IEEE 802.11 WIRELESS LAN (WLAN) TECHNOLOGY

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Abstract - This paper describes and evaluates wireless IEEE 802.11 WIRELESS LAN. This paper introduces some major topics like wireless networks, IEEE 802.11 wireless LAN, IEEE 802.11 Medium Access Control and the ALOHA system. Section II introduces the wireless networks explaining the wireless network consist radio signals, the data format and the network structure and different architectures that enhances wireless communications and fulfill important functions necessary for specific applications. It concluded that wireless networks provides some essential benefits like Flexibility, Increased Efficiency,Adjustability,Security and VOIP technology.It focuses on IEEE 802.11 medium access control(MAC) which in wireless networks controls and manages the access and packet transmission through the shared channel in a distributed manner, with minimum possible overhead involved.IEEE 802.11 medium access control (MAC) introduces the two sublayers of IEEE 802.11 which uses distributed coordination function (DCF) and point coordination function (PCF). Another important aspect is IEEE 802.11 supports mainly three basic topologies: Independent Basic Service Set (IBSS), Basic Service Set (BSS), and Extended Service Set (ESS).Finally, the paper provided a comprehensive discussion on ALOHA system reviewing the main aim of the ALOHA protocol is to determine that which competing station must get the next chance of accessing the multi-access channel at MAC layer.

Index Terms - Wireless Networks, IEEE 802.11 Wireless LAN, IEEE 802.11 medium access control, ALOHA.

I. INTRODUCTION

Wireless LAN technology is being increasingly deployed and has been one of the fastest developing technologies of the communication industry because of its ability and potential to make users perform different tasks.Although the origins of radio frequency based wireless networking can be traced back to the University of Hawaii's ALOHANET research project in the 1970s, the key events that led to wireless networking becoming one of the fastest growing technologies of the early 21st century have been the ratification of the IEEE 802.11 standard in 1997, and the subsequent development of interoperability certification by the Wi-Fi Alliance (formerly WECA) [1].
Implementation of many wireless networks of various sizes, such as wireless personal area networks (WPANs), local area networks (WLANs), metropolitan area networks (WMANs), and wide area networks (WWANs) are of different format. The reason for the popularity of these wireless LAN networks is due to the flexibility, convenience and portability.

The shortcomings of the wireless technology has currently become a challenge because of everyday technological advancement which requires strong and newly improved networksecurity measures. Any access point can join a network without the implementation without any security measure. In wireless networks, the security is much more critical and compulsory than the wired networks simply because when the data is sent over the wireless network is actually broadcast for the neighborhood to hear[2].

II. WIRELESS NETWORKS

In the last few decades, wireless networks has been part of the communication system enabling multimedia communications between people and devices from any location. With the rapid growth of mobile telephony and networks, wireless technology has been one of the fastest developing technologies of the communication industry.With the deployment of wireless networks in business environments, organizations are working to implement security mechanisms that are equivalent to those of wire-based LANs [3]. The wireless network consist radio signals, the data format, and the network structure. Each is dependent on the other. The OSI reference model explains that the radio signal operates at the physical layer, and the data format controls of the higher layers. In a wireless network, the network structure includes the wireless network interface adapters and base stations that send and receive the radio signals.

A. Architectures for Wireless Networks

The architecture of a wireless network interconnects wireless users and end systems. It enhances wireless communications and fulfill important functions necessary for specific applications.Wireless networks usually exploit the fact that the radio waves die out as they travel, so the same slice of spectrum (frequency channel) can be reused in different locations with minimal interference.Wireless networks operate in both licensed and unlicensed parts of the spectrum. For example, wireless telephone networks operate in the bands licensed to the telecommunications networking companies.Fig 1.1 display different architecture development and how Internet Service

Providers(ISP) use this system to transport communications signals from a base station at a remote site such as a home or office to a base station near a communications facility.Fig 1.1(a) architecture is built using base stations and an access point (AP). Fig 1.1(b) is built using WiMax transmitter. WiMax technology was introduced in the 4th generation(4G) wireless communication networks

