Advanced security hardening in WebSphere Application Server V7, V8 and V8.5, Part 1: Overview and approach to security hardening

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Security consists of more than just some firewalls at the edge of your network protecting you from the outside. It is a difficult and complex set of actions and procedures that strive to strengthen your systems as much as is appropriate. This article discusses many aspects of security in general, including the IBM® WebSphere® Application Server security architecture, and discusses hardening a WebSphere Application Server environment. This updated article has been significantly revised for WebSphere Application Server V7, 8.0, and 8.5, and has been edited to focus solely on hardening. Part 1 of 2.

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Introduction

IBM WebSphere Application Server's security continues to evolve with each release. In addition to adding new function in each version, we also strive to enhance the default security of the product. By improving the default settings, we continue to improve how we meet the critical security principle of **secure by default**. An early version of this article focused on WebSphere Application Server V6 and the hardening steps required for that version. In subsequent releases of WebSphere Application Server, the number of hardening steps was significantly reduced and, more importantly, most of the steps that remain became less critical. A revised version of that article focused on WebSphere Application Server V6.1 with updates for V7.0. Because significant differences exist between V6.1 and later versions that clutter the discussion, we felt it would be beneficial to users of the more recent versions to prune the V6.1 details from the content. Now, WebSphere Application Server versions 8.0 and 8.5 have reduced the number of hardening steps necessary, plus have added new features that change — or allow additional — hardening requirements. Therefore, it has become time to update this article with current information.

This updated article begins with a brief discussion on why security is important and the challenges around hardening systems, and then discusses how to harden a WebSphere Application Server environment to address a variety of security vulnerabilities. So that this article can focus primarily on hardening, some information will be presented at a high level without delving into details.

Wherever possible, references to appropriate resources are provided so that you can further explore related subtopics.

While the information in this article is based on IBM WebSphere Application Server V8.5 and V8.0, most of the issues discussed here apply equally V7.0. although in some cases there are changes to security defaults in WebSphere Application Server V8.0. Where an issue is unique to a specific version, it will be identified as such. Because of the product changes that have been made to major versions of WebSphere Application Server over time, be sure to refer to the archived article if you are using WebSphere Application Server V6 or earlier, and refer to the previous article if you are using WebSphere Application Server V6.1.

A note about profiles

If you are familiar with WebSphere Application Server prior to V8.5 you know you must create one or more profiles. This could be an Application Server (or Base) profile, a Deployment Manager profile, and so on. For the remainder of this article these will be called “full” profiles. This distinction is made to contrast these profiles to a new addition in V8.5: the Liberty profile. This article also calls out recommendations specific to the new Liberty profile.

Why security?

Hopefully, you already realize that security is a key aspect of enterprise systems. Nonetheless, let’s briefly go through the exercise of justifying security anyway, just to introduce some common ways of thinking about it.

The fundamental purpose of security is to "keep the bad people out of your systems." More precisely, security is the process of applying various techniques to prevent unauthorized parties, known as intruders, from gaining unauthorized access.

There are many types of intruders out there: foreign spy agencies, corporations in competition with you, hackers, perhaps even your own employees. Each of these intruders has different motivations, different skills and knowledge, different access, and different levels of need. For example:

- An employee might have a grudge against the company. Employees have tremendous levels of internal access and system knowledge, but for the most part probably have limited resources and hacking skill.
- An external hacker is probably an expert in security attacks, but might not have any particular grudge against you.
- A foreign spy agency might have a great deal of interest in you, depending on your business, and could possess tremendous resources.

Intruders might be after your systems for one of two reasons: to gain access to information that they should not have, or to alter the behavior of a system in some way. In the latter case, they might seek to perform transactions that benefit them by changing the system behavior, or they might wish to simply cause your system to fail in some interesting way in an effort to harm your organization.

The point is that there are many different types of intruders, many different motivations for intruding, and, as you will see later, many different types of attacks. You must be aware of this as you plan your security.

Focus on internal as well as external threats

Security should not be seen as simply a gate that keeps the "outsiders" out. That is far too simplistic a view. Many organizations today focus their security efforts entirely on people outside of the organization in the mistaken belief that only outsiders are a danger. This is simply not the case. For a large corporation, there are literally thousands of people -- many of whom are not employees -- that have access to the internal network. These people are all possible intruders, and since they are on the inside, they have better access to the network. It is often a simple matter of plugging a laptop into a network connection to gain access to a corporate network. Several studies have indicated that perhaps as many as half of all break-ins are caused by or involve employees or contractors within an organization.

Even assuming you believe that every person on your network is trustworthy, can you also assume they never make a mistake? Given the rise of e-mail-based viruses that readily flow over e-mail accounts, JavaScript™-based attack programs, and programs brought in via unknown USB keys and CDs that get plugged into your computers and then attack from within the company network, it is reckless to assume your internal network can be trusted -- it cannot.

It is crucial that your security efforts protect your systems from all potential intruders, which accounts for why this article is as lengthy as it is. Security consists of more than just firewalls at the edge of your network protecting you from the "outside." It is a difficult and complex set of actions and procedures that strive to strengthen your systems as much as is appropriate.

Limitations and reality

It is important that you realize there is no such thing as a perfectly secure system. Your goal is to protect the system as well as you can within the constraints of the business. When thinking about security, you ideally should:

1. Analyze the various points of attack.
2. Consider the risk of an attack at each point.
3. Determine the potential for damage from a successful attack that results in a security breach.
4. Estimate the cost of preventing each attack.

When estimating the damage of a security breach, never forget that security breaches can cause users to lose faith in the system. Thus, the "cost of security breach" might include some very high indirect costs (for example, loss of investor confidence).

> As some hackers break into systems simply for the fun of it, what you can hope is that by creating a reasonably secure environment, intruders will move on to easier targets

Once you have performed the above steps, you can then determine appropriate tradeoffs of risk versus cost. Essentially, the goal is to make the intruder’s cost of breaking into your system exceed the value of what is gained, while at the same time ensuring that the business can bear the costs of running a secure system (see sidebar).

Ultimately, the level of security that is required is a business decision, not a technical one. However, as technicians, we must help all parties understand the value and importance of security. That said, with the exception of protection against internal application attacks, most of the security hardening steps suggested in this article are fairly low cost. Most organizations should be reasonably able to implement most of them. What this article does not discuss is more sophisticated (and expensive) security approaches –- stronger authentication, auditing, intrusion detection -– that go far beyond the native WebSphere Application Server product capabilities.

Security is a large topic, and it is impossible to completely cover all aspects of security in one article. This information is not intended to be an introduction to security or a tutorial on how to secure systems. Rather, it is a high-level overview, or checklist, of the core technical issues that need to be considered as they relate to WebSphere Application Server security. The information in this article should be used in conjunction with a much larger effort that is designed to create a secure enterprise.

Be sure to review the Related topics provided at the end if you are interested in learning more.

Social engineering

Since this is a technical article, the focus is on technical solutions to securing systems, and specifically on the WebSphere Application Server piece of the security puzzle. Nonetheless, be aware that it is often easier to compromise systems using social engineering techniques. That is, attackers are often able to gain improper access to systems and information by tricking the human beings that work for an organization. Perhaps the one relevant conclusion that you can learn from social engineering attack techniques is the fact that by using social engineering, your attackers might be coming from within your network. This again serves to emphasize the earlier point that focusing security solely on keeping the intruders out of the network is insufficient. The discussion here, then, will focus on security at multiple levels. Each level tries to thwart different types of attacks and also provides more barriers to attackers.

Total system view: The details matter

Before delving into specific point-by-point recommendations, let’s take a moment to outline the fundamental techniques for creating secure systems. The fundamental view is to look at every system boundary or point of sharing and examine what actors have access to those boundaries or shared components. That is, given that this boundary exists (presuming reasonable trust within a subsystem), what can an intruder do to break this boundary? Or, given that something is shared, can intruders share something inappropriately?

Most boundaries are obvious: network connections, process-to-process communication, file systems, operating system interfaces, and so on, but some boundaries are more subtle. For example, if one application uses J2C resources within WebSphere Application Server, you must consider the possibility that some other application might try to access those same resources. This occurs because there is a system boundary between the first application and WebSphere Application Server, and between a second application and WebSphere Application Server. Perhaps both applications can access this common resource (in fact, they can). This is a case of possible inappropriate sharing.

In a WebSphere Application Server environment, the operating system protections for APIs are of limited value because they are based on process identity, which is a very coarse-grained concept when you consider application servers servicing requests from thousands of users at once.

The way you prevent these various forms of attack is to apply a number of well-known techniques. For lower-level network-based attacks, apply encryption and network filtering. You essentially deny the intruders the ability to see or access things they should not see. You also rely on operating systems to provide mechanisms to protect operating system resources from abuse. For example, you wouldn't want ordinary user-level code to be able to gain access to the system bus and directly read internal communication. You also leverage the fact that most modern operating systems possess fairly robust protections for system APIs (see sidebar). At a high level, you apply authentication and authorization rigorously. Every API, every method, and every resource potentially needs to require some form of authorization. That is, access to these things must be restricted based upon need. And, of course, authorization is of little value without robust authentication. Authentication is concerned with reliably determining the identity of the caller. *Robust* is specified here because authentication that can be easily forged is of little value.

Where appropriate authentication and authorization are not available, then you must resort, frankly, to clever design and procedures to prevent potential problems. This is how you protect J2C resources. Because WebSphere Application Server does not provide for authorization of access to J2C resources, you instead apply other techniques to limit (based on configuration) the ability of applications to inappropriately reference J2C resources.

As you might imagine, examining all of the system boundaries and shared components is a difficult task. And, in fact, securing a system can lead to thinking deeply about complexity. Perhaps the hardest truth about security is that creating a secure system works against abstraction. That is, one of the core principles of good abstraction is the hiding of concerns from higher-level components. That is a highly desirable and good thing. Unfortunately, intruders aren't kind. They don't care about your abstractions or your good designs. Their goal is to break your systems any way they can, and look for holes in your design as they do so. Therefore, in order to validate a system's security, you have to think about it at every level of abstraction: at the highest architectural level, but also as the lowest level of detail. While there are a number of application scanning tools that can assist in code reviews (such as IBM Rational® AppScan®), it's still essential that you manually review every line of code and design decision to prevent application attacks, even if you employ a scanning tool. Rigorous reviews of everything are required.

The smallest mistake can undermine the integrity of an entire system. This is best exemplified by the technique of taking control of C/C++ based systems by using buffer overrun techniques. Essentially, an intruder passes in a string that is too large for some existing buffer. The extra information then overlays a part of the running program and causes the runtime to execute instructions that it should not execute. With care, an intruder can cause a program to do almost anything. As a security architect, to even identify this attack, you have to understand deeply how the C/C++ runtime manages memory and executes running programs. You also have to review every line of code to find this particular hole, assuming you understood that it existed. Today, we know about the attack, yet it continues to be successful because individual programmers

make very small bad decisions that compromise entire systems. Thankfully, this particular attack seems to be infeasible in Java™, but do not believe that there aren't other small errors that lead to compromise.

Think hard about security; it is hard.

Hardening security overview

The Java EE specification and WebSphere Application Server provide a powerful infrastructure for implementing secure systems. Unfortunately, many people are not aware of all of the issues surrounding creating a secure WebSphere Application Server-based system. Because there are many degrees of freedom and many different sources of this information, some users tend to overlook security issues and deploy systems that are not particularly secure. To address this, this section attempts to summarize the key issues of greatest importance.

Security hardening is the act of configuring WebSphere Application Server, developing applications, and configuring various other related components in a way to maximize security -– in essence, to prevent, block, or mitigate various forms of attack. In order to do this effectively, it is important to consider the forms of attack. There are four basic approaches to attacking an application server:

- **Network-based attacks:** These attacks rely on low-level access to network packets and attempt to harm the system by altering this traffic or discovering information from these packets.
- **Machine-based attacks:** In this case, the intruder has access to a machine on which WebSphere Application Server is running. Here, Your goal is to limit the ability to damage the configuration or to see things that shouldn't be seen.
- **Application-based external attacks:** In this scenario, an intruder uses application-level protocols (HTTP, IIOP, JMX, Web services, and so on) to access the application, perhaps via a Web browser or some other client type, and uses this access in an attempt to circumvent the normal use of the application usage and do inappropriate things. The key is that the attack is executed using well-defined APIs and protocols. The intruder is not necessarily outside the company, but rather is executing code from outside of the application itself. These types of attacks are the most dangerous, as they usually require the least skill and can be done from a great distance as long as IP connectivity is available.
- **Application-based internal attacks** (also known as application isolation): In this case, you are concerned with the danger of a rogue application. In this scenario, multiple applications share the same WebSphere Application Server infrastructure and you do not completely trust each application.

To help you tie these techniques back to these classes of attack, each technique will use this key to represent these vulnerabilities:

- **N:** Network-based attack.

- **M:** Machine-based attack.
- **E:** Application-based external attack.
- **I:** Application-based internal attack.

The appropriate key(s) will be shaded to indicate the type of attack(s) each technique helps to prevent. Keep in mind that internal applications can always take advantage of external methods of attack as well. Therefore, **I** (internal) will not be explicitly indicated when **E** (external) is already present.

Be aware that one other form of technical attack is not considered here: denial of service (DoS) attacks. While very important, DoS attacks are beyond the scope of this article. Preventing DoS attacks requires very different techniques that go well beyond what an application server can provide. You need to consider network traffic monitors, rate limiters, intrusion detection tools, and more, in order to defend against a DoS attack.

Hardening approach

Let’s identify the various known steps you should take to protect the WebSphere Application Server infrastructure and applications from these four forms of attack. (We say "known" steps because, of course, it is possible that other weaknesses exist that have not yet been identified.) It would be ideal to be able to organize the information into four buckets, one for each form of attack. Unfortunately, attacks don't neatly divide along those lines. Several different protection techniques help with multiple forms of attack, and sometimes a single attack can leverage multiple forms of intrusion to achieve the end goal. For example, in the simplest case, network sniffing can be used to obtain passwords, and those passwords can then be used to mount an application-level attack. Instead, hardening techniques are generally organized into a logical structure based on when the activity occurs, or based on the role of the person concerned with these issues:

- **Infrastructure:** Actions that can be taken to configure the WebSphere Application Server infrastructure for maximum security. These are typically done once when the infrastructure is built out and involve only the system administrators.
- **Application configuration:** Actions that can be taken by application developers and administrators and are visible during the deployment process. Essentially, these are application design and implementation decisions that are visible to the WebSphere Application Server administrator and are verifiable (possibly with some difficulty) as part of the deployment process. This section will have many techniques, further reinforcing the point that security is not bolted-on; security is the responsibility of every person involved in the application design, development, and deployment.
- **Application design and implementation:** Actions that are taken by developers and designers during development that are crucial to security but might have little impact on the deployment process.
- **Application isolation:** This is explicitly discussed separately because of complexity of the issues involved.

