Security Principles and Policies
CS 239
Computer Security
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January 10, 2007

Outline

- Security terms and concepts
- Security policies
  - Basic concepts
  - Security policies for real systems

Security and Protection

- *Security* is a policy
  - E.g., "no unauthorized user may access this file"
- *Protection* is a mechanism
  - E.g., "the system checks user identity against access permissions"
- Protection mechanisms implement security policies

Policy vs. Mechanism

People shouldn't drive that fast in my neighborhood!
SPEED LIMIT 25
That's a mechanism
That's a policy

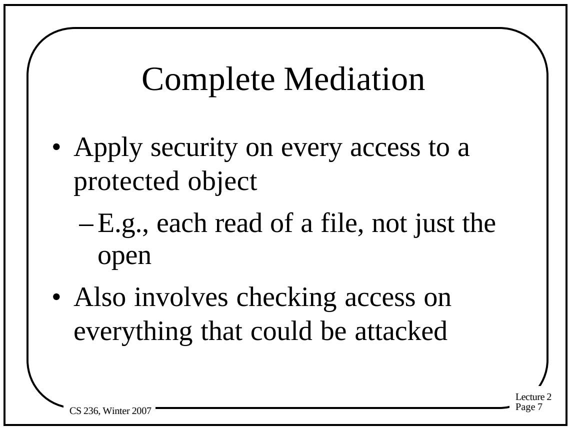
That's a different type of mechanism

Design Principles for Secure Systems

- Economy
- Complete mediation
- Open design
- Separation of privileges
- Least privilege
- Least common mechanism
- Acceptability
- Fail-safe defaults

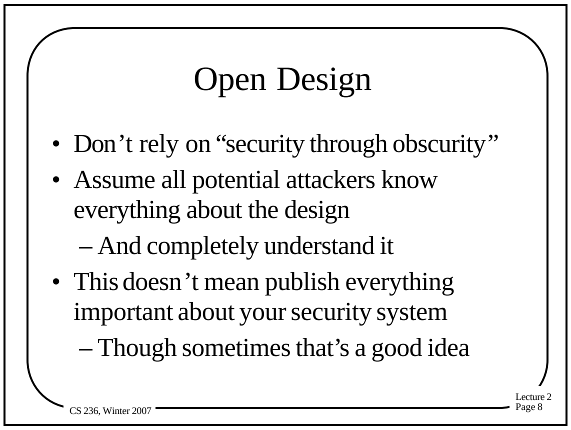
Economy in Security Design

- Economical to develop
  - And to use
  - And to verify
- Should add little or no overhead
- Should do only what needs to be done
- Generally, try to keep it simple and small



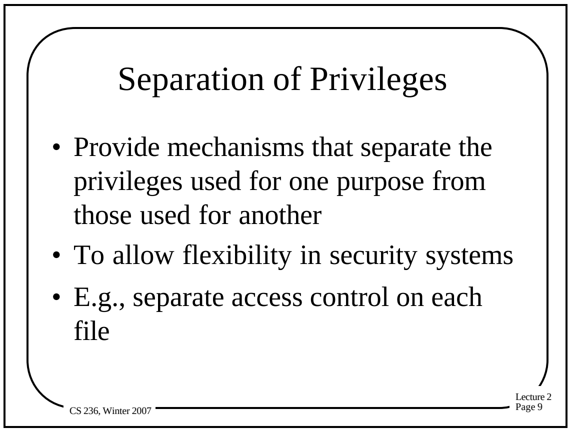
Complete Mediation

- Apply security on every access to a protected object
  - E.g., each read of a file, not just the open
- Also involves checking access on everything that could be attacked



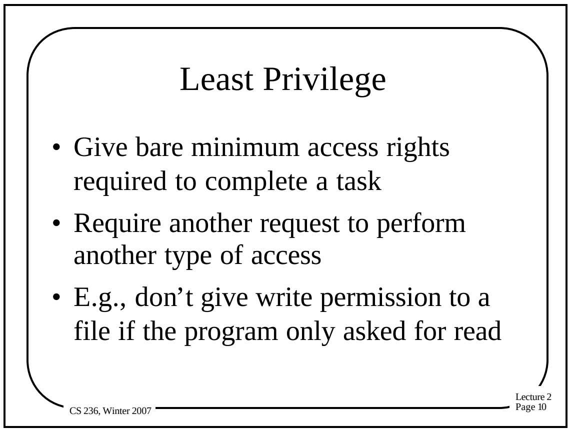
Open Design

- Don't rely on "security through obscurity"
- Assume all potential attackers know everything about the design
  - And completely understand it
- This doesn't mean publish everything important about your security system
  - Though sometimes that's a good idea



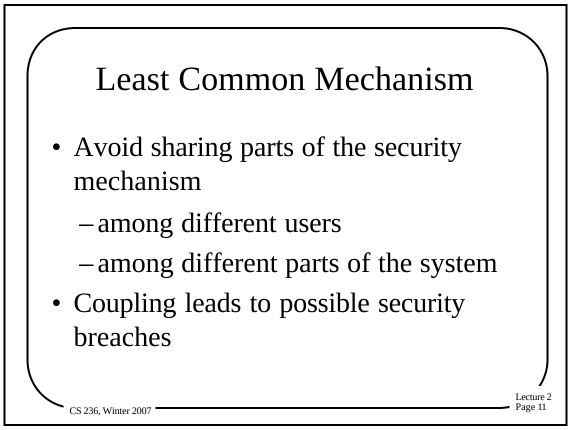
Separation of Privileges

- Provide mechanisms that separate the privileges used for one purpose from those used for another
- To allow flexibility in security systems
- E.g., separate access control on each file



