University of Glasgow

COMPSCI4062/COMPSCI5063 Cyber Security Fundamentals (CSF)

Lecture 2

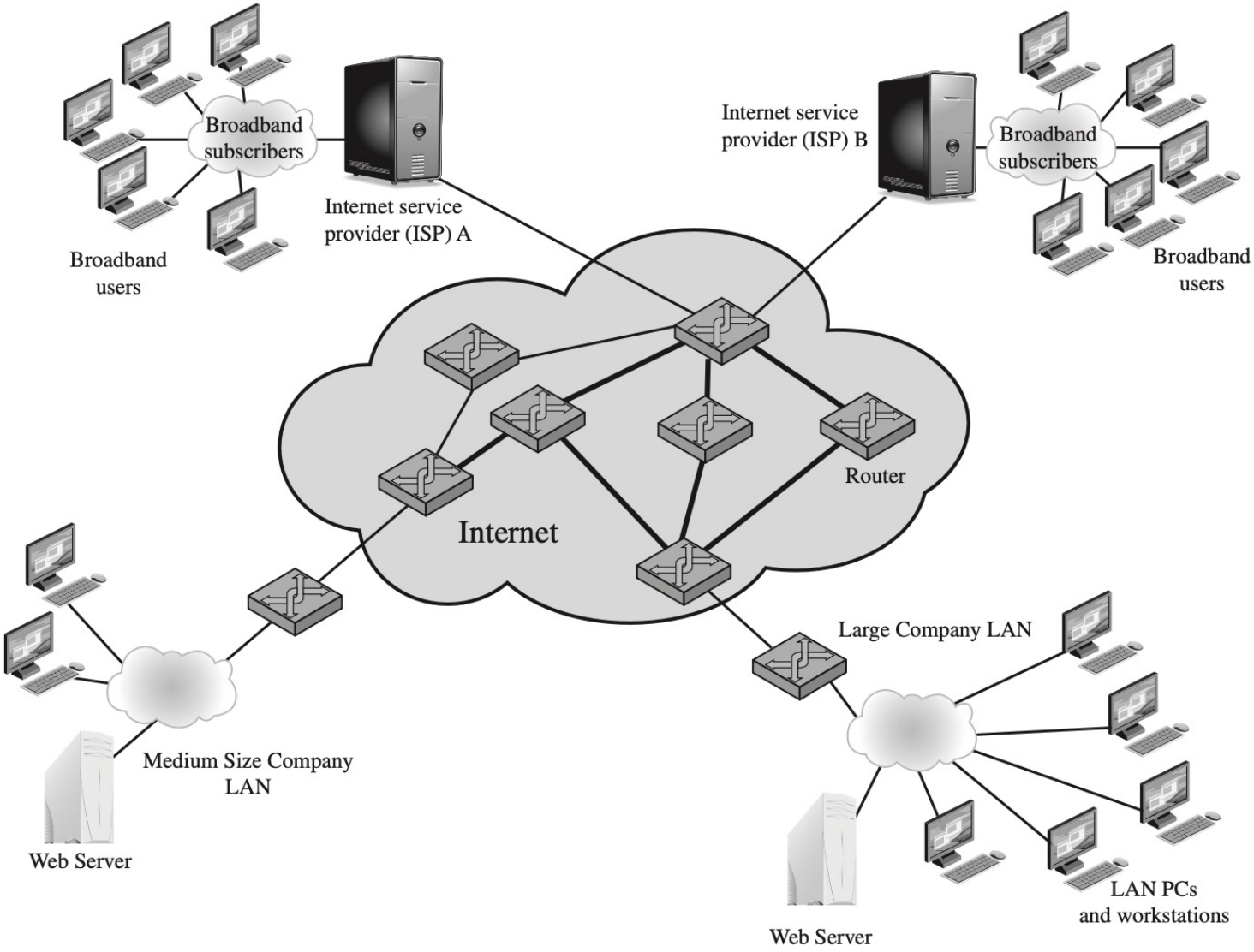
Cyber Attacks and Security Protocols

NETWORK STRUCTURES

Network Types

- Local Area Network (LAN)
  - Wireless Local Area Network (WLAN)
- Personal Area Network (PAN)
- Metropolitan Area Network (MAN)
- Wide Area Network (WAN)
- Virtual Private Network (VPN)

A Typical Network



Open Systems Interconnection model (OSI model)开放系统互连模型

7. Application	Serves as a window for users and application processes to access network service.
6. Presentation	Concerned with the syntax and semantics of the information exchanged between the two systems.
5. Session	Establish, maintain and synchronizes the interaction between communicating devices (authentication & Authorization)
4. Transport	Reliable transmission of data segments between points on a network (TCP, UDP protcols)
3. Network	Structuring and managing a multi-node network, including addressing, routing and traffic control
2. Data link	Transmission of data frames between two nodes connected by a physical layer (media access control)
1. Physical	Transmission and reception of raw bit streams over a physical medium (e.g., optical fibre, cable, wireless radio) 通过物理介质（如光纤、电缆、无线无线电）

CYBERATTACKS

Defination

- A cyberattack is any offensive maneuver that targets computer information systems, computer networks, infrastructures, or personal computer devices

Types of attack

- Active attack
  - attempts to alter system resources or affect their operation, e.g., Denial-of-service attack, Spoofing, Man-in-the-middle attack, ARP poisoning (Layer 2)
- Passive attack
  - attempts to learn or make use of information from the system but does not affect system resources, e.g., wiretapping, fiber tapping

利用

窃听、光纤窃听

Forms of Cyber Threats

- Environmental
  - Break-in, physical damage, natural disaster, etc.
- Unintentional 无意的
  - Human error, poor training, insufficient documentation, etc.
- Intentional
  - Internal, e.g., Staff
- External 外部的
  - Intelligence agencies情报机构, hackers, terrorists, crackers, criminals, industrial intelligence, etc.

