



**Threagile**

Agile Threat Modeling

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# Threat Model Report

## Google Meet Threat Model

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## Management Summary

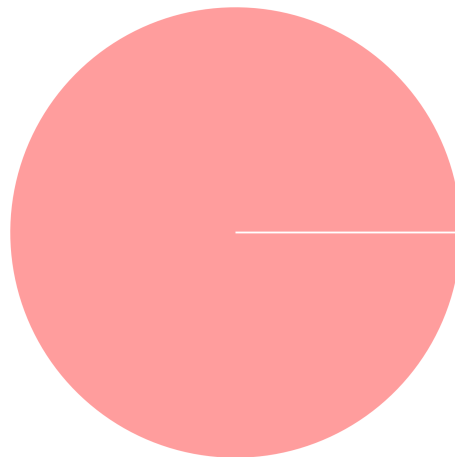
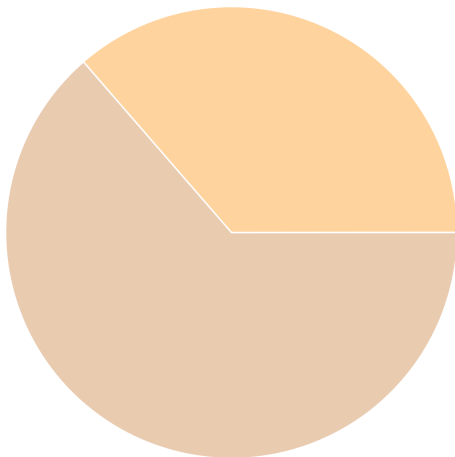
Threagile toolkit was used to model the architecture of "Google Meet Threat Model" and derive risks by analyzing the components and data flows. The risks identified during this analysis are shown in the following chapters. Identified risks during threat modeling do not necessarily mean that the vulnerability associated with this risk actually exists: it is more to be seen as a list of potential risks and threats, which should be individually reviewed and reduced by removing false positives. For the remaining risks it should be checked in the design and implementation of "Google Meet Threat Model" whether the mitigation advices have been applied or not.

Each risk finding references a chapter of the OWASP ASVS (Application Security Verification Standard) audit checklist. The OWASP ASVS checklist should be considered as an inspiration by architects and developers to further harden the application in a Defense-in-Depth approach. Additionally, for each risk finding a link towards a matching OWASP Cheat Sheet or similar with technical details about how to implement a mitigation is given.

In total **22 initial risks** in **13 categories** have been identified during the threat modeling process:

**0 critical risk**  
**0 high risk**  
**8 elevated risk**  
**14 medium risk**  
**0 low risk**

**22 unchecked**  
**0 in discussion**  
**0 accepted**  
**0 in progress**  
**0 mitigated**  
**0 false positive**



This threat model addresses the security aspects related to Google Meet, focusing on video streaming, user data management, and integration with other Google services.

# Impact Analysis of 22 Initial Risks in 13 Categories

The most prevalent impacts of the **22 initial risks** (distributed over **13 risk categories**) are (taking the severity ratings into account and using the highest for each category):

Risk finding paragraphs are clickable and link to the corresponding chapter.

Elevated: **Cross-Site Scripting (XSS)**: 2 Initial Risks - Exploitation likelihood is *Likely with High impact*.

If this risk remains unmitigated, attackers might be able to access individual victim sessions and steal or modify user data.

Elevated: **Missing Cloud Hardening**: 2 Initial Risks - Exploitation likelihood is *Unlikely with Very High impact*.

If this risk is unmitigated, attackers might access cloud components in an unintended way.

Elevated: **Missing Hardening**: 2 Initial Risks - Exploitation likelihood is *Likely with Medium impact*.

If this risk remains unmitigated, attackers might be able to easier attack high-value targets.

Elevated: **Server-Side Request Forgery (SSRF)**: 3 Initial Risks - Exploitation likelihood is *Likely with Medium impact*.

If this risk is unmitigated, attackers might be able to access sensitive services or files of network-reachable components by modifying outgoing calls of affected components.

Medium: **Container Base Image Backdooring**: 1 Initial Risk - Exploitation likelihood is *Unlikely with High impact*.

If this risk is unmitigated, attackers might be able to deeply persist in the target system by executing code in deployed containers.

Medium: **Cross-Site Request Forgery (CSRF)**: 3 Initial Risks - Exploitation likelihood is *Very Likely with Low impact*.

If this risk remains unmitigated, attackers might be able to trick logged-in victim users into unwanted actions within the web application by visiting an attacker controlled web site.

Medium: **DoS-risky Access Across Trust-Boundary**: 2 Initial Risks - Exploitation likelihood is *Unlikely with Medium impact*.

If this risk remains unmitigated, attackers might be able to disturb the availability of important parts of the system.

Medium: **Missing Identity Propagation**: 2 Initial Risks - Exploitation likelihood is *Unlikely with Medium impact*.

If this risk is unmitigated, attackers might be able to access or modify foreign data after a successful compromise of a component within the system due to missing resource-based authorization checks.

Medium: **Missing Identity Provider Isolation**: 1 Initial Risk - Exploitation likelihood is *Unlikely with High impact*.

If this risk is unmitigated, attackers successfully attacking other components of the system might have an easy path towards highly sensitive identity provider assets and their identity datastores, as they are not separated by network segmentation.

Medium: **Missing Two-Factor Authentication (2FA)**: 1 Initial Risk - Exploitation likelihood is *Unlikely* with *Medium* impact.

If this risk is unmitigated, attackers might be able to access or modify highly sensitive data without strong authentication.

Medium: **Missing Vault (Secret Storage)**: 1 Initial Risk - Exploitation likelihood is *Unlikely* with *Medium* impact.

If this risk is unmitigated, attackers might be able to easier steal config secrets (like credentials, private keys, client certificates, etc.) once a vulnerability to access files is present and exploited.

Medium: **Mixed Targets on Shared Runtime**: 1 Initial Risk - Exploitation likelihood is *Unlikely* with *Medium* impact.

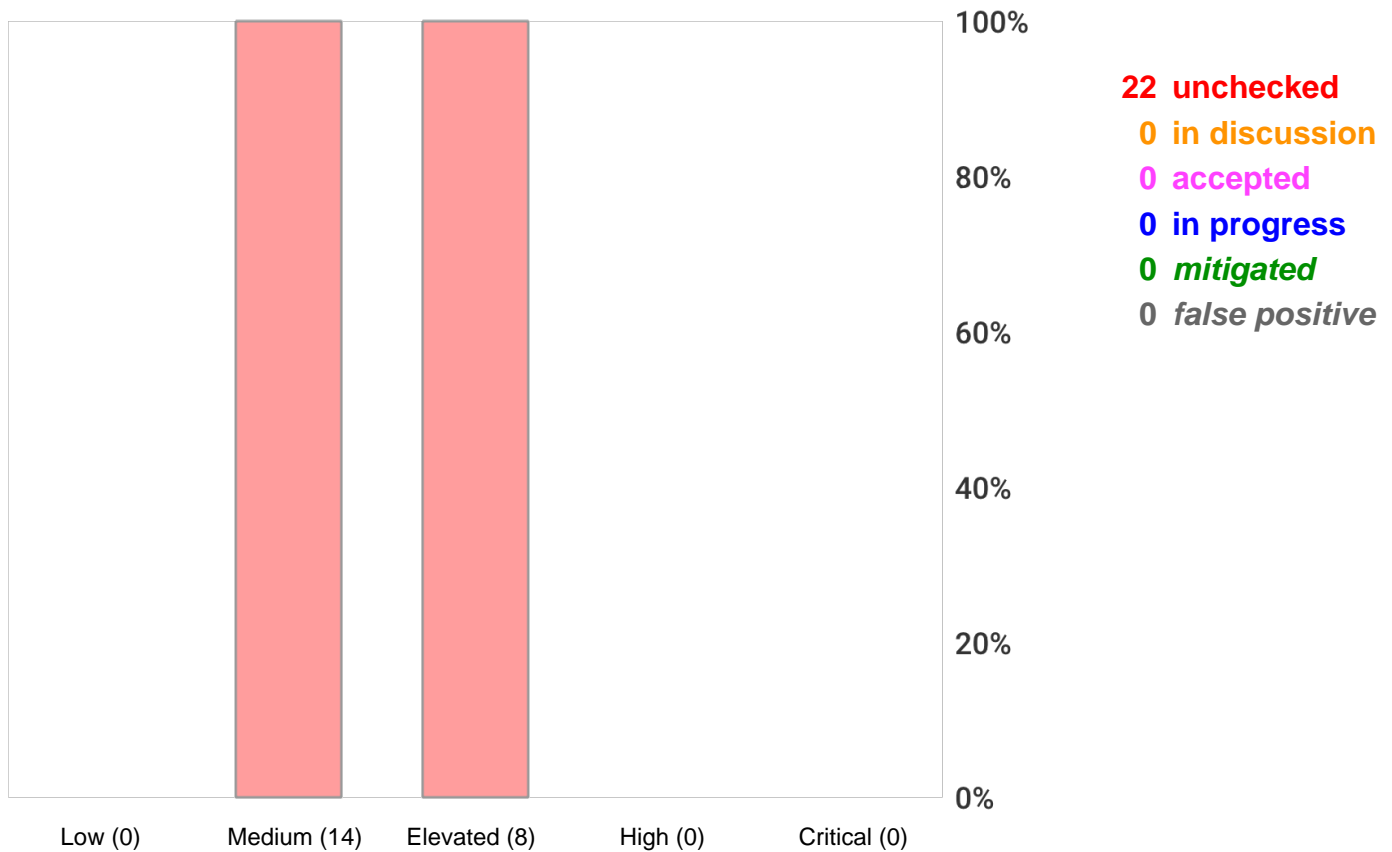
If this risk is unmitigated, attackers successfully attacking other components of the system might have an easy path towards more valuable targets, as they are running on the same shared runtime.

Medium: **Unencrypted Communication**: 1 Initial Risk - Exploitation likelihood is *Unlikely* with *High* impact.

If this risk is unmitigated, network attackers might be able to to eavesdrop on unencrypted sensitive data sent between components.

## Risk Mitigation

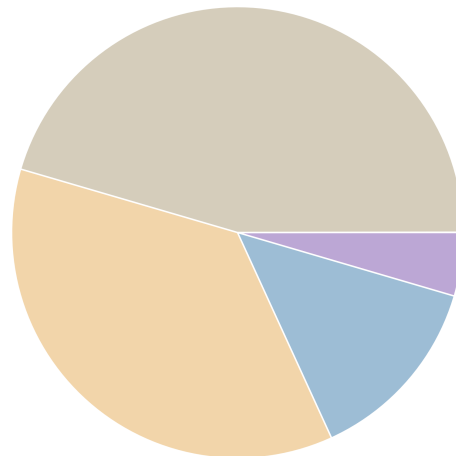
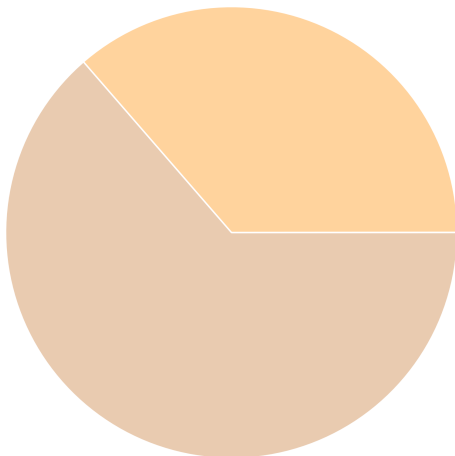
The following chart gives a high-level overview of the risk tracking status (including mitigated risks):



After removal of risks with status *mitigated* and *false positive* the following 22 remain unmitigated:

0 unmitigated critical risk  
0 unmitigated high risk  
8 unmitigated elevated risk  
14 unmitigated medium risk  
0 unmitigated low risk

1 business side related  
3 architecture related  
8 development related  
10 operations related



# Impact Analysis of 22 Remaining Risks in 13 Categories

The most prevalent impacts of the **22 remaining risks** (distributed over **13 risk categories**) are (taking the severity ratings into account and using the highest for each category):

Risk finding paragraphs are clickable and link to the corresponding chapter.

Elevated: **Cross-Site Scripting (XSS)**: 2 Remaining Risks - Exploitation likelihood is *Likely with High impact*.

If this risk remains unmitigated, attackers might be able to access individual victim sessions and steal or modify user data.

Elevated: **Missing Cloud Hardening**: 2 Remaining Risks - Exploitation likelihood is *Unlikely with Very High impact*.

If this risk is unmitigated, attackers might access cloud components in an unintended way.

Elevated: **Missing Hardening**: 2 Remaining Risks - Exploitation likelihood is *Likely with Medium impact*.

If this risk remains unmitigated, attackers might be able to easier attack high-value targets.

Elevated: **Server-Side Request Forgery (SSRF)**: 3 Remaining Risks - Exploitation likelihood is *Likely with Medium impact*.

If this risk is unmitigated, attackers might be able to access sensitive services or files of network-reachable components by modifying outgoing calls of affected components.

Medium: **Container Base Image Backdooring**: 1 Remaining Risk - Exploitation likelihood is *Unlikely with High impact*.

If this risk is unmitigated, attackers might be able to deeply persist in the target system by executing code in deployed containers.

