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SITA1503

FOG AND CLOUD COMPUTING

UNIT 4

MANAGEMENT IN CLOUD COMPUTING AND SECURITY

Cloud data centres - **Energy efficiency in data centre** - Data Management in Cloud Computing - Mobile cloud computing service models – Open Source and Commercial Clouds, Cloud Simulator – sensor cloud- Fundamental Cloud security – Cloud security Threads – Additional considerations – Security solutions a case study.

CLOUD DATA CENTERS

- A data center (or datacenter) is a facility composed of networked computers and storage that businesses or other organizations use to organize, process, store and disseminate large amounts of data.
- A business typically relies heavily upon the applications, services and data contained within a data center, making it a focal point and critical asset for everyday operations.

CLOUD DATA CENTERS

- Data centers are not a single thing, but rather, a conglomeration of elements.
- A data center must also contain an adequate infrastructure, such as power distribution and supplemental power subsystems, including electrical switching; uninterruptable power supplies; backup generators and so on; ventilation and data center cooling systems, such as computer room air conditioners; and adequate provisioning for network carrier (telco) connectivity.
- All of this demands a physical facility with physical security and sufficient physical space to house the entire collection of infrastructure and equipment

WHAT IS A DATA CENTER?

- At its simplest, a data center is a physical facility that organizations use to house their critical applications and data.
- A data center's design is based on a network of computing and storage resources that enable the delivery of shared applications and data.
- The key components of a data center design include routers, switches, firewalls, storage systems, servers, and application-delivery controllers.

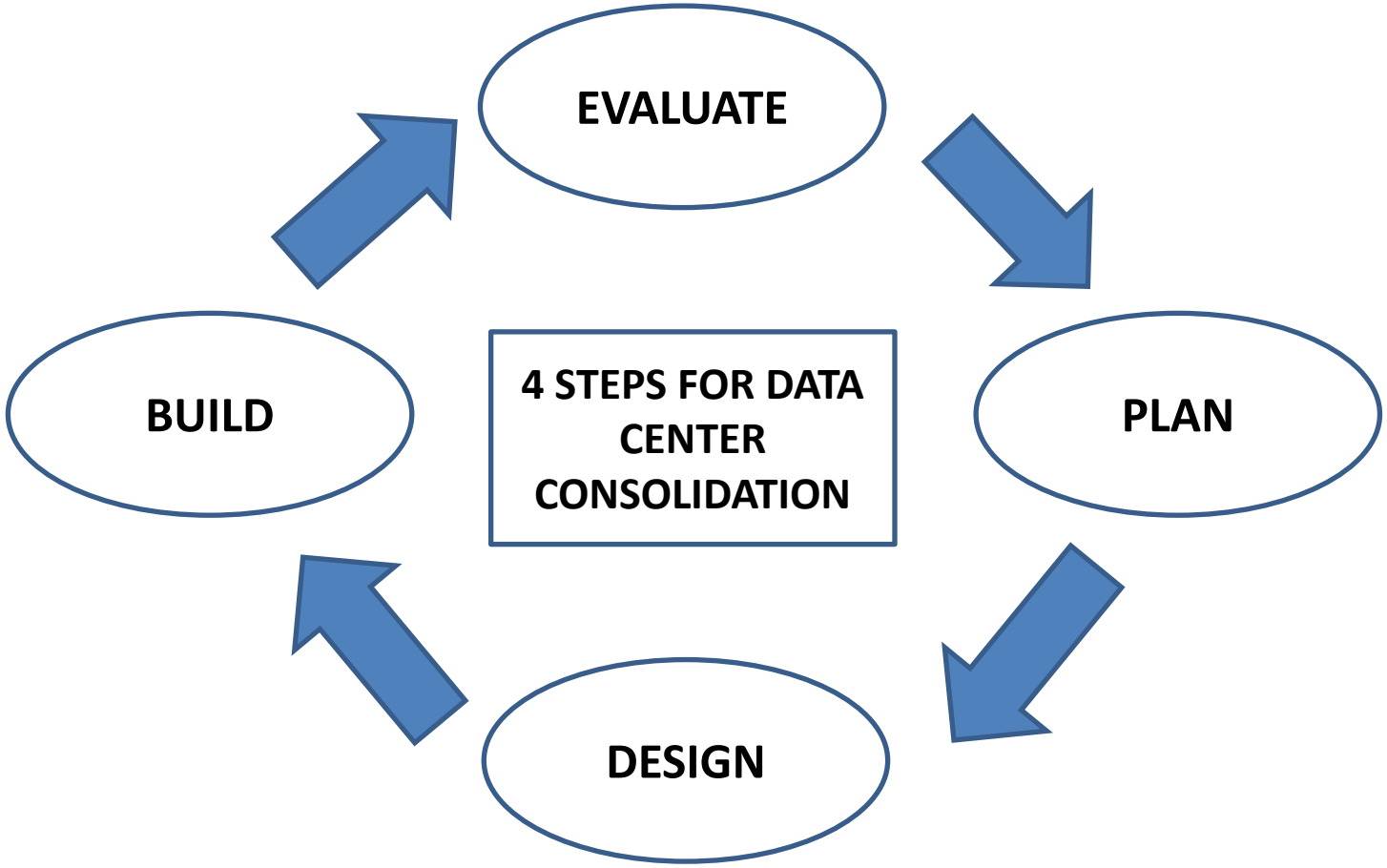
DATA CENTER CONSOLIDATION AND COLOCATION

- **Data Center Consolidation** is the process of downsizing or consolidating many servers, storage systems, networking systems, or even locations into a more efficient set of systems.
- The purpose is to lower cost and improve performance, among other things.

DATA CENTER CONSOLIDATION AND COLOCATION

- There is no requirement for a single data center, and modern businesses may use two or more data center installations across multiple locations for greater resilience and better application performance, which lowers latency by locating workloads closer to users.

DATA CENTER CONSOLIDATION AND COLOCATION



Before beginning a data center consolidation, it's important to have an accurate map of your current environment(s), and so the team should conduct assessments of all the physical locations.

As with most data center projects, such as a migration, a consolidation involves significant risk.

Once the evaluation and planning steps are complete, the company is ready to begin architecting the consolidated location.
Depending on whether an existing location is being used, this phase will take on a different form.

When a data center design has been finalized, it's time to determine the logistics of transportation,procurement, and construction. Before you can build the data center, you'll need to build your consolidation project team.