Common Security Problems

- Snooping 窥探
  - Unauthorized reading or interception of information
- Modification 修改
  - Unauthorized change of information
- Masquerading or spoofing 伪装或欺骗
  - Impersonation 扮演 of one entity by another

Common Security Problems

- Repudiation
  - False denial of sending or creating information
- Denial of receipt
  - False denial of receiving information
- Delay
  - Temporary inhibition of access to services or information
- Denial of service
  - Long-term or permanent inhibition of access to services or information

Denial-of-service attack

- A **denial-of-service (DoS)** attack is an attempt to compromise availability by hindering or blocking completely the provision of some service
  - Exhaust some critical resources associated with the service
  - Example: flooding a Web server with so many spurious requests that it is unable to respond to valid requests from users in a timely manner

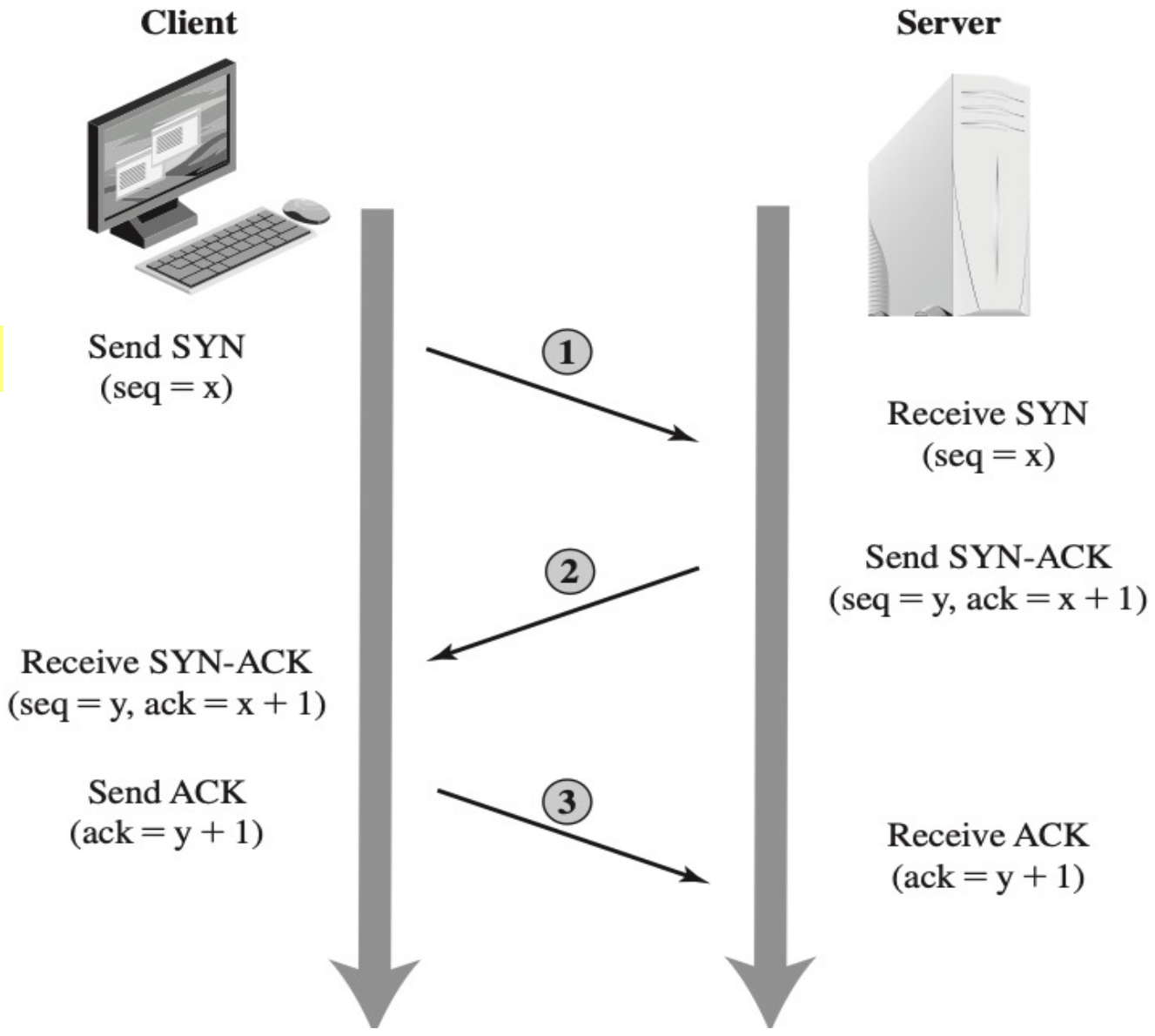
- The resources could be attacked:
  - Network bandwidth
  - System resources
  - Application resources
- A typical Network

