CHAPTER THREE

NETWORK OPERATING SYSTEMS

3. Network Operating System (NOS)

- A **Network Operating System (NOS)** is an **operating system** designed to **support networking capabilities**, providing **essential services** for **managing network resources**, **communication** between **devices**, and the **administration** of **network security**.
- Unlike a **general-purpose operating system** (**e.g., Windows, Linux, macOS**), which **manages** the **resources** of a **single computer**, a **Network Operating System manages** the **resources** of **multiple devices** within a **network** and **facilitates** their **communication** and **coordination**.

3.1 Key Features of a Network Operating System

- A **Network Operating System** typically offers several key **features** that are essential for **managing** a **network effectively**:

1.Resource Sharing:

- The **NOS** enables **users** and **devices** on a **network** to **share resources** like **files**, **printers**, and **applications**.

✓This includes the **management** of **shared folders**, **network printers**, and **centralized applications**.

2. Security and Access Control:

- A **NOS** provides **security** features to **protect** the **network** from **unauthorized access** and to define who can **access specific resources**.

✓This may include **authentication methods**, **encryption**, and **user permissions**.

3.1 Key Features of a Network Operating System----

3. Network Communication:

- The **NOS facilitates communication** between **network devices** (**computers**, **servers**, **printers**, etc.) using **network protocols** such as **TCP/IP, UDP**, and **HTTP**.

4. File Management:

- It **manages file storage** and **access**, **ensuring** that **files** are available to users on the **network** and can be **accessed** or **modified** in **real-time**.

5. Centralized Administration:

- **Network Operating Systems** allow for **centralized management**, where **administrators** can **configure**, **monitor**, and **troubleshoot network services** from a **single location**.

✓This can include **user account management**, **system updates**, and **resource allocation**.

3.1 Key Features of a Network Operating System----

6. Network Protocol Support:

- The **NOS supports** various **network protocols** that **allow devices** on the **network** to **communicate**.
- These protocols include **TCP/IP, NetBIOS, SMB (Server Message Block)**, and others.

7. Support for Network Devices:

- A NOS can **manage** and **interact** with various **network devices**

  like **routers**, **switches**, **firewalls**, and **network interface cards** (**NICs**),

  allowing these **devices** to **work cohesively** as part of the **network infrastructure**.

8. Remote Access:

- Many **network operating systems** allow **users** to **remotely access network resources** and **systems** through **virtual private networks** (**VPNs**), **remote desktop protocols (RDP),** or other **remote access methods**.

Types of Network Operating Systems

- There are several **types** of **network operating systems** designed to meet **different needs** and **environments**. Some of the most common types include:

1. Peer-to-Peer (P2P) Network Operating Systems

- In a **Peer-to-Peer (P2P) network**, each **device** on the **network** can act as both a **client** and a **server**.
- There is **no central server** that **manages** the **entire network**.
- These systems are typically used in **small-scale networks** where a few **devices** need to **share resources** with each other **without centralized management**.

➢ **Examples**:

- Windows 10 Home (P2P model)
- Linux-based systems in a P2P configuration

Types of Network Operating Systems-----

2. Client-Server Network Operating Systems

- A **Client-Server network model** involves a **centralized server** that **manages** and **controls** the **network resources**, and **client** devices **connect** to the **server** to **access** those **resources**.
- The **server** provides **services** such as **file storage, print services**, and **network authentication**.
- **Client** devices do **not** have **direct access** to other **client machines**, only the **server**.

➢**Examples**:

- **Windows Server** (e.g., Windows Server 2022, Windows Server 2019)
- **Unix-based systems** (e.g., Linux, BSD)
- **Novell NetWare** (historically)

Types of Network Operating Systems-----

3. Hybrid Network Operating Systems

- These **systems combine** aspects of both **peer-to-peer** and **client-server models**.
- In a **hybrid network**, certain resources may be # **shared directly** between **peer devices**, while others may be **accessed** through a **central server**.

➢ **Examples**:

- **Windows Server** in a **network** with **workgroups** and **domains**.
- **Linux servers** acting as **centralized file servers** in a mostly **peer-to-peer environment.**

Popular Network Operating Systems

1. Microsoft Windows Server

- Microsoft's **Windows Server** is one of the most commonly used **network operating systems** for **businesses** and **enterprises**.
- It provides a robust **platform** for **managing network resources**, **centralized security**, **user authentication**, **file sharing**, and more.

➢Key **features** of **Windows Server**:

- **Active Directory** integration for **centralized user** and **resource management**.
- **Group Policy** for **enforcing security** and **configurations**.
- **File** and **print services**.
- **Network monitoring** and **administration tools**.
- **Virtualization support** via **Hyper-V**

Popular Network Operating Systems----

2. Linux-based NOS

- **Linux**, an **open-source operating system**, is widely used as a **network operating system**, especially for **servers**.
- It is highly **customizable** and often used for **web servers**, **file servers**, and **database servers**.

