

IEEE Standard for Architectural Building Blocks Enabling Network-Device Distributed Decision Making for Optimized Radio Resource Usage in Heterogeneous Wireless Access Networks

Amendment 1: Architecture and Interfaces for Dynamic Spectrum Access Networks in White Space Frequency Bands

IEEE Communications Society

Sponsored by the
Standards Committee

IEEE
3 Park Avenue
New York, NY 10016-5997
USA

IEEE Std 1900.4a™-2011
(Amendment to
IEEE Std 1900.4™-2009)

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IEEE Standard for Architectural Building Blocks Enabling Network-Device Distributed Decision Making for Optimized Radio Resource Usage in Heterogeneous Wireless Access Networks

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Communications Society

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Abstract: Additional components of the IEEE 1900.4 system are defined in this amendment to enable mobile wireless access service in white space frequency bands without any limitation on used radio interface (physical and media access control layers, carrier frequency, etc.).

Keywords: dynamic spectrum access, IEEE 1900.4, IEEE 1900.4a, mobile wireless access, white space frequency bands

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Introduction

This introduction is not part of IEEE Std 1900.4a-2011, IEEE Standard for Architectural Building Blocks Enabling Network-Device Distributed Decision Making for Optimized Radio Resource Usage in Heterogeneous Wireless Access Networks—Amendment 1: Architecture and Interfaces for Dynamic Spectrum Access Networks in White Space Frequency Bands.

Multimode reconfigurable devices are increasingly being adopted within the wireless industry. The choice among various supported air interfaces on a single wireless device is already a reality today, with devices offering, for example, second and third generation cellular radio access technologies and IEEE 802® wireless standards. Last but not least, devices and networks with dynamic spectrum access capabilities that allow the use of spectrum resource simultaneously among different systems are emerging and will be part of the radio eco space. Furthermore, there has been an advocated need for these devices and networks being capable of operation in white space frequency bands to improve spectrum usage.

This amendment IEEE Std 1900.4a-2011 as well as the original IEEE Std 1900.4-2009 define an overall system architecture and information exchange between the network and devices that will allow the devices to optimally choose among the available radio resources including white space frequency bands and simultaneously use several of these resources. This IEEE Std 1900.4a-2011 also facilitates cost-effective and multi-vendor production of wireless access system, including cognitive base stations and terminals, capable of operation in white space frequency bands without any limitation on used radio interface, as well as, accelerates commercialization of this system to improve spectrum usage.

The IEEE 1900 Standards Committee was established in the first quarter 2005 jointly by the IEEE Communications Society and the IEEE Electromagnetic Compatibility Society. The objective of this effort is to develop supporting standards dealing with new technologies and techniques being developed for next generation radio and advanced spectrum management. On March 22, 2007, the IEEE Standards Association Standards Board (SASB) approved the reorganization of the IEEE 1900 effort as Standards Coordinating Committee 41 (SCC41) on Dynamic Spectrum Access Networks (DySPAN). The IEEE Communications Society and Electromagnetic Compatibility Society were sponsoring societies for this effort, as they had been for the IEEE 1900 effort. On December 8, 2010, IEEE SASB authorized that all activities of SCC41 be transferred to the Communication Society and that SCC41 be disbanded. The IEEE Communications Society Standards Board is the sponsor for all projects previously sponsored by SCC41. In February 2007, the IEEE 1900.4 working group was launched, originating from the IEEE 1900.B study group, and entitled “Architectural Building Blocks Enabling Network-Device Distributed Decision Making for Optimized Radio Resource Usage in Heterogeneous Wireless Access Networks.”

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Amendment 1: Architecture and Interfaces for Dynamic Spectrum Access Networks in White Space Frequency Bands

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NOTE—The editing instructions contained in this amendment define how to merge the material contained therein into the existing base standard and its amendments to form the comprehensive standard.¹

The editing instructions are shown in ***bold italic***. Four editing instructions are used: change, delete, insert, and replace. ***Change*** is used to make corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed by using ~~strike through~~ (to remove old material) and underscore (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Deletions and insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. ***Replace*** is used to make changes in figures or equations by removing the existing figure or equation and replacing it with a new one. Editing instructions, change markings, and this NOTE will not be carried over into future editions because the changes will be incorporated into ***the base standard***.

¹ Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

1. Overview

1.1 Scope

Change the paragraph as shown below:

The standard defines the building blocks comprising (i) network resource managers, (ii) device resource managers, and (iii) the information to be exchanged between the building blocks, for enabling coordinated network-device distributed decision making that will aid in the optimization of radio resource usage, including spectrum access control, in heterogeneous wireless access networks. The standard is limited to the architectural and functional definitions at a first stage. This standard enables mobile access service in white space frequency bands without any limitation on used radio interface (physical and media access control layers, carrier frequency, etc.) by defining additional components of the IEEE 1900.4a system. The corresponding protocols definition related to the information exchange will be addressed at a later stage.

