WILLIAM & MARY
CHARTERED 1693

CSCI 667: Concepts of Computer Security

Lecture 11

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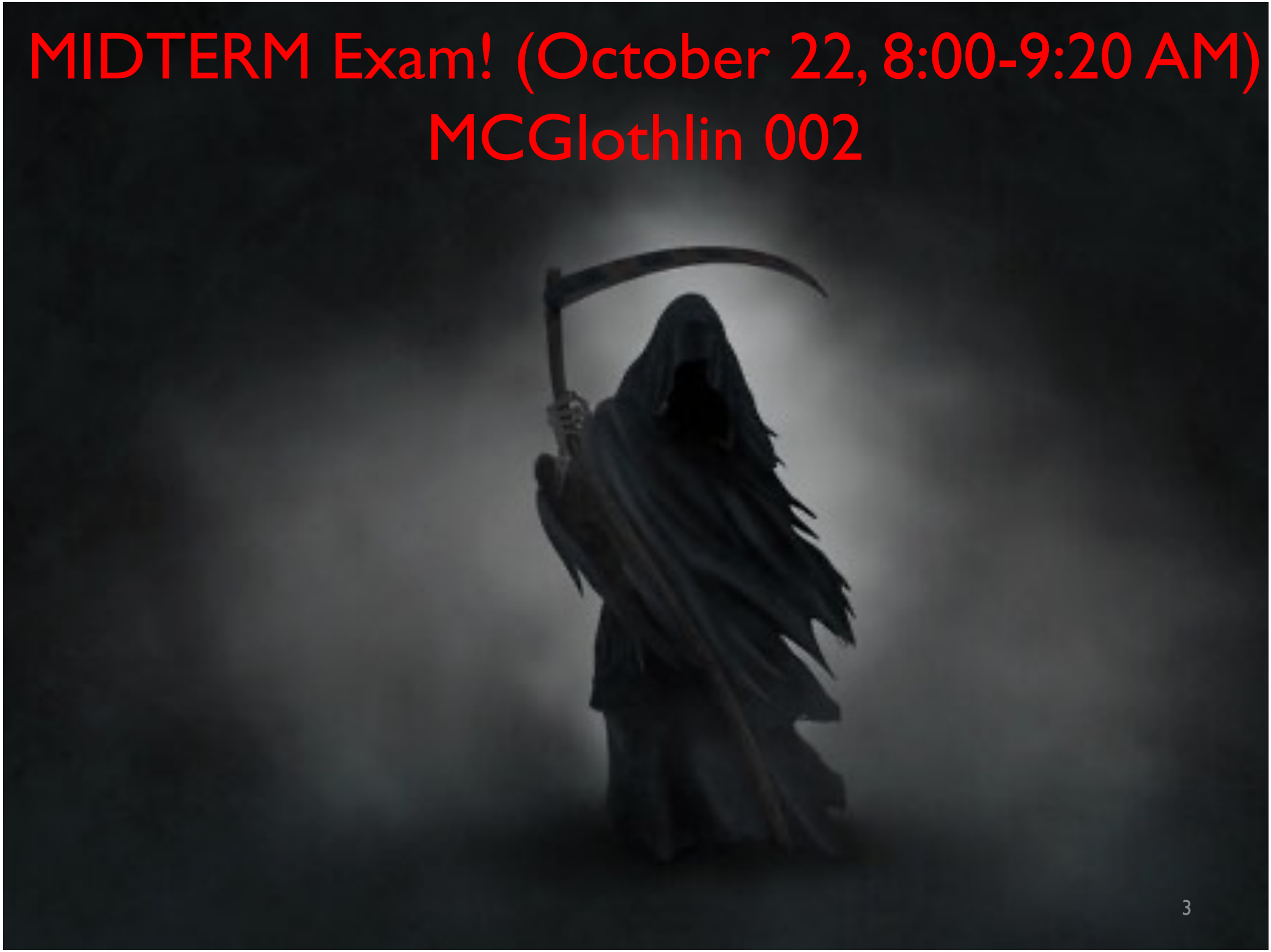
Derived from slides by William Enck, Patrick McDaniel and Trent Jaeger

Announcements!

