MAMI Management and Measurement Summit (M3S)

March 16, 2018

London

mami

measurement and architecture for a middleboxed internet

measurement | architecture | experimentation

Welcome!

- Thanks for participating and thanks for presenting!

- How-to for WiFi access provided on paper!

- Agenda and participants list as well!

The MAMI Project

Measurement and Architecture for a Middleboxed Internet

measurement

of deployed middleboxes

experimentation

of use case applicability and deployability

architecture

for middlebox cooperation

- Strong interaction with relevant standards organizations for impact on deployment
- FIRE testbed (MONROE) for measurement as well as experimentation, especially on mobile broadband access networks
- Learn more at http://mami-project.eu/ and follow us on twitter **@mamiproject**

Scope and Goals

- Discussion about challenges in network management and measurement
  - Review existing techniques
  - Challenges that arise based on new protocols
  - Approaches to address these challenges

- Collect input and develop a common understanding
  - Publish white paper to provide a common basis for a broader discussion in the Internet community!

Chatham House Rules and White Paper

- Please let me know if it is okay to publish your slides after the meeting, or send me a publishable version
- We have note takers assigned for each session
  - Thanks to Tobias Bühler, Gorry Fairhurst, and Diego Lopez!
- White paper will be based on slides and notes!
  - We will ask for feedback and confirmation before we publish the white paper!
  - Let us know if you'd like to be involved early and help!

Dinner Reservation

- for 10-20 people at Mele e Pere, 6:30pm
- http://www.meleepere.co.uk

Today's Agenda

9:00 Welcome and Intro

9:15 Where we are? Overview of new technologies in the IETF (Mirja Kühlewind, ETH)

9:35 Related work items in IEEE, ETSI, ITU, and 3GPP (Arnaud Taddei, Symantec)

9:40 Impacts of Encryption (Gorry Fairhurst, University of Aberdeen)

10:00 Path Signals and Wire Image (Brian Trammell, ETH)

10:30 *Coffee Break*

11:00 **Session I: Monitoring** (chair: Brian Trammell, ETH)

12:30 *Lunch*

13:30 **Session II: Performance Enhancing Proxies** (chair: Thomas Fossati, Nokia)

15:00 *Coffee Break*

15:30 **Session III: DDoS Protection** (chair: Gorry Fairhurst, University of Aberdeen)

17:00 Wrap up and Conclusion

Session I: Monitoring

- Current monitoring practices (Al Morton, AT&T) - 5 minutes
- How we do Network Performance Monitoring (Pavel Minarik, Flowmon) - 10 minutes
- Use of TCP headers to monitor network health and customer experience (Chris Seal, HWEL - 3 Solutions) - 10 minutes
- Analyzing OTT video over QUIC (Craig Radcliffe, Netscout) - 15 minutes
- Distributed Security Operations Use Case (Roman Danyliw, CERT) - 10 minutes

Session II: Performance Enhancing Proxies

- Transport-split proxying for encrypted traffic (Thomas Fossati, Nokia) - 15 minutes
- Use case: HTTP proxy for network multicast support (Roni Even, Huawei) - 5 minutes
- Use-case differences for "Transport Only Intercept" vs "Application Layer Intercept“ (David Wells, Symantec) - 20 minutes

Session III: DDoS Protection

- Akamai's DDoS Protection (Aaron Falk, Akamai) - 15 minutes
- DDoS Open Threat Signaling (Roman Danyliw, CERT)
  - 10 minutes
- Challenges in building learning models when traffic is encrypted (Vijay Gurbani, Nokia) - 15 minutes

Where we are?
Overview of new technologies in the IETF

Mirja Kühlewind

M3S, March 16, 2018, London

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Overview
Encryption in the IETF

- TLS 1.3 and DTLS - improved end-to-end encryption
- QUIC - encrypted transport
- DoH - encrypted DNS over HTTPS
- ACME Star - Short term certificates to enable delegation

- Not covered: object security (e.g. jose, cose)

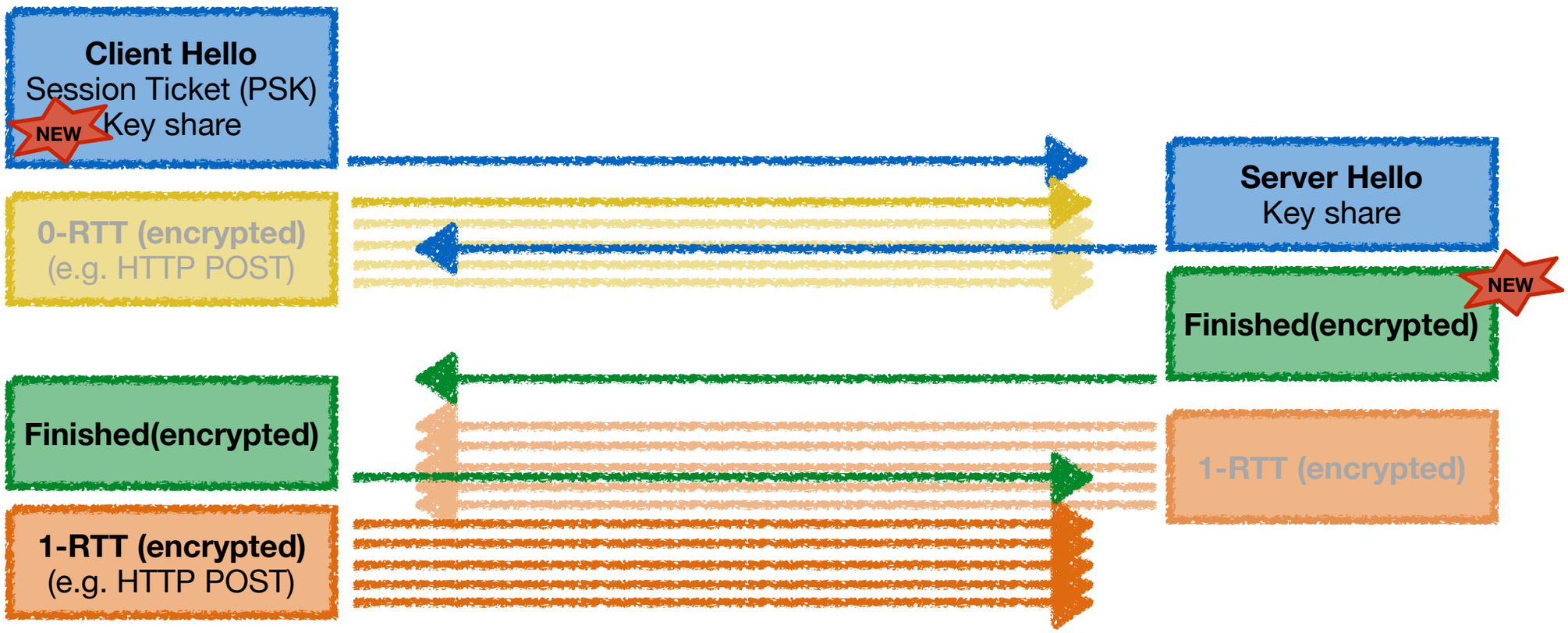
Why encryption?