1.2 Purpose

Insert new paragraph as shown below:

The purpose is to improve overall composite capacity and quality of service of wireless systems in a multiple Radio Access Technologies (RATs) environment, by defining an appropriate system architecture and protocols that will facilitate the optimization of radio resource usage, in particular, by exploiting information exchanged between network and mobile Terminals, whether or not they support multiple simultaneous links and dynamic spectrum access.

This standard facilitates cost-effective and multi-vendor production of wireless access system, including cognitive base stations and terminals, capable of operation in white space frequency bands without any limitation on used radio interface, as well as, accelerates commercialization of this system to improve spectrum usage.

3. Definitions, acronyms, and abbreviations

3.1 Definitions

Insert new definitions after 3.1.25 as follows:

3.1.26 back-up white space frequency band: Part(s) of white space frequency bands where the secondary radio system is not currently operating, but to which the secondary radio system can switch in a timely manner, preferably, without degradation of the quality of services provided by the secondary radio system.

3.1.27 cognitive base station (CBS): A base station capable of operating in white space frequency bands.

3.1.28 cognitive base station (CBS) Measurement Collector: The entity that collects CBS context information and provides it to CBSRM.

3.1.29 cognitive base station (CBS) Reconfiguration Controller: The entity that controls reconfiguration of CBS based on requests from CBSRM.

3.1.30 cognitive base station (CBS) Reconfiguration Manager: The entity that manages CBS and Terminals for network-terminal distributed optimization of spectrum usage.

3.1.31 cognitive base station (CBS) registration information: This term is used to refer to the information related to the owner of the CBS (such as name, address and phone number) and the CBS identification.

3.1.32 operating white space frequency band: Part(s) of white space frequency bands where the secondary radio system is currently operating.

3.1.33 protected white space frequency band: Part(s) of the white space frequency bands where primary radio system is currently operating as indicated in the white space data base and/or detected by using spectrum sensing and/or determined by other means in accordance with the radio regulations.

3.1.34 silent period: This term refers to a period of time where a transmitter stops transmitting in specific white space frequency bands. A silent period is characterized by a duration and (a set of) frequency bands.

3.1.35 spectrum sensing: The act of measuring information indicative of spectrum occupancy (information may include frequency ranges, signal power levels, bandwidth, location information etc.). Spectrum sensing may include determining how the sensed spectrum is used.

3.1.36 white space: Part(s) of spectrum allocated to a particular radio system (primary radio system) in particular location(s) that may be temporary unused by this primary radio system in some location(s) and thus allowed by radio regulations to be used by another radio system(s) (secondary radio system) on a temporary secondary basis without causing harmful interference to the primary radio system, where harmful interference and protection mechanisms are defined in the radio regulations.

3.1.37 white space data base: A data base that provides information on currently available white space resources in particular location(s).

3.1.38 white space frequency band: Any frequency band where white space may exist as defined by the radio regulations.

3.1.39 white space manager: The entity that enables collaboration between IEEE 1900.4a system and IEEE 1900.4 system, provides regulatory context information to CBS Reconfiguration Manager (CBSRM), records the statuses of the cognitive base station (CBSs) connected to it, and enables communication between CBSRM and white space database.

3.1.40 white space resource management: management of white space resource usage performed by the CBS Reconfiguration Manager (CBSRMs) and the Terminal Reconfiguration Manager (TRMs) for the purpose of self-coexistence inside one secondary system and for coexistence between different secondary systems. White space resource management includes classification of white space resources by the CBSRM(s) and the TRM(s), exchange of the classification results between the CBSRM(s) and the TRM(s), and coordination of white space resource usage between several CBSRM(s).

3.2 Acronyms and abbreviations

Insert the following abbreviations to 3.2 Acronyms and abbreviations in alphabetical order as follows:

CBS	cognitive base station
CBSRM	CBS Reconfiguration Manager
CBSMC	CBS Measurement Collector

CBSRC	CBS Reconfiguration Controller
WSM	White Space Manager
WS	white space

4. Overall system description

Insert new subclause 4.4 after 4.3 as follows:

4.4 IEEE 1900.4a overview

IEEE Std 1900.4a™-2011 uses IEEE Std 1900.4™-2009 as a baseline. It concentrates on dynamic spectrum sharing use case of IEEE Std 1900.4-2009. IEEE Std 1900.4a-2011 defines additional entities and interfaces to enable efficient operation of white space wireless systems. Figure 2 and Figure 3 introduce the IEEE 1900.4a system.

