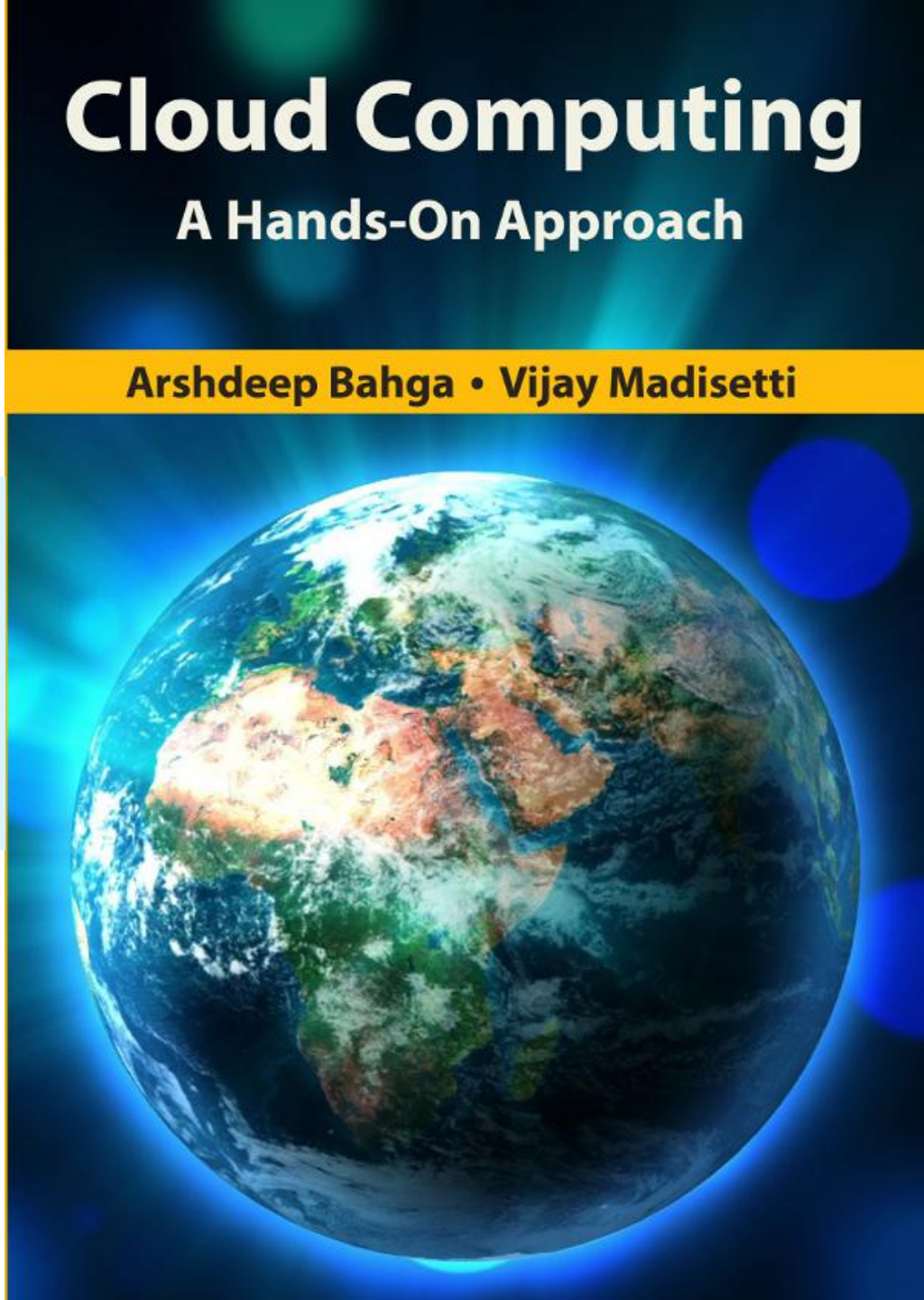
Chapter 1

Introduction & Concepts



Outline

- Cloud Computing definition
- Characteristics of cloud computing
- Cloud deployment models
- Cloud service models
- Cloud Services
- Cloud Applications

Definition of Cloud Computing

The U.S. National Institute of Standards and Technology (NIST) defines cloud computing as:

- Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Characteristics of Cloud Computing

- On-demand self service:
  - Cloud computing resources can be provisioned on-demand by the users, without requiring interactions with the cloud service provider. The process of provisioning resources is automated.

- Broad network access:
  - Cloud computing resources can be accessed over the network using standard access mechanisms that provide platform-independent access through the use of heterogeneous client platforms such as workstations, laptops, tablets and smartphones.

Characteristics of Cloud Computing

- Resource pooling:
  - The computing and storage resources provided by cloud service providers are pooled to serve multiple users using multi-tenancy. Multi-tenant aspects of the cloud allow multiple users to be served by the same physical hardware.

- Rapid elasticity:
  - Cloud computing resources can be provisioned rapidly and elastically. Cloud resources can be rapidly scaled up or down based on demand.

Characteristics of Cloud Computing

- Measured service:
  - Cloud computing resources are provided to users on a pay-per-use model. The usage of the cloud resources is measured and the user is charged based on some specific metric.

- Performance:
  - Cloud computing provides improved performance for applications since the resources available to the applications can be scaled up or down based on the dynamic application workloads.

Characteristics of Cloud Computing

- Reduced costs:
  - Cloud computing provides cost benefits for applications as only as much computing and storage resources as required can be provisioned dynamically, and upfront investment in purchase of computing assets to cover worst case requirements is avoid.

