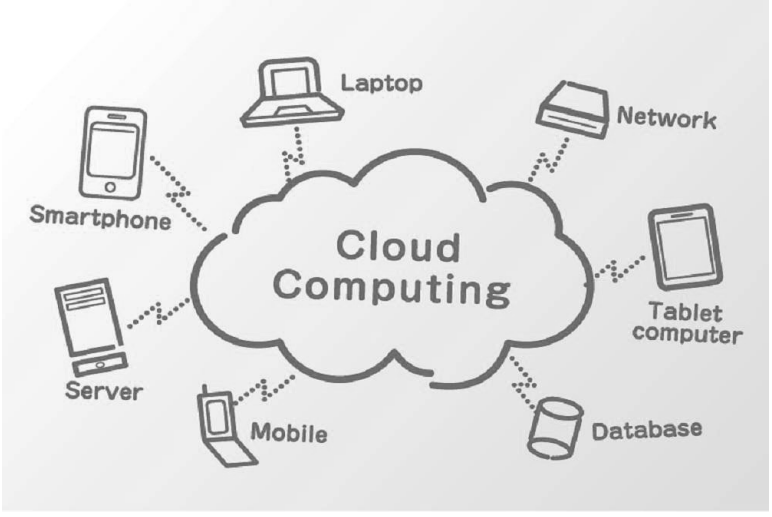
ABCs of Cloud Computing



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SECTION I

Basics of Cloud Computing

This section describes the basics of Cloud Computing under the tiles:

Introduction to Cloud Computing

Cloud Based Service Offerings

Evolution (Generations) of Computers

Major Classification of Computers

Basic Internet Terminology

Getting Connected to Internet

The Emergence of Cloud Computing

Popular Cloud Service Providers

Chapter 1

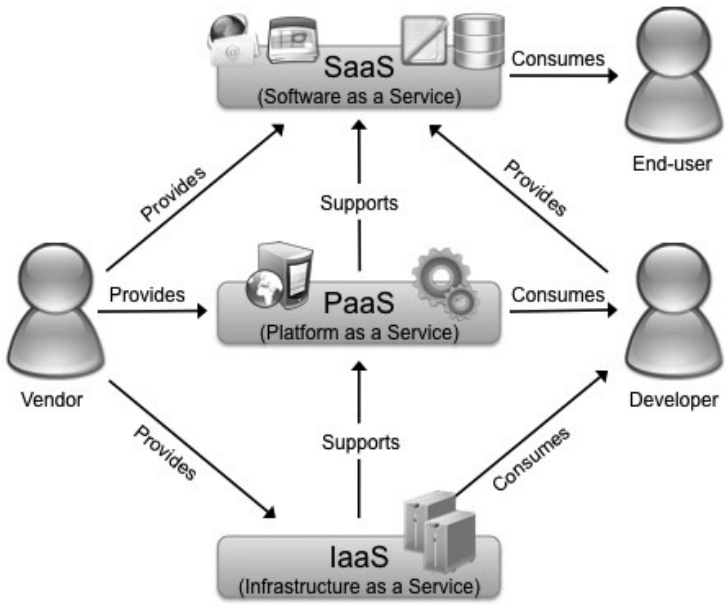
Introduction to Cloud Computing

Cloud Computing is a paradigm of distributed computing that delivers on-demand and utility based services to its customers. It provides a set of shared computing resources such as networking, computation, storage and applications in the form of services over the Internet.

The major benefits of cloud computing include on-demand self-service and cost effectiveness. For the

customer, there are no up-front costs involved in purchasing the hardware and software required for installing and running the applications.

Different cloud providers provide cloud services at different abstraction levels namely Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). Among the three, Software as a Service (SaaS) is a type of cloud computing that delivers applications through a browser to thousands of customers using a multi-user architecture.



Cloud Based Service Offerings

Salesforce.com is the best known example of SaaS computing among enterprise applications. Google Apps is another example of SaaS, which provides online access via

a web browser to the most common office and business applications used today.