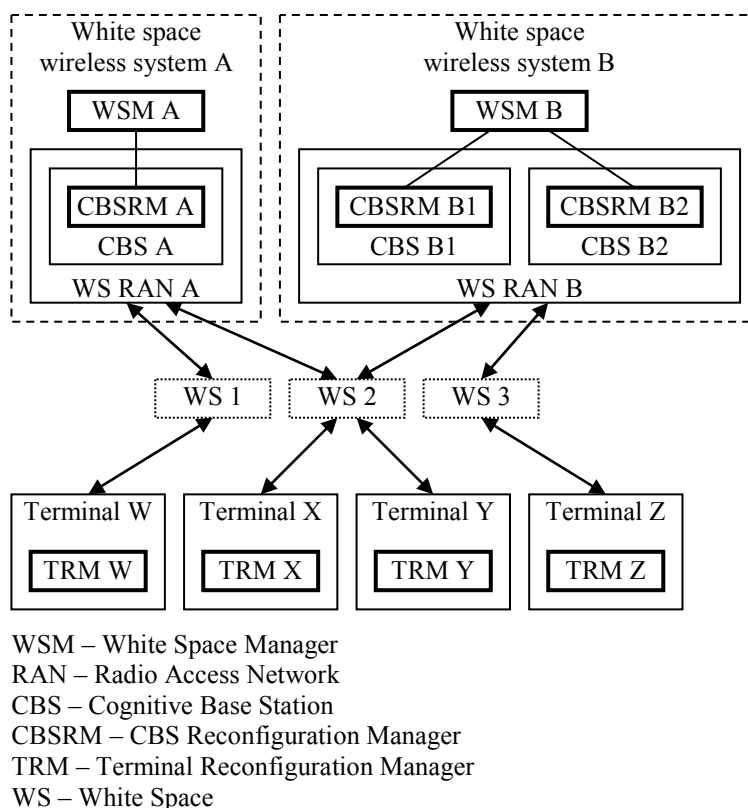


Figure 2—IEEE 1900.4a system overview

In Figure 2, the White Space Manager (WSM) provides regulatory context information to Cognitive Base Station Manager (CBSRM), and enables communication between CBSRM and white space database.

The CBSRM is the entity that manages CBS and Terminals for network-terminal distributed optimization of spectrum usage. The key functions of the CBSRM specific to dynamic spectrum access in white space frequency bands are: management of spectrum sensing, e.g., by coordinating silent periods for measurements, classification of white space frequency bands, coordination of white space frequency bands usage with CBSRMs of the same RAN for radio resource management and with CBSRMs of other RANs for coexistence.

Within the dynamic spectrum sharing use case, IEEE Std 1900.4a-2011 use cases identify two stages of operation: white space wireless system start-up and white space wireless system operation. These stages occur during the three scenarios: sharing spectrum with non-IEEE 1900.4 system, sharing spectrum with IEEE 1900.4 system, and sharing spectrum with other IEEE 1900.4a system.

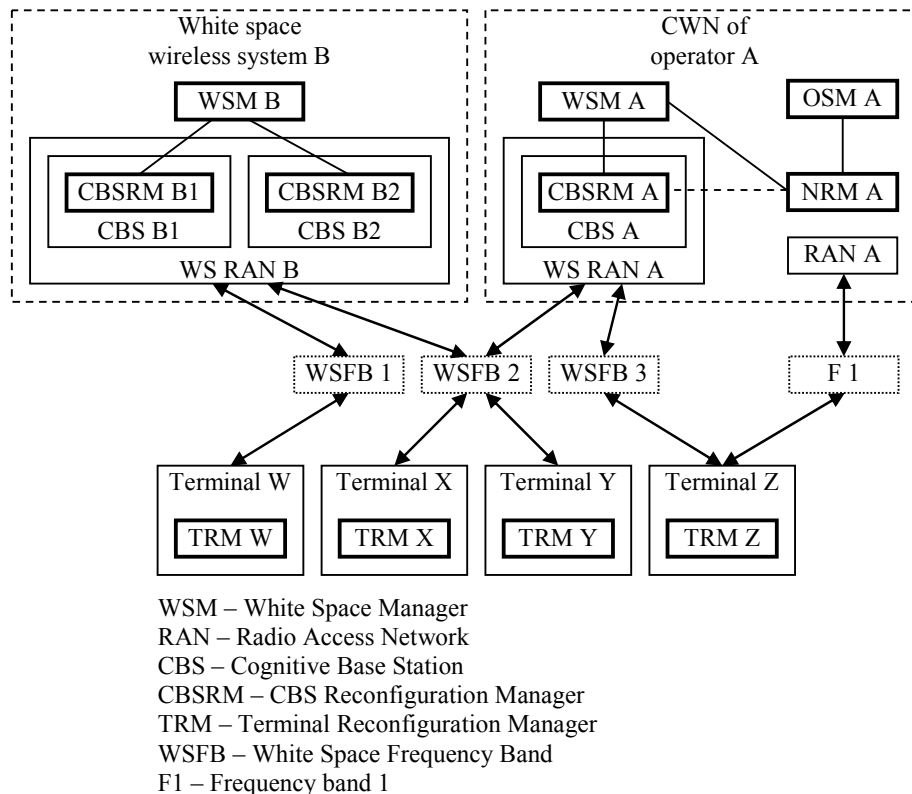


Figure 3—IEEE 1900.4a system overview: collaboration with IEEE 1900.4 system

Figure 3 shows the interaction between white space wireless system and heterogeneous wireless system. In this case, WSM enables collaboration between IEEE 1900.4a system and IEEE 1900.4 system. Especially, a CBS deployed in a CWN can operate in a white space frequency band or in another frequency band; and a terminal can connect either only to systems operating in a white space frequency band or to both systems operating in a white space frequency band and systems operating in a band other than white space frequency band.

