

DAY 1

Introduction to Networking

Basic Concepts • Hosts, Clients, Servers • Peer-to-Peer • Network Types • Data-Center Fabrics
09:00 – 16:00 | 8 × 45-minute lessons | 1-hour lunch break

Daily Schedule

Time	Session	Topic
09:00 – 09:45	Lesson 1	What is a Network? Hosts, Clients, Servers
09:45 – 10:30	Lesson 2	Peer-to-Peer vs. Client/Server Architecture
10:30 – 11:15	Lesson 3	LAN — Local Area Network & PAN
11:15 – 12:00	Lesson 4	MAN — Metropolitan Area Network & WAN
12:00 – 13:00	☕ LUNCH BREAK	
13:00 – 13:45	Lesson 5	The Internet & Data-Center Fabrics
13:45 – 14:30	Lesson 6	Comparing Network Types — Guided Activity
14:30 – 15:15	Lesson 7	Real-World Scenarios & Group Discussion
15:15 – 16:00	Lesson 8	Review, Q&A & End-of-Day Assessment

09:00 – 09:45 **Lesson 1** What is a Network? Hosts, Clients & Servers

Learning Objectives

- Define what a computer network is and why it exists.
- Identify the concept of a host and give examples.
- Distinguish between a client, a server, and the relationship between them.
- Explain what a protocol is and why protocols are necessary.

1.1 What is a Computer Network?

A computer network is two or more devices connected together so they can share information and resources. Without a network, data can only be moved physically — for example, on a USB drive.

Networks make it possible to:

- Share files, documents, and databases instantly.
- Send email and messages across the world.
- Access websites, applications, and cloud services.
- Share hardware — printers, scanners, storage — among many users.
- Make voice calls and hold video conferences.

Key Takeaway

A network = devices + connections + protocols. All three parts are required. Missing any one of them and communication fails.

1.2 What is a Host?

Any device that is connected to a network and has an IP address is called a host. The word 'host' is the generic term — it covers all device types.

Device Type	Example	Is it a Host?
Desktop PC	Office workstation	Yes
Laptop	Student's notebook	Yes
Smartphone	Mobile phone on Wi-Fi	Yes
IP Camera	Security camera on LAN	Yes
VoIP Phone	Office desk phone	Yes
Printer	Network-attached printer	Yes
Server	Web or file server	Yes

Concept Check

A switch or router is NOT a host — it is a network device whose job is to forward data, not to originate or consume it.

1.3 What is a Client?

A client is a host that requests data or a service from another device. The client initiates communication.

Examples of clients:

- Your browser (Chrome, Firefox) requesting a web page from a web server.
- Your email app requesting new messages from a mail server.
- Your phone requesting a map from Google Maps' servers.

1.4 What is a Server?

A server is a host that provides data or a service in response to a request. A server waits for requests and then responds.

Server Type	What it provides	Example
Web Server	Web pages (HTTP/HTTPS)	apache.org hosts the Apache website
File Server	Shared file storage	A NAS drive in an office
Mail Server	Email sending and receiving	Gmail, Outlook 365
DNS Server	Translates domain names to IPs	8.8.8.8 (Google DNS)
DHCP Server	Assigns IP addresses automatically	Your home router
Database Server	Stores and queries data	MySQL, PostgreSQL

Key Takeaway

Client = asks. Server = answers. A client can become a server in certain architectures, and vice versa.

1.5 Protocols — The Rules of Communication

For two hosts to communicate, they must agree on a common set of rules. These rules are called protocols.

Think of protocols like a formal language: you and a colleague can only exchange information clearly if you both use the same language and follow the same grammar.

Protocol	Full Name	What it does
IP	Internet Protocol	Addresses devices and routes data between networks
TCP	Transmission Control Protocol	Ensures data arrives reliably and in order
HTTP	HyperText Transfer Protocol	Transfers web pages between browser and server
HTTPS	HTTP Secure	Encrypted version of HTTP
SMTP	Simple Mail Transfer Protocol	Sends email between mail servers
DNS	Domain Name System	Translates 'google.com' to an IP address

 **Think About It**

When you type 'www.example.com' in a browser and press Enter, at least four protocols work together before the page appears: DNS (name lookup), IP (routing), TCP (reliable delivery), and HTTP/HTTPS (page content). Protocols always work in cooperation.

09:45 – 10:30 Lesson 2 Peer-to-Peer vs. Client/Server Architecture

Learning Objectives

- Describe the peer-to-peer (P2P) network architecture.
- Describe the client/server network architecture.
- Compare the two architectures across key criteria.
- Identify which architecture is appropriate for a given scenario.

