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Telecommunications and information exchange between systems — Wireless Regional Area Networks (WRAN) — Specific requirements —

Part 22: Cognitive Wireless RAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications: Policies and procedures for operation in the bands that allow spectrum sharing where the communications devices may opportunistically operate in the spectrum of primary service

Télécommunications et échange d'information entre systèmes — Réseaux régionaux sans fil (WRAN) — Exigences spécifiques —

Partie 22: Spécifications du contrôle d'accès du milieu sans fil cognitif (MAC) et de la couche physique (PHY) : Politiques et procédures pour le fonctionnement dans les bandes qui permettent le partage du spectre, où les dispositifs de communication peuvent fonctionner de manière opportuniste dans le spectre du service primaire

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Abstract: This standard specifies the air interface, including the cognitive medium access control layer (MAC) and physical layer (PHY), of point–to–multipoint wireless regional area networks (WRANs) comprised of a professional fixed base station (BS) with fixed and portable user terminals operating in the VHF/UHF TV broadcast bands between 54 MHz to 862 MHz, and potentially in the 1300 MHz to 1750 MHz, and 2700 MHz to 3700 MHz bands provided the regulatory regime allows it.

Keywords: broadband wireless access network, cognitive radio, fixed user terminals, IEEE 802.22™, portable user terminals, radio spectrum sensing, regional area network, WRAN standards

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This standard specifies the air interface, including the cognitive radio MAC and PHY, of point-to-multipoint and backhaul WRANs comprised of a professional fixed BS with fixed and portable user terminals. The standard specifies operation in the bands that allow spectrum sharing where the communications devices may opportunistically operate in the spectrum of the primary service, such as the VHF/UHF TV broadcast bands between 54 MHz to 862 MHz, and the 1300 MHz to 1750 MHz and 2700 MHz to 3700 MHz bands provided the regulatory regime allows it.

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**IEEE Standard for Information Technology—
Telecommunications and information exchange between systems
Wireless Regional Area Networks (WRAN)—
Specific requirements**

Part 22: Cognitive Wireless RAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications: Policies and Procedures for Operation in the Bands that Allow Spectrum Sharing where the Communications Devices May Opportunistically Operate in the Spectrum of Primary Service

1. Overview

1.1 Scope

This standard specifies the air interface, including the cognitive radio medium access control layer (MAC) and physical layer (PHY), of point-to-multipoint and backhaul wireless regional area networks (WRANs) comprised of a professional fixed base station (BS) with fixed and portable user terminals. The standard specifies operation in the bands that allow spectrum sharing where the communications devices may opportunistically operate in the spectrum of the primary service, such as the VHF/UHF TV broadcast bands between 54 MHz to 862 MHz, and the 1300 MHz to 1750 MHz and 2700 MHz to 3700 MHz bands provided the regulatory regime allows it.

1.2 Purpose

This standard is intended to enable deployment of interoperable IEEE 802® multivendor WRAN products, to facilitate competition in broadband access by providing alternatives to wireline broadband access and extending the deployability of such systems into diverse geographic areas, including sparsely populated rural areas, while preventing harmful interference to incumbent licensed services. The standard specifies operation in the bands that allow spectrum sharing where the communications devices may opportunistically operate in the spectrum of the primary service, such as the VHF/UHF TV broadcast bands between 54 MHz to 862 MHz, and the 1300 MHz to 1750 MHz and 2700 MHz to 3700 MHz bands provided the regulatory regime allows it.

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1.3 Introduction

The WRANs for which this standard has been developed are expected to operate primarily in low population density areas in order to provide broadband access to data networks. The WRAN systems will use vacant channels in the VHF and UHF bands allocated to the Television Broadcasting Service in the frequency range between 54 MHz and 862 MHz while avoiding interference to the broadcast incumbents in these bands. A typical application can be the coverage of the rural area around a village, as illustrated in Figure 1(a), within a radius of 10 km to 30 km from the BS depending on its EIRP and antenna height. The MAC can also accommodate user terminals located as far as 100 km with proper scheduling of the traffic in the frame when exceptional radio frequency (RF) signal propagation conditions are present. With the PHY implemented in this standard, WRAN systems can cover up to a radius of 30 km without special scheduling.

