

INTERNATIONAL  
STANDARD

ISO/IEC/  
IEEE  
8802-1AB

First edition  
2014-02-15

---

---

**Information technology —  
Telecommunications and information  
exchange between systems — Local and  
metropolitan area networks —**

**Part 1AB:  
Station and Media Access Control  
Connectivity Discovery**

*Technologies de l'information — Télécommunications et échange  
d'information entre systèmes — Réseaux locaux et métropolitains —  
Partie 1AB*



Reference number  
ISO/IEC/IEEE 8802-1AB:2014(E)



© IEEE 2009

Withdrawn

© IEEE 2009

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without permission in writing from ISO, IEC or IEEE at the respective address below.

ISO copyright office  
Case postale 56  
CH-1211 Geneva 20  
Tel. + 41 22 749 01 11  
Fax + 41 22 749 09 47  
E-mail [copyright@iso.org](mailto:copyright@iso.org)  
Web [www.iso.org](http://www.iso.org)

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland  
E-mail [inmail@iec.ch](mailto:inmail@iec.ch)  
Web [www.iec.ch](http://www.iec.ch)

Institute of Electrical and Electronics Engineers, Inc.  
3 Park Avenue, New York  
NY 10016-5997, USA  
E-mail [stds.ipr@ieee.org](mailto:stds.ipr@ieee.org)  
Web [www.ieee.org](http://www.ieee.org)

Published in Switzerland

## Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. The IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and serve without compensation. While the IEEE administers the process and establishes rules to promote fairness in the consensus development process, the IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards.

The main task of ISO/IEC JTC 1 is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Attention is called to the possibility that implementation of this standard may require the use of subject matter covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. ISO/IEEE is not responsible for identifying essential patents or patent claims for which a license may be required, for conducting inquiries into the legal validity or scope of patents or patent claims or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance or a Patent Statement and Licensing Declaration Form, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility. Further information may be obtained from ISO or the IEEE Standards Association.

ISO/IEC/IEEE 8802-1AB was prepared by the LAN/MAN Standards Committee of the IEEE Computer Society (as IEEE Std 802.1AB-2009). It was adopted by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems*, in parallel with its approval by the ISO/IEC national bodies, under the “fast-track procedure” defined in the Partner Standards Development Organization cooperation agreement between ISO and IEEE. IEEE is responsible for the maintenance of this document with participation and input from ISO/IEC national bodies.

ISO/IEC/IEEE 8802 consists of the following parts, under the general title *Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks*:

- *Part 11: Wireless LAN medium access control (MAC) and physical layer (PHY) specifications*
- *Part 1X: Port-based network access control*
- *Part 1AB: Station and media access control connectivity discovery*
- *Part 1AE: Media access control (MAC) security*
- *Part 1AR: Secure device identity*
- *Part 1AS: Timing and synchronization for time-sensitive applications in bridged local area networks*

- *Part 15-4: Wireless medium access control (MAC) and physical layer (PHY) specifications for low-rate wireless personal area networks (WPANs)*

Withdrawn



**IEEE Standard for**

**Local and metropolitan area networks—**

# **Station and Media Access Control Connectivity Discovery**

---

**IEEE Computer Society**

Sponsored by the  
LAN/MAN Standards Committee

IEEE  
3 Park Avenue  
New York, NY 10016-5997, USA

17 September 2009

**IEEE Std 802.1AB™-2009**  
(Revision of  
IEEE Std 802.1AB-2005)

802.1AB™

(blank page)

Withdrawn

**IEEE Std 802.1AB™-2009**

(Revision of  
IEEE Std 802.1AB-2005)

**IEEE Standard for  
Local and metropolitan area networks—**

**Station and Media Access Control  
Connectivity Discovery**

Sponsor

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

Approved 11 September 2009

**IEEE-SA Standards Board**

**Abstract:** This document defines a protocol and a set of managed objects that can be used for discovering the physical topology from adjacent stations in IEEE 802<sup>®</sup> LANs.

