

Principles of Computer Networks

An introduction to data communication, networking fundamentals, transmission modes, and the building blocks that connect our digital world.



What Is Data Communication?

Data

Raw facts collected before processing. Example: all students' marks in a test result sheet.

Information

Processed data that enables decisions. Example: knowing your own score tells you whether you passed or failed.

Data communication is the **transmission of electronic data** over a medium such as cables or microwaves – converting raw data into meaningful information across distances.



Fundamental Characteristics of Data Communication

The effectiveness of any data communications system depends on four key characteristics:



Delivery

Data must reach the correct destination and the correct user.



Accuracy

Data must be delivered without errors; corruption during transmission reduces accuracy.



Timeliness

Audio and video must be delivered without delay – known as **real-time transmission**.

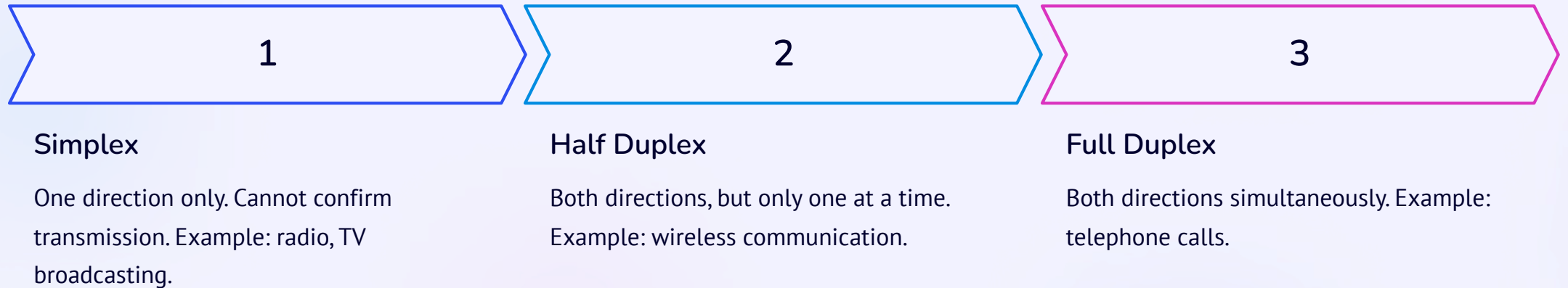


Jitter

Variation in packet arrival time that can disrupt the timeliness of data delivery.

Modes of Data Communication

The manner in which data travels from one location to another is called the **data transmission mode**. There are three modes:



Simplex Mode

In simplex mode, data travels in **only one direction**. A terminal can either send or receive – never both. Successful transmission cannot be confirmed.

This mode is not widely used in modern networks.

Examples

Speaker, radio broadcasting, television broadcasting – the signal travels from transmitter to antenna with no return signal.

Advantage

Cheapest communication method available.

Disadvantage

Only allows communication in one direction.

Half Duplex Mode

In half duplex, data can be transmitted in **both directions but only one at a time**. Each device alternates between transmitting and receiving, which slows overall data transmission rate. Transmission can be confirmed.

✓ Advantages

- Costs less than full duplex
- Enables two-way communication

✗ Disadvantages

- Costs more than simplex
- Only one device can transmit at a time



Full Duplex Mode

How It Works

Data is transmitted in **both directions simultaneously**. No time is wasted switching directions, making it the fastest transmission mode.

Example

A telephone call – both users can talk and listen at the same time.

✓ Advantage

Enables simultaneous two-way communication.

✗ Disadvantage

Most expensive method – requires two bandwidth channels.

Elements of Data Communication

Four basic elements are required for any communication system to function:



Message

The information sent – numbers, text, photos, audio, video. Broken into **packets** with a payload (data) and header (routing info).



Receiver

The device that gets and reassembles the message. Examples: computers, phones, radios, printers, televisions.



Sender

The device generating the message. Examples: computers, smartphones, cameras, fax machines, radio stations.



Medium

The channel carrying the message – twisted wire, LAN cable, fibre optic, microwave, or satellite signal.



The Role of Protocols

A protocol is a set of rules that guides how data communication is carried out. Every device that wants to communicate must use the **same protocol** to exchange messages.

The keys to any protocol are **syntax**, **semantics**, and **timing**. These standards allow devices from many different manufacturers to communicate seamlessly. Examples include **TCP/IP** (used by every device on the Internet) and **AppleTalk**.

Data Transmission: Analog vs. Digital Signals

Electromagnetic or light waves that transfer data in encoded form are called **signals**. Data transmission occurs in two forms:

Analog Signal

Transfer of data as continuous electrical waves. Measured in **volts**; frequency in **hertz (Hz)**.

-  Allows multiple transmissions on one cable
-  Suffers less from attenuation
-  Susceptible to EMI
-  One-direction without complex equipment

Digital Signal

Transfer of data as binary digits **0 and 1** using electrical pulses. Used for computer-to-computer transmission.

-  Cheaper and simpler equipment
-  Bidirectional on a cable
-  Less susceptible to EMI
-  Only one signal at a time; suffers attenuation

Techniques of Data Transmission

There are two techniques for sending data from sender to receiver:

Parallel Transmission

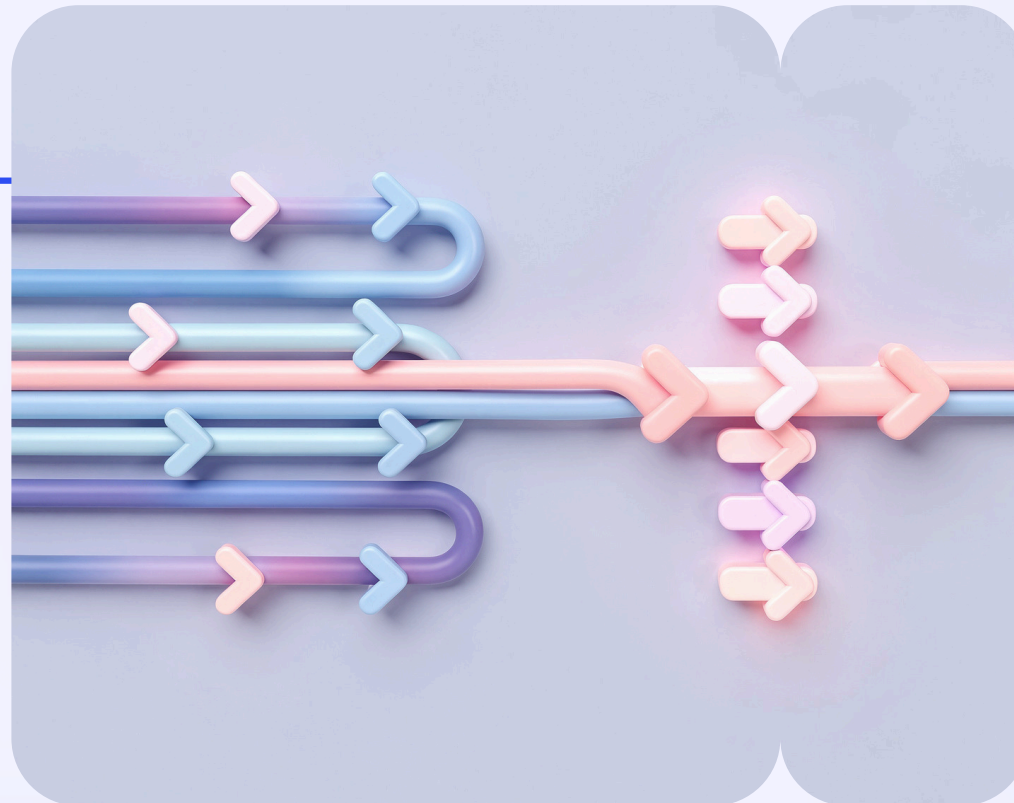
Each bit of a character has a **separate channel**. All bits of a character are transmitted **simultaneously**. Transmission is parallel, character by character – faster but requires more channels.

Serial Transmission

Data is sent **one bit at a time** through a single channel. All bits share the same signal path – simpler and more common over long distances.

Parallel Transmission

Multiple bits sent simultaneously on separate channels



Serial Transmission

Bits sent sequentially one at a time on one channel

Computer Networking

A **computer network** is a group of computers connected electronically so they can communicate and share information with each other – typically at speeds faster than a standard Internet connection.

- ❶ One of the earliest networks was the U.S. military's **SAGE** radar system. In 1969, UCLA, Stanford Research Institute, UC Santa Barbara, and the University of Utah were connected as **ARPANET** – the network that evolved into the modern Internet.



Why Networks Matter



Communication

Facilitate email, video conferencing, and instant messaging.



File & Software Sharing

Allow file sharing and access to software on remote systems across the network.



