Content Today

- Unit overview and Canvas
  - Unit outline
  - AWS Cloud Practitioner certification
  - Labs
  - Assessment
- Introducing cloud computing
- AWS Global Infrastructure

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Content Today

- Unit overview and Blackboard
- **Introducing cloud computing**
  - ☐ Virtualisation and Cloud Computing
  - ☐ 3 Models of cloud Computing – IaaS, PaaS, SaaS
  - ☐ Advantages of Cloud Computing
  - ☐ Cloud Providers
- AWS Global Infrastructure

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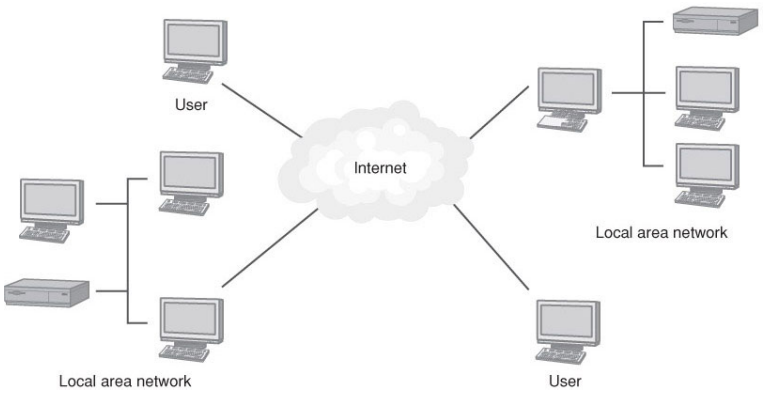
Why Use the Term "Cloud"

For years developers and network administrators have represented the Internet as a cloud.

e.g. iCloud



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What is Cloud Computing?

- Cloud computing is the ***on-demand*** delivery of compute power, database storage, applications, and other IT resources through a cloud services platform ***via the internet*** with ***pay-as-you-go*** pricing.
- Computing as a ***service*** delivered over the internet
- Virtualisation
- Automation

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The most basic way to define what the "cloud" is that it is a computer located somewhere else that is accessed via the Internet and utilized in some way. *Web services* is also another name for what people call *the cloud*.

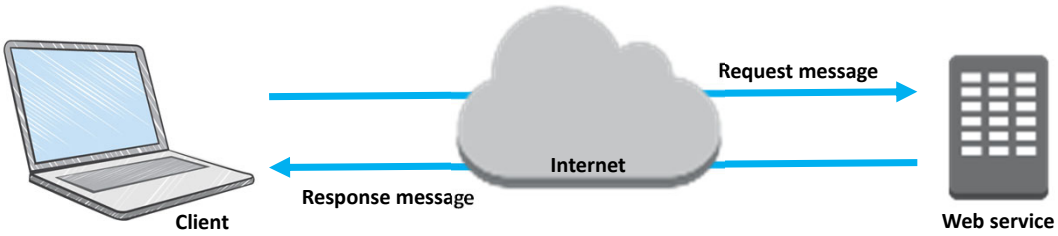
The cloud is comprised of server computers located in large data centers in different locations around the world. When you use a cloud service like Amazon Web Services (AWS), you are utilizing the computers owned by AWS. AWS is a cloud services provider.

The computers contain various technology features and services, like building blocks, that can be used to assemble solutions that help a user meet their business goals and technology requirements. With cloud computing, organizations can consume on-demand computing and storage resources rather than building, operating, and improving infrastructure on their own.

For more information, see https://aws.amazon.com/what-is-cloud-computing/.

What are Web Services?

A **web service** is any piece of software that makes itself available over the internet and uses a **standardized format** (XML or JSON) for the request and the response of an **API interaction**.



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A web service is any service that:

- Is available over the Internet or private (intranet) networks
- Uses a standardized data format (XML or JSON)
- Is not tied to any one operating system or programming language
- Is self-describing via an interface definition file
- Is discoverable

Before Cloud Computing

Cloud computing enables you to **stop thinking of your infrastructure as hardware**, and instead **think of it (and use it) as software.**

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Before cloud computing, you would have to provision capacity based on guessing theoretical maximum peaks. If you didn't meet your projected maximum peaks, or you exceeded them, you would be paying for expensive resources that would stay idle or have insufficient capacity to meet your needs.

Before Cloud Computing

- Hardware solutions are **physical**. This means they require:
  - Space
  - Staff
  - Physical security
  - Planning
  - Capital expenditure
- Guess at theoretical maximum peaks
  - Is there enough resource capacity?
  - Do we have sufficient storage?

What if your needs change?

*You have to go through the **time, effort, and cost** required to change all these.*

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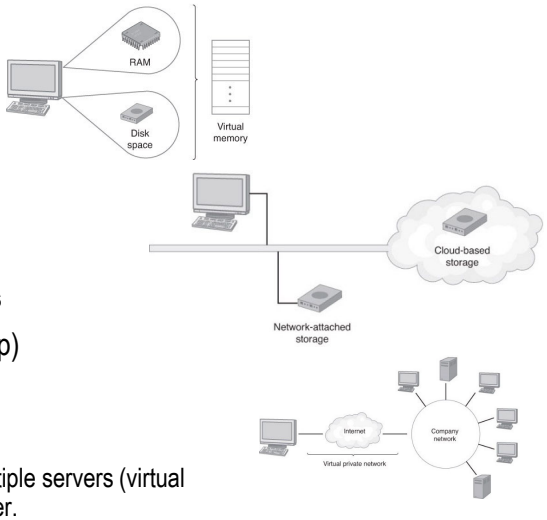
Managing hardware takes away time and resources you could be using to improve your architecture and your application.

For example, before cloud computing, if you wanted to provision a new web site, you would have to go out and buy the hardware, rack and stack it, put it in a data center, and then manage it or have someone else manage it. This approach is very expensive.

