Protection and Security

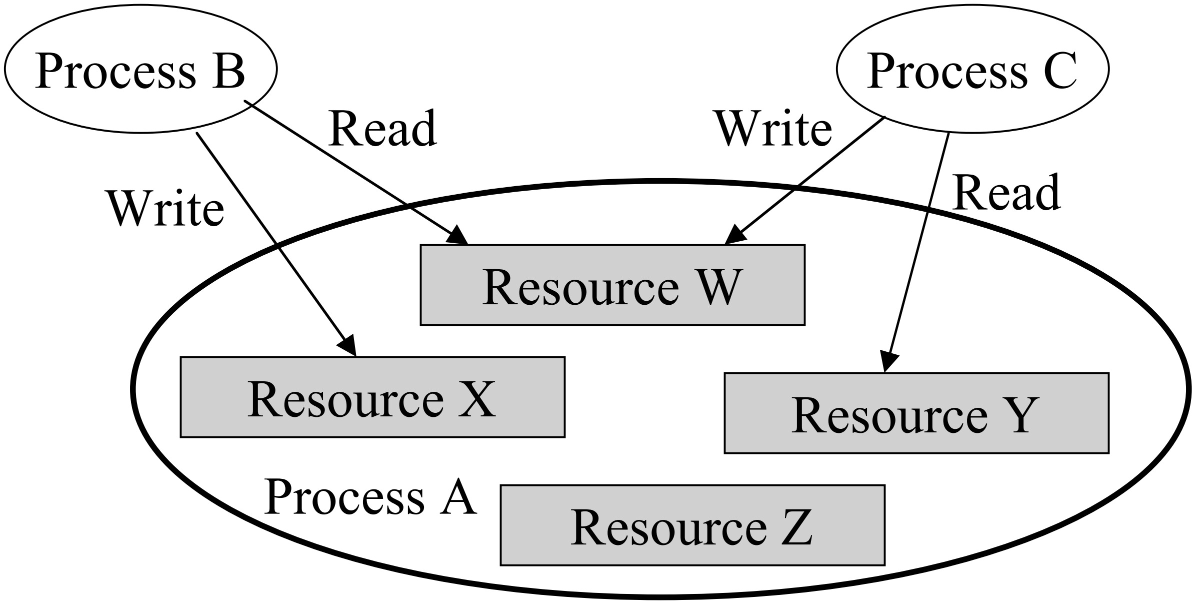
Policy & Mechanism

- *Protection mechanisms* are used to authenticate access to resources
  - File protection
  - Memory protection
- A *security policy* reflects an organizations strategy to authorize access to the computer’s resources
  - Managers have access to personnel files
  - OS processes have access to the page table

Authentication

- User/process authentication
  - Is this user/process who it claims to be?
    - Passwords
    - More sophisticated mechanisms
- Authentication in networks
  - Is this computer who it claims to be?
    - File downloading
    - Obtaining network services
    - The Java promise

Internal Access Authentication

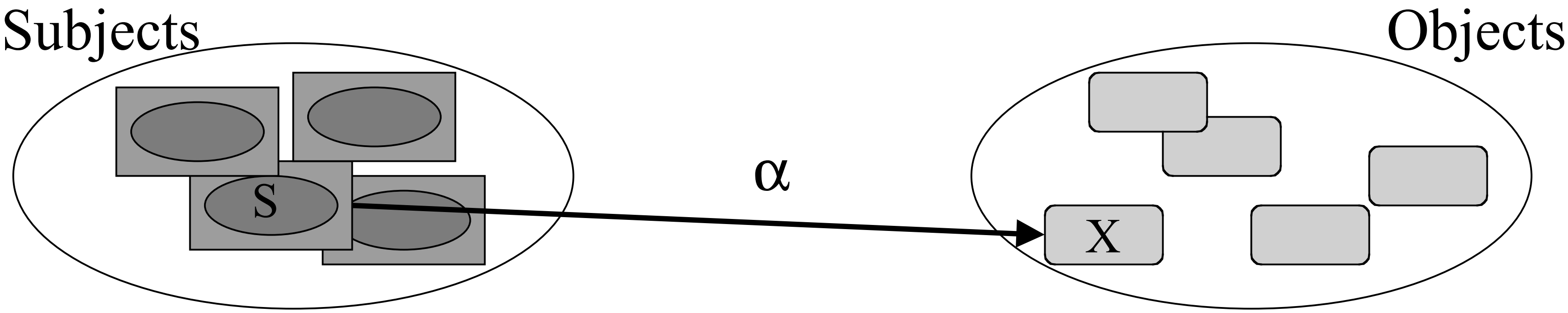


- Sharing parameters
- Confinement
- Allocating rights
- Trojan horse

Lampson’s Protection Model

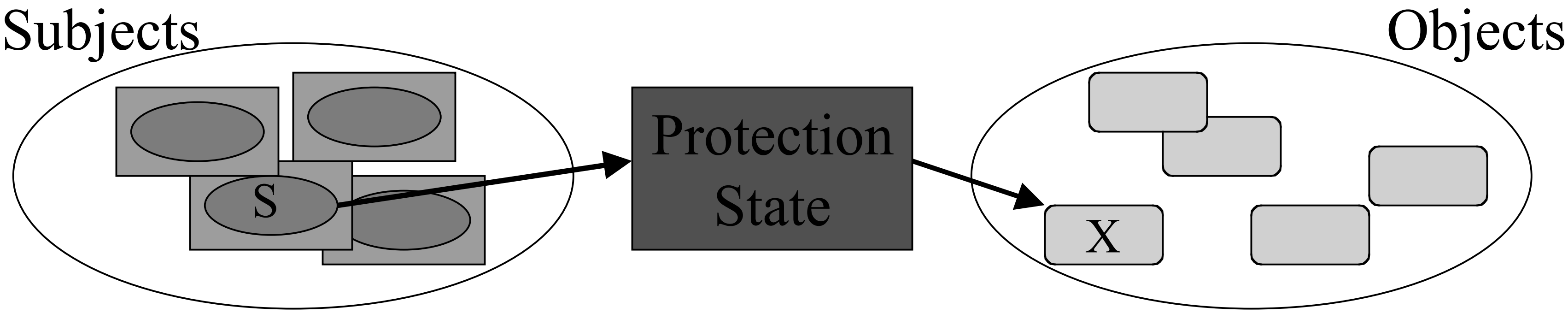
- Active parts (e.g., processes)
  - Operate in different domains
  - *Subject* is a process in a domain
- Passive parts are called *objects*
- Want mechanism to implement different security policies for subjects to access objects
  - Many different policies must be possible
  - Policy may change over time

