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Modeling and Analysis of Cloud Collaborative Commerce

نمذجة وتحليل غيمة التجارة الالكترونية التعاونية

By

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Supervisor

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Submitted in partial fulfillment of the requirement of the Master Degree in Computer Information System.

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(December - 2012)

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Dedication

((وَإِذْ تَأَذَّنَ رَبُّكُمْ لَئِنْ شَكَرْتُمْ لَأَزِيدَنَّكُمْ))

Almighty Allah says “And remember! Your Lord caused to be declared (publicly): "If ye are grateful, I will add more (favours) unto you”.

So all praise is for Allah, the exalted, for his favours that cannot be counted.

I dedicate this work to my great parents, my brothers, my sister, my cheeky daughter Baylasan, my relatives, my friends, and all those who taught, helped, and supported me.

I lovingly dedicate this thesis to my wife, who supported me during all steps of the way.

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List of Abbreviations

3CT	cc-commerce Tool
AES	Advanced Encryption Standard
AJAX	Asynchronous Java Script
API	Application Programming Interface
AS	Autonomous System
ATM	Automated Teller Machines
B2B	Business to Business
B2C	Business to Customer
BGP	Border Gateway Protocol
BPM	Business Process Management
BPML	Business Process Modeling Language
cc-commerce	Cloud Collaborative Commerce
c-commerce	Collaborative Commerce
CDC	Computer Development Center
CEBP	Communication Enabled Business Process
CPC	Collaborative Product Commerce
CSP	Cloud Service Provider
DC	Data Connection
DES	Data Encryption Standard
ebXML	electronic business XML
e-commerce	Electronic Commerce
EDI	Electronic Data Interchange
EFDP	E-Federated Distributed Processor
EFT	Electronic Funds Transfer
EIP	Enterprise Information Portals
HCI	Human-Computer Interaction
HPC	High Performance Computing
HTTP	Hypertext Transfer Protocol
IaaS	Infrastructure as a Service
ICT	Information and Communication Technology
IDEs	Integrated Development Environments
IMS	Inventory Management Systems
IS	Information Systems
LANs	Local Area networks
MAS	Multi-Agent System
MDA	Model-driven architecture
MIDs	Mobile Internet Devices
OS	Operating Systems
OTP	Online Transaction Processing
P2P	Point To Point
PaaS	Platform as a Service
PANs	Personal Area networks
PDA	Personal Digital Assistants
QoS	Quality-of-Service
RMSs	Resource Management Systems
S	Speedup Factor
SaaS	Software as a Service

SCM	Supply Chain Management
SDKs	Software Development Kits
SLAs	Service Level Agreements
SMBs	Small and Medium Businesses
SOA	Service Oriented Architecture
SOAP	simple Access Project access
SSL	Secure Socket Layer
T_{avg}	Average Response Time
T_i	Response Time
VMs	Virtual Machines
WANs	Wide area networks
XML	Extensible Markup Language
σ	Associated Standard Deviation

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Abstract

Cloud computing has the potential to be particularly suitable for collaboration commerce (c-commerce) because it generally requires less extensive customization, development, integration, operation, and maintenance than other computing resources. Using cloud technology effectively is essential for business companies to flourish in today's highly competitive marketplace. Small and midsized enterprises are often unable to leverage technology because of the high cost and complexity of on premises solutions which makes it difficult for them to compete against large enterprises. Cloud computing drastically reduces these challenges by giving small and midsized enterprises the same tools used by large enterprises at a reasonable cost. However, upgrading c-commerce IT infrastructure, to run on cloud computing, faces a number of challenges, such as lack of effective design and implementation models.

This thesis presents a description and performance evaluation of a new model of c-commerce that utilizes the evolving cloud computing technologies; therefore, it is referred to as cloud collaborative commerce (cc-commerce) model. The model consists of six main components, these are: client, provider, auditor, broker, security and privacy, and communications network. It can be deployed using two configurations, namely, the provider-access and broker-access configurations. In the first configuration, the client accesses a provider, which has accessed to all required resources locally, while in the second configuration, a client accesses a provider, which may acquire resources from other clouds hosted under different public Internet protocol (IP) addresses. A special case of the broker-access configuration is a c-commerce system when each collaborating cloud hosts resources for only one enterprise.

The new cc-commerce model is used to develop a simple and flexible test tool, namely, the cc-commerce test (3CT) tool. The performance of the new model is evaluated in different scenarios using the 3CT tool. The scenarios simulate three different c-commerce configurations and one cc-commerce configuration. For each configuration, the average response time and speedup factor are calculated and compared. The results obtained demonstrate that the cc-commerce application performs faster than an equivalent c-commerce application for various equivalent data retrieving processes. In other words, for the scenarios simulated in this thesis, the response time is always less for cc-commerce than c-commerce, and the resulting speedup factor is always more than 2. Finally, based on the obtained results conclusions are drawn and recommendations for future work are pointed-out.

نمذجة وتحليل غيمة التجارة الالكترونية التعاونية

الطالب

عوض عبدالله الصباح

المشرف

الدكتور حسين البهادلي

الملخص

تعتبر الغيمة الالكترونية من أفضل الحلول في الوقت الحالي لقطاع التجارة التعاونية لاعتبارها اقل تكلفة وأفضل أداء :لعدة اسباب منها قلة تكلفة صيانتها وتطويرها وإدارتها .

إن استخدام الغيمة الالكترونية يزيد من فعالية في عمل الشركات التجارية الصغيرة ومتوسطة الحجم ، بالرغم من عدم قدرة هذه الشركات على التأثر الكبير بتلك التقنيات الحديثة بسبب التكلفة العالية والتعقيد وبالتالي ضعف منافستها للشركات الكبيرة التي وجدت طريقا اسهل لتلك التقنيات.

الغيمة الالكترونية تقلل من هذه التحديات بشكل جذري من خلال تزويد تلك الشركات بأدوات تستخدمها قريناتها من الشركات الكبيرة بتكلفة مناسبة ،إلا ان تطوير البيئة التحتية لتكنولوجيا المعلومات من التجارة التعاونية الى غيمة التجارة التعاونية الالكترونية تواجه عدة تحديات بسبب نقص النماذج الفعالة في هذا المجال مما دفعنا للبحث ودراسة مثل هذا النموذج .

هذه الرسالة تقدم وصف وتقييم لأداء النموذج الذي يتعلق بنموذج التجارة التعاونية بحيث يستخدم تقنيات الغيمة الالكترونية المتطورة لهذا السبب تم تسميته غيمة التجارة الالكترونية التعاونية (CC-COMERCE) ، النموذج يحتوي على ست مكونات رئيسية هي العميل والمزود والمدقق و الوسيط التجاري والخصوصية والسرية وأخيرا شبكة الاتصالات ،و يقوم النموذج على اعدادين اثنين :الاول (الإعداد لوصول المزود) والثاني(الإعداد لوصول الوسيط) ، حيث أن الاعداد الاول يصل العميل الى المزود بحيث يكون الوصول الى جميع مصادر هذا المزود محليا ،بينما يحتاج العميل في الاعداد الثاني الى مصادر من غيمات الكترونية اخرى ، تم وضعها على نطاق وسير فر يملك عنوان انترنت (IP) مختلف ، يوجد حالة خاصة لإعداد

وصول الوسيط عندما تضم التجارة التعاونية الالكترونية مصادر الغيمة الالكترونية التعاونية لشركة واحدة.

غيمة التجارة التعاونية الالكترونية قامت بتطوير اداة اختبار بيئية ومرنة سميت (3CT) وتم تقييم اداء النموذج الجديد من خلال اربعة سيناريوهات مختلفة باستخدام تلك الاداة ، السيناريوهات يمثلون 3 إعدادات لتجارة تعاونية وواحدة للتجارة الالكترونية تعاونية ثم تم حساب واستخراج معدل وقت الاستجابة وعامل السرعة لكل سيناريو وتمت مقارنتهم جميعا وخرجت لدينا النتائج بان تطبيق التجارة الالكترونية التعاونية ادى مهامه اسرع من نظيره تطبيق التجارة التعاونية لعدة عمليات استرجاع معلومات متساوية بالحجم ، وتم ايجاد عامل السرعة حيث تجاوز دائما القيمة (2) للتجارة الالكترونية التعاونية .

في الختام بناءا على النتائج المعطاة تم كتابة التقارير اللازمة والنتائج والتوصيات.

Chapter One

Introduction

1.1 Overview

During the last two decades, the world has witnessed a tremendous revolution in the field of information and communications technology (ICT), and still more and more to emerge. The revolution has been notably recorded in four main related fields; these are:

(1) Computer technology: Development of extremely high performance computers of high speed processors, large memories, and huge storage media (Patterson & Hennessy 2011,Floyd 2009).

(2) Communication technology: Emergent of various wire/wireless networks designs, such as: wide area networks (WANs), local area networks (LANs), personal area networks (PANs), cellular networks, telephone exchange technologies, and satellite communications (Forouzan 2007, Stallings 2010).

(3) Internet: Development of masses of applications and tools open the door towards an amazing world of information and knowledge exchange (Schewick 2012, Gralla 2006).

(4) Mobile technology: Emergent of high performance, small-size, low-power, and mobile devices (e.g., laptops, notebooks, smart phones, etc), which have led to the emergent of a wide range of tools and applications (Duffy 2012, Bentley & Barrett 2012).

The development in the above closely related ICT disciplines move hand-in-hand with the development in business, industry, economy, civilian life-style, management, and all other fields of knowledge. These developments, in particular, development in ICT and business, introduce a new form of business, which called electronic business (e-business). (Meier & Stormer 2009).

One of the fastest growing applications for the Internet is the electronic commerce (E-commerce), which is generally considered to be the sales aspect of e-business, i.e., the term e-business is broader than E-commerce (Schneider 2010). Essentially, E-commerce is about carrying out transactions on the Web, such as buying and selling products, training, procurement, and supply chain management. While these fields have evolved somewhat independently over the past two decade, they have a lot to contribute to each other, i.e., collaborate.

Recently, organizations are going beyond E-commerce and have to work across international boundaries, collaboratively carry out transactions, as well as share and collaborate on activities and projects, i.e., organizations are collaboratively carrying out transactions using the Web to go beyond organizational boundaries. But organizations remain autonomous and yet cooperate with each other. This new form of collaboration is known as collaborative commerce (c-commerce) (Chong 2009).

In c-commerce, organizations must be able to share information, and at the same time protect their privacy as well as sensitive information. As organizations build their resource management systems (RMSs) independently, it is expected to have disparate heterogeneous RMSs, which have to be integrated to form federations and subsequently work effectively within as well as across organizations for c-commerce.

Furthermore, organizations usually run their RMSs on individually and locally installed LANs, which are accessed and interconnected through the Internet using WAN protocols and infrastructures. Thus, many challenges must be addressed to meet users' (clients' or customers'), organizations', and applications' satisfactions and maintain satisfactory quality-of-service (QoS); such as: high bandwidth, low-cost bit-rate, high network and link reliability, high efficiency, availability, scalability, security, etc. Adding to the above challenges are the high cost of the installation and operation of local RMSs. Also, all local resources need to be continuously maintained and updated.

A more recent technological breakthrough is the emergent of cloud computing, which is the delivery of computing resources (hardware and software) as a service rather than a product, whereby shared resources, software, and information are provided to computers and other devices as a metered service over a communications network, typically the Internet (Buyya & Yeo, 2009).

Cloud computing is also defined as a marketing term for technologies that provide computation, software, data access, and storage services that do not require end-user knowledge of the physical location and configuration of the system that delivers the services. A parallel to this concept can be drawn with the electricity grid, wherein end-users consume power without needing to understand the component devices or infrastructure required to provide the power service. Cloud computing providers deliver applications via the Internet, which are accessed from Web browsers and desktop and mobile applications, while the business software and data are stored on servers at a remote location(Peiris, Sharma, & Balachandran 2011).

It is very interesting to perceive how c-commerce can benefit from this tremendous cloud computing technological development and relax the many challenges that are facing wider c-commerce promotion, and meet users', organizations', and applications' satisfactions and also maintain satisfactory QoS.

This thesis, first, develops a new c-commerce model that utilizes cloud computing concept as a platform for running c-commerce application, which is referred to as cloud-based collaborative commerce (cc-commerce). The cc-commerce components and the deployment configurations for the proposed model are described in details. Second, the performance of the new model is evaluated qualitatively and quantitatively. The quantitative performance is evaluated in terms of two parameters, namely, the average response-time and speedup factor. Finally, the benefits and advantages of the new cc-commerce model over the conventional c-commerce model are identified.

1.2 Electronic commerce (E-commerce)

Electronic commerce, commonly known as E-commerce, is the buying and selling of products or services over electronic systems such as the Internet and other computer networks (Khosrowpour 2006). E-commerce draws on such technologies as electronic funds transfer (EFT), supply chain management (SCM), Internet marketing, online transaction processing (OTP), electronic data interchange (EDI), inventory management systems (IMS), and automated data collection systems. Modern E-commerce, typically, uses the Web at least at one point in the transaction's life-cycle, although it may encompass a wider range of technologies such as e-mail, mobile devices and telephones as well (Laudon &Traver 2011).

Originally, E-commerce was identified as the facilitation of commercial transactions electronically, using technology such as EDI and EFT. These were both introduced in the late 1970s, allowing businesses to send commercial documents like purchase orders or invoices electronically. The growth and acceptance of credit cards, automated teller machines (ATM) and telephone banking in the 1980s were also forms of E-commerce. Another form of E-commerce was the airline reservation system. Beginning of the 1990s, E-commerce extended to include enterprise resource planning (ERP) systems, data mining and data warehousing (Al-Qirim 2006).

By the year 2000, many business companies start offering their services electronically through the Web, due to increase popularity of the Internet, availability of powerful Web browser, and introduction of security protocols. Thus, people associate E-commerce with the ability of purchasing various goods through the Internet using secure protocols and electronic payment services.

However, E-commerce is not only e-business activities that utilize modern communication technologies (e.g., Internet technologies) but it is also promoting business model to utilize modern information technology (IT) and computer information system (CIS), and so as to be e-business activities. So that E-commerce can be defined as the implementation of the whole business development activities using electronic tools and technologies, especially, the Internet to realize commodity exchanging in high efficiency and low cost.

1.3 Collaborative Commerce (C-Commerce)

C-commerce is a form of e-business; conducting business on the Internet, not only buying and selling (E-commerce) but also servicing customers and collaborating with business partners. C-commerce is conducted via inter-enterprise Internet connections and enables multiple enterprises to work interactively online to find ways to serve their customers and to solve business problems. C-commerce are also defined as enterprise capable Web-based solutions that use the Internet to allow employees, customers, and suppliers to collaboratively develop, build, manage, sell, and support products throughout their life cycle.C-commerce is also called collaborative product commerce (CPC) (Chen et al 2007).

1.3.1 C-Commerce Models

In order for organizations to carry out c-commerce collaboratively, one needs suitable business models(Chen et al 2007). Seller to buyer relationships in c-commerce can take one of many forms; these are:

(1) Tightly coupled c-commence

(2) Loosely coupled c-commerce

In a tightly coupled model, one party dominates the business practices and the others conform to them. Because the dominating party is so large, it is either the dominant seller or the dominant buyer in the market. Therefore, it has the power to dictate what system will be used to conduct the transaction. Tightly coupled relationships can take the form of a one-to-one, a many-to-one, or one-to-many relationship.

In a one-to-one relationship between buyer and seller, both parties are the primary customer or supplier for each other. However, either the supplier or the customer will dominate the relationship and the other will conform to the dominant’s standards. In a many-to-one or one-to-many relationships, one larger supplier or customer deals with many other smaller businesses or consumers, which all conform to the larger organization’s business practices.

Conversely, in a loosely coupled model, no party has the power to dictate the system used to conduct transactions. In a loosely coupled environment a company does not have one main supplier or customer, instead it may deal with whichever company it pleases, taking into account such things as price, value, and reputation. In order to complete the transaction, the companies must either constantly be changing their business practices to adapt to new partners or there must be some sort of mitigation system which can resolve differences between partners. This would allow a business to form a relationship with another with minimal effort or changes to their E-commerce infrastructure. However, the forming of such a mitigation system is not trivial and may require serious investment.

1.3.2 The Vision of C-Commerce

The ultimate objectives of c-commerce initiatives are to maximize return on IT investment, increase business agility and the quality of customer service, and enhance supply chain integration. By integrating applications using latest standards and open technologies, business partners are able to

(1) Coordinate complex transactions.

(2) Share latest information.

(3) Collaborate on product planning.

(4) Communicate product design ideas.

(5) Integrate their workflows.

C-commerce can help companies gain competitive advantages by:

(1) Connecting and automating processes with their partners, customers, and suppliers.

(2) Reducing processing latencies.

(3) Developing new capabilities that improve service levels while reducing costs.

(4) Making planning, design, and operational decisions dynamically based on real-time information.

In c-commerce, in order to enable collaborative business processes, interactions must increase among all internal and external applications involved to achieve visibility of end-to-end processes.

Technologies for c-commerce must support inter-operability because trading partners often use diverse systems. Consequently, solutions for c-commerce must be based on standards to support loose coupling, autonomy, and flexibility on the one hand, as well as ensure trust and security on the other hand. There area few standards and related technologies that are considered specifically suitable for c-commerce, including messaging standards such as simple object access protocol (SOAP) for accessing software components in a distributed environment; common document specification languages such as XML and ebXML (electronic business XML) for data interchange; and business process specifications such as business process modeling language (BPML) for describing workflows (Chen 2007).

1.4 Traditional Computing Services

Before we explain cloud computing, lets first review how IT solutions are typically delivered to businesses before the emergent of cloud computing. Two broad approaches can be identified to providing computing services; these are(Osterman Research 2011):

(1) On-premises IT services

(2) Data canter IT services

In what follows we will briefly describe these two IT services and highlight their advantages and disadvantages.

(1) On-premises IT services

On-premises IT is where the business purchases, installs and maintains all servers, software licenses, backup devices and telephony equipment which are housed on-site in the business office. Of course, technology is complicated so IT experts are always required to maintain the system operation at business or company site. Companies either hire on-staff IT employees or hire local IT services firms to perform this maintenance. Maintaining the variety of systems needed to run a business is no easy task and very often the IT staff is overworked and subsequently the business has to wait for IT support. Figure (1.1) illustrates on-premises IT services architecture.

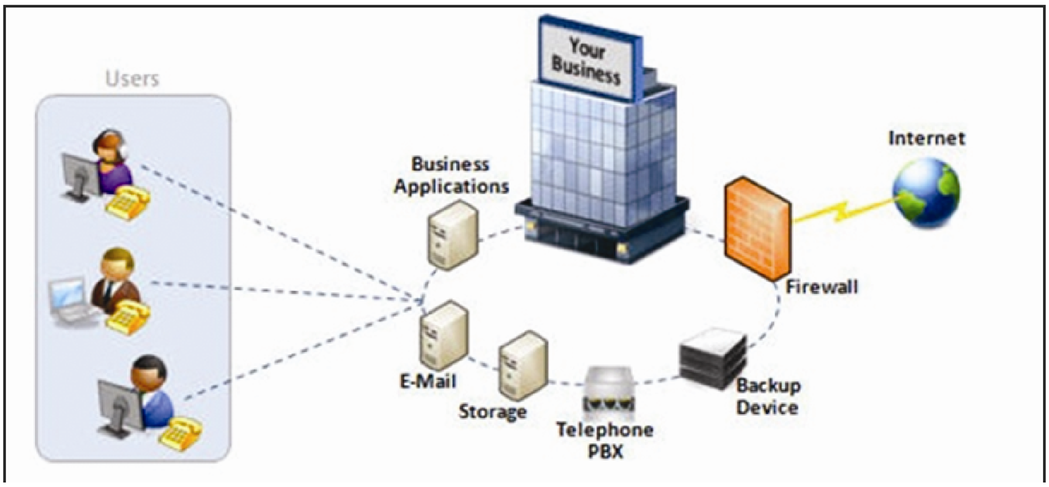

Figure (1.1).On-premises IT services (Web 0.7 ,2011).

On-premises IT services have many advantages and disadvantages, which are summarized in Table (1.1).

Table (1.1)
Advantages and disadvantage of on-premises IT services. (Web 0.7 ,2011).

Advantages	Disadvantages
• Higher level of internal control. • Ability to customize services. • Data is on-site. • Can operate without Internet.	• Requires specialized IT support staff. • Initial and operation capital cost intensive. • Difficult to upgrade and patch. • Unpredictable additional costs. • Difficult to maintain compliancy. • Data center may not provide high availability, for example due to power failure.

(2) Data center IT services

The data center option is very often confused with cloud computing, where it is not cloud computing. This option does allow companies to move their systems to a dedicated managed data center, and has many advantages over traditional on-premises installations, but it does still require the company to purchase servers (sometimes), licenses and often pay the provider specifically for the maintenance of their system or still employ an internal IT staff. Figure (1.2) illustrate managed data center IT services architecture.

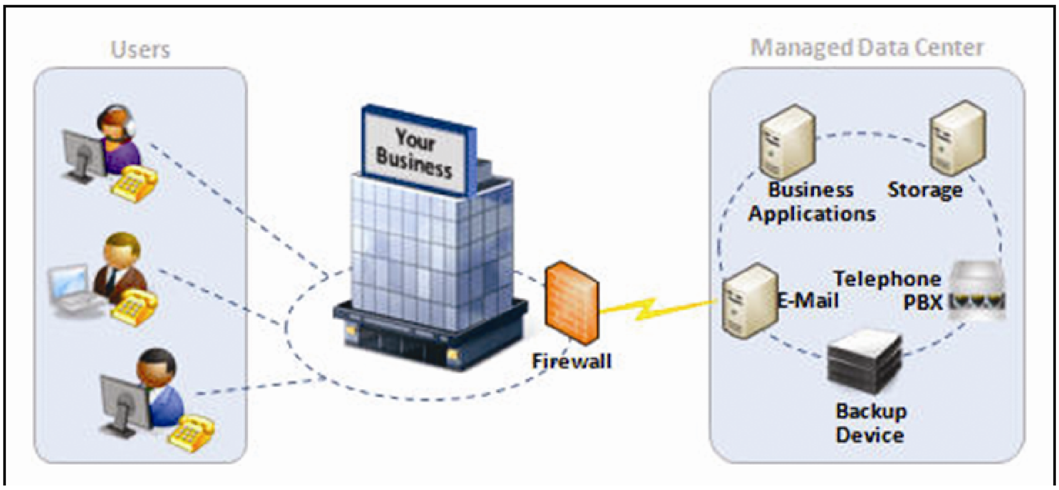

Figure (1.2). Data center IT services (Web 0.7 ,2011).

Managed data centers have many advantages and disadvantages, which are summarized in Table (1.2).

Table (1.2)
Advantages and disadvantage of managed data center IT services. (Web 0.7 ,2011).

Advantages	Disadvantages
• Higher level of internal control. • Ability to customize services. • Leverages facilities of professionally managed data center.	• Requires IT staff. • Capital cost intensive. • Difficult to upgrade and patch. • Unpredictable costs. • High costs for managed services. • Redundant cost if some systems are still on premises.

