Threagile
Agile Threat Modeling

AppSec Village

Threagile:

Agile Threat Modeling with Open-Source Tools from within your IDE

Christian Schneider @cschneider4711 www.Christian-Schneider.net

`whoami`

Christian Schneider
Security Architect, Pentester, Trainer

my work areas:

Agile Threat Modeling
Security Architecture
DevSecOps
Pentesting

www.Christian-Schneider.net
mail@Christian-Schneider.net
@cschneider4711 on Twitter

Threagile - Agile Threat Modeling Toolkit

Idea: Bridge the gap between classic threat modeling and agile development teams.

Threat Models as declarative YAML file containing
- Data Assets
- Components
- Communication Links
- Trust Boundaries

Checked-in along with the source-tree.

Benefits of YAML model file: diff-able, collaboration capable, testable, verifiable, …

Threagile - Agile Threat Modeling Toolkit

Modeled elements contain technology and protocol type on detailed level.

Threagile analyzes the model YAML file as a graph of connected components with data flowing between them and generates:

- Model Graphs
- Potential Risks / Threats
- Hardening Recommendations
- Reports / Documentation
- … as PDF, Excel, and JSON (for DevSecOps automation in build pipelines)

Custom identified risks (during workshops for example) can be added as well.

Threagile - Agile Threat Modeling Toolkit

Technology-aware model types

~40 Coded risk rules checking the graph (and growing)

Custom risk rule plugin interface

Calculation of RAA (Relative Attacker Attractiveness) for each component

Calculation of DLP (Data Loss Probability) for each data asset

Model macros to automate certain model modifications

Risk mitigation state maintained in same YAML file

Released as open-source software

Running Threagile

Either as

- command-line interface (CLI), or
- server with REST API

Available as a Docker container:

```
docker run --rm -it
threagile/threagile
```

First Steps with Threagile

Create either a minimal stub model or a filled example model

The YAML file is the only source of input to Threagile an contains

- Data Assets
- Technical Assets
- Communication Links
- Trust Boundaries

— *and optionally more things*

Example Model: Data Assets

```yaml
data_assets:


  Customer Contracts: &customer-contracts # this example sho
    id: customer-contracts
    description: Customer Contracts (PDF)
    usage: business # values: business, devops
    tags:
    origin: Customer
    owner: Company XYZ
    quantity: many # values: very-few, few, many, very-many
    confidentiality: confidential # values: public, internal
    integrity: critical # values: archive, operational, impo
    availability: operational # values: archive, operational
```

Example Model: Technical Assets

```yaml
Apache Webserver:
  id: apache-webserver
  description:
  type: process # values: external-entity, pr
  usage: business # values: business, devops
  used_as_client_by_human: false
  out_of_scope: false
  justification_out_of_scope:
  size: application # values: system, service
  technology: web-server # values: see help
  tags:
    - linux
    - apache
    - aws:ec2
  internet: false
  machine: container # values: physical, virt
  encryption: none # values: none, transparer
  owner: Company ABC
  confidentiality: internal # values: public,
  integrity: critical # values: archive, oper
  availability: critical # values: archive, c
  justification_cia_rating:
  multi_tenant: false
  redundant: false
  custom_developed_parts: true
```

Example Model:
Referencing Data Assets (Processed & Stored)

```yaml
data_assets_processed: # sequence of IDs to reference
  - customer-accounts
  - customer-operational-data
  - customer-contracts
  - internal-business-data
data_assets_stored: # sequence of IDs to reference
  - client-application-code
  - server-application-code
data_formats_accepted: # sequence of formats like: json, xml, serialization, file, csv
  - json
  - file
```

Example Model: Communication Links

```yaml
communication_links:
  ERP System Traffic:
    target: erp-system
    description: Link to the ERP system
    protocol: https # values: see help
    authentication: token # values: none, credentials, session-id, token,
    authorization: technical-user # values: none, technical-user, enduser
    tags:
    vpn: false
    ip_filtered: false
    readonly: false
    usage: business # values: business, devops
    data_assets_sent: # sequence of IDs to reference
      - customer-accounts
      - customer-operational-data
      - internal-business-data
    data_assets_received: # sequence of IDs to reference
      - customer-accounts
      - customer-operational-data
      - customer-contracts
      - internal-business-data
```

Example Model: Trust Boundaries

```yaml
trust_boundaries:


  Web DMZ:
    id: web-dmz
    description: Web DMZ
    type: network-cloud-security-group # values: see help
    tags:
    technical_assets_inside: # sequence of IDs to reference
      - apache-webserver
      - marketing-cms
    trust_boundaries_nested: # sequence of IDs to reference


  ERP DMZ:
    id: erp-dmz
    description: ERP DMZ
    type: network-cloud-security-group # values: see help
    tags:
      - some-erp
    technical_assets_inside: # sequence of IDs to reference
      - erp-system
      - contract-fileserver
      - sql-database
    trust_boundaries_nested: # sequence of IDs to reference
```

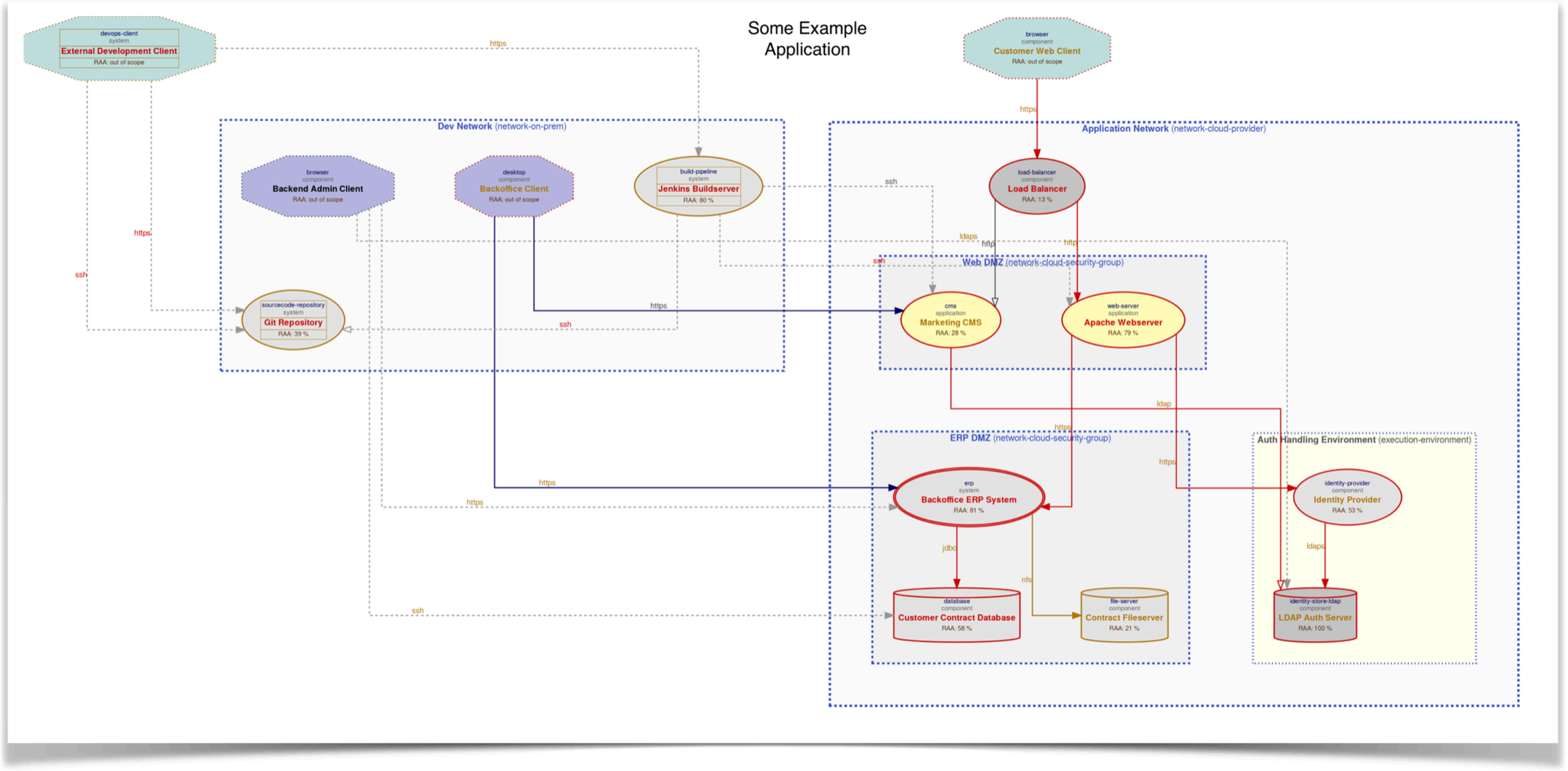
Execute a Threagile Run

Processes the YAML input

Applies risk rules (including custom developed ones)

Creates some nice output

Model Graph Generation (Data Flows)



PDF & Excel Report Generation

Threagile
Agile Threat Modeling

Threat Model Report
Some Example Application

1 July 2020

Christian Schneider

www.example.com

Threat Model Report via Threagile

Table of Contents - Some Example Application

Table of Contents

Results Overview
Management Summary
Impact Analysis of 84 Initial Risks in 28 Categories
Risk Mitigation
Impact Analysis of 82 Remaining Risks in 27 Categories
Application Overview
Data-Flow Diagram
Security Requirements
Abuse Cases
Tag Listing
STRIDE Classification of Identified Risks
Assignment by Function
RAA Analysis
Data Mapping
Out-of-Scope Assets: 4 Assets
Potential Model Failures: 3 / 3 Risks
Questions: 1 / 3 Questions

Risks by Vulnerability Category
Identified Risks grouped by Vulnerability Category
Some Individual Risk Example: 2 / 2 Risks
SQL/NoSQL-Injection: 1 / 1 Risk
XML External Entity (XXE): 1 / 1 Risk
Cross-Site Scripting (XSS): 4 / 4 Risks
Missing Authentication: 2 / 2 Risks
Missing Cloud Hardening: 5 / 5 Risks
Missing File Validation: 1 / 1 Risk
Missing Hardening: 6 / 6 Risks
Path-Traversal: 1 / 1 Risk
Server-Side Request Forgery (SSRF): 2 / 2 Risks
Unencrypted Communication: 4 / 4 Risks
Unguarded Access From Internet: 3 / 3 Risks
Untrusted Deserialization: 2 / 2 Risks
Accidental Secret Leak: 1 / 1 Risk
Code Backdooring: 2 / 2 Risks
Container Baseimage Backdooring: 2 / 2 Risks
Cross-Site Request Forgery (CSRF): 7 / 7 Risks
Missing Identity Propagation: 1 / 1 Risk

Threat Model Report via Threagile — confidential —

Management Summary - Some Example Application

Management Summary

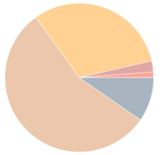
Threagile toolkit was used to model the architecture of "Some Example Application" and derive risks by analyzing the components and data flows. The risks identified during this analysis are shown in the following chapters. Identified risks during threat modeling do not necessarily mean that the vulnerability 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 "Some Example Application" whether the mitigation advices have been applied or not.

