

# **Cloud Computing Architectural Model**

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# Everything as a Service (XaaS)

- This is one of the most important elements of cloud computing: Cloud services from different providers can be combined to provide a completely integrated solution covering all the computing stack of a system
- IaaS providers can offer the bare metal in terms of virtual machines where PaaS solutions are deployed. When there is no need for a PaaS layer, it is possible to directly customize the virtual infrastructure with the software stack needed to run applications
- This is the case of virtual Web farms: a distributed system composed of Web servers, database servers, and load balancers on top of which prepackaged software is installed to run Web applications.
- This possibility has made cloud computing an interesting option for reducing startups' capital investment in IT, allowing them to quickly commercialize their ideas and grow their infrastructure according to their revenues

# Cloud Computing Services Classification

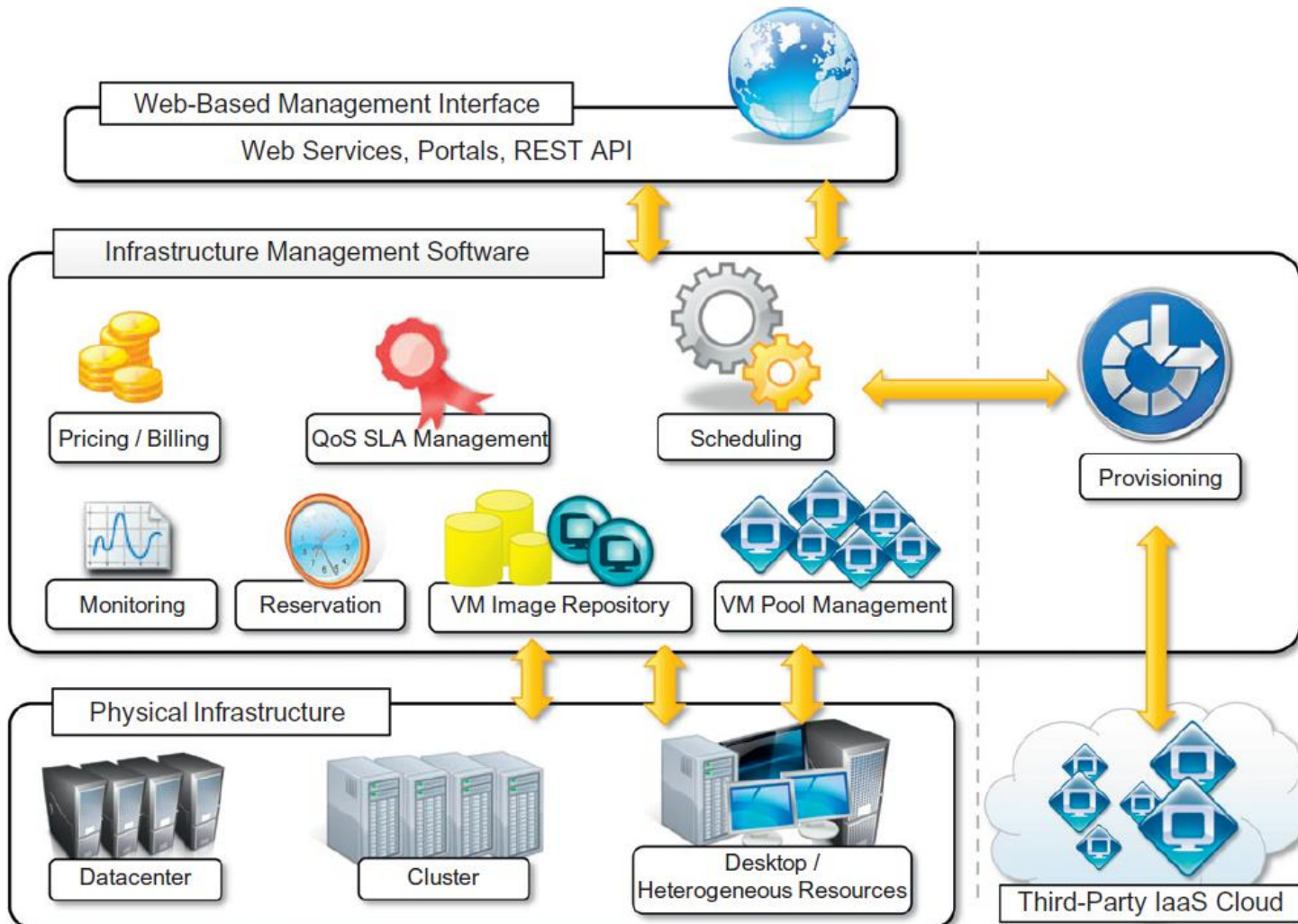
**Table 4.1** Cloud Computing Services Classification