A Protection System



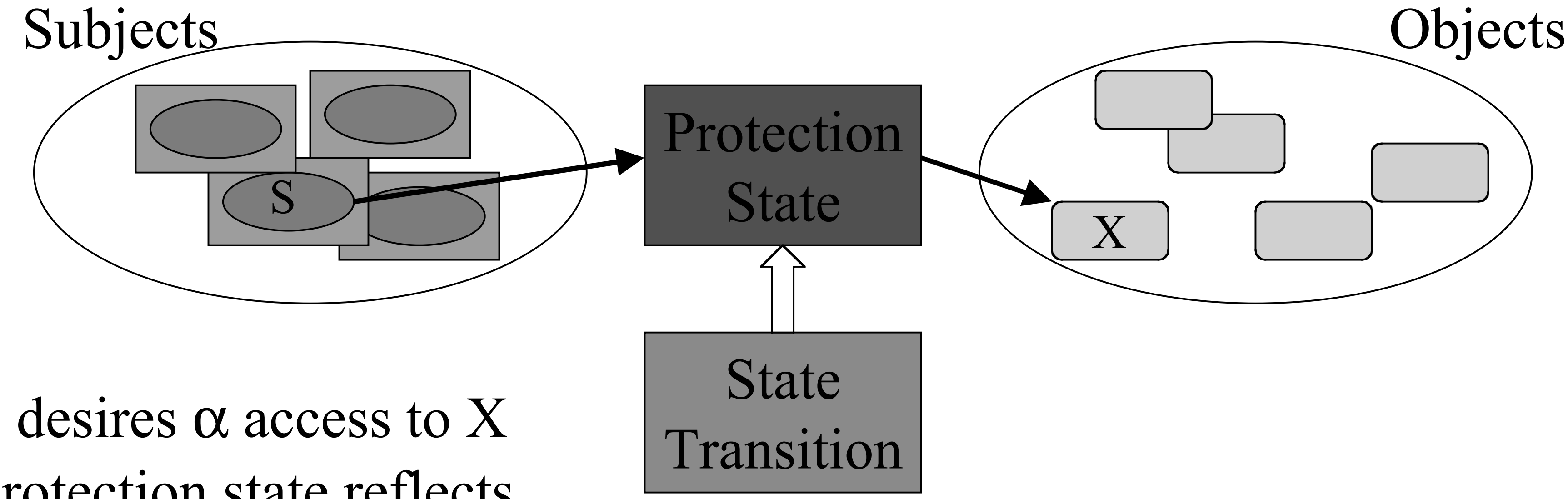
- S desires α access to X

A Protection System



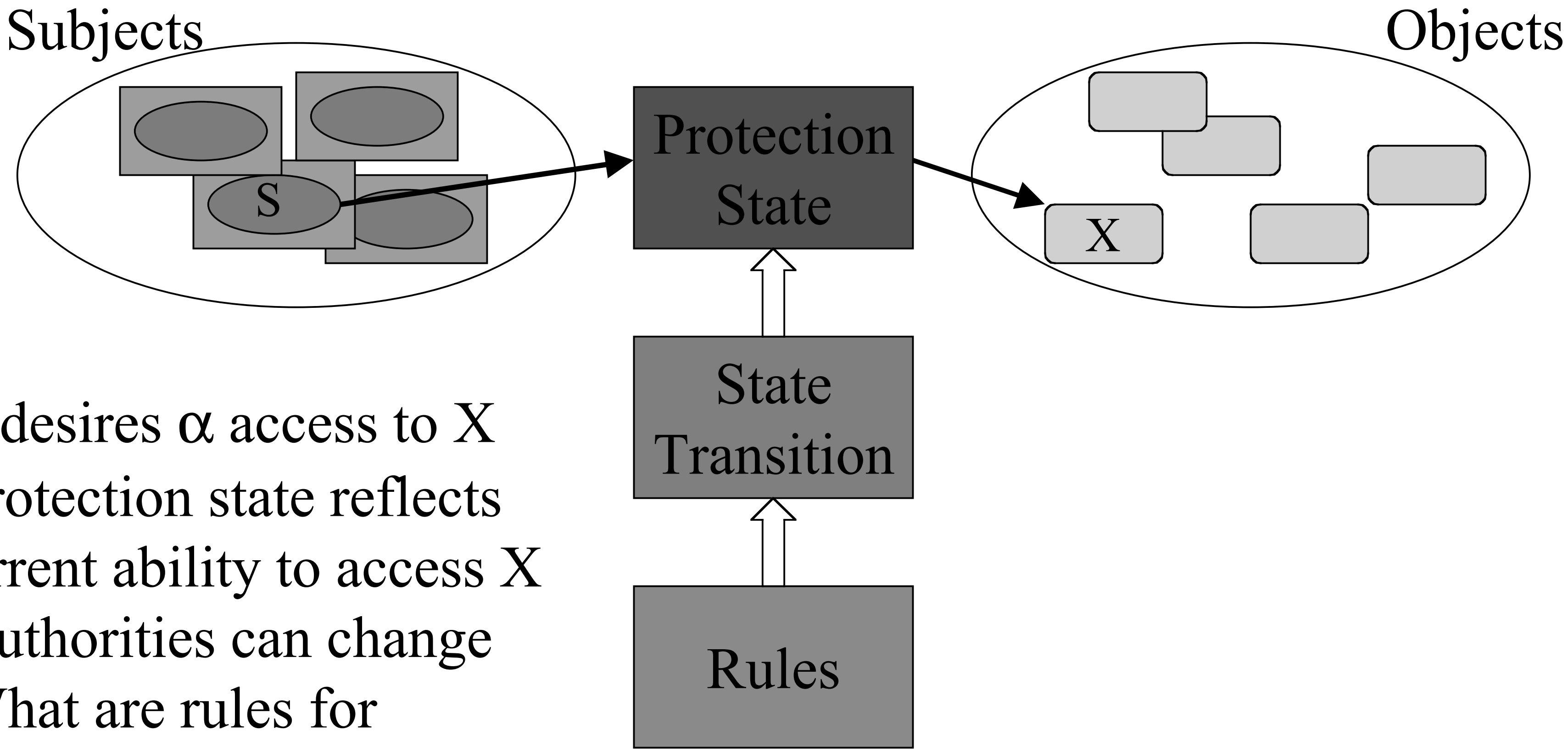
- •S desires α access to X
- •Protection state reflects current ability to access X

