



Protection and Security

An overview of basic principles

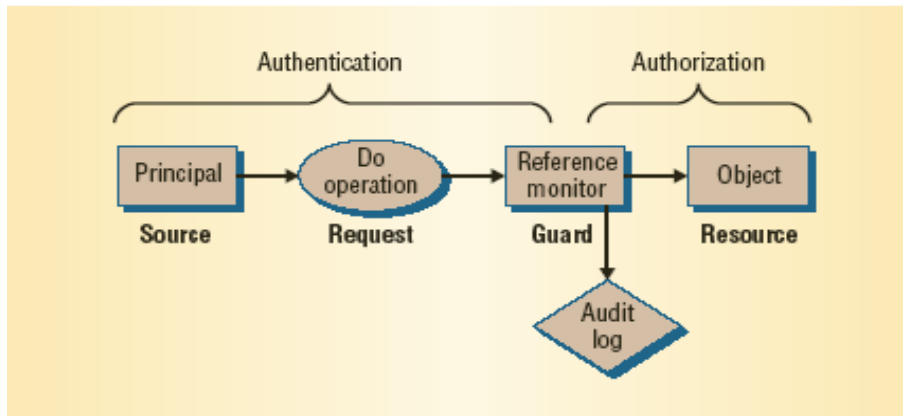
Protection and Security

Issues:

authentication: verifying a claim of identity

authorization: verifying a claim of permission

audit: verifying the (non)occurrence of previous actions



- **A**uthentication
- **A**uthorization
- **A**udit

(**Au** = gold)

aka: AAA

Reference Monitor Model

From: "Computer Security in the Real World", Lampson, 2004.

Security Goals and Principles

Goals:

- integrity - modification only by authorized parties
- confidentiality - access only by authorized parties
- non-repudiation - inability to disclaim authorship
- authenticity - verifiability of source
- availability - continuous access by authorized parties

Principles:

- least privilege - minimization of rights
- separation of duties (by task, by person)
- economy of mechanism - simplest means of enforcement
- acceptability – adoptable/usable by user community
- complete mediation - universal enforcement of control
- open design - secrecy of enforcement mechanisms is not important

