RLC FEC Schemes for QUIC (update)

draft-roca-nwcrg-rlc-fec-scheme-for-quic-02

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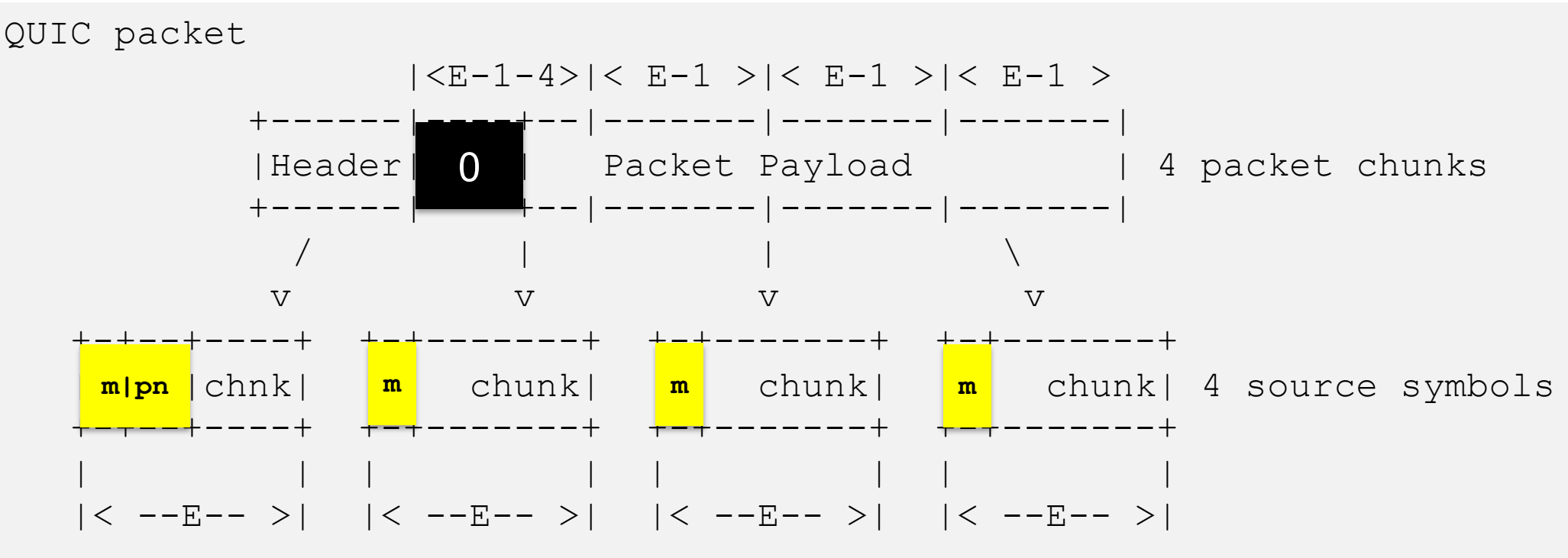
IETF106, Singapore, November 21st, 2019

Main considerations

- **inline with “Coding for QUIC” -03 I-D**
  - “cross packet FRAMES” approach
  - being FRAME agnostic and compatible with DATAGRAM FRAMES is a must
- leverages on **RFC 8681** (RLC) and **RFC 8682** (TinyMT32) specifications
  - do not repeat code internals, focus on **QUIC specific mapping and signaling**

    ➔ keeps this I-D very compact
- potentially add **similar I-Ds** for other FEC codes and FEC schemes
  - different features, different use cases, for instance (to be tested):
    - real-time, a few tens of packets ➔ RLC on GF(2^8)
    - higher BDP, a few thousands of packets ➔ block code (Raptor(Q), LDPC)

