IEEE 802.19.1a
Wireless Coexistence

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| Text proposal on treatment of WSO definition |
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Abstract

This document provides text proposal on treatment of WSO definition as shown in 19-16/0095r0.

=======(Text start)

1. Definitions, acronyms, and abbreviations
	1. Definitions

***Insert the following definitions in lexical order:***

**coexistence system:** A set of one or more coexistence enablers (CEs), coexistence managers (CMs), coordination enablers (COEs) and a coexistence discovery and information server (CDIS).

**coordination enabler (COE)**: An entity that can communicate with coexistence manager (CM) within the same coexistence system and with the coordination enabler (COE) within the other coexistence system.

general authorization: Frequency authorization that a device would be entitled to use the spectrum with no individual frequency planning/coordination (not be entitled to interference protection from the others).

geo-location capability: The ability of a device to identify its geographical coordinate with certain accuracy.

geo-location capable object (GCO): An entity that represents a device or network of devices operating under general authorization with geo-location capability. WSO is under an umbrella of GCO. The entity is connected to a coexistence enabler to consume coexistence services.

**priority-based channel assignment:** Assignment of a channel by the CM to a GCO in such a way that the GCO can operate alone in such channel for a specific reservation period and in a specific area based on particular minimum protection requirements of the GCO operating under general authorization in same frequency band.

**spectrum management database (SMDB)**: A database system approved by the relevant national regulatory authority which can communicate with GCOs and provide information on spectrum availability taking into account any operational changes from the protected incumbents. SMDB includes TVWS database, geo-location database, SAS database, and such kind of database system.

***Change the definitions as follows:***

**coexistence:** The ability of two or more spectrum-dependent devices or networks to operate without harmful interference under the same frequency authorization in the same frequency band each other.

**coexistence algorithms:** Procedures executed inside the coexistence system in order to provide the coexistence services. coexistence discovery: Procedure executed inside the coexistence system in order to find out a coexistence set for a coexistence enabler (CE) and its white space/geo-location capable object (WSO/GCO).

coexistence discovery: Procedure executed inside the coexistence system in order to find out a coexistence set for a coexistence enabler (CE) and its white space/geo-location capable object (WSO/GCO).

**coexistence discovery and information server (CDIS):** An entity that is responsible for determining for coexistence managers (CMs) those white space/geo-location capable objects (WSOs/GCOs) that may affect performance of the WSOs/GCOs that the CMs serve.

**coexistence enabler (CE):** An entity that represents a white space/geo-location capable object (WSO/GCO) in the coexistence system and serves one WSO/GCO at a time.

**coexistence manager (CM):** An entity that is responsible for making coexistence decisions related to reconfiguration of white space/geo-location capable objects (WSOs/GCOs) to solve coexistence problems among them.

**coexistence services:** Services provided by the coexistence system to dissimilar or independently operated white space/geo-location capable objects (WSOs/GCOs) as well as services provided by the entities of the coexistence system to other entities of the coexistence system.

**coexistence set:** A set of white space/geo-location capable objects (WSOs/GCOs) associated to a WSO/GCO containing those WSOs/GCOs that may affect performance of the WSO/GCO.

**coexistence set element:** One white space/geo-location capable object (WSO/GCO) of a coexistence set.

distributed decision making: A decision-making topology where one coexistence manager (CM) makes its decisions in coordination with ~~another~~ the other CM.

neighbor coexistence managers: At least two coexistence managers that serve white space/geo-location capableobjects (WSOs/GCOs) that may affect performance of each other.

profile: A statement of the procedures, messages, and parameters that are mandatory and that are optional for the implementation of IEEE 802.19.1/802.19.1a compliant coexistence system entity.

**registered location secure server (RLSS):** An entity that accesses and manages a database that organizes storage of information by ~~geographic~~geo-location and securely holds the location and some operating parameters of one or more basic service sets ~~(adapted from IEEE Std 802.11af™)~~.

* 1. Acronyms and abbreviations

***Insert the following definitions in lexical order:***

COE coordination enabler

SAS spectrum access system

SMDB spectrum management database

GCO geo-location capable object

1. System description
	1. System architecture

~~The~~A coexistence system defined in this draft standard has ~~three~~four logical entities and ~~five~~six logical interfaces. Two independent coexistence systems use one logical interface for information exchange, as shown in Figure 1. Each logical entity is defined by its functional roles and interfaces with other logical entities. System architecture is used to describe functional components of the coexistence system. The architectural descriptions are not intended to represent any specific physical implementation of the coexistence system.

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1. ・System architecture.

The Coexistence Discovery and Information Server (CDIS) provides coexistence discovery service to the Coexistence Managers (CMs) it serves. Within this service the CDIS informs the CMs about potential neighbors of the White Space/Geo-location Capable Objects (WSOs/GCOs) served by these CMs. Also, the CDIS supports the discovery of CMs by other CMs in order to open interfaces between them. In order to provide the coexistence discovery service, the CDIS obtains all necessary information and performs coexistence discovery.