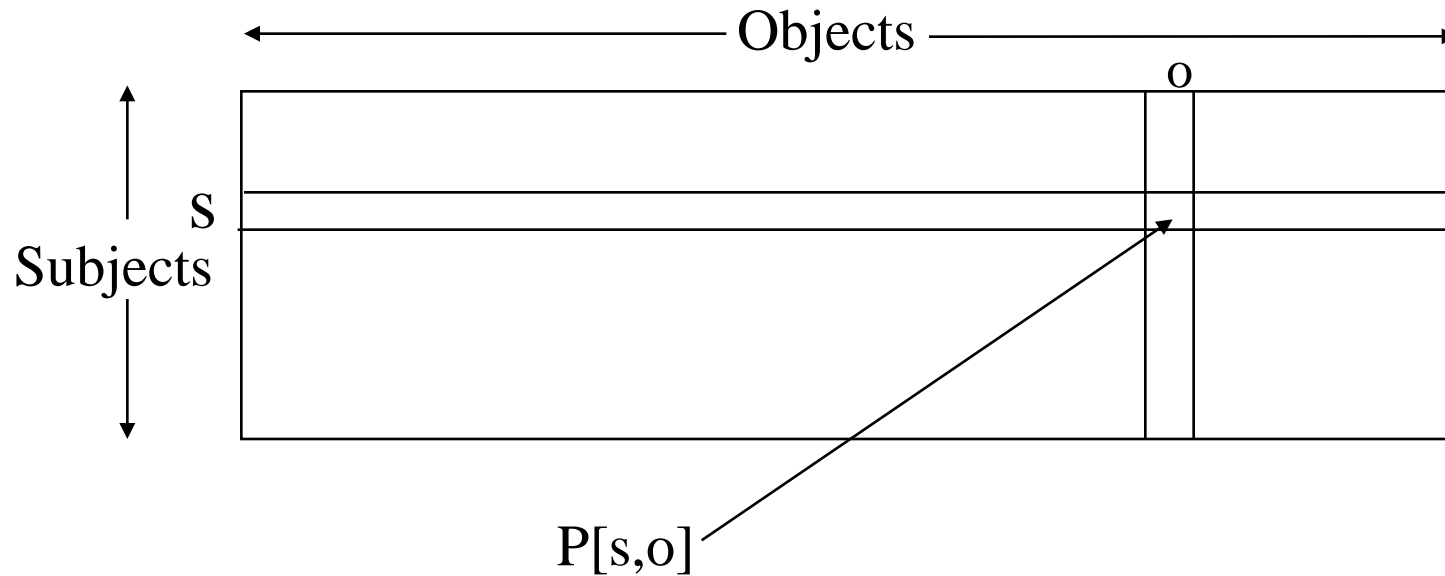
Elements of a Secure System

- Specification/Policy
 - secrecy
 - integrity
 - availability
 - accountability
- Implementation/Mechanism
 - isolation (impractical)
 - exclusion (code signing, firewalls)
 - restriction (sandboxing)
 - recovery
 - punishment
- Correctness/Assurance
 - trusted computing base
 - defense in depth
 - usability
 - theory

From: “Computer Security in the Real World”, Lampson, 2004

Access Matrix

Access Matrix Model



Access Matrix

objects

subjects

	S_1	S_2	S_3	F_1	F_2	D_1	D_2
S_1	control	owner block unblock	owner control	read* write*	read write	seek	owner
S_2	block unblock	control		owner	update	owner	seek*
S_3			control	delete	owner execute		

Manipulating the Access Matrix

Rule	Command (by S_0)	Conditions	Operation
R_1	transfer $\{a/a^*\}$ to S,X	a^* in $A[S_0,X]$	store $\{a/a^*\}$ in $A[S,X]$
R_2	grant $\{a/a^*\}$ to S,X	<i>owner</i> in $A[S_0,X]$	store $\{a/a^*\}$ in $A[S,X]$
R_3	delete a from S,X	<i>control</i> in $A[S_0,S]$ or <i>owner</i> in $A[S_0,X]$	delete a from $A[S,X]$
R_4	$w = \text{read } S,X$	<i>control</i> in $A[S_0,S]$ or <i>owner</i> in $A[S_0,X]$	copy $A[S,X]$ into w
R_5	create object X		add column for X to A ; place <i>owner</i> in $A[S,X]$
R_6	destroy object X	<i>owner</i> in $A[S_0,X]$	delete column for X from A
R_7	create subject S		add a row for S to A ; place <i>owner</i> in $A[S_0,S]$; place <i>control</i> in $A[S,S]$
R_8	destroy subject S	<i>owner</i> in $A[S_0,X]$	delete row for S from A ;

Capability Lists

	O_1	O_2	O_3	
S_1	r_1		r_2	
S_2		r_3	r_4	
S_3	r_5			

↓ grouped by subject

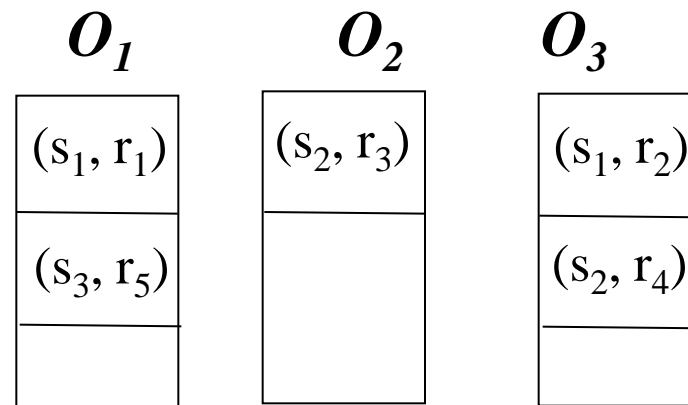
S_1	(r_1, O_1)	(r_2, O_3)	
S_2	(r_3, O_2)	(r_4, O_3)	
S_3	(r_5, O_1)		

Capability Lists

Access Control Lists

	O_1	O_2	O_3	
S_1	r_1		r_2	
S_2		r_3	r_4	
S_3	r_5			

↓ Grouped by object



Access Control Lists

Role-Based Access Control (RBAC)

	O_1	O_2	O_3	
S_1	r_1	r_2		
S_2	r_1	r_2		
S_3		r_3	r_4	
S_4		r_3	r_4	
S_5		r_3	r_4	

grouped by multiple subjects

Role
assignment

S_1	Role₁
S_2	Role₁
S_3	Role₂
S_4	Role₂
S_5	Role₂

Role₁	(r_1, O_1)	(r_2, O_2)	
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Role₂	(r_3, O_2)	(r_4, O_3)	
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Privilege assignment

Role-Based Access Control (RBAC)

- Roles model particular jobs or duties in an organization
- Single user may play multiple roles at the same or different times
- Multiple users may play the same role at the same or different times
- The user-role assignment may be made separately from the role-permission assignment

