Wireless Basics
Arduino

Robotics Week Instructor

Joy Shetler, PhD

Overview

What's cooler than a robot? A robot with a wireless network adapter!

Wireless Communication
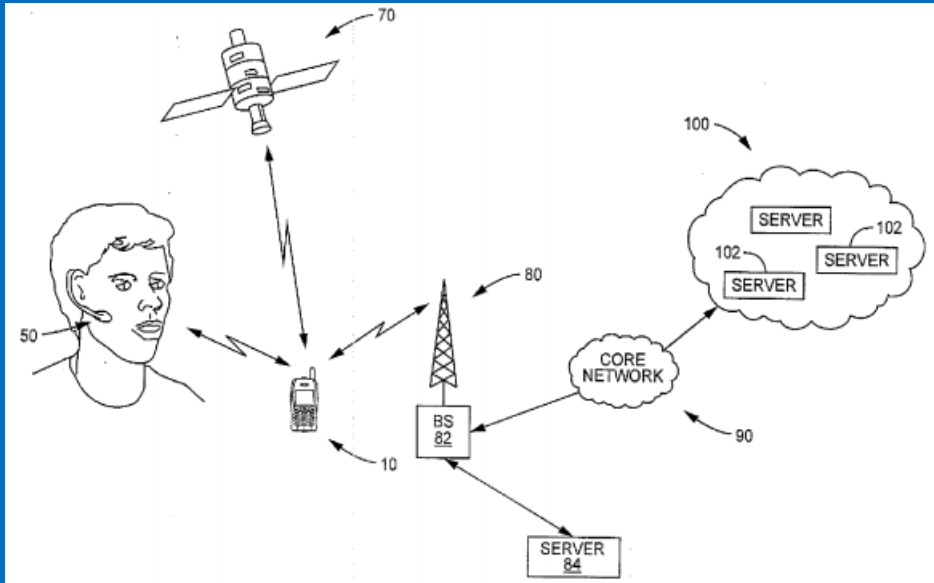
ZigBee

Networks

ZigBee Stack

XBee

Summary

To be happy in this world, first you need a cell phone and then you need an airplane. Then you're truly wireless.
~ Ted Turner

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Wireless Communications

Transfer of information between two or more points that are not physically connected.

Distances can be short, such as a few meters for a television remote control, or as far as thousands or even millions of kilometers for deep-space radio communications.

It's Ubiquitous -

existing or being everywhere, especially at the same time;

Wireless Communications encompasses various types of fixed, mobile, and portable two-way radios, cellular telephones, personal digital assistants (PDAs), and wireless networking. As well as

GPS units, garage door openers, wireless computer mice, keyboards and headset (audio), headphones, radio receivers, satellite television, broadcast television and cordless telephones.

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Wireless Communications

Lower frequency => longer wavelength, longer distances

Electromagnetic Waves
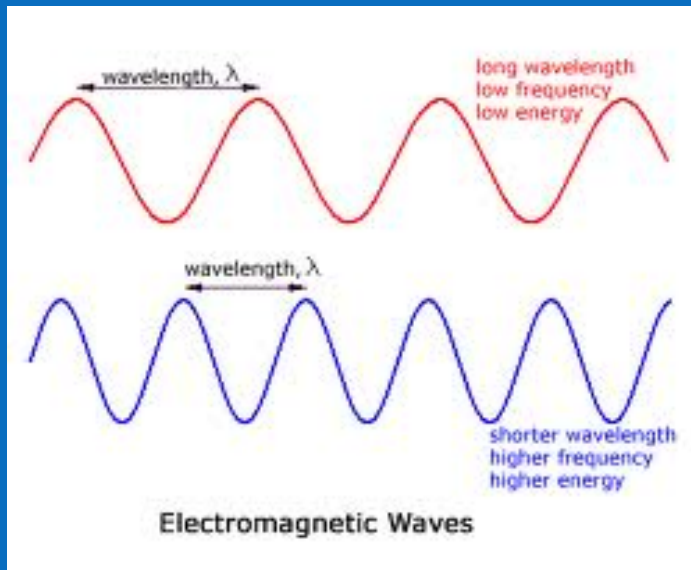
Higher frequency => short wavelength, short distances