The various techniques presented here are ordered within each section by priority. Prioritization is, of course, subjective, but the threats within each area have been prioritized roughly using this thinking:

- Machine-based threats are less likely than network threats because access to the machine in production is usually restricted. If this isn’t the case in your environment, then these threats become very likely and you should first act to restrict access to those machines.
- Attacks that can be performed remotely using only IP connectivity are the most serious. This implies that all communication must be authenticated.
- Traffic should be encrypted to protect it, but encryption of WebSphere Application Server internal traffic is less important than encryption of traffic that travels "beyond" WebSphere Application Server because the network traversed might have more points where an attacker can snoop traffic.

SSL/TLS overview

The remainder of this article uses the term "SSL" when referring to either the protocols SSL or TLS. In all cases where the SSL protocol is available, TLS is also available and in fact used by default if both sides of the connection support TLS.

SSL/TLS (hereafter referred together as SSL) is a key component of the WebSphere Application Server security architecture, used extensively for securing communication. SSL is used to protect HTTP traffic, IIOP traffic, LDAP traffic, MQ traffic, JDBC traffic, messaging traffic over the SIBus between WebSphere messaging engines, J2C and SOAP traffic. SSL requires the use of public/private key pairs, and, in the case of WebSphere Application Server, these keys are stored in key stores. Because of the key importance of SSL in securing the infrastructure, let’s digress momentarily to cover some key aspects of SSL as they relate to WebSphere Application Server. (This discussion is intentionally superficial and discusses only the key points you need in order to properly configure SSL.)

Public Key Cryptography is fundamentally based upon a public/private key pair. These two keys are related cryptographically. The important point is that the keys are asymmetric; information encrypted with one key can be decrypted using the other key. The private key is, well, private. That is, you must always protect that private key. Should anyone else ever gain access to the private key, they can then use it as "proof" of identity and act as you; it is like a password, only more secure and more difficult to change. Possessing the **private** key is proof of identity. The **public** key is the part of the key pair that can be shared with others.

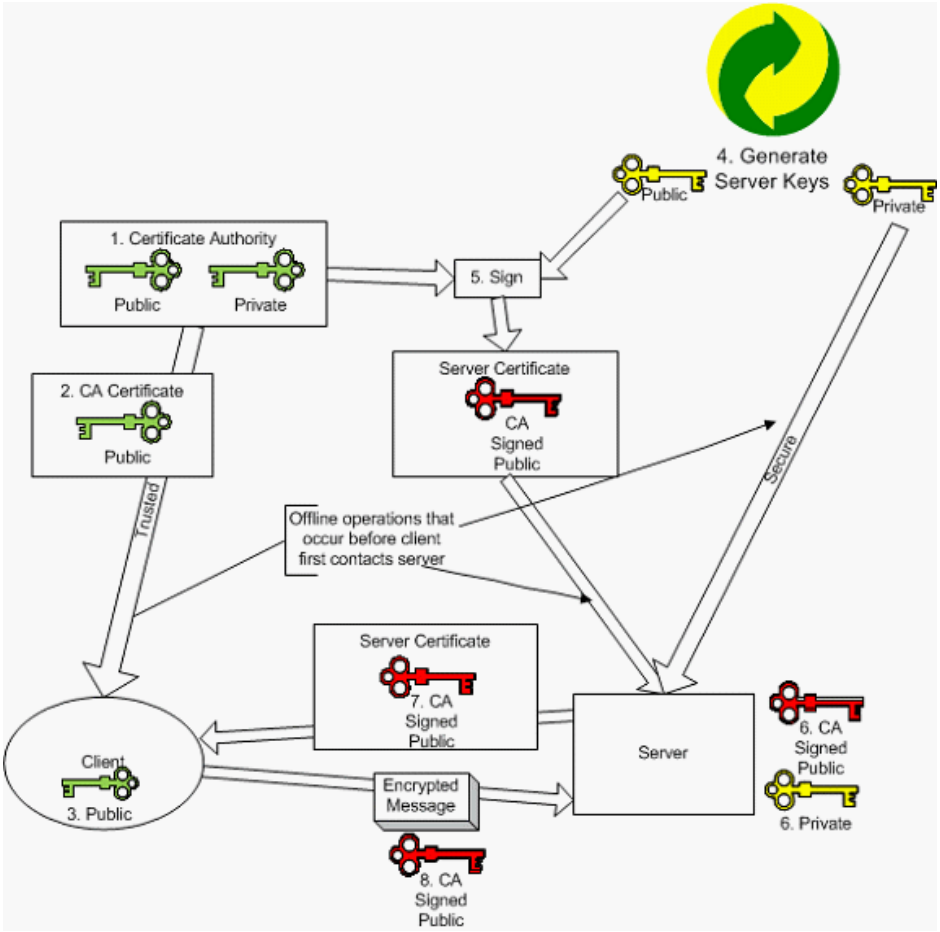
If there was a secure way to distribute public keys to parties, that would be enough. Since there is no such globally acceptable technique, Public Key Cryptography introduces the idea of signed public keys. A signed public key has a digital signature (quite analogous to a human signature) that states that the signer vouches for the public key. The signer is assuring that the party that possesses the private key corresponding to the signed public key is the party identified by the key. These signed public keys are called certificates. Well-known signers are called Certificate Authorities (CA). It is also possible to sign a public key using the corresponding private key. These are known as self-signed certificates. These self-signed certificates are no less secure than certificates signed by a certificate authority. They are just harder to manage, as you'll see in a moment.

Figure 1 shows the basic process of creating a certificate using a CA and distributing it, in this case, to perform server authentication with SSL. That is, the server possesses a certificate

that it uses to identify itself to the client. The client does not have a certificate and is therefore anonymous to SSL.

Steps 1-3 are performed in advance to configure the client to trust all certificates issued by the CA. Steps 4-6 are performed in advance on the server to enable it to leverage that CA trust in the client. When the client starts a connection to the server, steps 7 and 8 occur.

Figure 1. Server SSL authentication: certificate creation and distribution



When looking at this figure, notice that the client must possess the certificate that signed the generated public key of the server. This is the crucial part of trust. Since the client trusts any signing certificate it has (which in this case includes the CA certificate), it trusts all valid certificates that the CA has signed. Validation can include ensuring that the issuer is trusted (shown in Figure 1), checking that the certificate is not expired (outside of validity dates), checking that usage as defined in the certificate matches what it is being used for, and checking if the certificate has been revoked.

To use an analogy to explain the difference between validation and verification, let's imagine that certificates are driver's licenses. They are issued by a number of provinces/states/countries. An official can validate a driver's license by examining the issuing country (is it one of the trusted provinces/states/countries?) confirming it hasn't been tampered with (digital signature validation is

an analog of physical examination), check to see if it has expired, verify that the sex matches the bearer, verify the license is for the vehicle type the bearer is using it for (sex, and type: automobile vs. motorcycle vs truck are analogs of certificate extension attributes), and, finally, check to see if the bearer has outstanding warrants, similar to a revocation check. On the other hand, verification of the driver's license is confirming that the picture on the license (the identity) matches the person using it.

It's worth noting that if you were to use self-signed certificates, you would need to distribute manually the self-signed certificate to each client rather than relying on a well-known CA certificate that is likely already built into the client. This is no less secure, but if you have many clients, it is much harder to manage distributing all of those signing certificates (one for each server) to all clients. It's much easier to distribute just one CA certificate that signs many certificates; these CA certificates typically have a longer life, and client applications (such as browsers) typically automatically push out updates or replacements prior to expiry.

There is a serious downside to trusting all certificates issued by powerful CAs. A breach of a CA can result in massive loss of trust. In 2011, a CA that issues certificates for approximately 25% of all sites on the Internet (Comodo) was hacked and certificates issued by this CA are now suspect. A second CA, Diginotar, was hacked, resulting in the closure of the company; all certificates used by Diginotar are now useless.

That's pretty much it for server authentication using SSL. After the initial handshake, SSL will actually switch to secret key encryption using a key created during the handshake to secure the channel, but the details of that aren't germane to this discussion.

When a client authenticates itself to a server, the process is similar, although the roles are reversed. In order for a server to authenticate a client (this is often called client certificate authentication, or when combined with server authentication this is known as two way SSL, or Mutual SSL), the client must possess a private key and corresponding certificate, while the server must possess the corresponding signing certificate or a copy of the client's certificate. That's really all there is to it. Notice what wasn't required: SSL certificate authentication merely determines that the certificate is valid; it does not verify who the certificate represents. Verification is the responsibility of later, post-SSL processing. This has significant implications as you'll see shortly.

In summary, since SSL uses certificate authentication, each side of the SSL connection must possess the appropriate keys in a key store file. Whenever you configure SSL key stores, think about the fundamental rules about which party needs which keys. Usually, that will tell you what you need.

Limiting access using only SSL

As mentioned above, once SSL validates the certificate, the authentication process is over from SSL's perspective. Ideally, what should happen next is that another component will look at the identity in the certificate and then use that identity to make an authorization decision. That authorization decision could be the client deciding the server is trusted (Web browsers do this when verifying that the name in the certificate is the same as the Web server's hostname) or the

server extracting the user’s name and then using that to create credentials for future authorization decisions (this is what WebSphere Application Server does when users authenticate). Unfortunately, not all systems have that capability. This is where you can take advantage of a popular SSL trick: limiting the valid certificates.

In the previous scenario involving client authentication, the client presents a certificate which is validated by the server against the set of trusted certificate signers. Once it is validated, the SSL handshake completes. If you limit the signers you trust on the server, you can limit who can even complete that SSL handshake. In the extreme case with self-signed certificates, you can create a situation where there is only one signer: the self-signed certificate. This means that there is only one valid client side private key that can be used to connect to this SSL endpoint: the private key you generated when you created the self-signed certificate in the first place. This is how you can easily limit who can connect to a system over SSL -- even if the server side components don’t provide authorization. Think of this as creating a secure trusted tunnel at the network layer. I call this idea the "SSL tunnel trick." Assuming you’ve configured everything correctly, only special trusted clients can even be connecting over this transport. That’s very useful in several situations in WebSphere Application Server which will be discussed later.

Expanding on the capability of only trusted clients (or trusted servers) to connect over a secured transport, IBM strongly recommends and encourages the use of SSL or TLS everywhere that includes all connections into and out of WebSphere Application Server to protect any information transmitted over the network. A firewall alone is not sufficient to prevent a breach. Many compromises are the result of internal attacks to the private network, and it is critical to ensure that all network connections are protected by TLS in order to prevent any sensitive information from being highjacked. IBM recognizes that some users consider their network to be completely locked down and that some might be using intrusion detection or semantic analysis tools, which in turn requires TLS be disabled so that the detection software can examine the content. In that case, IBM strongly recommends that you carefully assess the risk in any decision to disable TLS. It is the IBM position that using TLS is the best and recommended option for ensuring the protection of information transmitted over the network.

Managing SSL

As you have already seen, WebSphere Application Server manages keys in key store files. There are two types of key files: key stores and trust stores. A trust store is nothing more than a key store that, by convention, contains only trusted signers. Thus, you should place CA certificates and other signing certificates in a trust store and private information (personal certificates with private keys) in the key store.

Unfortunately, there is a catch to this simple system. Most of WebSphere Application Server uses the PKCS12 format. (WebSphere Application Server SSL configurations in fact support three modern key database formats: JKS, JCEKS, and PKCS12.) The IBM HTTP Server and the WebSphere Application Server Web server plug-in use an older key format known as the KDB format (or more correctly the CMS format). The two formats are similar in function but are incompatible in format. Therefore, you must be careful not to mix them up.

WebSphere Application Server SSL configurations

As of WebSphere Application Server V6.1, a robust infrastructure is provided for managing certificates and SSL within the product. The remainder of this article assumes you are familiar with that information.

Hardening WebSphere Application Server

WebSphere Application Server V6.1 and later versions were designed with the security principle of **secure by default**. While not perfectly achieved, the goal was to release a product whereby, in the most common configurations and simpler environments, the product is configured reasonably securely by default. Obviously, more complex environments will possess unique issues that simply cannot be anticipated, but for simpler environments the objective was a default installation and configuration that resulted in a reasonably secure system; not *perfectly secure* because such a thing is not possible. Nor did we eliminate every vulnerability because many are minor and closing them by default would greatly complicate application development, management, or compatibility. But where a vulnerability could reasonably be eliminated in a way in which most clients we felt would concur, we did so.

Administrative security and the Liberty profile

On your first (or perhaps second) look at the Liberty profile, you might notice that out of the box, there is no administrative security enabled. The WebSphere Application Server product has gone to great lengths in prior releases to move from an insecure-by-default to a secure-by-default model starting with V6.1. At first glance, the Liberty profile security posture might seem to be a step backwards. However, there is an important, critical difference between the Liberty profile and the full profiles (base and Network Deployment). The full WebSphere Application Server profiles are designed to be administered remotely via the admin console, wsadmin, JMX access, and various server to server communications paths that exist in a full profile (Figure 2).

The V8.5 Liberty profile administration model is based on read/write OS level access to files on the server on which the profile is running (be aware that if you have similar OS level access to the full WebSphere Application Server profiles, you have total administrative control of the cell; by editing the security.xml file, you can change all other settings). Remote administrative access is enabled in the Liberty profile by adding one of the JMX connector features:

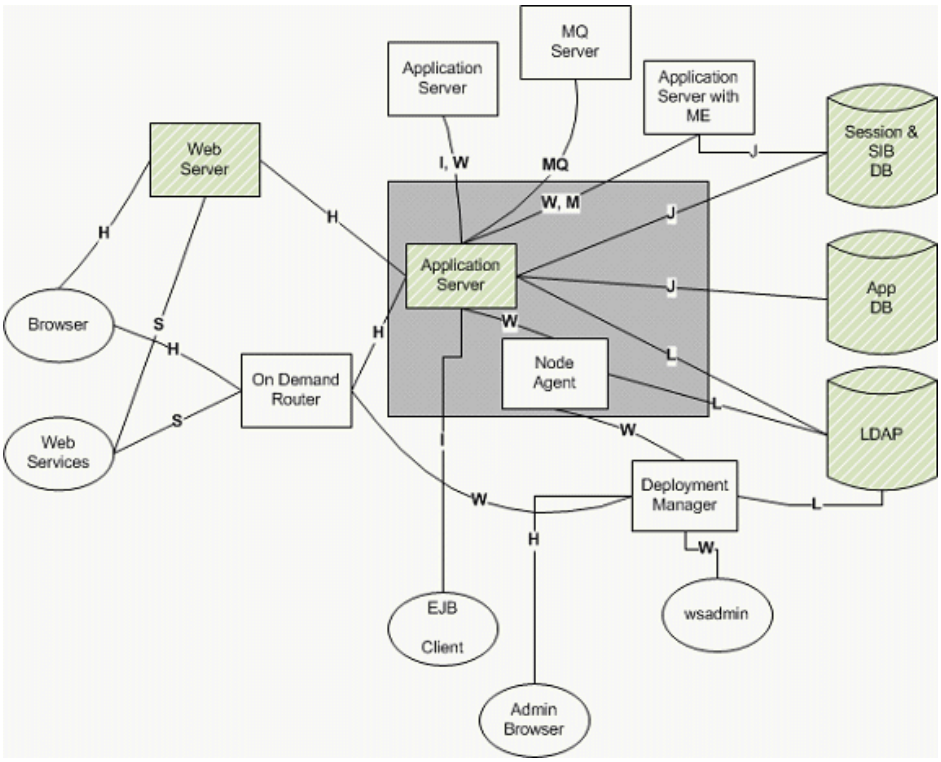
- The localConnector-1.0 feature requires that the JMX client application run on the same host, and under the same OS user ID.
- The restConnector-1.0 feature can be enabled for JMX clients to access the server remotely.

