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ANALYZING WLANS STANDARDS FOR WIRELESS SENSOR NETWORK

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Wireless sensor network is a special kind of wireless network, design to communicate with distributes wireless nodes (which supplies the information). Data collection from leaf sensor node to the central node for manipulation and prepare into information in useful format to the next observer node. Wireless sensor network may adopt variety of IEEE WLANs standards, where each standard has different architecture, performance, characteristics, communication method, data rate and range etc. in this paper we analyze and compare various wireless technologies and find out their suitability for wireless sensor network.

1. Introduction

Standardization of wireless technologies is a continuous process, and even established standards are updated and modified in response to changes in the technology and the marketplace. One such example is the successful IEEE 802.11 standard for wireless local area networks (WLANs), which was originally designed for 1 and 2 Mb/s traffic, and is now being upgraded to support 600 Mb/s in 802.11n and being considered as a high-throughput (up to 1 Gb/s) wireless interface for the nomadic scenarios of the next generation of wireless systems. Similarly, enhancements to the IEEE 802.16 standard for wireless metropolitan area networks (WMANs) are being considered to develop a mobile air interface with support for up to 100 Mb/s in high mobility scenarios. IEEE 802.15 is also very useful standards for wireless communication. This continuous evolution of the IEEE 802.11 WLAN and 802.16 WMAN standards is made possible with new innovation and contribution from both academia and industry. Given the rapid growth of these technologies, it is important to understand what new application scenarios have triggered the recent developments within WLAN and WMAN standards, how they are evolving, the technological challenges they face, and the opportunities for both the industry and research communities. The new emerging technology is also going to published i.e. 802.20 and many more. [1, 5, 14]

2. Analysis of Architecture

Bluetooth: The radio layer is somewhat similar to the physical layer of the Internet model. Bluetooth devices are low power and have range of 10 m. It uses a 2.4 GHz ISM band which are further divided into 79 channels of 1 MHz each. In order to avoid the interference from other devices and other network it uses frequency hopping spread spectrum method and it hops 1600 tps.The base band layer works as the MAC layer in LANs. In order to access the given layer it uses the TDMA. All the master and slave communicate using time slot (625 µs). In the case of master and slave configuration Bluetooth can create two types of physical links: SCO (synchronous connection-oriented) is used when first preference goes to avoid latency rather than error free delivery (integrity). ACL (asynchronous connectionless link) in the reverse case of SCO means when first preference goes to error free delivery (integrity).The logical Link Control and Adaptation Protocol (L2CAP) is similar to LLC sub layer in LANs. ACL physical link follows the said protocol; SCO doesn't follow it. [1, 11, 12, 13, 14]

Wi-Fi: All extensions of 802.11 like (a, b, g, etc) follows five layers TCP model and data link layer is divided into two sub layers: Media Access Control (MAC): Logical Link Control (LLC).Five layer TCP Model: The two lower layers are specified by IEEE 802 networks: 802.2 – LLC, 802.3 – PHY and MAC, Ethernet, 802.11 – PHY and MAC, Wi-Fi. The primary task of physical layer is to perform encoding scheme, modulation and deals with the transmission of radio signals in actual through space. As we know that physical layer implementation work in particular specific bands means some specific frequency allocated for some specific applications. Medium Access Control (MAC) layer is sub layer of Data link Layer (DDL). The primary task of said layer is to control the transmission and sometimes it can be used to provide services like mobility management. The format of MAC address of Wi-Fi is similar to the MAC address of Ethernet (802.3) i.e. 6 octets. It uses the CSMA/CA (means to prevent collision before they happen) is similar to the mechanism used in Ethernet (802.3) i.e. CSMA/CD. Both act as a peer-to-peer protocol. IEEE 802.11 defines

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lots of services but in this paper we only discuss the two main services i.e. Station services (SS): The services defined by: Authentication, De-authentication and privacy etc. and Distributed System Services (DSS): The services defined by: Association, Reassociation, Disassociation, Distribution and Integration. [1, 2, 3, 8, 11, 12, 13, 14]

