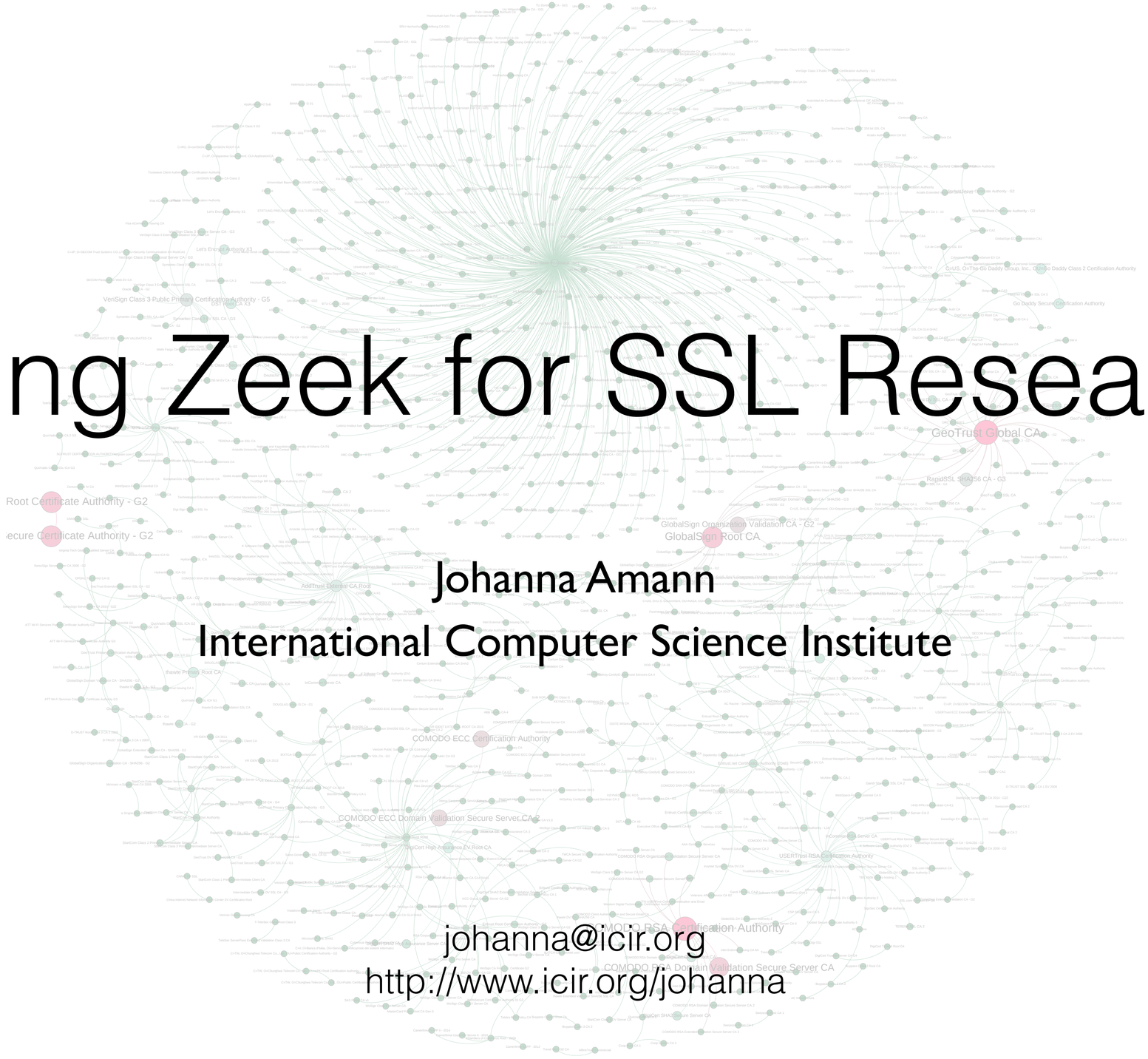
Using Zeek for SSL Research



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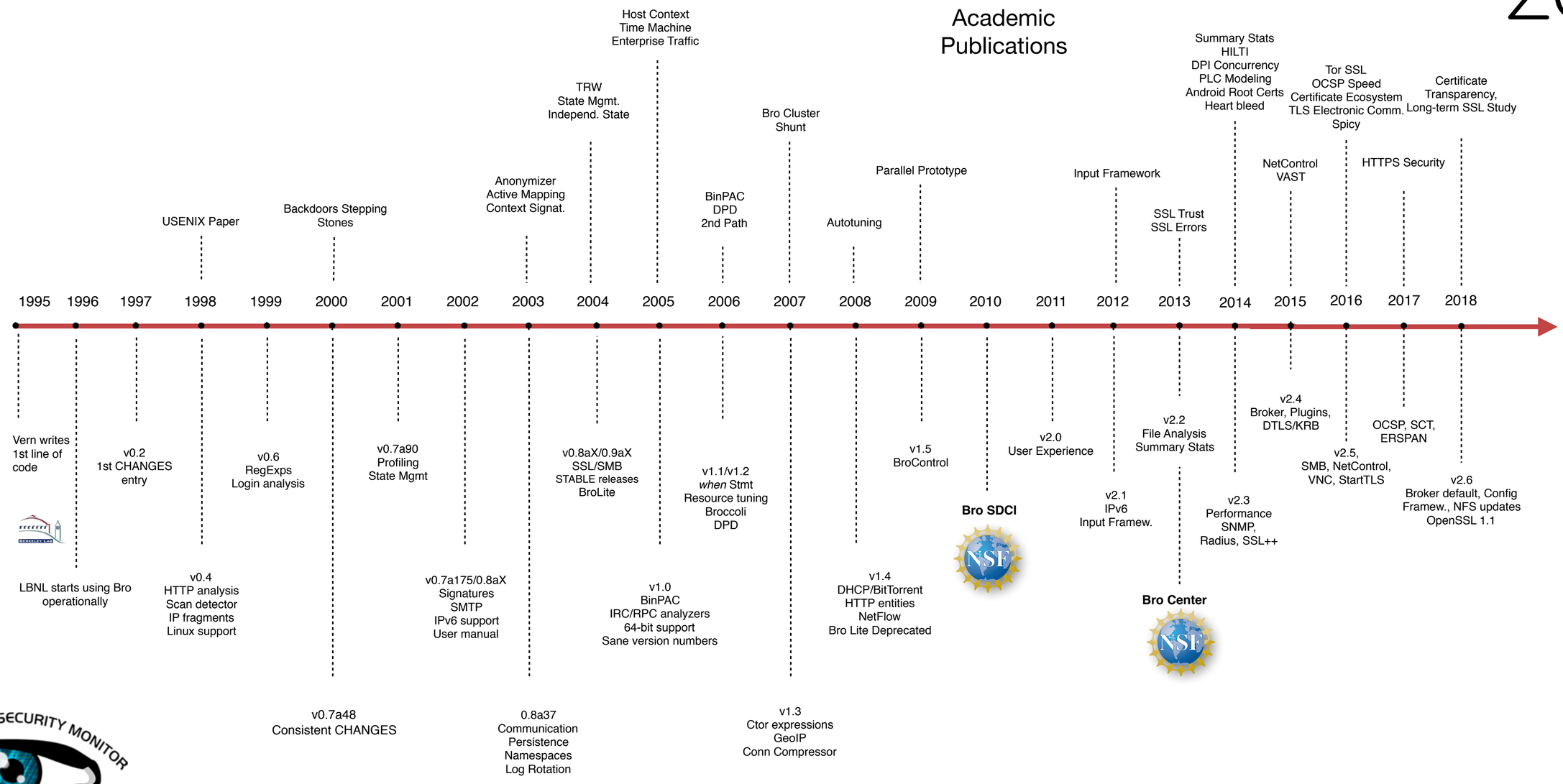
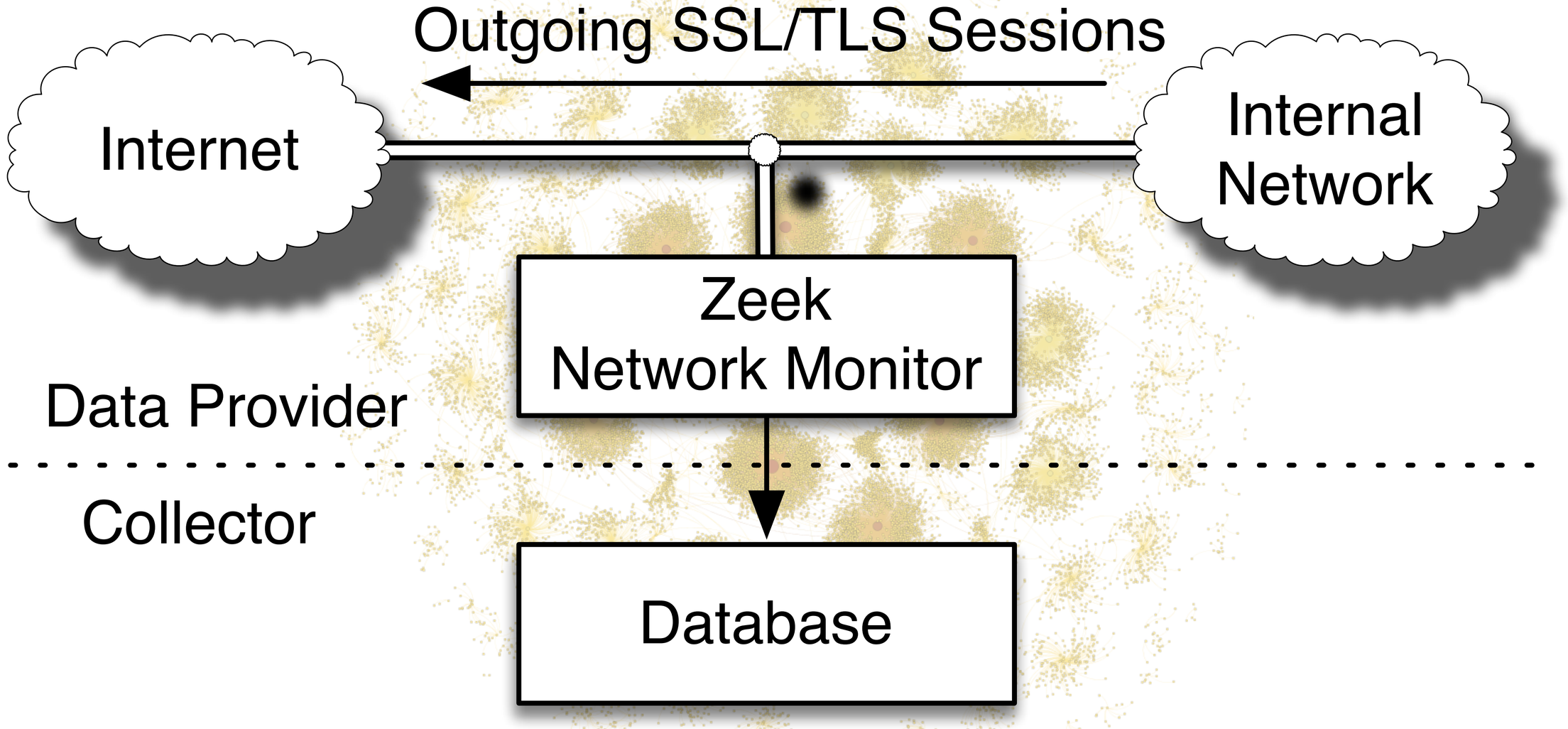
http://www.icir.org/johanna