Radio frequencies and their primary mode of propagation

Band		Frequency	Wavelength	Propagation via
ELF	Extremely Low Frequency	3–300 Hz	1000-100,000 km	
VLF	Very Low Frequency	3–30 kHz	100–10 km	Guided between the earth and the ionosphere.
LF	Low Frequency	30–300 kHz	10–1 km	Guided between the earth and the D layer of the ionosphere. Surface waves.
MF	Medium Frequency	300–3000 kHz	1000–100 m	Surface waves. E, F layer ionospheric refraction at night, when D layer absorption weakens.
HF	High Frequency (Short Wave)	3–30 MHz	100–10 m	E layer ionospheric refraction. F1, F2 layer ionospheric refraction.
VHF	Very High Frequency	30–300 MHz	10–1 m	Infrequent E ionospheric refraction. Extremely rare F1, F2 layer ionospheric refraction during high sunspot activity up to 80 MHz. Generally direct wave. Sometimes tropospheric ducting.
UHF	Ultra High Frequency	300–3000 MHz	100–10 cm	Direct wave. Sometimes tropospheric ducting.
SHF	Super High Frequency	3–30 GHz	10–1 cm	Direct wave.
EHF	Extremely High Frequency	30–300 GHz	10–1 mm	Direct wave limited by absorption.

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Wireless Communications

One of the earliest forms of wireless communication was radio.

One of the earliest "hobbies" using wireless communications was Amateur Radio.

NASA astronaut Col. Doug Wheelock, KF5BOC, Expedition 24 flight engineer, operates the NA1SS ham radio station in the Zvezda Service Module of the International Space Station. Equipment is a Kenwood TM-D700E transceiver.

Many Amateur Radio operators (or hams) begin with a fascination of radio communication and then combine other personal interests to make pursuit of the hobby rewarding. Some of the focal areas amateurs pursue include radio contesting, radio propagation study, public service communication, technical experimentation, and computer networking.

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ZigBee

ZigBee uses three frequency bands.
A frequency of 915MHz is used in the U.S., 868MHz in Europe, and 2.4GHz in Japan.

The ZigBee specification includes a suite of high level communication protocols using small, low-power digital radios based on an IEEE 802 standard for personal area networks.

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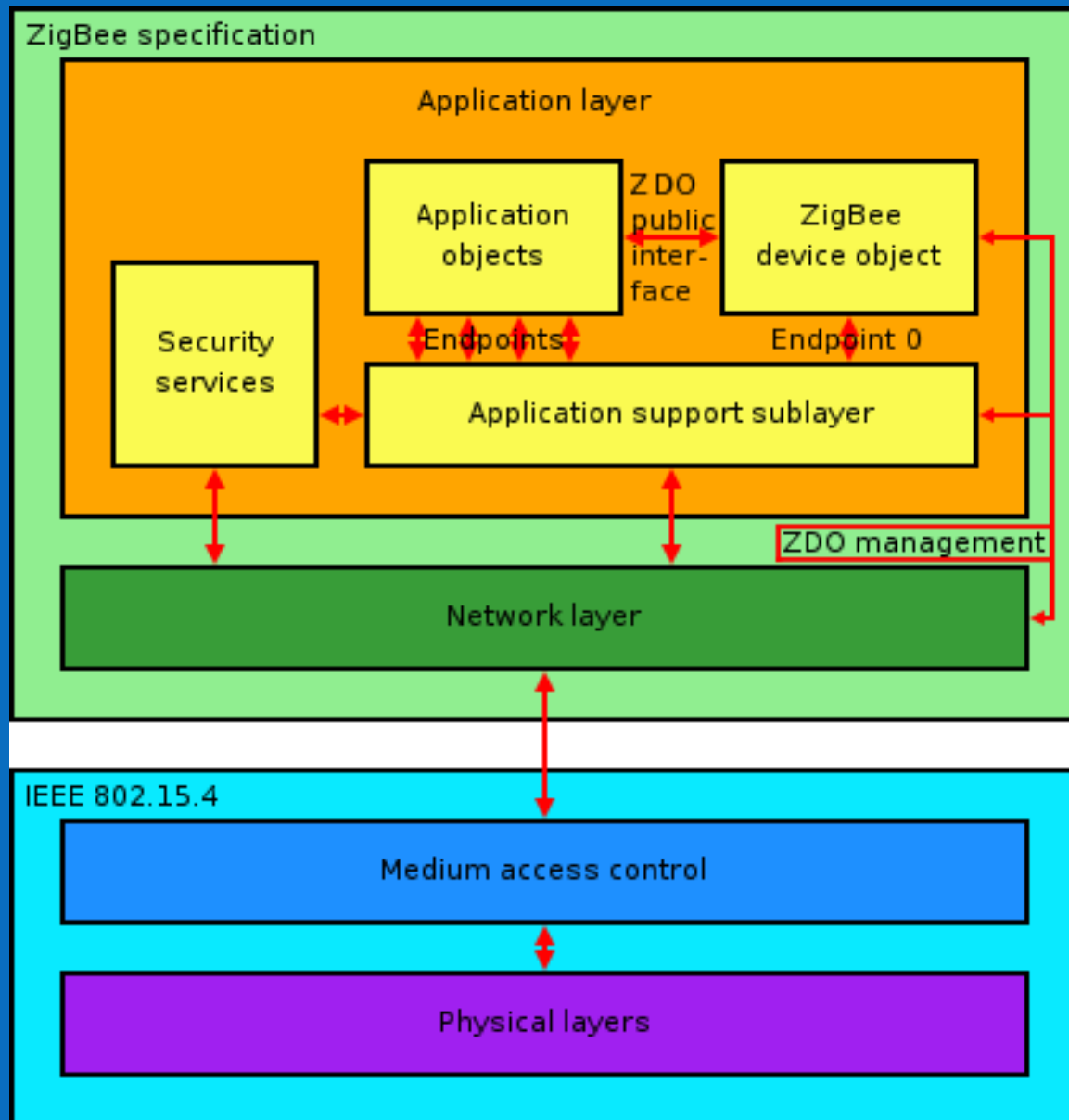
ZigBee

