



G L O B A L R A I N

Artemis Financial Vulnerability Assessment Report

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Document Revision History

Version	Date	Author	Comments
1.0	3/10/24	Conor Steward	A full write up of security vulnerabilities, mitigation plans, and assessment of typical financial security risks.

Client



Developer
Conor Steward

1. Interpreting Client Needs

As a financial institution, keeping your software safe has a multitude of implications. The protection of customer assets is vital not only to your reputation but to your stability as a financial institution. If this software should be breached, you could face much more than a loss of customer data. The assets themselves could become compromised and you would most likely not survive the outcome of such an attack. If you plan to work internationally you will need to comply with the financial regulations in any country you operate within. If you are working within the EU you will need to follow General Data Protection Agency guidelines. Not doing so can result in fines of 2 million euro or 4% of your company's revenue, whichever is higher. If you plan on working in California, you will need to follow the California Consumer Privacy Act. Failing to do so results in fines of 2.5-7.5k. To ensure that you are adhering to regulations you will need to get consumer consent before processing their personal data, minimize the personal data you hold, let consumers have access to their own data, and implement appropriate security for customer data. For your own security and the security of your customers you will need to implement various security measures in your software and within your company at large. Cyber security programs will educate employees on how to avoid cyber attacks, implementing multi-factor authentication will secure user logins, anti-virus and intrusion detection systems should be implemented for end-point security, data encryption for data in transit and at rest, and implementing a robust security breach response program will all help your company stay above the board with cyber security. Leveraging pre-built libraries with large variety of architectures and features will aid in the growth of the application in a cost/time effective manner. We will be sure to check for vulnerabilities within these system and dependencies so that your application remains secure. Using cloud services for a serverless architecture aids in scalability, performance, and user experience in backend services. Modern authentication, security, and secure coding practices will also help Artemis Financial keep its data protected. Data analytics should be used to gain actionable insights into what your customers need and use most often, and how best you can stay ahead of the competition in customer experience.

2. Areas of Security

Artemis Financial has several areas of security that should be focused on due to their status as an online financial institution. Firstly, handling user inputs with validation and security. This is a particularly easy area of attack for hackers as they can use a large variety of injection methodologies to compromise your system and leak massive amounts of data.

Since you are using a RESTful application, your integration with APIs and third parties is a high priority area of potential compromise. A large majority of successful attacks come through third party interactions and securing these interactions will be essential for company success. This can be done through dependency checks, which will be reviewed later in this document, and through dynamic testing.

We will be implementing encryption for data in transit and data at rest. This includes encrypting data stored in databases, encrypting communication channels using protocols like TLS/SSL, and implementing secure cryptographic algorithms. Effective use of cryptography helps prevent data breaches and unauthorized access to confidential information, ensuring the confidentiality and integrity of client data.

Secure and robust error handling will be essential to Artemis Financial as well. If hackers can find ways to trip errors in your software, they can gain access to sensitive data as well as new and exciting ways to compromise your system.

Finally, ensuring quality code that is made with security, verification, and efficient function will massively aid in the security of your application. This will minimize vulnerabilities and make for a fast and secure user experience.

3. Manual Review

SQL Injection Vulnerability:

In the DocData class, the read_document method establishes a connection to MySQL using JDBC. The method does not properly sanitize or validate the key and value parameters, making the application vulnerable to SQL injection attacks. Malicious input provided for key and value could lead to malicious database access or data manipulation.

Sensitive Data Exposure:

In the CRUDController class, the read method takes business_name as input and reads data from a DocData object. This operation returns a CRUD object containing sensitive information. Exposing this information directly to users without proper authentication or authorization controls could lead to unauthorized access and the compromise of sensitive data.

Lack of Input Validation:

The CRUDController class has another problem. It does not perform sufficient input validation on the business_name received from client requests. Lack of input validation could allow attackers to apply malicious input, leading to security vulnerabilities in the application.

No Authentication or Authorization Mechanism:

The application does not implement any authentication or authorization mechanisms to control access to sensitive resources or operations. Lack of proper authentication and authorization controls will lead to unauthorized access or privilege escalation attacks and the implementation of authorization techniques is a simple way to protect the company and its users in the long and short term.

Potential Resource Leak:

In the DocData class, the database connection is established within the read_document method but is not explicitly closed afterward. This could lead to resource leaks or exhaustion of database connection pool resources, impacting application performance and scalability as well as leaking important data.

Insecure Default Configurations:

There are no explicit configurations in place to mitigate security risks associated with default settings or external dependencies, such as the MySQL database connection parameters or other APIs. Insecure default configurations could expose the application to preventable vulnerabilities or attacks.

4. Static Testing

A static test was done using maven-dependency-check to procure a list of known vulnerabilities in the dependencies the application uses. 13 dependencies were found to be at risk from 131 different vectors.

bcprov-jdk15on-1.46.jar dependency has vulnerabilities CVE-2016-1000338, CVE-2016-1000342, CVE-2016-1000343, CVE-2016-1000344, CVE-2016-1000352, CVE-2016-1000341, CVE-2016-1000345, CVE-2017-13098, CVE-2020-15522, CVE-2023-33202, CVE-2016-1000339, CVE-2015-7940, CVE-2018-5382, CVE-2013-1624, and CVE-2016-1000346.

