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Wireless Building Control

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Siemens, Control Products and Systems
November 13, 2012

Agenda

Introduction
- Understanding building control architecture

Why Wireless?

Wireless basics

Why ZigBee?

Benefits of BACnet and ZigBee as a team

Questions and Answers

Early Wireless Adoption

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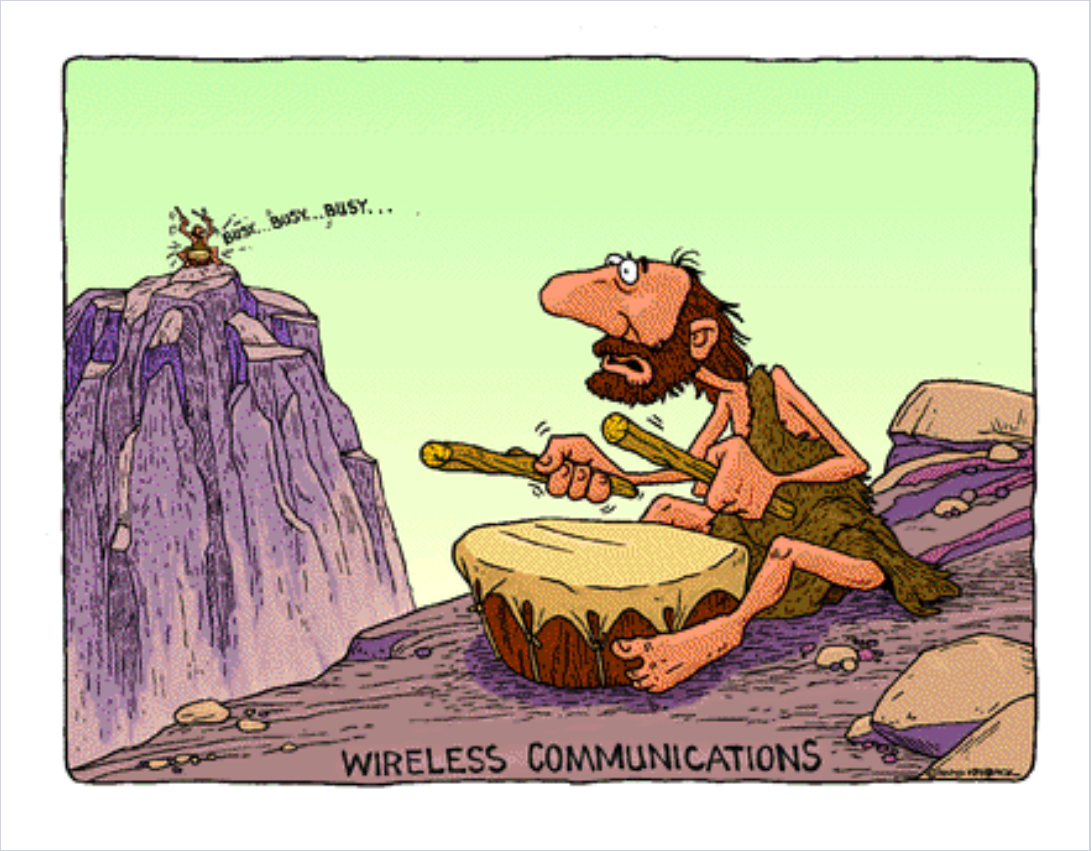


Building Automation System Architecture

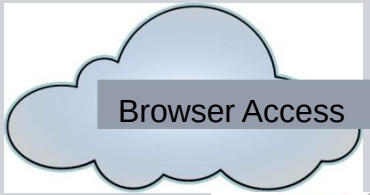
Management

Automation

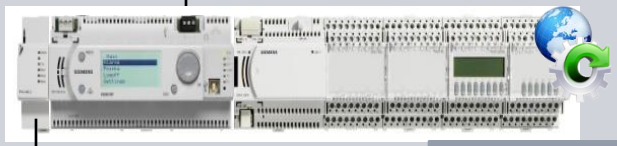
Field/Room

IP (BACnet IP and Web services)

APOGEE Insight and InfoCenter Suite



Browser Access

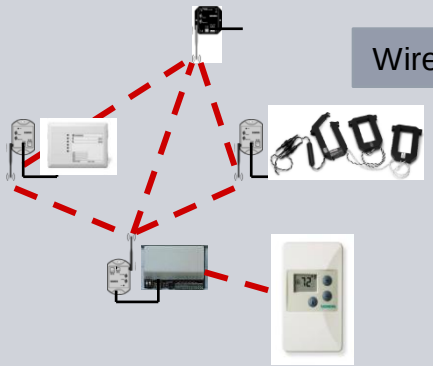


PXC Range with Embedded Web UI

BACnet MSTP

UEC and PTEC

PPM and ATEC



Wireless

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Why Wireless?

