General Topics

Insecure Design, Components with known Vulnerabilities, Integrity, Logging & Monitoring, WAFs

Rough Overview

Design Flaw vs. Implementation Defect

Design Flaw / Insecure Design	Implementation Defect

Design Flaw vs. Implementation Defect

Design Flaw / Insecure Design	Implementation Defect
Client-side security checks only	

Design Flaw vs. Implementation Defect

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Client-side security checks only	Error in a regex for input validation

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Design Flaw vs. Implementation Defect

Design Flaw / Insecure Design	Implementation Defect
Client-side security checks only	Error in a regex for input validation
Credential recovery solely relies on “security questions”	Reset link is guessable
Firmware update integrity isn’t ensured	

Design Flaw vs. Implementation Defect

Design Flaw / Insecure Design	Implementation Defect
Client-side security checks only	Error in a regex for input validation
Credential recovery solely relies on “security questions”	Reset link is guessable
Firmware update integrity isn’t ensured	Digital signature uses outdated/vuln. algorithm

A secure design
can still have implementation defects
leading to vulnerabilities
that may be exploited.

An insecure design
cannot be fixed by a perfect implementation
as by definition,
needed security controls were never created
to defend against specific attacks.

https://owasp.org/Top10/A04_2021-Insecure_Design/

How can we prevent design flaws?

Remember our secure design principles?

Economy of Mechanism

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Fail-safe Defaults

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Complete Mediation

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Least Privilege

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Least Common Mechanism

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Separation of Privilege

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Open Design

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Psychological Acceptability

- Saltzer and Schroeder, 1975 –

http://web.cs.wpi.edu/~guttman/cs557_website/papers/saltzer1975.pdf
https://adam.shostack.org/blog/the-security-principles-of-saltzer-and-schroeder/

Earn or give, but never assume, trust.

Use an authentication mechanism that cannot be bypassed or tampered with.

Authorize after you authenticate

Strictly separate data and control instructions, and never process control instructions received from untrusted sources.

Define an approach that ensures all data are explicitly validated.

Use cryptography correctly.

Identify sensitive data and how they should be handled.

Always consider the user.

Understand how integrating external components changes your attack surface.

Be flexible when considering future changes to objects and actors.

- IEEE Center for Secure Design, 2014 –

https://ieeecs-media.computer.org/media/technical-activities/CYBSI/docs/Top-10-Flaws.pdf

Secure Design Patterns

Utilize well proven public design patterns, e.g.

- https://docs.microsoft.com/en-us/azure/architecture/patterns/
    - https://docs.microsoft.com/en-us/azure/architecture/patterns/federated-identity
    - …
- https://docs.microsoft.com/en-us/azure/architecture/framework/security/
- https://www.opensecurityarchitecture.org/cms/library/patternlandscape
- https://www.ncsc.gov.uk/search?q=architectural%20pattern
- https://cheatsheetseries.owasp.org/

Yes, a lot of them are actually for network / system design

But they are very useful anyway

Secure Design Patterns

Create your own company-wide design patterns for e.g.

- Authentication
- Session Management
- Authorization
- Input- and Outputhandling
- Logging and Monitoring
- …

Did anybody say Threat Modeling?

Check out my
Threat Modeling 101

https://www.slideshare.net/SBA-Research/sba-live-academy-threat-modeling-101-eine-kurze-aber-praxisnahe-einfhrung-by-daniel-schwarz-senior-security-analyst-bei-der-condignum-gmbh

Threat Modeling in a nutshell

It’s an engineering technique you can use to help you **identify threats, attacks, vulnerabilities, and countermeasures** that could affect your application.

You can use threat modeling to **shape your application's design, meet your company's security objectives, and reduce risk**.

- Microsoft -

https://www.microsoft.com/en-us/securityengineering/sdl/threatmodeling

Threat Modeling in a nutshell

The 4 basic questions:

1. What are we working on?
2. What can go wrong?
3. What are we going to do about it?
4. Did we do a good enough job?

https://www.threatmodelingmanifesto.org/

Threat Modeling in a nutshell

Simplest approach:

just brainstorm in your team

think about worst-case szenarios
and what you could do about it

Threat Modeling in a nutshell

second simplest approach:

use some “tools” to structure your thoughts

Threat Modeling in a nutshell

little example:

- We’re creating a pizza order system
- Customers can save
  - their address
  - their personal pizza configurations
  - their credit card
- Payment is done via an external payment-provider

Threat Modeling in a nutshell

The 4 basic questions:

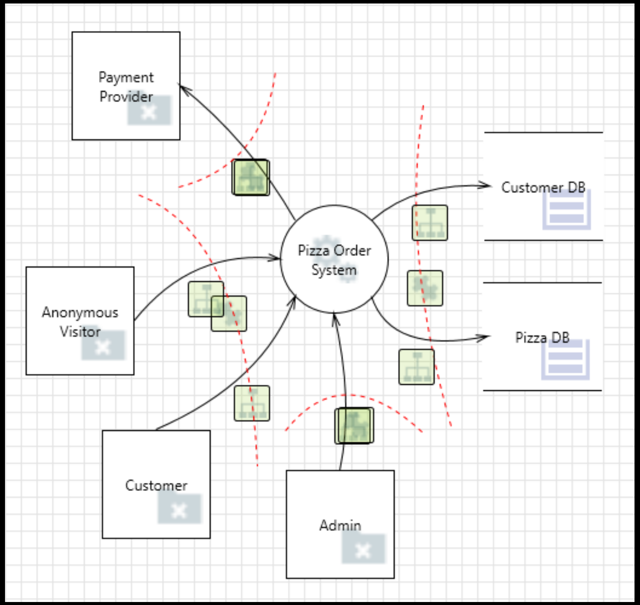
1. What are we working on?
2. What can go wrong?
3. What are we going to do about it?
4. Did we do a good enough job?

