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Explicit Congestion Notification (ECN) Experimentation
draft-ietf-tsvwg-ecn-experimentation-04

Abstract

This memo updates RFC 3168, which specifies Explicit Congestion Notification (ECN) as a replacement for packet drops as indicators of network congestion. It relaxes restrictions in RFC 3168 that would otherwise hinder experimentation towards benefits beyond just removal of loss. This memo summarizes the anticipated areas of experimentation and updates RFC 3168 to enable experimentation in these areas. An Experimental RFC is required to take advantage of any of these enabling updates. In addition, this memo makes related updates to the ECN specifications for RTP in RFC 6679 and for DCCP in RFC 4341, RFC 4342 and RFC 5622. This memo also records the conclusion of the ECN Nonce experiment in RFC 3540, and provides the rationale for reclassification of RFC 3540 as Historic; this reclassification enables new experimental use of the ECT(1) codepoint.

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1. Introduction

This memo updates RFC 3168 [RFC3168] which specifies Explicit Congestion Notification (ECN) as a replacement for packet drops as indicators of network congestion. It relaxes restrictions in RFC 3168 that would otherwise hinder experimentation towards benefits beyond just removal of loss. This memo summarizes the proposed areas of experimentation and updates RFC 3168 to enable experimentation in these areas. An Experimental RFC MUST be published for any protocol or mechanism that takes advantage of any of these enabling updates. Putting all of these updates into a single document enables experimentation to proceed without requiring a standards process exception for each Experimental RFC that needs changes to RFC 3168, a Proposed Standard RFC.

There is no need to make changes for protocols and mechanisms that are documented in Standards Track RFCs, as any Standards Track RFC can update RFC 3168 without needing a standards process exception.

In addition, this memo makes related updates to the ECN specification for RTP [RFC6679] and for three DCCP profiles ([RFC4341], [RFC4342] and [RFC5622]) for the same reason. Each experiment is still required to be documented in one or more separate RFCs, but use of Experimental RFCs for this purpose does not require a process exception to modify any of these Proposed Standard RFCs when the modification falls within the bounds established by this memo (RFC 5622 is an Experimental RFC; it is modified by this memo for consistency with modifications to the other two DCCP RFCs).

Some of the anticipated experimentation includes use of the ECT(1) codepoint that was dedicated to the ECN Nonce experiment in RFC 3540 [RFC3540]. This memo records the conclusion of the ECN Nonce experiment and provides the explanation for reclassification of RFC 3540 as Historic in order to enable new experimental use of the ECT(1) codepoint.

1.1. ECN Terminology

ECT: ECN-Capable Transport. One of the two codepoints ECT(0) or ECT(1) in the ECN field [RFC3168] of the IP header (v4 or v6). An ECN-capable sender sets one of these to indicate that both transport end-points support ECN.

Not-ECT: The ECN codepoint set by senders that indicates that the transport is not ECN-capable.

CE: Congestion Experienced. The ECN codepoint that an intermediate node sets to indicate congestion. A node sets an increasing proportion of ECT packets to CE as the level of congestion increases.

1.2. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

2. Proposed ECN Experiments: Background

Three areas of ECN experimentation are covered by this memo; the cited Internet-Drafts should be consulted for the detailed goals and rationale of each proposed experiment:

Congestion Response Differences: As discussed further in Section 4.1, an ECN congestion indication communicates a higher likelihood that a shorter queue exists at the network bottleneck node by comparison to a packet drop that indicates congestion [I-D.ietf-tcpm-alternativebackoff-ecn]. This difference suggests that for congestion indicated by ECN, a different sender congestion response (e.g., reduce the response so that the sender backs off by a smaller amount) may be appropriate by comparison to the sender response to congestion indicated by loss, e.g., as proposed in [I-D.ietf-tcpm-alternativebackoff-ecn] and [I-D.ietf-tsvwg-ecn-l4s-id] - the experiment in the latter draft couples the backoff change to Congestion Marking Differences changes (next bullet). This is at variance with RFC 3168's requirement that a sender's congestion control response to ECN congestion indications be the same as to drops. IETF approval, e.g., via an Experimental RFC, is required for any sender congestion response used in this area of experimentation.