SYN Spoofing-1

- **SYN spoofing** attack targets the table of TCP connections on the server (Layer 4)
- A type of DoS attack

SYN Spoofing-2

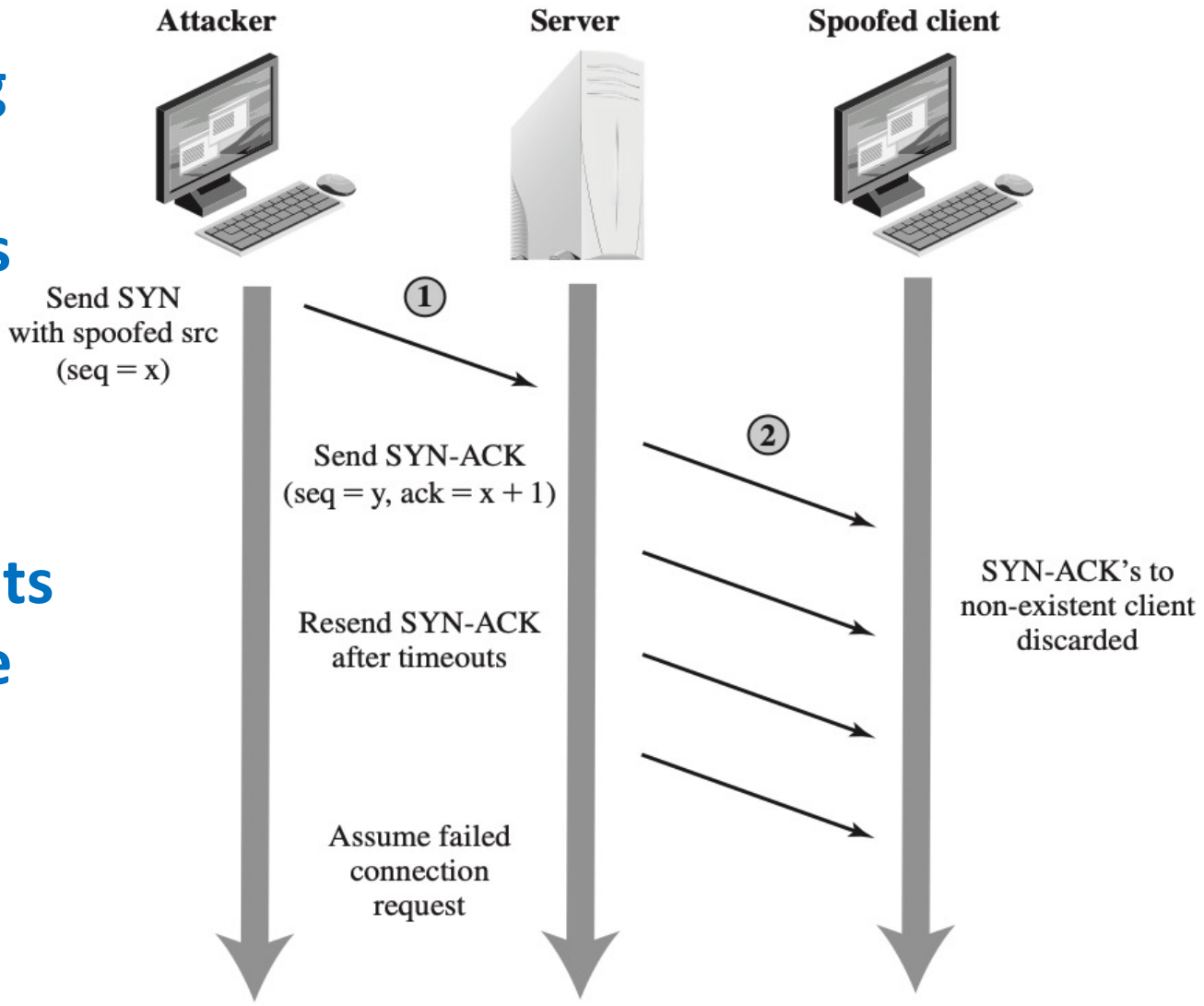
TCP's three-way handshake used to establish a connection



