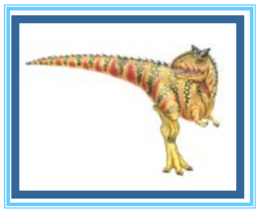
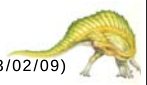
Chapter 14: Protection



Chapter 14: Protection

- Goals of Protection
- Principles of Protection
- Domain of Protection
- Access Matrix
- Implementation of Access Matrix
- Access Control
- Revocation of Access Rights
- Capability-Based Systems
- Language-Based Protection



(slides selected/reordered/fixed by R. Doemer, 03/02/09)

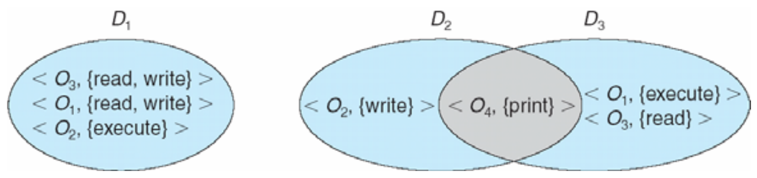
Goals and Principles of Protection

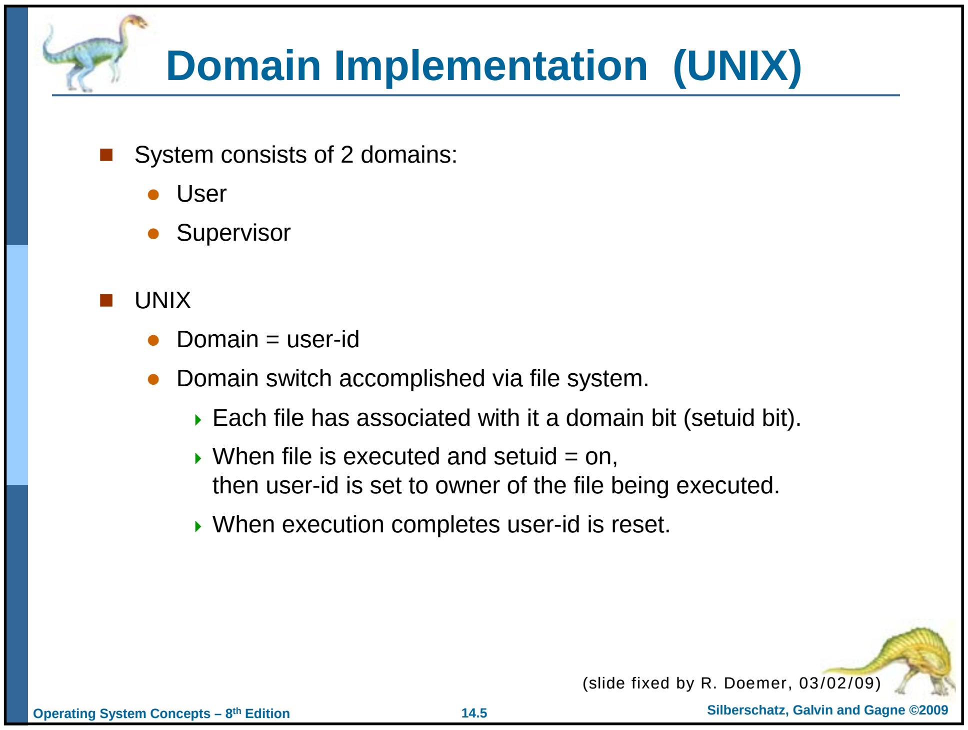
- Operating system consists of a collection of objects, hardware or software
- Each object has a unique name and can be accessed through a well-defined set of operations.
- Protection problem
  - ensure that each object is accessed correctly, and
  - only by those processes that are allowed to do so.
- Guiding principle – principle of least privilege
  - Programs, users and systems should be given just enough privileges to perform their tasks

(slide fixed/combined by R. Doemer, 03/02/09)

Domain Structure

- Access-right = <*object-name*, *rights-set*> where *rights-set* is a subset of all valid operations that can be performed on the object.
- Domain = set of access-rights

