IEEE SA
STANDARDS ASSOCIATION

IEEE Standard for Interoperability of Internet Protocol Security (IPsec) Utilized within Utility Control Systems

STANDARDS

IEEE Power and Energy Society

Developed by the
Power System Communications and Cybersecurity Committee

IEEE Std 2030.102.1™-2020

IEEE

IEEE Standard for Interoperability of Internet Protocol Security (IPsec) Utilized within Utility Control Systems

Developed by the

Power System Communications and Cybersecurity Committee
of the
IEEE Power and Energy Society

Approved 3 December 2020

IEEE SA Standards Board

Abstract: Specific configuration requirements within the relevant Internet Engineering Task Force (IETF) Request for Comments (RFC) for implementation of the Internet Protocol Security (IPsec) protocol suite within a utility control system are identified in this standard. It is not intended to be a comprehensive guide to implementing IPsec. Promoting interoperability between products developed by different vendors is the primary goal in developing this standard. Configuration parameters needed to support the establishment and sustained operation of an IPsec Virtual Private Network (VPN) tunnel between two devices which have implemented IPsec conforming to this standard are the focus of this standard. Minimizing configuration errors involving IPsec implementations within utility control systems is a secondary goal of this standard. Product agnosticism and applicability to any device (e.g., router, substation gateway, intelligent electronic device, etc.) is the intent of this standard, within the utility control system as the end user deems necessary for their unique system architecture.

Keywords: control systems, cyber security, encryption, ICS, IEEE 2030.102.1™, IPsec, Lemnos, privacy, Virtual Private Network, VPN

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

PDF: ISBN 978-1-5044-7293-7 STD24553
Print: ISBN 978-1-5044-7294-4 STDPD24553

Important Notices and Disclaimers Concerning IEEE Standards Documents

IEEE Standards documents are made available for use subject to important notices and legal disclaimers. These notices and disclaimers, or a reference to this page (https://standards.ieee.org/ipr/disclaimers.html), appear in all standards and may be found under the heading "Important Notices and Disclaimers Concerning IEEE Standards Documents."

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

IEEE Standards documents are developed within the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE SA) Standards Board. IEEE develops its standards through an accredited consensus development process, which brings together volunteers representing varied viewpoints and interests to achieve the final product. IEEE Standards are documents developed by volunteers with scientific, academic, and industry-based expertise in technical working groups. Volunteers are not necessarily members of IEEE or IEEE SA, 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 completeness 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. In addition, IEEE does not warrant or represent that the use of the material contained in its standards is free from patent infringement. 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: THE NEED TO PROCURE 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 is 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, nor 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 the presenter's views should be considered the personal views of that individual rather than the formal position of IEEE, IEEE SA, the Standards Committee, or the Working Group.

Comments on standards

Comments for revision of IEEE Standards documents are welcome from any interested party, regardless of membership affiliation with IEEE or IEEE SA. However, **IEEE does not provide interpretations, 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 evaluating comments or in revisions to an IEEE standard is welcome to join the relevant IEEE working group. You can indicate interest in a working group using the Interests tab in the Manage Profile and Interests area of the IEEE SA myProject system. An IEEE Account is needed to access the application.

Comments on standards should be submitted using the Contact Us form.

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 constitute 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.

Data privacy

Users of IEEE Standards documents should evaluate the standards for considerations of data privacy and data ownership in the context of assessing and using the standards in compliance with applicable laws and regulations.

Copyrights

IEEE draft and approved standards are copyrighted by IEEE under US 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 licensing fees, 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; https://www.copyright.com/. 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 10 years. When a document is more than 10 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 IEEE Xplore or contact IEEE. For more information about the IEEE SA or IEEE's standards development process, visit the IEEE SA Website.

Errata

Errata, if any, for all IEEE standards can be accessed on the IEEE SA Website. Search for standard number and year of approval to access the web page of the published standard. Errata links are located under the Additional Resources Details section. Errata are also available in IEEE Xplore. Users are encouraged to periodically check for errata.

Patents

IEEE Standards are developed in compliance with the IEEE SA Patent Policy.

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 https://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.

IMPORTANT NOTICE

IEEE Standards do not guarantee or ensure safety, security, health, or environmental protection, or ensure against interference with or from other devices or networks. IEEE Standards development activities consider research and information presented to the standards development group in developing any safety recommendations. Other information about safety practices, changes in technology or technology implementation, or impact by peripheral systems also may be pertinent to safety considerations during implementation of the standard. Implementers and users of IEEE Standards documents are responsible for determining and complying with all appropriate safety, security, environmental, health, and interference protection practices and all applicable laws and regulations.

