Principles for Secure Software

Lecture-10

Department of CSE, IUT

Making secure software

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- **Flawed approach**: Design and build software, and ***ignore security at first***
  - Add security once the functional requirements are satisfied

Making secure software

- **Flawed approach**: Design and build software, and ***ignore security at first***
  - Add security once the functional requirements are satisfied

- **Better approach**: ***Build security in*** from the start
  - Incorporate security-minded thinking into all phases of the development process

Development process

- Many development processes; **four common phases**:
  - **Requirements**
  - **Design**
  - **Implementation**
  - **Testing/assurance**

- Where does **security engineering** fit
- in?

  All phases!

Security engineering

<u>Phases</u>

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Note that different SD processes have different phases and artifacts, but all involve the basics above. We'll keep it simple and refer to these.

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  - ***Security Requirement Analysis***
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Secure Architecture & Design

Designing secure systems

- **Model** your threats
- Define your **security requirements**
  - What distinguishes a security requirement from a typical “software feature”?
- Apply good security **design principles**

Threat Modeling

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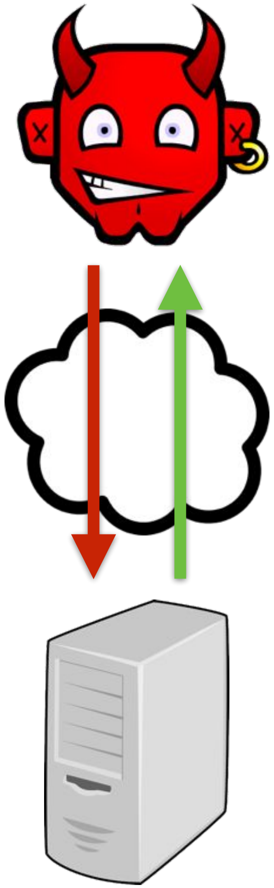
- The threat model is **critically important**
  - If you are not explicit about what the attacker can do, how can you assess whether your design will repel that attacker?

A few different network threat models



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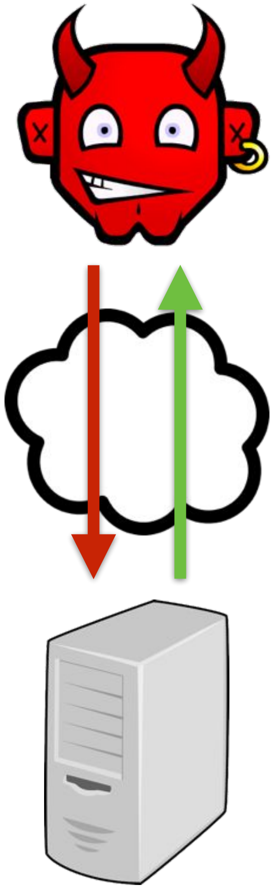

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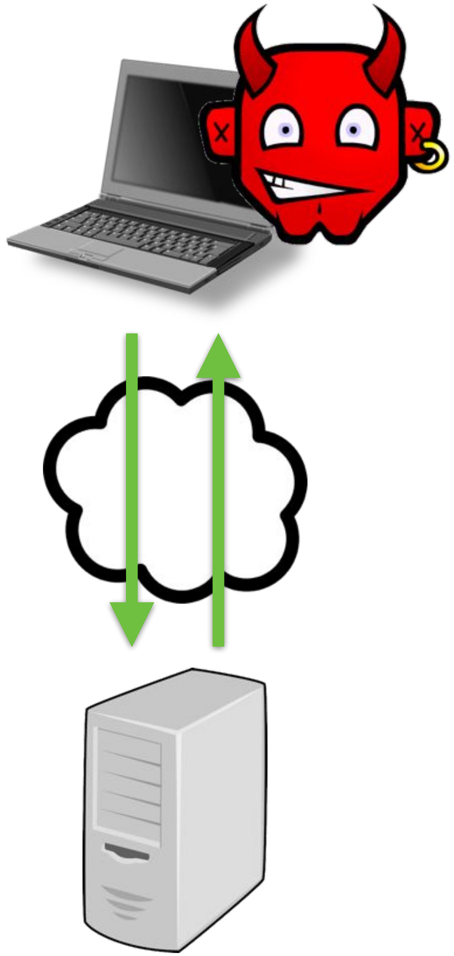

