New Specification of Current 802 LLC

Document Number: maint-Marks-llc-spec-copyright-0420-04

Date Submitted:
2020-06-03

Source:
Roger B. Marks
EthAirNet Associates
404 Montview Blvd
Denver, CO 80207 USA

Voice: +1 802 227 2253
E-mail: roger@ethair.net

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

Abstract
This document proposes a detailed description of LLC, as commonly implemented in 802, to replace 802.2. It supports only the protocol multiplexing function of 802.2 and also supports protocol multiplexing based on Ethertype, providing a detailed specification of LPD and EPD and including the architectural role of VLAN tagging. The results are not intended to provide any novel protocols but instead simply to specify architecture and terminology in accordance with current usage. This contribution is a followup to maint-Marks-hlpde-0919-redacted.pdf, maint-Marks-epd-lpd-0719-v02, and maint-Marks-hlpde-spec-0420-copyright-v01.

Note:
This document represents the current views of the author only and is offered as a basis for discussion. More development is needed.

The author appreciates valuable contributions and comments from Norm Finn and Mick Seaman.

Copyright information

Portions of this document are Copyright © IEEE.

Per IEEE copyright policy:

- this document is “Previously Published”
- the contributor is fulfilling his responsibility to immediately inform the WG Chair that the contribution requires permission from copyright owner(s) and cannot be presented or included in the draft until that permission is granted, and offering to assist the WG Chair in requesting the permission, if possible
- the WG Chair is responsible to use the IEEE-SA Permission Request and Response Form Templates to request permission (http://standards.ieee.org/develop/stdsreview.html)

New Specification of Current 802 LLC

Roger B. Marks
EthAirNet Associates
2020-06-03
IEEE 802.1 Maintenance TG

Summary

- A prior contribution <maint-Marks-hlpde-0919-redacted.pdf> said:
  - *The de facto LLC is the HLPDE. The root of the problem is that the HLPDE is not specified. It should possible to specify the HLPDE for clarification, without altering current understanding of the expected operation.*
- maint-Marks-hlpde-spec-0420-copyright-v01 proposed to specify HLPDE so that HLPDE and 802.2 comprise the LLC.
- Contributors have noted defects with 802.2 and the obsolescence of the standard; however, 802.2 cannot be maintained since the standard was withdrawn.
- Instead of specifying specify HLPDE, this contribution proposes to delete the reference to 802.2 and instead provide a specification of the LLC, as currently understood in 802, that incorporates only the protocol multiplexing function of 802.2 and also supports protocol multiplexing based on Ethertype, including a detailed specification of LPD and EPD.
- The results are not intended to provide a novel protocol but instead simply to specify architecture and terminology in accordance with current usage.
- Bridging architecture is not proposed for specification in IEEE Std 802.

IEEE 802 LLC

- LLC is a core concept in IEEE 802
  - Per IEEE Std 802, DLC has two sublayers: LLC and MAC
  - LLC is the client of the MAC service

- LLC is not specified in IEEE Std 802
  - it vaguely discusses a “higher layer protocol discrimination entity”
  - examples show components of MAC frames without naming their origins
  - frame examples are complicated because they aggregate all layers

- IEEE Std 802 has one mention of IEEE Std 802.2 (“Logical link control”):
  - *IEEE Std 802.2™-1989 (reaffirmed 2003) was administratively withdrawn as an IEEE standard on 11 January 2011 in deference to the stabilized standard ISO/IEC 8802-2:1998 where the same material continues to be available.*

- Many (most) aspects of 802.2 are not currently implemented.
- A withdrawn standard cannot be revised or amended.

MAC Expectations of LPDU

- The 802 MAC standards specify expectations of the LPDU format
- 802.3: "The services provided by the MAC sublayer allow the local MAC client entity to exchange LLC data units with peer LLC sublayer entities."
  - LLC data unit (MSDU) is not an opaque packet; it is presumed to have structure known to the MAC [a bit of a layer violation] starting with a Length/Type field.
  - *The MAC service per IEEE 802.3 (normative subclause 4A.3.2) specifies:*
    - *lengthOrType: The value of the first two octets at the start of the mac_service_data_unit*
    - *data: The value of mac_service_data_unit excluding the first two octets*
    - This LDPU format is not specified in any 802 LLC standard.
- 802.11 expects a particular LLC format that is not documented in IEEE Std 802:
  - *Logical Link Control (LLC) sublayer entities use the MAC sublayer service to exchange PDUs with peer LLC sublayer entities. These PDUs are termed MAC sublayer SDUs (MSDUs) when sent to the MAC sublayer.*
  - *There are two LLC sublayer protocols used (see IEEE Std 802); LLC Protocol Discrimination (LPD) (see ISO/IEC 8802-2:1998) and Ethertype Protocol Discrimination (EPD) (see IEEE Std 802.3-2012).*
  - *MSDU format parameter indicates if the received MSDU is in EPD or LPD format.*
  - EPD format is not specified in any 802 LLC standard.
  - 802.11 has no normative specification of the Length/Type field
    - e.g. when it's a length and when it's a type
    - What if an 802.11 length is later interpreted as an 802.3 type?

➢ We need an LLC specification, common to all MACs, to specify the LPDU format(s)

802.2 Functionality

- 802.2 supports three LLC types
  - Type 1: connectionless and unacknowledged
  - Type 2: connection-oriented
  - Type 3: connectionless but acknowledged
- This LLC specification supports only Type 1 multiplexing function
  - does not support Type 2 or 3
- 802.2 supports four “classes” of LLC operation
- This LLC specification supports only Class I
  - Class I is “data-link connectionless-mode”
- Per the 802.2 Type 1 description:
  - *There exists for each MAC service access point one and only one LLC entity, consisting of the various operating components.*
  - *In Class I LLC operation, each LLC can have zero or more SAPs being serviced (i.e., active) at any one time, independent of each other, which are differentiated by the DSAP address.*

HLPDE per IEEE Std 802-2014

The LLC sublayer contains a variety of entities, as illustrated in Figure 6.

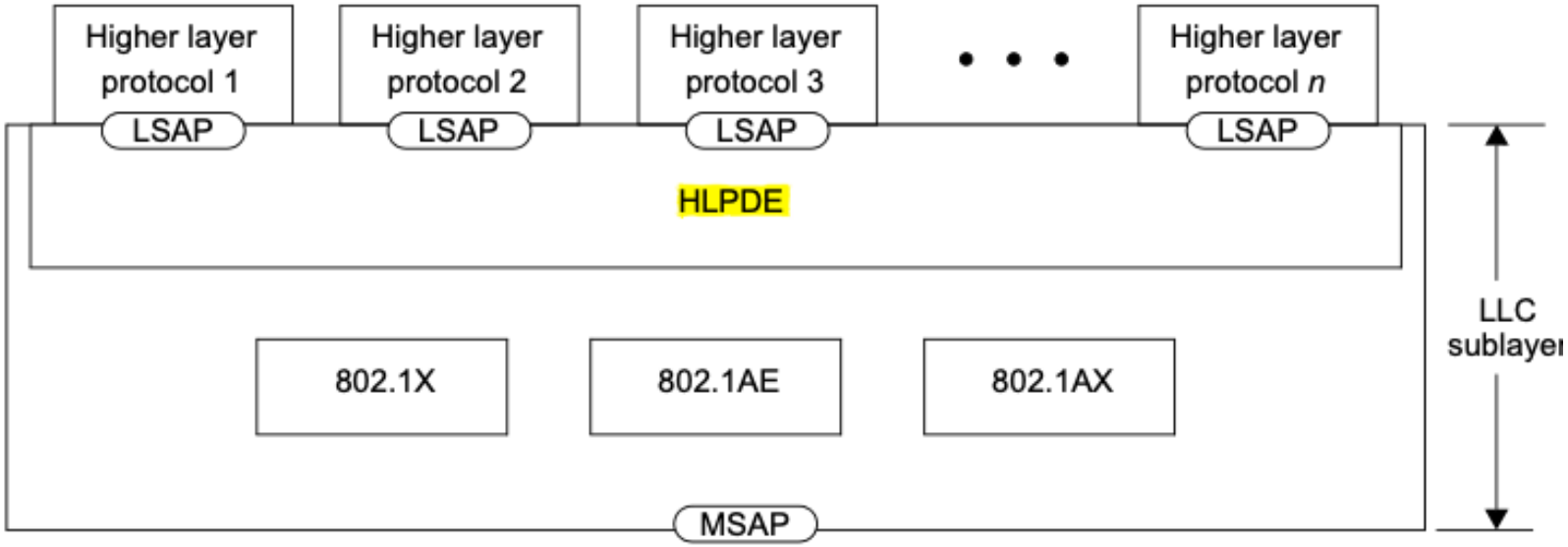


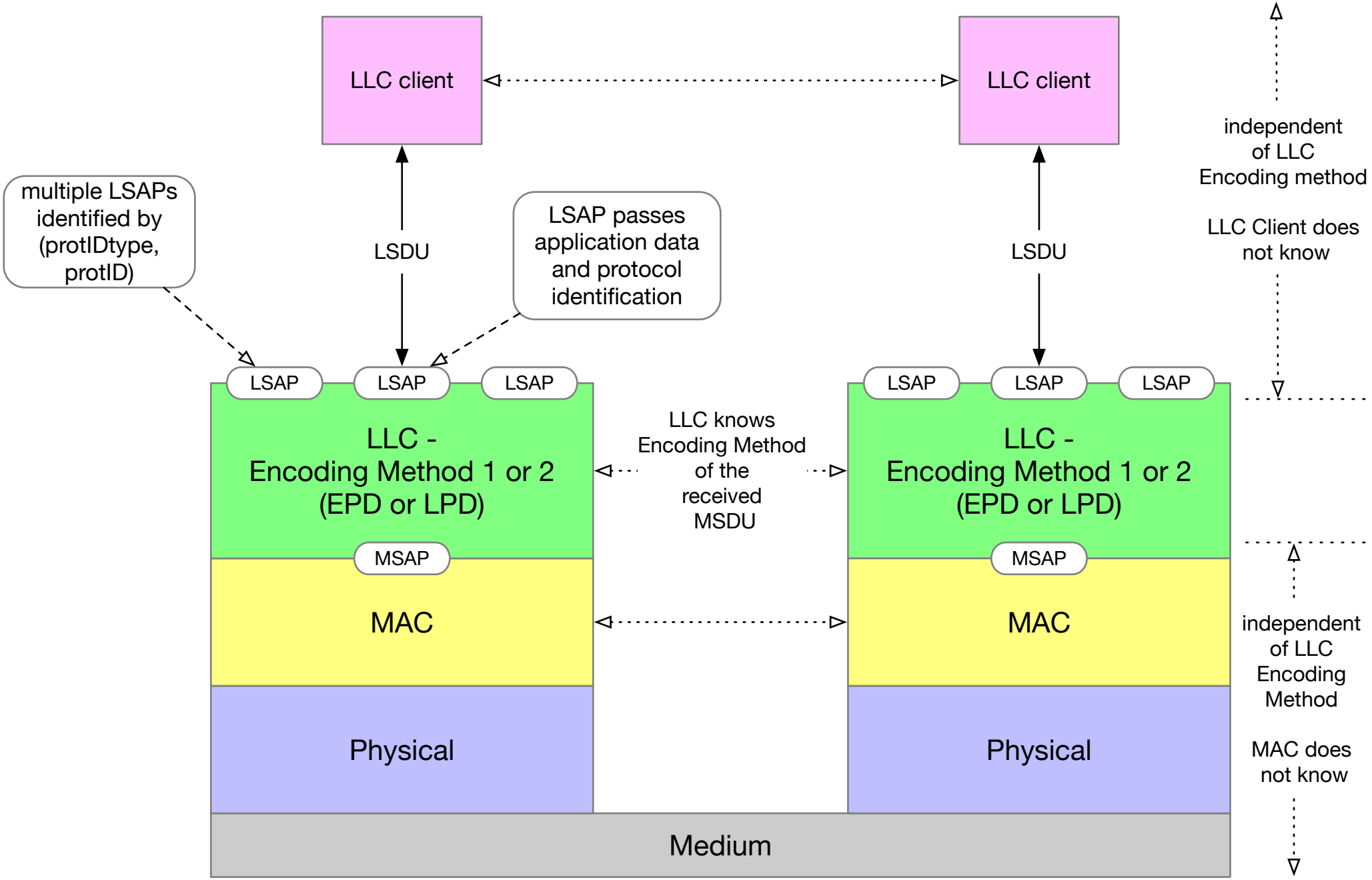
Figure 6—LLC sublayer in 802 RM

IEEE Std 802-2014:
The higher layer protocol discrimination entity (HLPDE) is used by the LLC sublayer to determine the higher layer protocol to which to deliver an LLC sublayer protocol data unit (PDU). Two methods may be used in the HLPDE. The two methods are:

