IEEE SA
STANDARDS ASSOCIATION

STANDARDS

IEEE Standard for Policy Language for Dynamic Spectrum Access Systems

IEEE Communications Society

Developed by the
Dynamic Spectrum Access Networks Standards Committee

IEEE Std 1900.5.1™-2020

IEEE

IEEE Standard for Policy Language for Dynamic Spectrum Access Systems

Developed by the

Dynamic Spectrum Access Networks Standards Committee
of the
IEEE Communications Society

Approved 3 December 2020

IEEE SA Standards Board

Abstract: A vendor-independent policy language for managing the functionality and behavior of dynamic spectrum access networks based on the language requirements defined in IEEE Std 1900.5™, IEEE Standard Policy Language Requirements and System Architectures for Dynamic Spectrum Access Systems, is defined in this standard.

Keywords: Description Logic, Dynamic Spectrum Access, First Order Logic, Horn-based rules, IEEE 1900.5.1™, IEEE 1900.5.2™, Policy Language, RIF Framework for Logic Dialect (RIF-FLD), rule interchange format (RIF), Spectrum Consumption Modeling, Web Ontology Language (OWL 2)

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

PDF: ISBN 978-1-5044-7261-6 STD24537
Print: ISBN 978-1-5044-7262-3 STDPD24537

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 & 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.

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 completed, the Policy Language and Architectures for Managing Cognitive Radio for Dynamic Spectrum Access Applications Working Group had the following membership:

Tony Rennier, *Chair*
Darcy-Swain Walsh, *Vice Chair*
Carlos Caicedo, *Secretary*

David Chester
Colb Harper
Nilesh Khamberkar
Mieczyslaw Kokar
Yuriy Posherstnik
Venkatesha Prasad
Sam Schmitz
Reinhard Schrage
John Stine

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

Demetrio Bucaneg Jr
Carlos Caicedo
Juan Carreon
Pin Chang
Todor Cooklev
Marc Emmelmann
Avraham Freedman
Tim Godfrey
Randall C. Groves
Marco Hernandez
Werner Hoelzl
Oliver Holland
Atsushi Ito
Piotr Karocki
Stuart Kerry
Mieczyslaw Kokar
Alexander Lackpour
Hyeong Ho Lee
Kin Hong Lee
Jeffery Masters
Edward McCall
Nicks A. Nikjoo
Arumugam Paventhan
Clinton Powell
Venkatesha Prasad
Ranga Reddy
Tony Rennier
Maximilian Riegel
Benjamin Rolfe
Thomas Starai
John Stine
Walter Struppler
Mark-Rene Uchida
John Vergis
Lisa Ward
Hung-Yu Wei
Andreas Wolf
Oren Yuen

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

Gary Hoffman, *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 1900.5.1-2020, IEEE Standard for Policy Language for Dynamic Spectrum Access Systems.

Acknowledgments

OWL 2 Web Ontology Language Structural Specification and Functional-Style Syntax (Second Edition). W3C Recommendation, 11 December 2012. Available at http://www.w3.org/TR/owl2-syntax/

OWL 2 Web Ontology Language Direct Semantics (Second Edition). W3C Recommendation, 11 December 2012. Available at http://www.w3.org/TR/owl2-direct-semantics/

OWL 2 Web Ontology Language Profiles (Second Edition). W3C Recommendation, 11 December 2012. Available at http://www.w3.org/TR/owl2-profiles/#Feature_Overview_3

RIF Framework for Logic Dialects (Second Edition). W3C Recommendation, 5 February 2013. Available at http://www.w3.org/TR/rif-fld/#Semantic_Framework

RIF Core Dialect (Second Edition). W3C Recommendation 5 February 2013. Available at http://www.w3.org/TR/rif-core/

OWL Web Ontology Language Reference, M. Dean, G. Schreiber, Editors, W3C Recommendation, 10 February 2004. Available at http://www.w3.org/TR/owl-ref/

Resource Description Framework (RDF): Concepts and Abstract Syntax], G. Klyne, J. Carrol, Editors, W3C Recommendation, 10 February 2004, http://www.w3.org/TR/2004/REC-rdf-concepts-20040210/. Available at http://www.w3.org/TR/rdf-concepts/

RIF Basic Logic Dialect (Second Edition) Harold Boley, Michael Kifer, eds. W3C Recommendation, 5 February 2013, http://www.w3.org/TR/2013/REC-rif-bld-20130205/. Available at http://www.w3.org/TR/rif-bld/

