Explicit Congestion Notification (RFC 3168)

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Overview

- Congestion Signaling Mechanism defined in RFC 3168
  - It uses two bits in the TCP header and two bits in the IP header
  - It marks the packets, where marking = flipping a bit in the headers
- ECN can be used with AQM algorithms
  - Instead of ‘dropping’ the packets, they can be ‘marked’
  - This avoids retransmissions (and hence, saves time!)
- Sender, Receiver and Router ‘all’ must support ECN functionality
  - Currently, ECN is implemented in all operating systems, but disabled by default
- Recommended by RFC 3168: ECN must not be applied to TCP control packets
  - SYN, SYN/ACK, ACK, FIN, RST, PSH, URG packets cannot be marked with ECN

ECN bits in the TCP header

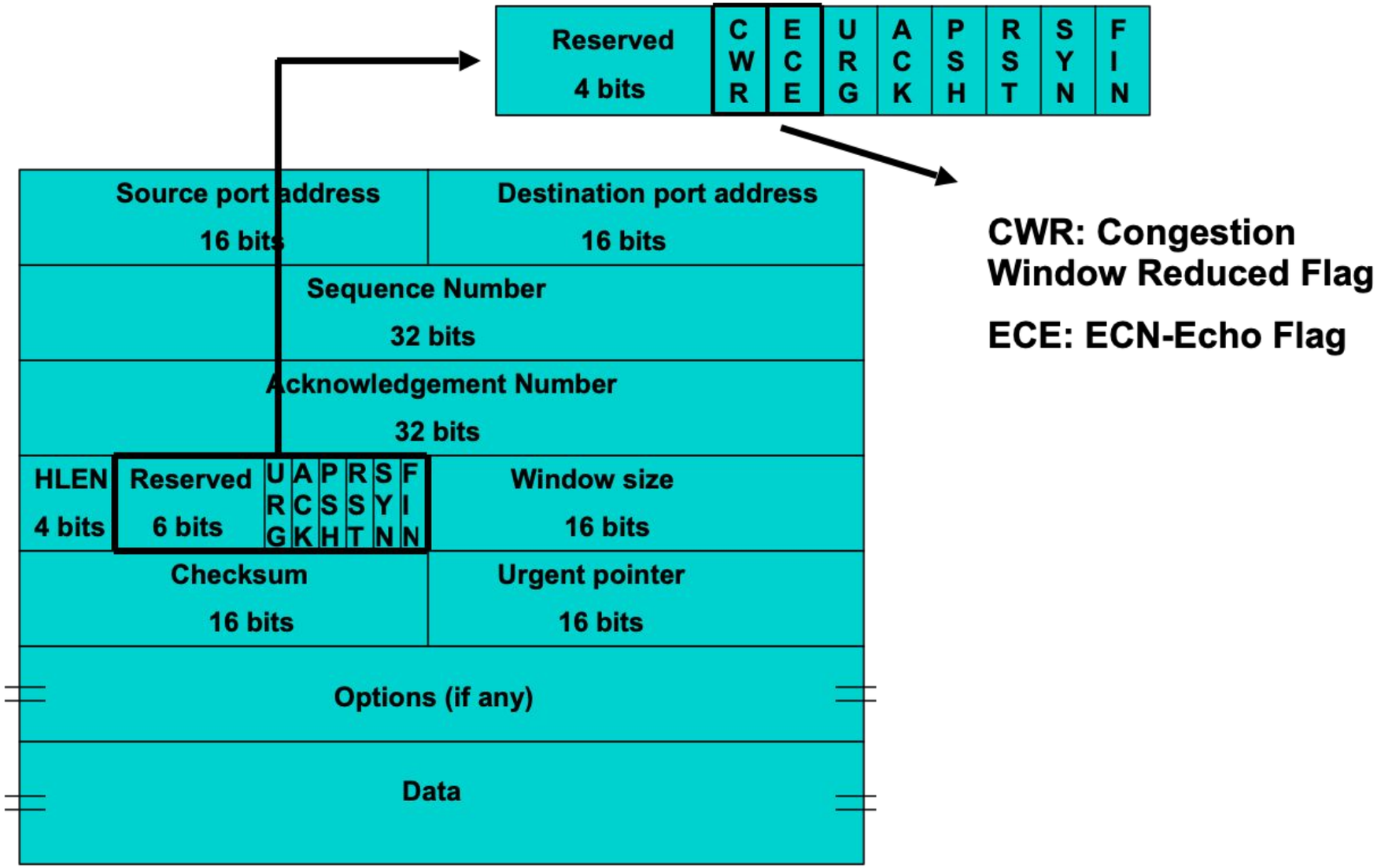
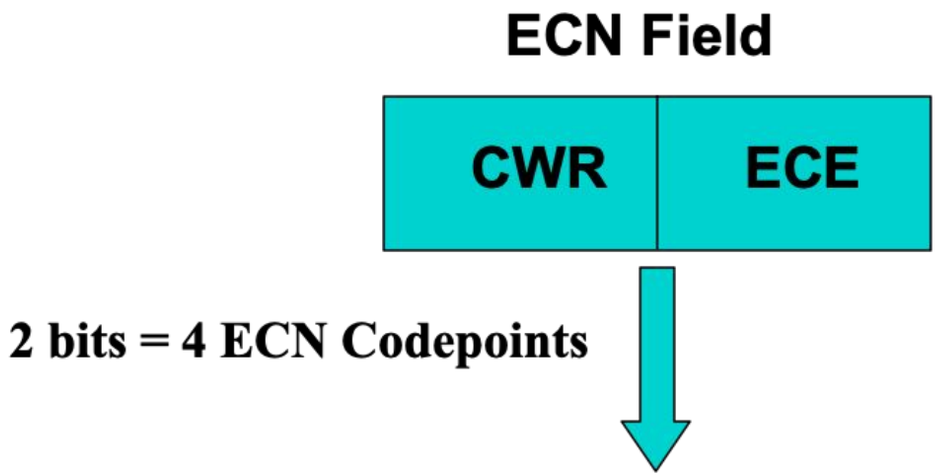