- In Bouncy Castle JCE Provider version 1.55 and earlier the DSA does not fully validate ASN.1 encoding of signature on verification. It is possible to inject extra elements in the sequence making up the signature and still have it validate, which in some cases may allow the introduction of 'invisible' data into a signed structure.
- In the Bouncy Castle JCE Provider version 1.55 and earlier ECDSA does not fully validate ASN.1 encoding of signature on verification. It is possible to inject extra elements in the sequence making up the signature and still have it validate, which in some cases may allow the introduction of 'invisible' data into a signed structure.
- In the Bouncy Castle JCE Provider version 1.55 and earlier the DSA key pair generator generates a weak private key if used with default values. If the JCA key pair generator is not explicitly initialized with DSA parameters, 1.55 and earlier generates a private value assuming a 1024 bit key size. In earlier releases this can be dealt with by explicitly passing parameters to the key pair generator.
- In the Bouncy Castle JCE Provider version 1.55 and earlier the DHIES implementation allowed the use of ECB mode. This mode is regarded as unsafe and support for it has been removed from the provider.
- In the Bouncy Castle JCE Provider version 1.55 and earlier the ECIES implementation allowed the use of ECB mode. This mode is regarded as unsafe and support for it has been removed from the provider.
- In the Bouncy Castle JCE Provider version 1.55 and earlier DSA signature generation is vulnerable to timing attack. Where timings can be closely observed for the generation of signatures, the lack of blinding in 1.55, or earlier, may allow an attacker to gain information about the signature's k value and ultimately the private value as well.
- In the Bouncy Castle JCE Provider version 1.55 and earlier the DHIES/ECIES CBC mode vulnerable to padding oracle attack. For BC 1.55 and older, in an environment where timings can be easily observed, it is possible with enough observations to identify when the decryption is failing due to padding.
- BouncyCastle TLS prior to version 1.0.3, when configured to use the JCE (Java Cryptography Extension) for cryptographic functions, provides a weak Bleichenbacher oracle when any TLS cipher suite using RSA key exchange is negotiated. An attacker can recover the private key from a vulnerable application. This vulnerability is referred to as "ROBOT."
- Bouncy Castle BC Java before 1.66, BC C# .NET before 1.8.7, BC-FJA before 1.0.1.2, 1.0.2.1, and BC-FNA before 1.0.1.1 have a timing issue within the EC math library that can expose information about the private key when an attacker is able to observe timing information for the generation of multiple deterministic ECDSA signatures.
- Bouncy Castle for Java before 1.73 contains a potential Denial of Service (DoS) issue within the Bouncy Castle org.bouncycastle.openssl.PEMParser class. This class parses OpenSSL PEM encoded streams containing X.509 certificates, PKCS8 encoded keys, and PKCS7 objects. Parsing a file that has crafted ASN.1 data through the PEMParser causes an OutOfMemoryError, which can enable a denial of service attack. (For users of the FIPS Java API: BC-FJA 1.0.2.3 and earlier are affected; BC-FJA 1.0.2.4 is fixed.)
- In Legion of the Bouncy Castle BC before 1.61 and BC-FJA before 1.0.1.2, attackers can obtain sensitive information about a private exponent because of Observable Differences in Behavior to Error Inputs. This occurs in org.bouncycastle.crypto.encodings.OAEP_Encoding. Sending invalid ciphertext that decrypts to a short payload in the OAEP Decoder could result in the throwing of an early exception, potentially leaking some information about the private exponent of the RSA private key performing the encryption.

- In the Bouncy Castle JCE Provider version 1.55 and earlier the primary engine class used for AES was AESFastEngine. Due to the highly table driven approach used in the algorithm it turns out that if the data channel on the CPU can be monitored the lookup table accesses are sufficient to leak information on the AES key being used. There was also a leak in AESEngine although it was substantially less. AESEngine has been modified to remove any signs of leakage (testing carried out on Intel X86-64) and is now the primary AES class for the BC JCE provider from 1.56. Use of AESFastEngine is now only recommended where otherwise deemed appropriate.
- The Bouncy Castle Java library before 1.51 does not validate a point is within the elliptic curve, which makes it easier for remote attackers to obtain private keys via a series of crafted elliptic curve Diffie Hellman (ECDH) key exchanges, aka an "invalid curve attack."
- The default BKS keystore uses an HMAC that is only 16 bits long, which can allow an attacker to compromise the integrity of a BKS keystore. Bouncy Castle release 1.47 changes the BKS format to a format which uses a 160 bit HMAC instead. This applies to any BKS keystore generated prior to BC 1.47. For situations where people need to create the files for legacy reasons a specific keystore type "BKS-V1" was introduced in 1.49. It should be noted that the use of "BKS-V1" is discouraged by the library authors and should only be used where it is otherwise safe to do so, as in where the use of a 16 bit checksum for the file integrity check is not going to cause a security issue in itself.
- The TLS implementation in the Bouncy Castle Java library before 1.48 and C# library before 1.8 does not properly consider timing side-channel attacks on a noncompliant MAC check operation during the processing of malformed CBC padding, which allows remote attackers to conduct distinguishing attacks and plaintext-recovery attacks via statistical analysis of timing data for crafted packets, a related issue to CVE-2013-0169.
- In the Bouncy Castle JCE Provider version 1.55 and earlier the other party DH public key is not fully validated. This can cause issues as invalid keys can be used to reveal details about the other party's private key where static Diffie-Hellman is in use. As of release 1.56 the key parameters are checked on agreement calculation.
- Bouncy Castle in Android before 5.1.1 LMY49F and 6.0 before 2016-01-01 allows attackers to obtain sensitive information via a crafted application, aka internal bug 24106146.

