

LLC Theory and Protocol Discrimination in the 802 Architecture

Date: 2021-01-13

Authors:

Name	Affiliations	Address	Phone	email
Roger B. Marks	EthAirNet Associates	Denver, CO, USA	+1-802-capable	roger@ethair.net

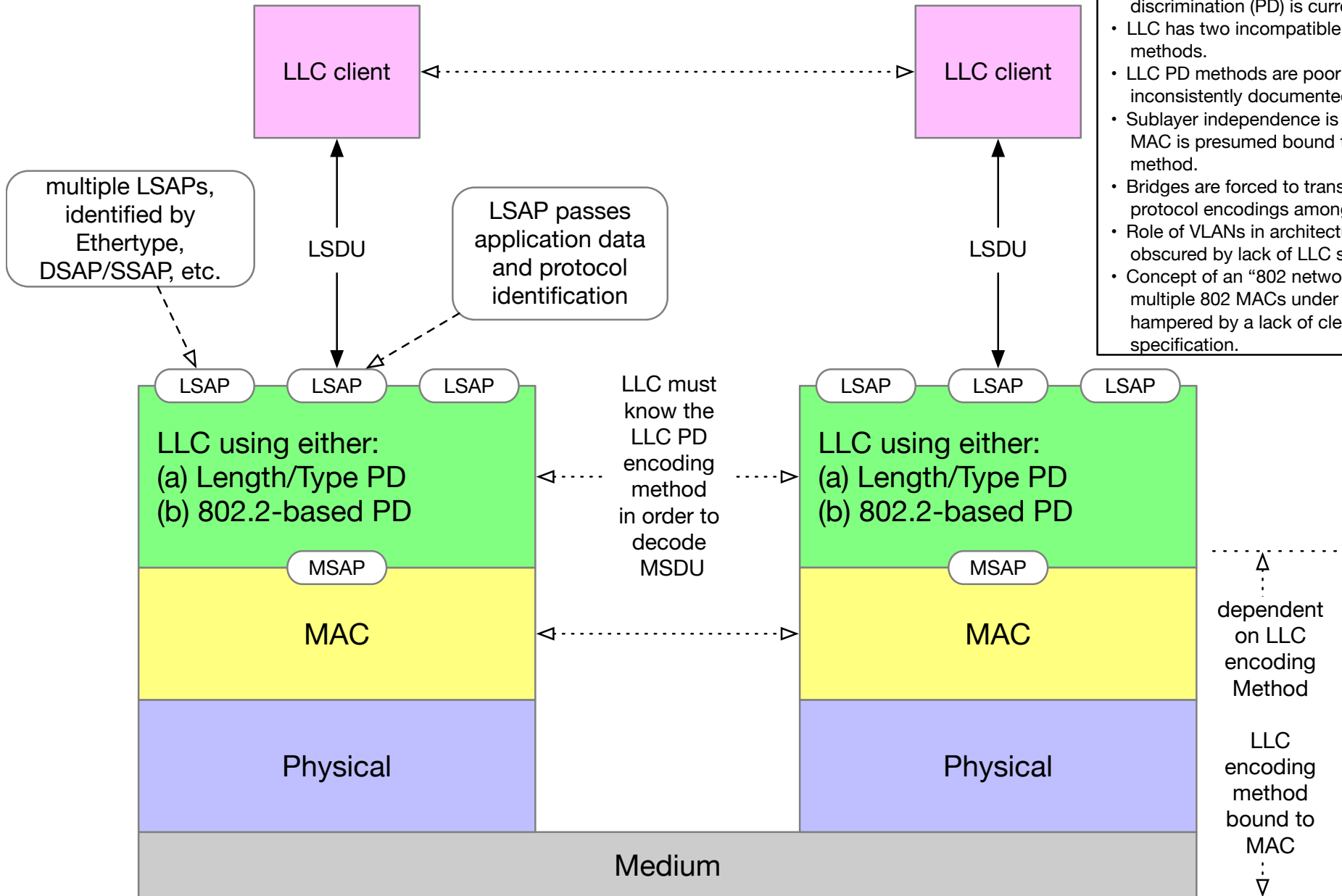
Abstract

Protocol discrimination in IEEE Std 802 is dependent on the LLC in the 802 architecture. The issue is most critical for WLAN since IEEE Std 802.11 supports two incompatible protocol discrimination methods. A proposed architectural model of the LLC avoids layer violations and the need for bridge translations. The model is used to demonstrate the conditions allowing a Universal Protocol Discrimination method in the LLC. Enhancement of the LLC specification will add value to IEEE Std 802.11 by improving protocol discrimination and in other ways.

Summary

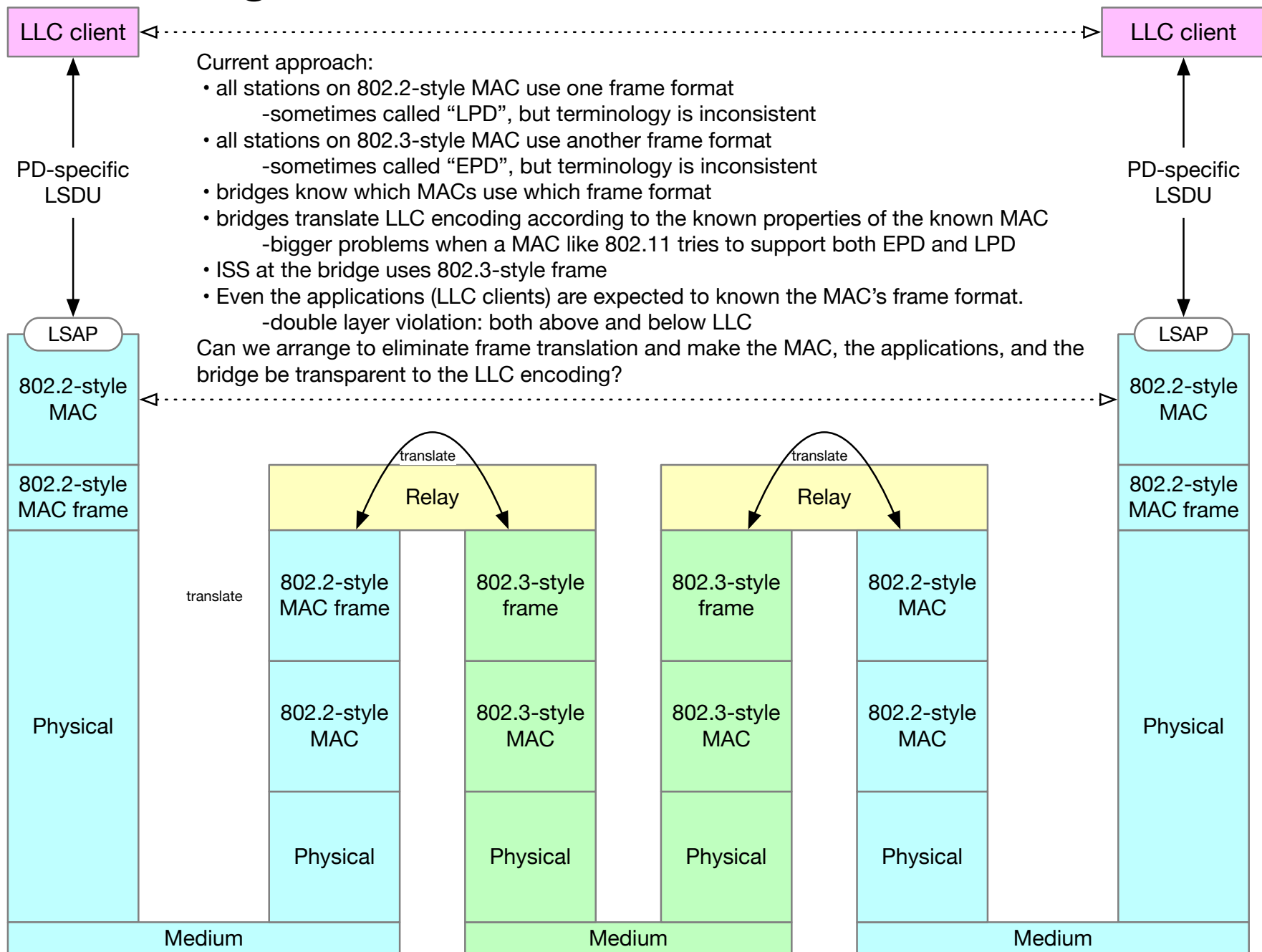
- All 802 MACs specify operation under the 802 LLC.
- LLC is documented only in 802.2, which is withdrawn and not in use; cannot be amended or revised.
- LLC functionality, except PD, is currently unused.
- LLC includes two incompatible PD methods.
- LLC PD methods are poorly and inconsistently documented.
- Sublayer independence is violated, as MAC is presumed bound to one PD method.
- Bridges are forced to translate LLC protocol encodings among LANs.
- Role of VLANs in architecture is obscured by lack of LLC specification.
- Concept of an “802 network” of multiple 802 MACs under one LLC is hampered by a lack of clear LLC specification.

LLC in the 802 Architecture

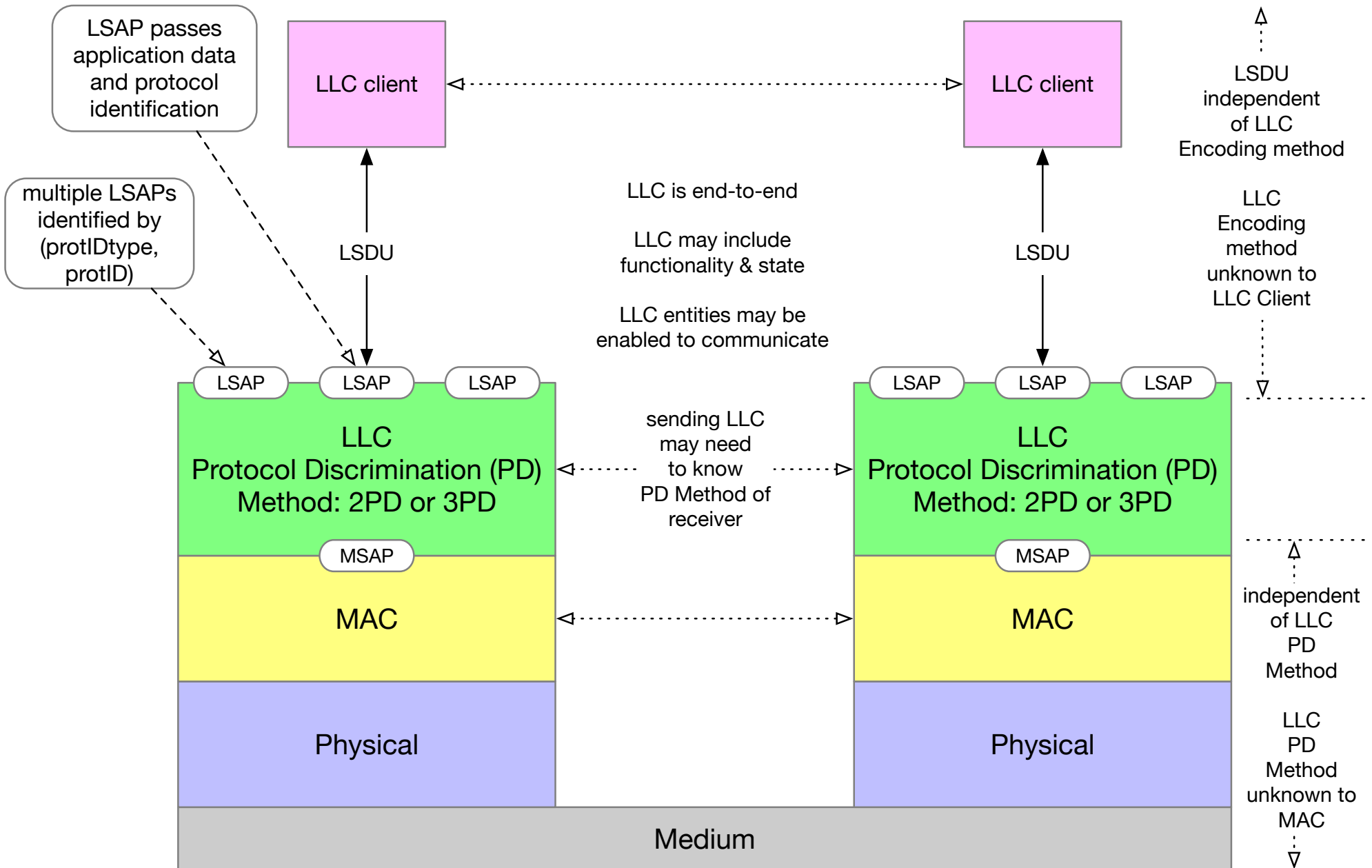


- All 802 MACs specify operation under 802 LLC.
- LLC is documented only in 802.2, which is withdrawn and not in use; cannot be amended or revised.
- LLC functionality except protocol discrimination (PD) is currently unused.
- LLC has two incompatible PD methods.
- LLC PD methods are poorly and inconsistently documented.
- Sublayer independence is violated, as MAC is presumed bound to one PD method.
- Bridges are forced to translate LLC protocol encodings among LANs.
- Role of VLANs in architecture is obscured by lack of LLC specification.
- Concept of an "802 network" of multiple 802 MACs under one LLC is hampered by a lack of clear LLC specification.

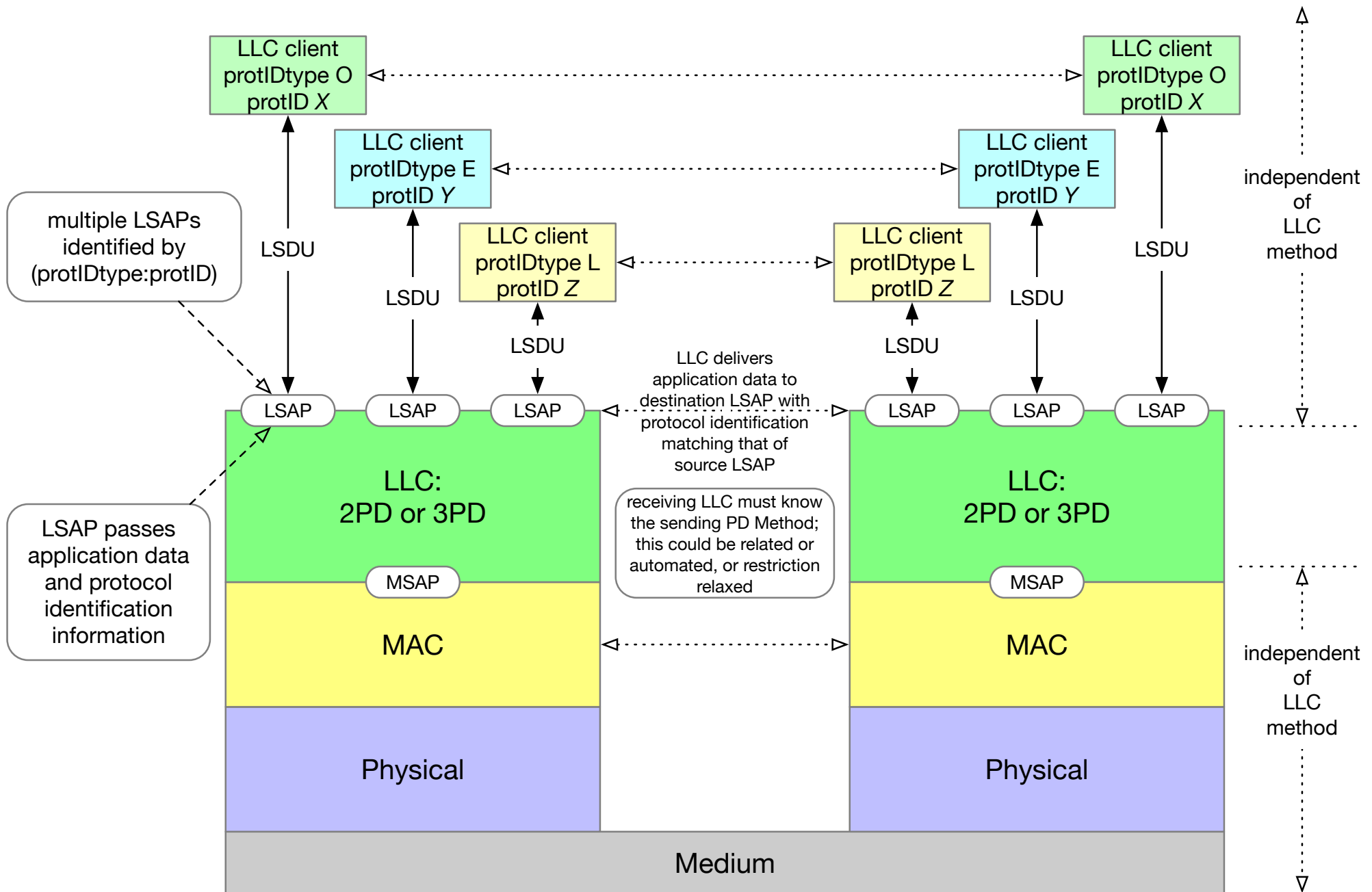
Bridged 802 Architecture with current LLC



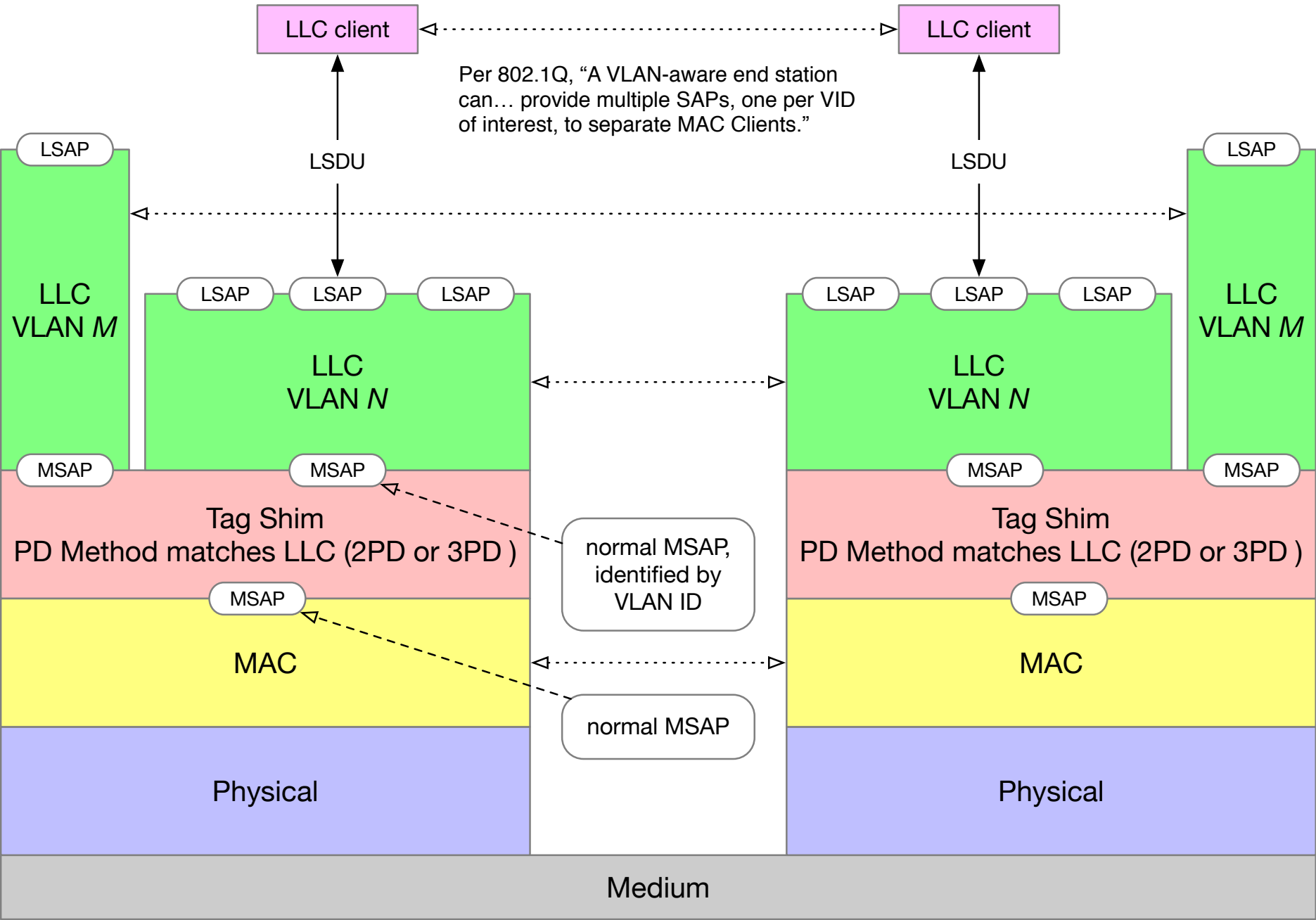
New Theory of LLC in the 802 Architecture



LLC Clients match by (protIDtype:protID)



End Station Tagging Shim in the 802 Architecture



protIDtype and protID

The LSAP is identified by a protocol identifier (*protIDtype:protID*), characterized by:

- (a) protocol type *protIDtype* (either “L”, “E”, or “O”)
- (b) protocol 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.