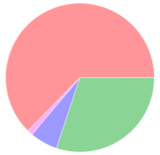
Each risk finding references a chapter of the OWASP ASVS (Application Security Verification Standard) audit checklist. The OWASP ASVS checklist should be considered as an inspiration by architects and developers to further harden the application in a Defense-in-Depth approach. Additionally, for each 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 **83 initial risks** in **27 categories** have been identified during the threat modeling process:

1 critical risk
2 high risk
26 elevated risk
46 medium risk
8 low risk

52 unchecked
0 in discussion
1 accepted
5 in progress
25 *mitigated*
0 *false positive*





Just s

Threat M

Page 5

Table of Contents - Some Example Application

Missing Two-Factor Authentication (2FA): 9 / 9 Risks 74
Missing Vault (Secret Storage): 1 / 1 Risk 77
Missing Web Application Firewall (WAF): 4 / 4 Risks 79
Mixed Targets on Shared Runtime: 1 / 1 Risk 81
Push instead of Pull Deployment: 2 / 2 Risks 83
Unchecked Deployment: 3 / 3 Risks 85
Unencrypted Technical Assets: 8 / 8 Risks 87
DoS-risky Access Across Trust-Boundary: 5 / 5 Risks 90
Missing Network Segmentation: 2 / 2 Risks 92
LDAP-Injection: 0 / 2 Risks 94

Risks by Technical Asset
Identified Risks grouped by Technical Asset 96
Customer Contract Database: 4 / 4 Risks 97
Backoffice ERP System: 19 / 19 Risks 100
Apache Webserver: 14 / 14 Risks 106
Contract Fileserver: 4 / 4 Risks 111
Identity Provider: 6 / 7 Risks 114
Jenkins Buildserver: 8 / 8 Risks 117
LDAP Auth Server: 3 / 3 Risks 121
Load Balancer: 1 / 1 Risk 124
Marketing CMS: 10 / 11 Risks 127
Git Repository: 8 / 8 Risks 132
Backend Admin Client: out-of-scope 136
Backoffice Client: out-of-scope 139
Customer Web Client: out-of-scope 141
External Development Client: out-of-scope 143

Data Loss Probabilities by Data Asset
Identified Data Loss Probabilities grouped by Data Asset 146
Build Job Config: 9 / 9 Risks 147
Client Application Code: 34 / 34 Risks 148
Customer Accounts: 55 / 57 Risks 150
Customer Contract Summaries: 8 / 8 Risks 152
Customer Contracts: 37 / 37 Risks 153
Customer Operational Data: 38 / 38 Risks 155
Database Customizing and Dumps: 9 / 9 Risks 157
ERP Customizing Data: 15 / 15 Risks 158
ERP Logs: 15 / 15 Risks 159
Marketing Material: 23 / 23 Risks 160

Threat Model Report via Threagile — confidential — Page 3

Impact Analysis of 84 Initial Risks in 28 Categories - Some Example Application

Impact Analysis of 84 Initial Risks in 28 Categories

The most prevalent impacts of the **84 initial risks** (distributed over **28 risk categories**) are (taking the severity ratings into account and using the highest for each category):
Risk finding paragraphs are clickable and l

Critical: **Some Individual Risk**
Very High impact.
Some text describing the impact

High: **SQL/NoSQL-Injection**: 1
If this risk is unmitigated, attacke
data and eventually further esca

High: **XML External Entity (XX**
impact.
If this risk is unmitigated, attacke
key/credential files, deployment
components and/or access sens

Elevated: **Cross-Site Scripting**
impact.
If this risk remains unmitigated,
steal or modify user data.

Elevated: **LDAP-Injection**: 2 In
If this risk remains unmitigated,
data from the LDAP server than

Elevated: **Missing Authenticat**
impact.
If this risk is unmitigated, attacke
unauthenticated way.

Elevated: **Missing Cloud Hard**
High impact.
If this risk is unmitigated, attacke

Elevated: **Missing File Validati**
impact.
If this risk is unmitigated, attacke

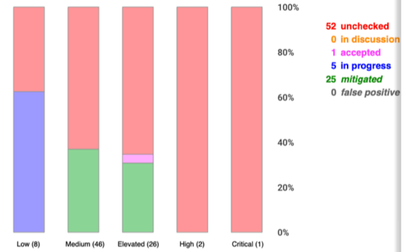
Elevated: **Missing Hardening**
If this risk remains unmitigated,

Threat Model Report via Threagile

Risk Mitigation - Some Example Application

Risk Mitigation

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

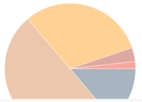


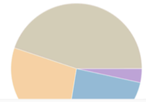
52 unchecked
0 in discussion
1 accepted
5 in progress
25 *mitigated*
0 *false positive*

After removal of risks with status *mitigated* and *false positive* the following **58 remain unmitigated**:

1 unmitigated critical risk
2 unmitigated high risk
18 unmitigated elevated risk
29 unmitigated medium risk
8 unmitigated low risk

2 business side related
14 architecture related
16 development related
26 operations related





Impact Analysis of 58 Remaining Risks in 23 Categories - Some Example Application

Impact Analysis of 58 Remaining Risks in 23 Categories

The most prevalent impacts of the **58 remaining risks** (distributed over **23 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.

Critical: **Some Individual Risk Example**: 2 Remaining Risks - Exploitation likelihood is *Frequent* with *Very High* impact.
Some text describing the impact...

High: **SQL/NoSQL-Injection**: 1 Remaining Risk - Exploitation likelihood is *Very Likely* with *High* impact.
If this risk is unmitigated, attackers might be able to modify SQL/NoSQL queries to steal and modify data and eventually further escalate towards a deeper system penetration via code executions.

High: **XML External Entity (XXE)**: 1 Remaining Risk - Exploitation likelihood is *Very Likely* with *High* impact.
If this risk is unmitigated, attackers might be able to read sensitive files (configuration data, key/credential files, deployment files, business data files, etc.) form the filesystem of affected components and/or access sensitive services or files of other components.

Elevated: **Cross-Site Scripting (XSS)**: 4 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 Authentication**: 2 Remaining Risks - Exploitation likelihood is *Likely* with *Medium* impact.
If this risk is unmitigated, attackers might be able to access or modify sensitive data in an unauthenticated way.

Elevated: **Missing Cloud Hardening**: 5 Remaining Risks - Exploitation likelihood is *Unlikely* with *Very High* impact.
If this risk is unmitigated, attackers might access cloud components in an unintended way and .

Elevated: **Missing File Validation**: 1 Remaining Risk - Exploitation likelihood is *Very Likely* with *Medium* impact.
If this risk is unmitigated, attackers might be able to provide malicious files to the application.

Elevated: **Server-Side Request Forgery (SSRF)**: 2 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.

Elevated: **Unencrypted Communication**: 4 Remaining Risks - Exploitation likelihood is *Likely* with *High* impact.
If this risk is unmitigated, network attackers might be able to to eavesdrop on unencrypted sensitive data sent between components.

Threat Model Report via Threagile — confidential — Page 10

Some Example Application

	A	B	C	D	E	F	G	H	I	J	K
1	Severity	Likelihood	Impact	STRIDE	Function	CWE	Risk Category	Technical Asset	Communication Link	RAA %	Identified Risk
2	Critical	Likely	Medium	Repudiation	Business Side	CWE-693	Some Individual Risk Example	Customer Contract Database		58	Example Individual Risk at Database
3	Medium	Frequent	Very High	Repudiation	Business Side	CWE-693	Some Individual Risk Example	Contract Fileserver		21	Example Individual Risk at Contract Filesystem
4	High	Very Likely	High	Tampering	Development	CWE-89	SQL/NoSQL-Injection	Backoffice ERP System	Database Traffic	81	SQL/NoSQL-Injection risk at Backoffice ERP System against database C
5	High	Very Likely	High	Information Disclosure	Development	CWE-611	XML External Entity (XXE)	Backoffice ERP System		81	XML External Entity (XXE) risk at Backoffice ERP System
6	Elevated	Likely	High	Tampering	Development	CWE-79	Cross-Site Scripting (XSS)	Apache Webserver		79	Cross-Site Scripting (XSS) risk at Apache Webserver
7	Elevated	Likely	High	Tampering	Development	CWE-79	Cross-Site Scripting (XSS)	Backoffice ERP System		81	Cross-Site Scripting (XSS) risk at Backoffice ERP System
8	Elevated	Likely	High	Tampering	Development	CWE-79	Cross-Site Scripting (XSS)	Identity Provider		53	Cross-Site Scripting (XSS) risk at Identity Provider
9	Elevated	Likely	High	Tampering	Development	CWE-79	Cross-Site Scripting (XSS)	Marketing CMS		28	Cross-Site Scripting (XSS) risk at Marketing CMS
10	Elevated	Likely	Medium	Elevation of Privilege	Architecture	CWE-306	Missing Authentication	Marketing CMS	CMS Content Traffic	28	Missing Authentication covering communication link CMS Content Tra
11	Elevated	Likely	Medium	Elevation of Privilege	Architecture	CWE-306	Missing Authentication	Contract Fileserver	NFS Filesystem Access	21	Missing Authentication covering communication link NFS Filesystem A
12	Elevated	Unlikely	Very High	Tampering	Operations	CWE-1008	Missing Cloud Hardening			0	Missing Cloud Hardening (AWS) risk at Application Network: <u>CIS B
13	Elevated	Unlikely	Very High	Tampering	Operations	CWE-1008	Missing Cloud Hardening	Apache Webserver		79	Missing Cloud Hardening (EC2) risk at Apache Webserver: <u>CIS Ben
14	Elevated	Unlikely	Very High	Tampering	Operations	CWE-1008	Missing Cloud Hardening			0	Missing Cloud Hardening risk at ERP DMZ
15	Elevated	Unlikely	Very High	Tampering	Operations	CWE-1008	Missing Cloud Hardening			0	Missing Cloud Hardening risk at Web DMZ
16	Medium	Unlikely	High	Tampering	Operations	CWE-1008	Missing Cloud Hardening	Contract Fileserver		21	Missing Cloud Hardening (S3) risk at Contract Fileserver: <u>Security
17	Elevated	Very Likely	Medium	Spoofing	Development	CWE-434	Missing File Validation	Apache Webserver		79	Missing File Validation risk at Apache Webserver
18	Elevated	Likely	Medium	Tampering	Operations	CWE-16	Missing Hardening	Apache Webserver		79	Missing Hardening risk at Apache Webserver
19	Elevated	Likely	Medium	Tampering	Operations	CWE-16	Missing Hardening	Backoffice ERP System		81	Missing Hardening risk at Backoffice ERP System
20	Elevated	Likely	Medium	Tampering	Operations	CWE-16	Missing Hardening	Customer Contract Database		58	Missing Hardening risk at Customer Contract Database
21	Elevated	Likely	Medium	Tampering	Operations	CWE-16	Missing Hardening	Identity Provider		53	Missing Hardening risk at Identity Provider
22	Elevated	Likely	Medium	Tampering	Operations	CWE-16	Missing Hardening	Jenkins Buildserver		80	Missing Hardening risk at Jenkins Buildserver
23	Elevated	Likely	Medium	Tampering	Operations	CWE-16	Missing Hardening	LDAP Auth Server		100	Missing Hardening risk at LDAP Auth Server
24	Elevated	Very Likely	Medium	Information Disclosure	Development	CWE-22	Path-Traversal	Backoffice ERP System	NFS Filesystem Access	81	Path-Traversal risk at Backoffice ERP System against filesystem Contra
25	Elevated	Likely	Medium	Information Disclosure	Development	CWE-918	Server-Side Request Forgery (SSRF)	Apache Webserver	ERP System Traffic	79	Server-Side Request Forgery (SSRF) risk at Apache Webserver server-s
26	Elevated	Likely	Medium	Information Disclosure	Development	CWE-918	Server-Side Request Forgery (SSRF)	Apache Webserver	Auth Credential Check Traffic	79	Server-Side Request Forgery (SSRF) risk at Apache Webserver server-s
27	Elevated	Likely	High	Information Disclosure	Operations	CWE-319	Unencrypted Communication	Marketing CMS	Auth Traffic	28	Unencrypted Communication named Auth Traffic between Marketing
28	Elevated	Likely	High	Information Disclosure	Operations	CWE-319	Unencrypted Communication	Load Balancer	Web Application Traffic	13	Unencrypted Communication named Web Application Traffic between
29	Medium	Unlikely	High	Information Disclosure	Operations	CWE-319	Unencrypted Communication	Backoffice ERP System	Database Traffic	81	Unencrypted Communication named Database Traffic between Backo
30	Medium	Unlikely	Medium	Information Disclosure	Operations	CWE-319	Unencrypted Communication	Backoffice ERP System	NFS Filesystem Access	81	Unencrypted Communication named NFS Filesystem Access between
31	Medium	Very Likely	Medium	Elevation of Privilege	Architecture	CWE-501	Unguarded Access From Internet	Jenkins Buildserver	Jenkins Web-UI Access	80	Unguarded Access from Internet of Jenkins Buildserver by External De
32	Medium	Very Likely	Low	Elevation of Privilege	Architecture	CWE-501	Unguarded Access From Internet	Git Repository	Git-Repo Code Write Access	39	Unguarded Access from Internet of Git Repository by External Develo
33	Medium	Very Likely	Low	Elevation of Privilege	Architecture	CWE-501	Unguarded Access From Internet	Git Repository	Git-Repo Web-UI Access	39	Unguarded Access from Internet of Git Repository by External Develo
34	Elevated	Likely	Very High	Tampering	Architecture	CWE-502	Untrusted Deserialization	Jenkins Buildserver		80	Untrusted Deserialization risk at Jenkins Buildserver
35	Elevated	Likely	Very High	Tampering	Architecture	CWE-502	Untrusted Deserialization	Backoffice ERP System		81	Untrusted Deserialization risk at Backoffice ERP System
36	Medium	Unlikely	High	Information Disclosure	Operations	CWE-200	Accidental Secret Leak	Git Repository		39	Accidental Secret Leak (Git) risk at Git Repository: <u>Git Leak Preven
37	Medium	Unlikely	High	Tampering	Operations	CWE-912	Code Backdooring	Git Repository		39	Code Backdooring risk at Git Repository
38	Medium	Unlikely	High	Tampering	Operations	CWE-912	Code Backdooring	Jenkins Buildserver		80	Code Backdooring risk at Jenkins Buildserver
39	Medium	Unlikely	High	Tampering	Operations	CWE-912	Container Baseimage Backdooring	Apache Webserver		79	Container Baseimage Backdooring risk at Apache Webserver
40	Medium	Unlikely	High	Tampering	Operations	CWE-912	Container Baseimage Backdooring	Marketing CMS		28	Container Baseimage Backdooring risk at Marketing CMS
41	Medium	Very Likely	Low	Spoofing	Development	CWE-352	Cross-Site Request Forgery (CSRF)	Apache Webserver	Web Application Traffic	79	Cross-Site Request Forgery (CSRF) risk at Apache Webserver via Web A

Impact Summary (before & after mitigation)

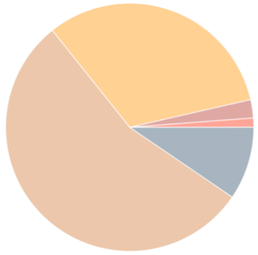
Management Summary

Threagile toolkit was used to model the architecture of "Some Example Application" 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 "Some Example Application" whether the mitigation advices have been applied or not.