hibernate-validator-6.0.18.Final.jar dependency has vulnerability CVE-2020-10693.

- A flaw was found in Hibernate Validator version 6.1.2.Final. A bug in the message interpolation processor enables invalid EL expressions to be evaluated as if they were valid. This flaw allows attackers to bypass input sanitation (escaping, stripping) controls that developers may have put in place when handling user-controlled data in error messages.

jackson-databind-2.10.2.jar dependency has vulnerabilities CVE-2020-25649, CVE-2020-36518, CVE-2021-46877, CVE-2022-42003, CVE-2022-42004, and CVE-2023-35116.

- A flaw was found in FasterXML Jackson Databind, where it did not have entity expansion secured properly. This flaw allows vulnerability to XML external entity (XXE) attacks. The highest threat from this vulnerability is data integrity.
- jackson-databind before 2.13.0 allows a Java StackOverflow exception and denial of service via a large depth of nested objects.
- jackson-databind 2.10.x through 2.12.x before 2.12.6 and 2.13.x before 2.13.1 allows attackers to cause a denial of service (2 GB transient heap usage per read) in uncommon situations involving JsonNode JDK serialization.
- In FasterXML jackson-databind before versions 2.13.4.1 and 2.12.17.1, resource exhaustion can occur because of a lack of a check in primitive value deserializers to avoid

deep wrapper array nesting, when the UNWRAP_SINGLE_VALUE_ARRAYS feature is enabled.

- In FasterXML jackson-databind before 2.13.4, resource exhaustion can occur because of a lack of a check in BeanDeserializer._deserializeFromArray to prevent use of deeply nested arrays. An application is vulnerable only with certain customized choices for deserialization.
- jackson-databind through 2.15.2 allows attackers to cause a denial of service or other unspecified impact via a crafted object that uses cyclic dependencies. NOTE: the vendor's perspective is that this is not a valid vulnerability report, because the steps of constructing a cyclic data structure and trying to serialize it cannot be achieved by an external attacker.



log4j-api-2.12.1.jar dependency has vulnerability CVE-2020-9488.

- Improper validation of certificate with host mismatch in Apache Log4j SMTP appender. This could allow an SMTPS connection to be intercepted by a man-in-the-middle attack which could leak any log messages sent through that appender. Fixed in Apache Log4j 2.12.3 and 2.13.1

logback-core-1.2.3.jar dependency has vulnerabilities CVE-2023-6378, and CVE-2021-42550.

- A serialization vulnerability in logback receiver component part of logback version 1.4.11 allows an attacker to mount a Denial-Of-Service attack by sending poisoned data.
- In logback version 1.2.7 and prior versions, an attacker with the required privileges to edit configurations files could craft a malicious configuration allowing to execute arbitrary code loaded from LDAP servers.

snakeyaml-1.25.jar dependency has vulnerabilities CVE-2022-1471, CVE-2017-18640, CVE-2022-25857, CVE-2022-38749, CVE-2022-38751, CVE-2022-38752, CVE-2022-41854, and CVE-2022-38750.

- SnakeYaml's Constructor() class does not restrict types which can be instantiated during deserialization.   Deserializing yaml content provided by an attacker can lead to remote code execution. We recommend using SnakeYaml's SafeConstructor when parsing untrusted content to restrict deserialization. We recommend upgrading to version 2.0 and beyond.
- The Alias feature in SnakeYAML before 1.26 allows entity expansion during a load operation, a related issue to CVE-2003-1564.
- The package org.yaml:snakeyaml from 0 and before 1.31 are vulnerable to Denial of Service (DoS) due missing to nested depth limitation for collections.
- Using snakeYAML to parse untrusted YAML files may be vulnerable to Denial of Service attacks (DOS). If the parser is running on user supplied input, an attacker may supply content that causes the parser to crash by stackoverflow.
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- Those using Snakeyaml to parse untrusted YAML files may be vulnerable to Denial of Service attacks (DOS). If the parser is running on user supplied input, an attacker may

supply content that causes the parser to crash by stack overflow. This effect may support a denial of service attack.

