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| Software Components | |
| **OS (Operating System)** | Provides the UI (User Interface) with a CLI (Command Line Interface) and optional GUI (Graphical User Interface). |
| **Applications** | A computer program which is a set of instructions that run to perform a specific function. |
| Hardware Components | |
| **CPU/Processor** | Runs instructions it receives from applications and the OS |
| **Memory/RAM** | Temporary volatile storage for data and instructions from the CPU. *MB/GB.* |
| **Storage Drives** | Persistent non-volatile storage preserved once the pc is off. *MB/s or IOPS.* |
| **Network Adapter** | Provide means to communicate over a network with/without wire. *GB/s.* |
| **GPU** | Provides texture and scenery within video, power-intensive requires 1GB RAM at bare minimum. |

**Cloud Computing Introduction**

**A Server** responds to Client Computer Requests across the Network, with more RAM & CPUs than Desktops (*i.e. – Web, Database, Mail*) residing in a Data Centre.

**A Web Service** is any piece of software available over the internet, with a standardised format (*XML/JSON*) for its request and response.

**How are Webpages loaded?**

1. Client sends Web Application Request.
2. Web Server sends request to Web Application.
3. Web Application accesses Application Data.
4. Database Server returns Application Data to Web Server.
5. Web Server returns an Application Webpage.

**A Data Centre** hosts an organisations PC and Networking Equipment in an ideal climate for it to operate. (*i.e. – Servers, Storage, Network Devices, etc*).

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| Data Centre Ownership Models |  |
| **Traditional/On-Premises**   * User-Owned and Hosted. * Buy, Install, Configure & Manage all Soft/Hardware physically. * Hire Staff to manage/maintain. * Users own their own Data Centre Resources. | **Cloud**   * Cloud Service Provider-Owned. * All ware’s handled. * Providers handle Staff/Personnel. * Users pay to use the Provider’s Data Centre Resources. |

**A Virtual Machine (VM)** is a software-based computer which runs an OS on a host computer, accessing PC resources through a software layer (hypervisor). *Multiple VMs on a single computer is possible through virtualization.*

* Cost-Saving: Reduced need to purchase another PC.
* Efficient: Running Multiple VMs increase PC utilization.
* Reusable/Portable: VMs can be copied or moved between PCs.

**Virtual Machines** are a Fundamental Computing Unit within the Cloud, they feature *Self-Service, Pay-As-You-Go and Scalability.*

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| **Software Development Life Cycle** | |
| **Plan** | Identifying project goals taking several factors into account (*i.e. – Economical, Operational, Technical, etc*) and resources required to implement them. |
| **Analyse** | Defining and Documenting Product Requirements in a Software Requirement Specification (SRS), which is approved by the customer and referenced. |
| **Design** | Evaluating Architectures to use, comparing within a Design Specification Document (DSD) containing detailed functional descriptions, selecting the best design after reviewing for: *Risk, Budget and Time Constraints.* |
| **Develop** | Writing the Code & Building the Product in accordance with the DSD and Organisations Standards/Guidelines. |
| **Test** | Code cam be written to test other code (Automated Testing). Test types include *Unit, Integration, Security and Performance.* |
| **Implement /Deployment** | Customer Approval & Application Completion Sign-Off, the Application is released and used in production. |
| **Maintain** | Applications are monitored to ensure correct operation, examples include *Corrective, Adaptive, Perfective and Preventive Maintenance.* |

**Cloud Service & Deployment Models**

**Cloud Computing** is the on-demand delivery of c*omputing power, databases, storage and other resources* provided through the internet with pay-as-you-go pricing.

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| Cloud Service Models | |
| **Infrastructure as a Service (IAAS)** | Users manage the Server (PC/VM) and the Operating System. The Data Server has no access to your Server. *AWS, Google Cloud.* |
| **Platform as a Service (PAAS)** | A Third-Party manages Hardware & Operating Systems. Users can run Applications without Infrastructure (*i.e. – Patching, Updates, etc*) and provides a Framework for Developers to create Customized Applications. *AWS Lambda, Java Runtimes, MySQL Databases.* |
| **Software as a Service (SAAS)** | Users manage Files, Software and how it’s used. Provider manages everything else and provides users with Complete Product the service provides, runs and manages (*Facebook Contacts, Dropbox Files, etc*). |