5. Requirements

5.1 System requirements

5.1.1 Reconfiguration managers

There shall be an entity inside the packet-based network, called Network Reconfiguration Manager (NRM), responsible for managing the CWN and Terminals for network-terminal-distributed optimization of spectrum usage.

There shall be an entity inside the CBS, called CBS Reconfiguration Manager (CBSRM), responsible for managing the CBS and Terminals for network-terminal-distributed dynamic spectrum access in white space frequency bands.

There shall be an entity inside the Terminal, called Terminal Reconfiguration Manager (TRM), responsible for managing the Terminal for network-terminal-distributed optimization of spectrum usage including dynamic spectrum access in white space frequency bands.

5.1.2 Context awareness

5.1.2.1 Context information collection entities

There shall be entities on network side, inside CBSs, and inside Terminals responsible for context information collection.

5.1.2.2 RAN context information

Context information collection entity on network side shall collect RAN context information.

RAN context information may include the following (see Annex B for more details):

- RAN radio resource optimization objectives
- Operator capabilities
- RAN radio and transport capabilities
- RAN configuration
- RAN measurements

The NRM shall be able to obtain RAN context information from context information collection entity on network side.

The NRM may receive RAN context information from context information collection entity on network side periodically and/or in response to request from the NRM and/or on event.

Context information collection entity on network side may be implemented in a distributed manner.

RAN context information may be collected by an entity inside CBS.

5.1.2.3 CBS context information

Context information collection entity inside the CBS shall collect CBS context information.

CBS context information may include the following (see Annex B for more details):

- CBS radio and transport capabilities
- CBS configuration
- CBS measurements
- CBS location information
- CBS registration information
- CBS state
- Neighbouring CBSs.

The CBSRM shall be able to obtain CBS context information from context information collection entity inside the CBS.

The CBSRM may receive CBS context information from the context information collection entity inside CBS periodically and/or in response to request from the CBSRM and/or on event.

CBSRM shall be able to request context information collection entity inside CBS to request CBS to perform specific measurements according to specific timing. Context information collection entity inside CBS shall be able to request CBS to perform specific measurements according to specific timing.

CBSRM shall be able to request context information collection entity inside CBS to request CBS to implement silent periods. Context information collection entity inside CBS shall be able to request CBS to implement silent periods.

5.1.2.4 Terminal context information

Context information collection entity inside the Terminal shall collect terminal context information.

Terminal context information may include the following (see Annex B for more details):

- User subscriptions
- User preferences
- Application parameters including QoS requirements
- Application measurement capabilities
- Application measurements
- Terminal capabilities
- Terminal configuration
- Terminal measurements including active link measurements and observed channel measurements
- Terminal location information
- Terminal registration information.

The TRM shall be able to obtain terminal context information from context information collection entity inside the Terminal.

The TRM may receive terminal context information from the context information collection entity inside Terminal periodically and/or in response to request from the TRM and/or on event.

TRM shall be able to request context information collection entity inside terminal to request terminal to perform specific measurements according to specific timing. Context information collection entity inside terminal shall be able to request terminal to perform specific measurements according to specific timing.

TRM shall be able to request context information collection entity inside terminal to request terminal to implement silent periods. Context information collection entity inside terminal shall be able to request terminal to implement silent periods.

The TRM shall be able to maintain classification of WS frequency bands.

The TRM should distinguish protected, operating, and back-up WS frequency bands.

5.1.2.5 Regulatory context information and communication between CBSRM and white space database

There shall be an entity on network side responsible for providing regulatory context information to CBSRM and enabling communication between CBSRM and white space database.

Regulatory context information may include the following (see Annex B for more details):

- Frequency bands allowed for secondary usage
- Radio interfaces allowed in particular frequency bands
- Primary user protection requirements in particular frequency bands.

Communication between CBSRM and white space database may include the following:

- Providing white space database information (information on frequency bands currently available for secondary usage) to CBSRM
- Providing CBS context information (CBS location and registration information) to white space database
- Providing terminal context information (Terminal location and registration information) to white space database.

5.1.2.6 Exchange of context information

5.1.2.6.1 Exchange of context information between NRM and TRM

The NRM and the TRM shall exchange context information.

The NRM shall send RAN context information related to its RANs to the TRM.

The NRM may send RAN context information related to other RANs to the TRM.

The NRM may send terminal context information related to other Terminals to the TRM.

The NRM may send this context information to the TRM periodically and/or in response to request from the TRM and/or on event.

NRM should be able to send this context information to a specific set of TRMs in order to avoid inefficient usage of radio resource.