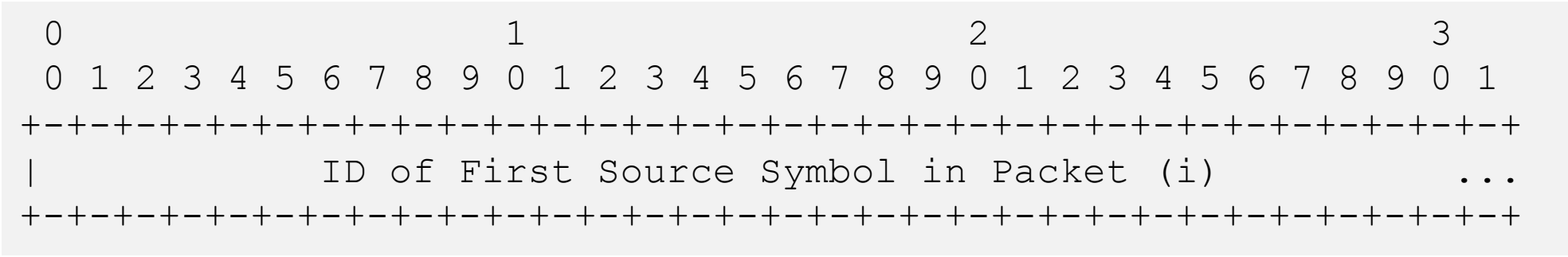
QUIC packet to source symbols mapping



- to be used for FEC encoding/decoding, not transmitted per se

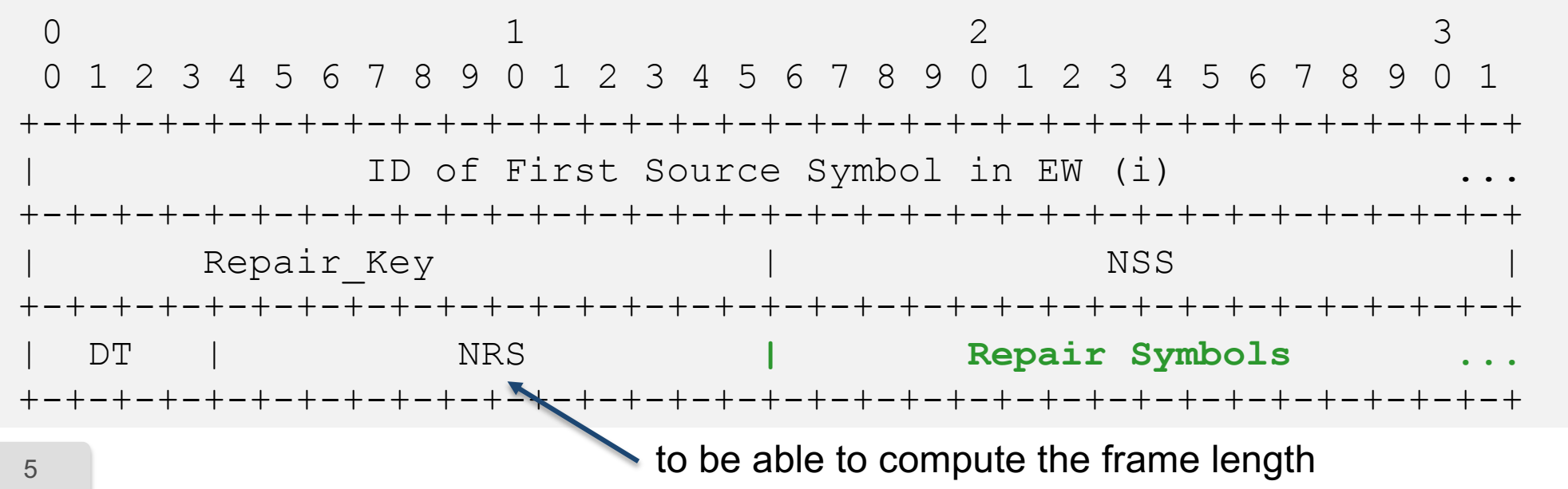
Source QUIC packets with their FPI

- add a **SRC_FPI frame** to the original QUIC packet, then send it
  - **no other change to the original QUIC packet** (no padding, no meta-data, we do not transmit source symbols per se)
  - the SRC_FPI frame is **ignored** by a QUIC receiver that does not support FEC



Repair QUIC packets

- transmit repair symbols in dedicated **REPAIR frames**
  - it includes repair FPI signaling information
  - one or more REPAIR frames can be packed in the same QUIC packet (e.g., if E is small WRT the PMTU), for reduced overhead
  - a REPAIR frame is **ignored** by a QUIC receiver that does not support FEC



Situation

- François has a compliant open-source implementation
  - we know it can work as specified
- A few open questions:
  - (from ietf105 discussion:) considering a subset of the QUIC packet frames
  - (from ietf105 discussion:) choice of E
  - move the ”source symbols mapping” to this I-D
    - it’s FEC scheme dependent
  - QUIC frames are all idempotent:
    - “a valid frame does not cause undesirable side effects or errors when received more than once.”

