A Reference Model for E-Commerce

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Abstract: - This paper proposes a six-layers reference model for E-Commerce, including infrastructures, science techniques, elementary services, business strategies, business modes and society environment layer. Main classifications and some concrete entities in each layer are given. An explicit, machine-readable specification for each layer would help E-Commerce participants to exchange their concepts easily and implement them effectively or even automatically. So, some topics on the ontology for reference model are also discussed.

Key-Words: - E-Commerce, Reference Model, Ontology Knowledge, Classifications, Integration.

1 Introduction

The years of 2001 and 2002 witnessed twists and turns of E-Commerce. Many dot-com related companies went into bankruptcy while stock markets seemed to lose interests in IT industry. However, a worldwide common faith remains quite certain: E-Commerce would ultimately establish thriving and prosperous it promised. On the other hand, E-Commerce is an evolution instead of revolution and "we can't rush evolution" [1].

Such a setback could also be regarded as a self "relief to customs and companies that are bombarded with new E-Commerce business paradigms and solutions they don't understand" [2]. Therefore, an important measure for progressive E-Commerce is to help customs and companies fundamentally understand what E-Commerce would mean to them and how they should prepare for it.

E-Commerce is collaborative; it encompasses "inter-organizational systems that facilitate many kinds of communications involved in a commercial transaction" [3]. Unfortunately, this description is abstract and would lead us to fuzziness when we are going to set foot in E-Commerce. What is our responsibility according to our profession? What are the relationships between different parts of this electronic phenomenon? What problems should be settled with priority? A series of similar questions would come across our minds sooner or later when we look at E-Commerce deeply.

One three-layers reference model is given in [4]. It can be used to develop a proposal for a graduate program in E-Commerce. This paper presents a new reference model for E-Commerce and we hope it could benefit us to understand, design, implement, participate in and improve E-Commerce.

The rest of this paper is organized as follows. The overall reference model is illustrated in section 2. Main classifications and some concrete entities in each layer are also introduced to show a vivid vision. Because using ontology to regulate the reference model is useful for the collaboration and automation of E-Commerce, some relevant topics are discussed in section 3. Section 4 concludes this paper.

2 Reference Model

This reference model comprises six layers: infrastructures, science techniques, elementary services, business strategies, business modes and society environment layer. The overall vision is shown in Fig. 1.

Infrastructures layer and society environment layer constitutes the bottom and top layer of the reference model respectively. The functions and performance of each layer is supported and restricted by its under layer while the operational rules and value-added of each layer are contained in and originated from its upper layer.

Fig. 1 Reference Model for E-Commerce

The detail information of each layer is discussed as follows.

2.1 Infrastructures Layer

Infrastructures layer comprises all kinds of fundamental establishments, equipments, human resources, and other related substances.

The entities in this layer could be divided into four main groups: transportation infrastructures, network infrastructures, equipments and human resources. According to the classification methods depicted in Table 1, we could find the positions for all concrete entities in a similar manner.

Table 1. Classification of Infrastructures

Main Classification	Sub Classification	Sub-Sub Classification
Transportation Infrastructures	Waterage Infrastructures	Harbor
		Port
		Dock
		…
	Landway Infrastructures	Highway
		Railway
		…
	Aviation Infrastructures	Airport
		…
Network Infrastructures	Wired Telecom Infrastructures	PSTN Infrastructures
		ISDN Infrastructures
		…
	Wireless Telecom Infrastructures	Relay Station
		Transmission Station
		…
	Telecast Infrastructures	TV Station
		Radio Station
		CATV Station
		…
	Internet Infrastructures	Fiber Optics
		EDI Infrastructures
		…
Equipments	Production Equipments	Workshop
		Machine
		…
	Communication Equipments	Fax
		Mobile phone
		…
	Delivery Equipments	Truck
		Train Wagon
		…
	Digital & Network Equipments	Bar code Scanner
		Smart Card
		Modem
		PC
		…
Human Resources	For Management	…
	For R&D	…
	For Production	…
	For Marketing	…
	For Distribution	…
	For Maintenance	…
	For Public Relations	…

The entities in this layer are mainly physical matters and manpower of E-Commerce. Their obvious characteristic is investment.