Resource Sharing

Enable multiple users to share hardware like printers and scanners.



Information Access

Make information easier to access and maintain among all network users.

Types of Networks: LAN & WAN

LAN — Local Area Network

Connects devices over a **short distance** such as a home, office, school, or group of buildings. Uses Ethernet and Token Ring technologies.

High speed: **1000 Mbps**.

WAN — Wide Area Network

Spans a **large physical distance**, crossing metropolitan, regional, or national boundaries. The Internet is the largest WAN. Uses MPLS, ATM, Frame Relay, and X.25. Speed: **150 Mbps**. A **router** connects LANs to a WAN.

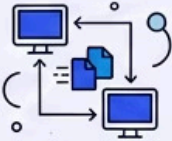
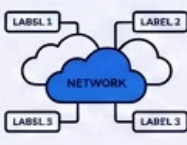
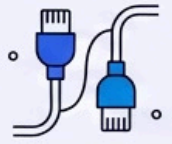
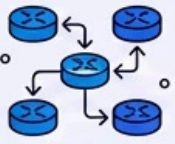
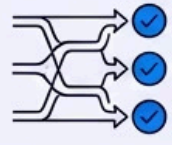
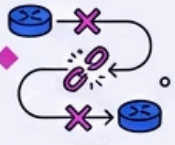
LAN vs. WAN: Performance & Design

Feature	LAN	WAN
Speed	1000 Mbps (high)	150 Mbps (lower)
Bandwidth	High bandwidth	Low bandwidth
Congestion	Less congestion	More congestion
Data Transfer Errors	Fewer errors	More errors
Fault Tolerance	Higher (fewer systems)	Lower (many systems)
Geographical Area	Up to 100 m	More than 100 m (worldwide)

LAN vs. WAN: Ownership & Cost

Feature	LAN	WAN
Ownership	Single person or organization	Collective/distributed ownership
Set-up Costs	Low – adding devices is inexpensive	Higher – remote connections costly; VPN can reduce costs
Maintenance	Easier, lower cost	Difficult, higher cost
Connection Type	Ethernet, Token Ring; connected via telephone lines or radio waves	Public networks, leased lines, or satellites
Components	Switches, bridges, hubs, repeaters (Layers 1–2)	Routers, multilayer switches, ATM/Frame-relay devices (Layer 3)

LAN vs. WAN at a Glance

LAN		WAN	
Speed: 1000 Mbps			Speed: 150 Mbps
Geographic Spread: local, up to 100m			Geographic Spread: worldwide, connecting cities/
Ownership: managed by a single organization			Ownership: distributed among different ISPs/telecoms
Technology: uses Ethernet or Token Ring			Technology: uses MPLS, ATM, or Frame Relay
Fault Tolerance high reliability			lower reliability, subject to connection issues
Set-up Cost low upfront cost			high initial investment and ongoing expenses

LAN excels in speed, reliability, and low cost within a confined area, while WAN enables global connectivity at the expense of higher complexity, cost, and lower fault tolerance.

Data Communication: Summary Table

Every communication system relies on five core components working together:

Component	Role	Example
Transmitter	The device that sends the message	Computer, Radio Station
Receiver	The device that receives the message	Telephone handset, Workstation
Medium	The channel over which the message is sent	Radio waves, Coaxial cable
Message	The information or data being communicated	Video, Text
Protocol	Rules guiding how data is transmitted, encoded, and decoded	TCP/IP, AppleTalk

Key Concepts Recap

01

Data Communication

Transmission of electronic data over a medium; effectiveness depends on delivery, accuracy, timeliness, and jitter.

02

Transmission Modes

Simplex (one-way), Half Duplex (alternating), and Full Duplex (simultaneous two-way).

03

Signals & Techniques

Analog vs. digital signals; parallel vs. serial transmission techniques.

04

Networking

LANs cover short distances with high speed; WANs span the globe connecting multiple LANs via routers.





Features of LAN

A comprehensive guide to Local Area Networks – their components, media types, configurations, bandwidth, and protocols.

CHAPTER 2

What Is a Local Area Network?

Definition

A LAN is a data communication network – typically a packet communication network – limited in geographic scope. It provides **high-bandwidth communication** over inexpensive transmission media.

Relationship to Other Networks

LANs share key elements with long-haul packet communication networks, including software protocols that range from low-level packet transport to high-level application protocols. These protocols are integral to both LANs and their long-haul relatives.

Components of a LAN

Transmission Medium

Twisted pair, coaxial cable, or fibre optics carry signals between devices.

Transmission Control

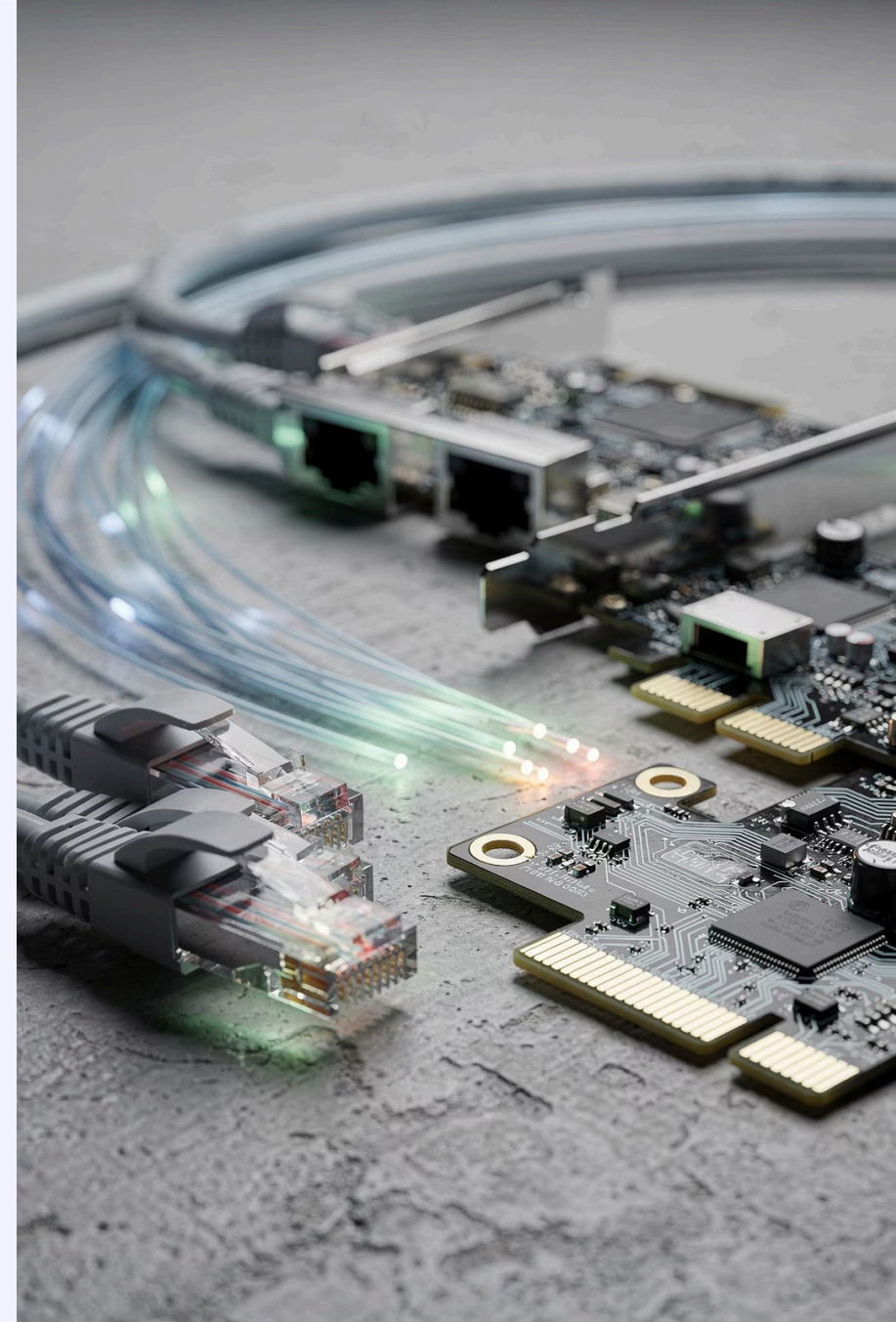
A mechanism that governs how and when devices transmit over the shared medium.

Network Interface

Hardware that connects host computers and other nodes to the network.

Software Protocols

Implemented in host devices to control information transmission across the network.



Uses of LAN



Centralized IT Administration

Manage many computers from a single platform. IT admins can remotely troubleshoot problems across the network rather than in person.