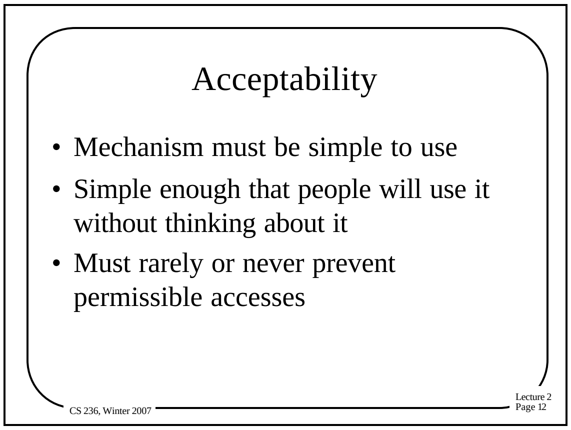
Least Privilege

- Give bare minimum access rights required to complete a task
- Require another request to perform another type of access
- E.g., don't give write permission to a file if the program only asked for read



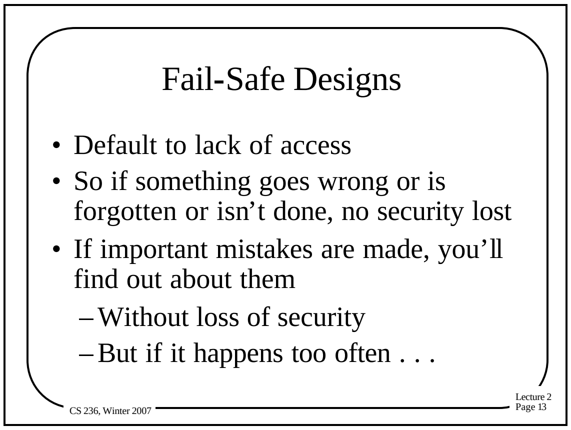
Least Common Mechanism

- Avoid sharing parts of the security mechanism
  - among different users
  - among different parts of the system
- Coupling leads to possible security breaches



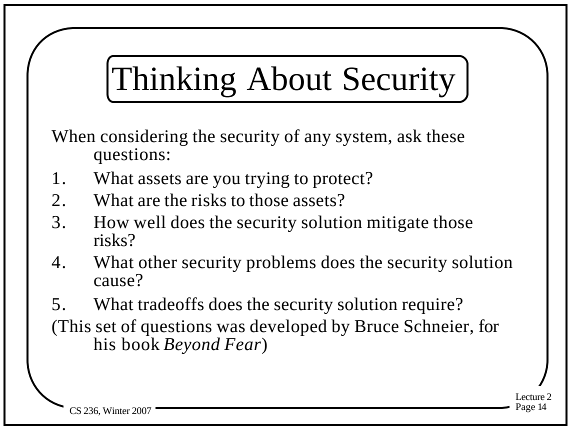
Acceptability

- Mechanism must be simple to use
- Simple enough that people will use it without thinking about it
- Must rarely or never prevent permissible accesses



Fail-Safe Designs

- Default to lack of access
- So if something goes wrong or is forgotten or isn’t done, no security lost
- If important mistakes are made, you’ll find out about them
  - Without loss of security
  - But if it happens too often . . .

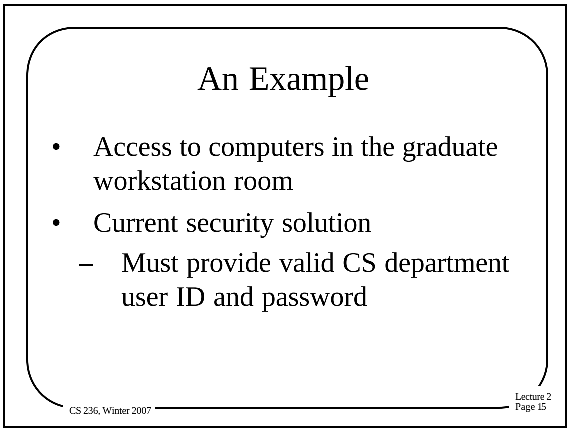


Thinking About Security

When considering the security of any system, ask these questions:

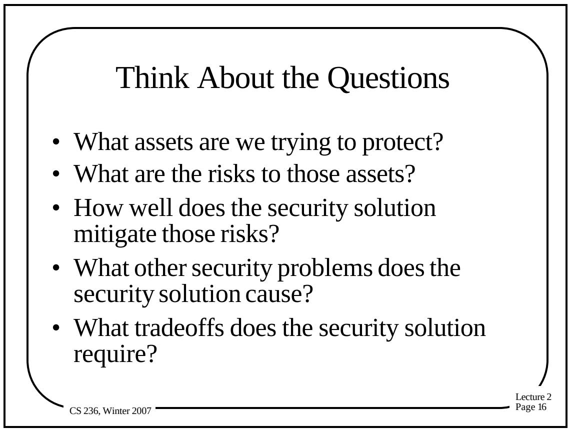
1. What assets are you trying to protect?
2. What are the risks to those assets?
3. How well does the security solution mitigate those risks?
4. What other security problems does the security solution cause?
5. What tradeoffs does the security solution require?