Virtualisation – is *everywhere* in computing

- Memory virtualisation
  - Virtual memory
- Storage virtualisation
  - Logical disks and file systems
  - Networked attached storage → **Cloud storage**
- Network virtualisation
  - VLANs (segmentation), VPNs (tunneling), **VPCs**
- Operating System virtualisation (virtual desktop)
  - Multiple OS on the one computer (host-guest)
- Machine virtualisation
  - Hyper-visors (e.g. Hyper-V, VMWare) allow multiple servers (virtual machines) to be run on a single "metal" computer.



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https://www.youtube.com/watch?v=KXkBZCe699A

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Motivation to Virtualize

- Increased device utilization (particularly CPU utilization)
- Decreased device footprint
- Decreased power consumption
- Simplified operating system and application administration
- Ease of software provisioning and patch releases
- Device and storage scalability
- Increased user access to key resources
- Increased flexibility in supporting multiple operating system environments
- Improved use and management of software licenses
- Improved utilization reporting, which leads to improved capacity planning
- Improved disaster recovery and business continuity

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Virtualisation and Automation

- Virtual environments are defined in software
- Software enables the *creation* and *modification* of virtual environments to be automated.
- Example: Extra web servers are automatically ‘stood up’ when demand increases.

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Not All Applications suit Virtualization

- **Applications with unique hardware requirements**: If an application requires a unique device or hardware device driver, the virtualization software may be unable to support the device.
- **Graphics-intensive applications**: If an application is graphics intensive, such as a 3-D modeling program, the virtual device drivers may slow down the I/O processing to an unacceptable level.

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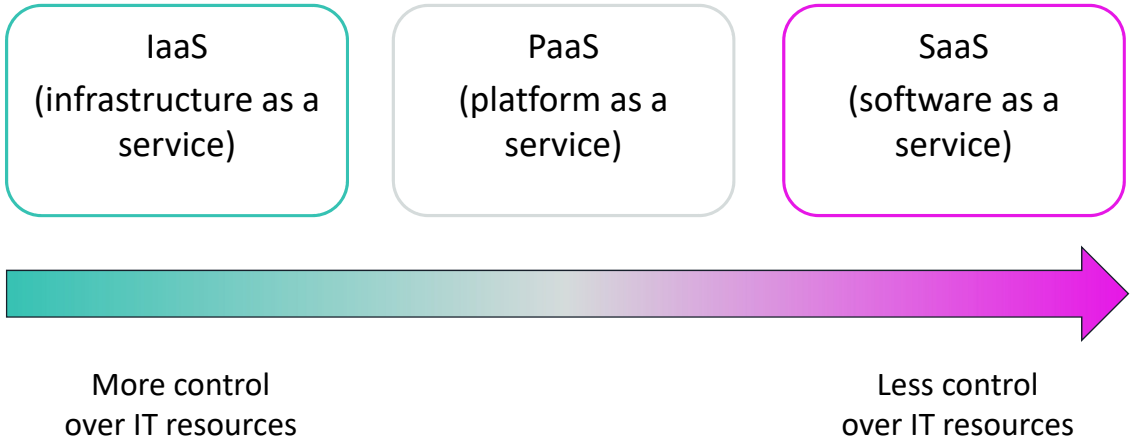
Cloud service models



There are three main cloud service models. Each model represents a different part of the cloud computing stack and gives you a different level of control over your IT resources:

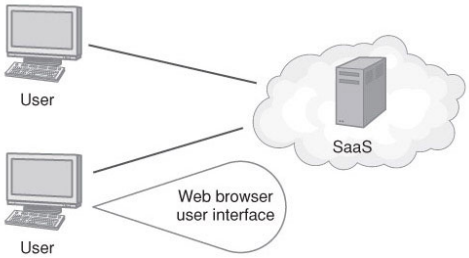
- **Infrastructure as a service (IaaS)**: Services in this category are the basic building blocks for cloud IT and typically provide you with access to networking features, computers (virtual or on dedicated hardware), and data storage space. IaaS provides you with the highest level of flexibility and management control over your IT resources. It is the most similar to existing IT resources that many IT departments and developers are familiar with today.

- **Platform as a service (PaaS)**: Services in this category reduce the need for you to manage the underlying infrastructure (usually hardware and operating systems) and enable you to focus on the deployment and management of your applications.

- **Software as a service (SaaS)**: Services in this category provide you with a completed product that the service provider runs and manages. In most cases, *software as a service* refers to end-user applications. With a SaaS offering, you do not have to think about how the service is maintained or how the underlying infrastructure is managed. You need to think only about how you plan to use that particular piece of software. A common example of a SaaS application is web-based email, where you can send and receive email without managing feature additions to the email product or maintaining the servers and operating systems that the email program runs on.

Software as a Service (SaaS)

- SaaS provides a cloud-based foundation for ***software applications*** on demand.
- Web-delivered content that users access via a web browser.
- The software can reside within any of the deployment-model clouds.



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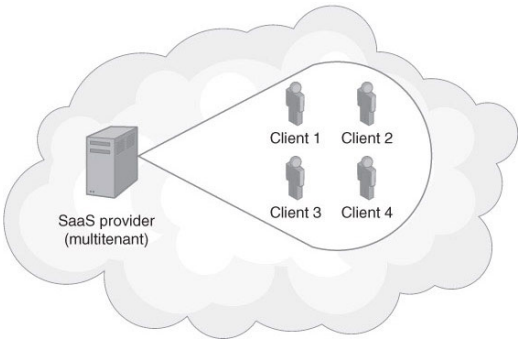
Multitenant SaaS Solutions

SaaS applications are often **multitenant solutions**

- Within the single SaaS application, two or more tenant companies share the same server resources.
- Each tenant can customize their own version of the software for their clients.



