Securing Web Resources

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Introduction

When securing corporate information resources, there are a few questions that need to be considered:

- What are the security threats/risks you are concerned with?
- What measures can be taken to control these risks?
- What mechanisms (e.g. human processes or technologies) will be used to control these risks?

The answers to these questions are not always obvious. Each organization addresses these in their own unique way.

This white paper will only address a small, but important, portion of the overall information security needs of an enterprise, that of accessing documents and applications over a network using the Hypertext Transfer Protocol (HTTP). While other protocols can be used besides HTTP to reach a Web resource, this document is restricted to HTTP since it is the most common and is the only known protocol supported by the Tomcat Servlet Container that the WEB Agent runs in. As Tomcat and the WEB Agent may support other protocols in the future, much of the information in this document could apply to them as well.

This document guides you through some important considerations when securing web resources in general and, specifically, with the iLock Security Service's WEB Agent.

Security Mechanisms (E+3A)

As mentioned in the next section, there are many aspects of information security that are out of scope for this document. The specific Web resource security topics addressed in this document are:

- Encrypting HTTP message traffic
- Authentication of web users
- Access authorization for specific web resources
- Auditing web resource requests

A Small Piece of a Big Pie

This document is strictly limited in scope. Therefore, the following will not be addressed in this document. It is assumed the reader is familiar with them, or they have other resources at their disposal to address them:

- Configuring and maintaining your Web server(s)
- Configuring and maintaining the Tomcat Servlet Container
- Configuring and maintaining iLock Security Services
- Providing a firewall between public networks (e.g. the Internet) and your corporate network
- Your organization's security needs, requirements and policies

- The security requirements of your Web resources (e.g. Web pages and Web applications)
- Where the security provided by the WEB Agent fits within the larger scheme of overall Web architecture and enterprise information security

To expand on the last point just a little further, some of the topics of your overall Web security may likely include the following. It can take many people, with many different skills, spending extensive time to continually plan, execute and monitor the security of an enterprise's information resources. This document will not address these important topics.

- Proxy servers
- Reverse proxy servers
- Demilitarized Zones
- Security for back-end beans/services/applications
- Trust level of web applications
- Files/services accessible from Web applications
- Host operating system security
- Network security
- File system security
- Data base security
- Controlling physical access to computers
- Protection against computer viruses
- The user ID and group a Web server runs as
- The integrity and confidentiality of the Web server's log files
- Backup policies
- Procedure for reviewing/analyzing log/audit file
- Intrusion monitoring
- Single sign on
- Managing digital certificates

Managing Access Needs vs. Protection Needs

In the past, Web resource security concentrated on keeping the bad guys out. The firewall was a major component in allowing an enterprise's employees to access the Internet while keeping outsiders from accessing the corporate Intranet.

Today, corporations are finding new ways to utilize the power of the Internet for communicating with customers, vendors, remote employees and business partners. This has added the need to let the good guys in, to efficiently perform trusted, e-business and extend the internal Intranet to remote employees. This adds levels of complexity far beyond the traditional model of security. Business trust depends upon keeping personal and corporate information private. Some use the term "application firewall" to refer to the software mechanisms used to control access at the application level.

Web resource security breaches can result in the disclosure of critical information or the loss of a capability that can have a significant effect on an organization. Securing Web servers and their Web resources should be an important part of your information security strategy. Many security problems arise from misconfigured Web servers, plug-ins and Web applications.

Web resources may need to be restricted in one way or another. Some reasons for restricting access to Web resources are:

- Contractual agreements with other parties, such as business partners, may require protecting proprietary information that is exchanged
- Software licenses from vendors are made to protect their intellectual property, often including restrictions on their use
- Copyrights often restrict dissemination
- Governing laws may require restrictions, such as protecting the confidentiality of medical history or giving equal access to a corporations financial status
- A corporation's internal documents may be proprietary to prevent competitors accessing them and using the information against them in the market place

Secure relationships are crucial for business processes and interactions. Businesses today deal with thousands to millions of customers. To offer the highest standards of service and convenience, businesses need to provide their customers with secure Web access to many of their enterprise systems, enabling purchase management and much more. Business partners may require access to systems in a distributed network environment. As a result, portions of internal systems, applications and databases may be shared with business partners.

