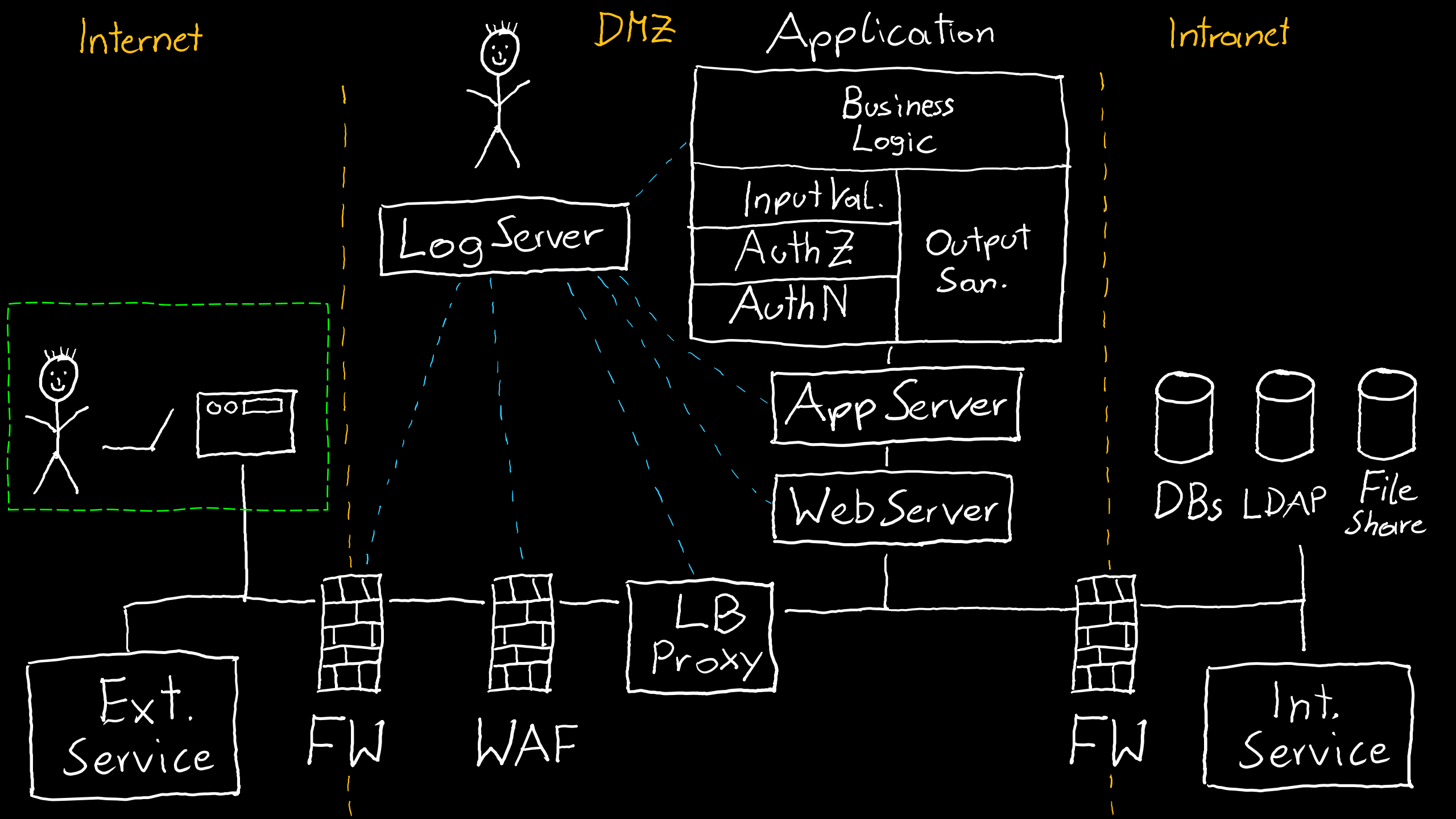
Architecture & Basic Web Procedure

DNS Hijacking, Information Disclosure,
Plaintext Transmission

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

How does the typical architecure of a web application look like?


Internet
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AuthZ
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Output San.
Log Server
App Server
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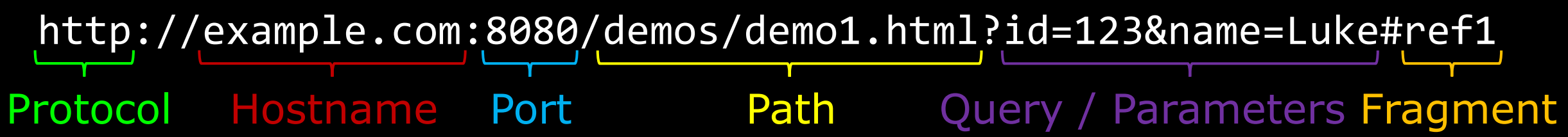
FW
WAF
FW
Int. Service

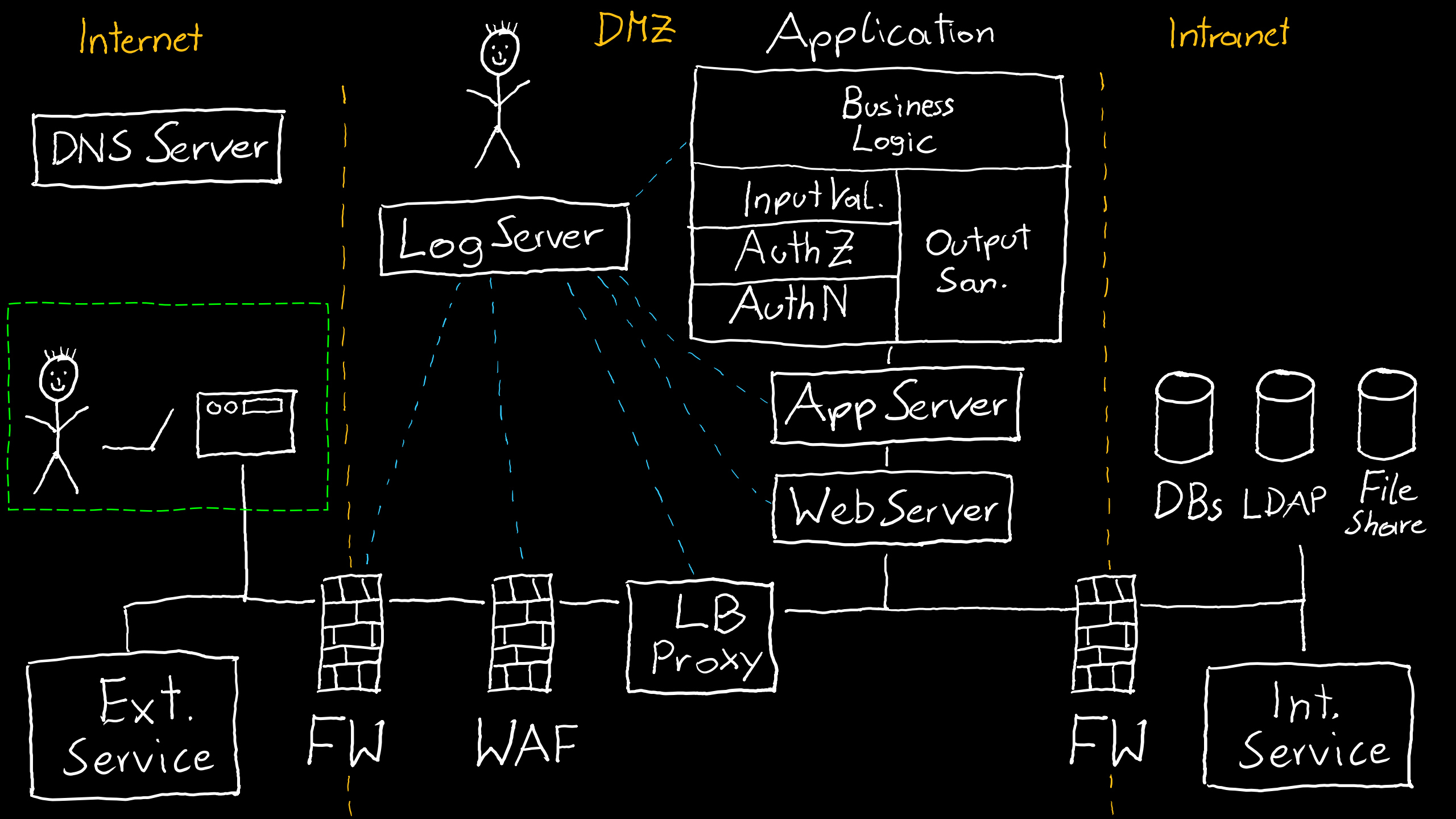
How do you access a website?
(except for googling it...)

You enter a URL
Uniform Resource Locator



and hit enter…

What‘s next ?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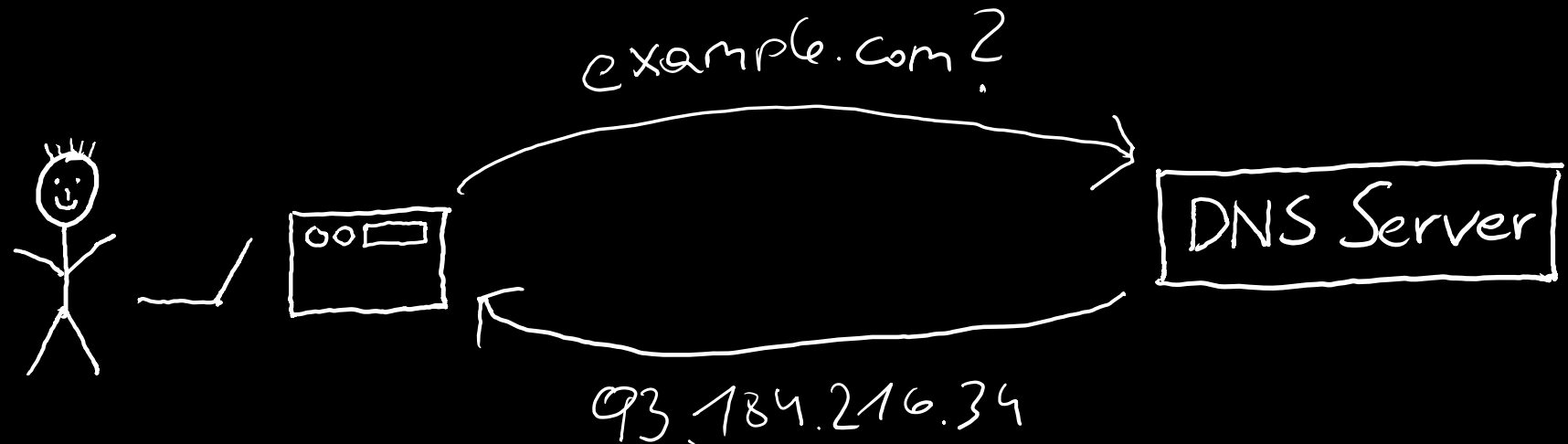
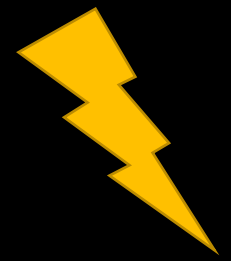


http://example.com:8080/demos/demo1.html?id=123&name=Luke#ref1

You already know DNS
What can go wrong?