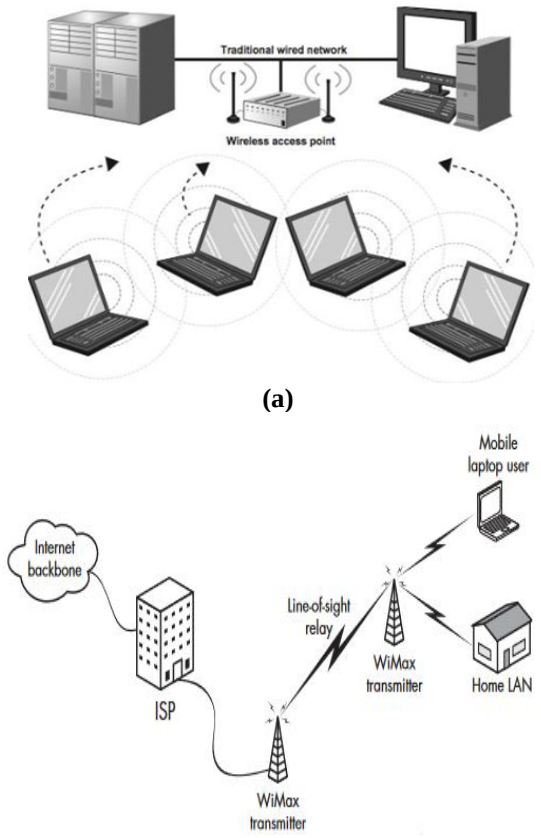


Fig 1.1 Wireless Network Architectures

B. Benefits of Wireless Networks

Wireless network system has off late been accepted in many industries transportation, military, healthcare, business and manufacturing. Below are some discussed benefits of wireless networks;

(1) Flexibility:Every user in the wireless communication system wants to quickly install a small WLAN for temporary needs such as a conference, online easy access of internet etc.User can connect easily when location is changed. Public transport, subway station, railway station, home, office can provide wireless network to users anywhere located in such places.

(2) Increased Efficiency: Wireless network has increased because of low cost. The cost to install and maintain a wireless network is much less than the wired alternative.

(3) Adjustability:Specific configuration can be made to meet the need of specific application depending on your organization's needs. It seldom involves another expenditure when relocating or new users are added. It easy and convenient to use.

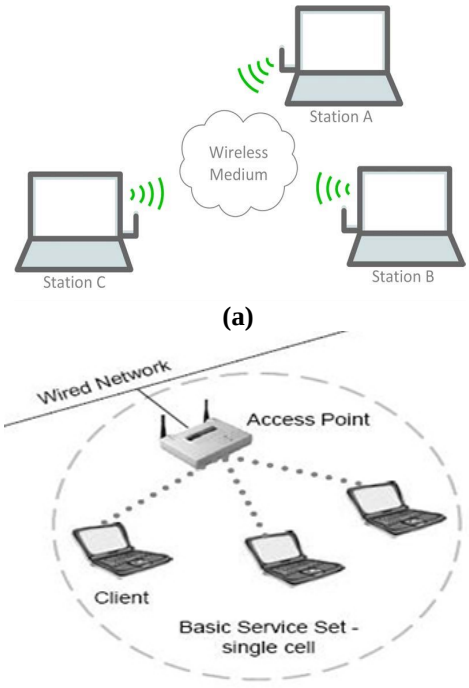
(4) Security:The security of wireless is actually the most essential benefit as it prevent information and data of users or organizations from being stolen or hacked. The best and latest security invented in the wirelessnetwork is the encryption technology. This is where password are encrypted and made unreadable to the hacker. Encryption like Wired Equivalent Privacy (WEP), Temporal Key Integrity Protocol (TKIP),Advanced Encryption Standard (AES),Wireless Protected Access (WPA) andWired Equivalent Privacy (WEP). WPA2 is currently the upgraded version of WPA.

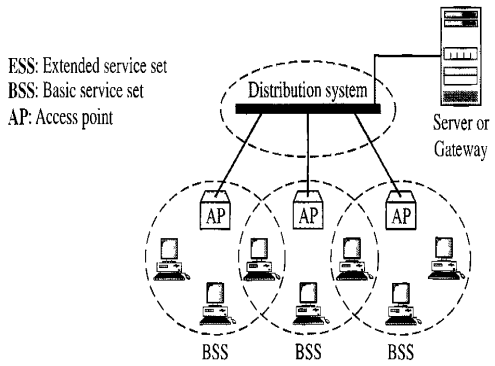
(5) VOIP technology: Voice Over Internet Protocol (VOIP) is mentioned as one of the inventions that has immensely made communication easy and free depending on the country. Users mostly in the same network can make calls using the VOIP technology.

III. IEEE 802.11 WIRELESS LAN (WLAN)

Wireless Fidelity(Wi-Fi) refers to wireless local area network based on IEEE 802.11standard.Wi-Fi Alliance is a non-profit organization that does the compatibility testing (WiFi.org). In 1997, the IEEE released 802.11 as the first internationally sanctioned standard for wireless LANs. IEEE 802.11 supports mainlythree basic topologies: Independent Basic Service Set (IBSS), Basic Service Set (BSS), and Extended Service Set (ESS).

IBSS is simply comprised of one or more Stations which communicate in a wireless medium on an ad-hoc or peer to peer mode as shown in Fig 2.1(a). BSS is Set of stations associated with one Access Point (AP) as shown in Fig 2.1(b). ESS is an interconnected two or more BSS forming a single network as shown in Fig 2.1(c).





