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         Terminology in IPv6 over Time Slotted Channel Hopping
                draft-palattella-6tsch-terminology-00

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

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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-vehicle 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 capabilies 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

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate
Requirement Levels", BCP 14, RFC 2119, March 1997.

6.2. Informative References

[I-D.draft-thubert-6tsch-architecture]

              Thubert, P., Ed., Assimiti, R., and T. Watteyne, "An
              Architecture for IPv6 over Time Synchronized Channel
              Hopping. draft-thubert-6tsch-architecture-00 (work in
              progress) ", March 2013.

   [I-D.draft-wang-6tsch-6tus]
              Wang, Q., Ed., Vilajosana, X., and T. Watteyne, "6tus
              Adaptation Layer Specification. draft-wang-6tsch-6tus-00
              (work in progress) ", March 2013.

   [I-D.ietf-roll-terminology]
              Vasseur, J., "Terminology in Low power And Lossy
              Networks", draft-ietf-roll-terminology-11 (work in
              progress), February 2013.

   [I-D.watteyne-6tsch-tsch-lln-context]
              Watteyne, T., "Using IEEE802.15.4e TSCH in an LLN context:
              Overview, Problem Statement and Goals", draft-watteyne-
              6tsch-tsch-lln-context-01 (work in progress), February
              2013.

6.3. External Informative References

   [IEEE802154e]
              IEEE standard for Information Technology, "IEEE std.
              802.15.4e, Part. 15.4: Low-Rate Wireless Personal Area
              Networks (LR-WPANs) Amendment 1: MAC sublayer", April
              2012.

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