

802.15.4 and ZigBee™

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Technical Support

Live Chat: www.maxstream.net

E-mail: rf-xperts@maxstream.net

Phone: (801) 765-9885

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Abstract

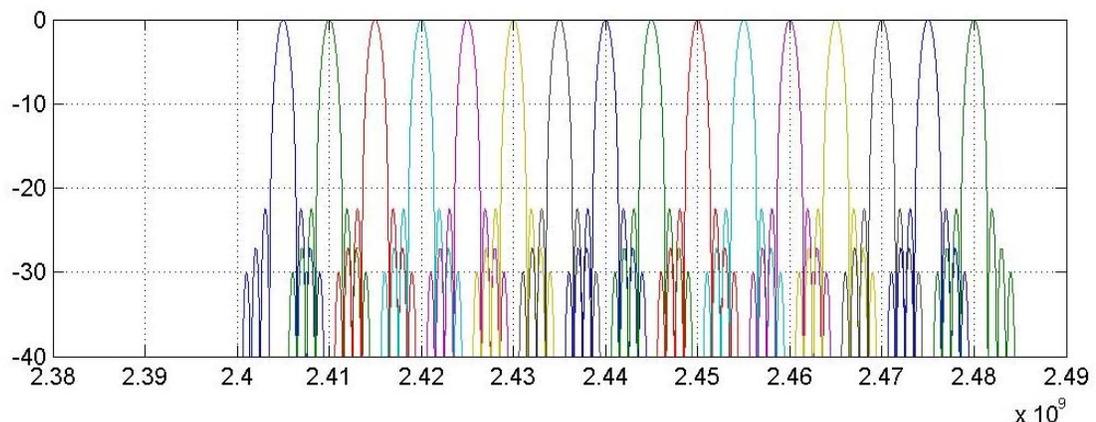
Creating wireless networks can be done using a variety of RF protocols. Some protocols are proprietary to individual vendors, others are industry standards. This Application Note will explore the ZigBee protocol industry standard for data transmission, and the IEEE 802.15.4 protocol on which it was built. We will define the frequencies used, the bandwidth it occupies, and networking features unique to this protocol.

802.15.4

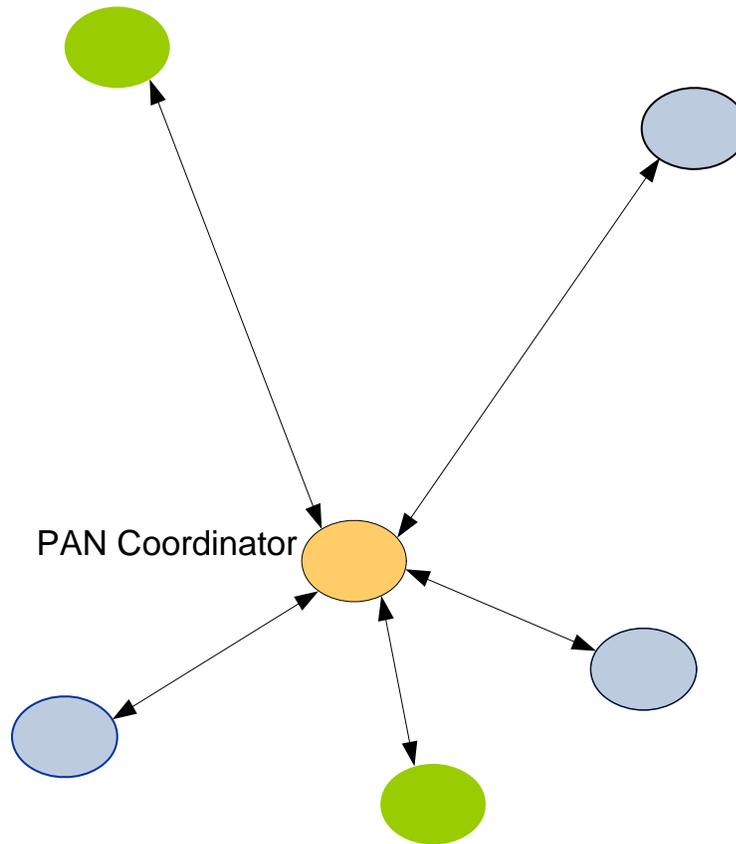
802.15.4 is a standard for wireless communication put out by the IEEE (Institute for Electrical and Electronics Engineers). The IEEE is a technical professional association that has put out numerous standards to promote growth and interoperability of existing and emerging technologies. IEEE has published the standards that define communication in areas such as the Internet, PC peripherals, industrial communication and wireless technology. As a few examples, the IEEE 802.11 standard defines communication for wireless LAN and 802.16 defines communication for broadband wireless Metropolitan Area Networks.

