Hypertext Transfer Protokoll

HTTP ~~1.1~~ 2

QUICK UDP Internet Connections

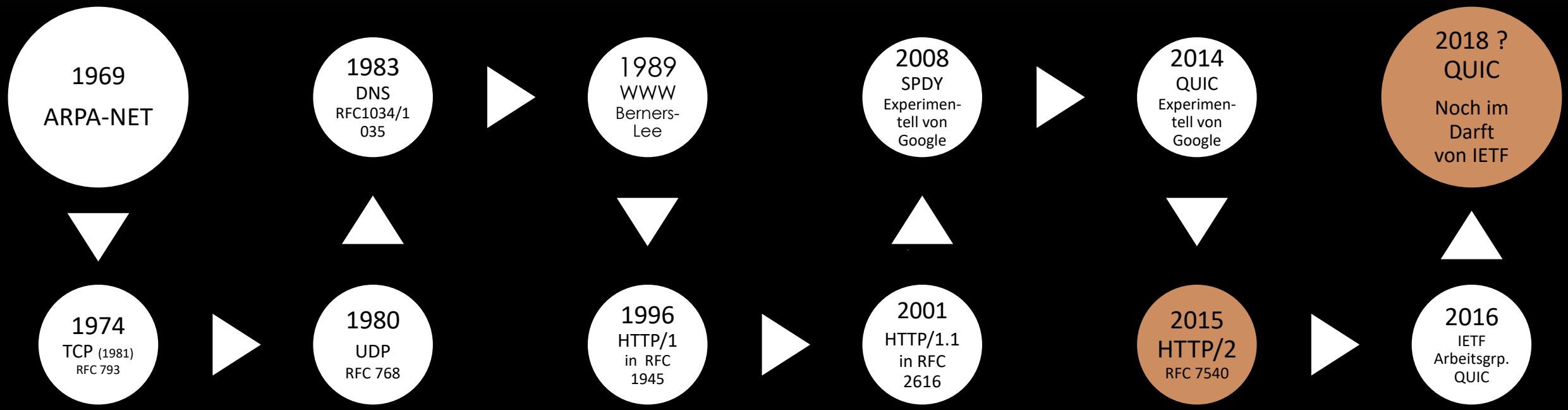
QUIC

Nach IETF Arbeitsgruppe QUIC, „könnten schon bald 70 bis 80 % des Internet-Verkehrs über das neue Transportprotokoll QUIC laufen. “

Agenda HTTP/2

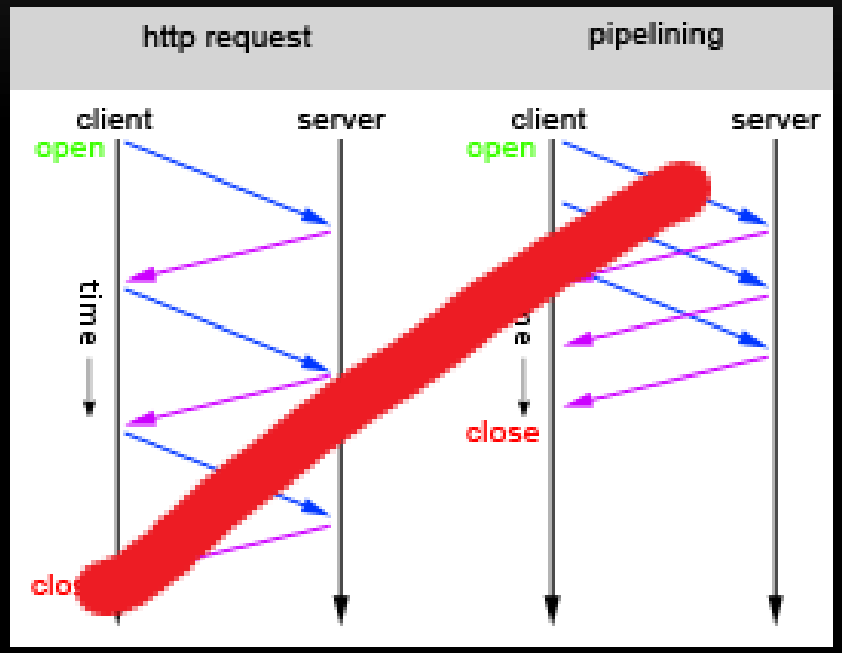
- Einordnung
- Vorbetrachtung
  - Ziele
  - Allgemeines
  - Neue Features
- Protokoll-Betrachtung
  - Frames
  - Steams (Multiplexing)
  - Header Kompression

Einordnung


1969
ARPA-NET
1983
DNS
RFC1034/1
035
1989
WWW
Berners-
Lee
2008
SPDY
Experimen-
tell von
Google
2014
QUIC
Experimen-
tell von
Google
2018 ?
QUIC
Noch im
Darft
von IETF
1974
TCP (1981)
RFC 793
1980
UDP
RFC 768
1996
HTTP/1
in RFC
1945
2001
HTTP/1.1
in RFC
2616
2015
HTTP/2
RFC 7540
2016
IETF
Arbeitsgrp.
QUIC

Ziele

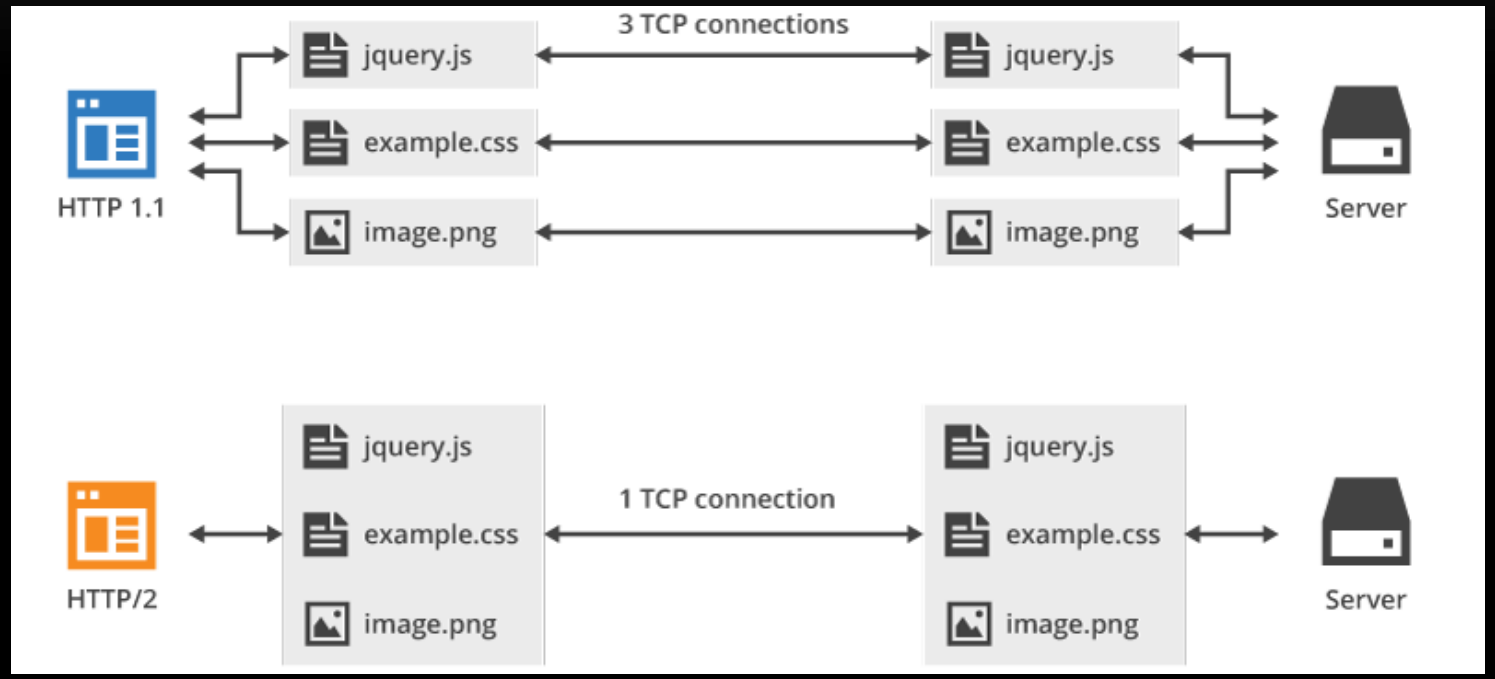
- Negotiation Mechanism (ALPN)
- Reduktion Latenz
- Abwärtskompatibilität
- Server-initiierte Datenübertragungen
- Datenkompression



https://i.stack.imgur.com/Zp2lf.png

Neue Features

- Binäres Protokoll (Framing)
- Multiplext (Parallelism)
- Header Kompression (HPACK)
- Flow-Control
- Server Push