2.2 Science Techniques Layer

However, "you don't win a marathon by buying faster shoes" [5]. Using science techniques to leverage the value of the infrastructures is one important point from which value-added comes. This forms a very active layer: science techniques layer.

Special technical problems and their solutions are focused here. They are building blocks of intact services. Although almost all techniques could

contribute to E-Commerce, we generalize only six of them for concision: computer, Internet, telecom, security, automatization and optimization.

Because our major is computer science, we give some detailed classifications in these fields to show what are the concreted entities in this layer (See Table 2).

Table 2. Classification of Science Techniques

Main Classification	Sub Classification	Sub-Sub Classification
Computer Techniques	Hardware Techniques	Parallel Computer
		Super Computer
		Cluster Computer
		…
	Software Engineering	OOD/Component
		Agent
		UML
		…
	Programming	Java
		C++
		Pascal
		CORBA
		DCOM
		…
	Database	Data Mining
		OLAP
		Data Warehouse
		KDD
		Distributed Database
		Parallel Database
		…
	Multimedia	…
	AI	…
	Pattern Recognition	…
	…	…
Internet Techniques	Architecture	Intranet
		Extranet
		WAN
		…
	Protocol	TCP/IP
		Reliable Multicast
		IPV6
		P2P [6]
		…
	Programming	XML
		HTML
		WML [7]
		ebXML
		…
	…	…
Telecom	Wired Telecom	...
	Wireless Telecom	…
Security Techniques [8]	Cryptography Techniques	DES
		RSA
		…
	Certification Techniques	Digital Signatures
		Dynamic Password
		…
	Protocol	SET
		SSL
		EDI
		…
	Firewall Techniques	Virus Identification
		Intrusion Detection
		Access Control
		Recovery
		…
	…	…
Automatization	...	...
Optimization	…	…

Of course, the classification of science techniques is not going to let them break up and live apart. In fact, new techniques often stem from multi-fields.

The entities in this layer are mainly scientific and technical terms. The value-added of this layer comes from the problem oriented technical innovations.

2.3 Elementary Services Layer

Science techniques remain some fragments of services until they are integrated together to provide a certain service. Thus forms elementary services layer that preliminarily supports E-Commerce applications. Single function for each service is strengthened here, i.e., we should not try to offer variety kinds of services with one entity in this layer.

As shown in Table 3, the services are classified according to the processes involved in E-Commerce activity and traditional services are still preserved.

Table 3. Classification of Elementary Services

Main Classification	Sub Classification
Information Publishing	Catalog Service [9]
	Newsgroup Service
	Telecast Service
	Newspaper Service
	…
Information Acquiring	Search Service
	FTP Service
	Subscribe Service
	…
Communication	Internet-Phone Service [10]
	E-mail Service
	Internet Based Fax Service
	Mobile Service
	…
Negotiation [11]	Biding Service (Including On-line Ordering)
	Auction Service
	Bargaining Service
	…
Electronic Payment	E-Cash Service
	E-Check Service
	E-Purse Service
	Smart Card/ IC Service
	ATM
	POS
	…
Management	ERP
	SCM [12]
	DSS
	…
Delivery	Packing Service
	Express Service
	…
After Services	Install Service
	Maintenance Service
	Goods Return Services
	…

Because the function of elementary service should concentrate only on one point, its architecture must be flexible enough for integration. Otherwise, according to some changing business strategies to re-develop them would be a thorn. Some relevant architecture issues are discussed in literature [13]. On

the other hand, there are several different integration levels for elementary services [14, 15]. We should choose a correct level based on our own situation.

The entities in this layer could be regarded as rudiment applications of E-Commerce. Except some existing traditional services, their value-added lies in converting techniques into some mission oriented professional services.

