DATA SECURITY MANAGEMENT

AUDITING THE ELECTRONIC COMMERCE ENVIRONMENT

Chris Hare, CISSP

INSIDE

Strategy; Legal; Privacy; Export Controls; Legislation; Project Management; Reliability; Development; Connectivity; Security; Securing the E-Commerce Server; Operating System Security; Back Office Applications; E-nough!

INTRODUCTION

With the proliferation of Internet access and the shift to performing some brick-and-mortar transactions online, the need for stability and reliability in the E-commerce arena is becoming increasingly apparent. E*Trade, one of the many successful E-commerce sites, depends completely upon its online presence to stay in business. An outage, regardless of cause, can potentially cost millions of dollars. For example, consider the Distributed Denial-of-Service (DDoS) attacks against Yahoo and CNN earlier this year. Once a way to stop the attack had been found, thousands of dollars were spent to facilitate the system cleanup, in addition to the lost revenue. This article describes a methodology to assess the security and reliability of E-commerce. Based on this author's previous experiences with risk assessment, security, reliability, and Web "touch and feel — ease of use" can be identified as critical to the ongoing success of E-commerce. The approach described in this article can assist any E-commerce Web site owner, manager, or auditor in identifying and securing some of these key risk areas.

PAYOFF IDEA

With the proliferation of Internet access and the shift to performing some brick-and-mortar transactions online, the need for stability and reliability in the E-commerce arena is becoming increasingly apparent. E*Trade, one of the many successful E-commerce sites, depends completely on its online presence to stay in business. An outage, regardless of cause, can potentially cost millions of dollars. This article describes a methodology to assess the security and reliability of E-commerce. Experiences with risk assessment have identified security, reliability, and Web "touch and feel — ease of use" as critical to the ongoing success of E-commerce. The approach described here can assist any E-commerce Web site owner, manager, or auditor in identifying and securing some of these key risk areas.

It Is Possible to Get Your E-Commerce Infrastructure under Control

The most significant challenge in the development and implementation of

Auerbach Publications

one's E-commerce environment will be gluing it all together. Success is dependent on a careful marriage of process, technology, and implementation to achieve the end result. Achieving the final goal depends on a comprehensive strategy, understanding legal and export issues, the processes in use, as well as the technology available to perform the work. Design the environment with confidentiality, integrity, and availability as priorities — not as after thoughts.

STRATEGY

Do not get caught up in the waves of technology and methods of doing things. Technology is only one part of the entire puzzle. One uses technology to implement already-operational manual processes to reach a larger market. The operational aspect drives the technological requirements, which in turn affect the overall development of the required systems. The implementation of the project is often affected by changing business and legal needs rather than by changes in technology.

Strategy is the key to the development of an effective E-commerce implementation. The people within an organization must have a vision they can use to drive their planning and development activities. This vision determines the goals senior management has and lays the groundwork for how to measure success. Without a strategy, it will be impossible for you, your employees, your shareholders and customers to determine if you have achieved anything.

Strategy must also be based on the business decisions that an organization will make. The existing corporate policies must be reviewed and implemented to provide consistency in dealing with the public, regardless of the medium the customer uses to access one's services.

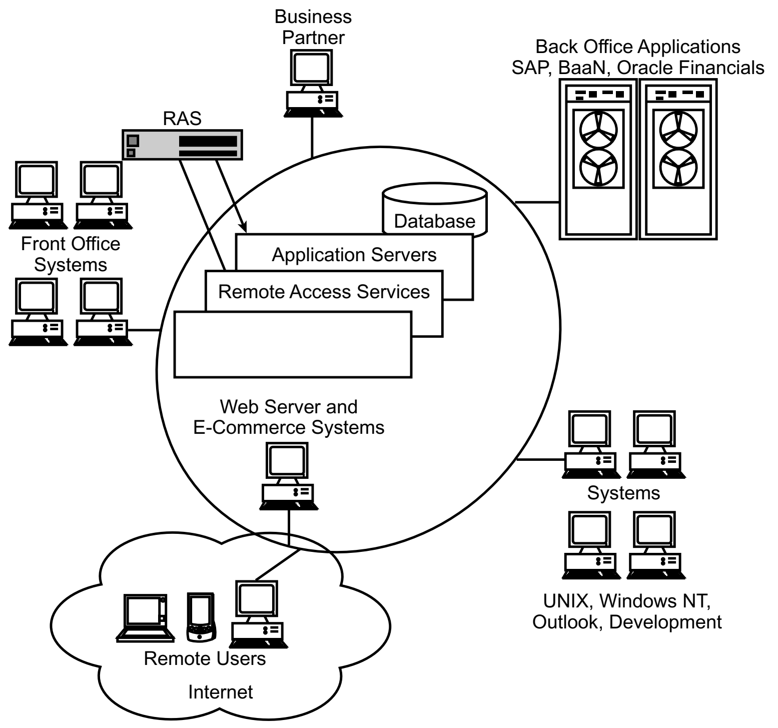
Technology Is Only the Method of Implementing Desire

One's team will use the strategy to establish goals they can translate into project plans and then into manageable activities to meet the strategy. When developing an E-commerce strategy, one must consider:

- What are you trying to achieve by moving to E-commerce?
- How closely is your electronic commerce strategy aligned with your existing corporate strategy?
- What existing corporate business processes must be integrated?
- Who is going to use the service? Is it business-to-business, business-to-consumer, or both?
- Who is going to use the services being offered?
- What do our customers want us to offer?

