

ZigBee 3.0 – The Open, Global Standard for the Internet of Things

December 2, 2014

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Agenda & Speakers

- **Introducing ZigBee 3.0**
  - Tobin Richardson, President & CEO, ZigBee Alliance
- **ZigBee 3.0 Base Device Behavior**
  - Phil Jamieson, Specialist Engineer, Standardisation Research, Philips Research Europe
- **ZigBee 3.0 Devices and Application Clusters**
  - Arasch Honarbacht, Managing Director, Ubisys
- **ZigBee and the Internet of Things**
  - Ryan Maley, Director of Strategic Marketing, ZigBee Alliance
- **Question & Answer Session**

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Introducing ZigBee 3.0

Tobin Richardson
President & CEO
ZigBee Alliance

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ZigBee 3.0 is the unification of ZigBee standards.



Now it is even easier for developers to create products and services that interoperate seamlessly with the widest variety of everyday devices.

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Connecting More Devices Enables Innovative Applications

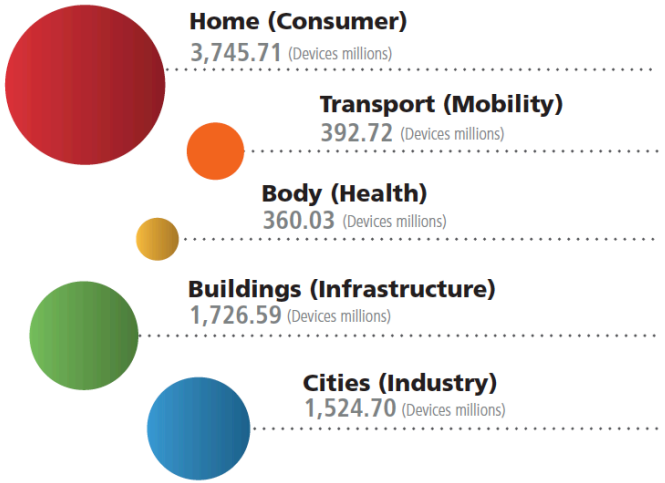
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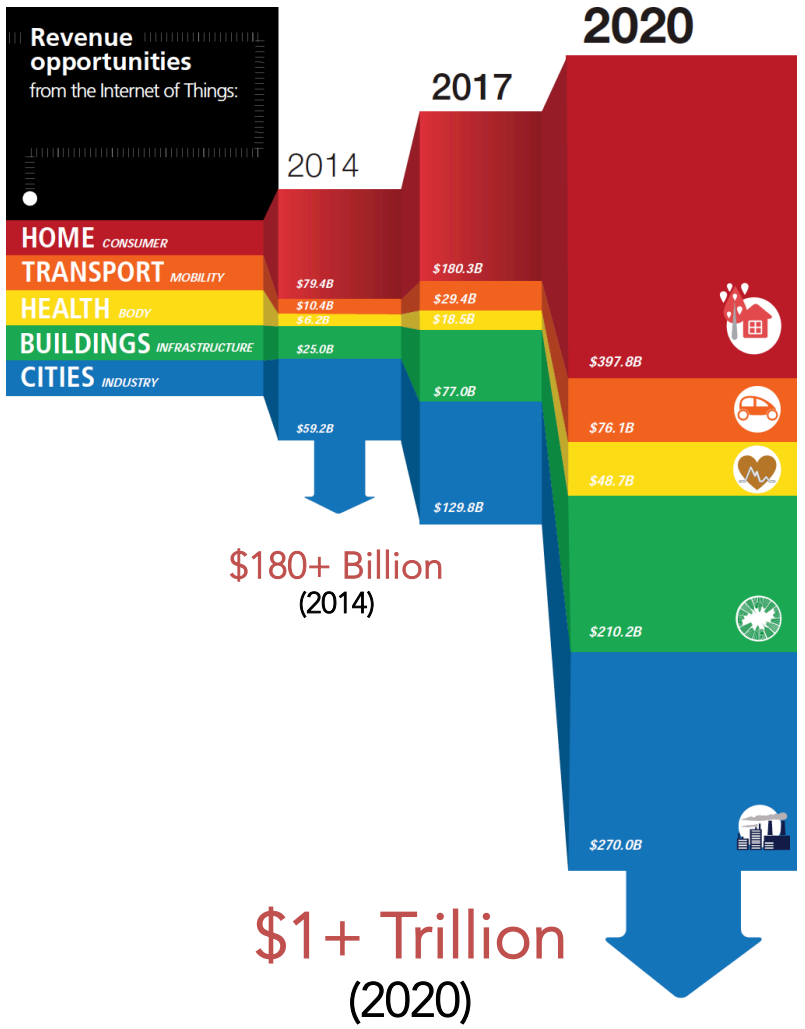
Harbor Research IoT Market

