

What are EPD and LPD?

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Re: 802.1 Maintenance, related to IEEE Std 802-2014, IEEE Std 802.1AC-2016, and IEEE Std 802.1Q-2018

Venue:

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Abstract:

This document describes inconsistencies in the description of EtherType protocol discrimination (EPD) between IEEE Std 802-2014, IEEE Std 802.1AC-2016, and IEEE Std 802.1Q-2018.

Notice:

This document represents the views of the author only and is offered as a basis for discussion.

What are EPD and LPD?

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Summary

- EtherType protocol discrimination (EPD) and LLC protocol discrimination (LPD) are discussed in IEEE Std 802, IEEE Std 802.1AC, and IEEE Std 802.1Q, and also IEEE Std 802.11.
- Overall, the descriptions are imprecise, inconsistent, and confusing.
- It's a problem for various reasons, particularly because new standards are supposed to support EPD.
- The best way forward to a consistent resolution is not yet clear.

EPD & LPD in IEEE Std 802

IEEE Std 802 subclause 5.2.2:

The higher layer protocol discrimination entity (HLPDE) is used by the LLC sublayer to determine the higher layer protocol ... Two methods may be used...

1) EtherType protocol discrimination (EPD), which uses the EtherType value made available to the LLC sublayer through the MSAP

2) LLC protocol discrimination (LPD), which uses the addresses defined in ISO/IEC 8802-2, including the Subnetwork Access Protocol (SNAP) format

“Including” is a little confusing. It seems to mean “which uses the addresses defined in ISO/IEC 8802-2, in some cases including the Subnetwork Access Protocol (SNAP) format”, rather than “which uses the sort of addresses defined in ISO/IEC 8802-2 that include the Subnetwork Access Protocol (SNAP) format”.

EPD & LPD in IEEE Std 802

IEEE Std 802 subclause 5.2.2:

IEEE Std 802.3 is capable of natively representing the EtherType within its MAC frame format, which is used to support EPD. IEEE Std 802.3 also natively supports ISO/IEC 8802-2 LPD (over a limited range of frame sizes).

It's not clear that this support is “native”, since IEEE Std 802.3 says nothing about using LLC or SNAP.

In other IEEE 802 networks, such as for IEEE Std 802.11™, LPD is also achieved using SNAP...

Note: 802.11 has since introduced EPD for some cases.

In either of these techniques, the EtherType is effectively being used as a means of identifying an LSAP that provides LLC sublayer service to the protocol concerned. ...

This can be little confusing; it's not only EtherType protocol discrimination that does protocol discrimination based on EtherType.

So, per IEEE Std 802, the EPD and LPD methods are reflected in the frame format, 802.3 supports both frame formats [depending on the value of the Length/Type field (<1501 EPD; >1535 LPD)] and both methods.

More from IEEE Std 802

IEEE Std 802 subclause 9.2.1:

Protocol discrimination performed by the EPD method is based on EtherTypes.

That's true of some LPD too.

For example, the value of the Type/Length field in the IEEE 802.3 MAC frame format directs the protocol parser into the LPD HLPDE if the value is less than 1536. This allows frames of both formats to be freely intermixed on a given IEEE 802 network and at a given station.

802.3 says nothing about this “direction” (and wouldn't say <1536 anyway).

This again suggests again that EPD and LPD are related to frame properties.

IEEE Std 802 subclause 9.4:

- *This subclause specifies the standard method for conveying Ethernet frames across IEEE 802 networks that offer only the LPD function and not the EPD function in the LLC sublayer.*

The method presumes the “Ethernet” frame carries an EtherType.

- *An Ethernet frame conveyed on an LPD-only IEEE 802 network...*

Again, some networks support EPD and LPD; others LPD only.

EPD and LPD: frame types and methods

Frame Format	Type/ Length Field (802.3)	LSAP	Discriminator	protocol identification
Type	Type	-	EtherType	EPD
OUI Extended EtherType (88-B7)	Type	-	Specified per OUI	EPD
Pure LLC*	Length	various	LSAP	LPD
SNAP	Length	AA or AB	Specified per OUI	LPD
SNAP/ RFC1042	Length	AA or AB	EtherType	LPD

*The (non-normative) Introduction to IEEE Std 802-2014 says “While the protocol identification mechanism specified by ISO/IEC 8802-2 is still used, its use for new standards has been deprecated.” The basis of this statement is not supported in the standard.

IEEE Std 802.1AC

IEEE Std 802.1AC-2016 subclause 5.2.2:

- *As described in Clause 9 of IEEE Std 802-2014, some media (e.g., IEEE 802.11) employ LLC Protocol Discrimination (LPD) and some media (e.g., IEEE 802.3) employ EtherType Protocol Discrimination (EPD) as the primary means for identifying the protocol ...*

802-2014 says nothing about the “primary” means of identifying the protocol. The method most often used use depends not on the medium but on the frames it carries.

