Overview of IEEE Protocol Suite

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Abstract- *IEEE 802 is a family of IEEE standards dealing with local area networks and metropolitan area networks. Even though there are various radio access technologies and multi-mode terminals incorporating multiple network interfaces appear, research and development interest on heterogeneous network interworking increases. IEEE 802 groups have standardized technologies on interworking between heterogeneous IEEE 802 networks and between an IEEE 802 network and a cellular network. This paper gives an idea about some IEEE standards and their usage.*

Keywords- IEEE802.1, IEEE 802.2, IEEE 802.3, IEEE 802.4, IEEE 802.5

I. INTRODUCTION

The Institute of Electrical and Electronics Engineers Standards Association (IEEE-**SA**) is an organization within IEEE that develops global standards in a broad range of industries, including: power and energy, biomedical and health care, information technology and robotics, telecommunication and home automation, transportation, nanotechnology, information assurance, and many more.

The IEEE 802 standards are restricted to networks carrying variable-size packets. The number 802 was simply the next free number IEEE could assign, though "802" is sometimes associated with the date the first meeting was held on February 1980.

The IEEE 802 LAN/MAN Standards Committee develops and maintains networking standards and recommended practices for local, metropolitan, and other area networks, using an open and accredited process, and advocates them on a global basis. The most widely used standards are for Ethernet, Bridging and Virtual Bridged LANs Wireless LAN, Wireless PAN, Wireless MAN, Wireless Coexistence, Media Independent Handover Services, and Wireless RAN. The services and protocols specified in IEEE 802 map to the lower two layers (Data Link and Physical) of the seven-layer OSI networking reference model.

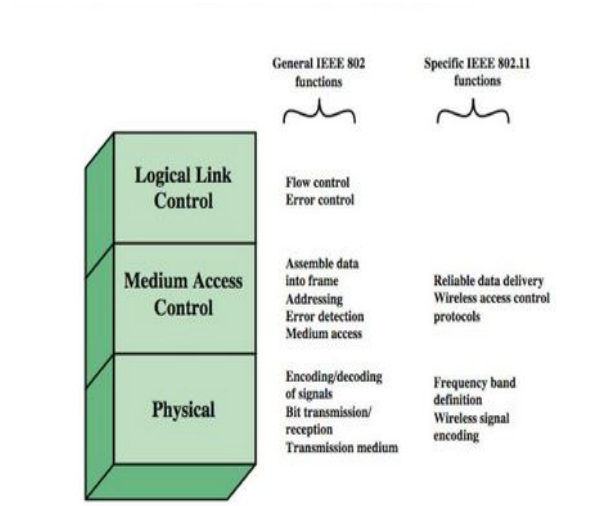

Fig. 1 IEEE 802 Protocol Architecture

II. IEEE STANDARDS

The IEEE 802 Standard comprises a family of networking standards that cover the physical layer specifications of technologies from Ethernet to wireless. IEEE 802 is subdivided into 22 parts that cover the physical and data-link aspects of networking. Some of the standards are explained below

IEEE 802.1	Bridging (networking) and network management
IEEE 802.2	Logical link layer
IEEE 802.3	Ethernet (CSMA/CD)
IEEE 802.4	Token bus (disbanded)
IEEE 802.5	Defines a MAC layer for a token ring (inactive)
IEEE 802.6	Metropolitan Area Networks (disbanded)
IEEE 802.7	Broadband LAN using coaxial cable(disbanded)
IEEE 802.8	Fiber optic TAG (disbanded)
IEEE 802.9	Integrated Services LAN (disbanded)
IEEE 802.10	Interoperable LAN Security (disbanded)
IEEE 802.11	Wireless LAN and mesh (Wi-Fi certification)

IEEE 802.12	Demand Priority (disbanded)
IEEE 802.13	Not used
IEEE 802.14	Cable modems (disbanded)
IEEE 802.15	Wireless PAN
IEEE 802.15.1	Blue-tooth certification
IEEE 802.15.4	ZigBee Certification
IEEE 802.16	Broadband Wireless Access (WiMax Certification)
IEEE 802.16e	(Mobile) Broadband Wireless Access
IEEE 802.17	Resilient Packet Ring
IEEE 802.18	Radio regulatory TAG
IEEE 802.19	Co-existence TAG
IEEE 802.20	Mobile Broadband Wireless Access
IEEE 802.21	Media Independent Handoff
IEEE 802.22	Wireless Regional Area Network