- Using snakeYAML to parse untrusted YAML files may be vulnerable to Denial of Service attacks (DOS). If the parser is running on user supplied input, an attacker may supply content that causes the parser to crash by stackoverflow.

spring-boot-2.2.4.RELEASE.jar dependency has vulnerabilities CVE-2023-20873, CVE-2022-27772, and CVE-2023-20883.

- In Spring Boot versions 3.0.0 - 3.0.5, 2.7.0 - 2.7.10, and older unsupported versions, an application that is deployed to Cloud Foundry could be susceptible to a security bypass. Users of affected versions should apply the following mitigation: 3.0.x users should upgrade to 3.0.6+. 2.7.x users should upgrade to 2.7.11+. Users of older, unsupported versions should upgrade to 3.0.6+ or 2.7.11+.
- spring-boot versions prior to version v2.2.11.RELEASE was vulnerable to temporary directory hijacking. This vulnerability impacted the `org.springframework.boot.web.server.AbstractConfigurableWebServerFactory.createTempDir` method. NOTE: This vulnerability only affects products and/or versions that are no longer supported by the maintainer.

spring-boot-starter-web-2.2.4.RELEASE.jar dependency has vulnerabilities CVE-2023-20873, CVE-2022-27772, and CVE-2023-20883.

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- In Spring Boot versions 3.0.0 - 3.0.6, 2.7.0 - 2.7.11, 2.6.0 - 2.6.14, 2.5.0 - 2.5.14 and older unsupported versions, there is potential for a denial-of-service (DoS) attack if Spring MVC is used together with a reverse proxy cache.

spring-core-5.2.3.RELEASE.jar dependency has vulnerabilities CVE-2022-22965, CVE-2021-22118, CVE-2020-5421, CVE-2022-22950, CVE-2022-22971, CVE-2023-20861, CVE-2023-20863, CVE-2022-22968, CVE-2022-22970, CVE-2021-22060, and CVE-2021-22096.

- A Spring MVC or Spring WebFlux application running on JDK 9+ may be vulnerable to remote code execution (RCE) via data binding. The specific exploit requires the application to run on Tomcat as a WAR deployment. If the application is deployed as a Spring Boot executable jar, i.e. the default, it is not vulnerable to the exploit. However, the nature of the vulnerability is more general, and there may be other ways to exploit it.
- In Spring Framework, versions 5.2.x prior to 5.2.15 and versions 5.3.x prior to 5.3.7, a WebFlux application is vulnerable to a privilege escalation: by (re)creating the temporary storage directory, a locally authenticated malicious user can read or modify files that

have been uploaded to the WebFlux application, or overwrite arbitrary files with multipart request data.

- In Spring Framework versions 5.2.0 - 5.2.8, 5.1.0 - 5.1.17, 5.0.0 - 5.0.18, 4.3.0 - 4.3.28, and older unsupported versions, the protections against RFD attacks from CVE-2015-5211 may be bypassed depending on the browser used through the use of a jsessionid path parameter.
- In Spring Framework versions 5.3.0 - 5.3.16 and older unsupported versions, it is possible for a user to provide a specially crafted SpEL expression that may cause a denial of service condition.
- In spring framework versions prior to 5.3.20+ , 5.2.22+ and old unsupported versions, application with a STOMP over WebSocket endpoint is vulnerable to a denial of service attack by an authenticated user.
- In Spring Framework versions 6.0.0 - 6.0.6, 5.3.0 - 5.3.25, 5.2.0.RELEASE - 5.2.22.RELEASE, and older unsupported versions, it is possible for a user to provide a specially crafted SpEL expression that may cause a denial-of-service (DoS) condition.
- In spring framework versions prior to 5.2.24 release+ ,5.3.27+ and 6.0.8+ , it is possible for a user to provide a specially crafted SpEL expression that may cause a denial-of-service (DoS) condition.
- In Spring Framework versions 5.3.0 - 5.3.18, 5.2.0 - 5.2.20, and older unsupported versions, the patterns for disallowedFields on a DataBinder are case sensitive which means a field is not effectively protected unless it is listed with both upper and lower case for the first character of the field, including upper and lower case for the first character of all nested fields within the property path.
- In spring framework versions prior to 5.3.20+ , 5.2.22+ and old unsupported versions, applications that handle file uploads are vulnerable to DoS attack if they rely on data binding to set a MultipartFile or javax.servlet.Part to a field in a model object.
- In Spring Framework versions 5.3.0 - 5.3.13, 5.2.0 - 5.2.18, and older unsupported versions, it is possible for a user to provide malicious input to cause the insertion of additional log entries. This is a follow-up to CVE-2021-22096 that protects against additional types of input and in more places of the Spring Framework codebase.
- In Spring Framework versions 5.3.0 - 5.3.10, 5.2.0 - 5.2.17, and older unsupported versions, it is possible for a user to provide malicious input to cause the insertion of additional log entries.

spring-webmvc-5.2.3.RELEASE.jar dependency has vulnerabilities CVE-2022-22965, CVE-2021-22118, CVE-2020-5421, CVE-2022-22950, CVE-2022-22971, CVE-2023-20861, CVE-2023-20863, CVE-2022-22968, CVE-2022-22970, CVE-2021-22060, and CVE-2021-22096.

