Data center in Cloud Computing

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Physical Server vs Cloud Server

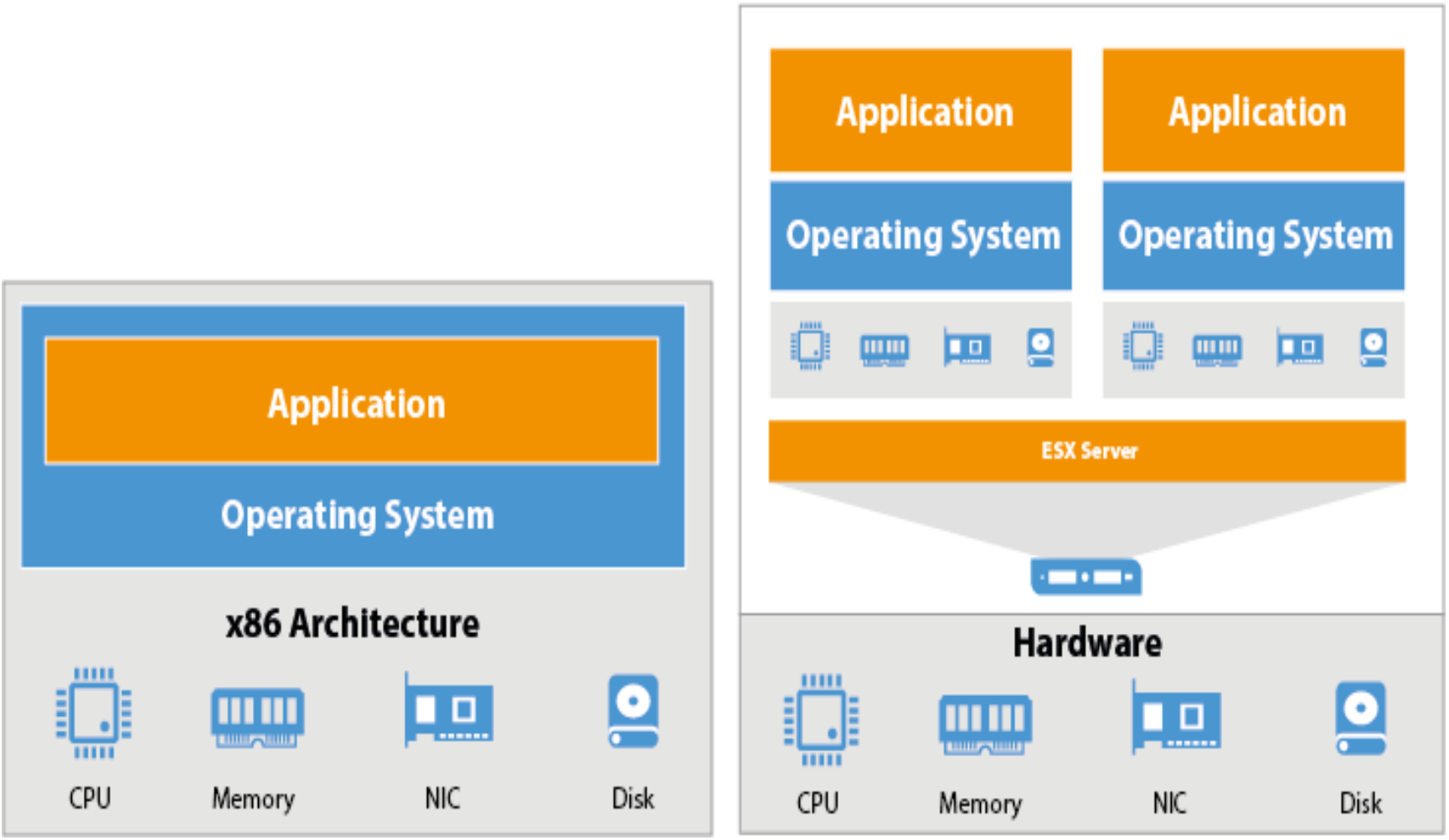
Physical server

- A **physical server**, also known as a 'bare-metal **server**,' is a single-tenant computer **server**, meaning that a specific **physical server** is designated to a single user.
- The resources and components of a **physical server** are not shared between multiple users.

Cloud Servers.

- **Cloud servers** can be configured to provide levels of performance, security and control similar to those of a dedicated **server**. But instead of being hosted on **physical** hardware that's solely used by you, they reside **in a** shared "virtualized" environment that's managed by your **cloud hosting** provider.

