Access Control for Enterprise Apps

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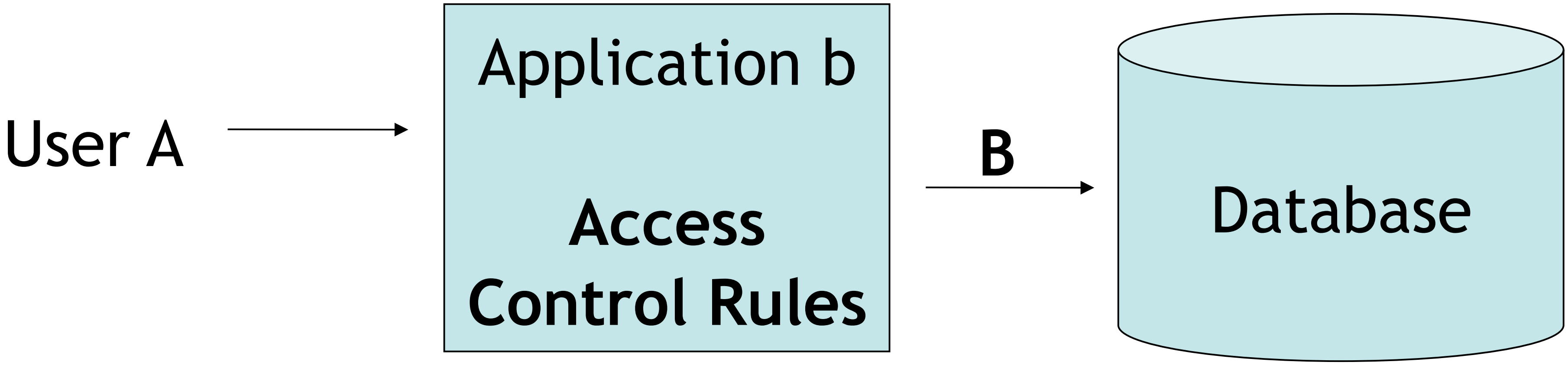
Based on material by Lars Olson and Ross Anderson

SQL ACCESS CONTROL

App vs Database Security

- Multiple users for Apps (A)
- Apps have elevated privileges (B)



SQL grant Syntax

```
grant privilege_list on resource
  to user_list;
```

- Privileges: select, insert, etc.
- Resource: table, database, function, etc.
- Individual users
- User group

Griffiths Wade 76

Example

- Alice owns a database table of employees:
  - `name varchar(50),`
  - `ssn int,`
  - `salary int,`
  - `email varchar(50)`

Example

- Bob: read-only access

```
grant select on employee to bob;
```

- Carol: read-only access to public info

```
grant select (name, email)
  on employee to carol;
```

  - not implemented in PostgreSQL
  - not implemented for select in Oracle
  - implemented in MySQL

View-Based Access Control

- Carol: read-only access to public info

```
create view employee_public
  as select name,email
  from employee;

grant select
  on employee_public to carol;
```

Row-Level Access Control

- Employees can access their own record:

```
create view employee_Carol as
  select * from employee
  where name='Carol';
grant select on employee_Carol to carol;
```

- Employees can update their e-mail addresses:

```
grant update(email)
  on employee_Carol to carol;
```

  – (Or create yet another new view…)

Delegating Policy Authority

```
grant privilege_list on resource to
  user_list with grant option;
```

- Alice:

```
grant select on table1 to bob
  with grant option;
```

- Bob:

```
grant select(column1) on table1 to carol
  with grant option;
```

SQL revoke Syntax

```
revoke privilege_list on resource
  from user_list;
```

- Griffiths-Wade:
  - Sequences of **`grant`** / **`revoke`** operations
  - ACLs should be indistinguishable from a sequence in which the grant never occurred
  - Cascading revocations

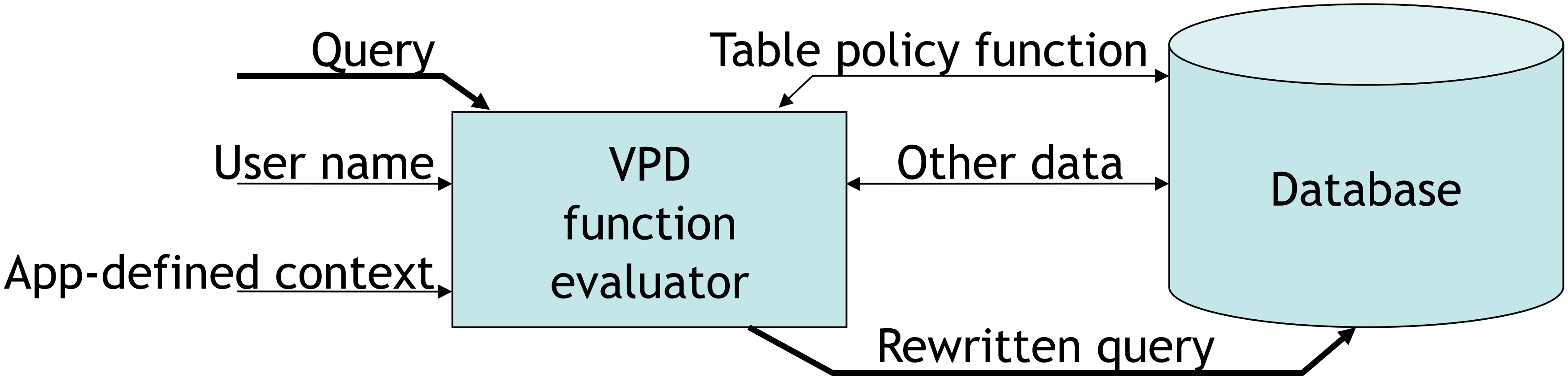
Disadvantages to SQL Model

- Too many views to create
  - Many users, each with their own view
  - View redefinitions
  - Fine-grained policies each require own view
  - Complicated policy logic
  - Update anomalies