Image Credits: https://slidetodoc.com/explicit-congestion-notification-ecn-rfc-3168-cisc-856/

ECN Codepoints in the TCP header



CWR	ECE	Names for the ECN bits	Sent from	To
0	0	**Non-ECN Setup**	Any	Any
0	1	**ECN Echo**	Receiver	Sender
1	0	**Congestion Window Reduced**	Sender	Receiver
1	1	**ECN Setup**	Sender	Receiver

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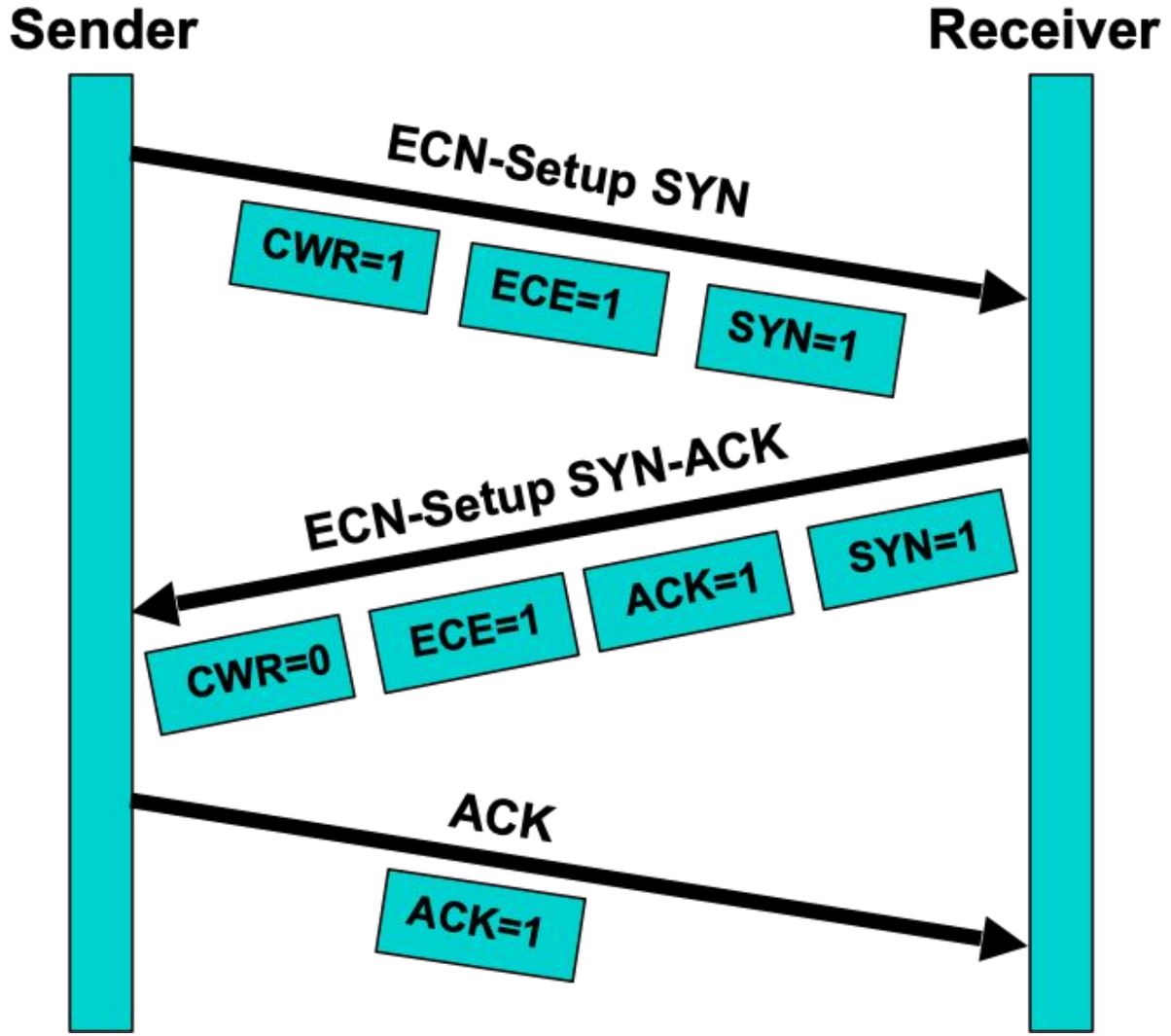
ECN Negotiation