- *On EPD media, either the first two octets are the length of the user data in the frame, which is then followed by a three- or four-octet LLC that identifies the protocol, or the first two octets are an EtherType that identifies the protocol.*

Note: Is “first two octets” clear? This is to cover all 802 networks.

This introduces the concept of an EPD medium as one that supports both EPD and LPD, differentiated with a Length/Type field, with EPD being “primary”.

- *On LPD media, the first three or four octets of the data are the destination and source Link Service Access Point (LSAP) identifiers and one or two Control octets that together identify the protocol.*

Note: LPD medium has no Length field.

Note: Is “first three or four octets of the data” clear?

Note: 802.3 and 802.11 are networks, not “media”.

EPD and LPD Media, per IEEE 802.1AC

Frame Format	Type/Length Field (802.3)	LSAP	Discriminator	IEEE Std 802 protocol identification	Frames on EPD Medium (e.g. 802.3)	Frames on LPD Medium** (e.g. 802.11)
Type	Type	-	EtherType	EPD	Yes EPD	no
OUI Extended EtherType (88-B7)	Type	-	Specified per OUI	EPD	no	no
Pure LLC*	Length	various	LSAP	LPD	Yes LPD	Yes LPD
SNAP	Length	AA or AB	Specified per OUI	LPD	no	no
SNAP/ RFC1042	Length	AA or AB	EtherType	LPD	no	no

**No Length/Type field.

More from IEEE 802.1AC

- *When receiving frames from or transmitting frames on a medium that uses LLC Protocol Discrimination (LPD), a conformant implementation shall translate the Media Access Control Service Data Unit (MSDU) as specified in Clause 12*

Implication is that medium that “uses” LPD cannot support EPD also, so frame translation is required. This is self-consistent.

IEEE 802.1Q (1/3)

- IEEE Std 802.1Q-2018 (EPD/LPD introduced via 802.1Qbz):
 - *3.85 EtherType Protocol Discrimination (EPD): A method for identifying the protocol contained in a frame in which the first two octets are an EtherType. See Clause 9 of IEEE Std 802-2014.*
 - *3.126 LLC Protocol Discrimination (LPD): A method for identifying the protocol contained in a frame in which the first three or four octets are a destination LSAP, a source LSAP, and one or two Control octets. See Clause 9 of IEEE Std 802-2014.*

Length-encapsulated Ethernet is not represented as either EPD or LPD.

The “first two octets” and “first three or four octets” are again ambiguous. Maybe the counting is inconsistent, so EPD starts counting with the Length/Type field and LPD starts counting afterwards. This may be an error caused by overlooking the fact that the single definition covers LPD in media that use a Length field and those that do not.

IEEE 802.1Q (2/3)

- IEEE Std 802.1Q-2018, subclause 6.22:
 - *As described more fully in Clause 9 of IEEE Std 802-2014, there are two methods that can be used to identify the format of the data parameter passed to or from a specific MAC procedure (see Figure 6-1 and 6-7), using the first few octets of the data parameter:*

What is “format of the data parameter”? Are we identifying a frame format or identifying the protocol?

- *a) LLC protocol discrimination (LPD) uses a three- or four-octet string consisting of destination and source Link Service Access Point identifiers (LSAPs) and one or two Control octets (see ISO/IEC 8802-2).*
- *b) EtherType protocol discrimination (EPD) uses a two-octet EtherType.*

Again the Length field disappeared from the count in LPD.

LPD in (a) is a little confusing because some readers could think that “uses” implies “uses only”.

IEEE 802.1Q (3/3)

- IEEE Std 802.1Q-2018, subclause 6.22:
 - *LLC media* (e.g., many uses of IEEE 802.11) employ LPD as the initial discriminant in a data parameter. The first three or four octets of the data parameter are the LSAP and Control octets. Specific values of those octets can be used to indicate the use of EPD, following the LSAP and Control octets, to identify the data format.
 - *Length/Type media* (e.g., IEEE 802.3) have a Length/Type field in the first two octets of the data parameter. Depending on the value of the Length/Type field (see IEEE Std 802.1AC), the Length/Type field is either an EtherType (i.e., EPD), or is a Length followed immediately by the LSAPs and Control octets (i.e., a Length and LPD).

A new concept here. Instead of “EPD media” and “LPD media”, like 802.1AC, we have “LLC media” and “Length/Type media”. Nice that “EPD” and “LPD” are not forced to serve two meanings.

“media” should be “networks”. The media (air, copper, etc.) don’t discriminate.