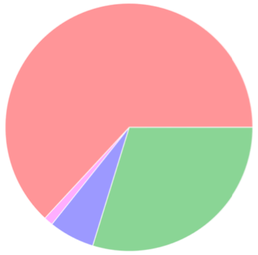
Each risk finding references a chapter of the OWASP ASVS (Application Security Verification Standard) audit checklist. The OWASP ASVS checklist should be considered as an inspiration by architects and developers to further harden the application in a Defense-in-Depth approach. Additionally, for each 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 **84 initial risks** in **28 categories** have been identified during the threat modeling process:

1 critical risk
2 high risk
27 elevated risk
46 medium risk
8 low risk



53 unchecked
0 in discussion
1 accepted
5 in progress
25 *mitigated*
0 *false positive*



Just some **more** custom summary possible here...

Impact Analysis of 84 Initial Risks in 28 Categories

The most prevalent impacts of the **84 initial risks** (distributed over **28 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.

Critical: **Some Individual Risk Example**: 2 Initial Risks - Exploitation likelihood is *Frequent* with *Very High* impact.
Some text describing the impact...

High: **SQL/NoSQL-Injection**: 1 Initial Risk - Exploitation likelihood is *Very Likely* with *High* impact.
If this risk is unmitigated, attackers might be able to modify SQL/NoSQL queries to steal and modify data and eventually further escalate towards a deeper system penetration via code executions.

High: **XML External Entity (XXE)**: 1 Initial Risk - Exploitation likelihood is *Very Likely* with *High* impact.
If this risk is unmitigated, attackers might be able to read sensitive files (configuration data, key/credential files, deployment files, business data files, etc.) form the filesystem of affected components and/or access sensitive services or files of other components.

Elevated: **Cross-Site Scripting (XSS)**: 4 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: **LDAP-Injection**: 2 Initial Risks - Exploitation likelihood is *Likely* with *High* impact.
If this risk remains unmitigated, attackers might be able to modify LDAP queries and access more data from the LDAP server than allowed.

Elevated: **Missing Authentication**: 2 Initial Risks - Exploitation likelihood is *Likely* with *Medium* impact.
If this risk is unmitigated, attackers might be able to access or modify sensitive data in an unauthenticated way.

Elevated: **Missing Cloud Hardening**: 5 Initial Risks - Exploitation likelihood is *Unlikely* with *Very High* impact.
If this risk is unmitigated, attackers might access cloud components in an unintended way and .

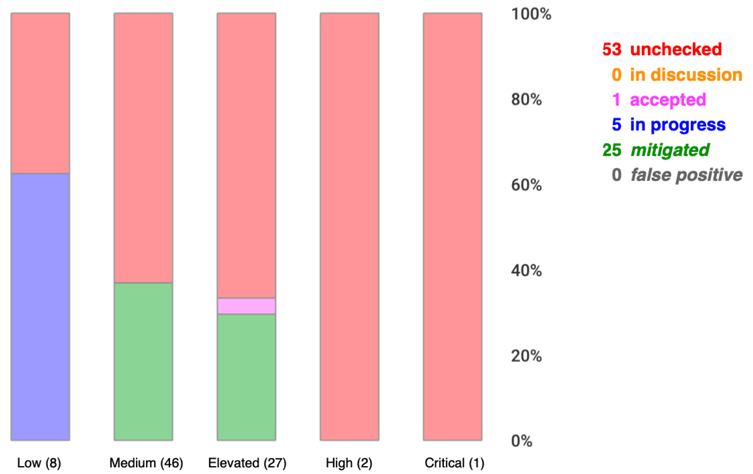
Elevated: **Missing File Validation**: 1 Initial Risk - Exploitation likelihood is *Very Likely* with *Medium* impact.
If this risk is unmitigated, attackers might be able to provide malicious files to the application.

Elevated: **Missing Hardening**: 6 Initial Risks - Exploitation likelihood is *Likely* with *Medium* impact.
If this risk remains unmitigated, attackers might be able to easier attack high-value targets.

Risk Mitigation

Risk Mitigation

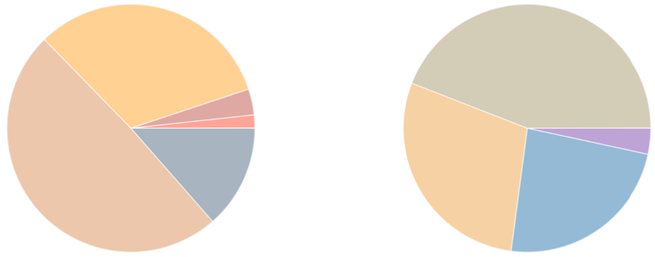
The following chart gives a high-level overview of the risk tracking status (including mitigated risks):



After removal of risks with status *mitigated* and *false positive* the following **59 remain unmitigated**:

1 unmitigated critical risk
2 unmitigated high risk
19 unmitigated elevated risk
29 unmitigated medium risk
8 unmitigated low risk

2 business side related
14 architecture related
17 development related
26 operations related



Impact Analysis of 59 Remaining Risks in 24 Categories

The most prevalent impacts of the **59 remaining risks** (distributed over **24 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.

Critical: **Some Individual Risk Example**: 2 Remaining Risks - Exploitation likelihood is *Frequent* with *Very High* impact.
Some text describing the impact...

High: **SQL/NoSQL-Injection**: 1 Remaining Risk - Exploitation likelihood is *Very Likely* with *High* impact.
If this risk is unmitigated, attackers might be able to modify SQL/NoSQL queries to steal and modify data and eventually further escalate towards a deeper system penetration via code executions.

High: **XML External Entity (XXE)**: 1 Remaining Risk - Exploitation likelihood is *Very Likely* with *High* impact.
If this risk is unmitigated, attackers might be able to read sensitive files (configuration data, key/credential files, deployment files, business data files, etc.) form the filesystem of affected components and/or access sensitive services or files of other components.

Elevated: **Cross-Site Scripting (XSS)**: 4 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 Authentication**: 2 Remaining Risks - Exploitation likelihood is *Likely* with *Medium* impact.
If this risk is unmitigated, attackers might be able to access or modify sensitive data in an unauthenticated way.

Elevated: **Missing Cloud Hardening**: 5 Remaining Risks - Exploitation likelihood is *Unlikely* with *Very High* impact.
If this risk is unmitigated, attackers might access cloud components in an unintended way and .

Elevated: **Missing File Validation**: 1 Remaining Risk - Exploitation likelihood is *Very Likely* with *Medium* impact.
If this risk is unmitigated, attackers might be able to provide malicious files to the application.

Elevated: **Path-Traversal**: 1 Remaining Risk - Exploitation likelihood is *Very Likely* with *Medium* impact.
If this risk is unmitigated, attackers might be able to read sensitive files (configuration data, key/credential files, deployment files, business data files, etc.) from the filesystem of affected components.

STRIDE Classification of Risks

STRIDE Classification of Identified Risks

This chapter clusters and classifies the risks by STRIDE categories: In total **84 potential risks** have been identified during the threat modeling process of which **8 in the Spoofing** category, **33 in the Tampering** category, **2 in the Repudiation** category, **18 in the Information Disclosure** category, **5 in the Denial of Service** category, and **18 in the Elevation of Privilege** category.
Risk finding paragraphs are clickable and link to the corresponding chapter.

Spoofing

Elevated: **Missing File Validation**: 1 / 1 Risk - Exploitation likelihood is *Very Likely* with *Medium* impact.
When a technical asset accepts files, these input files should be strictly validated about filename and type.

Medium: **Cross-Site Request Forgery (CSRF)**: 7 / 7 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

High: **SQL/NoSQL-Injection**: 1 / 1 Risk - Exploitation likelihood is *Very Likely* with *High* impact.
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.

Elevated: **Cross-Site Scripting (XSS)**: 4 / 4 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: **LDAP-Injection**: 0 / 2 Risks - Exploitation likelihood is *Likely* with *High* impact.
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.

Elevated: **Missing Cloud Hardening**: 5 / 5 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**: 0 / 6 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.

Information Disclosure

High: **XML External Entity (XXE)**: 1 / 1 Risk - Exploitation likelihood is *Very Likely* with *High* impact.
When a technical asset accepts data in XML format, XML External Entity (XXE) risks might arise.

Elevated: **Path-Traversal**: 1 / 1 Risk - Exploitation likelihood is *Very Likely* with *Medium* impact.
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.

Elevated: **Server-Side Request Forgery (SSRF)**: 2 / 2 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.

Elevated: **Unencrypted Communication**: 4 / 4 Risks - Exploitation likelihood is *Likely* 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.

Medium: **Accidental Secret Leak**: 1 / 1 Risk - Exploitation likelihood is *Unlikely* with *High* impact.
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.

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 Technical Assets**: 0 / 8 Risks - Exploitation likelihood is *Unlikely* with *High* impact.
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.

Denial of Service

Low: **DoS-risky Access Across Trust-Boundary**: 5 / 5 Risks - Exploitation likelihood is *Unlikely* with *Low* impact.
Assets accessed across trust boundaries with critical or mission-critical availability rating are more prone to Denial-of-Service (DoS) risks.

Assignment by Function

Assignment by Function

This chapter clusters and assigns the risks by functions which are most likely able to ch
mitigate them: In total **84 potential risks** have been identified during the threat modelin
which **11 should be checked by Business Side**, **14 should be checked by Architec
should be checked by Development**, and **40 should be checked by Operations**.
Risk finding paragraphs are clickable and link to the corresponding chapter.

Business Side

Critical: **Some Individual Risk Example**: 2 / 2 Risks - Exploitation likelihood is *Freq*
Very High impact.
Some text describing the mitigation...

Medium: **Missing Two-Factor Authentication (2FA)**: 0 / 9 Risks - Exploitation likelih
Unlikely with *Medium* impact.
Apply an authentication method to the technical asset protecting highly sensitive data
two-factor authentication for human users.

Architecture

Elevated: **Missing Authentication**: 2 / 2 Risks - Exploitation likelihood is *Likely* with
impact.
Apply an authentication method to the technical asset. To protect highly sensitive dat
the use of two-factor authentication for human users.

Elevated: **Unguarded Access From Internet**: 3 / 3 Risks - Exploitation likelihood is
with *Medium* impact.
Encapsulate the asset behind a guarding service, application, or reverse-proxy. For a
maintenance a bastion-host should be used as a jump-server. For file transfer a
store-and-forward-host should be used as an indirect file exchange platform.

Elevated: **Untrusted Deserialization**: 2 / 2 Risks - Exploitation likelihood is *Likely* wi
impact.
Try to avoid the deserialization of untrusted data (even of data within the same trust-
long as it is sent across a remote connection) in order to stay safe from Untrusted De
vulnerabilities. Alternatively a strict whitelisting approach of the classes/types/values
deserialize might help as well. When a third-party product is used instead of custom
software, check if the product applies the proper mitigation and ensure a reasonable

Medium: **Missing Identity Propagation**: 1 / 1 Risk - Exploitation likelihood is *Unlikel*
Medium impact.
When processing requests for endusers if possible authorize in the backend against
propagated identity of the enduser. This can be achieved in passing JWTs or similar
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*
Medium impact.
Consider using a Vault (Secret Storage) to securely store and access config secrets (lik
credentials, private keys, client certificates, etc.).

Medium: **Push instead of Pull Deployment**: 2 / 2 Risks - Exploitation likelihood is *Unli*
Medium impact.
Try to prefer pull-based deployments (like GitOps scenarios offer) over push-based dep

Medium: **Unchecked Deployment**: 3 / 3 Risks - Exploitation likelihood is *Unlikely* with
impact.
Apply DevSecOps best-practices and use scanning tools to identify vulnerabilities in so
byte-code,dependencies, container layers, and optionally also via dynamic scans again
test systems.