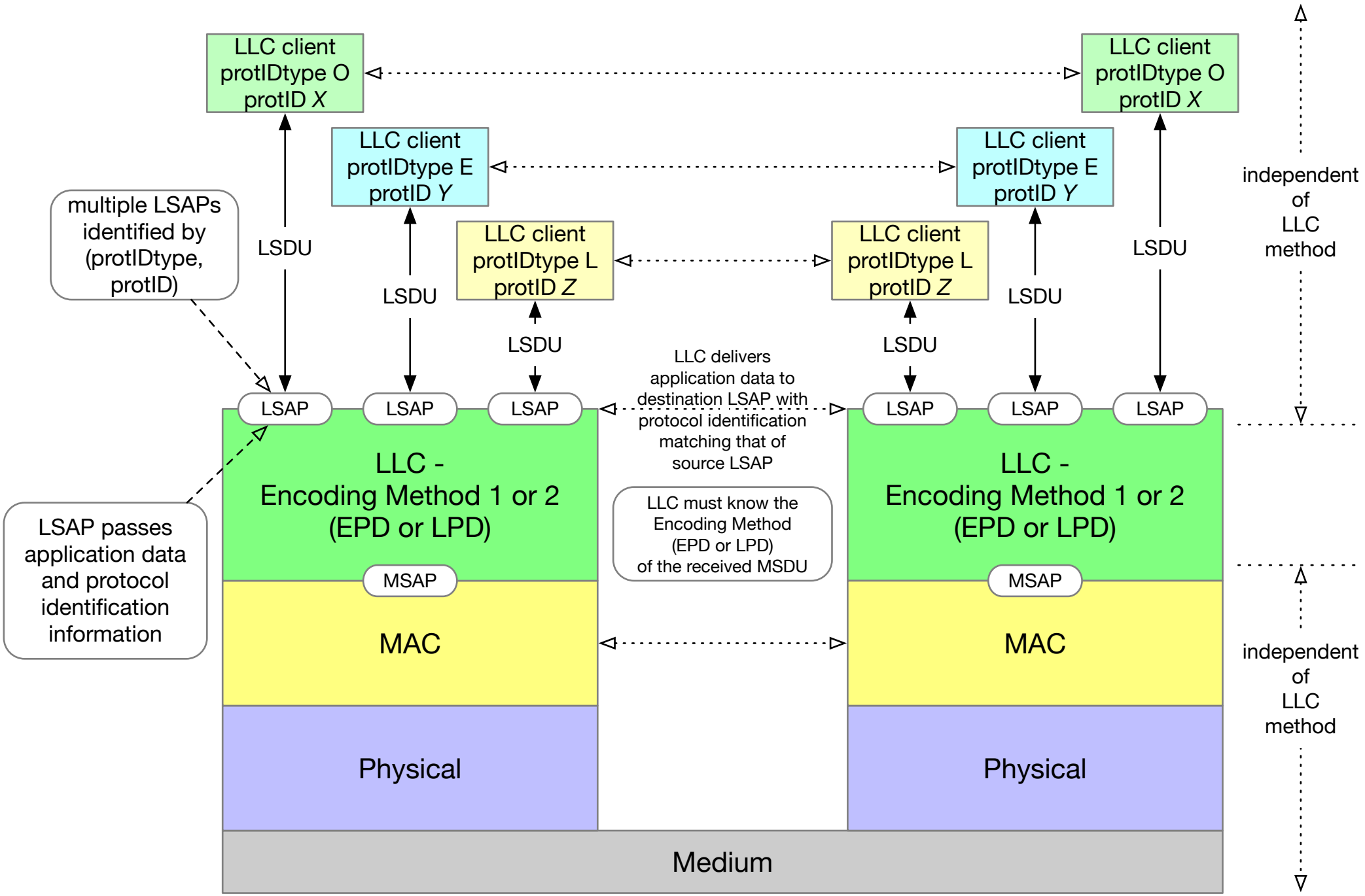
1) EtherType protocol discrimination (EPD), which uses the EtherType value made available to the LLC sublayer through the MSAP
2) LLC protocol discrimination (LPD), which uses the addresses defined in ISO/IEC 8802-2, including the Subnetwork Access Protocol (SNAP) format

- As discussed in prior contributions, the descriptions of EPD and LPD in IEEE Std 802-2014, 802.1AC, and 802.1Q are inconsistent.
- Since EPD and LPD are HLDPE methods, this contribution seeks to resolve the issues by proposing development of a detailed specification of the LLC incorporating higher layer protocol discrimination.

New LLC Spec in the 802 Architecture



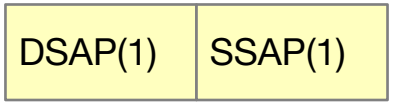
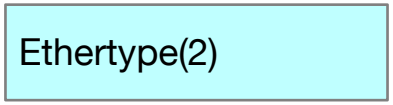
LLC Clients match by (protIDtype, protID)



protIDtypes and protID formats

The LSAP is identified by a protocol identifier, characterized by:
(a) prototol type *protIDtype* (either “L”, “E”, or “O”)
(b) prototol value *protID*, using a specific format for each protIDtype

Upon receipt of a frame from MAC, LLC identifies *protIDtype* and *protID* and delivers frame to the identified LSAP.

protIDtype	**protocol identifier**	**protID format**
L	LSAP Identifier	
E	Ethertype	
O	O Identifier	

Note 1: LSAP identifier is a compound identifier consisting of DSAP (destination identifier) and SSAP (source identifier). Packet is delivered to LSAP identified by DSAP.

Note 2: If DSAP is a group identifier, packet may be delivered to more than one LSAP within the end station (but this behavior could/should be deprecated, considering that it has been marked “for further study” for over 25 years.)

Note 3: The (protIDtype O) OUI/CID Extended identifier is specified in IEEE Std 802 to begin with a registered OUI, OUI-36, or CID, with additional bits specified by the assignee of that registered identifier to uniquely identify the protocol. For LLC purposes, the structure of the O Identifier is irrelevant, but it shall not begin with 00-00-00.

Note 4: if protIDtype = E, protID is $>1535_{10}$ and shall not equal to 0x88B7 or 0xC9D1.

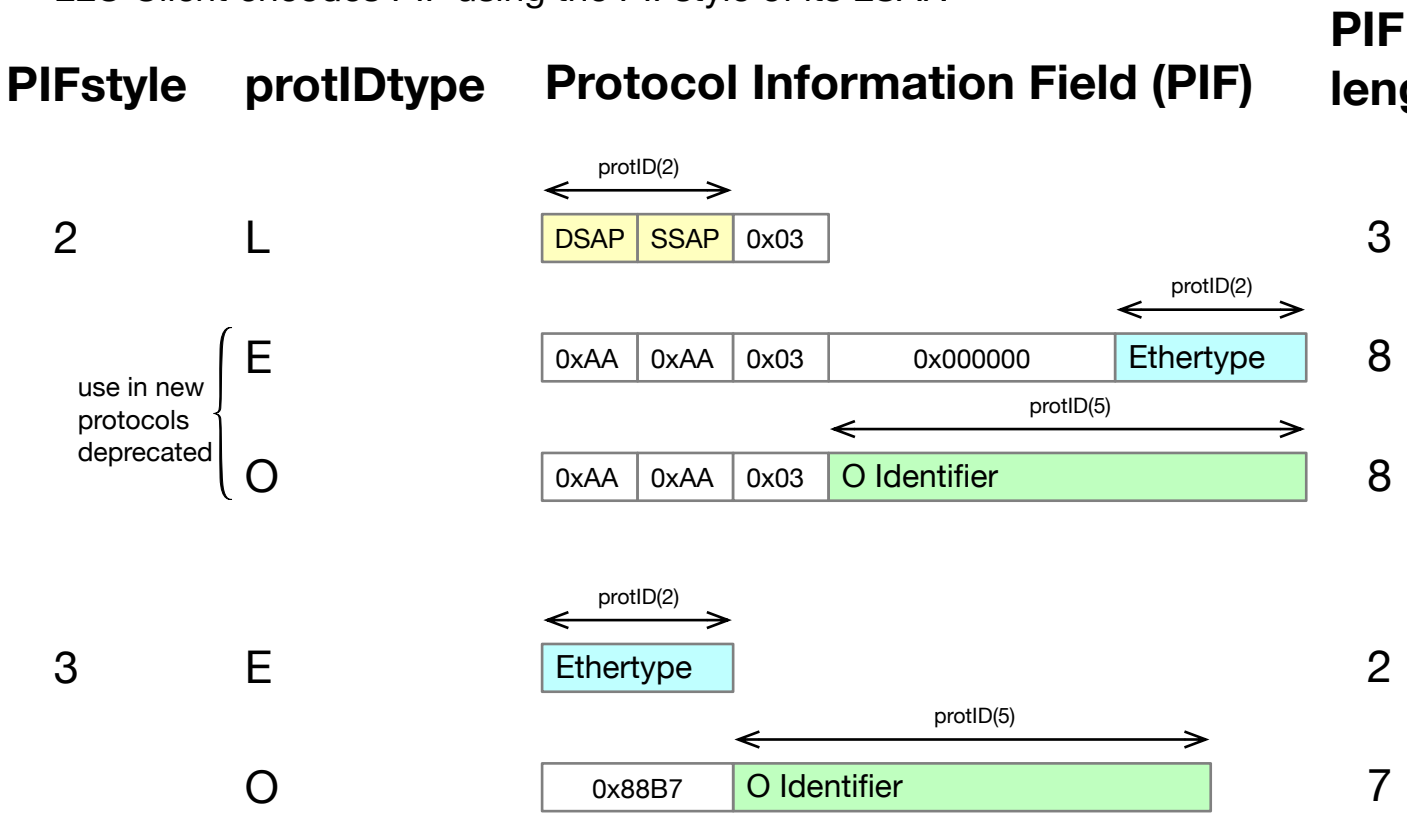
Protocol Information Field (PIF) and PIFstyle

To reiterate, the LSAP is identified by:
(a) *protIDtype* (either “L”, “E”, or “O”)
(b) *protID*

LSAP is also characterized by a *PIFstyle*, which has the value 2 or 3. The value is known to LLC Client and to LLC.
-local to the station; e.g. LSAP with Ethertype=X may have PIFstyle=2 at one station and PIFstyle=3 at another

LLC Client is responsible to encode protID (directly) and protIDtype (indirectly) into a Protocol Information Field (PIF).

LLC Client encodes PIF using the PIFstyle of its LSAP.



Given only a PIFstyle and sequence headed by a unknown-length PIF, one can recover the protIDtype (and therefore PIF length) and the protID:

If PIFstyle=2:

if the first 2 bytes are not 0xAAAA, then protIDtype=L and the first 2 bytes are the LSAP Identifier.

else if the first 6 bytes are 0xAAAA03000000, then protIDtype=E and the following 2 bytes are the Ethertype.

else the 5 bytes after the first 3 are the O Identifier

If PIFstyle=3:

if the first 2 bytes are 0x88B7, then protIDtype=O and the next 5 bytes are the O Identifier.