ZigBee is intended for embedded applications requiring low data rates and low power consumption.

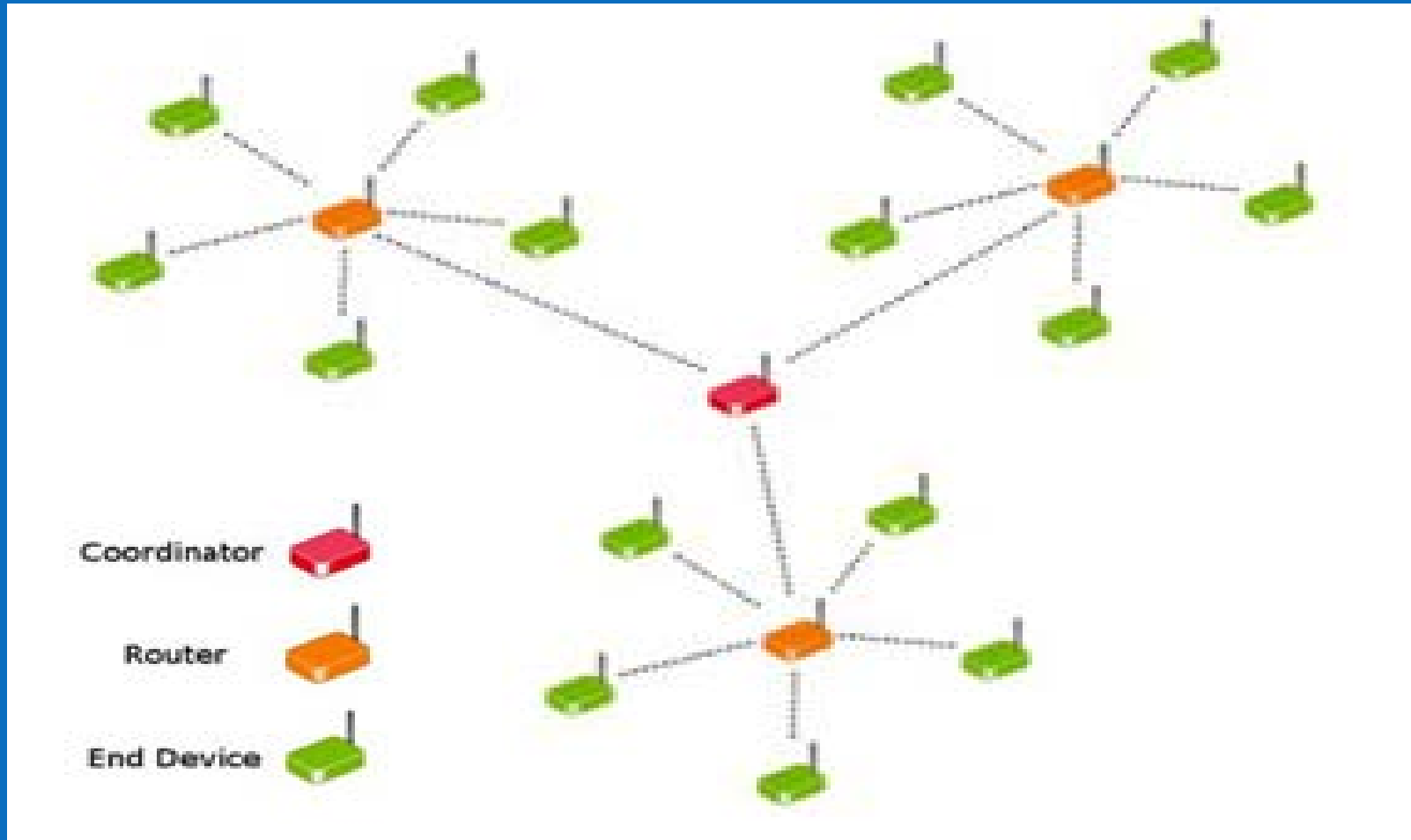ZigBee uses a