Faculté Polytechnique

INFORMATIQUE PARALLÈLE ET DISTRIBUÉE

CHAPTER 7 : CLOUD COMPUTING

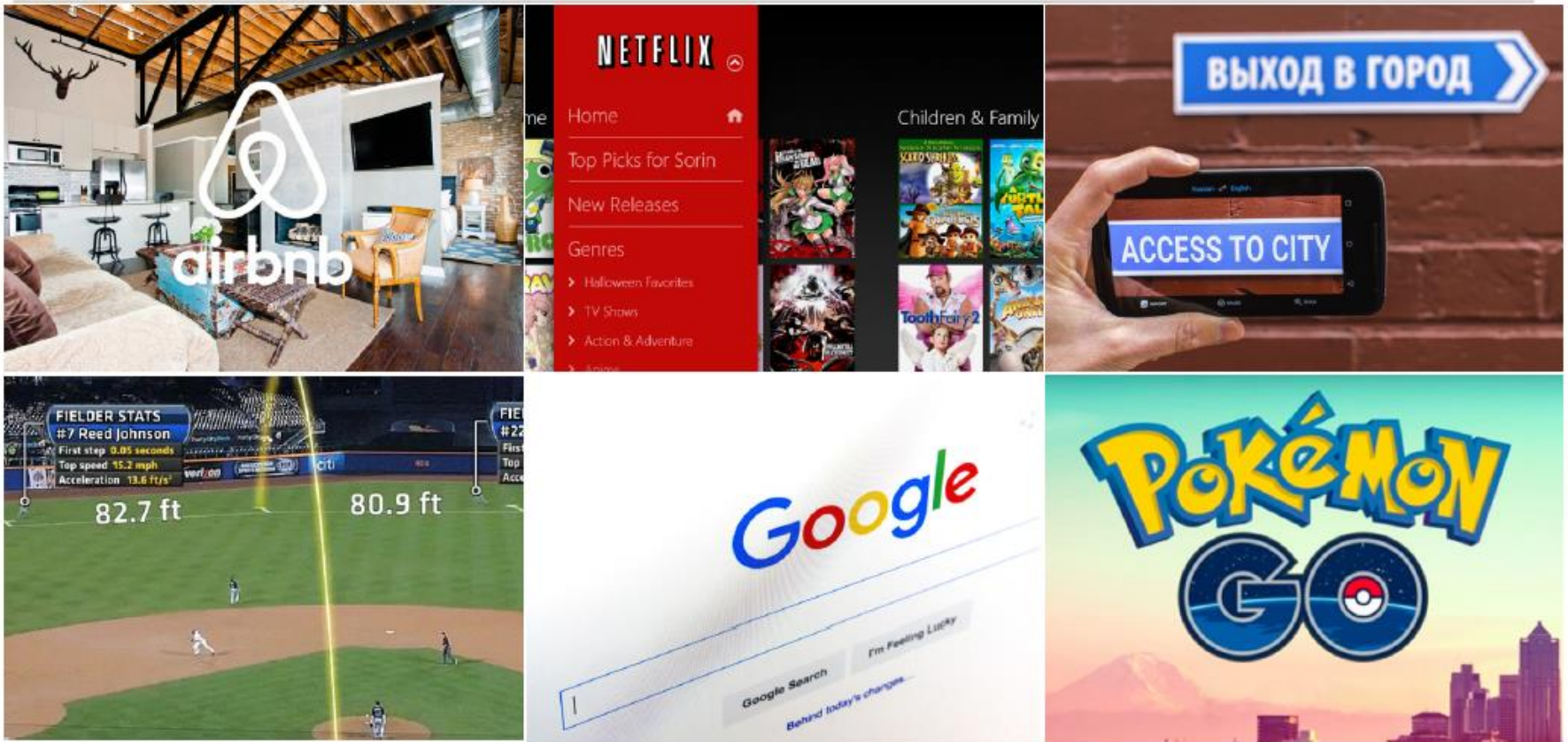**Sidi Ahmed Mahmoudi**

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PLAN

Introduction

I. **History of Cloud Computing and Big Data**

II. **Definitions**

III. **Cloud computing features**

- **Scaling**

- **Virtualization**

IV. **Cloud computing architectures**

V. **Cloud deployment models**

VI. **Examples of cloud platforms**

Conclusion

Introduction

The Cloud is everywhere

History of Cloud computing & Big Data

Founder of mathematical abstractions and algorithms

Algorithms, ~800

5 tons : computes 16 digits & 6 orders of difference
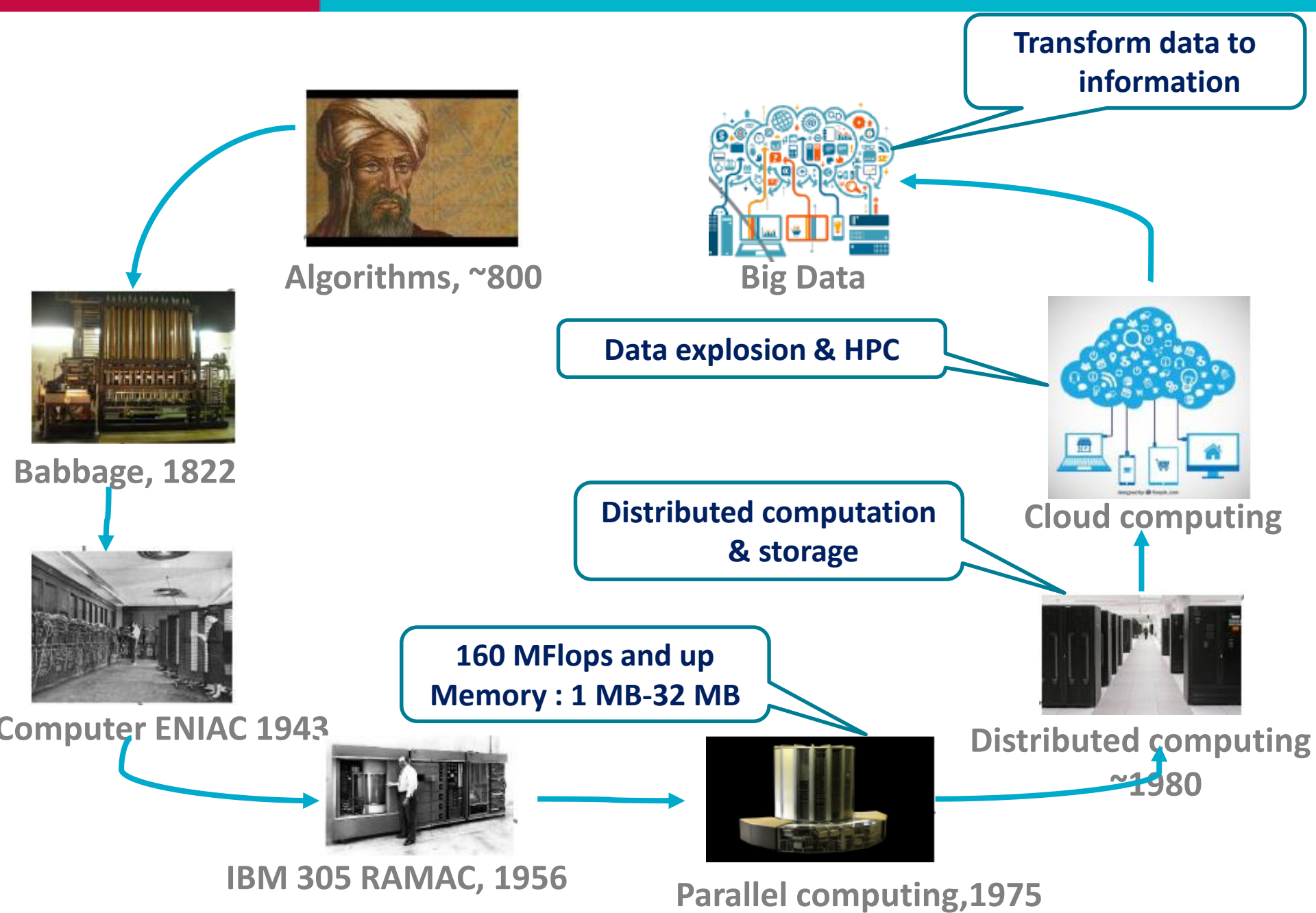
Babbage, 1822

167 m^2, 50 tons

Computer ENIAC 1943

9 x15 m^2, 1 tons

IBM 305 RAMAC, 1956

Algorithms, ~800

Babbage, 1822

Computer ENIAC 1943

IBM 305 RAMAC, 1956

Parallel computing, 1975

Distributed computing ~1980

Cloud computing

Big Data

Transform data to information

Data explosion & HPC

Distributed computation & storage

**160 MFlops and up Memory : 1 MB-32 MB**

Definitions

- Cloud computing : allows to manage resources (servers) and adapt infrastructure very quickly in a completely transparent way for the administrator and users.

- The proposed applications within cloud computing mode are no longer found in a computer server, hosted at the user, but in a cloud formed by the interconnection of geographically distinct servers called datacenters.