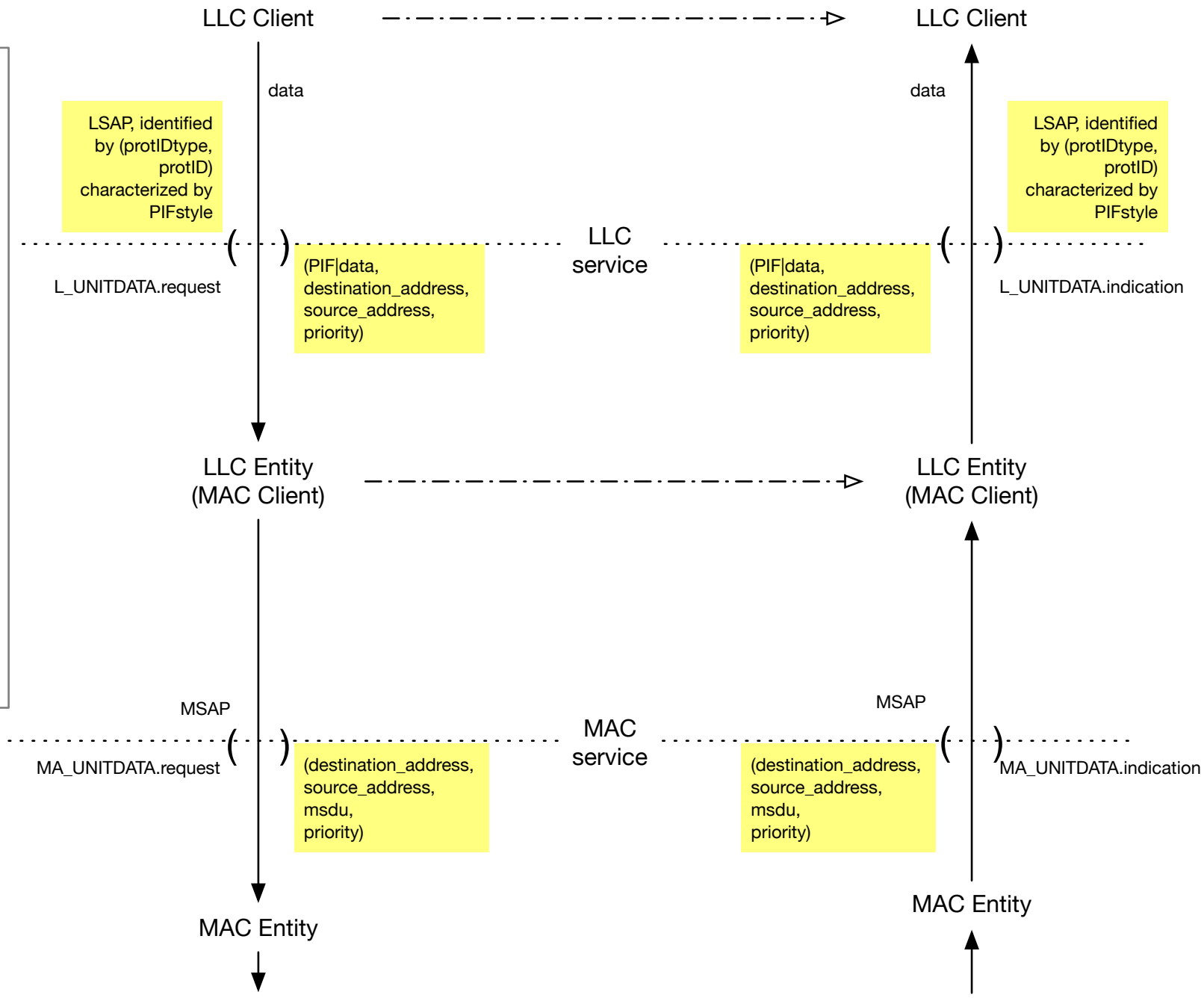
else protIDtype=E and the first 2 bytes are the Ethertype

LSAP Service Primitives in New LLC Spec

Analogous 802.2 primitive is DL-UNITDATA request (source_address, destination_address, data, priority)

Per 802.2:
The "source_address" and "destination_address" parameters provide at a minimum the logical concatenation of the MAC address field (SA and/or DA) and the LLC address field (SSAP and/or DSAP).

That is, it's not the job of the LLC to determine the MAC DA and SA; that needs to be passed down from LLC Client.



LLC Operation

- LSAP is identified by (protIDtype, protID) and characterized by PIFstyle
- LLC Client concatenates PIF to data and delivers PIF|data as LSDU to LSAP
  along with MAC DA/SA
- LLC encodes PIF into PDF and generates the MSDU as PDF|data
  PDF: Protocol Discrimination Field
- LLC sends MSDU to MSAP, along with MAC DA/SA
- Peer LLC, from MSAP, receives MSDU (PDF|data) with MAC DA/SA
- From MSDU, LLC extracts (PIF|data, protIDtype**,** protID)
- LLC forwards PIF|data (& MAC DA/SA) to LLC Client at LSAP
  as identified by (protIDtype, protID)
  matching original (protIDtype, protID)

LLC Encoding Methods

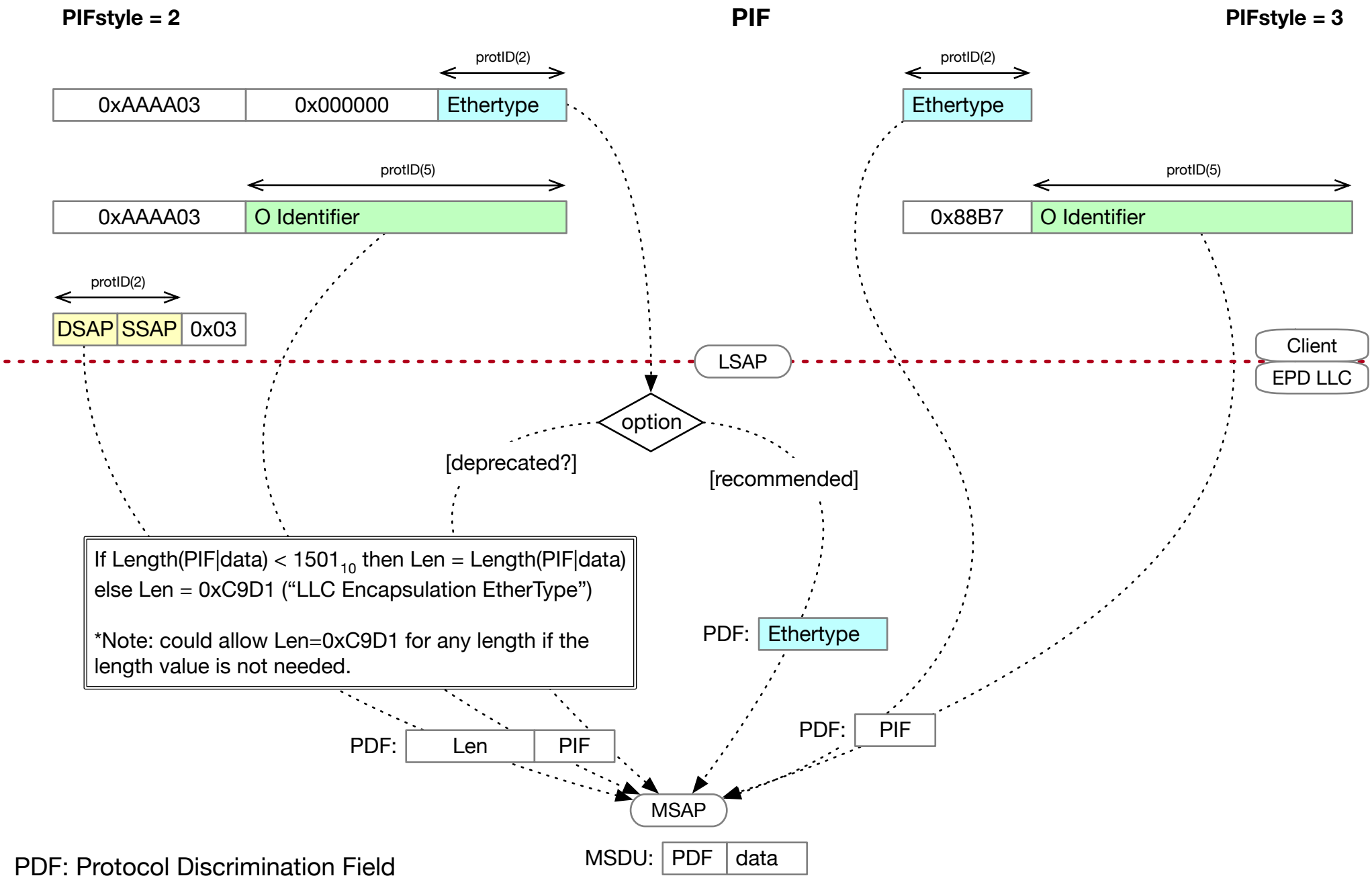
•Two LLC Encoding Methods are supported:
  -Method 1: EPD (Length/Type)
  -Method 2: LPD

•The two Methods are different and incompatible, so the receiver LLC must know the LLC Encoding Method of the received frame in order to be able to decode it.

•Both Methods support all three protIDtypes and both PIFstyles.

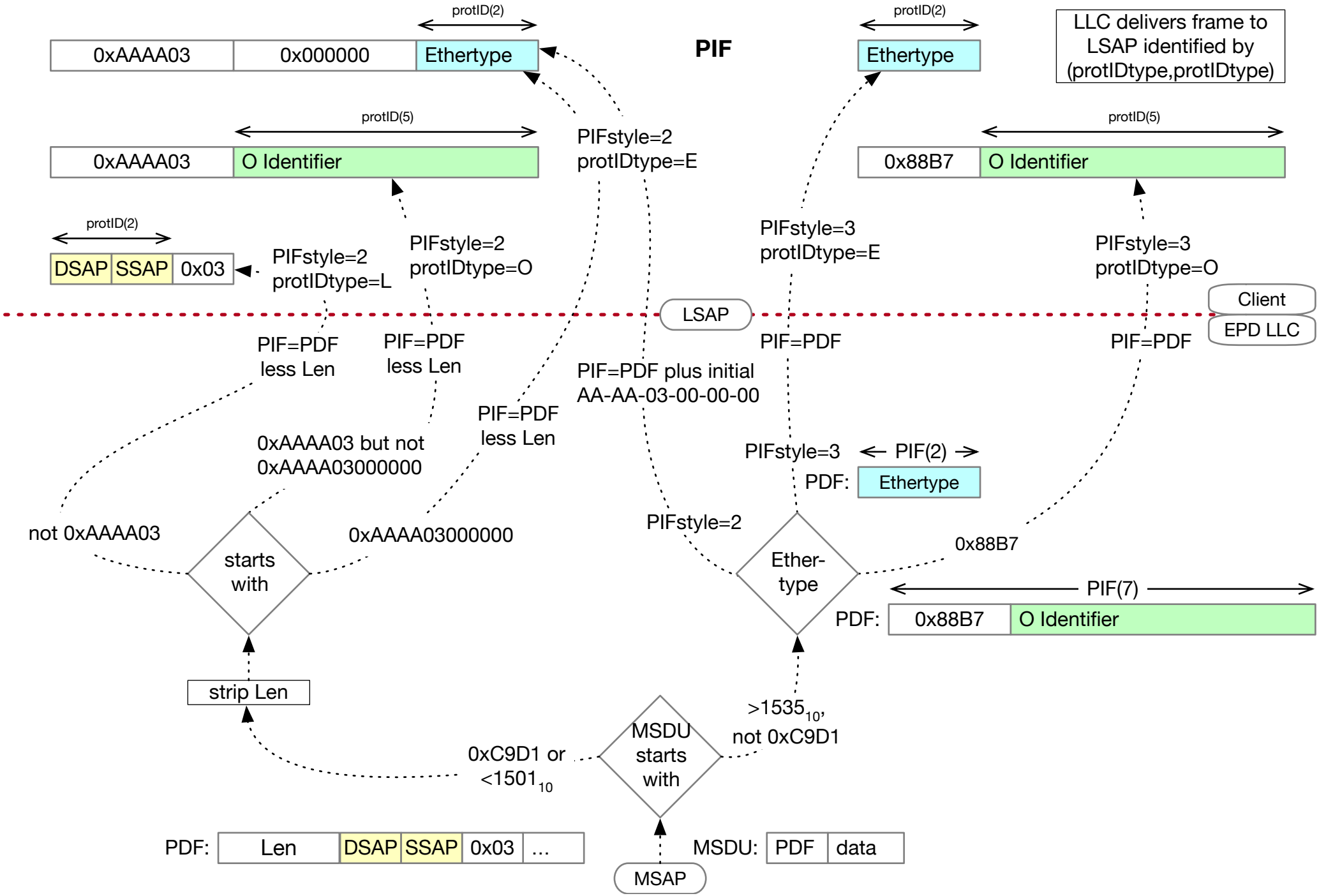
•The client (LSAP and up) and the MAC (MSAP and down) are Method-independent
  -note: a MAC need not be limited to “EPD” or “LPD”
  -however, a MAC specification may specify which method it presumes or how the method may be identified at a station
    -currently, the LLC method is typically inferred from the MAC