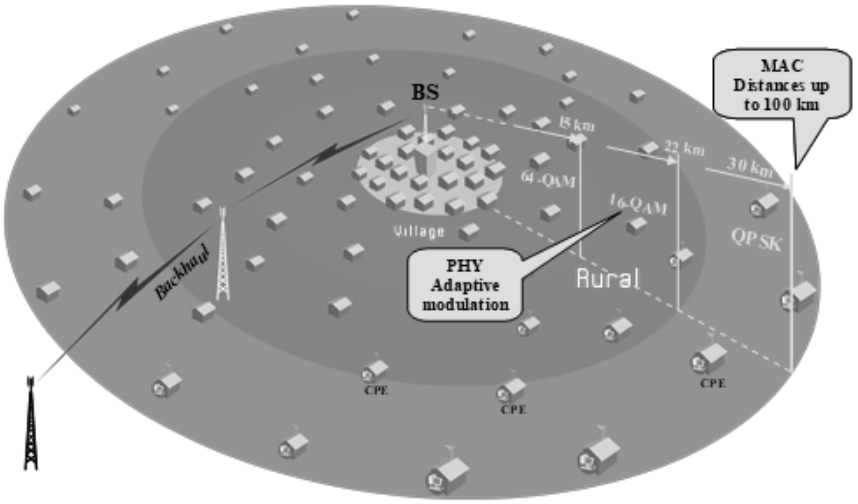


Figure 1(a)—IEEE 802.22 WRAN cell with a base station and user terminals

A BS complying with this standard shall be able to provide high-speed Internet service for up to 512 fixed or portable customer premise equipment (CPE) devices or groups of devices within its coverage area assuming different quality of service (QoS) requirements for various CPEs, while meeting the regulatory requirements for protection of the incumbents.

This standard includes cognitive radio techniques to mitigate interference to incumbents, including geolocation capability, provision to access a database of incumbent services, and spectrum-sensing technology to detect the presence of incumbent services, other WRAN systems, and IEEE 802.22.1 wireless beacons.

The Advanced Wireless Regional Area Networks (A-WRANs) for which this standard has also been developed are expected to support enhanced broadband services and monitoring applications such as real-time and/or near real-time monitoring, emergency broadband services, remote medical services, etc. The A-WRAN provides all essential functionalities of PHY, MAC, security, and cognitive radio technologies defined in the original IEEE 802.22 WRAN and supports an additional PHY Operational mode (PHY-OM2) and additional functionalities of multi-hop relay operations, multiple channel operations, multiple-input-multiple-output (MIMO) operations, and advanced security to extend regional area broadband services to the regional monitoring applications and the enhanced broadband services. The A-WRAN provides connectivity through two new types of services, multi-hop relay and multi-channel operation. Figure 1(b) and Figure 1(c) are examples of the A-WRAN providing enhancement to connectivity using multi-hope relay. Figure 1(d) and Figure 1(e) are examples of the A-WRAN increasing capacity in the network using multi-channel operation at the A-BS, or at the A-BS and A-CPEs. The A-WRAN can only operate in the multirelay or multi-channel services at any given time.

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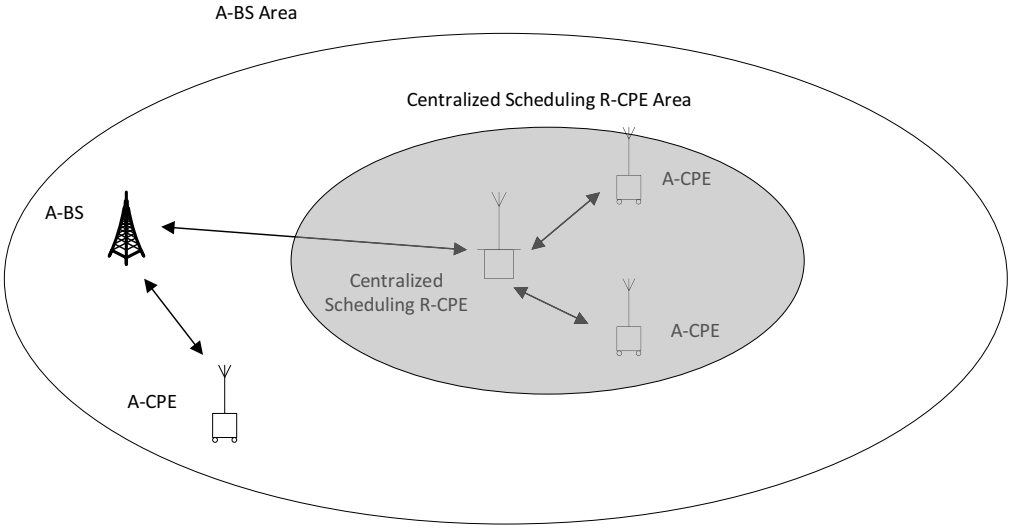


Figure 1(b)—Example of an IEEE 802.22 A-WRAN cell with centralized scheduling multi-hop relay

