

# COMPUTER ORGANIZATION AND ARCHITECTURE (COA)

**EET 2211**  
**4<sup>TH</sup> SEMESTER – CSE & CSIT**  
**CHAPTER 1, LECTURE 4**

# CHAPTER 1 – BASIC CONCEPTS AND COMPUTER EVOLUTION

## TOPICS TO BE COVERED

- Arm Architecture
- Cloud Computing

## LEARNING OBJECTIVES

- Define embedded systems.
- List some of the requirements and constraints that various embedded systems meet.
- List the importance of cloud computing.

## ALREADY COVERED

- The Evolution of the Intel x86 Architecture
- Embedded Systems

# CISC vs. RISC

- ✓ Two important processor families are Intel x86 and ARM Architectures.
- ✓ X86 represent the complex instruction set computers (CISC).
- ✓ X86 incorporates the sophisticated design principles found on mainframes and supercomputers.
- ✓ The ARM architecture used in variety of embedded systems is one of the most powerful and best-designed reduced instruction set computers (RISC).
- ✓ The x86 provides excellent advances in computer hardware over the past 35 years.

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CISC	RISC
Stands for Complex Instruction Set Computers.	Stands for reduced Instruction Set Computers.
A full set of computer instructions that intends to provide the necessary capabilities in an efficient way.	An instruction set architecture that is designed to perform a smaller number of computer instructions so that it can operate at a higher speed.
The original microprocessor ISA.	Redesigned ISA that emerged in the early 1980s.
Hardware centric design (the ISA does as much as possible using hardware circuitry).	Software centric design (high level compilers take on most of the burden of coding and many software steps from the programmer).
Instruction cycles can take several clock cycles to execute.	Single cycle instructions execution takes place.

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CISC	RISC
Pipelining is difficult.	Pipelining is easy.
Extensive use of microprogramming (where instructions are treated like small programs).	Complexity in compiler and there is only one layer of instructions.
Complex and variable length instructions	Simple, standardized instructions.
Large number of instructions.	Small number of fixed length instructions.
Compound addressing modes.	Limited addressing modes.
Less registers.	Uses more registers.
Requires a minimum amount of RAM.	Requires more RAM.
Used in Microprogrammed Control Unit; used in applications such as desktop computer and laptops.	Used in Hardwired Control Unit; used in applications such as mobile phones and tablets.

# ARM ARCHITECTURE

- ✓ It has evolved from RISC design principle.
- ✓ It is used in embedded systems.

## ARM EVOLUTION

- ✓ ARM is a family of RISC based microcontrollers and microprocessors designed by ARM holdings.
- ✓ ARM chips are high speed processors.
- ✓ They have small die size and require very less power.
- ✓ They are widely used in Smartphones and other hand held devices including game stations and consumer products.

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- ✓ ARM chips are the processors in Apple's popular iPod and iPhone devices.
- ✓ It is the most widely used embedded processor architecture.
- ✓ **Acron RISC Machine**/ ARM was the first to develop the commercial RISC processor.
- ✓ The ARM design matched the growing commercial need for a high-performance, low-power-consumption, small size and low-cost processor for embedded applications.

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## **INSTRUCTION SET ARCHITECTURE**

- ✓ ARM instruction set is highly regular, designed for efficient implementation of the processor and efficient execution.
- ✓ All instructions are 32 bits long and follow a regular format.
- ✓ ARM ISA is the Thumb instruction set, which is a re-encoded subset of the ARM instruction set.
- ✓ Thumb is designed to increase the performance of ARM implementations that use a 16-bit or narrower memory data bus and allow better code density than provided by the ARM instruction set.
- ✓ The Thumb instruction set contains a subset of the ARM 32-bit instruction recoded into 16-bit instructions.