(This set of questions was developed by Bruce Schneier, for his book *Beyond Fear*)



An Example

- Access to computers in the graduate workstation room
- Current security solution
  - Must provide valid CS department user ID and password



Think About the Questions

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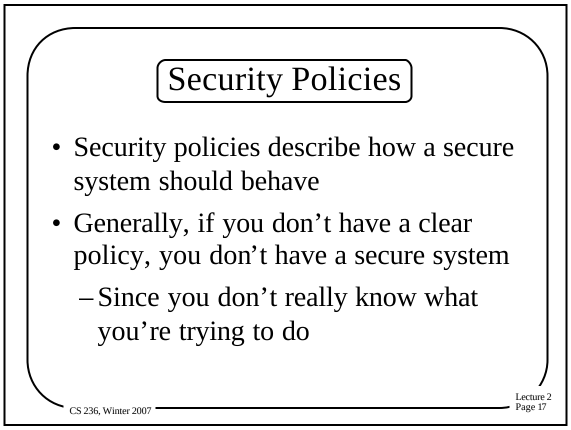
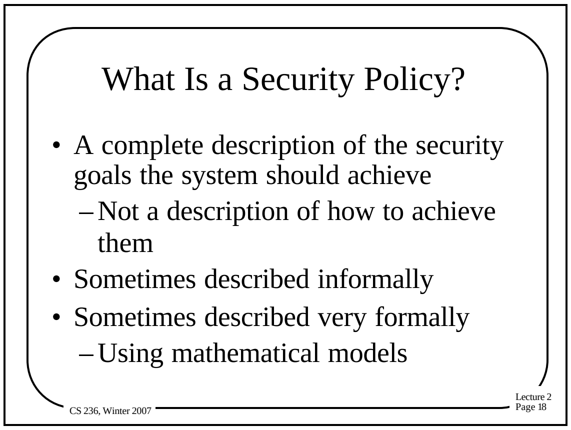


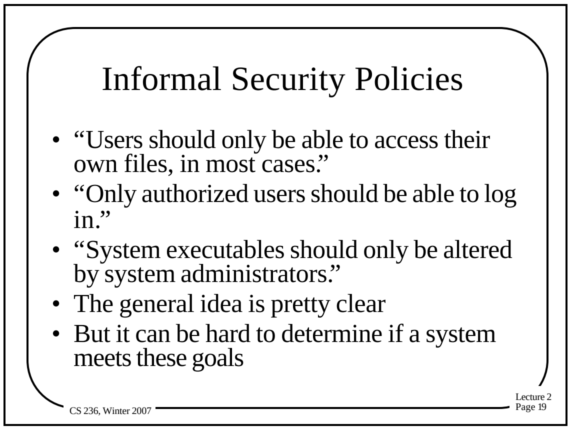
Security Policies

- Security policies describe how a secure system should behave
- Generally, if you don’t have a clear policy, you don’t have a secure system
  - Since you don’t really know what you’re trying to do



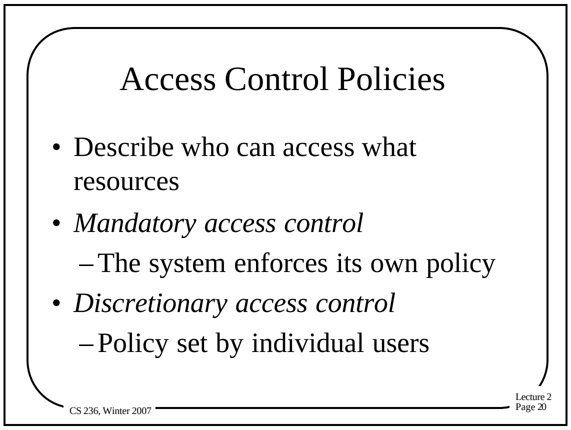
What Is a Security Policy?

- A complete description of the security goals the system should achieve
  - Not a description of how to achieve them
- Sometimes described informally
- Sometimes described very formally
  - Using mathematical models



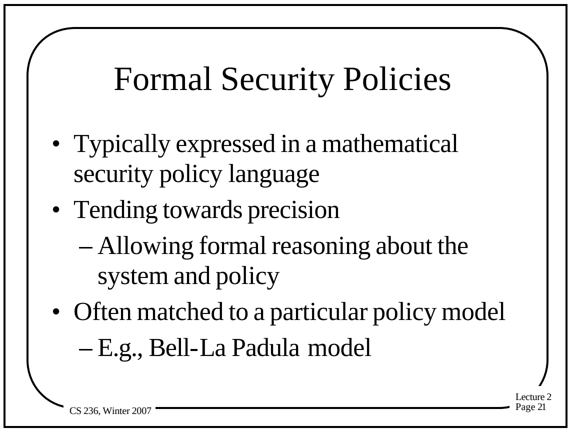
Informal Security Policies

- “Users should only be able to access their own files, in most cases.”
- “Only authorized users should be able to log in.”
- “System executables should only be altered by system administrators.”
- The general idea is pretty clear
- But it can be hard to determine if a system meets these goals