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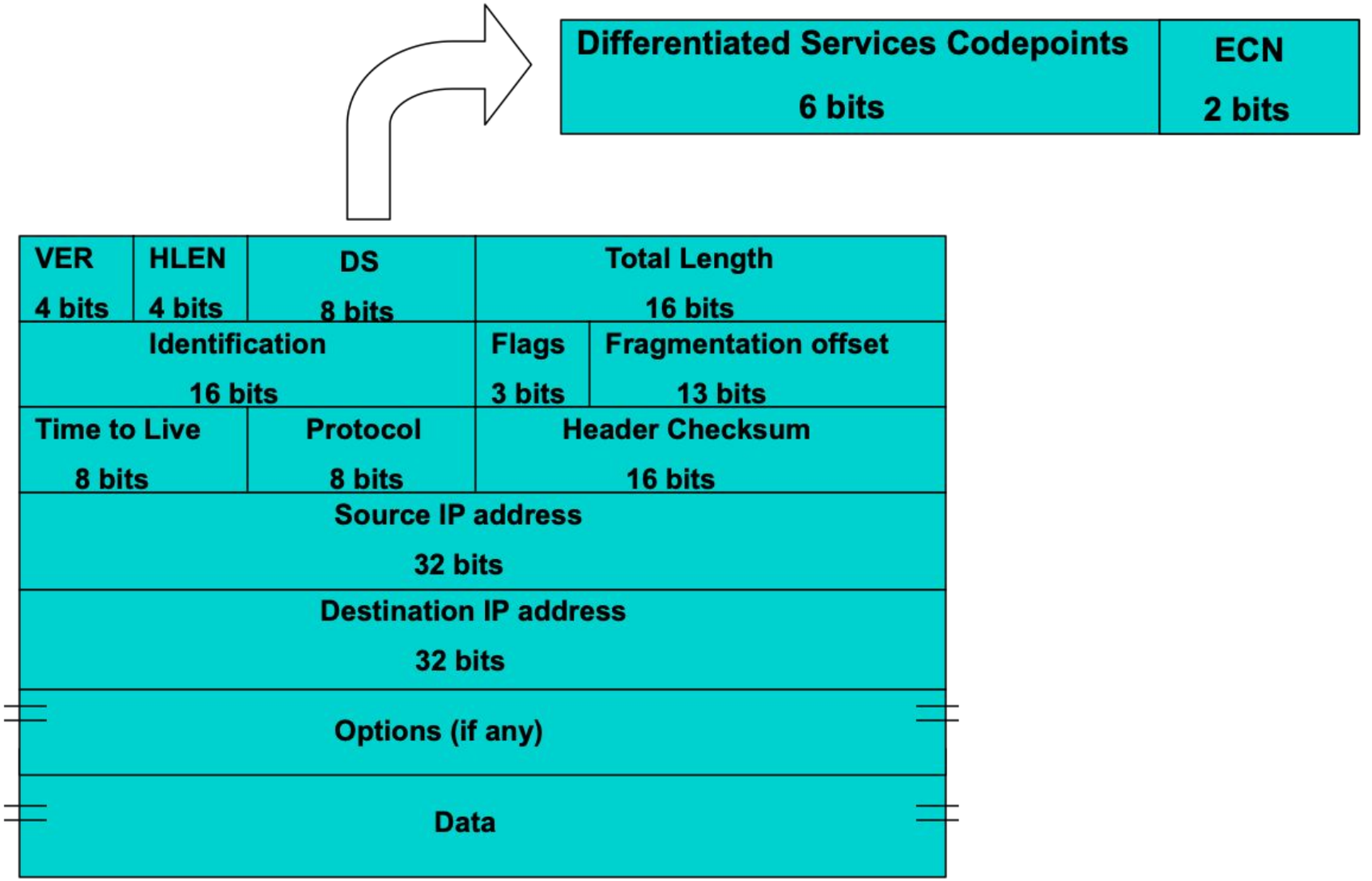
ECN bits in the IP header



