



NARSIMHA REDDY ENGINEERING COLLEGE

**An Autonomous Institution | Affiliated to JNTUH | Approved by AICTE
Accredited by NBA & NAAC with 'A' Grade**

Department of Computer Science and Engineering

Program Name : B.Tech CSE

Subject: CLOUD COMPUTING

Course Code : 23CS706

Semester & Year: I/IV

Faculty Name : G. MAHESH

UNIT-1

Introduction

Computing

- The process of utilizing computer technology to complete a task.
- Computing may involve computer hardware and/or software, but must involve some form of a computer system.

Paradigms

- A style or a way of doing something.
- A set of practices to be followed to accomplish a task.

Computing Paradigms

- In the domain of computing, there are many different standard practices being followed based on inventions and technological advancements.

Computing Paradigms

- The various computing paradigms:
 - ~ High performance computing,
 - ~ Parallel computing
 - ~ Cluster computing,
 - ~ Distributed computing
 - ~ Grid computing,
 - ~ Cloud computing,
 - ~ Bio-computing,
 - ~ Mobile computing,
 - ~ Quantum computing,
 - ~ Optical computing,
 - ~ Nano computing.

High Performance Computing

High Performance Computing

- In high-performance computing systems, a pool of processors are connected with other resources like memory, storage, and input and output devices, and the deployed software is enabled to run in the entire system of connected components.
- The processor machines can be of homogeneous or heterogeneous type.
- The legacy meaning of high-performance computing (HPC) is the supercomputers; however, it is not true in present-day computing scenarios.

- Thus, examples of HPC include a small cluster of desktop computers or personal computers (PCs) to the fastest supercomputers.
- HPC systems are normally found in those applications where it is required to use or solve scientific problems.
- Most of the time, the challenge in working with these kinds of problems is to perform suitable simulation study, and this can be accomplished by HPC without any difficulty.
- Scientific examples such as protein folding in molecular biology and studies on developing models and applications based on nuclear fusion are worth noting as potential applications for HPC.

High Performance Computing



High Performance Computing



- **HPC Use In Africa And How Different Industries Can Take Advantage of It**

High Performance Computing

UCL to host National High Performance Computing Hub for Materials Science

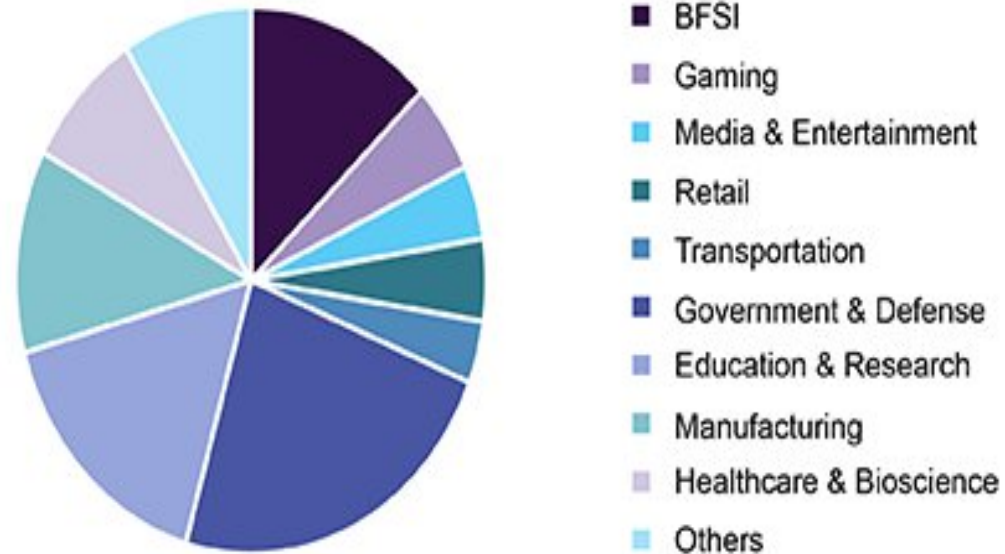


A UCL-led consortium has been awarded to establish a new national High Performance Computing (HPC) facility for the Materials and Molecular Modelling community.

High Performance Computing

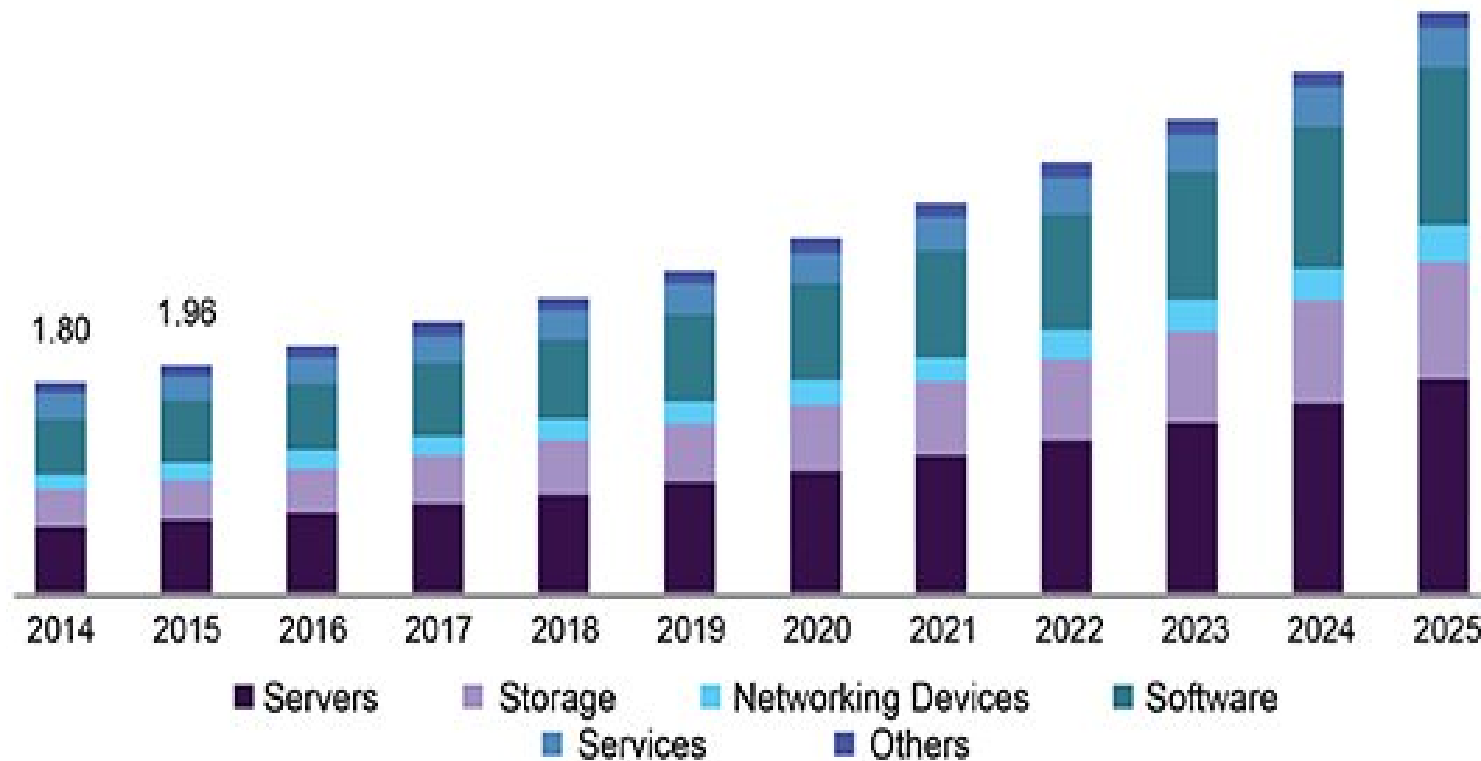
Global High Performance Computing market

Global High Performance Computing (HPC) market share, by end use, 2017 (%)



High Performance Computing

China High Performance Computing (HPC) market size, by component, 2014 - 2025 (USD Billion)



Source: www.grandviewresearch.com

Parallel Computing

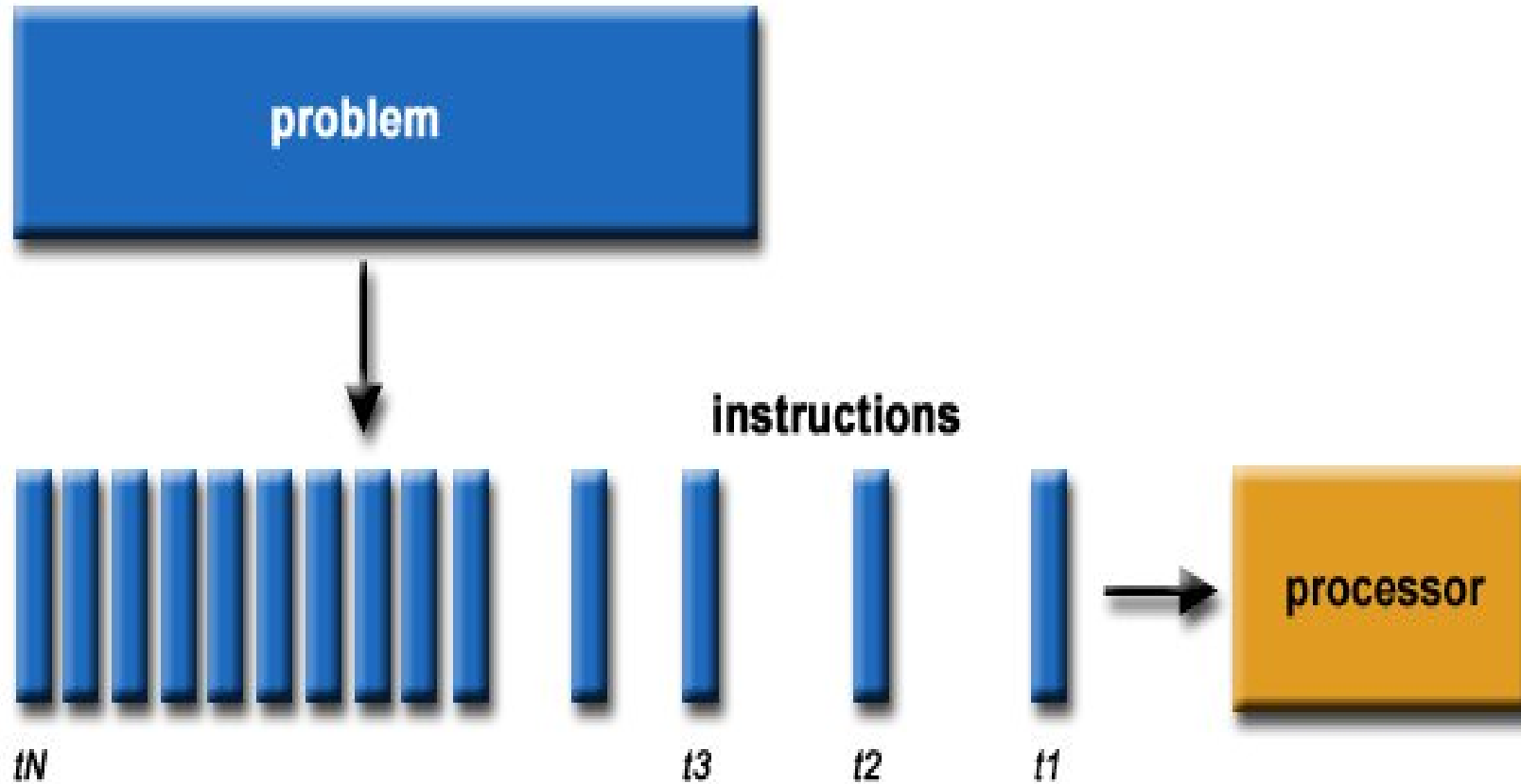
Parallel Computing

Serial Computing

- Traditionally, software has been written for *serial* computation
 - A problem is broken into a discrete series of instructions
 - Instructions are executed sequentially one after another
 - Executed on a single processor
 - Only one instruction may execute at any moment in time

