CS 155 Spring 2006

Access Control and Operating System Security

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Outline

- Access Control Concepts
  - Matrix, ACL, Capabilities
  - Multi-level security (MLS)
- OS Mechanisms
  - Multics
    - Ring structure
  - Amoeba
    - Distributed, capabilities
  - Unix
    - File system, Setuid
  - Windows
    - File system, Tokens, EFS
  - SE Linux
    - Role-based, Domain type enforcement
- Assurance, Limitations
  - Secure OS
    - Methods for resisting stronger attacks
  - Assurance
    - Orange Book, TCSEC
    - Common Criteria
    - Windows 2000 certification
  - Some Limitations
    - Information flow
    - Covert channels

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Access control

- Assumptions
  - System knows who the user is
    - Authentication via name and password, other credential
  - Access requests pass through gatekeeper
    - System must not allow monitor to be bypassed

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Access control matrix [Lampson]

Objects

Subjects	File 1	File 2	File 3	...	File n
User 1	read	write	-	-	read
User 2	write	write	write	-	-
User 3	-	-	-	read	read
...					
User m	read	write	read	write	read

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Two implementation concepts

- Access control list (ACL)
  - Store column of matrix with the resource
- Capability
  - User holds a "ticket" for each resource
  - Two variations
    - store row of matrix with user, under OS control
    - unforgeable ticket in user space

	File 1	File 2	...
User 1	read	write	-
User 2	write	write	-
User 3	-	-	read
...			
User m	read	write	write

Access control lists are widely used, often with groups

Some aspects of capability concept are used in Kerberos, ...

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Capabilities

- Operating system concept
  - "... of the future and always will be ..."
- Examples
  - Dennis and van Horn, MIT PDP-1 Timesharing
  - Hydra, StarOS, Intel iAPX 432, Eros, ...
  - Amoeba: distributed, unforgeable tickets
- References
  - Henry Levy, Capability-based Computer Systems http://www.cs.washington.edu/homes/levy/capabook/
  - Tanenbaum, Amoeba papers

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ACL vs Capabilities

- Access control list
  - Associate list with each object
  - Check user/group against list
  - Relies on authentication: need to know user
- Capabilities
  - Capability is unforgeable ticket
    - Random bit sequence, or managed by OS
    - Can be passed from one process to another
  - Reference monitor checks ticket
    - Does not need to know identify of user/process

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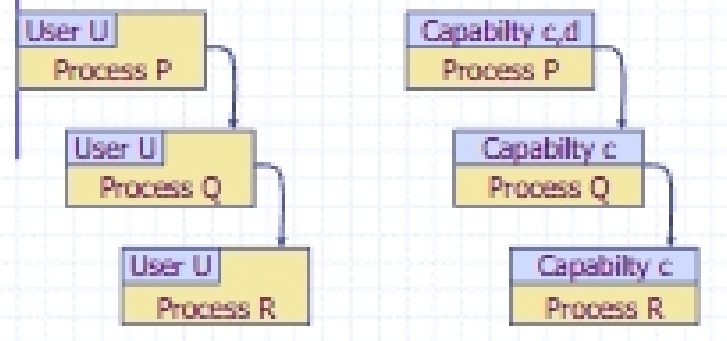
ACL vs Capabilities



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ACL vs Capabilities

- Delegation
  - Cap: Process can pass capability at run time
  - ACL: Try to get owner to add permission to list?
    - More common: let other process act under current user
- Revocation
  - ACL: Remove user or group from list
  - Cap: Try to get capability back from process?
    - Possible in some systems if appropriate bookkeeping
      - OS knows what data is capability
      - If capability is used for multiple resources, have to revoke all or none ...
      - Other details ...

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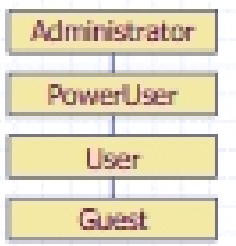
Roles (also called Groups)

- Role = set of users
  - Administrator, PowerUser, User, Guest
  - Assign permissions to roles; each user gets permission
- Role hierarchy
  - Partial order of roles
  - Each role gets permissions of roles below
  - List only new permissions given to each role



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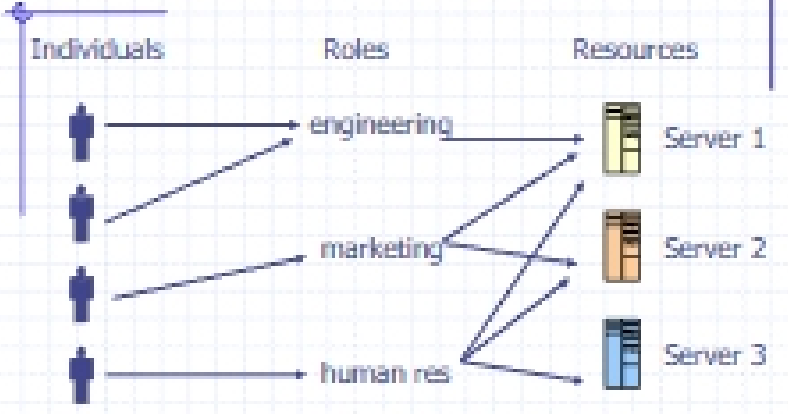
Role-Based Access Control



