Computer Networks – Study Guide (CS.1.03)

Week 4–4 · Learning Outcome: identify and explain computer networks, and interpret and evaluate the main types of networks and network classification.

Module: 3 - Network (Week 4) · **Standard code:** CS.1.03

Task skills:

1. Students understand and identify the concept of networks and their importance.
2. Emotional goal: students understand and practice using computer networks.

Key concepts to master: LAN, WAN, Peer-to-Peer networks, and the System Administrator. The most important part of this guide is section 3, where each concept is explained in detail.

1. What is a Computer Network?

A **computer network** is a group of two or more devices (computers, phones, printers, servers, etc.) that are connected to each other so they can **share data, resources, and communication**.

Devices are connected through:

- **Cables** (e.g. Ethernet) or **wireless signals** (e.g. Wi-Fi)
- **Networking devices** such as switches, routers, and access points

Examples of what networks let us share: files, printers, internet connection, applications, messages and emails.

2. Why Should We Use Computer Networks?

- **Resource sharing:** many users share hardware (printers, scanners, storage drives), software licenses, and one internet connection.
- **Communication:** email, chat, video calls.
- **File and data sharing:** share files quickly without USB drives, and several users can access and edit them at the same time from different places.
- **Centralized data and backup:** important data is stored in one place and backed up easily.
- **Cost saving:** buy fewer devices and licenses and share them.

- **Better control and security:** an administrator can manage users and permissions from one place, and security policies and updates are applied uniformly to all connected devices.

3. Key Concepts

3.1 LAN (Local Area Network)

- A network that covers a **small area**: one room, a lab, a school, a home, or an office building.
- **High speed** and **low cost**.
- Usually privately owned and managed by one person or organization, with low latency (fast response time).
- **Example:** the computers in your school lab, or your home Wi-Fi.

How a LAN works: devices in the same building connect to a central device (usually a **switch** or a Wi-Fi **access point**). The switch passes data only to the device it is meant for. A **router** then connects the LAN to other networks such as the Internet.

Main components of a LAN:

- **End devices:** computers, laptops, printers, smartphones, servers
- **Network Interface Card (NIC):** the hardware inside each device that lets it connect to the network
- **Transmission media:** Ethernet cables (wired) or Wi-Fi (wireless)
- **Switch / access point:** connects the devices together
- **Router:** connects the LAN to the Internet or other networks

Advantages of a LAN:

- Fast data transfer (commonly 100 Mbps to 10 Gbps)
- Cheap to build and maintain
- Easy to share printers, files, and Internet access
- The owner has full control over security and settings

Limitations of a LAN:

- Covers only a small area
- If the central device (switch) fails, the devices connected to it lose the network
- Poor security settings can let one infected device affect the others

Examples: a school computer lab, a home Wi-Fi network, an office, a hospital department, an Internet café.

3.2 WAN (Wide Area Network)

- A network that covers a **large geographical area**: cities, countries, or even the whole world.
- Connects multiple smaller networks (like LANs) together, often using leased telecommunication lines, fiber optics, satellites, or public infrastructure.
- Usually **slower and more expensive** than a LAN, and often uses leased lines or service providers (ISPs).
- **Example: The Internet** is the biggest WAN. A bank connecting its branches across different cities is another example.

How a WAN works: a WAN links many separate LANs (for example, a company's offices in Cairo, Alexandria, and Aswan). The data travels through **routers** and across the infrastructure of **Internet Service Providers (ISPs)** and telecom companies, using fiber-optic cables, undersea cables, satellites, or mobile networks.

Main components of a WAN:

- **Routers:** direct data between different networks and choose the best path
- **Modems:** convert signals so data can travel over telephone, cable, or fiber lines
- **Communication links:** leased lines, fiber optics, satellite, and cellular connections
- **ISPs / telecom providers:** own and operate the long-distance infrastructure

Advantages of a WAN:

- Connects people and branches anywhere in the world
- Allows sharing of data and central systems (such as a bank's database) across cities
- Supports communication tools like email, video calls, and cloud services

Limitations of a WAN:

- Expensive to build and maintain
- Slower than a LAN, with more delay (latency)
- Harder to secure, because data crosses public or shared infrastructure
- Problems can be harder to find and fix

Examples: the Internet, a bank linking its branches and ATMs, a company connecting its offices in different cities, a government network linking ministries.