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SaaS Advantages

- Eliminate the need for an on-site data center.
- Eliminate the need for application administration.
- Allow customers to pay on demand for software use, normally on a per-user basis.
- Offer application, processor, and data storage scalability.
- Offer device-independent access to applications.
- Increase disaster recovery and business continuity.

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SaaS Disadvantages

- The biggest concern, or potential disadvantage, is that the data, like the applications, reside in the cloud. Many companies are concerned about letting go of their data.
- Also, because the company does not own the solution, it can be challenging or expensive to customize the application.
- (government regulations)

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Real World: Salesforce.com

- Cloud-based **customer relationship management (CRM)** solutions.
- Companies accomplish the following:
  - ☐ Manage sales contacts and leads
  - ☐ Centralize contact information, presentations, and project details
  - ☐ Access sales information and reports from anyplace, at any time, with any device
  - ☐ Manage project quotes and project work flow
  - ☐ Sync sales contacts and meetings with existing tools, such as Microsoft Outlook

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Platform as a Service (PaaS)

- PaaS provides the underlying hardware technology, such as one or more servers (or virtual servers), operating systems, database solutions, developer tools, and network support, for developers to deploy their own solutions.
- The hardware and software within a PaaS solution is managed by the platform provider.
- Developers need not worry about performing hardware or operating system upgrades. Instead, developers can focus on their own applications.

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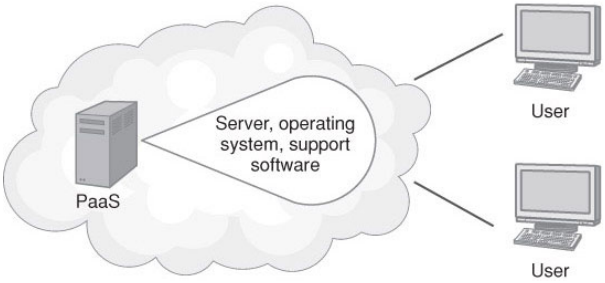
Platform as a Service (PaaS)

- Provide a collection of hardware and software resources that developers can use to build and deploy applications within the cloud.
- Depending on their needs, developers may use a Windows-based PaaS solution or a Linux-based PaaS.



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PaaS Advantages

- Developers eliminate the need to buy and maintain hardware, and the need to install and manage operating system and database software.
- Because the computing resources no longer reside in the data center, but rather in the cloud, the resources can scale on demand and the company can pay for only resources it consumes.
- Further, because PaaS eliminates the developers' need to worry about servers, they can more quickly deploy their web-based solutions.

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PaaS Disadvantages

- Some developers and administrators want finer control over the underlying systems (versions, patch releases/applications, …)

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Real World: Windows Azure as a PaaS

- Microsoft .NET has driven the development of many dynamic web solutions and web services.
- Windows Azure is a PaaS running within Microsoft data centers.
- Users pay only for the scalable processor resources that they consume.
- SQL Azure provides a cloud-based database solution for applications running within Windows Azure.
- Windows Azure goes beyond .NET and includes support for Java, PHP, and Ruby. Developers can build and deploy their solutions to Azure using an IDE such as Visual Studio or Eclipse.
- Developers can interface to SQL Azure using much of the same code they would use to access a local database.

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Infrastructure as a Service (IaaS)

- IaaS provides a virtual data center within the cloud.
- IaaS provides servers (physical and virtualized), cloud-based data storage, and more.
- Developers must install their own operating system, database management software, and support software.
- Then the developers (or the company's system administrators) must manage both the hardware and the software.

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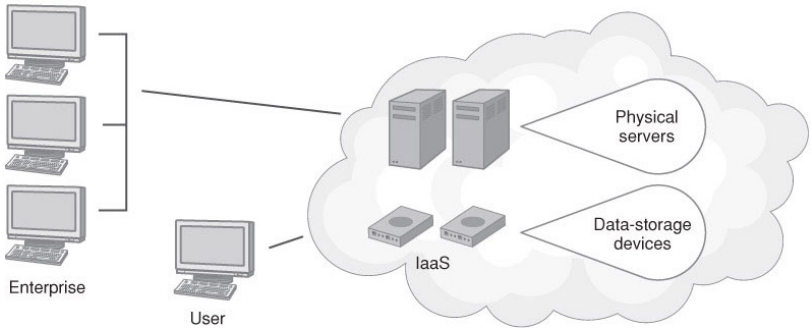
IaaS Defined

An IaaS provider makes all of the computing hardware resources available, and the customers, in turn, are responsible for installing and managing the systems, which they can normally do, for the most part, over the Internet.



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What Data Centers Must Provide

- Access to high-speed and redundant Internet service
- Sufficient air conditioning to eliminate the heat generated by servers and disk storage devices
- Conditioned power with the potential for uninterrupted power supply in the short term and long term through the use of on-site diesel powered generators
- Fire suppression systems
- Administrative staffing to support hardware, networks, and operating systems