While both of those wireless standards are concerned with higher bandwidth Internet access applications, 802.15.4 was developed with lower data rate, simple connectivity and battery application in mind. The 802.15.4 standard specifies that communication can occur in the 868- 868.8MHz, the 902-928 MHz or the 2.400-2.4835 GHz Industrial Scientific and Medical (ISM) bands. While any of these bands can technically be used by 802.15.4 devices, the 2.4 GHz band is more popular as it is open in most of the countries worldwide. The 868 MHz band is specified primarily for European use, whereas the 902-928 MHz band can only be used in the United States, Canada and a few other countries and territories that accept the FCC regulations.

The 802.15.4 standard specifies that communication should occur in 5 MHz channels ranging from 2.405 to 2.480 GHz. In the 2.4 GHz band, a maximum over-the-air data rate of 250 kbps is specified, but due to the overhead of the protocol the actual theoretical maximum data rate is approximately half of that. While the standard specifies 5 MHz channels, only approximately 2 MHz of the channel is consumed with the occupied bandwidth. At 2.4 GHz, 802.15.4 specifies the use of Direct Sequence Spread Spectrum and uses an Offset Quadrature Phase Shift Keying (O-QPSK) with half-sine pulse shaping to modulate the RF carrier. The graph below shows the various channels at the spacing specified by 802.15.4.



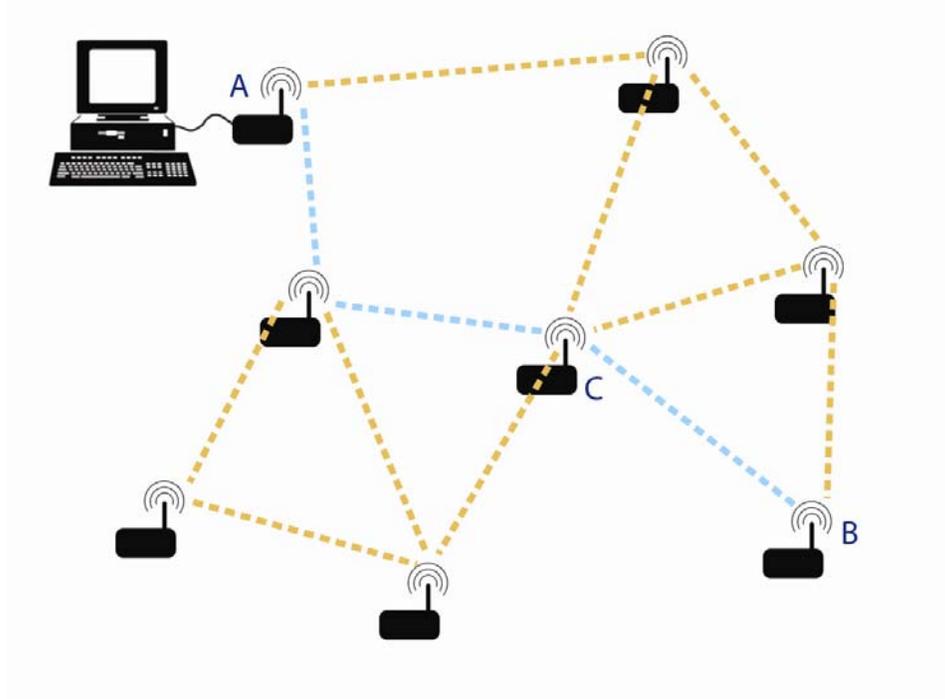
The 802.15.4 standard allows for communication in a point-to-point or a point-to-multipoint configuration.



MaxStream's XBee family of radios can be set up to operate in a point-to-point, point-to-multipoint or a peer-to-peer configuration. While standard 802.15.4 always requires a coordinator, the MaxStream radios are set up so that a coordinator is not required.

ZigBee

ZigBee is a protocol that uses the 802.15.4 standard as a baseline and adds additional routing and networking functionality. What ZigBee is designed to do is add mesh networking to the underlying 802.15.4 radio. Mesh networking is used in applications where the range between two points may be beyond the range of the two radios located at those points, but intermediate radios are in place that could forward on any messages to and from the desired radios.



As an example, in the figure above suppose we wanted to transmit data from point A to point B, but the distance was too great between the points. The message could be transmitted through point C and a few other radios to reach the destination.

Another feature of ZigBee is its ability to self-heal. If the radio at point C was removed for some reason, a new path would be used to route messages from A to B. Devices in the ZigBee specification can either be used as End Devices, Routers or Coordinators. Routers can also be used as End Devices. Since the ZigBee protocol uses the 802.15.4 standard to define the PHY and MAC layers, the frequency, signal bandwidth and modulation techniques are identical.

Conclusion

If the application strictly needs to communicate in a point-to-point or a point-to-multipoint fashion, 802.15.4 will be able handle all the communications between your devices and will be simpler to implement than trying to use a module with ZigBee firmware to accomplish the same goal. ZigBee is necessary if you need to use repeating or the mesh networking functionality.