Development

High: **SQL/NoSQL-Injection**: 1 / 1 Risk - Exploitation likelihood is *Very Likely* with *High*
Try to use parameter binding to be safe from injection vulnerabilities. When a third-party
is used instead of custom developed software, check if the product applies the proper m
and ensure a reasonable patch-level.

High: **XML External Entity (XXE)**: 1 / 1 Risk - Exploitation likelihood is *Very Likely* with
impact.
Apply hardening of all XML parser instances in order to stay safe from XML External En
vulnerabilities. When a third-party product is used instead of custom developed softwar
the product applies the proper mitigation and ensure a reasonable patch-level.

Elevated: **Cross-Site Scripting (XSS)**: 4 / 4 Risks - Exploitation likelihood is *Likely* with
impact.
Try to encode all values sent back to the browser and also handle DOM-manipulations
way to avoid DOM-based XSS. When a third-party product is used instead of custom de
software, check if the product applies the proper mitigation and ensure a reasonable pa

Elevated: **LDAP-Injection**: 0 / 2 Risks - Exploitation likelihood is *Likely* with *High* impac
Try to use libraries that properly encode LDAP meta characters in searches and queries
access the LDAP sever in order to stay safe from LDAP-Injection vulnerabilities. When
third-party product is used instead of custom developed software, check if the product a
proper mitigation and ensure a reasonable patch-level.

Elevated: **Missing File Validation**: 1 / 1 Risk - Exploitation likelihood is *Very Likely* with
impact.
Filter by file extension and discard (if feasible) the name provided. Whitelist the accepte
types and determine the mime-type on the server-side (for example via "Apache Tika" c
checks). If the file is retrievable by endusers and/or backoffice employees, consider per
scans for popular malware (if the files can be retrieved much later than they were uploa
apply a fresh malware scan during retrieval to scan with newer signatures of popular ma

Also enforce limits on maximum file size to avoid denial-of-service like scenarios.

Elevated: **Path-Traversal**: 1 / 1 Risk - Exploitation likelihood is *Very Likely* with *Medium* impact.
Before accessing the file cross-check that it resides in the expected folder and is of the expected
type and filename/suffix. Try to use a mapping if possible instead of directly accessing by a
filename which is (partly or fully) provided by the caller. 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)**: 2 / 2 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)**: 7 / 7 Risks - Exploitation likelihood is *Very Likely*
with *Low* impact.
Try to use anti-CSRF tokens ot 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**: 5 / 5 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**: 0 / 6 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).

Elevated: **Unencrypted Communication**: 4 / 4 Risks - Exploitation likelihood is *Likely* with *High*
impact.
Apply transport layer encryption to the communication link.

Medium: **Accidental Secret Leak**: 1 / 1 Risk - Exploitation likelihood is *Unlikely* with *High* impact.
Establish measures preventing accidental check-in or package-in of secrets into sourcecode
repositories and artifact registries. This starts by using good .gitignore and .dockerignore files, but
does not stop there. See for example tools like *"git-secrets" or "Talisman"* to have check-in
preventive measures for secrets. Consider also to regularly scan your repositories for secrets
accidentally checked-in using scanning tools like *"gitleaks" or "gitrob"*.

Relative Attacker Attractiveness (RAA)

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.

LDAP Auth Server: RAA 100%
LDAP authentication server

Backoffice ERP System: RAA 81%
ERP system

Jenkins Buildserver: RAA 80%
Jenkins buildserver

Apache Webserver: RAA 75%
Apache Webserver

Customer Contract Database: RAA 58%
The database behind the ERP system

Identity Provider: RAA 53%
Identity provider server

Git Repository: RAA 39%
Git repository server

Marketing CMS: RAA 28%
CMS for the marketing content

Contract Fileserver: RAA 21%
NFS Filesystem for storing the contract PDFs

Load Balancer: RAA 13%
Load Balancer (HA-Proxy)

Also reflected in the created data flow diagram

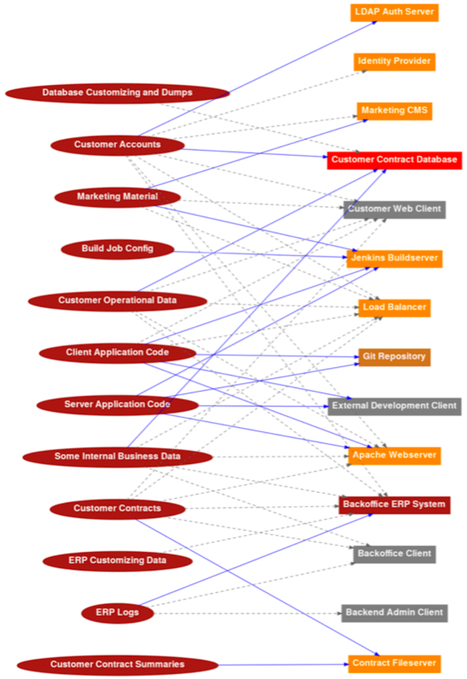
Custom calculation algorithms possible as plugins

Data Loss Probabilities (DLP)

Colors due to risks of where the data is processed and stored

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 loss probability and risk level (see the "Data Loss 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.



Customer Contract Summaries: 6 / 7 Risks

Customer Contract Summaries

ID:	contract-summaries	
Usage:	business	
Quantity:	very-few	
Tags:	none	
Origin:	Customer	
Owner:	Company XYZ	
Confidentiality:	restricted	(rated 3 in scale of 5)
Integrity:	operational	(rated 2 in scale of 5)
Availability:	operational	(rated 2 in scale of 5)
CIA-Justification:	Just some summaries.	
Processed by:	none	
Stored by:	Contract Fileserver	
Sent via:	none	
Received via:	none	
Data Loss:	**probable**	
Data Loss Risks:	This data asset has data loss potential because of 6 remaining risks:	

Probable: missing-cloud-hardening@application-network

Probable: missing-cloud-hardening@contract-fileserver

Probable: missing-cloud-hardening@erp-dmz

Possible: missing-authentication@erp-system>nfs-filesystem-access@erp-system@contract-fileserver

Possible: unencrypted-communication@erp-system>nfs-filesystem-access@erp-system@contract-fileserver

Improbable: mixed-targets-on-shared-runtime@webapp-virtualization

Risk Mitigation Recommendations

Server-Side Request Forgery (SSRF): 2 / 2 Risks

Description (Information Disclosure): CWE 918

When a server system (i.e. not a client) is accessing other server systems v
Server-Side Request Forgery (SSRF) or Local-File-Inclusion (LFI) or Remot
risks might arise.

Impact

If this risk is unmitigated, attackers might be able to access sensitive service
network-reachable components by modifying outgoing calls of affected com

Detection Logic

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

Risk Rating

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

False Positives

Servers not sending outgoing web requests can be considered as false posi

Mitigation (Development): SSRF Prevention

Try to avoid constructing the outgoing target URL with caller controllable val
mapping (whitelist) when accessing outgoing URLs instead of creating them
controllable values. When a third-party product is used instead of custom de
if the product applies the proper mitigation and ensure a reasonable patch-l

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 ch

XML External Entity (XXE): 1 / 1 Risk

Description (Information Disclosure): CWE 611

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

Impact

If this risk is unmitigated, attackers might be able to read sensitive files (configuration data, key/credential files, deployment files, business data files, etc.) form the filesystem of affected components and/or access sensitive services or files of other components.

Detection Logic

In-scope technical assets accepting XML data formats.

Risk Rating

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

False Positives

Fully trusted (i.e. cryptographically signed or similar) XML data can be considered as false positives after individual review.

Mitigation (Development): XML Parser Hardening

Apply hardening of all XML parser instances in order to stay safe from XML External Entity (XXE) vulnerabilities. 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: V14 - Configuration Verification Requirements
Cheat Sheet: XML_External_Entity_Prevention_Cheat_Sheet

Check

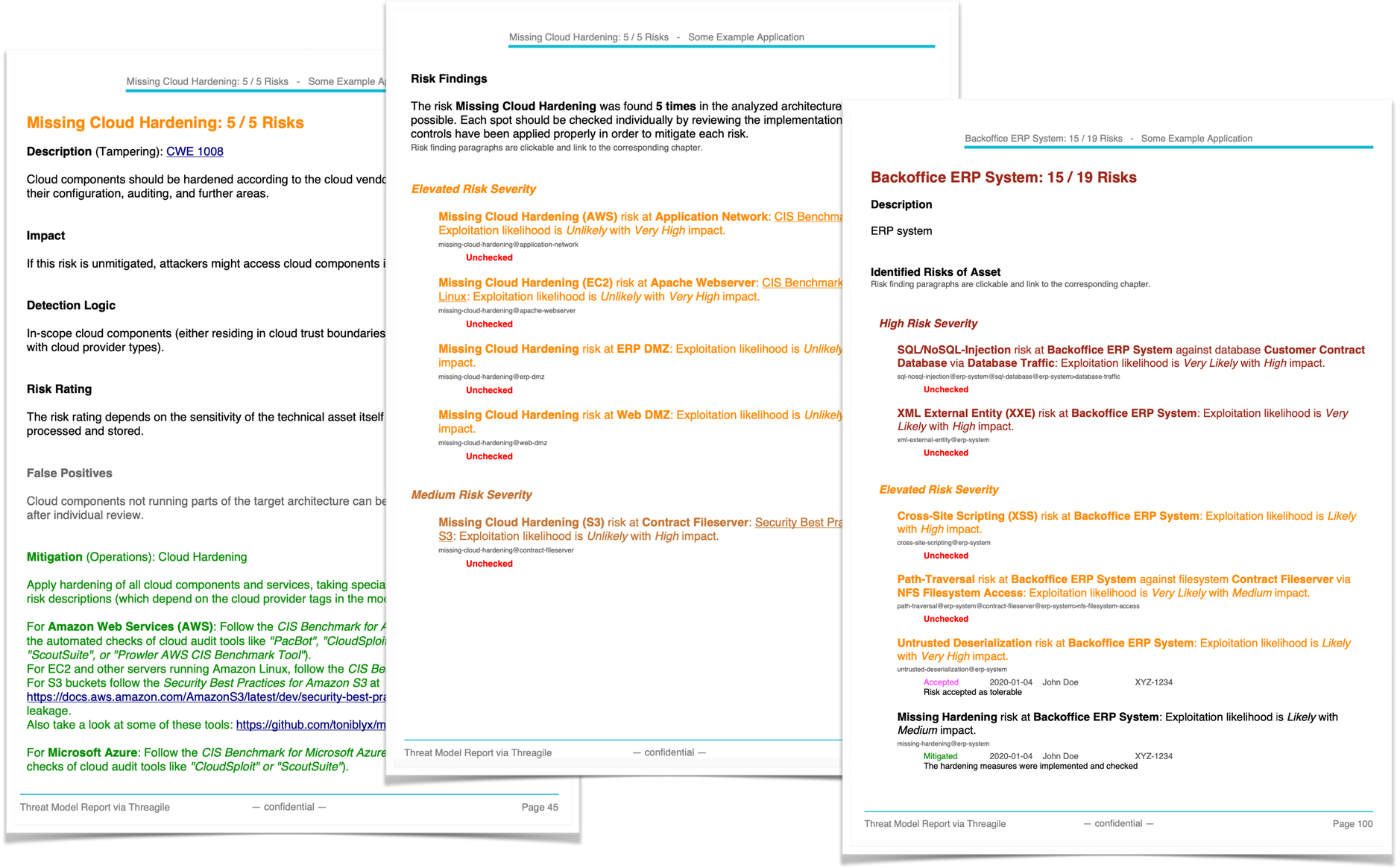
Are recommendations from the linked cheat sheet and referenced ASVS chapter applied?

Detailed mitigations along with links to

- OWASP ASVS chapter and

- OWASP cheat sheet

Risk Instances (by vulnerability & by tech asset)



Missing Cloud Hardening: 5 / 5 Risks

Description (Tampering): CWE 1008

Cloud components should be hardened according to the cloud vendo
their configuration, auditing, and further areas.

Impact

If this risk is unmitigated, attackers might access cloud components i

Detection Logic

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

Risk Rating

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

False Positives

Cloud components not running parts of the target architecture can be
after individual review.

