

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

Submission Title: The CamCom LLC Dilemma

Date Submitted: Sept 2013

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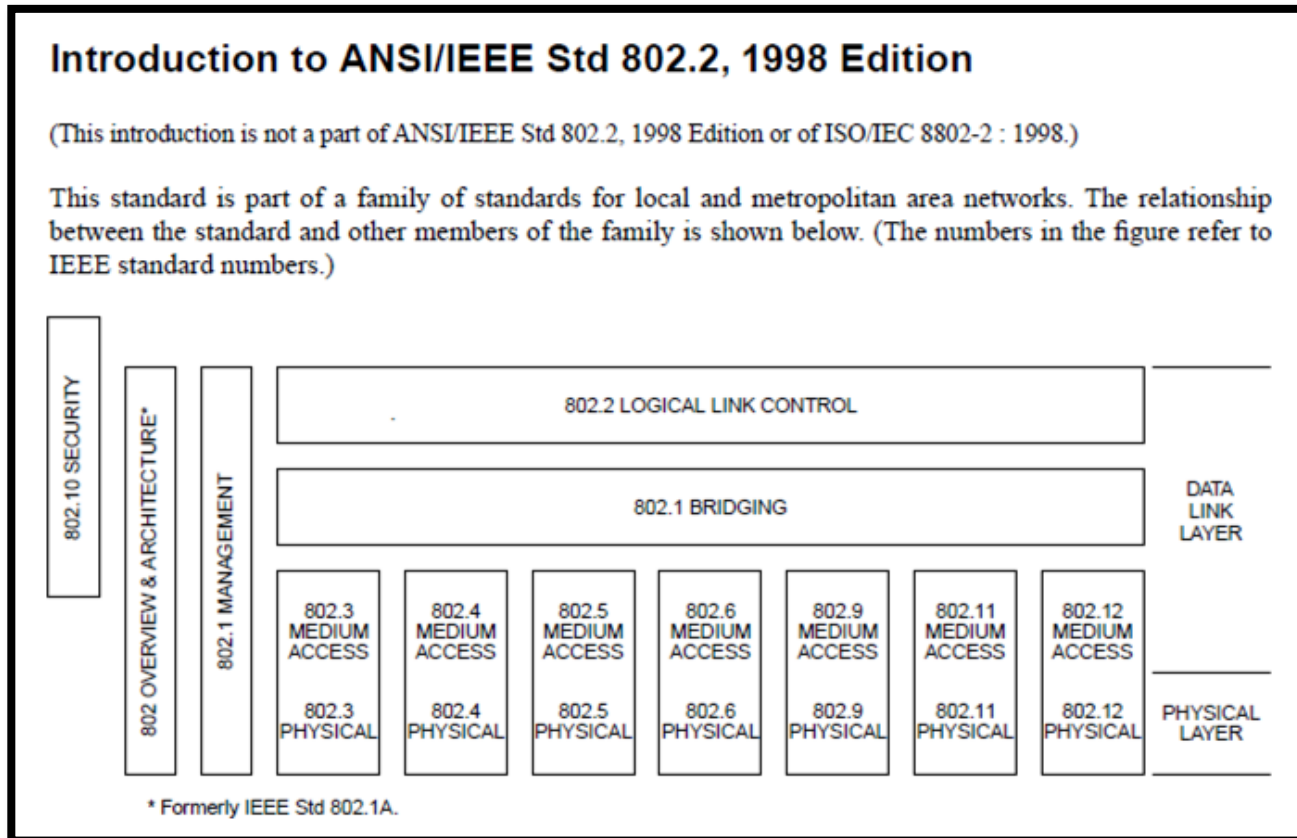
Abstract: In regards to CamCom, there is a potential problem with interfacing to the mandatory IEEE802.2 LLC. This contribution introduces the issues and asks several questions. Resolving these questions would be the task of the LED IG.

Purpose:

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During the July 2013 meeting it was pointed out that CamCom needs to interface with LLC



Support of the LLC will require at least one mode of bi-directional communications for CamCom. This contribution discusses this.