Armed with the answers to these questions, it becomes possible to start addressing the technology solutions that may provide the imple-

EXHIBIT 1 — E-Commerce System Infrastructure


Business Partner
Back Office Applications SAP, BaaN, Oracle Financials
RAS
Database
Front Office Systems
Application Servers
Remote Access Services
Web Server and E-Commerce Systems
Systems
UNIX, Windows NT, Outlook, Development
Remote Users
Internet

mentation. As illustrated in Exhibit 1, the technology solution is complex and involves many components. Before choosing the individual components to achieve the technology implementation, one must understand how each component in the business process interacts with the others.

LEGAL

It is a challenge for most companies to ensure compliance with the legislation of the country where they are located or the countries in which they do business. There are local, state, national, and international laws. There are additional regulations, depending on the industry and if you are a publicly traded company. However, doing business electronically poses new challenges.

PRIVACY

Consumers are concerned about the privacy of their information, while you are concerned about the privacy of information they provide to you or you share with them. Aside from legal requirements in various parts of the world regarding the privacy of information, it would not be good business not to provide privacy controls. If consumers are aware that you do not take this into consideration, they will not do business with you electronically.

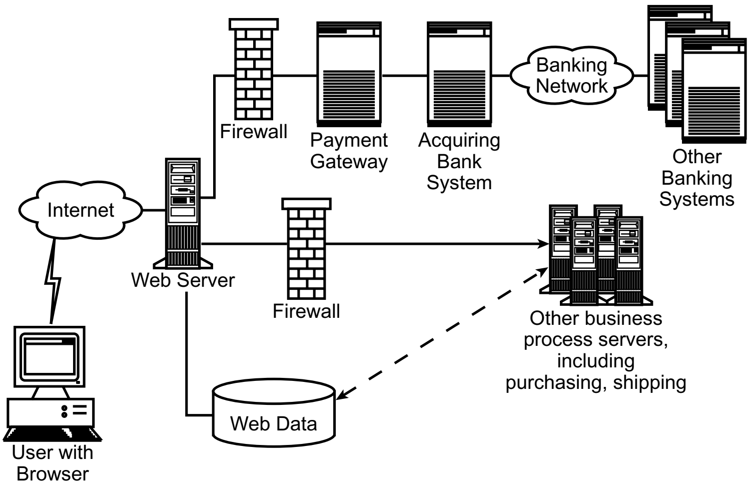
The privacy issue can mean some real challenges for an organization. For example, during 1999, the European Union (EU) enacted standards surrounding privacy and the protections of information. The EU stated they might choose to not do business with companies or countries who do not implement similar privacy standards. Consequently, one should specifically state what the organization's privacy policy is. This demonstrates a commitment on the organization's part to the protection of its consumer's information.

Solving the privacy issue means that technical implementers will use words like encryption, digital signatures, and digital certificates. These are technologies used to provide the privacy components to help increase the protection of information sent and received while users interact with an electronic business site.

It is the privacy issue regarding consumer purchasing habit information that led to the development of Secure Electronic Transaction protocols by Mastercard and VISA, as illustrated in Exhibit 2.

All transactions must be properly secured to prevent the loss, through transmission or unauthorized access, of important business information. This must be calculated into the strategy. Doing so will mitigate the risk of information loss and poor performance or reliability from improperly implemented processes or technology.

EXHIBIT 2 — Sample SET Transaction Environment



EXPORT CONTROLS

Export controls are established by governments to regulate export of materials to countries considered dangerous or not in support of the national interest. Most countries do this and in some situations, such as encryption technologies, there are countries that prevent the import of the material.

Compliance with relevant export control legislation is strongly advised. The punishments for noncompliance can be significant, depending on the country and the material exported. Recent years have seen changes in some export rules, again specifically surrounding encryption. Countries have been adopting changes in encryption import/export rules in an effort to allow their producers to compete in the global marketplace.

It is important to review import/export legislation when developing an E-commerce infrastructure. There may be information or technology affected by these rules and they may impact to whom one can deliver the service and resulting products.

LEGISLATION

Legislation is a major area for many companies. There is a variety of legislation controlling how privacy issues are handled and how business is conducted in general. Much of this legislation is not limited to electronic business. Internet laws and regulations pertain to everything from intellectual copyright to cyber-squatting (registering URLs for profit).

The use of a qualified attorney is highly recommended due to the diverse issues and laws involved. With the assistance of an attorney, one should carefully consider the impact of law on the ability to get one's electronic business into full gear.

Considering the vast nature of the law, some areas of concern include, but certainly are not limited to:

- What national and international laws are applicable to E-commerce?
- How is legislative compliance ensured?
- What countries is the business prohibited from selling to through E-commerce?
- Are there distribution agreements and contracts that can be held in force electronically?
- Do the businesses support digital signatures, and are they considered legally binding within the business' jurisdiction?
- How are domestic and international disputes resolved?
- Is there technology or information requiring export permits before it can be available through the E-commerce infrastructure?

PROJECT MANAGEMENT

With the strategy defined, the team can proceed to define the manageable activities resulting in the actual development and implementation of the infrastructure. However, project management is geared more toward ensuring that everyone understands what work must be done, the timeline in which to do it, and how much to budget.

There are a lot of pitfalls in allowing the team to implement electronic commerce services without project management. It will be difficult to gauge where the project is, and even more difficult to determine when it is finished and how much it will cost.

Project management provides the needed controls to define the project, and ensure it meets the business requirements and is completed on time and within budget. A project management strategy is critical to define the tasks required to complete the project. The project plan defines who owns the project and related subprojects, and how users will be involved in the definition, development, and testing of the E-commerce implementation.

The project manager defines the work breakdown structure and establishes the milestones to measure progress on the project. The project manager allocates responsibilities and manages cost and resource budgets.

Without effective project management, the E-commerce project can become an expensive never-ending endeavor that fails to meet the business needs.