1.5 Cloud Computing

Although, we have defined cloud computing earlier, it is defined in this section in more details. Cloud computing is a model of hardware and software deployment where the software application is hosted on extremely high performance hardware, as a service provided to customers across the Internet (Velte, Elsenpeter 2009, Goscinski, Brock, 2011). Cloud computing is also can be defined as a shorthand for centralized computing services that are delivered over the Internet. By eliminating the need to install and run the application on the customer's own server or premises, the burden of software maintenance, ongoing operation and support has been removed.

Resources (software and hardware) are paid for through a subscription instead of a license. Businesses no longer need to purchase and maintain either software or hardware assets on their premises. Computing becomes a predictable operating expense (Issa, Chang 2010). Figure (1.3) shows the logical diagram of cloud computing (Johnston 2009).

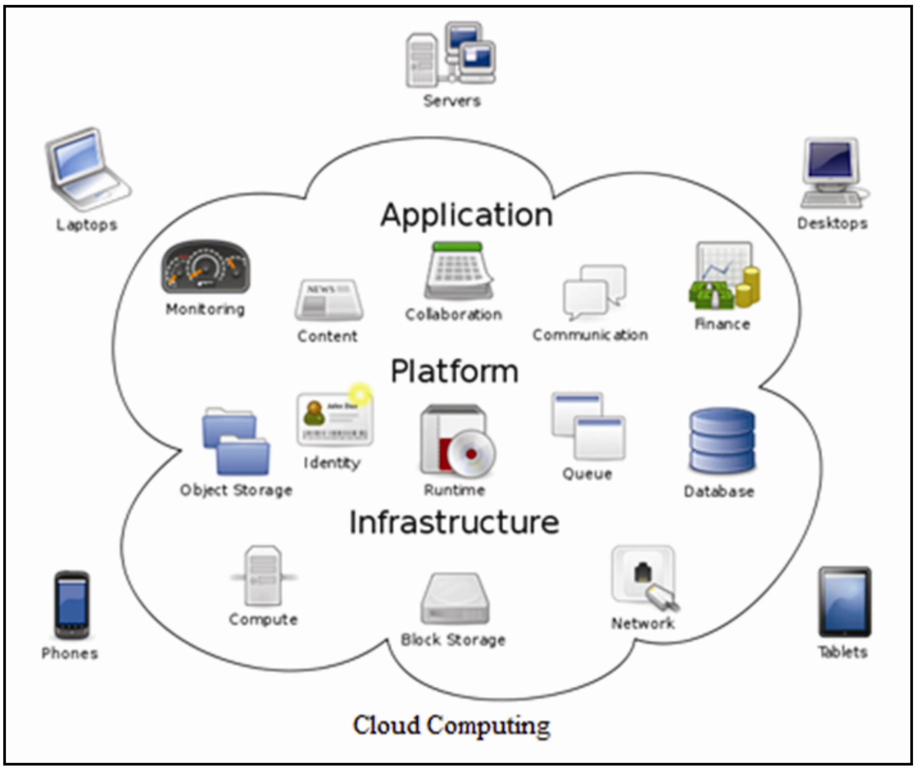

Figure (1.3).The logical diagram of cloud computing (Johnston 2009).

One of the biggest advantages of cloud computing is that customers are able to leverage the economies of scale created by the cloud service providers ability to purchase and manage repeatable processes and technologies. Providers typically focus on common services so they don't need to support (and pay for) a very diverse set of technologies and expensive labor force to maintain it. These costs are passed on to the subscriber. Unlike Web hosting solutions, there is only a limited number of clouding computing service providers. But the good news is that all the major hardware and software brands of the world including Google and Microsoft are already providing cloud solutions. Major cloud service providers are HP, DELL, Amazon and IBM.

Cloud computing providers deliver applications via the Internet, which are accessed from Web browsers and desktop and mobile applications, while the business software and data are stored on servers at a remote location. In some cases, legacy applications (line of business applications that until now have been prevalent in thin client Windows computing) are delivered via a screen-sharing technology, while the computing resources are consolidated at a remote data center location; in other cases, entire business applications have been coded using Web-based technologies such as asynchronous JavaScript and XML (AJAX).

1.5.1 Types of Cloud Computing Services

Currently, cloud computing customers can expect to get three types of services from cloud service providers (CSP); these are (Buyya & Yeo, 2009):

(1) Cloud infrastructure as a service (IaaS): All required hardware to run a business is provided by CSPs and customers manage their application software.

(2) Could platform as a service (PaaS): A customer pays to the service provider to use their platform as their IT solution. For example, if you need E-mail system or database software for your business, you can use a third party's computing service that prove email and database solutions.

(3) Application software as a service (SaaS): If you only need to use a specific kind of software to get an output or to perform an analysis, then it is much cheaper to use that software service from a CSP rather than buying, installing and maintaining it.

Figure (1.4) shows the cloud computing services, which is divided between two main layers, users and cloud computing.

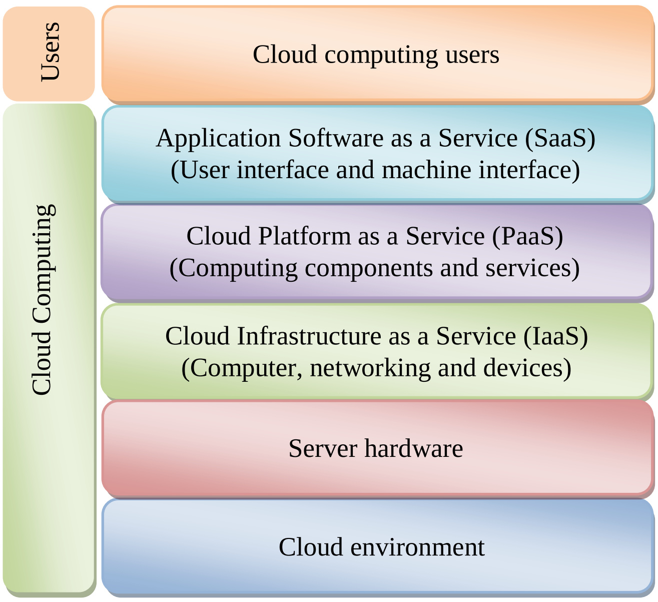

Figure (1.4).Types of cloud computing services.

1.5.2 Benefits of Cloud Computing

The main benefit of using cloud computing is saving cost in IT infrastructure installation and management; because in a cloud environment, users do not have to buy any hardware (Sasikala 2011). Users just need to buy the computing services from a CSP and those services can be accessed online. It is seen that to run a small and mid-size business, the majority of the investment are wasted in buying hardware and software. On the other hand, a cloud computing solution can save initial investment on hardware purchase, and thus help small business owners to spend more money on the core areas of business.

The main benefits of cloud computing can be summarized as follows:

- Employees work anywhere.
- Lower capital expenditures.
- Focus on business not technology.
- No worry upgrades.
- Faster implementations.
- Lower upfront and ongoing costs.
- Pay only for services you need.
- Guaranteed service-level agreements (SLAs).
- Predictable spending.

It is not surprising that businesses, especially start-ups, see the cloud and hosted services as a very attractive option. However, more experienced businesses should be looking far beyond costs as a sole consideration. Larger organizations, particularly those operating in industries with strict legislation and compliance regulations should factor in:

- Third-parties are handling confidential data (i.e., information security).
- Requires reliable Internet connection.
- A subscription service could be expensive over time and as business grows.
- Customization and integration with custom systems could be an issue.
- Lack of full control over data and processes.

1.6 Problem Definition

Nowadays, the c-commerce IT technologies have a tremendous effect on business success; therefore, many business give a great attention to this vital success factor. Many businesses, especially, small and medium businesses (SMBs) are often unable to possess their own suitable c-commerce IT technologies to enable them providing satisfactory services to meet their business and customers needs on one hand, and to compete against large businesses on the other hand. This is true for many reasons, such as:

- Lack of financial resources to build a satisfactory infrastructure.
- Software licensing costs are too expensive for a start-up.
- Lack of human resources, especially in IT.
- Lack of technical know-how to maximize benefits of IT systems.
- High operation, maintenance, and upgrading costs.

Furthermore, c-commerce faces a number of challenges that need to be carefully considered:

(1) The IT technologies of all partners or participants must be comparable to each other (i.e., have equivalent performance).Partners with low-performance c-commerce IT technologies may affect the overall performance of the c-commerce system.

(2) The internetworking infrastructures of the partners acquire a number of requirements, such as: high-bandwidth, reliability, availability, etc. Poor internetworking infrastructure may affect the overall performance of the c-commerce system.

(3) The IT and internetworking infrastructures must have a powerful information and network security.

(4) The heterogeneous infrastructures of the partners may acquire a number of middleware applications.

1.7 Solution and Motivation

Cloud computing platforms have the potential to be particularly well-suited for applications required collaboration between different parties, such as those imposed by c-commerce applications. It generally requires less customization, development, integration, and installation, operation, and maintenance costs, than other enterprise applications.

Thus, in this thesis, we set out to develop and analyze the performance of a new Model of c-commerce that utilizes the evolving cloud technologies, and we refer to it as cloud collaborative commerce, which is abbreviated as cc-commerce.

The main motive for this research is that we believe using cloud technology effectively is essential for business companies to flourish in today's highly competitive marketplace, specially SMBs. Cloud computing drastically reduces these challenges by giving SMBs the same tools used by large businesses at a reasonable cost. Furthermore, as the price of storage and bandwidth continues to drop fast, cloud-based services are becoming more and more cheaper and attractive to SMBs, which are seeking to reduce licensing costs, avoid recruiting IT staff and focus fully on their core responsibility – growing the business, i.e., the cloud provides SMBs with a cost-effective alternative.

Moving c-commerce applications from current distributed collaborative premises to cloud collaborative platforms (i.e., cc-commerce) is not an easy step to carry on and, as a new concept; it faces a number of challenges, such as:

(1) It requires further research to develop an efficient and effective design model.

(2) There is no clear roadmap to adopt for implementing c-commerce applications to run efficiently on cloud platforms.

(3) The cc-commerce has no clear performance measures.

(4) The cc-commerce applications need to have more evaluation and analysis.

1.8 Objectives of the Thesis

The main objectives of this work are:

(1) Develop a generic model for cc-commerce applications.The model should meet all users and business needs, acquiring minimum system resources and application support, relaxing all challenges facing expansion of cloud computing in c-commerce applications, etc.

(2) Introduce some performance measures for evaluating and comapring the performance of the the new cc-commerce model against the different c-commerce models. In particular, in this work, we introduce two parameters, namely, the average response time and the speedup factor.

(3) Pefrom a number of scenarios to evaluate and analyze the performance of the new cc-commerce model for various range of applications.In particular, four different scenarios are considered and for each of them the response time for equivalent data retrieval tasks from the NorthWind.MDF database (http://northwinddatabase.codeplex.com) are measured more than once and the average response time and the associated standard deviation are calculated. Furthermore, the speedup factor that is defined as the average response time of the c-commerce configuration divided by the average response time of the cc-commerce configuration is calculated.

(4) Draw a raod-map for upgrading current c-commerce businesses to cc-commerce.

1.9 Organization of the Thesis

The thesis is developed into five chapters. The First chapter introduces the main theme and concept of the thesis. The rest of this thesis is organized as follows. Second Chapter presents a literature review that provides a background on the components of c-commerce systems and summarizes the most recent and related work, Third chapter provides a general description of the proposed cc-commerce model. The components of the cc-commerce model are described, which are the client, provider, auditor, broker, security and privacy, and communications network components. The secure socket layer (SSL) protocol as a basic security component in cc-commerce, the relation between client and provider components, the provider and broker deployment configurations, and finally the implementation of the model and the performance measures are also explained in Chapter 3.

The Fourth Chapter presents a description of four scenarios representing c-commerce and cc-commerce configurations that are performed to evaluate and compare the performance of the cc-commerce model against the performance of different c-commerce configurations. The obtained results are also analyzed and discussed in Chapter 4. Finally, in the fifth Chapter, based on the obtained results conclusions are drawn and recommendations for future work are pointed-out.

Chapter Two
Background and Literature Review

This chapter provides a background and literature review on the three main concepts covered by this research, namely, collaborative commerce (c-commerce), cloud computing, and cloud-computing-based c-commerce (cc-commerce). It is divided into three sections. Section 2.1 discusses the c-commerce, in particular, it discusses the building blocks of c-commerce, these are: electronic business (e-business) and electronic commerce (E-commerce), knowledge management, and collaboration. Then it moves to discuss the assembling and the federated architecture of c-commerce.

The cloud computing is discussed in Section 2.2, where it provides the history of the development of cloud computing, the cloud collaboration, the capabilities of cloud environment, and the cloud storage. Finally, in Section 2.3, we provide a literature review of the most recent and related work, starting with brief review on c-commerce followed by the state-of-the-art of cc-commerce.

2.1 Collaborative Commerce (C-Commerce)

The main building blocks of c-commerce are essentially:

(1) Electronic commerce (E-commerce).

(2) Knowledge management.

(3) Collaboration.

This section discusses these building blocks.

2.1.1 E-Business and E-commerce

E-commerce means carrying out commerce on the Web, which includes buying and selling of products. The term e-business is about carrying out any business on the Web and is broader than E-commerce. Various types of corporations are now in e-business, including corporations that provide consulting as well as solutions and products such as IBM, and smaller corporations such as the dot-com companies. Some of these smaller corporations can connect consumers with healthcare providers, lawyers, real estate agents and other professionals who provide services of various kinds. Consulting companies may come in and assess the state of a corporation's business practices and advise it on how to develop e-business solutions. One of the latest trends is to provide fully integrated enterprise resource management and business process reengineering capabilities on the Web.

2.1.2 Knowledge Management

Knowledge management essentially changes the way an organization functions. Instead of competition, it promotes collaboration. This means managers have to motivate employees, to share ideas and collaborate, by giving awards and other incentives. Team spirit is essential for knowledge management. People are often threatened imparting knowledge to others as they feel their jobs may be on the line. They are reluctant to share their expertise. This type of behavior could vary from culture to culture. It is critical that managers eliminate this kind of behavior not by forcing the issue but by motivating and educating the staff in all the benefits that can occur with good knowledge management practices; this aspect becomes especially important when one is dealing with situations involving borders of different types.

Organizational behavior and team dynamics play major roles in knowledge management.

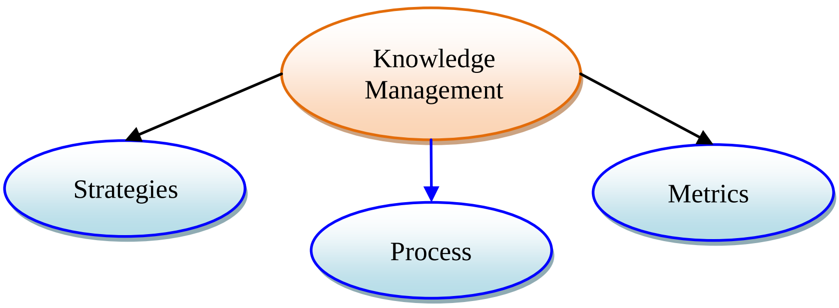

Figure (2.4).Knowledge management components.

The Web plays a big role in promoting knowledge management. Many corporations now have an Intranet, which is a very powerful knowledge management tool. Thousands of employees are connected through the Web in an organization. Large corporations have sites all over the world and employees are becoming well connected with one another. Email can be regarded to be one of the early knowledge management tools. Now there are many tools such as search engines and E-commerce tools. With the proliferation of Web data management and E-commerce tools, knowledge management will become an essential part of the Web and E-commerce. Figure (2.5) illustrates the knowledge management activities on the Web such as creating Web pages, building E-commerce sites, sending email, and collecting metrics on Web usage.

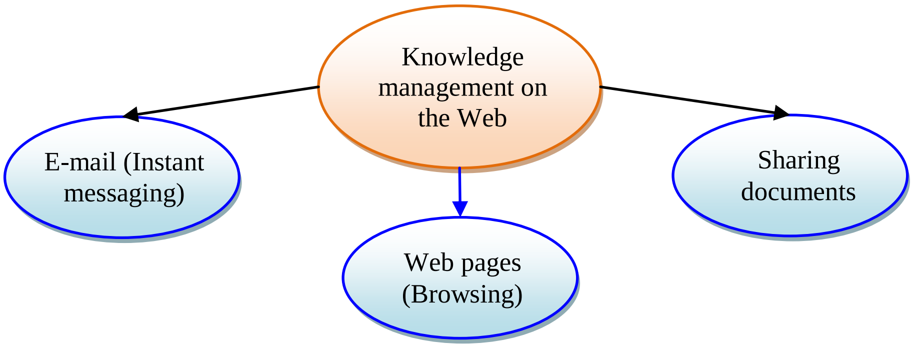

Figure (2.5).Knowledge management on the Web.

2.1.3 Collaboration

Communications and collaboration tools can improve the way companies collaborate and share information faster and more seamlessly. Such tools include e-mail, shared documents and document management, person-to-person workflow processes, and unified communications. Such capabilities become valuable because they enable companies to connect with partners, customers and employees. They also arrange interaction between teams in different locations and allow for them to work together on, and share, documents and data. They allow for live meetings that take place technologically rather than physically (Hartman 2009).

Collaboration technologies link people together in ways that changes the way people work. It also changes the way they think about how they go about their work. It's not just about access to documents and voice communication. It also involves more efficient processes using routing and presence. Routing enables a communication connection by office phones, mobile devices, and computers. The idea of presence technologies enables people to see if someone is available and accessible for conversations across various channels. With collaboration technologies, a communications process now becomes more accessible and immediate.

Reducing the delay involved in connecting and sharing information becomes increasingly important in today's fast-paced world. In the doctor's case study above, the amount of time it took to communicate and obtain information occurred faster because the technology provided presence status and quick access to colleagues through designated routing options. Other significant advantages are that it reduces the delay involved in implementation and it doesn't require IT to always be involved.

2.1.4 Building Blocks of C-Commerce

One of the key aspects here is how does E-commerce differ from c-commerce and what is the role of knowledge management in c-commerce? While E-commerce may assume an environment where sellers sell their products on the Web while buyers purchase these products, c-commerce assumes an environment where organizations have to collaborate with each other to carry out transactions. Web collaboration is an essential part of c-commerce. For example, groups of designers and manufactures have to collaborate with one another in order to come up with a new design or product. C-commerce assumes that organizations are autonomous but collaborating entities that carry out business with each other. Knowledge management plays a key role in c-commerce. It captures the best practices and experiences from previous transactions and makes use of them effectively to carry out c-commerce. Figure (2.6) illustrates the integration of the building blocks for c-commerce. More details on the building blocks can be found in (Kumaraswamy & Latif, 2009).

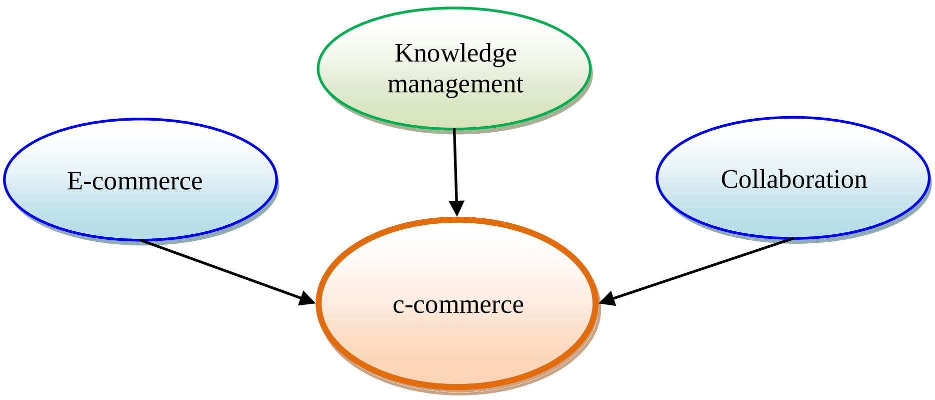

Figure (2.6).Building blocks of c-commerce.

The models and architectures for c-commerce are discussed above. The question now is how does knowledge management support c-commerce? knowledge management helps e-learning and eventually would help E-commerce as well as c-commerce. One needs to learn from experiences experts when creating and managing c-commerce sites. One can also use previous experiences to carry out transactions with organizations. Figure (2.7) illustrate how knowledge management contributes to c-commerce (Kumaraswamy & Latif, 2009).

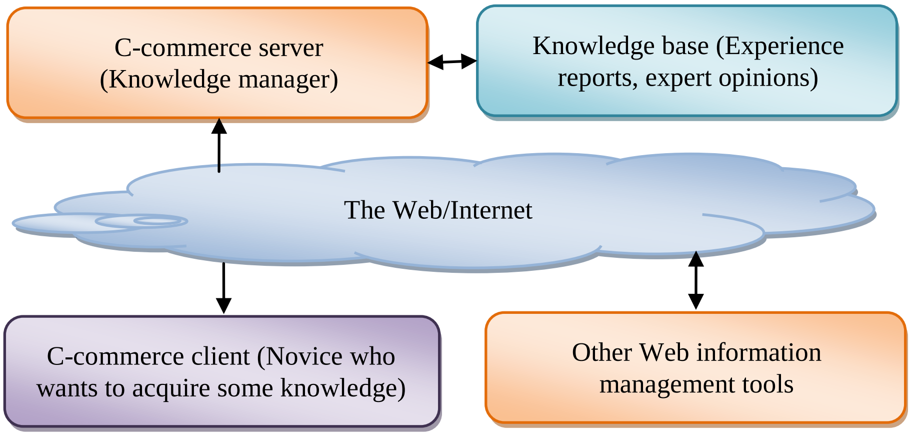

Figure (2.7).Knowledge management for c-commerce.

2.1.5 Federated Architecture for C-Commerce

The various c-commerce sites have to form federations so that the organizations can collaborate on transactions and projects and yet maintain their autonomy. That is, a collection of cooperating c-commerce servers, which are possibly autonomous, may form a federation. The intent is for an organization to continue its local operation and at the same time participate in a federation if it wants to. Architecture for a federated environment to carry out c-commerce is illustrated in Figure (2.8).

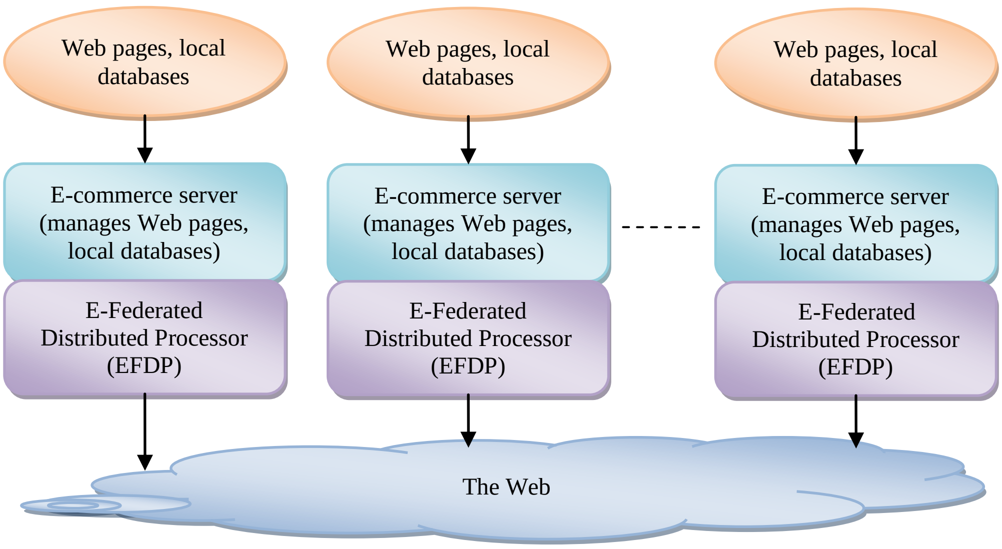

Figure (2.8).Federated architecture for c-commerce.