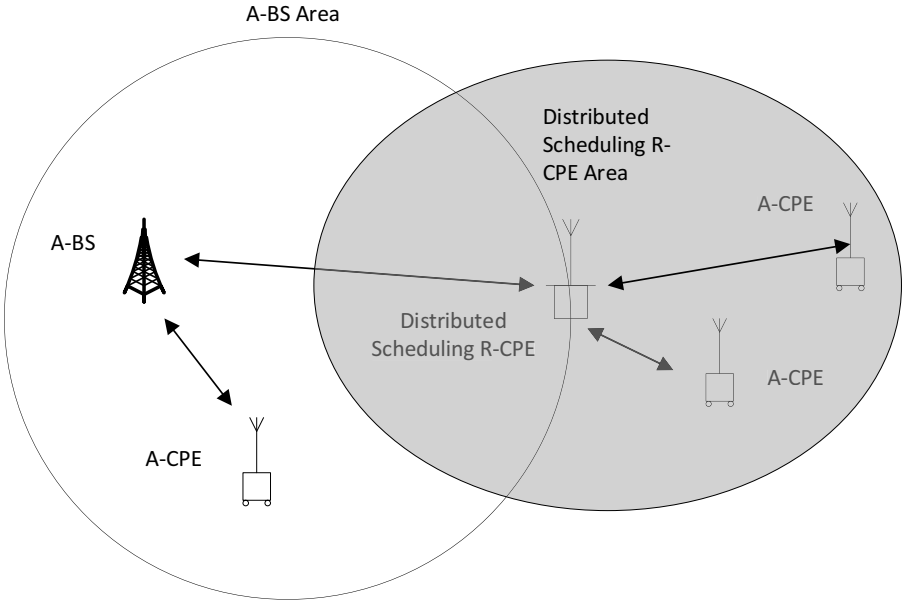


Figure 1(c)—Example of IEEE 802.22 A-WRAN cell with distributed scheduling multi-hop relay

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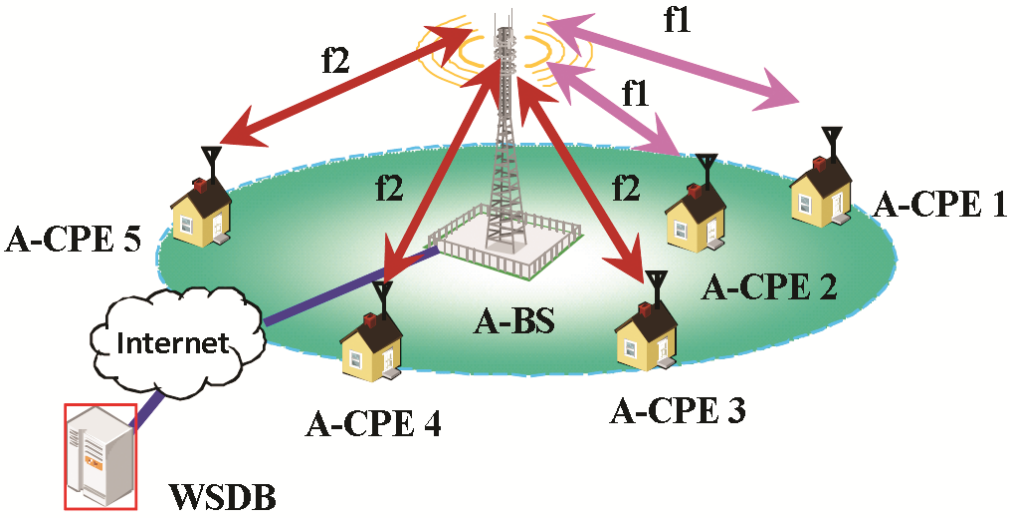


Figure 1(d)—Example of IEEE 802.22 A-WRAN cell with multi-channel operation at the A-BS

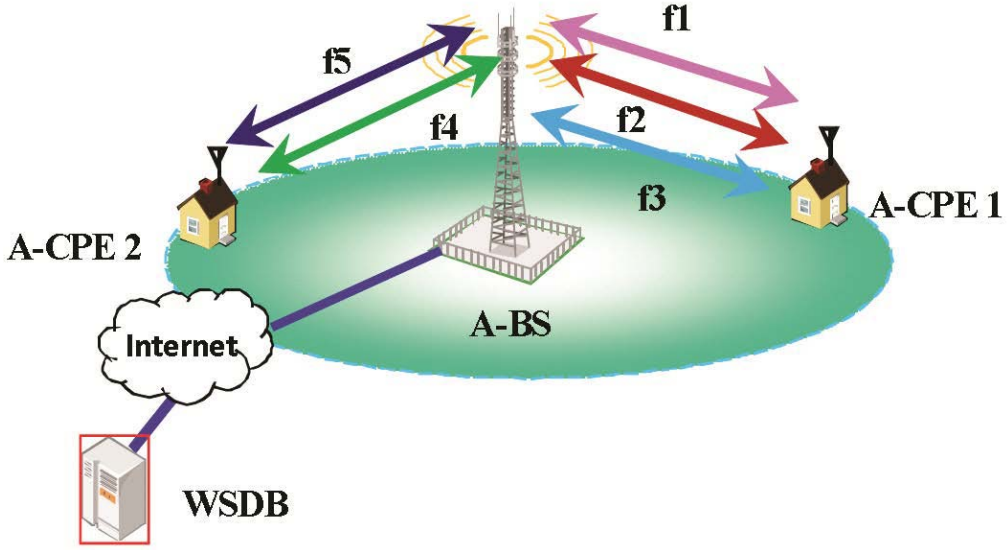


Figure 1(e)—Example of IEEE 802.22 A-WRAN cell with multi-channel operation at the A-BS and the A-CPE

An advanced base station (A-BS) complying with this standard shall be able to provide broadband services for the CPEs such as the advanced CPE (A-CPE) through direct connectivity to the A-BS, and/or through a relay CPE (R-CPE) that is an A-CPE configured to act as a relay CPE. An A-BS complying with this standard shall be able to provide broadband services to A-CPEs operating on multiple channels when multi-channel operation is enabled.