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## **ARM PRODUCTS**

- ✓ ARM Holdings licenses a number of specialized microprocessors and related technologies, but the bulk of their product line is the Cortex family of microprocessor architectures.
- ✓ There are 3 Cortex architectures, conveniently labeled with the initials A, R and M.
  1. CORTEX-A/CORTEX-A50
  2. CORTEX-R
  3. CORTEX-M

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## ✓ **CORTEX-A/CORTEX-A50**

- i. They are application processors
- ii. They are intended for mobile devices as Smartphones and eBooks readers as well as consumer devices such as digital TV and home gateways.
- iii. These processors run at higher clock frequency.
- iv. They support a MMU which is required for full feature Oss such as Linux, Android, MS Windows and Mobile Oss.
- v. The two architectures use both the ARM and Thumb-2 instruction sets.
- vi. Cortex-A is a 32-bit machine and Cortex-A50 is a 64-bit machine.

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✓ **CORTEX-R**

- i. It is designed to support real-time applications, in which the timing of events needs to be controlled with rapid response to events.
- ii. They run at a higher clock frequency and have a very low response latency.
- iii. It includes enhancements both to the instruction set and to the processor organization to support deeply embedded real-time devices.
- iv. Most of these processors don't have MMU(memory management unit), limited data requirements and limited number of simultaneous processes eliminates the need for elaborate hardware and software support for virtual memory.
- v. It does not have a MPU(memory protection unit), cache and other memory features designed for industrial applications.
- vi. E.g. automotive braking systems, mass storage controllers and networking and printing devices.

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## ✓ **CORTEX-M**

- i. They have been developed primarily for the microcontroller domain where the need for fast, highly deterministic interrupt management is coupled with the desire for extremely low gate count and lowest possible power consumption.
- ii. They have MPU but no MMU.
- iii. It uses the Thumb-2 instruction set.
- iv. E.g. IoT devices, wireless sensor/actuator networks used in factories and other enterprises, automotive body electronics.
- v. There are currently 4 versions viz. Cortex-M0, Cortex-M0+, Cortex-M3 and Cortex-M4.

# CLOUD COMPUTING

- ✓ General concepts for cloud computing had developed in 1950s.
- ✓ The cloud services first became available in the early 2000s and particularly targeted at large enterprises.
- ✓ Then cloud computing has spread to small and medium size businesses and recently to consumers.
- ✓ Evernote, the cloud based notetaking and archiving services were launched in 2008.
- ✓ Apple's iCloud was launched in 2012.

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## **BASIC CONCEPTS**

- ✓ **CLOUD COMPUTING** : A model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction.
- ✓ All information technology (IT) operations are moved to an Internet connected infrastructure known as enterprise cloud computing.

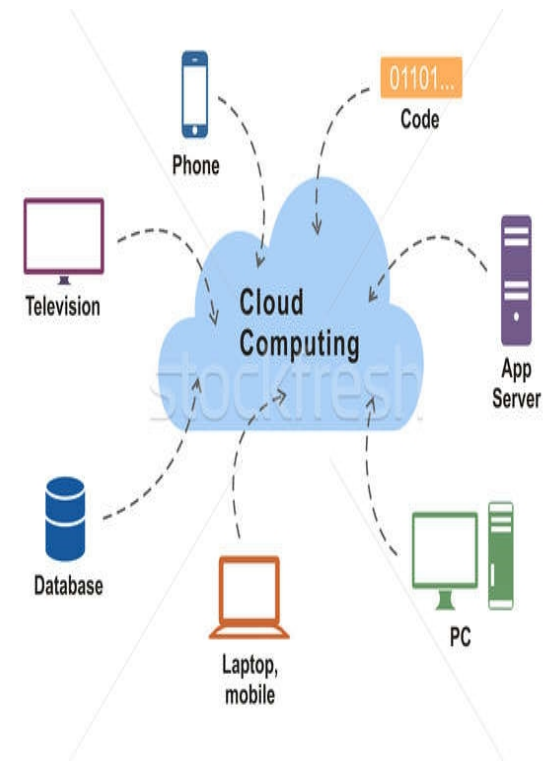


Fig.1 : Cloud Computing

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- ✓ We get economics of scale, professional network management and professional security management with cloud computing.
- ✓ These features are attractive to companies, government agencies and individual PC and mobile users.
- ✓ The individual or company only needs to pay for the storage capacity and services they need.
- ✓ The setting up a database system, acquiring the hardware they need, doing maintenance and backing up the data are all parts of the cloud services.
- ✓ The cloud also takes care of the data security.