DATA CENTER CONSOLIDATION AND COLOCATION

DC Consolidation activities

Reduce the cost of the data center

- Reduce the size and number of data centers and servers
- Migrate to new virtualized HW (possibly including private and public clouds) during the consolidation
- Implement strategic DR functionality as a bi-product of the move

DATA CENTER COLOCATION

- Alternatively, data center operators can pay a fee to rent server space and other hardware in a colocation facility.
- Colocation is an appealing option for organizations that want to avoid the large capital expenditures associated with building and maintaining their own data centers.
- Today, colocation providers are expanding their offerings to include managed services, such as interconnectivity, allowing customers to connect to the public cloud.

BENEFITS OF DATA CENTER CONSOLIDATION

- **PHYSICAL LOCATIONS :** Consolidating multiple physical locations can reduce operational expenses through lower energy consumption, fewer leases, and lower maintenance costs.
- **PROCUREMENT :** Consolidation can reduce the quantity of necessary equipment such as servers, storage, and networking equipment. Indeed, this saves the organization significant procurement costs.
- **SOFTWARE :** Consolidation of software onto fewer systems can reduce software licensing costs as well as maintenance costs

BENEFITS OF DATA CENTER CONSOLIDATION

- **ENVIRONMENTAL BENEFITS :** It's no secret that data centers are massive energy hogs (efficiency) and a large contributing factor to global warming.
  - Data center consolidations reduce total energy consumption, greatly reducing the carbon footprint of the organization.
- **SECURITY :** Consolidating data centers improves security in a few ways.
  - You have fewer points of entry, for one.
  - You're also reducing the total number of programs and systems to secure.
  - And, with less area to cover, avoiding vulnerabilities
- **REDUCE ERRORS :** Complexity breeds errors. Data center consolidation simplifies processes like system discovery and network management.

AVOIDING THE RISKS OF DATA CENTER CONSOLIDATION

- DISRUPTED EMPLOYEES
- DATA LOSS
- OPERATIONAL DOWNTIME

DATA CENTER TIERS

Four Tiers for Data Center

- **Tier 1**
  - A Basic Data Center
- **Tier 2**
  - A Redundant Data Center
- **Tier 3**
  - A Concurrently Maintainable Data Center
- **Tier 4**
  - A Fault Tolerant Data Center

DATA CENTER TIERS

Tier 1- A Basic Data Center

- Non-redundant capacity w/ single distribution path
- Vulnerable to human and operational errors
- Requires annual maintenance to prevent serious operation failure
- Maintenance requires site wide shutdown

DATA CENTER TIERS

Tier 2- A Redundant Data Center

- Redundant capacity component w/ single distribution path
- Component can be removed without impacting computer equipment
- Vulnerable to human and operational errors
- Annual maintenance requires site wide shutdown

DATA CENTER TIERS

Tier 3 – A Concurrently Maintainable Data Center

- Redundant capacity component w/ multiple, independent distribution path
- Component can be removed without impacting computer equipment
- Somewhat vulnerable to human and operational errors
- Annual maintenance can be completed while data center remains operational

DATA CENTER TIERS

Tier 4 – A Fault Tolerant Data Center

- Multiple, independent, physically isolated capacity components and distribution paths
- Physically isolated system prevent massive infrastructure failure
- Component can be removed without impacting computer equipment

DATA CENTER TIERS

Tier 4 – A Fault Tolerant Data Center (cont.)

- System Self Heals – Automatically respond to prevent further site failure
- Not vulnerable to human and operational errors
- Annual maintenance can be completed while data center remains operational

DATA CENTER ARCHITECTURE AND DESIGN

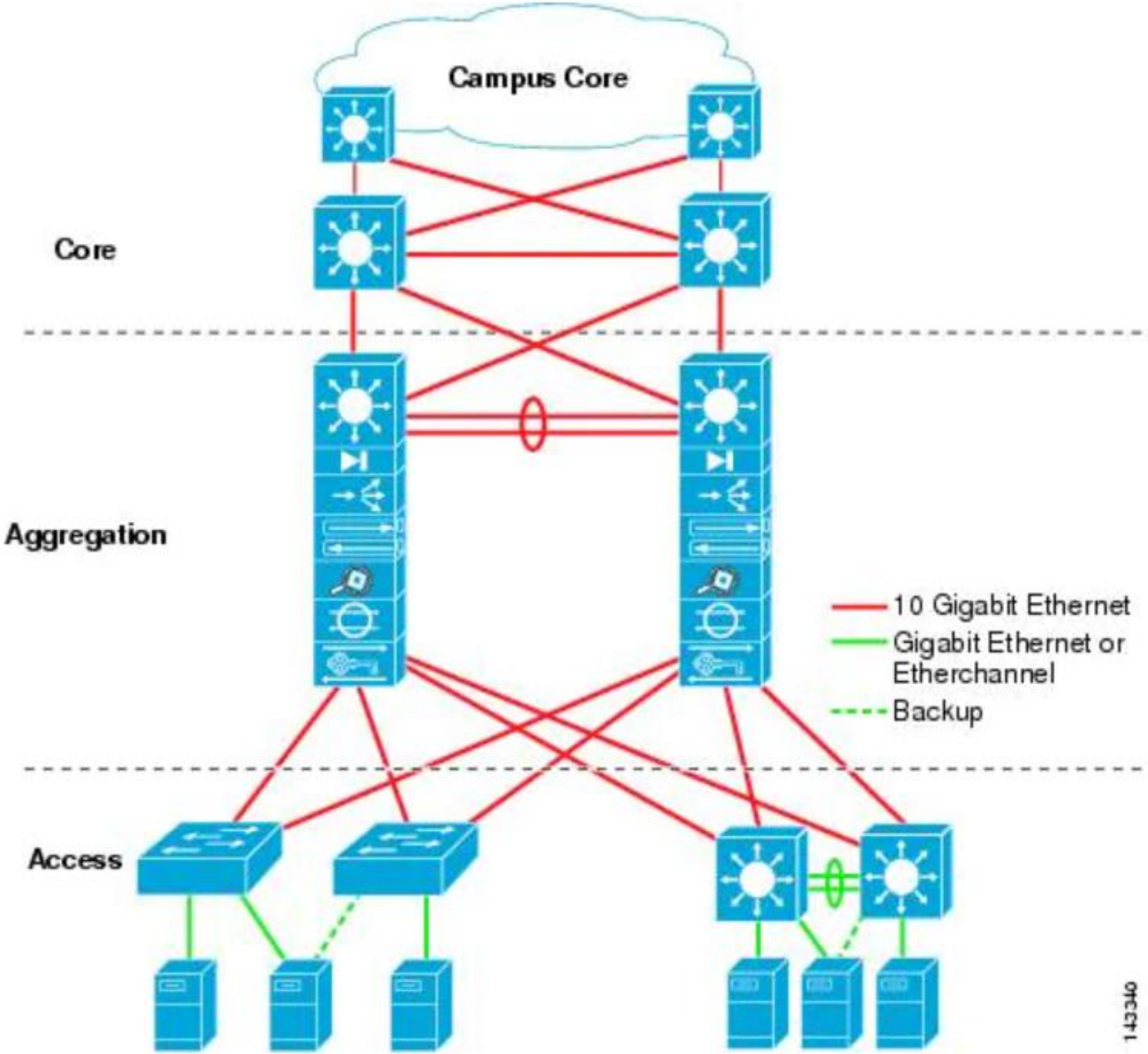
- The data center is home to the computational power, storage, and applications necessary to support an enterprise business.
- The data center infrastructure is central to the IT architecture, from which all content is sourced or passes through.
- Proper planning of the data center infrastructure design is critical, and performance, resiliency, and scalability need to be carefully considered.