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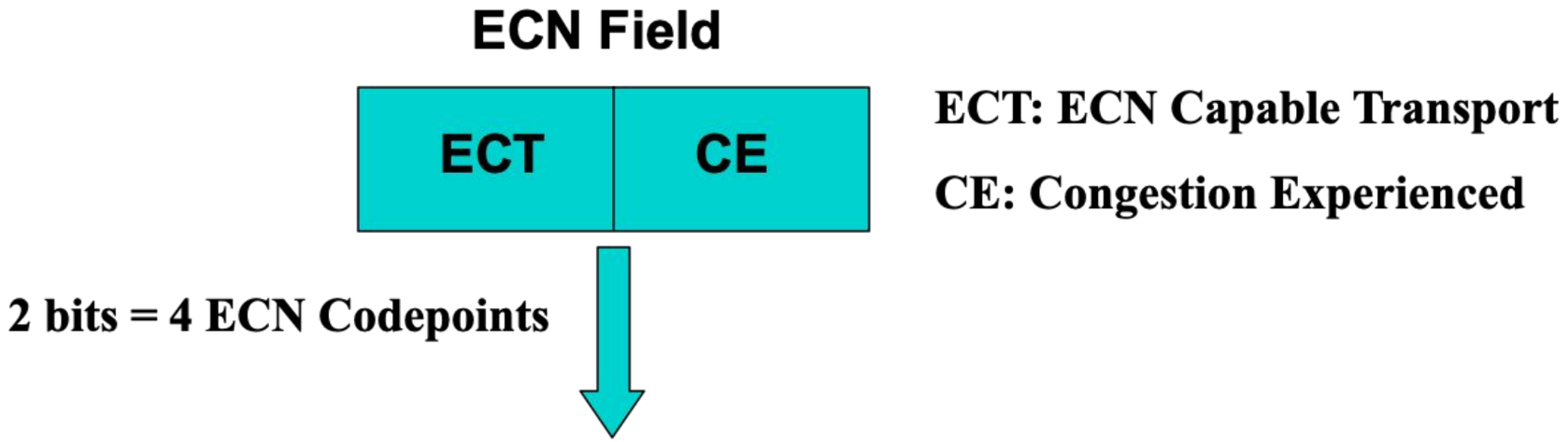

ECT	CE	Names for the ECN bits	Sent from	To
0	0	**Not-ECT** (Not ECN Capable Transport)	Any	Any
0	1	**ECT(1)** (ECN Capable Transport (1))	Sender	Receiver
1	0	**ECT(0)** (ECN Capable Transport (0))	Sender	Receiver
1	1	**CE** (Congestion Experienced)	Router	Receiver

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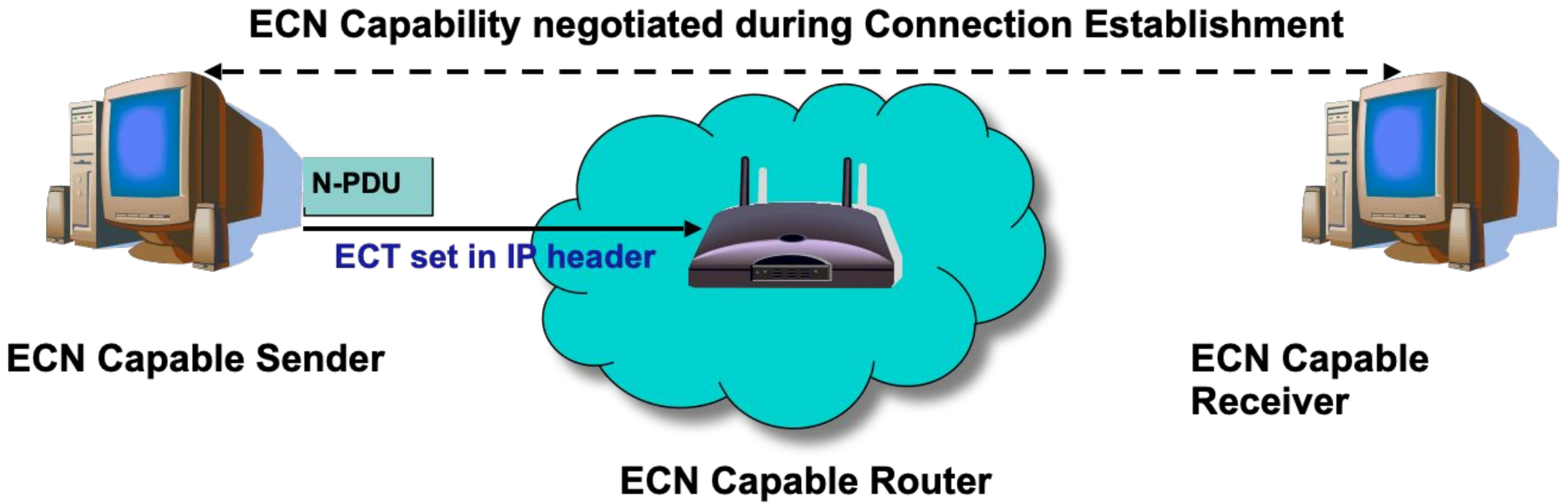
Working of ECN