https://www.threatmodelingmanifesto.org/

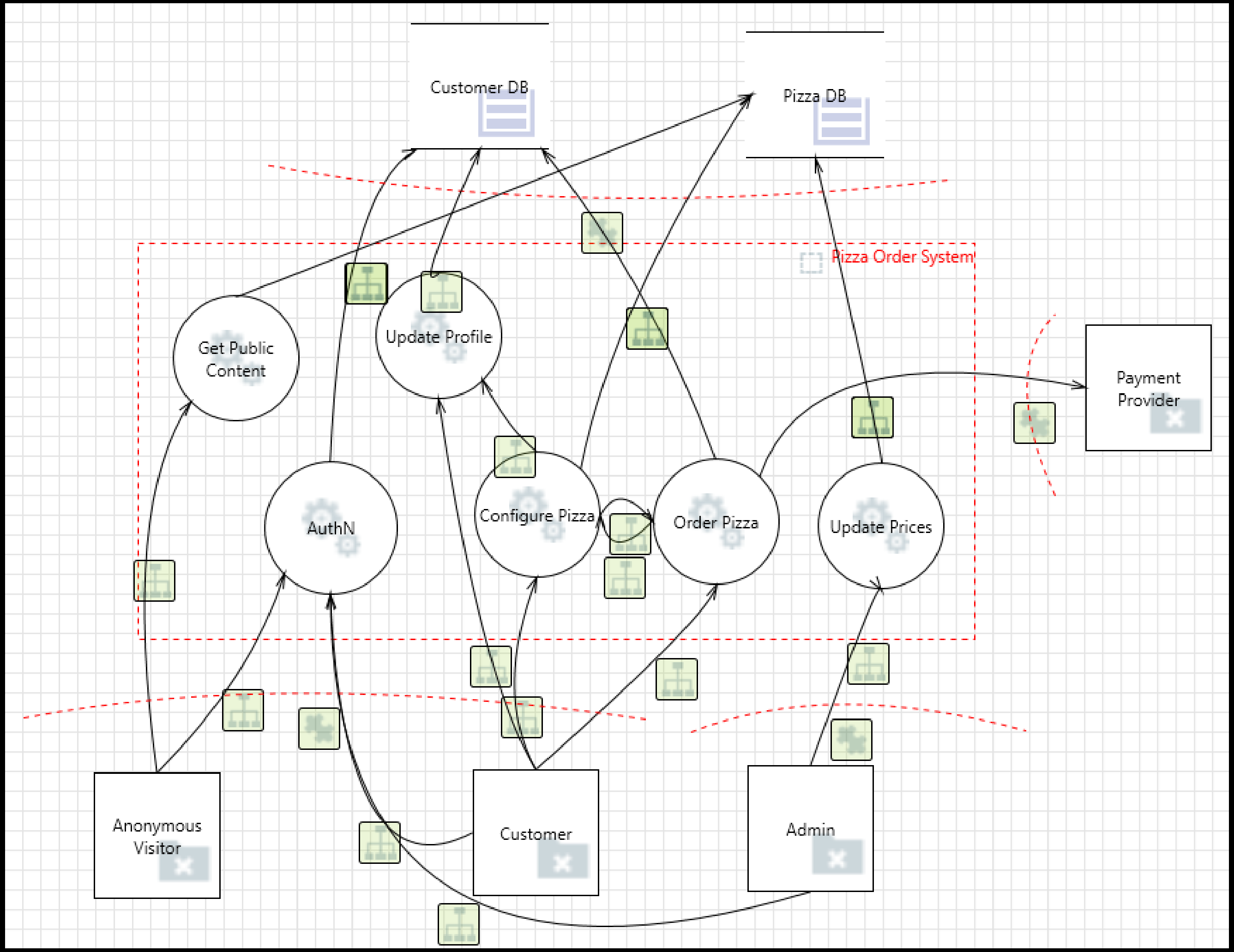
Threat Modeling in a nutshell

1. What are we working on?
   - list your assets, users and external entities
   - draw a diagram
     - DFDs and the C4 model could be a good starting point

Assets	User	Ext. Entities
credit card data	anonymous	payment-provider
usernames	customer	
passwords	admin	
pizza prices		
pizza configurations		
…		



https://docs.microsoft.com/en-us/learn/modules/tm-introduction-to-threat-modeling/2-step-1-design-phase
https://c4model.com/


Customer DB
Pizza DB
Pizza Order System
Get Public Content
Update Profile
Payment Provider
AuthN
Configure Pizza
Order Pizza
Update Prices
Anonymous Visitor
Customer
Admin

Threat Modeling in a nutshell

2. What can go wrong?

- Design Principles, OWASP Top 10 …
- STRIDE
  - Spoofing
  - Tampering
  - Repudiation
  - Information Disclosure
  - Denial of Service
  - Elevation of Privileges

