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COMPUTER AND NETWORK ARCHITECTURE

PHASE-II STUDY NOTES FOR NABARD GR. A IT OFFICER EXAM

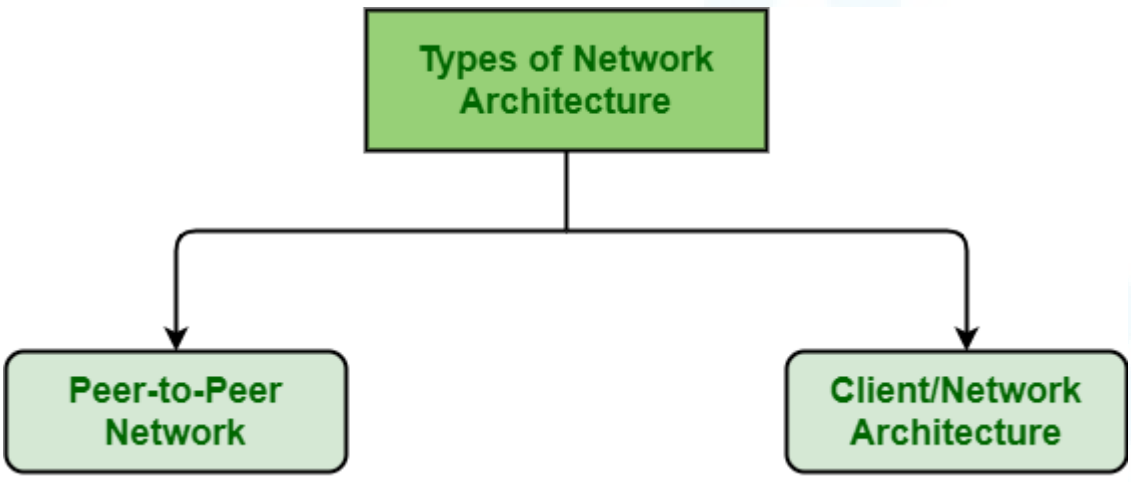
Computer and Network Architecture

Phase-II Study Notes for NABARD Gr. A IT Officer Exam

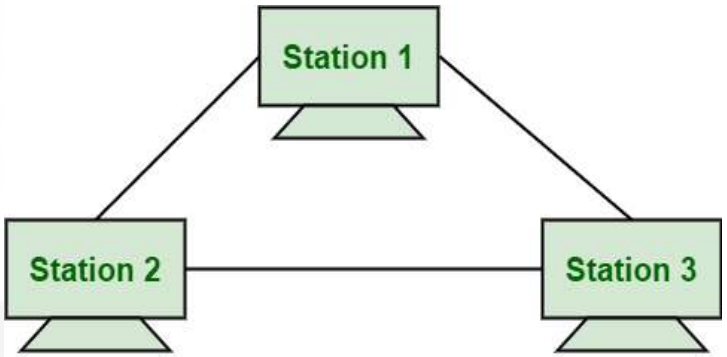
Introduction

- Computer networks are usually developed **to fulfil the needs of their clients and users.**
- Network architecture generally refers **to the design of a computer network or communications network.**
- It simply describes allocation tasks between all of the computers in the network. It is simply a way in which all network devices and services **are organized and managed to connect clients like laptops, tablets, servers, etc. and also how tasks are allocated to the computer.**
- It also facilitates system-level functionality **even robustness, extensibility, and evolvability.**
- It is basically defined and described as the physical and **logical design of software, hardware, protocols, and media of data transmission.**

Classification of Networks Architecture - Based on the Use of Computer Nodes



1. **Peer-to-Peer Network**



Peer-to-Peer Architecture

- In the P2P (Peer-to-Peer) network, **"peers" generally represent a computer system. These peers are connected to each other with help of the Internet.**
- Files might be shared directly **without the requirement of a central server among these systems on the network**.
- It can be said that each computer **on a P2P network usually becomes a file server or even a client also.**
- In this architecture, the system is generally decomposed into various computational nodes that contain **the same and equivalent capabilities, abilities, and responsibilities**.
- In this network, tasks are allocated to each and **every device available on the network. This network is very essential and important for small environments, usually up to at least 10 computers**.
- There is also no separate division of **clients and servers. Each and every computer in this network are treated the same and equally and might send or even receive a message directly.**
- This P2P network is generally **useful in various fields such as business, education, military, etc.**
- A dedicated server or centralized **is not very essential, so a P2P network is less costly and is very cheaper.**
- **It is affordable.**