Added IT Security

Network devices include built-in firewalls. Network backups add data security, and servers in locked rooms can't be stolen or accessed physically.



Centralized Backups

Backups are centrally managed, scheduled, and can be saved to off-site locations – secure from office downtime or disasters.

More Uses of LAN

Access to Business Applications

All office users access the same applications and company information. Networks also enable advanced communications like **VoIP** and **video conferencing**.

Local Data Sharing

Thousands of employees can share data quickly. Before networking, files were physically carried on floppy disks – the so-called "*sneakernet*." Intranets and extranets further distribute corporate information between sites and partners.

Communication

LAN enables users to communicate with one another, saving time and resources across the organization.

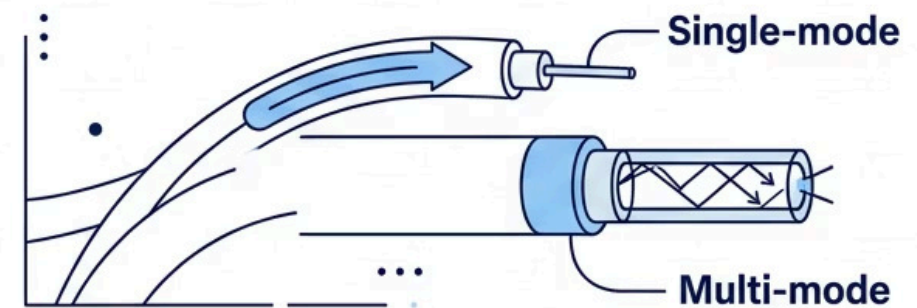
Types of LAN Media

The term "**media**" refers to the physical connectors, wires, or devices used to connect network components. There are four main categories of LAN media.

COPPER



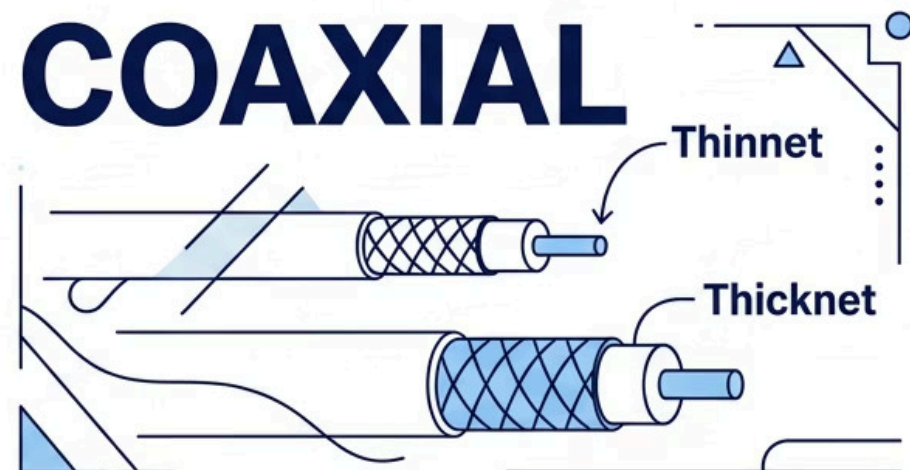
FIBRE OPTIC



WIRELESS



COAXIAL





Coaxial Cable

Coaxial cable has a solid copper core surrounded by insulation, braided wire, and metal foil shielding against electromagnetic interference.

Thinnet

~ $\frac{1}{4}$ inch thick, flexible, connects directly to workstations via BNC connector. Max length: **185 meters**. Used for short distances.

Thicknet

~ $\frac{1}{2}$ inch thick, supports longer distances. Max length: **500 meters**. Used as a backbone to connect smaller thinnet-based networks. Bandwidth: **10 Mbps**.

Twisted Pair Cable

The most common LAN cabling today. Pairs of wires are twisted to cancel out magnetic interference — a process called **cancellation**. Two types exist: **STP** (Shielded) and **UTP** (Unshielded). UTP uses an RJ-45 connector and is the most common networking media.

Category	Purpose	Transfer Rate
Cat 1	Voice Only	—
Cat 2	Data	4 Mbps
Cat 3	Data	10 Mbps
Cat 4	Data	16 Mbps
Cat 5	Data	100 Mbps
Cat 5e	Data	1 Gbps
Cat 6	Data	1/10 Gbps

Optical Fibre Cabling

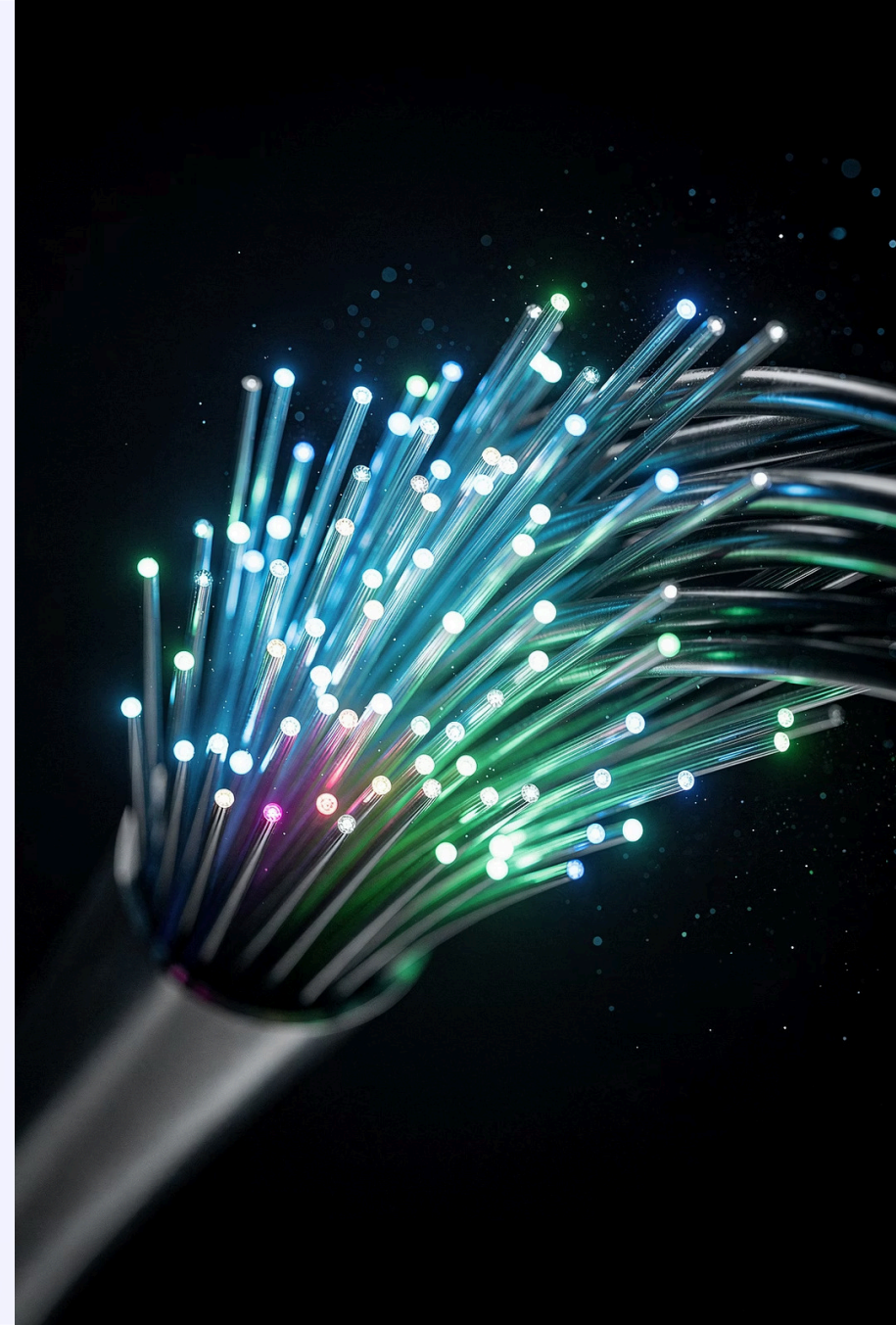
Fibre optic cables carry digital data as **modulated pulses of light** through an extremely thin glass core surrounded by cladding. Each cable has two fibres – one to transmit, one to receive.

Single Mode Fibre (SMF)

Uses a **single ray of light** to carry transmission over **long distances**. Ideal for wide-area backbone connections.

Multi Mode Fibre (MMF)

Uses **multiple rays of light simultaneously**, each at a different reflection angle, to carry transmission over **short distances**.



