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Partie 1AX: Agrégation de lien

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IEEE Std 802.1AX™-2020
(Revision of IEEE Std 802.1AX-2014)

IEEE Standard for Local and Metropolitan Area Networks—

Link Aggregation

Developed by the

LAN/MAN Standards Committee
of the
IEEE Computer Society

Approved 30 January 2020

IEEE SA Standards Board

Abstract: Link Aggregation allows parallel 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. This standard defines a MAC-independent Link Aggregation capability and provides general information relevant to specific MAC types.

Keywords: Aggregated Link, Aggregator, Distributed Resilient Network Interconnect, DRNI, interconnect, Link Aggregation, Link Aggregation Group, local area network, management, Network-Network Interface, NNI

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Introduction

(This introduction is not part of IEEE Std 802.1AX-2020, IEEE Standard for Local and Metropolitan Area Networks—Link Aggregation.)

Link Aggregation allows one or more links to be aggregated together to form a Link Aggregation Group (LAG) so that the Link Aggregation Client can treat the LAG as if it were a single link. Link Aggregation was originally published as IEEE Std 802.3ad™-2000 and subsequently incorporated into the IEEE Std 802.3™, 2000 Edition. In 2008 Link Aggregation was removed from IEEE Std 802.3 and published as IEEE Std 802.1AX-2008. These standards specified the aggregation of full-duplex point-to-point links using IEEE Std 802.3 media of the same speed.

An amendment, IEEE Std 802.1AXbk™-2012, specified changes to the addressing used by the link aggregation control and marker protocols to allow a LAG to span Two-Port Media Access Control (MAC) Relays (TPMRs) and to span Provider Bridged Networks and Provider Backbone Bridge Networks.

A revision, IEEE Std 802.1AX-2014, extended Link Aggregation in three areas. First, it explicitly allowed the aggregation of point-to-point links of any speed using any physical media or logical connection capable of supporting the Internal Sublayer Service specified in IEEE Std 802.1AC™. Second, it specified Conversation-Sensitive Collection and Distribution (CSCD) that provides a mechanism to identify the distribution algorithm in use to map data frames to individual links in the LAG and to convey that information to the Link Aggregation Partner via Link Aggregation Control Protocol Data Units (LACPDUs) containing version 2 type/length/values (TLVs). Third, it specified Distributed Resilient Network Interconnect (DRNI) that allows a LAG to terminate at two or three cooperating Systems so that the LAG provides resiliency to System-level failures as well as link level failures. A corrigendum, IEEE Std 802.1AX-2014/Cor 1-2017, provided technical and editorial corrections to CSCD.

This revision, IEEE Std 802.1AX-2020, makes significant refinements and simplifications to the Link Aggregation Control Protocol (LACP) as well as to CSCD and DRNI. In LACP, the Periodic state machine and Transmit state machine are combined to a single machine, and the Mux machine is optimized to reduce the likelihood of excessive Link Aggregation Control Protocol Data Unit (LACPDU) transmissions. CSCD is refined to eliminate the TLVs that led to LACPDUs greater than 128 bytes in length. DRNI is significantly revised and simplified to support a LAG terminating at just two (not three) cooperating Systems.

Every effort has been made to maintain interoperability, without prior configuration, with LACP implementations conforming to IEEE Std 802.3ad-2000, IEEE Std 802.1AX-2008, or IEEE Std 802.1AX-2014 and with CSCD implementations conforming to IEEE Std 802.1AX-2014. The changes to DRNI, and in particular the Distributed Relay Control Protocol (DRCP), are such that an implementation conforming to this standard will not interoperate with a DRCP implementation conforming to IEEE Std 802.1AX-2014. The DRCP version number in this standard has been changed to version 2, and care has been taken so that a DRCP implementation conformant to IEEE Std 802.1AX-2014 will discard version 2 DRCPDUs as invalid and that implementations of this standard will discard version 1 DRCPDUs.

This standard contains state-of-the-art material. The area covered by this standard is undergoing evolution. Revisions are anticipated within the next few years to clarify existing material, to correct possible errors, and to incorporate new related material. Information on the current revision state of this and other IEEE 802 standards may be obtained from

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IEEE 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 point-to-point links to be aggregated together to form a Link Aggregation Group (LAG) so that a Link Aggregation Client can treat the LAG as if it were a single link.

— Conversation-Sensitive Collection and Distribution (CSCD) that specifies a means to identify the distribution algorithm in use to assign frames to individual links in a LAG and to convey that information to the System at the other end of the LAG.

— Distributed Resilient Network Interface (DRNI) that enables a LAG to terminate at a pair of cooperating Systems in order to provide system-level as well as link-level resiliency.

1.2 Purpose

Link Aggregation allows the establishment of 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.

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1.3 State diagram conventions

This standard uses the state diagram conventions in Annex E of IEEE Std 802.1Q™-2018.[1]

When implementation of a state diagram is required for conformance, all states and transitions shown with solid lines shall be implemented. States and transitions shown with dashed lines may be implemented.

If a conflict exists 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.

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2. Normative references

The following referenced documents are indispensable for the application of this standard (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this standard 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 802.1Q™, IEEE Standard for Local and Metropolitan Area Networks—Bridges and Bridged Networks.

IEEE Std 802.3™, 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, Mar. 1991.[4]

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

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

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

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

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

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

IETF RFC 3415 (STD 62), View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP), Wijnen, B., R. Presuhn, and K. McCloghrie, Dec. 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 (https://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 from the Internet Engineering Task Force (https://www.rfc-archive.org/).