In 2014 nearly **2 billion** connected devices will be shipped

This number will grow to nearly **8 billion** devices for the year 2020

*Not including mobile phones



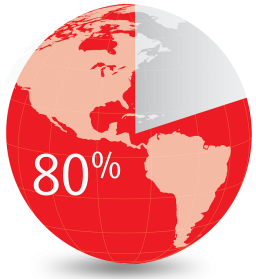


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Open Standards Grow the Market

- Single products can be deployed globally
- Consumers have choice
- Foster product competition
  - Competing for quality
  - Competing for innovation
  - Competing for price
- Foster supplier competition
  - No vendor lock in to particular silicon manufacturers
  - Multiple sources for building interoperable ecosystems



ZigBee continues to be the primary driver toward standardization and interoperability and will see further strong growth across many markets, accounting for almost 80% of total IEEE 802.15.4 enabled device shipments in 2018 (ABI Research)

ZigBee will lead the fixed wireless sensor network market to 1 billion units in 2018 (ON World)

$4.3 Billion

2016 market for wireless and wired home energy management equipment (ON World)

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ZigBee 3.0 Standard Documents

ZigBee PRO Specification

Device networking

ZigBee 3.0 Base Device Behavior Specification

How devices join and form a network

ZigBee 3.0 Application Architecture

Implementation guidance

ZigBee 3.0 Cluster Library

Defines application level functionality

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ZigBee 3.0 Base Device Behavior

Phil Jamieson
Specialist Engineer, Standardisation Research
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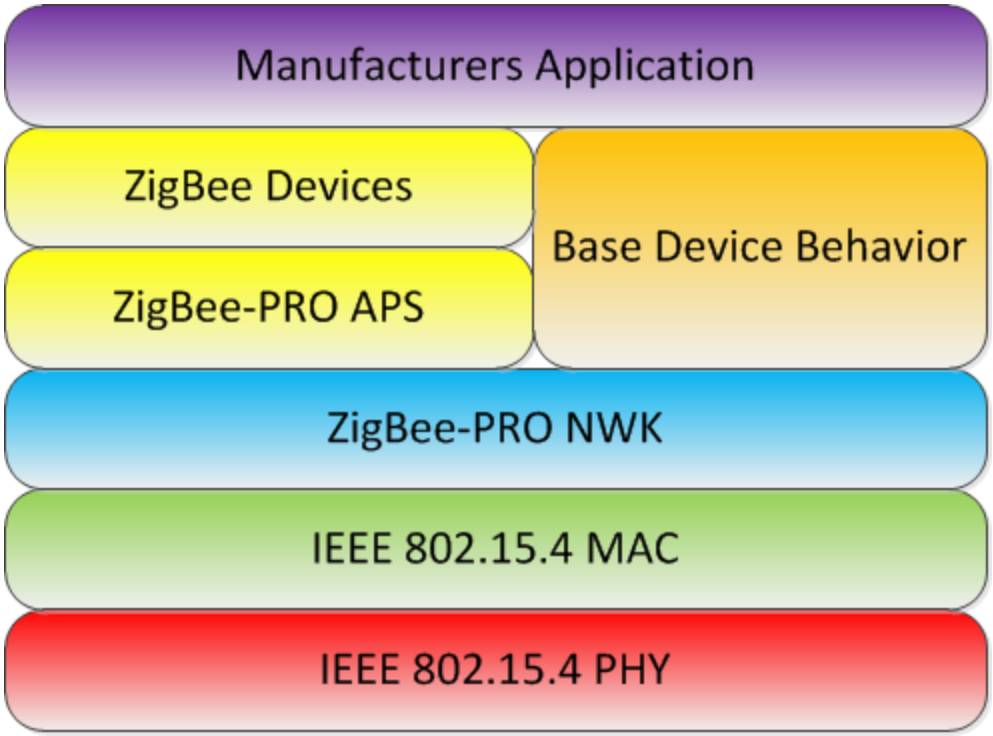
Base Device Behavior: Contents

