6TiSCH
Internet-Draft
Intended status: Informational
Expires: January 3, 2019

J. Munoz, Ed.
Inria
D. Barthel
Orange Labs
July 2, 2018

6TiSCH Example Frames
draft-munoz-6tisch-examples-03

Abstract

This draft contains example frames exchanged by nodes implementing 6TiSCH. Both the raw binary and fully parsed contents of each frame is presented. This document can be used as a reference when implementing 6TiSCH.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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

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

This Internet-Draft will expire on January 3, 2019.

Table of Contents

1. TEMPORARY EDITORIAL NOTES 2
2. Tools Used 3
3. Network Topology 3
4. Examples Frames 3
4.1. Enhanced Beacon 4
4.2. Keep-Alive Frame 9
4.3. ACK Frame 10
4.4. Constrained Join Protocol Packets 11
4.5. RPL DIO 21
4.6. RPL DAO 29
4.6.1. RPL DAO from 2 29
4.6.2. RPL DAO from 3 31
4.7. ICMPv6 echo request/reply 36
4.7.1. ping 2 36
4.7.2. ping 3 40
4.8. 6P Commands and Response 48
4.8.1. 6P ADD 48
4.8.2. 6P COUNT 50
4.8.3. 6P DELETE 53
4.8.4. 6P RELOCATE 55
4.8.5. 6P LIST 58
4.8.6. 6P CLEAR 61
5. [TEMPORARY] Known Bugs/Issues 64
6. IANA Considerations 64
7. Security Considerations 64
8. Acknowledgments 64
9. References 64
9.1. Normative References 64
9.2. External Informative References 64
Authors' Addresses 65

1. TEMPORARY EDITORIAL NOTES

This document is an Internet Draft, so work-in-progress by nature. It contains the following work-in-progress elements:

- "TODO" statements are elements which have not yet been written by the authors for some reason (lack of time, ongoing discussions with no clear consensus, etc).https://github.com/openwsn-berkeley/openwsn-fw/commit/961c53778fe411533d74ce24918c95400d834199 The statement does indicate that the text will be written at some point.

- "TEMPORARY" appendices are there to capture current ongoing discussions, or the changelog of the document. These appendices will be removed in the final text.

- "IANA_*" identifiers are placeholders for numbers assigned by IANA. These placeholders are to be replaced by the actual values they represent after their assignment by IANA.

- "RFCXXXX" refers to the RFC number of this specification, once published.

- The string "REMARK" is put before a remark (questions, suggestion, etc) from an author, editor or contributor. These are on-going discussions at the time of writing, and will not be part of the final text.

- This section will be removed in the final text.

2. Tools Used

All results presented in this document are collected by running the [OpenWSN] firmware in simulation mode and capturing the frame exchanged using Wireshark.

These are the version of the source code used:

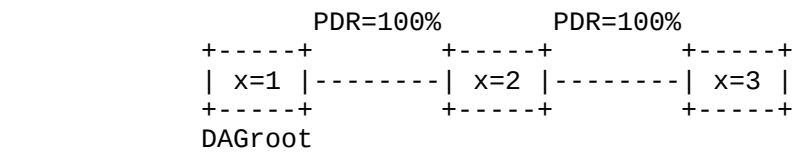
1. Wireshark: from version 2.9.0-80-g31aece5d (v2.9.0rc0-80-g31aece5d) and later.

2. OpenWSN firmware: https://github.com/openwsn-berkeley/openwsn-fw/commit/961c53778fe411533d74ce24918c95400d834199

3. OpenWSN software: https://github.com/openwsn-berkeley/openwsn-sw/commit/9c935d15b3e6b7dea5622e6173c04a0a4fd7ae5d

3. Network Topology

Network prefix: bbbb::/64
MAC address: 14-15-92-cc-00-00-00-0x



4. Examples Frames

4.1. Enhanced Beacon

Enhanced Beacon sent by 1

```
== Dissected packet ==

IEEE 802.15.4 Enhanced Beacon, Dst: Broadcast,
                               Src: 14:15:92:cc:00:00:00:01
Frame Control Field: 0xea40, Frame Type: Beacon, PAN ID Compression,
Information Elements Present, Destination Addressing Mode: Short/16-bit,
Frame Version: IEEE Std 802.15.4-2015,
Source Addressing Mode: Long/64-bit
    .... .... .... .000 = Frame Type: Beacon (0x0)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..0. .... = Acknowledge Request: False
    .... .... .1.. .... = PAN ID Compression: True
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..1. .... .... = Information Elements Present: True
    .... 10.. .... .... = Destination Addressing Mode:
                                                    Short/16-bit (0x2)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 196
Destination PAN: 0xcafe
Destination: 0xffff
Extended Source: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
Header IEs, Header Termination 1 IE
    Header Termination 1 IE (Payload IEs follow)
        IE Header: 0x3f00, Type: Header, Id: Header Termination 1 IE,
                                                          Length: 0
            0... .... .... .... = Type: Header (0)
            .011 1111 0... .... = Id: Header Termination 1 IE (0x7e)
            .... .... .000 0000 = Length: 0
Payload IEs, MLME IE
    MLME IE
        Payload IE TLV: 0x881a, Type: Payload, Id: MLME IE
            1... .... .... .... = Type: Payload (1)
            .000 1... .... .... = Id: MLME IE (0x1)
            .... .000 0001 1010 = Length: 26
        Time Synchronization IE
            Payload Sub IE (short): 0x1a06, Type: Short, Sub Id (Short):
                                              TSCH Synchronization IE
                0... .... .... .... = Type: Short (0)
                .001 1010 .... .... = Sub Id (Short):
                                        TSCH Synchronization IE (0x1a)
                .... .... 0000 0110 = Length: 6
            Absolute Slot Number: 180790
```

```
            Join Metric: 0
        TSCH Timeslot IE
            Payload IE TLV: 0x1c01, Type: Short, Sub Id (Short):
                                                    TSCH Timeslot IE
                0... .... .... .... = Type: Short (0)
                .001 1100 .... .... = Sub Id (Short):
                                          TSCH Timeslot IE (0x1c)
                .... .... 0000 0001 = Length: 1
            Data: 00
        Channel Hopping IE
            Payload Sub IE (long): 0xc801, Type: Long, Sub Id (Long):
                                               Channel Hopping IE
                1... .... .... .... = Type: Long (1)
                .100 1... .... .... = Sub Id (Long): Channel Hopping IE
                                                              (0x9)
                .... .000 0000 0001 = Length: 1
            Hopping Sequence ID: 0x00
        TSCH Slotframe and Link IE
            Payload Sub IE (short): 0x1b0a, Type: Short, Sub Id (Short):
                                         TSCH Slotframe and Link IE
                0... .... .... .... = Type: Short (0)
                .001 1011 .... .... = Sub Id (Short):
                                    TSCH Slotframe and Link IE (0x1b)
                .... .... 0000 1010 = Length: 10
            Number of Slotframes: 1
            Slotframes [1]
                Slotframe handle: 0
                Slotframe size: 101
                Number of Links: 1
                Link Information
                    Timeslot: 0
                    Channel Offset: 0
                    Link Options: 15
FCS: 0x75a3 (Correct)


== Raw Bytes ==

0000   40 ea c4 fe ca ff ff 01 00 00 00 cc 92 15 14 00
0010   3f 1a 88 06 1a 36 c2 02 00 00 00 01 1c 00 01 c8
0020   00 0a 1b 01 00 65 00 01 00 00 00 00 0f a3 75

   Enhanced Beacon sent by 2

== Dissected packet ==

IEEE 802.15.4 Enhanced Beacon, Dst: Broadcast,
                               Src: 14:15:92:cc:00:00:00:02
```

```
Frame Control Field: 0xea40, Frame Type: Beacon, PAN ID Compression,
Information Elements Present, Destination Addressing Mode: Short/16-bit,
Frame Version: IEEE Std 802.15.4-2015,
Source Addressing Mode: Long/64-bit
    .... .... .... .000 = Frame Type: Beacon (0x0)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..0. .... = Acknowledge Request: False
    .... .... .1.. .... = PAN ID Compression: True
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..1. .... .... = Information Elements Present: True
    .... 10.. .... .... = Destination Addressing Mode:
                                                  Short/16-bit (0x2)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 189
Destination PAN: 0xcafe
Destination: 0xffff
Extended Source: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
Header IEs, Header Termination 1 IE
    Header Termination 1 IE (Payload IEs follow)
        IE Header: 0x3f00, Type: Header, Id: Header Termination 1 IE,
                                                          Length: 0
            0... .... .... .... = Type: Header (0)
            .011 1111 0... .... = Id: Header Termination 1 IE (0x7e)
            .... .... .000 0000 = Length: 0
Payload IEs, MLME IE
    MLME IE
        Payload IE TLV: 0x881a, Type: Payload, Id: MLME IE
            1... .... .... .... = Type: Payload (1)
            .000 1... .... .... = Id: MLME IE (0x1)
            .... .000 0001 1010 = Length: 26
        Time Synchronization IE
            Payload Sub IE (short): 0x1a06, Type: Short, Sub Id (Short):
                                              TSCH Synchronization IE
                0... .... .... .... = Type: Short (0)
                .001 1010 .... .... = Sub Id (Short):
                                        TSCH Synchronization IE (0x1a)
                .... .... 0000 0110 = Length: 6
            Absolute Slot Number: 180790
            Join Metric: 1
        TSCH Timeslot IE
            Payload IE TLV: 0x1c01, Type: Short, Sub Id (Short):
                                                  TSCH Timeslot IE
                0... .... .... .... = Type: Short (0)
                .001 1100 .... .... = Sub Id (Short):
                                              TSCH Timeslot IE (0x1c)
                .... .... 0000 0001 = Length: 1
```

```
            Data: 00
        Channel Hopping IE
            Payload Sub IE (long): 0xc801, Type: Long, Sub Id (Long):
                                                    Channel Hopping IE
                1... .... .... .... = Type: Long (1)
                .100 1... .... .... = Sub Id (Long):
                                                  Channel Hopping IE (0x9)
                .... .000 0000 0001 = Length: 1
            Hopping Sequence ID: 0x00
        TSCH Slotframe and Link IE
            Payload Sub IE (short): 0x1b0a, Type: Short, Sub Id (Short):
                                                 TSCH Slotframe and Link IE
                0... .... .... .... = Type: Short (0)
                .001 1011 .... .... = Sub Id (Short):
                                                  TSCH Slotframe and Link IE (0x1b)
                .... .... 0000 1010 = Length: 10
            Number of Slotframes: 1
            Slotframes [1]
                Slotframe handle: 0
                Slotframe size: 101
                Number of Links: 1
                Link Information
                    Timeslot: 0
                    Channel Offset: 0
                    Link Options: 15
FCS: 0x6ca4 (Correct)

== Raw Bytes ==

0000   40 ea bd fe ca ff ff 02 00 00 00 cc 92 15 14 00
0010   3f 1a 88 06 1a 36 c2 02 00 00 01 01 1c 00 01 c8
0020   00 0a 1b 01 00 65 00 01 00 00 00 00 0f a4 6c

   Enhanced Beacon sent by 3

== Dissected packet ==

IEEE 802.15.4 Enhanced Beacon, Dst: Broadcast,
                               Src: 14:15:92:cc:00:00:00:03
Frame Control Field: 0xea40, Frame Type: Beacon, PAN ID Compression,
Information Elements Present, Destination Addressing Mode: Short/16-bit,
Frame Version: IEEE Std 802.15.4-2015,
Source Addressing Mode: Long/64-bit
    .... .... .... .000 = Frame Type: Beacon (0x0)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..0. .... = Acknowledge Request: False
    .... .... .1.. .... = PAN ID Compression: True
```

```
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..1. .... .... = Information Elements Present: True
    .... 10.. .... .... = Destination Addressing Mode:
                                                  Short/16-bit (0x2)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 56
Destination PAN: 0xcafe
Destination: 0xffff
Extended Source: 14:15:92:cc:00:00:00:03 (14:15:92:cc:00:00:00:03)
Header IEs, Header Termination 1 IE
    Header Termination 1 IE (Payload IEs follow)
        IE Header: 0x3f00, Type: Header, Id: Header Termination 1 IE,
                                                            Length: 0
            0... .... .... .... = Type: Header (0)
            .011 1111 0... .... = Id: Header Termination 1 IE (0x7e)
            .... .... .000 0000 = Length: 0
Payload IEs, MLME IE
    MLME IE
        Payload IE TLV: 0x881a, Type: Payload, Id: MLME IE
            1... .... .... .... = Type: Payload (1)
            .000 1... .... .... = Id: MLME IE (0x1)
            .... .000 0001 1010 = Length: 26
        Time Synchronization IE
            Payload Sub IE (short): 0x1a06, Type: Short, Sub Id (Short):
                                              TSCH Synchronization IE
                0... .... .... .... = Type: Short (0)
                .001 1010 .... .... = Sub Id (Short):
                                          TSCH Synchronization IE (0x1a)
                .... .... 0000 0110 = Length: 6
            Absolute Slot Number: 180992
            Join Metric: 2
        TSCH Timeslot IE
            Payload IE TLV: 0x1c01, Type: Short, Sub Id (Short):
                                                TSCH Timeslot IE
                0... .... .... .... = Type: Short (0)
                .001 1100 .... .... = Sub Id (Short):
                                              TSCH Timeslot IE (0x1c)
                .... .... 0000 0001 = Length: 1
            Data: 00
        Channel Hopping IE
            Payload Sub IE (long): 0xc801, Type: Long, Sub Id (Long):
                                                  Channel Hopping IE
                1... .... .... .... = Type: Long (1)
                .100 1... .... .... = Sub Id (Long):
                                            Channel Hopping IE (0x9)
                .... .000 0000 0001 = Length: 1
            Hopping Sequence ID: 0x00
```

```
        TSCH Slotframe and Link IE
            Payload Sub IE (short): 0x1b0a, Type: Short, Sub Id (Short):
                                              TSCH Slotframe and Link IE
                0... .... .... .... = Type: Short (0)
                .001 1011 .... .... = Sub Id (Short):
                                       TSCH Slotframe and Link IE (0x1b)
                .... .... 0000 1010 = Length: 10
            Number of Slotframes: 1
            Slotframes [1]
                Slotframe handle: 0
                Slotframe size: 101
                Number of Links: 1
                Link Information
                    Timeslot: 0
                    Channel Offset: 0
                    Link Options: 15
FCS: 0x045b (Correct)

== Raw Bytes ==

0000   40 ea 38 fe ca ff ff 03 00 00 00 cc 92 15 14 00
0010   3f 1a 88 06 1a 00 c3 02 00 00 02 01 1c 00 01 c8
0020   00 0a 1b 01 00 65 00 01 00 00 00 00 0f 5b 04
```

