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COMPARISON OF DIGITAL OBJECT ARCHITECTURE AND DOMAIN NAME SYSTEM ACCORDING TO E-COMMERCE REQUIREMENTS

by

ERDOĞAN OLCAY

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Approved by

Kip BECKER, PhD

Professor of Boston University Metropolitan College

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ABSTRACT

This study aims to compare digital object architecture (DOA) and domain name system (DNS) according to requirements of e-commerce. Within this context, first the literature about e-commerce, internet, DNS and DOA was reviewed in chapter 2. Then the brief history of e-commerce was given and problems and requirements of e-commerce were explained in the 3rd chapter. In the 4th chapter the history of Internet and the existing infrastructure and basics of DNS and DOA were explained. In the 5th chapter DNS and DOA were compared. Analytical Hierarchy Process (AHP) was used in comparison. Finally the results of the AHP model were discussed and the conclusions were given in the 6th chapter. The results of this study showed that DOA is better than DNS in meeting the security and digital divide requirements while DNS is better than DOA according to the management factors.

Keywords: electronic commerce, digital object architecture, domain name system.

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LIST OF ABBREVIATIONS

AHP	:	Analytic Hierarchy Process
ASCII	:	American Standard Code for Information Interchange
B2B	:	Business to Business
B2C	:	Business to Consumer
B2G	:	Business to Government
C2C	:	Consumer to Consumer
CCTLD	:	Country Code Top Level Domain Name
CNRI		Corporation for National Research Initiatives
DNS	:	Domain Name System
DNSSEC		Domain Name System Security Extensions
DOA	:	Digital Object Architecture
DOI	:	Digital Object Identifier
DONA	:	Digital Object Numbering Authority
E-business	:	Electronic Business
E-commerce	:	Electronic Commerce
EDI	:	Electronic Data Interchange
EFT	:	Electronic Funds Transfer
EU	:	European Union
GTLD	:	Generic Top Level Domain Name

IANA	:	Internet Assigned Numbers Authority
ICANN	:	Internet Corporation for Assigned Names and Numbers
IDF	:	International DOI Foundation
IDNs	:	Internationalized Domain Names
IDNA	:	Internationalizing Domain Names in Applications
IETF	:	Internet Engineering Task Force
IP	:	Internet Protocol
ITU	:	International Telecommunications Union
M-commerce	:	Mobile Commerce
MPAs	:	Multi-Primary Prefix Administrators
OECD	:	Organization for Economic Co-operation and Development
P2P	:	Peer to Peer
PKI	:	Public Key Infrastructure
TCP	:	Transmission Control Protocol
TLD	:	Top Level Domain
UDRP	:	Uniform Dispute Resolution Policy
UN	:	United Nations
WSIS	:	World Summit on Information Society
WTO	:	World Trade Organization
WWW	:	World Wide Web

CHAPTER 1: INTRODUCTION

In the 20th century our world have become more and more globalized as technologies, economies and cultures have integrated through the developments in communications, transportation, and trade. (Ball, Geringer, Minor & McNett, 2010). Thanks to globalization and the growth of Internet usage, economic activities were transferred to electronic forms and the world was introduced to the concept of electronic commerce (e-commerce).

Although the first e-commerce applications are said to be begin in late 1970s with the use of electronic data interchange (EDI) and electronic funds transfer (EFT), these applications are referred to as precursor systems and the real e-commerce is considered to start in late 1990s with the use of Internet and Web (Laudon & Traver, 2009). The early years of e-commerce were the era of explosive growth. However the rising star of 1990s' business world, experienced problems in early 2000s (Goldfarb, David & Miller, 2007).

After 2000, e-commerce became more business driven as the large traditional companies started to use Web as a more effective tool to increase their market shares and brand recognitions. In 2006 e-commerce experienced another transition with the rise of social media concept. As our world became more and more globalized e-commerce became more and more customer oriented. Companies started to use Internet based techniques not only for advertising but also for communicating with customers. Social media concept took further the customer communication by allowing creation of customer communities where they communicate with each other and share their thoughts

about products and services. Nowadays e-commerce growth rates are between 10-15% and the sector is expected to have a brighter future because of the developments in communications technology and social media based business models (Laudon & Traver, 2009).

Although e-commerce is said to be evolved and adapted in time, based on the past lessons and new developments, there is still something unchanged that Internet is the main tool and infrastructure of e-commerce. It is the factor that determines the strengths and weaknesses of e-commerce. So the results of the Internet related discussions are key factors for the future of e-commerce.

Today information security and protection of privacy are the major concerns of many customers. As on-line frauds and Internet based crimes increase, customers require more secure transactions and more secure e-commerce systems. Additionally, regulation of e-commerce is still an area that needs to be further studied. Intellectual property rights, competition, consumer rights are some of the issues that still needs to be clarified especially in international level (Bajaj & Leonard, 2004).

Digital divide is another factor that has the potential to affect the future of e-commerce. Despite the big developments of last decade in information and communications technologies, there are still many countries that are far behind these developments. The digital divide is the term that used to define this fact that there are big differences among developing countries and the industrialized ones in accessibility to information and communications technologies (Kshetri, 2007).

Internet governance has become a very hot topic of discussions between countries and international organizations. As the information and communications technologies have become more and more strategic, many parties started to talk about their concerns regarding the way Internet had been managed and the accessibility to information and communication technologies (Weber, 2008).

Internet is based on Domain Name System (DNS) which enables using recognizable letters and words instead of internet protocol addresses that provides communication in Internet infrastructure. The functions of DNS have being coordinated by Internet Corporation for Assigned Names and Numbers (ICANN) which is a nonprofit private organization that was created on September 18, 1998 (Internet Assigned Numbers Authority [IANA], 2001).

DNS is the tool that provides the world the global Internet. However it is not the only tool that can do this. Digital Object Architecture (DOA) is another system that can be used as an alternative. DOA was developed by Corporation for National Research Initiatives (CNRI) under the leadership of Dr. Robert E. Kahn who is known as co-designer of the transmission control protocol (TCP) / Internet Protocol (IP) protocol along with Vinton Cerf. Although it is not very well known with its original name "DOA", it is the system behind the digital object identifiers (DOI) used in academic publications and cross references (CNRI, 2010).

This study aims to compare DOA and DNS according to requirements of e-commerce. Within this context, first the literature about e-commerce, internet, DNS and DOA was reviewed in chapter 2. Then the brief history of e-commerce was given and

problems and requirements of e-commerce were explained in 3rd chapter. In the 4th chapter the history of Internet and the existing infrastructure and of DNS and DOA were explained. In the 5th chapter DNS and DOA were compared according to e-commerce requirements, using with Analytical Hierarchy Process (AHP) which is a multi-criteria decision making tool and allows transferring qualitative factors to quantitative values in order to make reasonable choices between alternatives. Finally the results of the AHP model were discussed and the conclusions were given in the 6th chapter.

CHAPTER 2: LITERATURE REVIEW

In this chapter the literature about e-commerce, internet, DNS and DOA were examined. The literature review is focused on the latest trends and requirements of e-commerce and the critiques about the Internet and DNS.

Laudon and Traver, (2009) stated that e-commerce became more customer oriented after 2006. They also explained the trends from business, society and technology point of views. The security concerns, the increase in online fraud and invasion of privacy were highlighted as problems in e-commerce. Rattan, Sinha, Bali and Rathore (2010), highlighted the security requirements for e-commerce and explained how the public key infrastructure (PKI) can serve as a security tool. Huang and Zhao (2011), defined the security as the core of e-commerce and focused on network security.

Hong and Zhu (2006) focused on factors affecting e-commerce adoption and migration. They stated that higher level of technology integration makes it easier for firms to adopt e-commerce.

Gunasekaran, Marr, McGaughey and Nebhwani (2002) highlighted the fact that e-commerce requires technological developments infrastructure. They also stated that the infrastructure of e-commerce must be designed to meet security and flexibility requirements.

Akhter (2003) stated that digital divide is a major factor in electronic purchases. Kshetri (2007) stated that low internet penetration, lack of economies of scale and lack of electronic systems are the major economic barriers to e-commerce in developing

countries. Another result of this study was that there are rural areas that do not have even basic electrical infrastructure that clearly shows the size of the digital divide countries.

Tigre and Dedrick (2004), stated that lack of government regulations and concerns about privacy and security are major problems for e-commerce especially in developing countries. Gibbs, Kraemer and Dedrick (2003) stated that concerns about fraud are big handicap for development of e-commerce. They also highlighted that inadequate consumer protection legal protection for Internet purchases and concern over Internet taxation

There are also studies that consider the language problems in developing countries. Kenny (2003), stated that the lack of English language skills is a problem for access and use of technology. Language problems were also highlighted by Gibbs, Kraemer and Dedrick (2003) as a problem to reach the older generation consumers in developing countries.

Liu and Albitz (2006) explained the main features and infrastructure of DNS. They stated that DNS have security problems and needs security extensions. A detailed threat analysis of DNS was written by Atkins and Austein (2004) who specified the threats for DNS. Different security flaws of DNS and Domain Name System Security Extensions (DNSSEC) were discussed in many studies. Ariyapperuma and Mitchell (2007), Sadoun, Belouchrani, Bourennane and Zerguerras (2011), Friedlander, Mankin, Maughan and Crocker (2007), Jackson, Barth, Bortz, Shao and Boneh (2009), McPherson (2010), Mockapetris (2003) explained vulnerabilities of DNS and DNSSEC.

Walfish, Balakrishnan and Shenker (2004), discussed that DNS has restricted the flexibility of the Web. Paskin (2006) explained the basics of DOA and use the term handling system to highlight the functions of it. O'Donnell (2002) explained the advantages of handle system over DNS. O'Donnell (2003) offered use of open network handle system, to avoid the disputes about the use of names.

Preechaveerakul, O'Brien, Castro, and Bhattarakosol (2002) highlighted the problem that the increasing demand for an Internet is affecting the present DNS used to map host names to IP addresses. And the popular names are being exhausted by trademark. They also stated that methods developed to supplement the existing DNS do not solve the problems of intellectual property, cybersquatting, and name collisions.

Balakrishnan, Lakshminarayanan, Ratnasamy, Shenker, Stoica, and Walfish (2004), argued that there should be three levels of name resolution: from user-level descriptors to service identifiers; from service identifiers to endpoint identifiers; and from endpoint identifiers to IP addresses.

The lack of multilingual support in DNS is also discussed in many studies. Chaudri (2007) stated that DNS was not originally designed to support the characters outside ASCII. Lin, Ho, Tseng and Lai (2006) examined the efforts to upgrade the DNS to support internationalized domain names (IDNs). Wu (2002) stated the problems in IDN support efforts. Daithí (2010), examined the operations and procedures of ICANN about IDNs.

There are also studies about internet governance and existing operations of ICANN. Koppell (2005) criticized the ICANN's accountability. Lenard and White (2011)

also highlighted the concerns about ICANN's accountability. Weber (2008) explained the role of ICANN in domain name management and recommended that an organization with critical responsibilities needs to be managed in more democratic and legitimate manner. Kleinwächter (2000) foreseen that ICANN will have not only technical but also political responsibilities in internet governance and its operations have the potential to affect business world and social life through Internet. Weber (2009) discussed the need for a new legal framework for domain name management.

