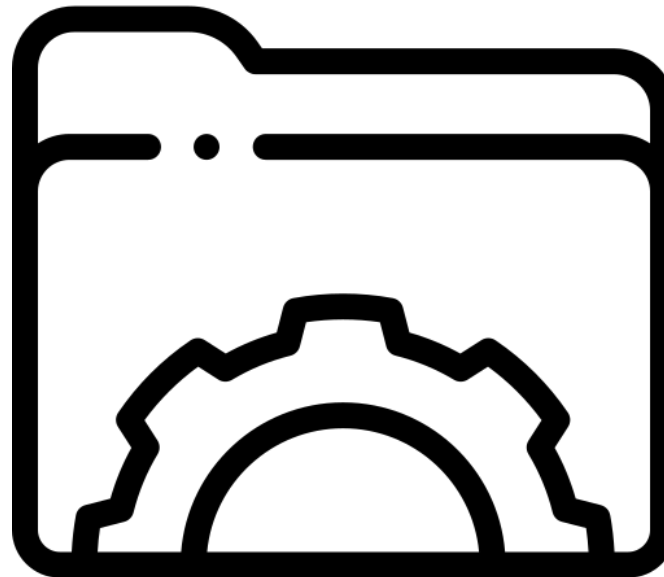


Dateisystem - LittleFS



LittleFS

- SPIFFS Projekt wird nicht aktiv weiterentwickelt
- Probleme mit größeren Speichern
- Daher besser LittleFS als Dateisystem
- Vgl.: <https://docs.espressif.com/projects/esp-idf/en/latest/esp32s3/api-guides/file-system-considerations.html>

LittleFS

- Ordnerstrukturen
- CRUD Operationen auf Dateien
- power failure resilience
- dynamic wear levelling
- Low RAM requirements

LittleFS

- Projektseite: <https://github.com/littlefs-project/littlefs>
- Codeanpassungen:
 - PlatformIO.ini → `board_build.filesystem = littlefs`
 - `#include <LittleFS.h>`
 - `LittleFS.begin()`
- Sonst analog zu SPIFFS