Congestion Marking Differences: As discussed further in Section 4.2, when taken to its limit, congestion marking at network nodes can be configured to maintain very shallow queues in conjunction with a different IETF-approved congestion response to congestion indications (CE marks) at the sender, e.g., as proposed in [I-D.ietf-tsvwg-ecn-l4s-id]. The traffic involved needs to be identified by the senders to the network nodes in order to avoid damage to other network traffic whose senders do not expect the more frequent congestion marking used to maintain nearly empty queues. Use of different ECN codepoints, specifically ECT(0) and ECT(1), is a promising means of traffic identification for this purpose, but that technique is at variance with RFC 3168's

requirement that ECT(0)-marked traffic and ECT(1)-marked traffic not receive different treatment in the network.

TCP Control Packets and Retransmissions: RFC 3168 limits the use of ECN with TCP to data packets, excluding retransmissions. With the successful deployment of ECN in large portions of the Internet, there is interest in extending the benefits of ECN to TCP control packets (e.g., SYNs) and retransmitted packets, e.g., as proposed in [I-D.bagnulo-tcpm-generalized-ecn]. This is at variance with RFC 3168's prohibition of use of ECN for TCP control packets and retransmitted packets.

The scope of this memo is limited to these three areas of experimentation. This memo expresses no view on the likely outcomes of the proposed experiments and does not specify the experiments in detail. Additional experiments in these areas are possible, e.g., on use of ECN to support deployment of a protocol similar to DCTCP [I-D.ietf-tcpm-dctcp] beyond DCTCP's current applicability that is limited to data center environments. The purpose of this memo is to remove constraints in standards track RFCs that stand in the way of these areas of experimentation.

3. ECN Nonce and RFC 3540

As specified in RFC 3168, ECN uses two ECN Capable Transport (ECT) codepoints to indicate that a packet supports ECN, ECT(0) and ECT(1), with the second codepoint used to support ECN nonce functionality to discourage receivers from exploiting ECN to improve their throughput at the expense of other network users, as specified in experimental RFC 3540 [RFC3540]. This section explains why RFC 3540 is being reclassified as Historic and makes associated updates to RFC 3168.

While the ECN Nonce works as specified, and has been deployed in limited environments, widespread usage in the Internet has not materialized. A study of the ECN behaviour of the Alexa top 1M web servers using 2014 data [Trammell15] found that after ECN was negotiated, none of the 581,711 IPv4 servers tested were using both ECT codepoints, which would have been a possible sign of ECN Nonce usage. Of the 17,028 IPv6 servers tested, 4 set both ECT(0) and ECT(1) on data packets. This might have been evidence of use of the ECN Nonce by these 4 servers, but might equally have been due to re-marking of the ECN field by an erroneous middlebox or router.

With the emergence of new experimental functionality that depends on use of the ECT(1) codepoint for other purposes, continuing to reserve that codepoint for the ECN Nonce experiment is no longer justified. In addition, other approaches to discouraging receivers from exploiting ECN have emerged, see Appendix B.1 of

[I-D.ietf-tsvwg-ecn-l4s-id]. Therefore, in support of ECN experimentation with the ECT(1) codepoint, this memo:

- o Declares that the ECN Nonce experiment [RFC3540] has concluded, and notes the absence of widespread deployment.

- o Updates RFC 3168 [RFC3168] to remove discussion of the ECN Nonce and use of ECT(1) for that Nonce. The specific text updates are omitted for brevity.

4. Updates to RFC 3168

The following subsections specify updates to RFC 3168 to enable the three areas of experimentation summarized in Section 2.

4.1. Congestion Response Differences

RFC 3168 specifies that senders respond identically to packet drops and ECN congestion indications. ECN congestion indications are predominately originated by Active Queue Management (AQM) mechanisms in intermediate buffers. AQM mechanisms are usually configured to maintain shorter queue lengths than non-AQM based mechanisms, particularly non-AQM drop-based mechanisms such as tail-drop, as AQM mechanisms indicate congestion before the queue overflows. While the occurrence of loss does not easily enable the receiver to determine if AQM is used, the receipt of an ECN Congestion Experienced (CE) mark conveys a strong likelihood that AQM was used to manage the bottleneck queue. Hence an ECN congestion indication communicates a higher likelihood that a shorter queue exists at the network bottleneck node by comparison to a packet drop that indicates congestion [I-D.ietf-tcpm-alternativebackoff-ecn]. This difference suggests that for congestion indicated by ECN, a different sender congestion response (e.g., reduce the response so that the sender backs off by a smaller amount) may be appropriate by comparison to the sender response to congestion indicated by loss. However, section 5 of RFC 3168 specifies that:

> Upon the receipt by an ECN-Capable transport of a single CE packet, the congestion control algorithms followed at the end-systems MUST be essentially the same as the congestion control response to a *single* dropped packet.