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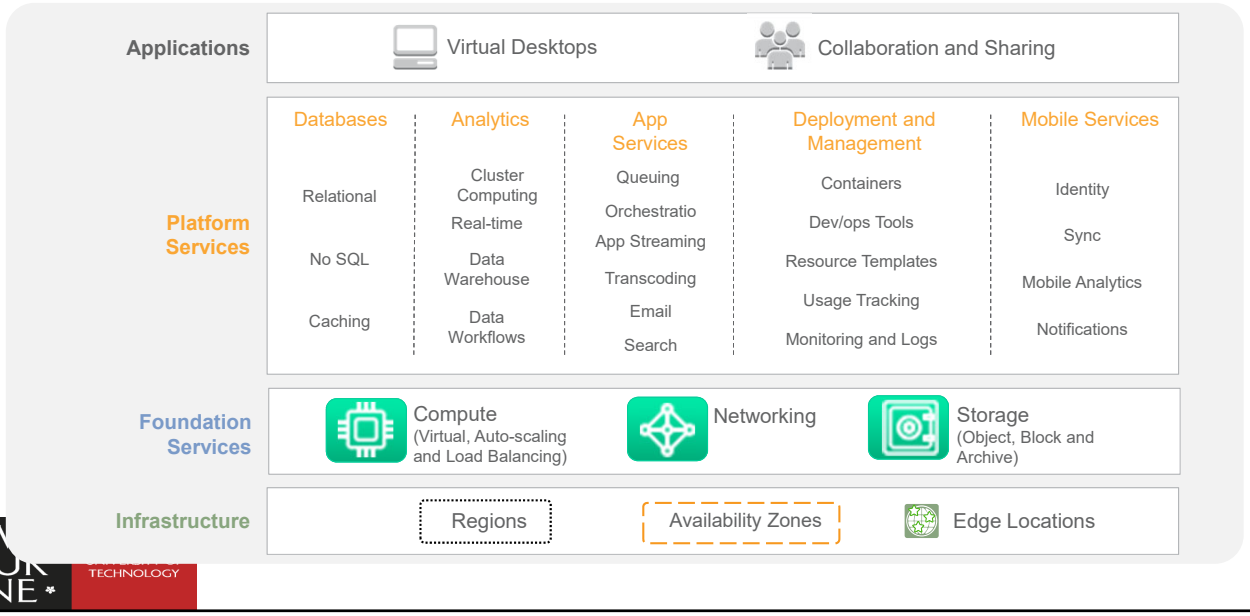
Combining IaaS, PaaS, SaaS. Example AWS

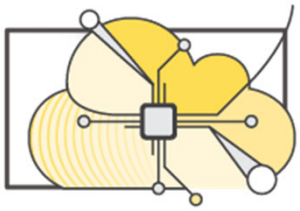


As we discussed earlier, AWS provides a broad set of services—such as compute power, storage options, networking, and databases—delivered as an on-demand utility that is available in seconds, with pay-as-you-go pricing. All of these services sit on AWS global infrastructure.

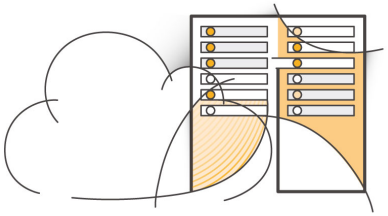
AWS's global infrastructure can be broken down into three elements: Regions, Availability Zones, and edge locations.

Let's take a more in depth look at the AWS infrastructure and see what these are.

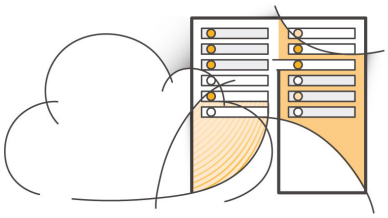
Three Cloud Deployment Models



Public Cloud



Hybrid



Private Cloud (On-premises)

https://aws.amazon.com/enterprise/hybrid/.

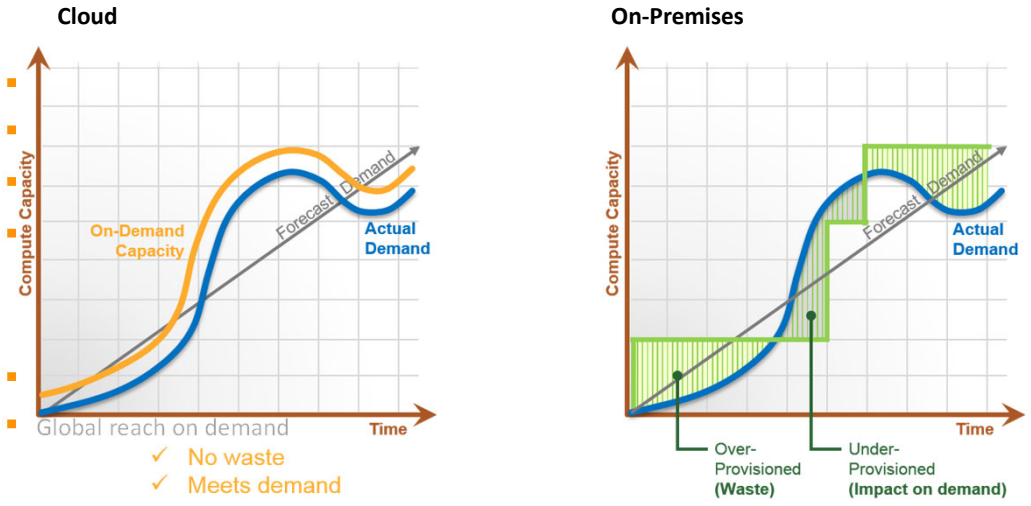
"All-In" Public Cloud:
A cloud-based application is fully deployed in the cloud, and all parts of the application run in the cloud. Applications in the cloud have either been created in the cloud or have been migrated from an existing infrastructure. Cloud-based applications can be built on low-level infrastructure pieces (for example, networking, compute or storage) or can use higher-level services that provide abstraction from the management, architecting, and scaling requirements of core infrastructure.

Hybrid:
A hybrid deployment is a way to connect infrastructure and applications between cloud-based resources and existing resources that are not located in the cloud. The most common method of hybrid deployment is between the cloud and existing on-premises infrastructure (sometimes called *on-prem*). On-premises infrastructure is located within the physical confines of an enterprise, often in the company's data center. A hybrid deployment model is used to extend an organization's infrastructure into the cloud while connecting cloud resources to an internal system. For more information on how AWS can help you with your hybrid deployment, please visit our hybrid page at https://aws.amazon.com/enterprise/hybrid/.

