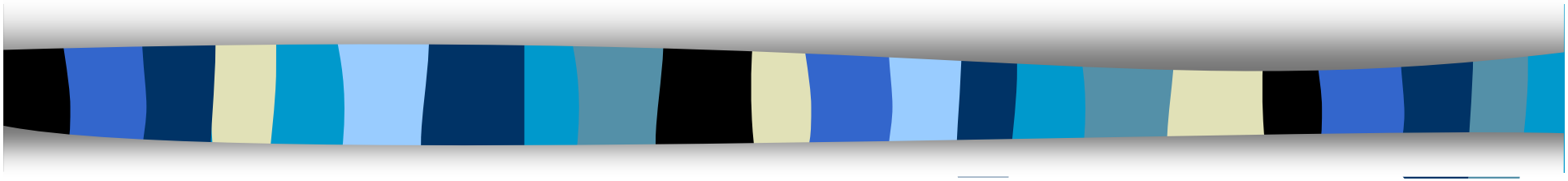
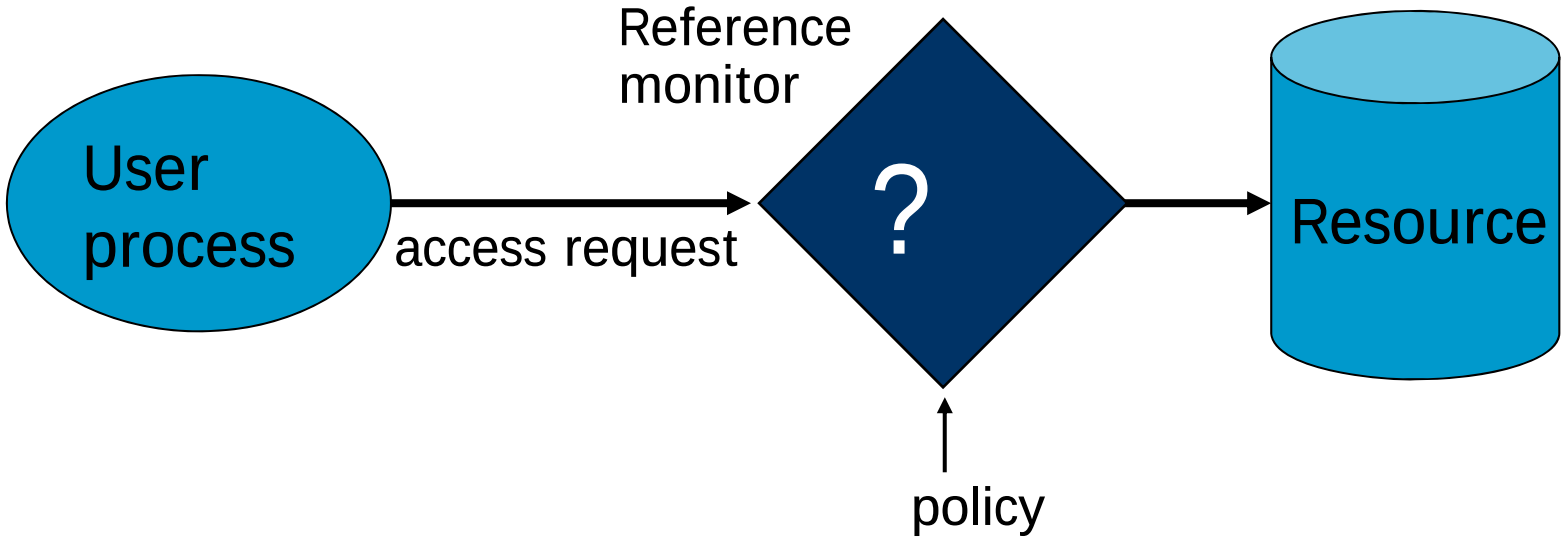
Computer Security
CS 426
Lecture 19