Table 1 IEEE 802 Standards

2.1 IEEE 802.1

The IEEE 802.1 Working Group (IEEE 802.1) is an IEEE Standards Association (IEEE-SA) group established to ensure network management and monitoring capabilities in networks developed according to IEEE 802 standards. IEEE 802.1 handles the architecture, security, management and internetworking of local area networks (LAN), metropolitan area networks (MAN) and wide area area networks (WAN) standardized by IEEE 802.It Designs and implements standards that regulate network management practices. It Provides services, including LAN/MAN management, media access control (MAC) bridging, data encryption/encoding and network traffic management.

IEEE 802.1 is comprised of four groups that focus on different standards and policies in the following areas

- Internetworking
- Audio/video (A/V) bridging
- Data center bridging
- Security

The Internetworking group handles overall architecture, link aggregation, protocol addressing, network path identification/calculation and other technical practices and recommendations.

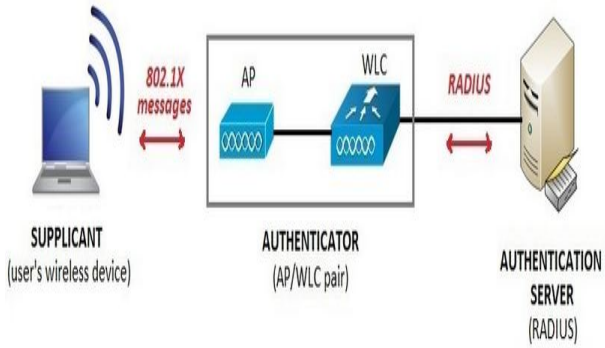

Fig 2.1 IEEE 802.1X Architecture

2.2 802.2 Logical Link Control

The standard for the upper Data Link Layer sub layer also known as the Logical Link Control layer. It is used with the 802.3, 802.4, and 802.5 standards (lower DL sub layers).

802.2 specify the general interface between the network layer (IP, IPX, etc) and the data link layer (Ethernet, Token Ring, etc). 802.2 is concerned with managing traffic over the physical network. It is responsible for flow and error control.

The Data Link Layer wants to send some data over the network, 802.2 Logical Link Control helps make this possible. It also helps by identifying the line protocol, like NetBIOS, or Netware.

The LLC acts like a software bus allowing multiple higher layer protocols to access one or lower layer networks. For example, if you have a server with multiple network interface cards, the LLC will forward packers from those upper layer protocols to the appropriate network interface. This allows the upper layer protocols to not need specific knowledge of the lower layer networks in use.

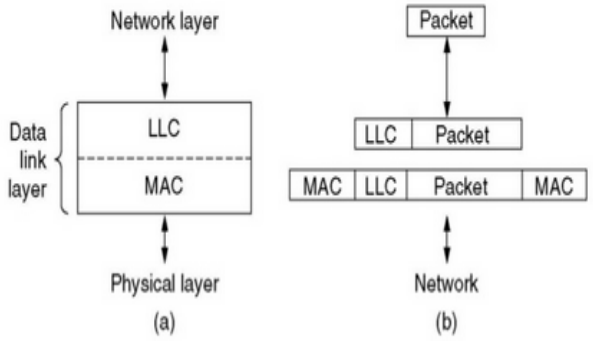

Fig 2.2 position of LLC and Protocol formats

2.3 802.3 Ethernet

802.3 is the standard which Ethernet operates by. It is the standard for CSMA/CD (Carrier Sense Multiple Access with Collision Detection). This standard encompasses both the MAC and Physical Layer standards. CSMA/CD is what Ethernet uses to control access to the network medium via network cable. If there is no data, any node may attempt to transmit, if the nwodes detect a collision, both stop transmitting and wait a random amount of time before retransmitting the data.

The original 802.3 standard is 10 Mbps (Megabits per second). 802.3u defined the 100 Mbps (Fast Ethernet) standard, 802.3z/802.3ab defined 1000 Mbps Gigabit Ethernet, and 802.3ae define 10 Gigabit Ethernet. Ethernet networks transmit data in packets, or small bits of information. A packet can be a minimum size of 72 bytes or a maximum of 1518 bytes. The most common topology for Ethernet is the star topology.

