



zigbee

ZigBee/IEEE 802.15.4

Bhupendra Pratap Singh

New trend of wireless technology



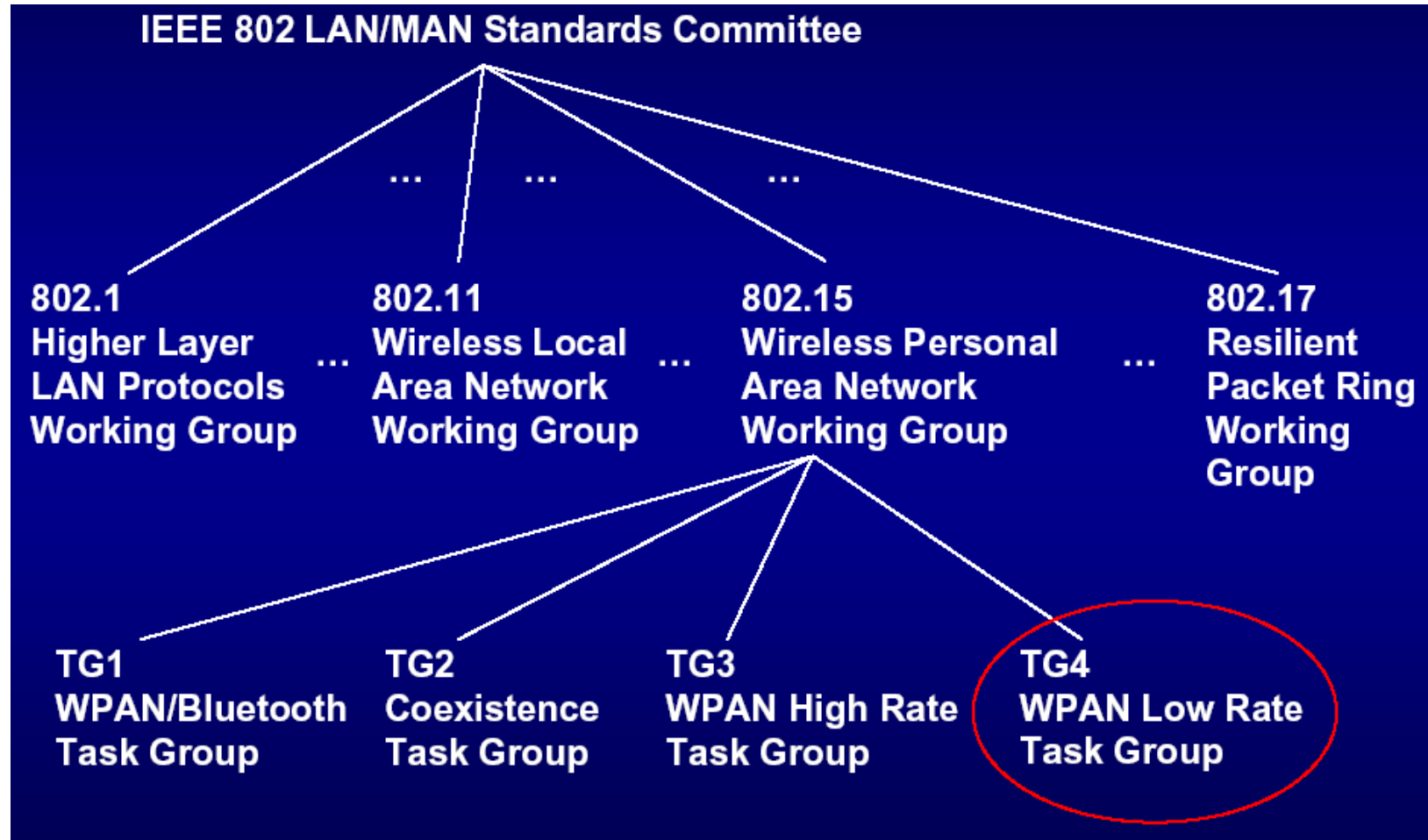
- Most Wireless industry focuses on increasing high data throughput
- A set of applications require simple wireless connectivity, relaxed throughput, very low power, short distance and inexpensive hardware.
 - Industrial
 - Agricultural
 - Vehicular
 - Residential
 - Medical

What is ZigBee Alliance?