Determination of such specific set of TRMs may be based on the following:

- TRMs of Terminals operating within given geo-localized area
- TRMs of Terminals operating in given frequency bands
- TRMs of Terminals operating within specific coverage area

The TRM shall send terminal context information related to its Terminal to the NRM.

The TRM may send terminal context information related to other Terminals to the NRM.

The TRM may send this context information to the NRM periodically and/or in response to request from the NRM and/or on event.

5.1.2.6.2 Exchange of context information between CBSRM and TRM

The CBSRM and the TRM shall exchange context information.

The CBSRM shall send CBS context information related to its CBS to the TRM.

The CBSRM may send CBS context information related to other CBSs to the TRM.

The CBSRM may send terminal context information related to other Terminals to the TRM.

The CBSRM may send this context information to the TRM periodically and/or in response to request from the TRM and/or on event.

The CBSRM should be able to send this context information to a specific set of TRMs in order to avoid inefficient usage of radio resource.

Determination of such specific set of TRMs may be based on the following:

- TRMs of Terminals operating within given geo-localized area
- TRMs of Terminals operating in given frequency bands
- TRMs of Terminals operating within specific coverage area

The CBSRM shall be able to send CBSRM classification of WS frequency bands to its TRM(s).

The TRM shall send terminal context information related to its Terminal to the CBSRM.

The TRM may send terminal context information related to other Terminals to the CBSRM.

The TRM may send this context information to the CBSRM periodically and/or in response to request from the CBSRM and/or on event.

The TRM shall be able to send TRM classification of WS frequency bands to its CBSRM.

5.1.2.6.3 Exchange of context information between several NRMs

Several NRMs may exchange RAN context information related to their RANs and terminal context information related to their Terminals.

The NRMs may exchange this context information periodically and/or in response to request from each other and/or on event.

5.1.2.6.4 Exchange of context information between several CBSRMs

Several CBSRMs may exchange CBS context information related to their CBSs, terminal context information related to their Terminals, regulatory context information, and white space database information.

The CBSRMs may exchange this context information periodically and/or in response to request from each other and/or on event.

5.1.2.6.5 Exchange of context information between several TRMs

Several TRMs may exchange RAN context information, CBS context information, and terminal context information.

The TRMs may exchange this context information periodically and/or in response to request from each other and/or on event.

5.1.2.6.6 Exchange of context information between NRM and CBSRM

The NRM and the CBSRM may exchange context information.

To enable such context information exchange, there shall be an entity on network side responsible for exchanging context information between NRM and CBSRM.

The NRM may send RAN context information related to its RANs and terminal context information related to its Terminals to the CBSRM via such entity on network side.

5.1.3 Decision making

5.1.3.1 Framework for NRM and CBSRM decisions

There shall be an entity inside the packet-based network within the operator's control responsible for generating spectrum assignment policies.

The NRM shall be able to obtain spectrum assignment policies.

Spectrum assignment policies shall adhere to regulations.

Spectrum assignment policies shall express operator needs and/or radio resource usage objectives related to dynamic spectrum assignment.

The NRM shall make spectrum assignment decisions compliant with received spectrum assignment policies.

The NRM shall provide information on its dynamic spectrum assignment decisions to the entity inside the packet-based network within the operator's control responsible for generating spectrum assignment policies.

The NRM shall make spectrum sharing decisions compliant with its spectrum assignment decisions and with received spectrum assignment policies.

The CBSRM shall make spectrum sharing decisions compliant with received regulatory context information and white space database information.

5.1.3.2 NRM radio resource selection policies

The NRM shall be able to generate NRM radio resource selection policies.

The NRM shall provide NRM radio resource selection policies to the TRM.

The NRM may have means to specify geo-location-based radio resource selection policies to TRM.

NRM should be able to send NRM radio resource selection policies to a specific set of TRMs in order to avoid inefficient usage of radio resource.

Determination of such specific set of TRMs may be based on the following:

- TRMs of Terminals operating within given geo-localized area
- TRMs of Terminals operating in given frequency bands
- TRMs of Terminals operating within specific coverage area

The TRM shall make decisions on Terminal reconfiguration compliant with received NRM radio resource selection policies.

If specified by NRM radio resource selection policies, TRM of geo-localization-capable Terminal shall make decisions based on Terminal location.

The NRM shall generate NRM radio resource selection policies compliant with its spectrum assignment decisions, its spectrum sharing decisions, and received spectrum assignment policies.

5.1.3.3 CBSRM radio resource selection policies

The CBSRM shall be able to generate CBSRM radio resource selection policies.

If NRM radio resource selection policies are received from NRM, CBSRM radio resource selection policies shall be combined with the NRM radio resource selection policies.

The CBSRM shall provide CBSRM radio resource selection policies to the TRM.

The CBSRM should be able to send the CBSRM radio resource selection policies to a specific set of TRMs in order to avoid inefficient usage of radio resource.