4.2. Keep-Alive Frame

```
   Keep Alive 2->1

== Dissected packet ==
IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:01,
                    Src: 14:15:92:cc:00:00:00:02
Frame Control Field: 0xec21, Frame Type: Data, Acknowledge Request,
Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                              Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..0. .... .... = Information Elements Present: False
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 188
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
Extended Source: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
FCS: 0xba18 (Correct)

== Raw Bytes ==

0000   21 ec bc fe ca 01 00 00 00 cc 92 15 14 02 00 00
0010   00 cc 92 15 14 18 ba
```

4.3. ACK Frame

ACK Frame

```
== Dissected packet ==

IEEE 802.15.4 Ack, Sequence Number: 57, Dst: 14:15:92:cc:00:00:00:03,
                                        Src: 14:15:92:cc:00:00:00:02
Frame Control Field: 0xee02, Frame Type: Ack,
Information Elements Present, Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015,
Source Addressing Mode: Long/64-bit
    .... .... .... .010 = Frame Type: Ack (0x2)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..0. .... = Acknowledge Request: False
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..1. .... .... = Information Elements Present: True
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 57
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:03 (14:15:92:cc:00:00:00:03)
Extended Source: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
Header IEs, Time Correction IE
    Time Correction IE
        IE Header: 0x0f02, Type: Header, Id: Time Correction IE,
                                                          Length: 2
            0... .... .... .... = Type: Header (0)
            .000 1111 0... .... = Id: Time Correction IE (0x1e)
            .... .... .000 0010 = Length: 2
        Time Sync Info: 0x0000, Time Correction: 0,
        Nack: Acknowledgement
FCS: 0x4141 (Correct)

== Raw Bytes ==

0000   02 ee 39 fe ca 03 00 00 00 cc 92 15 14 02 00 00
0010   00 cc 92 15 14 02 0f 00 00 41 41
```

4.4. Constrained Join Protocol Packets

The examples below deviate from [I-D.ietf-6tisch-minimal-security] in that layer 2 security is disabled and the COAP messages are not protected with OSCORE. Therefore, OSCORE COAP option is missing.

Join Request 3->2

```
IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:02,
Src: 14:15:92:cc:00:00:00:03
Frame Control Field: 0xec21, Frame Type: Data, Acknowledge Request,
Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015,
Source Addressing Mode: Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..0. .... .... = Information Elements Present: False
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
    Sequence Number: 0
    Destination PAN: 0xcafe
    Destination: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
    Extended Source: 14:15:92:cc:00:00:00:03 (14:15:92:cc:00:00:00:03)
    FCS: 0xe7da (Correct)
6LoWPAN
.... 0001 = Page Number: 1
6LoRH: Routing Protocol Information
    100. .... = Routing Header 6lo: Critical Routing Header (0x04)
    ...0 .... .... .... = Packet direction (bit O): Up
    .... 0... .... .... = Rank-Error (bit R): No
    .... .0.. .... .... = Forwarding-Error (bit F): No
    .... ..1. .... .... = RPL Instance (bit I): Elided
                          (RPL Instance ID: 0)
    .... ...1 .... .... = Sender Rank Compression size (bit K): 1 byte
    .... .... 0000 0101 = 6loRH Type:
                                    Routing Protocol Information (0x05)
    RPL Instance: 0x00
    Sender Rank: 0x15
IPHC Header
    011. .... = Pattern: IP header compression (0x03)
    ...1 1... .... .... = Traffic class and flow label: Version,
                          traffic class, and flow label compressed (0x3)
    .... .0.. .... .... = Next header: Inline
    .... ..10 .... .... = Hop limit: 64 (0x2)
    .... .... 0... .... = Context identifier extension: False
    .... .... .0.. .... = Source address compression: Stateless
    .... .... ..01 .... = Source address mode: 64-bits inline (0x0001)
    .... .... .... 0... = Multicast address compression: False
    .... .... .... .0.. = Destination address compression: Stateless
    .... .... .... ..01 = Destination address mode:
                                                  64-bits inline (0x0001)
```

```
    [Source context: fe80::]
    [Destination context: fe80::]
Next header: UDP (0x11)
Source: fe80::1415:92cc:0:3
Destination: fe80::1415:92cc:0:2
Internet Protocol Version 6, Src: fe80::1415:92cc:0:3,
Dst: fe80::1415:92cc:0:2
    0110 .... = Version: 6
    .... 0000 0000 .... .... .... .... .... = Traffic Class: 0x00
                                                (DSCP: CS0, ECN: Not-ECT)
        .... 0000 00.. .... .... .... .... .... = Differentiated
                                            Services Codepoint: Default (0)
        .... .... ..00 .... .... .... .... .... = Explicit Congestion
                                                  Notification: Not ECN-
                                                  Capable Transport (0)
    .... .... .... 0000 0000 0000 0000 0000 = Flow Label: 0x00000
    Payload Length: 38
    Next Header: UDP (17)
    Hop Limit: 64
    Source: fe80::1415:92cc:0:3
    Destination: fe80::1415:92cc:0:2
User Datagram Protocol, Src Port: 5683, Dst Port: 5683
    Source Port: 5683
    Destination Port: 5683
    Length: 38
    Checksum: 0x7b3e [unverified]
    [Checksum Status: Unverified]
    [Stream index: 1]
Constrained Application Protocol, Non-Confirmable, POST, MID:47284
    01.. .... = Version: 1
    ..01 .... = Type: Non-Confirmable (1)
    .... 0000 = Token Length: 0
    Code: POST (2)
    Message ID: 47284
    Opt Name: #1: Uri-Host: 6tisch.arpa
        Opt Desc: Type 3, Critical, Unsafe
        0011 .... = Opt Delta: 3
        .... 1011 = Opt Length: 11
        Uri-Host: 6tisch.arpa
    Opt Name: #2: Uri-Path: j
        Opt Desc: Type 11, Critical, Unsafe
        1000 .... = Opt Delta: 8
        .... 0001 = Opt Length: 1
        Uri-Path: j
    Opt Name: #3: Proxy-Scheme: coap
        Opt Desc: Type 39, Critical, Unsafe
        1101 .... = Opt Delta: 13
        .... 0100 = Opt Length: 4
```

```
        Opt Delta extended: 15
        Proxy-Scheme: coap
    End of options marker: 255
    [Uri-Path: coap://6tisch.arpa/j]
    Payload: Payload Content-Format: application/octet-stream
                                        (no Content-Format), Length: 5
        Payload Desc: application/octet-stream
        [Payload Length: 5]

    Payload is implicitly encoded as CBOR.
    Decoding from cbor.me is presented below:

    A1         # map: 1 element
    05         # unsigned integer (5): network identifier label
    42         # byte string: length 2
    CAFE       # "\xCA\xFE": network identifier (PAN ID)


== Raw Bytes ==

0000   21 ec 00 fe ca 02 00 00 00 cc 92 15 14 03 00 00
0010   00 cc 92 15 14 f1 83 05 15 7a 11 11 14 15 92 cc
0020   00 00 00 03 14 15 92 cc 00 00 00 02 16 33 16 33
0030   00 26 7b 3e 50 02 b8 b4 3b 36 74 69 73 63 68 2e
0040   61 72 70 61 81 6a d4 0f 63 6f 61 70 ff a1 05 42
0050   ca fe da e7


   Join Request 2->1

IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:01,
Src: 14:15:92:cc:00:00:00:02
Frame Control Field: 0xec21, Frame Type: Data, Acknowledge Request,
Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015,
Source Addressing Mode: Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..0. .... .... = Information Elements Present: False
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
    Sequence Number: 17
    Destination PAN: 0xcafe
```

```
    Destination: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
    Extended Source: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
    FCS: 0x042e (Correct)
6LoWPAN
.... 0001 = Page Number: 1
6LoRH: Routing Protocol Information
    100. .... = Routing Header 6lo: Critical Routing Header (0x04)
    ...0 .... .... .... = Packet direction (bit O): Up
    .... 0... .... .... = Rank-Error (bit R): No
    .... .0.. .... .... = Forwarding-Error (bit F): No
    .... ..1. .... .... = RPL Instance (bit I): Elided
                                                  (RPL Instance ID: 0)
    .... ...1 .... .... = Sender Rank Compression size (bit K): 1 byte
    .... .... 0000 0101 = 6loRH Type:
                                  Routing Protocol Information (0x05)
    RPL Instance: 0x00
    Sender Rank: 0x0b
IPHC Header
    011. .... = Pattern: IP header compression (0x03)
    ...1 1... .... .... = Traffic class and flow label: Version, traffic
                                 class, and flow label compressed (0x3)
    .... .0.. .... .... = Next header: Inline
    .... ..10 .... .... = Hop limit: 64 (0x2)
    .... .... 0... .... = Context identifier extension: False
    .... .... .1.. .... = Source address compression: Stateful
    .... .... ..01 .... = Source address mode: 64-bits inline (0x0001)
    .... .... .... 0... = Multicast address compression: False
    .... .... .... .1.. = Destination address compression: Stateful
    .... .... .... ..01 = Destination address mode:
                                                    64-bits inline (0x0001)
    [Source context: bbbb::]
    [Destination context: bbbb::]
Next header: UDP (0x11)
Source: bbbb::1415:92cc:0:2
Destination: bbbb::1415:92cc:0:1
Internet Protocol Version 6, Src: bbbb::1415:92cc:0:2,
                               Dst: bbbb::1415:92cc:0:1
    0110 .... = Version: 6
    .... 0000 0000 .... .... .... .... .... = Traffic Class: 0x00
                                              (DSCP: CS0, ECN: Not-ECT)
        .... 0000 00.. .... .... .... .... .... = Differentiated
                                         Services Codepoint: Default (0)
        .... .... ..00 .... .... .... .... .... = Explicit Congestion
                                                   Notification: Not ECN-
                                                   Capable Transport (0)
    .... .... .... 0000 0000 0000 0000 0000 = Flow Label: 0x00000
    Payload Length: 30
    Next Header: UDP (17)
```

```
    Hop Limit: 64
    Source: bbbb::1415:92cc:0:2
    Destination: bbbb::1415:92cc:0:1
User Datagram Protocol, Src Port: 5683, Dst Port: 5683
    Source Port: 5683
    Destination Port: 5683
    Length: 30
    Checksum: 0x0515 [unverified]
    [Checksum Status: Unverified]
    [Stream index: 2]
Constrained Application Protocol, Non-Confirmable, POST, MID:47284
    01.. .... = Version: 1
    ..01 .... = Type: Non-Confirmable (1)
    .... 0000 = Token Length: 0
    Code: POST (2)
    Message ID: 47284
    Opt Name: #1: Uri-Path: j
        Opt Desc: Type 11, Critical, Unsafe
        1011 .... = Opt Delta: 11
        .... 0001 = Opt Length: 1
        Uri-Path: j
    [Expert Info (Warning/Malformed): Invalid Option Number 40]
        [Invalid Option Number 40]
        [Severity level: Warning]
        [Group: Malformed]
    Opt Name: #2: Unknown Option: 14 15 92 cc 00 00 00 03
        Opt Desc: Type 40, Elective, Safe
        1101 .... = Opt Delta: 13
        .... 1000 = Opt Length: 8
        Opt Delta extended: 16
        Unknown: 141592cc00000003
    End of options marker: 255
    [Uri-Path: /j]
    Payload: Payload Content-Format: application/octet-stream
                                        (no Content-Format), Length: 5
        Payload Desc: application/octet-stream
        [Payload Length: 5]

    Payload is implicitly encoded as CBOR.
    Decoding from cbor.me is presented below:

    A1         # map: 1 element
    05         # unsigned integer (5): network identifier label
    42         # byte string: length 2
    CAFE       # "\xCA\xFE": network identifier (PAN ID)

== Raw Bytes ==
```

```
0000   21 ec 11 fe ca 01 00 00 00 cc 92 15 14 02 00 00
0010   00 cc 92 15 14 f1 83 05 0b 7a 55 11 14 15 92 cc
0020   00 00 00 02 14 15 92 cc 00 00 00 01 16 33 16 33
0030   00 1e 05 15 50 02 b8 b4 b1 6a d8 10 14 15 92 cc
0040   00 00 00 03 ff a1 05 42 ca fe 2e 04
```