1. Improvements in data and privacy protection (Snowden revelations)
   - "Encrypt it all!“
2. Reaction to ossification
   - Endpoint control about exposure to maintain evolution
   - Increase transparency on in-network handling
   - Middlebox traversal
   - Implementation correctness

TLS1.3

- draft-ietf-tls-tls13 (approved for publication by IESG)
- Use of Authenticated Encryption with Associated Data (AEAD)
- Perfect Forward Secrecy
  - Static RSA and Diffie-Hellman cipher suites removed
- All handshake messages after the ServerHello now encrypted
- New version negotiation mechanism based on extension due for (server and network) compatibility
- Session resumption in 0-RTT mode

TLS 1.3 Handshake (with session resumption)



- Session Tickets servers are stateless
  - 0-RTT PSK provides no Forward Secrecy if Session Ticket key is compromised
  - Replay attack requires idempotent data for 0-RTT

TLS1.3 Interception

- see also draft-camwinget-tls-use-cases

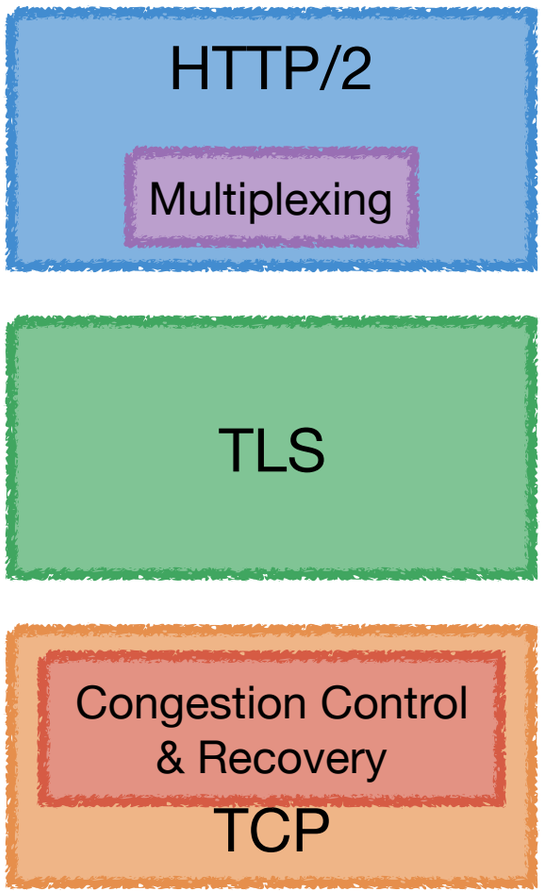
- Perfect Forward Secrecy
  - Keys cannot be shared apriori with middlebox
  - (see also draft-green-tls-static-dh-in-tls13)
- Encrypted Server Certificate
  - Server Identity hidden (as SNI might not match)
- Downgrade Protection
  - detects stripping of "supported_versions" extension

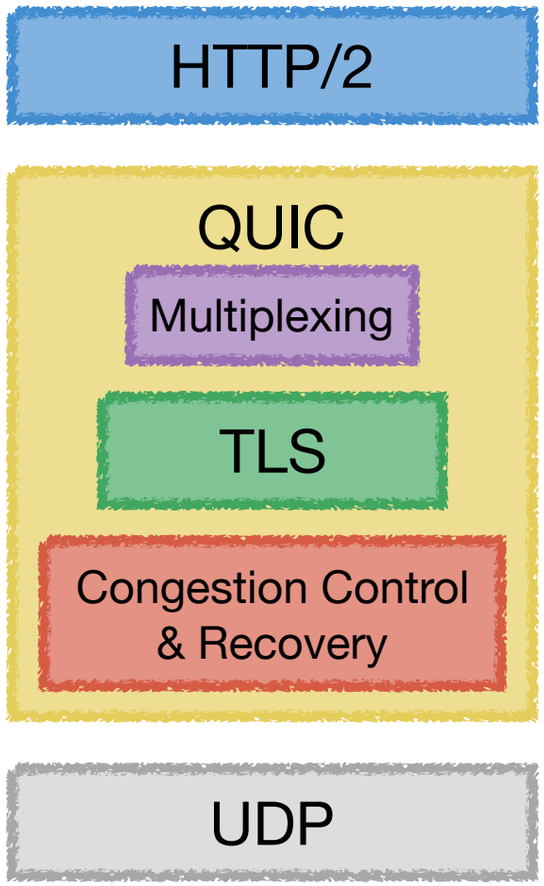
- Certificate pinning
  - see also draft-sheffer-tls-pinning-ticket

DTLS Connection ID

- draft-ietf-tls-dtls-connection-id
- Support for connection migration, e.g. NAT rebinding
  - provides additional information for security context selection when 5-tuple changes
- Extension is negotiated during handshake and connection ID is provided in TLS record layer
- Proposal for a generic DTLS Record Header (Wire Image) extension mechanism to make information more easily accessible
  - see draft-fossati-tls-ext-header