In this architecture, the E-commerce sites are connected through an electronic federated distributed processor (EFDP). The various E-commerce servers form a federation and have to cooperate with one another. They also have to maintain some kind of autonomy. The administrator of an E-commerce site would want to have as much autonomy as possible to carry out intra-organizational operations. At the same time he would want to carry out as many inter-organizational transactions as possible. That is, the administrators of the different E-commerce sites would have to cooperate with one another to share each other’s data as well as carry out transactions.

Autonomy and cooperation are conflicting goals and therefore a balance between the two has to be achieved. Autonomy enables an organization to join or leave a federation whenever it wishes to; therefore, it makes the task of developing a c-commerce environment quite complex. While there is much research to be done on federated architectures for E-commerce, many of the concepts and techniques for federated database management can be applied here. We discuss some of the issues.

In federated databases, various aspects of heterogeneity have been examined. These include policy heterogeneity, schema heterogeneity and data model heterogeneity. All these aspects have to be considered for federated E-commerce organizations. More importantly, each organization may enforce a different business model. For example, one organization could enforce a model where payments are received within a month while another organization may enforce a model where payments are received during purchase. This is just a simple example. There may be many other aspects to heterogeneity with respect to business models. Therefore, if organizations have to form federations and carry out c-commerce transactions they have to ensure that the differences are reconciled. Business model heterogeneity is illustrated in Figure (2.9).

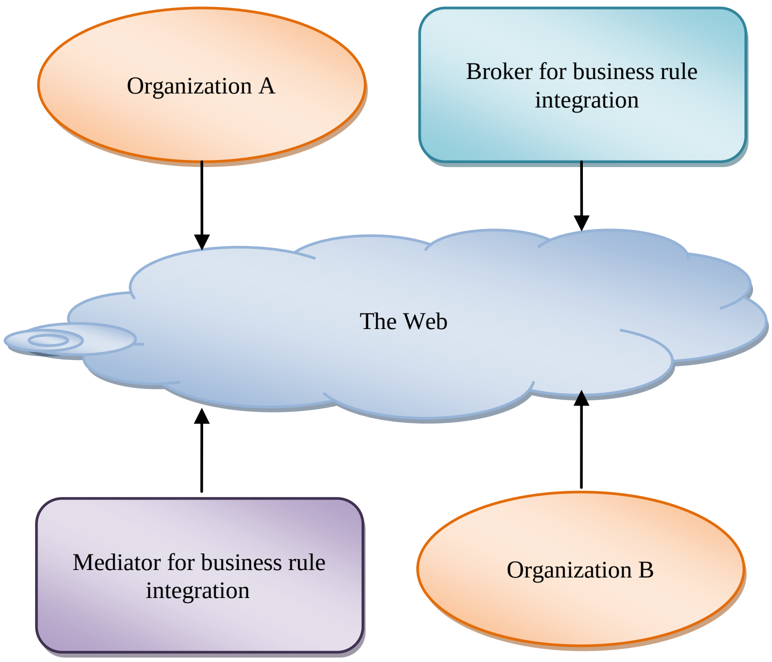

Figure (2.9).Business model heterogeneity.

2.2 Cloud Computing

Cloud computing is a general term for computer resources (hardware and software) that involves delivering hosted services over the Internet. As we have discussed in Chapter 1 that these services are broadly divided into three categories: infrastructure-as-a-service (IaaS), platform-as-a-service (PaaS) and software-as-a-service (SaaS).

The name cloud computing was inspired by the cloud symbol that's often used to represent the Internet in flowcharts and diagrams. This section provides the history of the development of cloud computing, the cloud collaboration, the capabilities of cloud computing environment, and the cloud storage.

2.2.1 Cloud History

The cloud computing concept dates back to 1960 when John McCarthy opined that "computation may someday be organized as a public utility"; indeed it shares characteristics with service bureaus which date back to the 1960s, and the term cloud was already in commercial use in the early 1990s to refer to large ATM networks. By the turn of the 21stcentury, cloud computing solutions had started to appear on the market, though most of the focus at this time was on software as a service (Chappell 2008).

Amazon.com played a key role in the development of cloud computing by modernizing their data centers after the dot-com bubble and (having found the new cloud architecture resulted in significant internal efficiency improvements) providing access to their systems by way of Amazon Web Services in 2002 on a utility computing basis.

The year 2007 saw increased activity, including Google, IBM and a number of universities embarking on a large scale cloud computing research project, around the time the term started gaining popularity in the mainstream press. It was a hot topic by mid-2008 and numerous cloud computing events had been scheduled. In August 2008 Gartner observed that "organizations are switching from company-owned hardware and software assets to per-use service-based models" and that the "projected shift to cloud computing will result in dramatic growth in IT products in some areas and in significant reductions in other areas".

2.2.2 Cloud Collaboration

Cloud collaboration is a newly emerging way of sharing and co-authoring computer files through the use of cloud computing, whereby documents are uploaded to a central cloud for storage, where they can then be accessed by others. New cloud collaboration technologies have allowed users to upload, comment and collaborate on documents and even amend the document itself, evolving the document within the cloud. Businesses in the last few years have increasingly been switching to use of cloud collaboration.

Cloud collaboration brings together new advances in cloud computing and collaboration that are becoming more and more necessary in firms operating in an increasingly globalised world. Cloud computing is a marketing term for technologies that provide software, data access, and storage services that do not require end-user knowledge of the physical location and configuration of the system that delivers the services.

Collaboration, in this case, refers to the ability of workers in a company to work together simultaneously on a particular task. In the past, most document collaboration would have to be completed face to face. However, collaboration has become more complex, with the need to work with people all over the world in real time on a variety of different types of documents, using different devices. While growth in the collaboration sector is still growing rapidly, it has been noted that the uptake of cloud collaboration services has reached a point where it is less to do with the ability of current technology, and more to do with the reluctance of workers to collaborate in this way. A report by Erica Regulates mapped out five reasons why workers are reluctant to collaborate more. These are:

(1) People resist sharing their knowledge.

(2) Users are most comfortable using e-mail as their primary electronic collaboration tool.

(3) People do not have incentive to change their behavior.

(4) Teams that want to or are selected to use the software do not have strong team leaders who push for more collaboration.

(5) Senior management is not actively involved in or does not support the team collaboration initiative.

As a result, many providers of cloud collaboration tools have created solutions to these problems. These include the integration of email alerts into collaboration software and the ability to see who is viewing the document at any time. All the tools a team could need are put into one piece of software so workers no longer have to rely on email based solutions.

While E-commerce enables organizations to carry out transactions, and knowledge management captures the knowledge of an organization, we still need a third component to enable organizations to work together and yet be autonomous. That third component is collaboration. As mentioned earlier, collaborative computing enables people, groups of individuals, and organizations to work together to accomplish a task or a collection of tasks. These tasks could vary from participating in conferences, solving a specific problem, or working on the design of a system. Specific contributions to collaborative computing include the development of team workstations (where groupware creates a shared workspace supporting dynamic collaboration in a work group), multimedia communication systems supporting distributed workgroups, and collaborative computing systems supporting cooperation in the design of an entity.

Using the cloud offers another approach to achieving business objectives that are enabled by collaboration solutions. And utilizing collaboration tools in the cloud has been demonstrated to be a relatively low-risk, high-return on investment approach to getting started in cloud. The fact is that some services available in the cloud already have a proven track record. They include Web conferencing services, such as Microsoft Live Meeting or WebEx. Most people have used these and other services and done so confidently for a long time – in the cloud.

As the reality of cloud computing begins to take hold for companies considering new IT opportunities, the benefits of collaboration technologies utilized as a service through the cloud become readily apparent.

Collaboration in the cloud immediately opens options for access to new and cost-effective ways to address company goals and objectives. For example:

(1) Being able to get communications and collaboration services up and running quickly.

(2) Lower upfront deployment costs.

(3) Ease of access.

(4) Pay for software solutions you need, when you need them.

(5) Access to automatically updated software and security.

If used effectively, collaboration in the cloud enables companies to capitalize on needed technology without the extensive, upfront capital expense that comes with the time-consuming installation and configuration of IT systems.

With cloud, companies need to determine, which applications they must own and control, and which ones are prime targets for the cloud because they require less control. In essence, companies must decide how much control over certain aspects of IT they truly need. Then they must compare how much economic value that control offers by being in-house compared to the economies of scale available in the cloud.

When considering cloud, companies need to know that the partners, or vendors, they work with are credible. They should have proven processes to support an organization's needs. It's equally important to identify companies with a track record of on-premise solutions. Those companies should also have a clear cloud vision, strategy and offerings that demonstrate stability and long-term viability. If personal data is put into the cloud, legal requirements for transferring, storing and using data must be addressed carefully in advance. These requirements vary from jurisdiction to jurisdiction.

2.2.3 Capabilities of Cloud Environment

Open cloud manifesto states three principles as crucial **Web 0.9** (2012) ; these are:

(1) Users should work together.

(2) Activities to keep the cloud open should be customer driven

(3) Existing standards should be used wherever possible.

Thus, the main capabilities and requirements that need to be standardized in a cloud environment to ensure interoperability, ease of integration and portability, are:

(1) Cloud computing must evolve as an open environment, minimizing vendor lock-in and increasing customer choice.

(2) Cloud providers must work together to ensure that the challenges to cloud adoption are addressed through open collaboration and the appropriate use of standards.

(3) Cloud providers must use and adopt existing standards wherever appropriate. The IT industry has invested heavily in existing standards and standards organizations; there is no need to duplicate or reinvent them. When new standards (or adjustments to existing standards) are needed, we must be judicious and pragmatic to avoid creating too many standards. We must ensure that standards promote innovation and do not inhibit it.

(4) Any community effort around the open cloud should be driven by customer needs, not merely the technical needs of cloud providers, and should be tested or verified against real customer requirements.

(5) Cloud computing standards organizations, advocacy groups, and communities should work together and stay coordinated, making sure that efforts do not conflict or overlap.

(6) Cloud providers must not use their market position to lock customers into their particular platforms and limiting their choice of providers.

(7) Rapid elasticity: Elasticity is defined as the ability to scale resources both up and down as needed. To the consumer, the cloud appears to be infinite, and the consumer can purchase as much or as little computing power as they

need. This is one of the essential characteristics of cloud computing in the NIST definition.

(8) Measured service: In a measured service, aspects of the cloud service are controlled and monitored by the cloud provider. This is crucial for billing, access control, resource optimization, capacity planning and other tasks.

(9) On-demand self-service: The on-demand and self-service aspects of cloud computing mean that a consumer can use cloud services as needed without any human interaction with the cloud provider.

2.2.4 Cloud Storage

Cloud storage is a model of networked online storage where data is stored in virtualized pools of storage, which are generally hosted by third parties. Hosting companies operate large data centers, and people who require their data to be hosted buy or lease storage capacity from them. The data center operators, in the background, virtualizes the resources according to the requirements of the customer and expose them as storage pools, which the customers can themselves use to store files or data objects. Physically, the resource may span across multiple servers. Cloud storage services may be accessed through a application programming interface (API), a cloud storage gateway or through a Web-based user interface (Mohamed, 2009).

Cloud storage architecture

One of the first milestones for cloud computing was the arrival of Sales force (www.salesforce.com) in 1999, which pioneered the concept of delivering enterprise applications via a simple website. The services firm paved the way for both specialist and mainstream software firms to deliver applications over the Internet. Files Anywhere(http://www.filesanywhere.com) also helped pioneer cloud-based storage services that also enable users to securely share files online. Both of these companies continue to offer those services today. (Mohamed, 2009)

Cloud storage advantages

The main advantages of cloud storage are (Mohamed 2009):

- Companies need only pay for the storage they actually use as it is also possible for companies by utilizing actual virtual storage features like thin provisioning.

- Companies do not need to install physical storage devices in their own datacenter or offices, but the fact that storage has to be placed anywhere stays the same (maybe localization costs are lower in offshore locations).

- Storage maintenance tasks, such as backup, data replication, and purchasing additional storage devices are offloaded to the responsibility of a service provider, allowing organizations to focus on their core business, but the fact stays the same that someone has to pay for the administrative effort for these tasks.

- Cloud storage provides users with immediate access to a broad range of resources and applications hosted in the infrastructure of another organization via a web service interface.

- Cloud storage can be used for copying virtual machine images from the cloud to on-premise locations or to import a virtual machine image from an on-premise location to the cloud image library. In addition, cloud storage can be used to move virtual machine images between user accounts or between data centers.

2.3 Previous Work

In this research, we mainly interested in three related topics: c-commerce, cloud computing, and cc-commerce. The research in c-commerce area includes business and information technology (IT) aspects. In business aspect, the research works mainly focus on cross-organizational business process integration, which is beyond the scope of this thesis. Therefore, in what follows we shall review some of the most recent and related to c-commerce and applications of cloud computing to c-commerce. However, we have realized that very little efforts being focused on cloud computing performance evaluation for c-commerce applications, many be mainly, because this is a very new area of research.

Over the last decade numerous efforts have been made in the area of c-commerce. Most of them focus on IT aspects. Huang & Fan (2007) proposed an integrated solution for c-commerce including the collaborative strategy, model and platform. The reference processes and strategy of c-commerce is derived using a structural top-down analysis approach. According to the analysis and abstract of c-commerce behavior, the collaborative meta-model is put forward to support the description of complex collaborative relationship in c-commerce environment. On the foundation of collaborative meta model, the collaborative model of c-commerce can be established. Finally, the service oriented architecture (SOA) and model-driven architecture (MDA) based-platform for c-commerce is developed to enable value-added collaboration between partners by providing new technical solutions, best practices, and collaboration tools. The platform represents a virtual, model-driven and service-oriented integration environment accessible to the involved companies within a heterogeneous IT-infrastructure.

Both manufacturer and supplier are enabled to collaborate via the platform. The main features and functions of the platform include:

(1) Provide a single engineering portal based on Internet technologies that supports multi-cultural collaboration partnerships

- Find appropriate, and evaluate potential suppliers/engineering partners in different cultural areas.
- Initiate contact to potential multi-cultural partners based on a cultural repository and a repository of best-practices.
- Establish a common computer-aided engineering process, safeguarding each partner’s intellectual property and considering cultural characteristics.

(2) Interconnect heterogeneous systems based on Web service

- The individual partner’s data are shared over the platform.
- The partner’s individual engineering processes are linked together to a comprehensive and integrated supply chain.

- Provide mechanisms to define classified (or unnecessary) information in order to hide information.

(3) Realizing a model and service driven engineering collaboration.

- Providing methods and tools for process modeling and execution as a basis for the engineering collaboration.

Chen, Zhang, & Zhou (2007) gave an in-depth analysis of business process management (BPM) and Web services in the context of c-commerce. They proposed architecture for Web services enabled BPM in c-commerce and provided technical insights into why Web services can enhance business process coordination. Also, they presented an implementation of a dynamic e-procurement application based on the proposed architecture. They concluded that with the advent of Web service standards and business process integration tools that support them, BPM systems enabled by Web services are empowering the development of more flexible and dynamic c-commerce.

Zhang, Chen, & Lai (2008) put forward a c-commerce model based on multi-agent system (MAS) technology that is characterized with the characteristics of autonomy, easy adaptation, flexibility and dynamic of agent technology. It can be used to describe the interaction relationship with partners and run on the cooperation among the different MAS layers. Many useful functions, including automated learning, data analysis and mining, best solution selection etc, can be realized in this unified c-commerce system.

Buyya et al (2009) defined cloud computing and provided the architecture for creating clouds with market-oriented resource allocation by leveraging technologies such as Virtual Machines (VMs). They provided insights on market-based resource management strategies that encompass both customer-driven service management and computational risk management to sustain service level agreement (SLA)-oriented resource allocation. In addition, they revealed their early thoughts on interconnecting clouds for dynamically creating global cloud exchanges and markets. Then, they presented some representative cloud platforms, especially those developed in industries, along with their current work towards realizing market-oriented resource allocation of clouds as realized in Aneka enterprise cloud technology. Furthermore, they highlighted the difference between high performance computing (HPC) workload and Internet-based services workload. They also described a meta-negotiation infrastructure to establish global cloud exchanges and markets, and illustrated a case study of harnessing storage clouds for high performance content delivery. Finally, they concluded with the need for convergence of competing IT paradigms to deliver our 21st century vision.

Chang & Wang (2011) explored the integration of internal and external business processes and the coordination of collaborative design teams. An initial qualitative investigation explores the practical applications of an Enterprise Information Portals (EIP) in an automobile company. A research model is then formulated and tested using a questionnaire survey of the R&D department of a motor company in Taiwan. The results of the data analysis reveal that presence of EIPs can help a company realize the benefits of c-commerce. EIPs also can improve c-commerce performance by promoting the degree of integration of the enterprise process and by strengthening the process innovation and communication of collaborative design teams. Their results suggest that managers should reinforce important factors, including knowledge management tools, process integration, and the quality of design teams, in order to achieve success in c-commerce.

Li & Xia (2011) made a preliminary study on how to make cloud computing be applied in the c-commerce chain and presents the principles, ideas and analysis of the architecture of cloud-computing-based c-commerce chain to provide references on the construction of cloud computing-based c-commerce chain. With the implementation of cloud computing by the major E-commerce companies, cloud computing can play a more and more important role in business collaboration. C-commerce chain is a new business model with net-chain structure which is built based on mutual benefit and win-win strategy and it meets with the needs of cooperation in production and management between branches of the enterprise, between enterprises and customers and business to business such as: Procurement, manufacturing, sales and after-sale services. It implements the effective planning and control on the business flow, logistics, capital flow and information flow involved in business operations and forms a strategic alliance body with core competitiveness.

Li et al. showed that cloud computing-based c-commerce chain has five layers which are structural layer, basic resource layer, middleware layer, logic layer, and collaborative application layer. When the architecture of cloud computing-based c-commerce chain is being designed, it should be considered that the different characteristics of collaboration chains have different focuses. It is worth mentioning that the resource structure highlights the security system as the security management tools and related strategies are designed to keep cloud computing to deal with business tasks safely. However, they did not discuss any implementation or performance evaluation to their proposed model.

Chanchary & Islam (2012) explored the key requirements of E-commerce business model based on cloud computing and cited it as cloud commerce. Assuming these requirements, they made a comprehensive study on existing facilities for e-business patterns in Saudi Arabia to assess the readiness of this country to adopt with the emerging trend. They used a structured framework for this assessment that separated in three distinguishable forms such as architectural readiness, infrastructure readiness and process readiness. To summarize each stage of this framework, they followed a pattern of data collection that mainly included interviews and questionnaires.

Exposito et al (2013) stated that the scalability of HPC applications depends heavily on the efficient support of network communications in virtualized environments. However, IaaS providers are more focused on deploying systems with higher computational power interconnected via high-speed networks rather than improving the scalability of the communication middleware. They analyzed the main performance bottlenecks in HPC application scalability on the Amazon EC2 Cluster Compute platform: (1) evaluating the communication performance on shared memory and a virtualized 10 Gigabit Ethernet network; (2) assessing the scalability of representative HPC codes, the NAS Parallel Benchmarks, using an important number of cores, up to 512; (3) analyzing the new cluster instances (CC2), both in terms of single instance performance, scalability and cost-efficiency of its use; (4) suggesting techniques for reducing the impact of the virtualization overhead in the scalability of communication-intensive HPC codes, such as the direct access of the virtual machine to the network and reducing the number of processes per instance; and (5) proposing the combination of message-passing with multithreading as the most scalable and cost-effective option for running HPC applications on the Amazon EC2 Cluster Compute platform

2.4 Example of CC-Commerce Software

CDC Software Corporation (Web 0.8, 2011) has recently announces a new Cloud-based Collaborative Inventory Management Solution, namely, CDC TradeBeam*i*-Supply 7.6. CDC Software Corporation is a global provider of enterprise software applications and services. This latest version of CDC Software’s cloud collaborative inventory management solution improves supply chain visibility to help minimize risk, reduce the need for emergency shipments and improve order accuracy and lead time. *i*-Supply helps supplier to cut costs, streamline processes and meet customer service goals.

CDC TradeBeam*i*-Supply 7.6 is delivered on a SaaS platform. This enables manufactures to give their suppliers real-time visibility into forecasts and inventory status, such as: what is on-hand, has been used, ordered, shipped and received, as well as real-time exception notifications. The new version extends support to supplier plants that produce and assemble products with lower inventory turns and longer lead times.

Typically, these suppliers are located far from the manufacturer, often in the medical device manufacturing industry. Other new features include enhancements in the following key functional areas: order management, low turn goods, forecast history and integration support including Average Daily Use and Forecasted Daily Use and outbound EDI Advance Shipping Notice messaging.

i-Supply provides manufacturers and their suppliers with improved supply chain visibility. This helps to increase the efficiency of their supply chains, mitigate risks and reduce costs. The latest version of *i*-Supply further advances collaboration between manufacturers and their suppliers so they can balance costs better; provide service on a daily basis and ultimately improve their bottom lines.

Chapter Three

Cloud Collaborative Commerce Model

Cloud computing is a model for enabling 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. Cloud computing model promotes availability and is composed of five essential characteristics (Foster et al 2008):

(1) On-demand self-service

(2) Broad network access

(3) Resource pooling

(4) Rapid elasticity

(5) Measured Service

As it has been discussed in Chapter 1, that cloud computing provides three service models, these are:

(1) Cloud Software as a Service (SaaS)

(2) Cloud Platform as a Service (PaaS)

(3) Cloud Infrastructure as a Service (IaaS)

Furthermore, till now, there are four deployment models that can be identified, namely:

(1) Private cloud

(2) Community cloud

(3) Public cloud

(4) Hybrid cloud

The key enabling technologies for successful cloud computing services include:

(1) Fast wide-area networks

(2) Powerful, inexpensive server computers

(3) High-performance virtualization for commodity hardware

The cloud computing model offers the promise of massive cost savings combined with increased IT agility. It is considered critical that government and industry begin adoption of this technology in response to difficult economic constraints. However, cloud computing technology challenges many traditional approaches to datacenter and enterprise application design and management. Despite the fact that there are a major barriers to broader adoption of cloud computing; such as security, interoperability, and portability; cloud computing is currently being used in a wide range of applications.