ICANN's procedures and policies in country code top level domain names (ccTLDs) are also discussed in several studies. Hagen (2003) mentioned about the concerns of countries about possible violations to their sovereign rights with existing operations of ICANN regarding ccTLDs. Kumar and Mowshowitz (2006), highlighted that the dispute resolution regarding ccTLDs can result hostile to governments. Kah Leng (2010) examined the domain name disputes from companies' perspective and highlighted its importance to business world. Dieguez (2008) explained ICANN's Uniform Dispute Resolution Policy (UDRP) and highlighted the need for reform.

CHAPTER 3: ELECTRONIC COMMERCE

This chapter is focused on e-commerce and firstly gives definitions and basic concepts. Then history and evolution of e-commerce is explained. Finally, latest developments trends and requirements of e-commerce are examined.

3.1. Definition and Types of E-commerce

E-commerce is defined by many international organizations. World Trade Organization (WTO) (1998), defined ecommerce as the production, advertising, sale and distribution of products via telecommunication networks. According to the Organization for Economic Co-operation and Development (OECD) (2012a), electronic commerce refers to commercial transactions occurring over open networks.

The United Nations Commission on International Trade Law has defined electronic commerce as commercial activities conducted through an exchange of information generated, stored, or communicated by electronic, optical, or analogous means (Stelloh & Stack, 2008).

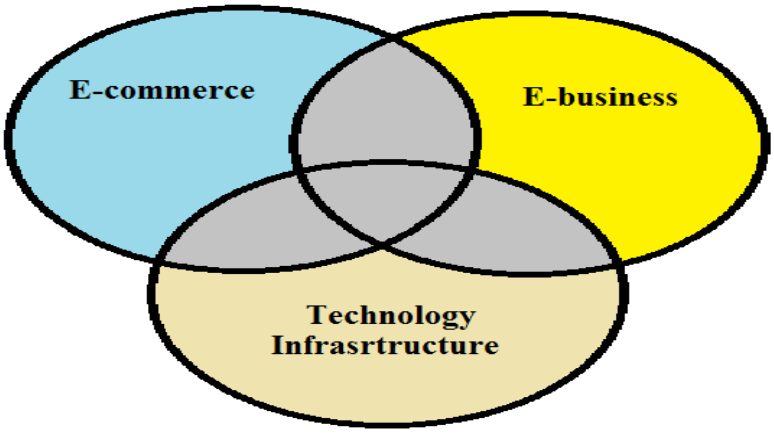
In 1996 Model Law on Electronic Commerce was enacted by United Nations (UN). In this law, the communication methods regarding e-commerce definition is detailed with these statements:"Among the means of communication encompassed in the notion of "electronic commerce" are the following modes of transmission based on the use of electronic techniques: communication by means of EDI defined narrowly as the computer-to-computer transmission of data in a standardized format; transmission of

electronic messages involving the use of either publicly available standards or proprietary standards; transmission of free-formatted text by electronic means, for example through the INTERNET" (UN, 1999). This definition highlights the tools of e-commerce.

According to European Union (EU) electronic commerce is based on the electronic processing and transmission of data, encompasses many diverse activities including electronic trading of goods and services, on-line delivery of digital content, electronic funds transfers, electronic share trading, public procurement, and so on. (EU, 1997)

There are also definitions of academics. According to Heng (2003), e-commerce is a commercial activity dealing directly with the trading of goods and services and with other related business activities, in which the electronic communication medium plays a central role. Some academics use electronic business (e-business) and e-commerce terms interchangeably. Loshin and Vacca (2004), used this approach.

However Laudon and Traver (2009) simply defined e-commerce as the use of Internet and Web to transact business. Additionally they made a distinction between electronic business (e-business) and e-commerce. They define e-business as digital enabling of transactions and processes within a firm and specified that e-business does not include commercial transactions. E-commerce transactions cross the firm boundaries and e-business activities transform to e-commerce if a value exchange exits (Laudon &Traver, 2009). This approach is used also in this study and represented in Figure 3.1 below.



Source: Laudon & Traver, 2009.

Figure 3.1. E-commerce and E-business

The parties that involved in determine the type of e-commerce. Gökmen (2011) defined the types of e-commerce as follows.

"• Business–to–Business (B2B): Online marketing to other business entities, selling supplies and necessary materials by quick digital means. Also comprises of the expansion of e-business activities on the global basis too,

• Business–to–Consumer (B2C): Online marketing to individual consumers,

• Business–to–Government (B2G); Businesses meeting the procurement necessities of state entities,

• Consumer–to–Consumer (C2C): Consumers selling to other consumers by way of a market making channel.

• Peer–to–Peer (P2P): Enables the Internet population to allocate files and digital sources without passing through a web server."

In addition to these, mobile commerce (m-commerce) which is defined as a type of electronic commerce uses wireless mobile networks for transactions, is become more and more popular in recent years (Yang & Chang, 2012). Laudon and Traver, (2009) explained the types of e-commerce with examples as shown in Table 3.1 below.

Table 3.1. Types of E-commerce

Type	***Example***
B2B	Foodtrader is an independent third party commodity exchange auctions provider and market information source that serves the food and agricultural industry.
B2C	Amazon is a general merchandiser that sells consumer products to retail customers.
C2C	On a large number of Web auction sites such as eBay, and listing sites such as Craiglist, consumers can auction or sell goods directly to other consumers.
P2P	BitTorrent is a software application that permits consumers to share videos and other high-bandwidth content with one another directly without the intervention of a market maker as in C2C e-commerce.
M-commerce	Wireless mobile devices such as personaldigital assistants and cell phones can be used to conduct commercial transactions.
Source: Laudon & Traver, 2009.	

3.2. Brief History and Evolution of E-Commerce

Information and communication technologies have being used in commercial activities since 1980s. However the precursors of e-commerce like ordering systems which used telephone based modems are known to be used since 1970s. Another precursor of e-commerce is electronic data interchange (EDI) which was started to be used in late 1970s and early 1980s. EDI played a big role in development of e-commerce by facilitating the exchange of business related documents between businesses (Laudon & Traver, 2009). EDI has being used by many companies and provides benefits including reduced shipment errors, higher inventory turnover, and reduced stock outs. (Yao, Dresner & Palmer, 2009).

However, the e-commerce as we know today can be said to be start with the use of Internet in 1995 (Ng, Pan & Wilson, 1998). According to Gökmen (2011), the Internet facilitated the business operations and multiplied the trade volume in the entire world by using information and communication technologies.

Gunasekaran, Marri, McGaughey and Nebhwani (2002) summarized the benefits of Internet to businesses as follows.

"The Internet enables businesses to;

• shorten procurement cycles through the use of on-line catalogues, ordering, and payment,

• cut costs on both stock and manufactured parts through competitive bidding

• reduce development cycles and accelerate time to market through collaborative engineering, product, and process design, regardless of the location of participants,

• gain access to worldwide markets at a fraction of traditional costs;

• ensure that the product, marketing information, and prices are always up to date;

• significantly increase the speed of communication, especially international communication

• drastically reduce purchasing and production cycles;

• reduce the cost of communications directly (E-mail and EDI save on postage) and speed up communication can reduce inventory and related inventory and purchasing costs,

• promote closer relationship with customers and suppliers, e.g. web sites enable companies to maintain customers and suppliers apprised of developments that concern them and practice effective relationship marketing;

• provide a quick and easy way of exchanging information about a company and its products internally and externally e.g. WWW sites, Intranets, and extranets;

• take advantage of alternative sales channels and

• tap new markets or markets niches."

Laudon and Traver (2009), divide the history of e-commerce in three eras. The first years of e-commerce between 1995 and 2000 are called as innovation period. From 1995 to 2000 e-commerce experienced annual growth rates over 100%. This period is also known as Dot Com Era (Goldfarb et.al, 2007).

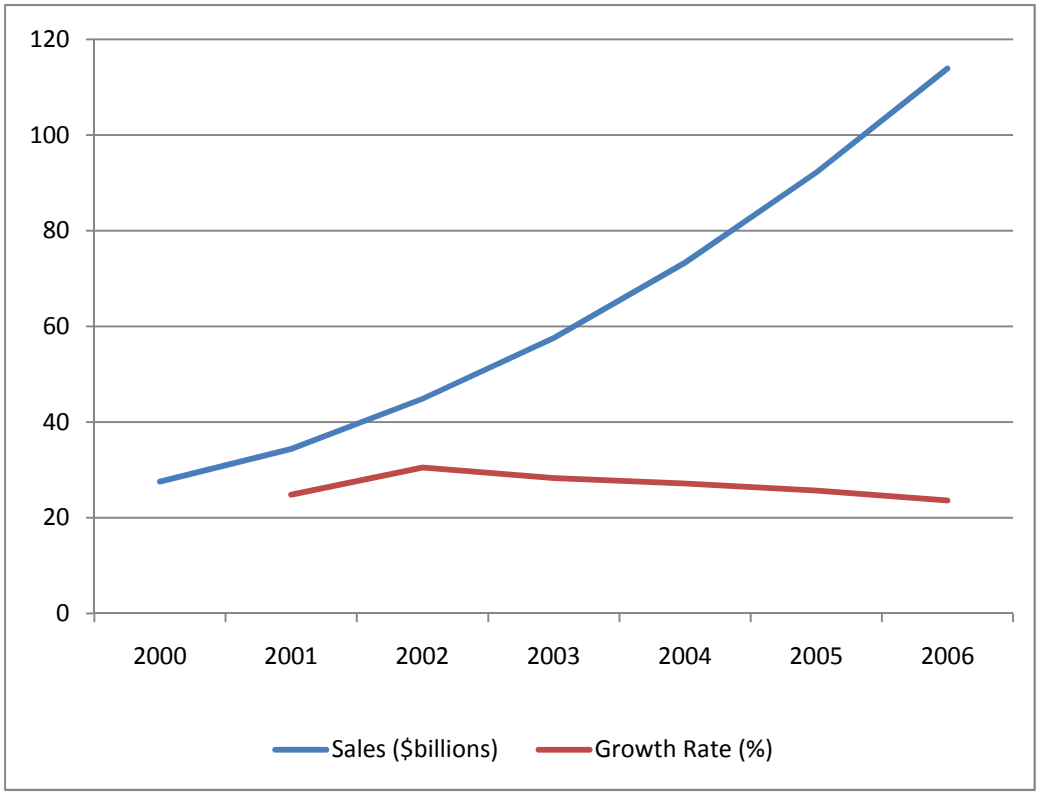
There are also academics that use the term Dot Com Bubble for this era. According to Goodnight and Green (2010) the period between 1992 and 2002 is the years of Dot Com Bubble. In this period lots of companies called as "dot-coms" were

established and started to operate from their online websites. Dot-com companies were popular because of their ability to provide easy and quick access to customers in different geographic areas and to lower initial investment. In late 1990s approximately 10,000 dot-coms were established most of which had the motivation to go to public (Wang, 2007). Dot com companies were pricing their products in lower levels and were focused on aggressive marketing. This strategy is called as get big fast and was good for the dot-coms until 2000. However, the golden era of these companies ended in 2000 (Oliva, Sterman & Giese, 2003).

According to Goldfarb et al., (2007), the rise and the fall was observed in Nasdaq index which was at 5,132 on March 10, 2000. This point was the top and it was more than 500% above its level on August 9, 1995, the day of the Netscape initial public offering. However on September 23, 2002, the Nasdaq index was at 1,185. The 18-month decline of stock prices resulted in $4.4 trillion of market value loss. The main reasons for the failure of dot-coms were poor service quality, inexperienced management, and high competition due to huge number of companies (Oliva et al., 2003; Thornton & Marche, 2003).