ICSI
INTERNATIONAL COMPUTER SCIENCE INSTITUTE

Zeek History

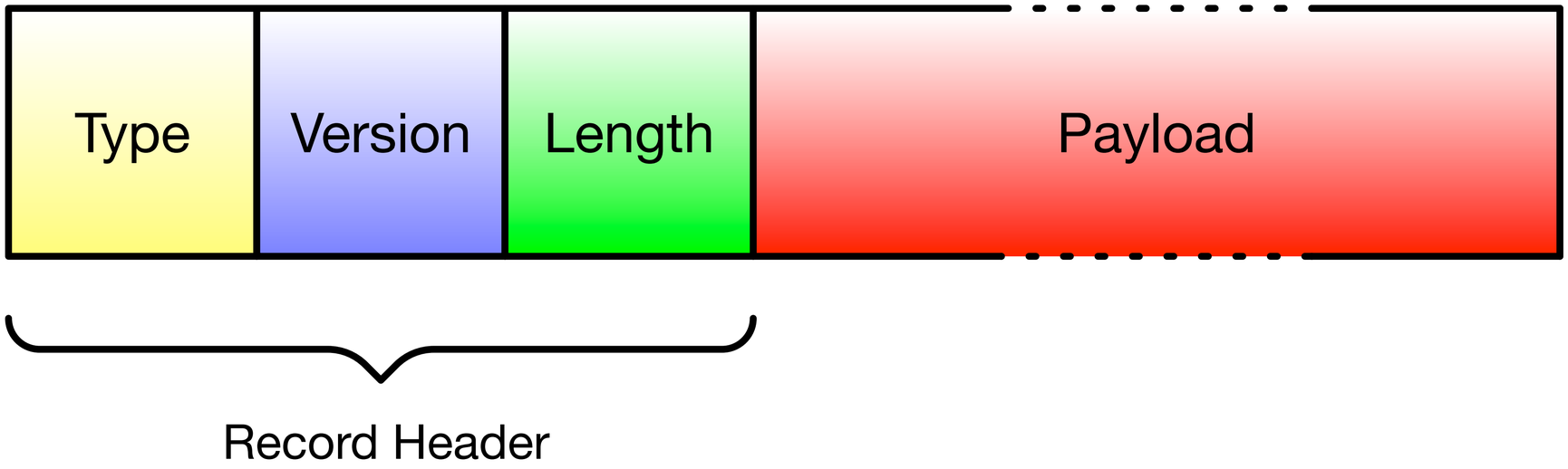


ICSI Notary


Outgoing SSL/TLS Sessions
Internet
Internal Network
Zeek Network Monitor
Data Provider
Collector
Database

SSL/TLS Protocol

- Record based protocol
- Record header is never encrypted, only payload is (after the handshake is done)



SSL/TLS Protocol

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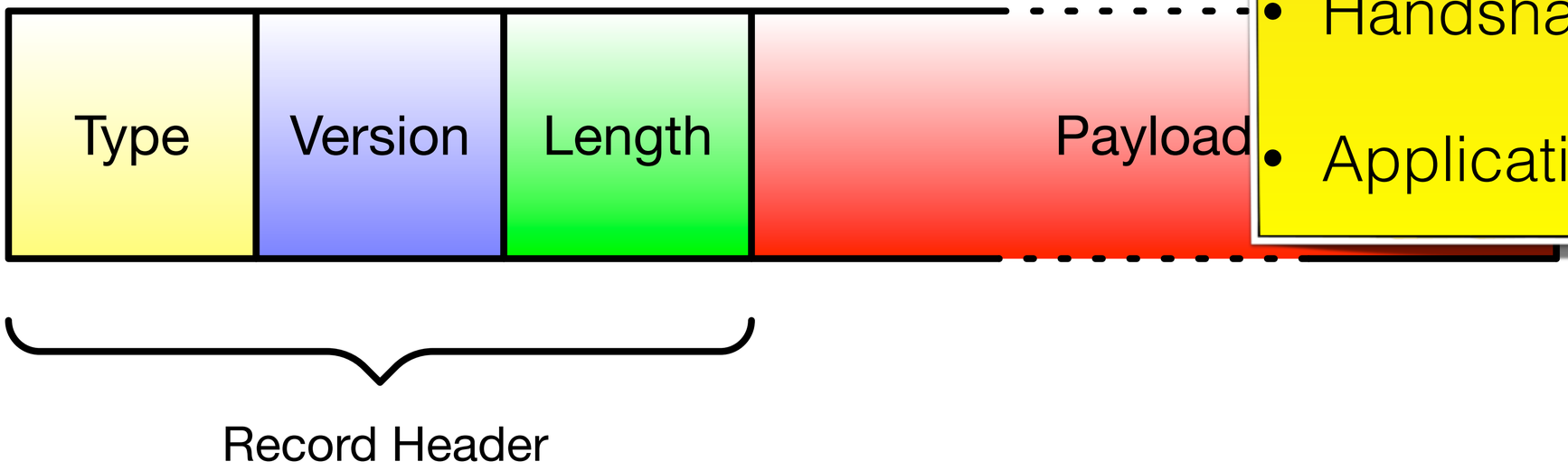
  (after the handshake is done)

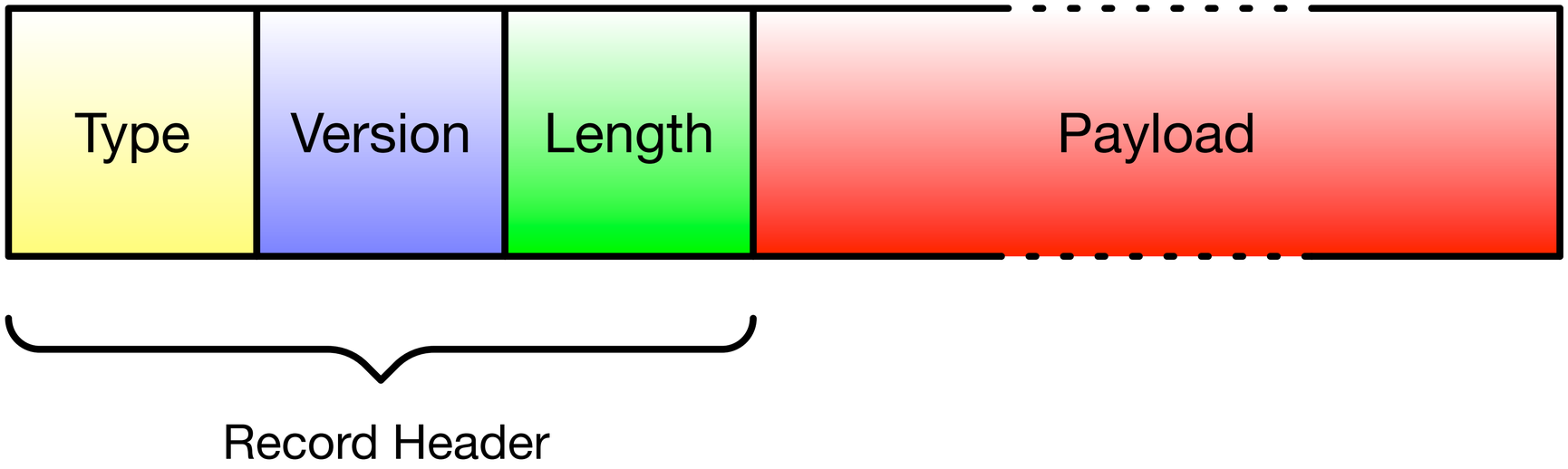


Common record types:

- Change Cipher Spec
- Alert
- Handshake
- Application Data

SSL/TLS Protocol

- Record based protocol
- Record header is never encrypted, only payload is (after the handshake is done)



