Amirkabir University of Technology
(Tehran Polytechnic)

Operating Systems

Security-Part2

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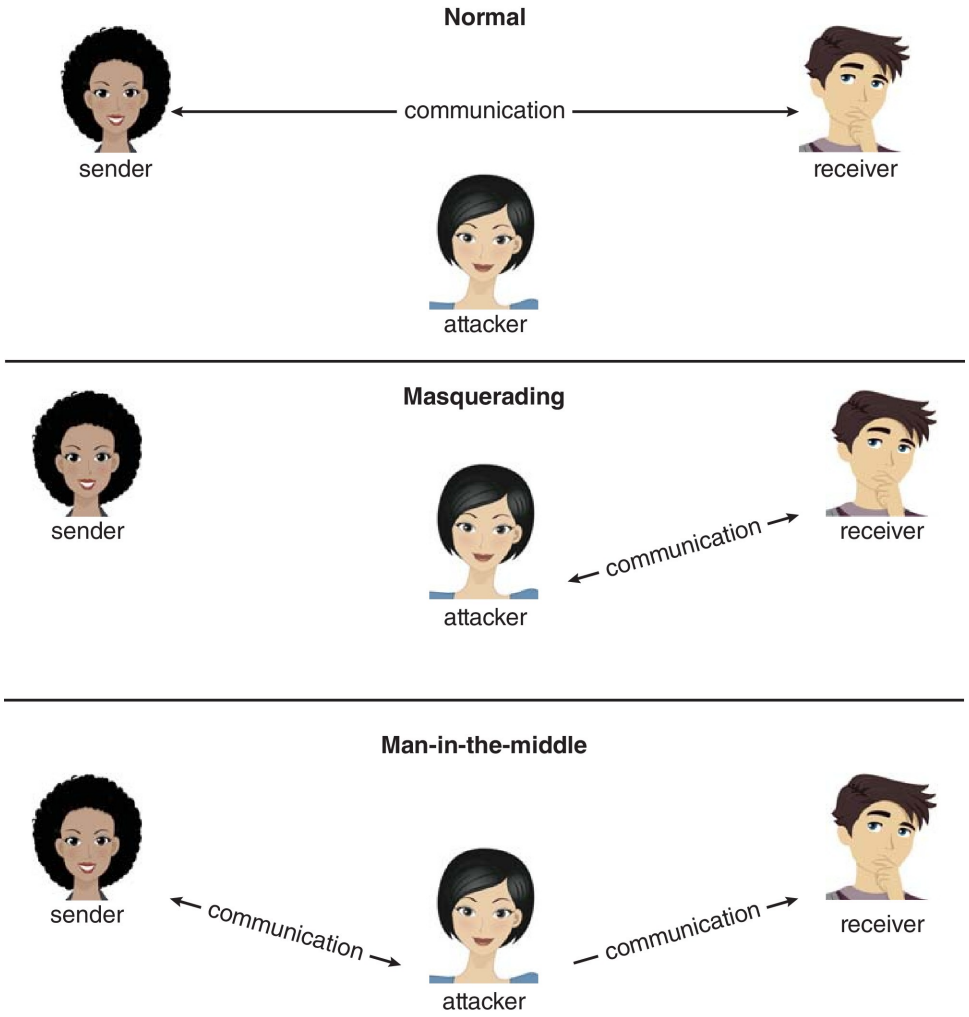
Standard Security Attacks