7. General requirements for an 802[®] LAN or MAN

7.1 Services supported

With the descriptions in Clause 6 as a basis, an IEEE 802[®] LAN or MAN can be characterized as a communication resource that provides sufficient capabilities to support the MAC service defined in ISO/IEC 15802-1, between two or more MSAPs. In particular, this requires the ability to convey LLC data from one MSAP to n other MSAPs, where n can be any number from 1 to all of the other MSAPs on the network. An IEEE 802[®] LAN is required, at a minimum, to support both LLC Type 1 and the MAC Internal Sublayer Service defined in ISO/IEC 15802-3. In addition, an ISLAN or MAN may optionally support isochronous bearer services compatible with ISDN services as defined in the ITU-T I-series Recommendations.

It is believed this also applies to WPANs.

Ref: IEEE Std 802-2001: IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture

6.2.2 LLC sublayer

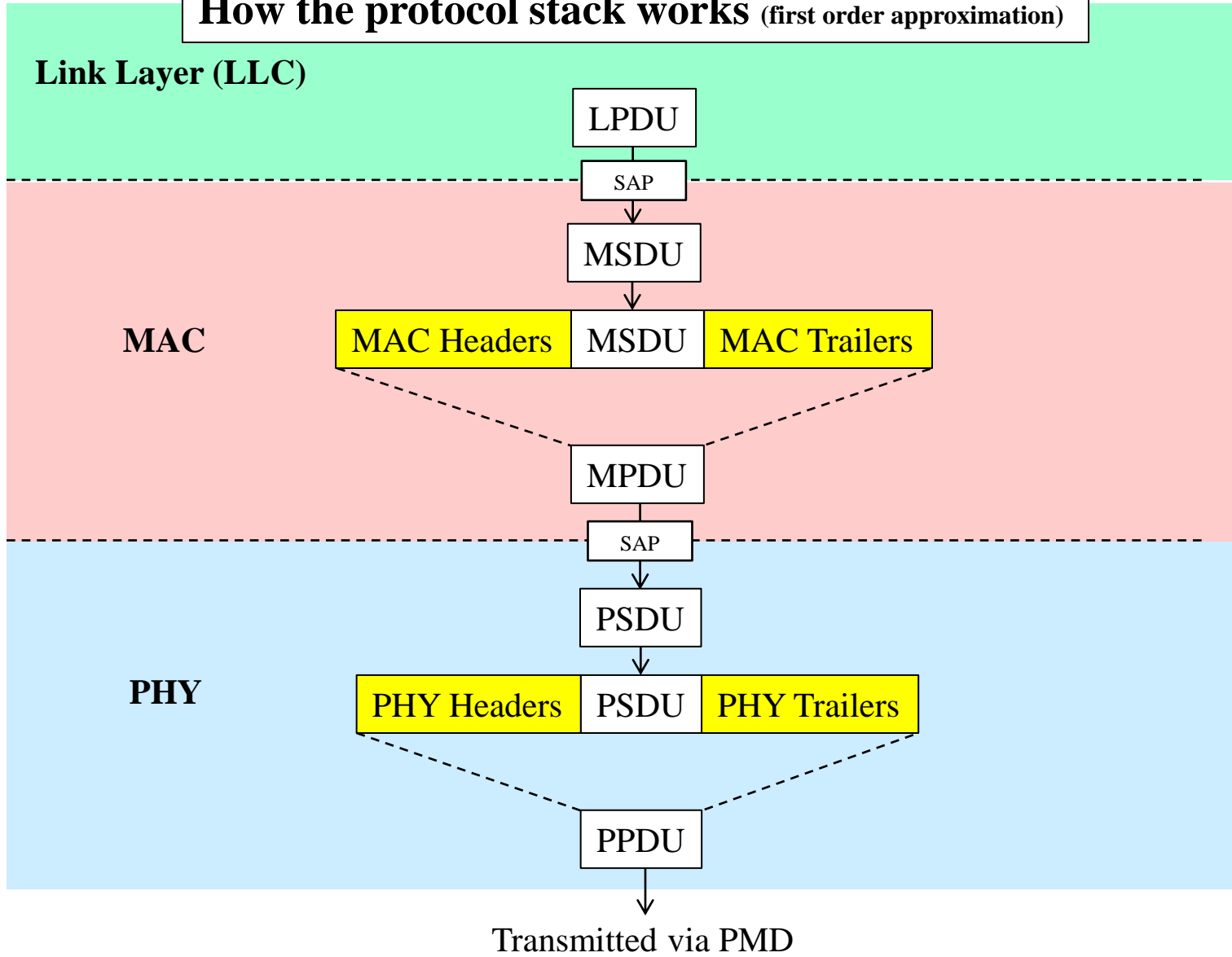
It is believed this means one can not have "just" unidirectional connectivity.

