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IEEE Standards for Local and Metropolitan Area Networks:

Supplement to Demand Priority Access Method, Physical Layer and Repeater Specifications:

Redundant Links

IEEE Computer Society

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Supplement to Demand Priority Access Method, Physical Layer and Repeater Specifications:

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IEEE Computer Society**

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Abstract: Revisions to the IEEE 802.12 Demand Priority Access Method allowing optional implementation of redundant links to facilitate automatic recovery of network connectivity in case of link or repeater failure anywhere in the network path are specified. Rules for connecting redundant links within a network are defined.

Keywords: demand priority access method, fault tolerance, local area networks, media access control, network interconnection, redundant link, repeater

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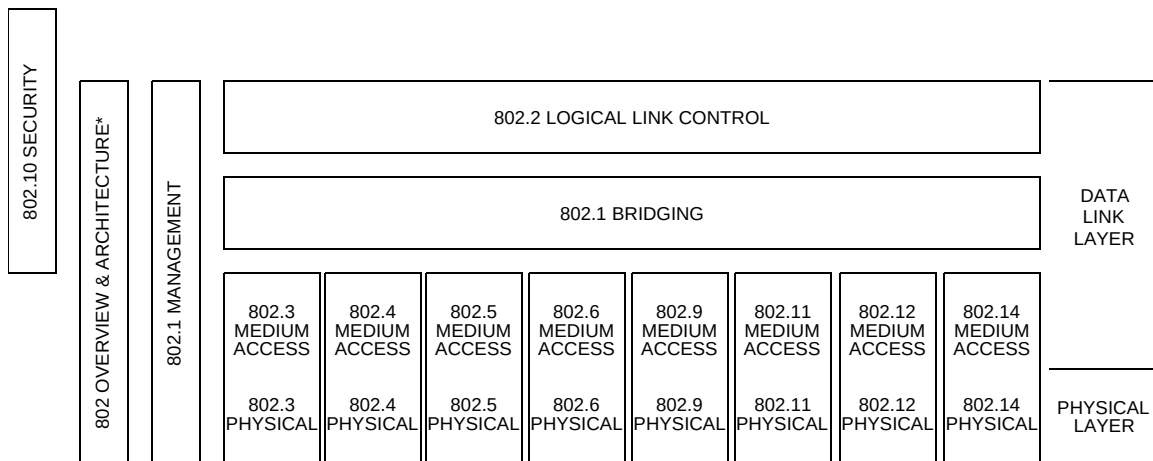
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Introduction

(This introduction is not part of IEEE Std 802.12d-1997, IEEE Standards for Local and Metropolitan Area Networks: Supplement to Demand Priority Access Method, Physical Layer and Repeater Specifications: Redundant Links.)

This standard is part of a family of standards for local and metropolitan area networks. The relationship between the standard and other members of the family is shown below. (The numbers in the figure refer to IEEE standard numbers.)



* Formerly IEEE Std 802.1A.

This family of standards deals with the Physical and Data Link layers as defined by the International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) Open Systems Interconnection Basic Reference Model (ISO/IEC 7498-1: 1994). The access standards define several types of medium access technologies and associated physical media, each appropriate for particular applications or system objectives. Other types are under investigation.

The standards defining the technologies noted above are as follows:

- IEEE Std 802 *Overview and Architecture.* This standard provides an overview to the family of IEEE 802 Standards. This document forms part of the 802.1 scope of work.
- ANSI/IEEE Std 802.1B and 802.1k [ISO/IEC 15802-2] *LAN/MAN Management.* Defines an Open Systems Interconnection (OSI) management-compatible architecture, and services and protocol elements for use in a LAN/MAN environment for performing remote management.
- ANSI/IEEE Std 802.1D [ISO/IEC 10038] *MAC Bridging.* Specifies an architecture and protocol for the interconnection of IEEE 802 LANs below the MAC service boundary.
- ANSI/IEEE Std 802.1E [ISO/IEC 15802-4] *System Load Protocol.* Specifies a set of services and protocol for those aspects of management concerned with the loading of systems on IEEE 802 LANs.
- ANSI/IEEE Std 802.2 [ISO/IEC 8802-2] *Logical Link Control*
- ANSI/IEEE Std 802.3 [ISO/IEC 8802-3] *CSMA/CD Access Method and Physical Layer Specifications*

