The Campus of Tomorrow

Higher Colleges of Technology

كليات التقنية العليا

CIS 4403: Cloud Computing

Week 1: LO1 - Introduction to Cloud Computing

Thursday, November 17, 2022

Course Description

- The course discusses classic data centres and how they can be migrated to a cloud solution. Examine cloud infrastructure solutions and build virtualised servers, desktops, applications and services. Implement a private cloud using the specification of a particular organisation.

Learning Outcomes

- CLO1 Analyze classic data centers and virtualized data center solutions.
- CLO2 Implement a Virtual Data Center (VDC) using network, storage, desktop, application and compute resources.
- CLO3 Design cloud infrastructure solutions using network, storage, desktop, application and compute resources.
- CLO4 Design a cloud solution based on specific requirements using appropriate technologies.

Assessment Strategy

- Assessment for the Course:
  - Quiz1: 10%
    - Week 4 - Theory quiz on BBLearn (CLO: 1)
  - Quiz2: 10%
    - Week 8 - Theory quiz on BBLearn (CLO: 2)
  - Practical Exam: 25%
    - Week 11 - Practical Group Project assessed through group report and individual presentations (CLO: 2 & 3)
  - Practical Project: 25%
    - Week 15 - Practical Group Project assessed through group report and individual presentations (CLO: All)
  - FWA Final Exam: 30%
    - Week 16 - Individual Exam (CLO: All)

Recommended Reading

- Text books: Course is based on:
  - Bhowmik, Sandeep. (2019), 'Cloud Computing', 2nd ed., Cambridge University Press, ISBN: 9781108302654
- Course Notes
  - Copies of lecture slides and labs along with other relevant information will be available via BBLearn.
- Electronic resources
  - A large number of resources exist on the Internet. These include book chapters, academic papers, FAQs, online workshops, programs and other relevant material from academic institutes around the world. The LRC also have subscriptions to huge databases of online books and journals.

Delivery Outline

- **W1: CLO1 - Introduction to Cloud Computing**
- W2: CLO1 - Cloud Computing Models and Services
- W3-4: CLO2 - Resource Virtualization and Pooling
- W5: CLO2 - Scaling and Capacity Planning
- W6: CLO2 - Load Balancing
- W7: CLO2 - File System and Storage
- W8: CLO3 - Database Technology
- W9-10: CLO3 - Cloud Computing Security
- W11: CLO3 - Privacy and Compliance
- W12: CLO4 - Content Delivery Network
- W13: CLO4 - Portability and Interoperability
- W14: CLO4 - Cloud Management
- W15: CLO all - Hot Research Topics

Week 1
LO1 - Introduction to Cloud Computing

Objectives

- Upon completing this chapter the learner should be able to:
  - Understand the limitations of traditional computing. **(*Chapter 1 of Text Book*)**
  - Explore the evolution of Cloud Computing. **(*Chapter 2 of Text Book*)**
  - Understand the concepts of Cluster, Grid and Cloud Computing. **(*Chapter 2 of Text Book*)**
  - Explore the benefits and challenges of Cloud Computing. **(*Chapter 3 of Text Book*)**

Traditional Computing

- Traditional computing has played a pivotal role in the field of computing and communication over the past few decades.
- Computers and computing have become an integral part of our daily lives.
- Easy and cheap access to computing facilities has become essential for everyone.
- The Three Layers of Computing: Application, Platform, Infrastructure