ECN Codepoints	ECT bit value	CE bit value
Non-ECT	0	0
ECT(1)	0	1
ECT(0)	1	0
CE	1	1

ECN Codepoints	CWR bit value	ECE bit value
Not ECN-set up	0	0
ECN-Echo	0	1
CWR	1	0
ECN-set up	1	1

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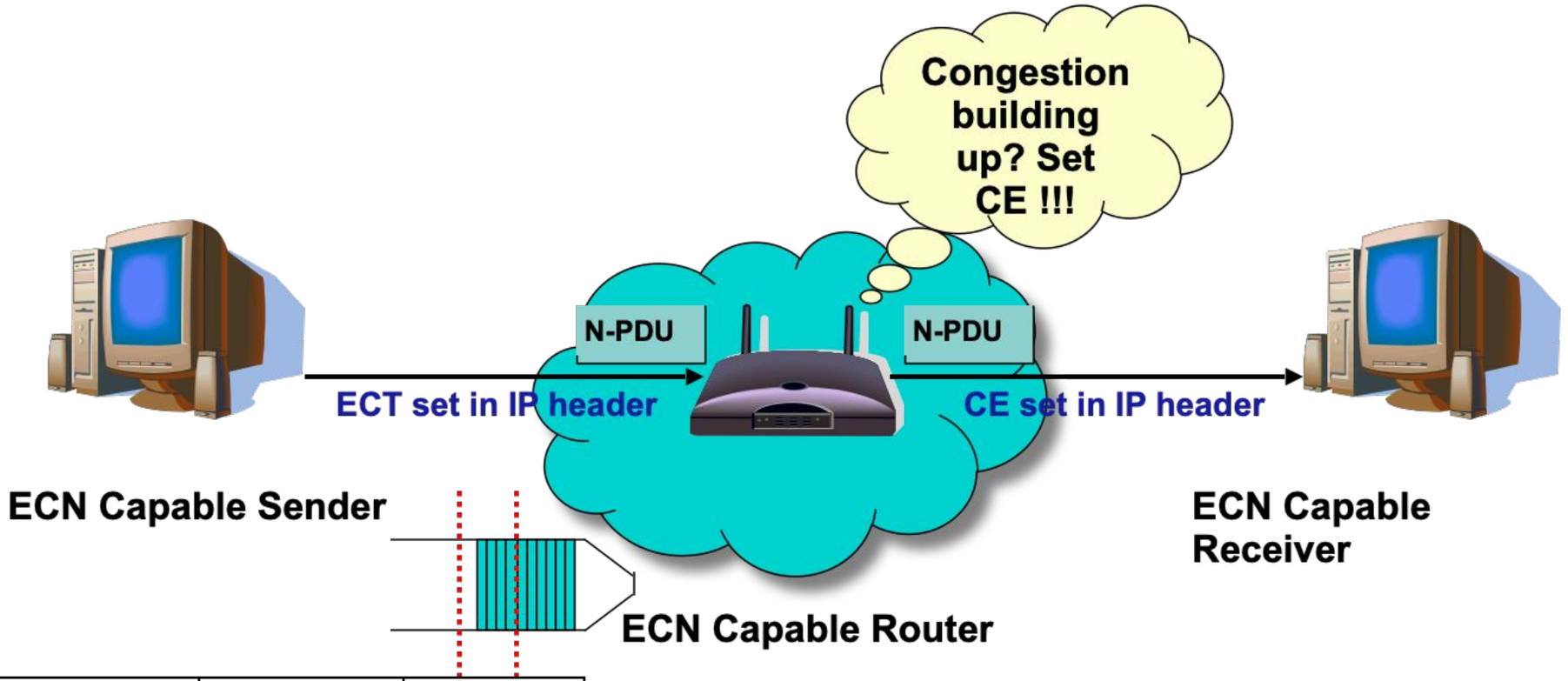
Working of ECN (contd ...)



