# IEEE P802.1Qdd

**Draft Standard for Local and Metropolitan Area Networks—**

# Bridges and Bridged Networks Amendment: Resource Allocation Protocol (RAP)

Sponsor
**LAN/MAN Standards Committee of the IEEE Computer Society**

Individual contribution
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**Abstract:** This amendment to IEEE Std 802.1Q-2018 specifies a Resource Allocation Protocol (RAP) that uses the Link-local Registration Protocol (LRP) and supports and provides backwards compatibility with the stream reservation and quality of service capabilities, controls and protocols specified in IEEE Std 802.1Q.
**Keywords:** Bridged Local Area Networks, Local Area Networks (LANs), MAC Bridges, Metropolitan Area Networks, Virtual Bridged Local Area Networks (virtual LANs), Time-Sensitive Networking (TSN), IEEE 802.1CS™, Link-local Registration Protocol (LRP), IEEE 802.1CB™, Frame Replication and Elimination for Reliability (FRER), resource reservation

## Editor's Foreword

<< 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. Certain text is also highlighted to attract the attention of reviewers. These notes and highlights, the temporary Annex Z (if present) containing some discussion of issues, the Editors' Foreword and Introduction to the current draft, and the preceding cover pages, will be removed prior to Sponsor Ballot and publication and are not part of the normative text. The records of participants in the development of the standard will be added at an appropriate time. >>

<< **Base text for this amendment**: This amendment is based on the text of IEEE Std 802.1Q-2018, as modified by those amendments that had been approved, but not incorporated into the base text the standard, at the time that this amendment was approved, namely IEEE Std 802.1Qcc-2018, IEEE Std 802.1Qcp-2018, P802.1Qcr, P802.1Qcw.
>>

**<< Overview: 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.

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). >>

**<< Editor's introduction to draft Dx.x >>**

## Project Authorization Request (PAR) and Criteria for Standards Development (CSD)

As part of our IEEE 802 process, the text of the PAR and CSD should be reviewed on a regular basis in order to ensure their continued validity. A vote of "Approve" on this draft is assumed also to be an affirmation by the balloter that the text of the PAR and CSD are still valid.

The following information is taken from the PAR for P802.1Qdd that was approved by the IEEE Standards Association on September 27, 2018 and will expire on December 31, 2022. The full text of the PAR can be found at https://development.standards.ieee.org/P1060100033/par.

**Scope of the Project:**

*This amendment specifies protocols, procedures, and managed objects for a Resource Allocation Protocol (RAP) that uses the Link-local Registration Protocol (LRP) and supports and provides backwards compatibility with the stream reservation and quality of service capabilities, controls and protocols specified in IEEE Std 802.1Q. RAP provides support for accurate latency calculation and reporting, can use redundant paths established by other protocols, and is not limited to bridged networks.*

**Need for the Project:**

*A signaling protocol that performs distributed and dynamic resource management and admission control is an essential component for automatic configuration in bridged LANs requiring latency and bandwidth guarantees. Current IEEE 802.1Q Multiple Stream Reservation Protocol (MSRP) is constrained by the capability of its underlying IEEE 802.1Q Multiple Registration Protocol (MRP) and does not efficiently support a large reservation database. For use in distributed stream reservation, IEEE 802.1Q MSRP does not make use of all available Quality of Service provisions and does not support reservation for the streams in need of high availability by use of the technologies specified in IEEE Std 802.1CB. The proposed amendment will address these issues.*

The following information is taken from the CSD that were approved by 802.1 and the 802 EC at PAR submission and can be found at http://www.ieee802.org/1/files/public/docs2018/dd-CSD-0718-v01.pdf.

**1. IEEE 802 criteria for standards development (CSD)**

The CSD documents an agreement between the WG and the Sponsor that provides a description of the project and the Sponsor's requirements more detailed than required in the PAR. The CSD consists of the project process requirements, 1.1, and the 5C requirements, 1.2.

**1.1 Project process requirements**

**1.1.1 Managed objects**

Describe the plan for developing a definition of managed objects. The plan shall specify one of the following:

a) The definitions will be part of this project.

b) The definitions will be part of a different project and provide the plan for that project or anticipated future project.

c) The definitions will not be developed and explain why such definitions are not needed.