A Protection System



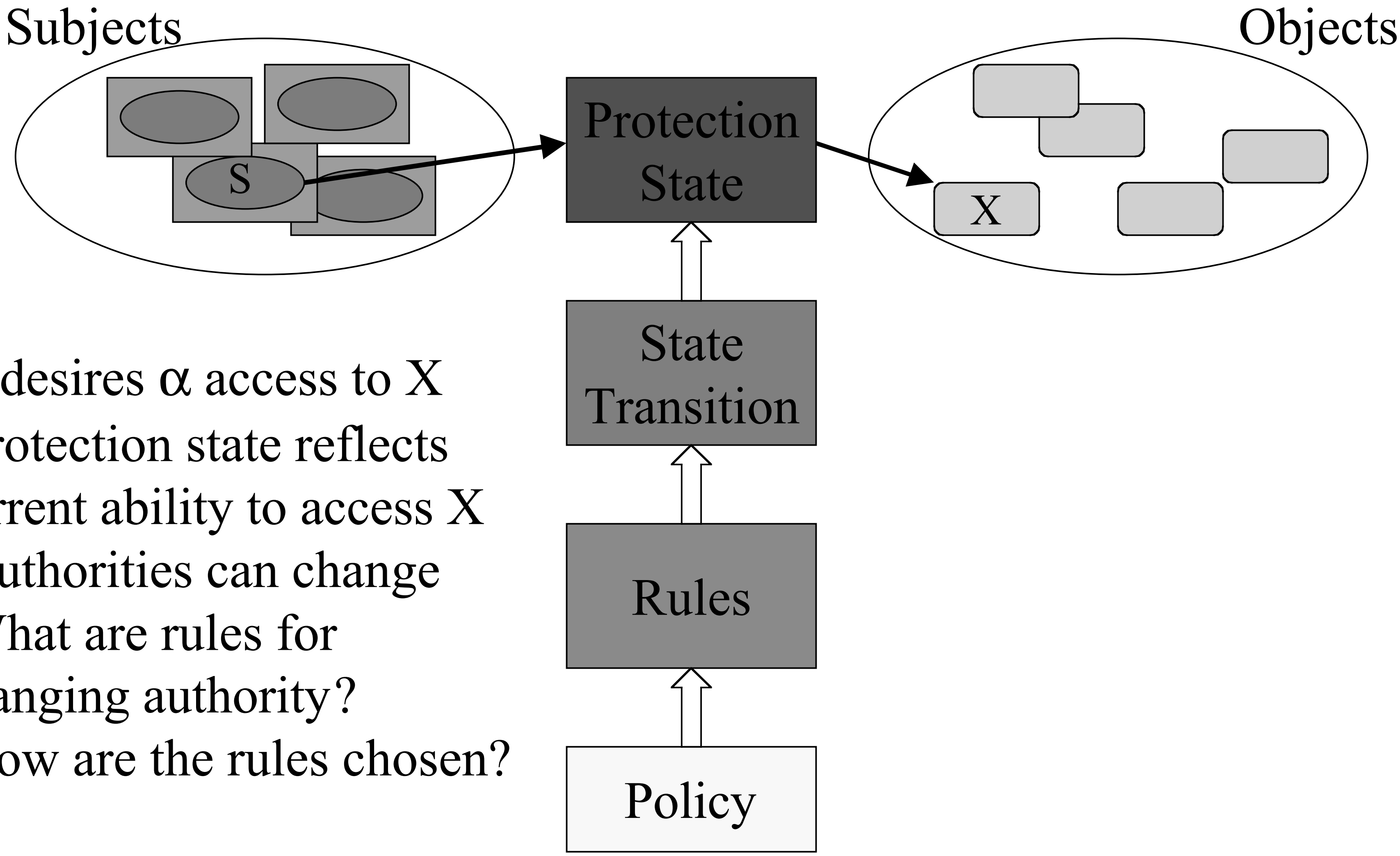
- S desires α access to X
- Protection state reflects current ability to access X
- Authorities can change

A Protection System



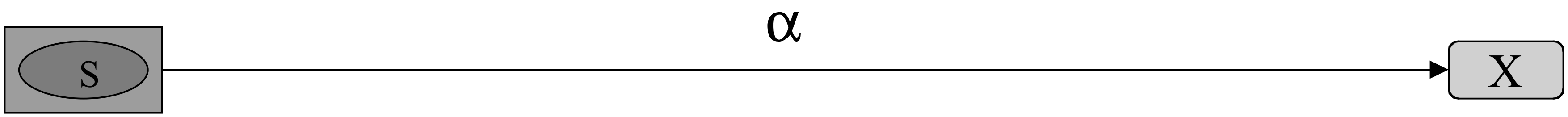
- •S desires α access to X
- •Protection state reflects current ability to access X
- •Authorities can change
- •What are rules for changing authority?

A Protection System



- S desires α access to X
- Protection state reflects current ability to access X
- Authorities can change
- What are rules for changing authority?
- How are the rules chosen?

Protection System Example



- S desires α access to X

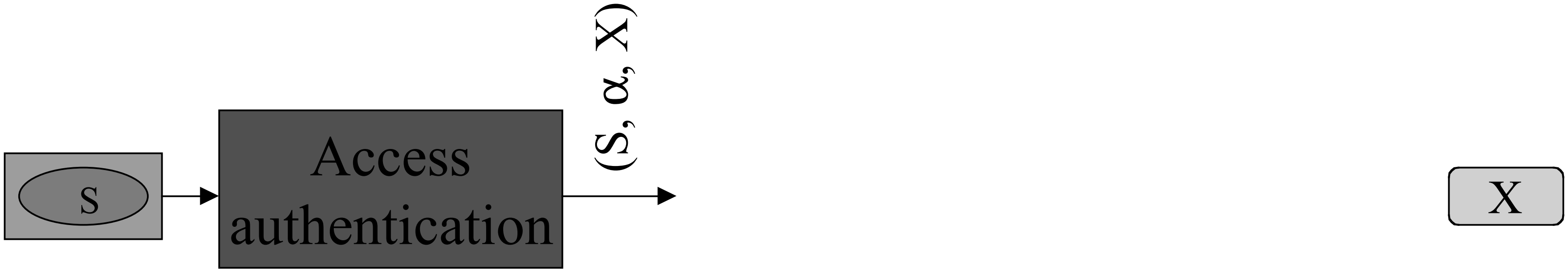
Protection System Example

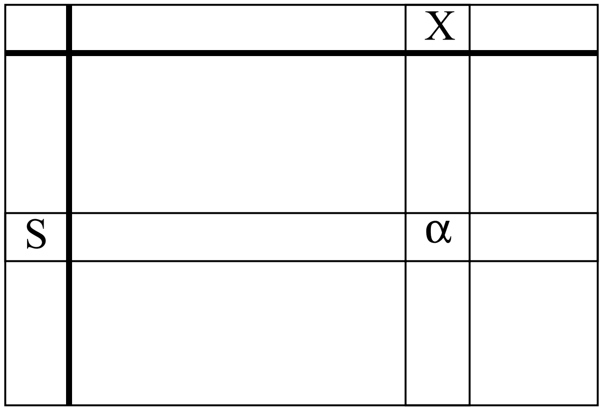
- S desires α access to X
- Captures the protection state