After the failure of dot-coms the e-commerce became more business driven rather than technology driven. The venture capital financing trend and aggressive revenue growth strategies of late 1990s were leaved. The companies realized that the customers were using Internet as an information source and preferring traditional purchasing. So pure online strategies replaced by mixed strategies. Companies started to use Internet promote their brand awareness. This approach continued until 2006 when the

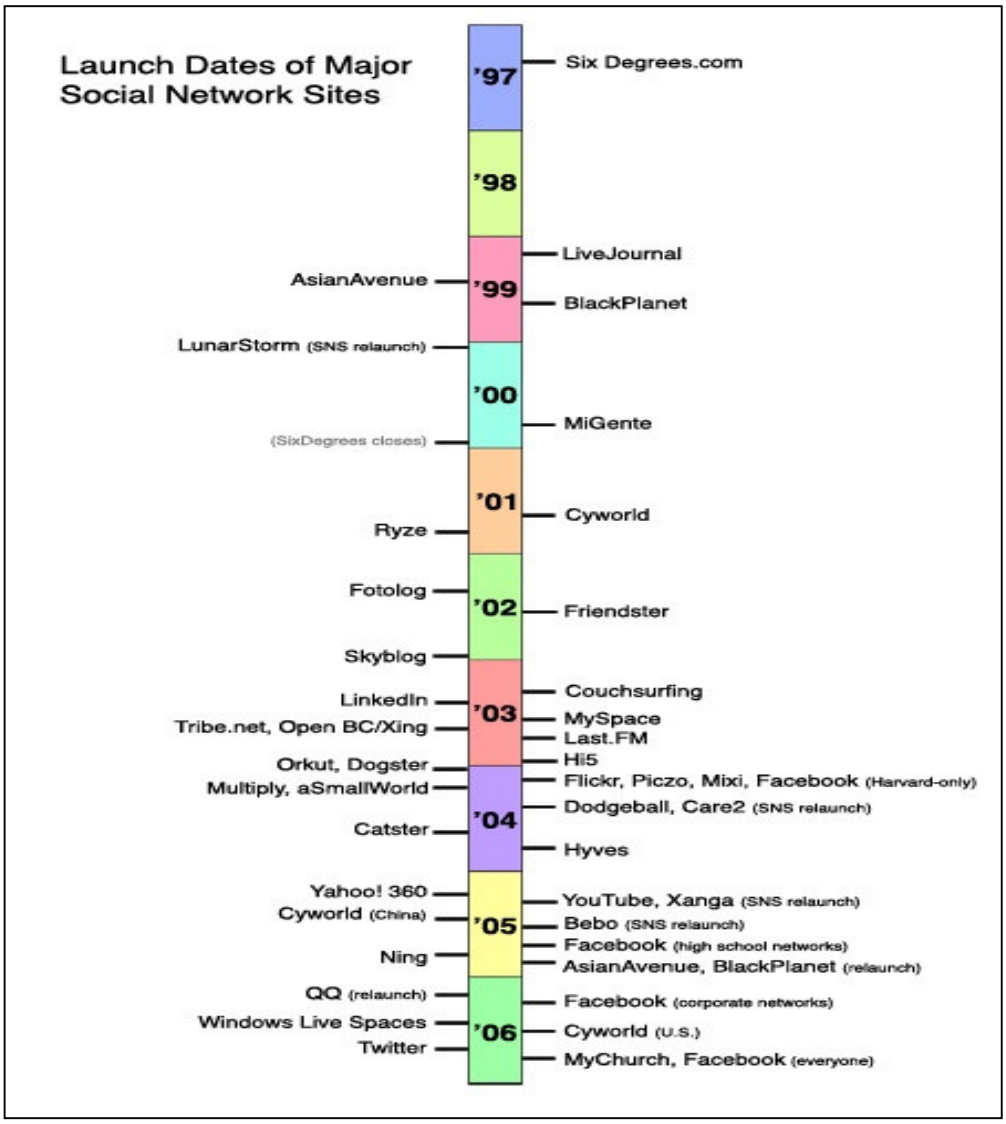
consolidation era of e-commerce ended. (Laudon & Traver, 2009). The annual growth rate of e-commerce varied between 20% and 30% in this period as shown in Figure 3.2 below.



Source: Data derived from White (2010).

Figure 3.2. U.S. E-commerce Sales and Growth Rates

While evolution of e-commerce was going on in late 1990s and early 2000s, the Internet leaded another new phenomenon called as social media or social network. As it can be seen in Figure 3.3, the pioneers of social networking sites were introduced in 1997. However the rise of the social media can be said to be recognized in 2006 after the Facebook was opened to use of everyone and the Twitter was established.



Source: Boyd and Ellison, (2007).

Figure 3.3. Time Line of Social Network Sites

According to Boyd and Ellison, 2007 social network sites are defined as "web-based services that allow individuals to construct a public or semi-public profile within a bounded system, articulate a list of other users with whom they share a connection, and

view and traverse their list of connections and those made by others within the system." In a short period social network sites became part of many people's daily life. The following stats in Table 3.2 may facilitate understanding the usage levels of social networking sites.

Table 3.2. General Social Media Statistics

Annual stats per individual	***General Facts***
• 415 pieces of content on Facebook	• Over 2.8 billion social media profiles,
• About 23 minutes a day on Twitter	• 70 million WordPress blogs worldwide
• 15,795 tweets	• 39 million Tumblr blogs worldwide
• 563 check in on Foursquare	• 4 out of 5 internet users visit social networks and blogs
• 196 hours of video upload on YouTube	
• Countless e-mails	• Over 465 million Twitter accounts
Source: Data derived from Pring,(2012).	

The rise of social media affected e-commerce and leaded the reinvention period e-commerce which started in 2006 and is still going on. The business driven approach of early 2000s turned into customer oriented approach. Regulations and government surveillance became an important factor. In addition to products services started to be provided through e-commerce. Mixed financing strategies started to be used by many companies (Laudon & Traver, 2009). Social media became one of the most effective marketing tools as it allows reaching huge potential consumer groups better than

television and radio and enables customer interaction. As the use of internet based marketing tools increased companies started to mix their marketing strategies and developed strategies which enable utilizing social media to bring consumer experiences to the forefront but also recognize that Internet-based media does not replace traditional media (Hanna, Rohm, & Crittenden, 2011). The statistics given in Table 3.3 show the usage of social media in business world.

Table 3.3. Social Media in Business World

General Facts	
• 50% of people follow brands in social media	• One in three small businesses are now using social media
• One out two mobile shoppers share their shopping experience on social networks	• 38% of CEOs label social media a high priority, and 57% of businesses plan to hike their social media spend in 2012
• 75% of companies now use Twitter as a marketing channel	• 40% of companies admit to having no training or governance of social media
• 36% of social media users post brand-related content	• 89 percent of agencies said they would use Facebook to advertise for their clients in 2012
• 41 percent of the class of 2011 used social media in their job search	• Mobile advertising is exploding – during Q4 2011, mobile advertising was up 39%
Source: Data derived from Pring,(2012).	

3.3. Problems and Requirements of E-commerce

Today's e-commerce business models are focused on social media and consumer generated content. Although the internet penetration growth level decrease, the purchase levels are increasing thanks to the fact that use of online shopping is growing very fast among teens and older adults. Travel, entertainment, retail apparel and home furnishing industries have significant growth potential for e-commerce. Small businesses focused on these sectors and are using e-commerce infrastructures of large firms. This trend is the main reason behind the growth of B2B. As the developments in information and communications technologies are going on the rise of m-commerce is being recognized more significantly. New generation services and devices are enhancing the growth of m-commerce not only in B2C but also B2B e-commerce. Blogs, wikis, virtual lives and social networks are replacing traditional media channels and the importance of user generated content is increasing (Laudon & Traver 2009).

The reinvention period of e-commerce is also the time that the barriers to e-commerce are started to be discussed. Limitations of B2C e-commerce, security concerns, digital divide, regulations, and Internet governance are some of the issues that are considered as the factors that will determine the future of e-commerce.

Recalling the definition of social network by Boyd and Ellison, (2007), we can say that the key factor in the social networking is sharing. When we talk about sharing, we must think about the limit of it for an individual. How much detail do you share about your personal life? How much information can your child learn about ideas of a terrorist group? What if one of your R&D personnel tweets like "I am working on … it is very

interesting" and shares a small detail of your new product? These questions lead people to the dilemma between security and freedom which is a common discussion in all Internet based applications.

The growth of the social network usage is not the only reason of security concerns. From the beginning, security has been one of the most important requirements of e-commerce and is still a barrier to expansion of e-commerce. Individuals, institutions and businesses require a secure network to protect trade secrets, personal information, privacy etc. According to a survey more than 68.37% of people do not like online shopping because of security concerns e-commerce (Huang and Zhao 2011).There is a common view in several studies (Rattan et al., 2010; Huang and Zhao, 2011; Gunasekaran et al., 2002; Gibbs et al., 2003), that security is a bottleneck of e-commerce development. So meeting the needs for confidentiality, integrity and non-repudiation is vital to provide secure transactions.

Security concerns also require regulations. Because of that, many developed countries and international organizations have already published or are working on Internet and e-commerce regulations including issues like network security, limited contents and access. Additionally there are many regulations about competition which are limiting the content of advertisements and promotions (Gunasekaran et al., 2002). Moreover many companies are preventing their employee's access to social media not only to promote security but also to reduce inefficient working time (Networkworld, 2012). So Internet and e-commerce regulations are going on to be a part of the endless debate on security-freedom dilemma.

On the other hand there are developing countries where the lack of regulations on privacy, security, business laws for e-commerce, Internet purchases and Internet taxation causes low consumer trust in e-commerce and willingness to buy online (Kshetri, 2007). Copyright and intellectual property issues are one of the most important aspects of regulation requirements. The lack of these regulations or differences in countries' practices is another problem for e-commerce (Bajaj & Leonard, 2004). So the need for standardized legal practices and clear regulations is critical for development of e-commerce.

As some of the barriers to e-commerce in developing countries have started to be explained above, it is appropriate to discuss the most known problem of these countries, the digital divide. According to OECD (2012b), the digital divide is defined as "the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard to both their opportunities to access information and communication Technologies and to their use of the Internet for a wide variety of activities. The digital divide reflects various differences among and within countries." Considering the fact that e-commerce requires the use of information and communication technologies, we can see the difficulties to expand e-commerce in countries where the necessary infrastructure and technology do not exist or not in adequate levels.

It can be said that establishing corporate, websites or email systems do not require many resources. But today's e-commerce requires more than that in order to perform secure online transactions and to have integrated internal business processes (Hong &

Zhu, 2006). E-commerce growth potential is bigger in developing countries than in developed countries. However;

- the lack of economies of scale,
- lower bandwidths and slow Internet access speed,
- low Internet penetration,
- low purchasing power,
- the lack of distribution channels and logistics,
- the lack of technological infrastructure
- the lack of education
- high cost of broadband connectivity
- lack of awareness and knowledge of e-commerce benefits
- lack of confidence in service providers.
- inadequate level of general and computer illiteracy
- lack of workforce with e-commerce expertise

in developing countries limit this potential (Kshetri, 2007; Bajaj & Leonard, 2004). Additionally the use of inadequate technology, infrastructure and required resources has very big potentials to cause failed e-commerce practices (Gunasekaran et al., 2002). So the efforts for utilizing e-commerce for economic development can easily turn to waste of limited resources for developing countries.