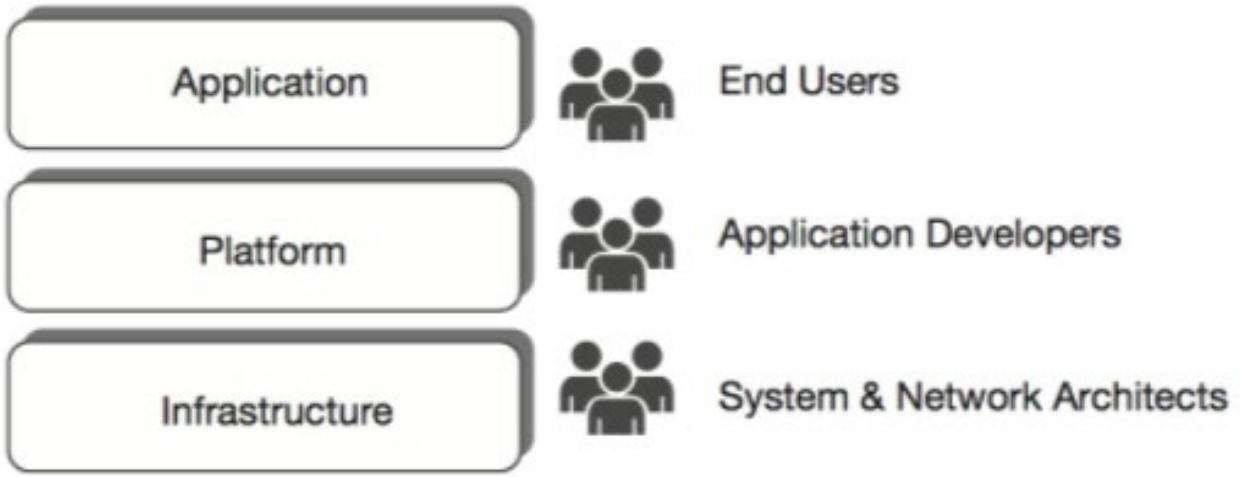

FIG 1.3: Different users/subscribers of three computing layers

Limitations of Traditional Computing

- Computing platform building activities involve installation of an operating system (OS), application runtimes or application development environments on computing infrastructure. These activities can cause difficulty for users (application developer or application user) and limit the development due but not limited to some of the following factors:
  - Expertise needed.
  - Infrastructure setting up cost and time.
  - Scalability limitations.
  - Protection and security burden.
  - Licensing costs.
  - Annual support costs.
  - Timebound installation of patches.
  - Maintenance.

Cloud Computing

- All kind of computing facilities can be delivered as services.
- The three main layers of computing, infrastructure, platform and application can be delivered to the consumers as ready-made stuff arranged and maintained by others, whenever they need it.
- The consumers are relieved from the burden of arranging all the stuff themselves.
- This new model of computing is known as **Cloud Computing**.

Computing as a Utility Service

- Three traditional computing components are delivered as services in the Cloud Computing model:
  - Infrastructure Service
  - Platform Service
  - Application or Software Service
- Users only require an Internet connection and any basic computing device (PC, laptop, tab etc.) where the software interface with cloud computing (usually a web browser) systems can run.

Enablers of Cloud Computing

- Universal Network Connectivity
- High-Performance Computing
- Commoditization
- Low Cost Solution
- Speed or Responsiveness
- Automation
- Less Maintenance Cost
- Mobility
- Flexibility