Category	Characteristics	Product Type	Vendors and Products
<i>SaaS</i>	Customers are provided with applications that are accessible anytime and from anywhere.	Web applications and services (Web 2.0)	<a href="https://www.salesforce.com">SalesForce.com</a> (CRM) <a href="https://www.clarizen.com">Clarizen.com</a> (project management) Google Apps
<i>PaaS</i>	Customers are provided with a platform for developing applications hosted in the cloud.	Programming APIs and frameworks Deployment systems	Google AppEngine Microsoft Azure Manjrasoft Aneka Data Synapse
<i>IaaS/HaaS</i>	Customers are provided with virtualized hardware and storage on top of which they can build their infrastructure.	Virtual machine management infrastructure Storage management Network management	Amazon EC2 and S3 GoGrid Nirvanix

# Infrastructure(IaaS) or hardware-as-a service (HaaS)

- Most popular and developed market segment of cloud computing
  - Customizable infrastructure on demand
  - On demand computing resources
  - No up-front commitment
  - Start small and grow as required
  - No contract, Only credit card!
  - Pay for what you use
  - No maintenance
  - Measured service
  - Scalability
  - Reliability

# IaaS/HaaS



# IaaS/HaaS

- **Three principal layers:** the physical infrastructure, the software management infrastructure, and the user interface
  - At the top layer the user interface provides access to the services exposed by the software management infrastructure. Interface is based on Web 2.0 technologies: Web services, RESTful APIs, and mash-ups
  - Web services and RESTful APIs allow programs to interact with the service without human intervention, thus providing complete integration within a software system
  - **The core features of an IaaS solution are implemented in the infrastructure management software layer**
  - **A central role is played by the scheduler, which is in charge of allocating the execution of virtual machine instances**

# IaaS/HaaS

- The scheduler interacts with the other components that perform a variety of tasks:
  - The pricing and billing component takes care of the cost of executing each virtual machine instance and maintains data that will be used to charge the user
  - The monitoring component tracks the execution of each virtual machine instance and maintains data required for reporting and analyzing the performance of the system
  - The reservation component stores the information of all the virtual machine instances that have been executed or that will be executed in the future

# IaaS/HaaS

- QoS/SLA management component will maintain a repository of all the SLAs made with the users; together with the monitoring component, this component is used to ensure that a given virtual machine instance is executed with the desired quality of service
- The VM repository component provides a catalog of virtual machine images that users can use to create virtual instances
- A VM pool manager component is responsible for keeping track of all the live instances
- a provisioning component interacts with the scheduler to provide a virtual machine instance that is external to the local physical infrastructure directly managed by the pool



# IaaS/HaaS

- The bottom layer is composed of the physical infrastructure, on top of which the management layer operates
  - A service provider will most likely use a massive datacenter containing hundreds or thousands of nodes
  - At the bottom of the scale it is also possible to consider heterogeneous environment where different types of resources—PCs, workstations, and clusters—can be aggregated
  - From an architectural point of view, the physical layer also includes the virtual resources that are rented from external IaaS providers

# IaaS/HaaS

- Public clouds vendors such as Amazon, GoGrid, Joyent, Rightscale, Terremark, Rackspace, ElasticHosts, and Flexiscale, which own large datacenters and give access to their computing infrastructures using an IaaS approach
- User interface and the infrastructure software management layers need They need to provide credentials to access thirdparty IaaS providers or to own a private infrastructure in which the management software is installed. This is the case with Enomaly, Elastra, Eucalyptus, OpenNebula, and specific IaaS (M) solutions from VMware, IBM, and Microsoft.