Another barrier to e-commerce is language and cultural factors which are also among the reasons of digital divide. According to Kshetri (2007), in Asia, people prefer personal face-to-face communications over e-mails and real relationships over virtual

ones. Furthermore they are very risk averse. So these cultural behaviors adversely affect e-commerce. Additionally the lack of English skills and local language web sites are playing a big role in limiting the e-commerce growth potential. Consumers want to enjoy the benefits of Internet and e-commerce in their own languages. So multilingualism becomes a requirement for e-commerce (Gibbs et al., 2003; Kshetri, 2007).

Finally, internet governance is another factor to affect the development of e-commerce. The existing relationship of ICANN and U.S. government and the role of ICANN in management of critical Internet resources like domain names and IP addresses are being argued by many countries and international organizations. The dissatisfaction of these parties may become a huge barrier to e-commerce (Koppell, 2005).

To sum up, although the times of explosive growth are ended, e-commerce is still growing and has bigger potential especially in developing countries. However meeting the above mentioned requirements will play a big role in utilizing this potential and will determine the future of e-commerce.

CHAPTER 4: INTERNET, DOMAIN NAME SYSTEM AND DIGITAL OBJECT ARCHITECTURE

Internet is the main tool that adds “e” to commerce. In this chapter firstly a brief history and concepts of Internet are given. Then DNS, ICANN and the existing situation in internet governance are analyzed. Finally the basics of DOA are explained.

4.1. Brief History and Basic Concepts of Internet

Internet is defined as “a global system of linked computer networks that allows data communication services such as remote log in, file transfer, electronic mail, bulletin boards and news groups” (OECD, 2012c). The history of Internet starts in older times than it is expected. In late 1960s Advanced Research Projects Agency of U.S. Department of Defense developed a computer network with the aim of mobilizing research resources and connecting important research organizations in U.S. (Castells, 2002; Liu & Albitz , 2006).

The network was called as Arpanet and it was developed based on the memos written in 1962 by MIT’s Joseph Carl Robnett Licklider outlining the galactic networking concept. The concerns about Soviet Union’s military power were an important motivation factor. Arpanet of 1960s evolved to an interconnected network of thousands of networks and millions of computers, linking businesses, educational institutions, government agencies and individuals, as we call Internet today (Laudon & Traver, 2009). The milestones from the history of Internet are given in Table 4.1.

Table 4.1. Internet Milestones

Date	***Milestone***	***Date***	***Milestone***
1961	• The packet switching concept was born.	***1990***	• Non-military applications allowed
1972	• E-mail was invented.	***1993***	• The first graphical web browser "Mosaic" was invented.
1973	• Ethernet and local area networks were invented.	***1994***	• The first commercial web browser "Netscape" was introduced.
1974	• Transmission control protocol (TCP) and Internet Protocol (IP) was invented.	***1995***	• Commercial civilian Internet was born • Pure online e-commerce applications started
1980	• TCP/IP became an official Department of Defense standard. • Personal computers were invented.	***1998***	• ICANN was founded and started to govern domain names and addresses.
1982	• Hyperlink concept was introduced.	***1999***	• The first full service Internet only bank was opened.
1984	• DNS was introduced	***2003***	• The Internet2 Abilene high-speed network was upgraded to 10 Gbps
1989	• World Wide Web (WWW) was invented.	***2005***	• Recognition of security and functionality needs of Internet
Source: Data derived from Laudon & Traver,(2009).			

It is appropriate to give some definitions and explanations of Internet related concepts before starting to discuss DNS and DOA.

First, the Internet and internets are different things. The Internet is the network whose brief history was given above starting from Arpanet of 1960s and that uses TCP/IP. However internet with small (i) refers to any network constitutes from multiple smaller networks which use the same protocols to communicate and interoperate. The internets can use protocols other than TCP/IP and do not have to be connected with the Internet. (Liu & Albitz , 2006).

Another clarification is needed to distinguish between WWW and the Internet. WWW is one of the Internet's most popular services, providing access to over 50 billion Web pages. WWW relates to software however the Internet is the hardware that is based on packet switching and uses TCP/IP (Laudon & Traver, 2009).

The Internet uses packet switching which is a telecommunications transmission technology that allows decentralized, flexible communication networks. It was developed by Paul Baran and Donald Davies. Packet switching breaks files into data packets before transferred over network instead of transferring files in their entirety. TCP is the transmission control protocol that is used for safe delivery of packets. It ensures that two computers can communicate with one another in a reliable fashion. IP is the internet protocol which handles packet delivery by formatting the packets and assigning the addresses. Packets are labeled with the addresses of the sending and receiving computers. (Castells, 2002; Laudon & Traver, 2009).

Another key term of Internet infrastructure is IP address. Communication over the Internet is based on delivering the packets to the designated addresses. These addresses are called as internet IP addresses. An IP address is defined as the numerical address by

which a location in the Internet is identified. Computers on the Internet use IP addresses to route traffic and establish connections among themselves (ICANN, 2012a).

4.2. Domain Name System and ICANN

The IP addresses are long numerical addresses which are not easy to remember for people. So people want to use more human friendly addresses instead of these numbers and need a system to represent IP addresses with words or letters. These human friendly words and letters are called as domain names and DNS is the system that provides the transformation of IP addresses to human friendly names (Liu & Albitz, 2006).

DNS has a hierarchical structure as shown in Figure 4.1.below.

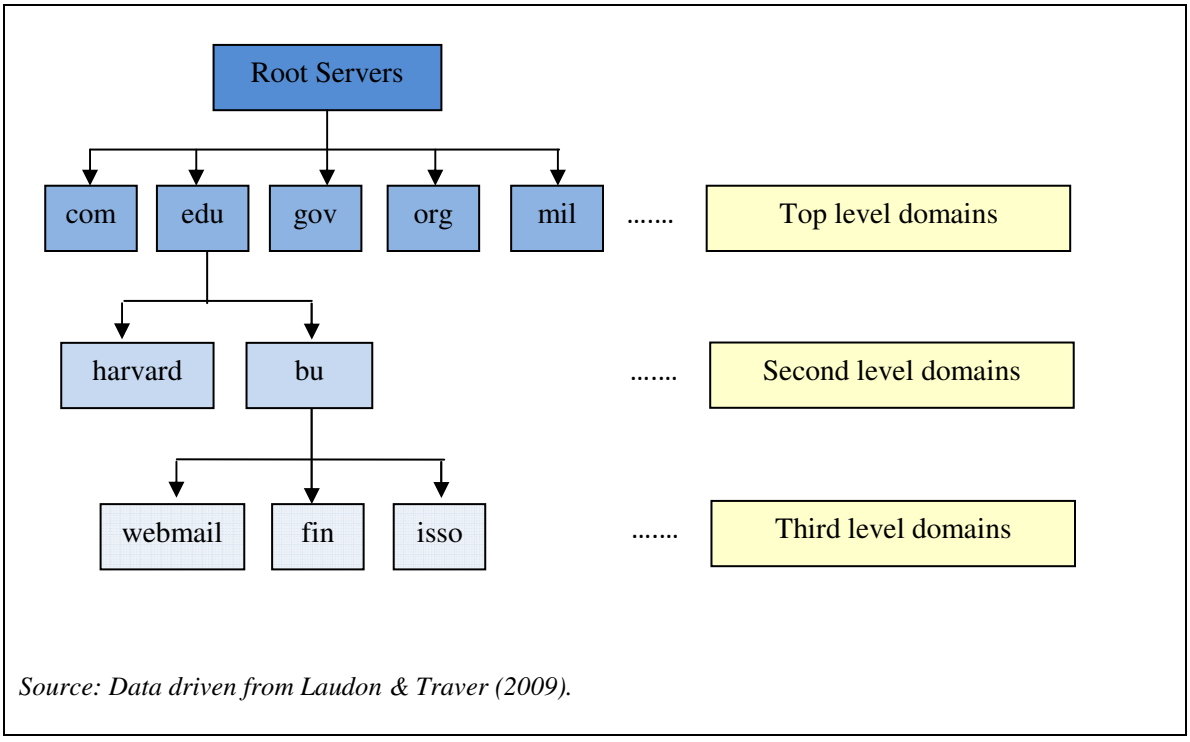


Figure 4.1. DNS Hierarchy

Root servers are at the top of the hierarchy. According to ICANN (2012b), root servers contain the IP addresses of all the top level domains (TLD), which are at the second stage in the hierarchy, including the global registries like .com, .org, etc. and the country-specific registries such as .tr (Turkey), .uk (United Kingdom), etc.. DNS servers which are databases that keep track of IP addresses and domain names, route the traffic using the information in Root servers. Under each top level domain there are second level domains. Second level domains are assigned to organizations or individuals like bu.edu for Boston University. Then the third level domain names represent a specific computer or a system includes computers like webmail.bu.edu for e-mail system of Boston University (Laudon & Traver, 2009).

DNS servers (or name servers) include authoritative name servers, recursive name servers and caching name servers. Authoritative name servers are configured to host the official record of the contents of a DNS zone. Each domain name must have a set of these so computers on the Internet can find out the contents of that domain. For example root servers are authoritative name servers for root level. There are also authoritative name servers for other levels of DNS hierarchy (IANA, 2012).

When we type webmail.bu.edu" to our browser the computer sends this query to local name server. The local name server queries a root name server for the address "webmail.bu.edu" and is referred to the ".edu" name servers. The local name server asks same question to ".edu" name servers and is referred to the "bu.edu" name servers. After asking same question local name server is referred to "webmail.bu.edu" name servers and gets the answer which is the IP address. This process is known as recursive resolution.

Resolution process can be shortened and simplified by non-recursive resolution or caching. In non-recursive resolution queried name servers send the query to other name servers in the hierarchy until the answer is found. In caching a name server remembers the answer of a query that has just looked up and does not start the resolution from the top of the hierarchy (Liu & Albitz, 2006). Caching name server remembers the results of previous lookups in a cache to speed future lookups. And recursive name server or caching resolver is configured to perform DNS lookups on behalf of other computers. This is often configured at corporate network boundaries and internet service providers for their network customers to use (IANA, 2012).

In DNS hierarchy each domain can be broken into sub domains. For example "bu.edu" which is a second level domain is a sub-domain of ".edu" which is a top level domain. Different organizations can be responsible for these sub-domains. These responsible organizations are called as delegating authority. Hierarchical structure of DNS eliminates name collisions. Each domain has a unique domain name. The delegating authority of a domain is free to name sub-domains within its domain. The names of these sub-domains do not conflict with other organizations' sub-domain names because it will end in their unique domain name (Liu & Albitz, 2006). For example EDUCAUSE is the delegating authority of ".edu" and delegates "bu.edu" to Boston University and "harvard.edu" to Harvard University. Boston University is the delegating authority of "bu.edu" and can break this domain to sub-domains like "webmail.bu.edu" or "alumni.bu.edu". And these domains do not conflict with similar sub-domains of Harvard University like "webmail.harvard.edu" or "alumni.harvard.edu".

The rules and procedures regarding delegation process is settled by Internet Assigned Numbers Authority (IANA) which is a department of ICANN tasked with providing various Internet coordination functions, primarily those described in a contract between ICANN and the US Government (IANA, 2012).