wireless mesh network to connect the devices.
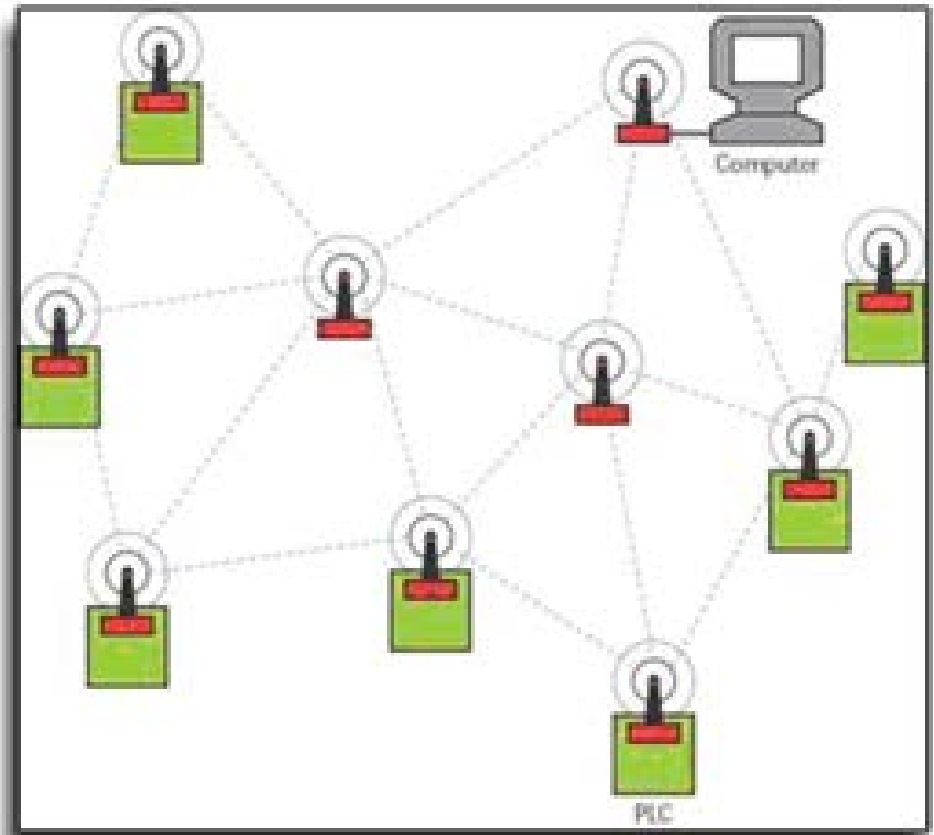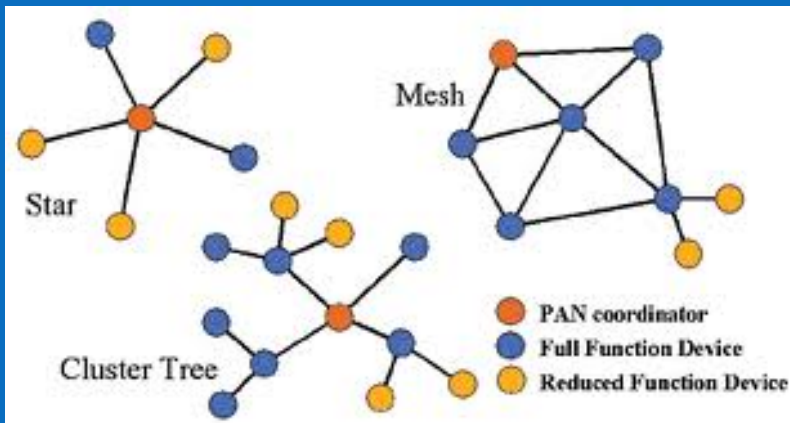
Mesh network configuration