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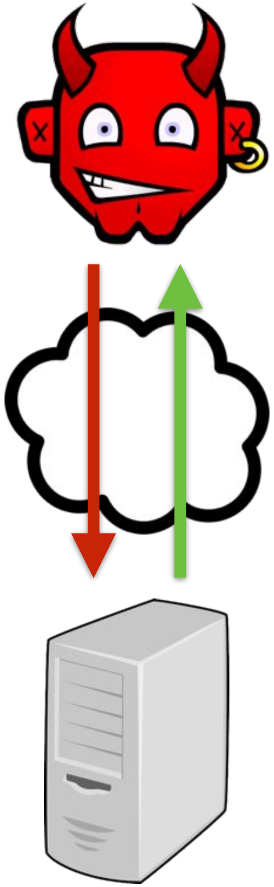

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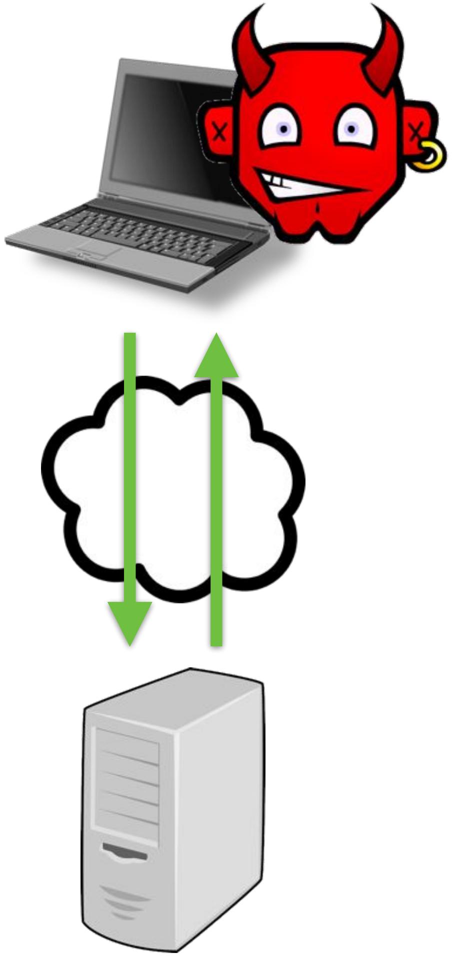

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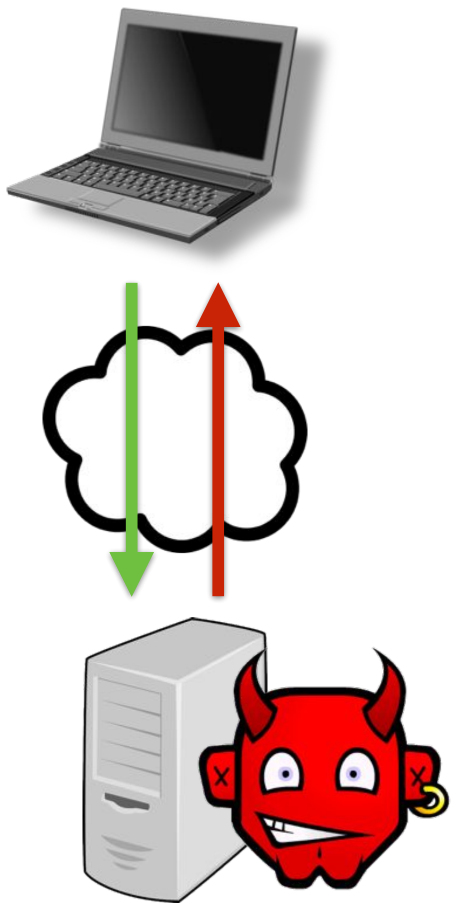