Mitigation (Operations): Cloud Hardening

Apply hardening of all cloud components and services, taking specia
risk descriptions (which depend on the cloud provider tags in the mo

For **Amazon Web Services (AWS)**: Follow the *CIS Benchmark for A*
the automated checks of cloud audit tools like *"PacBot", "CloudSploi*
"ScoutSuite", or "Prowler AWS CIS Benchmark Tool").
For EC2 and other servers running Amazon Linux, follow the *CIS Be*
For S3 buckets follow the *Security Best Practices for Amazon S3* at
https://docs.aws.amazon.com/AmazonS3/latest/dev/security-best-pra
leakage.
Also take a look at some of these tools: https://github.com/toniblyx/m

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

Risk Findings

The risk **Missing Cloud Hardening** was found **5 times** in the analyzed architecture
possible. Each spot should be checked individually by reviewing the implementation
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 (AWS) risk at **Application Network**: CIS Benchma
Exploitation likelihood is *Unlikely* with *Very High* impact.
missing-cloud-hardening@application-network
Unchecked

Missing Cloud Hardening (EC2) risk at **Apache Webserver**: CIS Benchmark
Linux: Exploitation likelihood is *Unlikely* with *Very High* impact.
missing-cloud-hardening@apache-webserver
Unchecked

Missing Cloud Hardening risk at **ERP DMZ**: Exploitation likelihood is *Unlikely*
impact.
missing-cloud-hardening@erp-dmz
Unchecked

Missing Cloud Hardening risk at **Web DMZ**: Exploitation likelihood is *Unlikely*
impact.
missing-cloud-hardening@web-dmz
Unchecked

Medium Risk Severity

Missing Cloud Hardening (S3) risk at **Contract Fileserver**: Security Best Pra
S3: Exploitation likelihood is *Unlikely* with *High* impact.
missing-cloud-hardening@contract-fileserver
Unchecked

Backoffice ERP System: 15 / 19 Risks

Description

ERP system

Identified Risks of Asset
Risk finding paragraphs are clickable and link to the corresponding chapter.

High Risk Severity

SQL/NoSQL-Injection risk at **Backoffice ERP System** against database **Customer Contract Database** via **Database Traffic**: Exploitation likelihood is *Very Likely* with *High* impact.
sql-nosql-injection@erp-system@sql-database@erp-system>database-traffic
Unchecked

XML External Entity (XXE) risk at **Backoffice ERP System**: Exploitation likelihood is *Very Likely* with *High* impact.
xml-external-entity@erp-system
Unchecked

Elevated Risk Severity

Cross-Site Scripting (XSS) risk at **Backoffice ERP System**: Exploitation likelihood is *Likely* with *High* impact.
cross-site-scripting@erp-system
Unchecked

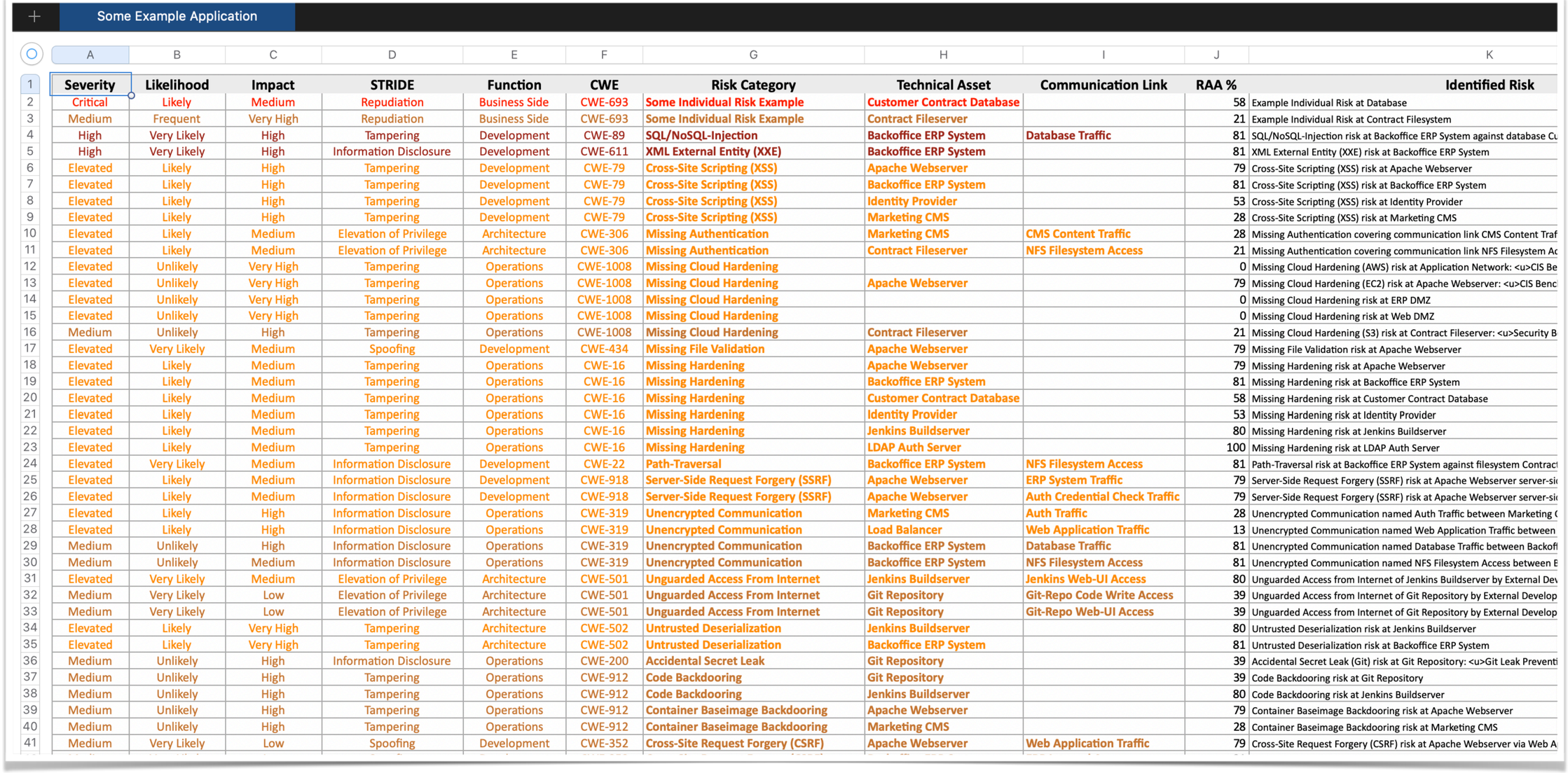
Path-Traversal risk at **Backoffice ERP System** against filesystem **Contract Fileserver** via **NFS Filesystem Access**: Exploitation likelihood is *Very Likely* with *Medium* impact.
path-traversal@erp-system@contract-fileserver@erp-system>nfs-filesystem-access
Unchecked

Untrusted Deserialization risk at **Backoffice ERP System**: Exploitation likelihood is *Likely* with *Very High* impact.
untrusted-deserialization@erp-system
Accepted 2020-01-04 John Doe XYZ-1234
Risk accepted as tolerable

Missing Hardening risk at **Backoffice ERP System**: Exploitation likelihood is *Likely* with *Medium* impact.
missing-hardening@erp-system
Mitigated 2020-01-04 John Doe XYZ-1234
The hardening measures were implemented and checked