2.4 Business Strategies Layer

By means of elementary services, another half meanings of E-Commerce, "COMMERCE", could be carried out. However, how to use those elementary services are problems of business strategies. This forms business strategies layer that is full of variety and chances.

The entities in this layer could be classified as management strategies, production strategies, marketing strategies, sale promotions strategies and public relations strategies. Marketing and sale promotions strategies are listed in Table 4.

Table 4. Classification of Business Strategies

Main Classification	Sub Classification	Sub-Sub Classification
Management	…	…
Production	…	…
Marketing Strategies [16]	Customer Oriented Strategies	Sex
		Age
		Profession
		Habits
		Objectives
		Education Level
		Motives
		Blood Type
		Districts
		…
	Goods Oriented Strategies	Hard Goods
		Soft Goods
		On-line Services
		…
	Quantity Oriented Strategies	Wholesale
		Retail
		…
	Distribution Oriented Strategies	Direct Distribution
		Agency
		…
	…	…
Sales Promotion Strategies	Advertisement	…
	Free Goods	…
	Discount	…
	Raffle	…
	Trial	…
	Award	
	After Services	…
	…	…
Public Relation	…	…

Business strategies are souls of E-Commerce. Without effective business strategies, most elementary services seem like toys for technicians.

The entities in this layer are outcomes of business knowledge and experiences. The value-added comes from commerce oriented knowledge innovations.

2.5 Business Modes Layer

For customers (including business, government, etc.), all kinds of business strategies and their underlying elementary services should be wrapped together to assist commerce activities. This forms business modes layer that directly contacts the customers.

Popular business modes include C2C, B2C, B2B, e-Marketplace, etc. In our opinion, though E-Learning and E-Government have their particular characteristics, they could still be regarded as certain kinds of E-Commerce solutions that are tailored for special groups.

The entities in this layer are some kinds of interactive platforms. Main challenges here are services composition [17], including the issues about service compatibility, correctness, synchronization and coordination. So, their value-added comes from commerce oriented services composition.

2.6 Society Environment Layer

E-Commerce is an electronic phenomenon of our society. It must obey the rules deeply rooted in our society, and in turn, it will go to change the society systems silently but steadily. This forms society environment layer.

The entities in this layer mainly include moral, law, custom, culture, education, preference, etc.

Some adult websites provide a kind of E-Commerce that help people to find partner who has the same bad habits. Is this moral?

"One can touch a loaf of bread, smell it, visually inspect it, and even taste a sample at a delicatessen. Even the most straightforward fresh grocery purchase involves subtle judgments, involving variables that are not currently accounted for in an on-line environment" [18]. Does E-Commerce accord with custom and how much does they match?

"The interaction involved in shopping such as meeting friends and exchanging gossip is an integral part of the shopping process, and servers a social need" [19]. Is this your preference?

As for law, culture and education, too much ink has been splashed on them.

When tackling the entities in this layer, we must distinguish majority between minorities, universality between particularities, and so on. This layer will reflect the social value of E-Commerce and finally test its success or failure factors.

The six layers above constitute the reference model for E-Commerce. Each layer is focused on one main topic and its related stuff. Different E-Commerce participants may take different responsibility for the constructions of different layers, e.g., officers mainly for society environment layer,

businessman mainly for business strategies layer, researchers/technicians mainly for business modes layer, elementary services layer and science techniques layer, etc.

3 Ontology for Reference Model

However, "successful E-Commerce requires an unprecedented degree of collaboration on social, economic and political issues…" [2]. Referring to the reference model above, E-Commerce is a synthesis of all six-layers. Therefore, a common method to describe and represent the entities in each layer would benefit us to exchange specifications between different layers and composite an effective E-Commerce platform. We call it as ontology for reference model, where ontology means "an explicit, machine readable specification of a shared conceptualization" [20].

Ontology has "proven to be an essential element in many application. They can also generate natural language, integrate intelligent information, provide semantic-based access to the Internet, and extract information from texts…" [20]. Important elements of ontology are "conceptions" (which are usually organized by taxonomies), "relations", "functions", "axioms", "instances", "facts" and "claims".