- **P2P is very simple and not complex.** This is because all computers that are connected in a network communicate **efficient and well-mannered with each other.**

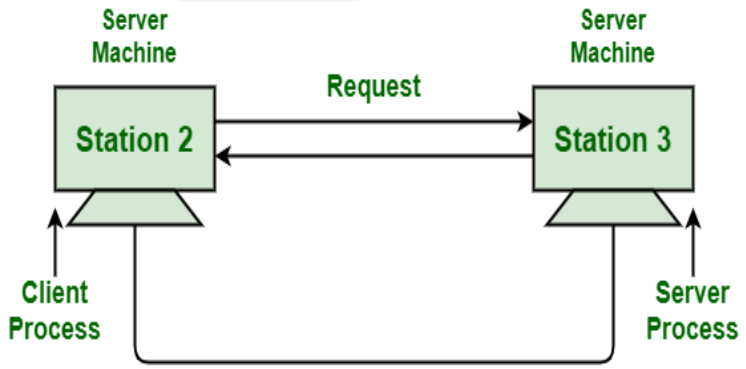
- It is very easy and simple **to set up and manage as installation and setup are less painless and the computer manages itself**. This is **because of built-in support in modern operating systems.**

- Security is one of the major issues in **this type of network**. This is because the message **that is sent flows freely among connected computers.**

- If the computer working with some of the resources is down and **sharing of resources might become a major problem.**

- Performance, security, and access can also become major problems and headaches **with an increase in the number of computers on this network.**

2. **Client/Server Network**



Client/Server Architecture

- **CSN (Client/Server Network) is a type of computer network in which one centralized and powerful computer** (commonly called a server) is a hub to which many personal computers that **are less powerful or workstations (commonly known as clients) are connected.**

- It is a type of system where **clients are connected to a server to just share or use resources**. These servers are generally considered the heart of the system. This type of network **is more stable and scalable compared to a P2P network.**

- In this architecture, the system is generally **decomposed into client and server processors or processes.** This architecture **supports the separation of functionality commonly based on the concept of service.**

Advantages

- A special Network Operating System (NOS) **is provided by the server to provide resources to many users that request them.**
- It is also very easy and simple **to set up and manage data updates.** This is because data is generally stored **in a centralized manner on a server.**
- The server usually **controls resources and data security.**
- This network also **boosts the speed of sharing resources.**
- If anyhow the server goes **down or crashes, the entire will be affected by this.**
- It is very expensive as compared to a P2P. This is due to needing for servers with greater memory **as well as the need for many networking devices such as hubs, routers, switches, etc.**
- The cost of NOS **being provided is very high.**

What is Network Architecture?

- **Network architecture** refers to a network's structural and logical layout.
- It describes how the network devices **are connected and the rules that govern data transfer between them.**
- There are many ways **to approach network architecture design**, which depend on the purpose and size of the network.
- Wide area networks (WAN), for example, refer **to a group of interconnected networks often spanning large distances.**
- Its network architecture will be vastly different from that **of a local area network (LAN) of a smaller office branch.**
- **Planning the network architecture** is vital because it either enhances or hinders the performance of the entire system.
- **Choosing the wrong transmission media or equipment for a particular expected server load**, for instance, can cause slowdowns on the network.
- **Network architecture can also facilitate security**, becoming increasingly important as more user devices connect to the network.

- **The design and protocols of the network need to support quick** and efficient user recognition and authorization.

- Most network architectures **adopt the Open Systems Interconnection Model or OSI.** This conceptual model separates the network tasks **into seven logical layers, from lowest to highest abstraction.**

- The Physical layer, **for instance, deals with the wire and cable connections of the network.** The highest layer, the Application layer, involves APIs that deal with application-specific functions **like chat and file sharing.**

- The OSI model makes it **easier to troubleshoot the network by isolating problem areas from each other.**

Types of Networking Architecture

- While there are myriads of ways to design your network architecture, you'll find that **most fall into one of two types.** These are the peer-to-peer and client/server architectures.