Advantage: user's change more frequently than roles

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Groups for resources, rights

- Permission = (right, resource)
- Permission hierarchies
  - If user has right r, and r>=s, then user has right s
  - If user has read access to directory, user has read access to every file in directory
- General problem in access control
  - Complex mechanisms require complex input
  - Difficult to configure and maintain
  - Roles, other organizing ideas try to simplify problem

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Multi-Level Security (MLS) Concepts

- Military security policy
  - Classification involves sensitivity levels, compartments
  - Do not let classified information leak to unclassified files
- Group individuals and resources
  - Use some form of hierarchy to organize policy
- Other policy concepts
  - Separation of duty
  - "Chinese Wall" Policy

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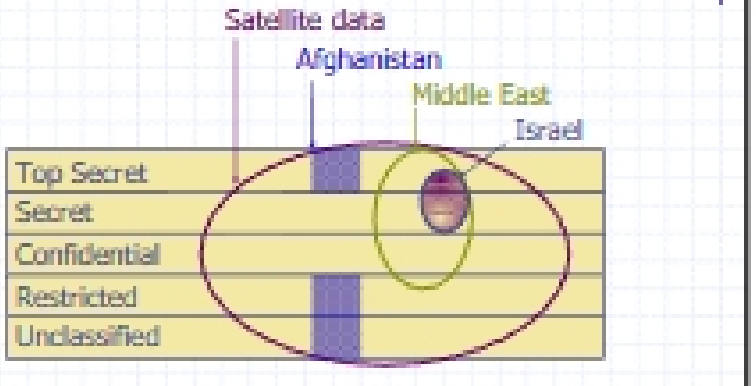
Military security policy

- Sensitivity levels
- Compartments



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Military security policy

- Classification of personnel and data
  - Class = ⟨rank, compartment⟩
- Dominance relation
  - $D_1 \leq D_2$ iff $rank_1 \leq rank_2$ and $compartment_1 \subseteq compartment_2$
  - Example: ⟨Restricted, Israel⟩ ≤ ⟨Secret, Middle East⟩
- Applies to
  - Subjects – users or processes
  - Objects – documents or resources

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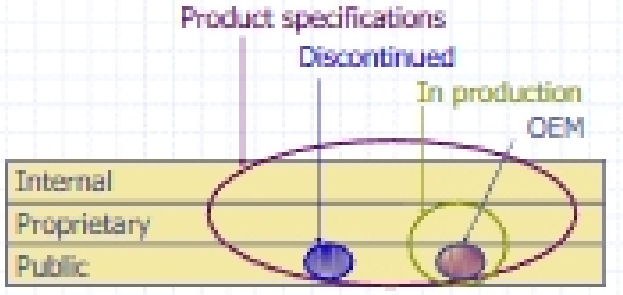
Commercial version



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Bell-LaPadula Confidentiality Model

- When is it OK to release information?
- Two Properties (with silly names)
  - Simple security property
    - A subject S may read object O only if C(O) ≤ C(S)
  - *-Property
    - A subject S with read access to O may write object P only if C(O) ≤ C(P)
- In words,
  - You may only *read below* your classification and only *write above* your classification

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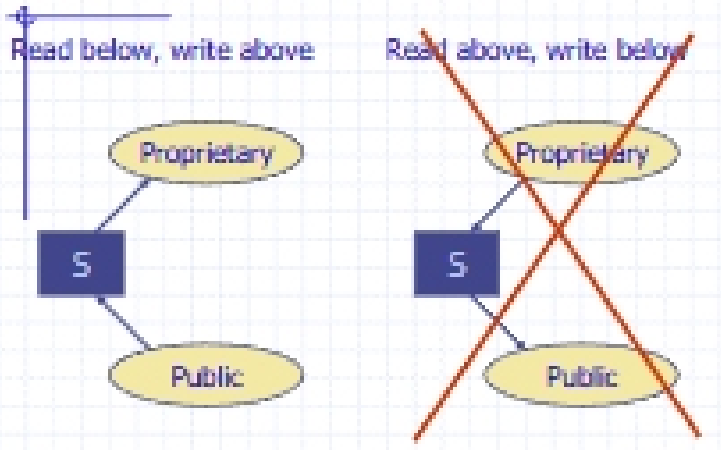
Picture: Confidentiality



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