Wireless LAN Media

How It Works

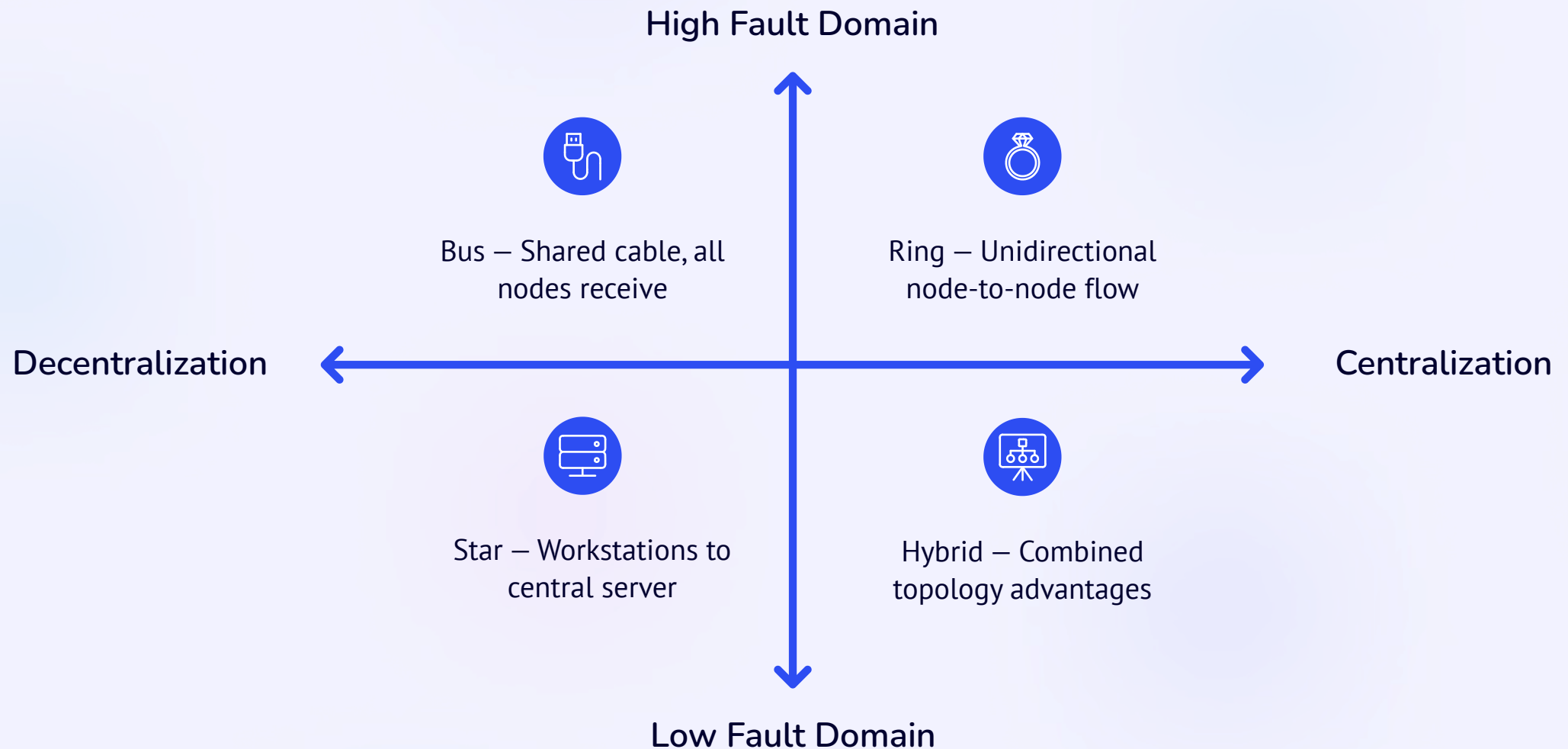
Wireless communication uses **radio frequencies (RF)** or **infrared (IR)** waves to transmit data. A wireless access point distributes signals; devices connect via a wireless NIC (adapter card).

Wireless signals travel through air or vacuum – no physical medium required. Frequencies range from **3 kHz to 300 GHz**, with data rates from **9 kbps up to 54 Mbps**.



LAN Configurations

Typical LAN configurations include three primary topologies: **Bus**, **Ring**, and **Star**. Each has distinct characteristics for how data flows and how failures are handled.



Bus, Ring & Star Networks

Bus Network

All nodes share a single cable (the bus). All receive transmitted data, but only the addressed node accepts it. Easy and cheap to install. **Ethernet** is the most popular example.

Ring Network

Workstations connected in a ring; signals travel in one direction node-to-node. A malfunctioning terminal won't disrupt others. **IBM Token Ring** is a classic example.

Star Network

Each workstation connects to a central server. Cable is not shared. If the server fails, all communication is lost – but individual workstation failures don't affect others. **AT&T StarLAN** is an example.

SECTION 2.5

LAN Bandwidth

LANs cover small areas – an office, a few buildings, or a home – and unlike WANs, require no leased telecom lines, enabling **very high data transfer rates**. Network managers must monitor bandwidth usage closely to avoid performance bottlenecks. LAN bandwidth comes in two forms: **Baseband** and **Broadband**.



Baseband vs. Broadband LANs

Baseband

Single-channel, supports **one transmission at a time**. Digital in nature. Provides 1–100 Mbps over coaxial, UTP, STP, or fibre. Supports ring, bus, tree, and star topologies. **By far the most popular** – Ethernet, Token Ring, and FDDI are all baseband. No modems needed; low-cost installation.

Broadband

Carries a **wide range of signal frequencies** – from audio to video. Supports **multiple simultaneous transmissions** via multiple frequency channels. Can carry TV, video conferencing, and voice. Examples: **ATM, ADSL, Cable TV**. Much less common in LANs than baseband.

LAN Protocols

LAN protocols govern how data is transmitted across the network. The three primary protocols are **Token Ring**, **Ethernet**, and **TCP/IP**.

Token Ring

Data link layer protocol using a special 3-byte token frame. Standardized as IEEE 802.5.

Ethernet

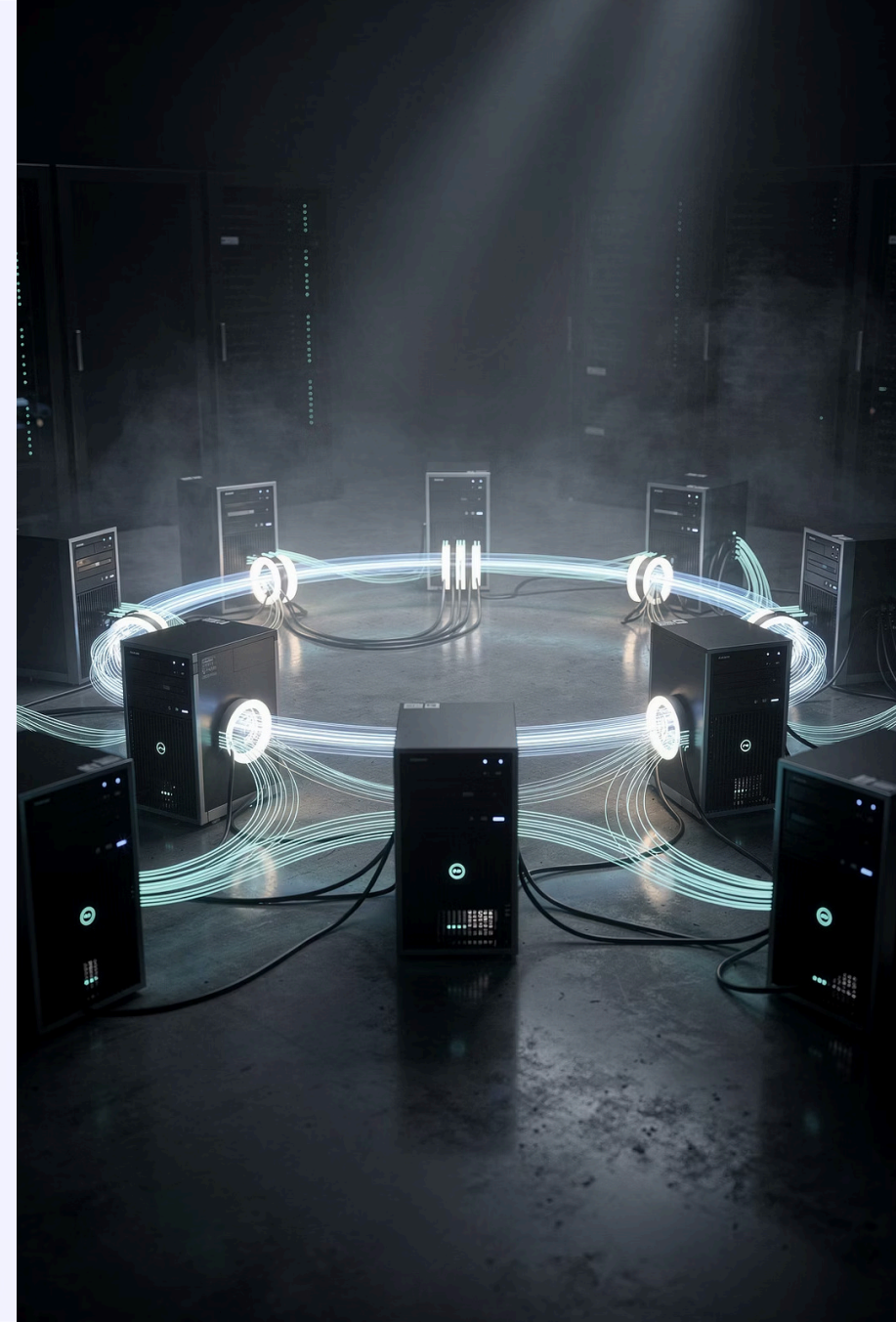
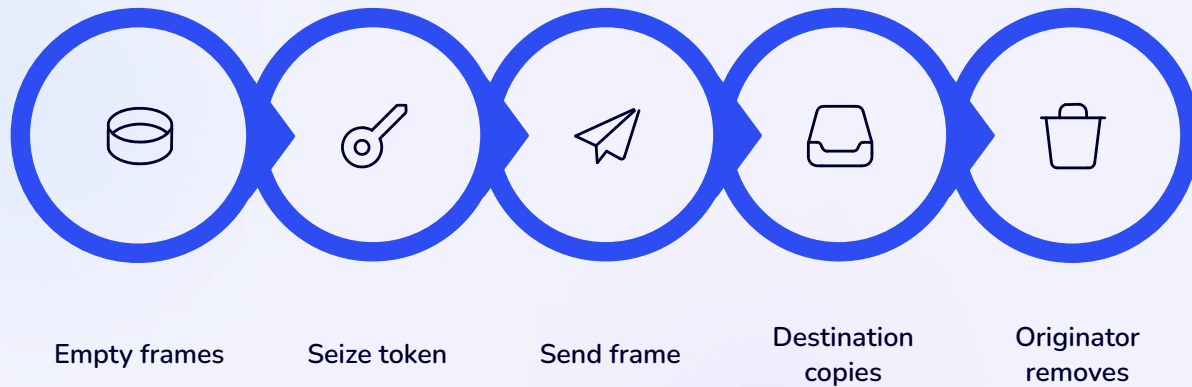
The most popular LAN protocol today. Controls data transmission over wired LANs using RJ-45 or coaxial connections.