- **In a peer-to-peer model, all devices in a network have equal responsibilities and privileges** with each other. This means tasks are allocated equally throughout the network.

- Files in one computer can be shared with every other computer, essentially making every node a **network storage drive.**

- **Resources like a printer connected to one device** are also visible to every other device on the network.

- A **peer-to-peer architecture** is suitable for small networks, such as a branch office. **Your home network, by the way, often uses a peer-to-peer model.**

- In a client/server architecture, all devices in the network, called "clients," **are connected to a central hub, called a "server."**

- The server handles the bulk of the network operations – **data storage, processing of client requests, cybersecurity, and access control.**

- **Most large networks, such as WANs**, often use the client/server model. The web server you're accessing this **article on, for instance, is a perfect example.**

- In this case, your computer or smartphone is the **client device. Client/server is also the preferred enterprise network architecture.**

- There's also **a hybrid architecture called edge computing**, which is becoming more popular with the Internet of Things (IoT). **It's similar to a client/server architecture.**

- However, instead of the server is responsible for all storage and processing tasks, some of **it is delegated to computers located closer to the client machine, called edge devices.**

Network Architecture Design

- **The design of any digital network architecture involves optimizing its building blocks. These include:**

Hardware

- These are the equipment that forms the components of a network, **such as user devices (laptops, computers, mobile phones), routers, servers, and gateways.**

- So, in a way, the goal of any network architecture **is to find the most efficient way to get data from one hardware point to another**.

Transmission Media

- Transmission media refers to the physical **connections between the hardware devices on a network.**

- Different media have various properties **that determine how fast data travels from one point to another.**

- **They come in two forms: wired and wireless**. Wired media involve physical cables for connection.

- **Examples include coaxial and fibre optic**. Wireless media, on the other hand, relies on microwave or radio signals**. The most popular examples are WiFi and cellular**.

Protocols

- Protocols are the rules and models **that govern how data transfers between devices in a network.**

- It's also the common language that **allows different machines in a network to communicate with each other.**

- Without protocols, your iPhone couldn't access a **web page stored on a Linux server.**

- There are many network protocols, depending on the nature of the data. **Examples include the Transmission Control Protocol / Internet Protocol (TCP/IP) used by networks to connect to the Internet, the Ethernet protocol for connecting one**

computer to another, and the File Transfer Protocol for sending and receiving files to and from a server.

Topology

- **Topology is the structure of the network**. This is important because factors like distance between network devices **will affect how fast data can reach its destination, impacting performance.** There are various network topologies, each with strengths and weaknesses.
- **A star topology, for example, describes a layout where all devices in the network are connected to a central hub.**
- The advantage of this layout is that it's easy **to connect devices to the network. However, if the central hub fails, the whole network goes down.**
- On the other hand**, bus topology is where all network devices are connected to a single pathway, called the bus**.
- **The bus acts like a highway that carries data from one part of the network to the other. While cheap and easy to implement**, its performance tends to slow down as more devices are added to the network.
- Today, **most network architectures use a hybrid topology**, combining different topologies to compensate for each individual's weakness.

Advantages and Disadvantages of Network Architecture

- Different network architectures have **their pros and cons and knowing them is the key to picking out the right one for your needs.**
- **Peer-to-peer models are often inexpensive** and easy to put up because you don't need to invest in a powerful server.
- Theoretically, **all you need are network cables or a router**, and you're good to go. It's also quite robust; if one computer goes down, the network stays up.
- The distributed nature also lessens or **at least spreads out the network load to prevent congestion.**
- However**, peer-to-peer models are harder to manage.** Since there's no centralized hub, you'd need **to configure each computer individually to set up, for example, security software.**
- Thus**, peer-to-peer networks are also less secure. One hacked computer is all it takes to hijack the network.**

- **Client/server models, on the other hand**, are easier to manage because they take on a centralized approach.