Cryptography

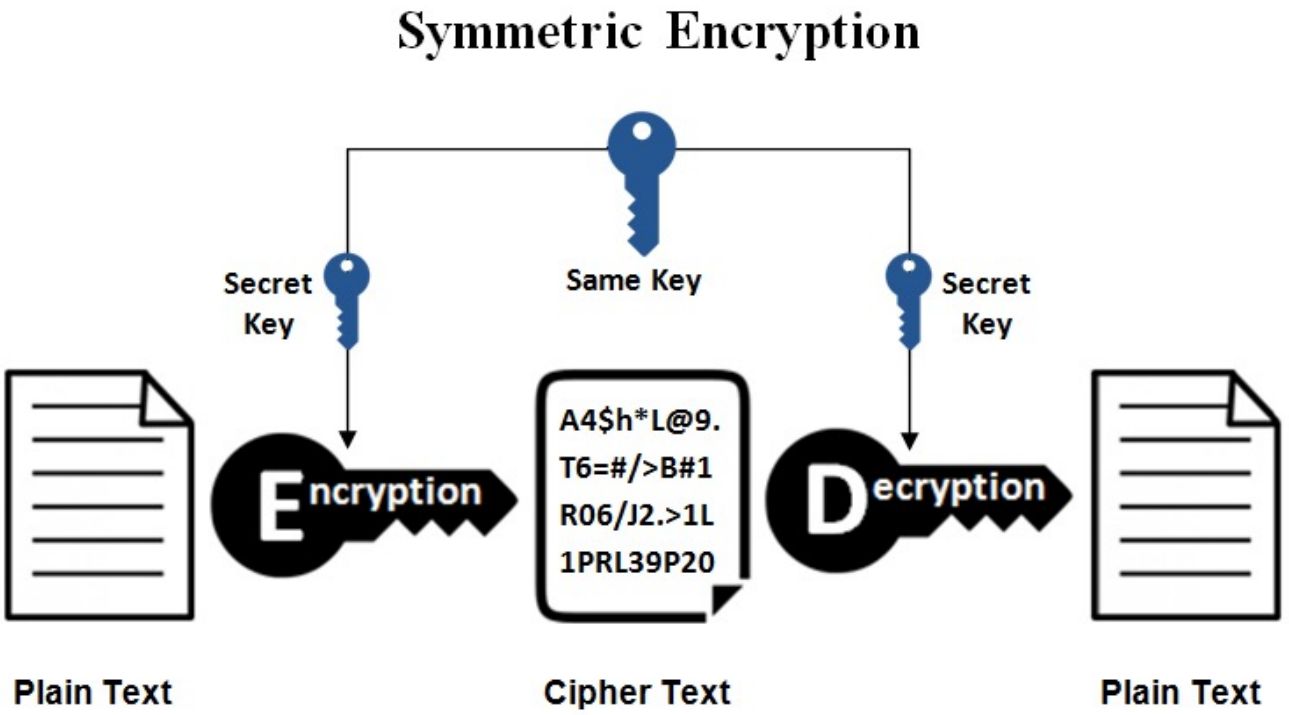
- Means to constrain potential senders (*sources*) and / or receivers (*destinations*) of *messages*
  - Based on secrets (**keys**)
  - Enables
    - Confirmation of source
    - Receipt only by certain destination
    - Trust relationship between sender and receiver