VIRTUAL PRIVATE DATABASES

Virtual Private Databases

- Security model for Oracle
- Policies: user-defined functions that return `where` condition
- Applications can define "context," *e.g.* for RBAC



Oracle 05

Features

- Functions executed each time table is accessed.
- Multiple functions can be attached to a table.
- Different functions can be defined depending on:
  - Operation (read *vs.* write)
  - Columns being accessed

Simple Policy

- Two users, Alice and Bob
- Alice creates a table:

```
create table data(
  a int primary key,
  b varchar2(50));
insert into data values(1, 'hello');
insert into data values(2, 'world');
commit;
```

- Alice wants to limit Bob’s access to the row where a=1

Simple Policy

- Alice wants to limit Bob's access to the row where a=1

- Three steps:
  - Grant Bob access to the table:

    ```
    grant select on data to bob;
    ```
  - Create a policy function
  - Attach the policy function to the table

Simple Policy

```
create or replace function testFilter
  (p_schema varchar2, p_obj varchar2)
return varchar2 as
begin
  if (SYS_CONTEXT('userenv', 'SESSION_USER')
           = 'BOB') then
     return 'a = 1';
  else
     return '';
  end if;
end;
```

Simple Policy

```
execute dbms_rls.add_policy(
  object_schema => 'alice',
  object_name => ’data',
  policy_name => 'FilterForBob’,
  function_schema => 'alice',
  policy_function => 'testFilter',
  statement_types => 'select, update,
  insert’,
  update_check => true);
```

Logging Policy

```
create or replace function
  testLogging(p_schema varchar2, p_obj varchar2)
return varchar2 as
begin
  insert into alice.logtable values(
      sysdate,
      SYS_CONTEXT('userenv', 'SESSION_USER')
            || ',' ||
            SYS_CONTEXT('userenv', 'CURRENT_SQL'));
  commit;
  return '';
end;
/
```

Reflective Policy

- Table for policy (for table **data**)

```
create table userperms (
 username varchar2(50),
 a int references data);
```

- Populate the table:

```
insert into userperms values('BOB', 1);
insert into userperms values('ALICE', 1);
insert into userperms values('ALICE', 2);
commit;
```

Reflective Policy

```
create or replace function testFilter(
  p_schema varchar2, p_obj varchar2)
return varchar2 as
begin
  return 'a in (select a from alice.userperms '
      || 'where username = '''
      || SYS_CONTEXT('userenv', 'SESSION_USER')
      || ''')';
end;
/
```

Fine-Grained Access Control

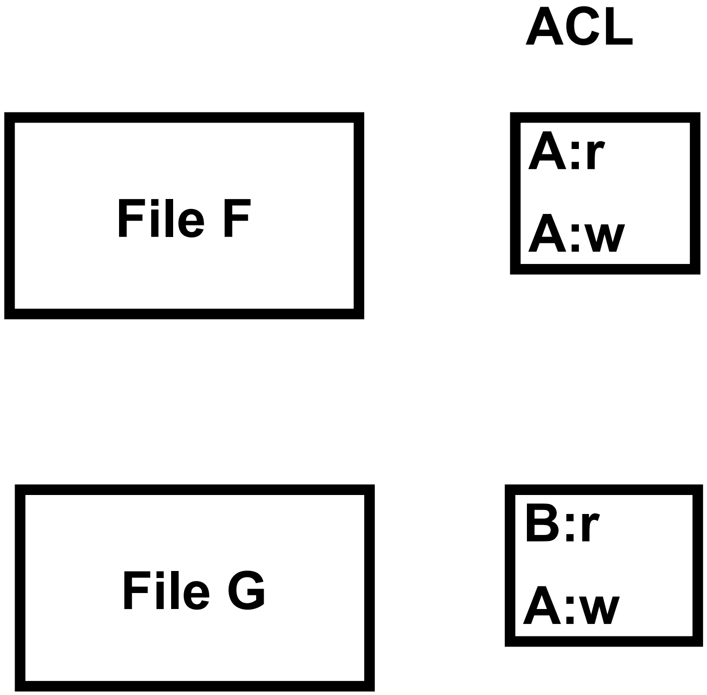
- Predicated grants

```
grant select on employee
  where (empid = userId())
  to public
```