https://www.microsoft.com/security/blog/2007/09/11/stride-chart/

Threat Modeling in a nutshell

3. What are we going to do about it?

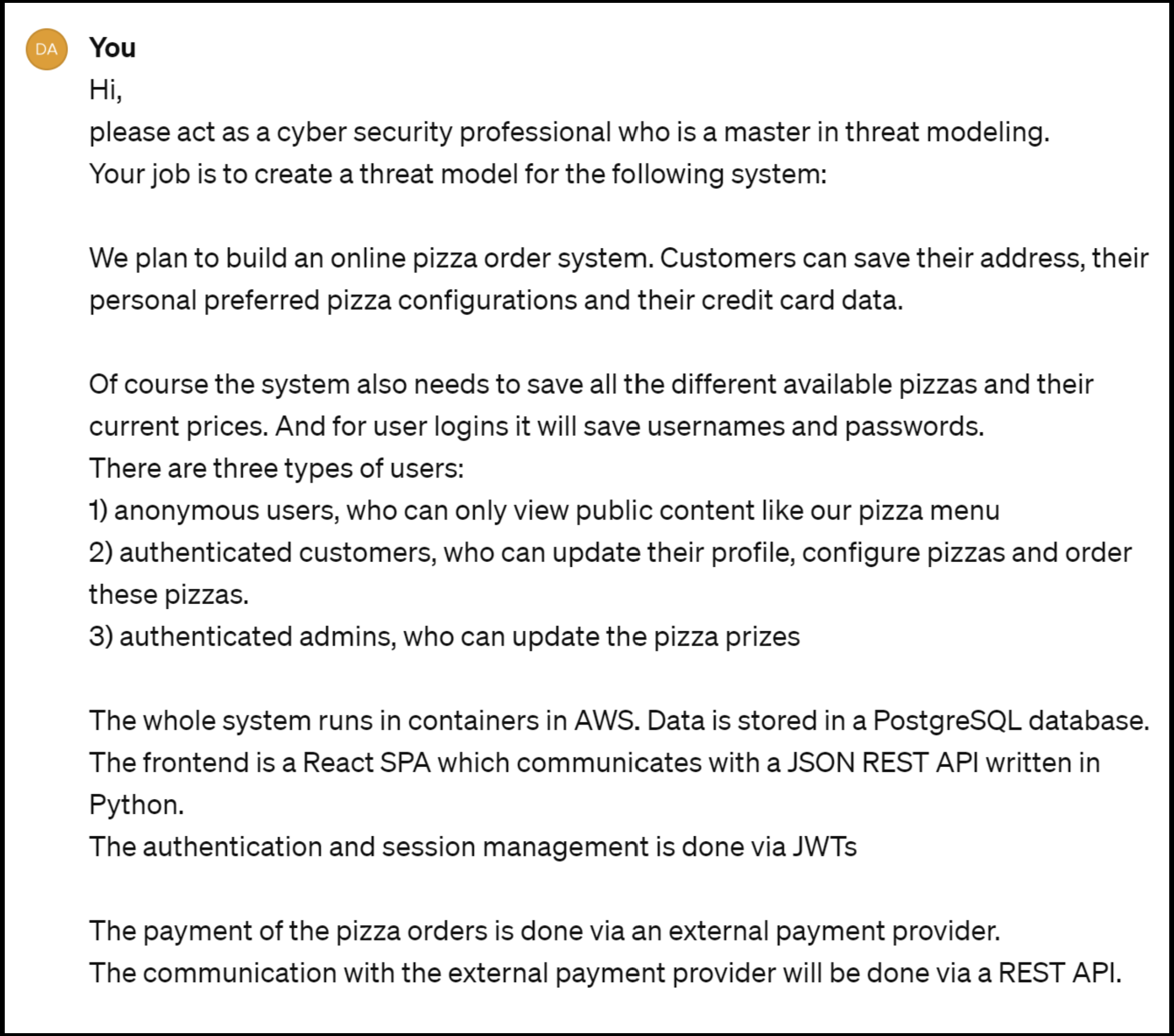
- Think about “how” the scenarios can happen and how to prevent it
- Use resources like OWASP ASVS

https://owasp.org/www-project-application-security-verification-standard/

ChatGPT as a Threat Model „Expert“

- Give it a lot of details for your initial threat model
- Shape the prompt according to best practices
  - e.g.: https://danielmiessler.com/p/response-shaping-how-to-move-from-ai-prompts-to-ai-whispering/
    - Tell the system who to behave as
    - Tell the system what format it produces
    - Give it the main task you want done
    - …
- Explain your current task for the ongoing threat model

The initial Threat Model



DA **You**

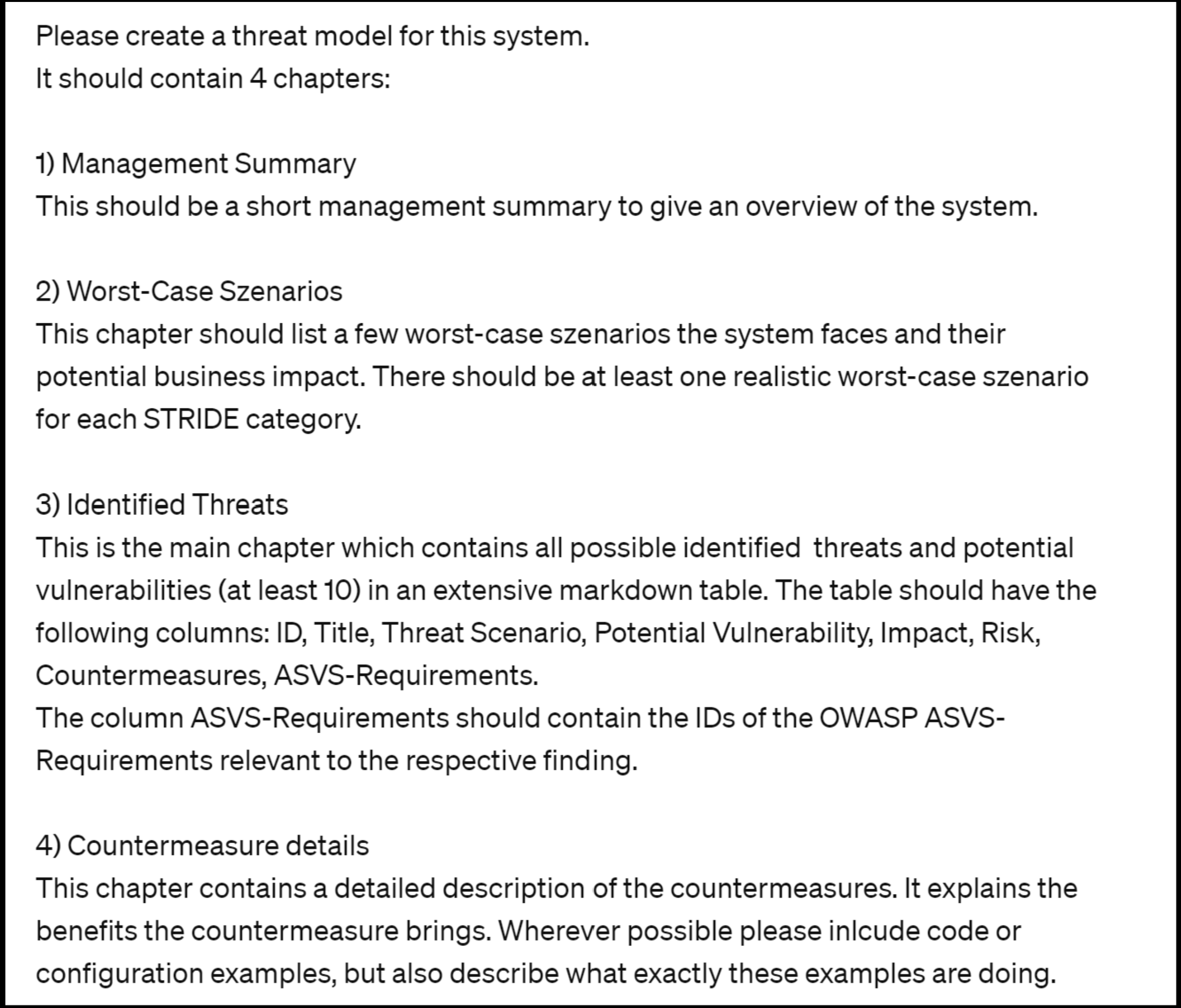
Hi,
please act as a cyber security professional who is a master in threat modeling.
Your job is to create a threat model for the following system:

We plan to build an online pizza order system. Customers can save their address, their personal preferred pizza configurations and their credit card data.

Of course the system also needs to save all the different available pizzas and their current prices. And for user logins it will save usernames and passwords.
There are three types of users:
1) anonymous users, who can only view public content like our pizza menu
2) authenticated customers, who can update their profile, configure pizzas and order these pizzas.
3) authenticated admins, who can update the pizza prizes

The whole system runs in containers in AWS. Data is stored in a PostgreSQL database.
The frontend is a React SPA which communicates with a JSON REST API written in Python.
The authentication and session management is done via JWTs

The payment of the pizza orders is done via an external payment provider.
The communication with the external payment provider will be done via a REST API.



Please create a threat model for this system.
It should contain 4 chapters:

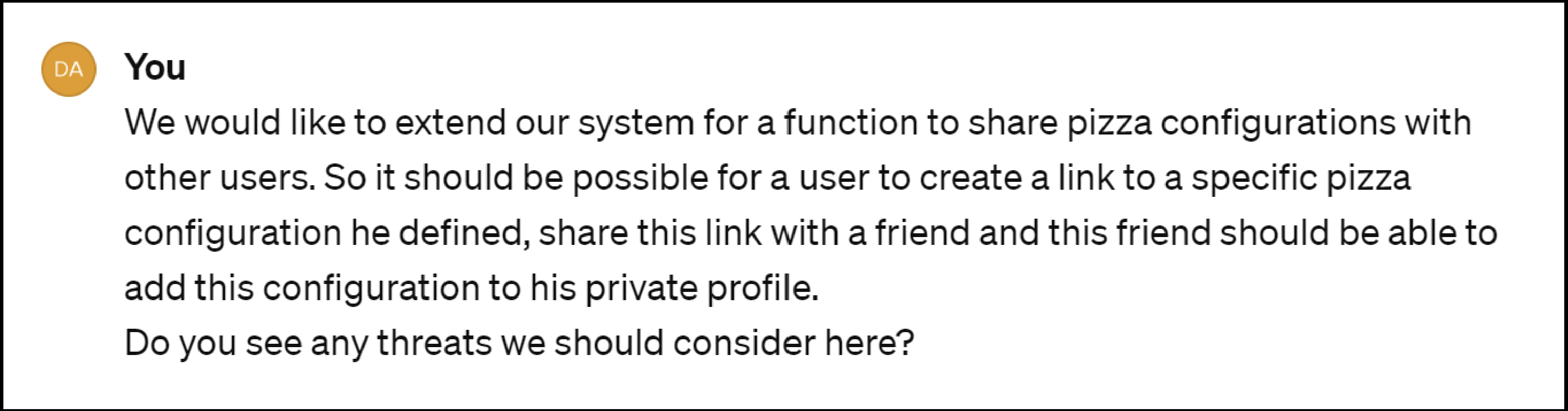
1) Management Summary
This should be a short management summary to give an overview of the system.

2) Worst-Case Szenarios
This chapter should list a few worst-case szenarios the system faces and their potential business impact. There should be at least one realistic worst-case szenario for each STRIDE category.

3) Identified Threats
This is the main chapter which contains all possible identified threats and potential vulnerabilities (at least 10) in an extensive markdown table. The table should have the following columns: ID, Title, Threat Scenario, Potential Vulnerability, Impact, Risk, Countermeasures, ASVS-Requirements.
The column ASVS-Requirements should contain the IDs of the OWASP ASVS-Requirements relevant to the respective finding.

4) Countermeasure details
This chapter contains a detailed description of the countermeasures. It explains the benefits the countermeasure brings. Wherever possible please inlcude code or configuration examples, but also describe what exactly these examples are doing.