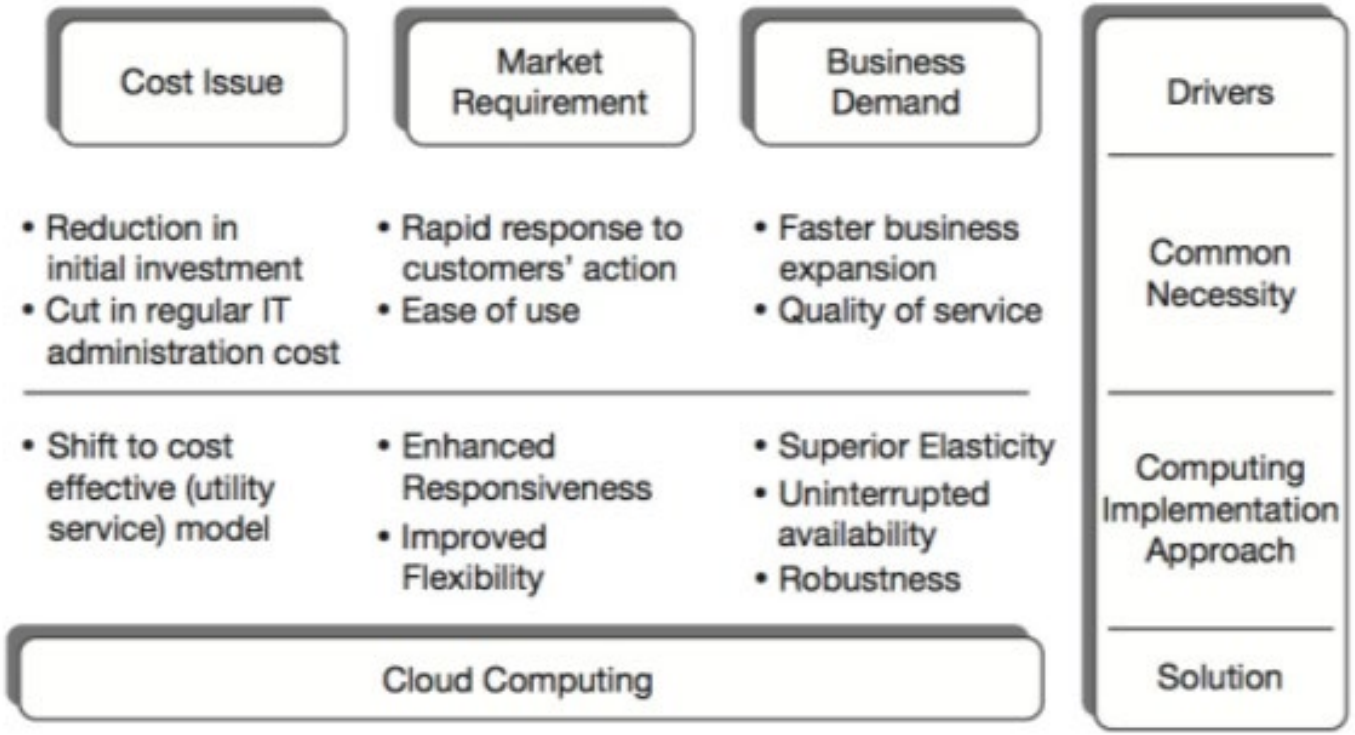

FIG 1.5: The way to opt for cloud computing

Evolution of Cloud Computing

- Cloud technology has been matured over the years with constant advancements in the field of computing.
- The beginning can be traced back to a time when remote access to time-shared computing system became a reality (the Mainframe Age).
- The realization of cloud computing has been closely linked with several other subsequent developments in the domain (parallel and distributed computing).
- As the hardware technology evolved, so did the software.
- The advancements in communication protocols, network communication technology as well as Internet also played a vital role in this process.

Mainframe, Distributed, Cluster and Grid Computing

- Mainframes: 1970s, large supercomputers (servers). Used based on a time-shared resource utilization concept. Organizations could access a single mainframe system from different offices or departments using computer "dump" terminals to fulfill computing requirements. Used to automate basic data processing tasks, like payroll management and others.
- Client-Server Computing: 1980s, used intelligent terminals (clients systems) to participate in partial execution of programs along with the servers (mainframe).
- PC Revolution: Computing Everything Locally: 1980s - 1990s, general purpose computing machines for users (personal computers or PCs). Everything could be computed locally, less expensive unlike mainframes, the organizations could afford many of them, and the need of maintaining expensive mainframe systems soon became less important.
- Network of PCs: 1990s, LAN (local area network) and WAN (wide area network) technologies connecting multiple PCs, enabling data sharing again.

Mainframe, Distributed, Cluster and Grid Computing

- Distributed Computing: 1990s, a step forward from parallel. It formed one powerful computing system by combining multiple computing systems, rather than having one computer with multiple processors (a collection of processors interconnected by communication network in which each processor has its own local memory and other basic computing peripherals).
- Cluster Computing: Creation of Resource Pools: 1990s, multiple nodes (computers) connected via network which perform similar tasks. All the nodes of a cluster together give impression of a single system. Required a cluster head.
- Grid Computing: Decentralization of Control, 1990s, connected heterogeneous computing systems (systems with diverse hardware configurations) which could be located at separate administrative domains. Each node connecting to the grid (or cluster of it) would have same priority and participate equally. Challenges are related to management of resources and security implementations of systems. Benefits are:
  - Large scale; Geographical distribution; Heterogeneity; Resource co-ordination; Pervasive access; Unlimited resource addition (scaling).
  - Grid computing is sometimes labelled as the direct predecessor of cloud computing.

