



IEEE Recommended Practice for the Analysis of In-Band and Adjacent Band Interference and Coexistence Between Radio Systems

IEEE Communications Society

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IEEE Standards Coordinating Committee 41 on
Dynamic Spectrum Access Networks

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Dynamic Spectrum Access Networks**

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Abstract: Technical guidelines are provided in this recommended practice for analyzing the coexistence or, alternatively, the interference between radio systems, operating in the same spectrum assignment or between different spectrum assignments.

Keywords: adaptive radio, coexistence, cognitive radio, dynamic spectrum access, interference, policy-defined radio, software-defined radio, spectrum, spectrum access

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Introduction

This introduction is not part of IEEE Std 1900.2-2008, IEEE Recommended Practice for the Analysis of In-Band and Adjacent Band Interference and Coexistence Between Radio Systems.

Introduction to IEEE SCC 41 and the IEEE 1900 series of standards

This recommended practice was developed under the auspices of IEEE Standards Coordinating Committee 41 (Dynamic Spectrum Access Networks, or DySPAN) (formerly IEEE 1900 Standards Committee on Next Generation Radio and Spectrum Management). SCC 41 (DySPAN) serves as a forum for the exchange of information in the area of dynamic spectrum access networks and to act as a sponsor for related standards projects. Taken together, current and future activities under the SCC 41 (DySPAN) will provide standards and recommended practices for addressing the many facets and issues introduced by DySPAN. Individual standards activities are designated as a series of p1900.x projects and include:

- Recommended practice for interference and coexistence analysis (this recommended practice)
- Recommended practice for dependability and conformance evaluation of regulatory compliance for radio systems with dynamic spectrum access
- Standard architectural building blocks enabling distributed decision making for optimized radio resource usage in heterogeneous wireless access networks
- Standard terms, definitions, and concepts for advanced radio spectrum management
- Other topics to be determined

Use and interpretation of this recommended practice (prepared by the IEEE P1900.2 Working Group) is expected to be aided and facilitated by referring to the products of the other, complementary projects under SCC 41 (DySPAN), as they are completed and published.

Introduction to IEEE Std 1900.2

Perhaps the critical question to be answered when analyzing interference is, at what point is there harmful interference among radio systems coexisting in common spectrum assignments? As it is commonly used, harmful interference is a broad concept, combining the physical facts of a situation with the economic perspective and values of the stakeholders involved. This document seeks to bring greater understanding and precision to the term and to apply more objective criteria to its assessment, particularly in a dynamic and changing coexistence environment.^a This recommended practice addresses several elements necessary for making an analysis of the potential for harmful interference. It seeks, wherever possible, to require a scientific and objective approach for an interference and coexistence analysis. It is hoped that by stating and clarifying assumptions and by providing a normalized structure for engineering analysis that the determination of the relative importance of the benefits and risks will be facilitated.

^aThe imprecise nature of the concept is best addressed by first determining the facts, differing assumptions that might be made, and then allowing the relevant decision-making authority to make its decision within the range of credible conclusions. This standard primarily serves to identify the agreed-on facts and to propose thresholds and objective criteria for a specific scenario.

^bIn the International Radio Regulations (see IRR, Appendix 5 [B18]), and relevant ITU-R recommendations, the terms “harmful,” “permissible,” and “accepted interference” are defined, demonstrating the consensus of that body that levels of interference exist that are acceptable under conditions of static spectrum assignment. (See the international radio regulations of the ITU-R 1.166, ITU-R 1.167, ITU-R 1.168, and ITU-R 1.169.) This standard is intended to extend to spectrum assignments that may change dynamically, perhaps rapidly in time, depending on traffic or other local conditions, among a number of radio systems, coexisting in a common spectrum assignment.

Stated simply, an interference and coexistence analysis involves answering questions, such as:

- Where am I?
- Who else is around me?
- What do I have to worry about?
- What are my rights and responsibilities relative to others?
- What can help us get along?

This recommended practice provides a structure and describes a method for analyzing the interference between radio services under a variety of coexistence scenarios. Many variables to be used in this analysis will be detailed. The annexes provide helpful supportive material and examples of analysis using this document.

One reason for the analytical structure specified in this document is to provide an objective and uniform framework for assessing and analyzing interference and coexistence. From this framework, an understanding is gained of assumptions, dependencies, and relative importance of the variables of the problem.