Definitions

- This is made possible by the virtualization process, which consist of operating multiple OS (operating systems) and their associated applications on a single physical server

- Virtualization makes it possible to recreate multiple virtual machines on one machine

- A method that deliver technology to the consumer by using internet servers for processing and data storage, while the client system uses the data.

Definitions
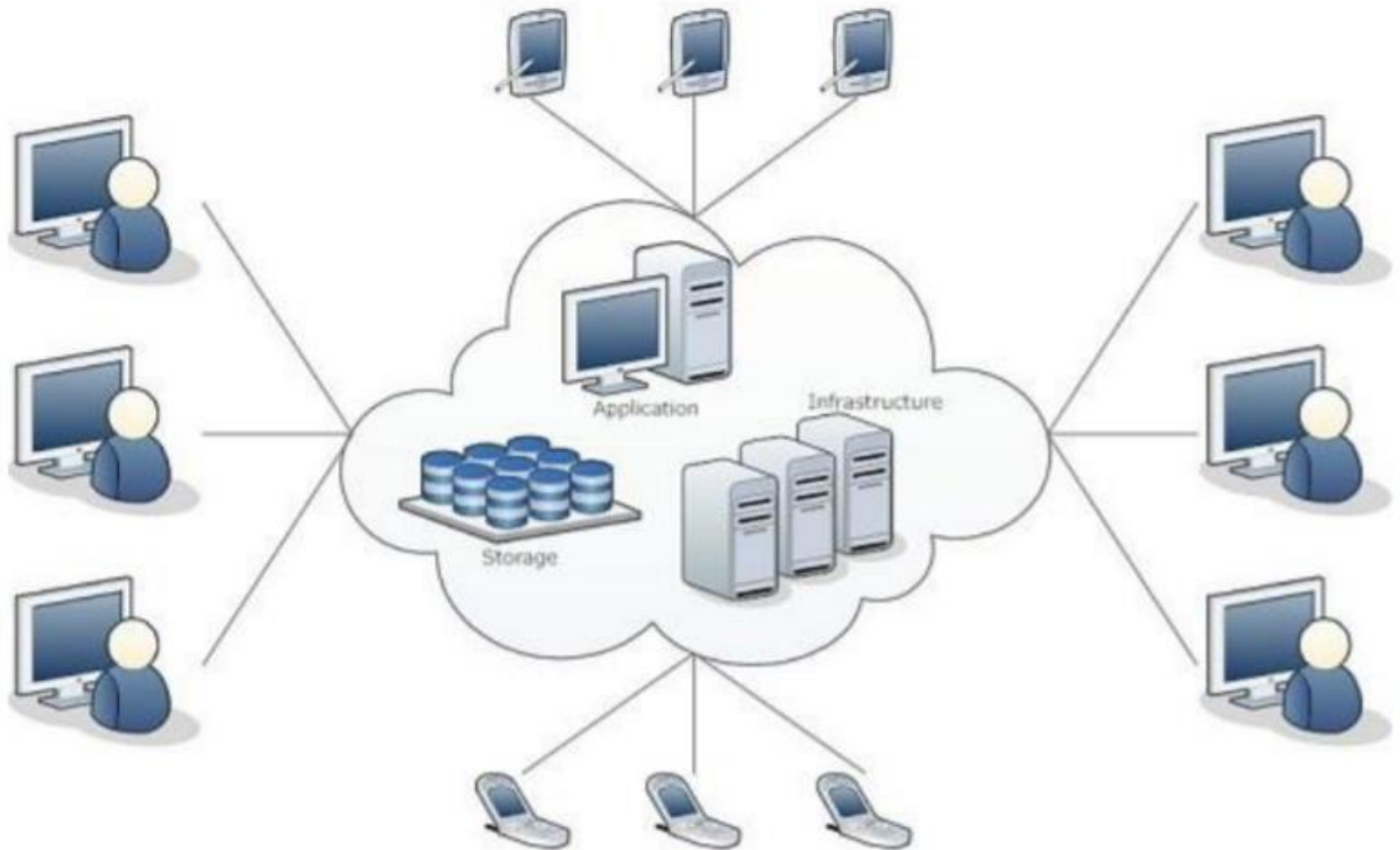
Server resource sharing
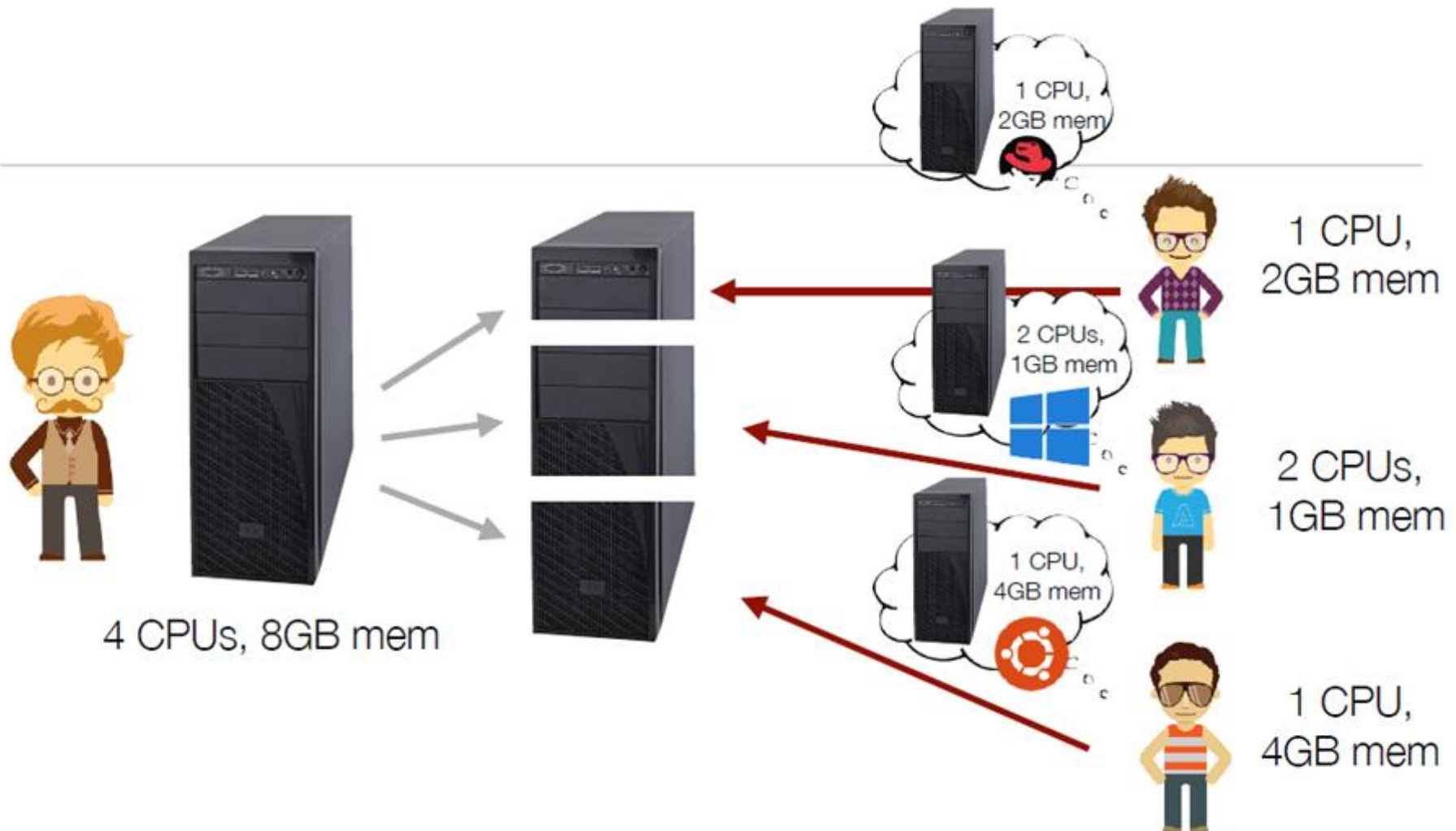
Cloud for Big Data