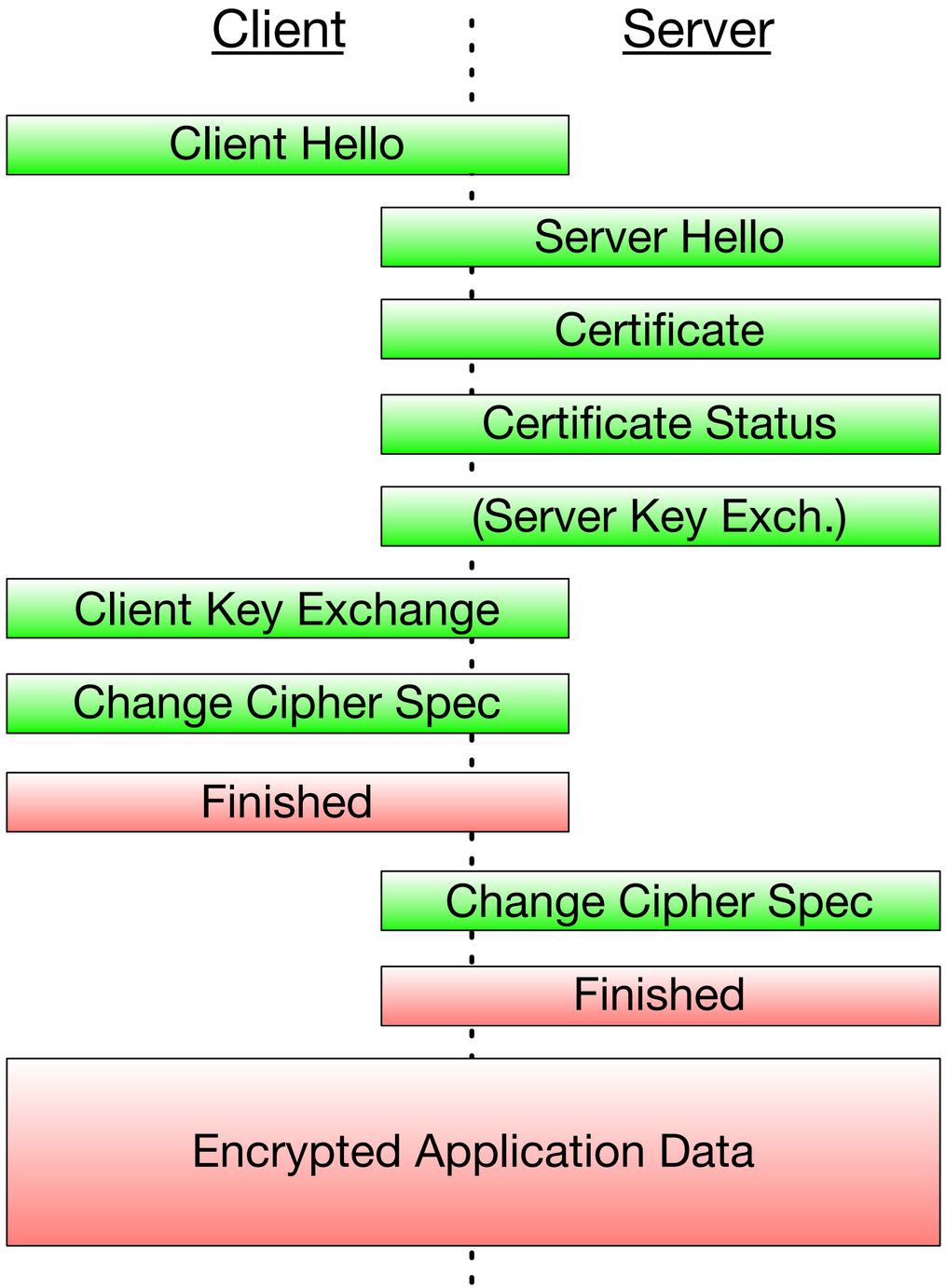
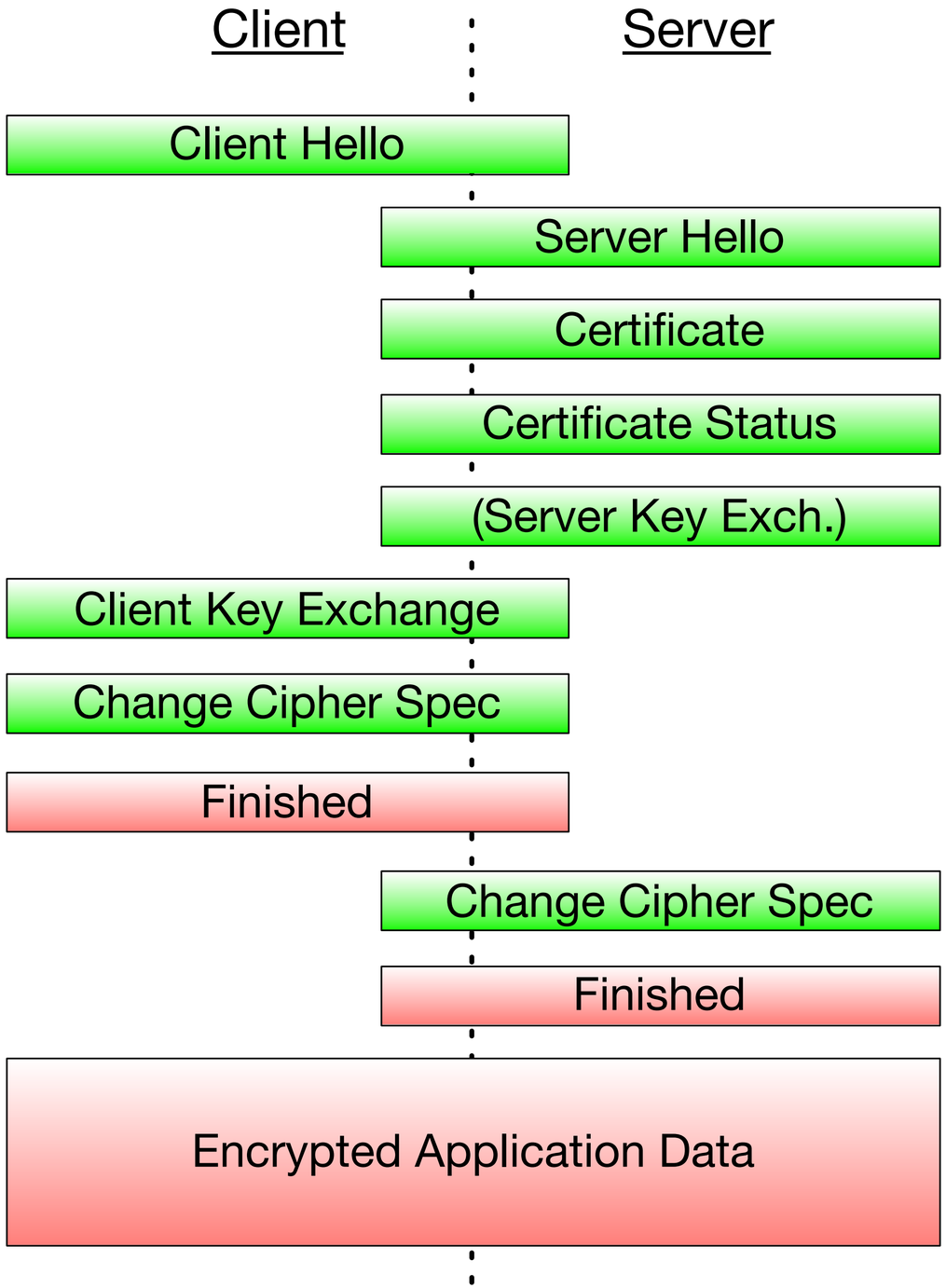

Client
Server
Client Hello
Server Hello
Certificate
Certificate Status
(Server Key Exch.)
Client Key Exchange
Change Cipher Spec
Finished
Change Cipher Spec
Finished
Encrypted Application Data