Determination of such specific set of TRMs may be based on the following:

- TRMs of Terminals operating within given geo-localized area
- TRMs of Terminals operating in given frequency bands

— TRMs of Terminals operating within specific coverage area

The TRM shall make decisions on Terminal reconfiguration compliant with received CBSRM radio resource selection policies.

If specified by CBSRM radio resource selection policies, TRM of geo-localization-capable Terminal shall make decisions based on Terminal location.

If specified by CBSRM radio resource selection policies, TRM shall request information collection entity inside terminal to request terminal to perform specific measurements according to specific timing.

If specified by CBSRM radio resource selection policies, TRM shall request context information collection entity inside terminal to request terminal to implement silent periods.

The CBSRM shall generate CBSRM radio resource selection policies compliant with its spectrum sharing decisions and received regulatory context information and white space database information.

5.1.3.4 Collaboration between reconfiguration managers

5.1.3.4.1 Collaboration between several NRMs

Several NRMs may collaborate in the process of radio resource usage optimization.

To support such collaboration, the NRMs may exchange spectrum assignment policies, RAN reconfiguration decisions, and NRM radio resource selection policies.

The NRMs may exchange spectrum assignment policies, RAN reconfiguration decisions, and NRM radio resource selection policies periodically and/or in response to request from each other and/or on event.

5.1.3.4.2 Collaboration between several CBSRMs

Several CBSRMs may collaborate in the process of radio resource usage optimization.

To support such collaboration, the CBSRMs may exchange CBS reconfiguration decisions and CBSRM radio resource selection policies.

The CBSRMs may exchange CBS reconfiguration decisions and CBSRM radio resource selection policies periodically and/or in response to request from each other and/or on event.

Several CBSRMs shall have capability to coordinate the silent periods of their CBSs and terminals.

Several CBSRMs shall have capability to coordinate WS frequency bands usage for self-coexistence inside one secondary system and for coexistence between different secondary systems.

5.1.3.4.3 Collaboration between several TRMs

Several TRMs may collaborate in the process of radio resource usage optimization.

To support such collaboration, the TRMs may exchange NRM radio resource selection policies, CBSRM radio resource selection policies, and terminal reconfiguration decisions.

The TRMs may exchange NRM radio resource selection policies, CBSRM radio resource selection policies, and terminal reconfiguration decisions periodically and/or in response to request from each other and/or on event.

5.1.3.4.4 Collaboration between NRM and CBSRM

The NRM and the CBSRM may collaborate in the process of radio resource usage optimization.

The NRM and the CBSRM may exchange RAN reconfiguration decisions, NRM radio resource selection policies, and RAN context information periodically and/or in response to request from each other and/or on event.

To enable such collaboration, there shall be an entity on network side responsible for communication between the NRM and the CBSRM.

The NRM may send RAN reconfiguration decisions to the CBSRM via such entity on network side.

5.1.4 Reconfiguration

5.1.4.1 RAN reconfiguration

There shall be an entity on network side responsible for RAN reconfiguration.

The NRM shall send RAN reconfiguration requests to the entity on network side responsible for RAN reconfiguration.

Following received RAN reconfiguration requests, the entity on network side responsible for RAN reconfiguration shall control reconfiguration of RANs.

The entity on network side responsible for RAN reconfiguration may be implemented in a distributed manner.

5.1.4.2 CBS reconfiguration

There shall be an entity inside the CBS responsible for CBS reconfiguration.

The CBSRM shall send CBS reconfiguration requests to the entity inside the CBS responsible for CBS reconfiguration.

Following received CBS reconfiguration requests, the entity inside the CBS responsible for CBS reconfiguration shall control reconfiguration of CBS.

5.1.4.3 Terminal reconfiguration

There shall be an entity inside the Terminal responsible for terminal reconfiguration.

The TRM shall send terminal reconfiguration requests to the entity inside the Terminal responsible for terminal reconfiguration.

Following received terminal reconfiguration requests, the entity inside the Terminal responsible for terminal reconfiguration shall control reconfiguration of Terminal.

If a maximum time interval for terminal reconfiguration is specified by NRM radio resource selection policies, reconfiguration of Terminal shall be performed within this time interval starting from the time when these NRM radio resource selection policies are received.

If a maximum time interval for terminal reconfiguration is specified by CBSRM radio resource selection policies, reconfiguration of Terminal shall be performed within this time interval starting from the time when these CBSRM radio resource selection policies are received.

5.2 Functional requirements

5.2.1 NRM functionality

Insert the 5.2.2 immediately after 5.2.1 as shown below:

5.2.2 CBSRM functionality

The CBSRM shall have capability to make dynamic spectrum sharing decisions.

The CBSRM shall have capability to request reconfiguration of its CBS corresponding to these dynamic spectrum sharing decisions. Actions should be taken by the CBSRM in the case where reconfiguration is not possible.

The CBSRM shall have capability to request such reconfiguration of its CBS that the CBS transmission doesn't cause harmful interference to primary radio systems.