Join Response 1->2

```
IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:02,
Src: 14:15:92:cc:00:00:00:01
Frame Control Field: 0xec21, Frame Type: Data, Acknowledge Request,
Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015,
Source Addressing Mode: Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..0. .... .... = Information Elements Present: False
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
    Sequence Number: 37
    Destination PAN: 0xcafe
    Destination: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
    Extended Source: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
    FCS: 0x3d41 (Correct)
6LoWPAN
.... 0001 = Page Number: 1
IPHC Header
    011. .... = Pattern: IP header compression (0x03)
    ...1 1... .... .... = Traffic class and flow label:
                          Version, traffic class, and flow label
                                                    compressed (0x3)
    .... .0.. .... .... = Next header: Inline
    .... ..10 .... .... = Hop limit: 64 (0x2)
    .... .... 0... .... = Context identifier extension: False
    .... .... .1.. .... = Source address compression: Stateful
    .... .... ..01 .... = Source address mode: 64-bits inline (0x0001)
    .... .... .... 0... = Multicast address compression: False
    .... .... .... .1.. = Destination address compression: Stateful
    .... .... .... ..01 = Destination address mode:
                                                  64-bits inline (0x0001)
    [Source context: bbbb::]
    [Destination context: bbbb::]
```

```
Next header: UDP (0x11)
Source: bbbb::1415:92cc:0:1
Destination: bbbb::1415:92cc:0:2
Internet Protocol Version 6, Src: bbbb::1415:92cc:0:1,
Dst: bbbb::1415:92cc:0:2
    0110 .... = Version: 6
    .... 0000 0000 .... .... .... .... .... = Traffic Class: 0x00
                                               (DSCP: CS0, ECN: Not-ECT)
        .... 0000 00.. .... .... .... .... .... = Differentiated
                                                   Services Codepoint:
                                                             Default (0)
        .... .... ..00 .... .... .... .... .... = Explicit Congestion
                                                   Notification: Not ECN-
                                                    Capable Transport (0)
    .... .... .... 0000 0000 0000 0000 0000 = Flow Label: 0x00000
    Payload Length: 44
    Next Header: UDP (17)
    Hop Limit: 64
    Source: bbbb::1415:92cc:0:1
    Destination: bbbb::1415:92cc:0:2
User Datagram Protocol, Src Port: 5683, Dst Port: 5683
    Source Port: 5683
    Destination Port: 5683
    Length: 44
    Checksum: 0x268f [unverified]
    [Checksum Status: Unverified]
    [Stream index: 2]
Constrained Application Protocol, Non-Confirmable,
2.04 Changed, MID:47284
    01.. .... = Version: 1
    ..01 .... = Type: Non-Confirmable (1)
    .... 0000 = Token Length: 0
    Code: 2.04 Changed (68)
    Message ID: 47284
    [Expert Info (Warning/Malformed): Invalid Option Number 40]
        [Invalid Option Number 40]
        [Severity level: Warning]
        [Group: Malformed]
    Opt Name: #1: Unknown Option: 14 15 92 cc 00 00 00 03
        Opt Desc: Type 40, Elective, Safe
        1101 .... = Opt Delta: 13
        .... 1000 = Opt Length: 8
        Opt Delta extended: 27
        Unknown: 141592cc00000003
    End of options marker: 255
    Payload: Payload Content-Format: application/octet-stream
                                          (no Content-Format), Length: 2
        Payload Desc: application/octet-stream
```

```
        [Payload Length: 21]

    Payload is implicitly encoded as CBOR.
    Decoding from cbor.me is presented below:

    A1         # map: 1 element
    02         # unsigned integer (2): link-layer key set label
    82         # array: 2 elements
    01         # unsigned integer (1): key_index value
    50         # byte string: length 16
    11111111111111111111111111111111 # key value

== Raw Bytes ==

0000   21 ec 25 fe ca 02 00 00 00 cc 92 15 14 01 00 00
0010   00 cc 92 15 14 f1 7a 55 11 14 15 92 cc 00 00 00
0020   01 14 15 92 cc 00 00 00 02 16 33 16 33 00 2c 26
0030   8f 50 44 b8 b4 d8 1b 14 15 92 cc 00 00 00 03 ff
0040   a1 02 82 01 50 11 11 11 11 11 11 11 11 11 11 11
0050   11 11 11 11 11 41 3d
```

Join Response 2->3

```
IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:03,
Src: 14:15:92:cc:00:00:00:02
Frame Control Field: 0xec21, Frame Type: Data, Acknowledge Request,
Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015,
Source Addressing Mode: Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..0. .... .... = Information Elements Present: False
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
    Sequence Number: 19
    Destination PAN: 0xcafe
    Destination: 14:15:92:cc:00:00:00:03 (14:15:92:cc:00:00:00:03)
    Extended Source: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
    FCS: 0x9e69 (Correct)
6LoWPAN
.... 0001 = Page Number: 1
6LoRH: Routing Protocol Information
```

```
    100. .... = Routing Header 6lo: Critical Routing Header (0x04)
    ...0 .... .... .... = Packet direction (bit O): Up
    .... 0... .... .... = Rank-Error (bit R): No
    .... .0.. .... .... = Forwarding-Error (bit F): No
    .... ..1. .... .... = RPL Instance (bit I): Elided
                                                  (RPL Instance ID: 0)
    .... ...1 .... .... = Sender Rank Compression size (bit K): 1 byte
    .... .... 0000 0101 = 6loRH Type: Routing Protocol Information
                                                                (0x05)
    RPL Instance: 0x00
    Sender Rank: 0x0b
IPHC Header
    011. .... = Pattern: IP header compression (0x03)
    ...1 1... .... .... = Traffic class and flow label: Version,
    ~                traffic class, and flow label compressed (0x3)
    .... .0.. .... .... = Next header: Inline
    .... ..10 .... .... = Hop limit: 64 (0x2)
    .... .... 0... .... = Context identifier extension: False
    .... .... .0.. .... = Source address compression: Stateless
    .... .... ..01 .... = Source address mode: 64-bits inline (0x0001)
    .... .... .... 0... = Multicast address compression: False
    .... .... .... .0.. = Destination address compression: Stateless
    .... .... .... ..01 = Destination address mode:
                                                  64-bits inline (0x0001)
    [Source context: fe80::]
    [Destination context: fe80::]
Next header: UDP (0x11)
Source: fe80::1415:92cc:0:2
Destination: fe80::1415:92cc:0:3
Internet Protocol Version 6, Src: fe80::1415:92cc:0:2,
Dst: fe80::1415:92cc:0:3
    0110 .... = Version: 6
    .... 0000 0000 .... .... .... .... .... = Traffic Class:
                                        0x00 (DSCP: CS0, ECN: Not-ECT)
        .... 0000 00.. .... .... .... .... .... = Differentiated
                                        Services Codepoint: Default (0)
        .... .... ..00 .... .... .... .... .... = Explicit Congestion
                                          Notification: Not ECN-
                                          Capable Transport (0)
    .... .... .... 0000 0000 0000 0000 0000 = Flow Label: 0x00000
    Payload Length: 34
    Next Header: UDP (17)
    Hop Limit: 64
    Source: fe80::1415:92cc:0:2
    Destination: fe80::1415:92cc:0:3
User Datagram Protocol, Src Port: 5683, Dst Port: 5683
    Source Port: 5683
    Destination Port: 5683
```

```
    Length: 34
    Checksum: 0x364a [unverified]
    [Checksum Status: Unverified]
    [Stream index: 1]
Constrained Application Protocol, Non-Confirmable, 2.04 Changed,
                                                              MID:47284
    01.. .... = Version: 1
    ..01 .... = Type: Non-Confirmable (1)
    .... 0000 = Token Length: 0
    Code: 2.04 Changed (68)
    Message ID: 47284
    End of options marker: 255
    Payload: Payload Content-Format: application/octet-stream
                                          (no Content-Format), Length: 2
        Payload Desc: application/octet-stream
        [Payload Length: 21]

    Payload is implicitly encoded as CBOR.
    Decoding from cbor.me is presented below:

    A1         # map: 1 element
    02         # unsigned integer (2): link-layer key set label
    82         # array: 2 elements
    01         # unsigned integer (1): key_index value
    50         # byte string: length 16
    11111111111111111111111111111111 # key value

== Raw Bytes ==

0000   21 ec 13 fe ca 03 00 00 00 cc 92 15 14 02 00 00
0010   00 cc 92 15 14 f1 83 05 0b 7a 11 11 14 15 92 cc
0020   00 00 00 02 14 15 92 cc 00 00 00 03 16 33 16 33
0030   00 22 36 4a 50 44 b8 b4 ff a1 02 82 01 50 11 11
0040   11 11 11 11 11 11 11 11 11 11 11 11 11 69 9e
```

4.5. RPL DIO

RPL DIO sent by 1

```
== Dissected packet ==

IEEE 802.15.4 Data, Dst: Broadcast, Src: 14:15:92:cc:00:00:00:01
Frame Control Field: 0xe841, Frame Type: Data, PAN ID Compression,
Destination Addressing Mode: Short/16-bit,
Frame Version: IEEE Std 802.15.4-2015,
Source Addressing Mode: Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
```

```
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..0. .... = Acknowledge Request: False
    .... .... .1.. .... = PAN ID Compression: True
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..0. .... .... = Information Elements Present: False
    .... 10.. .... .... = Destination Addressing Mode:
                                                  Short/16-bit (0x2)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 197
Destination PAN: 0xcafe
Destination: 0xffff
Extended Source: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
FCS: 0xeb21 (Correct)
6LoWPAN
IPHC Header
    011. .... = Pattern: IP header compression (0x03)
    ...1 1... .... .... = Traffic class and flow label: Version,
                          traffic class, and flow label compressed (0x3)
    .... .0.. .... .... = Next header: Inline
    .... ..10 .... .... = Hop limit: 64 (0x2)
    .... .... 0... .... = Context identifier extension: False
    .... .... .0.. .... = Source address compression: Stateless
    .... .... ..11 .... = Source address mode: Compressed (0x0003)
    .... .... .... 1... = Multicast address compression: True
    .... .... .... .0.. = Destination address compression: Stateless
    .... .... .... ..11 = Destination address mode:
                                                    8-bits inline (0x0003)
    [Source context: fe80::]
    [Destination context: fe80::]
Next header: ICMPv6 (0x3a)
Source: fe80::1615:92cc:0:1
Destination: ff02::1a
Internet Protocol Version 6, Src: fe80::1615:92cc:0:1, Dst: ff02::1a
0110 .... = Version: 6
.... 0000 0000 .... .... .... .... .... = Traffic Class: 0x00
                                             (DSCP: CS0, ECN: Not-ECT)
    .... 0000 00.. .... .... .... .... .... = Differentiated Services
                                                Codepoint: Default (0)
    .... .... ..00 .... .... .... .... .... = Explicit Congestion
                                               Notification:
                                          Not ECN-Capable Transport (0)
.... .... .... 0000 0000 0000 0000 0000 = Flow Label: 0x00000
Payload Length: 76
Next Header: ICMPv6 (58)
Hop Limit: 64
Source: fe80::1615:92cc:0:1
```

```
Destination: ff02::1a
[Source GeoIP: Unknown]
[Destination GeoIP: Unknown]
Internet Control Message Protocol v6
Type: RPL Control (155)
Code: 1 (DODAG Information Object)
Checksum: 0xbccd [correct]
[Checksum Status: Good]
RPLInstanceID: 0
Version: 0
Rank: 256
Flags: 0x88, Grounded (G), Mode of Operation (MOP): Non-Storing
                                                    Mode of Operation
    1... .... = Grounded (G): True
    .0.. .... = Zero: False
    ..00 1... = Mode of Operation (MOP): Non-Storing
                                          Mode of Operation (0x1)
    .... .000 = DODAG Preference: 0
Destination Advertisement Trigger Sequence Number (DTSN): 51
Flags: 0x00
Reserved: 00
DODAGID: bbbb::1415:92cc:0:1
ICMPv6 RPL Option (Prefix Information bbbb::/64)
    Type: Prefix Information (8)
    Length: 30
    Prefix Length: 64
    Flag: 0x60, Auto Address Config, Router Address
        0... .... = On Link: Not set
        .1.. .... = Auto Address Config: Set
        ..1. .... = Router Address: Set
        ...0 0000 = Reserved: 0
    Valid Lifetime: Infinity (4294967295)
    Preferred Lifetime: Infinity (4294967295)
    Reserved
    Destination Prefix: bbbb::
ICMPv6 RPL Option (DODAG configuration)
    Type: DODAG configuration (4)
    Length: 14
    Flag: 0x00
        0000 .... = Reserved: 0
        .... 0... = Authentication Enabled: Not set
        .... .000 = Path Control Size: 0
    DIOIntervalDoublings: 8
    DIOIntervalMin: 12
    DIORedundancyConstant: 0
    MaxRankInc: 8
    MinHopRankInc: 1
    OCP (Objective Code Point): 0
```

```
    Reserved: 0
    Default Lifetime: 255
    Lifetime Unit: 65535


== Raw Bytes ==

0000   41 e8 c5 fe ca ff ff 01 00 00 00 cc 92 15 14 7a
0010   3b 3a 1a 9b 01 bc cd 00 00 01 00 88 33 00 00 bb
0020   bb 00 00 00 00 00 00 14 15 92 cc 00 00 00 01 08
0030   1e 40 60 ff ff ff ff ff ff ff ff 00 00 00 00 bb
0040   bb 00 00 00 00 00 00 00 00 00 00 00 00 00 00 04
0050   0e 00 08 0c 00 00 08 00 01 00 00 00 ff ff ff 21
0060   eb
```

