22AIE305: CLOUD COMPUTING

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Cloud services are similar to cable TV subscription, but has more options and facilities

Google as a cloud provider

- Software as a service
  ex; Google apps

- Platform as a service

Dropbox is a cloud service that provides file backup and enables users to share files and folders

Characteristics

✓ **On-demand self service**

✓ **Broad network Access**

✓ **Rapid Elasticity**

✓ **Measured Service**

✓ **Time Saver**

✓ **Flexible options**

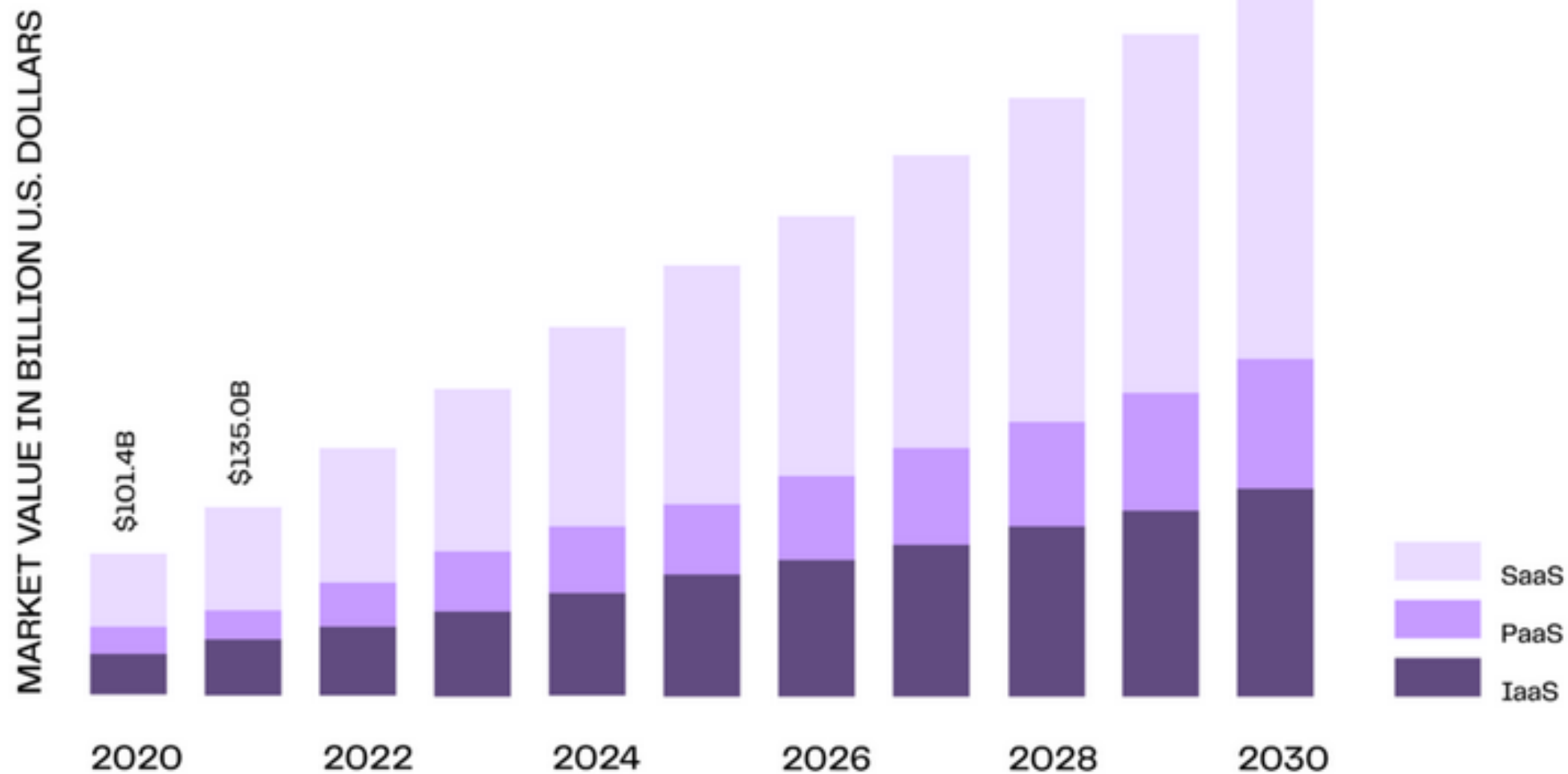# U.S. CLOUD COMPUTING
MARKET SIZE

MARKET VALUE IN BILLION U.S. DOLLARS

$101.4B

$135.0B

2020   2022   2024   2026   2028   2030

SaaS

PaaS
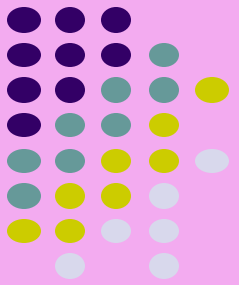
IaaS

Service Layers

- Cloud computing applications are composed of a set of layers upon which distributed applications are built or hosted.
- Depending on the type and level of service to be offered, a client can opt for a variety of combinations offered by the cloud provider.
- For example, you may need more processing power and small amount of data storage in one application; whereas another may need huge data storage and small processing.