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## **CLOUD NETWORKING**

- ✓ It refers to the networks and network management functionality that must be in place to enable cloud computing.
- ✓ It also refers to the collection of network capabilities required to access a cloud, including making use of specialized services over the internet, linking enterprise data centers to a cloud, and using firewalls and other network security devices at critical points to enforce access security policies.
- ✓ Cloud storage can be thought of one subset of cloud computing.
- ✓ Cloud storage consists of database storage and database applications hosted remotely on cloud servers.



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## TYPES OF CLOUD NETWORKS

### Private

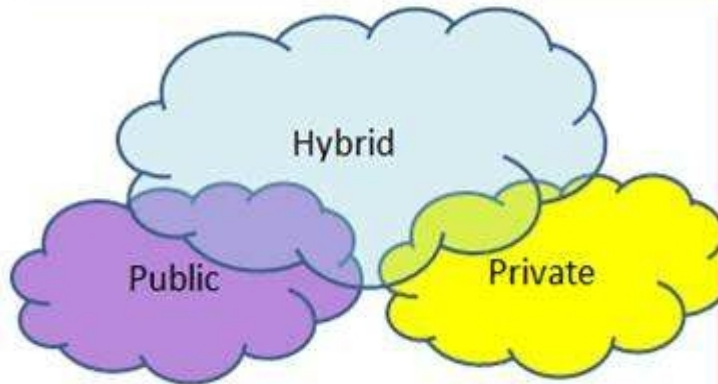
- Operated exclusively for the organization
- Can be operated internally or by an external provider
- Organization is in control of all aspects of the infrastructure

### Public

- External to the organization
- Owned and operated by Cloud Service Providers (CSPs)
- Services available to general public over the Internet

### Hybrid

- Combination of two or more clouds that are unique yet share resources
- Requires both on-site and off-site resources
- Offers benefit of multiple deployment models



### Security Concerns

- Private: Organization is in charge of security, must remain vigilant in maintaining aspects (e.g. secure hypervisor)
- Public: Public clouds can vary in composition and security; share resources with greater public, data privacy concerns exist
- Hybrid: Part of the cloud is owned and operated by a CSP, and the organization may not have complete control over configuration

Fig.2: Cloud Networks

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## CLOUD SERVICES

- ✓ A cloud service provider (CSP) maintains computing and data storage resources that are available over the internet or private networks.
- ✓ Customers can rent a portion of these resources as needed.
- ✓ All cloud services are provided using one of the three models: (i) SaaS (ii) PaaS (iii) IaaS.