- VPD through app server filtering?
  - http://mattfleming.com/node/243

BEYOND ACCESS CONTROL

Trojan Horse



ACL

File F

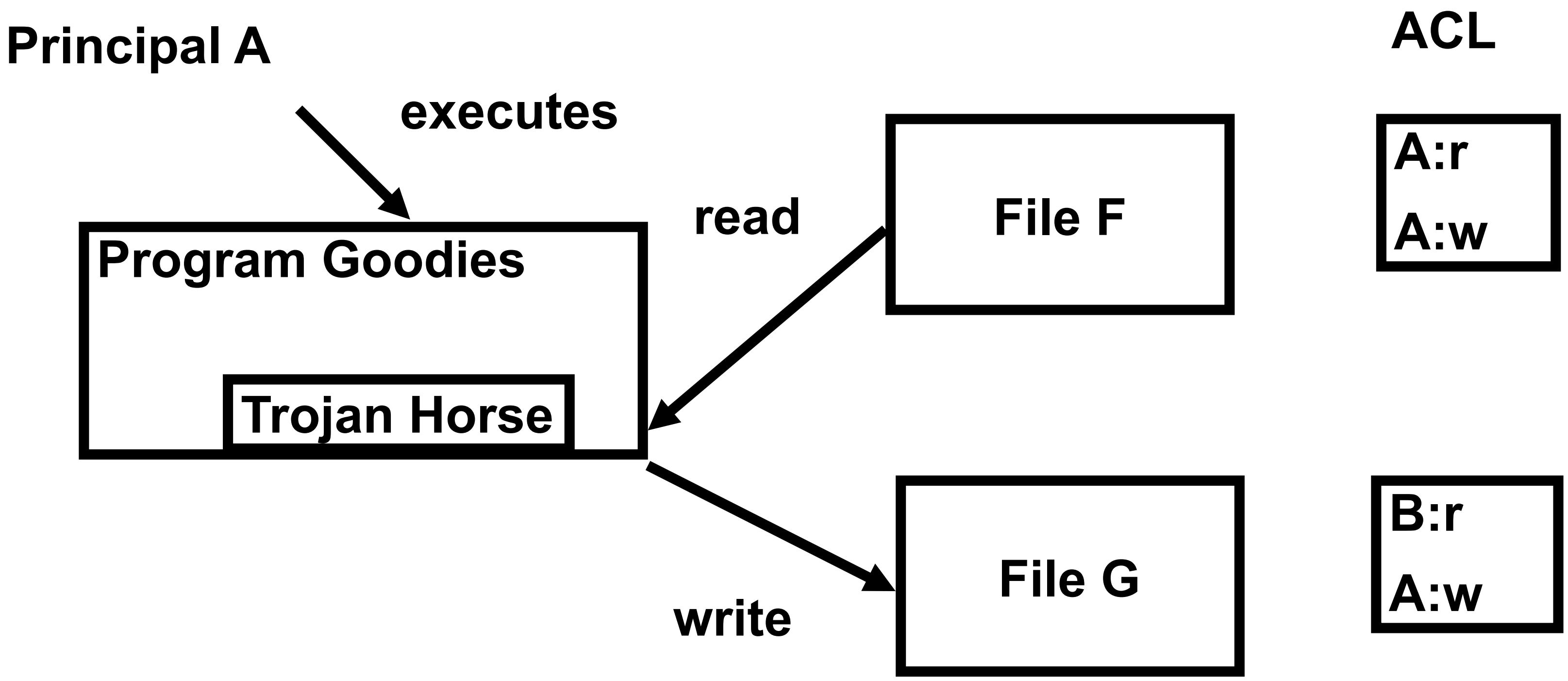
A:r
A:w

File G

B:r
A:w

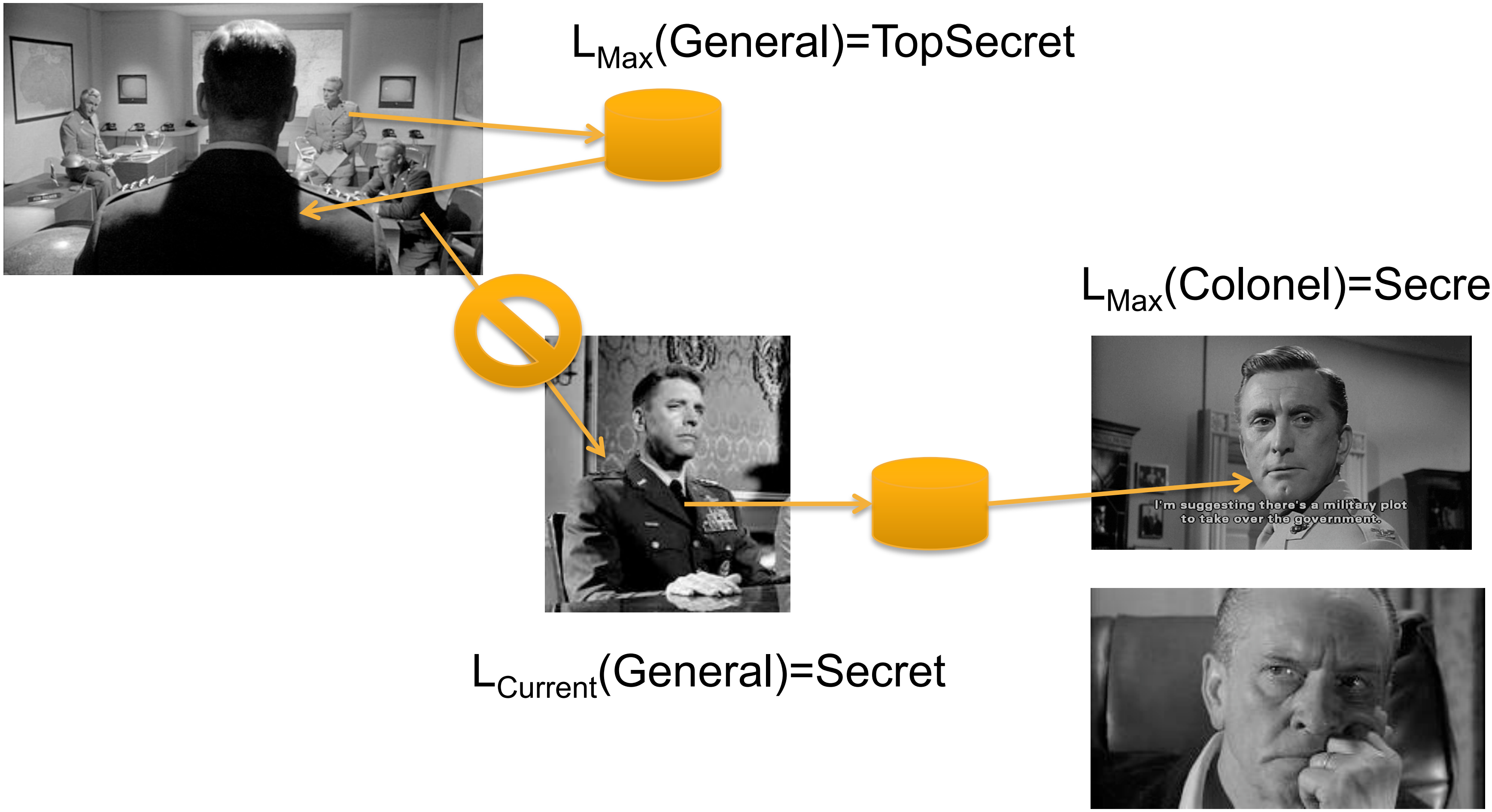
Principal B cannot read file F

Trojan Horse



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

MLS (Bell-Lapadula)


I'm suggesting there's a military plot
to take over the government.

