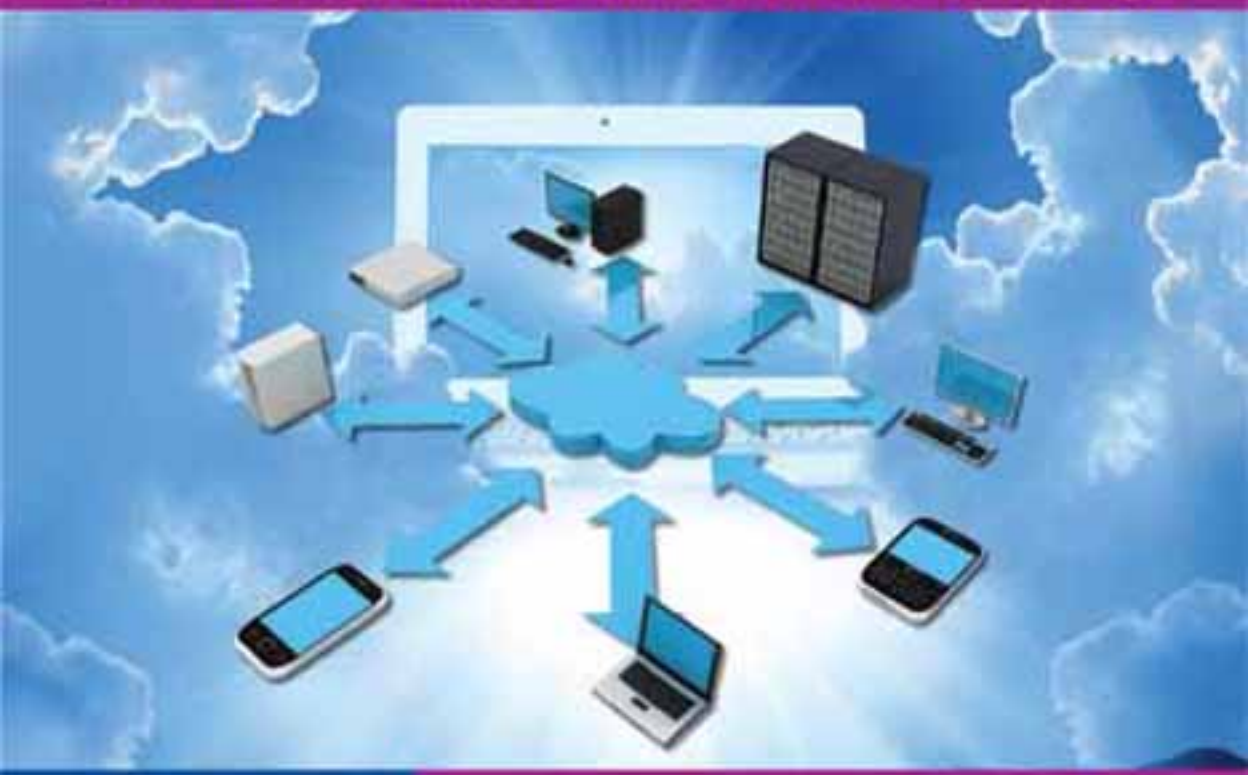
CLOUD COMPUTING

For the Students of Computer Science and Information Technology



Dr. U.S. PANDEY
Dr. KAVITA CHOUDHARY

S. CHAND

CLOUD COMPUTING

Dr. U.S. PANDEY
M.Sc., Ph.D. (Computer Science)
Associate Professor, School of Open Learning
University of Delhi, Delhi
Former Professor and Director-IT
Vivekananda Institute of Professional Studies
(Affiliated to G.G.S.I.P. University, Delhi)

Dr. KAVITA CHOUDHARY
M.C.A Ph.D (Computer Science)
Assistant Professor, Jagannath University
Jaipur