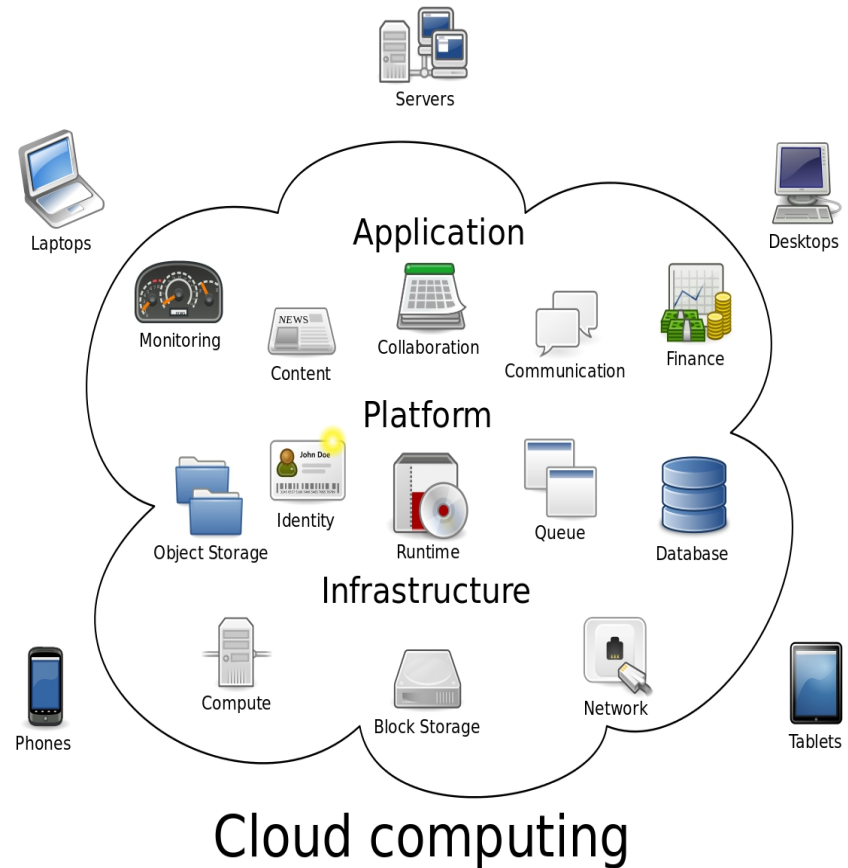


Fig.3: Cloud Services

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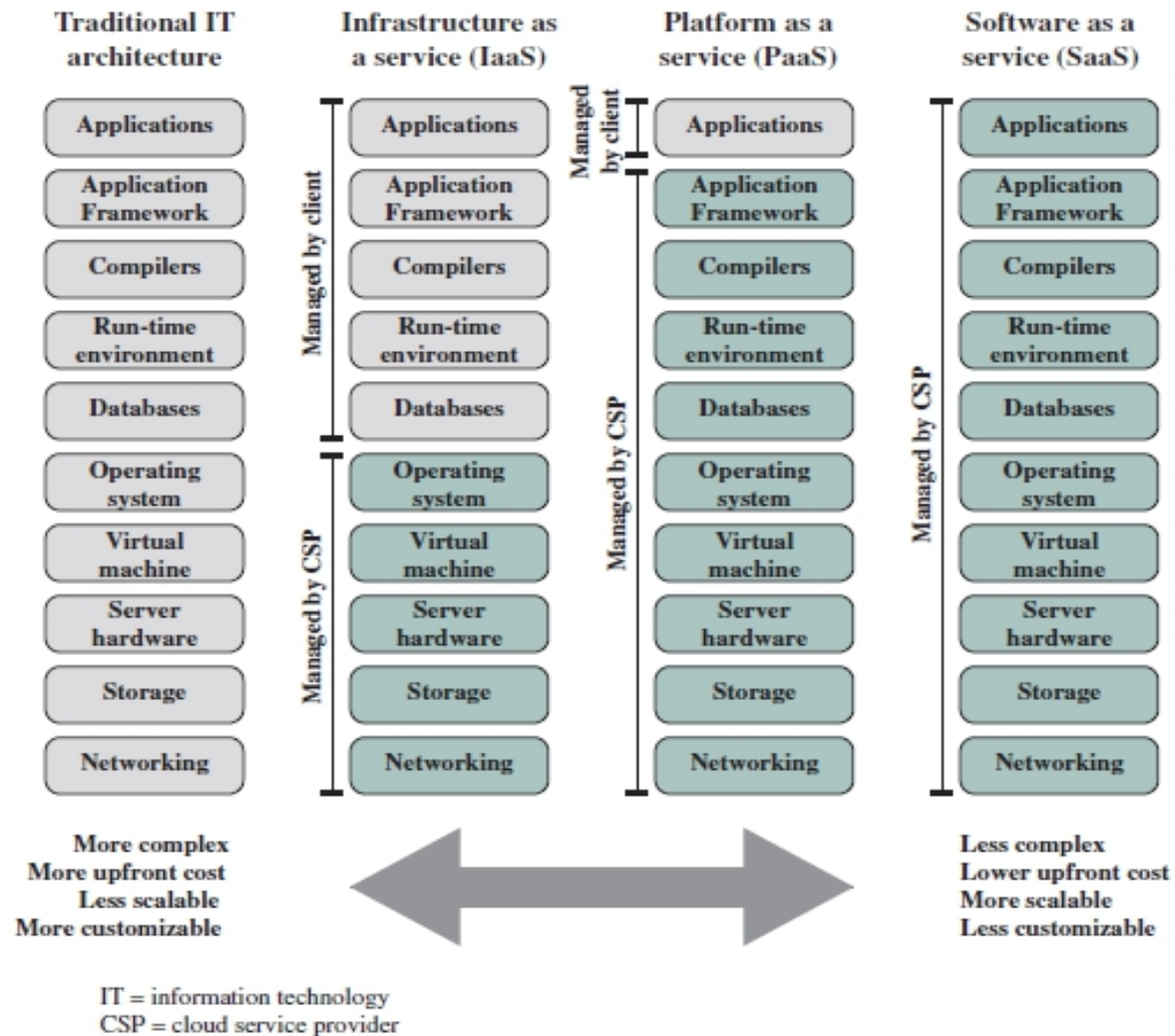