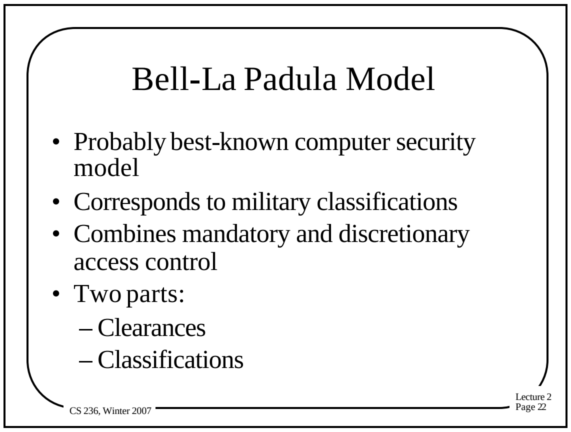
Access Control Policies

- Describe who can access what resources
- *Mandatory access control*
  - The system enforces its own policy
- *Discretionary access control*
  - Policy set by individual users



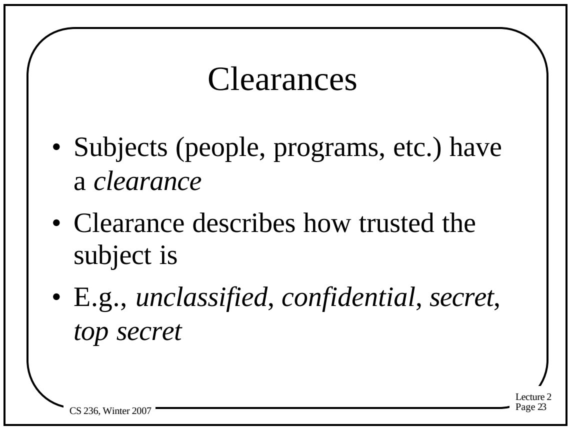
Formal Security Policies

- Typically expressed in a mathematical security policy language
- Tending towards precision
  - Allowing formal reasoning about the system and policy
- Often matched to a particular policy model
  - E.g., Bell-La Padula model



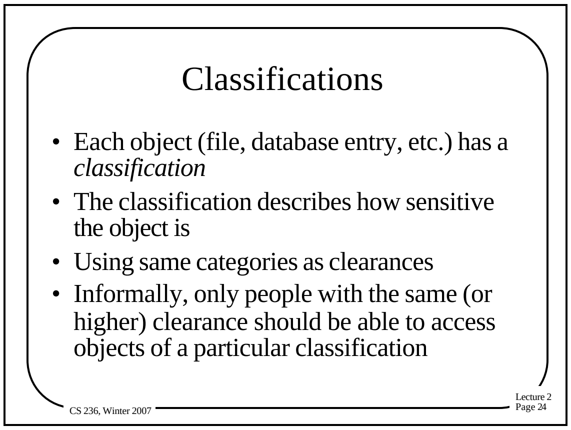
Bell-La Padula Model

- Probably best-known computer security model
- Corresponds to military classifications
- Combines mandatory and discretionary access control
- Two parts:
  - Clearances
  - Classifications



Clearances

- Subjects (people, programs, etc.) have a *clearance*
- Clearance describes how trusted the subject is
- E.g., *unclassified*, *confidential*, *secret*, *top secret*



Classifications

- Each object (file, database entry, etc.) has a *classification*
- The classification describes how sensitive the object is
- Using same categories as clearances
- Informally, only people with the same (or higher) clearance should be able to access objects of a particular classification

Goal of Bell-LaPadula Model

- Prevent any subject from ever getting read access to objects at higher classification levels than subject's clearance
- Concerned not just with objects
- Also concerned with the objects' contents
- Includes discretionary access control
  - Which we won't cover in lecture

Bell-LaPadula Simple Security Condition

- *Subject S can read object O iff* $l_O = l_S$
- Simple enough:
  - If S isn't granted top secret clearance, S can't read top secret objects
- Are we done?

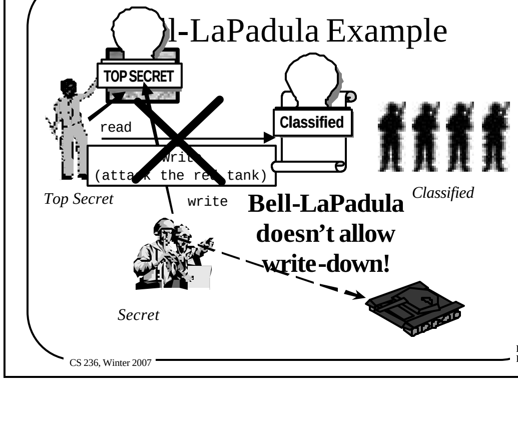
Why Aren't We Done?