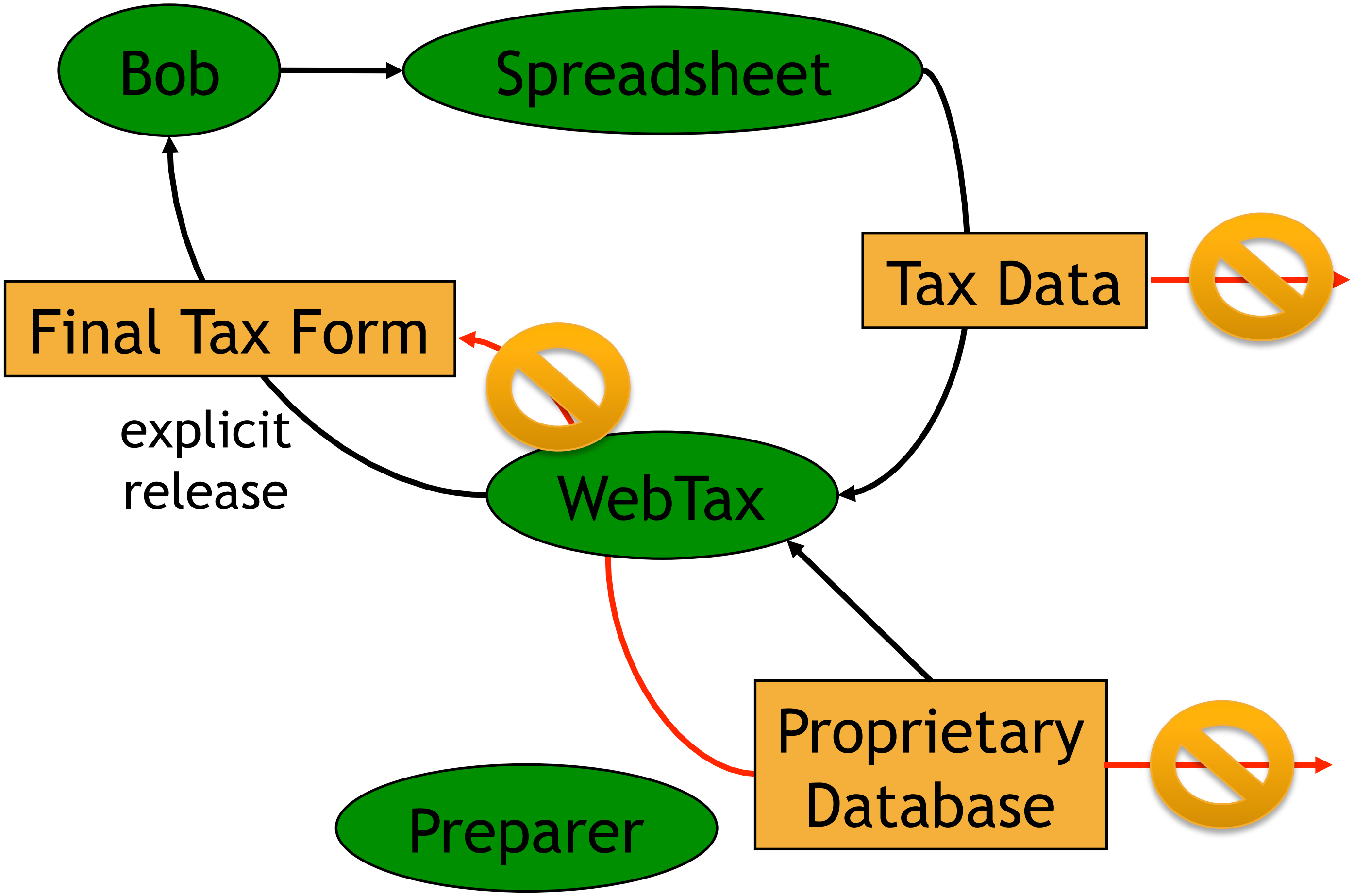
L_{Max}(General)=TopSecret

L_{Max}(Colonel)=Secret

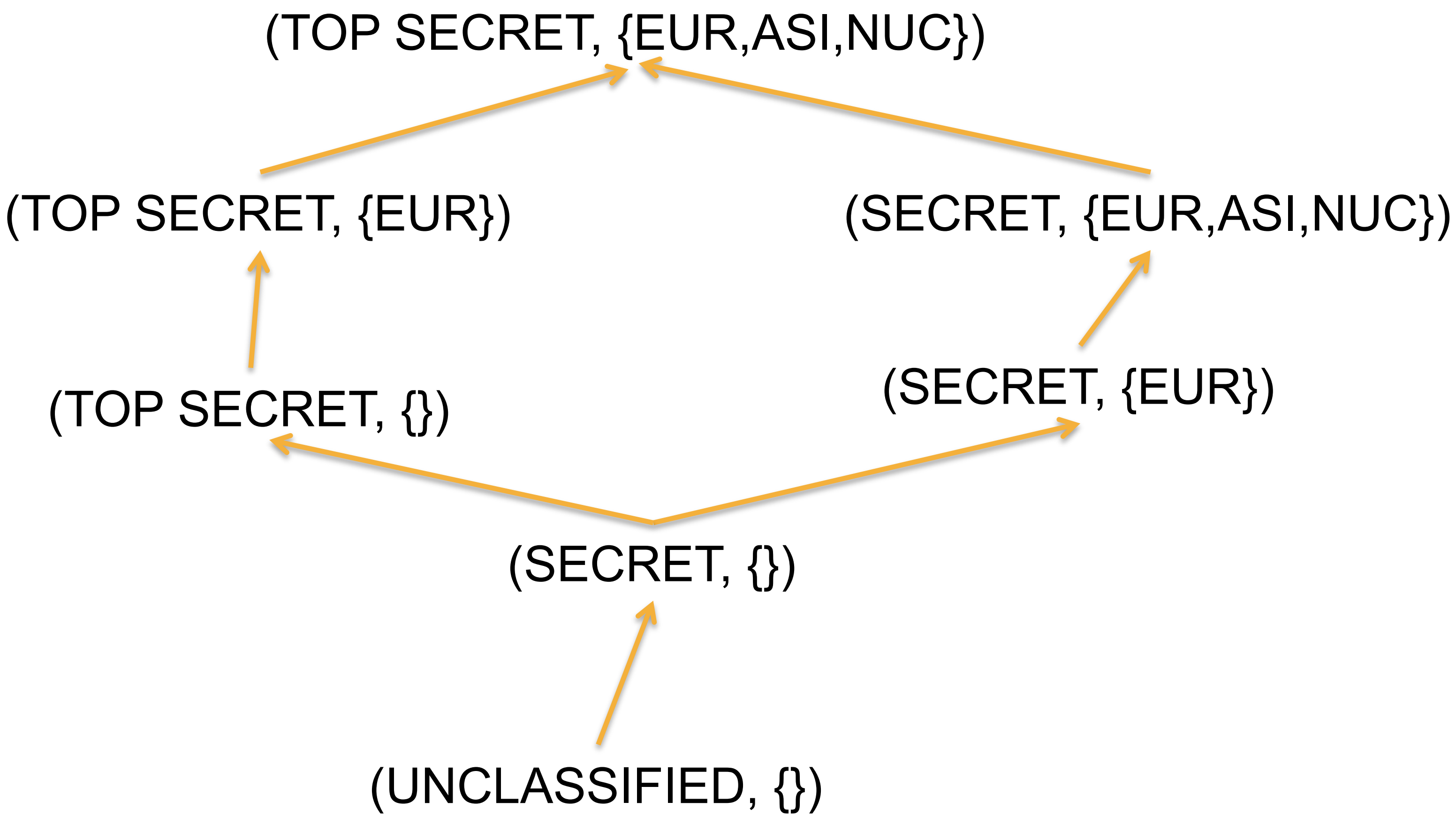
$L_{Current}$(General)=Secret

L_{Max}(President)=Classified

Declassification: Intentional Leaks



Multi-Level and Multi-Lateral



(TOP SECRET, {EUR,ASI,NUC})

(TOP SECRET, {EUR})

(SECRET, {EUR,ASI,NUC})

(TOP SECRET, {})

(SECRET, {EUR})

(SECRET, {})

(UNCLASSIFIED, {})

Clark-Wilson

- Principles for data integrity
  - Only access data through well-formed transactions
    - E.g. double-entry book-keeping (financial)
    - E.g. audit log (HPPA)
  - Separation of duties

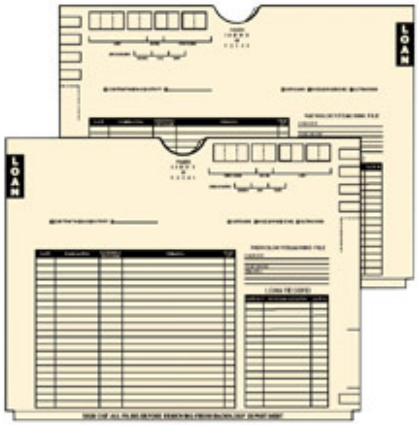
- Policy triples (S, TP, CDI)
  - S = subject
  - TP = transformation procedure
  - CDI = constrained data item