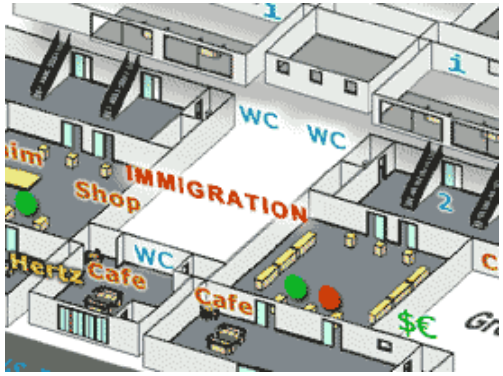
- Homework 3 due this Thursday
- HW2 grades and solution will be discussed on Thursday as well.
- Midterm review on Thursday

MIDTERM Exam! (October 22, 8:00-9:20 AM)
MCGlothlin 002



Policy

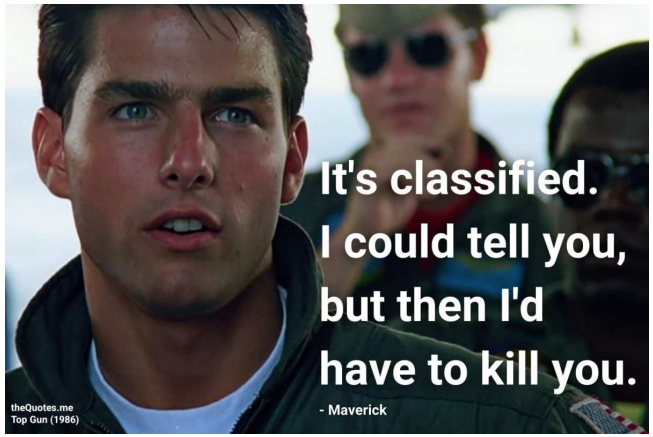
- A policy specifies the rules of security
  - Some statement of secure procedure or configuration that parameterizes the operation of a system
  - Example: Airport Policy
    - Take off your shoes
    - No bottles that could contain > 3 ozs
    - Empty bottles are OK?
    - You need to put your things through X-ray machine
    - Laptops by themselves, coat off
    - Go through the metal detector



- Goal: prevent on-airplane (metal) weapon, flammable liquid, dangerous objects … (successful?)

Computer Security Policy Goals

- Secrecy
  - Don't allow *reading* by unauthorized subjects
  - Control where data can be written by authorized subjects
    - Why is this important?
- Integrity
  - Don't allow *writing* by unauthorized subjects
  - Don't permit *dependence on lower integrity* data/code
    - Why is this important?
  - What is "dependence"?
- Availability
  - The necessary function must run
  - Doesn't this conflict with above?



… when policy goes wrong

- Driving license test: take until you pass
  - Mrs. Miriam Hargrave of Yorkshire, UK failed her driving test *39* times between 1962 and 1970!!!!
  - … she had 212 driving lessons ….
  - She finally got it on the 40th try.
  - Some years later, she was quoted as saying, "sometimes I still have trouble *turning right*"

"A policy is a set of acceptable behaviors."