3 Service Models

- Cloud computing providers offer their services according to **three fundamental models** Infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS) where IaaS is the most basic and each higher model abstracts from the details of the lower models.

- **Infrastructure as a Service (IaaS)**

  - In this most basic cloud service model, cloud providers offer computers – as physical or more often as virtual machines –, raw (block) storage, firewalls, load balancers, and networks. IaaS providers supply these resources on demand from their large pools installed in data centers. Local area networks including IP addresses are part of the offer. For the wide area connectivity, the Internet can be used or - in carrier clouds - dedicated virtual private networks can be configured.

  - To deploy their applications, cloud users then install operating system images on the machines as well as their application software. In this model, it is the cloud user who is responsible for patching and maintaining the operating systems and application software. Cloud providers typically bill IaaS services on a utility computing basis, that is, cost will reflect the amount of resources allocated and consumed.

Platform as a Service (PaaS)

- Cloud providers deliver a computing platform and/or solution stack typically including operating system, programming language execution environment, database, and web server.

- Application developers develop and run their software solutions on a cloud platform w/o the cost and complexity of buying and managing the underlying hardware and software layers.

- With some PaaS offers, the underlying compute and storage resources scale automatically to match application demand such that the cloud user does not have to allocate resources manually.

- The ability to quickly scale in/out service is called Rapid elasticity

Service Models

- **Software as a Service** (SaaS)
  - Cloud providers install and operate application software in the cloud and cloud users access the software from cloud clients.
  - The cloud users do not manage the cloud infrastructure and platform on which the application is running. This eliminates the need to install and run the application on the cloud user's own computers simplifying maintenance and support. What makes a cloud application different from other applications is its elasticity.
  - This can be achieved by cloning tasks onto multiple virtual machines at run-time to meet the changing work demand. Load balancers distribute the work over the set of virtual machines. This process is transparent to the cloud user who sees only a single access point.
  - To accommodate a large number of cloud users, cloud applications can be multitenant, that is, any machine serves more than one cloud user organization.
  - It is common to refer to special types of cloud based application software with a similar naming convention: desktop as a service, business process as a service, Test Environment as a Service, communication as a service.
- The pricing model for SaaS applications uses a workflow defined below

Cloud Clients

- Users access cloud computing using networked client devices, such as desktop computers, laptops, tablets and smartphones. Some of these devices - *cloud clients* - rely on cloud computing for all or a majority of their applications so as to be essentially useless without it. Examples are thin-clients and the browser-based Chromebook.

- Many cloud applications do not require specific software on the client and instead use a web browser to interact with the cloud application.

- With Ajax and HTML5 these Web user interfaces can achieve a similar or even better look-and-feel as native applications.

- Some cloud applications support specific client software dedicated to these applications (e.g., virtual desktop clients and most email clients). Some legacy applications (line of business applications that until now have been prevalent in thin client Windows computing) are delivered via a screen-sharing technology.