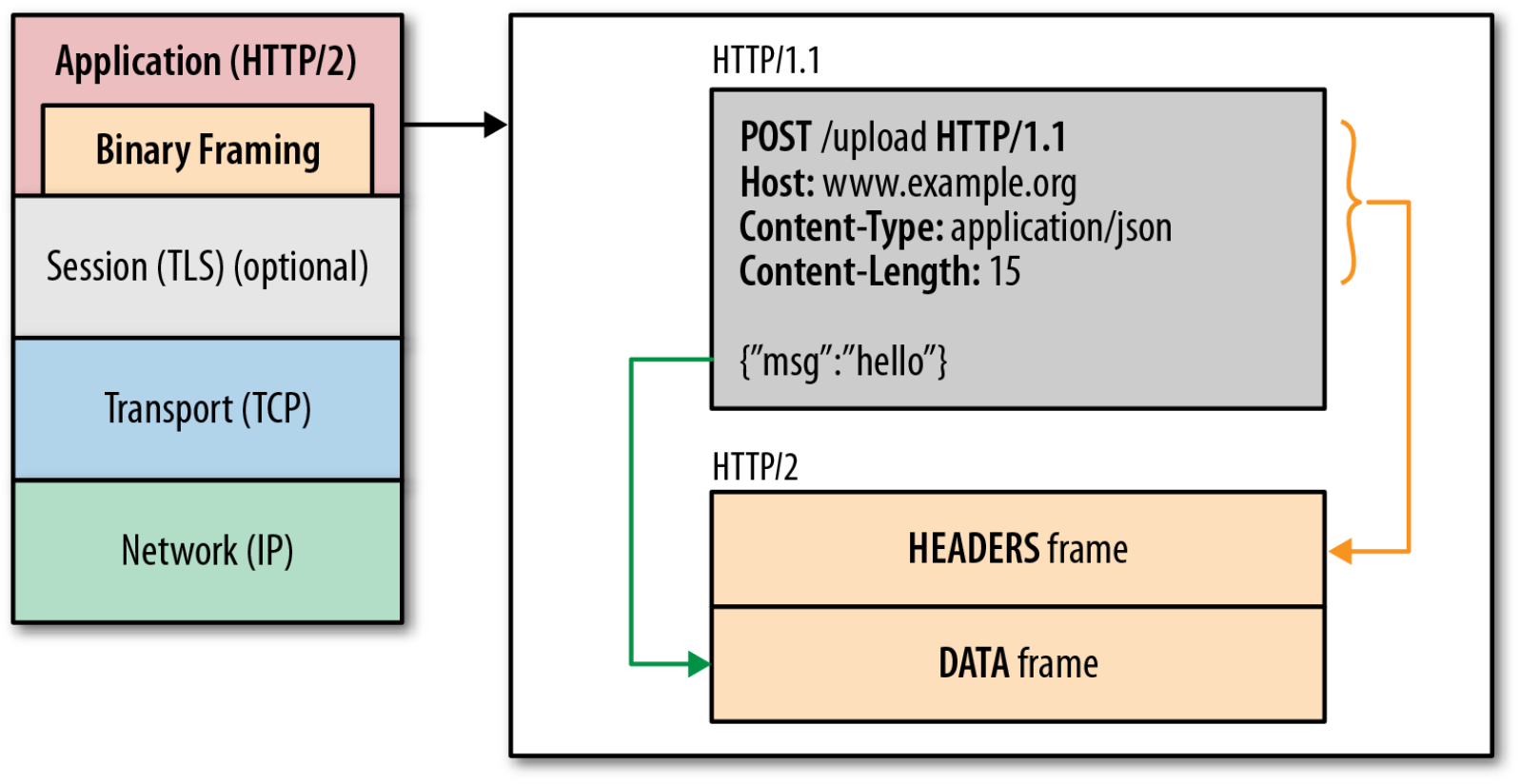


https://www.greenlanemarketing.com/blog/seo-101-http-vs-http2/

Frames

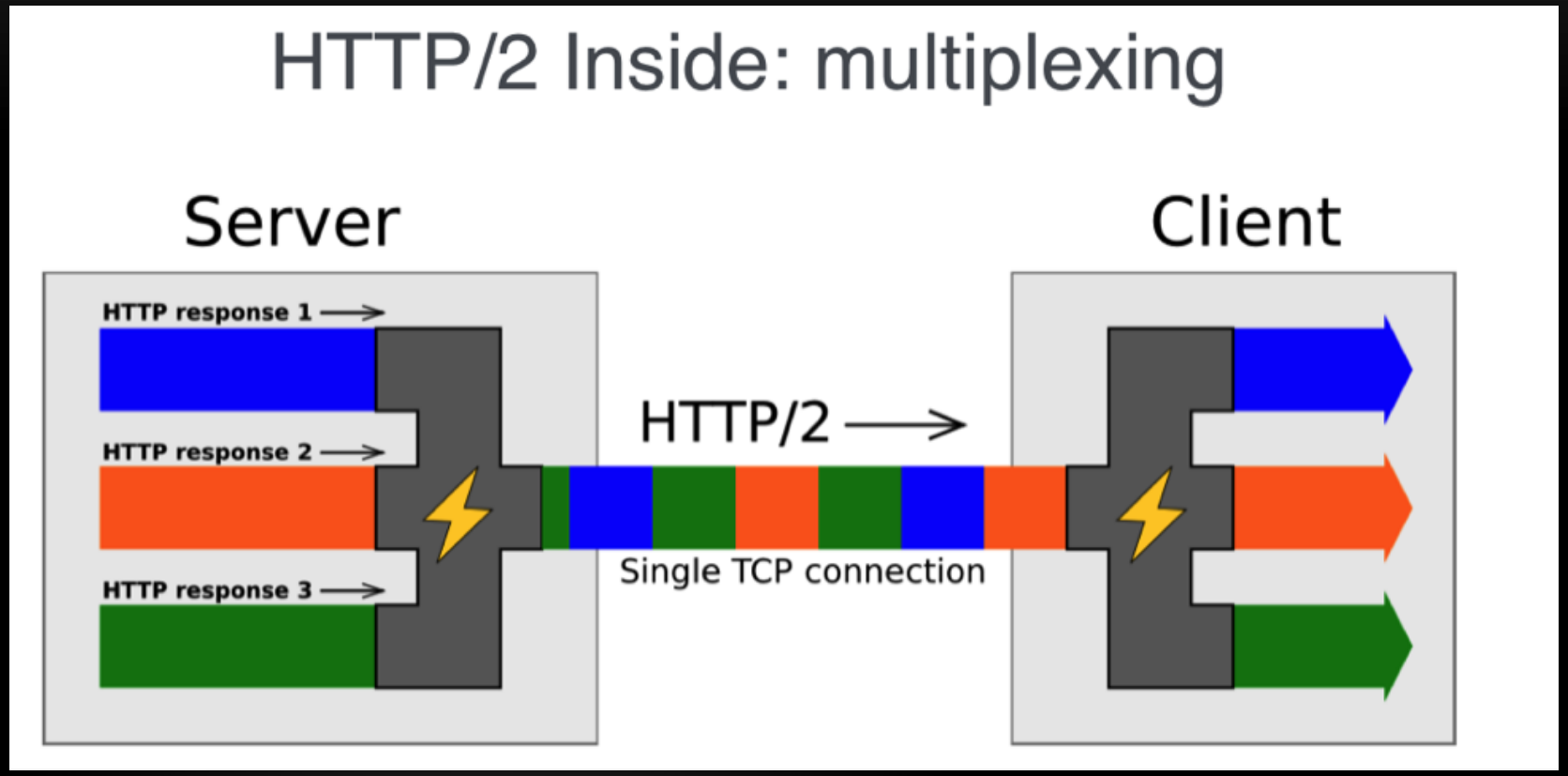
- Kleinste Einheit
- Binär kodiert
- Flusskontrolle
- Priorisierung
- Header Frames
- Daten Frames

```
+-----------------------------------------------+
|                 Length (24)                   |
+---------------+---------------+---------------+
| Type (8)      | Flags (8)     |
+-+-------------+---------------+-------------------------------+
|R|                 Stream Identifier (31)                      |
+=+===============================================================+
```