When the restConnector-1.0 feature is enabled, both the ssl-1.0 feature and appSecurity-1.0 feature are dynamically enabled to ensure the remote access is secured by default, similar to the full profile. Additionally, when either of these connectors are enabled, an administrative user must be added to the Liberty profile configuration, otherwise the connector cannot authenticate and connect with Liberty.

Infrastructure-based preventative measures

When securing the infrastructure, you must first understand the components to be secured. As with any vulnerability analysis, one starts by identifying the components and their external communication paths. (This analysis doesn't uncover internal application vulnerabilities, but does expose most others.) It's useful to review a standard WebSphere Application Server topology (full profile) and see all of the network links and protocols (Figure 2). The items with a shaded pattern in the boxes are those components that are relevant to the Liberty profile. As someone concerned about security, you need to know about all of these links and focus on securing them. These links represent the coarsest grained system boundaries mentioned earlier.

Figure 2. Network link picture



In Figure 2, the letters on the links indicate the protocols used across those communication links. Each protocol is listed below with its usage and some information on firewall friendliness, since that will be important later. The protocols are:

- **H** = HTTP traffic
  - Usage: Browser to Web server, Web server to app server, admin Web client.
  - Firewall friendly.
- **W**= WebSphere Application Server internal communication
  - Usage: Admin clients and WebSphere Application Server internal server admin traffic. WebSphere Application Server internal communication uses one of several protocols:
    - RMI/IIOP or SOAP/HTTP: Admin client protocol is configurable.
    - File transfer service (dmgr to node agent): Uses HTTP(S).

        - DCS (Distributed Consistency Service): Uses private protocol. Used by memory to memory replication, stateful session EJBs, dynacache, and the high availability manager.
    - SOAP/HTTP firewall friendly. DCS can be firewall friendly.
- **I** = RMI/IIOP communication
    - Usage: EJB clients (standalone and Web container).
    - Generally firewall hostile because of dynamic ports and embedded IP addresses (which can interfere with firewalls that perform Network Address Translation).
- **M** = SIB messaging protocol
    - Usage: JMS client to messaging engine.
    - Protocol: Proprietary.
    - Firewall friendly as can fix ports used. Likely NAT firewall hostile.
- **MQ** = WebSphere MQ protocol
    - Usage: MQ clients (true clients and application servers).
    - Protocol: Proprietary.
    - Firewall feasible (there are a number of ports to consider). Refer to WebSphere MQ support pac MA86.
- **L** = LDAP communication
    - Usage: WebSphere Application Server verification of user information in registry.
    - Protocol: TCP stream formatted as defined in LDAP RFC.
    - Firewall friendly.
- **J** = JDBC database communication via vendor JDBC drivers
    - Usage: Application JDBC access and WebSphere Application Server session DB access.
    - Protocol: Network protocol is proprietary to each DB.
    - Firewall aspects depend on database (generally firewall friendly).
- **S** = SOAP
    - Usage: SOAP clients.
    - Protocol: Generally SOAP/HTTP.
    - Firewall friendly when SOAP/HTTP.

As Figure 2 shows, a typical WebSphere Application Server configuration has a number of network links. WebSphere Application Server V8.5 includes the on demand router (ODR), previously only available in IBM WebSphere Virtual Enterprise. The ODR introduces some new network links that must be considered. Moreover, Intelligent Management for web servers in WebSphere Application Server V8.5.5 adds a native HTTP server alternative to the ODR: the ODLlib and the ODRLib require ports to the deployment manager and node agents.

It is important to protect traffic on each of those links as much as possible to stop intruders. The remainder of this section discusses the steps required to secure the infrastructure just described. The following list is in priority order and details for each item follow. The most important (in fact, critical) items are listed first. As you progress through the list, items become less critical. It is up to you to decide for your organization how far you wish to go on this list.

1. Put the Web server in the DMZ without WebSphere Application Server
2. Separate your production network from your intranet

1. Put the Web server in the DMZ without WebSphere Application Server

In a typical DMZ configuration, there is an outer firewall, the DMZ network containing as little as possible, and an inner firewall protecting the production internal network.

There are three fundamental principles of a DMZ (see sidebar) that need to be considered here:

- Inbound network traffic from outside must be terminated in the DMZ. A network transparent load balancer such as Network Dispatcher doesn't meet that requirement alone.
- The type of traffic and number of open ports from the DMZ to the intranet must be limited.
- Components running in the DMZ must be hardened and follow the principle of least function and low complexity.

Therefore, it is normal to place the Web server in the DMZ and the WebSphere Application Server application servers inside the inner firewall. This is ideal, as the Web server machine can then have a very simple configuration and require very little software. It also serves as a point in the DMZ that terminates inbound requests. And finally, the only port that must be opened on the inner firewall is the HTTP(S) port for the target application servers. These steps make the DMZ a very hostile place for an attacker. It is also appropriate to put a secure proxy server in the DMZ instead of or in addition to the Web server if that is preferred.

If you place WebSphere Application Server on a machine in the DMZ, then far more software must be installed on those machines and more ports must be opened on the inner firewall so that WebSphere Application Server can access the production network. This largely undermines the value of the DMZ.

You may choose to place something other than a Web server in the DMZ. It is also reasonable to put a secure proxy into the DMZ, such as IBM Tivoli® Access Manager WebSEAL, the WebSphere Application Server V7 secure proxy, or a hardened appliance such as IBM WebSphere DataPower®. The key is that what you put into the DMZ must NOT be a complex application server, must be hardened, and must terminate inbound connections.

2. Separate your production network from your intranet

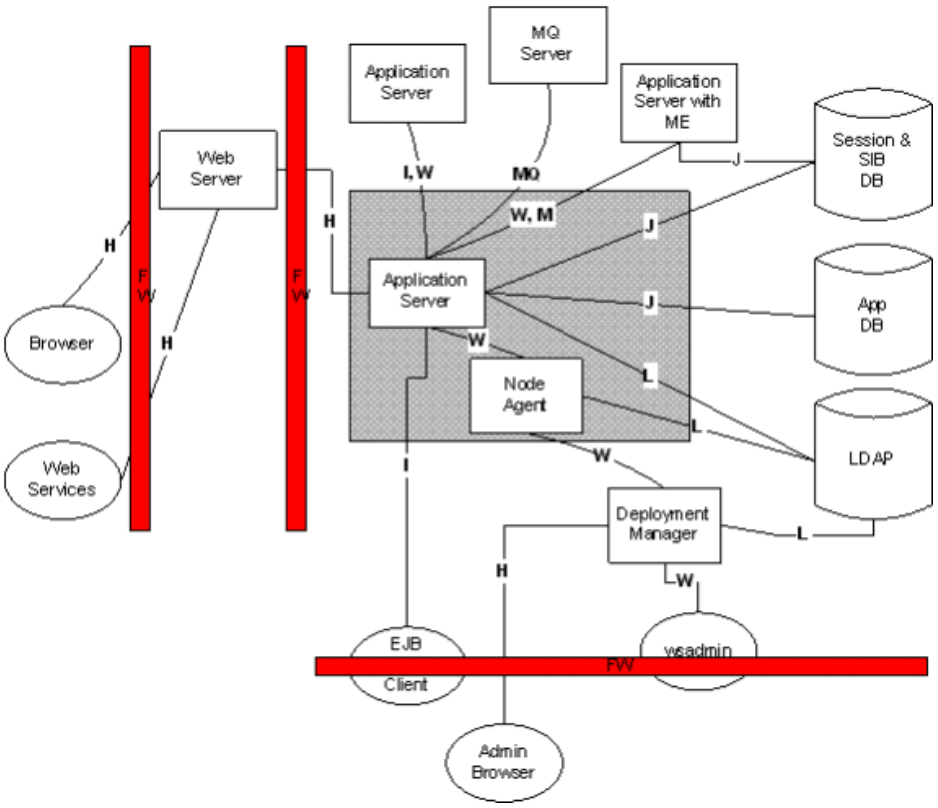
Most organizations today understand the value of a DMZ that separates the outsiders on the Internet from the intranet. However, far too many organizations fail to realize that many intruders are on the inside. As mentioned earlier, you need to protect against internal as well as external threats. Just as you protect yourself against the large untrusted Internet, you should also protect your production systems from the large and untrustworthy intranet.

Separate your production networks from your internal network using firewalls. These firewalls, while likely more permissive than the Internet-facing firewalls, can still block numerous forms of attack. After applying this step and the previous step, you should end up with a firewall topology like the one shown in Figure 3. (For more information on WebSphere Application Server firewall port assignments, see Firewall port assignments in WebSphere Application Server.)

Notice that wsadmin has been placed on the edge of the firewall. This is attempting to show that while it is preferred that wsadmin be run from only within the production network (within the protected area), wsadmin access can also be limited to selected addresses, corresponding to

administrator desktops, fairly easily through a firewall. Figure 3 also shows EJB clients on the edge, as they might be on either side of the firewall.

Figure 3. Recommended firewall configuration



A single firewall and not a full DMZ facing the intranet is shown here, as this is the most common topology. However, we increasingly see full DMZs (with a Web server in the internal DMZ) protecting the production network from the non-production intranet. That is certainly a reasonable approach.

If you are using the on demand router function, see the next hardening tip.

3. Do not put the ODR in the DMZ

N M E I

WebSphere Application Server V8.5 includes the on demand router (ODR), previously only available in WebSphere eXtreme Scale. The ODR is a Java-based system, with all of the issues mentioned in the previous topic. The secure topology for using the ODR is shown in Figure 4. Moreover, placement of the ODR in the DMZ is not supported.

Figure 4. On demand router placement

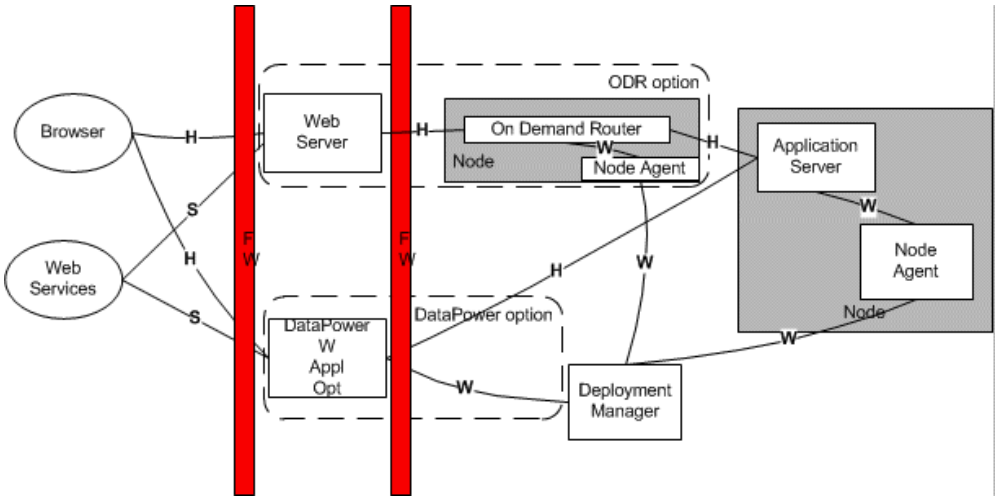


Figure 4 shows the placement of the Java-based ODR server, and contrasts that with the on demand routing abilities available with the Application Optimization (AO) feature of IBM DataPower SOA Appliances. While the Java ODR is not to be placed in the DMZ, the DataPower SOA appliance is a hardened device suitable for placement in the DMZ.

4. Use HTTPS from the browser

N M E I

While LTPA tokens can be transmitted over an unencrypted channel, for maximum protection, it is best that they are sent over an encrypted link. If an LTPA token is successfully captured, the thief can impersonate the user identified until it expires.

If your site performs any authentication or has any activities that should be protected, use HTTPS from the browser to the Web server. If HTTPS is not used, information such as passwords, user activities, WebSphere Application Server session cookies, and LTPA (see sidebar) security cookies can potentially be seen by intruders as the traffic travels over the external network.

For applications that enable HTTP traffic prior to authentication, make sure you pay close attention to cookies. If a cookie (such as the JSESSIONID) is set prior to HTTPS being used, that cookie is a potential risk after HTTPS is used because it might have been altered or captured by an intruder. This is why WebSphere Application Server has a separate cookie for authenticated users. An even more subtle attack is that any page returned over HTTP can be potentially altered by an intruder -- even URLs embedded in the page. Thus, a user might click on a "secure" URL on your page and actually be directed to an intruder’s site.

5. Keep up to date with patches and fixes

N M E I

This article assumes you have applied the most recent fixpacks (7.0.0.25, 8.0.0.4, and 8.5.0.0 at the time of writing; see Latest fix packs for WebSphere Application Server), as well as all recently published security APARs. These fixpacks and APARs address issues or close other vulnerabilities that are not documented in this article, and so it is critical for you to first ensure you are at recent fix levels and that you have validated your patches for any published vulnerabilities. You should of course continue to keep up with published security fixes as time progresses. There is little doubt that new issues will be found in the future.

As with any complex product, IBM occasionally finds and fixes security bugs in WebSphere Application Server, IBM HTTP Server, and other products. It is crucial that you keep up to date on these fixes. It is advisable that you subscribe to support bulletins for the products you use and, in the case of WebSphere Application Server, monitor the security bulletin site for your version. Those bulletins often contain notices for recently discovered security bugs and the fixes. You can be certain that potential intruders learn of those security holes quickly. The sooner you act the better.

More general information on WebSphere Application Server security, including recommendations on hardening the WebSphere Application Server infrastructure, is available on the WebSphere Application Server security page.