TCP/IP

The foundational protocol of the Internet, also used in private intranets and extranets. A two-layer program.

Token Ring Protocol

Token Ring resides at the **data link layer (DLL)** of the OSI model. A special 3-byte token travels around the ring; possession of the token grants permission to transmit.



Ethernet Protocol

What Is Ethernet?

Ethernet controls how data is transmitted over a LAN using wires — primarily **RJ-45** cables (similar to a phone jack but larger). Some large LANs use coaxial cables spanning multiple buildings.

Why It Dominates

Ethernet is **by far the most popular LAN protocol** in use today. Purchasing a standard network card means getting an Ethernet card by default, unless another protocol is specifically requested.



TCP/IP Protocol

TCP/IP is the basic communication language of the Internet and private networks. Every computer communicating over the Internet has a copy of TCP/IP.

Transmission Control Protocol (TCP) — Upper Layer

Assembles messages into smaller **packets** for transmission, then reassembles them at the destination into the original message.

Internet Protocol (IP) — Lower Layer

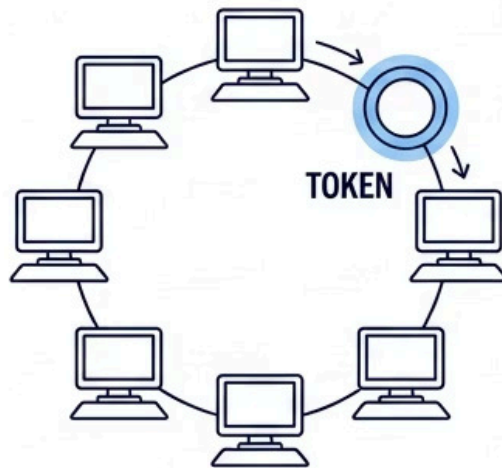
Handles the **address** of each packet so it reaches the correct destination. Each gateway checks the address and forwards accordingly — even if packets take different routes.

Client/Server & Stateless Model

TCP/IP uses a **client/server** model with point-to-point communication. It is "stateless" — each request is independent — freeing network paths for continuous use by all.

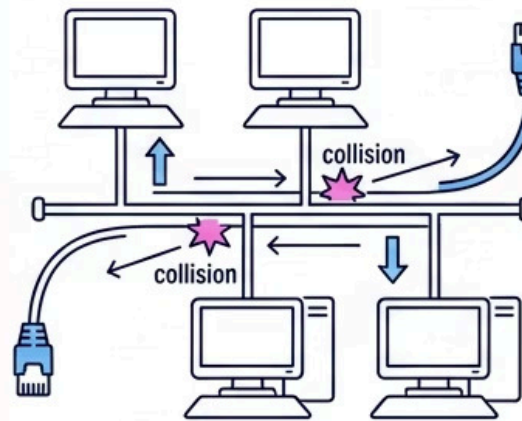
LAN Protocols at a Glance

TOKEN RING



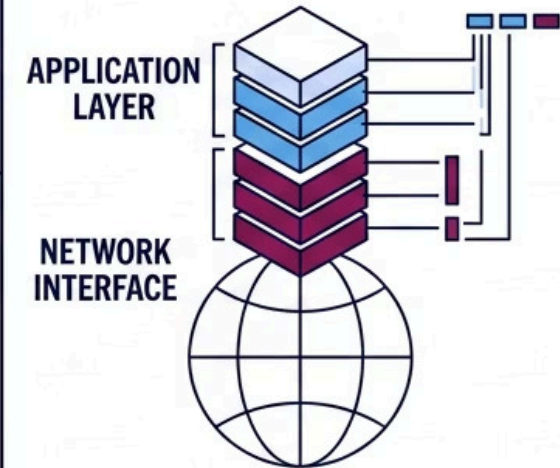
- IEEE 802.5
- DATA LINK LAYER
- RING TOPOLOGY
- TOKEN-BASED ACCESS
- ORIGINALLY IBM

ETHERNET



- MOST POPULAR
- WIRED: RJ-45 OR COAXIAL
- CSMA/CD ACCESS

TCP/IP



- INTERNET STANDARD
- TWO-LAYER
- CLIENT-SERVER MODEL
- STATELESS
- INTRANETS & EXTRANETS

Key Takeaways: Features of LAN

01

LAN Defined

A geographically limited, high-bandwidth packet communication network built from transmission media, control mechanisms, interfaces, and software protocols.

02

Media Types

Coaxial cable, twisted pair (UTP/STP), fibre optic (SMF/MMF), and wireless – each with distinct speed, distance, and cost trade-offs.

03

Topologies

Bus, Ring, and Star configurations each offer different approaches to data flow and fault tolerance.

04

Protocols

Token Ring, Ethernet (dominant), and TCP/IP govern how data is transmitted, addressed, and delivered across the network.



Creating a LAN Network

WINDOWS 7 GUIDE

A step-by-step guide to setting up a local area network (LAN) on Windows 7 – from hardware requirements to file sharing and Internet access.



Hardware You'll Need



Network Interface Card (NIC)

Each computer needs a NIC or on-board network port. HP and Compaq computers come network-ready. Confirm an RJ-45 port is present on the back of each machine.



Network Hub or Router

A hub may not be needed if your home has RJ-45 wall jacks or your DSL/cable modem provides ports. Consult a network specialist to find the right hub for your needs.



Network Cables

One network cable per computer. A crossover cable can connect two computers directly without a hub – but it is not expandable beyond two machines.

Before You Begin

Disconnect the Internet

If you have a DSL or cable modem, disconnect it before starting network setup.

Disable Firewall Software

Firewall software may interfere with network setup. Disable it temporarily – you can re-enable it once setup is complete.



STEP 1

Connect the Network Hardware & Cables



Power On Hub

Connect RJ-45 Cables

Power On Computers

Follow the manufacturer's instructions when setting up your hub or router. If using a crossover cable, connect it directly to the RJ-45 ports on each computer instead of routing through a hub.

STEP 2

Turn On Network Discovery & File Sharing

Perform these steps on **each computer** you want accessible on the network.

01

Open Control Panel

Click **Start**, then click **Control Panel**.