DNS Hijacking



Goal	Redirect user to a rogue server by manipulation of DNS records
How	
Solution	
OWASP Top 10	
(Primary) Violated Principle	

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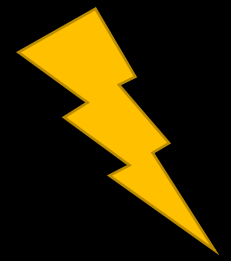

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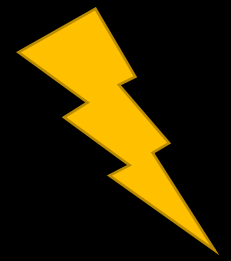

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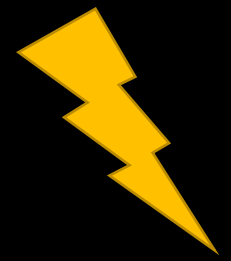

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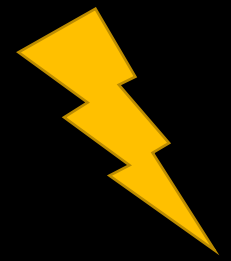

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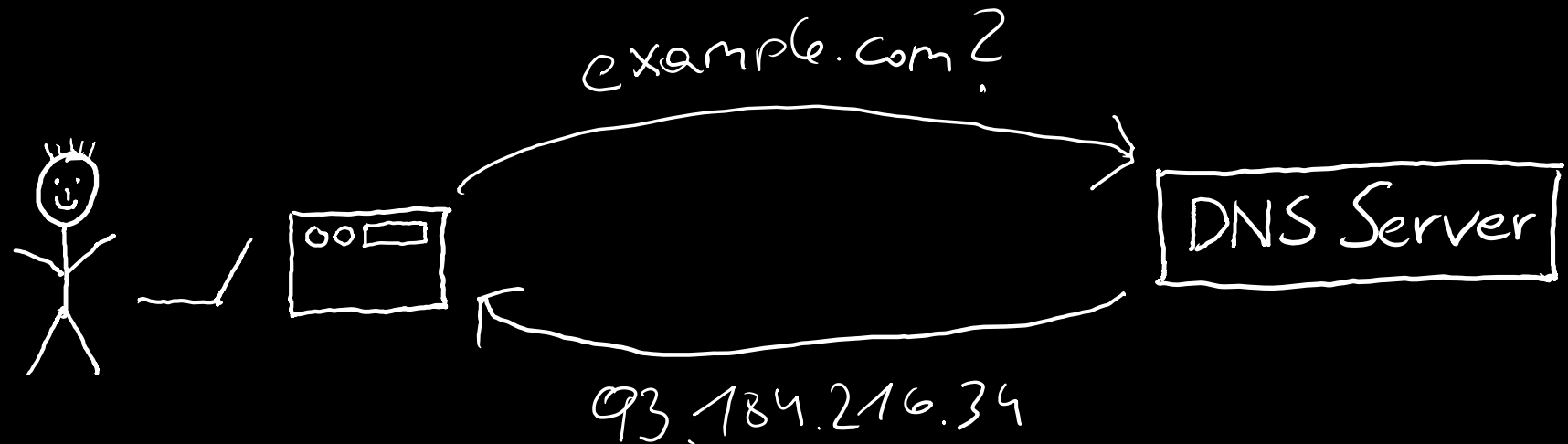
OWASP Top 10	-
(Primary) Violated Principle	„Earn or give, but never assume, trust.“



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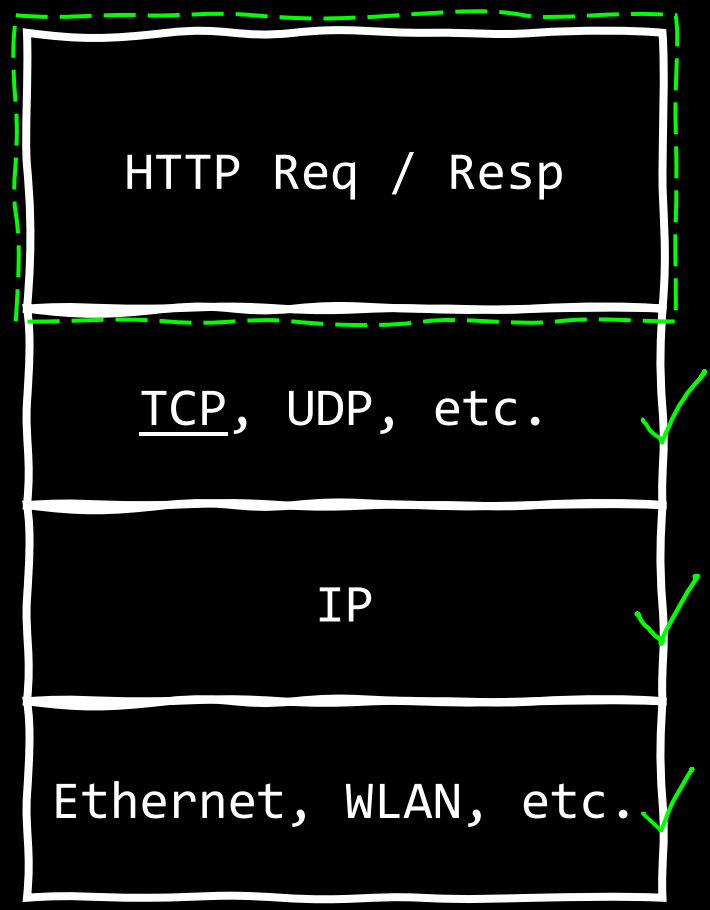
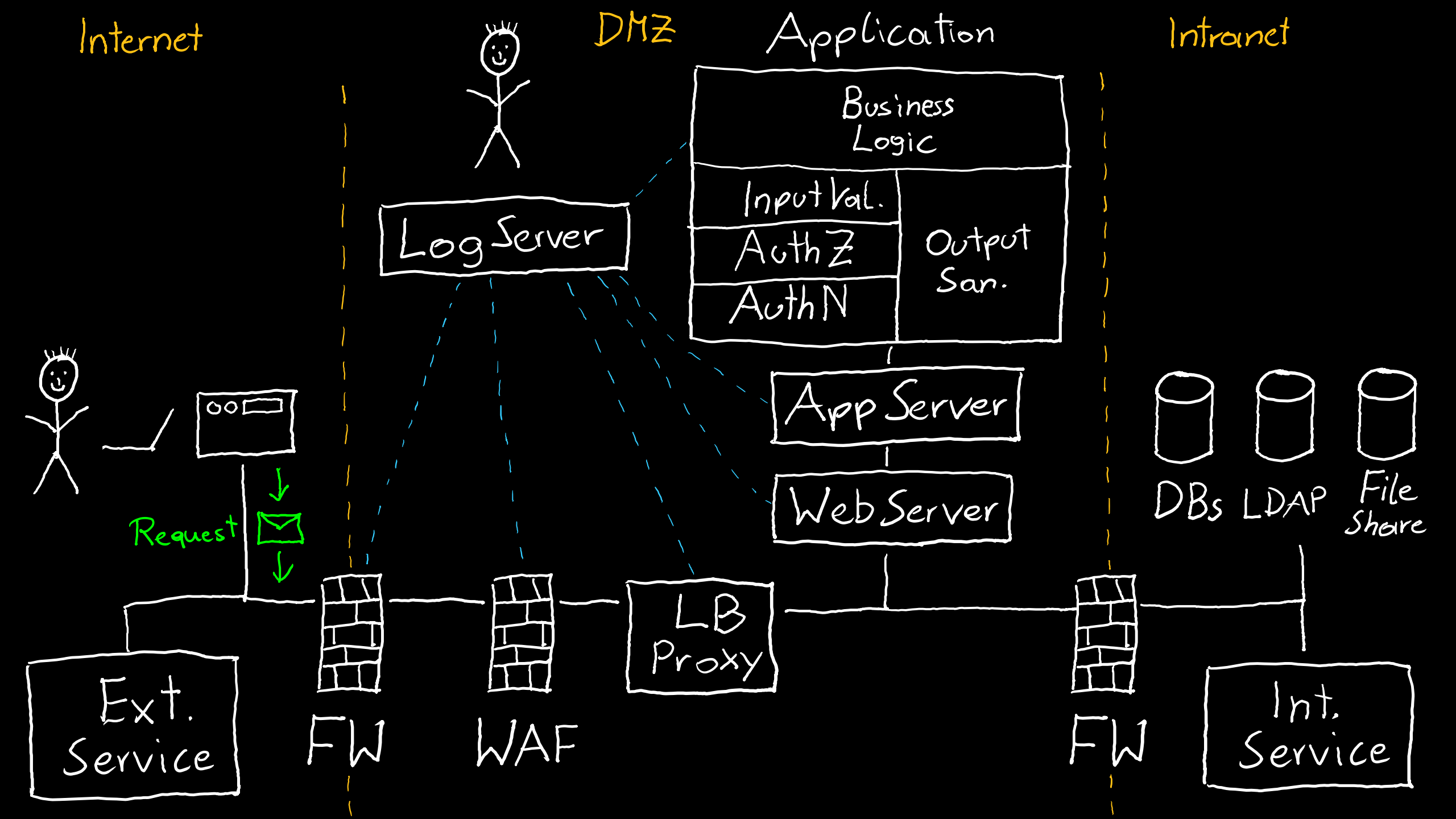
ISO/OSI Model

Application
Presentation
Session
Transport
Network
Data Link
Physical



Internet Protocol Suite (TCP/IP Model)

Application Layer
Transport Layer
Internet Layer
Link Layer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```
> curl -v http://example.com/demos/demo1.html

GET /demos/demo1.html HTTP/1.1
Host: example.com
User-Agent: curl/7.55.1
...
```

Does every request start like that?

HTTP Request Verbs / Methods

	Safe / Idempotent	Intended Use
GET	Y / Y	Read
HEAD	Y / Y	Read (no body)
POST	N / N	Send something to the server
PUT	N / Y	Update something
DELETE	N / Y	Delete something
PATCH	N / Y	Update a part of something
CONNECT	N / N	Establish a tunnel
OPTIONS	Y / Y	List allowed verbs/methods
TRACE	Y / Y	Message loop-back test

https://developer.mozilla.org/en-US/docs/Web/HTTP/Methods

HTTP Request Verbs / Methods

		`classic.com/customers?id=12`	`restapi.com/customer/12`
	Safe / Idempotent	Intended Use	Intended RESTful Use
GET	Y / Y	Read	Read Resource
HEAD	Y / Y	Read (no body)	Read Resource Metadata
POST	N / N	Send something to the server	Create Resource
PUT	N / Y	Update something	Create/Update Resource
DELETE	N / Y	Delete something	Delete Resource
PATCH	N / Y	Update a part of something	Update Resource
CONNECT	N / N	Establish a tunnel	-
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Host: example.com
User-Agent: curl/7.55.1
...
```

just the path you specified
we will talk much more about that later


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GET /demos/demo1.html HTTP/1.1
Host: example.com
User-Agent: curl/7.55.1
...
```

Protocol version	
HTTP/1.0	1996
HTTP/1.1	1999
HTTP/2.0	***2015***
HTTP/3.0	in dev.


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used by the target webserver
e.g. for name-based virtual hosting
since HTTP protocol version 1.1