HTTP/2 STREAMS

- Stream ID
- Flusskontrolle
- Parallelität
- Abhängigkeiten
- Priorisierung
- Status
- Server Push



2017 NGINX Documentation

HEADER KOMPRESSION (HPACK)

HPACK example (1/2)

63byte -> 16byte

Request Header

:method: GET
:scheme: http
:path: /
:authority: www.example.com

Decoded Data

82 ADD index 2
87 ADD index 7
86 ADD index 6
04 8b db6d 883e 68d1 cb12 25ba 7f
ADD key at index 4
value "www.example.com"

Static Table

1	:authority	
2	:method	GET
3	:method	POST
4	:path	/
5	:path	/index.html
6	:scheme	http
7	:scheme	https

Reference Set

1	:authority	www.example.com
2	:path	/
3	:scheme	http
4	:method	GET

common frame header

HPACK encoded headers

```
▼ HyperText Transfer Protocol 2
  ▼ Stream: HEADERS, Stream ID: 1, Length 20
      Length: 20
      Type: HEADERS (1)
    ▼ Flags: 0x05
        .... ...1 = End Stream: True
        .... .1.. = End Headers: True
        .... 0... = Padded: False
        ..0. .... = Priority: False
        00.0 ..0. = Unused: 0x00
      0... .... .... .... .... .... .... .... = Reserved: 0x00000000
      .000 0000 0000 0000 0000 0000 0000 0001 = Stream Identifier: 1
      [Pad Length: 0]
      Header Block Fragment: 8682418aa0e41d139d09b8f01e078453032a2f2a
      [Header Length: 100]
    ▶ Header: :scheme: http
    ▶ Header: :method: GET
    ▶ Header: :authority: localhost:8080
    ▶ Header: :path: /
    ▼ Header: accept: */*
        Name Length: 6
        Name: accept
        Value Length: 3
        Value: */*
        Representation: Literal Header Field with Incremental Indexing -
        Index: 19
```

https://hpbn.co

DEMO HTTP/2

http2.akamai.com/demo

Akamai

HTTP/2 is the future of the Web, and it is here!

Your browser supports HTTP/2!

This is a demo of HTTP/2's impact on your download of many small tiles making up the Akamai Spinning Globe.

HTTP/1.1

Latency: 34ms
Load time: 36.39s

HTTP/2

Latency: 30ms
Load time: 6.49s

Demo concept inspired by Golang's Gophertiles

Return to Akamai's HTTP/2 page

Elements | Console | Sources | Network | Performance | Memory | Application | Security | Audits

http2.akamai.com #1 | Screenshots | Memory

Disable JavaScript samples | Network: Fast 3G
Enable advanced paint instrumentation (slow) | CPU: No throttling

2000 ms 4000 ms 6000 ms 8000 ms 10000 ms 12000 ms 14000 ms 16000 ms 18000 ms 20000 ms 22000 ms 24000 ms 26000 ms 28000 ms 30000 ms 32000 ms 34000 ms 36000 ms 38000 ms 40000 ms

FPS
CPU
NET

5000 ms 10000 ms 15000 ms 20000 ms 25000 ms 30000 ms 35000 ms 40000 ms

Network

Frames
Main — https://http2.akamai.com/demo
Raster

Summary | Bottom-Up | Call Tree | Event Log

Filter | Group by URL

Self Time	Total Time	Activity
1196.8 ms 40.0 %	1964.7 ms 65.7 %	[unattributed]
694.0 ms 23.2 %	698.7 ms 23.4 %	https://http1.akamai.com/demo/h2_demo_frame.html
267.2 ms 8.9 %	273.3 ms 9.1 %	https://http2.akamai.com/demo/h2_demo_frame.html

https://medium.com/the-node-js-collection/node-js-can-http-2-push-b491894e1bb1

QUICK UDP Internet Connections

QUIC

Agenda QUIC

- Relevanz
- Vorbetrachtung
  - Ziele
  - Allgemeines
  - Struktur Elemente
- Protokoll-Betrachtung
  - Sitzungsteuerung u Verschlüsselung
  - Multiplexing
  - Forward Error Korrektion
  - Connection Migration

Wer Daten/Charts mag -> https://netray.io/

TOTAL RESULTS

1,308

TOP COUNTRIES

Germany	1,308

TOP CITIES

Zossen	99
Kirchseeon	95
Oldenburg	69
Hamburg	68
Frankfurt	49

TOP SERVICES

HTTPS	1,265
HTTP	43

TOP ORGANIZATIONS

O2 Deutschland	207
EWE-Tel GmbH	204
Versatel Deutschland	157
NetCologne GmbH	78
QSC CDN Caches	48

TOP PRODUCTS

Apache httpd	35
Mono-HTTPAPI	1
Microsoft IIS httpd	1

92.226.2.126
O2 Deutschland
Added on 2018-09-10 21:37:33 GMT
Germany, Kirchseeon
Details
QUIC Protocol
Versions: 44, 43, 39, 35

92.226.2.122
O2 Deutschland
Added on 2018-09-10 21:36:23 GMT
Germany, Kirchseeon
Details
QUIC Protocol
Versions: 44, 43, 39, 35

62.206.165.79
cache.google.com
QSC CDN Caches
Added on 2018-09-10 21:33:08 GMT
Germany
Details
QUIC Protocol
Versions: 44, 43, 39, 35

92.226.2.199
O2 Deutschland
Added on 2018-09-10 21:23:15 GMT
Germany, Kirchseeon
Details
QUIC Protocol
Versions: 44, 43, 39, 35

129.143.66.19
cache.google.com
Universitaet Stuttgart
Added on 2018-09-10 21:14:52 GMT
Germany, Stuttgart
Details
QUIC Protocol
Versions: 44, 43, 39, 35

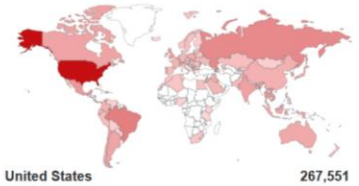
92.226.2.79
O2 Deutschland
Added on 2018-09-10 21:12:13 GMT
Germany, Kirchseeon
Details
QUIC Protocol
Versions: 44, 43, 39, 35

212.6.86.152
static-212-006-086-152.ewe-ip-backbone.de
EWE-Tel GmbH
Added on 2018-09-10 21:11:46 GMT
Germany, Oldenburg
Details
QUIC Protocol
Versions: 44, 43, 39, 35

TOTAL RESULTS

416,217

TOP COUNTRIES



United States	267,551
Brazil	15,851
Russian Federation	11,060
Viet Nam	7,662
AP	6,570