Finish projects on-time, on-budget

- Simplify difficult designs for wires
  - Minimal walls, marble walls, cinderblock walls, atriums, high ceilings, historical/vintage and other architectural challenges
  - Faster, easier, require less labor and are on-time!
- Reduce or eliminate wires and conduit
  - Less wire means faster installation
  - Eliminate troubleshooting hassles of wired networks
- Minimize disruption to facility and tenants
  - Limit disruption of walls, floors, ceilings
  - Reduce air contaminants during retrofit
  - Limit employee or tenant work disruption
  - Limit reconfiguration of work equipment

Considerations

- Wireless as an “Enabler”
- Many existing facilities cannot afford to install a modern BAS
- Wiring costs make projects too expensive
- Wireless controls overcome high wiring costs
- State of the art BAS allows significant reduction in operating costs
- Flexibility
- Ability to more cost-effectively reconfigure

New Construction vs. Retrofit

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- Significantly more difficult/expensive to run wire in existing building
- Historically most wireless solutions were used in retrofit
- Cost of wireless to point where some new construction projects are using
- Project able to move faster
- Desire flexibility
  - Moving devices
  - Mounting locations of sensors

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Examples

Industrial

- 400,000 square-foot assembly plant
- Challenges: high ceilings, long distances, conduit, production schedule.
- Wirelessly networked unit heaters, exhaust fans, AC units and lighting.
- 92 wireless FLN devices networked back to a front end
- Saved > $200K in electrician costs

Healthcare

- Outdated BAS
- Network cabling incompatible.
- Wireless eliminated running vast amounts of new cabling.
- Fewer ceiling & wall disturbances reduced risk of airborne contamination.
- Reduced cost of containment efforts required to minimize airborne contamination
- Quicker installation meant less downtime …minimized financial impact to hospital

University

- Outdated mechanical systems and controls caused fluctuating humidity levels
- Wireless allowed upgrade to happen in a timely and cost efficient manner
- Fewer wall disturbances reduced harm to historic building.
- Quicker installation meant less downtime …minimized financial impact to university.

“Shows alumni, donors, prospective students, and the community the fiscal responsibility and discretion of the administration.”

Wabash College

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Wireless Challenges

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How do building environments affect signal strength?

Wireless basics

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In order to have good communication between 2 radios there must be excess margin (db) available once the signal is received

- To determine this a link budget is determined between 2 radios

A **link budget** is the accounting of all of the gains and losses from the transmitter, through the medium (free space, cable, waveguide, fiber, etc.) to the receiver in a communication system. It accounts for the attenuation of the transmitted signal due to propagation, as well as the antenna gains, and miscellaneous losses.

$$P_{rx} = P_{tx} + G_{tx} + G_{rx} - A_{fs} - A_m$$

P_{rx} = received power at detector (dBW)

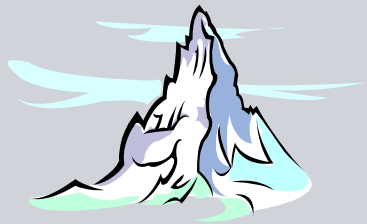
P_{tx} = transmitter output power (dBW)

G_{tx} = transmitter antenna gain (dBi)

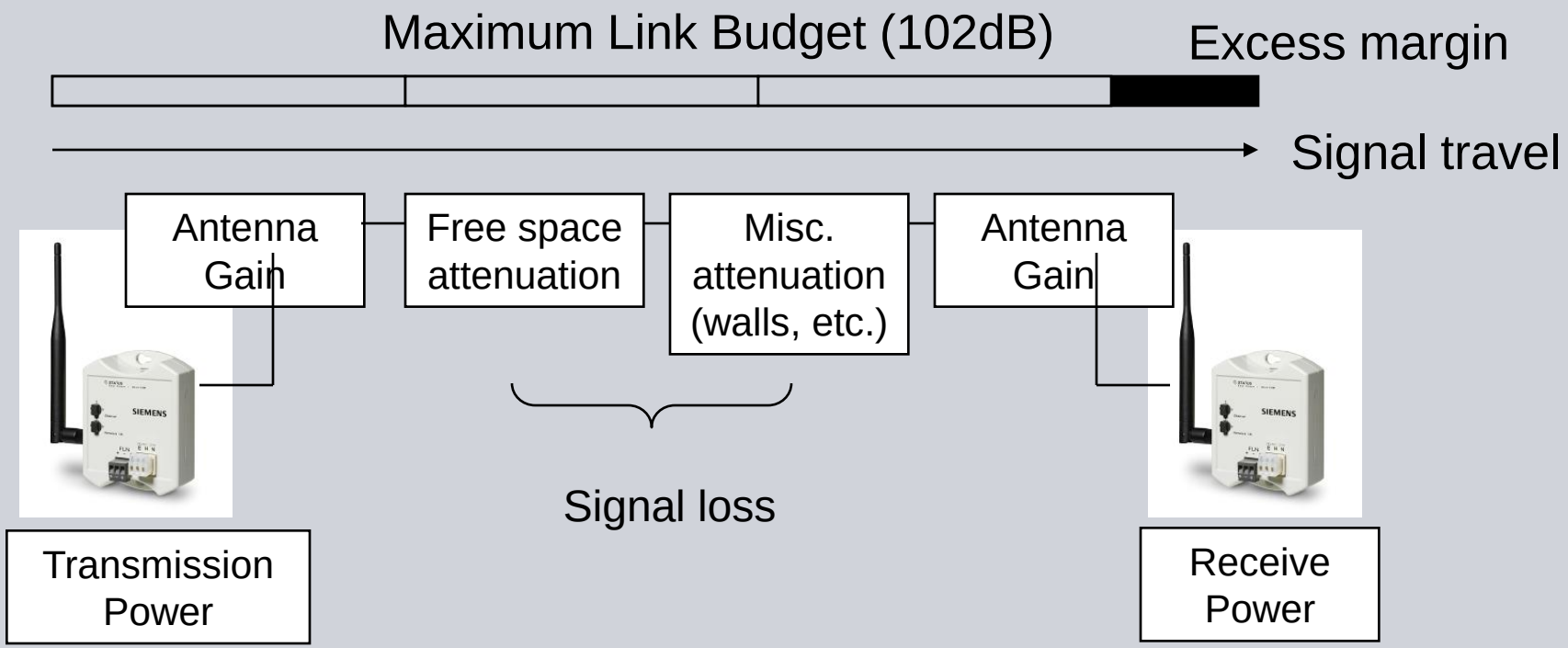
G_{rx} = receiver antenna gain (dBi)

A_{fs} = free space attenuation (dB)

A_m = miscellaneous attenuation (Multipath, walls, etc.)



