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| Updated Text for Dynamic Spectrum Allocation and AN Setup Procedure in IEEE 802.1CF | | | |
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# Abstract

This document is to update the proposal of omniran-14-0078-00 about the dynamic spectrum allocation and the access network setup procedure in Recommended Practice specification of IEEE 802.1CF. The proposal is based on IEEE P802.19.1 draft standard for authorized shared access methods and could be used to support potential mechanism of co-existence of IEEE 802 based technologies with LTE operating on unlicensed band (LTE-U).

IEEE 802 Dynamic Spectrum Allocation and Access Network Setup Procedure

1. Introduction and Scope
2. Abbreviations, Acronyms, Definitions, and Conventions

AN: Access Network

ANC: Access Network controller

ASA: Authorized Shared Access

CNS: Core Network Service

CIS: Coordination and Information Service

LSA: Licensed Shared Access.

The ASA (or LSA) is a mechanism that allows radio frequency spectrum that is licensed for international mobile telecommunications (IMT) to be used by more than one service entity in the share matter.

SA: Shared Access

SA-CIS: Shared access coordination and information service.

TE: Terminal

1. References

[1] IEEE 802.19.1 D3.06 Draft Standard for TV White Space Coexistence Methods

[2] IEEE 802.19

[3] IETF draft-ietf-paws-protocol-12 Protocol to Access White-Space (PAWS) Databases

1. Identifiers
2. Network Reference Model
   1. Overview
   2. Access Network Architecture

5.2.1 IEEE 802 based authorized shared access (ASA) network reference model



FIG 1. IEEE 802 based authorized shared access network reference model

FIG. 1 shows the logic entities and interfaces of network reference model for IEEE802 based services co-existence with primary services in the authorized shared spectrum such as TV White Space. This network reference model may also be used for co-existence of IEEE 802 based service with LTE services operating on unlicensed band. In this network reference model, each logic entity is defined by its functional roles and contains interfaces with other logic entities.

IEEE 802 based network reference model for authorized shared access consists of following logic network entities:

1. IEEE 802 based ASA terminal (ASA-TE)
2. IEEE 802 based ASA Access Network (ASA-AN), including
   * Node of Attachment (ASA-NA)
   * Backhaul (ASA-BH)
3. Shared access network controller (ASA-ANC)
4. Shared access coordination and information service (ASA-CIS)
5. Operator’s Core network (CNS)

A reference point is a logic interface between two logic entities which contains a set of communication protocols used for the information exchange between two logic entities. The IEEE 802 based authorized shared access network reference model contains a couple of reference points.

1. R1 reference point: R1 defines the radio access interface related to IEEE802 technologies over the authorized shared spectrum (or unlicensed spectrum). R1 describes the air interface between the access terminal (TE) and access network (i.e. node of attachment).
2. R2 reference point: R2 defines the interface between TE and Subscription Service entity in the Core Networks through the radio access connection. This logic interface includes protocols above transport layer across different network entities.
3. R3 reference point: R3 defines the interface of AN to one or multiple CNs through backhaul network such as Software Defined Network (SDN). R3 interface contains two planes:

* Data plan interface (R3d) consists of a set of data transmission protocols that are used for packet data communication between network entities of the backhaul of AN and CNS.
* Control plane interface (R3c) consists of a set of control plane protocols that are used to control the data plane’s setup, switching and teardown. R3c is the interface between ANC and CNC.
* Subscription plane interface (R3s) is a special interface between ANC and the Subscription Service (database). It consists of a set of protocols for ANC to acquire the information of subscribers from the subscription service database.

1. R6c reference point: R6c is the internal interface between ASA-NA and ASA-ANC within the access network, which is used to provision and control the ASA-NA operation in the authorized shared spectrum by the ASA-ANC. R6c contains a set of protocols to control ASA-NA setup, initialization and teardown in the authorized shared access spectrum.
2. R7c reference point: R7c is the internal interface between ASA-ANC and ASA-BH within the access network. R7c contains a set of protocol set to provision and control the ASA-BH’s forwarding functions.
3. R8c reference point: R8c is the interface between ANC and TE. It consists of a set of protocols for communication between ANC and TE which is used for ANC to control the TE’s operation.
4. R9c reference point: R9c is the external interface between ANC and CIS which is used for the ANC to query the ASA information on particular location and receive the instruction from the ASA-CIS.