*This project will use method a). The managed objects definitions will be part of this project.*

**1.1.2 Coexistence**

A WG proposing a wireless project shall demonstrate coexistence through the preparation of a Coexistence Assurance (CA) document unless it is not applicable.

a) Will the WG create a CA document as part of the WG balloting process as described in Clause 13? (yes/no)

b) If not, explain why the CA document is not applicable.

*This project will use method b). This project is not a wireless project.*

**1.2 5C requirements**

**1.2.1 Broad market potential**

Each proposed IEEE 802 LMSC standard shall have broad market potential. At a minimum, address the following areas:

a) Broad sets of applicability.

b) Multiple vendors and numerous users.

*The original version of IEEE 802.1Q Multiple Stream Reservation Protocol (MSRP) has been successfully and widely accepted by the professional, industrial, consumer, and automotive markets as an essential tool to realize automatic stream setup with dynamic resource allocation. The success of IEEE 802.1Q MSRP has expanded the requirements on that protocol beyond that capability. RAP addresses the expanded markets.*

*Multiple vendors and users for industrial automation, professional audio-video, automotive and other systems requiring a protocol to signal the resource reservation along the end-to-end paths of streams for time-sensitive applications will participate in the development of the project.*

### 1.2.2 Compatibility

Each proposed IEEE 802 LMSC standard should be in conformance with IEEE Std 802, IEEE 802.1AC, and IEEE 802.1Q. If any variances in conformance emerge, they shall be thoroughly disclosed and reviewed with IEEE 802.1 WG prior to submitting a PAR to the Sponsor.

a) Will the proposed standard comply with IEEE Std 802, IEEE Std 802.1AC and IEEE Std 802.1Q?

b) If the answer to a) is no, supply the response from the IEEE 802.1 WG.

The review and response is not required if the proposed standard is an amendment or revision to an existing standard for which it has been previously determined that compliance with the above IEEE 802 standards is not possible. In this case, the CSD statement shall state that this is the case.

*The amendment will be in conformance with IEEE Std 802, IEEE Std 802.1AC, and the existing provisions of IEEE Std 802.1Q.*

### 1.2.3 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.

*No existing IEEE 802 standard or approved project provides end-to-end distributed stream reservation that supports the required performance and capabilities.*

*This amendment differs from the existing IEEE 802.1Q MSRP and its enhancements being specified in IEEE P802.1Qcc in that Resource Allocation Protocol (RAP) will be an application for Link-local Registration Protocol (LRP) being specified by IEEE P802.1CS, while IEEE 802.1Q MSRP is specified as an application for IEEE 802.1Q Multiple Registration Protocol (MRP). RAP will leverage the LRP mechanisms to support much larger application databases and to transfer data more efficiently than IEEE 802.1Q MRP can support.*

*This amendment will specify a signaling protocol for use in the fully distributed model, which enables resource allocation for the streams that desire using the IEEE 802.1 Time-Sensitive Networking (TSN) features defined by IEEE Std 802.1Q and IEEE Std 802.1CB, such as the QoS functions and redundancy. Such capabilities are neither supplied by the original IEEE 802.1Q MSRP nor by its enhancements.*

### 1.2.4 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.

*RAP is similar in principle to the successful IEEE 802.1Q MSRP. RAP will build on LRP to provide additional capabilities.*

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

*There is a considerable body of experience in supplying data streams with guarantees for quality of service parameters such as latency, latency variation, or bandwidth. Mechanisms needed for this project are widely used by other protocols already, e.g. IEEE 802.1Q MSRP for use in bridged networks and the Resource Reservation Protocol (RSVP, IETF RFC 2205, and IETF RFC 2750) for routers and hosts that use the Internet Protocol.*

### 1.2.5 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).

b) Known cost factors.

c) Consideration of installation costs.

d) Consideration of operational costs (e.g., energy consumption).

e) Other areas, as appropriate.