Wireless basics



You have good communication when you have excess margin

Wireless basics

Figure 12 shows an example link margin calculation for a WFLN signal traveling 40 feet and through a concrete block wall. The signal has a maximum strength of 102 dB, which is reduced as it travels to the receiving device. Even at a final strength of 6 dB, the communication should be successful.

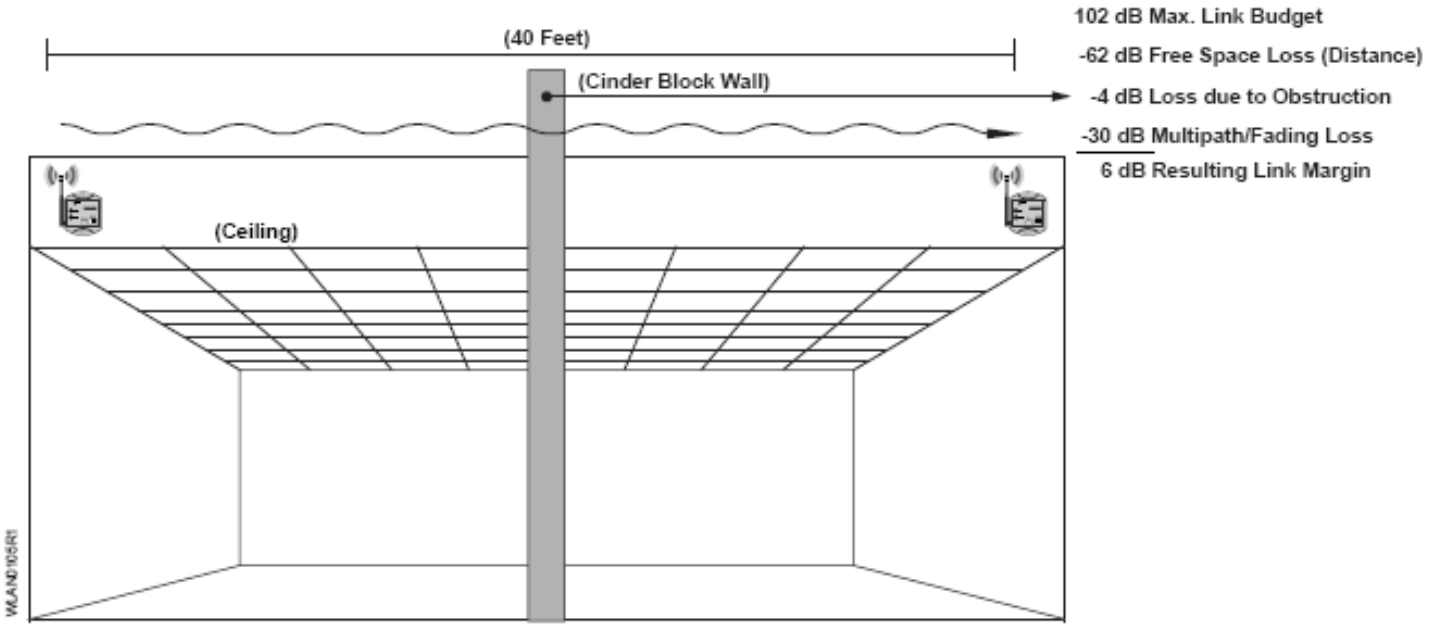


Figure 12. Link Margin Example.

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Why ZigBee?

What is ZigBee?

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Technology & Standard (global wireless language)

- Focus → Relatively Simple Devices
  - Low cost (open standard, multi-vendor availability)
  - Up to 250 kbit/second data rate
  - Low power (years on a AA battery / batteryless)

- Robust, reliable, simple deployment and maintenance (mesh, self-organizing, self-healing)
- Interoperability
- Sense and Control
- True Wireless Networks that Scale (not simply wireless links)

Purpose of ZigBee

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Create a much needed global wireless language

- ZigBee gives a *voice* to the myriad of everyday devices that surround us as we go about our daily lives.
- These devices are overlooked in an IT centric world:
  - Light switches, thermostats, electricity meters
  - More complex sensor devices found abundantly in the commercial building and industrial automation worlds

ZigBee solutions are member driven

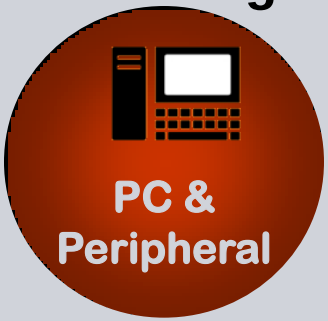
Security
HVAC
AMR
Lighting Control
Access Control

Demand Response
Net Metering
AMI, SCADA

TV
VCR
DVD/CD
Universal
Remotes

Chronic disease
Elder care
Fitness
Wellness

ZigBee RF4CE



Mouse
Keyboard
Joystick
Touchpad

M-commerce
Local gaming
Local chatting
Info Services

ZigBee PRO

Retail Store Mgmt
Asset Mgt
Process Control
Environmental
Energy Mgmt

Security
Safety
HVAC
Lighting Control
Access Control
Irrigation

Certified product logo

ZigBee Smart Energy certified product logo

ZigBee Home Automation certified product logo

ZigBee Building Automation certified product logo

Why ZigBee?

