

Network Working Group
Internet-Draft
Intended status: Standards Track
Expires: November 6, 2021

S. Burleigh
JPL, Calif. Inst. of Technology
F. Templin
The Boeing Company
May 5, 2021

Bundle Protocol Extended Class of Service (ECOS)
draft-burleigh-dtn-ecos-00

Abstract

This document describes an extension to the Delay-Tolerant Networking (DTN) Bundle Protocol (BP) that marks bundles with class-of-service designators. The class-of-service designators are an "ordinal" number that provides fine-grained prioritization of bundles, a "critical" flag, flags that explicitly request "timely" or "assured" convergence-layer transmission (or both), and an optional QoS tag.

Requirements Language

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

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of [BCP 78](#) and [BCP 79](#).

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at <https://datatracker.ietf.org/drafts/current/>.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on November 6, 2021.

Copyright Notice

Copyright (c) 2021 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to [BCP 78](#) and the IETF Trust's Legal Provisions Relating to IETF Documents (<https://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Simplified BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Simplified BSD License.

Table of Contents

1.	Introduction	2
2.	ECOS Block Format	3
3.	Processing	5
3.1.	Bundle Origination	5
3.2.	Bundle Forwarding	6
3.3.	Bundle Delivery	8
4.	IANA Considerations	8
5.	Security Considerations	8
6.	Normative References	8
Appendix A.	Congestion Experienced	9
	Authors' Addresses	9

[1.](#) Introduction

This document describes an extension to the Delay-Tolerant Networking (DTN) Bundle Protocol (BP) that marks bundles with class-of-service designators. The Bundle Protocol version 7 (BPv7) base specification [[I-D.ietf-dtn-bpbis](#)] defines no class of service designators, while its predecessor Bundle Protocol version 6 (BPv6) [[RFC5050](#)] defined a single designator for a bundle's class of service:

- o Priority, a value in the range 0 through 2, with higher values indicating greater urgency: 0 = "bulk", 1 = "normal", 2 = "expedited". Priority level 3 is reserved for future use.

For some applications, such as space flight and tactical unmanned air vehicle operations, additional variations in class of service may be required:

- o Many more levels of priority may be needed, enabling more fine-grained control over the precedence of user-selected application data types in the progress of bundles through the network.
- o A way of indicating emergency ("critical") traffic may be needed. Emergency traffic is not merely high-priority: it is so important that the user is willing to incur the network overhead of

transmitting the bundle along every potential route to its destination, rather than only on the route that would normally be selected as the "best" route according to the applicable routing value function. This expedient ensures that the bundle arrives at its destination in the least possible time, regardless of how accurately the routing system reckons end-to-end latency on any given route: the bundle arrives by whatever turns out to be the fastest route, as well as by all others.

- o There may be a need to request explicitly that all nodes forwarding the bundle use convergence-layer protocols that either always do or always don't perform retransmission upon detected loss of data. This designation may be important for bundles carrying application data for which timeliness of delivery is known to be more important than certainty, or vice versa. In some cases, retransmitted "old data" may be a waste of bandwidth that could instead be used to convey new data of greater value, or the out-of-order arrival of retransmitted data may degrade the usefulness of streaming data such as audio or video.
- o There may be a need for an opaque "QoS tag" that can be used by the application to pass a variety of transmission control parameters to the convergence-layer protocol.

The Extended Class of Service (ECOS) extension block for BPv7 is designed to provide these class of service designators.

2. ECOS Block Format

The ECOS block conforms to sections [4.3.2](#) and [4.4](#) of [\[I-D.ietf-dtn-bpbis\]](#), where the block SHALL be represented as a CBOR array with 5 elements (i.e., since CRC type is 0). The ECOS block is constrained as follows:

- o Block type code is TBD. (See "IANA Considerations" below.)
- o Block number is coded as discussed in Section 4.1 of [\[I-D.ietf-dtn-bpbis\]](#).
- o Per Section 4.2.4 of [\[I-D.ietf-dtn-bpbis\]](#), block processing control flags are next encoded as a CBOR unsigned integer. The following block processing control flag MUST be set to 1:
 - * Bit 0 - block must be replicated in every fragment.

The setting of other block processing control flags, where not mandated by the Bundle Protocol specification, is an implementation matter.

- o CRC type is set to 0 as discussed in Section 4.2.1 of [\[I-D.ietf-dtn-bpbis\]](#).
- o Block-type-specific data is represented as a single definite-length CBOR byte string containing a 16-bit Flags field, an 8-bit Priority field and (optionally) a 32-bit QoS Tag field.