Although DNS is an important tool and has been used for long years it has some problems. The security flaws of DNS have been well known since mid 1990s. In 1995 Steven M. Bellovin's study which explains how to perform DNS based attacks highlighted these problems (Bellowin, 1995). Then, Internet Engineering Task Force (IETF) introduced DNSSEC in RFC 2065 in 1997 (Eastlake & Kaufman, 1997). The DNSSEC is an official evidence for the security flaws of DNS. Furthermore, although DNSSEC solves the security problems caused by name based authentication attacks, it has its own vulnerabilities (Ariyapperuma & Mitchell, 2007).

Additionally, Mockapetris (2003), highlighted the fact that using digital signatures as DNSEC infrastructure is beneficial but the discussions on who gets to have signing authority are political ones. This is a precisely accurate finding. But it can be said to be disappointing as well, considering the status and results of political discussions on Internet governance which will be mentioned later in this chapter. Furthermore, DNSSEC deployment and DNS based attacks were still listed among the concerns of many internet service providers even several years after from the first introduction of DNSSEC (McPherson, 2010).

Some of the security threats for DNS and the vulnerabilities of DNSSEC are summarized in Table 4.2 below.

Table 4.2. Security threats for DNS and the vulnerabilities of DNSSEC

Security Threats for DNS	Vulnerabilities of DNSSEC
Packet interception	Chain of trust
Identity guessing	Key rollovers
Query prediction	Timing issues
Name chaining	Wildcard proof mechanism
Betrayal by trusted server	Zone private key storage
Denial of service	Increased computational load
Authenticated denial of domain names	Lack of management tools & consistency control
Wildcards	NSEC zone
Source: Data derived from Atkins and Austein (2004); Ariyapperuma and Mitchell (2007)	

In addition to security problems mentioned above DNS is criticized also for language issues. DNS does not allow using characters other than American Standard Code for Information Interchange (ASCII). That means, domain names can not include language specific characters. Some of the languages like Turkish, Spanish or Portuguese have a few characters out of ASCII. But the problem is bigger for other languages like Arabic or Chinese which use completely different alphabets. This weakness of DNS is important considering the effect of language barriers to Internet related content and resources and of course to e-commerce (Chaudri, 2007).

Language problems which are considered as one of the biggest reasons of digital divide have been highlighted in the studies under World Summit on Information Society (WSIS) especially by International Telecommunications Union (ITU) for years (ITU, 2010).

In order to meet the language requirements, Internationalized Domain Name (IDN) concept was introduced by IETF in RFC 3490 (Faltstrom, Hoffman & Costello, 2003). According to ICANN (2012c), “IDNs are defined as domain names that include characters used in the local representation of languages that are not written with the twenty-six letters of the basic Latin alphabet. The "hostname rule" requires that all domain names of the type under consideration here are stored in the DNS using only the ASCII characters. The Unicode form of an IDN therefore requires special encoding before it is entered into the DNS.”

Internationalizing domain names in applications (IDNA) which was introduced RFC 3490, is accepted as a standard. The IDNA does not change the architecture of Internet and does not replace the DNS. ASCII characters are still in use. as the basic underlying structure. But, the language specific characters in Unicode system are used in IDNs and these characters are converted to a form called as ‘Punycode’ in web browsers (Daithi, 2010). The parts of domain names which are separated by dots are called as labels. The ASCII form of an IDN label is called as "A-label". The Unicode form or the punycode form is called as "U-label". For example, the Hindi word for “परीका” which

means test is in U-label format. And the corresponding A-label is xn--11b5bs1di (ICANN, 2012c).

IDNA has limitations which has addressed in RFC 3490. Many important language-based and script-based mappings like a mix of traditional and simplified Chinese characters or Scandinavian names are not covered in IDNA (Faltstrom, Hoffman & Costello, 2003). Additionally the transform mechanism of IDNA is at the end user level or in web browsers in other words. To use the IDNs, the web browsers must be capable to recognize the domain name typed is an IDN and convert it to A-label format. This situation causes some implementation problems. For example older versions of web browsers do not support IDNs. A user must have the following browsers at minimum to use the IDNs.

- Internet Explorer 7.0
- Firefox 0.8
- Opera 7.11
- Mozilla 1.4 or Firebird
- Mozilla Firebird
- Netscape Navigator 7.1
- Konqueror KDE 3.2
- Safari 1.2

Some of the web browsers require specific patches to operate IDNs (ITU, 2012). On the other hand the use of IDNs through IDNA causes additional security vulnerabilities like spoofing (Daithi, 2010).

IDN proxies are able to provide solutions for IDN use with legacy Internet applications. In this case, internet service providers must establish IDN proxies and the consistency between all IDN proxies is a concern. Furthermore it is possible to experience problems with IDN proxies in recognizing all of the different kinds of encodings used (Lin, Ho, Tseng & Lai, 2006).

Although the use of IDNs is possible, the abovementioned problems are still being discussed. Additionally, many parties point out ICANN for solution of the problems. As it is the most important organization, in domain name management, it is expected to act more effectively (Daithi, 2010).

ICANN was established on September 18, 1998 (IANA, 2001). ICANN (2012d) defines itself as "an internationally organized, non-profit corporation that has responsibility for IP address space allocation, protocol identifier assignment, generic (gTLD) and country code (ccTLD) Top-Level Domain name system management, and root server system management functions."

Explanations may be needed for some of the terms related to ICANN's activities in DNS management. The top level domain names .aero, .biz, .com, .coop, .info, .museum, .name, .net, .org, and .pro can be registered through many different companies. These companies are accredited by ICANN and called as registrars. Internet users can register names ending with above mentioned TLDs through ICANN accredited registrars. Domain name allocation records of the contact information are kept by registrar while the technical information is submitted to registry. Registry is the authoritative, master database of all domain names registered in each Top Level Domain. The registry operator

keeps the master database and also generates the zone file which allows computers to route Internet traffic to and from top-level domains anywhere in the world (ICANN, 2012e). Domain name registrations can be subject to disputes. These disputes generally results in courts. However the related parties of the disputes may prefer a shorter and cheaper dispute resolution mechanism provided by dispute resolution service providers who act according to Uniform Dispute Resolution Policy (UDRP) of ICANN (ICANN, 2012f).

The main responsibilities of ICANN are to manage the DNS System, expand the Top-Level Domain Names, maintain registrar Competition and develop Dispute-Resolution mechanism (Koppell, 2005). ICANN decides on the number of gTLDs, and the organizations which can register for a website in a specific domain, and also the suffix for that domain. Additionally it also determines the registry organizations, and registrars. Furthermore, it sets the rules for resolution of disputes among website holders and manages the IP address allocations and DNS roots (Lenard & White, 2011). These functions clearly show the critical and dominant position of ICANN on Internet which is one of the most important and strategic global issues of the world. However ICANN's structure ironically is very different from political and organizational schemes which have been established to manage such global phenomena like Internet. It is not an intergovernmental treaty organization. It is also different from non-governmental organizations (Kleinwächter, 2000).

ICANN is managed by a CEO, has its own personnel and its decision making authority is board of directors. Advisory groups including IETF and similar advisory

bodies like Government Advisory Committee involve the coordination of ICANN's acts. ICANN emphasizes that the contribution of Internet community is very important for its decisions and rules. However in the end, it is ICANN's board that makes those decisions and the real function of these advisory bodies are arguable. Additionally the lack of government oversight and accountability of ICANN are major concerns of many parties (Lenard & White, 2011).

ICANN's unique organization structure has been criticized for years. ICANN can decide to add a new TLD to the root which is public policy decision. However it is not an international organization with sovereign competencies or a national regulatory body. So its authority to decide on public policy issues is not clear. Another contradictory part of ICANN's legal status is the fact that it was formed based on a Memorandum of Understanding between the US Department of Commerce and ICANN but it acts globally. Additionally the advisory status of governments does not satisfy the parties who have expectations that such an organization like ICANN should be sustained by a more democratic and legitimized background (Weber, 2008).

There are also criticisms for ICANN's procedures and policies regarding country code top level domain names (ccTLDs) which are two letter domains, such as .uk (United Kingdom), .de (Germany) and .jp (Japan) and correspond to a country, territory, or other geographic location. Governments have some concerns about possible violations to their sovereign rights with existing operations of ICANN regarding ccTLDs. The hierarchical infrastructure of DNS and the control of the root give ICANN and US government to affect the management of ccTLDs. Many governments believe that the power of domain

name management is big enough to affect distribution of IP addresses and domain names, e-commerce, strategic infrastructure and defense (Hagen, 2003). Additionally, governments have no rights on the ccTLD that represents their country if this ccTLD has been delegated to a particular entity. Governments can apply for dispute resolution regarding ccTLDs but dispute resolutions can result hostile to governments (Kumar and Mowshowitz, 2006).

Uniform Dispute Resolution Policy (UDRP) and the related rules are very important not only for governments but also for business world and e-commerce. Domain names are considered as business assets because they have a huge impact for advertising and marketing purposes Kah Leng (2010). So the dispute resolution mechanism should be clear and efficient enough to produce fair decisions. However UDRP is criticized for being in favor of complainants and ICANN is expected to update the UDRP and related rules to meet the requirements of business world and governments Dieguez (2008).

Consequently, DNS and ICANN, as the manager of it, are both criticized by many parties both from technical and political aspects. These criticisms support the idea of alternative systems and mechanisms or reforms in the DNS and ICANN's existing status.

4.3. Digital Object Architecture

Digital Object Architecture is defined as "a general-purpose distributed information system that provides efficient, extensible, and secure handle identifier and resolution services for use on networks such as the Internet" (CNRI, 2012). According to

Kahn (2005), “it is an open architecture that links together different information systems rather than just different networks and their computers.”

DOA was developed by Corporation for National Research Initiatives (CNRI) under the leadership of Dr. Robert Kahn who is known as co-designer of the TCP/IP Internet network protocol along with Vinton Cerf. In fact the history of DOA has started in 1980s (CNRI, 2010). However, it is not very known and popular because of the hot political discussions about internet governance. The studies on DOA are supported by ITU. A memorandum of understanding was signed between ITU and CNRI in 2008 aimed to enhance cooperation in related studies (Assefa, 2011).