HTTP/2 over QUIC

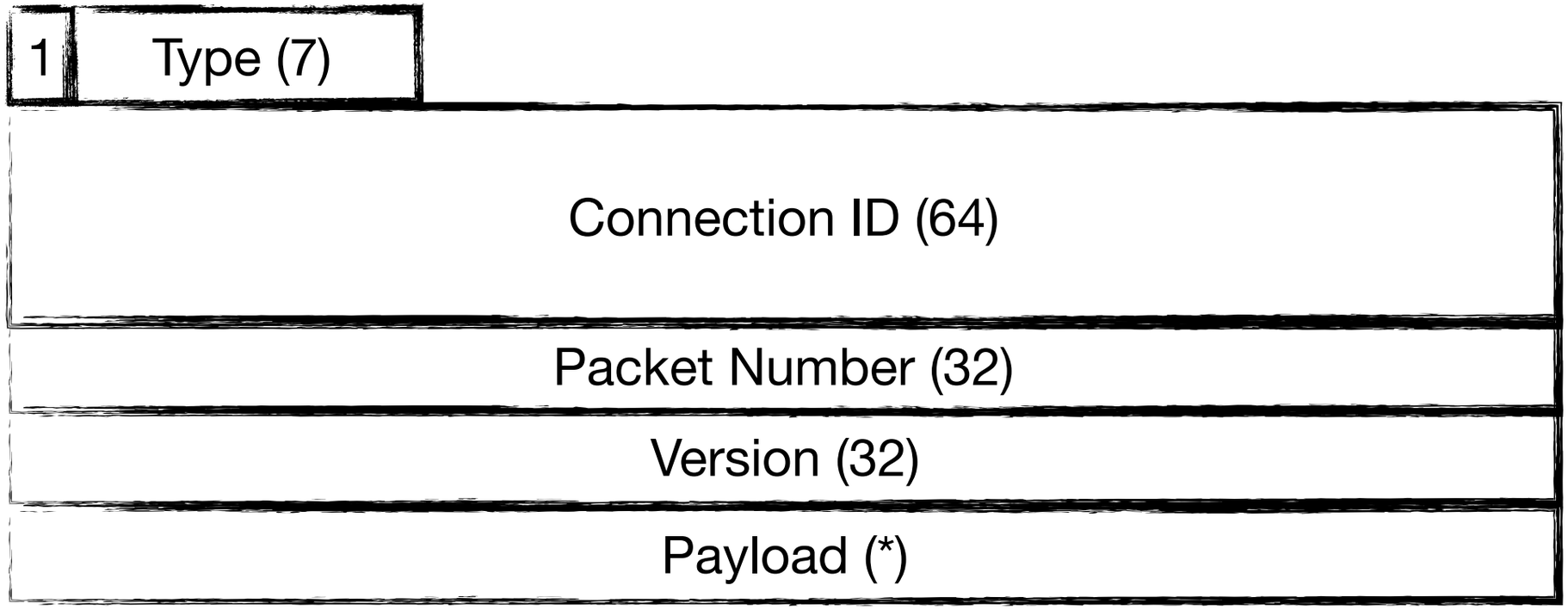




- Stream multiplexing avoids HoL of independent data resources
- Always authenticated and payload is fully encrypted

➡ **Stream & other control information (for e.g. recovery) is not visible to the network anymore!**

The QUIC wire image — Long header format (handshake & 0-RTT)



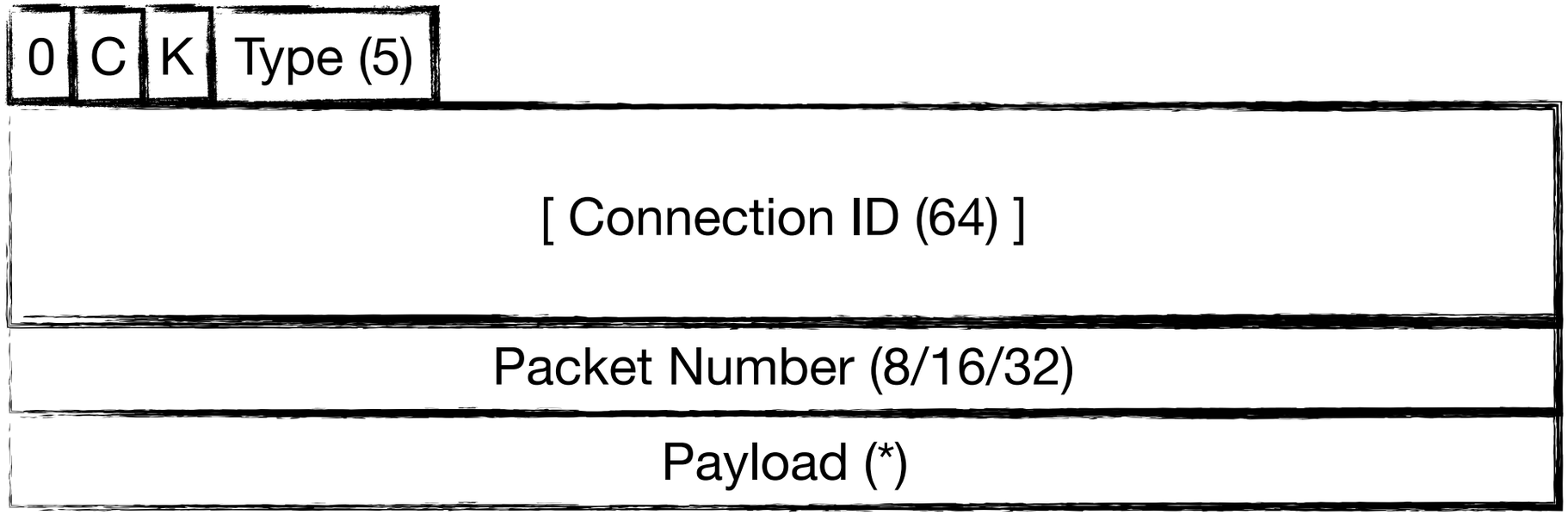
- Connection ID for migration and resilience to NAT rebinding
- Packet number is initiated to a random values and is unique within a connection
  - Packet Number also provides input to decryption

QUIC Long Header Types

Type	Name
0x7F	Initial
0x7E	Retry
0x7D	Handshake
0x7C	0-RTT **Protected**

- Cleartext packets for (Client) Initial, (Server Stateless(Retry, and (Server/Client) Handshake
- Encrypted payload for 0-RTT and short header 1-RTT data