This memo updates this RFC 3168 text to allow the congestion control response (including the TCP Sender's congestion control response) to a CE-marked packet to differ from the response to a dropped packet, provided that the changes from RFC 3168 are documented in an Experimental RFC. The specific change to RFC 3168 is to insert the

words "unless otherwise specified by an Experimental RFC" at the end of the sentence quoted above.

RFC 4774 [RFC4774] quotes the above text from RFC 3168 as background, but does not impose requirements based on that text. Therefore no update to RFC 4774 is required to enable this area of experimentation.

Section 6.1.2 of RFC 3168 specifies that:

> If the sender receives an ECN-Echo (ECE) ACK packet (that is, an ACK packet with the ECN-Echo flag set in the TCP header), then the sender knows that congestion was encountered in the network on the path from the sender to the receiver. The indication of congestion should be treated just as a congestion loss in non-ECN-Capable TCP. That is, the TCP source halves the congestion window "cwnd" and reduces the slow start threshold "ssthresh".

This memo also updates this RFC 3168 text to allow the congestion control response (including the TCP Sender's congestion control response) to a CE-marked packet to differ from the response to a dropped packet, provided that the changes from RFC 3168 are documented in an Experimental RFC. The specific change to RFC 3168 is to insert the words "Unless otherwise specified by an Experimental RFC" at the beginning of the second sentence quoted above.

4.2. Congestion Marking Differences

Taken to its limit, an AQM algorithm that uses ECN congestion indications can be configured to maintain very shallow queues, thereby reducing network latency by comparison to maintaining a larger queue. Significantly more aggressive sender responses to ECN are required to make effective use of such shallow queues; Datacenter TCP (DCTCP) [I-D.ietf-tcpm-dctcp] provides an example. In this case, separate network node treatments are essential, both to prevent the aggressive low latency traffic starving conventional traffic (if present) and to prevent any conventional traffic disruption to any lower latency service that uses the shallow queues. Use of different ECN codepoints is a promising means of identifying these two classes of traffic to network nodes, and hence this area of experimentation is based on the use of the ECT(1) codepoint to request ECN congestion marking behavior in the network that differs from ECT(0) counterbalanced by use of a different IETF-approved congestion response to CE marks at the sender, e.g., as proposed in [I-D.ietf-tsvwg-ecn-l4s-id].

Section 5 of RFC 3168 specifies that:

> Routers treat the ECT(0) and ECT(1) codepoints as equivalent.

This memo updates RFC 3168 to allow routers to treat the ECT(0) and ECT(1) codepoints differently, provided that the changes from RFC 3168 are documented in an Experimental RFC. The specific change to RFC 3168 is to insert the words "unless otherwise specified by an Experimental RFC" at the end of the above sentence.

When an AQM is configured to use ECN congestion indications to maintain a nearly empty queue, congestion indications are marked on packets that would not have been dropped if ECN was not in use. Section 5 of RFC 3168 specifies that:

> For a router, the CE codepoint of an ECN-Capable packet SHOULD only be set if the router would otherwise have dropped the packet as an indication of congestion to the end nodes. When the router's buffer is not yet full and the router is prepared to drop a packet to inform end nodes of incipient congestion, the router should first check to see if the ECT codepoint is set in that packet's IP header. If so, then instead of dropping the packet, the router MAY instead set the CE codepoint in the IP header.

This memo updates RFC 3168 to allow congestion indications that are not equivalent to drops, provided that the changes from RFC 3168 are documented in an Experimental RFC. The specific change is to change "For a router," to "Unless otherwise specified by an Experimental RFC" at the beginning of the first sentence of the above paragraph.

A larger update to RFC 3168 is necessary to enable sender usage of ECT(1) to request network congestion marking behavior that maintains nearly empty queues at network nodes. When using loss as a congestion signal, the number of signals provided should be reduced to a minimum and hence only presence or absence of congestion is communicated. In contrast, ECN can provide a richer signal, e.g., to indicate the current level of congestion, without the disadvantage of a larger number of packet losses. A proposed experiment in this area, Low Latency Low Loss Scalable throughput (L4S) [I-D.ietf-tsvwg-ecn-l4s-id] significantly increases the CE marking probability for ECT(1)-marked traffic in a fashion that would interact badly with existing sender congestion response functionality because that functionality assumes that the network marks ECT packets as frequently as it would drop Not-ECT packets. If network traffic that uses such a conventional sender congestion response were to encounter L4S's increased marking probability (and hence rate) at a network bottleneck queue, the resulting traffic throughput is likely to be much less than intended for the level of congestion at the bottleneck queue.