Medium: **Cross-Site Request Forgery (CSRF)**: 3 Remaining Risks - Exploitation likelihood is *Very Likely with Low impact*.

If this risk remains unmitigated, attackers might be able to trick logged-in victim users into unwanted actions within the web application by visiting an attacker controlled web site.

Medium: **DoS-risky Access Across Trust-Boundary**: 2 Remaining Risks - Exploitation likelihood is *Unlikely with Medium impact*.

If this risk remains unmitigated, attackers might be able to disturb the availability of important parts of the system.

Medium: **Missing Identity Propagation**: 2 Remaining Risks - Exploitation likelihood is *Unlikely with Medium impact*.

If this risk is unmitigated, attackers might be able to access or modify foreign data after a successful compromise of a component within the system due to missing resource-based authorization checks.

Medium: **Missing Identity Provider Isolation**: 1 Remaining Risk - Exploitation likelihood is *Unlikely with High impact*.

If this risk is unmitigated, attackers successfully attacking other components of the system might have an easy path towards highly sensitive identity provider assets and their identity datastores, as



they are not separated by network segmentation.

**Medium: Missing Two-Factor Authentication (2FA):** 1 Remaining Risk - Exploitation likelihood is *Unlikely* with *Medium* impact.

If this risk is unmitigated, attackers might be able to access or modify highly sensitive data without strong authentication.

**Medium: Missing Vault (Secret Storage):** 1 Remaining Risk - Exploitation likelihood is *Unlikely* with *Medium* impact.

If this risk is unmitigated, attackers might be able to easier steal config secrets (like credentials, private keys, client certificates, etc.) once a vulnerability to access files is present and exploited.

**Medium: Mixed Targets on Shared Runtime:** 1 Remaining Risk - Exploitation likelihood is *Unlikely* with *Medium* impact.

If this risk is unmitigated, attackers successfully attacking other components of the system might have an easy path towards more valuable targets, as they are running on the same shared runtime.

**Medium: Unencrypted Communication:** 1 Remaining Risk - Exploitation likelihood is *Unlikely* with *High* impact.

If this risk is unmitigated, network attackers might be able to to eavesdrop on unencrypted sensitive data sent between components.

# Application Overview

## Business Criticality

The overall business criticality of "Google Meet Threat Model" was rated as:

( archive | operational | important | critical | **MISSION-CRITICAL** )

## Business Overview

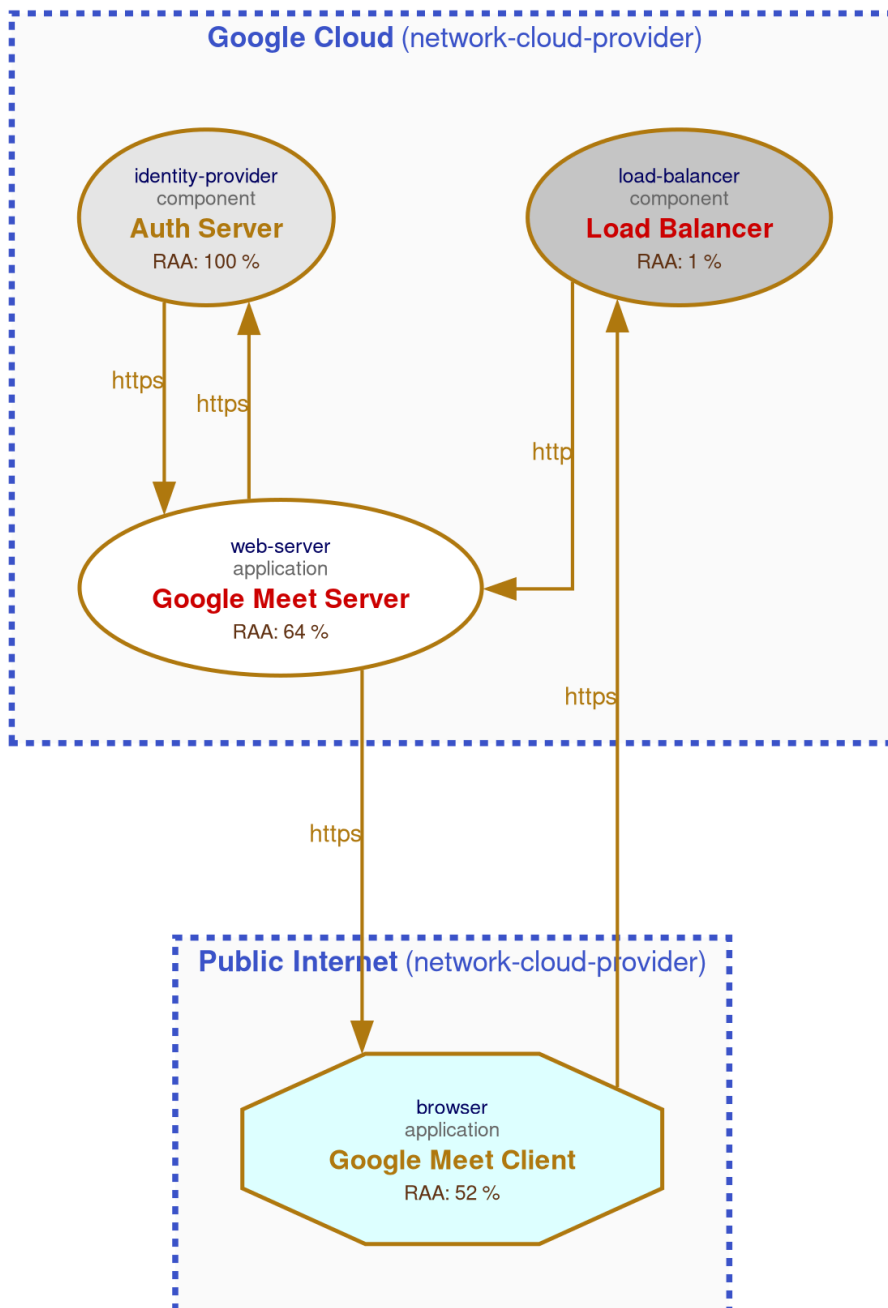
Google Meet is a video-communication service developed by Google. It is one of the key components of Google Workspace that allows high-quality video meetings secured with various layers of security to ensure business continuity and data protection.

## Technical Overview

Google Meet operates on a complex infrastructure designed to handle massive simultaneous connections, integrating seamlessly with other Google services like Calendar and Gmail to provide a comprehensive communication platform.

## Data-Flow Diagram

The following diagram was generated by Threagile based on the model input and gives a high-level overview of the data-flow between technical assets. The RAA value is the calculated *Relative Attacker Attractiveness* in percent. For a full high-resolution version of this diagram please refer to the PNG image file alongside this report.



# Security Requirements

This chapter lists the custom security requirements which have been defined for the modeled target.

## Encryption of Video Streams

Video streams must be encrypted using industry-standard protocols.

## Strong Authentication

Multi-factor authentication must be enforced to prevent unauthorized access.

*This list is not complete and regulatory or law relevant security requirements have to be taken into account as well. Also custom individual security requirements might exist for the project.*

# Abuse Cases

This chapter lists the custom abuse cases which have been defined for the modeled target.

## **Credential Stuffing**

As an attacker, I want to use breached or weak credentials to gain unauthorized access to user accounts and impersonate legitimate users.

## **Zoombombing**

As an attacker, I want to gain unauthorized access to private meetings to disrupt ongoing sessions or eavesdrop on confidential discussions.

*This list is not complete and regulatory or law relevant abuse cases have to be taken into account as well. Also custom individual abuse cases might exist for the project.*

# Tag Listing

This chapter lists what tags are used by which elements.

## **css3**

Google Meet Client

## **external**

Public Internet

## **google-workspace**

User Account Information

## **html5**

Google Meet Client

## **internet**

Public Internet

## **javascript**

Google Meet Client

## **jboss**

Auth Server

## **keycloak**

Auth Server

## **linux**

Auth Server

## **oauth**

User Account Information

## **webrtc**

Video Meeting Data

# STRIDE Classification of Identified Risks

This chapter clusters and classifies the risks by STRIDE categories: In total **22 potential risks** have been identified during the threat modeling process of which **3 in the Spoofing** category, **7 in the Tampering** category, **0 in the Repudiation** category, **5 in the Information Disclosure** category, **2 in the Denial of Service** category, and **5 in the Elevation of Privilege** category.

Risk finding paragraphs are clickable and link to the corresponding chapter.

## Spoofing

Medium: **Cross-Site Request Forgery (CSRF)**: 3 / 3 Risks - Exploitation likelihood is *Very Likely* with *Low* impact.

When a web application is accessed via web protocols Cross-Site Request Forgery (CSRF) risks might arise.

## Tampering

Elevated: **Cross-Site Scripting (XSS)**: 2 / 2 Risks - Exploitation likelihood is *Likely* with *High* impact.

For each web application Cross-Site Scripting (XSS) risks might arise. In terms of the overall risk level take other applications running on the same domain into account as well.

Elevated: **Missing Cloud Hardening**: 2 / 2 Risks - Exploitation likelihood is *Unlikely* with *Very High* impact.

Cloud components should be hardened according to the cloud vendor best practices. This affects their configuration, auditing, and further areas.

Elevated: **Missing Hardening**: 2 / 2 Risks - Exploitation likelihood is *Likely* with *Medium* impact.

Technical assets with a Relative Attacker Attractiveness (RAA) value of 55 % or higher should be explicitly hardened taking best practices and vendor hardening guides into account.

Medium: **Container Base Image Backdooring**: 1 / 1 Risk - Exploitation likelihood is *Unlikely* with *High* impact.

When a technical asset is built using container technologies, Base Image Backdooring risks might arise where base images and other layers used contain vulnerable components or backdoors.

## Repudiation

n/a

## Information Disclosure

**Elevated: Server-Side Request Forgery (SSRF): 3 / 3 Risks** - Exploitation likelihood is *Likely* with *Medium* impact.

When a server system (i.e. not a client) is accessing other server systems via typical web protocols Server-Side Request Forgery (SSRF) or Local-File-Inclusion (LFI) or Remote-File-Inclusion (RFI) risks might arise.

**Medium: Missing Vault (Secret Storage): 1 / 1 Risk** - Exploitation likelihood is *Unlikely* with *Medium* impact.

In order to avoid the risk of secret leakage via config files (when attacked through vulnerabilities being able to read files like Path-Traversal and others), it is best practice to use a separate hardened process with proper authentication, authorization, and audit logging to access config secrets (like credentials, private keys, client certificates, etc.). This component is usually some kind of Vault.

**Medium: Unencrypted Communication: 1 / 1 Risk** - Exploitation likelihood is *Unlikely* with *High* impact.

Due to the confidentiality and/or integrity rating of the data assets transferred over the communication link this connection must be encrypted.

## Denial of Service

**Medium: DoS-risky Access Across Trust-Boundary: 2 / 2 Risks** - Exploitation likelihood is *Unlikely* with *Medium* impact.

Assets accessed across trust boundaries with critical or mission-critical availability rating are more prone to Denial-of-Service (DoS) risks.

## Elevation of Privilege

**Medium: Missing Identity Propagation: 2 / 2 Risks** - Exploitation likelihood is *Unlikely* with *Medium* impact.

Technical assets (especially multi-tenant systems), which usually process data for endusers should authorize every request based on the identity of the enduser when the data flow is authenticated (i.e. non-public). For DevOps usages at least a technical-user authorization is required.

**Medium: Missing Identity Provider Isolation: 1 / 1 Risk** - Exploitation likelihood is *Unlikely* with *High* impact.

Highly sensitive identity provider assets and their identity datastores should be isolated from other assets by their own network segmentation trust-boundary (execution-environment boundaries do not count as network isolation).

**Medium: Missing Two-Factor Authentication (2FA): 1 / 1 Risk** - Exploitation likelihood is *Unlikely* with *Medium* impact.

Technical assets (especially multi-tenant systems) should authenticate incoming requests with two-factor (2FA) authentication when the asset processes or stores highly sensitive data (in terms of confidentiality, integrity, and availability) and is accessed by humans.



Medium: **Mixed Targets on Shared Runtime**: 1 / 1 Risk - Exploitation likelihood is *Unlikely* with *Medium* impact.

Different attacker targets (like frontend and backend/datastore components) should not be running on the same shared (underlying) runtime.

# Assignment by Function

This chapter clusters and assigns the risks by functions which are most likely able to check and mitigate them: In total **22 potential risks** have been identified during the threat modeling process of which **1 should be checked by Business Side**, **3 should be checked by Architecture**, **8 should be checked by Development**, and **10 should be checked by Operations**.

Risk finding paragraphs are clickable and link to the corresponding chapter.

## Business Side

Medium: **Missing Two-Factor Authentication (2FA)**: 1 / 1 Risk - Exploitation likelihood is *Unlikely* with *Medium* impact.

Apply an authentication method to the technical asset protecting highly sensitive data via two-factor authentication for human users.

## Architecture

Medium: **Missing Identity Propagation**: 2 / 2 Risks - Exploitation likelihood is *Unlikely* with *Medium* impact.

When processing requests for endusers if possible authorize in the backend against the propagated identity of the enduser. This can be achieved in passing JWTs or similar tokens and checking them in the backend services. For DevOps usages apply at least a technical-user authorization.

Medium: **Missing Vault (Secret Storage)**: 1 / 1 Risk - Exploitation likelihood is *Unlikely* with *Medium* impact.