Cloud Computing makes use of approaches, concepts and best practices that have already been established. Some of the technologies incorporated by cloud computing are virtualization, on-demand deployment, Internet delivery of services and Open Source Software (OSS).

Cloud computing gives the ability to its customers to store and access data or programs over the Internet instead of having it on the local computer's hard drive. Cloud itself consists of physical machines in the data centers of cloud providers. Virtualization is provided on top of these physical machines. These virtual machines are provided to cloud users.

Benefits of Cloud Computing:

Cloud computing enables small to medium sized business to implement IT infrastructure with a reduced commitment of company resources. Platform as a Service (PaaS) is a cloud computing model that helps a business achieve hardware cost savings. Business can also realize hardware cost savings from a SaaS (Software as a Srevice) model since the business incurs no additional hardware costs for implementation.

Some of the major benefits of using Cloud Computing are as follows:

1. Reduced implementation and maintenance costs
2. Increased mobility for a global workforce

3. Flexible and scalable infrastructures
4. Quick time to market
5. IT department transformation (focus on innovation vs. Maintenance and implementation)
6. "Greening" of the data center
7. Increased availability of high-performance applications to small/medium sized businesses.

Cloud Based Service Offerings

Globalization of computing assets is the biggest contribution the cloud has made to date. Cloud computing may be viewed as a resource available as a service for an individual or an organization over the Internet. The resources to support distributed computing models in-house typically reside in large and mid-size data centers.

While enterprises often keep their most sensitive data in-house, huge volumes of big data (owned by the organization or generated by third-party and public providers) may be located externally – some of it already in a cloud environment.

Cloud service providers tend to offer services that can be grouped into three categories: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). All the services provided on the cloud are accessible over the Internet to the whole world where the cloud acts as a single point of access for serving all its customers. For instance, Amazon's S3 is a data storage service designed for use across the Internet or cloud. Google Apps is another example of Cloud offering. It

provides online access via a web browser to the most common office and business applications used today.

Cloud works on pay-by-use, or pay-by-the-sip model where an application may exist to run a job for a few minutes, or hours, or it may exist to provide services to customers on a long-term basis.

For example, Compute clouds are built as if applications are temporary, and billing is based on resource consumption: CPU hours used, volumes of data moved, or gigabytes of data stored. The ability to use and pay for only the resources used shifts the risk of how much infrastructure to purchase from the organization using the resource to the cloud provider.

Software as a Service (SaaS):

Software as a Service (SaaS) is a type of cloud computing that delivers applications through a browser to thousands of customers using a multi-user architecture. The focus of SaaS is on the end user or the customer. For the customer, there are no up-front investment costs in servers or software licensing.

Salesforce.com is the best-known example of SaaS computing among enterprise applications. Salesforce.com was founded in 1999 by former Oracle executive Marc Benioff, who pioneered the concept of delivering enterprise applications via a simple website.

Nowadays, SaaS is also used for enterprise resource planning and human resource applications. SaaS features a complete application offered as a service on demand. A

single instance of the software runs on the cloud services multiple end users or client organizations.

Platform as a Service (PaaS):

PaaS is closely related to SaaS but delivers a platform from which to work rather than an application to work with. It is sometimes referred to simply as web services in the cloud. This variation of cloud computing delivers development environment as a service to programmers, analysts and software engineers for developing applications that can run on the cloud. An example of this model is the Google App Engine, which serves applications on Google's infrastructure.

Cloud computing helps an application developer to increase the velocity at which applications are deployed, helping to increase the pace of innovation. PaaS integrates an OS, middleware, application software, and even a development environment that is then provided to a customer as a service.

Someone using PaaS would see an encapsulated service that is presented to them through an API. The customer interacts with the platform through the API, and the platform does what is necessary to manage and scale itself to provide a given level of service. Microsoft Azure is a well-known PaaS solution.