And may actually use a few other configuration, too.

Star

Mesh

Cluster Tree

- PAN coordinator
- Full Function Device
- Reduced Function Device

ZigBee Devices

There are 3 types of ZigBee devices.

Coordinator

Router

End Device

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Zigbee devices

ZigBee Coordinator (ZC): The most capable device, the coordinator forms the root of the network tree and might bridge to other networks. There is exactly one ZigBee coordinator in each network since it is the device that started the network originally. It stores information about the network, including acting as the Trust Center & repository for security keys.

ZigBee Router (ZR): As well as running an application function, a router can act as an intermediate router, passing on data from other devices.

ZigBee End Device (ZED): Contains just enough functionality to talk to the parent node (either the coordinator or a router); it cannot relay data from other devices. This relationship allows the node to be asleep a significant amount of the time thereby giving long battery life. A ZED requires the least amount of memory, and therefore can be less expensive to manufacture than a ZR or ZC.

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XBee

XBee is the brand name from Digi International for a family of form factor compatible radio modules. The first XBee radios were introduced under the MaxStream brand in 2005[2] and were based on the 802.15.4-2003 standard designed for point-to-point and point-to-multipoint communications at over-the-air baud rates of 250 kbit/s.
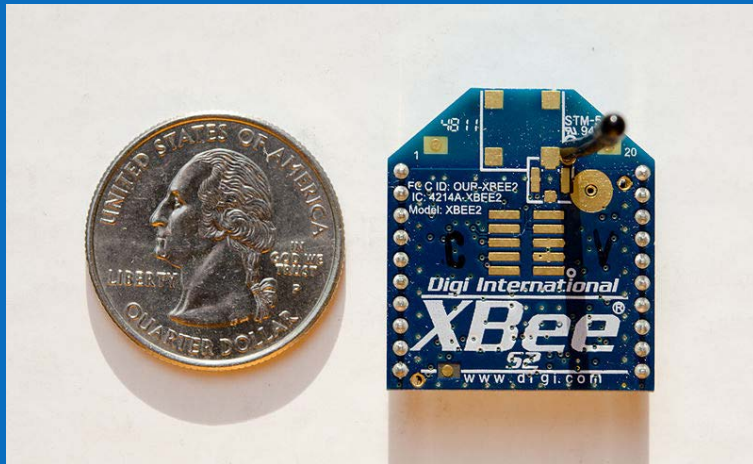
The XBee radios can all be used with the minimum four number of connections - power (3.3 V), ground, data in and data out (UART), with other recommended lines being Reset and Sleep.

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XBee

Is a very small piece of hardware that can connect wirelessly with another using the ZigBee communication protocols. There are many different models, including aerial types and power outputs.

