General Topics

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

Rough Overview

1. Introduction
2. Basic Principles and Resources
3. Architecture & Basic Web Procedure
4. Authentication and Session Management
5. Authorization
6. Server and Backend Attacks
7. Remaining Client Attacks
8. >> General Topics <<
9. Conclusions

Design Flaw vs. Implementation Defect

Design Flaw / Insecure Design	Implementation Defect

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Client-side security checks only	

Design Flaw vs. Implementation Defect

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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Firmware update integrity isn’t ensured	Digital signature uses outdated/vuln.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

Fail-safe Defaults

Complete Mediation

Least Privilege

Least Common Mechanism

Separation of Privilege

Open Design

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:

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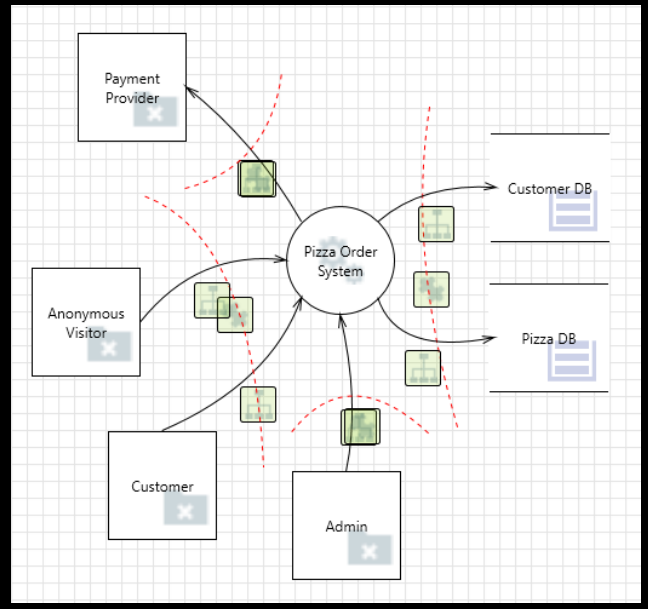
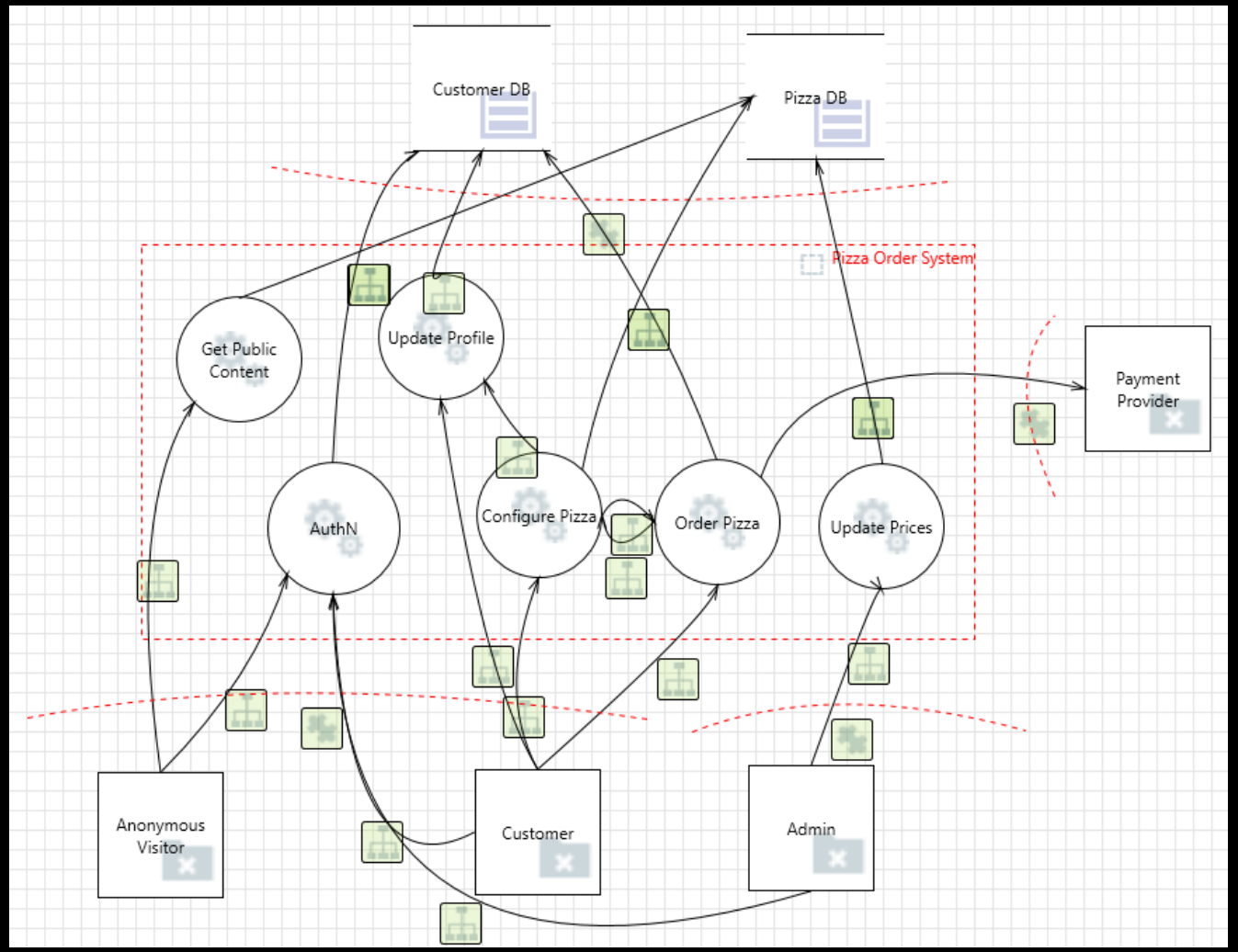
Threat Modeling in a nutshell