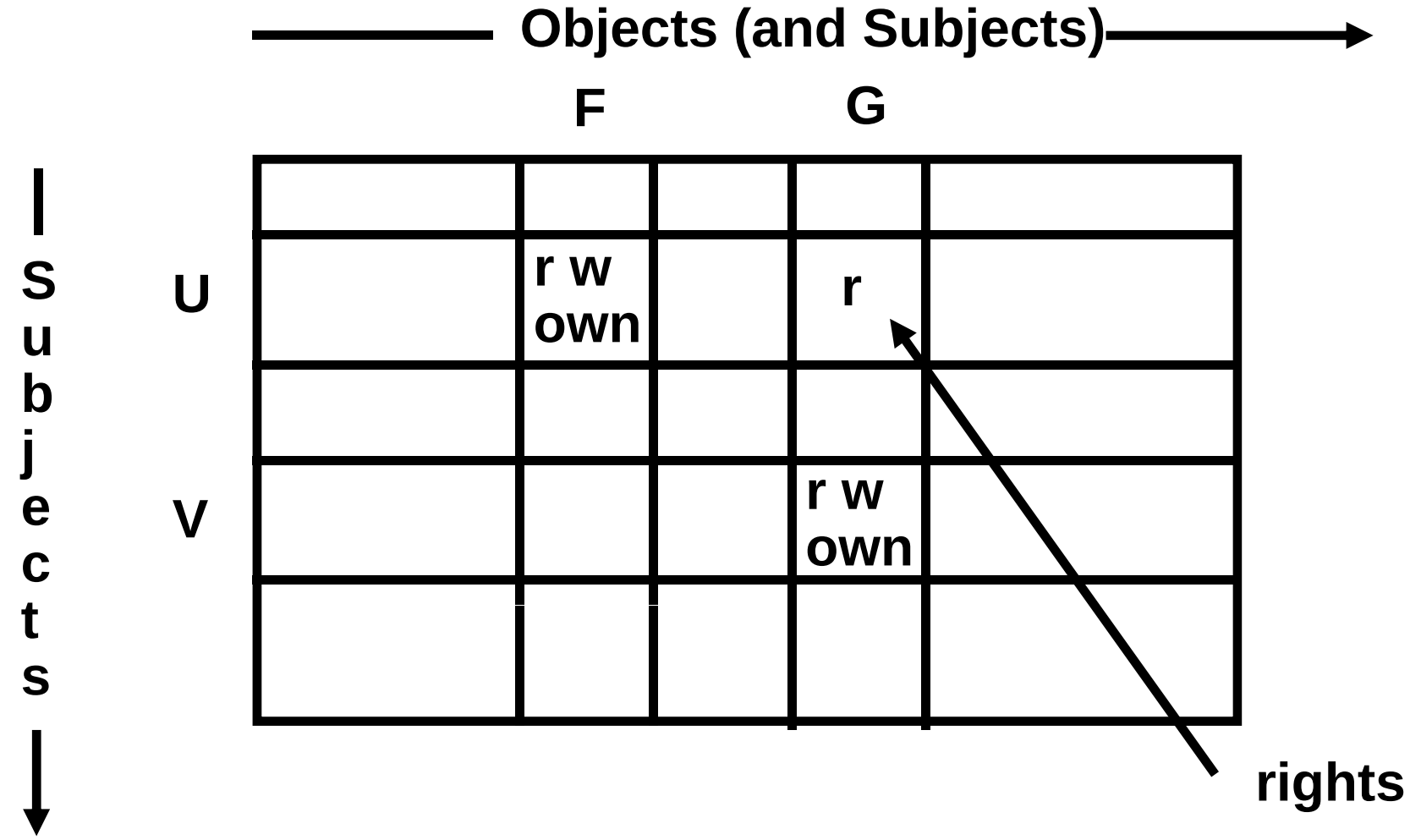
Discretionary Access Control

Access control

- Reference monitor mediate all access to resources
  - complete mediation: control **all** accesses to resources



