

EPD and LPD in IEEE Std 802 and Others

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Norman Finn

Huawei Technologies Co. Ltd

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1 Introduction

In the Maintenance TG meeting on March 19, 2020, Roger Marks led a discussion of [maint-Marks-802-epd-lpd-fix-0120](#), which describes changes needed to IEEE Std 802-2014 regarding confusion over EPD (Ethernet Protocol Discrimination) and LPD (LLC Protocol Discrimination). In this presentation, Roger and I had been focusing on coming up with the minimum changes needed to IEEE Std 802 required to make it right. In the discussion on Thursday, I mentioned a concept, the explanation of which is missing from IEEE Std 802, that I think could usefully be explained, but only if we were to perform a revision of that standard. I was encouraged to expand on this, and this note is the result. The concept is that EPD and LPD are properties of a protocol, not properties of a medium.

In writing down the EPD/LPD concept, I realized that there is a third class of protocols, those identified using an OUI/CID. I found that talking about three kinds of protocol identifiers and two kinds of encodings (Length-Type and LLC) helped to reduce the confusion. I believe that the biggest value of this contribution is to put ideas that are at the same conceptual level at the same textual level. The following is not suggested text for any particular clause in IEEE Std 802, because I have not tried to integrate it with the rest of the document. Some of this may be more appropriate for 802.1AC than for 802. Also, we may not want to put some of this information into any standard at all.

2 Idea list

2.1 Protocol Discrimination

There are three kinds of protocols, distinguished by the method chosen by the protocol designer to provide an identifier for the protocol.

- EPD protocols (Ethernet Protocol Discrimination): The identifier is a reserved EtherType value obtained from the IEEE RAC.
- LPD protocols (LLC Protocol Discrimination): The identifier is the value of the two LSAPs of an LLC (LSAP, LSAP, Control) afield defined in IEEE Std 802.2. This can be a reserved value obtained from the IEEE RAC.

<< footnote: Unlike EtherTypes, non-reserved values are legal in LSAP pairs. Non-reserved LSAP pairs identify a decode point at the receiver, and thus tacitly identify a protocol. I have tried to not prohibit this in the text of this contribution. The dynamic assignment of LSAP values does not seem to be specified by any IEEE 802 standard. >>

- OPD protocols (OUI or CID Protocol Discrimination): The identifier is a three-octet Organization Unique Identifier (OUI) or Company Identifier (CID) obtained from the IEEE RAC, followed by a 16-bit value assigned by the organization or individual assigned the OUI or CID.

2.2 Encoding

The meaning of the first two octets of the `mac_service_data_unit` field, passed in a MAC unit data indication or request across a SAP defined by a particular IEEE 802 Working Group. The two octets can hold one of two kinds value:

- Length-Type encoding: A 16-bit number that is either less than 1501 or greater than 1535. If less than 1501, the value is the length of the remainder of the frame, not including medium-required pad bytes, and following the length field are three LLC octets (see next paragraph). If greater than 1535, the value is the EtherType of an EPD protocol.
- LLC encoding: A pair of 8-bit LSAPs that together identify an LPD protocol.

Valid values for LSAPs can coincide with valid values for a Length-Type field.

Note that LPD is closely aligned with LLC encoding, while EPD is not at all synonymous with Length-Type encoding. This has been a source of confusion.

2.3 SAP type

A Service Access Point (SAP) defined by an IEEE 802 Working Group includes a data parameter (`mac_service_data_unit` in IEEE 802.3, for example). Historically, there have been media that always used either length/type coding or LLC encoding, and hence were called "EPD media, EtherType media, Ethernet media, ..." or "LLC media". This term is deprecated. Rather, we can speak of three kinds of SAPs:

- Length-Type SAPs: The data parameter uses Length-Type encoding.
- LLC SAPs: The data parameter uses LLC encoding.
- Mixed SAPs: The SAP interface includes a parameter, in at least one direction, indicating whether the data parameter uses Length-Type encoding or LLC encoding.

New MAC SAPs defined by IEEE 802 Working Groups shall be Length-Type SAPs.

An ISS SAP (see IEEE Std 802.1AC) is a Length-Type SAP.

2.4 Specific EPD and LPD protocols of interest

Tag protocols: There is a class of protocols called "tags". A tag is a peer-to-peer EPD protocol used to create a protocol data unit that encapsulates another protocol data unit that could stand on its own without the tag. A tag consists of an EtherType and 0 or more octets of data (the number of octets can be variable). Tags are inserted or removed at the head of a `mac_service_data_unit`. Following the tag is always a Length-Type encoding.

