Constrained Application Protocol (CoAP) over Bundle Protocol (BP)

draft-gomez-core-coap-bp-00

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IETF 119 Brisbane, DTN WG, March 2024
1. Introduction

• DTN architecture:
  • Enables communication in challenged networks
    – Intermittent connectivity, high delays, high error rates...
    – Deep space, temporarily disconnected areas...
  • BP is the fundamental component of DTN
    – Store-carry-forward overlay
    – Application functionality runs atop BP

• CoAP:
  • Application-layer protocol designed for IoT environments
  • Typical IoT environment constraints:
    – Low energy (often leading to intermittent connectivity), high delays, low bandwidth, high error rates...
  • Features:
    – Lightweight operation, asynchronous message exchanges, flexibility, based on REST
Draft: main goal and status

- Main goal:
  - Specify how CoAP is carried over BP

- Initial draft version (-00)
  - Intended Status: Standards Track

- Explore interest, collect feedback

- Target WG?
  - CoRE WG
    - Specifies CoAP and related ecosystem
  - DTN WG
    - Specifies BP and related ecosystem
  - In any case, the aim is to keep both WGs in the loop
3. Architecture

- Protocol stack model:
  - Based on Fig. 1 of RFC 9171
4.1. Messaging model (I/III)

- Abstract layering for CoAP over BP:
  - CoAP was originally designed to operate over UDP
  - Same CoAP messaging model applies over BP:
    - UDP and BP are message-oriented protocols, no retransmission
    - CoAP over reliable transports: different model
4.1. Messaging model (II/III)

• Requests
  – Sent by clients

• Responses
  – Sent by servers

• Message types:
  – Confirmable (CON)
    » Must be acknowledged
    » Stop & wait
      • Default
        » Timer-based retransmission, exponential back-off
  – Non-confirmable (NON)
  – Acknowledgment (ACK)
  – Reset (RST)
4.1. Messaging model (III/III)

- CoAP over BP:
  - A source bundle node MAY set the "request reporting of bundle delivery" flag in a bundle that encapsulates a CoAP CON message
  - The receiver MAY opt to only send the corresponding bundle delivery status report
    - Instead of sending a bundle encapsulating a CoAP ACK message
    - If and only if the CoAP ACK does not carry a payload
  - The status report sent in response to a bundle-encapsulated CON message serves as CoAP ACK for the CON message

- Assumption: the status report size is shorter than the size of a bundle encapsulating a CoAP ACK message with no payload
4.2. Message format

• CoAP message over BP:
  • The CoAP message MUST be carried as the block-type-specific data field of the Bundle Payload Block (block type 1) of an encapsulating bundle

• CoAP message format over BP:
  • Extending the Message ID field size from 16 bits to 24 bits
  • Avoiding a severe limitation on the number of messages a sender can send per time unit:
    – RFC 7252: the same Message ID MUST NOT be reused within the EXCHANGE_LIFETIME (default: 247 s; deep space: \(~10^3\) s to \(~10^4\) s)
    – Maximum message rate (Appendix B):
      » Default settings, Earth’s Internet: \(~265\) message/s
      » Default settings, Jupiter to Earth: \(~3\) message/s (1 retry)
5. CoAP parameter settings...

- **NSTART**
  - Max number of outstanding interactions
  - Default value: 1
    - Greater values possible when some mechanism ensures congestion safety

- **ACK_TIMEOUT (AT), ACK_RANDOM_FACTOR (AF)**
  - Initial RTO, randomly chosen from [AT, AT*AF]
  - Default values (respectively): 2 s, 1.5
    - ACK_TIMEOUT needs to be set to at least the RTT
    - ACK_RANDOM_FACTOR intended to avoid synchronization effects

- **MAX_RETRANSMIT**
  - Default value: 4
  - Due to exponential back-off, lower than default may be suitable
  - Congestion control: needed in BP environments?
5. ... and related times

- **MAX_LATENCY**
  - Max time since a datagram is sent until it is received
  - Defined as 100 s

- **EXCHANGE_LIFETIME**
  - Max time since first transmission attempt of a CON until its ACK
  - Default value: 247 s

- **NON_LIFETIME**
  - Max time since a NON message is sent until it is received
  - Default value: MAX_LATENCY (i.e., 100 s)

- Note: CoAP implementations using 8-bit timers may need to be adapted to operate over BP

At least 2 orders of magnitude greater over BP
6. Observe

- Allows a server to send notifications carrying a representation of the current state of a resource to observers [RFC7641]
  - The latter need to initially register their interest
- The client does not have to send a request to receive each notification
  - Beneficial in high latency and/or low energy or bandwidth scenarios
- If time between the two last notifications received is > 128 seconds, the last one received is also the latest sent
  - 128 seconds: greater than the default MAX_LATENCY
  - When CoAP is used over BP, 128 seconds may be insufficient
  - The duration needs to be chosen as a value greater than the MAX_LATENCY of the scenario (see Appendix A)
7. Block-wise transfers

• CoAP supports functionality that allows carrying large payloads by means of block-wise transfers: RFC 7959, RFC 9177

• BP also supports fragmentation and reassembly functionality

• RFC 7959: "the fragmentation/reassembly process burdens the lower layers with conversation state that is better managed in the application layer"
  • Implicit assumption: details on the data unit sizes that can be carried over the different links of an end-to-end path are known in advance

• For CoAP over BP, CoAP block-wise transfers MAY be used if the source knows in advance the duration and type of expected contacts
  • This does not preclude the use of BP fragmentation and reassembly when deemed necessary
  • RFC 9177 is more suitable (RFC 7959 leads to stop & wait)
  • Many Block-specific parameters may need to be tuned
8. CoAP over BP URI

• Several CoAP URI schemes exist:
  • RFC 7252: "coap" and "coaps"
  • RFC 8323: "coap+tcp", "coaps+tcp", "coap+ws", "coaps+ws"

• For CoAP over BP:
  • New URI scheme: "coap+bp"
  • Syntax:
    - coap-bp-URI = "coap+bp:" "/" endpoint_ID path-abempty [ "?" query ]
    - Section 6.1 of RFC 7252 applies, except that a BP endpoint ID is used instead of the "host" and "port" authority subcomponents
9. IANA considerations

- IANA is requested to register the URI scheme "coap+bp"
  - Request structure conforms to RFC 7595
- Scheme name:
  - coap+bp
- Status:
  - Permanent
- Applications/protocols that use this scheme name:
  - CoAP endpoints to access CoAP resources using BP
- Contact:
  - IETF chair (chair@ietf.org)
- Change controller:
  - IESG (iesg@ietf.org)
- Reference:
  - Section 8.1 in [RFCthis]
Appendix A. Ref. parameter values for interplanetary communication

- Idealized scenarios: latency comprises propagation delay only

<p>| RTT, ACK_TIMEOUT (or EXCHANGE_LIFETIME, for MAX_RETRANSMIT=0) |</p>
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<th>Mars</th>
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Appendix B. Max CoAP message rate

- Depending on
  - EXCHANGE_LIFETIME
  - Message ID
    - 16 bits (default)
    - 24 bits (suggested)

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<tr>
<th>EXCHANGE_LIFETIME (s)</th>
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<th>Message_ID 24 bits</th>
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Thanks!

Questions? Comments?

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IETF 119 Brisbane, DTN WG, March 2024