Compromised server

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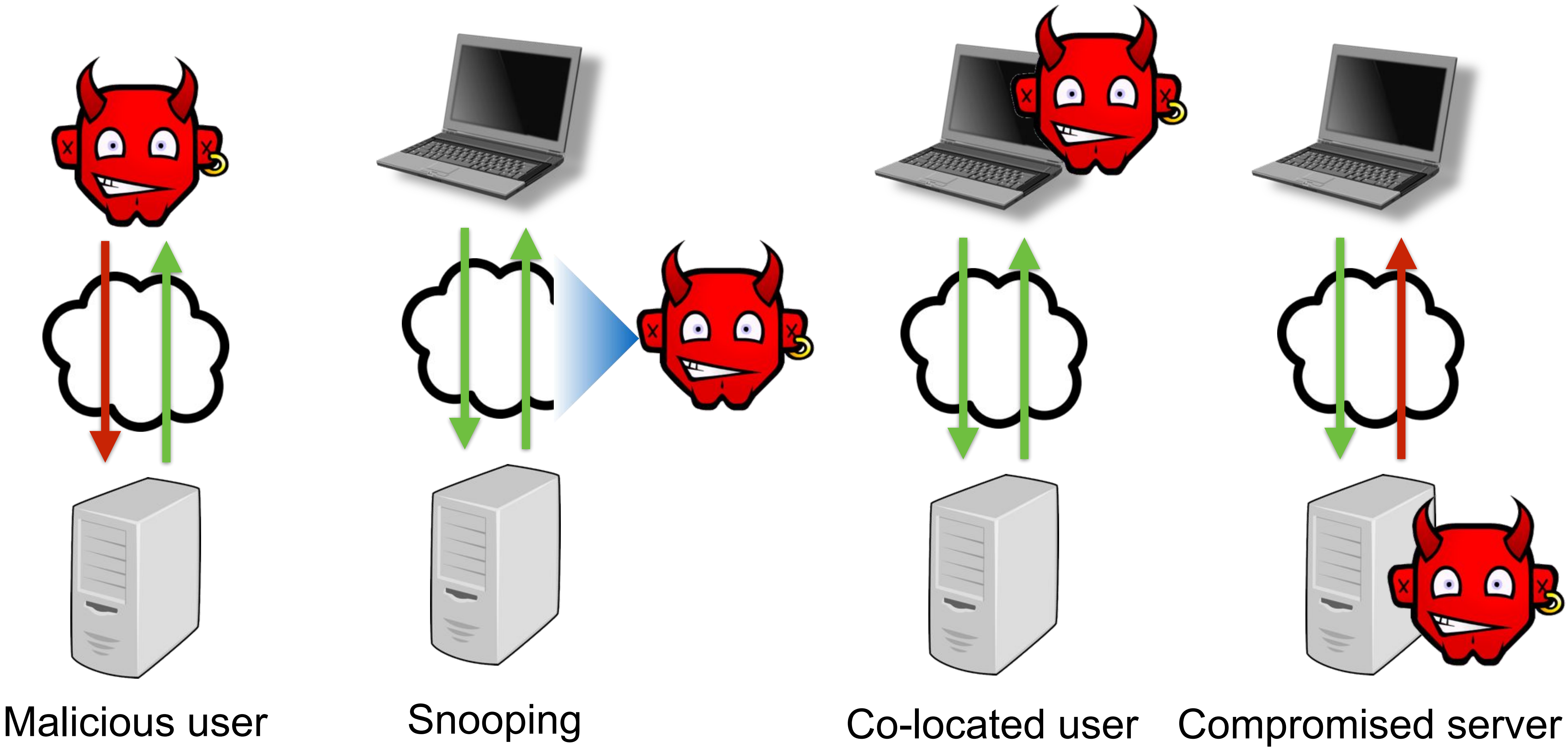