*The well-established balance between infrastructure and attached stations will not be changed by the proposed amendment.*

*The amendment will specify an application for LRP and add no additional hardware costs to bridges and end stations beyond the minimal and firmly bounded resources consumed by LRP.*

*The cost factors, including installation and operational costs are well-known from existing IEEE 802.1Q MSRP that is built on IEEE 802.1Q MRP. The proposed amendment will specify an application running over LRP that supports a larger database with fewer message exchanges and thus will provide better economic feasibility than IEEE 802.1Q MSRP built on IEEE 802.1Q MRP.*

# Contents

# IEEE P802.1Qdd

## Draft Standard for Local and Metropolitan Area Networks—

# Bridges and Bridged Networks Amendment: Resource Allocation Protocol (RAP)

(This amendment is based on IEEE Std 802.1Q™-2018, as modified by IEEE Std 802.1Qcc™-2018, IEEE Std 802.1Qcp™-2018, P802.1Qcr and P802.1Qcw)

NOTE—The editing instructions contained in this amendment define how to merge the material contained here into the base document and its other amendments to form the new comprehensive standard.

Editing instructions are shown in ***bold italic***. Four editing instructions are used: change, delete, insert, and replace. ***Change*** is used to make corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed either by using strikethrough (to remove old material) and underscore (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. ***Replace*** is used to make changes in figures or equations by removing the existing figure or equation and replacing it with a new one. Editing instructions, change markings, and this NOTE will not be carried over into future editions because the changes will be incorporated into the base standard.

## 1. Overview

### 1.3 Introduction

***Insert the following text at the end of subclause 1.3:***

This standard specifies protocols, procedures, and managed objects for a Resource Allocation Protocol (RAP) that uses the Link-local Registration Protocol (LRP) and supports and provides backwards compatibility with the stream reservation and quality of service capabilities, controls and protocols specified in IEEE Std 802.1Q. RAP provides support for accurate latency calculation and reporting, can use redundant paths established by other protocols, and is not limited to bridged networks.

## 2. Normative references

***Insert the following reference in alphanumeric order:***

IEEE Std 802.1CS™, IEEE Standard for Local and metropolitan area networks—Link-local Registration Protocol.

## 3. Definitions

***Insert the following definitions in alphabetic order, renumbering as appropriate:***

**3.x Resource Allocation Protocol (RAP):** A signaling protocol built on the Link-local Registration Protocol (LRP) as specified in IEEE Std 802.1CS and designed to provide resource reservation for the streams that desire using the TSN features like QoS functions and redundant transmission.

**3.x RAP native system:** RAP + LRP native (with portals and target ports)

**3.x RAP proxy system:** RAP + LRP proxy (with portals without target ports)

**3.x RAP slave system:** LRP slave + RAP specific info in LLDP

**3.x RAP Portal:** a Portal created by IEEE Std 802.1CS Link-local Registration Protocol (LRP) and associated with RAP

**3.x RAP target port:** A Virtual Local Area Network (VLAN) Bridge or end station Port with which a RAP Portal is associated

…

## 4. Abbreviations

***Insert the following abbreviations in alphabetic order:***

| | |
|---|---|
| LRP | Link-local Registration Protocol |
| RADE | RAP Attribute Declaration Entity |
| RAP | Resource Allocation Protocol |
| RARE | RAP Attribute Registration Entity |
| RPPE | RAP attribute Propagation and Processing Entity |
| RSDE | RAP Serialization and Deserialization Entity |

## 5. Conformance

### 5.4 VLAN Bridge component requirements

#### 5.4.1 VLAN Bridge component options

***Insert the following item at the end of the lettered list in 5.4.1:***

af) Support Resource Allocation Protocol (RAP; Clause 99).

***Insert the following new subclause at the end of subclause 5.4 using the next available subclause number:***

### 5.4.7 Resource Allocation Protocol (RAP) requirements

<< Question: for which of the following RAP systems do we need to specify the requirements in Clause 5 of 802.1Q?

- RAP native end station and native Bridge
- RAP proxy residing in a Bridge, in an end station or in a non-Bridge relay system (also a kind of end-station?)
- RAP slave end-station or salve Bridge

>>

A VLAN Bridge implementation that conforms to the provisions of this standard for RAP shall

a) Conform to the required capabilities specified in IEEE Std 802.1CS

b) …

A VLAN Bridge implementation that conforms to the provisions of this standard for RAP may

c) …

***Insert the following new subclause at the end of Clause 5 using the next available subclause number:***

### 5.33 End station requirements—RAP

An end station implementation that conforms to the provisions of this standard for RAP shall

a) Conform to the required capabilities specified in IEEE Std 802.1CS

b) …

An end station implementation that conforms to the provisions of this standard for RAP may

c) …

## 12. Bridge management

***Insert the following new subclause at the end of Clause 12 using the next available subclause number:***

### 12.33 Resource Allocation Protocol (RAP) management

The Bridges enhancements for support of RAP are defined in Clause 99.