Sources for Further Information

- IETF RFC 2616 Hypertext Transfer Protocol -- HTTP/1.1 Section 15 Security.
- Apache HTTP Server documentation
- Tomcat Servlet Container documentation
- OMG Security white paper - http://www.omg.org/docs/1994/94-04-16.pdf
- http://www.cert.org
- iLock Security Services Concepts Guide
- *Secrets & Lies: Digital Security in a Networked World* by Bruce Schneier

Encryption

Message protection is the term used to indicate that messages (typically in transit across networks) are protected from being viewed or modified by unauthorized persons. To protect messages from being viewed, the sending party typically encrypts messages and the receiving party has the ability to decrypt the message.

To protect the message from being modified, there is typically encrypted information about the message (perhaps a hash of the message) that can only be created by the sender and read by the receiver. If this information does not match the message contents, there is a strong indication that the message has been tampered with. This generally comes in the form of a digital signature.

Message protection techniques should almost always be used when messages travel through public networks (e.g. the Internet). Enterprises may or may not perceive the need for message protection within internal private networks.

Encryption is the process of converting information from a known content to a form where the content can only be read (decrypted) using a secret "key." The key is used to convert the information back to its original form and is kept secret so only certain entities are permitted to use it.

HTTP communication between a client (typically a Web browser) and Web server travels over a network. There are a couple of security risks for which encrypting HTTP traffic can help solve.

- **Confidentiality** — maintaining the confidentiality of information passed between Web clients and Web servers. When message or transaction information is transmitted "in the clear," hackers can intercept the transmissions to obtain sensitive information. There are many techniques that third parties can use (e.g. network sniffers) to listen to network traffic. If this communication is going over the Internet, it must be assumed that others are listening to the HTTP traffic. Even within a corporate Intranet there are plenty of opportunities for employees or vendors' equipment to record HTTP communication.
- **Integrity** — maintaining the integrity of information passed between Web clients and Web servers. The content of a message or transaction can be intercepted and altered en route, either maliciously or accidentally. User names, credit card numbers and dollar amounts sent "in the clear" are all vulnerable to such alteration. Typical HTTP communication passes through many computing systems and/or devices as the message "hops" from the source to the destination. This makes it possible for "man-in-the-middle" security attacks. Any intermediate system or device could alter the information before passing it on. For example, the dollar amount of a money transfer could be modified to withdraw extra money that gets deposited in a different account.

To prevent intruders from compromising the integrity of corporate information resources, the secrets (e.g. passwords) and proprietary information passed over the network needs to be protected, and the exact content passed from the source needs to be received by the target (no more and no less). The standard way to do this is by encrypting the traffic between the client and Web server in a way that third parties cannot listen to it or modify the contents.

The standard mechanism to encrypt HTTP traffic is to use the Secure Sockets Layer (SSL), also called Transport Layer Security (TLS), in the underlying transport. When HTTP is used with SSL it is called HTTPS. With SSL, server to client authentication is used so the client can be sure it is communicating with the server it thinks and the client can decide whether to trust the server, and vice versa.

Configuring the Web server determines whether HTTP vs. HTTPS is used for communication between a client (e.g. Web browser) and Web server. The Web browser must support HTTPS as well, which the popular Web browsers do. The details of configuring a Web server to use HTTPS may vary from server to server. However, the basic steps include:

- Acquiring a digital certificate for the Web server,
- Configuring a plug-in that handles SSL,
- Designating a port for listening to HTTPS requests. By default this is port 443, and
- Designating which Web resources are to use HTTPS. Any requests for those resources that originate using HTTP will be redirected to use HTTPS on the specified port.

The WEB Agent is not involved with the configuration of HTTPS, but it does know whether HTTP vs. HTTPS is being used. In the case where a Web server is misconfigured to allow secured resources to be reachable using HTTP, the WEB Agent can easily prevent this from happening. Access authorization policies can be configured to deny access unless HTTPS is used. Defining a URL pattern of http://*:*/*/*/*?* and attaching a policy that denies access by everyone for all HTTP operations. This will protect Web resources from being accessed with HTTP, but the user would have already been authenticated, with their user ID and password being passed in the clear over the network.

