Questions about the IEEE 802 Architecture

Notice to WG Chair: This contribution is “previously published” per the IEEE SA Copyright Policy, as it incudes material previously published in IEEE Std 802, IEEE Std 802.1Q, IEEE Std 802.1AX, and IEEE Std 802.1CB.

Note: Personal views of contributor expressed herein.

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20 January 2022

What is the IEEE 802 Family?

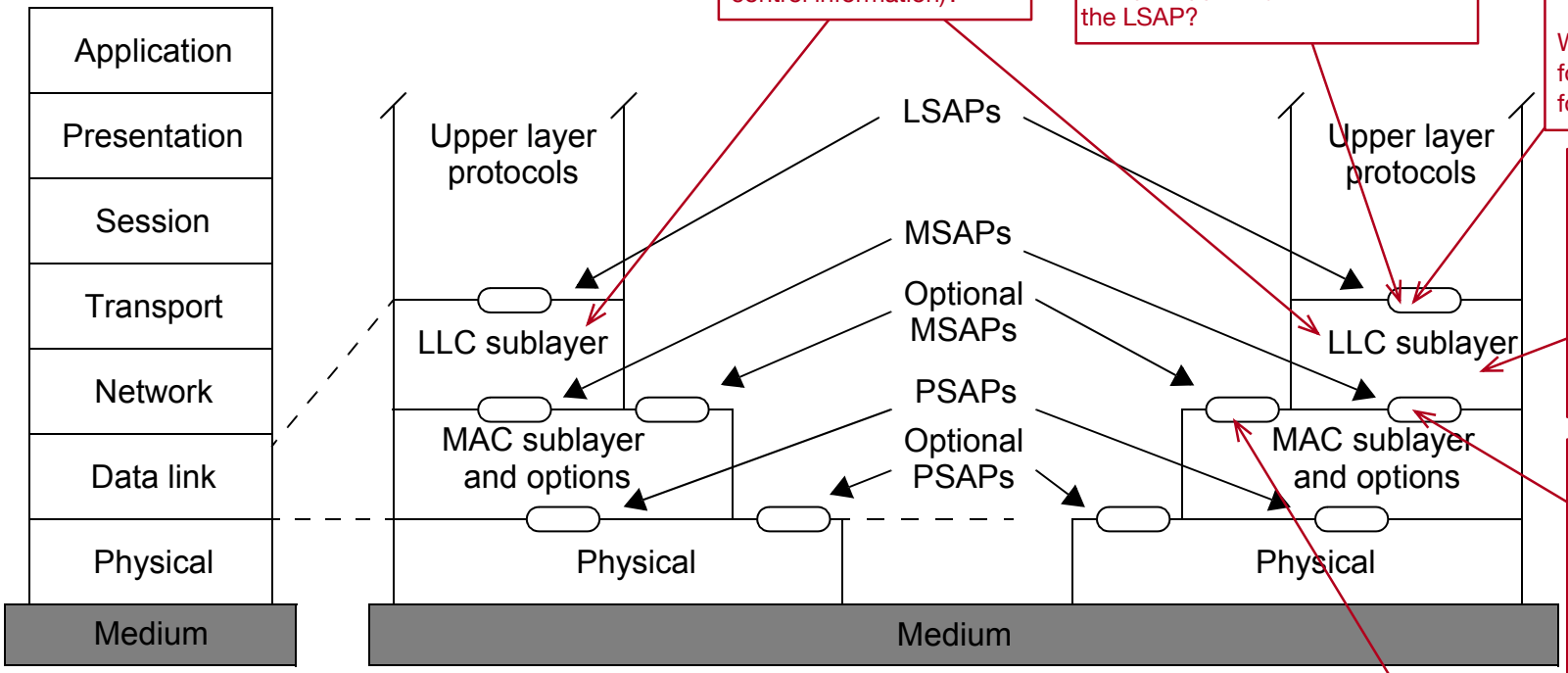
- IEEE Std 802 says:
  - *This standard serves as the foundation for the family of IEEE 802 standards published by IEEE for local area networks (LANs), metropolitan area networks (MANs), personal area networks (PANs), and regional area networks (RANs).*
  - *several types of medium access technologies are currently specified in the family of IEEE 802 standards*
- What is a "Family of Standards"?
- In what way are the standards "related":
  - The nature of the relationship is not explained or explored.
- What do IEEE 802 standards have in common?
  - They largely share addresses.
- So, is this a family, or simply a group of "roommates" with some shared addresses?

Architecture in IEEE Std 802

- IEEE Std 802 covers “Overview and Architecture”
- The Scope includes
  - “the IEEE 802 architecture is defined”
- The word “architecture” appears sparsely.
- No content purports to specify the architecture.
- The closest to a specification of the architecture is in Clause 5 (“Reference models (RMs)”), which says
  - “Figure 3 shows the architectural view of IEEE 802 RM for end stations and its relation to the OSI/RM. A variation of the model applies within bridges, as described in 5.3.2.”
- Where is the IEEE 802 architecture specified?

IEEE 802 Reference Model

MSAP MAC service access point
LSAP link service access point



Can two LLC entities communicate (e.g. share control information)?

How does the application express QoS requests?

How does LLC arbitrate when multiple upper layers have data for the LSAP?

What are the characteristics of the Link Layer service provided to the Link Layer client at the LSAP, analogous to the LLC specification in IEEE Std 802.2?

What parameters are passed?

What are the allowed frame formats? Which formats are forbidden or blocked?

What are the functions of the LLC?