Remember: a WAN is not owned by one person. The Internet is a worldwide network of networks, so no single organization owns all of it.

3.3 Peer-to-Peer (P2P) Networks

- Every computer is **equal**; each one can share its files and resources with the others.
- **No central server.**
- **Advantages:** cheap, simple to set up, good for small networks (2–10 computers).
- **Disadvantages:** weaker security, hard to manage as it grows, no central backup.
- **Example:** a few computers in a small office sharing a printer and folders.

Compare with **Client/Server**: a powerful central computer (server) provides resources and services, and other computers (clients) request them. It is more secure and easier to manage, but more expensive.

How it works: every computer (node) has equal capabilities, privileges, and responsibilities, and acts as both a **client** (requesting resources) and a **server** (providing files or resources) directly to the other nodes. The workload is shared among all participants instead of one central server managing traffic, permissions, and security.

Use cases: file-sharing networks, blockchain technologies, and small home or office networks where a dedicated server is unnecessary or too costly.

Why choose Peer-to-Peer? It needs no expensive server and no full-time administrator. Each user decides what to share from their own computer, for example a shared folder or a printer.

Problems with Peer-to-Peer:

- Each computer keeps its own passwords and sharing settings, so security is weak
- No central backup: if a computer breaks, its files may be lost
- Sharing slows down the computer that is being used by others
- Becomes confusing and hard to manage when there are many computers

Client/Server networks in more detail:

- A **server** is a powerful computer that stores data and provides services (files, email, web pages, printing)
- A **client** is a computer or device that requests those services
- User accounts, passwords, permissions, and backups are managed centrally on the server
- More secure and easier to manage for large networks, but needs a server and an administrator, so it costs more

- **Example:** a school where students log in with their accounts and save files on the school server

Peer-to-Peer vs Client/Server:

	Peer-to-Peer	Client/Server
Central server	No	Yes
Role of computers	All equal (client and server)	Clients request, server provides
Security	Weak, set on each computer	Strong, managed centrally
Backup	Each user does their own	Done centrally on the server
Cost	Low	Higher (server and administrator)
Best size	Small (about 2 to 10 computers)	Medium to large networks
Needs an administrator	Usually no	Yes
Example	Home or small office sharing a printer	School, bank, company

3.4 System Administrator

An IT professional (often called a SysAdmin) responsible for the upkeep and reliable operation of computer systems, especially servers and multi-user networks, by **setting up, managing, maintaining, and securing** the network.

Typical duties:

- Create and manage user accounts and passwords
- Control permissions (who can access what)
- Install and update software and hardware
- Back up data routinely, restore it when needed, and plan for disaster recovery
- Monitor the network and troubleshoot slowdowns, downtime, and system failures
- Protect the network from threats (set up firewalls and watch for unauthorized intrusions)

Why is the system administrator important? Without one, accounts become messy, data is not backed up, software is outdated, and the network is open to attacks. The administrator keeps the network **available** (working), **secure**, and **organized**.

Skills a system administrator needs:

- Knowledge of operating systems and networking basics
- Problem solving and troubleshooting
- Security awareness (passwords, firewalls, updates)
- Good communication, because they help users with their problems
- Attention to detail and careful documentation of changes

Example: in a school lab, the administrator creates an account for each student, limits which folders each student can open, installs updates over the weekend, backs up the teachers' files, and fixes the network when a computer cannot connect.

Key idea: the administrator controls **who** can use the network, **what** they can access, and **how safely** the network runs.