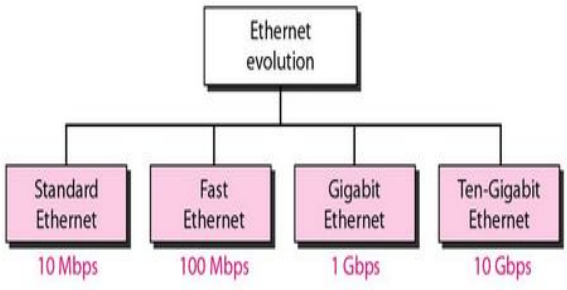

Fig 2.3 802.3 Ethernet evolution

2.4 802.4 Token Bus

The IEEE 802.4 standard specifies the Token-bus media access control method. It is one of two token passing access methods.IEEE802.4 is based on a physical bus or tree topology. The Token-bus approach requires a station to have possession of a token in order to transmit. The token is passed from station to station in a logical ring.

It uses highly reliable cable television equipments. It is more deterministic than 802.3, although repeated loss of token at critical times can introduce the uncertainness. It can easily handle shorter frames. (No limitation on frame size). It supports priorities and hence suitable for Real Time traffic. It also has excellent throughput and efficiency at high load.

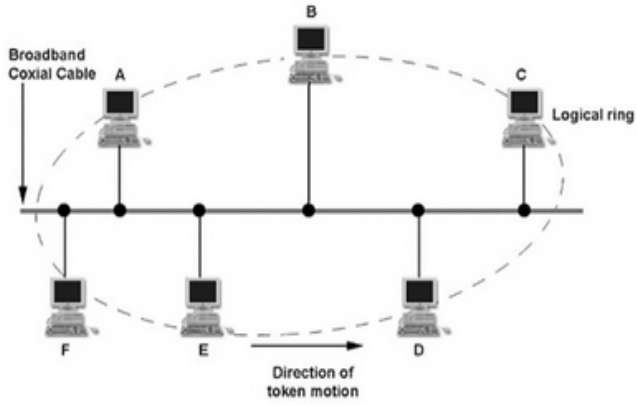

Fig 2.4 802.4 Token Bus

2.5 802.5 Token Ring

Token Ring was developed primarily by IBM. Token ring is designed to use the ring topology and utilizes a token to control the transmission of data on the network. The token is a special frame which is designed to travel from node to node around the ring. When it does not have any data attached to it, a node on the network can modify the frame, attach its data and transmit.

Each node on the network checks the token as it passes to see if the data is intended for that node, if so then it accepts the data and transmits a new token.

If it is not intended for that node, it retransmits the token on to the next node. The token ring network is designed in such a way that each node on the network is guaranteed access to the token at some point. This equalizes the data transfer on the network.

This is different from an Ethernet network where each workstation has equal access to grab the available bandwidth, with the possible of a node using more bandwidth than other nodes. Token ring operated at a speed of about 4 Mbps and 16 Mbps. 802.5t allows for 100 Mbps speeds and

802.5v provides for 1 Gbps over fibber. Token ring can be run over a star topology as well as the ring topology. There are three major cable types for token ring: Unshielded twisted pair (UTP), Shielded twisted pair (STP), and fibber. Token ring utilizes a Multi-station Access Unit (MAU) as a central wiring hub. This is also sometimes called a MSAU when referring to token ring networks.

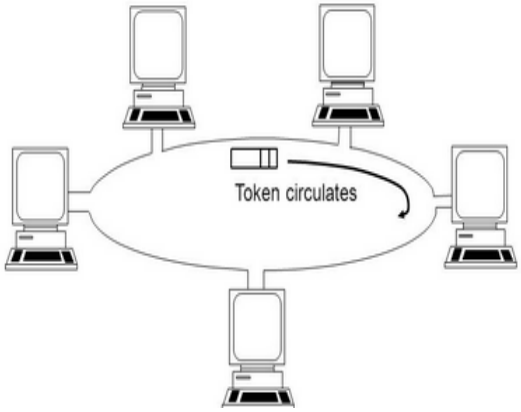

Fig 2.5 802.5 Token Ring

802.6 Distributed Queue Dual Bus

IEEE defined a MAN standard for covering an entire city. This was called Distributed Queue Data Interface (DQDB) and put up as IEEE standard 802.6. The basic geometry of DQDB is as shown in the figure below.

Two parallel unidirectional buses are laid down in the area to be covered by the network. The stations are attached to both the buses in parallel. Each bus has a head-end, which gene rates a steady stream of 53byte cells. Each cell travels downstream from the head end.