03

Enable Sharing

Turn on **Network discovery** and **File and printer sharing**. Review other settings and toggle as needed.

02

Homegroup Settings

Under **Network and Internet**, click **Choose Homegroup and sharing options**, then click **Change advanced sharing settings**.

04

Save Changes

Click **Save changes** to apply your settings.

STEP 3

Sharing Drives, Folders & Files

How to Share a Folder

1. Click **Start**, then click **Computer**
2. Browse to the folder you want to share
3. Right-click the folder and select **Share with**
4. Choose **Homegroup (Read)**, **Homegroup (Read/Write)**, or **Specific people**

Sharing with Specific People

If you choose **Specific people**, the File Sharing window opens. Click the down arrow, select the account to share with, and click **Add**.

Use the **Permission Level** arrow to set Read or Read/Write access per account or group, then click **Share**.

 A User Account Control prompt may appear – you must accept it to apply changes.

STEP 4

Test the Network

Open the **Windows 7 Network window** and browse shared folders on each computer. If a computer can read and access files from a remote machine, that machine is configured correctly.

Browse Every Computer

Access every available computer from each machine on the network to confirm full connectivity.

Troubleshoot Issues

If any issues arise, revisit the previous steps and verify all settings are correct before proceeding.





STEP 5

Enable Internet Access & Firewall

Once file transfer between computers is verified, reconnect and enable Internet connections for computers that require access.



Security Warning: Each Internet-connected computer must be protected with a firewall and have the latest critical updates from Microsoft Windows Update installed. Malicious activity entering through one computer can quickly spread across the entire network.

Accessing Shared Files & Directories

01

Enable Network Discovery

Ensure Network discovery and file sharing is turned **On** on the computer you are using.

03

Browse the Network

Double-click **Network**. The Network window displays all computers with shared folders detected on local networks.

02

Open Network and Sharing Center

Click **Start** → **Control Panel** → **Network and Internet** → **Network and Sharing Center**.

04

Access a Computer

Double-click the computer you want to access to browse its shared folders and files.

Troubleshooting: "Cannot Access PC" Error

When accessing shared files, you may encounter an access error. This is typically caused by one of the following:

Password Protection Conflict

Password Protection is On and the **Guest account is also On** – these settings conflict and block access.

Insufficient Permissions

The account does not have permission to access the share. This commonly occurs on systems with multiple shared folders and specific permission configurations.

 Windows 7 displays **all** shared folders – including those you do not have permission to access.

Resolving Access Errors

→ Check Account Permissions

Verify the account has the proper permissions to access the target computer and its shared folders.

→ Verify Spelling

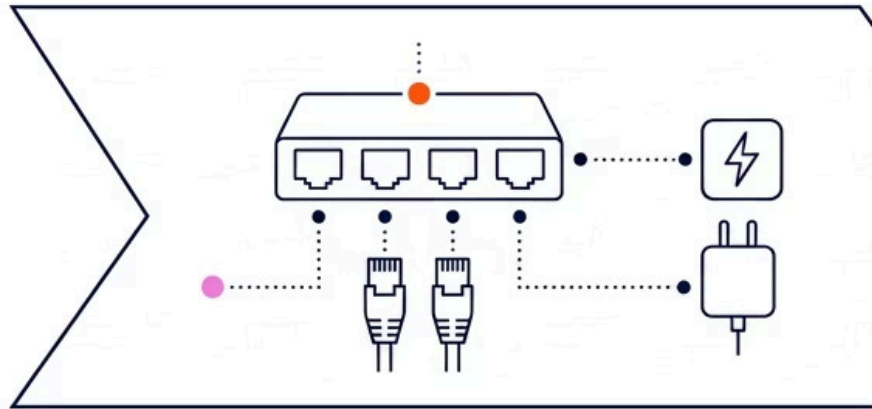
Confirm that both the **computer name** and **account name** are spelled correctly.

→ Check Firewall Settings

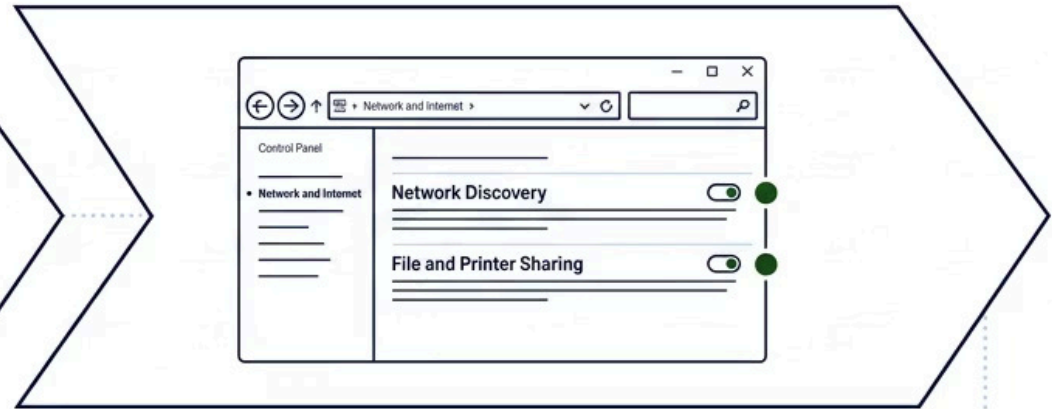
Ensure that firewall software on any connected computer is configured to **allow network access**.



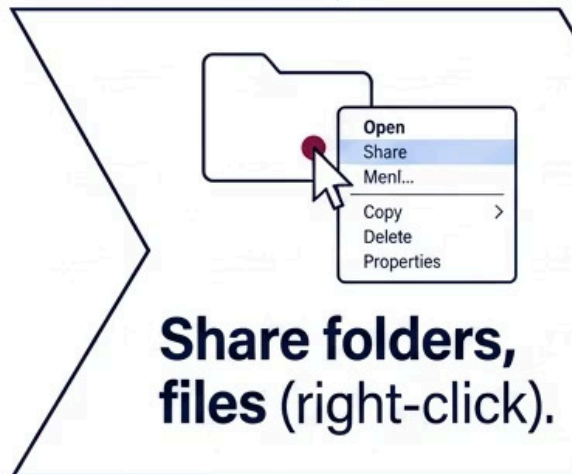
LAN Setup: Full Process Overview



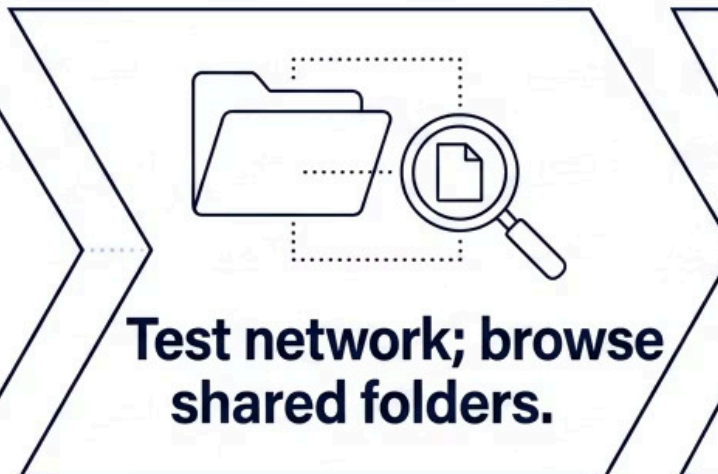
Connect hardware, cables.



Turn on Discovery, File Sharing.



Share folders, files (right-click).



Test network; browse shared folders.



Enable Internet, re-enable firewall.

Following all five steps in order ensures a stable, secure, and fully functional Windows 7 LAN – from physical cabling through to verified file sharing and protected Internet access.

Key Hardware Notes at a Glance



RJ-45 Port Required

Every computer must have an RJ-45 network port. HP/Compaq computers include NICs by default.



Crossover Cable Limit

A crossover cable connects two computers without a hub – but cannot be expanded beyond two machines.



Hub May Be Optional

If your home has RJ-45 wall jacks or your modem provides ports, a separate hub may not be needed.



Always Re-Enable Firewall

Disable the firewall only during setup. Re-enable it – along with Windows Updates – before connecting to the Internet.



Your LAN Is Ready

With hardware connected, sharing enabled, and the network tested, your Windows 7 LAN is fully operational. Keep security top of mind – maintain your firewall, apply Windows Updates, and verify permissions regularly to keep your network safe and running smoothly.

✓ Hardware Connected

✓ Sharing Enabled

✓ Network Tested

✓ Internet & Firewall Active

Features of Wide Area Networks (WAN)

An in-depth exploration of WAN architecture, uses, hardware requirements, and advantages – the backbone of global digital communication.



What Is a WAN?