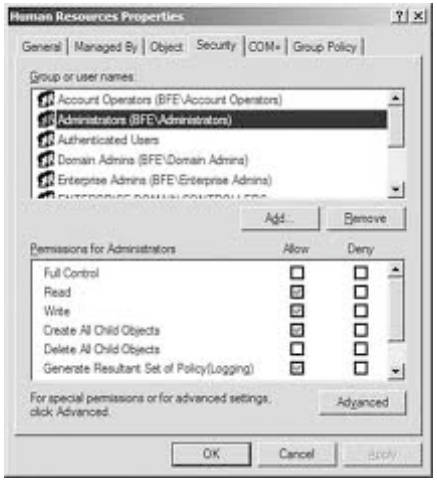
BMA Security Model

- Decentralized
  - Patient record = the maximum set of health information with a single access control list
  - "Peer-to-peer" alternative to centralized databases

BMA Principle #1

- Access Control
  - Each identifiable record is marked with an ACL naming the people or groups of people who may read it and append data to it





Group or user names:

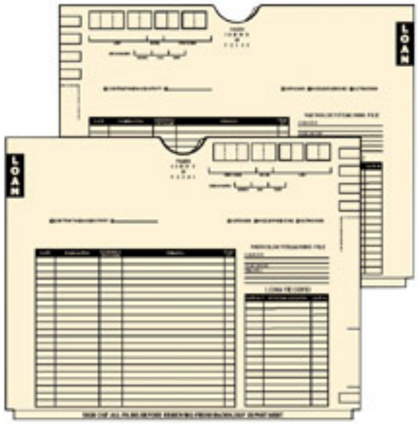
- Account Operators (BFE\Account Operators)
- Administrators (BFE\Administrators)
- Authenticated Users
- Domain Admins (BFE\Domain Admins)
- Enterprise Admins (BFE\Enterprise Admins)

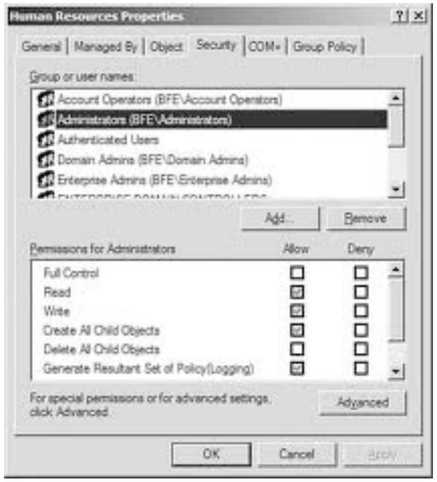
Permissions for Administrators	Allow	Deny
Full Control	□	□
Read	☑	□
Write	☑	□
Create All Child Objects	☑	□
Delete All Child Objects	□	□
Generate Resultant Set of Policy(Logging)	☑	□

For special permissions or for advanced settings, click Advanced.

BMA Principle #2

- Record Opening
  - Clinician can open a record with herself and patient on the ACL.
  - Where patient referred, can open record with herself, patient and referring clinician on ACL





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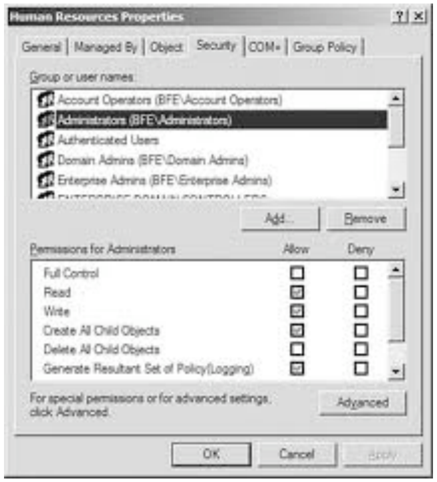
Create All Child Objects	☑	□
Delete All Child Objects	□	□
Generate Resultant Set of Policy(Logging)	☑	□

For special permissions or for advanced settings, click Advanced.

BMA Principle #3

- Designated Control
  - One of the clinicians on the ACL must be marked as being responsible
  - Only she may alter the ACL
  - Only health professionals should be added to ACL



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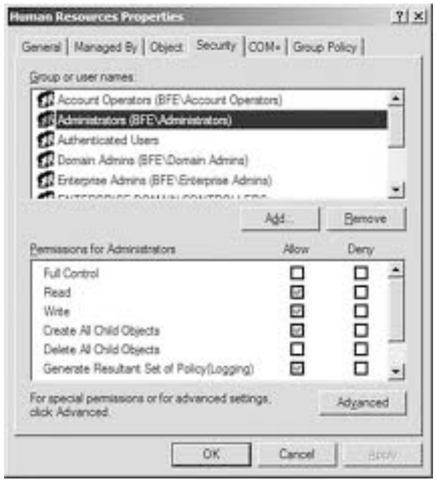
Permissions for Administrators	Allow	Deny
Full Control	□	□
Read	☑	□
Write	☑	□
Create All Child Objects	☑	□
Delete All Child Objects	□	□
Generate Resultant Set of Policy(Logging)	☑	□

For special permissions or for advanced settings, click Advanced.

