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Cloud Computing

Learning Objectives

- Describe what the Cloud is and what computing services are supported.
- Describe how distributed computing enhances performance and reliability.
- Identify and explain the three major sections of Cloud computing services: SaaS, PaaS, and IaaS

Cloud Economics and Computing as a Utility

Cloud is the commercial availability of individual computing services delivered remotely.

The services include, but are not limited to:

- Desktops
- Disk and storage
- Processing
- Networking
- Database and other services

Cloud supports a "on demand" model.

In other words, customers can use as many of the services as needed, and they are only charge for what is used.

For the customer, this represents a huge savings in computing infrastructure, hardware, software licensing and time.

This model also delivers computing scalability when needed, without the high overhead, and fixed costs that accompanies IT infrastructure.

Delivering Cloud Services

- Cloud services are delivered remotely, almost always, from off-site data centers.
- The delivery of the services is by way of the internet
- The "Cloud" has been a been a symbol for internet connection for years.

Scalable Compute and Storage Services

There is no question that Cloud economics are favorable.

The use of the computing services is charged either by the hour, or by subscription.

Cloud computing is 100% variable costs.

Firms can add services as needed, and even reduce services as needed to manage budgets.

Scalable Compute and Storage Services

- Cloud and other remote services are not a substitute for your device's native hardware and software.
- You, likely, have several devices, each with its own physical hardware, native operating system, and native software.
- The native hardware and software are called local resources.
- Any services accessed over the network are remote services.

Scalable Compute and Storage Services

The scalability of Cloud services makes it possible to manage computing infrastructure.

Infrastructure is an enterprise's entire collection of hardware, software, networks, facilities and related equipment used in application development, operation, monitoring, and/or support of information technology.

Cloud allows firms to add and reduce computing services as needed.

This is the definition of managed services, or managed infrastructure.

Scalable Cloud Computing and Storage Services

Scalable computing and storage services is an offering of Cloud computing. Virtualization makes it possible to scale up computing resources on-demand. This allows firms to add new computing resources just when they need it, and manage costs. The same is true for storage. Cloud makes it possible for firms to obtain more disk for storage, when it is needed.

For more information, explore the following link:

What is Cloud Computing?

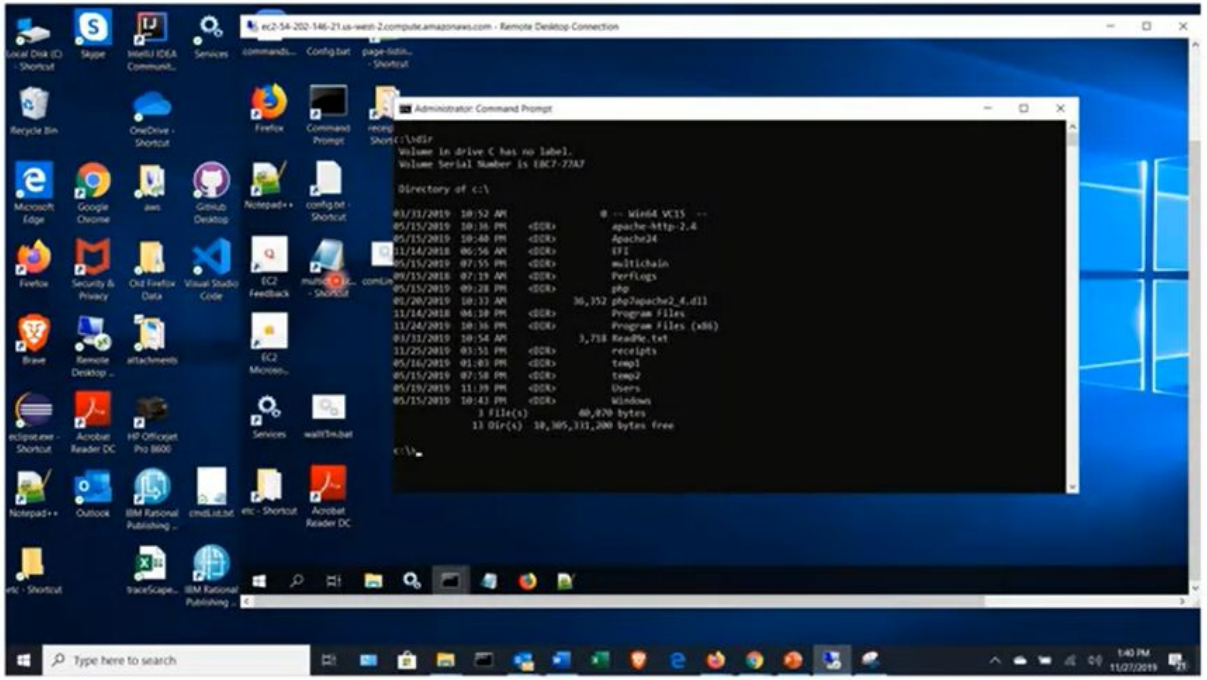
Distributed Computing for Performance and Reliability

- Often users cannot detect when computing services are Cloud services.
- Cloud services such as disk, networking, or memory are transparent to the user.
- Desktop services are reached by way of a remote desktop connection.

Distributed Computing for Performance and Reliability

Cloud desktops can be run from users' native desktops.

This greatly increases the computing resources for users.



Distributed Computing for Performance and Reliability

Almost all Cloud services are delivered in a virtualized method.

In this context, virtualization means the form of how the end user will consume it.

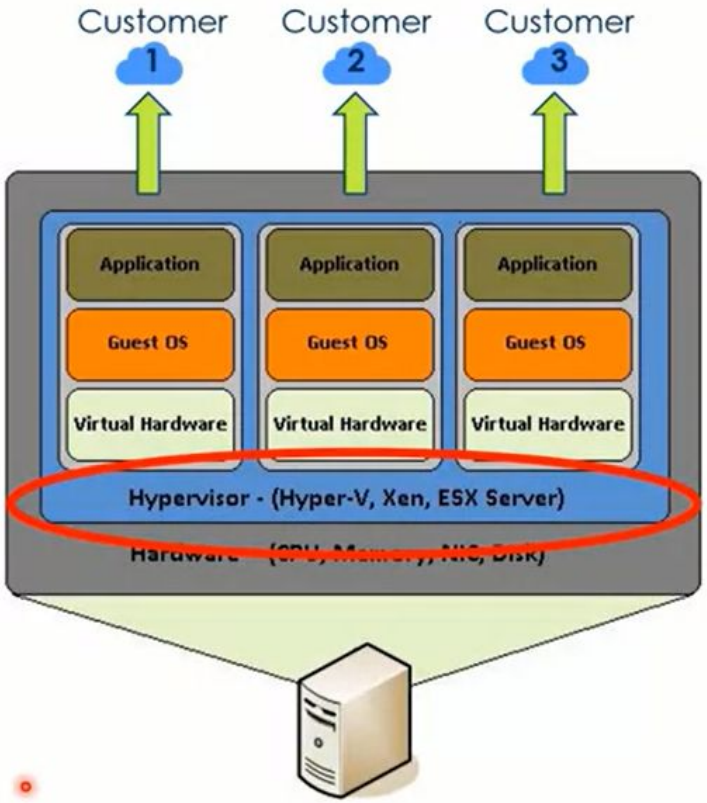
From the user's perspective, virtualized hardware processes information in an identically to physical hardware.

Virtual hardware is a part of the Cloud provider's, or data center's physical hardware, allocated to the customers for a periods of time, through the day.

Virtual processing shares the Cloud providers:

- Processing hardware.
- Disk and storage
- Memory
- Networking
- Desktop

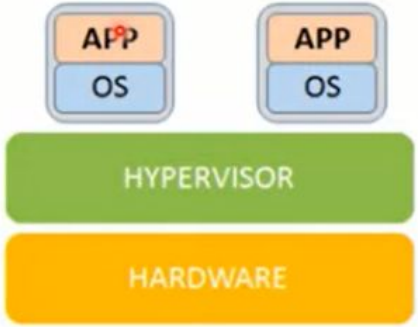
Distributed Computing for Performance and Reliability



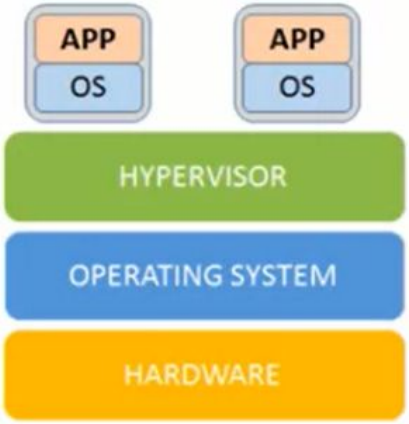
A Hypervisor is product run by the Cloud provider to allocate the services to individual instances to be consumed by the customer.

There are two types of Hypervisors:

- Type 1 runs directly on the hardware. The Hypervisor also provides the operating system.
- Type 2 the Hypervisor is managed by the operating system, like any other application.



Type 1 Hypervisor



Type 2 Hypervisor

Distributed Computing for Performance and Reliability

Managed infrastructure allows a firm to administer hardware and other services the exact same as managing software.

Software can be installed as needed, at a time when needed, with very little overhead.