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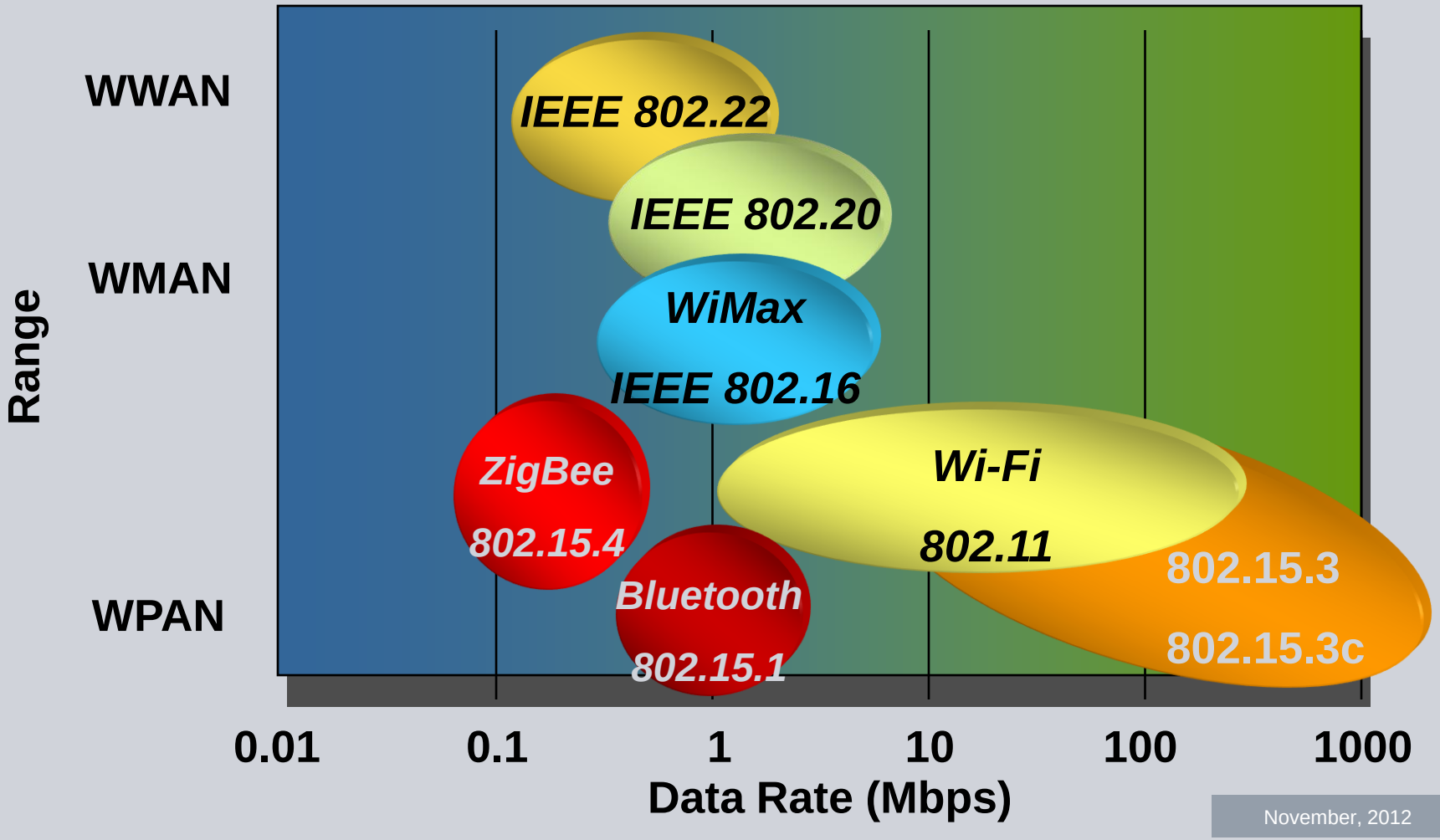
ZigBee Operates Within IEEE 802 Wireless Standards Family



Introduction

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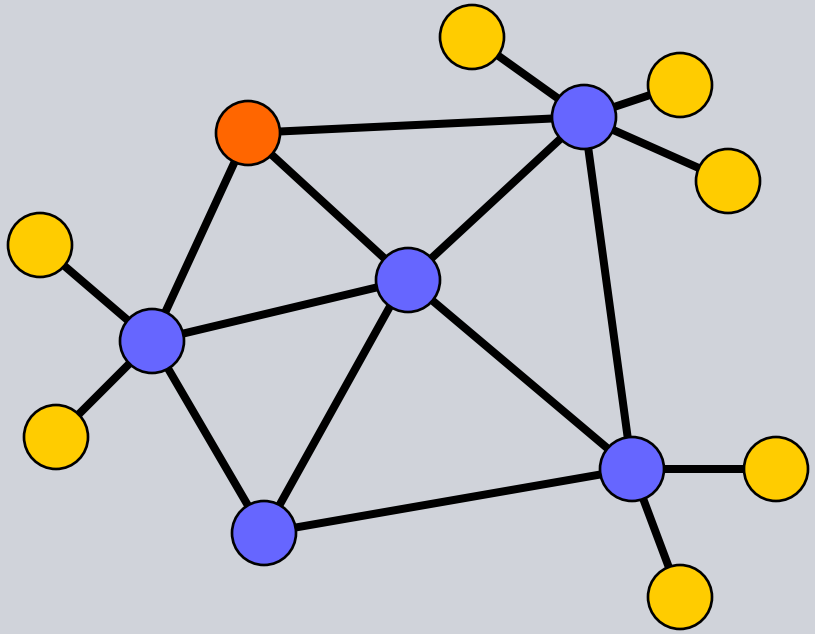
A ZigBee network is a set of wireless nodes that cooperate by forming a mesh network over which messages hop, from node to node, to reach a destination.

