

DELAY/DISRUPTION TOLERANT NETWORKING



Delay/Disruption Tolerant Networking (DTN) Implementer's Guide - Level 6 Recommendations

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Delay/Disruption Tolerant Networking (DTN) Implementer's Guide – L6 Recommendations Signature/Approval Page

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Preface

This document is under configuration management of the GSFC DTN Project Configuration Control Board (CCB). A complete revision or Document Change Notice (DCN) will be issued to update the document for any future approved changes.

Change History Log

Revision	Effective Date	Description of Changes
Preliminary Release 1	11/07/2023	Preliminary release per ESC-CCR-0486
Preliminary Release 2	07/12/2024	Released per ESC-CCR-0659 Added recommendations for order of error processing, order of bundle egress, dtn:none, CBOR encoding recommendations, compressed bundle reporting, restart and shutdown, Level 5 recommendations missing children, expanded classes of service, accepting ADUs reliably from applications, and convergence layer return notifications. Updated time recommendations and MIB variable recommendations. Added external parents to map recommendations to standards. Translated recommendations from functional elements to modules.
Preliminary Release 3	01/28/2026	Update to generic recommendations based on the standards. Updates for Build 7.0.5.

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Section	REQID	To-Be-Resolved (TBR) / To-Be-Determined (TBD) Item	Responsible Party
3.2.3	DTN.6.12960	Self-Test definition	R. Besser
3.3.2	DTN.6.27410	Extension block order	R. Besser

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Section 1. Introduction

This document is the Delay/Disruption Tolerant Networking (DTN) Implementer's Guide (DIG) – L6 Recommendations. This document specifies recommendations for a generic DTN Node and responds to the DTN Level 5 DIG generic DTN Node recommendations. Figure 1-1 shows the full recommendations tree with the current Level 6 DIG displayed as green.

These recommendations are described in “levels” that trace to each other, and are largely derived from DTN RFC's, CCSDS Blue Books, as well as best practices as determined by DTN teams. Figure 1-1 shows the full recommendations tree with the current Level 6 recommendations displayed in green.

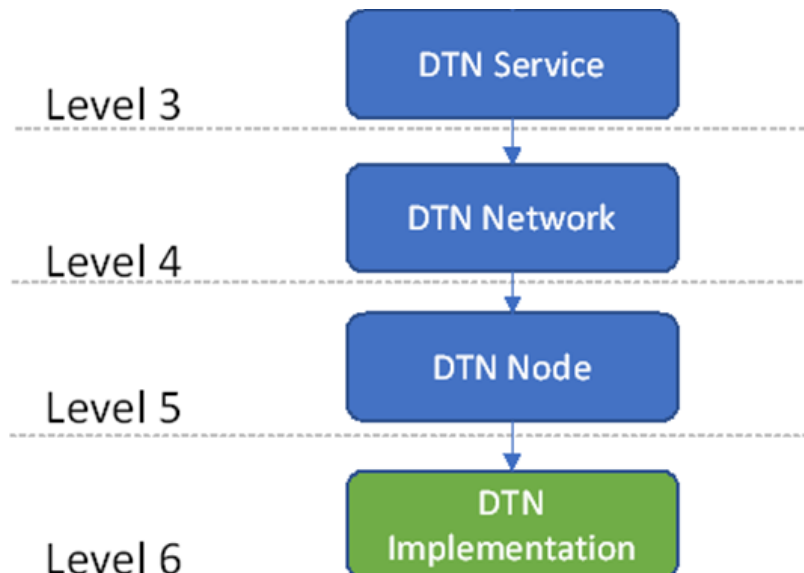


Figure 1-1 DTN Recommendations Tree

The reason this stack begins with Level 3 is that implementors may have higher level objectives and/or directives within their own organizations to which they may wish to trace these recommendations, and this structure provides an opportunity for implementors to do that if desired.

1.1 Purpose

This DTN Implementor's Guide provides guidance and recommendations for creating a generic DTN Node.

These recommendations are general and should be tailored to suit the specific needs that networks and/or platforms may have. Any language within the

recommendations that describes them as “requirements” is for reference purposes only and is not dictating usage.

1.2 Scope

All the recommendations in this DIG are Level 6 recommendations. The DTN Level 6 recommendations specify the implementation required for DTN operations with a generic DTN Node. Level 6 recommendations in this document are identified with a prefix “DTN.6.” follow by a unique five-digit number.

1.3 Overview

The GSFC DTN Project within the Technology Enterprise and Mission Pathfinder Office (TEMPO) manages the engineering and development efforts of DTN technologies at Goddard Space Flight Center (GSFC). TEMPO is an incubator for technologies and projects within the Exploration and Space Communications (ESC) projects division.

DTN is at the foundation of NASA's LunaNet architecture, which will enable robust communications, navigation, and networking capabilities to establish long-term presence on the Moon. LunaNet services will be established by service providers, known as LunaNet Service Providers (LNSPs), which will form a set of cooperating networks transferring data via DTN. DTN is a network architecture designed to provide internetworking functionality and standardized automated multi-hop, end-to-end data delivery in highly stressed environments that are not optimal for Internet Protocols.

DTN Bundle Protocol (BP) (RFC 9171) specifies a method for putting data into self-describing units called bundles that use information within the data stream (headers attached to data units) to accomplish end-to-end data delivery through network nodes. DTN uses a “Store and Forward” approach for application layer end-to-end data delivery. BP moves data from its source to its final destination through the network, storing it at each intermediate network node while waiting for the next node in the path to become available.

1.4 Configuration Control

Changes to this recommendations document shall be controlled using procedures set forth in the DTN Configuration Management Plan (450.2-DTN-CMP).

1.5 Document Organization

This DIG is organized as follows:

- **Section 1** specifies the purpose and content of this document.
- **Section 2** lists the applicable and reference documents.
- **Section 3** describes the modules of a generic DTN node and associated recommendations at Level 6.

1.6 Recommendations Attributes

Each recommendation is defined by a set of attributes as follows:

- **Recommendation ID:** A labeling system that uniquely identifies each recommendation statement for sorting and tracking purposes.
- **Recommendation Description:** The “shall” statement that defines the recommendation.
- **Rationale:** Supplements the “shall” statement by providing reason/context for the recommendation. Provides additional information to help clarify the intent of the recommendations.
- **Parent:** Hierarchical traceability to high level recommendations. Level 6 recommendations trace down from Level 5 recommendations.
- **External Parent:** Hierarchical traceability to external standards documents, including CCSDS and IETF.
- **Verification Method:** Method used to verify recommendation.

Recommendations are not listed in numeric order as they have been grouped by allocation instead of numeric order.

Section 2. Documentation

2.1 Applicable Documents

The following documents form a part of this specification to the extent specified herein. In the event of conflict between documents referenced and the detailed contents of this document, the requirements specified herein shall govern.

Documents in this table imply adherence to NPR 7123.1. Note that compliance with all NASA Policy Directives (NPDs) and NASA Procedural Requirements (NPRs), as well as appropriate center-level guidance, is mandatory, and these documents are not listed in this section.

Documents with Document No. prefix "RFC" are Request for Comments (RFC) documents from the Internet Engineering Task Force (IETF) that contain informational or standards specifications for computer networking.

Table 2-1 Applicable Documents

Document No.	Document Title
LNIS V0005	LunaNet Interoperability Specification Document (LNIS), Version 5
RFC 0768	User Datagram Protocol, August 1980
RFC 4838	Delay-Tolerant Networking Architecture, April 2007
RFC 5326	Licklider Transmission Protocol Specification, September 2008
RFC 9171	Bundle Protocol Specification (Version 7), January 2022
RFC 9172	Bundle Protocol Security (BPSec), January 2022
RFC 9174	Delay-Tolerant Networking TCP Convergence-Layer Protocol Version 4, January 2022
CCSDS 133.1-B-3	Encapsulation Packet Protocol, Blue Book, May 2020
CCSDS 734.1-B-1	Licklider Transmission Protocol (LTP) for CCSDS, Blue Book, May 2015
CCSDS 734.2	Bundle Protocol Specification, Orange Book, April 2025
CCSDS 734.6-O-1	Compressed Custody Signaling and Bundle Status Reporting, Orange Book, Draft M
450.2-DTN-DIG-L3	DTN Level 3 Implementer's Guide
450.2-DTN-DIG-L4	DTN Level 4 Implementer's Guide
450.2-DTN-DIG-L5	DTN Level 5 Implementer's Guide

Custody Transfer, network management interfaces, and other required protocol features are based on draft concepts being developed by the standards organization. Recommendations will be updated to reflect the standards as they mature.

2.2 Reference Documents

The following documents serve as reference material for this document.

Table 2-2 Reference Documents

Document No.	Document Title

Section 3. Recommendations

The DTN Node described in this document utilizes Bundle Protocol (BP) to perform delay and disruption tolerant communications services. The DTN Node software system described in this document provides full BPv7 DTN capability. BPv7 is defined in IETF RFC9171, the standards specification for bundle protocol.

3.1 DTN Node Architecture

A DTN Node is divided into three major subsystems. These subsystems provide all functionality needed for DTN Service operation within this node.

The major subsystems are:

- **Application Agent (AA):** Handles interaction with applications and activities associated with monitor and control (status, configuration)
- **Convergence Layer Adapter (CLA):** Data transport interpreter between network layers
- **Bundle Protocol Agent (BPA):** Bundle protocol related activities and functions

3.2 Application Agent (AA)

This section contains recommendations on the AA.

3.2.1 Application Handling

This section contains recommendations on AA application handling.

DTN.6.12451

Upon receiving an add-application directive, AA shall reject the directive and issue an error event if no channel instance is available to assign.

Rationale: Node Configuration must make sure that an instance is available for the new channel and send notification if it is not.

Parent: DTN.5.00008, DTN.5.00009, DTN.5.00726, DTN.5.00728

External Parent: N/A

Verification Method: Test

DTN.6.12440

Upon receiving an add-application directive, AA shall establish a connection with the client application as indicated by the given configuration.

Rationale: Node Configuration needs to send the request to Framework Proxy to establish a connection with the application.

Parent: DTN.5.00006, DTN.5.00007, DTN.5.00723, DTN.5.00724

External Parent: CCSDS BPv7 Section 4, PICS Section A4.4 Item 21

Verification Method: Test

DTN.6.12452

Upon receiving an add-application directive, AA shall reject the directive and issue an error event if a duplicate channel instance already exists.

Rationale: Node Configuration must make sure that there is no duplicate of the new channel and send notification if it is not.

Parent: DTN.5.00008, DTN.5.00009, DTN.5.00726, DTN.5.00728

External Parent: N/A

Verification Method: Test

DTN.6.12453

Upon receiving an add-application directive, AA shall verify that an instance of ADU Proxy has been assigned.

Rationale: Once the channel has been assigned, need to check that action was successful.

Parent: DTN.5.00008, DTN.5.00009, DTN.5.00726, DTN.5.00728

External Parent: CCSDS BPv7 Section 4.1, PICS Section A5.5 Item 21

Verification Method: Test

DTN.6.12460

Upon receiving an add-application directive, AA shall establish a mapping between the client application connection and the channel.

Rationale: The mechanism for this is implementation dependent.

Parent: DTN.5.00008, DTN.5.00009, DTN.5.00726, DTN.5.00728

External Parent: CCSDS BPv7 Section 4.1, PICS Section A5.5 Item 21

Verification Method: Test

DTN.6.12596

If BPA reports an error event on any add-application action, AA shall leave the channel unassigned.

Rationale: ADU Proxy needs to be available for another request if any step in the request fails.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Test

DTN.6.12431

Upon receiving an add-all-applications directive, AA shall execute the add-application directive for each application configured to start at startup.

Rationale: Node Configuration needs to execute add-application for the set of applications configured.

Parent: DTN.5.00006, DTN.5.00007, DTN.5.00723, DTN.5.00724

External Parent: N/A

Verification Method: Test

DTN.6.19020

Upon receiving a start-application directive, AA shall begin moving ADUs bidirectionally between the host framework and BPA for the given application.

Rationale: This typically follows the configuration accomplished by add-application to begin the flow of data between the client application and the BPA.

Parent: DTN.5.00930

External Parent: CCSDS BPv7 Section 4.4.4, CCSDS BPv7 Section 4.4.5, PICS Section A5.5 Item 21, PICS Section A5.5 Item 39

Verification Method: Test

DTN.6.19040

Upon receiving a start-all-applications directive, AA shall begin moving ADUs bidirectionally between the host framework and BPA for all applications as configured.

Rationale: This typically follows the configuration accomplished by add-application to begin the flow of data between the client applications and the BPA.

Parent: DTN.5.00930

External Parent: CCSDS BPv7 Section 4.4.4, CCSDS BPv7 Section 4.4.5, PICS Section A5.5 Item 21, PICS Section A5.5 Item 39

Verification Method: Test

DTN.6.19030

Upon receiving a stop-application directive, AA shall stop moving ADUs bidirectionally between the host framework and BPA.

Rationale: This is the opposite of start-application and may be used to pause the flow of data between the client application and the BPA. To pause only delivery of ADUs to client applications, the set-registration-state directive may be used to set the registration to "passive." If the flow of ADUs from an application to the BPA is paused by this directive, ADUs sent by the application may be lost.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Test

DTN.6.12660

Upon receiving a remove-application directive, AA shall terminate its connection with the given application.

Rationale: The nature of the connection is client- and implementation-specific.

Parent: DTN.5.00900

External Parent: CCSDS BPv7 Section 4.4.2, PICS Section A5.5 Item 21

Verification Method: Test

3.2.2 Bundle Create and Store

This section contains recommendations on AA bundle creation and storage.

DTN.6.19016

After obtaining an ADU from the application, AA shall apply rate limits, and request the BPA process the ADU.

Rationale: This is how ADUs enter the node from the application.

Parent: DTN.5.00008, DTN.5.00009, DTN.5.00726, DTN.5.00728

External Parent: CCSDS BPv7 Section 4.4.4, PICS Section A5.5 Item 21

Verification Method: Test

DTN.6.19230

Upon receiving an ADU from an application, AA shall request BPA send the ADU on the channel associated with the application.

Rationale: The specifics of client application to AA reliability are implementation dependent, but for custodial bundles, we don't want to violate the SLA on the way into the network.

Parent: DTN.5.00010

External Parent: CCSDS BPv7 Section 4.4.4, PICS Section A5.5 Item 21

Verification Method: Test

DTN.6.19240

Upon receiving an ADU from an unknown application, AA shall ignore the ADU.

Rationale: In some implementations it may not be possible for the AA to receive ADUs from unregistered applications, but if it is, they must not be transmitted through the network.

Parent: DTN.5.00010

External Parent: N/A

Verification Method: Analysis, Test

3.2.3 Bundle Storage Management

This section contains recommendations on AA bundle storage management.

DTN.6.12850

Upon receiving a reload-saved-data directive, AA shall reload saved node configurations.

Rationale: It is essential that DTN node restart with latest configurations and data.

Parent: DTN.5.01050, DTN.5.01065

External Parent: N/A

Verification Method: Test

DTN.6.12853

Upon receiving a reload-saved-data directive, AA shall reload saved Management Information Base (MIB) counters.

Rationale: Reload MIB variables saved in persistent storage per DTN.6.12792 after a restart.

Parent: DTN.5.01050

External Parent: N/A

Verification Method: Test

DTN.6.12960

Upon receiving a perform-self-test directive, AA shall perform TBD tests and return result of pass/fail.

Rationale: all the basic DTN internal functions are operating as expected, nothing defined yet, this place holder for mission specific tests.

Parent: DTN.5.01010, DTN.5.01020

External Parent: N/A

Verification Method: Test

DTN.6.19460

AA shall provide an API for file operations read, write, move and delete.

Rationale: File operations functionality is provided by the host, DTN node uses proxy to do the file operation. (defer to 7.2)

Parent: DTN.5.01050

External Parent: N/A

Verification Method: Test

3.2.4 Bundle Payload Delivery

This section contains recommendations on AA bundle payload delivery.

DTN.6.19220

For each configured channel that is in the "active" state, AA shall request an ADU from BPA.

Rationale: AA obtains a bundle from BPA to pass to client application.

Parent: DTN.5.00730, DTN.5.00750, DTN.5.00760

External Parent: RFC 9171 Section 5.7, CCSDS BPv7 Section 4.4.5, PICS Section A5.5 Item 39

Verification Method: Test

DTN.6.19015

After obtaining an ADU from the BPA, AA shall apply rate limits and request the host send the ADU to the application.

Rationale: This is how ADUs exit the node to the application.

Parent: DTN.5.00009, DTN.5.00726, DTN.5.00728

External Parent: RFC 9171 Section 5.7, CCSDS BPv7 Section 4.4.5, PICS Section A5.5 Item 21, PICS Section A5.5 Item 39

Verification Method: Test

DTN.6.19017

When applying an egress rate limit, AA shall maintain the outgoing rate below the configured rate +10%.

Rationale: Need to keep the rate to within a constant range over time to avoid rate jumps at any given point.

Parent: DTN.5.00010, DTN.5.00726

External Parent: N/A

Verification Method: Test

DTN.6.19250

Upon receiving a data ADU from BPA, AA shall reliably pass the ADU to the application associated with the channel.

Rationale: The specifics of AA to client application reliability is implementation dependent, but for custodial bundles, we don't want to violate the SLA on the last hop out of the network.

Parent: DTN.5.00730, DTN.5.00760

External Parent: RFC 9171 Section 5.7, PICS Section A5.5 Item 39

Verification Method: Test

3.2.5 Custody Signal Generation and Receipt

This section contains recommendations on AA custody signal generation and receipt.

DTN.6.09520

AA shall CBOR decode Administrative Record ADUs received from BPA.

Rationale: ADUs must be decoded to determine what type of admin record they are and what ARP needs to do with them.

Parent: DTN.5.00480

External Parent: N/A

Verification Method: Test

DTN.6.09530

If the ADU is a Compressed Custody Signal, AA shall send the Compressed Custody Signal to BPA.

Rationale: ARP collects custody signals sent to the node and sends them to CT to process.

Parent: DTN.5.00480

External Parent: N/A

Verification Method: Test

DTN.6.09485

Upon receipt of a Compressed Custody Signal from BPA, AA shall construct a Compressed Custody Signal Administrative Record.

Rationale: Required by the CCSDS specification for the custody signal. Each Bundle Sequence Collection (BSC) conveys a contiguous set of bundles with a common Bundle Sequence ID for which custody is being signaled. Gaps are conveyed by Bundle Sequence Numbers omitted from all BSC that signal custody accepted.

Parent: DTN.5.00400

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.09490

Upon receiving a Compressed Custody Signal Administrative Record, AA shall create a 2-element, definite-length CBOR array and set the 1st element of the array, the administrative record type field, to 13.

Rationale: Required by the CCSDS specification for the custody signal. Each BSC conveys a contiguous set of bundles with a common Bundle Sequence ID for which custody is being signaled. Gaps are conveyed by Bundle Sequence Numbers omitted from all BSC that signal custody accepted.

Parent: DTN.5.00400

External Parent: RFC 9171 Section 6.1, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4, PICS Section A5.5 Item 47

Verification Method: Test

DTN.6.26310

Upon receiving a Compressed Custody Signal Administrative Record, AA shall construct each Bundle Sequence Element as a 3-element definite-length CBOR array of given unsigned integers comprising in order the Bundle Sequence Start, Bundle Sequence Length, and Bundle Sequence ID.

Rationale: Required by the CCSDS specification for the custody signal. Each Bundle Sequence Element conveys a contiguous set of bundles with a common Bundle Sequence ID for which custody is being signaled.

Parent: DTN.5.00390

External Parent: RFC 9171 Section 4.3.1, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.09510

Upon successful CBOR encoding of the Compressed Custody Signal Administrative Record, AA shall request BPA create a bundle for the Compressed Custody Signal on the configured channel as indicated by the custodian EID.

Rationale: The size of Custody Signal may be limited by the underlying network.

Parent: DTN.5.00420

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

3.2.6 Bundle Status Report (BSR) Generate and Store

This section contains recommendations on AA Bundle Status Report (BSR) generation and storage.

DTN.6.09000

Upon notification of bundle received, AA shall generate a Bundle Reception Status Report if bundleSetBehaviorReceivedBSRGenerate and bundleSetBehaviorReceivedBSRGenerate[source] configurations are TRUE.

Rationale: The configuration allows network management to prevent or allow generation of each particular BSR for all flows and for any given source. Existence of variable is suggested by RFC 9171 section 5.1, and they are present in the MIB.

Parent: DTN.5.00360

External Parent: RFC 9171 Section 5.1, PICS Section A5.5 Item 32

Verification Method: Test

DTN.6.09010

Upon notification of bundle custody accepted, AA shall generate a Bundle Accepted Status Report if bundleSetBehaviorAcceptedBSRGenerate and bundleSetBehaviorAcceptedBSRGenerate[source] configurations are TRUE.

Rationale: The configuration allows network management to prevent or allow generation of each particular BSR for all flows and for any given source. Existence of variable is suggested by RFC 9171 section 5.1, and they are present in the MIB.

Parent: DTN.5.00394

External Parent: RFC 9171 Section 5.1, PICS Section A5.5 Item 32

Verification Method: Test

DTN.6.09020

Upon notification of bundle forwarded, AA shall generate a Bundle Forwarded Status Report if bundleSetBehaviorForwardedBSRGenerate and bundleSetBehaviorForwardedBSRGenerate[source] configurations are TRUE.

Rationale: The configuration allows network management to prevent or allow generation of each particular BSR for all flows and for any given source. Existence of variable is suggested by RFC 9171 section 5.1, and they are present in the MIB.

Parent: DTN.5.00394

External Parent: RFC 9171 Section 5.1, PICS Section A5.5 Item 32

Verification Method: Test

DTN.6.09030

Upon notification of bundle delivered, AA shall generate a Bundle Delivered Status Report if bundleSetBehaviorDeliveredBSRGenerate and bundleSetBehaviorDeliveredBSRGenerate[source] configurations are TRUE.

Rationale: The configuration allows network management to prevent or allow generation of each particular BSR for all flows and for any given source. Existence of variable is suggested by RFC 9171 section 5.1, and they are present in the MIB.

Parent: DTN.5.00394

External Parent: RFC 9171 Section 5.1, PICS Section A5.5 Item 32

Verification Method: Test

DTN.6.09040

Upon notification of bundle deleted, AA shall generate a Bundle Deleted Status Report if bundleSetBehaviorDeletedBSRGenerate and bundleSetBehaviorDeletedBSRGenerate[source] configurations are TRUE.

Rationale: The configuration allows network management to prevent or allow generation of each particular BSR for all flows and for any given source. Existence of variable is suggested by RFC 9171 section 5.1, and they are present in the MIB.

Parent: DTN.5.00240, DTN.5.00310, DTN.5.00810

External Parent: RFC 9171 Section 5.1, PICS Section A5.5 Item 32

Verification Method: Test

DTN.6.09120

AA shall generate Bundle Status Reports only to node IDs that are in the list of authorized report-to EIDs.

Rationale: For security and traffic control purposes, nodes should send status only to administratively allowed nodes. RFC 9171 section 5.1 states that "the decision on whether or not to generate a requested status report is left to the discretion of the BPA."

Parent: DTN.5.00540

External Parent: RFC 9171 Section 5.1, PICS Section A5.5 Item 32

Verification Method: Test

DTN.6.09130

AA shall set the status report's reason code, source EID, and creation timestamp to the values provided in the notification.

Rationale: The Report-to EID and Admin Record content are based on the content of the bundle for which status is being reported.

Parent: DTN.5.00540

External Parent: RFC 9171 Section 6.1, PICS Section A5.5 Item 47

Verification Method: Test

DTN.6.09140

If provided in the notification, AA shall set the status report's status time, fragment offset, and original ADU size to the given values.

Rationale: The Report-to EID and Admin Record content are based on the content of the bundle for which status is being reported.

Parent: DTN.5.00540

External Parent: RFC 9171 Section 6.1, PICS Section A5.5 Item 47

Verification Method: Test

DTN.6.09185

Upon creating a BSR, AA shall encode the BSR.

Rationale: Provides for creating and transmitting BSR bundles.

Parent: DTN.5.00520, DTN.5.00530, DTN.5.00550

External Parent: RFC 9171 Section 6.1.1, PICS Section A5.5 Item 1, PICS Section A5.5 Item 48

Verification Method: Test

DTN.6.09190

AA shall request BPA create a bundle for each generated BSR on the configured channel.

Rationale: Provides for creating and transmitting BSR bundles.

Parent: DTN.5.00520, DTN.5.00530, DTN.5.00550

External Parent: RFC 9171 Section 5.1, PICS Section A5.5 Item 32

Verification Method: Test

3.2.7 Compressed Reporting Signal (CRS) Generate and Store

This section contains recommendations on AA Compressed Reporting Signal (CRS) generation and storage.

DTN.6.09200

Upon notification of bundle received with compressed reporting requested, if `bundleSetBehaviorReceivedCBRGenerate` and `bundleSetBehaviorReceivedCBRGenerate[source]` configurations are TRUE, AA shall create or add to a Bundle Sequence Element for the given Report-to EID, Block Source Administrative EID, and Sequence ID, using the given counter value.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00360

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 2.3

Verification Method: Test

DTN.6.09210

Upon notification of bundle accepted with compressed reporting requested, if `bundleSetBehaviorAcceptedCBRGenerate` and `bundleSetBehaviorAcceptedCBRGenerate[source]` configurations are TRUE, AA shall create or add to a Bundle Sequence Element for the given Report-to EID, Block Source Administrative EID, and Sequence ID, using the given counter value.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.09220

Upon notification of bundle forwarded with compressed reporting requested, if `bundleSetBehaviorForwardedCBRGenerate` and `bundleSetBehaviorForwardedCBRGenerate[source]` configurations are TRUE, AA shall create or add to a bundle Sequence Element for the given Report-to EID, Block Source Administrative EID, and Sequence ID using the given counter value.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 2.3

Verification Method: Test

DTN.6.09230

Upon notification of bundle delivered with compressed reporting requested, if `bundleSetBehaviorDeliveredCBRGenerate` and `bundleSetBehaviorDeliveredCBRGenerate[source]` configurations are TRUE, AA shall create or add to a Bundle Sequence Element for the given Report-to EID, Block Source Node ID and Sequence ID using the given counter value.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 2.3

Verification Method: Test

DTN.6.09240

Upon notification of bundle deleted with compressed reporting requested, if `bundleSetBehaviorDeletedCBRGenerate` and `bundleSetBehaviorDeletedCBRGenerate[source]` configurations are TRUE, AA shall create or add to a Bundle Sequence Element for the given Report-to EID, Block Source Administrative EID, and Sequence ID, using the given counter value.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00810

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 2.3

Verification Method: Test

DTN.6.09290

If a Compressed Reporting Signal (CRS) does not exist for the given Report-to EID, AA shall create a CRS for the given Report-to EID and add a CBR to the CRS Report Array.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00400, DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 2.3

Verification Method: Test

DTN.6.09300

Upon creating a CRS, AA shall set the administrative record type to 14.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 2.3

Verification Method: Test

DTN.6.09350

Upon creating a CRS, AA shall set a timer for the CRS to the configured value for the destination custodian.

Rationale: CRS administrative records must be sent on a minimum cadence to prevent unnecessary bundle retransmissions.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 2.3

Verification Method: Test

DTN.6.09250

If a Compressed Reporting Signal (CRS) exists for the given Report-to EID; and if the CRS Report map for the given report type contains a CBR for the given Block Source Administrative EID, Bundle Sequence ID, and reason code; and if the given counter value is Count Sequence Start plus Sequence Length plus one, AA shall increment Sequence Length.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 2.3

Verification Method: Test

DTN.6.09270

If a CRS exists for the given Report-to EID; and if the CRS Report map for the given report type contains a CBR for the given Block Source Administrative EID, Bundle Sequence ID, and reason code; and if the given counter value is less than Count Sequence Start plus Sequence Length plus one, AA shall issue an error event.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 2.3

Verification Method: Test

DTN.6.09260

If a Compressed Reporting Signal (CRS) exists for the given Report-to EID; and if the CRS Report Array for the given report type contains a CBR for the given Block Source Administrative EID, Bundle Sequence ID, and reason code; and if the given counter value is greater than Count Sequence Start plus Sequence Length plus one, AA shall add a CBR to the CRS Reception Report Array.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 2.3

Verification Method: Test

DTN.6.09280

If a Compressed Reporting Signal (CRS) exists for the given Report-to EID; and if the CRS Report Array for the given report type does not contain a CBR for the given Block Source Administrative EID, Bundle Sequence ID and reason code; AA shall add a CBR to the CRS Report Array.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00410, DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 2.3

Verification Method: Test

DTN.6.09305

Upon creating a CRS, AA shall encode the CRS.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 2.3

Verification Method: Test

DTN.6.26320

Upon request to create a CRS, AA shall set the administrative record content to a CBOR definite-length array of 5 items, each of which is a CBOR definite-length array.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 2.3

Verification Method: Test

DTN.6.26330

Upon adding a CBR to a CRS Report Array, if the Bundle Sequence ID is zero, AA shall add to the array a CBOR definite-length array of 3 elements comprising the given Block Source Administrative EID, given counter value, and the value 1.

Rationale: Required by the orange book, section 3.3. The Block Source Node ID is required to be the destination EID of the subject bundle, the counter value is the Count Sequence Start and the Sequence Length is 1.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 3.3

Verification Method: Test

DTN.6.26340

Upon adding a CBR to a CRS Report Array, if the Bundle Sequence ID is non-zero, AA shall add to the array a CBOR definite-length array of 5 elements.