Photo by Markus Spiske on Unsplash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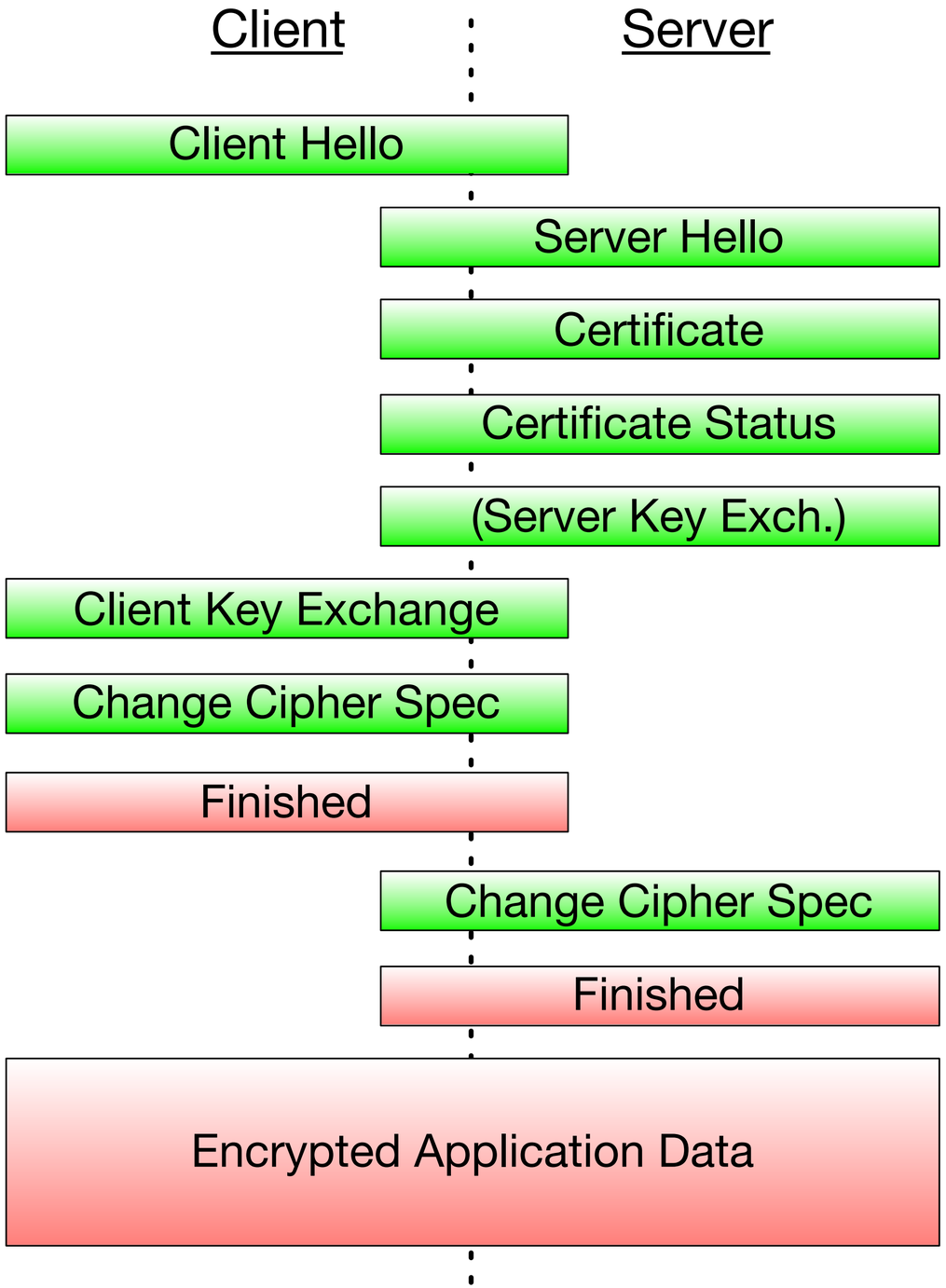
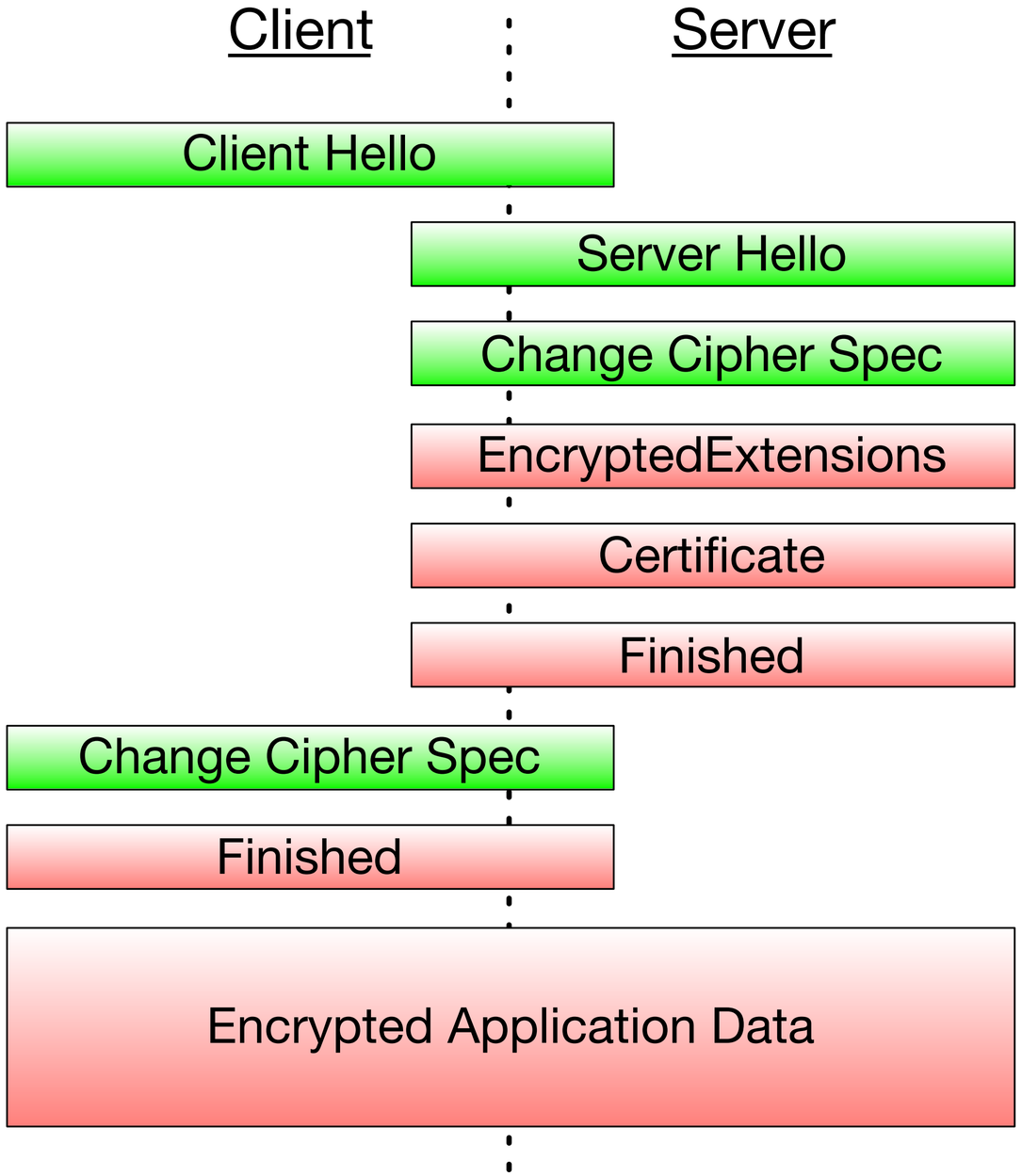
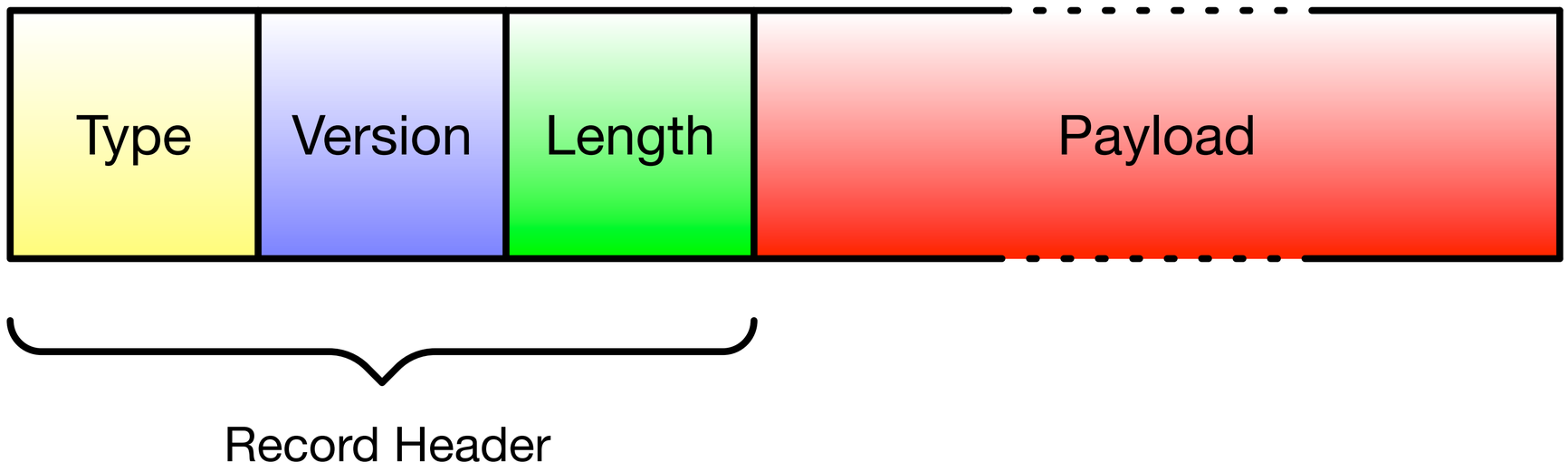
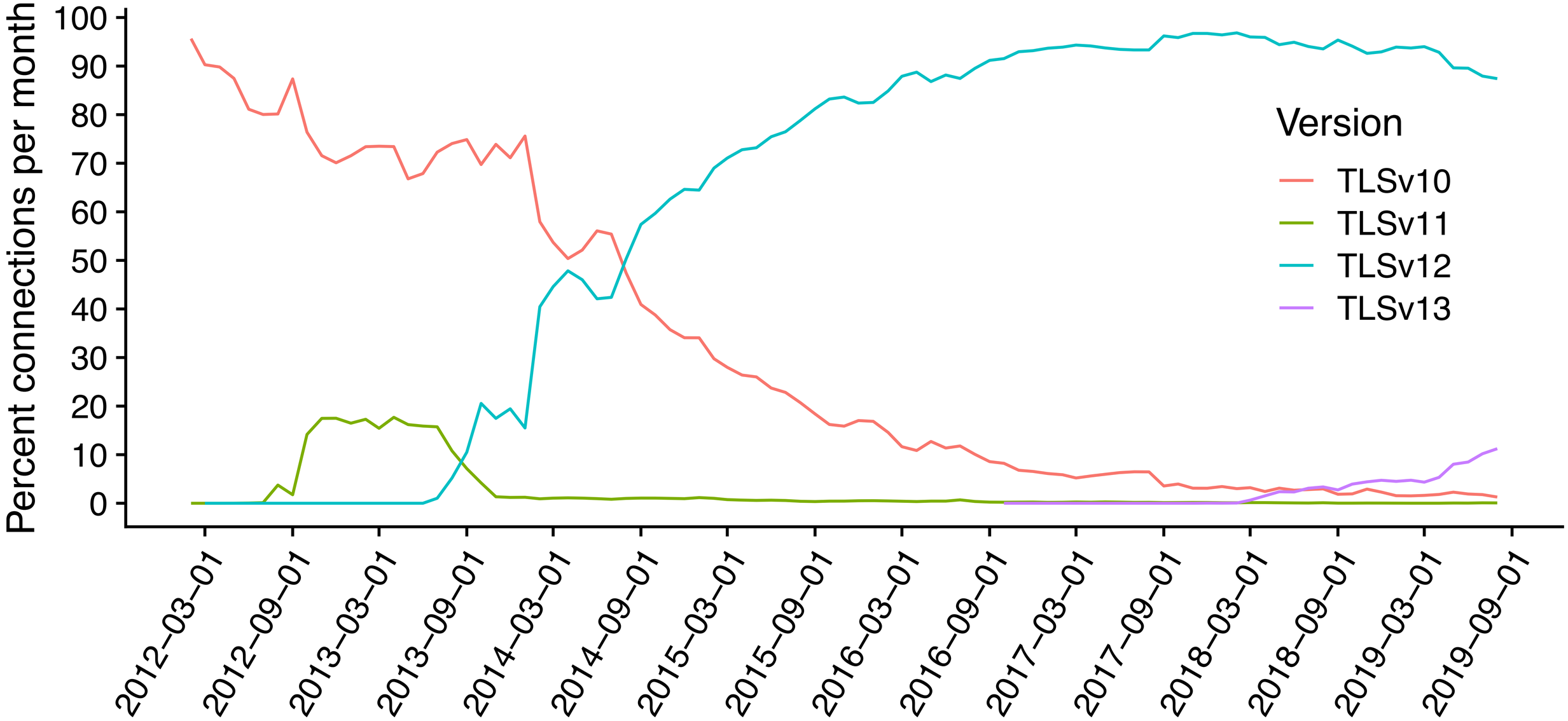

Client
Server
Client Hello
Server Hello
Certificate
Certificate Status
(Server Key Exch.)
Client Key Exchange
Change Cipher Spec
Finished
Change Cipher Spec
Finished
Encrypted Application Data


Client
Server
Client Hello
Server Hello
Change Cipher Spec
EncryptedExtensions
Certificate
Finished
Change Cipher Spec
Finished
Encrypted Application Data