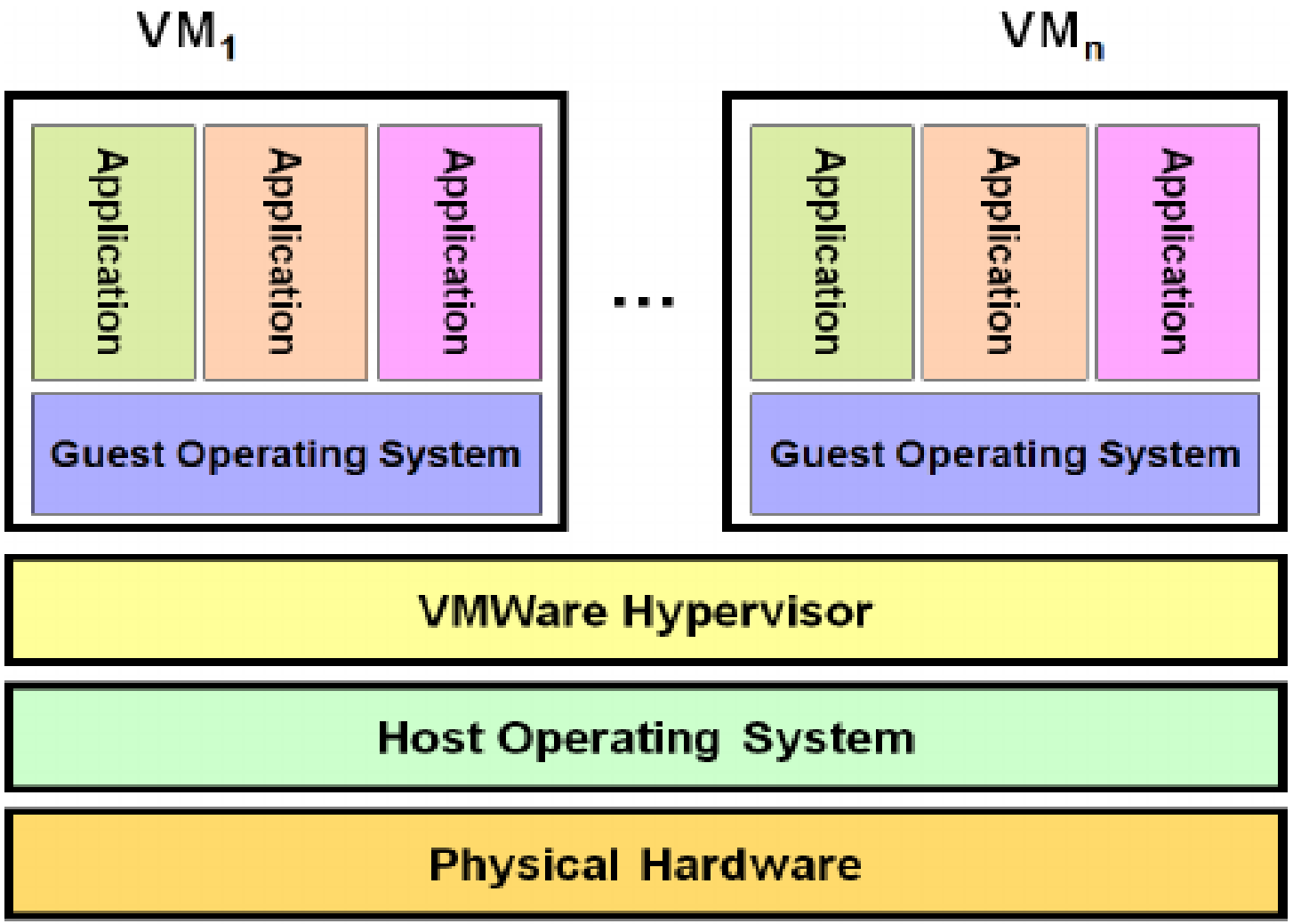
Physical server vs virtual machine



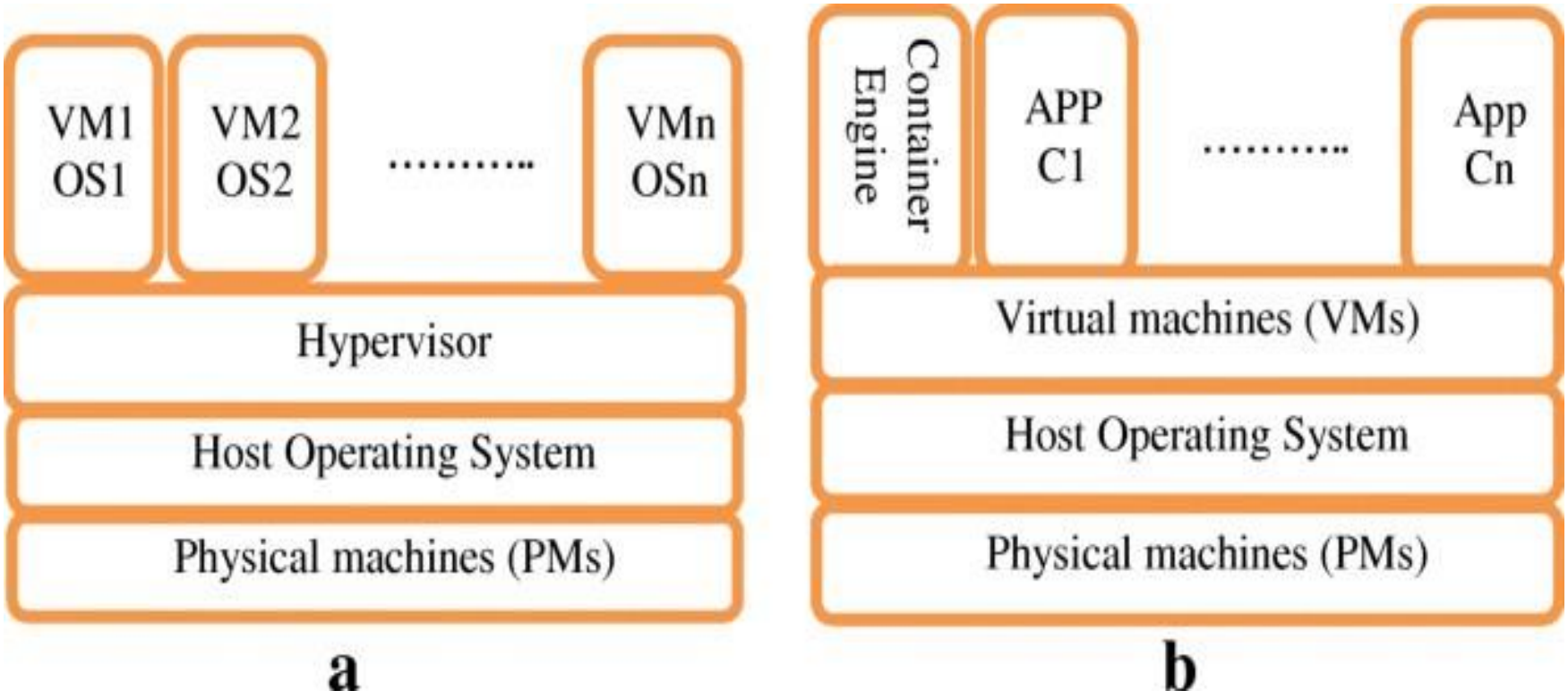
Virtual Servers vs. Physical Servers

- A physical server is a piece of equipment on which data is stored and read. This may be located onsite in your server room, or it could be stored at a colocation facility (a **data center**) with a trusted vendor.
- **Virtualization** is the act of placing multiple "virtual servers" on physical equipment. This allows physical server resources to be split between multiple workloads for maximum efficiency and cost savings.

Hosted Virtual Machine Architecture



A placement architecture for a container as a service (CaaS)



Data Center

What Is a Data Center

- 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 infrastructure refers to the core physical or hardware-based resources and components – including all IT infrastructure devices, equipment and technologies – that comprise a data center.
- Data Center is modeled and identified in a design plan that includes a complete listing of necessary infrastructure components used to create a data center.

What defines a modern data center?

- Infrastructure has shifted from traditional **on-premises** physical servers to **virtual networks** that support applications and workloads across pools of physical infrastructure and into a multi-cloud environment.
- In this era, data exists and is connected across multiple data centers, the edge, and public and private clouds.
- The data center must be able to communicate across these multiple sites, both on-premises and in the cloud.
- Even the public cloud is a collection of data centers. When applications are hosted in the cloud, they are using data center resources from the cloud provider.

A data center infrastructure

A data center infrastructure may include:

- Servers.
- Computers.
- Networking equipment, such as routers or switches.
- Security, such as firewall or biometric security system.
- Storage, such as **storage area network** (SAN) or backup/tape storage.
- **Data center** management software/applications.

It can also include non-computing resources, such as:

- Power and cooling devices, such as air conditioners or generators
- Physical server racks/ c hassis
- Cables
- Internet backbone

What are the core components of a data center?