➢ **Popular Linux-based network operating systems**:

2.1 Ubuntu Server:

✓ A **popular** and **user-friendly server distribution** that provides **tools** for **managing network resources**, web services, and file sharing.

2.2 Red Hat Enterprise Linux (RHEL):

- A **commercial Linux distribution** known for its **enterprise support** and **robust network management** features.

Popular Network Operating Systems----

2.3 CentOS:

✓A **community-supported distribution** based on **RHEL(Red Hat Enterprise Linux)**, commonly **used** for **web hosting** and **server deployments**.

2.4 Debian:

✓A **flexible** and **stable Linux distribution**, often used for **server installations** in **network environments**.

3. UNIX and UNIX-like Systems

- **UNIX-based systems** have been around for **decades** and **remain** a **staple** in **enterprise network environments**.
- **UNIX systems** are known for their **reliability**, **scalability**, and **robust networking capabilities**.
- **UNIX-like operating systems** (such as **Linux** and **macOS**) are commonly used in **networked environments**.

Popular Network Operating Systems----

➢Key **features** of **UNIX-based NOS**:

- **Multitasking** and **multiuser capabilities**.
- **Support** for **advanced networking protocols** and **security**.
- **Compatibility** with many **network management tools**.

4. Novell NetWare (Historical)

- **Novell NetWare** was one of the **earliest network operating systems**, which was popular in the 1980s and 1990s.
- It was **primarily** used in **small-** to **medium-sized businesses** for **file** and **print sharing**, **user authentication**, and **network management**.

Popular Network Operating Systems----

➢Key **features** of **NetWare**:

- **Efficient file** and **print sharing**.
- **Integrated directory services** (**NDS**, later renamed **eDirectory**).
- **Support** for **various network protocols** like **IPX**/**SPX**.

✓Though **Novell NetWare** is **no longer widely used**,

it played a **significant role** in the **development** of

modern network operating systems.

Components of a Network Operating System

- A **Network Operating System** typically includes **several core components** to **manage resources** and **facilitate communication across** a **network**:

1.Server Software:

- This includes the **operating system** on the **server** that provides **services** to **clients**, such as **file sharing**, **printing**, and **user authentication**.

2. Client Software:

- The **operating system** on **client devices** that allows them to **access network resources** and **services** provided by the **server**.

3. Directory Services:

- **Directory services** like **Active Directory** (**Windows**) or **LDAP** (**Linux/Unix**) provide **centralized management** of **network resources**, **user accounts**, and **security policies**.

Components of a Network Operating System-----

4. Network Protocols:

- A **NOS supports** various **protocols** for **communication** between devices on the **network**.

✓The most **common protocols** include:

A. TCP/IP:

- The **foundational protocol** for **communication** on the **internet** and most **modern networks**.

B. SMB/CIFS:

- Used for **file sharing** and **printer access** in **Windows-based networks**.

C. NFS:

- A **protocol** commonly used in **Unix/Linux systems** for **file sharing**.

Components of a Network Operating System-----

5. Security Services:

- A **NOS** includes **tools** and **features** to **manage network security**,

  such as **user authentication**, **permissions**,

  firewall configuration, and **encryption**.

6. Management Tools:

- These **tools allow network administrators** to

  monitor, **manage**, and **troubleshoot** the **network**.

- **Examples** include **Network Monitor**, **Remote Desktop**,

  Group Policy Management, and **Performance Monitoring**.

Functions of a Network Operating System

1. Network Resource Management:

- A **NOS** enables the **sharing** of **resources** such as **files**, **printers**, and **applications** across the **network**, allowing **users** and **devices** to **access** them **centrally**.

2. Centralized Authentication:

- It provides **authentication** and **authorization services** for **users** to **ensure** that only **authorized individuals** can **access network resources**.

3. Network Security:

- A **NOS** typically includes **security features** such as **firewalls**, **intrusion detection/prevention**, **encryption**, and **access control lists (ACLs)** to **protect** the **network** from **unauthorized access** and **threats**.

Functions of a Network Operating System-----

4. Remote Access:

- Remote users can connect to the network through VPNs or remote desktop services, allowing them to access files, applications, and other resources as if they were physically present on the network.

5. File and Print Services:

- A NOS manages the sharing of files and printers across the network, providing seamless access to these resources for users.

6. Monitoring and Troubleshooting:

- A NOS includes tools to monitor the health and performance of the network and troubleshoot issues that may arise.
- This can include bandwidth usage, system status, and connectivity issues.

Advantages of a Network Operating System

1. Centralized Management:

- **Administrators** can **manage** all **resources**, **security**, and **users** from a **central location**, **simplifying administrative tasks**.