		X	
S		α	

Access matrix

Protection System Example

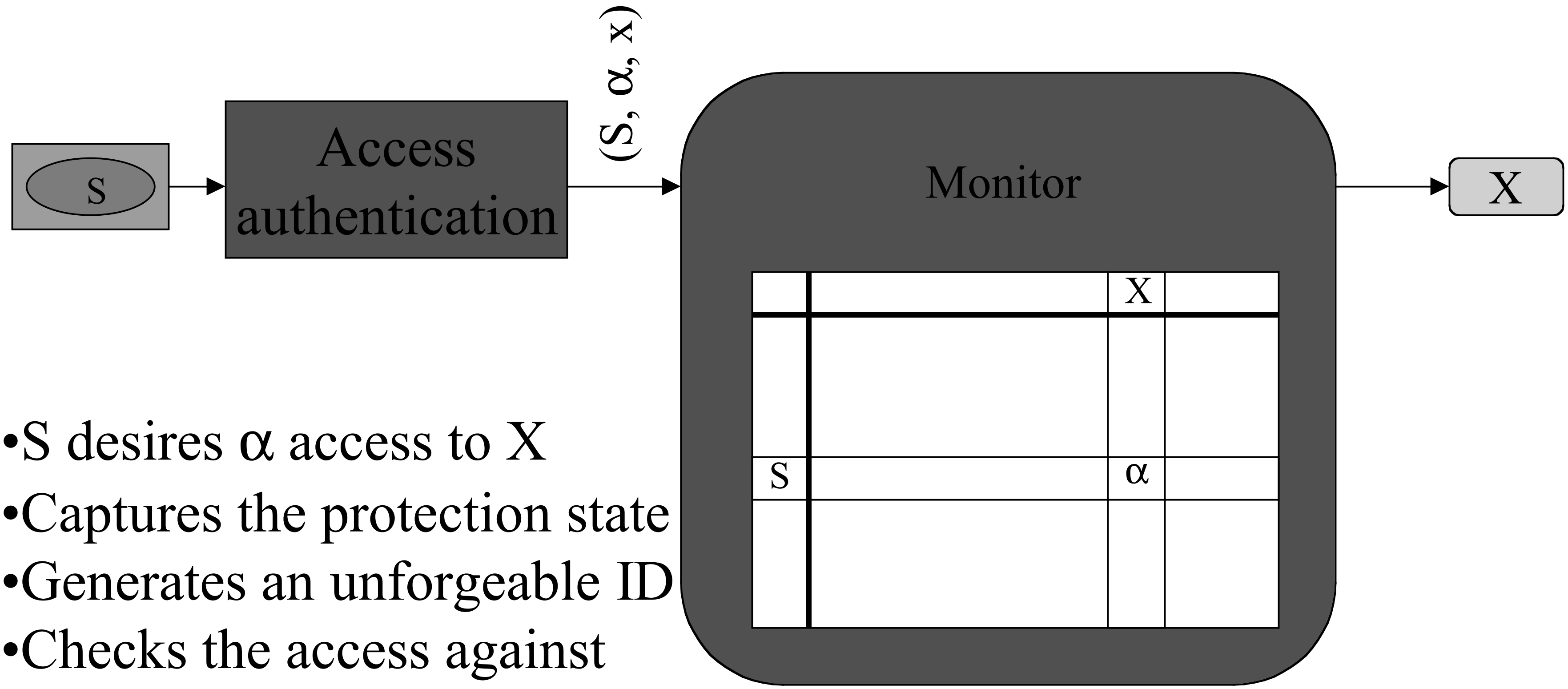




Access matrix

- S desires α access to X
- Captures the protection state
- Generates an unforgeable ID

Protection System Example

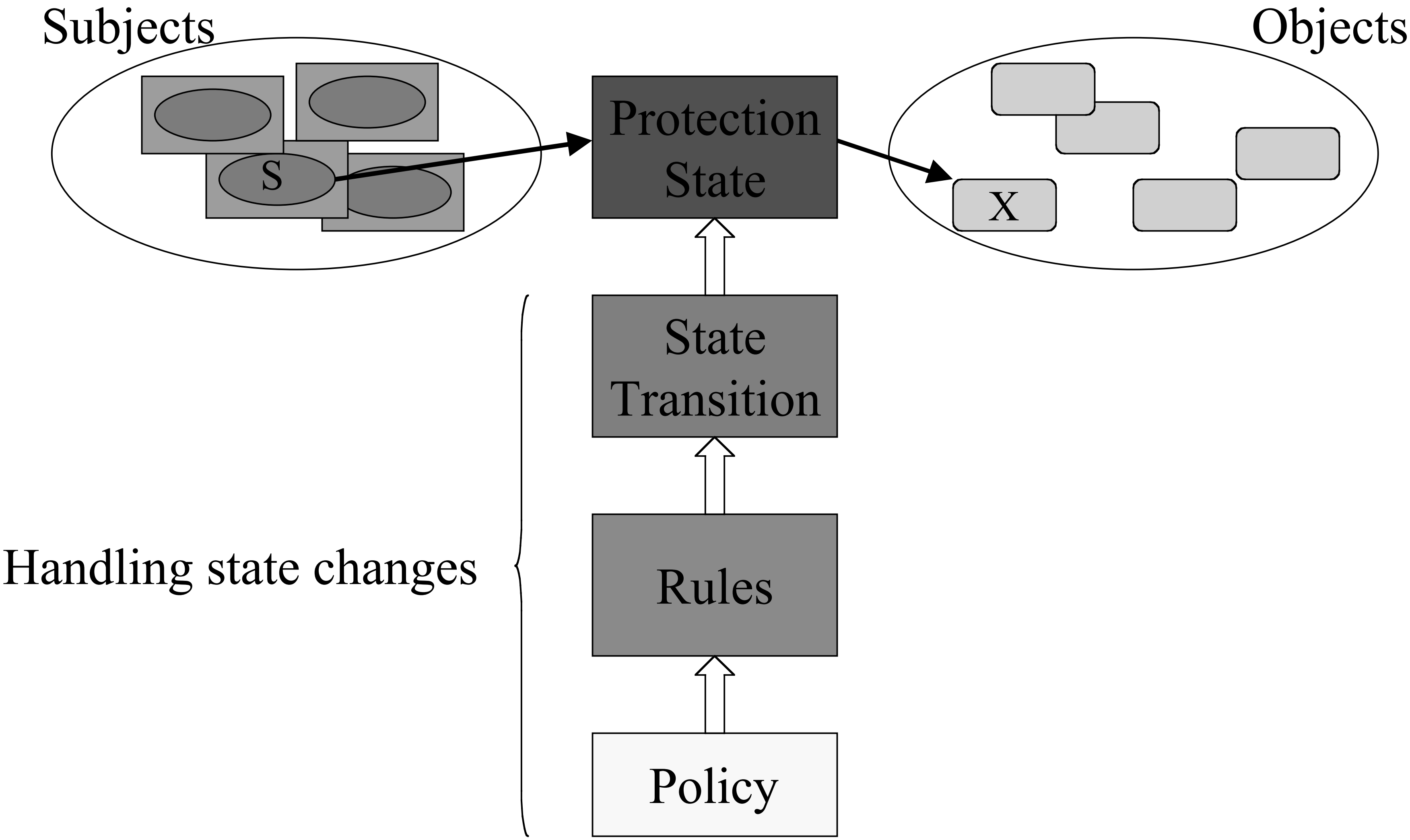


- S desires α access to X
- Captures the protection state
- Generates an unforgeable ID
- Checks the access against the protection state