The LLC sublayer standard, ISO/IEC 8802-2, describes three types of operation for data communication between service access points: unacknowledged connectionless-mode (type 1), connection-mode (type 2), and acknowledged connectionless-mode (type 3).

With type 1 operation, information frames are exchanged between LLC entities without the need for the prior establishment of a logical link between peers. The LLC sublayer does not provide any acknowledgments for these LLC frames, nor does it provide any flow control or error recovery procedures.

LLC type 1 also provides a TEST function and an Exchange Identification (XID) function. The capability to act as responder for each of these functions is mandatory: This allows a station that chooses to support initiation of these functions to check the functioning of the communication path between itself and any other station, to discover the existence of other stations, and to find out the LLC capabilities of other stations.

How the protocol stack works (first order approximation)



Will it be possible to be IEEE802 LLC compliant and fit CamCom under IEEE802.15.7 ?

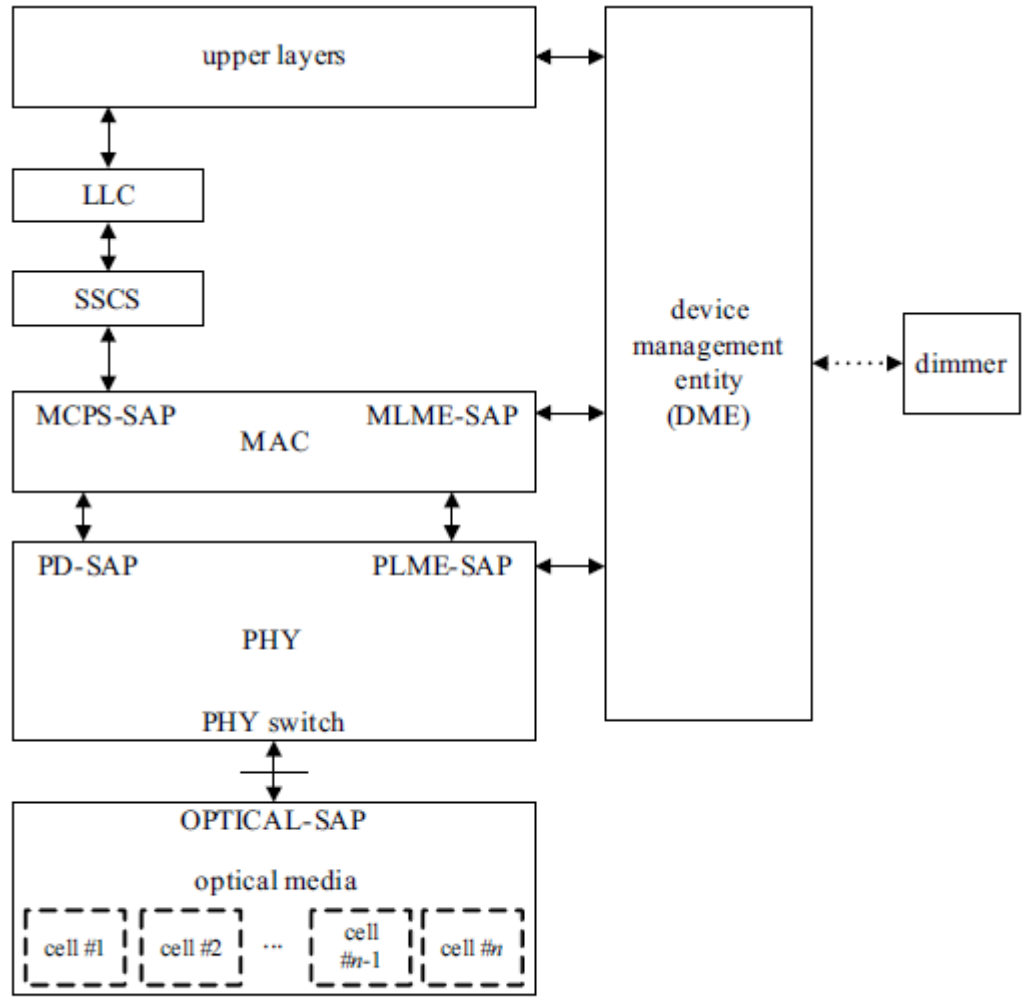


Figure 3—VPAN device architecture (IEEE802.15.7)

What is the issue? Why do we care?