6. Enable application security

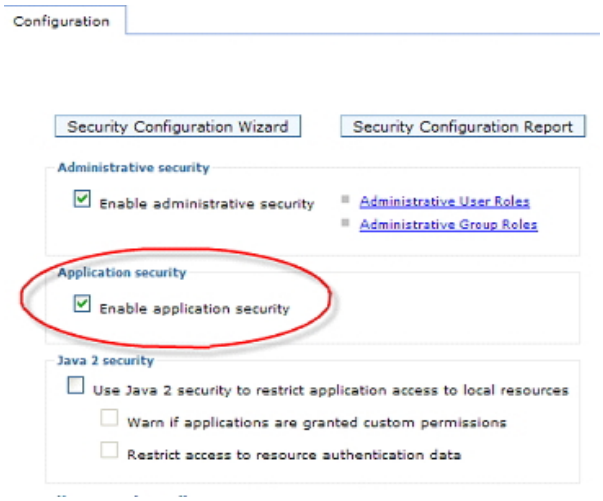
N M E I

By default, WebSphere Application Server full profiles are defined with administrative security enabled. Thus, for the most part, the infrastructure provides for reasonable authentication, authorization, and encryption of administrative traffic by default. When administrative security is enabled, the WebSphere Application Server internal links between the deployment manager and the application servers and traffic from the administrative clients (Web and command line) to the deployment manager are encrypted and authenticated (Figure 3). Among other things, this means that administrators will be required to authenticate when running the administrative tools. There are exceptions which will be discussed later.

In addition to leveraging the application server's security for administration, it is strongly recommend that you leverage it for application security. Doing so gives your applications access to a strong and robust standards-based security infrastructure. Applications that do not leverage application server security are typically found to have serious security holes. Designing and implementing a secure distributed infrastructure is not easy.

To enable application security, go to the global security panel and select **Enable application security** (there is no need to enable Java 2 security; as will be discussed later, it is usually inappropriate), as shown in Figure 5.

Figure 5. Application security



In a V8.5 Liberty profile, application security is enabled by including the element shown in Listing 1 to the profile's server.xml file.

Listing 1. Enabling application security in Liberty

```
<featureManager>
     <feature>appSecurity-1.0</feature>
</featureManager>
```

Caution: Simply enabling application security does not make your applications secure. It merely makes it possible for your applications to leverage the security features provided by the application server (including Java EE security). Upcoming sections will further address this topic.

7. Use ldapRegistry instead of the quickStartSecurity element or the basicRegistry

N M E I

The Liberty profile is designed with minimalism in mind. To easily support developers who want to test that their application works with security, a quickStartSecurity registry can be used containing a single userid with a password. The basicRegistry permits multiple users and groups to be defined. Both these security registries are contained within the server.xml.

Both the above simple registries could be adequate within a developer's personal environment. Beyond testing environments, these Liberty profiles should be configured to use the ldapRegistry feature.

8. Restrict access to WebSphere MQ messaging

N M E I

If you are using WebSphere MQ as your messaging provider, you'll need to address queue authorization via other techniques. WebSphere MQ by default does not perform any user authentication when using client/server mode (bindings mode relies on process to process authentication within a machine). In fact, when you specify a user ID and password on the connection factory for WebSphere MQ, those values are simply being ignored by WebSphere MQ.

WebSphere MQ security warning

Because this article is focused on WebSphere Application Server security, this section is concerned solely with securing the link from the application server to WebSphere MQ. This does not make WebSphere MQ secure. To properly harden WebSphere MQ, substantial additional steps are required.

One option to address this is to implement your own custom WMQ authentication plug-in on the WebSphere MQ server side to validate the user ID and password sent by WebSphere Application Server. A second, and likely simpler technique is to configure WebSphere MQ to use SSL with client authentication and then ensure that only the WebSphere Application Server server possesses acceptable certificates for connecting to WebSphere MQ. (See Securing connections between WebSphere Application Server and WebSphere MQ for more information; this article is a bit dated but the same principles and techniques apply to newer versions of both products. Remember to take into account the product changes to implement the guidance.)

9. Harden the Web server and host

If you are following the standard topology recommended in step 1, your Web server is running in the DMZ. Since a DMZ is the front line defense against potential intruders, special care must be taken to harden this server.

This article does not discuss the specifics of *Web server* hardening, but you should look specifically at things like operating system hardening, limiting the Web server modules being loaded, and other Web server configuration steps. (See Apache hardening information and the book Building Secure Servers with LINUX for more information.)

When hardening your Web server, there is one WebSphere Application Server specific item that you need to consider. It is possible for the WebSphere Application Server administrative infrastructure to manage Web servers. While this seems like a good thing from an ease of use perspective, this raises serious security issues. There are two ways that a Web server can be managed:

- Using a **managed node** requires that a node agent be placed on the Web server machine (which is typically in the DMZ) and that this agent be part of the WebSphere Application Server cell. This is completely unacceptable from a security perspective and thus should not be used except in those rare cases where there is no need for a DMZ. This is unacceptable for two reasons:

    - First, a node agent is a fully functional member of the cell and thus has full administrative authority. If it is compromised in the DMZ, the entire cell is compromised.
    - Second, WebSphere Application Server is a large and powerful product and therefore can be challenging to harden, as this article shows, and so such products don't belong in the DMZ.
- The second approach requires that **IBM HTTP Server** be used and that the HTTP admin server be configured. In this scenario, the deployment manager will send administrative requests to the HTTP admin server running on the Web server host. While better than employing a Java-based node agent, many still consider this to be risky and prefer to have no administrative function in the DMZ.

10. Remove JREs left by Web server and plug-in installers

When you install IBM HTTP Server, the installer leaves behind a JRE. Remove this JRE, as it provides functions that are not needed by the Web server or plug-in under normal conditions. Keep in mind that this will make it impossible to run some tools such as ikeyman on this Web server. This isn't a significant issue because running such tools in the DMZ is problematic anyway.

When you install the WebSphere Application Server HTTP Server plug-in using the IBM installer, it also leaves behind a JRE. As before, you should remove this post install.

If you do decide to remove the JREs, you should make a backup copy just in case for future use. One technique might be to zip or tar the JRE and replace it later, such as when it would be needed for the WebSphere Application Server update installer when applying fixes, and then zip/tar and remove it again when the process is complete.

11. Harden proxies

If you have chosen to use a secure proxy server in the DMZ instead of (or in addition to) a Web server, the previous advice applies to the proxy, although specific details won't be provided here as hardening is proxy specific.

One important point about WebSphere DataPower: Web security proxies are typically not appropriate for proxying Web services traffic because they cannot block the types of threats that are possible when transmitting XML. In order to provide secure Web services (or any XML-based protocol), use an XML firewall such as WebSphere DataPower.

12. Configure and use trust association interceptors carefully

TAIs are often used to enable WebSphere Application Server to recognize existing authentication information from a Web SSO proxy server, such as Tivoli Access Manager WebSEAL. Generally, this is fine. However, be careful when developing, selecting, and configuring TAIs. A TAI extends the trust domain. WebSphere Application Server is now trusting the TAI and whatever the TAI trusts. If the TAI is improperly developed or configured, it is possible to completely compromise the security of WebSphere Application Server. If you custom-develop a TAI, ensure that the TAI carefully validates the parameters passed in the request and that the validation is done in a secure way. We've seen TAIs that perform foolish things such as simply accepting a username in an HTTP header. That's useless unless care is taken to ensure that all traffic received by WebSphere Application Server must be sent via the authentication proxy, for example, using the techniques described above, and that the authentication proxy will always override an HTTP header set by the client because HTTP headers can be forged.

- **WebSEAL TAI configuration**
  To make clear the importance of careful configuration, this article specifically discusses the IBM provided legacy WebSEAL TAI, but any TAI requires careful design and configuration to be secure. Proper configuration of the trust relationships between WebSphere Application Server and Tivoli Access Manager WebSEAL is crucial to the creation of a secure configuration. In order to create this secure configuration, steps must be taken in both WebSphere Application Server and WebSEAL. Within WebSphere Application Server, both the Web container configuration and the WebSEAL TAI configuration must be set properly. The trust relationship between the two products is crucial because the WebSEAL TAI within WebSphere Application Server is accepting identity assertions from WebSEAL. If that link can be compromised, an intruder could then assert any identity and completely undermine the security of the infrastructure. The trust relationship between WebSphere Application Server and WebSEAL can be established through one of two mechanisms: mutual SSL authentication and password-based authentication. Either mechanism is appropriate within a secure environment. However, each must be configured properly or serious security breaches are possible. In either case, WebSEAL sends the end user’s user ID as an iv-user header on the HTTP request. The difference between the two configurations is in how WebSEAL proves itself to the application server
- **WebSEAL password configuration**
  When password authentication is used, WebSEAL sends its user ID and password as the basic auth header in the HTTP request (the user’s user ID is in the iv-user header). Password-based authentication is configured in two places. First, WebSEAL must be configured to send its user ID and password to the application servers for the junction being configured. This password is of course a secret that must be carefully protected. The WebSEAL TAI will validate this password against the registry when it is received.
  However, there is one subtle and easily overlooked point. If the LoginId property is not set on the WebSEAL TAI properties, then the TAI will verify the user ID and password combination sent from WebSEAL and trust it if it is any valid user ID and password combination. This is not a secure configuration because this then implies that any person knowing any valid user ID and password combination can connect to WebSphere Application Server and assert any user's identity. When you specify the LoginId property, the WebSEAL TAI will ignore the inbound user ID in the basic auth header and verify the LoginId and WebSEAL

password combination. In that case, there is then only one (presumably closely guarded secret) valid password that can be sent from WebSEAL. You should of course configure SSL from WebSEAL to the application server to ensure that the secret password is not sent in cleartext.

- **WebSEAL mutualSSL configuration**
  Mutual SSL is configured through three separate and critically important steps:
  1. WebSEAL must be configured to use SSL to communicate with WebSphere Application Server and that SSL configuration must include a client certificate whose private key is known only to WebSEAL.
  2. The application server Web container must be configured to perform client certificate authentication, and its trust store must be altered to include only the client certificate that WebSEAL is using. This step is crucial because this is how you guarantee that requests to the application server Web container are coming only from WebSEAL and not some intruder (simply using mutually authenticated SSL is not sufficient). You must also remove the non-HTTPS transports from the Web container to ensure that only mutually authenticated SSL is used when contacting the server.
  3. The WebSEAL TAI must be configured with `mutualSSL=true` in its properties. However, you must understand that this last step merely states to the TAI that it should assume the connection is secure and that it is using mutually authenticated SSL. If either of the two previous steps are not configured exactly correctly, your environment is now completely insecure.

  Thus, the choice to use mutualSSL must be taken with great care. Any configuration mistakes will result in an environment where any user can be impersonated.
  If you add a Web server to the mix, things get even more complicated. In this case, you must carefully configure a mutualSSL configuration between WebSEAL and the Web server and a second between the Web server plug-in and the WebSphere Application Server Web container.

Multiple WebSEAL TAIs

There are currently three different TAIs that can be used to provide SSO between WebSEAL and WebSphere Application Server:

- **Legacy WebSEAL TAI** (WebSealTrustAssociationInterceptor) that ships with WebSphere Application Server: Avoid using this TAI because it is deprecated in V7 and can be configured dangerously insecurely, as described above.
- **Tivoli Access Manager Interceptor Plus TAI** (TAMTrustAssociationInterceptorPlus) that ships with WebSphere Application Server. This TAI addresses the security vulnerabilities in the previous TAI and is preferred. However, it has some functional differences relative to the legacy TAI (including a requirement for a TAM client configuration), so some users prefer not to use it.
- **Enhanced Tivoli Access Manager TAI** (TAMETai) that can be downloaded from IBM.
  This TAI is properly hardened like the TAMPlus TAI but includes substantial additional function, including the ability to run without a Tivoli Access Manager client, just like the legacy WebSEAL TAI.

In general, you should use the second or third TAI as appropriate to your needs.

13. Use certificate authentication carefully

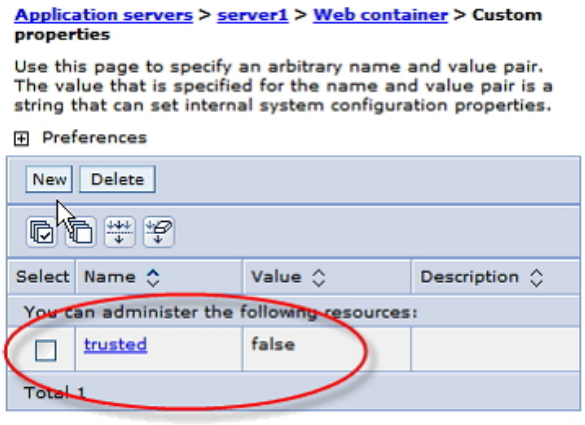
Certificate authentication raises two very specific risks:

- **Revocation:** Certificates can be compromised and provisions must be made to revoke compromised certificates.
  Certificates provide for a powerful form of authentication and are highly desirable from security perspective. However, you must take into account the problem of revocation. Since users control their private key, there is always the risk that it could be compromised. Therefore, all CAs provide for certificate revocation; basically the CA is stating that the certificate should no longer be trusted. For certificate revocation to work properly, the receiver of the certificate must check to see if it is still valid. Many people overlook this. Without proper support for revocation, using certificates for authentication is foolhardy. There are a variety of techniques that are used (and will not be discussed here in detail here); in brief, you can choose from:
  - Online Certificate Status Protocol (OCSP).
  - Certificate Revocation List, found via a single end point or distribution point information embedded in the certificate.
  - Self Signed Certificates, if you have a small number of certificates, you can simply issue self signed certificates. Revocation is then just a matter of deleting the corresponding signer.

  All of these techniques are supported by WebSphere Application Server, but all require configuration. Make sure you take steps to do so. The Liberty profile does not support OCSP or Certificate Revocation List.
- **Web authentication trust risk:** The mechanism used for validating certificates must be configured securely; by default, it is not for Web traffic.
  When certificate-based authentication is used for Web authentication, a very subtle potential trust issue occurs. When a Web client authenticates to the Web server, the Web server validates the certificate. Then, the WebSphere Application Server Web server plug-in forwards the certificate information from the Web server to the application server. This information is forwarded so that the Web container can map that certificate to a Java EE identity. The problem is that the information is just a description of the certificate (information that is available in the public certificate). If an intruder can connect directly to the Web container and bypass the Web server, the system is now vulnerable to compromise because the intruder could forge certificate information and trick the runtime, enabling them to become anyone. This means that if you are using certificates for authentication (Java EE based authentication or custom application code directly examining the certificate), you must block the vulnerability.

There are two cases to consider. If your intention is to use certificates to authenticate to the Web server and then have those certificates be available to the Web container for authentication, you will need to authenticate the Web server to Web container link (see the next section). If your intention is to use certificates to authenticate directly to the Web container (meaning there is no Web server in your scenario), you'll have to configure the Web container to ignore certificate information in the HTTP headers (in this scenario, such information would always be a forgery). To do this, you must configure the "trusted" custom property on the Web container for each application server and set its value to false as shown in Figure 6.

Figure 6. Setting Web container to ignore certificate headers from client



To configure the Liberty web container to ignore certificate headers from clients, include the webcontainer trust element to the profile's server.xml file, as shown in Listing 2.