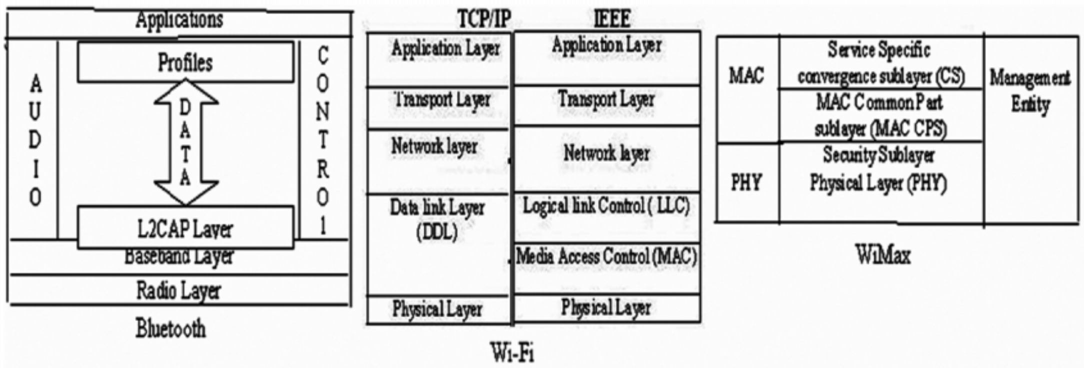

Fig. 1: Architecture of Various WLAN Technologies

WiMax: WiMAX (802.16) follows the unidirectional flow of packet known as service flow and have some set of Qos. These kind of service flow is identified as a 32-bit service flow identifier. WiMAX (802.16) is a connection oriented protocol and its connection identified by a 16-bit connection identifier (CID).WiMAX (802.16) Physical Layer: IEEE 802.16 – in 2001, microwave frequencies (10-66 Ghz), high data rate, LOS and PTP mode and fixed subscriber stations only. IEEE 802.16-2004- in 2004, frequencies (2-11 GHz) and (10-66 GHz bands), medium data rates, PTP, LOS, NLOS and PMP modes, fixed subscriber stations only.IEEE 802.16-2005- in 2005, low to medium data rates, PTP and PMP modes, both fixed and mobile subscriber stations. [8]Service Specific convergence sub layer (CS): converts higher layer packets into MAC level Service data Units (SDUs), interfaces with higher layers and finally maps higher-level transmission parameters to MAC level service flow and connection parameters. MAC Common Part sub layer (MAC CPS): follows retransmissions, Qos, link initialization, transmission scheduling, error control, fragmentation, control channel access and link initialization. Security Sub layer: it uses X.509 standard for certificate-based identification of nodes, encryption, key management, key distribution and authentication. [4, 6, 7, 9 14]

ZigBee: On the specification of PHY and MAC, we can able to access it on different types of networks like as star, mesh and cluster tree. Communication redundancy elimination is a unique feature of Zigbee network layer. PHY layer works on order to include energy and link quality detection, add clear channel assessment for improved coexistence with other wireless networks. After all to ensure power conservation, and low latency through guaranteed time slots routing schemes are designed [4]

Mobile-Fi (IEEE 802.20) is the youngest IEEE standard. In order to access fully mobile broadband, it is the first standard designed to carry native IP traffic with licensed airwave below 3.5 GHz and provides symmetrical wireless rates over long distance (~15km). Mobile-Fi, enables “worldwide deployment of affordable, ubiquitous, always-on and interoperable mobile broadband wireless access networks that meet the needs of business and residential market” this the first theme behind IEEE 802.20 uses packet based air interference optimized for transport of IP services.

If we compare all the factors with other technologies for ad hoc network, it has lower power than WiMax but has high mobility and has latency of 10 ms. This features can pursue even with fast moving vehicles and we can also compare it with 3G has 500ms and for optimization of packets uses small antennas

3. CHARACTERISTICS AND FEATURE ANALYSIS

A Bluetooth device has a built-in short range radio transmitter. The data rate of Bluetooth device is 1 Mbps with a 2.4-GHZ bandwidth. By this figure it might be possible it could interfere with IEEE.11b wireless LAN.IEEE 802.11 standard can be best suited for ad hoc network. In order to explore Wi-Fi we have some more extensions that are going to be implemented in the field of communication like: 802.11e – It follows quality of services, such as Streaming multimedia or VOIP. 802.11i – It is used for high security implementations. 802.11p – It is used to support exchange of data between high speed vehicles. Next on the agenda are: • 802.16c/d, published in Jan 2003, ‘c’ protocol relates to protocols, test suite structures and test purposes while ‘d’ fixes errata and protocols not covered in ‘c’, and creates the system profiles.• 802.16e, which adds mobility to the standard and really throws down the gauntlet to cellular. [14]

Property	Values
Data Rate	1 Mbps
Spectrum	2.4-GHZ
Maximum no. nodes	8
Modes of Operation	Point-to-point, point-to-multipoint, multihop mode

Bluetooth

PHY (MHz)	Frequency Band (MHz)	Spreading parameters		Data parameters		
		Chip rate (kchip/s)	Modulation	Bit rate (kb/s)	Symbol rate (ksymbols)	symbols
868/915	868-868.6	300	BPSK	20	20	Binary
	902-928	600	BPSK	40	40	Binary
2450	2400-2483.5	2000	O-QPSK	250	62.5	16-ary Orthogonal

ZigBee

Property	Values
Range	50 km(*LOS), 6-8 (*NLOS)
Data Rate	70 Mbps (shared)
Spectrum	2.3 – 2.7 Ghz, 3.4 – 3.6 Ghz, 5.8 Ghz (unlicensed)
Access Types	Fixed, nomadic/portable, mobile
Spectral efficiency	3.7 (bits/s)/Hz (for 802.16-2004)
Channel Size	1.5 MHz to 20 MHz (flexible)
Modes of Operation	Point-to-point, point-to-multipoint, mesh, multihop mode