1. Some use cases for CamCom reflect very simple protocols with very short repetitive messages with no network connection and potentially no need to interface to the LLC.
2. The principals behind some CamCom implementations are constrained by the low frame rate of the typical smartphone camera ... typically 30 frames per second. In one implementation the bit rate per LED is half the frame rate; hence, 15 bps per LED. Low overhead is absolutely necessary!

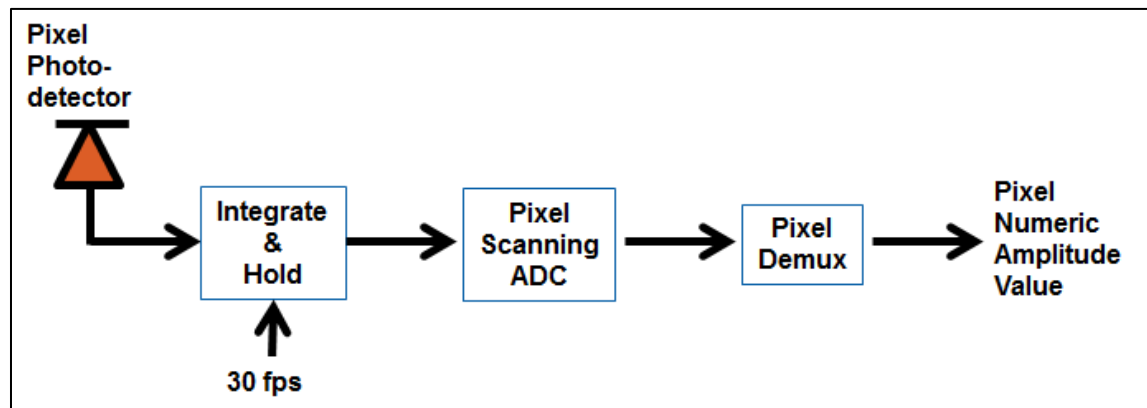


image sensor model: 2 dimensional lightwave-to-digital converter

For example, can CamCom tolerate the overhead of being LLC compliant given the extremely low data rates?

3.2 LLC PDU format

All LLC PDUs shall conform to the format shown in figure 4.

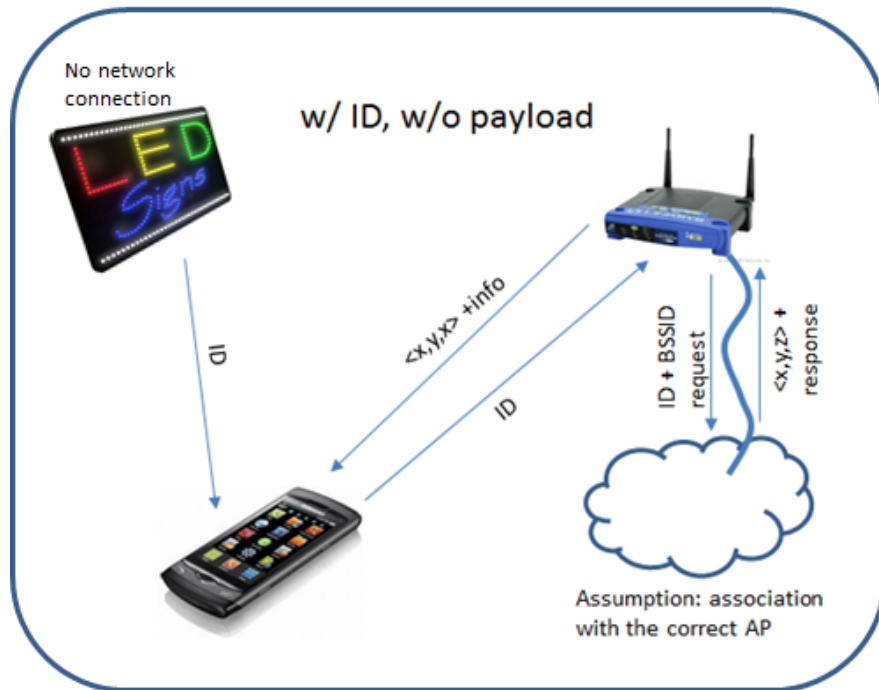
DSAP address	SSAP address	Control	Information
8 bits	8 bits	8 or 16 bits	M*8 bits