In this work, we propose and discuss one new major application of cloud computing, in which cloud computing is to be used as a powerful alternative platform for performing collaborative commerce (c-commerce), where all collaborative entities are hosted at the same cloud, and consequently, it will be referred to as cloud collaborative commerce (cc-commerce).

CC-Commerce is defined as the form of c-commerce that utilizes the evolving cloud computing services brining more cost-effective business opportunities and enabling more precise decision making. Businesses are always willing and would like to be able to use platform to drive an end-to-end E-commerce process without integrating to other systems, learning new taxonomies, or going anywhere else to get things done. They also would to be able to tap a network through which they can rapidly discover, connect, and collaborate with the trading partners that can deliver the greatest value to them; and they can leverage to exchange market knowledge and share best practice processes.

This chapter provides a detail description of a cc-commerce model, which can be deployed using two configurations, namely, provider-access configuration and broker-access configuration. The long term goal is to provide thought leadership and guidance around the cloud computing paradigm to catalyze its use within industry and government. We aim to shorten the adoption cycle, which will enable near-term cost savings and increased ability to quickly create and deploy enterprise applications. We also aim to foster cloud computing systems and practices that support interoperability, portability, and security requirements that are appropriate and achievable for important usage scenarios.

Section 3.1 provides a general description of the proposed cc-commerce model. The components of the cc-commerce model are described in Section 3.2, which includes the description of the client, provider, auditor, broker, security and privacy, and communications network. Section 3.3 describes the secure socket layer (SSL) protocol as a basic security component in cc-commerce. The relation between client and provider components is discussed in Section 3.4. The provider and broker deployment configurations are presented in Section 3.5. Finally, the implementation of the model and the performance measures are explained in Section 3.6.

3.1 The CC-Commerce Model

This section presents an overview of the reference architecture of the cc-commerce model, which identifies the major components, their activities and functions in cc-commerce. The proposed cc-commerce model is assumed to consist of six main components as depicted in Figure (3.1); these are:

(1) CC-Commerce client

(2) CC-Commerce provider

(3) CC-Commerce auditor

(4) CC-Commerce broker

(5) CC-Commerce security and privacy

(6) Communications network

Figure (3.1) depicts a generic high-level architecture and is intended to facilitate the understanding of the requirements, uses, characteristics and standards of cc-commerce.

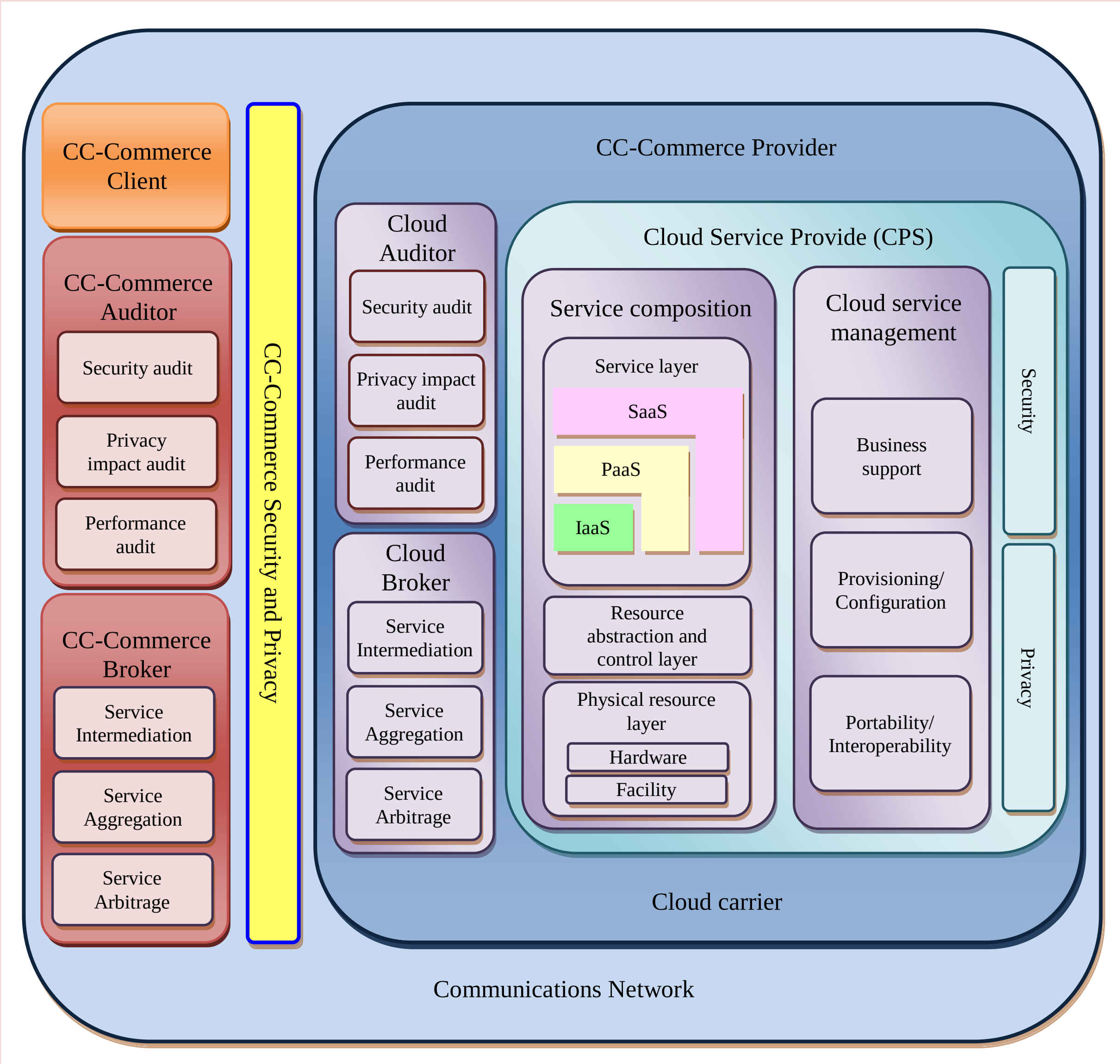

Figure (3.1).Architecture of the cc-commerce model.

Each component is an entity (a person or an organization) that participates in a transaction or process and/or performs tasks in cc-commerce. Table (3.1) briefly lists the components defined in the cc-commerce reference architecture. The general activities of the components are discussed in the remainder of this section, while the details of the architectural elements are discussed later in this chapter.

Figure (3.2) illustrates the interactions among the components. A cc-commerce client may request cc-commerce services from a cc-commerce provider directly or via a cc-commerce broker. A cc-commerce auditor conducts independent audits and may contact the others to collect necessary information. The details will be discussed in the following sections and presented in increasing level of details in successive diagrams.

Table (3.1) Components of the cc-commerce model	
Component	Definition
Client	A person or organization that maintains a business relationship with, and uses service provided by cc-commerce providers or brokers.
Provider	A person, organization, or entity responsible for making a service available to interested parties.
Auditor	A party that can conduct independent assessment of cc-commerce services, information system operations, performance and security of the cloud implementation.
Broker	An entity that manages the use, performance and delivery of cc-commerce services, and negotiates relationships between providers and cc-commerce clients.
Security and Privacy	An entity that is responsible for providing security and privacy across the system components using standard and/or specially developed protocols.
Communications Network	An intermediary that provides connectivity and transport of cc-commerce services between cc-commerce clients to providers/brokers.

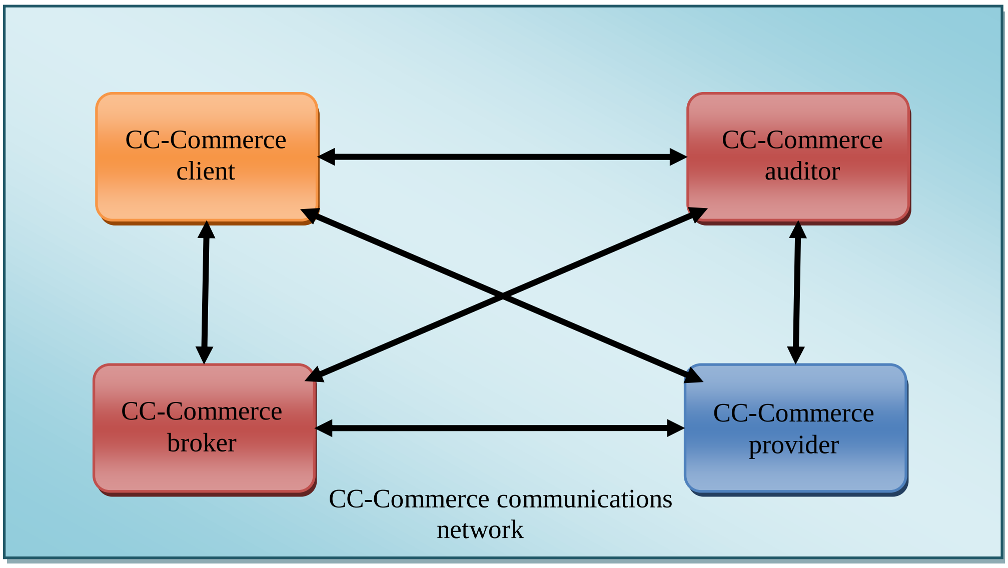

Figure (3.2) Interactions between the components in cc-commerce.

The model can be configured and used in three different ways; these are:

(1) **Configuration#1**: A cc-commerce may request service from a cc-commerce broker instead of contacting a cc-commerce provider directly. The cc-commerce broker may create a new service by combining multiple services or by enhancing an existing service. In this example, the actual cc-commerce providers are invisible to the cc-commerce client and the cc-commerce client interacts directly with the cc-commerce broker. This configuration is illustrated in Figure (3.3).

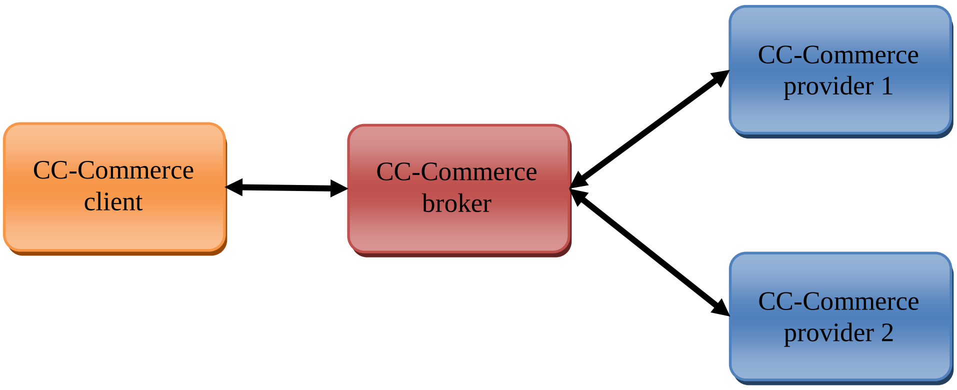

Figure (3.3).Interconnection in Configuration #1.

(2) **Configuration#2**: Communications network provides the connectivity and transport of cc-commerce services from cc-commerce providers to cc-commerce clients. As illustrated in Figure (3.4), a cc-commerce provider participates in and arranges for two unique service level agreements (SLAs), one with a communications network (e.g., SLA2) and one with a cc-commerce client (e.g., SLA1). A cc-commerce provider arranges SLAs with a communications network and may request dedicated and encrypted connections to ensure the cc-commerce services are consumed at a consistent level according to the contractual obligations with the cc-commerce clients. In this case, the provider may specify its requirements on capability, flexibility and functionality in SLA2 in order to provide essential requirements in SLA1.

Figure (3.4).Interconnection in Configuration #2.

(3) **Configuration#3**: For a cc-commerce service, a cc-commerce auditor conducts independent assessments of the operation and security and privacy of the cc-commerce service implementation. The audit may involve interactions with both the cc-commerce client and the cc-commerce provider. Figure (3.5) shows the interconnection between the collaborating components.

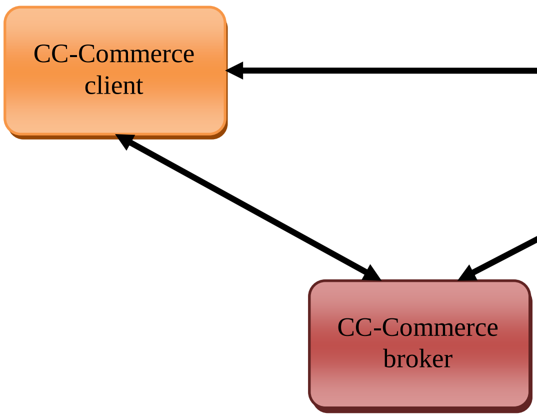

Figure (3.5).Interconnection in Configuration #3.

3.2 Description of the Model Components

This section describes in details the different components of the developed cc-commerce model, namely, client, provider, auditor, broker, security and privacy, and communication networks components.

3.2.1 CC-Commerce Client

The cc-commerce client is the principal stakeholder for the cc-commerce provider. A client represents a person or organization that maintains a business relationship with, and uses the service from a cc-commerce provider. A client browses the service catalog from a cc-commerce provider, requests the appropriate service, sets up service contracts with the cc-commerce provider, and uses the service. The client may be billed for the service provisioned, and needs to arrange payments accordingly.

Clients need SLAs to specify the technical performance requirements fulfilled by a cc-commerce provider. SLAs can cover terms regarding the quality-of-service (QoS), security, remedies for performance failures. A cc-commerce provider may also list in the SLAs a set of promises explicitly not made to clients, i.e. limitations, and obligations that clients must accept. A client can freely choose a cc-commerce provider with better pricing and more favorable terms. Typically, a cc-commerce provider pricing policy and SLAs are non-negotiable, unless the client expects heavy usage and might be able to negotiate for better contracts. Depending on the services requested, the activities and usage scenarios can be different among clients. CC-Commerce clients have access to the services provided by the cc-commerce components and by the CSPs.

3.2.2 CC-Commerce Provider

A cc-commerce provider is a person, an organization; it is the entity responsible for making a service available to interested parties. A provider acquires and manages the computing infrastructure required for providing the services, runs the cc-commerce software that provides the services, and makes arrangement to deliver the cloud services to the clients through network access. It can be seen in Figure (3.1) that the cc-commerce provider is basically a cloud computing service provider. It has its own cloud service provider (CSP), cloud auditor, cloud broker, and cloud carrier.

In this case, the cc-commerce provider can access the same services provided by the cloud computing infrastructure, and provide these services to its client (i.e., cc-commerce client). Figure (3.6) presents some examples of the services available to a cloud client and consequently to the cc-commerce client (Cloud Taxonomy, 2012).

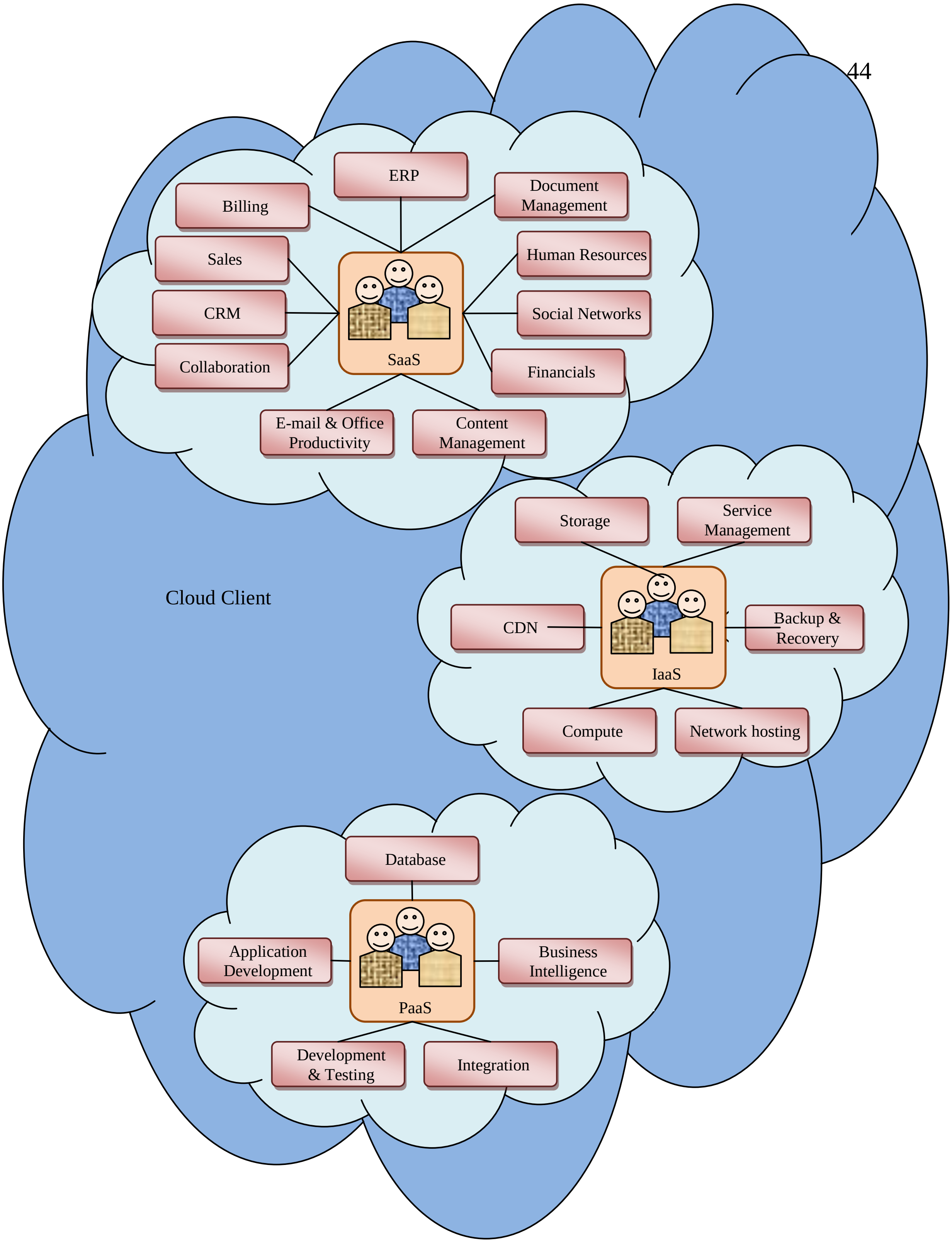

Figure (3.6).Example of services available to cc-commerce as well as cloud clients.

SaaS applications in the cloud are made accessible via a network to the SaaS clients. The clients of SaaS can be organizations that provide their members with access to software applications, end users who directly use software applications, or software application administrators who configure applications for end users. SaaS clients can be billed based on the number of end users, the time of use, the network bandwidth consumed, and the amount of data stored or duration of stored data.

For SaaS, the CSP deploys, configures, maintains and updates the operation of the software applications on a cloud infrastructure so that the services are provisioned at the expected service levels to clients. The CSP of SaaS assumes most of the responsibilities in managing and controlling the applications and the infrastructure, while the clients have limited administrative control of the applications.

Cloud clients of PaaS can employ the tools and execution resources provided by cloud providers to develop, test, deploy and manage the applications hosted in a cloud environment. PaaS clients can be application developers who design and implement application software, application testers who run and test applications in cloud-based environments, application deployers who publish applications into the cloud, and application administrators who configure and monitor application performance on a platform. PaaS clients can be billed according to, processing, database storage and network resources consumed by the PaaS application, and the duration of the platform usage.

For PaaS, the CSP manages the computing infrastructure for the platform and runs the cloud software that provides the components of the platform, such as runtime software execution stack, databases, and other middleware components. The PaaS CSP typically also supports the development, deployment and management process of the PaaS client by providing tools such as integrated development environments (IDEs), development version of cloud software, software development kits (SDKs), deployment and management tools. The PaaS client has control over the applications and possibly some of the hosting environment settings, but has no or limited access to the infrastructure underlying the platform such as network, servers, operating systems (OS), or storage.

Clients of IaaS have access to virtual computers, network-accessible storage, network infrastructure components, and other fundamental computing resources on which they can deploy and run arbitrary software. The clients of IaaS can be system developers, system administrators and IT managers who are interested in creating, installing, managing and monitoring services for IT infrastructure operations. IaaS clients are provisioned with the capabilities to access these computing resources, and are billed according to the amount or duration of the resources consumed, such as CPU hours used by virtual computers, volume and duration of data stored, network bandwidth consumed, number of IP addresses used for certain intervals..

For IaaS, the CSP acquires the physical computing resources underlying the service, including the servers, networks, storage and hosting infrastructure. The CSP runs the cloud software necessary to makes computing resources available to the IaaS Cloud client through a set of service interfaces and computing resource abstractions, such as virtual machines and virtual network interfaces. The IaaS client in turn uses these computing resources, such as a virtual computer, for their fundamental computing needs, compared to SaaS and PaaS clients, an IaaS client has access to more fundamental forms of computing resources and thus has more control over the more software components in an application stack, including the OS and network. The IaaS CSP, on the other hand, has control over the physical hardware and cloud software that makes the provisioning of these infrastructure services possible, for example, the physical servers, network equipments, storage devices, host OS and hypervisors for virtualization.

A CSPs' activities can be described in four major areas, as shown in Figure (3.7), a CSP conducts its activities in the areas of service deployment, service administration, cloud service management, and security and privacy.

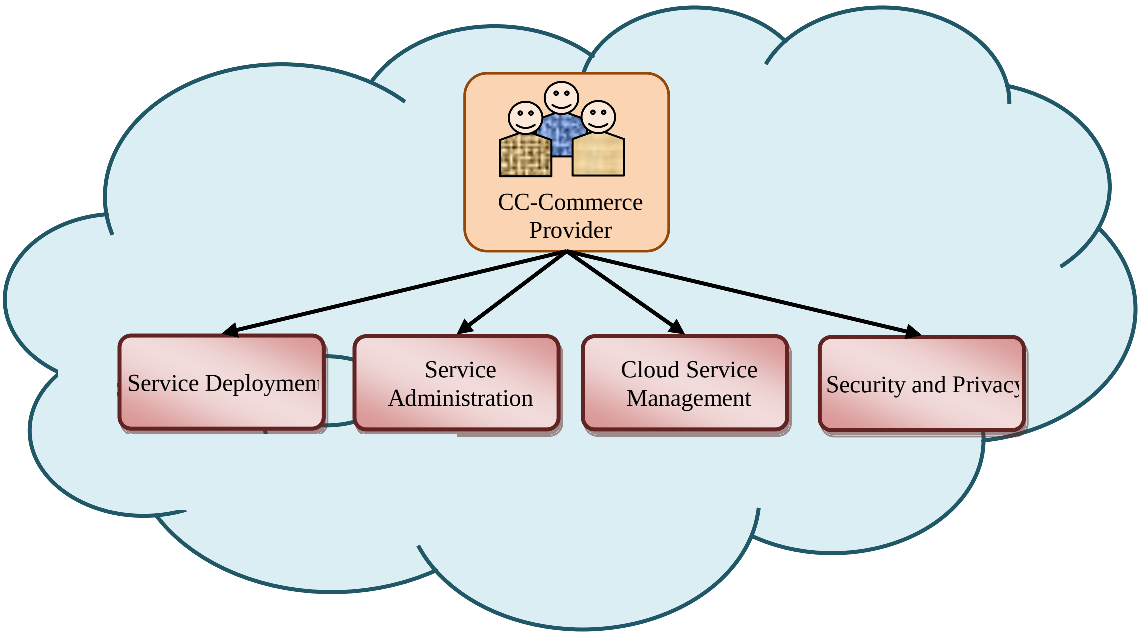

Figure (3.7).Major activities of a cc-commerce provider.

