Computer Networks and IEEE Wireless LAN Standards

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Abstract: The computer network is telecommunication channel to share data among different entities. It is a distributed system through which the data is transmitted and received over internet. The network should be reliable, secure and having good performance in terms of speed and throughput. The WLAN technology enables the wireless connection in frequent manner rather than wired connection within campus or building. The technology uses the radio frequency to send and receive data in air. The WLAN standard is developed by IEEE and common standard is IEEE 802.11 and IEEE 802.11x as family with different specifications. The IEEE 802.11 standard specifies an air interface between a base station and wireless client or two wireless clients. The study is discusses the different computer networks as LAN, MAN and WAN, Global communication coverage and different 802.xx standards.

Key words: Compute, technology, frequent, IEEE, WAN, specifications

INTRODUCTION

The computer network (Garg, 2014; Tanenbaum, 2015) is a group of connected computers using ethernet cables or physical wires. The computers over the networks are called nodes. The nodes can be connected using wired connection or wirelesses. The connected nodes follow specific topology can shared the data among all nodes associated in the ink. The associated and connected computers share files, printer internet and others to communicate and perform multifunction with the help of single computer or more. The network connections (Lee and Choi, 2008; Crow *et al.*, 1997) can follow mesh, star, ring, bus butterfly or hybrid topology based on requirements and applications.

There exist different types of communication networks. The classification is done based on geographical coverage, size and supports the number of nodes. The different networks are classified as:

- Personal Area Network (PAN)
- Local Area Network (LAN)
- Metropolitan Aarea Network (MAN)
- Wide Area Network (WAN)

The network which is configured around a person, office, residence or building is called PAN. The PAN network consist of one or more communicating nodes, tablets, peripherals, telephones, video game consoles, personal digital assistants, entertainment devices and other personal communication devices. It is used to perform intercommunication among the devices. The network is also referred as Home Area Network (HAN), if the multiple devices are using the same network with in the building or specific area. It is possible with the help of modem that can have wired or wireless links to all devices. The network can be supported by single computer and accessed by any one of the device over the link. Some examples of the PAN are: watching the movie as online streaming on TV, uploading the photos form your mobile to your personal computers, print the pages from your cabin. Some existing technologies for wireless PAN are IrDA in Steon, Bluetooth, Zigbee wireless are body USB and wearable devices in body area network. This is the network which has been proved one the more successful network for wearable computing and devices (Fig. 1).

LAN is a small network which covers small regions such as office, building, school, small colony. In LAN network, the nodes are sharing their data with the help of ethernet cables. The LAN communication is possible with the help of two nodes or more number of nodes. The largest LAN can have hundreds nodes. It can be wired or wireless. The wired LAN is low cost and high speed network. The LAN connections have the low speed

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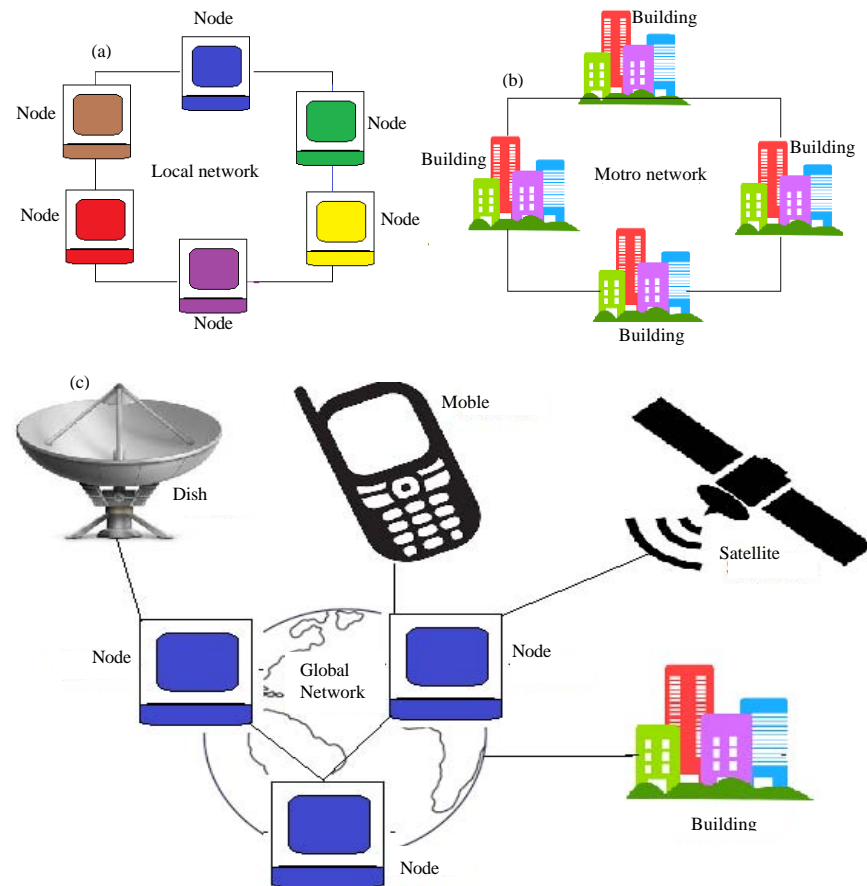
Fig. 1: Communication networks: a) LAN; b) MAN and WAN (Tanenbaum, 2015)

