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IEEE Standard for Definitions and Concepts for Dynamic Spectrum Access: Terminology Relating to Emerging Wireless Networks, System Functionality, and Spectrum Management

IEEE Communications Society

Sponsored by the
Dynamic Spectrum Access Networks Standards Committee (DySPAN-SC)

IEEE
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IEEE Std 1900.1™-2019
(Revision of IEEE Std 1900.1-2008)

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Abstract: Definitions and explanations of key concepts in the fields of spectrum management, spectrum trading, cognitive radio, dynamic spectrum access, policy-based radio systems, software-defined radio, and related advanced radio system technologies are provided. Beyond simple, short definitions, amplifying text explaining these terms in the context of the technologies that use them is provided. Also described is how these technologies interrelate and create new capabilities while at the same time providing mechanisms supportive of new spectrum management paradigms.

Keywords: cognitive radio, cognitive radio networks, dynamic spectrum access, IEEE 1900.1™, policy-based radio system, software-controlled radio, software-defined radio, spectrum management, spectrum trading

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Introduction

This introduction is not part of IEEE Std 1900.1-2019, IEEE Standard for Definitions and Concepts for Dynamic Spectrum Access: Terminology Relating to Emerging Wireless Networks, System Functionality, and Spectrum Management.

This standard establishes common terminology for describing emerging networks and nodes employing radio devices characterized by cognition, adaptation, environment awareness, and policy-based adaptive techniques. Specifically, the definitions provided in this document stem predominantly from a spectrum management point of view. It is anticipated that these definitions will ultimately mature and ideally achieve widespread acceptance among researchers, manufacturers, service providers, regulators, and operators.

The intent of this document is to promote a common understanding of systems technology and spectrum management terms so that technologists in a variety of fields such as radio science—including digital communications, computer science, and artificial intelligence—and regulators have a common understanding of the terminology. It is the intent of this document to provide concise definitions of key terms in advanced radio system technologies and in advanced spectrum management techniques.

The focus of this standard is on terms and concepts relating to emerging wireless networks, radio, technology, system functionality, and spectrum management. It was agreed that in some cases, multiple definitions for a specific term were appropriate. Development of this standard required:

a) The creation of some new terms (e.g., cognition) and the development of definitions for these new terms.

b) The development of alternative definitions for existing terms (e.g., dynamic frequency selection) that have been defined by other standards development organizations; these alternative definitions were required for next-generation radio and spectrum management because these terms have new meanings when used in the context of discussing advanced radio systems.

It is deemed to be outside the focus of this standard to include all of the terms relevant to wireless communications systems and spectrum management (e.g., radio frequency and radio signal). However, when deemed appropriate, existing terms from the ITU-R and other IEEE documents are included for the convenience of the reader even though the term and definition is unchanged for next-generation radio and spectrum management. These terms are clearly identified in the text.

This document provides normative terms and definitions to support the research and deployment of dynamic spectrum management (DSM) and dynamic spectrum access (DSA). Many factors are creating a need for DSM and DSA. Among the forces creating this need for change are as follows:

— The increasing use of wireless services and their need for spectrum

— The increasing data load being transmitted wirelessly, requiring increasing spectrum bandwidth

— The emergence of multimode products such as mobile, broadcast, and radiolocation into single devices

— Increasing pressure to guarantee spectrum access for priority services, such as public safety, while allowing other uses for that same spectrum when not in use by those priority services

Overview of new technologies

Terminology used to describe equipment, systems, and networks employing advanced radio functionality are contained within this standard that will provide researchers, manufacturers, service providers, regulators,

operators, and users with the means of describing advanced radio devices and spectrum management techniques. Some of the general features of these emerging radio and wireless networking systems are as follows:

— Flexibility
— Dynamic and adaptive behavior
— Awareness (e.g., location and radio environment), cognition, and intelligence
— Networking for group collaboration and interaction (e.g., sensing the spectrum usage environment)