The protocol, not the LAN, is enabled to specify the *protIDtype*.

protIDtype	protocol identifier	protID format		
L	LSAP Identifier	<table border="1"><tr><td>DSAP(1)</td><td>SSAP(1)</td></tr></table>	DSAP(1)	SSAP(1)
DSAP(1)	SSAP(1)			
E	Ethertype	<table border="1"><tr><td>Ethertype(2)</td></tr></table>	Ethertype(2)	
Ethertype(2)				
O	O Identifier	<table border="1"><tr><td>O Identifier(5)</td></tr></table>	O Identifier(5)	
O Identifier(5)				

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 0x88B7 or 0x8870.

Protocol Information Field (PIF) and PIFstyle

To reiterate, the LSAP is identified by (*protIDtype*, *protID*):

- *protIDtype* (either “L”, “E”, or “O”)

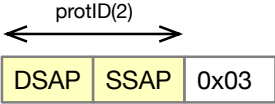
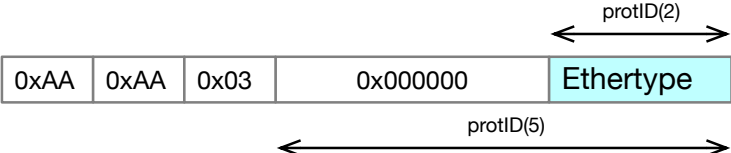
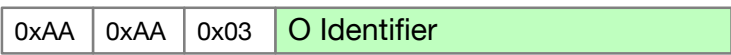
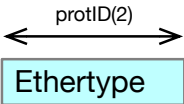
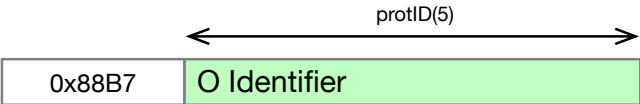
LSAP is also characterized by a *PIFstyle*, which has the value 2 or 3. The value is known to LLC Client and to LLC.

-local to the station; e.g. LSAP with Ethertype=*X* may have PIFstyle=2 at one station and PIFstyle=3 at another

Sending LLC Client is responsible to encode *protID* (directly) and *protIDtype* (indirectly) into a Protocol Information Field (PIF) according to the PIFstyle of the sending LSAP.

Receiving LLC delivers frame according to the PIFstyle of the receiving LSAP.

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

PIFstyle	protIDtype	Protocol Information Field (PIF)	PIF length
2	L		3
use in new protocols discouraged	E		8
	O		8
3	E		2
	O		7

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

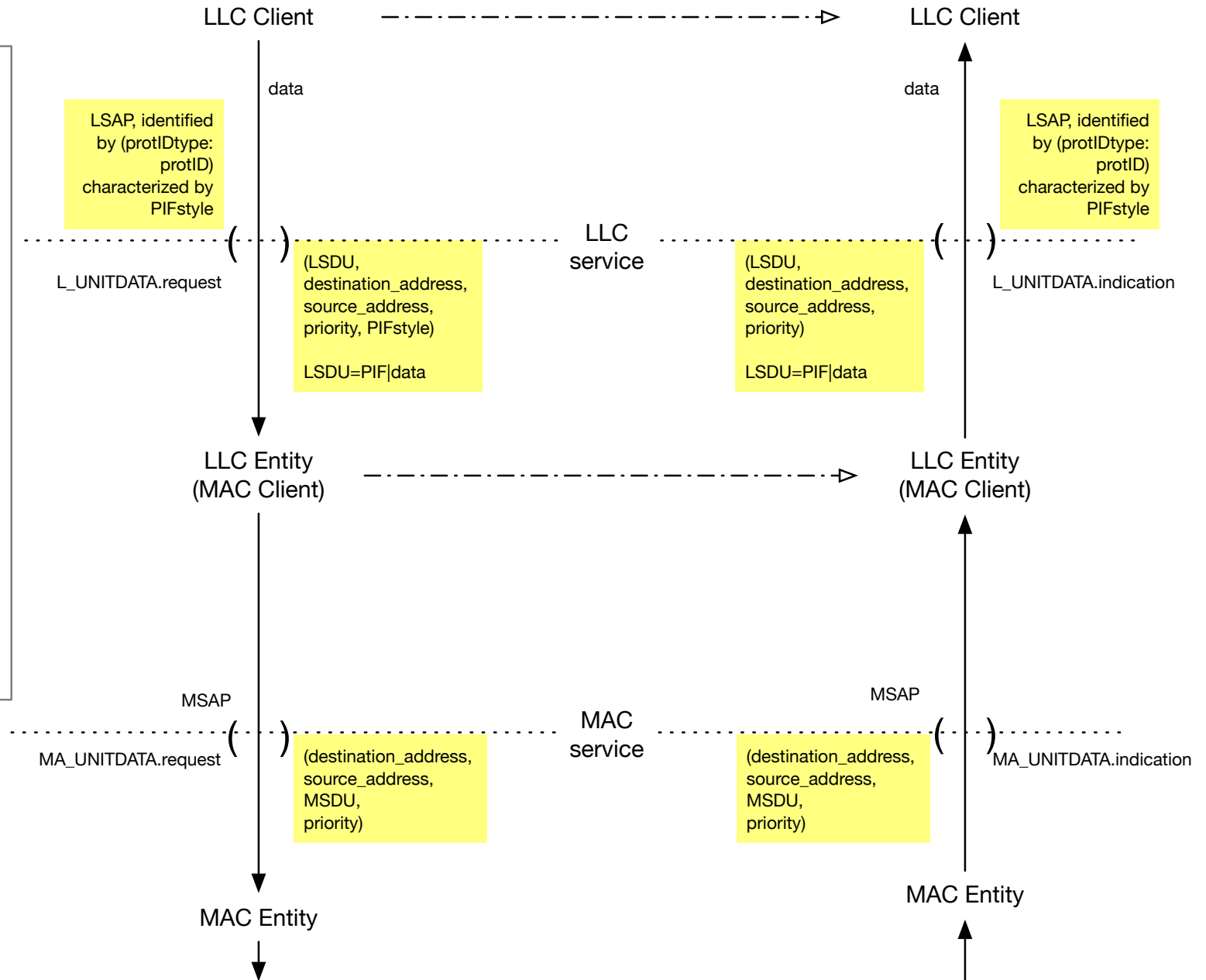
If PIFstyle=3:
 if the first 2 bytes are 0x88B7, then *protIDtype*=O and the next 5 bytes are the O Identifier.
 else *protIDtype*=E and the first 2 bytes are the Ethertype

LSAP Service Primitives in New LLC Theory

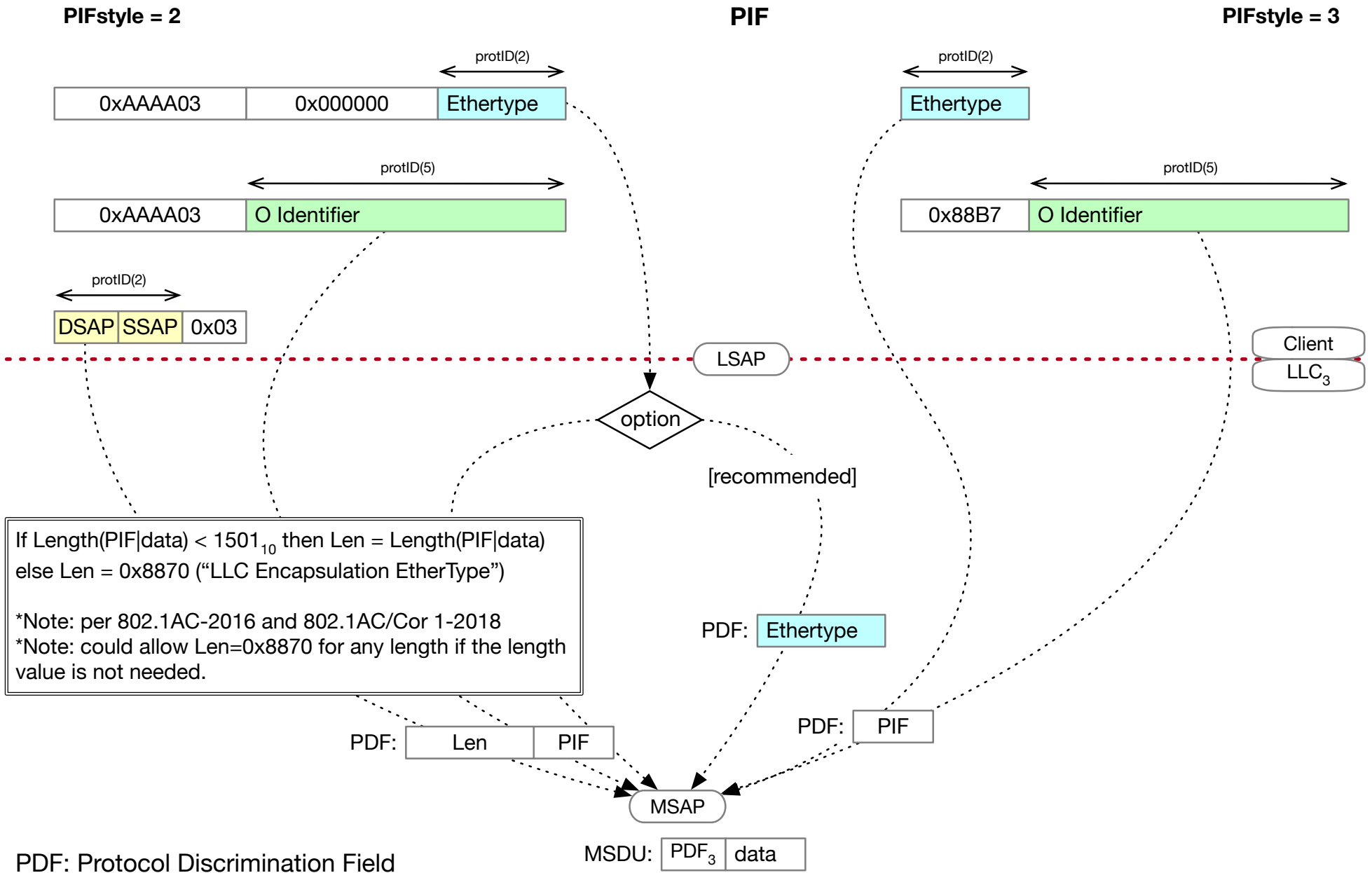
Analogous 802.2 primitive is DL-UNITDATA request (source_address, destination_address, data, priority)

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).

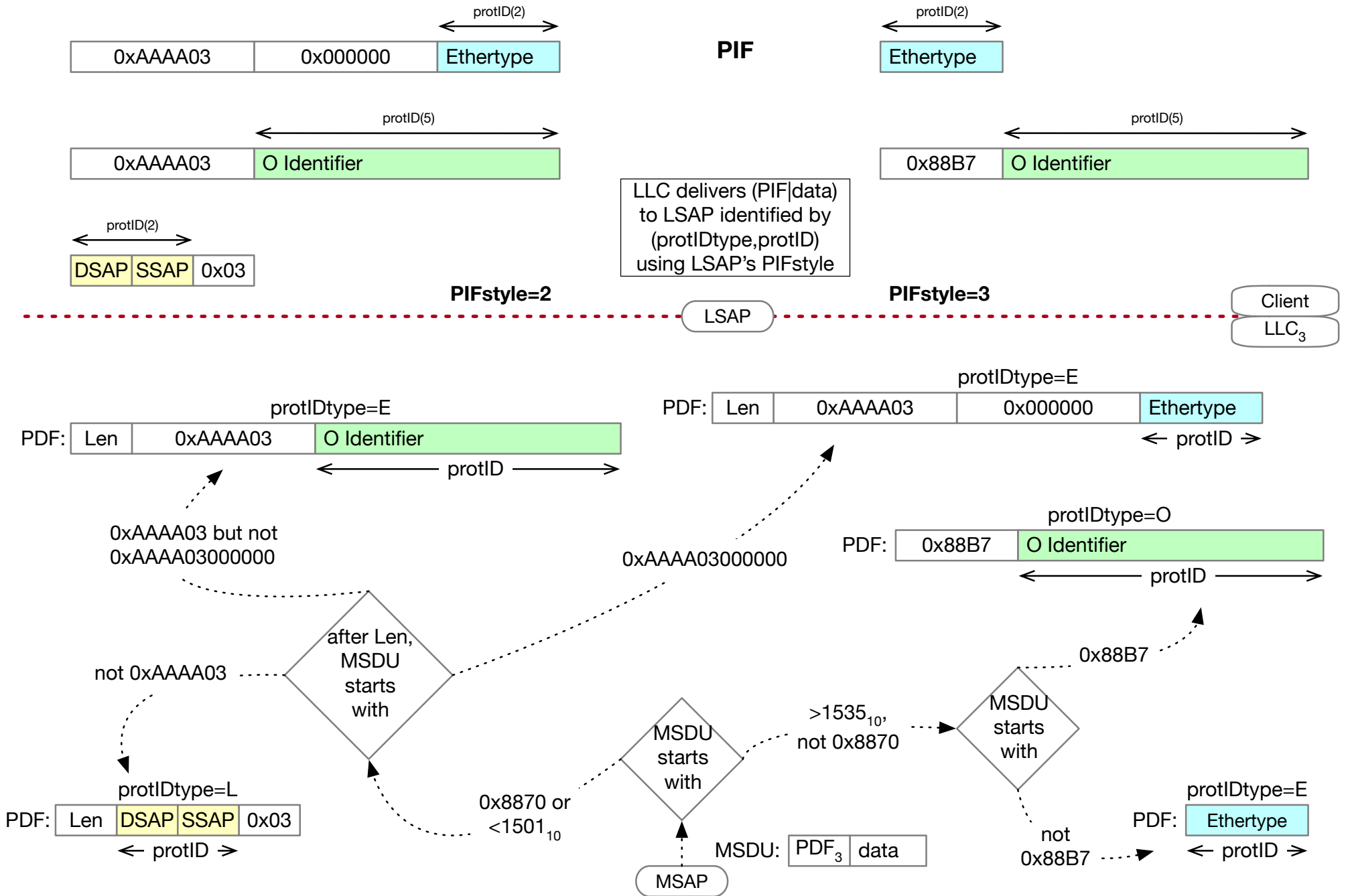
That is, it’s not the job of the LLC to determine the MAC DA and SA; that needs to be passed down from LLC Client.



