Zigbee™ Home Automation Profile
Electronic and Communications Engineering

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Organization
This document is organized into the following sections

Chapter 1 Introduction – provides an overview of the main components which integrate the entire project, as well as its purpose and use in Home Automation.

Capítulo 2 “CODE Ingenieria Home Automation Profile” – describes some general characteristics about the specific profile

Reference Material

- Zigbee Specification
- Zigbee Cluster Library Specification
- BeeStack Software Reference Manual
Chapter 1
1.1 Introduction
The growing demand for wireless technology in home automation systems has recently been increasing due to several advantages such as installation cost reduction, easy placement, easy extension, aesthetic benefits, and mobile device connectivity. Among the many wireless technologies, ZigBee is one of the most useful for home automation; a wireless home networking system can be configured using ZigBee alone.

Among the many existing wireless protocols, ZigBee is particularly well suited to home automation (HA). ZigBee is intended to enable reliable, cost-effective, low-power, wirelessly networked monitoring and control products based on an open standard.

By giving to the network the feature of scalability, which gives to the user expand and personalize to get an own implementation based on their needs, limitations and requeriments. This allows a lot of specified scenarios which are directly traduced to services based on hardware capabilities of each network devices.

The vision is to create a technology to tackle the above obstacles and allow growth in the home automation market. Such a technology can only be successful as a basis for interoperability in home automation if many market actors support it. Therefore Zigbee standard has been considered.

1.2 Zigbee Overview
The ZigBee Alliance has developed a very low-cost, very low-power consumption, two-way, wireless communications standard. Solutions adopting the ZigBee standard will be embedded in consumer electronics, home and building automation, industrial controls, PC peripherals, medical sensor applications, toys, and games.

The ZigBee stack architecture is made up of a set of blocks called layers. Each layer performs a specific set of services for the layer above. A data entity provides a data transmission service and a management entity provides all other services. Figure 1.1 shows the basic

![Figure 1.1 Basic Zigbee layers](image)
Each service entity exposes an interface to the upper layer through a service access point (SAP), and each SAP supports a number of service primitives to achieve the required functionality.

The IEEE 802.15.4-2003 standard defines the two lower layers: the physical (PHY) layer and the medium access control (MAC) sub-layer. The ZigBee Alliance builds on this foundation by providing the network (NWK) layer and the framework for the application layer. The application layer framework consists of the application support sub-layer (APS) and the ZigBee device objects (ZDO). Manufacturer-defined application objects use the framework and share APS and security services with the ZDO. IEEE 802.15.4-2003 has two PHY layers that operate in two separate frequency ranges: 868/915 MHz and 2.4 GHz.

The lower frequency PHY layer covers both the 868 MHz European band and the 915 MHz band, used in countries such as the United States and Australia. The higher frequency PHY layer is used virtually worldwide. The IEEE 802.15.4-2003 MAC sub-layer controls access to the radio channel using a CSMA-CA mechanism. Its responsibilities may also include transmitting beacon frames, synchronization, and providing a reliable transmission mechanism.

The ZigBee network layer (NWK) supports star, tree, and mesh topologies. In a star topology, the network is controlled by one single device called the ZigBee coordinator. The ZigBee coordinator is responsible for initiating and maintaining the devices on the network. All other devices, known as end devices, directly communicate with the ZigBee coordinator. In mesh and tree topologies, the ZigBee coordinator is responsible for starting the network and for choosing certain key network parameters, but the network may be extended through the use of ZigBee routers. In tree networks, routers move data and control messages through the network using a hierarchical routing strategy. Tree networks may employ beacon-oriented communication as described in the IEEE 802.15.4-2003 specification. Mesh networks allow full peer-to-peer communication. ZigBee routers in mesh networks do not currently emit regular IEEE 802.15.4-2003 beacons. This specification describes only intra-PAN networks, that is, networks in which communications begin and terminate within the same network.

1.3 BeeStack Overview
BeeStack is the term used to describe all of the software implementation of Freescale. BeeStack is comprised of ZigBee networking components, which provide access to ZigBee networking functionality, and platform components, which provide a framework for the application to operate and access the hardware.
BeeStack includes many features which help for the develop of a new specific profile. This implementation includes the next useful initialization:

• Initializes the MAC and PHY layers
• Initializes the Timer Module
• Initializes the APS Layer
• Initializes the ZigBee Device Objects
• Initializes the NWK Layer
• Initializes the NVM Module

Figure 1.2 shows the full components of BeeStack.

BeeStack uses cooperative multitasking. Each task is a separate function that must relinquish control often enough for the BeeStack components to get their work done in a timely manner. There are some inherent BeeStack components tasks, which initializes the full system for Zigbee activities.

The networking (NWK) task in BeeStack is responsible for routing packets, including broadcasting, route discovery, unicasting and rejecting packets not for this node or network.

The Application Support Sub-layer (APS) task is responsible for delivering and receiving application data, including binding endpoints, and end-to-end acknowledgements. APS also contains the authentication process for secure networks, including the trust center on ZigBee Coordinator (ZC) nodes.

The Application Framework (AF) task is responsible for delivery of data indications and confirms to the application endpoints.

The ZigBee Device Object (ZDO) task is responsible for the state of the network, and it includes functions to join and leave the network.

The ZigBee Device Profile (ZDP) task handles requests and responses for a set of common over-the-air ZigBee commands for managing nodes within the network. For example, any node may ask for the IEEE (or MAC) address of any other node in the network using a ZDP command.
The various platform management (PLM) components are responsible for interacting with the hardware such as switches, LEDs, the LCD or timers. All of the PLM components may be customized for a particular application.

The new Home Automation profile takes only the necessary components for Zigbee initialization. It has its own drivers, and implements its own application for specified features.
2.1 Introduction
The home automation systems, demand attractive designs and large functionality. Conscious on this demand on the market, CODE Ingenieria with Synergy Elements, are developing a full home automation system, which gives to users a solution with the highest innovation, integrating and improving the features given by conventional systems. The system allows an efficient energy management, also has the big feature of being scalable, easy to install and a friendly interface with user. The robust hardware design joined to the Zigbee wireless technology redefine the home automation concept, simplifying tasks and allows the user a best system control.

2.2 Development
The development of this system is private, all specifications involved with the project are property of CODE Ingenieria, so that the details about implementation cannot be revealed or published. Even this condition, there will be given at the end of the project, a demo exposition, where all the implemented features will be shown, and a basic explanation about all them will be exposed.

Some of the publish available information, is the Zigbee communication based, and the network capabilities of the devices, which provide to the system the functionality and scenarios whose improves the experience to the user.

2.3 Demonstration
The final demo will include the mandatory specifications proposed by Zigbee Alliance, so the specific implementation will be compatible with any system using a Zigbee communication Standard. This event will be show using a device, with some endpoints controlled by a Freescale Zigbee Demo Board, with the needed modifications in order to control the developed devices and show some of the features of the system.