ZigBee Mesh Network



Easy to install, self-forming, self-healing, redundant

Why ZigBee?

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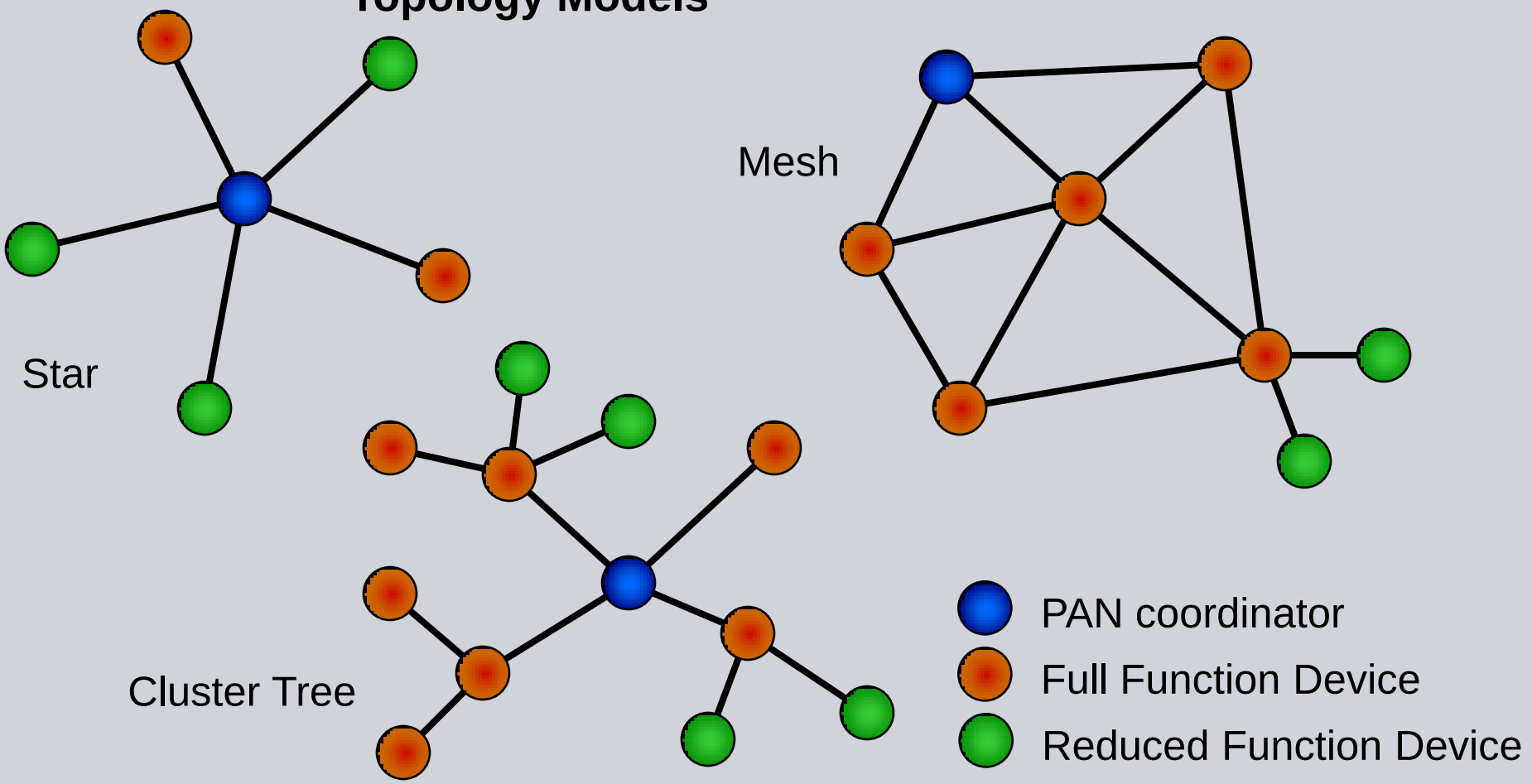
Topology Models



Why ZigBee?

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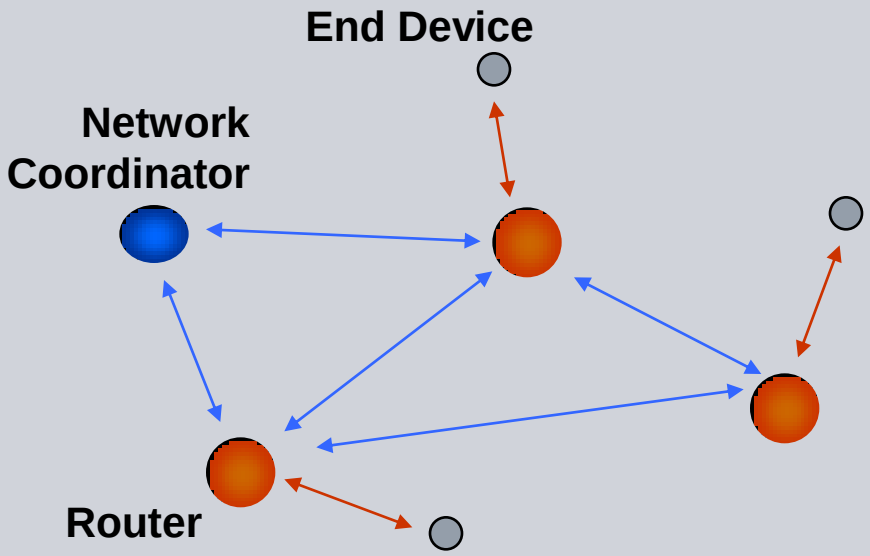
1. Powered Routers
   - Always on
   - Communicate with multiple nodes
   - Route message traffic for self and neighbors
2. Sleepy End Devices (Sensors)
   - Sleep most of the time
   - Only route their own traffic
   - Only communicate with one line-powered node at a time

Nodes on a Mesh Network



Why ZigBee?