WebServer

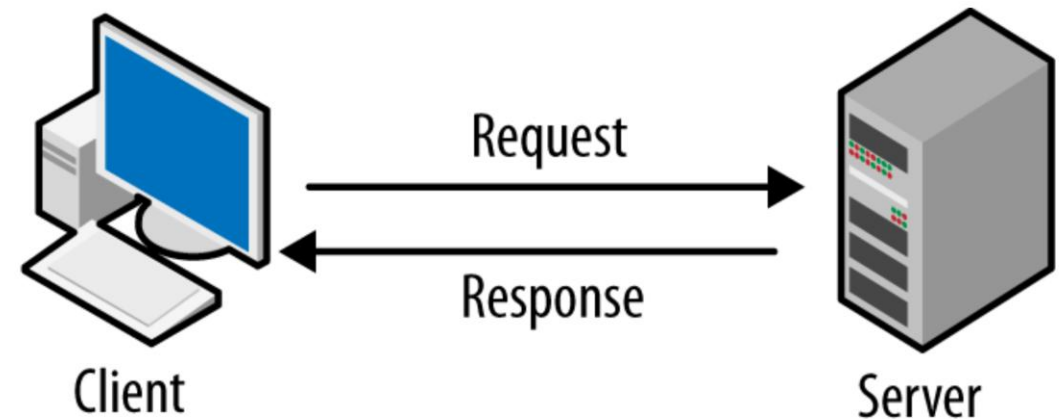


HTL ST. PÖLTEN

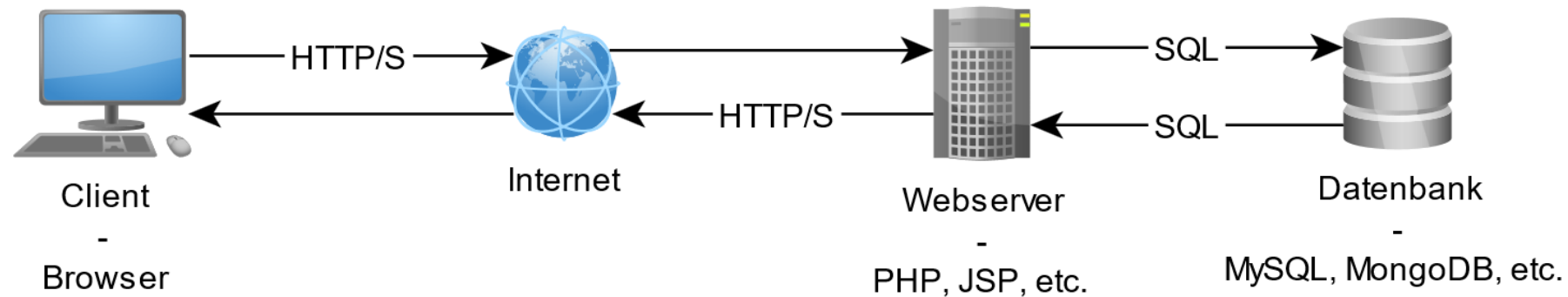


WebServer

- Ein WebServer ist ein Programm (Server), das Dokumente an Clients überträgt
- In unserem Fall:
 - Bereitstellung von Webseite (WebServer)
 - Anzeige in WebBrowser (Client)
- Übertragungsprotokoll: HTTP(S)



Kommunikation via HTTP



- Client fordert Daten vom Server an → HTTP Request
- Webserver reicht Anfrage an Applikation weiter
- Applikation baut Antwort zusammen → HTTP Response
- Client empfängt Daten und stellt sie dar

HTTP

- Hypertext Transfer Protocol – Zur Kommunikation zwischen Client und Server
- Stateless (zustandslos) Protocol
- Version 1.1 → RFC 7230 – Einführung u.a. von „persistent connection“
- Version 2 → RFC 7540 – Performance Verbesserungen
- Kommunikation mittels Request und Response

HTTP Requests



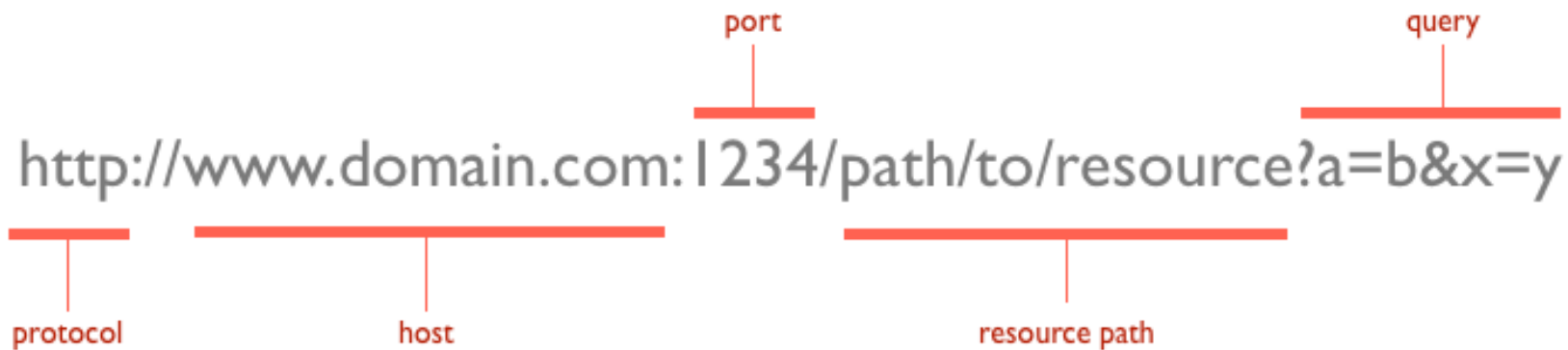
HTL ST. PÖLTEN

```
GET https://de.wikipedia.org/wiki/Hypertext_Transfer_Protocol HTTP/1.1
Host: de.wikipedia.org
Connection: keep-alive
Pragma: no-cache
Cache-Control: no-cache
Upgrade-Insecure-Requests: 1
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/71.0.3578.98 Safari/537.36
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,image/apng,*/*;q=0.8
Accept-Encoding: gzip, deflate, br
Accept-Language: en-US,en;q=0.9,de;q=0.8
Cookie: WMF-Last-Access-Global=07-Feb-2019; WMF-Last-Access=07-Feb-2019
```