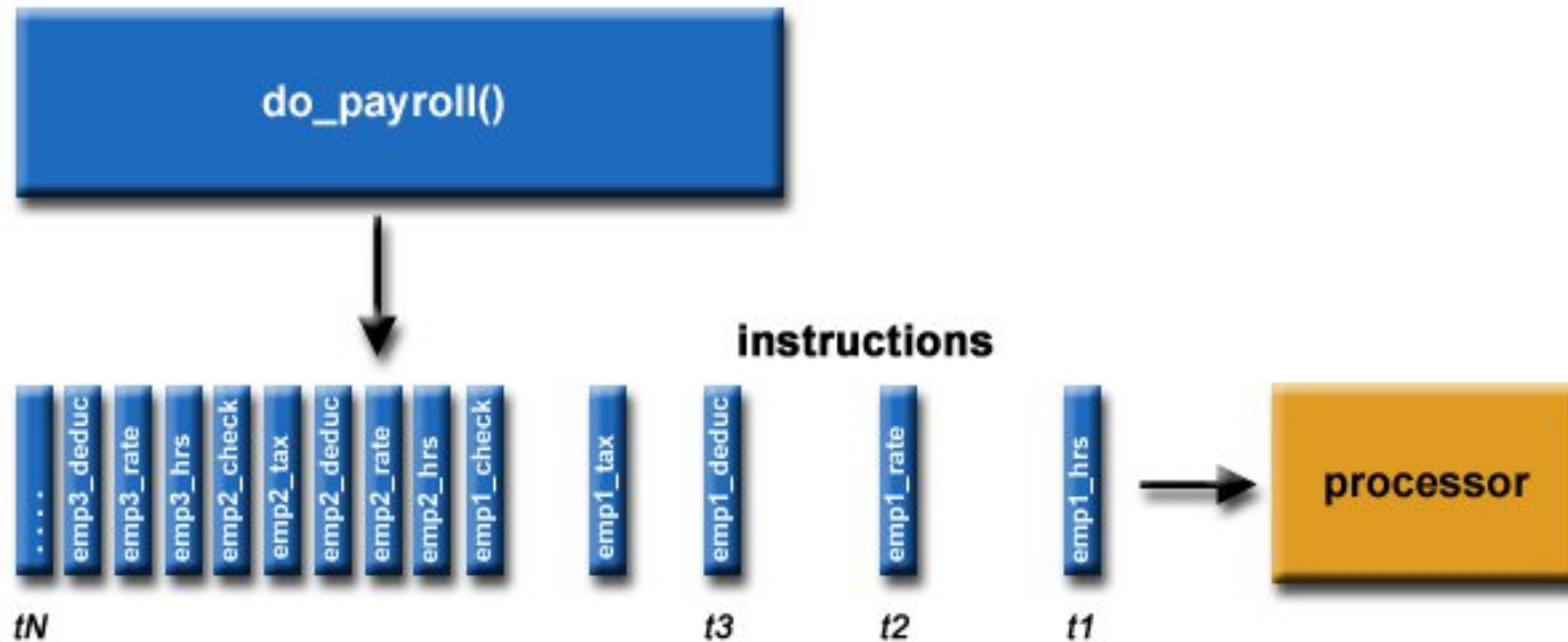
Parallel Computing

- Serial C



Parallel Computing

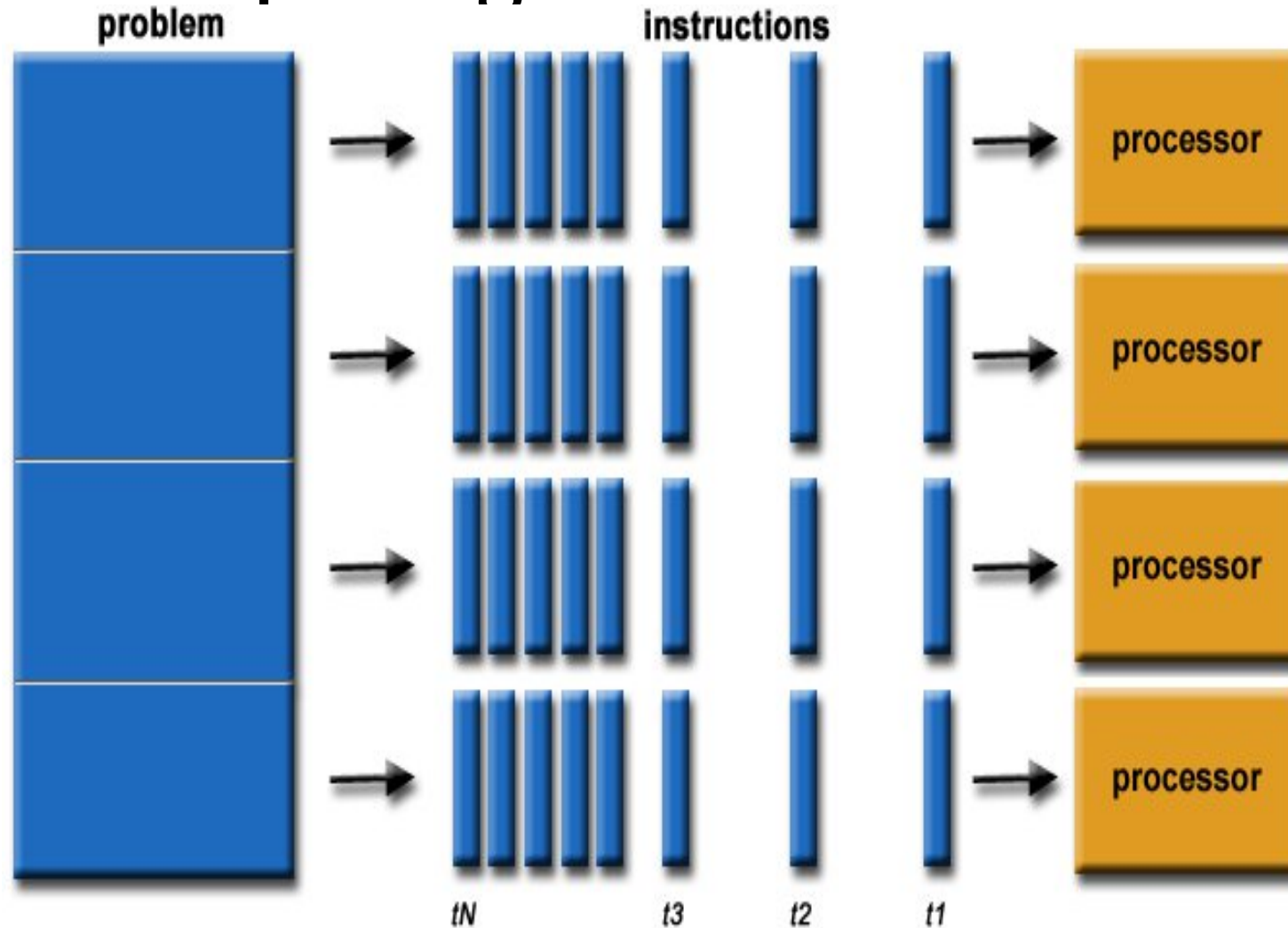
- **Serial Computing:**
- For Example-



Parallel Computing

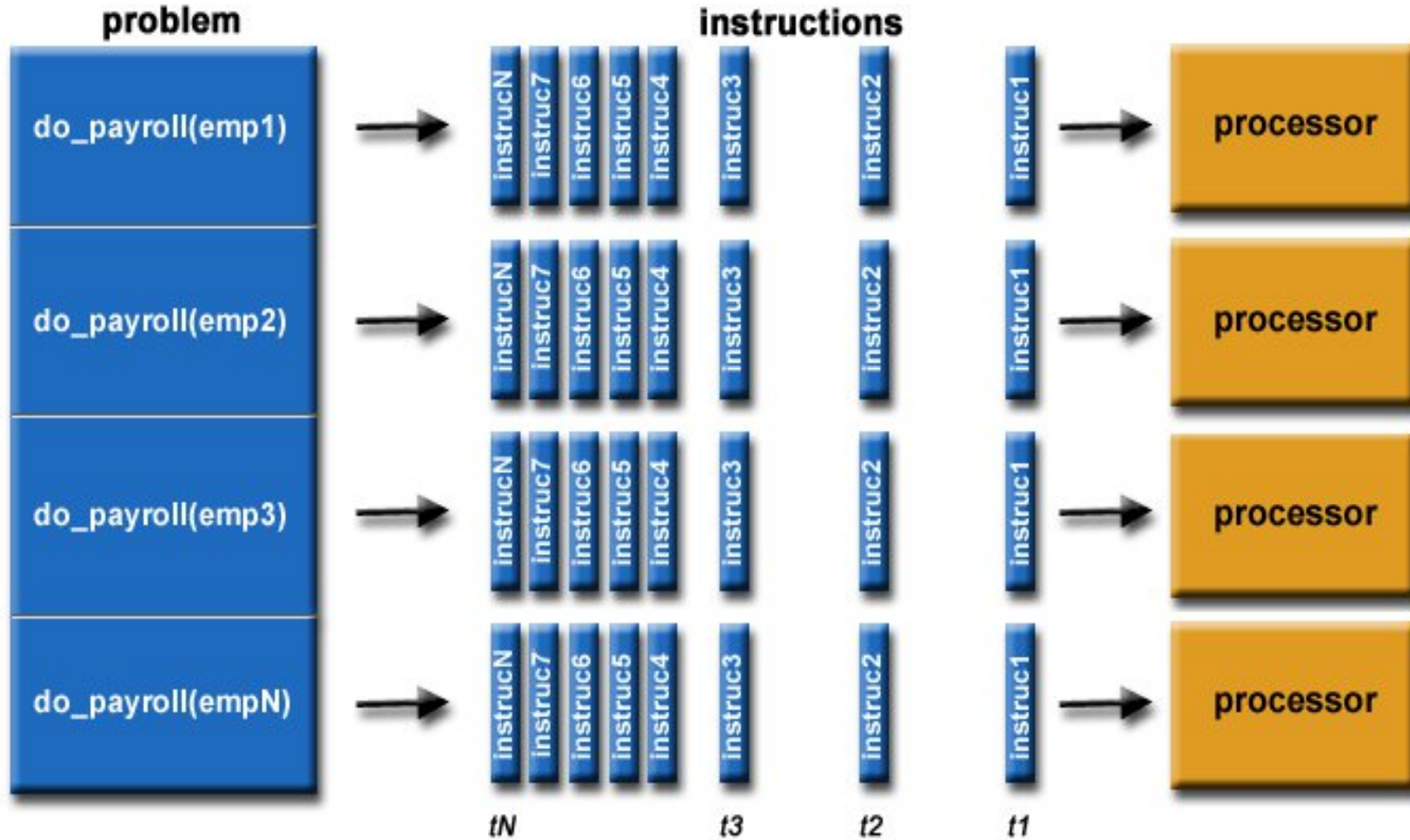
- **Parallel Computing:**
- In the simplest sense, *parallel computing* is the simultaneous use of multiple compute resources to solve a computational problem:
 - A problem is broken into discrete parts that can be solved concurrently
 - Each part is further broken down to a series of instructions
 - Instructions from each part execute simultaneously on different processors
 - An overall control/coordination mechanism is employed

Parallel Computing



Parallel Computing

- For Exa

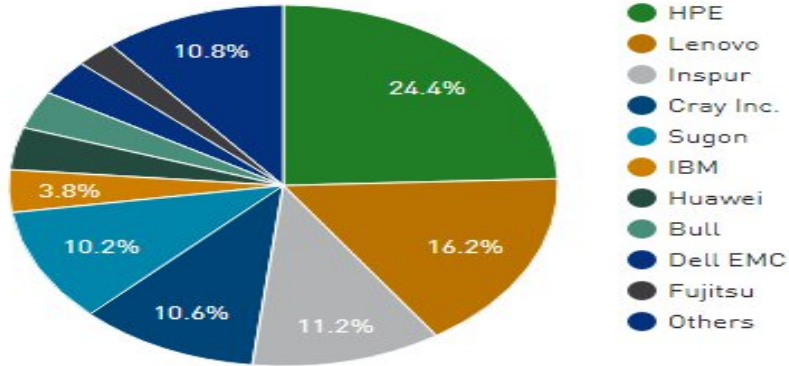


Parallel Computing

- The computational problem should be able to:
 - Be broken apart into discrete pieces of work that can be solved simultaneously;
 - Execute multiple program instructions at any moment in time;
 - Be solved in less time with multiple compute resources than with a single compute resource.
- The compute resources are typically:
 - A single computer with multiple processors/cores
 - An arbitrary number of such computers connected by a network

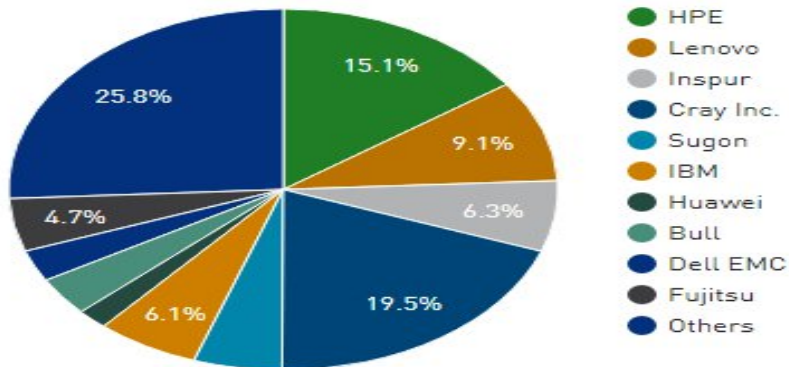
This figure is showing the majority of the world's large parallel computers (supercomputers) are clusters of hardware produced by a handful of (mostly) well known vendors.

Vendors System Share



Vendors	Count	System Share (%)
HPE	122	24.4
Lenovo	81	16.2
Inspur	56	11.2
Cray Inc.	53	10.6
Sugon	51	10.2
IBM	19	3.8
Huawei	19	3.8
Bull	17	3.4
Dell EMC	16	3.2
Fujitsu	12	2.4
Penguin Computing	10	2
NUDT	4	0.8
PEZY Computing / Exascaler Inc.	4	0.8
NEC	4	0.8
Atipa	3	0.6
Lenovo/IBM	3	0.6
Nvidia	2	0.4
Dell EMC / IBM-GBS	2	0.4
T-Platforms	2	0.4
IBM/Lenovo	2	0.4
Self-made	1	0.2
T-Platforms, Intel, Dell	1	0.2
ClusterVision	1	0.2
Supermicro	1	0.2
ExaScaler	1	0.2
E4 Computer Engineering S.p.A.	1	0.2
RSC Group	1	0.2

Vendors Performance Share



Distributed Computing

Distributed Computing

- Set of tightly coupled programs executing on one or more computers which are interconnected through a network and coordinating their actions. These programs know about one another and carry out tasks that none could carry out in isolation
- **Characteristics of distributed system**
- Autonomous components
- Mostly build using heterogeneous technology
- System components may be used exclusively
- Concurrent processes can execute
- Scalability- possibility of adding new hosts
- openness- easily extended and modified
- Heterogeneity-supports various H/W S/w platforms
- Resource sharing- H/w, S/W and data
- fault tolerance- ability to function correctly even if faults occur

Distributed Computing

- Distributed computing is also a computing system that consists of multiple computers or processor machines connected through a network, which can be homogeneous or heterogeneous, but run as a single system.
- The connectivity can be such that the CPUs in a distributed system can be physically close together and connected by a local network, or they can be geographically distant and connected by a wide area network.
- The heterogeneity in a distributed system supports any number of possible configurations in the processor machines, such as mainframes, PCs, workstations, and minicomputers.

- The goal of distributed computing is to make such a network work as a single computer.
- Distributed computing systems are advantageous over centralized systems, because there is a support for the following characteristic features:
 1. Scalability: It is the ability of the system to be easily expanded by adding more machines as needed, and vice versa, without affecting the existing setup.
 2. Redundancy or replication: Here, several machines can provide the same services, so that even if one is unavailable (or failed), work does not stop because other similar computing supports will be available.

Distributed Computing

- the following are the different application of the distributed system.
- Global positioning System
- World Wide Web
- Air Traffic Control System
- Automated Banking System
- In the World Wide Web application the data or application were distributed on the several number of the heterogeneous computer system, but for the end user or the browser it seems to be a single system from which user got the information.
- The multiple number of computer working concurrently and perform the resource sharing in the World Wide Web.