To avoid that interaction, this memo reserves ECT(1) for experimentation, initially for L4S. The specific update to Section 5 of RFC 3168 is to remove the following two paragraphs:

> Senders are free to use either the ECT(0) or the ECT(1) codepoint to indicate ECT, on a packet-by-packet basis.
>
> The use of both the two codepoints for ECT, ECT(0) and ECT(1), is motivated primarily by the desire to allow mechanisms for the data sender to verify that network elements are not erasing the CE codepoint, and that data receivers are properly reporting to the sender the receipt of packets with the CE codepoint set, as required by the transport protocol. Guidelines for the senders and receivers to differentiate between the ECT(0) and ECT(1) codepoints will be addressed in separate documents, for each transport protocol. In particular, this document does not address mechanisms for TCP end-nodes to differentiate between the ECT(0) and ECT(1) codepoints. Protocols and senders that only require a single ECT codepoint SHOULD use ECT(0).

and replace it with this paragraph:

> Protocols and senders MUST use the ECT(0) codepoint to indicate ECT unless otherwise specified by an Experimental RFC. Guidelines for senders and receivers to differentiate between the ECT(0) and ECT(1) codepoints will be addressed in separate documents, for each transport protocol. In particular, this document does not address mechanisms for TCP end-nodes to differentiate between the ECT(0) and ECT(1) codepoints.

Congestion Marking Differences experiments SHOULD modify the network behavior for ECT(1)-marked traffic rather than ECT(0)-marked traffic if network behavior for only one ECT codepoint is modified. Congestion Marking Differences experiments MUST NOT modify the network behavior for ECT(0)-marked traffic in a fashion that requires changes to sender congestion response to obtain desired network behavior. If a Congestion Marking Differences experiment modifies the network behavior for ECT(1)-marked traffic, e.g., CE-marking behavior, in a fashion that requires changes to sender congestion response to obtain desired network behavior, then the Experimental RFC for that experiment MUST specify:

- o The sender congestion response to CE marking in the network, and
- o Router behavior changes, or the absence thereof, in forwarding CE-marked packets that are part of the experiment.

In addition, until the conclusion of the L4S experiment, use of ECT(1) in IETF RFCs is not appropriate, as the IETF may decide to allocate ECT(1) exclusively for L4S usage if the L4S experiment is successful.

In addition, this memo updates RFC 3168 to remove discussion of the ECN Nonce, as noted in Section 3 above.

4.3. TCP Control Packets and Retransmissions

With the successful use of ECN for traffic in large portions of the Internet, there is interest in extending the benefits of ECN to TCP control packets (e.g., SYNs) and retransmitted packets, e.g., as proposed by ECN++ [I-D.bagnulo-tcpm-generalized-ecn].

RFC 3168 prohibits use of ECN for TCP control packets and retransmitted packets in a number of places:

- "To ensure the reliable delivery of the congestion indication of the CE codepoint, an ECT codepoint MUST NOT be set in a packet unless the loss of that packet in the network would be detected by the end nodes and interpreted as an indication of congestion." (Section 5.2)

- "A host MUST NOT set ECT on SYN or SYN-ACK packets." (Section 6.1.1)

- "pure acknowledgement packets (e.g., packets that do not contain any accompanying data) MUST be sent with the not-ECT codepoint." (Section 6.1.4)

- "This document specifies ECN-capable TCP implementations MUST NOT set either ECT codepoint (ECT(0) or ECT(1)) in the IP header for retransmitted data packets, and that the TCP data receiver SHOULD ignore the ECN field on arriving data packets that are outside of the receiver's current window." (Section 6.1.5)

- "the TCP data sender MUST NOT set either an ECT codepoint or the CWR bit on window probe packets." (Section 6.1.6)

This memo updates RFC 3168 to allow the use of ECT codepoints on SYN and SYN-ACK packets, pure acknowledgement packets, window probe packets and retransmissions of packets that were originally sent with an ECT codepoint, provided that the changes from RFC 3168 are documented in an Experimental RFC. The specific change to RFC 3168 is to insert the words "unless otherwise specified by an Experimental RFC" at the end of each sentence quoted above.