TOP SERVICES

HTTPS	415,801
HTTP	332
HTTP (8080)	14
8081	13
51106	4

TOP ORGANIZATIONS

Google Cloud	238,231
Google	18,568
Verizon Business	7,378
Vietnam Posts and Telecommu...	2,919
Vivo	2,059

TOP OPERATING SYSTEMS

Linux 3.x	1

TOP PRODUCTS

Apache httpd	136
nginx	11
Microsoft IIS httpd	5
Mono-HTTPAPI	1

35.211.16.112
112.16.211.35.bc.googleusercontent.com
Google Cloud
Added on 2018-09-10 21:42:50 GMT
United States, Mountain View
Details
QUIC Protocol
Versions: 44, 43, 39, 35

189.247.21.93
dsl-189-247-21-93-dyn.prod-infinitum.com.mx
Telmex
Added on 2018-09-10 21:42:26 GMT
Mexico
Details
QUIC Protocol
Versions: 44, 43, 39, 35

90.201.124.58
range2-ggc.enyrk.skybroadband.com
Sky Broadband
Added on 2018-09-10 21:42:14 GMT
United Kingdom, Rotherham
Details
QUIC Protocol
Versions: 44, 43, 39, 35

35.208.44.31
31.44.208.35.bc.googleusercontent.com
Google Cloud
Added on 2018-09-10 21:41:54 GMT
United States, Mountain View
Details
QUIC Protocol
Versions: 44, 43, 39, 35

35.209.124.210
210.124.209.35.bc.googleusercontent.com
Google Cloud
Added on 2018-09-10 21:41:51 GMT
United States, Mountain View
Details
QUIC Protocol
Versions: 44, 43, 39, 35

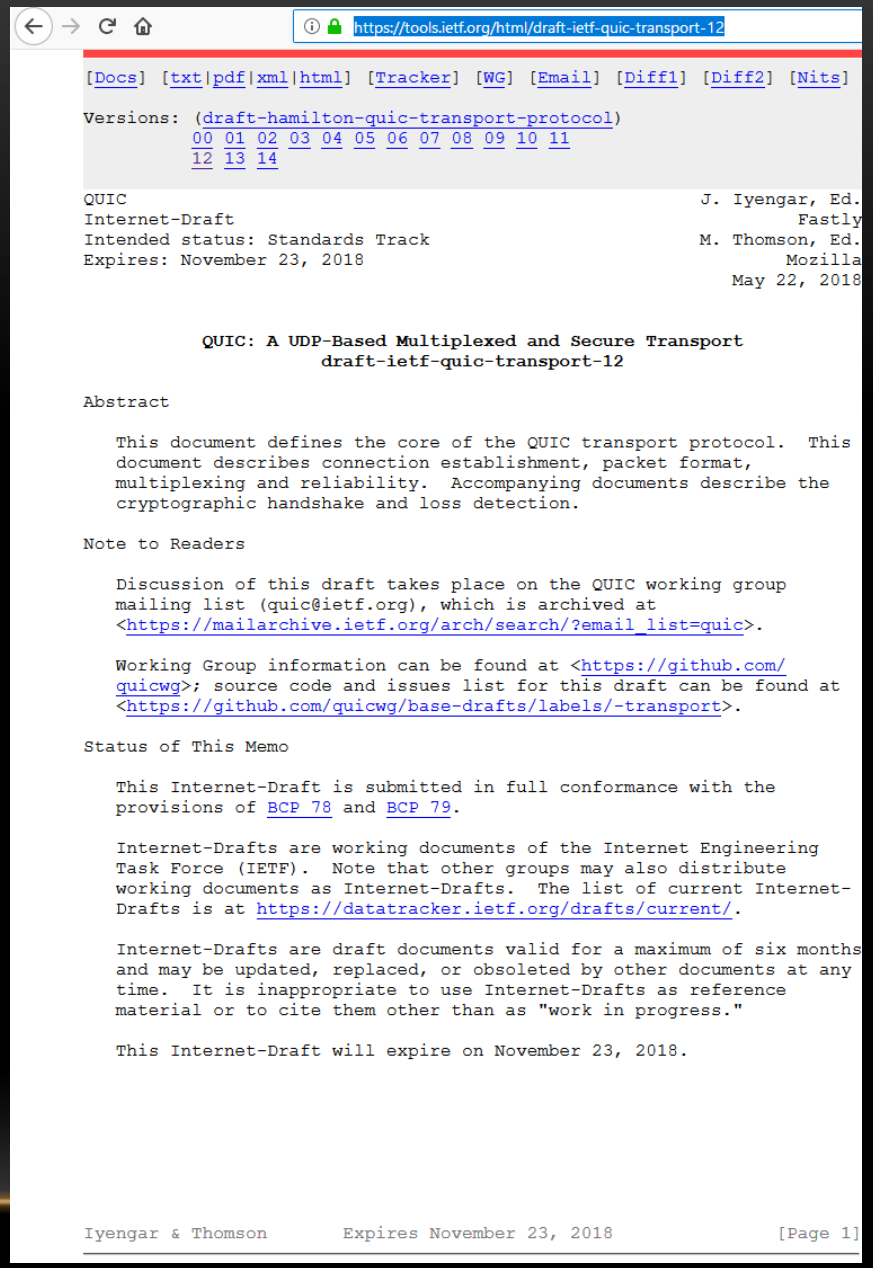
35.209.107.208
208.107.209.35.bc.googleusercontent.com
Google Cloud
Added on 2018-09-10 21:40:39 GMT
United States, Mountain View
Details
QUIC Protocol
Versions: 44, 43, 39, 35

35.190.38.90
90.38.190.35.bc.googleusercontent.com
Google Cloud
Added on 2018-09-10 21:40:22 GMT
QUIC Protocol
Versions: 44, 43, 39, 35

https://www.shodan.io/search?query=quic+protocol+versions

Ziele der IETF WG „QUIC“

- Beschleunigung des Datenverkehrs
- Multiplexing
- Roaming
- Link-Aggregation
- Eigenes Schlüssel Management
- Integrierte Verschlüsselung



https://tools.ietf.org/html/draft-ietf-quic-transport-12

[Docs] [txt|pdf|xml|html] [Tracker] [WG] [Email] [Diff1] [Diff2] [Nits]

Versions: (draft-hamilton-quic-transport-protocol)
00 01 02 03 04 05 06 07 08 09 10 11
12 13 14

QUIC
Internet-Draft
Intended status: Standards Track
Expires: November 23, 2018

J. Iyengar, Ed.
Fastly
M. Thomson, Ed.
Mozilla
May 22, 2018

QUIC: A UDP-Based Multiplexed and Secure Transport
draft-ietf-quic-transport-12

Abstract

This document defines the core of the QUIC transport protocol. This document describes connection establishment, packet format, multiplexing and reliability. Accompanying documents describe the cryptographic handshake and loss detection.

Note to Readers

Discussion of this draft takes place on the QUIC working group mailing list (quic@ietf.org), which is archived at <https://mailarchive.ietf.org/arch/search/?email_list=quic>.

Working Group information can be found at <https://github.com/quicwg>; source code and issues list for this draft can be found at <https://github.com/quicwg/base-drafts/labels/-transport>.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at https://datatracker.ietf.org/drafts/current/.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on November 23, 2018.