XaaS All Cloud Services Together
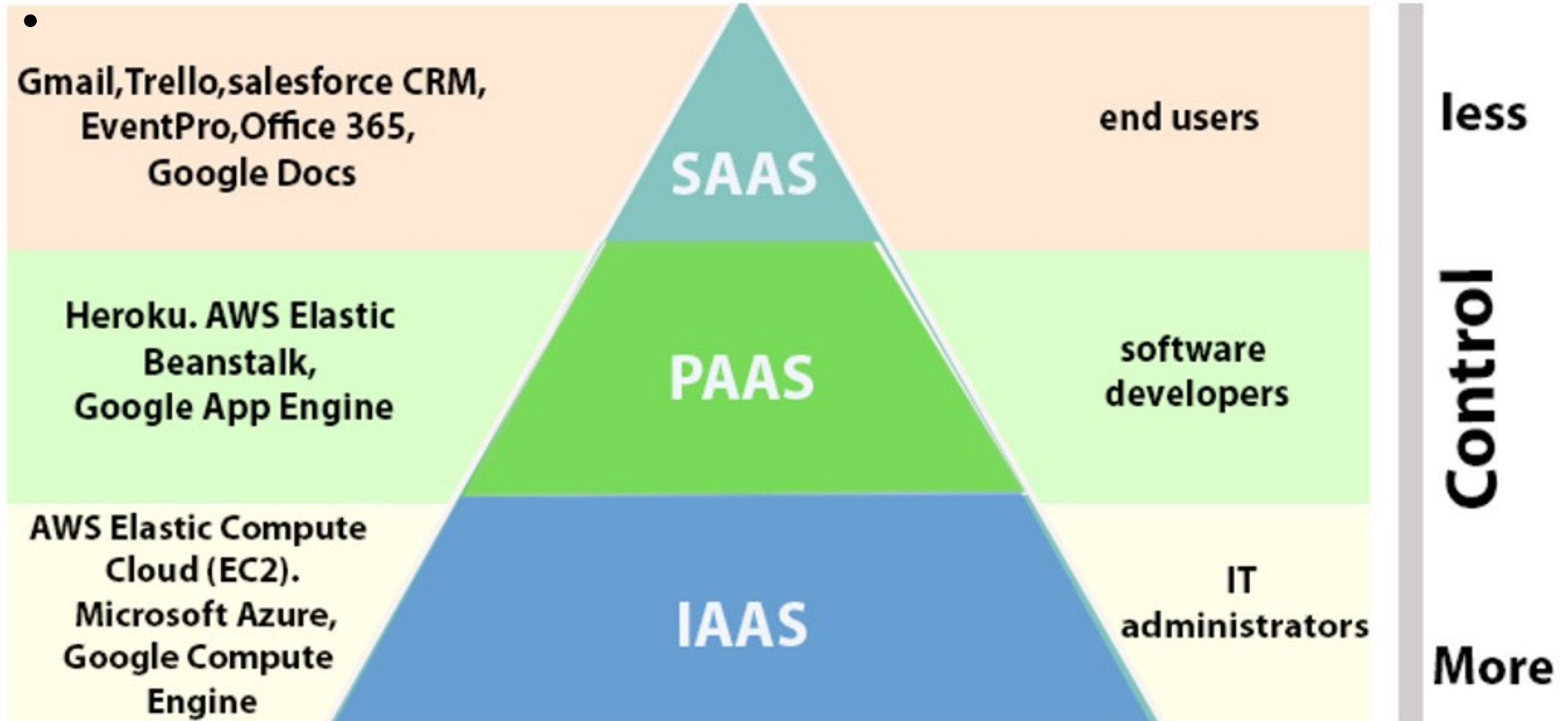
A four-layer Architecture of the Cloud

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Business Process (SOA)