RPL DIO sent by 2

```
== Dissected packet ==

IEEE 802.15.4 Data, Dst: Broadcast, Src: 14:15:92:cc:00:00:00:02
Frame Control Field: 0xe841, Frame Type: Data, PAN ID Compression,
Destination Addressing Mode: Short/16-bit,
Frame Version: IEEE Std 802.15.4-2015,
Source Addressing Mode: Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..0. .... = Acknowledge Request: False
    .... .... .1.. .... = PAN ID Compression: True
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..0. .... .... = Information Elements Present: False
    .... 10.. .... .... = Destination Addressing Mode:
                                                  Short/16-bit (0x2)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 197
Destination PAN: 0xcafe
Destination: 0xffff
Extended Source: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
FCS: 0xab62 (Correct)
6LoWPAN
IPHC Header
    011. .... = Pattern: IP header compression (0x03)
    ...1 1... .... .... = Traffic class and flow label: Version,
                          traffic class, and flow label compressed (0x3)
    .... .0.. .... .... = Next header: Inline
    .... ..10 .... .... = Hop limit: 64 (0x2)
    .... .... 0... .... = Context identifier extension: False
```

```
    .... .... .0.. .... = Source address compression: Stateless
    .... .... ..11 .... = Source address mode: Compressed (0x0003)
    .... .... .... 1... = Multicast address compression: True
    .... .... .... .0.. = Destination address compression: Stateless
    .... .... .... ..11 = Destination address mode:
                                                  8-bits inline (0x0003)
    [Source context: fe80::]
    [Destination context: fe80::]
Next header: ICMPv6 (0x3a)
Source: fe80::1615:92cc:0:2
Destination: ff02::1a
Internet Protocol Version 6, Src: fe80::1615:92cc:0:2, Dst: ff02::1a
0110 .... = Version: 6
.... 0000 0000 .... .... .... .... .... = Traffic Class:
                                           0x00 (DSCP: CS0, ECN: Not-ECT)
    .... 0000 00.. .... .... .... .... .... = Differentiated Services
                                                  Codepoint: Default (0)
    .... .... ..00 .... .... .... .... .... = Explicit Congestion
                                                       Notification:
                                            Not ECN-Capable Transport (0)
.... .... .... 0000 0000 0000 0000 0000 = Flow Label: 0x00000
Payload Length: 76
Next Header: ICMPv6 (58)
Hop Limit: 64
Source: fe80::1615:92cc:0:2
Destination: ff02::1a
[Source GeoIP: Unknown]
[Destination GeoIP: Unknown]
Internet Control Message Protocol v6
Type: RPL Control (155)
Code: 1 (DODAG Information Object)
Checksum: 0xbbcc [correct]
[Checksum Status: Good]
RPLInstanceID: 0
Version: 0
Rank: 512
Flags: 0x88, Grounded (G), Mode of Operation (MOP): Non-Storing
                                                        Mode of Operation
    1... .... = Grounded (G): True
    .0.. .... = Zero: False
    ..00 1... = Mode of Operation (MOP): Non-Storing
                                                   Mode of Operation (0x1)
    .... .000 = DODAG Preference: 0
Destination Advertisement Trigger Sequence Number (DTSN): 51
Flags: 0x00
Reserved: 00
DODAGID: bbbb::1415:92cc:0:1
ICMPv6 RPL Option (Prefix Information bbbb::/64)
```

```
    Type: Prefix Information (8)
    Length: 30
    Prefix Length: 64
    Flag: 0x60, Auto Address Config, Router Address
        0... .... = On Link: Not set
        .1.. .... = Auto Address Config: Set
        ..1. .... = Router Address: Set
        ...0 0000 = Reserved: 0
    Valid Lifetime: Infinity (4294967295)
    Preferred Lifetime: Infinity (4294967295)
    Reserved
    Destination Prefix: bbbb::
ICMPv6 RPL Option (DODAG configuration)
    Type: DODAG configuration (4)
    Length: 14
    Flag: 0x00
        0000 .... = Reserved: 0
        .... 0... = Authentication Enabled: Not set
        .... .000 = Path Control Size: 0
    DIOIntervalDoublings: 8
    DIOIntervalMin: 12
    DIORedundancyConstant: 0
    MaxRankInc: 8
    MinHopRankInc: 1
    OCP (Objective Code Point): 0
    Reserved: 0
    Default Lifetime: 255
    Lifetime Unit: 65535


== Raw Bytes ==

0000   41 e8 c5 fe ca ff ff 02 00 00 00 cc 92 15 14 7a
0010   3b 3a 1a 9b 01 bb cc 00 00 02 00 88 33 00 00 bb
0020   bb 00 00 00 00 00 00 14 15 92 cc 00 00 00 01 08
0030   1e 40 60 ff ff ff ff ff ff ff ff 00 00 00 00 bb
0040   bb 00 00 00 00 00 00 00 00 00 00 00 00 00 00 04
0050   0e 00 08 0c 00 00 08 00 01 00 00 00 ff ff ff 62
0060   ab

   RPL DIO sent by 3

== Dissected packet ==

IEEE 802.15.4 Data, Dst: Broadcast, Src: 14:15:92:cc:00:00:00:03
Frame Control Field: 0xe841, Frame Type: Data, PAN ID Compression,
Destination Addressing Mode: Short/16-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
```

```
                                                              Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..0. .... = Acknowledge Request: False
    .... .... .1.. .... = PAN ID Compression: True
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..0. .... .... = Information Elements Present: False
    .... 10.. .... .... = Destination Addressing Mode:
                                                    Short/16-bit (0x2)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 66
Destination PAN: 0xcafe
Destination: 0xffff
Extended Source: 14:15:92:cc:00:00:00:03 (14:15:92:cc:00:00:00:03)
FCS: 0x7daa (Correct)
6LoWPAN
IPHC Header
    011. .... = Pattern: IP header compression (0x03)
    ...1 1... .... .... = Traffic class and flow label: Version,
                          traffic class, and flow label compressed (0x3)
    .... .0.. .... .... = Next header: Inline
    .... ..10 .... .... = Hop limit: 64 (0x2)
    .... .... 0... .... = Context identifier extension: False
    .... .... .0.. .... = Source address compression: Stateless
    .... .... ..11 .... = Source address mode: Compressed (0x0003)
    .... .... .... 1... = Multicast address compression: True
    .... .... .... .0.. = Destination address compression: Stateless
    .... .... .... ..11 = Destination address mode:
                                                  8-bits inline (0x0003)
    [Source context: fe80::]
    [Destination context: fe80::]
Next header: ICMPv6 (0x3a)
Source: fe80::1615:92cc:0:3
Destination: ff02::1a
Internet Protocol Version 6, Src: fe80::1615:92cc:0:3, Dst: ff02::1a
0110 .... = Version: 6
.... 0000 0000 .... .... .... .... .... = Traffic Class:
                                          0x00 (DSCP: CS0, ECN: Not-ECT)
    .... 0000 00.. .... .... .... .... .... = Differentiated Services
                                               Codepoint: Default (0)
    .... .... ..00 .... .... .... .... .... = Explicit Congestion
                                                          Notification:
                                           Not ECN-Capable Transport (0)
.... .... .... 0000 0000 0000 0000 0000 = Flow Label: 0x00000
Payload Length: 76
Next Header: ICMPv6 (58)
```

```
Hop Limit: 64
Source: fe80::1615:92cc:0:3
Destination: ff02::1a
[Source GeoIP: Unknown]
[Destination GeoIP: Unknown]
Internet Control Message Protocol v6
Type: RPL Control (155)
Code: 1 (DODAG Information Object)
Checksum: 0xbabe [correct]
[Checksum Status: Good]
RPLInstanceID: 0
Version: 0
Rank: 781
Flags: 0x88, Grounded (G), Mode of Operation (MOP): Non-Storing
                                                    Mode of Operation
    1... .... = Grounded (G): True
    .0.. .... = Zero: False
    ..00 1... = Mode of Operation (MOP): Non-Storing
                                          Mode of Operation (0x1)
    .... .000 = DODAG Preference: 0
Destination Advertisement Trigger Sequence Number (DTSN): 51
Flags: 0x00
Reserved: 00
DODAGID: bbbb::1415:92cc:0:1
ICMPv6 RPL Option (Prefix Information bbbb::/64)
    Type: Prefix Information (8)
    Length: 30
    Prefix Length: 64
    Flag: 0x60, Auto Address Config, Router Address
        0... .... = On Link: Not set
        .1.. .... = Auto Address Config: Set
        ..1. .... = Router Address: Set
        ...0 0000 = Reserved: 0
    Valid Lifetime: Infinity (4294967295)
    Preferred Lifetime: Infinity (4294967295)
    Reserved
    Destination Prefix: bbbb::
ICMPv6 RPL Option (DODAG configuration)
    Type: DODAG configuration (4)
    Length: 14
    Flag: 0x00
        0000 .... = Reserved: 0
        .... 0... = Authentication Enabled: Not set
        .... .000 = Path Control Size: 0
    DIOIntervalDoublings: 8
    DIOIntervalMin: 12
    DIORedundancyConstant: 0
    MaxRankInc: 8
```

```
    MinHopRankInc: 1
    OCP (Objective Code Point): 0
    Reserved: 0
    Default Lifetime: 255
    Lifetime Unit: 65535


== Raw Bytes ==

0000   41 e8 42 fe ca ff ff 03 00 00 00 cc 92 15 14 7a
0010   3b 3a 1a 9b 01 ba be 00 00 03 0d 88 33 00 00 bb
0020   bb 00 00 00 00 00 00 14 15 92 cc 00 00 00 01 08
0030   1e 40 60 ff ff ff ff ff ff ff ff 00 00 00 00 bb
0040   bb 00 00 00 00 00 00 00 00 00 00 00 00 00 00 04
0050   0e 00 08 0c 00 00 08 00 01 00 00 00 ff ff ff aa
0060   7d
```

4.6. RPL DAO

4.6.1. RPL DAO from 2

[RPL DAO from 2] 2->1

```
== Dissected packet ==


IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:01,
Src: 14:15:92:cc:00:00:00:02
Frame Control Field: 0xec21, Frame Type: Data, Acknowledge Request,
Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                          Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..0. .... .... = Information Elements Present: False
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 223
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
Extended Source: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
FCS: 0xc883 (Correct)
```

```
6LoWPAN
.... 0001 = Page Number: 1
6LoRH: Routing Protocol Information
    100. .... = Routing Header 6lo: Critical Routing Header (0x04)
    ...0 .... .... .... = Packet direction (bit O): Up
    .... 0... .... .... = Rank-Error (bit R): No
    .... .0.. .... .... = Forwarding-Error (bit F): No
    .... ..1. .... .... = RPL Instance (bit I): Elided
                                                    (RPL Instance ID: 0)
    .... ...1 .... .... = Sender Rank Compression size (bit K): 1 byte
    .... .... 0000 0101 = 6loRH Type: Routing Protocol Information
                                                                (0x05)
    RPL Instance: 0x00
    Sender Rank: 0x02
IPHC Header
    011. .... = Pattern: IP header compression (0x03)
    ...1 1... .... .... = Traffic class and flow label: Version,
                          traffic class, and flow label compressed (0x3)
    .... .0.. .... .... = Next header: Inline
    .... ..10 .... .... = Hop limit: 64 (0x2)
    .... .... 0... .... = Context identifier extension: False
    .... .... .1.. .... = Source address compression: Stateful
    .... .... ..01 .... = Source address mode: 64-bits inline (0x0001)
    .... .... .... 0... = Multicast address compression: False
    .... .... .... .1.. = Destination address compression: Stateful
    .... .... .... ..01 = Destination address mode:
                                                    64-bits inline (0x0001)
    [Source context: bbbb::]
    [Destination context: bbbb::]
Next header: ICMPv6 (0x3a)
Source: bbbb::1415:92cc:0:2
Destination: bbbb::1415:92cc:0:1
Internet Protocol Version 6, Src: bbbb::1415:92cc:0:2,
                               Dst: bbbb::1415:92cc:0:1
0110 .... = Version: 6
.... 0000 0000 .... .... .... .... .... = Traffic Class:
                                           0x00 (DSCP: CS0, ECN: Not-ECT)
    .... 0000 00.. .... .... .... .... .... = Differentiated Services
                                                Codepoint: Default (0)
    .... .... ..00 .... .... .... .... .... = Explicit Congestion
                                                          Notification:
                                            Not ECN-Capable Transport (0)
.... .... .... 0000 0000 0000 0000 0000 = Flow Label: 0x00000
Payload Length: 66
Next Header: ICMPv6 (58)
Hop Limit: 64
Source: bbbb::1415:92cc:0:2
Destination: bbbb::1415:92cc:0:1
```

```
[Source GeoIP: Unknown]
[Destination GeoIP: Unknown]
Internet Control Message Protocol v6
Type: RPL Control (155)
Code: 2 (Destination Advertisement Object)
Checksum: 0x3aa5 [correct]
[Checksum Status: Good]
RPLInstanceID: 0
Flags: 0x40, DODAGID Present (D)
    0... .... = DAO-ACK Request (K): False
    .1.. .... = DODAGID Present (D): True
    ..00 0000 = Reserved: 0
Reserved: 00
DAO Sequence: 49
DODAGID: bbbb::1415:92cc:0:1
ICMPv6 RPL Option (RPL Target bbbb::1415:92cc:0:3/128)
    Type: RPL Target (5)
    Length: 18
    Reserved
    Target Length: 128
    Target: bbbb::1415:92cc:0:3
ICMPv6 RPL Option (Transit Information bbbb::1415:92cc:0:1)
    Type: Transit Information (6)
    Length: 20
    Flags: 0x00
        0... .... = External: Not set
        .000 0000 = Reserved: 0
    Path Control: 0
    Path Sequence: 48
    Path Lifetime: 170
    Parent Address: bbbb::1415:92cc:0:1


== Raw Bytes ==
0000   21 ec df fe ca 01 00 00 00 cc 92 15 14 02 00 00
0010   00 cc 92 15 14 f1 83 05 02 7a 55 3a 14 15 92 cc
0020   00 00 00 02 14 15 92 cc 00 00 00 01 9b 02 3a a5
0030   00 40 00 31 bb bb 00 00 00 00 00 00 14 15 92 cc
0040   00 00 00 01 05 12 00 80 bb bb 00 00 00 00 00 00
0050   14 15 92 cc 00 00 00 03 06 14 00 00 30 aa bb bb
0060   00 00 00 00 00 00 14 15 92 cc 00 00 00 01 83 c8
```