The ability to plan a project and then properly implement it allows for accurate cost control and planning decisions.

Things to consider:

- Does the project plan accurately define the end objectives in a measurable fashion?
- Are there adequate people and other resources to deliver the project on time and without unplanned resource costs?
- Has a standard project management review been conducted?
- How are project costs captured?
- Is the project on track from both a work and a financial perspective?

RELIABILITY

The E-commerce infrastructure must be available whenever a customer wants to use it (availability), and it must operate as the customer expects it to (integrity). Most people do not realize it but reliability is a major component of security. Consumers want to have confidence that when they go shopping online, the merchant they want to deal with will have all of its systems operating so that they can browse the catalog, enter their order, have any payment transactions properly completed, and then see the order arrive in a reasonable time frame.

But what happens when things go wrong? Customers need to have a method of contacting the merchant so they can advise that merchant of the problem and seek an acceptable resolution. However, reliability reaches beyond getting problems fixed. It includes the ability of an organization to know there may be a problem now or in the future. How will the performance of the system be measured? How does one resolve a problem for which one of the service providers is responsible?

Performance

The ability of the systems to provide a reliable, friendly, and valuable experience is essential. Users have high expectations about content, access to the services, and quickly finding what they are looking for. Performance, in the eye of the user, is measured by how long it takes to get the information displayed on their screen. A fancy Web site with numerous animations and pretty graphics may be eye-appealing once fully downloaded, but most users get frustrated and are not likely to revisit if the merchant's home page takes forever to load on their system. Develop for the smallest system and it will work on all others that need to access it.

The customer's view of performance is affected by the capacity planning of the merchant's Internet access and the servers used to offer the customer services. Failure on the part of the merchant to contemplate the actual level of performance one wants people to have will impact that merchant in the end. Capacity planning surrounding the network and server performance must be tempered by how many users one expects to have access to the site.

Having a plan to quickly respond to performance issues regardless of their cause is essential to stay ahead of customer demand. This translates into having capacity planning expertise on the team. These experts monitor performance on a daily basis to maximize the number of customers who can use the site and ensure there is adequate capacity to handle the increased number of users tomorrow.

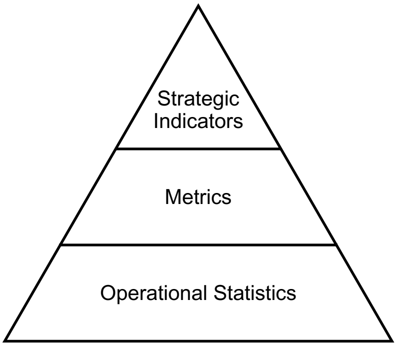
Architecture

The second component in addressing reliability has to do with the overall system and network architecture. What systems are involved in delivering the service to customers? It is important to understand how they interact with each other in providing the service. Just as capacity planners are important, E-commerce architects who understand the market are critical. Security professionals who understand security architectures to protect the overall corporation and how to implement them are also essential.

Measuring Performance

The collection of metrics for capacity planning, customer satisfaction, and usage is imperative. Operational statistics are collected as part of operating the business and include such items as technology outages and usage. These operational statistics are generally used to provide informa-

EXHIBIT 3 — Operational Statistics to Indicators



tion regarding problems and assist in determining where efforts should be focused to correct operational problems. Help desks or customer service areas can be invaluable for recording these kind of metrics.

As all of the operational statistics are collected, they must be analyzed and collated into metrics to report the state of the operation. How is the E-commerce environment working? How many customers have used the site? How much was spent and what was bought? However, metrics must be combined from across the organization to establish the strategic indicators used by top management to determine how the organization is doing and what they should be concerned about. This relationship is illustrated in Exhibit 3.

Some things to consider surrounding operational statistics and metrics include:

- What efforts are being made to collect, report, and validate the available metrics?
- What metrics are available from the internal and external service providers?
- Determine the reporting structure for these metrics.
- Determine how these metrics are used.
- What process is in place to use the metrics to create feedback to improve the system or correct problems?

Problem Resolution

The primary users of an E-commerce site are its customers. However, sometimes things go wrong, or customers have questions arise during their visit and would prefer to talk with someone regarding the issue. Consequently, they need to have a place to report these problems or ask their questions.

This requires the implementation of a customer call center where problem reports regarding the Web site can be taken and directed to the correct support groups for resolution, or product questions asked and answers provided. Effectively operating this customer call center requires the use of a call tracking system capable of tracking the customer's issue and a history of what was done to provide resolution.

If operating a global company — and face it, if you are running an E-commerce site, your consumer audience will be global — you will need to establish a method for people to reach you in real time from anywhere in the world.

The customer call center must be able to respond quickly to customer needs and provide the information they are requesting in a timely fashion. Doing so establishes confidence in the mind of the consumer about your abilities and enhances their buying experience.

When considering the call center, the following questions should be considered:

- How do both you and the customer evaluate satisfaction level?
- How long does it take to solve a problem once reported? Is the customer satisfied with the resolution? Is follow-up necessary?
- What are the common problems reported and what has been done to rectify them?
- What problem tracking and resolution system is in use?
- Are problems recorded so that metrics can be obtained and trending reasonably retrieved?

Service Level Agreements (SLAs)

Service level agreements (SLAs) establish the terms of service, including expected operational performance and problem escalation and resolution. Both issues are important in E-commerce activities. The operational performance of the service provided is critical because poor performance means the E-commerce services will be unavailable to the customer. This in turn can negatively impact both the bottom line and the image of the company on the Internet.

Timely resolution of problems is also important for the same reasons. Customers expect service level timelines for issues to be met. What SLAs are there with service providers, and are there penalties if they do not meet their commitments?