The QUIC wire image — Short header format (only 1-RTT)



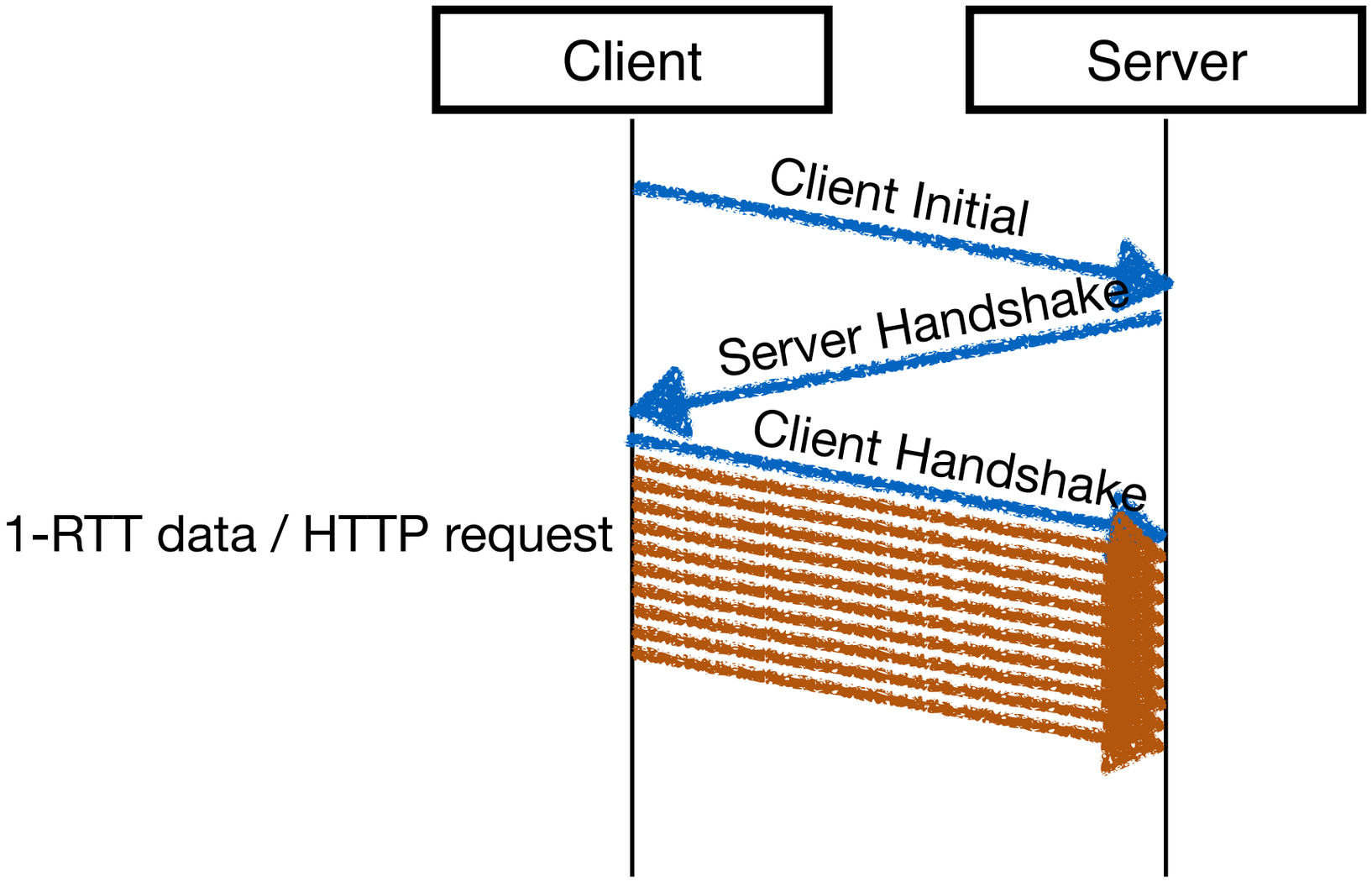
- Connection ID is optional as indicated by the C flag
- Packet Number length is indicated by the header type
- K bit indications key phase for decryption
- Payload is always encrypted

QUIC
Invariants

- Basically everything can change between QUIC version, except a few invariants that are needed for version negotiation!