4.6.2. RPL DAO from 3

[RPL DAO from 3] 3->2

```
== Dissected packet ==
```

```
IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:02,
                    Src: 14:15:92:cc:00:00:00:03
Frame Control Field: 0xec21, Frame Type: Data, Acknowledge Request,
Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                              Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..0. .... .... = Information Elements Present: False
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 6
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
Extended Source: 14:15:92:cc:00:00:00:03 (14:15:92:cc:00:00:00:03)
FCS: 0xee92 (Correct)
6LoWPAN
    .... 0001 = Page Number: 1
    6LoRH: Routing Protocol Information
        100. .... = Routing Header 6lo: Critical Routing Header (0x04)
        ...0 .... .... .... = Packet direction (bit O): Up
        .... 0... .... .... = Rank-Error (bit R): No
        .... .0.. .... .... = Forwarding-Error (bit F): No
        .... ..1. .... .... = RPL Instance (bit I):
                                              Elided (RPL Instance ID: 0)
        .... ...0 .... .... = Sender Rank Compression size (bit K):
                                                              2 bytes
        .... .... 0000 0101 = 6loRH Type:
                                    Routing Protocol Information (0x05)
        RPL Instance: 0x00
        Sender Rank: 0x0c2b
    IPHC Header
        011. .... = Pattern: IP header compression (0x03)
        ...1 1... .... .... = Traffic class and flow label: Version,
                              traffic class, and flow label compressed (0x3)
        .... .0.. .... .... = Next header: Inline
        .... ..10 .... .... = Hop limit: 64 (0x2)
        .... .... 0... .... = Context identifier extension: False
        .... .... .1.. .... = Source address compression: Stateful
        .... .... ..01 .... = Source address mode:
                                                 64-bits inline (0x0001)
        .... .... .... 0... = Multicast address compression: False
        .... .... .... .1.. = Destination address compression: Stateful
```

```
        .... .... .... ..01 = Destination address mode:
                                                64-bits inline (0x0001)
        [Source context: bbbb::]
        [Destination context: bbbb::]
    Next header: ICMPv6 (0x3a)
    Source: bbbb::1415:92cc:0:3
    Destination: bbbb::1415:92cc:0:1
Internet Protocol Version 6, Src: bbbb::1415:92cc:0:3,
                               Dst: bbbb::1415:92cc:0:1
    0110 .... = Version: 6
    .... 0000 0000 .... .... .... .... .... = Traffic Class:
                                        0x00 (DSCP: CS0, ECN: Not-ECT)
        .... 0000 00.. .... .... .... .... .... = Differentiated
                                       Services Codepoint: Default (0)
        .... .... ..00 .... .... .... .... .... = Explicit Congestion
                                                   Notification:
                                         Not ECN-Capable Transport (0)
    .... .... .... 0000 0000 0000 0000 0000 = Flow Label: 0x00000
    Payload Length: 46
    Next Header: ICMPv6 (58)
    Hop Limit: 64
    Source: bbbb::1415:92cc:0:3
    Destination: bbbb::1415:92cc:0:1
Internet Control Message Protocol v6
    Type: RPL Control (155)
    Code: 2 (Destination Advertisement Object)
    Checksum: 0xd218 [correct]
    [Checksum Status: Good]
    RPLInstanceID: 0
    Flags: 0x40, DODAGID Present (D)
        0... .... = DAO-ACK Request (K): False
        .1.. .... = DODAGID Present (D): True
        ..00 0000 = Reserved: 0
    Reserved: 00
    DAO Sequence: 2
    DODAGID: bbbb::1415:92cc:0:1
    ICMPv6 RPL Option (Transit Information bbbb::1415:92cc:0:2)
        Type: Transit Information (6)
        Length: 20
        Flags: 0x00
            0... .... = External: Not set
            .000 0000 = Reserved: 0
        Path Control: 0
        Path Sequence: 1
        Path Lifetime: 170
        Parent Address: bbbb::1415:92cc:0:2

== Raw Bytes ==
```

```
0000   21 ec 06 fe ca 02 00 00 00 cc 92 15 14 03 00 00
0010   00 cc 92 15 14 f1 82 05 0c 2b 7a 55 3a 14 15 92
0020   cc 00 00 00 03 14 15 92 cc 00 00 00 01 9b 02 d2
0030   18 00 40 00 02 bb bb 00 00 00 00 00 00 14 15 92
0040   cc 00 00 00 01 06 14 00 00 01 aa bb bb 00 00 00
0050   00 00 00 14 15 92 cc 00 00 00 02 92 ee
```

[RPL DAO from 3] 2->1

```
== Dissected packet ==

IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:01,
Src: 14:15:92:cc:00:00:00:02
Frame Control Field: 0xec21, Frame Type: Data,
Acknowledge Request, Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                          Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..0. .... .... = Information Elements Present: False
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 161
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
Extended Source: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
FCS: 0x4f42 (Correct)
6LoWPAN
    .... 0001 = Page Number: 1
    6LoRH: Routing Protocol Information
        100. .... = Routing Header 6lo: Critical Routing Header (0x04)
        ...0 .... .... .... = Packet direction (bit O): Up
        .... 0... .... .... = Rank-Error (bit R): No
        .... .0.. .... .... = Forwarding-Error (bit F): No
        .... ..1. .... .... = RPL Instance (bit I):
                                              Elided (RPL Instance ID: 0)
        .... ...0 .... .... = Sender Rank Compression size (bit K):
                                                              2 bytes
        .... .... 0000 0101 = 6loRH Type:
                                    Routing Protocol Information (0x05)
        RPL Instance: 0x00
        Sender Rank: 0x0229
```

```
    IPHC Header
        011. .... = Pattern: IP header compression (0x03)
        ...1 1... .... .... = Traffic class and flow label: Version,
                              traffic class, and flow label
                                                    compressed (0x3)
        .... .0.. .... .... = Next header: Inline
        .... ..10 .... .... = Hop limit: 64 (0x2)
        .... .... 0... .... = Context identifier extension: False
        .... .... .1.. .... = Source address compression: Stateful
        .... .... ..01 .... = Source address mode:
                                                    64-bits inline (0x0001)
        .... .... .... 0... = Multicast address compression: False
        .... .... .... .1.. = Destination address compression: Stateful
        .... .... .... ..01 = Destination address mode:
                                                    64-bits inline (0x0001)
        [Source context: bbbb::]
        [Destination context: bbbb::]
    Next header: ICMPv6 (0x3a)
    Source: bbbb::1415:92cc:0:3
    Destination: bbbb::1415:92cc:0:1
Internet Protocol Version 6, Src: bbbb::1415:92cc:0:3,
                               Dst: bbbb::1415:92cc:0:1
    0110 .... = Version: 6
    .... 0000 0000 .... .... .... .... .... = Traffic Class:
                                          0x00 (DSCP: CS0, ECN: Not-ECT)
        .... 0000 00.. .... .... .... .... .... = Differentiated
                                        Services Codepoint: Default (0)
        .... .... ..00 .... .... .... .... .... = Explicit Congestion
                                                          Notification:
                                          Not ECN-Capable Transport (0)
    .... .... .... 0000 0000 0000 0000 0000 = Flow Label: 0x00000
    Payload Length: 46
    Next Header: ICMPv6 (58)
    Hop Limit: 64
    Source: bbbb::1415:92cc:0:3
    Destination: bbbb::1415:92cc:0:1
Internet Control Message Protocol v6
    Type: RPL Control (155)
    Code: 2 (Destination Advertisement Object)
    Checksum: 0xd218 [correct]
    [Checksum Status: Good]
    RPLInstanceID: 0
    Flags: 0x40, DODAGID Present (D)
        0... .... = DAO-ACK Request (K): False
        .1.. .... = DODAGID Present (D): True
        ..00 0000 = Reserved: 0
    Reserved: 00
    DAO Sequence: 2
```

```
    DODAGID: bbbb::1415:92cc:0:1
    ICMPv6 RPL Option (Transit Information bbbb::1415:92cc:0:2)
        Type: Transit Information (6)
        Length: 20
        Flags: 0x00
            0... .... = External: Not set
            .000 0000 = Reserved: 0
        Path Control: 0
        Path Sequence: 1
        Path Lifetime: 170
        Parent Address: bbbb::1415:92cc:0:2

== Raw Bytes ==

0000   21 ec a1 fe ca 01 00 00 00 cc 92 15 14 02 00 00
0010   00 cc 92 15 14 f1 82 05 02 29 7a 55 3a 14 15 92
0020   cc 00 00 00 03 14 15 92 cc 00 00 00 01 9b 02 d2
0030   18 00 40 00 02 bb bb 00 00 00 00 00 00 14 15 92
0040   cc 00 00 00 01 06 14 00 00 01 aa bb bb 00 00 00
0050   00 00 00 14 15 92 cc 00 00 00 02 42 4f
```

4.7. ICMPv6 echo request/reply

4.7.1. ping 2

[ping 2] ICMPv6 echo request 1->2

```
== Dissected packet ==

IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:02,
                    Src: 14:15:92:cc:00:00:00:01
Frame Control Field: 0xec21, Frame Type: Data, Acknowledge Request,
Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                          Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..0. .... .... = Information Elements Present: False
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 74
Destination PAN: 0xcafe
```

```
Destination: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
Extended Source: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
FCS: 0x6ec7 (Correct)
6LoWPAN
.... 0001 = Page Number: 1
IPHC Header
    011. .... = Pattern: IP header compression (0x03)
    ...1 1... .... .... = Traffic class and flow label: Version,
                          traffic class, and flow label compressed (0x3)
    .... .0.. .... .... = Next header: Inline
    .... ..00 .... .... = Hop limit: Inline (0x0)
    .... .... 0... .... = Context identifier extension: False
    .... .... .1.. .... = Source address compression: Stateful
    .... .... ..01 .... = Source address mode: 64-bits inline (0x0001)
    .... .... .... 0... = Multicast address compression: False
    .... .... .... .1.. = Destination address compression: Stateful
    .... .... .... ..01 = Destination address mode:
                                                  64-bits inline (0x0001)
    [Source context: bbbb::]
    [Destination context: bbbb::]
Next header: ICMPv6 (0x3a)
Hop limit: 128
Source: bbbb::1
Destination: bbbb::1415:92cc:0:2
Internet Protocol Version 6, Src: bbbb::1, Dst: bbbb::1415:92cc:0:2
0110 .... = Version: 6
.... 0000 0000 .... .... .... .... .... = Traffic Class:
                                           0x00 (DSCP: CS0, ECN: Not-ECT)
    .... 0000 00.. .... .... .... .... .... = Differentiated Services
                                                Codepoint: Default (0)
    .... .... ..00 .... .... .... .... .... = Explicit Congestion
                                                          Notification:
                                            Not ECN-Capable Transport (0)
.... .... .... 0000 0000 0000 0000 0000 = Flow Label: 0x00000
Payload Length: 40
Next Header: ICMPv6 (58)
Hop Limit: 128
Source: bbbb::1
Destination: bbbb::1415:92cc:0:2
[Source GeoIP: Unknown]
[Destination GeoIP: Unknown]
Internet Control Message Protocol v6
Type: Echo (ping) request (128)
Code: 0
Checksum: 0xb662 [correct]
[Checksum Status: Good]
Identifier: 0x0001
Sequence: 58
```

```
[Response In: 2369]
Data (32 bytes)
    Data: 6162636465666768696a6b6c6d6e6f707172737475767761...
    [Length: 32]

== Raw Bytes ==

0000   21 ec 4a fe ca 02 00 00 00 cc 92 15 14 01 00 00
0010   00 cc 92 15 14 f1 78 55 3a 80 00 00 00 00 00 00
0020   00 01 14 15 92 cc 00 00 00 02 80 00 b6 62 00 01
0030   00 3a 61 62 63 64 65 66 67 68 69 6a 6b 6c 6d 6e
0040   6f 70 71 72 73 74 75 76 77 61 62 63 64 65 66 67
0050   68 69 c7 6e

   [ping 2] ICMPv6 echo reply 2->1

== Dissected packet ==

IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:01,
                    Src: 14:15:92:cc:00:00:00:02
Frame Control Field: 0xec21, Frame Type: Data, Acknowledge Request,
Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                              Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..0. .... .... = Information Elements Present: False
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 6
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
Extended Source: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
FCS: 0x1763 (Correct)
6LoWPAN
.... 0001 = Page Number: 1
6LoRH: Routing Protocol Information
    100. .... = Routing Header 6lo: Critical Routing Header (0x04)
    ...0 .... .... .... = Packet direction (bit O): Up
    .... 0... .... .... = Rank-Error (bit R): No
    .... .0.. .... .... = Forwarding-Error (bit F): No
    .... ..1. .... .... = RPL Instance (bit I):
                                            Elided (RPL Instance ID: 0)
```

```
    .... ...0 .... .... = Sender Rank Compression size (bit K): 2 bytes
    .... .... 0000 0101 = 6loRH Type:
                                    Routing Protocol Information (0x05)
    RPL Instance: 0x00
    Sender Rank: 0x028a
IPHC Header
    011. .... = Pattern: IP header compression (0x03)
    ...1 1... .... .... = Traffic class and flow label: Version,
                          traffic class, and flow label compressed (0x3)
    .... .0.. .... .... = Next header: Inline
    .... ..10 .... .... = Hop limit: 64 (0x2)
    .... .... 0... .... = Context identifier extension: False
    .... .... .1.. .... = Source address compression: Stateful
    .... .... ..01 .... = Source address mode: 64-bits inline (0x0001)
    .... .... .... 0... = Multicast address compression: False
    .... .... .... .1.. = Destination address compression: Stateful
    .... .... .... ..01 = Destination address mode:
                                                  64-bits inline (0x0001)
    [Source context: bbbb::]
    [Destination context: bbbb::]
Next header: ICMPv6 (0x3a)
Source: bbbb::1415:92cc:0:2
Destination: bbbb::1
Internet Protocol Version 6, Src: bbbb::1415:92cc:0:2, Dst: bbbb::1
0110 .... = Version: 6
.... 0000 0000 .... .... .... .... .... = Traffic Class:
                                          0x00 (DSCP: CS0, ECN: Not-ECT)
    .... 0000 00.. .... .... .... .... .... = Differentiated Services
                                               Codepoint: Default (0)
    .... .... ..00 .... .... .... .... .... = Explicit Congestion
                                                          Notification:
                                           Not ECN-Capable Transport (0)
.... .... .... 0000 0000 0000 0000 0000 = Flow Label: 0x00000
Payload Length: 40
Next Header: ICMPv6 (58)
Hop Limit: 64
Source: bbbb::1415:92cc:0:2
Destination: bbbb::1
[Source GeoIP: Unknown]
[Destination GeoIP: Unknown]
Internet Control Message Protocol v6
Type: Echo (ping) reply (129)
Code: 0
Checksum: 0xb562 [correct]
[Checksum Status: Good]
Identifier: 0x0001
Sequence: 58
[Response To: 2366]
```

```
[Response Time: 1857.163 ms]
Data (32 bytes)
    Data: 6162636465666768696a6b6c6d6e6f707172737475767761...
    [Length: 32]


== Raw Bytes ==

0000   21 ec 06 fe ca 01 00 00 00 cc 92 15 14 02 00 00
0010   00 cc 92 15 14 f1 82 05 02 8a 7a 55 3a 14 15 92
0020   cc 00 00 00 02 00 00 00 00 00 00 00 01 81 00 b5
0030   62 00 01 00 3a 61 62 63 64 65 66 67 68 69 6a 6b
0040   6c 6d 6e 6f 70 71 72 73 74 75 76 77 61 62 63 64
0050   65 66 67 68 69 63 17
```