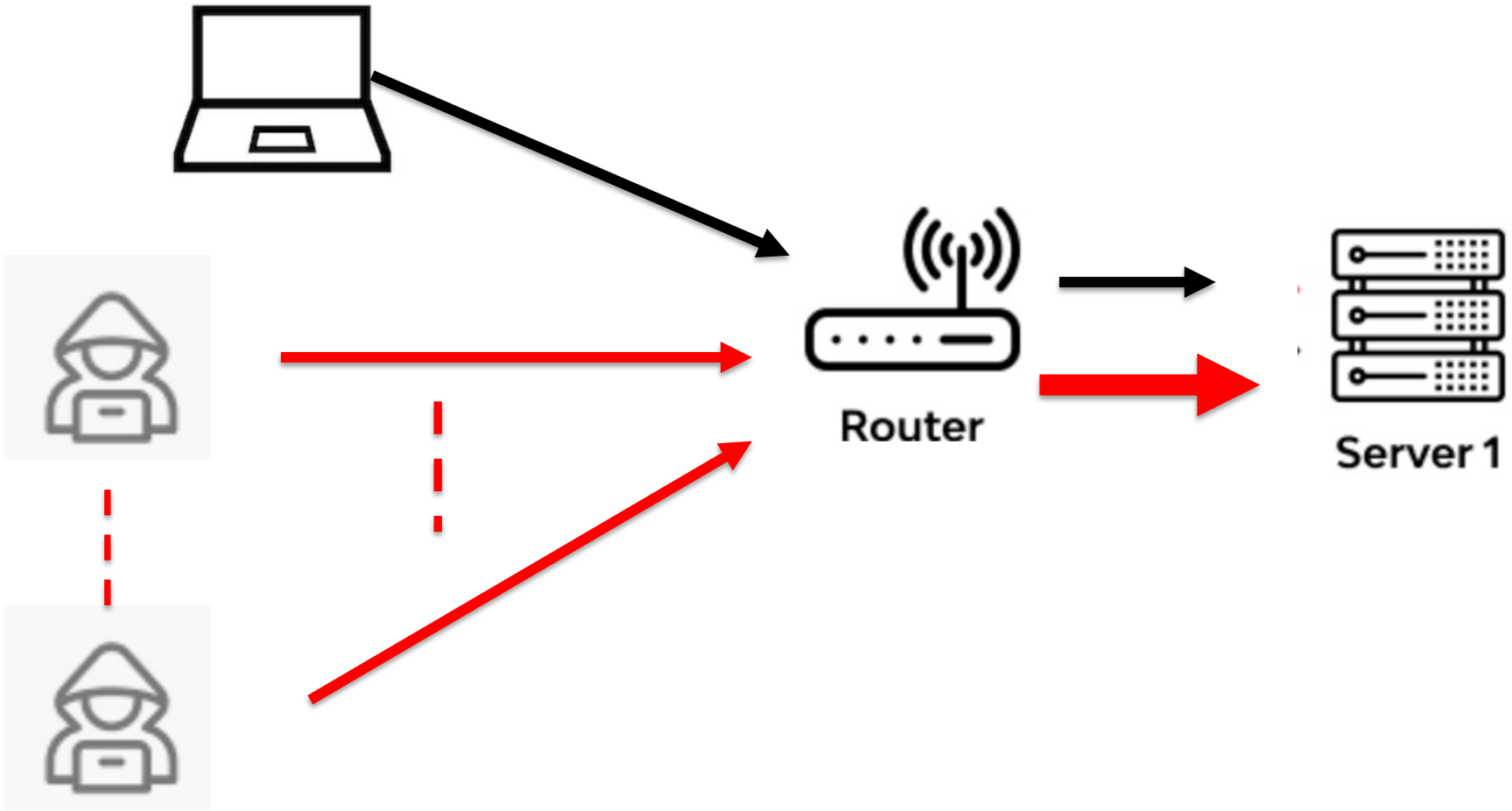
SYN Spoofing -3

TCP's SYN Spoofing Attack

- **Cause resources on the server binding on the malicious use**
- **Legitimate clients couldn't use the resource**