Participants

At the time this IEEE standard was submitted to the IEEE SA Standards Board for approval, the S3 Working Group had the following membership:

James Bougie, *Chair*
Marc Lacroix, *Vice Chair*

Xiangyu Ding
Michael Dood
James Formea
Colin Gordon
Steven Kunsman
Jason Lombardo
Yuri Luskind
Ralph Mackiewicz
Scott Morris
Craig Preuss

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

William Ackerman
Mihaela Albu
Christopher Belcher
Wallace Binder
Demetrio Bucaneg Jr.
Paul Cardinal
Pin Chang
George Clark
Michael Dood
Neal Dowling
Thomas Dunmore II
Kenneth Fodero
James Formea
Fredric Friend
Jean-Sebastien Gagnon
Edwin Goodwin
Roman Graf
Randall Groves
Werner Hoelzl
Gary Hoffman
Anthony Johnson
Brian Johnson
Innocent Kamwa
Yuri Khersonsky
Jim Kulchisky
Marc Lacroix
Jose Marrero
Alexander Micallef
Sepehr Mogharei
Jerry Murphy
Lorraine Padden
Bansi Patel
Howard Penrose
R.K. Rannow
Charles Rogers
Daniel Sabin
Thomas Schossig
Robert Seitz
Scott Sternfeld
David Tepen
James Van De Ligt
Benton Vandiver
John Vergis
Quintin Verzosa
Jeffrey Wischkaemper
Kipp Yule

When the IEEE SA Standards Board approved this standard on 3 December 2020, it had the following membership:

Gary Hoffmann, *Chair*
Jon Walter Rosdahl, *Vice Chair*
John D. Kulick, *Past Chair*
Konstantinos Karachalios, *Secretary*

Ted Burse
Doug Edwards
J.Travis Griffith
Grace Gu
Guido R. Hiertz
Joseph L. Koepfinger*
David J. Law
Howard Li
Dong Liu
Kevin Lu
Paul Nikolich
Damir Novosel
Dorothy Stanley
Mehmet Ulema
Lei Wang
Sha Wei
Philip B. Winston
Daidi Zhong
Jingyi Zhou

*Member Emeritus

Introduction

This introduction is not part of IEEE Std 2030.102.1–2020, IEEE Standard for Interoperability of Internet Protocol Security (IPsec) Utilized within Utility Control Systems.

Interoperability is not a new concept in the context of cyber security. It is, however, a difficult and challenging concept that poses a significant barrier to establishing and maintaining a secure posture for control systems deployed within the electric utility sector. This standard represents a continuation of work that began under the Lemnos Interoperable Security Project, which was a multiyear effort under the DOE Office of Electricity Delivery and Energy Reliability's Cybersecurity for Energy Delivery Systems (CEDS) program in support of the Roadmap to Secure Energy Delivery Systems. The Lemnos Project established a process to address this challenge by selecting open standards, namely Internet Engineering Task Force (IETF) Request for Comments (RFCs), and then developing profiles that detail specific configuration requirements within the RFC. The intent of these profiles is to be product-agnostic and able to be applied modularly to any device (e.g., router, substation gateway, intelligent electronic device) within the utility control system as the end user deems necessary for their unique system architecture.

This standard identifies specific configuration requirements within the relevant Internet Engineering Task Force (IETF) Request for Comments (RFCs) for implementation of the Internet Protocol Security (IPsec) protocol suite as part of a utility control system. It has been developed relative to IPv4. It is not intended to be a comprehensive guide to implementing IPsec.

Contents

IEEE Standard for Interoperability of Internet Protocol Security (IPsec) Utilized within Utility Control Systems

1. Overview

1.1 Scope

This standard specifies requirements for interoperability of devices utilized within utility control systems, which implement the Internet Protocol Security (IPsec) protocol suite within an IPv4 environment.

1.2 Purpose

The purpose of this document is to define a specific configuration profile for the Internet Protocol Security (IPSec) protocol suite suitable for use within a utility control system. The primary goal in developing this standard is to promote interoperability between products developed by different vendors. It focuses on those configuration parameters needed to support the establishment and sustained operation of an IPSec Virtual Private Network (VPN) tunnel between two devices that have implemented IPSec conforming to this standard. A secondary goal of this standard is to help minimize configuration errors involving IPSec implementations within utility control systems.

1.3 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals is *required to*).[1,2]

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals is *recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals is *permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals is *able to*).

[1]The use of the word *must* is deprecated and cannot be used when stating mandatory requirements, *must* is used only to describe unavoidable situations.
[2]The use of *will* is deprecated and cannot be used when stating mandatory requirements, *will* is only used in statements of fact.