

Cloud Database Development *and* Management

Lee Chao



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Preface

Today's e-commerce depends on various types of databases used to store and manage business information. In the e-commerce environment, users across the world should be able to access the databases from anywhere and at anytime through the Internet. A large number of IT infrastructures have been developed to support e-commerce. Developing and maintaining IT infrastructures can be difficult and expensive, especially for small companies. As a solution for supporting business activities in e-commerce, the cloud computing platform has been adopted by many companies. Internet-based databases and their applications can particularly benefit from cloud computing. The development of databases and applications in a cloud environment is motivated by the following factors.

Motivation

Owing to its flexibility, security, availability, scalability, and affordability, cloud computing has attracted the attention of the IT industry. The features provided by cloud computing are especially beneficial to small businesses and educational institutions that lack funding to maintain their own IT services.

Cloud computing is a type of Internet-based computing platform. With public clouds, companies and educational institutions do not have to invest in expensive IT infrastructures, which can significantly reduce the cost of IT expenditure. Although the use of cloud computing in supporting business activities gives some relief to this kind of burden, many IT professionals are not familiar with the cloud computing platform. For many small companies, there are still a handful of challenges in developing databases and applications in a cloud environment.

The potential of cloud computing and the challenges IT professionals are facing have inspired the author to write this book that includes enough knowledge to create database systems on the cloud platform.

Today's job market requires IT professionals to understand cloud computing theories and have hands-on skills for developing real-world database systems. Therefore, many IT professionals prefer a book that integrates database development and cloud computing at the same time, and they want the book to be easy to follow and the instructions for hands-on practice to be step by step. The book should also include instructions on setting up the database development environment in a cloud. To help IT professionals to catch up with the trend in cloud computing, this book will demonstrate how to integrate cloud computing into the database and application development process.

With the above motivation, this book is designed with the following objectives to help IT professionals to get a quick start in developing cloud-based database systems.

Objectives of the Book

The fundamental goal of this book is to prepare students and IT professionals to develop and manage databases in a cloud computing environment. This book is designed to provide the necessary knowledge and hands-on skills for developing a fully functioning database system and applications with the Microsoft Windows Azure cloud service. The content in the book is suitable for IT professionals to do self-study on developing cloud-based database systems.

This book will help readers to set up a cloud-based database development environment where they can carry out all the hands-on activities covered in this book. The cloud-based database development environment will allow readers to develop database systems collaboratively or individually at home through the Internet.

This book prepares students and IT professionals for developing cloud-based database systems. The process of database system development involves database design, implementation, and management. This book covers the knowledge related to all three aspects. The content covered in this book helps readers to create database systems that can be used for daily business activities.

With the cloud environment, we can speed up the implementation of databases and database applications. By taking advantage of the cloud-based database development environment, readers will be able to implement database systems and other data storage services in a short time.

Another intention of this book is to help readers understand how a database system works. It is written so that the database-related concepts are introduced in an orderly fashion and progress step by step.

Features of the Book

The author wrote this book for the convenience of readers. The book is self-contained. It provides detailed instructions that are suitable for self-study while covering all the important topics to meet the requirements of the database development process in the cloud. The following briefly describes the features of the book.

- *Self-contained content:* For the convenience of readers, the book is self-contained. It includes some necessary basic database concepts and theories, hands-on activities, and information about cloud-based database development tools.
- *Suitable for self-study:* This book provides detailed instructions that are suitable for self-study. It not only states the concepts and theories, but also explains them through examples, illustrations, and hands-on activities.
- *Designed for Windows Azure:* The book is specially designed for cloud-based database development. All the hands-on activities can be done with a Windows Azure's 3-month trial account.
- *A wide range of coverage:* This book covers a wide range of topics in database system development: database design, database implementation, and database deployment to the cloud environment. It also covers other topics such as data storage services: Table storage service, Blob storage service, and Queue storage service. It also discusses database application development.

- *Step-by-step instructions*: For the hands-on activities, the book provides step-by-step instructions and illustrations. The book also provides instructions on setting up the cloud environment for hands-on practice.
- *Real-world approach*: Examples, illustrations, and hands-on practice projects are included in each chapter. These materials are designed to help readers gain confidence and skills in developing cloud-based database systems that can be used in real-world businesses.

With these features, the book is suitable for IT professionals who do self-study on developing cloud-based database systems with Windows Azure.

Organization of the Book

This book includes 12 chapters. Each chapter contains an introduction of the content to be covered by that chapter, the main body of the chapter, a summary section to summarize the discussion in the chapter, and a review questions section to help readers review the knowledge learned from the chapter. Each chapter also includes hands-on activities to help readers practice the skills learned in the chapter.

Chapter 1 introduces the readers to database systems and cloud computing. It outlines what a database can do and the components included in the database. It presents a process used by the database developer to develop a database system. This chapter also gives an overview of cloud computing. It introduces several well-known computing services such as Software as a Service (SaaS), Infrastructure as a Service (IaaS), and Platform as a Service (PaaS). For the hands-on activity, this chapter provides instructions on creating a Windows Azure 3-month free account, developing a virtual machine with Windows Server 2012 as the guest operating system, and downloading Windows Azure SDK to the virtual machine.

The topics related to database design are presented in Chapter 2. This chapter deals with all three aspects of database design: conceptual design, logical design, and physical design. The physical design section emphasizes the cloud computing environment. The hands-on practice covers database logical design and the development of a Windows Azure SQL Database server as part of the physical design.

