Distributed Information Processing

18th Lecture

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Outline

- Information Protection
  - Information Protection in Computer Systems
- Q&A

Information Protection Basics

- Key Concern
  - Multiple Use
- System Requirement
  - Implementing Desired Authority Structure
- Terms
  - Security
    - Controlling who may use or modify a system and and information stored in It
  - Protection
    - Controlling access of programs to information
- Goal
  - Preventing All Unauthorized Use of Information

Information Protection

- Information Sharing Models
  - Multiuser System
  - Capability System
  - Access Control List System
- Essentials
  - Information Divided into Mutually Exclusive Partitions as Fundamental Objects
    - Authentication

Direct Access to Information

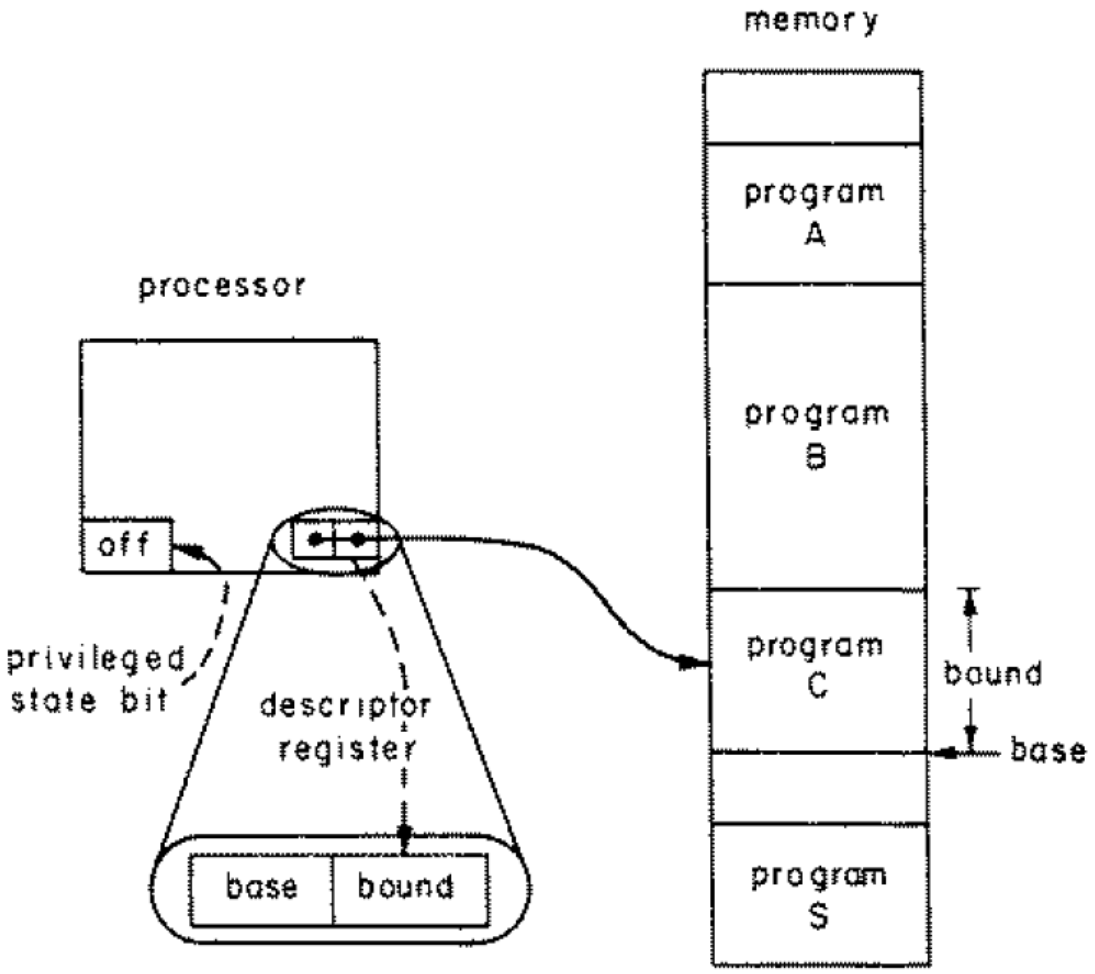
Multiuser System

- Use of a Descriptor Register (Base & Bound) for Each Program
  - Privileged State Bit
    - Indication of the program to load the register
    - Protection of the bit
- Authentication
  - Password
    - With defects lying in its choice & exposure
  - Unforgeable Object
    - With weakness of having to keep the resulting bit stream secret
  - Encipherment/Decipherment

