ANALYSIS OF TRANSMISSION TECHNOLOGIES IN WIRELESS SENSOR NETWORKS

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Abstract: In recent years, there has been an increasing interest in the adoption of emerging sensing technologies for instrumentation within a variety of structural systems. For a number of years, vendors have made use of proprietary technology for collecting performance data from devices. All wireless standards can be easily compared in terms of power requirements, throughput, and range. WSNs enable new applications and require non-conventional paradigms for protocol design due to several constraints. Owing to requirement for low device complexity together with low energy consumption, a proper balance between communication and signal/data processing capabilities must be found. Wi-Fi, GPRS, EDGE, ZigBee, WiMAX, Bluetooth, and 6LoWPAN are some technologies for transmission in Wireless Sensor Network. This reports an overview of different WSNs transmission technologies.
Keywords: WSNs, throughput, impairments, Zigbee, WiMAX.

I. INTRODUCTION

A WSN can be defined as a network of devices, denoted as nodes, which can sense the environment and communicate the information gathered from the monitored field (e.g., an area or volume) through wireless links. The data is forwarded, possibly via multiple hops, to a sink (sometimes denoted as controller or monitor) that can use it locally or is connected to other networks (e.g., the Internet) through a gateway. The nodes can be stationary or moving. The communication and collection of information is done with the help of wireless links, where each node is linked to one or a number of sensors. Replacement of wired connections among electronic devices with wireless network has revolutionized the way we organize our industrial, office and home environments. Wireless Sensor Networks are considered as one of the key technologies in the 21st century [1]. The maturity of wireless sensor networks was enforced by military applications, regularly used in war field surveillance. Wireless communication in Wireless Sensor Networks is mostly based on standardized technologies around 802.11 and 802.15 standard families, also known as Wireless Local Area Networks (WLAN) and Wireless Personal Area Networks (WPAN). It should immediately be noted that to maximize the opportunity for widespread and cost-effective deployment of WSN, one needs to make use of existing and/or emerging commercial off- the-shelf (COTS) wireless communications and infrastructures rather than having to develop an entirely new, specially designed apparatus [2-3]. WSNs can use a number of wireless COTS technologies, such as Bluetooth/PANs, Zigbee, Wireless LAN (WLANs)/hotspots, Broadband Wireless Access (BWA)/WiMAX and 3G [4].

II. TRANSMISSION IMPAIRMENTS

Most of the transmission technologies in Wireless Sensor Network are RF based. A lot of radio-transmission engineering has to do with how to deal with the noise problem; the goal is nearly always to optimize the signal-to-noise ratio, subject to specified constraints (e.g., bandwidth requirements, cost, reliability, power consumption, equipment and antenna size).[4] Signal strength fluctuations caused by the fact that the composite signal received comprises a number of components from the various sources of reflection from different directions as well as scattered and/or diffracted signal components affect both mobile and stationary receivers. Care is needed when placing sensors in order to minimize interference. One needs to keep WNs away from other sources of radio-frequency interference (RFI), Interference can also be caused by other legitimate or illegitimate users of a given frequency band. However, the benefits of a wireless solution are undeniable: lower installation and maintenance costs, increased flexibility, a broader set of addressable applications, and the freedom to take measurements almost anywhere phenomena like reflection, Diffraction, Scattering cause radio signal distortions and signal fading.

III. CHALLENGES WITH WIRELESS SENSOR NETWORK APPLICATION

The main application areas for WSNs are categorized according to the type of Information measured or carried by the network. Applications, on top of the stack, set requirements that drive the selection of protocols and transmission techniques; at the other end, the wireless channel poses constraints to the communication capabilities and performance. Based on the requirements set by applications and the constraints posed by the wireless channel, the communication protocols and techniques are selected.

Though wireless nature of WSNs has many advantages over wired network, it also includes some challenges when it comes to implementation or selecting the transmission technology.

- Security is the major concern in WSNs; it is easy for hackers to hack the network. We have to select the networking technology as well as security

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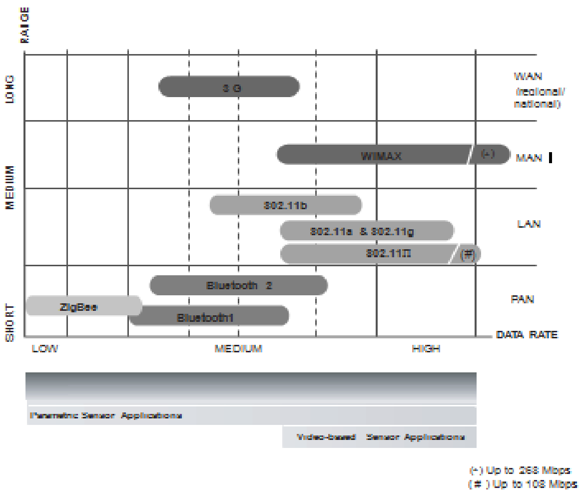
algorithm accordingly.