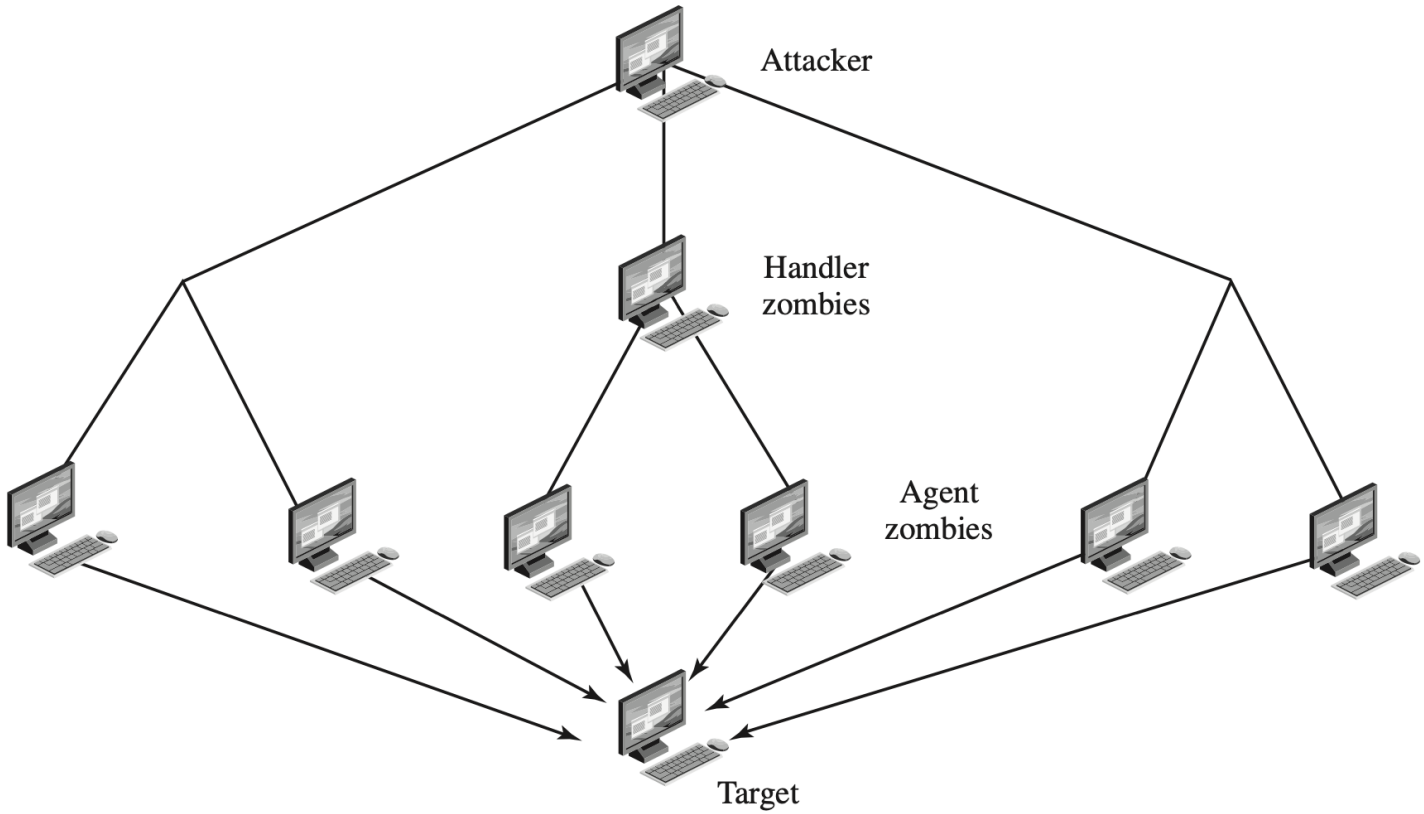
UDP Flood



* A type of DoS

Distributed DoS

1. **Application layer attacks**
2. **Protocol attacks**
3. **Volumetric attacks**