RIF Core Dialect (Second Edition) Harold Boley, Gary Hallmark, Michael Kifer, Adrian Paschke, Axel Polleres, Dave Reynolds, eds. W3C Recommendation, 5 February 2013, http://www.w3.org/TR/rif-core./

RIF Datatypes and Built-Ins 1.0 (Second Edition) Axel Polleres, Harold Boley, Michael Kifer, eds. W3C Recommendation, 5 February 2013, http://www.w3.org/TR/2013/REC-rif-dtb-20130205/. Available at http://www.w3.org/TR/rif-dtb/

RIF In RDF (Second Edition) Sandro Hawke, Axel Polleres, eds. W3C Working Group Note, 5 February 2013, http://www.w3.org/TR/2013/NOTE-rif-in-rdf-20130205/.

RIF Combination with XML data (Second Edition) Christian de Sainte Marie, editor. W3C Working Group Note, 5 February 2013, http://www.w3.org/TR/2013/NOTE-rif-xml-data-20130205/. Available at http://www.w3.org/TR/rif-xml-data/

RIF Overview, Kifer M. and Boley H. (Editors), W3C Rule Interchange Format Working Group Note. Available at http://www.w3.org/TR/rif-overview/

OWL 2 RL in RIF (Second Edition) Dave Reynolds, editor. W3C Working Group Note, 5 February 2013, http://www.w3.org/TR/2013/NOTE-rif-owl-rl-20130205/.

RIF Framework for Logic Dialects (Second Edition) Harold Boley, Michael Kifer, eds. W3C Recommendation, 5 February 2013, http://www.w3.org/TR/2013/REC-rif-fld-20130205/. Available at http://www.w3.org/TR/rif-fld/

RIF Production Rule Dialect (Second Edition) Christian de Sainte Marie, Gary Hallmark, Adrian Paschke, eds. W3C Recommendation, 5 February 2013, http://www.w3.org/TR/2013/REC-rif-prd-20130205/. Available at http://www.w3.org/TR/rif-prd/

RIF RDF and OWL Compatibility (Second Edition) Jos de Bruijn, Chris Welty, eds. W3C Recommendation, 5 February 2013, http://www.w3.org/TR/2013/REC-rif-rdf-owl-20130205/. Available at http://www.w3.org/TR/rif-rdf-owl/

RIF Test Cases (Second Edition) Stella Mitchell, Leora Morgenstern, Adrian Paschke, eds. W3C Working Group Note, 5 February 2013, http://www.w3.org/TR/2013/NOTE-rif-test-20130205/. Available at http://www.w3.org/TR/rif-test/

RIF Use Cases and Requirements (Second Edition) Adrian Paschke, Leora Morgenstern, David Hirtle, Allen Ginsberg, Paula-Lavinia Patranjan, Frank McCabe, eds. W3C Working Group Note, 5 February 2013, http://www.w3.org/TR/2013/NOTE-rif-ucr-20130205/.

RIF Approved Test Cases, Mitchell, S. (Editor), RIF Approved Test Cases. Available at http://www.w3.org/2005/rules/wiki/Category:Approved

Contents

IEEE Standard for Policy Language for Dynamic Spectrum Access Systems

1. Overview

1.1 Introductory prevailing conditions

In the development of this standard, the following conditions were to be met:

a) The development of this standard was required to follow the specifications of IEEE Std 1900.5™-2011.[1]

b) According to IEEE Std 1900.5-2011, the language should be based both on the Web Ontology Language (OWL 2) and on a rules language compatible with OWL 2, that is, be compatible with a suitable rule interchange format (RIF) dialect.

c) The development of the standard required some linguistic constructs that are not available in current RIF dialects as RIF Basic Logic Dialect (RIF-BLD), RIF Production Rule Dialect (RIF-PRD), and RIF-Core.

d) Consequently, this new standard is introducing a new dialect of RIF [RIF Spectrum Consumption Modeling (SCM) Dialect based on RIF Framework for Logic Dialect (RIF-FLD) called "RIF-DSA"].

e) Since this standard is addressed to the community of radio and networks community, to make the language usable to this community, introductory material on formal languages like RDF, OWL, and RIF, as well as logic and theory of computation, needed to be included.

f) One requirement of IEEE Std 1900.5-2011 was that the language should be able to use ontologies to define policies. Toward this end, an example ontology was used. This ontology is not part of the standard.

1.2 Scope

This document defines a standard for a formal language to specify policies for radio devices that use cognitive patterns in their operating behavior.

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