DATA CENTER ARCHITECTURE AND DESIGN

- Another important aspect of the data center design is flexibility in quickly deploying and supporting new services.
- Designing a flexible architecture that has the ability to support new applications in a short time frame can result in a competitive advantage.
- Such a design requires solid initial planning and thoughtful consideration in the areas of port density, access layer uplink bandwidth, true server capacity, and oversubscription, to name just a few.

DATA CENTER ARCHITECTURE AND DESIGN

- The data center network design is based on a proven layered approach, which has been tested and improved over the past several years in some of the largest data center implementations in the world.
- The layered approach is the basic foundation of the data center design that seeks to improve scalability, performance, flexibility, resiliency, and maintenance.


Campus Core
Core
Aggregation
Access
10 Gigabit Ethernet
Gigabit Ethernet or Etherchannel
Backup
143340

DATA CENTER DESIGN LAYERED APPROACH

- **Core layer—**Provides the high-speed packet switching backplane for all flows going in and out of the data center. The core layer provides connectivity to multiple aggregation modules
- **Aggregation layer modules—**Provide important functions, such as service module integration, Layer 2 domain definitions, Server-to-server multi-tier traffic flows through the aggregation layer and can use services, such as firewall and server load balancing, to optimize and secure applications.

DATA CENTER DESIGN LAYERED APPROACH

- **Access layer—**Where the servers physically attach to the network. The access layer network infrastructure consists of modular switches, fixed configuration 1 or 2RU switches, and integral blade server switches.

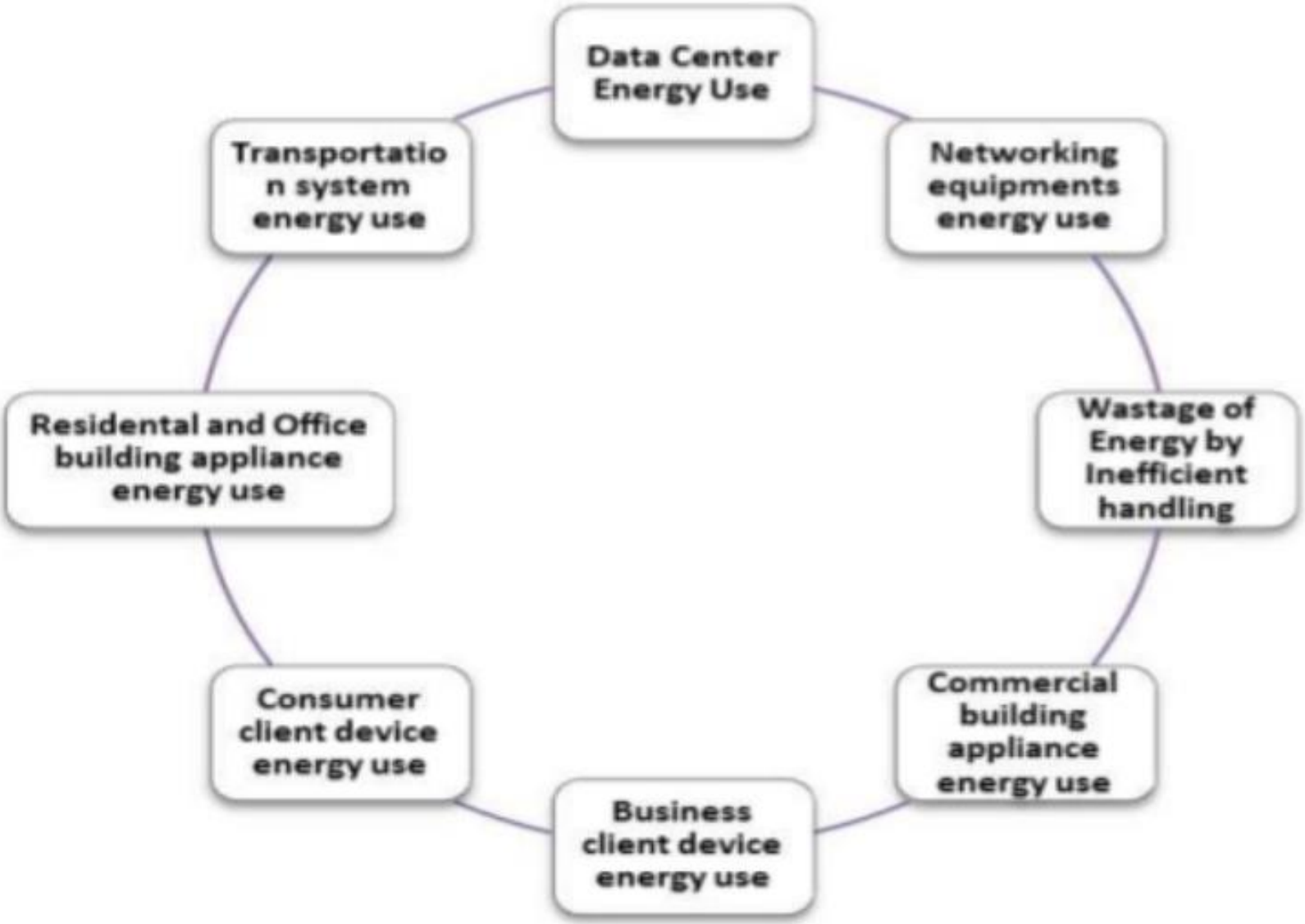
DATA CENTER DESIGN MODELS

- Multi-Tier Model
- Server Cluster Model
- Logical Overview
- Physical Overview

ENERGY CONSUMPTION AND EFFICIENCY

- Data center designs also recognize the importance of energy efficiency.
- A simple data center may need only a few kilowatts of energy, but an enterprise-scale data center installation can demand tens of megawatts or more.
- Organizations often measure data center energy efficiency through a metric called power usage effectiveness (PUE).
- This PUE represents the ratio of total power entering the data center divided by the power used by IT equipment.