S. CHAND
PUBLISHING
empowering minds

S. CHAND & COMPANY PVT. LTD.
(An ISO 9001 : 2008 Company)
RAM NAGAR, NEW DELHI - 110 055

S. CHAND
PUBLISHING
empowering minds

S. CHAND & COMPANY PVT. LTD.

(An ISO 9001 : 2008 Company)
***Head Office*: 7361, RAM NAGAR, NEW DELHI - 110 055**
Phone: 23672080-81-82, 9899107446, 9911310888 Fax: 91-11-23677446
Shop at: schandgroup.com; e-mail: info@schandgroup.com

Branches :

AHMEDABAD : 1st Floor, Heritage, Near Gujarat Vidhyapeeth, Ashram Road, **Ahmedabad** - 380 014, Ph: 27541965, 27542369, ahmedabad@schandgroup.com

BENGALURU : No. 6, Ahuja Chambers, 1st Cross, Kumara Krupa Road, **Bengaluru** - 560 001, Ph: 22268048, 22354008, bangalore@schandgroup.com

BHOPAL : Bajaj Tower, Plot No. 2&3, Lala Lajpat Rai Colony, Raisen Road, **Bhopal** - 462 011, Ph: 4274723, 4209587. bhopal@schandgroup.com

CHANDIGARH : S.C.O. 2419-20, First Floor, Sector - 22-C (Near Aroma Hotel), **Chandigarh** -160 022, Ph: 2725443, 2725446, chandigarh@schandgroup.com

CHENNAI : No.1, Whites Road, Opposite Express Avenue, Royapettah, **Chennai** - 600014 Ph. 28410027, 28410058, chennai@schandgroup.com

COIMBATORE : 1790, Trichy Road, LGB Colony, Ramanathapuram, **Coimbatore** -6410045, Ph: 2323620, 4217136 coimbatore@schandgroup.com **(Marketing Office)**

CUTTACK : 1st Floor, Bhartia Tower, Badambadi, **Cuttack** - 753 009, Ph: 2332580; 2332581, cuttack@schandgroup.com

DEHRADUN : 1st Floor, 20, New Road, Near Dwarka Store, **Dehradun** - 248 001, Ph: 2711101, 2710861, dehradun@schandgroup.com

GUWAHATI : Dilip Commercial (Ist floor), M.N. Road, Pan Bazar, **Guwahati** - 781 001, Ph: 2738811, 2735640 guwahati@schandgroup.com

HALDWANI : Bhatt Colony, Talli Bamori, Mukhani, **Haldwani** -263139 **(Marketing Office)** Mob. 09452294584

HYDERABAD : Padma Plaza, H.No. 3-4-630, Opp. Ratna College, Narayanaguda, **Hyderabad** - 500 029, Ph: 27550194, 27550195, hyderabad@schandgroup.com

JAIPUR : 1st Floor, Nand Plaza, Hawa Sadak, Ajmer Road, **Jaipur** - 302 006, Ph: 2219175, 2219176, jaipur@schandgroup.com

JALANDHAR : Mai Hiran Gate, **Jalandhar** - 144 008, Ph: 2401630, 5000630, jalandhar@schandgroup.com

KOCHI : Kachapilly Square, Mullassery Canal Road, Ernakulam, **Kochi** - 682 011, Ph: 2378740, 2378207-08, cochin@schandgroup.com

KOLKATA : 285/J, Bipin Bihari Ganguli Street, **Kolkata** - 700 012, Ph: 22367459, 22373914, kolkata@schandgroup.com

LUCKNOW : Mahabeer Market, 25 Gwynne Road, Aminabad, **Lucknow** - 226 018, Ph: 4076971, 4026791, 4065646, 4027188, lucknow@schandgroup.com

MUMBAI : Blackie House, IInd Floor, 103/5, Walchand Hirachand Marg, Opp. G.P.O., **Mumbai** - 400 001, Ph: 22690881, 22610885, mumbai@schandgroup.com

NAGPUR : Karnal Bagh, Near Model Mill Chowk**, Nagpur** - 440 032, Ph: 2720523, 2777666 nagpur@schandgroup.com

PATNA : 104, Citicentre Ashok, Mahima Palace , Govind Mitra Road, **Patna** - 800 004, Ph: 2300489, 2302100, patna@schandgroup.com