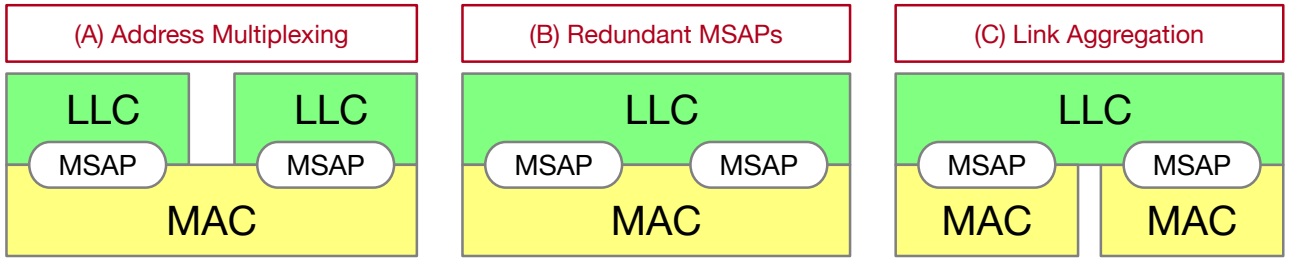
How are the parsing rules used to identify the service parameters (from LSAP and from MSAP)?

What are the allowed frame formats?

How is the MSAP characterized by MAC address; e.g., can an MSAP have multiple MAC addresses; e.g. multicast addresses).

Does the MAC handle this? Are there arbitration issues when both LLCs send data to the MAC?

Figure 3—IEEE 802 RM for end stations



Do the MSAP and Optional MSAP allow configurations (A), (B), and (C)? The figure seems to suggest (A). IEEE 802 says “MAC sublayer provides one or more MAC service access points (MSAPs) as interfaces to the LLC sublayer in an end station”; this could be (A) or (B). Is (B) allowed? Do we need (B)? Is Link Aggregation (C) within the architecture?

IEEE 802: LLC and HLPDE

IEEE Std 802 says "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… (EPD) and (LPD)."
- Does the MAC care which one is used?
- How does the recipient LLC know which one was used?
- Does the LL Client need to be able to support both, know the HLDPE method of the LLC, and format frames accordingly?
- Can each LL Client select its preferred identifier type (e.g. DSAP/SSAP, EtherType, OUI-based, etc.)?
- What does the IEEE Std 802 Introduction (which "is not part of IEEE Std 802-2014") mean by "While the protocol identification mechanism specified by ISO/IEC 8802-2 (IEEE Std 802.2™, withdrawn) is still used, its use for new standards has been deprecated." In which standard is it deprecated?
- Does the HLPDE function in the down direction as well as up?

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

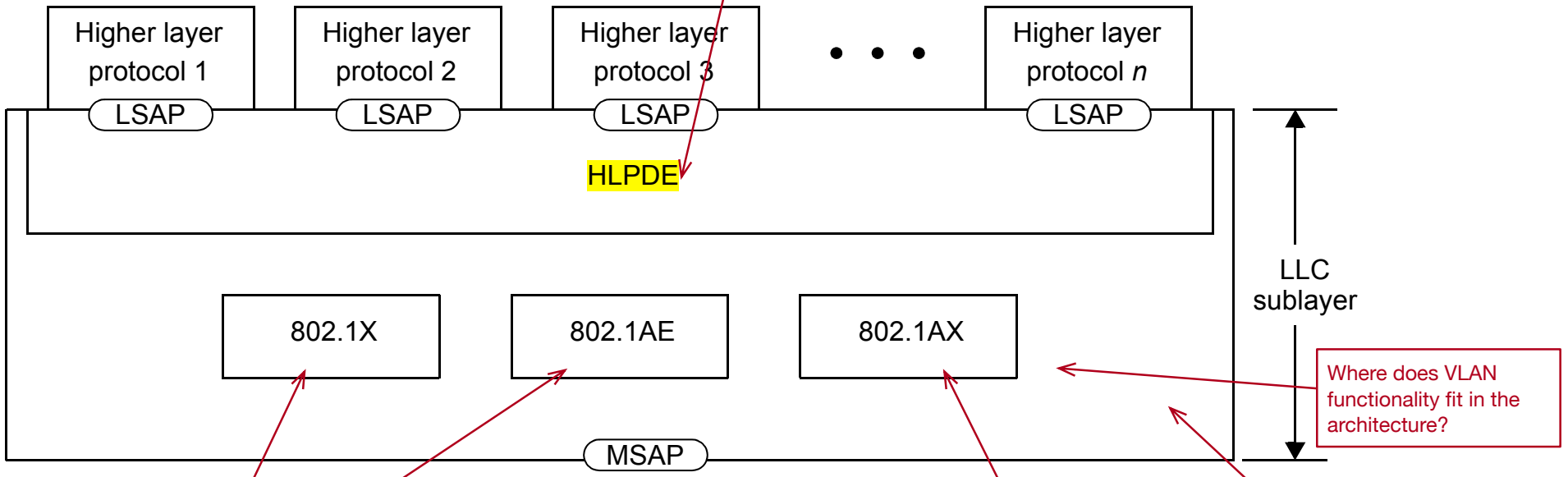


Figure 6—LLC sublayer in 802 RM

How do 802.1X Port-Based Network Access Control and 802.1AE MAC Security fit into the sublayered architecture?

How does 802.1AX Link Aggregation fit into the architecture? Does this imply multiple MSAPs (to multiple MAC entities) below an LSAP (C), even though only one is shown?

Where does VLAN functionality fit in the architecture?