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/

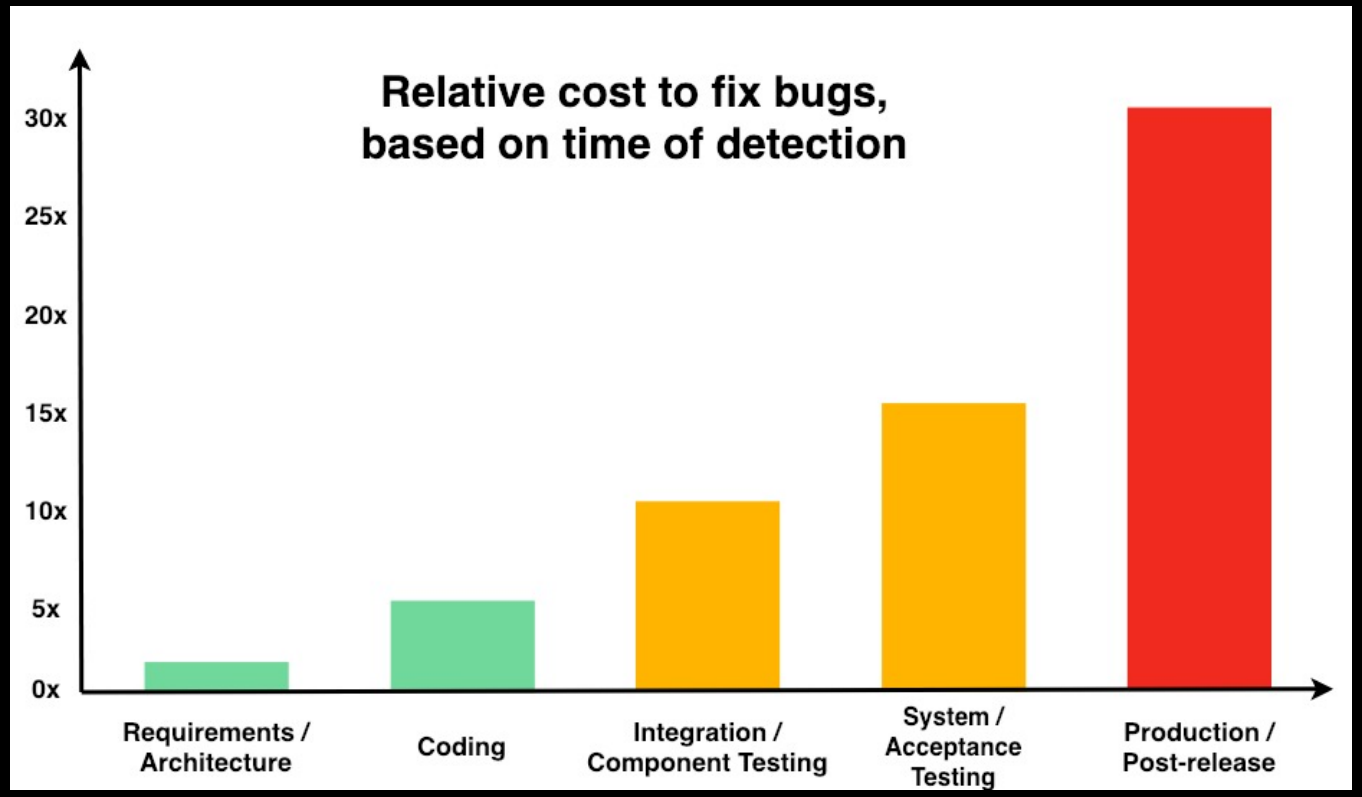
Threat Modeling in a nutshell

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/

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

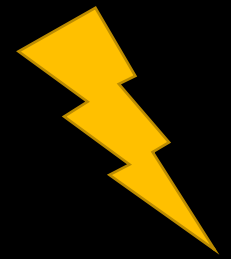
Design
- Every decision to combine these building blocks in a specific way

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

All architecture is design, but not all design is architecture.
- Grady Booch

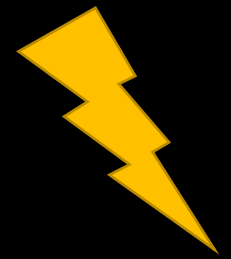
https://static.architectis.je/software-architecture-for-developers.pdf

Insecure Design



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

Insecure Design



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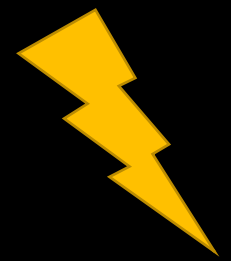

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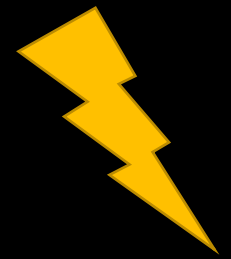

