TLS 1.3

draft-ietf-tls-tls13-14

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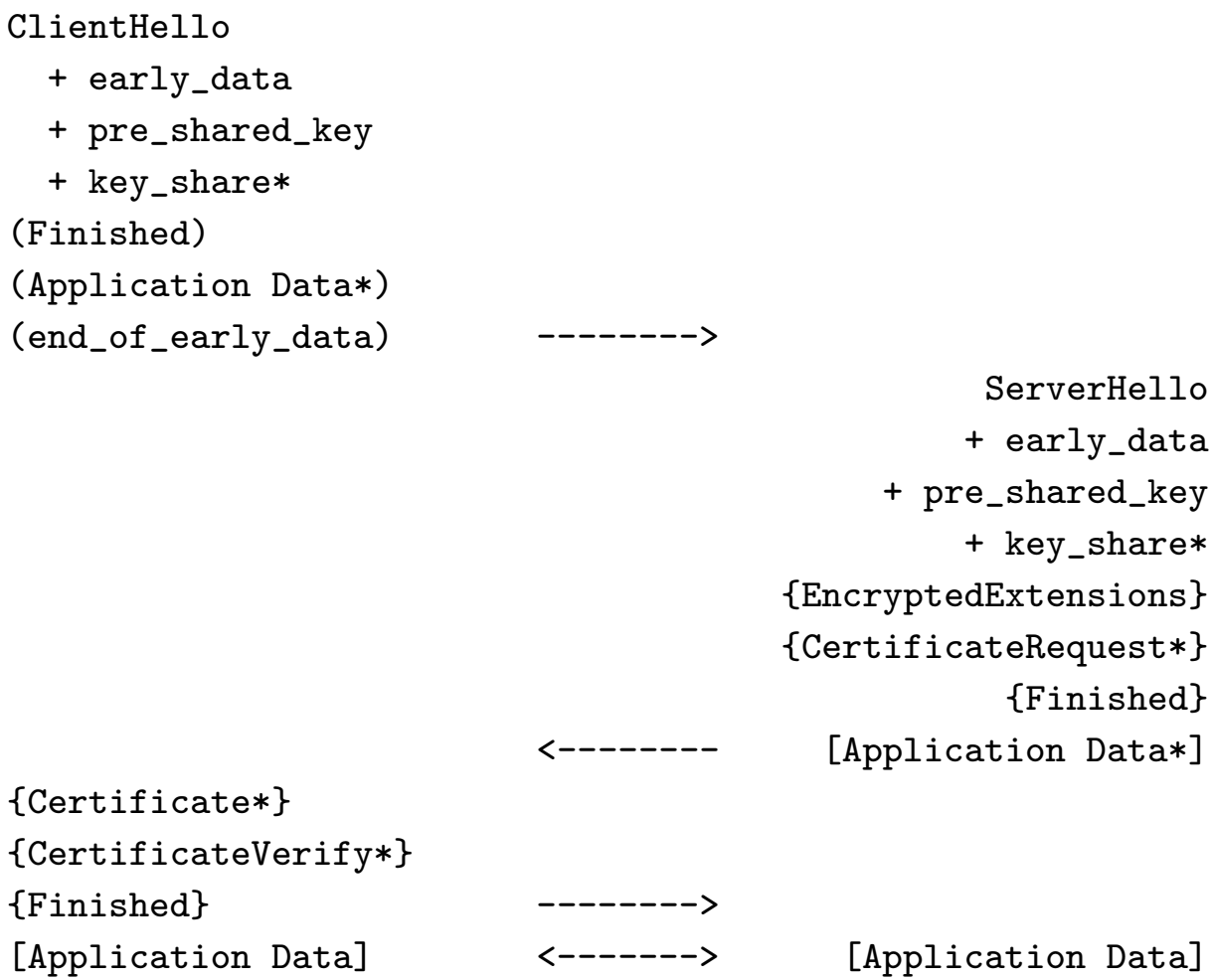
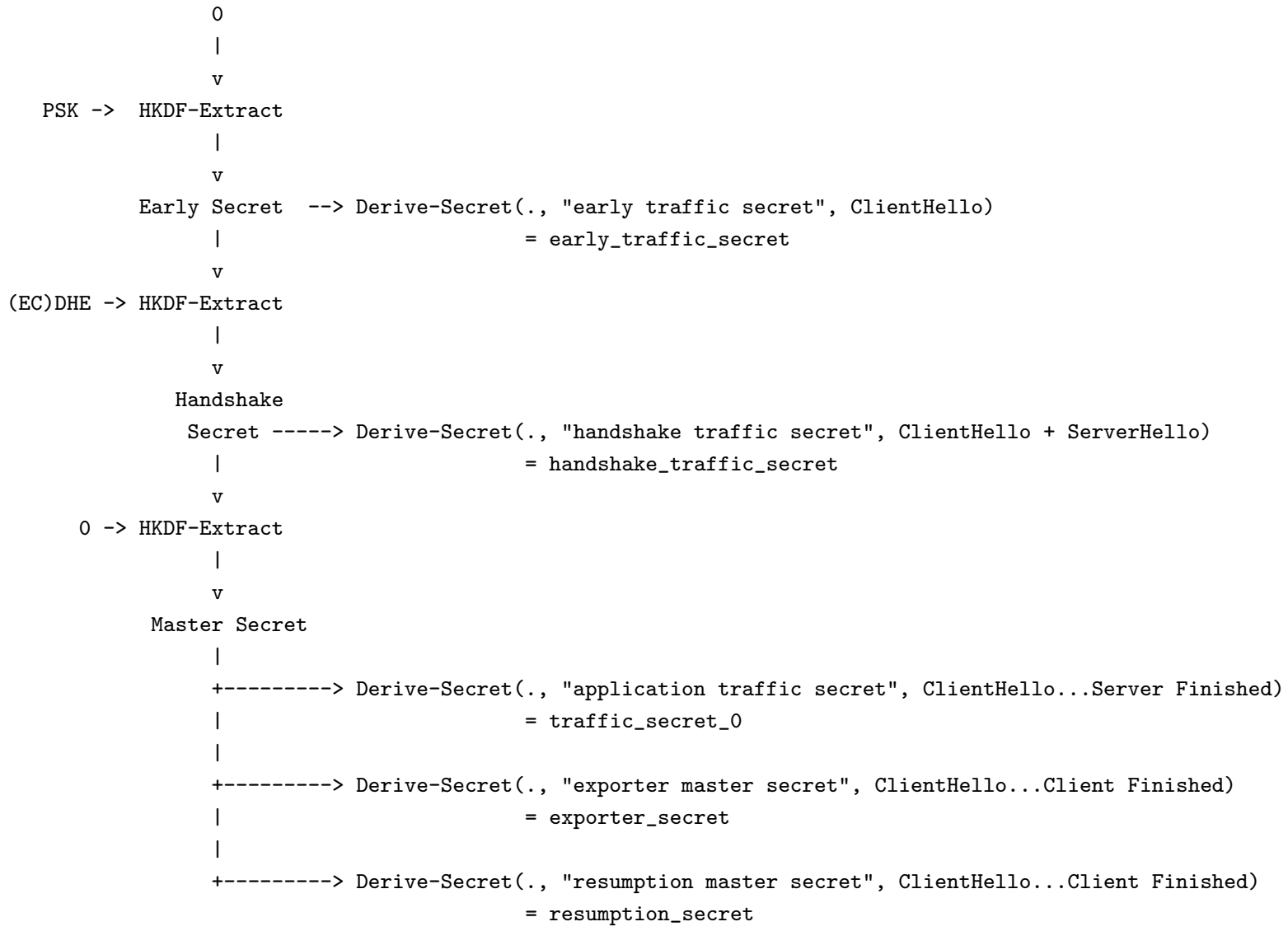
Major changes since draft-12