- Introduction
- Network security models
- Commissioning
  - Network steering
  - Network formation
  - EZ-Mode finding & binding
  - Touchlink
- Node reset
- Security
- Summary

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Introduction

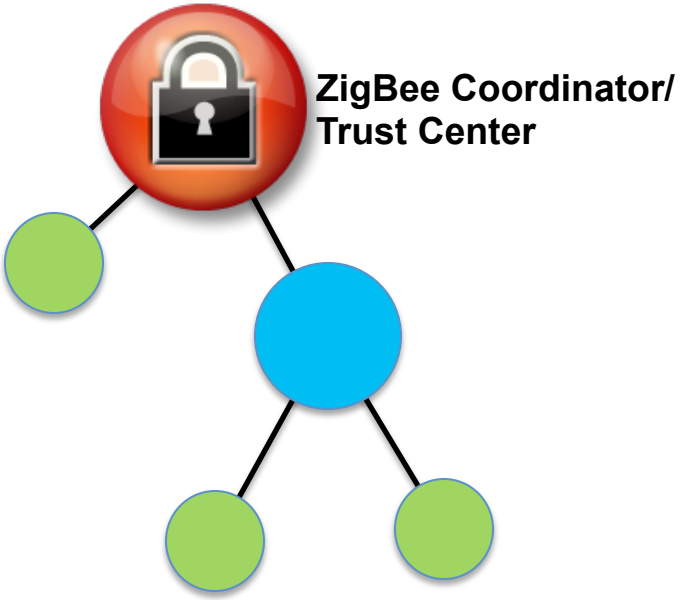


- The base device provides consistent behavior for nodes connecting to a ZigBee network
- Supports a uniform application space as the concept of profiles has been removed
- Defines a common set of mechanisms for commissioning
- Provides enhanced security for the network

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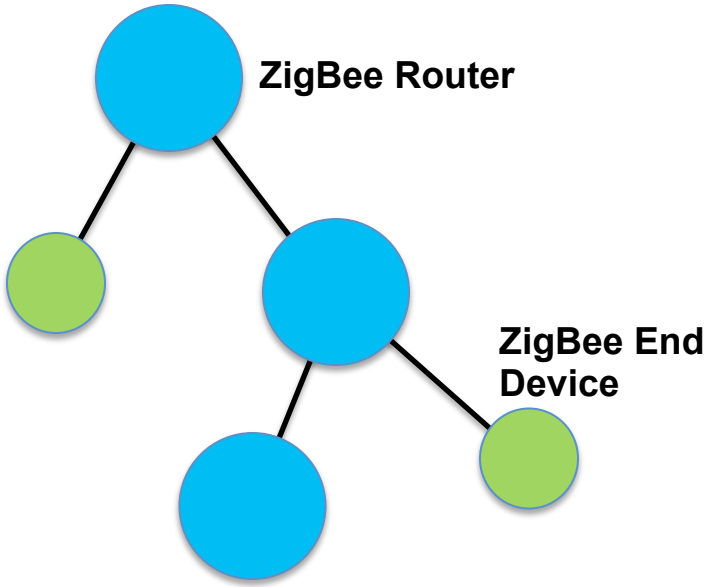
Network Security Models

Centralized security network



- Only ZigBee coordinators/Trust Centers can start centralized networks
- Nodes join, receive the network key and establish a unique TCLK