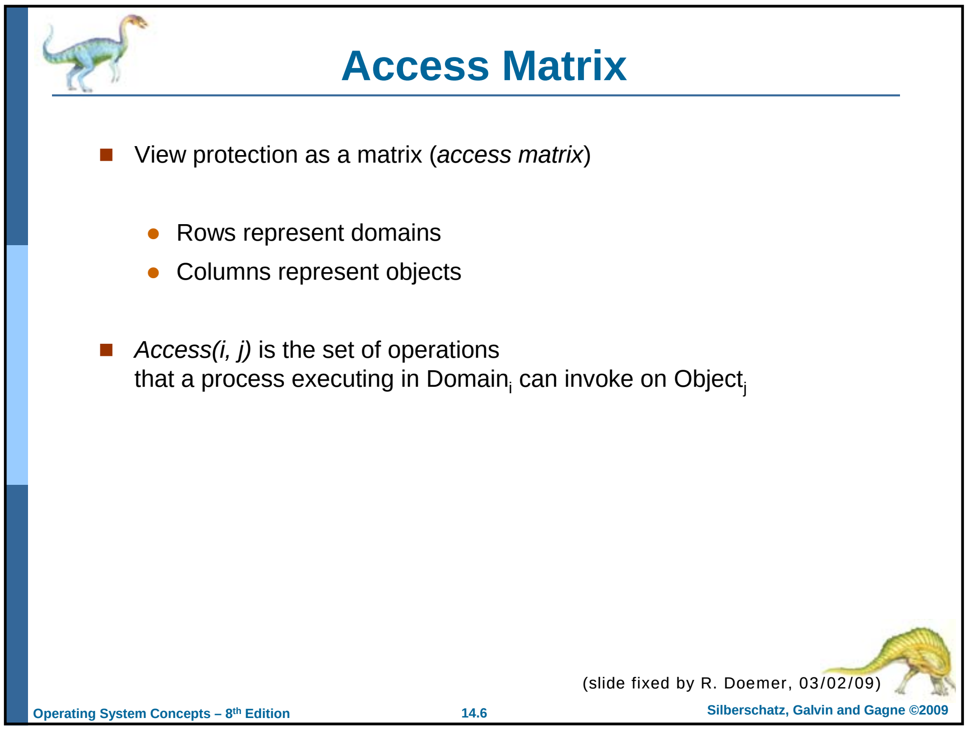




Domain Implementation (UNIX)

- System consists of 2 domains:
  - User
  - Supervisor
- UNIX
  - Domain = user-id
  - Domain switch accomplished via file system.
    - Each file has associated with it a domain bit (setuid bit).
    - When file is executed and setuid = on,
      then user-id is set to owner of the file being executed.
    - When execution completes user-id is reset.

(slide fixed by R. Doemer, 03/02/09)



Access Matrix

- View protection as a matrix (*access 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$_j$

(slide fixed by R. Doemer, 03/02/09)

Access Matrix

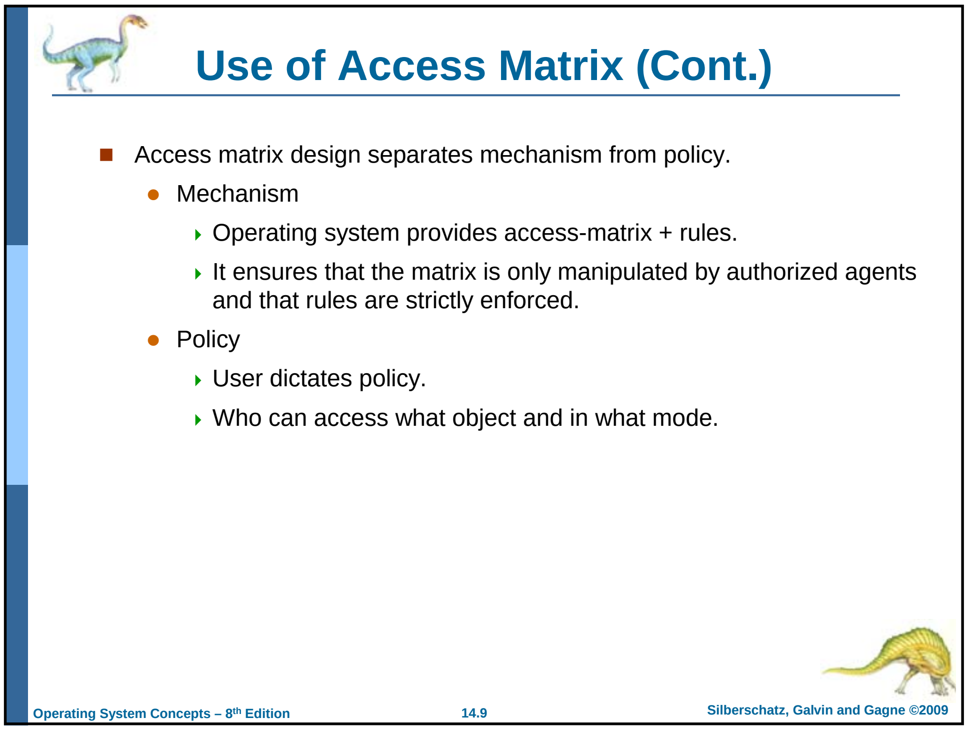
object / domain	F_1	F_2	F_3	printer
D_1	read		read	
D_2				print
D_3		read	execute	
D_4	read write		read write	