Everything linked and clickable inside the report for easy navigation

Excel Report



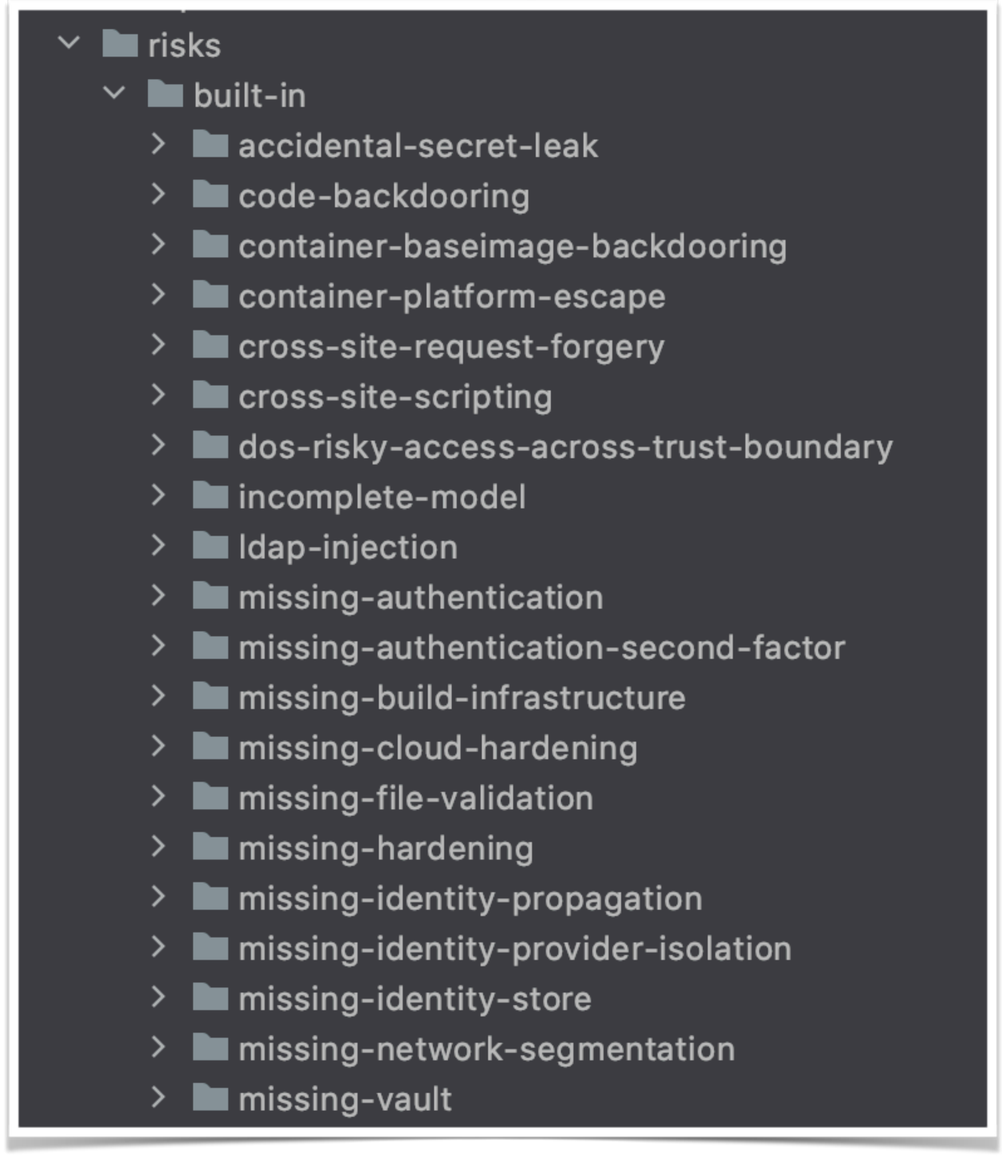
Some Example Application

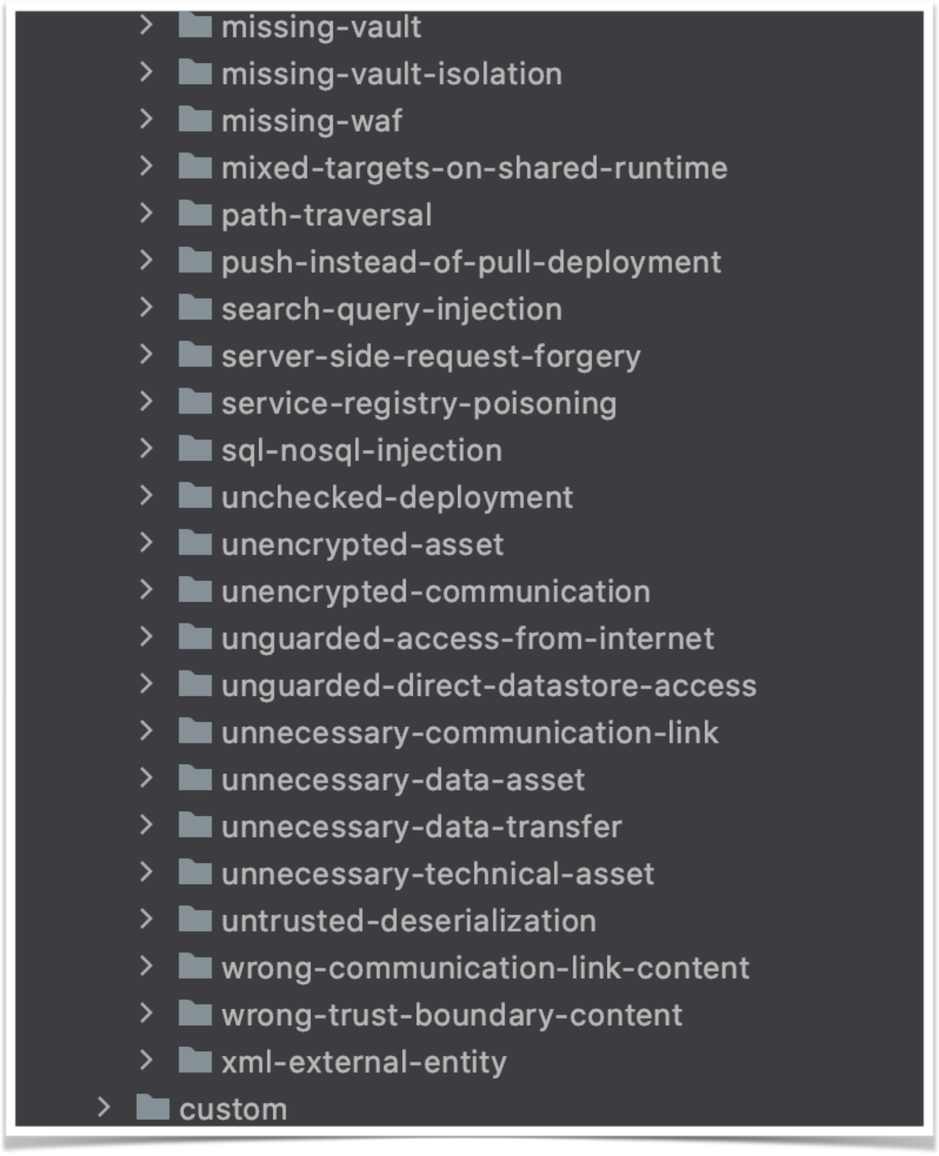
	A	B	C	D	E	F	G	H	I	J	K
1	Severity	Likelihood	Impact	STRIDE	Function	CWE	Risk Category	Technical Asset	Communication Link	RAA %	Identified Risk
2	Critical	Likely	Medium	Repudiation	Business Side	CWE-693	Some Individual Risk Example	Customer Contract Database		58	Example Individual Risk at Database
3	Medium	Frequent	Very High	Repudiation	Business Side	CWE-693	Some Individual Risk Example	Contract Fileserver		21	Example Individual Risk at Contract Filesystem
4	High	Very Likely	High	Tampering	Development	CWE-89	SQL/NoSQL-Injection	Backoffice ERP System	Database Traffic	81	SQL/NoSQL-Injection risk at Backoffice ERP System against database Cu
5	High	Very Likely	High	Information Disclosure	Development	CWE-611	XML External Entity (XXE)	Backoffice ERP System		81	XML External Entity (XXE) risk at Backoffice ERP System
6	Elevated	Likely	High	Tampering	Development	CWE-79	Cross-Site Scripting (XSS)	Apache Webserver		79	Cross-Site Scripting (XSS) risk at Apache Webserver
7	Elevated	Likely	High	Tampering	Development	CWE-79	Cross-Site Scripting (XSS)	Backoffice ERP System		81	Cross-Site Scripting (XSS) risk at Backoffice ERP System
8	Elevated	Likely	High	Tampering	Development	CWE-79	Cross-Site Scripting (XSS)	Identity Provider		53	Cross-Site Scripting (XSS) risk at Identity Provider
9	Elevated	Likely	High	Tampering	Development	CWE-79	Cross-Site Scripting (XSS)	Marketing CMS		28	Cross-Site Scripting (XSS) risk at Marketing CMS
10	Elevated	Likely	Medium	Elevation of Privilege	Architecture	CWE-306	Missing Authentication	Marketing CMS	CMS Content Traffic	28	Missing Authentication covering communication link CMS Content Traf
11	Elevated	Likely	Medium	Elevation of Privilege	Architecture	CWE-306	Missing Authentication	Contract Fileserver	NFS Filesystem Access	21	Missing Authentication covering communication link NFS Filesystem Ac
12	Elevated	Unlikely	Very High	Tampering	Operations	CWE-1008	Missing Cloud Hardening			0	Missing Cloud Hardening (AWS) risk at Application Network: <u>CIS Be
13	Elevated	Unlikely	Very High	Tampering	Operations	CWE-1008	Missing Cloud Hardening	Apache Webserver		79	Missing Cloud Hardening (EC2) risk at Apache Webserver: <u>CIS Benc
14	Elevated	Unlikely	Very High	Tampering	Operations	CWE-1008	Missing Cloud Hardening			0	Missing Cloud Hardening risk at ERP DMZ
15	Elevated	Unlikely	Very High	Tampering	Operations	CWE-1008	Missing Cloud Hardening			0	Missing Cloud Hardening risk at Web DMZ
16	Medium	Unlikely	High	Tampering	Operations	CWE-1008	Missing Cloud Hardening	Contract Fileserver		21	Missing Cloud Hardening (S3) risk at Contract Fileserver: <u>Security B
17	Elevated	Very Likely	Medium	Spoofing	Development	CWE-434	Missing File Validation	Apache Webserver		79	Missing File Validation risk at Apache Webserver
18	Elevated	Likely	Medium	Tampering	Operations	CWE-16	Missing Hardening	Apache Webserver		79	Missing Hardening risk at Apache Webserver
19	Elevated	Likely	Medium	Tampering	Operations	CWE-16	Missing Hardening	Backoffice ERP System		81	Missing Hardening risk at Backoffice ERP System
20	Elevated	Likely	Medium	Tampering	Operations	CWE-16	Missing Hardening	Customer Contract Database		58	Missing Hardening risk at Customer Contract Database
21	Elevated	Likely	Medium	Tampering	Operations	CWE-16	Missing Hardening	Identity Provider		53	Missing Hardening risk at Identity Provider
22	Elevated	Likely	Medium	Tampering	Operations	CWE-16	Missing Hardening	Jenkins Buildserver		80	Missing Hardening risk at Jenkins Buildserver
23	Elevated	Likely	Medium	Tampering	Operations	CWE-16	Missing Hardening	LDAP Auth Server		100	Missing Hardening risk at LDAP Auth Server
24	Elevated	Very Likely	Medium	Information Disclosure	Development	CWE-22	Path-Traversal	Backoffice ERP System	NFS Filesystem Access	81	Path-Traversal risk at Backoffice ERP System against filesystem Contract
25	Elevated	Likely	Medium	Information Disclosure	Development	CWE-918	Server-Side Request Forgery (SSRF)	Apache Webserver	ERP System Traffic	79	Server-Side Request Forgery (SSRF) risk at Apache Webserver server-si
26	Elevated	Likely	Medium	Information Disclosure	Development	CWE-918	Server-Side Request Forgery (SSRF)	Apache Webserver	Auth Credential Check Traffic	79	Server-Side Request Forgery (SSRF) risk at Apache Webserver server-si
27	Elevated	Likely	High	Information Disclosure	Operations	CWE-319	Unencrypted Communication	Marketing CMS	Auth Traffic	28	Unencrypted Communication named Auth Traffic between Marketing C
28	Elevated	Likely	High	Information Disclosure	Operations	CWE-319	Unencrypted Communication	Load Balancer	Web Application Traffic	13	Unencrypted Communication named Web Application Traffic between
29	Medium	Unlikely	High	Information Disclosure	Operations	CWE-319	Unencrypted Communication	Backoffice ERP System	Database Traffic	81	Unencrypted Communication named Database Traffic between Backoff
30	Medium	Unlikely	Medium	Information Disclosure	Operations	CWE-319	Unencrypted Communication	Backoffice ERP System	NFS Filesystem Access	81	Unencrypted Communication named NFS Filesystem Access between E
31	Elevated	Very Likely	Medium	Elevation of Privilege	Architecture	CWE-501	Unguarded Access From Internet	Jenkins Buildserver	Jenkins Web-UI Access	80	Unguarded Access from Internet of Jenkins Buildserver by External Dev
32	Medium	Very Likely	Low	Elevation of Privilege	Architecture	CWE-501	Unguarded Access From Internet	Git Repository	Git-Repo Code Write Access	39	Unguarded Access from Internet of Git Repository by External Develop
33	Medium	Very Likely	Low	Elevation of Privilege	Architecture	CWE-501	Unguarded Access From Internet	Git Repository	Git-Repo Web-UI Access	39	Unguarded Access from Internet of Git Repository by External Develop
34	Elevated	Likely	Very High	Tampering	Architecture	CWE-502	Untrusted Deserialization	Jenkins Buildserver		80	Untrusted Deserialization risk at Jenkins Buildserver
35	Elevated	Likely	Very High	Tampering	Architecture	CWE-502	Untrusted Deserialization	Backoffice ERP System		81	Untrusted Deserialization risk at Backoffice ERP System
36	Medium	Unlikely	High	Information Disclosure	Operations	CWE-200	Accidental Secret Leak	Git Repository		39	Accidental Secret Leak (Git) risk at Git Repository: <u>Git Leak Preventi
37	Medium	Unlikely	High	Tampering	Operations	CWE-912	Code Backdooring	Git Repository		39	Code Backdooring risk at Git Repository
38	Medium	Unlikely	High	Tampering	Operations	CWE-912	Code Backdooring	Jenkins Buildserver		80	Code Backdooring risk at Jenkins Buildserver
39	Medium	Unlikely	High	Tampering	Operations	CWE-912	Container Baseimage Backdooring	Apache Webserver		79	Container Baseimage Backdooring risk at Apache Webserver
40	Medium	Unlikely	High	Tampering	Operations	CWE-912	Container Baseimage Backdooring	Marketing CMS		28	Container Baseimage Backdooring risk at Marketing CMS
41	Medium	Very Likely	Low	Spoofing	Development	CWE-352	Cross-Site Request Forgery (CSRF)	Apache Webserver	Web Application Traffic	79	Cross-Site Request Forgery (CSRF) risk at Apache Webserver via Web A

Results as JSON → DevSecOps ready


```
{
  "category": "container-baseimage-backdooring",
  "risk_status": "unchecked",
  "severity": "medium",
  "exploitation_likelihood": "unlikely",
  "exploitation_impact": "high",
  "title": "\u003cb\u003eContainer Baseimage Backdooring\u003c/b\u003e risk at \u003cb\u003eApache Webserver\u003c/b\u003e",
  "synthetic_id": "container-baseimage-backdooring@apache-webserver",
  "most_relevant_data_asset": "",
  "most_relevant_technical_asset": "apache-webserver",
  "most_relevant_trust_boundary": "",
  "most_relevant_shared_runtime": "",
  "most_relevant_communication_link": "",
  "data_loss_probability": "probable",
  "data_loss_technical_assets": [
    "apache-webserver"
  ]
},
{
  "category": "container-baseimage-backdooring",
  "risk_status": "unchecked",
  "severity": "medium",
  "exploitation_likelihood": "unlikely",
  "exploitation_impact": "high",
  "title": "\u003cb\u003eContainer Baseimage Backdooring\u003c/b\u003e risk at \u003cb\u003eMarketing CMS\u003c/b\u003e",
  "synthetic_id": "container-baseimage-backdooring@marketing-cms",
  "most_relevant_data_asset": "",
  "most_relevant_technical_asset": "marketing-cms",
  "most_relevant_trust_boundary": "",
  "most_relevant_shared_runtime": "",
  "most_relevant_communication_link": "",
  "data_loss_probability": "probable",
  "data_loss_technical_assets": [
    "marketing-cms"
  ]
},
```

Risk Rules (constantly growing)





Custom Risk Rules (plugin interface)

```go
package ldap_injection

import ...

func Category() model.RiskCategory {
    return model.RiskCategory{
        Id:    "ldap-injection",
        Title: "LDAP-Injection",
        Description: "When an LDAP server is accessed LDAP-Injection risks might arise. " +
            "The risk rating depends on the sensitivi
        Impact:     "If this risk remains unmitigated
        ASVS:       "V5 - Validation, Sanitization ar
        CheatSheet: "https://cheatsheetseries.owasp.o
        Action:     "LDAP-Injection Prevention",
        Mitigation: "Try to use libraries that proper
            "the LDAP sever in order to stay safe fro
            "When a third-party product is used inste
        Check:           "Are recommendations from the
        Function:        model.Development,
        STRIDE:          model.Tampering,
        DetectionLogic: "In-scope clients accessing L
        RiskAssessment: "The risk rating depends on t
        FalsePositives: "LDAP server queries by searc
            "as false positives after individual revi
        ModelFailurePossibleReason: false,
        CWE:                        90,
    }
}
```

```go
func GenerateRisks() []model.Risk {
    risks := make([]model.Risk, 0)
    for _, technicalAsset := range model.ParsedModelRoot.TechnicalAssets {
        incomingFlows := model.IncomingTechnicalCommunicationLinksMappedByTargetId[technical
        for _, incomingFlow := range incomingFlows {
            if model.ParsedModelRoot.TechnicalAssets[incomingFlow.SourceId].OutOfScope {
                continue
            }
            if incomingFlow.Protocol == model.LDAP || incomingFlow.Protocol == model.LDAPS {
                likelihood := model.Likely
                if incomingFlow.Usage == model.DevOps {
                    likelihood = model.Unlikely
                }
                risks = append(risks, createRisk(technicalAsset, incomingFlow, likelihood))
            }
        }
    }
    return risks
}
```