The Tomcat Servlet Container can also be configured to require HTTPS to be used for all (or selected) Web resources. This can be done whether Tomcat is running as a standalone Web server or processing requests for another Web server, such as the Apache HTTP Server or Microsoft Internet Information Server. Tomcat does this by following the Java Servlet Specification that specifies using a *security-constraint* element with a transport guarantee of *CONFIDENTIAL* or *INTEGRAL*.

Authentication

Authentication is the term used to indicate that an individual or system has proven its identity. Authentication may work in both directions. That is, a Web client may be required to prove its identity to a Web server, and conversely, the Web service might be required to prove its identity to the Web client.

A Web server may require the client's identity for various reasons, including:

- To control access to certain Web resources by only certain individuals
- To know whom was responsible for a particular transaction or event
- To customize the Web resources for particular users

A Web client may require the Web server's identity for various reasons, including:

- To make sure secrets (e.g. passwords) it divulges are not to the wrong entity
- To make sure transactions they initiate are with the right entity
- To help provide proof of any transactions that were made

Using IP and DNS spoofing, traffic from legitimate Web servers can be redirected to clandestine Web servers, making Web users think they are communicating with the original organization. When HTTPS is used, the Web server's identity is given to the client via a digital certificate, as the secure connection is being set up. Clients need to be in the habit of reviewing the information in the digital certificate and making a conscious decision whether to trust it or not.

The authentication function is the cornerstone for all other security functions. Without reliable authentication, all other security features that may be used are effectively meaningless. In particular:

- Access authorization is based on allowing or denying access depending on the security attributes of the client. These security attributes are given to certain individuals or groups of individuals and cannot be known by a server until the identity of the client is known.
- If security related events are audited without knowing the identity of a client, they are of limited usefulness.
- Encrypting HTTP communication may keep third parties from seeing and modifying the contents, but it is worthless unless you are sure whom you are talking to.

There are various techniques used to authenticate individuals and/or systems. Web servers, including the Tomcat Servlet Container, typically support the first two techniques listed below.

- Shared secret - User ID and password
- Digital certificates
- Physical tokens such as ATM cards, Smart cards...
- Biometrics such as retina scan, thumbprint readers…

The authentication capabilities of the WEB Agent supports the first technique listed above. However, the WEB Agent access authorization can work with Tomcat's other authentication techniques. The WEB Agent authentication manages Access IDs and Groups in addition to the Roles that are supported by the Tomcat authentication mechanisms. It is likely that an enterprise already has a user database that the Tomcat authentication mechanisms can access.

The Tomcat Servlet Container implements the Java Servlet Specification, which defines a concept of an HTTP "session." By default, Tomcat only authenticates a user when a session is started. The user's identity and security attributes are cached for the length of the session. If a user's security attributes were to change during the session, the old security attributes would continue to be used until the session ends. A session may be ended for a number of reasons, including:

- Tomcat can be configured with the length of time a session stays alive.

- If Tomcat is stopped, the session is ended automatically. When it is restarted, Tomcat will not know of the session. A new one will be started the next time the client tries to access a Web resource that requires authentication.
- If the Web client is stopped and restarted, the session is usually ended. A new one will be started the next time the client tries to access a Web resource that requires authentication from that server.

Some special authentication processes that are used at times are listed below:

- In some Web server architectures, a Reverse Proxy Security Server (RPSS) may sit in front of a true Web server and provide authentication of users before a Web request is forwarded to the Web server. This requires special code in the Web server to understand and trust the authentication data inserted by the RPSS into the HTTP request.
- Sometimes the DNS domain and/or IP subnet of the Web client control access to Web resources. In this case, the identity of the specific client (person) may not matter, but they belong to the group of people from the DNS domain or IP subnet and are granted access based on their group rights. In this case, a specific authentication process is not needed as the identity (DNS hostname or IP host address) is known from the underlying communication layers. Care must be taken in trusting this information since it could be faked using IP or DNS spoofing techniques. In addition, auditing can be compromised as the specific person from the group at the DNS domain or IP subnet is not known.

Access Authorization

Access authorization relates to two common terms that are closely related, sometimes used interchangeably and often confused. These two terms are listed below.

