



International
Standard

**ISO/IEC/IEEE
8802-1AE**

**Telecommunications and exchange
between information technology
systems — Requirements for local
and metropolitan area networks —**

Part 1AE:
Media access control (MAC) security

**AMENDMENT 4: MAC Privacy
Protection**

*Télécommunications et échange entre systèmes informatiques —
Exigences pour les réseaux locaux et métropolitains —*

Partie 1AE: Sécurité du contrôle d'accès aux supports (MAC)

AMENDEMENT 4: Protection de la vie privée MAC

**Second edition
2020-08**

**AMENDMENT 4
2024-11**

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[ISO/IEC/IEEE 8802-1AE:2020/Amd 4:2024](https://standards.iteh.ai/catalog/standards/iso/2a446d5f-54c1-4a2b-b3c5-08e3d60be4bd/iso-iec-ieee-8802-1ae-2020-amd-4-2024)

<https://standards.iteh.ai/catalog/standards/iso/2a446d5f-54c1-4a2b-b3c5-08e3d60be4bd/iso-iec-ieee-8802-1ae-2020-amd-4-2024>



COPYRIGHT PROTECTED DOCUMENT

© IEEE 2023

All rights reserved. Unless otherwise specified, or required in the context of its implementation, 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 prior written permission. Permission can be requested from IEEE at the address below.

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

Email: stds.ipr@ieee.org
Website: 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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives or www.iec.ch/members_experts/refdocs).

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.

ISO and IEC draw attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO and IEC take no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO and IEC had received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents and <https://patents.iec.ch>. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html. In the IEC, see www.iec.ch/understanding-standards.

ISO/IEC/IEEE 8802-1AE:2020/Amd.4 was prepared by the LAN/MAN of the IEEE Computer Society (as IEEE Std 802.1AEdk-2023) and drafted in accordance with its editorial rules. It was adopted, under the "fast-track procedure" defined in the Partner Standards Development Organization cooperation agreement between ISO and IEEE, by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems*.

A list of all parts in the ISO/IEC/IEEE 8802 series can be found on the ISO and IEC websites.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Contents

1.	Overview.....	16
1.1	Introduction.....	16
1.2	Scope.....	17
2.	Normative references.....	19
3.	Definitions.....	21
4.	Abbreviations and acronyms.....	22
5.	Conformance.....	23
5.1	Requirements terminology.....	23
5.2	Protocol Implementation Conformance Statements (PICS).....	24
5.5	EDE Conformance.....	24
5.8	EDE-CC conformance.....	25
5.10	MAC Privacy protection Entity requirements.....	25
5.11	MAC Privacy protection Entity options.....	26
10.	Principles of MAC Security Entity (SecY) operation.....	27
10.7	SecY management.....	27
13.	MAC Security Entity MIB.....	30
13.1	Introduction.....	30
13.6	MAC Security Entity (SecY) MIB definition,.....	31
15.	Ethernet Data Encryption devices.....	69
15.6	Securing PBN connectivity with an EDE-CC.....	69
16.	Using MIB modules to manage EDEs.....	70
16.4	EDE-CC and EDE-SS Management.....	70
17.	MAC Privacy protection.....	71
17.1	Need for MAC Privacy protection.....	71
17.2	Protecting user data frames.....	72
17.3	Quality of Service impact and mitigation.....	74
17.4	Configuring MAC Privacy protection.....	76
18.	MAC Privacy protection protocol.....	81
18.1	Addressing.....	81
18.2	Data origin authenticity, frame data integrity and confidentiality.....	82
18.3	Applicability.....	82
18.4	Bandwidth utilization, fragmentation, and transit delay.....	83
18.5	Coexistence and use.....	84
19.	Encoding of MAC Privacy protection Protocol Data Units.....	85
19.1	Structure, representation, and encoding.....	85
19.2	MPPDU Format.....	85