A screenshot of a computer

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| Cloud Deployment Models | |
| **All-in-Cloud**   * No Upfront Costs * Low Ongoing Costs * Innovation-Focused * Flexible Capacity * Speed/Agility * Global Reach On-Demand * Economies of Scale * Trade Fixed Capital Expense for Variable Expense | **Private Cloud (on-premises cloud)**   * Large Upfront Costs * Labor, Patches & Upgrade Cycles * System Administration * Fixed Capacity * Long Procurement Cyle/Set-up * Limited Geographic Regions |

A **Fixed Capital Expense** as an upfront capital cost, such as the price of a car, whereas **Variable Expense** is ongoing operating cost, like the price of the fuel it takes to run it.

**AWS Infrastructure**

A diagram of a computer network

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**The Many Services offered by AWS.**

A screenshot of a computer

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**The Most Commonly used services from AWS**

A screenshot of a computer service

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**Fundamentals of Pricing**

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| **AWS Fundamental Cost Drivers** | |
| **Compute** | *Calculated by Hour/Second*, varies by instance. |
| **Storage** | *Charged per GB (typically).* |
| **Data Transfer** | Outbound aggregated & charged, Inbound has no charge (with exceptions), *Charged per GB (typically).* |

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| **Methods of Payment** | |
| **Pay for what you use** | Pay-as-you-go with No Upfront Costs, saving compared to on-premises (*which is a flat rate without variable cost*). |
| **Pay less when you reserve** | Largest discount through an All-Upfront Reserved Instance (*AURI*), followed by Partial Upfront Reserved Instance (*PURI*) and lastly No Upfront Payments Reserved Instance (*NURI*) |
| **Pay less when you use more** | Save more as usage increases, the more you use, the less you pay/GB. Multiple services mean lower storage costs. |
| **Pay less as AWS grows** | AWS have lowered pricing > 75x due to *Economies of Scale*. |

The **AWS** **Free Tier** is used to *gain hands-on-experience* and is available for 1 year to new customers. This makes transferring within buckets or within the same AWS region free. The following services are available under this payment tier:

* Amazon Virtual Private Cloud (VPC): Provision logically-isolated sections of the cloud to launch AWS resources in a Virtual Environment.
* AWS Elastic Beanstalk: Quickly Deploy & Manage Applications within the AWS Cloud.
* Amazon EC2 Auto-Scaling: Automatically adds/removes Resources according to User-Defined Conditions.
* AWS CloudFormation: Create a Collection of related AWS Resources and provision them.
* AWS Identity & Access Management (IAM): Control users’ access to AWS services & resources.

A Calculator for AWS services is available at <https://calculator.aws/#/>. to *aid customers in estimating service costs, identify cost reduction opportunities and use templates to compare services & deployment models.*

The **Total Cost of Ownership** (TCO) is a financial estimate to find direct/indirect system costs. It can be used to compare running costs of on-premises VS the cloud and build the business case for moving to the cloud. There are various considerations that must be considered that can be found below:

A close-up of several different colored boxes

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**AWS Global Infrastructure**

Regions & Available Zones are available for viewing at <https://aws.amazon.com/about-aws/global-infrastructure/regions_az/?p=ngi&loc=2>.

Latency can be tested at <https://www.cloudping.info/>

The **AWS Global Infrastructure** provides customers with the following benefits:

* Flexibility: Make quick changes where needed, Move between sites, etc.
* Reliability: Consistent Uninterrupted Supply of Services.
* Scalability: Able to grow unhinged.
* Fault-Tolerant: Build-In Component Redundancy
* Minimal Human Intervention

Each large **Region** has their own **Availability Zones,** each of which host multiple **Data Centres**.

**Data Centres** are locations where the physical data resides & is processed, *built in clusters across global regions.* They’re designed with certain allowances in mind:

* House 50-80k Servers (*typically*).
* Location evaluated to mitigate Environmental Risk.
* Redundant Design anticipates & tolerates Maintenance Failures.
* Ensure Availability through backing up to isolated locations (Availability Zones)
* Have Restricted Access
* Automated Processes move customer traffic if there’s a Failure.