The CM provides either information or management service to the WSO/GCOs it serves. Communication between the CM and the WSO/GCOs is performed via their Coexistence Enablers. Within the information service the CM provides the WSO/GCO information about its potential neighbors including their operating frequencies, potential interference levels etc. Within the management service the CM provides the WSO/GCO reconfiguration requests that create such configuration of this WSO/GCO that its operation is improved according to some criteria. In order to provide these information and management coexistence services, the CM obtains all necessary information and makes coexistence decisions.

The Coexistence Enabler (CE) is an interface element that represents one or several WSO/GCOs of the same type in the coexistence system.

The coordination enabler (COE) is an interface element that represents one or more CMs to communicate with the other COE that is included in the other independent coexistence system.

~~Interface B1 between a CE and a CM, interface B2 between a CM and a CDIS, and interface B3 between two CMs are specified in this standard.~~

Interface A between a CE and its WSO/GCO is defined in a generic format.

Interface B1 between a CE and a CM, interface B2 between a CM and a CDIS, interface B3 between two CMs and Interface B4 between a CM and a COE are specified within the same coexistence system. Interface B5 between two COEs in the independent coexistence systems is also specified in this standard.

Interface C between a CM and a spectrum management database (SMDB)~~TV white space database~~ is not defined in this standard and is implementation dependent. Thus the interface C is optional, and is not needed in the frequency band that SMDB does not exist. One of the implementation examples of the interface C is Protocol to Access ~~WS~~White Space database (PAWS) specification[[1]](#footnote-1) for TVWS operation.

* 1. Reference model

The coexistence system reference model has two service access points (SAPs): the coexistence transport SAP (COEX\_TR\_SAP) and the coexistence media SAP (COEX\_MEDIA\_SAP).

The COEX\_TR\_SAP provides means for a CE, a CM, a COE and a CDIS to communicate with each other and with external entities by using transport services provided by underlying layers.

Example reference model of a CE and a CM describing example of using COEX\_TR\_SAP for interface B1 is shown in Figure 2. Information required for coexistence and reconfiguration commands that are exchanged between a CE and a CM over the interface B1 are forwarded to transport layer [Transmission Control Protocol (TCP)] for transmission. This is done using the COEX\_TR\_SAP of the CE and the CM.



1. —Example of using the COEX\_TR\_SAP for interface B1

The COEX\_MEDIA\_SAP defines the interface A between a CE and a WSO/GCO.

An example reference model of a CE describing an example implementation of the interface A inside a base station is shown in Figure 3.

Typically, the radio interface is implemented in such a way that it provides a management interface for the WSO/GCO management entity. In Figure 3, such interface is represented by the PHY\_ME\_SAP, MAC\_ME\_SAP, and CS\_ME\_SAP, corresponding to the physical layer, the Media Access Control (MAC) sublayer, and the convergence sublayer. These SAPs can be used to obtain information from the radio interface and to request reconfiguration of the radio interface. Correspondingly, the CE can use these SAPs to implement interface A using the COEX\_MEDIA\_SAP. Communication between the radio interface management SAPs PHY\_ME\_SAP, MAC\_ME\_SAP, and CS\_ME\_SAP and the COEX\_MEDIA\_SAP is done via the WSO/GCO management entity. The WSO/GCO management entity provides the coexistence primitive mapping (CXPM) service. The CXPM converts COEX\_MEDIA\_SAP primitives into WSO/GCO-specific management/control primitives. A one-to-one mapping is highly desirable to fully support this standard, but feasibility of such an implementation depends on the standard the WSO/GCO complies with and the WSO/GCO implementation. The CXPM implementation is out of scope of this standard.



1. —Example reference model for the interface A

Different logical entities of the coexistence system have different reference models. Figure 4 shows the CE reference model. Figure 5 shows the reference model for the CM and CDIS.



1. —CE reference model



1. —CM, COE and CDIS reference model
	1. System profiles and interoperability

The coexistence system defined in this standard has four logical entities: CDIS, CM, COE and CE. This standard defines several profiles determining operation of these entities.

The profiles are defined as follows. The standard defines a common set of the data types, primitives, messages, and procedures. Each of the profiles uses only a specific part of the defined data types, primitives, messages, and procedures as defined in Clause 6.

However, profiles are designed in such way that the required level of interoperability is verified among entities operating according to different profiles. The defined profiles follow the following principles:

* Any CDIS shall be able to provide coexistence discovery service to any type of CM.
* Any CM shall be able to exchange information with any other type of CM.
* Any CM shall support at least one of the profiles specified in this specification.
* Any CM shall support both management service and information service.
* Any COE shall support at least one of the profiles specified in this specification.
* Any CE shall support at least one of the profiles specified in this specification.
* Any CE shall support at least management service or information service and may support both.
	1. Coexistence services
		1. Introduction

Coexistence services are services provided by the coexistence system to WSO/GCOs as well as services provided by the CDIS to the CMs. Correspondingly, the categories of the coexistence services are services provided to WSO/GCOs and services provided to CMs.