Infrastructure as a Service (IaaS):

Infrastructure as a Service (IaaS) delivers basic storage and compute capabilities as standardized services over the network. Servers, storage systems, switches,

routers, and other systems are pooled and made available to handle workloads that range from application components to high-performance computing applications. Commercial examples of IaaS include Joyent, whose main product is a line of virtualized servers that provide a highly available on-demand infrastructure.

Amazon Web Services is another example that offers IaaS through the Elastic Compute Cloud, or EC2. Most IaaS packages cover the storage, networking, servers, and virtualization components, while IaaS customers are usually responsible for installing and maintaining the operating system, databases, security components, and applications.

Chapter 2

Generations of Computers

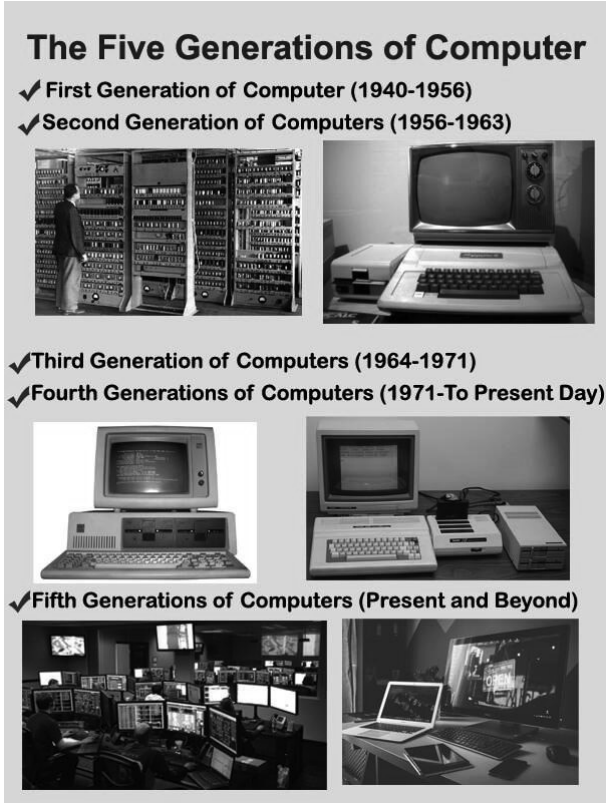
The early computers, which used vacuum tubes to control the flow of electronic signals, are called **First Generation Computers**. The computers of this generation are: ENIAC, EDSAC, EDVAC and UNIVAC. These computers used thousands of Vacuum tubes to do the entire operation.

Vacuum Tube is an electronic device that used filaments for producing electronic signals. Its size is about the size of an electric bulb. It produced lot of heat and burn out frequently. Because of the use of Vacuum tubes, first

generation computers were too bulky and failed to work too often.

First Generation Computers:

The **ENIAC (1943-1946)**, called Electronic Numerical Integrator And Calculator was the first electronic computer. It was completely developed in 1946 by a team led by Eckert and Mauchly at the University of Pennsylvania in U.S.A.



Generations of Computers

ENIAC used high-speed vacuum tube switching devices for the control of electronic signals. There were about 19,000 vacuum tubes in ENIAC. It had a very small memory and used wired plug boards as input devices. ENIAC took about 200 μs to add two digits and 2800 μs to multiply. It was primarily designed to calculate the trajectories of missiles.

The computers EDSAC and EDVAC, which were developed after the ENIAC, were called as 'Stored Program' computers, because they were designed to store instructions and data internally after the proposal of Von Neumann in the year 1946. His idea was to store machine instructions in the memory of the computer along with data.

EDSAC (1947-1949), abbreviation for Electronic Delay Storage Automatic Computer, was the first stored program computer. It was developed by a team of Scientists led by Prof. Maurice Wilkes at Cambridge University, U.K. This machine used mercury delay lines for storage.

EDVAC (1946-1952) is the abbreviation for Electronic Discrete Variable Automatic Computer (EDVAC) was the first effort made on the concept of Van Neumann. It used binary form (i.e., 0 and 1: called discrete or digital signals) to store data and instructions of the decimal number system used by human beings.