Classes, Levels, Domains

	O_1	O_2	O_3	O_4	O_5
S_1	r_1	r_1		r_1	
S_2			r_1	r_3	r_1
S_3	r_2	r_2	r_3		r_3



Grouped by multiple objects

 $O_1 \& O_2$

(s_1, r_1)
(s_3, r_2)

 $O_3 \& O_5$

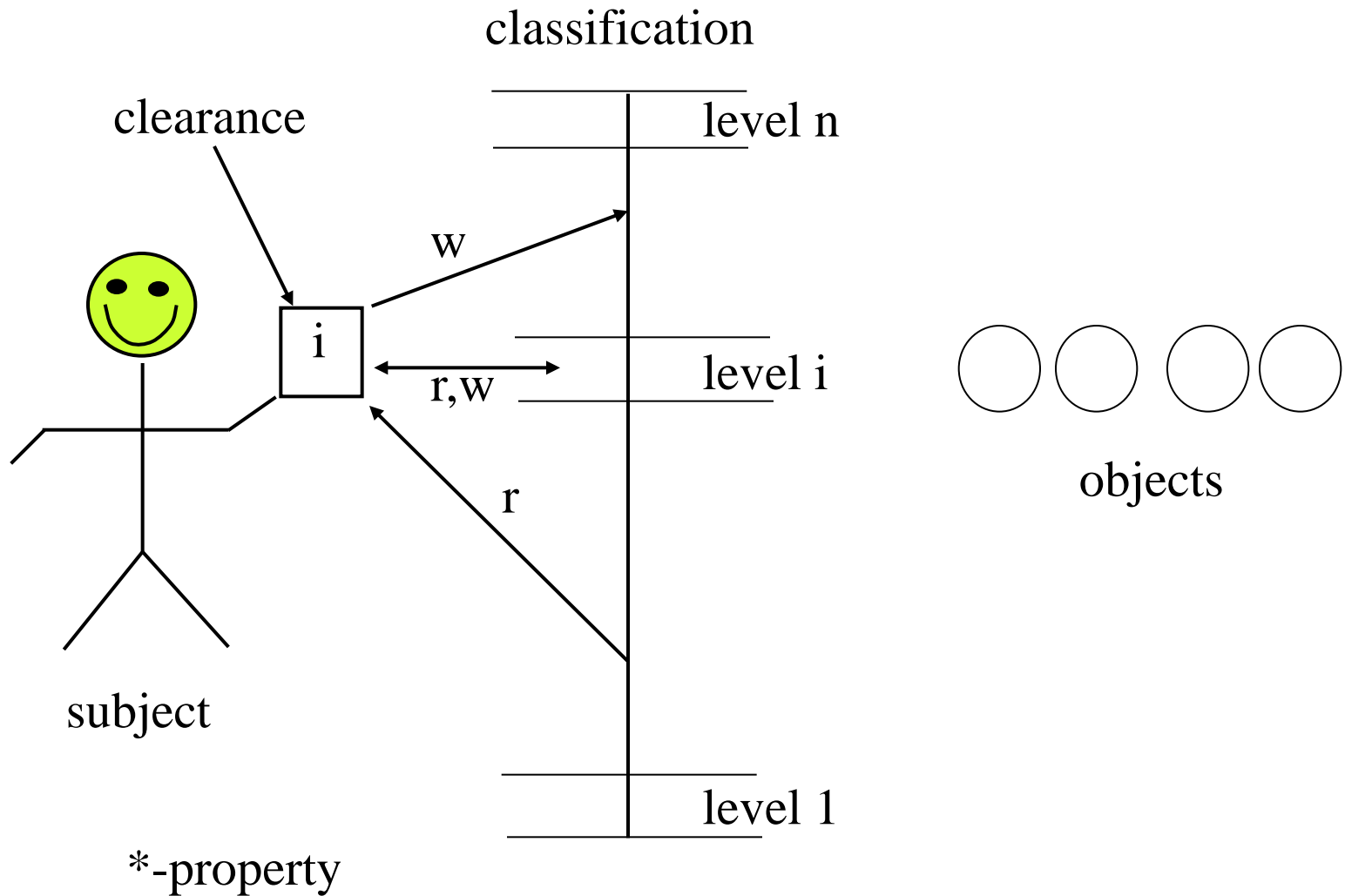
(s_2, r_1)
(s_3, r_3)

 O_4

(s_1, r_1)
(s_2, r_3)