- Data center design includes routers, switches, firewalls, storage systems, servers, and application delivery controllers. Because these components store and manage business-critical data and applications, data center security is critical in data center design. Together, they provide:
- **Network infrastructure**. This connects servers (physical and virtualized), data center services, storage, and external connectivity to end-user locations.
- **Storage infrastructure**. Data is the fuel of the modern data center. Storage systems are used to hold this valuable commodity.
- **Computing resources**. Applications are the engines of a data center. These servers provide the processing, memory, local storage, and network connectivity that drive applications.

How do data centers operate?

Data center services are typically deployed to protect the performance and integrity of the core data center components.

- **Network security appliances**. These include firewall and intrusion protection to safeguard the data center.
- **Application delivery assurance**. To maintain application performance, these mechanisms provide application resiliency and availability via automatic failover and load balancing.

What is in a data center facility?

- Data center components require significant infrastructure to support the center's hardware and software.
- These include power subsystems, uninterruptible power supplies (UPS), ventilation, cooling systems, fire suppression, backup generators, and connections to external networks.

Why are data centers important to business?

- Email and file sharing
- Productivity applications
- Customer relationship management (CRM)
- Enterprise resource planning (ERP) and databases
- Big data, artificial intelligence, and machine learning
- Virtual desktops, communications and collaboration services

PARAMETER	DATA CENTER	CLOUD
Infrastructure & Applications	Dedicated to one customer or organization	Shared across customers
Services model	Dedicated team of the customer/organization	Shared services across customers
Location	The physical location of data center can be within or outside the organisation's premises	Cloud Data center is located off-premise in service provider location
Accessed via	Dedicated and reliable WAN links like MPLS, P2P connections.	Primarily accessed over unreliable Internet
Security	More secured and better security can be implemented based on respective companies IT policy	Less Secured than traditional Data Center
Setup and upgrade time	Data Center takes much longer to be provisioned and high on operational cost	Almost available immediately based on subscription/payment by respective customer. Cloud systems can be built within moments and can be de-commissioned instantly.

PARAMETER	DATA CENTER	CLOUD
Implementation and operating cost	High since dedicated servers and supporting infrastructure needs to be provisioned.	Low since shared applications and servers are provisioned which multiple customers leverage. Hence the cost is shared across customers.
Scalability	Low on scalability. Capacity expansion of Data center requires to spend the significant amount of money to match increasing workloads	Cloud facility is highly scalable and quickly adapts to your business needs. Cloud offers unlimited capacity expansion based on vendor's products and service plans.
Reliability	Data Centers are generally less reliable than Cloud Data Centers	Cloud servers use multiple data centers in different geographical locations with appropriate backup. This provides safety from unwarranted downtime

What is MPLS in cloud ?

Multiprotocol level switching is a networking technology that routes traffic using the shortest path based on “levels”, rather than network addresses , to handle forwarding over private wide area network.

Types of data centers

- **Enterprise data centers**: These are built, owned, and operated by companies and are optimized for their end users. Most often they are housed on the corporate campus.
- **Managed services data centers:** These data centers are managed by a third party (or a managed services provider) on behalf of a company. The company leases the equipment and infrastructure instead of buying it.
- **Colocation data centers :** In colocation ("colo") data centers, a company rents space within a data center owned by others and located off company premises. The colocation data center hosts the infrastructure: building, cooling, bandwidth, security, etc., while the company provides and manages the components, including servers, storage, and firewalls.

Types of data centers

- **Cloud data centers**: In this off-premises form of data center, data and applications are hosted by a cloud services provider such as Amazon Web Services (AWS), Microsoft (Azure), or IBM Cloud or other public cloud provider.
- Essentially, a **cloud data** service is a remote version of a **data center** – located somewhere away from your company's physical premises – that lets you access your **data** through the internet.
- A **data center** traditionally refers to server hardware on your premises to store and access **data** through your local network

A cloud Data Center

- A cloud Data Center is not physically located in a particular organization's office – it's all online! When your data is stored on **cloud servers**, it automatically gets fragmented and duplicated across various locations for secure storage. In case there are any failures, your **cloud services provider** will make sure that there is a backup of your backup as well!