- ANSI/IEEE Std 802.4 [ISO/IEC 8802-4] *Token Passing Bus Access Method and Physical Layer Specifications*
- ANSI/IEEE Std 802.5 [ISO/IEC 8802-5] *Token Ring Access Method and Physical Layer Specifications*
- ANSI/IEEE Std 802.6 [ISO/IEC 8802-6] *Distributed Queue Dual Bus Access Method and Physical Layer Specifications*
- ANSI/IEEE Std 802.9 [ISO/IEC 8802-9] *Integrated Services (IS) LAN Interface at the Medium Access Control (MAC) and Physical (PHY) Layers*
- ANSI/IEEE Std 802.10 *Interoperable LAN/MAN Security*
- ANSI/IEEE Std 802.12 *Demand Priority Access Method, Physical Layer and Repeater Specifications*

In addition to the family of standards, the following is a recommended practice for a common Physical Layer technology:

- IEEE Std 802.7 *IEEE Recommended Practice for Broadband Local Area Networks*

The following additional working groups have authorized standards projects under development:

- IEEE 802.11 *Wireless LAN Medium Access Control (MAC) Sublayer and Physical Layer Specifications*
- IEEE 802.14 *Standard Protocol for Cable-TV Based Broadband Communication Network*

The reader of this standard is urged to become familiar with the complete family of standards.

Conformance test methodology

An additional standards series, identified by the number 1802, has been established to identify the conformance test methodology documents for the 802 family of standards. Thus the conformance test documents for 802.3 are numbered 1802.3. ISO has reserved 18802 to number conformance test standards for 8802 standards.

IEEE Std 802.12d-1997

This supplement defines revisions to the IEEE 802.12 Demand Priority Access Method that will allow optional implementation of redundant links to provide automatic recovery of network connectivity in case of link or repeater failure anywhere in the network path. Rules and recommendations for connecting redundant links are provided.

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 may be obtained from

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IEEE Standards for Local and Metropolitan Area Networks:

Supplement to Demand Priority Access Method, Physical Layer and Repeater Specifications:

Redundant Links

Revisions to IEEE Std 802.12-1995

This supplement to IEEE Std 802.12-1995 defines an optional redundant-link capability for repeaters and end nodes that will provide automatic recovery of network connectivity in case of link or repeater failure anywhere in the network path. Full interoperability is maintained with existing IEEE 802.12 standard products.

This supplement consists of editorial and technical changes and additions to clauses 1, 6, 10, 11, 12, and 13, and to annexes A, C, D, and E. Technical changes include:

- a) The training frame formats in 10.6 have been revised to include redundant-link capability. Figure 34 has been revised, a duplicate uplink (D) bit has been defined for the requested configuration field in 10.6.2, and the duplicate address (D) bit definition for the allowed configuration field in 10.6.3 has been expanded to indicate appropriate action if the training initiator is connected to a higher-level repeater that is not configured with local-port-redundant-link training capability and a duplicate address is detected.
- b) The scope of 11.1 has been expanded to allow a second MAC and redundant link as a specific end-node capability, and definitions for redundant-link operational modes have been added to 11.3.
- c) Figure 53 in clause 12 has been revised to show a second uplink from the cascade port of the RMAC. Subclause 12.2.1 has been expanded to include metastate diagrams (new figures 55.1 and 55.2) and state descriptions for cascade ports with redundant uplinks. New global types and variables for link status have also been added to 12.5.2.1 and 12.5.3, and the port meta-state description in 12.9.7.1 has been expanded. The paragraph in 12.9.8 that defines how the C bit in the allowed configuration field of the training response frame is determined has been expanded to include a decision tree (figure 92.2) for the C_d factor and for the D bit.
- d) New management objects have been added to clause 13. A link managed object class has been defined in 13.1.2.1.1; figure 113 has been revised; link monitoring capability has been added to the packages in 13.1.3; new objects and a link managed object class and object list have been

added to 13.1.3.1; and appropriate object definitions have been added to 13.2.4.5. These network management changes have also been reflected in the GDMO specifications of annex C and the object identifier lists of annex D.

- e) Tables A5.1, A5.2, A.6.1, and A.6.2 of the PICS proforma in annex A have been revised to include redundant-link capability queries.
- f) Annex E has been made normative and has been expanded to include topology rules for redundant links. Five new figures, E.1 through E.5, have been added.

Editing instructions for incorporating the revisions defined by this supplement into the indicated subclauses of the base standard (IEEE Std 802.12-1995) are shown in ***bold italic*** type. Text revisions are indicated by ***change bars*** in the outside margin of the affected subclauses. New figures are numbered with the number of the immediately previous figure in the base standard followed by a decimal fraction (e.g., figure xx.1 indicates the new figure is to be added after figure xx, figure xx.2 indicates the figure is to be added after figure xx.1, etc.). New footnotes are identified with a similar numbering scheme.