- F. Schneider

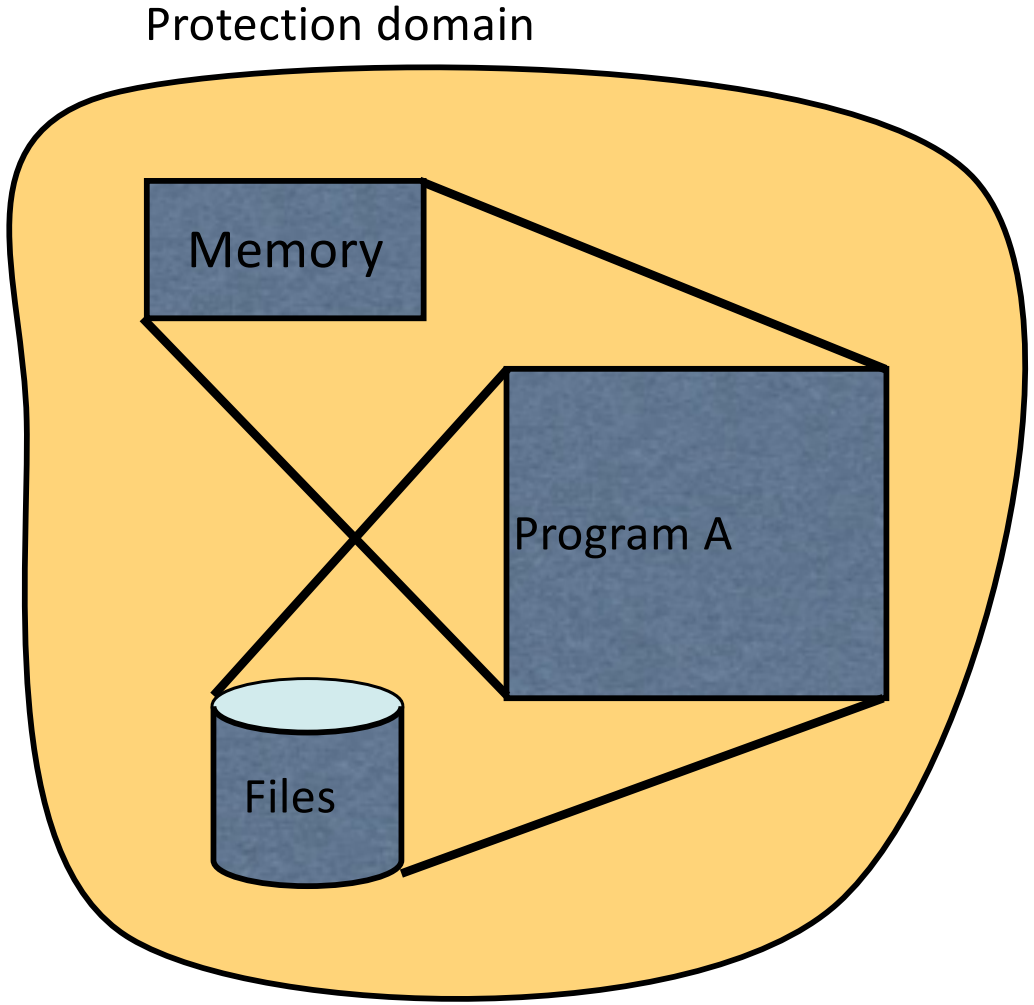
Access Control/Authorization

- An ***access control*** system determines what *rights* a particular *entity* has for a set of *objects*
- It answers the question
  - E.g., do you have the right to read /etc/passwd
  - Does Alice have the right to view the CS website?
  - Do students have the right to share project data?
  - Does Dr. Nadkarni have the right to change your grades?
- An Access Control Policy answers these questions

Simplified Access Control

- Subjects are the active entities that do things
  - E.g., you, Alice, students, Prof. Nadkarni
- Objects are passive things that things are done to
  - E.g., /etc/passwd, CSC website, project data, grades
- Rights are actions that are taken
  - E.g., read, view, share, change

Protection Domains



- A *protection domain* specifies the set of resources (objects) that a process can access and the operations that the process may use to access such resources.
- How is this done today?
  - Memory protection
  - E.g., UNIX protected memory, file-system permissions (rwx…)

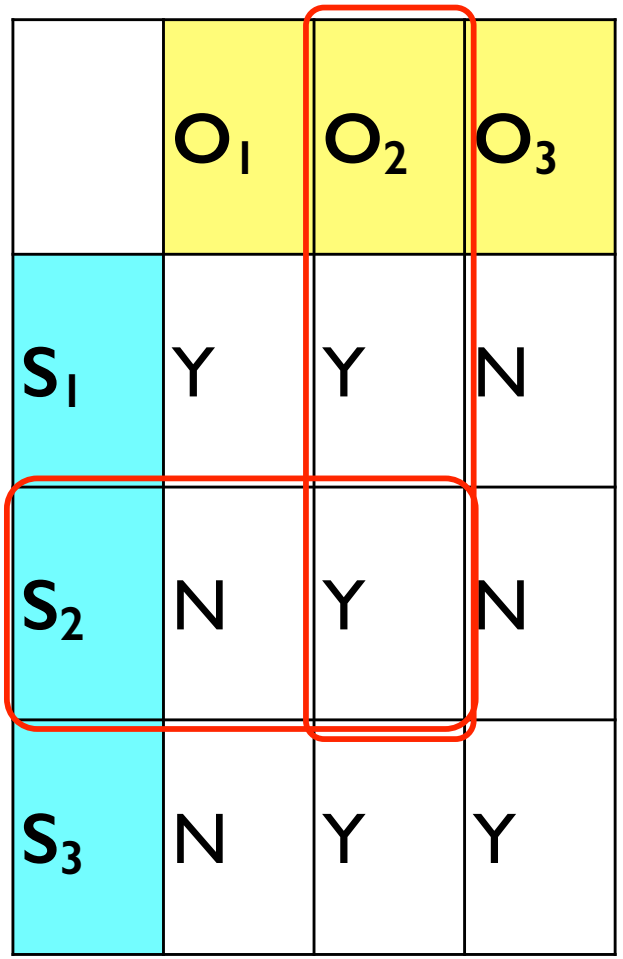
Policy is defined with respect to the protection domain it governs.