Benefits of cloud computing over the traditional data center

- **Low maintenance cost.** For a customer maintenance cost is almost nil. Since you are using hardware from the cloud provider's datacenter, you don't need to maintain hardware at all. Your cost is saved from geographical location cost, hardware purchase, upgrades, datacenter staff, power, facility management cost, etc. All this is bared by the cloud provider. Also, for cloud providers, this is also low since they are operating multiple clients from the same facility and hence cost is low compared to cost one has to bear when all those clients are operating from different datacenters. This is very much environment friendly too since you are reducing the need for multiple facilities to fewer ones.
- **Cheap resources.** Cloud providers have a pool of resources and from which you get assigned your share. This means cloud providers maintain and operate a large volume of resources and distribute smaller chunks to customers. This obviously reduces the cost of maintenance and operation for cloud providers and in turn provides low cost, cheap resources to customers.

Benefits of cloud computing over the traditional data center

- **Scale as per your need.** In a traditional data center you have to study and plan your capacity well in advance to finalize your hardware purchase. Once purchased you are stuck with purchased limited capacity and you can not accommodate if capacity requirement grows beyond limit before your estimated time. It again goes through planning, purchasing new hardware which is a time-consuming process. In the cloud you can scale up and scale down your computing capacity almost instantly (or way shorter in time than traditional purchase process). And don't even need to worry and follow for approvals, purchase, billing, etc things.
- **Pay as you use.** In traditional data centers whenever you buy hardware you make an investment upfront even if you don't use the full capacity of purchased hardware. In the cloud, you are billed per your use. So your expenditure on computing is optimum with your use.

Benefits of cloud computing over the traditional data center

- **The latest technology at your service.** Technology changing very fast these days. Hardware you buy today becomes obsolete in a couple of months. And if you are making huge investments in hardware, the company expects to use it at least for a couple of years. So you are stuck with the hardware you brought with a nice price tag and now way behind from its latest counterparts. Cloud provides you the latest tech always and you don't need to worry about upgrades or maintenance. All these hardware aspects are the headache of cloud providers and they take care of it in the background. As a customer, all the latest technology is at your service without any hassle.

Benefits of cloud computing over the traditional data center

- **Redundancy.** Redundancy in traditional datacenter means cost investment to build almost identical facilities of the primary. Along with it also involves cost for infrastructure which connects them. Also, on-site redundancy for power, network, etc. is also expensive and maintenance prone. When you are opting cloud, everything said previously is just vanished from your plate. Cloud at single entity level like single server, storage disk, etc is already redundant. Nothing to be done and no extra cost is being billed to you for it. For your infra design requirement if you want, you can use ready-made services provided by cloud (for redundancy) and you are all set from failures.
- **Accessibility.** With an on-premise datacenter, you have very limited connectivity mostly locally. If you want access to inside entities, you need to maintain your own VPN. Cloud services have a portal with access to almost all of their services over the web. It can be accessed from anywhere with internet. Also, if you want to opt-in for a VPN, you get a pre-configured secure VPN from your cloud provider. No need for designing and maintaining a VPN!

Cloud Infrastructure

- Cloud infrastructure refers to the hardware and software components, such as servers, storage, networking and virtualization software, that are needed to support the computing requirements of a cloud computing model.

- In addition, cloud infrastructures include a software abstraction layer that virtualizes resources and logically presents them to users through programmatic means.

What are the standards for data center infrastructure?

- The most widely adopted standard for data center design and data center infrastructure is ANSI/TIA-942. It includes standards for ANSI/TIA-942-ready certification, which ensures compliance with one of four categories of data center tiers rated for levels of redundancy and fault tolerance.
- **Tier 1: Basic site infrastructure**. A Tier 1 data center offers limited protection against physical events. It has single-capacity components and a single, **non redundant** distribution path.
- **Tier 2: Redundant-capacity component site infrastructure**. This data center offers improved protection against physical events. It has redundant-capacity components and a single, nonredundant distribution path.