In the end, a thorough interference and coexistence analysis provides an invaluable support when considering the acceptance of new technologies or systems that are to coexist in common, shared spectrum assignments.

Having this understanding of the physical reality and the technical facts, economic analysis or even a political formulation may be more effectively applied. To use the vernacular, you can figure out who pays whom and how much to make life good. Companies can also anticipate customer satisfaction and warranty costs for products that will be coexisting in dynamically assigned spectrum assignments.

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1. Overview

1.1 Relationship to traditional spectrum management

The introduction to the 2005 edition of the ITU-R National Spectrum Management Handbook states:

Society’s increasing use of radio-based technologies, and the tremendous opportunities for social development that these technologies provide, highlight the importance of radio-frequency spectrum and national spectrum management processes. Technological progress has continually opened doors to a variety of new spectrum applications that have spurred greater interest in, and demand for, the limited spectrum resource. Increased demand requires that spectrum be used efficiently and that effective spectrum management processes be implemented. In this framework, modern data handling capabilities and engineering analysis are important to accommodate the variety of potential users seeking access to the spectrum.

Radio communications is heavily used in a growing number of services such as national defense, public safety, broadcasting, business and industrial communications, aeronautical and maritime radio communications, navigation, and personal communications. Radio communication links, as opposed to wireless telecommunications, are necessary in a dynamic or mobile environment, where wire-line telecommunication may not be available, or where telecommunications have been disrupted, such as in emergency or natural disaster situations. Radio communication systems may operate from satellites or from terrestrial platforms.

If the spectrum is to be used efficiently, its use must be coordinated and regulated through both national regulations and the Radio Regulations of the International Telecommunication Union

(ITU). The ability of each country to take full advantage of the spectrum resource depends heavily on spectrum management activities that facilitate the implementation of radio systems and ensure minimum interference. To this end, administrations should, as appropriate, make use of computerized spectrum management systems.

The demand for spectrum continues to increase dramatically, and with it, the importance of efficient spectrum management is increasing. Fixed, universal rules to coordinate spectrum are not efficient. The most efficient spectrum allocation is not fixed to a single set of rules for all locations and situations nor is it static over time. Optimally spectrum management would be adaptive to specific situations and variable to the specific conditions at a given time and place. Dynamic and adaptive management of spectrum is now possible. The development of computer science, radio engineering, and related disciplines has reached the point where spectrum usage can now be controlled automatically by coexisting radio systems in real time. This replaces the manual method in which human radio-frequency (RF) planners used static frequency assignments.

1.2 Introduction to this recommended practice

Interference between systems occurs when operation of one system affects the performance of another system.¹ Two or more radio systems successfully coexist when the level of performance of all systems is judged to be acceptable. There may be some interference, but it is generally judged to be within acceptable limits.

Emerging technologies such as cognitive radio, ad hoc wireless networks, as well as dynamic and adaptive systems complicate the interference and coexistence analysis. For example, if a network can reroute data so loss of a particular link has no impact on end-to-end user performance, does loss of that link constitute interference? If it is judged to be interference, does it constitute harmful interference? If so, what is the appropriate remedy?

This recommended practice provides a structure for interference and coexistence analysis. The purpose of providing such a structure is to guide the analyst in considering all relevant issues in a systematic way. Furthermore, a uniform structure makes the comparison of different analyses easier. When different analyses utilize a common structure and method of analysis the reasons for similarities or differences in conclusions are more quickly identified. Thus, focus may be brought to the critical elements, where more data or further analysis may either confirm results or aid in the understanding of differing conclusions.

1.3 Scope

1.3.1 Formal scope²

This recommended practice will provide technical guidelines for analyzing the potential for coexistence or in contrast interference between radio systems operating in the same frequency band or between different frequency bands.

1.3.2 Discussion of scope

This is a recommended practice for analyzing the interference and coexistence among radio systems. It establishes a structured framework for analyzing interference and coexistence. It also establishes a structured document format for presenting the analysis to others.

¹Although the focus of this standard is interference and coexistence of radio systems, other kinds of systems utilize spectrum and are dependent on spectrum for their operation. The analytical methods proposed in this standard may be used when analyzing scenarios, including spectrum-dependent systems other than radio systems.

²The formal scope is the scope approved in the Project Authorization Request for this project.