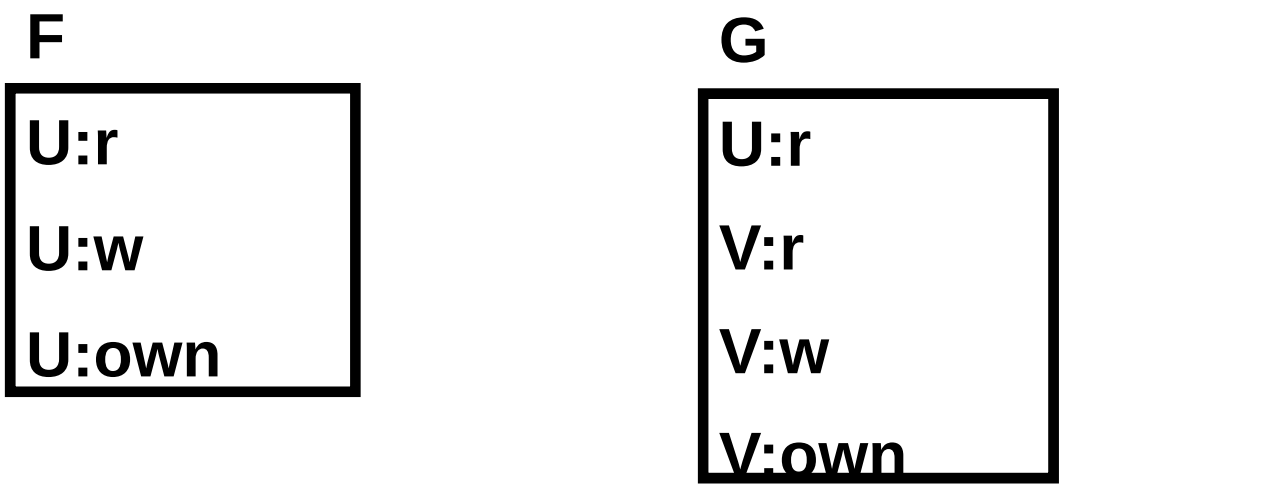
ACCESS MATRIX MODEL



IMPLEMENTATION OF AN ACCESS MATRIX

- Access Control Lists
- Capabilities
- Access control triples

ACCESS CONTROL LISTS (ACLs)



each column of the access matrix is stored with the object corresponding to that column

CAPABILITY LISTS

U **F/r, F/w, F/own, G/r**

V **G/r, G/w, G/own**

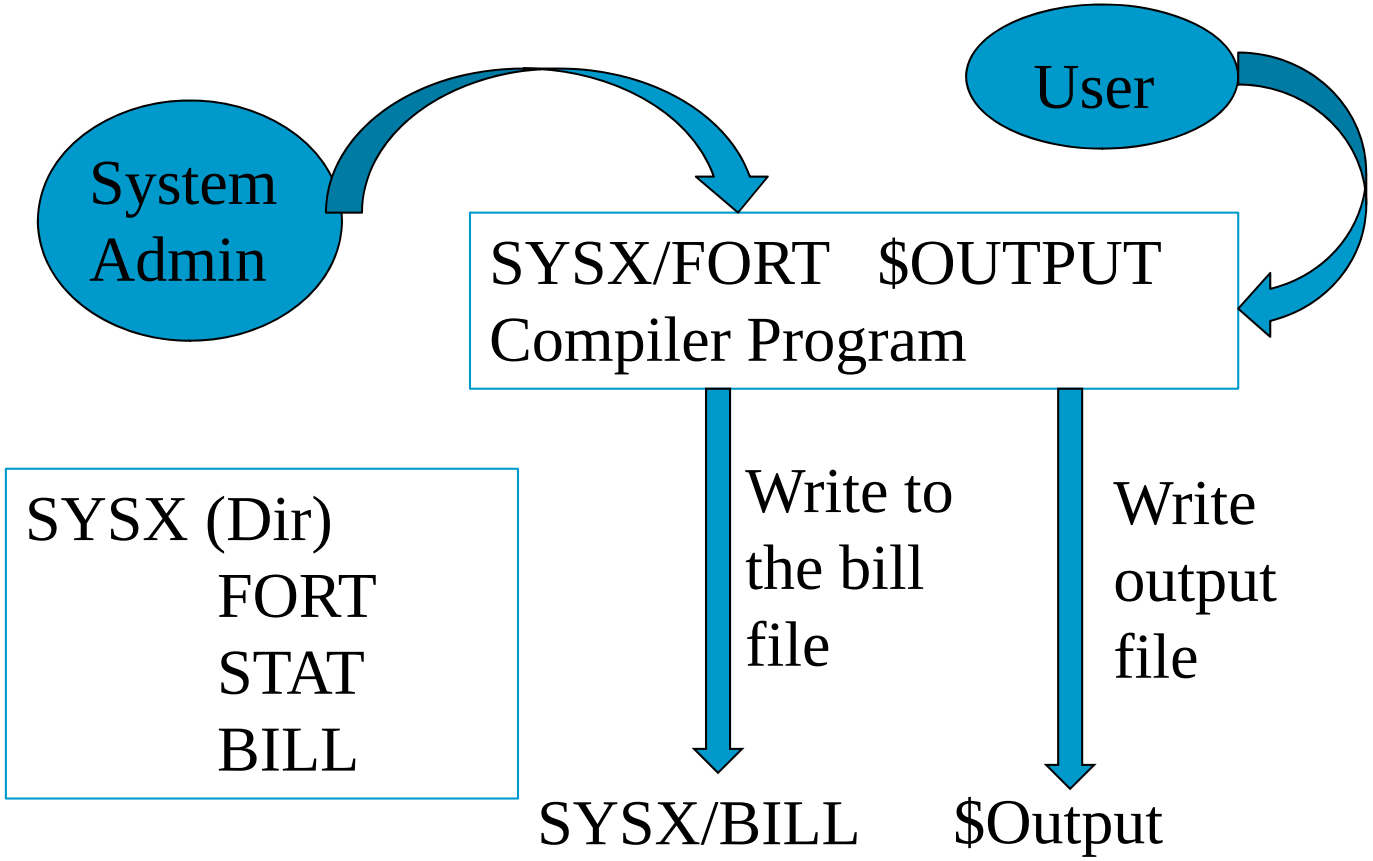
each row of the access matrix is stored with the subject corresponding to that row