**Keywords:** link layer discovery protocol, management information base, topology discovery, topology information

---

The Institute of Electrical and Electronics Engineers, Inc.  
3 Park Avenue, New York, NY 10016-5997, USA

Copyright © 2009 by the Institute of Electrical and Electronics Engineers, Inc.  
All rights reserved. Published 17 September 2009. Printed in the United States of America.

IEEE and 802 are registered trademarks in the U.S. Patent & Trademark Office, owned by The Institute of Electrical and Electronics Engineers, Incorporated.

PDF: ISBN 978-0-7381-6038-2 STD95957  
Print: ISBN 978-0-7381-6039-9 STDPD95957

*No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.*



**IEEE Standards** documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE-SA) Standards Board. The IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and serve without compensation. While the IEEE administers the process and establishes rules to promote fairness in the consensus development process, the IEEE does not independently evaluate, test, or verify the accuracy of any of the information or the soundness of any judgments contained in its standards.

Use of an IEEE Standard is wholly voluntary. The IEEE disclaims liability for any personal injury, property or other damage, of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, or reliance upon this, or any other IEEE Standard document.

The IEEE does not warrant or represent the accuracy or content of the material contained herein, and expressly disclaims any express or implied warranty, including any implied warranty of merchantability or fitness for a specific purpose, or that the use of the material contained herein is free from patent infringement. IEEE Standards documents are supplied “AS IS.”

The existence of an IEEE Standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE Standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard. Every IEEE Standard is subjected to review at least every five years for revision or reaffirmation, or every ten years for stabilization. When a document is more than five years old and has not been reaffirmed, or more than ten years old and has not been stabilized, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE Standard.

In publishing and making this document available, the IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity. Nor is the IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing this, and any other IEEE Standards document, should rely upon the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

Interpretations: Occasionally questions may arise regarding the meaning of portions of standards as they relate to specific applications. When the need for interpretations is brought to the attention of IEEE, the Institute will initiate action to prepare appropriate responses. Since IEEE Standards represent a consensus of concerned interests, it is important to ensure that any interpretation has also received the concurrence of a balance of interests. For this reason, IEEE and the members of its societies and Standards Coordinating Committees are not able to provide an instant response to interpretation requests except in those cases where the matter has previously received formal consideration. A statement, written or oral, that is not processed in accordance with the IEEE-SA Standards Board Operations Manual shall not be considered the official position of IEEE or any of its committees and shall not be considered to be, nor be relied upon as, a formal interpretation of the IEEE. At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position, explanation, or interpretation of the IEEE. Comments for revision of IEEE Standards are welcome from any interested party, regardless of membership affiliation with IEEE. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Recommendations to change the status of a stabilized standard should include a rationale as to why a revision or withdrawal is required.

Comments and recommendations on standards, and requests for interpretations should be addressed to:

Secretary, IEEE-SA Standards Board  
445 Hoes Lane  
Piscataway, NJ 08854  
USA

Authorization to photocopy portions of any individual standard for internal or personal use is granted by the Institute of Electrical and Electronics Engineers, Inc., provided that the appropriate fee is paid to Copyright Clearance Center. To arrange for payment of licensing fee, please contact Copyright Clearance Center, Customer Service, 222 Rosewood Drive, Danvers, MA 01923 USA; +1 978 750 8400. Permission to photocopy portions of any individual standard for educational classroom use can also be obtained through the Copyright Clearance Center.

## Introduction

This introduction is not part of IEEE Std 802.1AB-2009, IEEE Standard for Local and Metropolitan Area Networks—Station and Media Access Control Connectivity Discovery.

## Notice to users

### Laws and regulations

Users of these documents should consult all applicable laws and regulations. Compliance with the provisions of this standard does not imply compliance to any applicable regulatory requirements. Implementers of the standard are responsible for observing or referring to the applicable regulatory requirements. IEEE does not, by the publication of its standards, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

### Copyrights

This document is copyrighted by the IEEE. It is made available for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of engineering practices and methods. By making this document available for use and adoption by public authorities and private users, the IEEE does not waive any rights in copyright to this document.

### Updating of IEEE documents

Users of IEEE standards should be aware that these documents may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of amendments, corrigenda, or errata. An official IEEE document at any point in time consists of the current edition of the document together with any amendments, corrigenda, or errata then in effect. In order to determine whether a given document is the current edition and whether it has been amended through the issuance of amendments, corrigenda, or errata, visit the IEEE Standards Association website at <http://ieeexplore.ieee.org/xpl/standards.jsp>, or contact the IEEE at the address listed previously.