SLAs are also used to assist in measuring the capabilities of your service providers and are useful to have when renewing contracts. Having collected and maintained good information regarding performance and issue resolutions, one will have more success negotiating changes in the contract and price due to good or bad performance in the service delivery.

Things to remember when reviewing the SLAs in place for an E-commerce environment include:

- Obtain SLAs from suppliers such as ISPs and network providers.
- What quality-of-service provisions are in the SLAs? Are the service providers meeting these agreements?
- Do the service providers and your own organization maintain records on their performance?

Maintaining the Business

The ability of the infrastructure to recover from a systems failure, connectivity loss, or other issue is essential. Order entry for product sales is a critical activity that must be maintained. How will the organization handle the partial or complete loss of its E-commerce infrastructure? Are appropriate plans in place to maintain the E-commerce business?

Business continuity and disaster recovery planning form important elements in any business, but are not centered solely on the E-commerce services being offered. Business continuity is centered on maintaining the business operations after a fatal systems failure. For example, can E-commerce operations be maintained if several systems suddenly fail?

These are important questions to ask support organizations. If the organization is heavily dependent upon the ongoing operation of the E-commerce environment, then a failure for even a short period of several hours can have disastrous effects on the business. If operating an enterprise based more on "foot traffic," one may be able to afford the down time.

However, in today's information age, when an online business is offline, everyone hears about it — very quickly.

Areas of concern surrounding business continuity include:

- Has a business impact analysis been conducted to determine how important E-commerce is to the survival of the organization?
- Are the Web servers and other systems involved in the E-commerce delivery part of a contingency plan?
- Are there backup procedures, dependable backups, and regular data and system recovery testing?
- Is the status of systems' monitor to maintain integrity and operation?

DEVELOPMENT

As mentioned previously in this article, customers will remember their experience with an E-commerce system based upon how it worked for them. Consequently, the development of a consistent interface is required and can only be achieved through good development practices.

Standards and Practices

The key method of ensuring that consumers have a positive experience with an E-commerce site is to establish development standards and practices. These are independent of the "look and feel" established as their interactive experience.

The site developers use standards and practices to provide information and methods on how the applications will be developed. This includes things such as code standards, security, and how information submitted from the consumer will be validated and protected. Accordingly, security needs to be designed into the application from the start and not included as an after-thought.

Developers will make decisions regarding how they will develop and write their particular part of the system based upon their previous experience or education. These differences make it difficult for the ongoing maintenance and subsequent troubleshooting and issue resolution.

Change Control and Management

Change control is a critical part of the overall development/production cycle. Proper change control reduces the risk of improperly tested application code being placed into production, causing problems with data integrity, confidentiality, or reliability. It is also used to identify the changes that are made from day to day to the application code and allows for proper issue resolution and developer education.

A major issue with the development of application code is the fact that it is often put into production systems and "debugged" while customers are using it. This type of activity not only impacts the development of the system, but also affects the user's perception of the E-commerce site and the online presence of your enterprise.

Proper change control ensures that development code is tested in a development environment and is able to process not only the accurate information that the consumer provides, but also handling errors in the input, made either deliberately or accidentally.

Proper processing of information that is collected on the Web site affects business operations. Failure to process it correctly may result in improper or incorrect charges to the consumer, or delivery errors resulting in lost merchandise and increased costs.

When assessing the configuration and change control environment, one must consider:

- Software release change and version control, including both the application code and operating system changes
- Is it possible to maintain a stable operating environment in today's fast-paced world? Is it possible to automate the change process?
- Development, implementation, and migration standards

CONNECTIVITY

Connectivity is specifically concerned with the technologies used to establish network connectivity to public and private networks, how available bandwidth is calculated, and how the network is designed. E-commerce is very dependent on a successful network design and adequate capacity to ensure that consumers can get to a Web site, especially during the winter holiday season.

This means adequate Internet connectivity speed and capacity, and similar connectivity into your corporate network if applicable to your E-commerce design. Many network design people are leaders in their field, but adequate network capacity can be easily overlooked.

A network can also be overbuilt, having too much capacity and other resources built into it that ties up an enterprise's resources unnecessarily. It is necessary for the enterprise to have good technical management and network design staff to take the marketing and sales plans and build a network that will handle expected traffic and scale appropriately as demand increases.

The network staff must understand that an E-commerce site must be located in an appropriate place. This means that if one intends to operate on a global scale, one may want to consider having multiple locations to ensure the best connectivity and performance for the consumer. This can increase the complexity of one's environment in the process and in turn increase one's dependency upon good planning.

Part of this planning includes redundancy, which in turn forms part of one's contingency and business continuity planning. If one component or location becomes unavailable for any reason, one is able to maintain presence and continue operation of E-commerce enterprises.

Consumers are looking for a positive, encouraging experience when interacting with an E-commerce environment. Failing to provide this experience reflects negatively upon your online presence. This may result in a perception that the company is not prepared to handle E-commerce and consumers will be reluctant to conduct business with a site.

In reviewing network connectivity, remember to consider:

- Location(s) of E-commerce sites
- Network capacity
- Maintaining and monitoring of network availability
- Network topology
- Redundancy of the network
- Security
- How secure are transmission links
- Do you use a switched network
- Is any form of virtual private network (VPN) used in E-commerce delivery

SECURITY

There are four major components that make up the security area:

1. Client or user side of the connection
2. Network transmission system
3. Protection of the network information during transmission
4. User identification and authentication

Protection of the network security elements and the computer systems that reside in the E-commerce infrastructure is a major portion of protecting the data integrity and satisfying legal and best practices considerations. This level of protection is addressed through various means, all of which must be working cooperatively to establish defense in depth.