4.7.2. ping 3

[ping 3] ICMPv6 echo request 1->2

```
== Dissected packet ==

IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:02,
                    Src: 14:15:92:cc:00:00:00:01
Frame Control Field: 0xec21, Frame Type: Data, Acknowledge Request,
Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                              Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..0. .... .... = Information Elements Present: False
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 163
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
Extended Source: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
FCS: 0xd31e (Correct)
6LoWPAN
.... 0001 = Page Number: 1
6LoRH: Routing Header 3, 8 byte compression
    100. .... = Routing Header 6lo: Critical Routing Header (0x04)
    ...0 0000 .... .... = 6loRH Hop Number-1: 0x00
    .... .... 0000 0011 = 6loRH Type: Routing Header 3,
```

```
                                                    8 byte compression (0x03)
Source/8, Delta: ::1415:92cc:0:2
IPHC Header
    011. .... = Pattern: IP header compression (0x03)
    ...1 1... .... .... = Traffic class and flow label: Version,
                          traffic class, and flow label compressed (0x3)
    .... .0.. .... .... = Next header: Inline
    .... ..00 .... .... = Hop limit: Inline (0x0)
    .... .... 0... .... = Context identifier extension: False
    .... .... .1.. .... = Source address compression: Stateful
    .... .... ..01 .... = Source address mode: 64-bits inline (0x0001)
    .... .... .... 0... = Multicast address compression: False
    .... .... .... .1.. = Destination address compression: Stateful
    .... .... .... ..01 = Destination address mode:
                                                      64-bits inline (0x0001)
    [Source context: bbbb::]
    [Destination context: bbbb::]
Next header: ICMPv6 (0x3a)
Hop limit: 128
Source: bbbb::1
Destination: bbbb::1415:92cc:0:3
Internet Protocol Version 6, Src: bbbb::1, Dst: bbbb::1415:92cc:0:3
0110 .... = Version: 6
.... 0000 0000 .... .... .... .... .... = Traffic Class:
                                           0x00 (DSCP: CS0, ECN: Not-ECT)
    .... 0000 00.. .... .... .... .... .... = Differentiated Services
                                                Codepoint: Default (0)
    .... .... ..00 .... .... .... .... .... = Explicit Congestion
                                                          Notification:
                                            Not ECN-Capable Transport (0)
.... .... .... 0000 0000 0000 0000 0000 = Flow Label: 0x00000
Payload Length: 40
Next Header: ICMPv6 (58)
Hop Limit: 128
Source: bbbb::1
Destination: bbbb::1415:92cc:0:3
[Source GeoIP: Unknown]
[Destination GeoIP: Unknown]
Internet Control Message Protocol v6
Type: Echo (ping) request (128)
Code: 0
Checksum: 0xb65c [correct]
[Checksum Status: Good]
Identifier: 0x0001
Sequence: 63
[No response seen]
    [Expert Info (Warning/Sequence):
                      No response seen to ICMPv6 request in frame 3229]
```

```
Data (32 bytes)
    Data: 6162636465666768696a6b6c6d6e6f707172737475767761...
    [Length: 32]


== Raw Bytes ==

0000   21 ec a3 fe ca 02 00 00 00 cc 92 15 14 01 00 00
0010   00 cc 92 15 14 f1 80 03 14 15 92 cc 00 00 00 02
0020   78 55 3a 80 00 00 00 00 00 00 00 01 14 15 92 cc
0030   00 00 00 03 80 00 b6 5c 00 01 00 3f 61 62 63 64
0040   65 66 67 68 69 6a 6b 6c 6d 6e 6f 70 71 72 73 74
0050   75 76 77 61 62 63 64 65 66 67 68 69 1e d3

   [ping 3] ICMPv6 echo request 2->3

== Dissected packet ==

IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:03,
Src: 14:15:92:cc:00:00:00:02
Frame Control Field: 0xec21, Frame Type: Data, Acknowledge Request,
Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                          Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..0. .... .... = Information Elements Present: False
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 94
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:03 (14:15:92:cc:00:00:00:03)
Extended Source: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
FCS: 0x05ee (Correct)
6LoWPAN
IPHC Header
    011. .... = Pattern: IP header compression (0x03)
    ...1 1... .... .... = Traffic class and flow label: Version,
                          traffic class, and flow label compressed (0x3)
    .... .0.. .... .... = Next header: Inline
    .... ..00 .... .... = Hop limit: Inline (0x0)
    .... .... 0... .... = Context identifier extension: False
    .... .... .1.. .... = Source address compression: Stateful
```

```
    .... .... ..01 .... = Source address mode: 64-bits inline (0x0001)
    .... .... .... 0... = Multicast address compression: False
    .... .... .... .1.. = Destination address compression: Stateful
    .... .... .... ..01 = Destination address mode:
                                                  64-bits inline (0x0001)
    [Source context: bbbb::]
    [Destination context: bbbb::]
Next header: ICMPv6 (0x3a)
Hop limit: 128
Source: bbbb::1
Destination: bbbb::1415:92cc:0:3
Internet Protocol Version 6, Src: bbbb::1, Dst: bbbb::1415:92cc:0:3
0110 .... = Version: 6
.... 0000 0000 .... .... .... .... .... = Traffic Class: \
                                          0x00 (DSCP: CS0, ECN: Not-ECT)
    .... 0000 00.. .... .... .... .... .... = Differentiated Services
                                               Codepoint: Default (0)
    .... .... ..00 .... .... .... .... .... = Explicit Congestion
                                                          Notification:
                                           Not ECN-Capable Transport (0)
.... .... .... 0000 0000 0000 0000 0000 = Flow Label: 0x00000
Payload Length: 40
Next Header: ICMPv6 (58)
Hop Limit: 128
Source: bbbb::1
Destination: bbbb::1415:92cc:0:3
[Source GeoIP: Unknown]
[Destination GeoIP: Unknown]
Internet Control Message Protocol v6
Type: Echo (ping) request (128)
Code: 0
Checksum: 0xb65c [correct]
[Checksum Status: Good]
Identifier: 0x0001
Sequence: 63
[Response In: 3237]
Data (32 bytes)
    Data: 61626364656667686 96a6b6c6d6e6f707172737475767761...
    [Length: 32]
```

```
== Raw Bytes ==

0000   21 ec 5e fe ca 03 00 00 00 cc 92 15 14 02 00 00
0010   00 cc 92 15 14 78 55 3a 80 00 00 00 00 00 00 00
0020   01 14 15 92 cc 00 00 00 03 80 00 b6 5c 00 01 00
0030   3f 61 62 63 64 65 66 67 68 69 6a 6b 6c 6d 6e 6f
0040   70 71 72 73 74 75 76 77 61 62 63 64 65 66 67 68
```

```
0050   69 ee 05
```

[ping 3] ICMPv6 echo reply 3->2

== Dissected packet ==

```
IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:02,
                    Src: 14:15:92:cc:00:00:00:03
Frame Control Field: 0xec21, Frame Type: Data, Acknowledge Request,
Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                              Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..0. .... .... = Information Elements Present: False
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 177
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
Extended Source: 14:15:92:cc:00:00:00:03 (14:15:92:cc:00:00:00:03)
FCS: 0x2455 (Correct)
6LoWPAN
.... 0001 = Page Number: 1
6LoRH: Routing Protocol Information
    100. .... = Routing Header 6lo: Critical Routing Header (0x04)
    ...0 .... .... .... = Packet direction (bit O): Up
    .... 0... .... .... = Rank-Error (bit R): No
    .... .0.. .... .... = Forwarding-Error (bit F): No
    .... ..1. .... .... = RPL Instance (bit I):
                                              Elided (RPL Instance ID: 0)
    .... ...0 .... .... = Sender Rank Compression size (bit K): 2 bytes
    .... .... 0000 0101 = 6loRH Type:
                                    Routing Protocol Information (0x05)
    RPL Instance: 0x00
    Sender Rank: 0x039d
IPHC Header
    011. .... = Pattern: IP header compression (0x03)
    ...1 1... .... .... = Traffic class and flow label: Version,
                          traffic class, and flow label compressed (0x3)
    .... .0.. .... .... = Next header: Inline
    .... ..10 .... .... = Hop limit: 64 (0x2)
    .... .... 0... .... = Context identifier extension: False
```

```
    .... .... .1.. .... = Source address compression: Stateful
    .... .... ..01 .... = Source address mode: 64-bits inline (0x0001)
    .... .... .... 0... = Multicast address compression: False
    .... .... .... .1.. = Destination address compression: Stateful
    .... .... .... ..01 = Destination address mode:
                                                  64-bits inline (0x0001)
    [Source context: bbbb::]
    [Destination context: bbbb::]
Next header: ICMPv6 (0x3a)
Source: bbbb::1415:92cc:0:3
Destination: bbbb::1
Internet Protocol Version 6, Src: bbbb::1415:92cc:0:3, Dst: bbbb::1
0110 .... = Version: 6
.... 0000 0000 .... .... .... .... .... = Traffic Class:
                                           0x00 (DSCP: CS0, ECN: Not-ECT)
    .... 0000 00.. .... .... .... .... .... = Differentiated Services
                                                Codepoint: Default (0)
    .... .... ..00 .... .... .... .... .... = Explicit Congestion
                                                          Notification:
                                            Not ECN-Capable Transport (0)
.... .... .... 0000 0000 0000 0000 0000 = Flow Label: 0x00000
Payload Length: 40
Next Header: ICMPv6 (58)
Hop Limit: 64
Source: bbbb::1415:92cc:0:3
Destination: bbbb::1
[Source GeoIP: Unknown]
[Destination GeoIP: Unknown]
Internet Control Message Protocol v6
Type: Echo (ping) reply (129)
Code: 0
Checksum: 0xb55c [correct]
[Checksum Status: Good]
Identifier: 0x0001
Sequence: 63
[Response To: 3232]
[Response Time: 1913.163 ms]
Data (32 bytes)
    Data: 6162636465666768696a6b6c6d6e6f707172737475767761...
    [Length: 32]


== Raw Bytes ==

0000   21 ec b1 fe ca 02 00 00 00 cc 92 15 14 03 00 00
0010   00 cc 92 15 14 f1 82 05 03 9d 7a 55 3a 14 15 92
0020   cc 00 00 00 03 00 00 00 00 00 00 00 01 81 00 b5
0030   5c 00 01 00 3f 61 62 63 64 65 66 67 68 69 6a 6b
```

```
0040   6c 6d 6e 6f 70 71 72 73 74 75 76 77 61 62 63 64
0050   65 66 67 68 69 55 24
```

[ping 3] ICMPv6 echo reply 2->1

== Dissected packet ==

```
IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:01,
Src: 14:15:92:cc:00:00:00:02
Frame Control Field: 0xec21, Frame Type: Data, Acknowledge Request,
Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                          Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..0. .... .... = Information Elements Present: False
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 95
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
Extended Source: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
FCS: 0x9e34 (Correct)
6LoWPAN
.... 0001 = Page Number: 1
6LoRH: Routing Protocol Information
    100. .... = Routing Header 6lo: Critical Routing Header (0x04)
    ...0 .... .... .... = Packet direction (bit O): Up
    .... 0... .... .... = Rank-Error (bit R): No
    .... .0.. .... .... = Forwarding-Error (bit F): No
    .... ..1. .... .... = RPL Instance (bit I):
                                              Elided (RPL Instance ID: 0)
    .... ...0 .... .... = Sender Rank Compression size (bit K): 2 bytes
    .... .... 0000 0101 = 6loRH Type:
                                    Routing Protocol Information (0x05)
    RPL Instance: 0x00
    Sender Rank: 0x026d
IPHC Header
    011. .... = Pattern: IP header compression (0x03)
    ...1 1... .... .... = Traffic class and flow label: Version,
                          traffic class, and flow label compressed (0x3)
    .... .0.. .... .... = Next header: Inline
    .... ..10 .... .... = Hop limit: 64 (0x2)
```

```
    .... .... 0... .... = Context identifier extension: False
    .... .... .1.. .... = Source address compression: Stateful
    .... .... ..01 .... = Source address mode: 64-bits inline (0x0001)
    .... .... .... 0... = Multicast address compression: False
    .... .... .... .1.. = Destination address compression: Stateful
    .... .... .... ..01 = Destination address mode:
                                                  64-bits inline (0x0001)
    [Source context: bbbb::]
    [Destination context: bbbb::]
Next header: ICMPv6 (0x3a)
Source: bbbb::1415:92cc:0:3
Destination: bbbb::1
Internet Protocol Version 6, Src: bbbb::1415:92cc:0:3, Dst: bbbb::1
0110 .... = Version: 6
.... 0000 0000 .... .... .... .... .... = Traffic Class:
                                           0x00 (DSCP: CS0, ECN: Not-ECT)
    .... 0000 00.. .... .... .... .... .... = Differentiated Services
                                                Codepoint: Default (0)
    .... .... ..00 .... .... .... .... .... = Explicit Congestion
                                                          Notification:
                                            Not ECN-Capable Transport (0)
.... .... .... 0000 0000 0000 0000 0000 = Flow Label: 0x00000
Payload Length: 40
Next Header: ICMPv6 (58)
Hop Limit: 64
Source: bbbb::1415:92cc:0:3
Destination: bbbb::1
[Source GeoIP: Unknown]
[Destination GeoIP: Unknown]
Internet Control Message Protocol v6
Type: Echo (ping) reply (129)
Code: 0
Checksum: 0xb55c [correct]
[Checksum Status: Good]
Identifier: 0x0001
Sequence: 63
Data (32 bytes)
    Data: 61626364656667686 96a6b6c6d6e6f707172737475767761...
    [Length: 32]


== Raw Bytes ==

0000   21 ec 5f fe ca 01 00 00 00 cc 92 15 14 02 00 00
0010   00 cc 92 15 14 f1 82 05 02 6d 7a 55 3a 14 15 92
0020   cc 00 00 00 03 00 00 00 00 00 00 00 01 81 00 b5
0030   5c 00 01 00 3f 61 62 63 64 65 66 67 68 69 6a 6b
0040   6c 6d 6e 6f 70 71 72 73 74 75 76 77 61 62 63 64
```

```
0050   65 66 67 68 69 34 9e
```