In addition, beyond requiring TCP senders not to set ECT on TCP control packets and retransmitted packets, RFC 3168 is silent on whether it is appropriate for a network element, e.g. a firewall, to discard such a packet as invalid. For this area of ECN experimentation to be useful, middleboxes ought not to do that, therefore RFC 3168 is updated by adding the following text to the end of Section 6.1.1.1 on Middlebox Issues:

> Unless otherwise specified by an Experimental RFC, middleboxes SHOULD NOT discard TCP control packets and retransmitted TCP packets solely because the ECN field in the IP header does not contain Not-ECT. An exception to this requirement occurs in responding to an ongoing attack. For example, as part of the response, it may be appropriate to drop more ECT-marked TCP SYN packets than TCP SYN packets marked with not-ECT. Any such exceptional discarding of TCP control packets and retransmitted TCP packets in response to an attack MUST NOT be done routinely in the absence of an attack and SHOULD only be done if it is determined that the ECT capability is contributing to the attack.

4.4. Effective Congestion Control is Required

Congestion control remains an important aspect of the Internet architecture [RFC2914]. Any Experimental RFC that takes advantage of this memo's updates to any RFC is required to discuss the congestion control implications of the experiment(s) in order to provide assurance that deployment of the experiment(s) does not pose a congestion-based threat to the operation of the Internet.

5. ECN for RTP Updates to RFC 6679

RFC 6679 [RFC6679] specifies use of ECN for RTP traffic; it allows use of both the ECT(0) and ECT(1) codepoints, and provides the following guidance on use of these codepoints in section 7.3.1 :

> The sender SHOULD mark packets as ECT(0) unless the receiver expresses a preference for ECT(1) or for a random ECT value using the "ect" parameter in the "a=ecn-capable-rtp:" attribute.

The Congestion Marking Differences area of experimentation increases the potential consequences of using ECT(1) instead of ECT(0), and hence the above guidance is updated by adding the following two sentences:

> Random ECT values MUST NOT be used, as that may expose RTP to differences in network treatment of traffic marked with ECT(1) and ECT(0) and differences in associated endpoint congestion responses, e.g., as proposed in [I-D.ietf-tsvwg-ecn-l4s-id]. In

addition, ECT(0) MUST be used unless otherwise specified in an Experimental RFC.

Section 7.3.3 of RFC 6679 specifies RTP's response to receipt of CE marked packets as being identical to the response to dropped packets:

> The reception of RTP packets with ECN-CE marks in the IP header is a notification that congestion is being experienced. The default reaction on the reception of these ECN-CE-marked packets MUST be to provide the congestion control algorithm with a congestion notification that triggers the algorithm to react as if packet loss had occurred. There should be no difference in congestion response if ECN-CE marks or packet drops are detected.

In support of Congestion Response Differences experimentation, this memo updates this text in a fashion similar to RFC 3168 to allow the RTP congestion control response to a CE-marked packet to differ from the response to a dropped packet, provided that the changes from RFC 6679 are documented in an Experimental RFC. The specific change to RFC 6679 is to insert the words "Unless otherwise specified by an Experimental RFC" and reformat the last two sentences to be subject to that condition, i.e.:

> The reception of RTP packets with ECN-CE marks in the IP header is a notification that congestion is being experienced. Unless otherwise specified by an Experimental RFC:
>
> * The default reaction on the reception of these ECN-CE-marked packets MUST be to provide the congestion control algorithm with a congestion notification that triggers the algorithm to react as if packet loss had occurred.
>
> * There should be no difference in congestion response if ECN-CE marks or packet drops are detected.

The second sentence of the immediately following paragraph in RFC 6679 requires a related update:

> Other reactions to ECN-CE may be specified in the future, following IETF Review. Detailed designs of such additional reactions MUST be specified in a Standards Track RFC and be reviewed to ensure they are safe for deployment under any restrictions specified.

The update is to change "Standards Track RFC" to "Standards Track RFC or Experimental RFC" for consistency with the first update.

6. ECN for DCCP Updates to RFCs 4341, 4342 and 5622

The specifications of the three DCCP Congestion Control IDs (CCIDs) 2 [RFC4341], 3 [RFC4342] and 4 [RFC5622] contain broadly the same wording as follows:

> each DCCP-Data and DCCP-DataAck packet is sent as ECN Capable with either the ECT(0) or the ECT(1) codepoint set.

