

Selecting an IEEE 802.15.4, 2.4 GHz wireless solution

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Abstract

Companies searching for a low power 2.45 GHz wireless solution will find many different technical solutions. This white paper takes the reader thru the different solutions offered by Radiocrafts, highlights the advantages of each and guides the users to the technology solution best suited for them.

Introduction

When selecting a wireless technology as a solution for a given task, it is important to find the right tool for the task in hand. All solutions have their strengths and their drawbacks, so it is important to find the actual requirements to the wireless solution. Some of the requirements differentiating the Radiocrafts solutions are:

- Technical requirements
 - Ease of use
 - Coverage/mesh requirement
 - Interoperability
 - Integration with IP based networks
- Business requirements
 - Time to market
 - Development cost

Other requirements such as low cost, small size and low power consumption are not taken into account here since all Radiocrafts solutions satisfy this. But this could be important factors when comparing to other technologies like WLAN/Bluetooth etc.

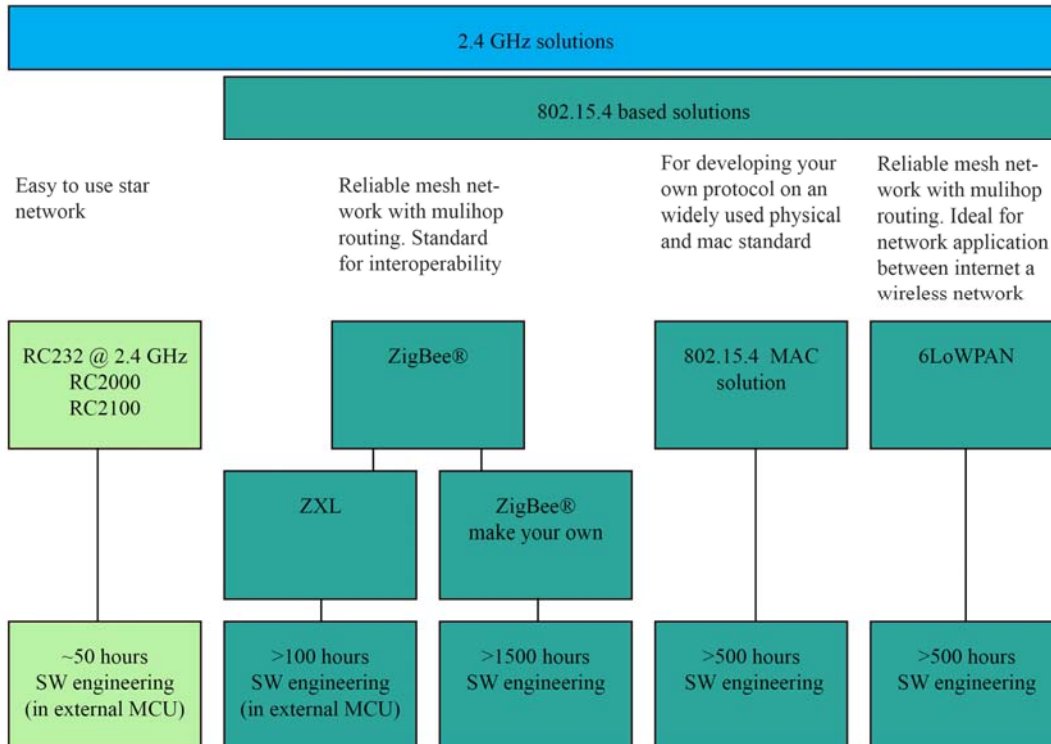
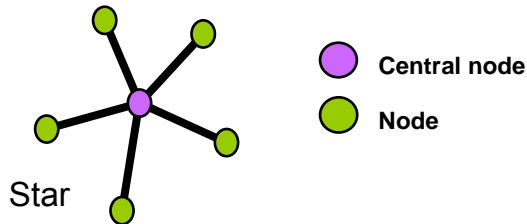


Figure 1. Radiocrafts' solutions at 2.4GHz

RC232

The RC232 is a simple solution with the shortest time to market. By using RC232 modules one can transfer serial port data from one module to another module (point to point) or several other modules (point to multipoint). This technology does not include a routing mesh technology and therefore the network is limited to a star topology. The communication is not compatible with IEEE 802.15.4 and not treated in depth here. Please read more about our RC232 solution on our website (www.radiocrafts.com).