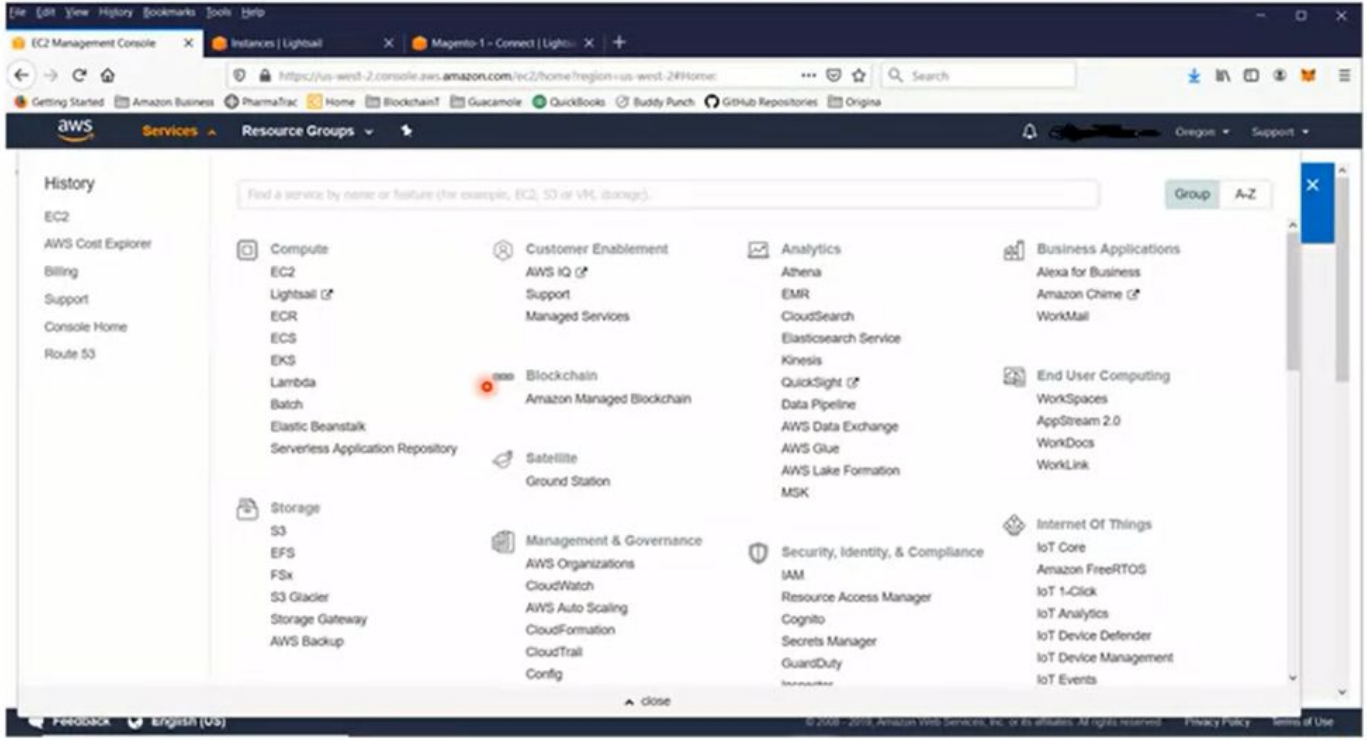
Software licenses can also be administered as needed.

Physical local hardware has a large overhead and allocated fixed costs when it is installed.

The cost is high enough that firms must install hardware the exceeds the firm's current needs so the firm can "grow into it".

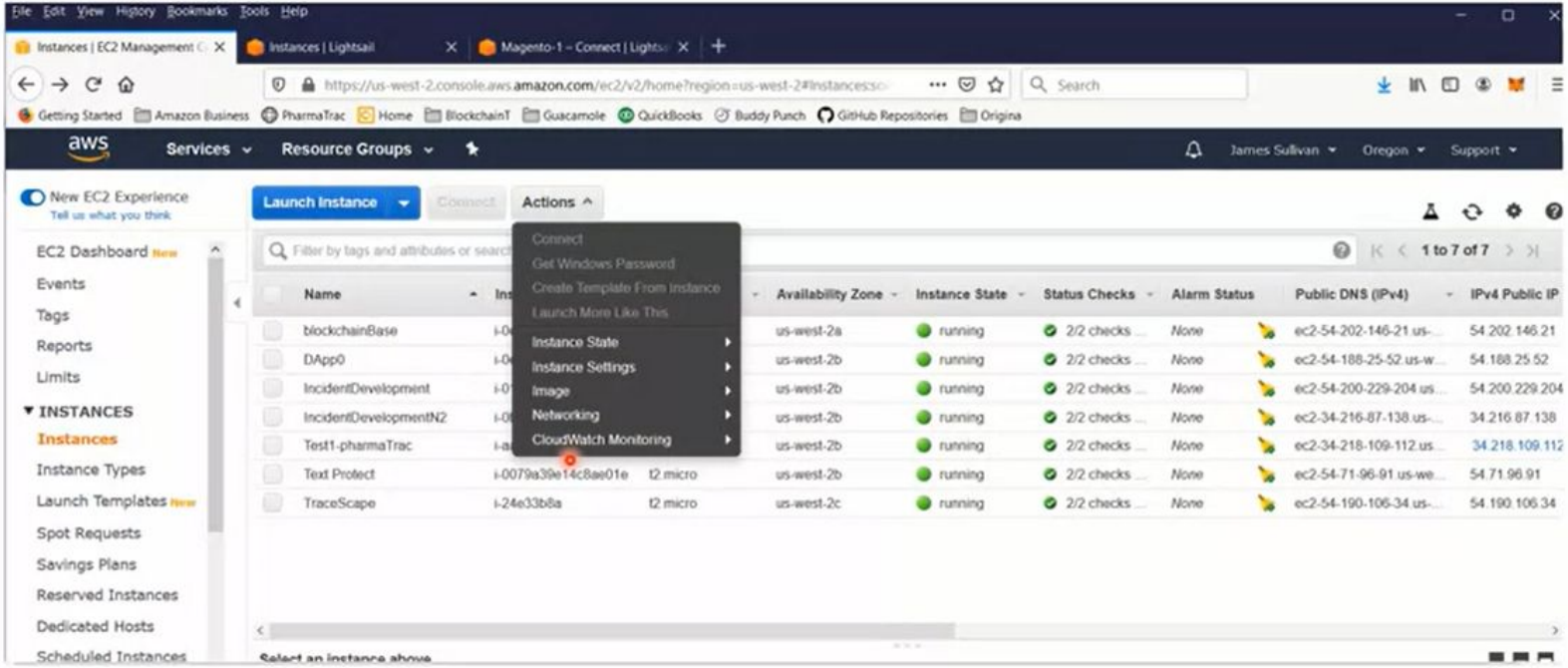
Distributed Computing for Performance and Reliability

Cloud provides rich consoles that allow administrators to manage the firm's infrastructure.



Distributed Computing for Performance and Reliability

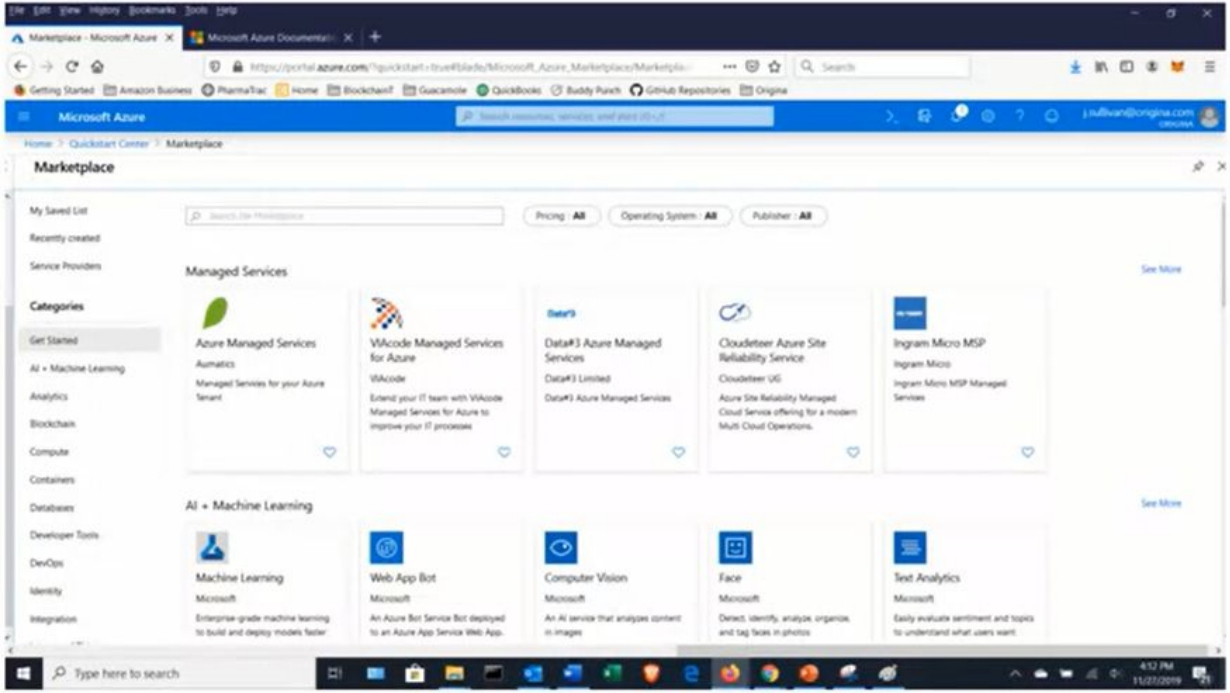
The console allows operators and administrators access to Cloud service offerings and to add or remove as services that are part of the firm's infrastructure.



Distributed Computing for Performance and Reliability

Services offerings from Azure.

- AI
- Analytics
- Blockchain
- Virtual Servers
- Databases
- Developer Tools
- DevOps
- Identity Management
- Internet-of-Things
- Networking
- More



Distributed Computing

Distributed computing is a field of computer science that studies distributed systems. A distributed system is a system whose components are located on different networked computers, which communicate and coordinate their actions by passing messages to one another. The components interact with one another in order to achieve a common goal. Three significant characteristics of distributed systems are: concurrency of components, lack of a global clock, and independent failure of components. Examples of distributed systems vary from SOA-based systems to massively multiplayer online games to peer-to-peer applications.