- A Spring MVC or Spring WebFlux application running on JDK 9+ may be vulnerable to remote code execution (RCE) via data binding. The specific exploit requires the application to run on Tomcat as a WAR deployment. If the application is deployed as a Spring Boot executable jar, i.e. the default, it is not vulnerable to the exploit. However, the nature of the vulnerability is more general, and there may be other ways to exploit it.
- In Spring Framework, versions 5.2.x prior to 5.2.15 and versions 5.3.x prior to 5.3.7, a WebFlux application is vulnerable to a privilege escalation: by (re)creating the temporary storage directory, a locally authenticated malicious user can read or modify files that

have been uploaded to the WebFlux application, or overwrite arbitrary files with multipart request data.

- In Spring Framework versions 5.2.0 - 5.2.8, 5.1.0 - 5.1.17, 5.0.0 - 5.0.18, 4.3.0 - 4.3.28, and older unsupported versions, the protections against RFD attacks from CVE-2015-5211 may be bypassed depending on the browser used through the use of a `jsessionid` path parameter.
- In Spring Framework versions 5.3.0 - 5.3.16 and older unsupported versions, it is possible for a user to provide a specially crafted SpEL expression that may cause a denial of service condition.
- In spring framework versions prior to 5.3.20+ , 5.2.22+ and old unsupported versions, application with a STOMP over WebSocket endpoint is vulnerable to a denial of service attack by an authenticated user.
- In Spring Framework versions 6.0.0 - 6.0.6, 5.3.0 - 5.3.25, 5.2.0.RELEASE - 5.2.22.RELEASE, and older unsupported versions, it is possible for a user to provide a specially crafted SpEL expression that may cause a denial-of-service (DoS) condition.
- In spring framework versions prior to 5.2.24 release+ ,5.3.27+ and 6.0.8+ , it is possible for a user to provide a specially crafted SpEL expression that may cause a denial-of-service (DoS) condition.
- In Spring Framework versions 5.3.0 - 5.3.18, 5.2.0 - 5.2.20, and older unsupported versions, the patterns for disallowedFields on a DataBinder are case sensitive which means a field is not effectively protected unless it is listed with both upper and lower case for the first character of the field, including upper and lower case for the first character of all nested fields within the property path.
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- In Spring Framework versions 5.3.0 - 5.3.10, 5.2.0 - 5.2.17, and older unsupported versions, it is possible for a user to provide malicious input to cause the insertion of additional log entries.

tomcat-embed-core-9.0.30.jar and tomcat-embed-websocket-9.0.30.jar dependencies have vulnerabilities CVE-2020-1938, CVE-2020-8022, CVE-2020-11996, CVE-2020-13934, CVE-2020-13935, CVE-2020-17527, CVE-2021-25122, CVE-2021-41079, CVE-2022-29885, CVE-2022-42252, CVE-2023-44487, CVE-2023-46589, CVE-2020-9484, CVE-2021-25329, CVE-2021-30640, CVE-2022-34305, CVE-2023-41080, CVE-2021-24122, CVE-2021-33037, CVE-2023-42795, CVE-2023-45648, CVE-2024-21733, CVE-2019-17569, CVE-2020-1935, CVE-2020-13943, CVE-2023-28708, and CVE-2021-43980.

- When using the Apache JServ Protocol (AJP), care must be taken when trusting incoming connections to Apache Tomcat. Tomcat treats AJP connections as having higher trust than, for example, a similar HTTP connection. If such connections are available to an attacker, they can be exploited in ways that may be surprising. In Apache Tomcat 9.0.0.M1 to 9.0.0.30, 8.5.0 to 8.5.50 and 7.0.0 to 7.0.99, Tomcat shipped with an AJP Connector enabled by default that listened on all configured IP addresses. It was

expected (and recommended in the security guide) that this Connector would be disabled if not required. This vulnerability report identified a mechanism that allowed: - returning arbitrary files from anywhere in the web application - processing any file in the web application as a JSP Further, if the web application allowed file upload and stored those files within the web application (or the attacker was able to control the content of the web application by some other means) then this, along with the ability to process a file as a JSP, made remote code execution possible. It is important to note that mitigation is only required if an AJP port is accessible to untrusted users. Users wishing to take a defence-in-depth approach and block the vector that permits returning arbitrary files and execution as JSP may upgrade to Apache Tomcat 9.0.31, 8.5.51 or 7.0.100 or later. A number of changes were made to the default AJP Connector configuration in 9.0.31 to harden the default configuration. It is likely that users upgrading to 9.0.31, 8.5.51 or 7.0.100 or later will need to make small changes to their configurations.