PUNE : Sadguru Enclave, Ground floor, Survey No. 114/3, Plot no. 8 Alandi Road , Vishrantwadi **Pune** – 411015 Ph: 64017298 pune@schandgroup.com

RAIPUR : Kailash Residency, Plot No. 4B, Bottle House Road, Shankar Nagar, **Raipur -** 492 007, Ph: 2443142,Mb. : 09981200834, raipur@schandgroup.com **(Marketing Office)**

RANCHI : Shanti Deep Tower, Opp.Hotel Maharaja, Radium Road, **Ranchi**-834001 Mob. 09430246440 ranchi@schandgroup.com

SILIGURI : 122, Raja Ram Mohan Roy Road, East Vivekanandapally, P.O., Siliguri, **Siliguri-**734001, Dist., Jalpaiguri, (W.B.) Ph. 0353-2520750 **(Marketing Office)** siliguri@schandgroup.com

VISAKHAPATNAM : No. 49-54-15/53/8, Plot No. 7, 1st Floor, Opp. Radhakrishna Towers, Seethammadhara North Extn., **Visakhapatnam** - 530 013, Ph-2782609 (M) 09440100555, visakhapatnam@schandgroup.com **(Marketing Office)**

First Edition 2014

ISBN : **Code :**

PRINTED IN INDIA
By Rajendra Ravindra Printers Pvt. Ltd., 7361, Ram Nagar, New Delhi -110 055
and published by S. Chand & Company Pvt. Ltd., 7361, Ram Nagar, New Delhi -110 055.

PREFACE

Cloud Computing is the biggest buzz in the computer world and latest evolution of computing, where IT resources are offered as services. Cloud computing describes the manner in which manages services like Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). Cloud computing provide an efficient environment which provide flexibility, scalability, high-performance computing. The growth and development of Cloud computing is where apps or data are accessible on the Internet instead of on a single computer or network. Online payment, customer self-scheduling, data storage and accounting software are some examples of cloud-based services.

The purpose of this book is to describe what cloud computing, how it is conducted over internet, working process, scope, advantages and disadvantages. In this book we have describe basics of cloud storage, service providers, security concerns etc.

Cloud computing means you can deliver applications to your end users faster than ever, without investing in new infrastructure, training new personnel, or licensing new software. Cloud computing also helps your organization compete in new markets and communicate with customers in new ways. You can drive down the costs of doing business and increase your ability to adapt to changing market conditions.

This book covers the contents of various Universities like University of Pune, Mumbai University, JNTU Hyderabad, NMU jalgaon, CSVTU Bhilai, VTU, RGTU, GTU, Jadhavpur University, Bharathidasan University Tiruchirappalli, Anna University Chennai, Assam University, Jagannath University etc. The aim of this book is also provide a practical exposure to students and professionals, intending to work in cloud computing environment to develop the cloud computing applications.

This book has covered all aspects of cloud computing which is the current trend in cloud technology. This book also describing many examples of cloud computing so all users can easily understand the language and can easily implement them. So Cloud computing is a practical approach to experience direct cost benefits and it has the potential to transform a data center from a capital-intensive set up to a variable priced situation. The most appropriate reason to use cloud applications is that these cloud applications are low in cost and are very easy to use for the users.

Dr. U. S. Pandey
Dr. Kavita Choudhary
(Authors)

CONTENTS

1. Introduction to Cloud computing **1–23**

1.1 Evolution of computing paradigms 2
1.2 Concept of cloud 3
1.3 Introduction to virtualization and virtual machine 5
1.4 Virtualization in fabric/cluster/grid context 9
1.5 Virtual network, Information model & data model for virtual machine 17
1.6 Service Oriented Architecture 17
1.7 On Demand Computing 18
1.8 Web services: SOAP versus REST 18
1.8.1 AJAX: Asynchronous 'rich' interfaces 20
1.8.2 Mashups: user interface services 20
1.8.3 Multitenant software: Multi-entity support 21
1.8.4 Multi-schema approach 21
1.8.5 Multi-tenance using cloud data stores 21
1.8.6 Data access control for enterprise applications 21
Summary 22

