UNIT 3: Enterprise Network Design

Campus Network Design, WAN Design Concepts, Data Center Basics, Redundancy & High Availability, Network Expansion.

Campus Network Design

📌 Definition

A **Campus Network** is a high-speed network that connects multiple buildings within a limited geographical area such as a college, university, office, or hospital.

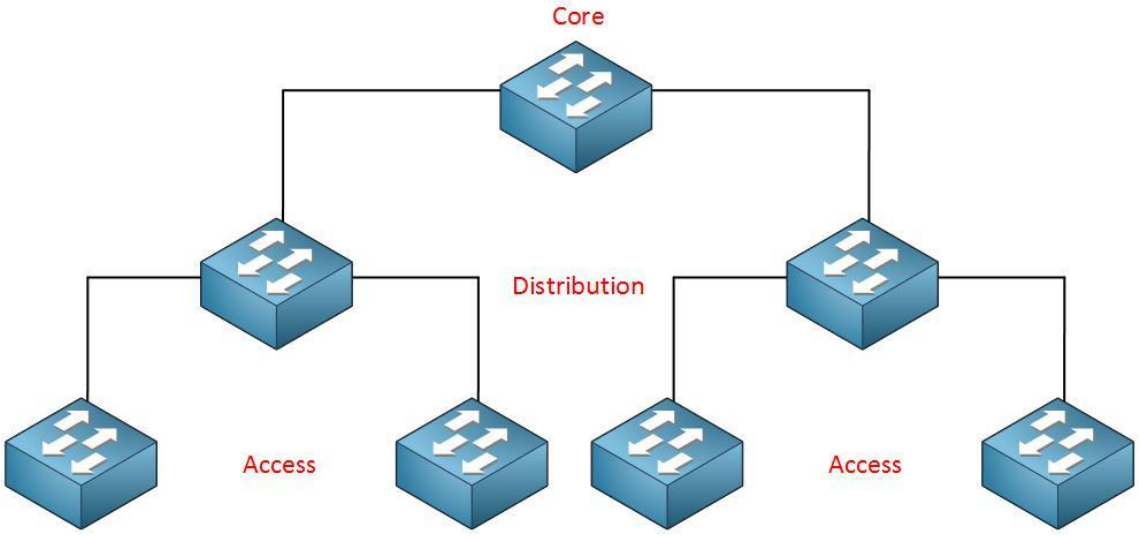
It is designed to provide **fast, secure, and scalable communication** between different departments and users.

Simple Idea

A campus network connects:

- Computer Labs
- Library
- Administration Office
- Departments
- Hostels
- Staff Rooms

All are connected through a **central backbone network**.



Access Layer

This is the **first layer where users connect**.

Devices:

- PCs

- Printers
- IP Phones
- Access Points

Functions:

- Connect end devices
- Assign VLANs
- Apply port security

2 Distribution Layer

This layer acts as a **middle layer between access and core**.

Functions:

- Inter-VLAN routing
- Policy enforcement
- Traffic filtering
- Load balancing

3 Core Layer

This is the **backbone of the network**.

Functions:

- High-speed data transfer
- Fast switching
- Reliable backbone connectivity
- Minimal processing for speed

Design Objectives

1. Scalability

Network should support future expansion.

2. Security

Prevent unauthorized access using VLANs and firewalls.

3. High Performance

Ensure fast data transfer with minimal delay.

4. Reliability

Network should be stable and always available.

🎯 5. Manageability

Easy monitoring and maintenance.

🔲 VLAN in Campus Network

VLANs divide the network logically:

- Students VLAN
- Staff VLAN
- Admin VLAN
- Guest VLAN

☞ Improves security and reduces broadcast traffic.

🔁 Inter-VLAN Routing

Communication between different VLANs is done using:

- Layer 3 Switch
- Router

Example:
Student VLAN accessing Library Server.

⚡ Advantages

- High-speed communication
- Centralized network control
- Better security
- Easy resource sharing
- Scalable design

❌ Disadvantages

- High installation cost
- Complex setup
- Requires skilled management
- Security risks if misconfigured

WAN Design Concepts (Wide Area Network)

📌 What is WAN?

