More Accurate ECN Feedback in TCP

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Background & Problem

- **Explicit Congestion Notification (ECN):** Routers make packets as Congestion Experienced (CE) instead of dropping them in case of incipient congestion
- **ECN Feedback in RFC6831:** Receiver only provides feedback once per RTT to the sender
- **Accurate ECN (AccECN):** Receiver feeds back the accurate number of seen markings (within each RTT)

Overview AccECN

- **Capability Negotiation**: Repurposing the former NS (ECN Nonce Sum) TCP header flag
  ➡ fully backward compatible

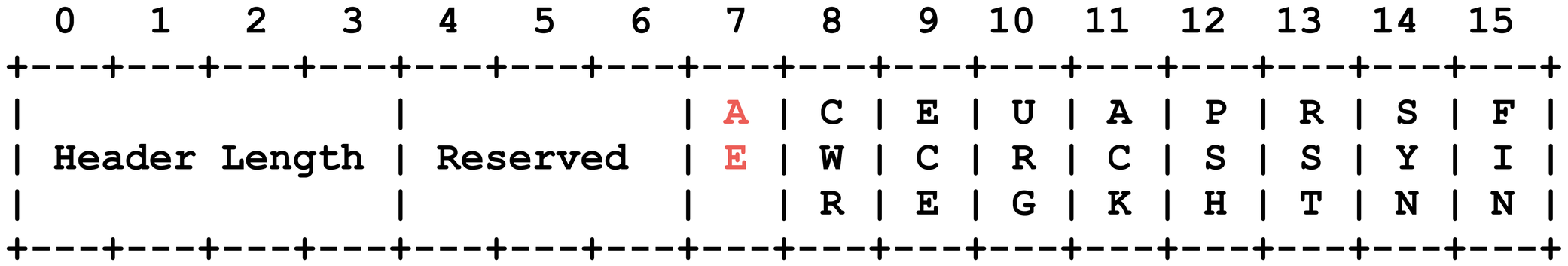
- **Essential Feedback:** Overloading the ECN TCP header flags (NS/ECE/CWR) as *Accurate ECN (ACE) field*
  - feed back the number of received CE marks (including control packets without payload)
  ➡ no overhead compared to classic ECN but limited resilience to loss

- **Supplementary Feedback:** Using a new *AccECN TCP Option*
  - provide additional feedback on the number of marked bytes

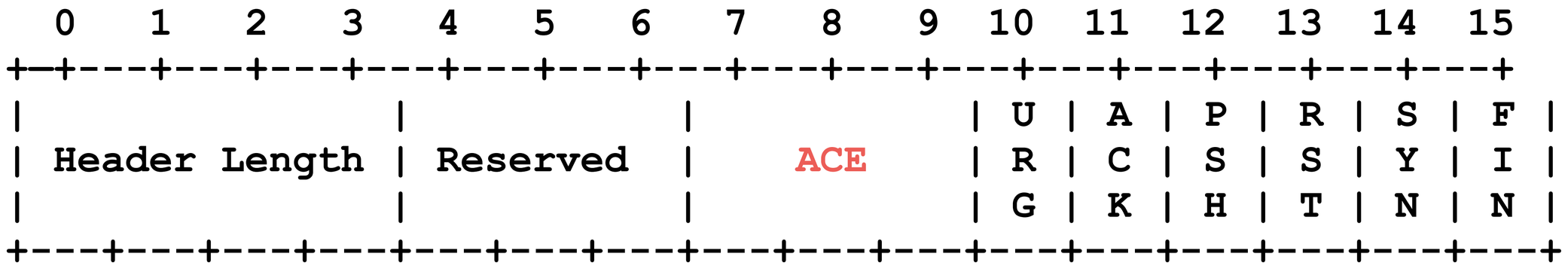
➡ **Both essential and supplementary parts:** receiver maintains ECN-IP-codepoint counters and AccECN repeats LSBs of counters for resilience