The CBSRM may have the capability to request reconfiguration of its CBS according to a reconfiguration request received from a NRM.

The CBSRM shall have capability to generate the CBSRM radio resource selection policies.

There shall be no conflict in the CBSRM radio resource selection policies.

The CBSRM radio resource selection policies and the NRM radio resource selection policies shall be combined, if the NRM radio resource selection policies are received from the NRM.

The CBSRM radio resource selection policies shall be defined in a way that they correspond to a targeted group of Terminals (could be composed of any number of Terminals).

The targeted group of Terminals should be defined based on the needs of CWN radio resource usage optimization objectives, Terminal location, and radio resource usage patterns of the Terminals.

The CBSRM radio resource selection policies shall guide TRMs in Terminals' reconfiguration decisions.

The CBSRM may specify the CBSRM radio resource selection policies referring to specific geo-location-based terminal measurements.

The CBSRM shall have capability to specify and control the time interval within which Terminal reconfiguration shall be performed.

The TRM shall perform Terminal reconfiguration within this time interval.

The CBSRM shall have capability to control Terminal(s) spectrum sensing using CBSRM radio resource selection policies.

The CBSRM shall have capability to request Terminal(s) to implement silent periods.

The CBSRM shall have capability to evaluate the efficiency of the current CBSRM radio resource selection policies.

These evaluation results shall be made available to the CBSRM to assist in improving the efficiency of the future CBSRM radio resource selection policies.

The CBSRM shall have capability to control its CBS spectrum sensing measurements.

The CBSRM shall have capability to request its CBS to stop transmission for a specific time period (silent period).

The CBSRM shall have capability to coordinate silent periods of its CBS with other CBSRMs.

The CBSRM shall have capability to receive, process, and store the following context information:

- RAN context information
- CBS context information
- Terminal context information

The CBSRM shall have the capability to use this context information for radio resource usage optimization purposes.

Several CBSRMs may collaborate to guide cooperative and/or collaborative spectrum sensing.

The CBSRM may have the capability of forwarding requests for RAN context information coming from the NRM to its context information collection entity.

The CBSRM functions should have capability to perform the following in cooperation with each other:

- Make dynamic spectrum sharing decisions
- Request reconfiguration of the CBS
- Generate the CBSRM radio resource selection policies
- Evaluate the efficiency of the current CBSRM radio resource selection policies
- Perform spectrum sensing management

The CBSRM should have capability to cooperate with the NRM for radio resource usage optimization purposes.

The CBSRM should have capability to cooperate with the other CBSRM for radio resource usage optimization purposes.

CBSRM shall register its CBS ID and location to WSM upon startup.

CBSRM shall send its CBS ID and CBS state (included in the CBS Context Information) to WSM when its state changes.

CBSRM shall have the capability to query the WSM for getting the list of neighboring CBSs.

CBSRM shall have the capability to query the WSM for getting the state of a particular CBS.

The CBSRM shall have the capability to register its CBS to the white space database upon start-up.

The CBSRM shall have the capability to de-register its CBS from the white space database before shutdown.

Renumber 5.2.2 TRM functionality and change text as follows:

5.2.3 ~~5.2.2~~ TRM functionality

The TRM shall have the capability to make dynamic spectrum sharing and distributed radio resource usage optimization decisions, as well as, to support dynamic spectrum assignment decisions ~~received from~~ of the NRM.

The TRM shall have the capability to request reconfiguration of its Terminal corresponding to these decisions. Actions should be taken by the TRM in cases where reconfiguration is not possible.

The TRM shall have capability to request such reconfiguration of its Terminal that the Terminal transmission doesn't cause harmful interference to primary radio systems.

The TRM shall have capability to control its Terminal spectrum sensing measurements.

The TRM shall have capability to request its Terminal to implement silent periods.

The TRM shall have the capability to receive, process, and store the following context information:

- Terminal context information
- CBS context information
- RAN context information

The TRM shall have the capability to use this context information for radio resource usage optimization purposes.

The TRM shall have the capability to select RANs for exchanging the NRM radio resource selection policies and context information between the NRM and the TRM.

The TRM shall have the capability to maintain classification of WS frequency bands. The TRM should distinguish protected, operating, and back-up WS frequency bands.

The TRM shall have the capability to send TRM classification of WS frequency bands to its CBSRM.

TRM functions should have the capability to perform the following in cooperation with each other:

- Make dynamic spectrum sharing and distributed radio resource usage optimization decisions
- Request reconfiguration of its Terminal
- Select RANs for exchanging the NRM radio resource selection policies and context information between the NRM and the TRM
- Perform spectrum sensing management
- Perform WS resource management

The TRM should have capability to cooperate with the other TRM for radio resource usage optimization purposes.

The TRM may have the capability to register its terminal to the white space database upon start-up.

The TRM may have the capability to de-register its terminal from the white space database before shutdown.

Insert new subclause immediately after 5.2.3 as follows:

5.2.4 WSM functionality

WSM shall have capability to provide regulatory context information to CBSRM.

