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COMPUTER AND NETWORK ARCHITECTURE

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

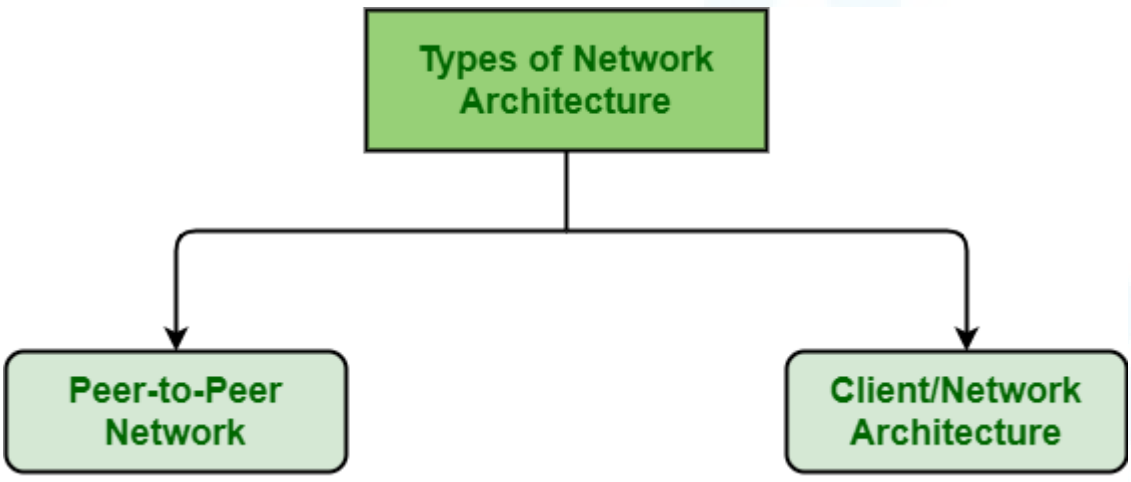
Computer and Network Architecture

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

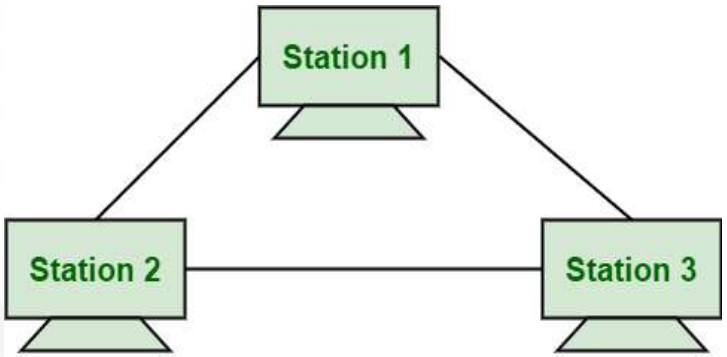
Introduction

- 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.**

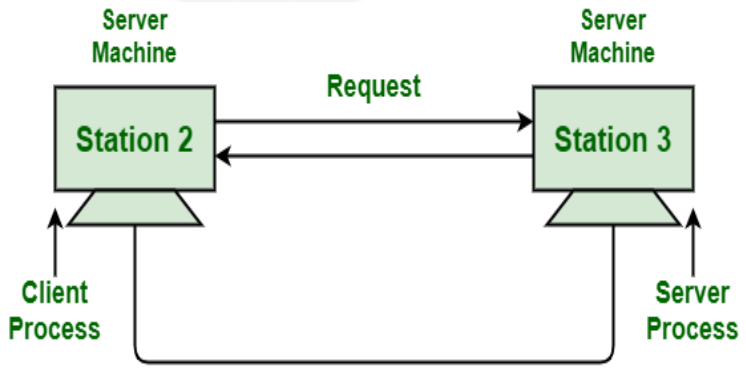
- It is very easy and simple **to set up and manage as installation and setup are less painless and the computer manages itself**. This is **because of built-in support in modern operating systems.**

- 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.**

Sources Referred:

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Computer Fundamentals

Phase-II Study Notes

For NABARD Gr. A IT Officer Exam

Introduction

- It can be described as the learning or studying some basic functions of computers starting from their origin to the modern day.
- Study of basic computer types to their characteristics, advantages and disadvantages are included in the Learning of fundamentals of computers.
- Before shifting to advance computer knowledge, it is highly recommended to be aware of this topic thoroughly as it would make you more confident and comfortable while acquiring more advanced computer skills.
- A computer can be defined or described as a machine or device which can work with information such as to store, retrieve, manipulate, and process data.
- The term computer is derived from the word “computare”.
- The word is derived from a “Latin” word which means to calculate.
- A computer can be further defined as a programmable machine that is used for numerical calculations.
- Some years back these devices machines were used only for the purpose of calculations but presently they are widely and proudly used in all sections of human society.
- Modern computers are incredibly advanced thanks to the new up-gradation and enhancement of technologies.
- They can store huge amounts of data in internal as well as external storage units.
- A computer’s hard disk is the external source of storing data.
- These days computer speed has dramatically increased the work or task which used to take long hours to perform can be done in few seconds this is because of the rapid development in the IT [Information Technology] sector especially in the computer hardware section.

- The computer peripherals and devices manufactured these days are of the highest quality at an affordable price.

- The technology has made these devices perform more speedily than ever before also this is the important characteristics of a computer system which made them very famous and a part of human lives.

- It has also been observed that the life of modern peripherals and devices has been extended due to the excellent quality of raw material used while preparations of these devices.

Speed of a Computer

The Speed of a computer mainly and primarily depends upon some factors such as the type of motherboard you are using, processor speed and RAM [Random Access Memory].

Motherboard: Computer where all other components are attached to it such as hard disk, processor, ram, etc. The motherboard is designed on a piece of PCB which is called a Printed Circuit Board.

Processor: The processor is again called CPU which stands for Central Processing Unit. It is also called as Heart Brain of the Computer System.

RAM: RAM stands for Random Access Memory which is a temporary storage medium and its volatile memory. They tend to lose data when power is off. However, the speed of the computer depends upon RAM as well.

Hard Disk: This is a permanent storage unit of a computer which can store data in high volume and also you can retrieve data whenever and wherever you need it.

Disadvantages of Computer System

As there are numerous advantages of using a modern-day personal computer there are disadvantages too:

- Spread of pornography
- Hate & violence related articles
- Cyber Crimes
- Negative Effects on Health

Computer Software and Hardware

Computer software can be described as a collection of small programs that are programmed in such a way which are capable of performing specific and special tasks whenever desired.

These types of software are developed by computer programmers or software developers who take care of users' needs and intent. There are mainly two types of software:

- System Software
- Application Software

System Software: These are the software that directly interacts with the computer system. The primary examples are Operating systems [OS] and device drivers.

Application Software: These are also called as customized software which is developed for personal use or developed for customers to perform some specific tasks.

Example: Tally, Ms-office, ERP Software.

What is a Computer?

A computer is an electronic device that is capable of receiving information or data and performing a series of operations in accordance with a set of operations.

It is a machine capable of solving problems and manipulating data. It accepts and processes the data by doing some mathematical and logical operations and gives us the desired output.

Therefore, we may define a computer as an electronic device that transforms data into information.

Data can be anything like marks obtained by you in various subjects, it can also be the name, age, sex, weight, height, etc. of all the students in your class or income, savings, investments, etc. of a country.

Operations Performed by a Computer

1. Storage: The data and instructions are saved/ stored permanently in the storage unit. The **storage unit performs the following major functions:**

- All data and instructions, before and after processing, are stored here, and
- Intermediate results of processing are also stored here.

2. Processing: The task of performing operations like arithmetic and logical operations is called processing.

The **Central Processing Unit (CPU)** takes data and instructions from the storage unit and makes all sorts of calculations based on the instructions given and the type of data provided. After this data is sent back to the storage unit.