Simple access matrix example

(slide fixed by R. Doemer, 03/02/09)

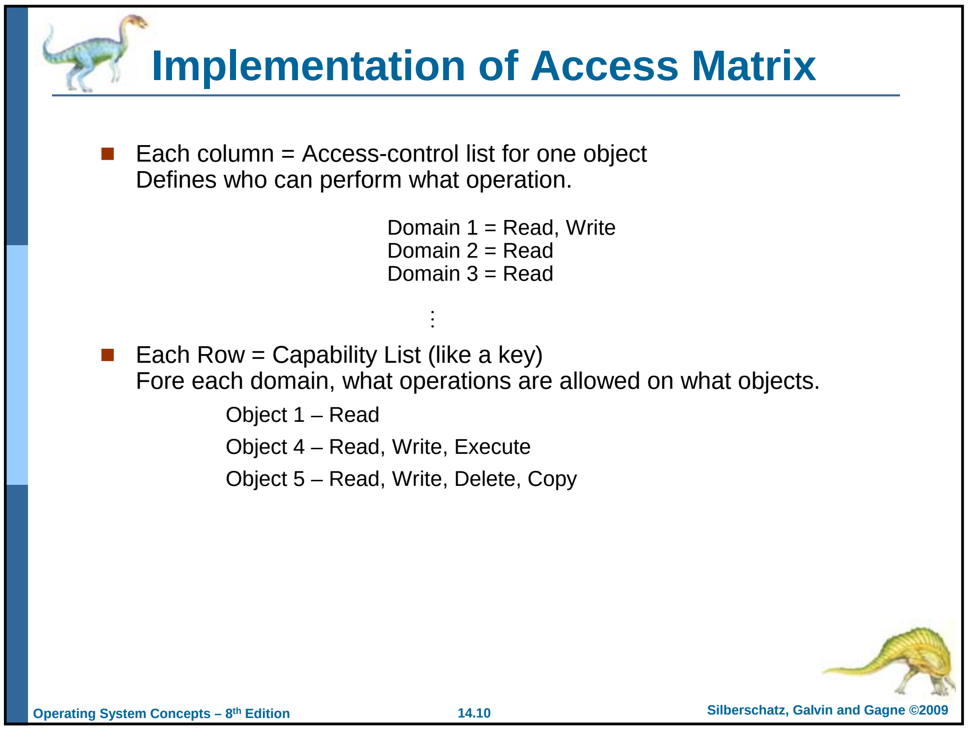
Use of Access Matrix

- If a process in Domain D_i tries to do "op" on object O_j, then "op" must be in the access matrix.
- Can be expanded to dynamic protection.
  - Operations to add, delete access rights.
  - Special access rights:
    - *owner of O_i*
    - *copy op from O_i to O_j*
    - *control – D_i can modify D_j access rights*
    - *transfer – switch from domain D_i to D_j*



Use of Access Matrix (Cont.)

- Access matrix design separates mechanism from policy.
  - Mechanism
    - Operating system provides access-matrix + rules.
    - It ensures that the matrix is only manipulated by authorized agents and that rules are strictly enforced.
  - Policy
    - User dictates policy.
    - Who can access what object and in what mode.



Implementation of Access Matrix

- Each column = Access-control list for one object
  Defines who can perform what operation.