As seen in Exhibit 4, the layering is visualized as a series of concentric circles, with the level of protection increasing to the center. Layer 1, or the network perimeter, guards against unauthorized access to the network itself. This would include firewalls, remote access servers, etc. Layer 2 is the network. Some information is handled on the network without any thought. As such, layer 2 addresses the protection of the data as it moves across the network. This technology includes link encryptors, VPN, and IPSec.

Layer 3 considers access to the server systems themselves. Many users do not need access to the server but to an application residing there. However, a user who has access to the server may have access to more information than is appropriate for that user. Consequently, layer 3 addresses access and controls on the server itself.

Finally, layer 4 considers application-level security. Many security problems exist due to inconsistencies in how each application handles or does not handle security. This includes access and authorization for specific functions within that application.

EXHIBIT 4 — Levels of Protection

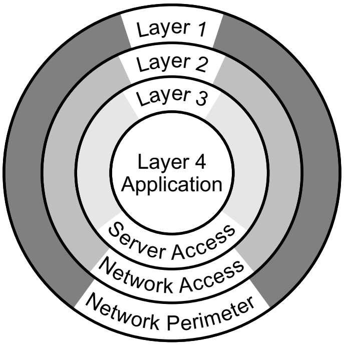
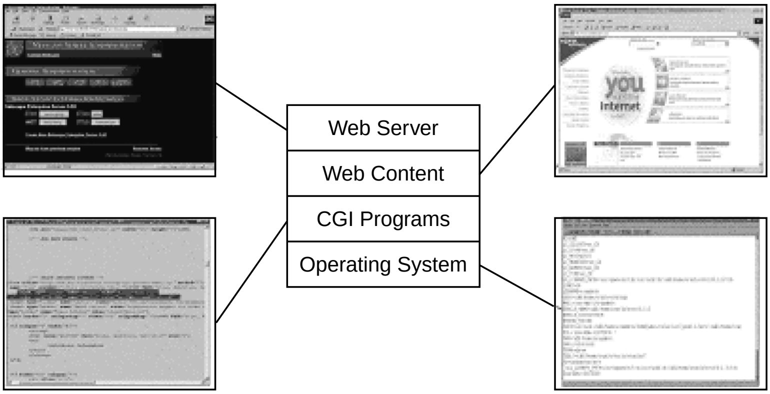


EXHIBIT 5 — Linking Layers



There are occasions where organizations implement good technology in bad ways, which results in a poor implementation. For example, the best firewall poorly configured by the user will not stop undesirable traffic to a site, or a database security system that has all of the data tables granted for "public" access does not protect the data they contain. This generally can lead to a false sense of security and lull the organization into complacency.

Consequently, by linking each layer (see Exhibit 5), it becomes possible to provide security that the user does not see in some cases, and will have minimal interaction with to provide access to the desired services. Integration between each layer makes this possible.

The same is true when implementing security within the E-commerce environment. It must be considered at all layers: the client, the network, the perimeter, and the associated servers. The Web interface has four primary layers: the operating system, the CGI programs, the Web content, and the Web server. Each layer is dependent on the components of the other layers working correctly.

Client Side (User)

Clients interact with the E-commerce infrastructure through their Web browser. The users, however, have certain expectations about how the interaction will look, act, and perform at their computer. For the experience to be a positive one, certain programming considerations must be addressed during design, development, and implementation.

The experience the user has will be different across the different browser implementations, and choosing to support browser extensions that are not supported by other browsers is not a good business decision.

The HTML, dynamic, and graphic content must be compatible with the different Web browsers available. E-commerce applications must consider this requirement. Not all users will want to enable extended features in their browser, such as cookies, Java, and JavaScript. This greatly affects the functionality that can be offered in the design of the application.

The users and businesses that will use a service may not be connected directly to the Internet. They may be using a proxy server to provide security or cache network requests. They may also be using a slow-speed network link. These factors must be included in the design to maintain a positive experience.

When considering client-side issues:

- Examine what types of Web browsers and proxy servers are in use and in what operating environments.
- Determine how a customer registers for E-commerce access.
- Determine the ease of use of the E-commerce interface.
- Decide what applications will be used to develop the interface.

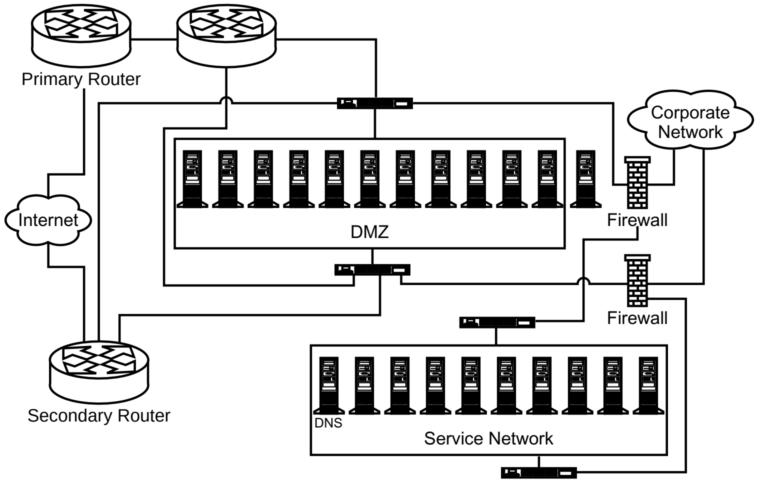
Firewalls

The firewall is an integral part of an E-business architecture. It is accepted that any computer directly on the Internet with no protection is a sacrificial host. One can expect it will be compromised at some point. While it is not reasonable hide everything behind the firewall, every system not needing to be directly visible to the Internet should be protected by a firewall. Additionally, no connections from any unprotected systems should pass directly through the firewall to the corporate network.