For more information about the IEEE Standards Association or the IEEE standards development process, visit the IEEE-SA website at <http://standards.ieee.org>.

### Errata

Errata, if any, for this and all other standards can be accessed at the following URL: <http://standards.ieee.org/reading/ieee/updates/errata/index.html>. Users are encouraged to check this URL for errata periodically.

### Interpretations

Current interpretations can be accessed at the following URL: <http://standards.ieee.org/reading/ieee/interp/index.html>.

## Patents

Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. A patent holder or patent applicant has filed a statement of assurance that it will grant licenses under these rights without compensation or under reasonable rates, with reasonable terms and conditions that are demonstrably free of any unfair discrimination to applicants desiring to obtain such licenses. Other Essential Patent Claims may exist for which a statement of assurance has not been received. The IEEE is not responsible for identifying Essential Patent Claims for which a license may be required, for conducting inquiries into the legal validity or scope of Patents Claims, or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility. Further information may be obtained from the IEEE Standards Association.

Withdrawal

## Contents

1. Overview.....	1
1.1 Scope.....	1
1.2 Purpose.....	2
2. Normative references.....	3
3. Definitions and numerical representation.....	5
3.1 Definitions.....	5
3.2 Numerical representation.....	6
4. Acronyms and abbreviations.....	7
5. Conformance.....	9
5.1 Terminology.....	9
5.2 Protocol Implementation Conformance Statement (PICS).....	9
5.3 Required capabilities.....	9
5.4 Optional capabilities.....	10
6. Principles of operation.....	11
6.1 Transmission and reception.....	12
6.2 LLDP operational modes.....	12
6.3 LLDP information categories.....	13
6.4 TLV selection.....	14
6.5 Transmission principles.....	14
6.6 Reception principles.....	14
6.7 Systems with multiple LLDP Agents.....	15
7. LLDPDU transmission, reception, and addressing.....	19
7.1 Destination address.....	19
7.2 Source address.....	21
7.3 Ethertype use and encoding.....	22
7.4 LLDPDU reception.....	22
8. LLDPDU and TLV formats.....	23
8.1 LLDPDU bit and octet ordering conventions.....	23
8.2 LLDPDU format.....	23
8.3 TLV categories.....	24
8.4 Basic TLV format.....	24
8.5 Basic management TLV set formats and definitions.....	26
8.6 Organizationally Specific TLVs.....	34
9. LLDP agent operation.....	37
9.1 Overview.....	37
9.2 State machines.....	40
10. LLDP management.....	57
10.1 Data storage and retrieval.....	57
10.2 The LLDP management entity's responsibilities.....	57

10.3	Managed objects .....	59
10.4	Data types .....	59
10.5	LLDP variables .....	59
11.	LLDP MIB definitions .....	62
11.1	Internet Standard Management Framework .....	62
11.2	Structure of the LLDP MIB .....	62
11.3	Relationship to other MIBs .....	67
11.4	Security considerations for LLDP base MIB module .....	68
11.5	LLDP MIB modules , .....	70
Annex A	(normative) PICS proforma .....	115
A.1	Introduction .....	115
A.2	Abbreviations and special symbols .....	115
A.3	Instructions for completing the PICS proforma .....	116
A.4	Major capabilities and options .....	119
Annex B	(normative) PTOPO MIB update .....	121
Annex C	(informative) Example LLDP transmission frame formats .....	122
C.1	Direct-encoded LLDP frame format .....	122
C.2	SNAP-encoded LLDP frame format .....	122
Annex D	(informative) Using LLDP to detect potential communication problems .....	123
D.1	Overview .....	123
D.2	IEEE 802.1 Organizationally Specific TLVs .....	123
D.3	IEEE 802.3 Organizationally Specific TLVs .....	125
Annex E	(normative) IEEE 802.1 Organizationally Specific TLVs .....	127
E.1	Requirements of the IEEE 802.1 Organizationally Specific TLV set .....	127
E.2	Port VLAN ID TLV .....	127
E.3	Port And Protocol VLAN ID TLV .....	128
E.4	VLAN Name TLV .....	129
E.5	Protocol Identity TLV .....	130
E.6	VID Usage Digest TLV .....	131
E.7	Management VID TLV .....	131
E.8	Link Aggregation TLV .....	132
E.9	IEEE 802.1 Organizationally Specific TLV management .....	132
E.10	IEEE 802.1/LLDP extension MIB .....	133
E.11	PICS proforma for IEEE 802.1 Organizationally Specific TLV extensions .....	163
Annex F	(normative) IEEE 802.3 Organizationally Specific TLVs .....	165
F.1	Requirements of the IEEE 802.3 Organizationally Specific TLV set .....	165
F.2	MAC/PHY Configuration/Status TLV .....	165
F.3	Power Via MDI TLV .....	167
F.4	Maximum Frame Size TLV .....	168
F.5	IEEE 802.3 Organizationally Specific TLV selection management .....	168
F.6	IEEE 802.3/LLDP extension MIB .....	169
F.7	PICS proforma for IEEE 802.3 TLV extensions .....	187
Annex G	(informative) Bibliography .....	189
Annex H	(informative) IEEE list of participants .....	191