When it reaches the end, it falls off the bus. Each cell carries a 44 byte payload field, making it compatible with some AAL modes. Each cell also holds two protocol bits, Busy set to indicate that a cell is occupied, and Request which can be set when a station wants to make a request.

2.7 IEEE 802.7

IEEE 802.7 is a sub-standard of the IEEE 802 which covers broadband local area networks. It provides specification for the design, installation and testing needed for broadband transmission. Broadband transmission allows simultaneous multiple transmission or signal using different communications channels at the same time.

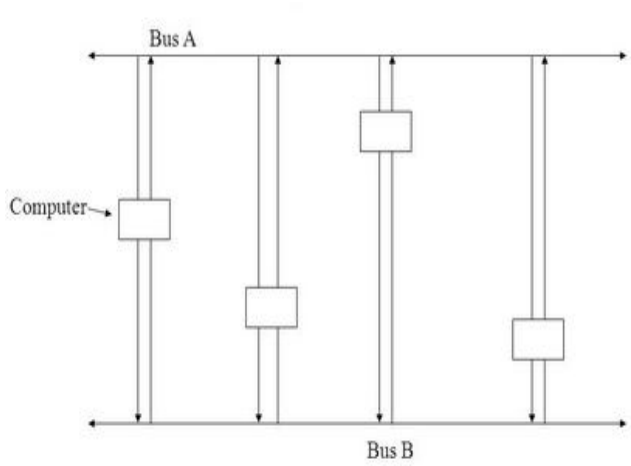

Fig 2.6 802.6 Distributed Queue Dual Bus

2.8 802.8 Fibre optic Networks

The Fibre Optic Technical Advisory Group was to create a LAN standard for fibre optic media used in token passing computer networks like FDDI. This was part of the IEEE 802 group of standards. This standard gives the recommendation for the configuration and testing of fibre-optic Local Area Network and Metropolitan Area Network. It follows Ring Topology and use fibre optic media

2.9 802.9 Integrated Voice and Data Local Area Network

The 802.9 Working Group of the IEEE 802 networking committee developed standards for integrated voice and data access over existing Category 3 twisted-pair network cable installations. Its major standard was usually known as isoEthernet.

The IEEE 802.9 working group is preparing draft standard for an Integrated Voice and Data Local Area Network (IVDLAN) interface for use in an office environment. The standard will define Medium Access Control (MAC) and Physical layers that are compatible with IEEE 802 and ISDN standards and architectures. These functions are provided in a single interface.

2.10 802.10 Virtual LANs

IEEE 802.10 provides specifications for an interoperable data link layer security protocol and associated security services. The Secure Data Exchange (SDE) protocol is supported by an application layer Key Management Protocol (KMP) that establishes security associations for SDE and other security protocols. A security label option is specified that enables rule-based access control to be implemented using the SDE protocol.

A method to allow interoperability with type-en-coded Medium Access Control (MAC) clients is also provided, as well as a set of managed object classes to be used in the management of the SDE sublayer and its protocol exchanges.

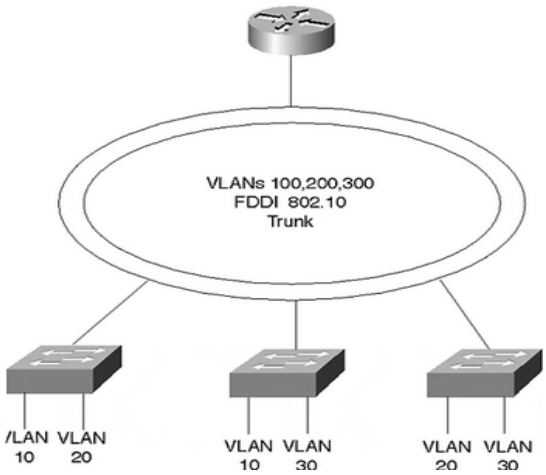

Fig 2.7 802.10 Virtual LANs

2.11 802.11 Wireless Network Standards

802.11 is the collection of standards setup for wireless networking. The three popular standards are 802.11a, 802.11b, 802.11g and latest one is 802.11n. Each standard uses a frequency to connect to the network and has a defined upper limit for data transfer speeds. 802.11a was one of the first wireless standards. 802.11a operates in the 5Ghz radio band and can achieve a maximum of 54Mbps. Wasn't as popular as the 802.11b standard due to higher prices and lower range.802.11b operates in the 2.4Ghz band and supports up to 11 Mbps. Range of up to several hundred feet in theory.