1. Overview

1.2 Purpose

Add the following at the end of this subclause:

- n) Support an option for redundant links that will enable automatic recovery of network connectivity in case of link or repeater failure anywhere in the network path.

1.3 Document organization

Replace the reference to Annex E in this subclause with the following:

Annex E (Network topology considerations) defines topology rules for IEEE 802.12 networks (normative).

3. Definitions

Add the following definition to this clause:

redundant link: A second link from an end node or from the cascade port of a repeater that provides an alternative path to maintain network connectivity in case of a repeater or link failure.

6. Introduction to the protocol

6.1 Network topology

Add new subclause 6.1.5 at the end of this subclause:

6.1.5 Redundant links

Both end nodes and repeater cascade ports may optionally be equipped with a second (redundant) link to maintain network connectivity in case of individual link or repeater failure in the network connection path. Specific requirements for implementing redundant links are given in clause 11 for end nodes and in clause 12 for repeaters. Rules for connecting redundant links and recommendations for interconnecting

redundant-link repeaters and end nodes in a network containing one or more repeaters that do not have redundant-link capability are defined in annex E.

6.8 Items for future study

Replace the text in this subclause with the following:

Areas being considered for future development include:

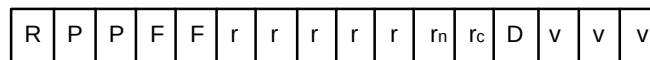
- a) A burst mode capability, allowing end nodes to send multiple short packets per grant.
- b) Higher speed operation.
- c) Full-duplex capability (on switched or two-node networks).

10. Medium Access Control (MAC) frame format structure

10.6 Elements of the IEEE 802.12 training frame

10.6.2 Requested configuration field format

Replace figure 34 with the following:



- R = repeater bit
- PP = promiscuous bits
- FF = format bits
- r = reserved bit (set to 0)
- r_n = not used—this bit corresponds with the access not allowed bit in the allowed configuration field (set to 0)
- r_c = not used—this bit corresponds to the configuration bit in the allowed configuration field (set to 0)
- D = duplicate (redundant) uplink bit
- vvv = version bits

Figure 34—IEEE 802.12 training frame requested configuration field format

10.6.2.5 vvv bits

Replace this subclause with new subclauses 10.6.2.5 and 10.6.2.6 as follows:

10.6.2.5 Duplicate uplink (D) bit

The duplicate uplink bit indicates whether or not a lower entity is training this link as the secondary link.

- a) D = 0, either the link is being trained as the primary link, or the lower entity does not have redundant-link capability.
- b) D = 1, the link is being trained as the secondary link.

The D bit is used by the training initiator to request that the higher-level entity disable duplicate-address checking for that local port. A value of one in the D bit of the requested configuration field shall cause a repeater with local-port-redundant-link capability to ignore the MAC address attribute of this port when performing duplicate-address checks. A value of one shall also always cause a repeater with local-port-

redundant-link capability to generate a value of zero for the D bit in the allowed configuration field of the training response frame, regardless of the value of the aCentralMgmtDetectedDupAddr network management attribute. The D bit in the requested configuration field is informational for network management.

10.6.2.6 vvv bits

The vvv bits are used to identify the version of the IEEE 802.12 MAC/RMAC training protocol with which the training initiator is compliant. The current version shall be numbered 001.

10.6.3 Allowed configuration field format

10.6.3.7 Duplicate address (D) bit

Replace the text in this subclause with the following:

The duplicate address bit indicates whether or not a duplicate address has been detected in the repeater's port address list.

- a) D = 0, no duplicate address has been detected.
- b) D = 1, a duplicate address has been detected.

If both links from a redundant-link training initiator are connected to local ports on the same higher-level repeater and that repeater is not equipped with local-port-redundant-link training capability, the D bit in the requested configuration field will be ignored and a duplicate address may be detected. In this case, it will be necessary for the lower entity to train at least one link with the null address so that the primary link can train with this repeater without duplicate address error.

11. Medium Access Control (MAC) protocol

11.1 Scope

Add the following paragraph to the end of this subclause:

An end node may be equipped with a second MAC and a second (redundant) link to maintain network connectivity in case of link or repeater failure. Recommendations for connecting redundant-link end nodes in an IEEE 802.12 network are given in E.5. The definition of redundant links for end nodes and the manner in which reception of duplicate packets is resolved if both links are simultaneously active are implementation issues and are beyond the scope of this standard.