A computer program that runs within a distributed system is called a distributed program (and distributed programming is the process of writing such programs). There are many different types of implementations for the message passing mechanism, including pure HTTP, RPC-like connectors and message queues.

Managed Infrastructure

As discussed, Cloud provides offer a Console with a suite of Cloud computing services.

The services can be categorized into three major sections:

- Software-as-a-Service (SaaS)
- Platform-as-a-Service (PaaS)
- Infrastructure-as-a-Service (IaaS)

Each of these sections consists of a large list of service offerings for software, computing, development services, and more.

Managed Infrastructure - SaaS

Software-as-a-Service (SaaS) continues to be a very popular Cloud service.

SaaS software products are hosted by a third party and made available to users over an internet connection.

SaaS is a method for delivering Software product services based on a subscription model.

With SaaS, firms are only charged for each user that needs the software products.

Managed Infrastructure - PaaS

Platform-as-a-Service (PaaS) is a popular developer offering.

PaaS delivers development platforms to firms.

PaaS enables firms to run and develop software systems without the complexity having to install and maintain a developer platform.

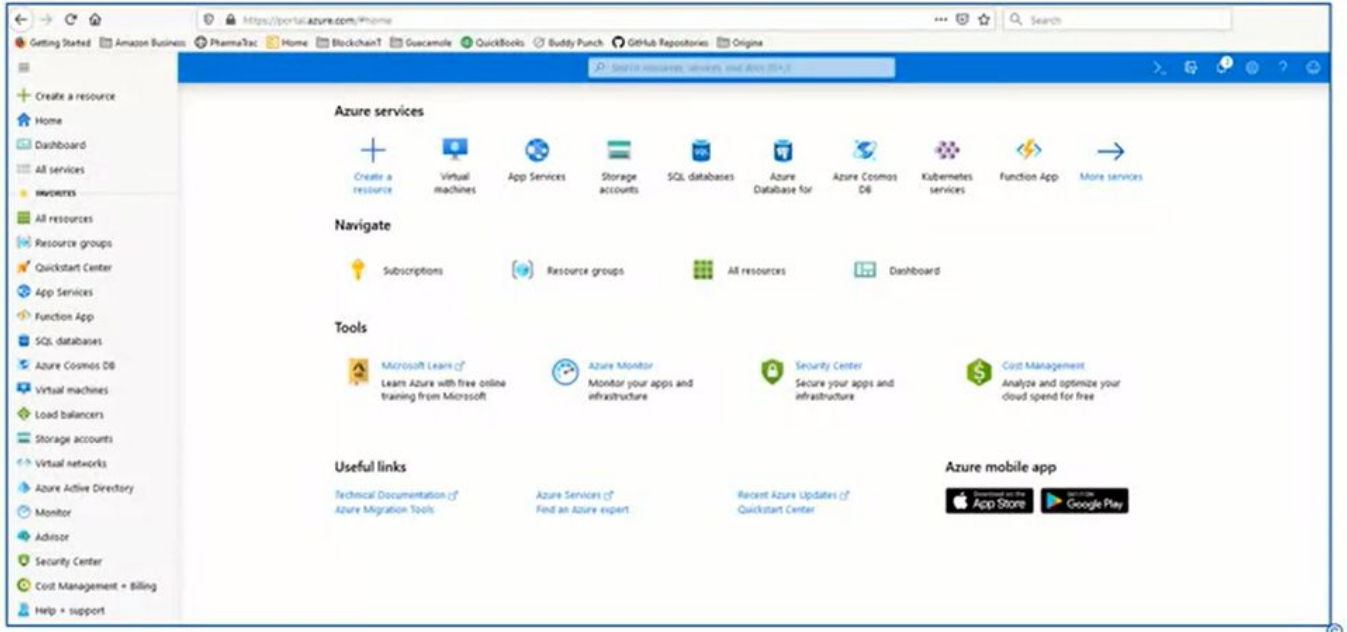
PaaS includes delivering networking, virtual servers, storage, operating system (OS), middleware such as Java or .NET development or runtime environment, database and other services to host the customer application.

Managed Infrastructure - IaaS

- Infrastructure-as-a-Service (IaaS) is another popular category of Cloud Computing.
- IaaS provides the basic layer of computing.
- IaaS closely resembles a typical outsourcing model.
- IaaS services include:
  - Outsourcing of Infrastructure
  - Hosting Services
  - Database Services
  - Networking and Storage services.

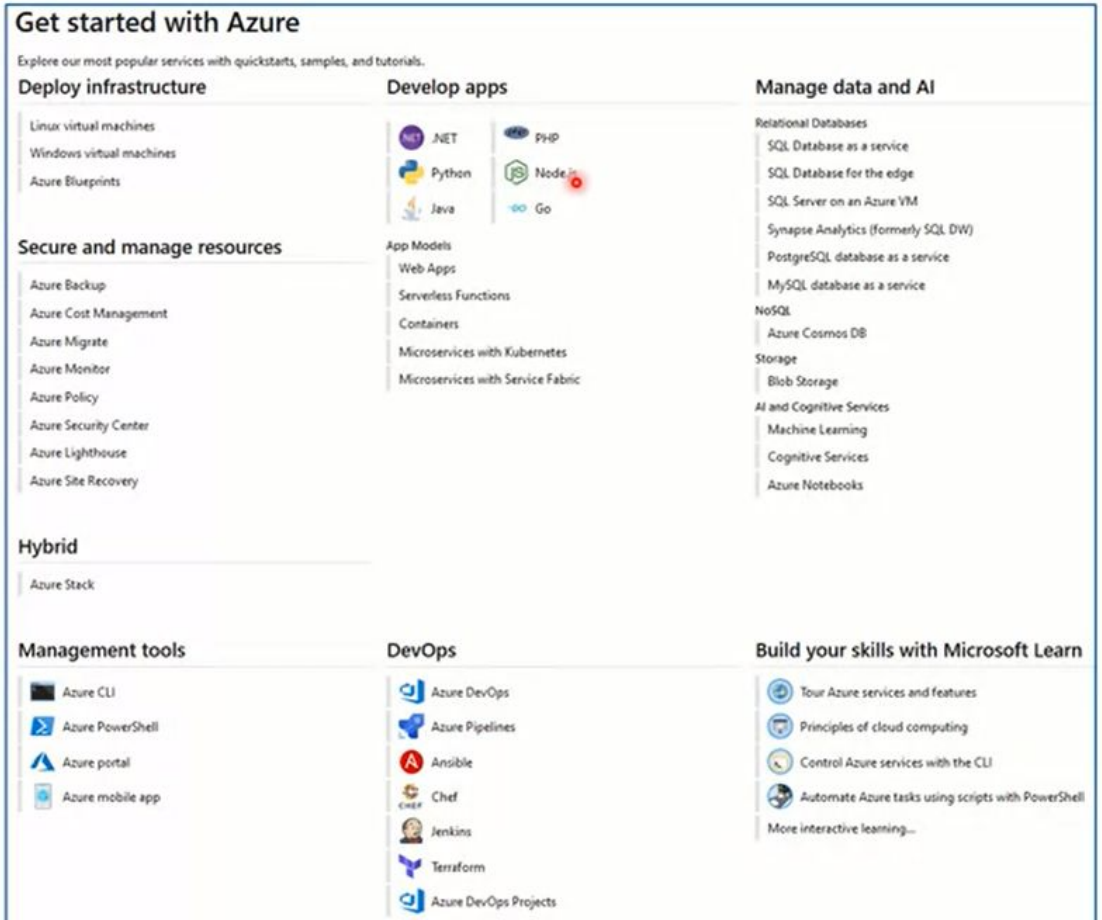
Azure Services and APIs

- Microsoft Azure is an example of Cloud Computing offering.
- Azure offers a full suite of services for Software, Platform, and Infrastructure.
- Azure features a rich, intuitive console for Cloud administration.
- Azure also offers cost management, and metrics.



Azure Services and APIs

Azure includes interfaces for several services including developer, DevOps, Data, Artificial Intelligence and more.



Azure Services and APIs

- Azure offers an API suite to interact with its Cloud services.
- The API empowers business partners to build costume interfaces to Azure services including user management, and metrics.
- The Azure Rest API gives users the ability to make calls to Azure using cURL, and http request/response.
- Customers can also use the API to make calls to run PowerShell applications.
- For more Azure API information consult the API "docs": https://azure.microsoft.com/en-us/services/api-management

Azure and APIs

Open the links below to learn more about the features and services provided by Azure.

Services and features of Microsoft Azure

Microsoft Azure's API Management

More features of APIs

Video: Azure APIs. Please watch the video below. The video is Microsoft's introduction to the Azure API.

Azure APIs

Assignment: View the Azure Cost Calculator

View the Azure cost calculator

This exercise will take you through the steps to add Azure Cloud services, and associate with a cost.

Navigate to link: https://azure.microsoft.com/en-in/pricing/calculator/

- Click: Virtual Machines

- Observe the cost, as it changes.

- Scroll Down, and view the Estimate panel for Virtual Machine

- Under Billing Options, review the number of Virtual Machines, Hours, and cost to the right.

- Increase the number of Virtual Machines to 2, and reduce the hours to 500.

Levels of Managed Services

IaaS

Infrastructure as a Service (IaaS) resembles a typical outsourcing model.

IaaS offerings include virtual servers, desktops, security, and networking.

IT Infrastructure involves efforts that require large investments to deploy, maintain and upgrade.

IaaS makes it possible for firms of any size to have the same infrastructure as any large firm.

IaaS

- Common IaaS Use Cases: Development and Test environments.
- IaaS provides a true single environment for all development and test efforts.
- Develop and testing in an environment that emulates production is the best scenario for quality.
- The IaaS approach uses virtualization to maintain consistency.
- With virtualization it is possible to manage hardware like software.
- Therefore an environment can be templated, and copied as many times as needed.