What's else is missing? Other methods using end-station tags; e.g.:
- 802.1CB Redundancy-tag for Frame Replication and Elimination for Reliability (FRER)
- CN-tag for congestion notification

(C) 802.1AX Link Aggregation in the LLC

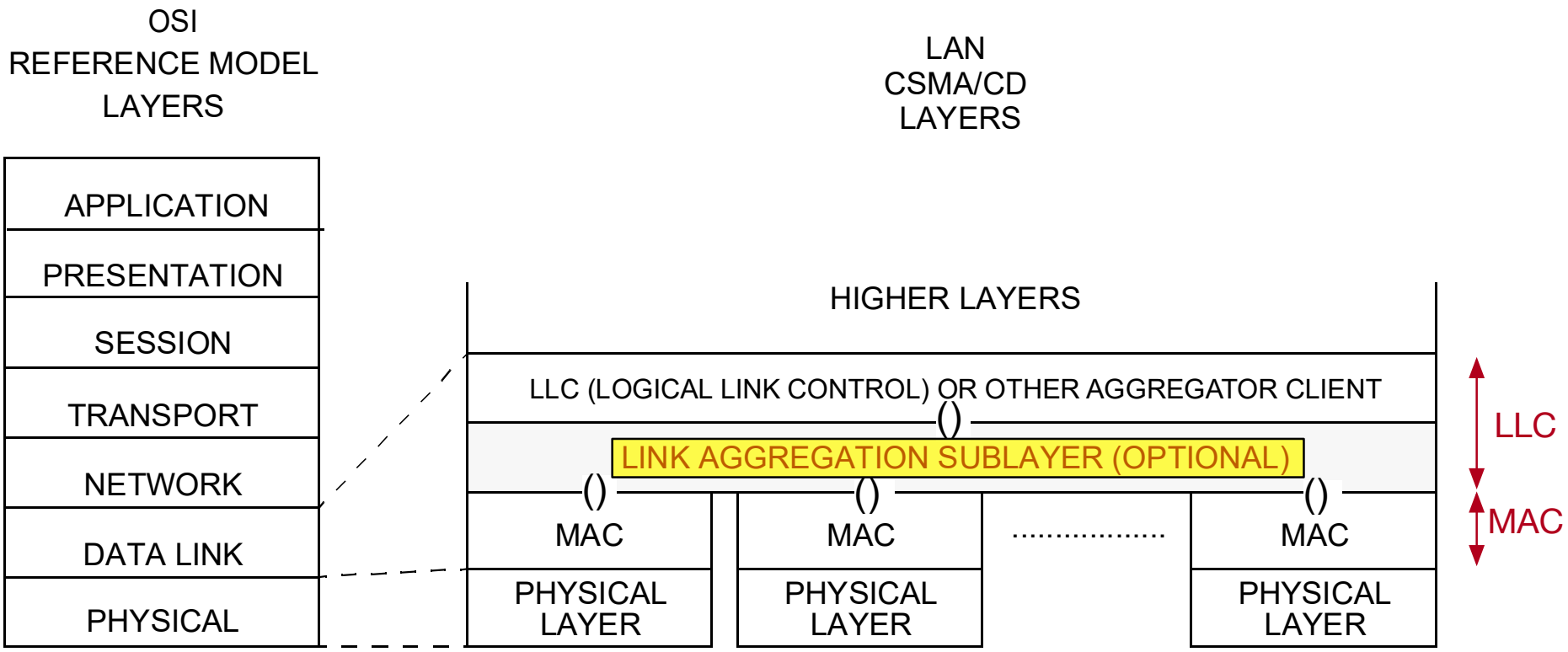


Figure 6-1—Architectural positioning of Link Aggregation sublayer

Tags and Shims

What is the role of tags and shims in the 802 architecture? They are not mentioned in IEEE Std 802.

Per 802.1Q:

- *Tag header: A header that allows priority information, and optionally, Virtual Local Area Network (VLAN) identification information, to be associated with a frame.*

- *Tagged frame: A frame that contains a tag header immediately following the Source MAC Address field of the frame.*

- *shim: A protocol entity that uses the same service as it provides.*
  NOTE—Within this standard, shims make use of the Internal Sublayer Service (ISS) or the Enhanced Internal Sublayer Service (EISS).

IEEE Std 802 need not detail bridge architecture, but some tags are used in end stations. Sometimes the architecture is unclear.

A VLAN-aware end station can use the EISS Multiplex Entity (6.17) to provide multiple SAPs, one per VID of interest, to separate MAC Clients.
-IEEE Std 802.1Q-2018

The EISS Multiplex Entity enables shims defined for the ISS to use the EISS. Figure 6-6 illustrates two EISS Multiplex Entities placed back-to-back.

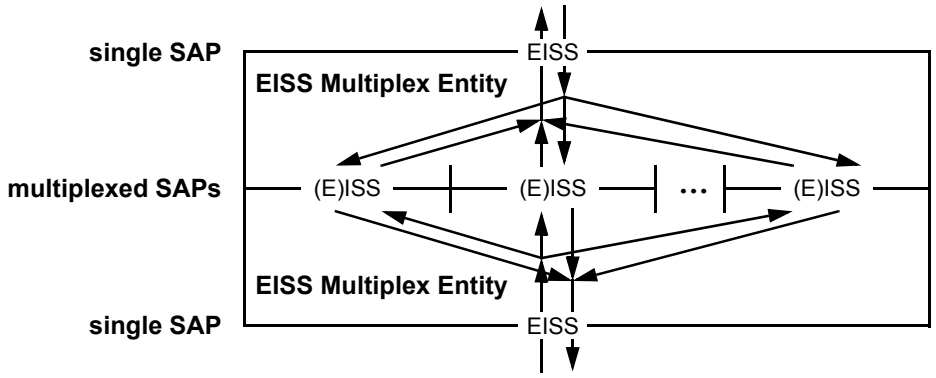


Figure 6-6—Two back-to-back EISS Multiplex Entities

Protocol stack per 802.1CB (FRER)
(Informative Annex C.1)

In the 802 architecture, everything between MAC and upper layers is LLC, so this is all within LLC.