Listing 2. Ignoring certificate headers from client in Liberty

```
<webcontainer trusted='false'/>
```

If your goal is to support certificate authentication to the Web server and the Web container, custom code will be required because neither of the solutions just mentioned are sufficient; both are vulnerable to attacks from the other connection path. Instead, a custom TAI or application code will need to be developed to leverage IBM specific features that make it possible for code running in the Web container to determine if the certificate information available via the Java EE APIs is that of someone connecting directly to the Web container (and thus trustworthy) or derived from HTTP headers (in which case not inherently trustworthy). If it's the latter case, custom code can look directly at the certificate information presented to the container as part of the SSL handshake and validate if the party that set the HTTP headers is trustworthy; for example, custom code can examine the SSL client certificates (available via the request property com.ibm.websphere.ssl.direct_connection_peer_certificates) to see if the direct container connection is from the WebSphere Application Server plug-in and, if it is, then choose to accept the asserted certificate information in the HTTP headers. This feature was added in 7.0.0.7 and is documented in the WebSphere Application Server Information Center.

14. Consider authenticating Web server to WebSphere Application Server HTTP link

The WebSphere Application Server Web server plug-in forwards requests from the Web server to the target application server. By default, if the traffic to the Web server is over HTTPS, then the plug-in will automatically use HTTPS when forwarding the request to an application server, thus protecting its confidentiality.

Further, with some care, you can configure the application servers (which contain a small embedded HTTP listener) to only accept requests from known Web servers. This prevents various sneak attacks that bypass any security that might be in front of or in the Web server and creates a trusted network path. This type of situation might seem unlikely, but is in fact very possible. Some examples, (by no means an all inclusive list) are:

- You have an authenticating proxy server that just sends the user ID as an HTTP header without any authentication information. An intruder that can access the Web container directly can become anyone simply by providing this same header. (IBM Tivoli Access Manager WebSEAL does not have this weakness.)
- You have a proxy server that performs important authorization to limit who can access what applications at a coarse grained level.
- You have a proxy server that performs critical auditing and do not want that bypassed.
- You are using client certificate authentication to the Web server as discussed in the previous section.

To create a trusted network path from the Web server to the application server, you configure the application server Web container SSL configuration to use client authentication. Once you have ensured that client authentication is in use, you need to ensure that only trusted Web servers can contact the Web container. To do this, you must either limit the parties that have access by applying the SSL tunnel trick from Limiting access using only SSL, or confirming the direct SSL peer as mentioned in the previous item. Specifically, to apply the SSL tunnel trick, you'll need to:

1. Create a key store and trust store for the Web container and a key store for the Web server plug-in.
2. Delete from all key stores (including the trust store) all of the existing signing certificates. At this point, no key store can be used to validate any certificates. That's intentional.
3. Create a self-signed certificate in the two key stores and export just the certificate (not the private key). Make sure you track when those certificates expire. Once the plug-in certificate expires, it will no longer be able to contact the Web container! Import the certificate exported from the Web container key store into the plug-in key store. Import the plug-in certificate into the Web container trust store. Now, each side contains only a single signing certificate. This means that each can be used to verify exactly one certificate -- the self-signed certificate created for the peer.
4. Install the newly created key stores into the Web container and Web server plug-in.

15. Don't run samples in production

WebSphere Application Server ships with several excellent examples to demonstrate various parts of WebSphere Application Server. These samples are not intended for use in a production environment. Do not run them there, as they create significant security risks. In particular, the snoop servlet can provide an outsider with tremendous amounts of information about your system. This is precisely the type of information you do not want to give a potential intruder. This is easily addressed by not running server1 (which by default contains the samples) in production or by not installing the samples during the profile creation, or uninstalling the example applications from server1.

16. Choose appropriate process identity

The WebSphere Application Server processes run on an operating system and must therefore run under some operating system identity. There are three ways to run WebSphere Application Server with respect to operating system identities:

- Run everything as root.
- Run everything as a single user identity, such as "was."
- Run the node agents as root and individual application servers under their own identities.

IBM tests for and fully supports the first two approaches. The third approach might seem tempting because you can then leverage operating system permissions, but it isn't very effective in practice for these reasons:

- It is very difficult to configure and there are no documented procedures. Many WebSphere Application Server processes need read access to numerous files and write access to the log and transaction directories.
- By running the node agent as root, you effectively give the WebSphere Application Server administrator and any applications running in WebSphere Application Server root authority. This potentially includes a Generic Server, which is a non-WebSphere Application Server process. This is can be a Java or native executable, which would be running as root.
- The primary value of this approach is to control file system access by applications. This can be achieved just as well using Java 2 permissions.
- This approach creates the false impression that applications are isolated from each other. They are not. The WebSphere Application Server internal security model is based on Java EE and Java 2 security and is unaffected by operating system permissions. Thus, if you choose this approach to protect yourself from "rogue" applications, your approach is misguided.

The first approach is obviously undesirable because, as a general best practice, it is best to avoid running any process as root if it can be avoided. This leaves the second approach, which is fully supported. In rare cases, where application isolation is not a concern but running applications

under different operating system identities for accounting purposes is desirable, the third approach can be used. This has no value from a security perspective and in fact slightly increases risks, but does make it possible to use operating system level accounting.

17. Protect configuration files and private keys

Don't take the idea of tightening permissions too far in development. We've seen far too many cases where developers -- during development -- aren't permitted to even view application server log files. Such ultra-sensitivity is unwarranted. During production, of course, you should lock down WebSphere Application Server as much as possible. During development, however, maximum security is neither necessary nor productive.

You should limit file system access to WebSphere Application Server's files by leveraging operating system file permissions. WebSphere Application Server, like any complex system, uses and maintains a great deal of sensitive information. In general, almost no one should have read or write access to most of the WebSphere Application Server information (see sidebar). In particular, the WebSphere Application Server configuration files (<root>/config) contain configuration information as well as passwords.

Password encryption for WebSphere security files

Prior to WebSphere Application Server V6.0.2, there was little you could do in general if you didn't like how WebSphere Application Server stored passwords for the J2C resources. You could write your own custom J2C login module to get passwords from a source outside of WebSphere Application Server, but this wouldn't help with other passwords used by WebSphere Application Server: LDAP bind, WebSphere Application Server admin, and so on.

WebSphere Application Server V6.0.2 introduced an interface where you can actually configure your own custom password encoder that can implement whatever protection you deem appropriate. To do this you implement the plugin interface (com.ibm.wsspi.security.crypto.CustomPasswordEncryption) and then specify two custom security properties in security.xml. You can also set these in PropFilePasswordEncoder.bat/sh. The two properties are:

- com.ibm.wsspi.security.crypto.customPasswordEncryptionClass
- com.ibm.wsspi.security.crypto.customPasswordEncryptionEnabled.

That stated, I don’t believe that encrypting these WebSphere Application Server passwords provides any meaningful protection over and above what is provided by encoding. The design point for encoding the passwords is to prevent accidental disclosure; for example, someone looking over your shoulder who can see a plain text password in a file. On the other hand, if someone has access to the file containing the passwords, neither encoding nor encryption prevents someone for accessing the password. Again, anyone with file access to the encrypted password still has access to the raw password. That’s because the key/certificate used for encryption must be stored on the file system so that the WebSphere Application Server process can decrypt the password and send it to wherever it is needed. Therefore, anyone with access to the file system has access to both the file with the (encrypted) passwords and the keys, which can then be used to decrypt the password.

Also, be careful to avoid incidental sharing of these keys. For example, do not use the same keys in production as in other environments. Many people will have access to development and test machines and their private keys. Guard the production keys carefully.

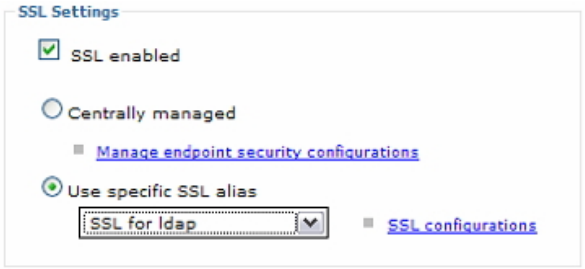
If you do not carefully control who has write access to the file system, a user can subvert the product security controls (such as auditing) by simply hand editing the configuration files.

18. Encrypt WebSphere Application Server to LDAP link

N M E I

When using an LDAP registry, WebSphere Application Server verifies a user's password using the standard ldap_bind. This requires that WebSphere Application Server send the user's password to the LDAP server. If that request is not encrypted, a hacker could use a network sniffer to steal the passwords of users authenticating (including administrative passwords!). Most LDAP directories support LDAP over SSL, and WebSphere Application Server can be configured to use this. On the LDAP user registry panel (Figure 7), check the **use SSL enabled** option and then configure an SSL configuration appropriate to your LDAP directory. You'll most likely need to place the signing key for the LDAP server's certificate) into the trust store. It's best to create a new SSL configuration just for LDAP to avoid causing problems with the existing SSL usage.

Figure 7. Enable LDAP SSL



If you use a custom registry, you'll obviously want to secure this traffic using whatever mechanism is available.

To enable LDAP SSL for the Liberty profile, include elements in the server's server.xml, similar to the example of the bold elements in Listing 3.

Listing 3. Encrypting LDAP connections in Liberty

```
<featureManager>
     <feature>ssl-1.0</feature>
</featureManager>

<ssl id="ldapSSLConfig" keyStoreRef="ldapTrustStore"
 trustStoreRef="ldapTrustStore"/><keyStore id="ldapTrustStore"
   location="ldapTrustStore.jks" type="JKS" password="123456" />

<ldapRegistry id="IBMDiretoryServerLDAP" realm="SampleLdapIDSRealm"
        host="host.domain.com" port="389" ignoreCase="true"
        baseDN="o=domain,c=us"
        ldapType="IBM Tivoli Directory Server"
        idsFilters="myidsfilters"
        sslEnabled="true"
        sslRef="ldapSSLConfig" />
```

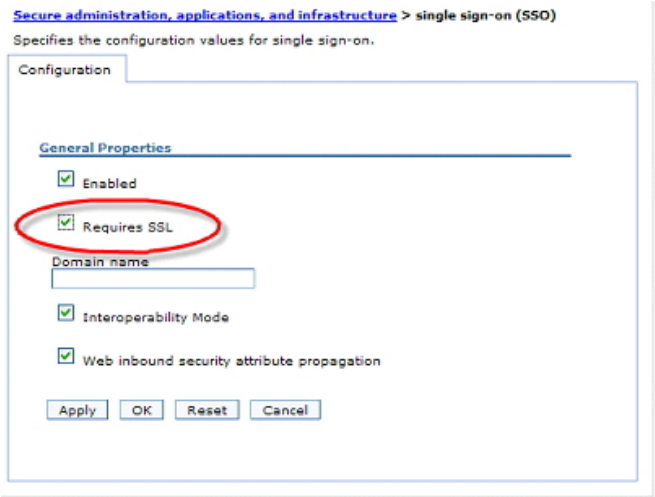
19. Ensure LTPA cookie flows only over HTTPS

N M E I

Web applications use cookies to track users across requests. These cookies, while typically not sensitive in themselves, connect you to your existing state on the back end system. If an intruder were to capture one of your cookies, they could potentially use the cookie to act as you. Since network traffic is often traveling over untrusted networks (consider your favorite WiFi hotspot), where capturing packets is quite easy, important Web traffic should be encrypted using SSL. This includes important cookies. Clearly, if SSL is used for all requests, the cookies are protected. However, many applications (perhaps accidentally) make some requests over HTTP without SSL, potentially exposing cookies. Fortunately, the HTTP specification makes it possible to tell the browser to only send cookies over SSL.

In the case of WebSphere Application Server, the most important cookie is the LTPA cookie, and therefore it should be configured to be sent only over SSL.

Figure 8. Limit LTPA cookies to SSL only



To limit the LTPA cookies to SSL only in the Liberty profile, include a webAppSecurity element in the server's server.xml that includes the ssoRequiresSSL attribute, as shown in the example in Listing 4.

Listing 4. Enabling application security in Liberty

```
<webAppSecurity ssoRequiresSSL='true'/>
```

You can also similarly limit the HTTP Session (JSESSION by default) cookie to SSL only as well by specifying a similar setting on the session management panel.

To limit the HTTP Session cookie SSL only in the Liberty profile, include an httpSession element in the server's server.xml that includes the cookieSecure attribute, as shown in the example in Listing 5.

Listing 5. Enabling HTTP Session cookie SSL in Liberty

```
<httpSession cookieSecure='true'/>
```

Caution: The Requires SSL flag does not work in WebSphere Application Server V7 prior to fixpack 7.0.0.9. Make sure you install it.

20. Ensure LTPA encryption keys are changed periodically

WebSphere Application Server encrypts various user tokens (including the LTPA cookie) using what are known as the LTPA encryption keys. As with any cryptographic keys, these should be changed periodically. Depending on your WebSphere Application Server version and patch level, automatic key generation might be on or off by default; the more recent the version, the more likely it is off by default. To avoid possible outages, ensure that this feature is off, as shown in Figure 9.

LTPA keys are generated when security is enabled for a Liberty server for the first time.

You should ensure that your LTPA keys are changed periodically. For full profiles, you can do this by either enabling the automatic LTPA key replacement as shown in Figure 9, or you can manually regenerate the keys as shown in Figure 10 or via the `AdminTask.generateKeyForKeySetGroup` command.

For the Liberty profile, create a new profile, enable security, start the server, then copy the newly generated ${server.config.dir}/resources/security/ltpa.keys file.

Make sure that you consider the problems of LTPA keys becoming inconsistent:

- First, if some nodes in your cell are left down for extended periods of time (and the keys change twice), the nodes can lose the ability to communicate.

- Second, if your LTPA keys are shared with something else (such as another cell or WebSphere DataPower), then when the keys change, you'll need to update them everywhere -- typically causing an outage.

Therefore, plan to change your LTPA keys during a scheduled outage. Distribute the new keys to all nodes in the cell, and to all external systems/cells during this outage window.