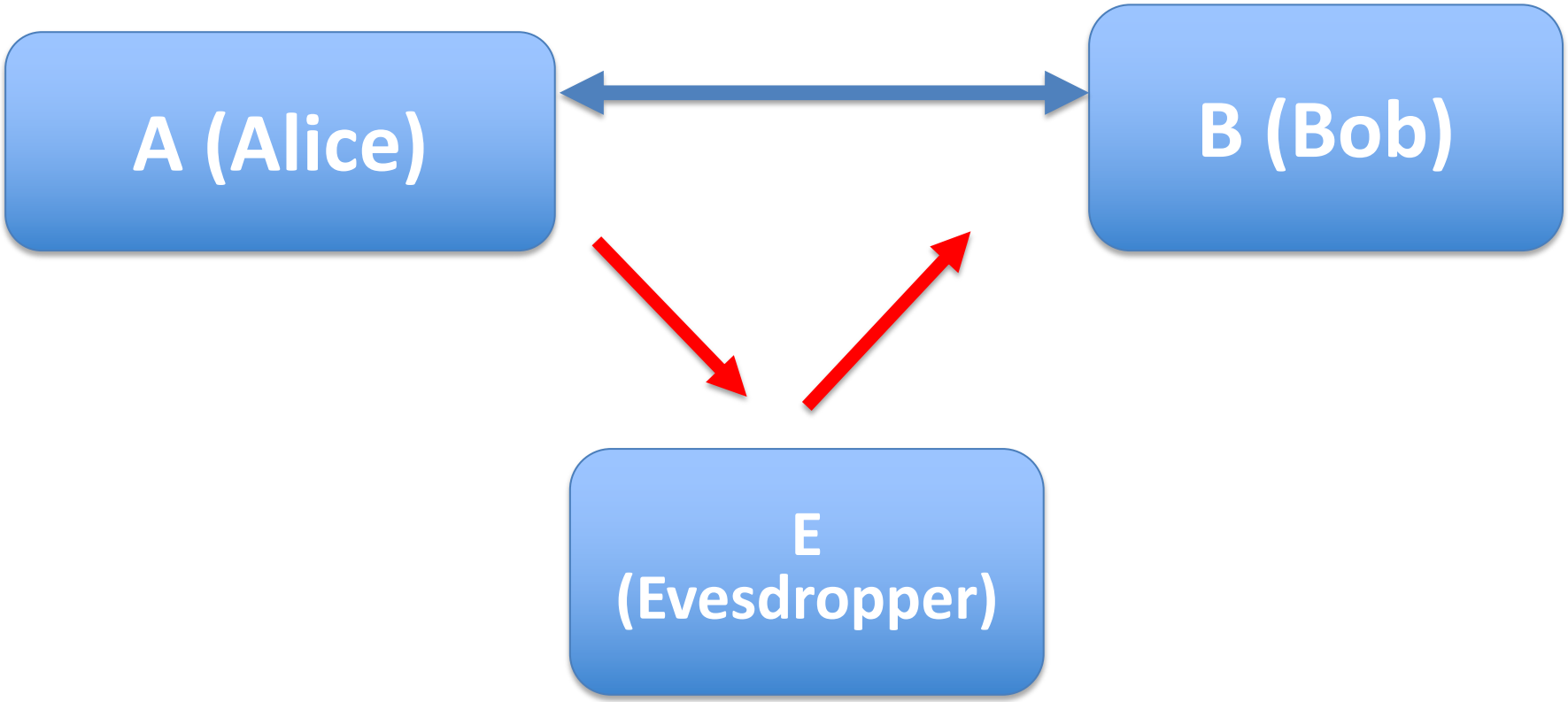


Defense Against DOS Attacks

- Anticipate the potential attacks in different situations and prepared enough resource
  - High traffic situation, e.g. sporting events like the Olympics or Soccer World Cup match
- Attack prevention and preemption (Before the attack)
- Attack detection and filtering (during the attack)
- Attack resource traceback and identification (during and after the attack)
- Attack reaction (after the attack)

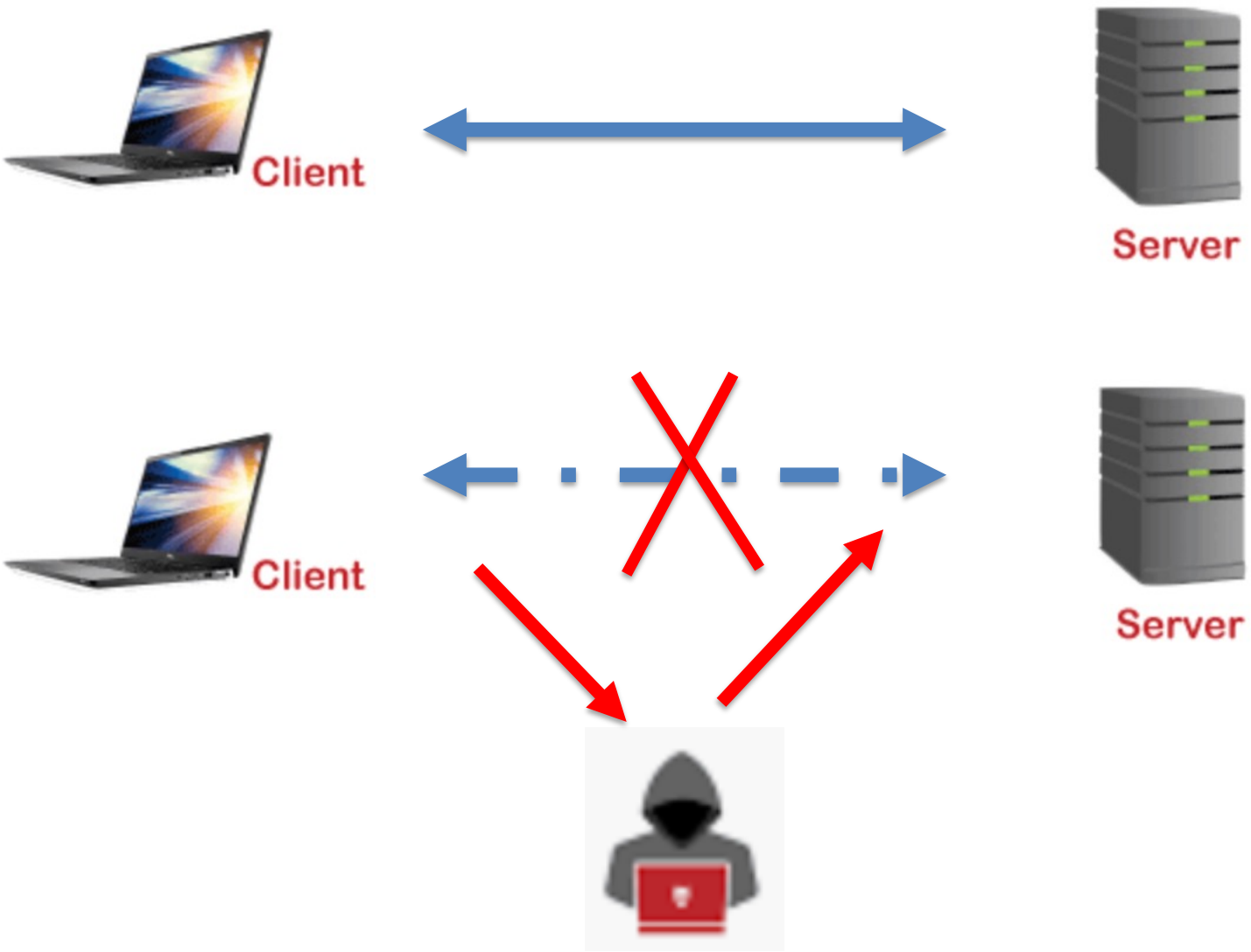
*** These attacks cannot be prevented entirely.**

Man-in-the middle Attack



Man-in-the-Middle (MITM)