```
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GET /demos/demo1.html HTTP/1.1
Host: example.com
User-Agent: curl/7.55.1
...
```
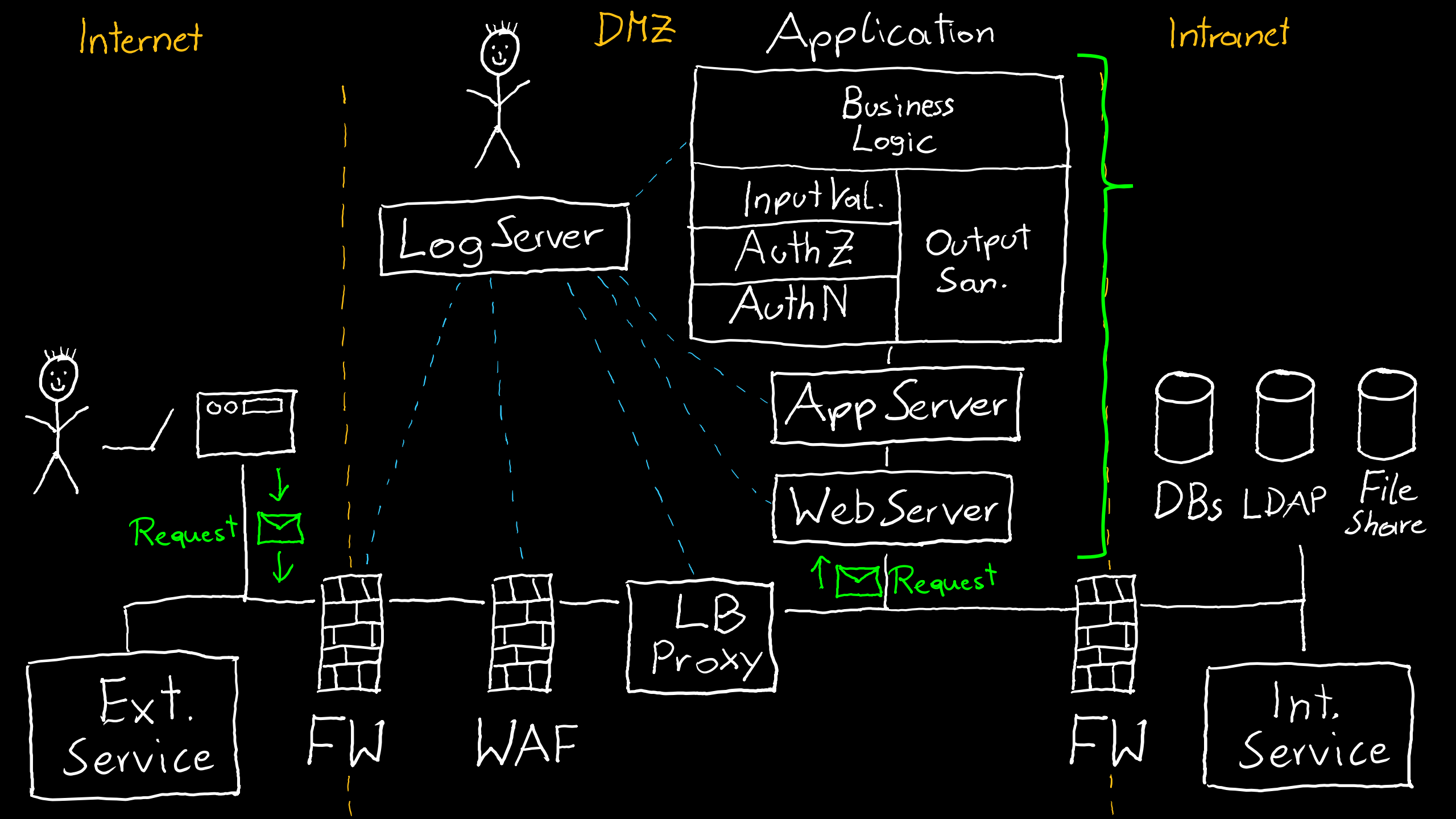

Indicates which program made the request
e.g. to enable mobile view
Never rely on it!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serves “static” content only
  e.g. pictures, data-files, client-side code (HTML, CSS, JavaScript)

Examples: Apache, nginx, MS IIS, Google Web Server

but no dynamic server-side actions
  e.g. process user input, store/load data from database, etc.

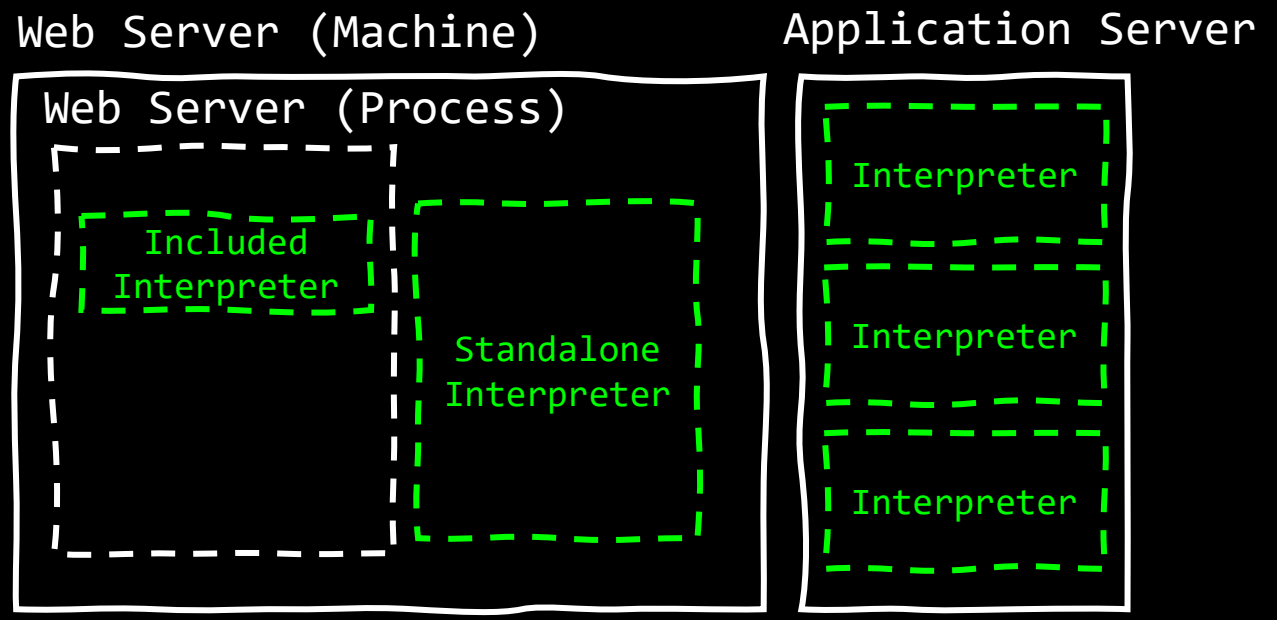
needs server-side programming/scripting languages and a suitable interpreter/runtime
  e.g. PHP, Python, Ruby, ASP.NET, Java …

this interpreter/runtime can be e.g.:

- included in the webserver
  - e.g. Apache modules (mod_php / mod_python / mod_...)

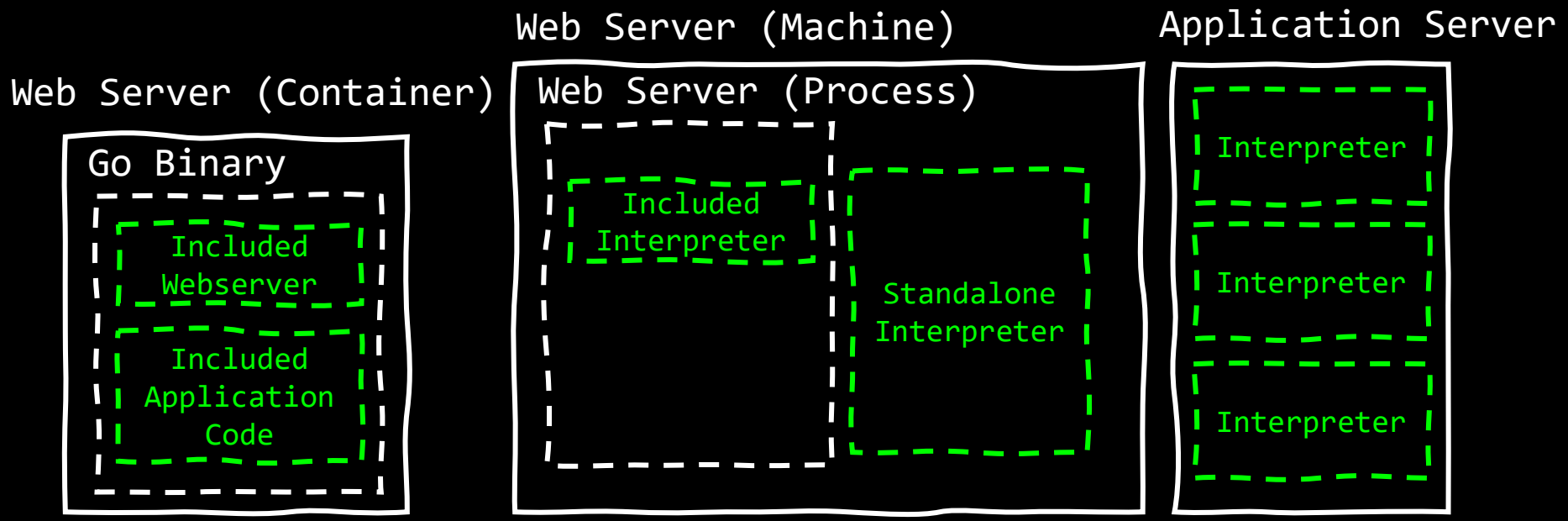
- standalone in an own process and called via
  - CGI, FastCGI, ISAPI, AJP,...
  - e.g. Apache Tomcat Java Servlets

- standalone in a dedicated application server
  - WebLogic
  - Payara
  - JBoss
  - Websphere
  - …

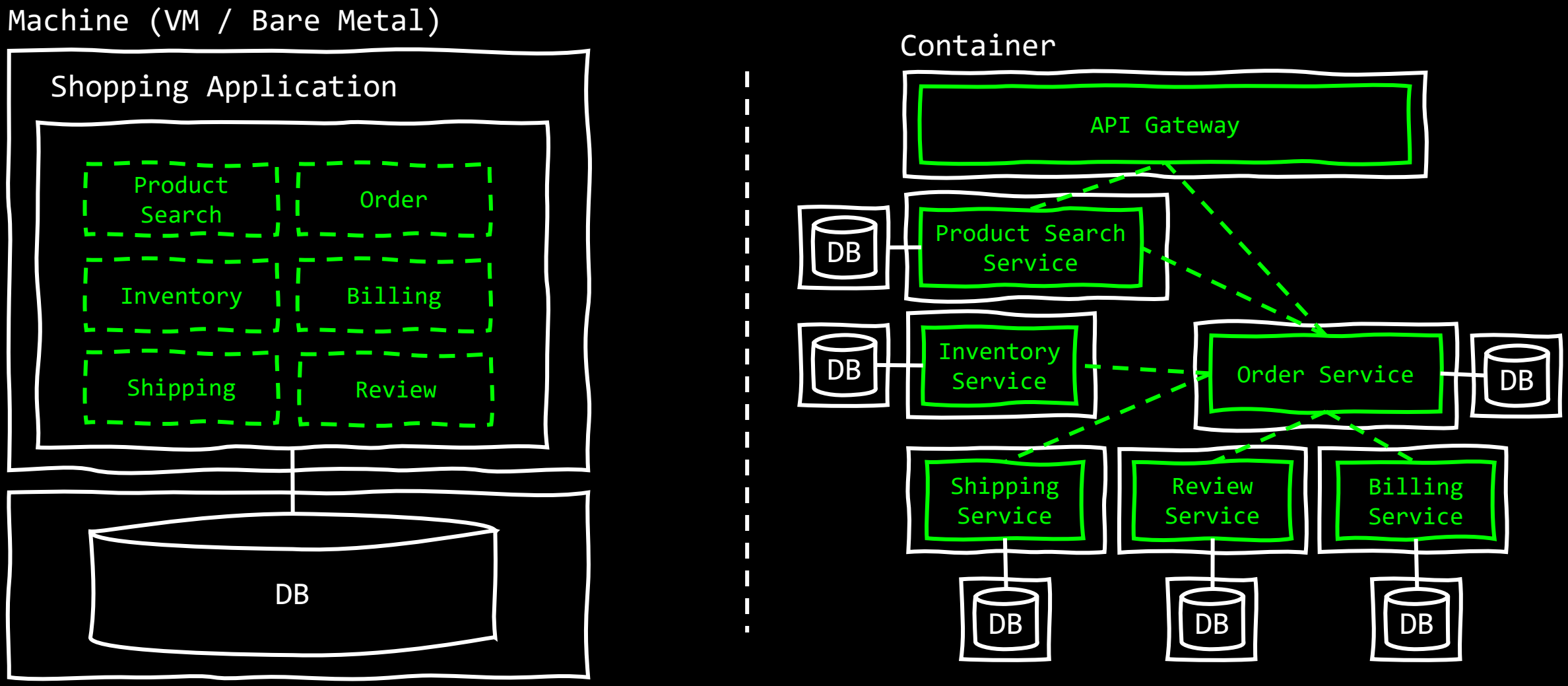


extreme example:

Go – just all in one native binary
+ performance
+ perfect for container and microservice architecture

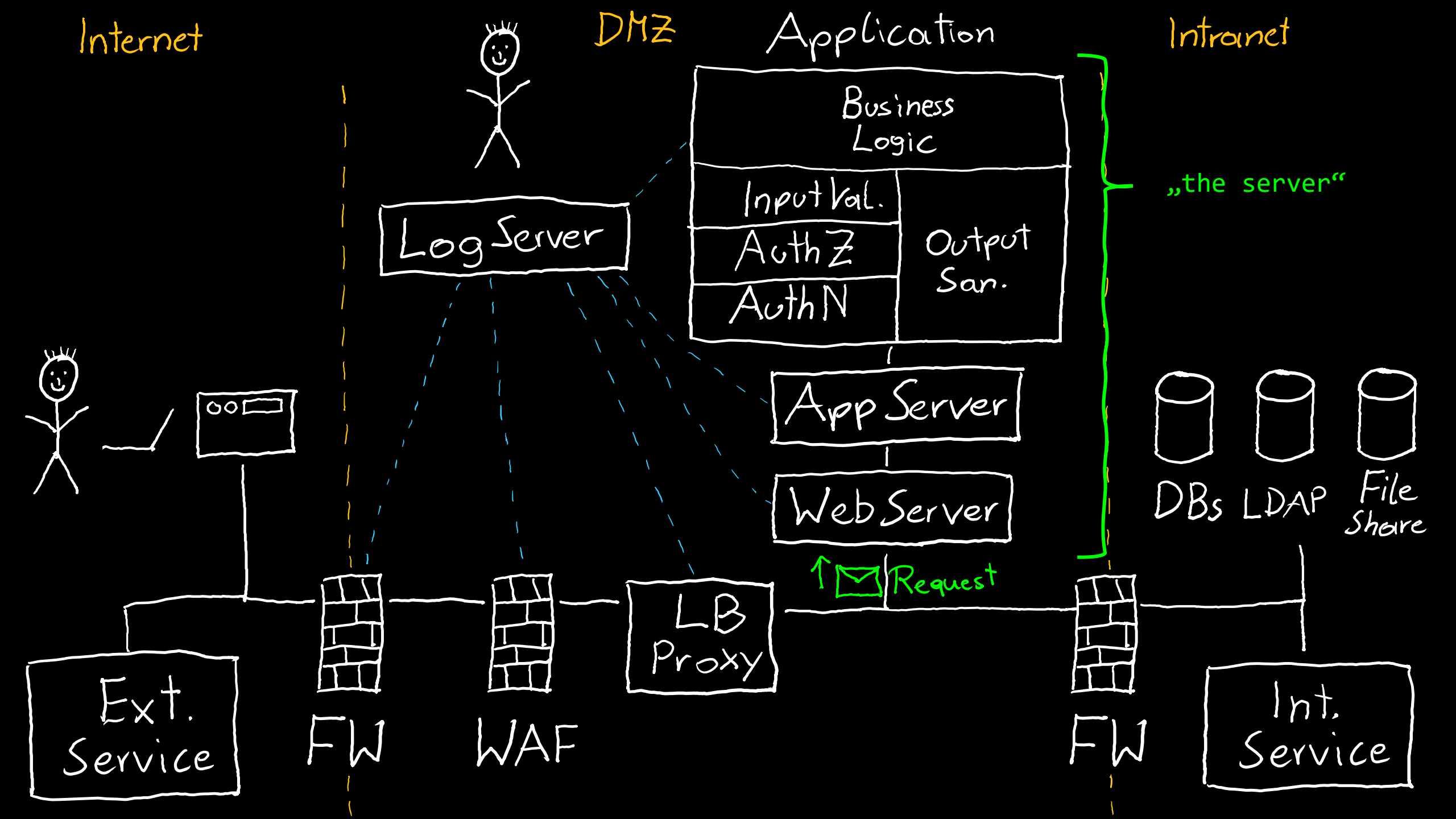


Monolithic vs. Microservice



from an outside view, all of this is completely abstracted

we actually just see „the server“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Request Routing

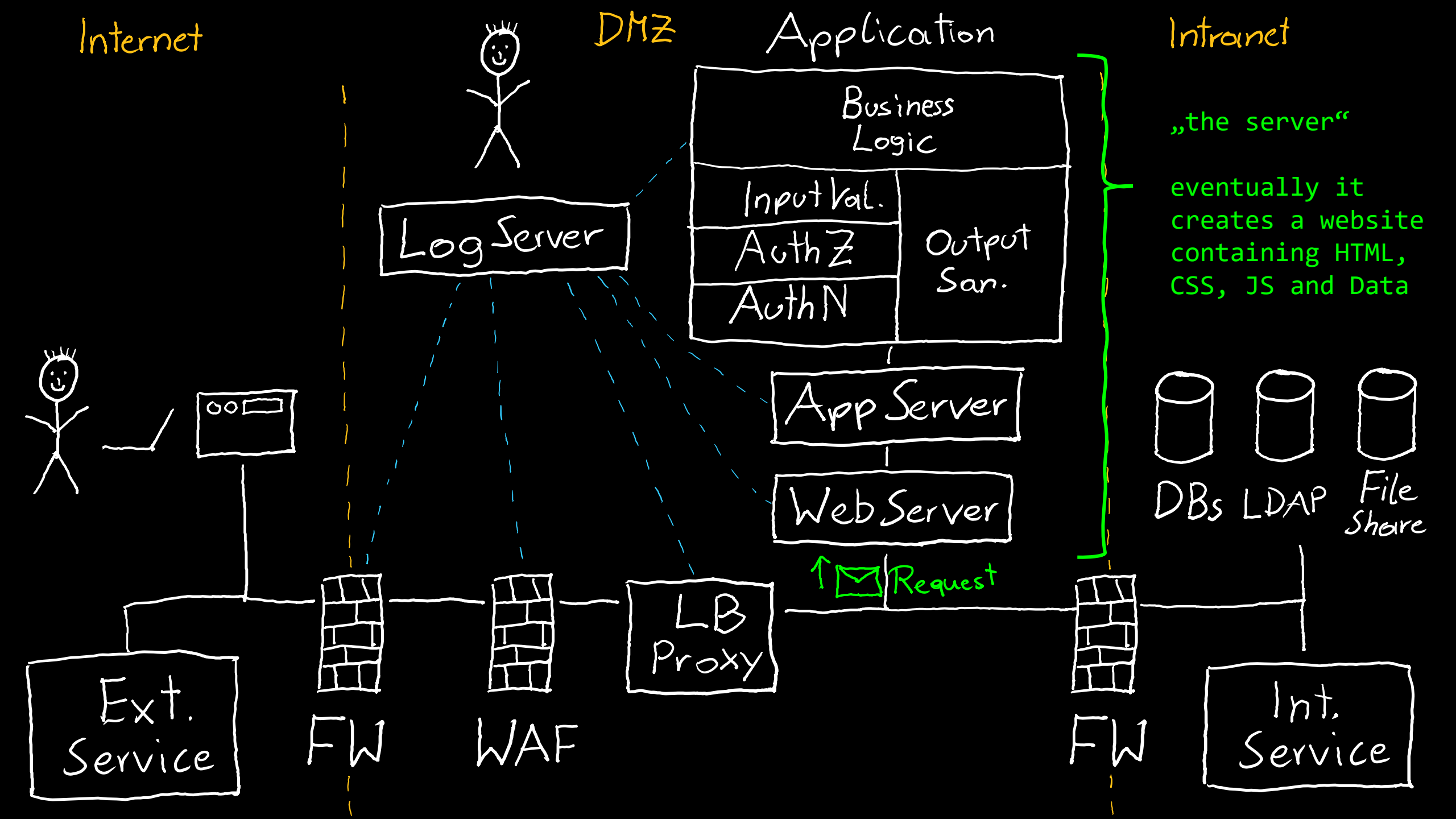
Classic routing: http://example.com/showprofile.php

it‘s php
file showprofile.php gets
executed with php interpreter

Explicit routing: http://example.com/showprofile

e.g. Laravel (PHP): `Route::get('/showprofile', [UserController::class, 'showprofile’]);`
https://laravel.com/docs/8.x/routing

e.g: Django (Python): `urlpatterns = [ path('/showprofile', views.userprofile)]`
https://docs.djangoproject.com/en/3.1/topics/http/urls/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„the server“
eventually it creates a website containing HTML, CSS, JS and Data
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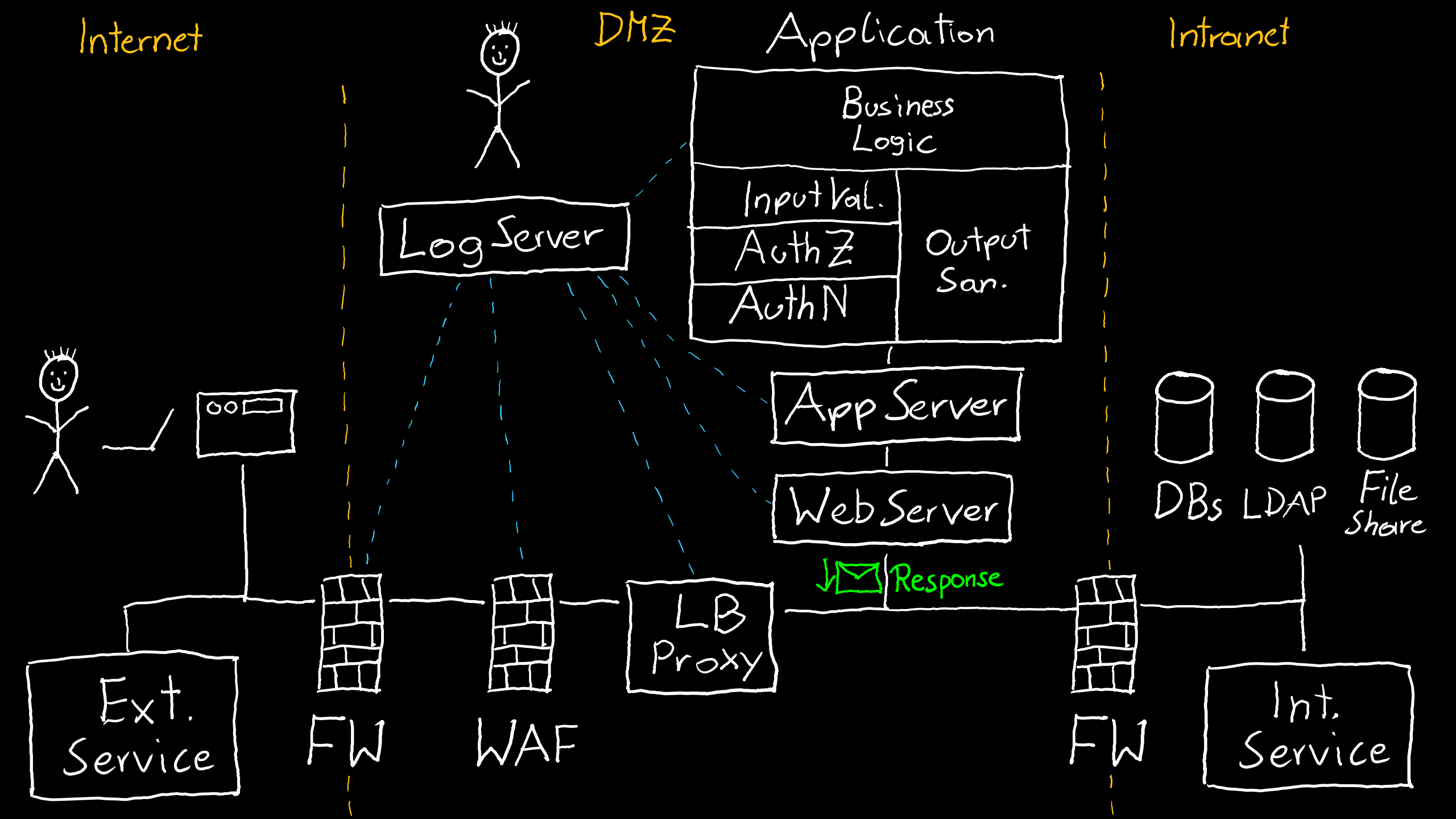
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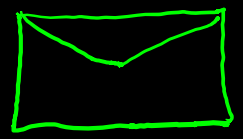


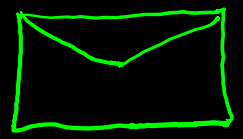
Response