LLC Method 1 (EPD) Encoding

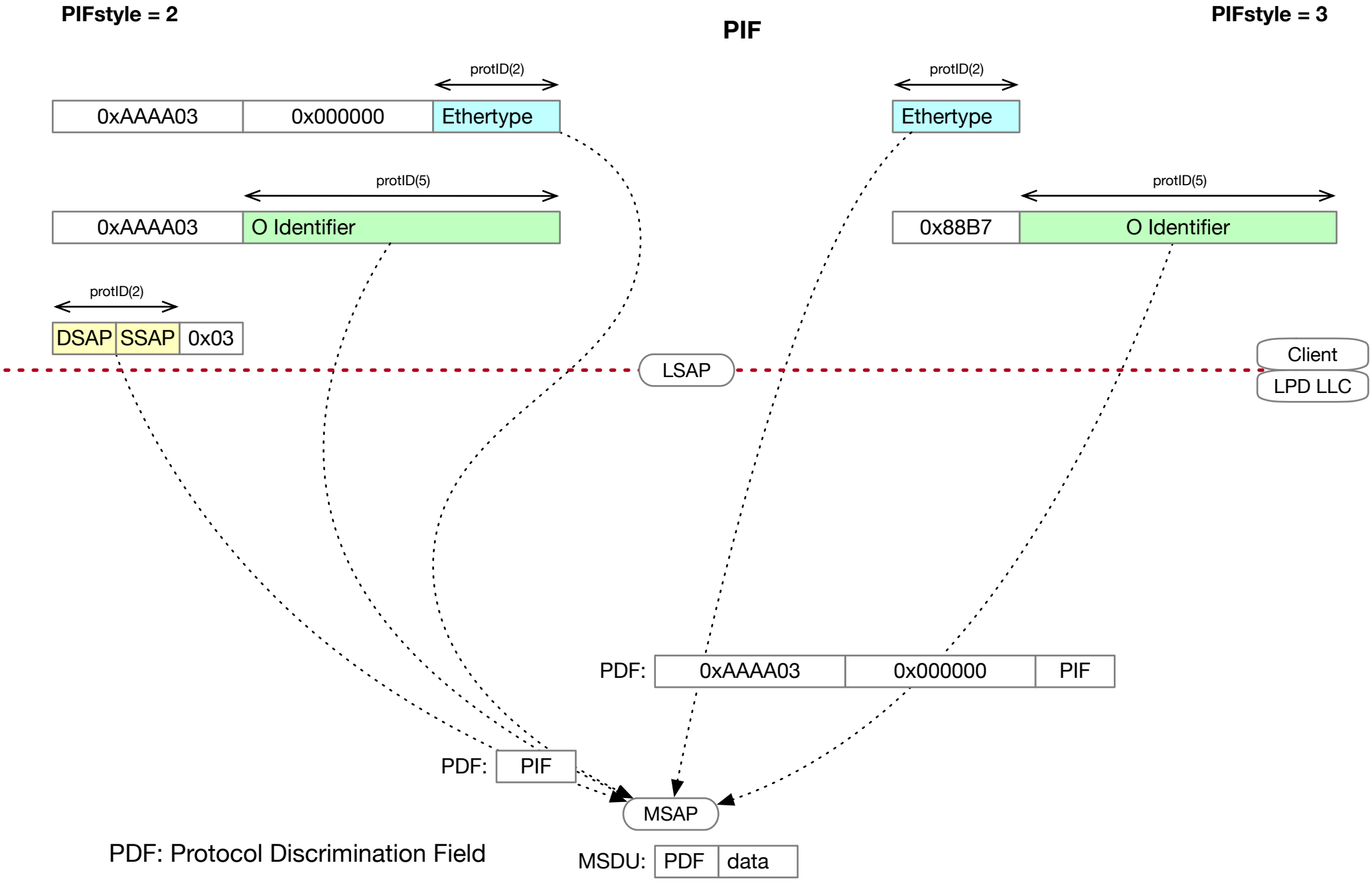


PDF: Protocol Discrimination Field

LLC Method 1 (EPD) Decoding

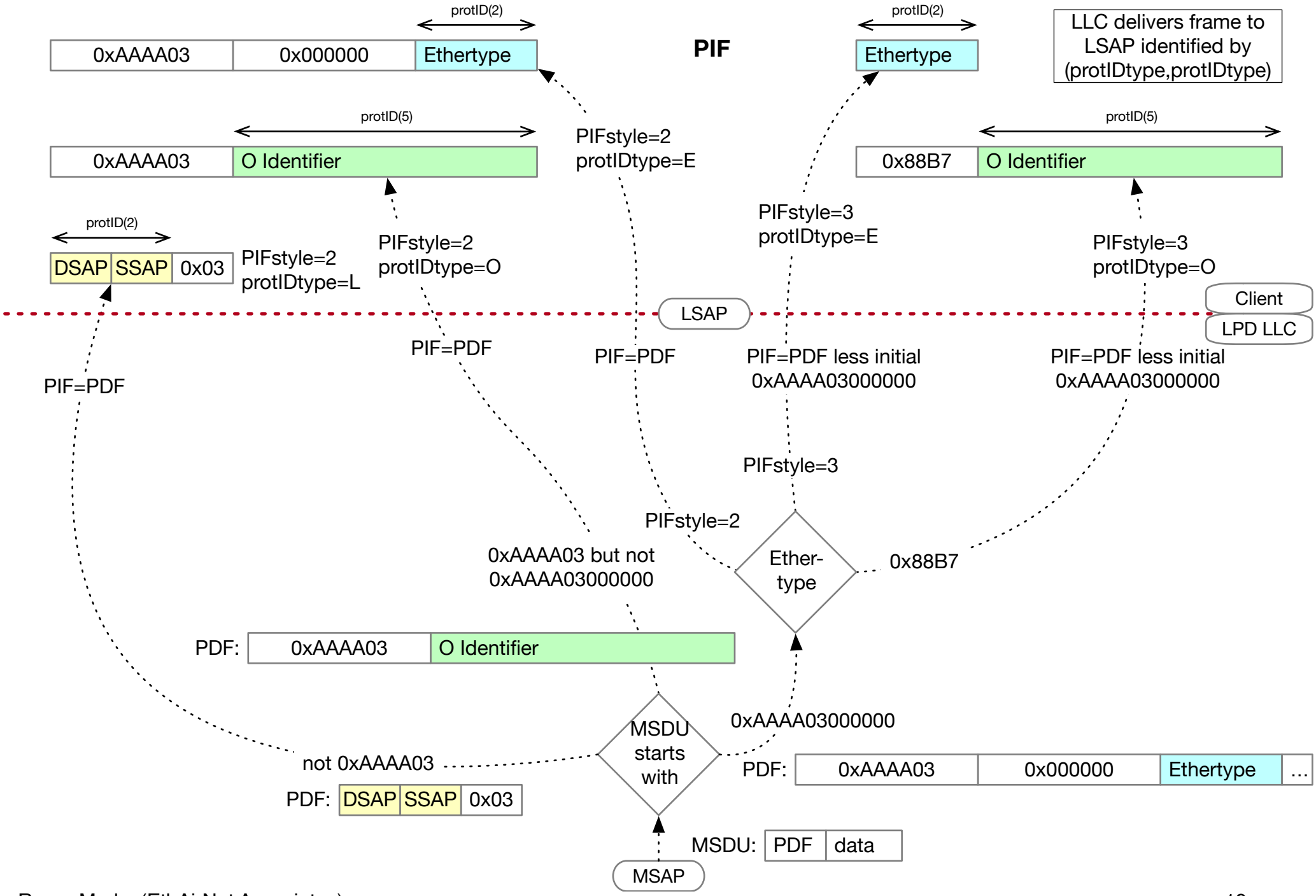


LLC Method 2 (LPD) Encoding

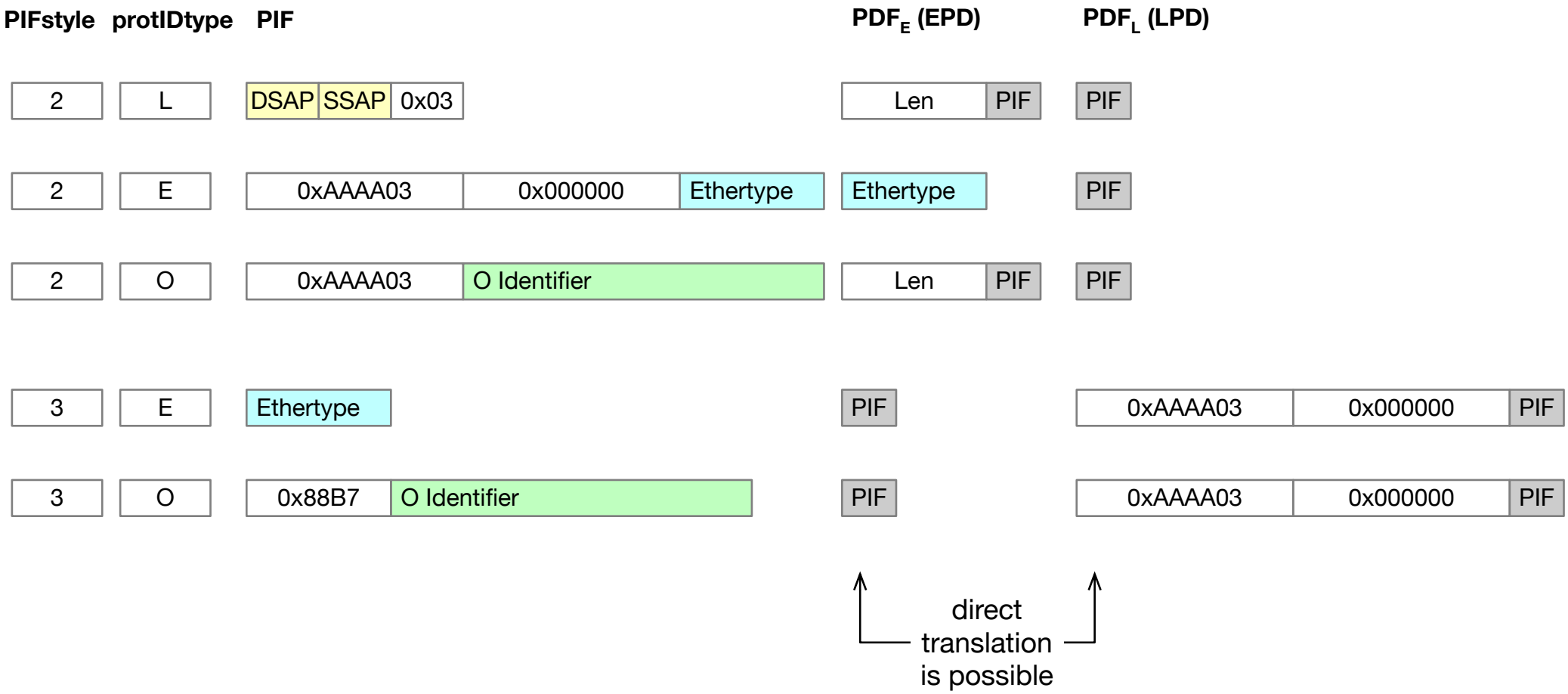


PDF: Protocol Discrimination Field

LLC Method 2 (LPD) Decoding



PIF/PDF Translation Summary



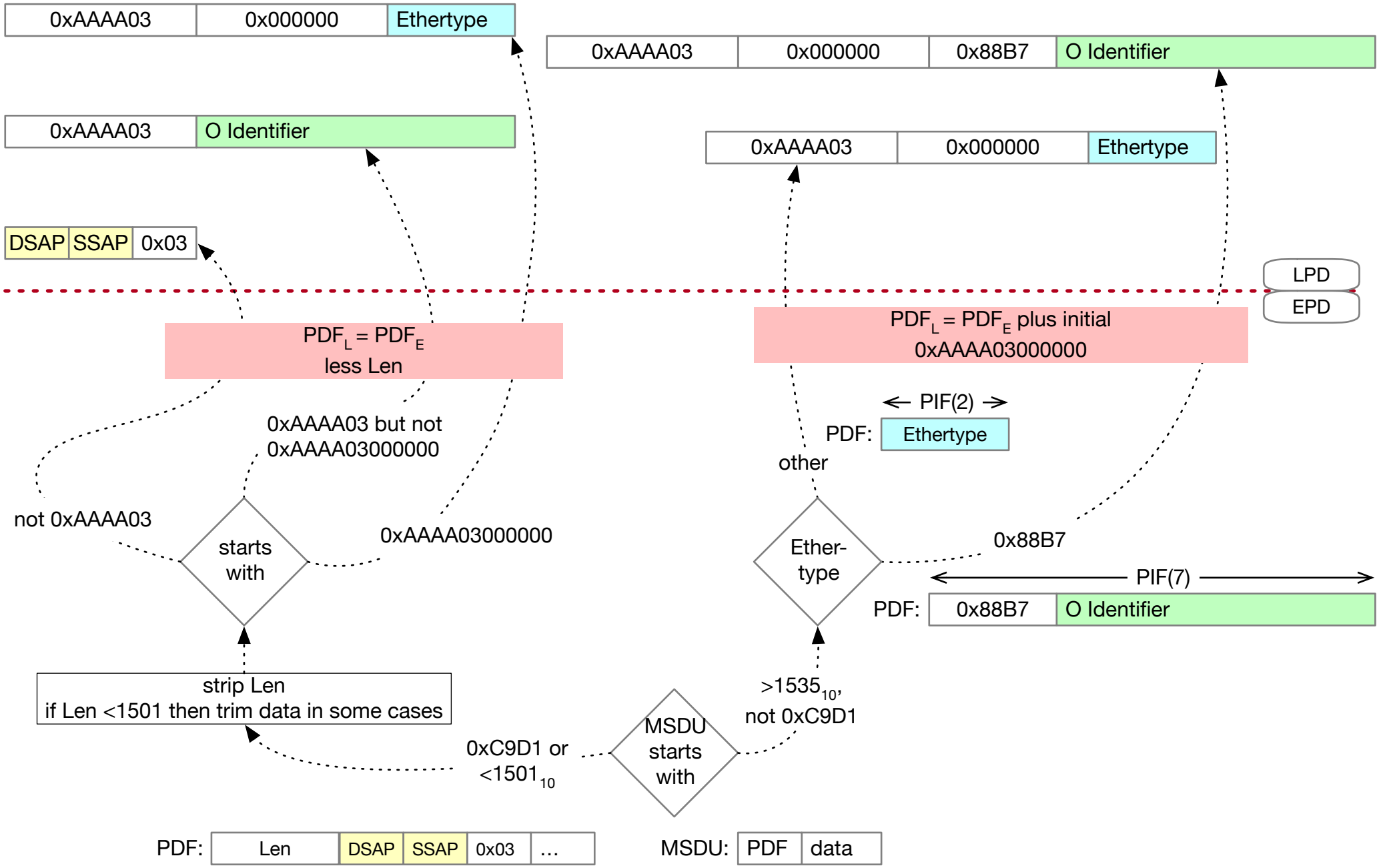
MSDU Translations

•It is possible to translate MSDU between LPD and EPD format.