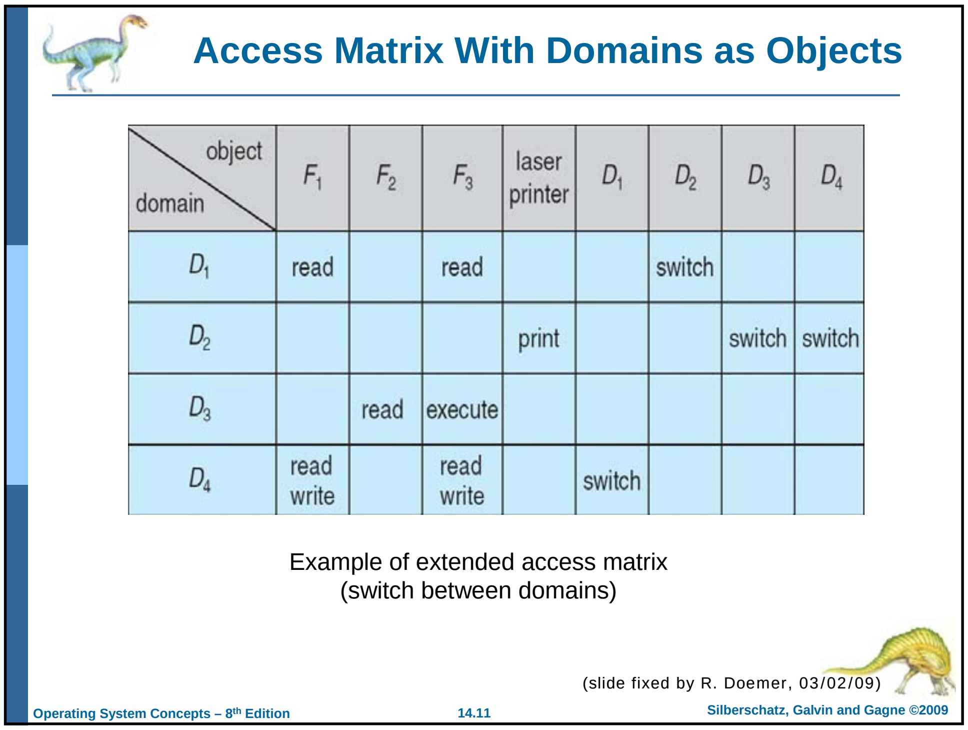
  Domain 1 = Read, Write
  Domain 2 = Read
  Domain 3 = Read

  ⋮
- Each Row = Capability List (like a key)
  Fore each domain, what operations are allowed on what objects.

  Object 1 – Read

  Object 4 – Read, Write, Execute

  Object 5 – Read, Write, Delete, Copy

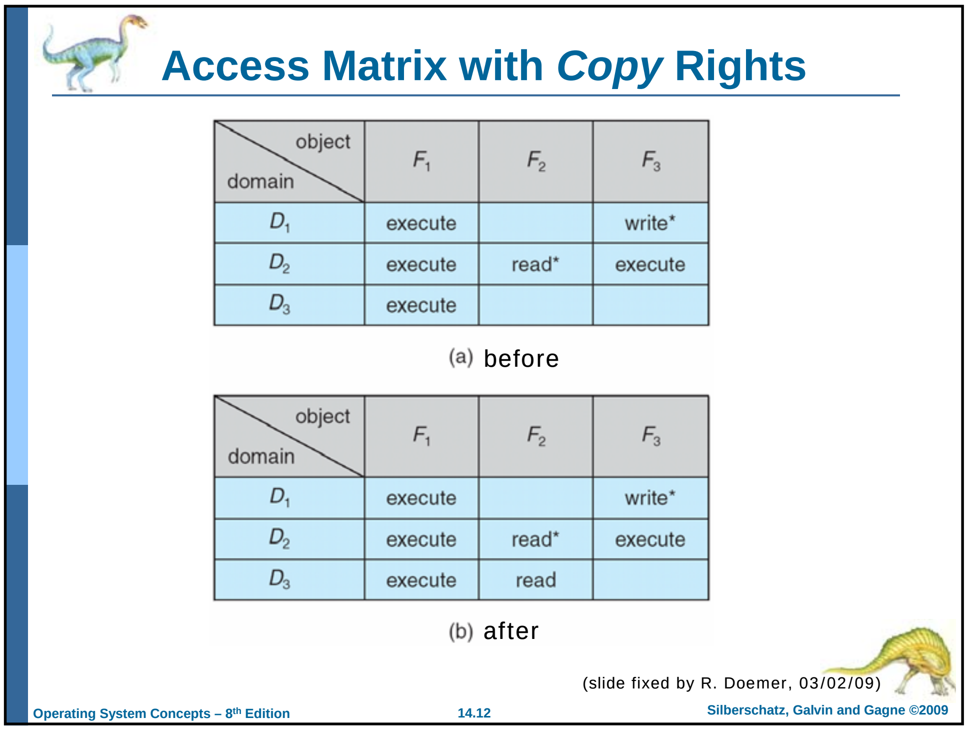


Access Matrix With Domains as Objects

object / domain	F_1	F_2	F_3	laser printer	D_1	D_2	D_3	D_4
D_1	read		read			switch		
D_2				print			switch	switch
D_3		read	execute					
D_4	read write		read write		switch			