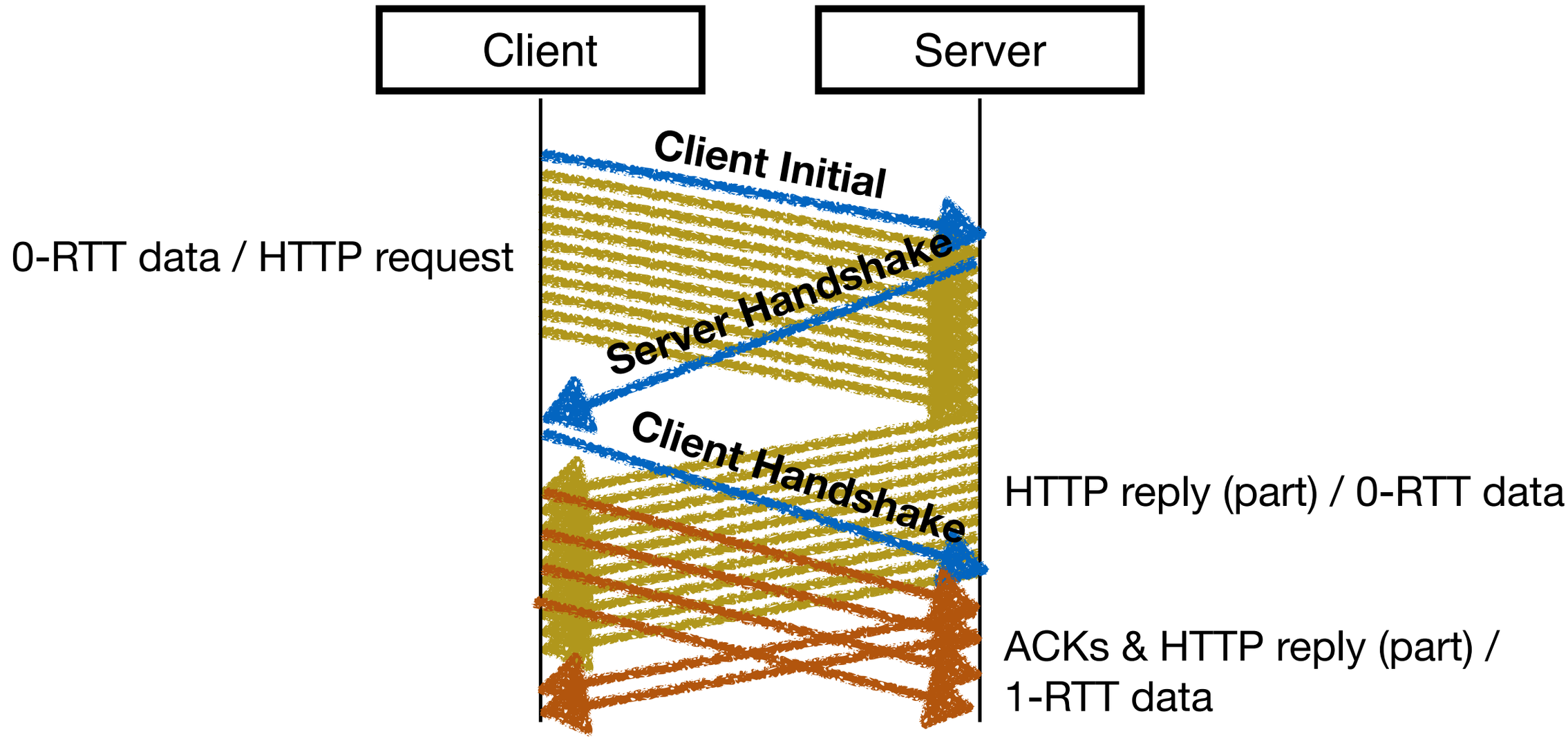
- Only to make version negotiation work, between different versions the following things need to remain the same:
  - the location and meaning of the header form flag,
  - the location and meaning of the Connection ID flag in the short header,
  - the location and size of the Connection ID field in both header forms,
  - the location and size and meaning of the Version field in long headers, and
  - the whole version negotiation packet.

QUIC Handshake



- Copy of the Client Initial and Server Cleartext are included in the encrypted part to verify content

QUIC Handshake — 0-RTT Session Resumption



- Client can send an initial window of data (10 packets) together with Client Initial

QUIC wire image — Measurements and Monitoring

- Packet Number can be utilized to measure **packet loss (or reordering) so far** (from the sender to the observation point)
  - ➡ Packet number is monotonously increasing
    - ➡ But gap can also be introduced by the sender
    - ➡ Retransmissions and ECN congestion indications are not visible to the path (to estimate whole-path congestion)
    - ➡ Packet might be encrypted as well

- **Round-Trip Time (RTT)** can be estimated during the handshake
  - ➡ No easy was to correlate two packets in both direction during the rest of the connection
  - ➡ Proposed spin-bit provides minimal explicit information to estimate one RTT sample per RTT

DNS Over HTTPS (doh)

- New working group: draft-ietf-doh-dns-over-https-03