“LLC media” introduces another new concept: SNAP/RFC1042 is both LPD and EPD, because it uses LLC fields and uses EtherType to identify the protocol.

In “Length/Type media”, the parenthetical “(i.e., a Length and LPD)” misuses the term “LPD” to mean a group of fields.

EPD and LPD Media, per IEEE 802.1AC and 802.1Q

			IEEE Std 802	IEEE Std 802.1AC		IEEE Std 802.1Q	
Frame Format	Type/Length Field	Discriminator	protocol identification	EPD Medium (802.3)	LPD Medium** (802.11)	Length/Type Medium (802.3)	LLC Medium (legacy 802.11)
Type	Type	EtherType	EPD	Yes	no	Yes EPD	no
OUI Extended EtherType (88-B7)	Type	Specified per OUI	EPD	no	no	Yes EPD	no
Pure LLC	Length	LSAP	LPD	Yes	Yes	Yes LPD	Yes LPD
SNAP	Length	Specified per OUI	LPD	no	no	Yes LPD	Yes LPD
SNAP/ RFC1042	Length	EtherType	LPD	no	no	Yes LPD+EPD?	Yes LPD+EPD

**No Length/Type field.

per IEEE 802.11

IEEE Std 802.11 Annex M (informative):

- *As specified in IEEE Std 802-2014, EPD encoding always starts with a Length/Type field that is either a 2-octet length or a 2-octet Ethertype while LPD encoding always starts with an LSAP octet.*

Here EPD is an “encoding.”

The statement is incorrect regarding IEEE Std 802:

*In IEEE Std 802, EPD never uses Length

*IEEE Std 802 says nothing about field ordering (“starts with...”)

Regarding both EPD and LPD, the statement is similar to that of 802.1AC, but it includes more frame formats because the descriptions are more general.

EPD and LPD Media, per 802.1AC, 802.1Q, 802.11

			IEEE Std 802	IEEE Std 802.1AC		IEEE Std 802.1Q		IEEE Std 802.11	
Frame Format	Type/Length Field	Discriminator	protocol identification	EPD Medium (802.3)	LPD Medium** (802.11)	Length/Type Medium (802.3)	LLC Medium	EPD Encoding (802.3 or 802.11)	LPD Encoding** (802.11)
Type	Type	EtherType	EPD	Yes	no	Yes EPD	no	Yes	no
OUI Extended EtherType (88-B7)	Type	Specified per OUI	EPD	no	no	Yes EPD	no	Yes	no
Pure LLC	Length	LSAP	LPD	Yes	Yes	Yes LPD	Yes LPD	Yes	Yes
SNAP	Length	Specified per OUI	LPD	no	no	Yes LPD	Yes LPD	Yes	Yes
SNAP/ RFC1042	Length	EtherType	LPD	no	no	Yes LPD+EPD?	Yes LPD+EPD	Yes	Yes

**No Length/Type field.

Summary

- In IEEE Std 802, Ethernet supports EPD and LPD methods.
- In IEEE Std 802.1AC, Ethernet is an EPD medium supporting EPD and LPD methods but, in each case, using only one of the frame formats described in IEEE Std 802.
- In the IEEE Std 802.1Q definitions, Ethernet supports EPD using Type encapsulation and does not support any protocol discrimination using Length encapsulation. However, in other parts of 802.1Q, Ethernet is indicated as a “Length/Type medium” supporting Type-encapsulated EPD and Length-encapsulated LPD, as well as a method using LPD+EPD.
- In IEEE Std 802.11, EPD encoding supports both EPD and LPD methods.
- For networks without EtherTypes at the MAC layer, the situation is a bit more difficult to summarize.

Some Extra Questions

- Should we replace “medium” with “network”, since different networks (with different protocol discrimination methods) can use the same medium?
- Is pure LLC deprecated? [If so, in what document?]
- Do we describe SNAP/RFC1042 as being formatted as LDP, EDP, or both?
- Is it possible for an LDP network to support EDP?

Why it matters

Per IEEE Std 802:

- *New IEEE 802 standards shall support protocol discrimination in the LLC sublayer using EPD.*
 - *The EPD method shall be the primary specified means for protocol identification at the LLC sublayer in IEEE 802 standards developed after January 2011, excluding amendments to existing standards.*
-
- ❑ Does this mean that they shall be “EPD media” and therefore shall support LPD as well as EPD?
 - ❖ e.g., if the EPD medium receives a length-encapsulated frame, is it required to carry that frame in length-encapsulated format?
 - ❑ What is “primary” means?
 - ❑ Should we amend or revise IEEE Std 802, IEEE Std 802.1AC, and or IEEE Std 802.1Q for alignment?
 - Can we at least make the situation less confusing?