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1.4 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (shall equals is required to).[1, 2]

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (should equals is recommended that).

The word *may* is used to indicate a course of action permissible within the limits of the standard (may equals is permitted to).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (can equals is able to).

[1] The use of the word *must* is deprecated and cannot be used when stating mandatory requirements, *must* is used only to describe unavoidable situations.

[2] The use of *will* is deprecated and cannot be used when stating mandatory requirements, *will* is only used in statements of fact.

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2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

ANSI X9.62-2005, Public Key Cryptography for the Financial Services Industry: The Elliptic Curve Digital Signature Algorithm (ECDSA).[3]

ANSI X9.63-2001, Public Key Cryptography for the Financial Services Industry: Key Agreement and Key Transport Using Elliptic Curve Cryptography.

Federal Communications Commission 08-260, Second Report and Order and Memorandum Opinion and Order in the Matter of Unlicensed Operation in the TV Broadcast Bands, November 14, 2008.[4]

Federal Communications Commission 10-174, Second Memorandum Opinion and Order in the Matter of Unlicensed Operation in the TV Broadcast Bands, September 23, 2010.

FIPS 180-3, Secure Hash Standard (SHS), October 2008.[5]

FIPS 186-3, Digital Signature Standard (DSS), June 2009.

FIPS 197, Advanced Encryption Standard, November 2001.

IEEE Std 802®, IEEE Standard for Local and metropolitan area networks: Overview and Architecture.[6, 7]

IEEE Std 802.1Qcp™-2018, IEEE Standard for Local and metropolitan area networks—Bridges and Bridged Networks—Amendment 30: YANG Data Model.

IEEE Std 802.3™, IEEE Standard for Ethernet.

IEEE Std 802.16™, IEEE Standard for Local and metropolitan area networks—Part 16: Air Interface for Broadband Wireless Access Systems.

IEEE Std 802.22.1™-2010, IEEE Standard for Information Technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements: Part 22.1: Standard to Enhance Harmful Interference Protection for Low-Power Licensed Devices Operating in TV Broadcast Bands.

IETF RFC 2437, PKCS #1: RSA Cryptography Specifications Version 2.0, October 1998.[8]

IETF RFC 2578, Structure of Management Information Version 2 (SMIv2), April 1999.

[3]ANSI publications are available from the American National Standards Institute (http://www.ansi.org/).

[4]FCC publications are available at https://www.fcc.gov/edocs.

[5]FIPS publications are available from the National Technical Information Service, U. S. Department of Commerce (http://www.ntis.org/).

[6]The IEEE standards or products referred to in Clause 2 are trademarks owned by The Institute of Electrical and Electronics Engineers, Incorporated.

[7]IEEE publications are available from the Institute of Electrical and Electronics Engineers (http://standards.ieee.org).

[8]IETF documents (i.e., RFCs) are available for download at http://www.rfc-archive.org/.

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IETF RFC 2758, Definitions of Managed Objects for Service Level Agreements Performance Monitoring, February 2000.

IETF RFC 3279, Algorithms and Identifiers for the Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile, April 2002.

IETF RFC 4492, Elliptic Curve Crytopgraphy (ECC) for Transport Layer Security (TLS), May 2006.

IETF RFC 5216, The EAP-TLS Authentication Protocol, March 2008.

IETF RFC 5246, The Transport Layer Security (TLS) Protocol Version 1.2, August 2008.

IETF RFC 5280, Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile, May 2008.

IETF RFC 5281, Extensible Authentication Protocol Tunneled Transport Layer Security Authenticated Protocol Version 0 (EAP-TTLSv0), August 2008.

IETF RFC 5649, Advanced Encryption Standard (AES) Key Wrap with Padding Algorithm, August 2009.

IETF RFC 6020, YANG—A Data Modeling Language for the Network Configuration Protocol (NETCONF), October 2010.

International Telecommunications Union, Radio Regulations, Geneva, Switzerland, Edition of 2008.[9]

NIST Special Publication 800-38D, Recommendation for Block Cipher Modes of Operation: Galois/ Counter Mode (GCM) and GMAC, November 2007.[10]

NMEA 0183, Interface Standard of the National Marine Electronics Association, Version 4.00.[11]

Standards for Efficient Cryptography Group (SECG), SEC 4: Elliptic Curve Qu-Vanstone Implicit Certificate Scheme (ECQV), Version 1.0, January 24, 2013.[12]

Trusted Computing Group, TPM Main Part 1 Design Principles Specification Version 1.2 Level 2 (Revision 103) 9 July 2007.[13]

Trusted Computing Group, TPM Main Part 2 TPM Structures Specification Version 1.2 Level 2 (Revision 116) 1 March 2011.

Trusted Computing Group, TPM Main Part 3 Commands Specification Version 1.2 Level 2 (Revision 116) 1 March 2011.