Efficiency Model

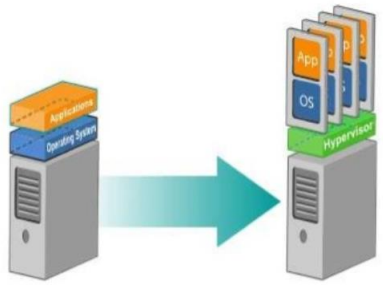


DIFFERENT APPROACHES FOR ENERGY EFFICIENCY

- Energy Efficient Hardware
- Virtualization
- Energy-aware job Scheduling
- Request Batching
- Multi-speed Disks

virtualization

- it is a technique that allows to share single physical instance of an application or resources among multiple organization.
- Virtualization reduces hardware utilization, saves energy and costs and makes it possible to run multiple applications and various operating systems on the same SERVER at the same time. It increases the utilization, efficiency and flexibility of existing computer hardware.



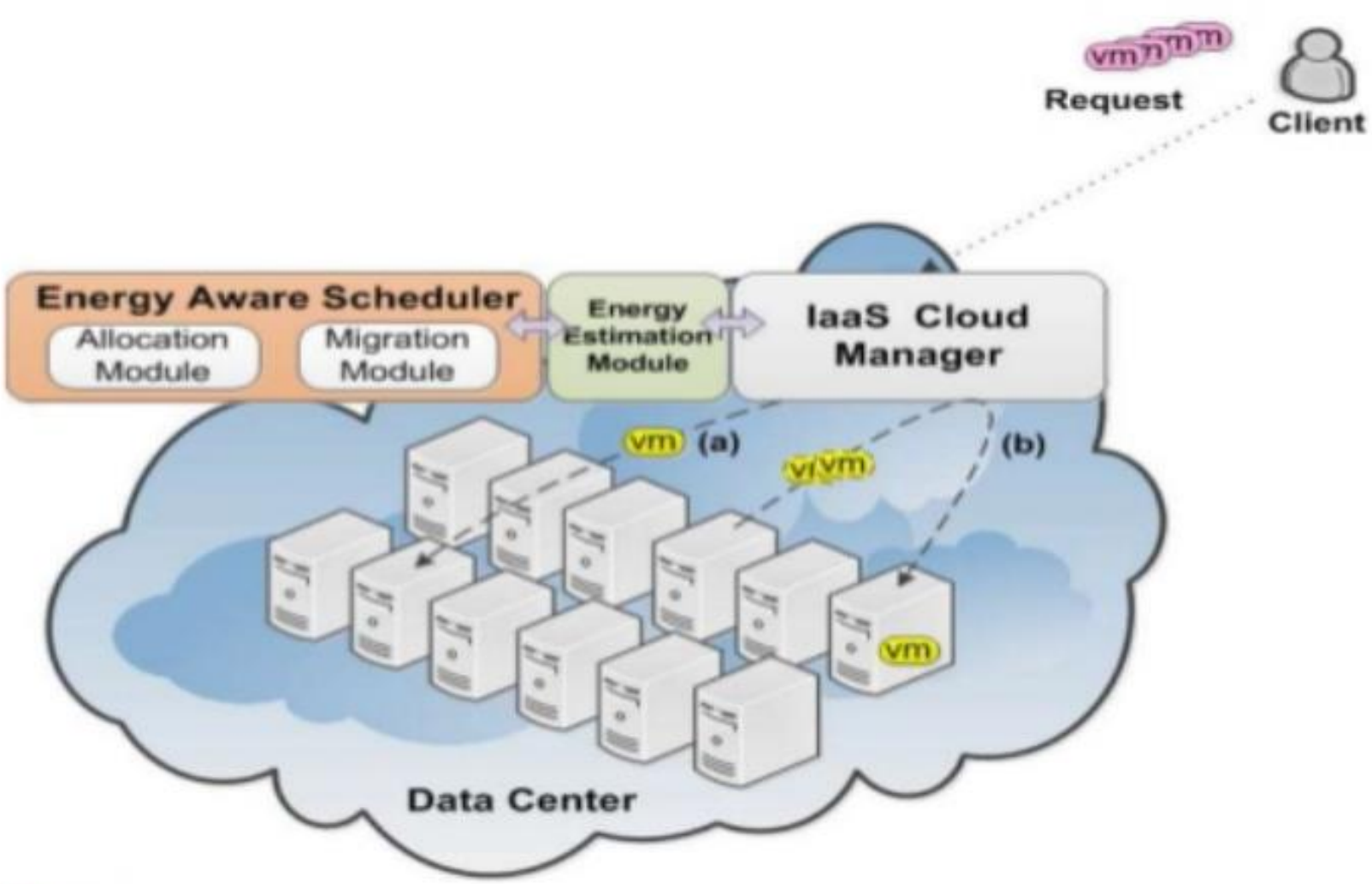
VIRTUALIZATION

- Virtualization reduces hardware utilization, saves energy and costs and makes it possible to run multiple applications and various operating systems on the same SERVER at the same time. It increases the utilization, efficiency and flexibility of existing computer hardware.

WHY DO WE NEED VIRTUALIZATION?

- Virtualization provides various benefits including saving time and energy, decreasing costs and minimizing overall risk.
- Provides ability to manage resources effectively.
- Provides for data loss prevention.
- Hardware Independence: Virtual machines run independently of underlying hardware.
- Portability: Virtual machines can be migrated between different hosts.

ARCHITECTURE



DATA CENTER SECURITY AND SAFETY

- **DATA CENTER SECURITY:**
- Data center security refers to the physical practices and virtual technologies used to protect a data center from external threats and attacks.
- **HOW TO SECURE A DATA CENTER?**
- Data centers are complex and to protect them, security components must be considered separately but at the same time follow one holistic security policy.
- Security can be divided into physical and software security.

DATA CENTER SECURITY AND SAFETY

- **PHYSICAL SECURITY**
- A data center building's most obvious security characteristics are related to design and layout.
- **SOFTWARE SECURITY**
- Software or virtual security prevents cybercriminals from entering the network by bypassing the firewall, cracking passwords, or through other loopholes.

