6lo Working Group
Internet-Draft
Intended status: Informational
Expires: October 26, 2018

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April 24, 2018

IEEE802.15.4 Informational Element encapsulation of 6tisch Join and Enrollment Information
draft-richardson-6tisch-enrollment-enhanced-beacon-01

Abstract

In TSCH mode of IEEE802.15.4, as described by [RFC8180], opportunities for broadcasts are limited to specific times and specific channels. Nodes in a TSCH network typically frequently send Enhanced Beacon (EB) frames to announce the presence of the network. This document provides a mechanism by which small details critical for new nodes (pledges) and long sleeping nodes may be carried within the Enhanced Beacon.

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1. Introduction

[RFC7554] describes the use of the time-slotted channel hopping (TSCH) mode of [ieee802154]. As further details in [RFC8180], an Enhanced Beacon is transmitted during a slot designated a broadcast slot.

EDNOTE: Explain why broadcasts are rare, and why we need them. What the Enhanced Beacon is, and what Information Elements are, and how the IETF has a subtype for that area. Explain what kind of things could be placed in Information Elements, how big they could be, and how they could be compressed.

1.1. Terminology

In this document, the key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" are to be interpreted as described in BCP 14, RFC 2119 [RFC2119] and indicate requirement levels for compliant STuPiD implementations.

1.2. Layer-2 Synchronization

As explained in section 6 of [RFC8180], the Enhanced Beacon has a number of purposes: synchronization of ASN and Join Metric, timeslot template identifier, the channel hopping sequence identifier, TSCH SlotFrame and Link IE.

The Enhanced Beacon (EB) is used by nodes already part of a TSCH network to annouce its existance. Receiving an EB allows a Joining Node (pledge) to learn about the network and synchronize to it. The EB may also be used as a means for a node already part of the network to re-synchronize [RFC7554].

There are a limited number of timeslots designated as a broadcast slot by each router. These slots are rare, and with 10ms slots, with a slot-frame length of 100, there may be only 1 slot/s for the beacon.

1.3. Layer-3 synchronization IPv6 Router solicitations and advertisements

At layer 3, [RFC2461] defines a mechanism by which nodes learn about routers by listening for multicasted Router Advertisements (RA). If no RA is heard within a set time, then a Router Solicitation (RS) may be multicast, to which an RA will be received, usually unicast.

Although [RFC6775] reduces the amount of multicast necessary to do address resolution via Neighbor Solicitation messages, it still requires multicast of either RAs or RS. This is an expensive operation for two reasons: there are few multicast timeslots for unsolicited RAs; if a pledge node does not hear an RA, and decides to send a RS (consuming a broadcast aloha slot with unencrypted traffic), many unicast RS may be sent in response.

This is a particularly acute issue for the join process for the following reasons:

1. use of a multicast slot by even a non-malicious unauthenticated node for a Router Solicitation may overwhelm that time slot.

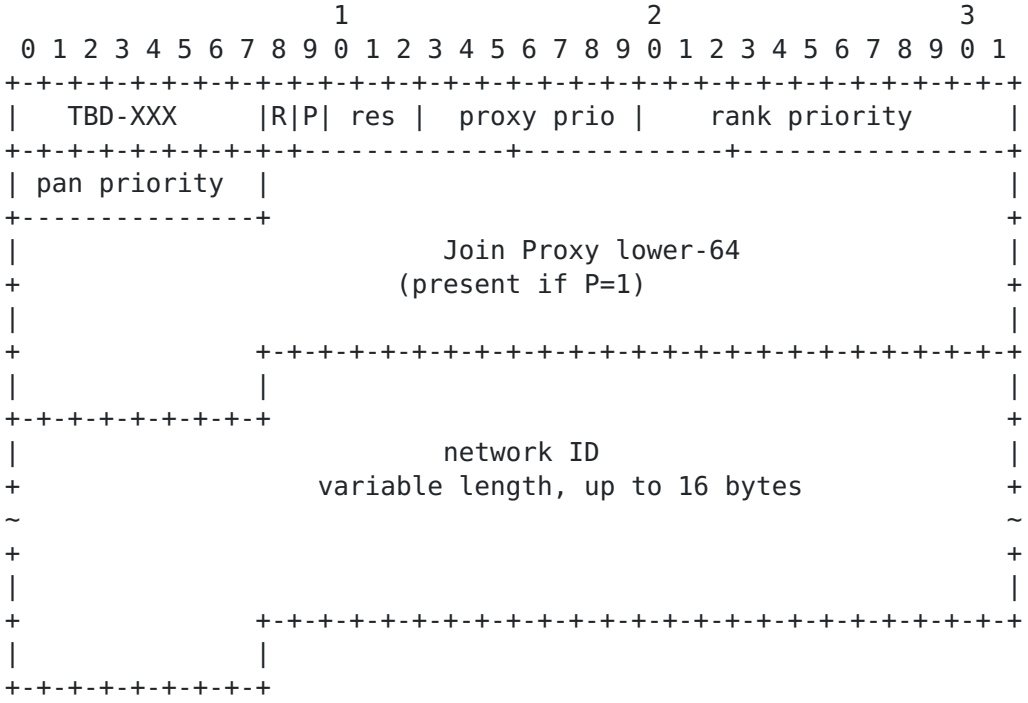
2. it may require many seconds of on-time before a new pledge hears a Router Soliciation that it can use.