URL

- Requests mittels Unified Resource Locator (URL)

http://www.domain.com:1234/path/to/resource?a=b&x=y



The diagram illustrates the components of the URL `http://www.domain.com:1234/path/to/resource?a=b&x=y`. Red horizontal lines are placed under each component, with a vertical line connecting the label to the line:

- protocol**: `http`
- host**: `www.domain.com`
- port**: `1234`
- resource path**: `/path/to/resource`
- query**: `?a=b&x=y`

HTTP Verben

- URL ist die Ressource mit der kommuniziert, HTTP Verb gibt die Art der Kommunikation an:
 - GET - Abfragen/Auslesen einer bestehenden Ressource
 - POST - Erzeugen einer Ressource, Senden von Daten
 - PUT - Aktualisieren einer Ressource (bzw. neu erstellen)
 - DELETE - Löschen einer Ressource

HTTP GET



HTL ST. PÖLTEN

```
GET https://www.w3schools.com/action_page.php?firstname=Peter&lastname=Griffin HTTP/1.1
Host: www.w3schools.com
Connection: keep-alive
Upgrade-Insecure-Requests: 1
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Ge
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,image/apng,*/*;
Referer: https://www.w3schools.com/html/tryit.asp?filename=tryhtml_form_get
Accept-Encoding: gzip, deflate, br
Accept-Language: en-US,en;q=0.9,de;q=0.8
```

HTTP POST



HTL ST. PÖLTEN

```
POST https://www.w3schools.com/action_page.php HTTP/1.1
Host: www.w3schools.com
Connection: keep-alive
Content-Length: 32
Cache-Control: max-age=0
Origin: https://www.w3schools.com
Upgrade-Insecure-Requests: 1
Content-Type: application/x-www-form-urlencoded
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/88.0.4397.80 Safari/537.36
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,image/apng,*/*;q=0.8
Referer: https://www.w3schools.com/html/tryit.asp?filename=tryhtml_form_post
Accept-Encoding: gzip, deflate, br
Accept-Language: en-US,en;q=0.9,de;q=0.8
Cookie: _ga=GA1.2.373207324.1549550297; _gid=GA1.2.1651006620.1549550297; snhl

firstname=Peter&lastname=Griffin
```

```
HITP/1.1 200 OK
Date: Thu, 07 Feb 2019 21:07:51 GMT
Content-Type: text/html; charset=UTF-8
Content-Length: 114709
Connection: keep-alive
Server: mw1273.eqiad.wmnet
X-Content-Type-Options: nosniff
P3P: CP="This is not a P3P policy! See https://de.wikipedia.org/wiki/Spezial:CentralAutoLogin/P3P for more info."
X-Powered-By: HHVM/3.18.6-dev
Content-language: de
Last-Modified: Tue, 05 Feb 2019 13:08:54 GMT
Backend-Timing: D=146269 t=1549372206795826
Vary: Accept-Encoding, Cookie, Authorization, X-Seven
X-Varnish: 488705054 977145500, 592581221 597986705, 458829495 728581212
Via: 1.1 varnish (Varnish/5.1), 1.1 varnish (Varnish/5.1), 1.1 varnish (Varnish/5.1)
Age: 115150
X-Cache: cp1077 hit/9, cp3042 hit/1, cp3042 hit/42
X-Cache-Status: hit-front
Server-Timing: cache;desc="hit-front"
Strict-Transport-Security: max-age=106384710; includeSubDomains; preload
X-Analytics: ns=0;page_id=2179;WMF-Last-Access=07-Feb-2019;WMF-Last-Access-Global=07-Feb-2019;https=1
X-Client-IP: [REDACTED]
Cache-Control: private, s-maxage=0, max-age=0, must-revalidate
Accept-Ranges: bytes

<!DOCTYPE html>
<html class="client-nojs" lang="de" dir="ltr">
<head>
<meta charset="UTF-8"/>
<title>Hypertext Transfer Protocol - Wikipedia</title>
<script>document.documentElement.className = document.documentElement.className.replace( /(^|\s)client-nojs(\s|$)/, "$1");mw.loader.implement("user.tokens@otffind",function($,jQuery,require,module){/*@nomin*/mw.user.tokens.set({"editToken":"","csrfToken":""});RLPAGEMODULES=["ext.cite.uv-enhancements","site","mediawiki.page.startup","mediawiki.page.ready","mediawiki.toolquickstart.stylesheet"];mw.loader.load(["w/load.php?debug=false&lang=de&modules=ext.cite.uv.styles%7Cext.cite.styles%7Cext.quickstart.styles%7Cjquery.cookie.js&only=scripts&skin=vector"]);</script>
<link rel="stylesheet" href="/w/load.php?debug=false&lang=de&modules=startup&only=scripts&skin=vector"></link>
```