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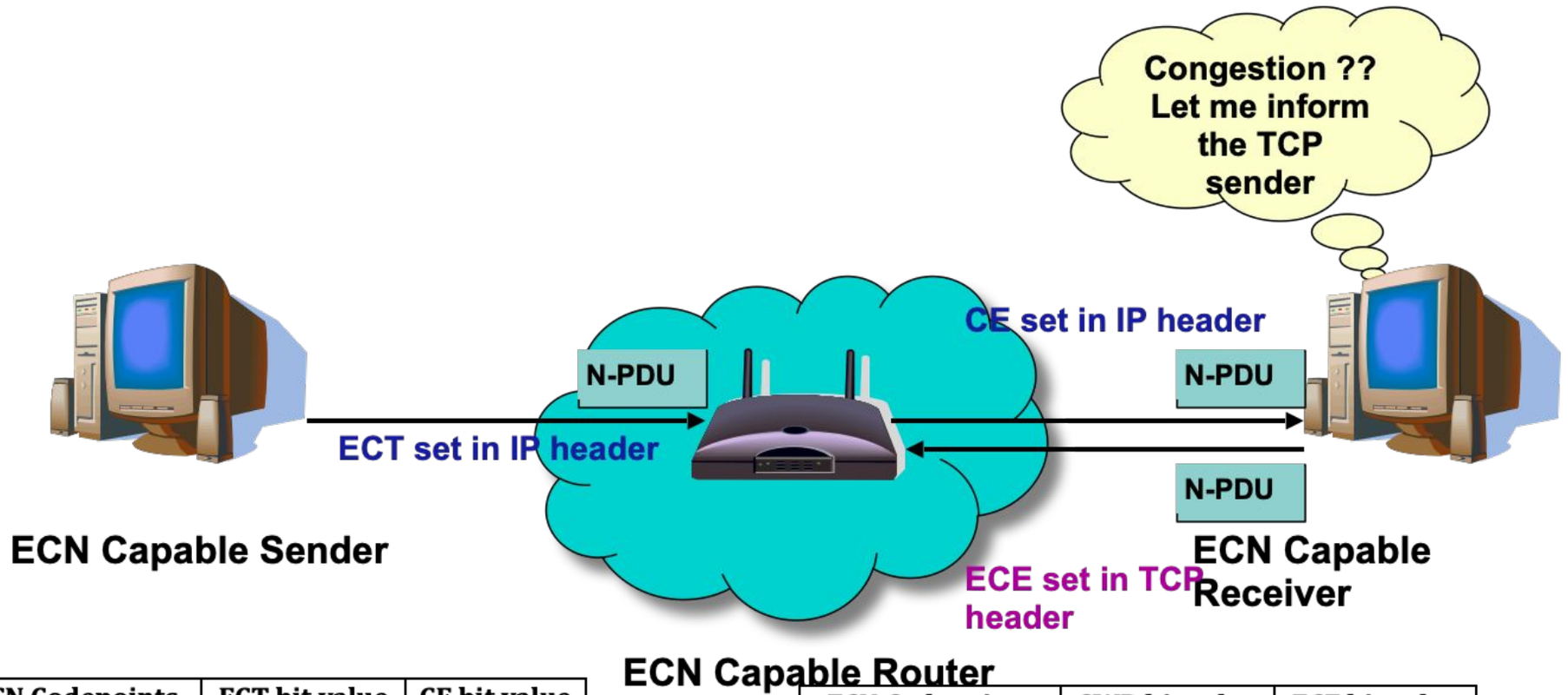