3. a new pledge may listen to many Enhanced Beacons before it can pick an appropriate network and/or closest Join Assistant to attach to. If it must listen for a RS as well as find the Enhanced Beacon, then the process may take a very long time.

2. Protocol Definition

[RFC8137] creates a registry for new IETF IE subtypes. This document allocates a new subtype TBD-XXX.

This document documents a new IE subtype structure is as follows. As explained in [RFC8137] the length of the Sub-Type Content can be calculated from the container, so no length information is necessary.



proxy priority the proxy prority value contains a number from 0 to 0x7f. Lower numbers are considered to be a higher preference. A priority of 0x7f indicates that the announcer should never be considered as a viable enrollment proxy. Lower value indicates willing to act as a Join Proxy as described in [I-D.ietf-6tisch-minimal-security]. Only unenrolled pledges look at this value.

pan priority the pan priority is a value set by the DODAG root to indicate the relative priority of this LLN compared to those with different PANIDs. This value may be used as part of the enrollment priority, but typically is used by devices which have already enrolled, and need to determine which PAN to pick. Unenrolled pledges MAY consider this value when selecting a PAN to join. Enrolled devices MAY consider this value when looking for an eligible parent device.

rank priority the rank "priority" is set by the 6LR which sent the beacon and is an indication of how willing this 6LR is to serve as an RPL parent within a particular network ID. This is a local value to be determined in other work. It might be calculated from RPL rank, and it may include some modifications based upon current number of children, or number of neighbor cache entries available. This value MUST be ignored by pledges, it is for enrolled devices only.

R the Router Advertisement flag is set if the sending node will act as a Router for host-only nodes that need addressing via unicast Router Solicitation messages.

P if the Proxy Address bit is set, then the lower 64-bits of the Join Proxy's Link Layer address follows the network ID. If the Proxy Address bit is not set, then the Link Layer address of the Join Proxy is identical to the Layer-2 8-byte address used to originate this enhanced beacon. In either case, the layer-2 address of any IPv6 traffic to the originator of this beacon may use the layer-2 address which was used to originate the beacon.

join-proxy lower-64 if the P bit is set, then 64 bits (8 bytes) of address are present. The Link Layer address of the Join Proxy is fe80 (as for any Link Layer address), and the bits given in this field.

network ID this is an variable length field, up to 16-bytes in size that uniquely identifies this network, potentially among many networks that are operating in the same frequencies in overlapping physical space. The length of this field can be calculated as being whatever is left in the Information Element.

In a 6tisch network, where RPL is used as the mesh routing protocol, the network ID can be constructed from a SHA256 hash of the prefix (/64) of the network. That is just a suggestion for a default value. In some LLNs where multiple PANIDs may lead to the same management device (the JRC), then a common value that is the same across all PANs MUST be configured.

2.1. Protocol Example

Here will be three examples of processing.

3. Security Considerations

All of the contents of this Information Element are sent in the clear. The containing Enhanced Beacon is not encrypted.

The Enhanced Beagon is authenticated at the layer-2 level using 802.15.4 mechanisms using the network-wide keying material. Nodes which are enrolled will have the network-wide keying material and can validate the beacon.

Pledges which have not yet enrolled are unable to authenticate the beacons.

4. Privacy Considerations

The use of a network ID may reveal information about the network. The use of a SHA256 hash of the DODAGID, rather than using the DODAGID directly provides some cover the addresses used within the network. The DODAGID is usually the IPv6 address of the root of the RPL mesh.

An interloper with a radio sniffer would be able to use the network ID to map out the extend of the mesh network.

5. IANA Considerations

Allocate a new number TBD-XXX from Registry IETF IE Sub-type ID. This entry should be called 6tisch-Join-Info.

6. Acknowledgements

Thomas Watteyne provided extensive editorial comments on the document.

7. References

7.1. Normative References

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Appendix A. Change history

The rank priority was expanded to 2 bytes.

00: The extension was originally for the use of Pledges only during the enrollment/join process. Additional information was desired for nodes which have already enrolled in order to aid in the joining (selecting of a parent) of an RPL DAG. The term "join" was realized to be ambiguous, meaning different things to different groups, and so

the activity where the pledge finds a "Join Proxy" has been named "enrollment"

-1: This is an evolution of an earlier proposal which provided for storing an entire IPv6 Router Adverisement in an Informational Element. It was deemed too general a solution, possibly subject to mis-use. This proposal restricts the use to just the key pieces of information required.

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