IaaS

- Application Hosting.
- IaaS provides virtual servers for application hosting.
- IaaS offers runtime servers that can be deployed or scaled up as needed.
- Application hosting can be for native, web, or mobile applications.
- This same approach can be used for storage and backup.
- IaaS delivers the environments, disk space, and memory to enable data backup and recovery.
- Resources for data backup can be deployed as needed.

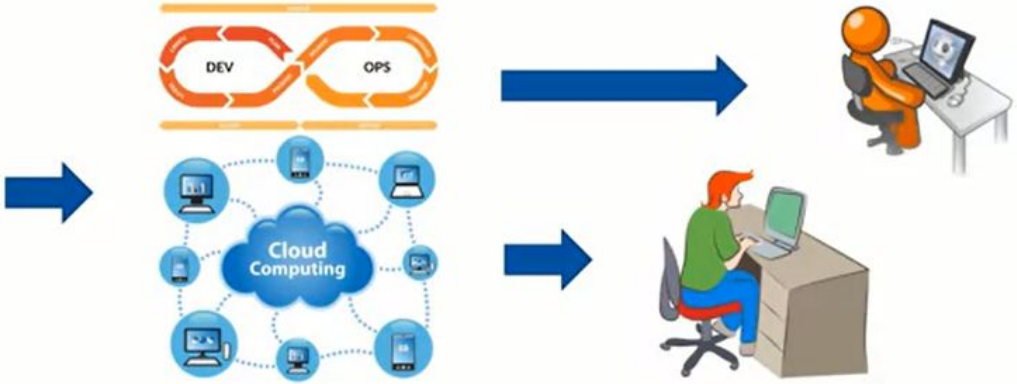
IaaS Business Advantages

- Savings and better results
  - Industry best practices for business continuity.
  - Respond sooner to changing business conditions
  - Keep business resources focused on core business.
  - Expert Technical staffing and/or consulting.
  - Faster time to market with applications, and other information assets.

- Examples of IaaS include:
  - AWS
  - Azure
  - Google Cloud

PaaS

- Platform as a Service (PaaS): delivers firms standard and "Top of the Line" development frameworks, and tools.
- Firms can implement development environments that match their needs.
- These development environments can come prepackage with the latest and best tools for application development and maintenance.



PaaS

- PaaS Business Advantages include lower costs, expertise, and lower overhead investment and effort.
- Multiple Operating System development at the same cost.
- Pay-as-you-go, or rental, options for sophisticated enterprise software.
- Enables geographic, "around the clock" development using the same investment.

- Use of an "out-of-the-box" application development life cycle process and tools also in a Pay-as-you-go model.
- Release applications using IaaS.
- Examples of PaaS: AWS Elastic Beanstalk, Windows Azure, Heroku, Force.com, Google App Engine, Apache Stratos.

SaaS

Software as a Service (SaaS) is the Cloud Computing model where a 3rd party hosts applications for the purpose of offering them to customers on-line.

SaaS is the most familiar variety of Cloud Computing to all users.

SaaS delivers enterprise software at a subscription price.

SaaS offerings are very common.

Accounting, Conference/meeting tools, time tracking, Payroll and other products are offered as SaaS.

SaaS also has wide market share with consumers.

SaaS

- SaaS eliminates the need for the business to install, host and maintain the software products.
- As technology advances, SaaS makes it possible for firms to have access to more technology products.
- In many cases, SaaS delivers technology that firms could not normally support, in the convectional sense.
- SaaS also delivers expertise and support.
- SaaS examples: Gmail, Office 365, SalesForce, PayCom, QuickBooks.

FaaS

- Function as a Service (FaaS) is a category of Cloud computing that is similar to Platform as a Service (PaaS).
- FaaS provides an application development environment, in the form of microservices.
- FaaS differs from PaaS in that it provides computing dynamically, on-demand.
- Customers only pay for the time that environment is used.
- FaaS is offered as runtime services.
- FaaS providers processing data, they do not store data.
- The environment stops during idle time, and customers do not incur any costs during idle time.

FaaS

FaaS is also referred to as "serverless" computing.

FaaS shields costumers from underutilizing Cloud servers.

FaaS can be slow at times.

If a runtime environment is stopped, and a request is made, the runtime environment must start up.

The start up time is generally only a few seconds, but it is not immediate, and often this is an immediate world.

Examples of FaaS include: AWS Lambda, Google Functions, and Azure Functions.

Disadvantages

- Cloud Computing does have disadvantages.
- The fact that Cloud Computing services are offered by a 3rd party makes firms dependent on the Cloud provider
- Security can be an issue if Cloud providers do not take necessary steps to guard data.
- The firm's data is under control of the Cloud provider.
- There is limited ability to move data away from the Cloud provider.

Levels of Managed Service

Infrastructure as a Service (IaaS) is a category of Cloud Computing where computing infrastructure is used by customers on a "pay-as-you-go" basis. Often IaaS is considered outsourcing. IaaS is scalable to meet the needs of customers. With IaaS, customers can have all the same computing services as very large firms.

Platform as a Service (PaaS) is a category of Cloud Computing that delivers development environments and tools for developing applications. PaaS delivers a pay-as-you-go suite of tools to firms of any size. The development tools can be the top line products that are very expensive.

Software as a Service (SaaS) is a category to of Cloud Computing where a 3rd party hosts software products, and makes them available to users over the internet. SaaS offers a pay-by-user, and pay-by-month options. These options are much more efficient than the perpetual license model offered by many software vendors.

Function as a Service (FaaS) is a very specialized category of Cloud Computing. FaaS delivers real time functionality to firms, when the functionality is needed. With FaaS, the customer does not pay for idle time. During idle time the processing stops. The processing starts again when the user requests the functionality. Only paying for "up time" is a major difference between FaaS, and IaaS. With IaaS, customer pay for the computing infrastructure with it is active, or inactive.

Assignment: Create a Free Azure Account

Create a free account on Microsoft Azure, https://azure.microsoft.com/en-us/free

Click "Start Free" and create a free Azure account.

WARNING: You will be required to enter a credit card even for a free account. If you do not intend to keep the Azure account, you must cancel within 30 calendar days!!!!

Once your free account is confirmed, navigate to: https://portal.azure.com/#home

This is the Azure portal.

Observe ALL the Azure services on the portal.

Click the "Virtual Machines" button.

WARNING: DO NOT create any Virtual Machines, or other resources. There will be a fee.

Only observe the Create Virtual Machine button.

This is how you would create a virtual server on Azure.

Quick Start for creating a Windows virtual machine on Azure. Click on

link: https://docs.microsoft.com/en-us/azure/virtual-machines/windows/quick-create-portal.

Read the Quick Start article.

Close all browsers.

Deployment Models

Different deployment models of cloud computing . Private and public deployment models, hybrid cloud, HPC cloud and big data cloud.

Learning Objectives

- Understand the differences between cloud deployment models.
- Define High Performance Cloud Computing and its benefits.
- Explain the big data cloud and how it is a solution for data analytics.

Deployment Models

- Like most technology Cloud computing has different deployment models.
- The different deployment models allows customers to tailor Cloud services to their needs.
- Cloud Computing is quite flexible, some call it elastic.
- The deployment models allows customers to respond to some of the downsides and risks of Cloud Computing.

Private Deployment Model

Private Deployment Models

- A Private Cloud is a Cloud computing deployment model where the firm controls or owns the data center providing the Cloud services.
- A Private Cloud does not use the public internet, Cloud services are delivered on the firm's network.
- Private Clouds enables firms to control their own data.
- Private Clouds can be physical, or virtual.
- A physical Private cloud is where the firms has physical custody of the data center where the Cloud is hosted.
- A Virtual Private Cloud (VPC) is where a public cloud provider dedicated a set of computing resources for a specific customer.

Private Deployment Models

- Virtual Private Cloud (VPC) uses a virtual private network (VPN) approach to deliver Cloud services over the firm's network.
- The VPN allows firms to extend their network to outside data centers using internet connections.
- The firm does not own or has custody of the computers in the data center.
- With VPCs, the Cloud provider has control of the data.
- Amazon, IBM, Azure and Google all offer VPCs.

Public Deployement Model

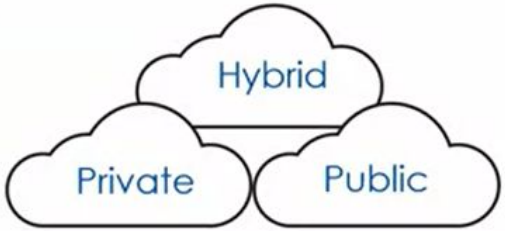
Public Deployment Models

- A public Cloud is a deployment model where a firm uses the services of a 3rd party provider.
- The Cloud computing services are delivered over the public internet.
- Public Cloud offerings are generally available to all.
- As discussed, Public Cloud services are invoiced on only what is used.
- Public Clouds are typically data centers, in a seismically stable location.

Hybrid Cloud

Hybrid Cloud

- A Hybrid Cloud is a mix of private, typically, on-premises Cloud services, and 3rd party public Cloud services.
- The private components of a Hybrid Cloud are typically commercial hardware, that have a hypervisor installed to manage the private Cloud services.



- The public component is typically a public Cloud provider such as Amazon, or Azure.
- A popular approach is for firms to use the private Cloud for key data.
- The public Cloud is used for infrastructure as a service, and provides such services as computing, and networking

High Performance Cloud Computing

HPC Cloud

- High Performance Computing (HPC) has become a popular offering of Cloud computing providers.
- HPC is actually an architecture, of arrayed computers or processors.
- The architecture runs together in a cluster.
- A cluster is a group of computers, acting as one.
- HPC uses parallel processing as a strategy.
- HPC architectures can run quadrillions (10^{15}) of calculations per second.
- A typical computer can run about 3 billion (10^{9}) calculations per second.

HPC Cloud

There are three components of HPC: computing, data storage and networking.

The Cloud's flexibility, or elasticity, supports quickly building a cluster, and dynamically adding to it if needed.

