



Home Automation & Smart Buildings



Code Camp 2016

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Introduction

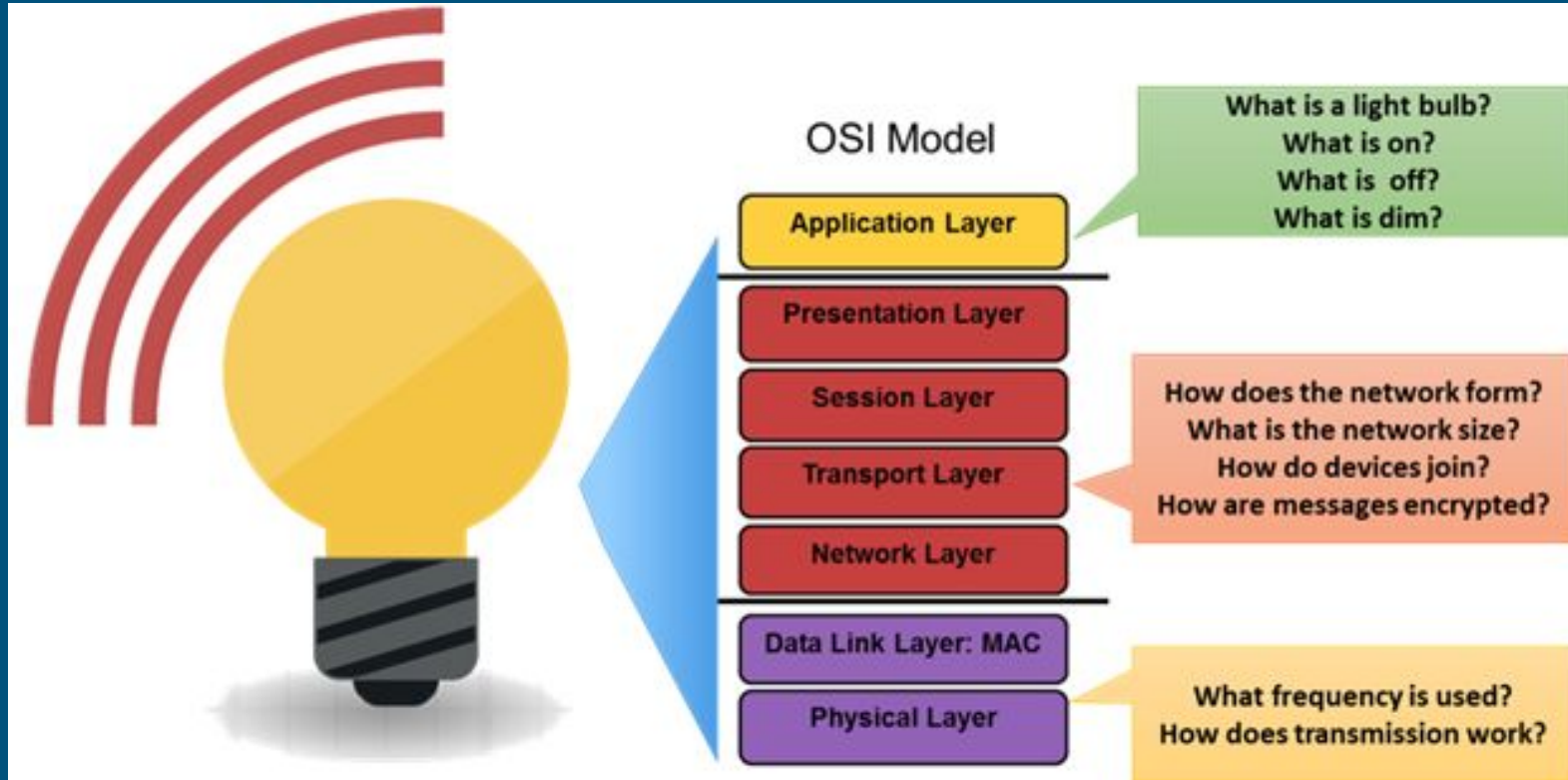
- Bottom-up approach for implementing a home automation.
- FHEM; a PERL server for home automation; binds home automation system and components of the hardware side.
- Software side: Assistance provided by modules. Appx. 200 modules available
- We are using FS20 module to connect interfaces.
- FHEM can be accessed via program, telnet, web front-end, mobile apps.
- Published under GPL.

