Protection

CS 256/456

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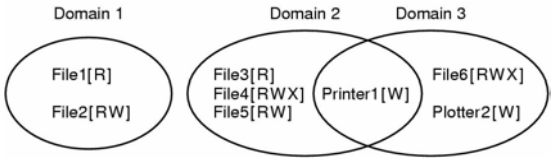
Operating System Protection

- Operating system consists of a collection of objects, hardware or software (e.g., files, printers)
- Protection problem - ensure that each object is accessed correctly and only by those processes that are allowed to do so.
  - a specific type of security problem
- Domain = group of processes having the same set of access-rights
  - what is a domain in traditional UNIX?
  - when process domain switches occur in traditional UNIX?



How to Track Objects/Rights in Domains?

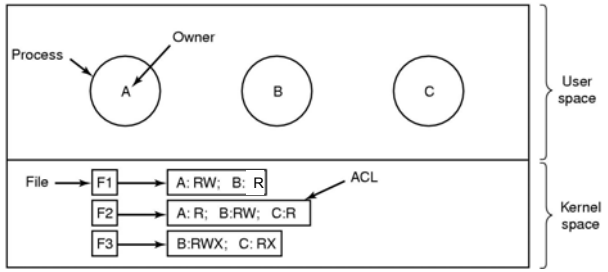
- View protection as a matrix (*protection matrix*)
  - Rows represent domains
  - Columns represent objects
  - *Access(i, j)* is the set of operations that a process executing in $Domain_i$ can invoke on $Object_j$
- Dynamic protection
  - Operations to add, delete access rights

Domain \ Object	File1	File2	File3	File4	File5	File6	Printer1	Plotter2
1	Read	Read Write						
2			Read	Read Write Execute	Read Write		Write	
3						Read Write Execute	Write	Write

Implementation of Protection

- The complete protection matrix consumes too much space and frankly it is very sparse.
  - two ways to condense it
- Each column = Access-control list for one object
  Defines who can perform what operation.
  Domain 1 = Read, Write
  Domain 2 = Read
  Domain 3 = Read
  ⋮
- Each Row = Capability List for each domain
  Define what operations allowed on what objects.
  Object 1 – Read
  Object 4 – Read, Write, Execute
  Object 5 – Read, Write, Delete, Copy
- What does traditional UNIX do?

Access Control Lists



Use of access control lists to manage file access

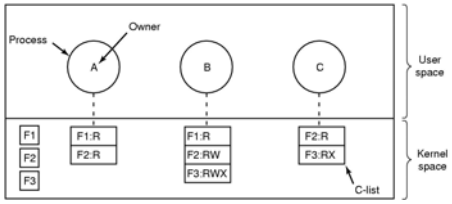
Revocation of access rights?

Capabilities

- Capability for a domain
  - abstraction that indicates access rights to objects for the domain
- Compare against ACL
  - may built-in with handle to objects (more efficient access right checking)
  - efficient mechanism to pass it around
- Important concern
  - a process should not be able to tamper its capabilities

Implementing Capabilities

- Kernel-space capability list
  - user programs use handles (e.g., file descriptors) to refer to them



- Tagged architecture
  - memory words containing capabilities are tagged; user programs can only read those words; only kernel programs can change those words
  - the protection system kernel does not need to track capabilities and capabilities can be passed by memory sharing

Cryptographically-protected Capabilities

- Cryptographically-protected capability
  - a random number (called "check") is generated for each file at creation time and maintained in secrecy
  - capability is formed cryptographically

Server	Object	Rights	f(Object, Rights, Check)

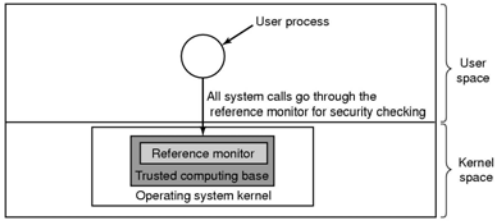
- Function f() is a one-way function that:
  - it is computationally infeasible to guess what "check" is even when object, rights, and f(object, rights, check) is known.
- Compared with tagged capabilities, cryptographically-protected capability
  - does not require new hardware support
  - can be passed around between distributed machines

Revocation of Access Rights for Capabilities

- Revocation:
  - change the secret check number?
- *total:* revoking rights to all processes
- *selective:* revoking rights to a selected group of processes (e.g., all processes belonging to a particular user)
  - Timeout & Reacquisition

Trusted Systems

- Trusted Computing Base
  - hardware and software for enforcing security rules
- If the TCB works according to specification, the system security cannot be compromised
- A reference monitor-based TCB:



Formal Models of Secure Systems

Objects

	Compiler	Mailbox 7	Secret
Eric	Read Execute		
Henry	Read Execute	Read Write	
Robert	Read Execute		Read Write

(a)

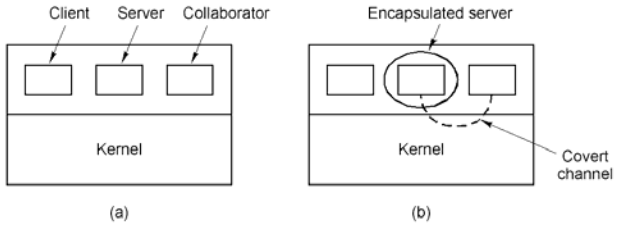
Objects

	Compiler	Mailbox 7	Secret
Eric	Read Execute		
Henry	Read Execute	Read Write	
Robert	Read Execute	Read	Read Write

(b)

- Protection commands: operations that can change protection matrix
- TCB must ensure that protection commands do not move the protection matrix from an authorized state to an unauthorized state

Covert Channels



Client, server and collaborator processes

Encapsulated server can still leak to collaborator via covert channels

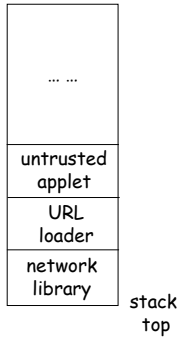
- Covert channels
  - Modulating CPU usage
  - Locking/unlocking files

Protection in UNIX

- Protection domains: users
- Access matrix for files:
  - a simplified access control list
- Protection commands for files:
  - each user can change protection on files it owns
  - superuser can do everything

Protection in Java

- A Java class can be loaded remotely; therefore can be dangerous
  - A class is assigned a protection domain when it is loaded by the JVM
  - The protection domain indicates what operations the class can (and cannot) perform.
- If a library method is invoked that performs a privileged operation, the stack is inspected for access right violation.



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