However, a firewall can be bolstered by the network design through the use of demilitarized zones (DMZs) and service networks (see Exhibit 6). The DMZ protects its systems through filters and access control lists in the routers. The service network is a separate network connected to the firewall. Any system that does not need direct Internet connectivity and does not need to be on the corporate network is put in the service network.

The customer interacts with the systems in the DMZ. Additional services required to provide the customer with their experience are obtained by systems in the services network. Any additional information that must be retrieved from systems on the corporate network is retrieved by the intermediate servers. While this seems to be an overly complex arrangement, there is a high degree of security inherent in the design. The systems outside the firewall have no ability to connect to the corporate network. The firewall is configured to only allow connections from the DMZ to the service network, and then only to specific IP addresses and network services. The systems in the service network are then authorized to connect with systems in the corporate network for the required information.

EXHIBIT 6 — Demilitarized Zones (DMZ) and Service Networks



The use of intrusion detection systems and periodic evaluation using vulnerability assessment tools is also highly recommended as part of an E-commerce security architecture due to the nature of the service and likelihood of attack.

When considering the firewall and network security implementation, examine:

- Vulnerability reports of all network elements using a network vulnerability tool such as Cybercop or ISS
- The DMZ systems to determine if they are “hardened” to reduce the potential attack points
- How the Web client and server negotiate SSL encryption and what encryption strengths are offered
- Non-HTTP ports opened through the firewall(s) for browsing and analyze security implications
- The firewall topology
- Firewall configuration files
- Access Control Lists of network devices
- Network communication protocols
- Configuration management on the network security elements

SECURING THE E-COMMERCE SERVER

The E-commerce server consists of a variety of components all connected together to provide the business service. Multiple systems are used to reduce the complexity of any single system in an effort to improve the chances of properly securing each system. These services include the HTTP or Web server itself, personalization systems, directory systems, e-mail gateways, and authentication systems.

Directory Services

Directory services provide a mechanism for maintaining an online repository of registered users and their related information. By using a central repository for this information, any of the systems requiring authentication data or information regarding the user can access it. Additionally, applications can query information regarding the user, including their mailing information when ordering or requesting hardcopy information or when products are shipped to them.

Several directory systems are available, but those based on X.500 and Lightweight Directory Access Protocol (LDAP) technology provide the highest level of integration and availability.

Because all of the information regarding the users is stored in a central repository, special care must be taken to protect the information on those systems and provide authenticated and secure transmission channels for the data. The repository must have high availability, as many systems will be dependent upon its ability to provide the information when requested. As previously stated, the consolidation of the data makes it easier for the administrators to provide confidentiality and maintain integrity while the information is stored, and during transmission across the network. One can argue that the consolidation of the data also makes the system a target for attack. However, the centralization also provides network security personnel with the opportunity to protect the system.

When evaluating the directory services provided, consider:

- How much data will be stored?
- How quickly must the directory provide the response?
- How many queries can the directory handle at a single time?
- What security functionality is integrated into the directory?
- Does the directory support authenticated connections?
- Does the customer understand that this data is being stored?

Mail Server

Electronic mail is a key component in any E-commerce infrastructure. It allows for the delivery of information from the E-commerce infrastructure systems to a user or business. Customers depend on e-mail to request information and to interact with customer service or support people when questions or problems arise. It can also be used by customers to report things they like or dislike about the experience. E-mail, while used for many things, should not be used as a transport method for information requiring special protection. Information sent via e-mail is as public as a postcard. Consequently, the distribution of credit card or purchase information, as well as username and passwords, must not be distributed through e-mail. This can be made possible and secure through encryption technologies such as S/MIME.

The operation of the mail server is critical to the infrastructure. E-mail servers are also regularly used by hackers to access other systems or send unsolicited bulk e-mail, or spam, as they are often not considered to be a major security risk. Many of the available commercial mail servers have idiosyncrasies related to their configuration that can both protect and expose information. Consider the incorrectly configured mail server that allows an external user to send e-mail as if they were an employee of the company, or using the mail server to relay spam to other mail servers.

Such examples are written and documented on a daily basis in the security industry and are usually related to simple misconfigurations, the use of out-dated software implementations, or not remaining current with software patches.

When addressing e-mail security and availability, consider:

- Which mail transport agents and mail user agents are being used
- Access permissions for the mail transport agent's (MTA) configuration files
- Periodic review of the mail server's delivery and error logs to determine the possibility of misuse
- Probing the MTA for common "exploits" to test vulnerabilities to various attacks
- Evaluating the use of virus protection technologies
- Content management and encryption technologies

Web Server

The Web server can be considered the most critical component in the E-commerce infrastructure. It is required to deliver Web-viewable content to the user, run programs to retrieve or send information to the user or other systems, and perform specific checks to determine the validity of requests. It is expected to be available all the time and to provide responses to the user within an acceptable time period. If users have to wait due to poor network or Web server performance, they will quickly leave your site. Once again they will form a negative perception of the business and not be likely to return.

There are a number of Web servers available, both as commercial and freeware software implementations. If one can afford it, buy a commercial implementation to have quick support when issues arise and gain vendor maintenance for the software. While the initial expense for freeware implementations may be low, and they are quite robust, the afterinstallation maintenance and support expenses can be quite high. Consider company turnover and retention of experts to maintain the freeware implementation. It is likely to be much easier to find trained experts on commercial software than someone who is familiar with a tailored freeware implementation.