Rationale: Required by the orange book section 3.3.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 3.3

Verification Method: Test

DTN.6.26350

Upon adding a 5-element CBR to a CRS Report Array, AA shall set the first two array elements to the given Block Source Administrative EID and Bundle Sequence ID.

Rationale: Required by the orange book section 3.3.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 3.3

Verification Method: Test

DTN.6.26360

Upon adding a 5-element CBR to a CRS Report Array, AA shall set the third array element, Count Sequence Start, to the given counter value, and the fourth array element, Sequence Length, to 1.

Rationale: Required by the orange book section 3.3.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 3.3

Verification Method: Test

DTN.6.26370

Upon adding a 5-element CBR to a CRS Report Array, AA shall set the final array element to the given reason code.

Rationale: Required by the orange book section 3.3. The recommendation says this field may contain a reason code or other data.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 3.3

Verification Method: Test

DTN.6.26380

Upon adding a CBR to a CRS Report Array, if the Bundle Sequence ID is non-zero, AA shall add to the array a CBOR definite-length array of 5 elements.

Rationale: Required by the orange book section 3.3.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 3.3

Verification Method: Test

DTN.6.26390

Upon adding a 5-element CBR to a CRS Report Array, AA shall set the first two array elements to the given Block Source Administrative EID and Bundle Sequence ID.

Rationale: Required by the orange book section 3.3.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 3.3

Verification Method: Test

DTN.6.26400

Upon adding a 5-element CBR to a CRS Report Array, AA shall set the third array element, Count Sequence Start, to the given counter value, and the fourth array element, Sequence Length, to 1.

Rationale: Required by the orange book section 3.3.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 3.3

Verification Method: Test

DTN.6.26410

Upon adding a 5-element CBR to a CRS Report Array, AA shall set the final array element to the given reason code.

Rationale: Required by the orange book section 3.3. The recommendation says this field may contain a reason code or other data.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 3.3

Verification Method: Test

DTN.6.09360

When a CRS becomes larger than the trigger size for the Block Source Administrative EID, AA shall request BPA create a bundle for the CRS on the configured channel as indicated by the Block Source Administrative EID.

Rationale: The size of CRS may be limited by the underlying network.

Parent: DTN.5.00420, DTN.5.00450, DTN.5.00460, DTN.5.00542, DTN.5.00552

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 2.3

Verification Method: Test

DTN.6.09370

When a CRS timer expires, AA shall request BPA create a bundle for the CRS on the configured channel indicated by the Block Source Administrative EID.

Rationale: CRS administrative records must be sent on a minimum cadence to prevent unnecessary bundle retransmissions.

Parent: DTN.5.00420, DTN.5.00450, DTN.5.00460, DTN.5.00542, DTN.5.00552

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.09380

If BPA successfully creates a bundle for the CRS, and if the CRS contained a non-empty Accepted Report Array, AA shall notify BPA that a custody report was generated.

Rationale: Closes the loop with Custody Transfer.

Parent: DTN.5.00480

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 2.3

Verification Method: Test

DTN.6.12420

Upon receiving a contact-stop directive, AA shall send any CRS under construction.

Rationale: Attempt to get out any in work CRS prior to the end of the contact. It is possible the CRS can be sent on a subsequent contact before it expires.

Parent: DTN.5.00900

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

3.2.8 Contact Handling

This section contains recommendations on AA contact handling.

DTN.6.12372

Upon receiving a contact-stop directive, AA shall increment bundleAgentAcceptedDirectiveCount (before executing the directive).

Rationale: This directive may take longer to execute than we want the AA to wait.

Parent: DTN.5.00900

External Parent: N/A

Verification Method: Test

DTN.6.12282

AA shall reject a contact-setup directive if it would exceed the maximum number of simultaneous contacts configured for the node (paramSetMaxSimultaneousContacts).

Rationale: Requirement DTN.6.16090 requires the node support multiple simultaneous contacts and this covers the case where we hit the limit. The node can't support an infinite number of contacts.

Parent: DTN.5.00165, DTN.5.00900

External Parent: N/A

Verification Method: Test

DTN.6.12290

Upon receiving a contact-setup directive, AA shall establish a CLA of the type indicated in the given contact configuration.

Rationale: The exact meaning of this is implementation dependent, but the concept is that a CLA of the given type is instantiated. More than one CLA of a given type may be instantiated at any given time. Analogous to spawning a task, starting a thread, running a program.

Parent: DTN.5.00900

External Parent: N/A
Verification Method: Test

DTN.6.12362

Upon accepting a contact-start directive, AA shall increment bundleAgentAcceptedDirectiveCount (before executing the directive).

Rationale: This directive may take longer to execute than we want the AA to wait.

Parent: DTN.5.00900

External Parent: N/A

Verification Method: Test

DTN.6.12390

Upon receiving a contact-teardown directive, AA shall dis-establish the CLA established for the contact.

Rationale: The exact meaning of this is implementation dependent, but the concept is that the CLA instance is deleted.

Parent: DTN.5.00900

External Parent: RFC 9171 Section 7.2

Verification Method: Test

3.2.9 Directive Execution

This section contains recommendations on AA directive execution.

DTN.6.19060

AA shall receive authenticated, syntactically validated directives.

Rationale: Directives provide for the control of the DTN node.

Parent: DTN.5.00860, DTN.5.00870, DTN.5.01040, DTN.5.01080

External Parent: N/A

Verification Method: Test

DTN.6.19080

AA shall validate all directives, including parameters, prior to execution.

Rationale: Directives provide for the control of the DTN node. All directives, including parameter values, must be validated to ensure node health and safety.

Parent: DTN.5.00880, DTN.5.00007, DTN.5.00724

External Parent: N/A

Verification Method: Test

DTN.6.19090

After validation, AA shall accept the following directives:

- reload-saved-data
- start-all-applications
- start-application
- stop-application
- node-shutdown
- reset-all-counters

reset-counter
reset-source-counters
reset-bundle-counters
reset-error-counters
set-MIB-item
add-MIB-array-key
add-storage-allocation
set-registration-state
add-application
add-all-applications
remove-MIB-array-key
remove-storage-allocation
remove-application
initialize-bundle-storage
clear-volatile
add-authorized-sources
remove-authorized-sources
add-authorized-custody-sources
remove-authorized-custody-sources
add-authorized-custodians
remove-authorized-custodians
add-authorized-report-to-eid
remove-authorized-report-to-eid
add-latency
remove-latency
contact-setup
contact-start
contact-stop
contact-teardown
verify-bundle-storage
verify-bundle-metadata
perform-self-test
rebuild-bundle-metadata

Rationale: Directives provide for the control of the DTN node. Pre-defined set of directives that can be sent to the node.

Parent: DTN.5.00880, DTN.5.00900, DTN.5.01025

External Parent: N/A

Verification Method: Test

DTN.6.19100

If a directive's header-specified length is not equal to the expected directive length, AA shall reject the directive.

Rationale: For robust and secure operations, directive must be validated prior to execution. Basic directive verification in the event of SEU or memory corruption.

Parent: DTN.5.00880

External Parent: N/A

Verification Method: Test

DTN.6.19110

If the directive is not a valid node directive, AA shall reject the directive.

Rationale: The node cannot execute a directive it fundamentally does not understand; for example, the directive "noop" is OK, but the directive "fire thruster" is not one the node understands.

Parent: DTN.5.00900

External Parent: N/A

Verification Method: Test

DTN.6.19120

If any parameters required for the given directive are missing, AA shall reject the directive.

Rationale: For robust and secure operations, invalid directives must be rejected and not executed.

Parent: DTN.5.00880

External Parent: N/A

Verification Method: Test

DTN.6.19130

If any extraneous parameters accompany a given directive, AA shall reject the directive.

Rationale: For robust and secure operations, AA must not accept flawed directives.

Parent: DTN.5.00880

External Parent: N/A

Verification Method: Test

DTN.6.19200

AA shall accept a no-operation directive.

Rationale: No-op directives can be used as a basic test for application aliveness.

Parent: DTN.5.00900

External Parent: N/A

Verification Method: Test

DTN.6.19210

AA shall execute accepted directives.

Rationale: Node Configuration must convert directives into configuration used by all the software modules.

Parent: DTN.5.00900

External Parent: N/A

Verification Method: Test

DTN.6.19340

AA shall receive directives from the host.

Rationale: This is the standard form of messages, which is how telecommands (directives) are conveyed to the node.

Parent: DTN.5.00860

External Parent: N/A

Verification Method: Test

DTN.6.19190

Except where required otherwise, after successfully executing a directive AA shall issue an information event detailing the directive executed.

Rationale: This is good practice, reinforced by cFS design patterns.

Parent: DTN.5.00900

External Parent: N/A

Verification Method: Test

3.2.10 Policy

This section contains recommendations on AA policy implementation.

DTN.6.19360

AA shall request validation of all incoming configuration updates.

Rationale: Configuration updates need to be validated by the modules which use that configuration prior to being activated.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Test

DTN.6.19390

AA shall receive configuration from the host.

Rationale: Host manages all tables and provides access to the node.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Test

DTN.6.12165

Upon receiving a set-MIB-item directive, AA shall set the given MIB configuration item to the given value.

Rationale: Provides a way to configure appropriate MIB elements to specific values.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Test

DTN.6.12180

AA shall allow only the following MIB configuration items to be set:

paramSetMaxSequenceNum

paramSetMaxLifetime

paramSetMaxPayloadlength

paramSetMaxBundleLength
paramSetMaxTransmissionId
paramSetMaxForwardingRetries
paramSetMaxSimultaneousContacts
bundleSetBehaviorReceivedBSRGenerate
bundleSetBehaviorAcceptedBSRGenerate
bundleSetBehaviorForwardedBSRGenerate
bundleSetBehaviorDeliveredBSRGenerate
bundleSetBehaviorDeletedBSRGenerate
bundleSetBehaviorReceivedCBRGenerate
bundleSetBehaviorAcceptedCBRGenerate
bundleSetBehaviorForwardedCBRGenerate
bundleSetBehaviorDeliveredCBRGenerate
bundleSetBehaviorDeletedCBRGenerate
paramSetMaxBSRGenerationRate
paramSetMaxCBRGenerationRate
paramSetBehaviorEventReporting
paramSupportCustody
paramSupportConfidentiality
paramSetBehaviorWrapResponse

Rationale: Most MIB elements are counters for which it is inappropriate to set them to specific non-zero values.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Inspection

DTN.6.12260

Upon receiving an add-MIB-array-key directive, AA shall add the given EID pattern as a key to the map of MIB elements accessed by source EID for MIB items.

Rationale: Many MIB elements are accessed by bundle source EID.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Test

DTN.6.12270

Upon receiving a remove-MIB-array-key directive, AA shall remove elements indexed by the given EID pattern from the map of MIB elements accessed by source EID for MIB items.

Rationale: Many MIB elements are accessed by bundle source EID.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Test

3.2.11 Telemetry and Event Reporting

This section contains recommendations on AA telemetry and event reporting.

DTN.6.12990

Upon startup, on a configured time interval, the AA shall generate a status message containing all MIB configuration settings, including:

systemNodeName
systemNodeOwner
systemSoftwareExec
systemSoftwareExecVersion
bundleAgentNodeNumber
bundleAgentVersion
bundleAgentOperationalState
bundleAgentConfiguration
bundleAgentAvailableStorage
bundleAgentCtdbSize
paramSetMaxSequenceNum
paramSetMaxLifetime
paramSetMaxPayloadLength
paramSetMaxTransmissionId
paramSetMaxForwardingRetries
paramSetMaxSimultaneousContacts
bundleSetBehaviorReceivedBSRGenerate
bundleSetBehaviorAcceptedBSRGenerate
bundleSetBehaviorForwardedBSRGenerate
bundleSetBehaviorDeliveredBSRGenerate
bundleSetBehaviorDeletedBSRGenerate
bundleSetBehaviorReceivedCBRGenerate
bundleSetBehaviorAcceptedCBRGenerate
bundleSetBehaviorForwardedCBRGenerate
bundleSetBehaviorDeliveredCBRGenerate
bundleSetBehaviorDeletedCBRGenerate
paramSetMaxBSRGenerationRate
paramSetMaxCBRGenerationRate
paramSetBehaviorEventReporting
paramSupportBIBE
paramSupportCustody
paramSupportConfidentiality
paramSetBehaviorReturnToSender
paramSetBehaviorTransIdReuse
paramSetBehaviorTransIdRollover
paramSetBehavior
paramSetBehaviorWrapResponse
BundleSizeNoFragment

Rationale: Telemetry messages report the state of the node and data accounting information.

Parent: DTN.5.00940, DTN.5.01040

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.20100

Upon startup, on a configured time interval, AA shall generate a status message containing all MIB counters, including the following where all except * are per-node and per-source:

bundleAgentAcceptedDirectiveCount
bundleAgentRejectedDirectiveCount
bundleCountGeneratedAccepted
bundleCountGeneratedRejected
bundleCountGeneratedCCS *
bundleCountGeneratedBsrReceived *
bundleCountGeneratedBsrAccepted *
bundleCountGeneratedBsrForwarded *
bundleCountGeneratedBsrDelivered *
bundleCountGeneratedBsrDeleted *
bundleCountReceivedBsrReceived
bundleCountReceivedBsrAccepted
bundleCountReceivedBsrForwarded
bundleCountReceivedBsrDelivered
bundleCountReceivedBsrDeleted
bundleCountMaxBsrRateExceeded
bundleCountGeneratedCrs *
bundleCountGeneratedCrsReceived *
bundleCountGeneratedCrsAccepted *
bundleCountGeneratedCrsForwarded *
bundleCountGeneratedCrsDelivered *
bundleCountGeneratedCrsDeleted *
bundleCountMaxCrsRateExceeded *
bundleCountReceivedCrs
bundleCountReceivedCrsReceived
bundleCountReceivedCrsAccepted
bundleCountReceivedCrsForwarded
bundleCountReceivedCrsDelivered
bundleCountReceivedCrsDeleted
bundleCountGeneratedFragment
bundleCountReceived
bundleCountReceivedFragment
bundleCountUnprocessedBlocks
bundleCountCustodySignalReceived
bundleCountForwarded
bundleCountForwardedFailed
bundleCountFragmented
bundleCountReassembled
bundleCountFragmentError
bundleCountDelivered
bundleCountAbandoned

aduCountDelivered
aduCountReceived
bundleCountStored
bundleCountDeleted
bundleCountDeletedExpired
bundleCountDeletedHopExceeded
bundleCountDeletedTrafficPared
bundleCountDeletedUnintelligible
bundleCountDeletedUnsupportedBlock
bundleCountDiscarded
bundleCountDeletedNoStorage
bundleCountDeletedUnauthorized
bundleCountDeletedtooLong
bundleCountCustodyTransferred
bundleCountCustodyRejected
bundleCountCustodyRequest
bundleCountInCustody
bundleCountCustodyReForwarded
bundleCountNoFurtherInfo
bundleCountRedundant
bundleCountDepleted
bundleCountUnintelligibleEid
bundleCountUnintelligibleBlock
bundleCountReceivedCustodySignal
bundleCountGeneratedCustodySignal
bundleCountRejectedCustody
nodeStartupCounter
bundleCountReceivedAdminRecord

Rationale: Telemetry messages report the state of the node and data accounting information.

Parent: DTN.5.00940

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.10121

Upon startup, AA shall issue an information event giving the node software version(s) and the value of the nodeStartupCounter.

Rationale: Detail event information is very helpful information for host and network management.

Parent: DTN.5.01040, DTN.5.01042, DTN.5.01050

External Parent: N/A

Verification Method: Test

DTN.6.09480

AA shall send telemetry per the Monitor and Control ICD.

Rationale: Send telemetry upon request

Parent: DTN.5.00940, DTN.5.00950

External Parent: N/A

Verification Method: Test

DTN.6.19370

AA shall receive telemetry information generated by the node as per the Monitor & Control ICD.

Rationale: Gather telemetry generated by the node.

Parent: DTN.5.00970, DTN.5.01080

External Parent: N/A

Verification Method: Test

DTN.6.19241

Upon ignoring an ADU from an unknown application, AA shall issue an information event.

Rationale: Notify host of unexpected ADUs.

Parent: DTN.5.00010

External Parent: N/A

Verification Method: Test

DTN.6.19170

When it rejects a directive, AA shall issue an error event giving the directive and the nature of the error.

Rationale: Events provide information to help determine why AA rejected the directive.

Parent: DTN.5.00920

External Parent: N/A

Verification Method: Test

DTN.6.19260

AA shall translate all event messages event types to host event types.

Rationale: DTN Node event types need to be mapped to host event types.

Parent: DTN.5.00980

External Parent: N/A

Verification Method: Test, Inspection

DTN.6.19320

AA shall connect to the host to send out event messages.

Rationale: DTN Node events need to be sent to the host.

Parent: DTN.5.00980, DTN.5.01053, DTN.5.01080

External Parent: N/A

Verification Method: Test

DTN.6.19380

AA shall packetize the telemetry and send it to the host.

Rationale: Host will collect and distribute telemetry.

Parent: DTN.5.00970, DTN.5.01080

External Parent: N/A

Verification Method: Test

DTN.6.19450

AA shall send performance information from all DTN Node Subsystems to the host.

Rationale: Performance profiling information of DTN node need to be sent to host. Performance ID, entry and exit information are sent to Performance Logger by the modules.

Parent: DTN.5.01070

External Parent: N/A

Verification Method: Test

3.2.12 Counters

This section contains recommendations on AA counters.

DTN.6.12120

Upon receiving a reset-counter directive, AA shall set the given Management Information Base (MIB) counter to zero.

Rationale: Architectural pattern for application operational interfaces. Allows for partial or full resetting of housekeeping counters. All reset operations should be observable.

Parent: DTN.5.00930

External Parent: CCSDS BPv7 Annex C2.4, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.12150

Upon receiving a reset-all-counters directive, AA shall set to zero all resettable MIB counters.

Rationale: The ability to reset all counters facilitates specific tests or operational activities.

Parent: DTN.5.00930

External Parent: CCSDS BPv7 Annex C2.4, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.12160

Upon receiving a reset-source-counters directive, AA shall set to zero all resettable MIB counters associated with the given source EID pattern.

Rationale: The ability to reset flow-specific counters facilitates certain tests or operational activities.

Parent: DTN.5.00930

External Parent: CCSDS BPv7 Annex C2.4, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.10111

Upon startup, AA shall increment nodeStartupCounter.

Rationale: This is very important information for ground and network management to see how many times node has been restarted.

Parent: DTN.5.01040, DTN.5.01042, DTN.5.01050

External Parent: N/A

Verification Method: Test

DTN.6.12710

AA shall increment bundleAgentRejectedDirectiveCount whenever an error occurs during a non-housekeeping directive.

Rationale: Have to account for errors on directives.

Parent: DTN.5.00862

External Parent: N/A

Verification Method: Test

DTN.6.20010

AA shall allow only the following MIB node counters to be reset:

bundleAgentAcceptedDirectiveCount
bundleAgentRejectedDirectiveCount
bundleCountGeneratedAccepted
bundleCountGeneratedRejected
bundleCountGeneratedCCS
bundleCountGeneratedBsrReceived
bundleCountGeneratedBsrAccepted
bundleCountGeneratedBsrForwarded
bundleCountGeneratedBsrDelivered
bundleCountGeneratedBsrDeleted
bundleCountReceivedBsrReceived
bundleCountReceivedBsrAccepted
bundleCountReceivedBsrForwarded
bundleCountReceivedBsrDelivered
bundleCountReceivedBsrDeleted
bundleCountMaxBsrRateExceeded
bundleCountGeneratedCrs
bundleCountGeneratedCrsReceived
bundleCountGeneratedCrsAccepted
bundleCountGeneratedCrsForwarded
bundleCountGeneratedCrsDelivered
bundleCountGeneratedCrsDeleted
bundleCountMaxCrsRateExceeded
bundleCountReceivedCrs
bundleCountReceivedCrsReceived
bundleCountReceivedCrsAccepted
bundleCountReceivedCrsForwarded
bundleCountReceivedCrsDelivered
bundleCountReceivedCrsDeleted
bundleCountGeneratedFragment

bundleCountReceived
 bundleCountReceivedFragment
 bundleCountUnprocessedBlocks
 bundleCountCustodySignalReceived
 bundleCountForwarded
 bundleCountForwardedFailed
 bundleCountFragmented
 bundleCountReassembled
 bundleCountFragmentError
 bundleCountDelivered
 bundleCountAbandoned
 aduCountDelivered
 aduCountReceived
 bundleCountDeleted
 bundleCountDeletedExpired
 bundleCountDeletedHopExceeded
 bundleCountDeletedTrafficPared
 bundleCountDeletedUnintelligible
 bundleCountDeletedUnsupportedBlock
 bundleCountDiscarded
 bundleCountDeletedNoStorage
 bundleCountDeletedUnauthorized
 bundleCountDeletedtooLong
 bundleCountCustodyTransferred
 bundleCountCustodyRejected
 bundleCountCustodyRequest
 bundleCountCustodyReForwarded
 bundleCountNoFurtherInfo
 bundleCountRedundant
 bundleCountDepleted
 bundleCountUnintelligibleEid
 bundleCountUnintelligibleBlock
 bundleCountReceivedCustodySignal
 bundleCountGeneratedCustodySignal
 bundleCountRejectedCustody
 bundleCountReceivedAdminRecord

Rationale: The ability to reset counters facilitates certain tests or operational activities. This requirement applies to node-global counters.

Parent: DTN.5.00930

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.20020

AA shall allow only the following MIB source counters to be reset:

bundleCountGeneratedAccepted
 bundleCountGeneratedRejected

bundleCountGeneratedCCS
bundleCountReceivedBsrReceived
bundleCountReceivedBsrAccepted
bundleCountReceivedBsrForwarded
bundleCountReceivedBsrDelivered
bundleCountReceivedBsrDeleted
bundleCountMaxBsrRateExceeded
bundleCountReceivedCrsReceived
bundleCountReceivedCrsAccepted
bundleCountReceivedCrsForwarded
bundleCountReceivedCrsDelivered
bundleCountReceivedCrsDeleted
bundleCountGeneratedFragment
bundleCountReceived
bundleCountReceivedFragment
bundleCountUnprocessedBlocks
bundleCountForwarded
bundleCountForwardedFailed
bundleCountFragmented
bundleCountReassembled
bundleCountFragmentError
bundleCountDelivered
bundleCountAbandoned
aduCountDelivered
aduCountReceived
bundleCountDeleted
bundleCountDeletedExpired
bundleCountDeletedHopExceeded
bundleCountDeletedTrafficPared
bundleCountDeletedUnintelligible
bundleCountDeletedUnsupportedBlock
bundleCountDiscarded
bundleCountDeletedNoStorage
bundleCountDeletedtooLong
bundleCountCustodyTransferred
bundleCountCustodyRejected
bundleCountCustodyRequest
bundleCountCustodyReForwarded
bundleCountNoFurtherInfo
bundleCountRedundant
bundleCountDepleted
bundleCountUnintelligibleEid
bundleCountUnintelligibleBlock
bundleCountReceivedCustodySignal
bundleCountGeneratedCustodySignal
bundleCountRejectedCustody

bundleCountReceivedAdminRecord

Rationale: The ability to reset counters facilitates certain tests or operational activities. This requirement applies to source-specific counters indexed by a source EID.

Parent: DTN.5.00930

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.20080

Upon receiving a reset-bundle-counter directive, AA shall set the following counters to zero where all except * are per-node and per-source:

bundleCountGeneratedAccepted

bundleCountGeneratedRejected

bundleCountGeneratedCCS *

bundleCountGeneratedBsrReceived *

bundleCountGeneratedBsrAccepted *

bundleCountGeneratedBsrForwarded *

bundleCountGeneratedBsrDelivered *

bundleCountGeneratedBsrDeleted *

bundleCountMaxBsrRateExceeded

bundleCountReceivedBsrReceived

bundleCountReceivedBsrAccepted

bundleCountReceivedBsrForwarded

bundleCountReceivedBsrDelivered

bundleCountReceivedBsrDeleted

bundleCountGeneratedCrs *

bundleCountGeneratedCrsReceived *

bundleCountGeneratedCrsAccepted *

bundleCountGeneratedCrsForwarded *

bundleCountGeneratedCrsDelivered *

bundleCountGeneratedCrsDeleted *

bundleCountMaxCrsRateExceeded *

bundleCountReceivedCrs

bundleCountReceivedCrsReceived

bundleCountReceivedCrsAccepted

bundleCountReceivedCrsForwarded

bundleCountReceivedCrsDelivered

bundleCountReceivedCrsDeleted

bundleCountGeneratedFragment

bundleCountReceived

bundleCountReceivedFragment

bundleCountUnprocessedBlocks

bundleCountCustodySignalReceived *

bundleCountForwarded

bundleCountForwardedFailed

bundleCountFragmented

bundleCountReassembled
 bundleCountFragmentError
 bundleCountDelivered
 bundleCountAbandoned
 aduCountDelivered
 aduCountReceived
 bundleCountDeleted
 bundleCountDeletedExpired
 bundleCountDeletedHopExceeded
 bundleCountDeletedTrafficPared
 bundleCountDeletedUnintelligible
 bundleCountDeletedUnsupportedBlock
 bundleCountDiscarded
 bundleCountDeletedNoStorage
 bundleCountDeletedUnauthorized
 bundleCountDeletedtooLong
 bundleCountCustodyTransferred
 bundleCountCustodyRejected
 bundleCountCustodyRequest
 bundleCountCustodyReForwarded
 bundleCountNoFurtherInfo
 bundleCountRedundant
 bundleCountDepleted
 bundleCountUnintelligibleBlock
 bundleCountReceivedCustodySignal
 bundleCountGeneratedCustodySignal
 bundleCountRejectedCustody
 bundleCountReceivedAdminRecord

Rationale: Sometimes it is necessary to clear on bundle related counters, not all counters.

Parent: DTN.5.00012, DTN.5.01050, DTN.5.00120, DTN.5.00192, DTN.5.00370, DTN.5.00382, DTN.5.00570, DTN.5.00600, DTN.5.00700, DTN.5.00770, DTN.5.00784, DTN.5.00862

External Parent: N/A

Verification Method: Test

DTN.6.20090

Upon receiving a reset-error-counter directive, AA shall set only the following error counters to zero:

bundleAgentRejectedDirectiveCount,
 bundleCountGeneratedRejected,
 bundleCountUnprocessedBlocks,
 bundleCountFragmentError,
 bundleCountAbandoned,
 bundleCountDeletedUnintelligible, bundleCountDeletedUnsupportedBlock,
 bundleCountDeletedNoStorage,

bundleCountDeletedUnauthorized,
bundleCountDeletedTooLong,
bundleCountCustodyRejected,
bundleCountRejectedCustody

Rationale: Sometimes it is necessary to clear only error counters.

Parent: DTN.5.01050

External Parent: N/A

Verification Method: Test

DTN.6.19160

When it rejects a directive, AA shall increment

bundleAgentRejectedDirectiveCount.

Rationale: Provide operator feedback; operators need to be made aware of directive rejection both in real-time through event messages and through housekeeping telemetry through counters.

Parent: DTN.5.00862, DTN.5.00920

External Parent: N/A

Verification Method: Test

DTN.6.19180

After successfully executing a non-housekeeping directive AA shall increment bundleAgentAcceptedDirectiveCount.

Rationale: Increment MIB variable once a directive was executed.

Parent: DTN.5.00862

External Parent: N/A

Verification Method: Test

DTN.6.09050

AA shall increment bundleCountGeneratedBsrDelivered each time it generates a Bundle Delivered Status Report.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00570

External Parent: N/A

Verification Method: Test

DTN.6.09051

AA shall increment bundleCountGeneratedCrsDelivered each time a delivered bundle report is added to a Compressed Reporting Signal (CRS) for each CRS.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00572

External Parent: N/A

Verification Method: Test

DTN.6.09052

AA shall increment bundleCountReceivedBsrDelivered each time it receives a Bundle Delivered Status Report.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00570

External Parent: N/A

Verification Method: Test

DTN.6.09053

AA shall increment bundleCountReceivedBsrDelivered[bundle_source] each time it receives a Bundle Delivered Status Report.

Rationale: Counter prescribed by proposed CCSDS MIB. Index is the source EID of the bundle that is the subject of the BSR.

Parent: DTN.5.00570

External Parent: N/A

Verification Method: Test

DTN.6.09054

AA shall increment bundleCountReceivedCrsDelivered for each received Bundle Delivered Status Report within any CRS.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00572

External Parent: N/A

Verification Method: Test

DTN.6.09055

AA shall add to the bundleCountReceivedCrsDelivered[source node ID] the number of bundles for which a CRS reports bundle delivered for each Block Source Administrative EID in the CRS.

Rationale: Counter prescribed by proposed CCSDS MIB. Index is the Block Source Node ID of each Bundle Sequence Element in the CRS Report's "delivered" map entry.

Parent: DTN.5.00572

External Parent: N/A

Verification Method: Test

DTN.6.09059

AA shall increment bundleCountGeneratedBsrAccepted each time it generates a Bundle Accepted Status Report.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00570

External Parent: N/A

Verification Method: Test

DTN.6.09061

AA shall increment bundleCountGeneratedCrsAccepted each time an accepted bundle report is added to a Compressed Reporting Signal (CRS) for each CRS.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00572

External Parent: N/A

Verification Method: Test

DTN.6.09063

AA shall increment bundleCountReceivedBsrAccepted[bundle_source] each time it receives a Bundle Accepted Status Report.

Rationale: Counter prescribed by proposed CCSDS MIB. Index is the source EID of the bundle that is the subject of the BSR.

