

Marcel Beyer

Comparing different implementations of Bundle Protocol version 7

Dresden, July 13, 2020

Outline

1. Introduction to DTN/Bundle Protocol
2. Implementations
3. Compared features
4. Summary

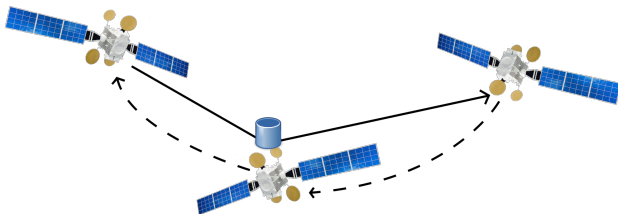
Introduction to DTN/Bundle Protocol

Delay Tolerant Networks

- originally for Interplanetary Internet
- sensor-based networks, satellite networks, underwater networks
- take care of
 - no end-to-end path for duration of communication
 - high packet loss
 - high latency

Bundle Protocol

- problems solved in Bundle Protocol
 - data transport in bundles
 - hop-by-hop approach
 - Custody
 - consider physical data movements in routing decisions



Implementations

ION

- developed at JPL
- written in C
- Python interface
- BPv7 from version 4.0.0 on

- developed by D3TN and TU Dresden
- written in C
- first implementation supporting BPv6 and BPv7
- Application Agent Protocol: register EIDs, send, receive and cancel bundles

pyDTN

- developed by X-Works
- written in Python
- first version started with BPv7
- currently no bundle forwarding
- REST API

LibDTN

- formerly known as “Terra”, now basis for DTN node Terra
- developed by RightMesh
- written in Java
- started with BPv7

Compared features

Status reporting

- Decision of requesting kept for upper layer application?
- Request of status time?

ION, μ PCN

- sending and receiving
- takes care of “report status time”

pyDTN

- flags implemented, requesting possible
- no reports sent for incoming bundles

LibDTN

- sending and receiving
- status time in all reports

Fragmentation and reassembly

- Is fragmentation supported?
- Proactive fragmentation?
- Reassembly “on the way”?

ION

- supported, except for DCCP CLA
- proactive fragmentation

μ PCN

- supported
- ignores “must not be fragmented” flag

Fragmentation and reassembly

pyDTN

- flags in internal representation
- functions not implemented

libDTN

- not supported

URI schemes

- Standard: `dtm`
- Compressed: `ipn`
- Multicast: `imc`

ION

- supports all three

μ PCN, pyDTN, libDTN

- only `dtm` and `ipn`

BIBE

- BIBE acts as CLA
- encapsulate bundles in bundles to achieve custody
- BIBE PDUs: administrative records

ION

- supported
- configuration “not as simple as one might think”

μ PCN

- not implemented
- processing code shared with BPv6 → Custody concept implemented

pyDTN, libDTN

- not supported

Extension blocks

- Previous node EB
- Bundle age EB
- Bundle hop count and limit EB
- Metadata EB

ION

- all four supported
- Query Extension Block, Spray and Wait Block
- easily extensible

μ PCN

- Bundle Age not yet used for lifetime check, no serializer
- hop count limit supported

Extension blocks

pyDTN

- Previous node, age, hop count limit supported
- Metadata EB not supported
- Blocks not used for received bundles, no forwarding

libDTN

- Previous node, age, hop count limit supported
- Metadata EB not supported
- Routing Block

BPsec

- First security implementation for BP: Bundle Security Protocol
- improved with Streamlined BSP
- BPsec for BPv7

ION ✓

μPCN not supported

pyDTN not supported

libDTN ✓

DTN IP Neighbor Discovery

- Discover neighbor nodes
- using the IP underlay

ION

- supported
- automatically informing CLA

μ PCN

- supported in past, removed

DTN IP Neighbor Discovery

pyDTN

- implementation not finished
- code existing, but not integrated

libDTN

- not supported

Malformed Bundles

- ... “may” be discarded or corrected
- discarded by all examined implementations

