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

**Part 1AE:
Media access control (MAC) security**

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

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



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IEEE Std 802.1AE™-2018
(Revision of IEEE Std 802.1AE-2006)

**IEEE Standard for
Local and metropolitan area networks—
Media Access Control (MAC) Security**

Sponsor
LAN/MAN Standards Committee
of the
IEEE Computer Society

Approved 27 September 2018
IEEE-SA Standards Board

Abstract: How all or part of a network can be secured transparently to peer protocol entities that use the MAC Service provided by IEEE 802[®] LANs to communicate is specified in this standard. MAC security (MACsec) provides connectionless user data confidentiality, frame data integrity, and data origin authenticity.

Keywords: authorized port, confidentiality, data origin authenticity, IEEE 802.1AE™, IEEE 802.1AEbn™, IEEE 802.1AEbw™, IEEE 802.1AEcg™, integrity, LANs, local area networks, MAC Bridges, MAC security, MAC Service, MANs, metropolitan area networks, port-based network access control, secure association, security, transparent bridging

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Introduction

This introduction is not part of IEEE Std 802.1AE-2018, IEEE Standard for Local and metropolitan area networks—Media Access Control (MAC) Security.

The first edition of IEEE Std 802.1AE was published in 2006. The first amendment, IEEE Std 802.1AEbn™-2011, added the option of using the GCM-AES-256 Cipher Suite. The second, IEEE Std 802.1AEbw™-2013, added the GCM-AES-XPB-128 and GCM-AES-XPB-256 Cipher Suites. These extended packet numbering Cipher Suites allow more than 2^{32} frames to be protected with a single Secure Association Key (SAK) and so ease the timeliness requirements on key agreement protocols for very high speed (100 Gb/s plus) operation. The third amendment, IEEE Std 802.1AEcg™-2017, specified Ethernet Data Encryption devices (EDEs) that provide transparent secure connectivity while supporting provider network service selection and provider backbone network selection as specified in IEEE Std 802.1Q™.

This revision, IEEE Std 802.1AE-2018, incorporates the text of IEEE Std 802.1AE-2006 and amendments IEEE Std 802.1AEbn-2011, IEEE Std 802.1AEbw-2013, and IEEE Std 802.1AEcg-2017.

Relationship between IEEE Std 802.1AE and other IEEE 802® standards

IEEE Std 802.1X™-2010 specifies Port-based Network Access Control, provides a means of authenticating and authorizing devices attached to a Local Area Network (LAN), and includes the MACsec Key Agreement protocol (MKA) necessary to make use of IEEE Std 802.1AE.

IEEE Std 802.1AE is not intended for use with IEEE Std 802.11™. That standard also uses IEEE Std 802.1X, thus facilitating the use of a common authentication and authorization framework for LAN media to which this standard applies and for Wireless LANs.

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IEEE Standard for Local and metropolitan area networks— Media Access Control (MAC) Security

1. Overview

1.1 Introduction

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.

MAC Security (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

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

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.

1.2 Scope

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 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 Management Information Base (MIB) module for managing the operation of MAC Security in TCP/IP networks.
- n) Specifies requirements, criteria, and choices of Cipher Suites for use with this standard.

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

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used; therefore, 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.

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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.

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

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>).

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/>).