Response Status Codes

- 1xx – Information – Server ist noch beschäftigt
- 2xx – Successful – Erfolgreiche Operationen an Client gemeldet
- 3xx – Redirect – Umleitung zu anderer URL
- 4xx – Client Error – Fehler im Request
- 5xx – Server Error – Fehler beim Server

HTTP Header

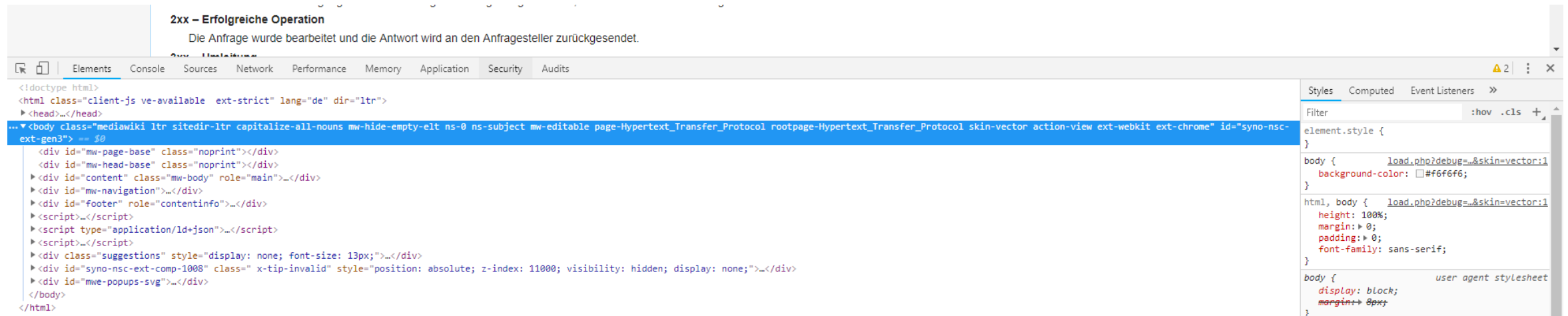
- Metainformation zur versendeten Nachricht
- general headers
- request specific headers
- response specific headers
- entity headers
- Details: <https://www.w3.org/Protocols/rfc2616/rfc2616-sec14.html>

MIME Type

- Beschreibt die Daten im Body einer HTTP Nachricht
- „Um was für eine Art von Daten handelt es sich?“
- HTTP Header → Content-Type
- Format: <Medientyp>/<Subtyp> [";" parameter]
- Beispiel: text/html; charset=UTF-8, multipart/mixed, image/jpeg, ...
- https://developer.mozilla.org/en-US/docs/Web/HTTP/MIME_types
- Wichtig damit der Empfänger weiß wie er die Daten anzeigen kann