Figure 9. Do not enable automatic LTPA key updates

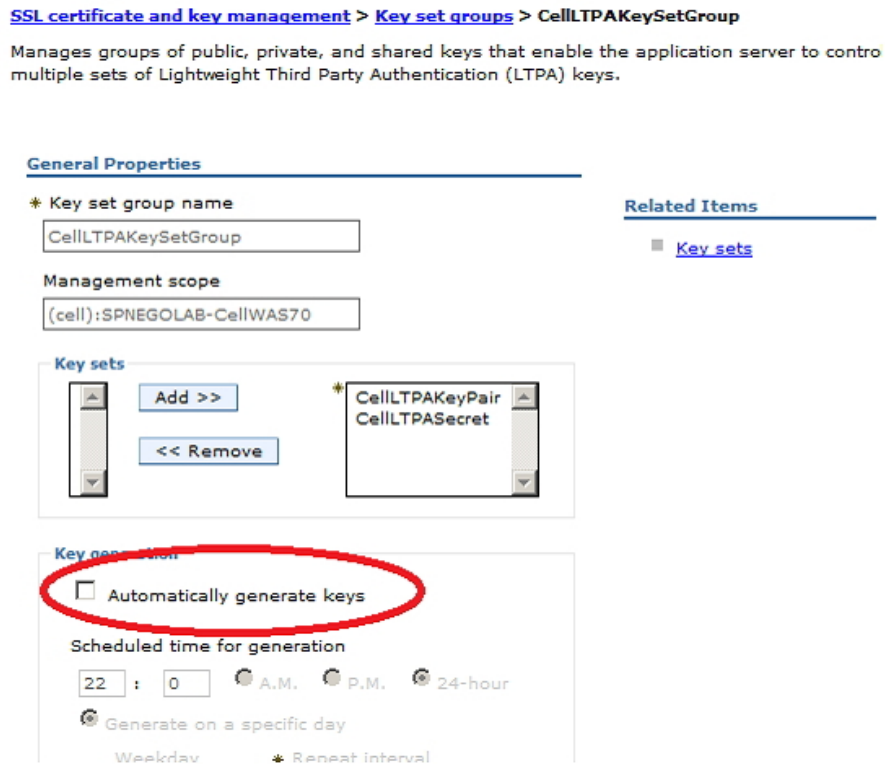
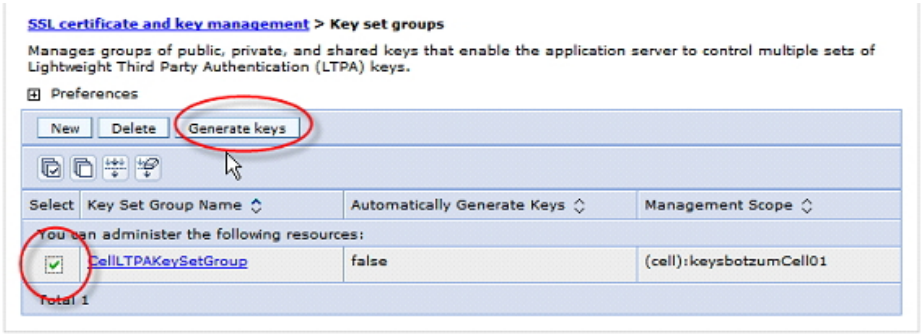


Figure 10. Manually generating new LTPA keys



21. Don't specify passwords on the command line

N M E I

Once security is enabled, the WebSphere Application Server administrative tools require that you authenticate in order to function. The obvious way you would think to do this is to specify the user ID and password on the command line as parameters to the tools. Do not do this. This exposes

your administrative password to anyone looking over your shoulder. And, on many operating systems, anyone that can see a list of processes can see the arguments on the command line. Also, previous commands are visible in the command history, including those password arguments. Instead, you should ensure that the administrative tools prompt for a user ID and password. Be aware that in all currently supported versions of WebSphere Application Server this is the default, so no explicit actions are needed to insure that this occurs.

If you find it annoying that the command line tools prompt graphically for a user ID and password, you can override this behavior and force the tools to use a simple text-based prompt. To do this, you must change the loginSource from prompt to stdin by editing the appropriate configuration file. By default, the administrative tools use SOAP and thus the soap.client.props file should be edited. If you are using RMI, edit sas.client.props. Look for the loginSource property in the appropriate file and change it to specify stdin.

This item does not apply to the Liberty profile in V8.5.

22. Consider using more salt in file-based Federated Repository registry

If you are using the Federated Repository registry and are also using the built-in file repository in that registry, then the users in that registry have their userids and passwords stored in the fileregistry.xml file in the cell config directory. These passwords are one-way hashed, which means that you cannot derive the actual password from the hashed value. The hashes are computed with some cryptographic salt. In WebSphere Application Server V8.0 and 8.5 it is possible to specify the length of that salt and the hashing algorithm used. This file should be protected by OS-defined access control lists so only privileged OS users should be able to read the file. To prevent against password cracking attacks via rainbow tables, you might consider increasing the amount of salt or using a stronger hashing function.

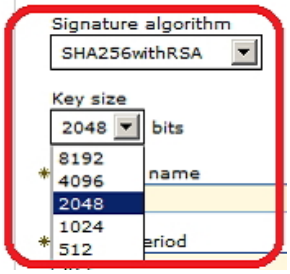
This item does not apply to the Liberty profile in V8.5.

23. Consider using longer key lengths for generated certificates

In WebSphere Application Server V8.0 the default key length used for generated certificates changed from 1024 to 2048. Since V7.0, it has been possible to specify larger key lengths than 1024 when generating keys via wsadmin. Since V8.0 the admin console (Figure 11) supports choosing the key length.

This item does not apply to the Liberty profile in V8.5.

Figure 11. Choosing key length in the Admin console



The supported key length range is 512-16384 (must be a multiple of 8).

This item does not apply to the Liberty profile in V8.5.

24. Create separate administrative user IDs

N M E I

> The primary administrative ID is not the same as the security server ID that is used for server to server communication. As of V6.1, that identity no longer has to exist in the registry or even have an associated password. It's just used for internal communication by default. You can specify a server ID and password if needed, but this is not recommend except when absolutely necessary -– when working with a mixed version cell (including V6.0 and earlier) or cross cell SSO with V6.0 or earlier

When security is configured for WebSphere Application Server V6.1 and later (except for Liberty profiles), a single primary administrative ID is initially configured (see sidebar). This ID is effectively the equivalent of root in WebSphere Application Server and can perform any administrative operation (including all administrative roles mentioned in the next section). Because of the importance of this ID, it is best not to widely share the password. Ideally, this ID should never be used after initial configuration. Liberty profiles in V8.5 are not enabled for security by default.

As with most systems, WebSphere Application Server does permit multiple principals to act as administrators. Simply use the administrative application and go to the system administration console Users (or Groups) section to specify additional users or groups that should be granted administrative authority. When you do this, each individual person can authenticate as himself or herself when administering WebSphere Application Server. All administrative actions that result in changes to the configuration of WebSphere Application Server are audited by the deployment manager, including the identity of the principal that made the change. As of V7, a new auditing framework has been introduced that can provide even more detailed information on administrative actions. Obviously, these audit records are more useful if each administrator has a separate identity.

The approach of giving individual administrators their own separate administrative access can be particularly handy in an environment where central administrators administer multiple WebSphere Application Server cells. You can configure all of these cells to share a common registry, and thus the administrators can use the same ID and password to administer each cell, while each cell has its own local "root" ID and password.

25. Leverage administrative roles

The full (non-Liberty) profiles of WebSphere Application Server allows for a variety of administrative roles depending on the version: Administrator, Operator, Monitor, Configurator, AdminSecurityManager, iscadmins, Deployer, Auditor. These roles make it possible to give individuals (and automated systems) access appropriate to their level of need. It is strongly recommend that you take advantage of roles whenever possible. By using the less powerful roles of monitor and operator, you can restrict the actions an administrator can take. For example, you can give the less senior administrators just the ability to start and stop servers and the night operators just the ability the watch the system (monitor). These actions greatly limit the risk of damage by trusting people with only the permissions they need.

Complete documentation on the roles and the authorities they have is available in the WebSphere Application Server Information Center. However, pay particular attention to these three interesting roles:

- **Monitor:** By giving a user or system this access level, you are giving only the ability to monitor the system state; the state cannot be changed, nor can the configuration be altered. For example, if you develop monitoring scripts that check for system health and have to store the user ID and password locally with the script, use an ID with the monitor role. Even if the ID is compromised, little serious harm can result.
- **AdminSecurityManager:** (added in V6.1) Users with this role have the ability to grant other users administrative roles. The Administrator role itself does not have that authority. Now, you can grant people various authorities (even Administrator authority) and still know that they cannot grant those authorities to others.
- **Auditor:** (added in V7) Users with this role can configure the auditing system and nothing else. Administrators on the other hand can configure anything but the auditing system. This provides a clear separation of duties. An administrator can change the configuration, but cannot “wipe out” his tracks because he can’t disable auditing.

This item does not apply to the Liberty profile in V8.5. The Liberty profile has only a single Administrator security role to which multiple principals can be bound.

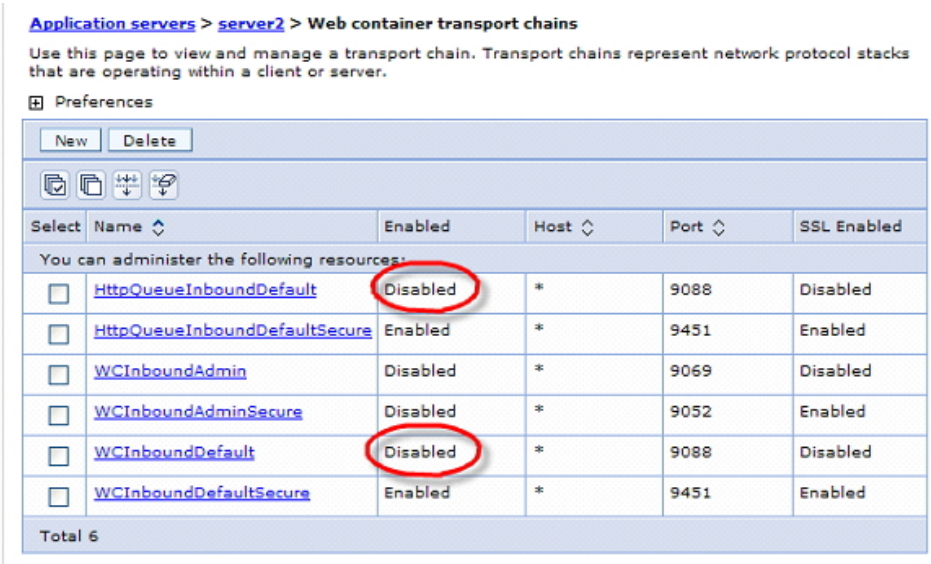
26. Consider encrypting Web server to Web container link

Even if you have chosen not to authenticate the link from the Web server to the Web container, you might want to consider encrypting it. The Web server plug-in transmits information from the Web server to the Web container over HTTP. If the request arrived at the Web server using HTTPS, the plug-in will forward the request on using HTTPS by default. If the request arrived over

HTTP, HTTP will be used by the plug-in. These defaults are appropriate for most environments. There is, however, one possible exception.

In some environments, sensitive information is added to the request after it has arrived on your network. For example, some authenticating proxy servers (such as WebSEAL) augment requests with password information. Custom code in the Web server might do something similar. If that's the case, you should take extra steps to protect the traffic from the Web server to the Web container. To force the use of HTTPS for all traffic from the plug-in, simply disable the HTTP transport from the Web container on every application server and then regenerate and deploy the plug-in. You must disable both the WCInboundDefault and the HttpQueueInboundDefault transport chains (Figure 12). Now, the plug-in can only use HTTPS and so it will use it for all traffic regardless of how the traffic arrived at the Web container.

Figure 12. Ensuring HTTPS only



To ensure HTTPS only to the Web container in the Liberty profile, include an httpEndpoint element in the server's server.xml that includes an httpsPort attribute, but does not include an httpPort attribute such as that shown in the example in Listing 6.

Listing 6. Ensuring HTTPs only to the web container in Liberty

```
<httpEndpoint id="defaultHttpEndpoint" host="localhost"
httpsPort="9443" />
```

27. Encrypt WebSphere MQ messaging links

N M E I

If you are using WebSphere MQ rather than the default messaging provider, you should of course use SSL to WebSphere MQ. See Related topics for more information on that. In WebSphere Application Server V7, WebSphere MQ client SSL configuration is a first class construct and can be done using the admin console much like other SSL configuration.

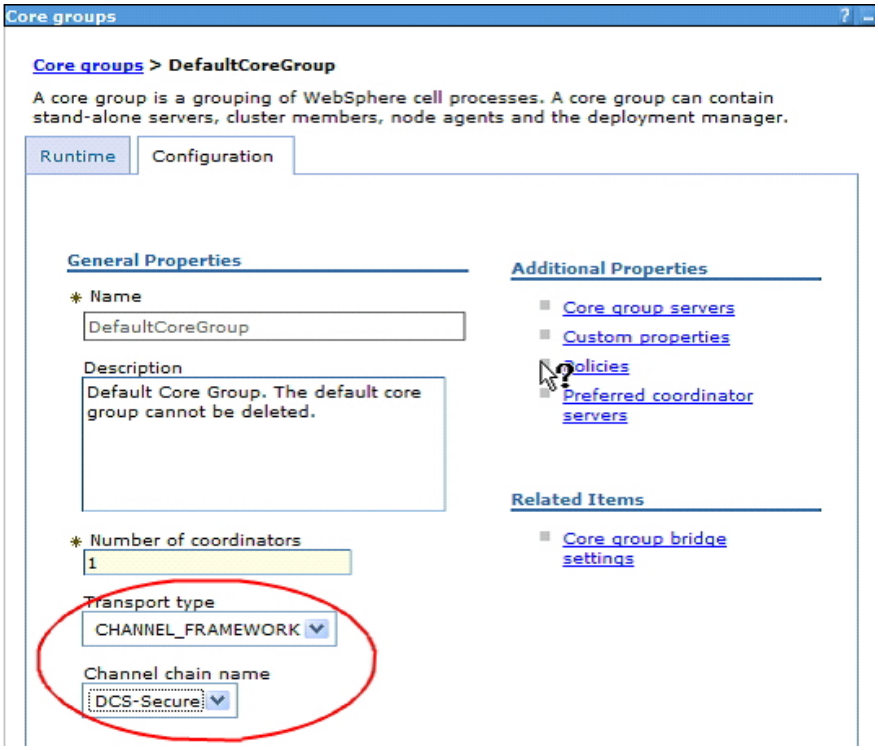
This item does not apply to the Liberty profile in V8.5.

28. Encrypt distribution and consistency services (DCS) transport link

N M E I

Core groups rely on DCS, which uses a reliable multicast message (RMM) system for transport. RMM can use one of several wire transport technologies. Depending on your environment, sensitive information might be transmitted over DCS. For example, data in DynaCache and the security subject cache are transmitted using DCS. To ensure this, select a transport type of channel framework and DCS-Secure as channel chain for each core group (Figure 13).

Figure 13. Configuring DCS to use a protected link



Be aware that DCS always authenticates messages when global security is enabled. Once the transport is encrypted, you then have a highly secure channel.

Once you have done this, all services that rely on DCS are now using an encrypted and authenticated transport. Those services are DynaCache, memory-to-memory session replication, core groups, Web services caching, and stateful session bean persistence.

29. Protect application server to database link

N M E I

Just as with any other network link, confidential information can be written to or read from the database. Most databases support some form of network encryption and you should leverage it.

Here is an IBM DB2 example.

This item does not apply to the Liberty profile in V8.5.

30. Consider restricting cookies to HTTP only

NMEI

If hackers are able to compromise a Web application by inserting malicious JavaScript into the browser (this is commonly known as cross-site scripting), then they can do any number of malicious actions and the application is essentially compromised. One of the many malicious things they can do is steal sensitive cookies such as the LTPA cookie. Most recent Web browsers support a concept known as HTTP Only cookies.