Cloud Computing: A natural technological evolution

- An evolution which has been an outcome based purely on the technological advancements in different fields of computing.

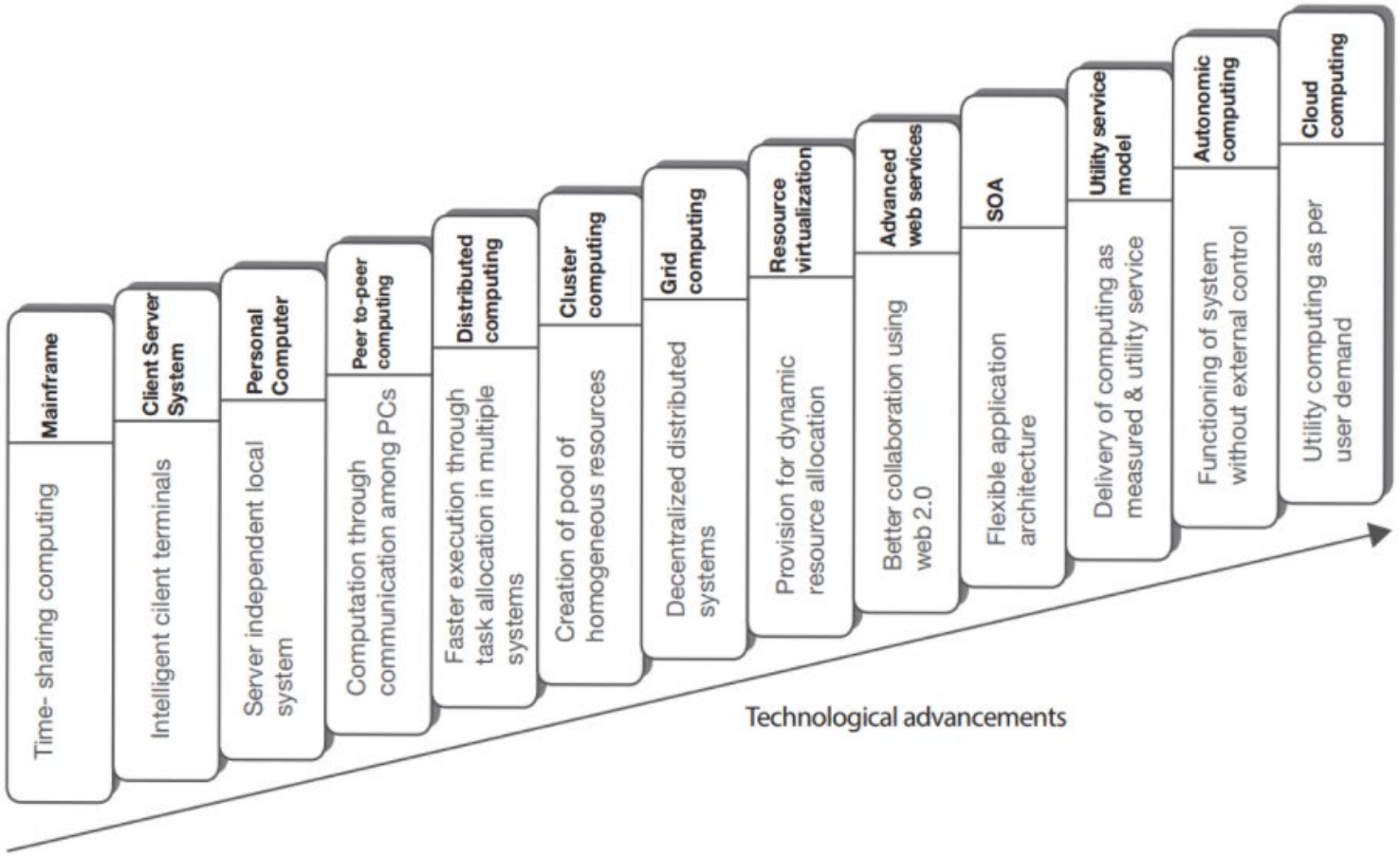

FIG 2.6: Technological advancements towards maturity of cloud computing

Cloud Computing: A Convergence of Technologies

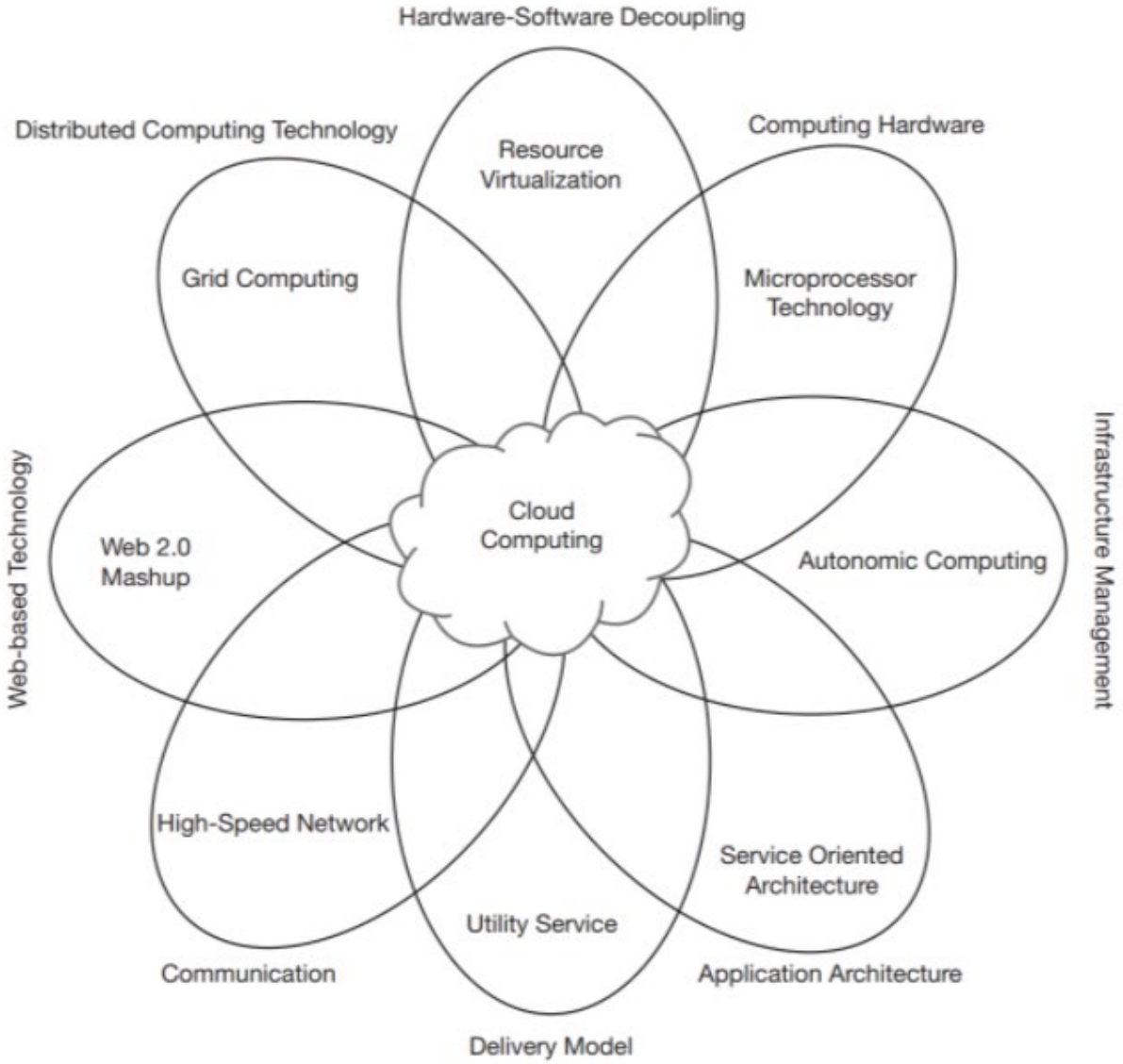

FIG 2.7: Convergence of technologies for evolution of cloud computing

Quick Comparison

Table 2.2 Comparison among cluster, grid and cloud computing

Cluster Computing	*Grid Computing*	*Cloud Computing*
A cluster is normally formed with computers of a single location, otherwise the system becomes complex.	Grid is inherently more distributed by its nature. The computers need not to be in the same geographical location.	It allows total distribution of resources like the grids. Hardware resources are maintained in multiple data centers spread across the globe.
Computation job takes place in one administrative domain owned by a single party.	Computation could occur over many administrative domains owned by multiple parties as connected together.	Computing resources of a cloud is usually owned by a single party. But multiple administrative domains can be combined together to perform the job.
In a cluster, all computing nodes should have similar hardware systems. That is, the system should be homogeneous in nature.	It can be heterogeneous in nature. The computers that are part of a grid can be made of different hardware architectures.	It can use heterogeneous collection of commodity hardware.
It features the centralized task management and scheduling system.	It features the distributed task management and decentralized scheduling.	It features the decentralized task management with more dynamic computing infrastructure.
Resources are generally pre-reserved for specific type of task.	Resources are generally pre-reserved for specific type of task.	Resources are not pre-reserved for specific task. Resource utilization is mainly demand-driven.
System is not dynamic in nature. Application mobility is not possible.	System is not dynamic in nature. Application mobility is not possible.	It is a dynamic system. Mobility of application is an inherent feature in this system.
One whole cluster behaves like a single system. As resources are managed by centralized resource manager, the individual computers can not be operated as separate computers.	Every node is autonomous that is, it has its own resource manager and behaves like an independent entity. So, each computer can be operated independently as distinct computer.	There is no concept of directly accessing any particular physical computing nodes. Underlying computing infrastructure remains hidden from the users.