    … except our SRC FPI frame that is attached to a given QUIC packet
    - not a major issue, it’s just an exception

Thanks

- Additional slides, from ietf105 “Coding for QUIC” presentation. They still apply here…

QUIC packet to source symbols mapping (1)

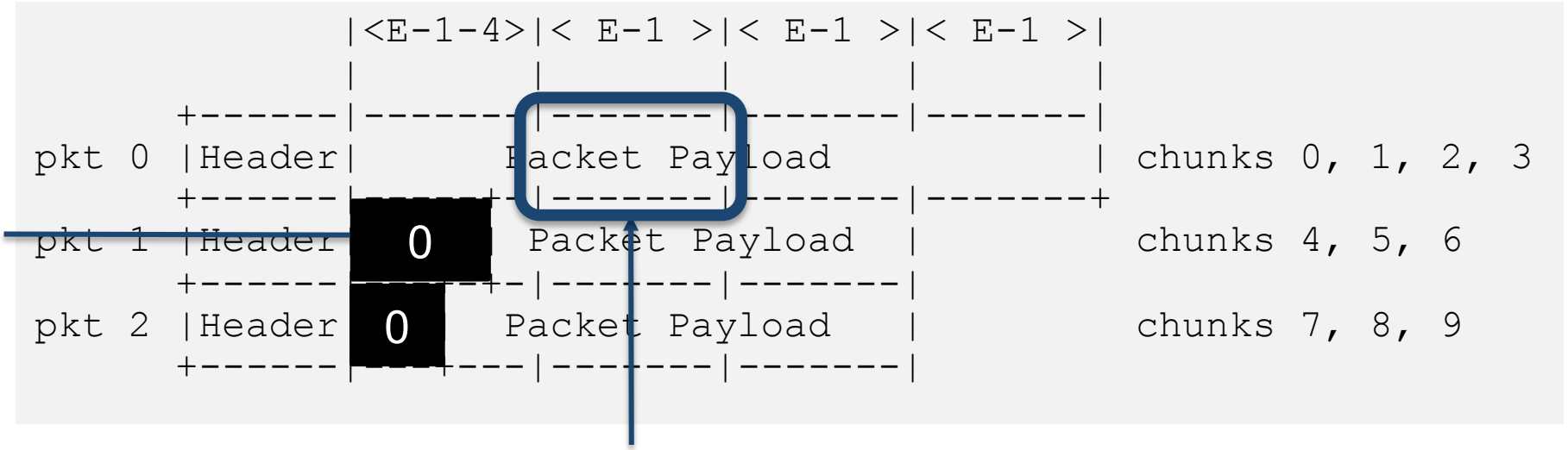
- requirements:
  1. packets are of variable size, symbols are of fixed size (E), so **we need a mapping**
  2. the **symbol size, E**, needs to be initialized wisely:
     - "small E" is fine when the QUIC packet sizes is largely variable (very small + a few very large packets), but has a cost
     - "large E" makes it simple (everything fits in a single symbol) but is suboptimal with a majority of small packets, and it may require to fragment the QUIC/UDP at IP level
     - E could be adjusted depending on the target use-case (if known)
  3. anticipate the potential need to **avoid exceeding the PMTU** (we add extra FEC related signaling)
     - choose E small enough

QUIC packet to source symbols mapping (2)

- **Step 1:** from QUIC packet payload to **chunks**
  - packet payload data is of **variable** size but source symbols are **fixed** size (E bytes)
  - use QUIC **zero padding FRAMES** **before*** the payload to align payload size