Definition

A Wide Area Network (WAN) covers large geographical areas, using leased communications circuits from telephone companies or carriers to connect intermediate nodes.

Typical transmission rates range from **2 Mbps** up to **625 Mbps** or more.

Real-World Examples

- Public packet networks
- Large corporate networks
- Military networks
- Banking networks
- Stock brokerage networks
- Airline reservation networks



Network Service Providers & the Internet

Organisations supporting WANs using the Internet Protocol are known as **Network Service Providers (NSPs)** – they form the core of the Internet.

Peering Points

NSP WANs connect via Internet Packet Interchanges, forming a global communication infrastructure.

Intermediate Organisations

NSPs deal with intermediate organisations for high-capacity communications rather than individual customers.

Quality of Service

NSPs agree to exchange data volumes at defined quality levels, varying in transit delay, transmission rate, and connectivity.

Uses of WAN



Remote Data Sharing

Users can share gigabytes of project data across locations in real time – e.g., a user in Johannesburg sharing files with a colleague in the US.



Applications Access

All users – in main offices, remote offices, or at home – get universal access to the same business applications, including VoIP and video conferencing.



Real-Time Communication

WAN enables real-time communication across vast distances, saving time and resources – e.g., a user in Chicago communicating with one in Tripoli.



Sharing Peripherals

Networks allow multiple users to share printers, plotters, and other peripherals simultaneously, eliminating the need for dedicated devices per user.



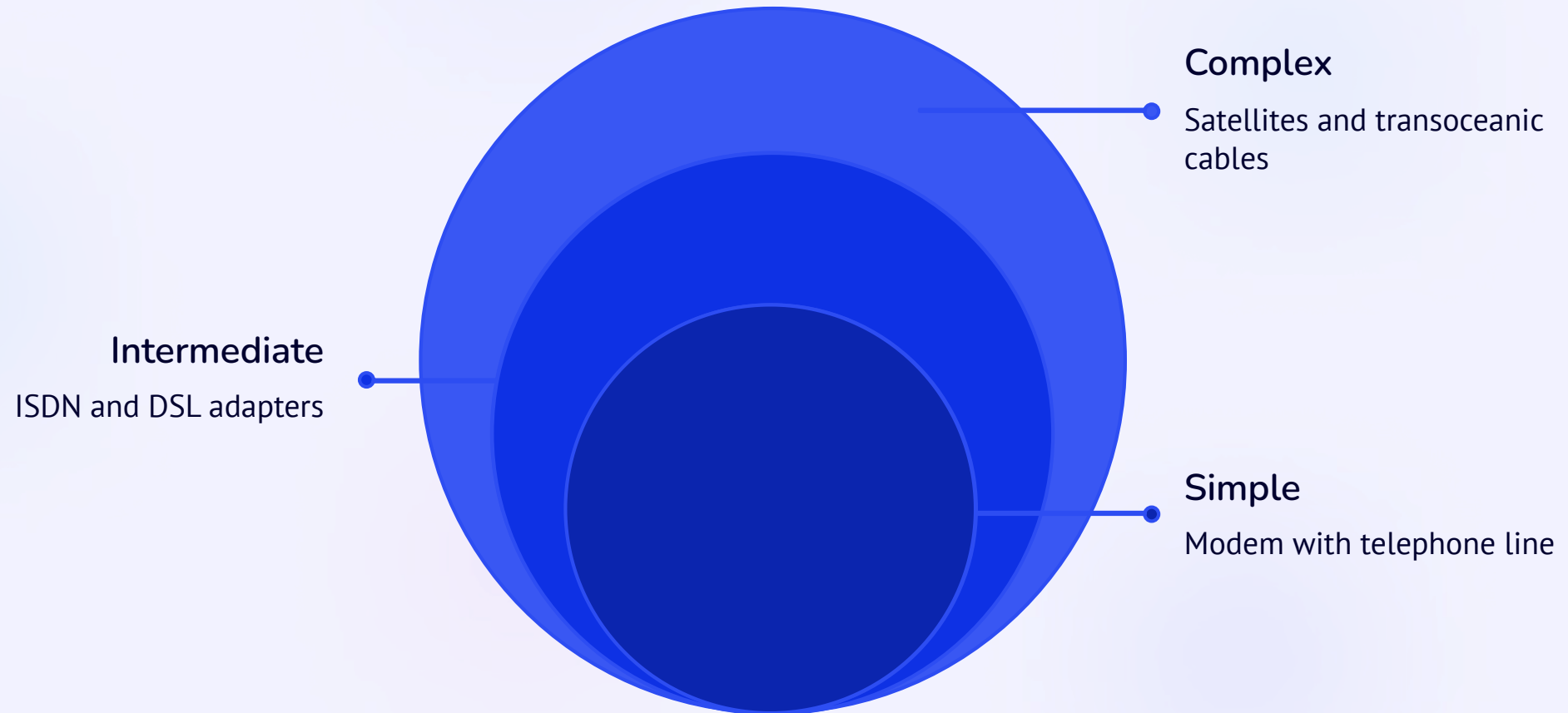
Peripheral Sharing in Practice

Before networks, each computer user required their own printer or plotter. A WAN environment enables several workstations to share a single printer simultaneously – a fundamental shift in how office resources are managed and allocated.

- i A typical networked environment allows five or more workstations to share a single printer, dramatically reducing hardware costs and improving workflow efficiency.

WAN Hardware Overview

A WAN spans metropolitan areas, nations, and even continents. The hardware required can range from a simple modem and telephone line to complex satellites and transoceanic cabling. The **PSTN** (Public Switched Telephone Network) and the entire Internet are both examples of WANs.



This spectrum illustrates how WAN hardware scales from consumer-grade to enterprise and global infrastructure.

Modems: Internal vs. External

Internal Modems

- Compact – fit into ISA or PCI slots
- No extra desktop space needed
- No serial cable required
- Runs off computer's power supply

External Modems

- Provide status lights (power, connected, transferring)
- Generally easier to configure and install
- Require a power cord and serial cable
- Need an available COM port (COM 1 or COM 2)

☐ Serial ports use a **UART** (Universal Asynchronous Receiver/Transmitter) chip – the chip type determines data transfer speed. Modem drivers act as liaisons between the hardware and the operating system.

ISDN & DSL Adapters

Devices connecting computers to **ISDN** (Integrated Services Digital Network) or **DSL** (Digital Subscriber Line) are more accurately called **terminal adapters** – they do not modulate/demodulate since the lines are digital.

ISDN Adapters

Available in internal and external varieties. Typical 128 Kbps service uses two 64 Kbps data channels, each with separate phone numbers and SPID (Service Profile Identifier) configuration.

DSL Adapters

Required at both ends of a DSL connection. Endpoints may be external or integrated with the NIC on the same card.



Customer Premises Equipment (CPE)

CPE is a general term for devices used to process transmissions on WAN links. These are deployed at the customer's location to interface with carrier infrastructure.

1

T-1 Lines

Standard digital transmission lines commonly used for business WAN connections.

2

T-3 Lines

Higher-capacity lines offering significantly greater bandwidth than T-1.

3

X.25 Connections

An older packet-switching protocol used in legacy WAN implementations.

4

Frame Relay Links

A cost-effective WAN protocol for connecting LANs across wide geographic areas.

Advantages of WAN

SCALE



REMOTE ACCESS

Access network resources from anywhere.



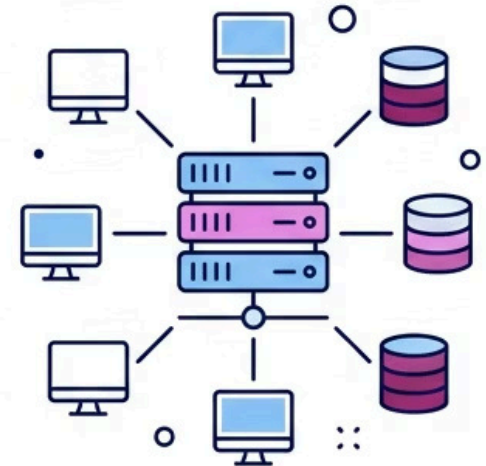
COST

Public infrastructure reduces connection costs.