3.2.3 CC-Commerce Auditor

A cc-commerce auditor is a party that can perform an independent examination of cc-commerce service controls with the intent to express an opinion thereon. Audits are performed to verify conformance to standards through review of objective evidence. A cc-commerce auditor can evaluate the services provided by a cc-commerce provider in terms of security controls, privacy impact, performance, etc.

Auditing is especially important for central agencies as agencies should include a contractual clause enabling third parties to assess security controls of cloud providers (Kundra, 2011). Security controls are the management, operational, and technical safeguards or countermeasures employed within an organizational information system to protect the confidentiality, integrity, and availability of the system and its information (NIST, 2010). For security auditing, a cc-commerce auditor can make an assessment of the security controls in the information system to determine the extent to which the controls are implemented correctly, operating as intended, and producing the desired outcome with respect to the security requirements for the system. The security auditing should also include the verification of the compliance with regulation and security policy. For example, an auditor can be tasked with ensuring that the correct policies are applied to data retention according to relevant rules for the authority. The auditor may ensure that fixed content has not been modified and that the legal and business data archival requirements have been satisfied.

A privacy impact audit can help law agencies comply with applicable privacy laws and regulations governing an individual's privacy, and to ensure confidentiality, integrity, and availability of an individual's personal information at every stage of development and operation (CIO, 2010).

3.2.4 CC-Commerce Broker

As E-commerce evolves, the integration of cc-commerce services can be too complex for cc-commerce clients to manage. A client may request cc-commerce services from a cc-commerce broker, instead of contacting a cc-commerce provider directly. A cc-commerce broker is an entity that manages the use, performance and delivery of cc-commerce services and negotiates relationships between cc-commerce providers and clients. In general, a cc-commerce broker can provide services in three categories (Gartner, 2009):

- Service intermediation: A cc-commerce broker enhances a given service by improving some specific capability and providing value-added services to cc-commerce clients. The improvement can be managing access to cloud services, identity management, performance reporting, enhanced security, etc.

- Service aggregation: A cc-commerce broker combines and integrates multiple services into one or more new services. The broker provides data integration and ensures the secure data movement between the cc-commerce clients and multiple providers.

- Service arbitrage: Service arbitrage is similar to service aggregation except that the services being aggregated are not fixed. Service arbitrage means a broker has the flexibility to choose services from multiple agencies. The cc-commerce broker, for example, can use a credit-scoring service to measure and select an agency with the best score.

3.2.5 CC-Commerce Security and Privacy

In order to enable cloud-driven cc-commerce growth and innovation, we must provide strong information and network security measures. However, to do so, we must have a clear framing on what is meant by information and network security (Jansen, 2011; Mather, Kumaraswamy, &Latif, 2009). The canonical goals of information security are (Stallings, 2010):authentication, access control, data confidentiality, data integrity, and non-repudiation. Furthermore, availability, accountability, assurance, and resilience, must be consider carefully considered (Chen, 2012;Friedman & West, 2010).

Although, we are not concern with security in this research, we believe it is important to discuss security concerns and measures, as they play a big role on the success of cc-commerce. Thus, in what follows, we will provide an introduction to the above terms and map them to the cc-commerce context, with a few examples of how they can be supported by both technical and non-technical mechanisms (Takabi, Joshi, &Ahn, 2010).

- *Authentication*.Assurance that the communicating entity is the one claimed. In cloud computing, inter-operations between data-storage and web-application providers prevent users from locking their data and applications into a single cloud provider. Currently, web-based access control standards are applicable only when data owners and cloud service providers are in the same trusted domain. Unfortunately, this condition cannot be satisfied in untrusted clouds, where cloud providers may access sensitive information without authorization. Therefore, it is necessary to have powerful authorization methodologies to ensure data confidentiality.

- *Access control*. Prevention of the unauthorized use of a resource by applying a certain policy. A cc-commerce access control policy can be defined as a security requirement that specifies how a user may access a specific resource and when. Thus, it is important to provide a robust authorization mechanism that incorporates multi-tenancy and virtualization aspects of resources. Such as by using a distributed architecture that incorporates principles from security and key requirements and management.

- *Data confidentiality*. Protection of data from unauthorized disclosure; i.e., it refers to keeping data private. Privacy is of enormous importance as data leaves the borders of the organization. Not only must internal secrets and sensitive personal data be safeguarded, but metadata and transactional data can also leak important details about firms or individuals. Confidentiality is supported by, among other things, technical tools such as encryption and access control, as well as legal protections.

- *Non-repudiation*. Protection against denial by one of the parties in a communication. CC-commerce may involve a lot of business data exchange and money transfer; therefore, it is vital to have powerful and efficient methodologies to ensure non-repudiation between collaborating parties.

- *Availability*. It means being able to use the system as anticipated. Cloud technologies can increase availability through widespread Internet-enabled access, but the client is dependent on the timely and robust provision of resources. Availability is supported by capacity building and good architecture by the provider, as well as well-defined contracts and terms of agreement.

- *Accountability*. It maps actions in the system to responsible parties. Inside the cloud, actions must be traced uniquely back to an entity, allowing for integration into organizational processes, conflict resolution and deterrence of bad behavior. Accountability is supported by robust identity, authentication and access control, as well as the ability to log transactions and then, critically, audit these logs.

- *Assurance*. It is defined as the need for a system to behave as expected. In the cc-commerce context, it is important that the provider provides what the client has specified. This is not simply a matter of the software and hardware behaving as the client expects but that the needs of the organization are understood, and that these needs are accurately translated into information architecture requirements, which are then faithfully implemented in the cc-commerce system. Assurance is supported by a trusted computing architecture in the cloud, and a by careful processes mapping from business case to technical details to legal agreements.

- *Resilience*. It is the measures taken by a system allowing it to cope with security threats, rather than failing critically. CC-commerce technology can increase resilience, with a broader base, backup data and systems, and the potential identify threats and dynamically counteract. However, by shifting critical systems and functions to an outside party, organizations can aggravate resilience by introducing a single point of failure. Resilience is supported by redundancy, diversification and real-time forensic capacity.

It is hard to imagine a cc-commerce system running without using strong security and privacy, and one of the most powerful security protocols that has been developed is the secure socket layer (SSL) protocol (Freier et al, 2011, Hu, 2011). This protocol is used in this work, and therefore in the next section, we will provide a brief introduction to this protocol with emphasis on its main features, objectives, applications, and communication procedure.

3.2.6 Communications Network

A communications network acts as an intermediary that provides connectivity and transport of cc-commerce services between cc-commerce clients and providers. Communications networks provide access to clients through network, telecommunication and other access devices. For example, cc-commerce clients can obtain cc-commerce services through network access devices, such as computers, laptops, mobile phones, mobile Internet devices (MIDs), etc.

The distribution of cc-commerce services is normally provided by network and telecommunication carriers or a transport agent, where a transport agent refers to a business organization that provides physical transport of storage media such as high-capacity hard drives. Note that a cc-commerce provider will set up SLAs with a cc-commerce communications network to provide services consistent with the level of SLAs offered to cc-commerce clients, and may require the communications network to provide dedicated and secure connections between cc-commerce clients and cloud providers.

In this work, we concern with two types of networks, namely, wide area network (WAN) and local area network (LAN), which we shall describe briefly below, and further details can be found in (Stallings 2011 and Forouzan 2010).

Wide Area Network (WAN)

A WAN is a network that spans a large geographical area, the most common example being the Internet the largest known WAN today. Typically, a WAN consists of two or more LANs connected by a communication sub-system, which usually comprised of autonomous system (AS) routers. Special software protocols have been created to support routing within communication sub-system of a WAN, namely, routing protocols. These protocols operate with smart algorithms that can adapt the flow of network traffic when problems occur. Protocols such as border gateway protocol (BGP) are widely used across the Internet today and this is the primary protocol used on the air-stream wireless network.

Local Area Network (LAN)

A LAN is a computer network that interconnects computers in a limited area such as a home, school, computer laboratory, or office building using network media. The defining characteristics of LANs, in contrast to WANs, include their usually higher data-transfer rates, smaller geographic area, lower delay or latency, and lack of a need for leased telecommunication lines. Figure (3.8) illustrates the interconnection across a communications network.

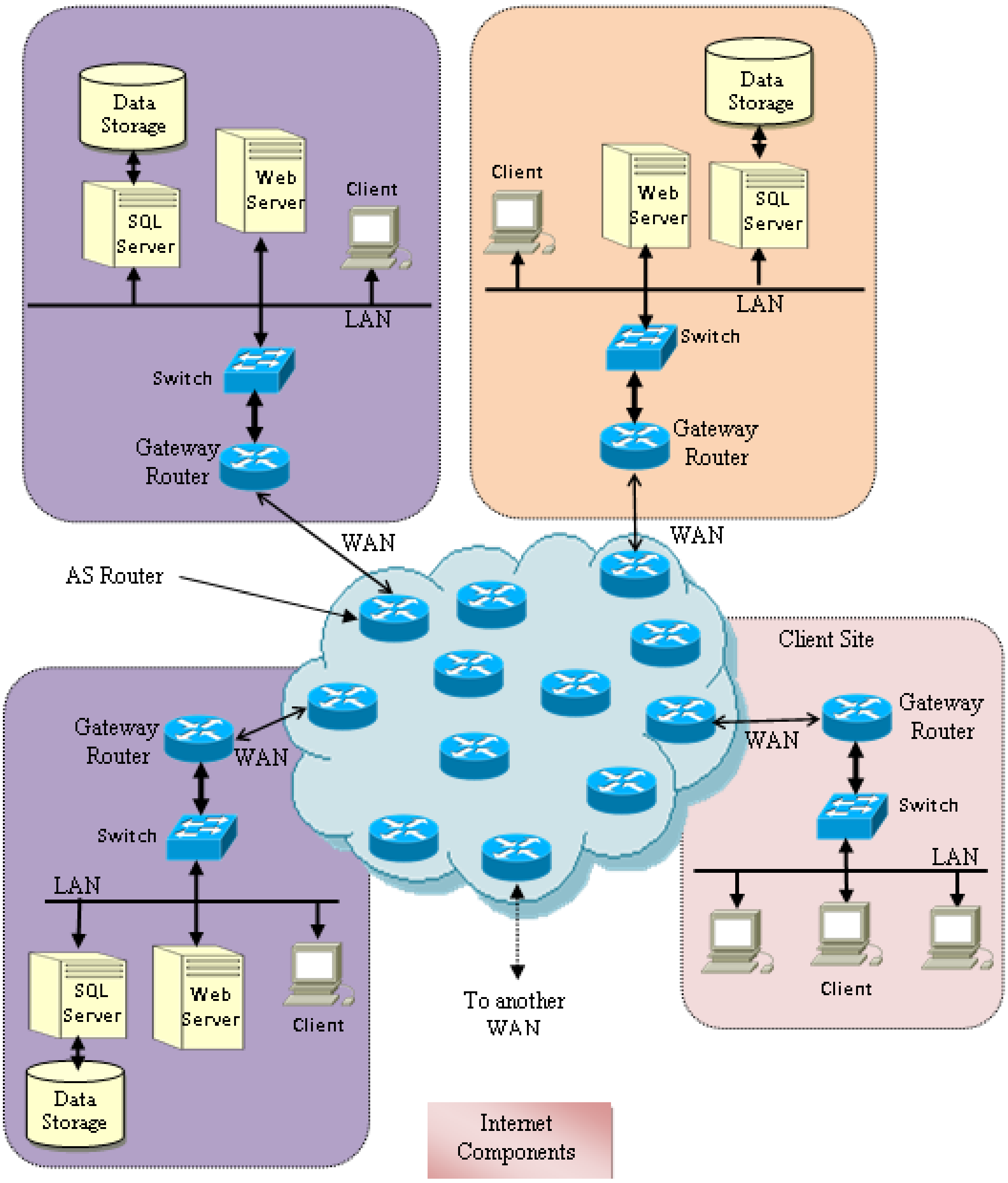

Figure (3.8).Interconnection across a communications network.

3.3 The Secure Socket Layer (SSL) Protocol

The SSL protocol is a cryptographic protocol used to guarantee information and telecommunication security (Lui et al, 2008). Created in 1994 by Netscape, in collaboration with Bank of America, MCI, Master card and Silicon Graphics, it immediately became the standard used to exchange data on the Internet. The protocol, now at its 3.0 release, is supported by the main Web clients and servers (Freier et al, 2011). For the moment it is the most largely used standard adopted by Web services. Used to protect data alterations, non authorized accesses, E-commerce services and trading online (Hu, 2011).

The SSL protocol was developed and evolved with the birth of Internet that brought the need for information security. Because the Internet is a highly insecure communication system it requires by nature instruments that guarantee protection against attacks (Spamming, phishing, spyware, Bot net, interception) that a company's information system is subject to everyday.

3.3.1 SSL Protocol Objectives

Following are the objectives that Netscape engineers set when developing the SSL protocol (Kryptotel, 2012, Freier et al, 2011):

- **Protected connection**: SSL enables a secure connection between two entities and guarantees that the data exchanged is non readable or interpretable by unauthorized third parties.
- **Interaction**: SSL's communication interface was designed to enable interaction among different devices. Programmers from different organizations are being able to develop applications by only making arrangements on the cryptographic algorithms without knowing each other's source code.
- **Easy Update**: SSL tries to supply a structure that allows future public and symmetric key cipher methods that by nature are modified due to the increasing calculating computation capabilities of the elaborators used for decoding, to be incorporated without having to develop a new protocol.

- **Efficiency**: Cryptographic operations tend to be laborious, especially during public key encryption processes. For this reason SSL incorporated session caching schemes (optional) to decrease the number of connections that require to be newly established, consequently decreasing the amount of activity on the network.

3.3.2 SSL Protocol Features

The SSL protocol guarantees security when data is exchanged in a non secure environment thanks to the following features that distinguish it (Freier et al, 2011, Keyptotel, 2012):

- **Connection Security**: To guarantee a secure connection between two users that are communicating, the SSL protocol uses cryptographic algorithms and symmetric keys that make the data exchanged between the users unreadable. For example; the data encryption standard (DES), the advanced encryption standard (AES).
- **Authentication**: Identity authentication during connection is guaranteed by using public key cryptography (example; RSA, DSS etc). This guarantees the fact that the clients are communicating with the right server, preventing eventual exchanges. Furthermore server and client certification is provided.
- **Integrity of the information exchanged**: The transmission level includes an integrity check on the message based on a message authentication code (MAC) tag that is generated by using the secure hash function made available by SSL (example; SHA, MD5 etc.). This allows verifying that the data exchanged between client and server has not been altered during transmission by checking the MAC field.

3.3.3 SSL Protocol Applications

The SSL protocol, as we have said earlier in this section, is widely used in many applications. It is used to (Freier et al, 2011, Keyptotel, 2012):

- Encrypt Web traffic using Hypertext Transfer Protocol (HTTP). When HTTP is used with SSL, it is conventionally called HTTPS.

- To authenticate Web servers and encrypt communications between browser and Web servers.

- As a base for new protocols. Since 2001 the Internet Engineering Task Force (IETF) uses SSL as the base for the development of its own transport layer security (TLS) protocol. SSL and TLS are strictly linked to each other, they both use the same known port and the majority of SSL's implementations support TLS.

- Encrypts the traffic generated through e-mails and newsgroups.

3.3.4 Communication Protection Process through the Use of SSL Protocol

In order to protect the information exchanged on the Internet the SSL protocol uses a hybrid encryption. It deals with a threesome of algorithms, a symmetric, an asymmetric and a hash, obtaining a perfect balance between security and calculation speed. Every session of the SSL protocol starts with the "handshake" phase, that is an exchange of messages using public key cryptography, with the goal of creating a secure and protected communication channel, peer-to-peer, between two terminals, a client and a server (authentication phase) (Web 0.2 ,2010).

The next phase consists in the creation, through client and server collaboration, of a session key used to increase the speed of the exchanged data, maintaining their confidentiality and integrity.

The SSL's protocol encryption process is outlined in Figure (3.9), and it can be summarized as following (Keyptotel, 2012):

(1) *ClientHello.* The client asks the server to establish a communication by sending, together with that information, the version number of the supported SSL, and the information on the private key encryption algorithms supported by the client.

(2) *ServerHello.* The server sends to the client the identification number of the SSL protocol version supported and the settings of the private key encryption algorithms in use.

(3) The client proceeds with the authentication of the server by examining the provided certificate, checking that the certificate authority (CA) that it was undersigned with appears in the list of trusted CAs.

(4) The server requests the certificate to the client for the authentication.

(5) The client sends the certificate to the server. If the server is not able to authenticate it, then an encrypted SSL connection cannot be established, instead if the authentication is successful we move on to the next phase.

(6) *ClientKeyExchange.* The client creates a premaster secret (session key) that can be used only for the present exchange of information and data, it is encrypted with the server's public key (contained in the server's certificate) and it sends the encrypted session key to the server.

(7) If the server has requested authentication to the client (optional step) the clients sends part of the data in this session and digitally signs this data and sends its certificate together with the encrypted session key.

(8) *ChangeCipherSpec*. Client and Server communicate to each other that the data that will be exchanged in the next phase will be encrypted with the session key previously exchanged.

(9) Finished. The server sends an encrypted message indicating, on its behalf, the end of the handshake session, the client consequently responds. The handshake phase ends and the real SSL session begins. The client and the server use the session key to encrypt and decrypt the data that they mutually exchange to validate the integrity.

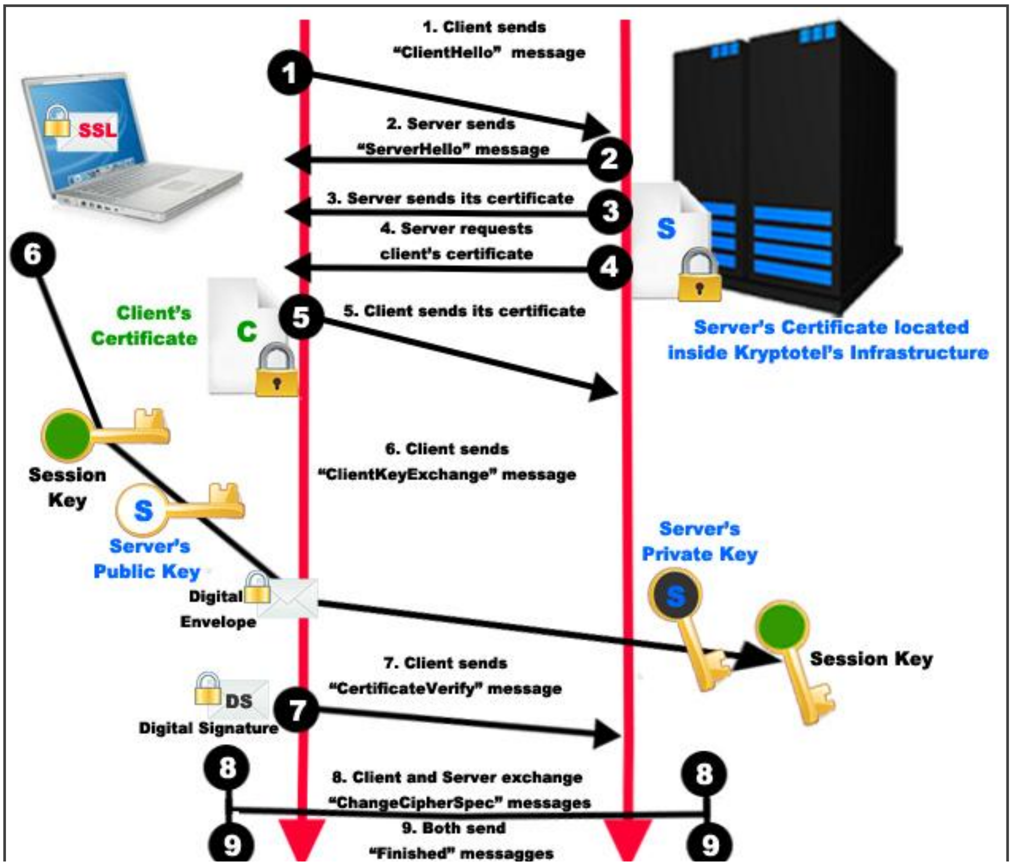

Figure (3.9).Infrastructure of the SSL protocol (Keyptotel, 2012).

3.4 Relationship between CC-Commerce Clients and Providers

The cc-commerce client and provider share the control of resources in a cc-commerce system. As illustrated in Figure (3.10), different service models affect an organization's control over the computational resources and thus what can be done in a cc-commerce system. Figure (3.10) shows these differences using a classic software stack notation comprised of:

(1) The application layer

(2) The middleware layer

(3) The OS layer

This analysis of delineation of controls over the application stack helps understand the responsibilities of parties involved in managing the cc-commerce application.

The application layer includes software applications targeted at end users or programs. The applications are used by SaaS clients, installed/managed/ maintained by PaaS clients, IaaS clients, and SaaS providers.

The middleware layer provides software building blocks (e.g., libraries, database, Java virtual machine, etc) for developing application software in the cc-commerce. The middleware is used by PaaS clients, installed/managed/maintained by IaaS clients or PaaS providers, and hidden from SaaS clients.

The OS layer includes operating system and drivers, and is hidden from SaaS clients and PaaS clients. An IaaS cc-commerce allows one or multiple guest OS‟ s to run virtualized on a single physical host. Generally, clients have broad freedom to choose which OS to be hosted among all the OS‟ s that could be supported by the cc-commerce provider. The IaaS clients should assume full responsibility for the guest OS's, while the IaaS provider controls the host OS.

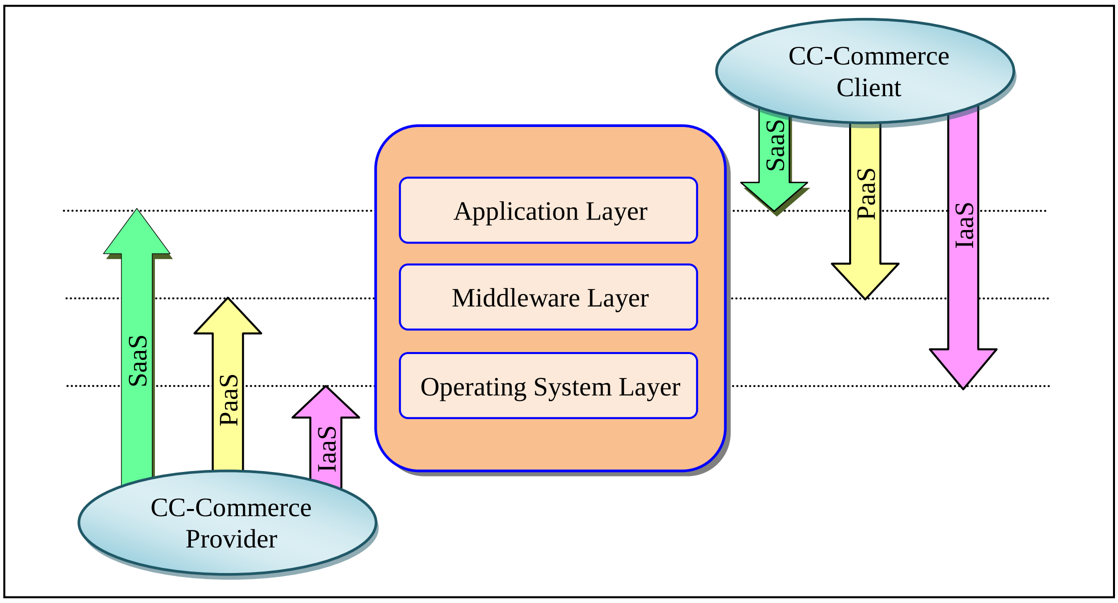

Figure (3.10).Scope of control between cc-commerce clients and providers .