Distributed security network



- No central node/Trust Center
- Routers are able to start distributed networks
- Nodes join and receive the network key

Nodes adapt to the model of the network to which they join

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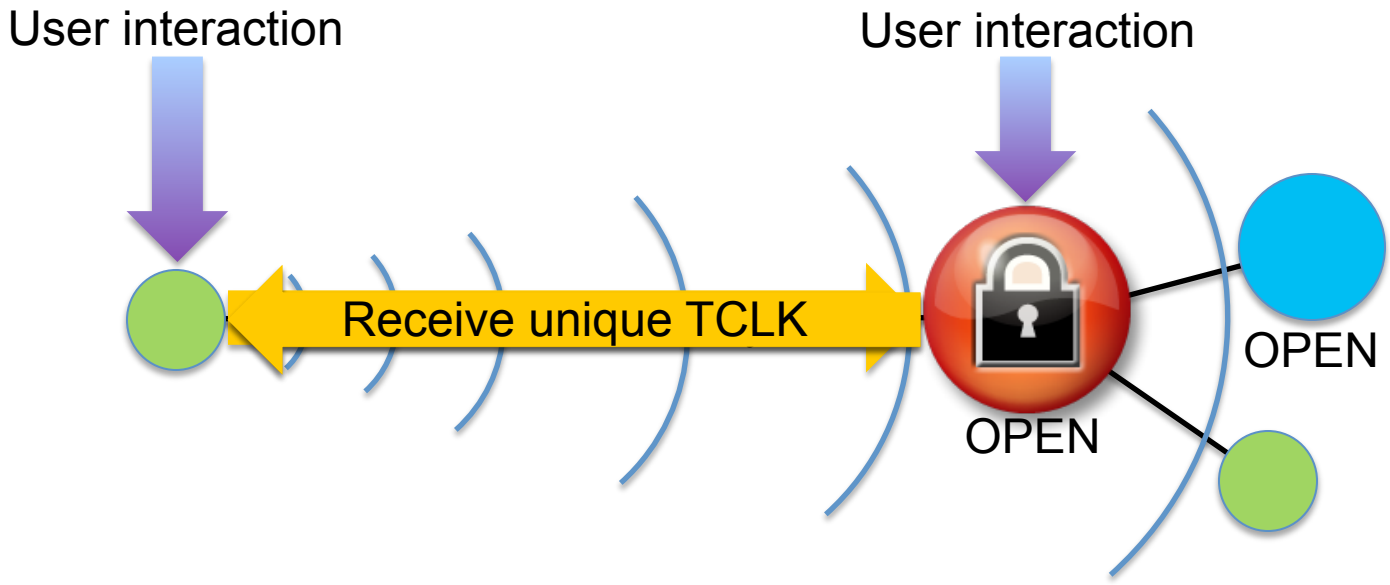
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Commissioning

- Commissioning is invoked through some interactive mechanism, e.g. a button press
- Node have the following capabilities
  - Network steering, to find and get on a network
  - Network formation, to create a network (if not end device)
  - EZ-Mode finding & binding, to establish application links
  - Touchlink, if supported, for proximity commissioning
- Nodes commission by calling individual procedures
  - Procedures can be invoked one at a time or concatenated, e.g. steer first and form if there are no networks
  - Procedures are dependent on the current state of the node, e.g. whether it is currently on a network
  - Procedures can be tied to a single or multiple user action, depending on the requirements of the application

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Network Steering



- Node not on a network
  - Perform a channel scan
  - Select an open network & associate
  - Receive the network key
  - If joining a centralized security network, exchange TCLK
- Node on a network
  - Open the network for 180s
  - Close the network