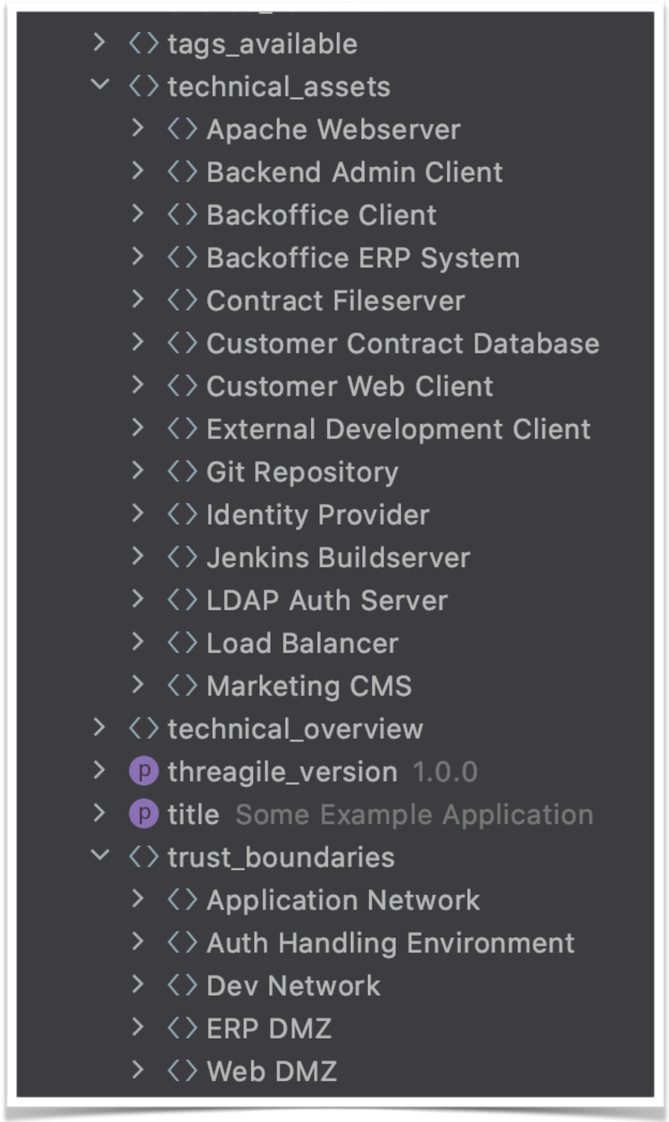
Manually Identified Risks (put into YAML)

```yaml
Some Individual Risk Example:
  id: something-strange
  description: Some text describing the risk category...
  impact: Some text describing the impact...
  asvs: V0 - Something Strange
  cheat_sheet: https://example.com
  action: Some text describing the action...
  mitigation: Some text describing the mitigation...
  check: Check if XYZ...
  function: business-side # values: business-side, arc
  stride: repudiation # values: spoofing, tampering, r
  detection_logic: Some text describing the detection
  risk_assessment: Some text describing the risk asses
  false_positives: Some text describing the most commo
  model_failure_possible_reason: false
  cwe: 693
```

```yaml
risks_identified:
  <b>Example Individual Risk</b> at <b>Database</b>:
    severity: critical # values: low, medium, elevated, high, critical
    exploitation_likelihood: likely # values: unlikely, likely, very-likely, frequent
    exploitation_impact: medium # values: low, medium, high, very-high
    data_loss_probability: probable # values: improbable, possible, probable
    data_loss_technical_assets: # list of technical asset IDs which might have data loss
      - sql-database
    most_relevant_data_asset:
    most_relevant_technical_asset: sql-database
    most_relevant_communication_link:
    most_relevant_trust_boundary:
    most_relevant_shared_runtime:
  <b>Example Individual Risk</b> at <b>Contract Filesystem</b>:
    severity: medium # values: low, medium, elevated, high, critical
    exploitation_likelihood: frequent # values: unlikely, likely, very-likely, frequent
    exploitation_impact: very-high # values: low, medium, high, very-high
    data_loss_probability: improbable # values: improbable, possible, probable
    data_loss_technical_assets: # list of technical asset IDs which might have data loss
    most_relevant_data_asset:
    most_relevant_technical_asset: contract-fileserver
    most_relevant_communication_link:
    most_relevant_trust_boundary:
    most_relevant_shared_runtime:
```

Editing Support in IDEs

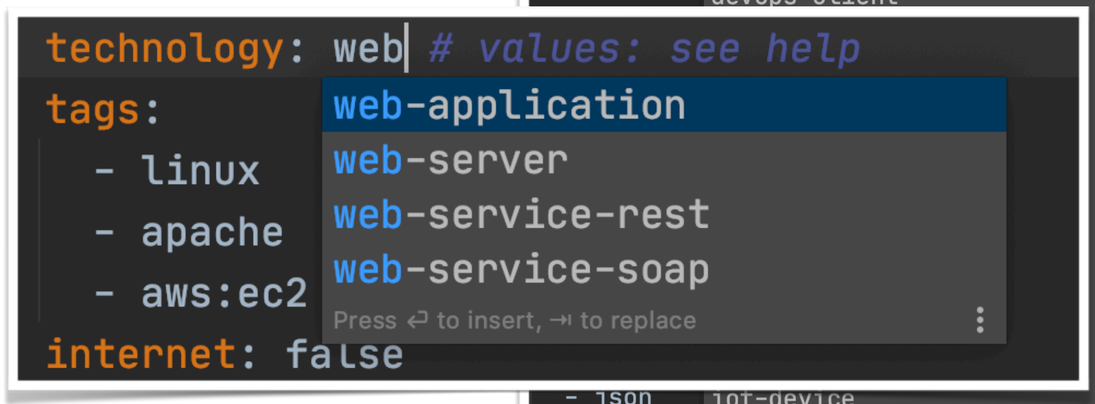
Nice structured YAML tree in many popular IDEs and YAML editors:



Editing Support in IDEs

Schema for YAML input available:

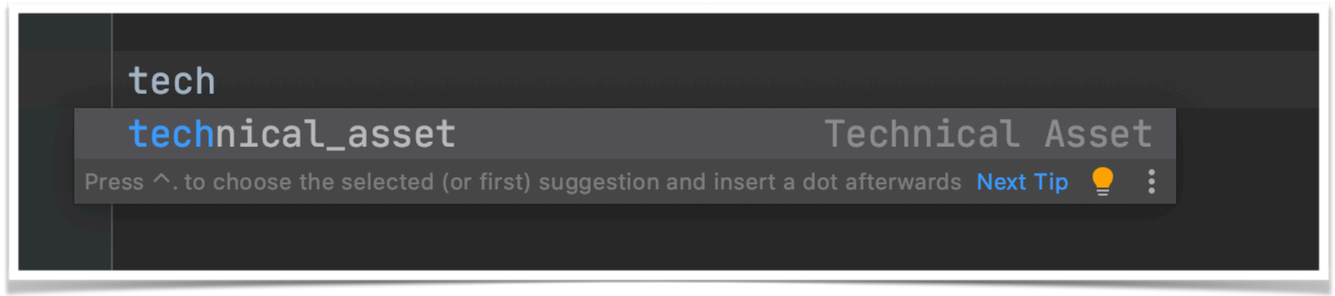
Enables syntax validation (error flagging) & auto-completion



Editing Support in IDEs

Live Templates:

Enables Template-based Quick Editing




```
:
  id:
  description:
  type:
  usage:
  used_as_client_by_human:
  out_of_scope: false
  justification_out_of_scope:
  size:
  technology:
  tags:
  internet:
  machine:
  encryption:
  owner:
  confidentiality:
  integrity:
  availability:
  justification_cia_rating:
  multi_tenant:
  redundant:
  custom_developed_parts:
  data_assets_processed: # sequence of IDs to reference
  data_assets_stored: # sequence of IDs to reference
  data_formats_accepted:
  communication_links:
```

Model Macros: Interactive Wizards

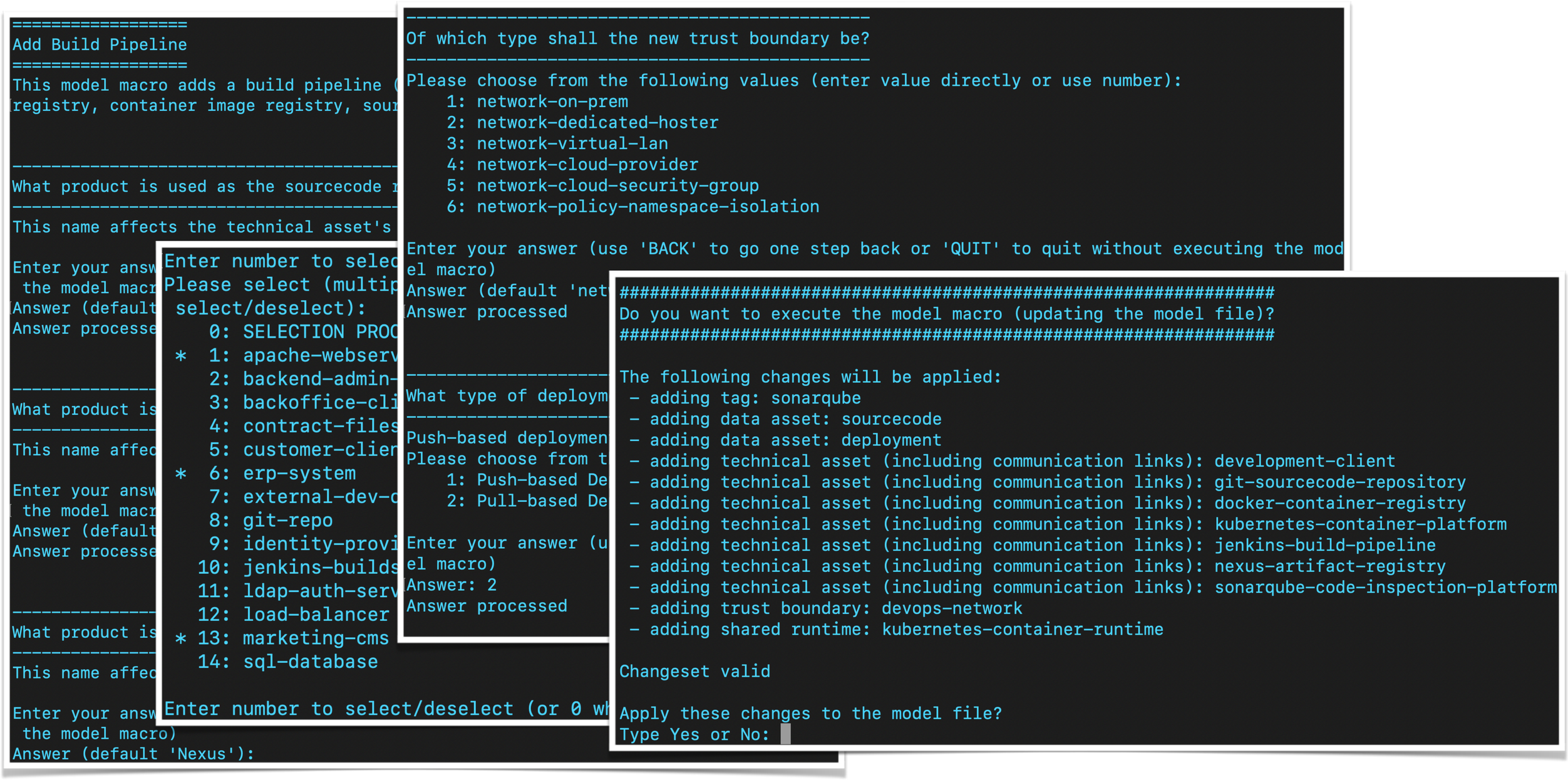
Interactive wizards reading existing models and modify/enhance them

Useful for repeating, often similar, model tasks like:

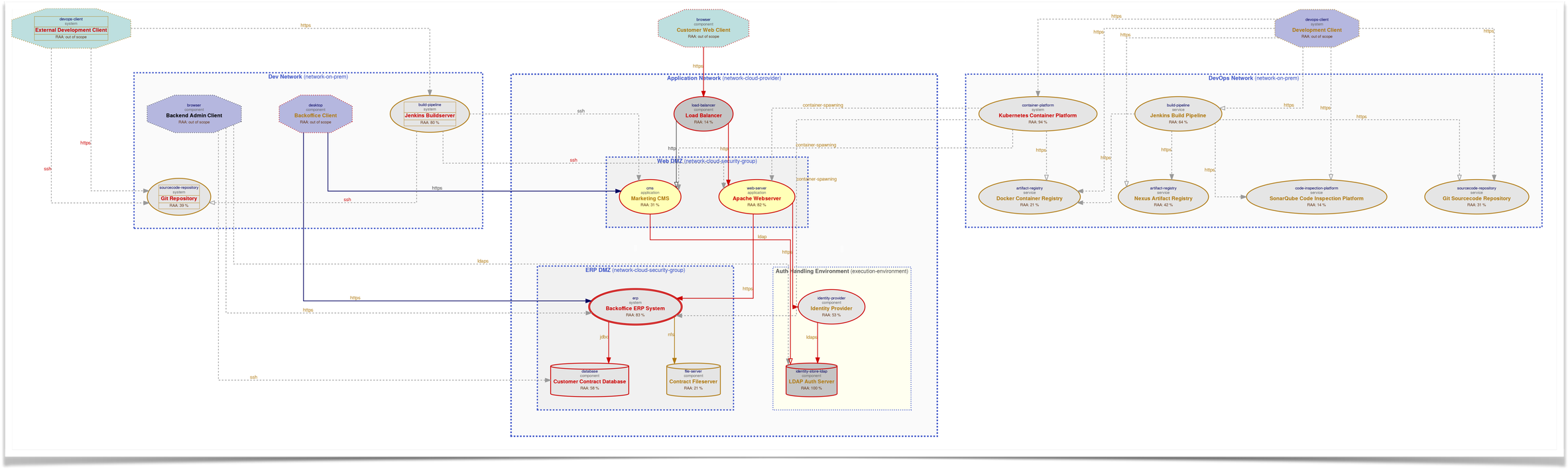
- Adding a Build-Pipeline to the model
- Adding a Vault to the model
- Adding Identity Provider and Identity Storage to the model
- etc.