The first real consumer option for wireless is very popular. 802.11g is a standard in the 2.4Ghz band operating at 54Mbps. Since it operates in the same band as 802.11b, 802.11g is compatible with 802.11b equipment. 802.11a is not directly compatible with 802.11b or 802.11g since it operates in a different band.

Wireless LANs primarily use CSMA/CA - Carrier Sense Multiple Access/Collision Avoidance. It has a "listen before talk" method of minimizing collisions on the wireless network. This results in less need for retransmitting data. Wireless standards operate within a wireless topology.

2.12 IEEE 802.12

The IEEE 802.12 standard is based on a 100-Mbps proposal promoted by AT&T, IBM, and Hewlett-Packard. Called 100VG-AnyLAN, the network is based on a star-wiring topology and a contention-based access method whereby devices signal the wiring hub when they need to transmit data.

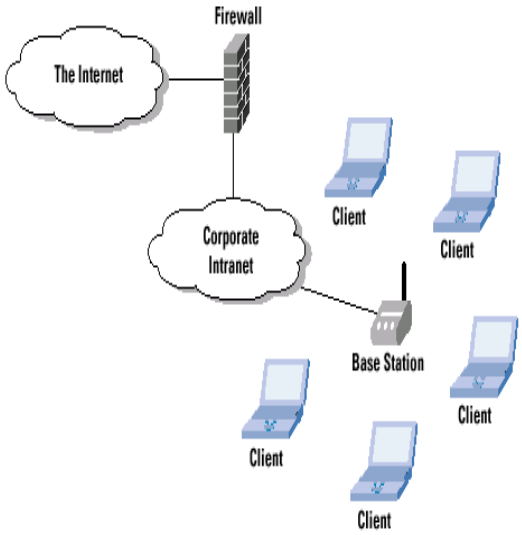

Fig 2.8 802.11 Wireless Network Standards

Devices can transmit only when granted permission by the hub. This standard is intended to provide a high-speed network that can operate in mixed Ethernet and Token Ring environments by supporting both frame types.

The IEEE 802.12 standards define the protocol and compatible interconnection of data communication equipment via a repeater-controlled, star-topology LAN (Local Area Network) using the demand-priority access method. This provides a round-robin arbitration method to provide LAN access based on message priority level.

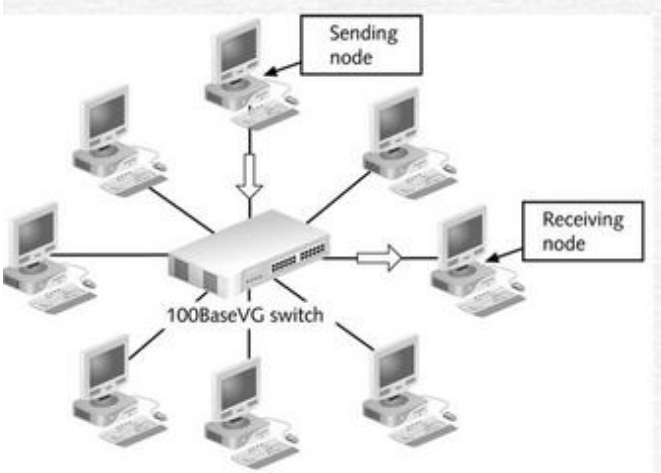

Fig 2.9 IEEE 802.12 Standard

2.13 IEEE 802.14

The IEEE 802.14 Working Group is currently standardizing a MAC protocol for cable television based data networks. This protocol will support Quality of Service (QoS) requirements of multiple traffic types, including CBR, VBR, and ABR. The IEEE 802.14 Working Group is presently evaluating several fundamentally different MAC protocols, ranging from contention protocols and polling schemes to reservation protocols and hybrid schemes.

2.14 IEEE 802.15

IEEE 802.15 is a working group of the Institute of Electrical and Electronics Engineers (IEEE) IEEE 802 standards committee which specifies wireless personal area network (WPAN) standards. There are 10 major areas of development, not all of which are active.

The number of Task Groups in IEEE 802.15 varies based on the number of active projects. Task group one is based on Bluetooth technology. It defines physical layer (PHY) and Media Access Control (MAC) specification for wireless connectivity with fixed, portable and moving devices within or entering personal operating space.