The first field of the Block-type-specific data is a 16-bit Flags byte. The bits of the flags signify the following conditions:

- o The 0x0001 bit, if True, indicates that the bundle is "critical": the bundle protocol agent is requested to forward one copy of the bundle along every path that might get it to its destination.
- o The 0x0002 bit, if True, indicates an explicit preference that delivery of the bundle be timely and in order: the bundle protocol agent is requested to forward the bundle on a "best-effort" basis, without retransmission.
- o The 0x0004 bit, if True, indicates that the Ordinal Number field of this ECOS block (the byte immediately following the Flags) is followed by a numeric QoS Tag field.
- o The 0x0008 bit, if True, indicates an explicit preference that delivery of the bundle be assured even if out of order: the bundle protocol agent is requested to forward the bundle reliably, with retransmission as necessary.
- o The 0x0010 bit, if True, means "BSSP required".
- o The 0x0020 bit, if True, means "BIBE required".
- o The 0x0040 bit, if True, means "(BIBE) Custody Transfer required".
- o Bits 0x0080 through 0x2000 are reserved for future use. For the purpose of this specification, they are set to 0 on transmission and ignored on reception (future specifications may define new settings and interpretations).
- o Bits 0x4000 and 0x8000 are reserved as Congestion Experienced (CE) indications. For the purpose of this specification, they are set to 0 on transmission and ignored on reception (future specifications may define new settings and interpretations).

Note that both the 0x0002 and 0x0008 bits might be set for a given bundle. This indicates an explicit preference that delivery of the bundle be timely and in-order if possible but in any case assured, as in a bundle streaming service: whenever loss is detected in "best-

effort" transmission, the lost data are retransmitted for eventual out-of-order delivery in background.

The Flags field is followed by an 8-bit Priority field with the most significant 2 bits containing a Service Class value as follows:

- o 00 = bulk
- o 01 = normal
- o 10 = expedited
- o 11 is reserved for future use.

The remaining 6 bits of the Priority field encode an unsigned Ordinal Number value in the range 0-63. For a bundle whose Service Class is 2 ("expedited"), the Ordinal Number indicates the relative priority of this bundle among all other expedited bundles: Ordinal Number value 63 indicates greater urgency than value 62, and so on. For a bundle whose Service Class is not 2, the Ordinal Number value has no significance.

If the 0x0004 bit of the Flags field is True, the third field of the block data is a numeric QoS Tag value. The significance of the QoS Tag is an implementation matter. Notionally, the QoS Tag is intended to be used to convey quality-of-service information to the convergence-layer protocol adapter. The bundle protocol agent's response to a QoS Tag whose significance is unknown is an implementation matter.

3. Processing

3.1. Bundle Origination

At the time a bundle is sourced it MAY contain one ECOS block. When a bundle contains an ECOS block, the ECOS block MUST precede the payload block and it MUST be the only ECOS block in the bundle.

The manner in which the application issuing the block communicates the values of the ECOS block data fields to the bundle protocol agent is an implementation matter.

If the ECOS block contains a QoS Tag field, then the 0x0004 bit of the block's Flags field MUST be set to 1 (True) and the QoS Tag MUST be a numeric value. Otherwise the 0x0004 bit of the block's Flags field MUST be set to 0 (False) and the QoS Tag field is omitted.

The Priority field of the ECOS block MUST contain a 2-bit Service Class value followed by a 6-bit Ordinal Number unsigned integer in the range 0-63.

3.2. Bundle Forwarding

This section applies only to nodes at which procedures for processing ECOS blocks are implemented. When a node at which such procedures are not implemented receives a bundle that contains one or more ECOS blocks, those blocks must be processed as prescribed in the Bundle Protocol specification.

When a received bundle contains multiple ECOS blocks or contains a single ECOS block that is invalid (that is, one that violates one or more of the provisions of [section 3.1](#) above), all ECOS blocks in the bundle MUST be ignored and SHOULD be deleted.

At the time a bundle that has no valid single ECOS block is received from a neighboring node, the bundle protocol agent MAY insert an ECOS block into the bundle. The values of the block data fields of such an ECOS block are an implementation matter, provided that they conform to this specification.

The forwarding of a bundle that contains a valid ECOS block, whether locally sourced or received from another bundle protocol agent or locally inserted upon reception from another bundle protocol agent, MUST comply with the following rules:

1. If the 0x0001 bit of the ECOS block's Flags field is set to 1, then exactly one copy of the bundle SHOULD be forwarded to every neighboring node that has some plausible prospect of being able to forward the bundle toward its final destination without returning it to the local node, a determination that is a matter left to the bundle protocol agent's route computation mechanism; also, the bundle MUST be queued for transmission as if its Service Class were 2 ("expedited") and its Ordinal Value were 63, regardless of the actual values of these fields. Each "critical" bundle MUST be forwarded **at most once** by each bundle protocol agent; that is, critical bundles MUST NOT be reforwarded in response to custody refusals, the expiration of custody transfer timers, the presence of a routing loop in the network, or any other condition, because such reforwarding could result in unbounded bundle transmission explosions. The manner in which this constraint is enforced is an implementation matter. One possible approach is to manage a list of the IDs and expiration times of all critical bundles received, removing bundles from the list only as the associated expiration times are reached; since "critical" bundles should be issued rarely, managing such a list

should not be a severe processing burden. Note that a bundle protocol agent MAY choose to handle a critical bundle as non-critical traffic and forward it on only a single path, but ignoring the "critical" flag may put network assets at risk and should be avoided unless necessary to preserve the continued operation of the bundle protocol agent.