Consider using a Vault (Secret Storage) to securely store and access config secrets (like credentials, private keys, client certificates, etc.).

## Development

Elevated: **Cross-Site Scripting (XSS)**: 2 / 2 Risks - Exploitation likelihood is *Likely* with *High* impact.

Try to encode all values sent back to the browser and also handle DOM-manipulations in a safe way to avoid DOM-based XSS. When a third-party product is used instead of custom developed software, check if the product applies the proper mitigation and ensure a reasonable patch-level.

Elevated: **Server-Side Request Forgery (SSRF)**: 3 / 3 Risks - Exploitation likelihood is *Likely* with *Medium* impact.

Try to avoid constructing the outgoing target URL with caller controllable values. Alternatively use a mapping (whitelist) when accessing outgoing URLs instead of creating them including caller controllable values. When a third-party product is used instead of custom developed software, check if the product applies the proper mitigation and ensure a reasonable patch-level.

Medium: **Cross-Site Request Forgery (CSRF): 3 / 3 Risks** - Exploitation likelihood is *Very Likely* with *Low* impact.

Try to use anti-CSRF tokens or the double-submit patterns (at least for logged-in requests). When your authentication scheme depends on cookies (like session or token cookies), consider marking them with the same-site flag. When a third-party product is used instead of custom developed software, check if the product applies the proper mitigation and ensure a reasonable patch-level.

## Operations

Elevated: **Missing Cloud Hardening: 2 / 2 Risks** - Exploitation likelihood is *Unlikely* with *Very High* impact.

Apply hardening of all cloud components and services, taking special care to follow the individual risk descriptions (which depend on the cloud provider tags in the model).

Elevated: **Missing Hardening: 2 / 2 Risks** - Exploitation likelihood is *Likely* with *Medium* impact.

Try to apply all hardening best practices (like CIS benchmarks, OWASP recommendations, vendor recommendations, DevSec Hardening Framework, DBSAT for Oracle databases, and others).

Medium: **Container Base Image Backdooring: 1 / 1 Risk** - Exploitation likelihood is *Unlikely* with *High* impact.

Apply hardening of all container infrastructures (see for example the *CIS-Benchmarks for Docker and Kubernetes* and the *Docker Bench for Security*). Use only trusted base images of the original vendors, verify digital signatures and apply image creation best practices. Also consider using Google's *Distroless* base images or otherwise very small base images. Regularly execute container image scans with tools checking the layers for vulnerable components.

Medium: **DoS-risky Access Across Trust-Boundary: 2 / 2 Risks** - Exploitation likelihood is *Unlikely* with *Medium* impact.

Apply anti-DoS techniques like throttling and/or per-client load blocking with quotas. Also for maintenance access routes consider applying a VPN instead of public reachable interfaces. Generally applying redundancy on the targeted technical asset reduces the risk of DoS.

Medium: **Missing Identity Provider Isolation: 1 / 1 Risk** - Exploitation likelihood is *Unlikely* with *High* impact.

Apply a network segmentation trust-boundary around the highly sensitive identity provider assets and their identity datastores.

Medium: **Mixed Targets on Shared Runtime: 1 / 1 Risk** - Exploitation likelihood is *Unlikely* with *Medium* impact.

Use separate runtime environments for running different target components or apply similar separation styles to prevent load- or breach-related problems originating from one more attacker-facing asset impacts also the other more critical rated backend/datastore assets.

Medium: **Unencrypted Communication**: 1 / 1 Risk - Exploitation likelihood is *Unlikely* with *High* impact.

Apply transport layer encryption to the communication link.

# RAA Analysis

For each technical asset the "**Relative Attacker Attractiveness**" (RAA) value was calculated in percent. The higher the RAA, the more interesting it is for an attacker to compromise the asset. The calculation algorithm takes the sensitivity ratings and quantities of stored and processed data into account as well as the communication links of the technical asset. Neighbouring assets to high-value RAA targets might receive an increase in their RAA value when they have a communication link towards that target ("Pivoting-Factor").

The following lists all technical assets sorted by their RAA value from highest (most attacker attractive) to lowest. This list can be used to prioritize on efforts relevant for the most attacker-attractive technical assets:

Technical asset paragraphs are clickable and link to the corresponding chapter.

**Auth Server:** RAA 100%  
Authentication Server

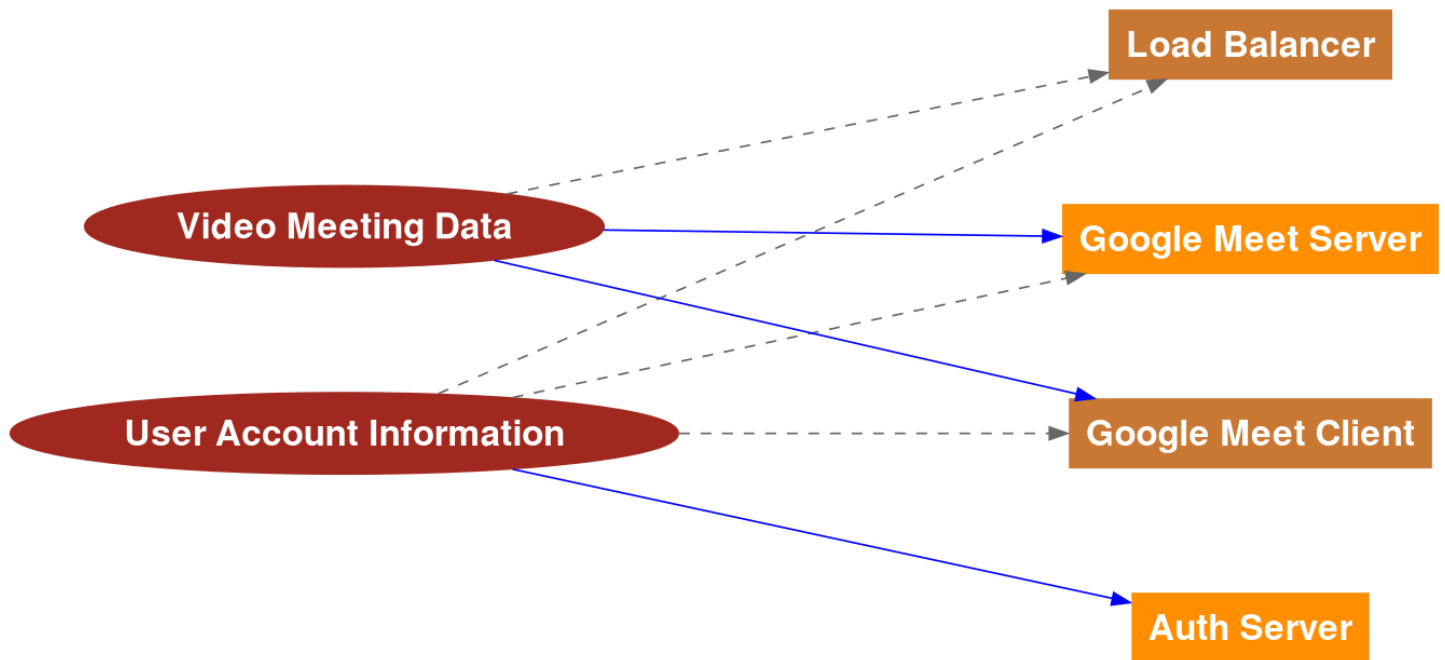
**Google Meet Server:** RAA 64%  
Google Meet Server

**Google Meet Client:** RAA 52%  
Google Meet Client

**Load Balancer:** RAA 1%  
Load Balancer (HA-Proxy)

## Data Mapping

The following diagram was generated by Threagile based on the model input and gives a high-level distribution of data assets across technical assets. The color matches the identified data breach probability and risk level (see the "Data Breach Probabilities" chapter for more details). A solid line stands for *data is stored by the asset* and a dashed one means *data is processed by the asset*. For a full high-resolution version of this diagram please refer to the PNG image file alongside this report.



## Out-of-Scope Assets: 0 Assets

This chapter lists all technical assets that have been defined as out-of-scope. Each one should be checked in the model whether it should better be included in the overall risk analysis:

Technical asset paragraphs are clickable and link to the corresponding chapter.

No technical assets have been defined as out-of-scope.

## Potential Model Failures: 1 / 1 Risk

This chapter lists potential model failures where not all relevant assets have been modeled or the model might itself contain inconsistencies. Each potential model failure should be checked in the model against the architecture design:

Risk finding paragraphs are clickable and link to the corresponding chapter.

**Medium: Missing Vault (Secret Storage): 1 / 1 Risk - Exploitation likelihood is *Unlikely* with *Medium* impact.**

In order to avoid the risk of secret leakage via config files (when attacked through vulnerabilities being able to read files like Path-Traversal and others), it is best practice to use a separate hardened process with proper authentication, authorization, and audit logging to access config secrets (like credentials, private keys, client certificates, etc.). This component is usually some kind of Vault.



## Questions: 0 / 1 Question

This chapter lists custom questions that arose during the threat modeling process.

### **How are video streams encrypted?**

*Video streams are encrypted using TLS and SRTP protocols to ensure that all communication is secured.*

## Identified Risks by Vulnerability Category

In total **22 potential risks** have been identified during the threat modeling process of which **0 are rated as critical, 0 as high, 8 as elevated, 14 as medium, and 0 as low.**

These risks are distributed across **13 vulnerability categories**. The following sub-chapters of this section describe each identified risk category.

## Cross-Site Scripting (XSS): 2 / 2 Risks

**Description** (Tampering): [CWE 79](#)

For each web application Cross-Site Scripting (XSS) risks might arise. In terms of the overall risk level take other applications running on the same domain into account as well.

### Impact

If this risk remains unmitigated, attackers might be able to access individual victim sessions and steal or modify user data.

### Detection Logic

In-scope web applications.

### Risk Rating

The risk rating depends on the sensitivity of the data processed or stored in the web application.

### False Positives

When the technical asset is not accessed via a browser-like component (i.e not by a human user initiating the request that gets passed through all components until it reaches the web application) this can be considered a false positive.

### Mitigation (Development): XSS Prevention

Try to encode all values sent back to the browser and also handle DOM-manipulations in a safe way to avoid DOM-based XSS. When a third-party product is used instead of custom developed software, check if the product applies the proper mitigation and ensure a reasonable patch-level.

ASVS Chapter: [V5 - Validation, Sanitization and Encoding Verification Requirements](#)

Cheat Sheet: [Cross Site Scripting Prevention Cheat Sheet](#)

### Check

Are recommendations from the linked cheat sheet and referenced ASVS chapter applied?

## Risk Findings

The risk **Cross-Site Scripting (XSS)** was found **2 times** in the analyzed architecture to be potentially possible. Each spot should be checked individually by reviewing the implementation whether all controls have been applied properly in order to mitigate each risk.

Risk finding paragraphs are clickable and link to the corresponding chapter.

### *Elevated Risk Severity*

**Cross-Site Scripting (XSS)** risk at **Google Meet Server**: Exploitation likelihood is *Likely* with *High* impact.

[cross-site-scripting@google-meet-server](#)

**Unchecked**

**Cross-Site Scripting (XSS)** risk at **Auth Server**: Exploitation likelihood is *Likely* with *Medium* impact.

[cross-site-scripting@auth-server](#)

**Unchecked**

## Missing Cloud Hardening: 2 / 2 Risks

**Description** (Tampering): [CWE 1008](#)

Cloud components should be hardened according to the cloud vendor best practices. This affects their configuration, auditing, and further areas.

### Impact

If this risk is unmitigated, attackers might access cloud components in an unintended way.

### Detection Logic

In-scope cloud components (either residing in cloud trust boundaries or more specifically tagged with cloud provider types).

### Risk Rating

The risk rating depends on the sensitivity of the technical asset itself and of the data assets processed and stored.

### False Positives

Cloud components not running parts of the target architecture can be considered as false positives after individual review.

### Mitigation (Operations): Cloud Hardening

Apply hardening of all cloud components and services, taking special care to follow the individual risk descriptions (which depend on the cloud provider tags in the model).

For **Amazon Web Services (AWS)**: Follow the *CIS Benchmark for Amazon Web Services* (see also the automated checks of cloud audit tools like "PacBot", "CloudSploit", "CloudMapper", "ScoutSuite", or "Prowler AWS CIS Benchmark Tool").

For EC2 and other servers running Amazon Linux, follow the *CIS Benchmark for Amazon Linux* and switch to IMDSv2.

For S3 buckets follow the *Security Best Practices for Amazon S3* at

<https://docs.aws.amazon.com/AmazonS3/latest/dev/security-best-practices.html> to avoid accidental leakage.

Also take a look at some of these tools: <https://github.com/toniblyx/my-arsenal-of-aws-security-tools>

For **Microsoft Azure**: Follow the *CIS Benchmark for Microsoft Azure* (see also the automated checks of cloud audit tools like "CloudSploit" or "ScoutSuite").

For **Google Cloud Platform**: Follow the *CIS Benchmark for Google Cloud Computing Platform* (see also the automated checks of cloud audit tools like "*CloudSploit*" or "*ScoutSuite*").

For **Oracle Cloud Platform**: Follow the hardening best practices (see also the automated checks of cloud audit tools like "*CloudSploit*").