Pluggable interface allows for custom model macros

Model Macros: Interactive Wizards

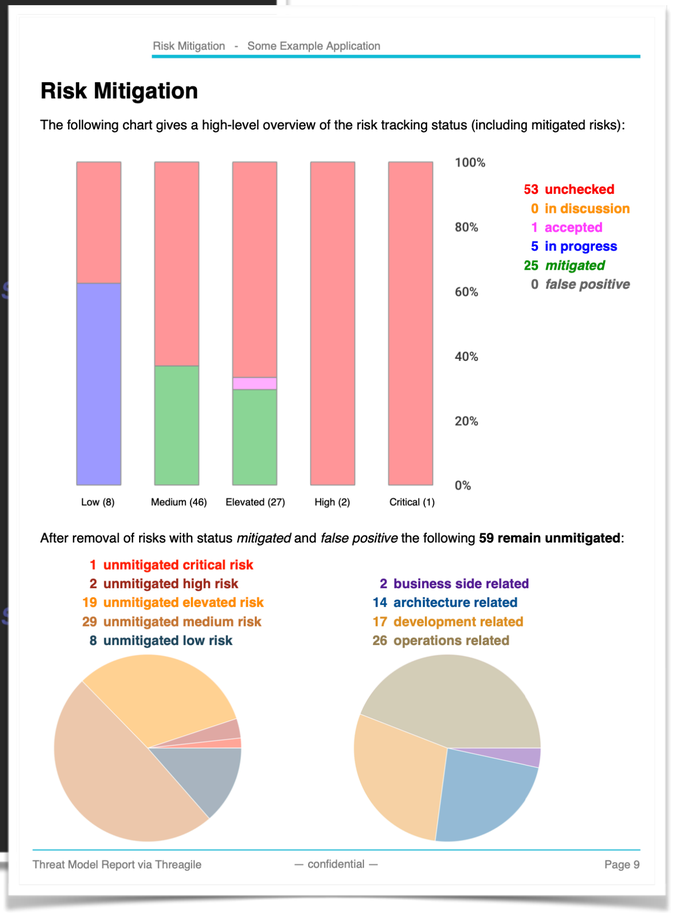


Model Macros: Results



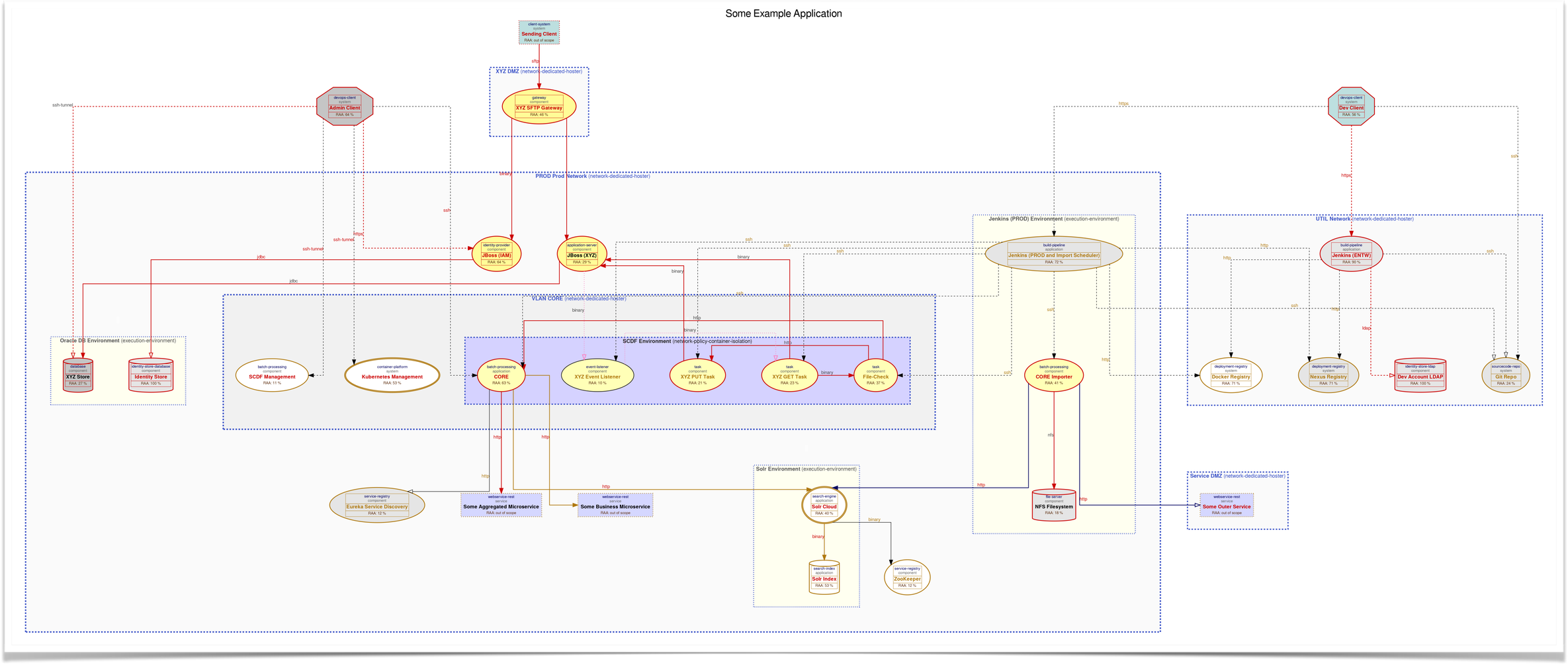
Risk Tracking (inside the YAML file by Risk-ID)

```yaml
risk_tracking:

  untrusted-deserialization@erp-system: # wildcards "*" between the @ characters are possible
    status: accepted # values: unchecked, in-discussion, accepted, in-progress, mitigated, false-positive
    justification: Risk accepted as tolerable
    ticket: XYZ-1234
    date: 2020-01-04
    checked_by: John Doe

  ldap-injection@*@ldap-auth-server@*: # wildcards "*" between the @ characters are possible
    status: mitigated # values: unchecked, in-discussion, accepted, in-progress, mitigated, fals
    justification: The hardening measures were implemented and checked
    ticket: XYZ-5678
    date: 2020-01-05
    checked_by: John Doe

  unencrypted-asset@*: # wildcards "*" between the @ characters are possible
    status: mitigated # values: unchecked, in-discussion, accepted, in-progress, mitigated, fals
    justification: The hardening measures were implemented and checked
    ticket: XYZ-1234
    date: 2020-01-04
    checked_by: John Doe
```



Model-Macro exists for quick seeding of risk instances for tracking in YAML model file

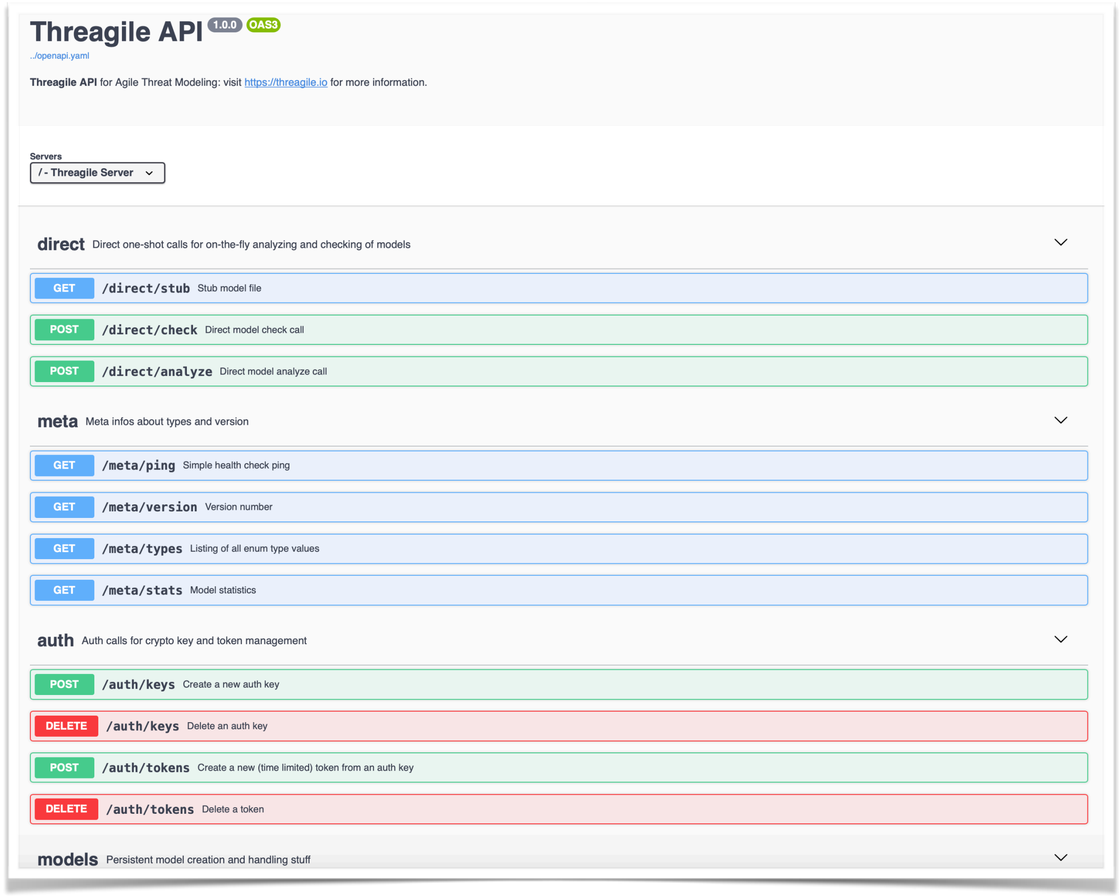
What About Bigger Models?



REST-Server

Also within the Docker container

Playground online available for instant playing as well: https://run.threagile.io



Possible Effects

Custom coded risk rules
can analyze the model graph

(helps big corporations with individual policies)

Possible Effects

Uniform documentation of system landscape built bottom-up

(by dev teams in their IDEs along with the codebase)

Possible Effects

Instant regeneration of project risk landscape on changes

(what happens when a data classification changes or some component moves into the cloud)

Possible Effects

Instant regeneration of corporate-wide risk landscape on changes

(just modify a risk rule due to a policy change
and instantly regenerate threat models across all projects)

Possible Effects

CI/CD-Pipelines can check the generated JSON for unmitigated risks

(trend graphs & warning when rollout contains new unchecked high risks)

Threat Modeling as a part of DevSecOps

Possible Effects

Security is less bottleneck for threat model sign-offs

(risks rules as code automate threat model vetting)

Released as Open-Source

Threagile
Agile Threat Modeling

Website:
- https://threagile.io

Playground:
- https://run.threagile.io

Source:
- https://github.com/threagile

Docker Images:
- https://hub.docker.com/r/threagile

Questions?

www.Christian-Schneider.net
mail@Christian-Schneider.net
@cschneider4711 on Twitter

Thanks to all beta users for valuable feedback

especially to (in alphabetical order)

@bob5ec
@ektoplant
@izar_t
@PhyberApex
@secalert
@siggim81

Thank You

Threagile
Agile Threat Modeling

https://threagile.io

Q & A

Christian Schneider

Twitter: @cschneider4711
mail@Christian-Schneider.net
www.Christian-Schneider.net