Iyengar & Thomson Expires November 23, 2018 [Page 1]

Allgemein

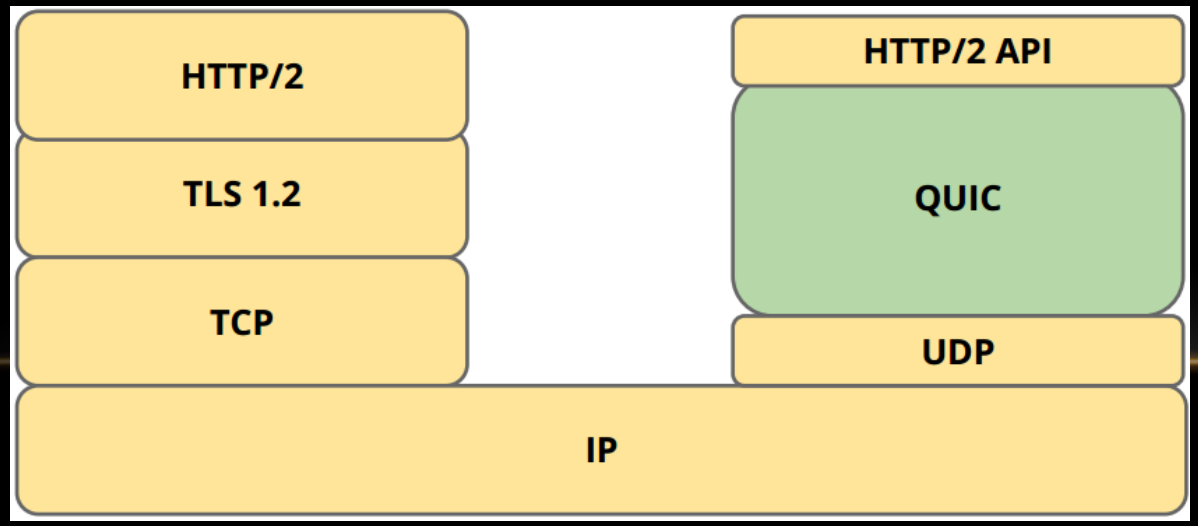
- Neuester Entwurf 22.05.2018
- Transportprotokoll, welches auf UDP aufsetzt.
- Schreibt Verschlüsselung (TLS 1.3) vor.
- Nutzt Mechanismen von TCP
- Muss von Anwendung unterstützt werden.

TCP+TLS+HTTP/2

- Initialer 3 Wege Handschlag
- TCP und HTTP/1.1 + TLS
- HTTP/2

UDP+QUIC+HTTP/2

- Reduzieren der Latenz
- Vertraulichkeit wird erhöht
- HoL Blocking entfällt
- Fehlerkorrektur (Robustheit)
- Connection Migration



Header

- Paket Typen
- Initial, retry, Handshake,
- 0-RTT Protected
- Connection ID
- Version Negotiation
- Paket Nummer
- Short Header für SubSequent Con.

