What is security?

Mainack Mondal

CS 60081
Autumn 2024

Roadmap

- Defining computer security
- CIA model
- How do security violations happen in practice?
- Basic security analysis

Security: Many definitions

- "The *protection of data* and resources from accidental and malicious acts, usually by taking appropriate actions …These acts many be modification, destruction, access, disclosure or acquisition if not authorized."

-- ISO/IEC, 1998

Security: Many definitions

- "The *protection of data* and resources from accidental and malicious acts, usually by taking appropriate actions …These acts many be modification, destruction, access, disclosure or acquisition if not authorized."

  -- ISO/IEC, 1998

- Building Systems to remain dependable in the face of malice, error or mischance

  -- Ross Anderson

Roadmap

- Defining computer security
- CIA model
- How do security violations happen in practice?
- Basic security analysis

Properties of a secure system (CIA model)

- Confidentiality
  - Non-public information should be accessible only to authorized parties (access control, encryption, policies)
- Integrity
  - System and data should remain unaltered, except for authorized parties (error correction code, sha3)
- Availability
  - Information and system should remain accessible for authorized use (protection against DDOS, related to usability)

CIA model needs a few more properties to function

- Authentication
  - Verifying that the identify of an entity is genuine relative to expectations arising from context (Password)
- Authorization
  - Ensuring that system and data are only accessible to intended entities (access control)
- Accountability
  - Identifying entities responsible for past actions (blockchain, append-only logs)

Roadmap

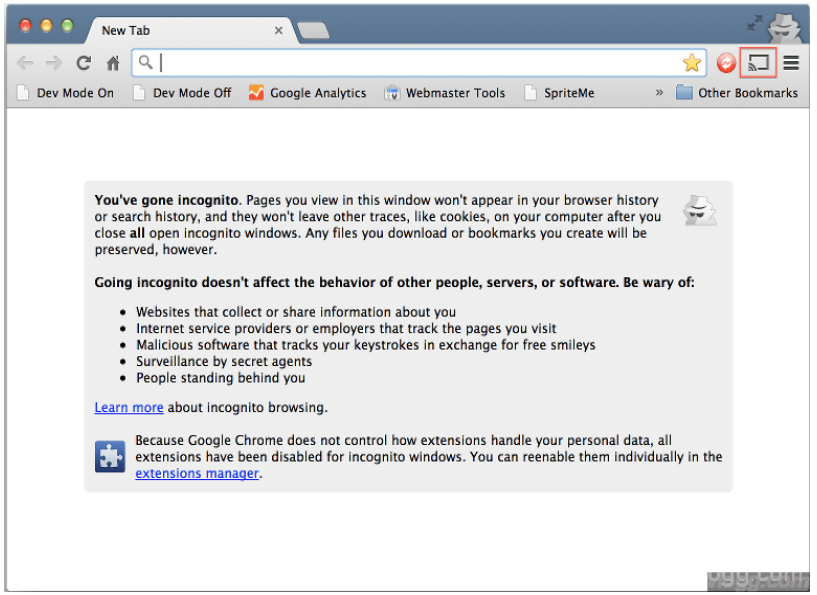
- Defining computer security
- CIA model
- How do security violations happen in practice?
- Basic security analysis

Security violations in practice

- Source: "A Summary of Computer Misuse Techniques," by Peter G. Neumann and Donn B. Parker, 1989
  - External misuse
  - Hardware misuse
  - Masquerading
  - Setting up subsequent misuse
  - Bypassing intended controls
  - Active misuse
  - Passive misuse
  - Inactive misuse
  - Indirect misuse

A brief look at these misuses

- External misuse
  - Generally nontechnological (physical scavenging, visual spying, deception)



- Hardware misuse
  - Passive (logical scavenging, eavesdropping)
  - Active (trojan horse, introducing faults)

A brief look at these misuses

- Masquerading
  - Impersonation; playback and spoofing attacks; may be indistinguishable from legitimate activity
- Setting up subsequent misuse
  - Logic bombs, zero days, malicious worms, botnets, ransomwares, viruses
- Bypassing intended controls
  - Using trapdoors (e.g., known bugs), authorization attacks (cracking passwords)

A brief look at these misuses

- Active misuse : Modifying data, DoS attacks
- Passive misuse: Browsing, analyzing collected data without changing the system
- Inactive misuse: Misuse because user was too lazy (e.g. giving phone to repair shop without erasing data)
- Indirect misuse: Breaking cryptographic keys and then use it for listening to encrypted communications

Roadmap

- Defining computer security
- CIA model
- How do security violations happen in practice?
- Basic security analysis

How to do basic security analysis for a system?