2. Resource Sharing:

- A **NOS allows** for the **sharing** of **resources** such as **printers**, **files**, and **applications** across **multiple users**, **improving efficiency** and **collaboration**.

3. Security:

- A **NOS** provides mechanisms to **secure** the **network**, including **user authentication**, **access controls**, and **encryption**, which are **essential** for **protecting data** and **preventing unauthorized access**.

Advantages of a Network Operating System------

3. Scalability:

- A **network operating system** can **easily** be **scaled** as the **network grows**, with the **addition** of **new devices**, **users**, and **resources**.

4. Reliability and Availability:

- Many **NOSs** are designed for **high availability**, providing **redundancy** and **fault tolerance**, **ensuring** that **network services** are **consistently available**.

Disadvantages of a Network Operating System

1. Complexity:

- **Setting up** and **maintaining** a **NOS** can be **complex**, **especially** in **larger environments**.
- **Network administrators** need **specialized knowledge** to **configure** and **manage** the **system properly**.

2. Cost:

- **Enterprise-grade NOSs**, like **Windows Server** or **Red Hat Enterprise Linux**, can be **costly** due

Network Operating System (NOS) Services

- A **Network Operating System (NOS)** provides a variety of **essential services** that enable the **efficient management**, **communication**, and **security** of **networked resources** across **computers** and **devices**.
- These **services** allow a **network** to **function smoothly**, **facilitating centralized administration**, **resource sharing**, and ensuring **secure** and **reliable operations** for all **devices connected** to the **network**.

✓Here's a breakdown of the key **services** provided by a **Network Operating System**:

Network Operating System (NOS) Services------

1. File and Print Services

- One of the **fundamental services** of a **Network Operating System** is to allow the **sharing** and **management** of **files** and **printers across** the **network**.

A. File Services:

- This **enables** the **sharing** of **files**, **folders**, and **directories** across **different users** and **devices** in the **network**.
- The **NOS manages access rights**, ensuring that **users** can **read**, **write**, **modify**, or **delete files** based on their **permissions**.

✓**Example**: **Network File System (NFS)** for **Linux-based systems** or **Server Message Block (SMB)** for **Windows-based systems**.

Network Operating System (NOS) Services-----

B. Print Services:

- The **NOS** enables **multiple users** to **access** and use **printers connected** to the **network**.
- The **NOS manages print queues**, **jobs**, and **printer permissions**.

✓**Example**: **Windows Print Services** or **CUPS (Common Unix Printing System)** for **Linux**.

2. Authentication and Security Services

- **Authentication** and **security** are core to the **functioning** of a **NOS**, ensuring that **network resources** are **protected** and **accessible** only by **authorized users**.

A. User Authentication:

- This process ensures that **users** are **who** they **claim** to be by **verifying credentials** (like **usernames** and **passwords**).
- **Services** like **Kerberos** (used in **Active Directory**) are commonly used for **secure authentication**.

Network Operating System (NOS) Services-----

B. Access Control:

- **NOSs** allow the **creation** of **user accounts** and **groups** with specific **permissions** for **accessing network resources**.
- **Access** is often managed using **Access Control Lists (ACLs),** which **determine who** can **access** specific **files** or **devices** and what actions they can **perform** (**read**, **write**, **execute**, etc.).

C. Single Sign-On (SSO):

- In **enterprise environments**, a **NOS** can support **SSO**, which allows **users** to **authenticate** once and **access multiple services** without **needing** to **re-enter credentials**.
- **Example**:

✓**Active Directory** (**Windows Server**) or **LDAP** (**Lightweight Directory Access Protocol**) for **directory-based authentication**.

Network Operating System (NOS) Services-----

3. Directory Services

- **Directory services manage** and **store information** about **resources**, **users**, and **devices** in a **network**.

A. Centralized Directory Management:

- A **NOS** can provide **directory services** that **store information** about **users**, **groups**, **computers**, and **network resources**.

✓This **makes** it **easier** to **manage network objects** and **permissions** from a **single point** of **administration**.

- **Active Directory (AD)** in **Windows Server** is a widely used **directory service** that **organizes network objects** and provides **access control**, **authentication**, and **security policies**.
- **LDAP (Lightweight Directory Access Protocol)** is another **directory service standard** used in many **NOSs** for **accessing** and **maintaining directory information**

Network Operating System (NOS) Services-----

4. Network Communication Services

- A **NOS** enables **communication** between **devices** on a **network**, **facilitating** the **transfer** of **data**, **messages**, and **resources**.

A. TCP/IP (Transmission Control Protocol/Internet Protocol):

- The most commonly used **suite** of **communication protocols** in **modern** **NOSs** that allows **devices** to **communicate over local area networks (LANs)**, **wide area networks (WANs),** and the **internet**.