ethernet (10 Mbps), fast speed ethernet (100 Mbps) and more fast speed as gigabit Ethernet (1000 Mbps). The geographical area of the WAN is more in comparison to LAN. It is the collection of several LAN covering some part of city. It allows the sharing of regional resources. It is also high speed network but not more than LAN. Moreover, a specific node can serve as the gateway to set up LAN communication and handle the communication among several LAN and other networks. Internet access is one of the examples of WAN.

WLAN GLOBAL COMMUNICATION

IEEE 802 (Carthern *et al.*, 2015; Mitchell, 2017) is the IEEE standard for LAN and MAN. The standards are varying with respect to data size and type of network. In the cell structures the data is small. The telecommunication networks follow the data in octets or in groups in regular intervals. The services relating to 802 are associated with the data link and physical layers of the OSI reference model. The IEEE 802 data link layer is divided into two sub units Logical Link Control (LLC)

sublayer and Medium Access Control (MAC) sublayer. The data link layer transfers the data between the adjacent nodes in WAN and between the nodes in same LAN. It also transfers the data between communicating entities and detect the possible errors, occurred in physical layer. The data link layer is also responsible for the local frames delivery between the devices in same LAN. The global addressing, routing of data packets internetworking is the function of upper layers. The data link layer allows the local addressing, delivery and logical arbitration. Moreover, the data link layer focused more on neighborhood traffic and provides the arbitration among the multiple clients need to access the same medium. The frame collision error may occur in case of simultaneous access of the same medium. The data link layer specifies the detection and recovery technique from the frame collision. The frame header consists of source node address, destination address and data and indicates which device is initiating the frame and destination device need to access the frame. The LLC sublayer multiplexes the different protocols (Charaan *et al.*, 2017) of data link and optionally control the flow, errors and

acknowledgments. It also decides the mechanism used for addressing different stations over transmitting medium and controls the exchange of data between the source and target nodes. MAC sublayer decides that who is allowed to access the specific medium in one time for, e.g., CSMA/CD and access method for frame under MAC address. The MAC layer follows the distributed and centralized approach for mdium control.

The network hardware transmission is relating to the physical layer. It is the main layer for the logical data structure and their functions at high level in the network. The raw data is transmitted logically in physical layer instead of data packets which connects the different nodes and complex link is associated with communicating nodes. The data stream in the form bits is grouped in code words and symbols and converted to physical signal which is transferred over the hardware transmission medium. The physical layer gives mechanical, electrical and consequent interface to the transmission medium such as frequency of broadcasting, modulation methods, electrical connectors shape and properties, etc., (Fig. 2).