Fig.4: Alternative Information Technology Architectures [Source: Computer Organization and Architecture by William Stallings]

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## **SaaS – Software as a Service**

- In simple this is a service which leverages business to roll over the internet. SaaS is also called as “on-demand software” and is priced on pay-per-use basis. SaaS allows a business to reduce IT operational costs by outsourcing hardware and software maintenance and support to the cloud provider. SaaS is a rapidly growing market as indicated in recent reports that predict ongoing double digit growth.

## **PaaS – Platform as a Service**

- PaaS is quiet similar to SaaS rather than SaaS been offered through web the PaaS creates software, delivered over the web.
- PaaS provides a computing platform and solution stack as a service. In this model user or consumers creates software using tools or libraries from the providers. Consumer also controls software deployment and configuration settings. Main aim of provider is to provide networks, servers, storage and other services.

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## **IaaS – Infrastructure as a Service**

- Infrastructure is the foundation of cloud computing.
- It provides delivery of computing as a shared service reducing the investment cost, operational and maintenance of hardware.
- Infrastructure as a Service (IaaS) is a way of delivering Cloud Computing infrastructure – servers, storage, network and operating systems – as an on-demand service.
- Rather than purchasing servers, software, datacenter space or network equipment, clients instead buy those resources as a fully outsourced service on demand.

# OTHER SERVICES OF CLOUD COMPUTING

Here the components in the sense refer to the platforms like cloud delivery, usage of network's front end back end which together forms the cloud computing architecture.

**1.Storage-as-a-service:** In this component, we can avail storage as we do it at the remote site. It is the main component and called as disk space on demand.

**2.Database-as-a-service:** This acts as a live database and main aim of this component is to reduce the price of dB by using more number of software and hardware.

**3.Information-as-a-service:** Data that can approach from anywhere is known as information-as-a-service. Internet banking, online news and much more are included in it.

**4.Process-as-a-service:** Combination of different sources like information and services is done in process-as-a-service; it is mainly helpful for mobile networks.

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**5. Application-as-a-service:** It is a complete application which is ready to use and it is the final front end for the users. Few sample applications are Gmail, Google calendar and much more.

**7. Integration-as-a-service:** This deals with components of an application that are built and need to integrate with other applications.

**8. Security-as-a-service:** This component is required to many customers because the security has the initial preference.

**9. Management-as-a-service:** This component is useful for the management of the clouds.

**10. Testing-as-a-service:** This component refers to the testing of applications that are hosted remotely.

# ADVANTAGES

1. **Say 'Goodbye' to costly systems:** Cloud hosting enables the businesses to enjoy minimal expenditure. As everything can be done in the cloud, the local systems of the employees have very less to do with. It saves the dollars that are spent on costly devices.
2. **Access from infinite options:** Another advantage of cloud computing is accessing the environment of cloud not only from the system but through other amazing options. These options are tablets, iPad, netbooks and even mobile phones. It not only increases efficiency but enhances the services provided to the consumers.
3. **Software Expense:** Cloud infrastructure eliminates the high software costs of the businesses. The numbers of software are already stored on the cloud servers. It removes the need for buying expensive software and paying for their licensing costs.
4. **The cooked food:** The expense of adding new employees is not affected by the applications' setup, installation and arrangement of a new device. Cloud applications are right at the desk of employees that are ready to let them perform all the work. The cloud devices are like cooked food.
5. **Free Cloud Storage:** Cloud is the best platform to store all your valuable information. The storage is free, limitless and forever secure, unlike your system.