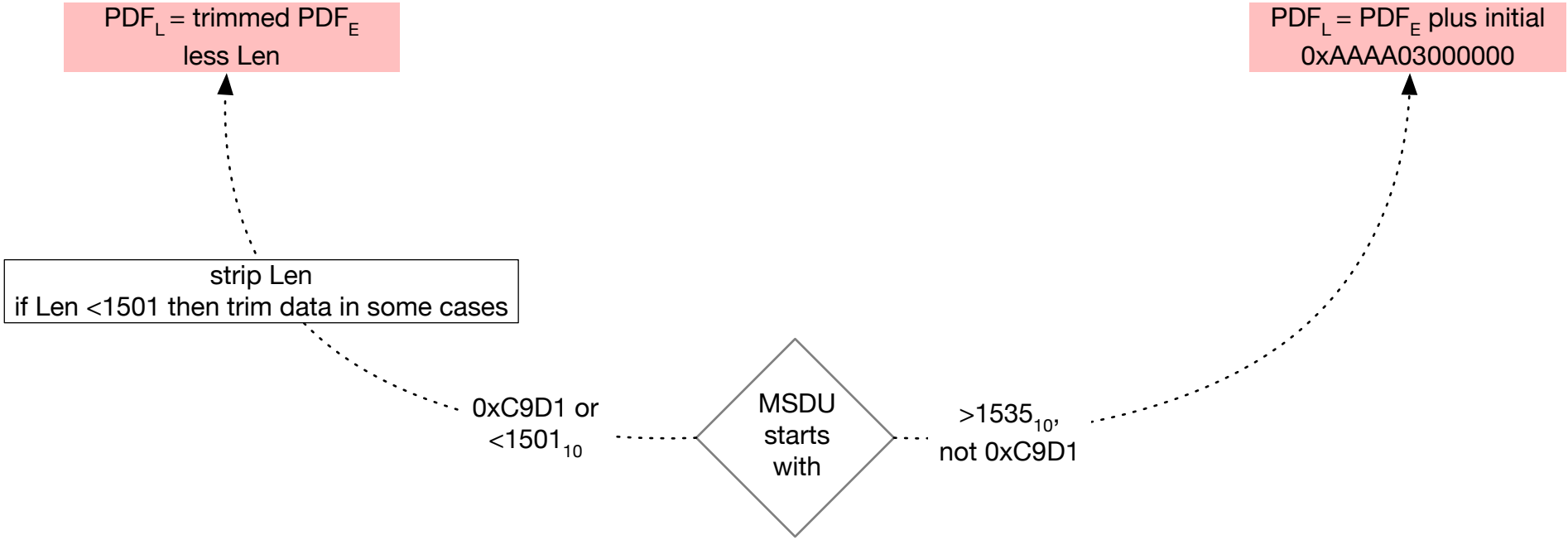
•This can be useful when an MSDU encoded by an LPD LLC needs to be decoded by an EPD LLC, or vice versa.

•Such a translation could be useful, for example, in a bridge in translating a frame from a network in which EPD is presumed to one in which LPD is presumed, or vice versa.

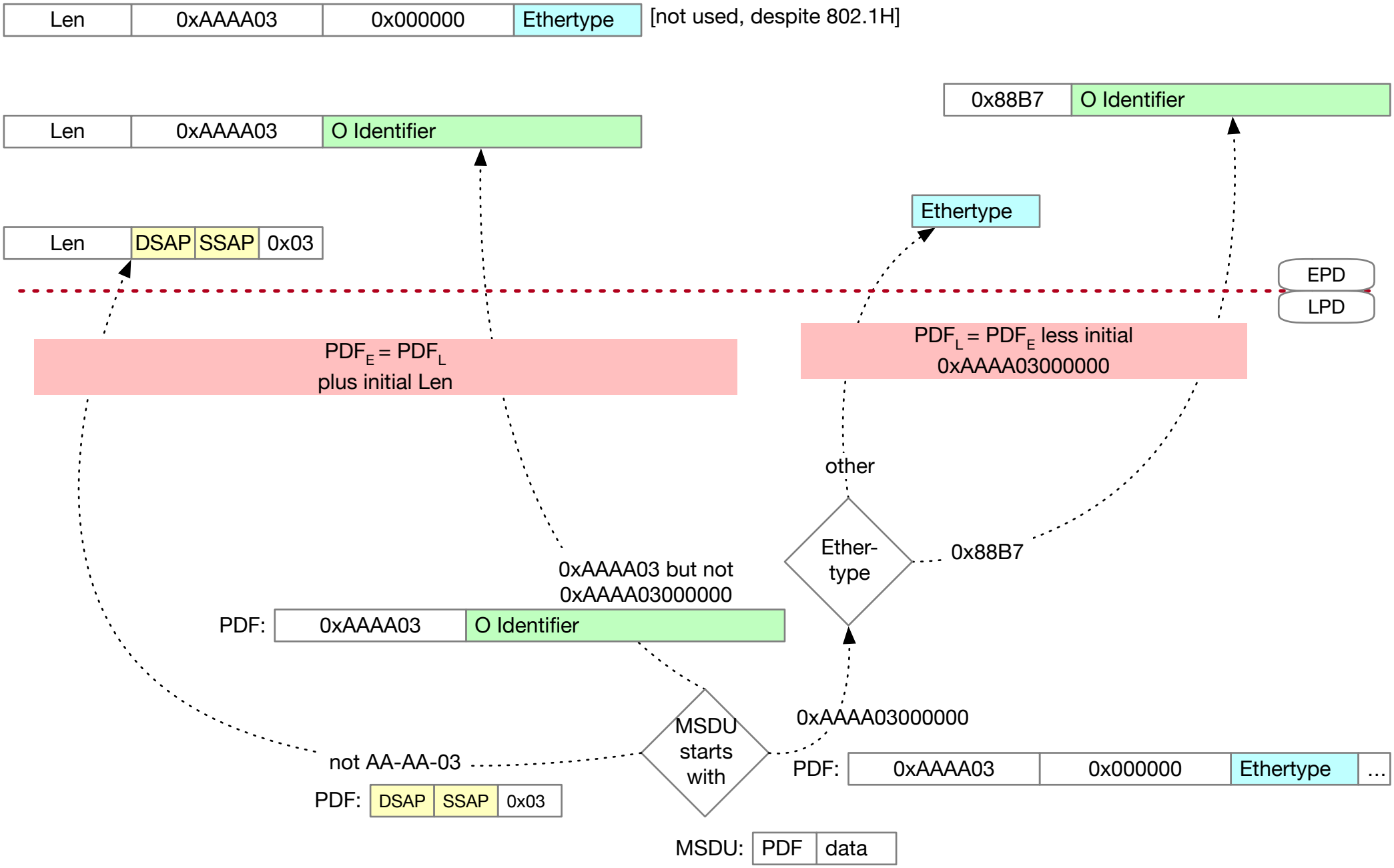
PDF Translation – EPD to LPD



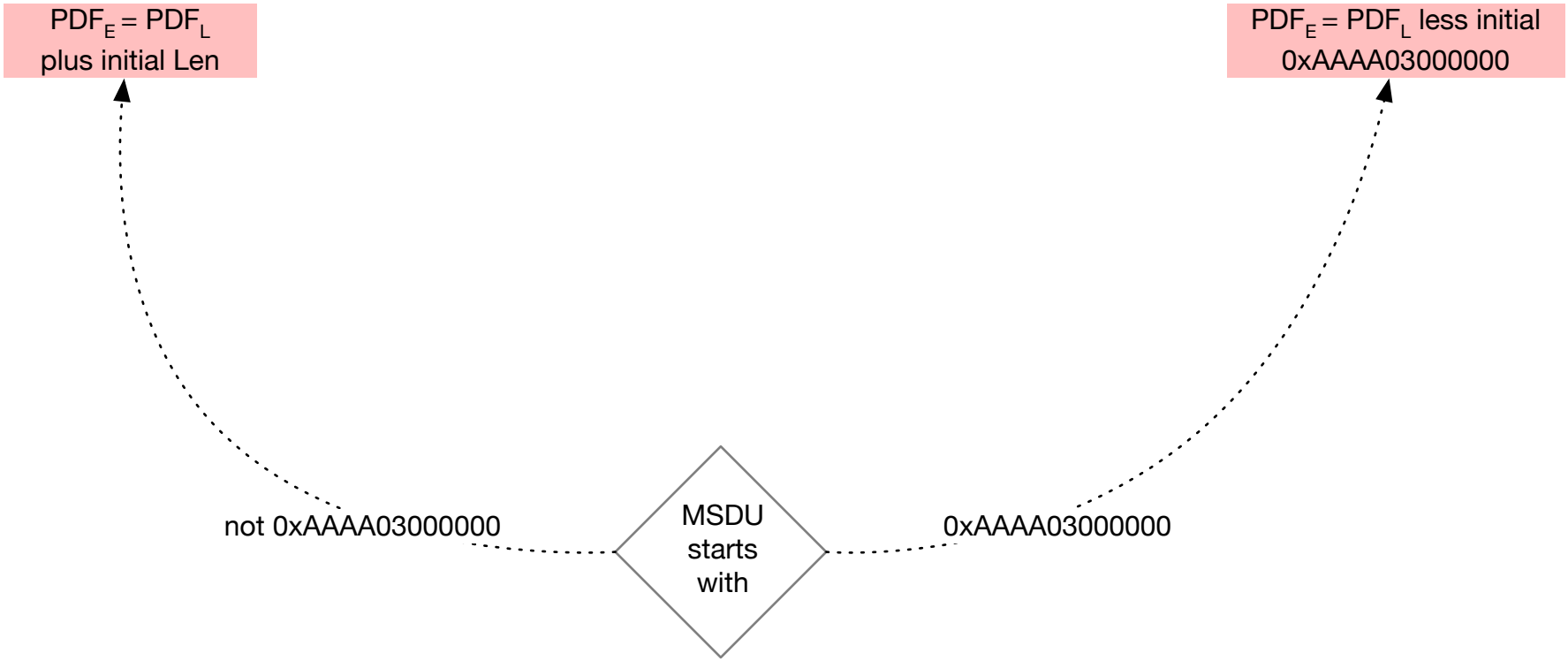
PDF Translation – EPD to LPD (simplified)



