Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [802.15.4 use by external SDOs]
Date Submitted: [19 March 2013]
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Re: [802.15.4 Maintenance Standing Committee.]

Abstract: [This contribution identifies several issues when 802.15.4 is used as a basis for standards developed by external (non-IEEE) Standards Development Organisations.]

Purpose: [To suggest new procedures and amendments to enable 802.15.4 standards to be more successfully adopted by external SDOs.]

802.15.4 use by external SDOs

Summary

- 802.15.4 standards have established themselves as definitive standards in a number of important areas
  - Smart Metering / Smart Grid (device)
  - Health Care
  - General Sensor Networks
- Several industry standards organisations build on 15.4
  - ZigBee
  - ISA
  - HART
- International Standards Organisations are now also referencing 15.4 standards for their work
  - ETSI
    - ERM TG28 (SRD) standards TS 102 887-1 & 2
  - TIA
    - ANSI/TIA-4957 standards .100 (PHY), .200 (MAC)
- However, this success brings some issues to light…

ETSI Liaison Statement

- TC ERM
  - Parent committee of TG28 SRD
  - Balloted and approved a Liaison Statement to IEEE 802.15 4
  - Congratulated IEEE on the success of its 802.15.4 standards and informed 15.4 of ETSI standards being built on 15.4g & 15.4/4e
  - Identified 3 issues arising
    - Frame ID name space
    - IE ID name space
    - IE Descriptor format

Main Issues

- 802.15.4 PHY standards are used by multiple ‘functional standards’ in the same spectrum – but 802.15.4 has used up the Frame ID name space
- 802.15.4e adds IEs to the 15.4 MAC structures but the unmanaged name space for IE IDs is not suitable for use by SDOs
- The IE descriptor structure is inverted with no discernable advantage and causes redundancy and confusion

Frame ID

- The name space for 15.4 Frame IDs is fully used
- The remaining value (0b111) must be used as an extension signal
- SDOs have already found the need to identify new Frame Structures
  - ANSI/TIA-4957.200 has defined a 3-bit extension
  - ETSI TS 102 887-2 endorses 4957
- It would be MOST beneficial to align ALL SDO use of Frame ID extensions

b2	b1	b0	b2	b2	b0	
0	0	0	Beacon			
1	0	0	Data			
0	1	0	Ack			
1	1	0	Command			
0	0	1	LLDN			
1	0	1	Multipurpose			
0	1	1	TBD (4k?)			
1	1	1	0	0	0	Extended
1	1	1	1	0	0	IEEE
1	1	1	0	1	0	
1	1	1	1	1	0	
1	1	1	0	0	1	
1	1	1	1	0	1	SDO
1	1	1	0	1	1	
1	1	1	1	1	1	ANSI/TIA-4957

IE IDs (already discussed)

- Currently 802.15.4 defines:
  - Header IE IDs
    - Unmanaged (0x00-0x19)
    - Managed (0x1A-0xFF)
  - Payload IE IDs
    - Managed
      - 0x0-0x1, 0xF
    - Unmanaged
      - 0x2-0x9
    - Reserved
      - 0xA-0xE
- There are no rules for use of ‘unmanaged’ meaning there can be no guarantee of uniqueness
- This is NOT satisfactory for SDO enhancements by definition of new IEs and their semantics
  - SDO’s MUST have guarantees that their use of resource IDs is unique

IE Descriptor

- IEs are used by MANY standards and have a common TLV structure
- 15.4e introduced IEs using a similar commonly used TLV structure
- In the last ballot (d7) the descriptor order was changed to LTV
- Analysis by external SDOs has failed to identify any advantage to this order reversal
- Low power in-line processing devices (very long lifetime battery or scavenged energy sensors etc) cannot parse IE descriptors with memory & additional code complexity since the Type is not known until the full descriptor is received as the length field depends on the Type
- Inconsistency causes confusion and unnecessary consumption of many resources – memory, code, CPU cycles and, ultimately, energy

TLV's in Standards
Transmitted Type–Length–Value

- IEEE
  - 802.3ac - Management frames
  - 802.11 - Management frames
  - 802.15.3 (big-endian format rightmost-bit first..... V-L-T)
  - 15.5 (which uses 15.3 MAC)
  - 15.7 (TLV - little endian, left-right transmission)
  - 802.16
  - LLDP (802 IP protocol)
  - ….
- IETF
  - OSPF - e.g./ RFC 4970
  - Draft MLE – explicitly builds on 802.15.4 but defined TLV IEs
  - ….
- ISO
  - ISO IS-IS
  - ….
- Other
  - Radius - Attribute-value pairs
  - WiMedia MAC - General IEs
  - …
- Standard and open source TLV parsers...

802.11

8.4.2 Information elements

8.4.2.1 General

Elements are defined to have a common general format consisting of a 1 octet Element ID field, a 1 octet Length field, and a variable-length element-specific Information field. Each element is assigned a unique Element ID as defined in this standard. The Length field specifies the number of octets in the Information field. See Figure 8-81.