Concepts are also known as classes, objects or categories. Attributes are its main elements. Relations are interactions between concepts. Functions are special kind of relations with one return argument. Axioms are also known as assertions, which can be used to constrain information, verify correctness, or deducing new information. Instances, facts and claims are concrete items of concepts, relations (functions) and axioms respectively.
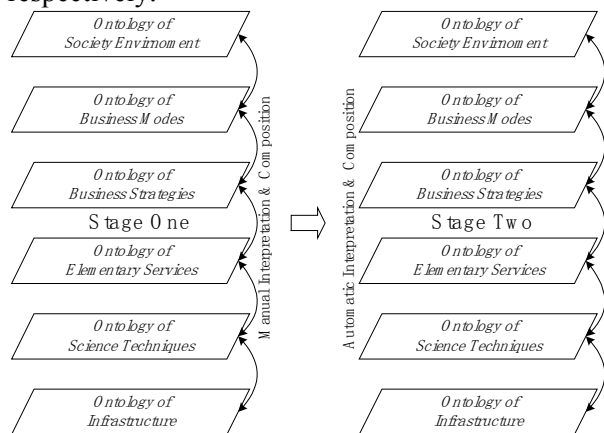

**Fig. 2 Two Stages of Using
Ontology for Reference Model**

In our opinion, there are two stages for us to use ontology for reference model. At the first stage, the entity specifications of the reference model are regulated with certain ontology languages in order to help all participants to exchange their concepts easily and implement them effectively.

At the second stage, we hope it would be possible to exchange the specifications between each layers and composite E-Commerce solutions automatically with some mechanisms shown in Fig. 3.
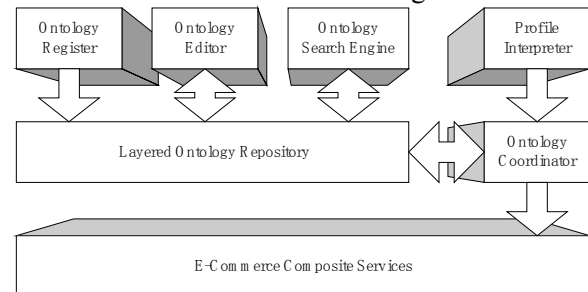

**Fig. 3 Mechanism for Automatic Ontology
Interpretation and Composition**

With ontology register, editor and search engine, we could register/deregister, edit and find a certain piece of ontology knowledge. All ontology knowledge is organized in ontology repository according to their layers. When needed, business profile could be inputted and interpreted for ontology coordinator to composite some satisfying solutions.

Of course, one necessary step to achieve this goal is to design a reasonable reference model firstly.

4 Conclusion

This paper proposes a six-layers reference model for E-Commerce. Although it is not intact, we hope it could be helpful to grasp the whole view of E-Commerce, understand the relationship between each part, focus on the main tasks and find out potential problems.

In this reference model, each layer concentrates one main topic about E-Commerce, which is confined by its under layer and in turn has decisive influence on its under layer. Therefore, collaboration between each layer is a necessary condition for successful E-Commerce. Mapping reference model into ontology knowledge will lead us to easy communication and integration, or even automatic composition of E-Commerce.

By this reference model, we could find out that almost every walk of life may contribute to E-Commerce and find its own interests in E-Commerce. Therefore, E-Commerce is not an "economic Trojan horse that is used by cyber-invaders to take over commerce domains that the nation's citizens would otherwise rule".

In fact, we are in E-Commerce. This is an inevitable tendency and an unshakable destination of modern civilization.

References:

[1] Munindar P. Singh, An Evolutionary Look at E-Commerce, *IEEE Internet Computing*, Vol.5, No.2, 2001, pp. 6-7.

[2] Raj Veeramani and Nancy Talbert, Where Are We in Global E-Commerce, *IT Professional*, Vol.1, No.6, 1999, pp. 46-52.