PDF Translation – LPD to EPD



PDF Translation – LPD to EPD (simplified)



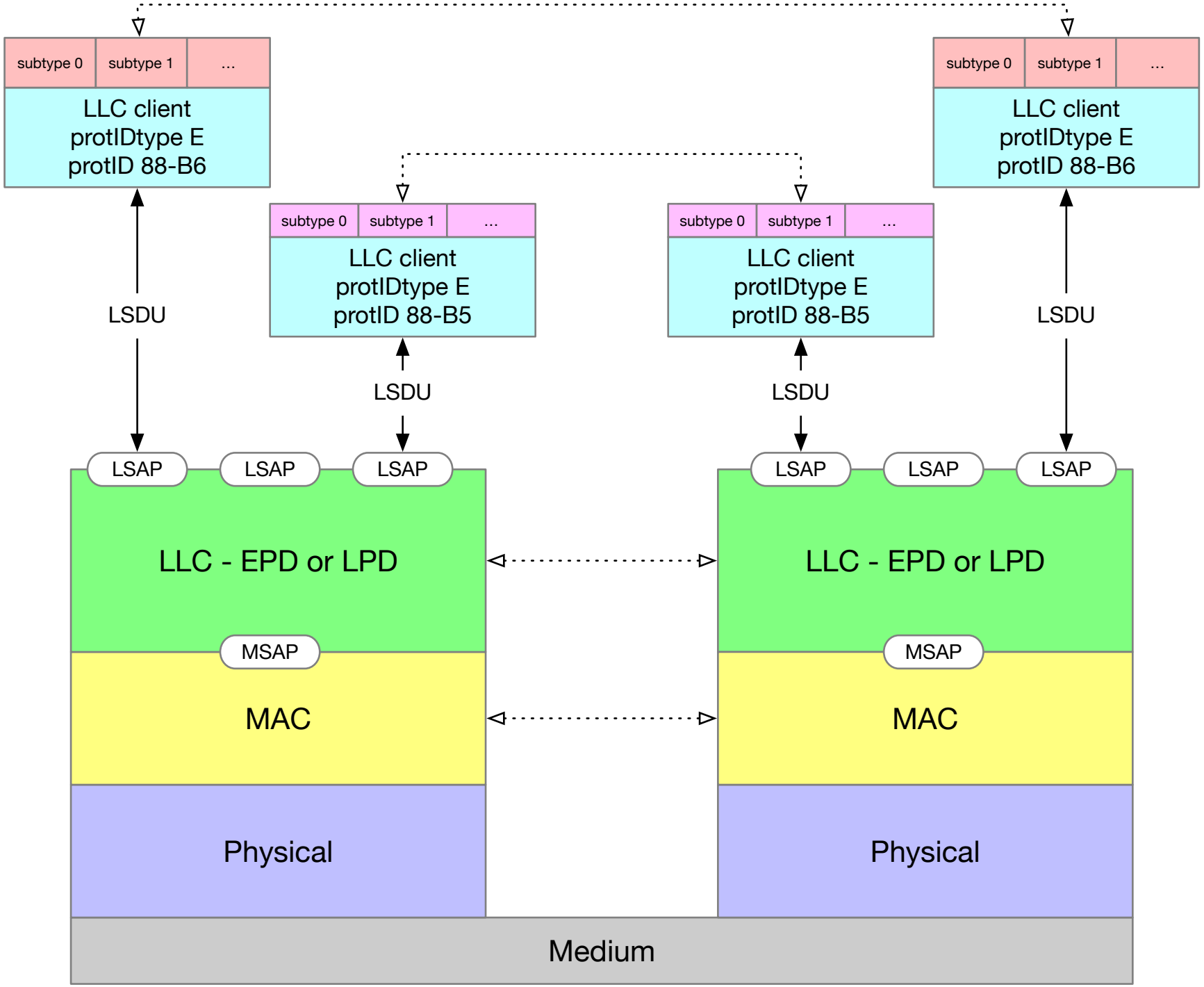
Playpen EtherType

Local Experimental EtherType (Playpen EtherType):

- Introduced in IEEE Std 802a-2003 (“Ethertypes for prototype and vendor-specific protocol development”)
- specified in IEEE Std 802 with a subtype and version, of unspecified length, that are locally interpreted, not resolved in the LLC
- LLC directs the frame to the LSAP identified by 88-B5 or 88-B6
- The locally-specified application at that LSAP is responsible to take any appropriate actions corresponding to the local protocol subtype and protocol version fields.
- This is fully consistent with the proposed LLC architecture, without modification.

Local Experimental EtherType 1:	88-B5	protocol subtype	protocol version	data
Local Experimental EtherType 2:	88-B6	protocol subtype	protocol version	data

Playpen Ethertype



End-Station Tagging

•We should represent tagging in the architecture.
  -at the end station
  -bridging architecture is separate not suitable for description in IEEE Std 802

•Tag is identified by Tag Protocol Identifier (TPID), which is an Ethertype (protIDtype=E)

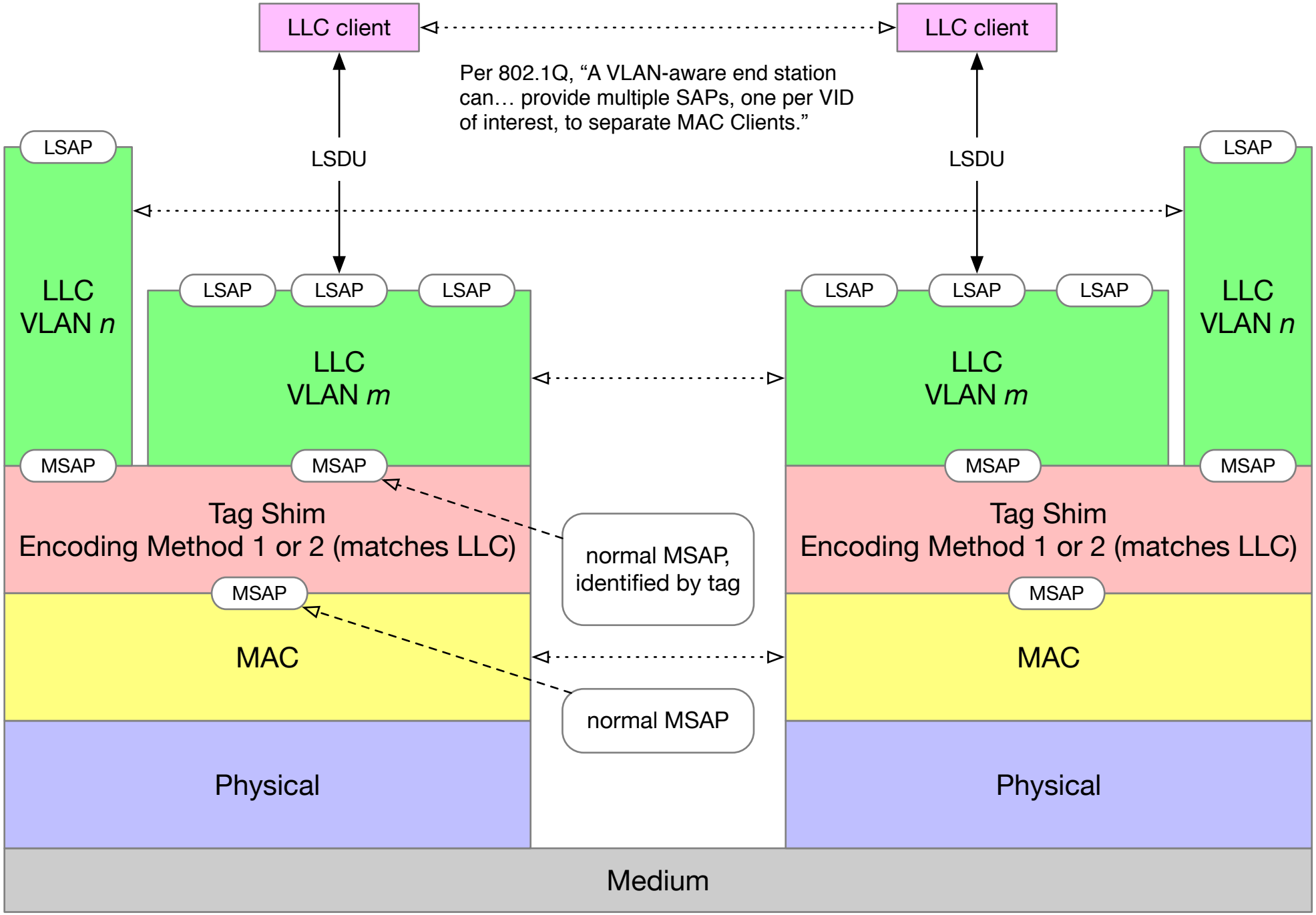
•Two Tagging Methods are supported:
  -EPD tagging tag based on PIFstyle=3
  -LPD tagging tag based on PIFstyle=2

•Per 802.1AC, LPD tagging also changes the data's protocol identification encoding (added in the LLC sublayer) from LPD format to EPD format going down, reversing it going up.