- A Incorrect Default Permissions vulnerability in the packaging of tomcat on SUSE Enterprise Storage 5, SUSE Linux Enterprise Server 12-SP2-BCL, SUSE Linux Enterprise Server 12-SP2-LTSS, SUSE Linux Enterprise Server 12-SP3-BCL, SUSE Linux Enterprise Server 12-SP3-LTSS, SUSE Linux Enterprise Server 12-SP4, SUSE Linux Enterprise Server 12-SP5, SUSE Linux Enterprise Server 15-LTSS, SUSE Linux Enterprise Server for SAP 12-SP2, SUSE Linux Enterprise Server for SAP 12-SP3, SUSE Linux Enterprise Server for SAP 15, SUSE OpenStack Cloud 7, SUSE OpenStack Cloud 8, SUSE OpenStack Cloud Crowbar 8 allows local attackers to escalate from group tomcat to root. This issue affects: SUSE Enterprise Storage 5 tomcat versions prior to 8.0.53-29.32.1. SUSE Linux Enterprise Server 12-SP2-BCL tomcat versions prior to 8.0.53-29.32.1. SUSE Linux Enterprise Server 12-SP2-LTSS tomcat versions prior to 8.0.53-29.32.1. SUSE Linux Enterprise Server 12-SP3-BCL tomcat versions prior to 8.0.53-29.32.1. SUSE Linux Enterprise Server 12-SP3-LTSS tomcat versions prior to 8.0.53-29.32.1. SUSE Linux Enterprise Server 12-SP4 tomcat versions prior to 9.0.35-3.39.1. SUSE Linux Enterprise Server 12-SP5 tomcat versions prior to 9.0.35-3.39.1. SUSE Linux Enterprise Server 15-LTSS tomcat versions prior to 9.0.35-3.57.3. SUSE Linux Enterprise Server for SAP 12-SP2 tomcat versions prior to 8.0.53-29.32.1. SUSE Linux Enterprise Server for SAP 12-SP3 tomcat versions prior to 8.0.53-29.32.1. SUSE Linux Enterprise Server for SAP 15 tomcat versions prior to 9.0.35-3.57.3. SUSE OpenStack Cloud 7 tomcat versions prior to 8.0.53-29.32.1. SUSE OpenStack Cloud 8 tomcat versions prior to 8.0.53-29.32.1. SUSE OpenStack Cloud Crowbar 8 tomcat versions prior to 8.0.53-29.32.1.
- A specially crafted sequence of HTTP/2 requests sent to Apache Tomcat 10.0.0-M1 to 10.0.0-M5, 9.0.0.M1 to 9.0.35 and 8.5.0 to 8.5.55 could trigger high CPU usage for several seconds. If a sufficient number of such requests were made on concurrent HTTP/2 connections, the server could become unresponsive.
- An h2c direct connection to Apache Tomcat 10.0.0-M1 to 10.0.0-M6, 9.0.0.M5 to 9.0.36 and 8.5.1 to 8.5.56 did not release the HTTP/1.1 processor after the upgrade to HTTP/2. If a sufficient number of such requests were made, an OutOfMemoryException could occur leading to a denial of service.
- The payload length in a WebSocket frame was not correctly validated in Apache Tomcat 10.0.0-M1 to 10.0.0-M6, 9.0.0.M1 to 9.0.36, 8.5.0 to 8.5.56 and 7.0.27 to 7.0.104. Invalid payload lengths could trigger an infinite loop. Multiple requests with invalid payload lengths could lead to a denial of service.