2.1 What is a Network Architecture?

Network architecture describes how devices are organised and what roles they play. The two fundamental architectures are peer-to-peer and client/server.

2.2 Peer-to-Peer (P2P) Architecture

In a peer-to-peer network, all devices are equal. There is no dedicated server. Every device (peer) can both request services and provide services to other peers.

 **Real-World Example**

Two laptops on the same Wi-Fi share a folder directly with each other — one laptop browses the other's shared folder with no file server in between. Another example is BitTorrent file sharing: every user downloading a file is simultaneously uploading pieces of it to others.

Advantages of P2P

- Simple to set up — no server hardware required.
- Low cost — no dedicated server to purchase or maintain.
- Works well for small groups (2–10 devices).

Disadvantages of P2P

- Hard to manage — no central control point.
- Data is scattered across all machines — backups are difficult.
- Weak security — each device must be individually secured.
- Performance degrades as the number of peers grows.
- Not suitable for large organizations.

2.3 Client/Server Architecture

In a client/server network, devices have dedicated roles. Servers are always available, waiting for requests. Clients connect and request services as needed.

Real-World Example

All staff in an office connect their laptops (clients) to a central file server. All company documents are stored on that server. When an employee needs a file, their laptop (client) sends a request to the server; the server responds with the file. The server runs 24/7; the laptop can be turned off.

Advantages of Client/Server

- Data is centralised — easy to back up and manage.
- Strong security — access control is enforced at the server.
- Scalable — can serve hundreds or thousands of clients.
- Consistent performance — server hardware is optimised for the role.

Disadvantages of Client/Server

- Single point of failure — if the server fails, all clients lose access. (Mitigated by redundancy.)
- Higher upfront cost — server hardware and software licences.
- Requires dedicated IT administration.

2.4 Comparison Table

Criterion	Peer-to-Peer	Client/Server
Setup complexity	Low	Higher
Cost	Low	Higher (server hardware)
Scale	Small (2–10 devices)	Large (10 – thousands)
Central management	No	Yes
Data backup	Difficult	Easy (back up the server)
Security control	Weak	Strong (centralised)
Single point of failure	No	Yes (mitigated by redundancy)
Typical use case	Home sharing, small workgroups	Offices, enterprises, internet services

Key Takeaway

Client/Server is the dominant architecture in modern organizational networks. Peer-to-peer is still used for home file sharing, small setups, and applications like BitTorrent.

Learning Objectives

- Define a LAN and list its key characteristics.
- Give practical examples of LANs in different settings.
- Define a PAN and explain when it is used.
- Distinguish a PAN from a LAN.

3.1 LAN — Local Area Network

A Local Area Network (LAN) is a network that covers a limited geographic area — typically a single building, a single floor, or a campus of closely related buildings. One organization owns and manages the entire LAN.

LAN Characteristic	Detail
Geographic coverage	One building, one floor, or one campus
Typical size	Up to a few kilometres in diameter
Speed	100 Mbps to 10 Gbps (Ethernet)
Ownership	Single organisation
Dominant technology	Ethernet (IEEE 802.3) for wired; Wi-Fi (IEEE 802.11) for wireless
Connection medium	Twisted-pair copper (Cat5e/Cat6) or fibre optic cable

LAN Examples

- All computers in a school computer lab.
- All workstations and printers in a company office.
- The network connecting devices in a hospital ward.
- A home network connecting a laptop, phone, smart TV, and printer.

Wired LAN vs. Wireless LAN (WLAN)

A wired LAN connects devices with physical cables (Ethernet). A WLAN connects devices wirelessly using radio waves (Wi-Fi). Both are LANs — the difference is only in the physical medium. In modern environments, both exist simultaneously.

Key Takeaway

LAN = your building or campus. It is fast, private, and under your organisation's full control.

3.2 PAN — Personal Area Network

A Personal Area Network (PAN) is the smallest category of network. It covers only the space around a single person — typically within 10 metres. A PAN connects the personal devices belonging to one individual.

PAN Characteristic	Detail
Geographic coverage	Around one person — typically up to 10 metres
Typical purpose	Connecting personal devices to each other
Primary technologies	Bluetooth, USB, Wi-Fi Direct, NFC, infrared (IrDA)
Ownership	A single individual
Examples	Smartphone ↔ wireless earbuds; laptop ↔ phone (hotspot); smartwatch ↔ phone

PAN Examples

- A smartphone paired with wireless earbuds via Bluetooth.
- A laptop using a phone as a Wi-Fi hotspot.
- A smartwatch syncing health data to a smartphone.
- A wireless keyboard and mouse connected to a PC via Bluetooth.
- Transferring a photo from phone to laptop using NFC or Wi-Fi Direct.