19.3	MAC Privacy protection EtherType	86
19.4	Protocol Version strategy.....	87
19.5	MPPDU component encoding	87
19.6	MPPDU generation.....	90
19.7	MPPDU validation.....	91
20.	MAC Privacy protection Entity (PrY) operation.....	93
20.1	PrY overview	93
20.2	Model of operation.....	94
20.3	PrY architecture	94
20.4	MAC status and point-to-point parameters.....	95
20.5	Privacy Selection	95
20.6	Unprotected frame transmission	96
20.7	Privacy Frame transmission.....	96
20.8	Privacy Channel transmission.....	97
20.9	Privacy Channel MPPDU Generation	97
20.10	Privacy Channel Encapsulation	100
20.11	MPPDU reception and demultiplexing.....	101
20.12	MPPDU component validation and extraction.....	103
20.13	Protected frame reception and reassembly	103
20.14	PrY management.....	106
20.15	PrY performance requirements.....	109
21.	MAC Privacy protection in Systems	110
21.1	MAC Privacy protection interface stacks	110
21.2	Privacy protection for end station interfaces	112
21.3	MAC Privacy protection for bridge interfaces	112
21.4	Privacy protection for Link Aggregation.....	113
21.5	EDEs with MAC Privacy protection	114
21.6	Privacy protection with shared media.....	115
21.7	Privacy protection and multi-access LANs	116
21.8	Separate privacy protection devices	116
22.	MAC Privacy protection Entity (Pry) MIB	117
22.1	Introduction.....	117
22.2	The Internet-Standard Management Framework.....	117
22.3	Relationship to other MIBs.....	117
22.4	Security considerations	119
22.5	Structure of the MIB module	120
23.	YANG Data Models	139
23.1	YANG Framework	140
23.2	MAC Security Entity (SecY) model.....	141
23.3	Security considerations for the SecY model.....	145
23.4	MAC Privacy protection (PrY) model.....	146
23.5	Security considerations for the PrY model.....	148
23.6	Interface stack models	149
23.7	Security considerations for interface stack models.....	151
23.8	System models	151
23.9	Security considerations for system models.....	152
23.10	YANG module schema.....	153
23.11	YANG modules	157

ISO/IEC/IEEE 8802-1AE:2020/Amd.4:2024(en)

Annex B (informative) Bibliography	186
Annex D (normative) PICS Proforma for an Ethernet Data Encryption device	188
D.5 EDE type and common requirements	188
D.8 EDE-CC Configuration.....	189
Annex G (informative) SecY Management and MIB revisions	190
Annex H (normative) PICS proforma for MAC Privacy protection	191
H.1 Introduction.....	191
H.2 Abbreviations and special symbols.....	191
H.3 Instructions for completing the PICS proforma.....	192
H.4 PICS proforma for IEEE Std 802.1AE MAC Privacy protection	194
H.5 Mandatory capabilities.....	195
H.6 Optional capabilities	196
Annex I (informative) Privacy considerations in bridged networks	197
I.1 Personal devices.....	197
I.2 Goals of adversaries.....	197
I.3 Network operation	198
I.4 Network security and privacy.....	199
I.5 Privacy exposures	199
I.6 Standard specific considerations.....	201

(<https://standards.iteh.ai>)
Document Preview

[ISO/IEC/IEEE 8802-1AE:2020/Amd 4:2024](https://standards.iteh.ai/catalog/standards/iso/2a446d5f-54c1-4a2b-b3c5-08e3d60be4bd/iso-iec-ieee-8802-1ae-2020-amd-4-2024)

<https://standards.iteh.ai/catalog/standards/iso/2a446d5f-54c1-4a2b-b3c5-08e3d60be4bd/iso-iec-ieee-8802-1ae-2020-amd-4-2024>