- An organization with a mission to define reliable, cost effective, low-power, wirelessly networked, monitoring and control products based on an open global standard
- Alliance provides interoperability, certification testing, and branding

IEEE 802.15 working group



Comparison between WPAN

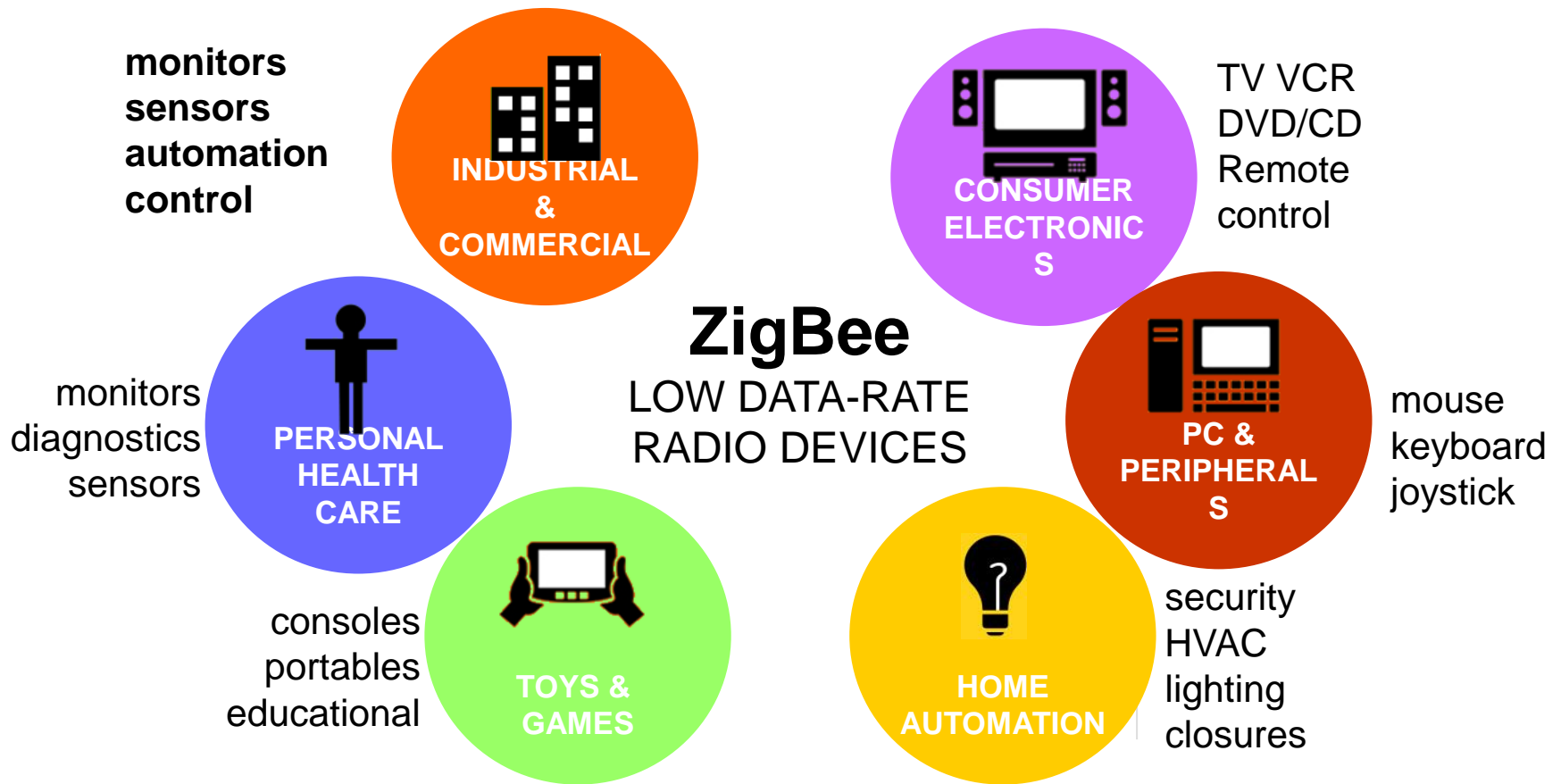
Project	Data Rate	Range	Configuration	Other Features
802.15.1 (Bluetooth)	1 Mbps	10M (class 3) 100M (class 1)	8 active device Piconet/ Scatternet	Authentication, Encryption, Voice
802.15.3 High Rate	22, 33, 44, 55 Mbps	10M	256 active device Piconet/ Scatternet	FCC part 15.249 QoS, Fast Join Multi-Media
802.15.4 Low Rate	up to 250Kbps	10M nominal 1M-100M based on settings	Master/Slave (256 Devices or more) Peer to Peer	Battery Life: multi-month to infinite
802.15.2 Coexistence	Develop a Coexistence Model and Mechanisms Document as a Recommended Practice			