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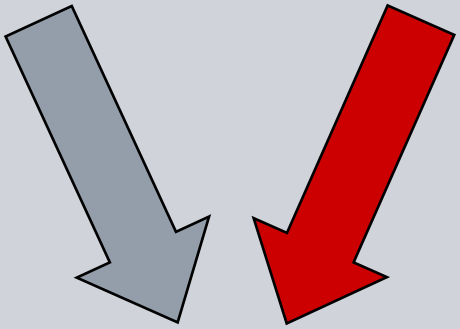
Two separate tracks to the standardization

1. ZigBee in the ASHRAE BACnet committees (SSPC-135)
2. BACnet in the ZigBee Alliance (Commercial Building Automation group)



ZigBee Building Automation **= True Wireless BAS Standard**

Benefits of ZigBee and BACnet as a team

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BACnet – focus on building automation needs

ZigBee – focus on wireless needs

- Additions will include
  - Green Power
  - Over-the-air upgrades (OTA)
  - ZigBee IP

But what about…

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ZigBee Reliability

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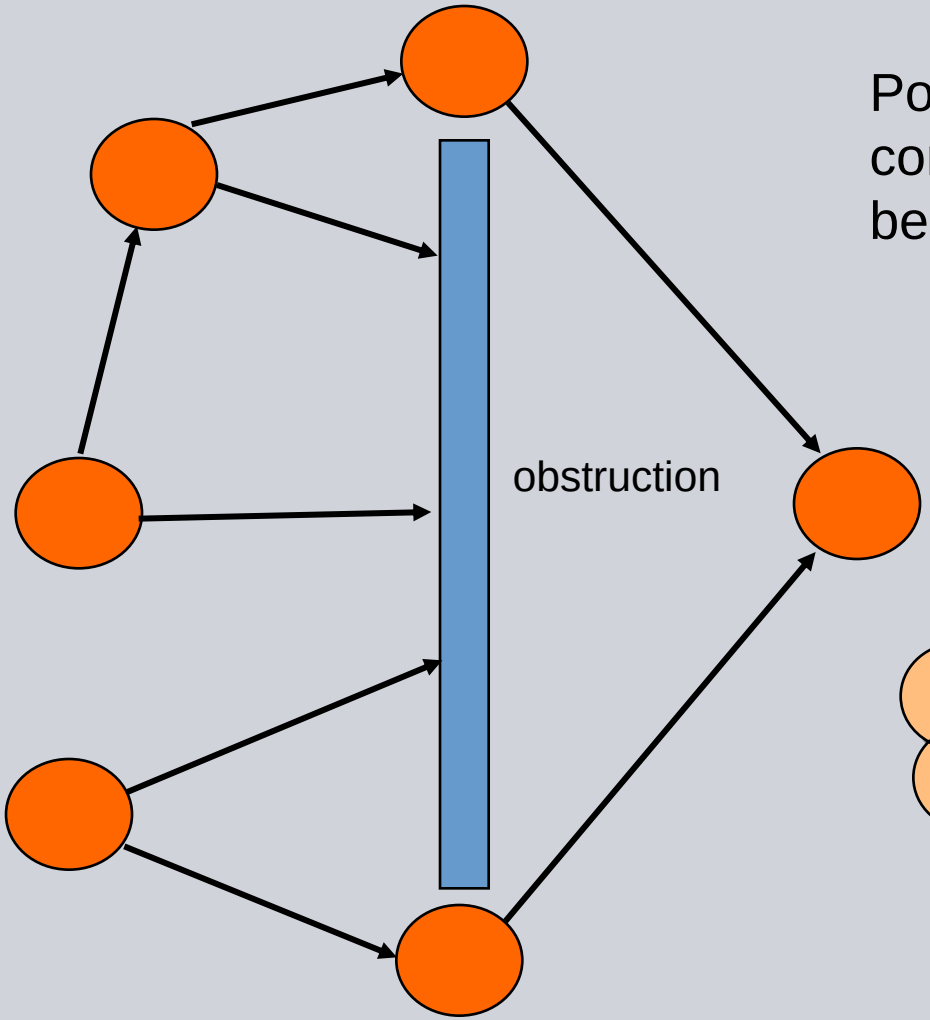

