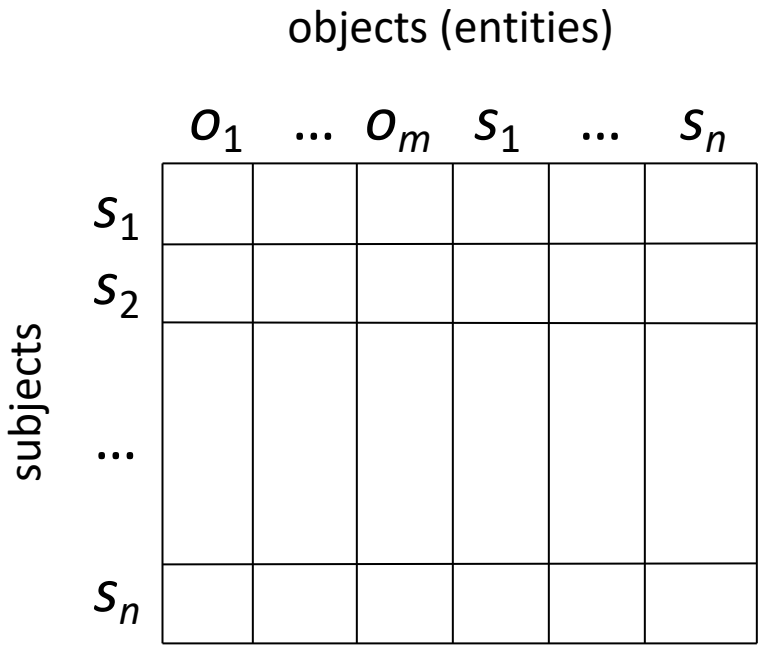
ECS 235B Module 4
Access Control Matrix

Description



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

	telegraph	*nob*	*toadflax*
telegraph	*own*	*ftp*	*ftp*
nob		*ftp, mail, nfs, own*	*ftp, nfs, mail*
toadflax		*ftp, mail*	*ftp, mail, nfs, own*

Example 3

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

	counter	*inc_ctr*	*dec_ctr*	*manage*
inc_ctr	+			
dec_ctr	–			
manager		*call*	*call*	*call*

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)

	A	*B*	*S*	*H*
bishop	*rwxo*	*r*	*x*	*rwxo*
zheng	*rx*	*r*	*x*	*x*
root	*rwx*	*rwo*	*rwxo*	*rwx*

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

	A	*B*	*S*	*H*
bishop	*rwxo*	*r*	*x*	*rwxo*
muwei		*r x*		
root	*rwx*	*rwo*	*rwxo*	*rwx*

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

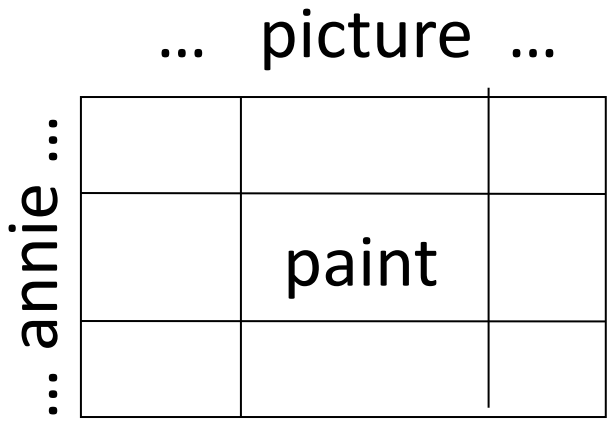
Example

- Subject annie
  - Attributes *role* (artist), *group* (creative)
- Verb paint
  - Default 0 (deny unless explicitly granted)
- Object picture
  - Rule:

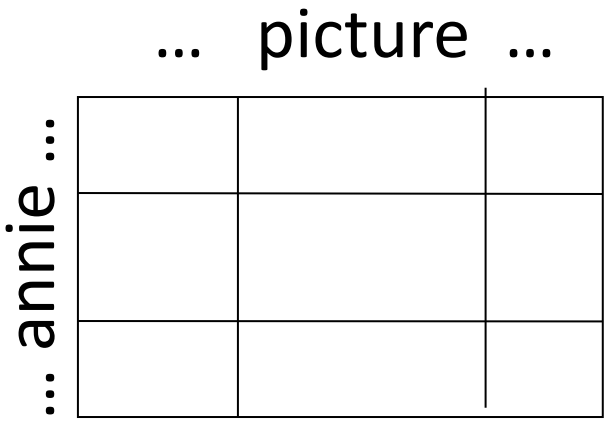
    paint: ‘artist’ in subject.role and
    ‘creative’ in subject.groups and
    time.hour ≥ 0 and time.hour ≤ 4

ACM at 3AM and 10AM

At 3AM, time condition met
ACM is:



At 10AM, time condition not met
ACM is:



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

	sys_kernel_file	*tmp_file*
main	delete	delete
helper_proc		delete

- When program starts, current rights:

	sys_kernel_file	*tmp_file*
main	delete	delete
helper_proc		delete
process	delete	delete

After *helper_proc* Called

- Process rights are intersection of static, previous "current" rights:

	sys_kernel_file	*tmp_file*
main	delete	delete
helper_proc		delete
process		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:
  - $S' = S \cup \{ s \}$, $O' = O \cup \{ s \}$
  - $(\forall y \in O')\ [A'[s, y] = \varnothing]$, $(\forall x \in S')\ [A'[x, s] = \varnothing]$
  - $(\forall x \in S)(\forall y \in O)\ [A'[x, y] = A[x, y]]$

Create Object

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

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:
  - $S' = S - \{ s \}$, $O' = O - \{ s \}$
  - $(\forall y \in O')\ [A'[s, y] = \varnothing]$, $(\forall x \in S')\ [A'[x, s] = \varnothing]$
  - $(\forall x \in S')(\forall y \in O')\ [A'[x, y] = A[x, y]]$

Destroy Object

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

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•read•file•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.