- Outsourced Management:
  - Cloud computing allows the users (individuals, large organizations, small and medium enterprises and governments) to outsource the IT infrastructure requirements to external cloud providers.

Characteristics of Cloud Computing

- Reliability:
  - Applications deployed in cloud computing environments generally have a higher reliability since the underlying IT infrastructure is professionally managed by the cloud service.

- Multi-tenancy:
  - The multi-tenanted approach of the cloud allows multiple users to make use of the same shared resources.
  - In virtual multi-tenancy, computing and storage resources are shared among multiple users.
  - In organic multi-tenancy every component in the system architecture is shared among multiple tenants

Cloud Service Models

- Software as a Service (SaaS)
  - Applications, management and user interfaces provided over a network
- Platform as a Service (PaaS)
  - Application development frameworks, operating systems and deployment frameworks
- Infrastructure as a Service (IaaS)
  - Virtual computing, storage and network resource that can be provisioned on demand

Software-as-a-Service (SaaS)

- Software/Interface
  - SaaS provides the users a complete software application or the user interface to the application itself.
- Outsourced Management
  - The cloud service provider manages the underlying cloud infrastructure including servers, network, operating systems, storage and application software, and the user is unaware of the underlying architecture of the cloud.
- Thin client interfaces
  - Applications are provided to the user through a thin client interface (e.g., a browser). SaaS applications are platform independent and can be accessed from various client devices such as workstations, laptop, tablets and smartphones, running different operating systems.
- Ubiquitous Access
  - Since the cloud service provider manages both the application and data, the users are able to access the applications from anywhere.

Software-as-a-Service (SaaS)

SaaS

Benefits

- Lower costs
- No infrastructure required
- Seamless upgrades
- Guaranteed performance
- Automated backups
- Easy data recovery
- Secure
- High adoption
- On-the move access

Characteristics

- Multi-tenancy
- On-demand software
- Open integration protocols
- Social network integration

Adoption

- Individual users: High
- Small & medium enterprises: High
- Large organizations: High
- Government: Medium

Examples

- Google Apps
- Salesforce.com
- Facebook
- Zoho
- Dropbox
- Taleo
- Microsoft Office 365
- Linkedin
- Slideshare
- CareCloud

Platform-as-a-Service (PaaS)

- Development & Deployment:
  - PaaS provides the users the capability to develop and deploy application in the cloud using the development tools, application programming interfaces (APIs), software libraries and services provided by the cloud service provider.
- Provider Manages Infrastructure:
  - The cloud service provider manages the underlying cloud infrastructure including servers, network, operating systems and storage.
- User Manages Application:
  - The users, themselves, are responsible for developing, deploying, configuring and managing applications on the cloud infrastructure.

Platform-as-a-Service (PaaS)

PaaS

Benefits

- Lower upfront & operations costs
- No IT infrastructure management costs
- Improved scalability
- Higher performance
- Secured access
- Quick & easy development
- Seamless integration

Characteristics

- Multi-tenancy
- Open integration protocols
- App development tools & SDKs
- Analytics

Adoption

- Individual users: Low
- Small & medium enterprises: Medium
- Large organizations: High
- Government: Medium

Examples

- Google App Engine
- Windows Azure Platform
- Force.com
- RightScale
- Heroku
- Github
- Gigaspaces
- AppScale
- OpenStack
- LongJump

Infrastructure-as-a-Service (IaaS)

- Resource Provisioning
  - Provides the users the capability to provision computing and storage resources.
- Virtual Machines
  - These resources are provided to the users as virtual machine instances and virtual storage. Users can start, stop, configure and manage the virtual machine instances and virtual storage.
- Provider Managers Infrastructure:
  - The cloud service provider manages the underlying infrastructure.
- Pay-per-use/Pay-as-you-go:
  - Virtual resources provisioned by the users are billed based on a pay-per-use/pay-as-you-go paradigm.

Infrastructure-as-a-Service (IaaS)

IaaS

Benefits

- Shift focus from IT management to core activities
- No IT infrastructure management costs
- Pay-per-use/pay-per-go pricing
- Guaranteed performance
- Dynamic scaling
- Secure access
- Enterprise grade infrastructure
- Green IT adoption

Characteristics

- Multi-tenancy
- Virtualized hardware
- Management & monitoring tools
- Disaster recovery

Adoption

- Individual users: Low
- Small & medium enterprises: Medium
- Large organizations: High
- Government: High

Examples

- Amazon Elastic Compute Cloud (EC2)
- RackSpace
- GoGrid
- Eucalyptus
- Joyent
- Terremark
- OpSource
- Savvis
- Nimbula
- Enamoly

Cloud Deployment Models

- Public Cloud
  - Available for public use or a large industry group
- Private Cloud
  - Operated for exclusive use of a single organization
- Community Cloud
  - Available for shared use of several organizations supporting a specific community
- Hybrid Cloud
  - Combines multiple clouds (public and private) that remain unique but bound together to offer application and data portability

Cloud Service Examples

- IaaS:
  - Amazon EC2
  - Google Compute Engine
  - Windows Azure VMs
- PaaS:
  - Google App Engine
- SaaS:
  - Salesforce

Cloud Computing Applications

- Banking & Financial Apps
- E-Commerce Apps
- Social Networking
- Healthcare Systems
- Energy Systems
- Intelligent Transportation Systems
- E-Governance
- Education
- Mobile Communications

Further Reading

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