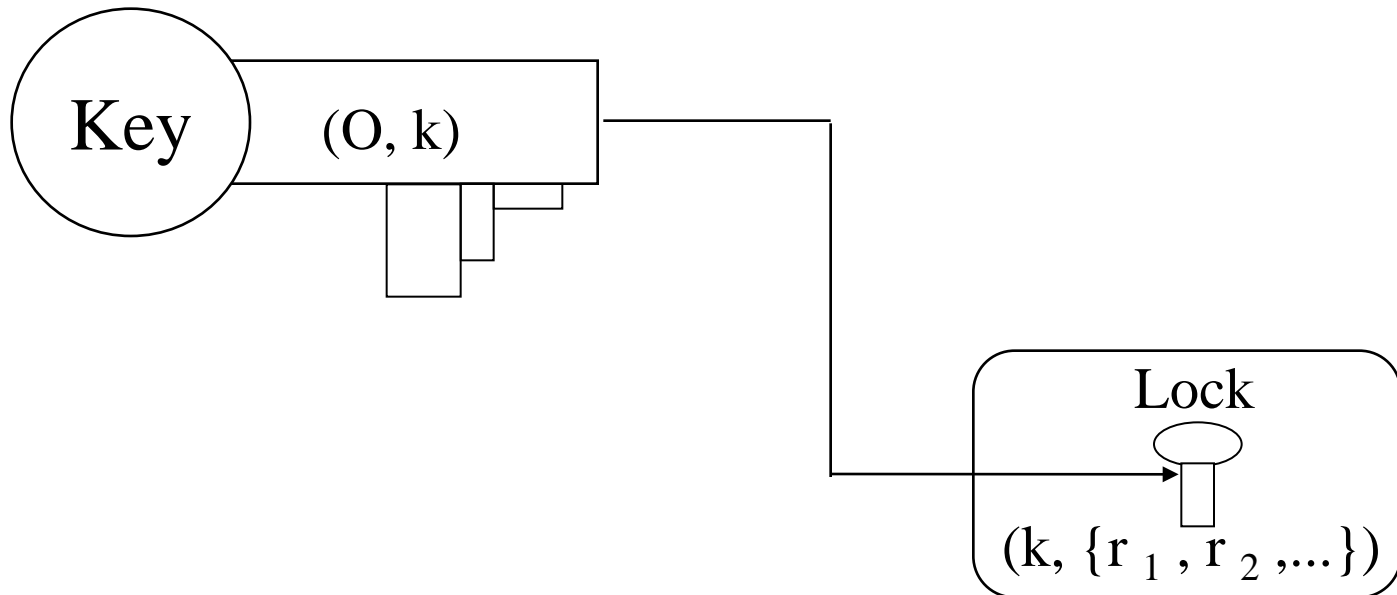
classes, levels, domains

Bell-LaPadula Model















Lock and Key Method

**subjects possess
a set of keys:**



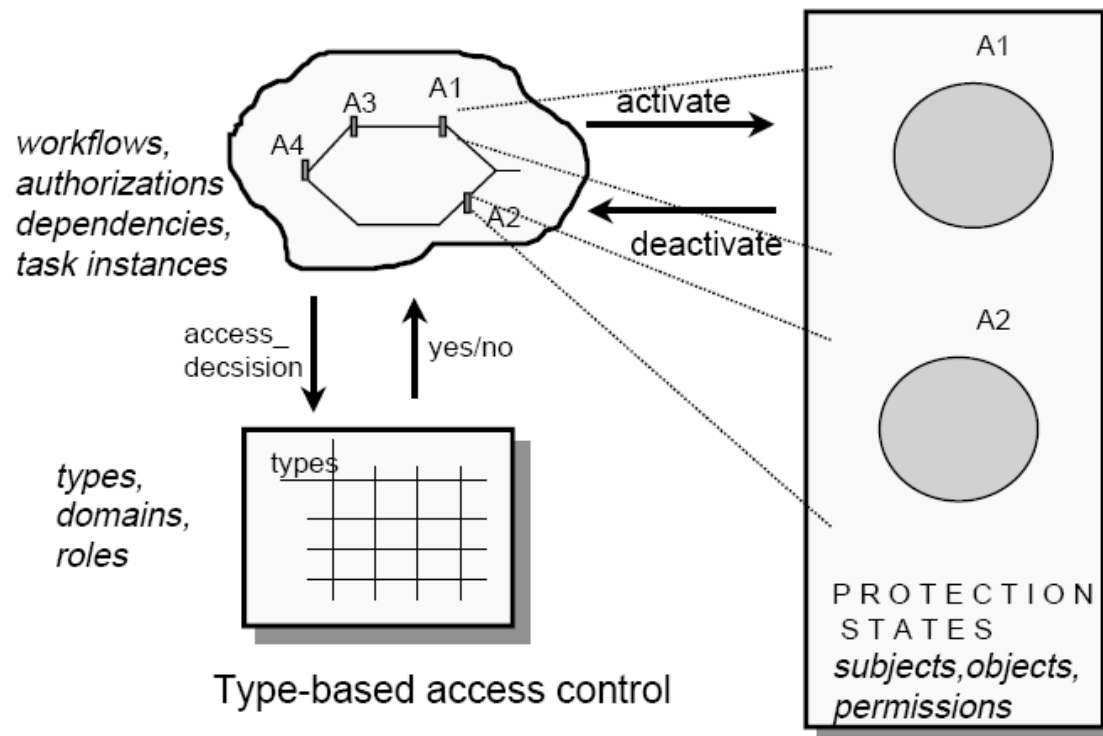
**objects are associated
with a set of locks**