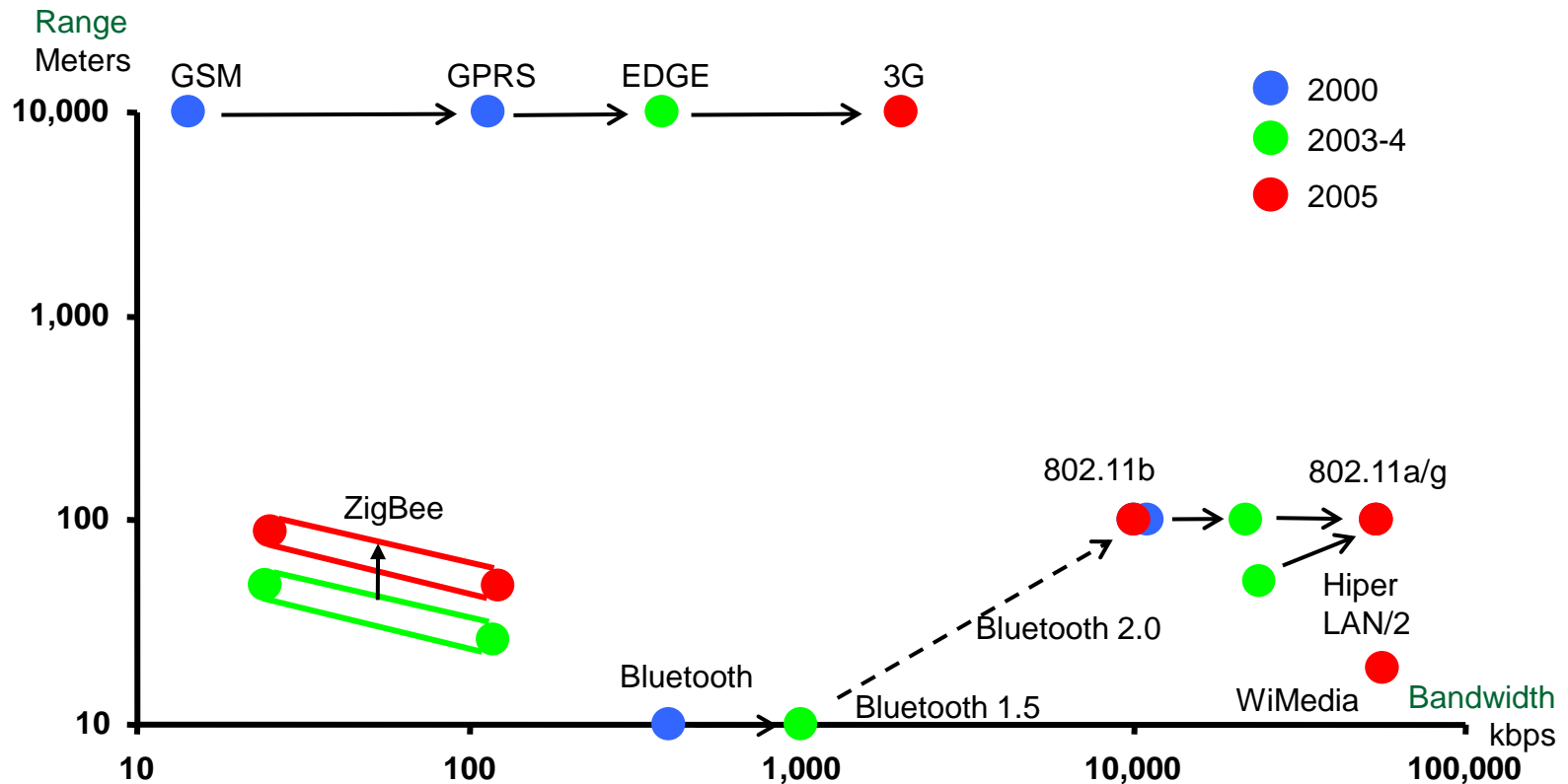
ZigBee/IEEE 802.15.4 market feature

- Low power consumption
- Low cost
- Low offered message throughput
- Supports large network orders ($\leq 65k$ nodes)
- Low to no QoS guarantees
- Flexible protocol design suitable for many applications

ZigBee network applications

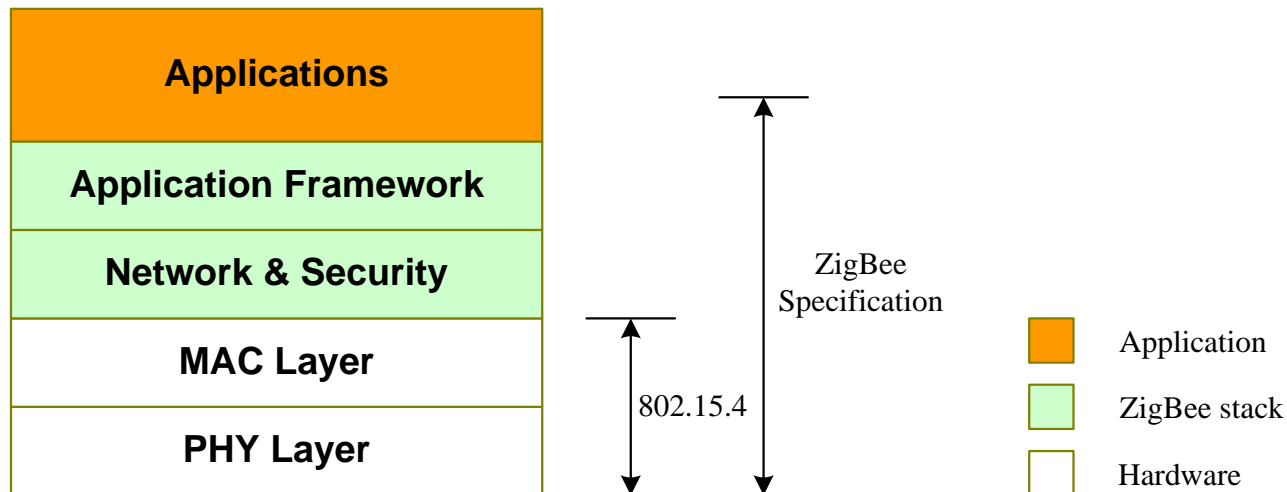


Wireless technologies



ZigBee/802.15.4 architecture

- ZigBee Alliance
 - 45+ companies: semiconductor mfrs, IP providers, OEMs, etc.
 - Defining upper layers of protocol stack: from network to application, including application profiles
 - First profiles published mid 2003
- IEEE 802.15.4 Working Group
 - Defining lower layers of protocol stack: MAC and PHY



How is ZigBee related to IEEE 802.15.4?

- ZigBee takes full advantage of a powerful physical radio specified by IEEE 802.15.4
- ZigBee adds logical network, security and application software
- ZigBee continues to work closely with the IEEE to ensure an integrated and complete solution for the market