ACCESS CONTROL TRIPLES

Subject	Access	Object
U	r	F
U	w	F
U	own	F
U	r	G
V	r	G
V	w	G
V	own	G

commonly used in relational DBMS

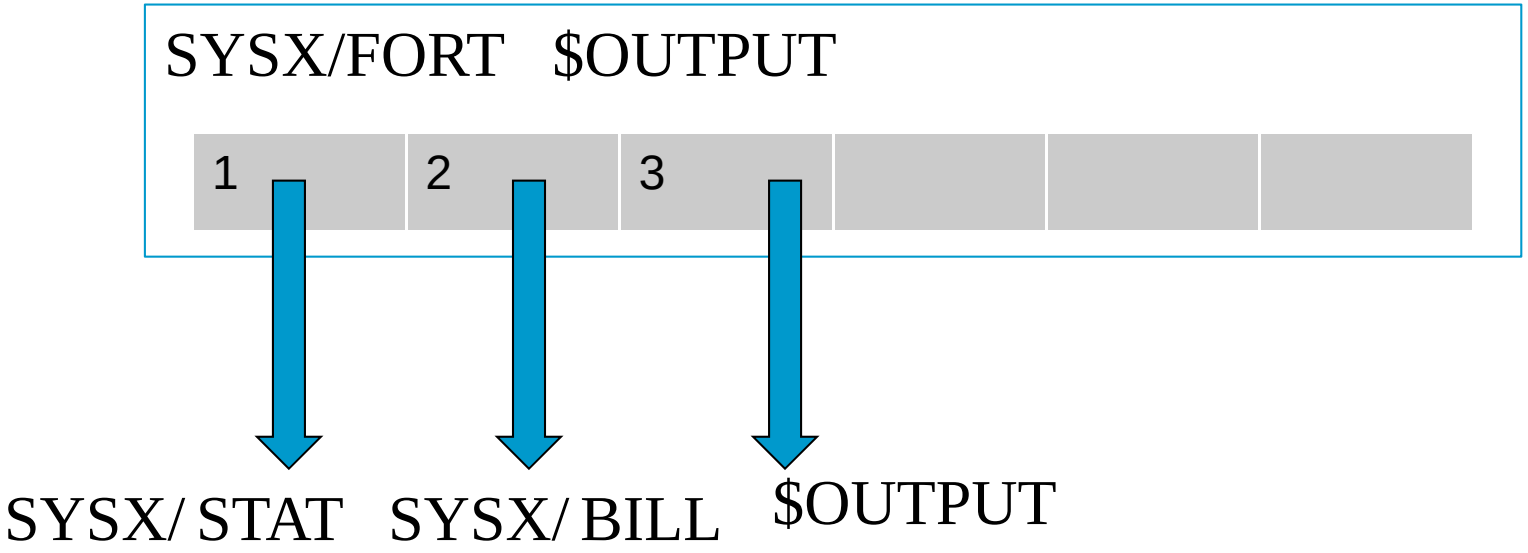
ACL vs. Capabilities
The Confused Deputy Problem