2. Cloud Computing Technologies **24–54**

2.1 Introduction to Cloud Computing 25
2.2 Cloud Architecture and Cloud Storage 28
2.3 Characteristics of cloud computing 32
2.4 Components and Organizational scenarios of clouds 33
2.5 Administering and Monitoring cloud services 34
2.6 Benefits and Limitations of cloud computing 35
2.7 Deploy application over cloud: 39
2.7.1 Infrastructure as service: Amazon EC2 39
2.7.2 Platform as Service: Google App Engine 44
2.7.3 Microsoft windows Azure 47

2.7.4 Utility Computing and Elastic Computing 49
2.8 Cloud computing technology 49
2.8.1 Hardware and infrastructure 49
2.8.2 Network 50
2.8.3 Security 50
2.8.4 Clients 51
2.8.5 Services 51
2.9 Accessing the cloud 51
2.9.1 Platforms 52
2.9.2 Web Browsers. 52
2.9.3 Web Applications 52
2.9.4 Web APIs 52
2.9.5 Cloud Storage Providers 52
Summary 53

3. Cloud Applications 55 –71

3.1 Migrating to the Cloud 56
3.2 Software Licenses 58
3.3 Cloud Cost Model 58
3.4 Service Levels for Cloud Applications 59
3.4.1 Security: Disaster Recovery 60
3.4.2 Web Application Design 63
3.4.3 Machine Image Design 64
3.4.4 Privacy Design 64
3.4.5 Database Management 66
3.4.6 Data Security, Network Security and Host Security 69
Summary 71

4. Web Services and Platforms 73–90

4.1 Service Models 74
4.1.1 Software-as-a-Service 75
4.1.2 Platform-as-a-Service 78
4.1.3 Infrastructure -as-a-Service 81
4.1.4 Process-as-a-Service 83
4.1.5 Application-as-a-Service 83
4.1.6 Storage-as-a-Service 84
4.1.7 Information-as-a-Service 84
4.1.8 Integration-as-a-Service 85
4.1.9 Security-as-a-Service 86

4.1.10 Management/Governance-as-a-Service 87
4.1.11 Testing-as-a-Service 87
4.1.12 Comparison among IAAS, PAAS, SAAS Cloud computing platforms 87
Summary 89

5. Cloud Disaster Management 91–108

5.1 Cloud Disaster Management 91
5.1.1 Disaster Recovery 91
5.1.2 Disaster Recovery Planning 93
5.1.3 Benefits of a cloud Disaster Recovery service 94
5.1.4 Disaster Recovery as a Cloud Service 97
5.1.5 Cloud data Centres 97
5.1.6 Comparing approaches 97
5.1.6.1 Xen, 97
5.1.6.2 OpenNebula 100
5.1.6.3 Eucalyptus 104
5.1.6.4 Amazon 105
5.1.6.5 Nimbus 106
Summary 107

6. Cloud Computing Security 109–127

6.1 Cloud security fundamentals 109
6.2 Vulnerability assessment tool for cloud, Privacy and Security in cloud 110
6.3 Cloud computing security architecture 113
6.3.1 Architectural Considerations- General Issues 114
6.3.2 Trusted Cloud computing 114
6.3.3 Secure Execution Environments and Communications 115
6.3.4 Micro-architectures 115
6.3.5 Identity Management and Access control 115
6.3.6 Autonomic Security and Autonomic Systems 116
6.4 Cloud computing security challenges 117
6.4.1 Virtualization security management 120
6.4.1.1 Virtual threats 121
6.4.1.2 VM Security Recommendations 122
6.4.1.3 VM-Specific Security techniques 123
6.4.1.4 Secure Execution Environments and Communications in cloud 124
Summary 127

7. Cloud Computing Economics 128-137

7.1 Is cloud infrastructure cheaper? 130
7.2 Economics of private clouds 133
7.3 Software productivity in the cloud 134
7.4 Economies of scale: public vs. private clouds 135
7.5 Comparison between Public and Private Clouds 136
Summary 137