IEEE 802.15.4

overview

General characteristics

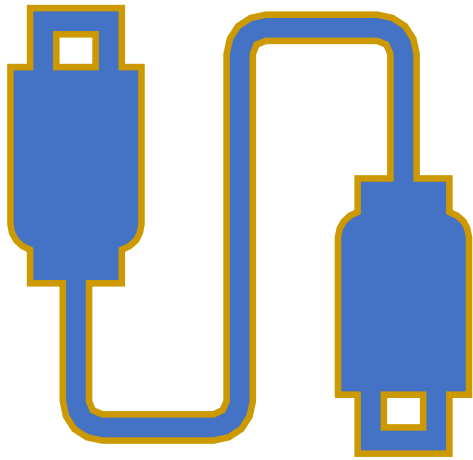
- Data rates of 250 kbps , 20 kbps and 40kbps.
- **Star or Peer-to-Peer operation.**
- Support for low latency devices.
- CSMA-CA channel access.
- Dynamic device addressing.
- Fully handshaked protocol for transfer reliability.
- Low power consumption.
- Channels:
 - 16 channels in the 2.4GHz ISM band,
 - 10 channels in the 915MHz ISM band
 - 1 channel in the European 868MHz band.
- Extremely low duty-cycle (<0.1%)

IEEE 802.15.4 basics

- 802.15.4 is a simple packet data protocol for lightweight wireless networks
 - ❑ Channel Access is via Carrier Sense Multiple Access with collision avoidance and optional time slotting
 - ❑ Message acknowledgement
 - ❑ Optional beacon structure
 - ❑ Target applications
 - Long battery life, selectable latency for controllers, sensors, remote monitoring and portable electronics
 - ❑ Configured for maximum battery life, has the potential to last as long as the shelf life of most batteries

IEEE 802.15.4

Device Types



- There are two different device types :
 - A full function device (FFD)
 - A reduced function device (RFD)
- The FFD can operate in three modes by serving as
 - Device
 - Coordinator
 - PAN coordinator
- The RFD can only serve as:
 - Device



FFD vs RFD

■ Full function device (FFD)

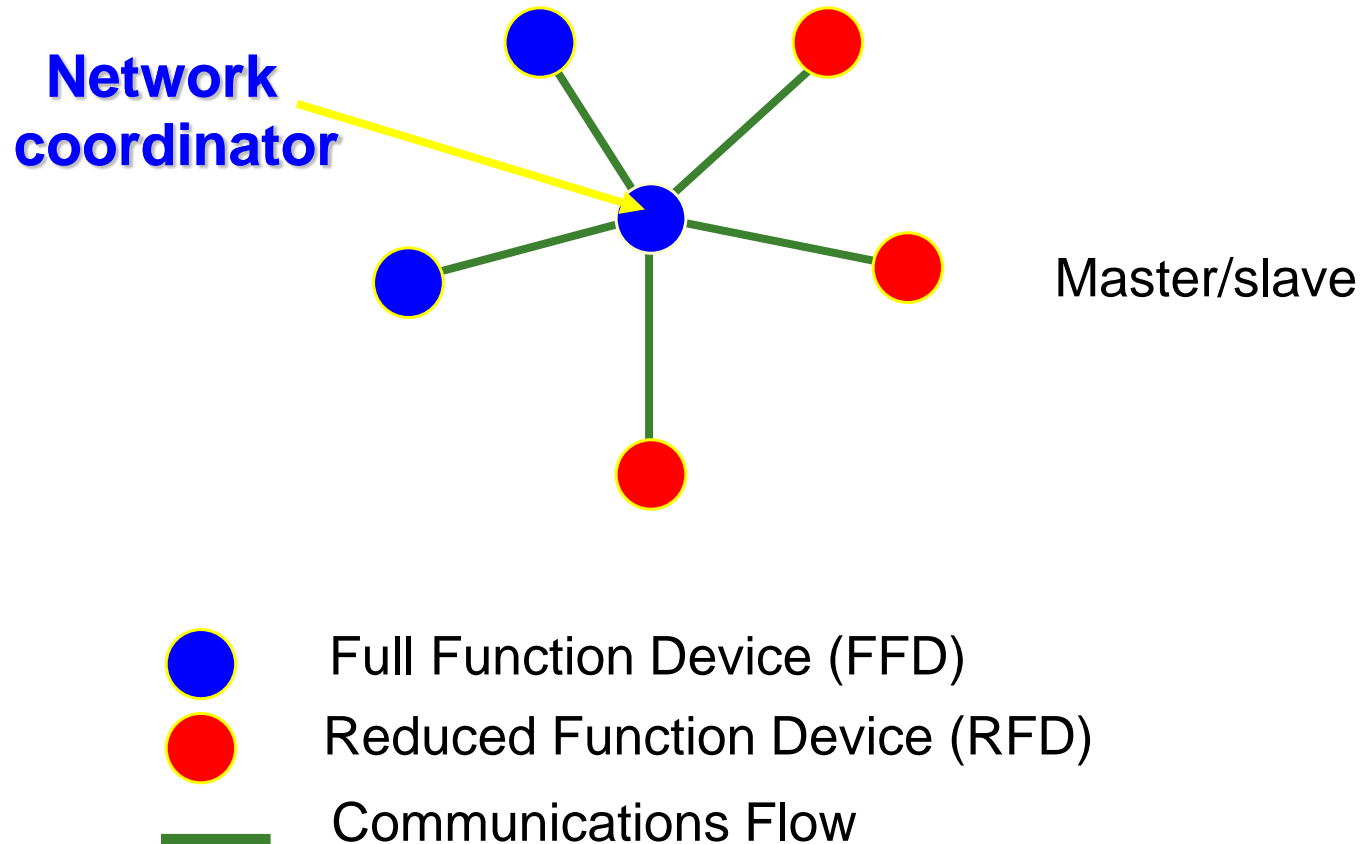
- ❑ Any topology
- ❑ Network coordinator capable
- ❑ Talks to any other device

