OPERATING SYSTEMS

I/O Management, System Protection and Security

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Domain of Protection: Unix, MULTICS examples

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Slides Credits for all PPTs of this course

- The slides/diagrams in this course are an **adaptation**, **combination**, and **enhancement** of material from the following resources and persons:

1. Slides of Operating System Concepts, Abraham Silberschatz, Peter Baer Galvin, Greg Gagne - 9th edition 2013 and some slides from 10th edition 2018
2. Some conceptual text and diagram from Operating Systems - Internals and Design Principles, William Stallings, 9th edition 2018
3. Some presentation transcripts from A. Frank – P. Weisberg
4. Some conceptual text from Operating Systems: Three Easy Pieces, Remzi Arpaci-Dusseau, Andrea Arpaci Dusseau

Domain Implementation (UNIX)

- Domain = user-id
- Domain switch accomplished via file system
  - Each file has associated with it a domain bit (setuid bit)
  - When file is executed and setuid = on, then user-id is set to owner of the file being executed
  - When execution completes user-id is reset
- Domain switch accomplished via passwords
  - su command temporarily switches to another user's domain when other domain's password provided
- Domain switching via commands
  - sudo command prefix executes specified command in another domain (if original domain has privilege or password given)

OPERATING SYSTEMS

Domain Implementation (MULTICS)

- The protection domains are organized hierarchically into a ring structure.
- Each ring corresponds to a single domain
- The rings are numbered from 0 to 7.
- A process executing in domain Do has the most privileges.
- MULTICS has a segmented address space.
- Each segment is a file, and each segment is associated with one of the rings.
- It includes three access bits to control reading, writing, and execution

Multiplexed Information and Computing Service

- was a cooperative project led by MIT along with General Electric and Bell Labs.

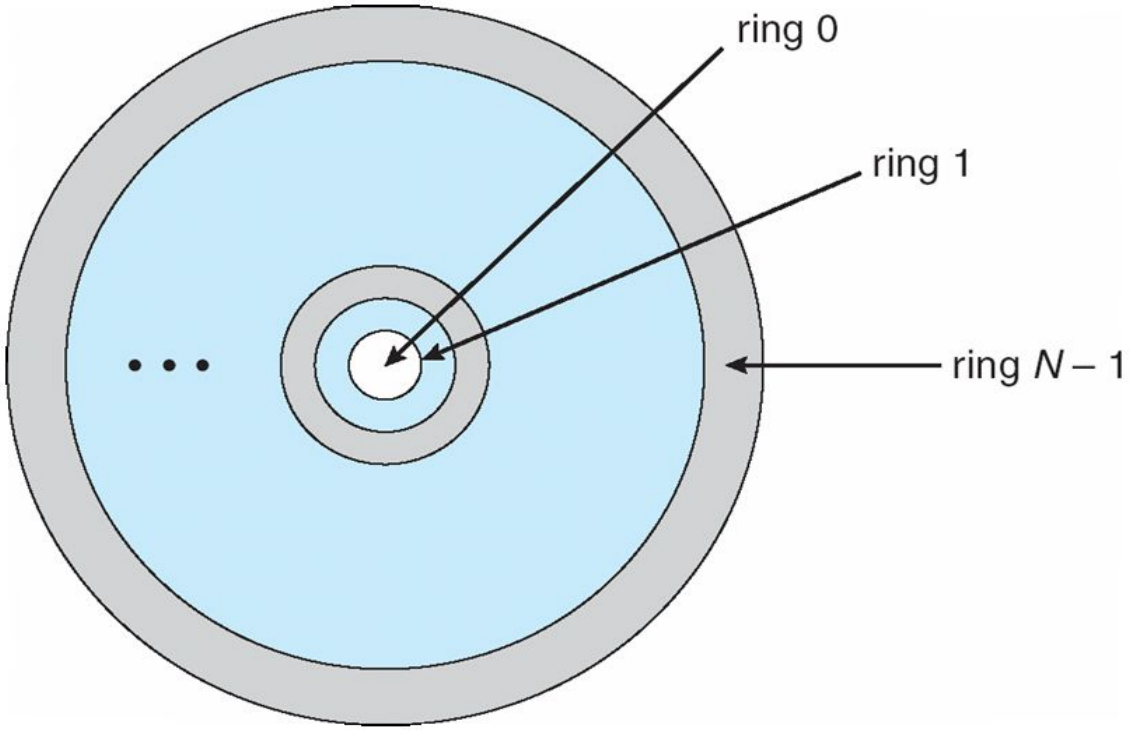
-was started in 1964 and has influenced all modern operating systems from microcomputers to mainframes

--was the first major OS to be designed as a secure system

-- had hardware support for ring-oriented security

Multics ring Structure

- Let Di and Dj be any two domain rings.
- If $j < i \Rightarrow Di \subseteq Dj$



Multics Domain Implementation

- A current-ring-number counter is associated with each process, identifying the ring in which the process is executing currently.
- When a process is executing in ring i, it cannot access a segment associated, with ring j (j < i).
- It can access a segment associated with ring k (k > i).
- Domain switching in MULTICS occurs when a process crosses from one ring to another by calling a procedure in a different ring.

Multics Domain Switching

Ring field of the segment descriptor include the following:

1. Access bracket. A pair of integers, b1 and b2, such that b1<= b2.
2. Limit. An integer b3 such that b3 > b2.
3. List of gates. Identifies the entry points (or gates) at which the segments may be called.

- If a process operating in ring i calls a segment whose bracket is such that b1 <= i <= b2, then the call succeeds and the current ring no of process remains i.
- Otherwise a trap to the OS occurs, and is handled as follows:
  - If i < b1, then the call is allowed, because we are transferring to a procedure with fewer privileges.
  - If i > b2, then the call is allowed only if i <= b3 and the call is directed to one of the entries on the list of gates.

THANK YOU

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