Discarding Old Keys

QUIC, IETF 104, Prague, March 2019
Martin Thomson

Goals

As discussed in the Tokyo interim:

Discard Initial keys as soon as possible

Discard Handshake keys when appropriate

Signal when a key update can be initiated

Use explicit signals rather than implicit ones, or timers

Basic Idea

Use a frame to signal all transitions

- Initial -> Handshake
- Handshake (+ 0-RTT) -> 1-RTT
- 1-RTT$_n$ -> 1-RTT$_{n+1}$

The frame indicates when it is safe to discard old keys

Options

KEYS_READY #2237

RETIRE_KEYS #2492

MAX_KEY_UPDATES #2504

KEYS_READY

KEYS_READY is sent when read keys are available

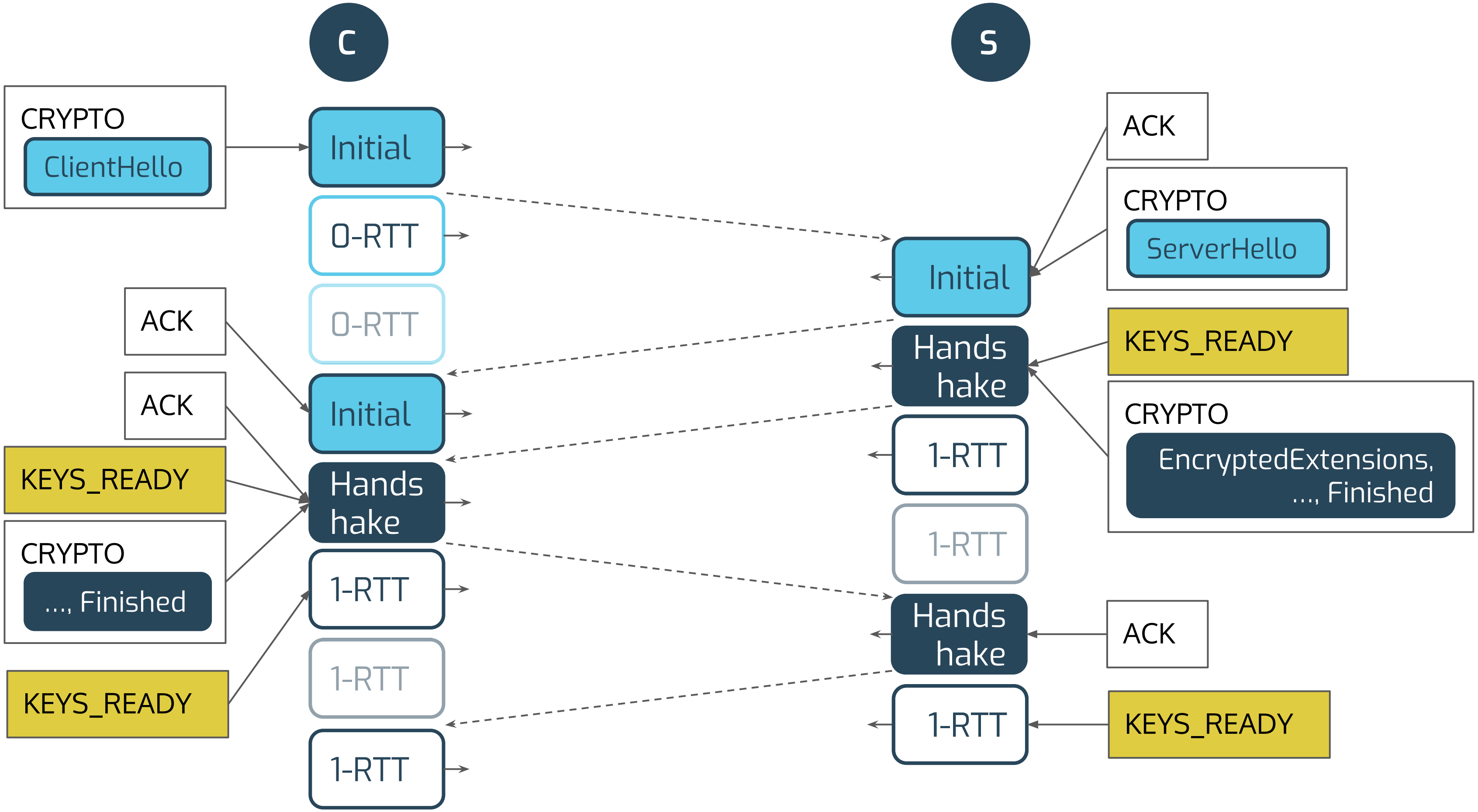
Implicitly identifies keys

- Initiator of a key update has to suppress old frames

When ~~sent and~~ received

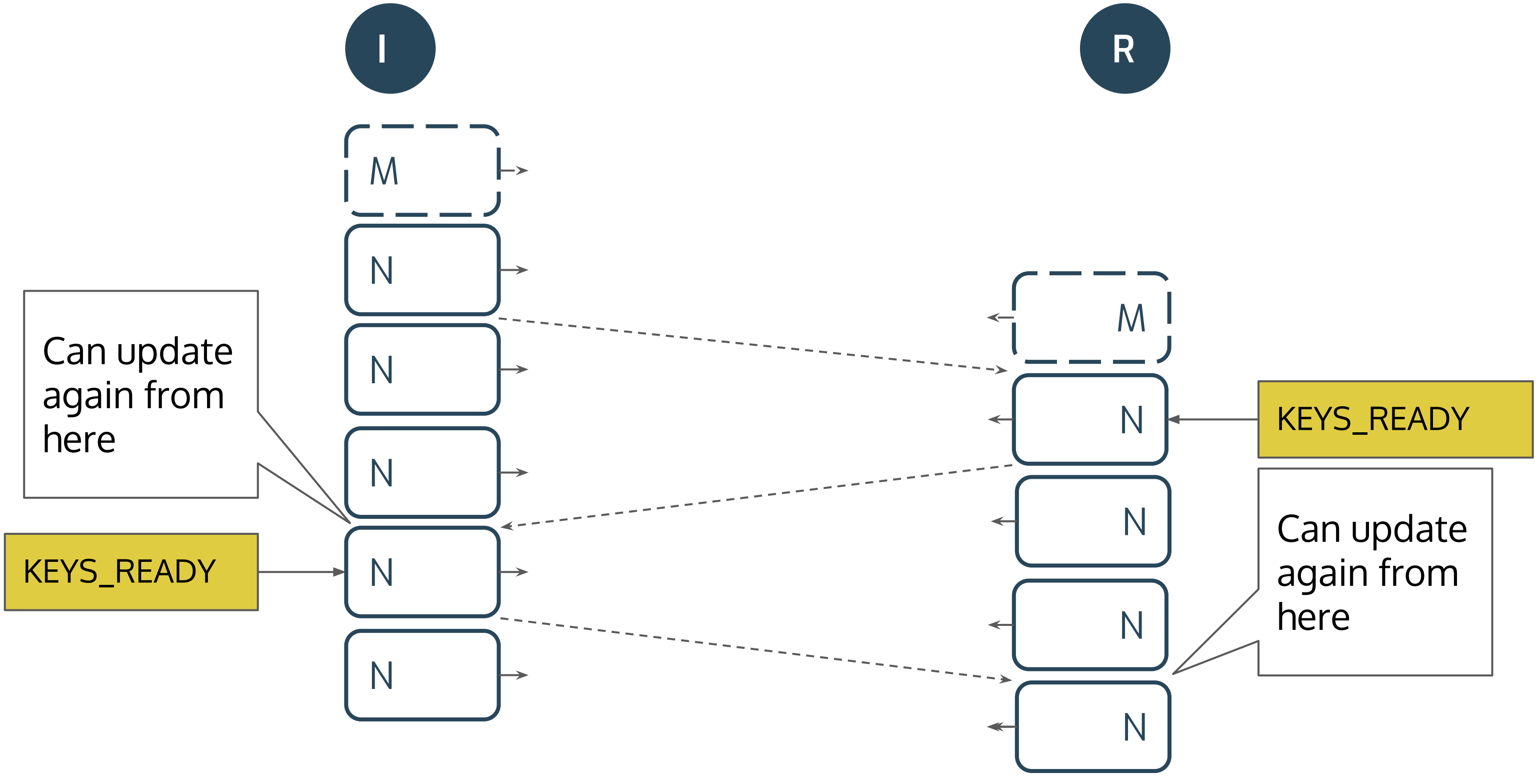
- older keys can be discarded
  and new key updates initiated

KEYS_READY



QUIC

KEYS_READY Key Update



Can update again from here

Can update again from here

RETIRE_KEYS

RETIRE_KEYS send when no more data will be sent

- Initial->Handshake = first packet (special case for server)
- Handshake->1-RTT = after all data is acknowledged
- Key Update = sent when new keys installed