Parent: DTN.5.00570

External Parent: N/A

Verification Method: Test

DTN.6.09065

AA shall increment bundleCountReceivedCrsAccepted for each received Bundle Accepted Status Report within any CRS.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00572

External Parent: N/A

Verification Method: Test

DTN.6.09066

AA shall add to the bundleCountReceivedCrsAccepted[source node ID] the number of bundles for which a CRS reports bundle accepted for each Block Source Administrative EID in the CRS.

Rationale: Counter prescribed by proposed CCSDS MIB. Index is the Block Source Node ID of each Bundle Sequence Element in the CRS Report's "accepted" map entry.

Parent: DTN.5.00572

External Parent: N/A

Verification Method: Test

DTN.6.09070

AA shall increment bundleCountGeneratedBsrForwarded each time it generates a Bundle Forwarded Status Report.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00570

External Parent: N/A

Verification Method: Test

DTN.6.09071

AA shall increment bundleCountGeneratedCrsForwarded each time a forwarded bundle report is added to a Compressed Reporting Signal (CRS) for each CRS.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00572

External Parent: N/A

Verification Method: Test

DTN.6.09072

AA shall increment bundleCountReceivedBsrForwarded each time it receives a Bundle Delivered Status Report.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00570

External Parent: N/A

Verification Method: Test

DTN.6.09074

AA shall increment bundleCountReceivedBsrForwarded[bundle_source] each time it receives a Bundle Delivered Status Report.

Rationale: Counter prescribed by proposed CCSDS MIB. Index is the source EID of the bundle that is the subject of the BSR.

Parent: DTN.5.00570

External Parent: N/A

Verification Method: Test

DTN.6.09075

AA shall increment bundleCountReceivedCrsForwarded for each received Bundle Forwarded Status Report within any CRS.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00572

External Parent: N/A

Verification Method: Test

DTN.6.09076

AA shall add to the bundleCountReceivedCrsForwarded[source node ID] the number of bundles for which a CRS reports bundle forwarded for each Block Source Administrative EID in the CRS.

Rationale: Counter prescribed by proposed CCSDS MIB. Index is the Block Source Node ID of each Bundle Sequence Element in the CRS Report's "forwarded" map entry.

Parent: DTN.5.00572

External Parent: N/A

Verification Method: Test

DTN.6.09080

AA shall increment bundleCountGeneratedBsrReceived each time it generates a Bundle Reception Status Report.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00570

External Parent: N/A

Verification Method: Test

DTN.6.09081

AA shall increment bundleCountGeneratedCrsReceived each time a received bundle report is added to a Compressed Reporting Signal (CRS) for each CRS.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00572

External Parent: N/A

Verification Method: Test

DTN.6.09082

AA shall increment bundleCountReceivedBsrReceived each time it receives a Bundle Delivered Status Report.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00570

External Parent: N/A

Verification Method: Test

DTN.6.09084

AA shall increment bundleCountReceivedBsrReceived[bundle_source] each time it receives a Bundle Delivered Status Report.

Rationale: Counter prescribed by proposed CCSDS MIB. Index is the source EID of the bundle that is the subject of the BSR.

Parent: DTN.5.00570

External Parent: N/A

Verification Method: Test

DTN.6.09085

AA shall increment bundleCountReceivedCrsReceived for each received Bundle Received Status Report within any CRS.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00572

External Parent: N/A

Verification Method: Test

DTN.6.09086

AA shall add to the bundleCountReceivedCrsReceived[source node ID] the number of bundles for which a CRS reports bundle received for each Block Source Administrative EID in the CRS.

Rationale: Counter prescribed by proposed CCSDS MIB. Index is the Block Source Node ID of each Bundle Sequence Element in the CRS Report's "received" map entry.

Parent: DTN.5.00572

External Parent: N/A

Verification Method: Test

DTN.6.09090

AA shall increment bundleCountGeneratedBsrDeleted each time it generates a Bundle Deleted Status Report.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00570

External Parent: N/A

Verification Method: Test

DTN.6.09091

AA shall increment bundleCountGeneratedCrsDeleted each time a deleted bundle report is added to a Compressed Reporting Signal (CRS) for each CRS.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00572

External Parent: N/A

Verification Method: Test

DTN.6.09092

AA shall increment bundleCountReceivedBsrDeleted each time it receives a Bundle Delivered Status Report.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00570

External Parent: N/A

Verification Method: Test

DTN.6.09093

AA shall increment bundleCountReceivedBsrDeleted[bundle_source] each time it receives a Bundle Delivered Status Report.

Rationale: Counter prescribed by proposed CCSDS MIB. Index is the source EID of the bundle that is the subject of the BSR.

Parent: DTN.5.00570

External Parent: N/A

Verification Method: Test

DTN.6.09095

AA shall increment bundleCountReceivedCrsDeleted for each received Bundle Deleted Status Report within any CRS.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00572

External Parent: N/A

Verification Method: Test

DTN.6.09096

AA shall add to the bundleCountReceivedCrsDeleted[source node ID] the number of bundles for which a CRS reports bundle deleted for each Block Source Administrative EID in the CRS.

Rationale: Counter prescribed by proposed CCSDS MIB. Index is the Block Source Node ID of each Bundle Sequence Element in the CRS Report's "deleted" map entry.

Parent: DTN.5.00572

External Parent: N/A

Verification Method: Test

DTN.6.09101

AA shall increment bundleCountReceivedCrs each time it receives a CRS.

Rationale: Counter prescribed by proposed CCSDS MIB.

Parent: DTN.5.00572

External Parent: N/A

Verification Method: Test

DTN.6.09170

If generating a BSR would exceed the configured global maximum rate, AA shall increment the bundleCountMaxBsrRateExceeded counter in lieu of generating the BSR.

Rationale: Provides network management insight into potentially excessive BSR generation.

Parent: DTN.5.00540, DTN.5.00570

External Parent: N/A

Verification Method: Test

DTN.6.09180

If generating a BSR would exceed the configured per-source maximum rate, AA shall increment the bundleCountMaxBsrRateExceeded[source] counter in lieu of generating the BSR.

Rationale: Provides network management insight into potentially excessive BSR generation by a specific source.

Parent: DTN.5.00540, DTN.5.00570

External Parent: N/A

Verification Method: Test

DTN.6.09390

AA shall increment bundleCountGeneratedCrs when a bundle is created with a CRS.

Rationale: Provides insight for network management.

Parent: DTN.5.00572

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.09450

If generating a CRS would exceed the configured global maximum rate, AA shall increment the bundleCountMaxCrsRateExceeded counter in lieu of generating the CRS.

Rationale: Provides network management insight into potentially excessive CRS generation.

Parent: DTN.5.00542, DTN.5.00572

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 2.3

Verification Method: Test

3.2.13 Node Shutdown

This section contains recommendations on AA support of node shutdown activities.

DTN.6.12792

Upon receiving a node-shutdown directive, AA shall write MIB counters to persistent storage.

Rationale: This is to make sure that persistence data is not cleared during node startup.

Parent: DTN.5.01065

External Parent: N/A

Verification Method: Test

DTN.6.12820

Upon receiving a node-shutdown directive, AA shall stop and teardown all established CLAs.

Rationale: There should not be active and open connections after the node shutdown.

Parent: DTN.5.01065

External Parent: N/A

Verification Method: Test

DTN.6.12840

Upon receiving a node-shutdown directive, AA shall stop receiving ADUs from applications.

Rationale: If DTN node is in the process of storing the bundle, that job needs to be completed before node shutdown, this is to make sure no errors in the bundle storage.

Parent: DTN.5.01050, DTN.5.01065

External Parent: N/A

Verification Method: Test

DTN.6.12841

Upon receiving a node-shutdown directive, AA shall stop delivering ADUs to applications.

Rationale: If DTN node is in the process of storing the bundle, that job needs to be completed before node shutdown, this is to make sure no errors in the bundle storage.

Parent: DTN.5.01050, DTN.5.01065

External Parent: N/A

Verification Method: Test

DTN.6.12845

Upon receiving a node-shutdown directive, AA shall execute remove-application for all applications.

Rationale: There should not be active and open connections after the node shutdown.

Parent: DTN.5.01065

External Parent: N/A

Verification Method: Test

DTN.6.12860

Upon receiving a node-shutdown directive, AA shall terminate running threads.

Rationale: No running threads after node shutdown. Make sure resource allocation is handled correctly.

Parent: DTN.5.01065

External Parent: N/A

Verification Method: Test, Inspection

3.3 Bundle Protocol Agent (BPA)

This section contains recommendations on the BPA.

3.3.1 Application Handling

This section contains recommendations on BPA application handling.

DTN.6.03151

Upon request from AA, BPA shall validate application channels configuration updates.

Rationale: Validate incoming configuration updates prior to accepting the new values.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Test

DTN.6.01000

Upon accepting an add-application directive, BPA shall allocate a channel for the purpose of sending or receiving application data units (ADUs).

Rationale: Establishing a network endpoint is fundamental to transferring data over a DTN.

Parent: DTN.5.00009, DTN.5.00726

External Parent: CCSDS BPv7 Section 4.3.7

Verification Method: Test

DTN.6.01005

For each channel, the BPA channel configuration shall specify values for the following client application parameters:

- channel state ("active" or "passive", with "active" the default choice)
- delivery action ("abandon" or "defer", with "defer" the default choice)
- ADU wrapping on/off
- ADU unwrapping on/off
- maximum ADU send/receive rate
- all primary block bundle processing control flags per RFC 9171, section 4.2.3
- local service number
- foreign Endpoint ID (EID)
- Report-To EID (with "dtm:none" the default choice)
- bundle lifetime
- block number for each included extension block
- all block processing control flags for each included canonical block per RFC 9171, section 4.2.4
- CRC type for the primary block
- CRC type for each included canonical block.

Rationale: Parameters for operation of each channel need to be part of the channel configuration.

Parent: DTN.5.00006, DTN.5.00007, DTN.5.00060, DTN.5.00070, DTN.5.00723, DTN.5.00724, DTN.5.00748, DTN.5.00930

External Parent: RFC 9171 Section 4.3

Verification Method: Test

DTN.6.01030

BPA shall configure a local endpoint ID for a given channel to the configured node ID (bundleAgentNodeNumber) and the service ID indicated by the channel configuration.

Rationale: Every bundle primary block contains a source & destination EID as required by RFC 9171 sections 4.3.1 and 4.3.2. When sending, this is the source EID and identifies a particular flow. When receiving, this is the destination EID.

Parent: DTN.5.00006, DTN.5.00723

External Parent: RFC 9171 Section 4.3.1, RFC 9171 Section 4.3.2, PICS Section A5.5 Item 21, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.01032

Upon validating the channel configuration, if the given local service ID has already been configured for another channel, BPA shall log an error and reject activation of the channel configuration.

Rationale: Allowing multiple channels to share the same service ID means ADUs from bundles destined to that service on this node would have to be duplicated and sent to each, which is not a feature of BP.

Parent: DTN.5.00007, DTN.5.00724

External Parent: CCSDS BPv7 Section 3.5.2

Verification Method: Test

DTN.6.01060

Upon validating the channel configuration, if any requested endpoint ID for a channel is invalid, BPA shall log an error and reject activation of the channel configuration.

Rationale: EIDs are specified to BPA as URIs, so an invalid EID is one that is missing the "scheme:" part or for which the scheme is unknown, or for which the scheme-specific part is improper for the given scheme. An example of the last is an "ipn:" that is not followed by two or three dot-delimited unsigned integers or a "dtn:" that is not followed by "none".

Parent: DTN.5.00007, DTN.5.00724

External Parent: N/A

Verification Method: Test

DTN.6.02340

For each given channel, BPA channel configuration shall specify whether a Previous Node block will be included in all bundles sent on the channel.

Rationale: One of 3 extension blocks defined by RFC 9171. Channel must be configured to include this block or not.

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.4, PICS Section A5.5 Item 3, PICS Section A5.5 Item 21

Verification Method: Test

DTN.6.02350

For each given channel, BPA channel configuration shall specify whether a Hop Count block will be included in all bundles sent on the channel.

Rationale: One of 3 extension blocks defined by RFC 9171. Channel must be configured to include this block or not.

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.4, PICS Section A5.5 Item 7, PICS Section A5.5 Item 21

Verification Method: Test

DTN.6.02360

For each given channel, BPA channel configuration shall specify whether a Bundle Age block will be included in all bundles sent on the channel.

Rationale: One of 3 extension blocks defined by RFC 9171. Channel must be configured to include this block or not.

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.4, PICS Section A5.5 Item 5, PICS Section A5.5 Item 21

Verification Method: Test

DTN.6.02500

For each given channel, BPA channel configuration shall specify whether a Compressed Reporting Extension Block (CREB) will be included in all bundles sent on the given channel.

Rationale: Compressed bundle status reporting provides a more efficient alternative to RFC 9171 bundle status reports.

Parent: DTN.5.00006

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.1

Verification Method: Test

DTN.6.02510

If a CREB is included in the channel configuration, BPA shall initialize the CREB's Bundle Sequence Number for the given channel to zero.

Rationale: Counters must be initialized.

Parent: DTN.5.00006

External Parent: N/A

Verification Method: Test

DTN.6.02530

For each given channel containing a CREB, BPA channel configuration shall specify values for the following items:

- CREB Block Source Administrative EID
- CREB Bundle Sequence ID
- CREB Status Report Request Flags
- CREB Report-To EID.

Rationale: Typically, this will be this node's ID, but there may be reasons for using other values.

Parent: DTN.5.00006

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 3.2

Verification Method: Test

DTN.6.02680

BPA shall size the Bundle Sequence Number so that it does not roll over within the lifetime of bundles on the given channel.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00006

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Analysis

DTN.6.03171

For each given channel, BPA channel configuration shall specify whether a Custody Transfer Extension Block (CTEB) will, if paramSupportCustody is true, be included in all bundles sent on the given channel.

Rationale: Request allows AA to configure each channel to request custody transfer on newly created bundles if the node is configured to provide custody transfer at all.

Parent: DTN.5.00006,
DTN.5.00007

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.03172

Upon receiving an add-application directive, if custody is requested by the client application configuration but paramSupportCustody is false, BPA shall reject the directive and log an error.

Rationale: If the node is configured not to provide custody transfer, requests to do so must be rejected.

Parent: DTN.5.00007

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.03173

Upon receiving an add-application directive, if custody transfer is not requested for all bundles on the channel as indicated by client application configuration, BPA shall so configure the channel.

Rationale: Request allows AA to configure each channel to create bundles without custody transfer.

Parent: DTN.5.00006, DTN.5.00007

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.04320

Upon receiving an add-application directive, BPA shall create an "output queue" for bundles for which the destination EID matches a set of EIDs indicated by the given contact configuration.

Rationale: This query interface is used to select bundles for a local destination or for forwarding to another node.

Parent: DTN.5.00660

External Parent: RFC 9171 Section 5.2, PICS Section A5.5 Item 33

Verification Method: Test, Inspection

DTN.6.03000

Upon receiving an add-application directive, BPA shall associate the given newly created BPA output queue with the given client application's channel.

Rationale: Connects Payload Interface to its source of bundles.

Parent: DTN.5.00730

External Parent: N/A

Verification Method: Test

DTN.6.08030

BPA shall reject an add-application directive and issue an error event if the channel has not been successfully configured.

Rationale: If AA configures for custody transfer and if the node supports it, the request will succeed. It will fail if the node does not support custody transfer.

Parent: DTN.5.00007

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.01020

BPA shall send and receive administrative records over an assigned channel.

Rationale: RFC 9171 includes the concept of sending administrative records containing bundle status reports or containing custody signals. Admin records will be sent to and received from Service 0, which will be AA BSP.

Parent: DTN.5.00726

External Parent: RFC 9171 Section 5.1, RFC 9171 Section 5.7, PICS Section A5.5 Item 39, PICS Section A5.5 Item 49

Verification Method: Test

DTN.6.01021

BPA shall attach the assigned administrative records channel to AA's Administrative Element.

Rationale: RFC 9171 includes the concept of sending administrative records containing bundle status reports or containing custody signals. Admin records will be sent to and received from Service 0, which will be AA BSP.

Parent: DTN.5.00726

External Parent: RFC 9171 Section 5.1, RFC 9171 Section 5.7, PICS Section A5.5 Item 39, PICS Section A5.5 Item 49

Verification Method: Test

DTN.6.02120

Upon validating the channel configuration, if the primary block CRC type is configured to none for a given channel, and if the given channel is not configured to create a bundle integrity block with the primary block as its security target, BPA shall log an error and reject activation of the channel configuration.

Rationale: RFC 9171 section 4.3.1 requires a non-zero primary block CRC unless it is protected by an integrity block

Parent: DTN.5.00008

External Parent: RFC 9171 Section 4.3.1

Verification Method: Test

DTN.6.03080

Upon receiving a set-registration-state directive, BPA shall configure a given channel's delivery failure action, "defer" or "abandon", to the given value in the directive.

Rationale: Defined by RFC 9171 as to possible actions: abandon the bundle or defer delivery. Channel behavior must be configured.

Parent: DTN.5.00782

External Parent: RFC 9171 Section 5.7, PICS Section A5.5 Item 39

Verification Method: Test

DTN.6.03100

Upon receiving a set-registration-state directive, BPA shall configure a given channel's state, "active" or "passive", to the given value in the directive.

Rationale: Required by RFC 9171 section 3.2. State of the channel with respect to bundle delivery must be set.

Parent: DTN.5.00748

External Parent: RFC 9171 Section 3.2, PICS Section A5.5 Item 21

Verification Method: Test

DTN.6.02351

For each channel containing a Hop Count block, the BPA channel configuration shall specify the value of the hop limit.

Rationale: One of 3 extension blocks defined by RFC 9171. Channel must be configured to include this block or not.

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.4, PICS Section A5.5 Item 7, PICS Section A5.5 Item 21

Verification Method: Test

DTN.6.02690

BPA shall compute the ingestion rate of ADUs and store the result in `aduIngestedRateBitsPerSec` and `aduIngestedRateADUsPerSec`.

Rationale: Provides a useful metric for network management.

Parent: DTN.5.00012

External Parent: N/A

Verification Method: Test

DTN.6.02700

BPA shall compute the ingestion rate of ADUs for each configured source EID and store the result in `aduIngestedRateBitsPerSec[source]` and `aduIngestedRateADUsPerSec[source]`.

Rationale: Provides a useful metric for network management.

Parent: DTN.5.00012

External Parent: N/A

Verification Method: Test

DTN.6.03210

BPA shall compute the delivery rate of ADUs and store the result in `aduDeliveryRateBitsPerSec` and `aduDeliveryRateADUsPerSec`.

Rationale: Provides a useful metric for network management.

Parent: DTN.5.00770

External Parent: N/A

Verification Method: Test

DTN.6.03220

BPA shall compute the delivery rate of ADUs from each configured source EID and store the result in `aduDeliveryRateBitsPerSec[source]` and `aduDeliveryRateADUsPerSec[source]`.

Rationale: Provides a useful metric for network management.

Parent: DTN.5.00770

External Parent: N/A

Verification Method: Test

DTN.6.08072

Upon contact-start directive, BPA shall set the CTEB Block Source Administrative EID to this node's ID and service number zero.

Rationale: This will cause the resulting report to be sent to this node.

Parent: DTN.5.00006

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08074

Upon contact-start directive, BPA shall set the CTEB Bundle Sequence ID for each contact to a unique non-zero value.

Rationale: The number is meaningful only to the sending node, but affects the construction of reporting sequences. It should be used to keep things efficient for both sides. The values should be configured using an implementation-dependent scheme.

Parent: DTN.5.00070

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.04370

Upon receiving a remove-application directive, BPA shall discard the given output queue associated with the given channel.

Rationale: This would be done at the end of a contact or when removing an application.

Parent: DTN.5.00660

External Parent: N/A

Verification Method: Test, Inspection

DTN.6.05360

Upon receiving a remove-application directive, after a channel is destroyed, BPA shall discard any ADUs being reassembled for the given channel.

Rationale: This is part of closing the channel.

Parent: DTN.5.00726

External Parent: RFC 9171 Section 3.3, CCSDS BPv7 Section 4.4.2.4

Verification Method: Test

DTN.6.01070

Upon receiving a remove-application request from AA, BPA shall destroy the given ADU channel associated with the given application.

Rationale: The application needs a way to unregister and shut down a channel.

Parent: DTN.5.00009, DTN.5.00726

External Parent: RFC 9171 Section 5.7, PICS Section A5.5 Item 21

Verification Method: Test

3.3.2 Bundle Create and Store

This section contains recommendations on BPA bundle creation and storage.

DTN.6.05200

Upon request from AA, BPA shall process a given ADU. ("send ADU request")

Rationale: Some Bundles may be too large to be forwarded through resource limited nodes.

Parent: DTN.5.00655

External Parent: RFC 9171 Section 5.8, PICS Section A5.5 Item 41

Verification Method: Test

DTN.6.05210

If the ADU size is less than or equal to the maximum bundle payload size, BPA shall construct a bundle for the ADU for transmission on the channel on which the ADU is sent.

Rationale: This is the basis for constructing a bundle to convey an ADU through the DTN. Allows smaller ADUs to pass through Fragmentation unchanged.

Parent: DTN.5.00010, DTN.5.00060

External Parent: N/A

Verification Method: Test

DTN.6.05230

If the ADU is greater than the maximum bundle payload size, and configuration for the given channel allows fragmentation, BPA shall divide the ADU into fragments of maximum payload size, with the remainder forming an additional fragment.

Rationale: This is the essence of fragmentation.

Parent: DTN.5.00655

External Parent: RFC 9171 Section 5.8, PICS Section A5.5 Item 41

Verification Method: Test

DTN.6.05236

If the ADU is greater than the maximum bundle payload size, BPA shall reject the ADU and log an error.

Rationale: This protects the node and network from excessively large ADUs. It is assumed that this maximum is a hard-coded value documented in the node user's guide.

Parent: DTN.5.00030, DTN.5.00140

External Parent: N/A

Verification Method: Test

DTN.6.02180

For each bundle it creates, BPA shall set the reception time to the current node monotonic time.

Rationale: Required by RFC 9171 section 4.2.7. Reception time is used for updating bundle age blocks (if an age block is included) or for lifetime expiration scans if the host clock is invalid.

Parent: DTN.5.00060, DTN.5.00270, DTN.5.00670

External Parent: RFC 9171 Section 4.2.7, CCSDS BPv7 Section 3.3.1, CCSDS BPv7 Section 4.3.12, PICS Section A5.5 Item 13, PICS Section A5.5 Item 29

Verification Method: Test

DTN.6.02010

BPA shall construct a bundle for a given ADU fragment for transmission on the channel on which the ADU is sent using the given timestamp, fragment offset, and original ADU length.

Rationale: This is the basis for constructing a bundle to convey an ADU fragment through the DTN.

Parent: DTN.5.00060, DTN.5.00655

External Parent: RFC 9171 section 5.8, PICS Section A5.5 Item 41

Verification Method: Test

DTN.6.02370

For each bundle it creates, BPA shall create a Primary Block with values configured for the given channel on which the ADU is sent.

Rationale: The Destination EID, Bundle Processing Flag, and other Primary Block content may be initialized differently based upon which source provided the payload data.

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.4, PICS Section A5.5 Item 21, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.02030

For each bundle it creates, BPA shall set the bundle version field to 7.

Rationale: Represents Bundle Protocol version 7.

Parent: DTN.5.00060

External Parent: CCSDS BPv7 Section 9.2, CCSDS BPv7 Annex E2, PICS Section A5.5 Item 8

Verification Method: Test

DTN.6.02080

For each bundle it creates, BPA shall set the bundle processing control flags as configured for the channel on which the ADU is sent.

Rationale: Defined by RFC 9171 section 4.2.3.

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.2.3, CCSDS BPv7 Section 4.3.5.2, CCSDS BPv7 Annex E.2, PICS Section A5.5 Item 29

Verification Method: Test

DTN.6.02110

For each bundle it creates, BPA shall set the CRC type of the primary block as configured for the channel on which the ADU is sent.

Rationale: RFC 9171, section 4.3.1, requires nodes to protect the integrity of the primary block either with a CRC or BIB.

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1

Verification Method: Test

DTN.6.02130

For each bundle it creates, BPA shall set the destination EID in the primary block to the foreign EID configured for the channel on which the ADU is sent.

Rationale: Every bundle primary block contains a destination EID as required by RFC 9171 section 4.3.1.

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.02140

For each bundle it creates, BPA shall set the source EID in the primary block to the local EID configured for the channel on which the ADU is sent.

Rationale: Every bundle primary block contains a source EID as required by RFC 9171 section 4.3.1.

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, CCSDS BPv7 Section 3.3.1, CCSDS BPv7 Section 4.33.2, PICS Section A5.5 Item 13, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.02150

For each bundle it creates, BPA shall set the report-to EID in the primary block to the report-to EID configured for the channel on which the ADU is sent.

Rationale: Every bundle primary block contains a report-to EID as required by RFC 9171 section 4.3.3.

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.23061

If the host time is valid, BPA shall set the creation timestamp for new bundles by converting the reception time to DTN time based on a DTN Epoch of 2000-001-00:00:00.000.

Rationale: If the host clock is unsynced, DTN time returned by Time Management is 0 and the creation timestamp remains 0. Otherwise, the timestamp will be the number of milliseconds elapsed since 2000-01-01 00:00:00.

Parent: DTN.5.00275

External Parent: RFC 9171 Section 4.2.7, CCSDS BPv7 Section 3.3.1, CCSDS BPv7 Section 4.3.4, PICS Section A5.5 Item 13, PICS Section A5.5 Item 29

Verification Method: Test

DTN.6.17040

If the host flags time as bad, BPA shall set DTN Time to zero, indicating that it is not available.

Rationale: DTN time is used for bundle creation timestamps.

Parent: DTN.5.00275

External Parent: RFC 9171 Section 4.2.6, CCSDS BPv7 Section 5.2.2

Verification Method: Test

DTN.6.02210

For each bundle it creates, BPA shall set the lifetime to the lifetime configured for the channel on which the ADU is sent.

Rationale: Required by RFC 9171 section 4.3.1.

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.02305

For each bundle it creates, BPA shall set the CRC type of all canonical blocks to the value configured for the channel on which the ADU is sent.

Rationale: Required by RFC 9171 section 4.3.2. All bundles sent must have this value set to some configured value.

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.3.2, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.02190

For each bundle it creates, BPA shall set the creation timestamp's sequence number to a monotonically increasing positive integer.

Rationale: Required by RFC 9171 section 4.2.7.

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.2.7, PICS Section A5.5 Item 13

Verification Method: Test

DTN.6.02331

For each bundle it creates, BPA shall include in a deterministic order any Extension Blocks configured for the channel on which the ADU is sent.

Rationale: Allows any set of extension blocks to be included in new bundles.

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.4

Verification Method: Test

DTN.6.02336

For each bundle it creates, BPA shall set the block processing control flags for each Extension Block to the value configured for the channel on which the ADU is sent.

Rationale: Application need to be able to set the flags defined by RFC 9171 section 4.2.4.

Parent: DTN.5.00006

External Parent: RFC 9171 Section 4.2.4, RFC 9171 Section 4.3.2, PICS A5.5 Item 30

Verification Method: Test

DTN.6.08060

For each bundle it creates, BPA shall set each Extension Block's block processing control flags bit 1, transmit status report if block can't be processed, to zero.

Rationale: Required by RFC 9171 section 4.2.4. In the future, processing status should be sent via a Network Management report via a process described in a Network Management ConOps. For now, no reports should be sent.

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.2.4, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.02333

For each bundle it creates, if an Age Block is requested on the channel on which the ADU is sent, BPA shall initialize the Bundle Age Block's age to zero.

Rationale: Required by RFC 9171. It will be updated on bundle egress.

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.4.2, PICS Section A5.5 Item 5

Verification Method: Test

DTN.6.02334

For each bundle it creates, if a Hop Count Block is requested on the channel on which the ADU is sent, BPA shall initialize the Hop Count Block's hop count to zero and hop limit to the value configured for the channel on which the ADU is sent.

Rationale: Required by RFC 9171. It will be updated on bundle egress.

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.4.3, PICS Section A5.5 Item 7

Verification Method: Test

DTN.6.02335

For each bundle it creates, if a Previous Node Block is requested on the channel on which the ADU is sent, BPA shall initialize the Previous Node Block's node ID to this node's ID.

Rationale: This violates the letter of RFC 9171, but there is no harm, and it makes sense to add it here.

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.4.1, PICS Section A5.5 Item 3

Verification Method: Test

DTN.6.08090

For each bundle it creates, if custody transfer is requested on the channel on which the ADU is sent, BPA shall add a Custody Transfer Extension Block (CTEB) to the bundle.

Rationale: The CTEB is the mechanism by which a bundle requests custody transfer and provides necessary data to acknowledge custody transfer.

Parent: DTN.5.00070

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08100

For each bundle it creates, if custody transfer is requested on the channel on which the ADU is sent, BPA shall set the CTEB's block type code to 13.

Rationale: All blocks have a type code, but this one is not yet assigned by CCSDS.

Parent: DTN.5.00070

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.26180

After constructing a CREB, BPA shall increment the Bundle Sequence Number for the given channel.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00006

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.02230

For each bundle it creates, if the given payload is a fragment, BPA shall include a fragment offset value indicating the offset from the start of the original ADU in bytes in the primary block of the bundle.

Rationale: Required by RFC 9171 section 4.3.1.

Parent: DTN.5.00006

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.02240

For each bundle it creates, if the given payload is a fragment, BPA shall include the original ADU length in the primary block of the bundle.

Rationale: Required by RFC 9171 section 4.3.1.

Parent: DTN.5.00006

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.05250

For each bundle it creates, if the bundle includes a ADU fragment, BPA shall include the identical creation timestamp with each fragment of a given ADU.