Simple Authority Check on a Request to Access Memory

Verifying the User at a Terminal When Associating the Terminal with a Virtual Machine

Multiple Virtual Machines



. Use of a descriptor register to simulate multiple virtual machines. Program C is in control of tho processor. The privileged state bit has value OFF, indicating that program C is a user program. When program S is running, the privileged state bit has value ON. In this (and later) figures, lower addresses are nearer the bottom of the figure.

Multiuser System (Cont'd)

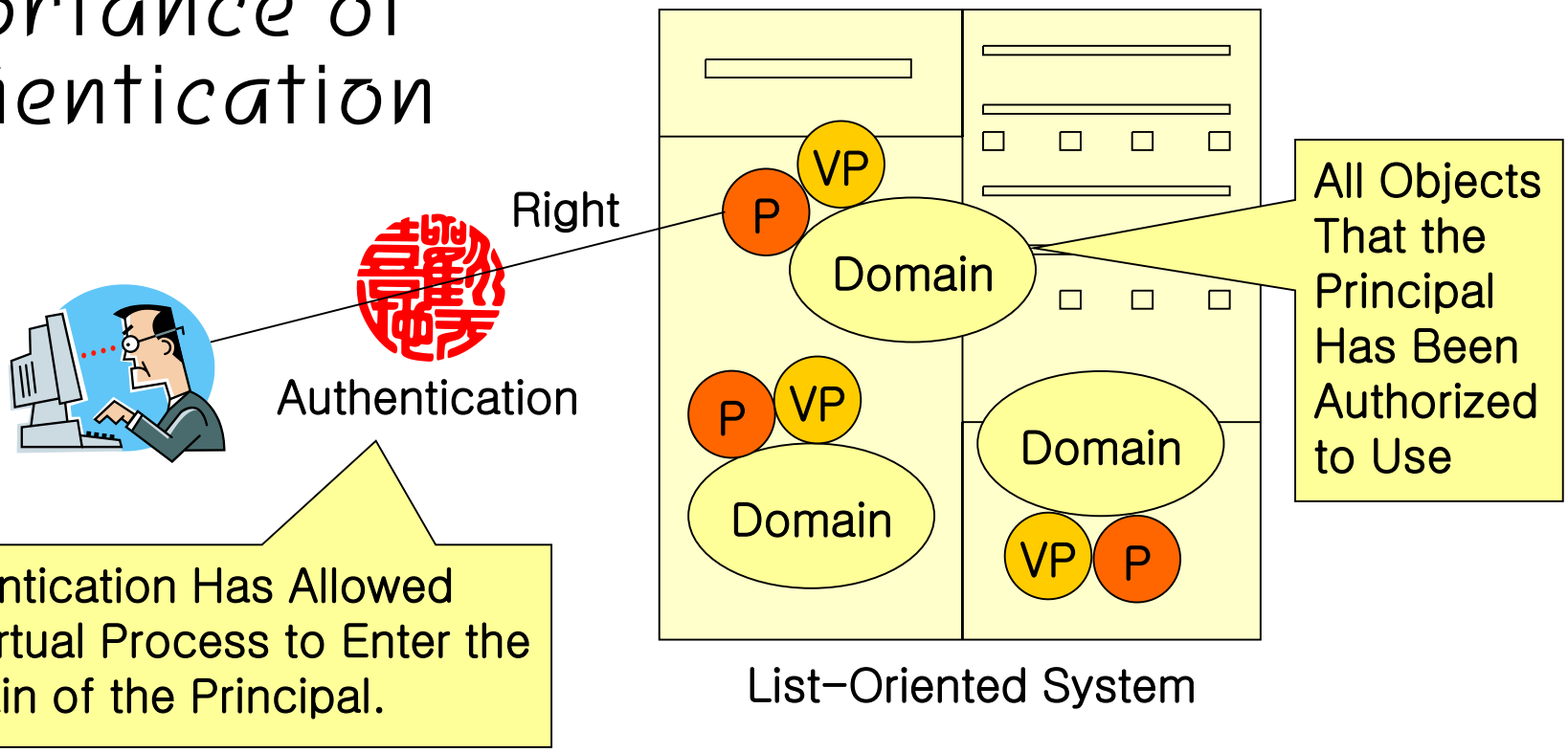
- Information Sharing
  - List-Oriented Mechanism (with Costly Associative Matching)
    - Guard holding a list of IDs of authorized users
      - E.g., a store clerk checking list of credit customers
    - Checking at the access request time
  - Ticket-Oriented Mechanism
    - Guard holding the description of a single ID
      - E.g., a locked door that opens with a key (ticket)
    - Checking at the information selection time