- Remember, we really care about the information in an object
- A subject with top secret clearance can read a top secret object
- If careless, he could write that information to a confidential object
- Then someone with confidential clearance can read top secret information

The Bell-LaPadula *-Property

- *S can write O iff* $l_S = l_O$
- Prevents *write-down*
  - Privileged subjects writing high-classification information to low-classification objects
  - E.g., a top secret user can't write to a confidential data file
- Can be proven that a system meeting these properties is "secure"

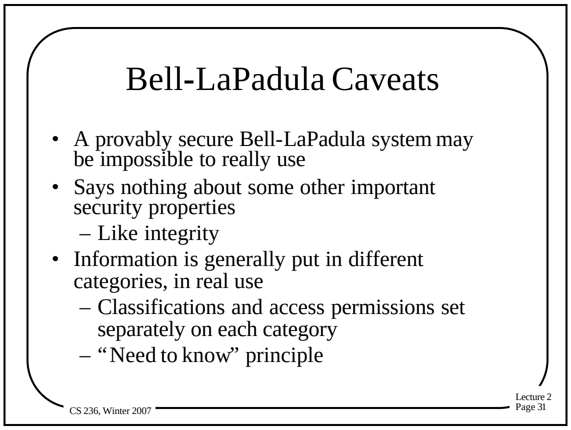
l-LaPadula Example



Bell-LaPadula doesn't allow write-down!

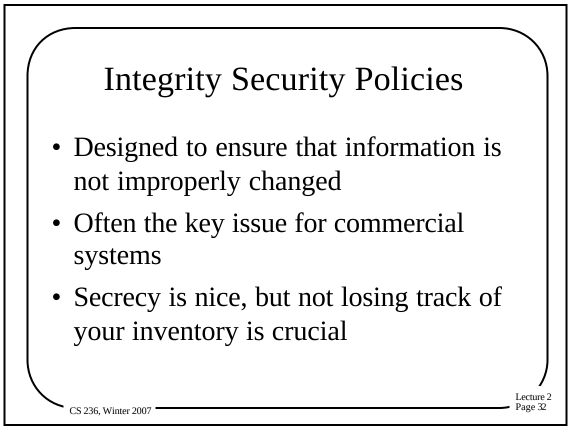
So How Do You Really Use The System?

- There have to be mechanisms for reclassification
- Typically, a document at a higher classification is set to a lower one
  - Usually requiring explicit operation
- Danger that reclassification process will be done incautiously



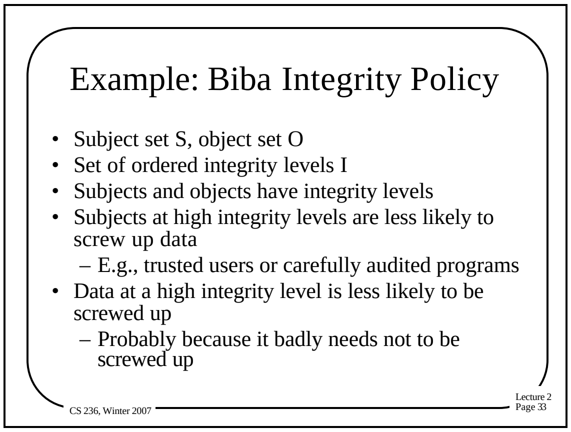
Bell-LaPadula Caveats

- A provably secure Bell-LaPadula system may be impossible to really use
- Says nothing about some other important security properties
  - Like integrity
- Information is generally put in different categories, in real use
  - Classifications and access permissions set separately on each category
  - "Need to know" principle



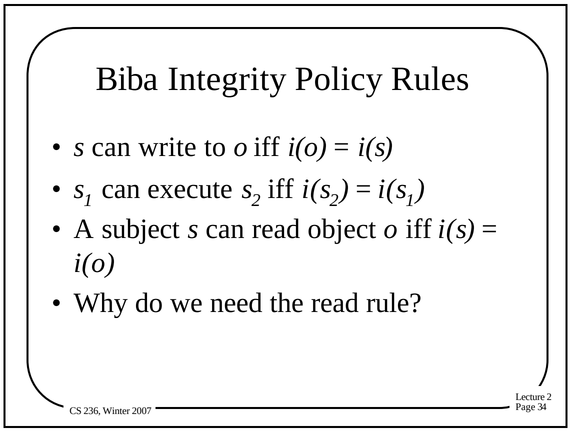
Integrity Security Policies

- Designed to ensure that information is not improperly changed
- Often the key issue for commercial systems
- Secrecy is nice, but not losing track of your inventory is crucial



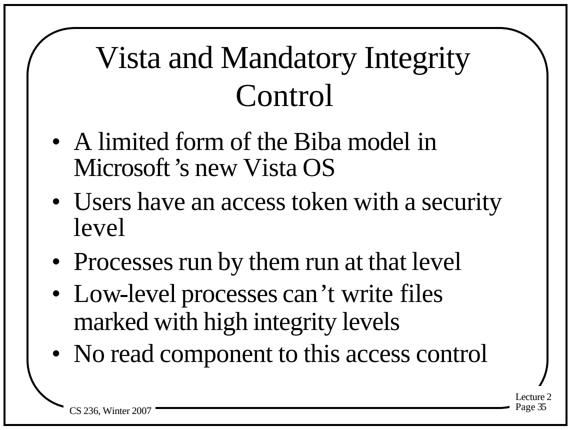
Example: Biba Integrity Policy

- Subject set S, object set O
- Set of ordered integrity levels I
- Subjects and objects have integrity levels
- Subjects at high integrity levels are less likely to screw up data
  - E.g., trusted users or carefully audited programs
- Data at a high integrity level is less likely to be screwed up
  - Probably because it badly needs not to be screwed up