What is IEEE 802.15.4 and what is the ZigBee® protocol?

The IEEE 802.15.4 is a wireless standard for the physical communication layer (PHY) and media access (MAC) layer. The physical layer includes specification on frequencies, modulation, data rate etc. The 802.15.4 specifies 1 channel at 868 MHz, 10 channels at 915 MHz and 16 channels at 2.4 GHz, but only the 2.4 GHz channels are widely used and are treated in this document.

The MAC layer includes access method which is a combination of time division multiple access (TDMA) and carrier sense multiple access with collision detect (CSMA-CD). The MAC specification also includes a point to point acknowledgement and encryption.

The ZigBee Alliance adopted the IEEE 802.15.4 standard as their physical and MAC layer and built the ZigBee protocol standard on top of that. The ZigBee standard includes the network layer (NWK) as well as the application layer (APL). The network layer includes the routing which enables mesh networks. Somewhat simplified it can be said that IEEE 802.15.4 provide a point-to-point link specification, while ZigBee specified how to communicate in a network with multi-hops which is self-configuring and self-healing.

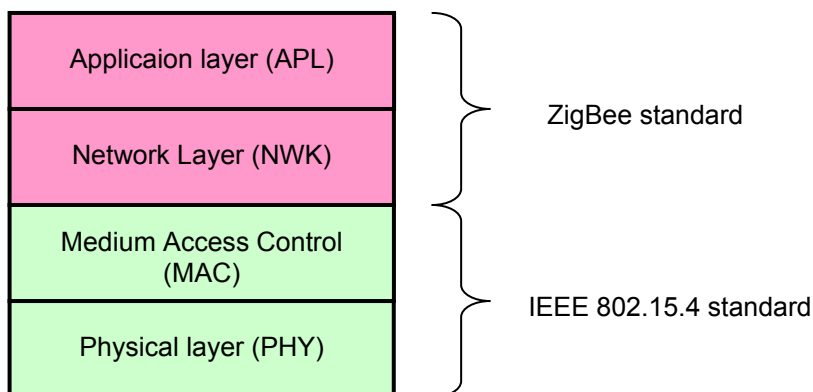


Figure 2. IEEE 802.15.4 and ZigBee protocol stack

802.15.4

There are a number of solutions available that is built on the IEEE 802.15.4 standard, including ZigBee and 6LoWPAN (IPv6 over Low Power Personal Area Network) . One alternative way for you to build a wireless network is to build your own proprietary standard on top of the popular IEEE 802.15.4 layers. The IEEE 802.15.4 PHY / MAC protocol stack is free to download for the RC220x and the RC230x modules. For more details on how to implement an IEEE 802.15.4 solution on RC220x and RC230x please see reference [1].

ZigBee®

ZigBee is the leading worldwide standard for low power wireless network targeting applications like Home Automation (HA), Advanced Metering Infrastructure (AMI), Building automation (BA) and Wireless Sensor Networks (WSN). It is a mesh network consisting of a Coordinator, Routers and End Devices. The mesh network enables a robust, self-configuring, self-healing network. End Devices can be in power saving sleep mode most of the time and hence be battery operated.

All the above mentioned applications are what are called **profiles** within ZigBee. A profile is a specification on the application level of how the device shall operate. That means the profile specifies what device parameters exists and what functions call the device supports. For example, the HA profile specify a dimmer light that has brightness and on/off as parameters and functions for turning light on/off and brightness control. It is important to include this standardization at the application level in order to achieve interoperability between devices from different vendors.

There are two ways of implementing a ZigBee solution with Radiocrafts modules. One is to download a free ZigBee stack and then write the application code, compile and load the FW onto a module. The second is to use a ZigBee module that acts as a ZigBee modem with a serial API-command interface.