- You can set up access privileges, firewalls, and proxy servers to boost the network's security. **Thus, a client/server setup is best for large networks over larger distances.**

- The disadvantage of this approach is that a client/server architecture is more expensive to set up, as you need a powerful server **to handle the network load. It also requires a dedicated administrator to manage the server, which adds to the payroll.**

- But the **biggest con of a client/server model is that the server is a weak link. If the server goes down, the entire network shuts down**. Thus, security is often the most robust at and near the server.

Examples of Computer Network Architecture

- **Each location, such as a factory, will have its own network. If the manufacturing site** uses Internet of Things (IoT) sensors on its equipment, it will most likely use edge computing. These sensors will be connected via **Wi-Fi to an edge gateway device or an on-site server**. This can also accept user devices **in the factory, such as employee workstations and mobile phones.**

- These **mini networks will then be connected to the company's wide area network (WAN),** often using a client/server architecture. Corporate headquarters will often house the central server**, although a server on the cloud is also a possibility these days**. Regardless, network administrators on HQ can monitor and manage the whole WAN infrastructure.

- **The enterprise WAN is also connected to the Internet via a broadband connection, courtesy of their service provider.**

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INTRODUCTION TO SOFTWARE

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FOR NABARD GR. A IT OFFICER EXAM

Introduction to Software

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Introduction

- Software is a set of instructions, data or programs used **to operate computers and execute specific tasks.**
- It is the opposite of hardware, **which describes the physical aspects of a computer.**
- Software is a generic term used to refer **to applications, scripts and programs that run on a device.**
- It can be thought of as the variable part of a computer, while the hardware is the invariable part.
- The two main categories of software are **application software and system software.**
- **An application is software that fulfils a specific need or performs tasks.** System software is designed to run a computer's hardware and provides a platform for applications to run on.
- Other types of software include programming software, which provides the programming tools software developers need; **middleware, which sits between system software and applications; and driver software**, which operates computer devices and peripherals.

Examples and Types of Software

Among the various categories of software, the most common types include the following:

1. Application Software

The most common type of software, application software is a computer software package that performs a specific function for a user, or in some cases, for another application. An application can be self-contained, or it can be a group of programs that run the application for the user.

Examples of modern applications include office suites, graphics software, databases and database management programs, web browsers, word processors, software development tools, image editors and communication platforms.

2. System Software

These software programs are designed to run a **computer's application programs and hardware**. System software coordinates the activities and functions of the hardware and software.

In addition, it controls the operations of the computer hardware and provides an environment or platform for all the other types of software to work in. The OS is the best example of system software; it manages all the other computer programs.

Other examples of system software include firmware, computer language translators and system utilities.

3. Driver Software

Also known as device drivers, this software is often considered a type of system software.

Device drivers control the devices and peripherals connected to a computer, enabling them to perform their specific tasks. Every device that is connected to a computer needs at least one device driver to function.

Examples include software that comes with any nonstandard hardware, including special game controllers, as well as the software that enables standard hardware, such as USB storage devices, keyboards, headphones, and printers.

4. Middleware

The term middleware describes software that mediates between application and system software or between two different kinds of application software.

For example, middleware enables Microsoft Windows to talk to Excel and Word. It is also used to send a remote work request from an application on a computer that has one kind of OS, to an application on a computer with a different OS. It also enables newer applications to work with legacy ones.

5. Programming Software

Computer programmers use programming software to write code. Programming software and programming tools enable developers to develop, write, test and debug other software programs.

Examples of programming software include assemblers, compilers, debuggers, and interpreters.

How Does a Software Work?

All software provides the directions and data computers need to work and meet users' needs. **However, the two different types -- application software and system software -- work in distinctly different ways.**

- **Application Software**

  Application software consists of many programs that perform specific functions for end-users, such as writing reports and navigating websites.

  Applications can also perform tasks for other applications. Applications on a computer cannot run on their own; they require a computer's OS, along with other supporting system software programs, to work.

  These desktop applications are installed on a user's computer and use the computer memory to carry out tasks. They take up space on the computer's hard drive and do not need an internet connection to work.

  However, desktop applications must adhere to the requirements of the hardware devices they run on.