WHO NEEDS DATA CENTER SECURITY?

- Every data center needs some form of security to ensure its continued use.
- Some aspects of “security” are actually made up of uptime features, such as multiple power sources, multiple environmental controls and more
- Data centers can be placed into four tiers: each tier is associated with a specific business function and sets an appropriate criterion for cooling,

WHO NEEDS DATA CENTER SECURITY?

- **Tier 1 + 2**
- These are generally used by small businesses that do not provide real-time delivery of products or services as a significant part of their revenue.
- **Tier 3 + 4**
- Rigorous uptime requirements and long-term viability are usually the reason for selecting strategic solutions found in Tier III and Tier IV site infrastructure.
- These data centers are considered more robust and less prone to failures.

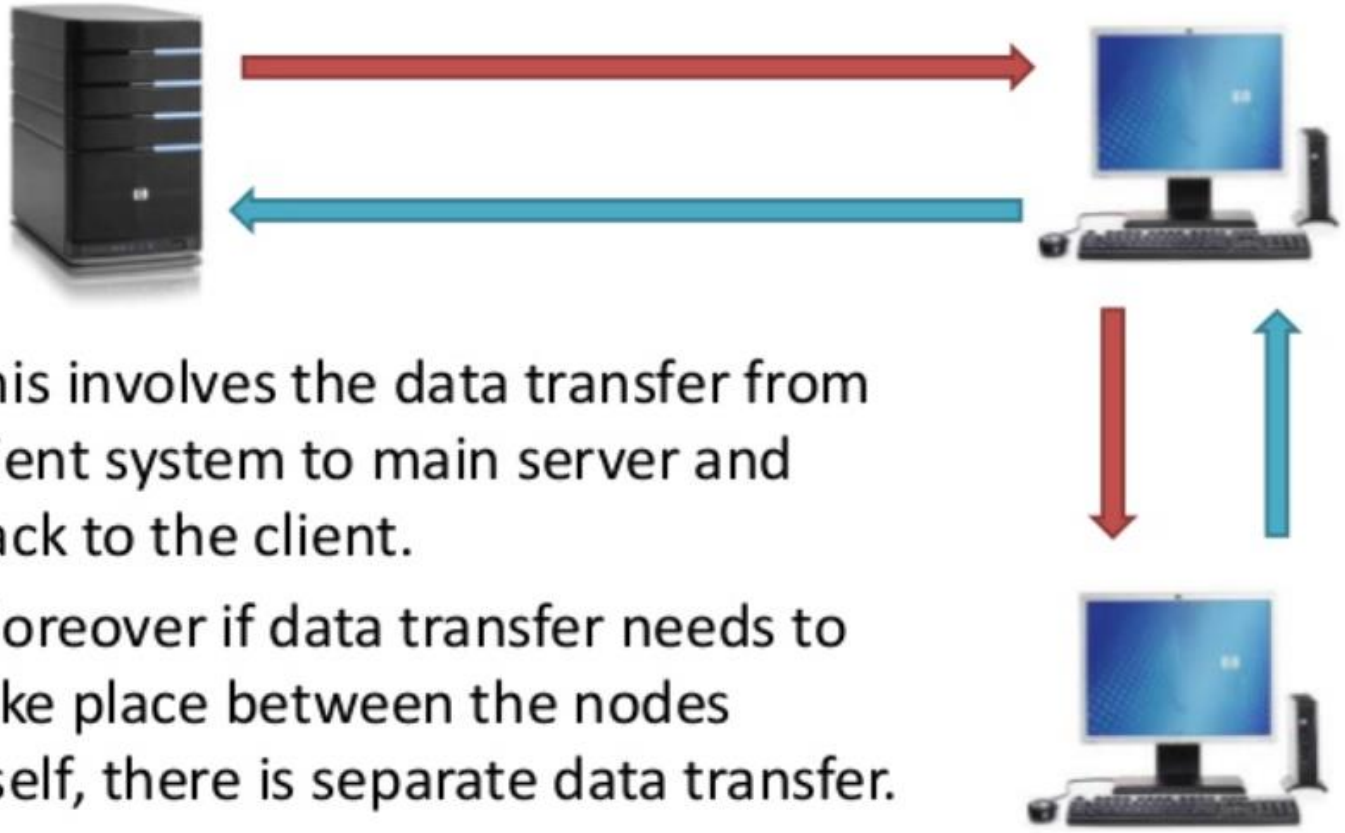
DATA CENTER ENERGY USE

When companies use their dedicated data centers they need to have a lot of resources which primarily involves

- Air Conditioning unit.
- Dedicated Hardware.
- Resource Person
- Power Backup
- Security

TRANSPORTATION ENERGY USE

Transportation System Energy Use



- This involves the data transfer from client system to main server and back to the client.
- Moreover if data transfer needs to take place between the nodes itself, there is separate data transfer.

SWITCHING TO THE CLOUD – SAVING ENERGY

Switching to the cloud would mean…

There is direct transfer from client to server thus saving energy that was wasted in transport.