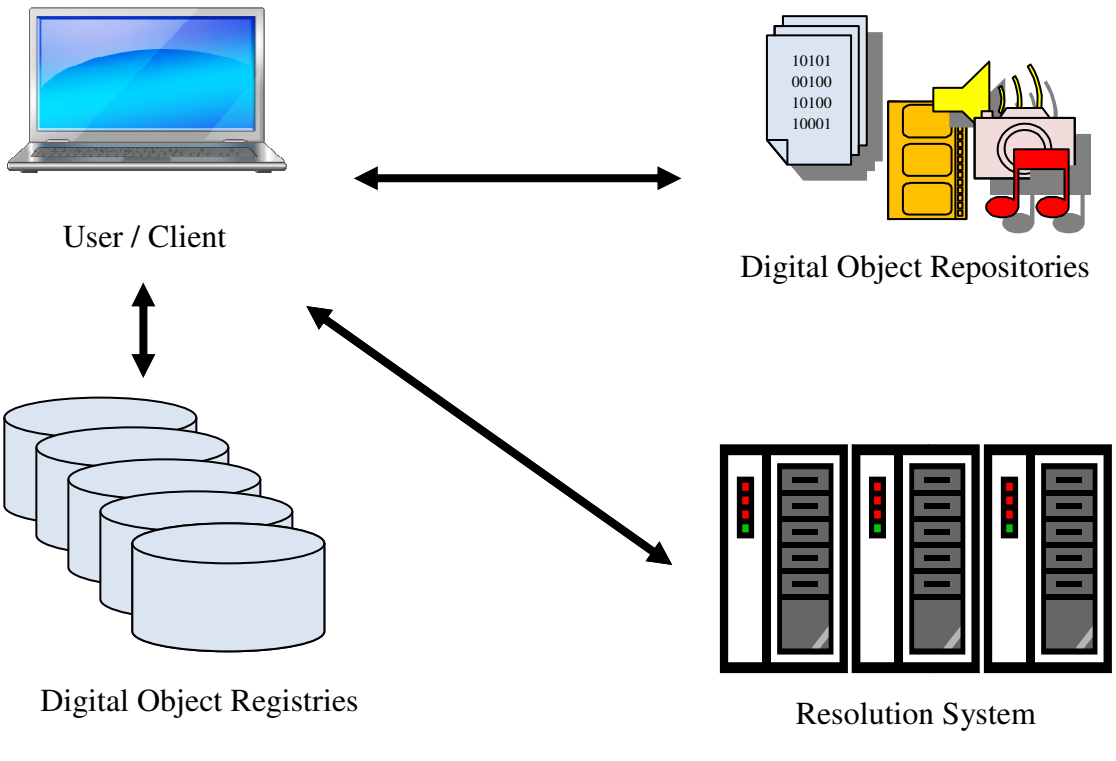
DOA uses handles which are unique, persistent identifiers and it provides a registry to find things online just like DNS. But DNS registers machines, while DOA registers digital objects. DOA deals with specific information objects, instead of just flows of packets between servers (Dyson, 2003). The main components of DOA are digital object repository, resolution system and digital object registry.

Digital object repository stores digital objects and provides access to them. The number of depositories in the system is not limited. Digital object repository uses a software to manage the objects. Storage system is the other component of the digital object repository which holds the objects. Each digital object is assigned a unique persistent identifier and all access to the digital object repository is based on the use of identifiers (CNRI, 2010).

The resolution system is a principle function of the Handle System. Handle system has been used for 15 years. For example International DOI Foundation (IDF),

uses DOI System. This system is an application of Handle System. In DOA architecture handle system maps known identifiers into handle records containing useful state information about the digital object being identified (Dyson, 2003; CNRI, 2010).

The digital object registry is used to define collections of digital objects with appropriate access controls. It provides a user interface to browse and search. Additionally it includes an application for external programs to search the registry (Kahn, 2011). The main components of DOA are shown in Figure 4.2 below.



Source: Kahn (2011).

Figure 4.2. Components of DOA

The DOA provides many benefits and advanced features to meet the requirements of Internet community. DOA uses UTF-8 encoding and allows use of Unicode

characters. So it has native support to multilingualism in identifier names. This feature provides the ability to use IDNs without problems (Assefa, 2011).

The handle protocol has been optimized for speed, reliability and scaling. An unlimited number of entities can provide their own local handle services and thus ensure local control of identifier information. DOA provides more efficient request handling and larger storage in a record (CNRI, 2012). DOA is not a hierarchical architecture. It separates control of handle from control of server. This feature provides location independency (Dyson, 2003).

According to CNRI (2012), "DOA provides secured handle resolution. Security services such as data confidentiality, data integrity and non-repudiation can be provided at the client's request. Transactions can thus be made secure and certified, offering the potential to improve cybersecurity. A prefix administrator may control changes to its handle records using its intrinsic PKI capability. This means that handle records can be managed securely over the Internet by its administrator".

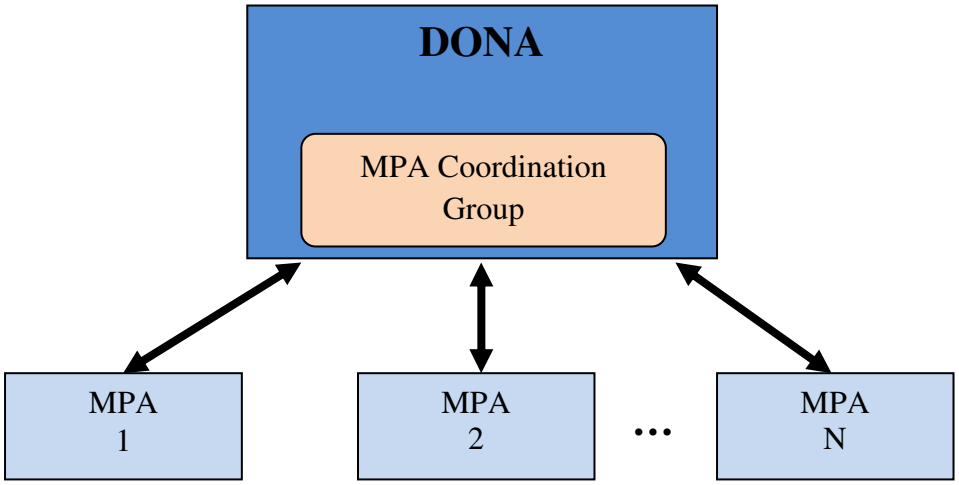
DOA is based on an open-defined protocol and data model free protocol, which means that it can be used as engine to support other named identifiers and interoperability of alternative identifier systems. Furthermore the control of the handle records is distributed. (Kahn, 2011).

The benefits and features of DOA are summarized in Table 4.3 below.

Table 4.3. The benefits and features of DOA

Benefits & Features	Explanation
Enhanced security	Secure communication with digital objects.
Multilingual support	Native support for IDNs.
Persistency	Persistency, irrespective of the object's location, owner and type and technology.
Enhanced search capabilities	Searches can be specified through metadata registries that hold relevant information about digital objects
Secure record update	Secure, Easy and distributed information management.
Distributed technical management	Management is distributed to multiple independent parties which are working in collaboration
Compatibility and interoperability	DOA is backward compatible, and it can interoperate with existing architectures including DNS.
Source: Data derived from Assefa (2011).	

In addition to above mentioned technical features and benefits of DOA, CNRI is offering a management model. Today global handle registry is managed by CNRI. However according to the offered management model shown in Figure 4.3, Digital Object Numbering Authority (DONA) will determine the administrators and CNRI will be one of them (Kahn, 2011).



Source: Internet Society (2012).

Figure 4.3. Offered Management Model for DOA

DONA will be responsible for technical oversight of the critical infrastructure. It will be the policy maker for technical management issues. Day-to-day operations related to technical infrastructure will be under the responsibility of multi-primary prefix administrators (MPAs). DONA will set the requirements under which MPAs would operate. Additionally a coordination group called as MPA Coordination Group will be formed as a part of DONA. This group will be responsible for coordination among MPAs (Internet Society, 2012).

According to the offered management system, DONA will act as an independent authority will be a non-profit organization. Decision making body of DONA will be a board which consists of members with relevant technical background and expertise. The members of the board can be individual or represent governments, private sector, civil

society and international organizations. The decisions of the board will be taken by consensus. The board will have a chairman. The chairmanship will be in a rotating basis.

Besides the abovementioned basic rules about organizational structure, the details about the terms and conditions of DOA, policies and procedures about intellectual property matters, evolution of the technology, technical policy matters and management of critical resources are still not clear. The missing parts of the framework are planned to be prepared in close cooperation with appropriate parties in order to meet the requirements on a global basis and to establish a framework that is globally accepted (Kahn, 2011).

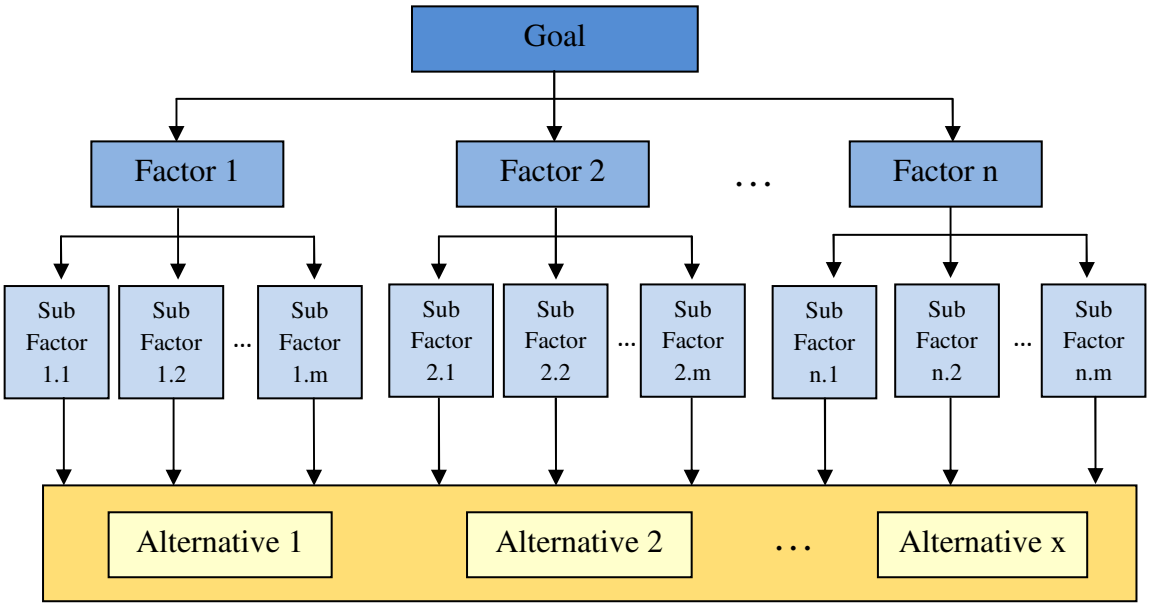
According to Assefa (2011), there are approximately 1,000 services built on DOA, in 64 countries. The most significant use of the system is International DOI Foundation's System that has over 50 million registered identifiers. The average resolution request per month in top-level DOA global root servers is nearly 100 million. So it can be said that although the DOA offers advanced technical features and benefits, it is not a well known system compare to DNS. And there are still areas, especially in the management framework, that need to be further clarified and developed.

CHAPTER 5: COMPARISON OF DOMAIN NAME SYSTEM AND DIGITAL OBJECT ARCHITECTURE

In this chapter, DOA and DNS are compared according to e-commerce requirements with AHP which is a multi-criteria decision making technique. AHP allows transferring qualitative evaluations to quantitative values in order to make reasonable choices between alternatives according to determined factors (Saaty, 2008).

5.1. Methodology

AHP is a useful multi-criteria decision making technique which uses a hierarchical decision structure. The hierarchical structure of AHP is shown in Figure 5.1 below.



Source: Wind and Saaty (1980)

Figure 5.1. AHP Model Structure

The goal is at the top of the hierarchy. It represents the desired result that the evaluated alternatives are expected to provide. Second stage of the hierarchy consists of main criterions or the factors that used for the evaluation of alternatives. The factors can be broken into sub-factors if the decision maker needs detailed evaluations from different aspects. The sub-factors are called as children of factors. The sub-factors can also have children if the decision process requires more details. The alternatives are the last stage of the hierarchy (Wind & Saaty, 1980).

Evaluation starts from the top. First the factors are evaluated with respect to the goal. Then sub-factors are evaluated with respect to the related factor. And finally the alternatives are evaluated with respect to sub-factors. The evaluation tool of AHP is called pair-wise comparison matrix shows evaluations of the elements in the same hierarchic level with respect to an upper level element. Pair-wise comparison matrices are formed for;

- Alternatives with respect to sub factors,
- Sub-factors with respect to factors
- Factors with respect to the goal.