Protection State Example

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

A Protection System



Policy Rules Example

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

Rules for a Particular Policy

Rule	**Command by S_0**	**Authorization**	**Effect**
1	transfer($\alpha\vert\alpha*$) to (S, X)	$\alpha* \in A[S_0, X]$	$A[S, X] = A[S, X] \cup \{\alpha\vert\alpha*\}$
2	grant($\alpha\vert\alpha*$) to (S, X)	owner $\in A[S_0, X]$	$A[S, X] = A[S, X] \cup \{\alpha\vert\alpha*\}$
3	delete α from (S, X)	control $\in A[S_0, S]$ or owner $\in A[S_0, X]$	$A[S, X] = A[S, X] - \{\alpha\}$

Protection Domains

- Lampson model uses processes and domains -- how is a domain implemented?
  - Supervisor/user hardware mode bit
  - Software extensions -- *rings*
- Inner rings have higher authority
  - Ring 0 corresponds to supervisor mode
  - Rings 1 to S have decreasing protection, and are used to implement the OS
  - Rings S+1 to N-1 have decreasing protection, and are used to implement applications

Protection Domains (cont)

- Ring crossing is a domain change
- Inner ring crossing ⇒ rights amplification
  - Specific *gates* for crossing
  - Protected by an authentication mechanism
- Outer ring crossing uses less-protected objects
  - No authentication
  - Need a return path
  - Used in Multics and Intel 80386 (& above) hardware

Implementing Access Matrix

- Usually a sparse matrix
  - – Too expensive to implement as a table
  - – Implement as a list of table entries
- Column oriented list is called an *access control list* (ACL)
  - – List kept at the object
  - – UNIX file protection bits are one example
- Row oriented list is a called a *capability list*
  - – List kept with the subject (i.e., process)
  - – Kerberos ticket is a capability
  - – Mach mailboxes protected with capabilities

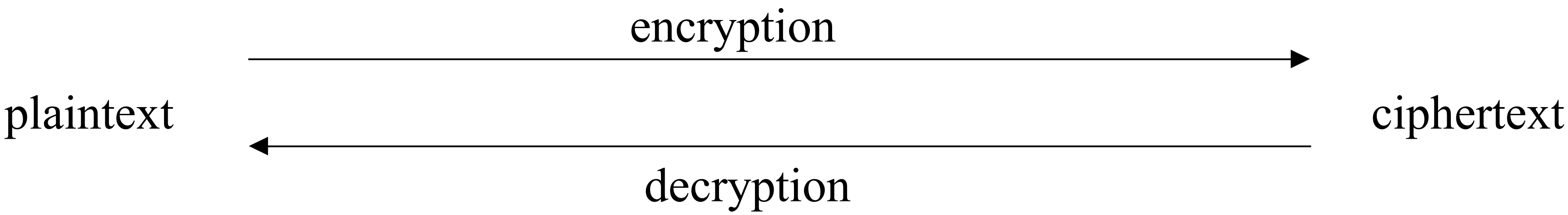
More on Capabilities

- Provides an address to object from a very large address space
- Possession of a capability represents authorization for access
- Implied properties:
  - Capabilities must be very difficult to guess
  - Capabilities must be unique and not reused
  - Capabilities must be distinguishable from randomly generated bit patterns

Cryptography

- Information can be encoded using a *key* when it is written (or transferred) -- *encryption*
- It is then decoded using a key when it is read (or received) -- *decryption*
- Very widely used for secure network transmission