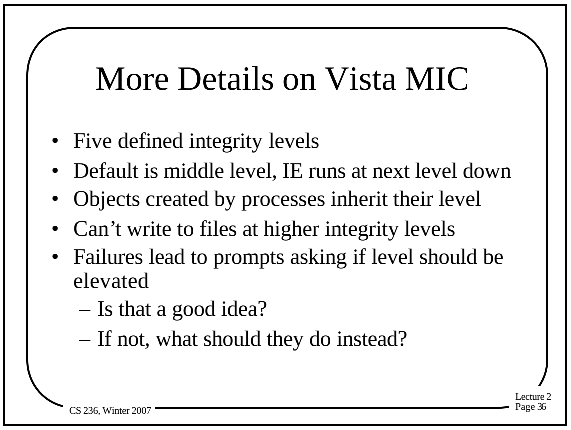
Biba Integrity Policy Rules

- s can write to o iff $i(o) = i(s)$
- s_1 can execute s_2 iff $i(s_2) = i(s_1)$
- A subject s can read object o iff $i(s) = i(o)$
- Why do we need the read rule?



Vista and Mandatory Integrity Control

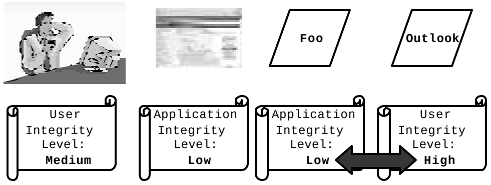
- A limited form of the Biba model in Microsoft's new Vista OS
- Users have an access token with a security level
- Processes run by them run at that level
- Low-level processes can't write files marked with high integrity levels
- No read component to this access control



More Details on Vista MIC

- Five defined integrity levels
- Default is middle level, IE runs at next level down
- Objects created by processes inherit their level
- Can't write to files at higher integrity levels
- Failures lead to prompts asking if level should be elevated
  - Is that a good idea?
  - If not, what should they do instead?

An Example


Foo
Outlook
User Integrity Level: Medium
Application Integrity Level: Low
Application Integrity Level: Low
User Integrity Level: High

The application downloads an executable foo

foo runs and tries to write to the Outlook executable

Vista MIC denies the write

Hybrid Models

- Sometimes the issue is keeping things carefully separated
- E.g., a brokerage that handles accounts for several competing businesses
- Microsoft might not like the same analyst working on their account and IBM's
- There are issues of both confidentiality and integrity here

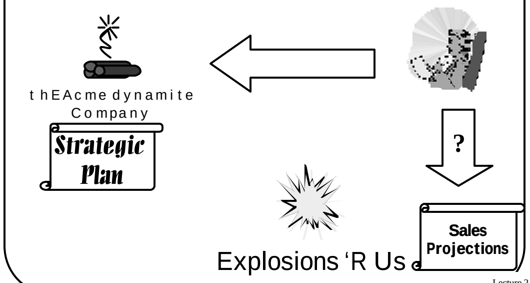
The Chinese Wall Model

- Keep things that should be separated apart
- Objects *O* are items of information related to a company
- A company dataset *CD* contains all of a company's objects
- A conflict-of-interest class *COI* contains the datasets of companies in competition
  - I.e., the things needing to be kept apart

Chinese Wall Security Conditions

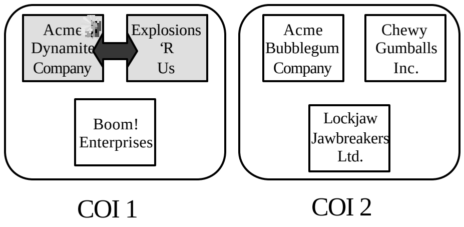
- *S* can read *O* iff any of the following holds:
  1. There is an object *O?*that *S* has accessed and *CD(O) = CD(O?)*
  2. For all objects *O?, O?? PR(S) ? COI(O?) ? COI(O)* (*PR(S)* is the set of objects *S* has already read)
  3. *O* is a sanitized object
     - While *O* may be in a forbidden *CD* for *S*, anything sensitive has been removed

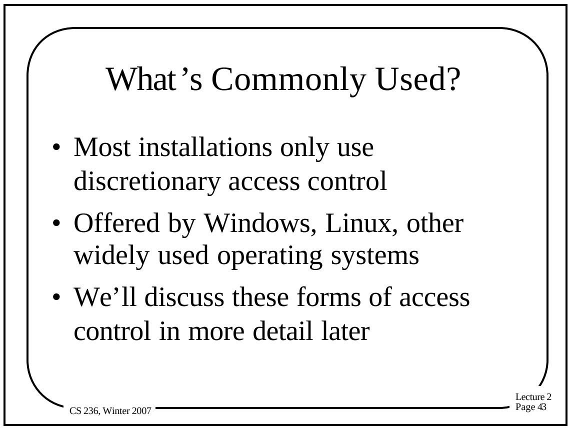
Chinese Wall Example



Should This Be Allowed?