In order to make evaluations the scale given in Table 5.1 is used. This scale transfers the quantitative assessments (like good, very good, important, less important etc.) to numerical values called as intensities of importance. The pair-wise comparison matrices consist of these numerical values. Since they represent comparison of an element with itself, the diagonal elements of all pair-wise comparison matrices are 1 (Saaty, 2008).

Table 5.1. The evaluation scale

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one activity over another
5	Strong importance	Experience and judgment strongly favor one activity over another
7	Very strong or demonstrated importance	An activity is favored very strongly over another; its dominance demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between two adjacent assessments	
Source: Data derived from Wind and Saaty (1980)		

Another common attribute of all pair-wise comparison matrices is the use of reciprocal values for corresponding elements. The example for pair-wise comparison matrix shown in Table 5.2 may be helpful for better understanding of this attribute.

Table 5.2. Example for pair-wise comparison matrix

With respect to goal	Factor 1	Factor 2	Factor 3
Factor 1	1	3	5
Factor 2	1/3	1	9
Factor 3	1/5	1/9	1

According to the example matrix given above, Factor 1 has moderate importance over Factor 2 with respect to the goal. So the intensity of importance is 3 which is the value in the intersection of row 1 and column 2. So the t value in the intersection of row 2 and column 1 is 1/2.

The principal eigenvector of all pair-wise comparison matrices in each level are derived and weighted to calculate numerical weights of the evaluated elements. Numerical weights are used in calculations of the upper level matrices. Finally, the alternative with the bigger weight is chosen. In order to have statistically meaningful results, the consistency ratios of all pair-wise comparison matrices should be equal or less than 0.1. Otherwise the inconsistent matrices should be altered to achieve valid results (Wind & Saaty, 1980).

5.2. Implementation

The AHP model for comparison of DNS and DOA with respect to e-commerce requirements as follows. First, the goal is meeting the e-commerce requirements. Considering the research on e-commerce given in 3rd chapter, the factors are determined

as security, digital divide and management. The sub-factors are in the next level of hierarchy. There are three sub-factors under each factor. And final stage of the hierarchy consists of alternatives which are DNS and DOA. The AHP model for comparison of DNS and DOA is given in Figure 5.2.

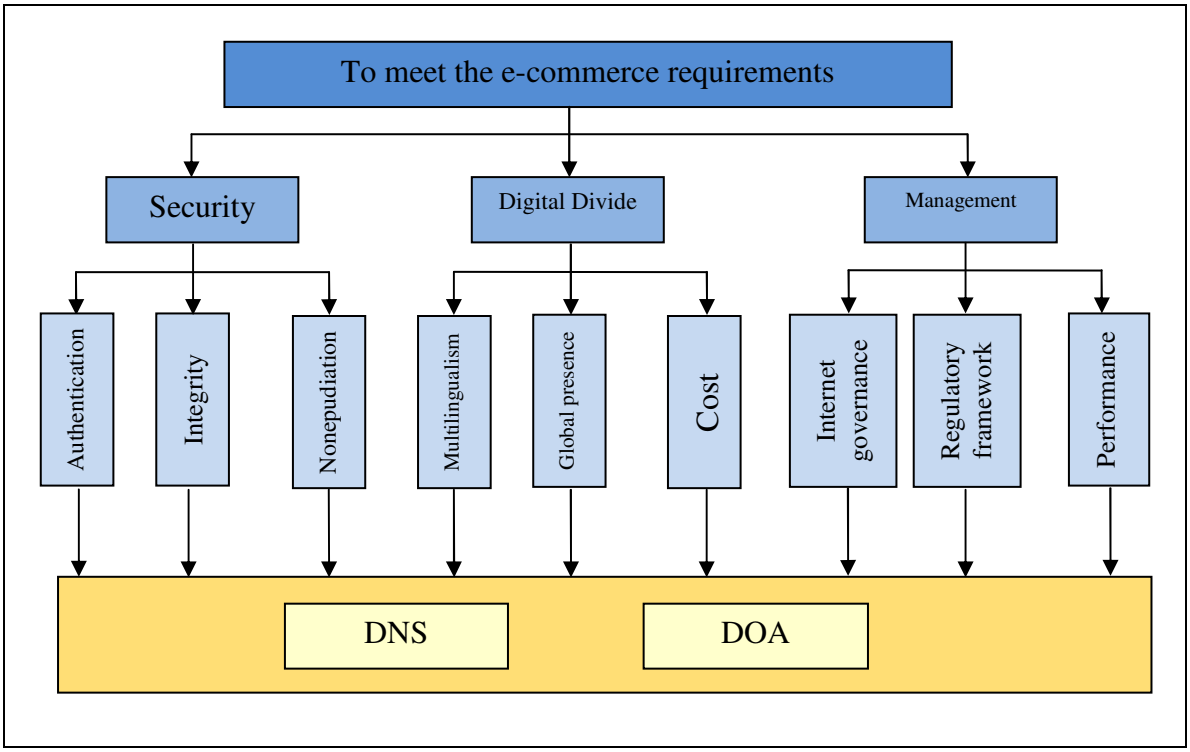


Figure 5.2. AHP Model for Comparison of DNS and DOA

The evaluations are based on a survey which was conducted recently. The participants are professionals working in the area of information and communication technologies and have the expertise on e-commerce, Internet and related technologies. The evaluations of the participants were taken through a questionnaire (consists of empty matrices). The personal information of the participants and the name of organizations

they work for are not disclosed in any part of this study as it was the precondition of most of them to participate the survey. However general information related to participant profile is given. The questionnaire was sent to 167 individuals 106 of whom agreed to participate. Statistics about distribution of participants are given in Figure 5.3.

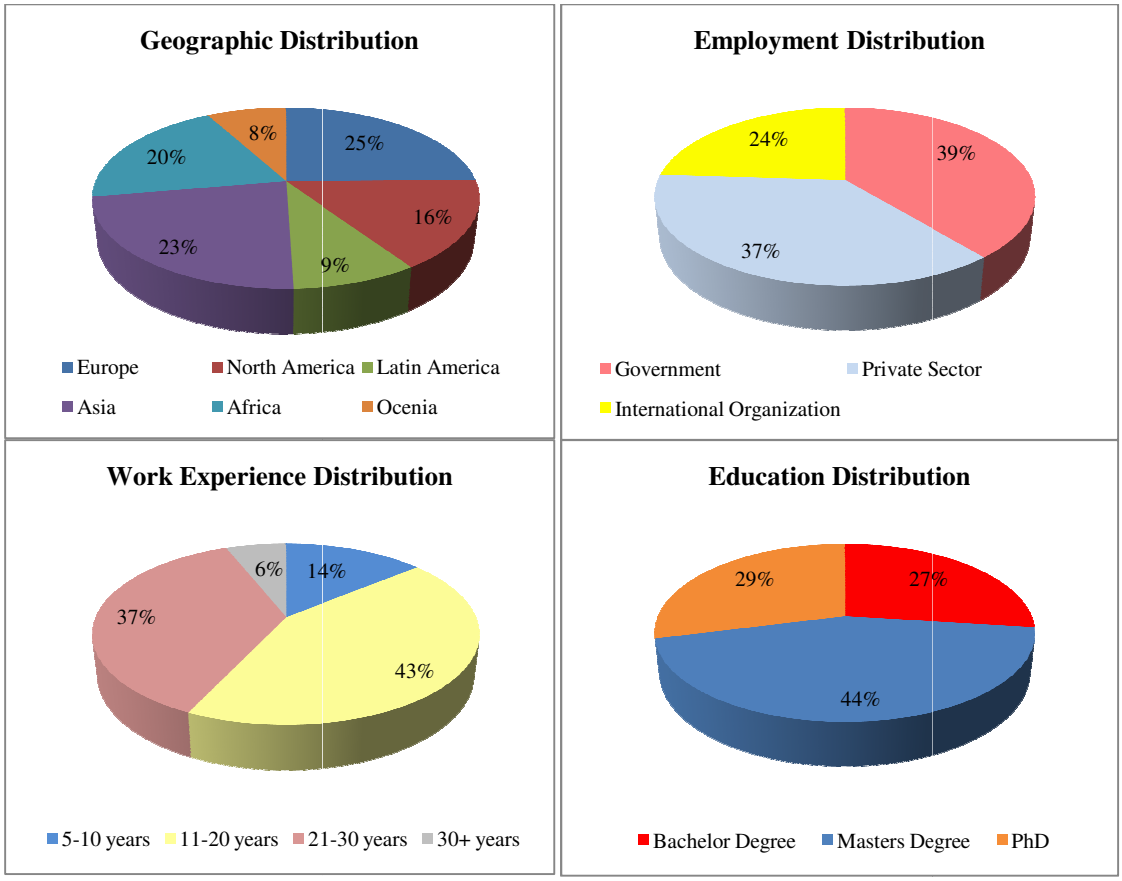


Figure 5.3. Participant Profile Statistics

The pair-wise comparison matrices of the model were established with the average values of participants' evaluations. The decimals were rounded to nearest integer.

5.3. Results of the Model

The model consists of 13 matrices which are given in Appendix. The consistency ratio of each matrix is less than 0.10 which shows the model is consistent. The results are summarized in Table 5.3. According to the total results of the model DOA is better than DNS in overall as it is also in security and digital divide. But DNS is the better alternative with respect to management factor.

Table 5.3. Results of the model

	Total		**North America**		**Developing Countries**		**Developed Countries**	
	DNS	**DOA**	**DNS**	**DOA**	**DNS**	**DOA**	**DNS**	**DOA**
Overall	**0.310**	**0.690**	**0.491**	**0.509**	**0.267**	**0.733**	**0.382**	**0.618**
• Security	0.294	0.706	0.333	0.667	0.280	0.720	0.333	0.667
–Authentication	*0.250*	*0.750*	*0.333*	*0.667*	*0.750*	*0.250*	*0.333*	*0.667*
–Integrity	*0.333*	*0.667*	*0.333*	*0.667*	*0.333*	*0.667*	*0.333*	*0.667*
–Non-repudiation	*0.333*	*0.667*	*0.333*	*0.667*	*0.333*	*0.667*	*0.333*	*0.667*
• Digital Divide	0.269	0.731	0.498	0.502	0.246	0.754	0.460	0.540
–Multilingualism	*0.125*	*0.875*	*0.167*	*0.833*	*0.100*	*0.900*	*0.143*	*0.857*
–Global Presence	*0.875*	*0.125*	*0.889*	*0.111*	*0.900*	*0.100*	*0.857*	*0.143*
–Cost	*0.333*	*0.667*	*0,250*	*0.750*	*0.333*	*0.667*	*0.333*	*0.667*
• Management	0.507	0.493	0.593	0.407	0.504	0.496	0.538	0.462
–Internet Governance	*0.250*	*0.750*	*0.333*	*0.667*	*0.200*	*0.800*	*0.333*	*0.667*
–Regulatory Framework	*0.889*	*0.111*	*0.889*	*0.111*	*0.900*	*0.100*	*0.900*	*0.100*
–Performance	*0.333*	*0.667*	*0.333*	*0.667*	*0.333*	*0.667*	*0.333*	*0.667*

The results for North America only, developing countries and developed countries (excluding North American countries) are also available. The results do not change in these groups and DNS is still better than DOA according to management factor while DOA is preferable in overall and according to the security and digital divide factors. But the differences in alternative values are observed among groups.

The weights of the factors and sub-factors are given in Table 5.4. In total results, security is the most important factor with respect to the goal while the digital divide has the 2nd place.