More on Cryptography



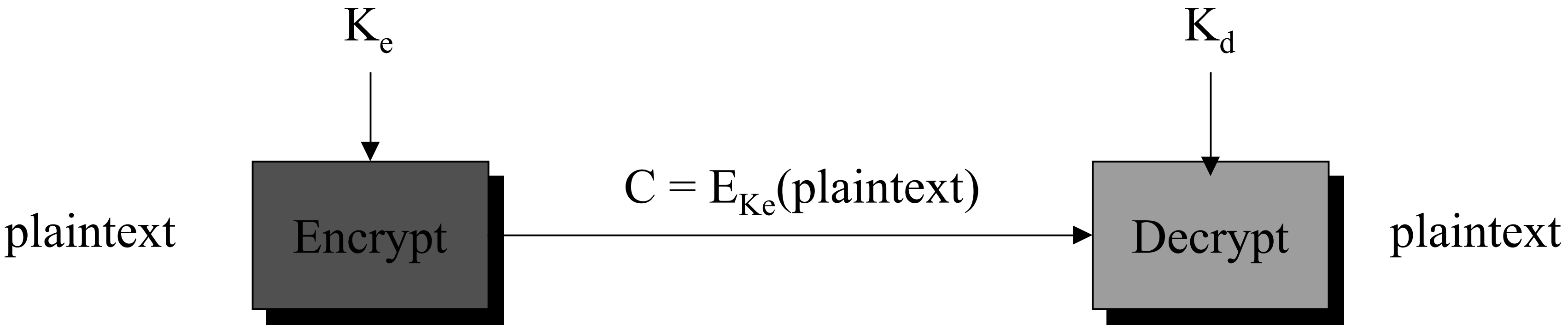
encryption

plaintext

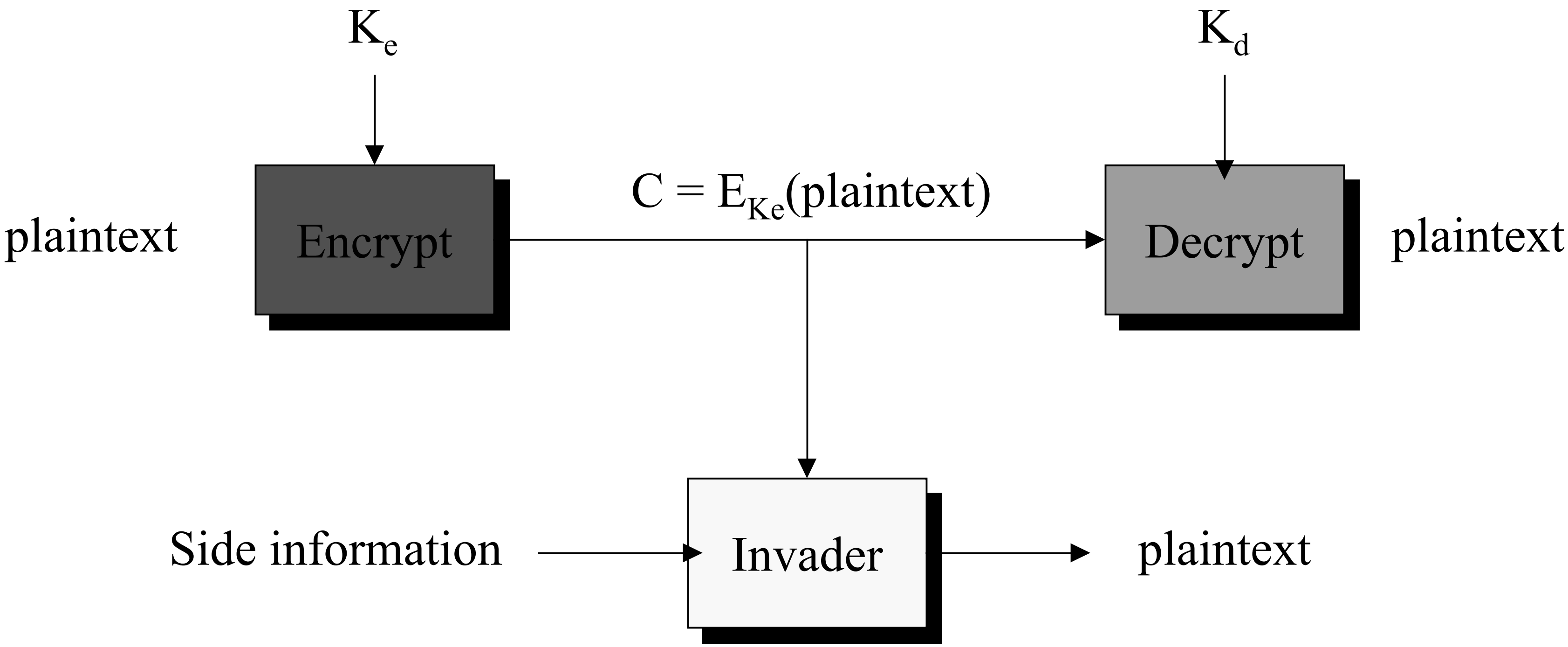
ciphertext

decryption

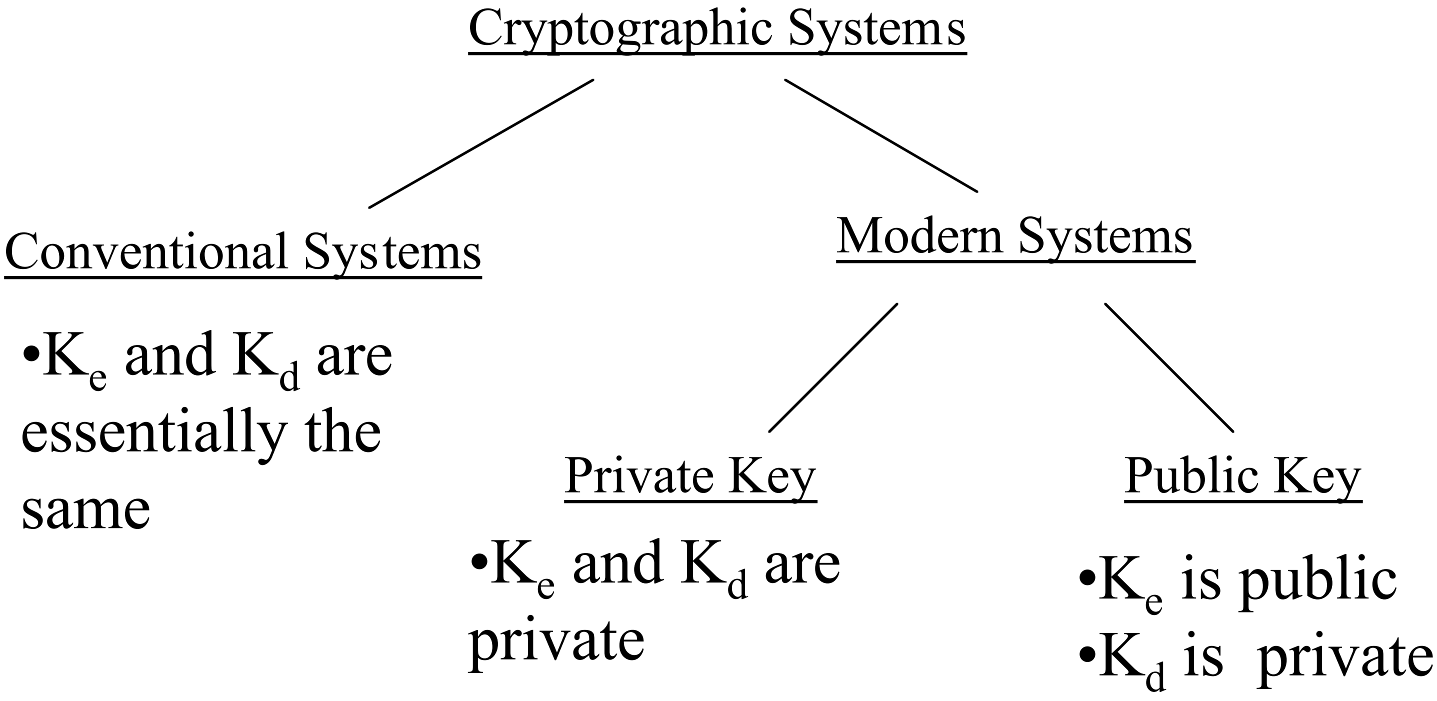
More on Cryptography



More on Cryptography



Cryptographic Systems



Cryptographic Systems

Conventional Systems