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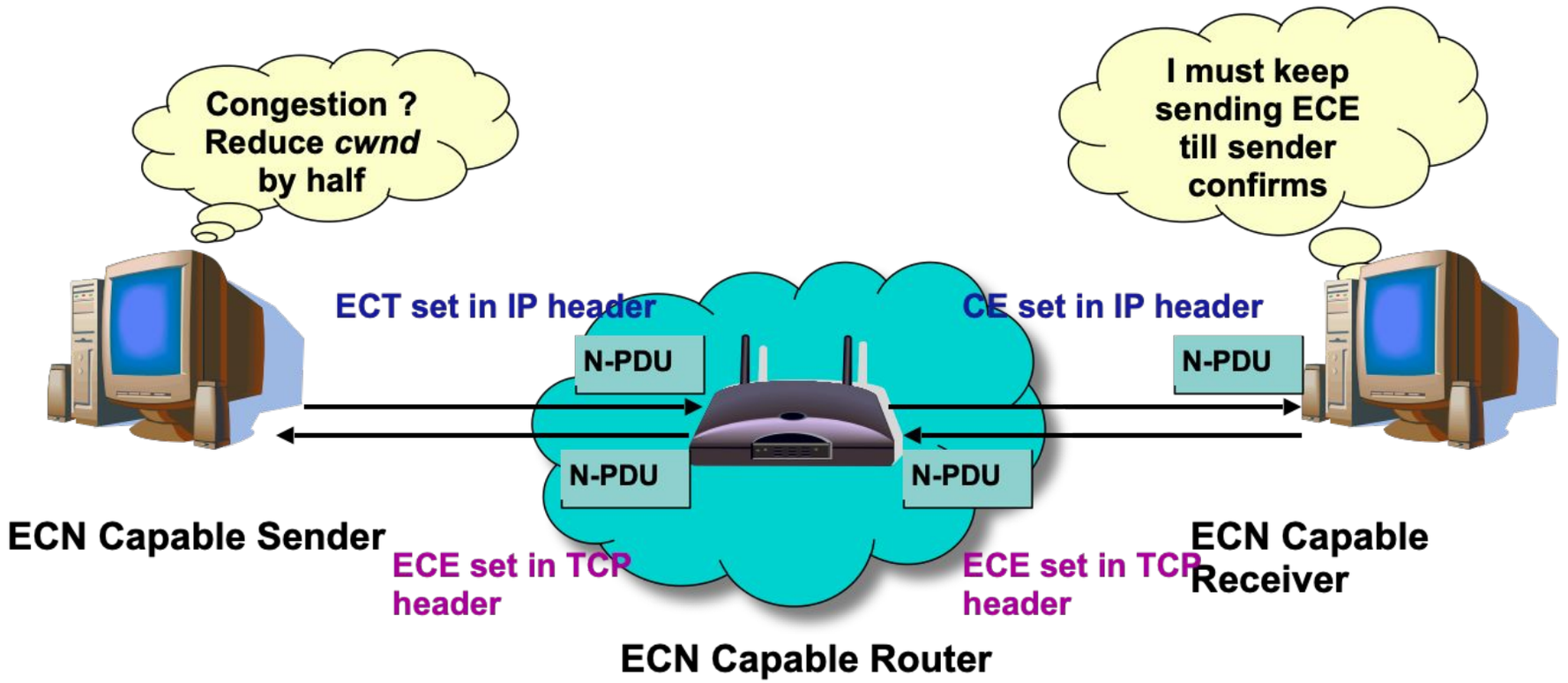

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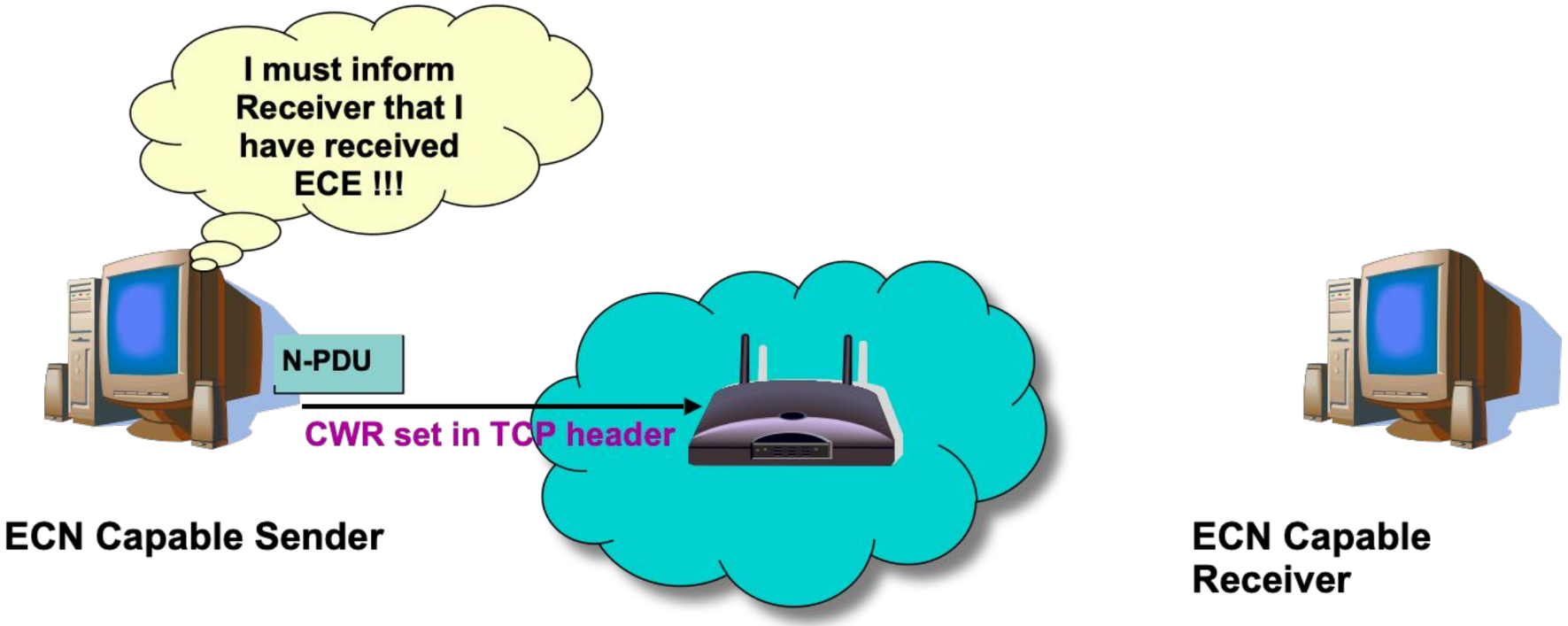