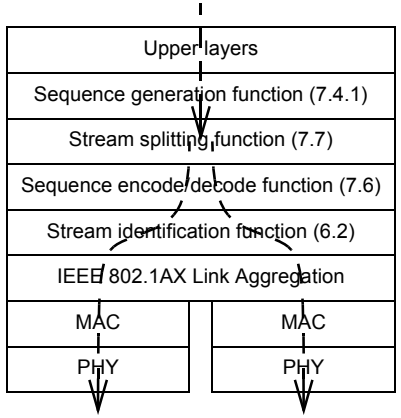


Figure C-2—Protocol stack for End System B in Figure C-1

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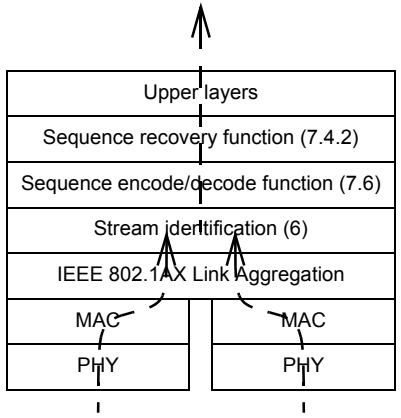
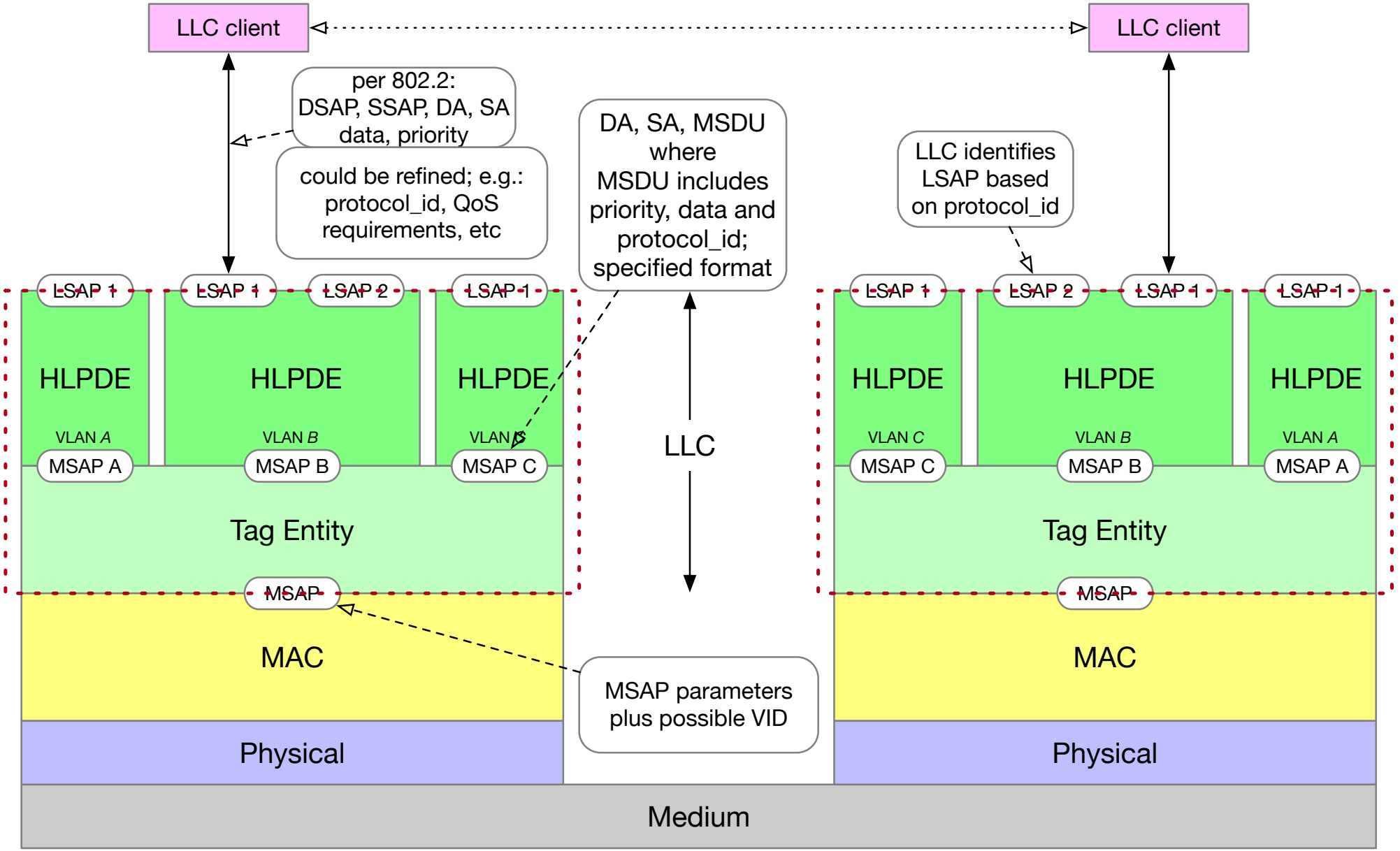


Figure C-3—Protocol stack for End System G in Figure C-1 and Figure C-4

Field	Offset	Length
Destination MAC address	**0**	**6**
Source MAC address	**6**	**6**
C-TAG EtherType	**12**	**2**
Priority, DE, VLAN ID	**14**	**2**
R-TAG EtherType	**16**	**2**
Reserved	**18**	**2**
Sequence number	**20**	**2**
Payload Length/EtherType	**22**	**2**
Data	**24**	***n***
Frame Check Sequence	**24+*n***	**4**

