IEEE P802.1CBdb

(individual contribution)

March 13, 2019

Draft Standard for Local and metropolitan area networks — Frame Replication and Elimination for Reliability — Amendment:

Extended Stream identification functions

Prepared by the Time-Sensitive Networking Task Group of IEEE 802.1 of the

LAN MAN Standards Committee
of the
IEEE Computer Society

IEEE Standards Activities Department

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Abstract: This standard specifies procedures, managed objects and protocols for bridges and end systems that provide identification and replication of packets for redundant transmission, identification of duplicate packets, and elimination of duplicate packets. It is not concerned with the creation of the multiple paths over which the duplicates are transmitted.
Keywords: TSN, Time-Sensitive Networking, Redundancy, Bridging, Bridges, Frame Replication, Frame Elimination, Bridged Local Area Networks, IEEE 802®, IEEE 802.1Q™, IEEE 802.1CB™, local area networks (LANs), MAC Bridges, Virtual Bridged Local Area Networks (virtual LANs).

Editor's Foreword

<<Notes>>

<<Throughout this document, all notes such as this one, presented between angle braces, are temporary notes inserted by the Editors for a variety of purposes; these notes and the Editors' Foreword will all be removed prior to publication and are not part of the normative text.>>

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Comments on this document may be sent to the 802.1 email exploder, to the editors, or to the Chairs of the 802.1 Working Group and Time-Sensitive Networking Task Group.

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<<The draft text and accompanying information

This document currently comprises:

— A title page for the proposed standard including an Abstract and Keywords. This title page will be retained following working group approval of this draft, i.e. prior to sponsor ballot.

— The editors' forewords, including this text. These include an unofficial and informal appraisal of history and status, introductory notes to each draft that summarize the progress and focus of each successive draft, and requests for comments and contributions on major issues.
— IEEE boilerplate text.
— A record of participants (not included in early drafts but added prior to publication).
— The introduction to this standard.
— The proposed standard proper.
— An Annex Z comprising the editors' discussion of issues. This annex will be deleted from the document prior to sponsor ballot.

During the early stages of draft development, 802.1 editors have a responsibility to attempt to craft technically coherent drafts from the resolutions of ballot comments and the other discussions that take place in the working group meetings. Preparation of drafts often exposes inconsistencies in editors instructions or exposes the need to make choices between approaches that were not fully apparent in the meeting. Choices and requests by the editors' for contributions on specific issues will be found in the editors' introductory notes to the current draft, at appropriate points in the draft, and in Annex Z. Significant discussion of more difficult topics will be found in the last of these.

The ballot comments received on each draft, and the editors' proposed and final disposition of comments, are part of the audit trail of the development of the standard and are available, along with all the revisions of the draft on the 802.1 web site (for address see above).

>>

<< **Introductory notes to P802.1CBdb**

This contribution was prepared as an individual contribution for TG discussion.

>>

<< Project Authorization Request, Scope, Purpose, and Five Criteria

A PAR (Project Authorization Request) for P802.1CBdb was approved by the IEEE Standards Association on May 14, 2018. The following information is taken from the 802.1CBdb PAR and CSD.

Scope of Proposed Project:

This amendment specifies procedures and managed objects that add new stream identification functions. Additionally this amendment addresses errors and clarifications.

Purpose of Proposed Project:

This document will not include a purpose clause.

Need for the Proposed Project:

Stream identification is required by an increasing number of traffic management mechanisms implemented in Layer 2: ingress policing, traffic scheduling, congestion management, mapping to traffic classes, that make Ethernet networks suitable for a growing number of applications. Current stream identification methods defined in IEEE Std 802.1CB are insufficient for some of these applications.

1. Broad Market Potential

A standards project authorized by IEEE 802 shall have a broad market potential. Specifically, it shall have the potential for:

a) Broad sets of applicability.

The extension of the stream identification capability to new mechanisms will allow more customer applications to use the existing QoS mechanisms, defined by 802.1Q and 802.1CB, such as scheduling, policing, congestion management and redundancy. These customer applications include data-center networks and more general application domains where handling of the data communications is based on information available in the upper layers of the protocol stacks.

b) Multiple vendors and numerous users

Network equipment and integrated circuit vendors for Industrial Automation, In-vehicle networking, Professional Audio-Video (AV), Data Center and other systems requiring application-based traffic classification will participate in the development of the project.