- DSAP address = Destination service access point address field
- SSAP address = Source service access point address field
- Control = Control field [16 bits for formats that include sequence numbering, and 8 bits for formats that do not (see 5.2)]
- Information = Information field
- * = Multiplication
- M = An integer value equal to or greater than 0. (Upper bound of M is a function of the medium access control methodology used.)

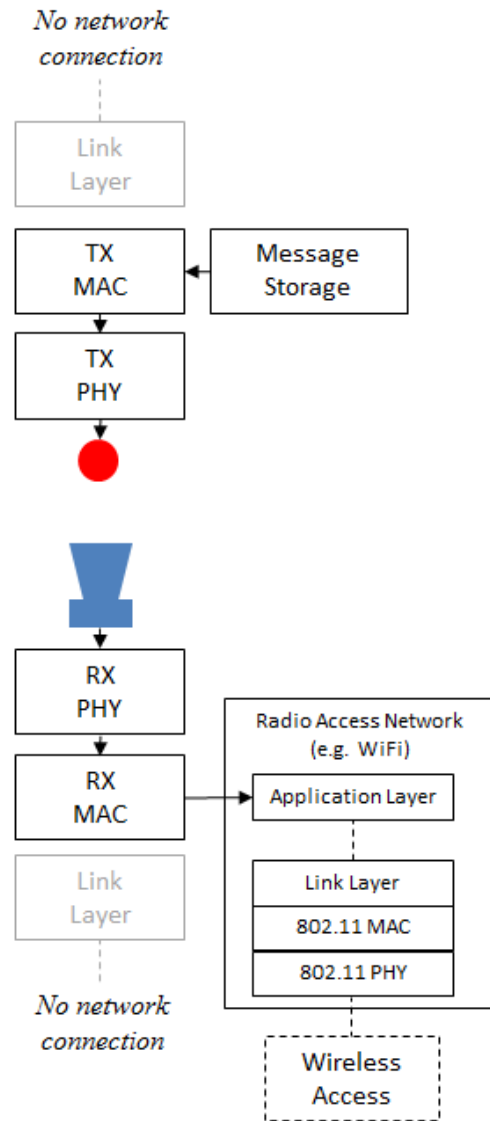
Figure 4—LLC PDU format

At 15 bps, just sending the LPDU overhead (assume 4 bytes) could take 2.13 seconds ... and that is not even sending a payload along with the MAC and PHY header overhead!!! (A typical CamCom frame might be 1 byte payload with 2 bit overhead).