ASVS Chapter: [V1 - Architecture, Design and Threat Modeling Requirements](#)

Cheat Sheet: [Attack Surface Analysis Cheat Sheet](#)

## Check

Are recommendations from the linked cheat sheet and referenced ASVS chapter applied?

## Risk Findings

The risk **Missing Cloud Hardening** was found **2 times** in the analyzed architecture to be potentially possible. Each spot should be checked individually by reviewing the implementation whether all controls have been applied properly in order to mitigate each risk.

Risk finding paragraphs are clickable and link to the corresponding chapter.

### *Elevated Risk Severity*

**Missing Cloud Hardening** risk at **Google Cloud**: Exploitation likelihood is *Unlikely* with *Very High* impact.

[missing-cloud-hardening@google-cloud](#)

**Unchecked**

**Missing Cloud Hardening** risk at **Public Internet**: Exploitation likelihood is *Unlikely* with *Very High* impact.

[missing-cloud-hardening@public-internet](#)

**Unchecked**

## Missing Hardening: 2 / 2 Risks

**Description** (Tampering): [CWE 16](#)

Technical assets with a Relative Attacker Attractiveness (RAA) value of 55 % or higher should be explicitly hardened taking best practices and vendor hardening guides into account.

### Impact

If this risk remains unmitigated, attackers might be able to easier attack high-value targets.

### Detection Logic

In-scope technical assets with RAA values of 55 % or higher. Generally for high-value targets like datastores, application servers, identity providers and ERP systems this limit is reduced to 40 %

### Risk Rating

The risk rating depends on the sensitivity of the data processed or stored in the technical asset.

### False Positives

Usually no false positives.

### Mitigation (Operations): System Hardening

Try to apply all hardening best practices (like CIS benchmarks, OWASP recommendations, vendor recommendations, DevSec Hardening Framework, DBSAT for Oracle databases, and others).

ASVS Chapter: [V14 - Configuration Verification Requirements](#)

Cheat Sheet: [Attack Surface Analysis Cheat Sheet](#)

### Check

Are recommendations from the linked cheat sheet and referenced ASVS chapter applied?



## Risk Findings

The risk **Missing Hardening** was found **2 times** in the analyzed architecture to be potentially possible. Each spot should be checked individually by reviewing the implementation whether all controls have been applied properly in order to mitigate each risk.

Risk finding paragraphs are clickable and link to the corresponding chapter.

### *Elevated Risk Severity*

**Missing Hardening** risk at **Google Meet Server**: Exploitation likelihood is *Likely* with *Medium* impact.

[missing-hardening@google-meet-server](#)

**Unchecked**

### *Medium Risk Severity*

**Missing Hardening** risk at **Auth Server**: Exploitation likelihood is *Likely* with *Low* impact.

[missing-hardening@auth-server](#)

**Unchecked**

## Server-Side Request Forgery (SSRF): 3 / 3 Risks

**Description** (Information Disclosure): [CWE 918](#)

When a server system (i.e. not a client) is accessing other server systems via typical web protocols Server-Side Request Forgery (SSRF) or Local-File-Inclusion (LFI) or Remote-File-Inclusion (RFI) risks might arise.

### Impact

If this risk is unmitigated, attackers might be able to access sensitive services or files of network-reachable components by modifying outgoing calls of affected components.

### Detection Logic

In-scope non-client systems accessing (using outgoing communication links) targets with either HTTP or HTTPS protocol.

### Risk Rating

The risk rating (low or medium) depends on the sensitivity of the data assets receivable via web protocols from targets within the same network trust-boundary as well on the sensitivity of the data assets receivable via web protocols from the target asset itself. Also for cloud-based environments the exploitation impact is at least medium, as cloud backend services can be attacked via SSRF.

### False Positives

Servers not sending outgoing web requests can be considered as false positives after review.

### Mitigation (Development): SSRF Prevention

Try to avoid constructing the outgoing target URL with caller controllable values. Alternatively use a mapping (whitelist) when accessing outgoing URLs instead of creating them including caller controllable values. When a third-party product is used instead of custom developed software, check if the product applies the proper mitigation and ensure a reasonable patch-level.

ASVS Chapter: [V12 - File and Resources Verification Requirements](#)

Cheat Sheet: [Server Side Request Forgery Prevention Cheat Sheet](#)

### Check

Are recommendations from the linked cheat sheet and referenced ASVS chapter applied?

## Risk Findings

The risk **Server-Side Request Forgery (SSRF)** was found **3 times** in the analyzed architecture to be potentially possible. Each spot should be checked individually by reviewing the implementation whether all controls have been applied properly in order to mitigate each risk.

Risk finding paragraphs are clickable and link to the corresponding chapter.

### *Elevated Risk Severity*

**Server-Side Request Forgery (SSRF)** risk at **Auth Server** server-side web-requesting the target **Google Meet Server** via **Google Meet Server**: Exploitation likelihood is *Likely* with *Medium* impact.

`server-side-request-forgery@auth-server@google-meet-server@auth-server>google-meet-server`

**Unchecked**

**Server-Side Request Forgery (SSRF)** risk at **Google Meet Server** server-side web-requesting the target **Auth Server** via **User Authentication Access**: Exploitation likelihood is *Likely* with *Medium* impact.

`server-side-request-forgery@google-meet-server@auth-server@google-meet-server>user-authentication-access`

**Unchecked**

**Server-Side Request Forgery (SSRF)** risk at **Google Meet Server** server-side web-requesting the target **Google Meet Client** via **Web Interface**: Exploitation likelihood is *Likely* with *Medium* impact.

`server-side-request-forgery@google-meet-server@google-meet-client@google-meet-server>web-interface`

**Unchecked**

## Container Base Image Backdooring: 1 / 1 Risk

**Description** (Tampering): [CWE 912](#)

When a technical asset is built using container technologies, Base Image Backdooring risks might arise where base images and other layers used contain vulnerable components or backdoors.

See for example:

<https://techcrunch.com/2018/06/15/tainted-crypto-mining-containers-pulled-from-docker-hub/>

### Impact

If this risk is unmitigated, attackers might be able to deeply persist in the target system by executing code in deployed containers.

### Detection Logic

In-scope technical assets running as containers.

### Risk Rating

The risk rating depends on the sensitivity of the technical asset itself and of the data assets.

### False Positives

Fully trusted (i.e. reviewed and cryptographically signed or similar) base images of containers can be considered as false positives after individual review.

### Mitigation (Operations): Container Infrastructure Hardening

Apply hardening of all container infrastructures (see for example the *CIS-Benchmarks for Docker and Kubernetes* and the *Docker Bench for Security*). Use only trusted base images of the original vendors, verify digital signatures and apply image creation best practices. Also consider using Google's *Distroless* base images or otherwise very small base images. Regularly execute container image scans with tools checking the layers for vulnerable components.

ASVS Chapter: [V10 - Malicious Code Verification Requirements](#)

Cheat Sheet: [Docker Security Cheat Sheet](#)

### Check

Are recommendations from the linked cheat sheet and referenced ASVS/CSVS applied?

## Risk Findings

The risk **Container Base Image Backdooring** was found **1 time** in the analyzed architecture to be potentially possible. Each spot should be checked individually by reviewing the implementation whether all controls have been applied properly in order to mitigate each risk.

Risk finding paragraphs are clickable and link to the corresponding chapter.

### *Medium Risk Severity*

**Container Base Image Backdooring** risk at **Google Meet Server**: Exploitation likelihood is *Unlikely with High impact*.

[container-baseimage-backdooring@google-meet-server](#)

**Unchecked**

## Cross-Site Request Forgery (CSRF): 3 / 3 Risks

**Description** (Spoofing): [CWE 352](#)

When a web application is accessed via web protocols Cross-Site Request Forgery (CSRF) risks might arise.

### Impact

If this risk remains unmitigated, attackers might be able to trick logged-in victim users into unwanted actions within the web application by visiting an attacker controlled web site.

### Detection Logic

In-scope web applications accessed via typical web access protocols.

### Risk Rating

The risk rating depends on the integrity rating of the data sent across the communication link.

### False Positives

Web applications passing the authentication state via custom headers instead of cookies can eventually be false positives. Also when the web application is not accessed via a browser-like component (i.e not by a human user initiating the request that gets passed through all components until it reaches the web application) this can be considered a false positive.

### Mitigation (Development): CSRF Prevention

Try to use anti-CSRF tokens or the double-submit patterns (at least for logged-in requests). When your authentication scheme depends on cookies (like session or token cookies), consider marking them with the same-site flag. When a third-party product is used instead of custom developed software, check if the product applies the proper mitigation and ensure a reasonable patch-level.

ASVS Chapter: [V4 - Access Control Verification Requirements](#)

Cheat Sheet: [Cross-Site Request Forgery Prevention Cheat Sheet](#)

### Check

Are recommendations from the linked cheat sheet and referenced ASVS chapter applied?

## Risk Findings

The risk **Cross-Site Request Forgery (CSRF)** was found **3 times** in the analyzed architecture to be potentially possible. Each spot should be checked individually by reviewing the implementation whether all controls have been applied properly in order to mitigate each risk.

Risk finding paragraphs are clickable and link to the corresponding chapter.

### *Medium Risk Severity*

**Cross-Site Request Forgery (CSRF) risk at Auth Server via User Authentication Access from Google Meet Server:** Exploitation likelihood is *Very Likely* with *Low* impact.

[cross-site-request-forgery@auth-server@google-meet-server>user-authentication-access](#)

**Unchecked**

**Cross-Site Request Forgery (CSRF) risk at Google Meet Server via Google Meet Server from Auth Server:** Exploitation likelihood is *Very Likely* with *Low* impact.

[cross-site-request-forgery@google-meet-server@auth-server>google-meet-server](#)

**Unchecked**

**Cross-Site Request Forgery (CSRF) risk at Google Meet Server via Google Meet Traffic from Load Balancer:** Exploitation likelihood is *Very Likely* with *Low* impact.

[cross-site-request-forgery@google-meet-server@load-balancer>google-meet-traffic](#)

**Unchecked**

## DoS-risky Access Across Trust-Boundary: 2 / 2 Risks

**Description** (Denial of Service): [CWE 400](#)

Assets accessed across trust boundaries with critical or mission-critical availability rating are more prone to Denial-of-Service (DoS) risks.

### Impact

If this risk remains unmitigated, attackers might be able to disturb the availability of important parts of the system.

### Detection Logic

In-scope technical assets (excluding load-balancer) with availability rating of critical or higher which have incoming data-flows across a network trust-boundary (excluding devops usage).

### Risk Rating

Matching technical assets with availability rating of critical or higher are at low risk. When the availability rating is mission-critical and neither a VPN nor IP filter for the incoming data-flow nor redundancy for the asset is applied, the risk-rating is considered medium.

### False Positives

When the accessed target operations are not time- or resource-consuming.

### Mitigation (Operations): Anti-DoS Measures

Apply anti-DoS techniques like throttling and/or per-client load blocking with quotas. Also for maintenance access routes consider applying a VPN instead of public reachable interfaces. Generally applying redundancy on the targeted technical asset reduces the risk of DoS.

ASVS Chapter: [V1 - Architecture, Design and Threat Modeling Requirements](#)

Cheat Sheet: [Denial of Service Cheat Sheet](#)

### Check

Are recommendations from the linked cheat sheet and referenced ASVS chapter applied?



## Risk Findings

The risk **DoS-risky Access Across Trust-Boundary** was found **2 times** in the analyzed architecture to be potentially possible. Each spot should be checked individually by reviewing the implementation whether all controls have been applied properly in order to mitigate each risk.

Risk finding paragraphs are clickable and link to the corresponding chapter.

### Medium Risk Severity

**Denial-of-Service** risky access of **Google Meet Client** by **Google Meet Server** via **Web Interface**: Exploitation likelihood is *Unlikely* with *Medium* impact.

[dos-risky-access-across-trust-boundary@google-meet-client@google-meet-server@google-meet-server>web-interface](#)

**Unchecked**

**Denial-of-Service** risky access of **Google Meet Server** by **Google Meet Client** via **Web Server** forwarded via **Load Balancer**: Exploitation likelihood is *Unlikely* with *Medium* impact.

[dos-risky-access-across-trust-boundary@google-meet-server@google-meet-client@google-meet-client>web-server](#)

**Unchecked**

## Missing Identity Propagation: 2 / 2 Risks

**Description** (Elevation of Privilege): [CWE 284](#)

Technical assets (especially multi-tenant systems), which usually process data for endusers should authorize every request based on the identity of the enduser when the data flow is authenticated (i.e. non-public). For DevOps usages at least a technical-user authorization is required.

### Impact

If this risk is unmitigated, attackers might be able to access or modify foreign data after a successful compromise of a component within the system due to missing resource-based authorization checks.

### Detection Logic

In-scope service-like technical assets which usually process data based on enduser requests, if authenticated (i.e. non-public), should authorize incoming requests based on the propagated enduser identity when their rating is sensitive. This is especially the case for all multi-tenant assets (there even less-sensitive rated ones). DevOps usages are exempted from this risk.

### Risk Rating

The risk rating (medium or high) depends on the confidentiality, integrity, and availability rating of the technical asset.

### False Positives

Technical assets which do not process requests regarding functionality or data linked to end-users (customers) can be considered as false positives after individual review.