■ Reduced function device (RFD)

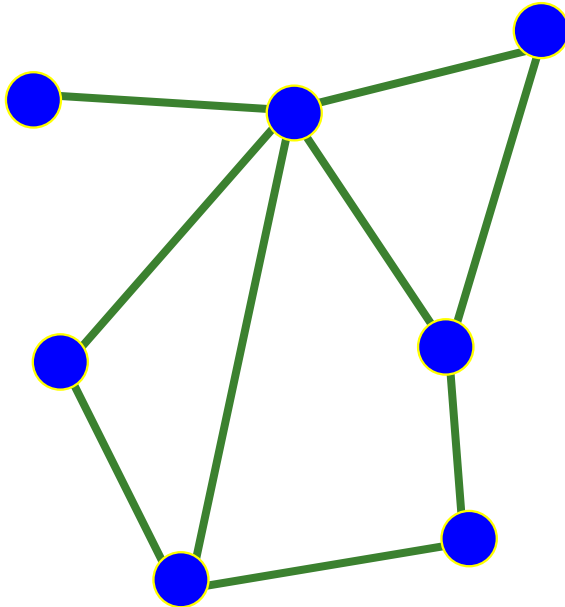
- ❑ Limited to star topology
- ❑ Cannot become a network coordinator
- ❑ Talks only to a network coordinator
- ❑ Very simple implementation



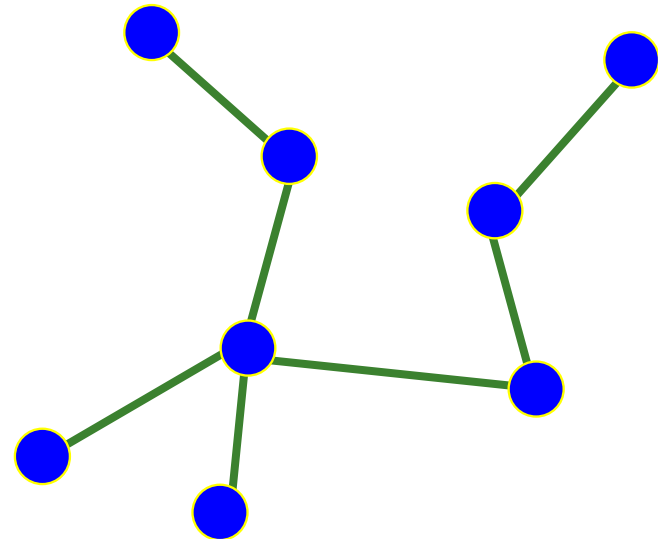
Star topology



Peer to peer topology



Point to point



Tree



Device addressing

- Two or more devices communicating on the same physical channel constitute a WPAN.
 - ❑ A WPAN includes at least one FFD (PAN coordinator)
 - ❑ Each independent PAN will select a unique PAN identifier
- Each device operating on a network has a unique 64-bit extended address. This address can be used for direct communication in the PAN. (IEEE MAC address)
- A device also has a 16-bit short address, which is allocated by the PAN coordinator when the device associates with its coordinator.