2. Compatibility

IEEE 802 defines a family of standards. All standards shall be in conformance with the IEEE 802.1 Architecture, Management and Interworking standards as follows: 802 Overview and Architecture, 802.1D, 802.1Q and parts of 802.1f. If any variances in conformance emerge, they shall be thoroughly disclosed and reviewed with 802.

a) This is an amendment to IEEE Std 802.1CB and will conform to IEEE Std 802, IEEE Std 802.1AC, and the existing provisions of IEEE 802.1Q.

Each standard in the IEEE 802 family of standards shall include a definition of managed objects which are compatible with systems management standards.

3. Distinct Identity

Each proposed IEEE 802 LMSC standard shall provide evidence of a distinct identity. Identify standards and standards projects with similar scopes and for each one describe why the proposed project is substantially different.

This project enhances IEEE Std 802.1CB to meet expressed user needs; it does not duplicate existing capabilities. There is no other IEEE 802 standard or approved project that overlaps with the scope of this project.

4. Technical Feasibility

Each proposed IEEE 802 LMSC standard shall provide evidence that the project is technically feasible within the time frame of the project. At a minimum, address the following items to demonstrate technical feasibility:

a) Demonstrated system feasibility.

The proposed amendment incorporates techniques for stream identification that are currently available in many Ethernet bridges.

b) Proven similar technology via testing, modeling, simulation, etc.

This standard is based on mature virtual LAN bridging and identifies streams by using techniques similar to the existing IETF flow classification.

5. Economic Feasibility

Each proposed IEEE 802 LMSC standard shall provide evidence of economic feasibility. Demonstrate, as far as can reasonably be estimated, the economic feasibility of the proposed project for its intended applications. Among the areas that may be addressed in the cost for performance analysis are the following:

a) Balanced costs (infrastructure versus attached stations).
The proposed amendment does not significantly change the cost characteristics of bridges and end stations. The amendment would add a contained incremental cost to bridges and end stations.
b) Known cost factors.
By extending the stream identification functions with flexible, future-proof identification mechanisms, the same Ethernet bridges can be used in a wider range of application domains, leading to equipment cost reduction.
c) Consideration of installation costs.
The installation cost of enhanced VLAN bridges and end stations is expected to be similar to existing implementations.
d) Consideration of operational costs (e.g., energy consumption).
The proposed amendment incorporates existing technologies and as a consequence is not expected to significantly affect the operational cost of the targeted application networks.

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Contents

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Name, *Past Chair*

Introduction to IEEE P802.1CBdb™

This introduction is not part of IEEE Project 802.1CBdb, IEEE Standards for Local and Metropolitan Area Networks—Extended Stream identification functions

This Standard defines Extended Stream identification functions.

This standard contains state-of-the-art material. The area covered by this standard is undergoing evolution. Revisions are anticipated within the next few years to clarify existing material, to correct possible errors, and to incorporate new related material. Information on the current revision state of this and other IEEE 802 standards can be obtained from

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IEEE Draft Standard for Local and metropolitan area networks — Frame Replication and Elimination for Reliability — Amendment: Extended Stream Identification Functions

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1. Overview

1.1 Scope

This amendment specifies procedures and managed objects that add new stream identification functions. Additionally this amendment addresses errors and clarifications.

1.2 Rationale

Stream identification is required by an increasing number of traffic management mechanisms implemented in Layer 2: ingress policing, traffic scheduling, congestion management, mapping to traffic classes, that make Ethernet networks suitable for a growing number of applications. Current stream identification methods defined in IEEE Std 802.1CB are insufficient for some of these applications.

1.6 Introduction

This amendment defines an additional passive stream identification function, which input parameters are not limited to the addressing parameters provided by the EISS indication primitive (destination_address, source_address and vlan_identifier) and, or, to some specific upper layer protocol (e.g. IP) information. The Extended Stream identification function is based on a mask-and-match scheme, where a set of masks is first applied to a subset of the parameters passed by the EISS primitive: destination_address, source_address, vlan_identifier and mac_service_data_unit. The resulting masked information fields are then compared against a set of values, one for each mask, that identify a particular Stream. Masks and match values are defined by managed objects.

<< Editor’s Note: TBC >>

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies. Non-normative references (i.e., that provide additional information not required for the application of this document) are given in Annex D.

IEEE Std 802®, IEEE Standard for Local and metropolitan area networks: Overview and Architecture.[1, 2]

IEEE Std 802.1AC™, IEEE Standard for Local and metropolitan area networks—Media Access Control (MAC) Service Definition.

IEEE Std 802.1Q™, IEEE Standard for Local and metropolitan area networks—Bridges and Bridged Networks.