2. If the 0x0002 bit of the ECOS block's Flags field is set to 1, then the bundle protocol agent SHOULD forward the bundle by invoking an adapter for a convergence layer protocol that does NOT perform retransmission of data lost in transit. If the bundle protocol agent has no access to such a convergence layer adapter then this flag may be ignored, but in that case application data units may arrive out of transmission order at the destination (possibly degrading application performance) and/or transmission bandwidth may be wasted on unnecessary retransmission, reducing the effective throughput of the network.
3. If the 0x0008 bit of the ECOS block's Flags field is set to 1, then the bundle protocol agent SHOULD forward the bundle by invoking an adapter for a convergence layer protocol that DOES perform retransmission of data lost in transit. If the bundle protocol agent has no access to such a convergence layer adapter then this flag may be ignored, but in that case application data units may not arrive at the destination, possibly degrading application performance.
4. If both the 0x0002 bit and the 0x0008 bit of the ECOS block's Flags field are set to 1, then the bundle protocol agent SHOULD forward the bundle by invoking an adapter for a convergence layer protocol that functions as a bundle streaming service: whenever loss is detected in "best-efforts" transmission, the lost data are retransmitted for eventual out-of-order delivery in background. If the bundle protocol agent has no access to such a convergence layer adapter then this flag may be ignored, but in that case application performance may be degraded.
5. If the bundle's Service Class is 2 (expedited), then the bundle protocol agent MUST forward this bundle only after forwarding all other bundles that are to be forwarded to the same node with Service Class 2 and have explicit or implicit ordinal value that is higher than or equal to the ECOS block's ordinal value. Moreover, the bundle protocol agent MUST forward this bundle before forwarding any other bundle that is to be forwarded to the same node and either (a) has Service Class 2 and an explicit or implicit ordinal value lower than the ECOS block's Ordinal Number field or (b) has Service Class less than 2. An implicit ordinal

value is the value for a bundle that has no valid ECOS block;
that value is 0.

The valid ECOS block of a received bundle that is to be forwarded to another node MUST NOT be deleted from the bundle.

3.3. Bundle Delivery

When a bundle that contains an ECOS block is delivered to its final destination, the values of ECOS block fields MAY be provided to the application but otherwise have no impact on bundle delivery procedures.

4. IANA Considerations

The IANA is requested to allocate a codepoint TBD for the Extended Class of Service (ECOS) block in the Bundle Block Type registry defined in [[I-D.ietf-dtn-bpbis](#)] and with reference to this specification. The registration should appear as follows:

+-----+-----+-----+-----+-----+				
Bundle	Value	Description	Reference	
Protocol				
Version				
+-----+-----+-----+-----+-----+				
7	TBD	Extended Class of Service	[RFCXXXX]	

5. Security Considerations

Clearly the injection of bundles with the "critical" flag set to True could increase the impact of a denial of service attack. As with all such attacks, the best available defense is to require the use of BPsec [[I-D.ietf-dtn-bpsec](#)] on all received bundles.

6. Normative References

[[I-D.ietf-dtn-bpbis](#)]

Burleigh, S., Fall, K., and E. J. Birrane, "Bundle Protocol Version 7", [draft-ietf-dtn-bpbis-31](#) (work in progress), January 2021.

[I-D.ietf-dtn-bpsec]

III, E. J. B. and K. McKeever, "Bundle Protocol Security Specification", [draft-ietf-dtn-bpsec-27](#) (work in progress), February 2021.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.

[RFC3986] Berners-Lee, T., Fielding, R., and L. Masinter, "Uniform Resource Identifier (URI): Generic Syntax", STD 66, [RFC 3986](#), DOI 10.17487/RFC3986, January 2005, <<https://www.rfc-editor.org/info/rfc3986>>.

[RFC5050] Scott, K. and S. Burleigh, "Bundle Protocol Specification", [RFC 5050](#), DOI 10.17487/RFC5050, November 2007, <<https://www.rfc-editor.org/info/rfc5050>>.

[Appendix A](#). Congestion Experienced

[Section 2](#) of this specification reserves two ECOS flag bits as Congestion Experienced (CE) indications and mandates their values be set to 0. Further study on whether BPv7 would benefit from CE indications can therefore be conducted in parallel with the progression of this specification.

Authors' Addresses

Scott Burleigh
JPL, Calif. Inst. of Technology
4800 Oak Grove Drive, m/s 301-490
Pasadena, CA 91109
USA

Phone: +1 818 393 3353
Email: Scott.C.Burleigh@jpl.nasa.gov

Fred Templin
The Boeing Company
P.O. Box 3707
Seattle, WA 98124
USA

Phone: +1 425 802-9039
Email: fltemplin@acm.org