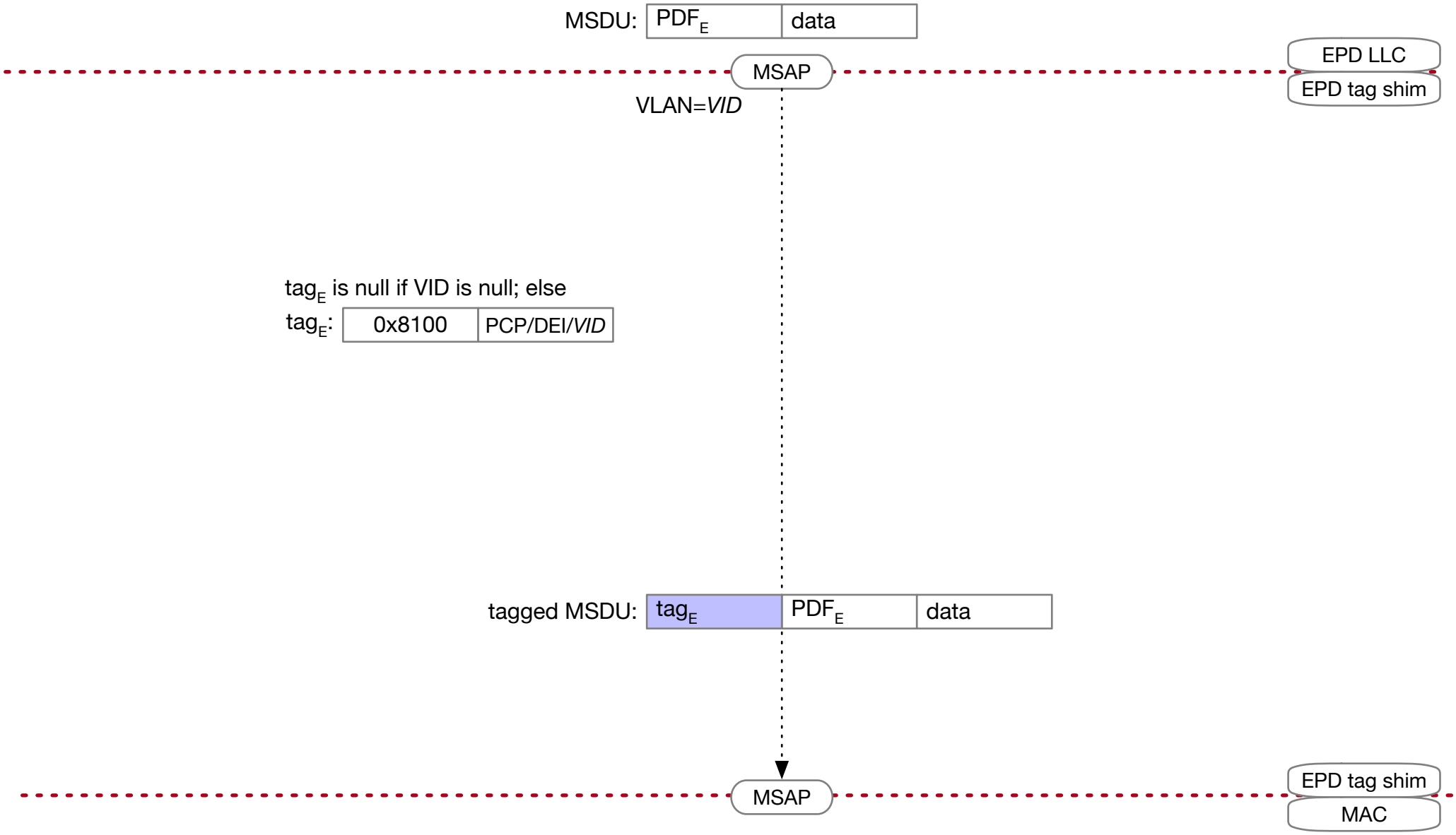
•The two Methods are different and incompatible, so the receiver LLC must know the encoding of the received frame in order to be able to decode it.

•Both methods support all three protIDtypes.

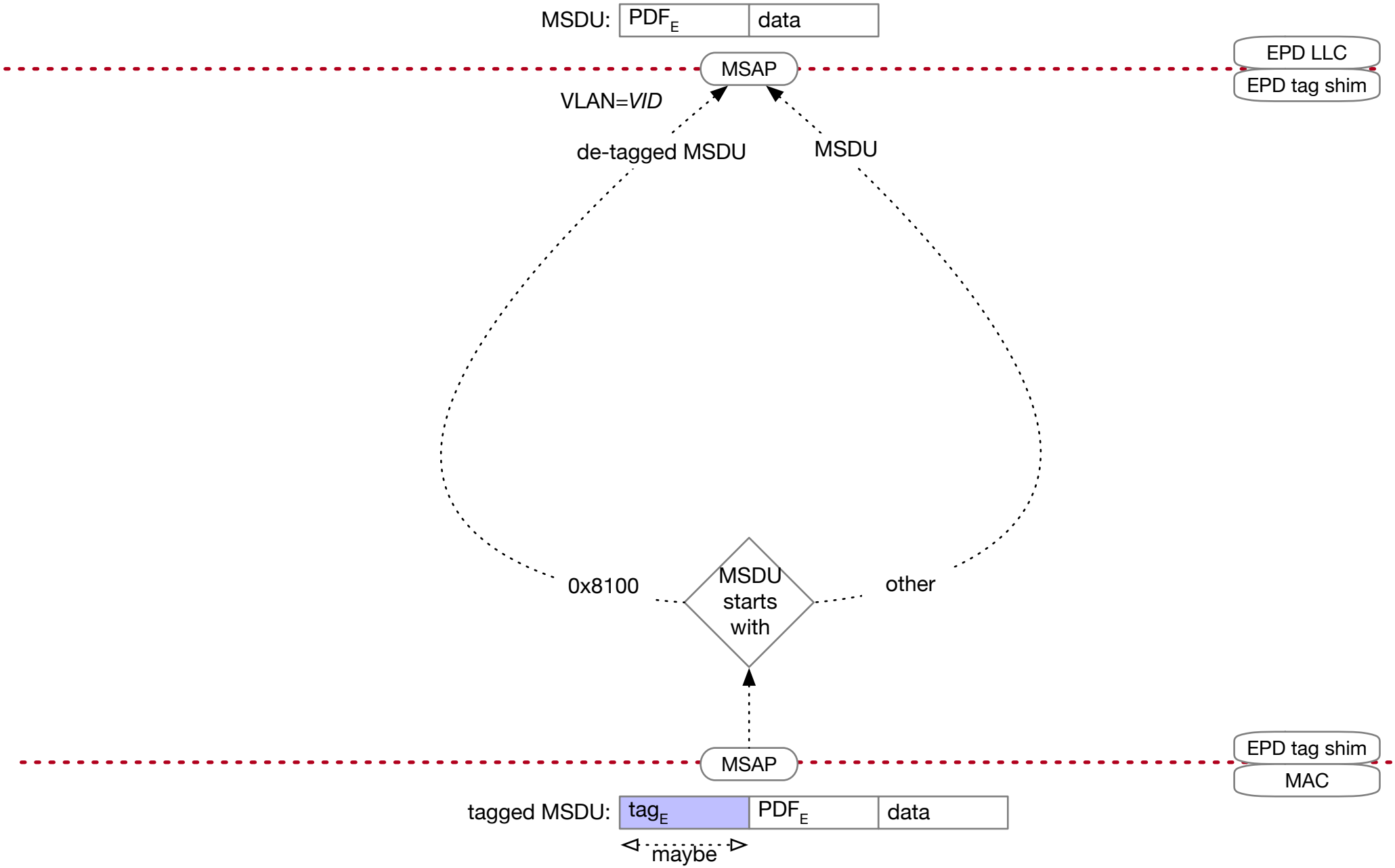
End Station Tagging Shim in the 802 Architecture



