INTERNATIONAL STANDARD

ISO/IEC/ IEEE 8802-1AX

First edition
2016-01-15

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

Part 1AX: Link Aggregation

Technologies de l'information — Télécommunications et échange d'information entre systèmes — Réseaux locaux et métropolitains — Exigences spécifiques —

Partie 1AX: Agrégation de lien

Reference number
ISO/IEC/IEEE 8802-1AX:2016(E)

COPYRIGHT PROTECTED DOCUMENT

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org
Published in Switzerland

Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York
NY 10016-5997, USA
E-mail stds.ipr@ieee.org
Web www.ieee.org

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 8802-1AX was prepared by the LAN/MAN of the IEEE Computer Society (as IEEE 8802-1AX-2014). 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.

IEEE STANDARDS ASSOCIATION IEEE

IEEE Standard for
Local and metropolitan area networks—

Link Aggregation

IEEE Computer Society

Sponsored by the
LAN/MAN Standards Committee

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

IEEE Std 802.1AX™-2014
(Revision of
IEEE Std 802.1AX-2008)

IEEE Std 802.1AX™-2014
(Revision of
IEEE Std 802.1AX-2008)

IEEE Standard for
Local and metropolitan area networks—

Link Aggregation

Sponsor
LAN/MAN Standards Committee
of the
IEEE Computer Society

Approved 10 December 2014
IEEE SA-Standards Board

Abstract: MAC-independent Link Aggregation capability and general information relevant to specific MAC types are defined in this standard. Link Aggregation allows parallel full-duplex point-to-point links to be used as if they were a single link and also supports the use of multiple links as a resilient load sharing interconnect between multiple nodes in two separately administered networks.

Keywords: Aggregated Link, Aggregator, Distributed Resilient Network Interconnect, DRNI, IEEE 802®, IEEE 802.1AX™, interconnect, Link Aggregation, Link Aggregation Group, local area network, management, Network-Network Interface, NNI

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

Print: ISBN 978-0-7381-9448-6 STD20052
PDF: ISBN 978-0-7381-9449-3 STDPD20052

Important Notices and Disclaimers Concerning IEEE Standards Documents

IEEE documents are made available for use subject to important notices and legal disclaimers. These notices and disclaimers, or a reference to this page, appear in all standards and may be found under the heading "Important Notice" or "Important Notices and Disclaimers Concerning IEEE Standards Documents."

Notice and Disclaimer of Liability Concerning the Use of IEEE Standards Documents

IEEE Standards documents (standards, recommended practices, and guides), both full-use and trial-use, are developed within IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association ("IEEE-SA") Standards Board. IEEE ("the Institute") develops its standards through a consensus development process, approved by the American National Standards Institute ("ANSI"), which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and participate without compensation from IEEE. While IEEE administers the process and establishes rules to promote fairness in the consensus development process, 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.

IEEE does not warrant or represent the accuracy or content of the material contained in its standards, and expressly disclaims all warranties (express, implied and statutory) not included in this or any other document relating to the standard, including, but not limited to, the warranties of: merchantability; fitness for a particular purpose; non-infringement; and quality, accuracy, effectiveness, currency, or completeness of material. In addition, IEEE disclaims any and all conditions relating to: results; and workmanlike effort. IEEE standards documents are supplied "AS IS" and "WITH ALL FAULTS."

Use of an IEEE standard is wholly voluntary. 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.

In publishing and making its standards available, IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity nor is IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing any IEEE Standards document, should rely upon his or her own independent judgment in the exercise of reasonable care in any given circumstances or, as appropriate, seek the advice of a competent professional in determining the appropriateness of a given IEEE standard.

IN NO EVENT SHALL IEEE BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO: PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE PUBLICATION, USE OF, OR RELIANCE UPON ANY STANDARD, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE AND REGARDLESS OF WHETHER SUCH DAMAGE WAS FORESEEABLE.

Translations

The IEEE consensus development process involves the review of documents in English only. In the event that an IEEE standard is translated, only the English version published by IEEE should be considered the approved IEEE standard.

Official statements

A statement, written or oral, that is not processed in accordance with the IEEE-SA Standards Board Operations Manual shall not be considered or inferred to be the official position of IEEE or any of its committees and shall not be considered to be, or be relied upon as, a formal position of 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 of IEEE.

Comments on standards

Comments for revision of IEEE Standards documents are welcome from any interested party, regardless of membership affiliation with IEEE. However, IEEE does not provide consulting information or advice pertaining to IEEE Standards documents. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Since IEEE standards represent a consensus of concerned interests, it is important that any responses to comments and questions also receive 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 comments or questions except in those cases where the matter has previously been addressed. For the same reason, IEEE does not respond to interpretation requests. Any person who would like to participate in revisions to an IEEE standard is welcome to join the relevant IEEE working group.

Comments on standards should be submitted to the following address:

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

Laws and regulations

Users of IEEE Standards documents should consult all applicable laws and regulations. Compliance with the provisions of any IEEE Standards document 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

IEEE draft and approved standards are copyrighted by IEEE under U.S. and international copyright laws. They are made available by IEEE and are adopted 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 these documents available for use and adoption by public authorities and private users, IEEE does not waive any rights in copyright to the documents.