Point-to-point communications can be blocked

Mesh networks self-form and self-heal to route around obstructions

Mesh Networks – Self Configuring

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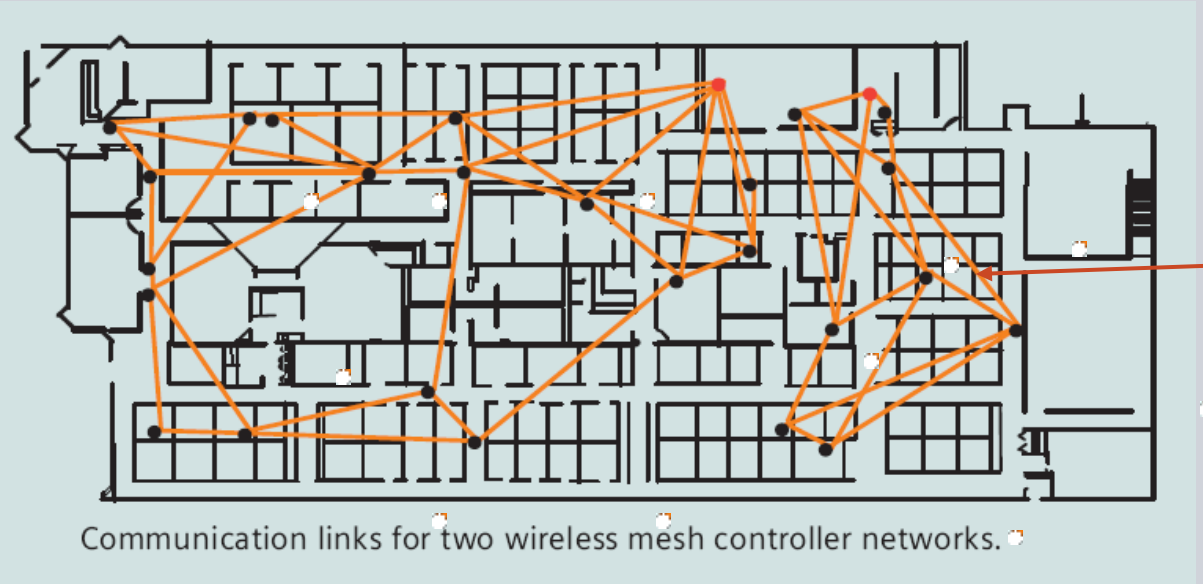
Networks automatically establish robust network
No RF engineering



Communication links for two wireless mesh controller networks.

Each routing node is an intelligent **Sender**, **Receiver** and **Router**.

ZigBee Performance and Power Consumption

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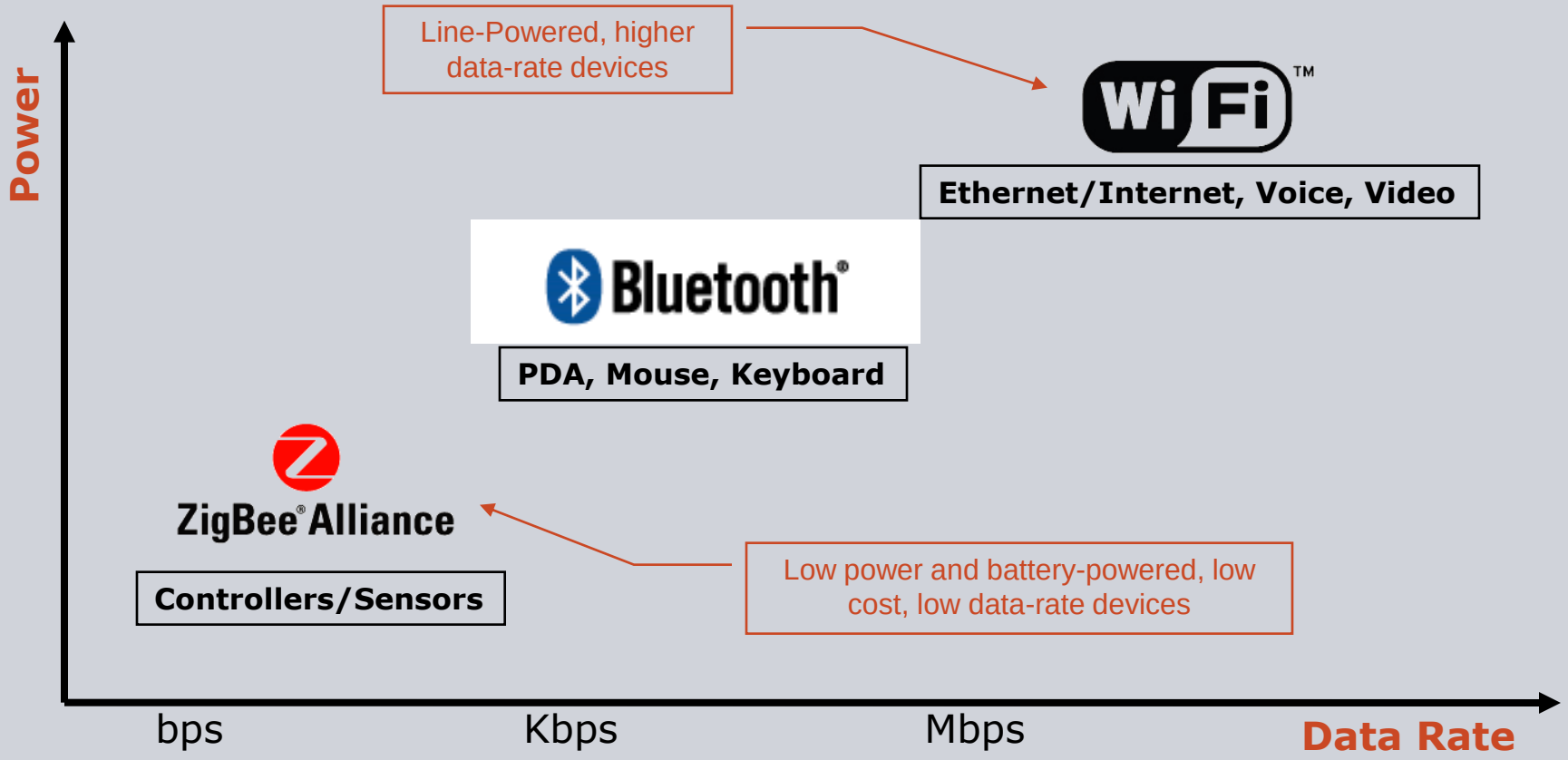
Wireless Communication Standards