(c)

Fig 2.1 Three basicIEEE 802.11 WLAN Topologies.

There are several extensions in the IEEE 802.11 family. (1) IEEE 802.11a which provides up to 54-Mbps in the 5GHz band and use Orthogonal Frequency Division Multiplexing (OFDM) encoding technology. (2) IEEE 802.11b also known as 802.11 High Rate or Wi-Fi uses direct sequence spread spectrum (DSSS) system and provides 11 Mbps transmission in the 2.4 GHz band. (3) IEEE 802.11e added Quality of Service (QoS) to the existing 802.11a and 802.11b. (4) IEEE 802.11g is used for transmission specifically WLAN over short distances at 54-Mbps in the 2.4 GHz bands.(5) IEEE 802.11n invented Multiple-Input Multiple-Output (MIMO) and its speed is 4-5 times faster than 802.11g. (6) IEEE 802.11ac delivers data rates of about 433Mbps per spatial stream and operates in the 5GHz frequency range. (7) IEEE 802.11ac Wave 2uses Multiple User- Multiple-Input Multiple-Output(MU-MIMO) technology to help increase the speed of wireless technology.(8) IEEE 802ah has the ability to penetrate walls and other barriers and operates in frequency bands below one gigahertz (900 MHz) considerably better than previous Wi-Fi standards. (9) IEEE 802.11r supports Voice over Wi-Fi (VoWi-Fi) handover process between access points to enable VOIP roaming on a Wi-Fi network with IEEE 802.1X authentication. (10) IEEE 802.11X is an IEEE standard for port-based Network Access Control that provides security between authenticated and authorized devices. (11) IEEE 802.11p is an improved version of the IEEE 802.11 standard to add wireless access in vehicular environments (WAVE), a vehicular communication system.Similar to 802.3, basic 802.11 MAC operatesaccording to a listen-before-talk scheme,and is known as the distributed coordination function (DCF); It implements carrier sense multiple access with collision avoidance (CSMA/CA) rather than collision detection as in 802.3 [4].

IV. IEEE 802.11 MEDIUM ACCESS CONTROL

Medium Access Control (MAC) protocol in wireless networks controls and manages the access and packet transmission through the shared channel in a distributed manner, with minimum possible overhead involved [5].Carrier Sense Multiple Access with Collision Detection (CSMA/CD) is mostly used as IEEE 802.11 protocol in most wired LANs. The sublayer of IEEE 802.11 uses three different types of messages. They are, (1) Data messages which are handled via the MAC data service path, (2) Management messages handled via the management service path and (3) the delivery of IEEE 802.11 data and management messages are successful with the help of Control messages.

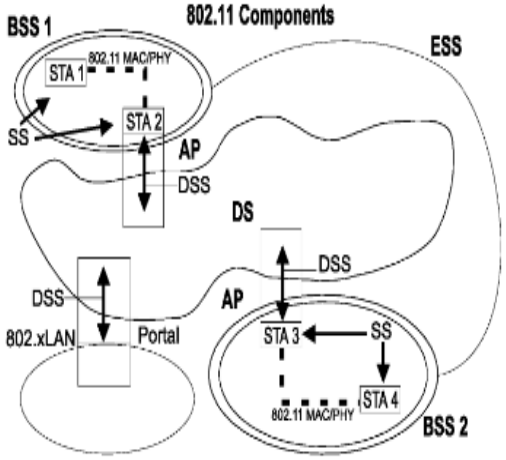


Fig 3.1 IEEE 802 MAC Sublayer Architecture

Considering a data message sent from Station One (STA 1) to STA 4 in Fig 3.1, STA 2 initially receives the data message sent from STA 1 in BSS 1. STA 2 becomes the input Access Point (AP). The input AP releases the message to thedistribution service of the Distributed System(DS) and makes sure that the message is delivered andarrives at the appropriate DS destination for the expected recipient. The data message is delivered to the output AP (STA 3). Lastly, through wireless medium the data message is delivered from the output AP to STA 4.

The performance of the medium access control (MAC) sublayer, which consists of distributed coordination function (DCF) and point coordination function (PCF), is determined by simulating asynchronous data traffic in a 1 Mbps ad hoc network, and asynchronous data and packetized voice traffic in a 1 Mbps infrastructure network [6].

In 802.11, the DCF is the fundamental access method used to support asynchronous data transfer on a best effort basis. DCF comes with two technologies for packet switching and transmitting. It involves the two-way handshaking mechanism, also called as basic access method and a four-way handshaking mechanism, which uses request-to-send/clear-to-send(RTS/CTS) technique to reserve the channel before data transmission.