Computers, which operate on discrete or digital signals like 0 and 1, high or low are called **Digital Computers**, whereas **Analog computers** operate on analog signals, which are continuously varying in nature. Some of the examples for Analog device are Voltmeter, Ammeter

and Speedo meter. EDVAC is an example for Digital computer, which used binary values 0 and 1 for storage and calculation.

Universal Automatic Computer (UNIVAC) was the first computer produced for commercial purpose. It was developed in 1951. It was available for commercial use from 1954.

Second Generation Computers:

Bardeen, Brattain and Shockley invented transistor in 1947. Transistors are made of Germanium Semiconductor material. Compared to vacuum tubes, transistors were highly reliable, occupied less space and used only one tenth of the power required by tubes.

The computers, which were made of transistors, are called Second Generation computers. They were introduced around 1959 and lasted till 1965. The use of transistors made 'second' generation computers faster, smaller and reliable.

Magnetic Core Memories were also invented during second-generation of computers. Magnetic core memories were made up of magnetic cores, which are tiny rings (0.02 inch diameter) made of ferrite. They are magnetized in either clockwise or anticlockwise direction to represent 0 and 1. This type of memory was used to construct RAM up to the size of 100 KB.

Other Developments:

1. Magnetic disk storage was developed during this period.

2. Higher level languages - FORTRAN, COBOL, ALGOL and SNOBAL were introduced.
3. The early operating system called Batch Operating System was developed during this time. For e.g., the Batch OS used in IBM 7000 series computer.
4. Commercial applications like Payroll, Inventory Control, Marketing, Production Planning and General Ledger were rapidly developed.

Third Generation Computers:

Integrated Circuits (ICs) were used as the switching device in third generation computers. Germanium transistors were replaced with Silicon transistors in the construction of CPU. Because of the use of Silicon transistors in ICs, the switching speed and reliability of CPU increased by a factor of 10. Power dissipation and the size of CPU were decreased by a factor of 10. This resulted in increase in speed of the third generation computers was 1 MIPS. The System/360 introduced by IBM around 1965 was the first third generation computer.

An IC is a small chip consists of electronic components like transistors, resistors and capacitors on a silicon metal plate. The components were integrated together on a silicon material in order to eliminate the wired interconnection between components.

The technologies used for the construction of ICs of third generation were SSI and MSI. SSI technology can integrate about 10 transistors in a chip. The integration

capacity was increased 10 times in MSI technology to hold up to 100 transistors in one chip.

Other Developments:

1. Time-sharing OS like multiprocessing, multiprogramming and multi-user OS were introduced to increase programmer productivity.
2. The High-level language PL/1 of IBM was emerged. Many important on-line systems like dynamic Production control system, Airline reservation system, and Interactive query system were implemented.
3. Significant improvements were made in the design of Core memories. As a result, the size of the main memory reached about 4 MB. Magnetic disk memory was also available up to the size of 100 MB.
4. The standard I O devices keyboard and monitor were newly introduced.

Fourth Generation Computers:

Fourth generation computers used LSI and VLSI technologies for the construction of CPU, memory and supporting chips. The VLSI chip used as the switching device in fourth generation computers is called Microprocessor *(μP)*. Introduction of microprocessor as CPU in the fourth generation computer led to the following developments:

1. Extremely powerful Personal Computers (PC) were emerged.

2. Computer cost came down rapidly.
3. Computer's workload was decentralized. As opposed to a Mainframe computer, which uses a single powerful CPU to be shared by many terminals for many applications, a PC has its own μP to do its processing and can be connected in a network.

