Survey of IEEE 802.15 Task Work Group
Kirti¹, Tajender Malik²
M.Tech Student¹, Associate Professor²
Department of Electronic and Communication Engineering
M.R.I.E.M, Rohtak, India

Abstract:
ZigBee was developed by IEEE 802.15.4 Task Group and ZigBee Alliance. ZigBee (IEEE 802.15.4-2006 standard) is a category in the IEEE 802 family, along with some of the well-known protocols such as Wi-Fi, Bluetooth which use the 2.4 GHz Industrial, Scientific and Medical (ISM) radio band. ZigBee also utilizes 868 MHz and 915 MHz in different parts of the world according to local standards. Unlike Wi-Fi and Bluetooth, ZigBee was developed for low-rate WPAN (LR-WPAN) which features long battery life by having low data rates. IEEE 802.15.4/ZigBee is also a worldwide open standard for wireless radio networks which provides network, security and application support services operating on top of the IEEE 802.15.4 Medium Access Control (MAC) and Physical Layer (PHY) wireless standard. ZigBee alliance is responsible for ZigBee standard which uses the transported services of the 802.15.4 network specification just like TCP/IP uses the IEEE 802.11b network specification. The primary goal of the wireless sensors is to gather relevant data from their surrounding and subsequently, to route the gathered data to a central processing node, commonly referred to as sink. ZigBee is one of the most promising and prevalent WSN standards in use today. This standard defines both the physical (Layer 1) and data-link (Layer 2) layers of the OSI model. The first edition of the 802.15.4 standard was released in May 2003. Several standardized and proprietary networks (or mesh) layer protocols run over 802.15.4-based networks, including IEEE 802.15.5, ZigBee, LRWPAN, Wireless HART, and ISA100.11a. ZigBee is a specification for a suite of high level communication protocols using small, low-power digital radios based on an IEEE 802 standard for personal area networks. ZigBee devices are often used in mesh network form to transmit data over longer distances, passing data through intermediate devices to reach more distant ones. This allows ZigBee networks to be formed ad-hoc, with no centralized control or high-power transmitter/receiver able to reach all of the devices.

Keywords: WSN, LR-WPAN, MAC IEEE 802.15.4, ZigBee

Introduction: Wireless Sensor Networks (WSNs) have emerged as a new research technology in the distributed computing environment and plays a very important role in the pervasive computing to support various applications. It has a great potential to be utilized in battlefields and in different commercial applications like traffic surveillance, habitat monitoring, construction structures, smart homes, offices and many more. Research on several aspects of WSNs like energy efficiency, power management, routing, topology control, data management and security are progressing extensively. New applications based on embedded systems and mobile technologies have caused a significant growth in wireless communication systems. Those related with Internet, such as web browsing or e-mail, require high data throughput and bandwidth. The Institute of Electrical and Electronic Engineers (IEEE) published the standard 802.11, defining wireless local area networks. This standard is used in the majority of these services. There are a number of versions of this standard, working in different frequency bands and providing different transmission rates and communication ranges. The version 802.11n is currently under development and it will allow data rates of up to 300Mbit/s [2]. Wireless personal area networks (WPANs)[29] are based strictly in ad-hoc communication and do not employ any kind of fixed infrastructure. IEEE standardized the previous development performed by the Bluetooth Special Interest Group (SIG)[1] creating the 802.15 group[2]. More recently, a special type of WPANs has been defined, with lower throughput requirements and generally involving sensing mechanisms. These are known as low-rate WPANs (LRWPANs) or more commonly, wireless sensor networks (WSNs)[22].

A very clarifying initial definition of a WSN is proposed by Hill [23]. The equation:
Sensing + CPU + Radio = Thousands of potential applications

IEEE 802.15 TASK GROUPS: The Institute of Electrical and Electronics Engineers (IEEE) 802.15 is the 15th task group of IEEE 802 and the task group is specializes in Wireless Personal Area Network (WPAN). This task group is divided into seven task groups numbered from 1 to 7. The basic functionality of seven task groups are described below:

IEEE 802.15.1 (WPAN/Bluetooth)
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. Standards were issued in 2002 and 2005. The Institute of Electrical and Electronics Engineers (IEEE) 802.15.1 standard is derived from the Bluetooth specification (version 1.1). In fact they have just added two clauses to the existing specification; WPAN architecture overview and Service access points (SAPs). In other words, the 802.15.1 standard presents a wireless personal area network (WPAN) that utilizes the Bluetooth wireless technology [6]. A PAN is defined as a computer network used for communication among computer devices close to one person. The Bluetooth wireless technology uses a short-range radio link that is optimized for power-conscious, battery-operated, small size, lightweight personal devices. A Bluetooth WPAN supports...
both synchronous communication channels for telephony-grade voice communication and asynchronous communications channels for data communications. These facilities enable a rich set of devices and applications to participate in the Bluetooth WPAN. For example, a cellular phone may use the circuit-switched channels to carry audio and from a headset while concurrently using a packet-switched channel to exchange data with a notebook computer [6]. A Bluetooth WPAN has a limited life span. It is created in an ad hoc manner whenever an application in a device desires to exchange data with matching applications in other devices. The Bluetooth WPAN may cease to exist when the applications involved have completed their tasks and no longer need to continue exchanging data.

**Task Group 2: IEEE 802.15.2 Coexistence:**
Task group two addresses the coexistence of wireless personal area networks (WPAN) with other wireless devices operating in unlicensed frequency bands such as wireless local area networks (WLAN). The IEEE 802.15.2-2003 standard was published in 2003[3] and task group two went into "hibernation".