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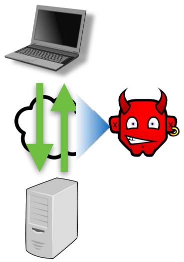

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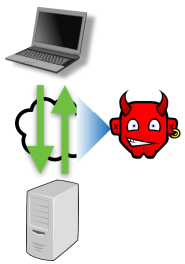

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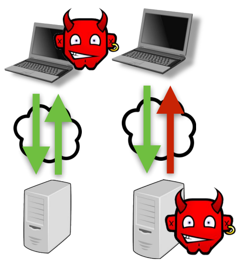

- **Co-located attacker:** can **access local files, memory**
  - Cannot store unencrypted secrets, like passwords
  - Likewise with a compromised server

Threat-driven Design

- The **basic concept behind each vulnerability and attack** needs to be **understood** in order to create a general secure design.

- Then, the design can be constructed keeping in mind all the security prerequisites of the application.

- Developers can also make use of Secure Design Patterns to deal with security-related issues and solve known security problems.

Attack Surfaces

Consist of the reachable and exploitable vulnerabilities in a system

Examples:

- Open ports on outward facing Web and other servers, and code listening on those ports
- Services available on the inside of a firewall
- Code that processes incoming data, email, XML, office documents, and industry-specific custom data exchange formats
- Interfaces, SQL, and Web forms
- An employee with access to sensitive information vulnerable to a social engineering attack

Reference: Section 1.5 of Computer Security Principles and Practice (3rd_Edition)

Attack Surface Categories

Network Attack Surface

Vulnerabilities over an enterprise network, wide-area network, or the Internet

Included in this category are network protocol vulnerabilities, such as those used for a denial-of-service attack, disruption of communications links, and various forms of intruder attacks

Software Attack Surface

Vulnerabilities in application, utility, or operating system code

Particular focus is Web server software

Human Attack Surface

Vulnerabilities created by personnel or outsiders, such as social engineering, human error, and trusted insiders

Attack Trees

A branching, hierarchical data structure that represents a set of potential vulnerabilities

Objective: to effectively exploit the info available on attack patterns

- published on CERT or similar forums
- Security analysts can use the tree to guide design and strengthen countermeasures