LSI & VLSI Technologies:

In LSI Technology, thousands of components were fit onto one chip, whereas in VLSI technologies, 10 to 50 thousands of transistors were integrated onto a single chip. The ability to fit so much onto an area about half the size of one-rupee coin helped diminish the size and price of computers. The other developments that took place during fourth generation are as follows:

1) Magnetic Core memories were replaced by Semiconductor memories for the construction of RAM. Thus RAM with the size of 16 MB and a cycle time of 200 ns were in common use.
2) Hard disk size for the secondary storage was greatly improved in the order of Giga Bytes. 1 GB of disk on PCs became common in 1994.
3) Optical disks like CD-ROM and DVD-ROM (Digital Versatile Disk ROM) emerged as mass storage devices particularly for read only files. The size of the disk was of the order of 600 MB on a 5.25" disk.
4) High-level languages such as C, C++, ADA and PROLOG were developed. CASE tools were

also developed for the Analysis and Design of software.

5) Interactive graphic devices and language interfaces to graphic systems were introduced.

Fifth Generation Computers:

The fifth-generation computers are under development. Fifth generation computers will make use of ULSI chips which consist of millions of components into a single IC. Such computers will use intelligent programming, knowledge-based problem solving techniques, high performance multiprocessor system and improved human-machine interfaces.

The input and output for these computers will be in the form of speech and graphic images. Vision system will be incorporated in order to perceive the surroundings. The computers of this age will be able to understand natural languages like English, Japanese, and Hindi. This will diminish the need for learning computer programming languages by programmers.

Using intelligent programming, the user can tell the computer what to do but not how to do. The computer will do the task of programming itself. The first four generations of computers used Von Neumann's architecture for the design of digital computers. In Von Neumann architecture, a processor executes simple instructions in a sequence. But the fifth generation computers will use a different design and architecture.

Data flow architecture will be used as the basic design for the construction of fifth generation computers. There will be an extensive use of parallel processing and PROLOG is going to be the language for performing parallel processing. Special coprocessors will be used to make logical inferences and manage massive amounts of stored knowledge. In General, fifth generation computers will be knowledge-based computers.

Chapter 3

Classification of Computers

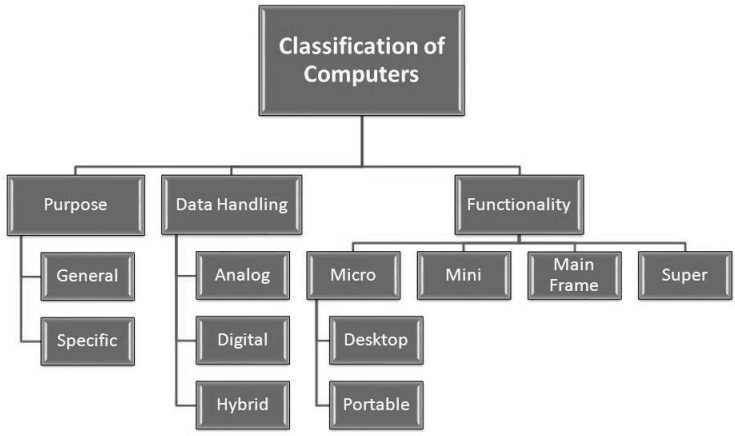
Based on the technology used for the construction of CPU in the computers, they are classified as Microcomputers, Mini computers, Mainframe computers and Super computers. Based on the interconnection of computers, we can classify them as distributed computers and parallel computers.

The computers, which use Microprocessors as their CPU, are called Microcomputers. Today most of the computers are of this category. Based on the mode of use,

microcomputers are further classified into Personal computers, Portable computers and Workstations.

Personal Computers (PCs)

Personal computers are computers used by individuals for the purpose of running the stand-alone applications like Word Processing, Spread Sheet etc. Data and applications stored in a PC are not available for sharing by other computer users. To make use of the resources available in a PC from other PCs, it must be connected to a network.



Major Classification of Computers

There are two major manufactures of PCs – IBM and APPLE. The machines made by IBM are called IBM PCs. The PCs made by APPLE are called Apple Macintosh. Other manufacturers of PCs also followed the

same specifications and design of IBM PCs for the manufacturing of their PCs. The PCs made by third party vendors are known as IBM compatible PCs.