Rationale: All fragments must carry an identical creation timestamp because the source EID plus timestamp is what identifies a set of fragments as comprising parts of the same ADU, so it must be passed in from BPA Fragmentation. This allows reassembly.

Parent: DTN.5.00006, DTN.5.00655

External Parent: RFC 9171 Section 5.8, PICS Section A5.5 Item 41, RFC 9171 section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.02400

For each bundle it creates, BPA shall construct a Payload Block that contains the given payload (ADU or fragment).

Rationale: Transmission of the data payload is the primary reason for Registration.

Parent: DTN.5.00100

External Parent: CCSDS BPv7 Section 4.3.8, PICS Section A5.5 Item 21

Verification Method: Test

DTN.6.08170

For each bundle it creates, if the channel on which the ADU is sent is configured for custody transfer, BPA shall store the bundle in custodial storage with its metadata.

Rationale: This presumably is some sort of non-volatile storage.

Parent: DTN.5.00040, DTN.5.00142

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08180

For each bundle it creates, if the channel on which the ADU is sent is not configured for custody transfer, BPA shall store the bundle as non-custodial with its metadata.

Rationale: This may be volatile storage.

Parent: DTN.5.00040

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.04300

BPA shall discard the bundle if sufficient space is not available in Bundle Storage allocated for the given bundle's source.

Rationale: A flow must not be allowed to exceed its allocation and impact other flows or the node overall.

Parent: DTN.5.00050, DTN.5.00210, DTN.5.00532

External Parent: CCSDS BPv7 Section 5.2.1

Verification Method: Test

DTN.6.04310

BPA shall discard the bundle if no space is allocated in Bundle Storage for the given bundle's source.

Rationale: It would be a configuration error for this to occur, but it must be handled so as not to impact properly configured flows.

Parent: DTN.5.00050

External Parent: N/A

Verification Method: Test

DTN.6.07200

BPA shall CBOR encode bundles and compute CRCs for each block.

Rationale: CBOR and CRC are required prior to forwarding a bundle. Required by RFC 9171 sections 4.3.1 and 4.3.2.

Parent: DTN.5.00060, DTN.5.00070, DTN.5.00100

External Parent: RFC 9171 Section 4.3.1, RFC 9171 Section 4.3.2, PICS Section A5.5 Item 1

Verification Method: Test

DTN.6.26040

BPA shall CBOR encode values in using the least space.

Rationale: CBOR allows two representations for numbers less than or equal to 23 ($n \leq 23$). Minimize bandwidth, take advantage of small numbers (e.g. in hop blocks) and ensure that there is one deterministic bundle for given a given bundle.

Parent: DTN.5.00060, DTN.5.00070, DTN.5.00100

External Parent: RFC 9171 Section 4.3.1

Verification Method: Test

DTN.6.26070

For each bundle block it encodes, if the CRC type is non-zero, BPA shall calculate the CRC of each block according to the type configured and include it in the block.

Rationale: Required by RFC 9171 section 4.3.1.

Parent: DTN.5.00006

External Parent: RFC 9171 section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.26000

BPA shall CBOR encode block type-specific data upon request.

Rationale: CBOR encode must occur prior to sending out a bundle.

Parent: DTN.5.00060, DTN.5.00070, DTN.5.00100

External Parent: RFC 9171 Section 4.3, RFC 9171 Section 4.4, PICS Section A5.5 Item 1, PICS Section A5.5 Item 30, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27000

Upon request to encode a bundle, BPA shall create a CBOR indefinite-length array representing the bundle.

Rationale: Required by RFC 9171 section 4.1 "Bundle Structure".

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.1

Verification Method: Test

DTN.6.27040

After creating the bundle indefinite-length array, BPA shall create as the first element of the bundle array the definite-length array representing the bundle's primary block.

Rationale: Required by RFC 9171 section 4.1 "Bundle Structure".

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.1

Verification Method: Test

DTN.6.27050

If the bundle is not a fragment and has no CRC, BPA shall set the length of the Primary Block array to 8.

Rationale: Required by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27060

If the bundle is not a fragment and has a CRC, BPA shall set the length of the Primary Block array to 9.

Rationale: Required by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27070

If the bundle is a fragment and has a no CRC, BPA shall set the length of the Primary Block array to 10.

Rationale: Required by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27080

If the bundle is a fragment and has a CRC, BPA shall set the length of the Primary Block array to 11.

Rationale: Required by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27090

BPA shall create as the first field of the primary block array an unsigned integer with the version of the given deserialized bundle.

Rationale: Required by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27100

BPA shall create as the second field of the primary block array a 64-bit unsigned integer set to the bundle processing control flags of the given deserialized bundle.

Rationale: Required by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27110

BPA shall create as the third field of the primary block array an 8-bit unsigned integer set to the CRC type of the given deserialized bundle.

Rationale: Required by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.26050

When constructing an EID, BPA shall encode it as a CBOR definite-length array of two elements in which the first is the CBOR unsigned integer 2 and the second is a CBOR definite-length array of two elements in which the first is the node ID and the second is the service ID, and both encoded as a CBOR unsigned integers.

Rationale: This is the canonical way to encode an IPN EID.

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.2.5, PICS Section A5.5 Item 9, PICS Section A5.5 Item 11, PICS Section A5.5 Item 12

Verification Method: Test

DTN.6.27120

BPA shall create as the fourth field of the primary block array an EID representing the Destination EID.

Rationale: Required by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27130

BPA shall create an EID as a 2-element definite-length array.

Rationale: Required by RFC 9171 section 4.2.5.1 "Endpoint ID."

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.2.5.1, PICS Section A5.5 Item 29

Verification Method: Test

DTN.6.27140

If the EID scheme is "dtn", BPA shall create as the first field of the EID array an unsigned integer with the value 1.

Rationale: Required by RFC 9171 section 4.2.5.1 "Endpoint ID" and 9.6 "Bundle Protocol URI Scheme Types."

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.2.5.1, 9.6, PICS Section A5.5 Item 29

Verification Method: Test

DTN.6.27150

If the EID scheme is "dtn" and the scheme-specific part is "none", BPA shall create as the second field of the EID array an unsigned integer with the value 0.

Rationale: Required by RFC 9171 section 4.2.5.1.1 "The dtn URI Scheme."

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.2.5.1.1, PICS Section A5.5 Item 29

Verification Method: Test

DTN.6.27160

If the EID scheme is "dtn" and the scheme-specific part is not "none", BPA shall create as the second field of the EID array a character string with the value of the scheme-specific part of the given EID.

Rationale: Required by RFC 9171 section 4.2.5.1.1 "The dtn URI Scheme."

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.2.5.1.1, PICS Section A5.5 Item 29

Verification Method: Test

DTN.6.27170

If the destination EID scheme is "ipn", BPA shall create as the first field of the EID array an unsigned integer with the value 2.

Rationale: Required by RFC 9171 section 4.2.5.1 "Endpoint ID" and 9.6 "Bundle Protocol URI Scheme Types."

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.2.5.1, 9.6, PICS Section A5.5 Item 9

Verification Method: Test

DTN.6.27180

If the EID scheme is "ipn", BPA shall create as the second field of the EID array a definite-length array of length 2 representing the scheme-specific part.

Rationale: Required by RFC 9171 section 4.2.5.1.2 "The ipn URI Scheme."

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.2.5.1.2, PICS Section A5.5 Item 9, PICS Section A5.5 Item 29

Verification Method: Test

DTN.6.27190

If the EID scheme is "ipn", BPA shall create as the first field of the scheme-specific array to the node ID of the given EID.

Rationale: Required by RFC 9171 section 4.2.5.1.2 "The ipn URI Scheme."

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.2.5.1.2, PICS Section A5.5 Item 9, PICS Section A5.5 Item 29

Verification Method: Test

DTN.6.27200

If the EID scheme is "ipn", BPA shall create as the second field of the scheme-specific array to the service ID of the given EID.

Rationale: Required by RFC 9171 section 4.2.5.1.2 "The ipn URI Scheme."

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.2.5.1.2, PICS Section A5.5 Item 9, PICS Section A5.5 Item 29

Verification Method: Test

DTN.6.27210

BPA shall create as the fifth field of the primary block array an EID representing the Source EID.

Rationale: Required by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27220

BPA shall create as the sixth field of the primary block array an EID representing the Report-To EID.

Rationale: Required by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27230

BPA shall create as the seventh field of the primary block array a 2-element definite-length array representing the Creation Timestamp.

Rationale: Required by RFC 9171 section 4.3.1 "Primary Bundle Block" and 4.2.7 "Creation Timestamp"

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, 4.2.7, PICS Section A5.5 Item 29, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27240

BPA shall create as the first field of the Creation Timestamp an unsigned integer with the value of the given deserialized bundle's creation time.

Rationale: Required by RFC 9171 section 4.2.7 "Creation Timestamp"

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.2.7, PICS Section A5.5 Item 29

Verification Method: Test

DTN.6.27250

BPA shall create as the second field of the Creation Timestamp an unsigned integer with the value of the given deserialized bundle's creation timestamp serial number.

Rationale: Required by RFC 9171 section 4.2.7 "Creation Timestamp"

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.2.7, PICS Section A5.5 Item 29

Verification Method: Test

DTN.6.27260

BPA shall create as the eighth field of the primary block array an unsigned integer with the value of the deserialized bundle's lifetime.

Rationale: Required by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27270

If the bundle is a fragment, BPA shall create as the ninth field of the primary block array an unsigned integer with the value of the fragment offset in the given deserialized bundle.

Rationale: Required by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27280

If the bundle is a fragment, BPA shall create as the tenth field of the primary block array an unsigned integer with the value of the total ADU length in the given deserialized bundle.

Rationale: Required by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27290

If the bundle is a fragment and the CRC type is not zero, BPA shall create as the eleventh field of the primary block array an unsigned integer with the value of the encoded primary block's CRC calculated in accordance with the given CRC type.

Rationale: Required by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27300

If the bundle is not a fragment and the CRC type is not zero, BPA shall create as the ninth field of the primary block array an unsigned integer with the value of the encoded primary block's CRC calculated in accordance with the given CRC type.

Rationale: Required by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27310

BPA shall create all other elements of the bundle array as canonical blocks.

Rationale: Required by RFC 9171 section 4.3.2 "Canonical Bundle Block Format".

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.3.2, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27410

BPA shall create extension blocks in the following order (TBR): Previous Node Block, Bundle Age Block, Hop Count Block, Custody Transfer Extension Block (CTEB), and Compressed Reporting Extension Block(s) (CREB).

Rationale: Blocks should be created in a consistent order. This is the order of the extension blocks appearing in RFC 9171, plus a logical order of the two defined in the draft Orange Book on compressed reporting and custody transfer.

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.4, PICS Section A5.5 Item 3, PICS Section A5.5 Item 5, PICS Section A5.5 Item 7, PICS Section A5.5 Item 31

Verification Method: Test, Inspection

DTN.6.26170

When a CREB exists within a bundle, BPA shall encode the Bundle Sequence as a CBOR unsigned integer.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00006

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.27470

BPA shall create as the penultimate element of the bundle array a canonical block representing the payload of the deserialized bundle.

Rationale: Required by RFC 9171 section 4.1 "Bundle Structure".

Parent: DTN.5.00100

External Parent: RFC 9171 Section 4.1

Verification Method: Test

DTN.6.27480

BPA shall create as the last element of the bundle array the "break" stop code 0xff.

Rationale: Required by RFC 9171 section 4.1 "Bundle Structure".

Parent: DTN.5.00100

External Parent: RFC 9171 Section 4.1

Verification Method: Test

3.3.3 Bundle Ingest, Validate, and Store

This section contains recommendations on BPA bundle ingest, validation, and storage.

DTN.6.23090

Upon receiving a candidate bundle from the CLA, BPA shall process the bundle.

Rationale: Custody transfer needs to record and acknowledge bundles that request custody transfer.

Parent: DTN.5.00200

External Parent: N/A

Verification Method: Test

DTN.6.06350

BPA shall discard with reason code "Bundle too large" any bundle larger than paramSetMaxBundleLength.

Rationale: Having a maximum length protects the node against buffer overruns and resource depletion caused by enormous payloads.

Parent: DTN.5.00180, DTN.5.00657

External Parent: CCSDS BPv7 Section 3.6, PICS Section A5.5 Item 19

Verification Method: Test

DTN.6.06430

BPA shall capture the reception time of a bundle based on the node monotonic clock.

Rationale: Reception time is used for updating bundle age blocks (if an age block is included) or for lifetime expiration scans if the host clock is invalid.

Parent: DTN.5.00270, DTN.5.00670

External Parent: RFC 9171 Section 4.2.7, PICS Section A5.5 Item 29

Verification Method: Test, Inspection

DTN.6.26190

Upon encountering an error in CBOR decoding, BPA shall stop processing the candidate bundle.

Rationale: CBOR should stop processing as soon as an error is found to prevent wasting resources and report it to the module that requested encoding/decoding.

Parent: DTN.5.00180, DTN.5.01052

External Parent: N/A

Verification Method: Test

DTN.6.26020

BPA shall parse bundle blocks in the order in which they appear in the CBOR array.

Rationale: CBOR parsing can only be done in order!

Parent: DTN.5.00300

External Parent: RFC 9171 Section 4.1

Verification Method: Test

DTN.6.26010

BPA shall decode block-type-specific data upon request.

Rationale: CBOR decode must occur in order to validate a bundle or read contents of a payload.

Parent: DTN.5.00220

External Parent: RFC 9171 Section 4.3, RFC 9171 Section 4.4, PICS Section A5.5 Item 1, PICS Section A5.5 Item 30, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.06640

BPA shall perform higher level bundle block checks in the same order as the blocks appear in the bundle.

Rationale: Higher level checks are above the parsing errors, ex: interactions with other blocks

Parent: DTN.5.00195

External Parent: N/A

Verification Method: Test

DTN.6.06000

Upon successfully CBOR-decoding a bundle block, BPA shall validate the given block.

Rationale: This is the mechanism for bundles to enter the BPA. This is a request because the reply provides flow control to the CLA.

Parent: DTN.5.00170

External Parent: RFC 9171 Section 5.6, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.04030

Upon notification that a bundle failed validation, BPA shall discard the bundle.

Rationale: Such bundles cannot be further processed by the node or network.

Parent: DTN.5.00790

External Parent: RFC 9171 Section 5.11, PICS Section A5.5 Item 45

Verification Method: Test

DTN.6.26210

BPA shall discard all CLA inputs in which the top-level CBOR indefinite-length array contains more than a configured number of items (blocks).

Rationale: Keeps the node from looping excessively processing a silly number of bundle blocks. Suggest 12 extension blocks, 10 plus margin, to cover all the typical extension blocks This should be configured via policy.

Parent: DTN.5.00180

External Parent: N/A

Verification Method: Test

DTN.6.06010

If a candidate bundle is not a CBOR indefinite length-array of 2 or more items (blocks), BPA shall discard the bundle.

Rationale: The BP agent cannot process a bundle that is fundamentally mis-formatted. See RFC 9171 section 4.1 "Bundle Structure".

Parent: DTN.5.00180

External Parent: RFC 9171 Section 4.1, RFC 9171 Section 5.6, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.26030

BPA shall discard bundles for which the first element of the indefinite array, the primary block, is not an array of 8 to 11 elements.

Rationale: The BP agent cannot process a bundle in which the primary block is fundamentally mis-formatted. See RFC 9171 section 4.1 "Bundle Structure".

Parent: DTN.5.00180

External Parent: RFC 9171 Section 4.1, RFC 9171 Section 4.3.1, PICS Section A5.5 Item 1, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.06040

BPA shall discard bundles if the first field in the primary block is not unsigned integer 7.

Rationale: The only valid bundle version is 7. See RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00190

External Parent: RFC 9171 Section 4.3.1, RFC 9171 Section 5.6, PICS Section A5.5 Item 8, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06050

BPA shall discard bundles if the second field in the primary block, bundle processing control flags, is not an unsigned integer.

Rationale: Format required by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00190

External Parent: RFC 9171 Section 4.3.1, RFC 9171 Section 5.6, PICS Section A5.5 Item 30, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06080

BPA shall discard bundles if the third field in the primary block, CRC Type, is not an unsigned integer set to a valid CRC type value of 0, 1, or 2.

Rationale: Format required by RFC 9171 section 4.3.1 "Primary Bundle Block" and section 4.2.1 "CRC Type".

Parent: DTN.5.00190

External Parent: RFC 9171 Section 4.3.1, RFC 9171 Section 4.2.1, RFC 9171 Section 5.6, PICS Section A5.5 Item 29, PICS Section A5.5 Item 30, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06150

BPA shall discard bundles if the primary block CRC type is one and the ninth field of a non-fragment bundle or eleventh field of a fragment bundle is missing, or if that field is not a 2-element byte string.

Rationale: Primary block integrity is critical for correct bundle processing. See by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00190

External Parent: RFC 9171 Section 4.3.1, RFC 9171 Section 5.6, PICS Section A5.5 Item 30, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06092

BPA shall discard bundles if the CRC Type is set to zero, and the primary block is not the target of a Bundle Integrity Block.

Rationale: Required by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00190

External Parent: RFC 9171 Section 4.3.1, RFC 9171 Section 5.6, PICS Section A5.5 Item 30, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.26240

BPA shall check the CRC on every block for which the CRC Type field is non-zero.

Rationale: Required by RFC 9171 section 5.6 step 3.

Parent: DTN.5.00220

External Parent: RFC 9171 Section 5.6, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06151

BPA shall discard bundles if the primary block CRC type is two and the ninth field of a non-fragment bundle or eleventh field of a fragment bundle is missing, or if that field is not a 4-element byte string.

Rationale: Primary block integrity is critical for correct bundle processing. See by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00190

External Parent: RFC 9171 Section 4.3.1, RFC 9171 Section 5.6, PICS Section A5.5 Item 30, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06230

If the CRC check on any block in a bundle fails, BPA shall discard the bundle for reason "Block unintelligible."

Rationale: Required by RFC 9171 section 5.6 step 3.

Parent: DTN.5.00190, DTN.5.00220

External Parent: RFC 9171 Section 5.6, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06102

BPA shall discard bundles if the fourth, fifth, and sixth fields in the primary block -- source, destination and report-to EIDs -- are not 2-item arrays, or if the first array item does not contain a valid EID URI scheme ID (unsigned integer 1 or 2), or if the second item does not contain a properly formatted EID for the given scheme.

Rationale: Bundles cannot be delivered with a valid destination. While anonymous sources are permitted by RFC 8171, we have chosen to disallow them. See RFC 9171 section 4.3.1 "Primary Bundle Block". Anonymous EIDs are not permitted.

Parent: DTN.5.00190

External Parent: RFC 9171 Section 4.3.1, RFC 9171 Section 5.6, PICS Section A5 Item 9, PICS Section A5.5 Item 30, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06480

BPA shall discard with reason code "Source not authorized" bundles carrying source node IDs that are not in the set of authorized source EIDs.

Rationale: This protects the node against traffic from unauthorized sources.

Parent: DTN.5.00185, DTN.5.01170

External Parent: RFC 9171 Section 8, CCSDS BPv7 Annex D1.1

Verification Method: Test

DTN.6.06492

When it discards a bundle because it is from an unauthorized source, BPA shall issue an information event.

Rationale: Network management needs to know what source is sending unauthorized bundles to our node. This event should be filtered to avoid a denial-of-service attack.

Parent: DTN.5.00185, DTN.5.01170

External Parent: N/A

Verification Method: Test

DTN.6.06130

BPA shall discard bundles if the seventh field in the primary block, the lifetime, is not an unsigned integer.

Rationale: Any other type for this field indicates a malformed primary block. See by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00190

External Parent: RFC 9171 Section 4.3.1, RFC 9171 Section 5.6, PICS Section A5.5 Item 30, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06110

BPA shall discard bundles if the eighth field in the primary block, the creation timestamp, is not a 2-item array of unsigned integers.

Rationale: Any other type for this field or its parts indicates a malformed primary block. See RFC 9171 section 4.3.1 "Primary Bundle Block", section 4.2.6 "DTN Time", and section 4.2.7 "Creation Timestamp".

Parent: DTN.5.00190

External Parent: RFC 9171 Section 4.3.1, RFC 9171 Section 4.2.6, RFC 9171 Section 4.2.7, RFC 9171 Section 5.6, PICS Section A5.5 Item 30, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06140

BPA shall discard bundles if the bundle processing control flags indicate the bundle is a fragment, and the ninth and tenth fields are not unsigned integers.

Rationale: Fragments cannot be processed without an offset and total ADU length. See by RFC 9171 section 4.3.1 "Primary Bundle Block".

Parent: DTN.5.00190

External Parent: RFC 9171 Section 4.3.1, RFC 9171 Section 5.6, PICS Section A5.5 Item 30, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06060

BPA shall ignore unrecognized bundle processing control flags.

Rationale: Required by RFC 9171 section 4.2.3 "Bundle Processing Control Flags".

Parent: DTN.5.00190

External Parent: RFC 9171 Section 4.2.3, RFC 9171 Section 5.6, PICS Section A5.5 Item 29, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06070

BPA shall discard bundles carrying administrative records for which bundle processing control flags status report request flags are non-zero.

Rationale: Required by RFC 9171 section 4.2.3 "Bundle Processing Control Flags".

Parent: DTN.5.00190

External Parent: RFC 9171 Section 4.2.3, RFC 9171 Section 5.6, PICS Section A5.5 Item 29, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06180

If a bundle that contains any canonical block that is not a CBOR array of 5 or 6 elements, BPA shall discard the bundle with reason code "Block unintelligible"

Rationale: RFC 9171 section 5.6 step 3 requires deleting bundles with syntactically incorrect blocks.

Parent: DTN.5.00220, DTN.5.00255

External Parent: RFC 9171 Section 5.6, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06190

If the third field in any canonical block (block processing control flags) is not an unsigned integer, BPA shall discard the bundle for reason "Block unintelligible."

Rationale: RFC 9171 section 5.6 step 3 requires deleting bundles with syntactically incorrect blocks.

Parent: DTN.5.00220, DTN.5.00255

External Parent: RFC 9171 Section 5.6, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06200

If the fourth field in any canonical block is not an unsigned integer CRC type value of 0, 1, or 2, BPA shall discard the bundle for the reason "Block unintelligible."

Rationale: Other CRC types are undefined, so the block integrity cannot be verified or safely ignored.

Parent: DTN.5.00220, DTN.5.00255

External Parent: RFC 9171 Section 4.2.1, RFC 9171 Section 5.6, PICS Section A5.5 Item 29, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06210

If any canonical block contains a non-zero CRC type and the sixth field is missing or not an unsigned integer, BPA shall discard the bundle for reason "Block unintelligible".

Rationale: A missing or malformed CRC can be treated as a failed CRC check, in which case RFC 9171 section 5.6 step 3 requires the bundle be deleted.

Parent: DTN.5.00220, DTN.5.00255

External Parent: RFC 9171 Section 5.6, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06380

If the fifth field, block-type-specific data, of the Hop Count Block is not a CBOR array of 2 unsigned integers, BPA shall discard the bundle for reason "Block unintelligible."

Rationale: RFC 9171 section 5.6 step 3 requires deleting bundles with syntactically incorrect blocks.

Parent: DTN.5.00220, DTN.5.00255

External Parent: RFC 9171 Section 4.4.3, RFC 9171 Section 5.6, PICS Section A5.5 Item 6, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06240

BPA shall discard with reason code "Block Unintelligible" all bundles which contain blocks with a block number of 0.

Rationale: Block number zero is reserved; implicitly identifies the Primary Block.

Parent: DTN.5.00220, DTN.5.00255

External Parent: RFC 9171 Section 4.1, RFC 9171 Section 5.6, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06250

BPA shall discard with reason code "Block Unintelligible" all bundles which contain multiple blocks with the same block number.

Rationale: RFC 9171 section 4.1 requires block numbers to be unique.

Parent: DTN.5.00220

External Parent: RFC 9171 Section 4.1, RFC 9171 Section 5.6, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06260

BPA shall discard with reason code "Block Unintelligible" all bundles containing more than one of the following canonical blocks:

1. Bundle Age block,
2. Previous Node block,
3. Hop Count block,
4. Payload block, or
5. Custody Transfer Extension Block.

Rationale: RFC 9171 section 4.4 requires there to be only zero or one (1) of each type of extension block. Section 4.1 requires there be only 1 Payload Block.

Parent: DTN.5.00220

External Parent: RFC 9171 Section 4.4, RFC 9171 Section 4.1, PICS Section A5.5 Item 2, PICS Section A5.5 Item 4, PICS Section A5.5 Item 6

Verification Method: Test

DTN.6.06358

BPA shall discard with reason code "Invalid Payload Block" any bundle with an invalid payload block.

Rationale: Without a valid payload block, a data bundle contains nothing to deliver.

Parent: DTN.5.00320

External Parent: RFC 9171 Section 5.6, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06172

After processing all bundle blocks, BPA shall discard the bundle with reason code "Lifetime Expired" if it does not contain a Bundle Age block and if the delta between the bundle creation time and the current time is greater than the bundle's effective lifetime.

Rationale: RFC 9171 presumes that beyond a bundle's lifetime its payload is no longer useful.

Parent: DTN.5.00800, DTN.5.00195

External Parent: RFC 9171 Section 5.5, RFC 9171 Section 5.6, RFC 9171 Section 5.11, PICS Section A5.5 Item 37, PICS Section A5.5 Item 38, PICS Section A5.5 Item 45

Verification Method: Test

DTN.6.06173

After processing all bundle blocks, BPA shall discard the bundle with reason code "Lifetime expired" if the bundle contains a Bundle Age block, does not contain a valid non-zero creation timestamp, and if the Bundle Age block age plus the delta between the current monotonic time and the bundle reception time is greater than the bundle effective lifetime.

Rationale: RFC 9171 presumes that beyond a bundle's lifetime its payload is no longer useful.

Parent: DTN.5.00800, DTN.5.00195

External Parent: RFC 9171 Section 5.5, RFC 9171 Section 5.6, RFC 9171 Section 5.11, PICS Section A5.5 Item 37, PICS Section A5.5 Item 38, PICS Section A5.5 Item 45

Verification Method: Test

DTN.6.23063

If a bundle's creation timestamp is zero and the bundle does not contain a Bundle Age Block, BPA shall add a Bundle Age Block to the bundle and set the bundle age to the delta between the current time and the reception time.

Rationale: The Age Block must be updated to reflect the time the Bundle remained in storage on this node. It is represented in milliseconds using the node's monotonic clock.

Parent: DTN.5.00090

External Parent: RFC 9171 Section 4.4.2, PICS Section A5.5 Item 5

Verification Method: Test

DTN.6.23064

If the BPA determines that a bundle's creation timestamp is in the future or is earlier than paramSetEarliestValidCreationTime, and the bundle does not contain a Bundle Age Block, BPA shall add a Bundle Age Block to the bundle and set it to the delta between the current time and the reception time.

Rationale: The Age Block must be updated to reflect the time the Bundle remained in storage on this node. It is represented in milliseconds using the node's monotonic clock.

Parent: DTN.5.00090

External Parent: RFC 9171 Section 4.4.2, PICS Section A5.5 Item 5

Verification Method: Test

DTN.6.06270

If a bundle contains a block type that cannot be processed and if block processing control flag bit 2 ("Delete bundle if block can't be processed") is true, BPA shall discard the bundle for reason "Block unsupported."

Rationale: Required by RFC 9171, section 4.2.4. Type codes other than 1, 6, 7, 10, 11, and 12 cannot be processed by the node.

Parent: DTN.5.00255, DTN.5.00260

External Parent: RFC 9171 Section 4.2.4, RFC 9171 Section 5.6, PICS Section A5.5 Item 29, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06280

If a bundle contains a block type that cannot be processed, and if the block processing control flag bit 4 ("Discard block if it can't be processed") is true, BPA shall remove the block from the bundle.

Rationale: Required by RFC 9171, sections 4.2.4 and 5.6 step 4.

Parent: DTN.5.00250

External Parent: RFC 9171 Section 4.2.4, RFC 9171 Section 5.6, PICS Section A5.5 Item 29, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.08250

If a received bundle does not request custody transfer, BPA shall store the bundle in non-custodial storage with its metadata.

Rationale: Custody Transfer is requested through a CTEB in the bundle. Custodial bundles should be stored in non-volatile storage.

Parent: DTN.5.00200

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08280

If a received bundle requests custody transfer and if the bundle's source EID and creation timestamp is in the set of bundles in custody, BPA shall signal custody accepted and discard the bundle.

Rationale: Signaling the sender is necessary in case a previous signal was lost. Since the bundle is in custody already, we can discard this copy.

Parent: DTN.5.00390

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08290

If a received bundle requests custody transfer and if the bundle's source EID is in the set of authorized custody sources and the bundle's custodian EID is in the map of authorized custodians, BPA shall store the bundle in custodial storage with its metadata.

Rationale: Only accept custody for authorized flows from custodians to which we can acknowledge.

Parent: DTN.5.00490

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08300

If a received bundle requests custody transfer and if the bundle's source EID is in the set of authorized custody sources and the bundle's custodian EID is NOT in the map of authorized custodians, BPA shall store the bundle in non-custodial storage with its metadata.

Rationale: Since we cannot acknowledge custody, we treat the bundle as non-custodial.

Parent: DTN.5.00200

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08310

If a received bundle requests custody transfer and if the bundle's source EID is NOT in the map of authorized custody sources, BPA shall store the bundle in non-custodial storage with its metadata.

Rationale: The source is allowed to send to us, but we are not allowed to accept custody, so we treat the bundle as non-custodial.