**Available Zones** are interconnected areas designed for fault isolation, *selected by the User*. They’re also designed with some allowances:

* Located in Low-Risk Flood Plains.
* Have a Discrete, Uninterruptible Power Supply.
* Have On-Site Backup.
* Reduce single failure points through feeding into different independent utility grids.

**Regions** are Physical Geographical Locations where the AWS has several availability Zones, and *regions are also selected by the user who decides which is best based on latency and compliance requirements*. They also have their own specific qualities.

* Isolated to achieve Fault-Tolerance and Stability.
* Data stored isn’t Replicated across Regions.
* Data Governance and Legal Requirements should be considered.

**Amazon CloudFront** is a Content Delivery Network (CDN) used to distribute content to end users and reduce latency. *Its Domain Name System (DNS) is Route 53.*

**AWS Services & Categories**

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| **Storage Service Category** | |
| **Amazon Simple Storage Service (S3)** | Object Storage offering Scalability, Data Availability, Security & Performance, Back-Up, Restore, Archive & IoT. |
| **Amazon Elastic Block Store (EBS)** | High-Performance Block Storage used with EC2 for intensive workloads (i.e. *– Big Data Analytics Engines, File Systems, Media Workflows, etc*). |
| **Amazon Elastic File System (EFS)** | Scalable, Fully-Managed Network File System, Reduces Capacity Provision need. |
| **Amazon Simple Storage Service Glacier** | Secure, Durable & Low-Cost S3 for Data-Archiving & Long-Term Backup. |
| **Compute Service Category** |  |
| **Amazon Elastic Compute Cloud (EC2)** | Provides resizable Compute Capacity as VMs |
| **Amazon EC2 Auto-Scaling** | Add/Remove EC2 Instances according to conditions. |
| **AWS Elastic Beanstalk** | Deploy & Scale Web Apps & Services on familiar servers (i.e. – *Apache HTTP, etc*) |
| **AWS Lambda** | Run Code without Provision/Managing Servers. PAYG consumption, not charged when not run. |
| **Containers Service Category** | |
| **Amazon Elastic Container Service (ECS)** | Scalable, High-Performing Container Orchestration supporting Docker Containers. |
| **Amazon Elastic Container Registry (ECR)** | Fully-Managed Docker Container Registry which stores, managers and deploys container images. |
| **Amazon Elastic Kubernetes Service (EKS)** | Deploy, Manage & Scale Containerized Applications that use Kubernetes. |
| **AWS Fargate** | Compute Engine for ECS to run containers without managing servers/clusters. |
| **Database Service Category** | |
| **Amazon Relational Database Service (RDS)** | Set-Up, Operate & Scale Relational Databases. Resizable Capacity while automating tasks (*i.e. – Hardware Provisioning, Patching, Backups*) |
| **Amazon Aurora** | Relational Database compatible with MySQL & PostgreSQL. Faster than both. |
| **Amazon Redshift** | Run Analytic Queries against data stored locally or in S3. Fast performance and any scale. |
| **Amazon DynamoDB** | Key-Value & Document Database with millisecond performance at any scale with capabilities (*built-in security, backup & restore*) |
| **Networking & Content Delivery Service Category** | |
| **Amazon Virtual Private Cloud (VPC)** | Provision Logically Isolated AWS Cloud parts. |
| **Elastic Load Balancing** | Auto-Distributes incoming app traffic across targets (i.e. – *EC2 instances, containers, Ip addresses & lambda functions*) |
| **Amazon CloudFront** | Contend Delivery Network (CDN) delivering data, video, apps and APIs with low latency & high transfer speed. |
| **AWS Transit Gateway** | Users connect their VPCs & on-premises networks to single gateway. |
| **Amazon Route 53** | Scalable DNS which gives reliable way to route end users to internet apps, translating web URLs into IP addresses. |
| **AWS Direct Connect** | Establish Dedicated Private Network Connections from data centre/office to AWS. Can reduce network cost and up bandwidth. |
| **AWS Client VPN** | Provides secure private tunnel from the user to the AWS Global Network. |
| **Security, Identity & Compliance Service Category** | |
| **AWS Identity & Access Management (IAM)** | Manage access to AWS services & resources securely. |
| **AWS Organisations** | Restrict services/actions allowed on an account. |
| **Amazon Cognito** | Add User Sign-Up, Sign-In & access control to web & mobile apps. |
| **AWS Key Management Service (AWS KMS)** | Create/Manage Keys and control encryption use across AWS services & user apps. |
| **AWS Shield** | Managed DDoS protection service safeguarding apps on AWS. |
| **AWS Cost Management Service Category** | |
| **AWS Cost & Usage Report** | Comprehensive set of AWS cost & usage data and metadata about AWS services, pricing & reservations. |
| **AWS Budgets** | Set Custom Budgets that alert users when cost/usage exceeds budgeted amount. |
| **AWS Cost Explorer** | Easy Interface to Visualize, Understand & Manage AWS Costs & Usage. |
| **Management & Governance Service Category** | |
| **AWS Management Console** | Web-Based UI for accessing AWS account. |
| **AWS Config** | Track Resource Inventory & Changes. |
| **Amazon CloudWatch** | Monitor Resources & Applications |
| **AWS Auto-Scaling** | Scale Multiple Resources to meet Demand. |
| **AWS Command Line Interface (CLI)** | Unified Tool to manage AWS Services. |
| **AWS Trusted Advisor** | Optimize Performance & Security. |
| **AWS Well-Architected Tool** | Help Review/Improve Workloads. |
| **AWS CloudTrail** | Track User Activity & API Usage. |