Encryption

- Constrains the set of possible receivers of a message

Symmetric Encryption

- Same key used to encrypt and decrypt
  - Therefore *k* must be kept secret

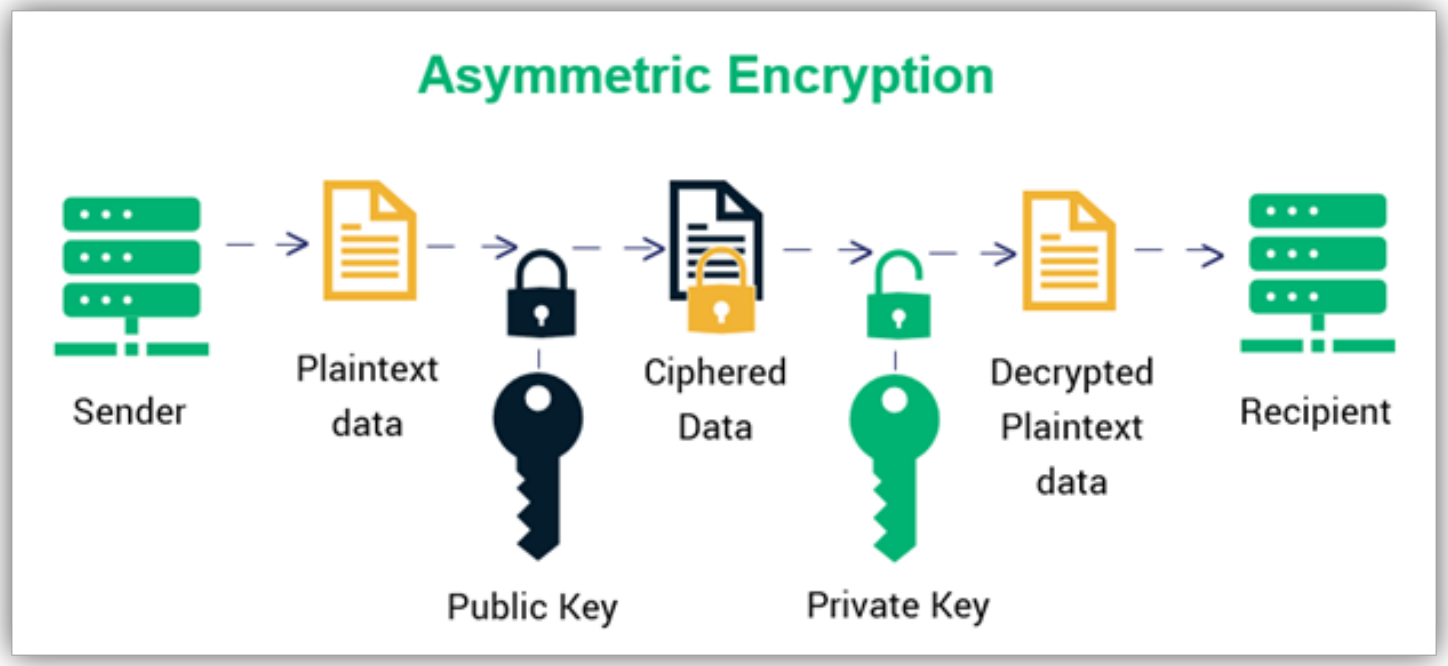


Symmetric Encryption (cont.)

- **DES** was most commonly used symmetric block-encryption algorithm (created by US Govt)
  - Encrypts a block of data at a time
  - Keys too short so now considered insecure
- 2001 NIST adopted new block cipher
- Advanced Encryption Standard (**AES**)
  - Keys of 128, 192, or 256 bits, works on 128 bit blocks

Asymmetric Encryption

- **Public-key encryption** based on each user having two keys:
  - **public key** – published key used to encrypt data
  - **private key** – key known only to individual user used to decrypt data

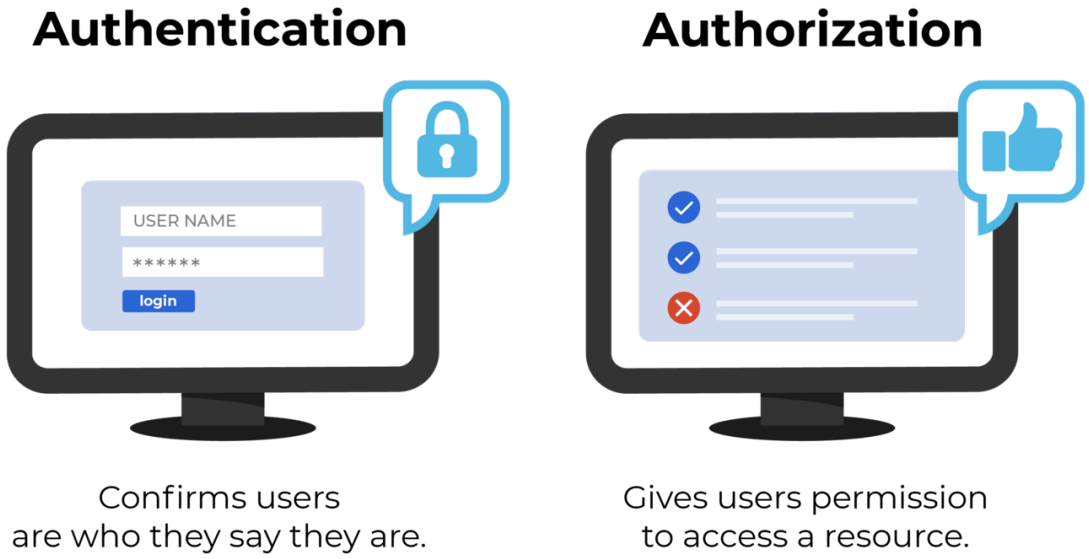


Cryptography (cont.)

- Asymmetric much more compute intensive
  - Typically not used for bulk data encryption
  - Typically used for secure key exchange
- Symmetric encryption is used for bulk data encryption

User Authentication

- Crucial to identify user correctly, as protection systems depend on user ID
- User identity most often established through **passwords**, can be considered a special case of either keys or capabilities



User Authentication

- Passwords must be kept secret
  - Frequent change of passwords
  - History to avoid repeats
  - Use of “non-guessable” passwords
  - Log all invalid access attempts (but not the passwords themselves)
  - Unauthorized transfer

User Authentication

- Passwords may also either be encrypted or allowed to be used only once
  - Does encrypting passwords solve the exposure problem?
    - Might solve **sniffing**
    - Consider **shoulder surfing**
    - Consider Trojan horse keystroke logger
    - How are passwords stored at authenticating site?