- K_e and K_d are essentially the same

Modern Systems

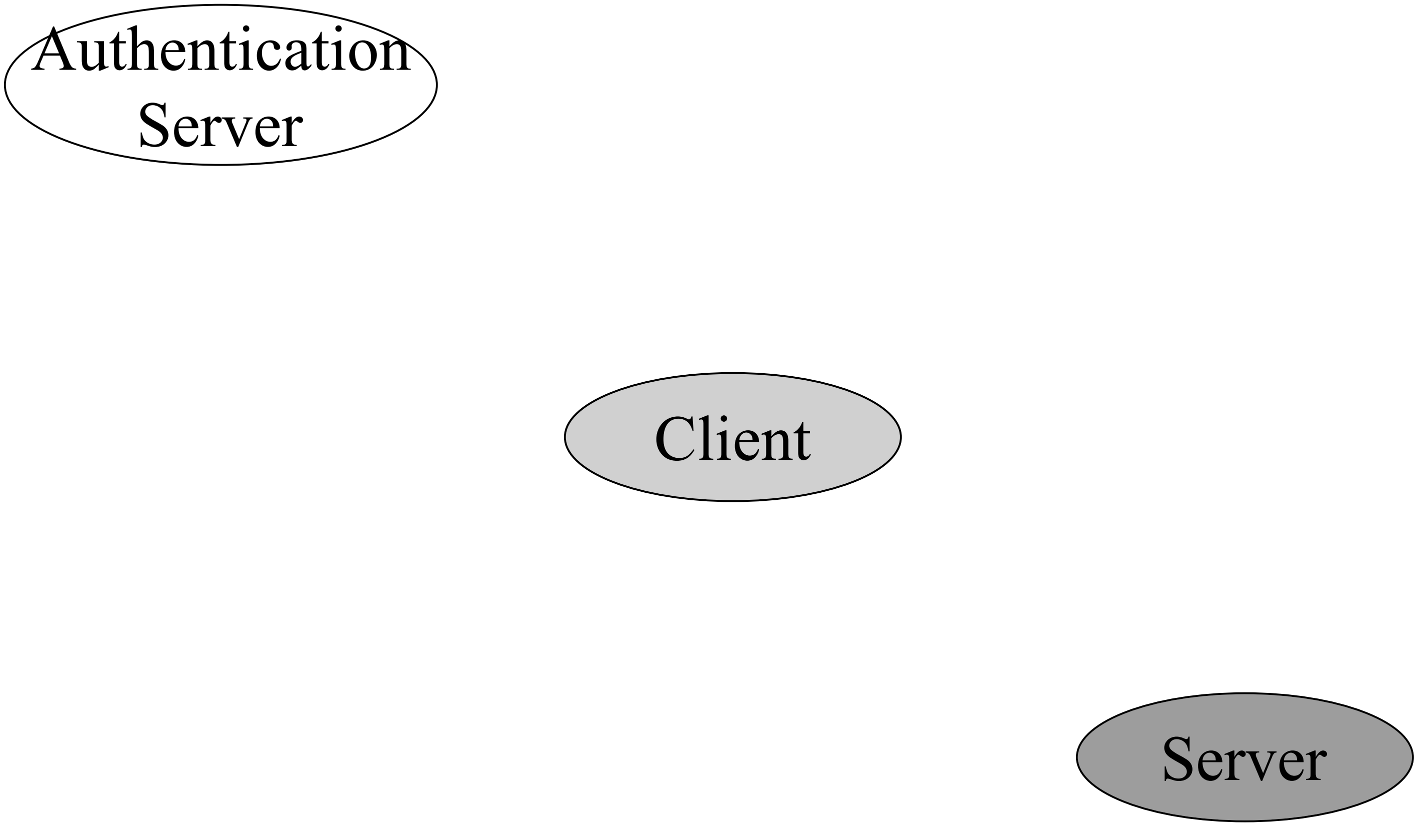
Private Key

- K_e and K_d are private

Public Key

- K_e is public
- K_d is private

Kerberos

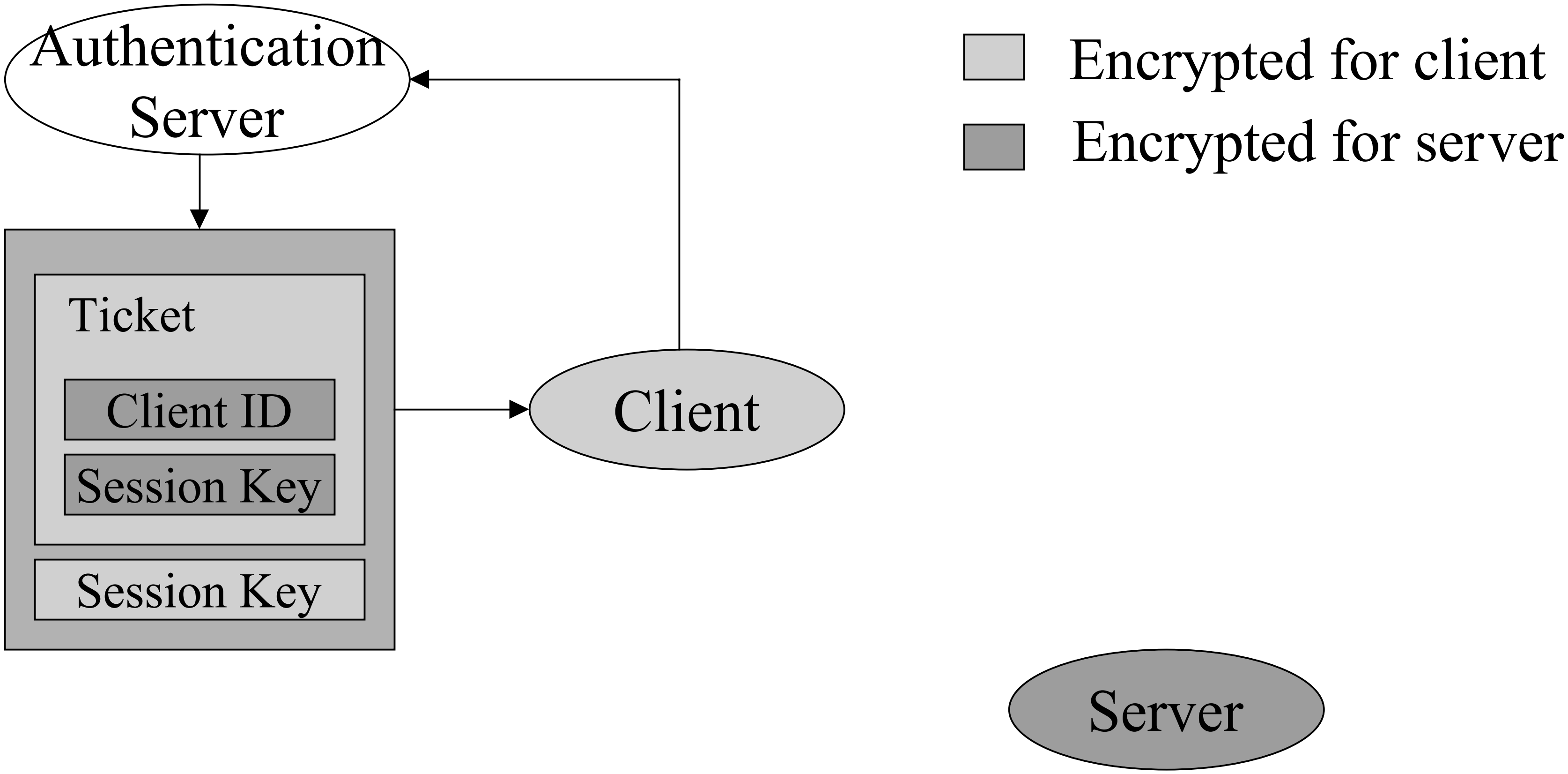


Authentication Server

Client

Server

Kerberos



Authentication Server

Ticket

Client ID

Session Key