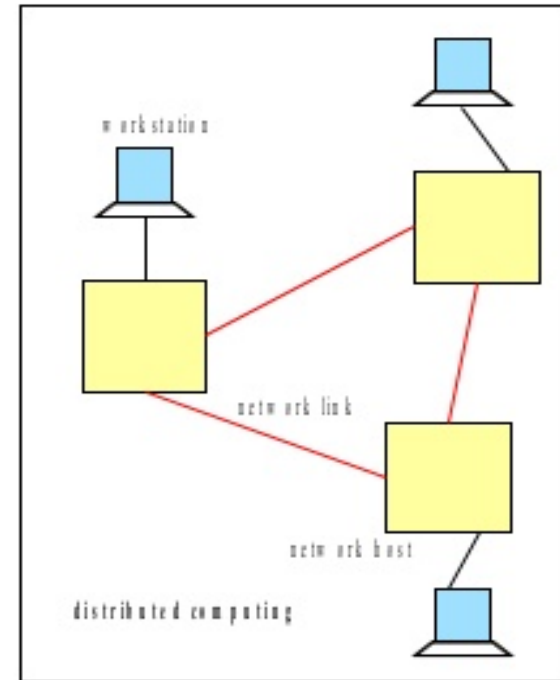
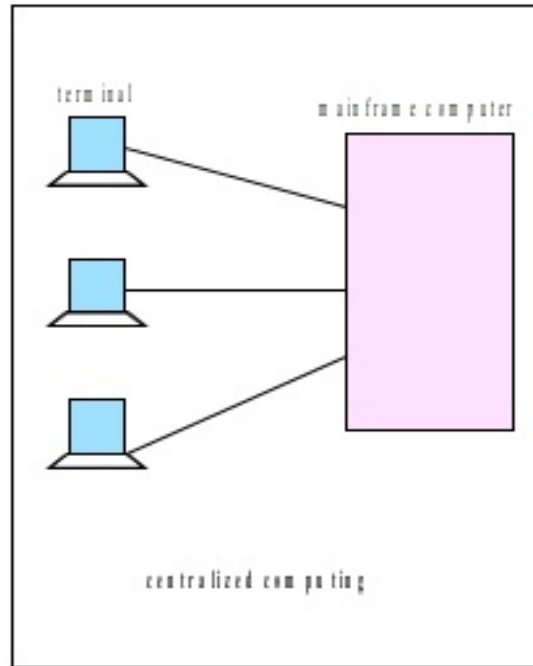
Centralized Computing

- A system with centralized multiprocessor parallel architecture. In the late 1980 s Centralized systems have been progressively replaced by distributed systems.

Characteristics of centralized system

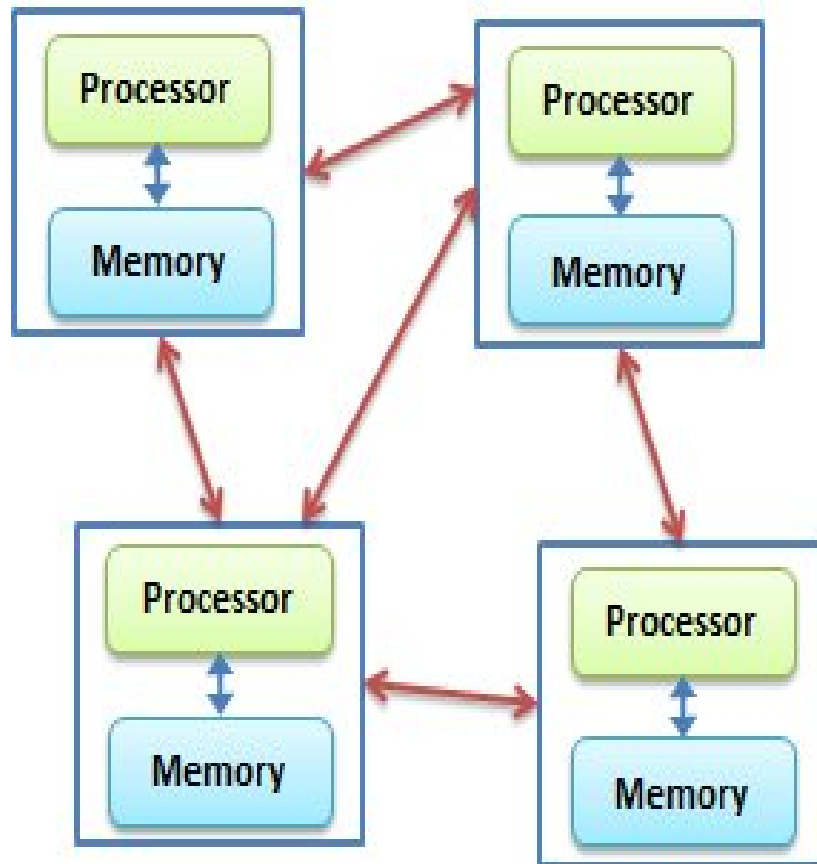
- Non autonomous components
- usually homogeneous technology
- Multiple users share the same resources at all time
- single point of control
- single point of failure

CENTRALIZED VS. DISTRIBUTED COMPUTING

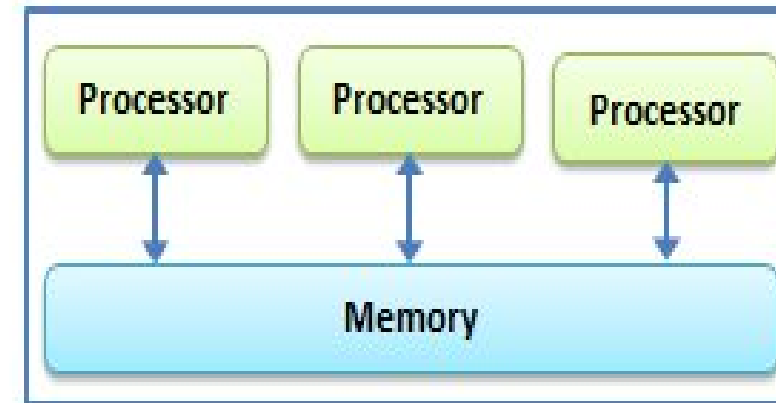


Distributed Computing vs Parallel Computing

Distributed Computing



Parallel Computing



Cluster Computing

- A cluster computing system consists of a set of the same or similar type of processor machines connected using a dedicated network infrastructure.
- All processor machines share resources such as a common home directory and have a software such as a message passing interface (MPI) implementation installed to allow programs to be run across all nodes simultaneously.
- This is also a kind of HPC category.
- The individual computers in a cluster can be referred to as *nodes*.

- The reason to realize a cluster as HPC is due to the fact that the individual nodes can work together to solve a problem larger than any computer can easily solve.
- And, the nodes need to communicate with one another in order to work cooperatively and meaningfully together to solve the problem in hand.
- If we have processor machines of heterogeneous types in a cluster, this kind of clusters become a subtype and still mostly are in the experimental or research stage.

- A computer cluster help to solve complex operations more efficiently with much faster processing speed, better data integrity than a single computer and they only used for mission-critical applications.
- The Clustering methods have identified as- HPC IAAS, HPC PAAS, that are more expensive and difficult to setup and maintain than a single computer.
- A computer cluster defined as the addition of processes for delivering large-scale processing to reduce downtime and larger storage capacity as compared to other desktop workstation or computer.

- Some of the critical Applications of Cluster Computers are Google Search Engine, Petroleum Reservoir Simulation, Earthquake Simulation, Weather Forecasting.

- **Cluster Can be classified into two category**

Open and Close Cluster

- **Open Cluster:** All nodes in Open Cluster are needed IPs, and that are accessible through internet/web, that cause more security concern.

Close Cluster: On the other hand Close Cluster are hide behind the gateway node and provide better security.

Types of Cluster computing

1. **Load-balancing clusters:** As the name implies, This system is used to distribute workload across multiple computers. That system distributes the processing load as possible across a cluster of computers.

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2. **High availability (HA) clusters:** A high availability clusters (HA cluster) are the bunch of computers that can reliably utilise for

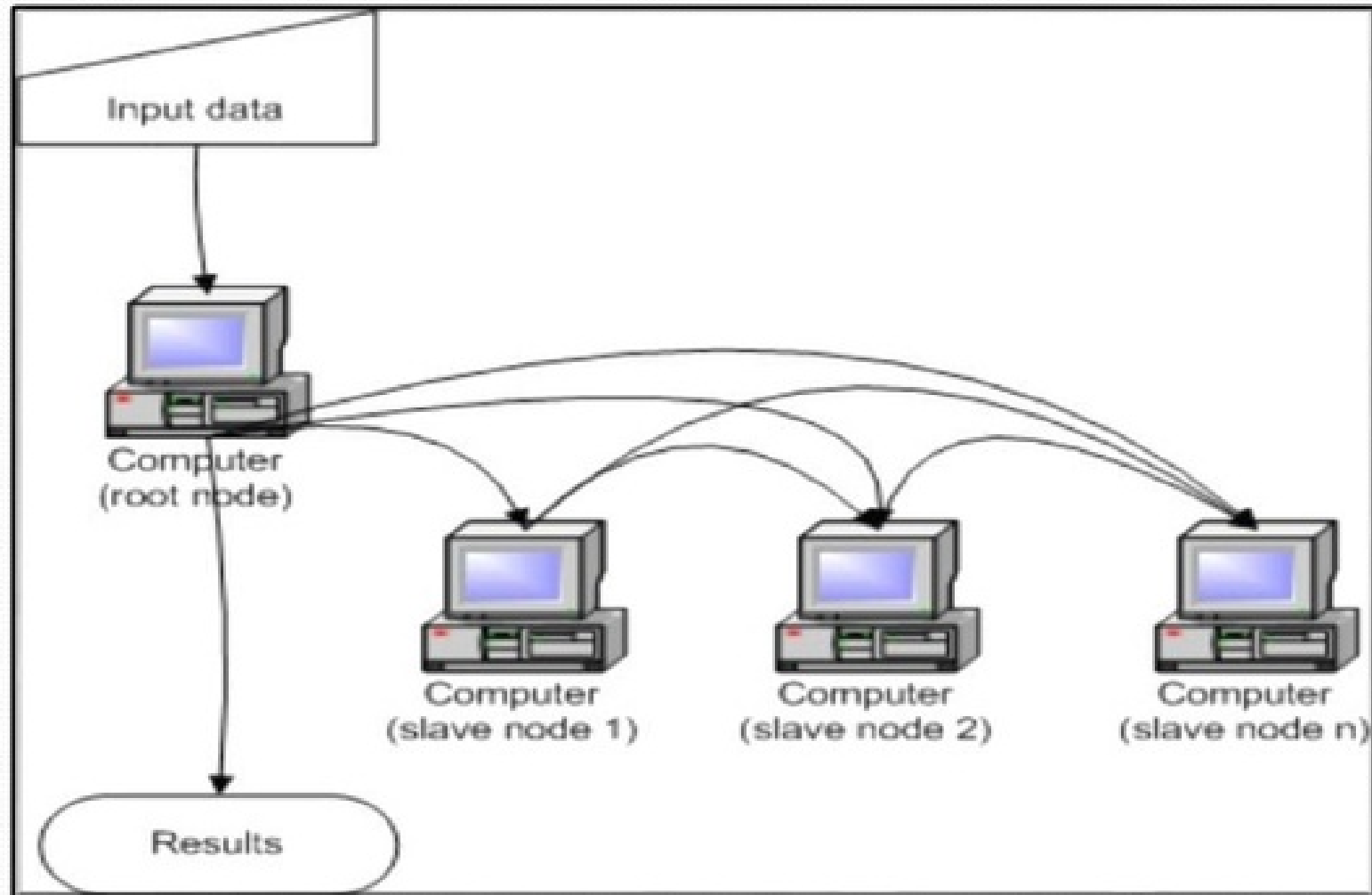
redundant operations in the event of nodes failure in Cluster computing.

3. **High performance (HP) clusters:** This computer networking methodology use supercomputers and Cluster computing to solve advanced computation problems.

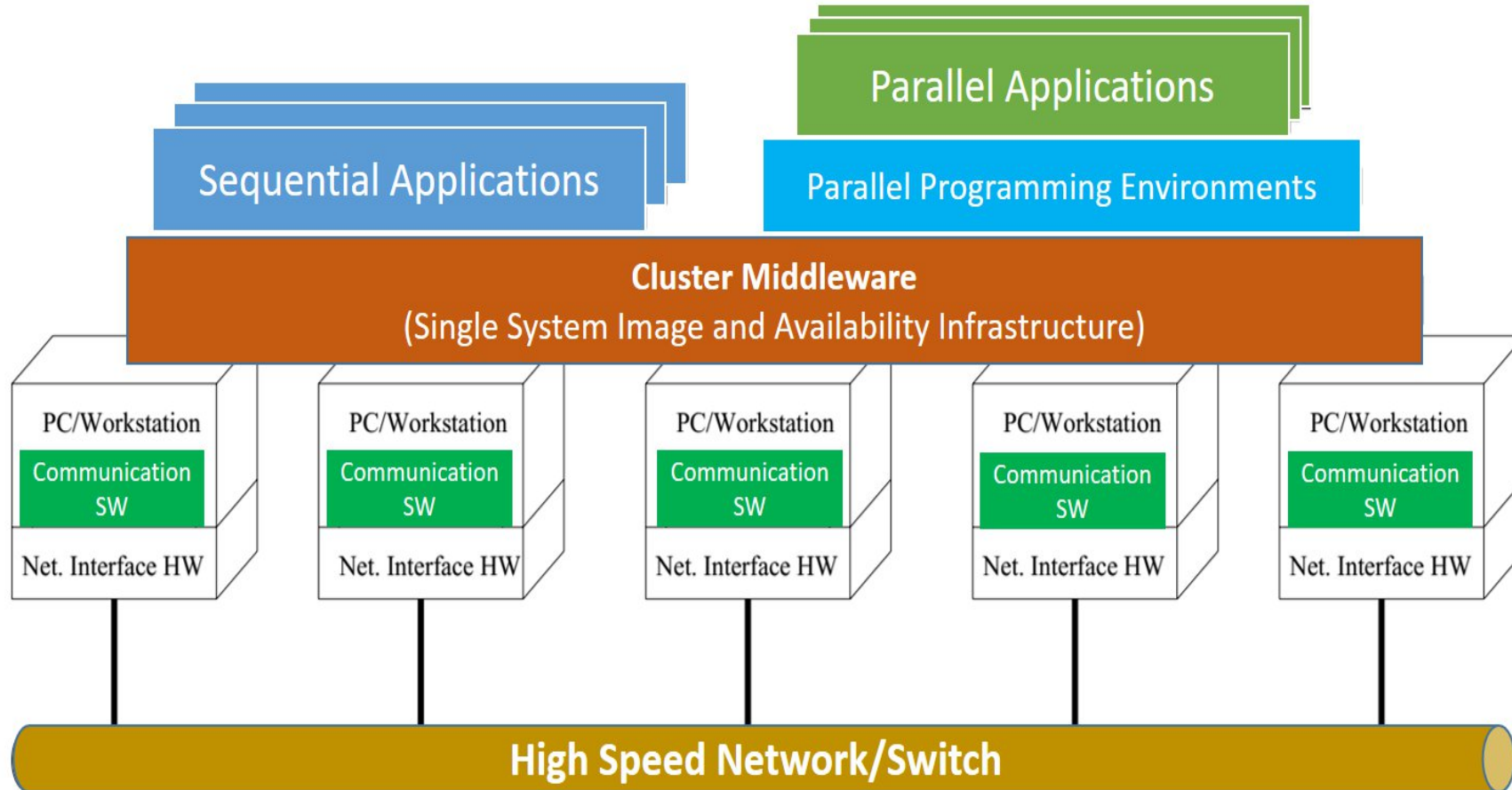
Advantages of using Cluster computing

- 1. **Cost efficiency:** In a Cluster computing Cost efficiency is the ratio of cost to output, that is the connecting group of the computer as computer cluster much cheaper as compared to mainframe computers.
-
- 2. **Processing speed:** The Processing speed of computer cluster is the same as a mainframe computer.
-
- 3. **Expandability:** The best benefit of Cluster Computing is that it can be expanded easily by adding the additional desktop workstation to the system.
-
- 4. **High availability of resources:** If any node fails in a computer cluster, another node within the cluster continue to provide uninterrupted processing. When a mainframe system fails, the entire system fails.