8. Data in the Cloud 138–153

8.1 Relational databases 139
8.2 Cloud File systems: GFS and HDFS 140
8.3 Features and Comparisons among GFS, HDFS. 143
8.4 Big-Table, H-Base and Dynamo 145
8.5 Cloud data stores: Data store and Simple-DB 151
Summary 152

9. Map Reduce and Extensions 154–170

9.1 Parallel computing 154
9.2 The Map Reduce model, 155
9.3 Applications of Map Reduce 157
9.4 Parallel efficiency of Map Reduce 161
9.5 Relational operations using Map Reduce 162
9.6 Enterprise batch processing using Map Reduce 168
Summary 169

10. Cloud Development and Windows Azure Platform Architecture 171–201

10.1 Introduction to Cloud Development 171
10.2 Google App Engine 172
10.3 How Mobile Apps Fast in Speed 177
10.3.1 Understanding Windows Azure Platform Architecture 180
10.3.2 The Windows Azure Developer Portal 181
10.3.3 Creating and Running Projects in the Azure Development Platform 189
10.3.4 Using Azure Application Templates for Visual Studio 189
10.3.5 Advantage of Auxiliary Cloud Services 193
10.3.6 Deploying Applications and Services to the Azure Cloud 194
Summary 200

11. Analyzing the Windows Azure Operating System 202–217

11.1 A Quick Tour of the Windows Azure OS 203
11.2 The Lifecycle of a Windows Azure Service 205
11.3 Securing and Isolating Services and Data 207
11.4 Assuring Fabric Controller Availability 211
11.5 Virtualizing Windows Servers for Azure 215
Summary 217

12. Scaling Azure Table and Blob Storage 218–251

12.1 Creating Storage Accounts 230
12.2 Using or Wrapping the Azure Storage Services' REST APIs 233
12.3 Understanding Azure Table Storage 239
12.4 Storing and Retrieving Blobs 239
Summary 250

13. Minimizing Risk When Moving to Azure Cloud Services 252–269

13.1 Bypassing Barriers to Cloud Computing 255
13.2 Implementing Secure Sockets Layer Transmission Encryption for Web Roles 257
13.3 Encrypting Personal Information in Azure Storage Services 264
13.4 Auditing Conformance to Regulatory and Industry Standards 266
Summary 268

14. Authenticating and Authorizing Service Users 270–302

14.1 Taking Advantage of ASP.NET Membership Services 271
14.2 Adapting ASP.NET Authentication and Role Management to Windows Azure Web Roles 272
14.3 Analyzing the AspProviders Library's Classes 275
14.4 Moving the AspProvidersDemo's Data Source to the Cloud 275
14.5 Integrating Membership Services with an Azure Service 286
14.6 Authenticating Users with Windows Live ID 286
Summary 300

15. Optimizing the Scalability and Performance of Azure Tables 303–316

15.1 Assigning Primary Key Values to Entities 305
15.2 Handling Associated Entities 308
15.3 Taking Advantage of Entity Group Transactions 310
15.4 Uploading Table Data 311
15.5 Displaying Data from Heterogeneous Tables in Grids 311
Summary 315

16. Messaging with Azure Queues 317–326

16.1 Creating and Processing Azure Queues and Messages 320
16.2 Enhancing the Thumbnails.sln Sample Solution 324
Summary 326

17. Authenticating Users with .NET Access Control Services 327–346

17.1 Installing the .NET Services SDK and Other Tools 328
17.2 Creating a .NET Services Solution 328
17.3 Creating CardSpace Credentials at FederatedIdentity.net 341
17.4 Using a Managed CardSpace Credential with ACS 345
Summary 346

18. Interconnecting Services with the .NET Service Bus 347–361

18.1 Creating a .NET Services Solution and Installing Prerequisites 349
18.2 Relaying Messages with SB 350
18.3 Analyzing the .NET Services SDK's EchoSample Solution 351
18.4 Using the Configuration File to Specify WSHttp Relay Binding 356
Summary 361