SSL/TLS Protocol

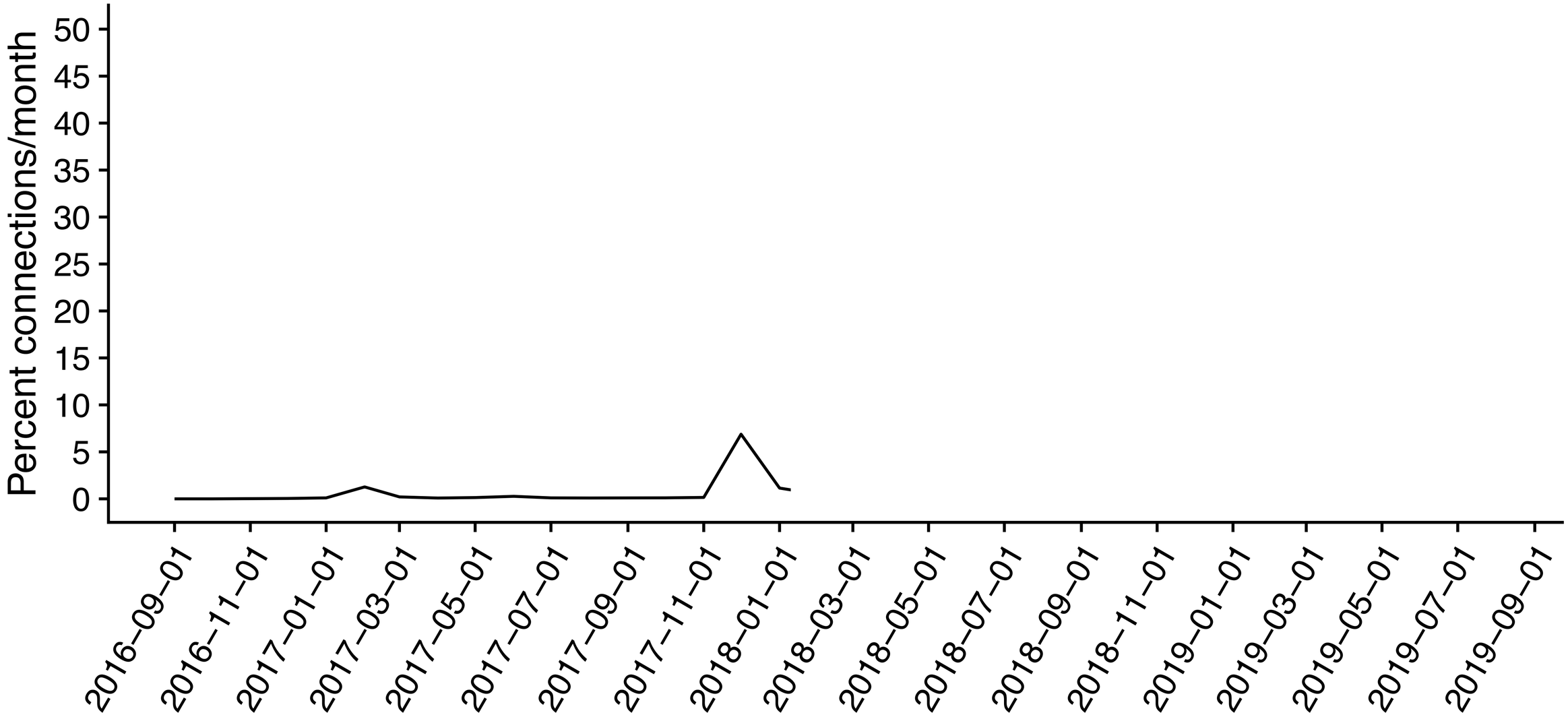


Negotiated Versions



https://arxiv.org/abs/1907.12762

Client offered



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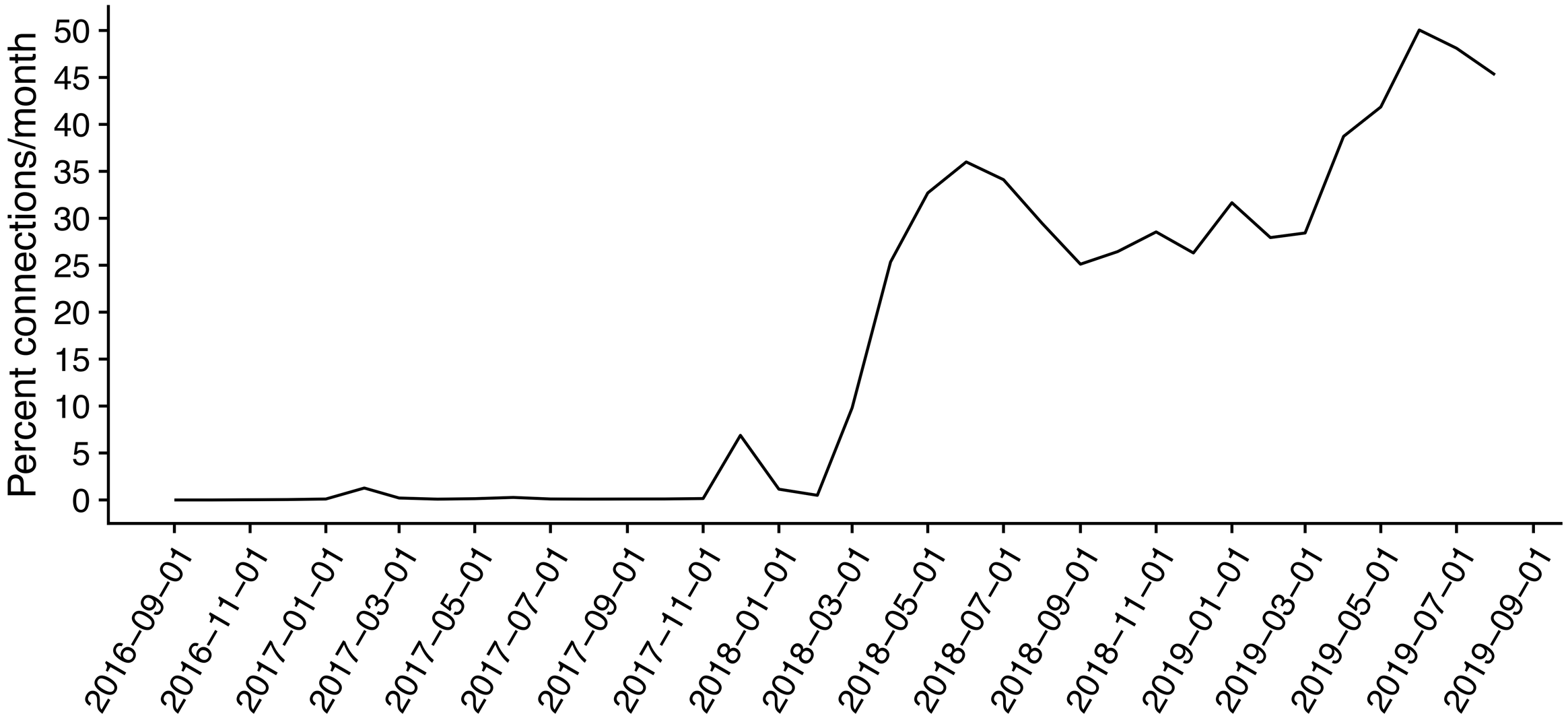
Client offered



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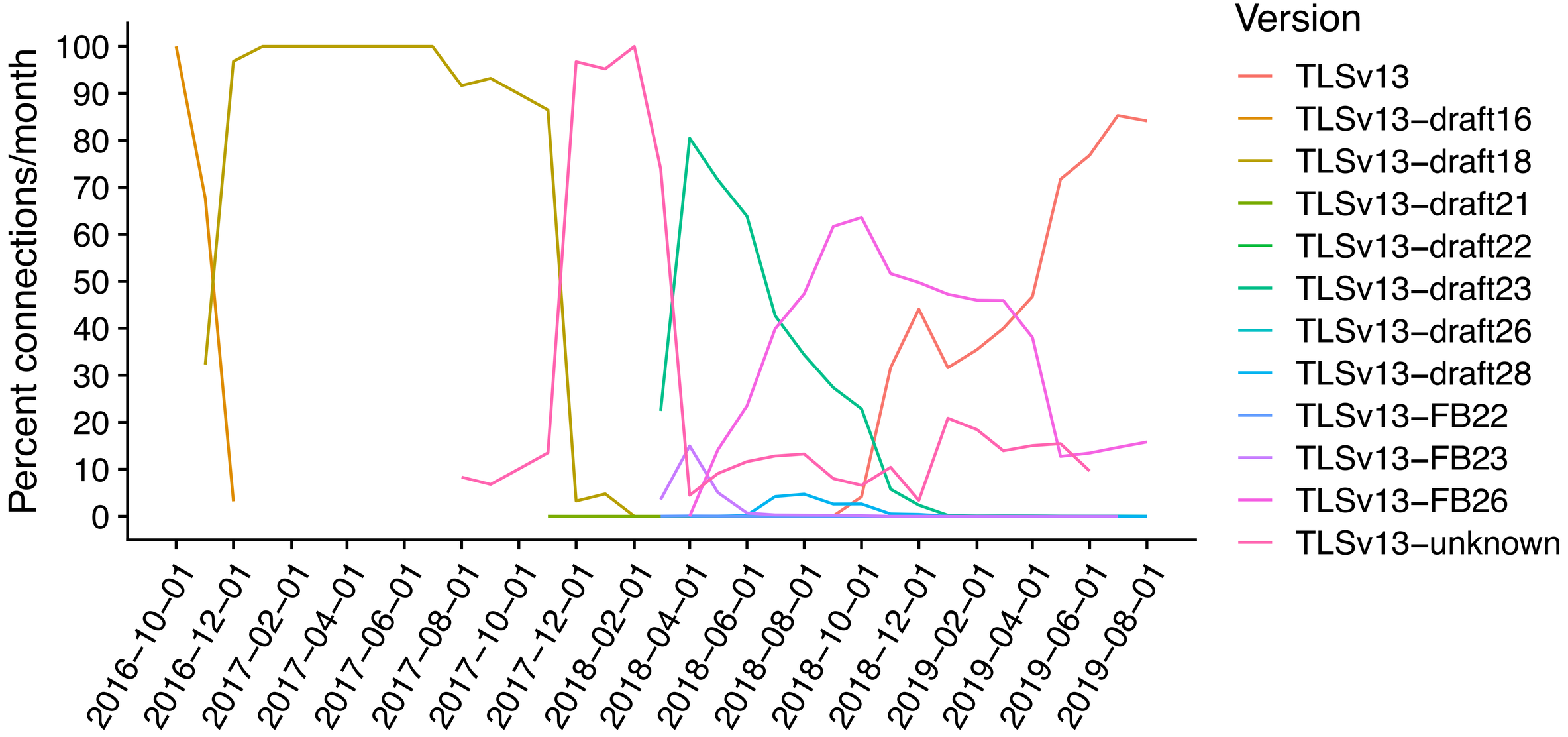
Client offered



Offered/negotiated versions

Version	*Server Conn.*	*Client Conn.*
TLS 10	1.28%	44.07%
TLS 11	0.07%	42.96%
TLS 12	**87.42%**	**97.06%**
TLS 13	9.45%	**44.93%**
TLS 13-7E01	none	< 0.01%
TLS 13-7E02	none	< 0.01%
TLS 13-draft18	none	0.02%
TLS 13-draft22	none	< 0.01%
TLS 13-draft23	< 0.01%	0.25%
TLS 13-draft26	< 0.01%	< 0.01%
TLS 13-draft27	none	< 0.01%
TLS 13-draft28	< 0.01%	0.03%
TLS 13-FB23	none	< 0.01%
TLS 13-FB26	1.78%	1.78%

https://arxiv.org/abs/1907.12762

Connections to different providers

	% Connections		% IPs	
	TLS1.3	$\leq$ *TLS1.2*	*TLS1.3*	$\leq$ *TLS1.2*
Facebook	**60.78** (1)	1.02 (7)	3.22 (4)	0.12 (10)
Cloudflare	9.66 (3)	1.39 (6)	**70.45** (1)	4.86 (4)
Google	8.33 (4)	12.87 (3)	4.91 (3)	1.47 (5)
Amazon	0.42 (5)	**33.64** (2)	2.32 (5)	**68.02** (1)
Akamai	0.41 (6)	7.2 (5)	0.86 (6)	6.13 (3)
Digitalocean	0.05 (7)	0.16 (9)	0.65 (7)	0.69 (6)
Squarespace	0.04 (8)	<0.01 (12)	0.01 (11)	<0.01 (12)
Alibaba	0.02 (9)	0.04 (11)	0.04 (10)	0.04 (11)
Ovh	0.02 (10)	0.2 (8)	0.24 (8)	0.43 (8)
Azure	<0.01 (11)	8.88 (4)	0.07 (9)	0.45 (7)
Godaddy	<0.01 (12)	0.06 (10)	0.01 (12)	0.37 (9)
Others	20.26 (2)	34.54 (1)	17.2 (2)	17.42 (2)