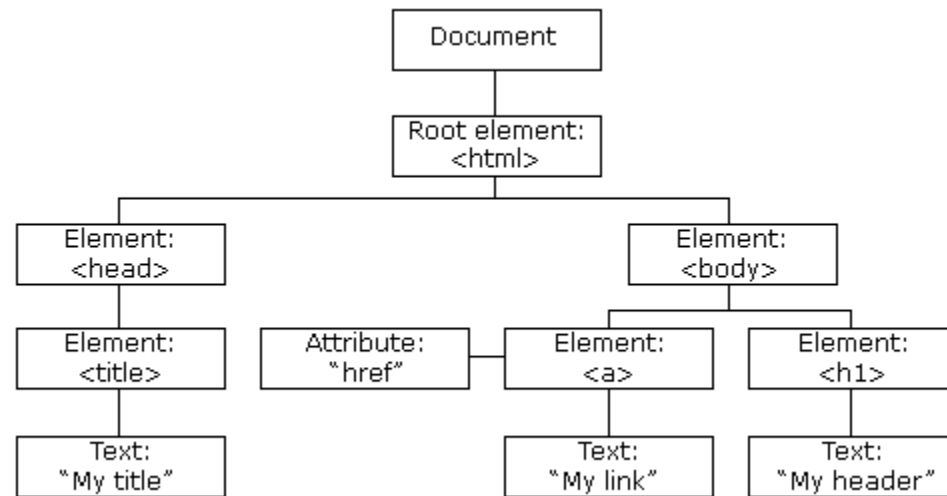
Tools (1)

- Browser Developer Tools (F12)



DOM

- Document Object Model
- Beim Laden der Webseite wird ein DOM Baum erzeugt



- Basierend darauf können Elemente der Webseite dynamisch verändert werden

Tools (2)

- Web Debugging Proxies - Fiddler

Progress Telerik Fiddler Web Debugger

File Edit Rules Tools View Help

WinConfig Replay X Go Stream Decode Keep: All sessions Any Process Find Save Browse Clear Cache TextWizard Tearoff MSDN Search...