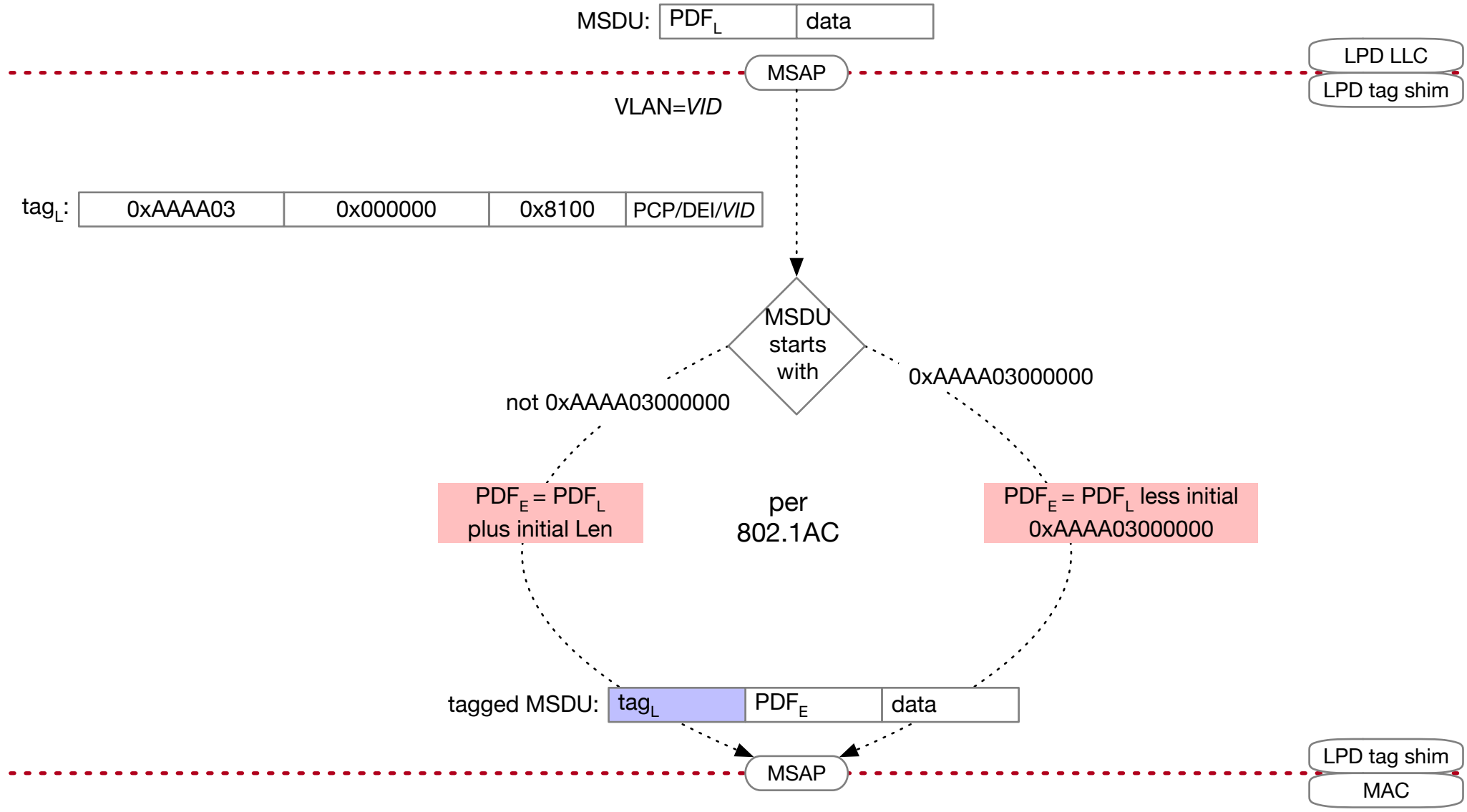
EPD VLAN Tagging



EPD VLAN De-Tagging



LPD VLAN Tagging

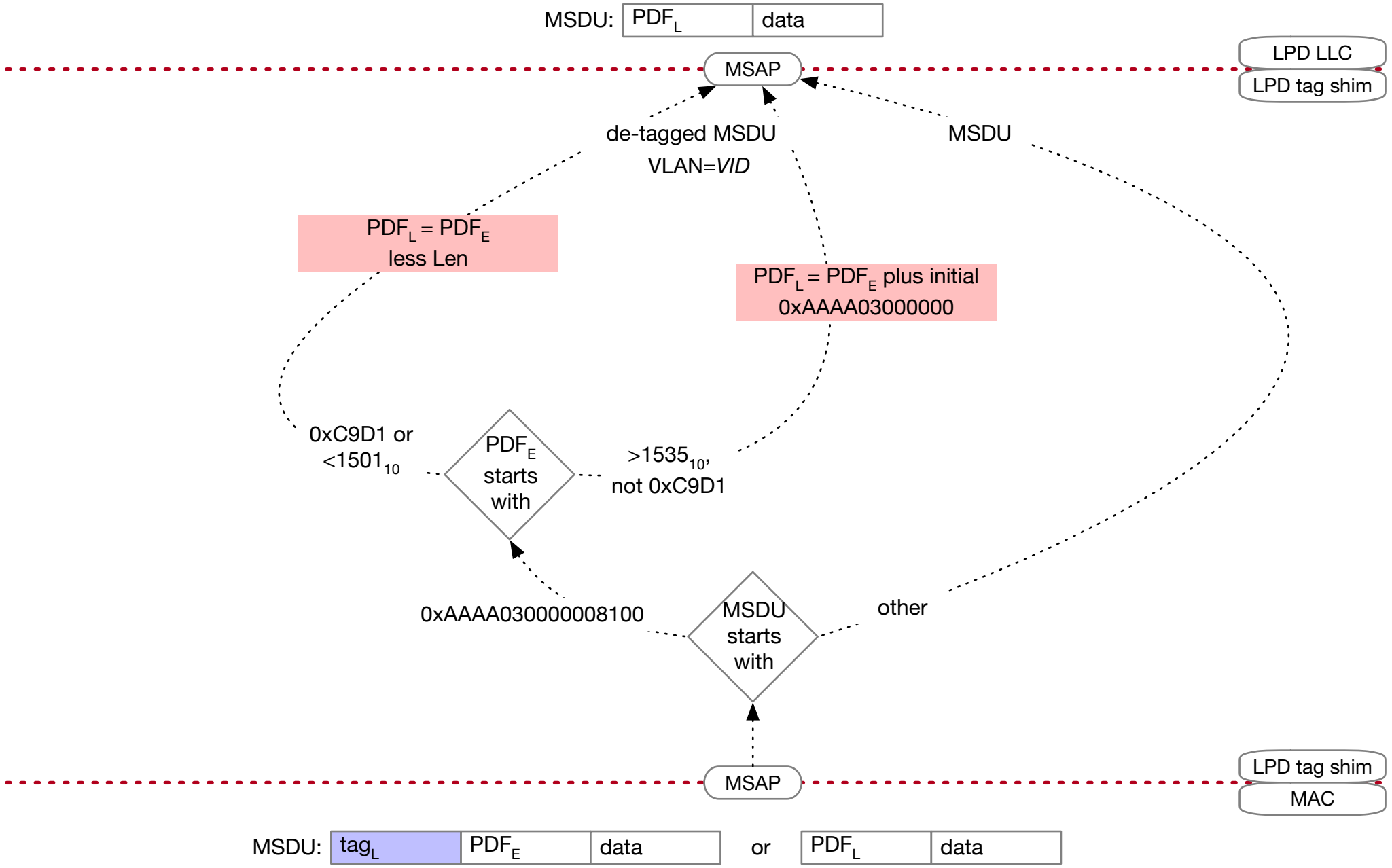


Note: The Len field serves no purpose here; could be replaced by 0xC9D1:

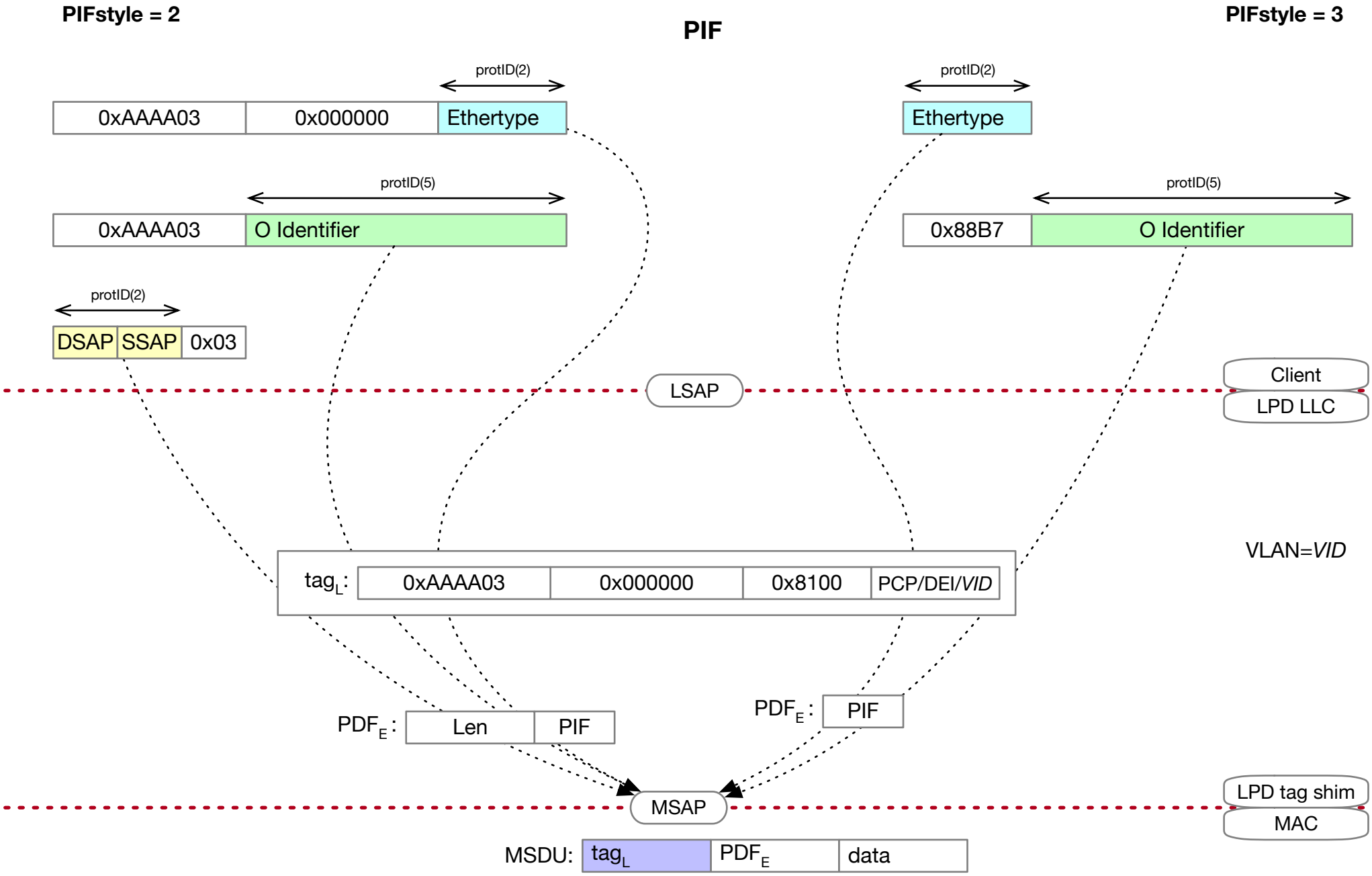
0xAAAA03	0x000000	0x8100	PCP/DEI/*VID*	Len	0xAAAA03	O Identifier

0xAAAA03	0x000000	0x8100	PCP/DEI/*VID*	Len	DSAP	SSAP	0x03

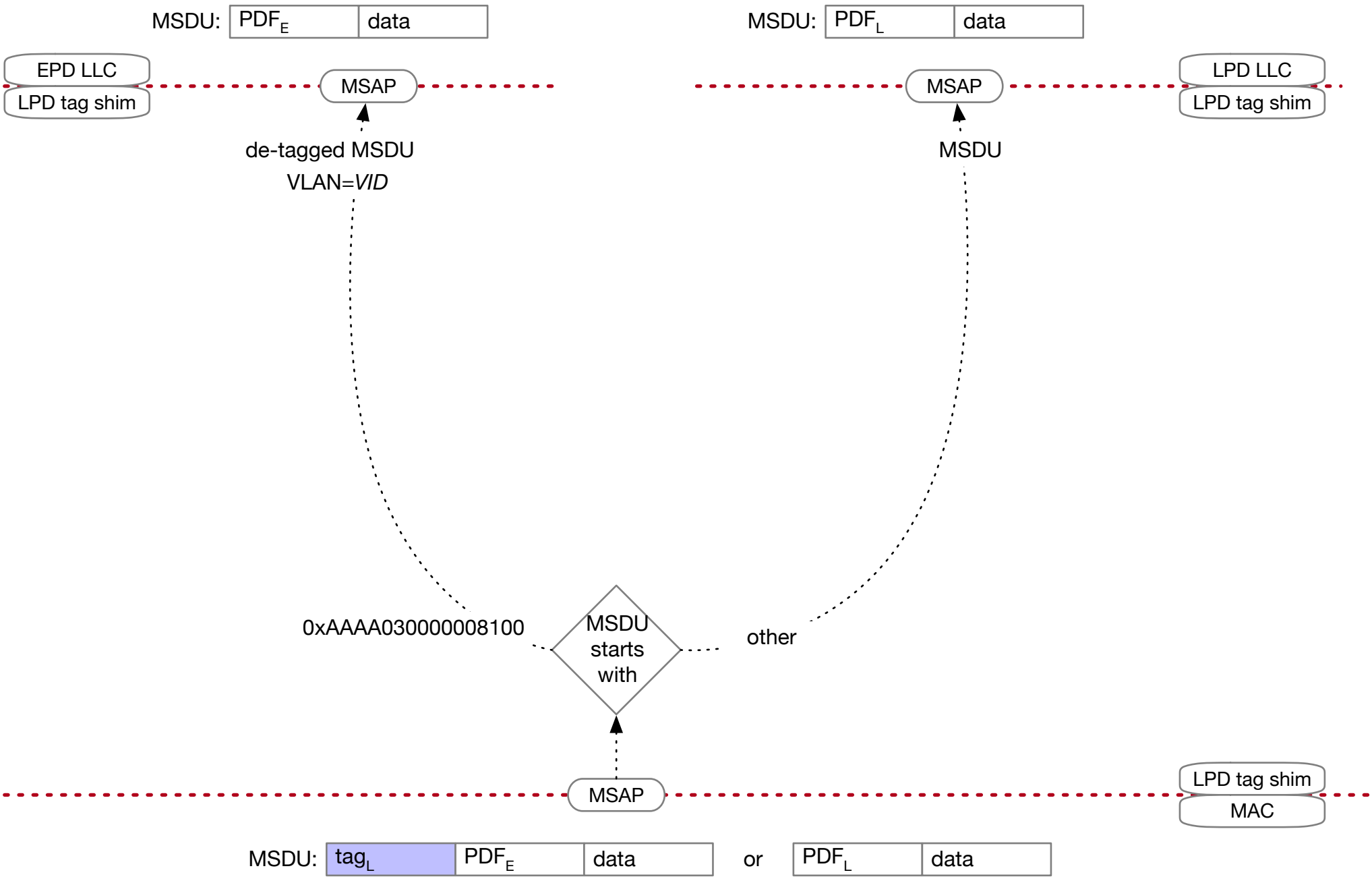
LPD VLAN De-Tagging



Combined LPD LLC Encoding and VLAN Tagging



LPD VLAN De-Tagging, Simplified



Proposals

(1) IEEE Std 802 should be thoroughly revised, with a detailed specification of the LLC that is independent of 802.2 and includes protocol discrimination functionality based on DSAP/SSAP values, Ethertype value, and O Identifiers

(2) EPD and LPD should be specified as LLC methods so that the rest of the architecture is independent of the LLC method

-Note: EPD and LPD in this proposal are completely different than in IEEE Std 802 but similar to 802.1AC and 802.11

(3) IEEE Std 802 should clarify the architecture and detail the roles and functions of LLC and tagging

(4) IEEE Stds 802.1AC, 802.1Q, and 802.11 should be reviewed for consistency and clarified as necessary

Conclusion

- 802 is no longer reliant on the 802.2 LLC
- There is no LLC specified in active IEEE 802 standards
- LLC should be specified within the IEEE 802 family
  - Should go into a revision of IEEE Std 802
- It should possible to specify the LLC and its current role in protocol discrimination without altering the current understanding of the expected operation.
  - Bridging architecture is not proposed for IEEE Std 802.
- This contribution proposes a view of the LLC specification.

Bibliography

- R. Marks, “What are EPD and LPD?”
  maint-Marks-epd-lpd-0719-v02.pdf
- R. Marks, “Clarifying EPD and LPD with an HLPDE Protocol”
  maint-Marks-hlpde-0919-redacted.pdf
- N, Finn, “Why the EPD/LPD information in IEEE 802, IEEE 802.1AC, and 802.1Q must be fixed”
  maint-finn-epd-lpd-errors-0919-v02.pdf
- R. Marks and N. Finn, “Clarifying EPD and LPD”
  maint-Marks-Finn-epd-lpd-1119-copyright.pdf
- R. Marks and N. Finn, “Fixing EPD and LPD in IEEE Std 802-2014”
  maint-Marks-802-epd-lpd-fix-0120-v02.pdf
- N. Finn, “EPD and LPD in IEEE Std 802 and Others”
  maint-finn-802-epd-lpd-0320-v01.pdf
- M. Seaman, “Protocol identification in 802 LANs”
  maint-seaman-protocol-identification-0420-v00.pdf
- R. Marks, “Proposed HLPDE Specification?”
  maint-Marks-hlpde-spec-0420-copyright-v01