```
HTTP/1.1 200 OK
Date: Sat, 10 Oct 2020 18:45:25 GMT
Server: Apache/2.4.38 (Debian) PHP/7.3.19-1~deb10u1
Last-Modified: Sat, 10 Oct 2020 16:49:41 GMT
ETag: "29cd-5b153da05baf0"
Accept-Ranges: bytes
Content-Length: 10701
Vary: Accept-Encoding
Content-Type: text/html
```

HTTP Response Status Codes

Code	Meaning
1xx	**Informational** Everything fine, continue what you‘re doing
2xx	**Success** Yes, everything worked out
3xx	**Redirection** Look at some other place
4xx	**Client errors** Server doesn‘t understand you or you try to do something you‘re not allowed to
5xx	**Server errors** Something didn‘t work out

https://developer.mozilla.org/en-US/docs/Web/HTTP/Status



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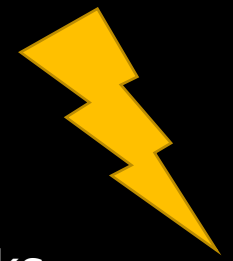
do you see any problems?

Information Disclosure



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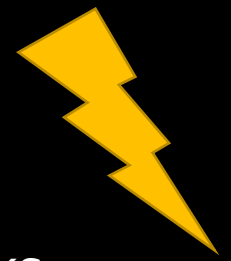

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More technical information disclosures…

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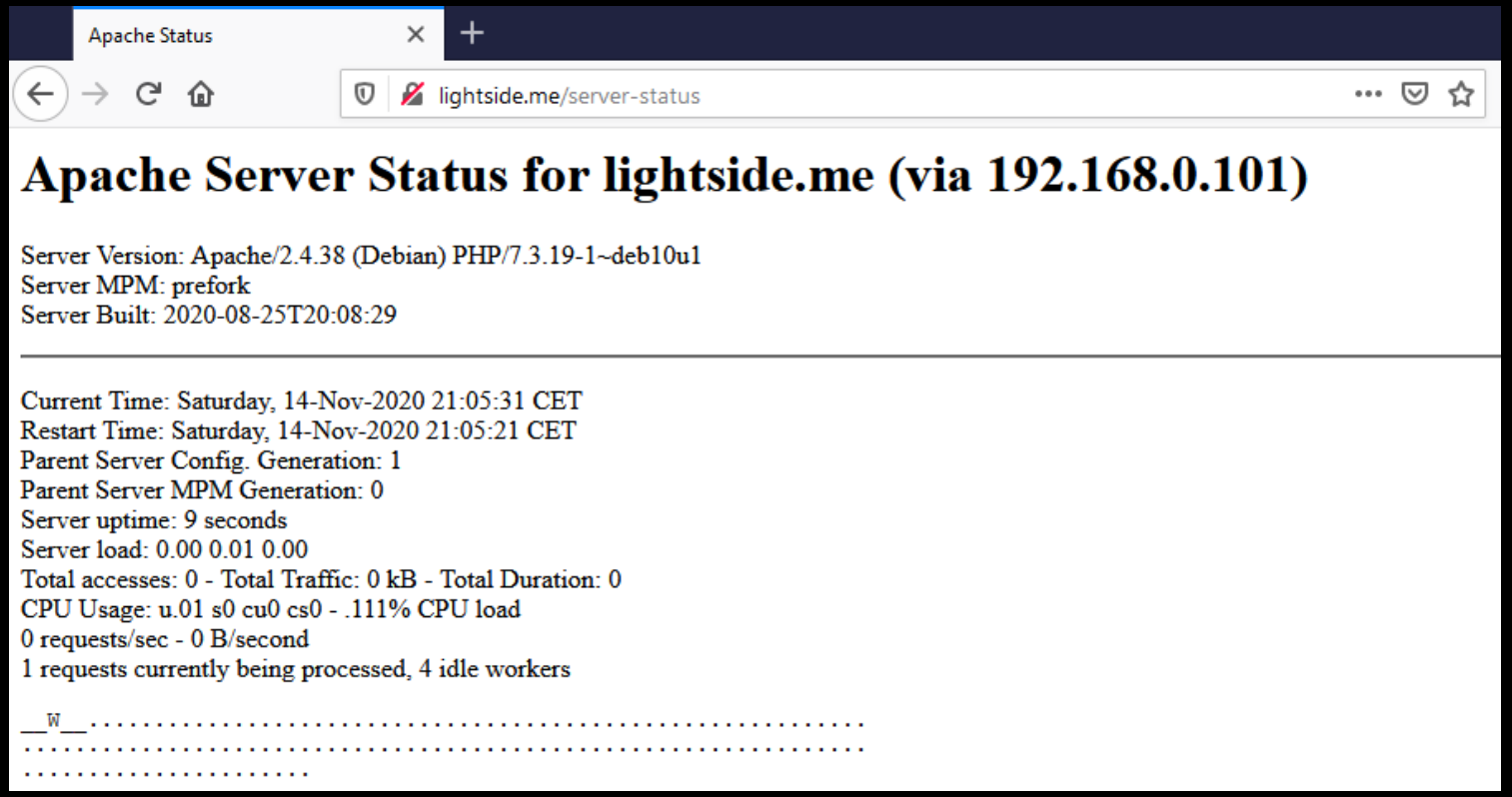
- Status pages



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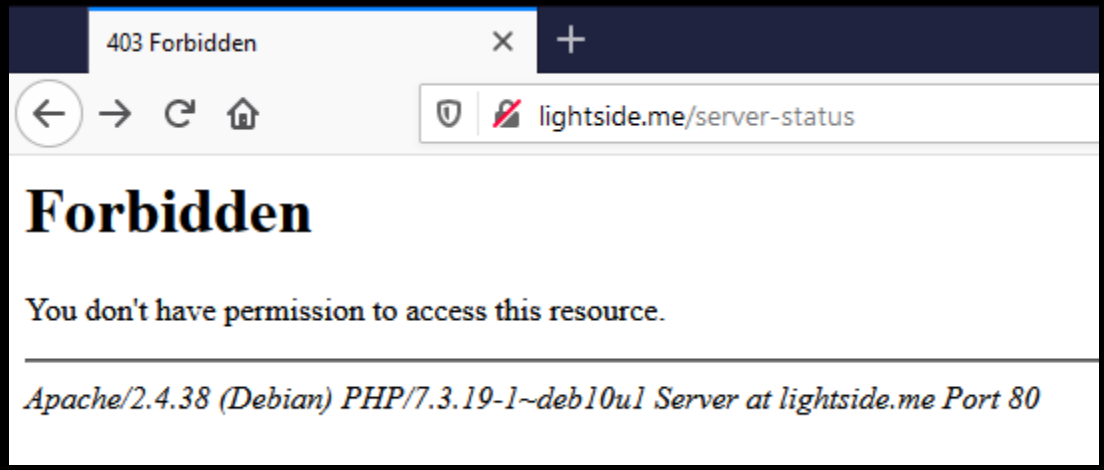

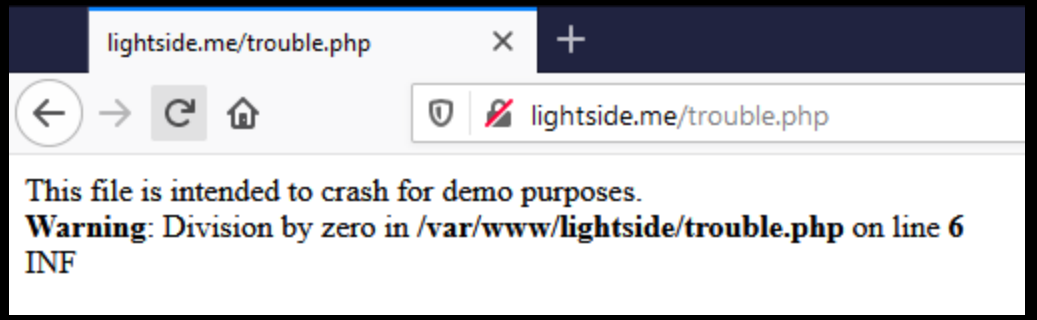

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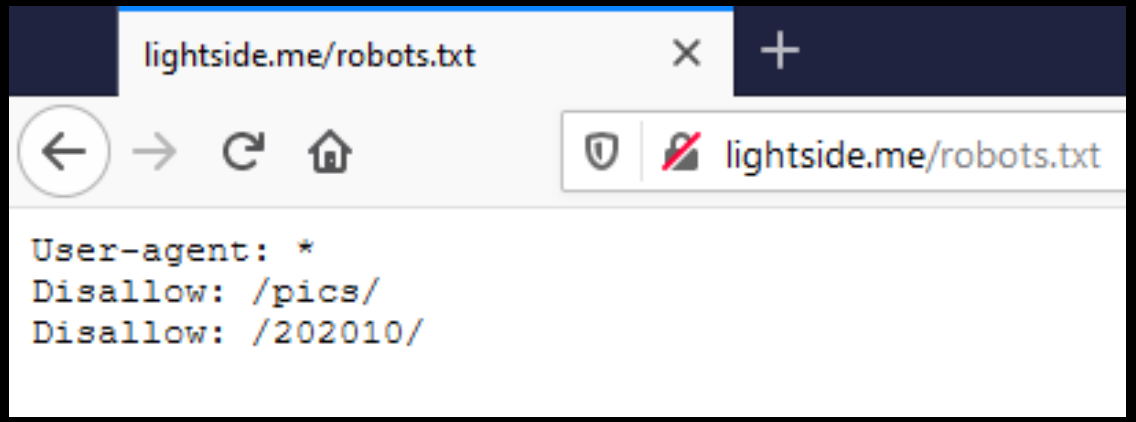
- …



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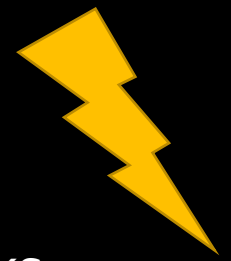

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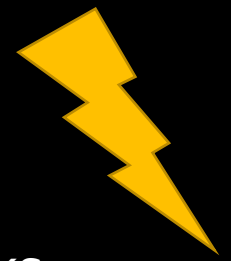

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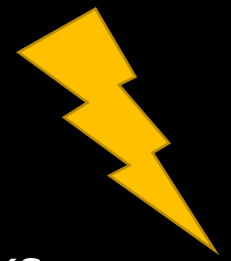

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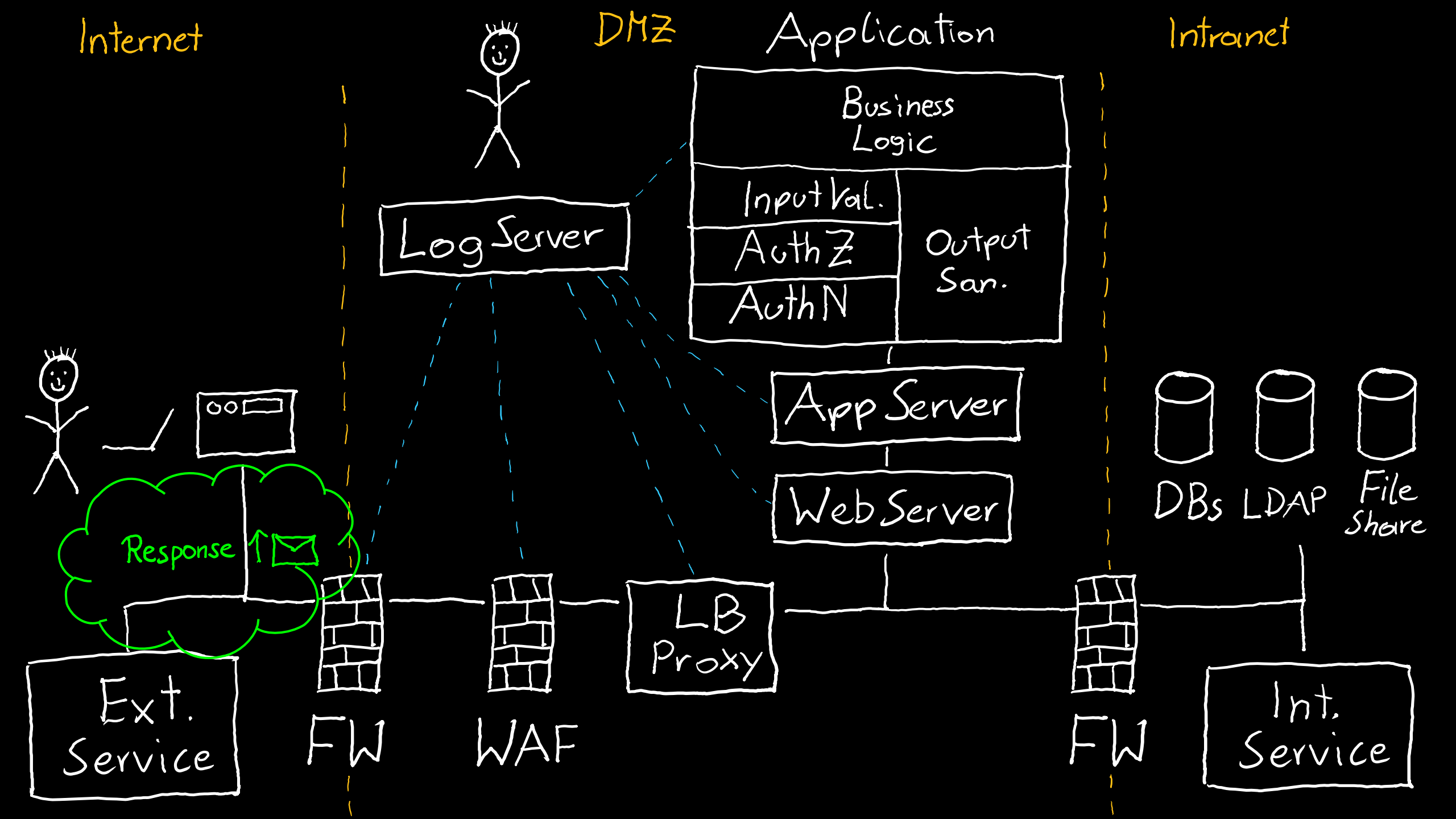
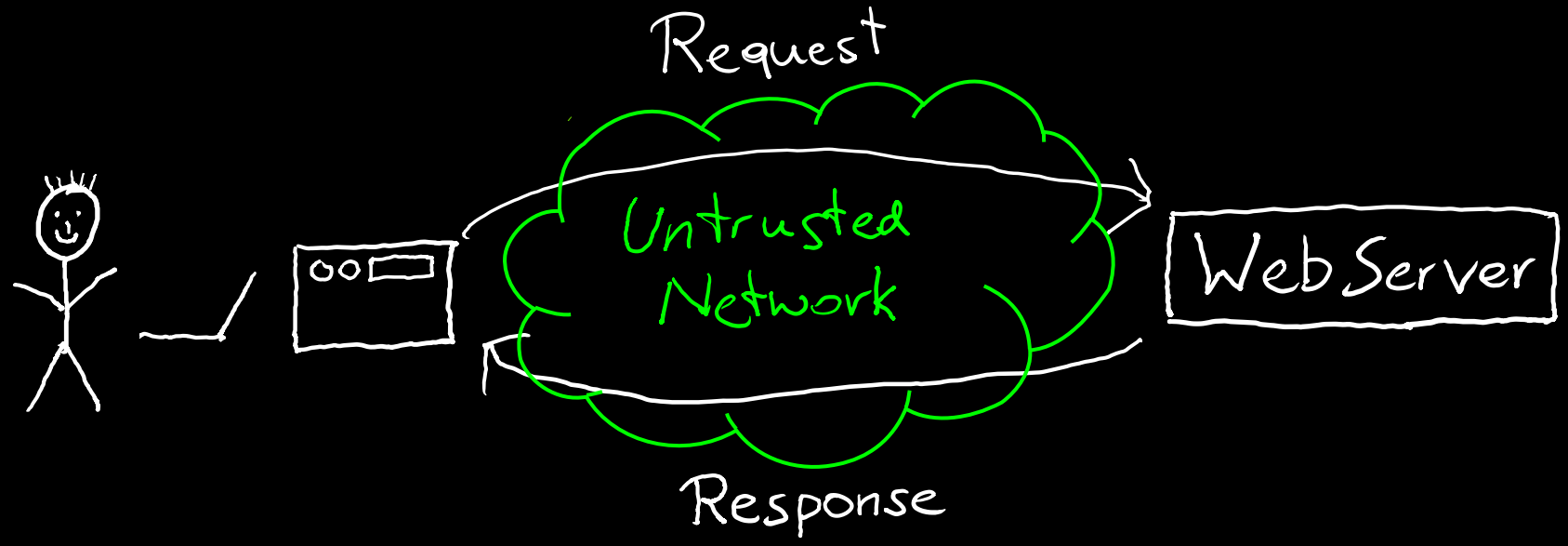
Solution	Webserver configuration hardening Error-Handling Secure Coding
OWASP Top 10	A6:2017-Security Misconfiguration A3:2017-Sensitive Data Exposure
(Primary) Violated Principle	„Identify sensitive data and how they should be handled.“

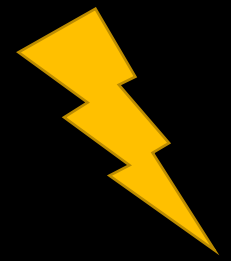

Internet
DMZ
Application
Intranet
Business Logic
Input Val.
AuthZ
AuthN
Output San.
Log Server
App Server
Web Server
DBs
LDAP
File Share
Response
LB Proxy
Ext. Service
FW
WAF
FW
Int. Service



http://example.com:8080/demos/demo1.html?id=123&name=Luke#ref1

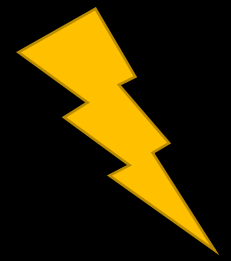
Versions <= HTTP/2 are plaintext by default

Plaintext Transmission (Info-Discl.)



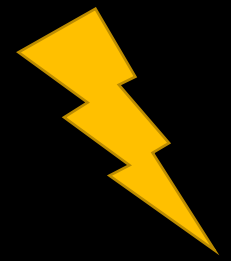
Goal	Read or modify data in transit
How	
Solution	
OWASP Top 10	
(Primary) Violated Principle	

Plaintext Transmission (Info-Discl.)



Goal	Read or modify data in transit