[9]ITU-T publications are available from the International Telecommunications Union (http://www.itu.int/).
[10]NIST publications are available from the National Institute of Standards and Technology (http://www.csrc.nist.gov/).
[11]NMEA publications are available from the National Marine Electronics Association at https://www.nmea.org/.
[12]Available at https://www.secg.org/.
[13]Trusted Computing Group publications available at https://trustedcomputinggroup.org/resource/tpm-main-specification/.

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3. Definitions

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.[14]

access zone (AZ): A communication zone between an advanced base station (A-BS) and relay customer premise equipment (R-CPE) or between an A-BS and an advanced customer premise equipment (A-CPE) in a frame defined by frame structure for PHY Operation Mode 2 (PHY-OM2).

advanced base station (A-BS): A generalized equipment set providing connectivity, management, and control of the advanced customer premise equipment (A-CPE) and the relay customer premise equipment (R-CPE).

NOTE—The functionalities attributed to the A-BS, in the context of this standard, may be implemented by a device or a collection of devices.[15]

advanced customer premise equipment (A-CPE): A generalized equipment set providing connectivity between an advanced base station (A-BS) and a subscriber premise, or between an relay customer premise equipment (R-CPE) and a subscriber premise. A-CPE is used for any customer premise equipment that is not a CPE or an R-CPE. When multi-hop relay is not operational in the Advanced Wireless Regional Area Network (A-WRAN), the A-CPE can be configured to operate in multi-channel mode.

Advanced Wireless Regional Area Network (A-WRAN): The A-WRAN provides all essential functionalities of PHY, MAC, security, and cognitive radio technologies defined in the IEEE 802.22 WRAN and supports additional functionalities of an additional PHY Operation Mode 2 (PHY-OM2), multi-hop relay operations, multiple channel operations, multiple-input-multiple-output (MIMO) operations, and advanced security to extend regional area broadband services to the regional monitoring applications and the enhanced broadband services.

analog television: Radio frequency (RF) transmission of audio and video by analog signals [e.g., NTSC, PAL, SECAM).

NOTE—See ITU-R BT.470 [B47].[16]

authenticator: An entity at one end of a point-to-multipoint Wireless Regional Area Network (WRAN) link that facilitates the authentication of the entity attached at the other end of that link.

backup channel: A channel that has been cleared [i.e., verified that no incumbent service will be affected by Wireless Regional Area Network (WRAN) operation in this channel] to immediately become the operating channel in case the WRAN needs to switch channel.

NOTE—See 11.2.2.

base station (BS): Generalized equipment set providing connectivity, management, and control of the customer premise equipment (CPE).

NOTE—The functionalities attributed to the BS, in the context of this standard, may be implemented by a device or a collection of devices.

broadcast connection: A connection established to transport MAC management messages and data from the base station (BS) to all of the customer premise equipment (CPE) in the cell on the downstream (DS).

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

[15] Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

[16] The numbers in brackets correspond to those of the bibliography in Annex H.

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burst: A two-dimensional segment of OFDM subchannels (frequency domain) and symbols (time domain). It may comprise multiple MAC Protocol Data Units (PDUs) that are encoded with the same physical modulation and coding.

candidate channel: A channel that, once cleared from potential harmful interference to incumbents, can become a backup channel.

NOTE—See 11.2.2.

carrier-to-noise ratio (CNR): Ratio of the power of a subcarrier to the noise power in a bandwidth corresponding to the subcarrier spacing for a set of system parameters.

NOTE—See Table 248.

cell: An IEEE 802.22 cell (or simply, a cell) is formed by a single IEEE 802.22 base station (BS) and zero or more IEEE 802.22 customer premise equipment (CPE) associated with and under control of this IEEE 802.22 BS. The coverage area of this cell extends up to the point where the signal received from the IEEE 802.22 BS is sufficient to allow IEEE 802.22 CPEs to associate and maintain communication with the BS.

centralized relay zone (CRZ): A communication zone between a centralized scheduling relay customer premise equipment (R-CPE) and advanced customer premise equipment (A-CPE) in a frame defined by frame structure for PHY Operation Mode 2 (PHY-OM2).

centralized scheduling relay customer premise equipment (R-CPE): A generalized equipment set providing relay connectivity between an advanced base station (A-BS) and advanced customer premise equipment (A-CPE) using centralized scheduling mode.

centralized scheduling mode: A mode where an advanced customer premise equipment (A-CPE) operates as a centralized scheduling relay customer premise equipment (R-CPE).

channel: Refers to a specific physical radio frequency (RF) channel, a contiguous segment of spectrum in the TV broadcast frequency bands, which may be 6 MHz, 7 MHz, or 8 MHz wide, depending on the relevant regulatory domains. *See also:* **logical channel.**

cognitive plane: The cognitive plane consists of all the entities in the IEEE 802.22 reference architecture that relate to cognitive functions. These cognitive functions are the spectrum manager/spectrum automaton, spectrum sensing function, the geolocation function, and the security sublayer 2. The spectrum manager/ spectrum automaton reside at the same level as the MAC common part sublayer in the data plane whereas the spectrum sensing function (SSF) and the geolocation function reside at the same level as the PHY in the data plane.