3.5 CC-Commerce Deployment Models

The cc-commerce model developed in this work can be deployed using one of the following configurations:

(1) Provider-access configuration

(2) Broker-access configuration

In the provider-access configuration, a client directly accesses a cc-commerce provider, where the cc-commerce infrastructure and computing resources are made available to the general public (clients) over a public network. The configuration can be owned by an organization selling cloud services or by an organization hiring cloud services and deploy its cc-commerce technology on top of it to serve a diverse pool of clients. Figure (3.11) presents a simple view of the provider-access configuration.

In the broker-access configuration, a client accesses a cc-commerce broker to accomplish a certain mission or query, the broker, in turn, analyze the query and choose the best path to accomplish the mission, which could be through intra-connection with local recourses (cc-commerce 1) or through interconnection with other cc-commerce sites (cc-commerce 2, cc-commerce 3, …, cc-commerce *n*). In this case, the broker either outsources the query to one or more cc-commerce sites or collaborates with other cc-commerce sites. The interconnection with other cc-commerce sites can be done through dedicated links or through existing Internet infrastructure.

A special case of the broker-access configuration is that when collaborating sites host resources only for one enterprise or organization, then it can be considered as a c-commerce configuration. Figure (3.12) illustrates a simple view of a broker-access configuration.

For more efficient implementation, we highly recommend to host the cc-commerce auditor at the same site of the cc-commerce provider/broker. Furthermore, it is always recommended to host a cc-commerce broker and at least one provider at the same site. These two suggestions are illustrated in Figures (3.11) and (3.12). The security and privacy components must be installed at all sites. However, it is necessary to realize that installation of security and privacy components and interconnection through WAN links increase query processing time or response time.

In other words, it is expected that provider-access configuration always performs faster than the broker access configuration, specially, if the broker outsources part or the entire requested query.

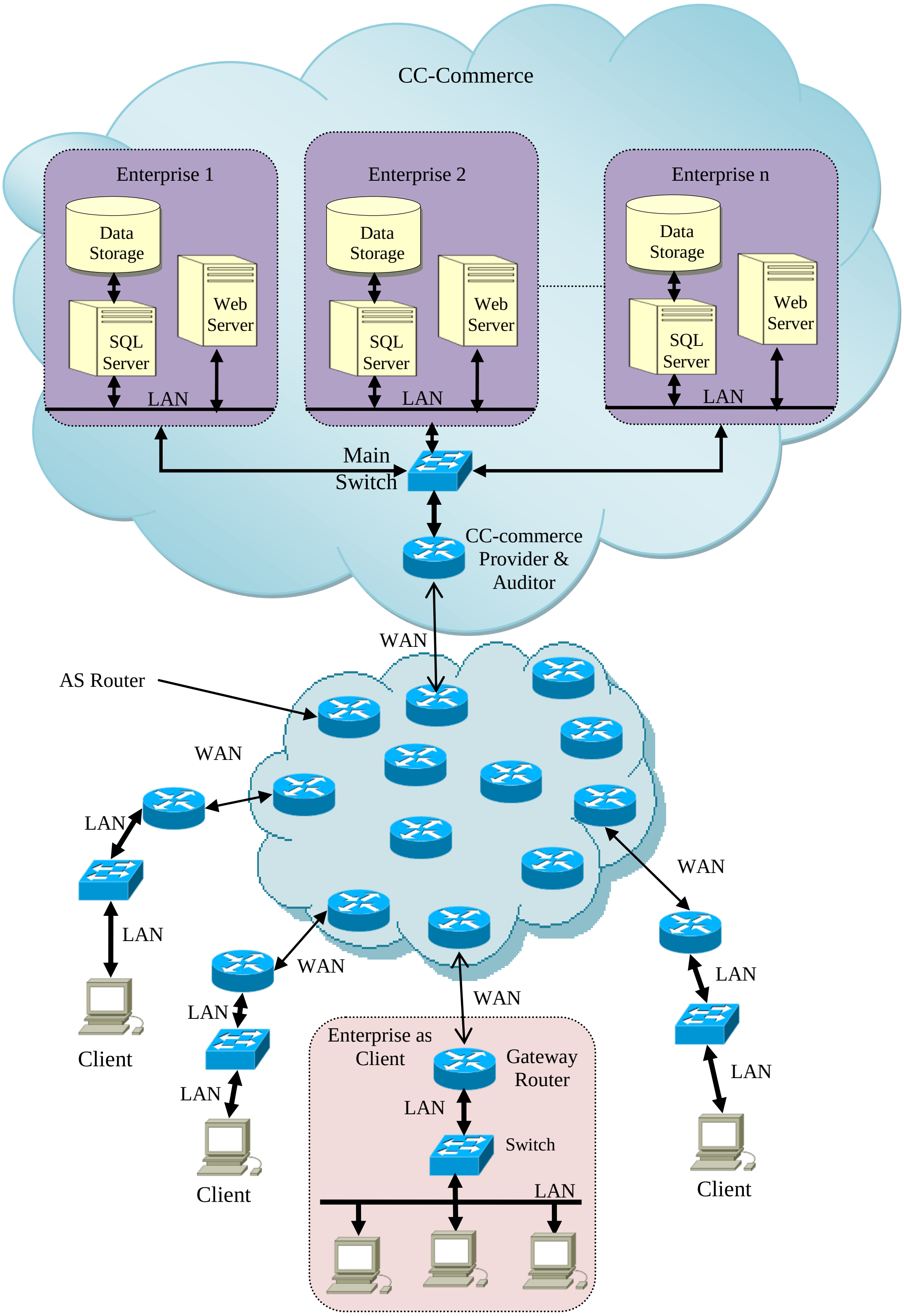

Figure (3.11).Simple view of a provider-access configuration.

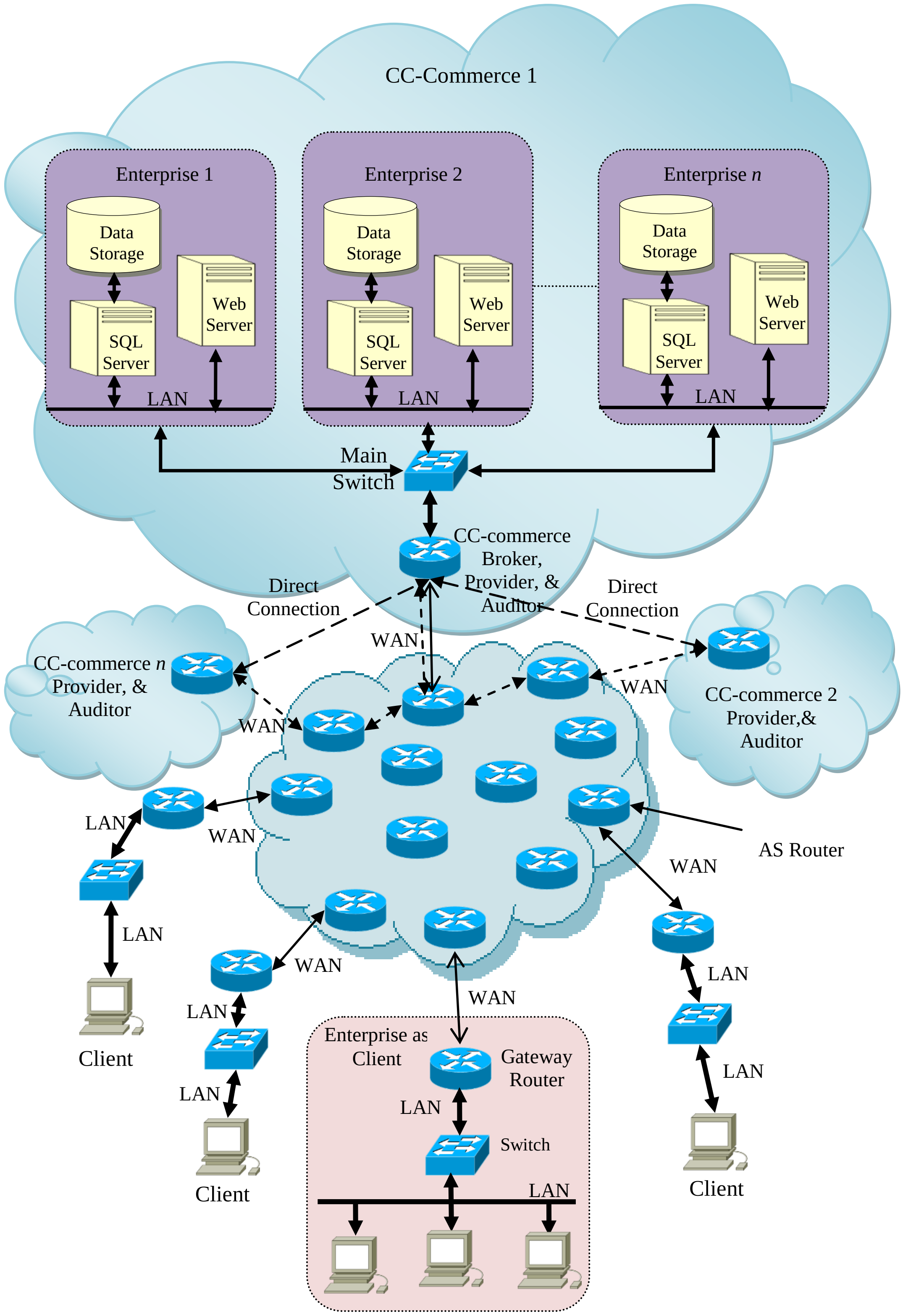

Figure (3.12).Simple view of a broker-access configuration.

3.6 Implementation and Performance Measures

In order to evaluate the performance of the cc-commerce model described in previous sections, and compare its performance against conventional c-commerce models, we developed a test tool, which is referred to as 3CT tool for cc-commerce test tool. It can be used to evaluate the performance of the model through performing c-commerce and cc-commerce processes across the Internet. In particular, we subscribe for three Websites at three different hosting providers as described in Table (3.1).

Table (3.1)
Public IP addresses of the sites.

Site	Web Host Name	Web Host URL	Public IP address
1	ixwebhosting	http://www.ixwebhosting.com/	98.130.174.2
2	WebsitePanel	http://ccp.my-hosting-panel.com/	204.93.174.60
3	networksolutions	http://www.networksolutions.com/	205.178.152.126

Then, the NorthWind.MDF database (http://northwinddatabase.codeplex.com) is uploaded to all those Websites to be used as a test data, where queries can be performed requesting a certain data from the NorthWind.MDF database as it will be explained in details in Chapter 4. NorthWind.MDF database can be downloaded as an executable SQL script (285 KB only) or as a backup that can be restored with sample data currently works with SQL Server 2005 and SQL Server 2008.

The 3CT tool is very simple tool, a pseudo code for the 3CT tool is outlined in Figure (3.13). However, it can be used in provider or broker access configurations. It consists of a single Webpage interface through which we can initiate a request (query) for retrieving data from the uploaded NorthWind.MDF database. The 3CT Tool is programmed using ASP.NET (C#), LINQ to SQL Class (See Appendix A for details), Microsoft Visual Studio 2008, C# Web application, and MS SQL Express 2008 Server. The Webpage is shown in Figure (3.13) and it is hosted at the ixwebhosting Web hosting (URL: www.ixwebhosting.com, IP address: 98.130.174.2). It can be accessed at http://www.awad.texcept.com/default.aspx.

```
Start
    Do
        Start timer
            Establish a connection
                Retrieve data and fill-in all rows in dataset
```

Close the connection Stop timer Calculate and store the response time (T_i) Loop for *n* trials Calculate average response time (T_{avg}) and associated standard deviation (σ) Save and display results End

Figure (3.13).The pseudo code of the 3CT tool.

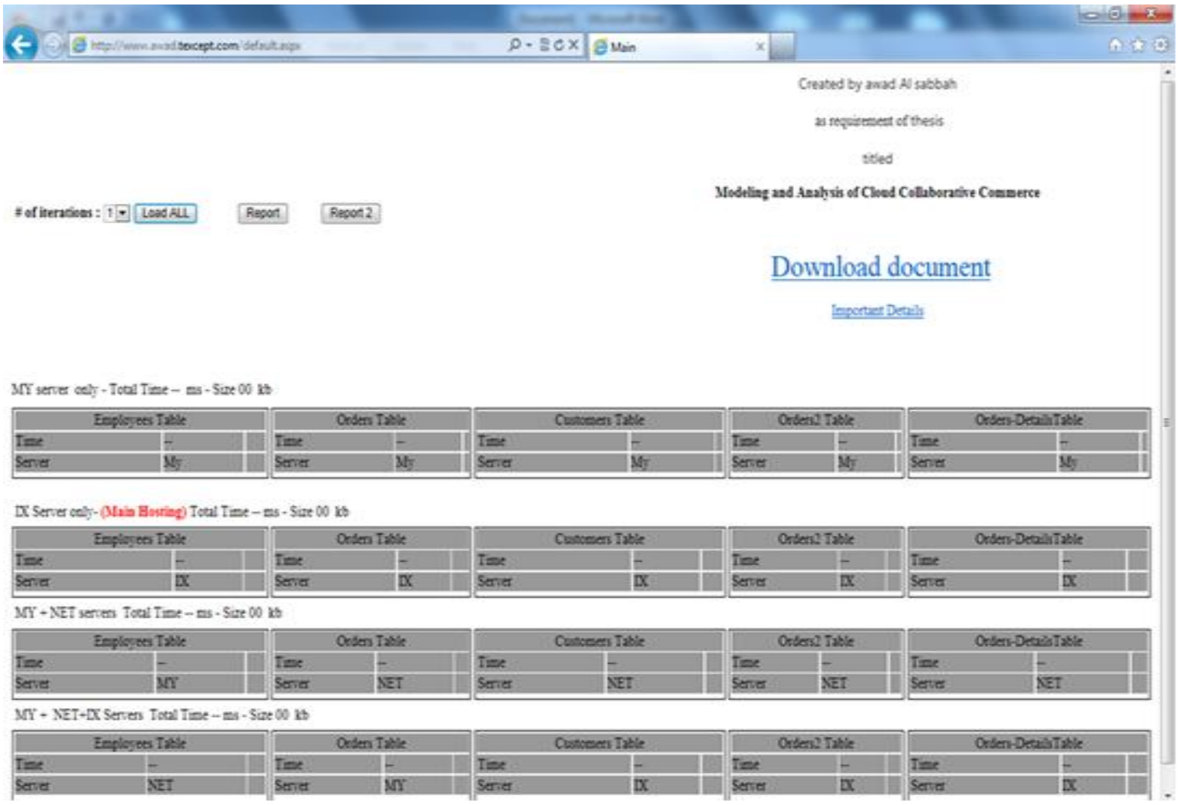

Figure (3.14).The interface of the 3CT Tool.

In addition to the many advantages of cloud computing that can benefit from in cc-commerce, we believe that cc-commerce can have one other advantage which is the fast response as compared to c-commerce. In order to numerically estimate the improvement in performance, we define two parameters; these are:

(1) The response time (T). It is defined as the CPU time required by the main Website to retrieve the requested data from the various servers. Due to network instability, the response time for equivalent data retrieval tasks are

usually measured more than once and the average response time (T_{avg}) and the associated standard deviation (σ) should be calculated. The calculated T_{avg} depends on:

- The amount of the retrieved data.
- The number of collaborating hosts including the main Website server.
- The network configuration.
- The bandwidth and delay of the P2P WAN data communication links between the client and the main server and between the main server and other collaborating servers.

(2) The speedup factor (S). It represents how much a cc-commerce runs faster than a certain c-commerce configuration. It is calculated by dividing the response time of the c-commerce configuration by the response time of the cc-commerce configuration. It can be represented mathematically as:

$$S = \frac{T_{avg}\,(for\ c{-}commerce\ \ configuration\ )}{T_{avg}\,(for\ cc{-}commerce\ \ configurati\ on)} \qquad (3.1)$$

To evaluate the performance of the provider-access configuration, the tool retrieves the data from the same hosting server; i.e., it represents a cc-commerce model. For broker-access configuration evaluation, the tool retrieves data from various hosting servers. However, since each hosting server is assumed to host data for a single enterprise or organization, then it can be considered as a c-commerce evaluation.

Chapter Four

Results and Discussions

In collaborative commerce (c-commerce) usually a client accesses a specific Website, which is called the main Website, for the sake of performing a certain task, for example, retrieving data stored at one or more servers (hosts) located at various locations that are internetworked using different point-to-point (P2P) wide area network (WAN) technologies and protocols and having various public IP addresses on the Internet. The server that hosts the main Website is called the main Server.

In the new cloud collaborative commerce (cc-commerce) model, the main Web server and all collaborating servers are located at the same location under the same public IP address interconnected using local area network (LAN) technologies and protocols. Thus, it is expected to reduce the response time significantly because it replaces the P2P WAN data communication links between the main Web server and other collaborating servers by the high bandwidth and small delay LAN data communication links.

This chapter uses the cc-commerce test (3CT) tool described in Chapter 3 (Section 3.6) to compare the performance of the new cc-commerce model against the performance of the c-commerce models of different distributions in terms of response time for retrieving the same amount of data. In particular, four scenarios are considered, three of them represent different c-commerce configurations (broker-access configuration with one enterprise per site) and one of them represents a cc-commerce configuration (provider-access configuration).

It has been discussed in Chapter 3 that the 3CT tool has a Webpage, called the MainWebInterface, which is hosted at a main Web server called the MainWebServer. The Webpage represents the provider in a provider-access cc-commerce configuration, and the broker in a broker-access cc-commerce configuration. But, since, in this work, each host is assumed to host data for only one enterprise, then this configuration is considered as a commerce configuration.

In all scenarios the response time for equivalent data retrieval tasks from the NorthWind.MDF database (http://northwinddatabase.codeplex.com) are measured more than once and the average response time (T_{avg}) and the associated standard deviation (σ) are calculated and presented in tables and graphs. Furthermore, in this work, the speedup factor (S) that is defined in Eqn. (3.1) as the response time of the c-commerce configuration divided by the response time of the cc-commerce configuration, is calculated.

The four scenarios that have been implemented in this work can be summarized as follows:

(1) Scenario #1: Three hosts c-commerce (Non-participating MainWebServer)

(2) Scenario #2: Three hosts c-commerce (Participating MainWebServer)

(3) Scenario #3: Two hosts c-commerce(Non-participating MainWebServer)

(4) Scenario #4: cc-commerce

4.1 Scenario#1: Three Hosts C-Commerce (Non-Participating MainWebServer)

This scenario simulates a c-commerce system that consists of three sites, which are hosted under three different public IP addresses, as shown in Figure (4.1). As it can be seen in this figure, Site 1 hosts the MainWebServer, which is loaded with the main user interface (MainWebInterface) discussed in Chapter 3. The MainWebInterface of the 3CT tool is equivalent to a cc-commerce broker, because the other two sites are acting as collaborating sites providing all necessary data. In other words, the MainWebInterface is acting as a broker outsourcing the execution of the received query to other sites and keep records of the start and end times to calculate T_i for all trials and then calculate T_{avg} and σ. Each of the above sites (including the main site) includes a Web Server and SQL Server connected to data storages, where the NorthWind.MDF database is uploaded and stored. The IP addresses of these sites are given in Table (4.1).

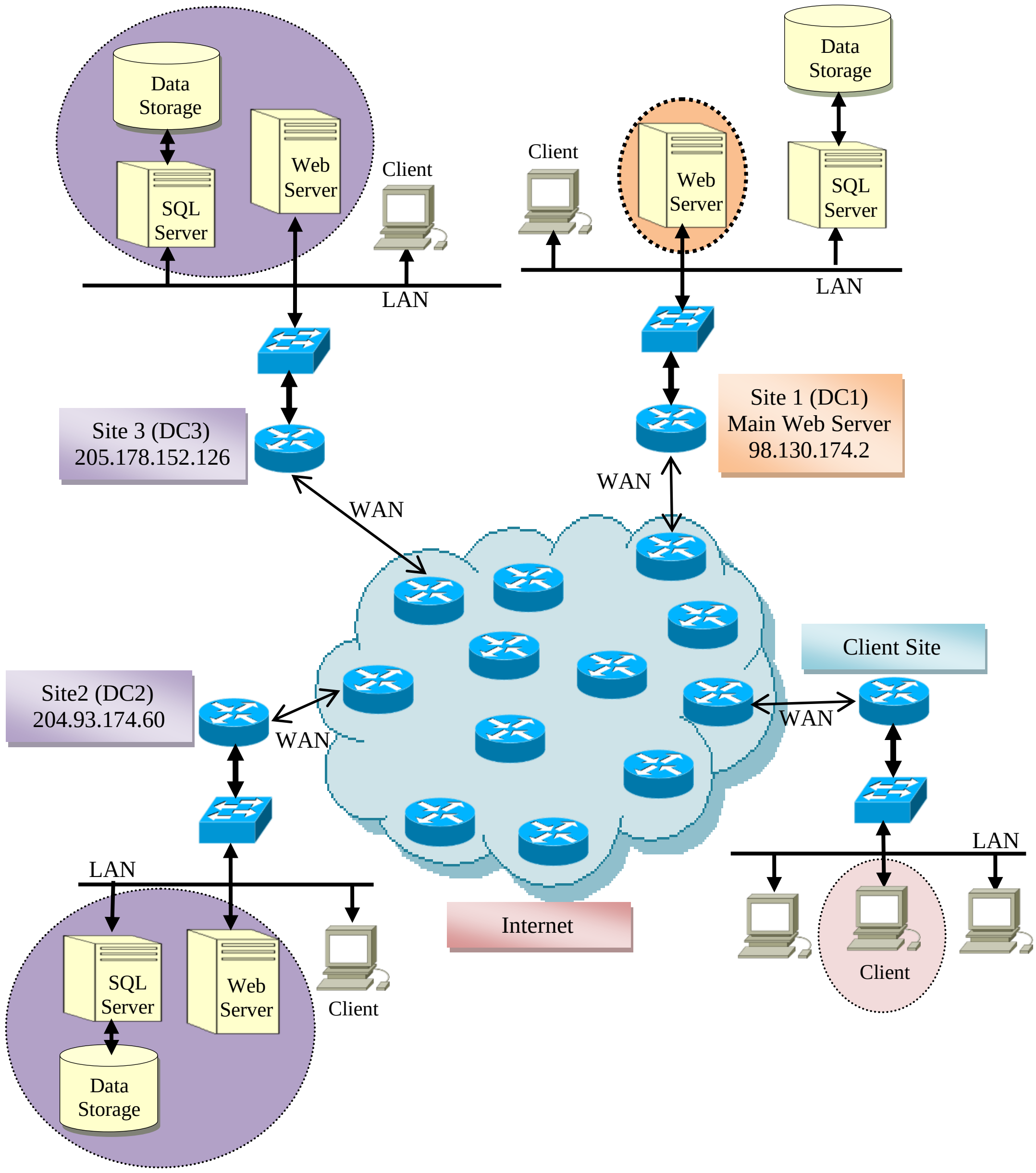

Figure (4.1).The configuration for Scenario #1.