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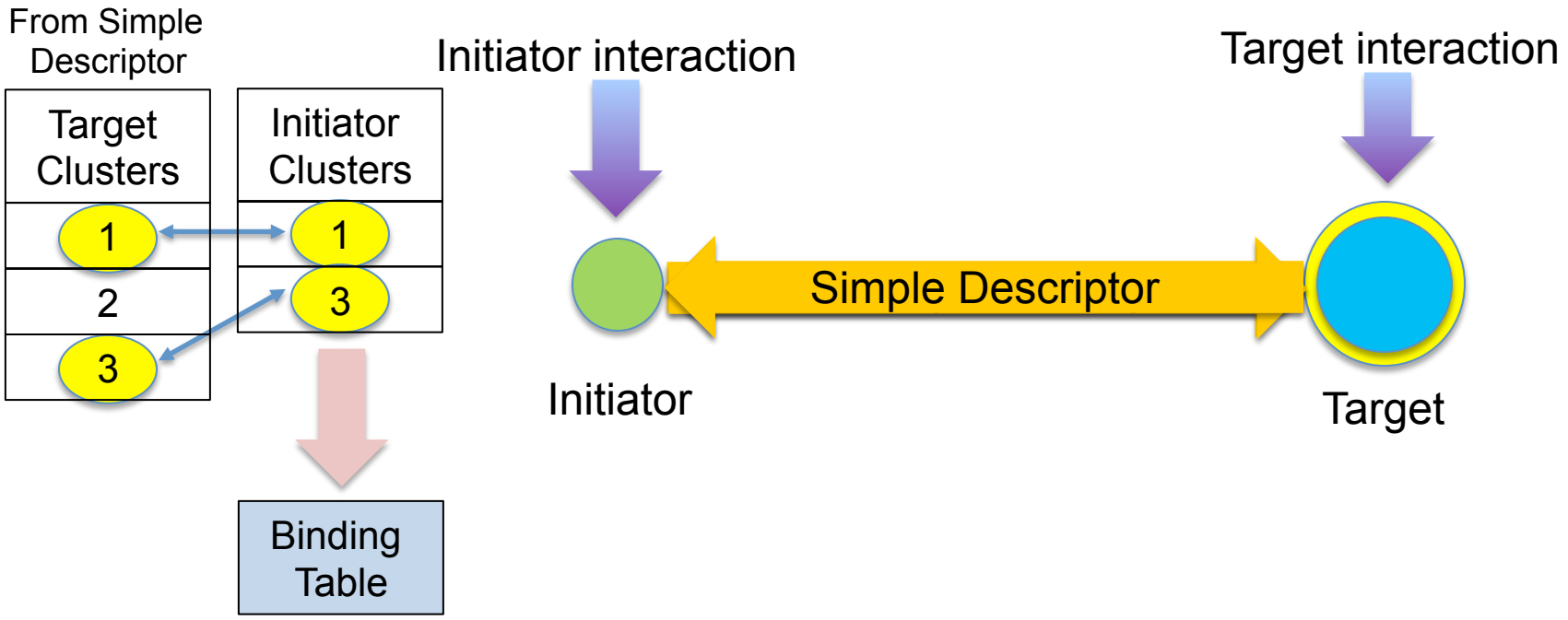
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Formation

- Node performs a channel scan
- Node selects a suitable channel and other network parameters
- If node is a coordinator
  - Form a centralized security network
  - Initiate Trust Center functionality
- If node is a router
  - Form a distributed security network