Private Cloud (On-premises):
When you run a cloud infrastructure from your own data center, that's called on-premises or private cloud. While this kind of deployment lacks many of the benefits of cloud computing, it does provide dedicated resources and is a popular choice for

organizations who need to meet certain compliance standards. In most cases, this deployment model is the same as legacy IT infrastructure while using application management and virtualization to increase resource utilization.

Cloud versus On-Premises

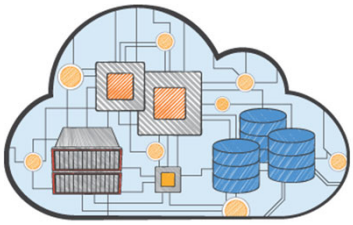


Let's take a closer look at *capacity* in the All-In Cloud and On-Premises solutions.

In the "All In" solution, capacity is in sync with demand. Resources are provisioned and decommissioned in response to demand with only a couple clicks.

In contrast, in "On-Premises" deployments, because you rely on physical hardware, you have to forecast your capacity needs well in advance of the actual demand. Instead of resources that expand and contract with demand, the on-premises solution results in idle, wasted resources waiting for demand to catch up. If demand suddenly outpaces capacity, the shortfall may result in unhappy customers. Your ability to respond quickly to this situation can be limited by long procurement cycles or by constraints on where you house your IT resources. Furthermore, building an on-premises infrastructure can be slow and expensive.

All-In Cloud versus On-Premises



All-In Cloud

- No upfront investment
- Low ongoing costs
- Focus on innovation
- Flexible capacity
- Speed and agility
- Global reach on demand

On-Premises

- Large initial purchase
- Labor, patches, and upgrade cycles
- Systems administration
- Fixed capacity
- Long procurement cycle and setup
- Limited geographic regions

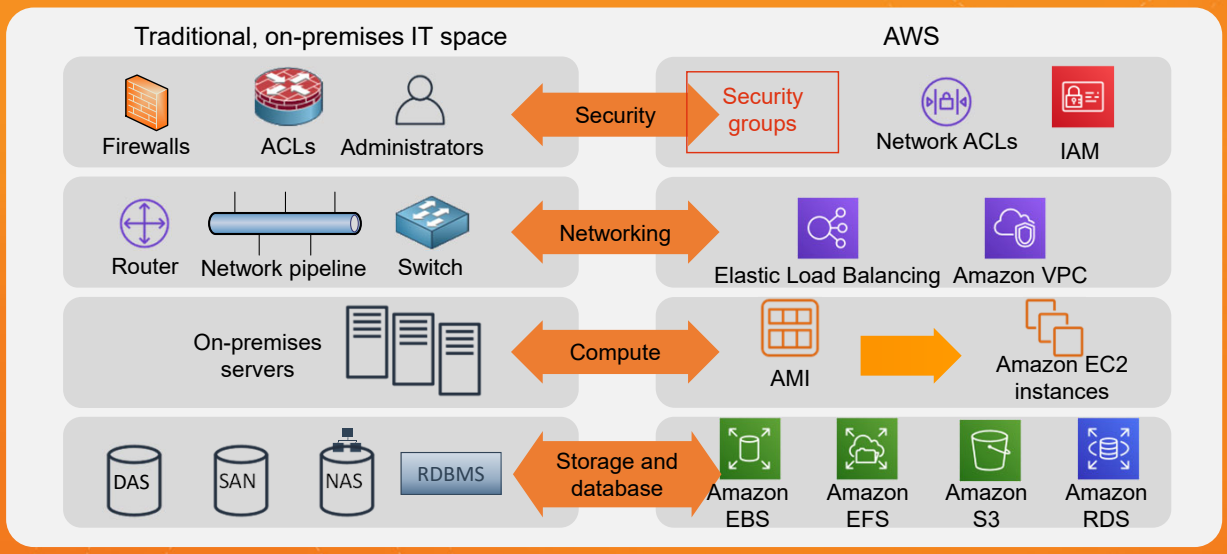
To summarize:

- With the All-In solution, you avoid the large capital purchases required for an On-Premises solution. You have immediate access to resources without having to procure, install, and configure cabling, racks, servers, and storage in a physical location with appropriate facilities like cooling and power. Instead, you just click to order and pay for the resources you need, which are available almost immediately.
- Cloud computing helps you reduce ongoing IT costs in multiple ways. AWS continually lowers prices due to massive economies of scale and continual improvements. Multiple pricing options also help you optimize costs based on your unique workloads. You **pay only for what you use** on a **variable**, monthly basis. On-premises solutions typically require upgrades on 1-year, 3-year, or 5-year cycles.
- Cloud gives you managed IT resources on demand, at a fraction of the cost of traditional infrastructure. This cost savings empowers organizations to shift resources toward **innovative** new projects that grow their business by focusing on “apps not ops.”
- Predicting how customers are going to adopt your new application is complex, making it difficult to estimate your infrastructure capacity needs. **Flexible capacity** means that your resources are dynamic. You can quickly provision resources as demand goes up and turn off what you don’t need as demand declines.
- Cloud computing’s **speed and agility** makes it possible for you to respond to changing market conditions. With AWS, resources can be provisioned as needed. This self-service environment

changes how you develop and deploy applications, allowing your team to experiment more quickly and more frequently. The amount of time it takes to get a server procured, delivered, and running limits this in a traditional infrastructure.

- With on-premises, it is hard to deliver great performance to a distributed user base. So, companies focus on one geographic region at a time to save costs and time. Without geographical limitations, you can deploy your application in any of the AWS regions around the world with lower latency and at minimal cost.