This managed resource comprises the following objects:

a) RAP Bridge Base Table (12.33.1)
b) RAP Portal Table (12.33.2)
c) RAP Latency Parameter Table (12.33.3)
d) RAP Stream Table (12.33.4)
e) RAP Reservations Table (12.33.5)

#### 12.33.1 RAP Bridge Base Table

<< This table contains per Bridge parameters. >>

#### 12.33.2 RAP Portal Table

<< This table contains per-Portal parameters, e.g. rapEnabledStatus >>

#### 12.33.3 RAP Latency Parameter Table

<< There is one such table per Portal, containing latency parameters per traffic class supported on the target port associated with that Portal. A target port can be either a local port or a remote port that is located at a RAP slave system and associated with this Portal. >>

#### 12.33.4 RAP Stream Table

<< There is one such table per Bridge, containing parameters, e.g. Tspec, for each registered stream identified by StreamID. >>

#### 12.33.5 RAP Reservations Table

<< There is one such table per target port, containing a set of stream attribute parameters, e.g. accumulatedLatency, registered on that target port and identified by StreamID, >>

## 17. Management Information Base (MIB)

## 34. Forwarding and Queuing Enhancements for time-sensitive streams (FQTSS)

<< Changes in this Clause are applied to the base text of IEEE Std 802.1Q-2018 as modified by IEEE Std 802.1Qcc-2018. >>

### 34.1 Overview

***Change the text of subclause 34.1 as follows:***

<< Add additional text to reflect that RAP is an alternative tool that can be used to support FQTSS. >>

### 34.2 Domain detection for stream reservation

***Change the title of the existing 34.2 as shown. Insert a new subclause 34.2.1 titled with "Detection of SRP domains", containing the existing content from 34.2. Insert a new subclause 34.2.2 titled with "Detection of RAP domains", containing the new text shown below.***

#### 34.2.1 Detection of SRP domains

#### 34.2.2 Detection of RAP domains

<< With a similar purpose of subclause 34.2 intended for use of SRP, this new subclause should describe mechanisms for detection of stream reservation domains for RAP >>

### 34.3 The bandwidth availability parameters

<< This subclause should add additional text to describe how RAP deals with the bandwidth availability parameters on the Bridge Ports in support of a SRclass that is mapped to the shaper algorithm other than the default CBS, such as 802.1Qch-CQF or P802.1Qcr-ATS. >>

### 34.6 Transmission Selection

<< New subclauses are needed to specify shaper-specific rules of using RAP to make reservations for streams that use a TSN transmission selection algorithm other than CBS. >>

#### 34.6.4 Cyclic queuing and forwarding

#### 34.6.5 Asynchronous traffic shaping

## 46. Time-Sensitive Networking (TSN) configuration

## 48. YANG Data Model

***Insert the following new clause and change the temporal clause number 99 to the next available clause number in 802.1Q.***

## 99. Resource Allocation Protocol (RAP)

<< This clause is the main body of the RAP specification. >>

### 99.1 Introduction

<< This subclause prefaces the clause with an introduction into the organization of the subsequent subclauses, for each of which a brief description is provided in an itemized list. >>

## 99.2 RAP Overview

<< This subclause provides an overview of RAP, including the objectives/non-objectives, the architecture with a short description of each RAP component, and some informative introduction to use of RAP with other protocols or mechanisms. >>

### 99.2.1 Objectives and non-objectives

<< see the proposed list in Annex Z >>

### 99.2.2 RAP architecture

Figure 99-1 illustrates the architecture of RAP in the case of a two-Port Bridge and an end station.