WiMax

Wi-Fi Characteristics	IEEE 802.11 Protocols			
	802.11a	802.11b	802.11g	802.11n*
Operating Frequency	5.3 GHz and 5.8 GHz	2.4 GHz		2.4 GHz or 5 GHz
Average Signal Range**	~30 to 35 m			~60 to 70 m
Available Bandwidth per Channel	~20 to 22 MHz			20 or 40 MHz
Data Rate (Min.-Max)	6, 9, 12, 18, 24, 36, 48, 54 Mbps 6, 12, and 24 Mbps are mandatory	1, 2, 5.5, 11 Mbps	1, 2, 5.5, 11, 6, 9, 12, 18, 24, 33, 36, 48, 54 Mbps 1, 2, 5.5, 11, 6, 12 and 24 Mbps are mandatory	1, 2, 5.5, 6, 9, 11, 12, 18, 24, 36, 48, 54, 121.5, 130, 144.44, 270, 300 Mbps
Typical Throughput for Max Data Rate	18 to 22 Mbps	6 Mbps	18 to 22 Mbps	74 Mbps
Modulation Technique	OFDM	CCK or DSSS	OFDM	OFDM using MIMO and CB
Channels	36, 40, 44, 48, 52, 56, 60, 64, 149, 153, 157, 161	1-11		3 non-overlapping 2.4 GHz 12 non-overlapping UNII channels in 5 GHz
Special Considerations	HF signals have more trouble with physical obstruction	2.4 GHz subject to interference from: Bluetooth products, cordless phones, microwaves, radar, remote controls, ZigBee networks, etc.		

— Wi-Fi

Fig. 2: Behavior Analysis of Various WLAN Technologies

4. COMPARATIVE ANALYSIS

From the given figure we can easily see that hoe these wireless standards comparable to each other and how they can be best suited for ad hoc environment.

Table 1
Comparison of Various WLAN standards

Wireless Parameter	Bluetooth	Wi-Fi	ZigBee
Frequency band	2.4 GHz	2.4 GHz	2.4 GHz
Physical/MAC layers	IEEE 802.15	IEEE 802.11	IEEE 802.15.4
Protocol stack size	250 KB	1 MB 32 KB	32 KB, 4 KB (for limited function end devices)
Minimum quiet bandwidth required	15 MHz (dynamic)	22 MHz (static)	3 MHz (static)
Number of channels	19	13	16
Maximum number of nodes per network	7	32 per access point	64 K
Raw datarate	1 Mbps	11 Mbps	250 Kbps
Range	9 m	75 to 90 m	Indoors: up to 30 m Outdoors (line of sight): up to 100 m
Current consumption	60 mA (Tx mode)	400 mA (Tx mode) 20mA (Standby mode)	25-35 mA (Tx mode) 3 μA (Standby mode)
Typical network join time	>3 sec	variable, 1 sec typically	30 ms typically
Interference avoidance method	FHSS (frequency-hopping spread spectrum)	DSSS (direct-sequence spread spectrum)	DSSS (direct-sequence spread spectrum)

IEEE 802.15, 802.11 AND 802.15.4

Characterstics	WiMax	Wi-Fi
AIRWAVE	Licensed and license-exempt 128-bit Triple-DES and 1024-bit RSA security	License-exempt only WPA+WEP security, inadequate though 802.11i will Improve
COVERAGE	Optimised for outdoor non-line of sight mesh networks, advanced smart antenna	Optimised for indoor, No mesh, Smart antenna
RANGE	50km Point to multipoint, ,Tolerant of greater multipath delay spread up to 10ms, PHY and MAC designed for multimile range Standard MAC	100 meters Point to point, PHY and MAC optimised for 100m range, Range can be extended but then MAC non standard
QUALITY OF SERVICE	Grant request MAC Designed to support voice and video from the start Supports differentiated service levels e.g. TDD/FDD/HFDD - symmetric or asymmetric, Centrally enforced QoS	Contention-based MAC, no guaranteed QoS Standard cannot guarantee latency for voice or video, TDD only-asymmetric Proposed 802.11e QoS standard is prioritisation only
PERFORMANCE	Bandwidth 10, 20MHz; 1.75, 3.5, 7, 14Hz; 3, 6MHz, Maximum data rate 70Mbps Maximum 5.0 bps/Hz	Bandwidth 20MHz, Maximum data rate 54Mbps, Maximum 2.7 bps/Hz
SCALABILITY	Sectorization, Scalable independent of bandwidth with 1.5MHz to 20MHz width channels MAC supports thousands of users	MAC supports tens of users

IEEE 802.16 and 802.11

5. CONCLUSION

Various IEEE WLANs standards exhibit different properties in terms of coverage area, data rate, network architecture, hopping mechanism, security and network performance. For wireless sensor network selection of any WLAN standards still a number of challenges in the area of security, performance and implementation (cost). Design of efficient hybrid sensor network is required which graps the better performance contents by applying multiple WLANs standards in a single network. This paper compares the architecture, characteristics and performance of various

IEEE standards. Every standard have some merits leaded by some limitations. We can design a hybrid approach which contains the better features of different IEEE standards.

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