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5. **Lowers traditional servers' cost:** Cloud for business removes the huge costs at the front for the servers of the enterprise. The extra costs associated with increasing memory, hard drive space and processing power are all abolished.
6. **Data Centralization:** Another key benefit of cloud services is the centralized data. The information for multiple projects and different branch offices are stored in one location that can be accessed from remote places.
7. **Data Recovery:** Cloud computing providers enables automatic data backup on the cloud system. The recovery of data when a hard drive crash is either not possible or may cost a huge amount of dollars or wastage of valuable time.
8. **Sharing Capabilities:** We talked about documents accessibility, let's hit sharing too. All your precious documents and files can be emailed, and shared whenever required. So, you can be present wherever you are not!
9. **Cloud Security:** Cloud service vendor chooses only the highest secure data centers for your information. Moreover, for sensitive information in the cloud there are proper auditing, passwords, and encryptions.
10. **Instantly Test:** Various tools employed in cloud computing permits you to test a new product, application, feature, upgrade or load instantly. The infrastructure is quickly available with flexibility and scalability of distributed testing environment.

# DISADVANTAGES

1. **Net Connection:** For cloud computing, an internet connection is a must to access your precious data.
2. **Low Bandwidth:** With a low bandwidth net, the benefits of Cloud computing cannot be utilized. Sometimes even a high bandwidth satellite connection can lead to poor quality performance due to high latency.
3. **Affected Quality:** The internet is used for various reasons such as listening to audios, watching videos online, downloading and uploading heavy files, printing from the cloud and the list goes on. The quality of Cloud computing connection can get affected when a lot of people utilize the net at the same time.
4. **Security Issues:** Of course, cloud computing keeps your data secure. But for maintaining complete security, an IT consulting firm's assistance and advice is important. Else, the business can become vulnerable to hackers and threats.
5. **Non-negotiable Agreements:** Some cloud computing vendors have non-negotiable contracts for the companies. It can be disadvantageous for a lot of businesses.

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6. **Cost Comparison:** Cloud software may look like an affordable option when compared to an in-house installation of software. But it is important to compare the features of the installed software and the cloud software. As some specific features in the cloud software can be missing that might be essential for your business. Sometimes you are charged extra for unrequired additional features.
7. **No Hard Drive:** As Steve Jobs, the late chairman of Apple had exclaimed “I don’t need a hard disk on my computer if I can get to the server faster... carrying around these non-connected computers is byzantine by comparison.” But some people who use programs cannot do without an attached hard drive.
8. **Lack of full support:** Cloud-based services do not always provide proper support to the customers. The vendors are not available on e-mail or phones and want the consumers to depend on FAQ and online community for support. Due to this, complete transparency is never offered.
9. **Incompatibility:** Sometimes, there are problems of software incompatibility. As some applications, tools, and software connect particularly to a personal computer.
10. **Fewer insights into your network:** It’s true cloud computing companies provide you access to data like CPU, RAM, and disk utilization. But just think once how minimal your insight becomes into your network. So, if it’s a bug in your code, a hardware problem or anything, without recognizing the issue it is impossible to fix it.
11. **Minimal flexibility:** The application and services run on a remote server. Due to this, enterprises using cloud computing have minimal control over the functions of the software as well as hardware. The applications can never be run locally due to the remote software.

# REVIEW QUESTIONS

1. What in general is the distinction between computer organization and computer architecture?
2. What is the distinction between computer structure and computer functions?
3. What are the four main functions of a computer?
4. List and briefly define the main structural components of a computer.
5. List and briefly define the main structural components of a processor.
6. What is a stored program computer?
7. Explain Moore's Law.
8. List and explain the key characteristics of computer family.
9. What is the key distinguishing feature of a microprocessor?
10. On the IAS, describe the process that the CPU must undertake to read a value from memory and write a value to memory in terms of what is put into MAR, MBR, address bus, data bus and control bus.

**THANK YOU**