- Remove 0-RTT (EC)DHE and client auth *
- Complete 0-RTT PSK mode *
- Restructure key schedule *
- Add session context *
- Fully define HelloRetryRequest *
- NewSession ticket use flags
- Allow server to send SupportedGroups
- Move CertificateStatus to an extension
- Add ticket age for anti-replay
- Allow resumption after fatal alerts
- Remove non-closure warning alerts
- Add Security Analysis section

0-RTT is now PSK-only




0
|
v
PSK -> HKDF-Extract
|
v
Early Secret --> Derive-Secret(., "early traffic secret", ClientHello)
|
= early_traffic_secret
v
(EC)DHE -> HKDF-Extract
|
v
Handshake
Secret -----> Derive-Secret(., "handshake traffic secret", ClientHello + ServerHello)
|
= handshake_traffic_secret
v
0 -> HKDF-Extract
|
v
Master Secret
|
+---------> Derive-Secret(., "application traffic secret", ClientHello...Server Finished)
|
= traffic_secret_0
|
+---------> Derive-Secret(., "exporter master secret", ClientHello...Client Finished)
|
= exporter_secret
|
+---------> Derive-Secret(., "resumption master secret", ClientHello...Client Finished)
= resumption_secret

Session Context

- Multiple requests to include more context when resuming (Krawczyk, Bhargavan)

```
resumption_psk = HKDF-Expand-Label(resumption_secret,
                                   "resumption psk", "", L)

resumption_context = HKDF-Expand-Label(resumption_secret,
                                       "resumption context", "", L)
```

- Merged into handshake hashes whenever used

```
Hash(Messages) + Hash(resumption_context)
```

Cookies for HelloRetryRequest

- Derived from DTLS (and originally Photuris)
- Server can provide a cookie with HRR
- Client echoes it with new ClientHello
- Usable for stateless reject by pickling the handshake state in the cookie

Post-Handshake Key Separation

- General consensus on list to leave as-is
- Analysis from Hugo Krawczyk indicates this is OK
- IMPORTANT: We still have key separation for ordinary-handshake and app data

Cipher Suite Negotiation: Problem Statement

- The cipher suite negotiation has gotten clunky and non-orthogonal
- Already was bad in 1.2
  - Cipher suite, signature algorithms, named groups
- Worse in 1.3
  - PSK, key shares
- Can we radically simplify?

Cipher Suite Negotiation: Overview

- Break up into the following axes
  - AEAD-PRF
  - Signature algorithms
  - Key shares/named groups
  - PSK
- Negotiate each separately
  - Straightforward for public key
  - PSK makes things a bit complicated

Public key algorithm negotiation

- Cipher suite just indicates AEAD and PRF
  - Probably define new cipher suites
  - Added bonus of letting us prune!
- Signature algorithms determines server cert/key and signature scheme
- Key shares and supported groups determine the key exchange
  - Model everything as (EC)DHE
  - Server's key share indicates which group it picked

What about PSK?