B. DNS (Domain Name System):

- The **NOS** supports **DNS services**, **translating** **human-readable domain names** (**e.g., www.example.com**) into **IP addresses** that **devices** use to **communicate** with each other.

Network Operating System (NOS) Services-----

C. DHCP (Dynamic Host Configuration Protocol):

- The **NOS assigns IP addresses dynamically** to **devices** on the **network**, allowing them to **communicate** without needing **static IP configurations**.

5. Network Management Services

- **Network management services** are essential for **monitoring**, **troubleshooting**, and **maintaining** the **network's health** and **performance**.

A. Network Monitoring:

- **NOSs** provide **tools** to **monitor network traffic**, **device status**, **bandwidth utilization**, and **connectivity issues**.
- **Example**: **Simple Network Management Protocol (SNMP)** can be used for **monitoring network devices** and their **status**.

Network Operating System (NOS) Services-----

B. Traffic Management:

- A **NOS** can offer **Quality** of **Service** (**QoS**) and **traffic shaping** to **prioritize** specific **types** of **network traffic** (e.g**., voice, video)** to **ensure smooth communication** in **critical applications**.

C. System Logs and Event Monitoring:

- The **NOS generates logs** and **system events** to help **administrators track activity** on the **network**, **identify issues**, and **perform troubleshooting**.

Network Operating System (NOS) Services-----

6. Remote Access Services

- **Remote access services** allow **users** to **connect** to the **network** from **remote locations securely**.

A. Virtual Private Network (VPN):

- A **NOS** may include **VPN services** to **securely connect remote users** or **offices** to the **network**.
- **VPNs encrypt traffic** to ensure **security** while **users access resources remotely**.
- **Example**: **Windows Server's Routing** and **Remote Access Service (RRAS)** or **OpenVPN** on Linux.

B. Remote Desktop:

- Many **NOSs support remote desktop services**, enabling **users** to **access** their **desktop environment remotely** and **work** as if they were **physically** at their **workstation**.
- **Example**: **Windows Remote Desktop Protocol (RDP)** or **VNC (Virtual Network Computing)** on **Linux**.

Network Operating System (NOS) Services-----

7. Database and Application Services

- A **NOS** may provide **services** that allow **applications** to **run** on the **network**, often using **centralized databases** or **shared application resources**.

A. Database Management:

- A **NOS** may integrate with **database servers** like **SQL Server**, **MySQL**, or **PostgreSQL**, **enabling multiple users** to **access** and **interact** with **databases stored** on the **network**.

B. Application Hosting:

- **Network operating systems** can **host** and **manage software applications** that **multiple users** can **access simultaneously**.
- **Example**: **Windows Server's Terminal Services** for **application hosting** or **Apache Tomcat** for **Java applications** on **Linux**

Network Operating System (NOS) Services-----

8. Backup and Recovery Services

- A NOS includes tools to back up data and recover it in case of hardware failure, system crash, or other disasters.

A. Automated Backups:

- Network Operating Systems often support automated backup solutions that regularly back up data, configurations, and network settings.
- Example: **Windows Server Backup** or **rsync** on Linux for file synchronization and backup.

B. Disaster Recovery:

- The NOS can provide options for recovering from catastrophic data loss, including system snapshots, incremental backups, and the ability to restore previous versions of files or entire systems.

Network Operating System (NOS) Services-----

9. Virtualization Services

- Network Operating Systems also provide virtualization capabilities, allowing for the creation and management of virtual machines (VMs) to run multiple operating systems on a single physical server.

A. Virtual Machine Management:

- A NOS may include tools for creating, managing, and optimizing virtual machines, allowing administrators to run multiple operating systems and applications on one server.

✓Example: **Hyper-V** (on Windows Server) or **KVM** (on Linux).

B. Containerization:

- In addition to VMs, containerization technologies like **Docker** or **Kubernetes** allow applications to be isolated and run on virtualized environments for better resource utilization.

Network Operating System (NOS) Services-----

10. Time Synchronization Services

- Network operating systems ensure that all devices in the network are synchronized to the same time, preventing issues caused by mismatched timestamps.

A. Network Time Protocol (NTP):

- NOSs use NTP services to synchronize the time across devices on the network, ensuring consistency in logs, transactions, and authentication processes.

11. Collaboration Services

- Some NOSs provide tools and services that enable team collaboration and productivity, especially in a business environment.

Network Operating System (NOS) Services-----

A. Email Services:

- The NOS can provide email services or integrate with email servers to facilitate communication within the organization.

✓Example: **Microsoft Exchange** for email, calendaring, and collaboration.

B. Groupware:

- Groupware applications, such as **Microsoft SharePoint**, allow multiple users to collaborate on projects, share documents, and manage tasks.