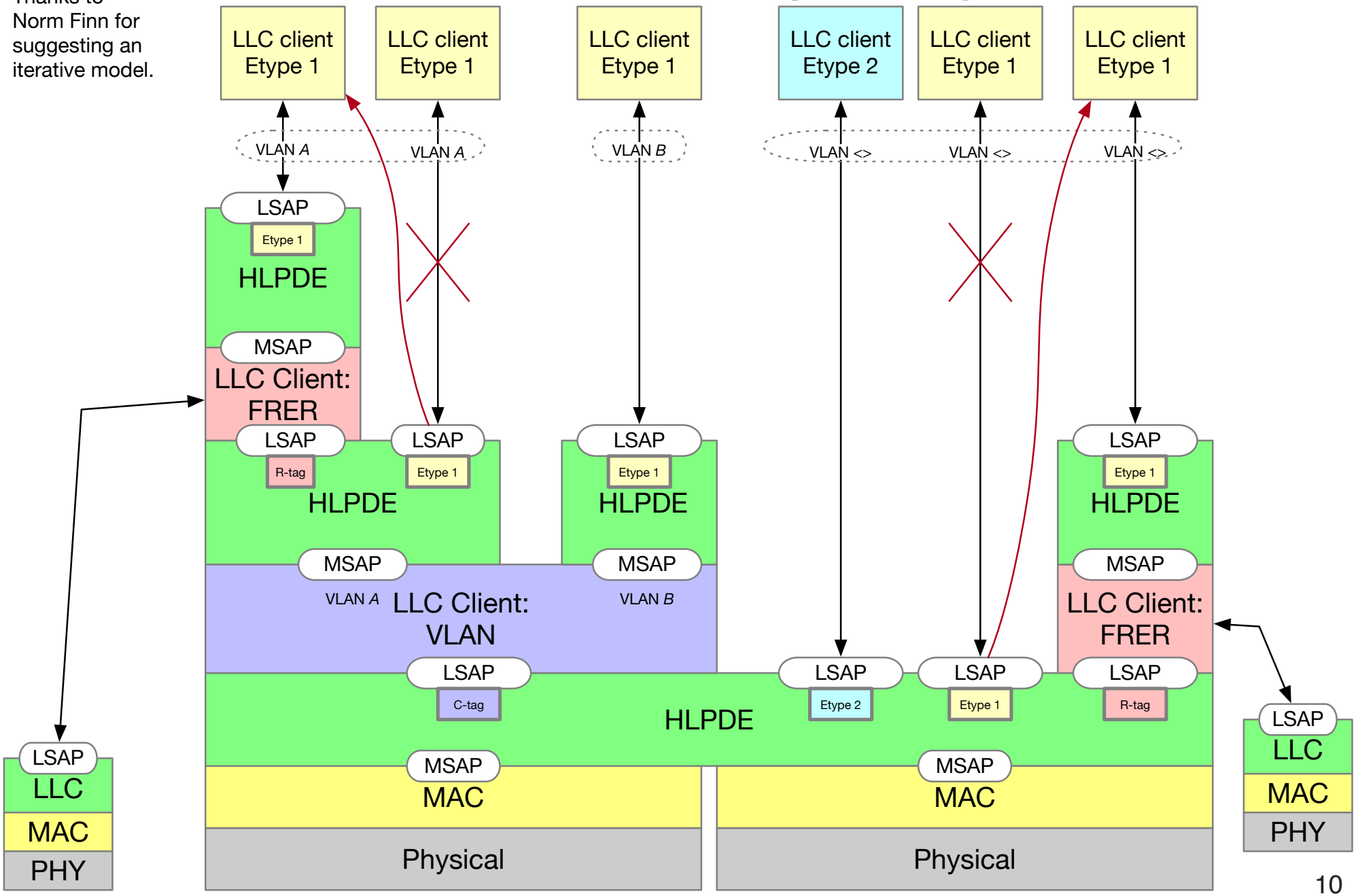
Figure 8-3—Example Ethernet frame format