**Mitigation** (Architecture): Identity Propagation and Resource-based Authorization

When processing requests for endusers if possible authorize in the backend against the propagated identity of the enduser. This can be achieved in passing JWTs or similar tokens and checking them in the backend services. For DevOps usages apply at least a technical-user authorization.

ASVS Chapter: [V4 - Access Control Verification Requirements](#)

Cheat Sheet: [Access Control Cheat Sheet](#)

### Check

Are recommendations from the linked cheat sheet and referenced ASVS chapter applied?

## Risk Findings

The risk **Missing Identity Propagation** was found **2 times** in the analyzed architecture to be potentially possible. Each spot should be checked individually by reviewing the implementation whether all controls have been applied properly in order to mitigate each risk.

Risk finding paragraphs are clickable and link to the corresponding chapter.

### *Medium Risk Severity*

**Missing Enduser Identity Propagation** over communication link **Google Meet Server** from **Auth Server to Google Meet Server**: Exploitation likelihood is *Unlikely* with *Medium* impact.

[missing-identity-propagation@auth-server>google-meet-server@auth-server@google-meet-server](#)

**Unchecked**

**Missing Enduser Identity Propagation** over communication link **Google Meet Traffic** from **Load Balancer to Google Meet Server**: Exploitation likelihood is *Unlikely* with *Medium* impact.

[missing-identity-propagation@load-balancer>google-meet-traffic@load-balancer@google-meet-server](#)

**Unchecked**

## Missing Identity Provider Isolation: 1 / 1 Risk

**Description** (Elevation of Privilege): [CWE 1008](#)

Highly sensitive identity provider assets and their identity datastores should be isolated from other assets by their own network segmentation trust-boundary (execution-environment boundaries do not count as network isolation).

### Impact

If this risk is unmitigated, attackers successfully attacking other components of the system might have an easy path towards highly sensitive identity provider assets and their identity datastores, as they are not separated by network segmentation.

### Detection Logic

In-scope identity provider assets and their identity datastores when surrounded by other (not identity-related) assets (without a network trust-boundary in-between). This risk is especially prevalent when other non-identity related assets are within the same execution environment (i.e. same database or same application server).

### Risk Rating

Default is high impact. The impact is increased to very-high when the asset missing the trust-boundary protection is rated as strictly-confidential or mission-critical.

### False Positives

When all assets within the network segmentation trust-boundary are hardened and protected to the same extend as if all were identity providers with data of highest sensitivity.

### Mitigation (Operations): Network Segmentation

Apply a network segmentation trust-boundary around the highly sensitive identity provider assets and their identity datastores.

ASVS Chapter: [V1 - Architecture, Design and Threat Modeling Requirements](#)

Cheat Sheet: [Attack Surface Analysis Cheat Sheet](#)

### Check

Are recommendations from the linked cheat sheet and referenced ASVS chapter applied?

## Risk Findings

The risk **Missing Identity Provider Isolation** was found **1 time** in the analyzed architecture to be potentially possible. Each spot should be checked individually by reviewing the implementation whether all controls have been applied properly in order to mitigate each risk.

Risk finding paragraphs are clickable and link to the corresponding chapter.

### *Medium Risk Severity*

**Missing Identity Provider Isolation** to further encapsulate and protect identity-related asset **Auth Server** against unrelated lower protected assets **in the same network segment**, which might be easier to compromise by attackers: Exploitation likelihood is *Unlikely* with *High* impact.

[missing-identity-provider-isolation@auth-server](#)

**Unchecked**

## Missing Two-Factor Authentication (2FA): 1 / 1 Risk

**Description** (Elevation of Privilege): [CWE 308](#)

Technical assets (especially multi-tenant systems) should authenticate incoming requests with two-factor (2FA) authentication when the asset processes or stores highly sensitive data (in terms of confidentiality, integrity, and availability) and is accessed by humans.

### Impact

If this risk is unmitigated, attackers might be able to access or modify highly sensitive data without strong authentication.

### Detection Logic

In-scope technical assets (except load-balancer, reverse-proxy, waf, ids, and ips) should authenticate incoming requests via two-factor authentication (2FA) when the asset processes or stores highly sensitive data (in terms of confidentiality, integrity, and availability) and is accessed by a client used by a human user.

### Risk Rating

medium

### False Positives

Technical assets which do not process requests regarding functionality or data linked to end-users (customers) can be considered as false positives after individual review.

### Mitigation (Business Side): Authentication with Second Factor (2FA)

Apply an authentication method to the technical asset protecting highly sensitive data via two-factor authentication for human users.

ASVS Chapter: [V2 - Authentication Verification Requirements](#)

Cheat Sheet: [Multifactor Authentication Cheat Sheet](#)

### Check

Are recommendations from the linked cheat sheet and referenced ASVS chapter applied?

## Risk Findings

The risk **Missing Two-Factor Authentication (2FA)** was found **1 time** in the analyzed architecture to be potentially possible. Each spot should be checked individually by reviewing the implementation whether all controls have been applied properly in order to mitigate each risk.

Risk finding paragraphs are clickable and link to the corresponding chapter.

### *Medium Risk Severity*

**Missing Two-Factor Authentication** covering communication link **Google Meet Traffic** from **Google Meet Client** forwarded via **Load Balancer** to **Google Meet Server**: Exploitation likelihood is *Unlikely* with *Medium* impact.

`missing-authentication-second-factor@load-balancer>google-meet-traffic@load-balancer@google-meet-server`

**Unchecked**

## Missing Vault (Secret Storage): 1 / 1 Risk

**Description** (Information Disclosure): [CWE 522](#)

In order to avoid the risk of secret leakage via config files (when attacked through vulnerabilities being able to read files like Path-Traversal and others), it is best practice to use a separate hardened process with proper authentication, authorization, and audit logging to access config secrets (like credentials, private keys, client certificates, etc.). This component is usually some kind of Vault.

### Impact

If this risk is unmitigated, attackers might be able to easier steal config secrets (like credentials, private keys, client certificates, etc.) once a vulnerability to access files is present and exploited.

### Detection Logic

Models without a Vault (Secret Storage).

### Risk Rating

The risk rating depends on the sensitivity of the technical asset itself and of the data assets processed and stored.

### False Positives

Models where no technical assets have any kind of sensitive config data to protect can be considered as false positives after individual review.

### Mitigation (Architecture): Vault (Secret Storage)

Consider using a Vault (Secret Storage) to securely store and access config secrets (like credentials, private keys, client certificates, etc.).

ASVS Chapter: [V6 - Stored Cryptography Verification Requirements](#)

Cheat Sheet: [Cryptographic Storage Cheat Sheet](#)

### Check

Is a Vault (Secret Storage) in place?



## Risk Findings

The risk **Missing Vault (Secret Storage)** was found **1 time** in the analyzed architecture to be potentially possible. Each spot should be checked individually by reviewing the implementation whether all controls have been applied properly in order to mitigate each risk.

Risk finding paragraphs are clickable and link to the corresponding chapter.

### *Medium Risk Severity*

**Missing Vault (Secret Storage)** in the threat model (referencing asset **Google Meet Client** as an example): Exploitation likelihood is *Unlikely* with *Medium* impact.

[missing-vault@google-meet-client](#)

**Unchecked**

## Mixed Targets on Shared Runtime: 1 / 1 Risk

**Description** (Elevation of Privilege): [CWE 1008](#)

Different attacker targets (like frontend and backend/datastore components) should not be running on the same shared (underlying) runtime.

### Impact

If this risk is unmitigated, attackers successfully attacking other components of the system might have an easy path towards more valuable targets, as they are running on the same shared runtime.

### Detection Logic

Shared runtime running technical assets of different trust-boundaries is at risk. Also mixing backend/datastore with frontend components on the same shared runtime is considered a risk.

### Risk Rating

The risk rating (low or medium) depends on the confidentiality, integrity, and availability rating of the technical asset running on the shared runtime.

### False Positives

When all assets running on the shared runtime are hardened and protected to the same extend as if all were containing/processing highly sensitive data.

### Mitigation (Operations): Runtime Separation

Use separate runtime environments for running different target components or apply similar separation styles to prevent load- or breach-related problems originating from one more attacker-facing asset impacts also the other more critical rated backend/datastore assets.

ASVS Chapter: [V1 - Architecture, Design and Threat Modeling Requirements](#)

Cheat Sheet: [Attack Surface Analysis Cheat Sheet](#)

### Check

Are recommendations from the linked cheat sheet and referenced ASVS chapter applied?

## Risk Findings

The risk **Mixed Targets on Shared Runtime** was found **1 time** in the analyzed architecture to be potentially possible. Each spot should be checked individually by reviewing the implementation whether all controls have been applied properly in order to mitigate each risk.

Risk finding paragraphs are clickable and link to the corresponding chapter.

### *Medium Risk Severity*

**Mixed Targets on Shared Runtime** named **Google Cloud Platform** might enable attackers moving from one less valuable target to a more valuable one: Exploitation likelihood is *Unlikely* with *Medium* impact.

[mixed-targets-on-shared-runtime@gcp](#)

**Unchecked**

## Unencrypted Communication: 1 / 1 Risk

**Description** (Information Disclosure): [CWE 319](#)

Due to the confidentiality and/or integrity rating of the data assets transferred over the communication link this connection must be encrypted.

### Impact

If this risk is unmitigated, network attackers might be able to to eavesdrop on unencrypted sensitive data sent between components.

### Detection Logic

Unencrypted technical communication links of in-scope technical assets (excluding monitoring traffic as well as local-file-access and in-process-library-call) transferring sensitive data.

### Risk Rating

Depending on the confidentiality rating of the transferred data-assets either medium or high risk.

### False Positives

When all sensitive data sent over the communication link is already fully encrypted on document or data level. Also intra-container/pod communication can be considered false positive when container orchestration platform handles encryption.

### Mitigation (Operations): Encryption of Communication Links

Apply transport layer encryption to the communication link.

ASVS Chapter: [V9 - Communication Verification Requirements](#)

Cheat Sheet: [Transport Layer Protection Cheat Sheet](#)

### Check

Are recommendations from the linked cheat sheet and referenced ASVS chapter applied?

## Risk Findings

The risk **Unencrypted Communication** was found **1 time** in the analyzed architecture to be potentially possible. Each spot should be checked individually by reviewing the implementation whether all controls have been applied properly in order to mitigate each risk.

Risk finding paragraphs are clickable and link to the corresponding chapter.

### *Medium Risk Severity*

**Unencrypted Communication** named **Google Meet Traffic** between **Load Balancer** and **Google Meet Server** transferring authentication data (like credentials, token, session-id, etc.):  
Exploitation likelihood is *Unlikely* with *High* impact.

`unencrypted-communication@load-balancer>google-meet-traffic@load-balancer@google-meet-server`

**Unchecked**

## Identified Risks by Technical Asset

In total **22 potential risks** have been identified during the threat modeling process of which **0 are rated as critical, 0 as high, 8 as elevated, 14 as medium, and 0 as low.**

These risks are distributed across **4 in-scope technical assets**. The following sub-chapters of this section describe each identified risk grouped by technical asset. The RAA value of a technical asset is the calculated "Relative Attacker Attractiveness" value in percent.

## Auth Server: 5 / 5 Risks

### Description

Authentication Server

### Identified Risks of Asset

Risk finding paragraphs are clickable and link to the corresponding chapter.

#### *Elevated Risk Severity*

**Cross-Site Scripting (XSS)** risk at **Auth Server**: Exploitation likelihood is *Likely* with *Medium* impact.

`cross-site-scripting@auth-server`

**Unchecked**

**Server-Side Request Forgery (SSRF)** risk at **Auth Server** server-side web-requesting the target **Google Meet Server** via **Google Meet Server**: Exploitation likelihood is *Likely* with *Medium* impact.

`server-side-request-forgery@auth-server@google-meet-server@auth-server>google-meet-server`

**Unchecked**

#### *Medium Risk Severity*

**Missing Identity Provider Isolation** to further encapsulate and protect identity-related asset **Auth Server** against unrelated lower protected assets **in the same network segment**, which might be easier to compromise by attackers: Exploitation likelihood is *Unlikely* with *High* impact.

`missing-identity-provider-isolation@auth-server`

**Unchecked**

**Cross-Site Request Forgery (CSRF)** risk at **Auth Server** via **User Authentication Access** from **Google Meet Server**: Exploitation likelihood is *Very Likely* with *Low* impact.

`cross-site-request-forgery@auth-server@google-meet-server>user-authentication-access`

**Unchecked**

**Missing Hardening** risk at **Auth Server**: Exploitation likelihood is *Likely* with *Low* impact.

`missing-hardening@auth-server`

**Unchecked**

### Asset Information

ID: auth-server  
Type: process

Usage:	business
RAA:	100 %
Size:	component
Technology:	identity-provider
Tags:	jboss, keycloak, linux
Internet:	false
Machine:	virtual
Encryption:	data-with-symmetric-shared-key
Multi-Tenant:	false
Redundant:	false
Custom-Developed:	false
Client by Human:	false
Data Processed:	User Account Information
Data Stored:	User Account Information
Formats Accepted:	JSON

## Asset Rating

Owner:	Google	
Confidentiality:	confidential	(rated 4 in scale of 5)
Integrity:	critical	(rated 4 in scale of 5)
Availability:	critical	(rated 4 in scale of 5)
CIA-Justification:	The auth data of google users	

## Outgoing Communication Links: 1

Target technical asset names are clickable and link to the corresponding chapter.