IEEE 802.xx WLAN STANDARDS

IEEE defined the standard for telecommunications information technology and information exchange between systems in LAN and MAN with Specific requirements as Part 11, called IEEE 802.11 LAN standards: wireless LAN Medium Access Control (MAC) and Physical layer (PHY) specifications. The standards are described in Table 1.
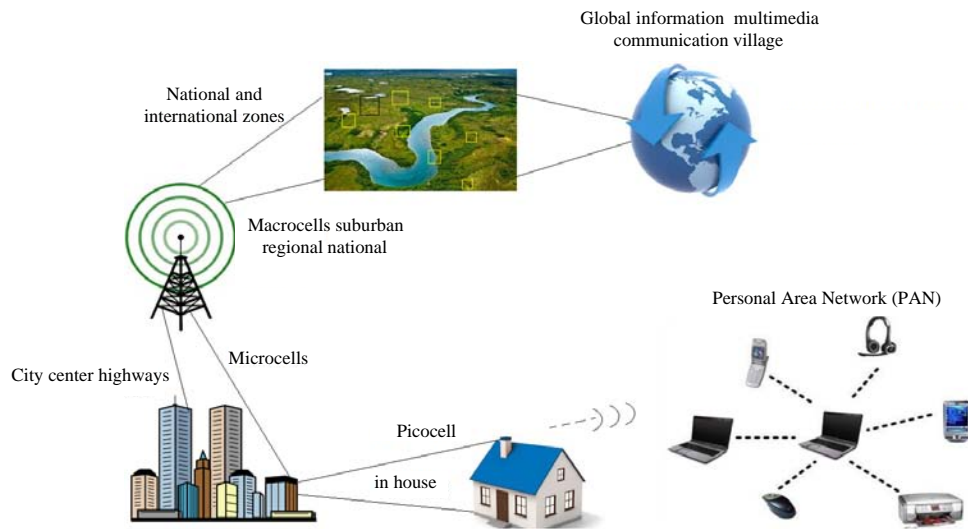

Fig. 2: Global coverage of communication technology

Table 1: WLAN standards (Crow *et al.*, 1997; Ghosh, 2017)

Names	Defined standard	Description
IEEE 802.1	LAN-MAN architecture and interconnecting	It is network management and higher layer LAN protocols for Bridging. Interconnection among LAN, MAN and 802 WAM, Link security (Chen, 2013) and overall network management
IEEE 802.2	Logical Link layer (LLC)	It is the is one of the data communication protocol under data link layer of the OSI-seven layer (Tanenbaum, 2015) Model
IEEE 802.3	Ethernet	One of the computers networking technology used in LAN and MANs
IEEE 802.4	Token bus	It is network following the token ring concept in a virtual ring over coaxial cable
IEEE 802.5	Defines the MAC layer for a token ring	It is the frame transfer technique from servers that follow the token and configures in a logical ring. The passing of token is method for channel access for all the stations to avoid the collisions
IEEE 802.6	MANs (DQDB)	It is a computer network larger than LAN but smaller than WAN. The network can cover the interconnections of a city and its connections over a single large network
IEEE 802.7	Broadband lan using coaxial cable	It is the standard which covers broadband LAN. The digital data is transferred into higher frequency before the transmission over a medium and modulation techniques is followed by the baseband signal
IEEE 802.8	Fiber optic TAG	It is fiber optical group based on token passing networks such as FDDI in which optical fiber is used for underlying physical medium
IEEE 802.9	Integrated services LAN	It is the standard was developed for the integrated data and voice/video over twisted pair network under ethernet. It is also called as isoethernet that follows 10 Mbps Ethernet and ISDN B channels with 64 Kbps