<< Editor's Note: other normative references will be added, as appropriate >>

[1]The IEEE standards or products referred to in Clause 2 are trademarks owned by The Institute of Electrical and Electronics Engineers, Incorporated.

[2]IEEE publications are available from The Institute of Electrical and Electronics Engineers (http://standards.ieee.org).

3. Definitions

<< Editor’s Note: Definitions will be added, as appropriate >>

Mask: aaabbb

4. Acronyms and abbreviations

<< Editor’s Note: to be added to the existing list >>

XXX Text

YYYY Text

5. Conformance

This clause specifies the mandatory and optional capabilities provided by conformant implementations of this standard.

5.5 Stream identification component optional behaviors

Insert new item d) as shown and re-number subsequent items:

a) The items in 5.3 and 5.4 on more than one port;
b) The items in 5.3 and 5.4 for some number of Compound Streams greater than 1;
c) An IP Stream identification function (6.7); ~~and/or~~
d) An Extended Stream identification function (crossref); and/or
e) Additional types of Stream identification functions.

5.8 Talker end system optional behaviors

Insert new item d) as shown and re-number subsequent items:

a) The items in 5.8 and 5.7 on more than one port;
b) The items in 5.8 and 5.7 for some number of Compound Streams greater than 1;
c) An IP Stream identification function (6.7);
d) An Extended Stream identification function (crossref);
e) Additional types of Stream identification functions;
f) The HSR sequence tag (7.9);
g) The PRP sequence trailer (7.10); and/or
h) Additional types of Sequence encode/decode functions.

5.11 Listener end system optional behaviors

Insert new item d) as shown and re-number subsequent items:

a) The items in 5.11 and 5.10 on more than one port;
b) The items in 5.11 and 5.10 for some number of Compound Streams greater than 1;
c) An IP Stream identification function (6.7);
d) An Extended Stream identification function (crossref);
e) Additional types of Stream identification functions;
f) The HSR sequence tag (7.9);
g) The PRP sequence trailer (7.10);
h) Additional types of Sequence encode/decode functions; and/or
i) At least two instances of Individual recovery functions (7.5), each using the VectorRecoveryAlgorithm (7.4.3.4).

5.13 Relay system recommended behaviors

Insert new item c) as shown:

a) Active Destination MAC and VLAN Stream identification functions (6.6) for encoding and decoding packets; and
b) IP Stream identification functions (6.7); or

c) Extended Stream identification function (crossref) for identifying packets.

NOTE—IP Stream identification enables a relay system to proxy for a FRER-unaware end system.

6. Stream identification

Change the text of the first paragraph as shown:

Clause 7 of IEEE Std 802.1AC describes the IEEE 802.1 layering model, that Frame Replication and Elimination for Reliability (FRER) follows. Stream identification utilizes a single Service Access Point (SAP) to a connectionless packet service offered by the layer below it [e.g., the Intermediate Sublayer Service (ISS) of Clause 11 of IEEE Std 802.1AC, or the Enhanced Internal Sublayer Service (EISS) of Clause 6.8 of IEEE Std], and offers an array of SAPs to the layers above it, corresponding to different Streams. The Stream identification model is illustrated in Figure 6-1.

Change the text of the note as shown:

NOTE—In principle, any number of different methods for identifying and encoding Streams can be defined. Several required methods are specified in the following subclauses (6.4, 6.5, 6.6, 6.9, crossref).

Change the text of item c) and Table 6-1 as shown:

c) ~~Four~~Five specific IP Stream identifications are described: Null Stream identification (6.4), Source MAC and VLAN Stream identification (6.5), Active Destination MAC and VLAN Stream identification (6.6), ~~and~~ IP Stream identification (6.9), and Extended Stream identification (crossref).

.

Table 6-1—IP Stream identifications

IP Stream identification	Active/passive	Examines	Overwrites	Reference
Null Stream identification	Passive	destination_address, vlan_identifier	None	6.4, 9.1.2
Source MAC and VLAN Stream identification	Passive	source_address, vlan_identifier	None	6.5, 9.1.6
Active Destination MAC and VLAN Stream identification	Active	destination_address, vlan_identifier	destination_address, vlan_identifier, priority	6.6, 9.1.4
IP Stream identification	Passive	destination_address, vlan_identifier, IP source address, IP destination address, DSCP, IP next protocol, source port, destination port	None	6.9, 9.1.5
Extended Stream identification function	Passive	destination_address, source_address, vlan_identifier, mac_service_data_unit	None	6.8, 9.1.6

<< Editor's Note: cross-references to be updated >>

6.1 Stream service subparameters

Change the text of the first paragraph as shown:

The ISS defined in IEEE Std 802.1AC and the EISS defined in IEEE Std 802.1Q include~~s~~ a connection_identifier parameter that is of local significance (to a system) only. The parameter is not carried across the underlying service. Stream identification makes use of this parameter to carry parametrized information. Stream identification has need for more than one subparameter, but an implementor can create mathematical algorithms to combine those subparameters (and/or other subparameters for other layers) into a single connection_identifier parameter, especially since the connection_identifier's values are undefined outside the system implementing them. In this document, parameters that are assumed to be encoded in the connection_identifier are deemed *subparameters*.