Application Services

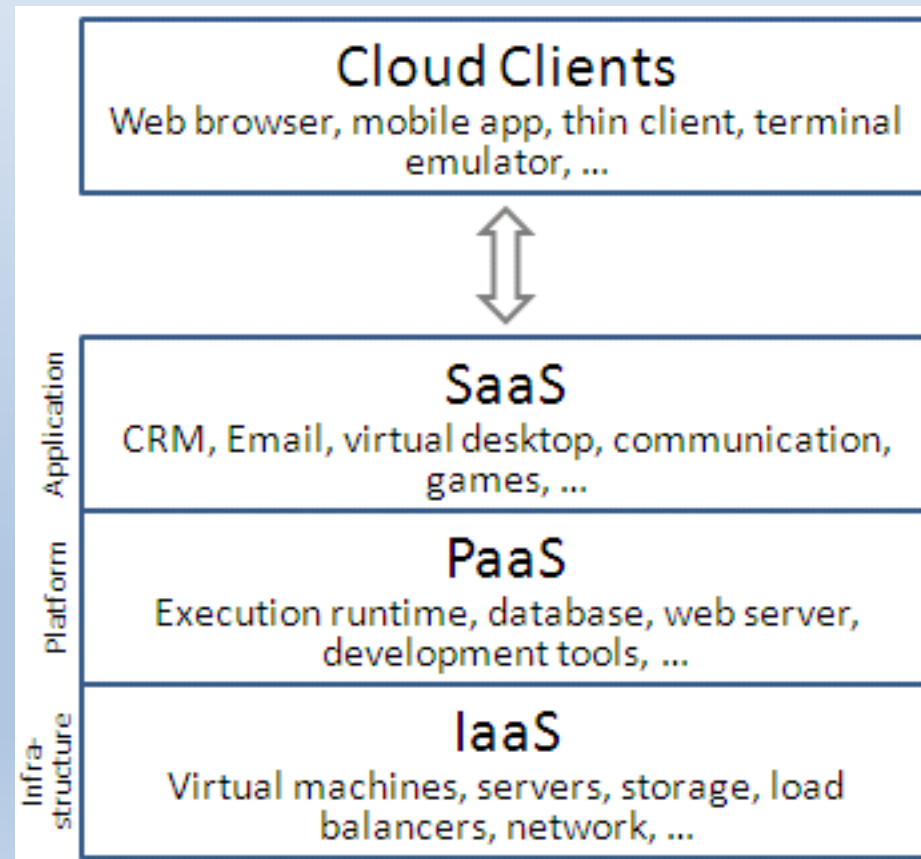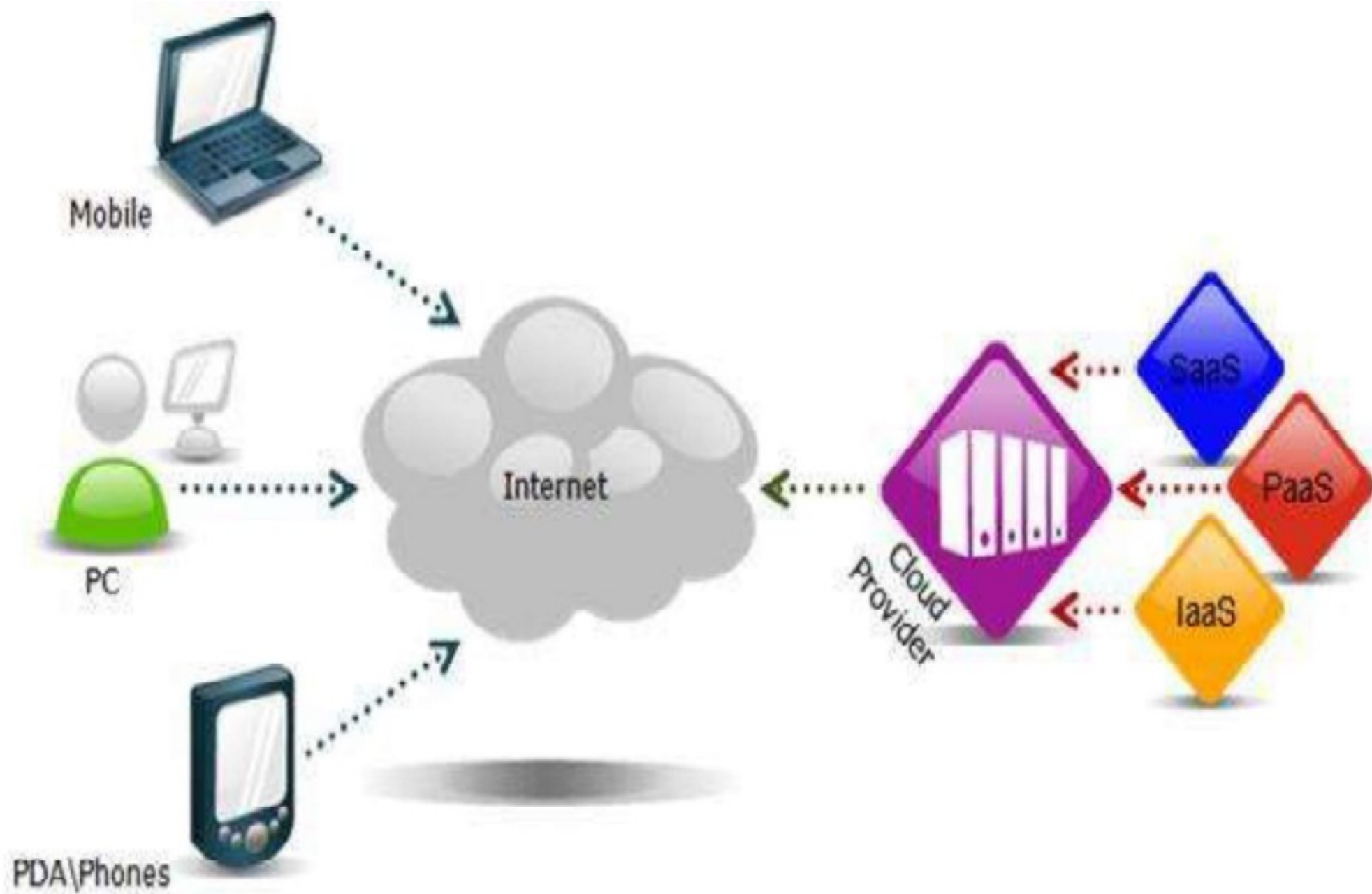Platform Services