Figures

Figure 10-5	SecY managed objects	28
Figure 13-1	MACsec Interface Stack	30
Figure 17-1	Privacy-protected communication between bridges	73
Figure 17-2	A privacy protected user data frame	73
Figure 17-3	Privacy selection, priority and traffic class mapping.....	80
Figure 19-1	MACsec protected MPPDU	85
Figure 19-2	MPPDU Examples	86
Figure 19-3	MAC Privacy protection EtherType encoding.....	87
Figure 19-4	MPPDU component format	87
Figure 19-5	MPPDU component encoding	88
Figure 19-6	Frame Fragments.....	89
Figure 20-1	PrY and SecY	93
Figure 20-2	PrY architecture	94
Figure 20-3	Privacy Channel Encapsulation state machine.....	102
Figure 20-4	Protected frame reception and reassembly.....	104
Figure 20-5	Reassembly state machine	105
Figure 20-6	PrY Managed objects	107
Figure 21-1	A Privacy-protecting interface stack.....	110
Figure 21-2	Privacy-protected Bridge Ports	112
Figure 21-3	Privacy protection and Link Aggregation.....	113
Figure 21-4	EDE-CC with privacy-protection.....	114
Figure 21-5	EDE-CCs communicating over a PBN	114
Figure 21-6	Privacy-protection using existing EDEs	116
Figure 22-1	PrY Interfaces	117
Figure 22-2	PrY MIB structure.....	121
Figure 23-1	YANG hierarchy, models and objects	140
Figure 23-2	SecY model system nodes and references	142
Figure 23-3	SecY model system nodes and references	143
Figure 23-4	PrY model interface nodes.....	147
Figure 23-5	Explicit and augmented interface stack models for an end station	149
Figure 23-6	Two further interface stack modeling choices	149
Figure 23-7	An interface stack model for link aggregation and MACsec.....	150
Figure 23-8	An interface stack with LLDP instances.....	150

Tables

Table 19-1	MAC Privacy protection EtherType allocation	86
Table 22-1	Use of ifGeneralInformationGroup Objects	118
Table 22-2	Use of ifCounterDiscontinuityGroup Object.....	119

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[ISO/IEC/IEEE 8802-1AE:2020/Amd 4:2024](https://standards.iteh.ai/catalog/standards/iso/2a446d5f-54c1-4a2b-b3c5-08e3d60be4bd/iso-iec-ieee-8802-1ae-2020-amd-4-2024)

<https://standards.iteh.ai/catalog/standards/iso/2a446d5f-54c1-4a2b-b3c5-08e3d60be4bd/iso-iec-ieee-8802-1ae-2020-amd-4-2024>

IEEE Standard for Local and Metropolitan Area Networks —

Media Access Control (MAC) Security

Amendment 4: MAC Privacy Protection

[This amendment is based on IEEE Std 802.1AE™-2018.]

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

The editing instructions are shown in ***bold italics***. 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 by using ***strikethrough*** (to remove old material) and ***underline*** (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Deletions and 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

1.1 Introduction

Change 1.1 as follows:

IEEE 802® Local Area Networks (LANs) are often deployed in networks that support mission-critical applications. These include corporate networks of considerable extent, and public networks that support many customers with different economic interests. The protocols that configure, manage, and regulate access to these networks typically run over the networks themselves. Preventing disruption and data loss arising from transmission and reception by unauthorized parties is highly desirable, since it is not practical to secure the entire network against physical access by determined attackers.

[The MAC Security protocol](#) (MACsec), as defined by this standard, allows authorized systems that attach to and interconnect LANs in a network to maintain confidentiality of transmitted data and to take measures against frames transmitted or modified by unauthorized devices.

MACsec facilitates

- a) Maintenance of correct network connectivity and services
- b) Isolation of denial of service attacks
- c) Localization of any source of network communication to the LAN of origin
- d) The construction of public networks, offering service to unrelated or possibly mutually suspicious customers, using shared LAN infrastructures
- e) Secure communication between organizations, using a LAN for transmission
- f) Incremental and non-disruptive deployment, protecting the most vulnerable network components

To deliver these benefits, MACsec has to be used in conjunction with appropriate policies for higher-level protocol operation in networked systems, an authentication and authorization framework, and network management. IEEE Std 802.1X™ provides authentication and cryptographic key distribution.¹

MACsec protects communication between trusted components of the network infrastructure, thus protecting the network operation. MACsec cannot protect against attacks facilitated by the trusted components themselves, and is complementary to, rather than a replacement for, end-to-end application-to-application security protocols. The latter can secure application data independent of network operation, but cannot necessarily defend the operation of network components, or prevent attacks using unauthorized communication from reaching the systems that operate the applications.

[MAC Privacy protection protocol, as defined by this standard, can be used in conjunction with MACsec to reduce the ability of adversaries to correlate the MAC addresses, sizes, and transmission timing of user data frames with individual persons, network applications, details of those applications, and levels of application activity.](#)

¹ Information on other references can be found in Clause 2.