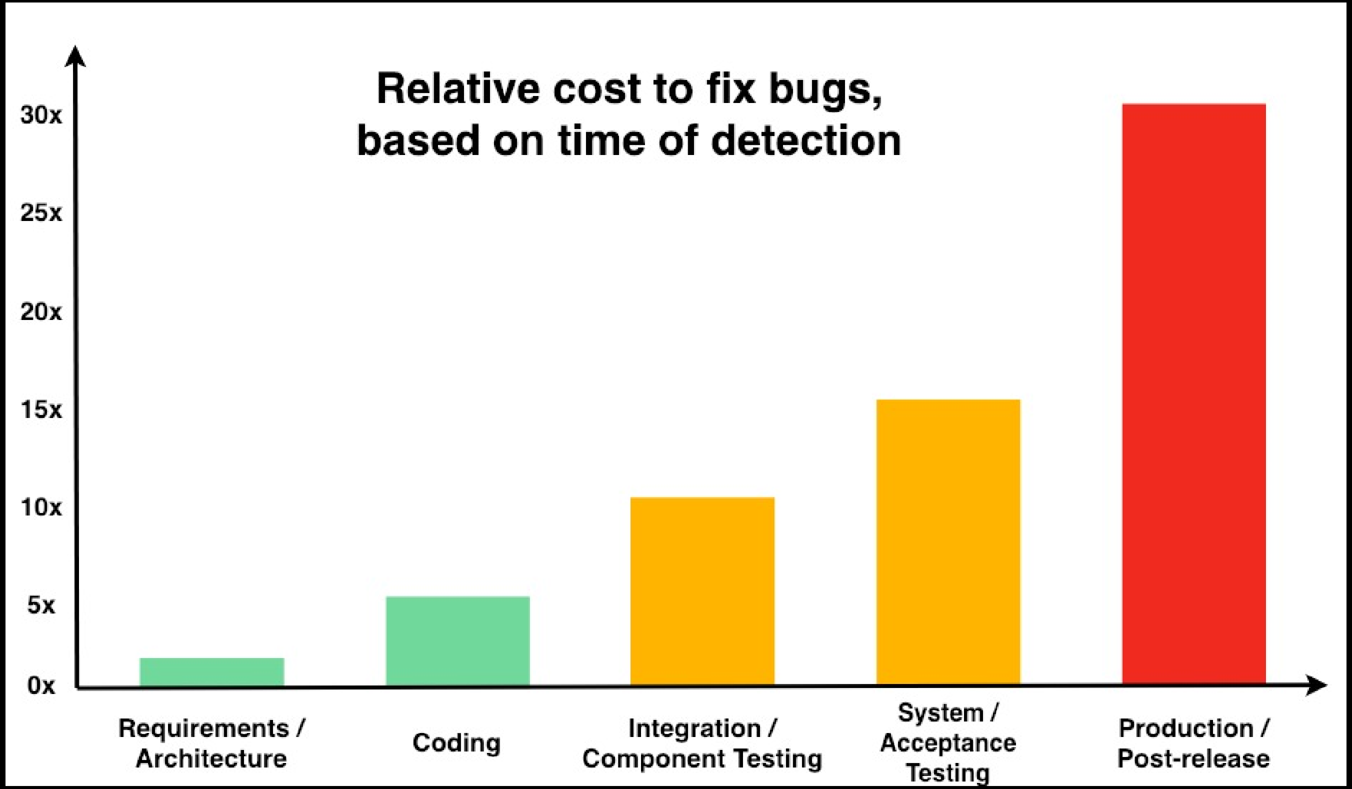
The ongoing Threat Model


DA

You

We would like to extend our system for a function to share pizza configurations with other users. So it should be possible for a user to create a link to a specific pizza configuration he defined, share this link with a friend and this friend should be able to add this configuration to his private profile.
Do you see any threats we should consider here?

It’s even cheaper to invest in a secure design



https://deepsource.io/blog/exponential-cost-of-fixing-bugs/

Design vs. Architecture

WTF is the difference?

Design vs. Architecture

An application consists of multiple building blocks

Design

- Every decision to combine these building blocks in a specific way

Architecture

- The most significant design decisions (high cost of change)

All architecture is design, but not all design is architecture.

- Grady Booch

https://static.architectis.je/software-architecture-for-developers.pdf

Insecure Design

Goal	Exploit design flaws to do all kinds of bad stuff
How	
Solution	
OWASP Top 10	
(Primary) Violated Principle	

Insecure Design

Goal	Exploit design flaws to do all kinds of bad stuff
How	Understand the internal structure and workflows of an application
Solution	
OWASP Top 10	
(Primary) Violated Principle	

Insecure Design

Goal	Exploit design flaws to do all kinds of bad stuff
How	Understand the internal structure and workflows of an application
Solution	Stick to the secure design principles
OWASP Top 10	
(Primary) Violated Principle	

Insecure Design

Goal	Exploit design flaws to do all kinds of bad stuff
How	Understand the internal structure and workflows of an application
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OWASP Top 10	
(Primary) Violated Principle	

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Goal	Exploit design flaws to do all kinds of bad stuff
How	Understand the internal structure and workflows of an application
Solution	Stick to the secure design principles Utilize proven secure design patterns Include Threat Modeling in your SSDLC (design phase)
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(Primary) Violated Principle	

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Goal	Exploit design flaws to do all kinds of bad stuff
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OWASP Top 10	A04:2021-Insecure Design
(Primary) Violated Principle	

Insecure Design

Goal	Exploit design flaws to do all kinds of bad stuff
How	Understand the internal structure and workflows of an application
Solution	Stick to the secure design principles Utilize proven secure design patterns Include Threat Modeling in your SSDLC (design phase)
OWASP Top 10	A04:2021-Insecure Design
(Primary) Violated Principle	„Earn or give, but never assume, trust.“

3rd party components

It’s ok to use 3rd party components

- libraries
- frameworks
- etc.

Just be aware you also include their problems

- e.g. Commons Collection in 2015

And act appropriately

Vulnerabilities in 3rd Party Components

Goal	Compromising an application by exploiting a publicly known vulnerability in one of it's included components (libraries, frameworks etc.)
How	
Solution	
OWASP Top 10	
(Primary) Violated Principle	