This memo updates these sentences in each of the three RFCs as follows:

> each DCCP-Data and DCCP-DataAck packet is sent as ECN Capable. Unless otherwise specified by an Experimental RFC, such DCCP senders MUST set the ECT(0) codepoint.

In support of Congestion Marking Differences experimentation (as noted in Section 3), this memo also updates all three of these RFCs to remove discussion of the ECN Nonce. The specific text updates are omitted for brevity.

7. Acknowledgements

The content of this draft, including the specific portions of RFC 3168 that are updated draws heavily from [I-D.khademi-tsvwg-ecn-response], whose authors are gratefully acknowledged. The authors of the Internet Drafts describing the experiments have motivated the production of this memo - their interest in innovation is welcome and heartily acknowledged. Colin Perkins suggested updating RFC 6679 on RTP and provided guidance on where to make the updates.

The draft has been improved as a result of comments from a number of reviewers, including Spencer Dawkins, Gorry Fairhurst, Ingemar Johansson, Naeem Khademi, Mirja Kuehlewind, Karen Nielsen and Michael Welzl. Bob Briscoe's thorough review of an early version of this draft resulted in numerous improvements including addition of the updates to the DCCP RFCs.

8. IANA Considerations

To reflect the reclassification of RFC 3540 as Historic, IANA is requested to update the Transmission Control Protocol (TCP) Header Flags registry (https://www.iana.org/assignments/tcp-header-flags/tcp-header-flags.xhtml#tcp-header-flags-1) to remove the registration of bit 7 as the NS (Nonce Sum) bit and add an annotation to the registry to state that bit 7 was used by Historic RFC 3540 as the NS (Nonce Sum) bit.

9. Security Considerations

As a process memo that makes no changes to existing protocols, there are no protocol security considerations.

However, effective congestion control is crucial to the continued operation of the Internet, and hence this memo places the responsibility for not breaking Internet congestion control on the experiments and the experimenters who propose them, as specified in Section 4.4.

Security considerations for the proposed experiments are discussed in the Internet-Drafts that propose them.

See Appendix B.1 of [I-D.ietf-tsvwg-ecn-l4s-id] for discussion of alternatives to the ECN Nonce.

10. References

10.1. Normative References

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10.2. Informative References

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[I-D.ietf-tcpm-dctcp]
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[I-D.ietf-tsvwg-ecn-l4s-id]
Schepper, K. and B. Briscoe, "Identifying Modified Explicit Congestion Notification (ECN) Semantics for Ultra-Low Queuing Delay", draft-ietf-tsvwg-ecn-l4s-id-00 (work in progress), May 2017.

[I-D.khademi-tsvwg-ecn-response]
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Appendix A. Change History

[To be removed before RFC publication.]

Changes from draft-ietf-tsvwg-ecn-experimentation-00 to -01:

- o Add mention of DCTCP as another protocol that could benefit from ECN experimentation (near end of Section 2).

Changes from draft-ietf-tsvwg-ecn-experimentation-01 to -02:

- o Generalize to describe rationale for areas of experimentation, with less focus on individual experiments

- o Add ECN terminology section

- o Change name of "ECT Differences" experimentation area to "Congestion Marking Differences"

- o Add overlooked RFC 3168 modification to Section 4.1

- o Clarify text for Experimental RFC exception to ECT(1) non-usage requirement

- o Add explanation of exception to "SHOULD NOT drop" requirement in 4.3

- o Rework RFC 3540 status change text to provide rationale for a separate status change document that makes RFC 3540 Historic. Don't obsolete RFC 3540.

- o Significant editorial changes based on reviews by Mirja Kuehlewind, Michael Welzl and Bob Briscoe.

Changes from draft-ietf-tsvwg-ecn-experimentation-02 to -03:

- o Remove change history prior to WG adoption.

- o Update L4S draft reference to reflect TSVWG adoption of draft.

- o Change the "SHOULD" for DCCP sender use of ECT(0) to a "MUST" (overlooked in earlier editing).

- o Other minor edits.

Changes from draft-ietf-tsvwg-ecn-experimentation-03 to -04:

- o Change name of "Generalized ECN" experimentation area to "TCP Control Packets and Retransmissions."

- o Add IANA Considerations text to request removal of the registration of the NS bit in the TCP header.

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