ISO/IEC/IEEE 8802-1AE:2020/Amd.4:2024(en)

IEEE Std 802.1AE:2023
IEEE Standard for Local and Metropolitan Area Networks—Media Access Control (MAC) Security—Amendment 4: MAC Privacy Protection

1.2 Scope

Change 1.2 as follows:

The scope of this standard is to specify provision of connectionless user data confidentiality, frame data integrity, and data origin authenticity by media access independent protocols and entities that operate transparently to MAC Clients.

NOTE—The MAC Clients are as specified in IEEE Std 802, IEEE Std 802.1Q™, and IEEE Std 802.1X™.²

To this end it

- a) Specifies the requirements to be satisfied by equipment claiming conformance to this standard.
- b) Specifies the requirements for [MAC Security](#) ~~MACsec~~ in terms of provision of the MAC Service and the preservation of the semantics and parameters of service requests and indications.
- c) Describes the threats, both intentional and accidental, to correct provision of the service.
- d) Specifies security services that prevent, or restrict, the effect of attacks that exploit these threats.
- e) Examines the potential impact of both the threats and the use of MACsec on the Quality of Service (QoS), specifying constraints on the design and operation of MAC Security entities and protocols.
- f) Models support of the secure MAC Service in terms of the operation of media access control method independent MAC Security Entities (SecYs) within the MAC Sublayer.
- g) Specifies the format of the MACsec Protocol Data Unit (MPDUs) used to provide secure service.
- h) Identifies the functions to be performed by each SecY, and provides an architectural model of its internal operation in terms of Processes and Entities that provide those functions.
- i) Specifies each SecY's use of an associated and collocated Port Access Entity (PAE, IEEE Std 802.1X) to discover and authenticate MACsec protocol peers, and its use of that PAE's Key Agreement Entity (KaY) to agree and update cryptographic keys.
- j) Specifies performance requirements and recommends default values and applicable ranges for the operational parameters of a SecY.
- k) Specifies how SecYs are incorporated within the architecture of end stations, bridges, and two-port Ethernet Data Encryption devices (EDEs).
- l) Establishes the requirements for management of MAC Security, identifying the managed objects and defining the management operations for SecYs.
- m) Specifies ~~the a~~ Management Information Base (MIB) module for [SecY management](#) ~~managing the operation of MAC Security in TCP/IP networks~~.
- n) [Specifies a YANG configuration and operational state model for SecY management.](#)
- o) Specifies requirements, criteria, and choices of Cipher Suites for use with this standard.
- p) [Describes threats to individual privacy that can result from an adversary's observation of individual frames, even if those frames are integrity protected and their data confidentiality protected.](#)
- q) [Models support of a privacy protected secure MAC Service in terms of the operation of MAC Privacy protection Entities \(PrYs\) that encapsulate user data frames in MAC Privacy protection Protocol Data Units \(MPPDUs\) to hide the user source and destination MAC addresses and to reduce any correlation of the sizes and transmission timing of frames with user identities and communication purposes, applications, or content.](#)
- r) [Specifies the addressing, encoding, and decoding of MPPDUs.](#)
- s) [Identifies the functions to be performed by each PrY, and provides an architectural model of its internal operation in terms of Processes and Entities that provide those functions.](#)

² Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

ISO/IEC/IEEE 8802-1AE:2020/Amd.4:2024(en)

IEEE Std 802.1AEk-2023
IEEE Standard for Local and Metropolitan Area Networks—Media Access Control (MAC) Security—Amendment 4: MAC Privacy Protection

- t) [Specifies performance requirements and recommends default values and applicable ranges for the operational parameters of a PrY.](#)
- u) [Specifies how PrYs can be incorporated within the architecture of end stations, bridges, two-port Ethernet Data Encryption devices \(EDEs\), and bridged networks.](#)
- v) [Describes the requirements for management of MAC Privacy protection, identifying the managed objects and defining the managed objects for PrYs.](#)
- w) [Specifies a Management Information Base \(MIB\) module for PrY management.](#)
- x) [Specifies a YANG configuration and operational state model for PrY management.](#)

iTeh Standards
(<https://standards.itih.ai>)
Document Preview

[ISO/IEC/IEEE 8802-1AE:2020/Amd 4:2024](https://standards.itih.ai/catalog/standards/iso/2a446d5f-54c1-4a2b-b3c5-08e3d60be4bd/iso-iec-ieee-8802-1ae-2020-amd-4-2024)

<https://standards.itih.ai/catalog/standards/iso/2a446d5f-54c1-4a2b-b3c5-08e3d60be4bd/iso-iec-ieee-8802-1ae-2020-amd-4-2024>

2. Normative references

Change the list of normative references in Clause 2 as follows:

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.