Protocol: ZigBee



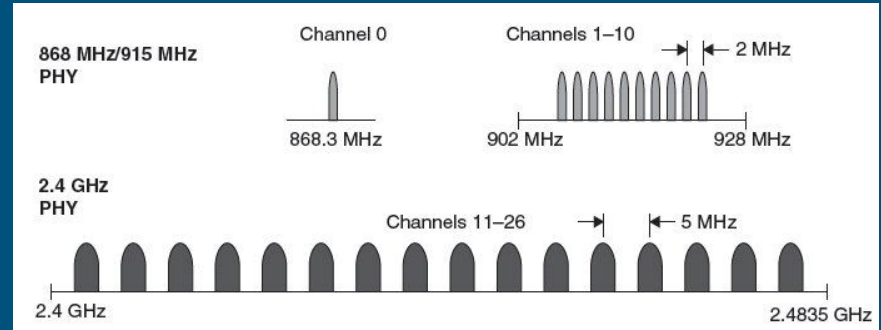
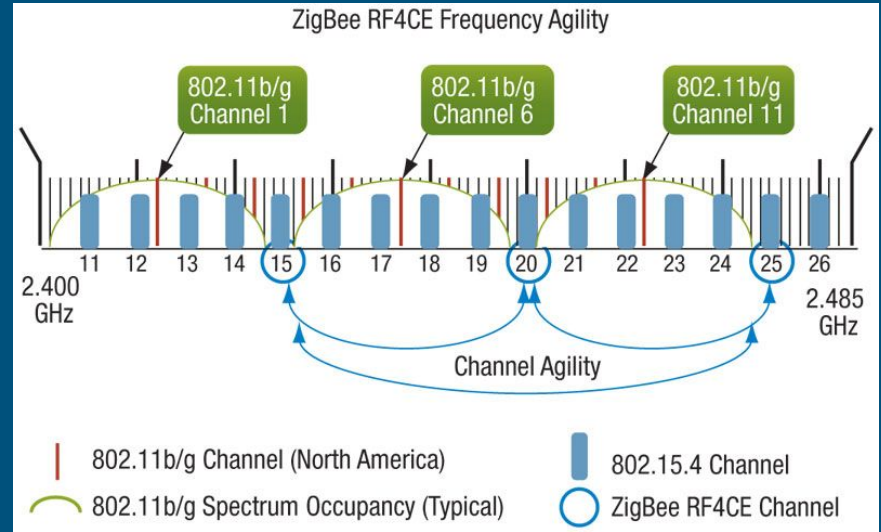
Standard based on IEEE 802.15.4

Frequency Band	Geographic Region	Data Rate	Modulation	Number of channels
868.3 Mhz	Europe	20 kbps	BPSK	1
902-928Mhz	Americas	40 kbps	BPSK	10
2405-2480Mhz	Worldwide	250 Kbps	QPSK	16



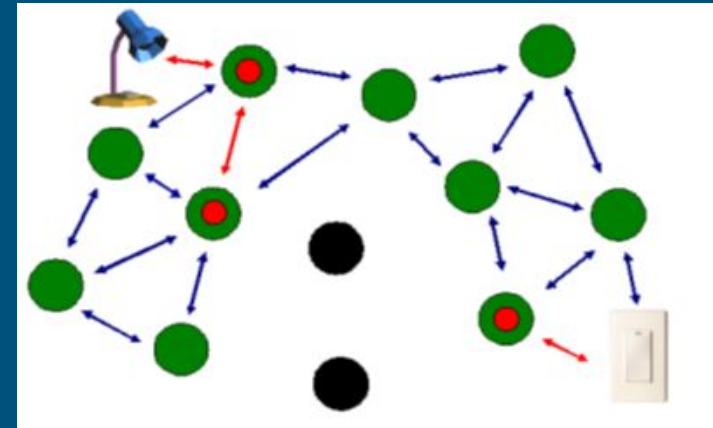
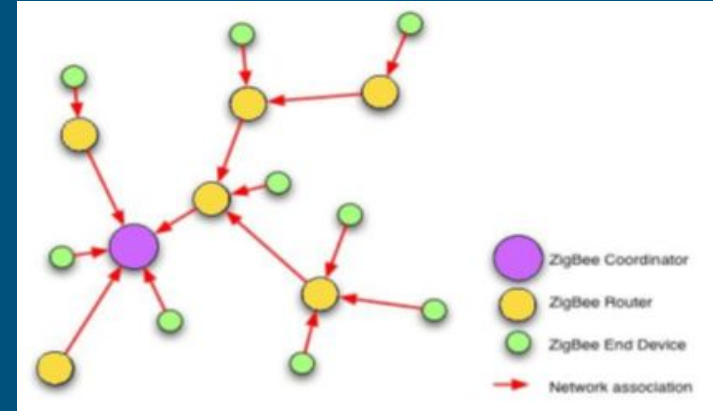
ZigBee and Wifi Coexistence

- The channel selection in the Zigbee network should not be restricted to one or two channels. There are possibilities to have several channels in use. This will allow the coordinator in the area to select the channel with the least amount of interference.
- Zigbee radios have varying levels of RF output power, from 0dB to +20dB, and Wi-Fi is fairly loud, at +20dB. It is better to have zigbee with the same amount of power to compete with ZigBee
- Avoid putting Zigbee radios right next to a Wi-Fi access point unless you know which channel the access point is on.