Analysis of The Confused Deputy Problem

- The compiler runs with authority from two sources
  - the invoker
  - the system admin (who installed the compiler and controls billing and other info)
- It is the deputy of two masters
- There is no way to tell which master the deputy is serving when performing a write

How the Capability Approach Solves the Confused Deputy Problem



- Invoker must pass in a capability for $OUTPUT, which is stored in slot 3.
- Writing to output uses the capability in slot 3.
- Invoker cannot pass a capability it doesn't have.

Capabilities vs. ACL: Ambient Authority

- Ambient authority means that a user's authority is automatically exercised, without the need of being selected.
  - causes the confused deputy problem
- No Ambient Authority in capability systems

Capability vs. ACL: Naming

- ACL systems need a namespace for objects
- In capability systems, a capability can serve both to designate a resource and to provide authority.

- ACLs also need a namespace for subjects
  - as they need to refer to subjects
- Implications
  - the set of subjects cannot be too many or too dynamic
  - most ACL systems treat user accounts (principals) as subjects, and do not support fine-grained subjects

Capability vs. ACL: Authority Management

- Subject-Aggregated Authority Management
- In (almost) all ACL systems, the power to edit authorities is aggregated by resource
  - naturally compatible with Discretionary Access Control, where there is often the notion of an owner
- In capabilities systems, the power to edit authorities is aggregated by subject

ACL'S VS CAPABILITIES

ACCESS REVIEW

- ACL's provide for superior access review on a per-object basis
- Capabilities provide for superior access review on a per-subject basis

REVOCATION

- ACL's provide for superior revocation facilities on a per-object basis
- Capabilities provide for superior revocation facilities on a per-subject basis

ACL'S VS CAPABILITIES

- ACL's require authentication of subjects
- Capabilities do not require authentication of subjects, but do require unforgeability and control of propagation of capabilities

Conjectures on Why Most Real-world OS Use ACL, rather than Capabilities

- Capability is more suitable for process level sharing, but not user-level sharing
  - user-level sharing is what is really needed
- Processes are more tightly coupled in capability-based systems because the need to pass capabilities around
  - programming may be more difficult

Discretionary Access Control

- No precise definition. Basically, DAC allows access rights to be propagated at subject's discretion
  - often has the notion of owner of an object
  - used in UNIX, Windows, etc.
- *"A means of restricting access to objects based on the identity and need-to-know of users and/or groups to which they belong. Controls are discretionary in the sense that a subject with a certain access permission is capable of passing that permission (directly or indirectly) to any other subject."*

Mandatory Access Control

- Mandatory access controls (MAC) restrict the access of subjects to objects based on a system-wide policy
  - denying users full control over the access to resources that they create. The system security policy (as set by the administrator) entirely determines the access rights granted

Multi-level Security (MLS)

- The capability of a computer system to carry information with different sensitivities (i.e. classified information at different security levels), permit simultaneous access by users with different security clearances and needs-to-know, and prevent users from obtaining access to information for which they lack authorization.
- Typically use MAC
- Primary Security Goal: Confidentiality