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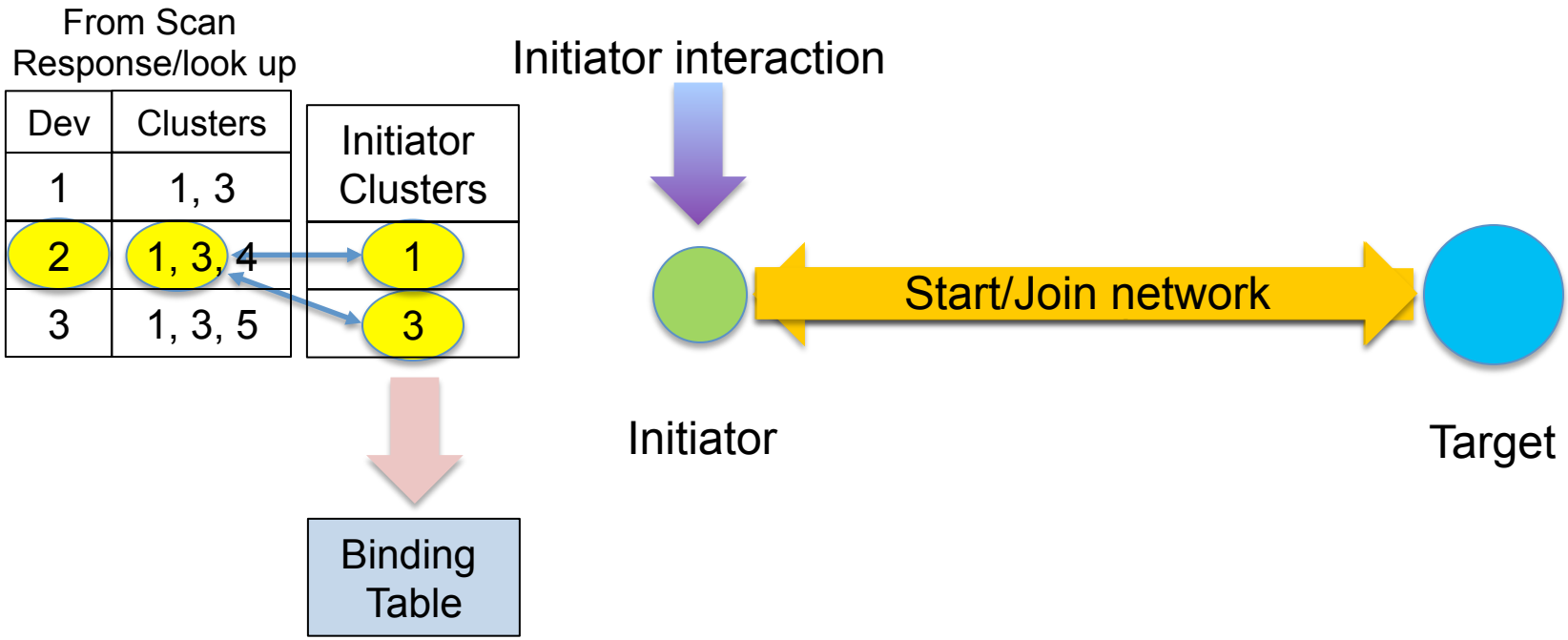
EZ-Mode Finding & Binding



- **Initiator endpoint**
  - Broadcast identify query request & receive responses
  - Request simple descriptor for an endpoint on the target
  - Match initiator and target clusters
  - Create entries in the binding table
- **Target endpoint**
  - Identify for 180s
  - Respond to requests from the initiator

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Touchlink



- **Initiator endpoint**
  - Broadcast scan request & receive responses
  - If initiator is on a network, request the target joins. Otherwise, request the target to start a network
  - Establish application links in the binding table using the information from the scan response
- **Target endpoint**
  - Verify scan request has sufficient RSSI and respond
  - On request, join the network of the initiator or start a new network

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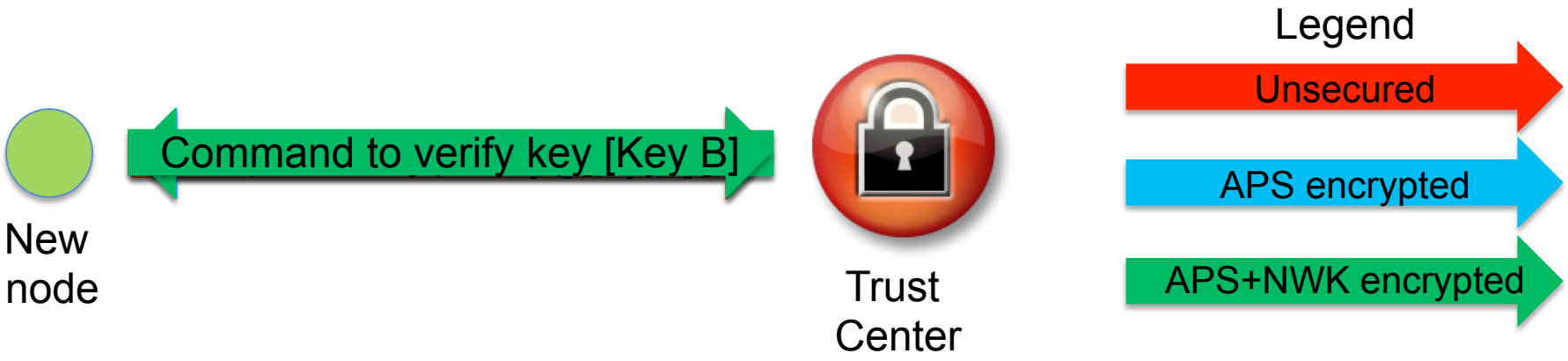
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Node Reset