A SIMPLE CLUSTER LAY OUT



Cluster Computing Architecture



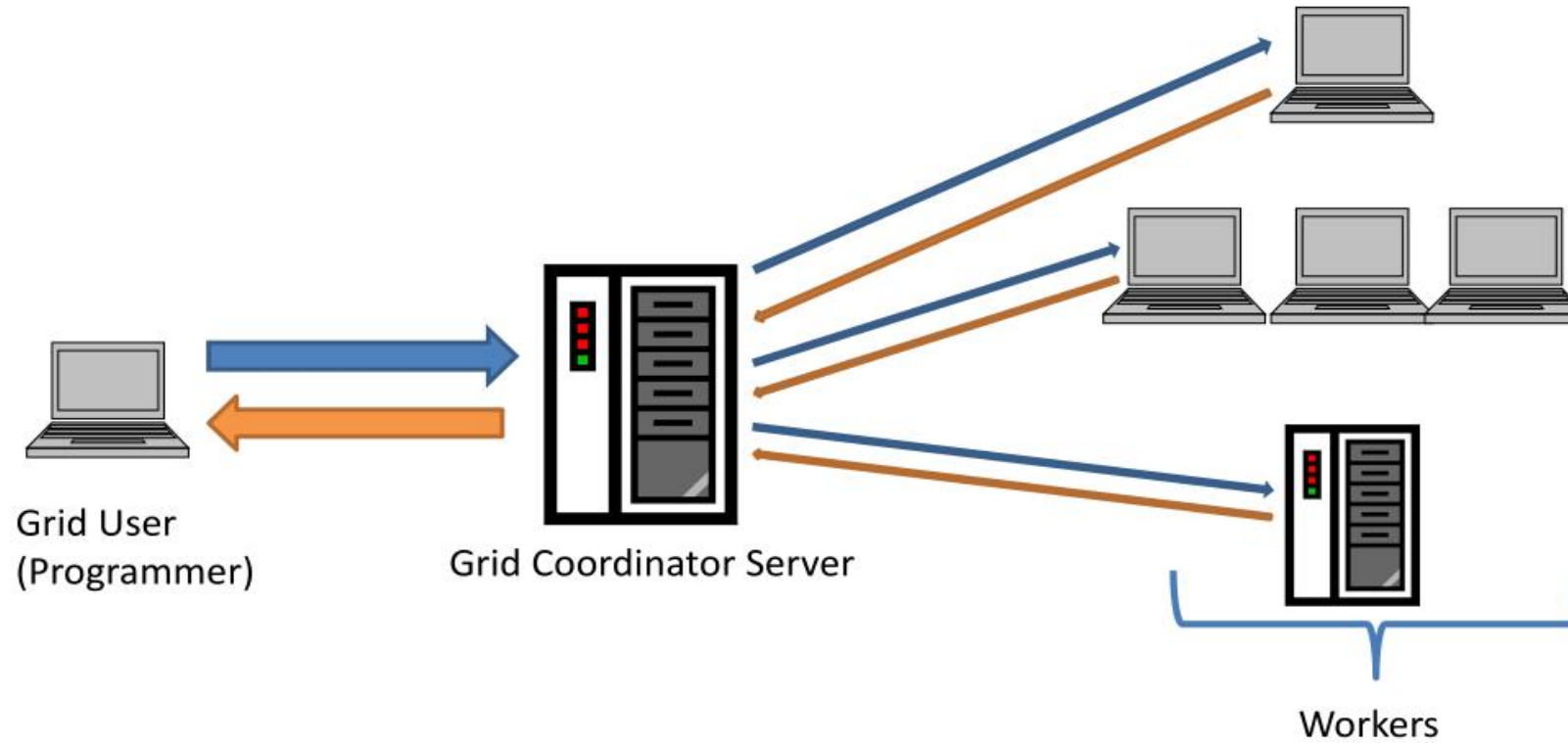
Computer Cluster Architecture

Grid Computing

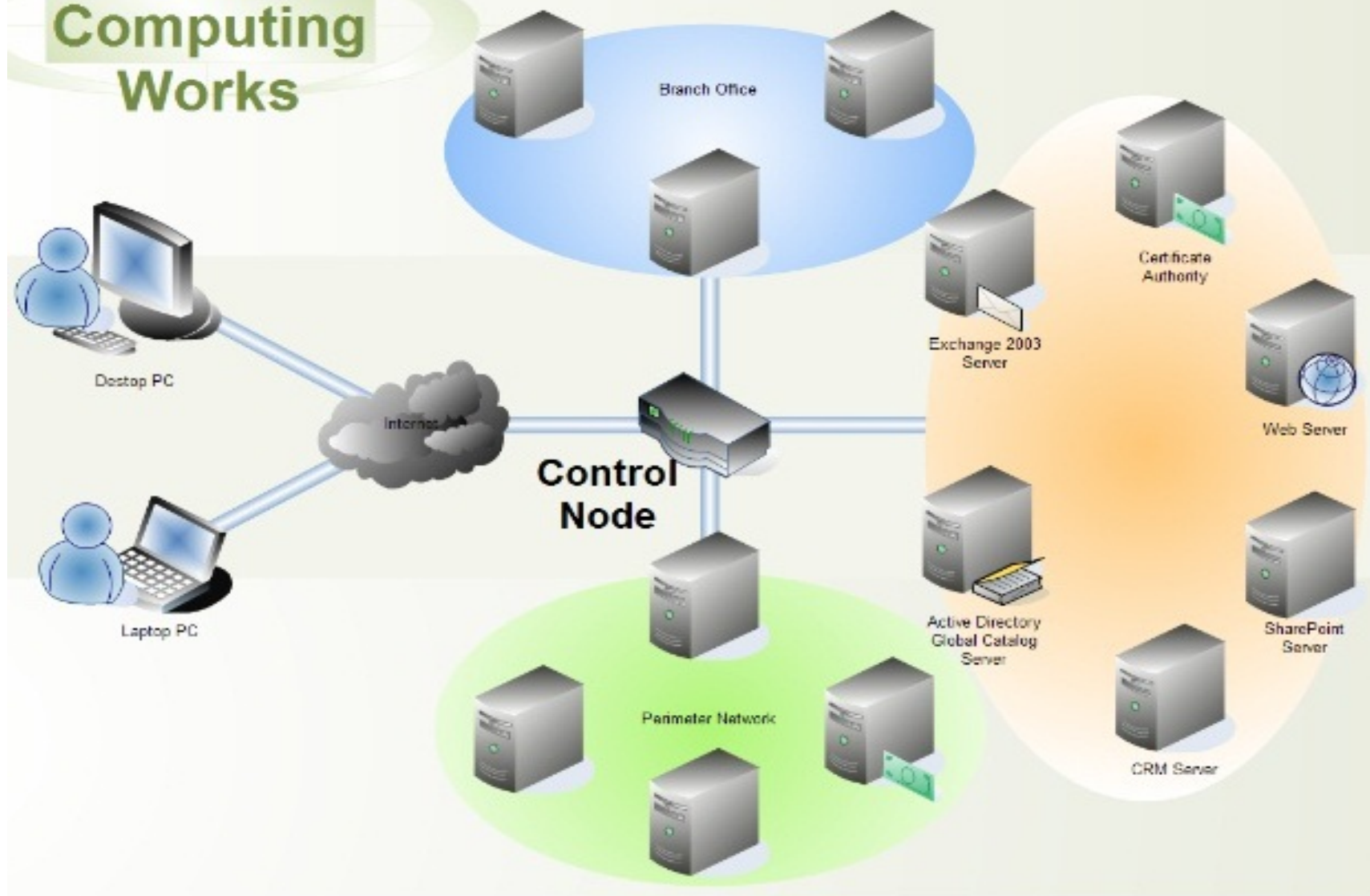
- The computing resources in most of the organizations are underutilized but are necessary for certain operations.
- The idea of grid computing is to make use of such non utilized computing power by the needy organizations, and thereby the return on investment (ROI) on computing investments can be increased.
- Thus, grid computing is a network of computing or processor machines managed with a kind of software such as middleware, in order to access and use the resources remotely.
- The managing activity of grid resources through the middleware is called grid services.

- Grid services provide access control, security, access to data including digital libraries and databases, and access to large-scale interactive and long-term storage facilities.
- Grid computing is more popular due to the following reasons:
 - ~ Its ability to make use of unused computing power, and thus, it is a cost-effective solution (reducing investments, only recurring costs)
 - ~ As a way to solve problems in line with any HPC-based application
 - ~ Enables heterogeneous resources of computers to work cooperatively and collaboratively to solve a scientific problem
- Researchers associate the term grid to the way electricity is distributed in municipal areas for the common man.

Grid Computer Architecture



How Grid Computing Works



Electrical Power Grid and Grid Computing

Electrical Power Grid

Never worry about where the electricity that we are using comes from; that is, whether it is from coal in Australia, from wind power in the United States, or from a nuclear plant in France, one can simply plug the electrical appliance into the wall-mounted socket and it will get the electrical power that we need to operate the appliance.

The infrastructure that makes this possible is called *the power grid*. It links together many different kinds of power plants with our home, through transmission stations, power stations, transformers, power lines, and so forth.

The power grid is *pervasive*: electricity is available essentially everywhere, and one can simply access it through a standard wall-mounted socket.

The power grid is a *utility*: we ask for electricity and we get it. We also pay for what we get.

Grid Computing

Never worry about where the computer power that we are using comes from; that is, whether it is from a supercomputer in Germany, a computer farm in India, or a laptop in New Zealand, one can simply plug in the computer and the Internet and it will get the application execution done.

The infrastructure that makes this possible is called *the computing grid*. It links together computing resources, such as PCs, workstations, servers, and storage elements, and provides the mechanism needed to access them via the Internet.

The grid is also *pervasive* in the sense that the remote computing resources would be accessible from different platforms, including laptops and mobile phones, and one can simply access the grid computing power through the web browser.

The grid computing is also a *utility*: we ask for computing power or storage capacity and we get it. We also pay for what we get.

Grid Computing: Applications

Life Science Application

- Computational biology, bioinformatics, genomics, computational neuroscience
- e.g. the Protein Data Bank, the myGrid Project, the Biomedical Information Research Network (BIRN), MCell].

Engineering-oriented Application

- NASA operation its research through grid

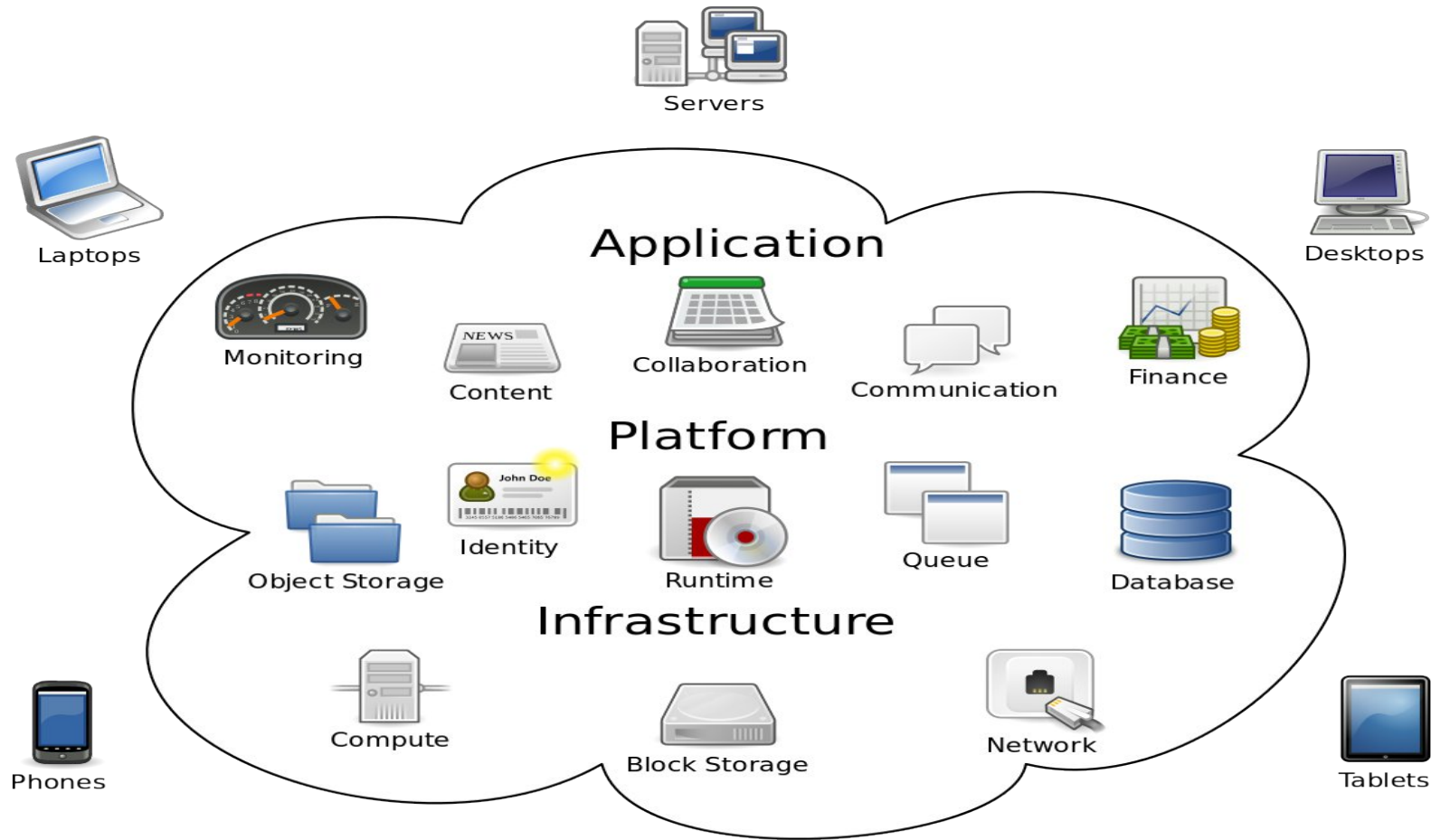
Data-oriented Application

- Data is emerging as the 'killer application' of the Grid.
- e.g. Distributed Aircraft Maintenance Environment (DAME).

