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Terminology in IPv6 over Time Slotted Channel Hopping
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Abstract

6TSCH proposes an architecture for an IPv6 multilink subnet that is composed of a high speed powered backbone and a number of IEEE802.15.4e TSCH wireless networks attached and synchronized by backbone routers. This document extends existing terminology documents available for Low-power and Lossy Networks to provide additional terminology elements.

Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

Status of This Memo

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

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1. Introduction

A new breed of Time Sensitive Networks is being developped to enable traffic that is highly sensitive to jitter and quite sensitive to latency. Such traffic is not limited to voice and video, but also includes command and control operations such as found in industrial automation or in-vehicule sensors and actuators.

At IEEE802.1, the "Audio/Video Task Group", was rename TSN for Time Sensitive Networking. The IEEE802.15.4 Medium Access Control (MAC) has evolved with IEEE802.15.4e which provides in particular the Time Slotted Channel Hopping (TSCH) mode for industrial-type applications. Both provide Deterministic capabities to the point that a packet that pertains to a certain flow crosses the network from node to node following a very precise schedule, like a train leaves intermediate

stations at precise times along its path.

This document provides additional terminology elements to cover terms that are new to the context of TSCH wireless networks and other deterministic networks.

2. Terminology

The draft extends [I-D.ietf-roll-terminology] which is included here by reference.

The draft does not reuse terms from IEEE802.15.4e such as "path" or "link" which bear a meaning that is quite different from classical IETF parlance.

This document adds the following terms:

6TSCH: Entity that sets up the schedule, controls the connectivity graph of the network, and the resources allocated to each scheduled cell in that connectivity graph. It may be an adaptation layer, a distributed reservation protocol, a centralized path computation entity, or any combination thereof.

6tus: 6tus (pronounced "sixtus") is the adaptation layer between TSCH and upper layers like 6LoWPAN and RPL. It is defined in [I-D.draft-wang-6tsch-6tus].

6tus Data Convey Model: Model describing how the 6tus adaptation layer feeds the data flow coming from upper layers into TSCH. It is composed by an I-MUX module, a MUX module, a set of priority queues, and a PDU (Payload Data Unit).

ASN: Absolute Slot Number, the timeslot counter, incremented by one at each timeslot. It is wide enough to not roll over in practice. See [I-D.watteyne-6tsch-tsch-lln-context].

Blacklisting: Set of frequencies which should not be used for communication.

Bundle: A group of equivalent scheduled cells, i.e. cells

identified by different (slotOffset, channelOffset), which are scheduled for a same purpose, with the same neighbor, with the same flags, and the same slotframe. The size of the bundle refers to the number of cells it contains. Given the length of the slotframe, the size of the bundle translates directly into bandwidth, either logical, or physical.

Cell: A single element in the TSCH schedule, identified by a slotOffset and a channelOffset value. A cell can be scheduled or unscheduled. During an unscheduled cell, the node does not communicate. When a cell is scheduled,

it is assigned a MAC-layer slotframe identifier, a neighbor MAC address (which can be the broadcast address), and one or more of the following flags: TX, RX, shared, timeskeeping, hard. A broadcast cell is an alias for "a scheduled cell with neighbor address the broadcast address".

ChannelOffset: Identifies a row in the TSCH schedule. The number of available channelOffsets is equal to the number of available frequencies. The channelOffset translates into a frequency when the communication takes place, resulting in channel hopping, as detailed in [I-D.watteyne-6tsch-tsch-lln-context].

Dedicated Cell: A cell that is reserved for a given node to transmit to a specific neigbor.

Distributed cell reservation: A reservation of a cell done by one or more in-network entities (typically a connection endpoint).

Distributed track reservation: A reservation of a track done by one or more in-network entities (typically a connection endpoint).

EB: Enhanced Beacon frame used by an avertising node to announce the presence of the network. It contains information about timeslot length, current ASN value, slotframes and timeslots the beaconing mote is listening

on, and a 1-byte join priority (i.e., number of hops separating the node sending the EB, and the PAN coordinator).

GMPLS: Generalized Multi-Protocol Label Switching, a 2.5 layer service that is used to forward packets based on the concept of generalized labels.

Hard Cell: A scheduled cell that is locked, i.e., it cannot be moved by 6tus in the schedule. See [I-D.draft-wang-6tsch-6tus].

IE: Information Elements, a list of Type-Length-Value containers placed at the end of the MAC header, used to pass data between layers or devices. A small number of types are defined by TSCH, but a range of types is available for extensions, and thus, is exploitable by 6TSCH. See [I-D.watteyne-6tsch-tsch-lln-context].

I-MUX module: Inverse-Multiplexer, a classifier that receives 6LoWPAN frames and places them into priority queues.

Logical Cell: A cell that correspond to granted bandwidth but is only lazily associated to a physical cell, based on usage.

MUX module: Multiplexer, the entity that dequeues frames from priority queues and associates them to a cell for transmission.

PCE: Path Computation Entity, the entity in the network which is responsible for building and maintaining the TSCH schedule, when centralized scheduling is used.

PCE cell reservation: The reservation of a cell done by the PCE.

PCE track reservation: The reservation of a track done by the PCE.

Provisioned Cell: A soft cell which provides redundancy above the required bandwidth to ensure some QoS level.

QoS: Quality of Service.

Shared Cell: A cell that is used by transmitted nodes at the same time and on the same channelOffset. Only cells with TX flag can be marked as "shared". A backoff algorithm is used to resolve contention.

SlotOffset: Identifies a column in the TSCH schedule, i.e. the number of timeslots since the beginning of the current iteration of the slotframe.

Slotframe: A MAC-level abstraction that is internal to the node and contains a series of timeslots of equal length and priority. Multiple slotframes can coexist in a node's schedule, i.e., a node can have multiple activities scheduled in different slotframes, based on the priority of its packets/traffic flows. The timeslots in the Slotframe are indexed by the SlotOffset; the first timeslot is at SlotOffset 0.

Soft Cell: A scheduled cell that is not locked, i.e., it may be moved in the schedule within a same slotframe by 6tus [I-D.draft-wang-6tsch-6tus].

Timeslot: A basic communication unit in TSCH which allows a transmitter node to send a frame to a receiver neighbor,

and that receiver neighbor to optionally send back an acknowledgment. The length of the timeslot determines the maximum size of the frame and the number of acknowledgements (in case multiple are used, e.g., duocast), that can be exchanged.

Time Source Neighbor: A neighbor a node uses as its time reference, and to which it needs to keep its clock synchronized. A node can have one or more time source neighbors.

Track: A determined sequence of cells along a multi-hop path. This is typically the result of a reservation.

TSCH: Time Slotted Channel Hopping, a medium access mode of the [IEEE802154e] standard which uses time synchronization to

achieve ultra low-power operation and channel hopping to enable high reliability.

TSCH Schedule: A matrix of cells, each cells indexed by a slotOffset and a channelOffset. The slotframe size (the "width" of the matrix) is the number of timeslots it contains. The number of channelOffset values (the "height" of the matrix) is equal to the number of available frequencies. The TSCH schedule contains all the scheduled cells from all slotframes and is sufficient to qualify the communication in the TSCH network.

3. IANA Considerations

This specification does not require IANA action.

4. Security Considerations

This specification is not found to introduce new security threat.

5. Acknowledgements

6. References

6.1. Normative References

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6.3. External Informative References

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