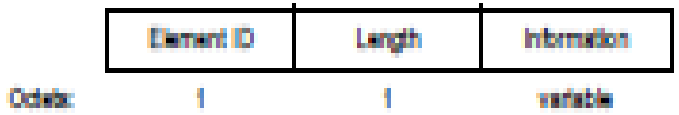


Figure 8-81—Element format

15.3

octets: L_n	1	1
IE payload	Length (=L_n)	Element ID

Figure 24—Information element format

15.3

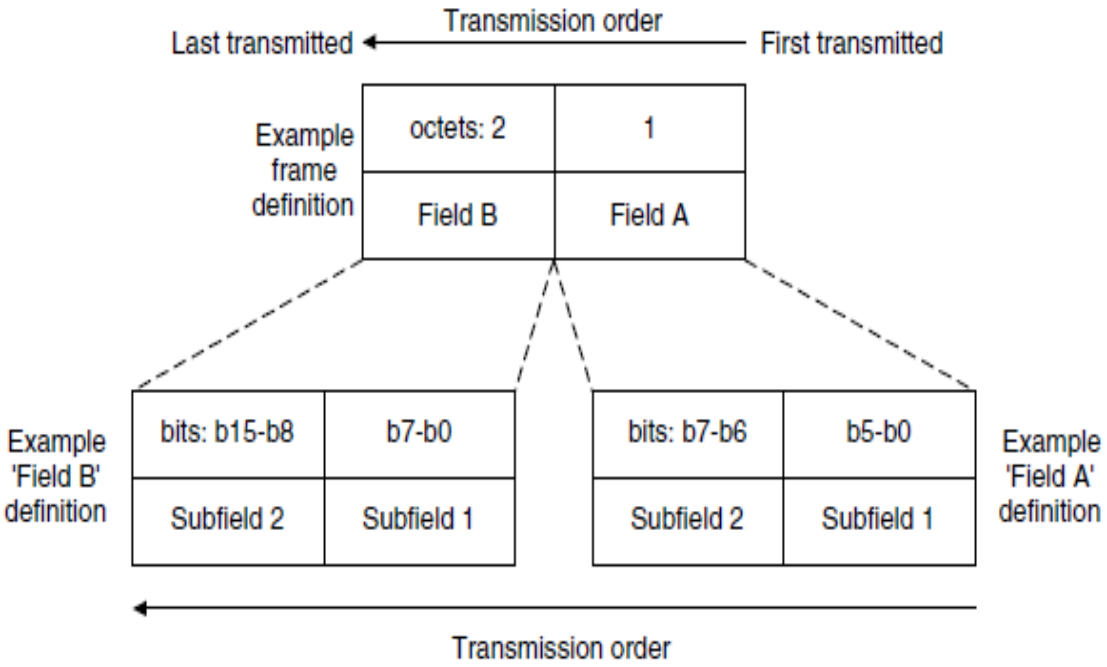


Figure 4—Example of bit and octet ordering.

MLE

- Abstract

- This document defines the mesh link establishment (MLE) protocol for
- establishing and configuring secure radio links in IEEE 802.15.4
- radio mesh networks. MLE extends IEEE 802.15.4 for use in multihop
- mesh networks by adding three capabilities: 1) dynamically
- configuring and securing radio links, 2) enabling network-wide
- changes to radio parameters, and 3) detecting neighboring devices.
- MLE operates below the routing layer, insulating it from the details
- of configuring, securing, and maintaining individual radio links
- within a larger mesh network.

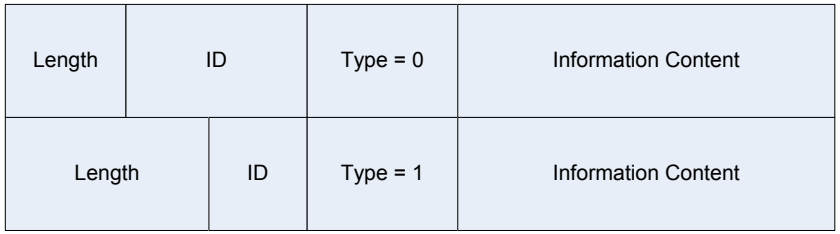
- 7. TLV Formats

- Values are encoded using a type-length-value format, where the type
- and length are one byte each and the length field contains the length
- of the value in bytes. There are no alignment requirements and no
- padding.

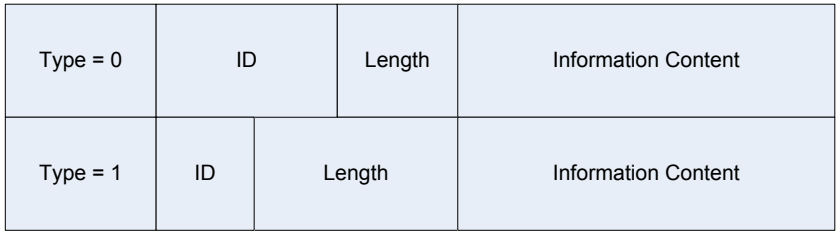
```
0               1               2               3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Type      |   Length    |   Value ...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

In-line Processing

This is what 15.4e has...



This is what it needs to be...



Resolutions

- Frame ID
  - TS 102 887-2 follows ANSI/TIA-4957
  - Frame ID 0b111 signals 3-bit extension
  - Full Frame ID is 6-bit 111 xxx
  - Assign
    - '111 000' → '111 111' for 802.15.4 standards
    - '111 111' → '111 000' for SDOs
    - Potentially meet in the middle
  - ANSI-TIA-4957.200 uses 111 111
    - Assumes unlikely that a second Frame ID extension would be needed
- Suggest adopting this extension format
  - Define a registration procedure (e.g. by IEEE RAC) for SDOs to request one or more Frame ID Extension value to be uniquely assigned to them

Resolution

- IE ID
  - Define a registration procedure (e.g. IEEE RAC) to manage IE ID name space
  - Redesignate (some of) managed and unmanaged IDs to be assigned by the registration procedure
  - SDOs may request ranges of IE ID name space to be uniquely assigned to them

Resolution

- IE Descriptor
  - Revert Descriptor to common TLV format used in IEEE and other standards
  - It is well understood that this will be difficult for 15.4 but it is a one-time pain to correct the erroneous descriptor choice which will avoid eternal confusion throughout widespread adoption of 15.4 supporting other standards