Insert new clause 6.8 as shown:

6.8 Extended Stream identification

The Extended Stream identification is a passive Stream identification that operates at the frame level. It can be defined using the Enhanced Internal Sublayer Service (EISS) described in 6.9 of IEEE Std 802.1Q-2018, in which case it is enhanced with the extra stream_handle subparameter of the connection_identifier, specified in 6.1 of the present standard.

It discards the stream_handle subparameter passed down the stack. It generates a stream_handle subparameter on frames passed up the stack based on information fields extracted from the frame's destination MAC address, source MAC address, VLAN ID and MAC service data unit. It does not change any of a packet's parameters. It is suitable for applications in which Streams are defined by a set of parameters derived from those provided through the EISS SAP. This parameter set includes a bit field of the destination MAC address, a bit field of the source MAC address, a bit field of the VLAN identifier and a set of bit fields of the MAC service data unit. In order to instantiate the Extended Stream identification function, the tsnStreamIdIdentificationType managed object (9.1.1.6) is encoded using the OUI (00-80-C2) and the type values as shown in Table 9-1.

Extended Stream identification can be coupled, for example, with Active Destination MAC and VLAN Stream identification (6.6) to assign a particular {MAC address, VLAN, priority} triplet to packets belonging to a particular unicast application Stream identified by the combination of the values of particular fields in the MAC service data unit, as shown in Figure 8-1, Port A, where Extended Stream identification would be in the box labeled "Passive Upper Extended Stream identification (6.8)." The managed objects for Extended Stream identification are described in (crossref 9.1.6).

NOTE—The drop_eligible parameter is also present, along with the VLAN identifier and priority, in an IEEE 802.1Q VLAN tag. FRER does not affect the use of this parameter. It passes through Extended Stream identification unchanged, and defaults to False when not present.

8. Frame Replication and Elimination for Reliability in Bridges

Change paragraph of clause 8.2 as shown:

8.2 FRER C-component input transformations

The Input transformations, marked with white boxed with boldface type in Figure 8-1, enable a Bridge to proxy for a non-FRER-capable end system. The expanded input port identifies packets belonging to a Stream (e.g., using IP Stream identification, 6.7, or Extended Stream identification, crossref 6.8), serializes the packets with a Sequence generation function (7.4.1), encodes the sequence number with an R-TAG (7.8), and then gives the packets belonging to this Stream a {vlan_identifier, destination_mac_address} pair that is unique, at least inside this Bridge, using Active Destination MAC and VLAN Stream identification (6.6). The IEEE 802.1Q Forwarding Process, enhanced with the Individual recovery function (7.5) and Sequence recovery function (7.4.2), then forwards the frame.

9. Stream Identification Management

9.1 Stream identity table

9.1.1 tsnStreamIdEntry

Insert new row in Table 9-1 as shown:

Table 9-1—Stream identification types

OUI/CID	Type number	Stream identification function	Controlling parameters
00-80-C2	0	Reserved	—
00-80-C2	1	Null Stream identification (6.4)	9.1.2
00-80-C2	2	Source MAC and VLAN Stream identification (6.5)	9.1.6
00-80-C2	3	Active Destination MAC and VLAN Stream identification (6.6)	9.1.4
00-80-C2	4	IP Stream identification (6.7)	9.1.5
00-80-C2	5	Extended Stream identification (crossref 6.8)	(crossref 9.1.6)
00-80-C2	5−255	Reserved	—
other	—	Defined by entity owning the OUI or CID	—

Insert Clause 9.1.6 as shown:

9.1.6 Managed objects for Extended Stream identification

When instantiating an instance of the Extended Stream identification function (crossref 6.8) for a particular input Stream, the managed objects in the following subclauses serve as the tsnStreamIdParameters managed object (9.1.1.2).