Parent: DTN.5.00200

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.04290

When storing a bundle, BPA shall store it in memory allocated for the bundle's source.

Rationale: Each configured flow is given a storage allocation under an SLA.

Parent: DTN.5.00040, DTN.5.00110, DTN.5.00330

External Parent: CCSDS BPv7 Section 5.2.1

Verification Method: Test

DTN.6.08320

After a successful request to store a custodial foreign bundle and if the custodian EID is in the map of authorized custodian EIDs, BPA shall signal custody accepted.

Rationale: Storing the bundle in custodial storage is the essence of having custody, so signal the current custodian that this node now has custody.

Parent: DTN.5.00390

External Parent: CCSDS BPv7 Annex E, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08330

After an unsuccessful request to store a custodial foreign bundle and if the custodian EID is in the map of authorized custodians, BPA shall signal custody rejected.

Rationale: Notify current custodian custody transfer failed.

Parent: DTN.5.00390

External Parent: CCSDS BPv7 Annex E, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08391

Upon signaling a custody action, if the BSC corresponding to the given Disposition Code does not contain a Bundle Sequence for the given Bundle Sequence ID, BPA shall add a Bundle Sequence for the given Bundle Sequence ID to the BSC.

Rationale: Required by the CCSDS specification for the custody signal. Each Bundle Sequence Element conveys a contiguous set of bundles with a common Bundle Sequence ID for which custody is being signaled. Gaps are conveyed by Bundle Sequence Numbers omitted from all Bundle Sequence Elements in the collection that signal custody accepted.

Parent: DTN.5.00390

External Parent: RFC 9171 Section 5.1, PICS Section A5.5 Item 32

Verification Method: Test

DTN.6.08340

After a successful request to store a custodial bundle, BPA shall add the bundle to the set of bundles in custody.

Rationale: Node needs to keep track of bundles in its custody.

Parent: DTN.5.00390, DTN.5.00142

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4.3

Verification Method: Test

DTN.6.06390

For any bundle containing a valid Hop Count Block, BPA shall increment that bundle's Hop Block Hop Count.

Rationale: The Hop Count Block prevents data congestion in the network by limiting the number of times a Bundle can be forwarded.

Parent: DTN.5.00280

External Parent: RFC 9171 Section 4.4.3, PICS Section A5.5 Item 6

Verification Method: Test

DTN.6.06400

For any bundle containing a valid Hop Count Block, if its hop count exceeds its hop limit, BPA shall discard the bundle with reason code "Hop limit exceeded".

Rationale: The Hop Count Block prevents data congestion in the network by limiting the number of times a Bundle can be forwarded.

Parent: DTN.5.00290, DTN.5.00192

External Parent: RFC 9171 Section 4.4.3, PICS Section A5.5 Item 6

Verification Method: Test

DTN.6.06650

BPA shall issue an information event whenever it discards a bundle prior to storing it, which includes the reason for discard and the specific CLA providing the candidate bundle.

Rationale: Provides additional information needed to better understand the nature of the error.

Parent: DTN.5.00980

External Parent: N/A

Verification Method: Test

DTN.6.04420

If not otherwise configured, BPA shall reject a bundle storage request if the bundle's destination node ID is this node's ID, and the bundle is not selected for any output queue.

Rationale: This behavior rejects bundles for this node for which the service ID is not registered, and configuration indicates deleting such bundles.

Parent: DTN.5.00330

External Parent: N/A

Verification Method: Test

3.3.4 Bundle Storage Management

This section contains recommendations on BPA bundle storage management.

DTN.6.04600

Upon receiving a clear-volatile directive, BPA shall clear volatile data including bundle metadata and bundles not in persistent storage.

Rationale: The clear-volatile directive is used to bring DTN node out of error state. Non-volatile data can still be used, and only RAM data can be deleted during DTN Node start up.

Parent: DTN.5.01050

External Parent: N/A

Verification Method: Test

DTN.6.04012

Upon receiving a reload-saved-data directive, BPA shall reload bundle cache data from persistent storage.

Rationale: It is essential that DTN node restart with latest configurations and data. Existing bundle metadata needs to be available to the node after a restart via persistent storage.

Parent: DTN.5.01050

External Parent: N/A

Verification Method: Test

DTN.6.04000

Upon receiving a verify-bundle-storage directive, BPA shall verify the header of all bundles in persistent storage.

Rationale: This is a low-level check of storage. The details are implementation dependent. Persistent storage includes all custodial bundles and some non-custodial bundles as allocated.

Parent: DTN.5.00790

External Parent: N/A

Verification Method: Test

DTN.6.04008

Upon receiving a verify-bundle-metadata directive, BPA shall verify bundle metadata to ensure it reflects actual bundle storage.

Rationale: Upon any restart, the content of bundle meta-data must be assessed.

Parent: DTN.5.00790

External Parent: CCSDS BPv7 Section 5.2.1, CCSDS BPv7 Annex C3

Verification Method: Test

DTN.6.04010

Upon receiving a rebuild-bundle-metadata directive, BPA shall rebuild Bundle Storage metadata from the stored bundles.

Rationale: Metadata may need to be re-created after a node restart if Bundle Storage is intact.

Parent: DTN.5.00790

External Parent: CCSDS BPv7 Section 5.2.1, CCSDS BPv7 Annex C3

Verification Method: Test

DTN.6.04490

Upon receiving a initialize-bundle-storage directive, BPA shall delete all stored bundles for which the source EID is in the given EID set.

Rationale: Provides a mechanism for operators to manage bundle storage.

Parent: DTN.5.00790

External Parent: CCSDS BPv7 Section 5.2.1

Verification Method: Test

DTN.6.04630

Upon request from AA, BPA shall validate storage configuration updates.

Rationale: Validate incoming configuration updates prior to accepting the new values.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Test

DTN.6.04500

Upon receiving an add-storage-allocation directive, BPA shall allocate a storage partition of the given size for storing bundles where the source EID matches the given pattern.

Rationale: An amount of storage is reserved based on customer SLAs

Parent: DTN.5.00790

External Parent: CCSDS BPv7 Section 5.2.1

Verification Method: Test

DTN.6.04510

Upon receiving an add-storage-allocation directive, if sufficient storage of the requested type is not available, BPA shall reject the directive and issue an error event.

Rationale: The node cannot provide storage is does not have available.

Parent: DTN.5.00790

External Parent: CCSDS BPv7 Section 5.2.1

Verification Method: Test

DTN.6.04520

Upon receiving an add-storage-allocation directive, if the given EID pattern is an exact duplicate of an EID pattern selecting another storage allocation, BPA shall reject the directive and issue an error event.

Rationale: Avoids potentially non-deterministic behavior

Parent: DTN.5.00790

External Parent: N/A

Verification Method: Test

DTN.6.04540

Upon receiving a remove-storage-allocation directive, BPA shall remove the storage partition corresponding to the given EID pattern.

Rationale: Needed to fully manage storage.

Parent: DTN.5.00790

External Parent: CCSDS BPv7 Section 5.2.1

Verification Method: Test

DTN.6.04550

Upon deallocating storage due to a remove-storage-allocation directive, BPA shall delete all bundles contained in the allocation.

Rationale: Bundles cannot be stored outside a memory allocation.

Parent: DTN.5.00790

External Parent: CCSDS BPv7 Section 5.2.1

Verification Method: Test

DTN.6.04560

Upon receiving a remove-storage-allocation directive, if the given EID pattern is not associated with a memory allocation, BPA shall reject the directive and issue an error event.

Rationale: propagate error back to AA.

Parent: DTN.5.00790

External Parent: CCSDS BPv7 Section 5.2.1

Verification Method: Test

DTN.6.04412

BPA shall store bundles if the bundles' destination node ID is this node's ID, the bundle is not selected for any output queue, but available storage allocation is associated with the bundle.

Rationale: Storage could be allocated for the whole node, in which case the DTN Node can store the bundle pending a later registration of the service.

Parent: DTN.5.00740

External Parent: CCSDS BPv7 Section 5.2.1

Verification Method: Test

DTN.6.04422

Upon request to store a bundle in which the destination node ID is this node's ID and the bundle is not selected for any output queue, BPA shall issue an information event.

Rationale: Network management should be aware that bundles are being received for an unregistered service.

Parent: DTN.5.00740

External Parent: N/A

Verification Method: Test

DTN.6.06500

BPA shall compute the ingress rate of bundles and store the result in bundleIngressRateBitsPerSec and bundleIngressRateBundlesPerSec.

Rationale: Provides a useful metric for network management.

Parent: DTN.5.00370

External Parent: N/A

Verification Method: Test

DTN.6.06501

BPA shall compute the ingress rate of bundles from each configured source EID and store the result in bundleIngressRateBitsPerSec[source] and bundleIngressRateBundlesPerSec[source].

Rationale: Provides a useful metric for network management.

Parent: DTN.5.00370

External Parent: N/A

Verification Method: Test

DTN.6.07065

BPA shall compute the egress rate of bundles and store the result in bundleEgressRateBitsPerSec and bundleEgressRateBundlesPerSec.

Rationale: Provides a useful metric for network management.

Parent: DTN.5.00700

External Parent: N/A

Verification Method: Test

DTN.6.07066

BPA shall compute the egress rate of bundles from each configured source EID and store the result in bundleEgressRateBitsPerSec[source] and bundleEgressRateBundlesPerSec[source].

Rationale: Provides a useful metric for network management.

Parent: DTN.5.00700

External Parent: N/A

Verification Method: Test

DTN.6.04045

If a given channel's delivery failure action is "abandon", and the channel's state is "passive", BPA shall delete with reason code "Destination endpoint ID unavailable" any bundle which is queued for the channel.

Rationale: Required by RFC 9171 section 5.7.

Parent: DTN.5.00782

External Parent: RFC 9171 Section 5.7, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, PICS Section A5.5 Item 39

Verification Method: Test

DTN.6.08760

Upon notification that a bundle was delivered, BPA shall delete the given bundle with reason code "No additional information."

Rationale: Delivery is analogous to transferring custody to the local application.

Parent: DTN.5.00490, DTN.5.00788

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.04272

Upon successfully transferred custody or successfully forwarded non-custodial bundle, BPA shall delete a given bundle from bundle storage.

Rationale: Custodial bundles for which custody has been transferred and non-custodial bundles which have been forwarded must be deleted from bundle storage.

Parent: DTN.5.00490, DTN.5.00694

External Parent: RFC 9171 Section 5.10, PICS Section A5.5 Item 44

Verification Method: Test

DTN.6.04610

BPA shall issue a debug event whenever it deletes a bundle from storage.

Rationale: Provides additional information needed to better understand the nature of the error.

Parent: DTN.5.00980

External Parent: N/A

Verification Method: Test

DTN.6.04570

Upon deleting a custodial bundle, BPA shall remove the bundle from its CTDB and cancel any retransmit timers for the bundle.

Rationale: When deleting a bundle, custody no longer needs to be tracked and the bundle needs to be removed from the CTDB and retransmit timers for the bundle can be canceled.

Parent: DTN.5.00490, DTN.5.00720, DTN.5.00790

External Parent: RFC 9171 Section 5.4.1, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08670

If the BSC reason code field indicates custody rejected, then for each bundle indicated in the BSC, BPA shall delete the bundle's custody timer.

Rationale: After the next hop refuses, there is little reason to retry until the next contact or direction from network management.

Parent: DTN.5.00495

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.04070

BPA shall use as the effective lifetime of any bundle the lesser of the maximum allowable lifetime or the lifetime given by the bundle's primary block.

Rationale: Allowed by RFC 9171 sections 4.3.1 and 5.5 and required to prevent network performance degradation due to long bundle lifetimes.

Parent: DTN.5.00800

External Parent: RFC 9171 Section 4.3.1, RFC 9171 Section 5.5, PICS Section A5.5 Item 37

Verification Method: Test

DTN.6.04080

If paramSetMaxLifetime has not been set, BPA shall use the lifetime given by the bundle's primary block as the bundle lifetime.

Rationale: Provides a reasonable fallback.

Parent: DTN.5.00800

External Parent: N/A

Verification Method: Test

DTN.6.04090

If a valid bundle creation timestamp can be compared to the current time, BPA shall delete bundles for which the delta between the creation time and the current time is greater than the bundle's effective lifetime ("expired bundles").

Rationale: RFC 9171 presumes that beyond a bundle's lifetime its payload is no longer useful. The time delta provided by Time Management is always less than or equal to the real delta (if time estimates are being used), so bundles should never be deleted prematurely.

Parent: DTN.5.00197, DTN.5.00800

External Parent: RFC 9171 Section 5.5, PICS Section A5.5 Item 37

Verification Method: Test

DTN.6.04100

If a bundle contains a Bundle Age block, does not contain a valid non-zero creation timestamp, and its reception time can be compared to the current time, BPA shall delete bundles for which the delta between the current time and the bundle reception time plus the bundle age is greater than the bundle effective lifetime ("expired bundles").

Rationale: RFC 9171 presumes that beyond a bundle's lifetime its payload is no longer useful.

Parent: DTN.5.00197, DTN.5.00800

External Parent: RFC 9171 Section 5.5, PICS Section A5.5 Item 37

Verification Method: Test

DTN.6.04195

If a valid bundle creation timestamp cannot be compared to the current time, BPA shall use the bundle reception time to delete bundles for which the delta between the reception time and the current time is greater than the bundle's effective lifetime ("expired bundles").

Rationale: RFC 9171 presumes that beyond a bundle's lifetime its payload is no longer useful. Creation time and current time cannot be compared if a host clock has never been synchronized, but the monotonic reception time can be used instead.

Parent: DTN.5.00800

External Parent: RFC 9171 Section 5.5, PICS Section A5.5 Item 37

Verification Method: Test

DTN.6.05352

BPA shall generate an information event indicating it discarded an ADU or incomplete ADU because its effective lifetime expired and include the effective lifetime in the message.

Rationale: The node does not count these explicitly, so this provides a way to discover why a CLA message was discarded. Because multiple channels can be active, the specific channel must be identified so the operator knows which generated the event.

Parent: DTN.5.00980

External Parent: N/A

Verification Method: Test

DTN.6.04150

When bundleAgeOutTime has elapsed since BPA has deleted a bundle, BPA shall discard the bundle by deallocating the metadata associated with the bundle.

Rationale: Free up storage space so new Bundles can be created or received.

Parent: DTN.5.00820

External Parent: RFC 9171 Section 5.11, PICS Section A5.5 Item 45

Verification Method: Test

DTN.6.05362

When discarding an ADU or incomplete ADU due to a removed channel, BPA shall generate an information event.

Rationale: The node does not count these explicitly, so this provides a way to discover why a CLA message was discarded. Because multiple channels can be active, the specific channel must be identified so the operator knows which generated the event.

Parent: DTN.5.00980

External Parent: N/A

Verification Method: Test

3.3.5 Bundle Reassembly

This section contains recommendations on BPA bundle reassembly.

DTN.6.05000

BPA shall request payloads for the given channel until it has a complete ADU to send to AA.

Rationale: Fragmentation is the highest level of the BP stack and so is the interface with AA. It must obtain bundle payloads from the next layer down, Payload Interface. The essence of ADU reassembly is to obtain payloads until the ADU is complete (or expires).

Parent: DTN.5.00730

External Parent: RFC 9171 Section 5.8, PICS Section A5.5 Item 41

Verification Method: Test

DTN.6.05040

If a payload received is a fragment, BPA shall reassemble the original ADU.

Rationale: Only ADUs may be returned to the AA.

Parent: DTN.5.00580

External Parent: RFC 9171 Section 5.9, PICS Section A5.5 Item 42

Verification Method: Test

DTN.6.05050

If a fragment's source EID and creation timestamp indicate it is part of an ADU already being reassembled, BPA shall add the fragment to the ADU according to the offset and size provided with the payload.

Rationale: This how ADUs are reassembled. If the fragment is not part of an ADU already being reassembled, we start reassembling the ADU for which we now have this fragment.

Parent: DTN.5.00590

External Parent: RFC 9171 Section 5.9, PICS Section A5.5 Item 42

Verification Method: Test

DTN.6.05060

If a fragment is part of an ADU already being reassembled, and if the total ADU length provided with the fragment does not match the total ADU length of the ADU being reassembled, BPA shall discard the fragment and increment an error counter, bundleCountFragmentError.

Rationale: An ADU cannot be reassembled if there are Inconsistencies among fragments.

Parent: DTN.5.00590, DTN.5.00600, DTN.5.00622

External Parent: RFC 9171 Section 5.9, PICS Section A5.5 Item 42

Verification Method: Test

DTN.6.05062

If a fragment is part of an ADU already being reassembled, and if the total ADU length provided with the fragment does not match the total ADU length of the ADU

being reassembled, BPA shall discard the fragment and increment an error counter, bundleCountFragmentError[source] for the bundle source EID.

Rationale: An ADU cannot be reassembled if there are Inconsistencies among fragments.

Parent: DTN.5.00590, DTN.5.00600, DTN.5.00622

External Parent: RFC 9171 Section 5.9, PICS Section A5.5 Item 42

Verification Method: Test

DTN.6.05070

If a fragment is part of an ADU already being reassembled, and if the fragment offset causes this fragment to overlap one already received, BPA shall discard the fragment and increment an error counter, bundleCountFragmentError.

Rationale: This is required by RFC 9171 section 5.9.

Parent: DTN.5.00590, DTN.5.00600, DTN.5.00622

External Parent: RFC 9171 Section 5.9, PICS Section A5.5 Item 42

Verification Method: Test

DTN.6.05072

If a fragment is part of an ADU already being reassembled, and if the fragment offset causes this fragment to overlap one already received, BPA shall discard the fragment and increment an error counter, bundleCountFragmentError[source] for the bundle source EID.

Rationale: This is required by RFC 9171 section 5.9.

Parent: DTN.5.00590, DTN.5.00600, DTN.5.00622

External Parent: RFC 9171 Section 5.9, PICS Section A5.5 Item 42

Verification Method: Test

DTN.6.05080

If a fragment is NOT part of an ADU already being reassembled and if the original ADU length is less than or equal to the configured maximum ADU length, BPA shall begin reassembling the original ADU.

Rationale: This involves allocating a buffer.

Parent: DTN.5.00580

External Parent: RFC 9171 Section 5.9, PICS Section A5.5 Item 42

Verification Method: Test

DTN.6.05120

After it has received and reassembled all fragments to form an ADU, BPA shall increment the bundleCountReassembled.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00600

External Parent: N/A

Verification Method: Test

DTN.6.05130

After it has received and reassembled all fragments to form an ADU, BPA shall increment the bundleCountReassembled[source] for the ADU's source.

Rationale: Accounting may be performed for data payloads provided by some sources to ensure mutual service level adherence.

Parent: DTN.5.00600

External Parent: N/A

Verification Method: Test

DTN.6.05350

If the effective lifetime of any fragment bundle being reassembled expires, BPA shall discard the assembled fragments.

Rationale: No further fragments will reach Fragmentation after this point, so the ADU cannot be completed.

Parent: DTN.5.00635, DTN.5.00800

External Parent: RFC 9171 Section 5.5, PICS Section A5.5 Item 37

Verification Method: Test

DTN.6.05110

After it has received and reassembled all fragments to form an ADU, BPA shall reply to the ADU delivery request with that ADU.

Rationale: A partial payload cannot be delivered to the destination.

Parent: DTN.5.00620

External Parent: RFC 9171 Section 5.9, PICS Section A5.5 Item 42

Verification Method: Test

DTN.6.05074

Upon incrementing bundleCountFragmentError, BPA shall issue a debug event.

Rationale: Provides additional context for this issue to aid debugging.

Parent: DTN.5.00980

External Parent: N/A

Verification Method: Test

3.3.6 Bundle Payload Delivery

This section contains recommendations on BPA bundle payload delivery.

DTN.6.05010

If a payload received is a complete ADU, BPA shall reply to the ADU delivery request with that ADU.

Rationale: In this case, Fragmentation is a pass-through function.

Parent: DTN.5.00730

External Parent: RFC 9171 Section 5.8, PICS Section A5.5 Item 41

Verification Method: Test

DTN.6.05140

BPA shall increment the count of delivered ADUs, `aduCountDelivered`, upon replying to an ADU delivery request.

Rationale: Network management needs to account for data.

Parent: DTN.5.00600, DTN.5.00770

External Parent: N/A

Verification Method: Test

DTN.6.05150

BPA shall increment the count of delivered ADUs from a source, `aduCountDelivered[source]`, upon replying to a request to deliver a payload.

Rationale: Network management needs to account for data on a flow-by-flow basis.

Parent: DTN.5.00600, DTN.5.00770

External Parent: N/A

Verification Method: Test

DTN.6.05155

When delivering an ADU for an administrative record bundle, BPA shall increment the count of received administrative record bundles `bundleCountReceivedAdminRecord`.

Rationale: Network management needs to account for data.

Parent: DTN.5.00770

External Parent: N/A

Verification Method: Test

DTN.6.05156

When delivering an ADU for an administrative record bundle, BPA shall increment the count of received administrative record bundles from a source `bundleCountReceivedAdminRecord[source]`.

Rationale: Network management needs to account for data on a flow-by-flow basis.

Parent: DTN.5.00770

External Parent: N/A

Verification Method: Test

DTN.6.05030

BPA shall include the "acknowledgement by application is requested" bundle processing control flag in its reply to an ADU delivery request.

Rationale: RFC 9171 section 4.2.7 indicates that this asks the destination application to acknowledge bundle reception to the source application.

Parent: DTN.5.00730

External Parent: RFC 9171 Section 4.2.7

Verification Method: Test

DTN.6.03020

BPA shall include the payload size in its reply to a ADU delivery request.

Rationale: This information is needed by Fragmentation to assemble the ADU.

Parent: DTN.5.00730

External Parent: RFC 9171 Section 5.9, PICS Section A5.5 Item 42

Verification Method: Test

DTN.6.05310

When it delivers an ADU, for each bundle containing the ADU or a fragment of it in which the bundle processing control flags request reporting of bundle delivery, BPA shall notify AA that it delivered the ADU.

Rationale: The configuration allows network management to prevent or allow generation of each particular BSR for all flows and for any given source. Existence of variable is suggested by RFC 9171 section 5.1, and they are present in the MIB.

Parent: DTN.5.00762

External Parent: RFC 9171 Section 5.1, PICS Section A5.5 Item 32

Verification Method: Test

DTN.6.05160

When an ADU is delivered, BPA shall remove any bundles which delivered that ADU from the CTDB.

Rationale: Bundles should be kept available in the CTDB until payload delivery.

Parent: DTN.5.00630

External Parent: RFC 9171 Section 5.7, PICS Section A5.5 Item 39

Verification Method: Test

3.3.7 Bundle Routing and Egress

This section contains recommendations on BPA bundle routing and egress.

DTN.6.04330

BPA shall order bundles in the given output queue according to latency policy for each bundle's source EID.

Rationale: This is used to order the list according to priorities set externally.

Parent: DTN.5.00662

External Parent: N/A

Verification Method: Test

DTN.6.04334

Within each latency category, BPA shall order bundles in output queues according to the time at which the bundles were received or created.

Rationale: egress bundles in the same order as they were received for a given source EID latency configuration.

Parent: DTN.5.00685

External Parent: N/A

Verification Method: Test

DTN.6.04340

BPA shall only queue bundles in a single output queue at any given time.

Rationale: Without this requirement we would have a potential multicast situation.

Parent: DTN.5.00660

External Parent: N/A

Verification Method: Inspection

DTN.6.04440

When re-forwarding bundles, BPA shall add the given bundle to the given output queue, ordered as appropriate based on latency policy for the bundle's source EID, but without respect to the time the bundle was received by the node.

Rationale: This mechanism is used by Custody Transfer to re-forward foreign bundles. Bundles are queued according to their latency requirements. Unlike when the output queue is created, though, bundle received time is not used for ordering the bundle in the output queue.

Parent: DTN.5.00660

External Parent: N/A

Verification Method: Test

DTN.6.08714

Prior to forwarding a bundle, if the bundle contains a CTEB, BPA shall remove the CTEB from the bundle.

Rationale: The existing CTEB was placed by the previous custodian and must be replaced by one specific to this node and contact.

Parent: DTN.5.00142

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08715

After removing a CTEB, BPA shall add to the bundle a CTEB with the Block Source Administrative EID set to the local node service 0 EID, Bundle Sequence ID set to indicate the given output queue, and the Bundle Sequence Number set to the counter value associated with the output queue.

Rationale: This inserts the CTEB for this node. The counter is associated with the output queue on the assumption that custody transfer transactions cannot span between contacts. It also provides separation between concurrent contacts. Detailed requirements for adding a CREB are in BPA Payload Interface and need not be repeated here.

Parent: DTN.5.00142

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08716

After adding the CTEB, BPA shall associate the Bundle Sequence Number with the bundle and increment the Bundle Sequence associated with the given output queue.

Rationale: Counter value is used by the downstream custodian to accept custody, so the BPA must be able to determine which bundles have been accepted by counter values.

Parent: DTN.5.00142

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08662

If the BSC reason code field indicates custody accepted (custody transfer succeeded), and if the BSC fails to include a bundle that was forwarded with custody transfer requested with others in the BSC, and if there is not a BSC rejecting custody for that bundle, BPA shall immediately queue the bundle for reforwarding and delete the custody timer associated with the bundle.

Rationale: This approach reduces the latency of the data set and may be required in a customer service level agreement (SLA).

Parent: DTN.5.00721

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08730

When a custody timer expires, BPA shall add the associated bundle to the output queue for the channel on which the bundle was sent.

Rationale: This results in bundle's retransmission.

Parent: DTN.5.00720

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.04390

Upon ("get bundle") request from CLA, BPA shall remove the next bundle in the given output queue and reply with that bundle.

Rationale: This is how BPA retrieve bundles from storage. Removing the returned bundle from the list ensures the same bundle is not delivered twice for the same identifier.

Parent: DTN.5.00660

External Parent: N/A

Verification Method: Test

DTN.6.07030

If the bundle contains a Previous Node Block, BPA shall set the block's data field to this Node ID.

Rationale: The Previous Node Block must point to the last node that forwarded the bundle.

Parent: DTN.5.00680

External Parent: RFC 9171 Section 4.4.1, PICS 9171 Section 5.4, PICS Section A5.5 Item 2

Verification Method: Test

DTN.6.23062

Upon forwarding a bundle, if the bundle contains a Bundle Age Block, BPA shall update the bundle age by adding it to the delta between the current time and the reception time.

Rationale: The Age Block must be updated to reflect the time the Bundle remained in storage on this node. It is represented in milliseconds using the node's monotonic clock. To maximize accuracy of the age, this should be done as close as practical to when the bundle is actually transmitted.

Parent: DTN.5.00670

External Parent: RFC 9171 Section 4.4.2, PICS Section A5.5 Item 5

Verification Method: Test

DTN.6.08710

Upon notification that a bundle was forwarded, if the bundle is in custody, BPA shall create a custody timer set to the custody timeout configured for the given contact.

Rationale: This will trigger retransmission of the bundle if custody is not accepted by the next node before the timer expires.

Parent: DTN.5.00720

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08712

Upon notification that a bundle was forwarded, if the bundle is not in custody, BPA shall delete the given bundle with reason code "No Additional Information."

Rationale: This node has discharged its responsibility regarding this non-custodial bundle.

Parent: DTN.5.00694

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.27020

When encoding a bundle, BPA shall use as-is the encoding for those blocks not created or updated by the node.

Rationale: The node must not re-encode the immutable primary block or blocks which might be the subject of security blocks.

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.3.1

Verification Method: Inspection

DTN.6.27320

If the given block's CRC type is zero, BPA shall encode canonical block as a 5-element array.

Rationale: Required by RFC 9171 section 4.3.2 "Canonical Bundle Block Format".

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.3.2, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27330

If the given block's CRC type is non-zero, BPA shall encode canonical block as a 6-element array.

Rationale: Required by RFC 9171 section 4.3.2 "Canonical Bundle Block Format".

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.3.2, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27340

BPA shall create as the first field in the canonical block array an unsigned integer set to the type code of the given deserialized block.

Rationale: Required by RFC 9171 section 4.3.2 "Canonical Bundle Block Format".

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.3.2, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27350

BPA shall create as the second field in the canonical block array an unsigned integer set to the block number of the given deserialized block.

Rationale: Required by RFC 9171 section 4.3.2 "Canonical Bundle Block Format".

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.3.2, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27360

BPA shall create as the third field in the canonical block array a 64-bit unsigned integer set to the block processing control flags of the given deserialized block.

Rationale: Required by RFC 9171 section 4.3.2 "Canonical Bundle Block Format".

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.3.2, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27370

BPA shall create as the fourth field in the canonical block array an unsigned integer set to the CRC type of the given deserialized block.

Rationale: Required by RFC 9171 section 4.3.2 "Canonical Bundle Block Format".

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.3.2, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27380

BPA shall create as the fifth field of the canonical block array a definite-length byte string containing the block-specific data of the given deserialized block.

Rationale: Required by RFC 9171 section 4.3.2 "Canonical Bundle Block Format".

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.3.2, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27390

If the canonical block is not the payload block, BPA shall use the encoded block-specific data as the contents of the block-specific data byte string.

Rationale: Required by RFC 9171 section 4.3.2 "Canonical Bundle Block Format". For all blocks except the payload block, the block-specific data is a data structure which must be CBOR encoded before it is included in the encoded canonical block as a byte string.

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.3.2, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27400

If the given block's CRC type is non-zero, BPA shall create as the sixth field of the canonical block array an unsigned integer with the value of the encoded canonical block's CRC calculated in accordance with the given CRC type.

Rationale: Required by RFC 9171 section 4.3.2 "Canonical Bundle Block Format".

