Cloud Computing Architectural Model

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Platform as a service (PaaS)

- Platform-as-a-Service (PaaS) solutions provide a development and deployment platform for running applications in the cloud
- They constitute the middleware on top of which applications are built
- Application management is the core functionality of the middleware
- PaaS implementations provide applications with a runtime environment and do not expose any service for managing the underlying infrastructure
- They automate the process of deploying applications to the infrastructure, configuring application components, provisioning and configuring supporting technologies such as load balancers and databases, and managing system change based on policies set by the user

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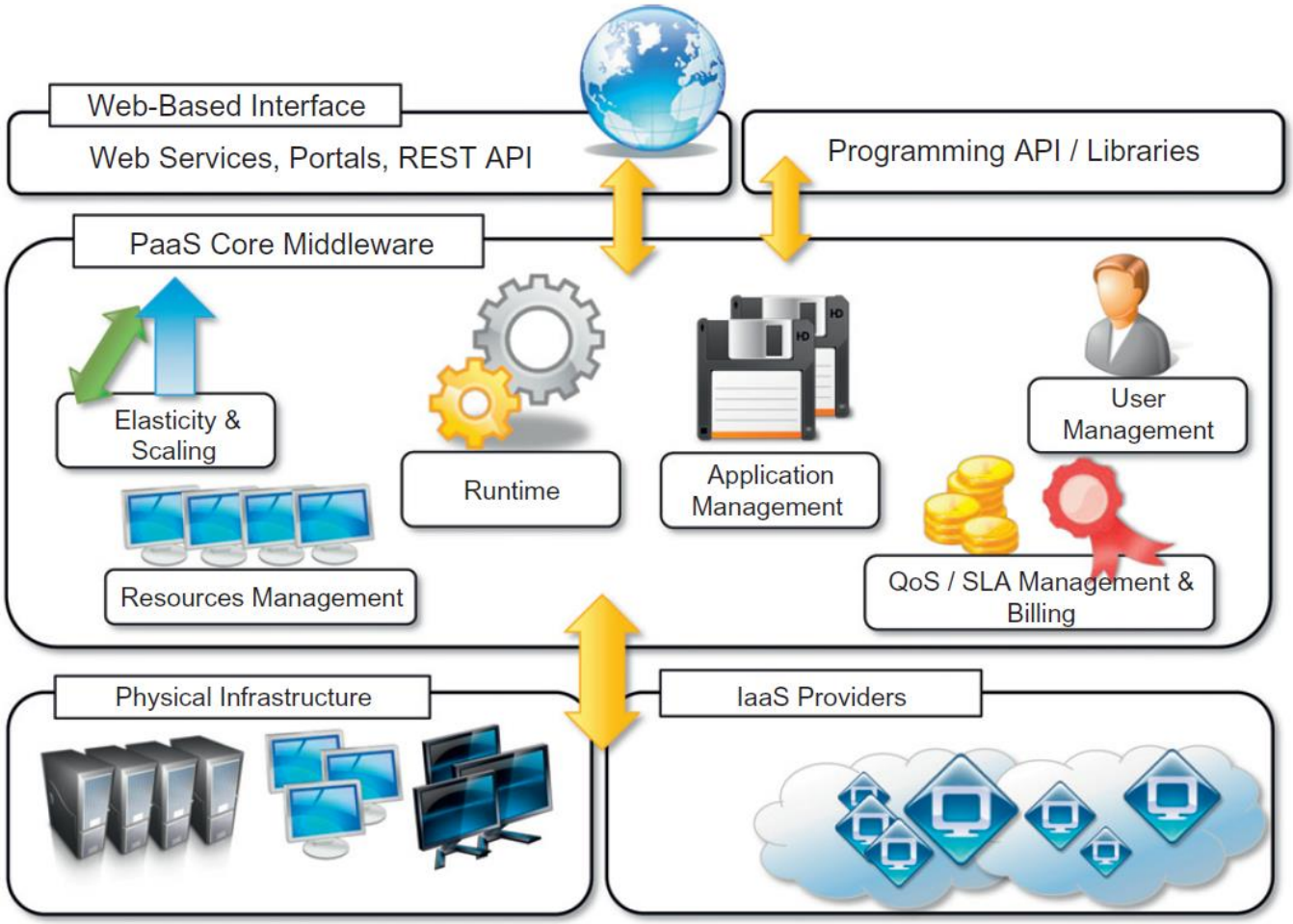
- Developers design their systems in terms of applications and are not concerned with hardware (physical or virtual), operating systems, and other low-level services
- The core middleware is in charge of managing the resources and scaling applications on demand or automatically, according to the commitments made with users
- From a user point of view, the core middleware exposes interfaces that allow programming and deploying applications on the cloud
- These can be in the form of a Web-based interface or in the form of programming APIs and libraries

PaaS Reference Model



Platform as a service (PaaS)