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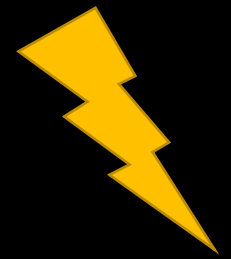

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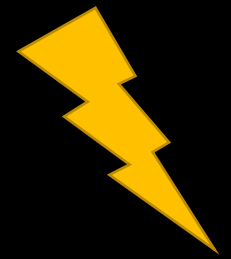

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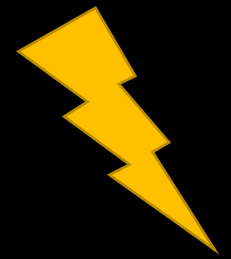

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3rd party components

It’s ok to use 3rd party components

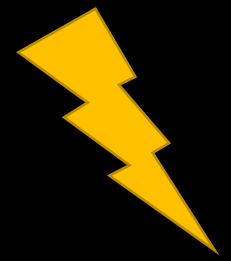
- libraries
- frameworks
- etc.

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	
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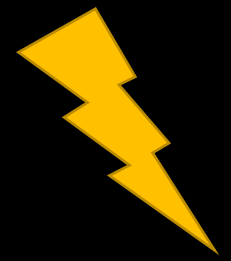
Vulnerabilities in 3rd Party Components



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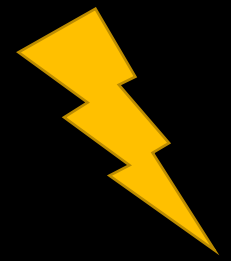

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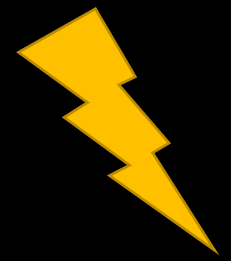
OWASP Top 10	
(Primary) Violated Principle	