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.3.2, PICS Section A5.5 Item 30

Verification Method: Test

DTN.6.27420

If the deserialized bundle includes a Previous Node Block, BPA shall create as the next element of the bundle array a canonical block array representing the Previous Node Block.

Rationale: Required by RFC 9171 section 4.4.1 "Previous Node".

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.4.1, PICS Section A5.5 Item 3, PICS Section A5.5 Item 31

Verification Method: Test

DTN.6.27490

Upon encoding Previous Node Block block-specific data, BPA shall create an EID using the "ipn" scheme and the given node ID.

Rationale: Required by RFC 9171 section 4.4.1 "Previous Node".

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.4.1, PICS Section A5.5 Item 3, PICS Section A5.5 Item 9, PICS Section A5.5 Item 31

Verification Method: Test

DTN.6.27430

If the deserialized bundle includes a Bundle Age Block, BPA shall create as the next element of the bundle array a canonical block array representing the Bundle Age Block.

Rationale: Required by RFC 9171 section 4.4.2 "Bundle Age".

Parent: DTN.5.00070, DTN.5.00090

External Parent: RFC 9171 Section 4.4.2, PICS Section A5.5 Item 5, PICS Section A5.5 Item 31

Verification Method: Test

DTN.6.27500

Upon encoding Bundle Age Block block-specific data, BPA shall create a CBOR unsigned integer using the given bundle age.

Rationale: Required by RFC 9171 section 4.4.2 "Bundle Age".

Parent: DTN.5.00070, DTN.5.00090

External Parent: RFC 9171 Section 4.4.2, PICS Section A5.5 Item 5, PICS Section A5.5 Item 31

Verification Method: Test

DTN.6.27440

If the deserialized bundle includes a Hop Count Block, BPA shall create as the next element of the bundle array a canonical block array representing the Hop Count Block.

Rationale: Required by RFC 9171 section 4.4.3 "Hop Count".

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.4.3, PICS Section A5.5 Item 6, PICS Section A5.5 Item 31

Verification Method: Test

DTN.6.27510

Upon encoding Hop Count Block block-specific data, BPA shall create a 2-element array.

Rationale: Required by RFC 9171 section 4.4.3 "Hop Count".

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.4.3, PICS Section A5.5 Item 7, PICS Section A5.5 Item 31

Verification Method: Test

DTN.6.27520

Upon encoding Hop Count Block block-specific data, BPA shall create as the first element in the Hop Count array an unsigned integer using the given hop limit.

Rationale: Required by RFC 9171 section 4.4.3 "Hop Count".

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.4.3, PICS Section A5.5 Item 7, PICS Section A5.5 Item 31

Verification Method: Test

DTN.6.27530

Upon encoding Hop Count Block block-specific data, BPA shall create as the second element in the Hop Count array an unsigned integer using the given hop count.

Rationale: Required by RFC 9171 section 4.4.3 "Hop Count".

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.4.3, PICS Section A5.5 Item 7, PICS Section A5.5 Item 31

Verification Method: Test

DTN.6.27450

If the deserialized bundle includes a Custody Transfer Extension Block, BPA shall create as the next element of the bundle array a canonical block array representing the CTEB.

Rationale: Required by draft orange book "Compressed Custody Signaling And Bundle Status Reporting."

Parent: DTN.5.00070

External Parent: Draft orange book "Compressed Custody Signaling And Bundle Status Reporting."

Verification Method: Test

DTN.6.26270

Upon encoding a CTEB, BPA shall set the CTEB's block-specific data to a definite-length CBOR array of three elements:

- Bundle Sequence ID
- First Sequence Number
- Bundle Sequence Range array.

Rationale: From the CCSDS definition of the Custody Transfer Extension Block.

Parent: DTN.5.00070

External Parent: RFC 9171 Section 4.2, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.26280

Upon encoding a CTEB, BPA shall set the 1st element of CTEB's block-specific data array, the Bundle Sequence Number, to a monotonically increasing unsigned integer value of up to 64 bits.

Rationale: From the CCSDS definition of the Custody Transfer Extension Block.

Parent: DTN.5.00070

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.26290

Upon encoding a CTEB, BPA shall set the 2nd element of CTEB's block-specific data array, the bundle Sequence ID, to the given unsigned integer value.

Rationale: From the CCSDS definition of the Custody Transfer Extension Block.

Parent: DTN.5.00070

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.26300

Upon encoding a CTEB, BPA shall set the 3rd element of CTEB's block-specific data array, the Block Source Administrative Endpoint (Node) ID, to the administrative EID of this node.

Rationale: From the CCSDS definition of the Custody Transfer Extension Block.

Parent: DTN.5.00070

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.26060

If the CTEB CRC Type is non-zero, BPA shall compute the block CRC using the indicated algorithm and set the CTEB's CRC to the computed value.

Rationale: Required by RFC 9171 section 4.3.2.

Parent: DTN.5.00060

External Parent: RFC 9171 Section 4.2.2, PICS Section A5.5 Item 29

Verification Method: Test

DTN.6.27460

If the deserialized bundle includes Compressed Reporting Extension Blocks, BPA shall create as the next elements of the bundle array canonical block arrays representing the CREBs.

Rationale: Required by draft orange book "Compressed Custody Signaling And Bundle Status Reporting."

Parent: DTN.5.00070

External Parent: Draft orange book "Compressed Custody Signaling And Bundle Status Reporting."

Verification Method: Test

DTN.6.26080

When a CREB exists within a bundle, if the Block Source Administrative EID, Bundle Sequence ID, Status Report Request Flags, and Report-To EID are unconfigured, BPA shall encode the block-type-specific data as a CBOR definite-length array of length 1, containing the Bundle Sequence Number.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00006

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.1

Verification Method: Test

DTN.6.26090

When a CREB exists within a bundle, if the Block Source Administrative EID Status Report Request Flags and Report-To EID are unconfigured, BPA shall encode the block-type-specific data as a CBOR definite-length array of length 2, containing the Bundle Sequence ID and Bundle Sequence Number in that order.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00006

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 3.2

Verification Method: Test

DTN.6.26100

When a CREB exists within a bundle, if the Block Source Administrative EID and Report-To EID are unconfigured, BPA shall set the block-type-specific data to a CBOR definite-length array of length 3, containing the Bundle Sequence ID, Bundle Sequence Number, and Status Report Request Flags in that order.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00006

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 3.2

Verification Method: Test

DTN.6.26110

When a CREB exists within a bundle, if the Report-To EID is unconfigured, BPA shall set the block-type-specific data to a CBOR definite-length array of length 4, containing the Block Source Administrative EID, Bundle Sequence ID, Bundle Sequence Number, and the Status Report Request Flags in that order.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00006

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 3.2

Verification Method: Test

DTN.6.26120

When a CREB exists within a bundle, if all parameters are configured, BPA shall set the block-type-specific data to a CBOR definite-length array of length 5 containing the Block Source Administrative EID, Bundle Sequence ID, Bundle Sequence Number, the Status Report Request Flags, and Report-To EID in that order.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00006

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.26130

When a CREB exists within a bundle, BPA shall encode the Block Source Administrative EID as an EID.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00006

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.26140

When a CREB exists within a bundle, BPA shall encode the Bundle Sequence ID as a CBOR unsigned integer.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00006

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.26150

When a CREB exists within a bundle, BPA shall encode the Status Report Request Flags as a CBOR unsigned integer.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00006

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.26160

When a CREB exists within a bundle, BPA shall encode the Report-To EID as an EID.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00006

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

3.3.8 Custody Signal Generation and Receipt

This section contains recommendations on BPA custody signal generation and receipt.

DTN.6.08580

BPA shall process each BSC in the given Compressed Custody Signal administrative record.

Rationale: Custody Transfer Bundles are returned from other DTN Nodes indicating whether the forwarding of indicated bundles was successful or not.

Parent: DTN.5.00480

External Parent: RFC 9171 Section 5.1, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08600

If the BSC reason code field indicates custody accepted (custody transfer succeeded), then for each bundle indicated in the BSC, BPA shall delete the bundle.

Rationale: Successfully transferred Bundles can be deleted. Data Accounting of the deletion is not recorded due to the custody transfer.

Parent: DTN.5.00490

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08630

If the BSC reason code field indicates custody accepted (custody transfer succeeded), then for each bundle indicated in the BSC, BPA shall remove the bundle from the set of bundles in custody.

Rationale: Node needs to keep track of bundles in its custody.

Parent: DTN.5.00490

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08640

If the BSC reason code field indicates custody accepted (custody transfer succeeded), then for each bundle indicated in the BSC, BPA shall delete the custody timer associated with the bundle.

Rationale: The timer is not needed any longer, so recover the resource.

Parent: DTN.5.00490

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08672

If the BSC reason code field indicates custody rejected, then for each bundle indicated in the BSC, BPA shall issue a debug event.

Rationale: Network Management functions need to be aware of the reason(s) for unsuccessful Custody Transfer attempts as it may impact fault handling.

Parent: DTN.5.00500

External Parent: N/A

Verification Method: Test

DTN.6.08380

Upon signaling a custody action, if a Compressed Custody Signal for the given Block Source Administrative EID is not already being constructed, BPA shall begin constructing a Compressed Custody Signal for that Block Source Administrative EID.

Rationale: Custody Signals are per-custodian and per-reason.

Parent: DTN.5.00400

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08390

Upon signaling a custody action, if the Compressed Custody Signal for the given Block Source Administrative EID does not contain a map entry for the given disposition code, BPA shall create a map entry for the given disposition code and a corresponding Bundle Sequence Collection (BSC) array.

Rationale: Required by the CCSDS specification for the custody signal. The Report is one- or two-element map where the key is the disposition code and the value is a Bundle Sequence Collection.

Parent: DTN.5.00400

External Parent: RFC 9171 Section 5.1, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4, PICS Section A5.5 Item 32

Verification Method: Test

DTN.6.08393

BPA shall use the disposition code "1" to signal custody accepted.

Rationale: Required by the CCSDS specification for the custody signal.

Parent: DTN.5.00390

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08395

BPA shall use the disposition code "-1" to signal custody rejected.

Rationale: Required by the CCSDS specification for the custody signal.

Parent: DTN.5.00440

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08397

BPA shall construct each Bundle Sequence Range as a definite-length array of unsigned integers with an odd number of elements such that the first (or only) element is the length of the first (or only) bundle (sub-)sequence included in the Bundle Sequence.

Rationale: Required by the CCSDS specification for the custody signal.

Parent: DTN.5.00440

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 2.1, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 2.2

Verification Method: Test

DTN.6.08440

Upon creating a Compressed Custody Signal, BPA shall set a timer for the Compressed Custody Signal to the configured value for the destination custodian.

Rationale: Custody Signal administrative records must be sent on a minimum cadence to prevent unnecessary bundle retransmissions.

Parent: DTN.5.00400

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4.3

Verification Method: Test

DTN.6.08460

When a Compressed Custody Signal reaches the trigger size for the destination custodian or when the timer associated with the Compressed Custody Signal expires, BPA shall create a bundle for the Compressed Custody Signal configured as indicated by the custodian EID.

Rationale: The size of Custody Signal may be limited by the underlying network. Custody Signal administrative records must be sent on a minimum cadence to prevent unnecessary bundle retransmissions.

Parent: DTN.5.00420

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08810

Upon receiving a contact-stop directive, BPA shall send any Compressed Custody Signals under construction.

Rationale: Attempt to get out any in work custody signals prior to the end of the contact.

Parent: DTN.5.00460

External Parent: N/A

Verification Method: Test

DTN.6.08465

When a Compressed Custody Signal is triggered, BPA shall CBOR encode the Compressed Custody Signal.

Rationale: The size of Custody Signal may be limited by the underlying network.

Parent: DTN.5.00420

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

3.3.9 BSR Generate and Store

This section contains recommendations on BPA BSR generation and storage.

DTN.6.06300

When sending a notification to AA due to block processing control flags requesting a status report, BPA shall include the bundle source EID and creation timestamp in each notification.

Rationale: Required to generate BSR defined in RFC 9171 section 6.1.1.

Parent: DTN.5.00230, DTN.5.00360

External Parent: RFC 9171 Section 6.1.1, PICS Section A5.5 Item 48

Verification Method: Test

DTN.6.06310

When sending a notification to AA due to block processing control flags requesting a status report, if the bundle's bundle processing control flags request status time reporting, BPA shall include the time the event occurred in the notification.

Rationale: Required by RFC 9171 sections 4.2.3 and 6.1.1.

Parent: DTN.5.00230, DTN.5.00360

External Parent: RFC 9171 Section 4.2.3, RFC 9171 Section 6.1.1, PICS Section A5.5 Item 48

Verification Method: Test

DTN.6.06320

When sending a notification to AA due to block processing control flags requesting a status report, if the bundle is a fragment, BPA shall include the fragment offset and original ADU length in the notification.

Rationale: Required by RFC 9171 sections 4.2.3 and 6.1.1.

Parent: DTN.5.00230, DTN.5.00360

External Parent: RFC 9171 Section 4.2.3, RFC 9171 Section 6.1.1, PICS Section A5.5 Item 48

Verification Method: Test

DTN.6.06290

If the bundle contains a block type that cannot be processed, and if the block processing control flags request a status report if block can't be processed, BPA shall notify AA of bundle received with reason code "Block unsupported".

Rationale: Required by RFC 9171 section 4.2.4. If more than one block in a bundle cannot be processed, this should be done only once, not for each block. Also, if this notification is issued, no other notification of block received should be issued.

Parent: DTN.5.00230, DTN.5.00360

External Parent: RFC 9171 Section 4.2.4, RFC 9171 Section 5.6, PICS Section A5.5 Item 29, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.08324

BPA shall notify AA of bundle accepted including the reason code when it accepts custody of a bundle in which the bundle processing control flags request reporting of custody accepted.

Rationale: The configuration allows network management to prevent or allow generation of each particular BSR for all flows and for any given source. Existence of variable is suggested by RFC 9171 section 5.1, and they are present in the MIB.

Parent: DTN.5.00382

External Parent: RFC 9171 Section 9.3

Verification Method: Test

DTN.6.04450

BPA shall notify AA of bundle deleted when it deletes a bundle in which the bundle processing control flags request reporting of bundle deletion.

Rationale: The configuration allows network management to prevent or allow generation of each particular BSR for all flows and for any given source. Existence of variable is suggested by RFC 9171 section 5.1, and they are present in the MIB.

Parent: DTN.5.00240, DTN.5.00310, DTN.5.00810

External Parent: RFC 9171 Section 5.1, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.02430

BPA shall notify AA of bundle received including the reason code when it creates a bundle in which the bundle processing control flags request reporting of bundle receipt.

Rationale: This allows BSR generation for all incoming bundles whether it ingressed locally or externally. The configuration allows network management to prevent or allow generation of each particular BSR for all flows and for any given source. Existence of variable is suggested by RFC 9171 section 5.1, and they are present in the MIB. Local node bundle creation is considered a bundle reception as though the bundle had ingressed via an external interface. Notice is required by RFC 9171 section 4.2.4 for receipt of unsupported blocks that cannot be processed. If more than one block in a bundle cannot be processed, this should be done only once, not for each block. Also, if this notification is issued, no other notification of block received should be issued.

Parent: DTN.5.00360

External Parent: RFC 9171 Section 5.1, PICS Section A5.5 Item 32

Verification Method: Test

DTN.6.07070

Upon notification from the CLA that a bundle has been transmitted, BPA shall notify AA of bundle forwarded if the bundle's bundle processing control flags request reporting of bundle forwarding.

Rationale: The configuration allows network management to prevent or allow generation of each particular BSR for all flows and for any given source. Existence of variable is suggested by RFC 9171 section 5.1, and they are present in the MIB.

Parent: DTN.5.00693

External Parent: RFC 9171 Section 5.1, PICS Section A5.5 Item 32

Verification Method: Test

3.3.10 CRS Generate and Store

This section contains recommendations on BPA CRS generation and storage.

DTN.6.04482

BPA shall notify AA of bundle deleted with compressed reporting requested and the reason code if the bundle contains a CREB in which the Status Report Request Flags request reporting of bundle deleted.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00810

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.05342

BPA shall notify AA of a bundle delivered with compressed reporting requested if the bundle contains a CREB in which the Status Report Request Flags request reporting of bundle delivered.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00810

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.1

Verification Method: Test

DTN.6.02470

BPA shall notify AA of bundle received with compressed reporting requested upon validating the bundle contains a CREB in which the Status Report Request Flags request reporting of bundle received.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00360

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.1

Verification Method: Test

DTN.6.08572

Upon accepting custody of a bundle, BPA shall notify AA of bundle accepted with compressed reporting requested if the bundle contains a CREB in which the Status Report Request Flags request reporting of bundle accepted.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00693

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.1

Verification Method: Test

DTN.6.07110

Upon notification from the CLA that a bundle has been transmitted, BPA shall notify AA of bundle forwarded with compressed reporting requested if the bundle contains a CREB in which the Status Report Request Flags request reporting of bundle forwarded.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00693

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.1

Verification Method: Test

DTN.6.08573

When sending a notification to AA due to compressed reporting requested, BPA shall include the CREB's Block Source Administrative EID, Bundle Sequence ID, Bundle Sequence Number, Report-To EID, and the reason code.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00693

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08574

When sending a notification to AA due to compressed reporting requested, if the CREB data contains fewer than 4 elements, BPA shall provide the bundle's source node ID as the Block Source Administrative EID and the Destination Node ID as the Bundle Sequence ID in the notification.

Rationale: Recommended by the draft CCSDS Compressed Bundle Status Reporting and Custody Signaling orange book, revision 5.

Parent: DTN.5.00693

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.1

Verification Method: Test

DTN.6.08401

BPA shall construct each Bundle Sequence Range such that following the first element are zero or more pairs giving the length of the subsequent sub-sequence included from the Bundle Sequence and the length of the subsequent sub-sequence excluded in the Bundle Sequence.

Rationale: This scheme provides good compression of aggregated custody information across many bundles from a given custodian for a given Bundle Sequence ID. A set of excluded bundles is included only if followed by a set of included bundles. Custody is not accepted for bundles omitted from the compressed custody signal.

Parent: DTN.5.00542

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 3.3.2

Verification Method: Test

3.3.11 Contact Handling

This section contains recommendations on BPA contact handling.

DTN.6.04322

Upon receiving a contact-setup directive, BPA shall create an "output queue" for bundles for which the destination EID matches a set of EIDs indicated by the given contact configuration.

Rationale: This query interface is used to select bundles for a local destination or for forwarding to another node.

Parent: DTN.5.00660

External Parent: RFC 9171 Section 5.2, PICS Section A5.5 Item 33

Verification Method: Test, Inspection

DTN.6.08420

Upon receiving a contact-setup directive, BPA shall set the Compressed Custody Signal time trigger for each indicated custodian to the given value indicated by the contact configuration.

Rationale: Custody Signal administrative records must be sent on a minimum cadence to prevent unnecessary bundle retransmissions. The time trigger depends on the propagation time to the custodian among other factors, and so must be configured per-custodian per-contact basis.

Parent: DTN.5.00400

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08430

Upon receiving a contact-setup directive, BPA shall set the Compressed Custody Signal size trigger for each indicated custodian to the given value indicated by the contact configuration.

Rationale: The size of Custody Signal may be limited by the underlying network. The size trigger can depend on the underlying network connecting the node to the custodian among other factors, and so must be configured on a per-custodian per-contact basis.

Parent: DTN.5.00400

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08435

Upon receiving a contact-setup directive, BPA shall configure the bundle custody transfer timeout to the given value indicated by the contact configuration and associate it with the given contact.

Rationale: The re-forwarding timeout depends on the propagation time to the next custodian. Implementation will have to manage this across multiple active outgoing contacts. In theory the timeout can vary by flow for each contact, but that seems excessively complex.

Parent: DTN.5.00690

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4.3

Verification Method: Test

DTN.6.08436

Upon receiving a contact-setup directive, BPA shall configure the bundle custody transfer timeout for non-custodial bundles to the given value indicated by the contact configuration and associate it with the given contact.

Rationale: The re-forwarding timeout needs to be set for bundles that don't require custody transfer. Implementation will have to manage this across multiple active outgoing contacts. In theory the timeout can vary by flow for each contact, but that seems excessively complex.

Parent: DTN.5.00690

External Parent: N/A

Verification Method: Test

DTN.6.04321

Upon receiving a contact-setup directive, if the given set of destination EIDs for an "output queue" contains duplicate destination EIDs, BPA shall issue a warning event.

Rationale: Warn user that there might be a typo in the set of EIDs.

Parent: DTN.5.00660

External Parent: N/A

Verification Method: Test

DTN.6.04371

Upon receiving a contact-teardown directive, BPA shall discard the given output queue associated with the given contact.

Rationale: This would be done at the end of a contact or when removing an application.

Parent: DTN.5.00660

External Parent: N/A

Verification Method: Test, Inspection

3.3.12 Directive Execution

This section contains recommendations on BPA directive execution.

DTN.6.12060

For directives executed directly by BPA, if any parameter accompanying a given directive is not within that parameter's prescribed range, BPA shall reject the directive.

Rationale: For robust and secure operations, AA must not accept flawed directives.

Parent: DTN.5.00880

External Parent: RFC 9171 Section 8

Verification Method: Test

DTN.6.04040

Upon AA request, BPA shall set the maximum allowable lifetime for stored bundles, paramSetMaxLifetime.

Rationale: Allowed by RFC 9171 sections 4.3.1 and 5.5 and required to prevent network performance degradation due to long bundle lifetimes.

Parent: DTN.5.00800

External Parent: RFC 9171 Section 4.3.1, RFC 9171 Section 5.5, PICS Section A5.5 Item 37

Verification Method: Test

DTN.6.04050

Upon AA request, BPA shall set the maximum allowable lifetime for stored bundles, paramSetMaxLifetime[source] for a given source.

Rationale: Allowed by RFC 9171 sections 4.3.1 and 5.5 and required to prevent network performance degradation due to long bundle lifetimes.

Parent: DTN.5.00800

External Parent: RFC 9171 Section 4.3.1, RFC 9171 Section 5.5, PICS Section A5.5 Item 37

Verification Method: Test

3.3.13 Policy

This section contains recommendations on BPA policy implementation.

DTN.6.05190

Upon receiving a set-MIB-item directive, BPA shall reject the directive and issue an error event if the requested maximum payload size is greater than paramSetMaxPayloadLength.

Rationale: Protects the node against misconfiguration.

Parent: DTN.5.00655

External Parent: RFC 9171 Section 5.8, PICS Section A5.5 Item 41

Verification Method: Test

DTN.6.12062

BPA shall accept fully qualified Endpoint IDs (EIDs) or EIDs containing wildcard characters as string-format Uniform Resource identifiers (URIs).

Rationale: The DTN Node needs to accept EIDs using both IPN and DTN schemes; the latter at least for the null endpoint "dtn:none". Single EID components such as the node number or a service number may be specified as an unsigned integer.

Parent: DTN.5.00180, DTN.5.00190

External Parent: RFC 9171 Section 4.2.5.1.1, CCSDS BPv7 Section 3.2.1, CCSDS BPv7 Section 3.2.2, PICS Section A5.5 Item 9, PICS Section A5.5 Item 10

Verification Method: Test

DTN.6.22000

Upon receiving an add-authorized-sources directive, BPA shall add the given EID pattern to its set of authorized source EIDs.

Rationale: This is part of adding a node to the network.

Parent: DTN.5.00930

External Parent: RFC 9171 Section 8

Verification Method: Test

DTN.6.22010

Upon receiving a remove-authorized-sources directive, BPA shall remove the given EID pattern from its set of authorized source EIDs.

Rationale: This is part of removing a node from the network. If it's not in the list, we will ignore that.

Parent: DTN.5.00930

External Parent: RFC 9171 Section 8

Verification Method: Test

DTN.6.22100

BPA shall initialize its set of authorized custody sources to all EIDs.

Rationale: Bundle Interface already maintains a set of source EIDs from which it will accept bundles. This only narrows that list when configured.

Parent: DTN.5.00390

External Parent: N/A

Verification Method: Test

DTN.6.22020

Upon receiving an add-authorized-custody-sources directive, BPA shall add the given EID pattern to its set of authorized custody source EIDs.

Rationale: Flows for which the node accepts custody of bundles is set by network management.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Test

DTN.6.22030

Upon receiving a remove-authorized-custody-sources directive, BPA shall remove the given EID pattern from its set of authorized custody source EIDs.

Rationale: Flows for which the node accepts custody of bundles is set by network management.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Test

DTN.6.22090

BPA shall initialize its map of authorized custodian EIDs to the empty map.

Rationale: This must be configured so we can open the necessary channels.

Parent: DTN.5.00390

External Parent: N/A

Verification Method: Test

DTN.6.22040

Upon receiving an add-authorized-custodians directive, BPA shall add the given EID pattern to its set of authorized custodian EIDs.

Rationale: Nodes to which the node acknowledges custody acceptance is set by network management.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Test

DTN.6.22050

Upon receiving a remove-authorized-custodians request from AA, BPA shall remove the given EID pattern from its set of authorized custodian EIDs.

Rationale: Nodes to which the node acknowledges custody acceptance is set by network management.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Test

DTN.6.22061

Upon receiving an add-authorized-report-to-eid request from AA, BPA shall add the given EID pattern to its set of authorized report-to EIDs.

Rationale: Nodes to which the node reports to is set by network management.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Test

DTN.6.22080

BPA shall reject an add-authorized-sources request if adding the given pattern would exceed the configured maximum size of the authorized source EID set.

Rationale: Protects against over running a limited resource.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Test

DTN.6.22071

Upon receiving a remove-authorized-report-to-eid directive, BPA shall remove the given EID pattern from its set of authorized report-to EIDs.

Rationale: Nodes to which the node reports to is set by network management.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Test

DTN.6.22075

Upon receiving an add-latency request from AA, BPA shall add the given source EID pattern and latency value to its set of authorized latency information.

Rationale: Latency needs to be set per source by network management.

Parent: DTN.5.00930

External Parent: RFC 9171 Section 8

Verification Method: Test

DTN.6.22076

Upon receiving a remove-latency directive, BPA shall remove the given source EID pattern and latency value from its set of authorized latency information.

Rationale: Latency needs to be set per source by network management.

Parent: DTN.5.00930

External Parent: RFC 9171 Section 8

Verification Method: Test

DTN.6.08820

Upon request from AA, BPA shall validate custody configuration updates.

Rationale: Validate incoming configuration updates prior to accepting the new values.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Test

DTN.6.22110

Upon request, BPA shall validate policy configuration updates.

Rationale: Validate incoming configuration updates prior to accepting the new values.

Parent: DTN.5.00930

External Parent: N/A

Verification Method: Test

3.3.14 Telemetry Reporting

This section contains recommendations on BPA telemetry reporting.

DTN.6.03161

BPA shall send telemetry per the Monitor and Control ICD.

Rationale: Send telemetry upon request

Parent: DTN.5.00940, DTN.5.00950

External Parent: N/A

Verification Method: Test

3.3.15 Counters

This section contains recommendations on BPA counters.

DTN.6.02414

If an error is encountered during bundle creation, BPA shall increment bundleCountGeneratedRejected.

Rationale: Tracks overall bundle creation requests which fail.

Parent: DTN.5.00150
External Parent: N/A
Verification Method: Test

DTN.6.08494

If it encounters an error during bundle creation, BPA shall increment bundleCountGeneratedRejected[source] for the source EID associated with the channel.

Rationale: Tracks overall bundle creation requests which fail.

Parent: DTN.5.00150
External Parent: N/A
Verification Method: Test

DTN.6.02415

If an error is encountered during bundle creation, BPA shall increment bundleCountGeneratedRejected[source] for the source EID associated with the channel.

Rationale: Tracks overall bundle creation requests which fail.

Parent: DTN.5.00150
External Parent: N/A
Verification Method: Test

DTN.6.03130

BPA shall update the count of Abandoned Bundles (bundleCountAbandoned) when a bundle is abandoned.

Rationale: Network management needs to account for data not delivered.

Parent: DTN.5.00784
External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28
Verification Method: Test

DTN.6.02402

After successfully constructing a bundle, BPA shall increment aduCountReceived.

Rationale: Allows network management insight into payloads entering the source node.

Parent: DTN.5.00010, DTN.5.00012
External Parent: N/A
Verification Method: Test

DTN.6.02403

After successfully constructing a bundle, BPA shall increment aduCountReceived[source] for the bundle's source EID.

Rationale: Allows network management insight into payloads entering the source node.

Parent: DTN.5.00010, DTN.5.00012
External Parent: N/A
Verification Method: Test

DTN.6.03060

BPA shall increment the count of delivered bundles, bundleCountDelivered, upon replying to a request to deliver a payload.

Rationale: Network management needs to account for data delivered.

Parent: DTN.5.00770

External Parent: N/A

Verification Method: Test

DTN.6.03070

BPA shall increment the count of delivered bundles from a source, bundleCountDelivered[source], upon replying to a request to deliver a payload.

Rationale: Network management needs to account for data delivered.

Parent: DTN.5.00770

External Parent: N/A

Verification Method: Test

DTN.6.03140

BPA shall update the count of abandoned Bundles from a source (bundleCountAbandoned[source]) when a bundle is abandoned.

Rationale: Network management needs to account for data not delivered on a flow-by-flow basis.