Photocopies

Subject to payment of the appropriate fee, IEEE will grant users a limited, non-exclusive license to photocopy portions of any individual standard for company or organizational internal use or individual, non-commercial use only. To arrange for payment of licensing fees, 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.

Updating of IEEE Standards documents

Users of IEEE Standards documents 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.

Every IEEE standard is subjected to review at least every ten years. When a document is more than ten years old and has not undergone a revision process, 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 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-SA Website at http://ieeexplore.ieee.org/expel/standards.jsp or contact IEEE at the address listed previously. For more information about the IEEE-SA or IOWA's standards development process, visit the IEEE-SA Website at http://standards.ieee.org.

Errata

Errata, if any, for all IEEE standards can be accessed on the IEEE-SA Website at the following URL: http://standards.ieee.org/findstds/errata/index.html. Users are encouraged to check this URL for errata periodically.

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 by the IEEE with respect to the existence or validity of any patent rights in connection therewith. If a patent holder or patent applicant has filed a statement of assurance via an Accepted Letter of Assurance, then the statement is listed on the IEEE-SA Website at http://standards.ieee.org/about/sasb/patcom/patents.html. Letters of Assurance may indicate whether the Submitter is willing or unwilling to grant licenses under patent 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.

Essential Patent Claims may exist for which a Letter 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.

Participants

The following individuals were officers and members of the Higher Layer LAN Protocols Working Group at the beginning of the Working Group ballot. Individuals may have not voted, voted for approval, disapproval, or abstained on this standard.

Glenn Parsons, *Working Group Chair*
John Messenger, *Working Group Vice Chair*
Stephen Haddock, *Chair, Interworking Task Group*
Michael Seaman, *Chair, Security Task Group*
Michael Johas Teener, *Chair, Time Sensitive Networking Task Group*
Pat Thaler, *Chair, Data Center Bridging Task Group*
Maximilian Riegel, *Chair, OmniRAN Task Group*
Eric Gray, *Recording Secretary*

Ting Ao
Christian Boiger
Paul Bottorff
David Chen
Feng Chen
Weiying Cheng
Diego Crupnicoff
Rodney Cummings
Patrick Diamond
Aboubacar Kader Diarra
Janos Farkas
Norman Finn
Geoffrey Garner
Anoop Ghanwani
Mark Gravel
Craig Gunther
Hitosh Hayakawa
Jeremy Hitt
Rahil Hussain
Anthony Jeffree
Peter Jones
Hal Keen
Marcel Kiessling
Yongbum Kim
Philippe Klein
Jouni Korhonen
Jeff Lynch
Ben Mack-Crane
Christophe Mangin
James McIntosh
Eric Multanen
Donald Pannell
Karen Randall
Dan Romascanu
Jessy V. Rouyer
Panagiotis Saltsidis
Behcet Sarikaya
Daniel Sexton
Johannes Specht
Kevin B. Stanton
Wilfried Steiner
Vahid Tabatabaee
Jeremy Touve
Karl Weber
Yuehua Wei
Brian Weis
Jordon Woods
Juan-Carlos Zuniga

The following members of the individual balloting committee voted on this standard. Balloters may have voted for approval, disapproval, or abstention.

Thomas Alexander
Richard Alfvin
Butch Anton
Jacob Ben Ary
Nancy Bravin
William Byrd
Juan Carreon
Keith Chow
Charles Cook
Patrick Diamond
Yezid Donoso
Sourav Dutta
Donald Eastlake, 3rd
Richard Edgar
Andrew Fieldsend
Yukihiro Fujimoto
Devon Gayle
Anoop Ghanwani
Randall Groves
Chris Guy
Stephen Haddock
Werner Hoelzl
Rita Horner
Victor Hou
Noriyuki Ikeuchi
James Innis
Osamu Ishida
Akio Iso
Atsushi Ito
Raj Jain
Anthony Jeffree
Michael Johas Teener
Peter Jones
Shinkyo Kaku
Piotr Karocki
Stuart Kerry
Yongbum Kim
Bruce Kraemer
Geoff Ladwig
Mark Laubach
John Lemon
Ru Lin
Elvis Maculuba
Roger Marks
Jeffery Masters
Brett Mcclellan
Jonathon Mclendon
Richard Mellitz
John Messenger
Charles Moorwood
Jose Morales
Michael Newman
Nick S.A. Nikjoo
Paul Nikolich
Satoshi Obara
Maximilian Riegel
Dan Romascanu
Jessy V. Rouyer
Panagiotis Saltsidis
Peter Saunderson
Michael Seaman
Kapil Sood
Thomas Starai
Rene Struik
Walter Struppler
William Taylor
Dmitri Varsanofiev
Prabodh Varshney
George Vlantis
Hung-Yu Wei
Andreas Wolf
Chun Yu
Charles Wong
Michael Wright
Oren Yuen
Daidi Zhong