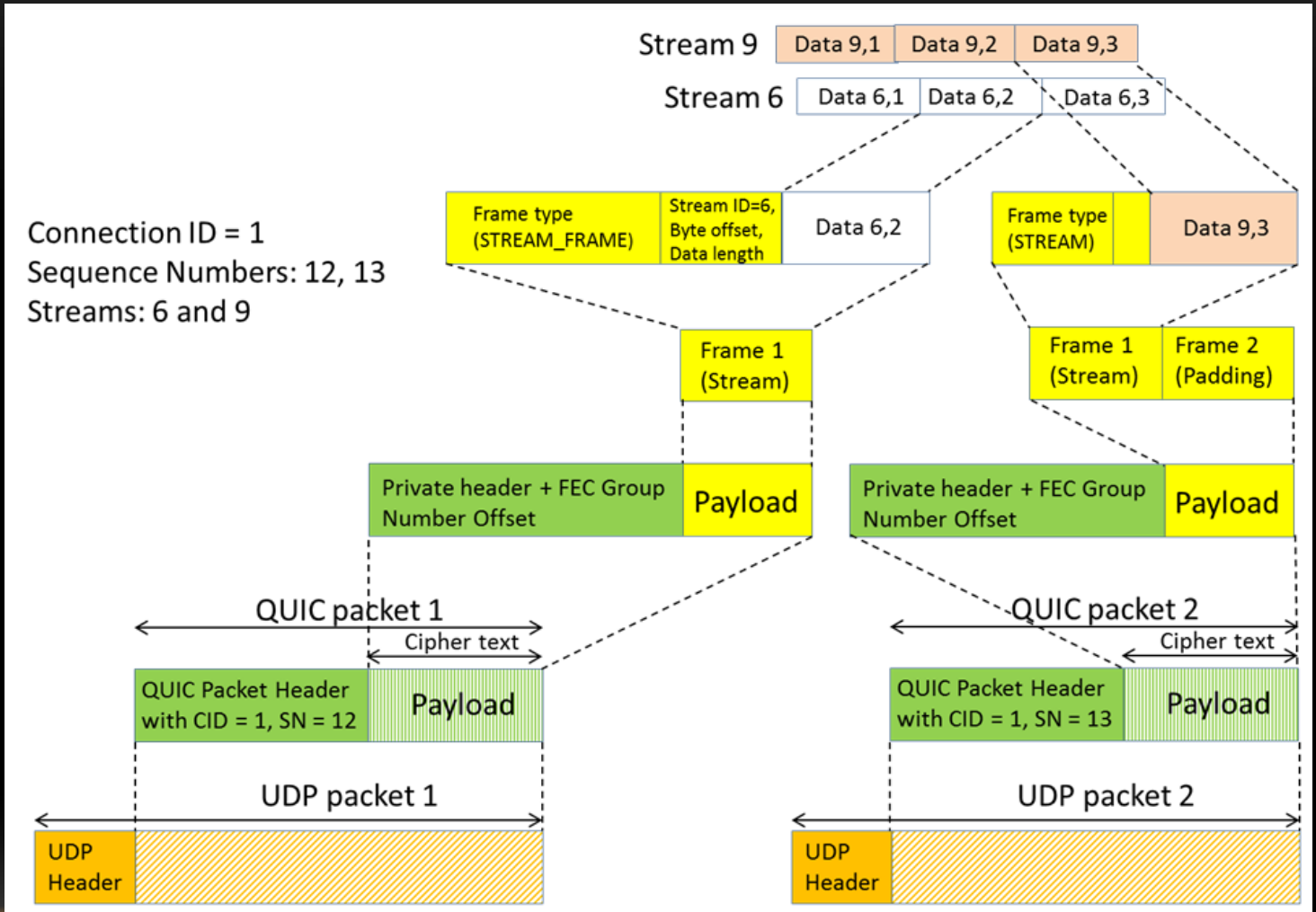
```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+
|1|   Type (7)  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+                        Connection ID (64)                     +
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Version (32)                         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Packet Number (32)                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Payload (*)                          ...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 1: Long Header Format

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+
|0|C|K| Type (5)|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+                     [Connection ID (64)]                      +
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Packet Number (8/16/32)                  ...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Protected Payload (*)                     ...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

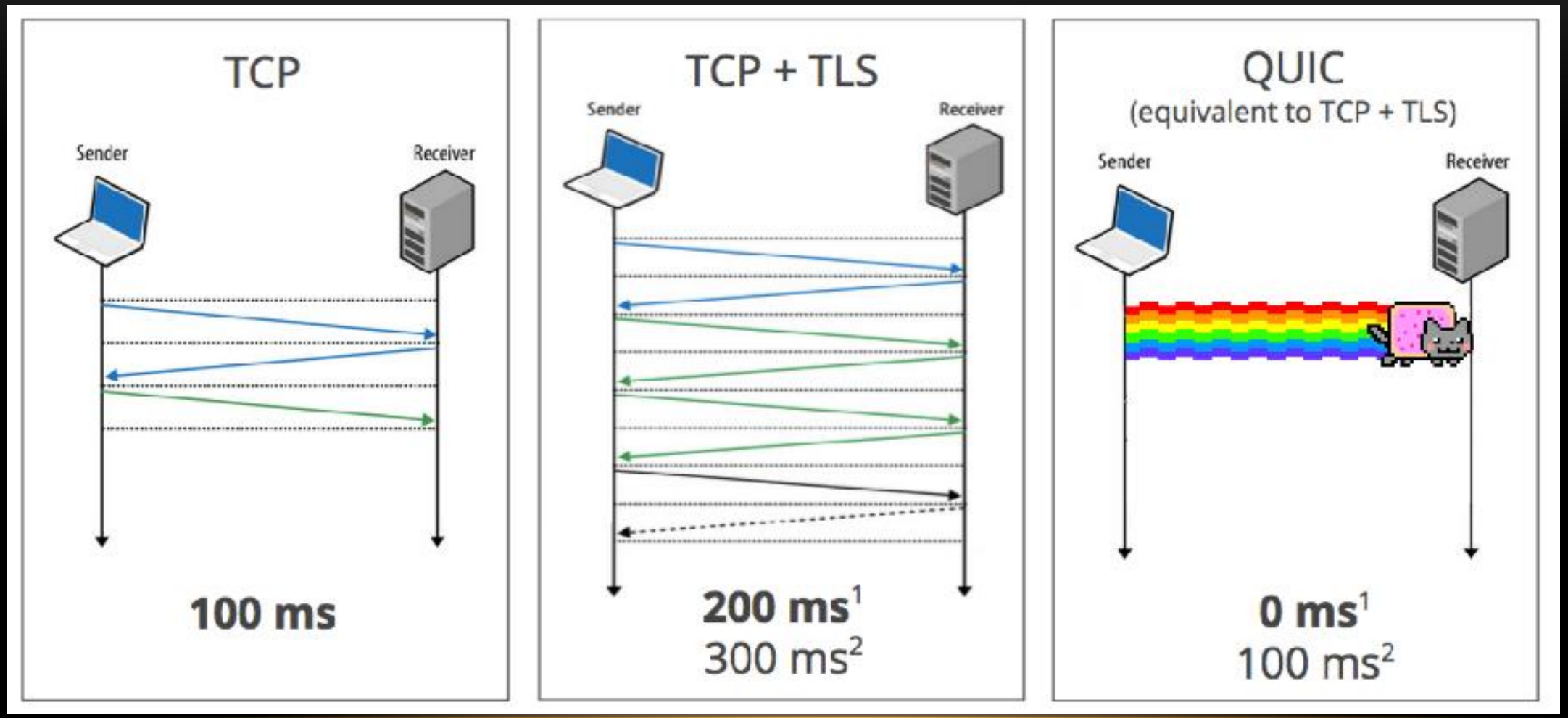
QUIC Struktur

- Daten in Streams
- Streams aus Frames
- Packet mir Frames
- QUIC in UDP



http://yucianga.info/?p=819

Sitzungssteuerung und Verschlüsselung vor QUIC

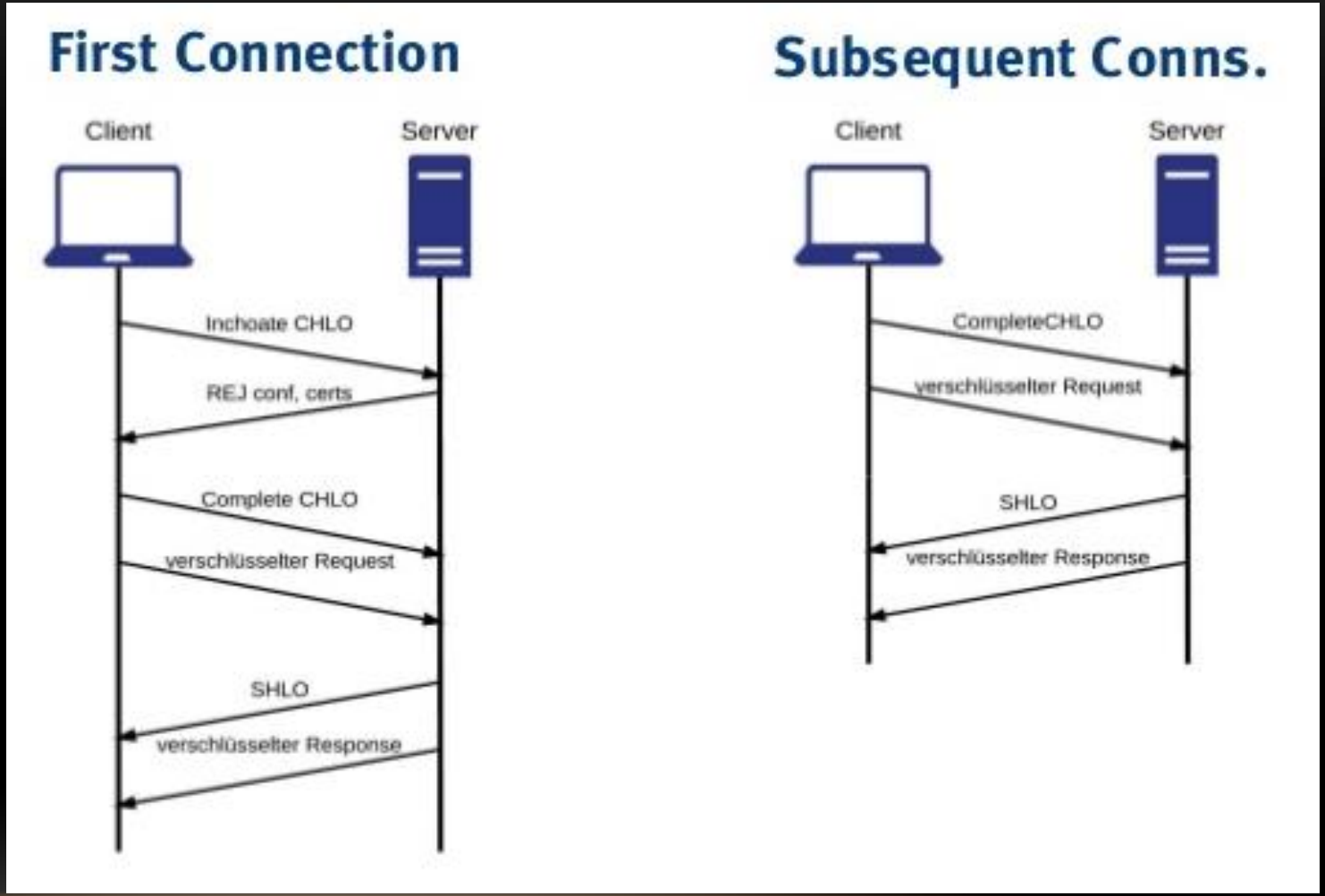


https://medium.com/@qratorlabs/past-threats-future-protocols-cc960515399b

Sitzungssteuerung und Verschlüsselung

- Verbindungsaufbau
- Verschlüsselung

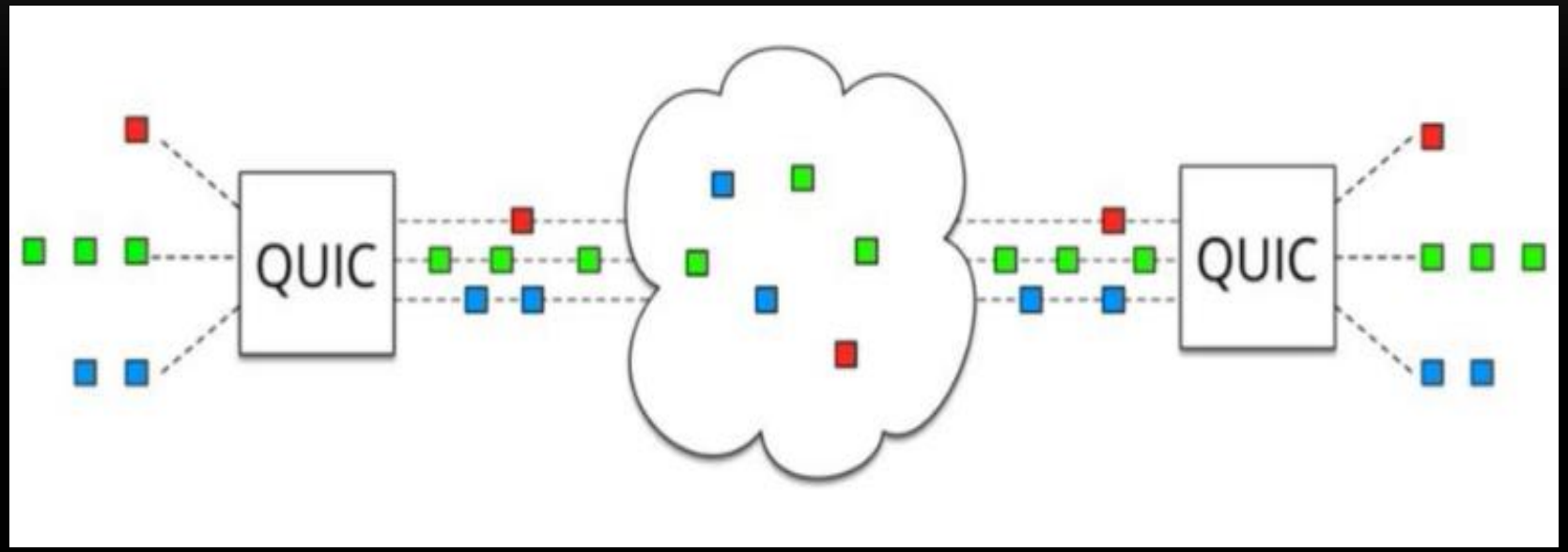
  Handshake
- Verbindungsabbau



https://www.slideshare.net/StephenKing/cleaning-up-the-dirt-of-the-nineties-how-new-protocols-are-modernizing-the-web

