Cloud Applications

Cloud computing has gained huge popularity in industry due to its ability to host applications for which the services can be delivered to consumers rapidly at minimal cost. The types of applications which can benefit from cloud includes scientific applications, business and consumer applications , social networking, media applications

1. **Scientific applications**

Scientific applications are a sector that is increasingly using cloud computing systems and technologies. The immediate benefit seen by researchers and academics is the potentially infinite availability of computing resources and storage at sustainable prices compared to a complete in-house deployment. Cloud computing systems meet the needs of different types of applications in the scientific domain: high-performance computing (HPC) applications, high-throughput computing (HTC) applications, and data-intensive applications. The opportunity to use cloud resources is even more appealing because minimal changes need to be made to existing applications in order to leverage cloud resources.

The most relevant option is IaaS solutions, which offer the optimal environment for running bag-of-tasks applications and workflows. Virtual machine instances are opportunely customized to host the required software stack for running such applications and coordinated together with distributed computing middleware capable of interacting with cloud-based infrastructures. PaaS solutions have been considered as well. They allow scientists to explore new programming models for tack-ling computationally challenging problems. Applications have been redesigned and implemented on top of cloud programming application models and platforms to leverage their unique capabilities. For instance, the MapReduce programming model provides scientists with a very simple and effective model for building applications that need to process large datasets. Therefore it has been widely used to develop data-intensive scientific applications. Problems that require a higher degree of flexibility in terms of structuring of their computation model can leverage platforms such as Aneka, which supports MapReduce and other programming models.

Healthcare: ECG analysis in the cloud

ECG is the electrical manifestation of the contractile activity of the heart's myocardium. This activity produces a specific waveform that is repeated over time and that represents the heartbeat. The analysis of the shape of the ECG waveform is used to identify arrhythmias and is the most common way to detect heart disease. Cloud computing technologies allow the remote monitoring of a patient's heart beat data, data analysis in minimal time, and the notification of first-aid personnel and doctors should these data reveal potentially dangerous conditions. This way a patient at risk can be constantly monitored without going to a hospital for ECG analysis. At the same time, doctors and first-aid personnel can instantly be notified of cases that require their attention.

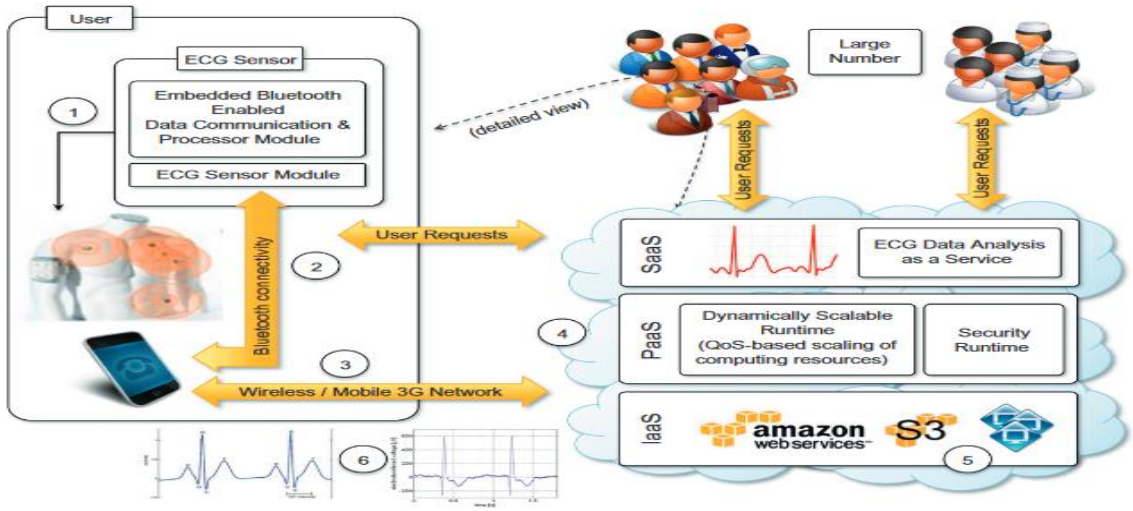

FIGURE 10.1
An online health monitoring system hosted in the cloud.

An illustration of the infrastructure and model for supporting remote ECG monitoring is shown in Figure 10.1. Wearable computing devices equipped with ECG sensors constantly monitor the patient's heartbeat. Such information is transmitted to the patient's mobile device, which will eventually forward it to the cloud-hosted Web service for analysis. The Web service forms the front-end of a platform that is entirely hosted in the cloud and that leverages the three layers of the cloud computing stack: SaaS, PaaS, and IaaS. The Web service constitute the SaaS application that will store ECG data in the Amazon S3 service and issue a processing request to the scalable cloud plat-form. For example Aneka controls the number of EC2instances used to execute the single tasks defined by the workflow engine for a single ECG processing job. Each of these jobs consists of a set of operations involving the extraction of the waveform from the heartbeat data and the comparison of the waveform with a reference waveform to detect anomalies. If anomalies are found, doctors and first-aid personnel can be notified to act on a specific patient.