MITM Attack

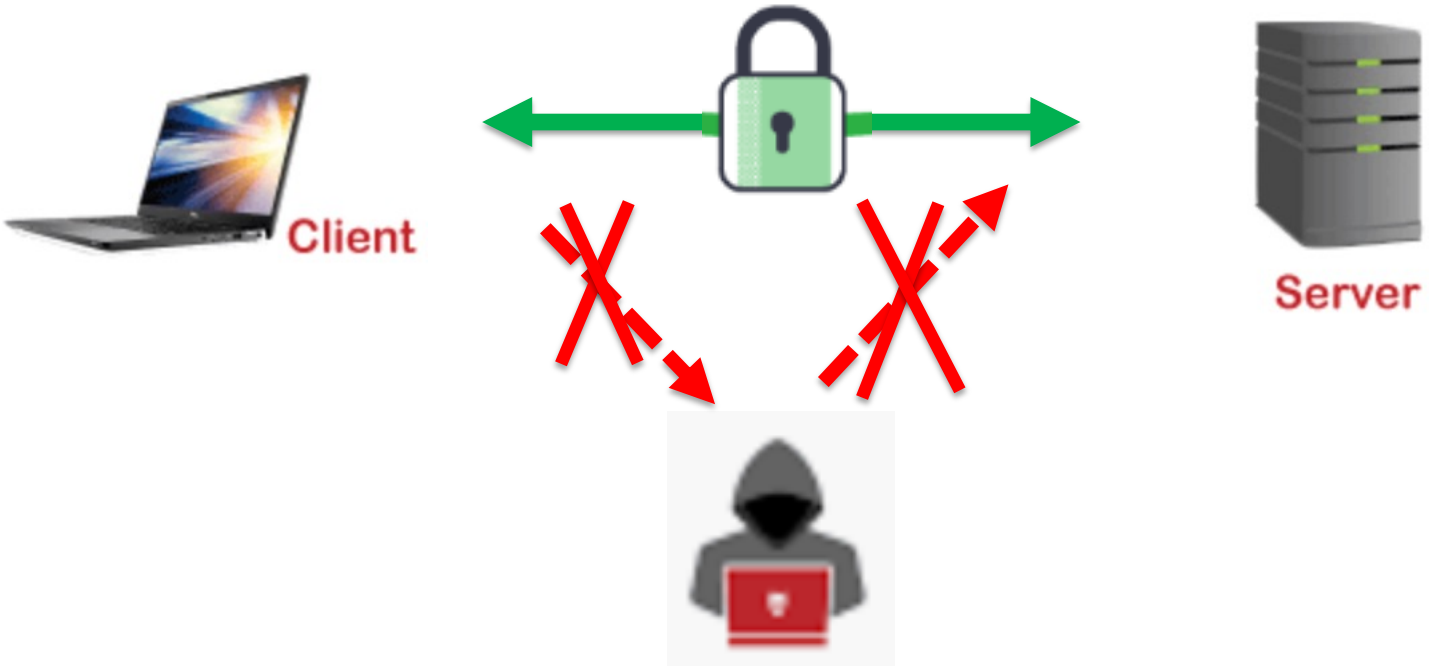


Types of MITM Attack

- Wifi Eavesdropping 偷听
  - Public wifi
- DNS Spoofing
  - A Fraudulent web server, redirect a targeted user to a malicious website under attacker contro
- IP spoofing
  - The attackers imitate an approved console's IP address
- ARP spoofing
  - fraudulent response, usually happens to a LAN with ARP protocol
- E-mail Hacking

Defending MITM

- Wireless Access Point Encryption
- Use a VPN
- Strong user Credentials
- Public Key Pair Authentication



SECURITY PROTOCOLS -KEEPING A SECRET

Keeping A Secret: Memorise

- We will start with the simplest cyber security problem, keeping a secret.
- Our first protocol is to memorise the secret.

- This is only appropriate if the secret is fairly short and easy to remember.
  - It could be a password or an encryption key.
  - It should not be a BitCoin ID!

Keeping A Secret: Paper

- If the secret is too long to remember, the next protocol is to write it down on a piece of paper
  - There is a limit to how long the secret can be.
  - It can be inconvenient to use if it has to be entered into a computer.
- The confidentiality threat relies on the attacker having physical access.
  - They can search our home or office.
- An availability threat is losing the piece of paper.
  - This can be mitigates**减轻** by backups, making a copy.
  - All copies now need to be secured.**保护**
  - We must keep track of all copies
  - destroy all copies when they are no longer needed

Keeping A Secret: Computer File

- Most documents are prepared on a computer, which introduces a number of **vulnerabilities** that can be exploited by 被利用attackers.
- The program used to create the document may make periodic backups, and so there are many different versions of the file that need to be protected.
- It is easy to create copies of the file.
- Deleted files can be recovered.

Computer File: Encryption

- An encryption program takes plaintext明文 as input and produces ciphertext as output.
- A decryption program takes ciphertext 密文 as input and produces plaintext as output.
- Decryption must undo encryption.撤消加密。

- Encryption followed by decryption must produce the same output as the original input.
- The original plaintext document must be erased.
  - Including all copies and backups.
- This protocol has a time limited vulnerability漏洞
  - While the plaintext document is in the file system.

Protocol: Secret Encryption Algorithm

- The details of the encryption and decryption algorithms are kept secret.
- Threat: finding the algorithms.
  - The algorithms will be computer programs.
  - They cannot be encrypted because they must be run on the computer.

