Bundle In Bundle Encapsulation (BIBE)

Scott Burleigh
IPN Group
29 June 2018
Overview

• A short history of BIBE
• Aggregate custody signaling
• Current BIBE design
• Applications
• Future
A short history of BIBE
The original BIBE specification

• Posted as draft-irtf-dtnrg-bundle-encapsulation-06 in August of 2009; authors were Susan Symington, Bob Durst, and Keith Scott of the MITRE Corporation.

• Conceived as a capability of the BP node’s application agent – that is, as a BP *application*.

• Motivations:
  • Support for content-centric networking (forwarding of cached bundles).
  • Efficient (targeted) custodial retransmission of multicast bundles.
  • Security tunneling, particularly defense against traffic analysis.
BIBE at the convergence layer

• BIBE idea resurrected in 2013, posted as draft-irtf-burleigh-bibe-00 in March of 2013; author was Scott Burleigh.

• Conceived as a convergence-layer protocol under BP.

• Motivation: a way of helping to disentangle routing from security. The BIBE tunnel takes the place of the “security source” and “security destination” features of the original Bundle Security Protocol specification.
Custody transfer and unidirectional links

• Much discussion of custody transfer in 2015 and 2016:
  • In the general case, custody transfer with custodial retransmission could not be made efficient:
    • Accurate estimation of round-trip time was – in the general case – not possible.
    • Bundle fragmentation by non-custodians could not be prevented and would always defeat custody transfer.
  • BUT in some deployment scenarios, especially those including unidirectional links, a delay-tolerant asymmetric acknowledgment mechanism is needed. Bundle protocol is the obvious choice.
Extracting custody transfer from BP

- Proposition: all BP transmission reliability should be accomplished between neighboring BP nodes, i.e., at the convergence layer.
- So do custody transfer at the convergence layer; that is, use BP as a convergence-layer protocol.
- Wait a minute….BIBE already does exactly that.
- So let’s just build custody transfer into BIBE and use BIBE for both purposes, independently or together:
  - Cross-domain security. (Security sources and destinations, and defense against traffic analysis.)
  - Reliable convergence-layer transmission over asymmetric paths.
Aggregate custody signaling

• Separately, in 2012 researchers at University of Colorado, Boulder, had designed an alternative, more bandwidth-efficient definition of custody transfer. Documented in draft-kuzminsky-aggregate-custody-signals-04 (not posted). Authors were Sebastian Kuzminsky and Andrew Jenkins.

• Conceived as an alternative administrative record plus an additional extension block in BP. Implemented as an option in ION.

• Motivation: enable custodial retransmission to be used for reliable BP communications with the International Space Station (ISS) over extremely asymmetrical link data rates.
The new BIBE specification

• ACS has been highly successful in ISS operational use of DTN, strongly endorsed by that user community.

• The result of merging the ACS concept into BIBE, replacing the original BP custody transfer design, is draft-burleigh-dtn-bibect-01, posted 20 May 2018, author Scott Burleigh.
  • Operates as an optionally reliable convergence-layer protocol under BP.
  • Encapsulated bundle (the payload of the encapsulating [convergence-layer] bundle) may be encrypted and/or signed.
A reliable convergence-layer protocol

• Payload of the encapsulating bundle comprises:
  • Transmission ID (zero if custody transfer is not requested).
  • Expected time of acknowledgment (zero if custody transfer is not requested).
  • Encapsulated bundle.

• Acknowledgment of the encapsulating bundle is aggregated into a new administrative record sent in a responding bundle.
  • Custody transfer disposition code (“custody accepted” or reason for refusal).
  • Sequences of consecutive transmission IDs of received bundles.

• If acknowledgement is not received by the expected time, transmission of the encapsulated bundle is assumed to have failed; the encapsulated bundle is queued to be re-forwarded.
Applications
Custodial reliability

Source node → BCLA node 1 → BIBE → BCLA node 2 → Dest. node

- Source bundle
- BIBE bundle (encapsulating)
- BIBE custody signal bundle
Cross-domain security

Source node → Fwd node 1 → Fwd node 2 → Dest. node

- Source bundle (encapsulated)
- BIBE bundle (encapsulating)
- Source bundle (signed)

TCP

safe → unsafe → safe
Defense against traffic analysis

Source node

TCP

BCLA node 1

BIBE

BCLA node 2

TCP

Dest. node

safe

unsafe

safe

Source bundle

BIBE bundle (encapsulating)

Source bundle (encrypted)
Transient quality of service

Source node

BCLA node 1

BIBE

BCLA node 2

TCP

Dest. node

local

trunk line

local

Source bundle *expedited*

BIBE bundle *standard*
Transient critical forwarding

- Source node
- TCP
- Dest. node
- BCLA node 1
- TCP
- BIBE
- BCLA node 2
- TCP
- Dest. node

Stable:
- Source bundle
- BIBE bundle (encapsulating)

Unstable:
- Source bundle
- BIBE bundle (encapsulating)

Diagram:
- Source bundle
- BIBE bundle (encapsulating)
Transient multicast

Source node → BCLA node 1 → BCLA node 2 → BCLA node 5 → BCLA node 9 → Dest. node

- Source bundle
- BIBE bundle (encapsulating)

Stable

Unstable

Stable
Source path routing

Source node → BCLAnode 1 → BCLAnode 9 → BCLAnode 5 → BCLAnode 2 → Dest. node

- Source bundle
- BIBE bundle
- Encapsulated BIBE bundle

Thanks to Lloyd Wood for pointing this out.
Combinations: certified multicast

Source
node

BCLA
node 1

BCLA
node 9

BCLA
node 2

BCLA
node 5

Dest. node

TCP

TCP

TCP

TCP

Source bundle

BIBE bundle (encapsulating)

Source bundle (signed)

stable, safe

unstable, unsafe

stable, safe

29 June 2018
Workshop on Intelligent Space Networks 2018
The future

• Bundle-in-Bundle Encapsulation is now being considered for adoption by the IETF DTN working group.

• Specification is brief and simple; implementation should not be difficult.

• It’s powerful. Applications are limited only by your imagination.
Questions?