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           Terminology in IPv6 over the TSCH mode of IEEE 802.15.4e
                     draft-ietf-6tisch-terminology-01

Abstract

   6TiSCH 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].

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1. Introduction

   A new breed of Time Sensitive Networks is being developed 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 in industrial
   automation or in-vehicle sensors and actuators.

   At IEEE802.1, the "Audio/Video Task Group", was renamed 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 capabilities 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] and use terms from RFC
   6550 [RFC6550] and RFC 6552 [RFC6552], which are all 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:

   6TiSCH: IPv6 over the Timeslotted Channel Hopping (TSCH) mode of
                IEEE 802.15.4e. It defines a set of IETF sublayers and
                protocols (in particular, for setting up a schedule with
                a centralized or distributed approach, managing the
                resource allocation), as well as the architecture to bind
                them together, for use in IPv6 TSCH based networks.

   6F: IPv6 Forwarding. One of the three forwarding model
                supported by 6TiSCH. Packets are routed at layer 3,
                where QoS and RED operations are expected to prioritize
                flows with differentiated services.

   6top: 6top is the adaptation layer between TSCH and upper
                layers like 6LoWPAN and RPL. It is defined in
                [I-D.draft-wang-6tsch-6top].

   6top Data Convey Model: Model describing how the 6top 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].

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

   BBR: Backbone Router. In the 6TiSCH architecture, it is an
                LBR and also a NEAR. It performs ND proxy operations
                between registered devices and classical ND devices that
                are located over the backbone.

   Broadcast cell: A scheduled cell whose neighbor MAC address is set
                to the broadcast address.

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, a channelOffset, a slotframeHandle. A cell
              can be scheduled or unscheduled.

ChannelOffset: Identifies a row in the TSCH slotframe. 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].

Channel distribution/usage (CDU) matrix: : Matrix of height equal to
              the number of available channels (i.e, ChannelOffsets),
              representing the spectrum(channel) distribution among the
              different (RPL parent) nodes in the networks. Every
              single element of the matrix belongs to a specific chunk.
              It has to be noticed that such matrix, even though it
              includes all the cells grouped in chunks, belonging to
              different slotframes, is different from the TSCH
              schedule.

Chunk: A well-known list of cells, well-distributed in time and
              frequency, within a slotframe; a chunk represents a
              portion of a slotframe that is globally known by all the
              nodes in the network, but it can be managed separately by
              a single node. A node can have multiple chunks, and use
              them according to a specific policy. Chunks may overlap.
              They can be pre-programmed, or can be computed by an
              external entity at the network bootstrap.

Chunk ownership appropriation: The process by which an individual
              node obtains a chunk to manage based on peer-to-peer
              interaction with its neighbors.

Chunk ownership delegation: The process by which an individual node
              obtains a chunk to manage based on point-to-point
              interaction with an external entity.

Communication Paradigm: It is Associated with the Information Model
            [RFC3444] of the state that is exchanged, and indicates:
            the location of that state (e.g., centralized vs.
            distributed, RESTful, etc.), the numbers of parties
            (e.g., P2P vs. P2MP) and the relationship between parties
            (e.g., master/slave vs. peers) at a high level of
            protocol abstraction. Layer 5 client/server REST is a
            typical communication paradigm, but industrial protocols
            also use publish/subscribe which is P2MP and source/sink
            which is MP2MP and primarily used for alarms and alerts
            at the application layer. At layer 3, basic flooding,
            P2P synchronization and path-marking (RSVP-like) are
            commonly used paradigms, whereas at layer 2, master/slave
            polling and peer-to-peer forwarding are classical
            examples.

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

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 advertising node to
            announce the presence of the network. It contains
            information about the timeslot length, the current ASN
            value, the 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).

FF: 6LoWPAN Fragment Forwarding. It is one of the three
            forwarding model supported by 6TiSCH. The 6LoWPAN
            Fragment is used as a label for switching at the 6LoWPAN
            sublayer, as defined in
            [I-D.thubert-roll-forwarding-frags].

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 which the 6top sublayer cannot
            reallocate. See [I-D.draft-wang-6tsch-6top].

   Hopping Sequence: Sequence of frequencies, identified by a
               Hopping_Sequence_ID, used for channel hopping, when
               translating the channel offset value into a frequency
               (i.e., PHY channel). See
               [I-D.watteyne-6tsch-tsch-lln-context].

   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
               6TiSCH. 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.

   Interaction Model: It is a particular way of implementing a
               communication paradigm. Defined at a lower level of
               abstraction, it includes protocol-specific details such
               as a particular method (e.g., a REST GET) and a Data
               Model for the state to be exchanged.

   KMP: Key Managment Protocol.

   LBR: LLN Border Router. It is an LLN device, usually powered,
               that acts as a Border Router to the outside within the
               6TiSCH architecture.

   Link: A communication facility or medium over which nodes can
               communicate at the link layer, i.e., the layer
               immediately below IP. Thus, the IETF parlance for the
               term "Link" is adopted, as opposed to the incompatible
               IEEE802.15.4e terminology. In the context of the 6TiSCH
               architecture, which applies to Low Power Lossy Networks
               (LLNs), an IPv6 subnet is usually not congruent to a
               single link and techniques such as IPv6 Neighbor
               Discovery Proxying and Routing Over LLNs are required to
               achieve reachability within the multilink subnet. A link
               is distinct from a track. In fact, link local addresses
               are not expected to be used over a track for end to end
               communication. Finally, from the Layer 3 perspective
               (where the inner complexities of TSCH operations are
               hidden to enable classical IP routing and Forwarding), a
               single radio interface may be seen as a number of Links
               with different capabilities for unicast or multicast
               services.

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

MAC: Medium Access Control.

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

NEAR: Energy Aware Default Router, as defined in
               [I-D.chakrabarti-nordmark-6man-efficient-nd].

NME: Network Management Entity, the entity in the network
               managing cells and other device resources. It may
               cooperate with the PCE. It interacts with LLN nodes
               through the backbone router.

PANA: Protocol for carrying Authentication for Network Access,
               as defined in [RFC5191] . It is the protocol used in the
               6TiSCH architecture for handling authentication during
               the join process.

PCE: Path Computation Element, 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.

QoS: Quality of Service.

(to) reallocate a cell: The action operated by the 6top sublayer of
               changing the slotOffset and/or channelOffset of a soft
               cell.

SA: Security Association.

(to) Schedule a cell: The action of turning an unscheduled cell into
               a scheduled cell.

Scheduled cell: A cell which is assigned a neighbor MAC address
               (broadcast address is also possible), and one or more of
               the following flags: TX, RX, shared, timeskeeping. A
               scheduled cell can be used by the IEEE802.15.4e TSCH
               implementation to communicate. A scheduled cell can be a
               hard cell or a soft cell.

Shared Cell: A cell that is used by more than one transmitter 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. It is characterized by a slotframe_ID, and a
              slotframe_size. 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 which the 6top sublayer can reallocate,
              as described in [I-D.draft-wang-6tsch-6top].

TF: Track Forwarding. It is the simplest and fastest
              forwarding model supported by 6TiSCH. It is a G-MPLS-
              like forwarding model. The input cell characterises the
              flow and indicates the output cell.

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 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.
              It is typically the result of a reservation. The node
              that initializes the process for establishing a track is
              the owner of the track. The latter assigns a unique
              identifier to the track, called TrackID.

TrackID: Unique identifier of a track, assigned by the owner of
              the track.

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 cell 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.

unscheduled cell: A cell which is not used by the IEEE802.15.4e TSCH
                implementation.

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

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