Table (4.1) Public IP addresses of the sites.		
Site	Public IP address	Data Connection (DC)
1	98.130.174.2	DC1 (MainWebServer)
2	204.93.174.60	DC2
3	205.178.152.126	DC3

In this scenario, the client accesses the MainWebServer at Site 1 requesting some data. Then, Site 1 server retrieves these data from the other servers at Sites 2 and 3 using the code in Figure (B.1) in Appendix B. In particular, in this work, to demonstrate and investigate the affect of the size of the retrieved data on the performance of the c-commerce system, we perform two queries requesting two different data sizes. The sizes of the requested data are:

(1) 850 KB for retrieving three entities from the NorthWind.MDF database, namely, Customers (48 KB), Employees (268 KB), and Orders (534 KB). Employees (268 KB) were retrieved from DC2 at 204.93.174.60, and Customers and Orders (582 KB) were retrieved from DC3 at 205.178.152.126.

(2) 1958 KB for retrieving five entities from the NorthWind.MDF database, namely, Customers, Employees, Orders (twice from two different sites), and Orders Details. Employees and Orders (802 KB) were retrieved from DC2 at 204.93.174.60; and Orders, Customers, and Order Details (1156 KB) were retrieved from DC3 at 205.178.152.126.

The sizes and number of records (rows) in these entities, and the IP addresses of the sites from which they were retrieved are given in Table (4.2).

Table (4.2)
Details of retrieved data from the NorthWind.MDF databse (Scenario #1).

Entity	850 KB			1958 KB		
	Size (KB)	Records	Site	Size (KB)	Records	Site
Customers	48	91	DC3	48	91	DC3
Employees	268	9	DC2	268	9	DC2
Orders	534	830	DC3	534	830	DC2
Orders	-	-	-	534	830	DC3
Order Details	-	-	-	574	2153	DC3

As, it has been discussed earlier that due to network instability, the response time for each data retrieving process is not constant and keeps changing. Therefore, in this work, we perform the data retrieving process 19 times, each time, the response time (T_i), which is defined as the CPU time required retrieving the data from their destination addresses to the MainWebServer, is calculated. Then, average response time (T_{avg}) and the associated standard deviation (σ) are calculated. The results for T_i, T_{avg}, and σ are given in Table (4.3).

As it can be seen in Table (4.3) that the results obtained for Scenario #1 demonstrate that T_{avg} increases as the size of the retrieved data is increasing. Furthermore, due to network instability, the σ is relatively high.

Table (4.3) The run and average response times for Scenario #1.		
Run	T_i (msec) (850 KB)	T_i (msec) (1958 KB)
1	937.5	968.8
2	421.9	937.5
3	406.3	1359.4
4	453.1	875.0
5	531.3	1171.9
6	421.9	1078.1
7	671.9	843.8
8	718.8	781.3
9	515.6	734.4
10	500.0	1000.0
11	578.1	953.1
12	765.6	937.5
13	1187.5	734.4
14	484.4	859.4
15	406.3	750.0
16	390.6	921.9
17	687.5	953.1
18	562.5	859.4
19	750.0	1406.3
$T_{avg}(\sigma)$	599.52 (207.75)	953.96 (188.55)

4.2 Scenario#2: Three Hosts C-Commerce (Participating MainWebServer)

This scenario simulates a c-commerce system similar to that in Scenario #1 except some of the data is retrieved from the data storage hosted at Site 1 (MainWebServer) at the public IP address 98.130.174.2, as shown in Figure (4.2). In particular, the data for the entity Customers (48 KB) is retrieved from the SQL Server at Site 1 (DC1), while the rest of the data is retrieved from the other sites as given in Table (4.4).

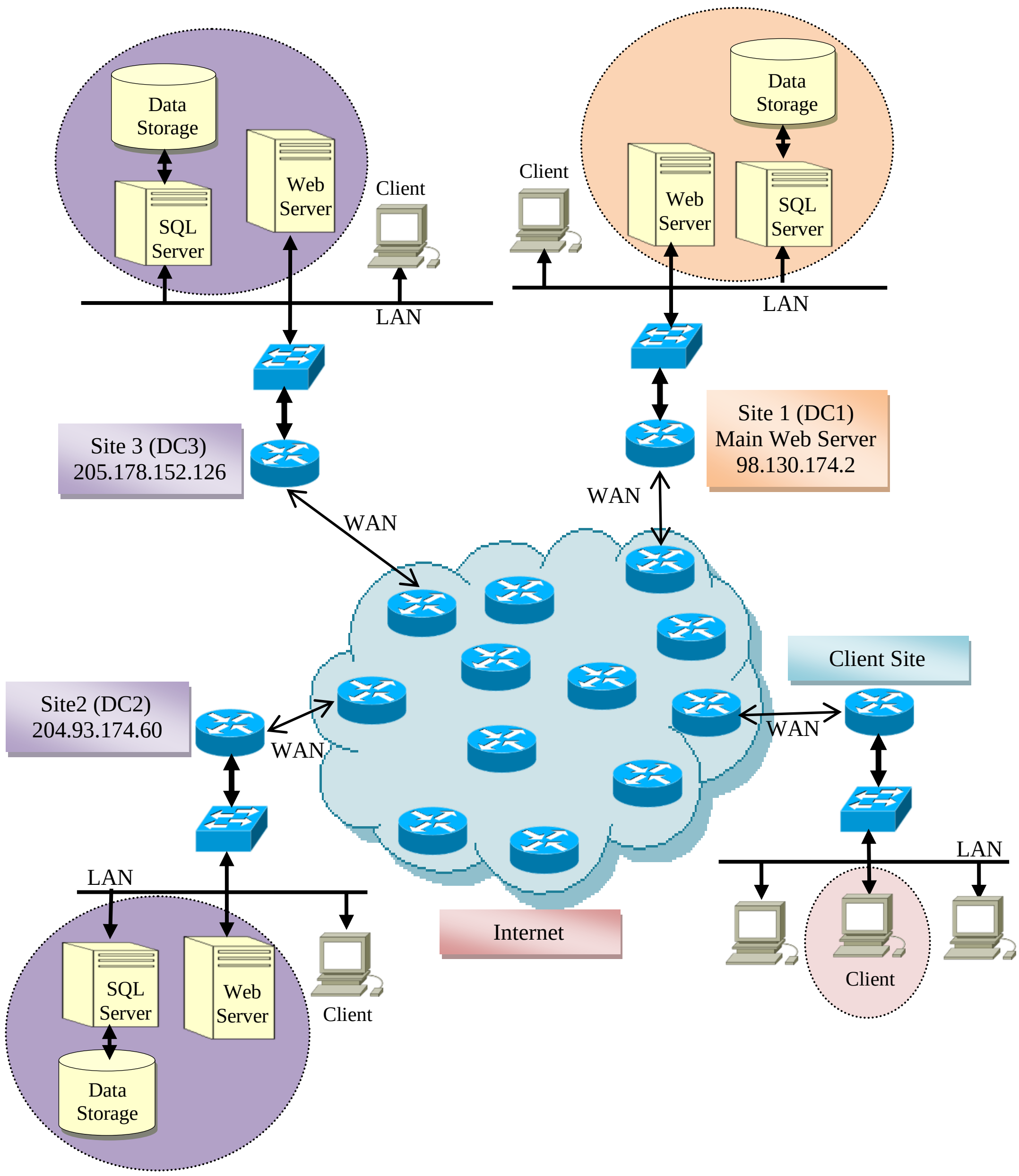

Figure (4.2).The configuration of Scenario #2.

The code for retrieving 850 KB data for Scenario #2 is listed in Figure (B.2). For the same reasons that were discussed in Scenario #1, the amounts of retrieved data are 850 KB and 1958 KB. For each data set (size of data), the retrieving process is performed 19 trials, for each trial T_i is recorded. Then, (T_{avg} and σ are calculated. The results obtained are listed in Table (4.5).

Table (4.4)
Details of retrieved data from the NorthWind.MDF databse (Scenario #2).

Entity	850 KB			1958 KB		
	Size (KB)	Records	Site	Size (KB)	Records	Site
Customers	48	91	DC1	48	91	DC1
Employees	268	9	DC2	268	9	DC2
Orders	534	830	DC3	534	830	DC2
Orders	-	-	-	534	830	DC3
Order Details	-	-	-	574	2153	DC3

Table (4.5)
The run and average response times for Scenario #2.

Run	T_i (msec) (850 KB)	T_i (msec) (1958 KB)
1	593.8	1140.6
2	375.0	703.1
3	390.6	1031.3
4	421.9	656.3
5	562.5	1000.0
6	687.5	671.9
7	437.5	953.1
8	390.6	1093.8
9	359.4	734.4
10	406.3	796.9
11	359.4	781.3
12	546.9	1031.3
13	343.8	1765.7
14	390.6	750.0
15	343.8	593.8
16	437.5	593.8
17	359.4	1359.4
18	421.9	765.6
19	1000.0	1078.1
$T_{avg}(\sigma)$	464.65 (160.68)	921.07 (294.10)

Similar to Scenario #1, T_{avg} is increased as the amount of retrieved data is increases, where it increases from 464.65 msec to 921.07 msec, when the data increases from 850 KB to 1958 KB. Also, σ is relatively high due to network instability.

It can be clearly seen that T_{avg} in Scenario #2 is less than that for Scenario #1 for both data sets (850 KB and 1958 KB). This is because some of the data was retrieved from local storage accessed through the LAN links, which reduces the amount of data exchange through the Internet (WAN links). The delay on LAN links is much smaller than WAN links. Because the amount of the locally retrieved data is small (48 KB compared to 850 KB and 1958 KB), there is only slight difference in T_{avg} and it is expected to increase more if the locally retrieved data increases.

4.3 Scenario#3: Two Hosts C-Commerce (Non-Participating MainWebServer)

This scenario simulates two hosts c-commerce, in which a client accessing the MainWebInterface of the 3CT tool described in Chapter 3 (Section 3.6) requesting some data that all will be retrieved by the MainWebInterface from a host connected to it through the Internet, as illustrated in Figure (4.3). In particular, in this Scenario, the client requesting information from the MainWebInterface at DC1 (public IP address 98.130.174.2). The MainWebInterface, in turn, realizes that the data is available at DC2 (public IP address 204.93.174.60). The sizes of data to be retrieved are 850 KB and 1958 KB similar to those in previous scenarios, which are also detailed in Table (4.6). The code for retrieving 850 KB data for Scenario #3 is listed in Figure (B.3).

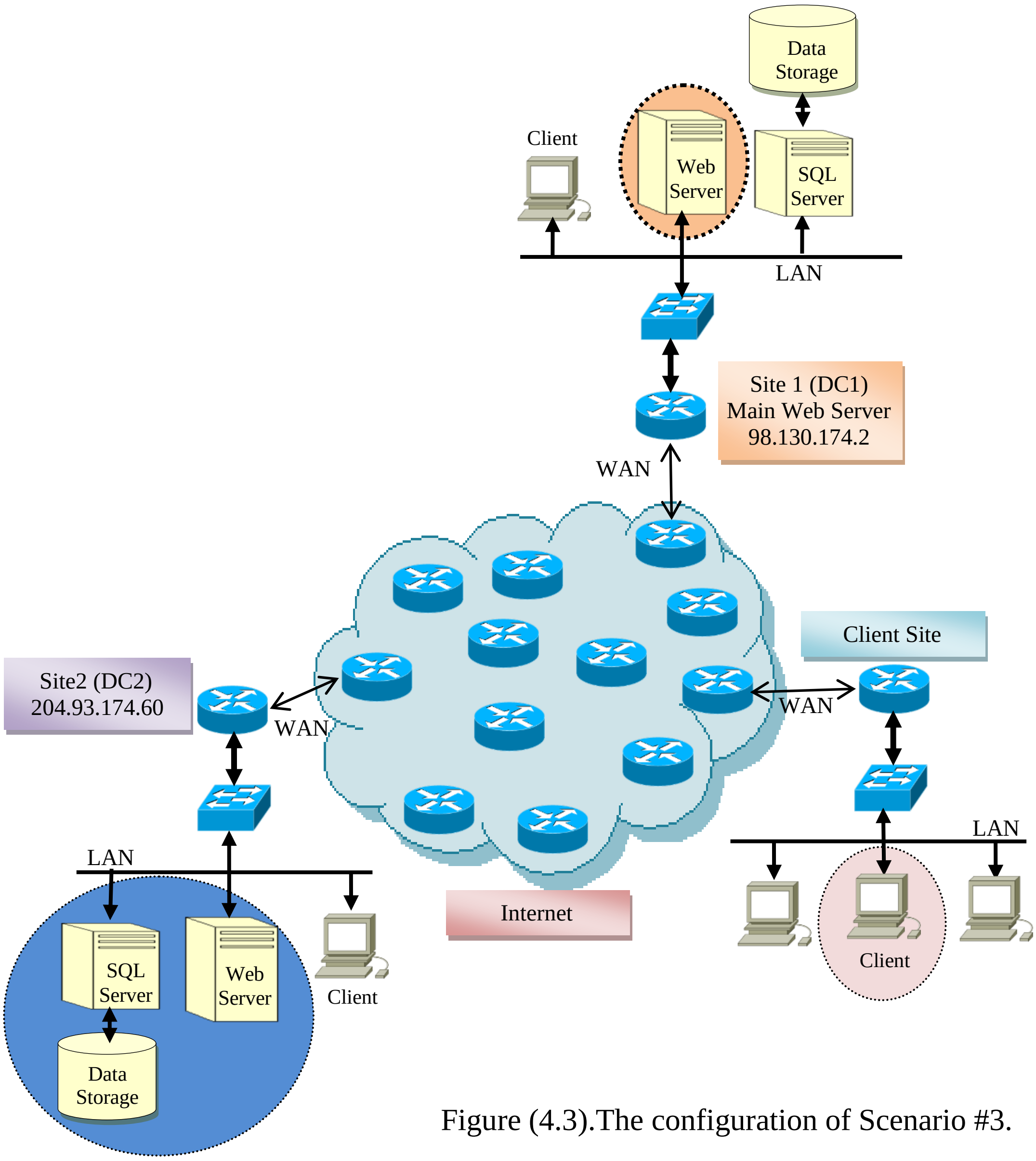

Figure (4.3).The configuration of Scenario #3.

The T_i measurements and the calculated T_{avg} and σ are listed in Table (4.7).

Table (4.6) Details of retrieved data from the NorthWind.MDF databse (Scenario #3).						
Entity	850 KB			1958 KB		
	Size (KB)	Records	Site	Size (KB)	Records	Site
Customers	48	91	DC2	48	91	DC2
Employees	268	9	DC2	268	9	DC2
Orders	534	830	DC2	534	830	DC2
Orders	-	-	-	534	830	DC2
Order Details	-	-	-	574	2153	DC2

Table (4.7) The run and average response times for Scenario #3.		
Run	T_i (msec) (850 KB)	T_i (msec) (1958 KB)
1	640.6	890.6
2	265.6	406.3
3	234.4	421.9
4	250.0	406.3
5	234.4	390.6
6	234.4	390.6
7	359.4	531.3
8	234.4	390.6
9	250.0	406.3
10	234.4	375.0
11	234.4	390.6
12	234.4	390.6
13	953.1	1171.9
14	281.3	437.5
15	250.0	390.6
16	250.0	406.3
17	250.0	406.3
18	250.0	406.3
19	1015.6	1281.3
$T_{avg}(\sigma)$	350.34 (242.29)	520.57 (274.62)

Similar to Scenarios #1 and #2, T_{avg} is increased as the amount of retrieved data increases, where it increases from 350.34 msec to 520.57 msec, when the data increases from 850 KB to 1958 KB. Also, σ is relatively high due to network instability and also the requirement for handshaking during some of the retrieving trials. It can be clearly seen that T_{avg} in Scenario #3 is less than that for Scenarios #1 and #2 for both data sets (850 KB and 1958 KB). This is because all data was retrieved from the same host, which means we do not need to look for two routing paths as it was the case in previous scenarios. Thus, the overall retrieval time is less.

4.4 Scenario#4: The CC-Commerce

This scenario simulates a cc-commerce, in which a client accesses the MainWebInterface of the 3CT tool described in Chapter 3 (Section 3.6) requesting data that will be retrieved by the MainWebServer from a local storage through LAN connection, as illustrated in Figure (4.4). In this case, the MainWebInterface is acting as a cc-commerce provider. In particular, in this Scenario, the client requesting information from the MainWebServer at DC1 (public IP address 98.130.174.2). The MainWebServer, in turn, realizes that all data is available locally.

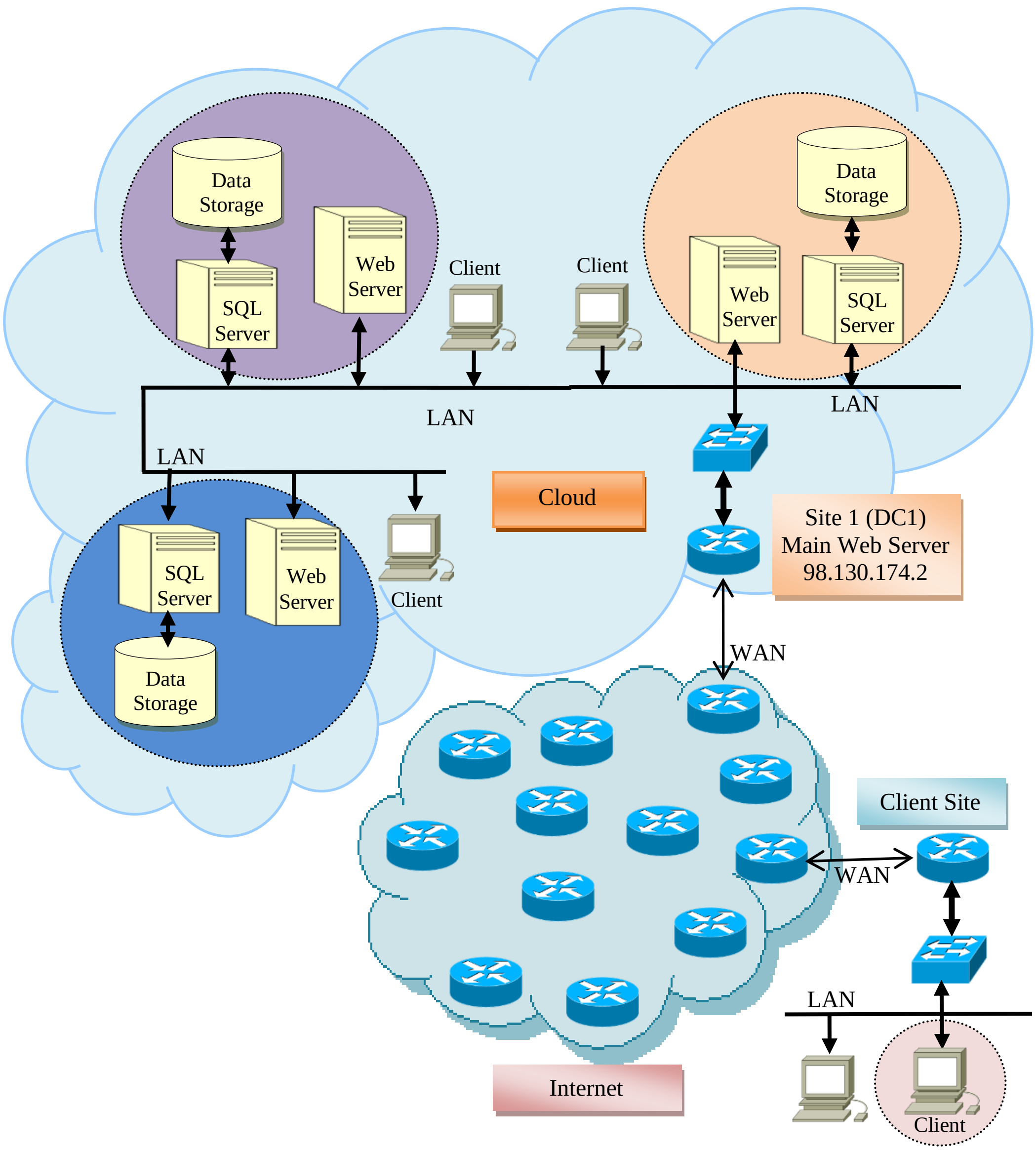

Figure (4.4).The configuration of Scenario #4.

The sizes of retrieved data are 850 KB and 1958 KB similar to those in previous scenarios, which are also detailed in Table (4.8). The code for retrieving 850 KB data for Scenario #4 is listed in Figure (B.4). The T_i measurements and the calculated T_{avg} and σ are listed in Table (4.9).

Table (4.8)
Details of retrieved data from the NorthWind.MDF databse (Scenario #3).

Entity	850 KB			1958 KB		
	Size (KB)	Records	Site	Size (KB)	Records	Site
Customers	48	91	DC1	48	91	DC1
Employees	268	9	DC1	268	9	DC1
Orders	534	830	DC1	534	830	DC1
Orders	-	-	-	534	830	DC1
Order Details	-	-	-	574	2153	DC1

Table (4.9)
The run and average response times for Scenario #4.

Run	T_i (msec) (850 KB)	T_i (msec) (1958 KB)
1	109.4	156.3
2	109.4	187.5
3	78.1	109.4
4	171.9	234.4
5	140.6	218.8
6	78.1	109.4
7	125.0	171.9
8	109.4	156.3
9	109.4	140.6
10	140.6	218.8
11	78.1	125.0
12	93.8	125.0
13	671.9	843.8
14	125.0	187.5
15	140.6	203.1
16	109.4	156.3
17	187.5	218.8
18	78.1	125.0
19	343.8	468.8
$T_{avg}(\sigma)$	157.90 (138.29)	218.77 (170.94)

Once again, T_{avg} is increased as the amount of retrieved data increases, where it increases from 157.90 msec to 218.77 msec, when the data increases from 850 KB to 1958 KB. Also, σ is relatively high due to network instability. It can be clearly seen that T_{avg} in Scenario #3 is less than that for previous scenarios for both data sets (850 KB and 1958 KB). This is because all data was retrieved from the local storage media, which means no WAN connection is required apart from that between the client and Site 1 (MainWebServer) and all other links for retrieving the data are local links.