19. Exploring .NET Service Bus Queues and Routers 362–372

19.1 Persisting Messages in Service Bus Queues 363
19.2 Delivering Messages with Service Bus Routers 371
19.3 Summary 372

20. Dev 2.0 platforms 373–386

20.1 Salesforce.com's Force.com platform 374
20.2 TCS Instant Apps on Amazon cloud 382
20.3 More Dev 2.0 platforms and related efforts 384
20.4 Advantages, applicability and limits of Dev 2.0 384
Summary 385

Index 387–390

1

INTRODUCTION TO CLOUD COMPUTING

Chapter Outline

1.1 Evolution of Computing Paradigms

1.2 Concept of Cloud

1.3 Introduction to virtualization and virtual machine

1.4 Virtualization in fabric/cluster/grid context

1.5 Virtual network, Information model & data model for virtual machine

1.6 Service Oriented Architecture

1.7 On Demand Computing

1.8 Web services: SOAP versus REST

- **1.8.1 AJAX: Asynchronous 'rich' interfaces**
- **1.8.2 Mashups: user interface services**
- **1.8.3 Multitenant software: Multi-entity support**
- **1.6.4 Multi-schema approach**
- **1.8.5 Multi-tenance using cloud data stores**
- **1.8.6 Data access control for enterprise applications**

Cloud computing is the latest business buzzword, and is also known as cloud technology, cloud applications, or cloud-based services. Cloud computing is where apps or data are accessible on the Internet instead of on a single computer or network. Online payment, customer self-scheduling, data storage and accounting software are some examples of cloud-based services.

Cloud Computing is an amazing technology that uses the internet and central remote servers to maintain data and different applications. Cloud computing allows consumers and businesses to use applications without installation and access their personal files at any computer with internet access. This technology allows for much more efficient computing by centralizing data storage, for better processing and bandwidth.

The Cloud computing technology is also able to access your data from anywhere with an internet connection and the ability to replace irregular heavy overheads on IT with regular and expected outfitted expenses. We have a simple example of cloud computing is Gmail, Hotmail, Yahoo mail or Rediffmail etc. All you need is just an internet connection and you can start sending emails and messages.

The server and email management software is all on the cloud which fully based on internet and is totally managed by the cloud service provider Yahoo, Google etc. The consumer or user gets the software alone and enjoy the different benefits of cloud services.

Cloud computing is broken down into three stages which are application, storage and connectivity. Each part has a different purpose and offers different products for businesses and those around the world. If we take an example of data storage that is storing your data on the cloud, you do not have to be bothered about purchasing storage devices or backing up your data yourself. Just bring into line your files to the cloud, and everything automatically backs up and updates anytime you make a change.

The most appropriate reason to use cloud applications is that these cloud applications are low in cost and are very easy to use for the users. So Cloud computing is a practical approach to experience direct cost benefits and it has the potential to transform a data center from a capital-intensive set up to a variable priced situation

Cloud computing is enabling a major transformation in which you can turn your datacenter into an IT-as-a-Service platform. This means you can deliver applications to your end users faster than ever, without investing in new infrastructure, training new personnel, or licensing new software. Cloud computing also helps your organization compete in new markets and communicate with customers in new ways. You can drive down the costs of doing business and increase your ability to adapt to changing market conditions.

1.1 EVOLUTION OF COMPUTING PARADIGMS

The term cloud has been used historically as a symbol for the Internet. This usage was originally derived from its common depiction in network diagrams as an outline of a cloud, used to represent the transport of data across carrier backbones to an endpoint location on the other side of the cloud. This concept dates back as early as 1961, when Professor John McCarthy suggested that computer time-sharing technology might lead to a future where computing power and even specific applications might be sold through a utility-type business model.

This idea became very popular in the late 1960s, but by the mid-1970s the idea faded away when it became clear that the IT-related technologies of the day were unable to sustain such a futuristic computing model. However, since the turn of the millennium, the concept has been revitalized. It was during this time of revitalization that the term cloud computing began to emerging technology circles.