Passwords

- Encrypt to avoid having to keep secret
  - But keep secret anyway (i.e. Unix uses superuser-only readably file `/etc/shadow`)
  - Use algorithm easy to compute but difficult to invert
  - Only encrypted password stored, never decrypted
  - Add “salt” to avoid the same password being encrypted to the same value

Passwords

- One-time passwords
  - Use a function based on a seed to compute a password, both user and computer
  - Hardware device / calculator / key fob to generate the password
    - Changes very frequently

Passwords

- Biometrics
  - Some physical attribute (fingerprint, hand scan)
- Multi-factor authentication
  - Need two or more factors for authentication
    - i.e., USB “dongle”, biometric measure, and password

Passwords (cont.)

STRONG AND EASY TO REMEMBER PASSWORDS

It is extremely important to use strong (hard to guess and hard to shoulder surf) passwords on critical systems like bank accounts. It is also important to not use the same password on lots of systems, as one less important, easily hacked system could reveal the password you use on more important systems. A good technique is to generate your password by using the first letter of each word of an easily remembered phrase using both upper and lower characters with a number or punctuation mark thrown in for good measure. For example, the phrase "My girlfriend's name is Katherine" might yield the password "Mgn.isK!". The password is hard to crack but easy for the user to remember. A more secure system would allow more characters in its passwords. Indeed, a system might also allow passwords to include the space character, so that a user could create a **passphrase** which is easy to remember but difficult to break.

Implementing Security Defenses

- **Defense in depth** is most common security theory – multiple layers of security

- **Security policy** describes what is being secured

- Vulnerability assessment compares real state of system / network compared to security policy

Implementing Security Defenses

- Intrusion detection endeavors to detect attempted or successful intrusions
  - **Signature-based** detection spots known bad patterns
  - **Anomaly detection** spots differences from normal behavior
    - Can detect **zero-day** attacks
  - **False-positives** and **false-negatives** a problem

Implementing Security Defenses

- Virus protection
  - Searching all programs or programs at execution for known virus patterns
  - Or run in **sandbox** so can't damage system
- Auditing, accounting, and logging of all or specific system or network activities
- Practice **safe computing** – avoid sources of infection, download from only "good" sites, etc