Tags in the architecture

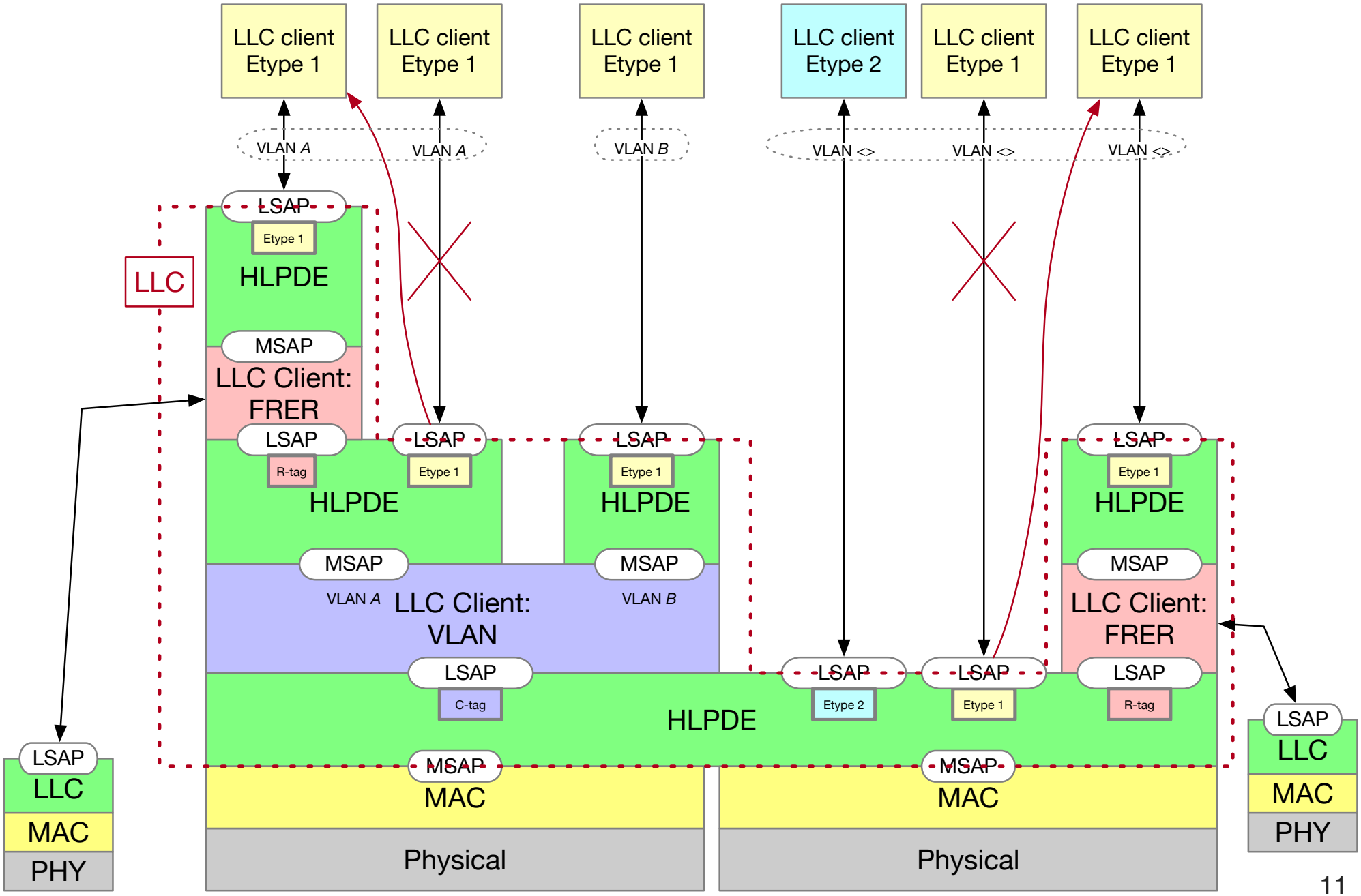


Model with multiple tags

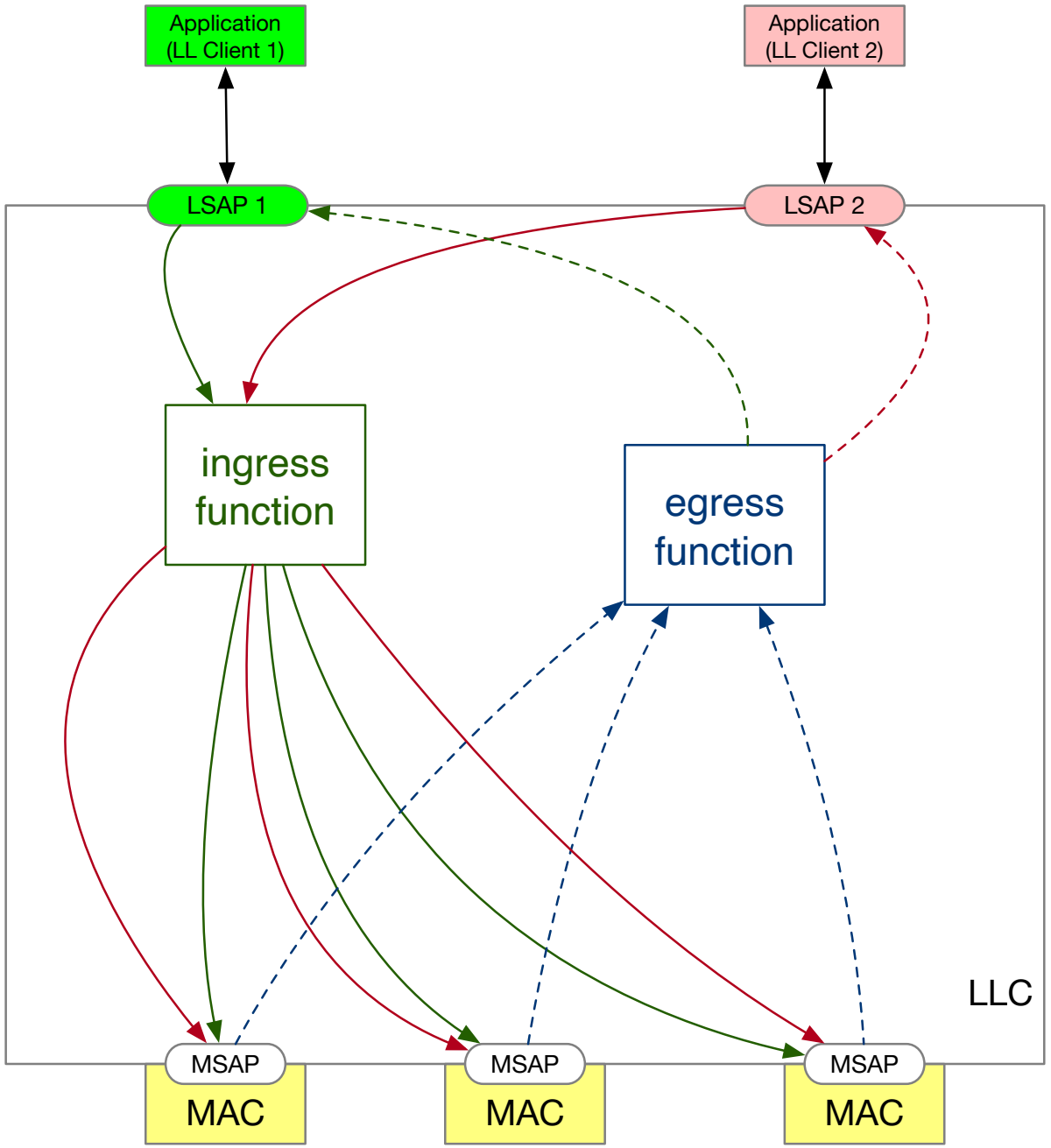
Thanks to Norm Finn for suggesting an iterative model.