How	MitM between client and server - ARP Spoofing in your network (WIFI) or the servers' network - Malicious ISP (employee) - Gateways to foreign countries - DNS Hijacking - …
Solution	
OWASP Top 10	
(Primary) Violated Principle	

Plaintext Transmission (Info-Discl.)



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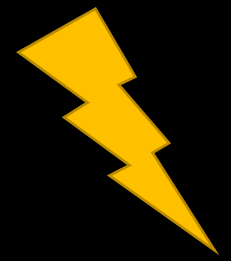
How	MitM between client and server - ARP Spoofing in your network (WIFI) or the servers' network - Malicious ISP (employee) - Gateways to foreign countries - DNS Hijacking - …
Solution	HTTPS (HTTP + SSL/TLS) HTTP/3 uses TLS 1.3 by default
OWASP Top 10	
(Primary) Violated Principle	

Plaintext Transmission (Info-Discl.)



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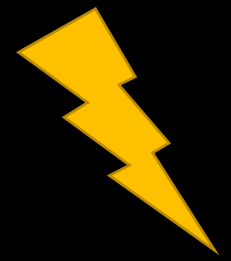

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Solution	HTTPS (HTTP + SSL/TLS) HTTP/3 uses TLS 1.3 by default
OWASP Top 10	A3:2017-Sensitive Data Exposure
(Primary) Violated Principle	„Earn or give, but never assume, trust. “

Transport Layer Security (TLS)

- TLS = successor of SSL (Secure Socket Layer)
  - SSL 1.0 ~ 1994/1995
  - …
  - TLS 1.3 ~ 2018
- Family of multiple protocols
  - Handshake, Change Cipher Spec., Alert, Application Data, Record
- Builds an authenticated encrypted tunnel
  - Authenticates the accessed website (at least)
  - Protects the confidentiality and integrity of the data in transfer
- HTTP over TLS = HTTPS (port 443 for https://)
- PKI needed
  - Chain of trust (> 1000 CAs & Intermediate CAs)
- HTTPS usage: https://transparencyreport.google.com/https/overview

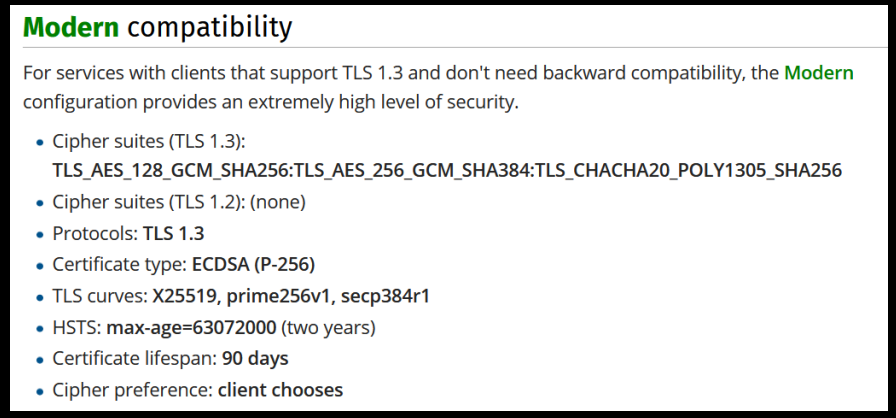
PFS – Perfect Forward Secrecy

- long-term secret is just used for authentication of session specific Diffie-Hellman Key Exchange
- previous sessions cannot be decrypted, even if
  - one of the old session keys is compromised
  - the long-term secret (server’s private key) is compromised
- most current TLS cipher suites implement PFS today

TLS - Avoid common pitfalls

- Make sure you only allow
  - up to date protocols (TLS 1.2 & TLS 1.3)
  - strong cipher suites

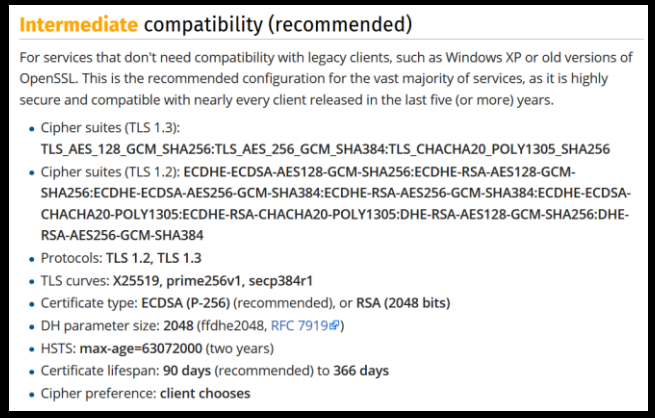
- Of course conflicts with browser compatibility
  - some resources can help you defining appropriate configs
    - e.g. https://wiki.mozilla.org/Security/Server_Side_TLS



Modern compatibility

For services with clients that support TLS 1.3 and don't need backward compatibility, the Modern configuration provides an extremely high level of security.

- Cipher suites (TLS 1.3): **TLS_AES_128_GCM_SHA256:TLS_AES_256_GCM_SHA384:TLS_CHACHA20_POLY1305_SHA256**
- Cipher suites (TLS 1.2): (none)
- Protocols: **TLS 1.3**