Cloud Computing

- The computing trend moved towards cloud from the concept of grid computing, particularly when large computing resources are required to solve a single problem, using the ideas of computing power as a utility and other allied concepts.
- However, the potential difference between grid and cloud is that grid computing supports leveraging several computers in parallel to solve a particular application, while cloud computing supports leveraging multiple resources, including computing resources, to deliver a unified service to the end user.

- In cloud computing, the IT and business resources, such as servers, storage, network, applications, and processes, can be dynamically provisioned to the user needs and workload.
- In addition, while a cloud can provision and support a grid, a cloud can also support non-grid environments, such as a three-tier web architecture running on traditional or Web 2.0 applications.



Cloud computing

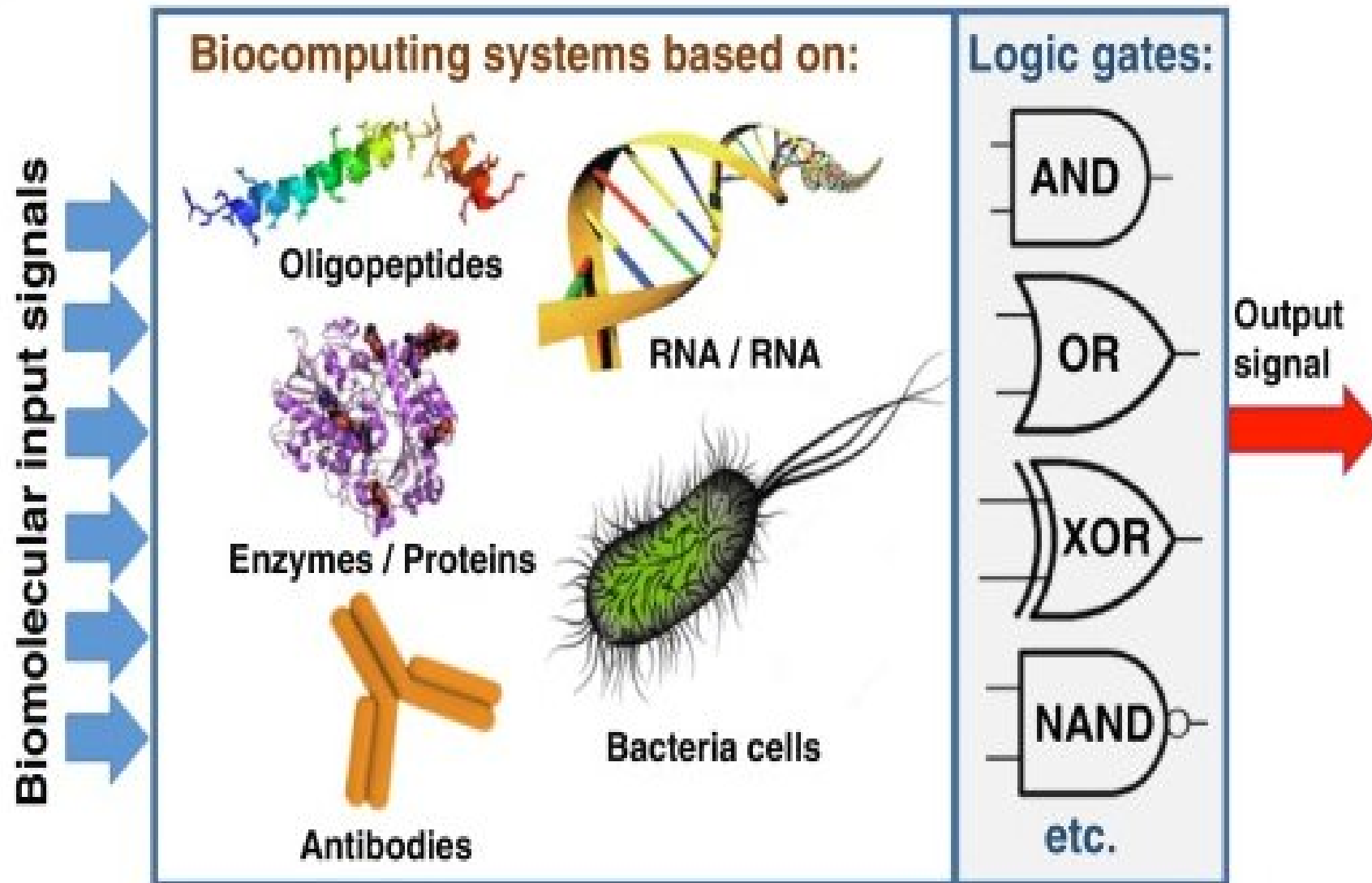


Grid Computing VS Cloud Computing

Criteria	Grid Computing	Cloud Computing
User Management	Decentralised management	Centralised management
Dependency	Other computer picks up the work whenever the computer stops	Totally dependent on internet
Operation	Operates within a corporate network	Can also operate through the internet
Accessibility	Through Grid middleware	Through standard Web protocols
Domains	Multiple Domains	Single Domain
Scalability	Normal	High
Architecture	Distributed computing architecture	Client-server architecture
Virtualization	Data and computing resources	Hardware and software platforms
Computation	Maximum computing	On-demand
Application Type	Batch	Interactive

Biocomputing

- Biocomputing systems use the concepts of biologically derived or simulated molecules (or models) that perform computational processes in order to solve a problem.
- The biologically derived models aid in structuring the computer programs that become part of the application.
- Biocomputing provides the theoretical background and practical tools for scientists to explore proteins and DNA.
- DNA and proteins are nature's building blocks, but these building blocks are not exactly used as bricks.



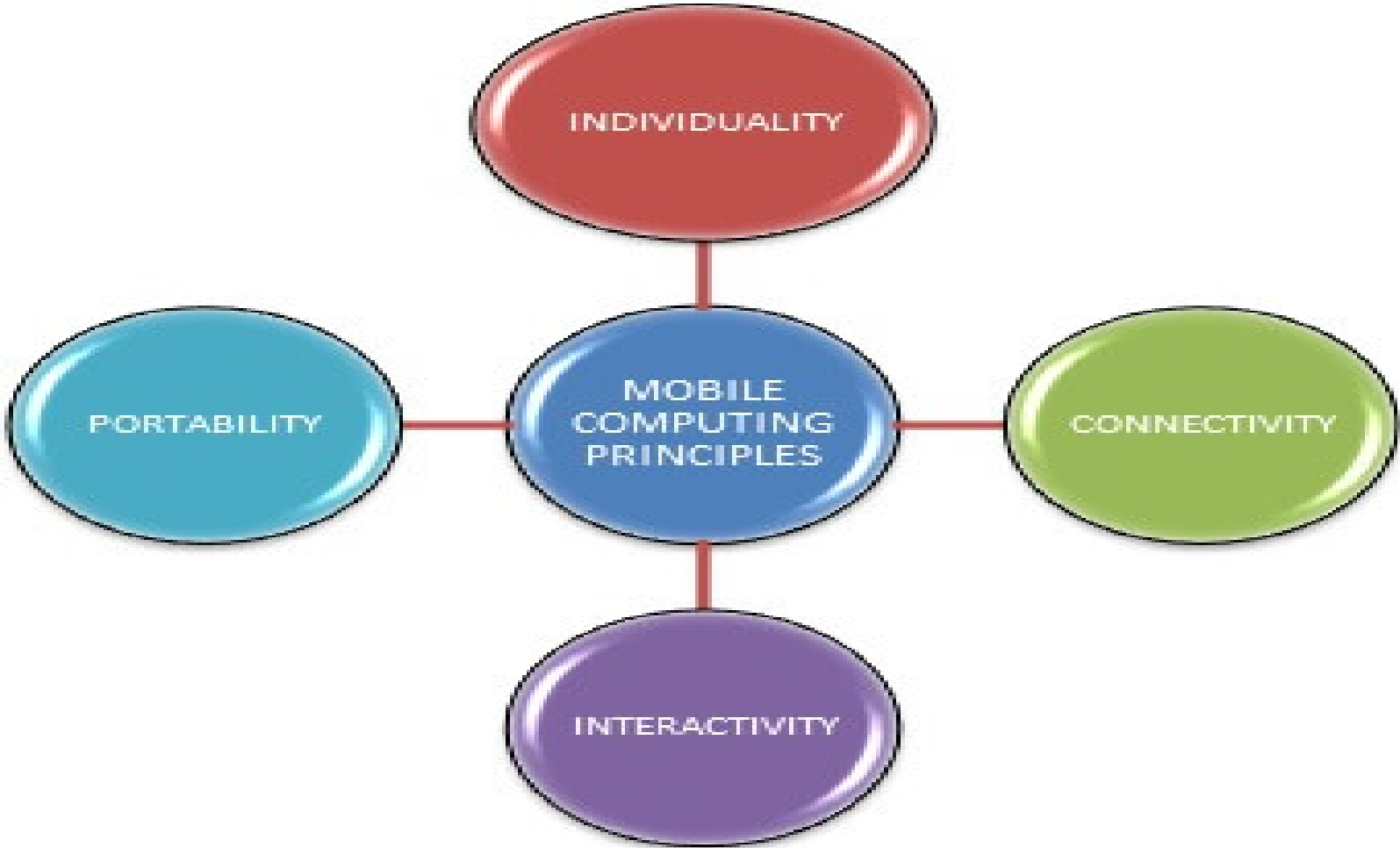
Mobile Computing

- In mobile computing, the processing (or computing) elements are small (i.e., handheld devices) and the communication between various resources is taking place using wireless media.
- Mobile communication for voice applications (e.g., cellular phone) is widely established throughout the world and witnesses a very rapid growth in all its dimensions including the increase in the number of subscribers of various cellular networks.
- An extension of this technology is the ability to send and receive data across various cellular networks using small devices such as smart phones.

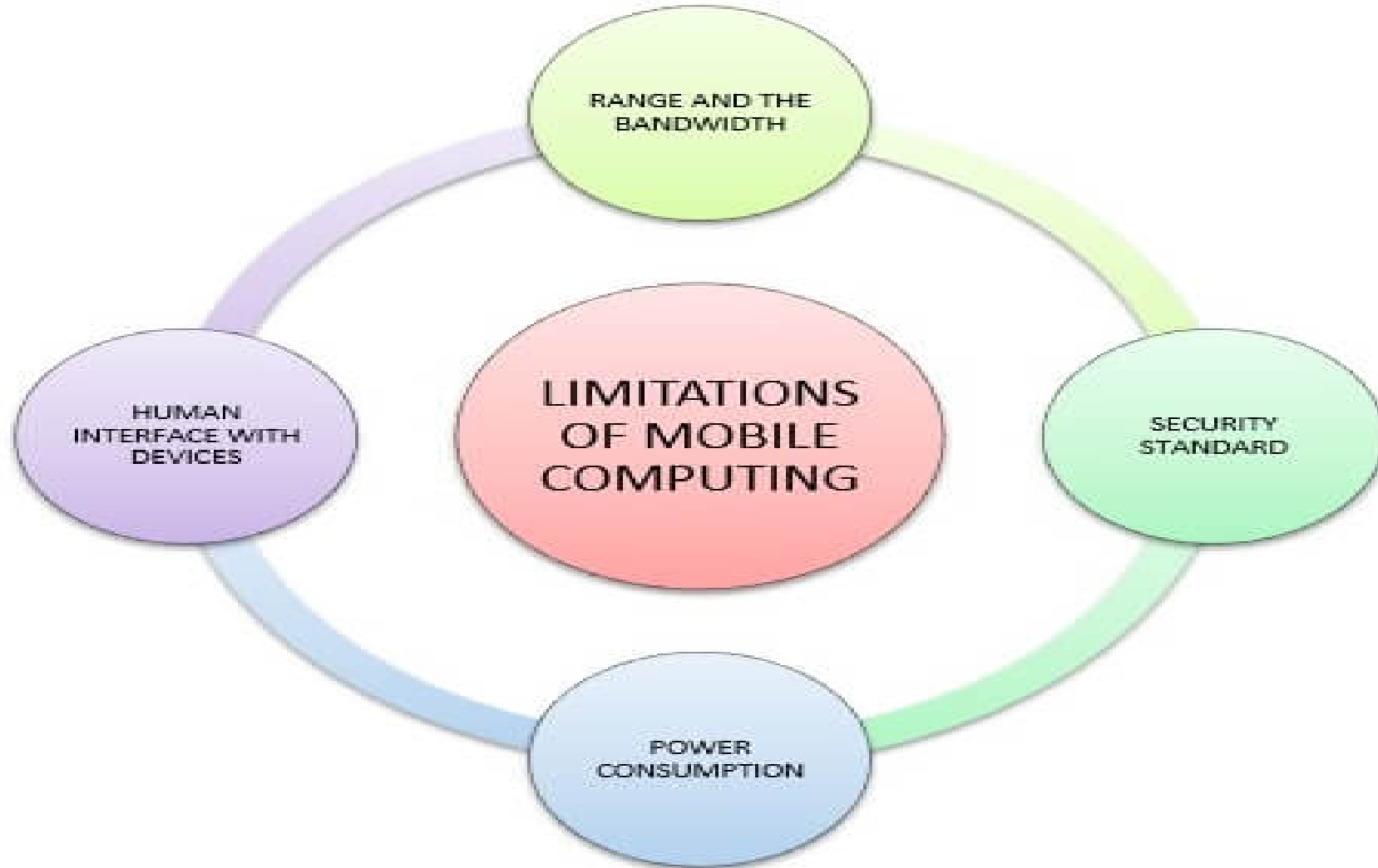
MOBILE

			
Smart Watch	GPS System	LapTops	Gaming Console
			
Tablets	Phablets	PDA	Robots
			
E-Readers	Notebook	Smart Phone	Portable Media Player
			
Smart Glass	VR-Headset	AR-Headset	SemiSelfDriving Car

PRINCIPLES OF MOBILE COMPUTING



LIMITATIONS OF MOBILE COMPUTING



Quantum Computing

- Quantum computing is the area of study focused on developing computer technology based on the principles of quantum theory, which explains the nature and behavior of energy and matter on the quantum (atomic and subatomic) level.
- Quantum computing is an as-of-yet theoretical computing model that uses a very different form of data handling to perform calculations.
- The emergence of quantum computing is based on a new kind of data unit that could be called non-binary, as it has more than two possible values.
- Manufacturers of computing systems say that there is a limit for cramming more and more transistors into smaller and smaller spaces of integrated circuits (ICs) and thereby doubling the processing power about every 18 months.