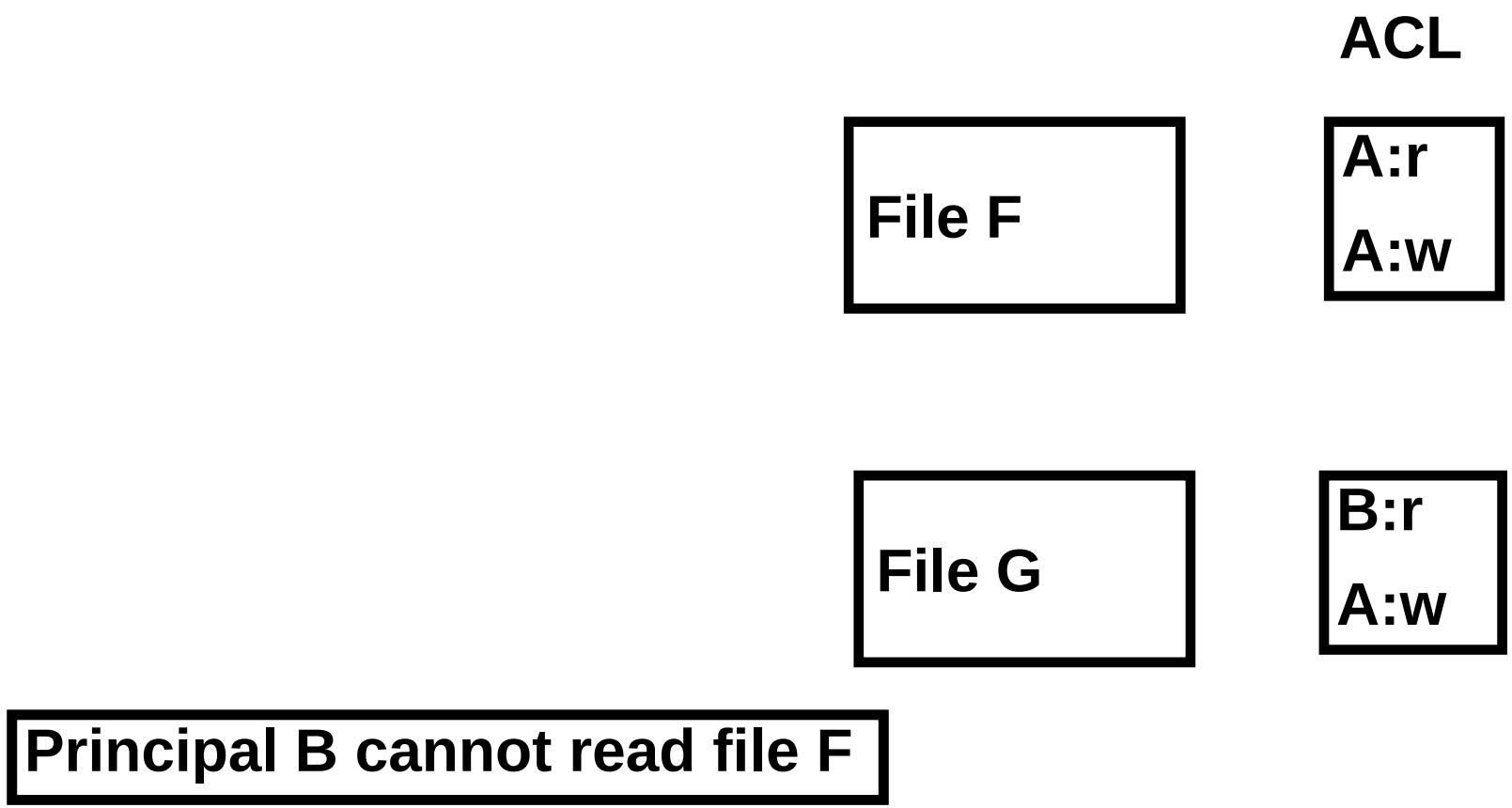
INHERENT WEAKNESS OF DAC

- Unrestricted DAC allows information from an object which can be read to any other object which can be written by a subject
  - do not provide multi-level security
- Suppose our users are trusted not to do this deliberately. It is still possible for Trojan Horses to copy information from one object to another.

