

Chapter 3.20

Data Communications Inside Vehicular Environments

Cheng-Min Lin

Nan Kai University of Technology, Taiwan, R.O.C.

Tzong-Jye Liu

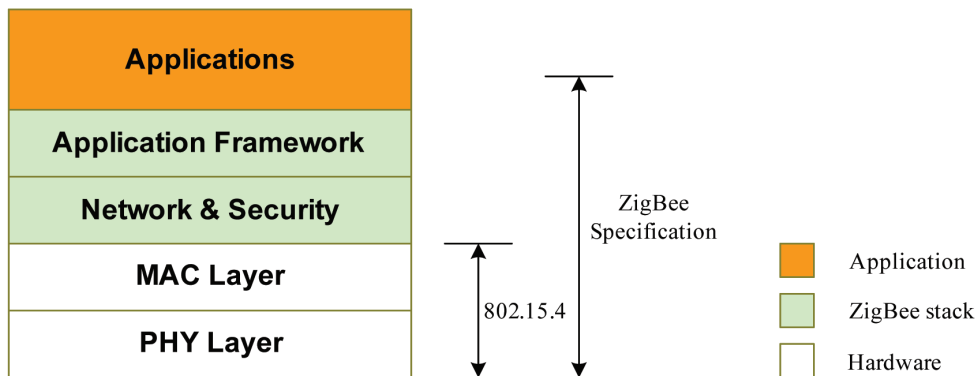
Feng Chia University, Taiwan, R.O.C.

ABSTRACT

ZigBee is based on IEEE 802.15.4 which specifies the physical layer and medium access control (MAC) for low-cost and low-power LR-WPAN. The technology can be applied in intelligent key, A/C operation and steering wheel inside vehicles. There are two types of devices in ZigBee, FFD and RFD. A FFD can communicate with RFDs and other FFDs, while a RFD can only communicate with a FFD. In ZigBee physical layer, it follows IEEE 802.15.4 standard and operates in unlicensed RF worldwide (2.4GHz global, 915MHz Americas or 868 MHz Europe). A superframe contained an active portion and an inactive portion is used in the MAC layer of ZigBee. The active portion includes CAP and CFP. In the inactive partition, the coordinator can enter sleep mode to save its power. Three main topologies of ZigBee are star, mesh, and tree. However, ZigBee is successfully produced into a low-cost controller applied for automotive applications, including vehicle control and status monitoring. According to the forecast of ON World in 2005 (ON WORLD, 2009), the deployed wireless sensing network nodes will increase to 127 million in 2010 from 1.2 million in 2005. It can be applied in home automation, battlefield surveillance, health care applications and vehicular environments. A wireless sensor network (WSN) constitutes a lot of wireless sensing nodes. In addition, a node in WSN consists of one or more sensors, a radio transceiver, and a microcontroller. The sensor can be used for sensing temperature, pressure, sound, vibration, motion or position, etc. to collect status from devices or environments. The transceiver is used to relay the information of the collected status computed by the microcontroller to a center node, called a gateway or sink. Therefore, a WSN belongs to one type of wireless ad-hoc networks. However, the nodes in a WSN are usually smaller than that in traditional wireless ad-hoc networks regarding node size, computing power, memory size, and transmission range. In other words, the transmission ability, computing power, and memory size of WSN nodes are limited.

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Figure 1. ZigBee/802.15.4 architecture



INTRODUCTION

In vehicular environments, a wireless personal area network (WPAN) is required because a driver is a master for the vehicle. The driver interacts with his/her vehicle according to the collected information from WPAN and a controller area network (CAN). The standard of WPANs is defined in the 15th working group of the IEEE 802.15. There are six task groups in the working group as shown in the following.

- **IEEE 802.15.1:** Bluetooth
- **IEEE 802.15.2:** Coexistence
- **IEEE 802.15.3:** High rate WPANs (HR-WPAN), UWB
- **IEEE 802.15.4:** Low rate WPANs (LR-WPAN), ZigBee
- **IEEE 802.15.5:** Mesh network
- **IEEE 802.15.6:** Body area network technologies

In this chapter, we will focus on the introduction of ZigBee based on IEEE 802.15.4, a standard completed in May 2003 which specifies the physical layer and medium access control (MAC) for low-cost and low-power LR-WPAN. Although ZigBee-style networks created by the Firefly Working Group in 1999 become ZigBee later, the group does not exist now. Today's ZigBee was

adopted in 2003 and built on the IEEE 802.15.4 LR-WPAN standard and the ZigBee Alliance ratified the first ZigBee standard in December 2004 (Geer, 2005).

OVERVIEW OF IEEE 802.15.4

The IEEE802.15.4 standard is the basis for the ZigBee specification. It specified the physical layer and MAC layer for LR-WPAN, providing the fundamental lower layers of WPAN. Upper layers of the protocol stack include application profiles defined by ZigBee Alliance. The architecture ZigBee/802.15.4 is shown in Figure 1.

The architecture focuses on low-cost, low-speed ubiquitous communication between devices. Furthermore, the features of IEEE 802.15.4 are illustrated as follows according to the mention of LR-WPAN Task Group (The IEEE 802.15.4 WPAN Task Group, 2009). Its applications are shown in Figure 2.

- Data rates of 250 kbps, 40 kbps, and 20 kbps
- Star or peer-to-peer operation
- Dynamic device addressing
- Two addressing modes are implemented, including 16-bit short and 64-bit IEEE addressing

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