IEEE 802.15.4 physical layer

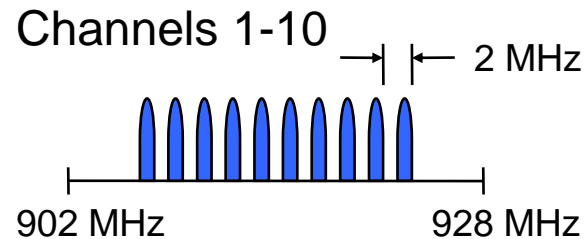
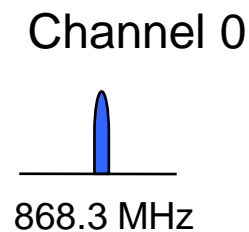
IEEE 802.15.4 PHY overview

- PHY functionalities:
 - ❑ Activation and deactivation of the radio transceiver
 - ❑ Energy detection within the current channel
 - ❑ Link quality indication for received packets
 - ❑ Clear channel assessment for CSMA-CA
 - ❑ Channel frequency selection
 - ❑ Data transmission and reception

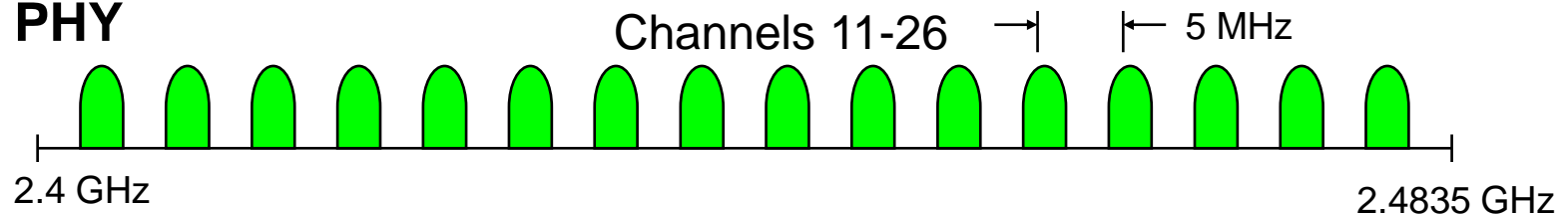
IEEE 802.15.4 PHY Overview

- Operating frequency bands

868MHz/ 915MHz PHY



2.4 GHz PHY

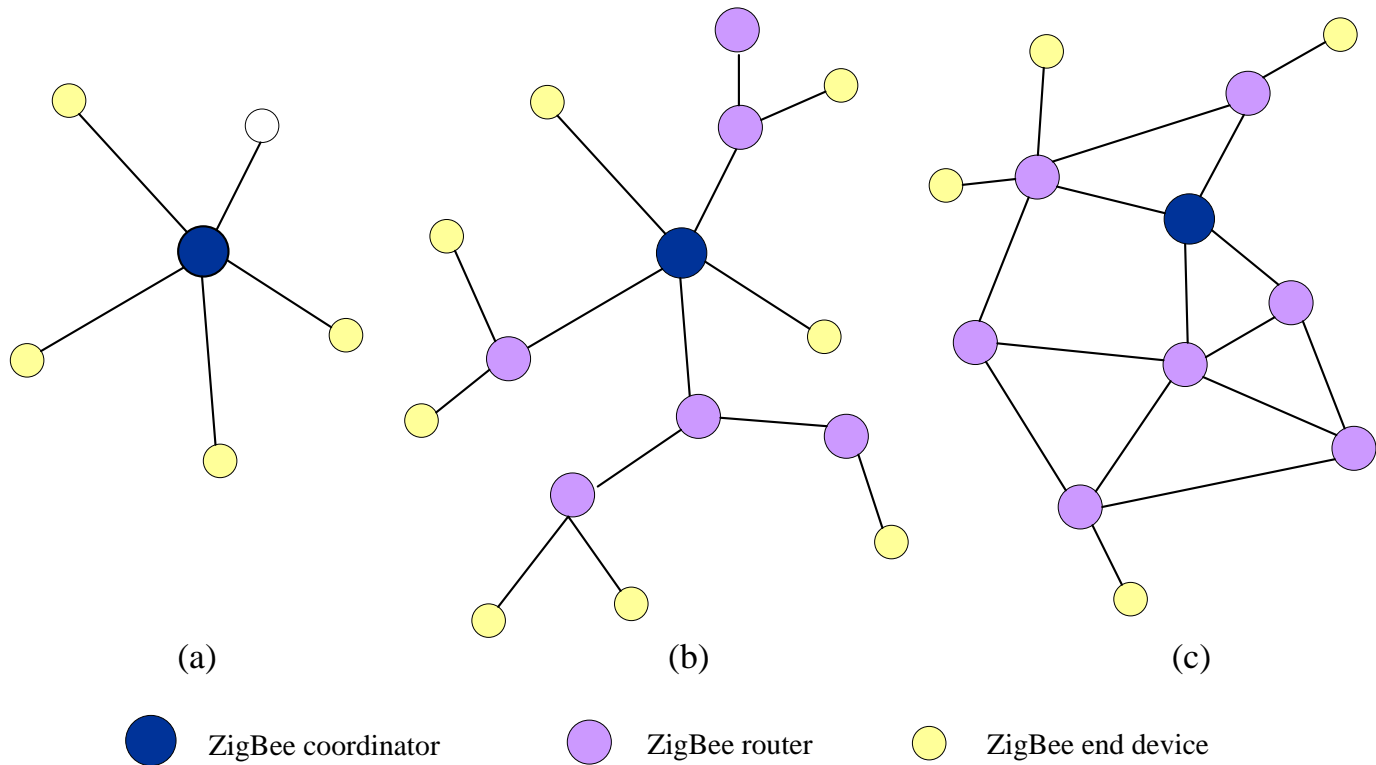


Frequency Bands and Data Rates

- The standard specifies two PHYs :
 - 868 MHz/915 MHz direct sequence spread spectrum (DSSS) PHY (11 channels)
 - 1 channel (20Kb/s) in European 868MHz band
 - 10 channels (40Kb/s) in 915 (902-928)MHz ISM band
 - 2450 MHz direct sequence spread spectrum (DSSS) PHY (16 channels)
 - 16 channels (250Kb/s) in 2.4GHz band

ZigBee Network Layer Overview

- Three kinds of networks are supported: **star**, **tree**, and mesh networks



ZigBee Module

- **QUICK OVERVIEW**

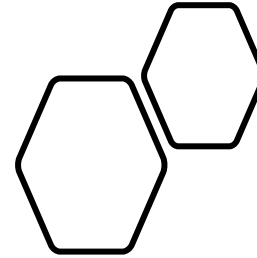
- Integrated, Wire Antenna
- Interoperable with other ZigBee-compliant devices.
- Programmable versions with onboard microprocessor enable custom ZigBee application development.
- Supports binding and multicasting for easy integration into a home automation platform.
- Data Rate: RF 250 Kbps, Serial up to 1 Mbps.
- Range: Indoor 200 ft (60 m), Outdoor (LOS) 4000 ft (1200 m).
- Transmit Power: 3.1 mW (+5 dBm)
- Channels: 16 channels.





Summary of ZigBee network layer

	Pros	Cons
Star	<ol style="list-style-type: none">1. Easy to synchronize2. Support low power operation3. Low latency	<ol style="list-style-type: none">1. Small scale
Tree	<ol style="list-style-type: none">1. Low routing cost2. Can form superframes to support sleep mode3. Allow multihop communication	<ol style="list-style-type: none">1. Route reconstruction is costly2. Latency may be quite long
Mesh	<ol style="list-style-type: none">1. Robust multihop communication2. Network is more flexible3. Lower latency	<ol style="list-style-type: none">1. Cannot form superframes (and thus cannot support sleep mode)2. Route discovery is costly3. Needs storage for routing table



Thank You !!
Q&A??