Vulnerabilities in 3rd Party Components



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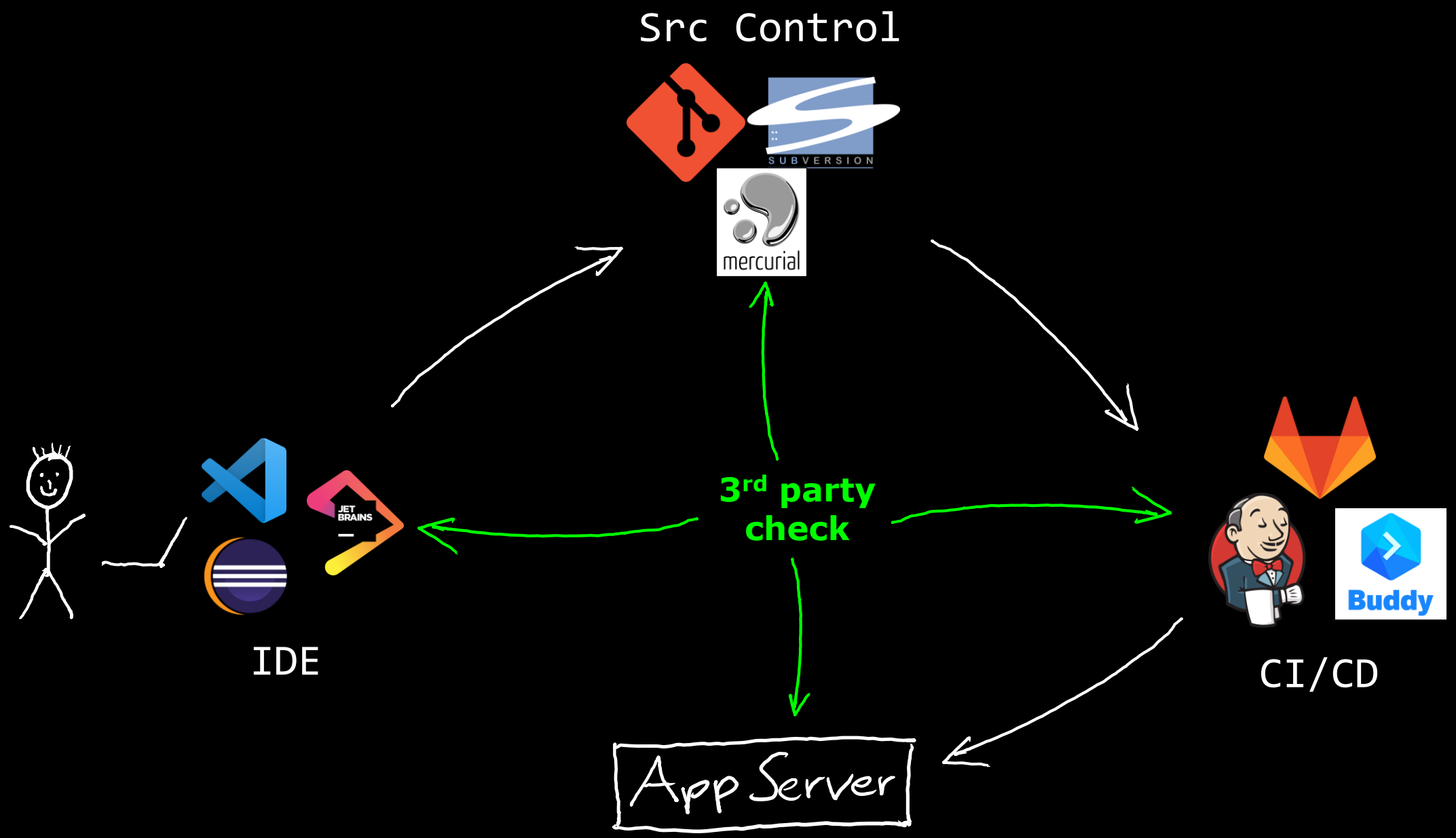
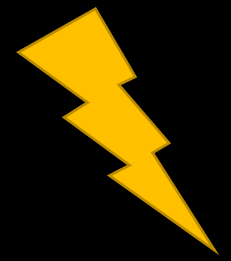