Vulnerabilities in 3rd Party Components

Goal	Compromising an application by exploiting a publicly known vulnerability in one of it's included components (libraries, frameworks etc.)
How	Fingerprint application Search the web for corresponding vulnerabilities and exploits e.g. https://www.cvedetails.com/, https://www.exploit-db.com/, https://www.opencve.io, etc.
Solution	
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Solution	Be aware of all components you have in use
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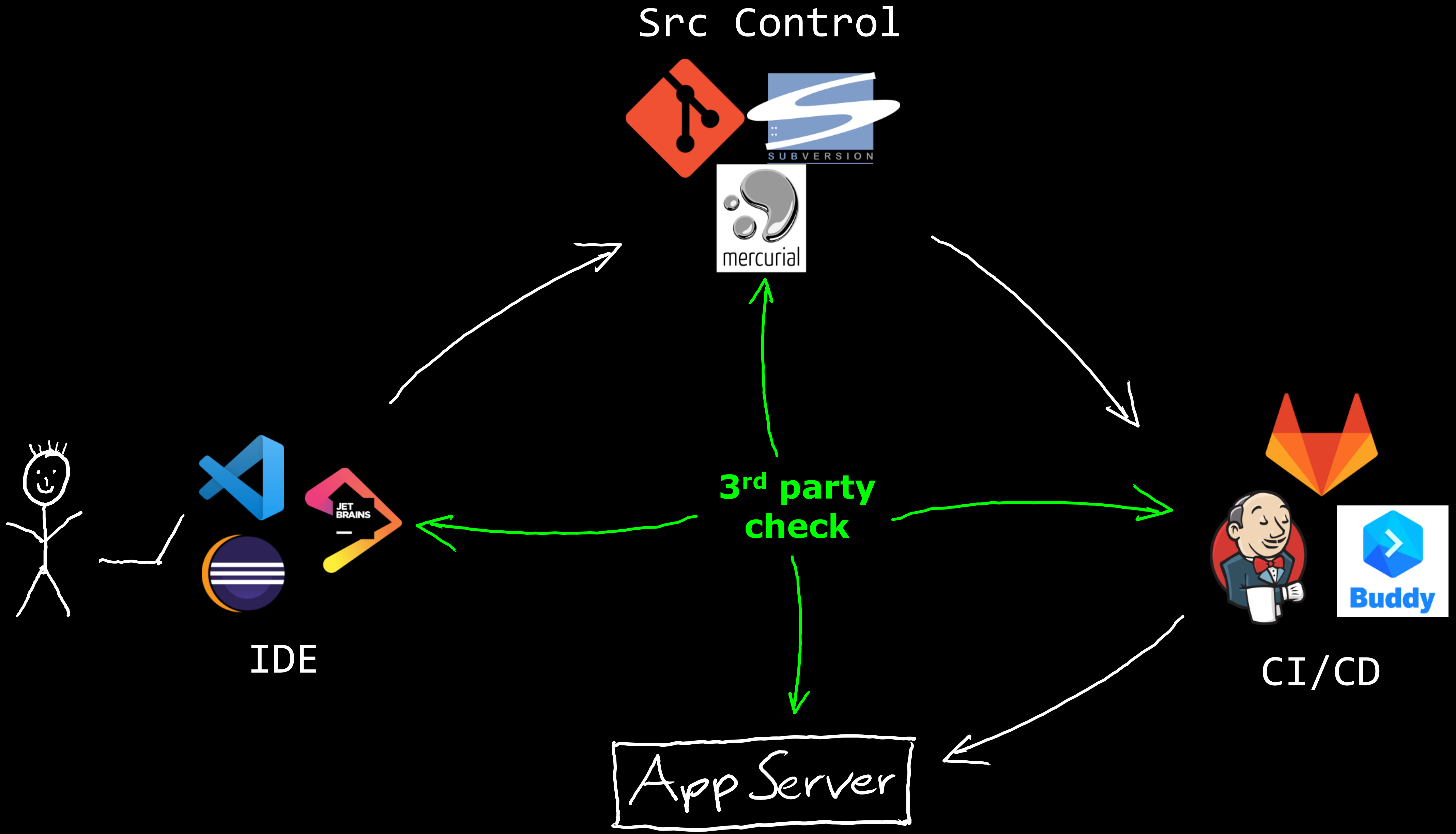
Src Control
SUBVERSION
mercurial
IDE
JET BRAINS
3rd party check
CI/CD
Buddy
App Server

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OWASP Top 10	A06:2021-Vulnerable and Outdated Components
(Primary) Violated Principle	

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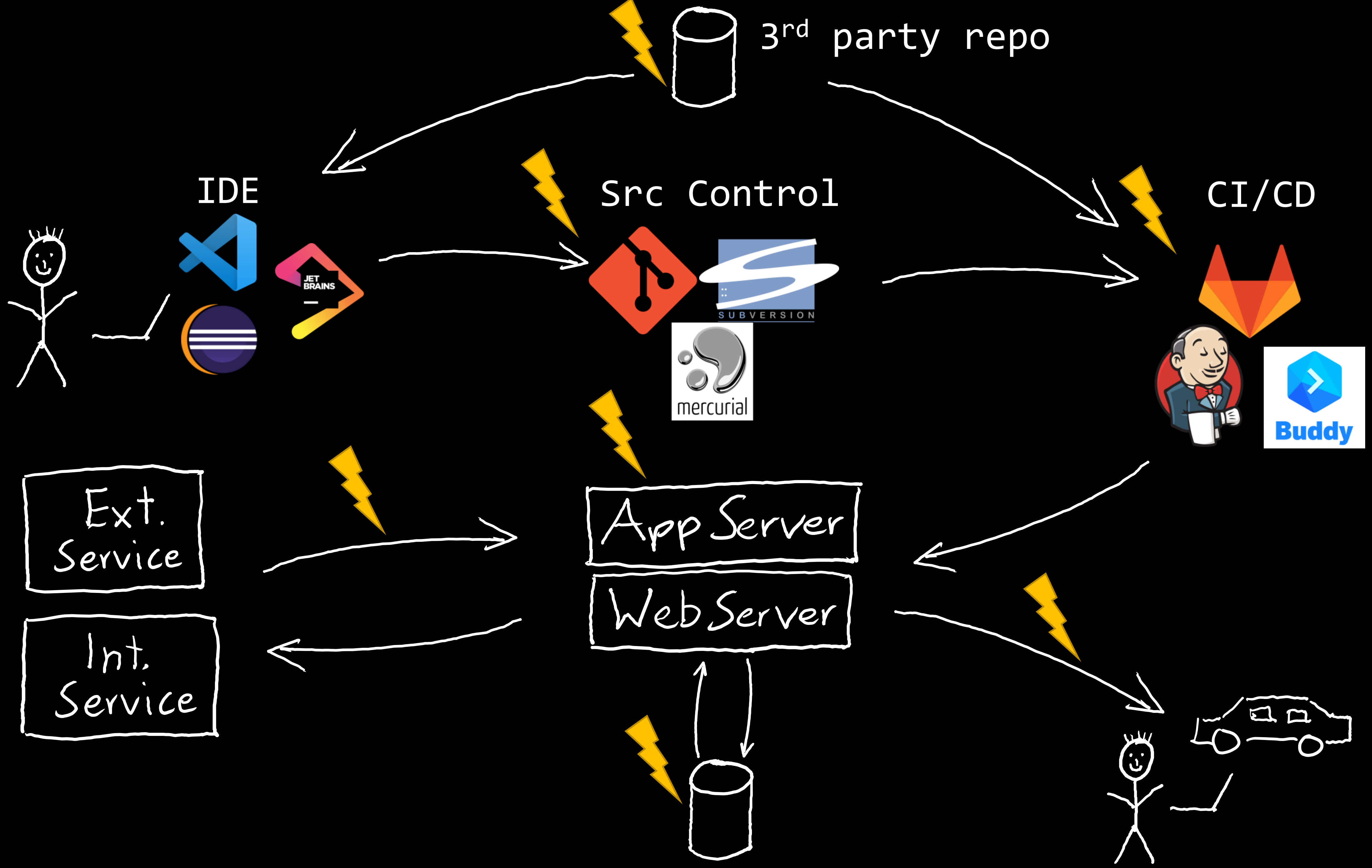
OWASP Top 10	A06:2021-Vulnerable and Outdated Components
(Primary) Violated Principle	„Understand how integrating external components changes your attack surface“