Cloud computing provides an ideal model for HPC.

As discussed, earlier Cloud can also provide the network and storage.

Big Data Cloud

Big Data Cloud

- Big Data is term for a family of strategies to analyze, extract information, or trends from large, complex data sets.
- This kind of data analytics requires large amounts of data storage, and high-performance processing.

- The Cloud can deliver a solution to store and analyze Big Data sets.
- Cloud clusters can be dynamically implemented to efficiently process the Big Data sets.
- Cloud solutions can also scale up or down as needed to accommodate the needs of the data to be analyzed.

Big Data Cloud

- The concept of a data warehouse was created to primarily to shield users from the poor performance cause by analyzing data.
- Typically the processing of data is scheduled to run off hours when users are not connected to the system.
- The processed data is then stored in the data warehouse for reporting.
- Cloud computing provides a great solution for data analytics.
- Again, Cloud's flexibility delivers an efficient solution for data reporting.

Deployment Models

The Private Cloud is Cloud computing services offered by an enterprise on its private internal network and only to select users instead of the general public. Also referred to as an internal or corporate cloud, private cloud computing gives businesses many of the benefits of Cloud computing such as: self-service, scalability, and elasticity. However, a private Cloud offered the enterprise control and customization of the data and hardware resources. The enterprise also has control over the computing infrastructure hosted on-premises. In addition, private clouds deliver a higher level of security and privacy through both company firewalls and internal hosting to ensure operations and sensitive data are not accessible to third-party providers. One disadvantage is that the enterprise's IT department is held responsible for the cost and accountability of managing the private cloud. So private clouds require the same staffing, management, and maintenance expenses as traditional data center ownership.

A Virtual Private Cloud (VPC) is an on-demand configurable pool of shared computing resources allocated by a public Cloud provider, within a public cloud, delivering Cloud computing services over a virtual private network (VPN). The VPN permits or creates a sub-network that is part of the enterprise's network. However, the VPN uses the internet as a medium for the enterprise connection. The VPN permits the enterprise to virtually work virtually in private.

A Public Cloud is a 3rd party provider that makes computing services available to any individual or business that seeks to purchase the services. The services are delivered over the public internet. Public Clouds make services available in a "pay as you go" model, where customers can scale up, or down as needed.

A Hybrid Cloud is a mix between on-premises private Cloud and services from a public Cloud provider. The mix allows the enterprise to reduce some of the disadvantages, and risks of the public Cloud. The enterprise can use the private portion of the solution to manage private or sensitive data. This can also keep control of the critical data. The private component can also reduce the reliance on a 3rd party provider.

The public component of the Hybrid Cloud typically adds infrastructure as a service. The public component delivers processing, networking, test environments, and other items. A Hybrid Cloud delivers all the advantages of Cloud computing, while still managing the downsides and risks.

High Performance Computing (HPC) is a computing strategy involving parallel processing. The parallel processing is enabled by a cluster. A cluster is a group of computers acting as one computer. The processing is shared by all the computers in the cluster. This strategy allows more calculations per second.

Big Data is the concept of analyzing complex data sets. The data sets are so complex, that only powerful computing resources can identify trends and further analyze the data. Big data also require large amounts of storage for the complex data sets. Cloud computing can deliver the computing resources to storage and process Big Data's complex data sets.

Cloud Computing Hosting Scenario

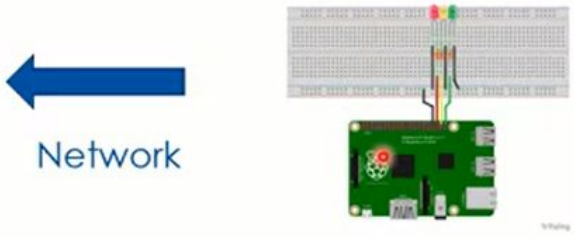
Bare-Metal computing (Single-tenant Physical Server)

Bare-metal Computing

- Bare metal is a hosting strategy where software products, including the operating system, are installed on the physical hardware.
- All software is installed on the native hardware, or bare metal.
- A laptop's native hardware and software is a good example.
- Most mobile devices operate this way.
- No virtualization is used.
- This is a time-tested reliable strategy.
- There obviously are multiple fixed costs associated with this approach.
- The team must have hardware to which they "grow into".

Bare-metal Computing

- However today's hardware is so fast, that it is highly like that the hardware will be underutilized.
- Including virtualization, allows the hardware to be more efficiently used, and accessed by more users.



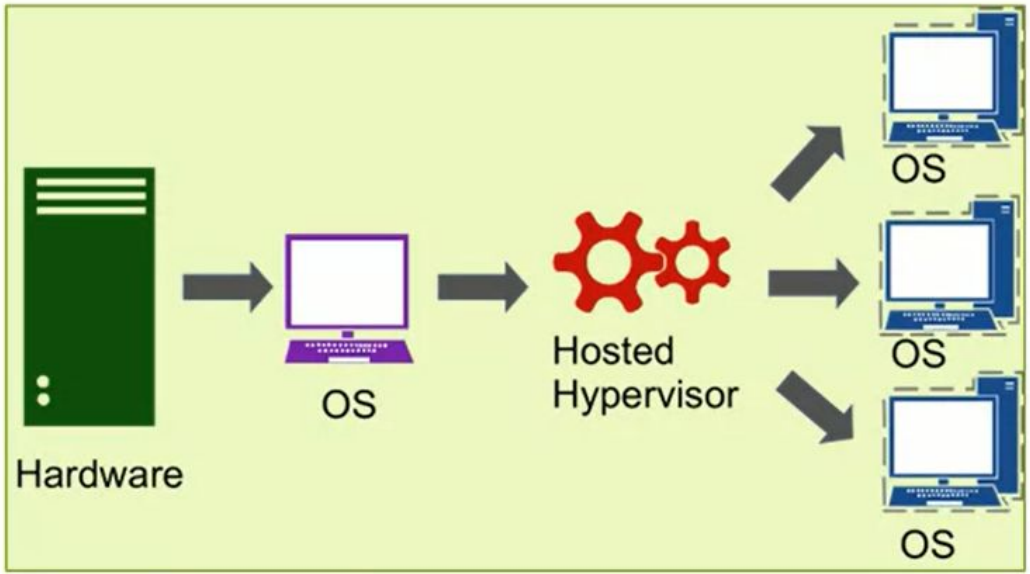
VMs, Docker and Kubernetes

VMs, Docker, and Kubernetes

Running Virtual Machines (VM) makes better use of the existing hardware.

The hypervisor manages access to the physical hardware for each VM.

This allows many instances of an operation system, and software to run on the same "bare metal" hardware.



VMs, Docker, and Kubernetes

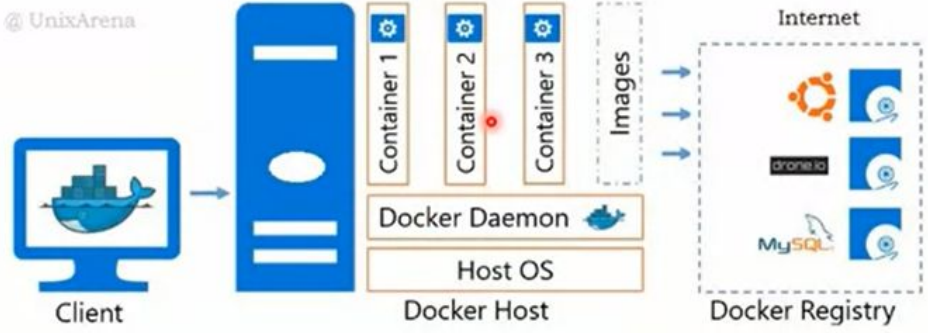
- As stated earlier, virtualization and Cloud allows the enterprise to manage hardware like software.
- Administrators can make virtual templates, of VM images.
- Multiple copies of the VM images can be made, each with their own IP address and host ID.
- Obviously, independent operating images will need a network.
- Virtualization, and Cloud provide virtual network adaptors to allow VM to communicate, identically to "bare metal" machines.
- VMs can provide stronger testing results as many copies of the live environment can be made for acceptance testing.

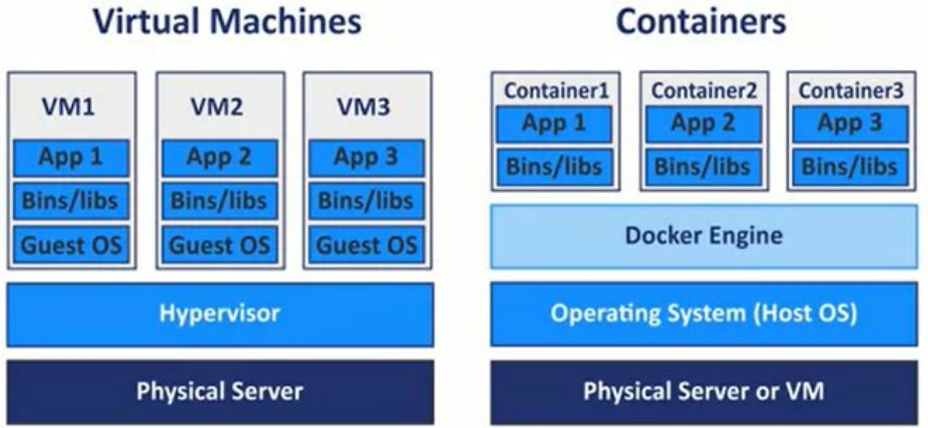
VMs, Docker, and Kubernetes

- Docker containers are a popular hosting and deployment strategy.
- Docker does not provide full VMs, however, Docker does use virtualization.
- Docker is a platform as a Service (PaaS) product that provide virtualized operating system environments called containers.
- Docker containers are 100% independent from each other, and they are bundled with their own software "bits", libraries, and other items.
- Docker container cannot run on their own.
- All Docker containers are run on a single operating system kernel called the Docker engine.
- The Docker containers are dependent on the single operating system kernel.
- The containers are much simpler than a full VM.