- Confidentiality and connectivity between DNS clients and recursive resolvers (over port 443)
  - Prevents on-path network devices from interfering with DNS operation
- Also implementation in web browsers
  - Gives web applications access to DNS information
- "Filtering or inspection systems that rely on unsecured transport of DNS will not function in a DNS over HTTPS environment"

ACME
Short-Term, Automatically Renewed certificates (STAR)

- Protocol machinery to handle issuance of "short-term" certificates (with minutes-hours-days TTLs) in an automated fashion
  - Built on top of ACME / Let's Encrypt
- Allows Relying Parties to avoid checking revocation of End Entity certificates
- Better privacy & latency compared to existing revocation status protocols (CRL, OCSP)
- Building block for an efficient name-delegation protocol, for example one that exists between a Content Provider (identity owner), a CDN (delegate), and the end users
- Use cases: Delegation for CDNs, Distributed Network (Security) Functions in multiple data centers, Corporate networks

Use Case Overview

- Explicit exposure of information for network consumption (integrity protected)
- Network to endpoint signaling (PLUS)
- Split-transport proxying (higher layer is encrypted)
- Full visibility for content inspection (no modification)
- Content modification (requires trust relationship)

Backup

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Path Layer UDP Substrate (PLUS)

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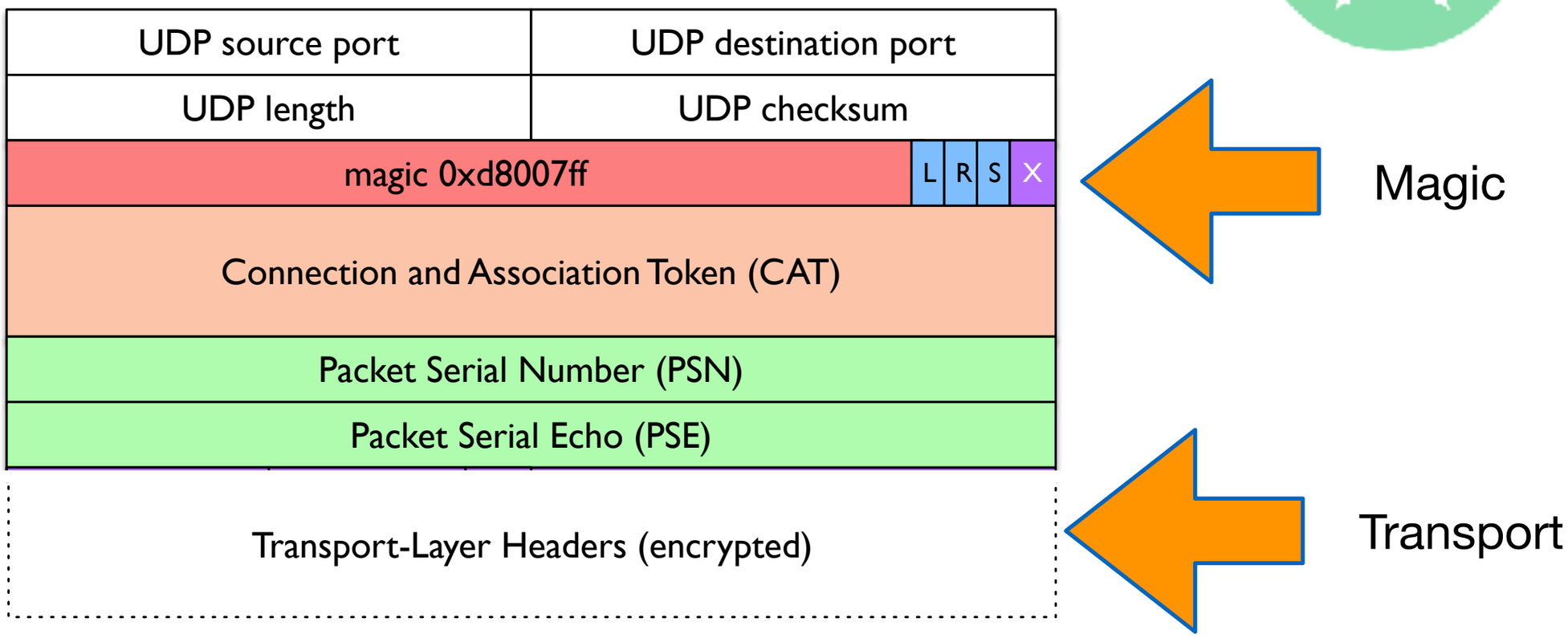
PLUS Design Goals