Table 5.4. The weights of the factors and sub-factors

Weights	With respect to Goal			With respect to Security		
	Security	Digital Divide	Management	Authentication	Integrity	Non-repudiation
Total	0.286	0.571	0.143	0.500	0.250	0.250
North America	0.320	0.122	0.558	0.333	0.333	0.333
Developing Countries	0.250	0.655	0.095	0.667	0.167	0.167
Developed Countries	0.648	0.230	0.122	0.333	0.333	0.333
Weights	With respect to Digital Divide			With respect to Management		
	Multilingualism	Global Presence	Cost	Internet Governance	Regulatory Framework	Performance
Total	0.648	0.122	0.230	0.429	0.429	0.142
North America	0.169	0.443	0.387	0.163	0.540	0.297
Developing Countries	0.683	0.117	0.200	0.476	0.452	0.072
Developed Countries	0.458	0.416	0.126	0.466	0.433	0.100

Among the security related sub-factors authentication is the most important alternative followed by non-repudiation and integrity respectively. Multilingualism has

the biggest weight with respect to digital divide and Internet governance is the most important with respect to management. The weights of the factors and sub-factors are different for each group. The comments on these differences are given in last conclusion chapter.

CHAPTER 6: CONCLUSION

Today e-commerce is nearly 20 years old. In 20 years we have experienced big events which significantly affected the entire world because of globalization. From economic crisis to terrorist attacks, from new technological developments to new policies, from new governments to new organizations, many changes affected people's life from technical, economical and social aspects. As a result of these changes the business world was introduced to new trends, new customer behaviors and needs, new regulatory requirements and competition conditions.

Not surprisingly, from mid 1990s to now e-commerce has also changed. It has grown, expanded, evolved and developed by using not only the new features and opportunities provided by information and communication technologies but also the lessons from past mistakes. Technology driven, ungoverned, product focused e-commerce of 1990s, has become customer oriented, heavily governed and expanded to services. Financing and management strategies have also changed. Large venture capital financing and revenue growth strategies replaced by mixed financing and social network growth. Marketing techniques has updated in order to meet the new customer requirements and competition conditions.

Besides the above mentioned developments and differences, there is one thing that is still unchanged. The Internet is the main tool and the infrastructure of e-commerce. Of course Internet and the information and communication technologies experienced many

developments and evolutions to meet the new requirements of the world. But the question is, “Is it enough?” or “Will it be enough in near future?”

Today people are discussing about the barriers to e-commerce. Security concerns, digital divide, regulatory conflicts, the allocation of IP addresses, the management of DNS, the policies and organizational structure of ICANN and many other similar issues are among the hot topics of parties including governments, private sector, international organizations, non-governmental organizations and even individuals.

As it was mentioned in early chapters, the existing management style of Internet and the DNS in particular, have being criticized both from technical and political aspects. These criticisms lead to search for alternative systems and mechanisms or reforms in the existing ones. One of the potential systems that can be considered in this manner is DOA which is compared with DNS in this study with AHP based on the evaluations of experts and professionals from different organizations and countries of the world.

The results of the AHP model showed that DOA is better than DNS in overall as it is also in security and digital divide in total group. But DNS is the better alternative with respect to management factor. This is also the case in North America, Developing Countries and Developed Countries results. So the results of all groups are consistent with the total result. This consistency is also seen in all levels of the model’s hierarchy. For all factors and sub-factors, the rankings of DNS and DOA are same in all groups and total. So it can be said that all the participants agree that; DOA is the preferable alternative with respect to the entire security related sub-factors and also to

multilingualism, cost, performance and internet governance. On the other hand DNS is better with respect to global presence and regulatory framework.

Besides the consistency in rankings, the final values of alternatives and weights of factors and sub-factors differ among groups. These differences lead to new discussions and comments. First, DNS's final value is greatest in North America and the least in developing countries which means that the North American participants are more in favor of DNS than the rest of the participants.

If we go through the details of this result, we can see that management factor is the most important factor for North American participants while it is the least important one for other groups. Furthermore, examining the sub-factors of management, it can be seen that regulatory framework is considered the most important sub-factor by North Americans while internet governance is the most important one for developed and developing countries. That is also the case for global presence sub-factor under the digital divide factor which makes multilingualism the least important sub-factor in North America group. Since the DNS has better rankings with respect to regulatory framework and global presence sub-factors it is an expected result that it has the greatest final value in North America group who give the greatest weights to these.

These results also show that the famous debates between the two extreme points of the Internet world, the North American countries and developing countries also reflected by the model. North American countries who are sitting in the driver seat in the management of Internet and related resources are supporting the idea that the existing technical and management systems are working for the good of the entire internet

community including all the countries. However the developing countries think that the existing system is unfair and the Internet is not being managed in democratic manner. The developing countries are the biggest parties that criticize ICANN and internet governance activities and they are the major supporters of the multilingualism and the accessibility.

Besides the above mentioned contradictory opinions, there is a common point that the security is a big requirement of e-commerce and the existing system has some flaws. Considering the fact that the online threats and crimes are growing day by day, any solutions to security problems means a contribution to the effort for elimination of the barrier to e-commerce.

Consequently, all the factors considered in this study more or less represent the requirements for expansion of e-commerce. So the existing technical and management infrastructure should be evaluated continuously from these aspects. The opportunities for upgrades and developments should be utilized with a global effort in order to eliminate barriers to e-commerce and make the benefits of it accessible to the entire world. And DOA may be one of the systems to be used in this manner.

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APPENDIX: The Pair-wise Comparison Matrices

1. Matrices established based on the evaluations of total participants.

With respect to goal	Security	Digital Divide	Management
Security	1	1/2	2
Digital Divide	2	1	4
Management	1/2	1/4	1

With respect to security	Authentication	Integrity	Non-repudiation
Authentication	1	2	2
Integrity	1/2	1	1
Non-repudiation	1/2	1	1

With respect to digital divide	Multilingualism	Global presence	Cost
Multilingualism	1	5	3
Global presence	1/5	1	1/2
Cost	1/3	2	1

With respect to management	Multilingualism	Global presence	Performance
Internet governance	1	1	3
Regulatory framework	1	1	3
Performance	1/3	1/3	1

1. Matrices established based on the evaluations of total participants (cont.)

With respect to authentication	DNS	DOA
DNS	1	1/3
DOA	3	1

With respect to integrity	DNS	DOA
DNS	1	1/2
DOA	2	1

With respect to nonrepudiation	DNS	DOA
DNS	1	1/2
DOA	2	1

With respect to multilingualism	DNS	DOA
DNS	1	1/7
DOA	7	1

With respect to global presence	DNS	DOA
DNS	1	7
DOA	1/7	1

With respect to cost	DNS	DOA
DNS	1	1/2
DOA	2	1

With respect to internet governance	DNS	DOA
DNS	1	1/3
DOA	3	1

With respect to regulatory framework	DNS	DOA
DNS	1	8
DOA	1/8	1

With respect to performance	DNS	DOA
DNS	1	1/2
DOA	2	1

2. Matrices established based on the evaluations of North America group.

With respect to goal	Security	Digital Divide	Management
Security	1	3	1/2
Digital Divide	1/3	1	1/4
Management	2	4	1

With respect to security	Authentication	Integrity	Non-repudiation
Authentication	1	1	1
Integrity	1	1	1
Non-repudiation	1	1	1

With respect to digital divide	Multilingualism	Global presence	Cost
Multilingualism	1	1/3	1/2
Global presence	3	1	1
Cost	2	1	1

With respect to management	Multilingualism	Global presence	Performance
Internet governance	1	1/3	1/2
Regulatory framework	3	1	2
Performance	2	1/2	1

2. Matrices established based on the evaluations of North America group (cont.).

With respect to authentication	DNS	DOA
DNS	1	1/2
DOA	2	1

With respect to integrity	DNS	DOA
DNS	1	1/2
DOA	2	1

With respect to nonrepudiation	DNS	DOA
DNS	1	1/2
DOA	2	1

With respect to multilingualism	DNS	DOA
DNS	1	1/5
DOA	5	1

With respect to global presence	DNS	DOA
DNS	1	8
DOA	1/8	1

With respect to cost	DNS	DOA
DNS	1	1/3
DOA	3	1

With respect to internet governance	DNS	DOA
DNS	1	1/2
DOA	2	1

With respect to regulatory framework	DNS	DOA
DNS	1	8
DOA	1/8	1

With respect to performance	DNS	DOA
DNS	1	1/2
DOA	2	1

3. Matrices established based on the evaluations of developing countries group.

With respect to goal	Security	Digital Divide	Management
Security	1	1/2	2
Digital Divide	2	1	9
Management	1/2	1/9	1

With respect to security	Authentication	Integrity	Non-repudiation
Authentication	1	4	4
Integrity	1/4	1	1
Non-repudiation	1/4	1	1

With respect to digital divide	Multilingualism	Global presence	Cost
Multilingualism	1	5	4
Global presence	1/5	1	1/2
Cost	1/4	2	1

With respect to management	Multilingualism	Global presence	Performance
Internet governance	1	1	7
Regulatory framework	1	1	6
Performance	1/7	1/6	1

3. Matrices established based on the evaluations of developing countries group (cont.).

With respect to authentication	DNS	DOA
DNS	1	1/3
DOA	3	1

With respect to integrity	DNS	DOA
DNS	1	1/2
DOA	2	1

With respect to nonrepudiation	DNS	DOA
DNS	1	1/2
DOA	2	1

With respect to multilingualism	DNS	DOA
DNS	1	1/9
DOA	9	1

With respect to global presence	DNS	DOA
DNS	1	9
DOA	1/9	1

With respect to cost	DNS	DOA
DNS	1	1/2
DOA	2	1

With respect to internet governance	DNS	DOA
DNS	1	1/4
DOA	4	1

With respect to regulatory framework	DNS	DOA
DNS	1	9
DOA	1/9	1

With respect to performance	DNS	DOA
DNS	1	1/2
DOA	2	1

4. Matrices established based on the evaluations of developed countries group.

With respect to goal	Security	Digital Divide	Management
Security	1	3	5
Digital Divide	1/3	1	2
Management	1/5	1/2	1

With respect to security	Authentication	Integrity	Non-repudiation
Authentication	1	1	1
Integrity	1	1	1
Non-repudiation	1	1	1

With respect to digital divide	Multilingualism	Global presence	Cost
Multilingualism	1	1	4
Global presence	1	1	3
Cost	1/4	1/3	1

With respect to management	Multilingualism	Global presence	Performance
Internet governance	1	1	5
Regulatory framework	1	1	4
Performance	1/5	1/4	1

4. Matrices established based on the evaluations of developed countries group (cont.).

With respect to authentication	DNS	DOA
DNS	1	1/2
DOA	2	1

With respect to integrity	DNS	DOA
DNS	1	1/2
DOA	2	1

With respect to nonrepudiation	DNS	DOA
DNS	1	1/2
DOA	2	1

With respect to multilingualism	DNS	DOA
DNS	1	1/6
DOA	6	1

With respect to global presence	DNS	DOA
DNS	1	6
DOA	1/6	1

With respect to cost	DNS	DOA
DNS	1	1/2
DOA	2	1

With respect to internet governance	DNS	DOA
DNS	1	1/2
DOA	2	1

With respect to regulatory framework	DNS	DOA
DNS	1	9
DOA	1/9	1

With respect to performance	DNS	DOA
DNS	1	1/2
DOA	2	1