* to avoid problems with STREAM frames that do not encode their length

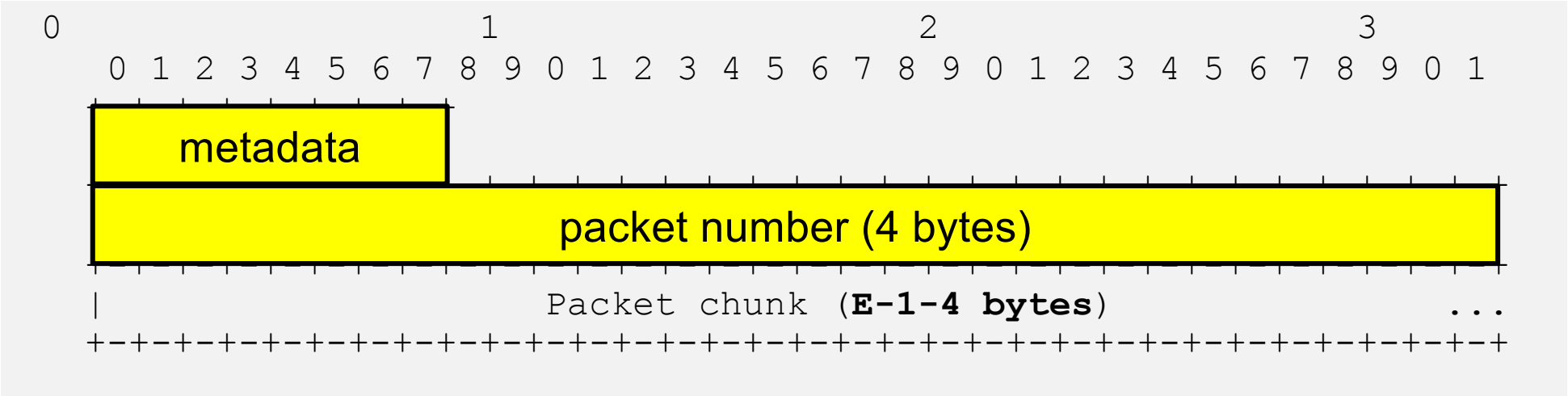
(1) pad with initial padding FRAMES to align packet size



(2) segment padded payloads into E-1 byte long chunks
(E-5 for the 1st one to leave room for additional info)

QUIC packet to source symbols mapping (3)

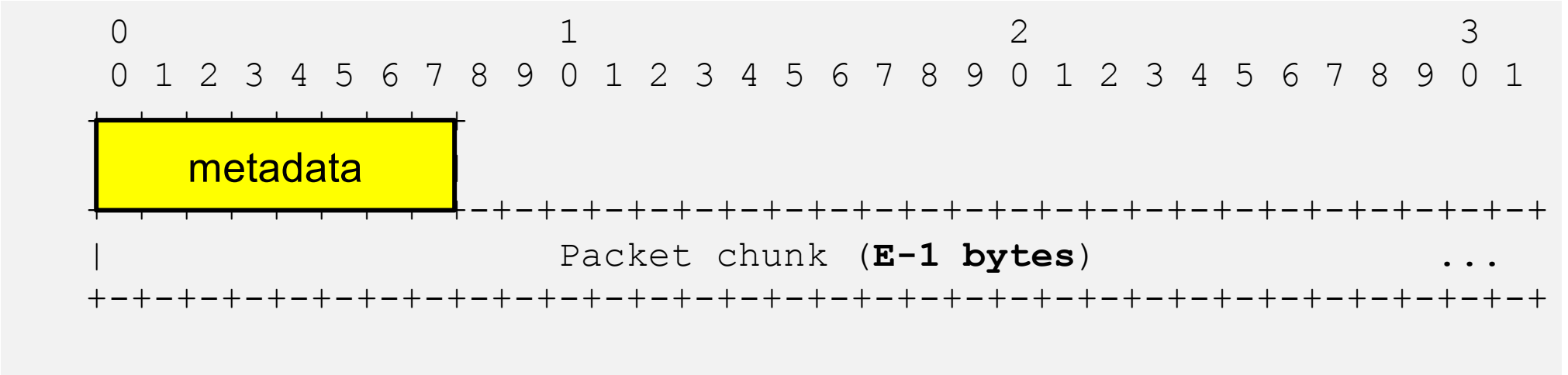
- **Step 2:** from a packet chunks to **source symbols**
  - **1st chunk:** prepend a long signaling (5 bytes)