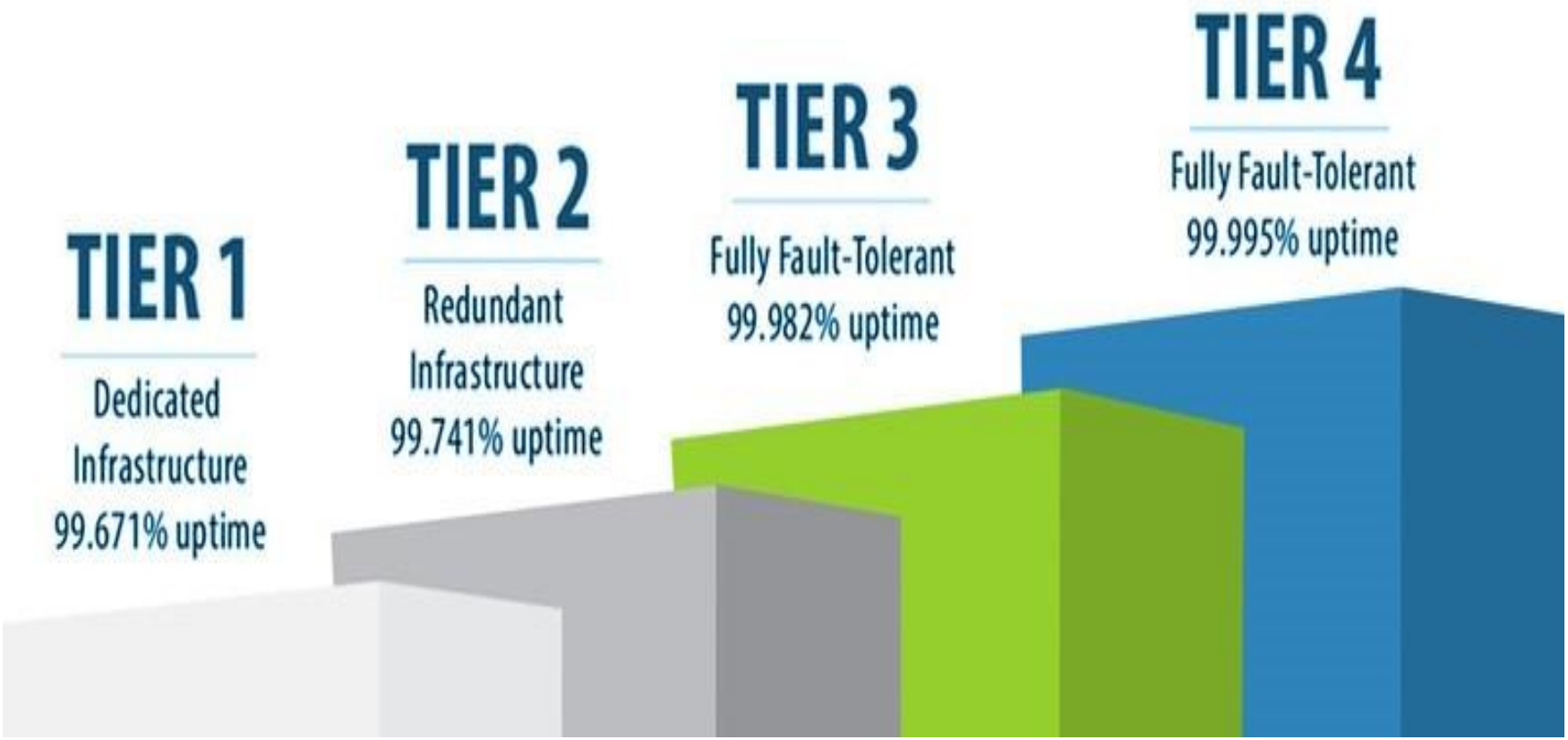
What are the standards for data center infrastructure?

- **Tier 3: Concurrently maintainable site infrastructure**. This data center protects against virtually all physical events, providing redundant-capacity components and multiple independent distribution paths. Each component can be removed or replaced without disrupting services to end users.
- **Tier 4: Fault-tolerant site infrastructure.** This data center provides the highest levels of fault tolerance and redundancy. Redundant-capacity components and multiple independent distribution paths enable concurrent maintainability and one fault anywhere in the installation without causing downtime.