Early PCs designed by IBM had Intel 8088 microprocessors as their CPU. The Operating Systems used by IBM PCs include MS DOS, MS Windows, Windows-NT, UNIX and OS/2. OS/2 is an OS designed specially for IBM PCs.

Apple Macintosh PCs use Apple's proprietary OS, which was well known for its user friendliness. Apple Macintosh machines started using Motorola 68030 as their microprocessors but later they switched over to Power PC 603 processors.

Portable Computers

Portable computers are smaller in size but more powerful than personal computers. They can be easily carried out by professionals, researchers and entrepreneurs while they are on the road. There are two types of portable computers: Palmtop and Laptop PCs.

Palmtop PCs:

Palmtop computers can be held in a palm like a mobile phone kit. Palmtop PCs have a small screen display for both input and output. They can accept handwritten inputs given using electronic pen. A Palmtop PC can also be used as a mobile phone, Fax and email machine. Windows-CE is the OS provided by Microsoft for the operation of Palmtop PCs.

Laptop PCs:

Laptop computers are also known as Notebook computers, which can be kept on the lap for working with it. A Laptop PC weighs around 2 Kg and can be carried out easily while traveling. Laptop PCs cost more - at least 3 to 4 times the cost of desktop PCs of the same capacity because of the use of miniature components, which consume low power. They can run on batteries as they have been designed to conserve energy. The configuration of a Laptop PC includes a keyboard, flat screen liquid crystal display, and a Pentium or Power PC processor.

Workstation PC

Workstations are more powerful and more expensive than desktop computers. They can operate at higher speeds – about 10 times faster than PCs. They are generally used by scientists, engineers, and other professionals for handling huge volume of data. They are more suitable for numeric and intensive graphic applications.

The configuration of a typical Workstation includes: a color Video Display Unit (19 inch monitors), 256 MB to 1 GB RAM as main memory and a hard disk of 40-80 GB. Workstations normally use RISC processors such as SUN's ULTRASPARC, HP's PA 8500 etc. The OS used by Workstations are UNIX, Linux, SUN Solaris and OS-8.

A system called X Windows is used for Workstations to display the status of multiple processes going on during execution. Most workstations have built-in hardware to connect them to a Local Area Network (LAN).

Mini Computers

Minicomputers, also known as mid range computers were first developed as special-purpose mainframe computers. They were introduced for controlling the machines used in manufacturing industry. However, now they are widely used as general-purpose computers. The most popular minicomputer system is VAM, made by Digital Equipment Corporation (DEC).

Mini computers work well for Distributed Computing Environment (DCE), where the processing power is decentralized and distributed across different computers. An example for distributed computer architecture is Client/Server architecture, in which end users can work with their own microcomputers, and at the same time they can also access and share the resources on the server, which usually is a minicomputer.

Mainframe & Super Computers

Mainframe computers are more powerful than workstations. They are much bigger, faster and more expensive than workstations. Mainframes can process several million-program instructions per second. Organizations like insurance companies, banks, airlines and railways make use of Mainframe computers for handling large number of on-line transactions.

Mainframes can store several Tera bytes of data and transfer data from disk to main memory at several hundred Megabytes/sec. They normally use proprietary operating systems, which usually provide extensive services such as user accounting, file security and control. There are very

few manufacturers of mainframe computers, which include IBM and Hitachi.

Supercomputers are the fastest computers available at any given time. They are normally used to solve problems, which require intensive numerical computations. Examples of such problems are: numerical weather prediction, designing supersonic aircrafts, design of drugs and modeling complex molecules. In order to solve such complex problems, many RISC processors are used in the construction of super computers.

The speed of operation of supercomputers is in terms of nanoseconds and even in Pico seconds. Besides arithmetic speed, supercomputers have a large main memory of around 16 GB and a secondary memory of 1000 GB. The speed of data transfer between the secondary memory and the main memory is at least one tenth of the speed of data transfer between main memory and CPU. Such great speed is achieved in super computers through a mechanism called **Parallelism**.