## List of figures

Figure 6-1	LLDP agent and its relationship to its LLC entity .....	11
Figure 6-2	Relationship between LLDP agents, LLC Entities, MSAPs, and the LLDP management entity .....	15
Figure 6-3	LLDP in a MAC Bridge .....	16
Figure 6-4	LLDP in an end system with port-based network access control .....	16
Figure 6-5	LLDP in a MAC Bridge that uses port-based network access control on both ports .....	17
Figure 6-6	Scope of group MAC addresses .....	17
Figure 6-7	Multiplexing and demultiplexing using shims .....	18
Figure 7-1	MSDU format .....	19
Figure 8-1	LLDPDU Format .....	23
Figure 8-2	Basic TLV format .....	24
Figure 8-3	End Of LLDPDU TLV format .....	26
Figure 8-4	Chassis ID TLV Format .....	26
Figure 8-5	Port ID TLV format .....	28
Figure 8-6	Time To Live TLV format .....	29
Figure 8-7	Port Description TLV format .....	29
Figure 8-8	System Name TLV format .....	30
Figure 8-9	System Description TLV format .....	31
Figure 8-10	System Capabilities TLV format .....	31
Figure 8-11	Management Address TLV format .....	33
Figure 8-12	Basic format for Organizationally Specific TLVs .....	35
Figure 9-1	Transmit state machine .....	54
Figure 9-2	Receive state machine .....	55
Figure 9-3	Transmit timer state machine .....	56
Figure 11-1	LLDP MIB block diagram .....	62
Figure C.1	IEEE 802.3 LLDP frame format .....	122
Figure C.2	IEEE 802.11 LLDP frame format .....	122
Figure E.1	Port VLAN ID TLV Format .....	128
Figure E.2	Port And Protocol VLAN ID TLV Format .....	128
Figure E.3	VLAN Name TLV format .....	129
Figure E.4	Protocol Identity TLV format .....	130
Figure E.5	VID Usage Digest TLV format .....	131
Figure E.6	Management VID TLV format .....	131
Figure E.7	Link Aggregation TLV format .....	132
Figure F.1	MAC/PHY configuration/status TLV format .....	166
Figure F.2	Power Via MDI TLV format .....	167
Figure F.3	Maximum Frame Size TLV format .....	168