cloud services are priced on a pay-per-use basis and with volume prices for large numbers of service requests. These two models provide a set of flexi-ble options that can be used to price the service, thus actually charging costs based on effective user rather than capital costs

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Business and consumer applications

The business and consumer sector is the one that probably benefits the most from cloud computing technologies. On one hand, the opportunity to transform capital costs into operational costs makes clouds an attractive option for all enterprises that are IT-centric. On the other hand, the sense of ubiquity that the cloud offers for accessing data and services makes it interesting for end users as well. Moreover, the elastic nature of cloud technologies does not require huge up-front investments, thus allowing new ideas to be quickly translated into products and services that can comfortably grow with the demand. The combination of all these

elements has made cloud computing the preferred technology for a wide range of applications, from CRM and ERP systems to productivity and social-networking applications.

CRM and ERP

Customer relationship management (CRM)and enterprise resource planning (ERP) applications are market segments that are flourishing in the cloud, with CRM applications the more mature of the two. Cloud CRM applications constitute a great opportunity for small enterprises and start-ups to have fully functional CRM software without large up-front costs and by paying subscriptions.

ERP solutions on the cloud are less mature and have to compete with well-established in-house solutions. ERP systems integrate several aspects of an enterprise: finance and accounting, human resources, manufacturing, supply chain management, project management, and CRM. Their goal is to provide a uniform view and access to all operations that need to be performed to sustain a complex organization. Because of the organizations that they target, the transition to cloud-based models is more difficult: The cost advantage over the long term might not be clear, and the switch to the cloud could be difficult if organizations already have large ERP installations. For this reason cloud ERP solutions are less popular than CRM solutions at this time.

salesforce.com

Salesforce.com is probably the most popular and developed CRM solution available today. As of today more than 100,000 customers have chosen Safesforce.com to implement their CRM solutions. The application provides customizable CRM solutions that can be integrated with additional features developed by third parties.Salesforce.com is based on the Force.com cloud development platform. This represents scalable and high-performance middleware executing all the operations of all Salesforce.com applications

The architecture of theForce.com platform is shown in Figure 10.5. Initially designed to support scalable CRM applications At the core of the platform resides its metadata architecture, which provides the system with flexibility and scalability. Rather than being built on top of specific components and tables, application core logic and business rules are saved as metadata into the Force.com store. Both application structure and application data are stored in the store. A runtime engine executes application logic by retrieving its metadata and then performing the operations on the data.

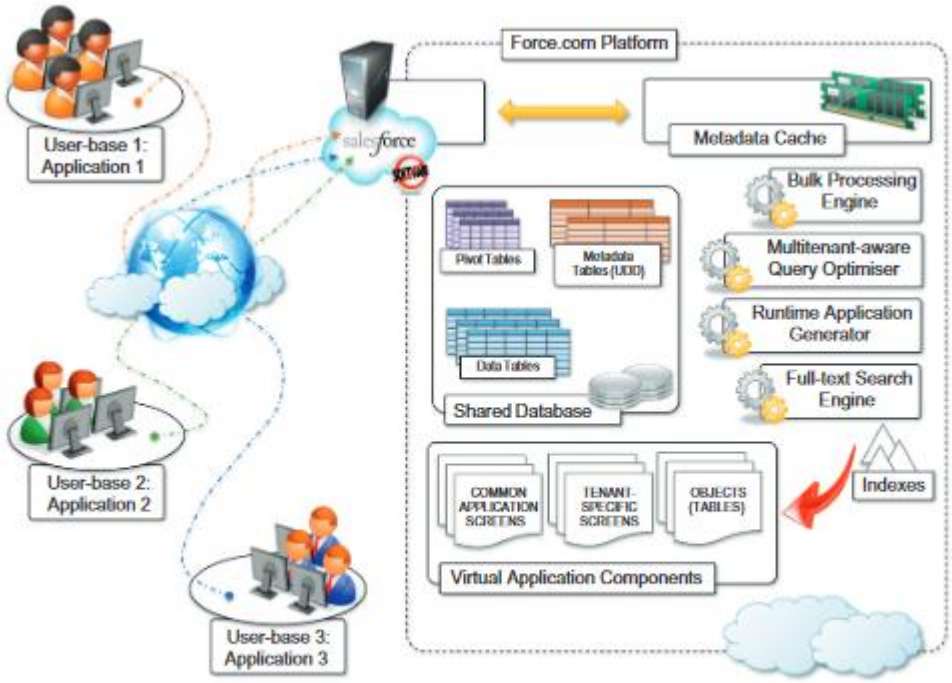

FIGURE 10.5
Salesforce.com and Force.com architecture.

Users can customize their application by leveraging the "native"Force.com application framework or by using programmatic APIs in the most popular programming languages. The application framework allows users to visually define either the data or the core structure of aForce.com application, while the programmatic APIs provide them with a more conventional way for developing applications that relies on Web services to interact with the platform. Customization of application processes and logic can also be implemented by developing scripts in APEX. This is a Java-like language that provides object-oriented and procedural capabilities for defining either scripts executed on demand or triggers. APEX also offers the capability of expressing searches and queries to have complete access to the data managed by theForce.com platform.