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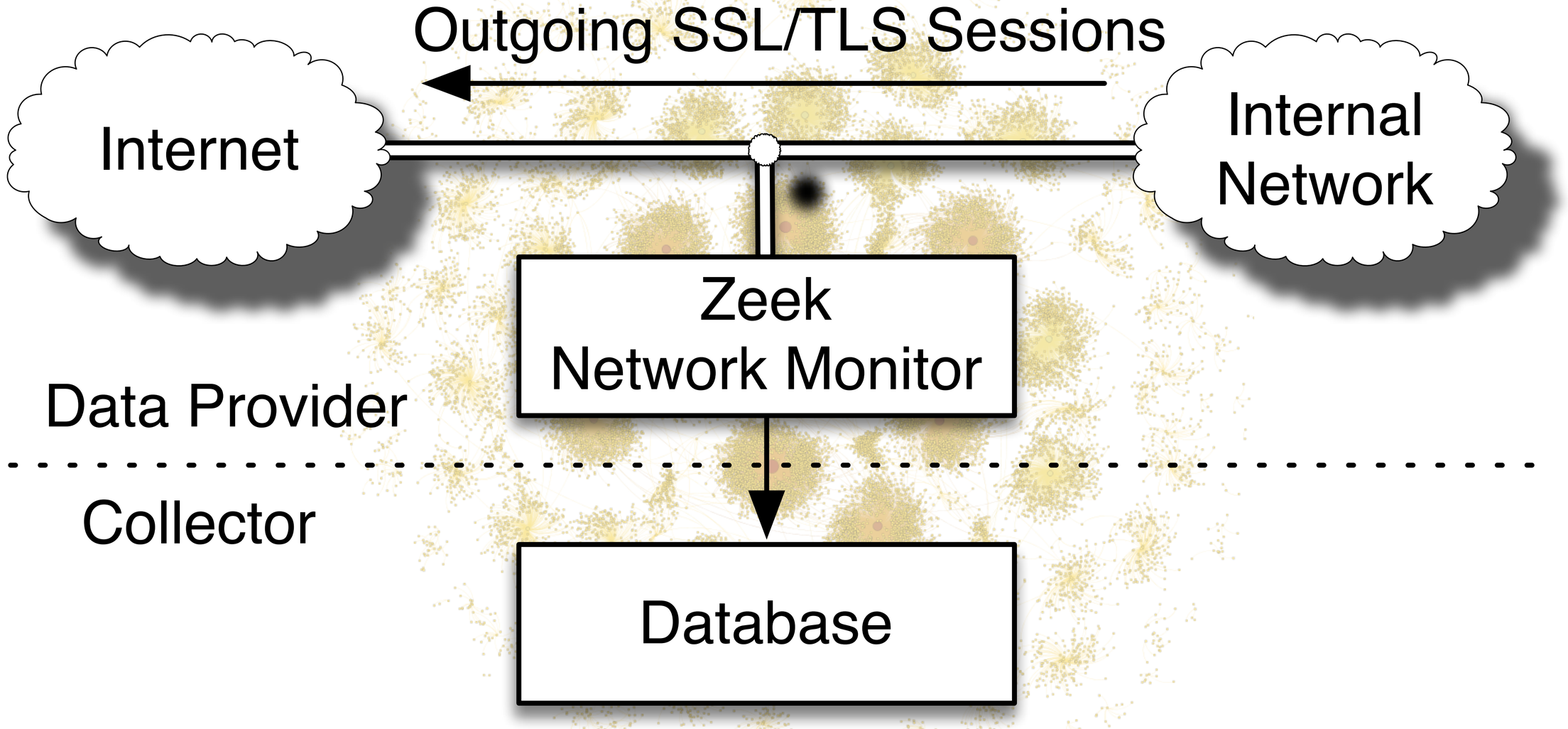
ICSI Notary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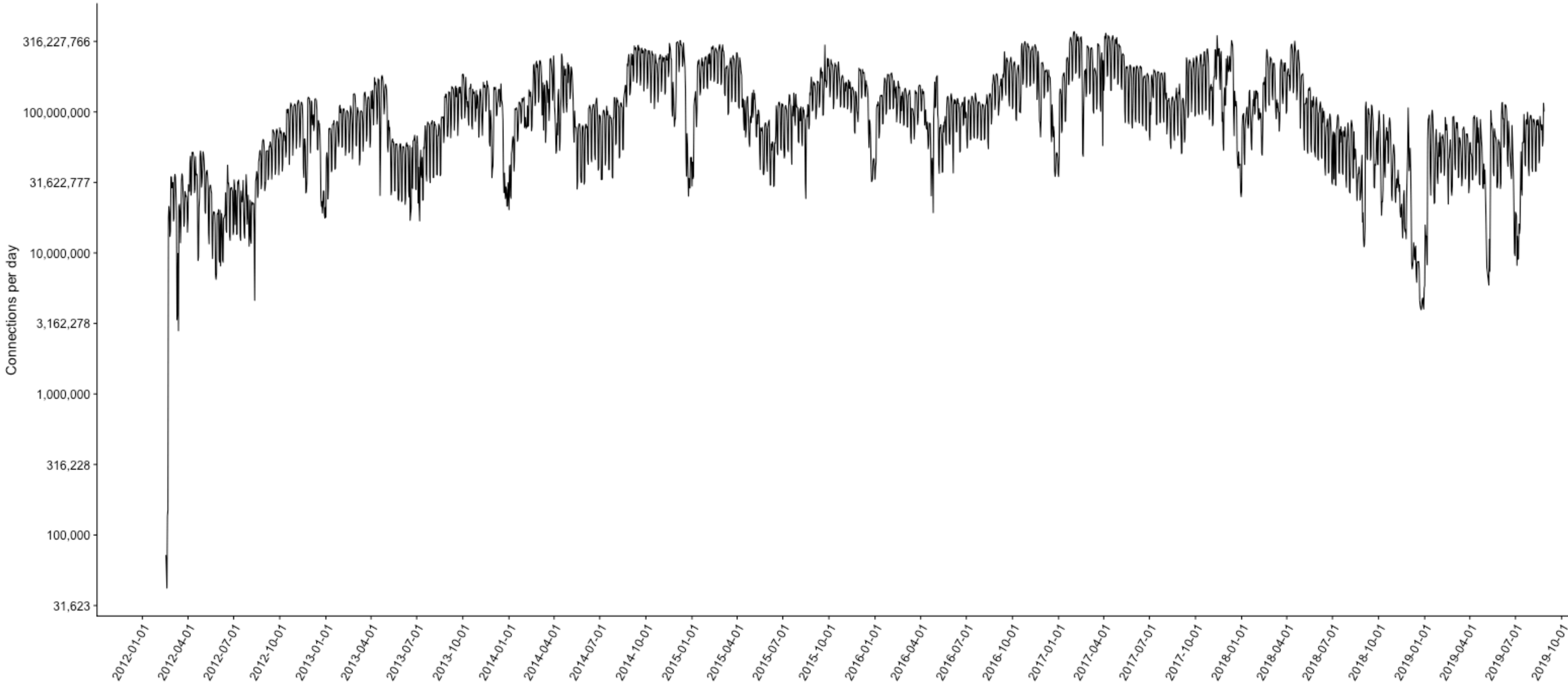
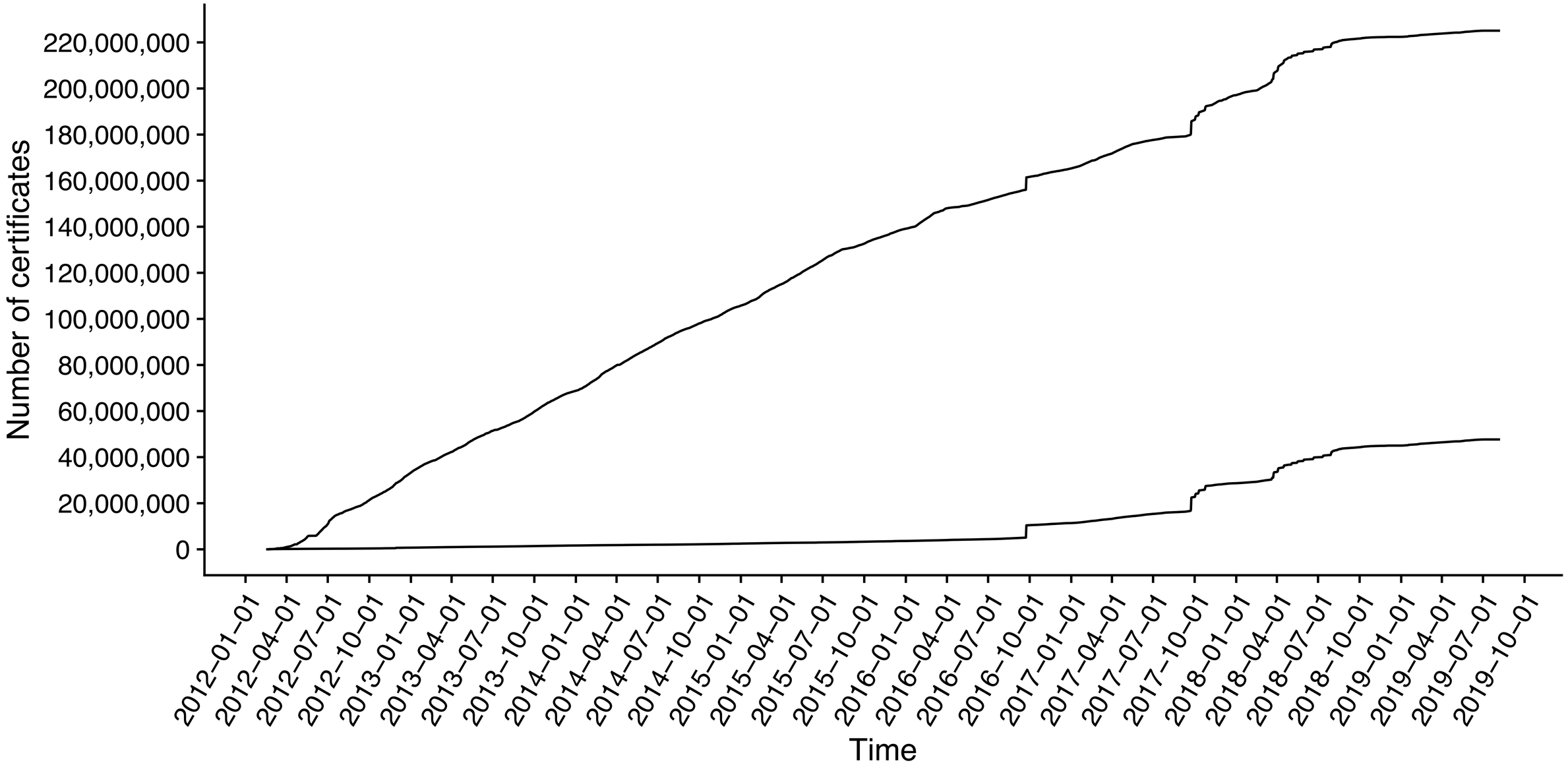
Notary - Connections



Notary - Certificates



Notary - Collected features

Available ciphers

Analyzer Error

Client & Server TLS extensions

Content length

Connection history

Duration

Client EC point formats

Send & received bytes

Timestamp

Packet loss

Selected cipher

Server certificates

Server IP

Server Name Indication

DH parameter size

Client & Server ALPN

Version

Hash(client session ID)

Hash(client IP, server IP)

Hash(server session ID)