WebSphere Application Server provides two ways to ensure that the LTPA cookie is marked as HTTP Only. The first way is enabled by setting this security custom property to true: com.ibm.ws.security.addHttpOnlyAttributeToCookies. This feature was added via fixpack 7.0.0.9.

This feature only protects the LTPA cookie with the HTTP Only flag. For a properly written application that leverages Java EE security and enables session security (discussed later), that should be sufficient.

A second feature, also shipped in fixpack 7.0.0.9, makes it possible to set the HTTP Only flag on arbitrary cookies. This feature is preferable to the first feature as it is more flexible and more complete. With this APAR, the cookies to protect are controlled by a Web container property, com.ibm.ws.webcontainer.httpOnlyCookies. That property is a comma separated listed of cookies to protect (with * indicating all cookies). In V7.0 (with 7.0.0.9 applied) this feature is disabled by default. To exploit it, you must explicitly set the property. In both versions 8.0 and 8.5 this attribute is enabled by default for the LtpaToken2, JSESSIONID, and WASReqUrl cookies, and no further action is required unless you want to apply it to other cookies. Be aware that users migrating from earlier versions might experience application breakage as a result of this change in default behavior.

By default, the LtpaToken2 (SSO), and the WASReqURL cookies are set to be HTTP only in the Liberty profile. To explicitly set this in the server's server.xml, include a webAppSecurity element that includes an httpOnlyCookies attribute, such as that shown in the example in Listing 7.

Listing 7. Restricting LTPA session cookies to HTTP only in Liberty

```
            <webAppSecurity httpOnlyCookies='true' /><!- - This is the default- ->
```

By default, the HTTP session is also set to be HTTP only in the Liberty profile. To explicitly set this in the server's server.xml, include an httpSession element that includes an cookieHttpOnly attribute, such as that shown in the example in Listing 8.

Listing 8. Restricting HTTP Session cookies to HTTP only in Liberty

```
<httpSession cookieHttpOnly='true' /><!- - This is the default- ->
```

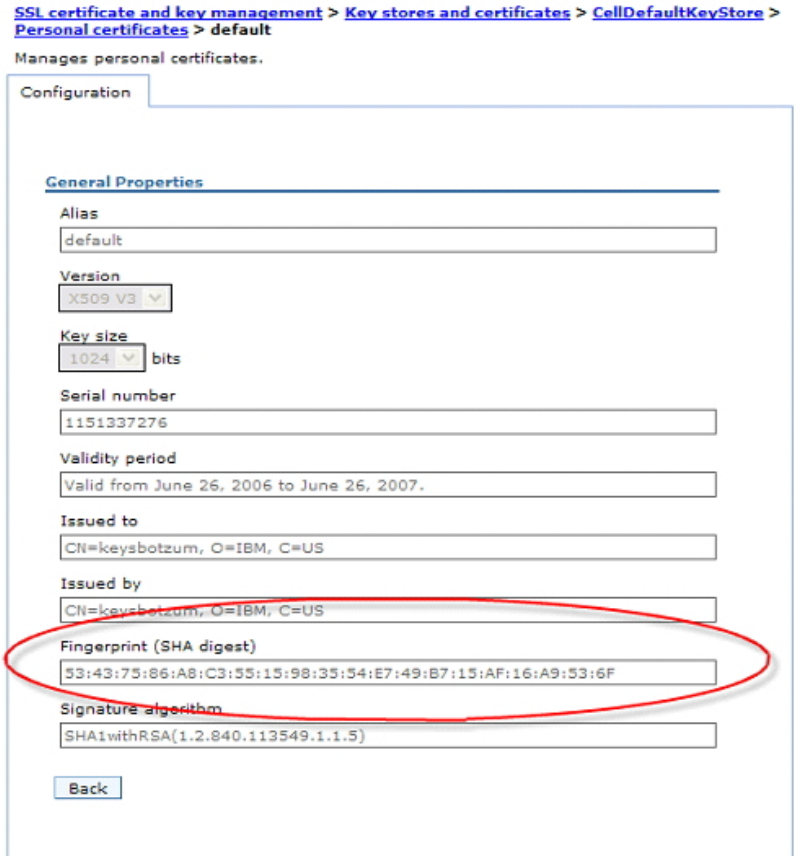
Caution: While these features may seem to be a solution for cross-site scripting, they are not. If a hacker can execute arbitrary code in your browser, he can do far more damage than just steal your cookies. They can actually see everything on the browser screen and capture every key stroke -- far more disturbing than stealing a cookie.

31. Train users to properly understand certificate warnings

When using SSL for communication, a key element of the secure exchange is validation of the server's certificate against the client trust store. Should the server present a certificate that is not trustworthy because the corresponding signer is not in the trust store, most clients (Web browsers, SSH, wsadmin, and so on) will prompt the user to decide what to do. These clients typically warn the user about the unknown certificate and present a fingerprint (typically SHA) for the certificate and ask *should I trust this?* Unfortunately, most users blindly click **yes**. That's a terrible decision. If you do this, you have no idea what server you are talking to. And, in the case of WebSphere Application Server administrative clients, the next thing you will do is send your administrative user ID and password to an unknown source.

Instead, administrators (and ideally end users) should examine the fingerprint information and determine if it is the correct fingerprint. The admin tools provide a way to see the fingerprint for certificates. Selecting a personal certificate in the admin console displays its fingerprint.

Figure 14. Certificate fingerprint



Users (particularly administrators) should be made aware of the fingerprint information and then, ideally, should validate it when prompted by a client, be it a Web browser (Figures 15 and 16) or wsadmin (Listing 9).

Figure 15. Web server certificate warning, Part 1

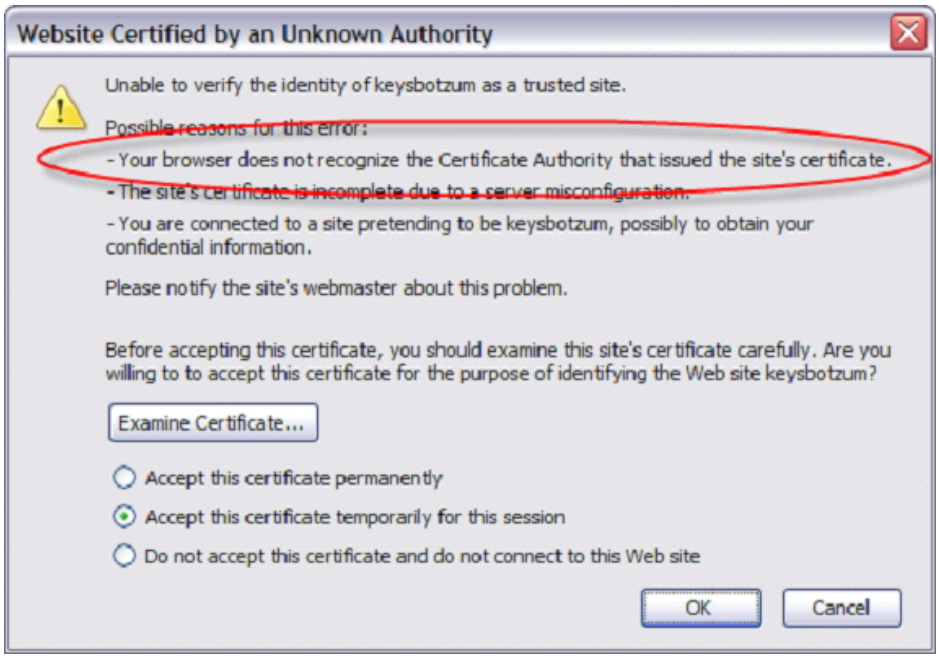
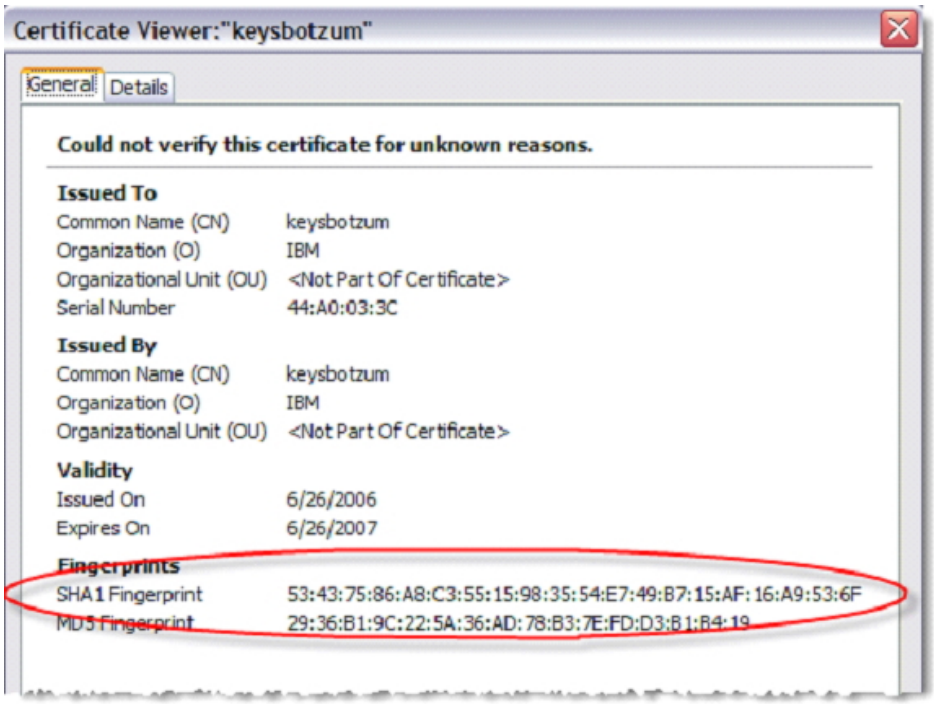


Figure 16. Web server certificate warning, Part 2



Listing 9. wsadmin certificate warning

```
./wsadmin.bat
*** SSL SIGNER EXCHANGE PROMPT ***
SSL signer from target host localhost is not found in trust store
 C:/IBM/WebSphere/AppServer/profiles/AppSrv02/etc/trust.p12
Here is the signer information (verify the digest value matches what
 is displayed at the server):
Subject DN:    CN=keysbotzum, O=IBM, C=US
Issuer DN:     CN=keysbotzum, O=IBM, C=US
Serial number: 1151337276
Expires:       Tue Jun 26 11:54:36 EDT 2007
SHA-1 Digest:  53:43:75:86:A8:C3:55:15:98:35:54:E7:49:B7:15:AF:16:A9:53:6F
MD5 Digest:    29:36:B1:9C:22:5A:36:AD:78:B3:7E:FD:D3:B1:B4:19
Add signer to the trust store now? (y/n)
```

Even if you don't follow this advice, at least when you get this challenge the first time, import the certificate into the client trust store. If you get message again, **find out why!** The prompt should not happen again until the certificate is changed. If you get that prompt unexpectedly, something could be terribly wrong.

32. Consider limiting size of HTTP data

N M E I

A common Denial Of Service (DOS) attack is to send an application very large HTTP headers, a large number of HTTP headers, or a large request body. We strongly believe in defense in depth. Ideally, an intrusion detection system, a firewall, a WebSphere DataPower SOA Appliance, or even the web server in front of the application server should be protecting your WebSphere Application Server from these size-based HTTP attacks. There are also controls in WebSphere Application Server to protect itself from these kinds of attacks.

The default maximum size of any single HTTP header is 32768 bytes. This can be set to a different value.

The default maximum number of HTTP headers is 50. This can be set to a different limit.

Another common DOS attack is to send a request resulting in a long running GET request. The ServerIOTimeoutRetry property in the WebSphere Application Server Plug-in can limit the number of retries on any request. This can reduce the effect of such a long running request. See the Information Center for details.

If you wish to limit the maximum size of any request body, this can also be set. For details, see the Information Center

33. Carefully limit trusted signers

N M E I

When using certificate authentication (client or server), you need to understand that each signer in the trust store represents a trusted provider of identity information (a certificate). You should trust as few signers as possible. Otherwise, it is possible that two signers might issue certificates that map to the same user identity. That would create a serious security hole in your architecture.

You should review the trust stores on the clients and servers and remove any signers which are not needed. By default, the trust stores contain far fewer trusted signers than in previous releases, in keeping with the goal of being secure by default. There are, however, still a few signer issues you might wish to address:

- In V7, the default cell trust store and CMS keyring files contain a WebSphere DataPower signing certificate, meaning that all DataPower machines can issue certificates that the application servers will trust. This should be removed for maximum security. Truststores and CMS keyring files created after recent fixpacks are installed are created without the DataPower signing certificate. You should check your truststore or keyring for this unneeded DataPower signing certificate and remove it if there.
- In V8.0 and V8.5, the DataPower signing certificate has been removed from generated truststores and CMS keyring files.

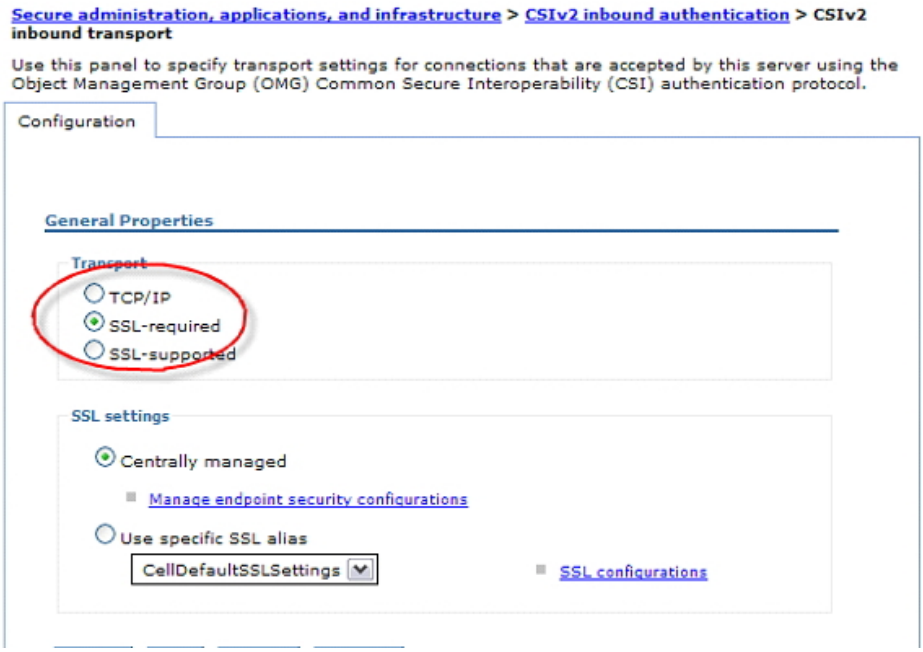
34. Enforce CSIv2 transport SSL use

(This item is addressed by default in V8, which is a change in behavior. As such, users migrating from earlier versions of WebSphere Application Server who had not enabled CSIv2 SSL should be aware that SSL authentication failures can result in V8 as a result.)