9.1.6.1 tsnCpeEsIdDestMacMask

Specifies a 48-bit mask including N consecutive bits set to 1 and the remaining 48-N bits set to 0, to be applied to the destination_address parameter passed by the EISS indication primitive to the Extended Stream identification function. The resulting N-bit information is the masked destination_address that is used as input for the Extended Stream identification function. If N=0, i.e. tsnCpeEsIdDestMacMask has a value of 0, the destination_address parameter is ignored.

9.1.6.2 tsnCpeEsIdDestMacMatch

Specifies the N-bit value of the masked destination_address, as defined in (crossref 9.1.6.1), that participates to the Stream identification by the Extended Stream function.

9.1.6.3 tsnCpeEsIdSrcMacMask

Specifies a 48-bit mask including N consecutive bits set to 1 and the remaining 48-N bits set to 0, to be applied to the source_address parameter passed by the EISS indication primitive to the Extended Stream identification function. The resulting N-bit information is the masked source_address that is used as input for the Extended Stream identification function. If N=0, i.e. tsnCpeEsIdSrcMacMask has a value of 0, the source_address parameter is ignored.

9.1.6.4 tsnCpeEsIdSrcMacMatch

Specifies the N-bit value of the masked source_address, as defined in (crossref 9.1.6.3), that participates to the Stream identification by the Extended Stream function.

9.1.6.5 tsnCpeEsIdTagged

An enumerated value indicating whether a packet in an EISS indication primitive to the Extended Stream identification function is permitted to have a VLAN tag. It can take the following values:

1) **tagged:** A frame must have a VLAN tag to be recognized as belonging to the Stream.
2) **priority:** A frame must be untagged, or have a VLAN tag with a VLAN ID = 0 to be recognized as belonging to the Stream.
3) **all:** A frame is recognized as belonging to the Stream whether tagged or not.

<< Editor's Note: this object provides a work-around to determine if a frame is VLAN-tagged. >>

9.1.6.6 tsnCpeEsIdVlanIdMask

Specifies a 12-bit mask including N consecutive bits set to 1 and the remaining 12-N bits set to 0, to be applied to the vlan_identifer parameter passed by the EISS indication primitive to the Extended Stream identification function. The resulting N-bit information is the masked vlan_identifier that is used as input for the Extended Stream identification function. If N=0, i.e. tsnCpeEsIdVlanIdMask has a value of 0, the vlan_identifier parameter is ignored.

9.1.6.7 tsnCpeEsIdVlanIdMatch

Specifies the N-bit value of the masked vlan_identifier, as defined in (crossref 9.1.6.6), that participates to the Stream identification by the Extended Stream function.

9.1.6.8 tsnCpeEsIdMsduFieldNb

Specifies the number of bit fields in the mac_service_data_unit parameter of the EISS indication primitive to the Extended Stream identification function to be used to identify the Stream. A value of 0 indicates that the mac_service_data_unit parameter is not used by the Extended Stream identification function. tsnCpeEsIdMsduFieldNb has a maximum value of XXX. If tsnCpeEsIdMsduFieldNb has a value N greater than 0, then N bit fields shall be defined using N mask definitions (tsnCpeEsIdMsduField1, ..., tsnCpeEsIdMsduFieldN (crossref 9.1.6.0)), and N matching values shall be defined by tsnCpeEsIdMsduFieldValue1, ..., tsnCpeEsIdMsduFieldValueN (crossref 9.1.6.10)

<< Editor's Note: XXX to be fixed. >>

9.1.6.9 tsnCpeEsIdMsduFieldN

Specifies a series of consecutive bits of the mac_service_data_unit parameter passed by the EISS indication primitive to the Extended Stream identification function. tsnCpeEsIdMsduFieldN is defined using two other objects indicating the location (tsnCpeEsIdMsduFieldOffsetN, (crossref 9.1.6.9.1)) and length (tsnCpeEsIdMsduFieldLengthN, (crossref 9.1.6.9.2) of the bit field.

9.1.6.9.1 tsnCpeEsIdMsduFieldOffsetN

Specifies the offset, expressed in bits, in the mac_service_data_unit parameter, of the first bit of tsnCpeEsIdMsduFieldN. A value of i indicates that the first bit of tsnCpeEsIdMsduFieldN is the $(i+1)^{th}$ bit of the mac_service_data_unit parameter. tsnCpeEsIdMsduFieldOffsetN has a value comprised between 0 and XXX.

<< Editor’s Note: XXX has to be fixed >>

9.1.6.9.2 tsnCpeEsIdMsduFieldLengthN

Specifies the length, expressed in bits, of tsnCpeEsIdMsduFieldN. tsnCpeEsIdMsduFieldLengthN has a value comprised between 1 and XXX.