3. Output: This is the process of producing results from the data for getting useful information. The output produced by the computer after processing is stored inside the computer before it is given to you in human-readable form. The output is also stored inside the computer for further processing.

4. Control: Controlling of all operations like input, processing and output are performed by a control unit. It takes care of the step-by-step processing of all operations inside the computer.

5. Computer System: In order to carry out its operations, a computer system is divided into three separate units. They are:

- Arithmetic logical unit,
- Control unit, and
- Central processing unit. All these three units are known as functional units.

6. Arithmetic Logical Unit (ALU): The processing of the data and instructions are performed by Arithmetic Logical Unit. The major operations performed by the ALU are addition, subtraction, multiplication, division, logic, and comparison. For processing, data is transferred from the storage unit to ALU. After processing, the output is returned back to the storage unit for further processing or for storing purposes.

7. Control Unit (CU): The next component of the computer is the Control Unit, which acts like the supervisor seeing that things are done in a proper way. The control unit determines the sequence in which computer programs and instructions are to be executed.

Activities like processing of programs stored in the main memory, interpretation of the instructions and issuing of signals for other units of the computer to execute them are carried out by CU.

It coordinates the activities of the computer's peripheral equipment which include input and output devices. The CPU (Central Processing Unit) is the device that interprets and executes instructions. A computer system includes a computer, peripheral devices, and software.

Characteristics of Computer

1. Speed: As you know computers can work very fast. It takes only a fraction of a second for calculations that manually take hours to complete. It takes a few minutes for the computer to process a huge amount of data and give the result.

2. Accuracy: The degree of accuracy of a computer is very high and every calculation is performed with the same accuracy. The accuracy level is determined on the basis of the design of the computer. The errors in computers are mainly due to humans and inaccurate data.

3. Diligence: A computer is free from tiredness, lack of concentration, fatigue, etc. It can work for hours without any error.

4. Versatility: The computer is highly versatile.

Generation of Computers

The history of computer development is in reference to different generations of computing devices. The first generation of computers appeared in mid-1940s.

The present-day computer, however, has undergone rapid changes over the last seven decades. This period, during which the evolution of the computer took place, can be divided into

- First 1946-59 Based on vacuum tube technology
- Second, 1957-64 Transistor-based technology replaces vacuum tube
- Third 1965-70 Integrated circuit (IC) technology developed
- Fourth 1970-90 Microprocessors developed
- Fifth 1990-till date Use of Bio-Chip technology

Types of Computers

Present-day computers can be categorized as below:

a) Supercomputers: These are the fastest computers and are very expensive. These are employed for specialized applications that require immense amounts of mathematical calculations. For example, weather forecasting requires a supercomputer. Other uses of supercomputers include animated graphics, fluid dynamic calculations, nuclear energy research, and petroleum exploration.

b) Mainframe Computer: It is a very large and expensive computer and is capable of supporting hundreds, or even thousands of users simultaneously. In the hierarchy that starts with a simple microprocessor (in watches, for example) at the bottom and moves to

supercomputers at the top, mainframes are just below supercomputers. In some ways, mainframes are more powerful than supercomputers because they support simultaneous programs. But supercomputers can execute a single program faster than a mainframe. The chief difference between a supercomputer and a mainframe is that a supercomputer channels all its power into executing a few programs as fast as possible, whereas a mainframe uses its power to execute many programs concurrently.

c) Minicomputer: It is a mid-sized computer in size and power. It lies between workstations and mainframes. In the past decade, the distinction between large minicomputers and small mainframes has blurred. In general, a minicomputer is a multiprocessing system capable of supporting from 4 to about 200 users simultaneously.

d) Micro Computer Desktop Computer: It is a personal or micro-minicomputer sufficient to fit on a desk

- **Laptop Computer:** It is a portable computer completes with an integrated screen and keyboard. It is generally smaller in size than a desktop computer and larger than a notebook computer.

- **Palmtop Computer/Digital Diary /Notebook /PDAs (Personal Digital Assistant):** It is a hand-sized computer, Palmtop, does not have a keyboard, but its screen serves both as an input and output device.