#	Result	Protocol	Host	URL	Body	Caching	Content-Type	Process	Comment
18	200	HTTP	Tunnel to	static.criteo.net:443	0			chrome...	
19	200	HTTP	Tunnel to	s3.amazonaws.com:443	0			chrome...	
20	200	HTTPS	code.tutsplus.com	/tutorials/http-the-protocol-every-w...	27 337	no-cache	text/html; c...	chrome...	
21	200	HTTPS	clients4.google.com	/chrome-sync/command?client=Go...	721	no-cac...	application/...	chrome...	
22	200	HTTPS	static.tutsplus.com	/assets/application-dcfba383fd595...	82 444	public, ...	text/css	chrome...	
23	200	HTTPS	fonts.googleapis.com	/css?family=Roboto:400,500,700	609	private...	text/css; c...	chrome...	
24	200	HTTPS	www.google-analyt...	/analytics.js	17 543	public, ...	text/javasc...	chrome...	
25	200	HTTP	Tunnel to	static.tutsplus.com:443	0			chrome...	
26	200	HTTP	Tunnel to	fonts.gstatic.com:443	0			chrome...	
27	200	HTTPS	static.tutsplus.com	/assets/application-17817ed984426...	79 017	public, ...	application/...	chrome...	
28	200	HTTP	Tunnel to	static.tutsplus.com:443	0			chrome...	
29	200	HTTPS	static.tutsplus.com	/assets/body-69afa38c9db3e5cdec...	124 108	public, ...	application/...	chrome...	
30	200	HTTPS	static.tutsplus.com	/assets/tuts_logo-cf1e6fd0e5ca6cc...	3 573	public, ...	image/svg...	chrome...	
31	200	HTTPS	static.tutsplus.com	/assets/redesign/code-92f4d6cb84a...	1 276	public, ...	image/svg...	chrome...	
32	200	HTTP	Tunnel to	cms-assets.tutsplus.com:443	0			chrome...	
33	200	HTTP	Tunnel to	static.tutsplus.com:443	0			chrome...	
34	200	HTTP	Tunnel to	static.tutsplus.com:443	0			chrome...	
35	200	HTTPS	static.tutsplus.com	/assets/translations/native-logo-26...	4 109	public, ...	image/png	chrome...	
36	200	HTTP	Tunnel to	static.tutsplus.com:443	0			chrome...	
37	200	HTTPS	static.tutsplus.com	/assets/ad-pinstripe-0f2204b78e74...	98	public, ...	image/png	chrome...	
38	200	HTTP	Tunnel to	static.tutsplus.com:443	0			chrome...	
39	200	HTTPS	static.tutsplus.com	/assets/free_trial/background-purpl...	8 818	public, ...	image/png	chrome...	
40	200	HTTPS	platform.twitter.com	/widgets.js	27 996	public, ...	application/...	chrome...	
41	200	HTTP	Tunnel to	net.tutsplus.com:443	0			chrome...	
42	200	HTTPS	static.tutsplus.com	/assets/social-facebook-767c0a32d...	799	public, ...	image/svg...	chrome...	
43	200	HTTPS	static.tutsplus.com	/assets/social-twt-73023d97b17190...	1 371	public, ...	image/svg...	chrome...	
44	200	HTTPS	static.tutsplus.com	/assets/social-google-0cc7e84c3864...	1 360	public, ...	image/svg...	chrome...	
45	200	HTTP	Tunnel to	fonts.gstatic.com:443	0			chrome...	
46	200	HTTPS	static.tutsplus.com	/assets/social-pinterest-50994b8793...	1 785	public, ...	image/svg...	chrome...	
47	200	HTTP	Tunnel to	fonts.gstatic.com:443	0			chrome...	
48	200	HTTPS	www.google-analyt...	/plugins/ua/ec.js	1 296	public, ...	text/javasc...	chrome...	
49	200	HTTP	Tunnel to	www.google-analyt...	0			chrome...	
50	200	HTTPS	www.google-analyt...	/plugins/ua/linked.js	856	public, ...	text/javasc...	chrome...	
51	200	HTTP	code.tutsplus.com	/api/categories.json	21 087	public, ...	application/...	chrome...	
52	200	HTTP	Tunnel to	code.tutsplus.com:443	0			chrome...	
53	200	HTTPS	code.tutsplus.com	/api/categories.json	21 087	public, ...	application/...	chrome...	

Request Headers

GET /tutorials/http-the-protocol-every-web-developer-must-know-part-1-net-31177 HTTP/1.1

Cache

Cache-Control: no-cache
Pragma: no-cache

Client

Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,image/apng,*/*;q=0.8
Accept-Encoding: gzip, deflate, br
Accept-Language: en-US,en;q=0.9,de;q=0.8
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/71.0.3578.98 Safari/537.36

Cookies

Cookie

__cfduid=da6573c3ccc8f5b3d727b149a94338b7e1549547783
_gads
ID=a7e32bca1f905c5f:T=1549547786:S=ALNI_MY_QChagfWl3UuzS33CdD72JG8H5w
_ga=GA1.2.1579115245.1549547787
_tuts_session=2abeb402af53a82181d1878bee868730

Miscellaneous

Referer: https://www.google.at/

Security

Upgrade-Insecure-Requests: 1

Transport

Connection: keep-alive
Host: code.tutsplus.com

Response Headers

HTTP/1.1 200 OK

Cache

Cache-Control: no-cache
Date: Fri, 08 Feb 2019 16:18:50 GMT
Vary: Accept-Encoding

Cookies / Login

Set-Cookie: _tuts_session=2abeb402af53a82181d1878bee868730; domain=.tutsplus.com; path=/; expires=Fri, 22 Feb 2019 16:18:50 -0000; secure; HttpOnly

WebServer – Grundlagen

- WebServer läuft über Standard Port: 80 (HTTP)
- Verschlüsselte Kommunikation mit Port: 443 (HTTPS)
- TCP Connection → Verbindung bleibt bestehen

WebServer – Vorbedingungen

- Einbindung der Dependency in platformio.ini
- Einbindung der library ESPAsyncWebServer.h