**Task Group 3: IEEE 802.15.3:**
(High-Rate WPAN / Ultra Wideband (UWB))
IEEE 802.15.3 is standard for high data rate WPAN designed to provide Quality of Service (QoS) for real time distribution of multimedia content like video and music. It is initially intended for a home multimedia wireless network. The original standard uses a "traditional" carrier-based 2.4 GHz radio as the physical layer (PHY). But a sister standard, 802.15.3a, is on the way. It will define an alternative PHY, based on UWB, which will provide in excess of 110 Mbps at a 10m distance and 480 Mbps at 2m [7]. Additionally there are different amendment was released to enhance the functionality of MAC and PHY layers for 802.15.3.

**Task Group 4: IEEE 802.15.4 (Low Rate WPAN):**
IEEE 802.15.4-2003 (Low Rate WPAN) deals with low data rate but very long battery life (months or even years) and very low complexity. The standard defines both the physical (Layer 1) and data-link (Layer 2) layers of the OSI model. The first edition of the 802.15.4 standard was released in May 2003. Several standardized and proprietary networks (or mesh) layer protocols run over 802.15.4-based networks, including IEEE 802.15.5, ZigBee, 6LoWPAN, WirelessHART, and ISA100.11a IEEE 802.15.4 is a standard defined by the IEEE only for low-rate (LR) WPANs. A LRWPAN is a simple, low cost communication network that allows wireless connectivity in applications with limited power and relaxed throughput requirements. The main objectives of a LR-WPAN are ease of installation, reliable data transfer, short-range operation, extremely low cost, and a reasonable battery life [1]. Like all IEEE 802 standards, the IEEE 802.15.4 standard encompasses only those layers up to and including portions of the data link layer (DLL). I.e. the standard defines the PHY and the medium access layer (MAC). In particular it defines two PHYs representing three license-free frequency bands that include sixteen channels at 2.4 GHz, ten channels at 902 to 928 MHz, and one channel at 868 to 870 MHz. The maximum data rates for each band are 250 kbps, 40 kbps and 20 kbps, respectively. The 2.4 GHz band operates worldwide while the sub-1 GHz band operates in North America, Europe, and Australia/New Zealand (see Table 3.1 [8]). The IEEE standard is intended to conform to established regulations in Europe, Japan, Canada and the United States [8]. The main features of this standard are network flexibility, low cost, very low power consumption, and low data rate in an ad hoc self-organizing network among inexpensive fixed, portable and moving devices. It is developed for applications with relaxed throughput requirements which cannot handle the power consumption of heavy protocol stacks.

IEEE 802.15.5 (Mesh Networking)

IEEE 802.15.5 provides the architectural framework enabling WPAN devices to promote interoperable, stable, and scalable wireless Mesh Networking. This standard is composed of two parts: low-rate WPAN mesh and high-rate WPAN mesh networks. The low-rate mesh is built on IEEE 802.15.4-2006 MAC, while the high rate mesh utilizes IEEE 802.15.3/3b MAC. The common features of both meshes include network initialization, addressing, and multihop unicasting. In addition, the low-rate mesh supports multicasting, reliable broadcasting, portability support, trace route and energy saving function, ad the high rate mesh supports multihop time-guaranteed service.

IEEE 802.15.6 (BAN):
This task group is focusing on BAN or Body Area Network Technologies. The goal is a low-power and low-frequency short-range wireless standard. 802.15.6 is a low-frequency technology intended to endow a future generation of short-range electronics—both in body and on or around it—with a wireless communication standard for exchanging information. How far into the future this standard and any electronics that utilize it will arrive, however, is anyone's guess; presently, there is no official timeline for ironing out the standard. A good real-world example of this technology in practice is a pacemaker that can alert or be controlled by a wristwatch. Of course, the military is also considering this technology's advantages, as BAN's short-range design will ideally reduce the chances of interference and eavesdropping. The need for security is also prevalent, given the sensitive nature of some of BAN's theoretical implementations. Compared to other short-range wireless technologies already on the market, such as Bluetooth, 802.15.6 and its BAN system appear to focus on functioning at relatively low frequencies, less than one megahertz, and short range use. By comparison, Bluetooth's journey to 2.0 and beyond has generally brought longer ranges, slightly more power consumption and greater data bandwidth.

IEEE 802.15.7 (VLC)
As of December 2011, The IEEE 802.15.7 Visible Light Communication Task Group has completed draft 5c of a PHY and MAC standard for Visible Light Communications (VLC). The inaugural meeting for Task Group 7 was held during January 2009, where it was chartered to write standards for wireless Mesh Networking. This standard is composed of two parts: low-rate WPAN mesh and high-rate WPAN mesh networks. The low-rate mesh is built on IEEE 802.15.4-2006 MAC, while the high rate mesh utilizes IEEE 802.15.3/3b MAC. The common features of both meshes include network initialization, addressing, and multihop unicasting. In addition, the low-rate mesh supports multicasting, reliable broadcasting, portability support, trace route and energy saving function, ad the high rate mesh supports multihop time-guaranteed service.

**Conclusion:**
The main objective is to analyse a variety of existing network topologies in ZigBee wireless sensor networks and to evaluate the best topology among them. Furthermore, work on variation of backoff exponent parameter existing in MAC layer of ZigBee sensor devices which affects the CSMA/CA mechanism among ZigBee sensor devices is also done. In this work, a model for the Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) protocol
according to IEEE 802.11 standard, for Wireless Personal Area Network is presented. Therefore to achieve our objectives optimally, we need a simulation tool and for this purpose we use OPNET Modeler 14.5. Since OPNET provides a comprehensive development environment supporting the modeling of communication networks and distributed systems. Both behavior and performance of modeled systems can be analyzed by performing discrete event simulations. The OPNET environment incorporates tools for all phases of a study, including model design, simulation, data collection, and data analysis.

References