Access Policy Enforcement

- A *protection state* defines what each subject can do
  - E.g., in an access bits --- the policy
- A *reference monitor* enforces the protection state
  - A service that responds to the query...
- A correct reference monitor implementation meets the following guarantees
  1. Tamperproof
  2. Complete Mediation
  3. Simple enough to verify
- A *protection system* consists of a protection state, operations to modify that state, and a reference monitor to enforce that state

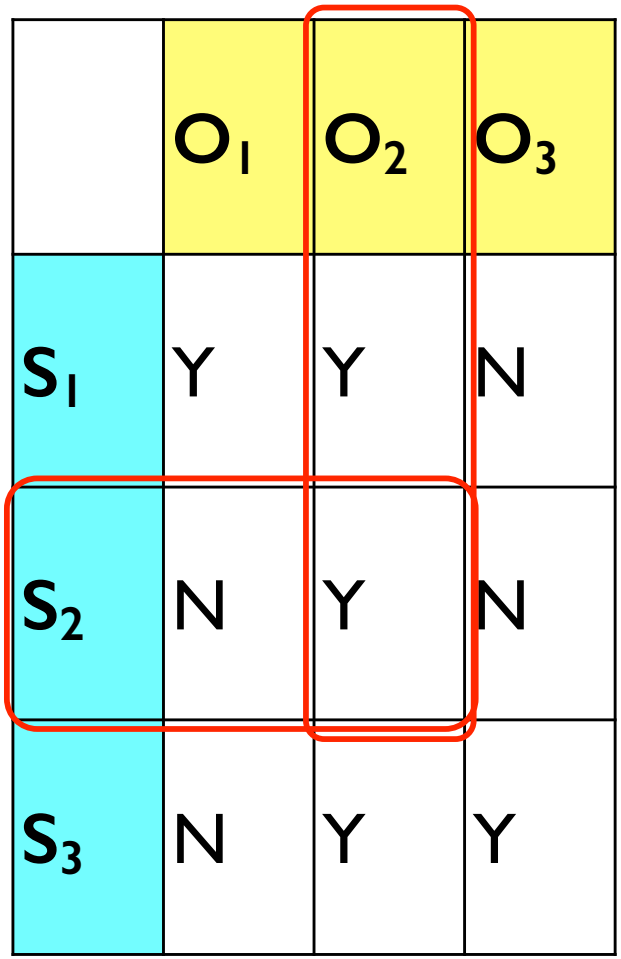
The Access Matrix

- An access matrix is one way to represent policy.
  - Frequently used mechanism for describing policy
- Columns are objects, subjects are rows.
  - To determine if S_i has right to access object O_j, find the appropriate entry.
  - There is a matrix for each right.
- The access matrix is a succinct descriptor for O(|S|*|O|) rules



The Access Matrix

- Do systems store the entire access control matrix?
- Two ways:
  - Store with the objects (Access control lists)
  - Store with the subjects (Capability Lists)
  - More on this next class!



Access Control

- Suppose the private key file for J is object O_1
  - Only J can read
- Suppose the public key file for J is object O_2
  - All can read, only J can modify
- Suppose all can read and write from object O_3
- What's the access matrix?

	O_1	O_2	O_3
J	?	?	?
S_2	?	?	?
S_3	?	?	?

Secrecy

- Does the following protection state ensure the secrecy of J's private key in O_1?

	O_1	O_2	O_3
J	R	RW	RW
S_2	-	R	RW
S_3	-	R	RW

Integrity

- Does the following access matrix protect the integrity of J's public key file O_2?

	O_1	O_2	O_3
J	R	RW	RW
S_2	-	R	RW
S_3	-	R	RW

Trusted Processes

- Does it matter if we do not trust some of J's processes?
  - *Trojan Horse*: Attacker controlled code run by J can violate secrecy.
  - *Confused Deputy*: Attacker may trick trusted code to violate integrity

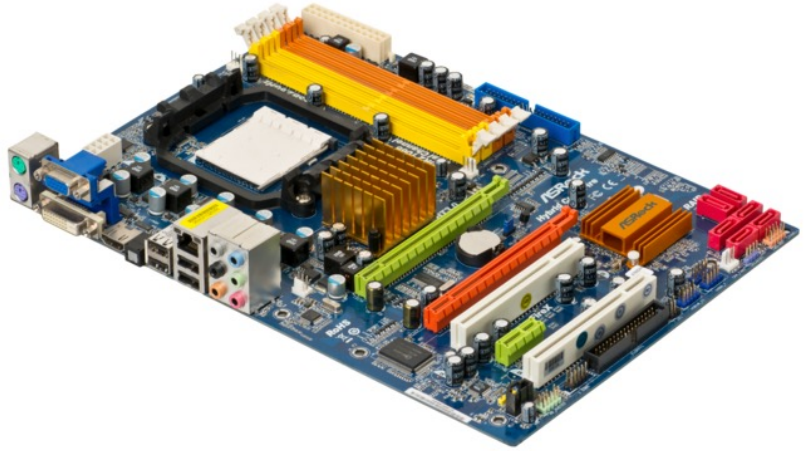
	O_1	O_2	O_3
J	R	RW	RW
S_2	-	R	RW
S_3	-	R	RW