3.5 Key Terms Glossary

Term	Meaning
Network	Connected devices that share data and resources
Node	Any device connected to a network (computer, printer, phone)
LAN	Local Area Network: a small area such as a lab, school, or home
WAN	Wide Area Network: a large area such as cities or countries
MAN	Metropolitan Area Network: a city or large campus
PAN	Personal Area Network: devices around one person
Peer-to-Peer	Network where all computers are equal, with no central server
Client	A device that requests services or data
Server	A powerful computer that provides services or data

Term	Meaning
Switch	Connects devices inside a LAN
Router	Connects different networks, such as a LAN to the Internet
NIC	Network Interface Card: lets a device connect to a network
ISP	Internet Service Provider: the company that gives you Internet access
System administrator	The person who manages, secures, and maintains the network

3.6 Network Devices (Additional)

Device	What it does
Switch	Connects devices inside a LAN and sends data only to the right device
Router	Connects different networks and sends data to the Internet
Modem	Connects your network to the ISP's line
Access point	Gives wireless (Wi-Fi) access to a wired network
Firewall	Blocks unwanted or dangerous traffic

3.7 Network Topologies (Additional)

A **topology** is the shape or layout of how devices in a network are connected.

Topology	Short description
Star	All devices connect to one central switch. The most common today.
Bus	All devices share one main cable. Simple, but one cable fault affects everyone.
Ring	Each device connects to two neighbors, forming a circle.
Mesh	Devices connect to many others. Very reliable but costly.

4. Network Classification

Networks can be classified in different ways.

By size / geographic area

Type	Full name	Area covered	Example
PAN	Personal Area Network	Around one person (a few meters)	Phone connected to Bluetooth headphones
LAN	Local Area Network	Room, building, school	School computer lab
MAN	Metropolitan Area Network	A city	A city's cable TV or university campuses network
WAN	Wide Area Network	Countries or world	The Internet

By structure / role of computers

Type	Description
Peer-to-Peer	All computers are equal, no central server
Client/Server	Central server provides services to client computers

5. LAN vs WAN (Quick Comparison)

	LAN	WAN
Area	Small	Very large
Speed	High	Lower
Cost	Low	High
Ownership	One organization	Several organizations / ISPs
Example	School lab	The Internet

6. Essential Questions – Model Answers

1. What is a computer network? A group of connected devices that share data, resources, and communication.

2. Why should we use computer networks? To share resources (printers, internet), exchange files and messages quickly, save cost, and manage and secure data from a central place.

3. Mention the main types of computer networks and classify them.

- By size: PAN, LAN, MAN, WAN.
- By structure: Peer-to-Peer and Client/Server.

7. Quick Review Questions

1. Define a computer network in one sentence.
2. Give three benefits of using a network.
3. What is the main difference between a LAN and a WAN?
4. Which network type has no central server?
5. Give one disadvantage of Peer-to-Peer networks.
6. What is the biggest WAN in the world?
7. List three tasks of a system administrator.
8. Classify: your home Wi-Fi, the Internet, Bluetooth earbuds. (Answers: LAN, WAN, PAN)

Extra practice:

- In a Peer-to-Peer network, is there a central server managing everything? Why or why not?
- Give two reasons why an organization would use a network instead of standalone computers.

Practice Quiz (Answers at the End)

1. Which network covers the **smallest** area?
    - A) WAN
    - B) MAN
    - C) LAN
    - D) PAN
2. The Internet is the best-known example of a:
    - A) LAN
    - B) WAN
    - C) PAN
    - D) Peer-to-Peer network
3. In a Peer-to-Peer network:

    - A) One central server controls everything
    - B) All computers have equal roles and there is no central server
    - C) Only the administrator can share files
    - D) Computers cannot share printers
4. Which is a disadvantage of Peer-to-Peer networks?
    - A) Very expensive to set up
    - B) Weak security and hard to manage as they grow
    - C) They need a dedicated server
    - D) They cannot share files
5. Which task belongs to a system administrator?
    - A) Creating user accounts and setting permissions
    - B) Designing the keyboard
    - C) Writing the textbook
    - D) Building a monitor
6. Which is NOT a benefit of using a network?
    - A) Sharing a printer
    - B) Sharing files quickly
    - C) Central backup
    - D) Making every computer faster by itself
7. Your home Wi-Fi is an example of a:
    - A) LAN
    - B) WAN
    - C) MAN
    - D) None of these
8. Bluetooth earbuds connected to your phone form a:
    - A) WAN
    - B) PAN
    - C) MAN
    - D) Client/Server network

Answer key: 1-D, 2-B, 3-B, 4-B, 5-A, 6-D, 7-A, 8-B

8. Resources from the Course

- Textbook: Introduction to Computer Networking
- Video 1: YouTube lesson
- Video 2: YouTube lesson