Practical Combination of a List-Oriented System at the Human Interface and a Ticket-Oriented Mechanism in the Underlying H/W

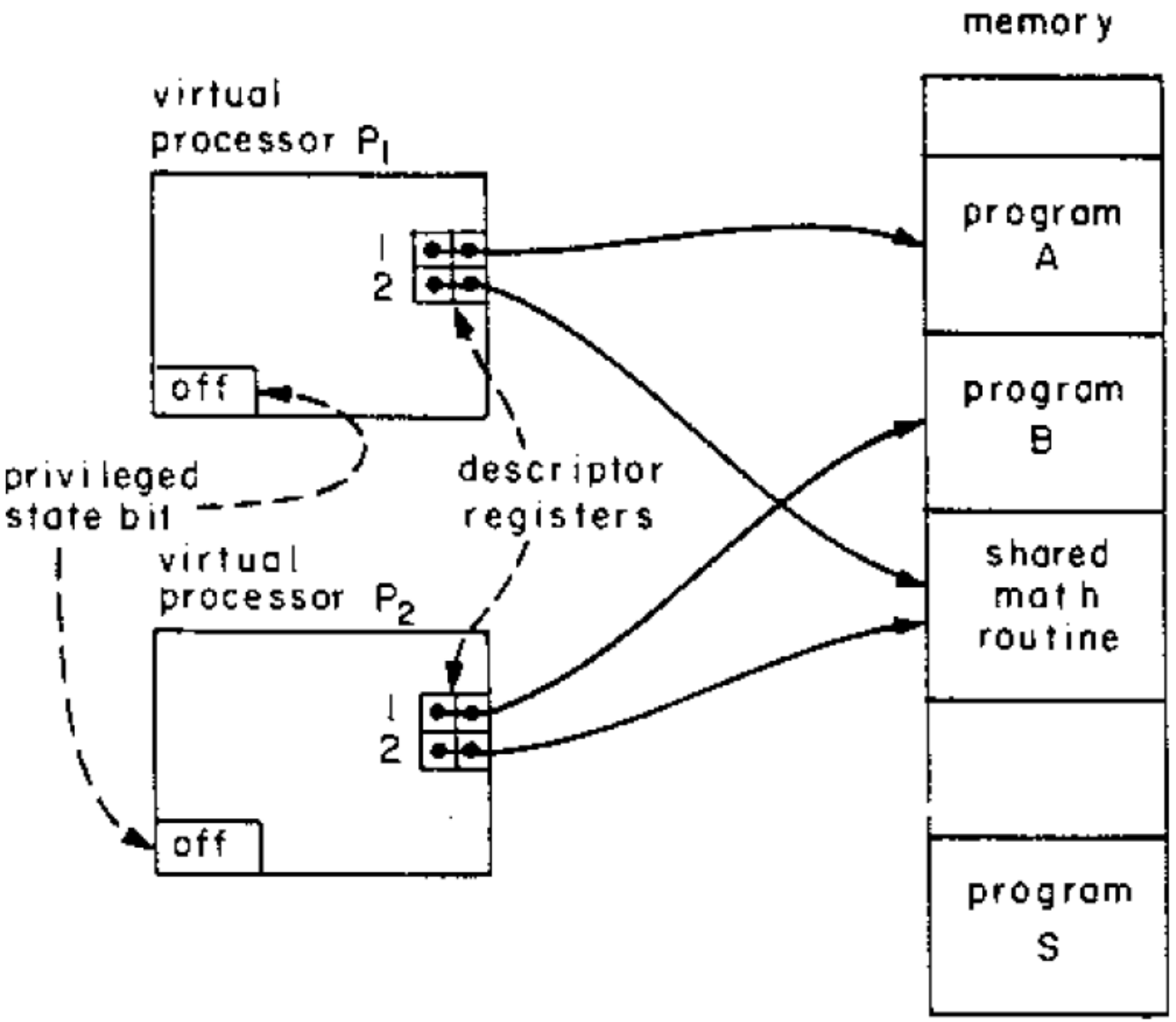
What to be Protected: Information, the Guard's Authorization Information, Association between a User and the Label or Set of Tickets