Quantum Computing

- Classical

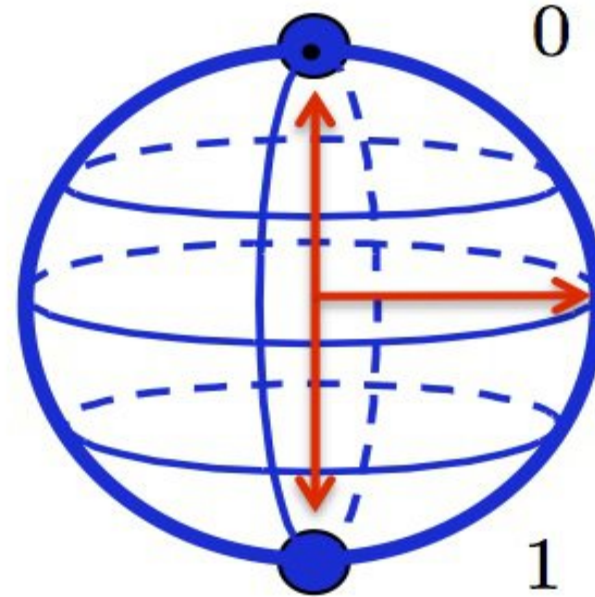


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Classical Bit



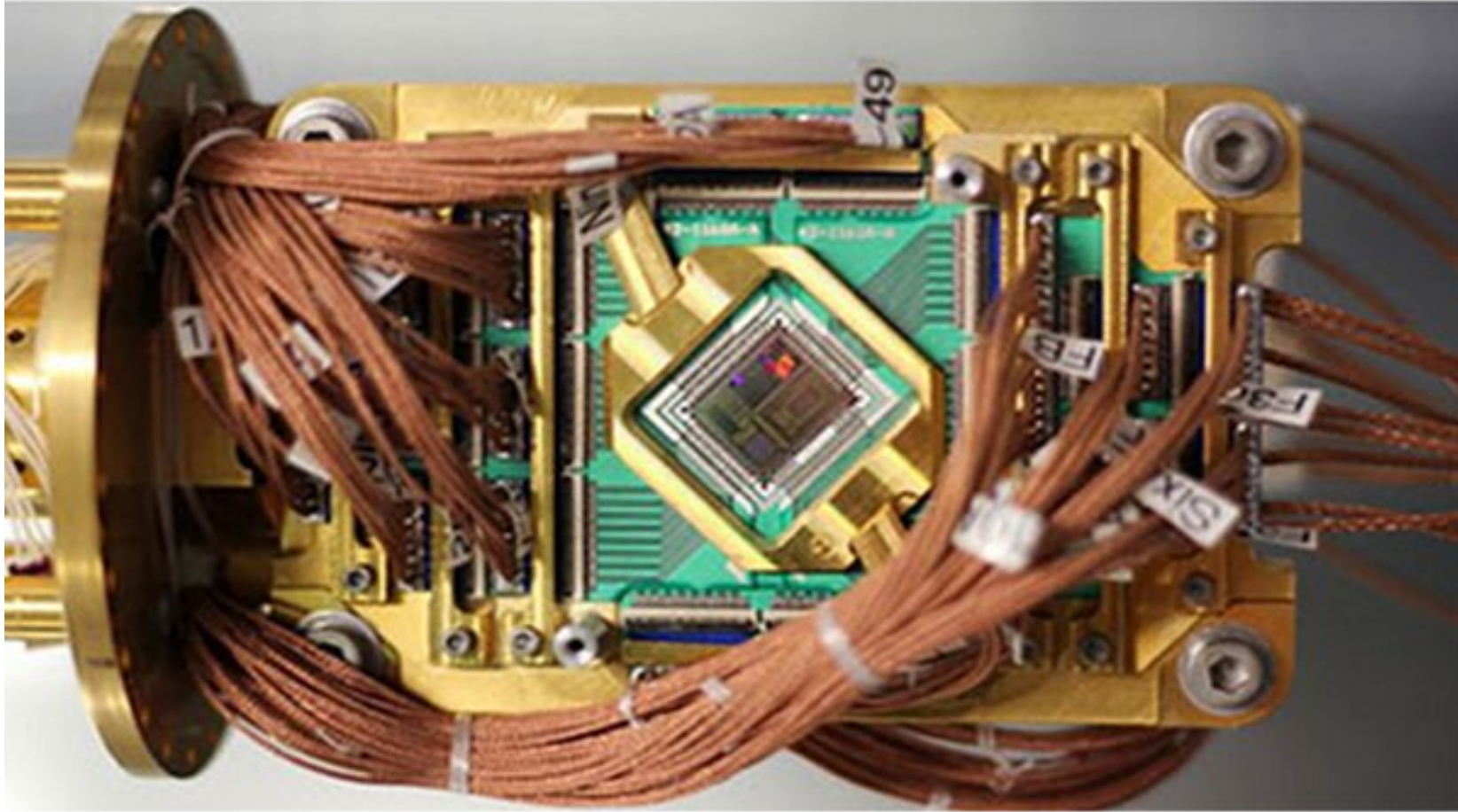
Qubit

Applications

Some of the applications of Quantum Computing:

Machine Learning, Computational Chemistry, Financial Portfolio Optimization, Logistics and Scheduling, Drug Design, Cyber Security, Code breaking, (Circuit, Software, and System Fault Simulation).

Quantum Computing



IBM Simulates a 56-Qubit Machine

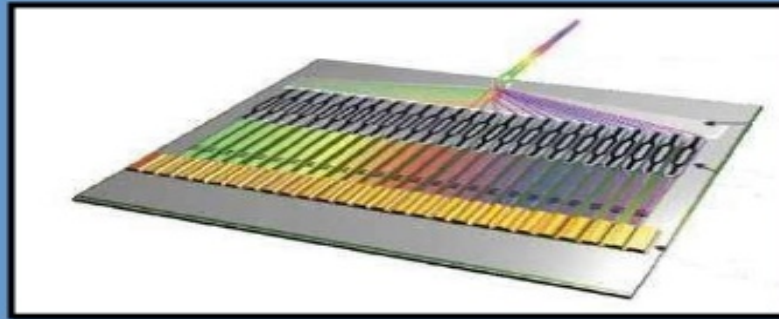


Optical Computing

- Optical computing system uses the photons in visible light or infrared beams, rather than electric current, to perform digital computations.
- An electric current flows at only about 10% of the speed of light.
- This limits the rate at which data can be exchanged over long distances and is one of the factors that led to the evolution of optical fiber.
- By applying some of the advantages of visible and/or IR networks at the device and component scale, a computer can be developed that can perform operations 10 or more times faster than a conventional electronic computer.

OPTICAL COMPUTER

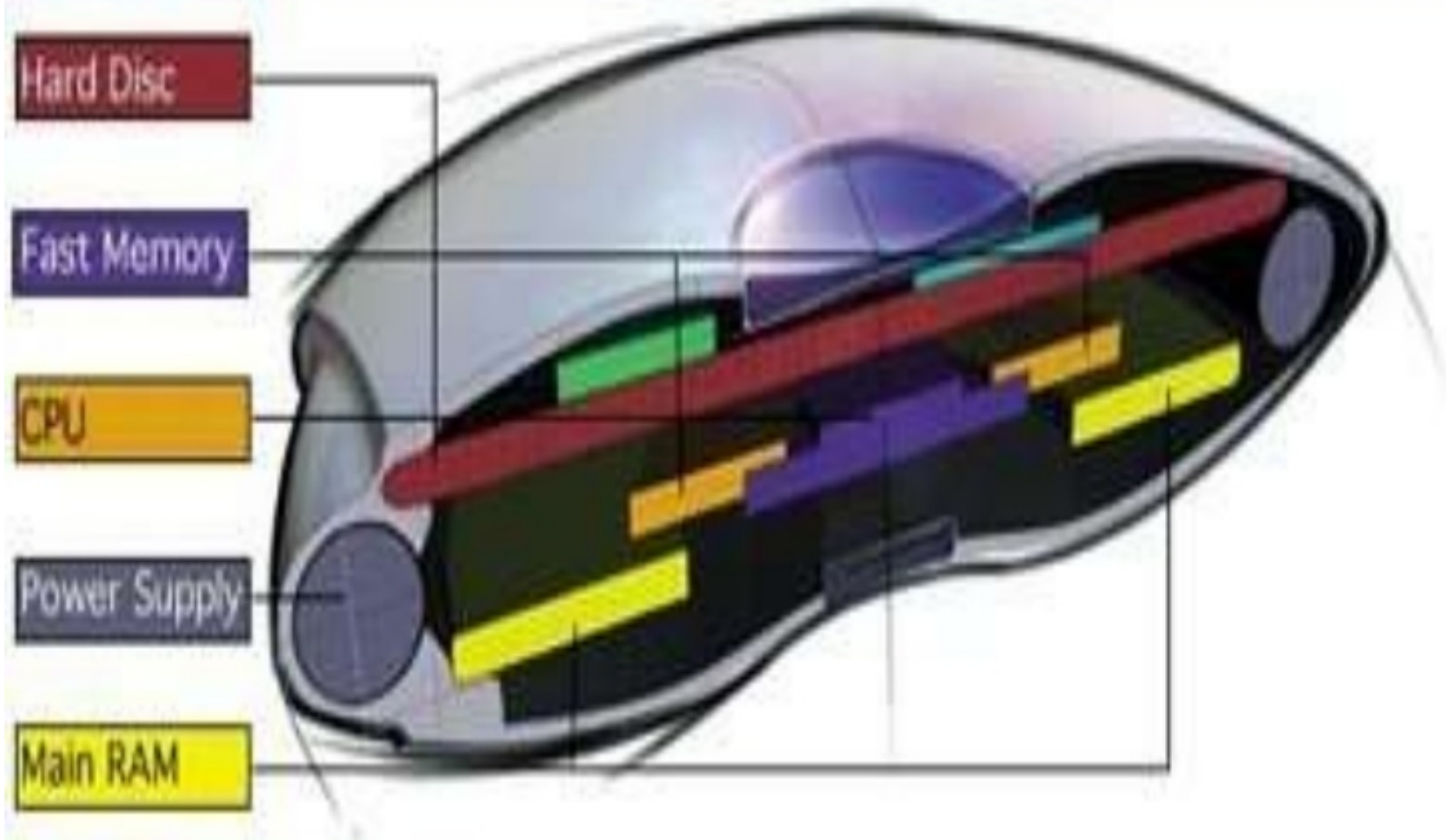
- Optical computing describes a new technological approach for constructing computer's processors and other components.
- An Optical Computer is a hypothetical device that uses visible light or infrared beams, rather than electric current, to perform digital computations.



Why Do We Need Optical Computers ?

- ❖ *Rapid growth of the Internet*
- ❖ *Network speeds currently limited by electronic circuits*
- ❖ *Terabit speeds are required*
- ❖ *Traditional silicon circuits have a physical limit*

OPTICAL COMPUTER



Application of Optical Computing

Optical Computing In Communication

- ❖ *Wavelength division multiplexing*
- ❖ *Optical Amplifiers*
- ❖ *Storage area network*
- ❖ *Fiber Channel Topologies*

Basic topologies:

F C-AL (Fiber Channel Arbitration Loop):

Cost effective, low performance solution

Switched:

Better performance, more expensive

Hybrid topologies:

Uses loops and switches as building blocks

Any interconnection network scheme can be realized

ADVANTAGES

- ✓ small size
- ✓ high density
- ✓ high speed
- ✓ low heating of junctions
- ✓ dynamically reconfigurable and scalable into larger or smaller topologies and network
- ✓ massively parallel computing capability
- ✓ applications in artificial intelligence applications

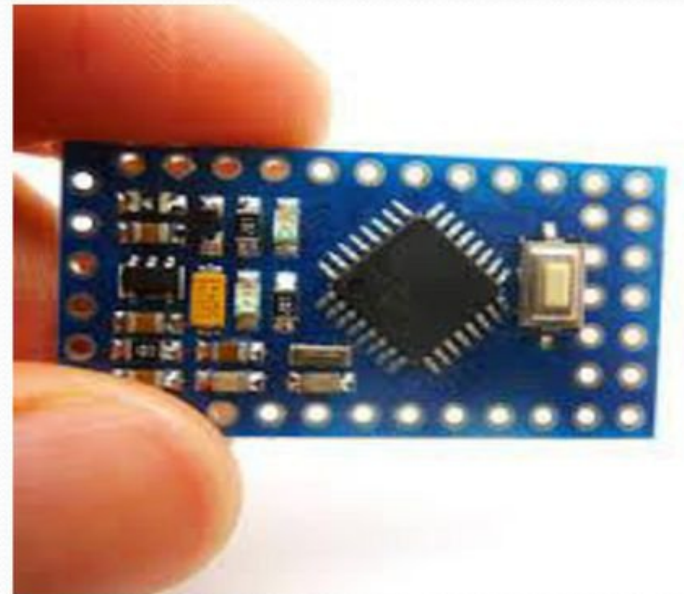
DRAWBACKS

Optical Computing using a coherent source is simple to compute and understand, but it has many drawbacks like any imperfections or dust on the Optical Components will create unwanted interference pattern due to scattering effects.

Nano computing

What is Nano computing

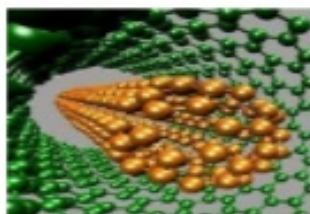
- Nano computing describes Those components that uses Extremely small or nano scale devices .
- ❑ Nano computers comes from Two sources:
 - ✓ It will be integrated into Existing products and technology(disk , driver).
 - ✓ Fundamentally new products , software, and architecture will be develop.



