

ECS 235B Module 4

Access Control Matrix

Description

		objects (entities)					
		O_1	...	O_m	S_1	...	S_n
subjects	s_1						
	s_2						
	...						
	s_n						

- Subjects $S = \{ s_1, \dots, s_n \}$
- Objects $O = \{ o_1, \dots, o_m \}$
- Rights $R = \{ r_1, \dots, r_k \}$
- Entries $A[s_i, o_j] \subseteq R$
- $A[s_i, o_j] = \{ r_x, \dots, r_y \}$ means subject s_i has rights r_x, \dots, r_y over object o_j

Example 1

- Processes p, q
- Files f, g
- Rights r, w, x, a, o

	f	g	p	q
p	rwo	r	$rwxo$	w
q	a	ro	r	$rwxo$

Example 2

- Host names *telegraph*, *nob*, *toadflax*
- Rights *own*, *ftp*, *nfs*, *mail*

	<i>telegraph</i>	<i>nob</i>	<i>toadflax</i>
<i>telegraph</i>	<i>own</i>	<i>ftp</i>	<i>ftp</i>
<i>nob</i>		<i>ftp, mail, nfs, own</i>	<i>ftp, nfs, mail</i>
<i>toadflax</i>		<i>ftp, mail</i>	<i>ftp, mail, nfs, own</i>

Example 3

- Procedures *inc_ctr*, *dec_ctr*, *manage*
- Variable *counter*
- Rights *+*, *−*, *call*

	<i>counter</i>	<i>inc_ctr</i>	<i>dec_ctr</i>	<i>manage</i>
<i>inc_ctr</i>	+			
<i>dec_ctr</i>	−			
<i>manager</i>		<i>call</i>	<i>call</i>	<i>call</i>

UNIX/Linux Access Controls

- Files
 - A is ~bishop/a.out (0755, or rwxr-xr-x)
 - B is /etc/passwd (0644, or rw-r--r--)
 - H is /home/bishop (0711, or rwx--x--x)
 - S is /bin/su (4711, or s--rwx--x--x)

	<i>A</i>	<i>B</i>	<i>S</i>	<i>H</i>
<i>bishop</i>	<i>rwxo</i>	<i>r</i>	<i>x</i>	<i>rwxo</i>
<i>zheng</i>	<i>rx</i>	<i>r</i>	<i>x</i>	<i>x</i>
<i>root</i>	<i>rwX</i>	<i>rwo</i>	<i>rwXO</i>	<i>rwX</i>

UNIX/Linux Access Controls

- Access control matrices are dynamic:
- After bishop executes `chmod 700 /home/bishop`:
 - Same as `chmod u=rwx,g-rwx,o-rwx /home/bishop`

	<i>A</i>	<i>B</i>	<i>S</i>	<i>H</i>
<i>bishop</i>	<i>rwxo</i>	<i>r</i>	<i>x</i>	<i>rwxo</i>
<i>muwei</i>		<i>rx</i>		
<i>root</i>	<i>rwX</i>	<i>rwo</i>	<i>rwXo</i>	<i>rwX</i>

Boolean Expression Evaluation

- ACM controls access to database fields
 - Subjects have attributes
 - Verbs define type of access
 - Rules associated with objects, verb pair
- Subject attempts to access object
 - Rule for object, verb evaluated, grants or denies access

Example

- Subject annie
 - Attributes *role* (artist), *group* (creative)
- Verb paint
 - Default 0 (deny unless explicitly granted)
- Object picture
 - Rule:
paint: 'artist' in subject.role and
 'creative' in subject.groups and
 time.hour ≥ 0 and time.hour ≤ 4

ACM at 3AM and 10AM

At 3AM, time condition met
ACM is:

... picture ...

...	annie ...			
		paint		

At 10AM, time condition not met
ACM is:

... picture ...

...	annie ...			

History

- Problem: what a process has accessed may affect what it can access now
- Example: procedure in a web applet can access other procedures depending on what procedures it has already accessed
 - S set of *static rights* associated with procedure
 - C set of *current rights* associated with each executing process
 - When process calls procedure, rights are $S \cap C$

Example Program

```
// This routine has no filesystem access rights  
// beyond those in a limited, temporary area
```

```
procedure helper_proc()  
    return sys_kernel_file
```

```
// But this has the right to delete files
```

```
program main()  
    sys_load_file(helper_proc)  
    tmp_file = helper_proc()  
    sys_delete_file(tmp_file)
```

- *sys_kernel_file* contains system kernel
- *tmp_file* is in limited area that *helper_proc()* can access

Before *helper_proc* Called

- Static rights of program

	<i>sys_kernel_file</i>	<i>tmp_file</i>
<i>main</i>	delete	delete
<i>helper_proc</i>		delete

- When program starts, current rights:

	<i>sys_kernel_file</i>	<i>tmp_file</i>
<i>main</i>	delete	delete
<i>helper_proc</i>		delete
<i>process</i>	delete	delete

After *helper_proc* Called

- Process rights are intersection of static, previous “current” rights:

	<i>sys_kernel_file</i>	<i>tmp_file</i>
<i>main</i>	delete	delete
<i>helper_proc</i>		delete
<i>process</i>		delete

State Transitions

- Change the protection state of system
- \vdash represents transition
 - $X_i \vdash_{\tau} X_{i+1}$: command τ moves system from state X_i to X_{i+1}
 - $X_i \vdash^* Y$: a sequence of commands moves system from state X_i to Y
- Commands often called *transformation procedures*