Table 1: Continue

Names	Defined standard	Description
IEEE 802.10	Interoperable LAN security	The standard is relating to security and control. It specifies key management, security association, data integrity, data confidentiality and access control. All the security functions are applicable for LAN and MAN
IEEE 802.11	Wireless LAN (WLAN) and Mesh (Wi-Fi certification)	It is wireless LAN in which two or multiple devices are connected using wireless distribution and the users are able to move in local coverage space such as computer laboratory, buildings and home. It provides the connectivity to internet. The examples of such network are cellular network, OFDM radio, spread spectrum, etc
IEEE 802.12	100 Base VG	100 BaseVG standard was proposed by HP Company in 1995 and ratified by ISO. It is a 100 Mbps Ethernet standard and defined to carry both token ring and Ethernet frame types can run over four pair of UTP. It is refereed as Voice Grade (VG)
IEEE 802.13	Unused	It is undefined yet and revered for the development of fast Ethernet
IEEE 802.14	Cable modems	The cable modem is one of the bridge networks that give bidirectional data communication over radio frequency channels. Generally, the modems are used to deliver broadband internet with larger bandwidth in the form of cable internet and Hybrid Fiber Coaxial (HFC)
IEEE 802.15	Wireless Personal Area Networks (WPAN)	It is applicable for PAN used for data transfer among tablets, telephones, computers and personal digital assistants. It is used for low powered devices for short distance wireless technology such as Irda, Insteon, Bluetooth, wireless USB, Z-wave, body area network, Zigbee, etc
IEEE 802.15.1	Bluetooth certification	It is the wireless technology standard used for the data exchange in short range. It is done using UHF radio waves in short length in ISM band ranging 2.4-2.485 Ghz with the help of fixed device or mobile device (LaMaire *et al.*, 1996) in PAN. It was invented by ericsson in 1994. It was an alternate solution to RS 232 cables. In this technology seven multiple devices can communicate with a PC over one adapter
IEEE 802.15.2	IEEE 802.15 and IEEE 802.11 coexistence	The coexistence of WPAN is considered for task group two addresses with other wireless devices working in unlicensed frequency bands. It was released in 2003 and task pair two went was into "hibernation"
IEEE 802.15.3 11-55	High-rate wireless PAN (Van Nee *et al.*, 1999)	The MAC and PHY layer standards for WLAN are considered at high rate Mbps
IEEE 802.15.4	Low rate wireless PAN (e.g., Wireless HART, ZigBee, MiWi, etc.) (Prasad, 2004)	The WPAN standard deals with the low data rate and low complexity. Although, the battery life of the device can be only, may vary upto months and years. The standard is defined for physical and data link layers of OSI Reference Model
IEEE 802.15.5	Mesh networking for WPAN	The standard is providing the architectural framework that enables WPAN devices to work in stable, promote interoperable and scalable wireless networking especially in mesh networks. The standard is the combination of the low data rate mesh network IEEE 802.15.4 and low data rate mesh network IEEE 802.15.3. The general features of both meshes include addressing, multihop unicasting and network initialization The low data rate mesh supports portable devices, multicasting, reliable broadcasting, energy saving and route tracking. The higher data rate mesh network supports the multihop time-guaranteed service
IEEE 802.15.6	Body area network	The Body Area Network (BAN) or Body Sensor Network (BSN) is applicable for warble devices and computing technologies. It is a wireless BAN in which devices are embedded insider the parts of body and communicates each other. The device may be implanted, surface mounted on the body parts in fixed position such as hand, pockets, clothes, bags, etc. The technology is helpful in the monitoring heath conditions and diseases
IEEE 802.15.7	Visible light communication	In this the standard of visible light communication is defined and the research group has standardized to write for free space optical communication in the presence of visible light
IEEE 802.15.8	Peer aware communication	The standard is developed for Peer Aware Communications (PAC) that can coordinate and fully distributed for peer to peer infrastructureless communication and works in frequency band of 11 GHz. This standard is targeting scalable data rates upto 10 Mbps. It is based on multi hop relay and can communicate in group simultaneously with the membership in all groups
IEEE 802.15.9	Key management protocol	The standard is relating to the Key Protocol (KMP) datagram and security. In some systems the lesser length of key can be the reason the security attacks. This is providing the security with different key size with respect to different security protocols (Charaan *et al.*, 2017) and hash key management
IEEE 802.15.10	Layer 2 routing	The standard is relating to the data packets routing for 802.15.4 wireless networks in dynamic way and minimum path routing handling. The main objective is to cover the area with the increment in the nodes. The routing capabilities is applicable for dynamic route reconfiguration, route establishment, breaking of established routes, discovery and addition of new nodes, loss and recurrence of routes, real time collection of link status, multicast support, broadcast support, frame forwarding and single hop mechanism at network layer

