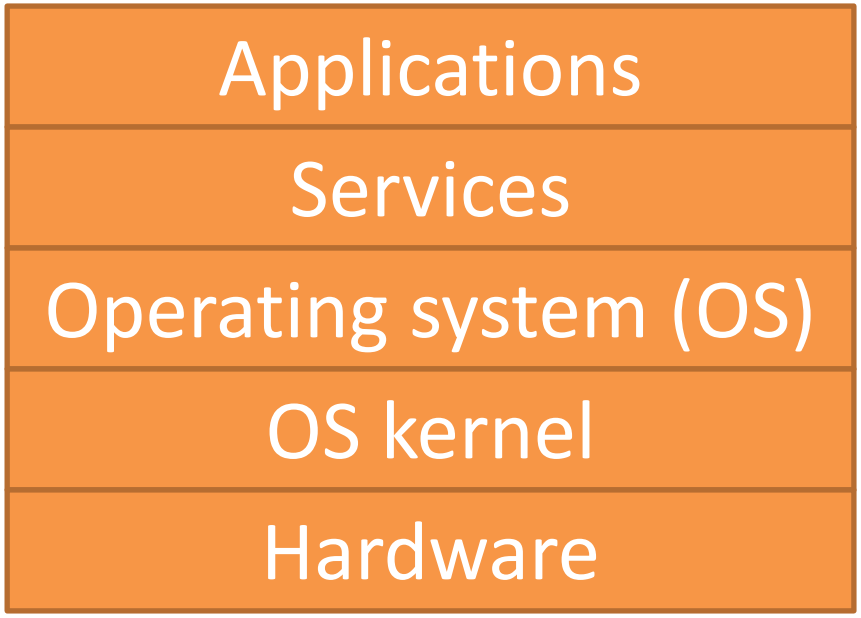
Operating Systems Security
Some basics

Layers of a computer system



- Where should the security of the system be placed?
- The security of a layer could normally be compromised by **attacks from lower layers!**

OS Protection Principles

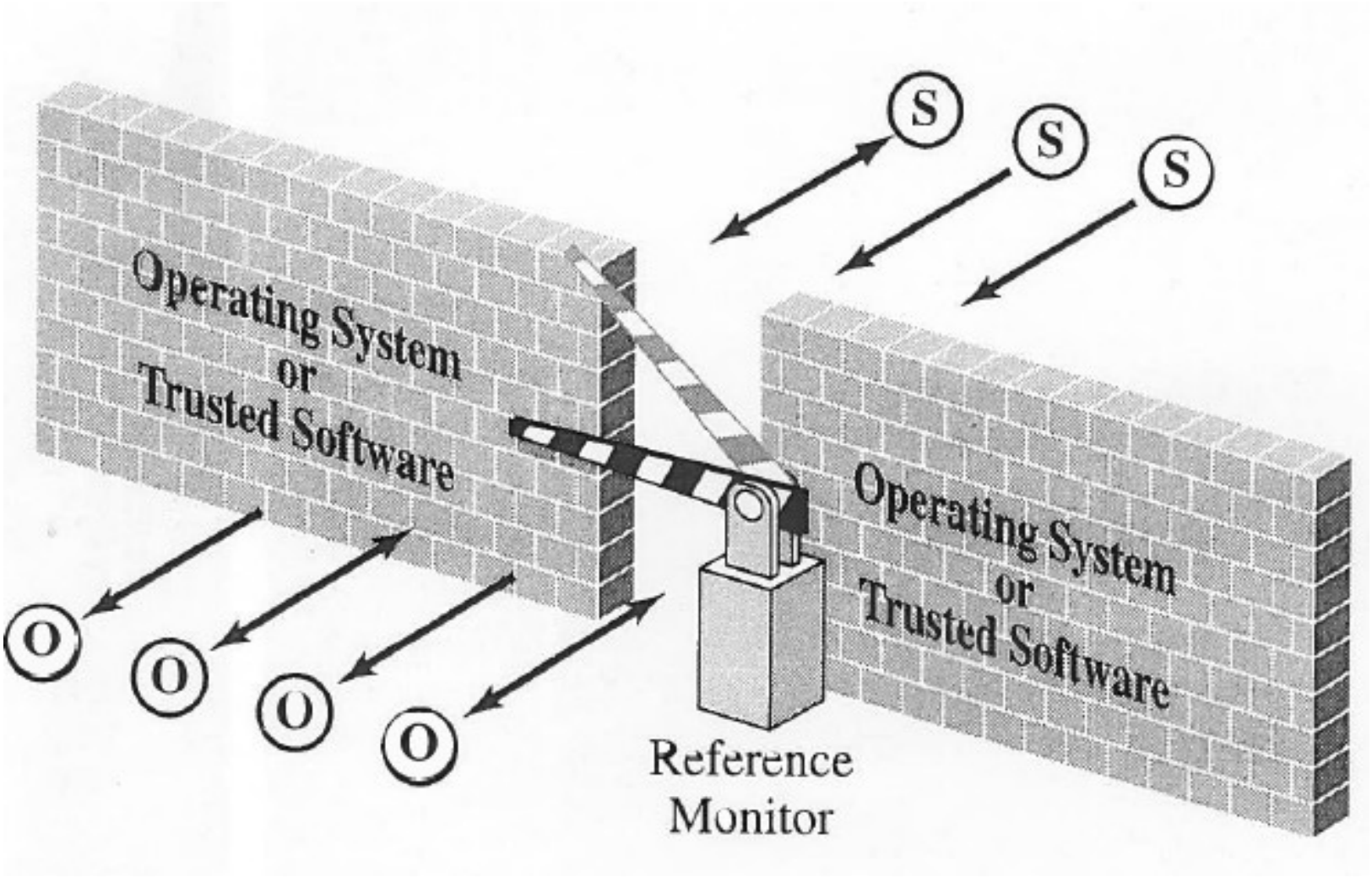
- The basis of OS protection is **separation.** The separation can be of four different kinds:
  - **Physical**: physical objects, such as CPU's, printers, etc.
  - **Temporal**: execution at different times
  - **Logical**: domains, each user gets the impression that she is ”alone” in the system
  - **Cryptographic**: hiding data, so that other users cannot understand them
- ”Computing is *sharing and non-location* – security is *separation*”