Primitive Operations

- **create subject s ; create object o**
 - Creates new row, column in ACM; creates new column in ACM
- **destroy subject s ; destroy object o**
 - Deletes row, column from ACM; deletes column from ACM
- **enter r into $A[s, o]$**
 - Adds r rights for subject s over object o
- **delete r from $A[s, o]$**
 - Removes r rights from subject s over object o

Create Subject

- Precondition: $s \notin S$
- Primitive command: **create subject s**
- Postconditions:
 - $S' = S \cup \{s\}, O' = O \cup \{s\}$
 - $(\forall y \in O') [A'[s, y] = \emptyset], (\forall x \in S') [A'[x, s] = \emptyset]$
 - $(\forall x \in S)(\forall y \in O) [A'[x, y] = A[x, y]]$

Create Object

- Precondition: $o \notin O$
- Primitive command: **create object** o
- Postconditions:
 - $S' = S, O' = O \cup \{ o \}$
 - $(\forall x \in S') [A'[x, o] = \emptyset]$
 - $(\forall x \in S)(\forall y \in O) [A'[x, y] = A[x, y]]$

Add Right

- Precondition: $s \in S, o \in O$
- Primitive command: **enter r into $A[s, o]$**
- Postconditions:
 - $S' = S, O' = O$
 - $A'[s, o] = A[s, o] \cup \{ r \}$
 - $(\forall x \in S')(\forall y \in O' - \{ o \}) [A'[x, y] = A[x, y]]$
 - $(\forall x \in S' - \{ s \})(\forall y \in O') [A'[x, y] = A[x, y]]$

Delete Right

- Precondition: $s \in S, o \in O$
- Primitive command: **delete** r **from** $A[s, o]$
- Postconditions:
 - $S' = S, O' = O$
 - $A'[s, o] = A[s, o] - \{ r \}$
 - $(\forall x \in S')(\forall y \in O' - \{ o \}) [A'[x, y] = A[x, y]]$
 - $(\forall x \in S' - \{ s \})(\forall y \in O') [A'[x, y] = A[x, y]]$

Destroy Subject

- Precondition: $s \in S$
- Primitive command: **destroy subject s**
- Postconditions:
 - $S' = S - \{s\}, O' = O - \{s\}$
 - $(\forall y \in O') [A'[s, y] = \emptyset], (\forall x \in S') [A'[x, s] = \emptyset]$
 - $(\forall x \in S')(\forall y \in O') [A'[x, y] = A[x, y]]$

Destroy Object

- Precondition: $o \in O$
- Primitive command: **destroy object o**
- Postconditions:
 - $S' = S, O' = O - \{ o \}$
 - $(\forall x \in S') [A'[x, o] = \emptyset]$
 - $(\forall x \in S')(\forall y \in O') [A'[x, y] = A[x, y]]$

Creating File

- Process p creates file f with r and w permission

```
command create•file( $p$ ,  $f$ )  
    create object  $f$ ;  
    enter own into  $A[p, f]$ ;  
    enter  $r$  into  $A[p, f]$ ;  
    enter  $w$  into  $A[p, f]$ ;  
end
```

Mono-Operational Commands

- Make process p the owner of file g

```
command make-owner( $p$ ,  $g$ )  
    enter own into  $A[p, g]$ ;  
end
```

- Mono-operational command
 - Single primitive operation in this command

Conditional Commands

- Let p give q r rights over f , if p owns f
command $grant \cdot read \cdot file \cdot 1(p, f, q)$
 if own **in** $A[p, f]$
 then
 enter r **into** $A[q, f];$
 end
- Mono-conditional command
 - Single condition in this command

Biconditional Commands (and)

- Let p give q r and w rights over f , if p owns f and p has c rights over q

```
command grant•read•file•2( $p, f, q$ )  
    if own in  $A[p, f]$  and  $c$  in  $A[p, q]$   
    then  
        enter  $r$  into  $A[q, f]$  ;  
        enter  $w$  into  $A[q, f]$  ;  
end
```

There Is No “or”

- Let p give q r and w rights over f , if p owns f or p has c rights over q

```
command grant•read•file•3( $p, f, q$ )  
    if own in  $A[p, f]$   
    then  
        enter  $r$  into  $A[q, f];$   
        enter  $w$  into  $A[q, f];$   
end  
command grant•read•file•4( $p, f, q$ )  
    if  $c$  in  $A[p, q]$   
    then  
        enter  $r$  into  $A[q, f];$   
        enter  $w$  into  $A[q, f];$   
end  
grant•read•file•3( $p, f, q$ );  
grant•read•file•4( $p, f, q$ )
```

General Form

```
command name of command(parameters)  
    if conditions (if many, separate with and)  
    then  
        list of commands or primitive  
        operations to be executed;  
end
```

- Only one **if**, and it must come *before* any primitive operations or subcommands
- When there is an **if**, no commands may follow it (but there can be commands in the body of the **if**)
- There is no **else**

Copy Flag and Right

- Allows possessor to give rights to another
- Often attached to a right (called a *flag*), so only applies to that right
 - r is read right that cannot be copied
 - rc is read right that can be copied
- Is copy flag copied when giving r rights?
 - Depends on model, instantiation of model

Own Right

- Usually allows possessor to change entries in ACM column
 - So owner of object can add, delete rights for others
 - May depend on what system allows
 - Can't give rights to specific (set of) users
 - Can't pass copy flag to specific (set of) users

Attenuation of Privilege

- Principle says you can't increase your rights, or give rights you do not possess
 - Restricts addition of rights within a system
 - Usually *ignored* for owner
 - Why? Owner gives herself rights, gives them to others, deletes her rights.