Src Control
SUBVERSION
mercurial
3rd party check
JET BRAINS
IDE
Buddy
CI/CD
App Server

Vulnerabilities in 3rd Party Components



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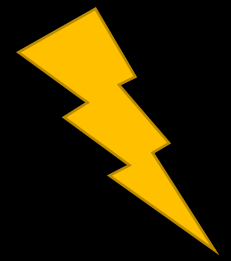

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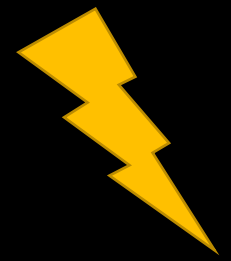

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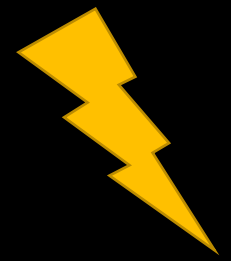

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OWASP Top 10	A06:2021-Vulnerable and Outdated Components
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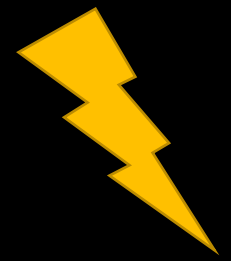
Vulnerabilities in 3rd Party Components



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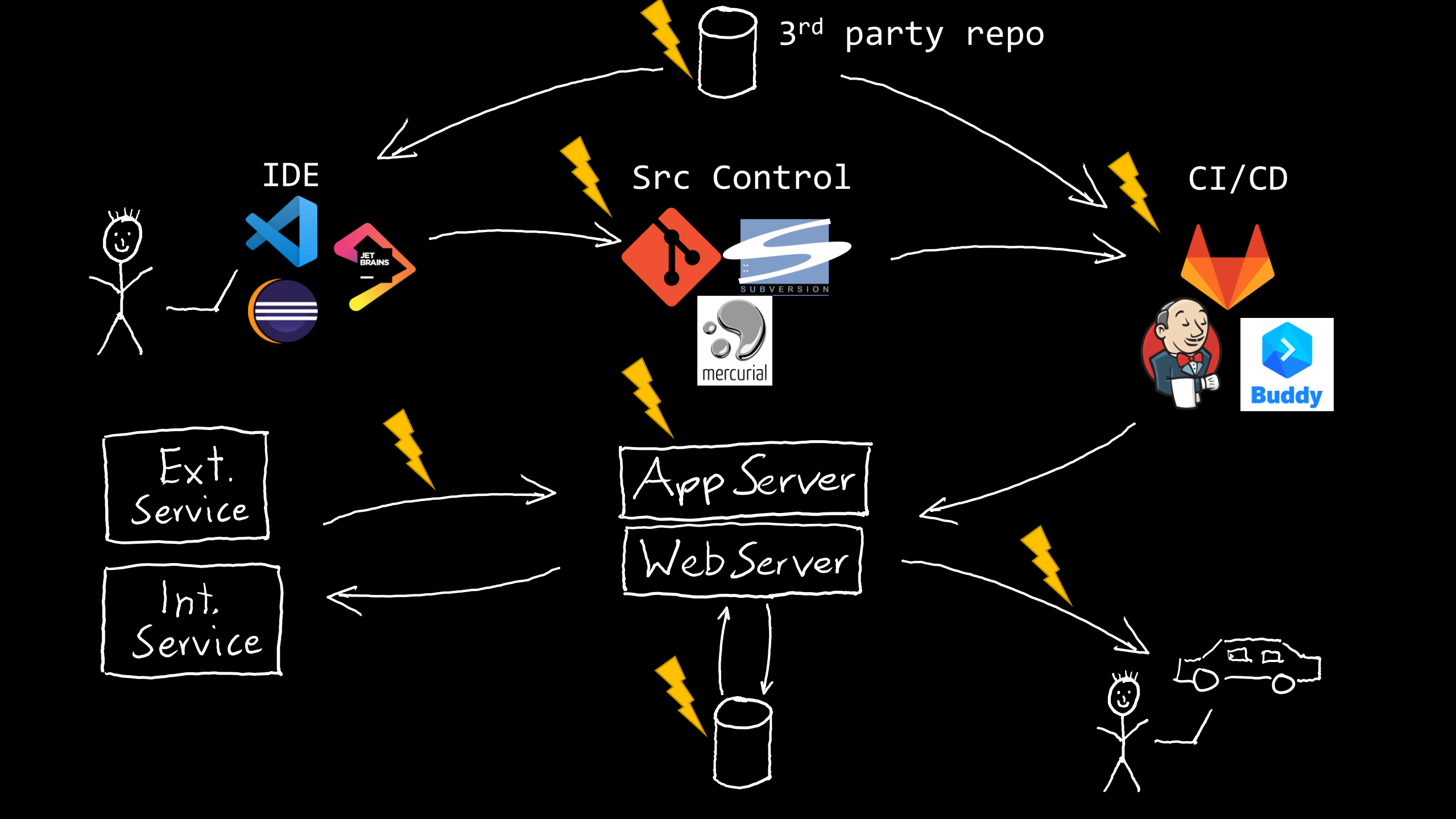
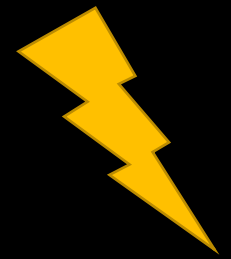
(Primary) Violated Principle	„Understand how integrating external components changes your attack surface“