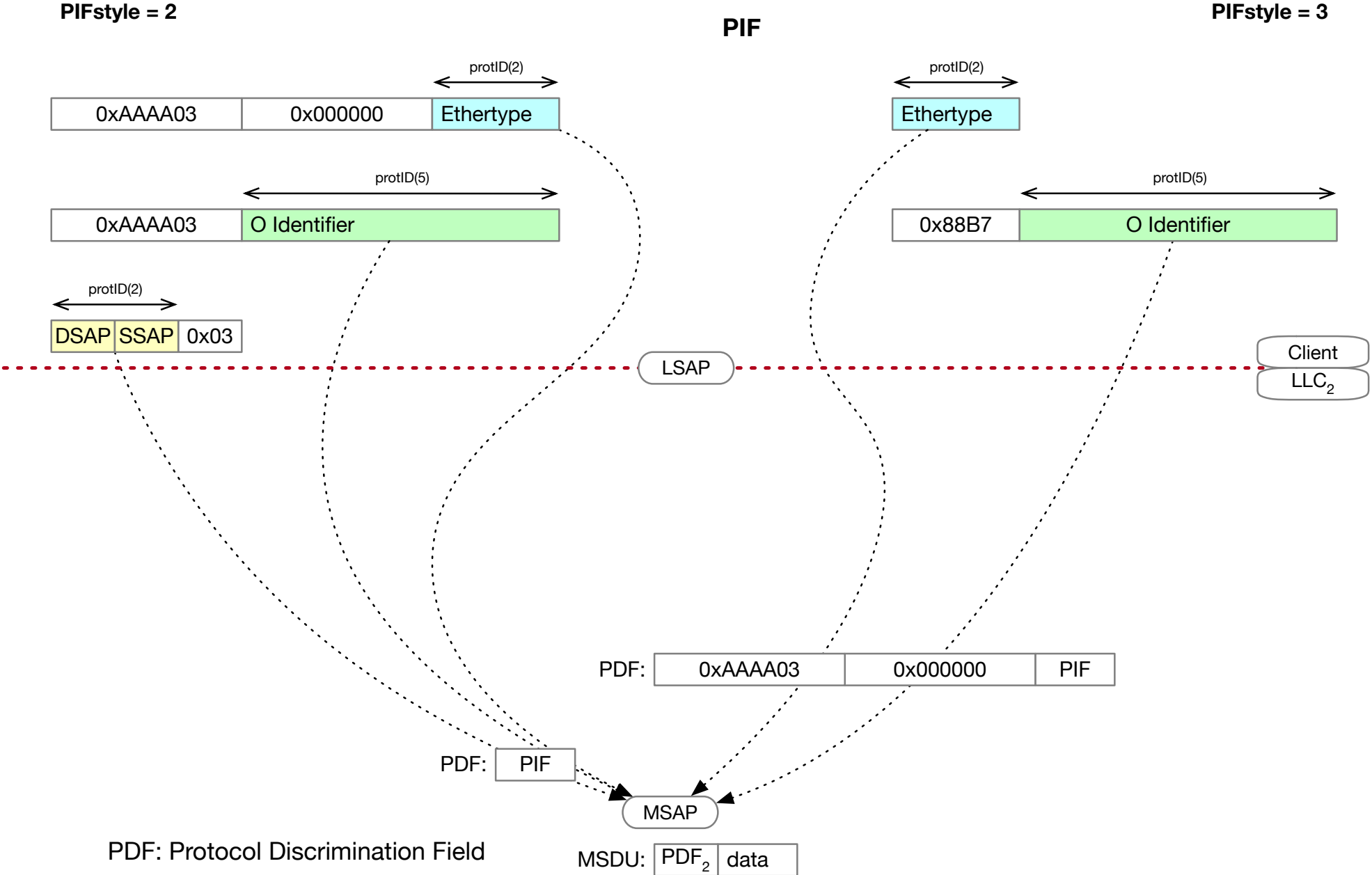
3PD (Length/Type) Encoding



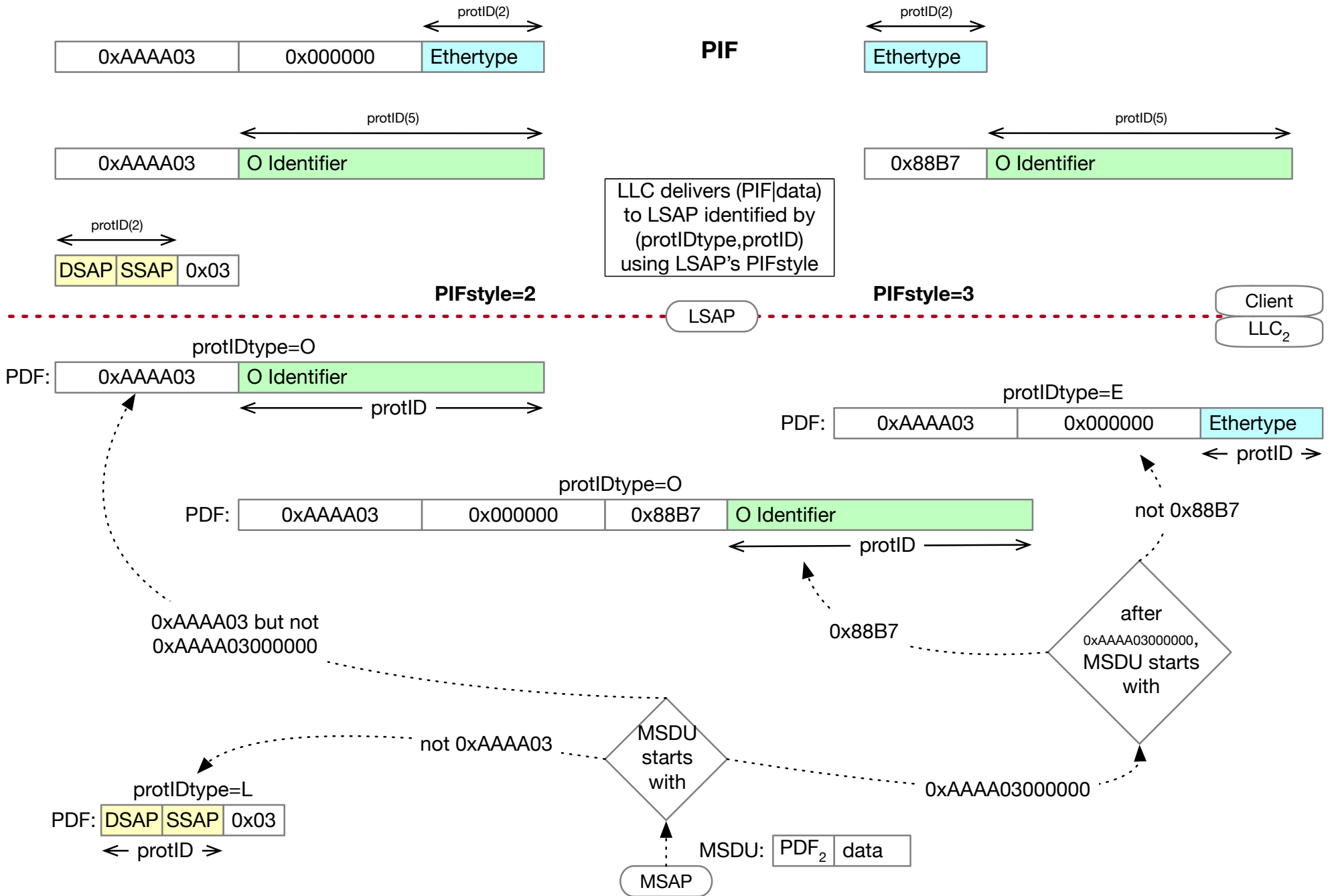
3PD (Length/Type) Decoding



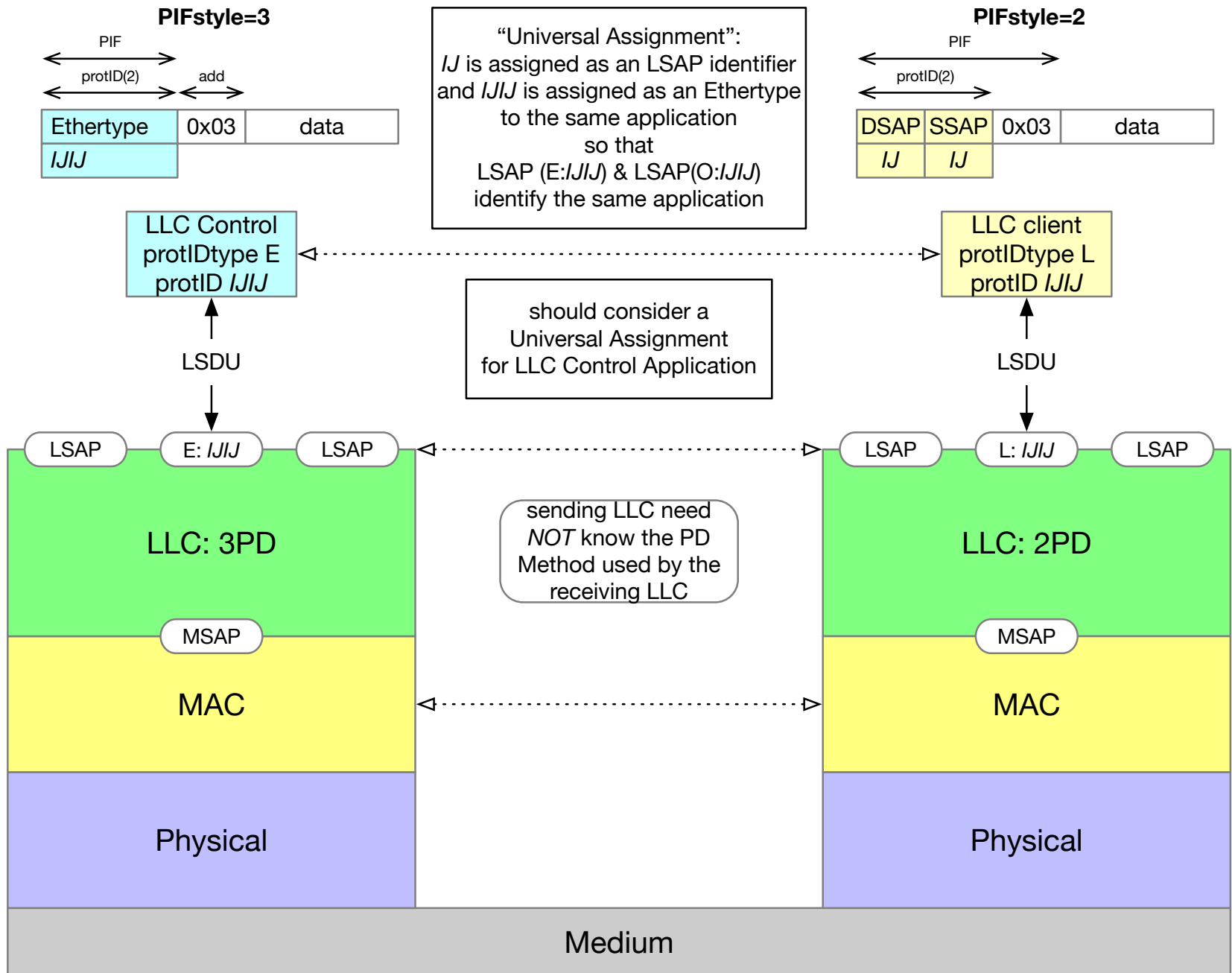
2PD Encoding



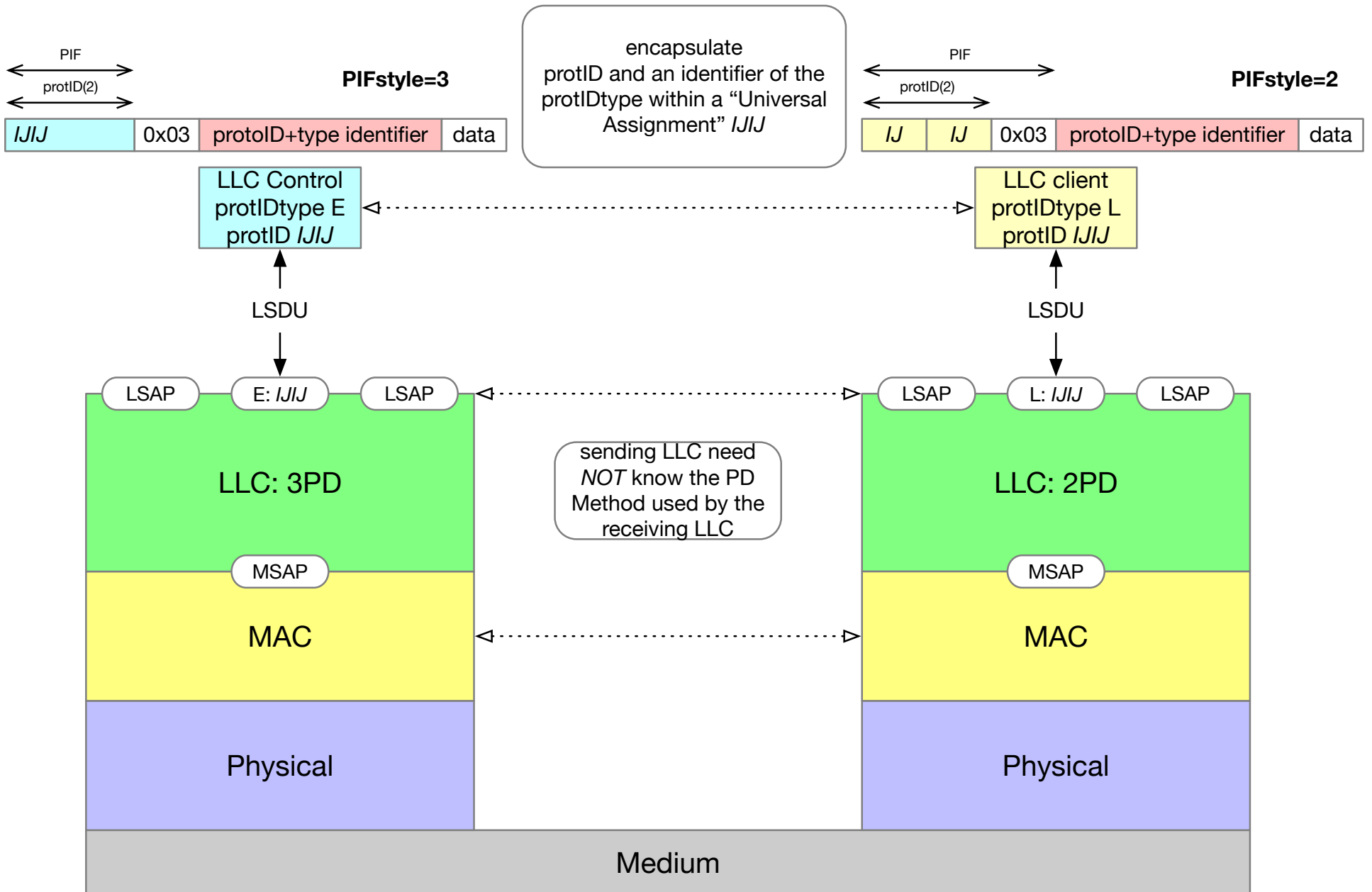
2PD Decoding



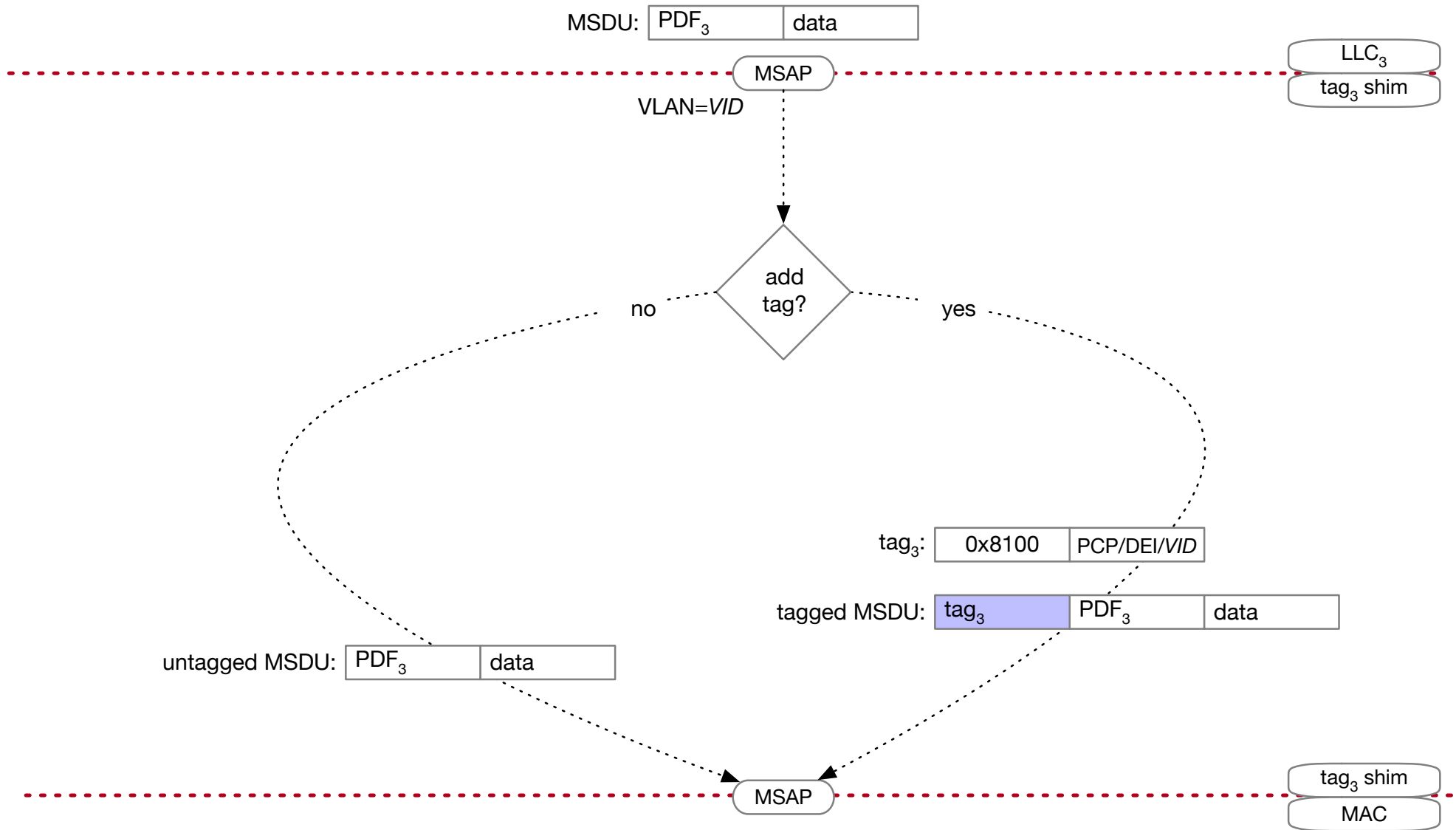
Universal Assignment



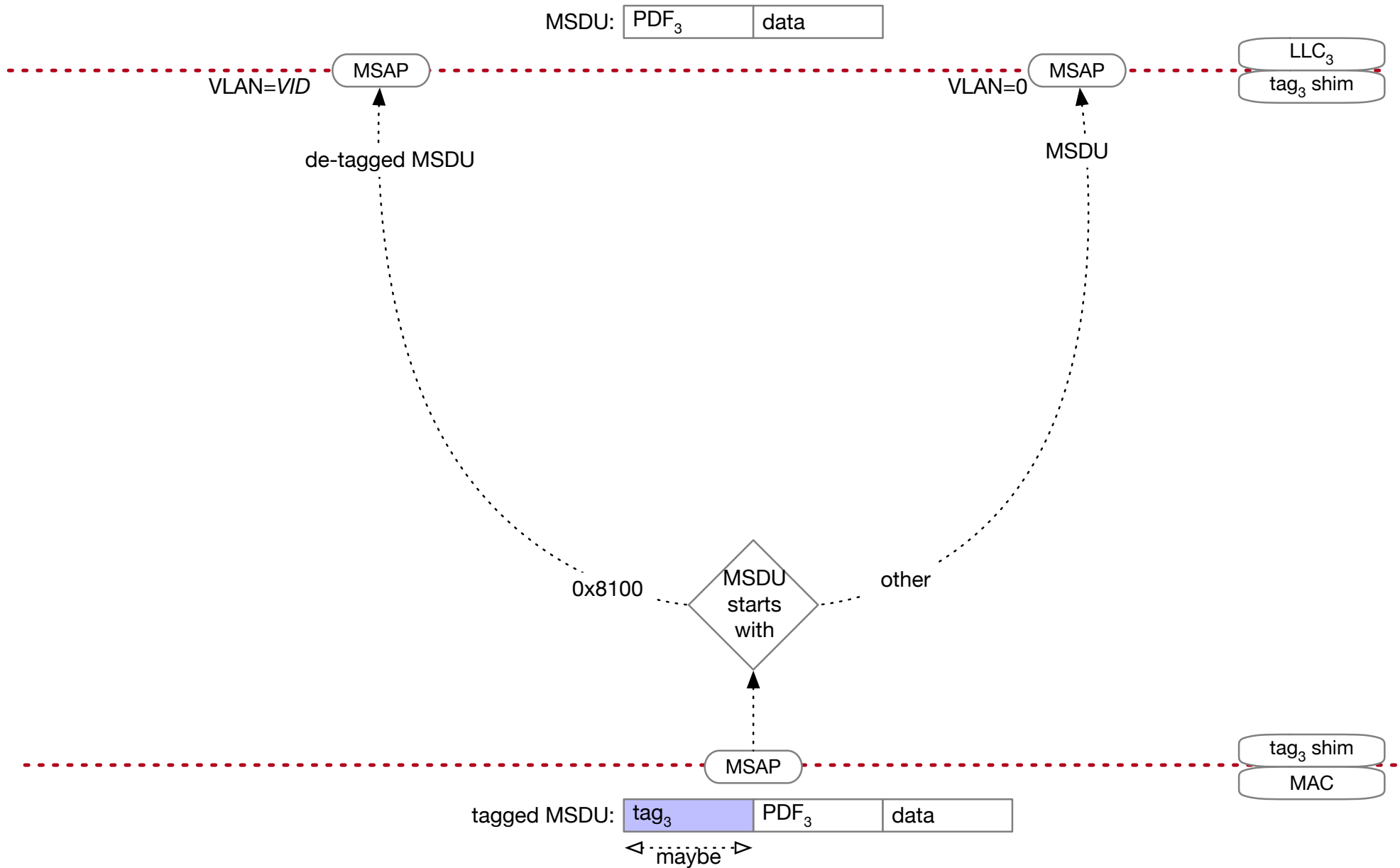
Universal LSAP Encapsulation for New Protocols