Battery Life

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Typical power consumption

- Wi-Fi – Hours
- Cellular Devices - Days
- Bluetooth – Hours to Months
  - Application dependent
- ZigBee – Years
  - Power harvesting solutions under development

ZigBee Security

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ZigBee wireless networks are extremely secure

- ZigBee PRO uses standard security
- AES128-bit encryption, NIST approved
- Key types – link and network
- Network and application layer security
- One source of key distribution - the trust center
- Trust center allows distribution of network key in a secure fashion

Key types – network and link

- Link keys are used to create secure communications with another device
- Trust center authenticates devices joining the network
- Network – used network wide (hop by hop)
- Trust center link key – secure end to end

ZigBee Cost

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- Low radio cost
- Single radio with the right attributes for
  - Sensor/end device communication
  - Equipment controller communication
  - The right attributes include
    - Battery life
    - Reliability (mesh, coexistence)
    - Security
    - Performance
    - Interoperability

Interference

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Question – Could the WFLN and WRTS network interfere with or be interfered by Wireless Ethernet networks (i.e. WiFi / 802.11)?

Answer -
Interference between the two networks is possible

- when the network's devices are in close proximity (< 3feet)
- and a channel utilization plan is not used

However…

- Non-interfering channels exist
  - Primary - Channels 15 & 16
  - Secondary - Channels 5 & 10
- If both networks do use the same channels experience has shown no issues as long as the network's devices are physically separated < 3 feet.

Interference (cont.)

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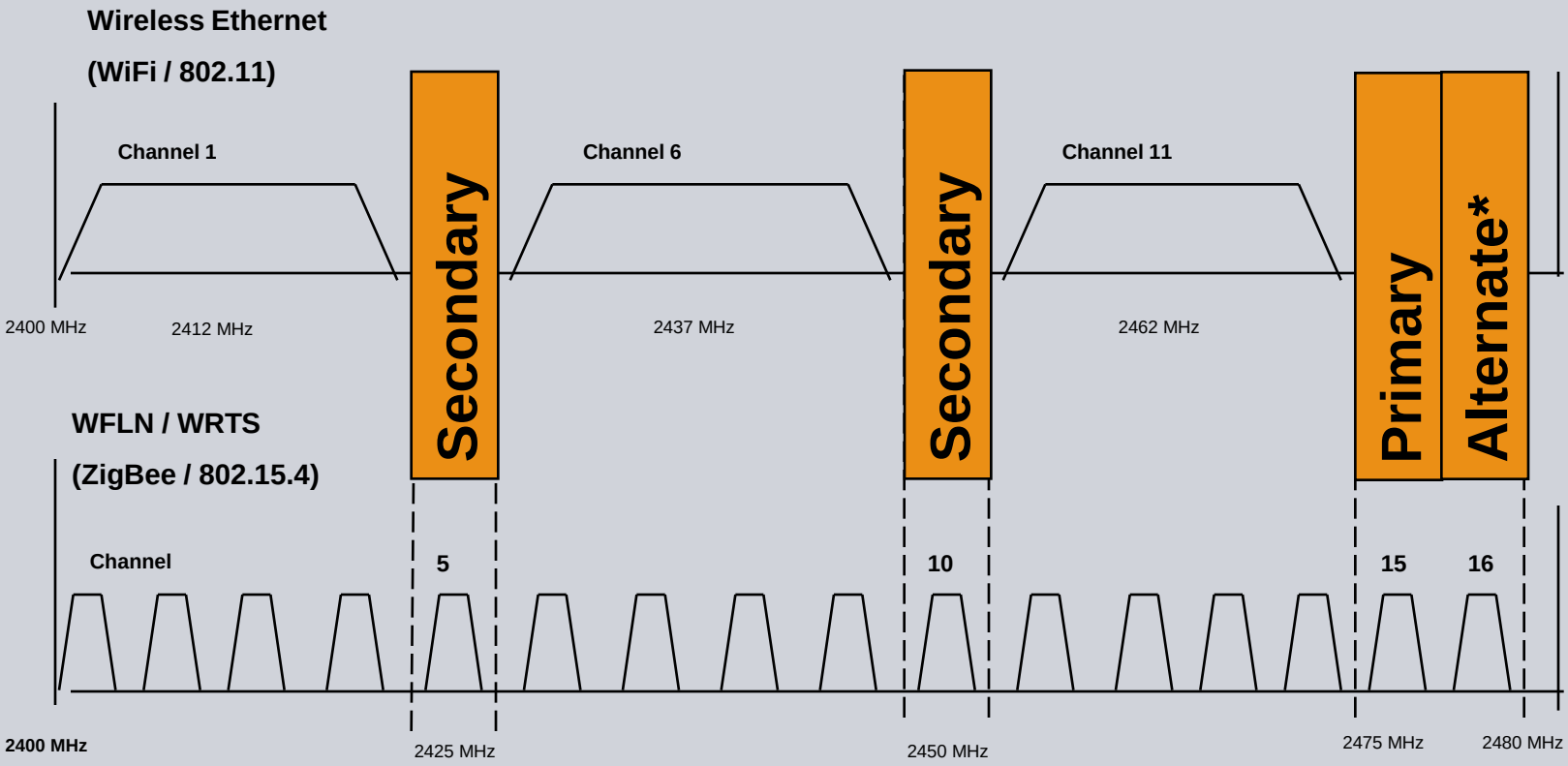

*Channel 16 operates at a reduced RF power level

Q&A

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Thank You

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