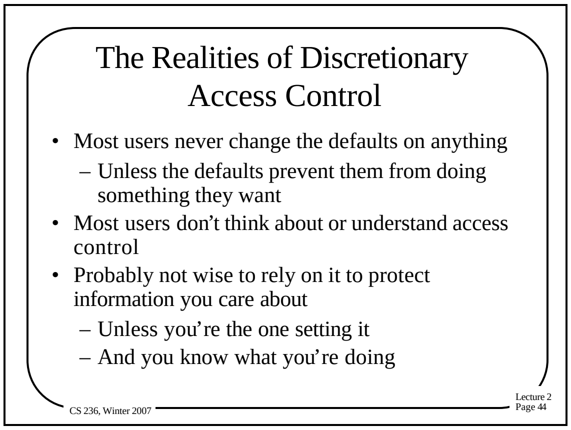
This access violates CW rule 2





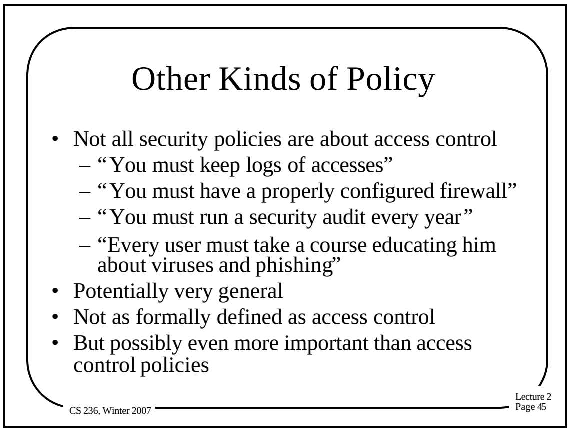
What’s Commonly Used?

- Most installations only use discretionary access control
- Offered by Windows, Linux, other widely used operating systems
- We’ll discuss these forms of access control in more detail later



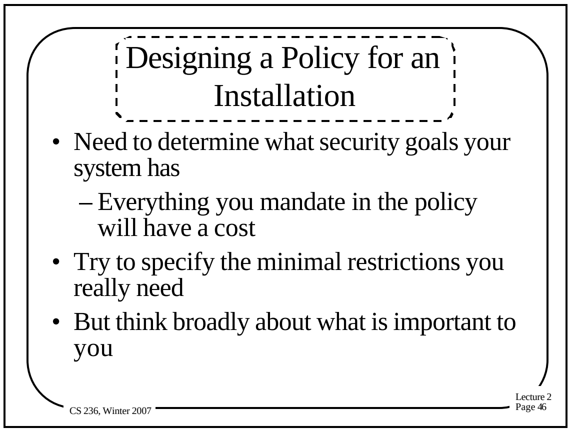
The Realities of Discretionary Access Control

- Most users never change the defaults on anything
  - Unless the defaults prevent them from doing something they want
- Most users don’t think about or understand access control
- Probably not wise to rely on it to protect information you care about
  - Unless you’re the one setting it
  - And you know what you’re doing



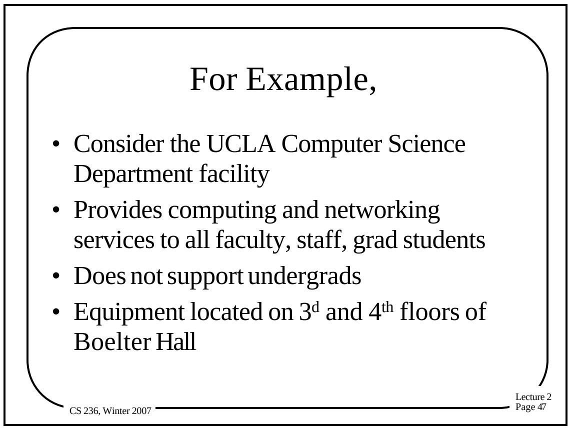
Other Kinds of Policy

- Not all security policies are about access control
  - “You must keep logs of accesses”
  - “You must have a properly configured firewall”
  - “You must run a security audit every year”
  - “Every user must take a course educating him about viruses and phishing”
- Potentially very general
- Not as formally defined as access control
- But possibly even more important than access control policies



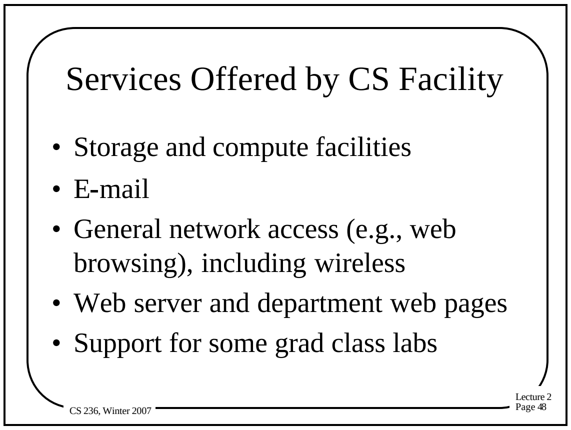
Designing a Policy for an Installation

- Need to determine what security goals your system has
  - Everything you mandate in the policy will have a cost
- Try to specify the minimal restrictions you really need
- But think broadly about what is important to you