## List of tables

Table 7-1	Group MAC addresses used by LLDP .....	20
Table 7-2	Support for MAC addresses in different systems .....	21
Table 7-3	LLDP EtherType .....	22
Table 8-1	TLV type values .....	25
Table 8-2	Chassis ID subtype enumeration .....	27
Table 8-3	Port ID subtype enumeration .....	28
Table 8-4	System capabilities .....	32
Table 9-5	Subclause/operating mode applicability .....	37
Table 9-6	State machine symbols .....	42
Table 11-1	MIB object groups and operating mode applicability .....	63
Table 11-2	LLDP MIB structure and object cross reference .....	63
Table E.1	IEEE 802.1 Organizationally Specific TLVs .....	127
Table E.2	Port and protocol capability/status .....	129
Table E.3	Link aggregation capability/status .....	132
Table E.4	IEEE 802.1 extension MIB object group conformance requirements .....	134
Table E.5	IEEE 802.1/LLDP extension MIB object cross reference .....	135
Table F.1	IEEE 802.3 Organizationally Specific TLVs .....	165
Table F.2	IEEE 802.3 auto-negotiation support/status .....	166
Table F.3	MDI power capabilities/status .....	167
Table F.4	IEEE 802.1 extension MIB object group conformance requirements .....	170
Table F.5	IEEE 802.3/LLDP extension MIB cross reference .....	170

# IEEE Standard for Local and metropolitan area networks—

## Station and Media Access Control Connectivity Discovery

*IMPORTANT NOTICE: This standard is not intended to ensure safety, security, health, or environmental protection in all circumstances. Implementers of the standard are responsible for determining appropriate safety, security, environmental, and health practices or regulatory requirements.*

*This IEEE document is made available for use subject to important notices and legal disclaimers. These notices and disclaimers appear in all publications containing this document and may be found under the heading “Important Notice” or “Important Notices and Disclaimers Concerning IEEE Documents.” They can also be obtained on request from IEEE or viewed at <http://standards.ieee.org/IPR/disclaimers.html>.*

### 1. Overview

The Link Layer Discovery Protocol (LLDP) specified in this standard allows stations attached to an IEEE 802<sup>®</sup> LAN to advertise, to other stations attached to the same IEEE 802 LAN, the major capabilities provided by the system incorporating that station, the management address or addresses of the entity or entities that provide management of those capabilities, and the identification of the station’s point of attachment to the IEEE 802 LAN required by those management entity or entities.

The information distributed via this protocol is stored by its recipients in a standard Management Information Base (MIB), making it possible for the information to be accessed by a Network Management System (NMS) using a management protocol such as the Simple Network Management Protocol (SNMP).

#### 1.1 Scope

The scope of this standard is to define a protocol and management elements, suitable for advertising information to stations attached to the same IEEE 802 LAN, for the purpose of populating physical topology and device discovery management information databases. The protocol facilitates the identification of



stations connected by IEEE 802 LANs/MANs, their points of interconnection, and access points for management protocols.

This standard defines a protocol that

- a) Advertises connectivity and management information about the local station to adjacent stations on the same IEEE 802 LAN.
- b) Receives network management information from adjacent stations on the same IEEE 802 LAN.
- c) Operates with all IEEE 802 access protocols and network media.
- d) Establishes a network management information schema and object definitions that are suitable for storing connection information about adjacent stations.
- e) Provides compatibility with the IETF PTOPO MIB (IETF RFC 2922 [B14]).<sup>1</sup>

## 1.2 Purpose

An IETF MIB (IETF RFC 2922 [B14]), as well as a number of vendor specific MIBs, have been created to describe a network's physical topology and associated systems within that topology.

This standard specifies the necessary protocol and management elements to

- a) Facilitate multi-vendor inter-operability and the use of standard management tools to discover and make available physical topology information for network management.
- b) Make it possible for network management to discover certain configuration inconsistencies or malfunctions that can result in impaired communication at higher layers.
- c) Provide information to assist network management in making resource changes and/or re-configurations that correct configuration inconsistencies or malfunctions identified in b) above.

---

<sup>1</sup>The numbers in brackets correspond to those in the bibliography in Annex G.

## 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 the 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.

IEEE Std 802<sup>®</sup>, IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture.<sup>2, 3</sup>

IEEE Std 802a<sup>™</sup>, IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture—Amendment 1: Ethertypes for Prototype and Vendor-Specific Protocol Development.

IEEE Std 802.1AE<sup>™</sup>, IEEE Standard for Local and Metropolitan Area Networks—Media Access Control (MAC) Security.

IEEE Std 802.1AX<sup>™</sup>, IEEE Standard for Local and Metropolitan Area Networks—Link Aggregation.