- **Authorization** – according to *The American Heritage® Dictionary of the English Language, Fourth Edition*, one of the definitions for authorizing is "To give permission for; sanction." The permission in this case is for an entity (typically a person) to perform some sort of action in relation to an information resource, such as deleting files. Some people tend to use the term "authorization" when referring to granting permission for relatively large grain resources and/or actions, such as running a specific application on a particular machine or utilizing the functionality of a particular service.
- **Access Control** – according to *WordNet ® 1.6, © 1997 Princeton University*, one of the definitions of "access" is "4: (computer science) the operation of reading or writing stored information [syn: memory access]". According to the same source, a definition of "control" is "2: a relation of constraint of one entity (thing or person or group) by another." In general use, "access" is often broadened to include additional actions besides just reading and writing. Some people tend to use the phrase "access control" when referring to constraining operations to resources of fairly fine grain, such as reading specific data records or executing particular operations of a service or application.

This document's concerns for the subject do not need to distinguish between the subtle nuance in meaning for the two terms. Therefore, we will use the term "access authorization" to refer to the general aspects of authorization and/or access control.

Access authorization is the mechanisms used to ensure that authenticated individuals and/or systems can only perform specific operations on protected Web resources for which they have permission. The term "protected web resource" is used to indicate any resource reachable via HTTP that needs protecting. It could be a Web server, a Web application, a servlet within a Web application or a specific resource managed by a servlet.

There are two aspects to access authorization.

1. Access Decision - is the process of making the decision to authorize access or not. This decision is based on the security policy that has been associated with the protected resource.
2. Access Enforcement - is the process of enforcing an access decision.

The WEB Agent, working with the policies set for Web resources in the iLock Security Center, performs both the access decision and access enforcement for the web resources it protects. The use of the WEB Agent presupposes you have at least one of the following security needs:

- At least some of the information on your Web server is proprietary or sensitive. Access must be authorized for a subset of the possible users that can reach the server.
- At least some of the applications on your Web must be limited to an authorized subset of the possible users that can reach the server.
- The integrity of at least some of the information is critical. It must not be compromised/modified through unauthorized mechanisms or users.

URL – the Web Resource Identifier

A web resource can be any entity reachable by a Web client, using HTTP. A Web resource is identified by the URLs that may be used to reach it over a local network or the Internet. When securing access to a Web resource, it is important to secure all possible URLs that may be used to reach it.

When a Web resource is reached via the Java Servlet Specification (which is used by the WEB Agent), the URL syntax can be broken down into a hierarchy of components as:

<scheme>://<host>:<port><contextpath><servletpath><pathinfo>?<query string>

Where:

<scheme>	=	"http" when HTTP is used, or "https" when HTTPS is used.
<host>	=	The DNS name or IP address of the Web server host machine.
<port>	=	The IP port number the Web server listens for requests on.
<contextpath>	=	The path to a particular Web application. This always starts with a "/".
<servletpath>	=	The path to a Web page or servlet. This always starts with a "/" unless it refers to the default servlet for a Web application. In this case it is "".
<pathinfo>	=	Additional information that may be passed to a servlet. This always starts with a "/" if there is any information. Otherwise it is "".
<query>	=	Additional information that follows the first "?" in the URL. If there is no information following the "?" then the value is taken as "".

What is "Access"?

For Web resources, the term "access" means perform one of the HTTP operations (a.k.a. "methods") on the resource. According to RFC 2616 of the Internet Engineering Task Force, the possible methods for HTTP 1.1 are listed below. Future versions of HTTP could add to these.

1. OPTIONS – This operation is used to discover the communication options for the Web resource identified by the URL.
2. GET – This operation returns the content of the Web resource identified by the URL
3. HEAD – This operation only returns the meta information that would be returned for a GET operation on the Web resource identified by the URL, without actually returning the Web resource.
4. POST – This operation creates a subordinate entity within the Web resource identified by the URL.
5. PUT – This operation creates or replaces the Web resource identified by the URL.
6. DELETE – This operation deletes the Web resource identified by the URL.

7. TRACE – This operation is used for tracing the communication path to the Web resource identified by the URL.
8. CONNECT – This is reserved for future versions of the HTTP protocol.

The Java Servlet Specification gives explicit access to servlets (hence, specific web resources) for the first 7 operations.

