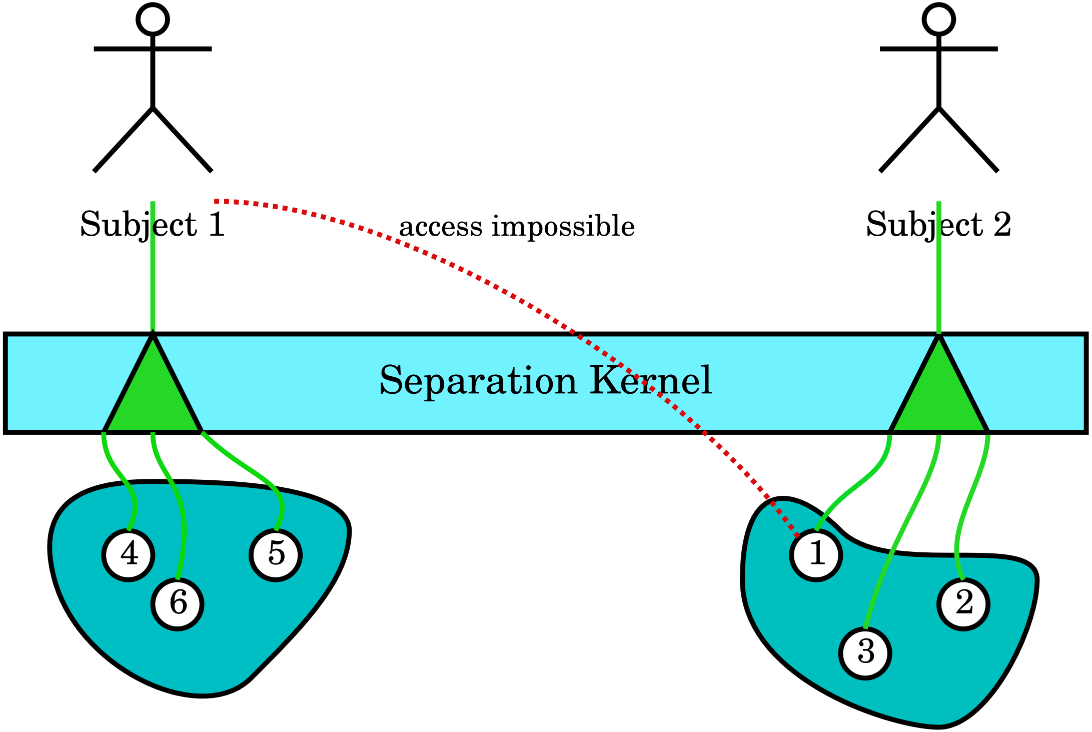
Separation Kernel



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- Object usage controls: control purpose, number of uses etc., so that e.g. a signing key can be used to create exactly one signature.

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Also, a malicious subject could subvert the controls.

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Summary

- Access Control
- Access Control Lists/Capabilities
- Bell-LaPadula
- Chinese Wall
- The cryptlib Separation Kernel
- Trusted Computing Base
- The K.I.S.S. Principle

Resources

- Peter Gutmann, *Cryptographic Security Architecture*, Springer

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- Peter Gutmann, *Cryptographic Security Architecture*, Springer
- Peter Gutmann, *cryptlib Encryption Toolkit*, http://www.cs.auckland.ac.nz/~pgut001/cryptlib/