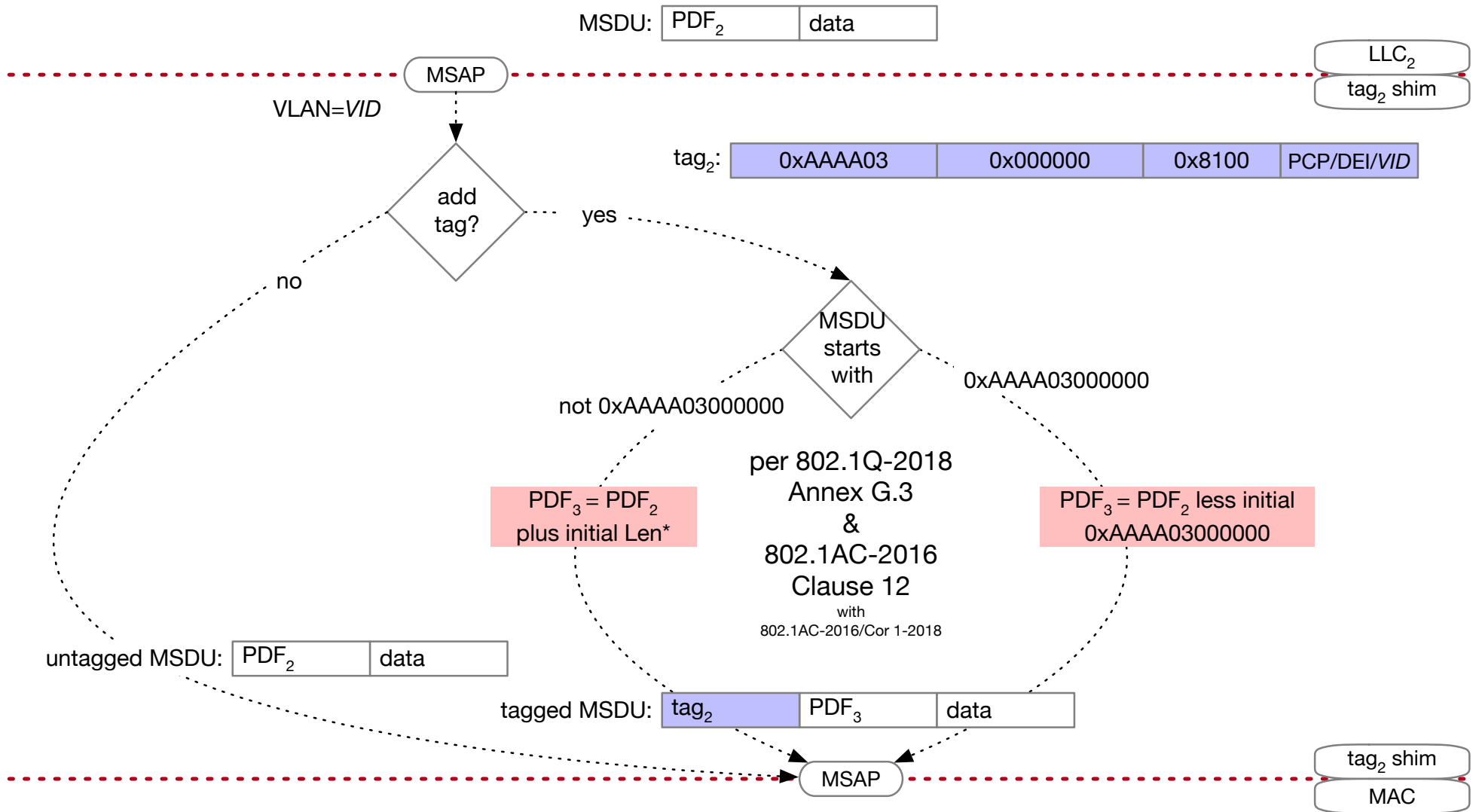
VLAN Tagging, 3PD



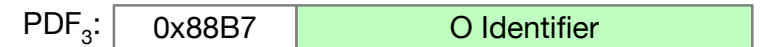
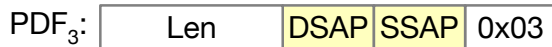
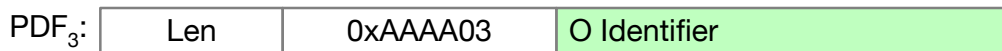
VLAN De-tagging, 3PD



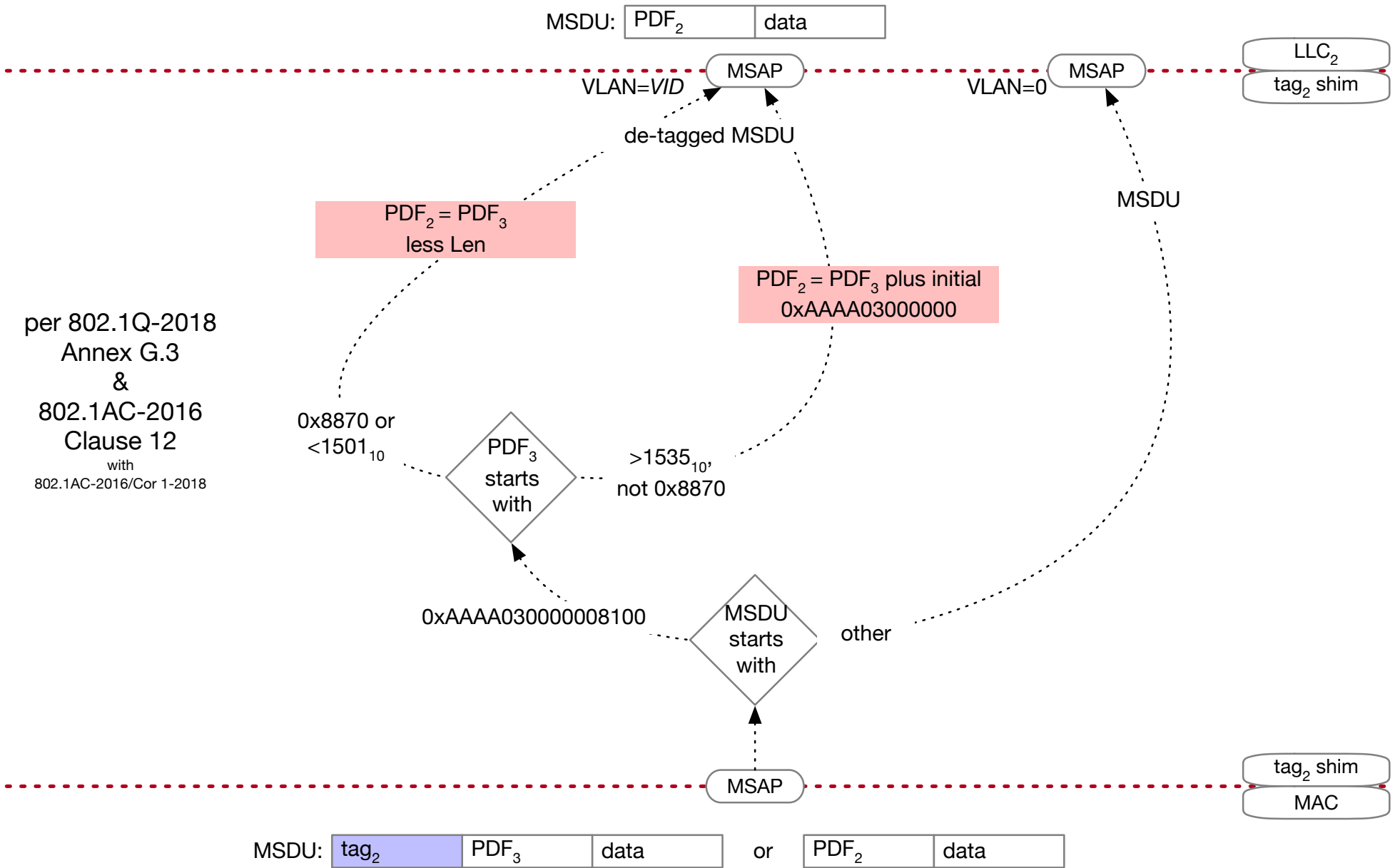
VLAN Tagging, 2PD



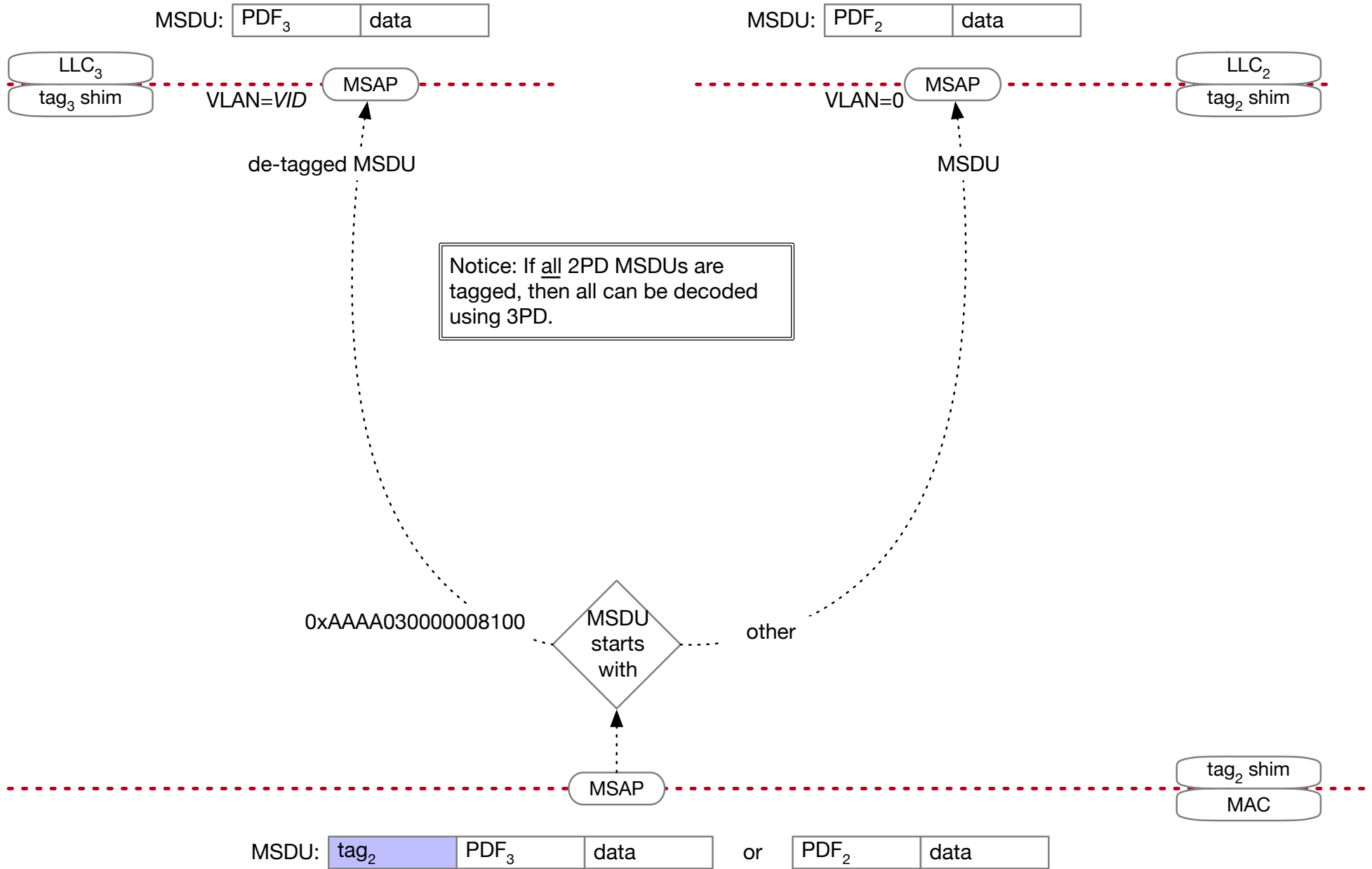
*Note: Providing the length in the Len field serves no purpose here; could be replaced by 0x8870 in all cases.