Ticket lifetime hint

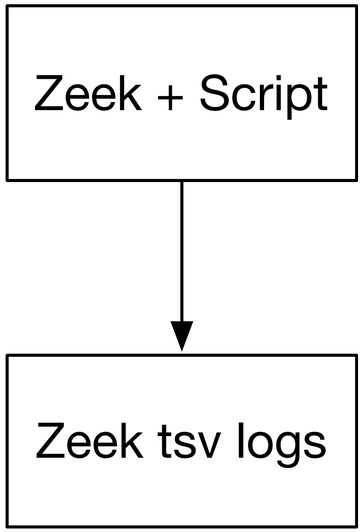
Client EC curve

Number Client Certs

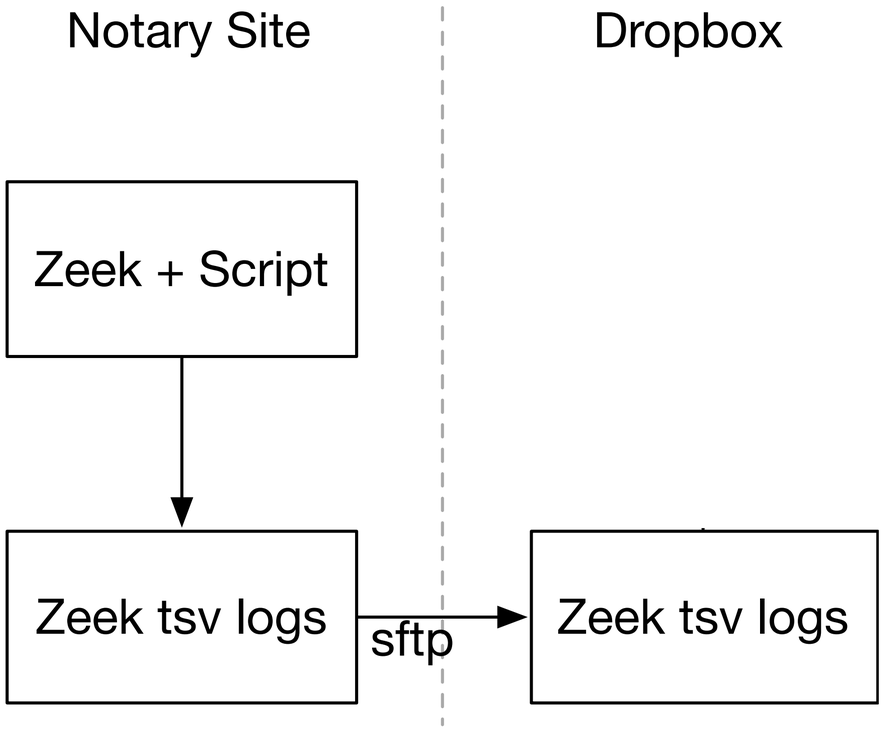
TLS Alerts

Dataflow

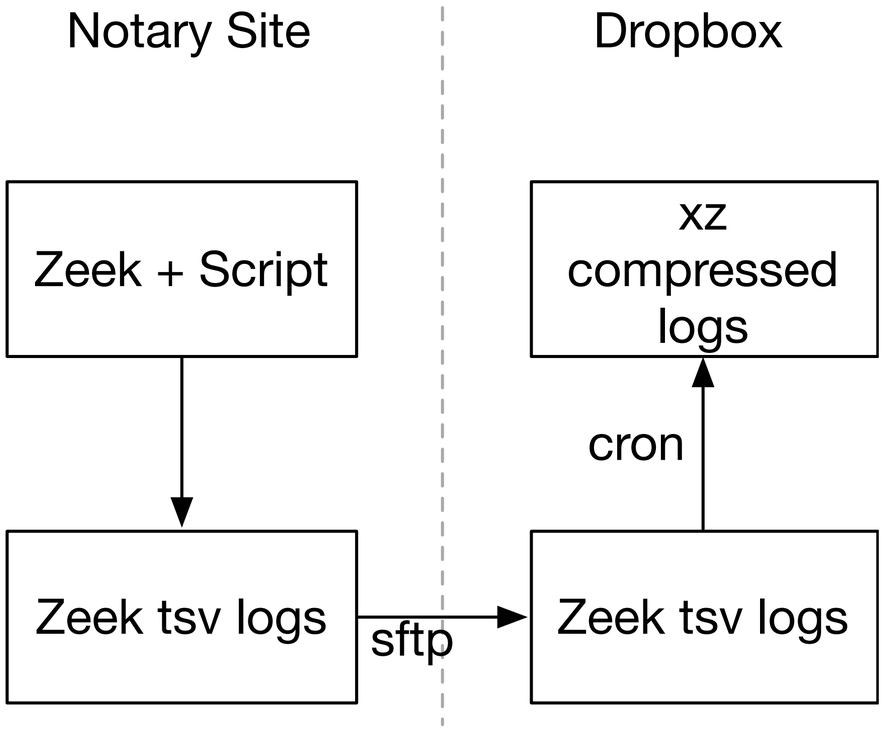
Notary Site



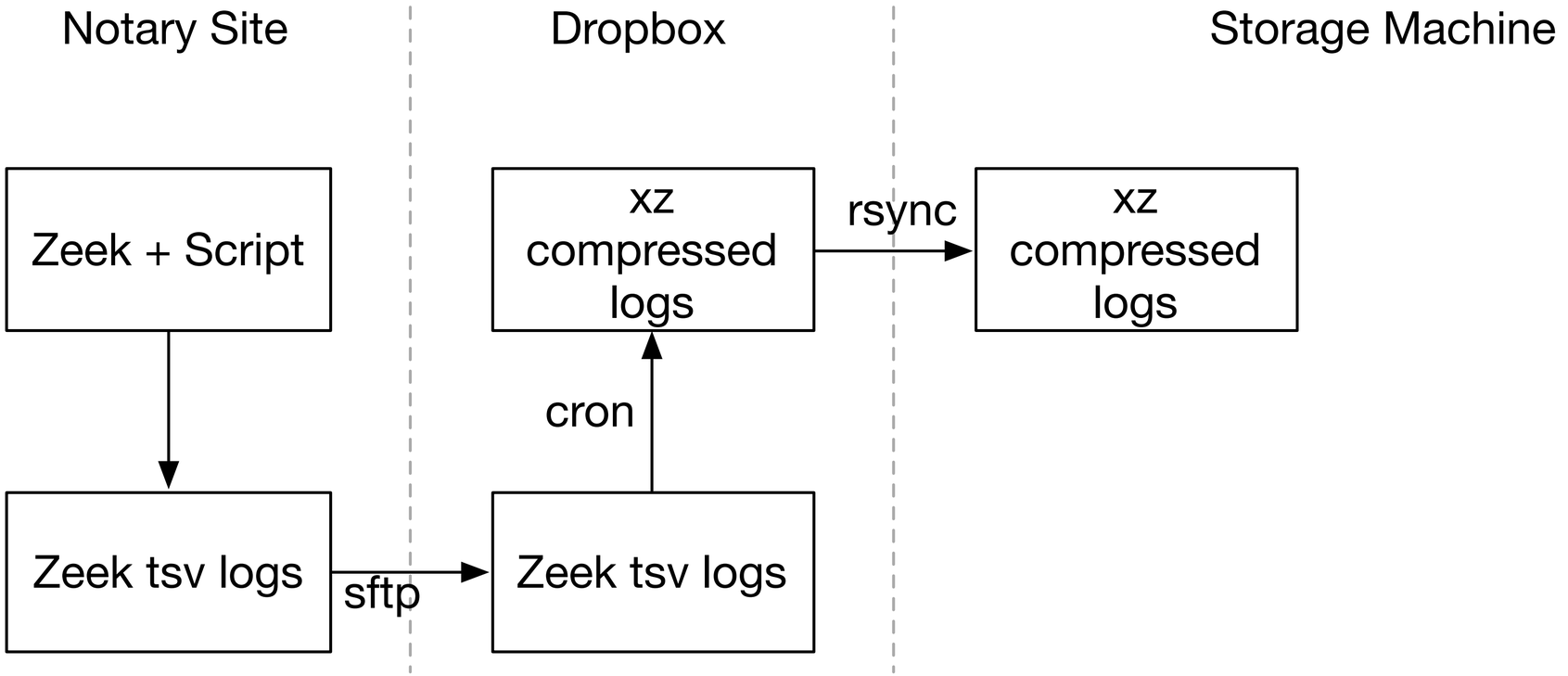
Dataflow


Notary Site
Dropbox
Zeek + Script
Zeek tsv logs
sftp
Zeek tsv logs

Dataflow


Notary Site
Dropbox
Zeek + Script
xz compressed logs
cron
Zeek tsv logs
sftp
Zeek tsv logs

Dataflow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Storage Machine
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sftp
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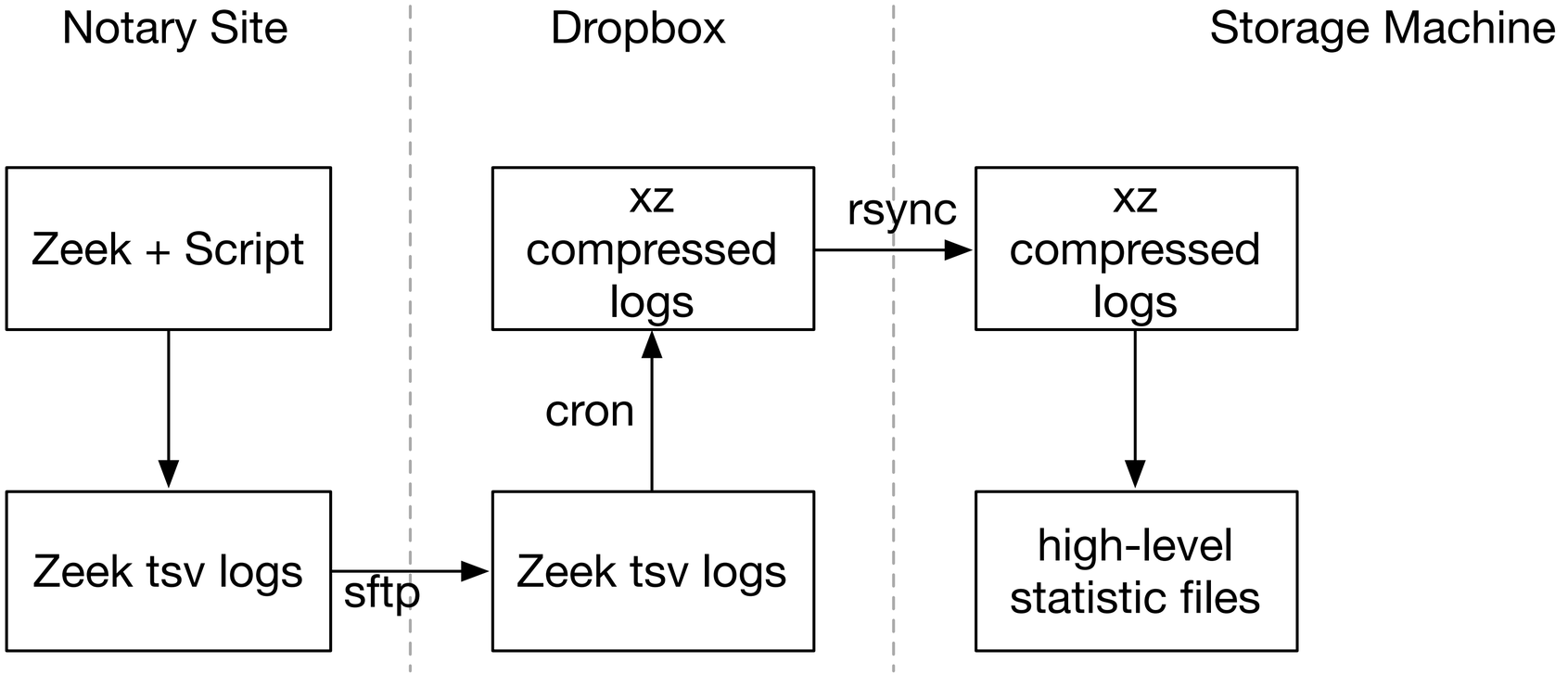
cron
xz
compressed
logs
rsync
xz
compressed
logs