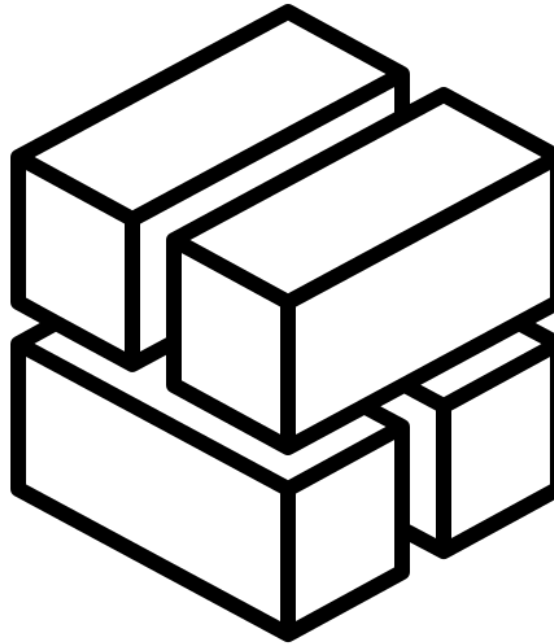
```
Demo > 🐛 platformio.ini
1  ; PlatformIO Project Configuration File
2  ;
3  ; Build options: build flags, source filter
4  ; Upload options: custom upload port, speed and extra flags
5  ; Library options: dependencies, extra library storages
6  ; Advanced options: extra scripting
7  ;
8  ; Please visit documentation for the other options and examples
9  ; https://docs.platformio.org/page/projectconf.html
10
11 [env:lolin32]
12 platform = espressif32
13 board = lolin32
14 framework = arduino
15 monitor_speed = 115200
16 lib_deps =
17 |   esphome/ESPAsyncWebServer-esphome@^2.1.0
```