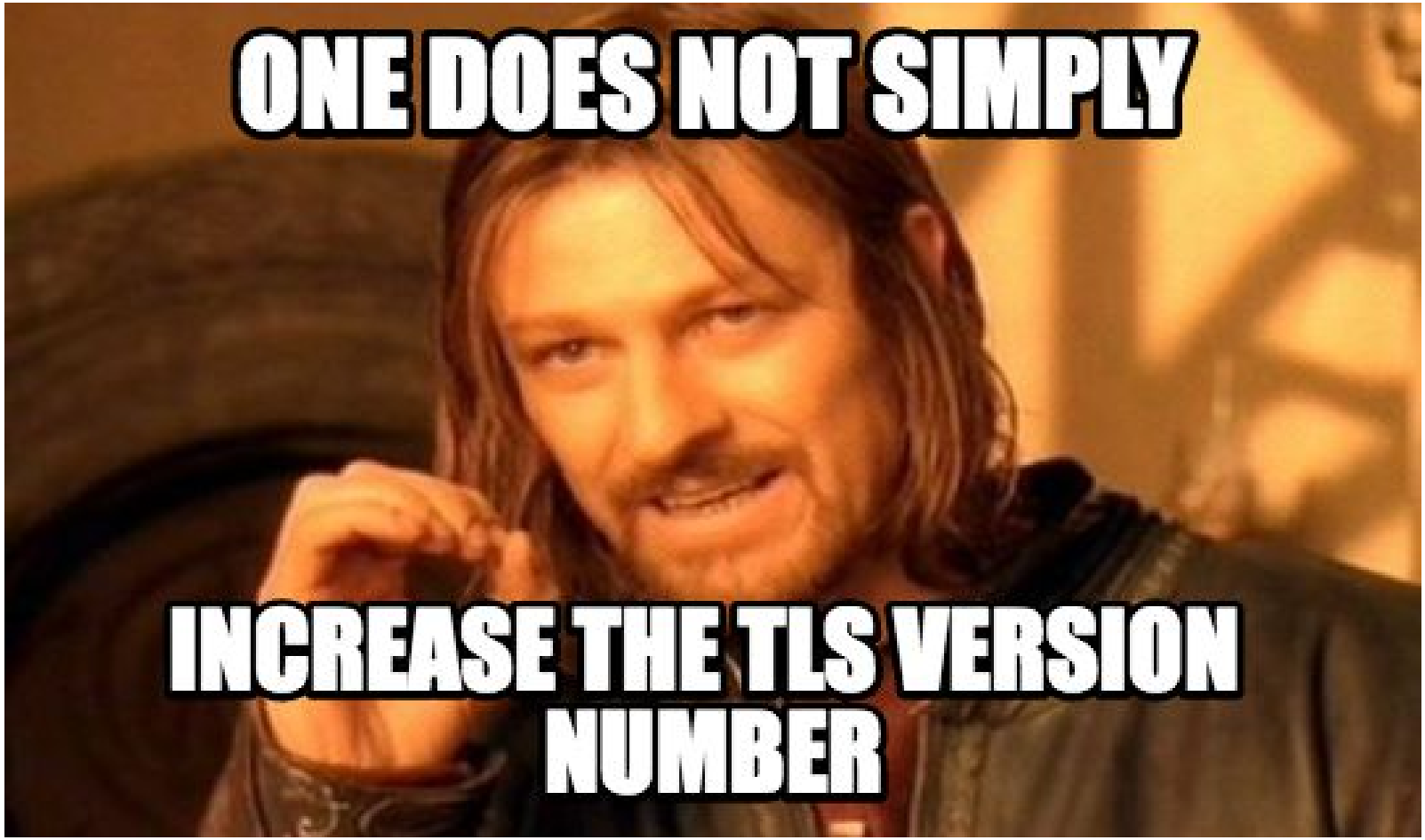
- PSK can be combined with (EC)DHE and signatures (new) (?)

```
enum { psk_ke(0), psk_dhe_ke(1), (255) } PskKeModes;
enum { psk_auth(0), psk_sign_auth(1), (255) } PskAuthModes;

struct {
   PskAuthMode auth_modes<1..255>;
   PskKeMode ke_modes<1..255>;
   opaque identity<0..2^16-1>;
} PskIdentity;

struct {
     select (Role) {
         case client:
             PskIdentity identities<2..2^16-1>;
          case server:
             PskAuthMode auth_mode;
             PskKeMode ke_mode;
             uint16 selected_identity;
     }
 } PreSharedKeyExtension;
```

Should we change negotiation?

- Cons
  - Big change at the last minute
  - Makes APIs more complicated because the cipher suite doesn't tell you everything
  - Doesn't let you express non-orthogonal options
- Pros
  - Much easier to implement (based on initial prototypes)
  - Removes odd pairing of (EC)DHE and PSK cipher suites
  - More expressive
- Proposal: provisionally adopt pending a PR

Version Negotiation



Alternate Proposal

- Keep `ClientHello` version number at 3, 3 (TLS 1.2)
- Introduce a new tls_version extension
  - Semantic is: a list of all supported versions
  - Example: `[ [3, 2], [3, 3], [3, 4], [53, 100] ]`
- ServerHello contains the negotiated version
- All future versions negotiated this way
  - Can fuzz for futureproofing
- Discuss