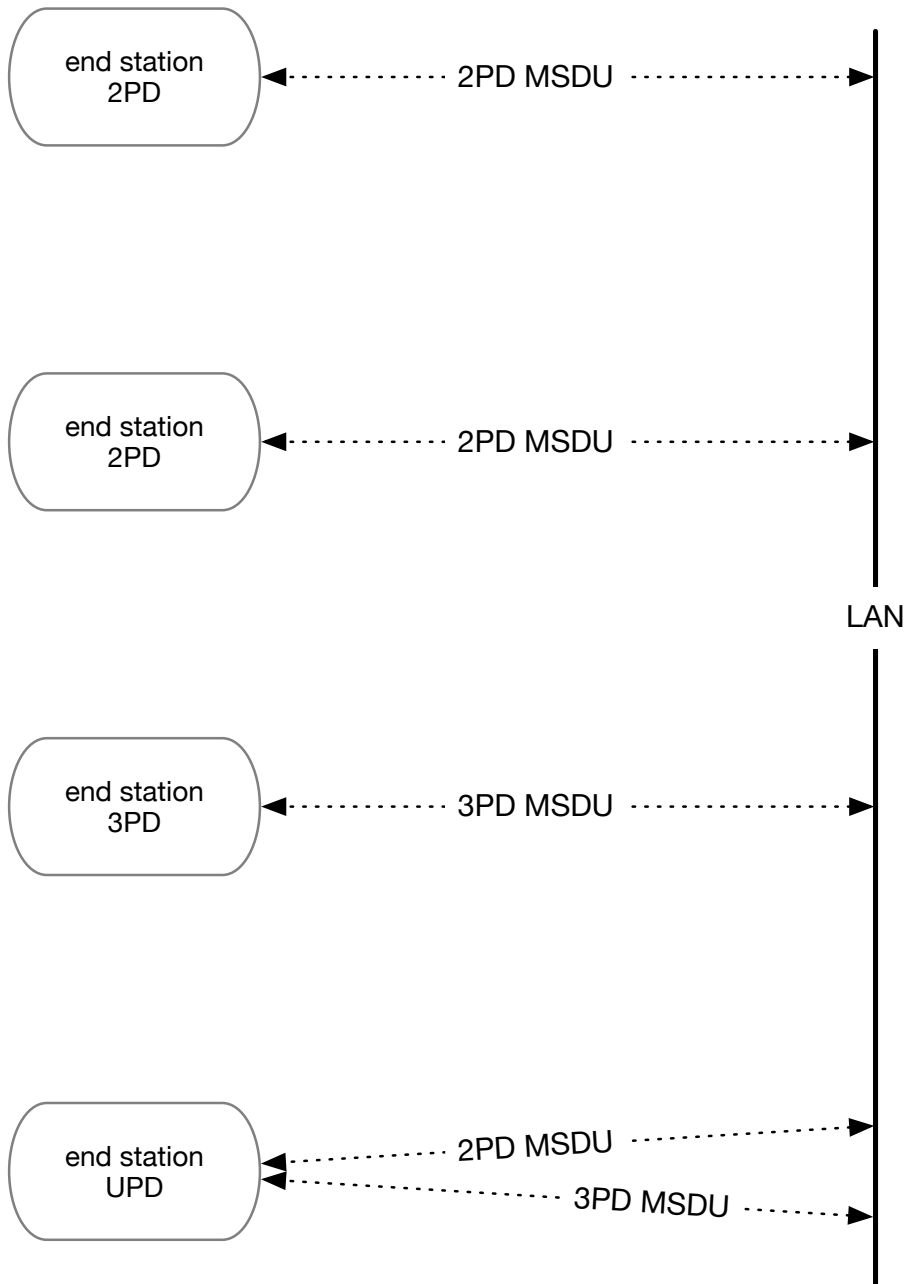
VLAN De-Tagging, 2PD



Simplified VLAN De-Tagging, 2PD



UPD : Universal Protocol Discrimination



UPD end station: decoding

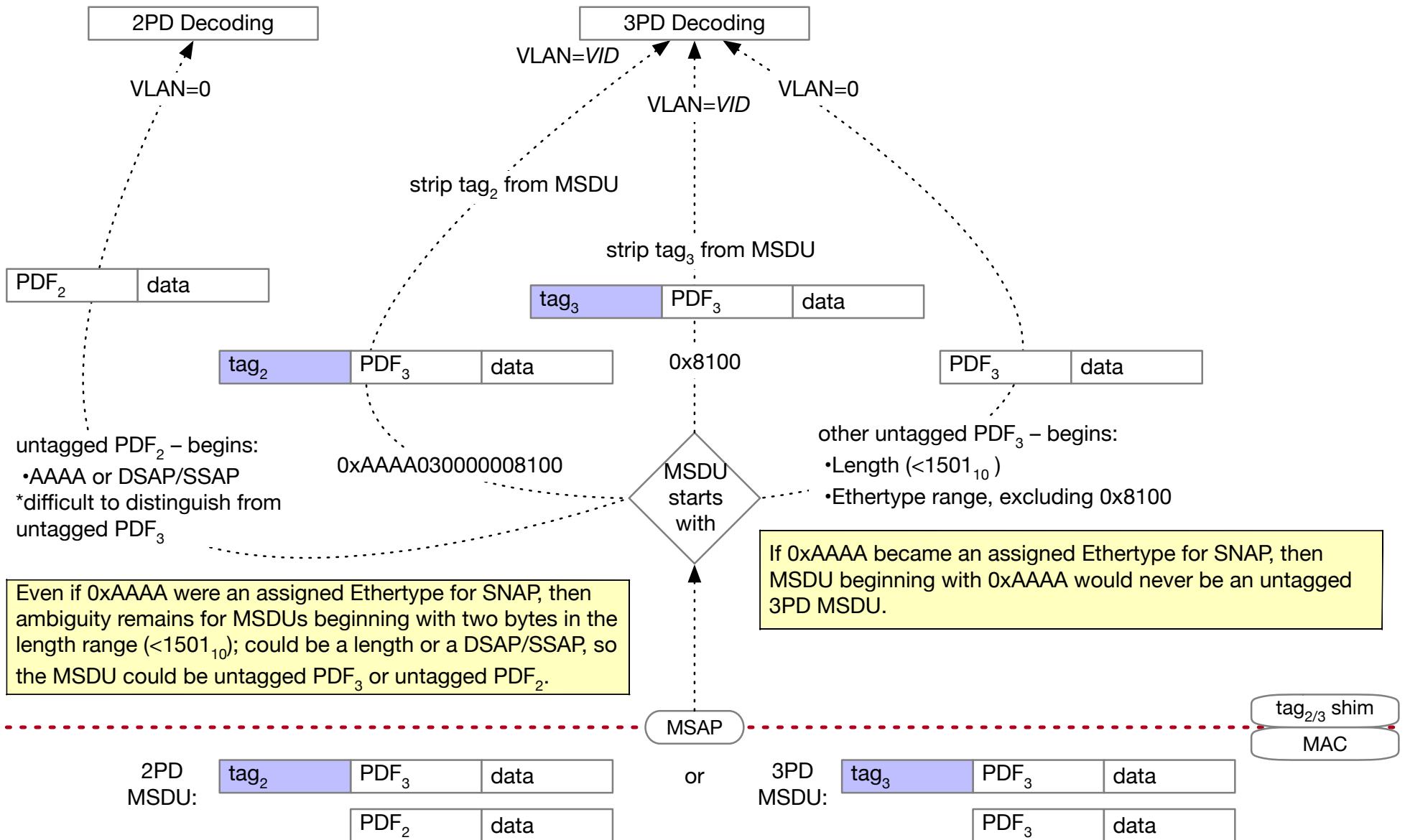
- receives intermixed frames from 2PD and 3PD stations
- distinguishes and decodes each

UPD end station: encoding

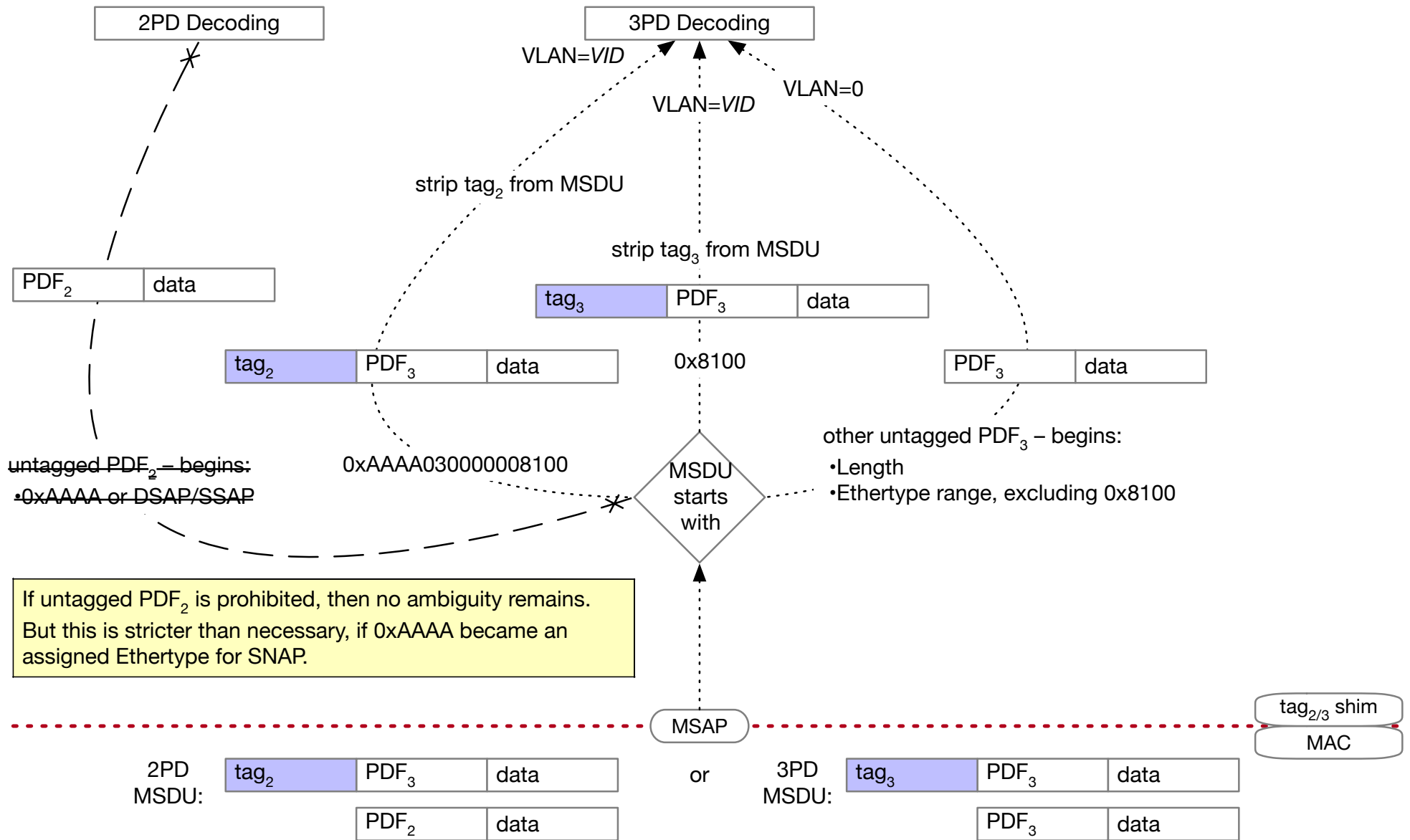
either:

- choose 2PD or 3PD based on destination capability, or
- use universal encoding that both 2PD and 3PD devices can read

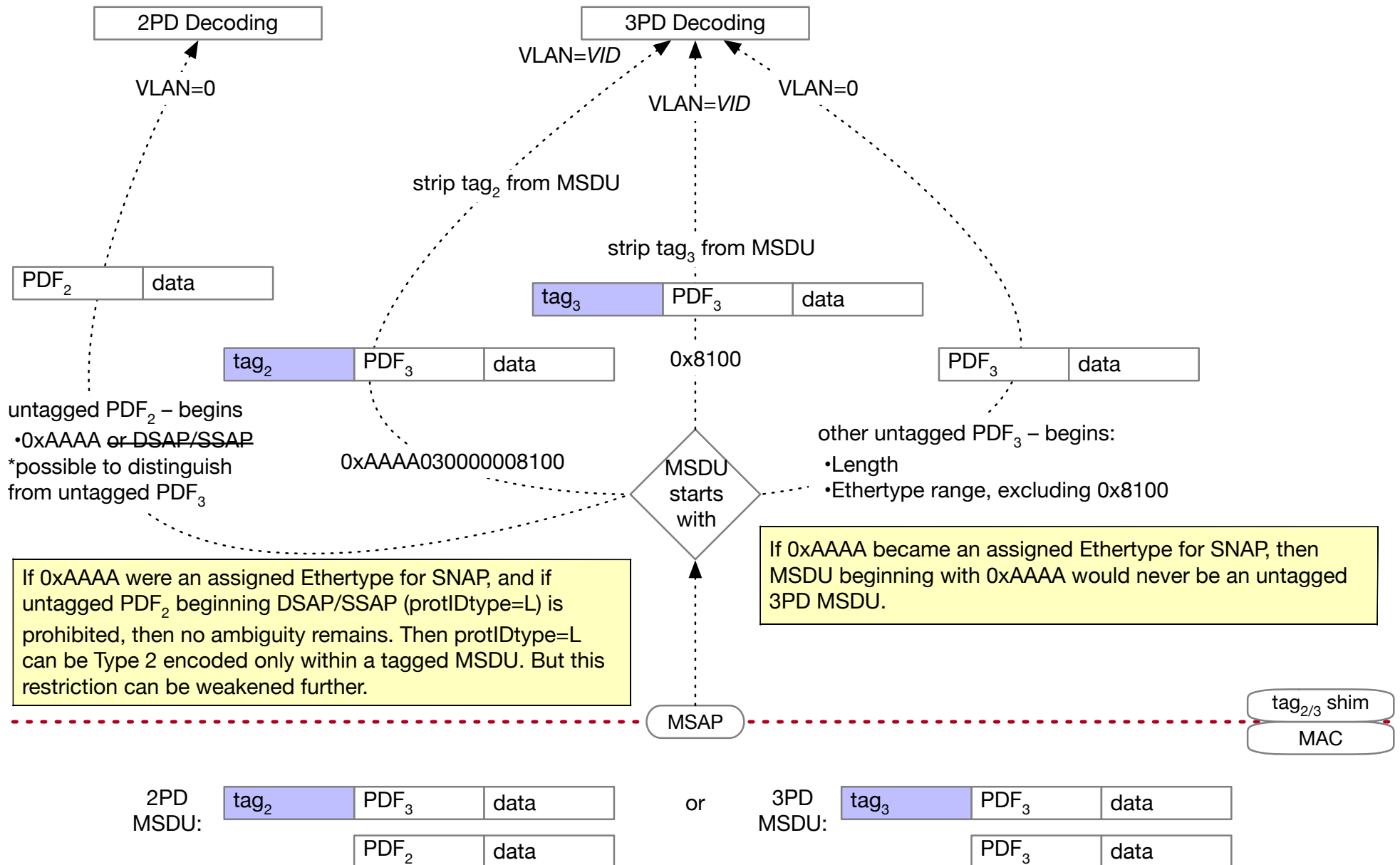
De-tagging, 2PD & 3PD Intermixed



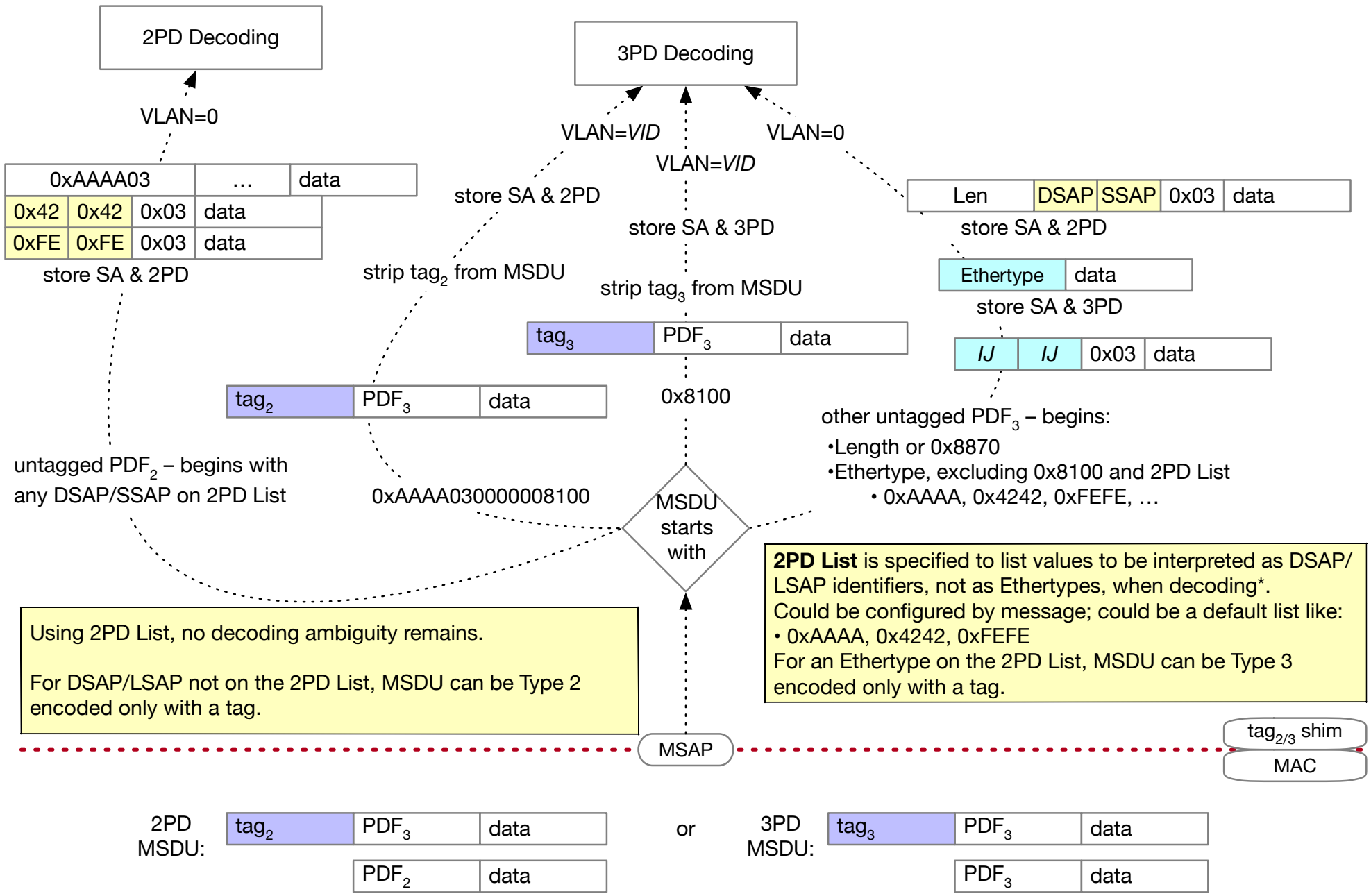
2PD & 3PD Intermixed: No untagged PDF₂



2PD & 3PD Intermixed: No untagged protIDtype=L



UPD with 2PD & 3PD Intermixed, using 2PD List



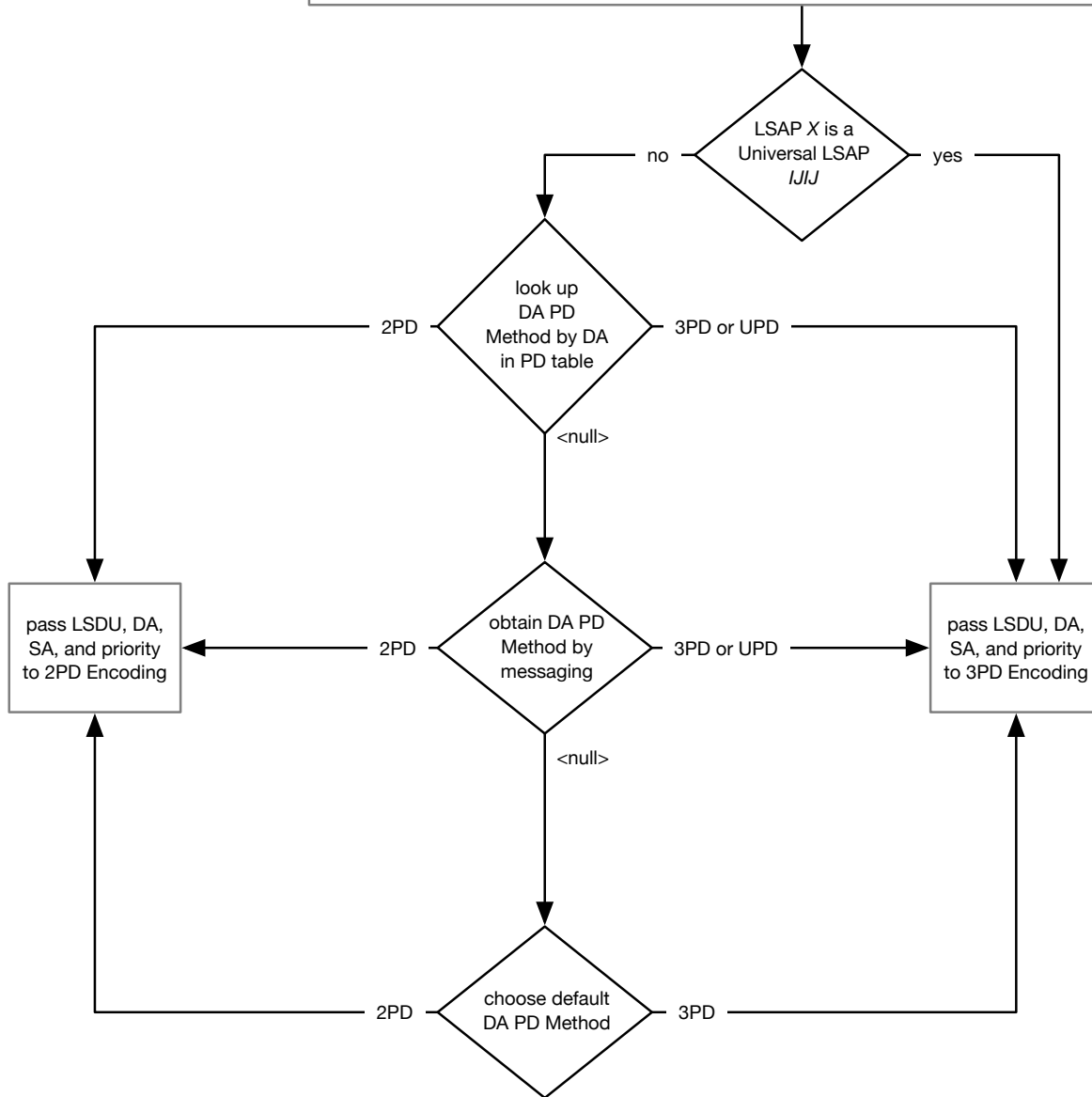
*All protIDs on the 2PD List are in the Ethertype range, so Ethernet will transport them unaltered, not pad or de-pad them.