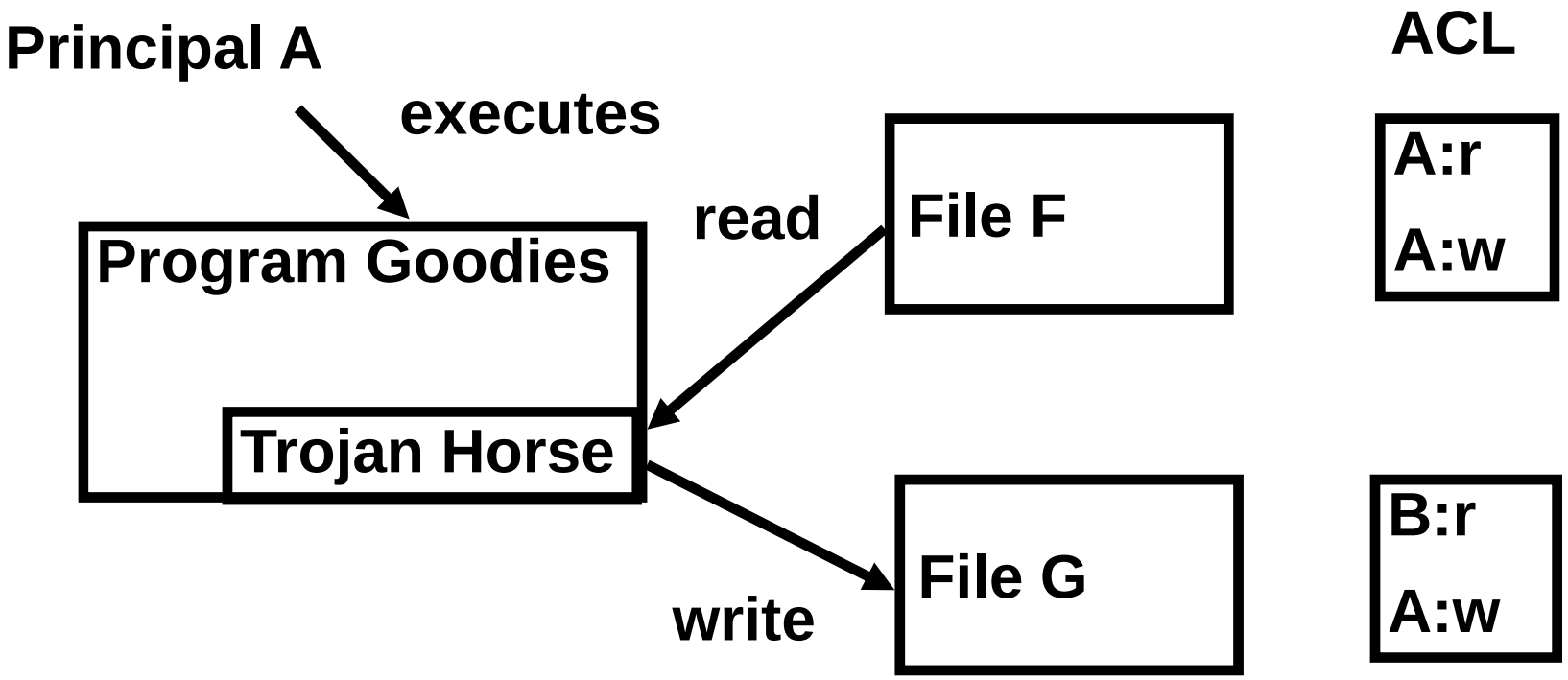
TROJAN HORSES

- A Trojan Horse is rogue software installed, perhaps unwittingly, by duly authorized users
- A Trojan Horse does what a user expects it to do, but in addition exploits the user's legitimate privileges to cause a security breach

TROJAN HORSE EXAMPLE



TROJAN HORSE EXAMPLE



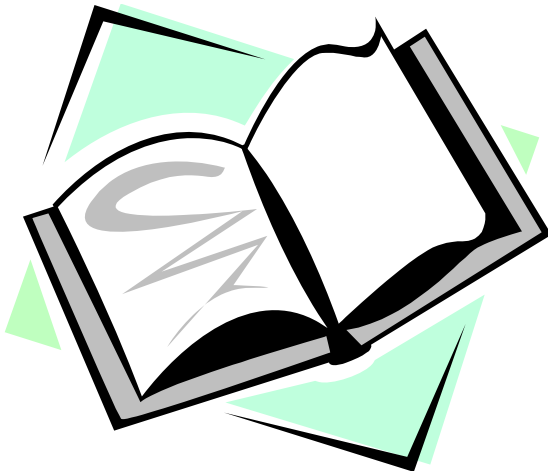
Principal B can read contents of file F copied to file G

Buggy Software Can Become Trojan Horse

- When a buggy software is exploited, it execute the code/intention of the attacker, while using the privileges of the user who started it.

Readings for This Lecture

- Wikipedia
  - Discretionary Access Control
- The Confused Deputy by Norm Hardy



Coming Attractions …

- The Bell LaPadula Model