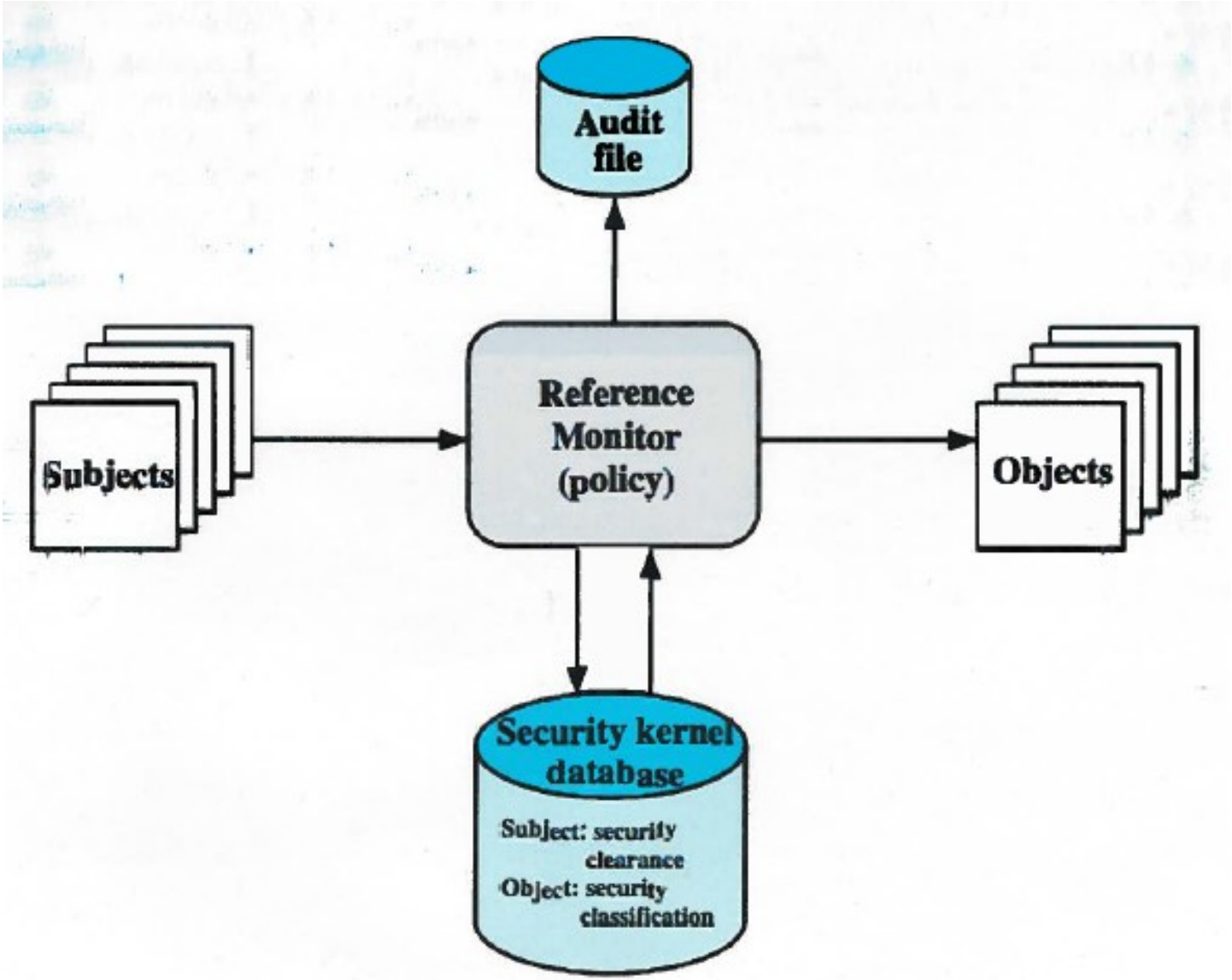
Protected objects

- In principle all objects in the OS need protection, but in particular those that are shareble, e.g.:
  - memory
  - I/O devices (disks, printers, tape drives, etc)
  - programs, procedures
  - data
  - ***hardware***, such as
    - normal operating system mechanisms
      (e.g. file management - logical, memory management - physical)
    - bus control
    - interrupt control
    - status registers

Trusted operating system concepts

- There are a few basic concepts that are fundamental when dealing with trusted OS:
  - the **kernel**: is the part of the OS that performs the lowest-level functions
  - the **security kernel**: is responsible for enforcing the security mechanisms of the entire OS
  - the **reference monitor** (RM): is the part of the security kernel that controls access to objects
  - the **trusted computing base** (TCB): is everything in the trusted OS necessary to enforce the security policy


S
S
S
Operating System
or
Trusted Software
Operating System
or
Trusted Software
O
O
O
O
Reference
Monitor


Audit file
Subjects
Reference Monitor (policy)
Objects
Security kernel database
Subject: security clearance
Object: security classification

Trusted operating system concepts

- There are a few basic concepts that are fundamental when dealing with trusted OS:
  - the **kernel**: is the part of the OS that performs the lowest-level functions
  - the **security kernel**: is responsible for enforcing the security mechanisms of the entire OS
  - the **reference monitor** (RM): is the part of the security kernel that controls access to objects
  - the **trusted computing base** (TCB): is everything in the trusted OS necessary to enforce the security policy

Security policy and security model

- A ***security policy*** is a statement of the security we expect the system to enforce. The security can be expressed as a number of well-defined, consistent and implementable rules.
- A ***security model*** is a representation of the security policy for the OS.
- A ***formal security model*** is a mathematical description (formalisation) of the rules of the security policy.
  It could be used for formal proofs of security.

Development of a secure OS

- The development of secure OS can be made in six steps:
  - ***analyze*** of the system
  - choose/define a ***security policy***
  - choose/create a security model (based on the policy)
  - choose ***implementation method***
  - make a (conceptual) ***design***
  - ***verify the correctness*** of the design
  - make an ***implementation***
  - ***verify the implementation*** (?)
- There are feed-back loops between all of the above steps. Errors may occur in all above steps.

The two types of security costs

Make a trade-off between costs!