The coexistence services are illustrated in Figure 6.



1. —Summary of coexistence services
	* 1. Services for WSO/GCOs

The coexistence system provides coexistence services to a WSO/GCO via interface A. To obtain services from the coexistence system, a WSO/GCO needs to subscribe to the coexistence services and register to the coexistence system.

After the registration, the WSO/GCO may get information services and/or management services.

A WSO/GCO may be subscribed to only one service at a time.

Within the information service, the WSO/GCO gets a coexistence report from the coexistence system. Such coexistence report provides enough information to the WSO/GCO to make autonomous coexistence decisions on its operating parameters.

Within the management service, the WSO/GCO gets reconfiguration requests generated by the coexistence system. The WSO/GCO needs to provide information to the coexistence system while using this service. Also, the WSO/GCO needs to perform measurements according to requests from the coexistence system. Both the information and measurement reports are used by the coexistence system to make coexistence decisions.

* + 1. Services for CM

A CDIS provides coexistence services to CMs via interface B2. A CM gets coexistence discovery service from a CDIS after it has subscribed to the CDIS coexistence discovery service and has registered to the CDIS.

The coexistence discovery service provides coexistence set information to the CM for WSO/GCOs served by this CM. Two types of coexistence discovery service are provided by the CDIS to the CM. With one type of service, the CM gets coexistence set information only for those WSO/GCOs that are served by other CMs. This is called *inter-CM coexistence discovery*. In this case, the CM performs intra-CM coexistence discovery by itself. With the other type of coexistence discovery service, the CM gets coexistence set information regardless of which CM serves the WSO/GCOs in the coexistence set. In this case the CDIS performs both inter-CM coexistence discovery and intra-CM coexistence discovery.

* 1. Coexistence algorithms
		1. Introduction

Coexistence algorithms are procedures executed inside the coexistence system in order to provide the coexistence services. The two classes of coexistence algorithms are coexistence discovery algorithms and coexistence decision algorithms.

Coexistence discovery algorithms are used by CDIS and CM to discover WSO/GCOs that may affect each other performance.

Coexistence decision algorithms are used by a CM to make coexistence decisions related to WSO/GCO reconfiguration.

This standard describes several algorithms for each class. Implementation is not intended to be limited to a particular algorithm.

* + 1. Coexistence discovery algorithms
			1. Algorithm based on statistical analysis of the expected interference
			2. Algorithm based on coverage and interference analysis
		2. Coexistence decision algorithms
			1. Algorithm based on operating channel selection
			2. Algorithm based on negotiation among CMs
			3. Resource allocation with fairness constraint
			4. Master CM selection
			5. Channel priority allocation
			6. Algorithm based on neighbor report and radio environment information
			7. Algorithm based on per-coordinate optimization
			8. Algorithm based on load balancing

The processing load balancing algorithm uses the distributed processing power of the CMs effectively and maximizes the number of the registered GCOs in accordance with the conditions of the coexistence system operation. The key component is to adapt different channel selection policies, which are centralized coordination by the master CM, cooperative coordination between CM and GCO itself and autonomous/distributed coordination by different CMs, to the conditions of the coexistence system operation.

In the centralized coordination method, the master CM makes final decisions on channel selections for its GCOs and for all GCOs of its slave CMs. With the cooperative coordination method the CM has capability to ask GCOs to make final decisions required for coexistence. In the autonomous/distributed coordination method the CM individually makes final decisions on channel selections for its GCOs.

* + - 1. Algorithm based on output power control

The output power level control algorithm addresses the aggregated interference problem in the target protection service contour due to the multiple simultaneous transmission of coexistence set elements. The calculation basis may be applicable in conducting an information service on a potential aggregated interference power level, or a management service on power control of GCOs.

* + - 1. Algorithm based on co-channel sharing via GCO network geometry classification

The co-channel sharing via GCO network geometry classification algorithm optimizes the efficiency of the frequency utilization as much as possible in managing GCOs operating under general authorization, in a case where the system cannot assign different channel among GCOs in a coexistence set. The key processing parts, which are conducted in CDIS or CM, are as follows:

* Coexistence discovery process based on network geometry classification
* Network coexistence protocol check process
* Interference power level check process
* Backhaul connection check process
	+ 1. Other algorithms related to coexistence
			1. Algorithm based on balanced sharing
			2. Temporarily released resource

====(End text)

1. http://tools.ietf.org/wg/paws/ [↑](#footnote-ref-1)