let‘s talk about integrity


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

Software and Data Integrity Failures



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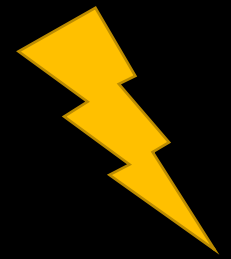
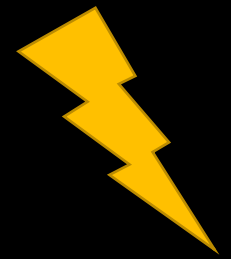
How	
Solution	
OWASP Top 10	
(Primary) Violated Principle	

Software and Data Integrity Failures



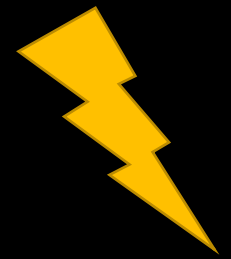
Goal	Manipulate the application itself or the application’s data.
How	Diverse manipulation options along the whole application lifecycle
Solution	
OWASP Top 10	
(Primary) Violated Principle	

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	Review process (e.g. 4 eyes principle) for all code changes
OWASP Top 10	
(Primary) Violated Principle	

Software and Data Integrity Failures



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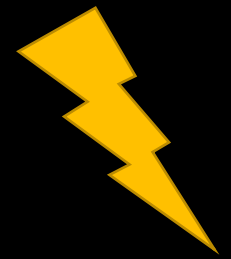

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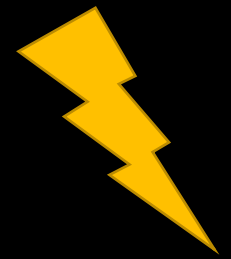

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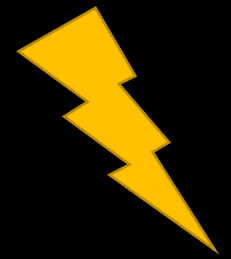
Software and Data Integrity Failures



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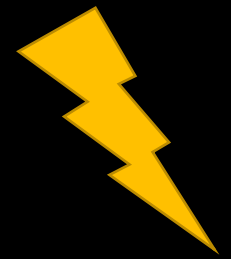
Software and Data Integrity Failures



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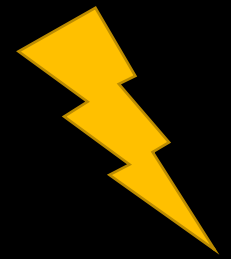
OWASP Top 10	A08:2021-Software and Data Integrity Failures
(Primary) Violated Principle	