LLC Model


LLC client Etype 1
LLC client Etype 1
LLC client Etype 1
LLC client Etype 2
LLC client Etype 1
LLC client Etype 1
VLAN A
VLAN A
VLAN B
VLAN <>
VLAN <>
VLAN <>
LLC
LSAP
Etype 1
HLPDE
MSAP
LLC Client: FRER
LSAP
R-tag
LSAP
Etype 1
HLPDE
LSAP
Etype 1
HLPDE
LSAP
Etype 1
HLPDE
MSAP
VLAN A
LLC Client: VLAN
MSAP
VLAN B
MSAP
LLC Client: FRER
LSAP
C-tag
LSAP
Etype 2
LSAP
Etype 1
LSAP
R-tag
HLPDE
LSAP
LLC
MAC
PHY
MSAP
MAC
MSAP
MAC
LSAP
LLC
MAC
PHY
Physical
Physical

LLC Model

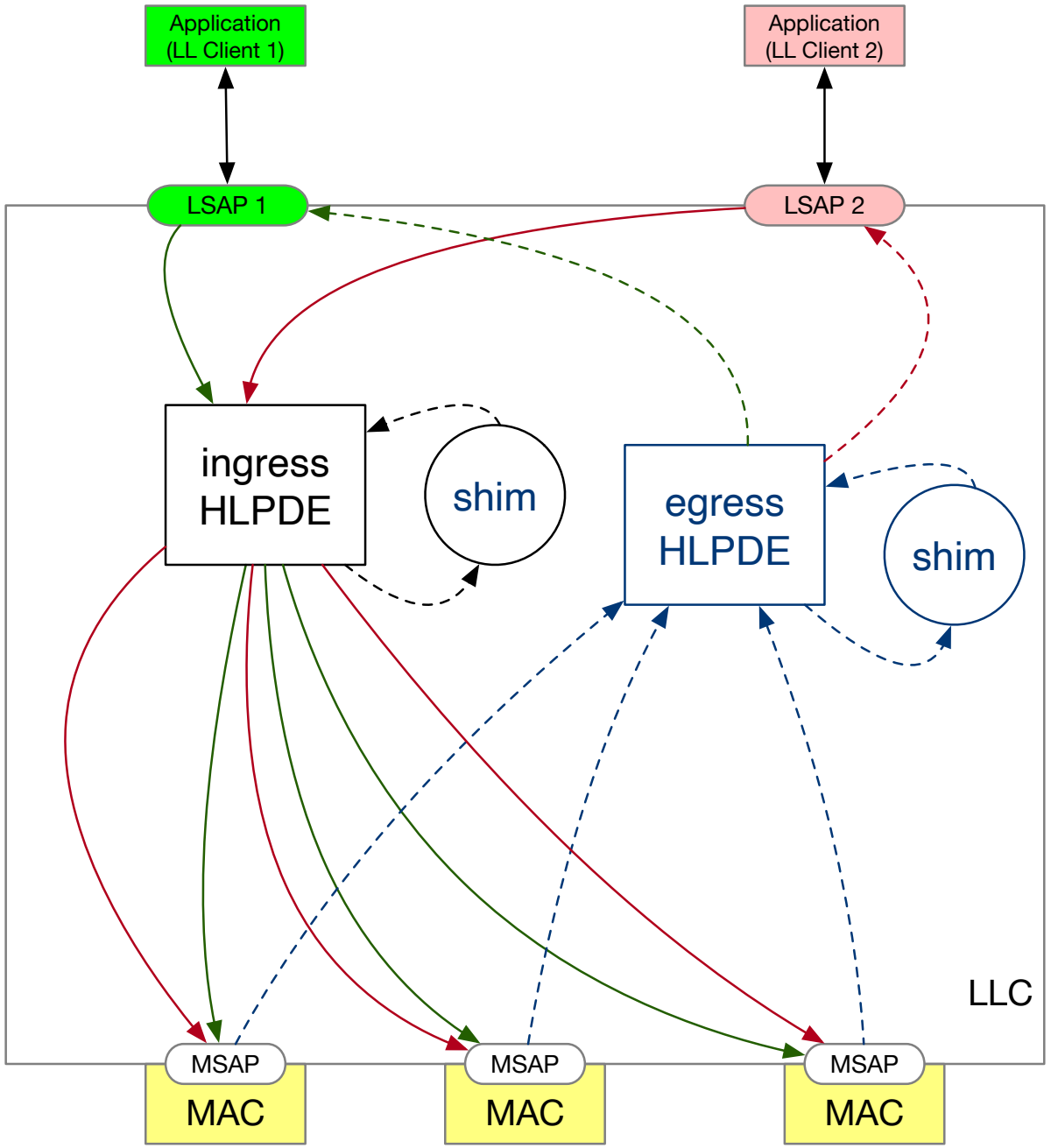


In 802.1CB FRER case, we can represent the Annex C.1 functionality within LLC.

ingress function:
- Sequence generation function
- Stream splitting function
- Sequence encode/decode function
- Stream identification
- 802.1AX Link Aggregation
- protocol ID insertion
- C-tagging
- MAC address insertion

egress function:
- MAC address filtering
- C-detagging and demultiplexing
- protocol ID demultiplexing
- 802.1AX Link Aggregation
- Stream identification
- Sequence encode/decode function
- Sequence recovery function