Key Takeaway

PAN = your personal space. It is the smallest network type, built around one person's devices. Bluetooth is the most common PAN technology.

Think About It

When you put on wireless earbuds and your phone automatically connects to them, you have just created a PAN. The moment you step into the office and connect to the office Wi-Fi, your phone joins a LAN as well. Both networks exist at the same time on the same device.

Learning Objectives

- Define a MAN and identify real-world examples.
- Define a WAN and explain how it differs from a LAN.
- Understand that the Internet is the world's largest WAN.
- Compare all four network types (PAN, LAN, MAN, WAN) on a single chart.

4.1 MAN — Metropolitan Area Network

A Metropolitan Area Network (MAN) covers the geographic area of a single city or large town. It is larger than a LAN (which is contained within a building) but smaller than a WAN (which crosses national or global distances).

MAN Characteristic	Detail
Geographic coverage	One city or large metropolitan area
Typical size	Up to ~50 kilometres in diameter
Speed	High-speed (often fibre backbone)
Ownership	Often an ISP, city authority, or telecom provider
Technologies	Fibre optic ring, metro Ethernet, MPLS
Purpose	Connects multiple LANs across a city

MAN Examples

- An Internet Service Provider (ISP) interconnecting its customers' offices across a city.
- A university with multiple campuses spread across a city, all connected to one network.
- A city government network linking all municipal offices, police stations, and fire stations.
- A hospital group connecting multiple hospitals within the same city.

Key Takeaway

MAN = one city. A MAN is the infrastructure that connects the city's LANs. It is usually managed by a service provider, not by a single organisation.

4.2 WAN — Wide Area Network

A Wide Area Network (WAN) spans large geographic distances — across cities, countries, or even continents. WANs connect multiple LANs and MANs together. The physical infrastructure of a WAN typically passes through networks owned by telecommunications companies.

WAN Characteristic	Detail
Geographic coverage	Cities, countries, continents — global
Speed	Lower than LAN (distance and shared infrastructure)
Ownership	Multiple organisations; telecom providers own the links

WAN Characteristic	Detail
Technologies	MPLS, SD-WAN, leased lines, satellite, submarine cables
Connection type	Often leased from a service provider
Examples	The Internet; corporate WAN connecting country offices

WAN Examples

- A multinational company's internal network connecting offices in London, Nairobi, and Singapore.
- A bank's private WAN linking all its branches across a country.
- The undersea fibre-optic cable systems that carry internet traffic between continents.
- A government's secure WAN connecting all ministries and regional offices.

The Internet is a WAN

The Internet is simply the world's largest WAN. It is a global network of networks, connecting billions of devices by passing data through routers across public and private telecommunications infrastructure.

4.3 Summary: All Four Network Types

Type	Full Name	Coverage	Speed	Owner	Example
PAN	Personal Area Network	~10 metres	Moderate	Individual	Phone + earbuds (Bluetooth)
LAN	Local Area Network	Building / campus	Very high	Organisation	Office network
MAN	Metropolitan Area Network	One city	High	ISP / city authority	City campus links
WAN	Wide Area Network	Country / global	Variable	Telco / multi-org	The Internet

Key Takeaway

Remember the scale order: PAN < LAN < MAN < WAN. Each step up in scale introduces more complexity, more parties, and usually lower per-link speed relative to a local connection.

12:00 – 13:00  **LUNCH BREAK — Return at 13:00**

13:00 – 13:45 **Lesson 5** The Internet & Data-Center Fabrics

Learning Objectives

- Describe what the Internet is and how it is structured.
- Explain what a data centre is and why specialised networks are needed inside them.
- Describe the spine-and-leaf topology used in modern data-centre fabrics.
- Understand why data-centre fabrics are a distinct network type.

5.1 The Internet

The Internet is not a single network — it is a global system of interconnected networks. Every network on the Internet is independently operated, but they all agree to use the same set of protocols (primarily the TCP/IP suite) so that data can travel seamlessly between them.

How the Internet is structured

- The Internet is divided into Autonomous Systems (AS) — independently operated networks (an ISP, a university, a corporation) that each manage their own internal routing.
- These autonomous systems are connected to each other at Internet Exchange Points (IXPs) — physical locations where multiple ISPs and organisations directly interconnect their networks.
- The largest, fastest network operators — called Tier 1 providers — form the backbone of the Internet. They carry traffic across continents, often over undersea fibre-optic cables.
- Tier 2 and Tier 3 ISPs buy bandwidth from Tier 1 providers and resell it to businesses and consumers.