Infrastructure Services
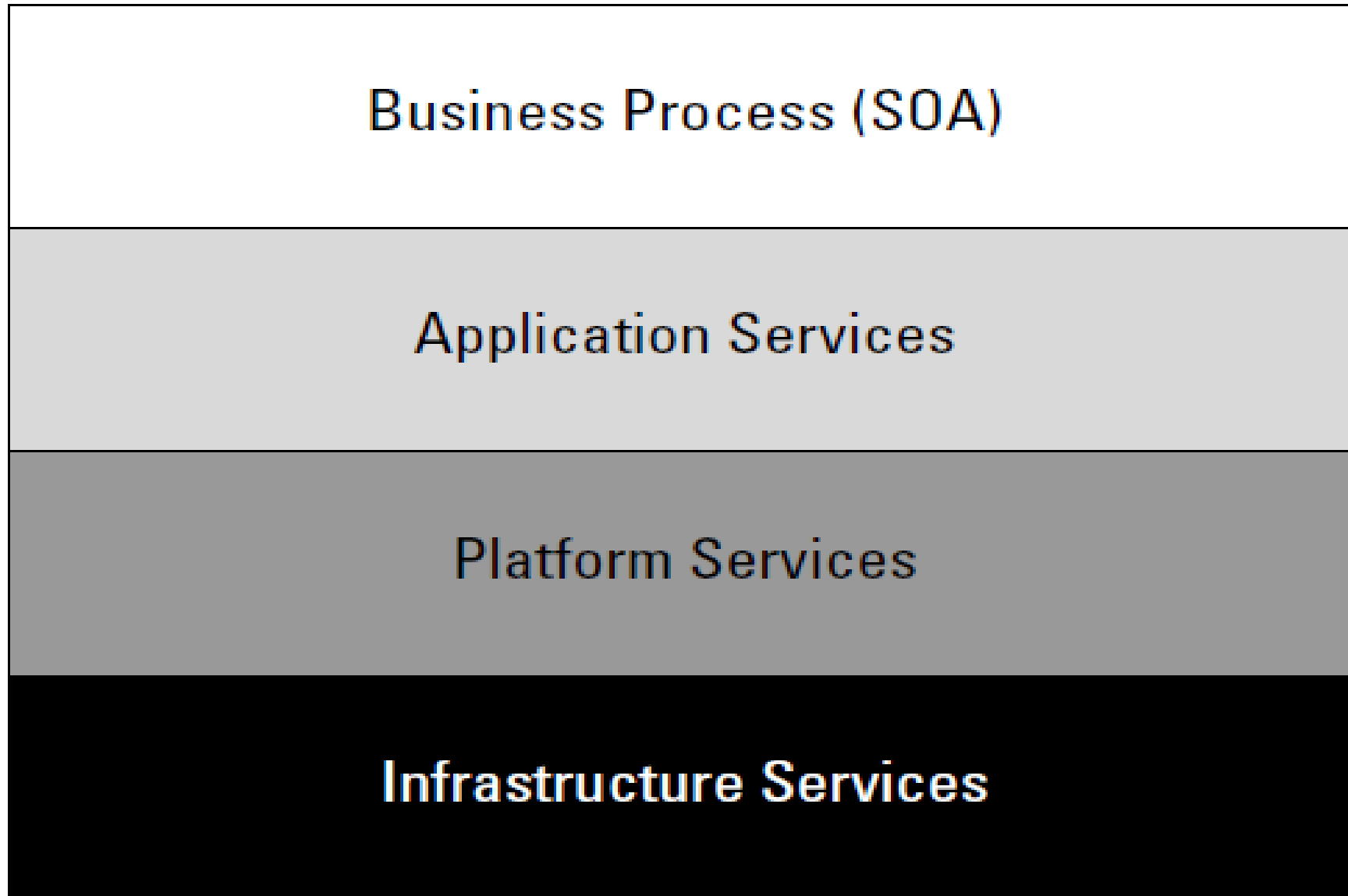
Cloud computing Ecosystem