- While investigating bug 64830 it was discovered that Apache Tomcat 10.0.0-M1 to 10.0.0-M9, 9.0.0-M1 to 9.0.39 and 8.5.0 to 8.5.59 could re-use an HTTP request header value from the previous stream received on an HTTP/2 connection for the request associated with the subsequent stream. While this would most likely lead to an error and the closure of the HTTP/2 connection, it is possible that information could leak between requests.
- When responding to new h2c connection requests, Apache Tomcat versions 10.0.0-M1 to 10.0.0, 9.0.0-M1 to 9.0.41 and 8.5.0 to 8.5.61 could duplicate request headers and a limited amount of request body from one request to another meaning user A and user B could both see the results of user A's request.
- Apache Tomcat 8.5.0 to 8.5.63, 9.0.0-M1 to 9.0.43 and 10.0.0-M1 to 10.0.2 did not properly validate incoming TLS packets. When Tomcat was configured to use NIO+OpenSSL or NIO2+OpenSSL for TLS, a specially crafted packet could be used to trigger an infinite loop resulting in a denial of service.
- The documentation of Apache Tomcat 10.1.0-M1 to 10.1.0-M14, 10.0.0-M1 to 10.0.20, 9.0.13 to 9.0.62 and 8.5.38 to 8.5.78 for the EncryptInterceptor incorrectly stated it enabled Tomcat clustering to run over an untrusted network. This was not correct. While the EncryptInterceptor does provide confidentiality and integrity protection, it does not protect against all risks associated with running over any untrusted network, particularly DoS risks.
- If Apache Tomcat 8.5.0 to 8.5.82, 9.0.0-M1 to 9.0.67, 10.0.0-M1 to 10.0.26 or 10.1.0-M1 to 10.1.0 was configured to ignore invalid HTTP headers via setting `rejectIllegalHeader` to false (the default for 8.5.x only), Tomcat did not reject a request containing an invalid Content-Length header making a request smuggling attack possible if Tomcat was located behind a reverse proxy that also failed to reject the request with the invalid header.
- The HTTP/2 protocol allows a denial of service (server resource consumption) because request cancellation can reset many streams quickly, as exploited in the wild in August through October 2023.
- Improper Input Validation vulnerability in Apache Tomcat. Tomcat from 11.0.0-M1 through 11.0.0-M10, from 10.1.0-M1 through 10.1.15, from 9.0.0-M1 through 9.0.82 and from 8.5.0 through 8.5.95 did not correctly parse HTTP trailer headers. A trailer header that exceeded the header size limit could cause Tomcat to treat a single request as multiple requests leading to the possibility of request smuggling when behind a reverse proxy.
- When using Apache Tomcat versions 10.0.0-M1 to 10.0.0-M4, 9.0.0-M1 to 9.0.34, 8.5.0 to 8.5.54 and 7.0.0 to 7.0.103 if a) an attacker is able to control the contents and name of a file on the server; and b) the server is configured to use the PersistenceManager with a FileStore; and c) the PersistenceManager is configured with `sessionAttributeValueClassNameFilter="null"` (the default unless a SecurityManager is used) or a sufficiently lax filter to allow the attacker provided object to be deserialized; and d) the attacker knows the relative file path from the storage location used by FileStore to the file the attacker has control over; then, using a specifically crafted request, the attacker will be able to trigger remote code execution via deserialization of the file under their control. Note that all of conditions a) to d) must be true for the attack to succeed.

- The fix for CVE-2020-9484 was incomplete. When using Apache Tomcat 10.0.0-M1 to 10.0.0, 9.0.0.M1 to 9.0.41, 8.5.0 to 8.5.61 or 7.0.0. to 7.0.107 with a configuration edge case that was highly unlikely to be used, the Tomcat instance was still vulnerable to CVE-2020-9494. Note that both the previously published prerequisites for CVE-2020-9484 and the previously published mitigations for CVE-2020-9484 also apply to this issue.
- A vulnerability in the JNDI Realm of Apache Tomcat allows an attacker to authenticate using variations of a valid user name and/or to bypass some of the protection provided by the LockOut Realm. This issue affects Apache Tomcat 10.0.0-M1 to 10.0.5; 9.0.0.M1 to 9.0.45; 8.5.0 to 8.5.65.
- In Apache Tomcat 10.1.0-M1 to 10.1.0-M16, 10.0.0-M1 to 10.0.22, 9.0.30 to 9.0.64 and 8.5.50 to 8.5.81 the Form authentication example in the examples web application displayed user provided data without filtering, exposing a XSS vulnerability. 9.0.0-M1 through 9.0.79 and from 8.5.0 through 8.5.92.
- When serving resources from a network location using the NTFS file system, Apache Tomcat versions 10.0.0-M1 to 10.0.0-M9, 9.0.0.M1 to 9.0.39, 8.5.0 to 8.5.59 and 7.0.0 to 7.0.106 were susceptible to JSP source code disclosure in some configurations. The root cause was the unexpected behaviour of the JRE API File.getCanonicalPath() which in turn was caused by the inconsistent behaviour of the Windows API (FindFirstFileW) in some circumstances.
- Apache Tomcat 10.0.0-M1 to 10.0.6, 9.0.0.M1 to 9.0.46 and 8.5.0 to 8.5.66 did not correctly parse the HTTP transfer-encoding request header in some circumstances leading to the possibility to request smuggling when used with a reverse proxy. Specifically: - Tomcat incorrectly ignored the transfer encoding header if the client declared it would only accept an HTTP/1.0 response; - Tomcat honoured the identify encoding; and - Tomcat did not ensure that, if present, the chunked encoding was the final encoding.
- Incomplete Cleanup vulnerability in Apache Tomcat. When recycling various internal objects in Apache Tomcat from 11.0.0-M1 through 11.0.0-M11, from 10.1.0-M1 through 10.1.13, from 9.0.0-M1 through 9.0.80 and from 8.5.0 through 8.5.93, an error could cause Tomcat to skip some parts of the recycling process leading to information leaking from the current request/response to the next.
- Improper Input Validation vulnerability in Apache Tomcat. Tomcat from 11.0.0-M1 through 11.0.0-M11, from 10.1.0-M1 through 10.1.13, from 9.0.0-M1 through 9.0.81 and from 8.5.0 through 8.5.93 did not correctly parse HTTP trailer headers. A specially crafted, invalid trailer header could cause Tomcat to treat a single request as multiple requests leading to the possibility of request smuggling when behind a reverse proxy.
- Generation of Error Message Containing Sensitive Information vulnerability in Apache Tomcat. This issue affects Apache Tomcat: from 8.5.7 through 8.5.63, from 9.0.0-M11 through 9.0.43.
- The refactoring present in Apache Tomcat 9.0.28 to 9.0.30, 8.5.48 to 8.5.50 and 7.0.98 to 7.0.99 introduced a regression. The result of the regression was that invalid Transfer-Encoding headers were incorrectly processed leading to a possibility of HTTP Request Smuggling if Tomcat was located behind a reverse proxy that incorrectly handled the invalid Transfer-Encoding header in a particular manner. Such a reverse proxy is considered unlikely.