2PD List Possibilities

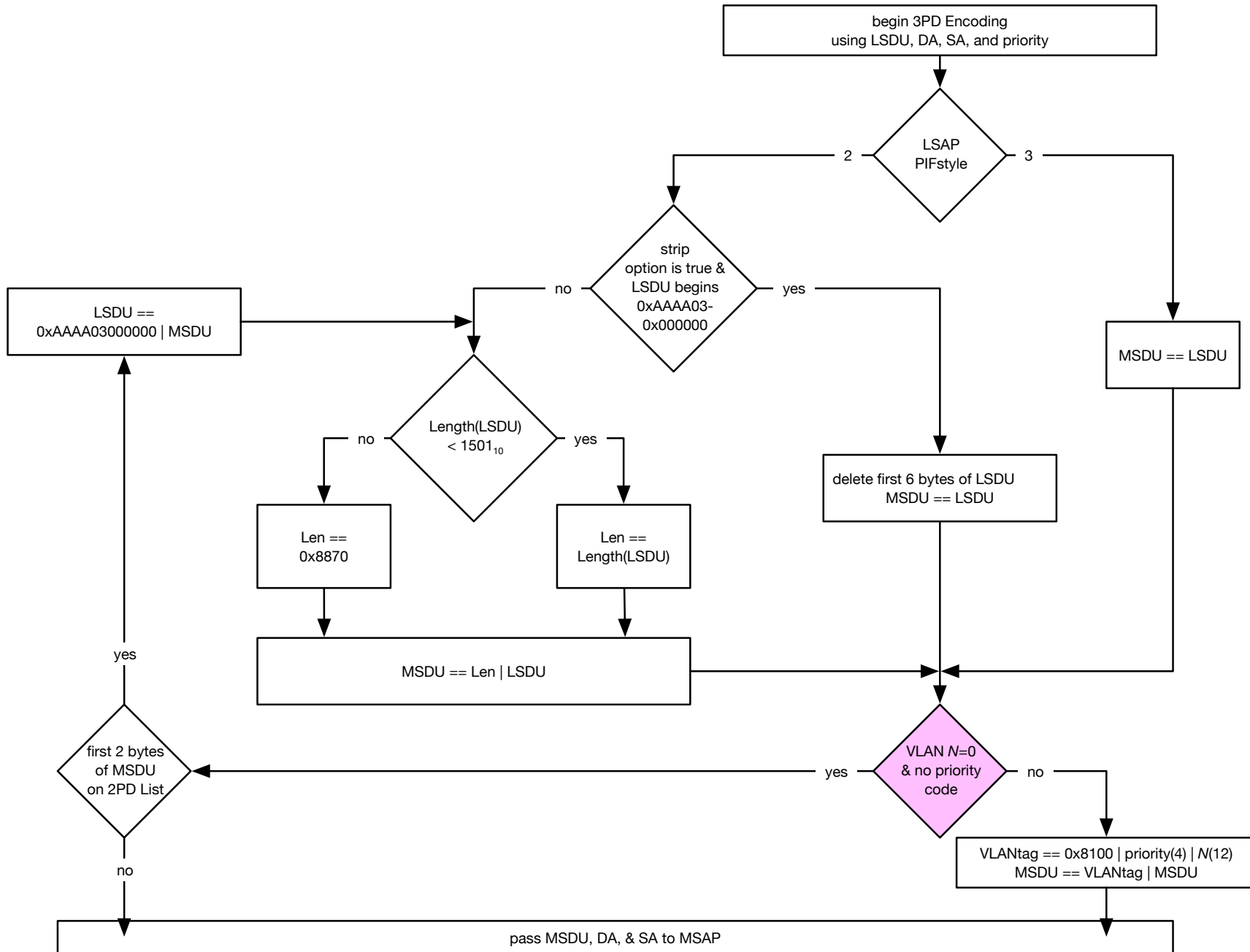
LSAP	protocol	conflicting Ethertype value	conflicting Ethertype assignment	proposed LSAP Priority	note
0x00	ISO/IEC 8802-2 null address	unallowed ($<1536_{10}$)	-		A Universal Assignment [Ethertype (<i>IJJ</i>) and matching LSAP (<i>IJ</i>)] would be useful for LLC-LLC communications.
0x02	802.1B (withdrawn)	unallowed ($<1536_{10}$)	-		
0x82	ASHRAE 135-1995 BACnet	0x8282	Assignment private		
0x42	ISO/IEC 10038 IEEE 802.1 BPDU	0x4242 assigned	PCS Basic Block Protocol ("Protocol unavailable")	0x4242	LSAP in wide use by 802.1; Ethertype assigned before 1990 and use unknown
0x0A	802.10B (withdrawn)	0x0A0A unassigned	-		
0xAA	IEEE 802 SNAP	0xAAAA unassigned	should request assignment to IEEE 802	0xAAAA	LSAP in use by 802 for SNAP; Ethertype is unassigned
0x06	ARPANET/IP (obsolete)	0x0606 unassigned	-		
0xA6	ISO/IEC 8802-2 (802.5 source routing; obsolete)	0xA6A6 unassigned	-		
0xE6	IEC 62056-46	0xE6E6 unassigned	-		
0x0E	IEC 955 Proway C	0x0E0E unassigned	-		
0x8E	IEC 955 Proway C	0x8E8E unassigned	-		
0x4E	ISO 9506: 1990 Manufacturing Message	0x4E4E unassigned	-		
0x7E	ISO/IEC 8208: 1995 X.25	0x7E7E unassigned	-		
0xFE	ISO/IEC TR 9577: 1999 extensible protocol identification	0xFEFE unassigned	should request reservation by IEEE RA	0xFEFE	LSAP in use as extensible identifier and for 802.1 IS-IS; Ethertype is unassigned

UPD Encoding

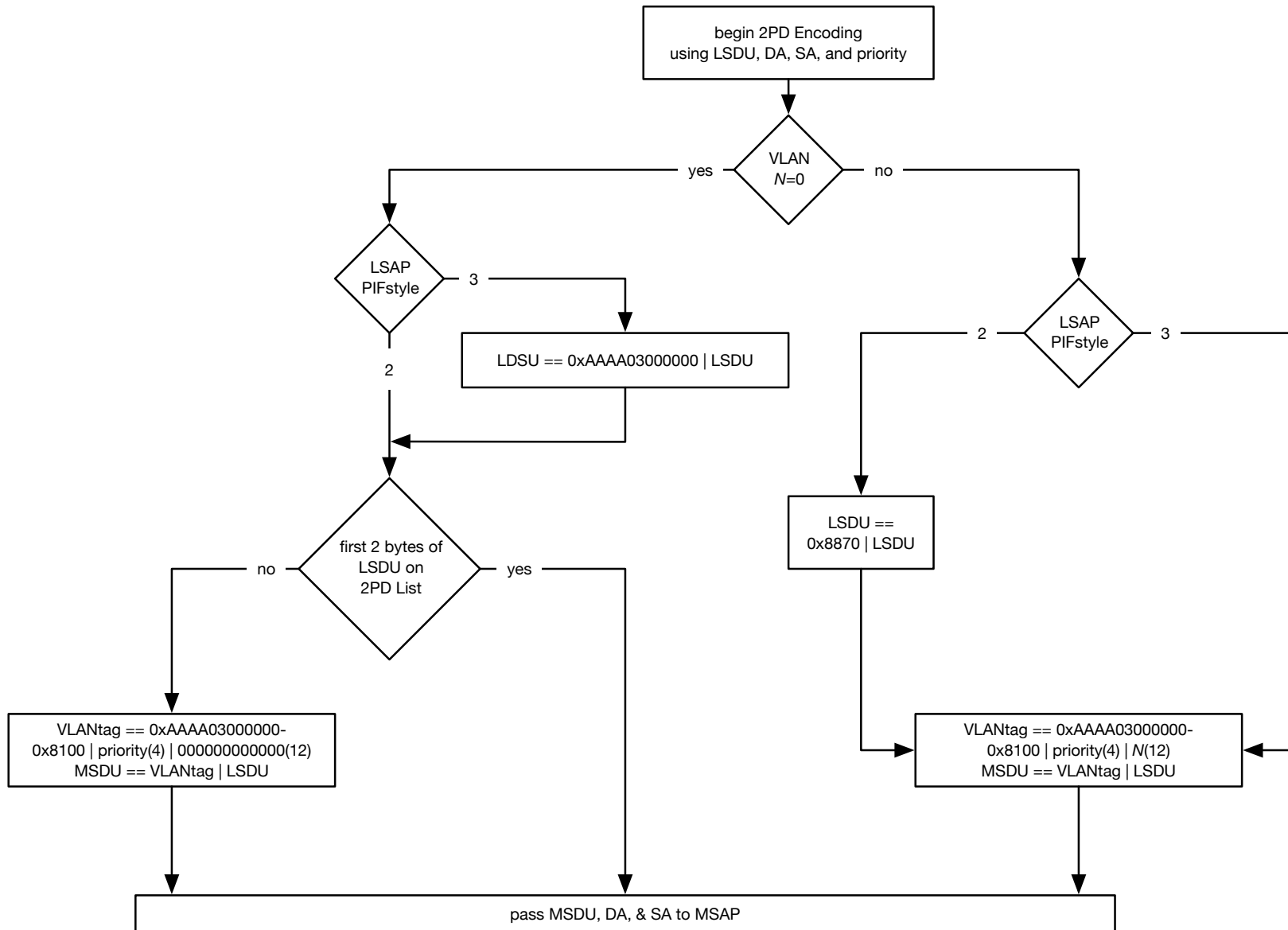
Application passes LSDU, DA, SA, and priority to LLC in VLAN *N* via LSAP *X*, where LSDU is the concatenation PIF|data, and where PIF identifies *X* (by protID, given the protIDtype determined implicitly based on the PIFstyle characterizing LSAP *X* at that end station and in VLAN *N*) among all LSAPs in VLAN *N* at the end station.