The data centers

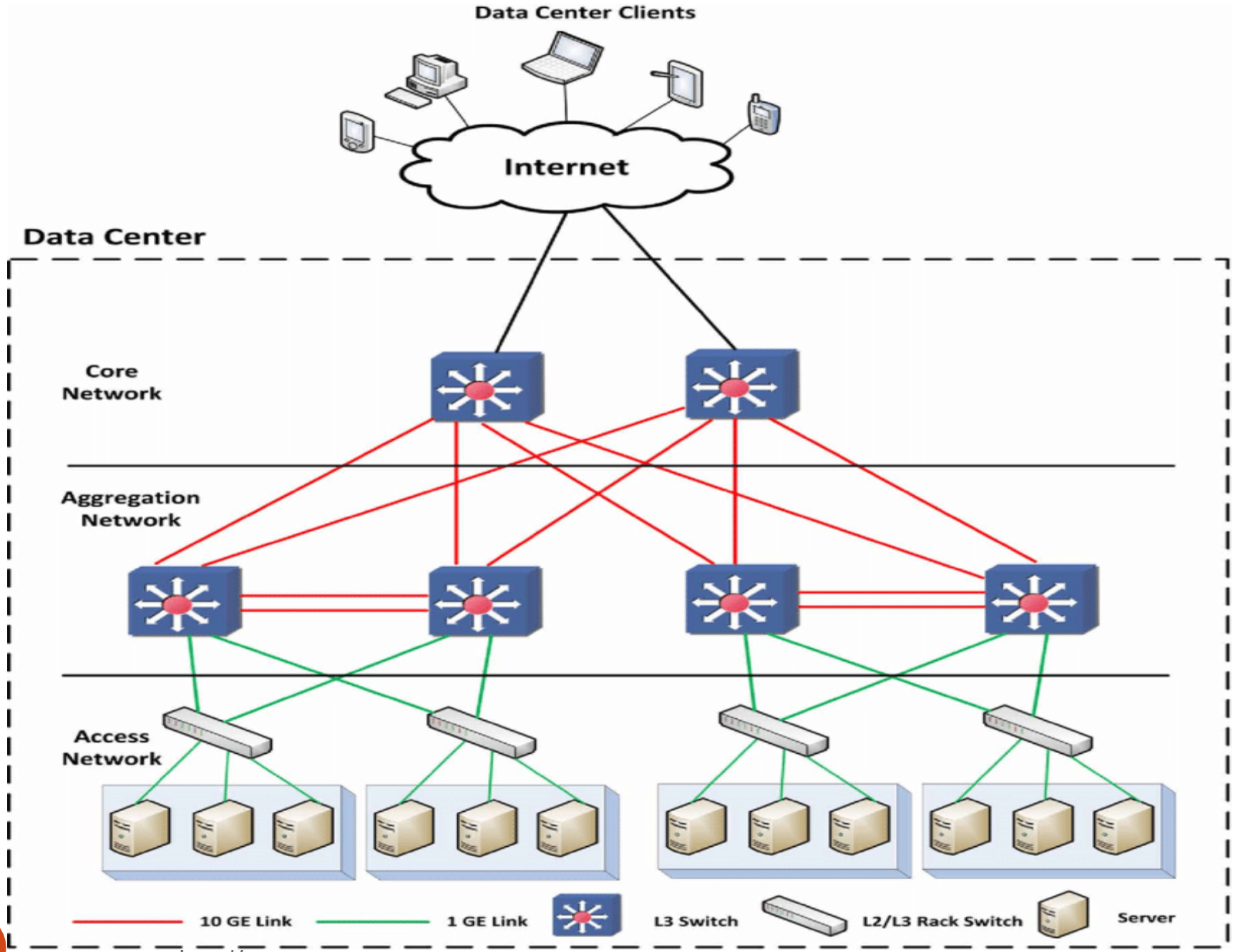
A large group of networked computer servers typically used by organizations for the remote storage, processing, or distribution of large amounts of data.

DATA CENTER TIERS



Data center networking

- **Data center networking** is the integration of a constellation of networking resources — switching, routing, load balancing, analytics, etc. — to facilitate the storage and processing of applications and data.
- Modern data center networking architectures leverage full-stack networking and security virtualization platforms that support a rich set of data services connecting everything from VMs, containers, and bare metal applications while enabling centralized management and granular security controls.


Data Center Clients
Internet
Data Center
Core Network
Aggregation Network
Access Network
10 GE Link
1 GE Link
L3 Switch
L2/L3 Rack Switch
Server

Requirements for a modern data center networking platform

- **Automation**. Achieving speed and agility in modern data centers depends greatly on automated provisioning of networking services for applications. Far faster and more reliable than a human administrator, modern networking platforms not only find the most efficient way to program a network, balance workloads, and automate time-consuming tasks, they also respond dynamically to changes in usage.
- **Consistent policies**. With modern data center networking responsible for integrating resources from edge to cloud, consistent application of policies is essential.
- **Single pane of glass**. Typically connecting resources located both on-premises, in the cloud, and at the edge, modern data center networking platforms offer centralized management from a single console.
- **Granular security**. Today's data center networking platforms often feature integrated security controls that can include micro-segmentation and IDS/IPS.
- **Global visibility**. Most data center networking platforms can display a visual representation of the network and its interconnections, which makes troubleshooting network issues much easier.