- **Sender-to-path signaling:** An endpoint should be able to explicitly expose any signals used by on-path devices.
- **Path-to- receiver signaling:** An endpoint should be able to request signals from devices on the path.
- **End-to-end integrity protection:** An on-path device should not be able to forge, change, or remove a signal sent by an endpoint.
- **Integrity protection over a scratch space:** An endpoint controls signaling between endpoints and the path, or from one on-path device to another.
- Does not assume a**uthentication of signals from on-path devices:** Possible to request and receive signals from a previously unknown on-path device.
- **Robust to attack**: The mechanism should present no significant surface for amplification attacks.

PLUS Basic Header Format



Header on top of UDP identified by magic number

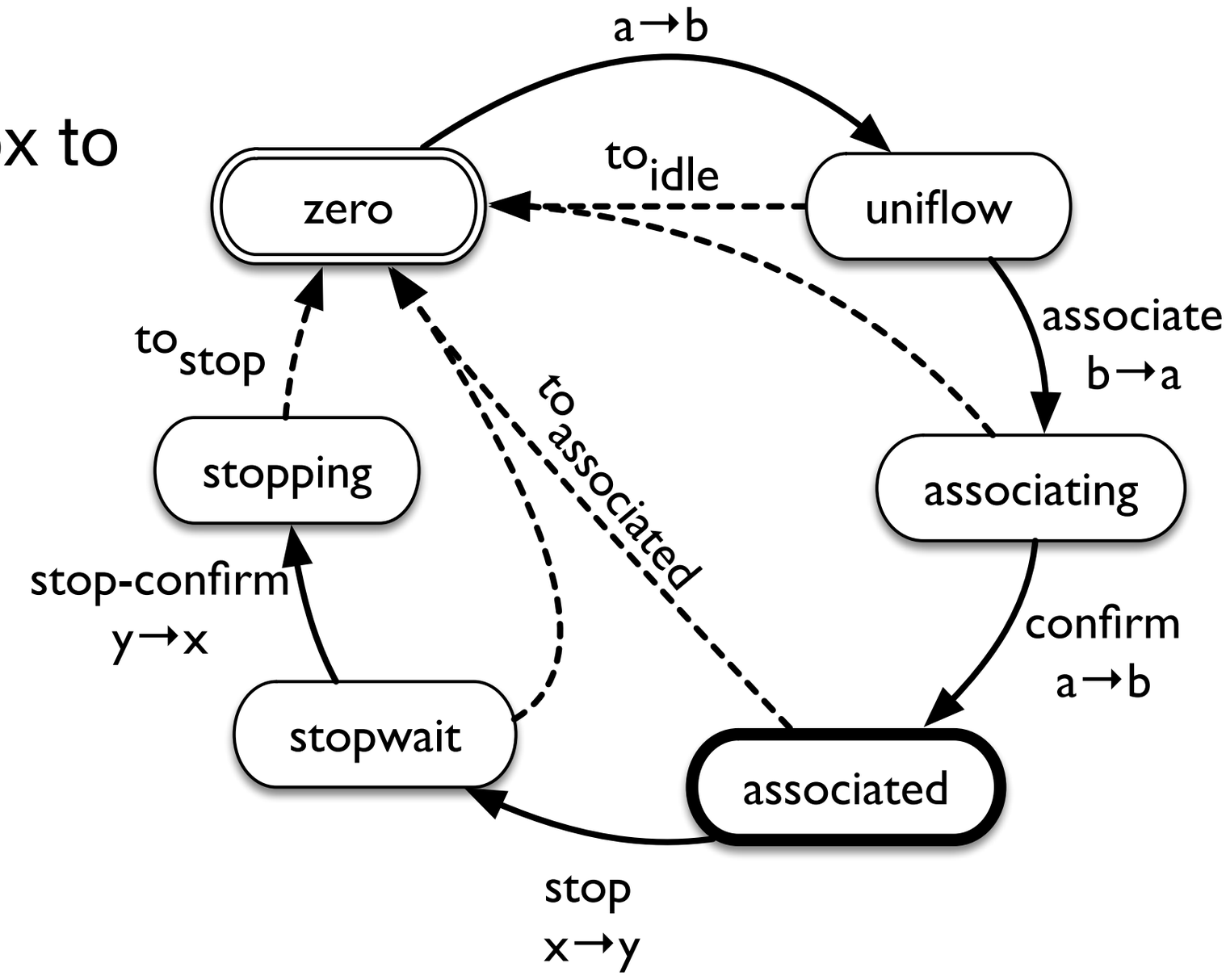
Basic and extended formats

L= Lola, R= May be reordered, S= Stop

Provides a common wire image for encrypted transports

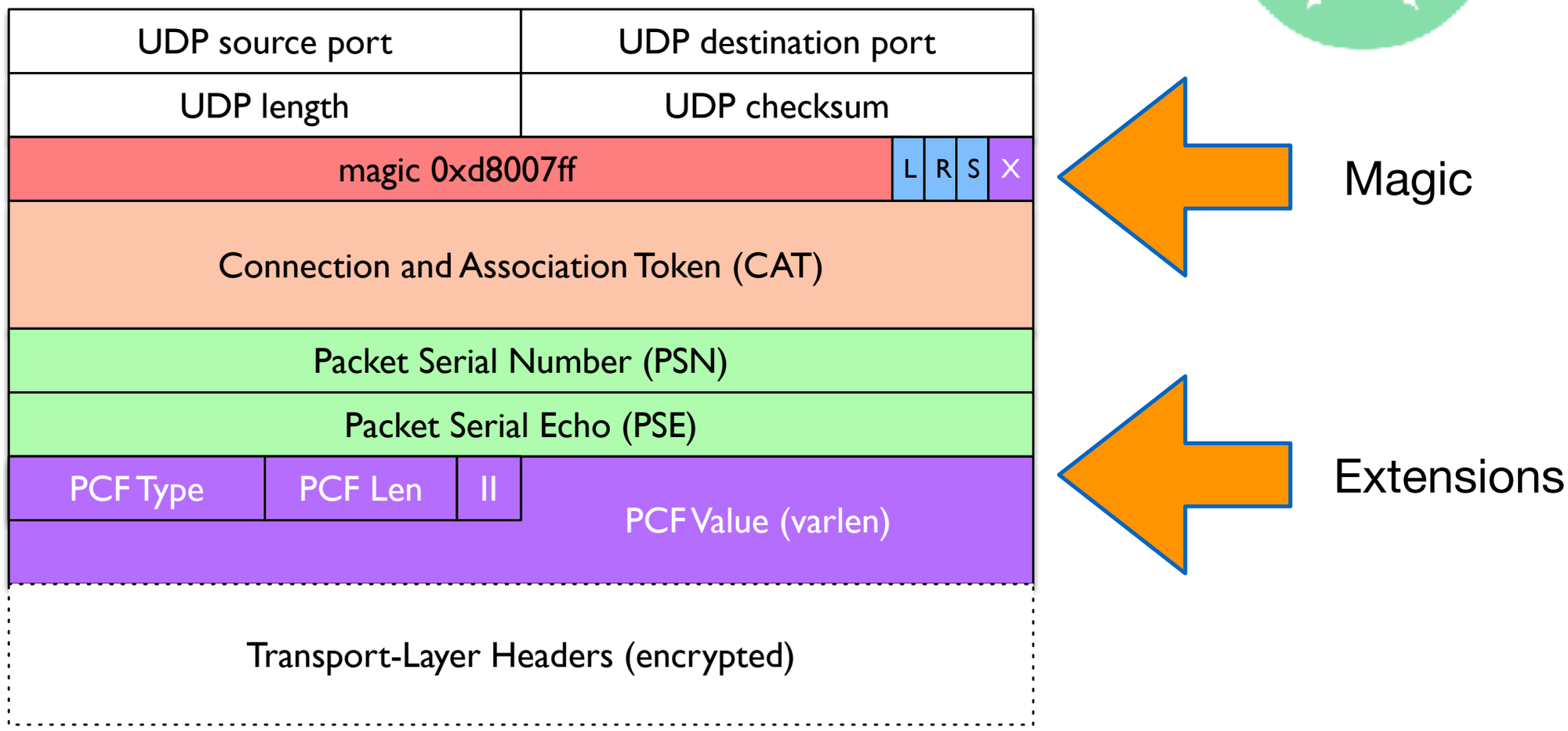
A transport-independent on-path state machine

- Enables a middlebox to track the flow state
- e.g. NAT/Firewall



[draft-trammell-plus-statefulness]