- Nano computing refers to computing systems that are constructed from nanoscale components.
- The silicon transistors in traditional computers may be replaced by transistors based on carbon nanotubes.
- The successful realization of nanocomputers relates to the scale and integration of these nanotubes or components.
- The issues of scale relate to the dimensions of the components; they are, at most, a few nanometers in at least two dimensions.
- The issues of integration of the components are twofold: first, the manufacture of complex arbitrary patterns may be economically infeasible, and second, nanocomputers may include massive quantities of devices.

TYPES OF NANOCOMPUTING

- ❖ Electronic nanocomputer.
- ❖ Chemical & bio-chemical nanocomputers.
- ❖ Mechanical nanocomputer.
- ❖ Quantum nanocomputer.



How nano computing works?

- Nano computer would work by storing data in the form of atomic quantum states or spin. (SEM and quantum dots)
- There are several methods of nano electronic data storage currently being researched. Among the most promising are set electron transistors and quantum dots.
- All of these devices function based upon the principles of quantum mechanics...



APPLICATION OF NANOTECHNOLOGIES

- Washing machine that that inhibits bacterial growth it washes the clothes
- It is on the market today and 60% of cars these fuel lines
- They make a refrigerator
- Contact lens that let you check your mind blood sugar level by looking at a mirror

Devices of nano computing



ipad, iPhone, HP Slate, Android devices like ICD Gemini etc

Introduction to Cloud Computing

- Modern computing with our laptop or desktop or even with tablets/smartphones using the Internet to access the data and details that we want, which are located/stored at remote places/computers, through the faces of applications like Facebook, e-mail, and YouTube, brings the actual power of information that we need instantaneously within no time.
- Even if millions of users get connected in this manner, from anywhere in the world, these applications do serve what these users—customers want.
- This phenomenon of supply of information or any other data and details to all the needy customers, as and when it is asked, is the conceptual understanding and working of what is known as cloud computing.

- **CLOUD:** The word ‘Cloud’ means a cluster of servers, network, software, interface etc., which are required for the user to execute a particular task.
- **COMPUTING:** It refers to the deliver of this cluster as a service to the user so that user can use it as and when required.
- **CLOUD COMPUTING:** It is the practice of using a network of remote servers hosted on the Internet to store, manage and process data, rather than a local server or a personal computer.

Motivation for Cloud Computing

- Let us review the scenario of computing prior to the announcement and availability of cloud computing:
- The users who are in need of computing are expected to invest money on computing resources such as hardware, software, networking, and storage;
- This investment naturally costs a bulk currency to the users as they have to buy these computing resources, keep these in their premises, and maintain and make it operational—all these tasks would add cost.
- And, this is a particularly true and huge expenditure to the enterprises that require enormous computing power and resources.

Motivation for Cloud Computing

- On the other hand, it is easy and handy to get the required computing power and resources from some provider (or supplier) as and when it is needed and pay only for that usage.
- This would cost only a reasonable investment or spending, compared to the huge investment when buying the entire computing infrastructure.
- This phenomenon can be viewed as capital expenditure versus operational expenditure.
- As one can easily assess the huge lump sum required for capital expenditure (whole investment and maintenance for computing infrastructure) and compare it with the moderate or smaller lump sum required for the hiring or getting the computing infrastructure only to the tune of required time, and rest of the time free from that.

Motivation for Cloud Computing

- Therefore, cloud computing is a mechanism of bringing–hiring or getting the services of the computing power or infrastructure to an organizational or individual level to the extent required and paying only for the consumed services.
- One can compare this situation with the usage of electricity (its services) from its producer-cum-distributor (in India, it is the state-/government-owned electricity boards that give electricity supply to all residences and organizations) to houses or organizations; here, we do not generate electricity (comparable with electricity production–related tasks); rather, we use it only to tune up our requirements in our premises, such as for our lighting and usage of other electrical appliances, and pay as per the electricity meter reading value.

Motivation for Cloud Computing

- Therefore, cloud computing is needed in getting the services of computing resources.
- Thus, one can say as a one-line answer to the need for cloud computing that it eliminates a large computing investment without compromising the use of computing at the user level at an operational cost.
- Cloud computing is very economical and saves a lot of money.
- A blind benefit of this computing is that even if we lose our laptop or due to some crisis our personal computer—and the desktop system—gets damaged, still our data and files will stay safe and secured as these are not in our local machine (but remotely located at the provider's place—machine).

Motivation for Cloud Computing

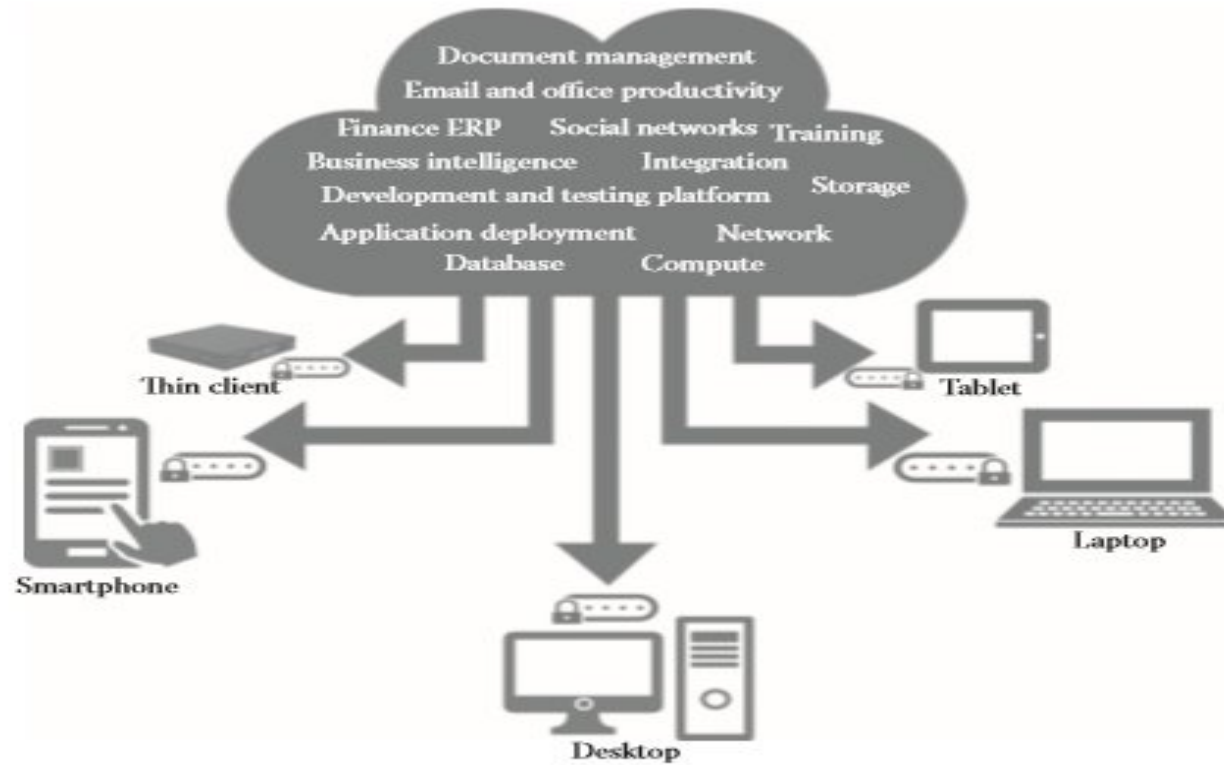


FIGURE 2.1
Cloud computing.

Motivation for Cloud Computing

- It is a computing solution growing in popularity, especially among individuals and small- and medium-sized companies (SMEs).
- In the cloud computing model, an organization's core computer power resides offsite and is essentially subscribed to rather than owned.
- Thus, cloud computing comes into focus and much needed only when we think about what computing resources and information technology (IT) solutions are required.
- This need caters to a way to increase capacity or add capabilities on the fly without investing in new infrastructure, training new personnel, or licensing new software.
- Cloud computing encompasses the subscription based or pay-per-use service model of offering computing to end users or customers over the Internet.

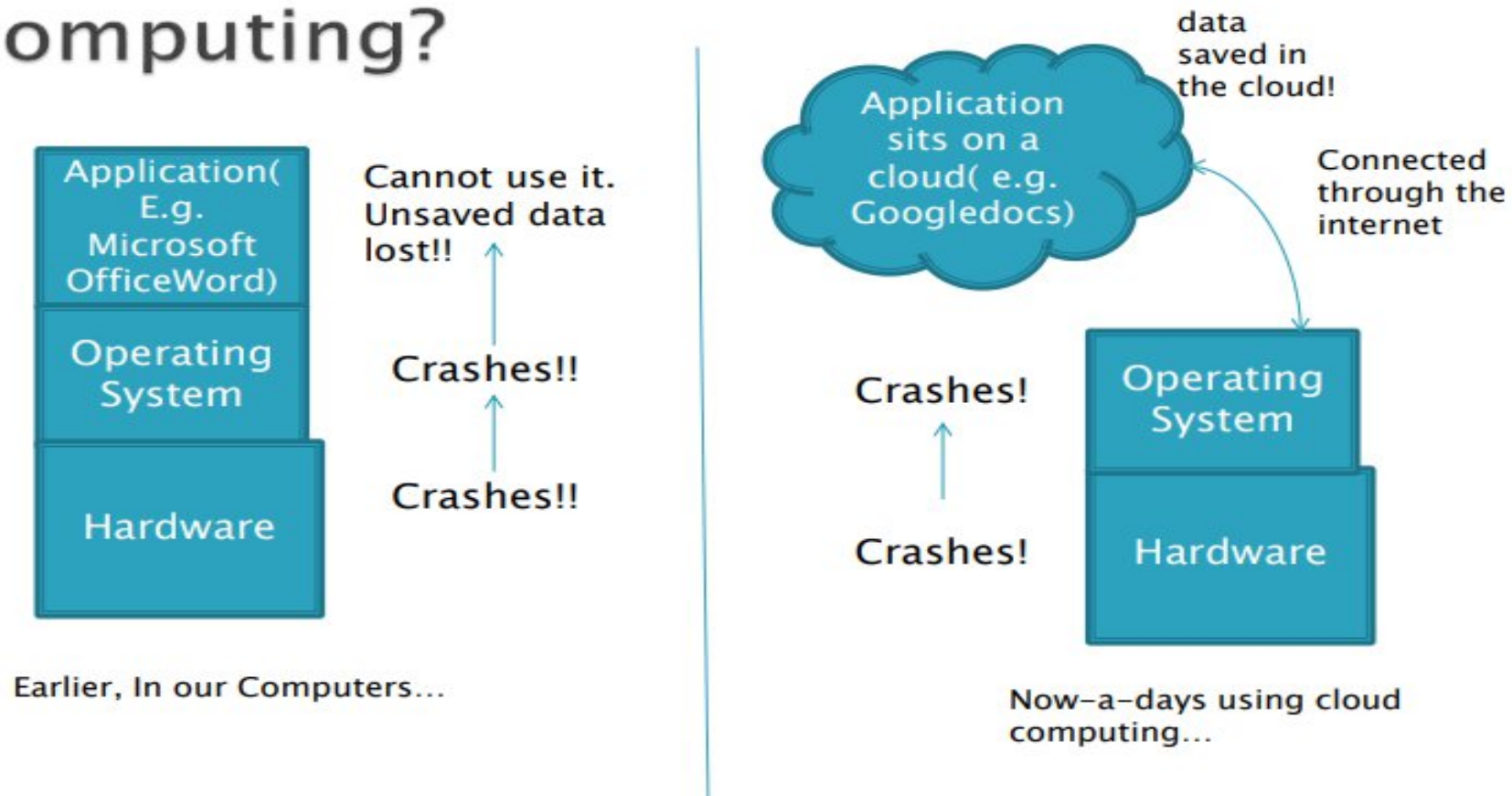
The Need for Cloud Computing

- The main reasons for the need and use of cloud computing are convenience and reliability.
- In the past, if we wanted to bring a file, we would have to save it to a Universal Serial Bus (USB) flash drive, external hard drive, or compact disc (CD) and bring that device to a different place.
- Instead, saving a file to the cloud (e.g., use of cloud application Drop box) ensures that we will be able to access it with any computer that has an Internet connection.
- The cloud also makes it much easier to share a file with friends, making it possible to collaborate over the web.

- While using the cloud, losing our data/file is much less likely.
- However, just like anything online, there is always a risk that someone may try to gain access to our personal data, and therefore, it is important to choose an access control with a strong password and pay attention to any privacy settings for the cloud service that we are using.

The Need for Cloud Computing

Why do we require cloud computing?



Defining Cloud Computing

- In the simplest terms, cloud computing means storing and accessing data and programs over the Internet from a remote location or computer instead of our computer's hard drive.
- This so called remote location has several properties such as scalability, elasticity etc., which is significantly different from a simple remote machine.
- The cloud is just a metaphor for the Internet.
- When we store data on or run a program from the local computer's hard drive, that is called local storage and computing.
- For it to be considered cloud computing, we need to access our data or programs over the Internet.
- The end result is the same; however, with an online connection, cloud computing can be done anywhere, anytime, and by any device.

Defining Cloud Computing

Customer Oriented Definition:

- Any time
- Any where
- with Any device(like mobile, laptop,tablet,...)
- Accessing Any Service(Iaas, Paas, Saas)

Business Oriented Definition

- Universal Access
- Scalable Services
- New Application Service Models(Xaas, Pay-as-you-go basis)

NIST Definition of Cloud Computing

The formal definition of cloud computing comes from the National Institute of Standards and Technology (NIST):

- “Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.”
- It means that the computing resource or infrastructure—be it server hardware, storage, network, or application software—all available from the cloud vendor or provider’s site/premises, can be accessible over the Internet from any remote location and by any local computing device.

NIST Definition of Cloud Computing

- In addition, the usage or accessibility is to cost only to the level of usage to the customers based on their needs and demands, also known as the pay-as-you-go or pay-as-per-use model.
- If the need is more, more quantum computing resources are made available (provisioning with elasticity) by the provider.
- Minimal management effort implies that at the customer's side, the maintenance of computing systems is very minimal as they will have to look at these tasks only for their local computing devices used for accessing cloud-based resources, not for those computing resources managed at the provider's side.
- This cloud model is composed of five essential characteristics, three service models, and four deployment models.

Cloud Computing is a Service

- The simplest thing that any computer does is allow us to store and retrieve information.
- We can store our family photographs, our favorite songs, or even save movies on it, which is also the most basic service offered by cloud computing.
- Let us look at the example of a popular application called Flickr to illustrate the meaning of this section.
- While Flickr started with an emphasis on sharing photos and images, it has emerged as a great place to store those images.