Table 1: Continue

Name	Defined standard	Description
IEEE 802.16	Broadband wireless access (WiMAX certification)	The standard is applicable for broadband networks for wireless metropolitan area and local area networks. It is commercialized for WiMAX access forum for industry alliance. It is standardized in two phase air interface: MAC layer and physical layer. In PHY layer OFDMA with is used as modulation using 2048 carriers, 64 bit QAM and MIMO antennas support. MAC is standardized for data encryption and decryption security during data transfer
IEEE 802.16.1	Local multipoint distribution service	Local Multipoint Distribution Service (LMDS) is the service categorized for DTV applications for fixed wireless modules. It operates in frequency band 26 and 29 GHz on microwave frequencies. In US states, the LMDS frequencies are from 31.0 through 31.3 GHz. The capacity, reliability and the throughput of the links depends on the modulation techniques either PSK or AM and common radio link
IEEE 802.17	Resilient packet ring	Resilient Packet Ring (RPR) is a standard protocol which is designed for the optical fiber ring networks in optimal data transfer. It is developed for the SONET/SDH networks for getting the resilience. It follow the packet data transfer technique instead of using circuit switching and provides efficient data transfer of ethernet and IP services
IEEE 802.18	Radio regularity TAG	The radio regulatory TAG monitors and recommends the regulations for six projects: IEEE 802.11 (WLAN), IEEE 802.15 (WPAN), IEEE 802.16 (WMAN), IEEE 802.20 wireless mobility, IEEE 802.21 Interoperability/Hand-off between networks, IEEE 802.22, WRAN-wireless regional area network
IEEE 802.19	Coexistence TAG	The Standard is for Technical Advisory Group (TAG) for wireless coexistence in LAN/MAN. The standard works between unlicensed wireless networks. Some of the wireless standards follow unlicensed spectrum, so it is required to address the problems associated in coexistence. The unlicensed wireless devices can work in same location and unlicensed frequency band. That's what is possible that interference can exist between two wireless networks working in the unlicensed band
IEEE 802.20	Mobile broadband wireless access	The standard Mobile Broadband (LaMaire *et al.*, 1996). Wireless Access (MBWA) is defined for mobile wireless networks over internet access. It is not activated so longer. The wireless technology is also called as iburst. It is a mobile system for broadband wireless access for radio interface standard under High Capacity Spatial Division Multiple Access (HC-SDMA). It is developed by Array Comm
IEEE 802.21	Media independent hand off	The standards is relating to the algorithms applied for seamless handover between the same types of networks as well as handover with different types of networks. It is referred as vertical handover or Media Independent Handover (MIH). The standards work under different handover mechanisms over 802.3, 802.15, 802.16, 802.11, 2GPP and 3GPP2 communication networks (Ximenes *et al.*, 2017)
IEEE 802.22	Wireless regional area network	The standard is relating to the Wireless Regional Area Network (WRAN) under white spaces in TV frequency spectrum. The objective of the standard is to utilize the Cognitive Radio (CR) technology under unused spectrum for shared geographical region in TV broadcasting, non-interfering basis costal places. It is the first standard defined for air interface for opportunistic use of TV spectrum based on interfacing basis, and follow CR technology. It also, assures that no harm in the incumbent operation in the broadcasting of analog and digital TV and low power deices
IEEE 802.23	Emergency services working group	The standard is defined for media independent framework within IEEE 802 that enables the consistent access and data to facilitate the compliance in the civil authorities and their requirements for communication system. It has the data link layer interface to view IP based emergency services required by citizens in the context of Engineering Task Force (ETF) and Emergency Context Resolution with Internet Technologies (ECRIT). The standard deals with information transmission and associated entities behavior required in emergency calls and their management
IEEE 802.24	Vertical applications TAG/smart grid TAG	It is the vertical applications Technical Advisory Group (TAG) group that focuses the different applications using IEEE 802 technology in Smart Grid, Smart Homes, eHealth, Smart Cities, Intelligent Transportation Systems (ITS). Smart grid has the variety of operations relating to electrical grid such as smart metering, smart appliances, efficient energy utilization, production, control and distribution of electricity, renewable energy resources and smart micro grid and cyber security
IEEE 802.25	Omni Range Area Network	It is not ratified yet and defined for Omni-Range Area Network

CONCLUSION

The wireless LAN communication technologies the user connects to the LAN network with the help of wireless radio connections. The IEEE 802.xx defines the different standards for LAN and MAN. The standards are ta5lted and studied properly with IEEE 802.1 (LAN-MAN architecture and interconnecting), to IEEE 802.25 (Omni Range Area Network). The connection establishment can follow several intermediate topology. The biggest advantage of WLAN is that the network can be accessed anytime and anywhere based on requirements. The study is helpful to know the overview of 802 families for communication technology.

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