PLUS Extended Header Format



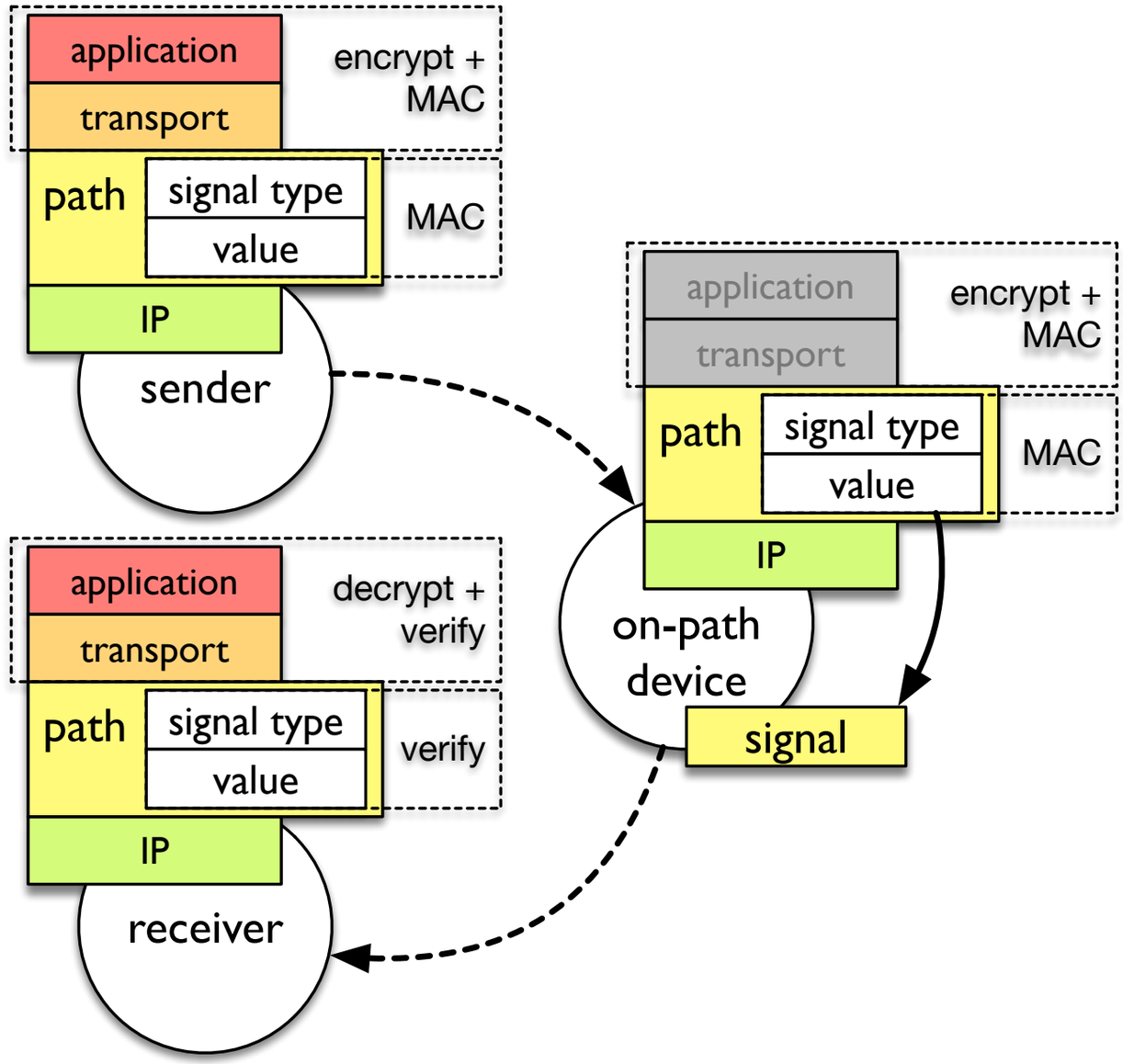
X=1

Each PLUS packet can carry only one PCF at a time

Sender decides which PCF is supported in a packet

Transport-independent in-band signaling: Sender to Path Signal

- Unencrypted signal
- Integrity protection
- Path can not verify
- Receiver may verify



L: LoLa

R: Reordering

S: Start of Session

PCF 1: Loss/Congestion Exposure

Transport-independent in-band signaling: Path to Receiver Signal

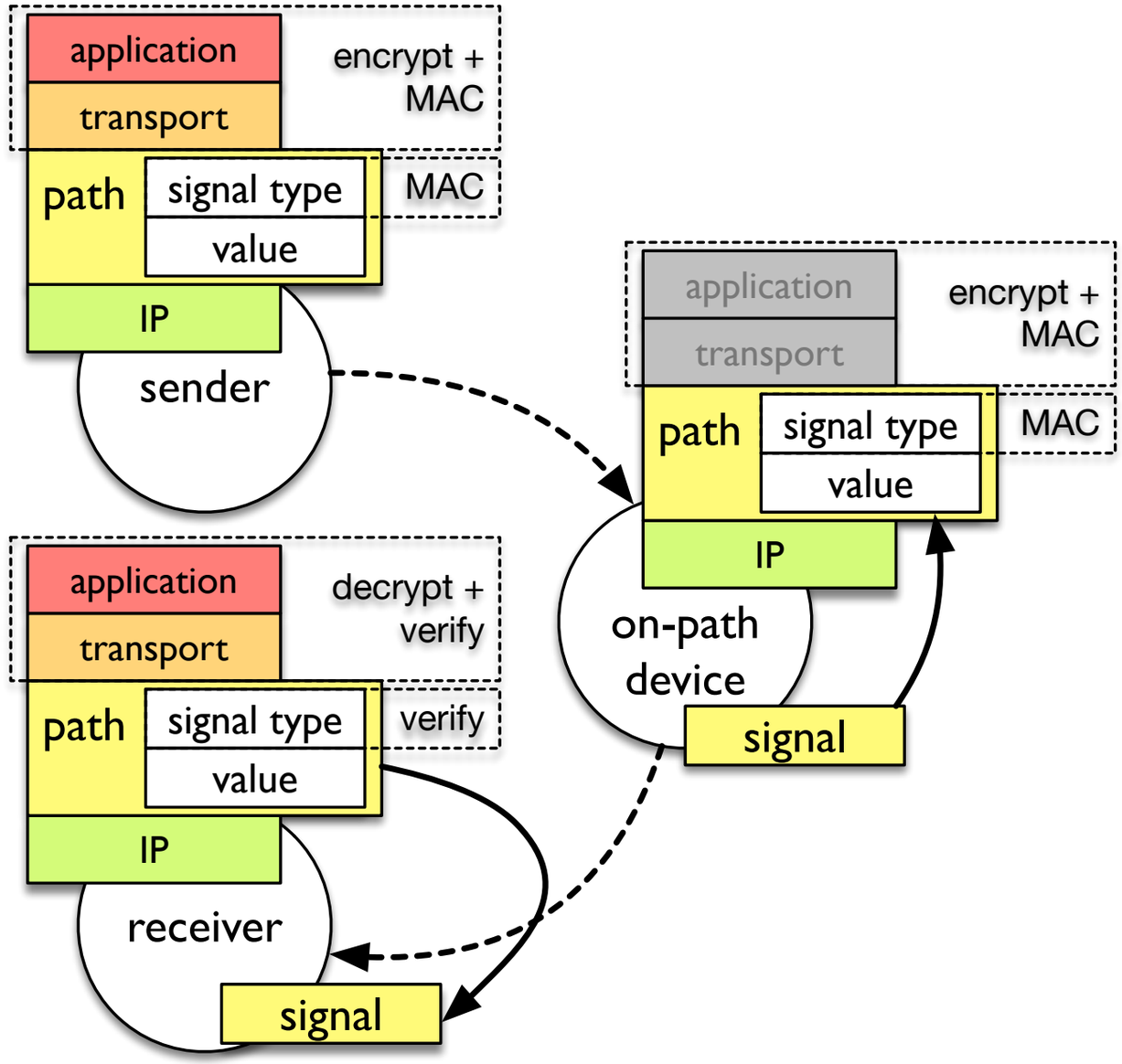
- Sender enables
- Unencrypted signal
- No integrity protection
- Use of info advisory

PCF 2: PMTU

PCF 3: Path tracing

MCP throughput guidance

…



IETF Documents

draft-trammell-spud-req

draft-trammell-plus-abstract-mech

draft-trammell-plus-statefulness

draft-trammell-plus-spec