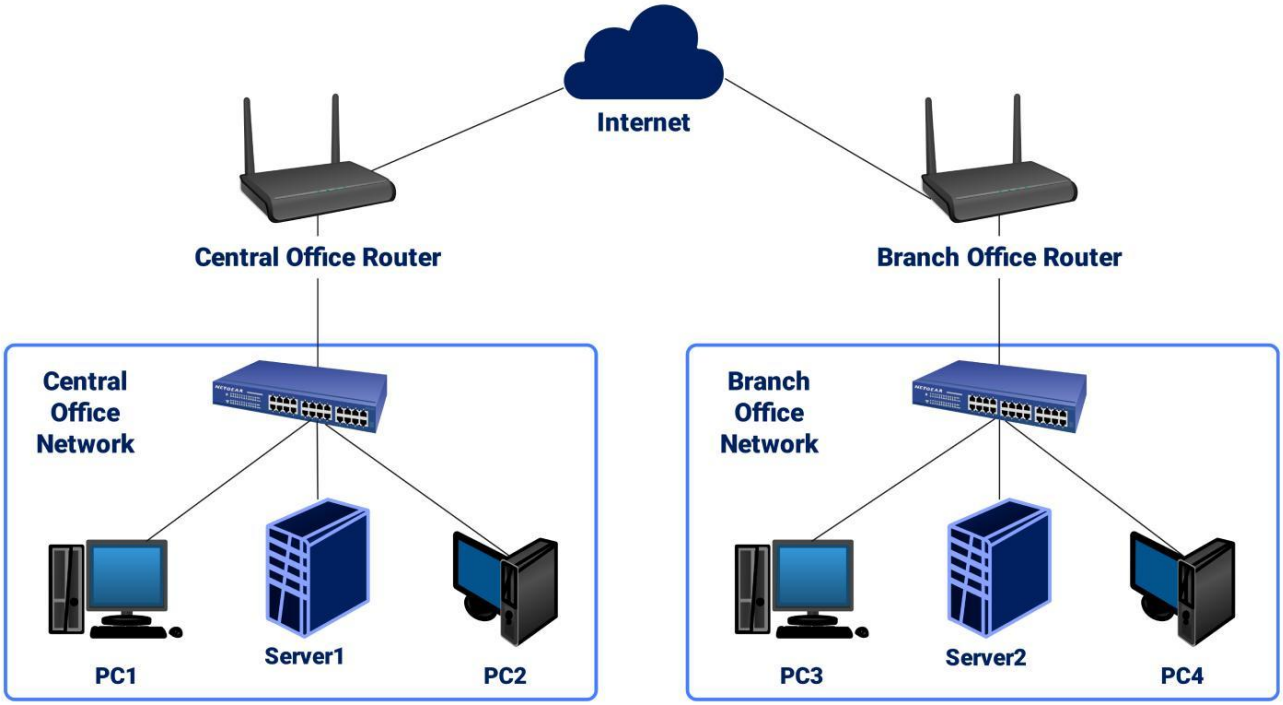
A WAN (Wide Area Network) is a network that connects computers and networks over a large geographical area such as cities, countries, or continents.

☞ Example:

- Internet is the largest WAN
- Bank networks connecting branches
- Company offices in different countries

Simple Definition

WAN connects multiple LANs (Local Area Networks) across long distances using service providers.



WAN Characteristics

📌 1. Large Coverage Area

- City to city
- Country to country
- Global communication

📌 2. Uses Service Providers

- ISP (Internet Service Provider)
- Telecom companies

📌 3. High Cost

- Expensive compared to LAN

📌 4. Lower Speed than LAN

- Due to long distance transmission

📌 5. More Latency

- Delay in data transfer is higher

WAN Design Components

- Routers
- Modems
- Switches (in LAN side)
- Firewalls
- Transmission media:
  - Fiber optics
  - Leased lines
  - Satellite links
  - MPLS networks

🏢 WAN Topologies

1️⃣ Point-to-Point

Direct connection between two sites.

2️⃣ Hub-and-Spoke

All branches connect to central HQ.

3️⃣ Full Mesh

Every site connects to every other site.

4️⃣ Partial Mesh

Some sites are interconnected.

WAN Design Objectives

🎯 1. Security

Protect data using:

- VPN
- Firewalls
- Encryption

🎯 2. Reliability

Ensure continuous connectivity

🎯 3. Scalability

Easy to add new branches

🎯 4. Performance

Low latency and high throughput

🎯 5. Cost Efficiency

Balance performance and cost

WAN Technologies

- MPLS (Multiprotocol Label Switching)
- SD-WAN (Software Defined WAN)
- Frame Relay (older technology)
- ATM (Asynchronous Transfer Mode)
- Internet VPN

Advantages of WAN

- Global connectivity
- Centralized data access
- Easy branch connectivity
- Supports cloud services
- Scalable architecture

❌ Disadvantages of WAN

- High installation cost
- Security risks
- Complex management
- Network latency
- Dependence on service providers

Data Center Basics (Fundamentals)

📌 What is a Data Center?

A **Data Center** is a dedicated facility that stores, processes, and manages large amounts of data and applications for organizations.

☞ It is the “central brain” of modern IT systems.