- Question: Is a given system secure OR how do you secure the system?
  - *What* do we intend to protect? (system model)
  - *Who* is the attacker or the threat? (threat model)
  - What are the security requirements? (Security Goals)
  - What security approaches can be effective? (Solution)

1. System model

1. Understand architecture of the system

2. Enumerate asset and their value in the system

- Possible questions you should ask:
  - What are the exact assets? (be as specific as possible)
  - What is the operating value (can be $, can be man hours)
  - What is the impact if this asset if breached?

Question: What is the system model for protecting against password guessing attack on a banking website?

2. Threat model

3. Identify potential attackers (script-kiddies, hacker-for-hire, your ex, a nation state?)

4. Enumerate attacker resources

- Estimate number of attacks, probability of attack

5. Mitigate attack for those attackers

Common adversary types in threat models

- Attacker action
  - Passive (eavesdropping), Active (man-in-the-middle attack)
- Attacker capability
  - Script kiddies to nation states (decides how resilient your solution should be)
- Attacker access
  - External (can only observe the system), Internal (inside the system, e.g., compromised user account)

Common adversary types in threat models

- Attacker action
  - Passive (eavesdropping), Active (man-in-the-middle attack)
- Attacker capability
  - Script kiddies to nation states (decides how resilient your solution should be)
- Attacker access
  - External (can only observe the system), Internal (inside the system, e.g., compromised user account)

Question: What is the threat model for protecting against password guessing attack on a banking website?

3. Security goals

- What are your security requirements
  - Confidentiality (encryption)
  - Integrity (cryptographic hashes)
  - Authenticity (MAC or keyed hash)
  - Availability (DDoS)
  - Auditability (Blockchain, tamper-proof-logs)
  - Access control
  - Privacy
  - Plausible deniability …

4. Designing systems

- Security via policy
  - Pass a law and make it illegal
- Use cryptography and security primitives
  - Encryption, hashes, VPNs, firewalls
- Make your system resilient to attack
  - Keep updated copies of systems (*hot standby*)
- Detection and recovery
  - Intrusion detection system, Redundancy etc.

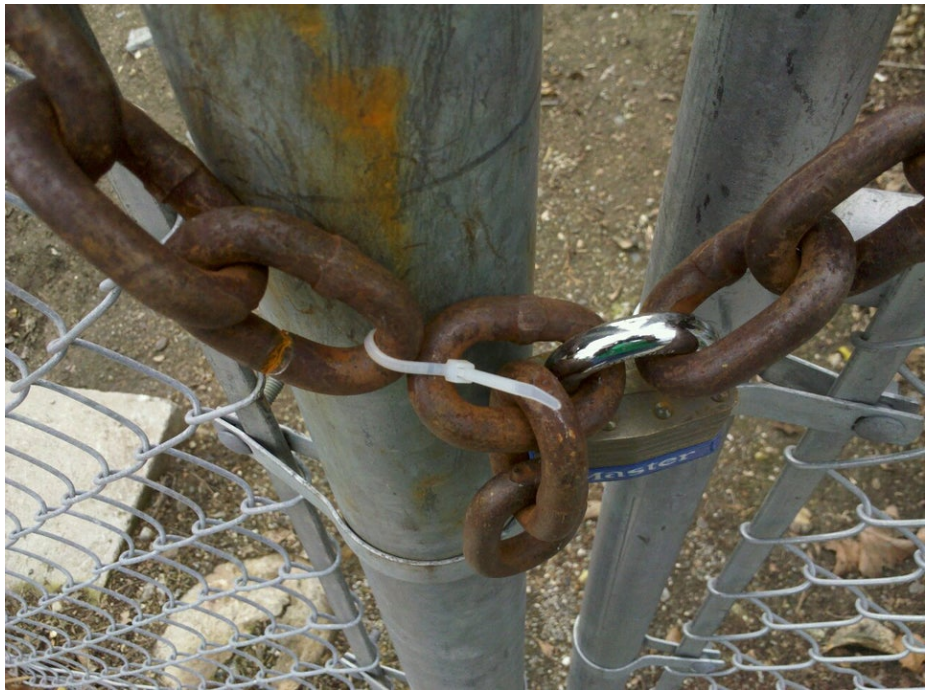
Pitfalls of security

- Can’t protect against everything
  - expensive and inconvenient

- Identify most likely avenues of attack
  - Identify *likely* attackers and their resources?
  - Identify *likely* consequences – financial loss or personal loss?
  - Accept your design will not defend against all attacks
  - Identify where will it not help? (is that reasonable)

You need to think like an attacker

- Adversary target *assets,* not defenses
  - Will try to exploit *weakest part* of the defenses (bribing, social engineering)



Summary

- Security is important AND difficult
- Security is NOT absolute
  - Your solution will depend on YOUR system model, threat/attacker model, security goals
  - Shoot for at least “raising the bar”

- Bonus: System and attack model of obtaining encrypted data
  - Security by obscurity
  - Kerckhoffs’s law/Shannon’s maxim (“Enemy knows the system”)