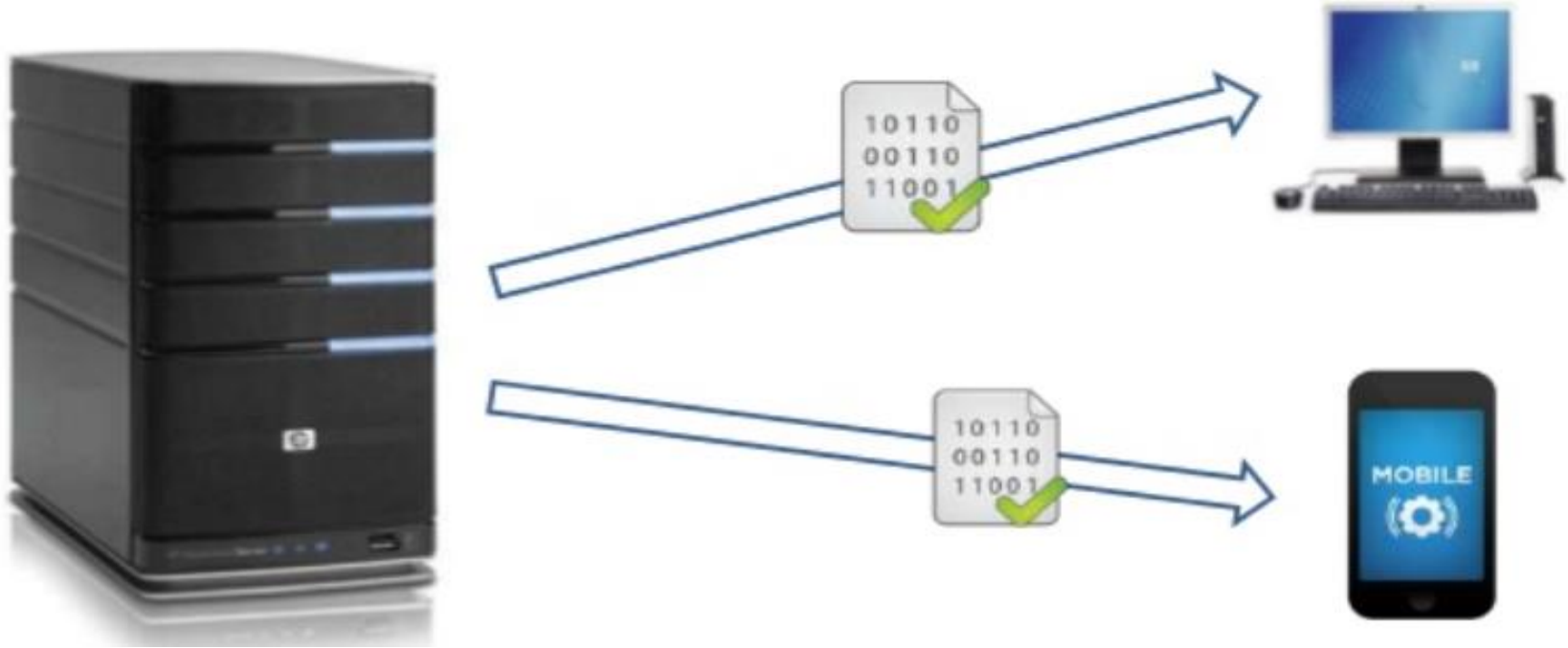
Residential and Office Building appliance energy use

- The individual electrical appliances further used leads to wastage.

No use of any extra appliances on the client side.

Business and Consumer Client device Energy Use

- This is related to the fact that if data transfer needs to be done from client to any other device the entire data is transferred.

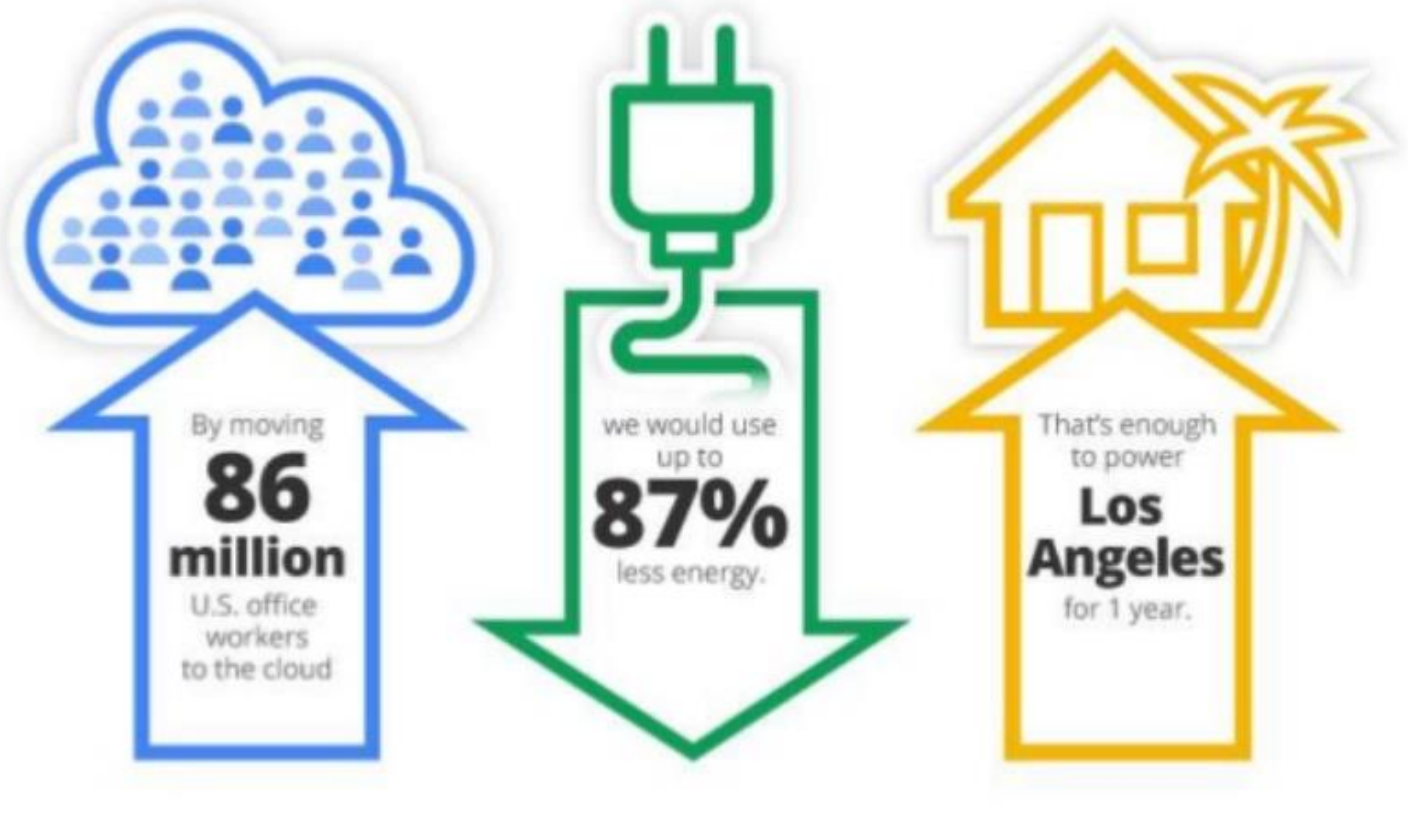


Whereas in cloud the data can be easily accessed thorough any device.

Network Equipment Energy Use

- There is a lot of networking components involved when there is a network of computers in a building.
- Instead if we go for internet connection and cloud architecture the energy can be saved.

Moving to the cloud can save up to 87% of IT energy



ENERGY CONSUMPTION

- Power consumption is decreased in cloud computing.
- Private and public cloud storage services are more energy efficient than storage on local hard disk drives when files are only occasionally accessed.
- There is an overall decrease in costs involved in computing equipment for an organization.