<meta-data + packet number + 1st chunk> constitute the source symbol

QUIC packet to source symbols mapping (4)

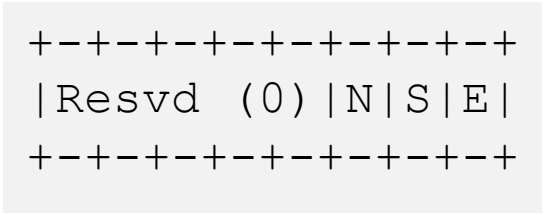
- **Step 2:** from a packet chunks to **source symbols**
  - 1st chunk: prepend a long signaling (5 bytes)
  - **following chunks:** prepend a short header (1 byte)



<meta-data + chunk> constitute the source symbol

QUIC packet to source symbols mapping (5)

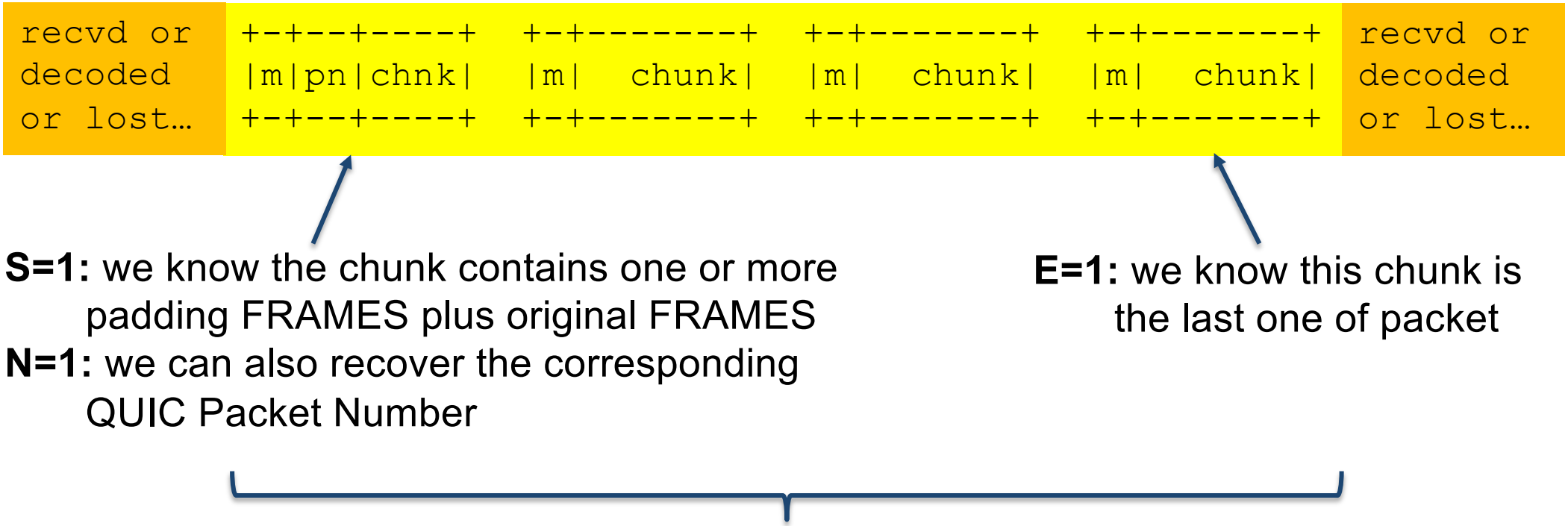
- **Step 2:** from a packet chunks to **source symbols**
  - meta-data (all chunks):
    - N: packet Number is there
    - S (start): first chunk of a QUIC packet
    - E (end): last chunk of a QUIC packet



  - Packet Number (4 bytes) (first chunk only, optional):
    - when "N" (Packet Number) field is 1 in the meta-data
    - required at a receiver to determine the QUIC packet number associated after decoding all the symbols of the lost packet

Yes, we need this extra meta-data / packet number

decoding successful for those 4 source symbols



S=1: we know the chunk contains one or more padding FRAMES plus original FRAMES

N=1: we can also recover the corresponding QUIC Packet Number

E=1: we know this chunk is the last one of packet

we have all chunks (S=1 | middle | middle | E=1) of the QUIC packet. Done ☺