cognitive radio: A functionality of some wireless communication devices in which either a network or a wireless node can change the devices' transmission and/or reception parameters to communicate efficiently and to avoid interference with licensed or license-exempt users. This alteration of parameters is based on the active monitoring of several factors in the external and internal radio environment, such as radio frequency spectrum, location information, user behavior, network state, etc.

coexistence: State by which license-exempt wireless communication systems of various types can share a same radio frequency (RF) transmission channel in a common area while minimizing harmful interference to each other by the use of appropriate means.

coexistence beacon: Series of bursts that is transmitted with the goal of improving self-coexistence among overlapping IEEE 802.22 cells, potentially improving coexistence among license-exempt wireless

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communication systems of various types if so equipped, regularly signaling the identity of the transmission device for potential interference resolution and enhancing geolocation ranging resolution between customer premise equipment (CPE) within a cell. The beacon is transmitted under the control of the base station (BS) during self-coexistence windows.

connection: Data path established between base station (BS) and customer premise equipment (CPE) for transport of data.

customer premise or portable equipment (CPE): A generalized equipment set providing connectivity between a base station (BS) and a subscriber premise.

cyclic prefix (CP): The portion of an OFDM symbol used to absorb inter-symbol interference caused by transmission channel time dispersion. The cyclic prefix is actually a copy of the last portion of the symbol appended to the front of the same symbol. Its size is defined in terms of a ratio to the useful part of the OFDM symbol

NOTE—See Table 249.

database service: Service officially operated under the rules of the local regulatory authority that provides a list of available channels and possibly the maximum EIRP allowable on these channels based on queries containing the geolocation of the Wireless Regional Area Network (WRAN) devices.

digital television: Radio frequency (RF) transmission of audio and video by digital signals (e.g., ATSC, DVB-T, ISDB-T).

NOTE—See ITU-R BT-798 [B49].

distributed relay zone (DRZ): A communication zone between a distributed scheduling relay customer premise equipment (R-CPE) and advanced customer premise equipment (A-CPE) frame defined by frame structure for PHY Operation Mode 2 (PHY-OM2).

distributed scheduling relay customer premise equipment (R-CPE): A generalized equipment set providing relay connectivity between an advanced base station (A-BS) and advanced customer premise equipment (A-CPE), and providing connectivity, management and control of the A-CPEs within a local network, while operating in distributed scheduling mode.

distributed scheduling mode: A mode where an operates as a distributed scheduling relay customer premise equipment (R-CPE).

downstream (DS): The direction of the transmitted signal from a base station (BS) to customer premise equipment (CPE).

downstream channel descriptor (DCD): A medium access control layer (MAC) message that describes the physical layer (PHY) characteristics of a downstream burst.

downstream interval usage code (DIUC): An interval usage code specific to a downstream burst. *See also:* **interval usage code.**

downstream map (DS-MAP): A medium access control layer (MAC) message that defines the structure of the downstream subframe, i.e., burst locations in the time and frequency domain of the OFDM.

flow Type (FT): An identifier that identifies a particular flow of traffic assigned to a specific customer premise equipment (CPE) or group of CPEs. *See also:* **station ID (SID)**.

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frame: Basic time unit over which base stations (BSs) and customer premise equipment (CPE) communicate with each other. It is comprised of one downstream subframe, one upstream subframe, and a self-coexistence window when present.

frame contention source (FC-SRC): A Wireless Regional Area Network (WRAN) cell that is demanding additional spectrum resources (i.e., data frame transmission opportunities on a channel) and is initiating an interactive frame contention process with the target frame contention destination (FC-DST).

frame contention destination (FC-DST): A Wireless Regional Area Network (WRAN) cell that is the target of the frame contention request initiated by a frame contention source (FC-SRC), and is the occupier of the spectrum resources being requested by the FC-SRC.

frame contention number (FCN): Number randomly generated by the frame contention sources (FC-SRCs) and frame contention destinations (FC-DSTs) for determining by contention the priority of frame access.

geolocation: The process of acquiring the location data of a device, determining its latitude and longitude, and producing the corresponding NMEA string.

group resource allocation (GRA): The group is composed of one relay customer premise equipment (R-CPE) and many advanced customer premise equipment (A-CPE). The advanced base station (A-BS) allocates the resources on a group basis, and manages the backup and candidate channels on a group basis.

harmful interference: Any emission, radiation, or induction that endangers the functioning of a radio navigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunications service operating in accordance with the ITU and local Regulations.