Once a database is designed, the next step is to convert a data model to a relational database. Before converting a data model to a relational database, the first task is to make sure that the tables are well defined to avoid anomalies. This leads to the coverage of normalization. Chapter 3 covers the topics related to the normalization process. The hands-on practice of this chapter creates a cloud-based relational database with Windows Azure SQL Database.

Chapter 4 introduces the SQL language and demonstrates how to use SQL to create database objects. It provides technical details about creating database objects on Windows Azure. During the hands-on activities, the reader will be creating database objects with SQL on the Windows Azure SQL Database portal. With SQL statements, the reader can manage the database objects. The SQL statements are also used to populate the database tables.

After the database is created, Chapter 5 introduces the migration of the database between Windows Azure and the on-premises SQL Server. The hands-on activities in this chapter cover several database migration tools: SQL Server Management Studio, Data-tier Application, Windows Azure SQL Database Migration Wizard, and SQL Server Integration Services. The hands-on practice also introduces and uses data transfer tools such as a bulk copy program and Extensible Markup Language (XML).

Chapter 6 demonstrates how to retrieve information from a database. The SQL language is used to select data from a database and properly present the data. This chapter introduces basic SQL statements for querying data from a single table. Then, the subquery and join are introduced to query data from multiple tables. Some of the built-in functions are also used to query data. In the hands-on activities, readers will experiment with various queries in the Windows Azure cloud environment.

For more sophisticated database querying tasks, Chapter 7 introduces programming units such as functions, stored procedures, and triggers. This chapter first explains how ANSI SQL is extended to T-SQL to meet some programming requirements. It then introduces various functions including built-in functions and user-defined functions. The stored procedure is another program unit covered in this chapter, which discusses how to view, execute, and modify stored procedures. To automatically carry out database management tasks, the programming unit “trigger” is presented in this chapter, which explains how triggers work and how to create triggers. The hands-on activities for this chapter include creating, modifying, and deleting programming units such as functions, stored procedures, and triggers in the Windows Azure cloud environment.

More database objects are introduced in Chapter 8. They are views, indexes, and federations. These database objects are used to support front-end database applications, which will be discussed in Chapter 9. The hands-on activities provide opportunities and instructions on how to create and manage these database objects in the Windows Azure cloud environment.

Once the SQL database is made available on Windows Azure, it is time to develop database applications. Through these applications, users can interact with the database to perform tasks such as importing and exporting data, enforcing constraints and security, and implementing business logic. Chapter 9 first discusses issues related to database application design. Then, database applications such as forms and reports are developed in the cloud environment emulated with the Windows Azure Software Development Kit (SDK) on a local computer. Packages such as Microsoft Visual Studio are used to create database applications. The hands-on practice in this chapter details the creation of a Web form.

Beginning with Chapter 10, the focus of the book switches to the deployment of database applications to Windows Azure. Chapter 10 demonstrates how to deploy database applications to Windows Azure. Once the database applications are deployed to Windows Azure, these applications become available on the Internet. They can be opened in a Web browser. The hands-on activities are carried out to deploy the Web form and report to Windows Azure.

Chapter 11 introduces Windows Azure storage services, including Table storage, Blob storage, and Queue storage. The Windows Azure storage services are used to store nonrelational data. The chapter discusses the features provided by these storage services and provides step-by-step instructions for the hands-on practice to develop these storage services.

Chapter 12 is about Windows Azure SQL Database management. This chapter discusses the management tasks that keep Windows Azure SQL Database running smoothly. The chapter first introduces database security and the management of user accounts. It also discusses issues related to monitoring and diagnostics. The hands-on activities use several database management tools: Windows Azure Management Portal, Service Management API, and Windows Azure Service Management PowerShell. This chapter’s hands-on activities cover these tools for SQL Database management, user management, and service monitoring.

One or more hands-on activities are included in each of the chapters. It is recommended that readers complete the activities in the previous chapters before starting a hands-on activity in the next chapter because some of the hands-on activities may depend on the ones in the previous chapters.

For real-world cloud solutions, this book provides the tools and knowledge to create a cloud-based database system. The book demonstrates to IT professionals how to take advantage of the cloud environment to develop a fully functioning database system with minimal cost. It shows how to properly design, implement, and manage database systems in Windows Azure. It also provides enough technical details to help readers develop database systems on their own. The book introduces a number of database tools that can make database development more efficient and flexible.

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Chapter 1

Introduction to Database Systems and Cloud Computing

Objectives

- Become familiar with major database components
- Understand database functions
- Be introduced to cloud computing

1.1 Introduction

Today's e-commerce has brought many new challenges for data storage and management. The number of new data generated by e-commerce has grown exponentially. Recently, over 65,000 petabytes of new data have been processed by various businesses each year. One petabyte is equal to one thousand terabytes. Web-based businesses can generate mega-scale datasets in a very short time, such as those on sale events around holidays. The data storage is required to quickly respond to these events. For the applications scaled out all over the world, the traditional databases inevitably face the difficulty of scalability. With the growth of datasets, the cost to store and manage the data increases accordingly. Facing the challenges in data storage and management, cloud computing has emerged as an efficient solution. By taking advantage of the cloud computing technology, companies are able to overcome difficulties in scalability and cost. Built on highly scalable infrastructure, the cloud can take care of the sudden increase of the data volume.

As cloud computing provides an ideal environment for processing data generated by today's online businesses, introducing the development of databases in a cloud environment is therefore the goal of this chapter, which discusses the components of a database, the tasks that can be accomplished by a database, and database management systems (DBMSs). It also provides an overview of cloud computing and cloud services such as Software as a Service (SaaS), Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and the personal cloud.