- Facebook: more than 1 billion (4.10^9) daily active users (2016)

- Google : more than 3 trillion ($3. 10^{12}$) queries per day (2016)

- YouTube: about 4 billions videos viewed per day (2016)

- About 80 millions Internet servers (AWS, Google, etc.)

- In 2020, experts predict about 40 zetabytes in the cloud

Cloud computing features

- **Scaling**

- **Virtualization**

Scaling up

Vertical scaling

Scaling out

Horizontal scaling
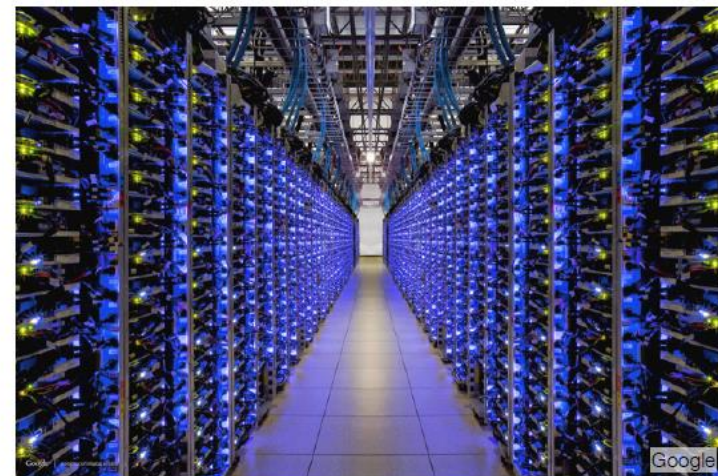
Scaling up from PC to Data centers

Server

Servers in rack

Data centers

Scaling up vs Scaling out

	Vertical (Scaling Up)	Horizontal (Scaling Out)
Cost	Exponential	Linear
Limits	Existing servers	None
Failure resilience	High	Low
Infrastructure complexity	Simple	Complex
Geographical distribution	---	+++
Typical usage	Relational DB	Worker/ Webserver

Virtualization

- Virtualization enables a single PC or server to run, in simultaneous way, multiple operating systems or multiple sessions (applications) of a single OS

- Virtualization allows efficient resource utilization and costs reduction

- A machine with virtualization software can host numerous applications, including those running on different operating systems, on a single platform

- The solution that enables virtualization is a VM monitor (VMM), or hypervisor.
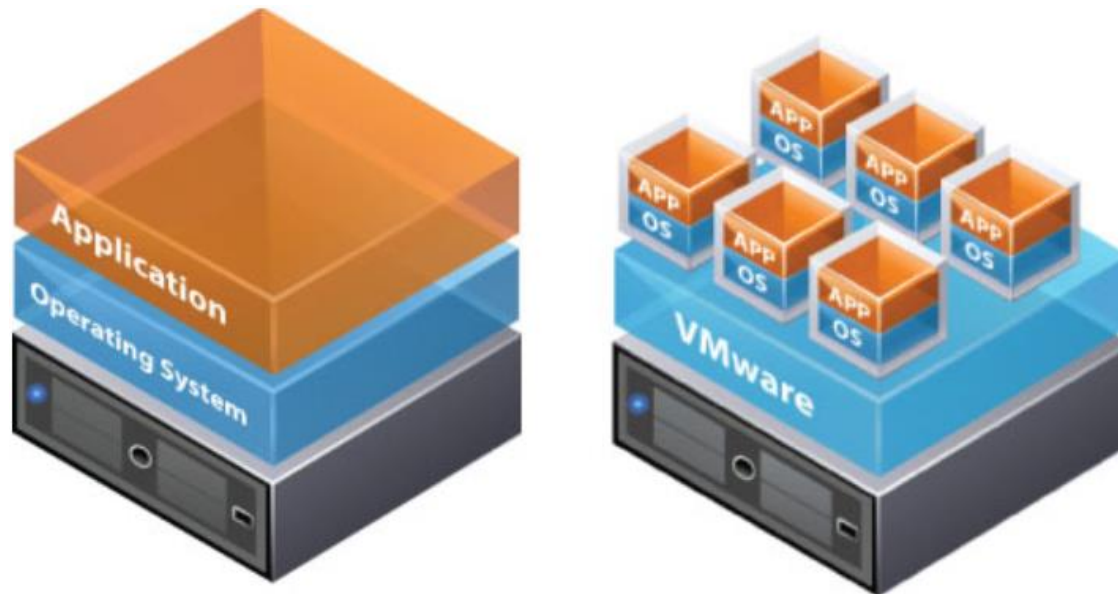
Virtualization

- The process of creating a virtual environment on an existing server to run your desired program, without interfering with any of the other services provided by the server or host platform to other users

- The Virtual environment can be a single instance or a combination of many such as operating systems, Network or Application servers, computing environments, storage devices and other such environments

- The host operating system can support several virtual machines, each one has the characteristics of a particular OS

Benefits of Virtualization

- Reduction in costs

- Efficient utilization and management of resources

- Better accessibility of computing resources

- Removal of special hardware and utility requirement

- Reduced risk of data loss, as data is backed up across multiple storage locations

Virtualization

The access to the virtual machine is facilitated by a software known as Hypervisor (or monitor). Hypervisor acts as a link between the hardware and the virtual environment and distributes the hardware resources such as CPU usage, memory allotment between the different virtual

Virtualization types

| Hardware Virtualization | Software Virtualization | Desktop Virtualization | Storage Virtualization |

Hardware Virtualization

An individual independent segment of hardware or a physical server is made up of multiple smaller hardware segments or servers.