NOTE—See Article 1 of the ITU Radio Regulations, 1.169, and the FCC 47 CFR 15.3(m).[17]

IEEE 802.22.1 wireless beacon: A radio frequency (RF) device that provides enhanced protection to licensed low-power auxiliary devices such as those used in the production and transmission of broadcast programs [e.g., devices licensed as secondary under Title 47 of the Code of Federal Regulations (CFR) in the USA and equivalent devices in other regulatory domains] from harmful interference potentially caused by Wireless Regional Area Network (WRAN) operation.

in-band: The operating channel (N) and its first adjacent channels (N–1 and N+1).

incumbents: Licensed transmission systems operating in the TV bands on a primary or secondary basis according to international and local regulatory rules.

interval usage code: A code identifying a particular burst profile that can be used for a downstream (DS) or upstream (US) transmission interval.

local cell: A cell is formed by a distributed scheduling relay customer premise equipment (R-CPE) and zero or more advanced customer premise equipment (A-CPEs) associated with and under control of the distributed scheduling R-CPE. The coverage area of this local cell extends up to the point where the signal received from the distributed scheduling R-CPE is sufficient to allow A-CPEs to associate and maintain communication with the advanced base station (A-BS) on relay connection.

logical channel: This is the channel number used by the medium access control layer (MAC), and does not necessarily reflect a physical channel. This can be mapped into any representation as defined by the physical layer (PHY). *See also:* **channel.**

[17]Information on references can be found in Clause 2.

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MAC Protocol Data Unit (PDU): The smallest unit of transmission/reception to be processed by the medium access control layer (MAC). It is comprised of the MAC header, the payload, and Cyclic Redundancy Check (CRC).

managed node: A node that collects and stores the managed objects in the format of a management information base (MIB) that is made available to the network management system via the Simple Network Management Protocol (SNMP).

managed object: A specific characteristic, among many, of a managed device. Managed objects are comprised of one or more object instances, which are essentially variables. A managed object is also referred to as a management information base (MIB) object or an object.

management connection: A connection established to transport medium access control layer (MAC) management messages and data between the base station (BS) and a particular customer premise equipment (CPE).

Management Information Base (MIB): A collection of information that is organized hierarchically. MIBs are accessed using Simple Network Management Protocol (SNMP). They are comprised of managed objects that are identified by object identifiers.

multicast management connection: A connection established to transport medium access control layer (MAC) management messages and data from the base station (BS) to a particular group of customer premise equipment (CPE) on the downstream (DS).

multicast transport connection: A connection established to transport user data from the base station (BS) to a particular group of customer premise equipment (CPE) on the downstream (DS).

multiple channel: Refers to more than one specific physical radio frequency (RF) channel in the TV broadcast frequency bands, which may be 6 MHz, 7 MHz, or 8 MHz wide depending on the relevant regulatory domains.

multiple-input, multiple-output (MIMO): A system employing at least two transmit (Tx) antennas and at least two receive (Rx) antennas to improve the system capacity, coverage, or throughput

OFDM slot: A two-dimensional entity defined as one OFDM symbol by one subchannel.

operating channel: Channel being used by a Wireless Regional Area Network (WRAN) system.

out-of-band: Any channel that is not in-band. *See also:* **in-band.**

PHY Operation Mode 1 (PHY-OM1): A physical layer mode supporting the system defined in Clause 9.

PHY Operation Mode 2 (PHY-OM2): A physical layer mode supporting the system defined in Clause 10.

protected contour: The regulator-defined boundary of an area within which a TV station is entitled to protection from harmful interference.

quiet period: A specific period of time during which the base station (BS) has scheduled a cessation of all transmission in its cell for the purpose of sensing.

receive/transmit transition gap (RTG): A gap between the last sample of the upstream (US) subframe and the first sample of the subsequent downstream (DS) subframe at the antenna port of the base station (BS) in a time division duplex (TDD) transceiver. This gap allows time for the BS to switch from receive (Rx) to

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transmit (Tx) mode. During this gap, the BS is not transmitting modulated data but simply allowing the BS transmitter carrier to ramp up and the Tx/Rx antenna switch to actuate.

relay customer premise equipment (R-CPE): An advanced customer premise equipment (A-CPE) configured to provide relay connectivity between an advanced base station (A-BS) and A-CPEs. An R-CPE can operate in one of two modes: centralized scheduling mode or distributed scheduling mode.

relay receive/transmit transition gap (RRTG): A gap between the last sample of the downstream (DS) access zone and the first sample of the subsequent DS relay zone at the antenna port of the relay customer premise equipment (R-CPE) in a time division duplex (TDD) transceiver. This gap allows time for the R-CPE to switch from receive (Rx) to transmit (Tx) mode. During this gap, the R-CPE is not transmitting modulated data but simply allowing the R-CPE transmitter carrier to ramp up and the Tx/Rx antenna switch to actuate.

relay transmit/receive transition gap (RTTG): A gap between the last sample of the upstream (US) access zone and the first sample of the subsequent US relay zone at the antenna port of the relay customer premise equipment (R-CPE) in a time division duplex (TDD) transceiver. This gap allows time for the R-CPE to switch from transmit (Tx) to receive (Rx) mode. During this gap, the R-CPE is not transmitting modulated data but simply allowing the R-CPE transmitter carrier to ramp down and the Tx/Rx antenna switch to actuate, and the R-CPE receiver section to activate.

relay zone (RZ): A communication zone between any relay customer premise equipment (R-CPE) and an advanced customer premise equipment (A-CPE) or advanced base station (A-BS). A relay zone is operated as one of the following two relay zones: centralized relay zone (CRZ) and distributed relay zone (DRZ).