PSK and Client Auth

- Draft implies support for client authentication even with PSK mode
  - Server just sends CertificateRequest
  - Semantics of this are odd.
  - 0-RTT is even worse
- Main proposal
  - CertificateRequest not allowed when using PSK
  - Use post-handshake client auth if you want this
- Fallback proposal
  - PSK client auth needs an identity that is "morally the same"
  - Then clients can refuse to refresh
- Proposed resolution: ban client auth PSK

Resumption Contexts and 0-RTT Finished

- From the 0-RTT Finished:
  - Proof of at least partial liveness of the PSK [via ticket age]
  - An integrity check for the information in the ClientHello
- From the resumption context:
  - Tie the context from the PSK-establishing connection to future handshakes.
- Issues
  - "0" resumption_context for out-of-band PSK is problematic
  - This seems duplicative
  - Reading the 0-RTT Finished is kind off a pain
  - Always adding the PSK context to the hash is clunky

Potential Options

- Remove 0-RTT Finished but use it as resumption_ctx
  - `resumption_ctx = HMAC(., ClientHello)`
- ~~Always require 0-RTT Finished even w/o 0-RTT (and include in the log)~~
- Always include a special Finished extension when using PSK
  - And discard `resumption_ctx`
  - This can be a bit tricky to implement
- Do nothing

- Proposal: ???

Crypto for Embedded 0-RTT Finished (thanks to Antoine)

```
Early Secret = HKDF-Extract(0, PSK)
early_finished_secret =
     Derive-Secret(Early Secret, "...", ClientHello-prefix)
ClientHello = ClientHello-prefix + HMAC(efs, ClientHello-prefix)
early_traffic_secret =
     Derive-Secret(Early Secret, "...", ClientHello)

Alternate, crazy idea:
ClientHello = ClientHello-prefix + AEAD(efs,
                                        ClientHello-prefix,
                                        <stuff>)
```

Multiple Concurrent Tickets (PR #8)

- Currently we implicitly support multiple tickets
  - Useful for de-linkage privacy, etc.
- Ticket encoding gives no guidance about how to use them
  - Is ticket N usable after I see ticket $N + 1$? Try it and see!
- Proposal: Add a field (generation?) to indicate whether a ticket supersedes others

Last-minute thought: EE in Second Flight

- Should we put an extensions block in client's second flight?
- Pro
  - Only place to put encrypted data from client
  - We might really want this later
- Con
  - Unspecified semantics
  - Not included in HS transcript

Interop Status

draft-ietf-tls-tls13-13 interop							
client ↓ | server →	NSS	BoringSSL	miTLS	ProtoTLS	mint	BoGo	TLS-tris
NSS	1RZC	1	1	1	1RZ	1	1R
BoringSSL	1	1CH	1	1	1	1CH	1
miTLS	1	1	1	1	1	1	1
ProtoTLS	1	1	1	1		1	1
mint	1RZ	@svaldez	1		1RZ	1	1
BoGo	1	1CH	1	1	1	1H	@nharper
TLS-tris							
	Legend:						
	self-test	interop	known broker	unknown	N/A		
To Test:	1=1-RTT						
	R=Resumption						
	Z=0-RTT						
	C=Client Auth						
	K=KeyUpdate						
	H=HelloRetryRequest						

Timeline: Option #1 (No big changes)

Aug 8th	draft-15: Wire format frozen ("Cryptographer's version")
Aug 22nd	Implementations of draft-15
Aug 29th	draft-16: Revised based on feedback
Aug 29th	WGLC
Sep 30th	WGLC Ends

Timeline: Option #2 (Change Negotiation or 0-RTT Finished)

Aug 8th	draft-15: Changes agreed at IETF 96
Aug 22nd	Implementations of draft-15
Aug 29th	draft-16: Revised; Wire format frozen ("cryptographer's version")
Sep 12th	Implementations of draft-16
Sep 19th	draft-17: Revised based on feedback
Sep 19th	WGLC
Oct 17th	WGLC Ends