VMs, Docker, and Kubernetes

- Docker containers provide 100% predictability on how an application will be installed, and how it will execute.
- Once the Docker deployment pattern is established, it can be repeated and automated.





VMs, Docker, and Kubernetes

Kubernetes is a Platform as a Service (PaaS) container orchestration product.

Kubernetes can also be offered as Infrastructure as a Service (IaaS).

Kubernetes automates application deployment, scaling and maintenance.

Kubernetes supports Docker containers, and is more complex than the Docker.

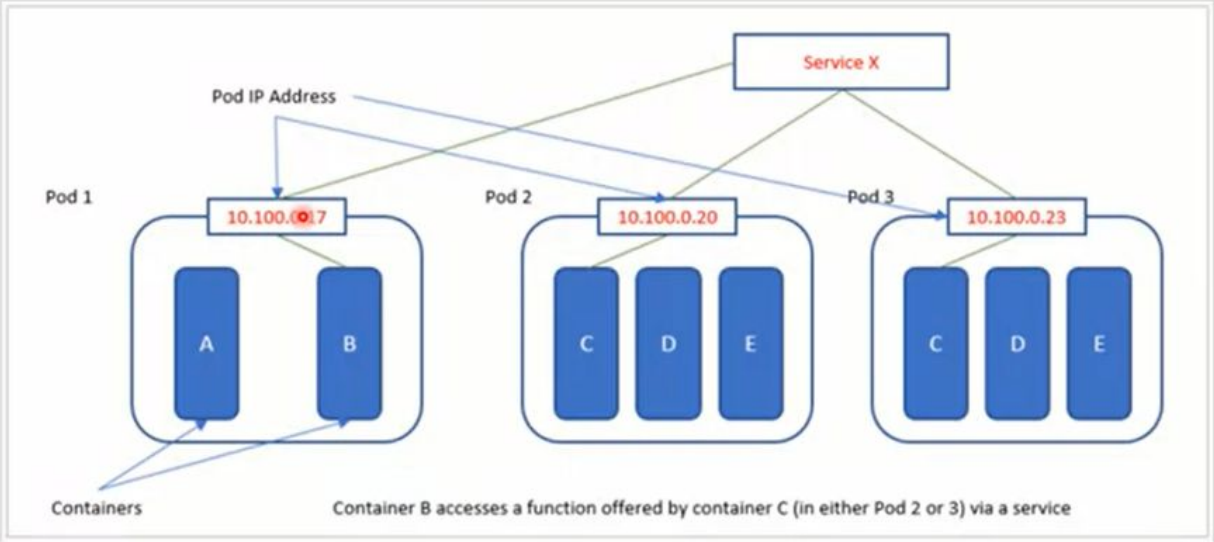
VMs, Docker, and Kubernetes

- Kubernetes is built on layers, or blocks. These are referred to as primitives.
- The blocks are built up, as the applications scale up.
- The Kubernetes architecture is based on a structure called a pod.
- Pods house containers, similar to Docker
- Pods make up Kubernetes clusters.
- A pod is independent and has its own IP address.
- A Kubernetes Service is a set of pods that work together within the Kubernetes cluster.

VMs, Docker, and Kubernetes

A Kubernetes service is a set of pods that use the cluster approach.

A service is a group of pods working as one.



AWS, GCP and IBM

Take a few minutes to read the following overview of AWS and look through the many services offered by Amazon Web Services:

Overview of AWS

AWS Services Offered

https://www.youtube.com/c/amazonwebservices/playlists

https://www.youtube.com/c/AWSTrainingCenter/playlists

To learn more about Google Cloud Platform, check out their YouTube Channel. Select and watch a few of the videos to delve a little deeper into GCP:

Google Cloud Platform YouTube Channel

For a list of what services GCP offers, read the following:

Google Cloud Computing

IBM Youtube

https://www.youtube.com/watch?v=LTGLeGHctfw&list=PLmesOgYt3nKCfsXqx-A5k1bP7t146U4rz&index=3

Cloud Problem ?

XYZ startup company has a software training product. The product will need computing resources, but XYZ does not have the budget or staff to implement the product. The firm decides they need a Cloud-based solution.

Which Cloud approach is the best? Please review the Cloud options and solutions discussed at this course.

Think about which solution you would propose.

For another project, XYZ Company needs customer data analyzed to determine which products to offer. XYZ chooses a Cloud solution.

Which Cloud option is best for XYZ? Please review the Cloud options and solutions discussed at this course.

For the next task, you'll discuss your solution and why you think it is the best option for XYZ.

Cloud solution

XYZ company has a software training product. The product will need computing resources, but XYZ does not have the budget or staff to implement the product. XYZ decides they need a Cloud based solution.

Based on the previous reading about XYZ and their needs, what do you suggest?

On Premises Computing

On-Premises Computing

- The concept of On-Premises Computing (on-prem) is the traditional computing model where all hardware is controlled by the firm.
- The computing services are delivered on the firm's network.
- Traditional on-premises computing requires large amount of up-front effort and investment.
- Often the hardware must be installed with excess capacity.
- Excess capacity is very inefficient.
- Cloud services can be delivered on-premises.
- With on-premises computing, the firm manages hypervisors and Cloud services delivered only on the firm's network.

On-Premises Computing

As stated earlier, on-premises computing enables the firm to control its data.

Cloud Computing

- Cloud services can be as simple as Software product remote hosting services.
- This service involves a one of the options of Cloud computing making use of virtualization.
- The Cloud options can be either Private, Public, or Hybrid.
- In either case, the Cloud uses one or more virtual machines to execute the software product.
- Delivery of the software services it delivered either by a public, private, or virtual private network.

Cloud Computing - Edge

Edge Computing is where computing services including processing and storage are brought physically closer to customer.

Edge computing origins come from content delivery of large data files including audio and video.

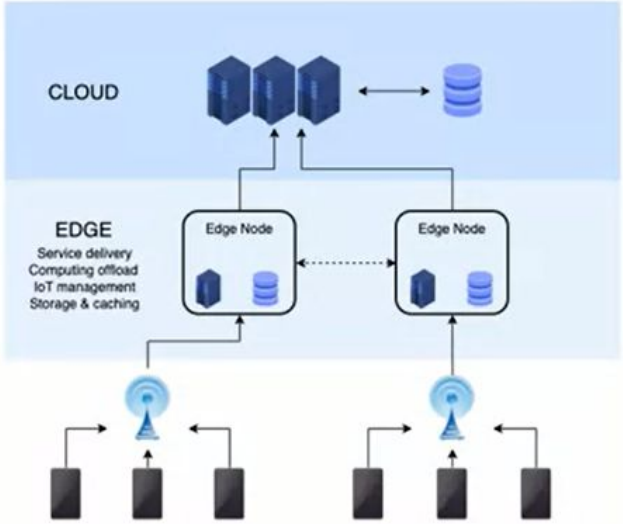
The delivery of this type of data needed to be close to users as it was subject to latency.

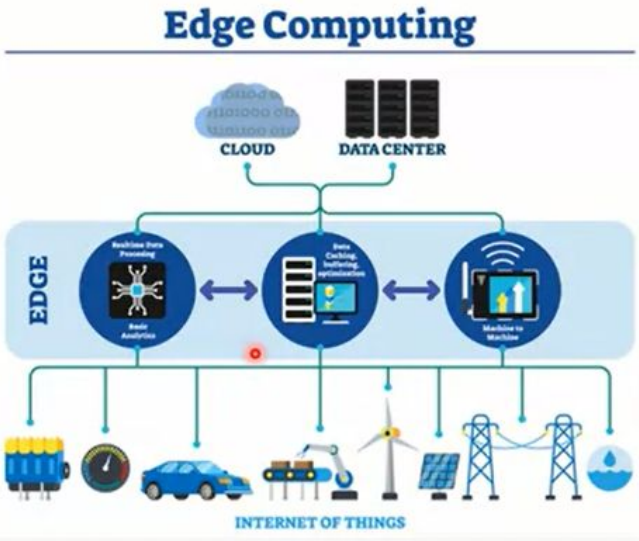
As Edge technology advanced it has moved into running software and applications, still keeping latency low.

Edge computing is popular in gaming and Internet-of-Things (IoT) as responsiveness is critical.

Cloud Computing - Edge

- Healthcare is another important Edge computing use case.
- Fast data processing, and network responsiveness is very critical in health care use cases.





On-premise Cloud vs 3rd-party Cloud Provider?

When is an on-premise Cloud better than an off-site 3rd party Cloud provider?

Best Practices and Use Cases of Cloud Computing

Best Practices and Use-Cases for Cloud Computing

- Understand the trade-offs of Cloud Computing, and what you can tolerate.
- Avoid up-front costs.
- Have a sensitive data strategy. Understand the risks if data is hosted by the Cloud provider.
- Start small and build a "Minimal Viable Cloud" solution.
- Know where the opportunities are to use Cloud to reduce costs.
- Often Infrastructure as a Service (IaaS), and Software-as-a-Service (SaaS) has the largest impact with productivity and costs.
- Use metrics and telemetry to exactly understand the value Cloud is delivering.

Best Practices and Use-Cases for Cloud Computing

Use telemetry to look for execution and runtime issues that are not obvious.

Also use telemetry to measure data points that the Cloud provider is not measuring.

Have a data mobility plan.

Best Practices and Use-Cases for Cloud Computing

- As Cloud matures, more and more use cases are applicable.
- However, there are some key use cases that are relevant for almost all users.
  - Software hosting and Software as a Service
  - On demand expertise, and support.
  - Email hosting.
  - Backup services and disk.
  - Virtual Desktops.
  - Development and test environments.
  - DevOps tools and process.