Multiuser System (Cont'd)

- Principle of Least Privilege
  - Use of Different Principals Depending on the Purposes
- Importance of Authentication

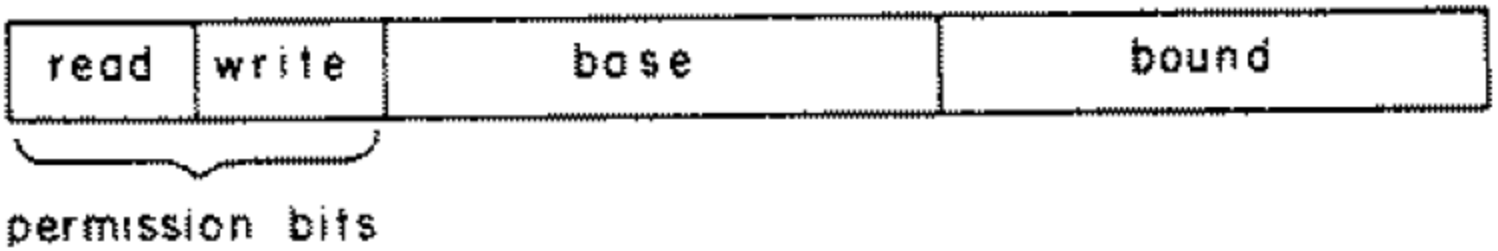


Sharing of a Routine



Sharing Implications

- Overwriting



- Shared Area Modifications
  - Shared Routine's Writing into Private Areas
- Need for Generalization
  - Capability Systems (Ticket-Oriented)
  - Access Control List Systems (List-Oriented)