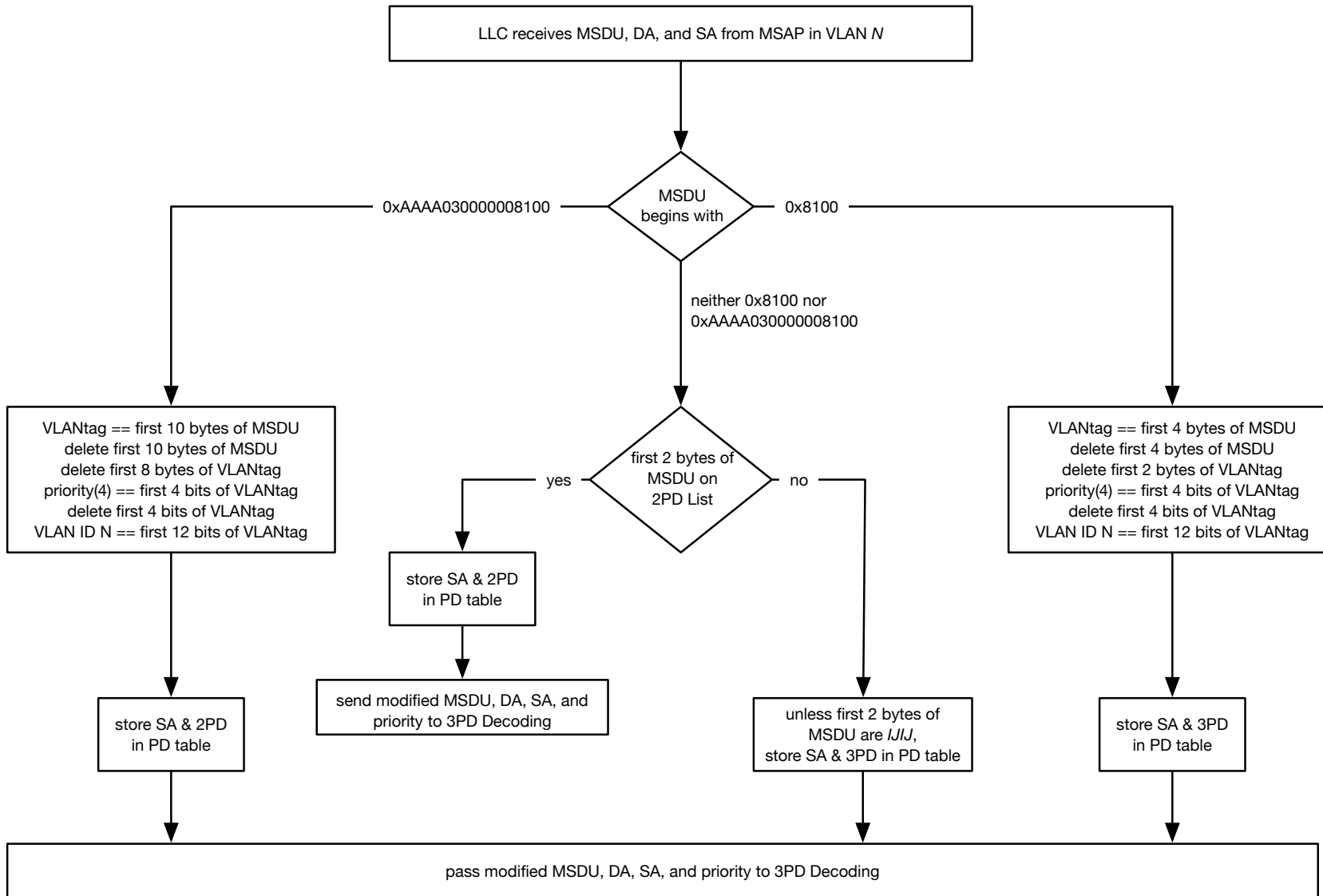
3PD Encoding



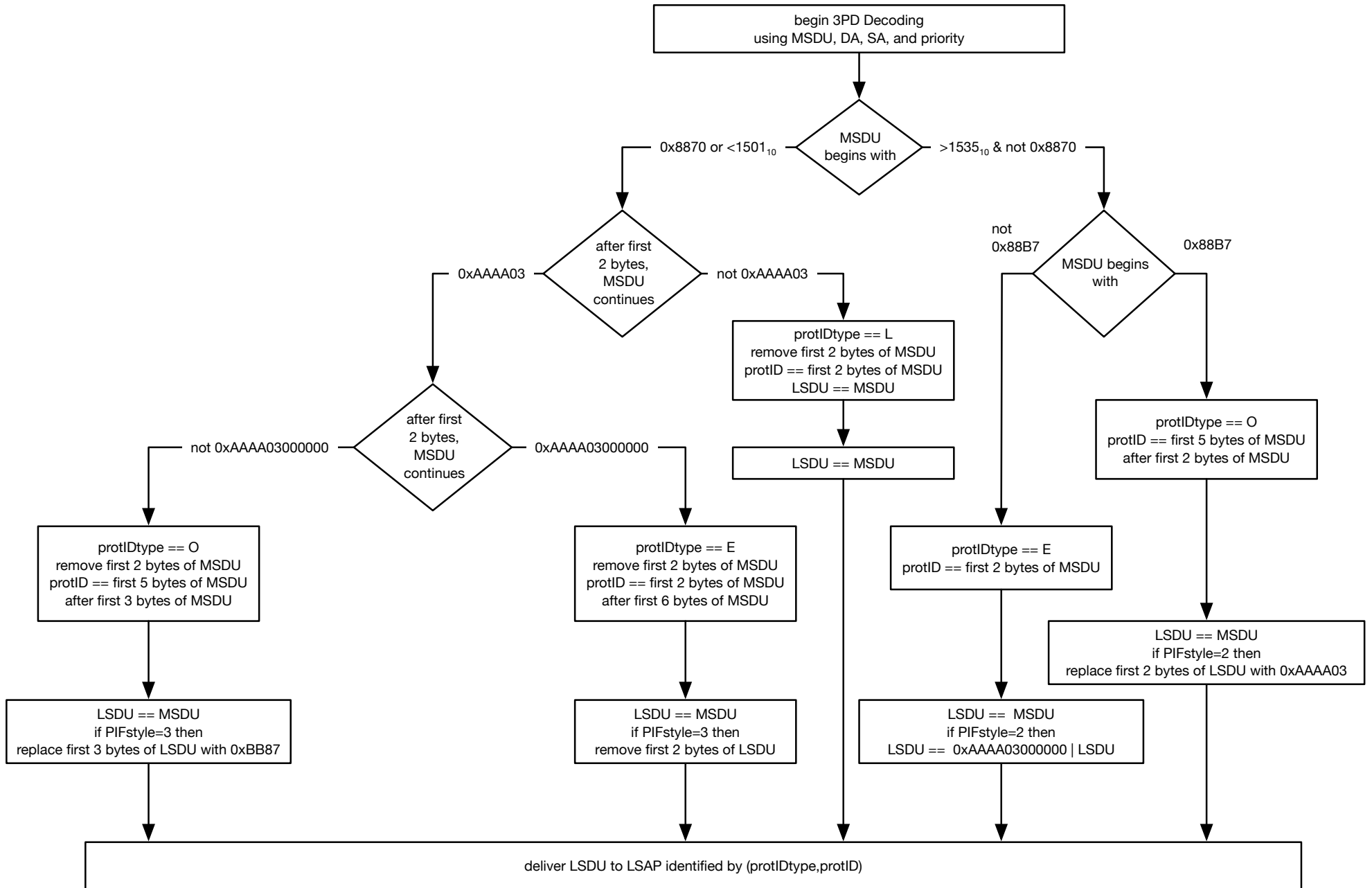
2PD Encoding



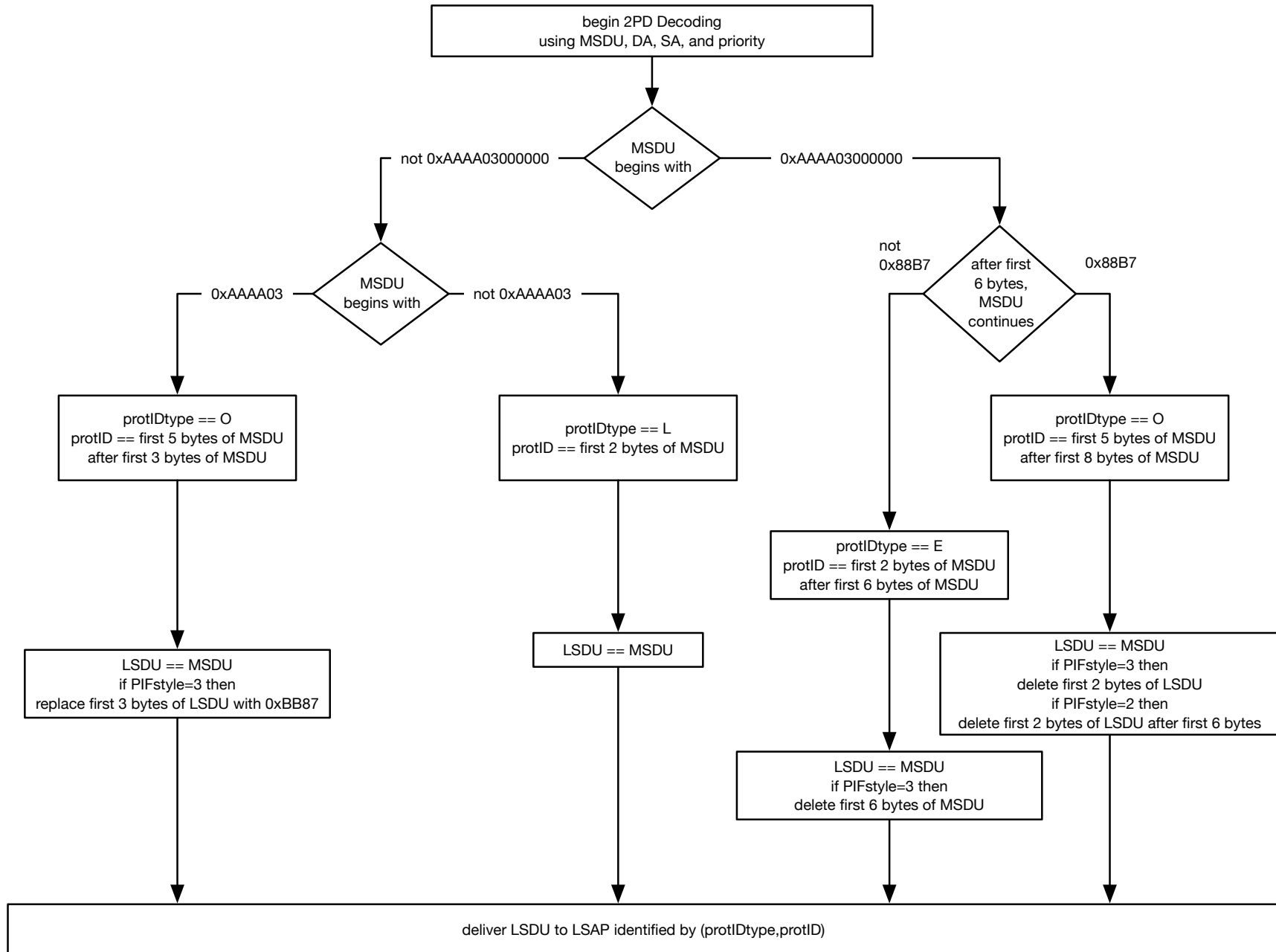
UPD Decoding



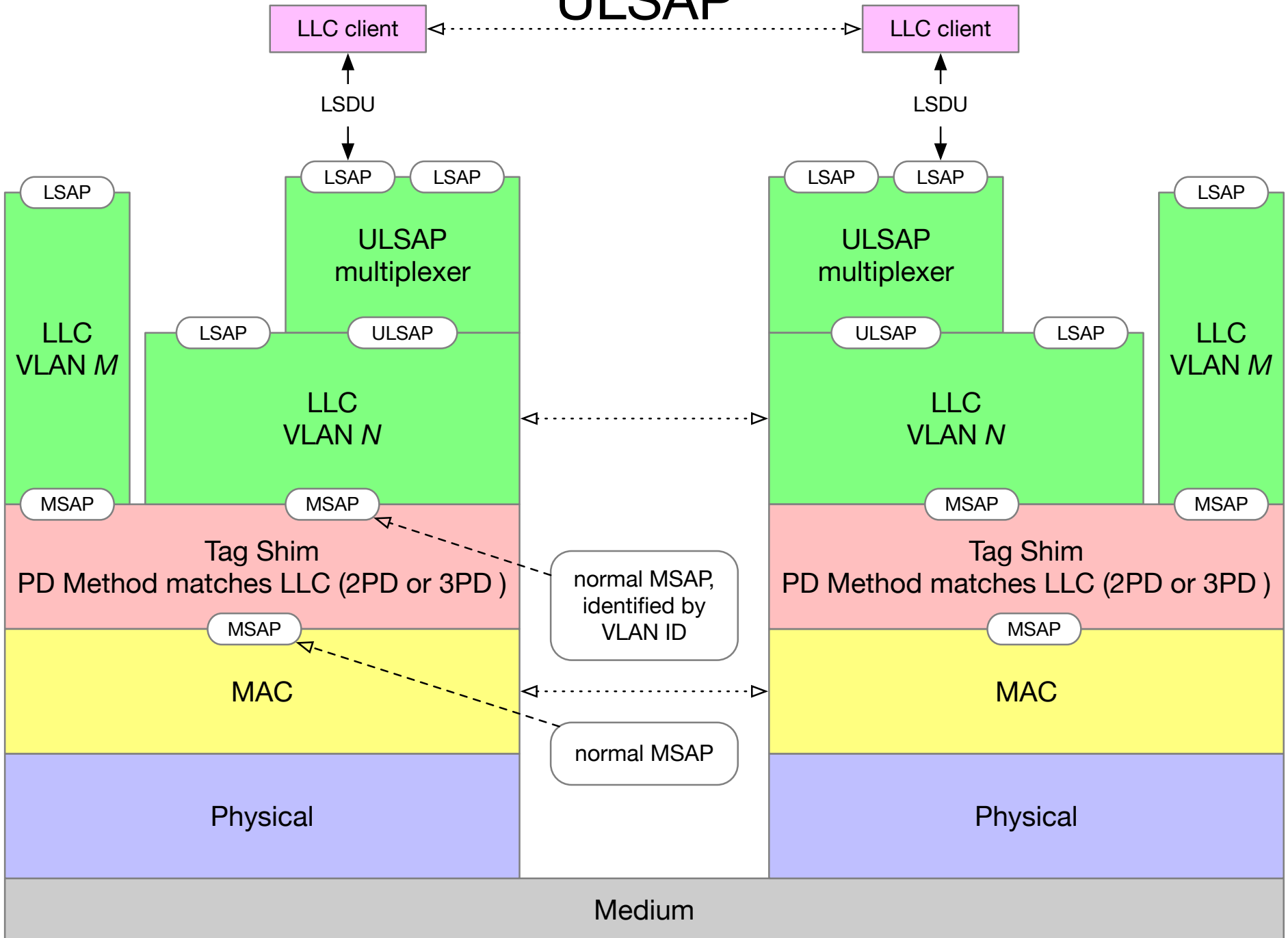
3PD Decoding



2PD Decoding



ULSAP

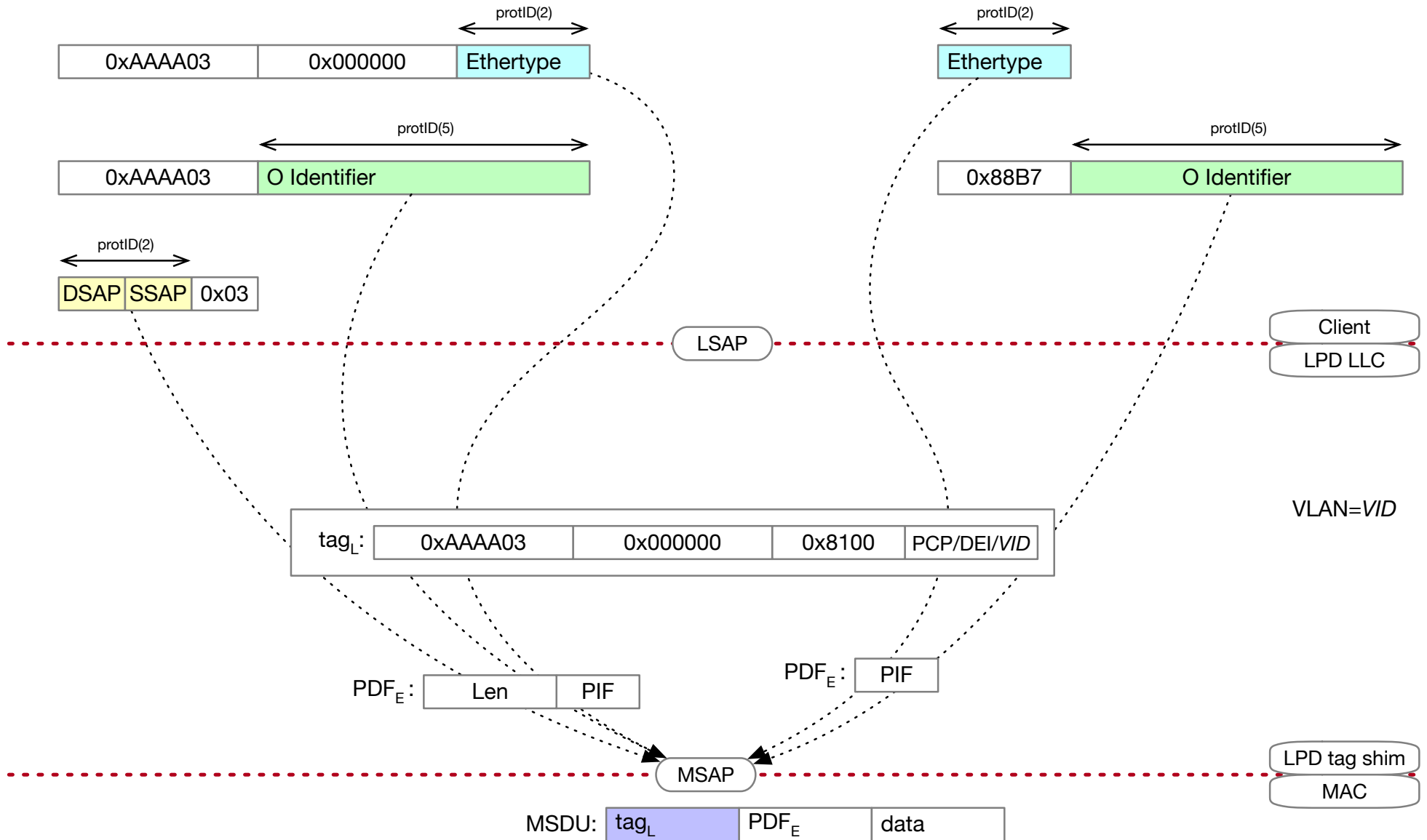


Combined Encoding & VLAN Tagging, 2PD

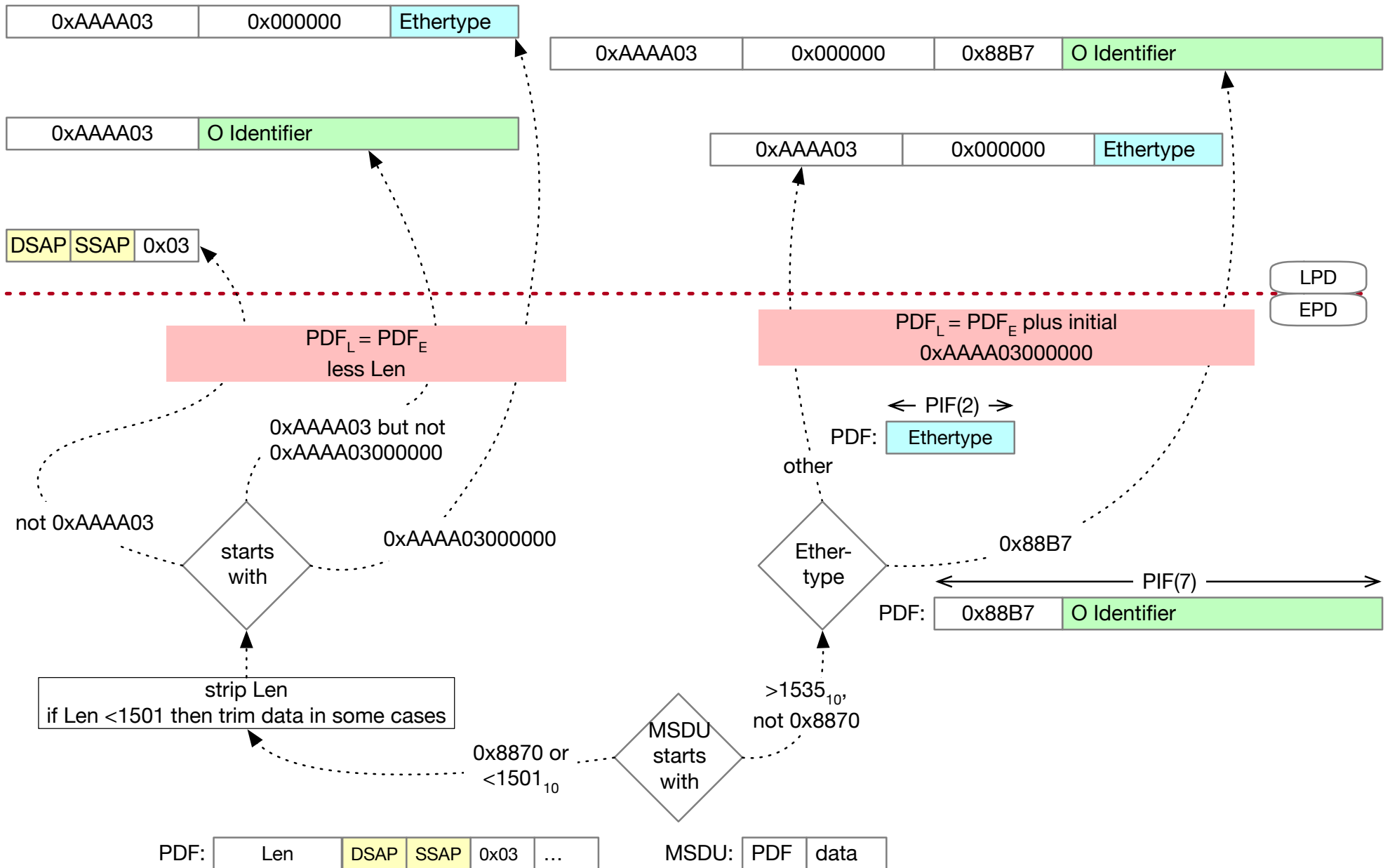
PIFstyle = 2

PIF

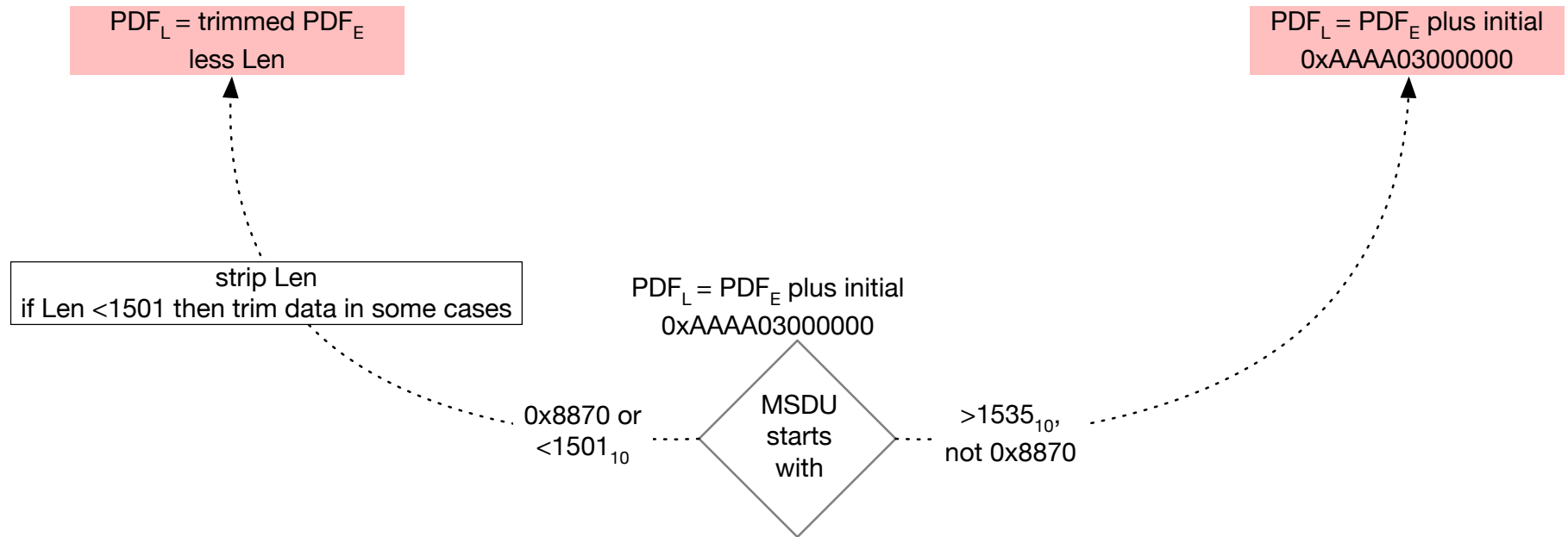
PIFstyle = 3



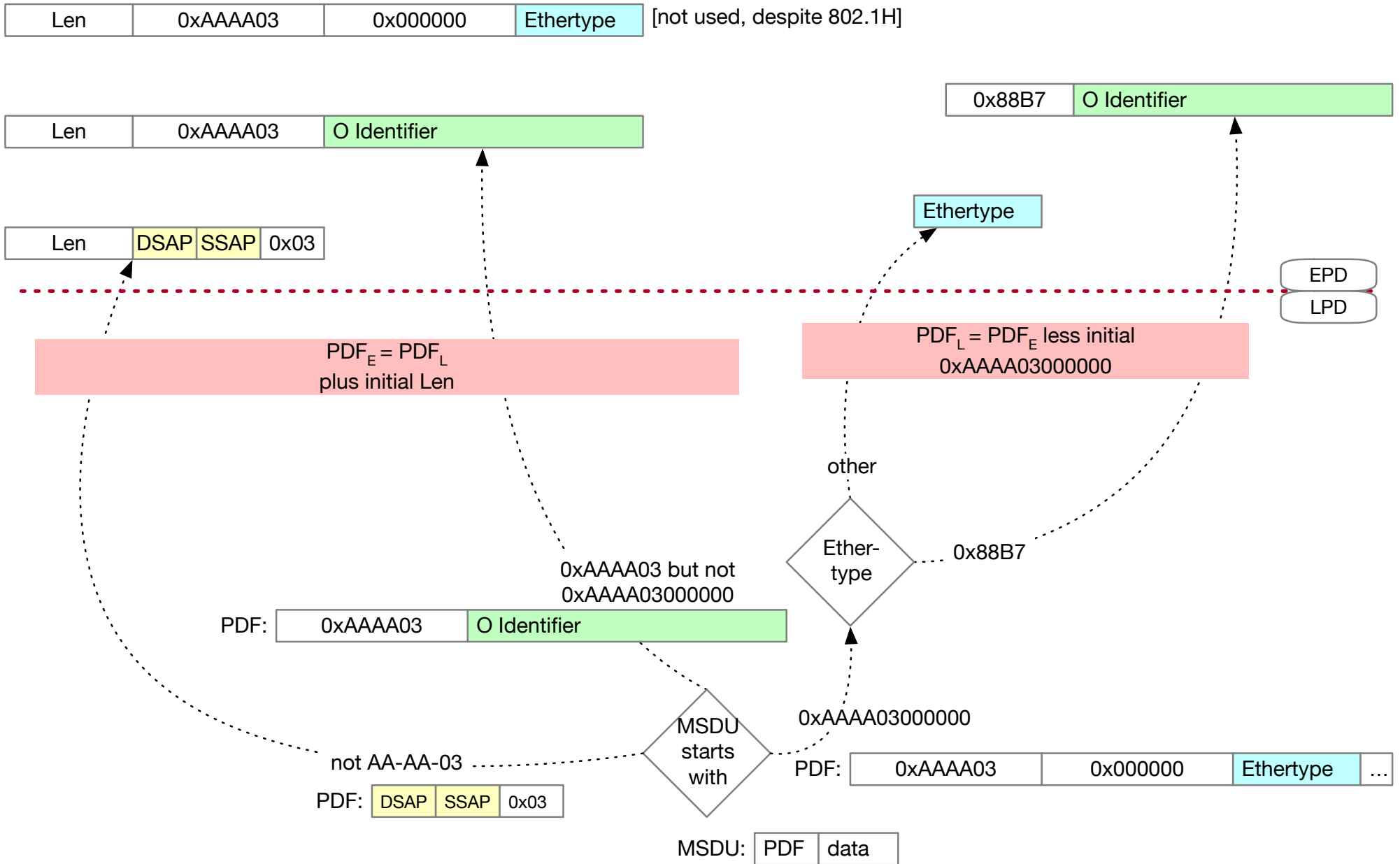
PDF Translation – EPD to LPD



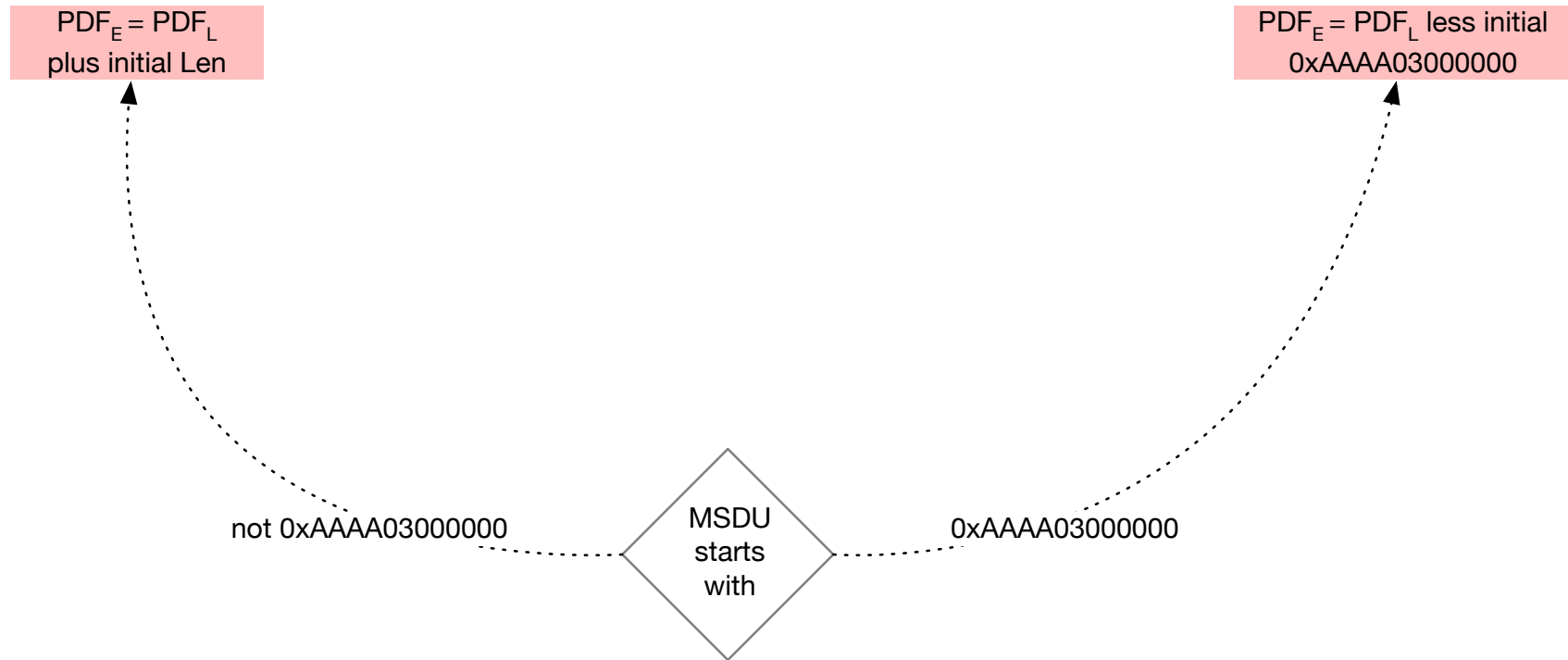
PDF Translation – EPD to LPD (simplified)



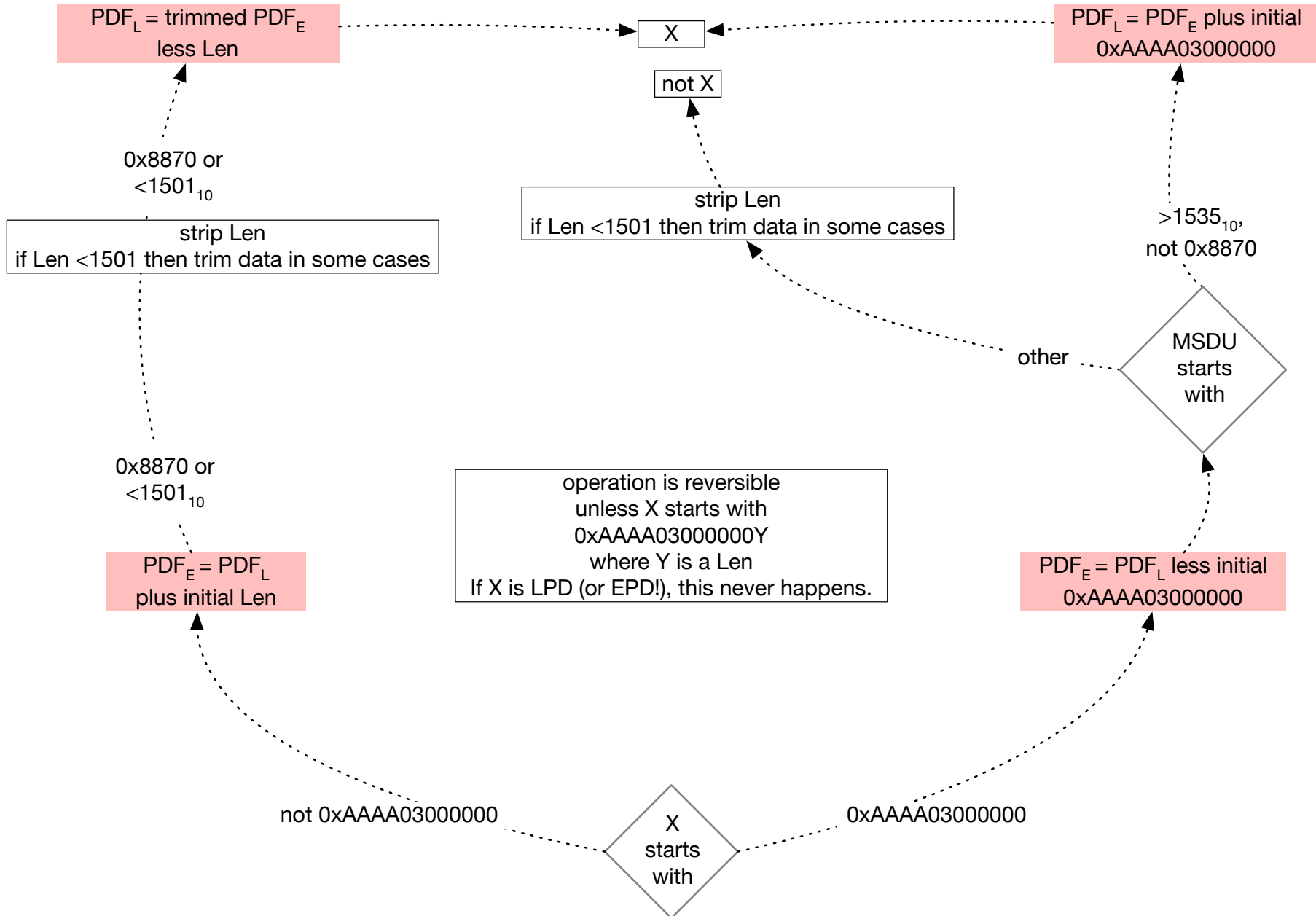
PDF Translation – LPD to EPD



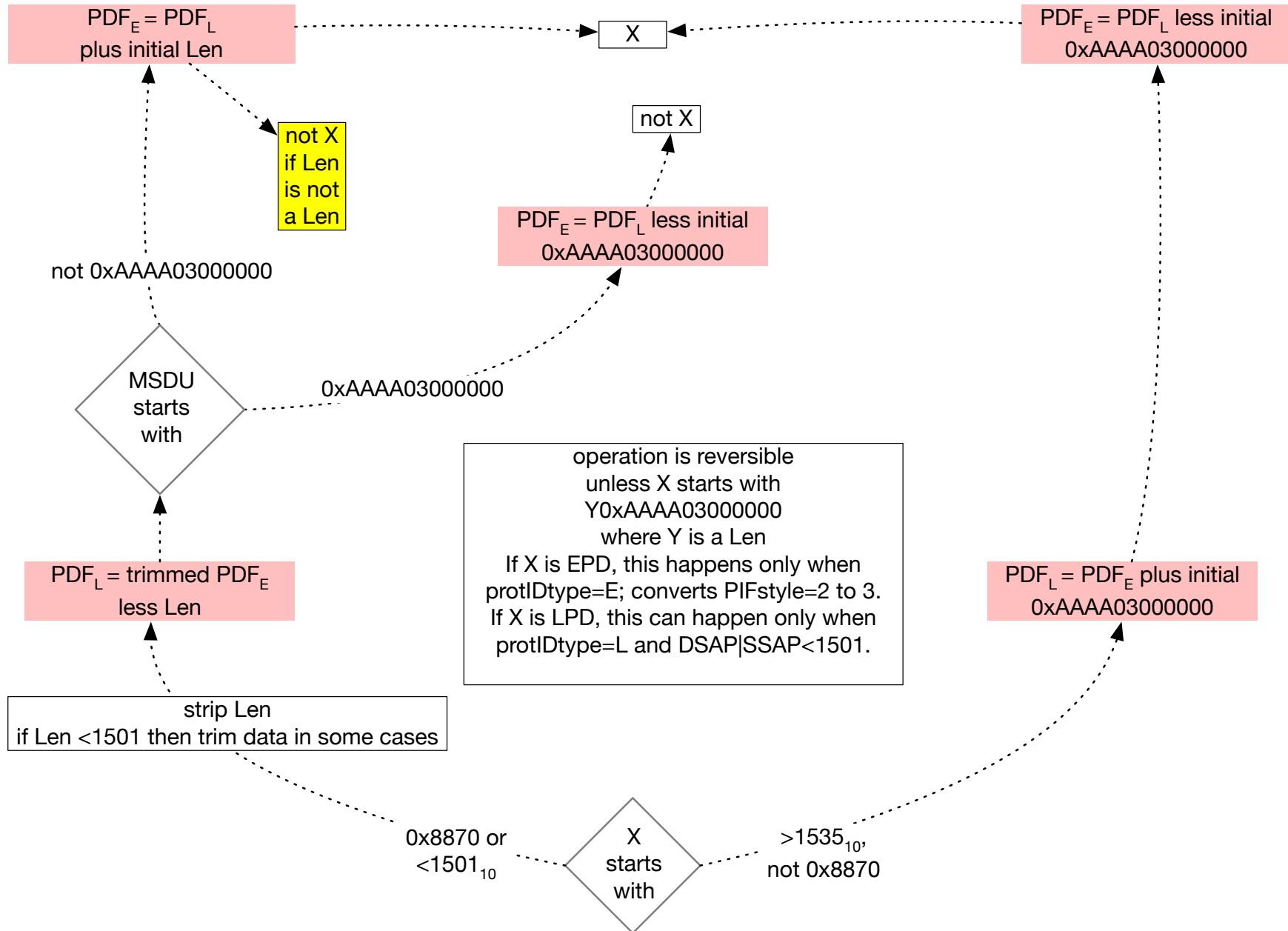
PDF Translation – LPD to EPD (simplified)



PDF Translation – X to EPD to LPD



PDF Translation – X to LPD to EPD



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.

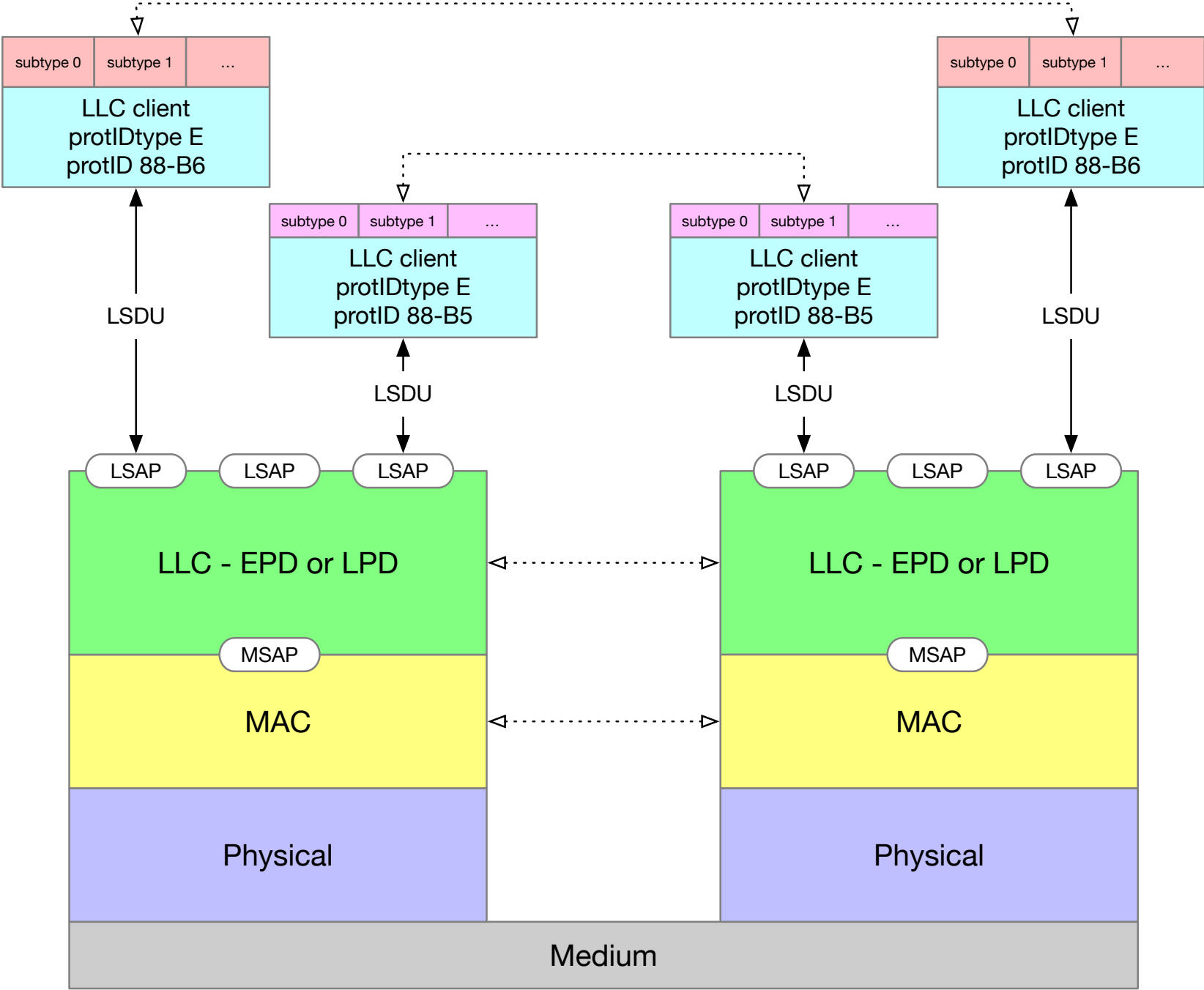
Local Experimental EtherType 1:

88-B5	protocol subtype	protocol version	data
-------	------------------	------------------	------

Local Experimental EtherType 2:

88-B6	protocol subtype	protocol version	data
-------	------------------	------------------	------

Playpen Ethertype



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 PD 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

Possible Ways Forward

- ARC should reach a consensus a way forward for the 802 LLC.
- Should consider the benefit of unified LLC specification supporting multiple 802 MACs, or at least 802.11 and 802.3.
- Should consider the benefit of an LLC specification without layer violations.
- Should consider the benefit of an LLC specification that allows LLC entities to have state, conduct processes, and to communicate among themselves.
- Should consider the benefit of a detailed LLC specification that supports 2PD and 3PD consistently, with backward compatibility.
- Should consider the benefit of UPD.
- Should consider other possible functionality that could be added to a refreshed LLC specification.
- Should consider how 802 might proceed to refresh the LLC specification (e.g., within IEEE Std 802, a new 802.2, etc.)

Background Contributions

- R. Marks, “What are EPD and LPD?”
maint-Marks-epd-lpd-0719-v02.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-hlpde-1119-copyright
- R. Marks, “New Specification of Current 802 LLC”
maint-Marks-llc-spec-copyright-0420-v04.pdf

Files available at:

<http://www.ieee802.org/1/files/public/docs2019/>