**AWS Cloud Security**

The AWS provides **Security of the Cloud**; however, **Security in the Cloud** is the users responsibility.

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| **Security of the Cloud** | **Security in the Cloud** |
| * Physical Security of Data Centres (controlled, need-based access, etc) * Hardware & Software Infrastructure (Storage Decommissioning, Hot OS, access logging, etc) * Network Infrastructure (Intrusion Detection) * Virtualization Infrastructure (Isolated Instance) | * Amazon EC2 Instance OS (Patching & Maintenance) * Applications (Passwords, Role-Base Access, etc) * Security Group Confirmation * OS/Host-Based Firewalls (Intrusion Detection/Prevention Systems) * Network Configurations * Account Management (Login & Permission Settings for all Users) |

A diagram of software components

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| **Security Across Cloud Infrastructure** | |
| IAAS | Customer has flexibility configuring Network & Storage Settings.  Customer is responsible for more Security Management.  Customer configures Access Controls. |
| PAAS | Customer doesn’t manage Infrastructure.  AWS handles OS, Database Patching, Firewall Config & Disaster Recovery  Customer manages Code/Data |
| SAAS | Software hosted centrally.  Subscription Model: Pay-As-You-Go Basis  Services accessed through Web Browser, Mobile App or API  Customers don’t manage Infrastructure. |

**Amazon S3**

**Amazon S3** is a Managed Cloud Storage Solution used to store data as *Objects* in a *Bucket*. It scales seamlessly and provides 99.9999999999% of durability.

* Objects: Any Data File which is given a Unique name (object key). To change users must change then reupload the entire file.
* Buckets: Logical Containers for Objects. Users can have multiple and control who can Create, Delete & List objects in each bucket. They’re often stored across multiple AWS facilities to durably store data even when two facilities crash.

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| **Amazon S3 Tiers** | |
| **S3 Standard** | Fast Retrieval, Highly Durable and Highly-Performing but High Cost. |
| **S3 Intelligent-Tiering** | Designed to Optimize Cost, moves data to most cost-effective access tier without affecting performance. |
| **S3 Standard-Infrequent Access** | For data rarely accessed but provides rapid access when it is, the low latency and high throughput also gives low price/GB. |
| **S3 One Zone-Infrequent Access** | For data even less accessed than above, still provides rapid access, but stores in an Availability Zone instead of at least three. |
| **S3 Glacier** | Secure, Durable and Low-Cost Data Archiving which doesn’t need the availability and resilience of the three above. Good for storing back-ups. |
| **S3 Glacier Deep Archive** | Lowest Cost and the longest retrieval time (*Up to 12 hrs*). Data typically retained here by customers for 7-10 years. |

A bucket and object with text

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| **Amazon S3 Pricing** | |
| Pay-As-You-Use | You Don’t Pay For |
| * GB/month. * Transfer out to other regions. * PUT, COPY, POST, LIST and GET requests. | * Transfer into Amazon S3. * Transfer from S3 to CloudFront/EC2 in same region. |

Amazon EC2