Multiple Access Authorization Points

During the fulfillment of a request for a Web resource from a Web client access may be authorized at many points along the way. We'll break the communication down into three areas, assuming the client and server are communicating over the Internet:

1. Client Domain – If the Web client is running within an enterprise's Intranet the request typically is routed through a firewall to get to the Internet. Corporate policies may dictate denying access to certain Web sites or certain times of the day or for clients in different parts of the company. There could be multiple levels of this before the request reaches the Internet.
2. Internet Domain – Within the Internet, Web requests tend to flow without authorization access being applied. However, ISPs could provide some, but that is beyond the scope of this document.
3. Server Domain – Once a request is received by the enterprise where the Web server is running, it is likely to go through many levels of access authorization.
   - The enterprise will typically have a firewall that can pass the request on or reject it. The firewall will likely make this decision based on the communication protocol, the host and the port. It can potentially be much more complicated than that, such as filtering based on the contents of the request.
   - Once a request gets through the outside firewall, there can be various architectures where it might pass through a Reverse Proxy Security Server (RPSS) or another firewall (to get out of a Demilitarized Zone). Each of these may perform its own access authorization before allowing the request to proceed.
   - At some point, the requests that have been authorized by the other systems gets to a Web server. Within the Web server, there may be multiple levels of access authorization. For example, the Apache Web server can have overall authorization access rules for the server, as well as rules for each path element in the URL.
   - A Servlet Container processes Web resources served according to the Java Servlet Specification. The Servlet Container authorizes access based on the Roles (of the user) as specified in the XML declaration of the web application that the Servlet is part of. The WEB Agent keys off this same XML declaration but uses the policies set up in the iLock Security Center instead of the Roles listed. The WEB Agent's authorization can either replace that of the access authorization of the Servlet Container or it may be used in addition to that of the Servlet Container's.
   - If access is authorized by all of the previous, a Java Servlet is run to serve the Web request. The servlet can perform its own access authorization based on its knowledge of the policies surrounding the resources in serves.
   - A Servlet often needs to access additional information resources outside its immediate control in order to process the request. These might be local resources on the same machine (such as files) or networked services such as databases, file services, or enterprise systems. Each of these resources are likely to have their own authorization access policies. However, the policies are usually based on the identity provided by the Servlet instead that of the original client.
   - Each of the networked services may call yet other networked services and access local resources that need further access authorization. This can go on for many hops as services utilize other services.

With all the levels of access authorization that can occur within the Server Domain, it can be a complex task giving access to just the right set of Web resources for each user and denying access to all other web resources. This can have some negative ramifications if not managed systematically:

- ➢ When the access authorization for Web resources by a user needs to change, it can be time consuming to get all policies changed for the different locations. Usually, different departments control the access policies for different aspects.
- ➢ If organizations have a difficult time getting access given for required capabilities, they sometimes short circuit the process by opening up access so widely that security risks are increased.
- ➢ Due to inconsistencies in the policies enforced at the different locations, security holes could open up that are not apparent and go undetected until an intrusion occurs.

WEB Agent Access Authorization

Using the WEB Agent for access authorization may help simplify the multiple levels of policies that need to be set to control access to a Web resource. The WEB Agent enforces policies set at any level of the URL components. This is not meant to replace the firewalls, RPSS, web server and Servlet Container but to supplement them. These other components will still be needed, but the access authorization they implement might be able to be simplified.

The WEB Agent only performs access authorization for resources that have been declared to require authentication and authorization according to the Java Servlet Specification. Otherwise, the WEB Agent has no affect on accessing the Web resource.

The WEB Agent authorizes access to Web resources based on rules set up in the iLock Security Center. The rules identify the Web resource based on its URL and are applied to the HTTP operations on the Web resource. The rules specify which users are allowed or denied access based on the security attributes (Roles, Access IDs and Groups) of the user.

Most of the security attributes for a user are associated with them permanently. They are given additional Group security attributes indicating the host DNS name and host IP address their Web browser is running on. This allows setting up access policies allowing or denying users running from specific network locations. Since these added security attributes do not require the user to go through an authentication process, the WEB Agent could authorize access based only on the user's location and not manage all the user identities. This requires a special configuration option to get the WEB Agent to authorize access when the user has not been authenticated. Care should be taken to understand the security risks in doing so, some of which were explained under the Authorization section.

The WEB Agent default processing of the authorization access policies on Web resources treats the URL components as a tree (hierarchy) where the <scheme> is the root of the hierarchy and the <querystring> values are the leaves of the tree. If policies are set at multiple levels within the hierarchy for a resource, they are all checked.