Multiplexing

- QUIC Connection
- QUIC Pakete
- QUIC Frames
- QUIC Streams
- QPACK

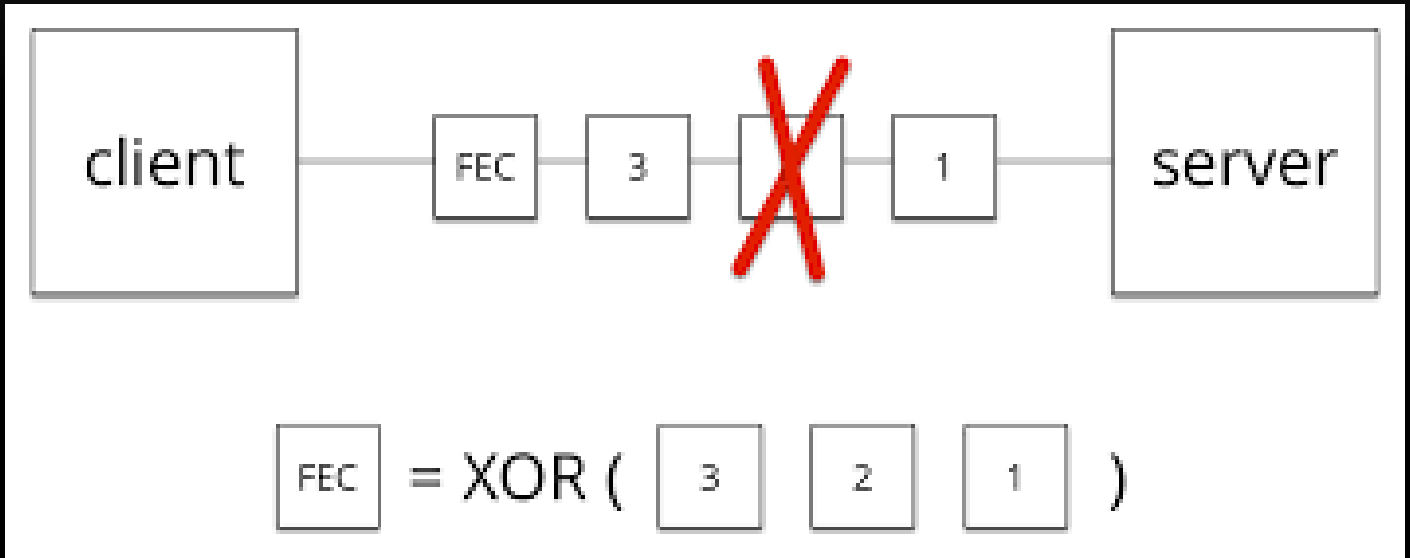


https://ma.ttias.be/googles-quic-protocol-moving-web-tcp-udp/

- Kein HoL Blocking trotz Multipfad und Multiplex

Forward Error Correction (FEC)

- RAID 5 auf Netzverkehr
- XOR über eine FEC-Gruppe
- Paritätspaket wird übertragen
- 1 Fehler kann korrigiert werde

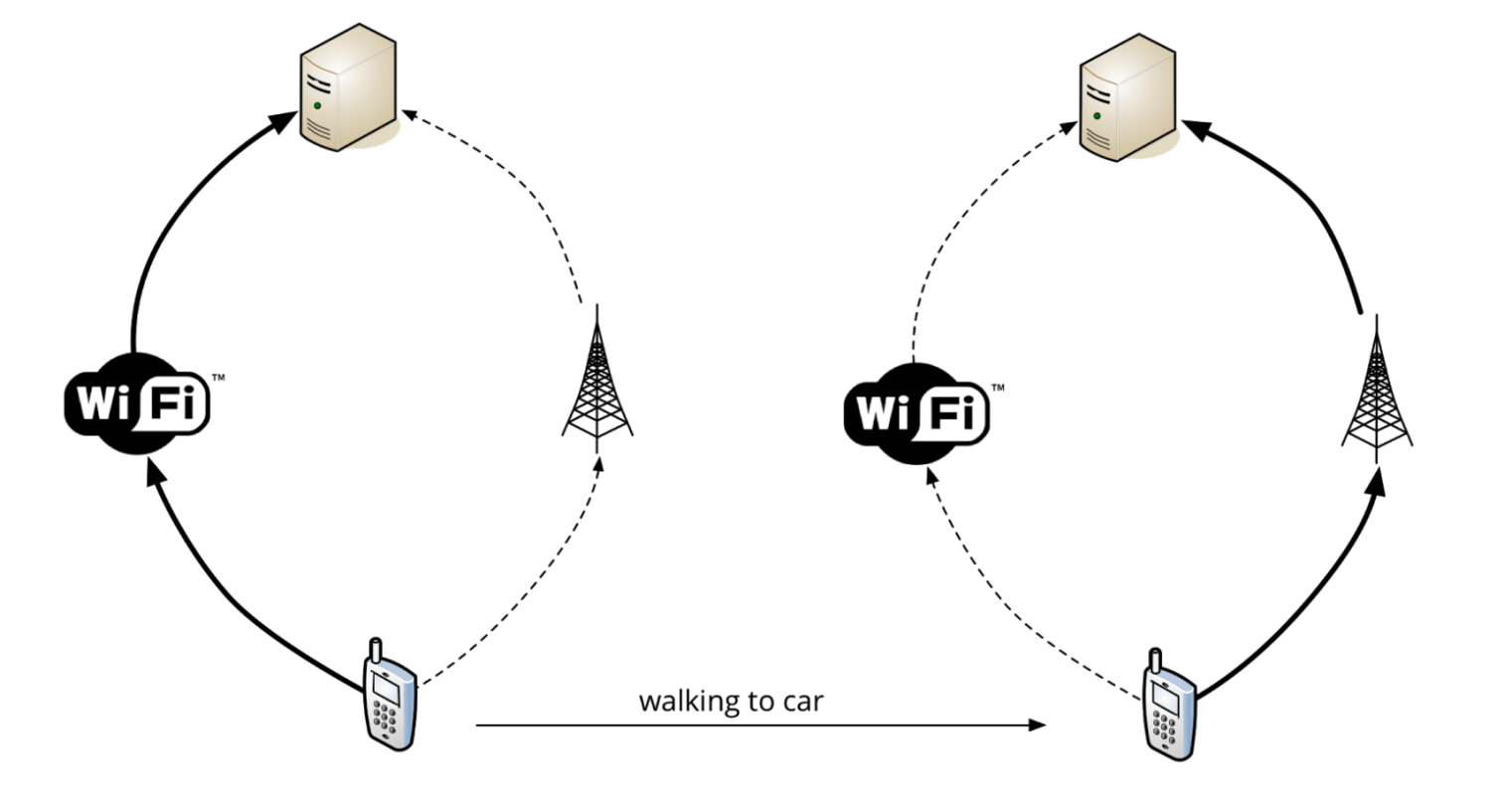


http://slides.com/ipeychev/http-2-0-and-quic-protocols-of-the-near-future-and-why-they-re-important#/24

- Schachstelle Fake Packet Injection

Connection Migration

- Verbindung wird an ein CID gebunden
- 64 Bit Connection ID
- Auch wenn sich Netz-Zugang ändert
- Middel Box Probleme
- Link Aggregation



https://ma.ttias.be/googles-quic-protocol-moving-web-tcp-udp/

DEMO QUIC

YouTube Suchen ANMELDEN

chrome://net-internals/#quic

jenadevs Meetup Softwerkskammer Jena

chrome://flags/#enable-quic

0:01 / 2:24:41

jenadevs Meetup #3: Elastic Stack - Talks & Demos about NoSQL and Big Data

QUIC sessions

View live QUIC sessions

Host	Version	Peer address	Connection ID	Active stream count	Active streams	Total stream count	Packets Sent	Packets Lost	Packets Received	Connected
r6---sn-4g5edn7y.googlevideo.com:443	QUIC_VERSION_43	[2a00:1450:4001:2b::c]:443	7033741032608739011	0	None	12	433	0	3591	true
www.google.de:443	QUIC_VERSION_43	[2a00:1450:4001:81c::2003]:443	8231023246150330818	0	None	1	7	0	7	true
www.youtube.com:443	QUIC_VERSION_43	[2a00:1450:4001:806::200e]:443	669550090617950162	0	None	18	73	0	94	true