NetSuite

NetSuite provides a collection of applications that help customers manage every aspect of the business enterprise.

Its offering is divided into three major products:

- NetSuite Global ERP,
- NetSuiteGlobal CRM, and
- NetSuite Global Ecommerce.

Moreover, an all-in-one solution:NetSuite OneWorld, integrates all three products together.

The services NetSuite delivers are powered by two large datacenters on the East and West coasts of the United States, connected by redundant links. This allows NetSuite to guarantee 99.5%uptime to its customers. Besides the prepackaged solutions, NetSuite also provides an infrastructure and a development environment for implementing customized applications. TheNetSuite BusinessOperating System (NS-BOS)is a complete stack of technologies for building SaaS business applications that leverage the capabilities of NetSuite products. On top of the SaaS infrastructure, theNetSuite Business Suite components offer accounting, ERP, CRM, and ecommerce capabilities.

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Geoscience: satellite image processing

Geoscience applications collect, produce, and analyze massive amounts of geospatial and non spatial data. As the technology progresses and our planet becomes more instrumented (i.e., through the deployment of sensors and satellites for monitoring), the volume of data that needs to be processed increases significantly. In particular, the geographic information system (GIS) is a major element of geoscience applications. GIS applications capture, store, manipulate, analyze, manage, and present all types of geographically referenced data. This type of information is now becoming increasingly relevant to a wide variety of application domains: from advanced farming to civil security and natural resources management. As a result, a considerable amount of geo-referenced data is ingested into computer systems for further processing and analysis. Cloud computing is an attractive option for executing these demanding tasks and extracting meaningful information to support decision makers.

Satellite remote sensing generates hundreds of gigabytes of raw images that need to be further processed to become the basis of several different GIS products. This process requires both I/O and compute-intensive tasks. Large images need to be moved from a ground station's local storage to compute facilities, where several transformations and corrections are applied. Cloud computing pro-vides the appropriate infrastructure to support such application scenarios. A cloud-based implementation of such a workflow has been developed by the Department of Space, Government of India

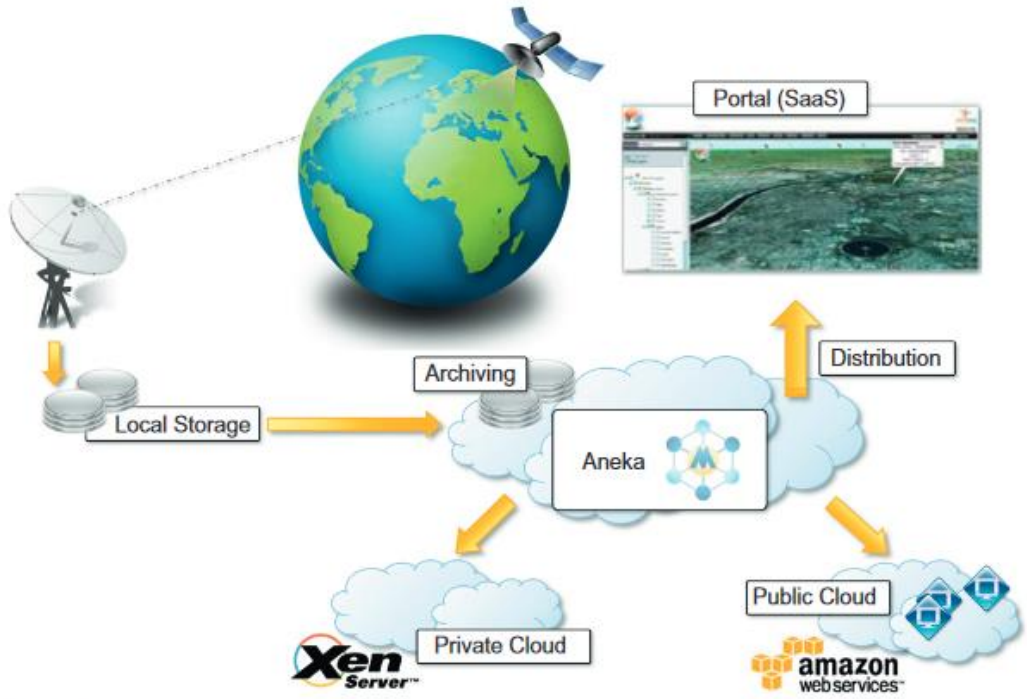

FIGURE 10.4

A cloud environment for satellite data processing.

he system shown in Figure 10.4 integrates several technologies across the entire computing stack. A SaaS application provides a collection of services for such tasks as geocode generation and data visualization. At the PaaS level, Aneka controls the importing of data into the virtualized infrastructure and the execution of image-processing tasks that produce the desired outcome from raw satellite images. The platform leverages a Xen private cloud and the Aneka technology to dynamically provision the required resources (i.e., grow or shrink) on demand.

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