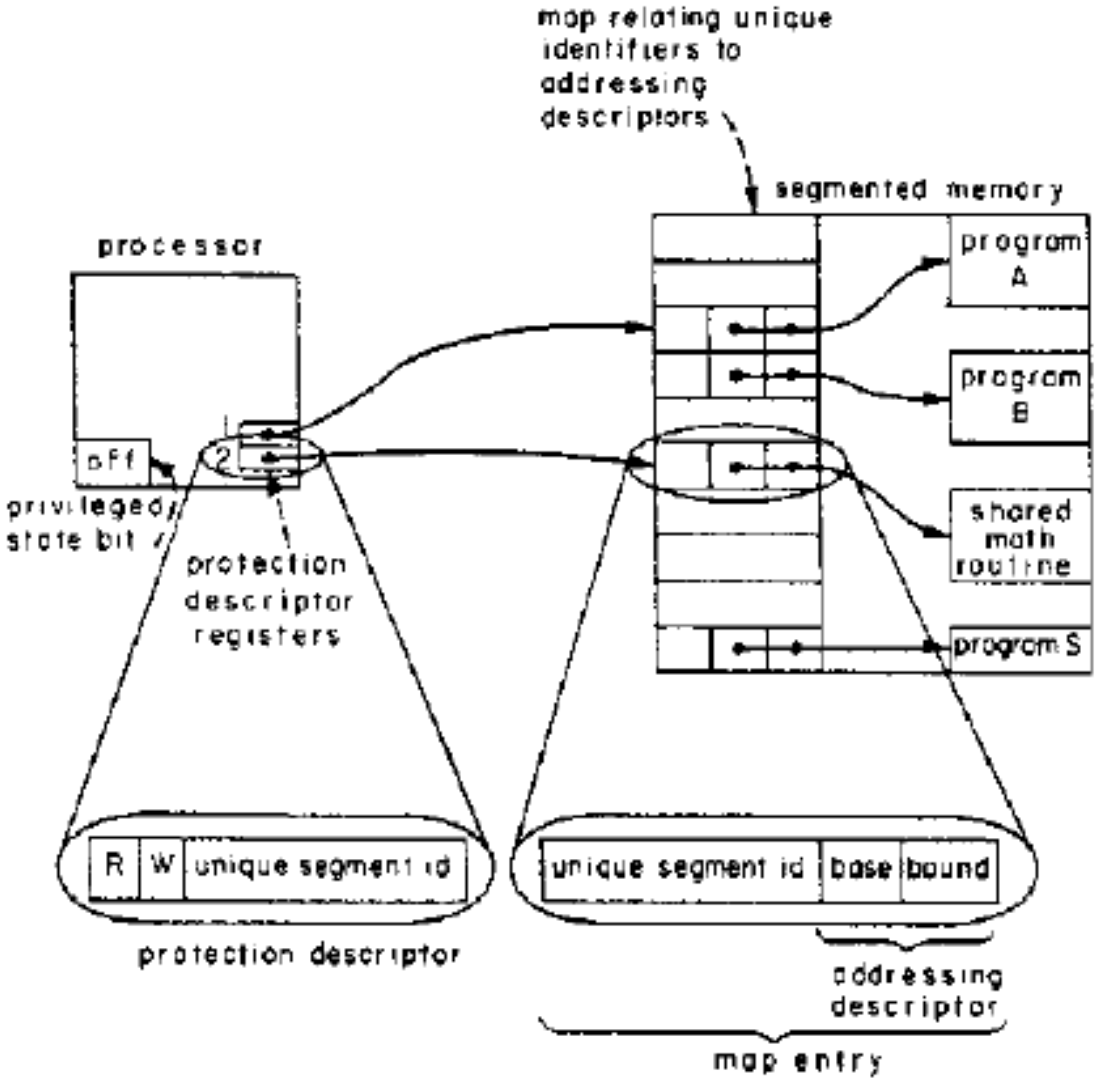
With More Descriptor Registers

Separation of Addressing & Protection

- System Address Space
  - Consisting of All Segments (Storage Areas)
    - Each segment with a distinct name, scope, and protection
- Processor Address Space
  - Defined by the Protection Descriptors