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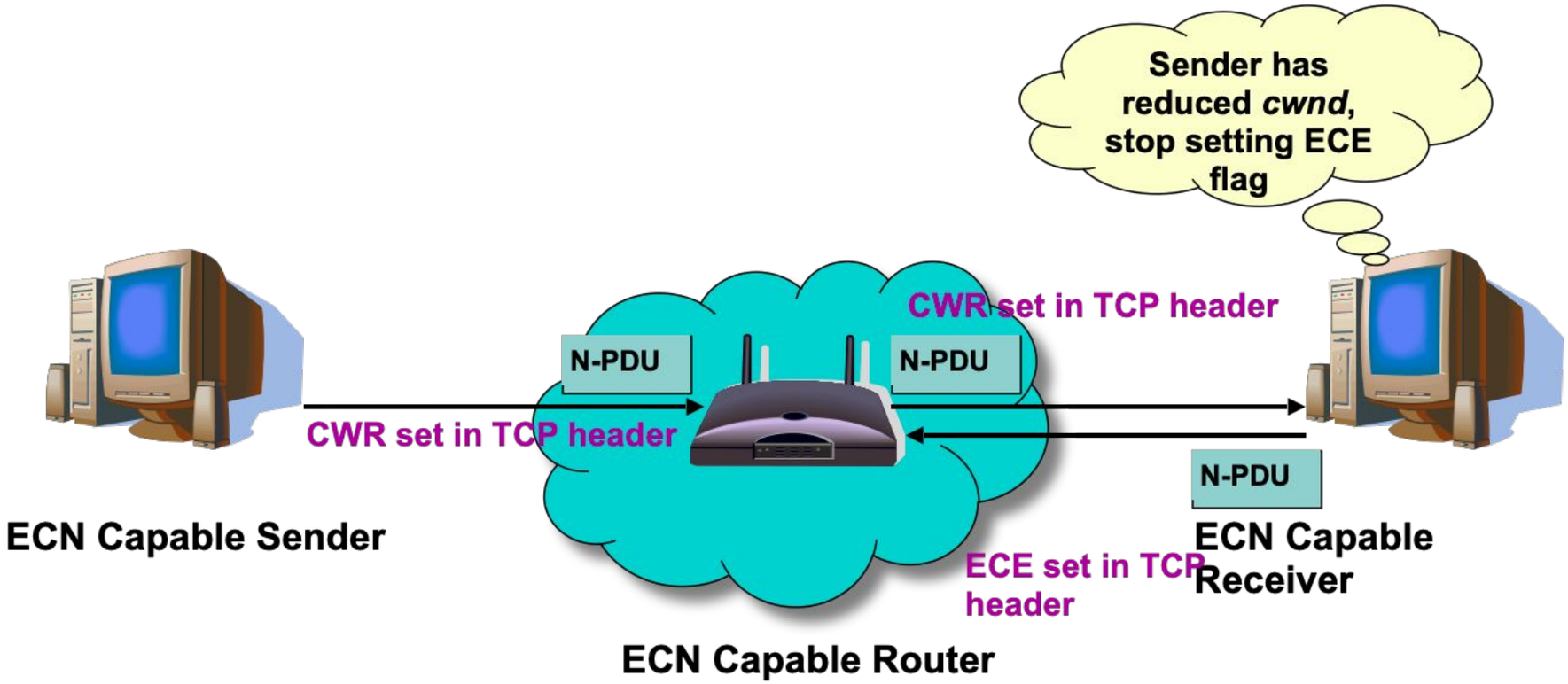

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Questions

Question 1:

What happens if a data packet arrives with CE as well as CWR at the receiver?

Question 2:

RFC 3168 recommends not to set CWR in a retransmitted packet. Why?

Question 3:

Should the sender set ECT(0) or ECT(1) on retransmitted packets?

Question 4:

How to enable ECN in the Linux kernel?

Recommended Reading

RFC 3168: The Addition of Explicit Congestion Notification (ECN) to IP
Link: https://datatracker.ietf.org/doc/html/rfc3168