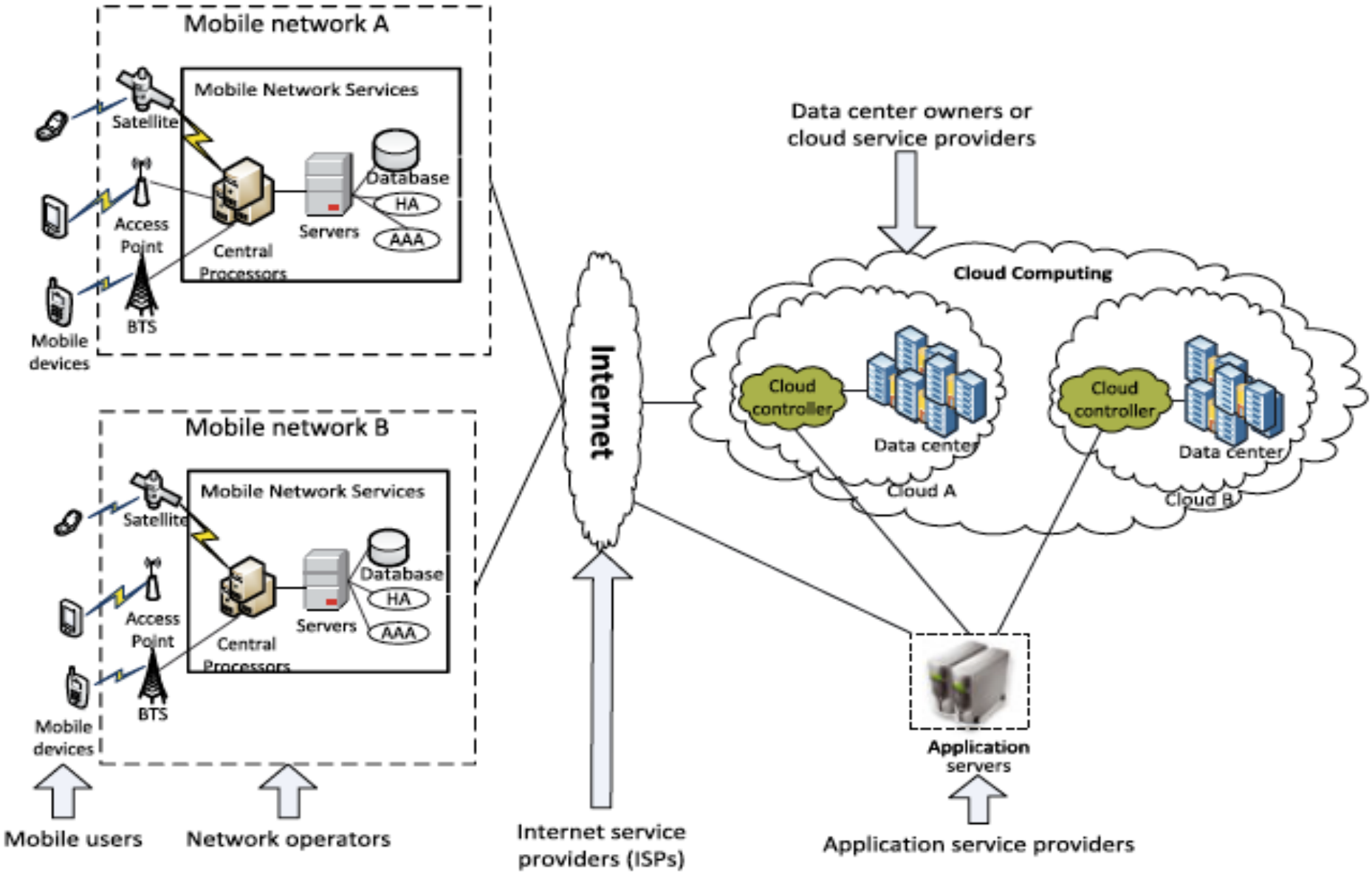
MOBILE CLOUD APPLICATION

- **What is Mobile Cloud Computing?**
- Mobile cloud computing (MCC) at its simplest, refers to an infrastructure where both the data storage and data processing happen outside of the mobile device.
- Mobile cloud applications move the computing power and data storage away from the mobile devices and into powerful and centralized computing platforms located in clouds.
- They are then accessed over the wireless connection based on a thin native client.

WHY MOBILE CLOUD COMPUTING?

- Mobile devices face **many resource challenges** (battery life, storage, bandwidth etc.)
- Cloud computing offers advantages to users by allowing them to use infrastructure, platforms and software by cloud providers at **low cost** and elastically in an **on-demand** fashion.
- Mobile cloud computing provides mobile users with data storage and processing services in clouds, obviating the need to have a powerful device configuration (e.g. CPU speed, memory capacity etc), as all resource-intensive computing can be performed in the cloud.

MCC ARCHITECTURE



MCC ARCHITECTURE

- Mobile devices are connected to the mobile networks via base stations that establish and control the connections and functional interfaces between the networks and mobile devices.
- Mobile users' requests and information are transmitted to the central processors that are connected to servers providing mobile network services.
- The subscribers' requests are delivered to a cloud through the Internet.
- In the cloud, cloud controllers process the requests to provide mobile users with the corresponding cloud services.

ADVANTAGES OF MCC

- Extending battery lifetime
- Improving data storage capacity and processing power
- Improving reliability and availability
- Dynamic provisioning
- Scalability
- Multi-tenancy
- Ease of Integration

ADVANTAGES OF MCC

- **Dynamic provisioning:**
  - Dynamic on-demand provisioning of resources on a fine-grained, self-service basis
  - No need for advanced reservation
- **Scalability:**
  - Mobile applications can be performed and scaled to meet the unpredictable user demands
- **Multi-tenancy:**
  - Service providers can share the resources and costs to support a variety of applications and large no. of users.
- **Ease of Integration:**
  - Multiple services from different providers can be integrated easily through the cloud and the Internet to meet the users' demands.

MCC APPLICATIONS

- **Mobile Commerce**
  - Examples: Mobile financial, mobile advertising, mobile shopping…
  - M-commerce applications face various challenges (low bandwidth, high complexity of devices, security, …)
  - Integrated with cloud can help address these issues
  - Example: Combining 3G and cloud to increase data processing speed and security level.