The ACE field

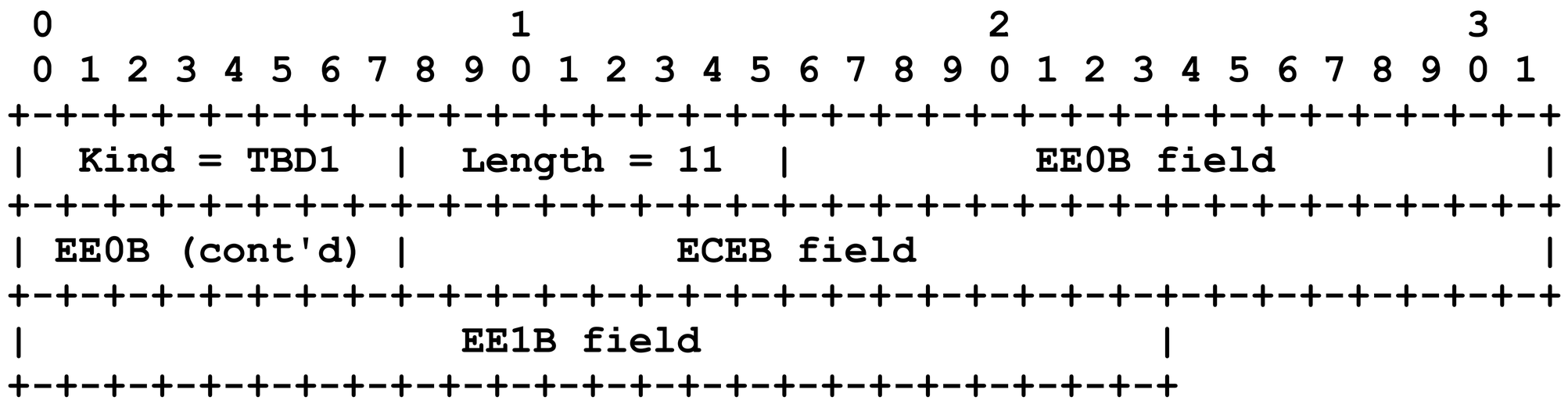
The (post-ECN Nonce) definition of the TCP header flags (bytes 13 & 14):



Definition of the ACE field (when AccECN has been negotiated and SYN=0):



The AccECN Option



EE0B number of bytes received with ECT(0) marked
ECEB* number of bytes received with CE marked
EE1B* number of bytes received with ECT(1) marked

***optional**

Usage of the AccECN TCP Option

- **Change-Triggered ACKs**
  MUST send immediate ACK If an arriving packet increments a different byte counter

- **Continual Repetition**
  SHOULD include if CE-bytes-counter has incremented (MUST give precedence to SACK if space is limited)

- **Full-Length Options Preferred**
  SHOULD always use full-length AccECN Options; MAY use shorter AccECN Options if space is limited, but it MUST include the counter(s) that have incremented since the previous AccECN Option

- **Beaconing Full-Length Options**
  MUST include a full-length AccECN TCP Option on at least three ACKs per RTT

Implementation Status

- Linux patch available: https://github.com/mirjak/linux-accecn/
  - Use of net.ipv4.tcp_ecn=4 to enable AccECN
  - Fallback detection mechanisms incl. recently added IP codepoint feedback in handshake not implemented yet
  - No counter wrap detection implemented yet
- TCP Experimental Option Experiment Identifier (TCP ExID) registered with IANA:
  - 0xACCE
  - TCP Option is requested with publication (IESG approval)

Re-assignment of the „NS“ flag

- RFC8311 "Relaxing Restrictions on Explicit Congestion Notification (ECN) Experimentation“ declares RFC 3540 (ECN Nonce) as historic and de-assigns the NS bit; now marked as „reserved“
- IANA TCP Header Flags registration policy is „Standards Action“
  - AccECN is an experimental TCP extension that uses the former NS bit for negotiation and as part of the ACE field
  - Hum at last tcpm meeting to assign to AccECN with IESG approval