### Google Meet Server (outgoing)

#### Google Meet Server

Target:	Google Meet Server
Protocol:	https
Encrypted:	true
Authentication:	token
Authorization:	technical-user
Read-Only:	false
Usage:	business
Tags:	none



VPN:	false
IP-Filtered:	false
Data Sent:	User Account Information
Data Received:	User Account Information

### Incoming Communication Links: 1

Source technical asset names are clickable and link to the corresponding chapter.

#### User Authentication Access (incoming)

Link to the auth server for managing users

Source:	Google Meet Server
Protocol:	https
Encrypted:	true
Authentication:	credentials
Authorization:	technical-user
Read-Only:	false
Usage:	business
Tags:	none
VPN:	false
IP-Filtered:	false
Data Received:	User Account Information
Data Sent:	User Account Information

## Google Meet Server: 11 / 11 Risks

### Description

Google Meet Server

### Identified Risks of Asset

Risk finding paragraphs are clickable and link to the corresponding chapter.

#### Elevated Risk Severity

**Cross-Site Scripting (XSS)** risk at **Google Meet Server**: Exploitation likelihood is *Likely* with *High* impact.

[cross-site-scripting@google-meet-server](#)

**Unchecked**

**Missing Hardening** risk at **Google Meet Server**: Exploitation likelihood is *Likely* with *Medium* impact.

[missing-hardening@google-meet-server](#)

**Unchecked**

**Server-Side Request Forgery (SSRF)** risk at **Google Meet Server** server-side web-requesting the target **Auth Server** via **User Authentication Access**: Exploitation likelihood is *Likely* with *Medium* impact.

[server-side-request-forgery@google-meet-server@auth-server@google-meet-server>user-authentication-access](#)

**Unchecked**

**Server-Side Request Forgery (SSRF)** risk at **Google Meet Server** server-side web-requesting the target **Google Meet Client** via **Web Interface**: Exploitation likelihood is *Likely* with *Medium* impact.

[server-side-request-forgery@google-meet-server@google-meet-client@google-meet-server>web-interface](#)

**Unchecked**

#### Medium Risk Severity

**Container Base Image Backdooring** risk at **Google Meet Server**: Exploitation likelihood is *Unlikely* with *High* impact.

[container-baseimage-backdooring@google-meet-server](#)

**Unchecked**

**Denial-of-Service** risky access of **Google Meet Server** by **Google Meet Client** via **Web Server** forwarded via **Load Balancer**: Exploitation likelihood is *Unlikely* with *Medium* impact.

[dos-risky-access-across-trust-boundary@google-meet-server@google-meet-client@google-meet-client>web-server](#)

**Unchecked**

**Missing Enduser Identity Propagation** over communication link **Google Meet Server** from **Auth Server** to **Google Meet Server**: Exploitation likelihood is *Unlikely* with *Medium* impact.

missing-identity-propagation@auth-server>google-meet-server@auth-server@google-meet-server

**Unchecked**

**Missing Enduser Identity Propagation** over communication link **Google Meet Traffic** from **Load Balancer** to **Google Meet Server**: Exploitation likelihood is *Unlikely* with *Medium* impact.

missing-identity-propagation@load-balancer>google-meet-traffic@load-balancer@google-meet-server

**Unchecked**

**Missing Two-Factor Authentication** covering communication link **Google Meet Traffic** from **Google Meet Client** forwarded via **Load Balancer** to **Google Meet Server**: Exploitation likelihood is *Unlikely* with *Medium* impact.

missing-authentication-second-factor@load-balancer>google-meet-traffic@load-balancer@google-meet-server

**Unchecked**

**Cross-Site Request Forgery (CSRF)** risk at **Google Meet Server** via **Google Meet Server** from **Auth Server**: Exploitation likelihood is *Very Likely* with *Low* impact.

cross-site-request-forgery@google-meet-server@auth-server>google-meet-server

**Unchecked**

**Cross-Site Request Forgery (CSRF)** risk at **Google Meet Server** via **Google Meet Traffic** from **Load Balancer**: Exploitation likelihood is *Very Likely* with *Low* impact.

cross-site-request-forgery@google-meet-server@load-balancer>google-meet-traffic

**Unchecked**

## Asset Information

ID:	google-meet-server
Type:	process
Usage:	business
RAA:	64 %
Size:	application
Technology:	web-server
Tags:	none
Internet:	false
Machine:	container
Encryption:	data-with-asymmetric-shared-key
Multi-Tenant:	false
Redundant:	false
Custom-Developed:	false
Client by Human:	false
Data Processed:	User Account Information, Video Meeting Data
Data Stored:	Video Meeting Data

Formats Accepted: JSON

## Asset Rating

Owner:

Confidentiality: internal (rated 2 in scale of 5)

Integrity: mission-critical (rated 5 in scale of 5)

Availability: mission-critical (rated 5 in scale of 5)

CIA-Justification:

## Outgoing Communication Links: 2

Target technical asset names are clickable and link to the corresponding chapter.

### Web Interface (outgoing)

Web Interface

Target: [Google Meet Client](#)

Protocol: https

Encrypted: true

Authentication: token

Authorization: technical-user

Read-Only: false

Usage: business

Tags: none

VPN: false

IP-Filtered: false

Data Sent: [User Account Information](#), [Video Meeting Data](#)

Data Received: [User Account Information](#), [Video Meeting Data](#)

### User Authentication Access (outgoing)

Link to the auth server for managing users

Target: [Auth Server](#)

Protocol: https

Encrypted: true

Authentication: credentials

Authorization: technical-user

Read-Only: false

Usage: business

Tags:	none
VPN:	false
IP-Filtered:	false
Data Sent:	User Account Information
Data Received:	User Account Information

## Incoming Communication Links: 2

Source technical asset names are clickable and link to the corresponding chapter.

### Google Meet Traffic (incoming)

Link to the web server

Source:	Load Balancer
Protocol:	http
Encrypted:	false
Authentication:	session-id
Authorization:	technical-user
Read-Only:	false
Usage:	business
Tags:	none
VPN:	false
IP-Filtered:	false
Data Received:	User Account Information, Video Meeting Data
Data Sent:	User Account Information, Video Meeting Data

### Google Meet Server (incoming)

Google Meet Server

Source:	Auth Server
Protocol:	https
Encrypted:	true
Authentication:	token
Authorization:	technical-user
Read-Only:	false
Usage:	business
Tags:	none
VPN:	false
IP-Filtered:	false
Data Received:	User Account Information

Data Sent:            User Account Information

## Google Meet Client: 2 / 2 Risks

### Description

Google Meet Client

### Identified Risks of Asset

Risk finding paragraphs are clickable and link to the corresponding chapter.

#### *Medium Risk Severity*

**Denial-of-Service** risky access of **Google Meet Client** by **Google Meet Server** via **Web Interface**: Exploitation likelihood is *Unlikely* with *Medium* impact.

[dos-risky-access-across-trust-boundary@google-meet-client@google-meet-server@google-meet-server>web-interface](#)

**Unchecked**

**Missing Vault (Secret Storage)** in the threat model (referencing asset **Google Meet Client** as an example): Exploitation likelihood is *Unlikely* with *Medium* impact.

[missing-vault@google-meet-client](#)

**Unchecked**

### Asset Information

ID:	google-meet-client
Type:	process
Usage:	business
RAA:	52 %
Size:	application
Technology:	browser
Tags:	css3, html5, javascript
Internet:	true
Machine:	virtual
Encryption:	data-with-asymmetric-shared-key
Multi-Tenant:	false
Redundant:	false
Custom-Developed:	false
Client by Human:	true
Data Processed:	User Account Information, Video Meeting Data
Data Stored:	Video Meeting Data
Formats Accepted:	JSON

## Asset Rating

Owner:	Google Inc.	
Confidentiality:	confidential	(rated 4 in scale of 5)
Integrity:	critical	(rated 4 in scale of 5)
Availability:	mission-critical	(rated 5 in scale of 5)
CIA-Justification:	The web application is the primary interface for users to interact with the service, requiring high confidentiality, integrity, and availability.	

## Outgoing Communication Links: 1

Target technical asset names are clickable and link to the corresponding chapter.

### Web Server (outgoing)

#### Web Server

Target:	Load Balancer
Protocol:	https
Encrypted:	true
Authentication:	token
Authorization:	technical-user
Read-Only:	false
Usage:	business
Tags:	none
VPN:	false
IP-Filtered:	false
Data Sent:	User Account Information, Video Meeting Data
Data Received:	User Account Information, Video Meeting Data

## Incoming Communication Links: 1

Source technical asset names are clickable and link to the corresponding chapter.

### Web Interface (incoming)

#### Web Interface

Source:	Google Meet Server
Protocol:	https
Encrypted:	true
Authentication:	token
Authorization:	technical-user



Read-Only: false  
Usage: business  
Tags: none  
VPN: false  
IP-Filtered: false  
Data Received: User Account Information, Video Meeting Data  
Data Sent: User Account Information, Video Meeting Data

## Load Balancer: 1 / 1 Risk

### Description

Load Balancer (HA-Proxy)

### Identified Risks of Asset

Risk finding paragraphs are clickable and link to the corresponding chapter.

#### *Medium Risk Severity*

**Unencrypted Communication** named **Google Meet Traffic** between **Load Balancer** and **Google Meet Server** transferring authentication data (like credentials, token, session-id, etc.):  
Exploitation likelihood is *Unlikely* with *High* impact.

`unencrypted-communication@load-balancer>google-meet-traffic@load-balancer@google-meet-server`

**Unchecked**

### Asset Information

ID:	load-balancer
Type:	process
Usage:	business
RAA:	1 %
Size:	component
Technology:	load-balancer
Tags:	none
Internet:	false
Machine:	physical
Encryption:	data-with-asymmetric-shared-key
Multi-Tenant:	false
Redundant:	false
Custom-Developed:	false
Client by Human:	false
Data Processed:	User Account Information, Video Meeting Data
Data Stored:	none
Formats Accepted:	none of the special data formats accepted

### Asset Rating

Owner:	Google
--------	--------

Confidentiality:	internal	(rated 2 in scale of 5)
Integrity:	mission-critical	(rated 5 in scale of 5)
Availability:	mission-critical	(rated 5 in scale of 5)
CIA-Justification:	The correct configuration and reachability of the load balancer is mandatory for all users of google meet	

## Outgoing Communication Links: 1

Target technical asset names are clickable and link to the corresponding chapter.

### Google Meet Traffic (outgoing)

Link to the web server

Target:	Google Meet Server
Protocol:	http
Encrypted:	false
Authentication:	session-id
Authorization:	technical-user
Read-Only:	false
Usage:	business
Tags:	none
VPN:	false
IP-Filtered:	false
Data Sent:	User Account Information, Video Meeting Data
Data Received:	User Account Information, Video Meeting Data

## Incoming Communication Links: 1

Source technical asset names are clickable and link to the corresponding chapter.

### Web Server (incoming)

Web Server

Source:	Google Meet Client
Protocol:	https
Encrypted:	true
Authentication:	token
Authorization:	technical-user
Read-Only:	false
Usage:	business
Tags:	none

VPN: false  
IP-Filtered: false  
Data Received: User Account Information, Video Meeting Data  
Data Sent: User Account Information, Video Meeting Data

## Identified Data Breach Probabilities by Data Asset

In total **22 potential risks** have been identified during the threat modeling process of which **0 are rated as critical, 0 as high, 8 as elevated, 14 as medium, and 0 as low.**

These risks are distributed across **2 data assets**. The following sub-chapters of this section describe the derived data breach probabilities grouped by data asset.

Technical asset names and risk IDs are clickable and link to the corresponding chapter.

## User Account Information: 19 / 19 Risks

User account data including authentication credentials and user preferences.

ID:	user-accounts
Usage:	business
Quantity:	very-many
Tags:	google-workspace, oauth
Origin:	User
Owner:	Google Inc.
Confidentiality:	confidential (rated 4 in scale of 5)
Integrity:	critical (rated 4 in scale of 5)
Availability:	critical (rated 4 in scale of 5)
CIA-Justification:	User account data is critical for user management and personalization of the service. It must be available and accurate to ensure user satisfaction and system integrity.
Processed by:	Auth Server, Google Meet Client, Google Meet Server, Load Balancer
Stored by:	Auth Server
Sent via:	Web Server, Web Interface, User Authentication Access, Google Meet Traffic, Google Meet Server
Received via:	Web Server, Web Interface, User Authentication Access, Google Meet Traffic, Google Meet Server
Data Breach:	<b>probable</b>
Data Breach Risks:	This data asset has data breach potential because of 19 remaining risks: <ul style="list-style-type: none"> <li>Probable: container-baseimage-backdooring@google-meet-server</li> <li>Probable: missing-cloud-hardening@google-cloud</li> <li>Probable: missing-cloud-hardening@public-internet</li> <li>Possible: cross-site-scripting@auth-server</li> <li>Possible: cross-site-scripting@google-meet-server</li> <li>Possible: missing-authentication-second-factor@load-balancer&gt;google-meet-traffic@load-balancer@google-meet-server</li> <li>Possible: server-side-request-forgery@auth-server@google-meet-server@auth-server&gt;google-meet-server</li> <li>Possible: server-side-request-forgery@google-meet-server@auth-server@google-meet-server&gt;user-authentication-access</li> <li>Possible: server-side-request-forgery@google-meet-server@google-meet-client@google-meet-server&gt;web-interface</li> <li>Possible: unencrypted-communication@load-balancer&gt;google-meet-traffic@load-balancer@google-meet-server</li> <li>Improbable: cross-site-request-forgery@auth-server@google-meet-server&gt;user-authentication-access</li> <li>Improbable: cross-site-request-forgery@google-meet-server@auth-server&gt;google-meet-server</li> <li>Improbable: cross-site-request-forgery@google-meet-server@load-balancer&gt;google-meet-traffic</li> <li>Improbable: missing-identity-propagation@auth-server&gt;google-meet-server@auth-server@google-meet-server</li> <li>Improbable: missing-identity-propagation@load-balancer&gt;google-meet-traffic@load-balancer@google-meet-server</li> <li>Improbable: missing-hardening@auth-server</li> <li>Improbable: missing-hardening@google-meet-server</li> <li>Improbable: missing-identity-provider-isolation@auth-server</li> <li>Improbable: mixed-targets-on-shared-runtime@gcp</li> </ul>

## Video Meeting Data: 15 / 15 Risks

Data related to the video meetings, including video and audio streams.