CENTRAL STORAGE

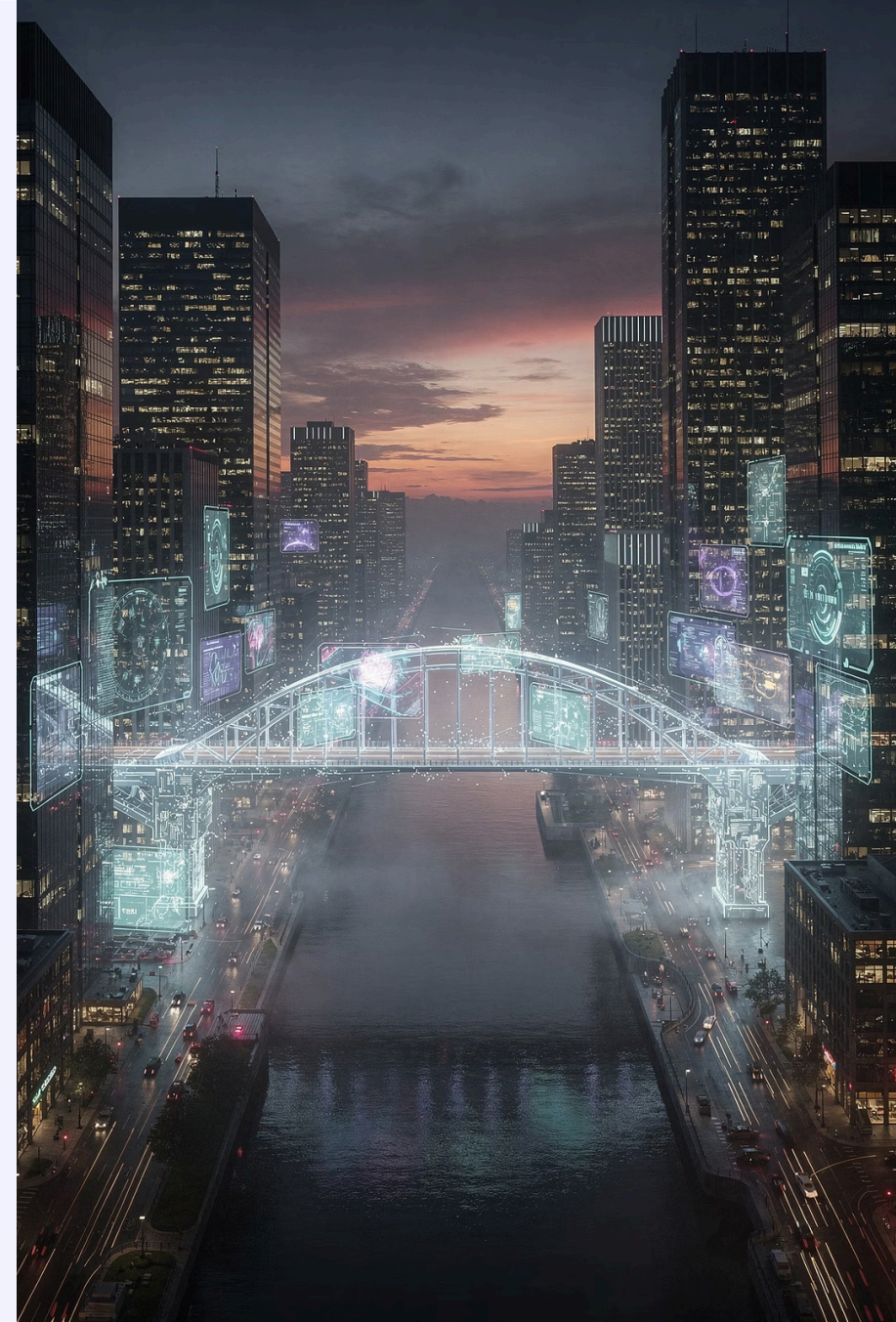
Central server acts as shared data bank for all connected users.



Advantage: Scale

The principal advantage of a WAN is its **size**. By linking multiple sites, WANs enable communication between entities on different sides of the country – or the world. This is especially beneficial for businesses centralizing key operations such as stock control.

- i While a LAN could theoretically achieve similar scale, it would present an extremely complex design challenge and would likely be **prohibitively expensive**.



Advantage: Remote Access

WAN technology enables employees to access a company's local network from home using their Internet connection – facilitating **flexible working**.

- Staff are not required to be physically in the office
- Work can be arranged around commitments like childcare
- Supports remote work during business travel

Key Benefit

Remote access decouples productivity from physical location, giving organisations and employees greater operational flexibility.



Advantage: Cost Efficiency

Using **public infrastructure** means connecting clients to a WAN can be less costly than building a LAN. Setting up a WAN connection can be as simple as installing software for remote Internet access – compared to purchasing and configuring every LAN component.



This cost advantage applies **only if** the infrastructure needed to access the WAN is already in place.

Advantage: Centralized Storage

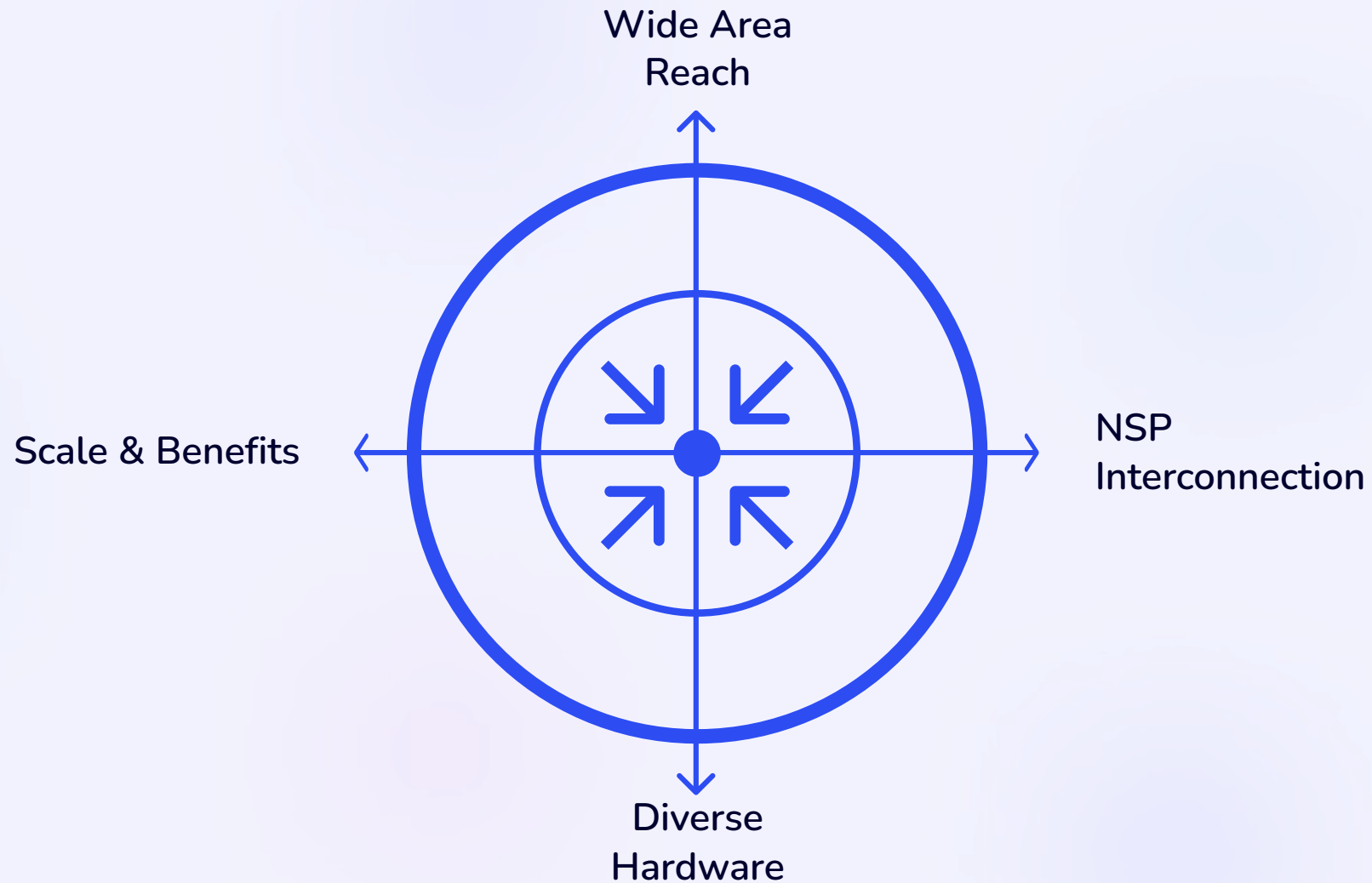
Central Data Bank

A central server on the WAN acts as a shared data bank. All files needed by the company are accessible to every connected computer – regardless of geographic distance.

Global Reach

WAN can connect computers across regions, islands, and even continents. This makes centralized storage a practical reality for multinational organisations managing distributed teams.

Key Takeaways: WAN at a Glance



WANs are the essential infrastructure underpinning global communication – from corporate networks to the Internet itself. Understanding their features, hardware, and advantages is foundational to modern networking./