Each small server can host a virtual machine, but the entire cluster of servers is treated as a single device by any process requesting the hardware.
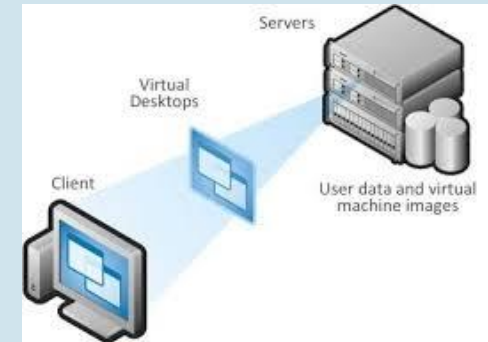
Software Virtualization

Creation of multiple virtual environments on the host machine. It creates a computer system complete with hardware that lets the guest operating system to run.

For example, it lets you run Android OS on a host machine natively using a Microsoft Windows OS, utilizing the same hardware as the host machine does

Desktop Virtualization

- The most common form of virtualization

- The user's desktop is stored on a remote server, allowing the user to access his desktop from any device or location.

- Employees can work conveniently from the comfort of their home.

- Data transfer over secure protocols : minimized risk of data loss

Storage Virtualization

- Multiple physical storage devices are grouped together, which then appear as a single storage device

- This provides various advantages such as homogenization of storage across storage devices of multiple capacity and speeds, reduced downtime, load balancing and better optimization of performance and speed.

- Partitioning your hard drive into multiple partitions is an example of this virtualization.

Other Virtualizations

- **Data virtualization**

- **Network virtualization**

- **Administrative virtualization**

Cloud types

SAAS

PAAS

IAAS

SAAS

Software as a Service (SaaS)

- Software distribution model in which a third-party provider hosts applications and makes them available to users over the Internet

- SaaS removes the need for organizations and users to install and run applications on their own computers or in their own data centers

- No expense of hardware acquisition, provisioning and maintenance, as well as software licensing, installation, configuration and support.

SAAS benefits

- **Flexible payments :**
    - Instead of purchasing software to install, customers subscribe to a SaaS
    - Pay only what your are using

- **Scalable usage**
    - high scalability : provide for customers the option to access more services or features on-demand

- **Automatic updates**
    - Instead of purchasing new software, customers can rely on a SaaS provider to automatically perform updates and patch management.
    - This further reduces the burden on in-house IT staff

- **Accessibility and persistence**
    - Since SaaS applications are delivered over the Internet, users can access them from any Internet-enabled device and location.

SAAS examples

- Dropbox : www.dropbox.com

- Google Apps : https://gsuite.google.com

- Doodle : www.doodle.com

- Microsoft office 365 : www.office.com
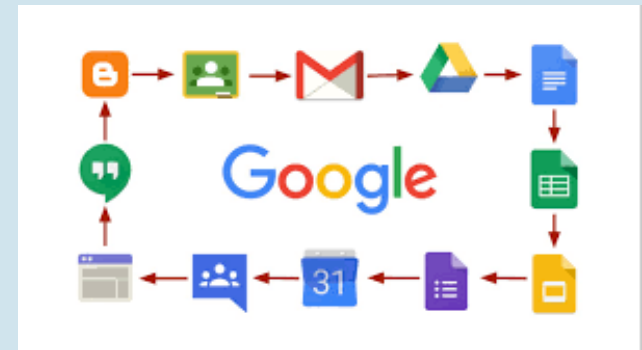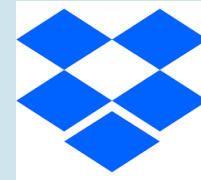
PAAS

Platform as a Service (PaaS)

- PaaS provider builds and supplies resilient and optimized environment on which users can install applications and data sets

- Users can focus on creating and running applications rather than constructing and maintaining the underlying infrastructure and services

- Text editing, version management, compiling and testing services

- Create new software quickly and efficiently

- Enables development teams to collaborate and work together.

PAAS

Advantages :

- Automatic deployment, no need to buy and install new software.

- Focus on development mainly.

Disadvantages :

- Limited to some technologies only such as :

  - Python or Java for Google AppEngine

  - .NET for Microsoft Azure.

IAAS

Infrastructure as a Service (IaaS)

- IaaS provider hosts the infrastructure components traditionally present in a data center, including servers, storage and networking hardware, as well as the virtualization or hypervisor layer

- IaaS customers access resources and services through a WAN (Wide Area Network), such as the internet, and can use the cloud provider's services to install the remaining elements of an application stack

- Example : the user can log in the IaaS+ platform to create virtual machines (VMs), install operating systems in each VM, etc.