Similarities between AWS and traditional IT



There are many similarities between AWS and the traditional, on-premises IT space:

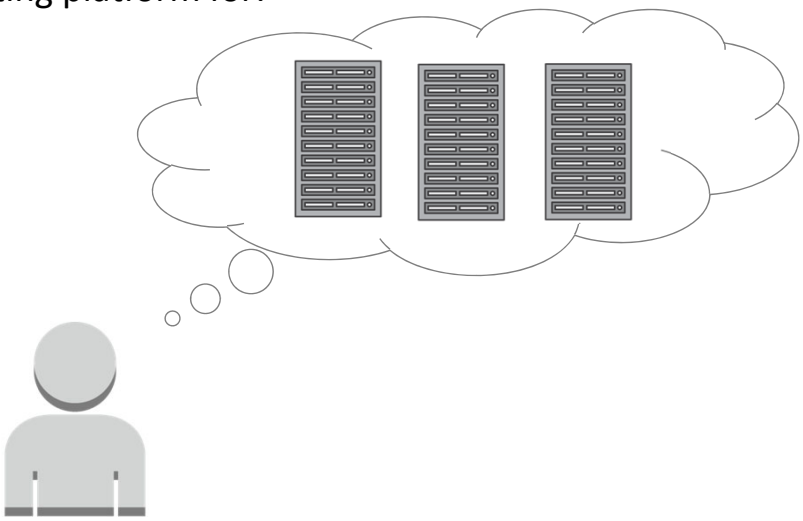
- AWS security groups, network access control lists (network ACLs), and AWS Identity and Access Management (IAM) are similar to firewalls, access control lists (ACLs), and administrators.
- Elastic Load Balancing and Amazon Virtual Private Cloud (Amazon VPC) are similar to routers, network pipelines, and switches.
- Amazon Machine Images (AMIs) and Amazon Elastic Compute Cloud (Amazon EC2) instances are similar to on-premises servers.
- Amazon Elastic Block Store (Amazon EBS), Amazon Elastic File System (Amazon EFS), Amazon Simple Storage Service (Amazon S3), and Amazon Relational Database Service (Amazon RDS) are similar to direct attached storage (DAS), storage area networks (SAN), network attached storage (NAS), and a relational database management service (RDBMS).

With AWS services and features, you can do almost everything that you would want to do with a traditional data center.

What can you do in the cloud?

You can use a cloud computing platform for:

- Application Hosting
- Backup and Storage
- Content Delivery
- Websites
- Enterprise IT
- Databases



You can use the cloud computing platform for the following:

- **Application Hosting** – use on-demand infrastructure to host internal or SaaS applications
- **Backup and Storage** - store data and build dependable backup solutions
- **Content Delivery** - distribute content worldwide, with high data transfer speeds
- **Websites** – host static and dynamic websites
- **Enterprise IT** - host internal- or external-facing IT applications in AWS's secure environment
- **Databases** – use a variety of scalable database solutions, from hosted enterprise database software to non-relational database solutions

Important Cloud Terminology

- **High Availability (Highly Available)**
  - Accessible when you need it
- **Fault Tolerance (Fault Tolerant)**
  - Ability to withstand a certain amount of failure and still remain functional
- **Scalability (Scalable)**
  - Ability to easily grow in size, capacity, and/or scope when required
  - Growth is (usually) based on demand
- **Elasticity (Elastic)**
  - Ability to grow (scale) when required and to reduce in size when resources are no longer needed

High availability, fault tolerance, scalability, and elasticity are four terms that often used when discussing the cloud. These concepts are the fundamental building blocks of AWS and will be referred to throughout the course.

High availability refers to a resource that is accessible when you attempt to access it. For example, if every time you go to the ATM to make a withdrawal it works as expected the ATM is highly available; however, if you go to use it and there is a sign on the front that says “Out of Order”, it is not highly available.

Fault tolerance is the ability to withstand a certain amount of failure and still remain functional. It also refers to the ability of a system to be self-healing and return to full capacity despite a failure. It is the ability of a system to fail in some way but still remain functional.

Scalability is the ability to easily grow in size, capacity, and/or scope when required particularly in response to demand. If something cannot quickly grow in an easy manner it is not scalable.

Elasticity is the ability to not only grow (scale) when required, but also to reduce or contract in size as needed. A system that is elastic can scale to grow as needed usually based on demand and contractnas demand decreases.

Advantages of cloud computing

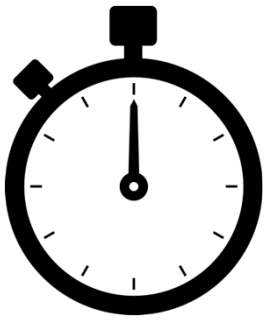
aws academy

Section 2: Advantages of cloud computing

Why are so many companies interested in moving to the cloud? This section presents six advantages of cloud computing.

Trade capital expense for variable expense

Data center investment based on forecast



Pay only for the amount you consume

Advantage #1—Trade capital expense for variable expense: *Capital expenses (capex)* are funds that a company uses to acquire, upgrade, and maintain physical assets such as property, industrial buildings, or equipment. Do you remember the data center example in the traditional computing model where you needed to rack and stack the hardware, and then manage it all? You must pay for everything in the data center whether you use it or not.

By contrast, a *variable expense* is an expense that the person who bears the cost can easily alter or avoid. Instead of investing heavily in data centers and servers before you know how you will use them, you can pay only when you consume resources and pay only for the amount you consume. Thus, you save money on technology. It also enables you to adapt to new applications with as much space as you need in minutes, instead of weeks or days. Maintenance is reduced, so you can spend focus more on the core goals of your business.