[5] ISO/IEC publications are available from the International Organization for Standardization (https://www.iso.org/), the International Electrotechnical Commission (https://www.iec.ch), and the American National Standards Institute (https://www.ansi.org/).

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3. Definitions

For the purposes of this standard, the following terms and definitions apply. The *IEEE Standards Dictionary Online* can be consulted for terms not defined in this clause.[6]

This standard makes use of the following terms defined in IEEE Std 802:

— end station
— logical link
— station

This standard makes use of the following terms defined in IEEE Std 802.1AC:

— client (7.1 of IEEE Std 802.1AC-2016)
— frame (7.2 of IEEE Std 802.1AC-2016)
— Internal Sublayer Service (ISS) (Clause 11 of IEEE Std 802.1AC-2016)
— port (7.4 of IEEE Std 802.1AC-2016)

NOTE 1—It is helpful for the reader of this standard to review IEEE Std 802.1AC's description of the basic architectural concepts and terms used in this standard.[7]

This standard makes use of the following terms defined in IEEE Std 802.1Q:

— Bridge
— service instance

Actor: The local entity in a Link Aggregation Control Protocol exchange.

Aggregateable: A link terminating at an Aggregation Port that is configured to allow that link to form a Link Aggregation Group with other Aggregation Links.

Aggregation Key: A parameter, associated with each Aggregation Port and with each Aggregator of an Aggregation System, that prohibits the participation of multiple Aggregation Ports and Aggregators in the same Link Aggregation Group if their Aggregation Keys differ.

Aggregation Link: A local area network (LAN) that connects two Aggregation Systems.

Aggregation Port: A Service Access Point in an Aggregation System that provides access to a single Aggregation Link.

Aggregation System: A system that includes one or more Aggregators, each capable of using one or more Aggregation Ports to provide service to an Aggregator Client.

Aggregator: A multiplexing/demultiplexing entity that is capable of providing service at an Aggregator Port using the services provided by one or more Aggregation Ports.

Aggregator Client: A protocol entity that makes use of the service provided by a single Aggregator.

Aggregator Port: A port that provides access to the service provided by a single Aggregator.

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[6] *IEEE Standards Dictionary Online* subscription is available at https://dictionary.ieee.org. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.
[7] Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

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conversation: A set of frames transmitted from one end station to another, with the assumption that the communicating end stations require intermediate systems to maintain the ordering of those frames.

Conversation ID: An integer in the range of 0 through 4095, where each value identifies one or more conversations.

Distributed Relay: Transmission and reception of frames by Distributed Resilient Network Interconnect (DRNI) Gateway Ports in a pair of DRNI Systems using Aggregator Ports and Intra-Relay Ports in both DRNI Systems.

Distributed Relay Client: A protocol entity that makes use of the service provided by a DRNI Gateway.

Distributed Resilient Network Interconnect (DRNI): The DRNI Gateways in a pair of Aggregation Systems that are connected by an Intra-Relay Connection and can be used to create a single Link Aggregation Group using Aggregation Ports from either or both of the Aggregation Systems.

Down frame: A frame that has entered a Distributed Relay from the Distributed Relay Client.

DRNI Gateway: A protocol entity in an Distributed Resilient Network Interconnect (DRNI) System that can be paired with a DRNI Gateway in a another DRNI System and that provides Distributed Relay service at a DRNI Gateway Port using the services provided by an Aggregator Port in each system.

DRNI Gateway Port: A port that provides access to the service provided by a single Distributed Resilient Network Interconnect (DRNI) Gateway.

DRNI System: An Aggregation System containing one or more Distributed Resilient Network Interconnect (DRNI) Gateways.

Gateway Conversation ID: A Conversation identifier (ID) associated with a frame for the purpose of selecting a Distributed Resilient Network Interconnect (DRNI) Gateway Port.

Home: The local entity in a Distributed Relay Control Protocol (DRCP) exchange.

Intra-Relay Connection (IRC): A logical link that connects a pair of Distributed Resilient Network Interconnect (DRNI) Gateways comprising a Distributed Relay.

Intra-Relay Port (IRP): The service interface of a Distributed Resilient Network Interconnect (DRNI) Gateway provided by an Intra-Relay Connection.

Key: *See:* **Aggregation Key.**

Link Aggregation Group (LAG): A group of links that appear to an Aggregator Client as a single link.

Link_Number: An Aggregation Link identifier that is unique within a Link Aggregation Group, with an operational value common to both the Actor and Partner Systems.

Neighbor: The remote entity in a Distributed Relay Control Protocol (DRCP) exchange.

Partner: The remote entity in a Link Aggregation Control Protocol (LACP) exchange.

Port Conversation ID: A Conversation identifier (ID) associated with a frame for the purpose of selecting an Aggregation Port.

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Service Identifier (Service ID): A value extracted from the header of a frame (e.g., VID, I-SID) that identifies the service instance with which that frame is associated.

NOTE 2—This standard makes use of service identifiers specified in IEEE Std 802.1Q.

Solitary: An Aggregation Link that cannot be included in a Link Aggregation Group with any other Aggregation Link, due to administrative configuration at either of the attached Aggregation Systems.

System: When used in this standard and not preceded by “Aggregation” or “DRNI”, “System” means an Aggregation System.

Up frame: A frame that has entered a Distributed Relay through an Aggregator Port.

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