Key Fact

When you send a message from your phone, it may travel through your local ISP, through a national backbone, across an undersea cable, and through several foreign ISPs before arriving at its destination — all in under a second.

5.2 What is a Data Centre?

A data centre is a facility that houses a large number of servers, storage systems, and the networking equipment needed to connect them. Data centres provide the computing infrastructure for cloud services (AWS, Azure, Google Cloud), enterprise applications, and the websites and services you use every day.

Data Centre Component	Purpose
Servers (compute)	Run applications, virtual machines, databases
Storage systems (SAN/NAS)	Store vast amounts of data reliably
Network switches & routers	Connect servers to each other and to the outside world
Load balancers	Distribute incoming requests across multiple servers
Firewalls & security appliances	Protect the infrastructure from attack
Power & cooling systems	Keep equipment running and at safe temperatures

5.3 What is a Data-Centre Fabric?

Inside a data centre, the network connecting thousands of servers must be extremely fast, low-latency, and highly available. A standard office LAN design does not scale to this requirement. Data centres therefore use a specialised network architecture called a data-centre fabric.

The Spine-and-Leaf Topology

The most common data-centre fabric design today is the spine-and-leaf (also called Clos) topology:

- Leaf switches connect directly to servers (one leaf switch per rack or group of racks).
- Spine switches sit above the leaf layer. Every leaf switch connects to every spine switch.
- No leaf switch connects directly to another leaf switch — all traffic between racks passes through the spine.
- No spine switch connects to another spine switch.

Property	Traditional 3-Tier LAN	Spine-and-Leaf Fabric
Design	Core → Distribution → Access	Spine → Leaf
Scale	Hundreds of devices	Tens of thousands of servers
Latency	Variable (depends on path)	Consistent — always 2 hops server-to-server
Bandwidth	Oversubscribed at core	Non-blocking or near-non-blocking
Fault tolerance	Depends on redundancy design	Built-in — multiple paths exist
Expansion	Complex (STP, VLANs)	Simple — add a new leaf switch

Key Takeaway

A data-centre fabric is a specialised, high-speed internal network designed for the unique demands of data centres: massive east-west traffic (server-to-server), extremely low latency, and very high bandwidth. Spine-and-leaf is the industry standard design.

East-West vs. North-South Traffic

Traditional networks were designed for north-south traffic: clients outside the data centre accessing services inside. Modern cloud and distributed applications generate mostly east-west traffic: servers communicating with other servers inside the same data centre. The spine-and-leaf fabric is optimised for east-west traffic.

13:45 – 14:30 **Lesson 6** Comparing Network Types — Guided Activity

Learning Objectives

- Apply knowledge from Lessons 1–5 to classify real-world scenarios.
- Articulate the reasoning behind each classification.
- Recognise that a single environment can involve multiple network types simultaneously.

6.1 Activity Instructions

For each scenario below, identify: (a) which network type(s) are involved, and (b) which architecture (P2P or client/server) best fits. Be ready to justify your answer in 30 seconds.

#	Scenario	Network Type(s)	Architecture
1	A student uses Bluetooth to send a photo from their phone to a nearby friend's phone.		
2	A company connects its Nairobi, Lagos, and Cairo offices over a private leased-line network.		
3	A hospital's 12 buildings across the same city all share one electronic patient-records system.		
4	Two employees in the same office share files directly between their laptops with no server.		
5	You open a browser and load 'www.bbc.com' from Rwanda.		
6	A cloud provider's data centre houses 50,000 servers that must communicate with each other at very low latency.		
7	A school lab has 30 PCs all connected to one central server that holds all student files.		
8	Your smartwatch tracks your heart rate and syncs data to your phone every 5 minutes.		

6.2 Answer Key (Instructor Reference)

#	Network Type(s)	Architecture	Reason
1	PAN	P2P	Personal devices within ~10m, Bluetooth, no server
2	WAN	Client/Server	Multiple cities, leased lines, central resources
3	MAN	Client/Server	Multiple sites in one city, centralised patient records
4	LAN	P2P	Same building, no server, direct sharing
5	LAN + WAN (Internet)	Client/Server	Your LAN → ISP → Internet → BBC's server

#	Network Type(s)	Architecture	Reason
6	Data-Centre Fabric	Client/Server (distributed)	Internal server-to-server, spine-and-leaf
7	LAN	Client/Server	Building network, central file server
8	PAN	P2P / direct sync	Personal device to personal device, Bluetooth

14:30 – 15:15 Lesson 7 Real-World Scenarios & Group Discussion

Learning Objectives

- Synthesise all Day 1 topics in realistic, multi-layered scenarios.
- Practise explaining networking concepts in plain language.
- Address any questions carried over from earlier lessons.