PCF is an optional contention-free service, used for non-QoS STA. The modified PCF uses a distributed polling protocol (DPP) as an access mechanism for the uplink transmission. The transmission

period in the modified PCF involves the distributed polling protocol period (DPPP) which is controlled by the DPP and the real-time traffic downlink period (RTDP).

V.ALOHA

The ALOHA System, an experimental UHF radio computer communication network was developed at the University of Hawaii during 1970s. ALOHA isthe earliest random-access method (1970s still used in wireless cellular systems for its simplicity.
ALOHA decreases data entry errors by validating the input values for accuracy and speed. ALOHA invented one of the world's first time-sharing networks that had the capability to use the packet radio technology as the communications medium. An apportioned unit of information transmitted in terms of specific number of bit is called a packet. The multiplexingtechnique that was utilized by the ALOHANET was a purely random access packet switching method that has come to be known as thepure ALOHA technique [7]. ALOHA proposed for packet radio environments where every node can hear every other node to avoid collisions. Analysis shows that many nodes in the ALOHA system shares a common channel and have comparable transmission.
The main aim of ALOHA protocol is to determine that which competing station must get the next chance of accessing the multi-access channel at MAC layer.There are two basic categories of ALOHA system, Slotted ALOHA and PureALOHA.The Slotted ALOHA procedure segments the time into slots of a fixed length. Slotted Aloha is a modified version of Aloha which introduced discrete time slots. When a node has a packet to send, it waits until the start of the next slot to send it, thus synchronization happens before a packet can be sent as shown in Fig 4.1.

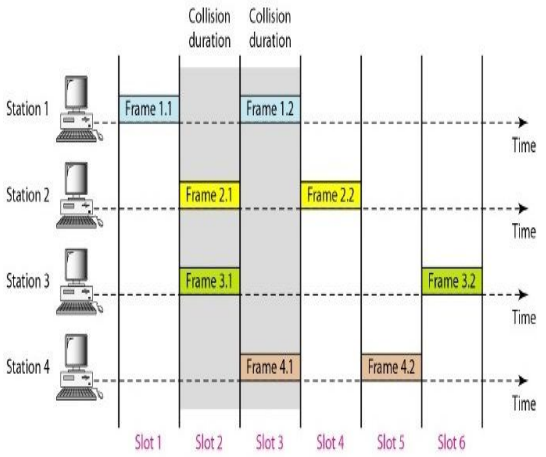


Fig 4.1 Slotted Aloha Frame Architecture

Nodes can be transmitted at any time and packets can be retransmitted if collision occurs in Pure ALOHA as shown in Fig 4.2

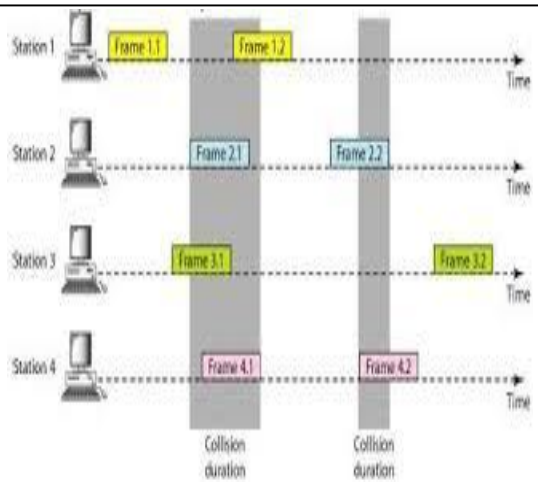


Fig 4.2 Pure ALOHA Frame Architecture

A. Mobile Slotted ALOHA (MS-ALOHA)

MS-ALOHA is a slotted MAC protocol, specifically designed forscalability, reliability, flexibilityand mobility. MS-Aloha is slotted because of its periodic frame structure, including fixed-length time slots representing the distinct resources to be allocated. Confirmation of slot reservation at each node transmission helps to manage mobility in a completely distributed way. Mobile Slotted Aloha is a wireless network protocol designed for applications such as vehicle networks. MS-Aloha and IEEE802. 11p can be used in different frequencies with the same radio front-end to prevent misalignment and clock loops.

CONCLUSION

In this paper, I conducted a comprehensive study on the generation ofIEEE 802.11 Wireless LAN. An extensive research and analysis was conducted about which emphasize that wireless network interface adapters and base stations that send and receive the radio signals.Next to this,wireless network systemprovides some essential benefits like Flexibility, Increased Efficiency, Adjustability, Security and VOIP technology. ALOHA system reviewed that, the main aim of the ALOHA protocol is to determine that which competing station must get the next chance of accessing the multi-access channel at MAC layer.It's concluded that the IEEE 802.11 technology together with the ALOHA system would enhance easy communication in the wireless LAN.

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