An Attack Tree

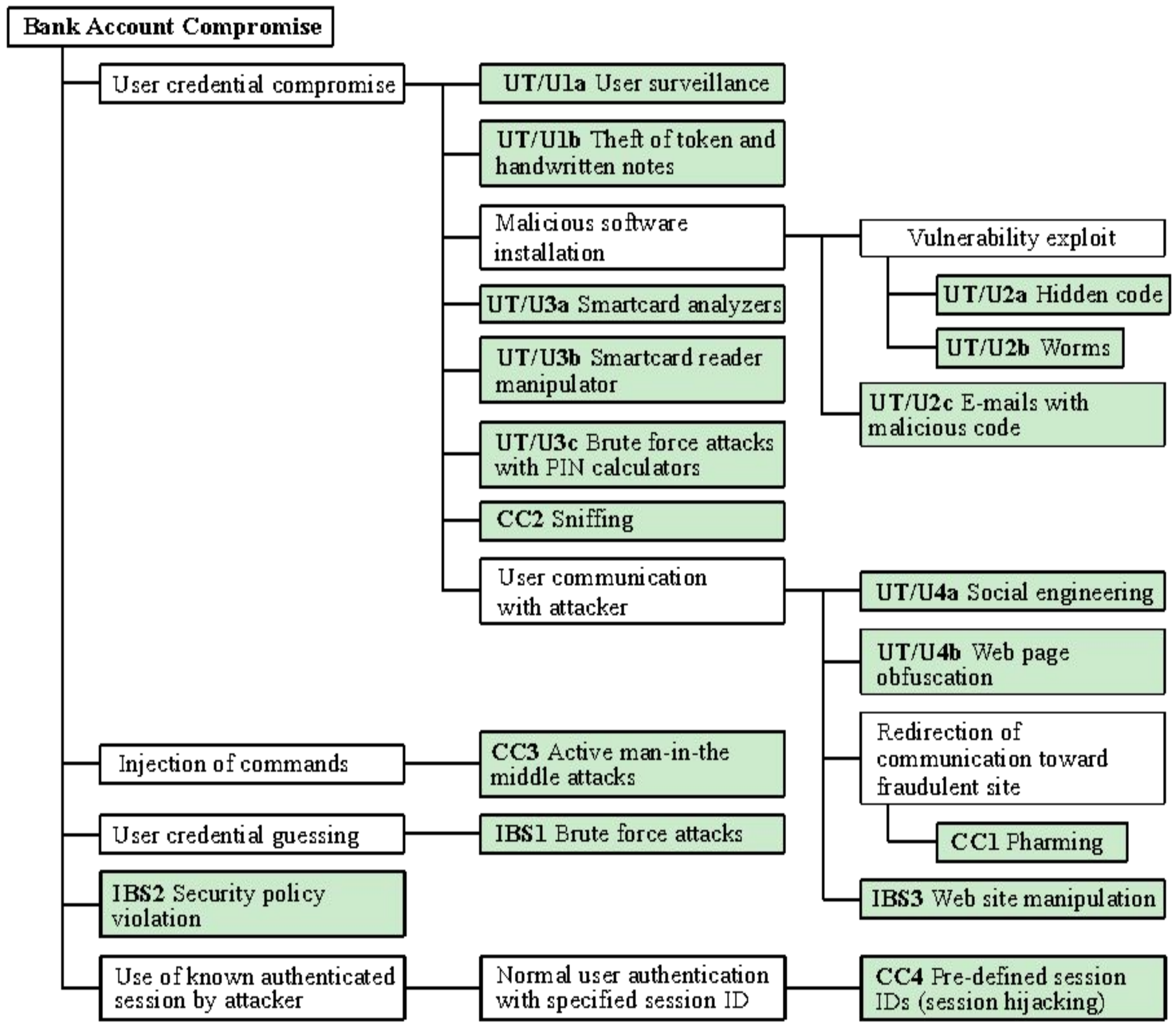

Figure 1.4 An Attack Tree for Internet Banking Authentication

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Attack Surface Analysis

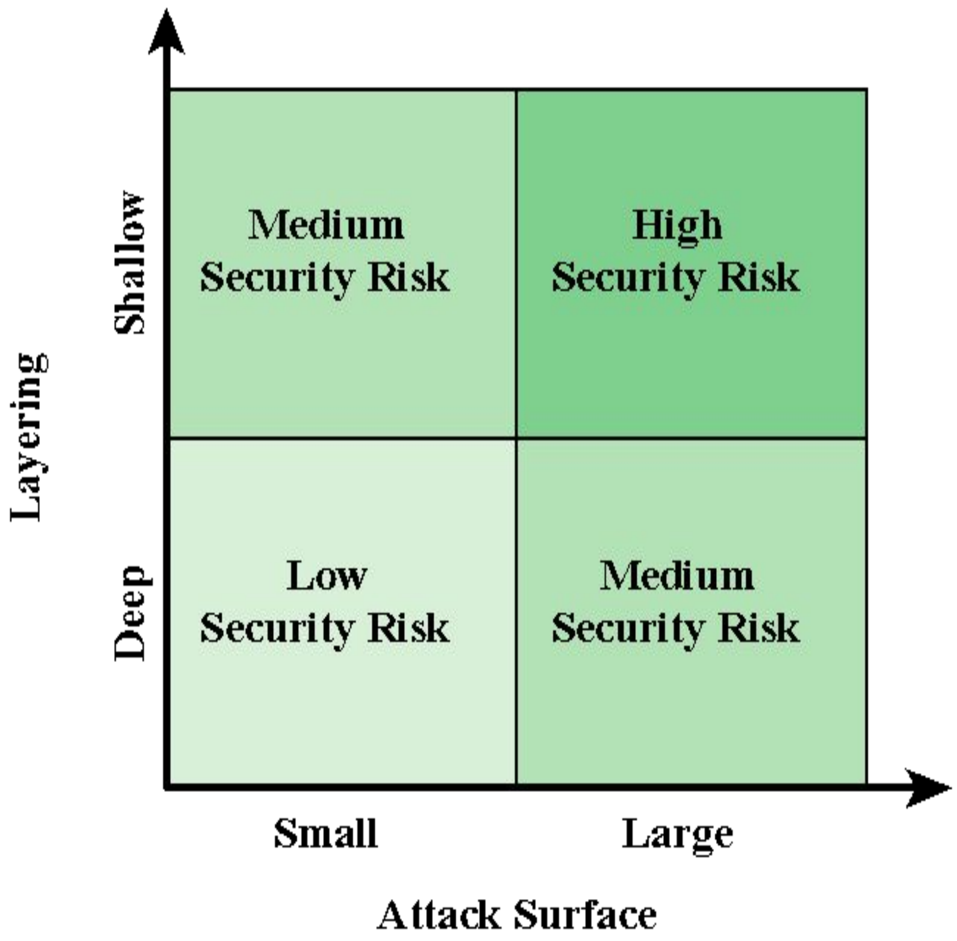

Figure 1.3 Defense in Depth and Attack Surface

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  Example **abuse case**: A user is able to spoof being a manager and thereby change the interest rate on an account

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  - Possible if messages are have no *nonce*. *What is a cryptographic nonce*

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  - **Assumption**: Timing channels carry little information
    - Not true! Timing measurements of previous RSA implementations could be used eventually reveal a remote SSL secret key

      Examples of this entity include the interpacket delays of a packet stream, the reordering packets in a packet stream, or the resource access time of a cryptographic module

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  - What happens if an assumption is untrue?
    - What would a breach potentially cost you?
  - How hard would it be to get rid of an assumption, allowing for a stronger adversary?
    - What would that development cost?

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      3. The password database is only accessible to login program.

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Retain enough info to determine the circumstances of a breach

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  - Which **attacks** cause the **greatest concern**?
    - Who are the likely adversaries and what are their goals and methods?
  - Which **attacks** have **already occurred**?
    - Within the organization, or elsewhere on related systems?

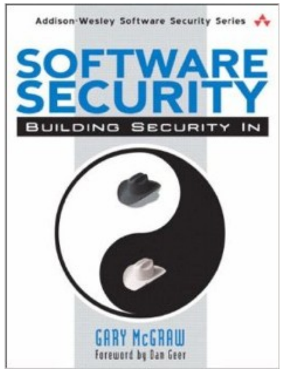
Security design principles

Design Defects = Flaws

- Recall that software defects consist of both flaws and bugs
  - **Flaws** are problems in the **design**
  - **Bugs** are problems in the **implementation**

- **We avoid flaws during the design phase**
- According to Gary McGraw,

  50% of security problems are flaws
  - So this phase is very important



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  - **Example**: Monitoring (e.g., expected invariants), snapshotting