The majority of definitions however originate from cloud computing service providers, consulting firms and market research companies. The market research company IDC for example defines cloud computing very general as “an emerging IT

development, deployment and delivery model, enabling real-time delivery of products, services and solutions over the Internet" (Gens 2008). In that sense, cloud computing is the technical basis for cloud services, offering consumer and business solutions that are consumed in real time over the internet.

The technological foundation of cloud computing includes infrastructure, system software, application development and deployment software, system and application management software as well as IP-based network services. IDC also mentions usage-bound pricing as a core characteristic (Gens 2008). Another example of a market research company's declaration is Gartner's definition of cloud computing as "a style of computing where massively scalable IT-enabled capabilities are delivered 'as a service' to external customers using Internet technologies" (Plummer et al. 2008).

Cloud Computing found its origin in the success of server virtualization and the possibilities to run IT more efficiently through server consolidation. Soon, visionaries came up with idea to bring virtualization to a next level by implementing some early storage and network virtualization techniques and thus making abstraction of the hardware in the entire data center. Add to this self-provisioning and auto scaling, and Cloud Computing was born. At the time it was called utility computing, however, and only Amazon – a bookstore was good at it. Amazon saw a growing popularity of its EC2 (compute) and S3 (storage) and the Amazon API was being used by thousands of developers and many more customers to deploy and run infrastructure in the Cloud (Chandru , 2013).

Currently, the battle has moved to the Private Clouds. Enterprises seem to be ready to cloud-enable their infrastructure either in a purely private or a hybrid (enabling cloud-bursting to Public Clouds for certain services) environment. All the leading software providers have announced their products and expect an important role for integrators and telcos to help enterprises to pick a best of breed for their own implementation.

1.2 CONCEPT OF CLOUD

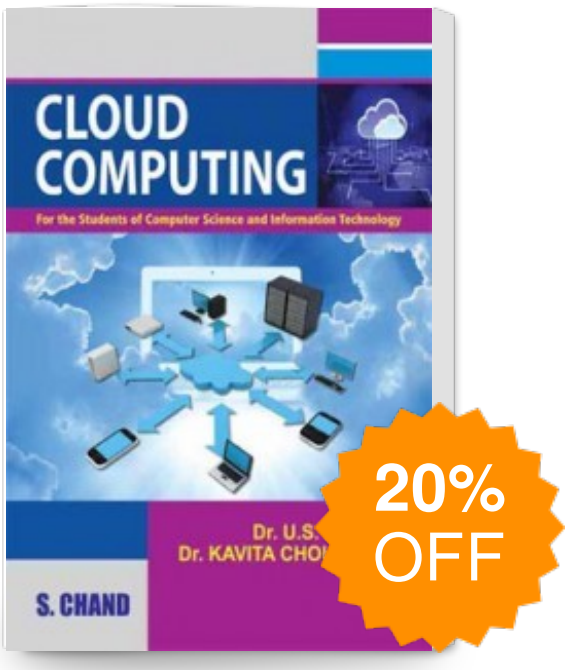
Cloud computing is one of the latest buzzwords in the world of Information Technology means Key to the definition of cloud computing is the "cloud" itself, but, the exactly meaning of the cloud is that clouded cover computing is a set of web based computing resources that deliver on demand information services to users from any location in the world.

It is essential to state that this form of computing is very different from service and grid computing. In the IT world, cloud generally refers to the internet, thus cloud computing implies using the internet for all your computing need and also according to user requirement.

The purpose of using cloud is that cloud is a large group of interconnected computers. These computers can be personal computers or network servers or they can be public or private. For example, Google hosts a cloud that consists of both smallish PCs and larger servers. Google's cloud is a private one that is publicly accessible by Google's users.

This cloud of computers extends beyond a single company or enterprise. The applications and data served by the cloud are available to wide group of users, cross-enterprise and cross-platform. Access is via the Internet. Any authorized user can access these documents and different applications from any computer over any

Cloud Computing



Publisher : SChand Publications ISBN : 9789383746736

Author : Dr. U. S. Pandey, Dr. Kavita Choudhary