These features create many new avenues for improving use and access to the radio spectrum. Specifically, they provide additional degrees of freedom that allow a device to choose the best method of spectrum access for a particular situation and to alter the method of access to respond to changing conditions. For example, dynamic spectrum access systems have been suggested as a fundamental, technology-enabled method to make more effective and efficient use of scarce available spectrum. In principle, the DSA concept advocates empowering radio systems with the local authority and responsibility to manage available spectrum. However, practical methods for designing, developing, and managing such systems remain in the early formative stages. Current spectrum management practices do not provide effective techniques for certifying these types of advanced radio devices or for managing their access to the radio spectrum. This situation could create barriers to the introduction of new radio technologies if resolution of spectrum issues for each new device must be addressed on a case-by-case basis.

Recent advancements in wireless communication technology have given rise to many new terms and concepts within the body of technical literature, including reconfigurable radio, software-defined radio, software-controlled radio, policy-defined radio, adaptive radio, cognitive radio, and others. Although radios certainly play an important part in the design and construction of wireless communication systems, these advanced technologies extend beyond what is commonly thought of as *radio*. When describing these technologies, therefore, it is more useful to consider them in the context of a complete communications system or network.

For example, the terms *cognitive radio* and *adaptive radio* are often used, and although it may be a convenient linguistic construct, it is unclear that the use of these terms is always both linguistically and logically correct. In wireless communication systems, radios are physical devices that transmit and receive information encoded on radio-frequency (RF) waveforms using antennas, transmitters, and receivers. That is, radios are designed to perform certain functions, for example receiving and transmitting. The development of this standard was founded on the premise that wireless communication systems will evolve to the point where cognitive and adaptive functionality play an important, essential role in their use of the radio spectrum, and that the industry is now approaching that point in history. Consequently, this standard provides definitions for terms describing this expanded functionality that are relevant to spectrum use by next-generation radios and networks. For example, the cognition function may not be just a radio function as radio is defined herein; some of the functionality may lie outside the radio itself. This focus is provided throughout the standard.

The term *cognitive* has recently entered into the lexicon of wireless networks in an attempt to describe a functionality that is inherently distributed within not only a given network but also potentially a network of networks. Consider, for example, a network of unlicensed band Wi-Fi[1] access points and stations providing Internet access for the population of a metropolitan area, operating alongside a public safety network, including police, fire, and ambulance communications in the same band, with both networks sharing information that allows them to coexist. This new cognitive functionality provides a mechanism for peaceful coexistence among multiple networks and the potential for equitable sharing of RF spectrum. As the term *cognitive* implies, at the heart of the new technology is knowledge, that is, information that is gathered and stored in possibly a distributed manner throughout the network of networks.

[1]Wi-Fi is a registered trademark of the Wi-Fi Alliance.

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1. Overview

1.1 Scope

This standard provides definitions and explanations of key concepts in the fields of spectrum management, spectrum trading, cognitive radio, dynamic spectrum access, policy-based radio systems, software-defined radio, and related advanced radio system technologies. The document goes beyond simple, short definitions by providing amplifying text that explains these terms in the context of the technologies that use them. The document also describes how these technologies interrelate and create new capabilities while at the same time providing mechanisms supportive of new spectrum management paradigms.

This revision to IEEE Std 1900.1™-2008 adds additional definitions, modifies existing definitions, and removes outdated definitions; it updates the auxiliary text and informative annexes to reflect new concepts and developments in advanced radio systems; introduces a taxonomy of terms which depicts relationships between definitions and concepts, and updates the document structure to align revised definitions, concepts, and relationships between terms and definitions.

1.2 Purpose

New concepts and technologies are rapidly emerging in the fields of spectrum management, spectrum trading, cognitive radio, dynamic spectrum access, policy-based radio systems, software-defined radio, and related advanced radio system technologies. Many of the terms used do not have precise definitions or have multiple definitions. This document facilitates the development of these technologies by clarifying the terminology and how these technologies relate to each other.

2. Acronyms and abbreviations

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.[2]

[2]*IEEE Standards Dictionary Online* is available at: http://dictionary.ieee.org.