  Web applications, on the other hand, only require internet access to work; they do not rely on the hardware and system software to run. Consequently, users can launch web applications from devices that have a web browser.

  Since the components responsible for the application functionality are on the server, users can launch the app from Windows, Mac, Linux, or any other OS.

- **System Software**

  System software sits between the computer hardware and the application software. Users do not interact directly with system software as it runs in the background, handling the basic functions of the computer.

  This software coordinates a system's hardware and software so users can run high-level application software to perform specific actions.

  System software executes when a computer system boots up and continues running as long as the system is on.

Design and Implementation

- The software development lifecycle is a framework that project managers use **to describe the stages and tasks associated with designing software.**

- The first steps in the design lifecycle are planning the effort and then analysing the needs of the individuals who will use the software and creating detailed requirements. **After the initial requirements analysis, the design phase aims to specify how to fulfil those user requirements.**

- The next step is implementation, where development work is completed, and then software testing happens. **The maintenance phase involves any tasks required to keep the system running.**

- The software design includes a description of the structure of the software that **will be implemented, data models, interfaces between system components and potentially the algorithms the software engineer will use.**

- The software design process transforms user requirements into a form that computer programmers can use to do the software coding and implementation. **The software engineers develop the software design iteratively, adding detail and correcting the design as they develop it.**

The Different Types of Software Design include the following:

- **Architectural design:** This is the foundational design, which identifies the overall structure of the system, **its main components, and their relationships with one another using architectural design tools.**

- **High-level design:** This is the second layer of design that focuses on how the system, **along with all its components, can be implemented in form of modules supported by a software stack.** A high-level design describes the relationships between data flow and the various modules and functions of the system.

- **Detailed design:** This third layer of design focuses **on all the implementation details necessary for the specified architecture.**

How to Maintain Software Quality?

- Software quality measures if the software meets **both its functional and non-functional requirements.**

- **Functional requirements identify what the software should do.** They include technical details, data manipulation and processing, **calculations or any other specific function that specifies what an application aims to accomplish.**

- **Non-functional requirements** -- also known as quality attributes -- determine how the system should work. **Non-functional requirements include portability, disaster recovery, security, privacy, and usability.**

- Software testing detects and solves technical issues **in the software source code and assesses the overall usability, performance, security, and compatibility of the product to ensure it meets its requirements.**

The Dimensions of Software Quality include the Following Characteristics:

- **Accessibility:** The degree to which a diverse group of people, including individuals who require adaptive technologies **such as voice recognition and screen magnifiers, can comfortably use the software.**
- **Compatibility:** The suitability of the software for use in a variety of environments, **such as with different OSes, devices, and browsers.**
- **Efficiency:** The ability of the software to perform well without wasting energy, resources, effort, time, or money.
- **Functionality:** Software's ability to carry out its specified functions.
- **Installability:** The ability of the software to be installed in a specified environment.
- **Localization:** The various languages, time zones and other such features a software can function in.
- **Portability:** The ability of the software to be easily transferred from one location to another.
- **Reliability:** The software's ability to perform a required function under specific conditions for a defined period of time without any errors.
- **Scalability:** The measure of the software's ability to increase or decrease performance in response to changes in its processing demands.
- **Security:** The software's ability to protect against unauthorized access, invasion of privacy, theft, data loss, malicious software, etc.

To maintain software quality once it is deployed, developers must constantly adapt it to meet new customer requirements and handle problems customers identify. This includes **improving functionality, fixing bugs, and adjusting software code to prevent issues.**

When it comes to performing maintenance, there are four types of changes developers can make, including:

- **Corrective**: Users often identify and report bugs that developers must fix, including coding errors and other problems that keep the software from meeting its requirements.

- **Adaptive:** Developers must regularly make changes to their software to ensure it is compatible with changing hardware and software environments, such as when a new version of the OS comes out.
- **Perfective:** These are changes that improve system functionality, such as improving the user interface or adjusting software code to enhance performance.
- **Preventive:** These changes are done to keep software from failing and include tasks such as restructuring and optimizing code.