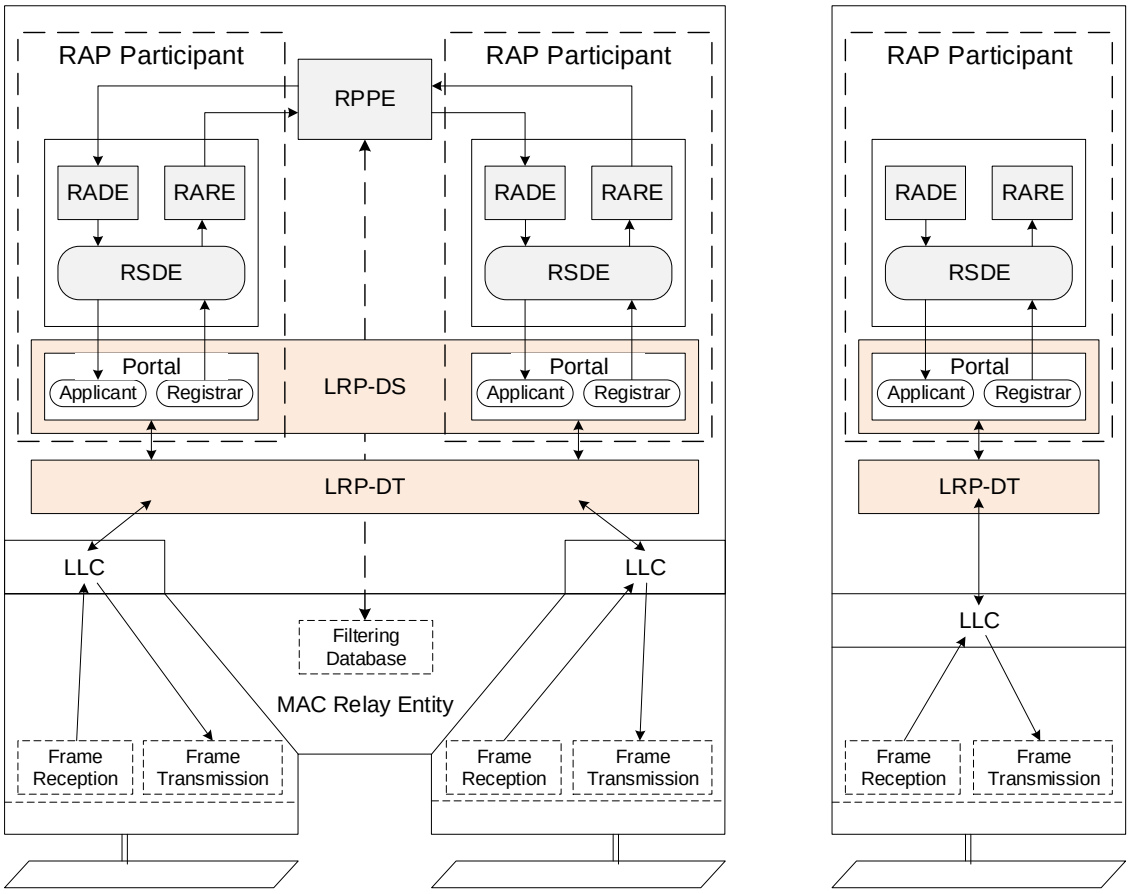


Figure 99-1—Operation of RAP

**RAP Attribute Declaration Entity (RADE):** a per-Portal component that handles the attribute declaration events happening on that Portal, triggered either by the reception of an attribute propagated from the other ports through the RAPE component on a Bridge or by a RAP service request primitive issued by the RAP application on an end station. The outputs of RADE are passed to the RSDE component, which serializes attributes into records for further processing in the underlying LRP applicant state machine.

**RAP Attribute Registration Entity (RARE):** a per-Portal component that handles the attribute registration events happening on that Portal and triggered by the reception of an attribute from the RSER component that deserializes the records received by the underlying LRP registrar state machine from the neighbor Portal. The outputs of RARE are fed into the RAPE component on a Bridge or cause a RAP service indication primitive issued to the RAP application on an end station.

**RAP Serialization and Deserialization Entity (RSDE):** a per-Portal RAP component that performs serialization of RAP attributes into LRP records and deserialization of LRP records into RAP attributes.

**RAP attribute Propagation and Processing Entity (RPPE):** a per-Bridge component that propagates and processes attributes between the per-Poral Participants.