IAAS

Advantages :

- High flexibility, total control of the system (administration within SSH protocol) by the possibility of installing any type of application.

Disadvantages :

- Need of system administrators as for classic servers.

IAAS examples

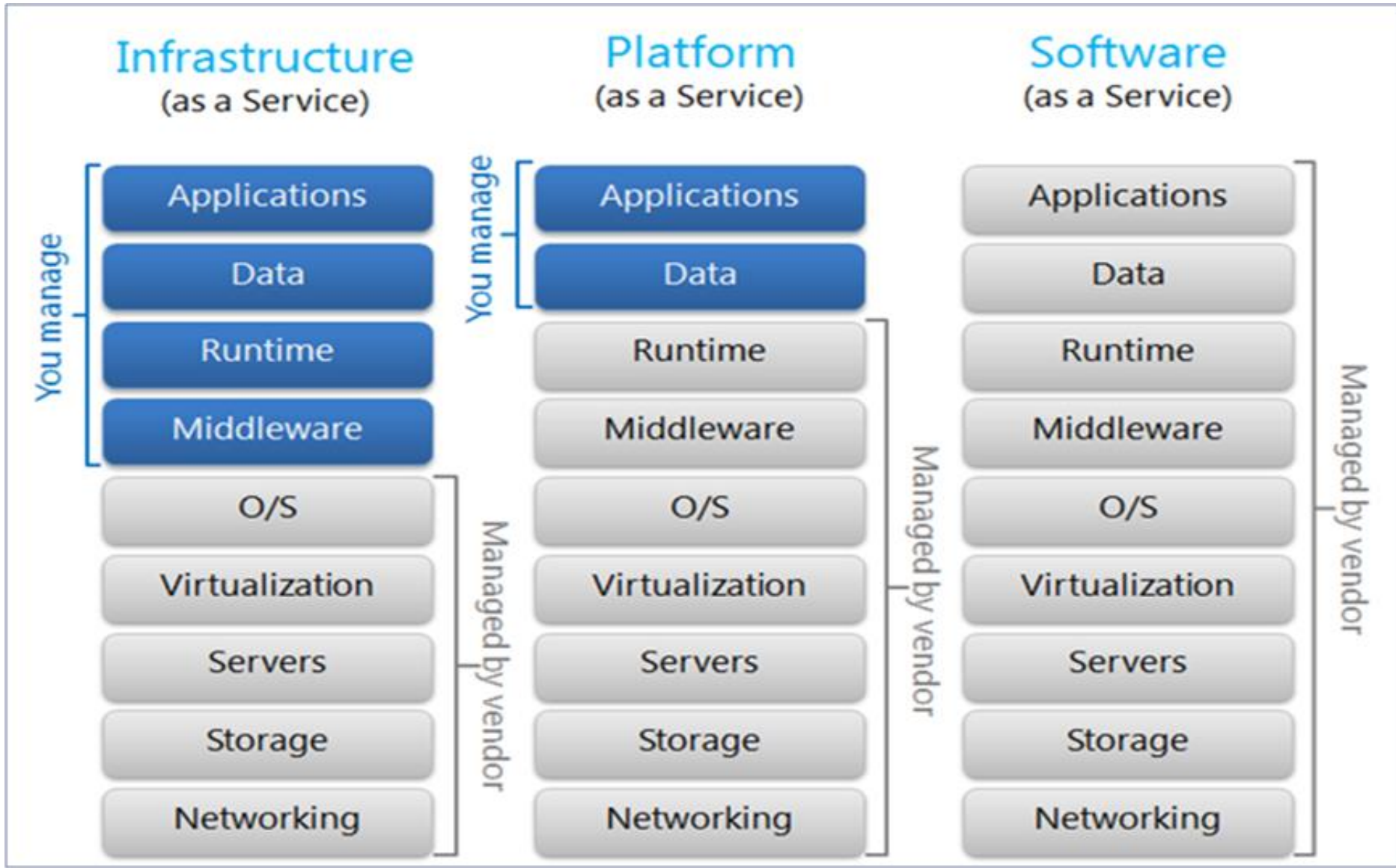- **Amazon Web Services (AWS): www.aws.amazon.com**

- **Google Cloud Platform (GCP): https://cloud.google.com/**

- **Open Stack : www.openstack.org**

Cloud computing deployment models

Public	Community	Private	Hybrid

Cloud computing deployment models

Private
- Single tenant implementation
- Owned and operated by IT organization
- Define your own data management policies
- Self-service and automation capabilities provide new agility

Hybrid
- Combination for Private & one or more public clouds
- Allows IT organizations to become brokers of services

Public
- Multi-tenant implementation
- Owned and operated by Service Provider
- Bound by multi-tenant data management policies
- Similar self-service and automation capabilities as Private Cloud

Public cloud

- A fully virtualized environment where providers have an architecture that enables users to share computing resources

- Each user remains isolated from other users

- Public cloud storage is typically redundant, using multiple data centers and careful replication of file versions. This characteristic has given it a reputation for resiliency.