RSSL: Received Wireless Regional Area Network (WRAN) signal strength level at a base station (BS) or customer premise equipment (CPE).

RSSI: Received signal strength indication (estimate) on the sensing signal path or Wireless Regional Area Network (WRAN) signal path in sensing mode 2 at a base station (BS) or customer premise equipment (CPE).

security association (SA): The set of security information a base station (BS) and one or more of its customer premise equipment (CPE) share in order to support secure communications. This shared information includes traffic encryption keys (TEKs) and the cipher suite that is to be applied to the SA.

security association identifier (SAID): An identifier shared between the base station (BS) and a customer premise equipment (CPE) that uniquely identifies a security association (SA).

security sublayer 1: Security functions for the Data/Control Plane.

security sublayer 2: Security functions for the Cognitive Plane.

self-coexistence: A state by which wireless communication systems of the same type can share a radio frequency (RF) transmission channel in a common area while minimizing harmful interference to each other by the use of appropriate means.

NOTE—In the case of IEEE 802.22, this means coexistence of multiple nearby IEEE 802.22 cells.

sensing mode: A mode of operation of the spectrum sensing function that specifies the valid outputs of the spectrum sensing function.

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service flow: Defines the quality of service (QoS) parameters for the Protocol Data Units (PDUs) that are exchanged on a connection, and provides a mechanism for upstream (US) and downstream (DS) QoS management.

service flow identifier (SFID): A unique identifier for a service flow dealing with how higher layer packets/application sessions are mapped to their quality of service (QoS) requirements and scheduling constraints.

signal type array (STA): A one-dimensional array indicating which signal types the spectrum sensing function is to sense.

spectrum manager: The cognitive function at the base station (BS) that will use the inputs from the database service based on the geolocation at the BS and the customer premise equipment (CPE), as well as the input from the spectrum sensing automaton (SSA) at the BS and the CPEs to decide on the channel to be used by the Wireless Regional Area Network (WRAN) cell as well as the EIRP limits imposed on the specific WRAN devices.

spectrum sensing automation: Cognitive function resident at the base station (BS) and the customer premise equipment (CPE) that includes essential features to allow autonomous and directed sensing at the BS and at the CPE as well as proper CPE operation when it is not under the control of a BS.

spectrum sensing function (SSF): The function that observes the radio frequency (RF) spectrum for a defined set of signal types and reports the results of its observations.

station ID (SID): A unique identifier for a customer premise equipment (CPE) under the control of a base station (BS). This can reflect a single CPE, or a group of CPEs (e.g., multicast group).

subchannel: The basic unit of a logical channel used for subcarrier allocation in both downstream (DS) and upstream (US). A subchannel is composed of 28 subcarriers (24 data and 4 pilot subcarriers).

subframe: Formed by a number of bursts transmitted in the same direction [e.g., downstream (DS) subframe, upstream (US) subframe].

superframe: Group of 16 frames initiated by the transmission from the base station (BS) of the superframe preamble and the Superframe Control header (SCH).

Supplicant: An entity at one end of a point-to-multipoint Wireless Regional Area Network (WRAN) link that seeks to be authenticated by an Authenticator attached to the other end of that link.

symbol period: Fundamental unit of duration in the time domain that is equal to the duration of an OFDM symbol in the time domain.

NOTE—See Table 284.

time division duplex (TDD): A duplex scheme where upstream (US) and downstream (DS) transmissions occur at different times but may share the same transmission channel.

transmit/receive transition gap (TTG): A gap between the last sample of the downstream (DS) subframe and the first sample of the subsequent upstream (US) subframe at the antenna port of the base station (BS) in a time division duplex (TDD) transceiver. This gap allows time for the BS to switch from transmit (Tx) to receive (Rx) mode. During this gap, the BS is not transmitting modulated data but simply allowing the BS transmitter carrier to ramp down and the Tx/Rx antenna switch to actuate, and the BS receiver section to activate.

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transport connection: A connection established to transport user data between the base station (BS) and a particular customer premise equipment (CPE).

upstream (US): The direction of the transmitted signal from a customer premise equipment (CPE) to the base station (BS).

upstream channel descriptor (UCD): A medium access control layer (MAC) message that describes the physical layer (PHY) characteristics of an upstream transmission burst.

upstream interval usage code (UIUC): An interval usage code specific to an upstream burst. *See also:* **interval usage code.**

upstream map (US-MAP): A medium access control layer (MAC) message that defines the media access parameters (i.e., burst start time, burst length, and subchannel usage) for the OFDMA upstream (US) subframe for the customer premise equipment (CPE) scheduled to transmit toward the base station (BS).

urgent coexistence situation (UCS): A situation where a Wireless Regional Area Network (WRAN) detects incumbents in the current operating channel.

wireless microphone: A wireless microphone with licensed use of the TV broadcast bands (e.g., Part 73 and 74 devices in the U.S.A.) and equivalent low-power auxiliary devices allowed under the rules of various regulatory domains.

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