The mapping of reference points with interfaces in other specifications is shown in Table 1.

Table 1. Mapping of Reference Point to Interfaces of other Specifications

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Reference Point** | **802.11** | **802.16** | **802.19.1** | **IETF** |
| R1 | IEEE802.11 | IEEE802.16 |  |  |
| R2 |  |  |  |  |
| R3c |  |  |  |  |
| R3d |  |  |  |  |
| R4 |  |  |  |  |
| R5 |  |  |  |  |
| R6c |  |  |  | CAPWAP |
| R7c |  |  |  |  |
| R8c |  |  | Interface A, ANQP |  |
| R9c |  |  | Interface C | PAWS |
|  |  |  |  |  |

* 1. Network Entity Descriptions

5.3.1 ASA Terminal (ASA-TE)

IEEE 802 based radio access network contains one or more terminals, or called stations (TE), which provides radio connection for the end user to access the service in Core Network. An ASA-TE is a logic entity of IEEE 802 based radio station operating in the authorized frequency channel(s) such as TV white space, which is shared with primary services of TV broadcast over the same authorized spectrum.

5.3.2 ASA Access Network (ASA-AN)

IEEE 802 based authorized shared access network contains one or more ASA Nodes of Attachment (ASA-NA). In some specification, ASA-NA also called the Master Device. ASA-NA could be controlled and managed by single network control entity (ASA-ANC). An ASA-NA provides radio access connectivity to the IEEE 802 based ASA-TEs (or called Slave Devices) in the authorized license frequency channel(s), which is shared with primary services over this authorized spectrum. The ASA-NA also represents the entity to interface to the backhaul and to perform the data forwarding function between ASA-TE and ASA-BH.

5.3.3 Shared Access Network Controller (ASA-ANC)

The shared access network controller (ASA-ANC) is a logic entity in the IEEE 802 based authorized shared access network which is used to manage and control operations of ASA-ANs, such as setup, provisioning, and/or tear-down over the authorized spectrum shared with primary services. The ASA-ANC also control operations of ASA-TEs over the authorized shared spectrum through the reference point R8c.

The ASA-ANC may support following but not limited to functions for co-existence with primary servers and/or other services over the authorized shared spectrum.

1. Co-existence management: it is responsible to control enabling ASA-NA to co-exist with primary wireless device in the authorized shared spectrum.
2. Co-existence discovery and information (local) server is used to store the co-existence information used for determining co-existence of ASA-NAs operating in the authorized spectrum shared with primary wireless services.

The ASA-ANC can communicate with one or more IEEE 802 based ASA-NAs through the Reference Point (R6c). In IEEE 802.19.1, the ASA-ANC communicates with IEEE 802 based ASA-NAs through the element called Co-existence Enabler (CE) that represents one or more IEEE 802 based NAs in the co-existence system.

Reference point is a logic interface between two logic entities which contains a set of communication protocols used for the information exchange between two logic entities.

The interface at a reference point could consist of separated planes

* Data Plane: it defines a set of protocols to perform functionalities implemented in two network entities regarding user data traffic encapsulation, sequencing, encryption, tunneling, forwarding amongst the CN, ASA-NA and ASA-TEs.
* Control Plane: the control plane defines a set of protocols used for implementing the control functions of individual service including user traffic connection setup and termination, mobility management, accounting, etc. The control plane can also include a set of protocols for implementing management functions of the network such as IEEE 802 based authorized shared access network’s authentication, authorization and provisioning.

The ASA-ANC uses R6c to communicate with one or more IEEE 802 based ASA-NAs for the authentication, authorization and provisioning, and uses R7c to communicate with ASA-BH entities to provision the forwarding functions of ASA-BH.

The ASA-ANC uses R8c to communicate with ASA-TE controller to control the operation of ASA-TE.

The ASA-ANC communicates with the shared access coordination and information service (ASA-CIS) through the reference point R9c to get the shared operation information and determine whether the ASA-NA could be turned on to share with the primary services over the shared spectrum in the same goe-location.