While configuring the Web server itself, development standards are needed for the design of applications and Web content. The Web server software must not execute on the system with any special or administrative permissions. This reduces the risk of an attacker gaining administrative privileges to compromise the server.

The operation of the server is also dependent on the availability of Common Gateway Interface (CGI) scripts to provide access to applications and forms. CGI programs require careful scrutiny during development and before final production to validate that there are no exposures to poorly written code resulting in security issues. Confidentiality and data integrity have been presented several times. The Web server should be capable of providing encrypted sessions through Secure Sockets Layer (SSL) or Transport Layer Security (TLS). Both SSL and TLS require no additional hardware and both use a server-side certificate. The issuance of a certificate for a site is beyond the scope of this article. Several reputable firms can issue certificates for Web servers.

Using SSL or TLS, the organization and customer can be confident that the information being displayed or sent is protected while in transit across the network.

When reviewing the Web server, consider the following:

- Review the userID and account permissions the Web server runs under (i.e., root, administrator).
- Determine which Web sites are public and which are controlled access.
- Analyze access permissions for HTML documents, ASP and CGI, directories and scripts.
- Examine Microsoft IIS or other Web server application configurations and log files.
- Determine how requests received by the Web server from the browser are verified.
- Determine how requests sent to a back-end processor are verified as completed.
- Examine Web-based applications and database connectivity including Java, JavaScript, and XML.
- Check for the existence of well-known ASP and CGI scripts and utilities that pose a security risk.
- Examine Web and proxy server configuration files.
- Check the Web server configuration files and certificates to enable SSL communications.

- Analyze high-availability components in the E-commerce service.
- Evaluate operating system and Web software patch levels and configuration files on critical servers.
- Evaluate application patch levels and configuration files.
- Determine how external E-commerce systems authenticate to internal systems.
- Consider the certificate authority that issued the server certificate and if there a method for the customer to validate the authenticity of the certificate.
- Evaluate the requirements of non-repudiation features.
- Evaluate CGI scripts and review the program code.
- Consider Web content management.

OPERATING SYSTEM SECURITY

All of the components previously described rely on the foundation services provided by the operating system. While each of the individual application components can be made more secure, without a strong, secure foundation, other efforts are affected. Today, the vast majority of E-commerce systems run on either Windows NT or UNIX operating systems. Each of these environments has its own advantages and disadvantages and system vulnerabilities.

Windows NT Operating System

Windows NT is a popular operating system used to perform specific computing tasks in any infrastructure. Proper configuration of the operating system is essential. If not properly configured and security is not properly implemented, it can be trivial to compromise.

Windows NT relies heavily on the registry to provide both operating system and application configuration settings. Several key services in Windows NT operate at the same network service port. This can provide a remote user with the ability to probe the system and collect important registry information. With this information in hand, such as disk sharing information, usernames, and system configuration details, a successful attack can be launched against the system.

When using Windows NT as an E-commerce operating system platform:

- Conduct a scan of all Windows NT systems providing E-commerce services using both host- and network-based vulnerability scanners. Analyze the results and attempt to exploit them on the operating system to gain unauthorized access.
- Review unnecessary services and ports.
- Review registry settings and operating system patch levels and configuration files on critical servers.

- Evaluate configuration and change management on the operating system components.
- Implement virus protection technologies.

UNIX Operating System

The UNIX operating system provides a multi-user, multi-processing environment used for many different tasks. Like Windows NT, however, improper configuration of the security modules and operating system can make it trivial to compromise. UNIX is a much more popular E-commerce environment than Windows NT. Despite the relative maturity of the operating system, new problems with UNIX implementations are discovered on a weekly basis. The visibility of some of the new security issues even makes it to the news media due to the dependence in the computing world upon this operating system.

Like Windows NT, UNIX is not intended to be a secure operating environment. Any security expert can provide a multitude of ways to defeat the security systems on either operating system. Considerable effort is required to "harden" the operating system and reduce the vulnerabilities in the E-commerce environment. As a multi-user operating system, UNIX has a large number of network-based services providing major parts of the system's functionality. Many of these services and ports are not necessary in order to provide E-commerce functionality. These services are often exploited to initiate confidentiality, data integrity, or system availability attacks.

When using UNIX as an E-commerce operating system, be sure to:

- Conduct a scan of all UNIX systems providing E-commerce services using host- and network-based vulnerability scanners. Analyze the results and attempt to exploit them on the operating system to gain unauthorized access.
- Review unnecessary services and ports.
- Evaluate operating system patch levels and configuration files on critical servers.
- Evaluate configuration and change management on the operating system components.

BACK OFFICE APPLICATIONS

The E-commerce infrastructure has communications paths to various back office applications, including search engines, Oracle, BaaN, and SAP to facilitate the ordering of products from the catalog. These systems are sufficiently protected, as well as the data sent across the network, to restrict protected information access. In addition, there are specific performance and security considerations for these applications.

Search Engine

The search engine is used to find specific documents or Web pages within the E-commerce environment. The quality of the search engine responses depends on how fast this "crawler" can traverse the Web links and pages to produce an index for the location of where relevant material is located. Most search engines perform this work in two stages. First, the search engine "crawls" through the Web pages and collects information. Second, it builds a searchable index for use later when the user requests the search.

Different search engines offer different levels of performance in the collection of this information. This affects the validity of the search results when the user requests the search. If pages that exist cannot be found when the search is requested, the user will think the information does not exist. Consider the negative perception this can have on the user's experience at the Web site. If pages that no longer exist or contain irrelevant information appear, the user will become frustrated.

For example, consider the graphs in Exhibit 7. Both graphs illustrate basic system activity for two different search engines running on exactly the same hardware. The system on the left makes much better use of the system's resources during the crawling and indexing phases. This improved use of system resources suggests the engine is working effectively. The graph on the right shows much lower resource utilization, suggesting the engine may not be capable of handling the workload despite the hardware resources.