- **Service models:**
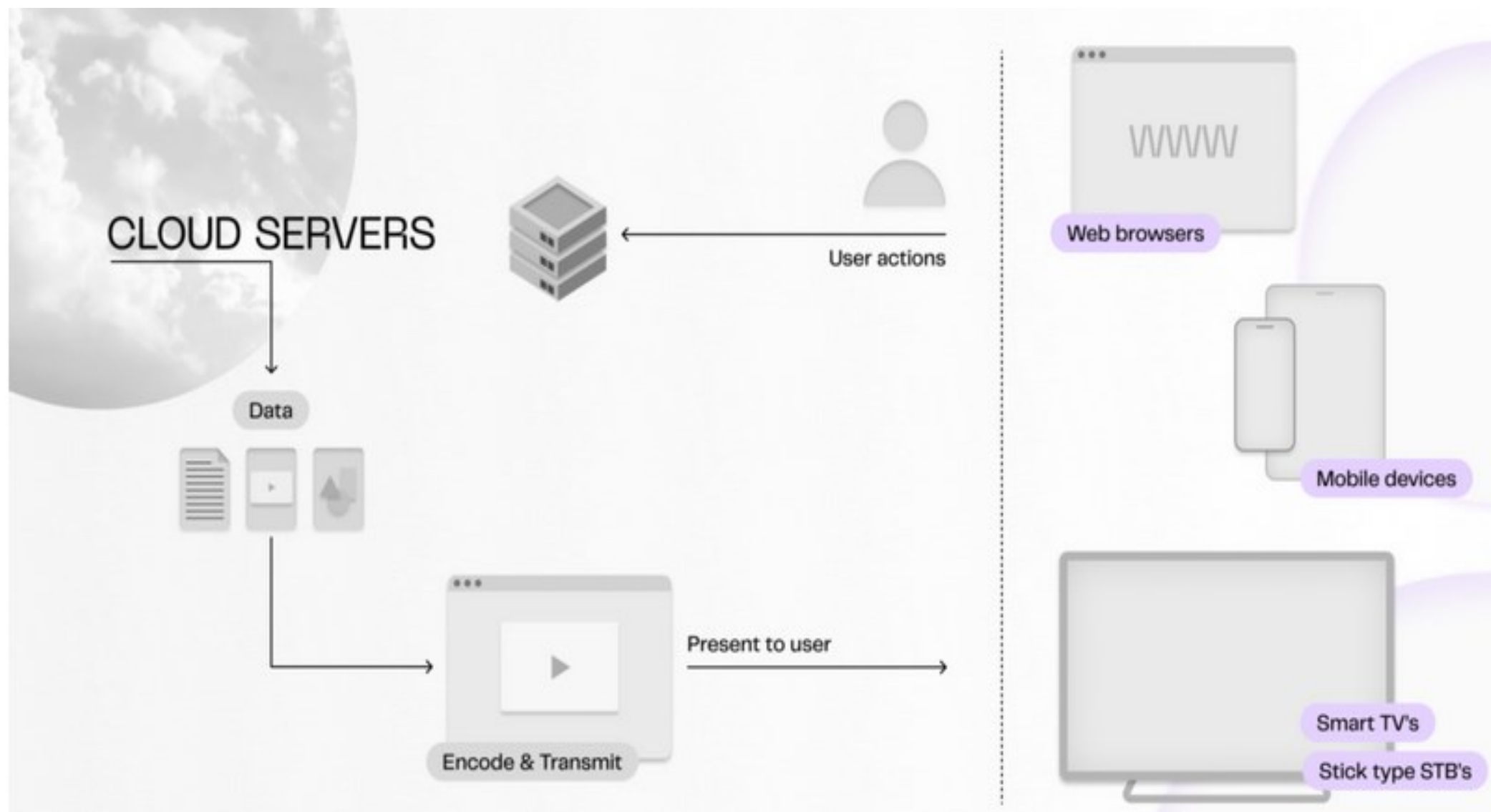 - **IaaS**: Infrastructure as a Service
    - e.g., Amazon EC2, Microsoft Azure, Google Compute Engine
  - **PaaS**: Platform as a Service
    - e.g., Google AppEngine, Heroku, Apache Stratos
  - **SaaS**: Software as a Service
    - Microsoft Office365, Amazon DynamoDB, gmail
- **IDaaS**: Identity as a Service provides authentication and authorization services on distributed networks.

Cloud Delivery Models

1. **Software as a Service (SaaS)** (high level)
2. **Platform as a Service (PaaS)**
3. **Infrastructure as a Service (IaaS)** (low level)