```
                    -----END CERTIFICATE-----

                    -----BEGIN CERTIFICATE-----
                    MIIDujCCAqKgAwIBAgILBAAAAAABD4Ym5g0wDQYJKoZIhvcNAQEFBQAwTDEgMB4G
                    A1UECxMXR2xvYmFsU2lnbiBSb290IENBIC0gUjIxEzARBgNVBAoTCkdsb2JhbFNp
                    Z24xEzARBgNVBAMTCkdsb2JhbFNpZ24wHhcNMDYxMjE1MDgwMDAwWhcNMjExMjE1
                    MDgwMDAwWjBMMSAwHgYDVQQLExdHbG9iYWxTaWduIFJvb3QgQ0EgLSBSMjETMBEG
                    A1UEChMKR2xvYmFsU2lnbjETMBEGA1UEAxMKR2xvYmFsU2lnbjCCASIwDQYJKoZI
                    hvcNAQEBBQADggEPADCCAQoCggEBAKbPJA6+Lm8omUVCxKs+IVSbC9N/hHD6ErPL
                    v4dfxn+G07IwXNb9rfF73OX4YJYJkhD10FPe+3t+c4isUoh7SqbKSaZeqKeMWhG8
                    eoLrvozps6yWJQeXSpkqBy+0Hne/ig+1AnwblrjFuTosvNYSuetZfeLQBoZfXklq
                    tTleiDTsvHgMCJiEbKjNS7SgfQx5TfC4LcshytVsW33hoCmEofnTlEnLJGKRILzd
                    C9XZzPnqJworc5HGnRusyMvo4KD0L5CLTfuwNhv2GXqF4G3yYROIXJ/gkwpRl4pa
                    zq+r1feqCapgvdzZX99yqWATXgAByUr6P6TqBwMhAo6CygPCm48CAwEAAaOBnDCB
                    mTAOBgNVHQ8BAf8EBAMCAQYwDwYDVR0TAQH/BAUwAwEB/zAdBgNVHQ4EFgQUm+IH
                    V2ccHsBqBt5ZtJot39wZhi4wNgYDVR0fBC8wLTAroCmgJ4YlaHR0cDovL2NybC5n
                    bG9iYWxzaWduLm5ldC9yb290LXIyLmNybDAfBgNVHSMEGDAWgBSb4gdXZxwewGoG
                    3lm0mi3f3BmGLjANBgkqhkiG9w0BAQUFAAOCAQEAmYFThxxol4aR7OBKuEQLq4Gs
                    J0/WwbgcQ3izDJr86iw8bmEbTUsp9Z8FHSbBuOmDAGJFtqkIk7mpM0sYmsL4h4hO
                    291xNBrBVNpGP+DTKqttVCL1OmLNIG+6KYnX3ZHu01yiPqFbQfXf5WRDLenVOavS
                    ot+3i9DAgBkcRcAtjOj4LaR0VknFBbVPFd5uRHg5h6h+u/N5GJG79G+dwfCMNYxd
                    AfvDbbnvRG15RjF+Cv6pgsH/76tuIMRQyV+dTZsXjAzlAcmgQWpzU/qlULRuJQ/7
                    TBj0/VLZjmmx6BEP3ojY+x1J96relc8geMJgEtslQIxq/H5COEBkEveegeGTLg==
                    -----END CERTIFICATE-----

                  --> build_timely = true
                  --> ct_compliance_status = "COMPLIES_VIA_SCTS"
t=265353 [st=    2]  QUIC_SESSION_CERTIFICATE_VERIFIED
                  --> subjects = ["*.google.com","*.android.com","*.appengine.google.com","*.cloud.google.com","*.db833953.google.cn","*.g.
t=265353 [st=    2]  QUIC_SESSION_CRYPTO_HANDSHAKE_MESSAGE_SENT
                  --> CHLO<
                        SNI : "www.youtube.com"
                        STK : 0xa4d110582d9ca29a247fa36f522d421629a155988c2e6a15f1eb55db360c349bde103dcdf852331f04f926a12d710722fb23a2246cc
                        VER : 'Q043'
                        CCS : 0x01e8816092921ae87eed8086a2158291
                        NONC: 0x5b96c68d3030303030303030304656b0c2e7bd96d1ee6e2e0e0709117b302480ea
                        AEAD: 'AESG'
                        UAID: "Chrome/69.0.3497.81 Windows NT 10.0; Win64; x64"
                        SCID: 0xaa3c1caf997df6cb29439dac399cea49
                        TCID: 0
                        PDMD: 'X509'
                        SMHL: 0x01000000
                        ICSL: 30
                        NONP: 0xaf451eb177726cd4b4aec99d8f88e80ff034072cbed14fe2a9458676604d0100
                        PUBS: 0xbd0de9a0b1614b20a901911854d35f414851e0160dfb7e79fa4ba50248b0bd2c
                        MIDS: 100
                        SCLS: 1
                        KEXS: 'C255'
                        XLCT: 0x6790b6ee5cfeae90
                        CSCT: 0x
                        COPT: '5RTO','ACKD','NSTP'
                        CCRT: 0x6790b6ee5cfeae9067f8adc58015e3ff
                        IRTT: 74878
                        CETV: 0x1101d4f0e147d88d3bdb92cd0b51e9ef08f32d7bb5b8ab5dfe31650e433e547946daa0704eb3424b13e9ba8133e8c028c5bfd093c12
                        CFCW: 15728640
                        SFCW: 6291456
                      >
t=265353 [st=    2]  QUIC_SESSION_STREAM_FRAME_SENT
```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Vielen Dank für Ihre Aufmerksamkeit

QUELLEN

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