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myQuad Shield

A XBee module has been designed into the myQuad Shield that you will be using as part of the Quadcopter. The XBee module allows your laptop computer to communicate with the Quadcopter!
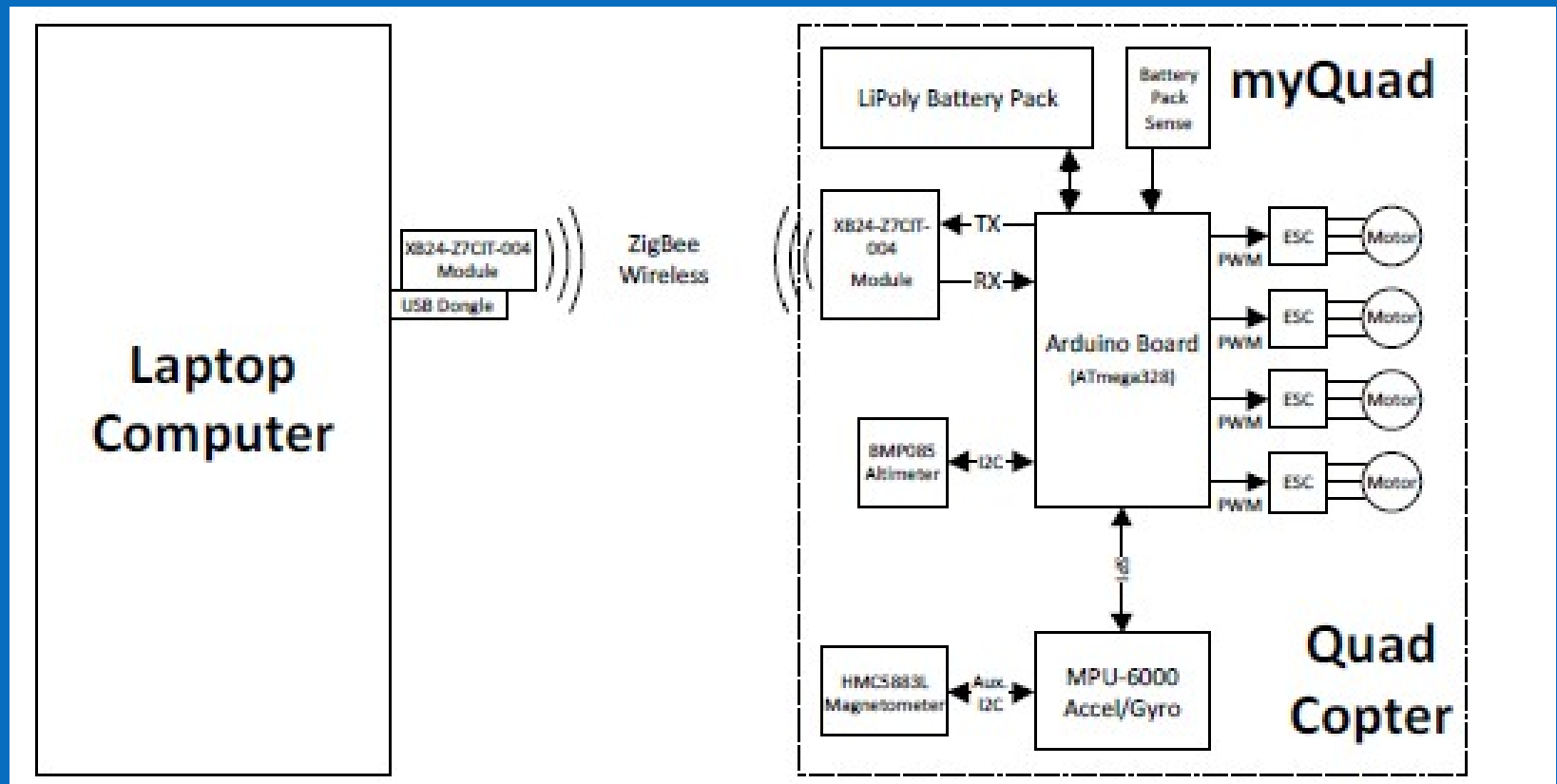
References and Videos!!

There's a LOT of references used for the myQuad presentations and projects. The list is included in the document myQuadReferences.

This also includes a number of youtube videos and other resources available for inquiring minds!

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Questions?

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Project 4

Testing out the XBee module with your laptop.

Follow the instructions for Project 4.

Remember, you may need to use code from the previous projects for this project!

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Project 4

Testing out the XBee module with your laptop.

Congratulations!

You've now developed your own wireless communication system!

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