source Wikipedia

CLOUD SERVERS

User actions

Data

Present to user

Encode & Transmit

Web browsers

Mobile devices

Smart TV's

Stick type STB's

Service Providers

- Amazon Web Services (AWS)
- Microsoft Azure.
- Google Cloud.
- Alibaba Cloud.
- IBM Cloud.
- Oracle.
- Salesforce.
- SAP
- Rackspace Cloud
- VMWare
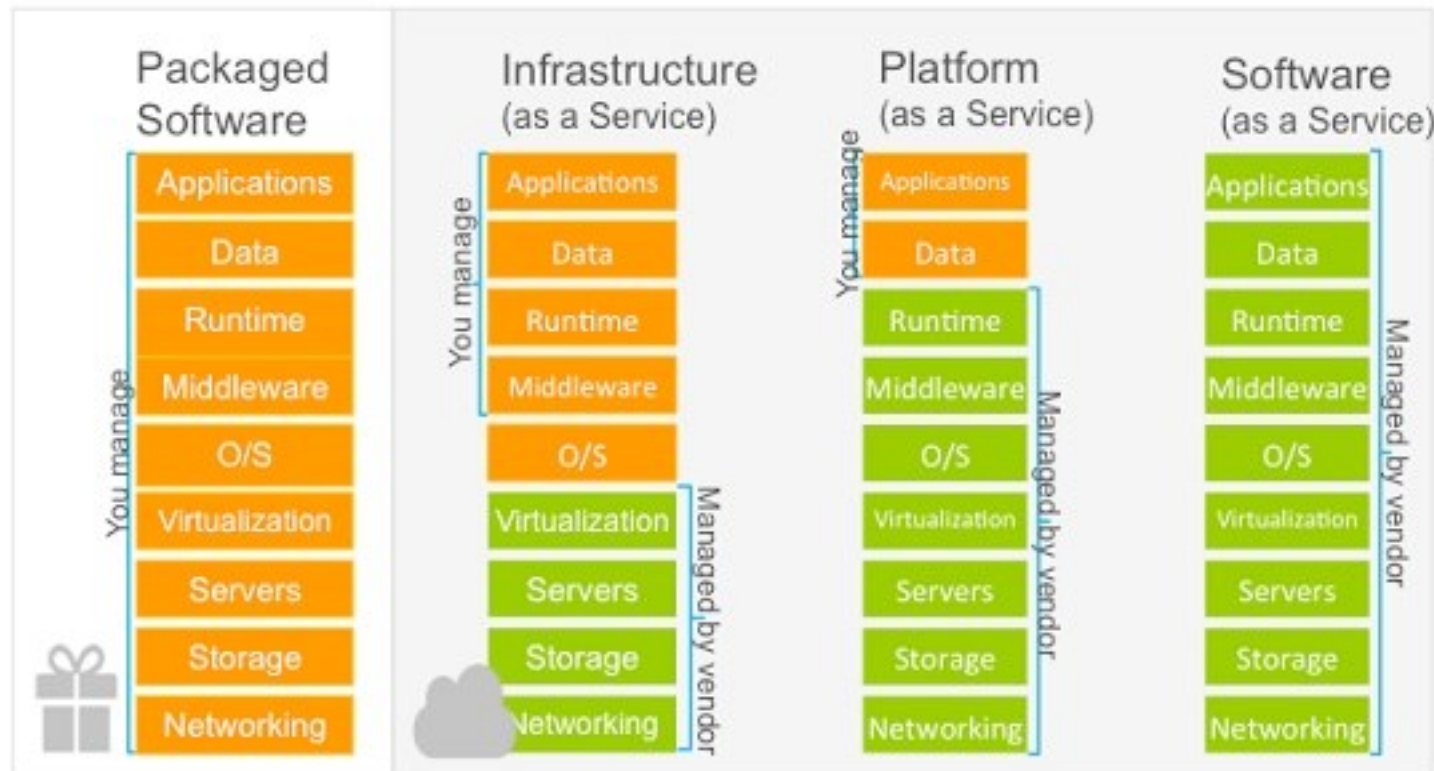
The Three delivery models of Cloud Computing

Figure 1.   Source: Microsoft Azure

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Infrastructure-as-a-Service (IaaS)

- Infrastructure is compute resources, CPU, VMs, storage, etc

- IaaS used to create virtual computing systems or networks

- The user is able to deploy and run arbitrary software, which can include operating systems and applications.

- The user does not manage or control the underlying Cloud infrastructure but has control over operating systems, storage, deployed applications, and possibly limited control of some networking components, e.g., host firewalls.

- Services offered by this delivery model include: **server hosting, storage, computing hardware, operating systems, virtual instances, load balancing, Internet access, and bandwidth provisioning**.

- Example: Amazon EC2

IaaS continued..

- The IaaS layer offers storage and compute resources that developers and IT organizations use to deliver custom business solutions.

- *IaaS* is the delivery of computer hardware (servers, networking technology, storage, and data center space) as a service.

- It may also include the delivery of operating systems and virtualization technology to manage the resources

- IaaS is on-demand access to cloud-hosted physical and virtual servers, storage and networking—the backend IT infrastructure for running applications and workloads in the cloud.

IaaS

- IaaS is arguably the most flexible of the three cloud service delivery models because it allows for almost complete control over a business's infrastructure.
- It is also easily scalable and allows for advanced customization. Traditionally, IT infrastructure is hosted in a data center on site.
- With IaaS, the infrastructure isn't hosted on site, but is based in the cloud.
- All things considered, businesses still have direct control over their operating systems, security components and applications.
- Implementing IaaS enables businesses to take on temporary, experimental or frequently changing projects without having to upgrade on-premise infrastructure. IaaS also doesn't require a pre-built base, so the migration is smooth.