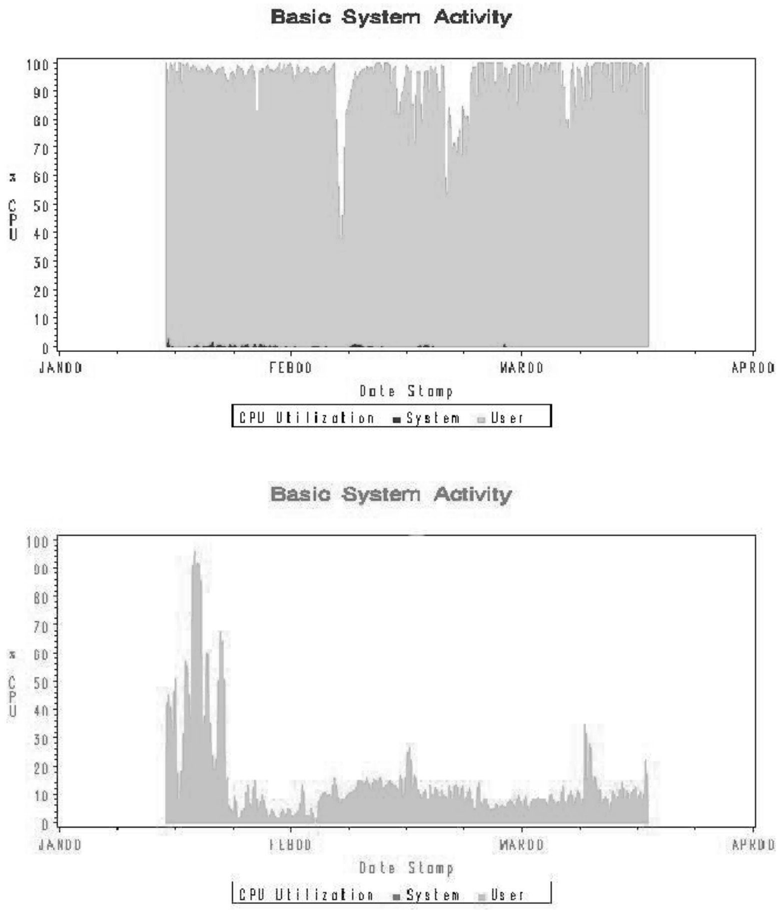
User interaction with the search engine is also critical. If the search engine itself has not been properly implemented, it is possible for performance, including the search, to be slow, due either to the software or the hardware on which it is running. Some search engine implementations do not handle simultaneous searches well. Careful review of the product, combined with simulated load testing, is required prior to implementation.

When evaluating the search engine, review:

- How well the crawling and indexing features work
- The success rate and relevance of the returned documents
- The CPU and LAN utilization
- How quickly search responses returned to the user
- The vendor's reputation

The back office systems provide information to the E-commerce user over which the organization wants to maintain strict control. In general, these same systems will be used to provide the day-to-day operations for the rest of the company. Because they are generally within the protection of the corporate network, they can be considered protected. The "hard and crunchy" network perimeter is becoming less and less practical as more and more users and customers are demanding services and access

EXHIBIT 7 — Basic System Activity for Two Different Search Engines



technologies. However, the issues previously presented regarding development, application, and operating system configuration must all be applied here as well.

Communication to these systems from the external E-commerce system is controlled by the firewall. The firewall will only allow specific external systems to communicate with specific internal systems to minimize the risk of total compromise in the event of an attack.

Being successful in implementing connectivity and protecting these back office systems is dependent on a thorough understanding of how data is moved from one system to another, what protocols and transport methods are used, who creates the data, who processes it on the receiving computer, and the sensitivity of the information itself.

When evaluating and implementing connectivity to back office systems, one must:

- Evaluate protection of sensitive organizational data
- Evaluate configuration management on the back office components
- Evaluate the use of virus protection technologies
- Evaluate database configuration and administration practices
- Evaluate order transmission from the Web site to the order management system
- Evaluate the order fulfillment process

E-NOUGH!

This article has discussed the components of E-commerce architecture and identified what the organization should focus on when developing its environment or preparing to perform an audit. This article is by no means an all-encompassing examination of each of the technology areas but is intended to show the reader the relationship and dependencies of various components that make up an E-commerce environment.

The implementation of an E-commerce environment allows any corporation to economically achieve global presence and enter the global marketplace successfully. In fact, some retailers have no or few storefront (bricks-and-mortar) premises due to E-commerce.

This is a challenging and fast-paced world where it is so important to be first — be visible and remembered. Do it fast, be quick and do it right; if you do not, you blow it.

This is the nature of E-business. If one does not get it right the first time, one will not have enough time to fix it later. This is our E-dilemma!

Acknowledgments

Very special thanks to my colleague and close friend, Mignona Cote. Her insight into many areas in technology, business, and risk areas have taught me many things. Without her assistance, this work would not have been completed.

Chris Hare's experience encompasses more than 14 years in the computing industry with key positions ranging from application design, quality assurance, system administration/engineering, network analysis, and security consulting, operations, and architecture. His management career, coupled with in-depth technical knowledge, provides the foundation to integrate the intricate risks of technology to the ongoing survival of major corporations. Accredited with the Certified Information Systems Security Professional (CISSP) designation, Chris teaches information security at Algonquin College (Ottawa, Canada) and sits on the Advisory Council for this program. Chris currently lives in Ottawa, Canada, and is employed by Nortel Networks as a Security and Control Consultant.