4.5 Results Summary and Comparison

In this section, the results obtained for T_{avg} and S for all previous four scenarios are summarized and compared in Table (4.10). The results in Table (4.10) for T_{avg} are plotted in Figure (4.5). The results show that the provider-access cc-commerce configuration provides an excellent performance in comparison with all c-commerce configurations, where for the data sets and configuration described above, it provides a speedup factor of more than 2 for two hosts c-commerce and more than that for three hosts' c-commerce configurations.

Thus, it can be concluded from the results obtained in this research that with the emergent of high performance cloud computing (tremendous processing speed, memory, and storage capacity), it is highly recommended that all enterprises are advised to host their data under the same cloud with their collaborated enterprises or businesses.

Table (4.10)
Results summary and comparison.

Size of retrieved data (KB)	Scenario #1		Scenario #2		Scenario #3		Scenario #4
	T_{avg}	S	T_{avg}	S	T_{avg}	S	T_{avg}
850	599.52	3.80	464.56	2.94	350.34	2.22	157.90
1958	953.94	4.36	921.07	4.21	520.57	2.38	218.88

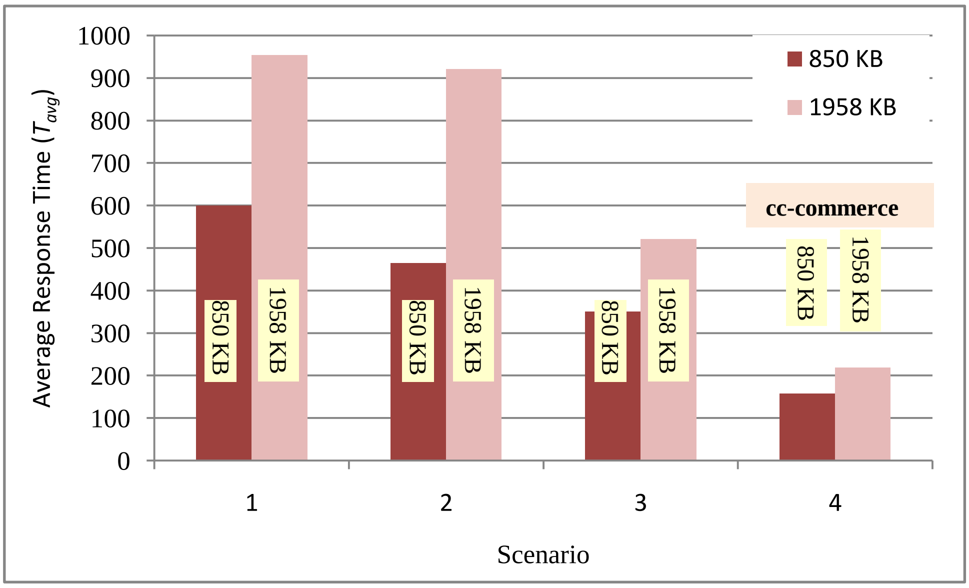

Figure (4.5). Comparison of average responses times (T_{avg}) for all scenarios.

Chapter Five 5

Conclusions and Recommendations for Future Work

5.1 Conclusions

This thesis, first, discusses one major application of cloud computing, in which cloud computing is used as a powerful alternative platform for performing collaborative commerce (c-commerce), where all collaborative entities are hosted at the same cloud, and consequently, it will be referred to as cloud collaborative commerce (cc-commerce). In other words, cc-commerce is defined as the form of c-commerce that utilizes the evolving cloud computing services brining more cost-effective business opportunities and enabling more precise decision making. Businesses also would to be able to tap a network through which they can rapidly discover, connect, and collaborate with the trading partners that can deliver the greatest value to them; and they can leverage to exchange market knowledge and share best practice processes.

Second, this thesis presents a description and performance analysis of a new cc-commerce model, which can be deployed using two configurations, namely, provider-access configuration and broker-access configuration. The new cc-commerce model consists of six main components, namely: client, provider, auditor, broker, security and privacy, and communications network. The new model is implemented and a simple tool called cc-commerce test (3CT) tool is developed to evaluate the performance of the new cc-commerce model through a number of scenarios. In these scenarios, various systems configurations are considered representing c-commerce and cc-commerce configurations. For each configuration, the average response times (T_{avg}) for retrieving different sets of data from the NorthWind.MDF database are calculated. Then, the speedup factor (S) achieved by the cc-commerce configuration over the various c-commerce configurations are computed and discussed.

Based on the results obtained, the main conclusions of this work can be summarized as follows:

(1) Cloud computing can play a big role in providing cost-effective computing resources for businesses willing to use E-commerce or be part of c-commerce systems. Especially, small and medium businesses who cannot afford the cost of installing on-premises computing resources.

(2) Cloud computing can be used as an alternative to the on-premises computing resources forming a high-performance cloud computing based c-commerce or cc-commerce. It eliminates the drawbacks of c-commerce (e.g., installation and running costs, delay, security, etc.).

(3) The developed cc-commerce model with both provider-accessed and broker-accessed configurations can be used in porting any c-commerce application to a powerful and a cost-effective cc-commerce application.

(4) The average response time of a cc-commerce application is always less than the average response time of its equivalent c-commerce application. Furthermore, the cc-commerce application provides better security, privacy, availability, scalability, reliability, and consequently, more clients and applications satisfactions. This is because it eliminates the needs for many unreliable and low-bandwidth point-to-point (P2P) wide area network (WAN) links and replaces them by reliable high-bandwidth local area network (LAN) links, and the only required P2P WAN links are between the clients and cloud service providers (CSP).

(5) The four scenarios examined in this thesis demonstrated that for the equivalent tasks a speedup factor of more than 2 can be achieved using a cc-commerce configuration over a c-commerce configuration.

Finally, the results obtained should be very encouraging for all enterprises (specially small and medium enterprises) to go for cloud computing as a common computing resource for E-commerce (i.e., using cc-commerce business model).

5.2 Recommendations for Future Work

The main recommendations for future work and research may include:

(1) Use the 3CT tool to perform further investigations, in particular, retrieve more data from more sites, and calculate and compare the performances of the c-commerce (broker-access configuration with one enterprise per site) and cc-commerce (provider-access configuration) in terms of T_{avg} and S.

(2) Evaluate the performance of broker-access cc-commerce configuration with more than one enterprise per site against the performance of provider-access cc-commerce configuration, considering equal retrieved data and collaborating enterprises.

(3) Develop and investigate the effects of different security and privacy measures and protocols on the performance of the c-commerce and cc-commerce models. Developing secure protocols increases clients trust to convert for cc-commerce.

(4) Investigate the effects of network reliability (network environment) on the performance of the c-commerce and cc-commerce models.

(5) Study the performance of the CSPs will help them to evaluate their services and work for updating their resources to meet their client needs and satisfy them, and have fewer problems during their operation.

A roadmap for electronic businesses (e-businesses) to migrate from c-commerce to cc-commerce may include the following steps:

(1) Understand the cloud-ready services available. The information technology (IT) experts at the enterprise are required to understand the state-of-the-art in cloud computing technologies to be able to effectively utilize them in boosting the business status. The enterprise may have to outsource this task partially or totally.

(2) Define a clearly migration strategy. The IT experts are required to define clear strategy considering the resources available in terms of cost and experiences

of the technical and administrative staff. They also need to look at the training program and cost of the training program and the availability of potential staff and programs.

(3) Draw a roadmap. With a clear strategy in place and an end goal determined, identify the direction your company needs to take to get there. Assess the products/platforms you need to support and build upon collaboration vision.

(4) Prepare a migration path. Migration and integration of legacy systems may require additional resources and see if outside support is required. Also, a monitoring and control plan is required to ensure successful migration.

Appendix A

LINQ to SQL

LINQ to SQL

LINQ to SQL is an object relational mapping(O/RM) implementation that ships in the Visual Studio.NET framework "Orcas" release, which allows modeling a relational database using .NET classes. Then the database can be queried using LINQ as well as update/insert/delete data from it.LINQ to SQL fully supports transactions, views, and stored procedures. It also provides an easy way to integrate data validation and business logic rules into a data model.Visual Studio "Orcas" ships with a LINQ to SQL designer that provides an easy way to model and visualize a database as a LINQ to SQL object model (Kumar,2010).

Using LINQ to SQL Class

LINQ to SQL class is an ORM which creates a class representing a table from the database. It creates a data context class.To perform query add a new class in the same class library project. Make this class as static. To create class follow the following steps:

(1) Create a new project of type class library.

(2) Right click on the project and add new item and select LINQ to SQL Class from Data tab.

(3) Select Server Explorer. Then Server Explorer will get open. Click on Data connection and Add new connection.

(4) In Server name give name of the database server and from drop down select the database.

(5) Once above steps have done, a dbml file is created in solution explorer.

Follow the diagrams in Figure (A.1), in order, left to right and then top to bottom.

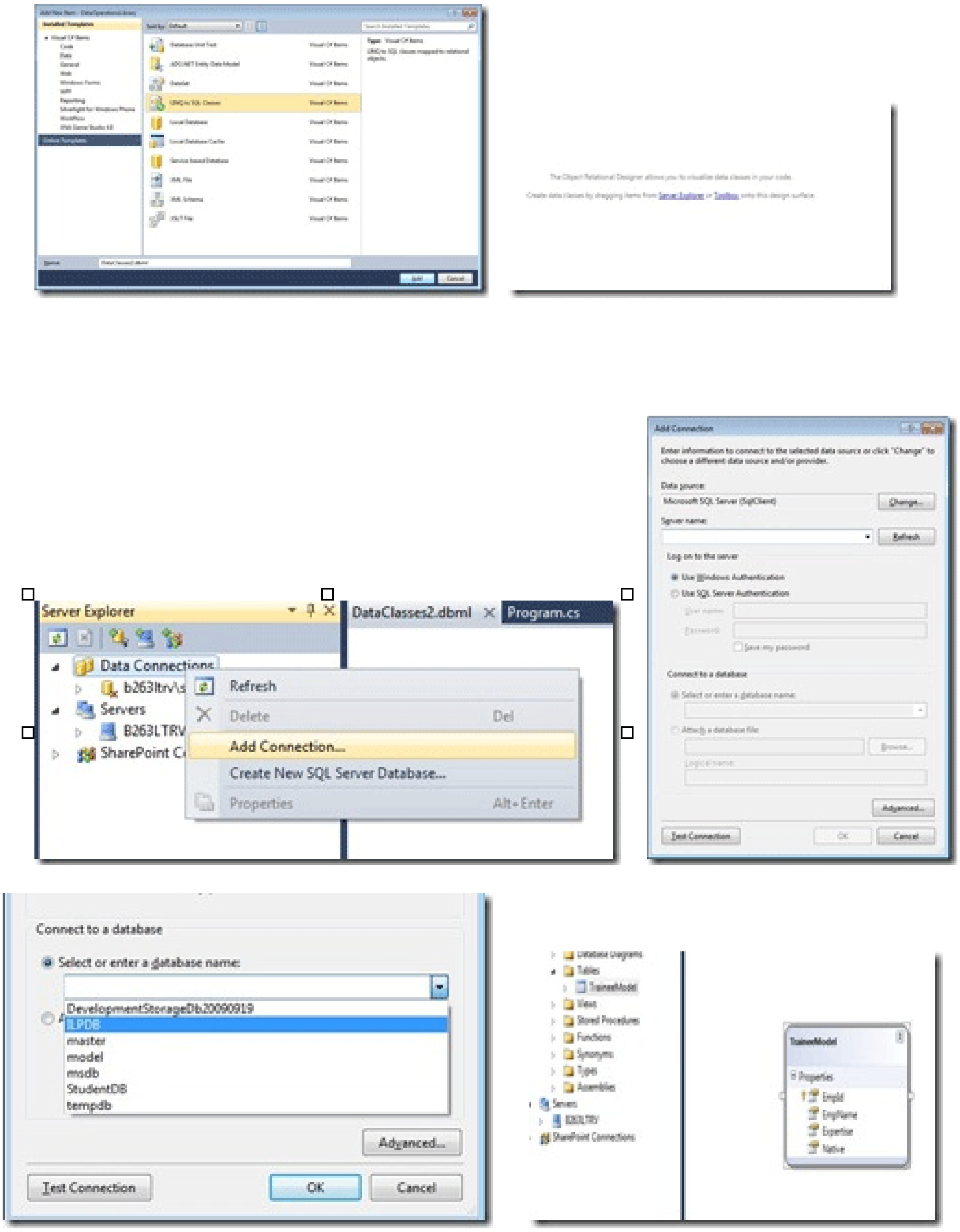

Figure (A.1). diagram showing the steps of creating a class.

The following class shows various static methods that can perform different types of query.

```
//   Code Started.
using System;
usingSystem.Collections.Generic;
usingSystem.Linq;
usingSystem.Text;
namespaceDataOperationsLibrary
{
    publicstaticclassCRUDRepository
    {
```

```
//   Query #1:  Retrieving all the records from table
//   1. Create an instance of DataContext class.
//   2. Apply LINQ query to retrieve all the records from the table TraineeModels inDataContext.
        publicstaticList<TraineeModel>GetTrainees()
        {
            DataClasses1DataContextcontext = newDataClasses1DataContext();
            varresult = from r incontext.TraineeModelsselect r;
            returnresult.ToList();
        }
```

```
//   Query #2: Retrieving selected records from table
//   1.  Create an instance of DataContextclass.
//   2. Apply a LINQ query to retrieve all the records from the table TraineeModels in DataContext.
//   3. Apply where clause to filter the data.

        publicTraineeModelGetSelectedTrainee(stringEmpId)
        {
            DataClasses1DataContextcontext = newDataClasses1DataContext();
            TraineeModeltraineeResult = (from r incontext.TraineeModels
                                         Wherer.EmpId == EmpId
                                         select r).First();
            return traineeResult;
        }
```

```
//   Query #3: Inserting a single record
//   1. Create an instance of DataContext class.
//   2. Input parameter to this method is object of TraineeModel class.
//   3. Use InsertOnSubmit method on the DataContext class to insert one record.
//   4. Call the SubmitChanges to commit the database on DataContext.

        publicstaticboolAddTrainee(TraineeModel trainee)
        {
            try
            {
                DataClasses1DataContextcontext = newDataClasses1DataContext();
                context.TraineeModels.InsertOnSubmit(trainee);
                context.SubmitChanges();
                returntrue;
            }
            catch
            {
                returnfalse;
            }
        }
```

```
//   Query #4: Updating a record
//   1. Create an instance of DataContext class.
//   2. Input parameter to this method is object of TraineeModel class.
//   3. Retrieve the object to be modified using where clause.
```

```
//   4. Call the SubmitChanges on DataContext.

        publicstaticboolUpdateTrainee(TraineeModel trainee)
        {
            try
            {
                DataClasses1DataContextcontext = newDataClasses1DataContext();
                TraineeModel res = (from rincontext.TraineeModels
                                   wherer.EmpId.Contains(trainee.EmpId)
                                    select r).First();
                res.EmpName = trainee.EmpName;
                res.Expertise = trainee.Expertise;
                res.Native = trainee.Native;
                context.SubmitChanges();
                returntrue;
            }
            catch
            {
                returnfalse;
            }
        }
```

```
//   Query #5: Deleting a record
//   1. Create instance of DataContext class.
//   2. Input parameter to this method is empID as string to be deleted.
//   3. Retrieve the object to be deleted using where clause.
//   4. Call the SubmitChanges on DataContext.

        publicstaticboolDeleteTrainee(stringempID)
        {
            try
            {
                DataClasses1DataContextcontext = newDataClasses1DataContext();
                TraineeModelobj = (from rincontext.TraineeModels
                                    wherer.EmpId.Contains(empID)
                                    select r).First();
                if(obj != null)
                {
                    context.TraineeModels .DeleteOnSubmit(obj);
                    context.SubmitChanges();
                    returntrue;
                }
                else
                {
                    returnfalse;
                }
            }
            catch
            {
                returnfalse;
            }
        }
```

```
//   Query #6: Adding list of records
//   1. Create an instance of DataContext class.
//   2. Input parameter to this method is List of TraineeModels to be inserted.
//   3. Insertthe records using InsertAllOnSubmit method on DataContext class.
//   4. Call the SubmitChanges on DataContext.

        publicstaticboolAddTrainees(List<TraineeModel>lstTrainee)
```

```
        {
            try
            {
                DataClasses1DataContextcontext = newDataClasses1DataContext();
                context.TraineeModels.InsertAllOnSubmit(lstTrainee);
                context.SubmitChanges();
                returntrue;
            }
            catch
            {
                returnfalse;
            }
        }
```

```
//  Query #7: Deleting list of records
//  1. Create an instance of DataContextclass.
//  2. Input parameter to this method is List of TraineeModels to be deleted.
//  3. Delete the records using DeleteAllOnSubmit method on DataContext class.
//  4. Call the SubmitChangesmethod on DataContext.

        publicstaticboolDeleteTrainees(List<TraineeModel>lstTrainee)
        {
            try
            {
                DataClasses1DataContextcontext = newDataClasses1DataContext();
                context.TraineeModels.DeleteAllOnSubmit(lstTrainee);
                context.SubmitChanges();
                returntrue;
            }
            catch
            {
                returnfalse;
            }
        }
```

```
//  Up to this step, all LINQ queries are writtento be used for CRUD operation. Now to use
//  this query just call the methods with class name.
    }
}
//  Code Ended.
```

Appendix B

List of Retrieving Codes for All Scenarios

```
// Scenario #1: Three Hosts C-Commerce (Non-Participating
MainWebServer)

DateTimeStartTime = DateTime.Now;
try
{
    DateTime ST = DateTime.Now;
    varEmpDS = from o in DC2.Employees select o; //DC2=204.93.174.60
    GridView1.DataSource = EmpDS.ToList();
    GridView1.DataBind();
    TimeSpan T = DateTime.Now - ST;
    Label1.Text = T.TotalMilliseconds.ToString();
}
catch
{
}
try
{
    DateTime ST = DateTime.Now;
    varOrdDS = from o in DC3.Orders select o; //DC3=205.178.152.126
    GridView2.DataSource = OrdDS.ToList();
    GridView2.DataBind();
    TimeSpan T = DateTime.Now - ST;
    Label2.Text = T.TotalMilliseconds.ToString();
}
catch
{
}
try
{
    DateTime ST = DateTime.Now;
    varCusDS = from o in DC3.Customers select o; //DC3=205.178.152.126
    GridView3.DataSource = CusDS.ToList();
    GridView3.DataBind();
    TimeSpan T = DateTime.Now - ST;
    Label3.Text = T.TotalMilliseconds.ToString();
}
catch
{
}
TimeSpan DD = DateTime.Now–StartTime;
Label4.Text = DD.TotalMilliseconds.ToString();
DC2.Connection.Close();
DC3.Connection.Close();
```

Figure (B.1). List of the code of Scenario #1 for retrieving 850 KB.

```
// Scenario #2: Three Hosts C-Commerce (Participating MainWebServer)
DateTimeStartTime = DateTime.Now;
try
{
    DateTime ST = DateTime.Now;
    varEmpDS = from o in DC3.Employees select o; //DC3=205.178.152.126
    GridView1.DataSource = EmpDS.ToList();
    GridView1.DataBind();
    TimeSpan T = DateTime.Now - ST;
    Label1.Text = T.TotalMilliseconds.ToString();
}
catch
{
}
try
{
    DateTime ST = DateTime.Now;
    varOrdDS = from o in DC2.Orders select o; //DC2=204.93.174.60
    GridView2.DataSource = OrdDS.ToList();
    GridView2.DataBind();
    TimeSpan T = DateTime.Now - ST;
    Label2.Text = T.TotalMilliseconds.ToString();
}
catch
{
}
try
{
    DateTime ST = DateTime.Now;
    varCusDS = from o in DC1.Customers select o; //DC1=98.130.174.2
    GridView3.DataSource = CusDS.ToList();
    GridView3.DataBind();
    TimeSpan T = DateTime.Now - ST;
    Label3.Text = T.TotalMilliseconds.ToString();
}
catch
{
}
TimeSpan DD = DateTime.Now–StartTime;
Label4.Text = DD.TotalMilliseconds.ToString();
DC1.Connection.Close();
DC2.Connection.Close();
DC3.Connection.Close();
```

Figure (B.2). List of the code of Scenario #2 for retrieving 850 KB.

```
// Scenario #3 - Two Hosts C-Commerce (Non-Participating
MainWebServer)

DateTimeStartTime = DateTime.Now;
try
{
    DateTime ST = DateTime.Now;
    varEmpDS = from o in DC2.Employees select o; //DC2=204.93.174.60
    GridView1.DataSource = EmpDS.ToList();
    GridView1.DataBind();
    TimeSpan T = DateTime.Now - ST;
    Label1.Text = T.TotalMilliseconds.ToString();
}
catch
{
}
try
{
    DateTime ST = DateTime.Now;
    varOrdDS = from o in DC2.Orders select o; //DC2=204.93.174.60
    GridView2.DataSource = OrdDS.ToList();
    GridView2.DataBind();
    TimeSpan T = DateTime.Now - ST;
    Label2.Text = T.TotalMilliseconds.ToString();
}
catch
{
}
try
{
    DateTime ST = DateTime.Now;
    varCusDS = from o in DC2.Customers select o; //DC2=204.93.174.60
    GridView3.DataSource = CusDS.ToList();
    GridView3.DataBind();
    TimeSpan T = DateTime.Now - ST;
    Label3.Text = T.TotalMilliseconds.ToString();
}
catch
{
}
TimeSpan DD = DateTime.Now–StartTime;
Label4.Text = DD.TotalMilliseconds.ToString();
DC2.Connection.Close();
```

Figure (B.3). List of the code of Scenario #3 for retrieving 850 KB.

```
// Scenario #4 – The CC-Commerce

DateTimeStartTime = DateTime.Now;
try
{
    DateTime ST = DateTime.Now;
    varEmpDS = from o in DC1.Employees select o; //DC1=98.130.174.2
    GridView1.DataSource = EmpDS.ToList();
    GridView1.DataBind();
    TimeSpan T = DateTime.Now - ST;
    Label1.Text = T.TotalMilliseconds.ToString();
}
catch
{
}
try
{
    DateTime ST = DateTime.Now;
    varOrdDS = from o in DC1.Orders select o; //DC1=98.130.174.2
    GridView2.DataSource = OrdDS.ToList();
    GridView2.DataBind();
    TimeSpan T = DateTime.Now - ST;
    Label2.Text = T.TotalMilliseconds.ToString();
}
catch
{
}
try
{
    DateTime ST = DateTime.Now;
    varCusDS = from o in DC1.Customers select o; //DC1=98.130.174.2
    GridView3.DataSource = CusDS.ToList();
    GridView3.DataBind();
    TimeSpan T = DateTime.Now - ST;
    Label3.Text = T.TotalMilliseconds.ToString();
}
catch
{
}
TimeSpan DD = DateTime.Now–StartTime;
Label4.Text = DD.TotalMilliseconds.ToString();
DC1.Connection.Close();
```

Figure (B.4). List of the code of Scenario #4 for retrieving 850 KB.

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