Software and Data Integrity Failures



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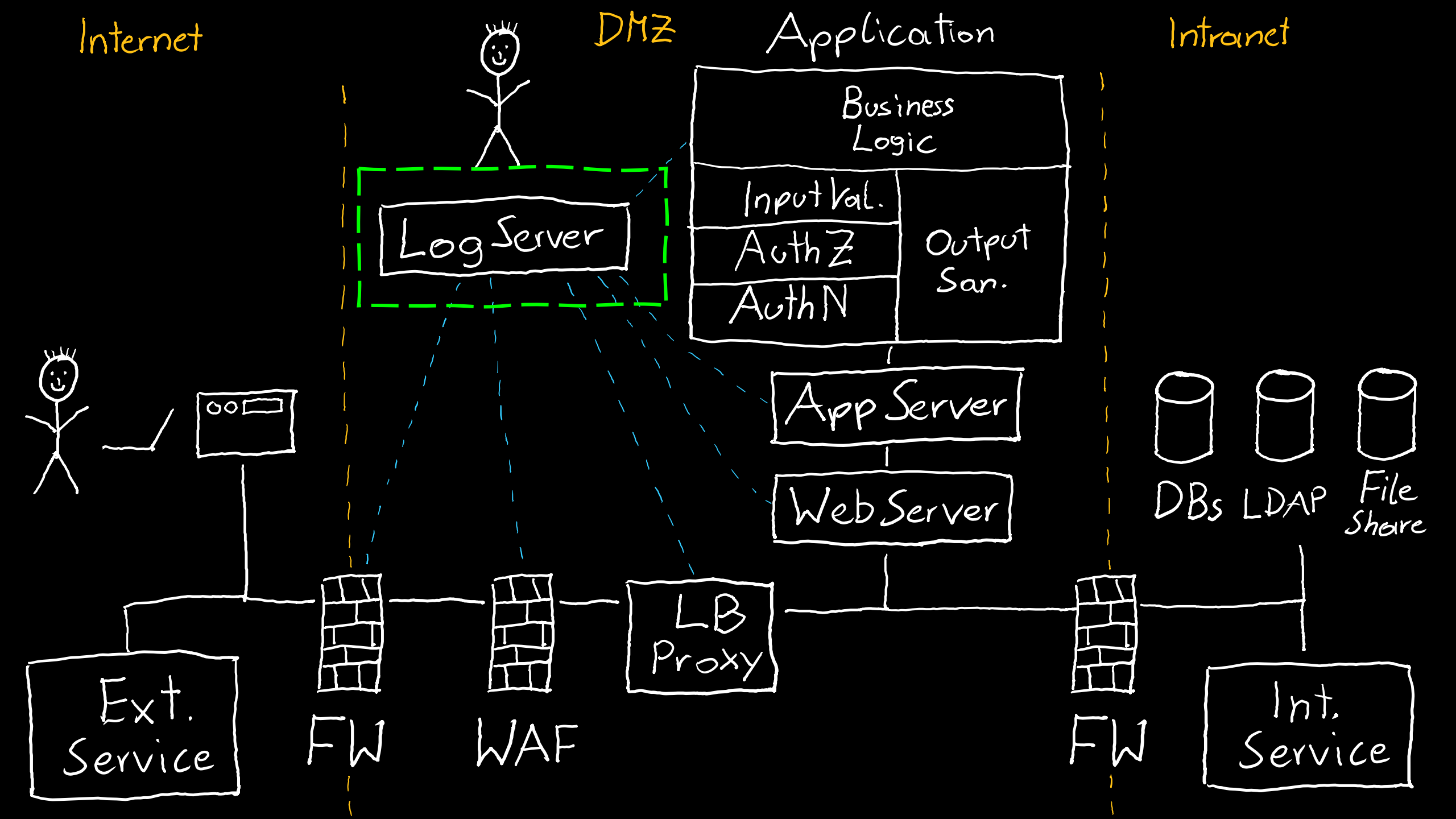
OWASP Top 10	A08:2021-Software and Data Integrity Failures
(Primary) Violated Principle	„Define an approach that ensures all data are explicitly validated.“


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

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(Primary) Violated Principle	