Both the RC2300 and the RC2200 platforms can be used for making ZigBee application. The RC2200 is the first generation module with an AVR microcontroller from Atmel combined with the industry leading CC2420 chip from TI/Chipcon. The RC2200 also comes in a high power version, RC2201HP, with up to 17 dBm output. Because of the high output power this module has an increased range, up to 750 meter line-of-sight with chip-antenna and 1500 meter with external antenna. The RC2300 is the second generation module based on the CC2430 SoC from TI/Chipcon. This is a very small and cost-competitive solution for ZigBee. For more details on how to proceed to develop solutions on RC2200 and RC2300, please see Application Note 3 [1].

To be able to call a product ZigBee *compliant*, it has to undergo a ZigBee qualification. Read more on how to certify your product in [1].

ZNM - a ZigBee Network Module

A ZigBee protocol stack is a complicated piece of firmware if you try to understand all of it. With numerous compiler directives, a large number of c-files interacting between each other and 600 pages of documentation it will be a time-consuming task to understand everything. This is why Radiocrafts offers the ZNM-module. This module includes the complete ZigBee stack and gives the user access to this stack thru a serial API interface. By using this module the user can control the ZigBee functionality through a small number of API commands. The user still has to understand ZigBee basics, like network creation, binding, joining etc, but he can now develop his application on an MCU of his own choice with a compiler of his own choice. All these factors will enable an easier and faster ZigBee development.

6LoWPAN

6LoWPAN is formally known as RFC 4944 and is a standard put forth by the Internet Engineering Task Force (IETF), the same people that gave us the Internet standards. They saw the need for a standard for transmitting IP packages over low power wireless networks. Hence the name 6LoWPAN; IPv6 over Low Power Wireless Personal Area Network. As the lower level protocol (PHY and MAC), the IETF chose the already established IEEE 802.15.4 standard. So their job simply became how to adapt IP to IEEE 802.15.4. The great advantage of using this standard is that the IP packages used in the wired world could also be routed to a sensor over a low power wireless link.

This simplifies the otherwise difficult task of integrating a wireless sensor network with an established IP network. For more information on Radiocrafts' 6LoWPAN solution, please contact us (contact information at the end of this paper).

WLAN, Bluetooth etc.

Many customers ask if they can use WLAN and Bluetooth. Both are excellent technologies, but it's always about matching the tool to the task in hand.

WLAN is excellent for PC to PC communication over short (0-100 meter) ranges. It has high throughput and is plug-and-play with today's computers. But the power consumption is high and with limited range and no mesh capabilities it is best at larger mains powered devices like computers.

Bluetooth is also a very good technology, but have limited range (0-10 meter) and a bit to high power consumption for battery powered devices (you have to charge a Bluetooth headset quite often). So for peripheral equipment to cellular phones, this technology works well (due to standardization), but for battery operated sensors and similar it has its limitations.

Summary

	RC232	ZNM	ZigBee	802.15.4	6LoWPAN
Ease of use	☺☺☺	☺☺	☺	☺	☺
Mesh	No	Yes	Yes	No ⁱ	Yes
Connection with IP world	☺	☺☺	☺☺	☺	☺☺☺
Interoperability	No	Yes	Yes	No	Yes ⁱⁱ
Development cost and time to market	☺☺☺	☺☺	☺	☺	☺

ⁱ Mesh functionality can be implemented on top of the 802.15.4 stack by the user

ⁱⁱ Interoperability is on IP level, not on application level.

References

- [1] AN003 Implementing ZigBee/802.15.4 Solutions on Radiocrafts modules

Document Revision History

Document Revision	Changes
1.0	First release

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Trademarks

RC232™ is a trademark of Radiocrafts AS. The RC232™ Embedded RF Protocol is used in a range of products from Radiocrafts. The protocol handles host communication, data buffering, error check, addressing and broadcasting. It supports point-to-point, point-to-multipoint and peer-to-peer network topologies.

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