Parent: DTN.5.00784

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04110

BPA shall increment the bundleCountDeletedExpired counter when a Bundle is deleted from storage because the lifetime given by its primary block was exceeded.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00192, DTN.5.00197

External Parent: RFC 9171 Section 5.5, CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04120

BPA shall increment the bundleCountDeletedExpired[source] counter when a Bundle is deleted from storage because the lifetime given by its primary block was exceeded.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00192, DTN.5.00197

External Parent: RFC 9171 Section 5.5, CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04130

BPA shall increment the bundleCountDeletedTrafficPared counter when a Bundle is deleted from storage because the node's maximum allowable lifetime was exceeded.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00192

External Parent: RFC 9171 Section 5.5, CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04140

BPA shall increment the bundleCountDeletedTrafficPared[source] counter when a Bundle is deleted from storage because the node's maximum allowable lifetime was exceeded.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00192

External Parent: RFC 9171 Section 5.5, CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04160

BPA shall increment the bundleCountDiscarded counter when a bundle is discarded from Bundle Storage.

Rationale: MIB counter is optional but useful for completeness

Parent: DTN.5.00192

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04170

BPA shall increment the bundleCountDiscarded[source] counter when a bundle is discarded from Bundle Storage.

Rationale: MIB counter is optional but useful for completeness

Parent: DTN.5.00192

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04180

BPA shall increment the bundleCountDeleted counter when a bundle is deleted from Bundle Storage.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00192

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04190

BPA shall increment the bundleCountDeleted[source] counter when a bundle is deleted from Bundle Storage.

Rationale: Accounting may be performed for data payloads provided by some sources to ensure mutual service level adherence.

Parent: DTN.5.00192

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04200

BPA shall decrement the bundleCountStored counter when a bundle is discarded from Bundle Storage.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00120

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04210

BPA shall decrement the bundleCountStored[source] counter when a bundle is discarded from Bundle Storage.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00120

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04220

BPA shall increase the kbyteCountStorageAvailable counter by the amount of storage consumed by the bundle when a bundle is discarded.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00120

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04230

BPA shall increase the kbyteCountStorageAvailable[source] counter by the amount of storage consumed by the bundle when a bundle is discarded.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00120

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04312

When a bundle is not stored upon request due to insufficient space or no allocation, BPA shall increment bundleCountDeletedNoStorage.

Rationale: Required MIB counter.

Parent: DTN.5.00050, DTN.5.00192

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04313

When a bundle is not stored upon request due to insufficient space or no allocation, BPA shall increment bundleCountDeletedNoStorage[source] for the source EID of the bundle.

Rationale: Required MIB counter.

Parent: DTN.5.00050, DTN.5.00192

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04314

When a bundle is not stored upon request, BPA shall increment bundleCountDiscarded.

Rationale: Bundle was never stored, so it has been discarded.

Parent: DTN.5.00050, DTN.5.00192

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04315

When a bundle is not stored upon request, BPA shall increment bundleCountDiscarded[source] for the source EID of the bundle.

Rationale: Bundle was never stored, so it has been discarded.

Parent: DTN.5.00050, DTN.5.00192

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04316

After storing a bundle, BPA shall increment bundleCountStored.

Rationale: Keeps a count of bundles stored by the node.

Parent: DTN.5.00120

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04317

After storing a bundle, BPA shall increment bundleCountStored[source] for the source EID of the bundle.

Rationale: Keeps a count of bundles stored by the node.

Parent: DTN.5.00120

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04318

When a bundle is not stored upon request, BPA shall increment bundleCountDeleted.

Rationale: Required MIB counter.

Parent: DTN.5.00050, DTN.5.00192

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.04319

When a bundle is not stored upon request, BPA shall increment bundleCountDeleted[source] for the source EID of the bundle.

Rationale: Required MIB counter.

Parent: DTN.5.00050, DTN.5.00192

External Parent: CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.05232

If the ADU is greater than the maximum ADU size, BPA shall increment bundleCountGeneratedRejected.

Rationale: This protects the node and network from excessively large ADUs. It is assumed that this maximum is a hard-coded value documented in the node user's guide.

Parent: DTN.5.00030, DTN.5.00150

External Parent: N/A

Verification Method: Test

DTN.6.05234

If the ADU is greater than the maximum ADU size, BPA shall increment bundleCountGeneratedRejected[source] for the source EID associated with the channel.

Rationale: This protects the node and network from excessively large ADUs. It is assumed that this maximum is a hard-coded value documented in the node user's guide.

Parent: DTN.5.00030, DTN.5.00150

External Parent: N/A

Verification Method: Test

DTN.6.05270

BPA shall increment the bundleCountFragmented counter when a Bundle is fragmented.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00600

External Parent: CCSDS BPv7 Annex C3.2, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.05280

BPA shall increment the bundleCountFragmented[source] counter when a Bundle is fragmented for the source associated with the channel.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00600

External Parent: CCSDS BPv7 Annex C3.2, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.05290

BPA shall increment the bundleCountGeneratedFragment counter for each Fragment when a Bundle is fragmented.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00600

External Parent: CCSDS BPv7 Annex C3.2, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.05300

BPA shall increment the bundleCountGeneratedFragment[source] counter for each Fragment when a Bundle is fragmented for the source associated with the channel.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00600

External Parent: CCSDS BPv7 Annex C3.2, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.06105

BPA shall increment bundleCountDeletedUnintelligible if the fourth, fifth, and sixth fields in the primary block -- source, destination and report-to EIDs -- are not 2-item arrays, or if the first array item does not contain a valid EID URI scheme ID (unsigned integer 1 or 2), or if the second item does not contain a properly formatted EID for the given scheme.

Rationale: Bundles cannot be delivered with a valid destination. While anonymous sources are permitted by RFC 8171, we have chosen to disallow them. See RFC 9171 section 4.3.1 "Primary Bundle Block". Anonymous EIDs are not permitted. MIB counter will be incremented in this case.

Parent: DTN.5.00192

External Parent: RFC 9171 Section 4.3.1, RFC 9171 Section 5.6, PICS Section A5.5 Item 9, PICS Section A5.5 Item 30, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.06170

For any bundles discarded due to an invalid primary block, BPA shall increment the bundleCountDeletedUnintelligible counter.

Rationale: Receipt of Bundles with invalid Primary Blocks is notable.

Parent: DTN.5.00192

External Parent: N/A

Verification Method: Test

DTN.6.06171

For any bundles discarded due to an invalid primary block, BPA shall increment the bundleCountDeletedUnintelligible[source] counter.

Rationale: Receipt of Bundles with invalid Primary Blocks is notable.

Parent: DTN.5.00192

External Parent: N/A

Verification Method: Test

DTN.6.06174

BPA shall increment the bundleCountDeletedExpired counter when a Bundle is discarded on ingress because the lifetime given by its primary block was exceeded.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00192

External Parent: CCSDS BPv7 Annex C4.2, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.06175

BPA shall increment the bundleCountDeletedExpired[source] counter when a Bundle is discarded on ingress because the lifetime given by its primary block was exceeded.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00192

External Parent: CCSDS BPv7 Annex C4.2, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.06176

BPA shall increment the bundleCountDeletedTrafficPared counter when a Bundle is discarded on ingress because the node's maximum allowable lifetime was exceeded.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00192

External Parent: N/A

Verification Method: Test

DTN.6.06177

BPA shall increment the bundleCountDeletedTrafficPared[source] counter when a Bundle is discarded on ingress because the node's maximum allowable lifetime was exceeded.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00192

External Parent: N/A

Verification Method: Test

DTN.6.06282

Upon removing a block from a bundle, BPA shall increment bundleCountUnprocessedBlocks.

Rationale: Required MIB counter.

Parent: DTN.5.00250, DTN.5.00370

External Parent: N/A

Verification Method: Test

DTN.6.06283

Upon removing a block from a bundle, BPA shall increment bundleCountUnprocessedBlocks[source] for the bundle's source EID.

Rationale: Required MIB counter.

Parent: DTN.5.00250, DTN.5.00370

External Parent: N/A

Verification Method: Test

DTN.6.06330

BPA shall increment the bundleCountDeletedUnsupportedBlock counter when discarding a bundle due to it containing an unsupported Extension Block.

Rationale: Data accounting must keep track of the number of Bundles that are dropped for any reason.

Parent: DTN.5.00192

External Parent: N/A

Verification Method: Test

DTN.6.06340

BPA shall increment the bundleCountDeletedUnsupportedBlock[source] counter when discarding a bundle due to it containing an unsupported Extension Block.

Rationale: Data accounting must keep track of the number of Bundles that are dropped for any reason.

Parent: DTN.5.00192

External Parent: N/A

Verification Method: Test

DTN.6.06352

BPA shall increment the bundleCountDeletedTooLong counter when discarding a bundle for being larger than paramSetMaxBundleLength.

Rationale: We want to have a complete accounting of bundles deleted for any reason.

Parent: DTN.5.00192

External Parent: N/A

Verification Method: Test

DTN.6.06353

BPA shall increment the bundleCountDeletedTooLong[source] counter when discarding a bundle for being larger than paramSetMaxBundleLength.

Rationale: Keeping a count by source allows network management to figure out what source is sending bundles that are too long.

Parent: DTN.5.00192

External Parent: N/A

Verification Method: Test

DTN.6.06360

For any bundles discarded due to an invalid payload block, BPA shall increment the bundleCountDeletedUnintelligible counter.

Rationale: Data accounting must keep track of the number of Bundles that are dropped for any reason.

Parent: DTN.5.00192

External Parent: N/A

Verification Method: Test

DTN.6.06370

For any bundles discarded due to an invalid payload block, BPA shall increment the bundleCountDeletedUnintelligible[source] counter.

Rationale: Data accounting must keep track of the number of Bundles that are dropped for any reason.

Parent: DTN.5.00192

External Parent: N/A

Verification Method: Test

DTN.6.06410

BPA shall increment the bundleCountDeletedHopExceeded counter when discarding a bundle due to it exceeding the maximum hop count.

Rationale: This is a mandatory MIB counter.

Parent: DTN.5.00192

External Parent: RFC 9171 Annex C4.2, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.06420

BPA shall increment the bundleCountDeletedHopExceeded[source] counter when discarding a bundle due to it exceeding the maximum hop count.

Rationale: This is a mandatory MIB counter.

Parent: DTN.5.00192

External Parent: RFC 9171 Annex C4.2, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.06440

BPA shall update the bundleCountDeletedUnintelligible counter when discarding a bundle with reason code "Block Unintelligible".

Rationale: Data accounting must keep track of the number of Bundles that are dropped for any reason.

Parent: DTN.5.00192

External Parent: RFC 9171 Annex C4.2, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.06450

BPA shall update the bundleCountDeletedUnintelligible[source] counter when discarding a bundle with reason code "Block Unintelligible".

Rationale: Data accounting must keep track of the number of Bundles that are dropped for any reason.

Parent: DTN.5.00192

External Parent: CCSDS BPv7 Annex C4.2, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.06490

When it discards a bundle because it is from an unauthorized source, BPA shall increment bundleCountDeletedUnauthorized.

Rationale: The node must account for all bundles.

Parent: DTN.5.00185, DTN.5.01170

External Parent: N/A

Verification Method: Test

DTN.6.06552

For each bundle not discarded, BPA shall increment bundleCountReceived.

Rationale: Required MIB counter.

Parent: DTN.5.00370

External Parent: CCSDS BPv7 Annex C3.2, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.06553

For each bundle not discarded, BPA shall increment bundleCountReceived[source] for the bundle's source EID.

Rationale: Required MIB counter.

Parent: DTN.5.00370

External Parent: CCSDS BPv7 Annex C3.2, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.06554

For each bundle not discarded that contains an ADU fragment, BPA shall increment bundleCountReceivedFragment.

Rationale: Required MIB counter.

Parent: DTN.5.00600

External Parent: CCSDS BPv7 Annex C3.2, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.06555

For each bundle not discarded that contains an ADU fragment, BPA shall increment bundleCountReceivedFragment[source] for the bundle's source EID.

Rationale: Required MIB counter.

Parent: DTN.5.00600

External Parent: CCSDS BPv7 Annex C3.2, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.07050

Upon notification from the CLA that a bundle has been transmitted, BPA shall increment bundleCountForwarded.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00700

External Parent: N/A

Verification Method: Test

DTN.6.07052

Upon notification from the CLA that a bundle has failed to be transmitted, BPA shall increment bundleCountForwardedFailed.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00700

External Parent: RFC 9171 Section 7.2, CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.07060

Upon notification from the CLA that a bundle has been transmitted, BPA shall increment bundleCountForwarded[source].

Rationale: Accounting may be performed for data payloads provided by some sources to ensure mutual service level adherence.

Parent: DTN.5.00700

External Parent: N/A

Verification Method: Test

DTN.6.07062

Upon notification from the CLA that a bundle has failed to be transmitted, BPA shall increment bundleCountForwardedFailed[source].

Rationale: Accounting may be performed for data payloads provided by some sources to ensure mutual service level adherence.

Parent: DTN.5.00700

External Parent: RFC 9171 Section 7.2, CCSDS BPv7 Annex C, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.08260

If a received bundle requests custody transfer, BPA shall increment bundleCountCustodyRequest.

Rationale: Accounting needed by network management.

Parent: DTN.5.00382

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08270

If a received bundle requests custody transfer, BPA shall increment bundleCountCustodyRequest[source].

Rationale: Accounting needed by network management.

Parent: DTN.5.00382

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08282

Upon signaling custody accepted for a bundle already in custody, BPA shall increment bundleCountRedundant.

Rationale: Provides insight for network management.

Parent: DTN.5.00382

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08283

Upon signaling custody accepted for a bundle already in custody, BPA shall increment bundleCountRedundant[source] for the source EID of the accepted bundle.

Rationale: Provides insight for network management.

Parent: DTN.5.00382

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08322

Upon signaling custody accepted, BPA shall increment bundleCountNoFurtherInfo.

Rationale: Provides insight for network management.

Parent: DTN.5.00382

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08323

Upon signaling custody accepted, BPA shall increment bundleCountNoFurtherInfo[source] for the source EID of the accepted bundle.

Rationale: Provides insight for network management.

Parent: DTN.5.00382

External Parent: CCSDS BPv7 Annex E, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08332

After an unsuccessful request to store a custodial foreign bundle due to depleted storage and if the custodian EID is in the map of authorized custodians, BPA shall increment bundleCountDepleted.

Rationale: Provides insight for network management.

Parent: DTN.5.00382

External Parent: CCSDS BPv7 Annex C, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08333

After an unsuccessful request to store a custodial foreign bundle due to depleted storage and if the custodian EID is in the map of authorized custodians, BPA shall increment bundleCountDepleted[source] for the source EID of the rejected bundle.

Rationale: Provides insight for network management.

Parent: DTN.5.00382

External Parent: CCSDS BPv7 Annex C, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08334

Upon signaling custody, BPA shall increment bundleCountGeneratedCustodySignal.

Rationale: Provides insight for network management.

Parent: DTN.5.00382

External Parent: CCSDS BPv7 Annex C, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08335

Upon signaling custody, BPA shall increment bundleCountGeneratedCustodySignal[source] for the source EID of the signaled bundle.

Rationale: Provides insight for network management.

Parent: DTN.5.00382

External Parent: N/A

Verification Method: Test

DTN.6.08336

Upon signaling custody rejected, BPA shall increment bundleCountRejectedCustody.

Rationale: Provides insight for network management.

Parent: DTN.5.00382

External Parent: N/A

Verification Method: Test

DTN.6.08337

Upon signaling custody rejected, BPA shall increment bundleCountRejectedCustody[source] for the source EID of the signaled bundle.

Rationale: Provides insight for network management.

Parent: DTN.5.00382

External Parent: N/A

Verification Method: Test

DTN.6.08350

Upon adding a bundle to the set of bundles in custody, BPA shall increment the bundleCountInCustody counter.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00390

External Parent: N/A

Verification Method: Test

DTN.6.08360

Upon adding a bundle to the set of bundles in custody, BPA shall increment the bundleCountInCustody[source] counter for the source EID that originated the bundles.

Rationale: Accounting may be performed for data payloads provided by some sources to ensure mutual service level adherence.

Parent: DTN.5.00382

External Parent: N/A

Verification Method: Test

DTN.6.08480

Upon notification from AA that a Compressed Custody Signal bundle was generated, BPA shall increment bundleCountGeneratedCCS.

Rationale: provides insight for network management as to how many custody signal bundles were generated.

Parent: DTN.5.00382

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08491

BPA shall increment bundleCountGeneratedAccepted if no errors occur during bundle creation.

Rationale: Tracks overall bundle creation requests which succeed.

Parent: DTN.5.00150

External Parent: N/A

Verification Method: Test

DTN.6.08492

BPA shall increment bundleCountGeneratedAccepted[source] for the source EID associated with the channel if no errors occur during bundle creation.

Rationale: Tracks overall bundle creation requests which succeed.

Parent: DTN.5.00150

External Parent: N/A

Verification Method: Test

DTN.6.08493

If it encounters an error during bundle creation, BPA shall increment bundleCountGeneratedRejected.

Rationale: Tracks overall bundle creation requests which fail.

Parent: DTN.5.00150

External Parent: N/A

Verification Method: Test

DTN.6.08585

Upon processing a Compressed Custody Signal, BPA shall increment bundleCountCCSReceived.

Rationale: Required MIB counter.

Parent: DTN.5.00382

External Parent: N/A

Verification Method: Test

DTN.6.08590

Upon processing a Compressed Custody Signal, BPA shall increment bundleCountReceivedCustodySignal for each bundle signaled in the BSC.

Rationale: Keeping various Bundle counts is needed for network data accounting.

Parent: DTN.5.00382

External Parent: N/A

Verification Method: Test

DTN.6.08592

Upon processing a Compressed Custody Signal, BPA shall increment bundleCountReceivedCustodySignal[source] for the source EID of each bundle signaled in the BSC.

Rationale: Keeping various Bundle counts is needed for network data accounting.

The source EID is not in the report itself, so the BPA must find the bundle associated with the Bundle Sequence Number and get the source EID from there.

Parent: DTN.5.00382

External Parent: N/A

Verification Method: Test

DTN.6.08610

If the BSC reason code field indicates custody accepted (custody transfer succeeded), then for each bundle indicated in the BSC, BPA shall increment bundleCountCustodyTransferred.

Rationale: Provides insight for network management.

Parent: DTN.5.00382

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08620

If the BSC reason code field indicates custody accepted (custody transfer succeeded), then for each bundle indicated in the BSC, BPA shall increment bundleCountCustodyTransferred[source] for the source EID of the bundle for which custody was transferred.

Rationale: Provides insight for network management.

Parent: DTN.5.00382

External Parent: CCSDS BPv7 Annex C, CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08650

Upon removing a bundle from the set of bundles in custody, then for each bundle indicated in the BSC, BPA shall decrement bundleCountInCustody.

Rationale: Provides insight for network management.

Parent: DTN.5.00390

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 3.2

Verification Method: Test

DTN.6.08660

Upon removing a bundle from the set of bundles in custody, then for each bundle indicated in the BSC, BPA shall decrement bundleCountInCustody[source] for the source EID of the bundle for which custody was transferred.

Rationale: Provides insight for network management.

Parent: DTN.5.00390

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 3.2

Verification Method: Test

DTN.6.08680

If the BSC reason code field indicates custody rejected, then for each bundle indicated in the BSC, BPA shall increment bundleCountCustodyRejected.

Rationale: Keeping various Bundle counts is needed for network data accounting. Network Management functions need to be aware of unsuccessful Custody Transfer attempts.

Parent: DTN.5.00382

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08690

If the BSC reason code field indicates custody rejected, then for each bundle indicated in the BSC, BPA shall increment bundleCountCustodyRejected[source] for the source EID of the bundle for which custody transfer was attempted.

Rationale: Keeping various Bundle counts is needed for network data accounting. Network Management functions need to be aware of unsuccessful Custody Transfer attempts.

Parent: DTN.5.00382

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 5.2

Verification Method: Test

DTN.6.08740

When a custody timer expires and the bundle is added to the output queue, BPA shall increment bundleCountCustodyReForwarded.

Rationale: Provides insight for network management.

Parent: DTN.5.00700

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

DTN.6.08750

When a custody timer expires and the bundle is added to the output queue, BPA shall increment bundleCountCustodyReForwarded[source].

Rationale: Provides insight for network management.

Parent: DTN.5.00700

External Parent: CCSDS Compressed Custody Signaling and Bundle Status Reporting Section 4

Verification Method: Test

3.3.16 Node Shutdown

This section contains recommendations on BPA support of node shutdown.

DTN.6.04580

Upon receiving a node-shutdown directive, BPA shall write bundle metadata to persistent storage.

Rationale: This is to make sure that bundle metadata is not lost during node restart.

Parent: DTN.5.01065

External Parent: N/A

Verification Method: Test

DTN.6.04590

Upon receiving a node-shutdown directive, BPA shall write Best Effort bundle data to persistent storage, if storage is available and if the bundle's source EID has allocated storage.

Rationale: This is to make sure that Best Effort (cache-only) bundle data is not lost during node restart, if possible. If there is not space available or allocated to that source EID, the bundle will still be dropped.

Parent: DTN.5.01065

External Parent: N/A

Verification Method: Test

3.4 Convergence Layer Adapter (CLA)

This section contains recommendations on the CLA.

DTN.6.15161

CLA shall interface with LTPv1 Convergence Layer.

Rationale: Per LNIS, DTN Node must support LTP CL

Parent: DTN.5.00170, DTN.5.00692, DTN.5.00172

External Parent: LNIS Section 3.1.2, CCSDS BPv7 Section B2.1.4, PICS Section A5.5 Item 24

Verification Method: Test

DTN.6.15271

CLA shall interface with EPP Convergence Layer.

Rationale: Per LNIS, DTN Node must support EPP CL

Parent: DTN.5.00170, DTN.5.00692, DTN.5.00173

External Parent: LNIS Section 3.1.2, CCSDS BPv7 Section B2.1.6, PICS Section A5.5 Item 27

Verification Method: Test

DTN.6.15281

CLA shall interface with UDP Convergence Layer.

Rationale: Per LNIS, DTN Node must support UDP CL

Parent: DTN.5.00170, DTN.5.00692, DTN.5.00174

External Parent: LNIS Section 3.1.2, CCSDS BPv7 Section B2.1.3, PICS Section A5.5 Item 25

Verification Method: Test

DTN.6.15291

CLA shall interface with TCPCLP Convergence Layer.

Rationale: Per LNIS, DTN Node must support TCP CL

Parent: DTN.5.00170, DTN.5.00692, DTN.5.00175

External Parent: LNIS Section 3.1.2, CCSDS BPv7 Section B2.1.2, PICS Section A5.5 Item 23

Verification Method: Test

3.4.1 Bundle Ingest, Validate, and Store

This section contains recommendations on CLA bundle ingest, validation, and storage.

DTN.6.15155

CLA shall receive bundles from multiple incoming simultaneous contacts up to a configured maximum.

Rationale: The design needs to support situations where a node has multiple bundle input paths available simultaneously. The maximum is likely to be a compile-time limit.

Parent: DTN.5.00165, DTN.5.00170

External Parent: N/A

Verification Method: Test

DTN.6.15051

After receiving a data message from the convergence layer, CLA shall request BPA process the message as a candidate bundle.

Rationale: This is how bundles enter the BPA.

Parent: DTN.5.00170

External Parent: CCSDS BPv7 Section 5.3, RFC 9171 Section 5.6, RFC 9171 Section 7.2, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.15073

CLA shall apply rate limits to the candidate bundle prior to requesting BPA process the message.

Rationale: This is how bundles exit the underlying network.

Parent: DTN.5.00170, DTN.5.01070

External Parent: CCSDS BPv7 Section 5.3, RFC 9171 Section 5.6, RFC 9171 Section 7.2, PICS Section A5.5 Item 38

Verification Method: Test

DTN.6.15014

If the incoming bundles would exceed the rate limit, the CLA shall send a warning event.

Rationale: Notify operator / network management that incoming bundle rate is too high.

Parent: DTN.5.01070

External Parent: N/A

Verification Method: Test

DTN.6.15074

When applying an egress rate limit, CLA shall maintain the outgoing rate below the configured rate +10%.

Rationale: Need to keep the rate to within a constant range over time to avoid rate jumps at any given point.

Parent: DTN.5.00660

External Parent: N/A

Verification Method: Test

DTN.6.15121

Upon notification from the convergence layer that the convergence layer is not ready, CLA shall pause sending data to or receiving data from the convergence layer.

Rationale: If the underlying layer is not connected or is otherwise unready, the CLA cannot actively use it to exchange bundles across the underlying network.

Parent: DTN.5.00170, DTN.5.00692

External Parent: CCSDS BPv7 Section 5.3, RFC 9171 Section 7.2

Verification Method: Test

DTN.6.15131

Upon notification from the convergence layer that the convergence layer is ready, CLA shall resume sending data to or receiving data from the convergence layer.

Rationale: When the underlying layer connects or otherwise becomes ready, the CLA resumes using it to exchange bundles across the underlying network.

Parent: DTN.5.00170, DTN.5.00692

External Parent: CCSDS BPv7 Section 5.3, RFC 9171 Section 7.2

Verification Method: Test

DTN.6.15235

Upon notification from LTP that a bundle has been received, CLA shall receive the given bundle of the given length on the given session (ID) from the given LTP engine ID.

Rationale: This notification is part of the LTP specification. In implementation, it could be that the call to poll for bundle reception is satisfied by this notification. It is important that the session ID is conveyed to the CLA so it can free the resources associated with the session such as the recorded session ID.

Parent: DTN.5.00170

External Parent: CCSDS BPv7 Section B2.1.4, PICS Section A5.5 Item 24

Verification Method: Test

DTN.6.15311

CLA shall interpret notification from TCPCLP that session state changed to Established as notification that the convergence layer is ready.

Rationale: This allows the CLA to know when to start sending bundles, if that information is available.

Parent: DTN.5.00170, DTN.5.00692

External Parent: CCSDS BPv7 Section B2.1.2, PICS Section A5.5 Item 23

Verification Method: Test

DTN.6.15321

CLA shall interpret notification from TCPCLP that session state changed to Connecting, Contact Negotiating, or Session Negotiating as notification that the convergence layer is not ready.

Rationale: This allows the CLA to know when a CL is not in a state to receive bundles, if that information is available.

Parent: DTN.5.00170, DTN.5.00692

External Parent: CCSDS BPv7 Section B2.1.2, PICS Section A5.5 Item 23

Verification Method: Test

DTN.6.15351

Upon notification from TCPCLP that a bundle has been received, CLA shall receive the given bundle of the given length.

Rationale: This notification is part of the TCPCLP specification. In implementation, it could be that the call to poll for bundle reception is satisfied by this notification.

Parent: DTN.5.00170

External Parent: CCSDS BPv7 Section B2.1.2, PICS Section A5.5 Item 23

Verification Method: Test

3.4.2 Bundle Routing and Egress

This section contains recommendations on CLA bundle routing and egress.

DTN.6.15157

CLA shall send bundles to multiple outgoing simultaneous contacts up to a configured maximum.

Rationale: The design needs to support situations where a node has multiple bundle output paths available simultaneously. The maximum is likely to be a compile-time limit.

Parent: DTN.5.00165, DTN.5.00692

External Parent: N/A

Verification Method: Test

DTN.6.15071

After obtaining a bundle from the BPA, CLA shall apply rate limits, and request the convergence layer send the bundle.

Rationale: This is how bundles enter the underlying network.

Parent: DTN.5.00692, DTN.5.01070

External Parent: CCSDS BPv7 Section 5.3, RFC 9171 Section 7.2

Verification Method: Test

DTN.6.15081

Upon notification from the convergence layer that a given bundle has been transferred through the convergence layer, CLA shall notify BPA that the given bundle has been transmitted.

Rationale: This constitutes bundle forwarding. In cases of LTP and TCPCLP the CL has positive confirmation the bundle has arrived at the next hop, but in other cases the best the CL can say is that the bundle was sent without encountering an immediate error.

Parent: DTN.5.00692

External Parent: CCSDS BPv7 Section 5.3, RFC 9171 Section 7.2

Verification Method: Test

DTN.6.15101

Upon notification from the convergence layer that a given bundle has failed to be transferred through the convergence layer, CLA shall notify BPA that the given bundle failed to be transmitted.

Rationale: This allows the BPA to try resending the failed bundle.

Parent: DTN.5.00692

External Parent: CCSDS BPv7 Section 5.3, RFC 9171 Section 7.2

Verification Method: Test

DTN.6.15181

If the convergence layer is LTP, CLA shall include the configured destination LTP engine ID and service ID in the request to send the bundle.

Rationale: These are required parameters to the LTP send request.

Parent: DTN.5.00692

External Parent: CCSDS BPv7 Section B2.1.4, PICS Section A5.5 Item 24

Verification Method: Test

DTN.6.15191

After sending a bundle to the LTP convergence layer, CLA shall associate the bundle with the session ID given by a reply indicating success.

Rationale: This association will be needed to notify the BPA that bundle transmission has completed or failed based on the engine ID.

Parent: DTN.5.00692

External Parent: CCSDS BPv7 Section B2.1.4, PICS Section A5.5 Item 24

Verification Method: Test

DTN.6.15201

Upon notification from LTP that a transmit session has completed, CLA shall notify BPA that the bundle associated with the given session ID has been transmitted.

Rationale: This allows the BPA to delete resources associated with the bundle.

Parent: DTN.5.00692

External Parent: CCSDS BPv7 Section B2.1.4, PICS Section A5.5 Item 24

Verification Method: Test

DTN.6.15231

Upon notification from LTP that an initial transmission has completed for a given session, CLA shall record the session has completed initial transmission.

Rationale: This can be used later to notify BPA that the bundle has been transmitted or that transmission definitely has failed.

Parent: DTN.5.00692

External Parent: CCSDS BPv7 Section B2.1.4, PICS Section A5.5 Item 24

Verification Method: Test

DTN.6.15331

Upon notification from TCPCLP that a bundle has been transmitted, CLA shall notify BPA that the bundle has been transmitted.