Dataflow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xz
compressed
logs
rsync
xz
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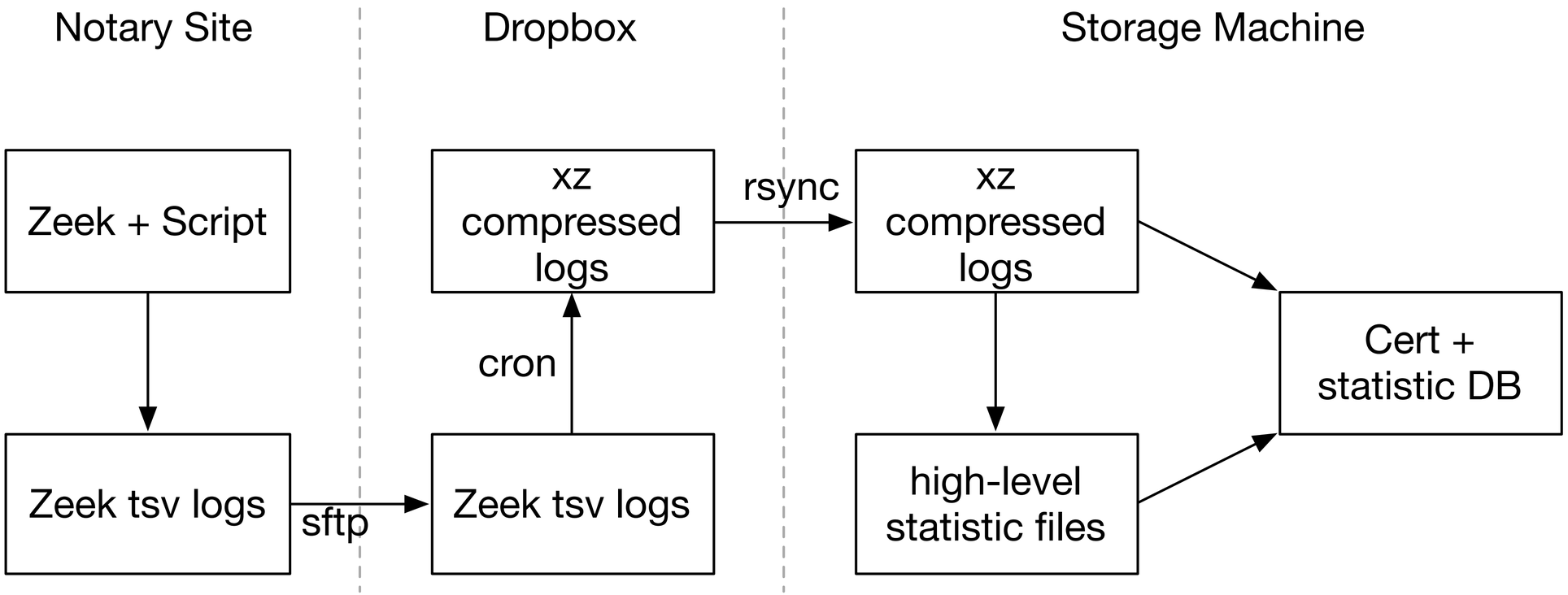
logs
high-level
statistic files

Dataflow


Notary Site
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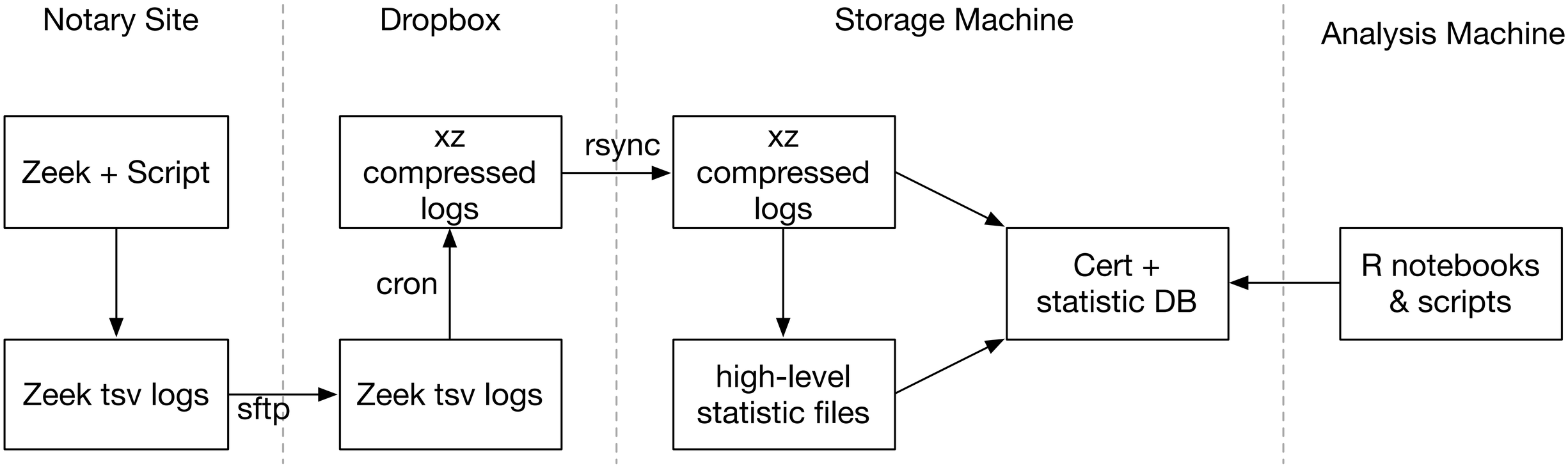
Zeek + Script
Zeek tsv logs
sftp
Zeek tsv logs
cron
xz compressed logs
rsync
xz compressed logs
high-level statistic files
Cert + statistic DB

Dataflow


Notary Site
Dropbox
Storage Machine
Analysis Machine
Zeek + Script
Zeek tsv logs
sftp
Zeek tsv logs
cron
xz compressed logs
rsync
xz compressed logs
high-level statistic files
Cert + statistic DB
R notebooks & scripts

Certificate Log

Timestamp	1414444290.810620
SHA1	3c757505c22c4e1cf325368280ef2a0dd2bb2bde
Certificate	3082052e30820416a003020102020308c40c300d06092a864886f70d01010505003c 310b3009060355040613025553311730150603550 40a130e47656f54727573742c2049 6e632e311430120603550403130b52617069645534c204341301e170d313231303131
Host	89.238.65.180
Host_p	443
Host_cert	T

Connection Log

Timestamp	1520820013.6215
server	52.32.149.186
server_p	443
version_num	771
client_version	771
client_ciphers	39578,4865,4866,4867,49195,49199,49196,49200,52393,52392,49171,49172,156,157,47,5
cipher_num	4865
sni	tls13.crypto.mozilla.org
ticket_lifetime_hint	-
ssl_client_exts	19018,65281,0,23,35,13,5,18,16,30032,11,51,45,43,10,24,31354,21
ssl_server_exts	51,43
server_certs	-
packet_loss	F
dh_param_size	-

Connection Log

Timesta	
serve	
server	
version_	
client_ve	
client_ci	57,47,5
cipher_	
sni	
ticket_lifeti	
ssl_clien	
ssl_serve	
server_c	
packet_	
dh_param_size	-

{"ts":
1398362902.971438,"sha1":"7359755c6df9a0abc3060bce369564c8ec4542a3","cert":"3082037d308202e6a0030201
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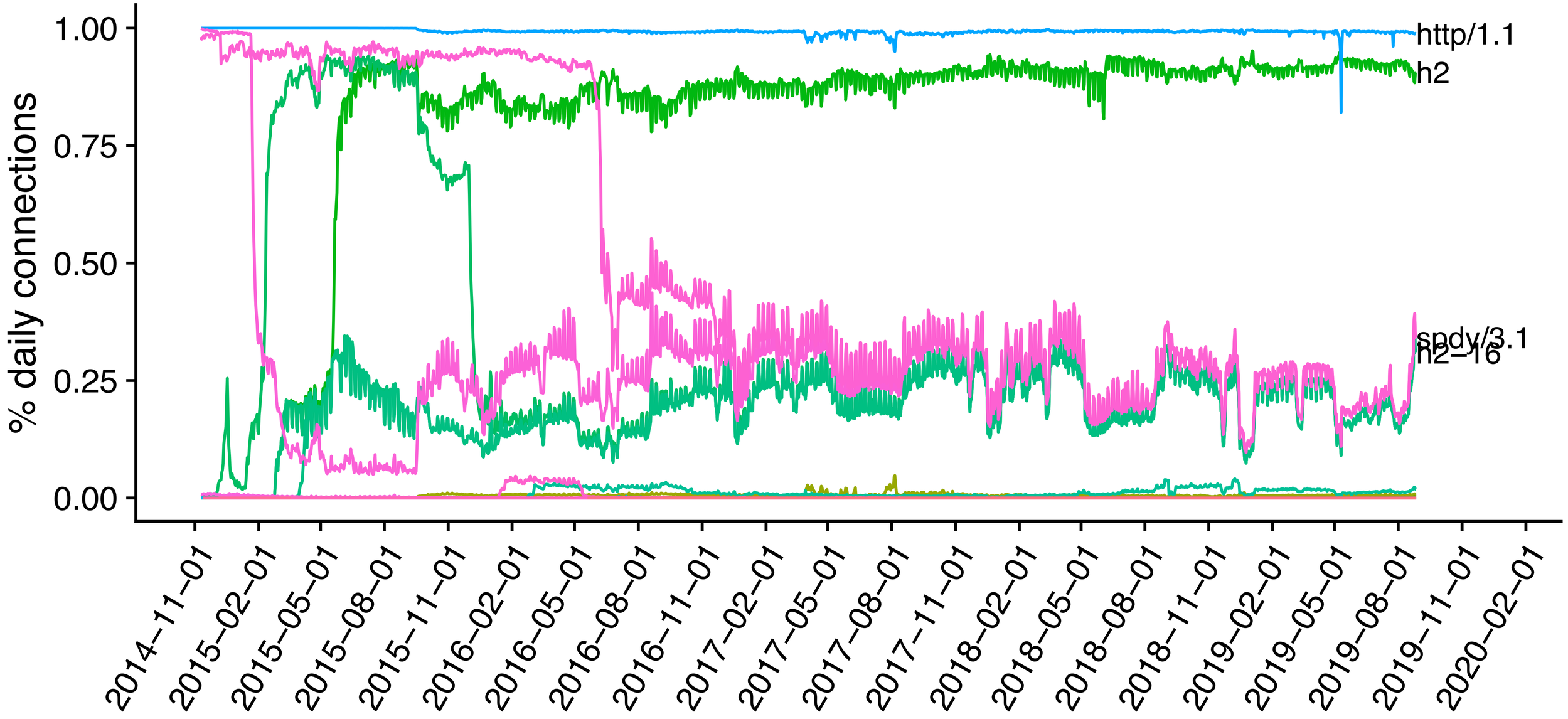
443,"host_cert":false}

Connection Log

Timestamp	1520820013.6215
server	52.32.149.186
server_p	443
version_num	771
client_version	771
client_ciphers	39578,4865,4866,4867,49195,49199,49196,49200,52393,52392,49171,49172,156,157,47,5
cipher_num	4865
sni	tls13.crypto.mozilla.org
ticket_lifetime_hint	-
ssl_client_exts	19018,65281,0,23,35,13,5,18,16,30032,11,51,45,43,10,24,31354,21
ssl_server_exts	51,43
server_certs	-
packet_loss	F
dh_param_size	-

Client ALPNs




zkg install 0xxon/tls-log-alternative