These Descriptors Are First Reloaded at a Control Switch

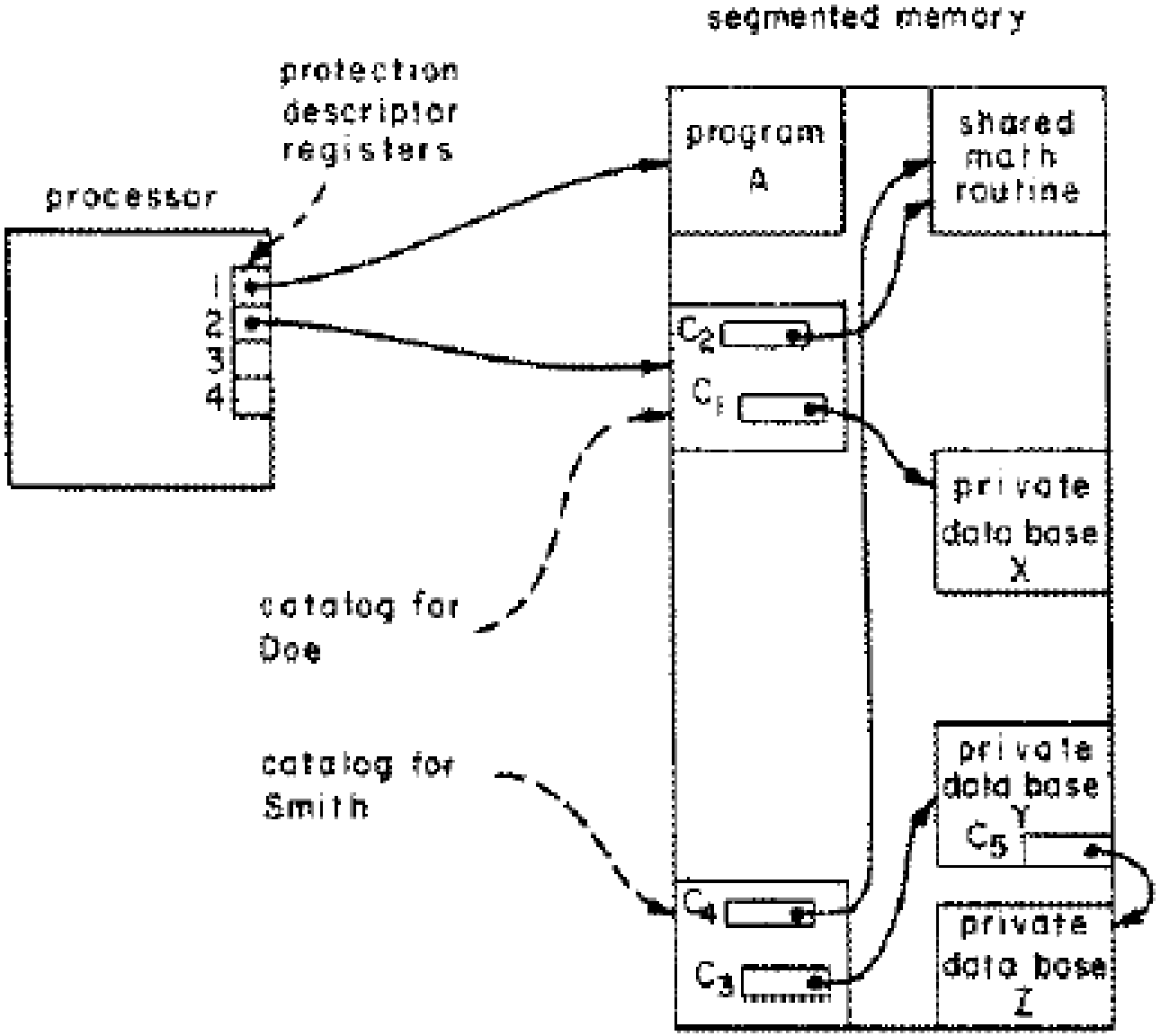
Separation of Addressing and Protection Descriptors