Public cloud

Public cloud architecture can be categorized by service model that include:

- Software as a service (SaaS), in which a third-party provider hosts applications and makes them available to customers over the internet

- Platform as a service (PaaS), in which a third-party provider delivers hardware and software tools

- Infrastructure as a service (IaaS), in which a third-party provider offers virtualized computing resources, such as VMs and storage, over the internet.

Community cloud

- Community Cloud employs Salesforce's Chatter social CRM platform [] for chat and screensharing, allowing users to exchange data and images in real time throughout an ongoing conversation.

- The platform supports customer relationship management (CRM) and provides channels for customers to find information and communicate with other customers. The console also includes a "Buy" button to enable e-commerce.

Community cloud

- Employees can use the platform for many types of workplace interactions, including human resources management (HRM) and help desk communications as well as collaboration among geographically dispersed teams.

- In a generic context, a community cloud is a multi-tenant infrastructure that enables collaboration among several organizations from a specific group with common computing concerns such as regulatory compilance, audit requirements or performance requirements.

Private cloud

- Delivers similar advantages to public cloud : scalability and self-service

- Limited to a proprietary architecture

- Unlike public clouds, which deliver services to multiple organizations, a private cloud is dedicated to the needs and goals of a single organization.

- Adapted with dynamic or unpredictable computing needs that require direct control over their environments, typically to meet security, business governance or regulatory compliance requirements.

Private cloud

- A private cloud is created and maintained by an individual enterprise

- The private cloud might be based on resources and infrastructure already present in an organization's on-premises data center or on new, separate infrastructure

- In both cases, the enterprise itself owns and operates the private cloud.

Hybrid cloud

- Cloud computing environment which uses a mix of private and public cloud services with orchestration between the two platforms.

- By allowing workloads to move between private and public clouds as computing needs and costs change, hybrid cloud gives businesses greater flexibility and more data deployment options.

- For example, an enterprise can deploy a private cloud to host sensitive or critical workloads, but use a public cloud provider, such as Google Compute Engine, to host less-critical resources, such as test and development workloads.

Hybrid cloud examples

- A transactional order entry system that experiences significant demand spikes around the holiday season is a good hybrid cloud candidate. The application could run in private cloud, but use cloud bursting to access additional computing resources from a public cloud when computing demands spike. To connect private and public cloud resources, this model requires a hybrid cloud environment

- Big Data processing : a company, for example, could use hybrid cloud storage to retain its accumulated business, sales, test and other data, and then run analytical queries in the public cloud, which can scale to support demanding distributed computing tasks.

Examples of cloud platforms

- Medical-based platform : www.bone.media-process.com

- Video Processing Platform : www.toolbox.media-process.com

- Machine learning platform: www.multimedia-processing.com

Medical-based platform

https://bone.media-process.com

Video processing platform

https://toolbox.media-process.com

Machine learning platform

Image Processing

Video Processing

Medical Applications

Deep Learning

Visitors

30		12	
9		3	
3		3	
2		2	
2		2	
1		1	
1		1	
1		1	
1		1	
1		1	

○ ○ ○

Color Histogram

Color Histogram

In image processing and photography, a color histogram is a representation of the distribution of colors in an image. For digital images, a color histogram

★ ★ ★ ★   10 reviews

SIFT

SIFT

The scale-invariant feature transform (SIFT) is an algorithm in computer vision to detect and describe local features in images. The algorithm was

★ ★   9 reviews

SURF

SURF

In computer vision, speeded up robust features (SURF) is a patented local feature detector and descriptor. It can be used for tasks such as object

★ ★ ★   1 reviews

Gaussian Filter

Median Filter

Blur Filter

Conclusion

- The Cloud computing domain represents a technology that was created in order to respond a specific need of organizations for using datacenter.

- Different types of cloud : SAAS, PAAS, IAAS

- Different deployment models : public, community, private and hybrid

- Main actors in the cloud : Amazon, Microsoft, Google, OpenStack, etc.

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THANK YOU