- PaaS solutions can offer middleware for developing applications together with the infrastructure or simply provide users with the software that is installed on the user premises
- The PaaS provider also owns large datacenters where applications are executed
- In Pure PaaS, the middleware constitutes the core value of the offering
- It is also possible to have vendors that deliver both middleware and infrastructure and ship only the middleware for private installations
- Table provides a classification of the most popular PaaS implementations

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Table 4.2 Platform-as-a-Service Offering Classification

Category	Description	Product Type	Vendors and Products
PaaS-I	Runtime environment with Web-hosted application development platform. Rapid application prototyping.	Middleware + Infrastructure Middleware + Infrastructure	Force.com Longjump
PaaS-II	Runtime environment for scaling Web applications. The runtime could be enhanced by additional components that provide scaling capabilities.	Middleware + Infrastructure Middleware Middleware + Infrastructure Middleware + Infrastructure Middleware + Infrastructure Middleware	Google AppEngine AppScale Heroku Engine Yard Joyent Smart Platform GigaSpaces XAP
PaaS-III	Middleware and programming model for developing distributed applications in the cloud.	Middleware + Infrastructure Middleware Middleware Middleware Middleware Middleware	Microsoft Azure DataSynapse Cloud IQ Manjrasof Aneka Apprenda SaaSGrid GigaSpaces DataGrid

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- The first category identifies PaaS implementations that completely follow the cloud computing style for application development and deployment
- They offer an integrated development environment hosted within the Web browser where applications are designed, developed, composed, and deployed
- This is the case of Force.com and Longjump. Both deliver as platforms the combination of middleware and infrastructure
- In the second class we can list all those solutions that are focused on providing a scalable infrastructure for Web application, mostly websites
- In this case, developers generally use the providers' APIs, which are built on top of industrial runtimes, to develop applications

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- Google AppEngine is the most popular product in this category. It provides a scalable runtime based on the Java and Python programming languages, which have been modified for providing a secure runtime environment and enriched with additional APIs and components to support scalability
- AppScale, an open-source implementation of Google AppEngine, provides interface- compatible middleware that has to be installed on a physical infrastructure
- Joyent Smart Platform provides a similar approach to Google AppEngine. A different approach is taken by Heroku and Engine Yard, which provide scalability support for Ruby- and Ruby on Rails-based Websites
- In this case developers design and create their applications with the traditional methods and then deploy them by uploading to the provider's platform

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- The third category consists of all those solutions that provide a cloud programming platform for any kind of application, not only Web applications
- Among these, the most popular is Microsoft Windows Azure, which provides a comprehensive framework for building service-oriented cloud applications on top of the .NET technology, hosted on Microsoft's datacenters
- Other solutions in the same category, such as Manjrasoft Aneka, Apprenda SaaSGrid, Appistry Cloud IQ Platform, DataSynapse, and GigaSpaces DataGrid, provide only middleware with different services

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- The PaaS umbrella encompasses a variety of solutions for developing and hosting applications in the cloud. Despite this heterogeneity, it is possible to identify some criteria that are expected to be found in any implementation
  - *Run time framework:* This framework represents the "software stack" of the PaaS model and the most intuitive aspect that comes to people's minds when they refer to PaaS solutions. The runtime framework executes end-user code according to the policies set by the user and the provider

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- *Abstraction:* PaaS solutions are distinguished by the higher level of abstraction that they provide. Whereas in the case of IaaS solutions the focus is on delivering "raw" access to virtual or physical infrastructure, in the case of PaaS the focus is on the applications the cloud must support. This means that PaaS solutions offer a way to deploy and manage applications on the cloud rather than a bunch of virtual machines on top of which the IT infrastructure is built and configured
- *Automation:* PaaS environments automate the process of deploying applications to the infrastructure, scaling them by provisioning additional resources when needed. This process is performed automatically and according to the SLA made between the customers and the provider. This feature is normally not native in IaaS solutions, which only provide ways to provision more resources.

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- *Cloud services*: PaaS offerings provide developers and architects with services and APIs, helping them to simplify the creation and delivery of elastic and highly available cloud applications. These services are the key differentiators among competing PaaS solutions and generally include specific components for developing applications, advanced services for application monitoring, management, and reporting
- Another essential component for a PaaS-based approach is the ability to integrate third-party cloud services offered from other vendors by leveraging service-oriented architecture
- Such integration should happen through standard interfaces and protocols

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- This opportunity makes the development of applications more agile and able to evolve according to the needs of customers and users
- Many of the PaaS offerings provide this facility, which is naturally built into the framework they leverage to provide a cloud computing solution
- A financial standpoint, although IaaS solutions allow shifting the capital cost into operational costs through outsourcing, PaaS solutions can cut the cost across development, deployment, and management of applications
- It helps management reduce the risk of ever-changing technologies by offloading the cost of upgrading the technology to the PaaS provider

Platform as a service (PaaS)

- This happens transparently for the consumers of this model, who can concentrate their effort on the core value of their business
- The PaaS approach, when bundled with underlying IaaS solutions, helps even small start-up companies quickly offer customers integrated solutions on a hosted platform at a very minimal cost
- These opportunities make the PaaS offering a viable option that targets different market segments