Benefits of Cloud Computing

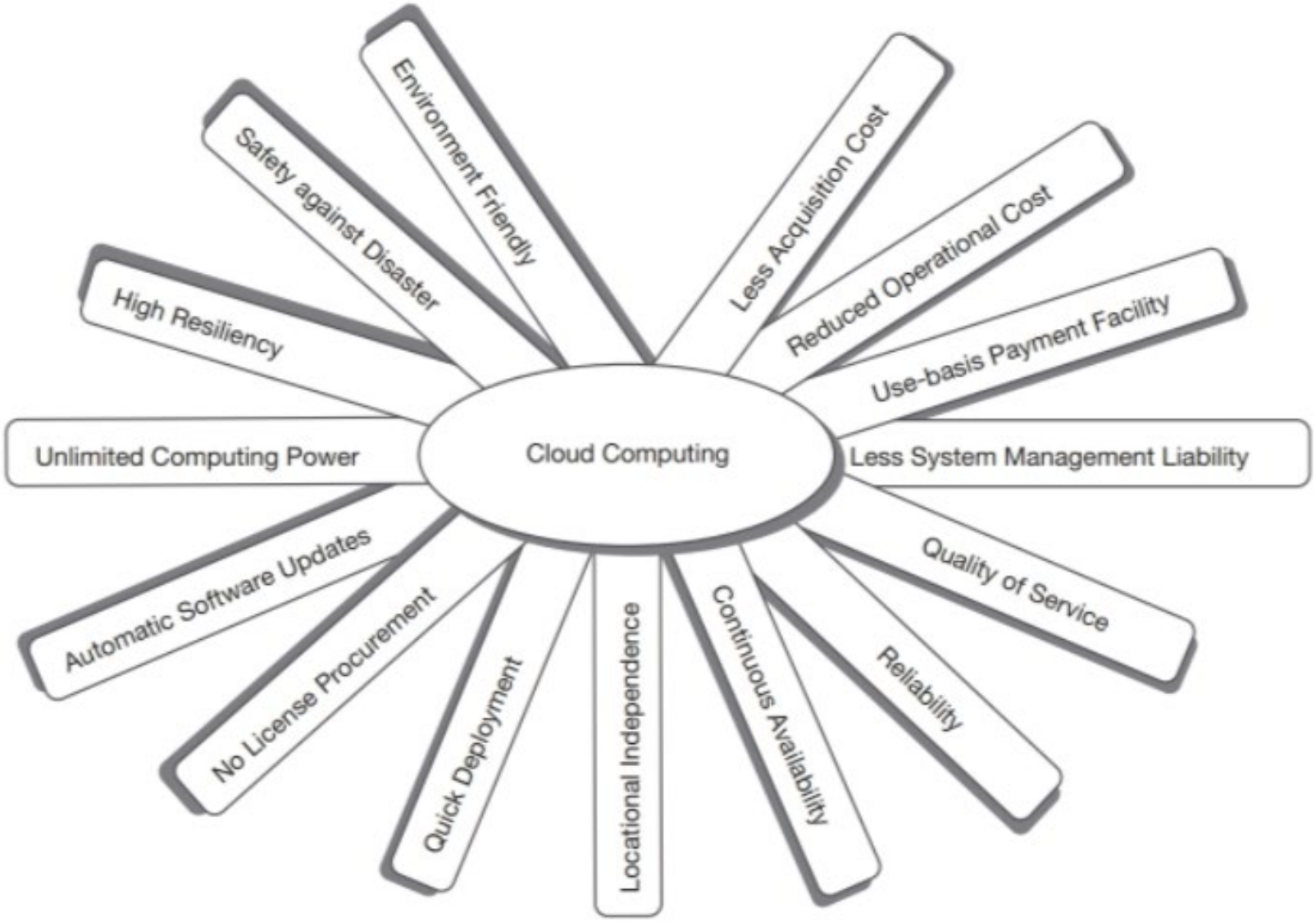

FIG 3.2: Advantages of cloud computing

Deployment Challenges

- Limited Portability between Cloud Providers
- Inter-operability Problem
- Data Security
- Reduced Control over Governance
- Multi-Regional Compliance and Legal Issues
- Bandwidth Cost

Summary

- Cloud computing has emerged as a new model of computing which promises to make the planet more smart.
- There were many limitations in the traditional computing approaches. Those limitations used to overburden the consumers and enterprises in terms of budgetary expense and responsibility for maintaining various computing facilities
- Cloud computing facilitates the delivery of computing services like any other utility service. Customers can use computing service just as electricity is consumed and pay bills at the end of the month.
- The key advantage of this new model of computing is the access to any kind and any volume of computing facilities from anywhere and anytime.
- Cloud computing is not a sudden innovation. It has been matured over the years with continuous development around different fields of computing.
- Technological advancements in the fields of hardware, software and network communication have contributed to the emergence of cloud computing.

Summary

- The introduction of distributed computing system enabled by advanced network communication technology during 1980s can be considered as the first major step towards cloud computing.
- Cluster computing advanced the distributed computing concept one step ahead by introducing pools of homogeneous computing resources. Resource pool is a prime necessity in creating a large and robust computing environment.
- Grid computing introduced during the 1990s is the successor of cluster computing. It eliminated several drawbacks of clustering. Grid system can be built using heterogeneous computing systems and allows decentralization of control.
- Hardware virtualization technology also emerged as a major innovation in the field of computing. It helps in designing dynamic and flexible computing system (by allowing application system mobility).
- Advancements in the field of web services and the introduction of service oriented architecture (SOA) emerged as tools for designing collaborative and flexible application respectively.

Summary

- Cloud computing provides lots of benefits to its subscribers. It has very low initial investment compared to traditional computing, minimum system management headache, low operational cost, almost unlimited resource availability and reliable and robust service as provided by the reputed vendors.
- Cloud computing is also known as ‘green computing’ or ‘eco-friendly’ computing as it minimizes electronic resource wastage.
- Among the challenges of cloud computing the portability, interoperability, information security and privacy are some major concerns for subscribers.
- Roles of web services are very important in any web base development and so in cloud computing as well. A web service is the way of establishing communication between two software systems over the internetwork.

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Thank You

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