When WebSphere Application Server servers and clients communicate using CSIv2 IIOP, they negotiate the transport security. Whatever is acceptable to both parties is chosen. Generally, that is fine, but you should be aware of one potential weakness. WebSphere Application Server supports CSIv2 over SSL or clear text. By default, both parties will typically negotiate to use SSL, thus ensuring an encrypted communication channel. However, if either party in the negotiation requests clear text, then clear text will be used. You might not even realize your traffic is being sent in the clear! This might happen, for example, if a client was mis-configured. If you want to guarantee that traffic is encrypted (and you should), it is safer to ensure that SSL is always used.

You can ensure that SSL is used for IIOP by indicating that it is required, and not optional, on the CSIv2 inbound transport panel. You should do the same for the CSIv2 Outbound Transport (Figure 17).

Figure 17. Configuring SSL only



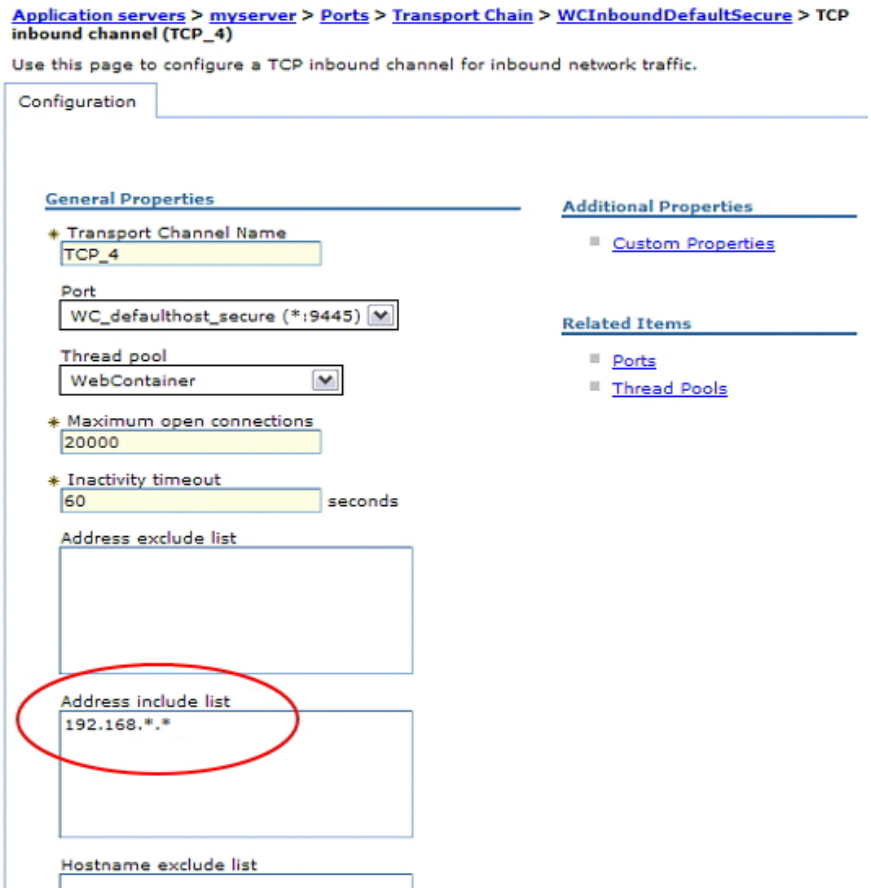
This item does not apply to the Liberty profile in V8.5, since there is no support for EJBs or for CSIv2.

35. Consider port filtering

N M E I

Sometimes it is desirable to limit who can connect based upon network information. While such configuration provides questionable security value, it is included here for completeness. Most of the transports in WebSphere Application Server (with the exception of IIOP) leverage the Channel Framework, which in turn makes it possible to filter inbound traffic based on IP address or DNS name using an inclusion or exclusion list.

Figure 18. Port filtering



Caution: IP address forgery is a fairly easy thing to do, and so relying on IP addresses for security is unwise. It is particularly unwise to filter based on IP address at the application layer. Firewalls and switches are better equipped to recognize when packets are coming from IP addresses that could not be valid. They can also check MAC addresses.

36. Consider hostname verification on outbound SSL connections

N M E I

When an SSL client opens an SSL connection to an SSL server, the server sends its certificate to the client. The expectation is that the SSL server's certificate will contain the hostname in its common name. Some clients confirm the common name on the certificate presented matches the hostname in the URL (for example, web browsers perform this check). This is called hostname verification.

In certain situations, a failure of this verification can be indicative of an SSL man-in-the-middle attack:

- When the certificate is trusted because it is self-signed, hostname verification is not necessary. The SSL handshake would not pass unless the certificate presented was an exact match of the trusted certificate.
- When the certificate is trusted because it is issued by a trusted CA, then a MITM attacker could return its legitimate certificate issued by the same trusted CA in place of the real certificate. Assuming that the CA does not issue more than one certificate with the same CN, verification of the hostname could detect the MITM attacker.

To enable hostname verification, a security custom property com.ibm.ssl.performURLHostNameVerification=true must be set.

The hostname verification is performed as required by RFC 2818 Section 3.1 Server Identity. In summary:

- If the URI is specified as an IP address rather than a hostname, verification is performed using iPAddress subjectAltName in the certificate and must exactly match the IP in the URI.
- If the URI is specified using a given DNS name, verification is performed using the certificate's subjectAltName extension of type dNSName, if present. Otherwise, the (most specific) Common Name field in the Subject field of the certificate is used. Although the use of the Common Name is existing practice, it is deprecated and Certification Authorities are encouraged to use the dNSName instead.
  Matching is performed using the matching rules specified by RFC2459. If more than one identity of a given type is present in the certificate (for example, more than one dNSName name, a match in any one of the set is considered acceptable.)

Considerations when this property is set:

- This property effects all URL based SSL traffic in the cell, including IIOP and WebSphere Application Server internal communications.
- During the creation of a WebSphere Application Server profile, you are permitted to configure the hostname of the node for the profile. You can override the value determined by the profile creation tool. Make sure it matches the hostname.
- If your system is multi-homed, with multiple hostnames, remember that only the single hostname of the SSL configuration's keystore's default certificate will be returned. It is possible to create a certificate with alternative hostnames; this is possible when acquiring the certificate from a CA.

In other words, while enabling this property can strengthen your security posture against man-in-the-middle attacks, your SSL certificates and hostname resolution must be impeccable. If it is not, your cell might no longer communicate over SSL because the internal communications might fail hostname verification.

37. Disable unused ports

A basic principle of security hardening is to minimize the attack surface for potential attacks. This is even true when there are no known security issues with a given service; if the service is not required for the system to correctly function, it should be removed to minimize the likelihood of an attacker taking advantage of this additional function at some point in the future. Examine Figure 20 and you'll see that a typical WebSphere Application Server application server is potentially listening on a lot of ports.

Figure 19. Default ports for a Network Deployment application server

Application servers > server1 > Ports

Specifies the TCP/IP ports this server uses for connections.

Preferences

New... Delete

Select	Port Name	Host	Port
You can administer the following resources:			
☐	BOOTSTRAP_ADDRESS	lansche.torolab.ibm.com	9811
☐	CSIV2_SSL_MUTUALAUTH_LISTENER_ADDRESS	lansche.torolab.ibm.com	9404
☐	CSIV2_SSL_SERVERAUTH_LISTENER_ADDRESS	lansche.torolab.ibm.com	9405
☐	DCS_UNICAST_ADDRESS	*	9353
☐	IPC_CONNECTOR_ADDRESS	${LOCALHOST_NAME}	9633
☐	ORB_LISTENER_ADDRESS	lansche.torolab.ibm.com	9101
☐	OVERLAY_TCP_LISTENER_ADDRESS	*	11004
☐	OVERLAY_UDP_LISTENER_ADDRESS	*	11003
☐	SAS_SSL_SERVERAUTH_LISTENER_ADDRESS	lansche.torolab.ibm.com	9401
☐	SIB_ENDPOINT_ADDRESS	*	7276
☐	SIB_ENDPOINT_SECURE_ADDRESS	*	7286
☐	SIB_MQ_ENDPOINT_ADDRESS	*	5558
☐	SIB_MQ_ENDPOINT_SECURE_ADDRESS	*	5578
☐	SIP_DEFAULTHOST	*	5060
☐	SIP_DEFAULTHOST_SECURE	*	5061
☐	SOAP_CONNECTOR_ADDRESS	lansche.torolab.ibm.com	8880
☐	WC_adminhost	*	9060
☐	WC_adminhost_secure	*	9043
☐	WC_defaulthost	*	9080
☐	WC_defaulthost_secure	*	9443

Total 20

Should a given service not be required, then its listening ports can be disabled. Looking at this list, potential candidates for disabling include:

- **SAS_SSL_SERVERAUTH_LISTENER_ADDRESS:** Used for compatibility with WebSphere Application Server V4 and earlier releases. This is the old IIOP security protocol. CSIv2 replaces it as of V5.
- **SIB_ENDPOINT_*:** These are used by the built-in messaging engine. If you aren't using messaging, then you don't need either.
- **SIB_MQ_*:** These are used by the messaging engine when connecting with WebSphere MQ.
- **SIP_*:** These are used by the SIP container.
- **WC_adminhost*:** These are used for administrative Web browser access. If your application server is not a deployment manager, you should ensure that these are disabled. Unfortunately, most application server Web containers are listening on two administrative ports even though there is no administrative application on those servers. This is because servers are usually created based on the server1 template that includes those ports. You should disable or remove those ports from all of your application servers.
- **WC_defaulthost*:** These are the default Web container listening ports. If you've added custom listener ports, then these might not be needed.

Different ports require different techniques for disabling them depending on how they are implemented:

- The SAS_SSL_SERVERAUTH_LISTENER_ADDRESS can be taken out of service by selecting CSI as the active protocol on the global security panel. SAS is disabled by default in V7 although the port is still listed.
- The WC_* ports are all for the Web container. They can best be removed, modified, or disabled from the Web container transport chain configuration panel (**Application servers > servername > Web container > transport chain**). The only listening Web ports you need are those used by your applications.
- The SIB_* ports are not started unless the messaging engine is enabled, so no action is necessary for them.
- The SIP_* ports are not started unless SIP applications are started, so no action is necessary for them either.

Caution: Use extreme care when determining which ports to disable and when actually disabling them. Otherwise, you might inadvertently disable one of the administrative ports, which will leave you without a mechanism to administer the process -- short of deleting and recreating the process (for example, server) definition.

38. Consider disabling password caching

When password based authentication occurs, the runtime caches the password as a one way hash for future validation. Since the hash is not reversible, there is no danger in the password being captured (even from a memory dump) but this cache does have implications. When future requests arrive that require authentication, and they use the same user ID and password combination, the cached password data (and user information) will be used. This means that

if a user's password is changed in the registry, he will still be able to authenticate using the old password until the cache expires (10 minutes by default).

Some consider this to be a security vulnerability (the author is not among them). If this concerns you, you can disable password caching with the JVM level property setting of `com.ibm.websphere.security.util.authCacheEnabled = BasicAuthDisabled`. Once set, passwords will no longer be cached and all password authentications will result in a query of the registry. Keep in mind that this can have significant negative performance implications. If you are using a protocol that is stateless and authenticates on every request (such as WS-security with UserNameTokens), this can generate heavy registry authentication traffic.

39. Consider enabling FIPS compliance or SP800-131 or Suite B compliance

There are a variety of cryptographic algorithms to choose from when performing encryption. In addition, when establishing SSL connections there are, in fact, three choices: SSL V2 (disabled by default), SSL V3, and TLS. The United State Government has defined standards with respect to computer security (Federal Information Processing Standards) that cover a number of areas. This standard was known as FIPS 140-2. As part of these standards, they specifically certify particular ciphers as being FIPS compliant and have also certified TLS (but not SSL V3).

The National Institute of Standards and Technology (NIST) has defined a new standard SP800-131 to replace the current FIPS 140-2. The National Security Agency (NSA) similarly developed a new standard called Suite B. These new standards further restrict the choice of ciphers that are used and require that TLS 1.2 be used; while FIPS 140-2 prohibited the use of SSL V3, SP800-131 prohibits the use of TLS 1.0 and TLS 1.1.

Users wishing to restrict their applications to use FIPS 140-2 compliant ciphers and TLS can either manually configure every endpoint, or simply enable FIPS compliance using the admin tools. Once FIPS is enabled, only FIPS compliant cryptography will be used.

WebSphere Application Server V8.5, and via fixpacks 8.0.0.3 and 7.0.0.23, introduced compliance to SP800-131 and NSA Suite B. Similar to FIPS compliance, the entire cell can be converted to SP800-131 and Suite B. Once enabled, only clients capable of supporting SP800-131 will be able to connect to the cell. Currently, few client applications support SP800-131 and TLS 1.2. Migration to this standard may take time and planning.

Summary

Part 1 of this two-part article discussed several aspects of security, focusing on the core theme of hardening a WebSphere Application Server environment. Hopefully, this information is providing you with the foundation you need to truly secure your Java EE environment.

Part 2 will cover even more ground, including application-based preventative measures, cell trust, cross-cell trust, administrative and application isolation, identity propagation, desktop development security, and much more.

If you are interested in learning more about WebSphere Application Server security, contact IBM Software Services for WebSphere for a customized on-site class in WebSphere Application Server security. The class covers security hardening, customizing authentication, integration, single sign on, and a variety of other related topics in depth.

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Related topics

- WebSphere Application Server V7 advanced security hardening, Part 1
- WebSphere Application Server V7 advanced security hardening, Part 2
- WebSphere Application Server V6 advanced security hardening, Part 1
- WebSphere Application Server V6 advanced security hardening, Part 2
- Rational AppScan information
- WebSphere Application Server security
- The Top 5 Internal Security Threatsby Cindy Waxer
- Enterprise Application Security
- Redbook: IBM WebSphere 7.0 Security, SG- 247660, IBM Corp, 2009
- Understanding and Deploying LDAP Directory Services by Timothy Howes, et al, ISBN 0672323168
- Understanding Malicious Content Mitigation for Web Developers
- Java Security Coding Guidelines
- Securing connections between WebSphere Application Server and WebSphere MQ
- IBM Security Scanner Tool for WebSphere Application Server from IBM support
- IBM WebSphere: Deployment and Advanced Configuration by Roland Barcia, Tom Alcott, Bill Hines, and Keys Botzum, ISBN 0-131468-626
- Advanced Authentication in WebSphere Application Server
- Database identity propagation in WebSphere Application Server V6
- Apache hardening information (applies to IHS as well)
- Building Secure Servers with LINUX
- Firewall Port Assignments in WebSphere Application Server
- The (XML) threat is out there
- DB2 Technical Tip: Setting up SSL
- SSL, Certificate, and Key Management Enhancements in WebSphere Application Server V6.1
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