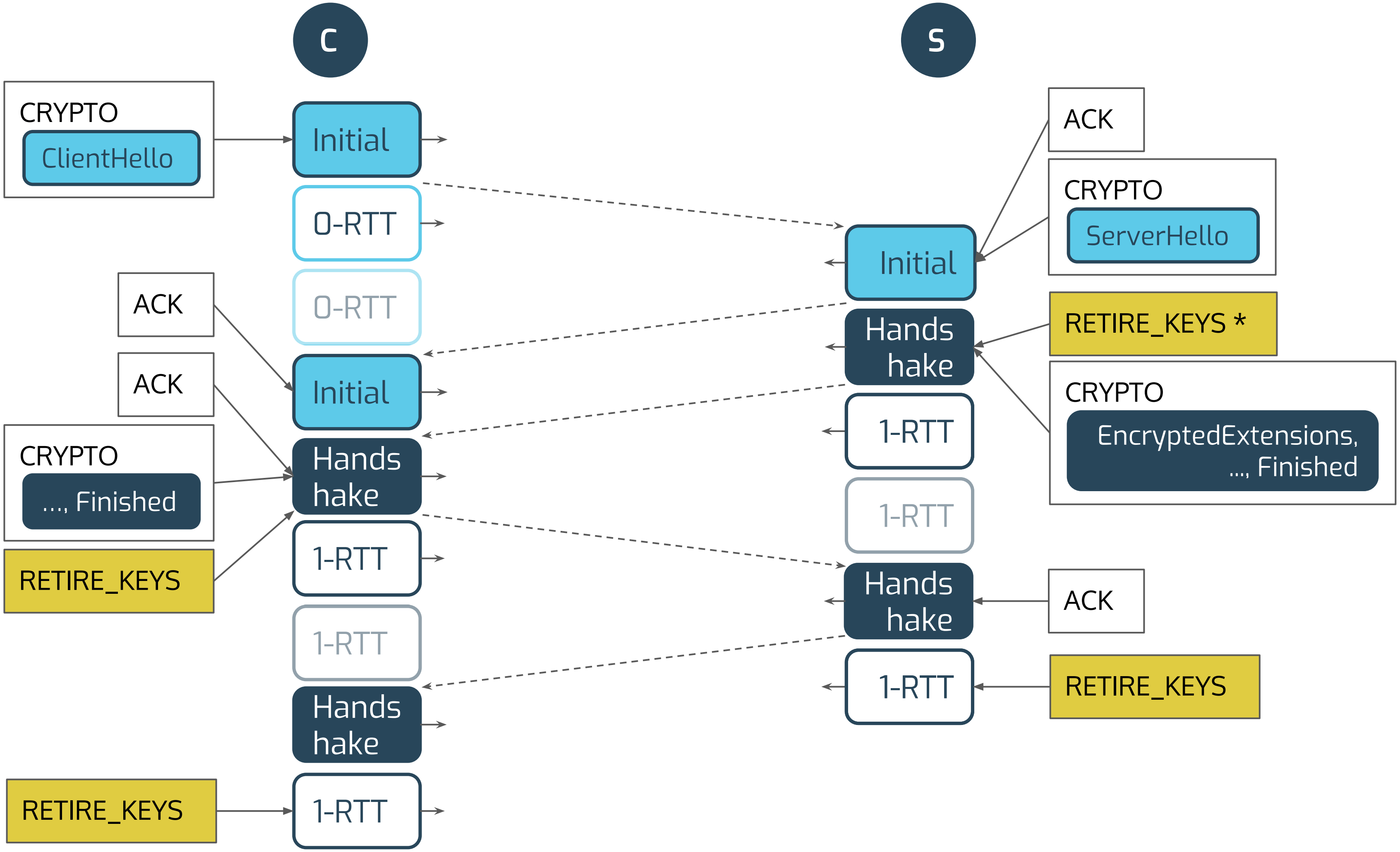
Implicitly identifies keys

- RETIRE_KEYS is retransmitted until acknowledged

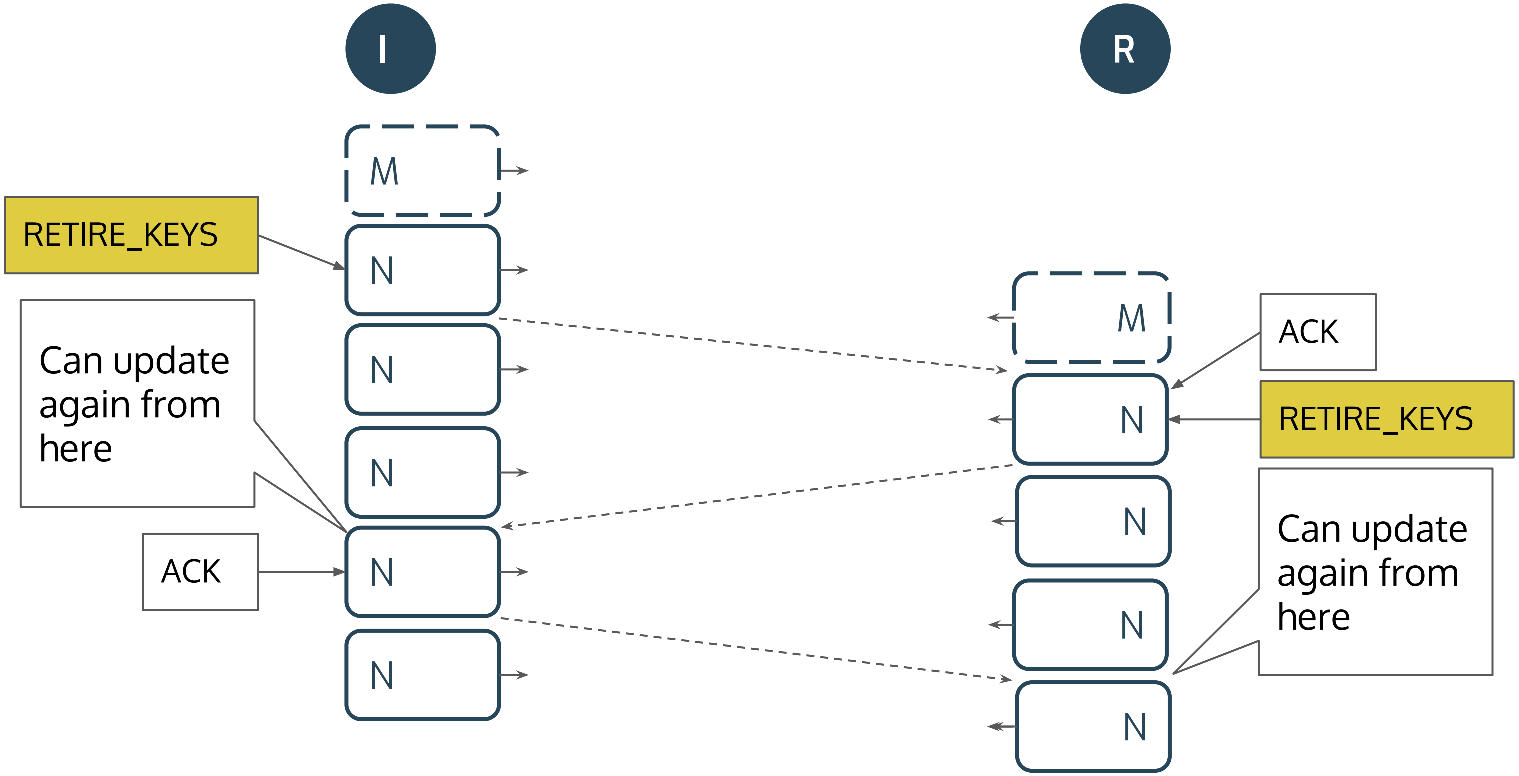
When both sent and received, old keys can be discarded

Subsequent key updates can be initiated once received and sent has been acknowledged

RETIRE_KEYS


C
S
CRYPTO
ClientHello
Initial
0-RTT
0-RTT
ACK
ACK
Initial
CRYPTO
..., Finished
Handshake
RETIRE_KEYS
1-RTT
1-RTT
Handshake
RETIRE_KEYS
1-RTT
ACK
CRYPTO
ServerHello
Initial
RETIRE_KEYS *
Handshake
CRYPTO
EncryptedExtensions,
..., Finished
1-RTT
1-RTT
Handshake
ACK
1-RTT
RETIRE_KEYS