- Certificate type: **ECDSA (P-256)**
- TLS curves: **X25519, prime256v1, secp384r1**
- HSTS: **max-age=63072000** (two years)
- Certificate lifespan: **90 days**
- Cipher preference: **client chooses**



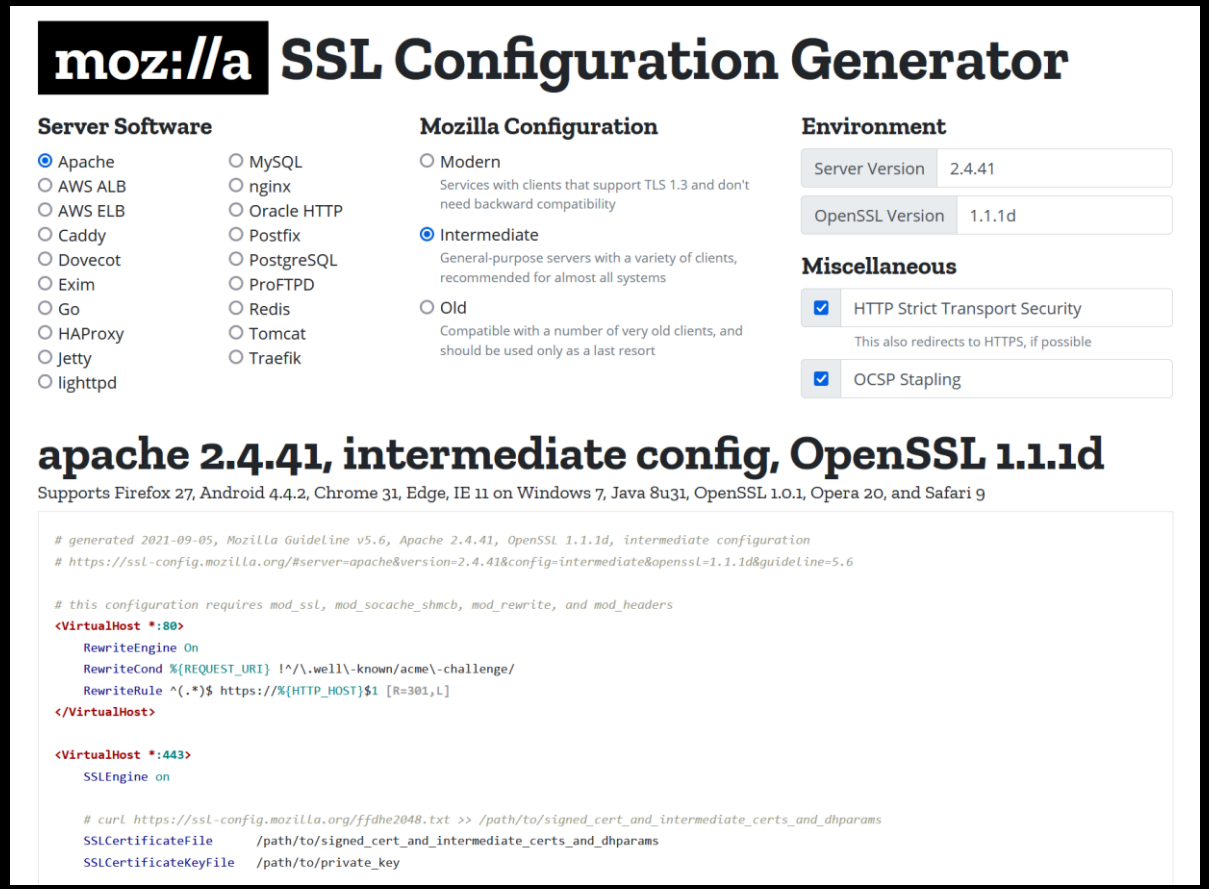
Intermediate compatibility (recommended)

For services that don't need compatibility with legacy clients, such as Windows XP or old versions of OpenSSL. This is the recommended configuration for the vast majority of services, as it is highly secure and compatible with nearly every client released in the last five (or more) years.

- Cipher suites (TLS 1.3): **TLS_AES_128_GCM_SHA256:TLS_AES_256_GCM_SHA384:TLS_CHACHA20_POLY1305_SHA256**
- Cipher suites (TLS 1.2): **ECDHE-ECDSA-AES128-GCM-SHA256:ECDHE-RSA-AES128-GCM-SHA256:ECDHE-ECDSA-AES256-GCM-SHA384:ECDHE-RSA-AES256-GCM-SHA384:ECDHE-ECDSA-CHACHA20-POLY1305:ECDHE-RSA-CHACHA20-POLY1305:DHE-RSA-AES128-GCM-SHA256:DHE-RSA-AES256-GCM-SHA384**
- Protocols: **TLS 1.2, TLS 1.3**
- TLS curves: **X25519, prime256v1, secp384r1**
- Certificate type: **ECDSA (P-256)** (recommended), or **RSA (2048 bits)**
- DH parameter size: **2048** (ffdhe2048, RFC 7919)
- HSTS: **max-age=63072000** (two years)
- Certificate lifespan: **90 days** (recommended) to **366 days**
- Cipher preference: **client chooses**

TLS - Avoid common pitfalls

https://ssl-config.mozilla.org



TLS - Avoid common pitfalls

deliver all your content via HTTPS only

it can compromise your whole security if some parts/methods/etc. are available via plain HTTP

(TLS Strip)

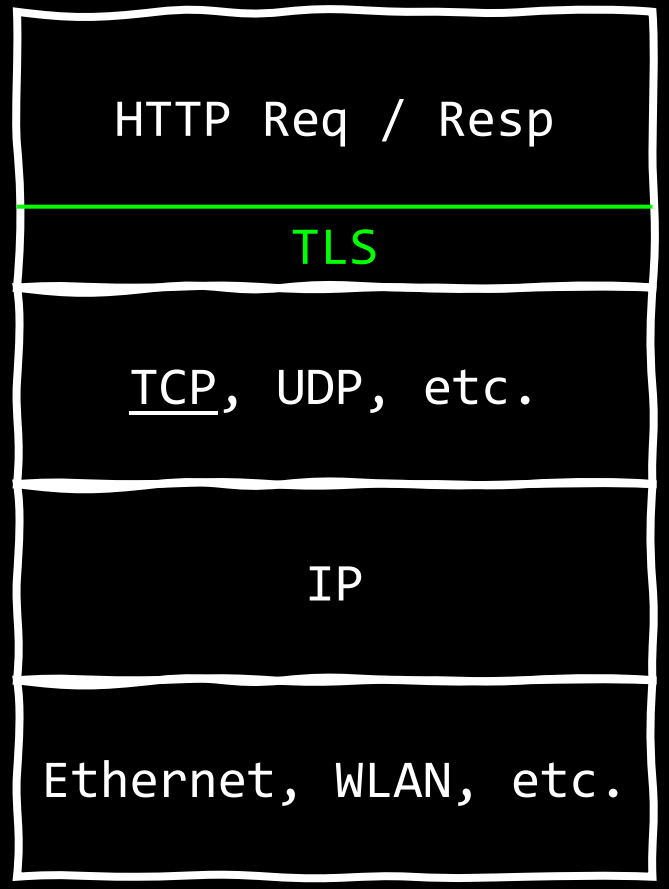
HSTS – HTTP Strict Transport Security

- Tells the browser to always use HTTPS for this site
  - e.g. for one year:
    - `Strict-Transport-Security: max-age=31536000`

- Of course, first visit is still not secure
  - possible solution: HSTS Preload list
    - `Strict-Transport-Security: max-age=31536000; includeSubDomains; preload`
    - https://hstspreload.org/

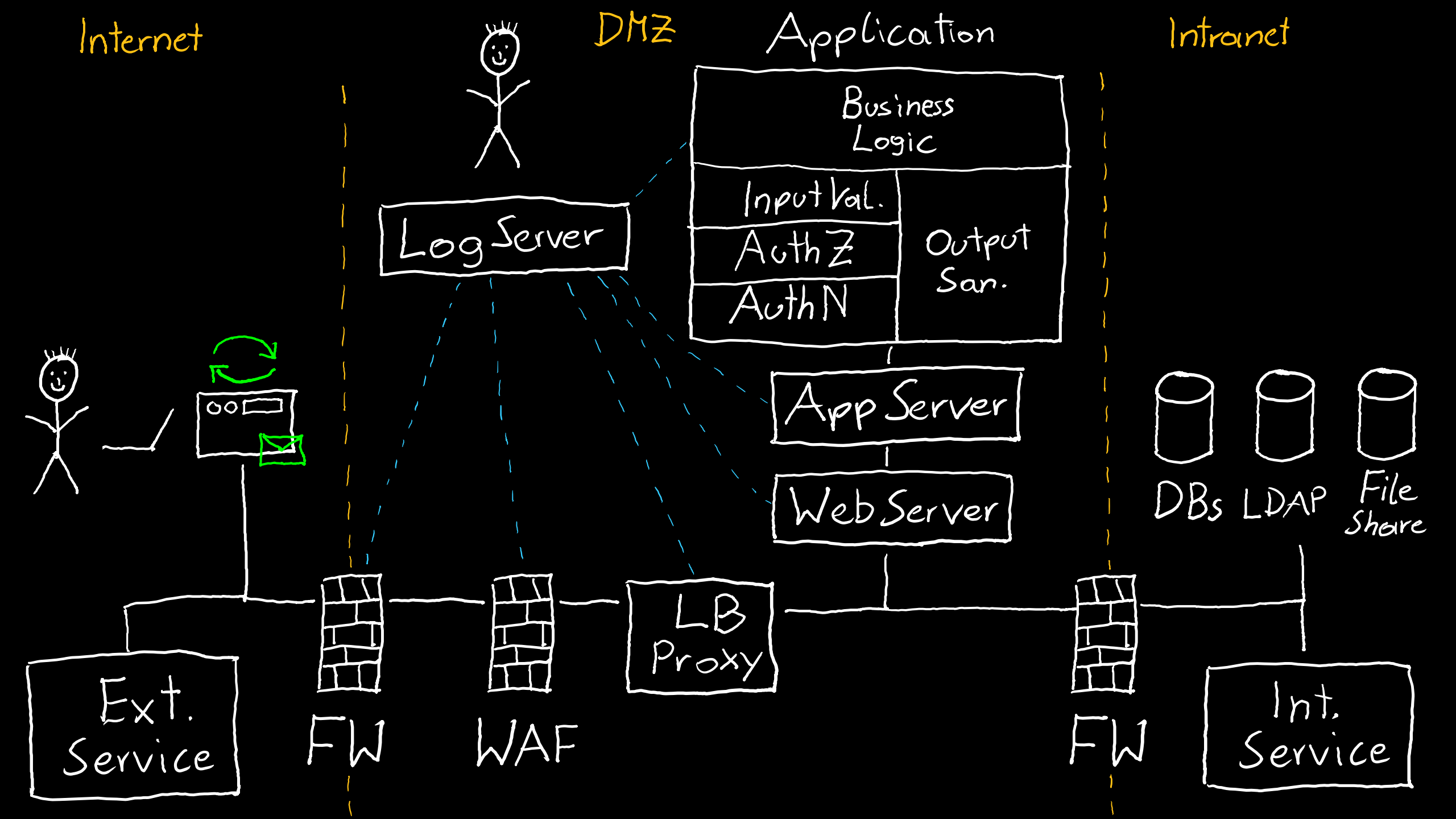
ISO/OSI Model

Application
Presentation
Session
Transport
Network
Data Link
Pyhsical

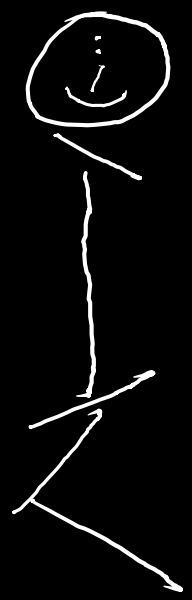


Internet Protocol Suite (TCP/IP Model)

Application Layer
Transport Layer
Internet Layer
Link Layer

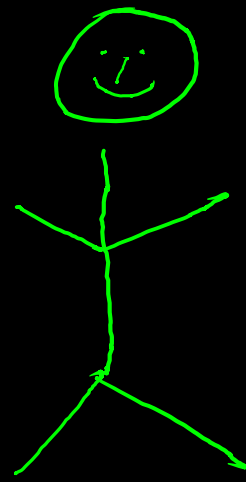

Internet
DMZ
Application
Intranet
Business Logic
Input Val.
AuthZ
AuthN
Output San.
Log Server
App Server
Web Server
DBs
LDAP
File Share
LB Proxy
Ext. Service
FW
WAF
FW
Int. Service

HTML only



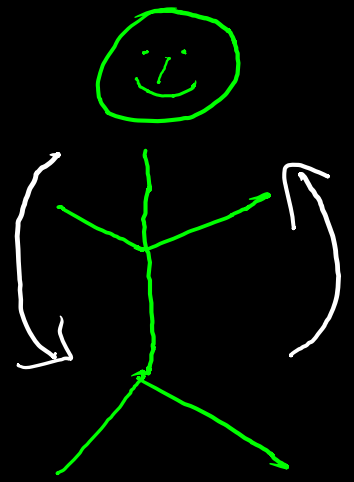
gives you building blocks
and a basic structure

HTML + CSS



makes it „pretty“

HTML + CSS + JS

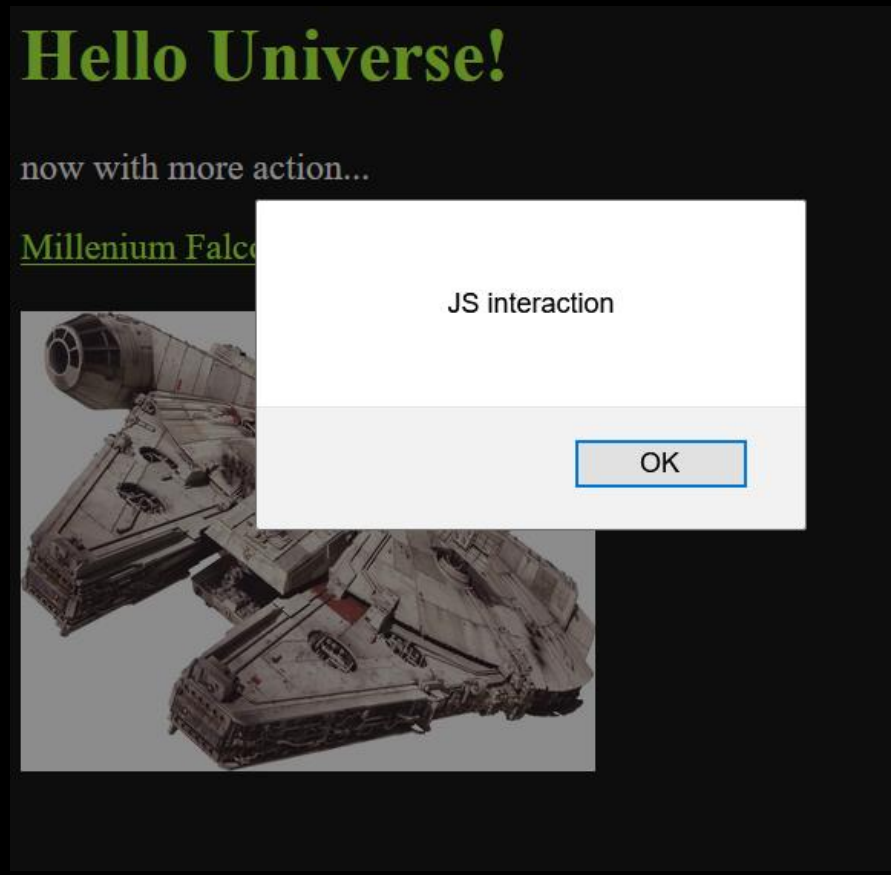


party hard!