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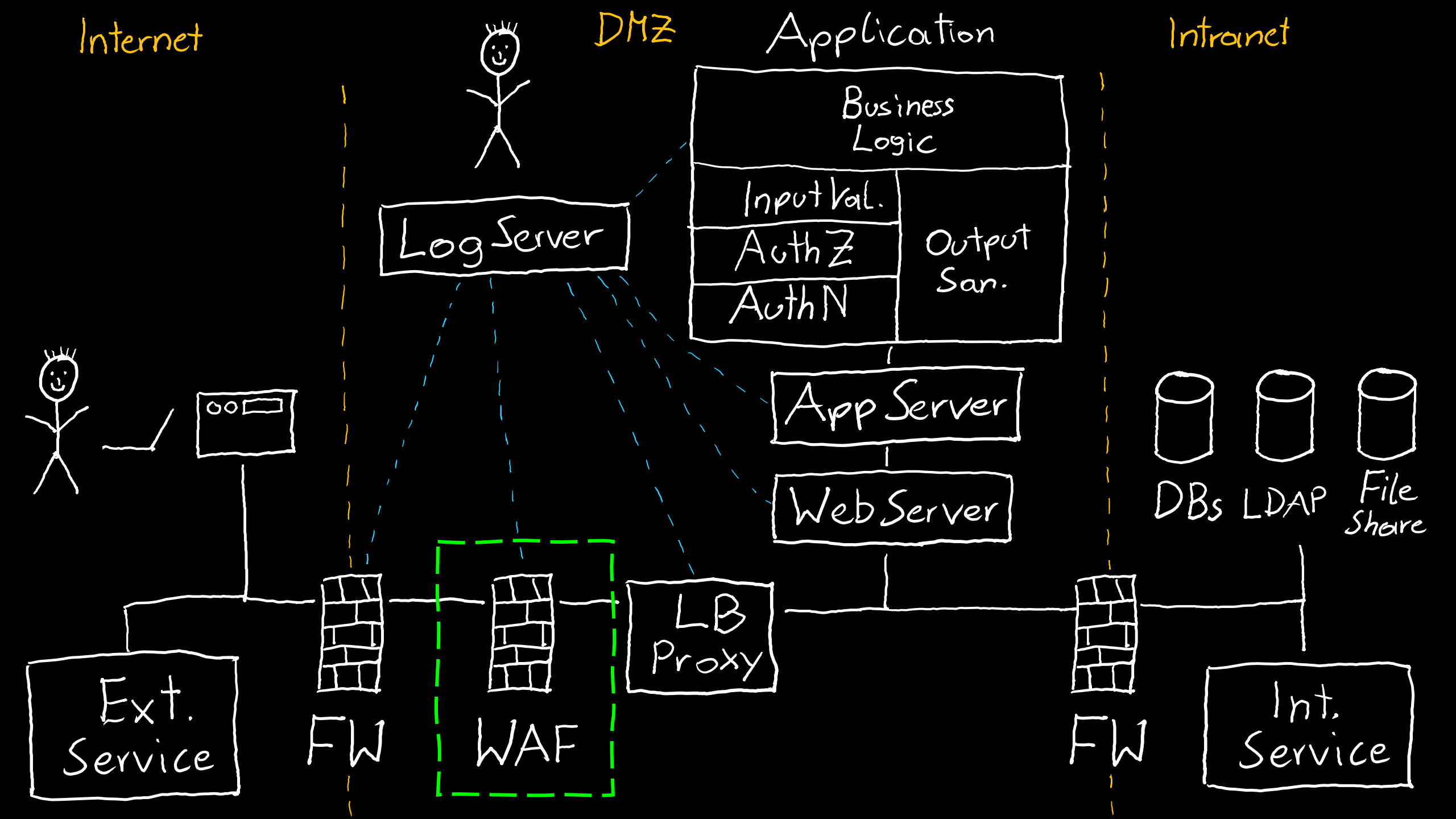
OWASP Top 10	A09:2021-Security Logging and Monitoring Failures
(Primary) Violated Principle	„Earn or give, but never assume, trust.“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File Share
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Ext. Service
FW
WAF
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Int. 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