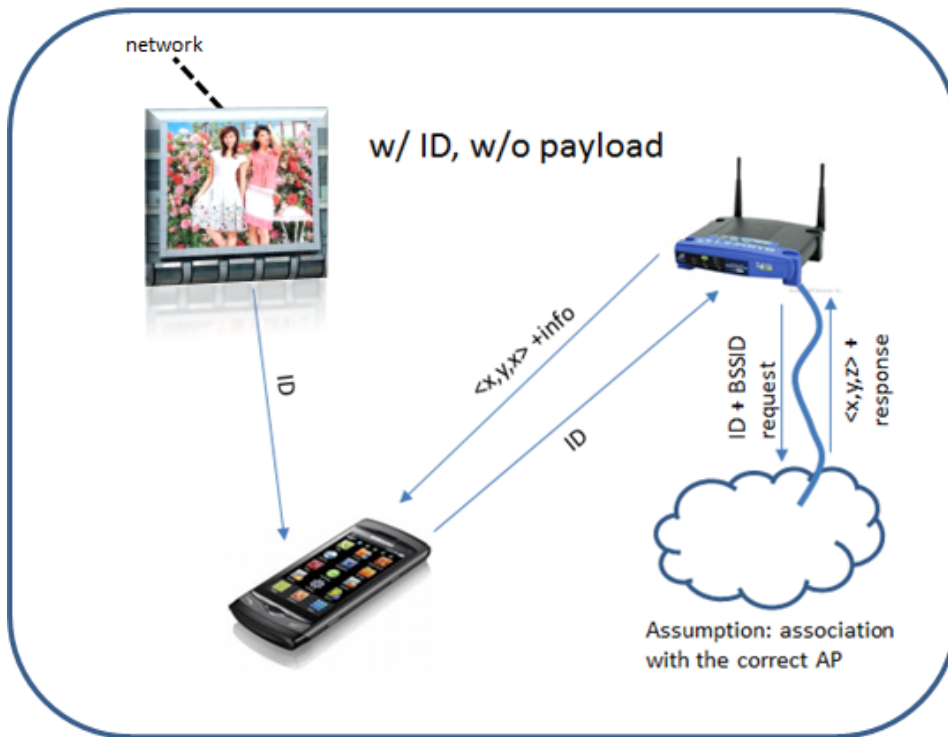
Example #1 CamCom w/o direct network connection