[3] Sowmyan Raman, E-Commerce and Globalization -Yesterday, Today and Tomorrow, *Proceedings of IEEE Engineering Management Society*, 2000, pp. 249-254.

[4] Daniel A. Menasci, A Reference Model for Designing an E-Commerce curriculum, *IEEE Concurrency*, Vol.8, No.1, 2000, pp. 82-85.

[5] Raj Veeramani and Nancy Talbert, Looking Back at Struggles, Looking Ahead to Opportunities, *IT Professional*, Vol.3, No.1, 2001, pp. 15-17.

[6] Manoj Parameswaran, Anjana Susarla and Andrew B. Wbinston, P2P Networking: An Information-Sharing Alternative, *Computer*, Vol.34, No.7, 2001, pp. 31-38.

[7] Chiwei Lan, Chunchou Chien, Mengyen Hsieh and Irene Chen, A Mobile E-Commerce Solution, *Proceedings of IEEE International Symposium on Multimedia Software Engineering*, 2000, pp. 215-222.

[8] Dieter Gollmann, E-Commerce Security, *Computing & Control Engineering Journal*, Vol.11, No.3, 2000, pp. 115-118.

[9] Dongkyu Kim, Jaebum Kim and Sanggoo Lee, Catalog Integration for Electronic Commerce through Category-Hierarchy Merging Technique, *Proceedings of IEEE 12th International Workshop on Research Issues in Data Engineering: Engineering E-Commerce/ e-Business Systems,* 2002, pp. 28-33.

[10] Howard Bernett and Melissa L. Jaramillo, Assessing Web-Enabled Call Center Technologies, *IT Professional*, Vol.3, No.3, 2001, pp. 24-30.

[11] Stanley Y. W. Su, Chunbo Huang and Joachin Hammer, A Replicable Web-based Negotiation Server for E-Commerce, *Proceedings of IEEE 33rd Annual Hawaii International Conference on System Sciences*, 2000, pp. 2973-2981.

[12] Mingling Chuang and Wade H. Shaw, Distinguishing the Critical Success Factors Between E-Commerce, Enterprise Resource Planning and Supply Chain Management, *Proceedings of IEEE Engineering Management Society*, 2000, pp. 596-601.

[13] Srinivas Koushik and Pete Joodi, E-Business Architecture Design Issues, *IT Professional*, Vol.2, No.3, 2000, pp. 38-44.

[14] Abmed K. Elmagarmid and William J. McIver Jr., The Ongoing March Toward Digital Government, *Computer*, Vol.34, No.2, 2001, pp. 32-38.

[15] Louis A. Lefebvre, Lue Cassuvu and Elisabeth Lefebvre, Business-to-Business E-Commerce: A Transition Model, *Proceedings of IEEE 34th Annual Hawaii International Conference on System Sciences*, 2001, pp. 2187-2196.

[16] Wu Yingliang, Theory and Applications of E-Commerce, *South China University of Technology Press*, 2002.

[17] Jian Yang, Mike P. Papazoglou and WillemJan van den Heuvel, Tackling the Challenges of Service Composition in E-Marketplace, *Proceedings of IEEE 12th International Workshop on Research Issues in Data Engineering: Engineering E-Commerce/ e-Business Systems,* 2002, pp. 125-133.

[18] Jawed Siddiqi, Babak Akghar, Carl Davies and Samir Al-Khayatt, E-Commerce: Continuous Growth or Leveling Out, *Proceedings of IEEE International Conference on Information Technology: Coding and Computing*, 2002, pp. 491-496.

[19] The Saturday debate Is E-Commerce the Only Future for British Business? Yes: Marcus Austin, No: Monica Seeley, Sat. Sep. 18, 1999, http://www.guardianonline.com.

[20] Asuncion Gomez-Perez and Oscar Corcho, Ontology Languages for the Semantic Web, *IEEE Intelligent Systems*, Vol.17, No.1, 2002, pp.54-60.