IaaS

- The IaaS customer rents computing resources instead of buying and installing them on their own server or data center.

- The service is typically paid for on a usage basis. The service may include *dynamic scaling* so that if the customer winds up needing more resources than expected, he can get them immediately (probably up to a given limit).

- Infrastructure can be dynamically scaled up or down, based on the requirements of the application. Some cloud providers let you to start with minimal resources (eg: one core) and add more resources later

Service level

- An agreed-upon *service level* states what the provider has agreed to deliver in terms of availability and response to demand.

- It might, for example, specify that the resources will be available 99.999 percent of the time and that more resources will be provided dynamically if greater than 80 percent of any given resource is being used.

- When the client interacts with an IaaS service and requests resources from the virtual systems, those requests are redirected to the **real servers** that do the actual work

Amazon EC2

- The most high-profile IaaS operation is **Amazon's Elastic Compute Cloud** (Amazon EC2). It provides a Web interface that allows customers to access virtual machines. EC2 offers scalability under the user's control with the user paying for resources by the hour (pay per use model).

- The use of the term *elastic* in the naming of Amazon's EC2 is significant. The elasticity refers to the ability that EC2 users have to easily increase or decrease the infrastructure resources assigned to meet their needs. The user needs to initiate a request, so this service provided isn't dynamically scalable. Users of EC2 can request the use of any operating system as long as the developer does all the work.

- Amazon itself supports a more limited number of operating systems (Linux, Solaris, and Windows). For an up-to-the-minute description of this service, go to http://aws.amazon.com/ec2.

Benefits of IaaS

- Compared to traditional IT, IaaS gives customers more flexibility build out computing resources as needed, and to scale them up or down in response to spikes or slow-downs in traffic. IaaS lets customers avoid the up-front expense and overhead of purchasing and maintaining its own on-premises data center.

- It also eliminates the constant tradeoff between the waste of purchasing excess on-premises capacity to accommodate spikes, versus the poor performance or outages that can result from not having enough capacity for unanticipated traffic bursts or growth.

- **Higher availability**: With IaaS a company can create redundant servers easily, and even create them in other geographies to ensure availability during local power outages or physical disasters.

- **Lower latency, improved performance:** Because IaaS providers typically operate data centers in multiple geographies, IaaS customers can locate apps and services closer to users to minimize latency and maximize performance. **Improved responsiveness**: Customers can provision resources in a matter of minutes, test new ideas quickly and quickly roll out new ideas to more users.

- **Comprehensive security:** With a high level of security onsite, at data centers, and via encryption, organizations can often take advantage of more advanced security and protection they might provide if they hosted the cloud infrastructure in-house.

- **Faster access to best-of-breed technology**: Cloud providers compete with each other by providing the latest technologies to their users, IaaS customers can take advantage of these technologies much earlier (and at far less cost) than they can implement them on premises.

Common IaaS use-cases

- **Disaster recovery**: Instead of setting up redundant servers in multiple locations, IaaS can deploy its disaster recovery solution to the cloud provider's existing geographically dispersed infrastructure.

  Ecommerce: IaaS is an excellent option for online retailers that frequently see spikes in traffic. The ability to scale up during periods of high demand and high-quality security are essential in today's 24-7 retail industry.

  Internet of Things (IoT), event processing, artificial intelligence (AI): IaaS makes it easier to set up and scale up data storage and computing resources for these and other applications that work with huge volumes of data.

  Startups: Startups can't afford to sink capital into on-premises IT infrastructure. IaaS gives them access to enterprise-class data center capabilities without the up-front investment in hardware and management overhead.

  Software development: With IaaS, the infrastructure for testing and development environments can be set up much more quickly than on-premises. (However, this use case is better suited to PaaS, as you'll read in the next section.)

IaaS workloads

- How do Cloud-service-providers measure the resource usage by clients for billing purpose?

- It is using the **workload** unit that simulates the ability of a certain type of real or physical server to do an am

- The **work done** can be measured by the number of Transactions Per Minute (**TPM**) or a similar metric against a certain type of hardware system.

- In addition to throughput, a workload has certain other attributes such as **Disk I/Os** measured in Input/Output Per Second IOPS, the **amount of RAM consumed** under load in MB, **network throughput and latency**, and so forth.

A virtual private server partition in an IaaS cloud

Virtual Machine Layer

Logical Unit Number (LUN)

Workload Partition 1

Workload Partition 2

Cloud Layer Interconnection Layer

RAID Layer

Virtual Application Software Layer

Workload Partition 3

Network Interface Layer

Ethernet

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