4.8. 6P Commands and Response

4.8.1. 6P ADD

6P Command ADD 2->1

```
IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:01,
Src: 14:15:92:cc:00:00:00:02
Frame Control Field: 0xee21, Frame Type: Data, Acknowledge Request,
Information Elements Present, Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                              Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..1. .... .... = Information Elements Present: True
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 0
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
Extended Source: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
Header IEs, Header Termination 1 IE
    Header Termination 1 IE (Payload IEs follow)
        IE Header: 0x3f00, Type: Header, Id: Header Termination 1 IE,
                                                                Length: 0
            0... .... .... .... = Type: Header (0)
            .011 1111 0... .... = Id: Header Termination 1 IE (0x7e)
            .... .... .000 0000 = Length: 0
Payload IEs, IETF IE
    IETF Payload IE
        Payload IE TLV: 0xa81d, Type: Payload, Id: IETF IE
            1... .... .... .... = Type: Payload (1)
            .010 1... .... .... = Id: IETF IE (0x5)
            .... .000 0001 1101 = Length: 29
        Sub-ID: 201
        6top IE
            .... 0000 = 6P Version: 0
            ..00 .... = Type: Request (0x0)
            00.. .... = Reserved: 0x0
            Code: 0x01 (ADD)
            SFID (6top Scheduling Function ID): 0x00
```

```
            .... 0000 = SeqNum: 0
            0000 .... = GEN: Clear (0)
            Metadata: 0x0000
            Cell Options: TX|RX|SHARED (0x07)
                .... ...1 = Transmit (TX) Cell: 0x1
                .... ..1. = Receive (RX) Cell: 0x1
                .... .1.. = SHARED Cell: 0x1
                0000 0... = Reserved: 0x00
            Number of Cells: 1
            CellList
                Cell: 3d000600
                    Slot Offset: 0x003d
                    Channel Offset: 0x0006
                Cell: 08000400
                    Slot Offset: 0x0008
                    Channel Offset: 0x0004
                Cell: 17000f00
                    Slot Offset: 0x0017
                    Channel Offset: 0x000f
                Cell: 3e000600
                    Slot Offset: 0x003e
                    Channel Offset: 0x0006
                Cell: 29000900
                    Slot Offset: 0x0029
                    Channel Offset: 0x0009
FCS: 0xd5e5 (Correct)
== Raw Bytes ==

0000   21 ee 00 fe ca 01 00 00 00 cc 92 15 14 02 00 00
0010   00 cc 92 15 14 00 3f 1d a8 c9 00 01 00 00 00 00
0020   07 01 3d 00 06 00 08 00 04 00 17 00 0f 00 3e 00
0030   06 00 29 00 09 00 e5 d5
```

6P Response to ADD 1->2

```
IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:02,
                    Src: 14:15:92:cc:00:00:00:01
Frame Control Field: 0xee21, Frame Type: Data, Acknowledge Request,
Information Elements Present, Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                            Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
```

```
    .... ..1. .... .... = Information Elements Present: True
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 97
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
Extended Source: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
Header IEs, Header Termination 1 IE
    Header Termination 1 IE (Payload IEs follow)
        IE Header: 0x3f00, Type: Header, Id: Header Termination 1 IE,
                                                                Length: 0
            0... .... .... .... = Type: Header (0)
            .011 1111 0... .... = Id: Header Termination 1 IE (0x7e)
            .... .... .000 0000 = Length: 0
Payload IEs, IETF IE
    IETF Payload IE
        Payload IE TLV: 0xa809, Type: Payload, Id: IETF IE
            1... .... .... .... = Type: Payload (1)
            .010 1... .... .... = Id: IETF IE (0x5)
            .... .000 0000 1001 = Length: 9
        Sub-ID: 201
        6top IE
            .... 0000 = 6P Version: 0
            ..01 .... = Type: Response (0x1)
            00.. .... = Reserved: 0x0
            Code: 0x00 (SUCCESS)
            SFID (6top Scheduling Function ID): 0x00
            .... 0000 = SeqNum: 0
            0000 .... = GEN: Clear (0)
            CellList
                Cell: 3d000600
                    Slot Offset: 0x003d
                    Channel Offset: 0x0006
FCS: 0xc934 (Correct)


== Raw Bytes ==

0000   21 ee 61 fe ca 02 00 00 00 cc 92 15 14 01 00 00
0010   00 cc 92 15 14 00 3f 09 a8 c9 10 00 00 00 3d 00
0020   06 00 34 c9
```

4.8.2. 6P COUNT

6P Command COUNT 2->1

```
IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:01,
```

```
Src: 14:15:92:cc:00:00:00:02
Frame Control Field: 0xee21, Frame Type: Data, Acknowledge Request,
Information Elements Present, Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                              Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..1. .... .... = Information Elements Present: True
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 22
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
Extended Source: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
Header IEs, Header Termination 1 IE
    Header Termination 1 IE (Payload IEs follow)
        IE Header: 0x3f00, Type: Header, Id: Header Termination 1 IE,
                                                               Length: 0
            0... .... .... .... = Type: Header (0)
            .011 1111 0... .... = Id: Header Termination 1 IE (0x7e)
            .... .... .000 0000 = Length: 0
Payload IEs, IETF IE
    IETF Payload IE
        Payload IE TLV: 0xa808, Type: Payload, Id: IETF IE
            1... .... .... .... = Type: Payload (1)
            .010 1... .... .... = Id: IETF IE (0x5)
            .... .000 0000 1000 = Length: 8
        Sub-ID: 201
        6top IE
            .... 0000 = 6P Version: 0
            ..00 .... = Type: Request (0x0)
            00.. .... = Reserved: 0x0
            Code: 0x04 (COUNT)
            SFID (6top Scheduling Function ID): 0x00
            .... 0010 = SeqNum: 2
            0000 .... = GEN: Clear (0)
            Metadata: 0x0000
            Cell Options: TX (0x01)
                .... ...1 = Transmit (TX) Cell: 0x1
                .... ..0. = Receive (RX) Cell: 0x0
                .... .0.. = SHARED Cell: 0x0
                0000 0... = Reserved: 0x00
FCS: 0x1fb7 (Correct)
```

```
== Raw Bytes ==

0000   21 ee 16 fe ca 01 00 00 00 cc 92 15 14 02 00 00
0010   00 cc 92 15 14 00 3f 08 a8 c9 00 04 00 02 00 00
0020   01 b7 1f

   6P Response to COUNT 1->2

IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:02,
Src: 14:15:92:cc:00:00:00:01
Frame Control Field: 0xee21, Frame Type: Data, Acknowledge Request,
Information Elements Present, Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                              Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..1. .... .... = Information Elements Present: True
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 104
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
Extended Source: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
Header IEs, Header Termination 1 IE
    Header Termination 1 IE (Payload IEs follow)
        IE Header: 0x3f00, Type: Header, Id: Header Termination 1 IE,
                                                                Length: 0
            0... .... .... .... = Type: Header (0)
            .011 1111 0... .... = Id: Header Termination 1 IE (0x7e)
            .... .... .000 0000 = Length: 0
Payload IEs, IETF IE
    IETF Payload IE
        Payload IE TLV: 0xa807, Type: Payload, Id: IETF IE
            1... .... .... .... = Type: Payload (1)
            .010 1... .... .... = Id: IETF IE (0x5)
            .... .000 0000 0111 = Length: 7
        Sub-ID: 201
        6top IE
            .... 0000 = 6P Version: 0
            ..01 .... = Type: Response (0x1)
            00.. .... = Reserved: 0x0
            Code: 0x00 (SUCCESS)
            SFID (6top Scheduling Function ID): 0x00
```

```
            .... 0010 = SeqNum: 2
            0000 .... = GEN: Clear (0)
            Total Number of Cells: 0
FCS: 0x6ca9 (Correct)
== Raw Bytes ==

0000   21 ee 68 fe ca 02 00 00 00 cc 92 15 14 01 00 00
0010   00 cc 92 15 14 00 3f 07 a8 c9 10 00 00 02 00 00
0020   a9 6c
```

4.8.3. 6P DELETE

6P Command DELETE 2->1

```
IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:01,
                    Src: 14:15:92:cc:00:00:00:02
Frame Control Field: 0xee21, Frame Type: Data, Acknowledge Request,
Information Elements Present, Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                              Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..1. .... .... = Information Elements Present: True
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 46
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
Extended Source: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
Header IEs, Header Termination 1 IE (Payload IEs follow)
    Header Termination 1 IE (Payload IEs follow)
        IE Header: 0x3f00, Type: Header, Id: Header Termination 1 IE,
                                                                Length: 0
            0... .... .... .... = Type: Header (0)
            .011 1111 0... .... = Id: Header Termination 1 IE (0x7e)
            .... .... .000 0000 = Length: 0
    Payload IEs, IETF Payload IE
        IETF Payload IE
            IE Header: 0xa80d, Type: Payload, Id: IETF IE, Length: 13
                1... .... .... .... = Type: Payload (1)
                .010 1... .... .... = Id: IETF IE (0x5)
                .... .000 0000 1101 = Length: 13
            Sub-ID: 201
```

```
            6top IE
                .... 0000 = 6P Version: 0
                ..00 .... = Type: Request (0x0)
                00.. .... = Reserved: 0x0
                Code: 0x02 (DELETE)
                SFID (6top Scheduling Function ID): 0x00
                1011 1110 = SeqNum: 190
                Metadata: 0x0000
                Cell Options: TX (0x01)
                    .... ...1 = Transmit (TX) Cell: 0x1
                    .... ..0. = Receive (RX) Cell: 0x0
                    .... .0.. = SHARED Cell: 0x0
                    0000 0... = Reserved: 0x00
                Number of Cells: 1
                CellList
                    Cell: 13000700
                        Slot Offset: 0x0013
                        Channel Offset: 0x0007
FCS: 0x5843 (Correct)

== Raw Bytes ==

0000   21 ee 2e fe ca 01 00 00 00 cc 92 15 14 02 00 00
0010   00 cc 92 15 14 00 3f 0d a8 c9 00 02 00 be 00 00
0020   01 01 13 00 07 00 43 58
```

6P Response to DELETE 1->2

```
IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:02,
                    Src: 14:15:92:cc:00:00:00:01
Frame Control Field: 0xee21, Frame Type: Data, Acknowledge Request,
Information Elements Present, Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                              Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..1. .... .... = Information Elements Present: True
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 107
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
Extended Source: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
```

```
Header IEs, Header Termination 1 IE (Payload IEs follow)
    Header Termination 1 IE (Payload IEs follow)
        IE Header: 0x3f00, Type: Header, Id: Header Termination 1 IE,
                                                                Length: 0
            0... .... .... .... = Type: Header (0)
            .011 1111 0... .... = Id: Header Termination 1 IE (0x7e)
            .... .... .000 0000 = Length: 0
Payload IEs, IETF Payload IE
IETF Payload IE
    IE Header: 0xa809, Type: Payload, Id: IETF IE, Length: 9
        1... .... .... .... = Type: Payload (1)
        .010 1... .... .... = Id: IETF IE (0x5)
        .... .000 0000 1001 = Length: 9
    Sub-ID: 201
    6top IE
        .... 0000 = 6P Version: 0
        ..01 .... = Type: Response (0x1)
        00.. .... = Reserved: 0x0
        Code: 0x00 (SUCCESS)
        SFID (6top Scheduling Function ID): 0x00
        1011 1110 = SeqNum: 190
        CellList
            Cell: 13000700
                Slot Offset: 0x0013
                Channel Offset: 0x0007
FCS: 0x8326 (Correct)

== Raw Bytes ==

0000   21 ee 6b fe ca 02 00 00 00 cc 92 15 14 01 00 00
0010   00 cc 92 15 14 00 3f 09 a8 c9 10 00 00 be 13 00
0020   07 00 26 83
```