ID:	meeting-data	
Usage:	business	
Quantity:	very-many	
Tags:	webrtc	
Origin:	User	
Owner:	Google Inc.	
Confidentiality:	confidential	(rated 4 in scale of 5)
Integrity:	operational	(rated 2 in scale of 5)
Availability:	critical	(rated 4 in scale of 5)
CIA-Justification:	Video and audio stream data are sensitive as they may contain confidential information discussed during meetings. This data requires high availability to ensure service functionality and user satisfaction.	
Processed by:	Google Meet Client, Google Meet Server, Load Balancer	
Stored by:	Google Meet Client, Google Meet Server	
Sent via:	Web Server, Web Interface, Google Meet Traffic	
Received via:	Web Server, Web Interface, Google Meet Traffic	
Data Breach:	<b>probable</b>	
Data Breach Risks:	This data asset has data breach potential because of 15 remaining risks:	

Probable: container-baseimage-backdooring@google-meet-server

Probable: missing-cloud-hardening@google-cloud

Probable: missing-cloud-hardening@public-internet

Possible: cross-site-scripting@google-meet-server

Possible: missing-authentication-second-factor@load-balancer>google-meet-traffic@load-balancer@google-meet-server

Possible: server-side-request-forgery@auth-server@google-meet-server@auth-server>google-meet-server

Possible: server-side-request-forgery@google-meet-server@auth-server@google-meet-server>user-authentication-access

Possible: server-side-request-forgery@google-meet-server@google-meet-client@google-meet-server>web-interface

Possible: unencrypted-communication@load-balancer>google-meet-traffic@load-balancer@google-meet-server

Improbable: cross-site-request-forgery@google-meet-server@auth-server>google-meet-server

Improbable: cross-site-request-forgery@google-meet-server@load-balancer>google-meet-traffic

Improbable: missing-identity-propagation@auth-server>google-meet-server@auth-server@google-meet-server

Improbable: missing-identity-propagation@load-balancer>google-meet-traffic@load-balancer@google-meet-server

Improbable: missing-hardening@google-meet-server

Improbable: mixed-targets-on-shared-runtime@gcp

# Trust Boundaries

In total **2 trust boundaries** have been modeled during the threat modeling process.

## Google Cloud

The boundary representing the google cloud

ID: google-cloud  
Type: network-cloud-provider  
Tags: none  
Assets inside: Auth Server, Google Meet Server, Load Balancer  
Boundaries nested: none

## Public Internet

The boundary representing the public internet access layer.

ID: public-internet  
Type: network-cloud-provider  
Tags: external, internet  
Assets inside: Google Meet Client  
Boundaries nested: none



# Shared Runtimes

In total **1 shared runtime** has been modeled during the threat modeling process.

## Google Cloud Platform

Google Cloud Platform services used to host and run Google Meet.

ID:	gcp
Tags:	none
Assets running:	Google Meet Server, Load Balancer, Auth Server

# Risk Rules Checked by Threagile

**Threagile Version:** 1.0.0

**Threagile Build Timestamp:** 20231104141112

**Threagile Execution Timestamp:** 20240510134247

**Model Filename:** /app/work/threagile.yaml

**Model Hash (SHA256):** bea0636d7ef972c93f44b4caf3e9775a8492aa315f2e9bedd7ccabb88c6467a9

Threagile (see <https://threagile.io> for more details) is an open-source toolkit for agile threat modeling, created by Christian Schneider (<https://christian-schneider.net>): It allows to model an architecture with its assets in an agile fashion as a YAML file directly inside the IDE. Upon execution of the Threagile toolkit all standard risk rules (as well as individual custom rules if present) are checked against the architecture model. At the time the Threagile toolkit was executed on the model input file the following risk rules were checked:

## Accidental Secret Leak

accidental-secret-leak

**STRIDE:** Information Disclosure

**Description:** Sourcecode repositories (including their histories) as well as artifact registries can accidentally contain secrets like checked-in or packaged-in passwords, API tokens, certificates, crypto keys, etc.

**Detection:** In-scope sourcecode repositories and artifact registries.

**Rating:** The risk rating depends on the sensitivity of the technical asset itself and of the data assets processed and stored.

## Code Backdooring

code-backdooring

**STRIDE:** Tampering

**Description:** For each build-pipeline component Code Backdooring risks might arise where attackers compromise the build-pipeline in order to let backdoored artifacts be shipped into production. Aside from direct code backdooring this includes backdooring of dependencies and even of more lower-level build infrastructure, like backdooring compilers (similar to what the XcodeGhost malware did) or dependencies.

**Detection:** In-scope development relevant technical assets which are either accessed by out-of-scope unmanaged developer clients and/or are directly accessed by any kind of internet-located (non-VPN) component or are themselves directly located on the internet.

**Rating:** The risk rating depends on the confidentiality and integrity rating of the code being handled and deployed as well as the placement/calling of this technical asset on/from the internet.

## Container Base Image Backdooring

container-baseimage-backdooring

**STRIDE:** Tampering

**Description:** When a technical asset is built using container technologies, Base Image Backdooring risks might arise where base images and other layers used contain vulnerable components or backdoors.

**Detection:** In-scope technical assets running as containers.

**Rating:** The risk rating depends on the sensitivity of the technical asset itself and of the data assets.

## **Container Platform Escape**

container-platform-escape

**STRIDE:** Elevation of Privilege

**Description:** Container platforms are especially interesting targets for attackers as they host big parts of a containerized runtime infrastructure. When not configured and operated with security best practices in mind, attackers might exploit a vulnerability inside an container and escape towards the platform as highly privileged users. These scenarios might give attackers capabilities to attack every other container as owning the container platform (via container escape attacks) equals to owning every container.

**Detection:** In-scope container platforms.

**Rating:** The risk rating depends on the sensitivity of the technical asset itself and of the data assets processed and stored.

## **Cross-Site Request Forgery (CSRF)**

cross-site-request-forgery

**STRIDE:** Spoofing

**Description:** When a web application is accessed via web protocols Cross-Site Request Forgery (CSRF) risks might arise.

**Detection:** In-scope web applications accessed via typical web access protocols.

**Rating:** The risk rating depends on the integrity rating of the data sent across the communication link.

## **Cross-Site Scripting (XSS)**

cross-site-scripting

**STRIDE:** Tampering

**Description:** For each web application Cross-Site Scripting (XSS) risks might arise. In terms of the overall risk level take other applications running on the same domain into account as well.

**Detection:** In-scope web applications.

**Rating:** The risk rating depends on the sensitivity of the data processed or stored in the web application.

## **DoS-risky Access Across Trust-Boundary**

**dos-risky-access-across-trust-boundary**

**STRIDE:** Denial of Service

**Description:** Assets accessed across trust boundaries with critical or mission-critical availability rating are more prone to Denial-of-Service (DoS) risks.

**Detection:** In-scope technical assets (excluding load-balancer) with availability rating of critical or higher which have incoming data-flows across a network trust-boundary (excluding devops usage).

**Rating:** Matching technical assets with availability rating of critical or higher are at low risk. When the availability rating is mission-critical and neither a VPN nor IP filter for the incoming data-flow nor redundancy for the asset is applied, the risk-rating is considered medium.

**Incomplete Model****incomplete-model**

**STRIDE:** Information Disclosure

**Description:** When the threat model contains unknown technologies or transfers data over unknown protocols, this is an indicator for an incomplete model.

**Detection:** All technical assets and communication links with technology type or protocol type specified as unknown.

**Rating:** low

**LDAP-Injection****ldap-injection**

**STRIDE:** Tampering

**Description:** When an LDAP server is accessed LDAP-Injection risks might arise. The risk rating depends on the sensitivity of the LDAP server itself and of the data assets processed or stored.

**Detection:** In-scope clients accessing LDAP servers via typical LDAP access protocols.

**Rating:** The risk rating depends on the sensitivity of the LDAP server itself and of the data assets processed or stored.

**Missing Authentication****missing-authentication**

**STRIDE:** Elevation of Privilege

**Description:** Technical assets (especially multi-tenant systems) should authenticate incoming requests when the asset processes or stores sensitive data.

**Detection:** In-scope technical assets (except load-balancer, reverse-proxy, service-registry, waf, ids, and ips and in-process calls) should authenticate incoming requests when the asset processes or stores sensitive data. This is especially the case for all multi-tenant assets (there even non-sensitive ones).

**Rating:** The risk rating (medium or high) depends on the sensitivity of the data sent across

the communication link. Monitoring callers are exempted from this risk.

### Missing Two-Factor Authentication (2FA)

missing-authentication-second-factor

STRIDE: Elevation of Privilege

Description: Technical assets (especially multi-tenant systems) should authenticate incoming requests with two-factor (2FA) authentication when the asset processes or stores highly sensitive data (in terms of confidentiality, integrity, and availability) and is accessed by humans.

Detection: In-scope technical assets (except load-balancer, reverse-proxy, waf, ids, and ips) should authenticate incoming requests via two-factor authentication (2FA) when the asset processes or stores highly sensitive data (in terms of confidentiality, integrity, and availability) and is accessed by a client used by a human user.

Rating: medium

### Missing Build Infrastructure

missing-build-infrastructure

STRIDE: Tampering

Description: The modeled architecture does not contain a build infrastructure (devops-client, sourcecode-repo, build-pipeline, etc.), which might be the risk of a model missing critical assets (and thus not seeing their risks). If the architecture contains custom-developed parts, the pipeline where code gets developed and built needs to be part of the model.

Detection: Models with in-scope custom-developed parts missing in-scope development (code creation) and build infrastructure components (devops-client, sourcecode-repo, build-pipeline, etc.).

Rating: The risk rating depends on the highest sensitivity of the in-scope assets running custom-developed parts.

### Missing Cloud Hardening

missing-cloud-hardening

STRIDE: Tampering

Description: Cloud components should be hardened according to the cloud vendor best practices. This affects their configuration, auditing, and further areas.

Detection: In-scope cloud components (either residing in cloud trust boundaries or more specifically tagged with cloud provider types).

Rating: The risk rating depends on the sensitivity of the technical asset itself and of the data assets processed and stored.

### Missing File Validation

missing-file-validation

STRIDE: Spoofing

- Description:** When a technical asset accepts files, these input files should be strictly validated about filename and type.
- Detection:** In-scope technical assets with custom-developed code accepting file data formats.
- Rating:** The risk rating depends on the sensitivity of the technical asset itself and of the data assets processed and stored.

## Missing Hardening

missing-hardening

- STRIDE:** Tampering
- Description:** Technical assets with a Relative Attacker Attractiveness (RAA) value of 55 % or higher should be explicitly hardened taking best practices and vendor hardening guides into account.
- Detection:** In-scope technical assets with RAA values of 55 % or higher. Generally for high-value targets like datastores, application servers, identity providers and ERP systems this limit is reduced to 40 %
- Rating:** The risk rating depends on the sensitivity of the data processed or stored in the technical asset.

## Missing Identity Propagation

missing-identity-propagation

- STRIDE:** Elevation of Privilege
- Description:** Technical assets (especially multi-tenant systems), which usually process data for endusers should authorize every request based on the identity of the enduser when the data flow is authenticated (i.e. non-public). For DevOps usages at least a technical-user authorization is required.
- Detection:** In-scope service-like technical assets which usually process data based on enduser requests, if authenticated (i.e. non-public), should authorize incoming requests based on the propagated enduser identity when their rating is sensitive. This is especially the case for all multi-tenant assets (there even less-sensitive rated ones). DevOps usages are exempted from this risk.
- Rating:** The risk rating (medium or high) depends on the confidentiality, integrity, and availability rating of the technical asset.

## Missing Identity Provider Isolation

missing-identity-provider-isolation

- STRIDE:** Elevation of Privilege
- Description:** Highly sensitive identity provider assets and their identity datastores should be isolated from other assets by their own network segmentation trust-boundary (execution-environment boundaries do not count as network isolation).
- Detection:** In-scope identity provider assets and their identity datastores when surrounded by other (not identity-related) assets (without a network trust-boundary in-between).

This risk is especially prevalent when other non-identity related assets are within the same execution environment (i.e. same database or same application server).

Rating: Default is high impact. The impact is increased to very-high when the asset missing the trust-boundary protection is rated as strictly-confidential or mission-critical.