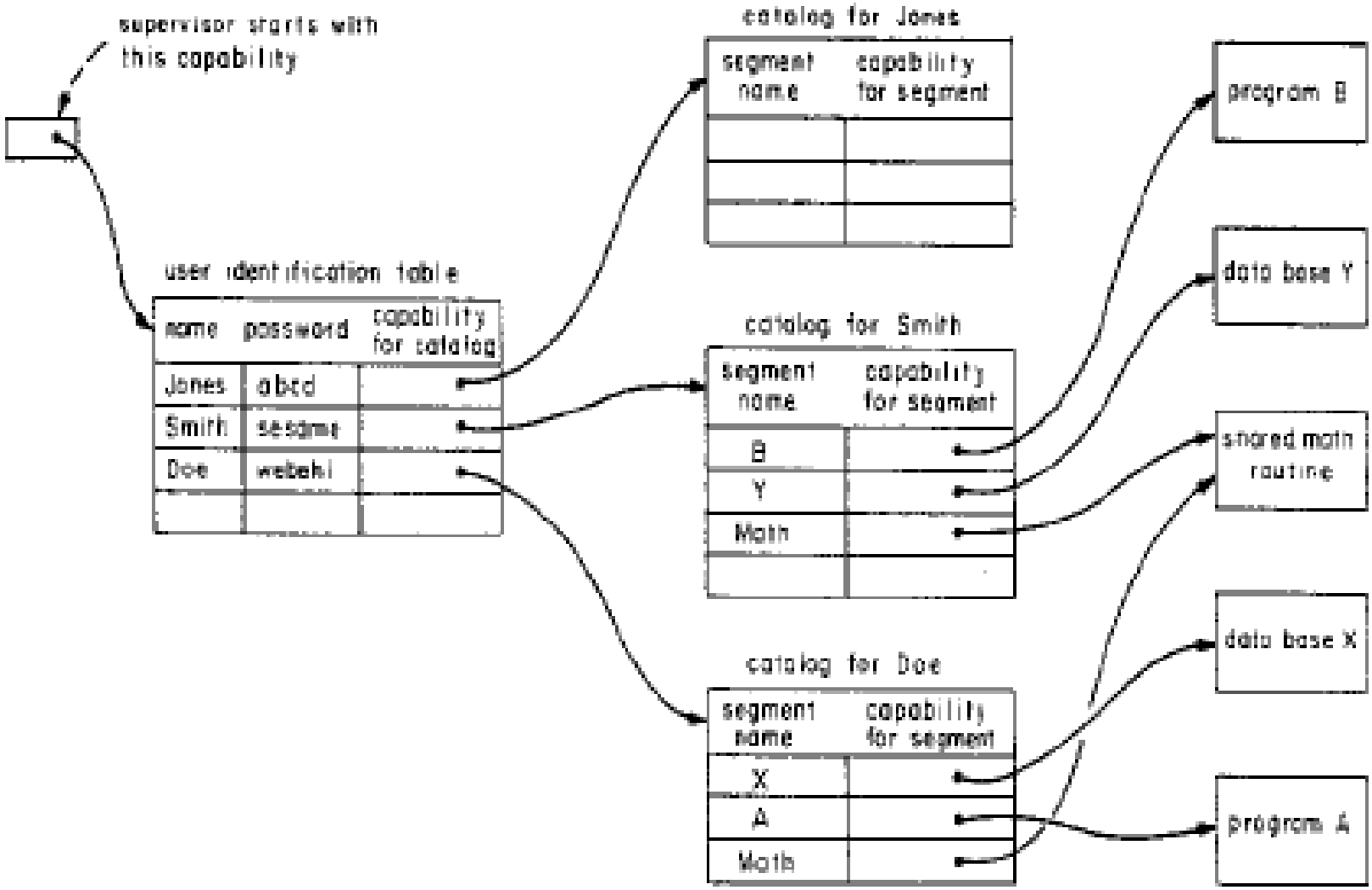
Capability System

- Tagged Architecture
  - Memory Storing Protection Descriptor Values or Capabilities (with the Tag Bits On) as Well as Ordinary Data Values
  - Processor Directed to Load a Capability and then Addressing the Space
    - Supervisor Initially Starting a Processor for User Identification Using a Table (Authentication)

Simple Capability System



Capability System with Provision for Authentication



Dynamic Authorization of Sharing

- Protection for Authorization Changing Mechanism (Copying of a Capability)
  - Assumption
    - IDs previously transmitted in an external communication
  - Method: Authority Check
    - Comparison of an inside principal ID (e.g., name) with outside authorization information
  - Issues
    - Single mailbox segment
    - Revocation with capability-holding segments and revocable indirect objects
    - Preventing propagation with a copy bit and a depth counter