When the IEEE-SA Standards Board approved this standard on 10 December 2014, it had the following membership:

John Kulick, *Chair*
Jon Walter Rosdahl, *Vice Chair*
Richard H. Hulett, *Past Chair*
Konstantinos Karachalios, *Secretary*

Peter Balma
Farooq Bari
Ted Burse
Clint Chaplain
Stephen Dukes
Jean-Phillippe Faure
Gary Hoffman
Michael Janezic
Jeffrey Katz
Joseph L. Koepfinger*
David J. Law
Hung Ling
Oleg Logvinov
T. W. Olsen
Glenn Parsons
Ron Peterson
Adrian Stephens
Peter Sutherland
Yatin Trivedi
Phil Winston
Don Wright
Yu Yuan

*Member Emeritus

Also included are the following nonvoting IEEE-SA Standards Board liaisons:

Richard DeBlasio, *DOE Representative*
Michael Janezic, *NIST Representative*

Michelle Turner
IEEE-SA Content Publishing

Kathryn Bennett
IEEE-SA Technical Community Programs

Introduction

This introduction is not part of IEEE Std 801.AX™-2014, IEEE Standard for Local and metropolitan area networks—Link Aggregation.

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 can be obtained from:

Secretary, IEEE-SA Standards Board
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08855-1331
USA

Contents

IEEE Standard for
Local and metropolitan area networks—

Link Aggregation

1. Overview

1.1 Scope

Link Aggregation provides protocols, procedures, and managed objects that allow the following:

— One or more parallel instances of full-duplex point-to-point links to be aggregated together to form a Link Aggregation Group (LAG), such that a MAC Client can treat the LAG as if it were a single link.

— A resilient interconnect using multiple full-duplex point-to-point links among one to three nodes in a network and one to three nodes in another, separately administered, network, along with a means to ensure that frames belonging to any given service will use the same physical path in both directions between the two networks.

This standard defines the MAC-independent Link Aggregation capability and general information relevant to specific MAC types that support Link Aggregation. The capabilities defined are compatible with previous versions of this standard.

1.2 Purpose

Link Aggregation allows the establishment of full-duplex point-to-point links that have a higher aggregate bandwidth than the individual links that form the aggregation, and the use of multiple systems at each end of the aggregation. This allows improved utilization of available links in bridged local area network (LAN) environments, along with improved resilience in the face of failure of individual links or systems. In

applications connecting separately administered networks, the networks are isolated from each other's fault recovery events.

1.3 State diagram conventions

This document uses the state diagram conventions of IEEE Std 802.1Q™-2011, Annex E.[1]

Should a conflict exist between a state diagram and either the corresponding global transition tables or the textual description associated with the state machine, the state diagram takes precedence.

[1]Information on references can be found in Clause 2.

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 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.[2, 3]

IEEE Std 802.1AC™, IEEE Standard for Local and Metropolitan Area Networks Media Access Control (MAC) Service Definition.

IEEE Std 802.1D™, IEEE Standard for Local and metropolitan area networks Media Access Control (MAC) Bridges.

IEEE Std 802.1Q™-2011, IEEE Standard for Local and metropolitan area networks: Media Access Control (MAC) Bridges and Virtual Bridged Local Area Networks.

IEEE Std 802.3™-2012, IEEE Standard for Ethernet.

IETF RFC 1213 (IETF STD 17), Management Information Base for Network Management of TCP/IP-based internets: MIB-II, McCloghrie K., and M. Rose, Editors, March 1991. [4]

IETF RFC 1321, The MD5 Message-Digest Algorithm, R. Rivest. April 1992.

IETF RFC 2578 (STD 58), Structure of Management Information Version 2 (SMIv2), K. McCloghrie, D. Perkins, J. Schoenwaelder. April 1999.

IETF RFC 2579 (STD 58), Textual Conventions for SMIv2, McCloghrie, K., Perkins, D., Schoenwaelder, J., Case, J., Rose, M. and S. Waldbusser, April 1999.

IETF RFC 2580 (STD 58), Conformance Statements for SMIv2, McCloghrie, K., Perkins, D., Schoenwaelder, J., Case, J., Rose, M. and S. Waldbusser, April 1999.

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

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

IETF RFC 3414 (STD 62), User-based Security Model (USM) for Version 3 of the Simple Network Management Protocol (SNMPv3), U. Blumenthal, B. Wijnen. December 2002.

IETF RFC 3415 (STD 62), View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP), B. Wijnen, R. Presuhn, K. McCloghrie, December 2002.

ISO/IEC 10165-4:1992, Information technology—Open Systems Interconnection—Structure of management information—Part 4: Guidelines for the definition of managed objects.[5]

[2]IEEE publications are available from The Institute of Electrical and Electronics Engineers (http://standards.ieee.org/).

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

[4]IETF documents (i.e., RFCs) are available for download at http://www.rfc-archive.org/.

[5]ISO/IEC publications are available from the ISO Central Secretariat (http://www.iso.org/). ISO publications are also available in the United States from the American National Standards Institute (http://www.ansi.org/).