**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) | |
| Title | **<Upper Data Link SubLayer >** | |
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| Abstract | [Description of document contents.] | |
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**Upper Data Link SubLayer (UDLSL) Overview**

* **Goal**
  + Provide upper layers (e.g. L2, L3, L4) with a preconfigured MAC/PHY and well documented interface that properly operates with the upper layers and maintains necessary network or point-to-point functions.
    - Example: configure the 802.15.4 MAC/PHY to look more like Ethernet to the upper layers.
* **UDLSL Interfaces**
  + 802.15.4 MAC and PHYs
  + 802.15.10 L2R mesh
  + 802.15.9 KMP
  + IETF 6LoWPAN
  + IETF CoAP
  + IETF CoMI
  + IETF PCF
  + IETF RPL
  + IETF Ace
* **Background**

The modus operandi of IEEE 802.15.4 is to keep the MAC simple and the PHY simpler. Up till now, whenever MAC behaviors had a need for complex decisions to be made or the intelligence to configure modes, the MAC passed the matter to the next higher layer. For example: should the node join a specific network? What short address should the coordinator allocate to the node? What data rates, modulations, et al should be used? And so forth.

Since the 802.11 MAC and 802.3 MAC do much of the behavior that 802.15.4 passes to a higher layer, 802.15.4 isn’t as easily used as its 802 peers.

The IETF 6tisch group has created a data link layer entity, 6top, that sits above the MAC but below 6LoWPAN to facilitate TSCH operation. TSCH has many network advantages, but it isn’t right for all applications.

* **Purpose**

Create an upper data link layer entity similar to 6top but for non-TSCH operation that would benefit those non-time scheduled applications. A proposed protocol stack is shown in Annex A.

While 6tisch has achieved significant progress, it has been hampered by disconnects between IETF and IEEE 802. It is believed that the UDLSL project would be better suited to operate within IEEE 802.15 since it will be more closely tied to the 802.15.4 MAC.

The task group may choose to investigate the option of integrating UDLSL with 6top to provide 6tisch with UDLSL capabilities, and to provide UDLSL with 6top’s interface to CoAP, etc.

* **Organizations with vested interests**

While there are standards that have already implemented portions of the proposed functionality of UDLSL, they have done so in a manner the serves their niches at the expense of a broader market. There are other standards that have created protocols similar to UDLSL but with a different MAC. It is believed that the UDLSL project will be well positioned to work with IETF, various IoTs, IPSO, WiSUN, etc..

* **Default Network Configuration**
  + Node Type (i.e. PAN Coordinator, Coordinator , or End Node)
  + PAN Coordinator default parameters
  + Ethertype header
  + Network set-up
    - PAN ID
    - Beacon-enabled or Nonbeacon-enabled
    - Frame and Packet Priority settings
    - Mesh vs. Star topologies
    - Neighbor tables
    - Link set up: channel(s), modulation parameters, data rate(s), transmit power(s), Low Energy mode(s), FCS size
  + Security set-up
    - Authentication and encryption
    - Key management
    - Authorization
  + Regulatory matters
    - Country of operation
  + Asymmetric Link Operation
    - Asymmetric Link Operation (ALO) is preferred for some networks with many end devices, as it allows the end devices to operate at low energy levels, etc.
    - Example applications include shelf tags, pipeline monitors, etc.
    - Optimized network operation for high performance device (HPD) along with low performance devices (LPDs)
    - HPDs acting as coordinators enable lower cost LPDs to reduce energy consumption
    - MAC ALO would free layers 3 and above from having to set up a network with HPDs and LPDs.
  + Channel Hopping Operation
    - Channel Hopping is preferred for some networks operating in interference prone environments.
    - Example applications include smart grid and industrial
    - Channel hopping networks require a:
      * known hop sequence
      * a channel white list and a channel black list
      * a method to alter hop sequence on-the-fly
      * a method to synchronize
      * a known clock (network wide? local area only?)
    - Channel hopping would not require layers 3 and above to understand radio operation
* **Configurable Behaviors**
  + Dynamic Data Rate Selection
    - Many PHYs have multiple data rates
    - Data rates are currently specified by a layer above the MAC but for some cases data rates could be better set by the MAC on a link-by-link basis
    - To allow UDLSL to set the data rate, it would need to:
      * Define an automatic data rate determination algorithm
      * Define common methods for MAC to select specific PHY data rates, FEC, PHY preambles, etc.
    - Since the MAC already knows whether frames have been dropped DDR selection would allow the MAC to understand the timing parameters
  + Dynamic Transmit Power Selection
    - Many PHYs have defined multiple transmit power levels
    - Transmit power levels are currently specified by a higher layer but often these levels could be better set by the MAC on a link-by-link basis
    - To allow MAC to set the transmit power level it may need to:
      * Determine the CSMA impact (note: GTS or TSCH operation would have no affect)
      * Define a default automatic power level determination algorithm with option to download another
      * Define common methods for MAC to select specific PHY power levels based upon PHY preambles, PHY FEC, signal strength, failed packets, etc.
      * Tell the device on the other side of the link what it’s contemplating
* Dynamic Channel Selection
  + Maintain current channel status as far as coexistence issues and interferers
  + Periodically search other channels for better link quality conditions
  + Change to another channel if advantageous
* Dynamic Preamble Selection
  + Many PHYs have multiple preamble options to optimize communications over good and poor conditions
  + Maintain list of available preambles on a device by device basis
  + Maintain list of preambles being used on a device by device basis
  + Maintain status of each link and change preamble as appropriate
* Dynamic Modulation Selection
  + Many PHYs have multiple modulation options to optimize communications over good and poor conditions
  + Maintain list of available modulations on a device by device basis
  + Maintain list of modulations being used on a device by device basis
  + Maintain status of each link and change modulation as appropriate
* Others?

**Annex A**

Macintosh HD:Users:patrickkinney:MyDocuments:IEEE:802.15:802.15.12.emf