IEEE Std 802[®], IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture.^{3,4}

IEEE Std 802.1Q[™], IEEE Standard for Local and Metropolitan Area Networks: Bridges and Bridged Networks.

IEEE Std 802.1X[™], IEEE Standard for Local and Metropolitan Area Networks: Port-Based Network Access Control.

~~IEEE Std 802.1Xbx[™] 2014, IEEE Standard for Local and Metropolitan Area Networks: Port-Based Network Access Control—Amendment 1: MAC Security Key Agreement Protocol (MKA) Extensions.~~

IEEE Std 802.1AB[™], IEEE Standard for Local and Metropolitan Area Networks: Station and Media Access Control Connectivity and Discovery.

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

IEEE Std 802.3[™], IEEE Standard for Ethernet.

IETF RFC 1213: Management Information Base for Network Management of TCP/IP-based internets: MIB-II, McCloghrie, K., and Rose, M. T., March 1991.⁵

IETF RFC 2578, STD 58, Structure of Management Information for Version 2 of the Simple Network Management Protocol (SNMPv2), McCloghrie, K., Perkins, D., Schoenwaelder, J., Case, J., Rose, M., and Waldbusser, S., April 1999.

IETF RFC 2579, STD 58, Textual Conventions for Version 2 of the Simple Network Management Protocol (SNMPv2), McCloghrie, K., Perkins, D., Schoenwaelder, J., Case, J., Rose, M., and Waldbusser, S., April 1999.

IETF RFC 2580, STD 58, Conformance Statements for SMIV2, McCloghrie, K., Perkins, D., Schoenwaelder, J., Case, J., Rose, M., and Waldbusser, S., April 1999.

IETF RFC 2863, The Interfaces Group MIB using SMIV2, McCloghrie, K., and Kastenholz, F., June 2000.

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

[IETF RFC 7317, A YANG Data Model for System Management, Bierman, A., Bjorklund, M., August 2014.](#)

[IETF RFC 7950, The YANG 1.1 Data Modeling Language, Bjorklund, M., August 2016.](#)

³ IEEE publications are available from The Institute of Electrical and Electronics Engineers (<https://www.standards.ieee.org>).

⁴ The IEEE standards or products referred to in this clause are trademarks of The Institute of Electrical and Electronics Engineers, Inc.

⁵ IETF RFCs are available from the Internet Engineering Task Force (<https://www.ietf.org/rfc.html>).

ISO/IEC/IEEE 8802-1AE:2020/Amd.4:2024(en)

IEEE Std 802.1AEk-2023
IEEE Standard for Local and Metropolitan Area Networks—Media Access Control (MAC) Security—Amendment 4: MAC Privacy Protection

[IETF RFC 8343, A YANG Data Model for Interface Management, Bjorklund, M., March 2018.](#)

ISO/IEC 14882, Information Technology—Programming languages—C++.⁶

NIST Special Publication 800-38D, Recommendation for Block Cipher Modes of Operation: Galois/Counter Mode (GCM) and GMAC, November 2007.⁷

iTeh Standards (<https://standards.iteh.ai>) Document Preview

[ISO/IEC/IEEE 8802-1AE:2020/Amd 4:2024](https://standards.iteh.ai/catalog/standards/iso/2a446d5f-54c1-4a2b-b3c5-08e3d60be4bd/iso-iec-ieee-8802-1ae-2020-amd-4-2024)

<https://standards.iteh.ai/catalog/standards/iso/2a446d5f-54c1-4a2b-b3c5-08e3d60be4bd/iso-iec-ieee-8802-1ae-2020-amd-4-2024>

⁶ ISO/IEC documents are available from the International Organization of Standardization (<https://www.iso.org/>) and from the International Electrotechnical Commission (<http://www.iec.ch>). These documents are also available from the American National Standards Institute (<https://www.ansi.org/>).

⁷ NIST Special Publications are available from the National Institute of Standards and Technology (<https://csrc.nist.gov/>).