5.3.4 Authorized Shared Access Coordination and Information Service (ASA-CIS)

ASA-CIS (or called Listing Database in some specification) is a logic entity in the IEEE 802 based authorized shared access network reference model to provide storage of the information used for the access services over the authorized spectrum shared with primary services. It could be implemented as a database server to provide information service for its clients. The information in ASA-CIS could include

1. authorized shared frequency band and channels information
2. shared access spectrum geo-location information
3. allowed maximum transmit power in the authorized shared access spectrum
4. primary service provider and secondary service providers and their operating status
5. potential neighboring services and their interference levels

ASA-ANC communicates with ASA-CIS through the reference point R9c to get the authorized shared access information. It may store them in the local memory and periodically update the local stored information to synchronize with ASA-CIS.

ASA-CIS is only used for shared access with primary services in the authorized spectrum.

* 1. Network Protocol Stacks

FIG 2. IEEE 802 based authorized shared access protocol stacks

FIG 2 shows an example of protocol stacks of control plane for control of ASA-AN in authorized shared access.

1. The reference point R9c defines a set of protocols (such as IETF-PAWS) over the IP/UDP layer for ANA-ANC to communicate with ASA-CIS.
2. The reference point R6c between ASA-ANC and ASA-NA defines a set of protocols for ASA-ANC to configure and control ASA-NAs according to information received over R9c.
3. The reference point R8c defines the protocols (such as IEEE 802.11 ANQP) on the top of IEEE 802 data link layer used by ASA-NA to broadcast the ASA radio configuration information to ASA-TEs. ASA-NA could also use the reference point R8c to control the transmissions from ASA-TEs
4. Functional Design and Decomposition
   1. ASA Access Network Setup and Configuration

The ASA-AN setup and configuration is to provide a procedure of operating ASA-NAs in the authorized spectrum environment shared with primary wireless devices. The procedure includes following steps

* ASA-CIS discovery
* Query the authorized shared spectrum information
* Configuration of radio access network to operate on the authorized shared access spectrum.

* 1. Operating in shared access frequency bands

In order to operate in the authorized access spectrum shared with primary services, the IEEE 802 based ASA-ANC needs to discover the ASA-CIS and is required to check the availability of shared authorized spectrum with ASA-CIS first before enabling radio transmission. IEEE 802 based ASA-ANC should request and get authorization of using the authorized shared spectrum for transmitting signal over the shared medium.

FIG 3 shows an example of the procedure of IEEE 802 based access network setup.

1. The IEEE 802 based ASA-NA establishes the backhaul IP connection using the control plane protocols to communicate to the ASA-ANC. After the IP connection is established, the ASA-NA and ASA-ANC can exchange the information through the interface of backhaul.
2. Once IP connection is established, the ASA-NA should discover the URI of ASA-ANC through pre-configured information. ASA-NA may update its stored URI information to adapt the deployment change. The ASA-NA would send a SA registration request message through the reference point R6c to the ASA-ANC to register with the ASA-ANC for the shared access service operation over the authorized shared spectrum. The SA registration request is used to provide the ASA-ANC the information about ASA-NA such as subscription information and location information for ASA operation. The ASA-ANC may forward this SA registration request message to the ASA-CIS for authentication and authorization over the reference point R9c using a protocol such as PAWS.
3. The ASA-CIS authenticates the ASA-NA to determine operation on the shared spectrum. The ASA-CIS sends the response message to ASA-ANC about the authentication and authorization result. Then the ASA-ANC sends the SA registration response message to the ASA-NA upon receiving the response message from the ASA-CIS.
4. Once the registration for the shared access service succeeds, the ASA-NA can query the ASA-CIS via sending the SA information request message to ASA-ANC to get the status of the shared spectrum usage information and status.
5. The ASA-ANC communicates with ASA-CIS over the reference point R9c to get the shared spectrum information and usage status and sends back the ASA-NA.
6. Based on received shared spectrum information and status, the ASA-NA decides how to operate the wireless services over the shared spectrum. If ASA-NA would operate the wireless access services over the shared spectrum, it sends the SA usage notification message to the ASA-ANC for updating the shared spectrum usage status.
7. The ASA-ANC sends an acknowledgement message to the ASA-NA after it communicates and updates the shared spectrum usage in ASA-CIS.
8. The ASA-NA can now turn on its radio transmission on the authorized shared spectrum to provide access services. ASA-NA may provide radio configuration information used for the ASA spectrum to the ASA-TEs in the overhead message in order to control the interference to the primary services.