The data centers

- A data center (sometimes spelled *datacenter*) is a centralized repository, either physical or virtual, for the storage, management, and dissemination of data and information organized around a particular body of knowledge or pertaining to a particular business.
- The terms "cloud" and "data center" may sound like interchangeable technical jargon or trendy buzz words referring to the same infrastructure, but the two computing systems have less in common than the fact that they both store data.

A cloud and a data center

- The main difference between a cloud and a data center is that a cloud is an off-premise form of computing that stores data on the Internet, whereas a data center refers to on-premise hardware that stores data within an organization's local network.
- While cloud services are outsourced to third-party cloud providers who perform all updates and ongoing maintenance, data centers are typically run by an in-house IT department.

Need a cloud or a data center 1/2

- A data center is ideal for companies that need a customized, dedicated system that gives them full control over their data and equipment. Since only the company will be using the infrastructure's power, a data center is also more suitable for organizations that run many different types of applications and complex workloads.
- A data center, however, has limited capacity -- once you build a data center, you will not be able to change the amount of storage and workload it can withstand without purchasing and installing more equipment.

Need a cloud or a data center 2/2

- A cloud system is scalable to your business needs. It has potentially unlimited capacity, based on your vendor's offerings and service plans.
- One disadvantage of the cloud is that you will not have as much control as you would a data center, since a third party is managing the system.
- Furthermore, unless you have a private cloud within the company network, you will be sharing resources with other cloud users in your provider's public cloud.

Cloud vs. data center costs

- For most small businesses, the cloud is a more cost-effective option than a data center. Because you will be building an infrastructure from the ground up and will be responsible for your own maintenance and administration, a data center takes much longer to get started and can cost businesses $10 million to $25 million per year to operate.
- Unlike a data center, cloud computing does not require time or capital to get up and running. Instead, most cloud providers offer a range of affordable subscription plans to meet your budget and scale the service to your performance needs. Whereas data centers take time to build, depending on your provider, cloud services are available for use almost immediately after registration.

Categorizing the data centers

https://uptimeinstitute.com/

The Uptime Institute categorizes the **data centers** by four levels: **Tier** I, **II**, **III** and IV. These levels correspond to a certain number of guarantees on the type of hardware deployed in the **data center** to ensure redundancy. Availability: 99.67%

The Uptime Institute has categorized data centers into four hosting tiers:

- **Tier I Data Centers:** Data centers with Tier I topology offers single uplink and servers, with 99.671% uptime. However, these data centers are non-redundant, catering to basic business demands. As a result, any unwarranted failure in the capacity system thwarts the ongoing performance.
- **Tier II Data Centers:** These modern data centers have single, non-redundant path for power source. Data centers listed with this topology offers redundant capacity components to ascertain smooth access, with 99.741% network uptime.
- **Tier III Data Centers:** Equipped with redundant components with manifold power and cooling options, these data centers can efficiently and expeditiously switch to maintain backup paths ensuring 99.982% network availability.
- **Tier IV data Centers:** These are fault -tolerant data center having multiple power and environment control channels with activedata backup options, providing 9.995% network availability.

Categorization of data centers

- **Tier 1**: composed of a single path for power and cooling distribution, without redundant components, providing 99.671% availability.
- **Tier II**: composed of a single path for power and cooling distribution, with redundant components, providing 99.741% availability
- **Tier III**: composed of multiple active power and cooling distribution paths, but only one path active, has redundant components, and is concurrently maintainable, providing 99.982% availability
- **Tier IV**: composed of multiple active power and cooling distribution paths, has redundant components, and is fault tolerant, providing 99.995% availability.

Categorizing the data centers

- Tier 1 to 4 data center is a standardized methodology used to define uptime of data center and useful for measuring: Data center performance, Investment, and ROI (return on investment)
- Tier 4 data center considered as **most robust and less prone** to failures. Tier 4 is designed to host mission critical servers and computer systems, with fully redundant subsystems (cooling, power, network links, storage etc) and compartmentalized security zones controlled by biometric access controls methods.
- Naturally, the simplest is a Tier 1 data center used by small business or shops.

What kind of upfront costs are associated with building your own data center?

- **Network connection cost** – you'll have to pay for fiber on-site from one more ISP.
- **Power** – this expense accounts for 70-80 percent of the total costs of running a data center, and is also highly variable by region.
- **Data center staffing** – around-the-clock monitoring, on-site maintenance and equipment optimization requires a dedicated and responsive operations staff, and accounts as the second largest expense after power.
- **Annual facility and infrastructure maintenance** – a more unpredictable cost of a data center ranging from 3-5 percent of the initial construction cost. Repairs and additions are expected around the third year of operation.