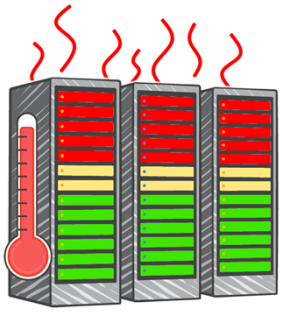
Massive economies of scale

Because of aggregate usage from all customers, AWS can achieve higher economies of scale and pass savings on to customers.

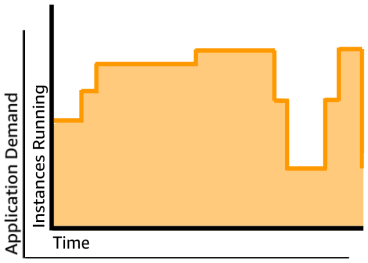
Advantage #2—Benefit from massive economies of scale: By using cloud computing, you can achieve a lower variable cost than you can get on your own. Because usage from hundreds of thousands of customers is aggregated in the cloud, providers such as AWS can achieve higher economies of scale, which translates into lower pay-as-you-go prices.

Stop guessing capacity

Overestimated server capacity



Underestimated server capacity

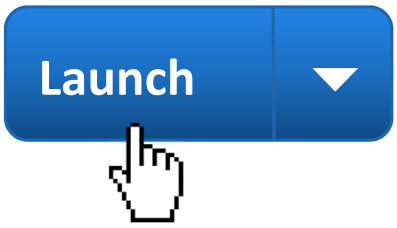


Scaling on demand

Advantage #3—Stop guessing capacity: Eliminate guessing about your infrastructure capacity needs. When you make a capacity decision before you deploy an application, you often either have expensive idle resources or deal with limited capacity. With cloud computing, these problems go away. You can access as much or as little as you need, and scale up and down as required with only a few minutes' notice.

Increase speed and agility

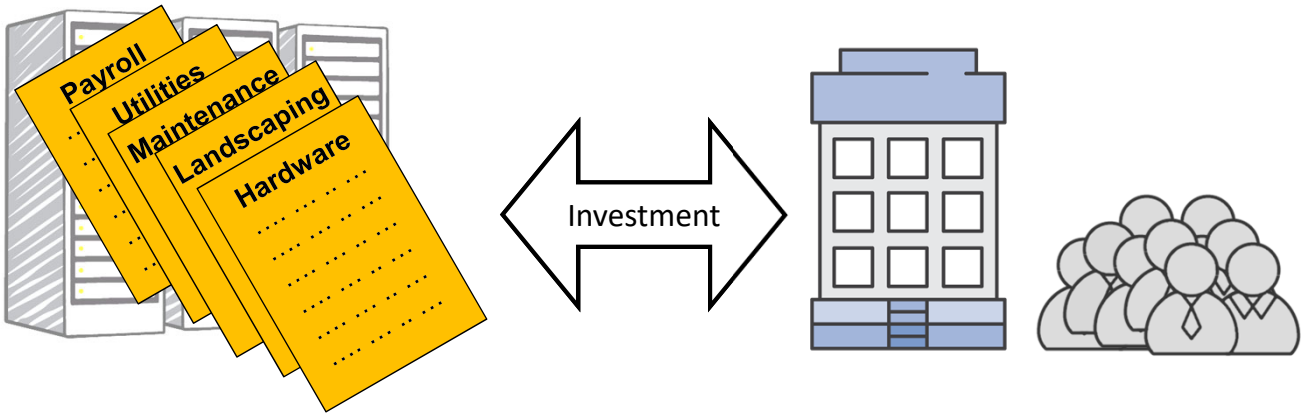
Weeks between wanting resources and having resources



Minutes between wanting resources and having resources

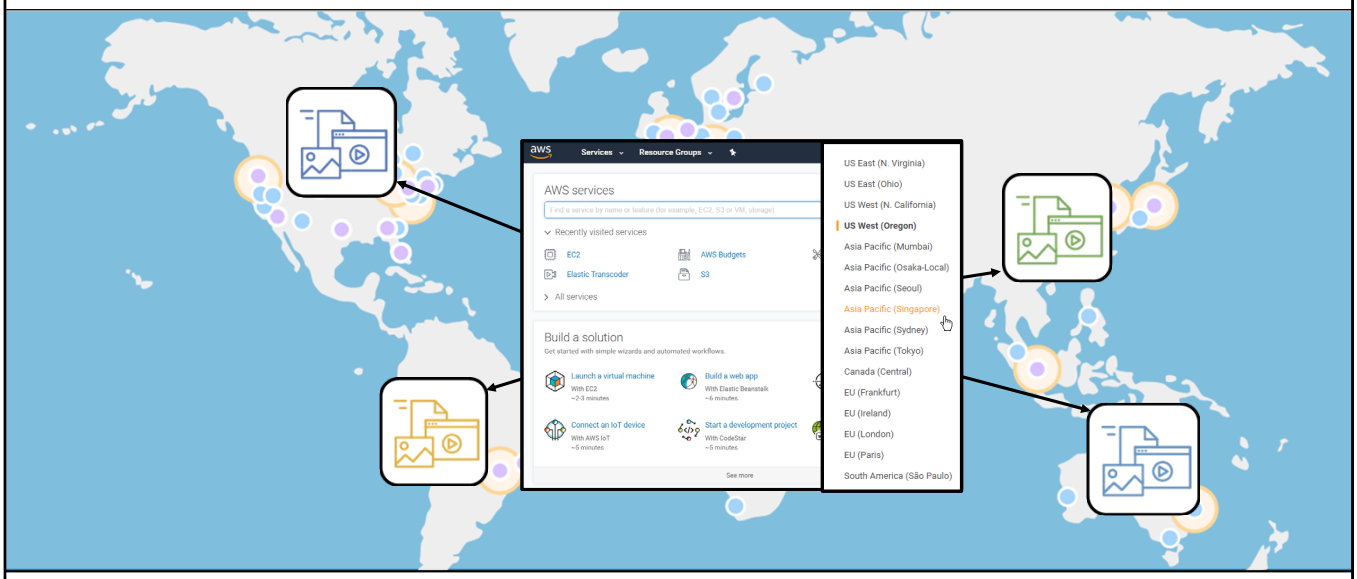
Advantage #4—Increase speed and agility: In a cloud computing environment, new IT resources are only a click away, which means that you reduce the time it takes to make those resources available to your developers from weeks to just minutes. The result is a dramatic increase in agility for the organization because the cost and time that it takes to experiment and develop are significantly lower.