- In Apache Tomcat 9.0.0.M1 to 9.0.30, 8.5.0 to 8.5.50 and 7.0.0 to 7.0.99 the HTTP header parsing code used an approach to end-of-line parsing that allowed some invalid HTTP headers to be parsed as valid. This led to a possibility of HTTP Request Smuggling if Tomcat was located behind a reverse proxy that incorrectly handled the invalid Transfer-Encoding header in a particular manner. Such a reverse proxy is considered unlikely.
- If an HTTP/2 client connecting to Apache Tomcat 10.0.0-M1 to 10.0.0-M7, 9.0.0.M1 to 9.0.37 or 8.5.0 to 8.5.57 exceeded the agreed maximum number of concurrent streams for a connection (in violation of the HTTP/2 protocol), it was possible that a subsequent request made on that connection could contain HTTP headers - including HTTP/2 pseudo headers - from a previous request rather than the intended headers. This could lead to users seeing responses for unexpected resources.
- When using the RemoteIpFilter with requests received from a reverse proxy via HTTP that include the X-Forwarded-Proto header set to https, session cookies created by Apache Tomcat 11.0.0-M1 to 11.0.0-M2, 10.1.0-M1 to 10.1.5, 9.0.0-M1 to 9.0.71 and 8.5.0 to 8.5.85 did not include the secure attribute. This could result in the user agent transmitting the session cookie over an insecure channel.
- The simplified implementation of blocking reads and writes introduced in Tomcat 10 and back-ported to Tomcat 9.0.47 onwards exposed a long standing (but extremely hard to trigger) concurrency bug in Apache Tomcat 10.1.0 to 10.1.0-M12, 10.0.0-M1 to 10.0.18, 9.0.0-M1 to 9.0.60 and 8.5.0 to 8.5.77 that could cause client connections to share an Http11Processor instance resulting in responses, or part responses, to be received by the wrong client.

5. Mitigation Plan

To mitigate the issues found in the static test and manual review of the codebase I recommend the below fixes.

- If bouncy castle is upgraded past version 1.66 all of the above issues are resolved.
- Oracle has released a patch to fix the issue with hibernate-validator-6.0.18.Final.jar. This can be found at <https://www.oracle.com/security-alerts/cpuapr2022.html>.
- Upgrading jackson-databind past version 2.15.2 will fix all of the vulnerabilities.
- Upgrade to log4-api-2.13.2.jar which supports this feature. Previous versions can set the system property mail.smtp.ssl.checkserveridentity to true to globally enable hostname verification for SMTPS connections.
- logback-core-1.2.3.jar can be resolved by updating to version 1.4.14.
- snakeyaml-1.25.jar dependency can be resolved by upgrading to version 2.0.
- spring-boot-2.2.4.RELEASE.jar dependency can be resolved by upgrading to version 3.0.6+.
- spring-boot-starter-web-2.2.4.RELEASE.jar dependency can be resolved by upgrading to version 3.0.7+.
- spring-core-5.2.3.RELEASE.jar dependency can be resolved by upgrading to version 6.0.8+.

- spring-webmvc-5.2.3.RELEASE.jar dependency can be resolved by upgrading to version 6.0.8+.
- tomcat-embed-core-9.0.30.jar and tomcat-embed-websocket-9.0.30.jar dependencies can be fixed by upgrading to tomcat 11.0.0-M12+.
- For vulnerability CVE-2022-2988 users running clustering over an untrusted network who require full protection should switch to an alternative solution such as running the clustering communication over a VPN.
- For vulnerability CVE-2023-44487 users may disable http2 endpoints to circumvent the flaw altogether until a fix is available.
- To prevent SQL injection vulnerabilities sanitize or validate the key and value parameters in the DocData class.
- To mitigate sensitive information exposure in the CRUDConrtoller class we will need to implement client authentication and authorization mechanisms, implement role-based access controls, enforce principle of least privilege, and encrypt the data.
- CRUDController class also needs validation for the “business_name” input.
- Authentication, authorization, and permissions need to be implemented across the entire application to control access and protect data.
- To fix insecure default configurations segment the network and implement firewall rules to control traffic flow between different network segments. Also, the recommended authentication, encryption, and authorization methods will aid in solving this security risk.