LLC Model showing shim iterations



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- MAC address filtering
- C-detagging and demultiplexing
- protocol ID demultiplexing
- 802.1AX Link Aggregation
- Stream identification
- Sequence encode/decode function
- Sequence recovery function

egress LLC function, first shim:
- C-tag detection
- C-detagging and demultiplexing

egress LLC function, second shim:
- R-tag detection
- R-detagging
- 802.1AX Link Aggregation
- Stream identification
  *may peek into next tag (protocol ID)
- Sequence encode/decode function
- Sequence recovery function

egress LLC function, third shim:
- protocol ID demultiplexing

Link Layer Service

- What is the Link Layer Service that IEEE 802 provides to the application at the upper layers?
- Open Systems Interconnection (OSI) specifies 7 layers.
- ITU-T X.212 (OSI "Data Link Service [DLS] Definition") describes the service provided by the DLS to the Network Layer
  - includes
    - Characterization of the service provided
    - Primitive actions and events
  - Abstract specification, but many details (body is 26 pages)
  - specifies that the DLS "transfers DLS user data transparently, without restricting or interpreting the content or format of the data."
  - Specifies that DLS user can request QoS characteristics
  - etc.
- IEEE Std 802.2 describes the LLC service
- What is IEEE 802 Link Layer Service at the LSAP?

Control and Management

- IEEE Std 802 says "IEEE 802 network management provides protocols for exchange of management information between stations. The media-independent control function (MICF) is a parallel control plane that provides control functions for different MAC and PHY sublayers."
  - MICF is specified in IEEE Std 802.21.
- Is this sufficient to describe all control in the IEEE 802 network?

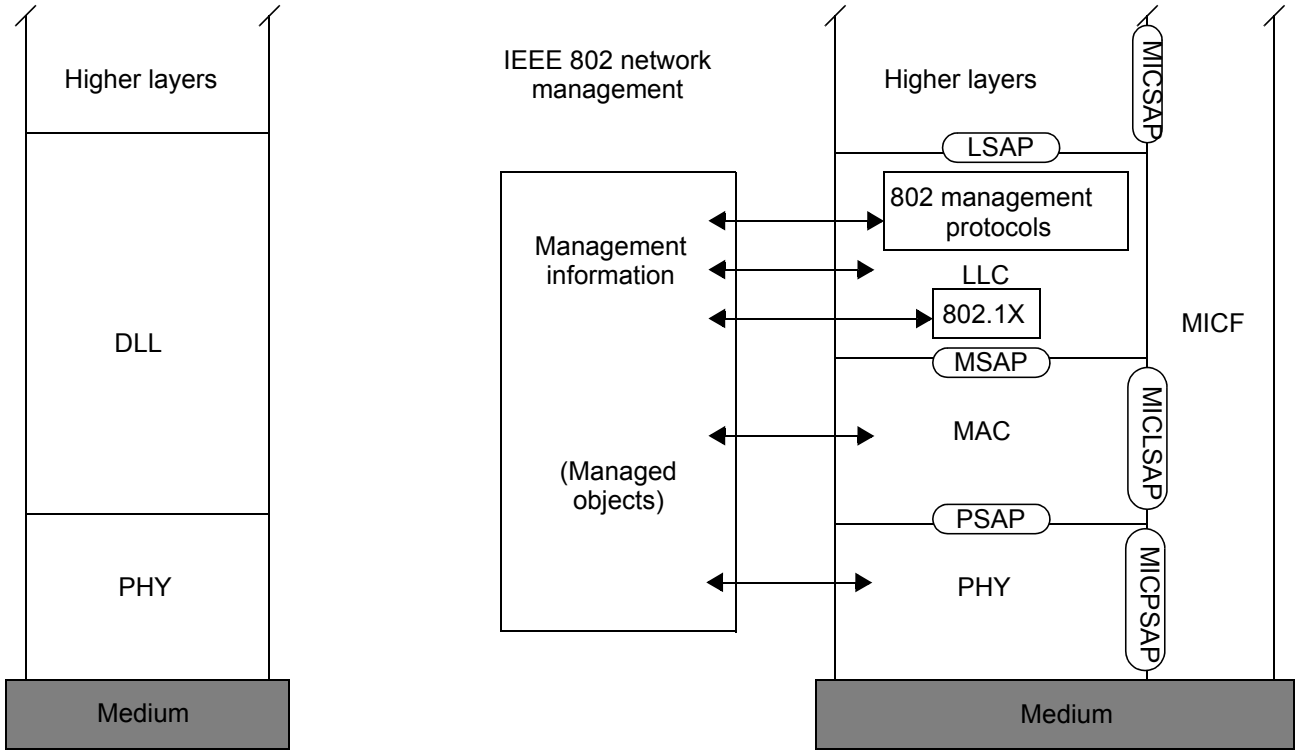

Figure 5—IEEE 802 RM with end-station management, security, and MIH

Followup Questions

- It is possible to answer the questions herein in a way that is consistent with existing IEEE 802 standards?
- Would a clarified IEEE 802 architecture and IEEE 802 Link Layer service provide an easier way for applications to make use of IEEE 802 networks, independent of the specific MAC in use?
- Would a clarified IEEE 802 architecture and IEEE 802 Link Layer service provide an easier route to improving IEEE 802 functionality and making it available to network clients?

Further information

- 802.1-21-0045-02-ICne (2021-09-23)
  - ELLA: What is the IEEE 802 Link Layer Service?
- 802.1-21-0060-04-ICne (2021-11-03)
  - ELLA: Proposed Aspects of IEEE Std 802 Revision
- 802.1-21-0073-00-ICne (2021-11-18)
  - ELLA: What's missing from the IEEE 802 Architecture?