Rationale: This notification means that the peer has received the bundle. This notification allows the BPA to delete resources associated with the bundle.

Parent: DTN.5.00692

External Parent: CCSDS BPv7 Section B2.1.2, PICS Section A5.5 Item 23

Verification Method: Test

DTN.6.15341

Upon notification from TCPCLP that a bundle transmission has failed, CLA shall notify BPA that the bundle has failed to be transmitted.

Rationale: This indicates definitively that transmission of the bundle has failed. Notifying the BPA allows it to attempt to retransmit the bundle immediately.

Parent: DTN.5.00692

External Parent: CCSDS BPv7 Section B2.1.2, PICS Section A5.5 Item 23

Verification Method: Test

3.4.3 Directive Execution

This section contains recommendations on CLA directive execution.

DTN.6.15001

Upon receiving a contact-setup request directive, CLA shall configure itself to use the given underlying convergence layer.

Rationale: This request creates a CLA. The underlying convergence layer is provided.

Parent: DTN.5.00170, DTN.5.00692

External Parent: CCSDS BPv7 Section 5.3, RFC 9171 Section 7.2

Verification Method: Test

DTN.6.15011

Upon receiving a contact-setup directive, the CLA shall configure itself to obtain bundles from the given BPA output queue to send through the convergence layer.

Rationale: This connects the CLA to the BPA for outgoing bundles for the upcoming contact.

Parent: DTN.5.00170, DTN.5.00692

External Parent: CCSDS BPv7 Section 5.3, RFC 9171 Section 7.2

Verification Method: Test

DTN.6.15012

Upon receiving a contact-setup directive, the CLA shall configure itself to limit the rate at which it sends bundles to the given value.

Rationale: This prevents the CLA from overrunning the capabilities of the underlying network and also helps prevent it from over-utilizing resources.

Parent: DTN.5.01070

External Parent: CCSDS BPv7 Section 5.3, RFC 9171 Section 7.2

Verification Method: Test

DTN.6.15013

Upon receiving a contact-setup directive, the CLA shall configure itself to limit the rate at which it receives bundles to the given value.

Rationale: This prevents the CL from overrunning the capabilities of the node and also helps prevent the node from over-utilizing resources.

Parent: DTN.5.01070

External Parent: CCSDS BPv7 Section 5.3, RFC 9171 Section 7.2

Verification Method: Test

DTN.6.15171

Upon contact-setup directive, CLA shall configure the destination LTP engine ID to the given value.

Rationale: This is a required parameter to the LTP send request.

Parent: DTN.5.00692

External Parent: CCSDS BPv7 Section B2.1.4, PICS Section A5.5 Item 24

Verification Method: Test

DTN.6.15301

Upon contact-setup directive, if the convergence layer is TCPCLP, CLA shall request TCPCLP establish a session with the peer entity configured into TCPCLP.

Rationale: This establishes the TCP connection, negotiates a contact, and negotiates a session.

Parent: DTN.5.00170, DTN.5.00692

External Parent: CCSDS BPv7 Section B2.1.2, PICS Section A5.5 Item 23

Verification Method: Test

DTN.6.15031

CLA shall reject a contact-start directive and issue an error event if CLA has not been successfully configured.

Rationale: CLA will not function correctly if it is not configured properly and completely.

Parent: DTN.5.00170, DTN.5.00692

External Parent: CCSDS BPv7 Section 5.3, RFC 9171 Section 7.2

Verification Method: Test

DTN.6.15041

Upon receiving a contact-start directive, CLA shall continuously receive messages from the convergence layer.

Rationale: Start the data flow after configuration for the contact is complete. TCP with additional protocol such as STCP or TCPCL is message-oriented, and the node assumes each message contains a single, complete frame, packet, or LTP PDU.

Parent: DTN.5.00170

External Parent: CCSDS BPv7 Section 5.3, RFC 9171 Section 7.2

Verification Method: Test

DTN.6.15061

Upon receiving a contact-start directive, while the underlying convergence layer is ready, CLA shall continuously request BPA provide bundles from the configured output queue.

Rationale: Start the data flow after configuration for the contact is complete. TCP with additional protocol such as STCP or TCPCL is message-oriented, and the node assumes each message contains a single, complete frame, packet, or LTP PDU.

Parent: DTN.5.00692

External Parent: CCSDS BPv7 Section 5.3, RFC 9171 Section 7.2

Verification Method: Test

DTN.6.15141

Upon receiving a contact-stop directive, CLA shall request the convergence layer cancel any transfers in progress for the given contact.

Rationale: Stop the data flow at the scheduled end of the contact prior to releasing resources. LTP and TCPCLP support this concept. Stop is a prelude to tearing down the underlying connections and allows the layers to clean up gracefully as needed.

Parent: DTN.5.00170, DTN.5.00692

External Parent: N/A

Verification Method: Test

DTN.6.15143

Upon receiving a contact-stop directive, if CLA is configured for receiving, CLA shall stop receiving messages from the convergence layer.

Rationale: Stop the data flow at contact-stop.

Parent: DTN.5.00170

External Parent: N/A

Verification Method: Test

DTN.6.15144

Upon receiving a contact-stop directive, if CLA is configured for sending, CLA shall stop requesting BPA provide bundles from the configured output queue.

Rationale: Stop the data flow at contact-stop.

Parent: DTN.5.00692
External Parent: N/A
Verification Method: Test

DTN.6.15241

Upon contact-stop directive, if CLA's convergence layer is LTP, CLA shall request LTP cancel each active session.

Rationale: It seems courteous to notify the peer engine that this engine is terminating. CLA knows about active sessions through its association of bundles to session IDs.

Parent: DTN.5.00170, DTN.5.00692

External Parent: CCSDS BPv7 Section B2.1.4, PICS Section A5.5 Item 24

Verification Method: Test

DTN.6.15251

Upon contact-stop directive, CLA shall notify BPA of bundle transmitted for each bundle associated with an active LTP session for which LTP has reported Initial Transmission Completed.

Rationale: This is all we know for some convergence layers, so it is good enough in cases like this where the CLA cannot know any more.

Parent: DTN.5.00692

External Parent: CCSDS BPv7 Section B2.1.4, PICS Section A5.5 Item 24

Verification Method: Test

DTN.6.15261

Upon contact-stop directive, CLA shall notify BPA of bundle transmission failure for each bundle associated with an active LTP session for which LTP has not reported Initial Transmission Completed.

Rationale: We know for certain that these bundles have not been successfully transmitted.

Parent: DTN.5.00692

External Parent: CCSDS BPv7 Section B2.1.4, PICS Section A5.5 Item 24

Verification Method: Test

DTN.6.15151

Upon receiving a contact-teardown directive, CLA shall free all resources associated with the given CLA instance.

Rationale: Provides a mechanism to free any CLA resources. As with setup, convergence layer teardown is outside this requirement.

Parent: DTN.5.00170, DTN.5.00692

External Parent: N/A

Verification Method: Test

DTN.6.15221

Upon notification from LTP that a session has completed or been cancelled, CLA shall release all CLA resources related to the given session ID.

Rationale: The session is completed and no longer exists in LTP, so things such as its association between the session ID and the bundle can be discarded.

Parent: DTN.5.00170, DTN.5.00692

External Parent: CCSDS BPv7 Section B2.1.4, PICS Section A5.5 Item 24

Verification Method: Test

3.4.4 Telemetry Reporting

This section contains recommendations on CLA telemetry reporting.

DTN.6.15158

CLA shall send telemetry per the Monitor and Control ICD.

Rationale: Send telemetry upon request

Parent: DTN.5.00940, DTN.5.00950

External Parent: N/A

Verification Method: Test

3.4.5 Node Shutdown

This section contains recommendations on CLA during node shutdown.

DTN.6.15142

Upon receiving a node-shutdown directive, CLA shall request all convergence layers cancel all transfers in progress.

Rationale: Stop the data flow for node shutdown prior to releasing resources. LTP and TCPCLP support this concept. Stop is a prelude to tearing down the underlying connections and allows the layers to clean up gracefully as needed.

Parent: DTN.5.00170, DTN.5.00692

External Parent: N/A

Verification Method: Test

DTN.6.15145

Upon receiving a node-shutdown directive, CLA shall stop receiving messages from all convergence layers.

Rationale: Stop the data flow at contact-stop.

Parent: DTN.5.00170

External Parent: N/A

Verification Method: Test

DTN.6.15146

Upon receiving a node-shutdown directive, CLA shall stop requesting BPA provide bundles from all output queues.

Rationale: Stop the data flow at contact-stop.

Parent: DTN.5.00692

External Parent: N/A

Verification Method: Test

3.5 All Node Recommendations

This section contains recommendations that apply to the entire node (all subsystems).

3.5.1 Event Handling

This section contains recommendations on event handling for the entire node.

DTN.6.16022

When issuing an event message, DTN Node Subsystems shall provide the context of the event, including the action being attempted and the parameters of that action.

Rationale: Provides additional information needed to better understand the nature of the error.

Parent: DTN.5.00980

External Parent: N/A

Verification Method: Test

DTN.6.16000

DTN Node Subsystems shall include in all events messages the time at which the event occurred.

Rationale: Needed for understanding the sequence and timing among event messages, as well as the absolute time at which an event occurs.

Parent: DTN.5.00980

External Parent: CCSDS BPv7 Annex C2, PICS Section A5.5 Item 28

Verification Method: Test

DTN.6.16023

When issuing an event related to a specific bundle, DTN Node Subsystems shall include the bundle's source and destination EIDs, creation timestamp, reason code (if applicable), and indication of whether the bundle was stored in the event message.

Rationale: Needed to understand the source of the event and identify the root cause, if necessary.

Parent: DTN.5.00980

External Parent: N/A

Verification Method: Test

DTN.6.16024

When issuing an event related to a specific bundle, and that bundle is a fragment, DTN Node Subsystems shall include the fragment offset and original ADU length.

Rationale: Needed to understand the source of the event and identify the root cause, if necessary.

Parent: DTN.5.00980

External Parent: N/A

Verification Method: Test

DTN.6.16025

When issuing an event related to a specific bundle, and that bundle's destination is this node, DTN Node Subsystems shall include the channel ID, if available.

Rationale: Needed to understand the source of the event and identify the root cause, if necessary.

Parent: DTN.5.00980

External Parent: N/A

Verification Method: Test

DTN.6.16015

BPA shall issue an information event whenever encountering an issue with input data.

Rationale: Provides additional information needed to better understand the nature of the input data error.

Parent: DTN.5.00030, DTN.5.00920, DTN.5.00180, DTN.5.00185, DTN.5.00190, DTN.5.00220

External Parent: N/A

Verification Method: Test

DTN.6.16010

The DTN Node Subsystems shall issue an error event whenever encountering an error.

Rationale: Provides additional information needed to better understand the nature of the error.

Parent: DTN.5.00535, DTN.5.00537, DTN.5.00920

External Parent: N/A

Verification Method: Test, Inspection

DTN.6.25020

If there is no available memory for an operation, the DTN Node shall issue an error event.

Rationale: Provides additional information needed to better understand the nature of the error.

Parent: DTN.5.01070

External Parent: N/A

Verification Method: Test

3.5.2 Initialization and Configuration

This section contains recommendations on initialization and configuration for the entire node.

DTN.6.25040

Upon initialization, the DTN Node shall configure the available memory pool size.

Rationale: Avoid Dynamic Memory Allocation during run time.

Parent: DTN.5.01070

External Parent: N/A

Verification Method: Test

DTN.6.21010

The DTN Node shall allow users to configure parameters to limit its processor utilization.

Rationale: NASA GSFC Gold Rules require that flight software includes margin on processor utilization.

Parent: DTN.5.01070

External Parent: GSFC-STD-1000H

Verification Method: Inspection

DTN.6.21020

The DTN Node shall remain below its configured processor utilization limit.

Rationale: NASA GSFC Gold Rules require that flight software includes margin on processor utilization.

Parent: DTN.5.01070

External Parent: GSFC-STD-1000H

Verification Method: Inspection

3.5.3 Directive Handling

This section contains recommendations on directive handling for the entire node.

DTN.6.25000

Upon accepting a node-shutdown request, the DTN Node shall release the allocated memory.

Rationale: make sure there is no memory leaks or allocated resources after the node shutdown.

Parent: DTN.5.01065

External Parent: N/A

Verification Method: Inspection

Appendix A. Acronyms

Acronym	Description
AA	Application Agent
ADD	Architecture Definition Document
ADU	Application Data Unit
BP	Bundle Protocol
BPA	Bundle Protocol Agent
BSC	Bundle Sequence Collection
BSR	Bundle Status Report
CBOR	Concise Binary Object Representation
CCB	Configuration Control Board
CCSDS	Consultative Committee for Space Data Systems
CLA	Convergence Layer Adapter
ConOps	Concept of Operations
CM	Configuration Management
CREB	Compressed Reporting Extension Block
CRS	Compressed Reporting Signal
CS	Custody Signal
CT	Custody Transfer
CTEB	Custody Transfer Extension Block
DCN	Document Change Notice
DTN	Delay/Disruption Tolerant Networking
EID	Endpoint ID
ESC	Exploration and Space Communications
GSFC	Goddard Space Flight Center
ICD	Interface Control Document
IPN	Internet Protocol Network
LNIS	LunaNet Interoperability Specification
LTP	Licklider Transmission Protocol
MIB	Management Information Base
NPD	NASA Policy Directives
NPR	NASA Procedural Requirements
PI	Payload Interface
RFC	Request for Comment
SCaN	Space Communication and Navigation
TBD	To-Be Determined
TBR	To-Be Refined
TEMPO	Technology Enterprise and Mission Pathfinder Office

Appendix B. Dictionary of Terms

Term	Definition
Accept	Successful verification that the received ADU/PDU meets policy, no configured constraints have been violated, is stored, not expired, and is ready to forward to the next functional process.
Accounting information	Includes overall node state/health and counters for bundles as they progress through the DTN service network. Supports DTN Network Management in determining network performance, allocation of network resources, schedule updates, fault handling, and ensuring service level agreements are being met.
<u>Administrative record</u>	Administrative records are standard ADUs that are used in providing some of the features of the Bundle Protocol. Bundle Protocol administrative record types are registered in the IANA "Bundle Administrative Record Types" registry [RFC5050];
Aggregate	Concatenate or group data units into larger protocol data units.
Application Data Unit (ADU)	Application generated data unit. Note this also includes DTN administrative data units. Excepting for DTN administrative ADUs, ADUs may be split into fragments. Fragments are partial ADUs and should always be referred to using the "partial ADU" phrase.
Application Interface Service	Provides APDU layer services to the sending application and/or the destination application. These services are above the bundle protocol services in the DTN stack. Currently defined services include: Ordered Delivery (In-order with gaps), Ordered Delivery with backfill (In-order with less gaps), Sequence Delivery (In-order without gaps based on best effort), Gap Detection, and Duplicate Suppression.
Application Protocol Data Unit (APDU)	The PDU provided by the user application to the DTN node. RTP Packet is an example of Application PDU. A number of RTP packets are likely to be combined to form an ADU, where ADU is the Block-type-specific data of the payload block of an unfragmented bundle, as defined in the RFC9171 section 4.3.2. Block-type-specific data of the payload block of a fragmented bundle contains only a part of the original ADU, also known as Partial ADU.

Authorized	Having permission or approval to execute a function. For DTN, authorization would typically be needed to execute a function based on an incoming data unit.
Best-Effort	Supports PDU transfer without the need for bi-directional links or more resource intensive acknowledged custody transfer. Note this class implies the DTN service will not drop PDUs without cause and make a reasonable effort to transport the PDU on the provider network. Somewhat analogous to UDP/IP.
Block Integrity Block (BIB)	BP extension block used to ensure the integrity of plaintext security target(s).
Bundle Hops (BOPS)	Path of the hops that a bundle traverses from source to destination node within the network.
Bundle in Bundle Encapsulation (BIBE)	A protocol that allows a bundle to be encapsulated in another (outer) bundle. Currently (Feb 5, 2024), there is no standard for it, but an expired draft exists, and it is expected that IETF will develop of such a standard in future. BIBE can be useful for provider networks, first hop/last hop services, security provisioning.
Bundle	The protocol data unit defined by the CCSDS Bundle protocol standard.
<u>Bundle Processing Control Flags</u>	Bundle processing control flags assert properties of the bundle as a whole rather than of any particular block of the bundle. They are conveyed in the primary block of the bundle.
<u>Canonical Block</u>	Any block other than the primary block
Channel	Interface with associated configuration to establish communication.
Convergence Layer (CL)	Underlying network layer(s) that transports DTN bundles between nodes. Example: TCP/IP, UDP/IP, and Licklider Transmission Protocol (LTP).
Convergence Layer Adapter (CLA)	A software implementation that abstracts the differences in the Convergence Layers to only the interfaces for ingressing and egressing bundles. Example: since TCP/IP is a byte streaming protocol, the TCP/IP CLA must extract bundles from the stream requiring the CLA to insert an identifiable encapsulating header to the egressing byte stream, and then remove that header when providing a DTN PDU to the Bundle layer.
Cold Restart	System startup with configuration set to defaults with an attempt to recover bundle storage. Operations can then resume from the default state.
Configure	Node functionality that is modified by parameters set by an interface external to the PDU. These parameters are typically static and applied during node startup, instantiation of a service, or new user. Configured -

	having received and accepted configuration parameters. Configuration is set, monitored, and distributed by the node(s) operator.
<u>Contact</u>	An interval during which it is expected that data will be transmitted by a sending node and that most or all of the transmitted data will be received by a receiving node.
<u>Contact Schedule</u>	Structured information that defines the time, duration, and DTN service stack configurations and to establish communication between two or more DTN nodes. Configuration includes a list (or reference to a list) of destination EIDs to be forwarded. See CCSDS 902.1-B-1 - SIMPLE SCHEDULE FORMAT SPECIFICATION as the starting document, though it is DTN neutral.
Custody	To be considered in custody, the PDU must have been accepted and successfully stored.
Custody Signal	An administrative record sent by a prospective custodian to the previous custodian, where previous custodian is the node that made the custody request. See CCSDS Orange Book on Compression and Custody Transfer.
Data Authentication Service	Security mechanisms that protect the infrastructure from unauthorized use. Data includes end user data and data in specified protocol blocks.
Data Confidentiality Service	Establishes a process for providing data confidentiality as data passes between security domains and possibly through Provider Networks.
Data Delivery Reliability Service	Provides levels of reliability for data delivery at multiple layers the DTN stack. Currently application layer, bundle layer and convergence layer reliability are selectable for both acknowledged and unacknowledged transport.
Data Integrity Service	Ensures that changes to target data within a bundle can be discovered.
Delete	Remove unconditionally all of the bundle's retention constraints, enabling the bundle to be removed from bundle storage.
Deliver	APDU has been presented to the node's application agent in a manner consistent with the state of that registration.
Delivered	APDU has been transferred to the user application. Depending on the reliability service configuration this may require user application acknowledgement of delivery acceptance.
Deserialized Bundle	A bundle representation without CBOR encoding, primarily used for manipulation by the node software. A serialized bundle is the bundle in CBOR encoding.
Directive	A run-time command to change configuration and operation. In commonly used space mission language

	these are tele-commands that can originate locally or remote.
Discard	Cease all operations on the bundle and functionally erase all references to it.
Dispatch	The selection of, and transfer to, the next applicable function. This is different than routing in that the selection is not solely based on indications in the PDU.
DTN Service	Set of all systems and processes required for DTN to operate. (Flight nodes, ground nodes, management, operators, providers, SLAs, Position/Navigation/Timing (PNT), antenna and link configuration, etc.)
Edge Node	DTN nodes with interfaces to end nodes or other service providers. Typically, an edge node is the user/customer facing node of a Provider Network. Note a Provider Network can have multiple edge nodes.
Egress	Successful buffering of an outgoing bundle PDU to the CLA.
Emergency Service	Request the establishment of a communication path to source nodes without going through the normal scheduling process to respond to emergency situations. Support for this service should be part of the SLA.
End Node	DTN nodes with an AppAgent ADU interface to non-DTN functionality. (Such as a science or exploration spacecraft/system or ground data system) End nodes are either the original source or the destination of ADUs.
Endpoint	<u>A bundle endpoint (or simply "endpoint") is a set of zero or more bundle nodes that all identify themselves for BP purposes by some common identifier, called a "bundle endpoint ID" (or, in this document, simply "endpoint ID"); endpoint IDs are described in detail in Section 4.2.5.1 of RFC 9171.</u>
Enqueue	Place/copy an ADU/PDU into a set of buffers to be received by another DTN functional element. Note this can be by reference/pointer.
Events	Async indications of state changes or error conditions. To send an event is to invoke the mechanism to transfer the indication to one or more applications. Note that async indication could happen at a high rate. Systems implementing event should have a filter mechanism.
Expired	The bundle time to live has been exceeded.
First Hop Relay Node	A DTN Node that has an application (called First Application, FH App) registered on a mission specified EID service number that receives an ADU to forward on the DTN transport. It is paired with a Last Hop Relay Node application EID service number. Unlike other source applications, this application can interface directly to low

	level communications hardware and creates an ADU encapsulating lower-level network data units. The intent is to allow the DTN transport of data link protocol units to the Last Hop Application for egress. Rationale: Such an application could be used to extract data from a spacecraft whose network layer is not functioning properly (during emergency) or allow non-DTN aware, legacy space assets to use the DTN network. See https://public.ccsds.org/Pubs/734x0g1e1.pdf , section 4.2.2.6.4. See Also: Last Hop Relay Node, Emergency Service
Flow	A series of related bundles identified by values in the authority.Node.Service (EID) tuple. Granularity can vary with a flow being identified by authority, authority.node, or authority.node.service. To reduce implementation and operational complexity the more granular flow instance will override the lower granularity instance. (If defined an org.node.service flow will override an org flow.)
Foreign	An application or system external to the local host. For DTN this would be systems with a different node ID.
Forward	To forward a bundle to a node is to invoke the services of one or more CLAs in a sustained effort to cause a copy of the bundle to be received by that (destination) node. Forwarded – (State) Bundle has been transferred to the next lower DTN communications layer. Typically, a CLA. Re-Forward - to forward again.
Gap	One or more missing PDUs as determined by indicated sequence identifiers.
Gap detection	Detected gap status provided to Service management and/or service user. Note that gap detection occurs within a defined time window. This window time will vary by contact schedule and is expected to be part of the destination node configuration.
Hard Reset	System startup with all configuration set to defaults and all bundle storage cleared.
Incoming	Data unit being received into a function or service. Generic term used with no specific format or function implied.
Indicate/Indicated	Functionality modified by parameters contained within the Protocol Data Unit (PDU).
Ingress	Successful buffering of an incoming PDU, only PDU location and length are known. No checks of PDU contents have been performed. Precursor to Receive functional process.
Initial restart	System startup with all configuration set to defaults.

Last Hop Relay Node	A DTN Node that has an application (called Last Application, LH App) paired with a First Application EID service number that extracts a lower-level network data unit from the ADU for egress at the specified network layer. Like the First Application, this application can interface directly with low level hardware for data unit egress. Rationale: Such an application could be used to support low-level commanding in case the destination spacecraft's network layer is not functioning properly (during emergency) or allow non-DTN aware, legacy space assets to use the DTN network. See https://public.ccsds.org/Pubs/734x0g1e1.pdf , section 4.2.2.6.3. See Also: First Hop Relay Node, Emergency Service
Latency Service	Allows specification for different levels of latency, such as lower latency for telemetry streaming or higher latency for science data.
Local	An application hosted on the same platform. For DTN, it is all applications with the same node ID.
Management Information Base (MIB)	Collection of parameters to configure and status a communications protocol stack.
Node	System implementing a set of DTN communications protocol services identified by a unique node id.
Node ID	The identifier that uniquely identifies a Bundle Protocol Agent and thereby also identifies the associated DTN Node. The Node ID is an element within the 3-tuple or 2-tuple EID array which consists of Org.NodeId.Service or NodeId.Service identifiers. The EID of any singleton endpoint is allowed to serve as a "node ID" identifying the node that is the sole member of that endpoint. "Administrative endpoint" is one such endpoint, as such the EID of a node's administrative endpoint SHALL uniquely identify that node. Every node will always have an "administrative endpoint."
Operator	System that controls and monitors one or more nodes. May include both human and machine automation.
Outgoing	Data unit sent out of a function or service. Generic term used with no specific format or function implied.
Payload	Generic term for the user original datagram. Nominally same as ADU but payload can be fragmented into multiple ADUs for transport.
Payload Sizing Service	User Application PDUs (APDU) may be small or too large to make optimal use of the DTN Service and would benefit from aggregating/concatenating multiple user datagrams into a single ADU or splitting (fragmenting) the APDU

	across multiple bundles. Service users may also inhibit bundle fragmentation.
Policy	One or more sets of conditions, constraints, and settings that are applied to protocol data units in the network that are modifiable during network operations. Policies generally consist of rules on how users access network services. Policies are set, monitored, and distributed through a combination of DTN Network Management, end user node management, and provider network management.
Provider Network	A set of one or more interoperating nodes implementing the DTN network stack, and routing/configuration services. Provider nodes interface to the user/customer End Nodes or other provider networks. Provider nodes are managed by the provider organization but require the exchange of schedule and routing information with end nodes and/or end nodes management systems.
Quality of Service (QoS)	A measurement of the overall performance of a network service for a particular service user. In the DTN Service, the QoS for user ADU transfers is determined by selecting a set of parameters affecting latency, reliability, and traffic shaping. These parameters are based on the user DTN service SLA and are selected by a combination of local and Network DTN policy of node configuration.
Reassemble	Reconstitute the original APDU from received APDU fragments.
Receive	Process a bundle PDU from ingress function and verify basic protocol compliance. PDU is considered received or in Receipt when basic compliance checks are complete. This is a precursor to accepting a PDU or otherwise forwarding for further processing.
Reject	An indication that a request or data unit will not be processed due to errors or constraints. Indication may be silent if so configured but will likely have an associated counter.
Relay Node	Provides store and forward, and routing services for DTN bundles. Note a typical DTN node will have both relay and end node functionality as DTN network management will need to process ADUs.
Reply	Response to a request. This can be a message or an application return code.
Retention Assurance Service	Basic store and forward service with different levels of data retention assurance. Currently, no retention, hold for forwarding, and acknowledged retention have been defined.

Routing Information	Includes scheduling and path information through the DTN service systems. Supports DTN Network Management in allocating network resources, schedule updates, and fault handling.
Safe Mode	A degraded operational mode with only basic DTN services running. The set of services can vary depending on the reason for Safe Mode entry. At a minimum, Safe mode must forward and receive DTN and host status and configuration over one or more default preconfigured best effort path(s).
Singleton endpoint	A singleton endpoint is an endpoint that always contains exactly one member.
Service Configuration Distribution Service	Distribution of generated configurations to DTN nodes and/or node operations centers.
Service Configuration Generation Service	Generate individual node and/or service provider configurations to enable service operations using information from the Transport, Storage, and Service Management functions.
Service Management Service	Gathers and processes node storage information, both current and predictive as input to Service Configuration Generation.
Service Monitoring Service	Gathering service-related parameters from DTN nodes and/or node operations centers.
Service Policy	Procedures defined by DTN Service Management that affect the processing of ADUs and PDUs within the DTN Service.
Service Request	A request from a DTN user or service provider to access the DTN network for data transport. A service request may be for initial service or as a change to existing service. It is expected that a common interface will be specified for service requests.
Signal	A parameter created and sent by function as notification of some condition, or to change a function's behavior. Signals contain information that must be acted on with a defined typically low latency.
Status	Periodic or when requested indications of state changes or error conditions.
Storage	Digital memory that retains data across power and/or system resets cycles. Persistent.
Storage Management Service	Gathers and processes node storage information, both current and predictive as input to Service Configuration Generation. It is expected that management will occur on a per user basis such that storage can be allocated per that user's SLA.

Store and Forward	A network design mechanism where a datagram is held in memory until a forwarding path is available. In DTN, nodes may store the datagram for minutes, hours, or days depending on path availability and the selected datagram lifetime.
Streaming SC	In-Order ADU delivery with minimal latency. Can have gaps.
Time-To-Live (TTL)	Time in seconds from creation time to bundle expiration. Bundles that exceed the TTL may be discarded.
Transmit	PDU sent to network Link layer for physical layer transmission.
Transmitted	Bundle has egressed the protocol stack physical layer or the lowest observable (by indication) layer.
Transport Management Service	Gathers and processes node network topology, contact information, available CLs, and SLA information to determine QoS configuration as input to Service Configuration Generation. The generated QoS is then applied within the nodes to identified bundles moving through the node.
User	Customer of DTN services. Users typically interface at the End Nodes. Users create and negotiate the Service Level Agreements (SLAs) provided to Service Providers.
User Data	The user data is not confined to block-specific data of the payload block of the bundle, but it may include other metadata, which may be included in the extension blocks.
User Data Accounting Service	Gathers and reports bundle status information to DTN service users. Supports end user to monitoring to determine SLA compliance.
User Defined Extension Block	An extension block that is defined by the user {end user, provider network, ...}, primarily for private communication and using block type number that is reserved for private or experimental use ("Block type codes 192 through 255 are not reserved and are available for private and/or experimental use. [RFC 9171]") Note that these blocks are NOT standardized, and they are not registered with IANA.
User Defined Extension Blocks Service	Allows end users to specify custom extensions blocks, where custom extensions block is not a standardized extension block.
Valid	An ADU/PDU is considered valid when it successfully parses including any integrity checks.
Warm Restart	DTN system attempts to recover previous operating state information and resume operations as configured. Note that this requires interfaces to the host system and may not be supported for all hosts.