4.8.4. 6P RELOCATE

6P Command RELOCATE 2->1

```
IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:01,
Src: 14:15:92:cc:00:00:00:02
Frame Control Field: 0xee21, Frame Type: Data, Acknowledge Request,
Information Elements Present, Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                              Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
```

```
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..1. .... .... = Information Elements Present: True
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 121
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
Extended Source: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
Header IEs, Header Termination 1 IE (Payload IEs follow)
    Header Termination 1 IE (Payload IEs follow)
        IE Header: 0x3f00, Type: Header, Id: Header Termination 1 IE,
                                                                Length: 0
            0... .... .... .... = Type: Header (0)
            .011 1111 0... .... = Id: Header Termination 1 IE (0x7e)
            .... .... .000 0000 = Length: 0
Payload IEs, IETF Payload IE
IETF Payload IE
    IE Header: 0xa819, Type: Payload, Id: IETF IE, Length: 25
        1... .... .... .... = Type: Payload (1)
        .010 1... .... .... = Id: IETF IE (0x5)
        .... .000 0001 1001 = Length: 25
    Sub-ID: 201
    6top IE
        .... 0000 = 6P Version: 0
        ..00 .... = Type: Request (0x0)
        00.. .... = Reserved: 0x0
        Code: 0x03 (RELOCATE)
        SFID (6top Scheduling Function ID): 0x00
        0011 0010 = SeqNum: 50
        Metadata: 0x0000
        Cell Options: TX (0x01)
            .... ...1 = Transmit (TX) Cell: 0x1
            .... ..0. = Receive (RX) Cell: 0x0
            .... .0.. = SHARED Cell: 0x0
            0000 0... = Reserved: 0x00
        Number of Cells: 1
        Rel. CellList
            Cell: 11000900
                Slot Offset: 0x0011
                Channel Offset: 0x0009
        Cand. CellList
        Cell: 19000700
            Slot Offset: 0x0019
            Channel Offset: 0x0007
        Cell: 16000500
            Slot Offset: 0x0016
            Channel Offset: 0x0005
```

```
        Cell: 14000300
            Slot Offset: 0x0014
            Channel Offset: 0x0003
FCS: 0xadd3 (Correct)


== Raw Bytes ==

0000   21 ee 79 fe ca 01 00 00 00 cc 92 15 14 02 00 00
0010   00 cc 92 15 14 00 3f 19 a8 c9 00 03 00 32 00 00
0020   01 01 11 00 09 00 19 00 07 00 16 00 05 00 14 00
0030   03 00 d3 ad
```

6P Response to RELOCATE 1->2

```
IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:02,
Src: 14:15:92:cc:00:00:00:01
Frame Control Field: 0xee21, Frame Type: Data, Acknowledge Request,
Information Elements Present, Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                              Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..1. .... .... = Information Elements Present: True
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 205
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
Extended Source: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
Header IEs, Header Termination 1 IE (Payload IEs follow)
    Header Termination 1 IE (Payload IEs follow)
        IE Header: 0x3f00, Type: Header, Id: Header Termination 1 IE,
                                                                Length: 0
            0... .... .... .... = Type: Header (0)
            .011 1111 0... .... = Id: Header Termination 1 IE (0x7e)
            .... .... .000 0000 = Length: 0
Payload IEs, IETF Payload IE
    IETF Payload IE
        IE Header: 0xa809, Type: Payload, Id: IETF IE, Length: 9
            1... .... .... .... = Type: Payload (1)
            .010 1... .... .... = Id: IETF IE (0x5)
            .... .000 0000 1001 = Length: 9
```

```
        Sub-ID: 201
        6top IE
            .... 0000 = 6P Version: 0
            ..01 .... = Type: Response (0x1)
            00.. .... = Reserved: 0x0
            Code: 0x00 (SUCCESS)
            SFID (6top Scheduling Function ID): 0x00
            0011 0010 = SeqNum: 50
            CellList
                Cell: 19000700
                    Slot Offset: 0x0019
                    Channel Offset: 0x0007
FCS: 0x6784 (Correct)

== Raw Bytes ==

0000   21 ee cd fe ca 02 00 00 00 cc 92 15 14 01 00 00
0010   00 cc 92 15 14 00 3f 09 a8 c9 10 00 00 32 19 00
0020   07 00 84 67
```

4.8.5. 6P LIST

6P Command LIST 2->1

```
IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:01,
Src: 14:15:92:cc:00:00:00:02
Frame Control Field: 0xee21, Frame Type: Data, Acknowledge Request,
Information Elements Present, Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                              Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..1. .... .... = Information Elements Present: True
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 99
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
Extended Source: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
Header IEs, Header Termination 1 IE (Payload IEs follow)
    Header Termination 1 IE (Payload IEs follow)
        IE Header: 0x3f00, Type: Header, Id: Header Termination 1 IE,
                                                                Length: 0
```

```
            0... .... .... .... = Type: Header (0)
            .011 1111 0... .... = Id: Header Termination 1 IE (0x7e)
            .... .... .000 0000 = Length: 0
Payload IEs, IETF Payload IE
    IETF Payload IE
        IE Header: 0xa80d, Type: Payload, Id: IETF IE, Length: 13
            1... .... .... .... = Type: Payload (1)
            .010 1... .... .... = Id: IETF IE (0x5)
            .... .000 0000 1101 = Length: 13
        Sub-ID: 201
        6top IE
            .... 0000 = 6P Version: 0
            ..00 .... = Type: Request (0x0)
            00.. .... = Reserved: 0x0
            Code: 0x05 (LIST)
            SFID (6top Scheduling Function ID): 0x00
            1000 1011 = SeqNum: 139
            Metadata: 0x0000
            Cell Options: TX (0x01)
                .... ...1 = Transmit (TX) Cell: 0x1
                .... ..0. = Receive (RX) Cell: 0x0
                .... .0.. = SHARED Cell: 0x0
                0000 0... = Reserved: 0x00
            Reserved: 0x00
            Offset: 1
            Maximum Number of Requested Cells: 4
FCS: 0x5fdd (Correct)

== Raw Bytes ==

0000   21 ee 63 fe ca 01 00 00 00 cc 92 15 14 02 00 00
0010   00 cc 92 15 14 00 3f 0d a8 c9 00 05 00 8b 00 00
0020   01 00 01 00 04 00 dd 5f
```

6P Response to LIST 1->2

```
IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:02,
Src: 14:15:92:cc:00:00:00:01
Frame Control Field: 0xee21, Frame Type: Data, Acknowledge Request,
Information Elements Present, Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                              Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
```

```
    .... ..1. .... .... = Information Elements Present: True
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 207
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
Extended Source: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
Header IEs, Header Termination 1 IE (Payload IEs follow)
    Header Termination 1 IE (Payload IEs follow)
        IE Header: 0x3f00, Type: Header, Id: Header Termination 1 IE,
                                                                Length: 0
            0... .... .... .... = Type: Header (0)
            .011 1111 0... .... = Id: Header Termination 1 IE (0x7e)
            .... .... .000 0000 = Length: 0
Payload IEs, IETF Payload IE
    IETF Payload IE
        IE Header: 0xa811, Type: Payload, Id: IETF IE, Length: 17
            1... .... .... .... = Type: Payload (1)
            .010 1... .... .... = Id: IETF IE (0x5)
            .... .000 0001 0001 = Length: 17
        Sub-ID: 201
        6top IE
            .... 0000 = 6P Version: 0
            ..01 .... = Type: Response (0x1)
            00.. .... = Reserved: 0x0
            Code: 0x01 (RC_EOL)
            SFID (6top Scheduling Function ID): 0x00
            1000 1011 = SeqNum: 139
            CellList
                Cell: 41000800
                    Slot Offset: 0x0041
                    Channel Offset: 0x0008
                Cell: 3c000700
                    Slot Offset: 0x003c
                    Channel Offset: 0x0007
                Cell: 19000700
                    Slot Offset: 0x0019
                    Channel Offset: 0x0007
FCS: 0x7594 (Correct)

== Raw Bytes ==

0000   21 ee 65 fe ca 01 00 00 00 cc 92 15 14 02 00 00
0010   00 cc 92 15 14 00 3f 11 a8 c9 00 02 00 8c 00 00
0020   07 01 3c 00 07 00 19 00 07 00 05 64
```

4.8.6. 6P CLEAR

6P Command CLEAR 2->1

```
IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:01,
                    Src: 14:15:92:cc:00:00:00:02
Frame Control Field: 0xee21, Frame Type: Data, Acknowledge Request,
Information Elements Present, Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                                Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..1. .... .... = Information Elements Present: True
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 181
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
Extended Source: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
Header IEs, Header Termination 1 IE (Payload IEs follow)
    Header Termination 1 IE (Payload IEs follow)
        IE Header: 0x3f00, Type: Header, Id: Header Termination 1 IE,
                                                              Length: 0
            0... .... .... .... = Type: Header (0)
            .011 1111 0... .... = Id: Header Termination 1 IE (0x7e)
            .... .... .000 0000 = Length: 0
Payload IEs, IETF Payload IE
    IETF Payload IE
        IE Header: 0xa807, Type: Payload, Id: IETF IE, Length: 7
            1... .... .... .... = Type: Payload (1)
            .010 1... .... .... = Id: IETF IE (0x5)
            .... .000 0000 0111 = Length: 7
        Sub-ID: 201
        6top IE
            .... 0000 = 6P Version: 0
            ..00 .... = Type: Request (0x0)
            00.. .... = Reserved: 0x0
            Code: 0x07 (CLEAR)
            SFID (6top Scheduling Function ID): 0x00
            0101 0001 = SeqNum: 81
            Metadata: 0x0000
FCS: 0x0e2c (Correct)
```

```
== Raw Bytes ==

0000   21 ee b5 fe ca 01 00 00 00 cc 92 15 14 02 00 00
0010   00 cc 92 15 14 00 3f 07 a8 c9 00 07 00 51 00 00
0020   2c 0e
```

6P Response to CLEAR 1->2

```
IEEE 802.15.4 Data, Dst: 14:15:92:cc:00:00:00:02,
                    Src: 14:15:92:cc:00:00:00:01
Frame Control Field: 0xee21, Frame Type: Data, Acknowledge Request,
Information Elements Present, Destination Addressing Mode: Long/64-bit,
Frame Version: IEEE Std 802.15.4-2015, Source Addressing Mode:
                                                              Long/64-bit
    .... .... .... .001 = Frame Type: Data (0x1)
    .... .... .... 0... = Security Enabled: False
    .... .... ...0 .... = Frame Pending: False
    .... .... ..1. .... = Acknowledge Request: True
    .... .... .0.. .... = PAN ID Compression: False
    .... ...0 .... .... = Sequence Number Suppression: False
    .... ..1. .... .... = Information Elements Present: True
    .... 11.. .... .... = Destination Addressing Mode: Long/64-bit (0x3)
    ..10 .... .... .... = Frame Version: IEEE Std 802.15.4-2015 (2)
    11.. .... .... .... = Source Addressing Mode: Long/64-bit (0x3)
Sequence Number: 185
Destination PAN: 0xcafe
Destination: 14:15:92:cc:00:00:00:02 (14:15:92:cc:00:00:00:02)
Extended Source: 14:15:92:cc:00:00:00:01 (14:15:92:cc:00:00:00:01)
Header IEs, Header Termination 1 IE (Payload IEs follow)
    Header Termination 1 IE (Payload IEs follow)
        IE Header: 0x3f00, Type: Header, Id: Header Termination 1 IE,
                                                                Length: 0
            0... .... .... .... = Type: Header (0)
            .011 1111 0... .... = Id: Header Termination 1 IE (0x7e)
            .... .... .000 0000 = Length: 0
Payload IEs, IETF Payload IE
    IETF Payload IE
        IE Header: 0xa805, Type: Payload, Id: IETF IE, Length: 5
            1... .... .... .... = Type: Payload (1)
            .010 1... .... .... = Id: IETF IE (0x5)
            .... .000 0000 0101 = Length: 5
        Sub-ID: 201
        6top IE
            .... 0000 = 6P Version: 0
            ..01 .... = Type: Response (0x1)
            00.. .... = Reserved: 0x0
            Code: 0x00 (SUCCESS)
            SFID (6top Scheduling Function ID): 0x00
            0101 0001 = SeqNum: 81
FCS: 0x3fe0 (Correct)

== Raw Bytes ==
0000   21 ee b9 fe ca 02 00 00 00 cc 92 15 14 01 00 00
0010   00 cc 92 15 14 00 3f 05 a8 c9 10 00 00 51 e0 3f
```

5. [TEMPORARY] Known Bugs/Issues

This document tracks the standardization activity, and reflects the state of the implementation. This document is updated regularly. Sometimes, the [OpenWSN] implementation falls behind on the standardization. In this section, we list the known issues or the elements that are not implemented. This section will be removed when the final version of the document is produced.

- All link-layer frames are presented without link-layer security. This will be fixed in future revisions, both types of frames will then be shown: secured (what actually goes over the air) and unsecured (which Wireshark can parse).

- ICMPv6 echo request packets use source and destination global addresses but their reply packets use link local addresses.

6. IANA Considerations

This memo includes no requests to IANA.

7. Security Considerations

This memo only presents example frames exchanged. It does not define any protocol; there are hence no security considerations in this document.

8. Acknowledgments

The authors would like to thank the OpenWSN community, the 6TiSCH working group and the participants at the 6TiSCH plugtests for their feedback which has helped shape this document.

9. References

9.1. Normative References

[I-D.ietf-6tisch-minimal-security]
Vucinic, M., Simon, J., Pister, K., and M. Richardson, "Minimal Security Framework for 6TiSCH", draft-ietf-6tisch-minimal-security-06 (work in progress), May 2018.

9.2. External Informative References

[OpenWSN] Watteyne, T., Vilajosana, X., Kerkez, B., Chraim, F., Weekly, K., Wang, Q., Glaser, S., and K. Pister, "OpenWSN: a Standards-Based Low-Power Wireless Development Environment", Transactions on Emerging Telecommunications Technologies , August 2012.

Authors' Addresses

Jonathan Munoz (editor)
Inria
2 rue Simone Iff
Paris 12 75012
France

Email: jonathan.munoz@inria.fr

Dominique Barthel
Orange Labs
28 Chemin du Vieux Chene
Meylan 38240
France

Email: dominique.barthel@orange.com