ESPAsyncWebServer

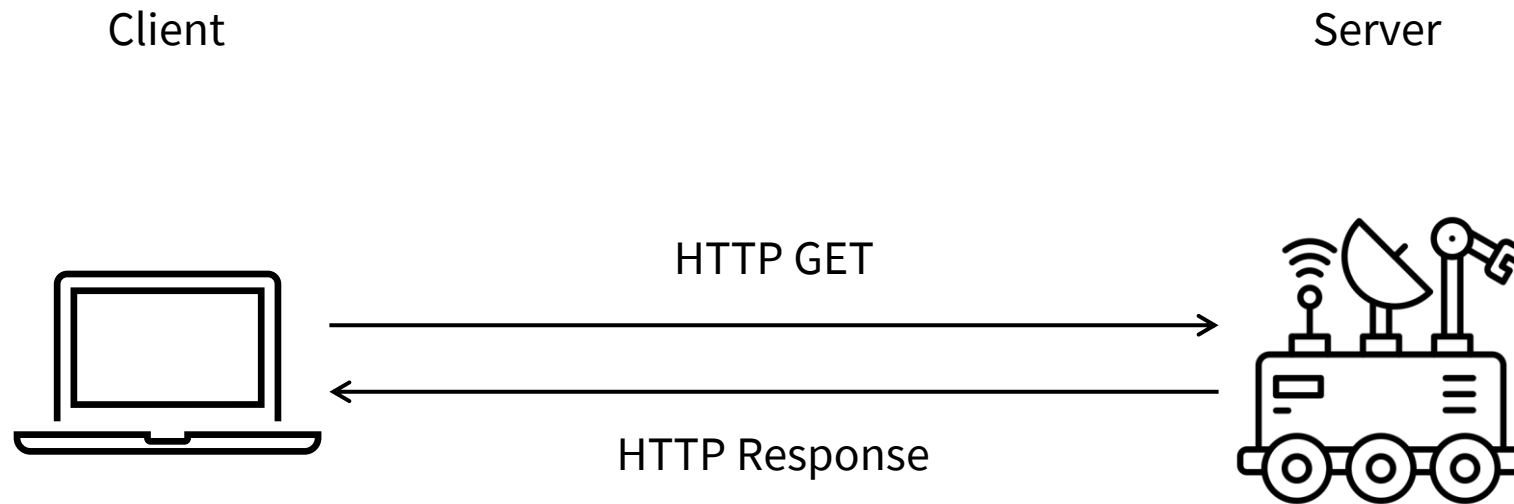


- Implementierung eines WebServers für ESP32
- Mehrere Verbindungen können gleichzeitig verarbeitet werden
- Einfache Template Processing Engine
- Erzeugt pro Anfrage ein Request Objekt
- Server kann dynamische, oder auch statische Inhalte liefern
- Dokumentation unter <https://github.com/me-no-dev/ESPAsyncWebServer>

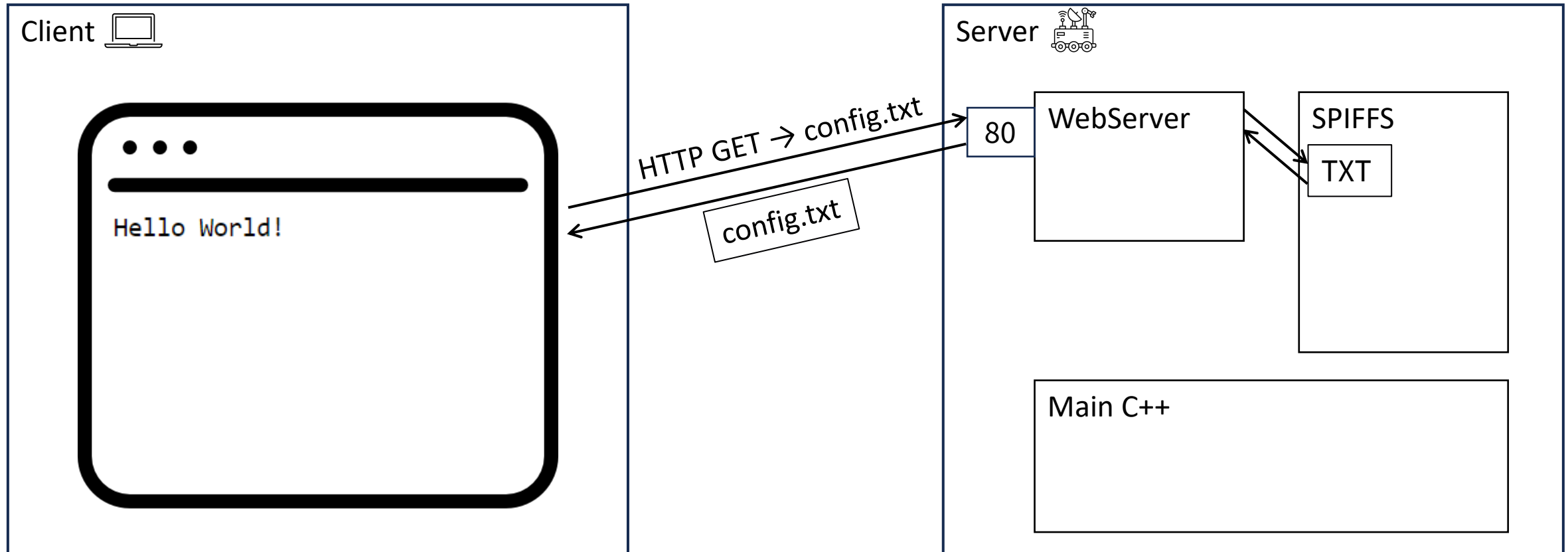
WebServer – Statische Inhalte



Software Architektur



Server Architektur



WebServer – Funktionen



- Globale Initialisierung → `AsyncWebServer server(80);`
- WebServer aufsetzen in `setup()`
 - Statische Inhalte von SPIFFS liefern → `server.serveStatic(uri, fs, path);`
 - Beispiel: `server.serveStatic("/", SPIFFS, "/");`
 - Server starten → `server.begin();`
- Kein weiterer WebServer Code in `loop()` notwendig!