Foundations of Electronic Commerce: Computer Science at Work

by Neal G. Shaw

Introduction

Many people and businesses are looking to the day when all of their business transactions can be conducted online. Rapid advancements in computer technology and the exponential growth of the Internet have provided a reason to believe that someday all business transactions (personal and commercial) can be processed online. Consequently, **electronic commerce (EC)** has become a favorite topic for both academic and commercial researchers from various backgrounds.

The work of computer scientists has been instrumental in the development of EC from both the hardware and software perspectives. Advances in microprocessor technology have allowed consumers to have PCs in their homes from which they may do online banking and bill payment. Software enhancements have allowed users worldwide to have access to information from the other side of the globe at the click of a mouse. A global electronic commerce revolution may take place in the near future, with computer scientists leading the way.

The Area of Electronic Commerce

Electronic commerce as a discipline is extremely young, and consequently most of its developments have been dependent upon other fields, such as computer science, information systems, etc. In fact, computer and systems engineering in the service sector of the economy is, in general, a multidisciplinary task [3]. The area of electronic commerce is full of confusion and lack of organization [2], and various models and frameworks have been proposed to give some organization to the field. A comprehensive framework for understanding electronic commerce based upon the **Open Systems Interconnection (OSI)** model for network architectures is given in Figure 1 [8]. (For one online book about OSI, see http://www.salford.ac.uk/docs/depts/iti/books/osi/osi.html.)

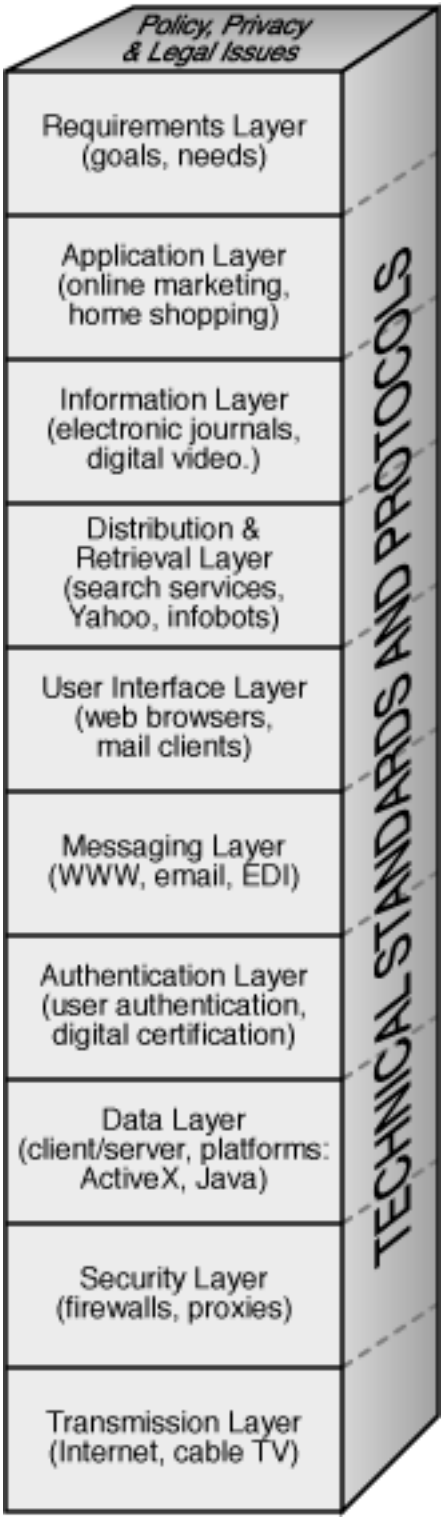

Figure 1: A Comprehensive Framework for Understanding Electronic Commerce

Notice that eight of the ten layers of the framework depend upon outgrowths from computer science. Consider the following applications of computer science necessary for the components of the bottom eight layers of the framework:

- **Information Layer** - The information layer provides information in a variety of formats to the upper layers of the framework. At the information layer, research is being done to enhance the

quality and quantity of information that is available. More effective and efficient forms of information are needed. For example, can we develop standards for digital video that will ensure smooth video as well as manageable file sizes?