Examples:

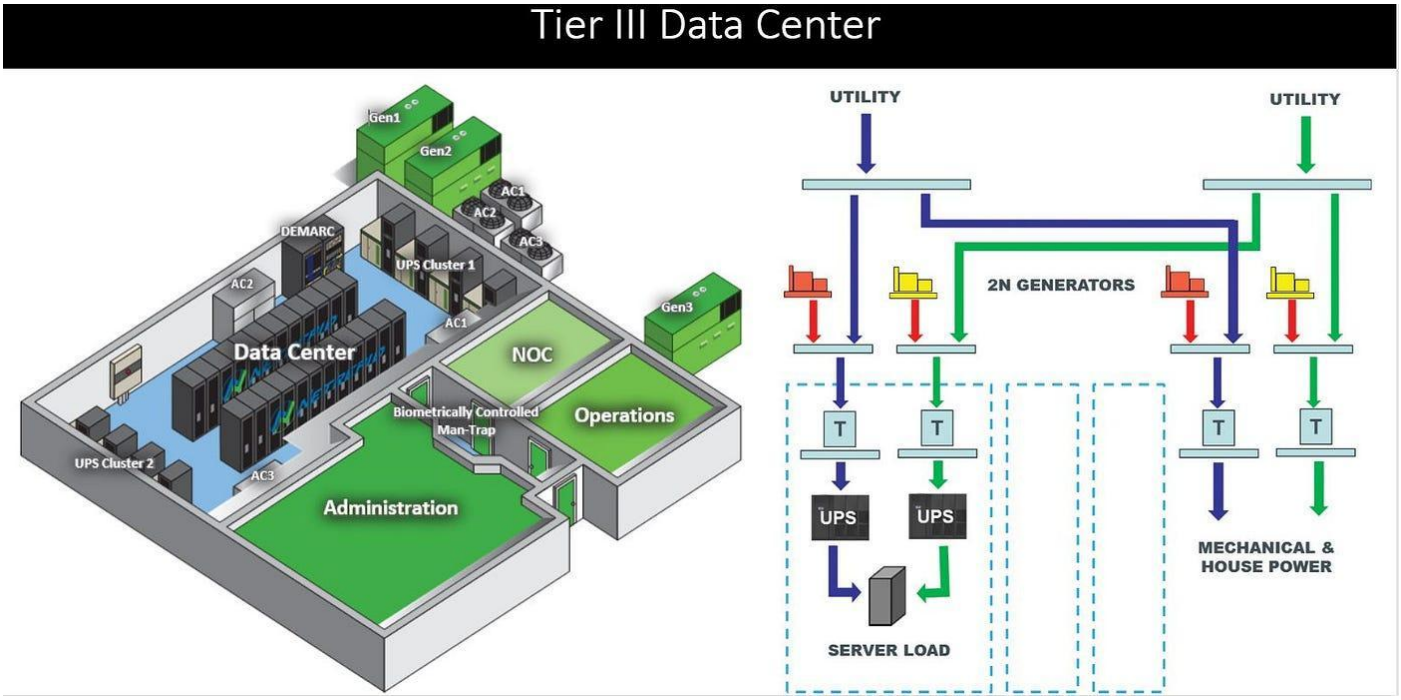
- Google data centers
- Amazon AWS data centers
- Banking data centers

Simple Definition

A data center is a place that contains:

- Servers
- Storage systems
- Networking equipment
- Security systems
- Cooling systems

All working together to keep services running 24/7.



Key Components of a Data Center

1 Servers

- Store and process applications and data
- Run websites, databases, and services

2 Storage Systems

- Store large data sets
- Types:
  - SAN (Storage Area Network)
  - NAS (Network Attached Storage)

3 Networking Equipment

- Switches
- Routers
- Firewalls
- Load balancers

4 Power Systems

- UPS (Uninterruptible Power Supply)
- Generators for backup power

5 Cooling Systems

- Air conditioning systems
- Prevent overheating of servers

🌐 Data Center Network Design

- High-speed switches (Layer 3)
- Redundant links (backup paths)
- VLAN segmentation
- Load balancing

🏢 Types of Data Centers

1 Enterprise Data Center

- Owned by companies
- Used internally

2 Colocation Data Center

- Shared facility
- Companies rent space

3 Cloud Data Center

- Provided by cloud providers
- Example: AWS, Azure, Google Cloud

Data Center Security

Physical Security:

- CCTV cameras
- Biometric access

- Security guards

Network Security:

- Firewalls
- IDS/IPS
- Encryption

Data Center Tier Levels

Tier 1

- Basic infrastructure
- No redundancy

Tier 2

- Partial redundancy

Tier 3

- High availability
- Maintenance without shutdown

Tier 4

- Fully fault tolerant
- Maximum uptime

⚙ Technologies Used

- Virtualization (VMware, Hyper-V)
- Cloud computing
- SDN (Software Defined Networking)
- Containerization (Docker, Kubernetes)

🏛 Advantages of Data Center

- Centralized data management
- High performance
- Easy backup & recovery
- Scalable infrastructure
- Secure environment

✖ Disadvantages

- Very high cost

- Complex management
- Requires skilled engineers
- High power consumption

Real-Life Example

Banking Data Center:

- Customer transactions
- ATM operations
- Online banking
- Fraud detection systems