7.1 Discussion Scenarios

Work through these scenarios as a class. There is no single 'right' answer — the goal is to apply correct terminology and demonstrate clear reasoning.

Scenario A — The Remote Office

A company headquarters is in Nairobi. It has a branch office in Mombasa. Each office has 50 staff using a central HR application hosted in a cloud data center in Johannesburg. Employees also carry laptops and Bluetooth mice.

- What network type connects the laptops to each office's local switches?
- What network type connects the two offices to each other?
- What network type connects both offices to the cloud data center?
- What network type is the Bluetooth mouse using?
- What architecture describes the HR application?

Scenario B — The University

A university has three campuses spread across a city. Each campus has multiple buildings, each with its own LAN. All campuses share a single student information system hosted on the university's own servers. Students connect to the internet for research.

- What network type connects buildings within one campus?
- What network type connects the three campuses across the city?
- What type of architecture does the student information system use?
- What network type does a student use when accessing the BBC website for research?

Scenario C — The Cloud Data Centre

A cloud provider operates a data center with 10,000 servers. Web servers receive requests from clients. Application servers process the requests. Database servers store the data. All three server types must communicate with each other hundreds of times per second.

- What network design is used inside the data center?
- What kind of traffic (east-west or north-south) dominates inside the data center?
- What architecture is being used from the perspective of the web client outside?

 Instructor Tip

If time permits, ask participants to draw a rough diagram on the whiteboard for one of these scenarios and label the network types. This solidifies the geographic-scale mental model.

15:15 – 16:00 Lesson 8 Review, Q&A & End-of-Day Assessment**Learning Objectives**

- Consolidate all Day 1 knowledge into a clear mental model.
- Identify and fill any remaining gaps through Q&A.
- Complete the end-of-day self-assessment.

8.1 Day 1 Key Concepts — Complete Reference

Concept	Definition / What to Remember
Network	Two or more devices connected to share information and resources.
Host	Any device connected to a network with an IP address (PC, phone, server, camera).
Client	A host that requests data or services from a server.
Server	A host that provides data or services in response to client requests.
Protocol	An agreed set of rules governing how devices send and receive data.
Peer-to-Peer (P2P)	All devices are equal — each can both request and provide. Simple, hard to scale.
Client/Server	Dedicated roles — servers provide, clients request. Scalable, centralized, secure.
PAN	Personal Area Network — up to ~10m, connects personal devices. Technology: Bluetooth.
LAN	Local Area Network — one building/campus, high speed, one organization. Technology: Ethernet/Wi-Fi.
MAN	Metropolitan Area Network — one city, connects LANs, managed by ISP or city authority.
WAN	Wide Area Network — crosses cities/countries. The Internet is the world's largest WAN.
Internet	A global WAN — a network of networks using TCP/IP, connected at IXPs.
Data Centre	A facility housing thousands of servers and the network connecting them.
Data-Centre Fabric	A high-speed internal network designed for massive east-west server-to-server traffic.
Spine-and-Leaf	The dominant data-center fabric topology: leaf connects to servers; spine connects all leaves. Consistent 2-hop latency.

8.2 End-of-Day Assessment Questions

Answer each question without referring to your notes. Compare your answers with the reference table above afterwards.

- 1. What is the difference between a client and a server?
- 2. Give two examples of a host that is not a PC or laptop.
- 3. Name three protocols and state what each one does.
- 4. What are the two main advantages of client/server over peer-to-peer?
- 5. What is the geographic coverage of a LAN?
- 6. Your phone is connected to your Bluetooth earbuds. What type of network is this?
- 7. A company connects its offices in three different countries. What network type is this?
- 8. What is the Internet?
- 9. What problem does a data-center fabric solve that a regular LAN design cannot?
- 10. In a spine-and-leaf topology, how many hops does it take for any two servers to communicate?

End-of-Day Summary

Today you learned the building blocks of networking: what a network is; the roles of hosts, clients, and servers; how peer-to-peer and client/server architectures differ; and the five network types — PAN, LAN, MAN, WAN, and Data-Centre Fabrics — and when each is used. Tomorrow builds on this foundation with the OSI and TCP/IP models.

Preparation for Day 2

Before tomorrow, think about this question: when your laptop sends a web page request, it has to go through many steps before the data leaves the cable. What are those steps? Day 2 will answer that with the OSI model.