- **Distribution and Retrieval Layer**- With the tremendous amount of information available at the click of a button, how can it ever be organized so that a company can make a profit in EC? Internet search services such as Yahoo, Infoseek, etc. must be continually refined and updated. In addition, users would be eternally grateful to any developer who could find a way to merge all of the existing search engines in use today (like some of the Multi-Search engines listed at http://www2.gol.com/users/steve/search/multi.htm).
- **User Interface Layer** - At the user interface layer lies the issue of how users will interact with online electronic commerce systems. With the ongoing battle between Microsoft and Netscape for web browser market share, it is difficult to predict if we will ever have one *de facto* standard for an EC interface. As researchers have pointed out, any EC application developed today will have to support both browsers in order to compete in the EC market [9].
- **Messaging Layer** - The messaging layer deals with the fundamental question of how electronic commerce transactions will be processed. Will the World Wide Web be the vehicle for EC? What about **electronic data interchange (EDI)**? (For a short introduction to EDI, see http://ksi.cpsc.ucalgary.ca/courses/547-95/seanh/edi.html.) Can a reasonable mix of the WWW and EDI be used to facilitate electronic commerce? Are there any new messaging services that can potentially be used?
- **Authentication Layer** - The authentication layer ensures that the party on the other end of a transaction is verifiable. Much research has gone into the issues of authentication and certification, especially in the area of public key authentication. (For one article about authentication, see "Mutual Authenticating Protocol With Key Distribution in a Client/Server Environment" at http://www.acm.org/crossroads/xrds2-4/authen.html.) What still remains unanswered though, are the questions about who will be the certificate authorities, etc.
- **Data Layer** - The data layer calls for investigation into the issues of the various platforms that are available for online business. For example, must a firm limit itself entirely to one platform, e. g. ActiveX, or can a firm successfully integrate all possible platforms so that its customers may choose according to their preferences?
- **Security Layer** - The security layer deals with low level security breach prevention mechanisms. Firewalls, encryption, and proxies are examples of security layer issues that must be addressed. (There are several articles on computer security Crossroad's issue 2-4, the index of which can be found at http://www.acm.org/crossroads/xrds2-4/xrds2-4.html.)
- **Transmission Layer** - At the transmission layer, basic research is needed to solve the bandwidth bottlenecks of today's networks, specifically that of the Internet. Emerging technologies such as ATM (see, for example, the Cell Relay FAQ at http://www.pku.edu.cn/new/on_line/ATM/atm_faq_html/FAQ/ATM-FAQ/FAQ.html) , ADSL (see, for example, http://www.matisse.net/files/glossary.html#ADSL) , etc. need to be enhanced and refined before they can become mainstream technologies. Without efficient, fundamental physical transmission of data, even the most advanced networking applications will not be usable.

Future Research and Development

Electronic commerce is one of the hottest issues for businesses and researchers today, and the business potential held by EC is immeasurable. In spite of recent technological advances, however, individuals and businesses alike seem to be hesitant to commit on a large scale to this new means of conducting business. What, then, is slowing the proliferation of such a promising idea in the online world?

Insecure Transactions

Almost certainly, the single most powerful deterrent against the widespread implementation of EC is the lack of security in electronic transactions, especially those on the Internet [1, 4, 6]. Currently, open networks such as the Internet foster security attacks on business transactions in many ways, i.e. eavesdropping, password sniffing, spoofing, data modification, repudiation, etc.[4]

Unreliable Data Transmission

Another potentially damaging problem that concerns businesses is the lack of reliability inherent in networks such as the Internet. Given the current state of the Internet, there is no way to avoid an occasional lost packet or a server that is temporarily (or permanently) out of service. Internet links go down all the time, and sometimes, there is simply too much network traffic to have a reasonable response time. For businesses, any server down time or lost packets can mean lost revenue. Consequently, many businesses have been unwilling to place their future in the hands of current technology.

Lack of Standardization

Another thorn in the side of electronic commerce is the inherent lack of standardization in the various protocols necessary for EC to become practical. As different companies back different standards, e.g. Microsoft vs. Netscape, DigiCash vs. CyberCash, etc., consumers and businesses are often forced to choose between standards. For companies, this often means alienating a large part of the customer base that adheres to a different standard. Businesses are unwilling and unable to sacrifice potential revenue to support electronic commerce, and research shows that EC systems must be capable of supporting multiple standards [9].

Research and Development

The previous three issues, along with various others, must be addressed by both academic researchers and commercial research and development teams if electronic commerce is to succeed. Future research and development efforts are likely to fall into four major categories:

1. **Extracting value from EC:** Once technology is in place, the most pressing issue for companies is how to extract value from that technology. In other words, how can a company use electronic commerce to enhance its virtual value chain [7]? Firms must learn to leverage the benefits and advantages provided by the use of computers and EC.
2. **Developing cross-platform software:** As noted above, there is increasing pressure on companies to provide support for all of the various combinations of hardware, software, and settings that are possible with today's technology. Developers of EC applications must be particularly aware that each user defines his own unique interface by what browser and setting he uses. Also, it is impossible to predict which standards, if any, will emerge above the others as the *de facto* standards for EC. Thus, systems must be designed to support multiple standards.
3. **Using security and authentication technologies:** Consumers and businesses alike are wary of transmitting sensitive data across open networks such as the Internet. Large scale electronic commerce will never become mainstream until security solutions are developed to ease the fears of the masses. In addition, an interesting study would be one that attempts to determine if security concerns are actually real problems or if the worries are mainly from perceived problems that actually do not exist.
4. **Developing an information infrastructure:** A recent study of information systems executives indicated that the most pressing concern to businesses today is *building a responsive information technology infrastructure* [5]. Computer and telecommunications hardware and software must continually be improved to handle the global flow of information that is increasing exponentially. Bandwidth concerns, in particular, must be addressed before the Internet simply bogs down completely.

Conclusions

The era of electronic commerce is upon us. Executives dream of the possibility of cutting costs by migrating to electronic transactions from paper-based transactions. Consumers fantasize about paying all bills from home and buying anything they need from the comfort of an easy chair. Before the EC revolution can truly begin, though, some fundamental issues must be addressed on all parts of the EC spectrum. Financial and organizational researchers are vigorously investigating the effects of EC on people, companies, and revenues. The most pressing issues, however, must be addressed by computer scientists.

Security, standards, and infrastructure issues are just a few of the many basic issues that must be addressed before widespread EC will become prevalent. Once these problems are solved, then as computers changed business with the PC revolution of the 1980s, so too will computers change business with the electronic commerce revolution of the future.

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