### 99.2.3 RAP information flow

<< An introductory description of the RAP reservation flow, including how reservation process is initiated by end stations and how to propagate attributes throughout the network. >>

### 99.2.4 RAP on LRP proxy/slave systems

<< An informal introduction to building a RAP proxy or slave system. >>

### 99.2.5 RAP and transmission selection algorithms

<< A brief description of RAP's support for different transmission selection algorithms. >>

### 99.2.6 RAP and 802.1CB FRER

<< A brief description of RAP's support for redundant stream transmission using 802.1CB FRER. >>

### 99.2.7 RAP and MSRP

<< A brief description of RAP's relationship with MSRP. >>

## 99.3 Definition of LRP protocol elements

<< This subclause defines LRP-specific specifications according to the requirements listed in Annex B.1 of P802.1CS/D2.0. >>

### 99.3.1 Choice of LLDP Instance

When the IEEE Std 802.1AB Link Layer Discovery Protocol (LLDP) is deployed to advertise and discover RAP Portals, the destination_address of the LLDP instance, which is selected to carry the AppId of RAP in the LRP ECP Discovery TLV or the LRP TCP Discovery TLV, shall be the Nearest Bridge Address (01-80-C2-00-00-0E) as specified in Table 8-1, Table 8-2, and Table 8-3.

### 99.3.2 Choice of LRP-DT mechanism

<< Specifications for use of ECP or TCP as LRP-DT mechanism, e.g. addresses >>

#### 99.3.3 RAP appId

<< Define the value of appId for RAP >>

#### 99.3.4 RAP Application Information TLV

<< Specify the Application Information TLV for RAP >>

#### 99.3.5 LRP timers

<< Define values for Hello time and cplCompleteListTimerReset >>

### 99.4 RAP service interface

<< This subclause specifies the service primitives for both Talker and Listener application entities to use the resource reservation services provided by RAP. >>

### 99.5 RAP Attribute definitions

<< This subclause specifies the syntax and semantics of the RAP attributes using TLV encoding. >>

### 99.6 RAP Attribute declaration and registration

<< This subclause specifies the functions of RADE and RADE on a per-attribute base. >>

#### 99.6.1 RAP Attribute declaration functions

#### 99.6.2 RAP Attribute registration functions

#### 99.6.3 LRP Record serialization and deserialization functions

<< This subclause specifies the functions of RSDE. >>

### 99.7 RAP Attribute propagation and processing

<< This subclause specifies the attribute propagation and processing rules on a per-attribute base for RPPE. >>

### 99.8 Diagnostics and failure information

## Annex A

(normative)

## PICS proforma—Bridge implementations

## Annex B

(normative)

## PICS proforma—End station implementations

## Annex Z

(informative)

<< Editor's Note: This is a temporary Annex intended to record issues and their resolutions as the project proceeds. It will be removed prior to Sponsor ballot. >>

### Proposed Objectives:

- support for RAP running on LRP native and proxy/slave systems
- support for use of either ECP or TCP as LRP-DT mechanism (TCP is required for RAP proxy)
- Target link monitoring (e.g. CFM), needed for both native and proxy/slave systems
    - LRP hello timeout is >= 30 s, way too slow for link status monitoring
    - Target link status is essential to a stream reservation protocol
    - Between two native systems, both stream data and LRPDUs are transmitted on the same path, but hello is too slow
    - For proxy/slave systems, LRPDUs are usually not transmitted on the target link used for stream data; monitoring connectivity status of the target link is required.
- restricted to use of “Talker Uni” (see contribution dd-finn-RAP-LRP-MSRP-Qcc-0918-v03.pdf)
    - limit RAP/LRP capabilities to things that can be done with a peer-to-peer implementation.
- enforcement of bounded per-hop max. latency, bandwidth and resources
- support for transmission selection algorithms
    - CBS (already supported by MSRPv0)
    - Qch-CQF (obvious and trivial)
    - Qcr-ATS (presentation is planned for May Interim)
    - Others (e.g. Qbv, SP) – if desired, contributions are expected
- support for Qci – contributions still required
- support for streams using 802.1CB-FRER (see contribution RAP-whitepaper-v02.pdf)

**Proposed Non-objectives:**

- using RAP to carry “third-party UNI” data between CUC and “fully-service” CNC (see contribution dd-finn-RAP-LRP-MSRP-Qcc-0918-v03.pdf)
- using RAP also as the protocol between a RAP proxy and a RAP slave
-