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 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
Use of a descriptor register to simulate multiple virtual machines. Program C is in control of the 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

A Principal Is an Entity Accountable for the Activities of a Virtual Process

List–Oriented System

Authentication Has Allowed the Virtual Process to Enter the Domain of the Principal.

All Objects That the Principal Has Been Authorized to Use
Sharing of a Routine

virtual processor \( P_1 \)

privileged state bit

virtual processor \( P_2 \)

descriptor registers

memory

program A

program B

shared math routine

program S
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)
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