Alice's digital file

SECURITY PROTOCOLS -COMMUNICATING A SECRET

Problem: Communicating a Secret

- Alice wants to send secret information to Bob without Eve finding out.
- This is usually a confidentiality problem保密问题.
- It can also be an integrity problem.完整性问题
  - If Eve changes the message before forwarding it to Bob.
- It can also be an availability problem. 可用性问题
  - If Eve prevents Bob from receiving the message.
  - How does Bob know that Alice has sent a message?

Protocol: Secure Transmission Medium

安全传输介质

- Alice and Bob meet in a secure room or location.
  - The only secure transmission medium.
- Electronic transmissions are easy to intercept.
  电子传输系统易于拦截。
  - Transponders can be attached to Ethernet cables and the traffic analysed.
    应答器可以连接到以太网电缆和所分析的流量上
  - Email is stored and can be analysed later.

Protocol: Secure Preparation

- Alice encrypts the message in a secure area.
- It is transmitted by an insecure medium
  - We assume that Eve can intercept, see and replace it.
- Bob decrypts the message in a secure area.
- Encryption followed by decryption cancel each other out.

加密后的解密相互抵消。

Using Encryption

Alice: Secure

Bob: Secure

Eve

P = plaintext

E = encryption algorithm

C = ciphertext

D = decryption algorithm

Secret

Public

Protocol: Use a Secret Algorithm

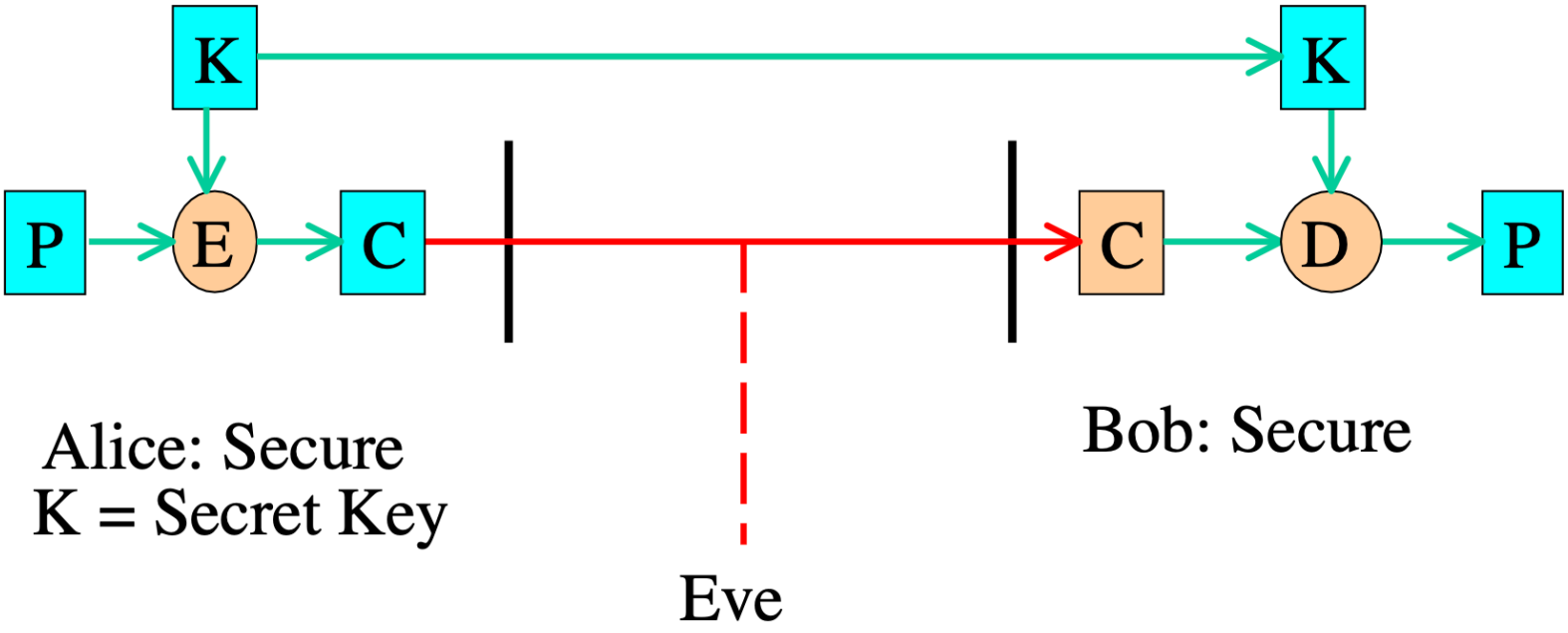
- Keep the details of the algorithm secret.
- This is bad for two reasons.
- The algorithm designers know the secret and may be physically at risk.
  - Threat of coercion.
- Peer review of a public algorithm reduces flaws. 对一个公共算法的同行评审减少了缺陷
  - It is easy to fool oneself that an algorithm is more secure than it really is.

-很容易欺骗自己算法比实际更安全。

Protocol: Public Algorithm, Secret Key (Private Key)

- Details of the encryption and decryption algorithms are public.
- They have a parameter, the key, which is kept secret.
- Knowledge of the algorithm is useless without the key.
- Also called a ***one key*** system.
- Also called ***symmetric encryption.***

Using a Secret Key



Reference Book

- Book: Computer Security Principles and Practice, by William Stallings and Lawrie Brown, 2014