Authorization access policies can be applied to any level of granularity within the hierarchy to control access to all resources at sublevels (toward the leaves). To define such a resource, you define all the top-level components with explicit values and use the "*" wild card for each of the sublevels. The default behavior (which can be changed) allows access if at least one policy is set to allow access in at least one of the levels in the hierarchy and no access policies in the hierarchy are set to deny access.

Example: The set of URL patterns that may apply to an example Web resource from a "marys-animals" Web application and a servlet path of "lamb" are shown below. If a policy that denies access to a particular security attribute is set on a particular operation for any of these resource patterns, then anyone with that security attribute will be denied access to the Web resource (i.e. full URL) using that operation. In addition, a policy must be set on at least one of these URL patterns, allowing access for an operation to at least one of the security attributes of a user before they are given access.

- https://www.zzz.com:443/marys-animals/lambs/wool?got-any

- https://www.zzz.com:443/marys-animals/lambs/wool?*
- https://www.zzz.com:443/marys-animals/lambs*?*
- https://www.zzz.com:443/marys-animals**?*
- https://www.zzz.com:443***?*
- https://www.zzz.com:****?*
- https://*:****?*
- *://*:****?*

Example: To control access to all resources on a host named "frank.2ab.com," the following resources would be defined and appropriate policies attached to them. These apply for all ports and all Web applications and all static Web resources.

- http://frank.2ab.com:****?*
- https://frank.2ab.com:****?*

Example: To allow access to all resources by anyone that has been authenticated, define the following root resource (with all wild cards) and attach a policy that allows everyone. The default behavior of the WEB Agent only does access authorization once a user has been authenticated.

- *://*:****?*

Example: To deny access to a resource that is not using SSL (i.e. HTTPS), define the following resource and attach a policy that denies everyone. This only denies http from being used. It does not allow anything. At least one URL pattern applying to a web resource (e.g. for https) will need a policy that allows access before it can be accessed.

- http://*:****?*

Example: To only allow access to the **book-review** Web application on "frank.2ab.com," using HTTPS (and default port of 443) by a group called *authors*, define the following web resource. Create a policy that only allows the *authors* group to access it and apply the policy to the following resource.

- https:frank.2ab.com:443/book-review**?*

Auditing

Auditing, as it relates to security, is the process of collecting potentially significant information about security events related to an information resource that can be used to detect or investigate security violations. The information collected is recorded and analyzed for relevant security ramifications.

The first requirement of auditing is collecting the information related to important events as they occur. If a security intrusion is detected, it is important that certain information be available to investigate the trail to determine who the intruder is and how they got in so it can be prevented in the future. Audit records may be needed to:

- alert administrators about suspicious activity.
- assist in investigating a security event.
- determine the extent and seriousness of an intruder's activity.
- help to recover your systems that were affected from an intrusion.
- provide critical information needed for legal purposes.

Auditing is necessary to ensure that users are accountable for their security-related actions. This can only be done if users have unique identities that are associated with the audit records of events they are responsible for. For this reason, auditing is dependent on properly authenticating users.

The audit records can provide information about the details of a security event once an intrusion has been discovered, but they are also valuable in discovering intrusions. Analyzing the records regularly can be important for detecting a security event before the ramifications of such an event have spread to cause more damage.

Audit records can be quite large and require a lot of time if they are analyzed manually. Therefore, having an automated way to analyze them is important. While this may not be perfect, it may uncover problems before they occur. The record may still be important for tracing information from those intrusions that are discovered by other means.

Web servers (including the Tomcat Servlet Container) have the ability to keep logs of events that can be used for auditing. It is critical that such capabilities are correctly configured so the security-related events are captured. On the other hand, keeping too much information can overflow the computer’s resources, causing loss of information and/or service.

When the WEB Agent authentication and/or access authorization capabilities are used, they default to keeping audit records for all failed and successful attempts. These can be individually turned off, as needs dictate.

How do I get further information?

This White Paper has intentionally only scratched the surface of webLock. Further information can be obtained by phone, fax or e-mail

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Comments on this White Paper or any other products in iLock Security Service suite of products are welcome. Please use the above contacts.

General information about iLock Security Services or any other 2AB products and professional services can be found at:

Web:	http://www.2ab.com/