Session Key

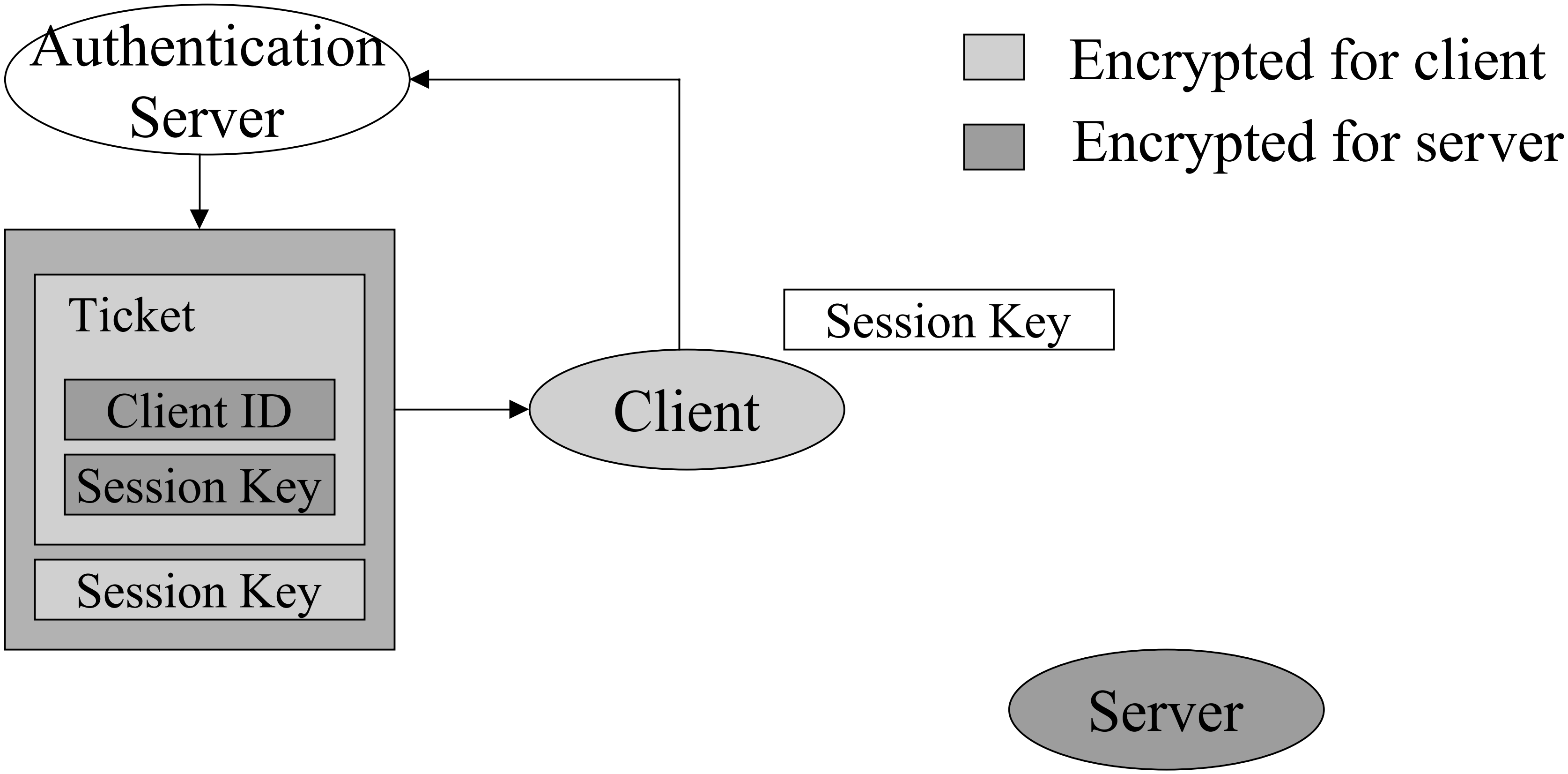
Client

Server

░ Encrypted for client

▓ Encrypted for server

Kerberos



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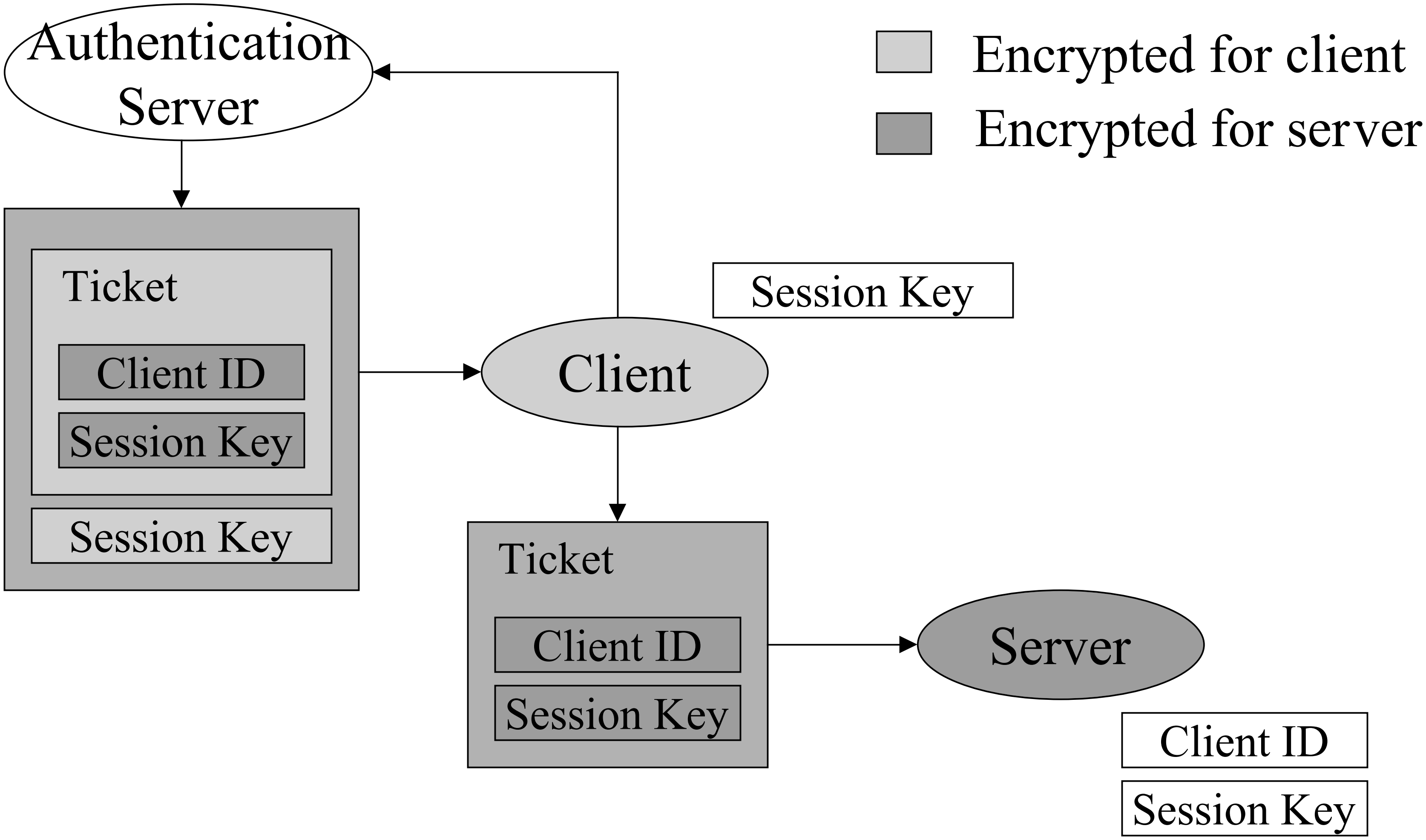

Authentication Server

Encrypted for client

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