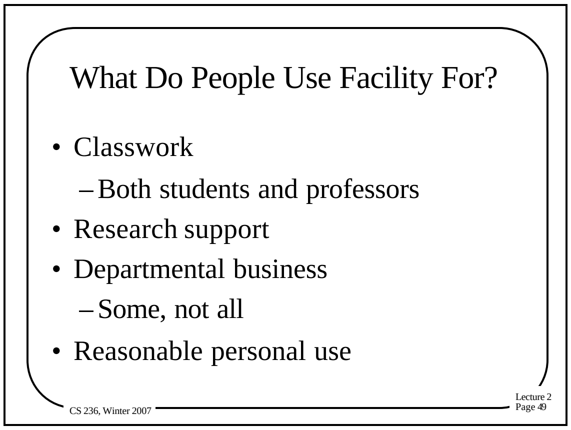
For Example,

- Consider the UCLA Computer Science Department facility
- Provides computing and networking services to all faculty, staff, grad students
- Does not support undergrads
- Equipment located on 3d and 4th floors of Boelter Hall



Services Offered by CS Facility

- Storage and compute facilities
- E-mail
- General network access (e.g., web browsing), including wireless
- Web server and department web pages
- Support for some grad class labs



What Do People Use Facility For?

- Classwork
  - Both students and professors
- Research support
- Departmental business
  - Some, not all
- Reasonable personal use

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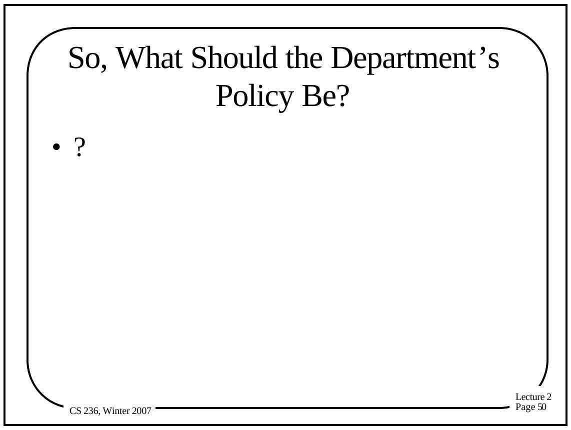

So, What Should the Department's Policy Be?

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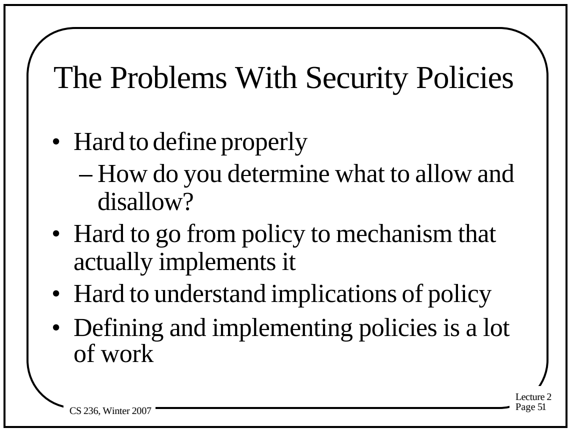

The Problems With Security Policies

- Hard to define properly
  - How do you determine what to allow and disallow?
- Hard to go from policy to mechanism that actually implements it
- Hard to understand implications of policy
- Defining and implementing policies is a lot of work

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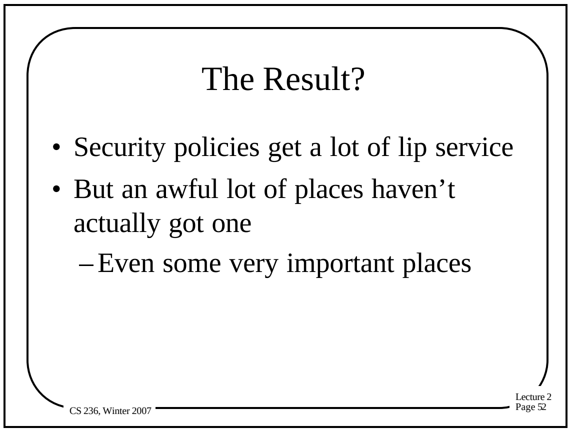

The Result?

- Security policies get a lot of lip service
- But an awful lot of places haven't actually got one
  - Even some very important places

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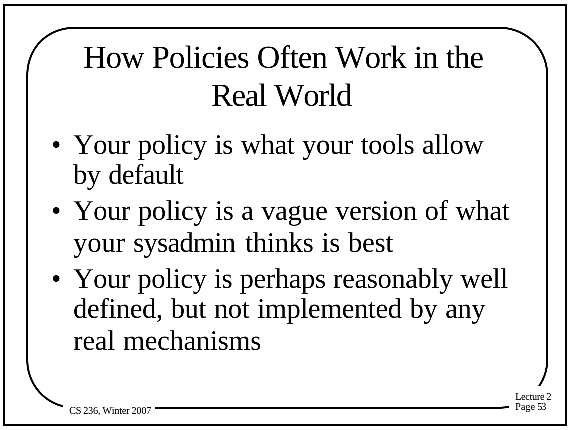

How Policies Often Work in the Real World

- Your policy is what your tools allow by default
- Your policy is a vague version of what your sysadmin thinks is best
- Your policy is perhaps reasonably well defined, but not implemented by any real mechanisms

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