Retransmission

- Bundles “may” be resent if it was not possible to send them with at least one CLA

ION

- using reliable CLA per default
- also retransmission on BP layer

μ PCN

- bundles are deleted
- (status reports are sent before bundle is discarded)

pyDTN, libDTN

- bundles are discarded

Summary

Supported features






	ION	μ PCN	pyDTN	libDTN
Status reports	✓	✓	~	✓
Fragmentation	✓	✓	✗	✗
URI schemes	dtn, ipn, imc	dtn, ipn	dtn, ipn	dtn, ipn
BIBE	✓	✗	✗	✗
BPsec	✓	✗	✗	✓
DTN IPND	✓	✗	started	✗
Malformed bun.	discarded by all implementations			
Transmission err.	retransmitted	deleted	discarded	

Table: Implemented features

Supported extension blocks

	Prev. Node	Bundle Age	Hop Count/Limit	Metadata
ION	✓	✓	✓	✓
μ PCN	✗	~	✓	✗
pyDTN	~	~	~	✗
libDTN	✓	✓	✓	✗

Table: Implemented extension blocks

-  S. Bradner.
Key words for use in RFCs to Indicate Requirement Levels.
BCP 14, March 1997
-  S. Burleigh.
Bundle-in-Bundle Encapsulation (draft-ietf-dtn-bibect-03).
Internet Draft, February 2020
-  E. Birrane, K. McKeever.
Bundle Protocol Security Specification
(draft-ietf-dtn-bpsec-22).
Internet Draft, March 2020
-  K. Scott and S. Burleigh.
Bundle Protocol Specification.
RFC 5050, November 2007
-  S. Burleigh, K. Fall and E. Birrane.
Bundle Protocol Version 7 (draft-ietf-dtn-bpbis-24).



S. Farrell, A. Lynch, D. Kutscher, A. Lindgren.
Bundle Protocol Query Extension Block
(draft-irtf-dtnrg-bpq-00).

Internet Draft, May 2012



M. Beyer.
Comparison of Bundle Protocol version 6 and 7.
August 2019, beyerm.de



H. Kruse, S. Jero, S. Ostermann.
Datagram Convergence Layers for the Delay- and
Disruption-Tolerant Networking (DTN) Bundle Protocol and
Licklider Transmission Protocol (LTP).

RFC 7122, March 2014



V. Cerf, S. Burleigh, A. Hooke, L. Torgerson, R. Durst, K. Scott, K.
Fall, H. Weiss.

Delay-Tolerant Networking Architecture.

RFC 4838, April 2007



S. Burleigh.

CBHE-Compatible Bundle Multicast
(draft-burleigh-dtnrg-imc-00).

Internet Draft, May 2011



Jet Propulsion Laboratory, California Institute of Technology.
Interplanetary Overlay Network (ION) Design and Operation.
November 2018, included in the ION release



D. Ellard, R. Altman, A. Gladd, D. Brown, R. in 't Velt.
DTN IP Neighbor Discovery (draft-irtf-dtnrg-ipnd-03).


Internet Draft, November 2015




S. Symington, S. Farrell, H. Weiss, P. Lovell.
Bundle Security Protocol Specification.

RFC 6257, May 2011

 S. Symington.
Delay-Tolerant Networking Metadata Extension Block.
RFC 6258, May 2011

 S. Burleigh.
Compressed Bundle Header Encoding (CBHE).
RFC 6260, May 2011

 E. Birrane.
Streamlined Bundle Security Protocol Specification
(draft-irtf-dtnrg-sbsp-00).
Internet Draft, July 2013

 Spyropoulos, Thrasylvoulos and Psounis, Konstantinos and Raghavendra, Cauligi S.
Spray and Wait: An Efficient Routing Scheme for Intermittently Connected Mobile Networks.
Association for Computing Machinery, 2005

<https://doi.org/10.1145/1080139.1080143>