RETIRE_KEYS Key Update



MAX_KEY_UPDATES

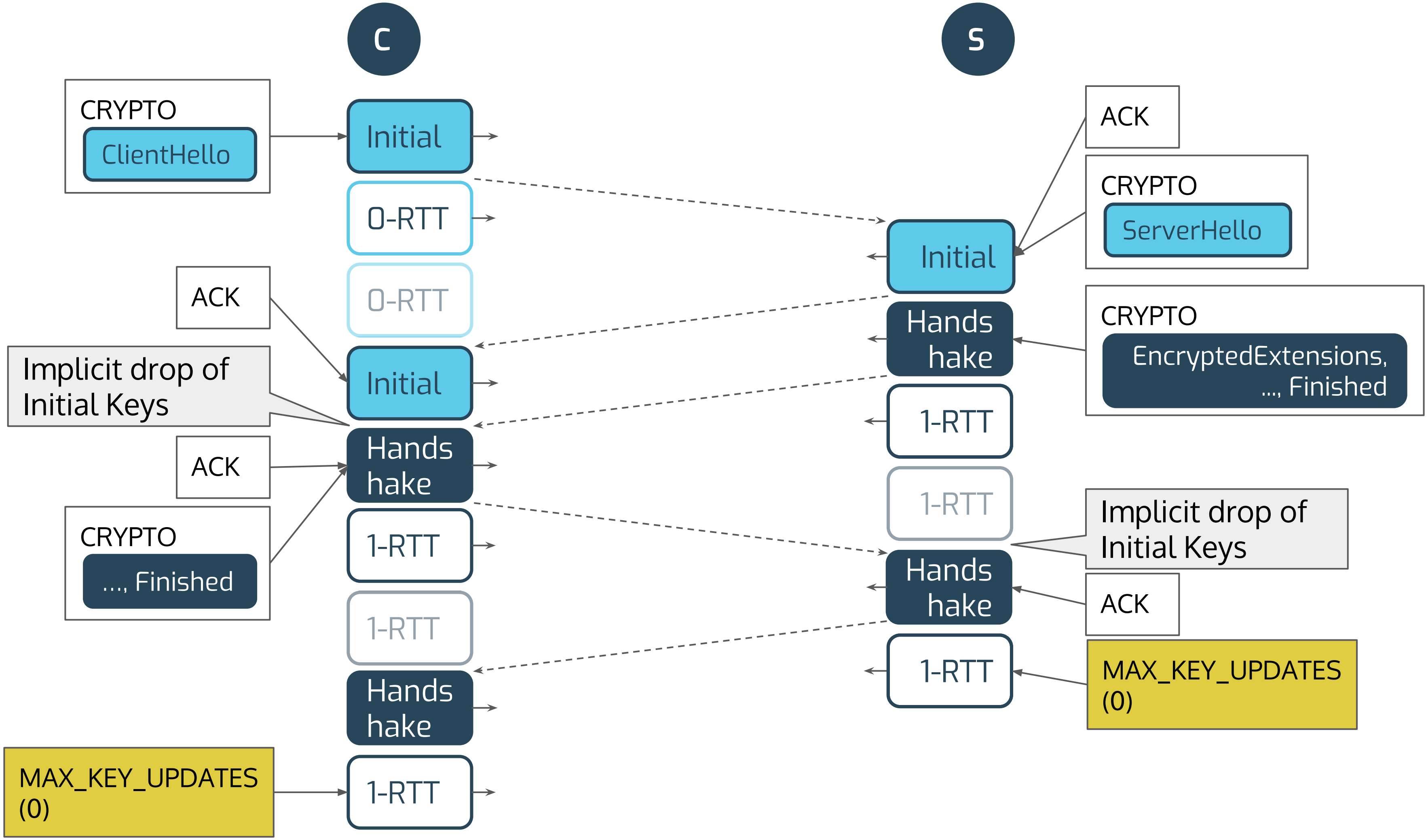
Cap key updates rather than control discarding of keys

Explicit counter in frame sets cap on updates

Fixes key update issues, limited fix for handshake:

- No signal for Initial->Handshake transition
- Handshake->1-RTT signaled with MAX_KEY_UPDATES=0
- First frame is sent after all Handshake data ack'd

MAX_KEY_UPDATES



Common characteristics

Use a frame (as agreed in Tokyo)

An endpoint can block key updates by not sending the frame

- Both KEYS_READY and MAX_KEY_UPDATES allow a 3PTO delay to cap active read keys at an endpoint to 2
- The time limit is aspirational, as no mechanism exists to force an endpoint to send the proposed frames

Difference: Explicit vs. Ambient Signal

Explicit: counter in frame

Drawbacks: octets, allows for >1 update

Ambient: use the encryption level

Drawbacks: need to suppress any retransmission when initiating a key update

Initial -> Handshake Transition

MAX_KEY_UPDATES says that the implicit signal is OK

The other proposals address use an explicit signal

Trigger

KEYS_READY - matching read keys available

RETIRE_KEYS

- Handshake: all data from previous epoch acknowledged exception for server: immediately
- 1-RTT: when all CRYPTO data is acknowledged
- Update: send immediately, no update until acknowledged

MAX_KEY_UPDATES - trigger isn’t important