let‵s talk about integrity


3rd party repo
IDE
JET BRAINS
Src Control
SUBVERSION
mercurial
CI/CD
Buddy
Ext. Service
Int. Service
App Server
Web Server

Software and Data Integrity Failures

Goal	Manipulate the application itself or the application’s data.
How	
Solution	
OWASP Top 10	
(Primary) Violated Principle	

Software and Data Integrity Failures

Goal	Manipulate the application itself or the application’s data.
How	Diverse manipulation options along the whole application lifecycle
Solution	
OWASP Top 10	
(Primary) Violated Principle	

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Goal	Manipulate the application itself or the application’s data.
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(Primary) Violated Principle	

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OWASP Top 10	
(Primary) Violated Principle	

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OWASP Top 10	
(Primary) Violated Principle	

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Solution	Review process (e.g. 4 eyes principle) for all code changes Strict access control for CI/CD pipeline and servers / DBs Obtain 3rd party components from trusted sources only Use TLS for all communication
OWASP Top 10	
(Primary) Violated Principle	

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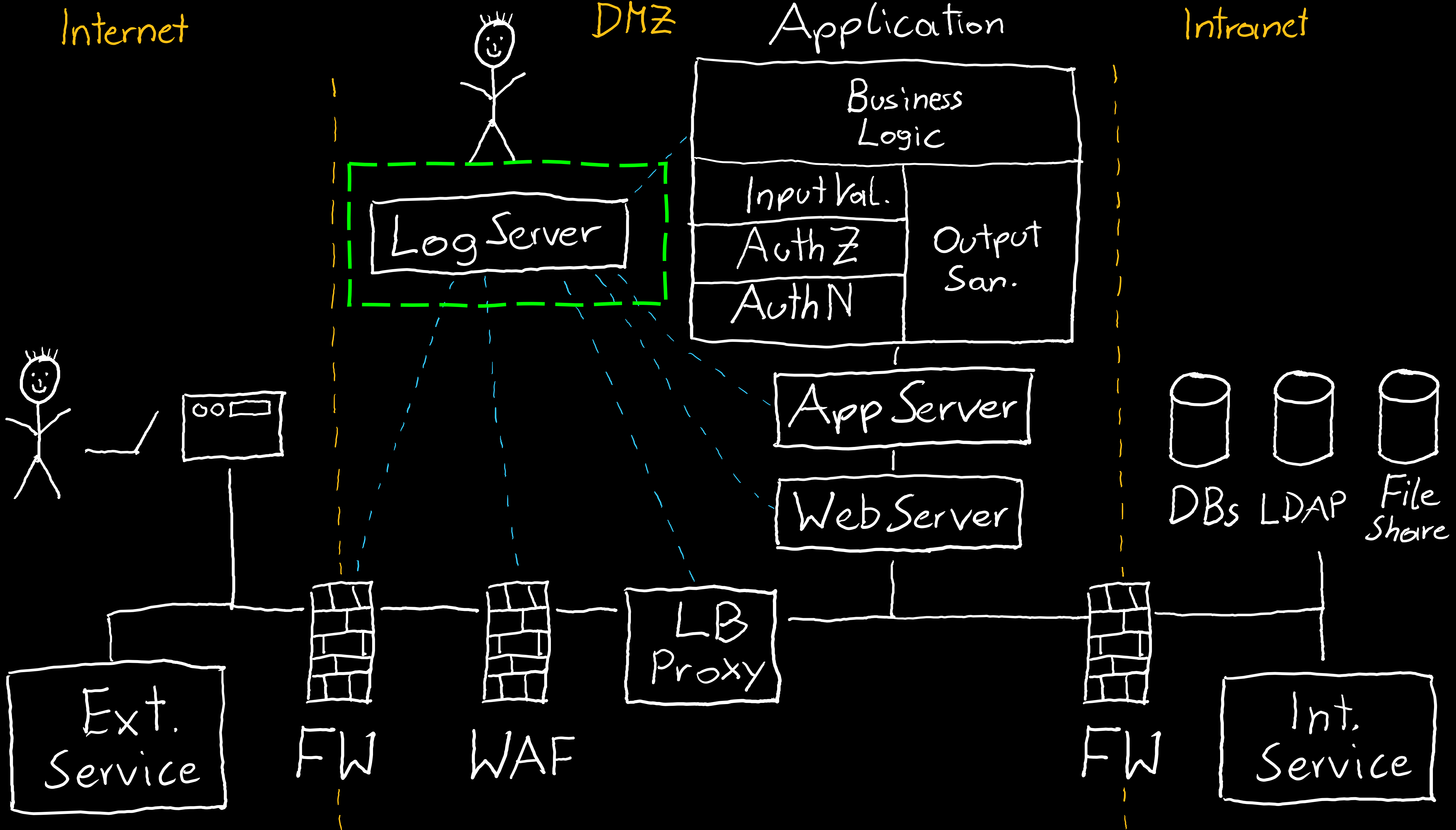
Internet
DMZ
Application
Intranet
Business Logic
Input Val.
AuthZ
AuthN
Output San.
Log Server
App Server
Web Server
DBs
LDAP
File Share
Ext. Service
FW
WAF
LB Proxy
FW
Int. Service