Cloud Computing is a Service

- In many ways, it is superior to storing the images on your computer:
 1. First, Flickr allows us to easily access our images no matter where we are or what type of device we are using. While we might upload the photos of our vacation from our home computer, later, we can easily access them from our laptop at the office.
 2. Second, Flickr lets us share the images. There is no need to burn them to a CD or save them on a flash drive. We can just send someone our Flickr address to share these photos or images.
 3. Third, Flickr provides data security. By uploading the images to Flickr, we are providing ourselves with data security by creating a backup on the web. And, while it is always best to keep a local copy—either on a computer, a CD, or a flash drive—the truth is that we are far more likely to lose the images that we store locally than Flickr is of losing our images.

Cloud Computing is a Service

Cloud Service Models:

- **Service Models** are the reference models on which the Cloud Computing is based. These can be categorized into three basic service models as listed below:

1. Infrastructure as a Service (IaaS)

2. Platform as a Service (PaaS)

3. Software as a Service (SaaS)



Cloud Computing is a Service

- **Infrastructure as a Service (IaaS)**
- IaaS refers to providing the complete access to the servers operating system. Typically, IaaS provides hardware, storage, servers and data center space or network components, it may also include software.
- IaaS gives users automated and scalable environments with extreme flexibility and control.
- Eg: EC2(Elastic Compute cloud)
- Usually billed based on usage
- Usually multi tenant virtualized environment
- Can be coupled with Managed Services for OS and application support

Cloud Computing is a Service

- **Platform as a Service (PaaS)**
- In PaaS, one does not get access to the whole operating system. Rather access is given at a Dashboard level, where a user uploads the data and the rest is taken care by the cloud provider.
- Eg: Elastic Beanstalk
- PaaS provides a framework for quickly developing and deploying applications by automating infrastructure provisioning and management.
- PaaS provides all of the facilities required to support the complete life cycle of building and delivering web applications and services entirely from the Internet.
- Multi tenant environments
- Highly scalable multi tier architecture

Cloud Computing is a Service

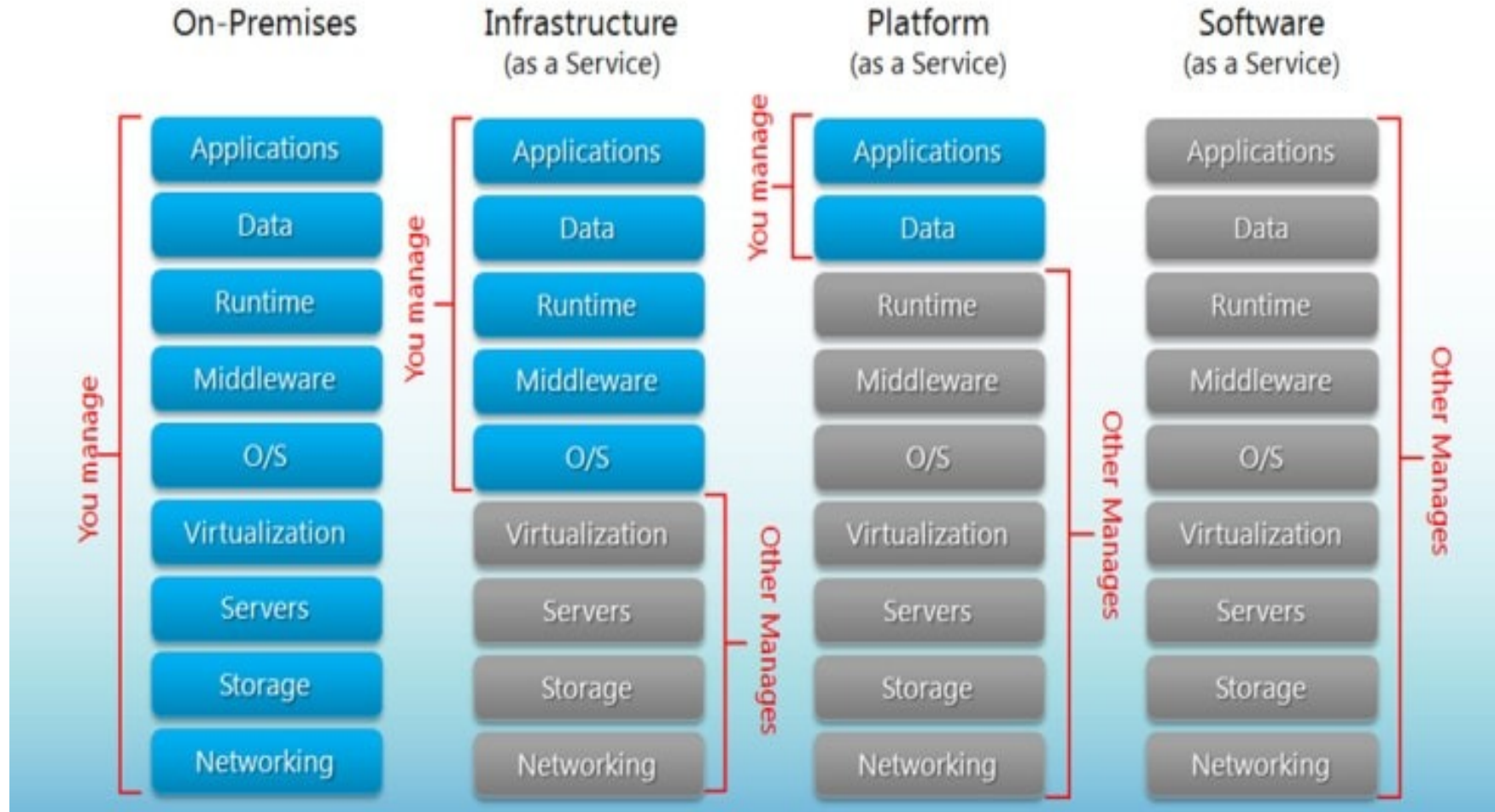
- **Software as a Service (SaaS)**
- SaaS refers to the practice of directly providing the software to the customer, without making any server or dashboard available to them.
- Eliminating the need to install and run programs on individual devices. SaaS makes applications available through the internet.
- Eg: Facebook, GoogleDocs, Netflix
- Usually billed based on usage
- Usually multi tenant environment
- Highly scalable architecture

Cloud Computing is a Service

- Examples of IaaS, PaaS, SaaS



Cloud Computing is a Service



Cloud Computing is a Service

Pizza as a Service



Cloud Computing Is a Platform

- The World Wide Web (WWW) can be considered as the operating system for all our Internet-based applications.
- However, one has to understand that we will always need a local operating system in our computer to access web based applications.
- The basic meaning of the term platform is that it is the support on which applications run or give results to the users.
- For example, Microsoft Windows is a platform. But, a platform does not have to be an operating system. Java is a platform even though it is not an operating system.

Cloud Computing Is a Platform

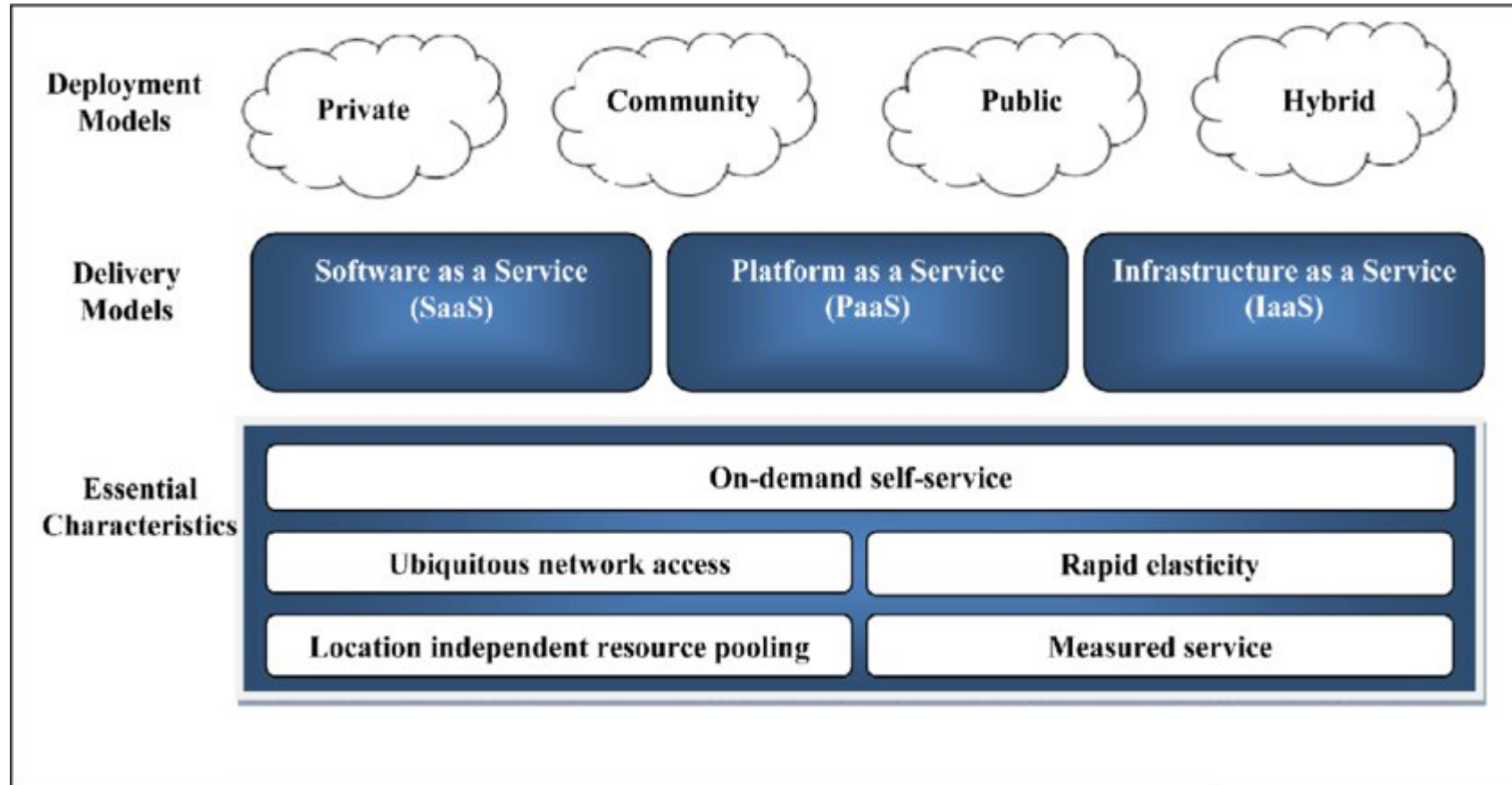
- Through cloud computing, the web is becoming a platform.
- With trends (applications) such as Office 2.0, more and more applications that were originally available on desktop computers are now being converted into web–cloud applications.
- Word processors like Buzzword and office suites like Google Docs are now available in the cloud as their desktop counterparts.
-
- All these kinds of trends in providing applications via the cloud are turning cloud computing into a platform or to act as a platform.

5-4-3 Principles of Cloud computing

The 5-4-3 principles put forth by NIST describe

- (a) the five essential characteristic features that promote cloud computing,
- (b) the four deployment models that are used to narrate the cloud computing opportunities for customers while looking at architectural models, and
- (c) the three important and basic service offering models of cloud computing.

5-4-3 Principles of Cloud computing



5-4-3 Principles of Cloud computing

Cloud computing has five essential characteristics which are shown in

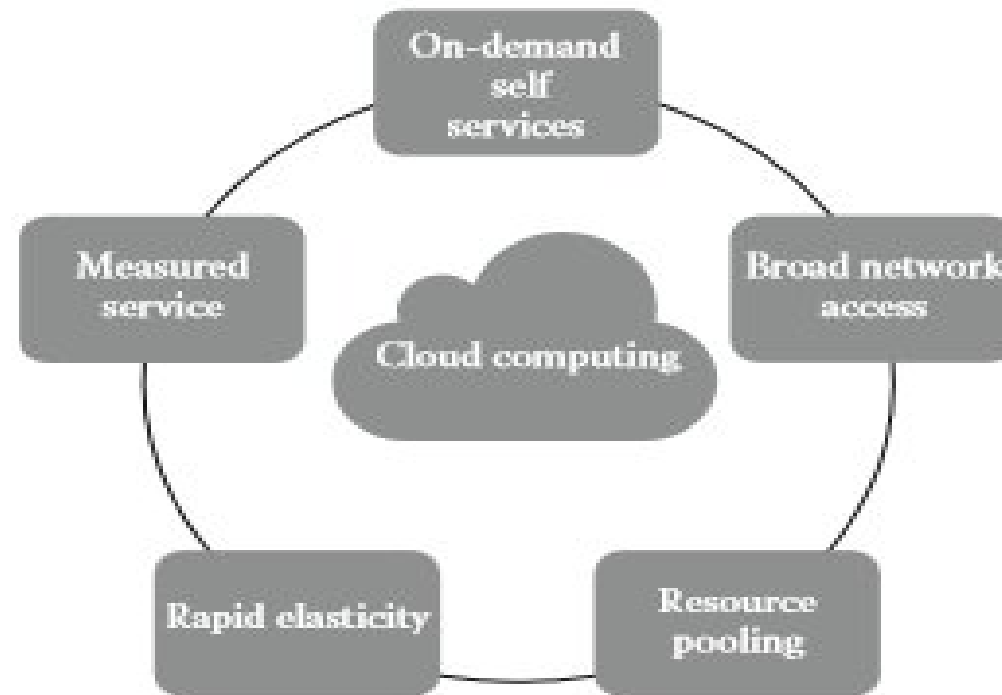


FIGURE 2.2
The essential characteristics of cloud computing.

5-4-3 Principles of Cloud computing

Essential, which means that if any of these characteristics is missing, then it is not cloud computing:

- 1. On-demand self-service:** A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service's provider.
- 2. Broad network access:** Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and personal digital assistants [PDAs]).

5-4-3 Principles of Cloud computing

3. Elastic resource pooling:

- The provider's computing resources are pooled to serve multiple consumers using a multitenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand.
- There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify the location at a higher level of abstraction (e.g., country, state, or data center).
- Examples of resources include storage, processing, memory, and network bandwidth.

5-4-3 Principles of Cloud computing

4. Rapid elasticity:

- Capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out and rapidly released to quickly scale in. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.

5. Measured service:

- Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts).
- Resource usage can be monitored, controlled, and reported providing transparency for both the provider and consumer of the utilized service.