<< Editor’s Note: XXX has to be fixed >>

9.1.6.10 tsnCpeEsIdMsduFieldValueN

Specifies the value of tsnCpeEsIdMsduFieldN, as defined in (crossref 9.1.6.9), that participates to the Stream identification by the Extended Stream function.

Annex A

(normative)

Protocol Implementation Conformance Statement (PICS) proforma

A.2 PICS proforma for Frame Replication and Elimination for Reliability

A.2.2 Stream identification component

Insert item IS5 and re-number subsequent entries in Table as shown:

Item	Feature	Subclause	Value/Comment	Status	Support
IS1	Can the system identify frames using the Null Stream identification function?	5.3:b, 6.4		IS: M	Yes [ ]
IS2	Does the system implement the required managed objects of Clause 9?	5.3:c, 9		IS: M	Yes [ ]
IS3	Can the system encode frames using the Active Destination MAC and VLAN Stream identification?	5.4:a, 6.6		IS: O	Yes [ ] No [ ] —[1]
IS4	Can the system identify packets using the IP Stream identification?	5.5:c, 6.7		IS: O	Yes [ ] No [ ]
IS5	Can the system identify packets using the Extended Stream identification [crossref]?	5.5:d, 6.8		IS: O	Yes [ ] No [ ]
IS6	For what additional Stream decodings can the system be configured?	5.5:e		IS: O	—
IS7	Explain the limits on which ports the above features can be configured.	5.5:a		IS: O	—
IS8	Explain the limits on the number of Streams for which the above features can be configured.	5.5:b		IS: O	—

[1]If “No,” supply a reason why.

A.2.3 Talker end system

Insert item TE16 and re-number subsequent entries in Table as shown:

Item	Feature	Subclause	Value/Comment	Status	Support
TE9	Can the system identify frames using the Null Stream identification function?	5.6:b, 6.4		TE: M	Yes [ ]
TE10	Can the system be configured with a Sequence generation function?	5.6:c, 7.4.1		TE: M	Yes [ ]
TE11	Can the system be configured with a Sequence encode/decode function?	5.6:d, 7.8		TE: M	Yes [ ]
TE12	Does the system implement the managed objects of Clause 9 and Clause 10 (10.7 not required)?	5.6:e, 9, 10		TE: M	Yes [ ]
TE13	Can the system encode frames using the Active Destination MAC and VLAN Stream identification?	5.7:a, 6.6		TE: O	Yes [ ] No [ ] ___[1]
TE14	Can the system be configured with a Stream splitting function?	5.7:b, 7.7		TE: M	Yes [ ] No [ ] ___[a]
TE15	Can the system identify packets using the IP Stream identification?	5.8:c, 6.7		TE: O	Yes [ ] No [ ]
TE16	Can the system identify packets using the Extended Stream identification [crossref]?	5.8:d, 6.8		TE: O	Yes [ ] No [ ]
TE17	For what additional Stream decodings can the system be configured?	5.8:e		TE: O	—
TE18	Can the system encode frames using HSR sequence tag?	5.8:f, 7.9		TE: O	Yes [ ] No [ ]
TE19	Can the system encode frames using PRP sequence trailer?	5.8:g, 7.10		TE: O	Yes [ ] No [ ]
TE20	For what additional Sequence encode/decode functions can the system be configured?	5.8:h		TE: O	—
TE21	Explain the limits on which ports the above features can be configured.	5.8:a		TE: O	—
TE22	Explain the limits on the number of Streams for which the above features can be configured.	5.8:b		TE: O	—

[1]If “No,” supply a reason why.

A.2.4 Listener end system

Insert item LE11 and re-number subsequent entries in Table as shown:

Item	Feature	Subclause	Value/Comment	Status	Support
LE1	Can the system identify frames using the Null Stream identification?	5.9:b, 6.4		LE: M	Yes [ ]
LE2	Can the system be configured with at least two Individual recovery functions?	5.9:c, 7.5		LE: M	Yes [ ]
LE3	Can the system be configured with at least one Sequence recovery function using the MatchRecoveryAlgorithm?	5.9:c, 7.4.2, 7.4.3.5		LE: M	Yes [ ]
LE4	Does the system support the Sequence recovery function using the VectorRecoveryAlgorithm with a value of frerSeqRcvyHistoryLength ≥ 2?	5.9:c, 7.4.2, 7.4.3.4		LE: M	Yes [ ]
LE5	Can the system be configured with at least two Individual recovery functions using the MatchRecoveryAlgorithm?	5.9:d, 7.5, 7.4.3.5		LE: M	Yes [ ]
LE6	Can the system be configured with a Sequence decoding function?	5.9:e, 7.8		LE: M	Yes [ ]
LE7	Does the system implement the managed objects of Clause 9 and Clause 10 (10.7 not required)?	5.9:f, 9, 10		LE: M	Yes [ ]
LE8	Does the Base recovery function process a frame before its FCS has been verified?	7.4.3		LE: M	No [ ]
LE9	Can the system decode frames using the Active Destination MAC and VLAN Stream identification?	5.10:a, 6.6		LE: O	Yes [ ] No [ ] —[1]
LE10	Can the system decode packets using the IP Stream identification?	5.11:c, 6.7		LE: O	Yes [ ] No [ ]
LE11	Can the system identify packets using the Extended Stream identification [crossref]?	5.11:d, 6.8		LE: O	Yes [ ] No [ ]
LE12	For what additional Stream decodings can the system be configured?	5.11:e		LE: O	—
LE13	Can the system decode frames using HSR sequence tag?	5.11:f, 7.9		LE: O	Yes [ ] No [ ]
LE14	Can the system decode frames using PRP sequence trailer?	5.11:g, 7.10		LE: O	Yes [ ] No [ ]

Item	Feature	Subclause	Value/Comment	Status	Support
LE15	For what additional Sequence decodings can the system be configured?	5.11:h		LE: O	—
LE16	Can the system be configured with at least two Individual recovery functions using the VectorRecoveryAlgorithm?	5.11:i, 7.5, 7.4.3.4		LE: O	Yes [ ]
LE17	Explain the limits on which ports the above features can be configured.	5.11:a		LE: O	—
LE18	Explain the limits on the number of Streams for which the above features can be configured.	5.11:b		LE: O	—

[1]If “No,” supply a reason why.

1 ### A.2.5 Relay system

2 ***Insert item RS12 and re-number subsequent entries in Table as shown:***

Item	Feature	Subclause	Value/Comment	Status	Support
RS1	Can the system identify frames using the Null Stream identification function?	5.12:b, 6.4		RS: M	Yes [ ]
RS2	Can the system be configured with a Sequence generation function?	5.12:c, 7.4.1		RS: M	Yes [ ]
RS3	Can the system be configured with at least two Individual recovery functions?	5.12:e, 7.5		RS: M	Yes [ ]
RS4	Can the system be configured with at least one Sequence recovery function using the MatchRecoveryAlgorithm?	5.12:e, 7.4.2, 7.4.3.5		RS: M	Yes [ ]
RS5	Does the system support the Sequence recovery function using the VectorRecoveryAlgorithm with a value of frerSeqRcvyHistoryLength $\geq$ 2?	5.12:e, 7.4.2, 7.4.3.4		RS: M	Yes [ ]
RS6	Can the system be configured with at least two Individual recovery functions using the MatchRecoveryAlgorithm?	5.12:f, 7.5, 7.4.3.5		RS: M	Yes [ ]
RS7	Can the system be configured with a Sequence encode/decode function?	5.12:d, 7.8		RS: M	Yes [ ]

Item	Feature	Subclause	Value/Comment	Status	Support
RS8	Does the system implement the managed objects of Clause 9 and Clause 10 (including 10.7)?	5.12:g, 9, 10		RS: M	Yes [ ]
RS9	Does the Base recovery function process a frame before its FCS has been verified?	7.4.3		RS: M	No [ ]
RS10	Can the system encode/decode frames using the Active Destination MAC and VLAN Stream identification?	5.13:a, 6.6		RS: O	Yes [ ] No [ ] ___[1]
RS11	Can the system identify packets using the IP Stream identification?	5.13:b, 6.7		RS: O	Yes [ ] No [ ] ___[a]
RS12	Can the system identify packets using the Extended Stream identification [crossref]?	5.13:c, 6.8		RS: O	Yes [ ] No [ ] ___[a]
RS13	For what additional Stream identification functions can the system be configured?	5.14:c		RS: O	—
RS14	Can the Stream splitting function be configured on the system?	5.14:d, 7.7		RS: O	Yes [ ] No [ ]
RS15	Can the system encode/decode frames using HSR sequence tag?	5.14:e, 7.9		RS: O	Yes [ ] No [ ]
RS16	Can the system encode/decode frames using PRP sequence trailer?	5.14:f, 7.10		RS: O	Yes [ ] No [ ]
RS17	For what additional Sequence encode/decode functions can the system be configured?	5.14:g		RS: O	—
RS18	Can the system be configured with at least two Individual recovery functions using the VectorRecoveryAlgorithm?	5.14:i, 7.5, 7.4.3.4		RS: O	Yes [ ] No [ ]
RS19	Can the system be configured for Autoconfiguration via the Managed objects for autoconfiguration?	5.14:j, 7.11, 10.7		RS: O	Yes [ ] No [ ]
RS20	Explain the limits on which ports the above features can be configured.	5.14:a		RS: O	—
RS21	Explain the limits on the number of Streams for which the above features can be configured.	5.14:b		RS: O	—
RS22	Explain the limits on whether the above features can be configured at in-facing or out-facing positions.	5.14:h		RS: O	—