MCC APPLICATIONS

- **Mobile Learning**
  - M-learning combines e-learning and mobility
  - Cloud-based m-learning can solve these limitations
  - Enhanced communication quality between students and teachers
  - Help learners access remote learning resources

MCC APPLICATIONS

- Mobile Healthcare:
- Mobile Gaming
- Assistive technologies
- **Other applications:**
  - Sharing photos/videos
  - Keyword-based, voice-based, tag-based searching
  - Monitoring a house, smart home systems
- ……..

SHARED SERVICES FOR CLOUD COMPUTING

The value-added that project management provides includes:

- Managing shared service relationships that are inherent with Cloud computing environments
- Reviewing contracts to ensure end-to-end service functionality, including service-level agreements
- Improving the understanding of issues impacting the Cloud computing environments

- AFTER THE VENDOR SELECTION, THE PROJECT TEAM WILL DECIDE WHETHER TO CONSIDER THE CLOUD OR NOT.

Deciding whether to Consider Cloud Computing

What factors should the project team consider before implementing Cloud computing? These types of questions should be formulated in a checklist:

- Would a pay-per-use service model make the most financial sense?
- Does a subscription-based service provide adequate coverage for the designated user base?
- Will the solution provide a value-added to the organization over premise-based solutions?

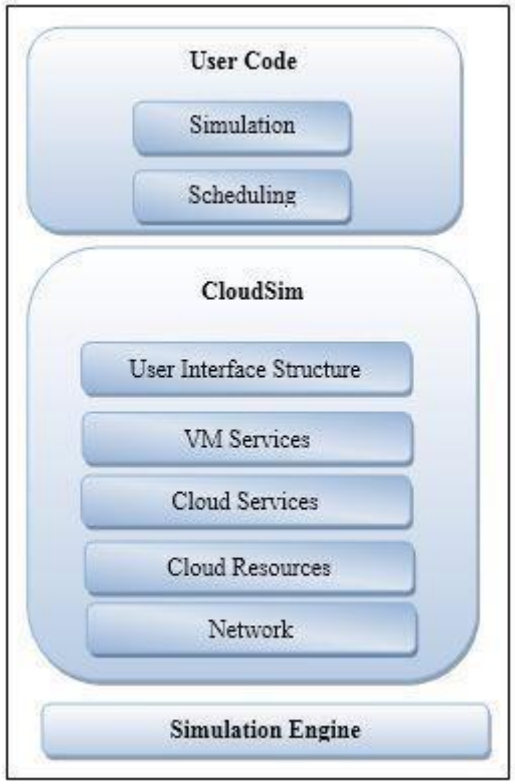
The CloudSim Simulator

- ***Architecture of CloudSim***

  CloudSimfollows the layered architecture.As is clear from the figure, the architecture mainly comprises of threelayers specifically user code, components of CloudSim and the simulation engine.

  It provides the full virtualized environment along with keen interface for virtual machine services, cloud services and network. Each of the components is briefly described as follows.

Architecture of CloudSim



- Sensor-cloud
- Sensor-Cloud is a new paradigm for cloud computing that **uses the physical sensors to accumulate its data and transmit all sensor data** into a cloud computing infrastructure. Sensor-Cloud handles sensor data efficiently, which is used for many monitoring applications.

- Advantages of Sensor-Cloud

  Cloud computing is very encouraging solution for Sensor-Cloud infrastructure due to several reasons like the agility, reliability, portability, real-time, flexibility, and so forth. Structural health and environment-based monitoring contains highly sensitive data and applications of these types cannot be handled by normal data tools available in terms of data scalability, performance, programmability, or accessibility. So a better infrastructure is needed that may contain tools to cope with these highly sensitive applications in real time. In the following, we describe the several advantages and benefits of Sensor-Cloud infrastructure that may be the cause of its glory, and these are as follows.

Advantages of Sensor-Cloud

- *Analysis*
- *Scalability*
- *Collaboration*
- *Visualization*
- *Free Provisioning of Increased Data storage and Processing Power*
- *Dynamic*
- *Multitenancy*

- *Automation*
- *Agility of Services*
- *Resource Optimization*
- *Quick Response Time*

Cloud security

- Cloud security is the protection of data, applications, and infrastructures involved in cloud computing. Many aspects of security for cloud environments (whether it's a public, private, or hybridcloud) are the same as for any on-premise IT architecture.
-
- High-level security concerns—like unauthorized data exposure and leaks, weak access controls, susceptibility to attacks, and availability disruptions—affect traditional IT and cloud systems alike. Like any computing environment, cloud security involves maintaining adequate preventative protections .

- Know that the data and systems are safe. Can see the current state of security.
- Know immediately if anything unusual happens. Can trace and respond to unexpected events.

SECURITY THREATS AND SOLUTIONS:

In today's technology-based world, chances are you've heard of the "cloud" or "cloud storage." In fact, nearly 90-percent of all U.S. broadband users acknowledge that cloud computing exists, yet just 29-percent knowingly utilize the technology. However, with cloud technology becoming more applicable and relevant with each passing day, these statistics are expected to soar over the coming years and more people will turn to the cloud for storing data, files, media and more.

Though the prevalence of the cloud has added ease, accessibility, and reliability to computing, it's brought with it a slew of new threats and risks. As you begin to rely more and more on cloud computing, be aware of these 5 security threats and how you can fix them.

Absence of Adequate Encryption

The risk:

Without proper encryption, cloud computing is often subjected to monitoring and eavesdropping by external sources like common Man-in-the-Middle (MitM) attacks. By impersonating critical aspects of the cloud computing process and bypassing authentication methods, hackers are able to access and hijack critical, "secure" data.

SECURITY THREATS AND SOLUTIONS:

The solution:

You can prevent this risk by encrypting communications and data with proper SSL/TLS code. By implementing cryptographic protocols and endpoint authentication, and by using a reliable proxy server, you can shield your cloud data from random attacks.

Feeble Security Management

The risk:

Cloud systems with weak security management will obviously be more subjected to external threats and risks. Poor security includes things such as failure to engage strong authentication measures, identity management and authorization procedures and more.

The solution:

In order to reliably manage the security of your cloud computing system, you have to synchronize data and use proper identity management services so that all systems in the cloud are able to work together. You should also establish an in-house backup system to store critical data that might be inappropriate for the cloud alone. Lastly, it's critical for you to have real-time, end-to-end visibility so that you'll be able to see each level of the network and quickly recognize and resolve security weaknesses.

STORAGE SECURITY

- Storage security is the collective processes, tools and technologies that ensure that only authorized and legitimate users store, access and use storage resources.
- It enables better security of any storage resource through the implementation of required technologies and policies on storage access and consumption and the denial of access to all unidentified and potentially malicious users.

Thank you