<< Footnote: Since the ISS is length/type only, and all tags are EPD protocols, tag addition and deletion is trivial. It is up to the media-specific shim between the ISS SAP and the MAC SAP to handle any LLC/SNAP/length issues on at the outermost level.>>

SNAP protocol: "SNAP encoding" (which is not recognized, here, as a separate "encoding" in the sense of Length-Type encoding vs. LLC encoding) is an LPD protocol. It is similar to a tag, in that it always precedes a protocol discriminator that is not LPD. It is different from a tag, in that it is not followed by a Length-Type encapsulation. It is required in two cases, is optional for one case, and has one obsolete use:

1. Across LLC SAPs, SNAP is required to identify EPD protocols.
2. Across LLC SAPs, SNAP is required to identify OPD protocols.
3. Across Length-Type SAPs, SNAP can be used to identify OPD protocols. The OUI Extended EtherType can also be used.
4. Historically, there were end stations that required Length-Type SAPs (namely 802.3) to always encode a length, and never an EtherType. This meant that they used a length and an LLC SNAP, followed by the EtherType. Interconnecting native EtherType end stations and SNAP end stations required extra protocols and/or configuration, so this usage has become obsolete.

OUI Extended EtherType protocol: Can be used, instead of SNAP, to support OPD protocols over Length-Type SAPs.

LLC Encapsulation EtherType protocol (defined in IEEE 802.1AC): Required to support an LPD protocol across a Length-Type SAP when the data is longer than 1536 octets.

<< footnote: One can argue whether such PDUs do, in fact, exist. >>

2.5 Translation

The 802.1AC stack and/or a bridge automatically and invariably translate between LLC encoding and Length-Type encoding for EPD protocols only, subject to 802.1H protocol-specific cruft.

Note that this only occurs at the outermost level, which is all that is defined and all that is needed.

2.6 Circularity

As illustrated by point 4, above, these protocols can be stacked circularly to produce absurd frames. Don't do that.

3 Background material

There are a number of ways in which the distinction between EtherTypes and LLC values are of interest, and seem to present a binary choice:

- A. The choice of protocol discrimination method, EPD or LPD, made by the protocol designer.
- B. The meaning of the first two octets of a received IEEE 802 frame, generally those octets immediately following the MAC addresses, either a Length/Type field or the first two of the LLC octets.
- C. An encoding method for an EtherType, either an EtherType directly, or else SNAP.
- D. A choice between two kinds of media, either 802.3, which employs the Length-Type field, versus 802.5 or (historically) 802.11, which employ LLC or SNAP.

These overlapping usages continue to produce confusion.

Very few protocols have ever had LSAP identities assigned; IEEE Std 802.1Q Bridge Protocol Data Units are one of those few. The IEEE Registration Authority prefers to grant EtherType values for new protocols.

Going forward, most new protocols will be defined using EPD, some with OPD. But, there are protocols of significant interest that are in widespread use and are defined using LPD. Therefore, it is a requirement for all IEEE 802 media to be able to carry both EPD and LPD protocols, mixed in any fashion from frame to frame, such that the receiver can identify the protocol carried in a frame unambiguously.

Just as importantly, it is a requirement that a bridge be able to interconnect end stations on different IEEE 802 media, so that a new protocol can be deployed among the end stations without requiring modification of the operation of the bridge.

4 One new issue

Insisting that the ISS be Length-Type solved a number of problems, especially with tagging and security laying, but raises a new one. The reason is that the choice among EtherType / SNAP /

OUI Extended EtherType / LLC Encapsulation EtherType can depend on the underlying medium's encoding, whereas the ISS hides that. In particular, OPD protocols have a choice between SNAP+OUI and the OUI Extended EtherType. I'm not sure how to deal with this. Two choices, both bad:

1. Separate out 4 PDs, EPD, LPD, EtherType OPD, and SNAP OPD, and do not automatically convert between them. This leads to SNAP encoding of the OUI Extended EtherType, which seems silly.
2. Automatically translate between OUI Extended EtherType and SNAP-non-0-OUI. This will probably break existing deployments, many of which never heard of the OUI Extended EtherType.

I don't have a fix. Hopefully, I misunderstand the problem.