Comparing Cloud Computing Alternatives

Comparing Cloud Platform Alternatives: Azure

Today, the services from the popular Cloud platform providers are very similar, and interchangeable.

Azure is the Cloud offering from Microsoft, azure.microsoft.com.

Azure went live in March of 2014.

Azure features such services as: virtual computing, mobile desktops, storage, backup, database, development, DevOps, Blockchain, Artificial Intelligence, and more.

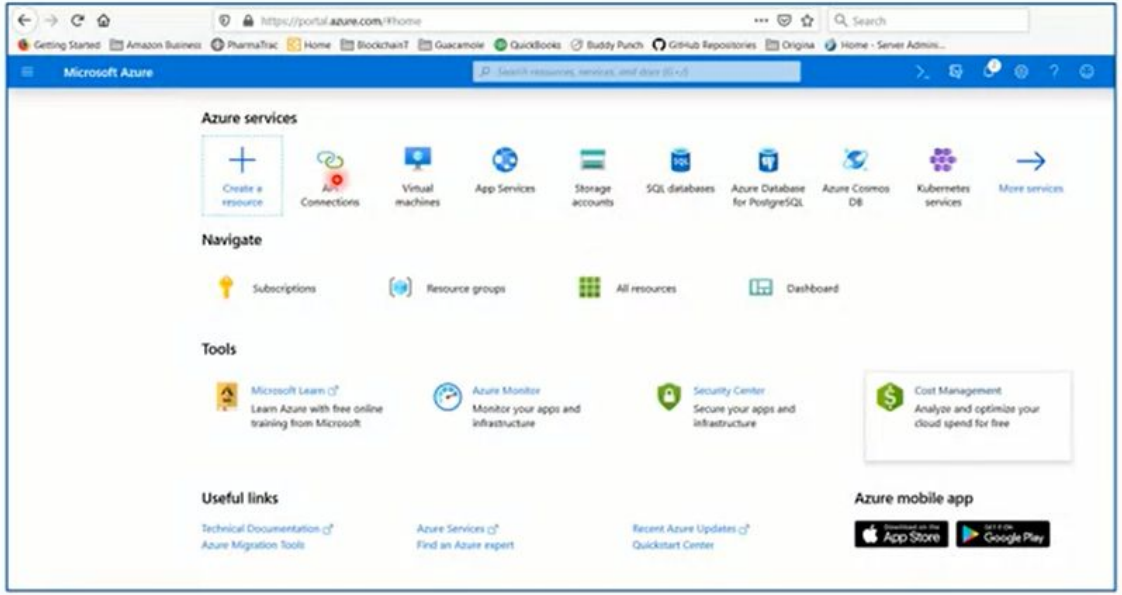
Azure offers Linux computing as well as Windows operating systems.

Azure offers packages for different sized firms from small to enterprise.

Comparing Cloud Platform Alternatives: Azure

Azure offers a rich console for administrators to manage its services.

The console tells much of the Azure Story.

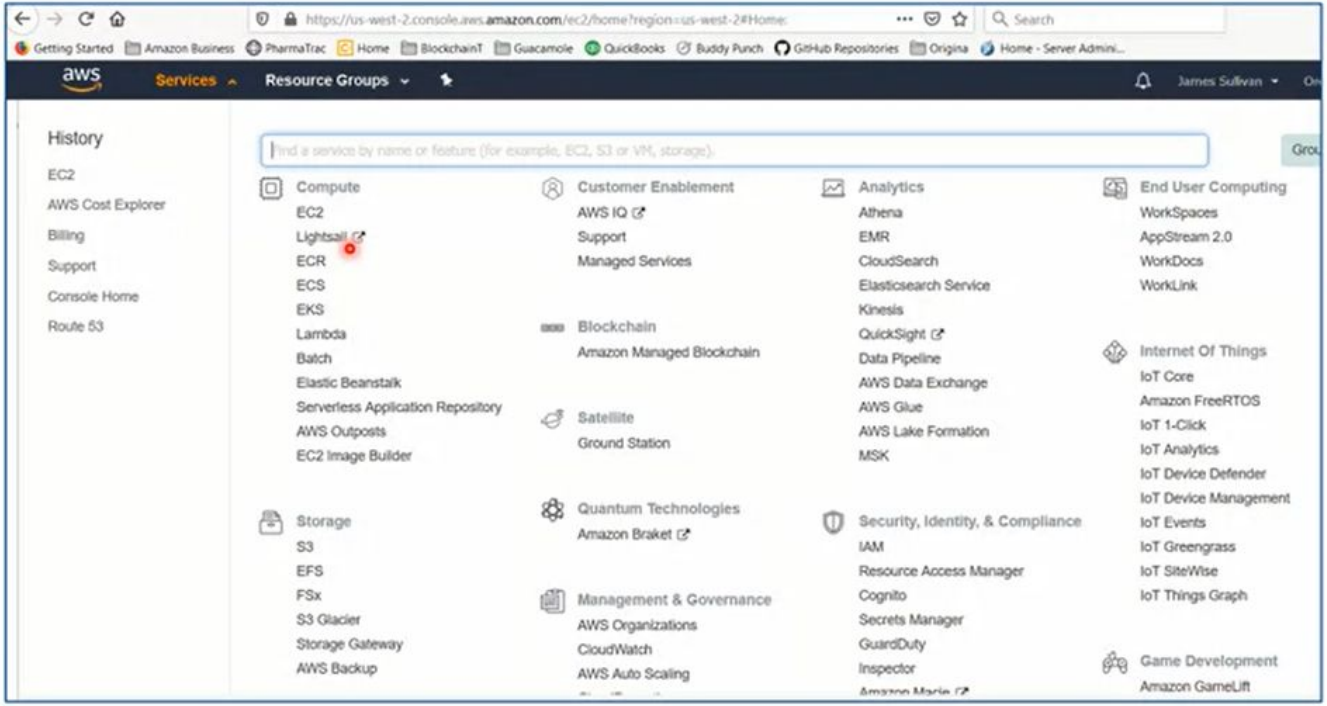


AWS Amazon Web Services

AWS (Amazon Web Sercives)

- Amazon Web Services is part e-commerce retailer Amazon.com.
- AWS offers metered, pay-as-you-go, computing services, including virtual servers, APIs, storage, networking, database, DevOps, Blockchain, Artificial Intelligence and more.
- AWS went live around March 2006.
- AWS popular "Elastic Cloud Computing" (EC2) has been used by governments, Netflix, Airbnb, and other popular applications.
- EC2, provides service including virtual desktops, clustering, networking.
- EC2 also enables teams to template running servers with a service called Amazon Machine Image (AMI).
- AMI allows team to copy and run templated images.
- AWS pricing is competitive and can fit any size shop.

AWS (Amazon Web Services)



- Administrators manage services using the AWS console.
- AWS offers varieties of: IaaS, SaaS, PaaS, FaaS.

GCP google Cloud Platform

GCP (Google Cloud Platform)

The Google Cloud Platform (GCP) provides Cloud services, such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Function as a Service (FaaS) customers.

Google lists over 100 products in their brand including:

- Application development.
- Storage and Database.
- Networking.
- Internet of Things (IoT).
- Artificial Intelligence.
- Data Analytics
- API

IBM Cloud

- The IBM SmartCloud (IBM Cloud) has had different manifestations over decades.
- Today's IBM Cloud emerged from several decades of central mainframe offerings.
- Today's IBM Cloud went live in 2010.

- The IBM Cloud offerings include IaaS, SaaS, PaaS, Private Cloud and virtual Private and Hybrid Cloud.
- The IBM Cloud offers the typical virtualization services, and also offers its products as solutions for DevOps.
- Data analytics are a major offering of the IBM Cloud.
- The IBM Cloud makes use of open standards including Open Source software as part of its solutions.
- The IBM Cloud does not offer a single console, as its Cloud offerings are so numerous.

Reading IBM Cloud

IBM Cloud

Take a few minutes to explore IBM Cloud:

https://www.ibm.com/cloud

Salesforce and alibaba

SalesForce

- SalesForce, or SalesForce.com, delivers primarily customer relationship management (CRM) Software-as-a-Service (SaaS) products.
- SalesForce.com was founded in 1999.
- Over time, SalesForce has expanded its offerings to include many other Cloud services including Platform-as-a-Service (PaaS), Lightning, Force.com and other offerings.
  - Lightning offers development environments and tools that are designed to integration with SalesForce's offerings.
  - SalesForce has also expanded to many other SaaS offerings including:
  - Community Cloud, a collaboration product for customers

SalesForce

- SalesForce has expanded to other SaaS offerings including:
  - Community Cloud, a collaboration product for customers.
  - Work.com a social network aimed at improving the lives of customers' employees.
  - An on-line app store called AppExchange
  - SaaS Help Desk, offered as Desk.com
  - A Marketing Cloud that offers Social Media, Digital, and other marketing services.
  - Blockchain offered through CRM
  - SalesForce API
- SalesForce.com pricing varies, but its services are competitive.

Alibaba

- Alibaba also offers Cloud Computing:
  - Alibaba offers typical metered, pay-as-you-go, computing services, including virtual servers, APIs, storage, networking, database, DevOps, Blockchain, Artificial Intelligence and more.
- For more information on the Alibaba Cloud, visit: https://us.alibabacloud.com

Distinguishing Factors of each Cloud Provider

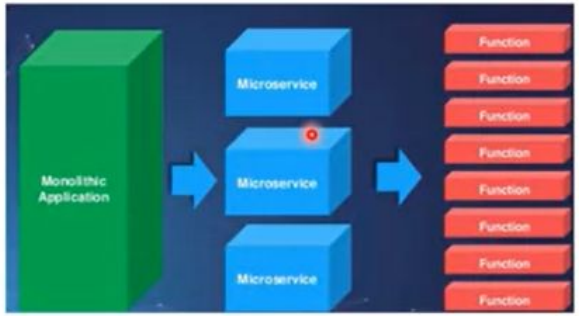
Discuss what distinguishes Azure, Amazon Web Services, IBM , Alibaba , Google Cloud from one another. It is clear what makes them similar, but in what does each Cloud provider specialize? Is there a scenario where one Cloud provider is better than the other Cloud providers?