- **Workstations:** It is a terminal or desktop computer in a network. In this context, a workstation is just a generic term for a user's machine (client machine) in contrast to a "server" or "mainframe".

Hardware and Software

Hardware refers to the physical equipment used for the input, processing, output, and storage activities of a computer system.

It consists of mechanical and electronic devices, which we are able to see and touch easily.

Some of them are **central processing units (CPU), primary storage devices, secondary storage devices, input and output units and communication devices**.

These are explained below:

- **Central Processing Unit (CPU):** It manipulates the data and controls the tasks performed by the other components.

- **Primary Storage:** It stores temporary data and program instructions during the processing.

- **Primary Memory (main memory):** These are RAM (Random Access Memory/Read-Write Memory), and ROM (Read-only-memory).

- **Secondary Storage:** These store data and programs for future use. These are Hard Disk (Local Disk) and External Hard Disc, Optical Disks, (CDR, CDRW, DVD-R, DVD-RW), Pen Drive, Memory Cards, etc.

- **Secondary Storage Devices Communication Devices:** These are used for communication or flow of data from one computer to another computer. Some of them are Modem, Switch, Router, TV tuner cards, etc.

A computer cannot do anything on its own. It has to be guided by the user. We have to give a sequence of instructions to the computer in order to do any specific job.

Software is simply a computer program or a set of instructions. Software guides the computer at every step indicating where to start and stop during a particular job. The process of software development is called programming.

Types of Software

There are two types of software, namely,

- **System Software** and
- **Application Software**

System software is a general-purpose program designed to perform tasks such as controlling all operations required to move data into and out of the computer.

It communicates with keyboard, printer, card reader, disk, tapes, etc. It also monitors the use of various hardware like memory, CPU, etc. System software acts as an interface between hardware and application software. Some of the system software are Disc Operating System (DOS), Windows, Unix/Linux, MAC/OS X etc.

Application software is a set of programs, which are written to perform specific tasks of the users of the computer.

These software are developed in high-level languages to help the user to get the computer to perform various tasks. Some of the application software are MS Office, Macromedia (Dreamweaver, Flash, Freehand), Adobe (PageMaker, PhotoShop), LIBSYS, SOUL, WINISIS, KOHA, etc.

Input & Output Unit

An input and output unit consists of two parts namely, input devices and output devices. Normally, an input and output unit can control one or more peripheral devices.

Input Unit: The data is entered / input into the computer through input devices. The input devices translate the data/information from a natural language in which the user is working, into the machine language that the computer can understand.

Computer language is in the form of binary code (0 and 1).

Input devices are classified as follows:

- Human data entry devices - Keyboard, mouse, joystick, trackball, digitizing labels and pick devices - light pen touch screens.
- Source data entry devices (Audio input –speech recognition; video input - digital camera; scanners - optical scanner OCR, OMR, MICR, Barcode Reader).

Output Unit: The output unit accepts output data from the computer via output devices and transforms the data into human-readable form. All the information inside the computer is in the form of binary digits (0 and 1).

Output devices convert them to numbers, words, graphics, sound, and motion which we can easily understand. Output devices are classified as:

- Hard copy device (Printer, Plotter, Computer Output on Microfilm)
- Soft copy devices (Monitor, Visual Display Terminal, Video Output and Audio Response).

Operating System

An **Operating System is a system software** that acts as an interface between a user and the hardware of a computer.

Modern operating systems usually feature a graphical user interface which **uses a pointing device such as a mouse or keyboard for input.**

Operating Systems are viewed as resource managers **that manage the resources of a computer.**

The main resource is the computer hardware, which **is in the form of processors, storage, input/output devices, communication devices, and data.**

A good operating system should be efficient, reliable, **take short time in execution of programs, and occupy small memory as small as possible.**

The Main Operating Systems are:

1. Network Operating System – **WINDOWS 2000 – Unix – Linux**
2. Desktop Operating System – **WINDOWS – DOS (Disc Operating System) – Mac OS**
3. Mobile Operating System – **Palm OS – Pocket PC**

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