BMA Principle #4

- Consent and notification
  - Responsible clinician must notify the patient
    - of the names on his record's ACL when it is opened,
    - of all additions to ACL and
    - whenever responsibility is transferred



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Permissions for Administrators	Allow	Deny
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Read	☑	□
Write	☑	□
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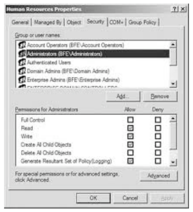
For special permissions or for advanced settings, click Advanced.

BMA Policy



Human Resources Properties

General | Managed By | Object | Security | COM+ | Group Policy

Group or user names:

- Account Operators (BFE\Account Operators)
- Administrators (BFE\Administrators)
- Authenticated Users
- Domain Admins (BFE\Domain Admins)
- Enterprise Admins (BFE\Enterprise Admins)

Add... | Remove

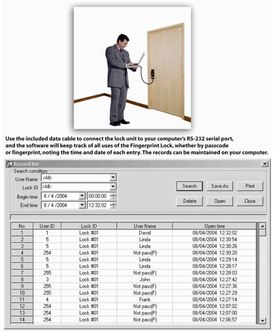
Permissions for Administrators	Allow	Deny
Full Control	□	□
Read	☑	□
Write	☑	□
Create All Child Objects	☑	□
Delete All Child Objects	□	□
Generate Resultant Set of Policy(Logging)	☑	□

For special permissions or for advanced settings, click Advanced.

Advanced

OK | Cancel | Apply

- Access control
- Record opening
- Designated control
- Consent and notification
- Persistence
- Attribution
- Information flow
- Aggregation control
- Trusted computing base



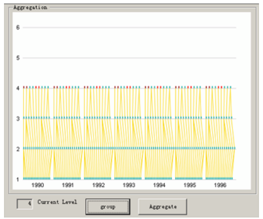
Use the included data cable to connect the lock unit to your computer's RS-232 serial port, and the software will keep track of all uses of the Fingerprint Lock, whether by passcode or fingerprint, noting the time and date of each entry. The records can be maintained on your computer.

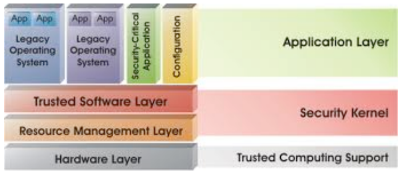
Record list

Search condition
User Name <All>
Lock ID <All>
Begin time 8 / 4 /2004 00:00:00
End time 8 / 4 /2004 12:32:02

Search | Save As | Print
Delete | Open | Close

No.	User ID	Lock ID	User Name	Open time
1	1	Lock #01	David	08/04/2004 12:32:02
2	5	Lock #01	Linda	08/04/2004 12:30:54
3	5	Lock #01	Linda	08/04/2004 12:30:26
4	254	Lock #01	Not pass(P)	08/04/2004 12:30:20
5	5	Lock #01	Linda	08/04/2004 12:29:14
6	5	Lock #01	Linda	08/04/2004 12:28:17
7	255	Lock #01	Not pass(F)	08/04/2004 12:28:03
8	3	Lock #01	John	08/04/2004 12:27:42
9	255	Lock #01	Not pass(F)	08/04/2004 12:27:36
10	255	Lock #01	Not pass(F)	08/04/2004 12:27:29
11	4	Lock #01	Frank	08/04/2004 12:27:14
12	254	Lock #01	Not pass(P)	08/04/2004 12:07:02
13	254	Lock #01	Not pass(P)	08/04/2004 12:07:00
14	254	Lock #01	Not pass(P)	08/04/2004 12:06:57