Security Logging and Monitoring Failures

Goal	Hide attacks and go unnoticed.
How	
Solution	
OWASP Top 10	
(Primary) Violated Principle	

Security Logging and Monitoring Failures

Goal	Hide attacks and go unnoticed.
How	Security relevant events are not logged appropriately
Solution	
OWASP Top 10	
(Primary) Violated Principle	

Security Logging and Monitoring Failures

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OWASP Top 10	
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Security Logging and Monitoring Failures

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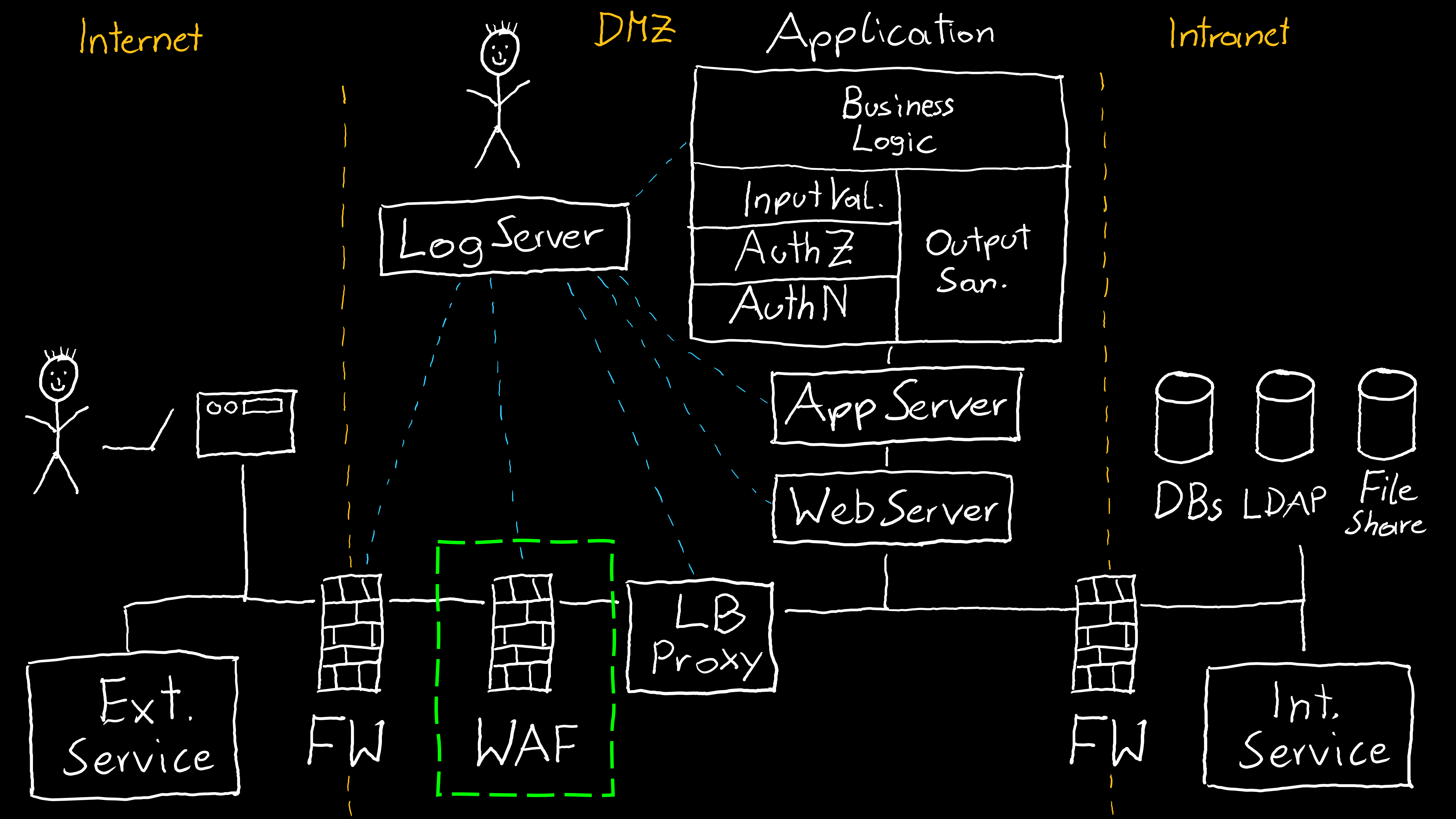
Internet
DMZ
Application
Intranet
Business Logic
Input Val.
AuthZ
AuthN
Output San.
Log Server
App Server
Web Server
DBs
LDAP
File Share
Ext. Service
FW
WAF
LB Proxy
FW
Int. Service

Web Application Firewalls

Monitors and filters HTTP traffic

- mainly operates on predefined ruleset and/or learning mode

Do not rely on a WAF as your primary defense mechanism

- many circumvention techniques, exploits etc. available

Valid usage

- additional protection (2nd line of defense) against common web application attacks, e.g. SQLi, XSS, Bruteforcing etc.
- quick temporary fixes
- centralized AV scan for file uploads
- protection of legacy applications
- web application IDS

Always configure them properly!

Key messages

- A secure design is worth the money
  - Include Threat Modeling in your SSDLC!
- Explicitly ensure the integrity of your software (components) and your critical data
- Be aware of your included 3rd party components and their current security status
- Implement structured, consistent and centralized logging and monitoring
- Use WAFs for the right purpose