```html
<html>
    <head>
        <title>First try...</title>
    </head>
    <body>
        <h1>Hello World!</h1>
        <p>
            Little bit lame...
        </p>
    </body>
</html>
```

```html
<html>
    <head>
        <title>Second try...</title>
        <style>
            body{
                background-color: black;
            }
            a{
                color: greenyellow;
            }
        </style>
    </head>
    <body>
        <h1 style="color: greenyellow;">Hello Universe!</h1>
        <p style="color: white;">
            better...
        </p>
        <a href="https://www.jedipedia.net/wiki/Millennium_Falke">
            Millenium Falcon
        </a></br></br>
        <img height="200px" width="250px"
            src="https://www.jedipedia.net/w/images/9/91/Millenium_Falcon_TFA.jpg" />
    </body>
</html>
```

```html
<html>
    <head>
        <title>Third try...</title>
        <style>
            body{
                background-color: black;
            }
            a{
                color: greenyellow;
            }
        </style>
        <script>
            var output = "JS interaction";
        </script>
    </head>
    <body>
        <h1 style="color: greenyellow;">Hello Universe!</h1>
        <p style="color: white;">
            now with more action...
        </p>
        <a href="https://www.jedipedia.net/wiki/Millennium_Falke">
            Millenium Falcon
        </a></br></br>
        <img height="200px" width="250px" onmouseover="alert(output)"
            src="https://www.jedipedia.net/w/images/9/91/Millenium_Falcon_TFA.jpg" />
    </body>
</html>
```



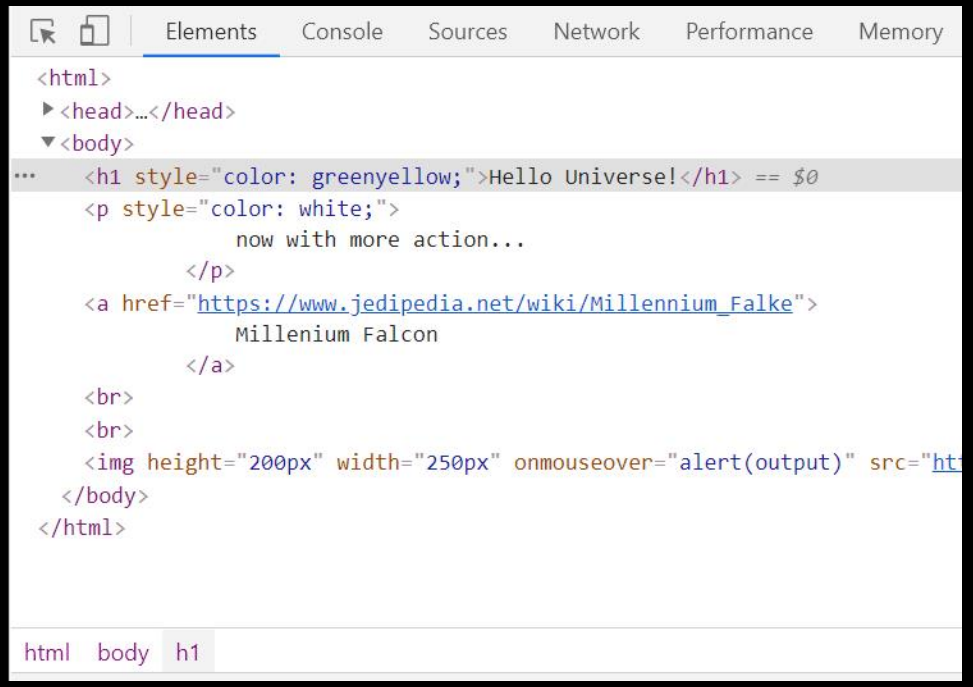
Document Object Model (DOM)

- Interface to treat a HTML/XML document as a tree with objects as it’s nodes
- Browser constructs a DOM-Tree of the loaded HTML
- JavaScript can interact with these DOM-Objects through a defined DOM-Interface

Hello Universe!

now with more action...

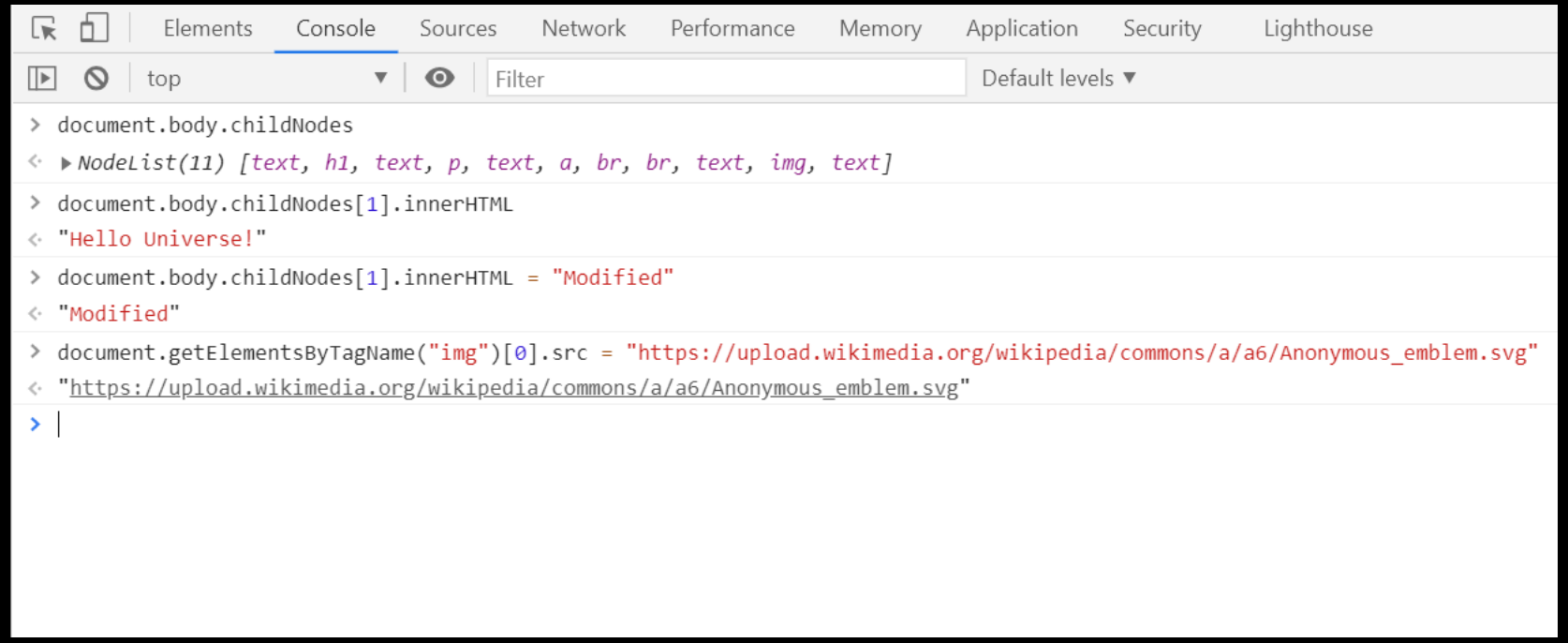
Millenium Falcon

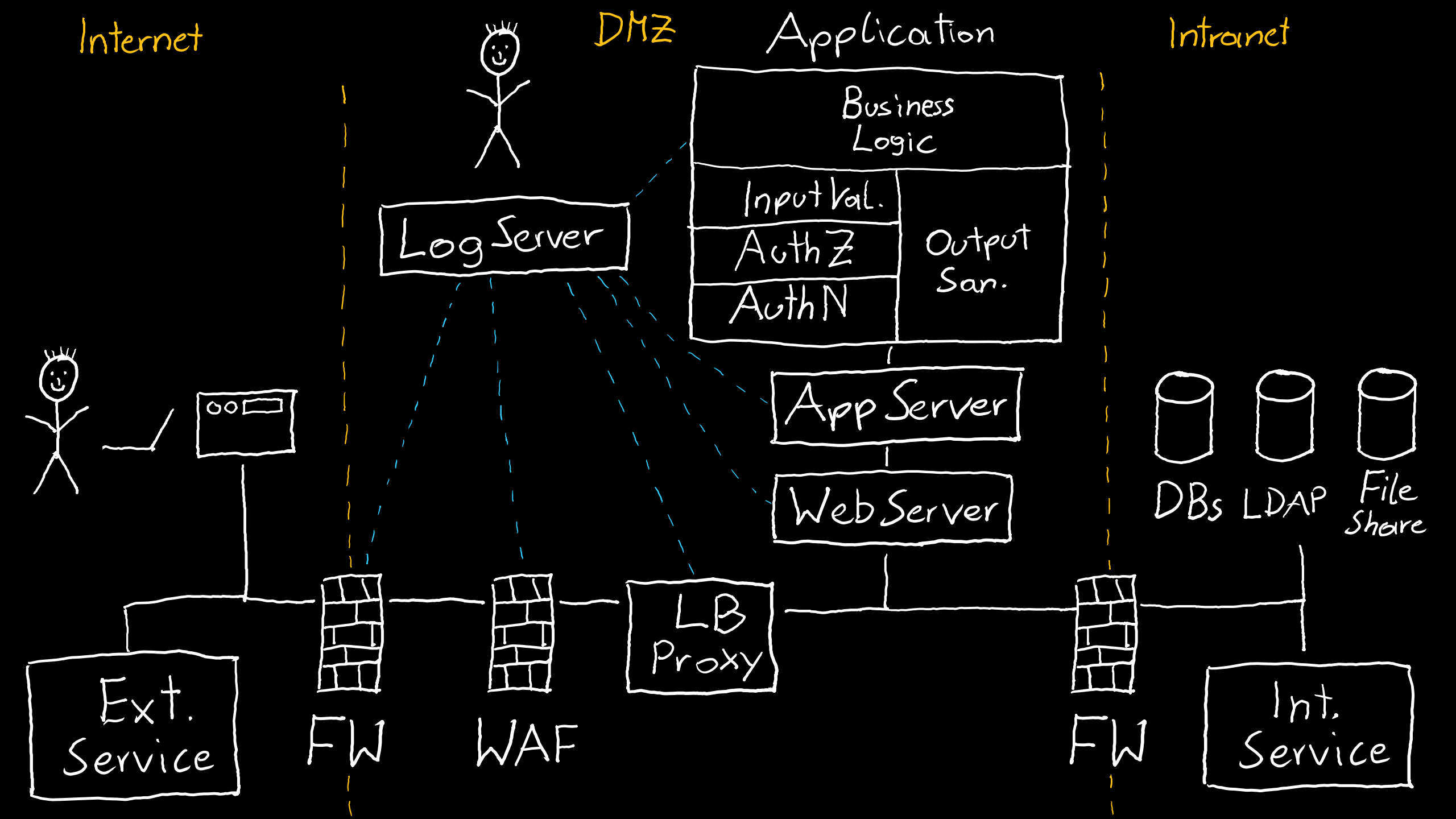


Modified

now with more action...

Millenium Falcon

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File Share
LB Proxy
Ext. Service
FW
WAF
FW
Int. Service

Key messages

- HTTP is a stateless application-layer protocol based on requests and responses
- It’s plaintext, so wrap it in well configured TLS
- Harden your webserver properly

Is it clear now what happens if you type in a URL and press enter?