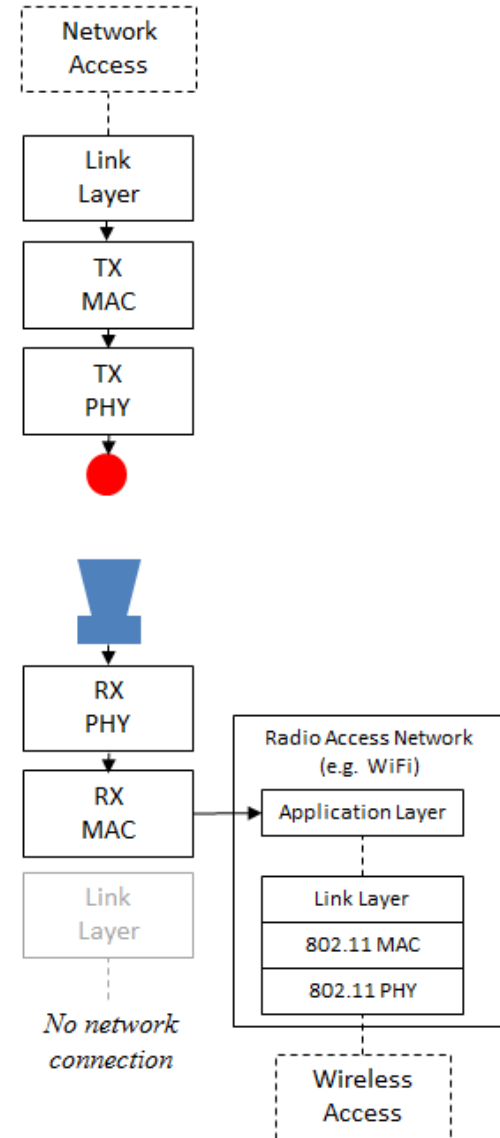
Exemplary Protocol Stack



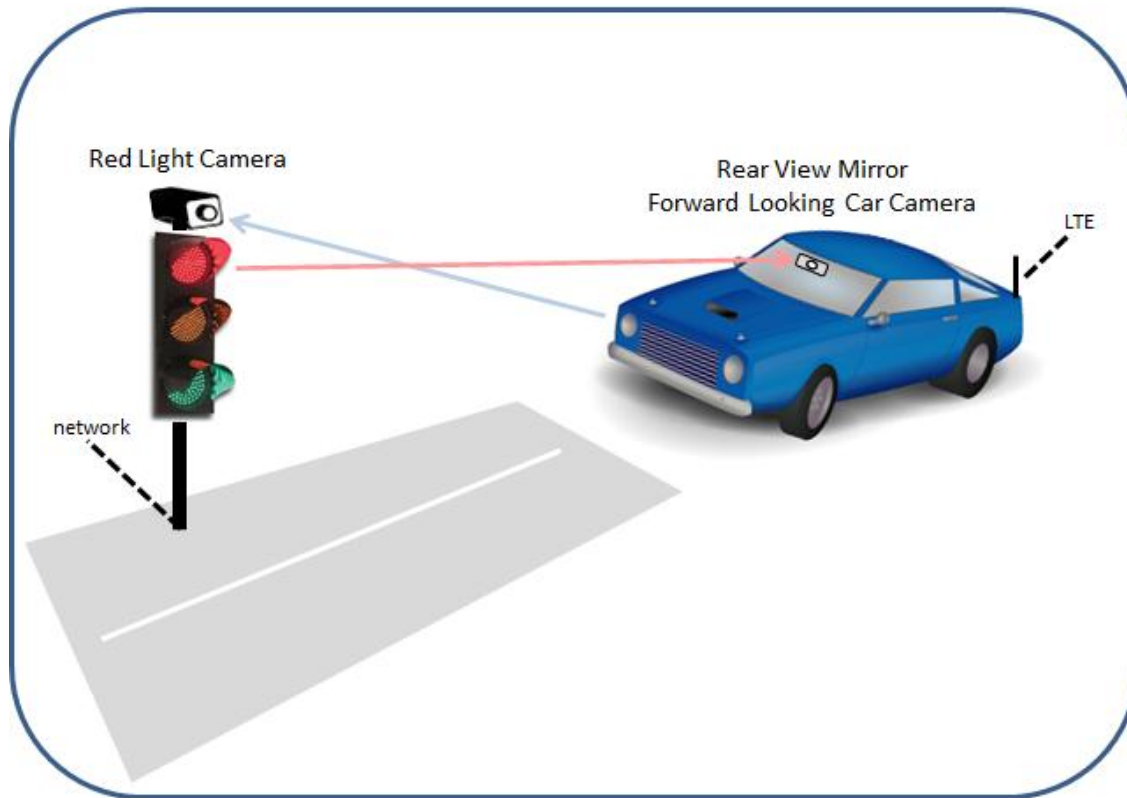
Example #2 CamCom w/ partial network connection



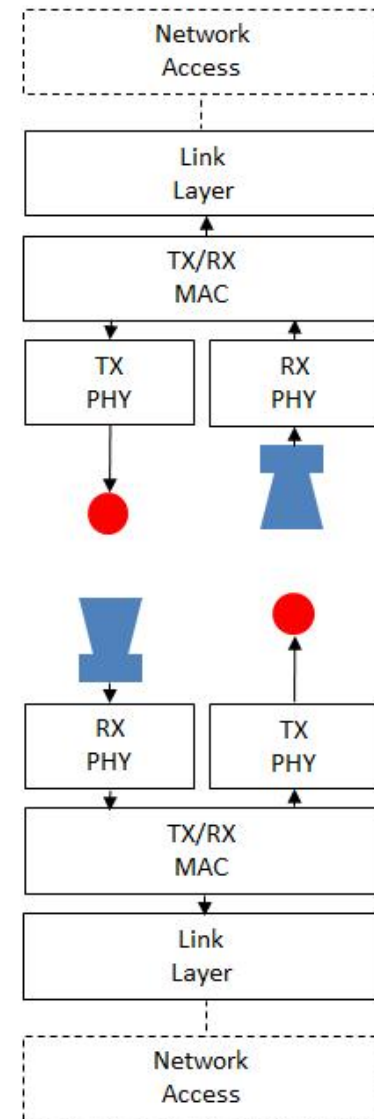
Exemplary Protocol Stack



Example #3 CamCom w/ full network connection



Exemplary Protocol Stack



Some questions and issues for the LED IG to consider.

1. Is it always required that the MSDU originate via the MAC SAP? Can the MSDU originate from the DME via the MLME SAP?
2. Is it required that the MSDU contain the overhead associated with the LPDU?
3. Can an amendment to IEEE802.15.7 be made that has MAC/PHY headers/trailers that are unique to the CamCom mode of operation (e.g. the MAC is altered based upon the PHY being used)?
4. Even though IEEE802.15.7 contains a broadcast mode of operation, is unidirectional operation “really legal” in regards to LLC compliance?
5. Can an IEEE802.15.7 amendment be constructed such that the reverse link is defined by the use of one or more existing radio access networks such as WiFi, Bluetooth, LTE, etc.? Has this been done in IEEE802?