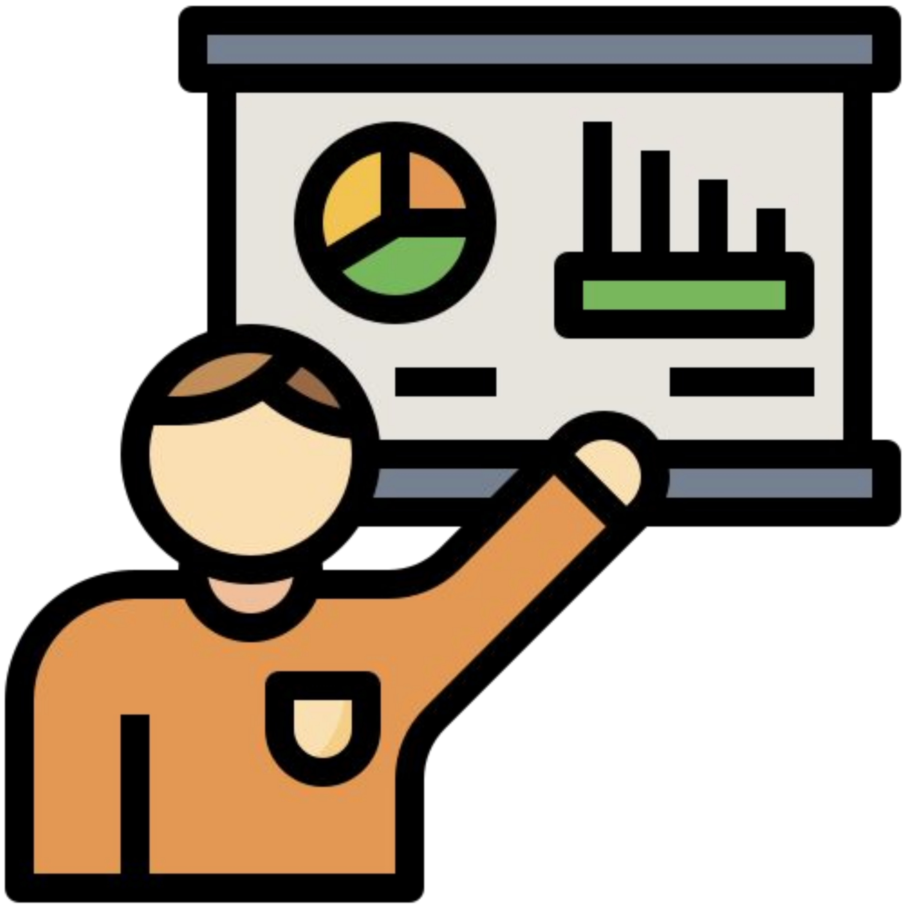
Principles for building secure systems

- Security is economics
- Principle of least privilege
- Use fail-safe defaults
- Use separation of responsibility
- Defend in depth
- Take human factors into
- account Ensure complete mediation

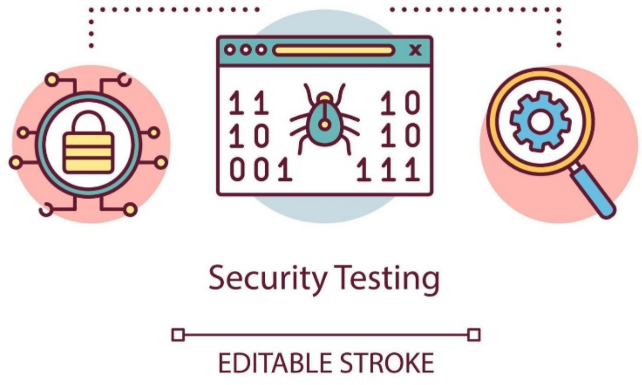
- Accept that threat models change
- If you can't prevent, detect
- Kerkhoff's principle (no security through obscurity)
- Design security from the ground up
- Prefer conservative designs
- Proactively study attacks

Secure Coding Practice

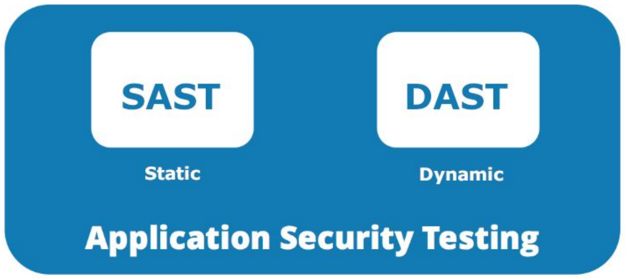
Your Assignment



Software Security Testing



Code Review



Penetration Testing

Fuzz Testing

References

- Some of the slides and content are from Mike Hicks' Coursera course