Regulatory context information may include the following:

- Frequency bands allowed for secondary usage
- Radio interfaces allowed in particular frequency bands
- Primary user protection requirements in particular frequency bands

WSM shall have capability to enable communication between CBSRM and white space database.

The WSM shall have the capability to abstract the heterogeneity that may arise due to different WS databases.

Communication between CBSRM and white space database includes the following:

- Providing CBS context information (CBS location and registration information) to white space database

Communication between CBSRM and white space database may include the following:

- Providing white space database information (information on frequency bands currently available for secondary usage) to CBSRM
- Providing terminal context information (Terminal location and registration information) to white space database

With respect to communication between CBSRM and white space database, the WSM may have capability to receive and process requests from CBSRM and to respond to these requests.

WSM shall have capability to enable context information exchange between NRM and CBSRM.

WSM shall record the statuses of the CBSs connected to it.

6. Architecture

6.1 System description

Replace figure (formerly known as Figure 2) with the renumbered Figure 4 as follows:

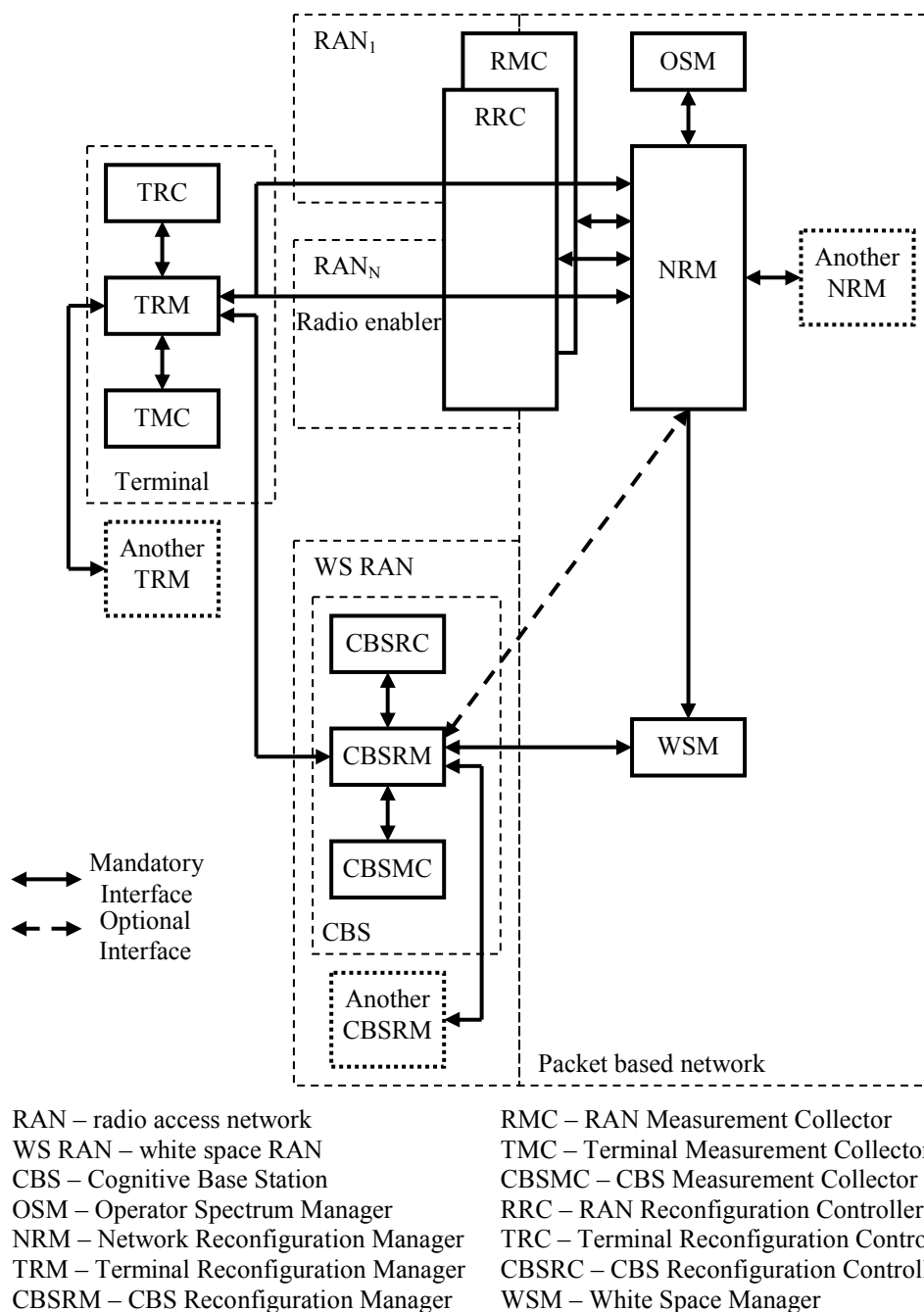


Figure 4—System architecture