Protection vs. Security

- Protection
  - Security goals met under *trusted* processes
  - Protects against an error by a non-malicious entity
- Security
  - Security goals met under *potentially malicious* processes
  - Protects against any malicious entity
- Hence, For J:
  - Non-malicious process shouldn't leak the private key by writing it to O_3
  - A potentially malicious process may contain a Trojan horse that can write the private key to O_3

Trusted Computing Base (TCB)

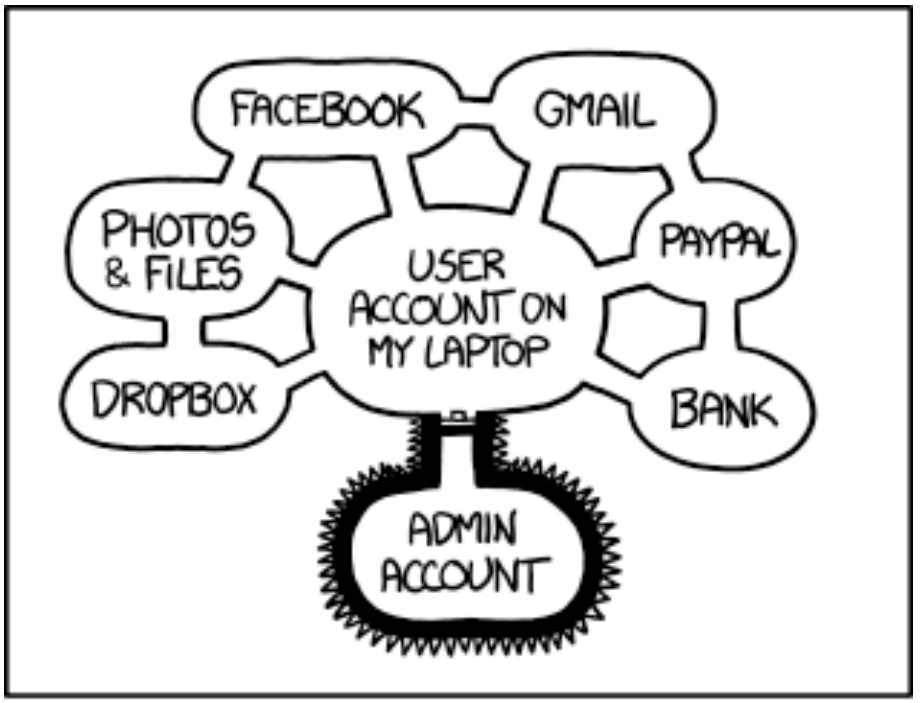
- The trusted computing base is the infrastructure that you assume will behave correctly
- What do we trust?
  - Hardware (keyboard, monitor, …)
  - Operating Systems
  - Implementations
  - Local networks
  - Administrators
  - Other users on the same system



- Axiom: the larger the TCB, the more assumptions you must make (and hence, the more opportunity to have your assumptions violated).

Do you own a computer?

- Linux/ Windows/ Mac?
- (DONOT) execute everything as the admin user!
  - Create a separate "standard" user. *Why?*
- Caveat: *Still need to protect the standard user account.*



IF SOMEONE STEALS MY LAPTOP WHILE I'M LOGGED IN, THEY CAN READ MY EMAIL, TAKE MY MONEY, AND IMPERSONATE ME TO MY FRIENDS,

BUT AT LEAST THEY CAN'T INSTALL DRIVERS WITHOUT MY PERMISSION.

Principle of Least Privilege

A system should only provide those rights needed to perform the processes function and no more.

- Implication 1: you want to reduce the protection domain to the smallest possible set of objects
- Implication 2: you want to assign the minimal set of rights to each subject
- Caveat: of course, you need to provide enough rights and a large enough protection domain to get the job done.

Least Privilege

- Limit permissions to those required and no more
- Consider three processes for user J
  - Restrict privilege of the process J_1 to prevent leaks

	O_1	O_2	O_3
J	R	RW	-
S_2	-	R	-
S_3	-	R	RW

Conflicting Goals

- Challenges of building a secure system
  - What are the *users*' goals?
  - What do *application developers* want?
  - What about the *data owners* (corporations/governments)?
  - What is the purpose of *system administrators*?
  - What about the requirements of *operating system designers*?
- Need a *satisfying* balance among these goals?