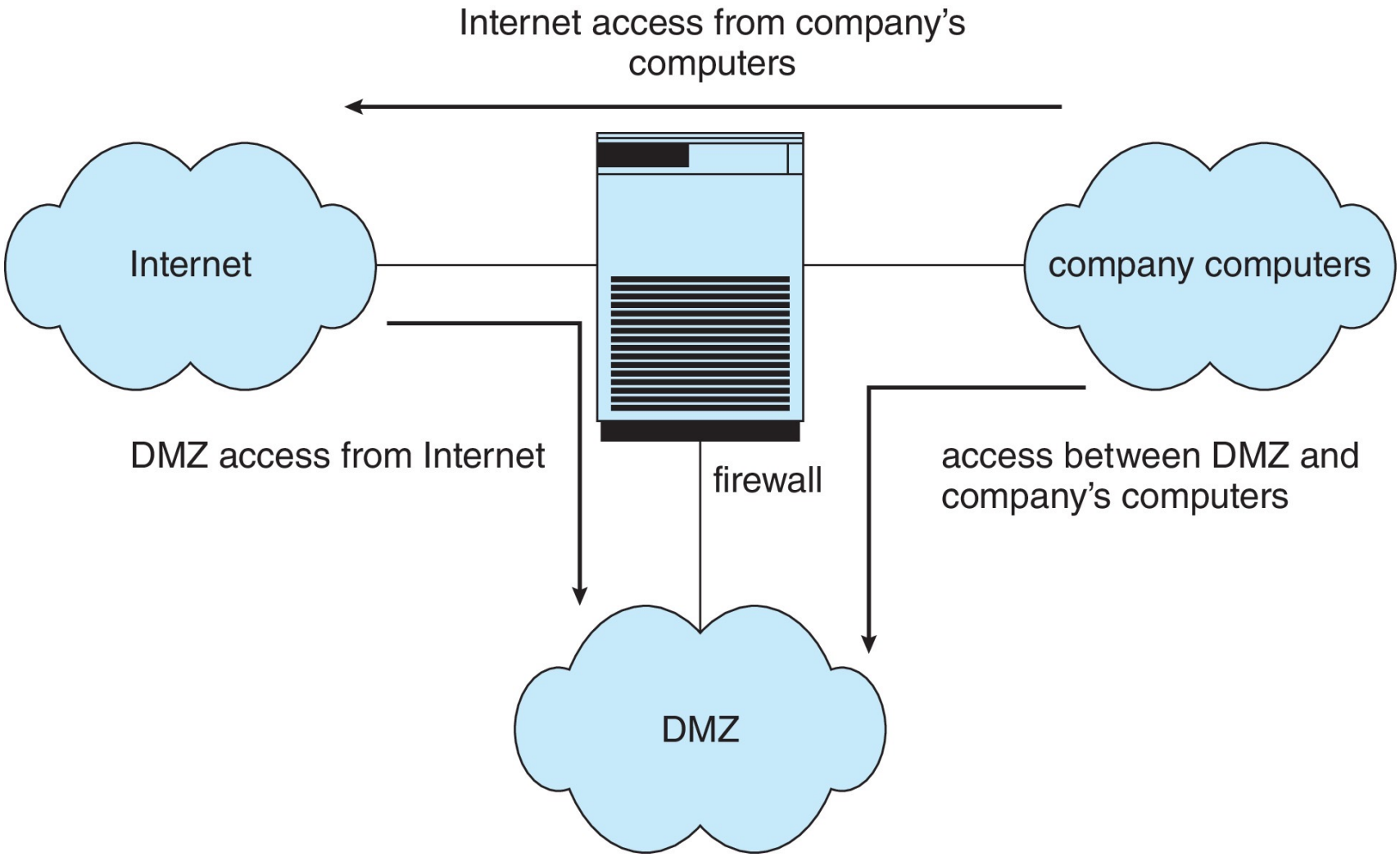
Firewalling to Protect Systems and Networks

- A network **firewall** is placed between trusted and untrusted hosts
  - The firewall limits network access between these two **security domains**
- Can be tunneled or spoofed
  - Tunneling allows disallowed protocol to travel within allowed protocol (i.e., telnet inside of HTTP)
  - Firewall rules typically based on host name or IP address which can be spoofed

Firewalling to Protect Systems and Networks

- **Personal firewall** is software layer on given host
  - Can monitor / limit traffic to and from the host
- **Application proxy firewall** understands application protocol and can control them (i.e., SMTP)
- **System-call firewall** monitors all important system calls and apply rules to them (i.e., this program can execute that system call)

Network Security Through Domain Separation Via Firewall



Security Defenses Summarized

- By applying appropriate layers of defense, we can keep systems safe from all but the most persistent attackers.
- In summary, these layers may include the following:
  - Educate users about safe computing
    - Don’t attach devices of unknown origin to the computer
    - Don’t share passwords
    - Use strong passwords
    - Avoid falling for social engineering appeals
    - Realize that an e-mail is not necessarily a private communication, and so on

Security Defenses Summarized

- In summary, these layers may include the following:
  - Educate users about how to prevent phishing attacks
    - Don’t click on email attachments or links from unknown (or even known) senders
    - Authenticate (for example, via a phone call) that a request is legitimate

Security Defenses Summarized

- In summary, these layers may include the following:
  - Use secure communication when possible
  - Physically protect computer hardware
  - Configure the operating system to minimize the attack surface; disable all unused services
  - Configure system daemons, privileges applications, and services to be as secure as possible

Security Defenses Summarized (cont.)

- Use modern hardware and software, as they are likely to have up-to-date security features
- Keep systems and applications up to date and patched
- Only run applications from trusted sources (such as those that are code signed)
- Enable logging and auditing; review the logs periodically, or automate alerts

Security Defenses Summarized (cont.)

- Install and use antivirus software on systems susceptible to viruses, and keep the software up to date
- Use strong passwords and passphrases, and don't record them where they could be found
- Use intrusion detection, firewalling, and other network-based protection systems as appropriate
- For important facilities, use periodic vulnerability assessments and other testing methods to test security and response to incidents

Security Defenses Summarized (cont.)

- Encrypt mass-storage devices, and consider encrypting important individual files as well

- Have a security policy for important systems and facilities, and keep it up to date