Advantages

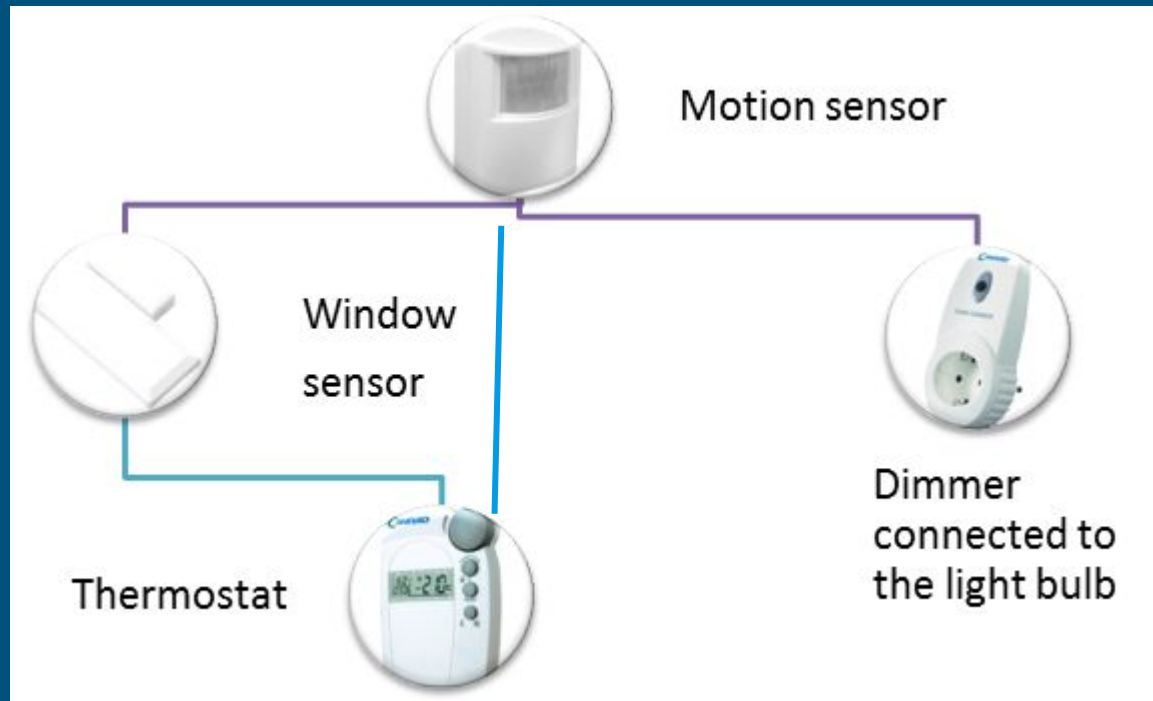
- It is low cost, and low power consumption, easy to implement and a wide coverage area using different types of topologies.
- Uses less power than other technologies ranges from 1mW to 100mW, also less memory from 4 to 32 Kb.
- It has better connection times than other protocols, making it more reliable, self-healing network, when some node goes down, the other nodes look for alternate routes, and permits the network to be operational in such situations.
- It has authentication and encryption during communication.



Scenario

1. The motion sensor operates as the main trigger of the system detecting presence of human
2. In case of presence the heating and lighting are turned on. After 15 minutes of inactivity both heating and lighting are turned down.
3. In case of opened window, detected by window sensor, the heating is also adjusted to the lower levels.
4. In case of high temperatures (above 22C) the heating is adjusted to the lower levels.
5. In case of system turning off the lights and equipment, automatic email notification is sent out.

Scenario



Implementation

Live Demo

Assumptions - for electrical equipment

Normal Scenario	Automation Scenario
9 working hours per day	7 working hours per day
5 days per week	5 days per week
46 weeks (4 weeks of vacations + 2 weeks for business trips)	46 weeks (4 weeks of vacations + 2 weeks for business trips)
1 PC, 2 Flat screens, 1 printer and lights (printer is in stand-by mode for 24 hours)	1 PC, 2 Flat screens, 1 printer and lights (printer is in stand-by mode for 12 hours)
Price of 1 kWh = 0.05 euros.	Price of 1 kWh = 0.05 euros.

Assumptions - for climate control equipment

Normal Scenario	Automation Scenario
12 working hours per day	9 working hours per day
5 days per week	5 days per week
52 weeks	46 weeks (4 weeks of vacations + 2 weeks for business trips)
18 m ² , electric heating, comfort temperature 20-22C.	18 m ² , electric heating, comfort temperature 20-22C.
Default CO ₂ emission for Finland = 0.225 kgCO ₂ /kWh	Default CO ₂ emission for Finland = 0.225 kgCO ₂ /kWh

Conclusion

	Energy consumption, equipment, kWh/year	Energy consumption, climate control, kWh/year	Energy consumption of automation equipment	CO2 emission, kgCO2/year	Costs, euros	In cups of Coffee
Normal mode	557	1593	0	491.85	104.2425	208
Automation mode	456	1063	28.44	350	70.65	140
Economy	101	530	28.44	141.85	33.59	68

References

- <http://ecometrica.com/assets/Electricity-specific-emission-factors-for-grid-electricity.pdf>
- <https://www.helen.fi/en/electricity/homes/electricity-products-and-prices/>
- http://www.coned.com/customercentral/calculators/EC_bus_Calc.html
- <http://vm.fi/documents/10623/1169930/Vn+periaatep%C3%A4%C3%A4t%C3%B6s+toimitilastrategiaksi+EN.pdf/a2ca1d38-e391-4565-8360-6cff96fb596>

Questions?