- Due to limited resources and dynamic topology, it is very difficult to design a reliable routing scheme for WSNs.
- In some application the sensors may be placed in harsh environment. Before designing the network or selecting the transmission technologies, the crucial environment conditions must be considered.
- Energy constraint is yet another crucial factor in Wireless Sensor Network because the sensor nodes have small battery size. To conserve energy, traffic scheduling and optimization of power consumption should be done.

IV. DIFFERENT TRANASMISSION TECHNOLOGIES

As large number of WSN applications use battery operated nodes, WPANs are used more often in Wireless Sensor Networks. Wireless Sensor Network is highly application specific in nature. Wireless communication in Wireless Sensor Networks is mostly based on standardized technologies around 802.11 and 802.15 standard families, also known as Wireless Local Area Networks (WLAN) and Wireless Personal Area Networks (WPAN) respectively. WLAN offers higher throughput & range at the cost of higher energy utilization compared to WPAN. As large number of WSN applications use battery operated nodes, WPANs are used more often in Wireless Sensor Networks. Let's compare transmission capabilities, energy budget & geo-location accuracy for some of the prevailing technologies.

Figure.1 Different Transmission Technologies



A). BLUETOOTH: Bluetooth wireless technology is a short-range communication system intended to replace the cables in WPANs. The key features of Bluetooth wireless technology are robustness, low power, and low cost.

The technology has restricted performance characteristics by design; hence, its applicability to WSN is rather limited in most cases. The Bluetooth specification defines a low-power, low-cost technology that provides a standardized platform for eliminating cables between mobile devices and facilitating connections between products. Bluetooth 4.0 is designed to be more intelligent (hence: Bluetooth Smart) about managing those connections, especially when it comes to conserving energy.[1] The new generation of Bluetooth technology places less emphasis on maintaining a constant stream of information. Instead, it focuses on sending smaller bits of data when needed and then puts the connection to sleep during periods of non-use. IEEE 802.15.1 standard, popularly known as Bluetooth, offers moderate data rates at lower energy levels. Due to this, it is ideally suited for high end WSN applications that require higher data rates with harder real time constraints. Bluetooth is used in star topology because of its basic characteristics. Bluetooth devices communicate with each other using set of standard Bluetooth profiles defined by standard body.

B). Wi-Fi: Wi-Fi represents group of WLAN technologies defined under IEEE 802.11 standard body. In addition to transmission standards like 802.11a/b/g/n, it also includes 802.11s standard for mesh networking. Wi-Fi technologies are capable of providing very high throughput (>100 Mbps) at longer range but required very high power budget. Also, Wi-Fi can locate end point location to the accuracy of several meters only. Because of this limitation, use of Wi-Fi is mostly restricted to devices with fixed power supply. It operates in unlicensed 2.4 GHz radio spectrum use Direct Sequence Spread Spectrum for modulation (DSSS), and has a range of about 50 meters default and it can be increased. . WNs typically transmit small volumes of simple data. For within-building applications, designers ruled out Wi-Fi (wireless fidelity, IEEE 802.11b) standards for sensors as being too complex and supporting more bandwidth than is actually needed for typical sensors.

C).Wi-Max: Wi-MAX is a Wireless Man technology. Wi-MAX comes under Broadband Wireless Access and is based on IEEE 802.16 standard. It operates on both licensed and unlicensed band less than 6 GHz. seeking to deploy high-performing, cost-effective broadband wireless networks

WiMAX provides two to four times the performance of 3G solutions today, with the ability to scale to ten times the performance in the future. WiMAX is more scalable than many other wireless technologies. It has two mandatory encryption modes which makes it more secure in its simple form. WiMAX has a better flexibility than Wi-Fi as it does not need Line-of-Sight with the base station.

D). 3G: 3G enables increased data handling rates and high speed bandwidth; It ranges from 144 kbps to 2.4 Mbps. Implementation of 3G may be expensive for some applications. 3G systems have fixed bandwidth unlike WiMAX which can have variable bandwidth. These systems have higher complexities due to addition of multiple antenna support.

E).UWB: Ultra wide band is a technology for transmitting information spread over a large bandwidth (>500 MHz) and it is ideally suited for short distance, high speed communications with very low power budget. As it is based on wide band technology, it can achieve very high geo-location accuracy to the sub-meter levels. UWB provides one of the best options for WSN networking only limited by its shorter range.