Example of extended access matrix
(switch between domains)

(slide fixed by R. Doemer, 03/02/09)



Access Matrix with *Copy* Rights

object / domain	F_1	F_2	F_3
D_1	execute		write*
D_2	execute	read*	execute
D_3	execute		

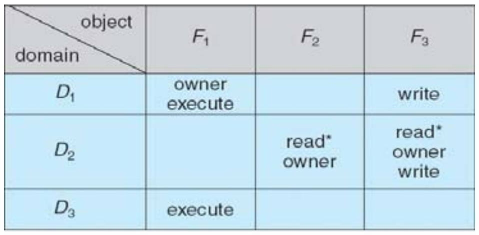
(a) before

object / domain	F_1	F_2	F_3
D_1	execute		write*
D_2	execute	read*	execute
D_3	execute	read	

(b) after

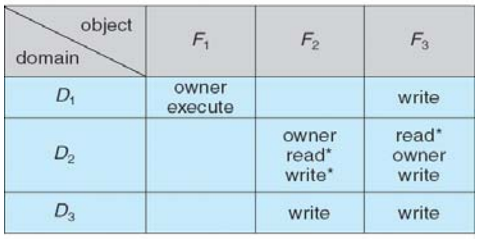
(slide fixed by R. Doemer, 03/02/09)

Access Matrix With *Owner* Rights



domain \ object	F_1	F_2	F_3
D_1	owner execute		write
D_2		read* owner	read* owner write
D_3	execute		

(a) before



domain \ object	F_1	F_2	F_3
D_1	owner execute		write
D_2		owner read* write*	read* owner write
D_3		write	write

(b) after

(slide fixed by R. Doemer, 03/02/09)

Revocation of Access Rights

- *Access List* –
  Delete access rights from access list.
  - Simple
  - Immediate
- *Capability List* –
  Scheme required to locate capability in the system before it can be revoked.
  - Reacquisition
  - Back-pointers
  - Indirection
  - Keys

(slide fixed by R. Doemer, 03/02/09)

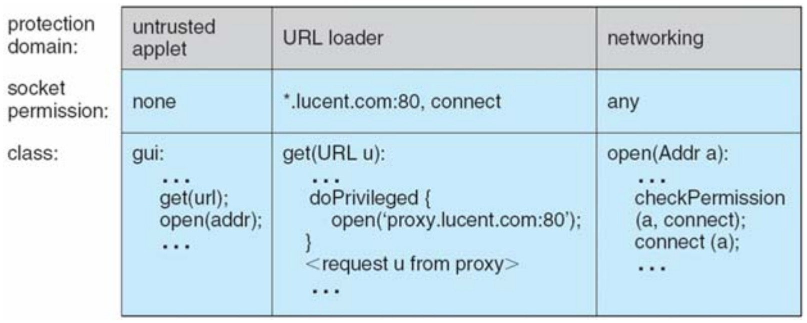
Language-Based Protection

- Specification of protection in a programming language allows the high-level description of policies for the allocation and use of resources.
- Language implementation can provide software for protection enforcement when automatic hardware-supported checking is unavailable.
- Interpret protection specifications to generate calls on whatever protection system is provided by the hardware and the operating system.

Protection in Java 2

- Protection is handled by the Java Virtual Machine (JVM)
- 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 to ensure the operation can be performed by the library.

Stack Inspection



protection domain:	untrusted applet	URL loader	networking
socket permission:	none	*.lucent.com:80, connect	any

class:	gui:
	…
	get(url);
	open(addr);
	…
		get(URL u):
		…
		doPrivileged {
		open('proxy.lucent.com:80');
		}
		<request u from proxy>
		…
			open(Addr a):
			…
			checkPermission
			(a, connect);
			connect (a);
			…

End of Chapter 14