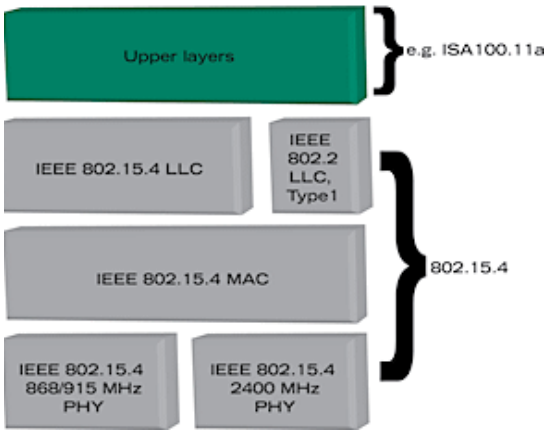

Fig 2.10 IEEE 802.15

2.15 IEEE 802.16

IEEE 802.16 is a series of wireless broadband standards written by the Institute of Electrical and Electronics Engineers (IEEE). The IEEE Standards Board established a working group in 1999 to develop standards for broadband for wireless metropolitan area networks.

2.16 IEEE 802.17

In Metropolitan and Wide Area Networks, fiber optic rings are widely deployed. These rings are currently using protocols that are neither optimized nor scalable to the demands of packet networks, including speed of deployment, bandwidth allocation and throughput, resiliency to faults, and reduced equipment and operational costs.

The IEEE 802.17 Resilient Packet Ring Working Group develops standards to support the development and deployment of Resilient Packet Ring (RPR) networks in Local, Metropolitan, and Wide Area Networks for resilient and efficient transfer of data packets at rates scalable to many gigabits per second. These standards build upon existing Physical Layer specifications, and develop new PHYs where appropriate. IEEE 802.17 is a unit of the IEEE 802 LAN/MAN Standards Committee.

2.17 IEEE 802.18

The IEEE 802.18 Radio Regulatory Technical Advisory Group (RR-TAG) supports the wireless Working Groups in the IEEE 802 community by interfacing with regulatory agencies and industry groups working on regulatory issues.

Administrations constantly upgrade their radio rules and regulations, providing brief opportunities for public comment. The RR-TAG monitors those with potential impact on IEEE 802 wireless standards groups and creates appropriate comment documents. The RR-TAG is also the liaison to other standards bodies on radio regulatory matters of mutual interest.

2.18 IEEE 802.19

The IEEE 802.19 Coexistence Technical

Advisory Group (C-TAG) develops and maintains policies defining the responsibilities of IEEE 802 standards developers to address issues of coexistence with existing standards and those under development. As required, it offers assessments to the Sponsor Executive Committee (SEC) on how well standards developers have conformed to these conventions. It also may develop coexistence documentation for the technical community outside of IEEE 802.

IEEE 802.19 provides technical assistance to the working groups developing unlicensed MAC/PHY standards.

2.19 IEEE 802.20

The IEEE 802.20 standard has been developed to provide a system which is able to provide mobile broadband wireless access, MBWA for users. It is intended that IEEE 802.20 will enable worldwide deployment of mobile

broadband wireless networks using multi-vendor equipment. Tagged "Mobile-Fi", the aim is that IEEE 802.20 MBWA will provide an interface that will allow low cost, always on mobile broadband connectivity using wireless technology.

2.20 IEEE 802.21

IEEE 802.21 is developing an extensible Media access Independent Services (MIS) framework (i.e., function and protocol) that enables the optimization of services including handover service when performed between heterogeneous IEEE 802 networks. It also facilitates these services when networking between IEEE 802 networks and Cellular networks.

2.21 IEEE 802.22

IEEE 802.22, is a standard for wireless regional area network (WRAN) using white spaces in the television (TV) frequency spectrum. The development of the IEEE 802.22 WRAN standard is aimed at using cognitive radio (CR) techniques to allow sharing of geographically unused spectrum allocated to the television broadcast service, on a non-interfering basis, to bring broadband access to hard-to-reach, low population density areas, typical of rural environments, and is therefore timely and has the potential for a wide applicability worldwide. It is the first worldwide effort to define a standardized air interface based on CR techniques for the opportunistic use of TV bands on a non-interfering basis.

III. SUMMARY

This paper analyzes the concepts of IEEE 802 protocol standards.

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