Example: the IBM Cloud is targeted as an enterprise level solution, where the Amazon Cloud also includes tiers for small businesses.

Future of Cloud Computing

Serverless Computing

Serverless Computing

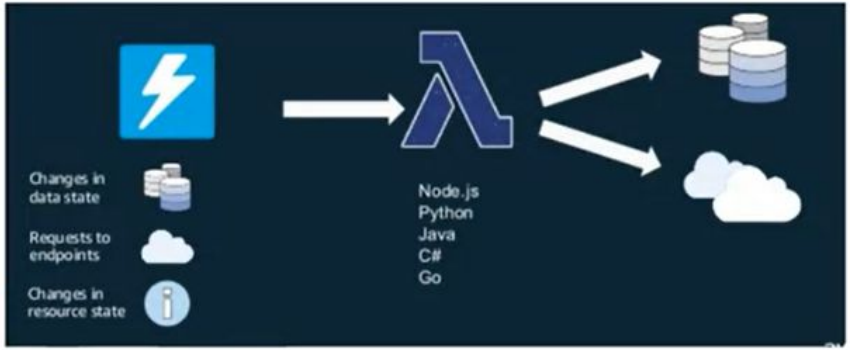


- Serverless Computing is an extension of Function-as-a-Service (FaaS).
- With Serverless Computing, the Cloud provider manages the computing resources in a way that they can be delivered in a dynamic fashion.
- Pricing is based on the runtime computing time used. Idle time is not charged.
- All of the large Cloud providers offer a form of Serverless computing.
- Recently, offerings of Serverless database and Serverless storage have become available.
- Serverless database products are general based on popular databases such as MySQL.

Serverless Computing

Serverless computing provides advantages with respect to cost, and software deployment.

Serverless computing is execution only, data is not stored with a Serverless offering.



There are trade-offs with Serverless computing:

Performance can be slow with Serverless computing, as there is startup time involved with Serverless computing, and resources are limited.

Serverless computing is often based on proprietary provider standards, therefore mobility can be a problem.

Distributed And Decentralized Applications

Distributed Applications

- Distributed Ledger Technology (DLT) has created an operating environment that is the equivalent to an operating network.
- DLT includes Blockchain technology. All Blockchains are DLT, but not all DLT is Blockchain.
- DLT is based on a network of computers called nodes.
- The nodes are able to store data in a way that it is immutable.
- The immutability comes from the concept of a hash.
- Hashing data converts it to a string of fixed length. Once data is hashed, the hash is stored on the node.
- If any data where tampered with, or hacked, this would be reflected in the hash, and other nodes can restored the attached node.

Distributed Applications

Cloud is an ideal environment for managing DLT and Blockchain nodes.

Nodes can be deployed as needed.

Many Cloud providers already offer DLT and Blockchain services.

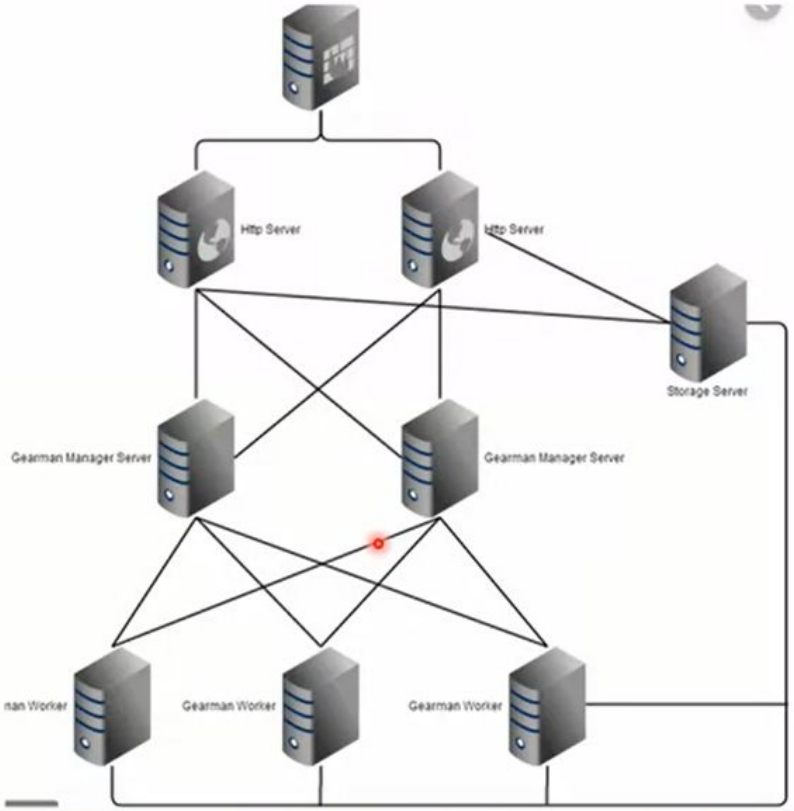
The DLT nodes can also run applications, called Distributed Applications or Dapps.

DApps can never be changed.

DApps can also use the ledger to complete transactions using either standard currency, or cryptocurrency.

Distributed Applications

DApps can run as a web or mobile application and are the basis of the new Internet of value.



The Future of Cloud: Distributed Applications

Distributed vs Decentralized

Read the following article for more about the differences between Distributed Apps and Decentralized Apps (DApps):

https://medium.com/nakamo-to/whats-the-difference-between-decentralized-and-distributed-1b8de5e7f5a4

Machine Learning and AI

Machine Learning and AI

- Artificial Intelligence (AI) is a computing strategy process processing data for computer programs to make decisions.
- The decision-making process rivals, or surpasses, that of humans.
- AI systems require vast amounts of current data to effectively make correct decisions.
- As AI process data and make correct decisions, the computer programs learn and store the correct decisions.
- AI learning also requires vast amounts of data storage.
- Cloud represents an excellent environment for data storage, retrieval, and processing required for AI.
- AI is very backend heavy, and ideal for Cloud computing.
- Also the development interfaces are similar in construction to standard APIs already offered by Cloud providers.

Machine Learning and AI

Some say AI will be responsible for the loss of many jobs.

Technology has been advancing at different rates since the wheel.

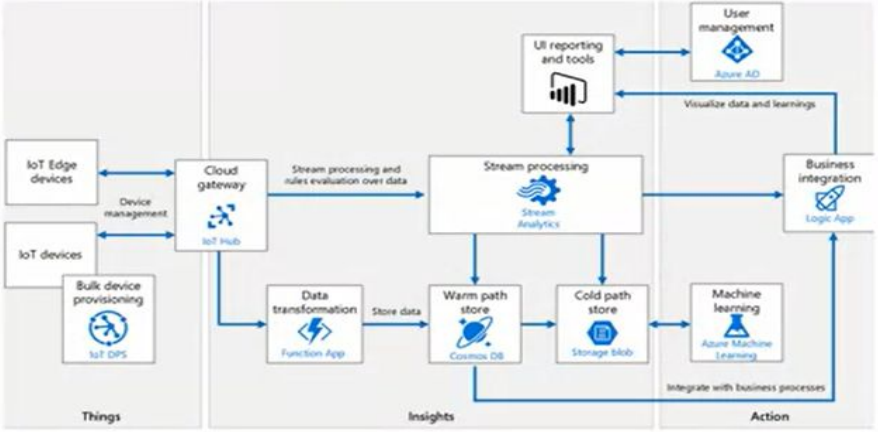
Today with all the technology advances since the wheel the unemployment rate continues to be in single digits.

AI may be responsible for loss of many jobs, but all historical trends are against that result.

Azure IOT

Azure IoT

- The Internet-of-Things (IoT) forms the foundation of Smart Devices, and automated devices.
- These devices will make drive up the productivity of work, and provide us with better, faster and safer lives.
- However, the IoT is vulnerable.
- Today most IoT devices are not secured, therefore when they connect to the Internet, it can result in major difficulties, and dangers.
- The Azure Cloud, provides a set of tools for the IoT that can manage the IoT efficiently, dynamically, and securely.



Azure IoT

- The Azure IoT is delivering a distinct suite of products for the IoT.
- Products such as IoT Central that provide a set of reusable objects that act like building blocks for IoT applications.
- Azure also provides Cloud based simulators and monitors for the IoT.
- Azure features IoT Edge to support deploy of Cloud Solutions
- Azure Digital Twins is an offering to model real world entities.
- Azure IoT Insights provides real time metrics on IoT solutions. It looks at for vulnerabilities.

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Discussion Question

Cloud for DApps

First, watch this video: Distributed Applications

After watching the video, discuss why is Cloud a great environment for Distributed Applications (DApps)? What does Cloud offer that would be beneficial for DApps?

- Describe what the Cloud is and what computing services are supported.
- Describe how distributed computing enhances performance and reliability.
- Identify and explain the three major sections of Cloud computing services: SaaS, PaaS, and IaaS.
- Explain Azure Services and APIs and how they relate to Cloud Computing.
- Identify each of the managed services and explain the differences between them.
- Describe the offerings of each service.
- Determine which of the four services would be most beneficial to your computing strategy.
- Describe serverless computing and its advantages.
- Explain Distributed Ledger Technology (DLT) and what it does.
- Explain why cloud computing is a good solution for AI.
- Discuss how Azure Cloud is beneficial to IoT.
- Describe bare-metal computing.
- Differentiate the benefits and uses of VMs, Docker, and Kubernetes.
- Explain the differences between on-premises computing and cloud computing.
- Describe Edge computing and give examples.
- Understand the differences between cloud deployment models.
- Define High Performance Cloud Computing and its benefits.
- Explain the big data cloud and how it is a solution for data analytics.