[1]If "No," supply a reason why.

Annex C

(informative)

Frame Replication and Elimination for Reliability in systems

C.2 Example 2: Various stack positions

Change 3rd paragraph of clause C.2, and Figure C-5 as shown:

Figure C-5 illustrates relay system B in Figure C-4. As the packets enter from the left, from End System A, they pass first through a Stream identification function [IP Stream identification (6.7), or Extended Stream identification (crossref 6.8)], which identifies the Stream. The Stream Transfer Function delivers the packet with all TSN parameters, including the stream_handle subparameter, to the Sequence generation function (7.4.1, marked "Seq." in Figure C-4), which adds a sequence_number subparameter with a steadily-increasing integer sequence value (modulo the size of the packet field carrying the sequence_number). The sequence_number subparameter is encapsulated into the packet by the Sequence encode/decode function (7.6). A Stream identification function [this time, Active Destination MAC and VLAN Stream identification (6.6)] modifies the two packets' destination MAC addresses and VLANs for identification through the bridged network. Relay system B's forwarding function then outputs the two packets on two different ports. The external form of the packets are labeled differently, as indicated by the italic numbers ***26*** and ***31*** in Figure C-4.

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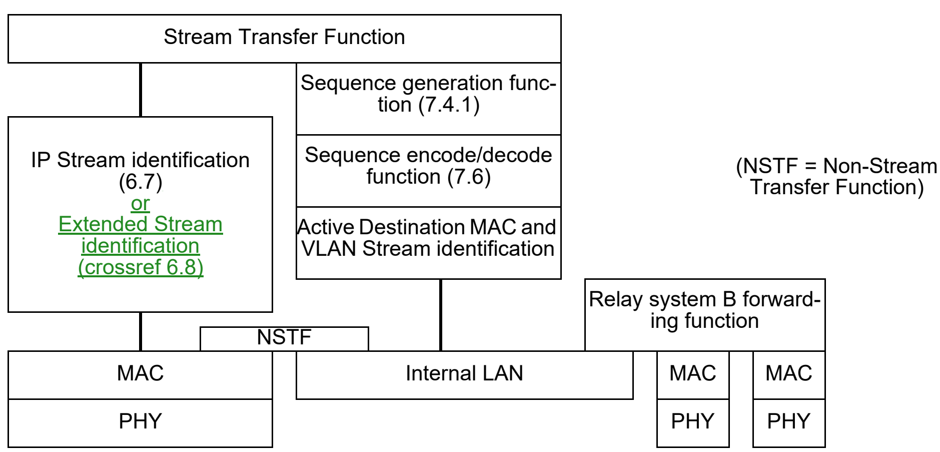

Figure C-5—Protocol stack for relay system B, proxying for End System A, in Figure C-4

C.5 Example 5: Protocol interworking

Change 1st paragraph of clause C.5 as shown:

Figure C-10 illustrates a simple protocol interworking function in one port of a relay system. In this example, two different encapsulation schemes **1** and **2** are used for the two legs of the Stream Transfer

Function, so that packets are transformed from using one encapsulation to using the other encapsulation as they pass through the port. No additional functions, e.g., a Sequence recovery function (7.4.2) are shown, although they would be perfectly admissible. If this were a port of a bridge attached to an end system, encapsulation **1** could be the Active Destination MAC and VLAN Stream identification (6.6), and encapsulation **2** could be the IP Stream identification (6.7) or the Extended Stream identification (crossref 6.8). The net result for the end system could be to convert a specific unicast IP Stream to use a specific multicast destination address and VLAN, in order to direct the packet through a specific path through the bridged network. Presumably, a similar interworking pair at the other end of the Stream would restore the packet to its original destination MAC address and VLAN.