Stop spending money on running and maintaining data centers



Advantage #5—Stop spending money on running and maintaining data centers: Focus on projects that differentiate your business instead of focusing on the infrastructure. Cloud computing enables you to focus on your own customers instead of the heavy lifting of racking, stacking, and powering servers.

Go global in minutes



Advantage #6—Go global in minutes: You can deploy your application in multiple AWS Regions around the world with just a few clicks. As a result, you can provide a lower latency and better experience for your customers simply and at minimal cost.

Key takeaways

- Trade capital expense for variable expense
- Benefit from massive economies of scale
- Stop guessing capacity
- Increase speed and agility
- Stop spending money on running and maintaining data centers
- Go global in minutes

The key takeaways from this section of the module include the six advantages of cloud computing:

- Trade capital expense for variable expense
- Massive economies of scale
- Stop guessing capacity
- Increase speed and agility
- Stop spending money on running and maintaining data centers
- Go global in minutes

Disadvantages?

- Cost?
- Security?
- Control?
- Legislative?

Features of Cloud-based Platforms

- **Scalability.** On demand resource scaling.
- **Redundancy.** Servers, storage, and networks.
- **Cost benefits from resource pooling.** Shares IT resources across a very large number of companies, which provides cost savings to each.
- **Outsourced server management.** Provides an IT staff who maintain operating systems and underlying support software.
- **Low cost of entry.** Companies do not need to invest in their own IT data center.

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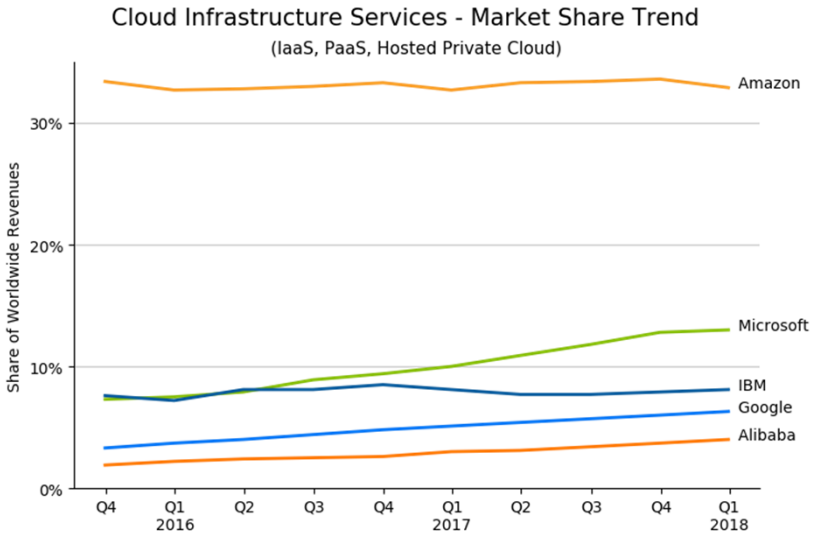
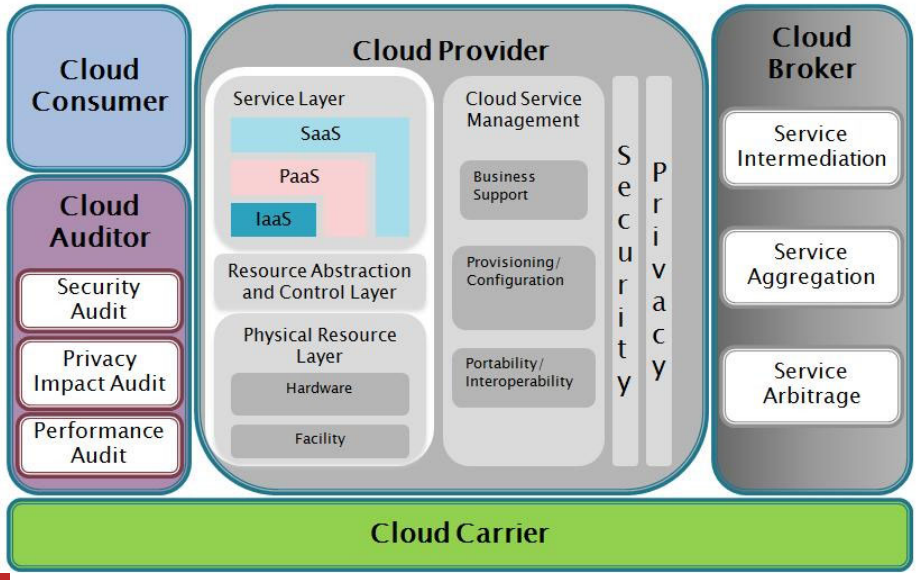
Cloud Providers



https://www.srgresearch.com/

NIST Reference Architecture



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Microsoft Azure

- https://mva.microsoft.com/en-US/training-courses/cloud-application-development-17172?l=5YgyxecZD_2811316548
- https://mva.microsoft.com/en-US/training-courses/cloud-application-development-17172?l=zQlAmhcZD_8411316548
- https://azure.microsoft.com/en-us/resources/videos/tour-of-microsoft-azure/
- https://www.redpixie.com/blog/microsoft-azure-aws-guide

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