IEEE Std 802.1D<sup>™</sup>, IEEE Standard for Local and Metropolitan Area Networks: Media Access Control (MAC) Bridges.

IEEE Std 802.1Q<sup>™</sup>, IEEE Standards for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks.

IEEE Std 802.1X<sup>™</sup>, IEEE Standard for Local and Metropolitan Area Networks—Port-Based Network Access Control.

IEEE Std 802.3<sup>™</sup>, IEEE Standard for Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.

IETF RFC 1812, Requirements for IP Version 4 Routers, Baker, F., June 1995.<sup>4</sup>

IETF RFC 2108, Definitions of Managed Objects for IEEE 802.3 Repeater Devices using SMIPv2, de Graaf, K., and Romascanu, D., February 1997.

IETF RFC 2863, The Interfaces Group MIB, McCloghrie, K. and Kastenholz, F., June 2000.

IETF RFC 3046, DHCP Relay Agent Information Option, Patrick, M., January 2001.

IETF RFC 3232, Assigned Numbers: RFC 1700 is Replaced by an On-line Database, Reynolds, J., January 2002.<sup>5</sup>

IETF RFC 3410, Introduction and Applicability Statements for Internet Standard Management Framework, Case, J., Mundy, R., Partain, D., and Stewart, B., December 2002.

<sup>2</sup>IEEE and 802 are registered trademarks in the U.S. Patent & Trademark Office, owned by the Institute of Electrical and Electronics Engineers, Incorporated.

<sup>3</sup>IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08855, USA (<http://standards.ieee.org>).

<sup>4</sup>Internet RFCs are retrievable by FTP at <ftp://ftp.rfc-editor.org/in-notes/rfcnnnn.txt>, or by Web browser at <http://www.rfc-editor.org/rfcNNNN.txt> (where NNNN is the RFC number prefixed with zeroes as necessary to make a four digit number). If the RFC number is not known, there is a search facility at <http://www.rfc-editor.org/>.

<sup>5</sup>The IETF RFC 3232 ianaAddressFamilyNumbers on-line database module is accessible through a web page (currently, <http://www.iana.org>).

IETF RFC 3417, Transport Mappings for the Simple Network Management Protocol (SNMP), Presuhn, R., Case, J., McCloghrie, K., Rose, M., Waldbusser, S., December 2002.

IETF RFC 3418, Management Information Base (MIB) for the Simple Network Management Protocol (SNMP), Presuhn, R., ED., December 2002.

IETF RFC 3621, Power Ethernet MIB, Berger, A. and Romascanu, D., December 2003.

IETF RFC 3629, UTF-8, a transformation format of ISO 10646, Yergeau, F. November 2003.

IETF RFC 4133, Entity MIB (Version 3), A. Bierman, K. McCloghrie, August 2005.

IETF RFC 4293, Management Information Base for the Internet Protocol (IP), S. Routhier, Ed., April 2006.

IETF RFC 4363, Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering, and Virtual LAN Extensions, D. Levi, D. Harrington, January 2006.

IETF RFC 4502, Remote Network Monitoring Management Information Base Version 2, Waldbusser, S., May 2006.

IETF RFC 4546, Radio Frequency (RF) Interface Management Information Base for Data over Cable Service Interface Specifications (DOCSIS) 2.0 Compliant RF Interfaces, D. Raftus, E. Cardona, June 2006.

IETF RFC 4639, Cable Device Management Information Base for Data-Over-Cable Service Interface Specification (DOCSIS) Compliant Cable Modems and Cable Modem Termination Systems, R. Woundy, K. Marez, December 2006.

IETF RFC 4789, Simple Network Management Protocol (SNMP) over IEEE 802 Networks, J. Schoenwaelder, T. Jeffrey, November 2006.

IETF RFC 4836, Definitions of Managed Objects for IEEE 802.3 Medium Attachment Units (MAUs), E. Beili, April 2007.

ISO/IEC 8824-1 [ITU-T Rec. X.680 (2002)], Abstract Syntax Notation One (ASN.1): Specification of Basic Notation.<sup>6</sup>

---

<sup>6</sup>ASN.1 standards are available on-line by Web browser at <http://asn1.elibel.tm.fr/en/standards/index.htm#asn1>.