Modern Software Development

- DevOps is an organizational **approach that brings together software development and IT operations teams.**
- It promotes communication and collaboration between these two groups.
- The term also describes the use of iterative software development practices **that use automation and programmable infrastructure. Get the full picture in our ultimate guide to DevOps.**

Software Licensing and Patents

- A software license is a legally binding document **that restricts the use and distribution of software.**
- Typically, software licenses provide users **with the right to one or more copies of the software without violating copyright.**
- The license outlines the responsibilities of the parties that enter **into the agreement and may place restrictions on how the software can be used.**
- **Software licensing terms and conditions generally include fair use of the software**, the limitations of liability, warranties, disclaimers, and protections if the software or its use infringes on the intellectual property rights of others.
- Licenses typically are for proprietary software, which remains the property of the organization, group or individual that created it; **or for free software, where users can run, study, change and distribute the software.**
- Open source is a type of software where the **software is developed collaboratively, and the source code is freely available.**
- With open-source software licenses, **users can run, copy, share and change the software similar to free software.**

- Over the last two decades, software vendors have moved away from selling software licenses **on a one-time basis to a software-as-a-service subscription model.**
- Software vendors host the software in the cloud and **make it available to customers, who pay a subscription fee and access the software over the internet.**
- Although a copyright can prevent others from copying a developer's code, a copyright **cannot stop them from developing the same software independently without copying.**
- A patent, on the other hand, enables a developer to prevent another person from using the functional aspects of the **software a developer claims in a patent, even if that other person developed the software independently.**
- In general, the more technical software is, the more likely it can be patented. **For example, a software product could be granted a patent if it creates a new kind of database structure or enhances the overall performance and function of a computer.**

History of Software

The **term software was not used until the late 1950s**. During this time, although different types of programming software were being created, they were typically not commercially available.

Consequently, users -- mostly scientists and large enterprises -- often had to write their own software.

A Brief Timeline of the History of Software

- **June 21, 1948:** Tom Kilburn, a computer scientist, writes the world's first piece of software **for the Manchester Baby computer at the University of Manchester in England.**
- **The early 1950s:** General Motors creates the first OS, for the IBM 701 Electronic Data Processing Machine. **It is called General Motors Operating System, or GM OS.**
- **1958:** Statistician John Tukey coins the word software **in an article about computer programming.**
- **The late 1960s:** Floppy disks are introduced and **are used in the 1980s and 1990s to distribute software.**
- **Nov. 3, 1971:** AT&T releases the **first edition of the Unix OS.**
- **1977:** Apple releases the Apple II and consumer software takes off.

- **1979:** VisiCorp releases VisiCalc for the Apple II, **the first spreadsheet software for personal computers.**
- **1981:** Microsoft releases MS-DOS, the OS on which many of the early IBM computers ran. **IBM begins selling software, and commercial software becomes available to the average consumer**.
- **The 1980s:** Hard drives become standard **on PCs, and manufacturers start bundling software in computers.**
- **1983:** The free software movement is launched with Richard Stallman's **GNU (GNU is not Unix) Linux project to create a Unix-like OS with source code that can be freely copied, modified, and distributed.**
- **1984:** Mac OS is released to run Apple's Macintosh line.
- **The mid-1980s:** Key software applications, **including AutoDesk AutoCAD, Microsoft Word and Microsoft Excel, are released.**
- **1985:** Microsoft **Windows 1.0 is released.**
- **1989:** CD-ROMs become standard and hold much more data than floppy disks. **Large software programs can be distributed quickly, easily, and relatively inexpensively.**
- **1991:** The Linux kernel, the **basis for the open-source Linux OS, is released.**
- **1997:** DVDs are introduced and able to hold more data than CDs, making it possible **to put bundles of programs, such as the Microsoft Office Suite, onto one disk.**
- **1999:** Salesforce.com uses cloud computing **to pioneer software delivery over the internet.**
- **2000:** The term software **as a service (SaaS) comes into vogue.**
- **2007:** iPhone is launched, and mobile applications **begin to take hold.**
- **2010 to the present: DVDs are becoming obsolete as users buy and download software from the internet and the cloud.** Vendors move to subscription-based models and SaaS has become common.

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