It is a short range high speed wireless technology nearly 10 times faster than 802.11b. UWB is designed to replace cables with short range, wireless connection but it offers the much higher bandwidth. UWB does not use an RF carrier. Thus it provides global interoperability. It uses frequency from 3.1 GHz to 10.6 GHz. Because of the low power requirement it is feasible to be used in wireless sensor network. With the characteristics of low power, low cost and very high data rates at limited range it is positioned to be better than high speed WPAN.

F). Zigbee: IEEE 802.15.4 wireless technology is a short range communication system intended to provide application with realized throughput and latency requirements in WPAN. ZigBee offers low complexity, low cost, low data rates at very low energy levels. Due to this, it is ideally suited for applications requiring infrequent smaller data transfers where battery life is an important issue[3]. This technology allows to basic topologies: star topology and peer to peer topology.

Star topology preferable in case coverage area is small and low latency is required by the application. In latter, the area covered should be large and latency is not a critical issue.

G). 6LowPAN: 6LowPAN is an open standard in order to use IPv6 over 802.15.4. 6LowPAN stands for IPv6 over Low-Power WPANs. It is a protocol definition describing how to utilize IPv6on top of low power, low data rate, low cost personal area network.[3]

The fundamental difference between 6LowPan and Zigbee is the IP interoperability of the first. For an application in which there is no need to interface with IP devices or the packet size is small, it is not necessary to implement 6LowPAN, which performs fragmentation.

Table.1:Comparesion of Different Technology

S. No	Technology	Area covered	Power consumption	Interference resilience	Complexity and cost	Data rate	Application
1.	Bluetooth	~100 meters	High	High	High	Bluetooth: V1.2 = 1Mbit/s V2.0 = 3Mbit/s	Health monitoring, environmental monitoring and security
2.	Wi-Fi	Long up to 100 meters	500mW-1W	Medium	High	High, 11 Mbps for 802.11b ,100+Mbps for 802.11n	Generally used in LAN systems
3.	WiMAX	radius of **30 miles** (50 km)	500mW-1W	Medium	Very High	30-40 Mbits/s	Residential users in a colony or society
4.	Zigbee	Short, <30 meters	Low, 20 mW-40mW	Low	Low	Low, 250 kbps	Medical care application, Fire emergency
5.	UWB	Short, <3o meters	Low, 30mW	High with high complexity receivers, low with simple	Low, medium, high all are possible	Medium, 1Mbits/s mandatory	Hospital locating, tracking in communication system

V. CONCLUSION

The aim of this article is to discuss some of the most relevant issues of WSNs, from the application, design and technology viewpoints. For designing a practical WSN solution, we need to select right technology with necessary customization. We have still not touched upon the challenges of designing miniature, low-power, accurate sensor systems for various measurements. In summary, WSN offers some of the revolutionary applications for consumers & industry but its design & implementation needs to be carried out. Cellular and WAN standards such as GPRS, WiMAX, and EDGE provide significant throughput and range, but these standards consume a significant amount of power, making them unfit as the communication protocol for long-term, and battery-powered deployments such as wireless sensor networks. Conversely, the Bluetooth protocol requires very little power, but does not provide adequate range for WSN systems in which communication distance requirements can be upwards of 100 to 500 meters. . For designing a practical WSN solution, we need to select right technology with necessary customization. For within-building applications, designers ruled out Wi-Fi standards for sensors as being too complex and supporting more bandwidth than is actually needed for typical sensors. WiMAX provides superior throughput and spectral efficiency compared to 3G and Wi-Fi.

REFERENCES

[1] Chiara Buratti , Andrea Conti, Davide Dardari and Roberto Verdone, " An Overview on Wireless Sensor Network Technology and Evolution" vol 9, no 9, pp. 6869-6896.

[2] Sohraby, K., Minoli, D., Znati, T. "Wireless sensor networks: technology, protocols, and applications" 1st ed., John Wiley and Sons, 2007.

[3] E. Ferro and F. Potorti, "Bluetooth and Wi-Fi wireless protocols: A survey and a comparison," IEEE Wireless Commun., vol. 12, no. 1, pp. 12-16, Feb. 2005.

[4] Baker, N. "ZigBee and Bluetooth: Strengths and weaknesses for industrial applications," IEE Computing & Control Engineering, vol. 16, no. 2, pp 20-25, April/May 2005

[5] J. S. Lee and Y. C. Huang, "ITRI ZBnode: A ZigBee/IEEE 802.15.4 platform for wireless sensor networks," in Proc. IEEE Int. Conf. Systems, Man & Cybernetics, Taipei, Taiwan, Oct. 2006, pp. 1462-1467.

[6] P. S. Neelakanta and H. Dighe, "Robust factory wireless communications: A performance appraisal of the Bluetooth and the ZigBee collocated on an industrial floor," in Proc. IEEE Int. Conf. Ind. Electron. (IECON'03), Roanoke, VA, Nov. 2003, pp. 2381-2386.