Comparison of methods

	Capability list	Access Control List	Locks & Keys
propagation	 1	 3	 1
review			 4
revocation			 4
reclamation	 2		

1. need copy bit/count for control
2. need reference count
3. need user/hierarchical control
4. need to know subject-key mapping

Task-based Access Control (TBAC)

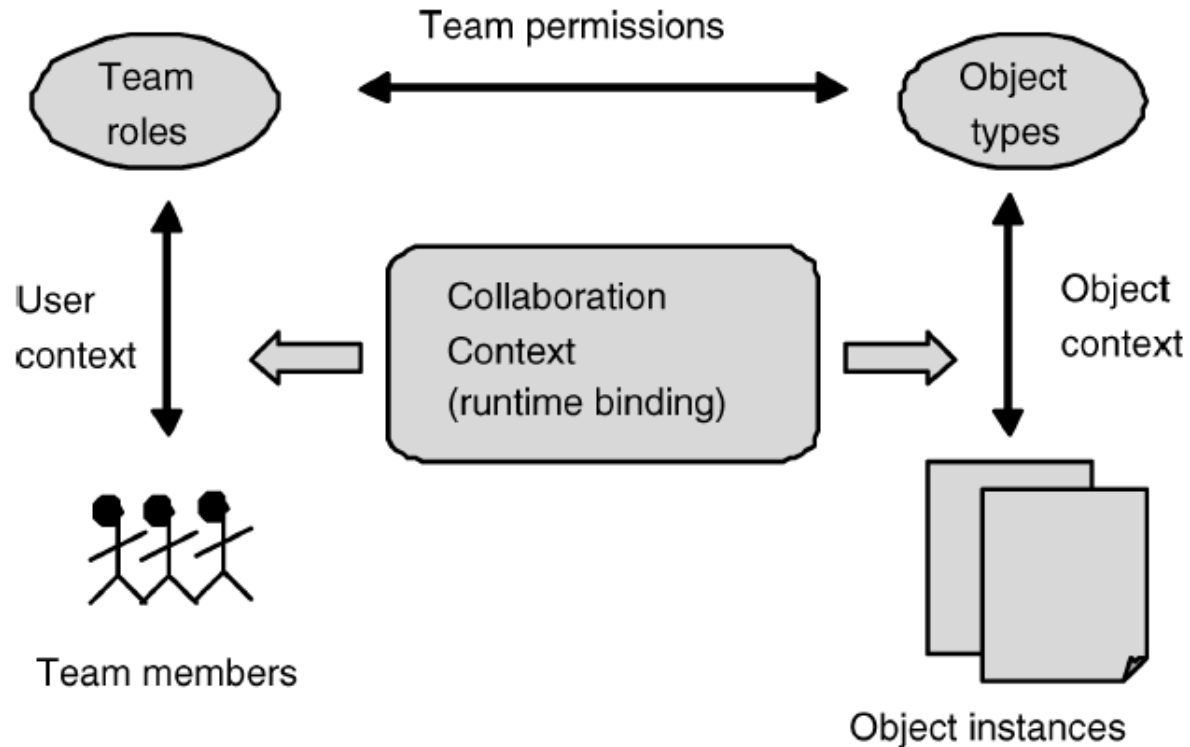


Type-based access control

Instance and usage based access control

R.K. Thomas and R.S. Sandhu, "Task-based Authorization Controls (TBAC): A Family of Model for Active and Enterprise-oriented Authorization Management."

Team-based Access Control



W. Tolone, G. Ahn, T. Pai, "Access Control in Collaborative Systems."