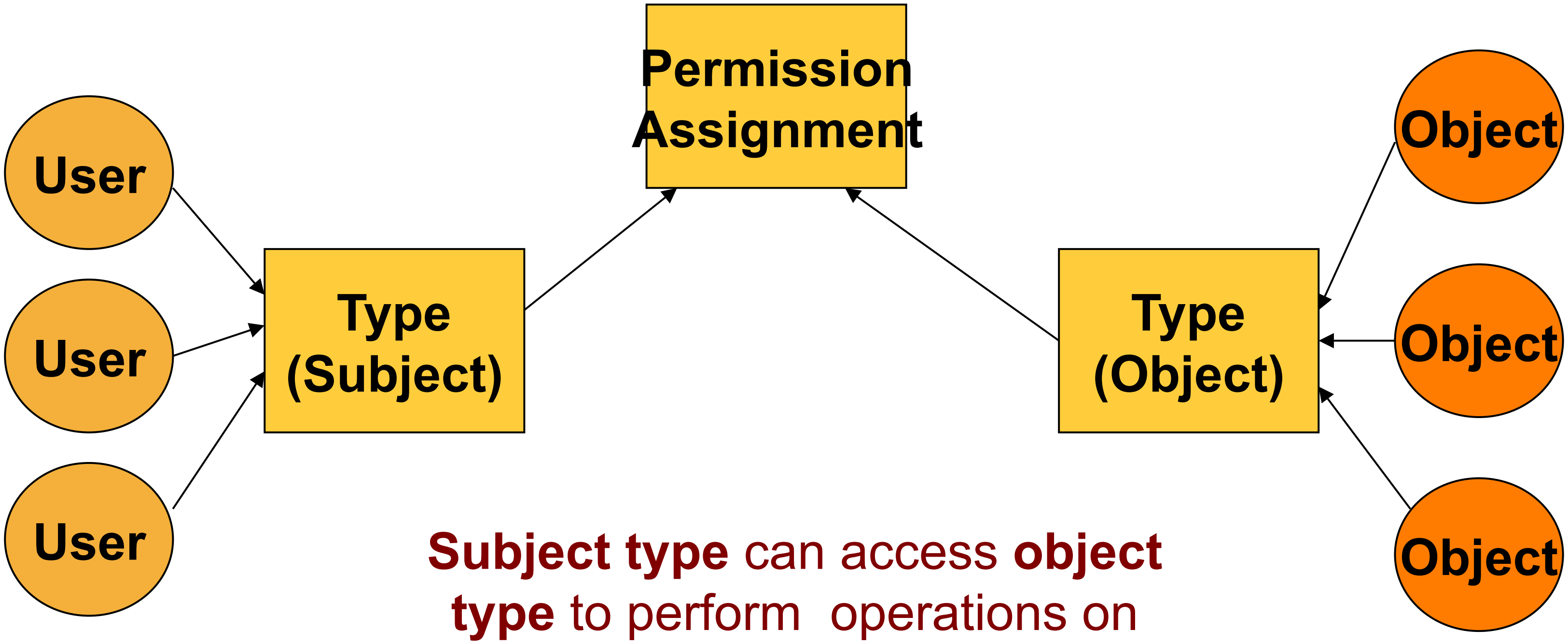




Relationship-Based Access Control (ReBAC)

- RBAC: Policies are sets
  - “Who are you?”
- ReBAC: Policies are relations
  - “Who do you know?”
- Scenario: Temporary access for consultation

Type Enforcement (SELinux)

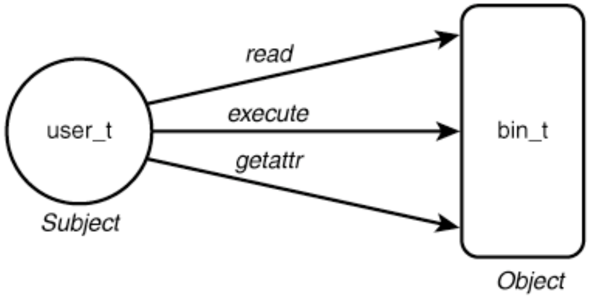


Subject type can access **object type** to perform operations on **objects**

Type Enforcement Access Control

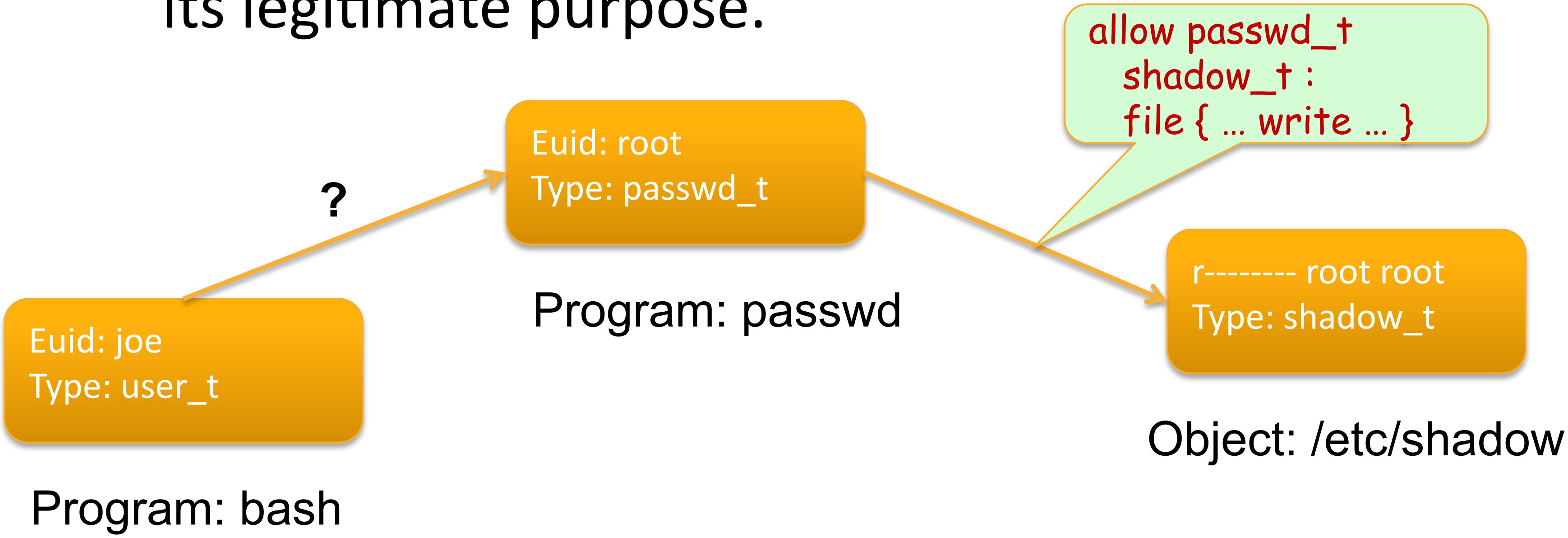
- All accesses must be explicitly granted in policy
- "Allow" rules specify:
  - Source type (domain type of process)
  - Target type (object type being accessed)
  - Object class
  - Permissions
- Example:

  allow user_t bin_t : file {read



Domain Transitions

- **Principle of Least Privilege:**
  - Any process must be able to access only such information and resources that are necessary to its legitimate purpose.



Conclusions

- Security is hard