### Missing Identity Store

missing-identity-store

STRIDE: Spoofing

Description: The modeled architecture does not contain an identity store, which might be the risk of a model missing critical assets (and thus not seeing their risks).

Detection: Models with authenticated data-flows authorized via enduser-identity missing an in-scope identity store.

Rating: The risk rating depends on the sensitivity of the enduser-identity authorized technical assets and their data assets processed and stored.

### Missing Network Segmentation

missing-network-segmentation

STRIDE: Elevation of Privilege

Description: Highly sensitive assets and/or datastores residing in the same network segment than other lower sensitive assets (like webserver or content management systems etc.) should be better protected by a network segmentation trust-boundary.

Detection: In-scope technical assets with high sensitivity and RAA values as well as datastores when surrounded by assets (without a network trust-boundary in-between) which are of type client-system, web-server, web-application, cms, web-service-rest, web-service-soap, build-pipeline, sourcecode-repository, monitoring, or similar and there is no direct connection between these (hence no requirement to be so close to each other).

Rating: Default is low risk. The risk is increased to medium when the asset missing the trust-boundary protection is rated as strictly-confidential or mission-critical.

### Missing Vault (Secret Storage)

missing-vault

STRIDE: Information Disclosure

Description: In order to avoid the risk of secret leakage via config files (when attacked through vulnerabilities being able to read files like Path-Traversal and others), it is best practice to use a separate hardened process with proper authentication, authorization, and audit logging to access config secrets (like credentials, private keys, client certificates, etc.). This component is usually some kind of Vault.

Detection: Models without a Vault (Secret Storage).

Rating: The risk rating depends on the sensitivity of the technical asset itself and of the data assets processed and stored.

## Missing Vault Isolation

missing-vault-isolation

STRIDE: Elevation of Privilege

Description: Highly sensitive vault assets and their datastores should be isolated from other assets by their own network segmentation trust-boundary (execution-environment boundaries do not count as network isolation).

Detection: In-scope vault assets when surrounded by other (not vault-related) assets (without a network trust-boundary in-between). This risk is especially prevalent when other non-vault related assets are within the same execution environment (i.e. same database or same application server).

Rating: Default is medium impact. The impact is increased to high when the asset missing the trust-boundary protection is rated as strictly-confidential or mission-critical.

## Missing Web Application Firewall (WAF)

missing-waf

STRIDE: Tampering

Description: To have a first line of filtering defense, security architectures with web-services or web-applications should include a WAF in front of them. Even though a WAF is not a replacement for security (all components must be secure even without a WAF) it adds another layer of defense to the overall system by delaying some attacks and having easier attack alerting through it.

Detection: In-scope web-services and/or web-applications accessed across a network trust boundary not having a Web Application Firewall (WAF) in front of them.

Rating: The risk rating depends on the sensitivity of the technical asset itself and of the data assets processed and stored.

## Mixed Targets on Shared Runtime

mixed-targets-on-shared-runtime

STRIDE: Elevation of Privilege

Description: Different attacker targets (like frontend and backend/datastore components) should not be running on the same shared (underlying) runtime.

Detection: Shared runtime running technical assets of different trust-boundaries is at risk. Also mixing backend/datastore with frontend components on the same shared runtime is considered a risk.

Rating: The risk rating (low or medium) depends on the confidentiality, integrity, and availability rating of the technical asset running on the shared runtime.

## Path-Traversal

path-traversal

STRIDE: Information Disclosure

Description: When a filesystem is accessed Path-Traversal or Local-File-Inclusion (LFI) risks might arise. The risk rating depends on the sensitivity of the technical asset itself



and of the data assets processed or stored.

Detection: Filesystems accessed by in-scope callers.

Rating: The risk rating depends on the sensitivity of the data stored inside the technical asset.

## Push instead of Pull Deployment

push-instead-of-pull-deployment

STRIDE: Tampering

Description: When comparing push-based vs. pull-based deployments from a security perspective, pull-based deployments improve the overall security of the deployment targets. Every exposed interface of a production system to accept a deployment increases the attack surface of the production system, thus a pull-based approach exposes less attack surface relevant interfaces.

Detection: Models with build pipeline components accessing in-scope targets of deployment (in a non-readonly way) which are not build-related components themselves.

Rating: The risk rating depends on the highest sensitivity of the deployment targets running custom-developed parts.

## Search-Query Injection

search-query-injection

STRIDE: Tampering

Description: When a search engine server is accessed Search-Query Injection risks might arise.

Detection: In-scope clients accessing search engine servers via typical search access protocols.

Rating: The risk rating depends on the sensitivity of the search engine server itself and of the data assets processed or stored.

## Server-Side Request Forgery (SSRF)

server-side-request-forgery

STRIDE: Information Disclosure

Description: When a server system (i.e. not a client) is accessing other server systems via typical web protocols Server-Side Request Forgery (SSRF) or Local-File-Inclusion (LFI) or Remote-File-Inclusion (RFI) risks might arise.

Detection: In-scope non-client systems accessing (using outgoing communication links) targets with either HTTP or HTTPS protocol.

Rating: The risk rating (low or medium) depends on the sensitivity of the data assets receivable via web protocols from targets within the same network trust-boundary as well on the sensitivity of the data assets receivable via web protocols from the target asset itself. Also for cloud-based environments the exploitation impact is at least medium, as cloud backend services can be attacked via SSRF.

## Service Registry Poisoning

**service-registry-poisoning****STRIDE:** Spoofing**Description:** When a service registry used for discovery of trusted service endpoints Service Registry Poisoning risks might arise.**Detection:** In-scope service registries.**Rating:** The risk rating depends on the sensitivity of the technical assets accessing the service registry as well as the data assets processed or stored.**SQL/NoSQL-Injection****sql-nosql-injection****STRIDE:** Tampering**Description:** When a database is accessed via database access protocols SQL/NoSQL-Injection risks might arise. The risk rating depends on the sensitivity technical asset itself and of the data assets processed or stored.**Detection:** Database accessed via typical database access protocols by in-scope clients.**Rating:** The risk rating depends on the sensitivity of the data stored inside the database.**Unchecked Deployment****unchecked-deployment****STRIDE:** Tampering**Description:** For each build-pipeline component Unchecked Deployment risks might arise when the build-pipeline does not include established DevSecOps best-practices. DevSecOps best-practices scan as part of CI/CD pipelines for vulnerabilities in source- or byte-code, dependencies, container layers, and dynamically against running test systems. There are several open-source and commercial tools existing in the categories DAST, SAST, and IAST.**Detection:** All development-relevant technical assets.**Rating:** The risk rating depends on the highest rating of the technical assets and data assets processed by deployment-receiving targets.**Unencrypted Technical Assets****unencrypted-asset****STRIDE:** Information Disclosure**Description:** Due to the confidentiality rating of the technical asset itself and/or the processed data assets this technical asset must be encrypted. The risk rating depends on the sensitivity technical asset itself and of the data assets stored.**Detection:** In-scope unencrypted technical assets (excluding reverse-proxy, load-balancer, waf, ids, ips and embedded components like library) storing data assets rated at least as confidential or critical. For technical assets storing data assets rated as strictly-confidential or mission-critical the encryption must be of type data-with-enduser-individual-key.

Rating: Depending on the confidentiality rating of the stored data-assets either medium or high risk.

### Unencrypted Communication

unencrypted-communication

STRIDE: Information Disclosure

Description: Due to the confidentiality and/or integrity rating of the data assets transferred over the communication link this connection must be encrypted.

Detection: Unencrypted technical communication links of in-scope technical assets (excluding monitoring traffic as well as local-file-access and in-process-library-call) transferring sensitive data.

Rating: Depending on the confidentiality rating of the transferred data-assets either medium or high risk.

### Unguarded Access From Internet

unguarded-access-from-internet

STRIDE: Elevation of Privilege

Description: Internet-exposed assets must be guarded by a protecting service, application, or reverse-proxy.

Detection: In-scope technical assets (excluding load-balancer) with confidentiality rating of confidential (or higher) or with integrity rating of critical (or higher) when accessed directly from the internet. All web-server, web-application, reverse-proxy, waf, and gateway assets are exempted from this risk when they do not consist of custom developed code and the data-flow only consists of HTTP or FTP protocols. Access from monitoring systems as well as VPN-protected connections are exempted.

Rating: The matching technical assets are at low risk. When either the confidentiality rating is strictly-confidential or the integrity rating is mission-critical, the risk-rating is considered medium. For assets with RAA values higher than 40 % the risk-rating increases.

### Unguarded Direct Datastore Access

unguarded-direct-datastore-access

STRIDE: Elevation of Privilege

Description: Datastores accessed across trust boundaries must be guarded by some protecting service or application.

Detection: In-scope technical assets of type datastore (except identity-store-ldap when accessed from identity-provider and file-server when accessed via file transfer protocols) with confidentiality rating of confidential (or higher) or with integrity rating of critical (or higher) which have incoming data-flows from assets outside across a network trust-boundary. DevOps config and deployment access is excluded from this risk.

**Rating:** The matching technical assets are at low risk. When either the confidentiality rating is strictly-confidential or the integrity rating is mission-critical, the risk-rating is considered medium. For assets with RAA values higher than 40 % the risk-rating increases.

### Unnecessary Communication Link

unnecessary-communication-link

**STRIDE:** Elevation of Privilege

**Description:** When a technical communication link does not send or receive any data assets, this is an indicator for an unnecessary communication link (or for an incomplete model).

**Detection:** In-scope technical assets' technical communication links not sending or receiving any data assets.

**Rating:** low

### Unnecessary Data Asset

unnecessary-data-asset

**STRIDE:** Elevation of Privilege

**Description:** When a data asset is not processed or stored by any data assets and also not transferred by any communication links, this is an indicator for an unnecessary data asset (or for an incomplete model).

**Detection:** Modelled data assets not processed or stored by any data assets and also not transferred by any communication links.

**Rating:** low

### Unnecessary Data Transfer

unnecessary-data-transfer

**STRIDE:** Elevation of Privilege

**Description:** When a technical asset sends or receives data assets, which it neither processes or stores this is an indicator for unnecessarily transferred data (or for an incomplete model). When the unnecessarily transferred data assets are sensitive, this poses an unnecessary risk of an increased attack surface.

**Detection:** In-scope technical assets sending or receiving sensitive data assets which are neither processed nor stored by the technical asset are flagged with this risk. The risk rating (low or medium) depends on the confidentiality, integrity, and availability rating of the technical asset. Monitoring data is exempted from this risk.

**Rating:** The risk assessment is depending on the confidentiality and integrity rating of the transferred data asset either low or medium.

### Unnecessary Technical Asset

unnecessary-technical-asset

**STRIDE:** Elevation of Privilege

**Description:** When a technical asset does not process or store any data assets, this is an

indicator for an unnecessary technical asset (or for an incomplete model). This is also the case if the asset has no communication links (either outgoing or incoming).

Detection: Technical assets not processing or storing any data assets.

Rating: low

## Untrusted Deserialization

untrusted-deserialization

STRIDE: Tampering

Description: When a technical asset accepts data in a specific serialized form (like Java or .NET serialization), Untrusted Deserialization risks might arise.

Detection: In-scope technical assets accepting serialization data formats (including EJB and RMI protocols).

Rating: The risk rating depends on the sensitivity of the technical asset itself and of the data assets processed and stored.

## Wrong Communication Link Content

wrong-communication-link-content

STRIDE: Information Disclosure

Description: When a communication link is defined as readonly, but does not receive any data asset, or when it is defined as not readonly, but does not send any data asset, it is likely to be a model failure.

Detection: Communication links with inconsistent data assets being sent/received not matching their readonly flag or otherwise inconsistent protocols not matching the target technology type.

Rating: low

## Wrong Trust Boundary Content

wrong-trust-boundary-content

STRIDE: Elevation of Privilege

Description: When a trust boundary of type network-policy-namespace-isolation contains non-container assets it is likely to be a model failure.

Detection: Trust boundaries which should only contain containers, but have different assets inside.

Rating: low

## XML External Entity (XXE)

xml-external-entity

STRIDE: Information Disclosure

Description: When a technical asset accepts data in XML format, XML External Entity (XXE) risks might arise.

Detection: In-scope technical assets accepting XML data formats.

Rating: The risk rating depends on the sensitivity of the technical asset itself and of the data

assets processed and stored. Also for cloud-based environments the exploitation impact is at least medium, as cloud backend services can be attacked via SSRF (and XXE vulnerabilities are often also SSRF vulnerabilities).

## Disclaimer

Mara Schulke conducted this threat analysis using the open-source Threagile toolkit on the applications and systems that were modeled as of this report's date. Information security threats are continually changing, with new vulnerabilities discovered on a daily basis, and no application can ever be 100% secure no matter how much threat modeling is conducted. It is recommended to execute threat modeling and also penetration testing on a regular basis (for example yearly) to ensure a high ongoing level of security and constantly check for new attack vectors.

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By using the resulting information you agree that Mara Schulke and the Threagile toolkit shall be held harmless in any event.

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In this particular project, a timebox approach was used to define the analysis effort. This means that the author allotted a prearranged amount of time to identify and document threats. Because of this, there is no guarantee that all possible threats and risks are discovered. Furthermore, the analysis applies to a snapshot of the current state of the modeled architecture (based on the architecture information provided by the customer) at the examination time.

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