- Reset invoked via application stimulus (user action) in the same way as commissioning
- Reset can be achieved
  - Via identify cluster
  - Via touchlink
  - Via local interaction
- Each action resets the node to its factory settings so that it may be re-commissioned

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Security in Centralized Networks



- The node contains an initial Trust Center link key (Key A)
- Node joins the network using MAC association
- Node receives the network key, secured with Key A
- Node requests a new link key, secured with Key A
- Trust Center sends new link key (Key B) to the node, secured with Key A
- On receipt of the new link key, the node issues a command to the Trust Center, secured with Key B

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Summary

- Networks can have a centralized or distributed security model
- Nodes are able to join a network of any type and adapt
- There are common mechanisms for getting on the network and establishing application links
- Nodes on a centralized security network replace their initial link keys with a Trust Center generated new link key

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ZigBee 3.0 Devices and Application Clusters

Arasch Honarbacht
Managing Director
Ubisys

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Device Types

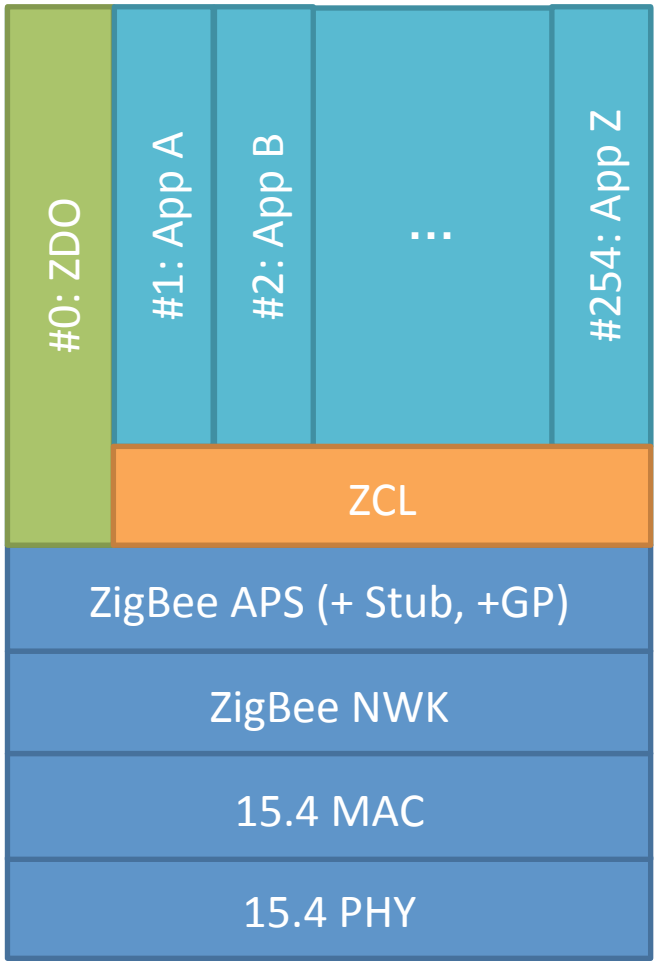
- ZigBee Green Power Device
  - Energy harvesting or life-long batteries
- ZigBee End-Device
  - Sleepy (battery-powered)
- ZigBee Router
  - Mains powered
- ZigBee Trust Center
  - A router dedicated to managing security credentials and performing other network management tasks in a centralized manner



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What is a ZigBee Device?

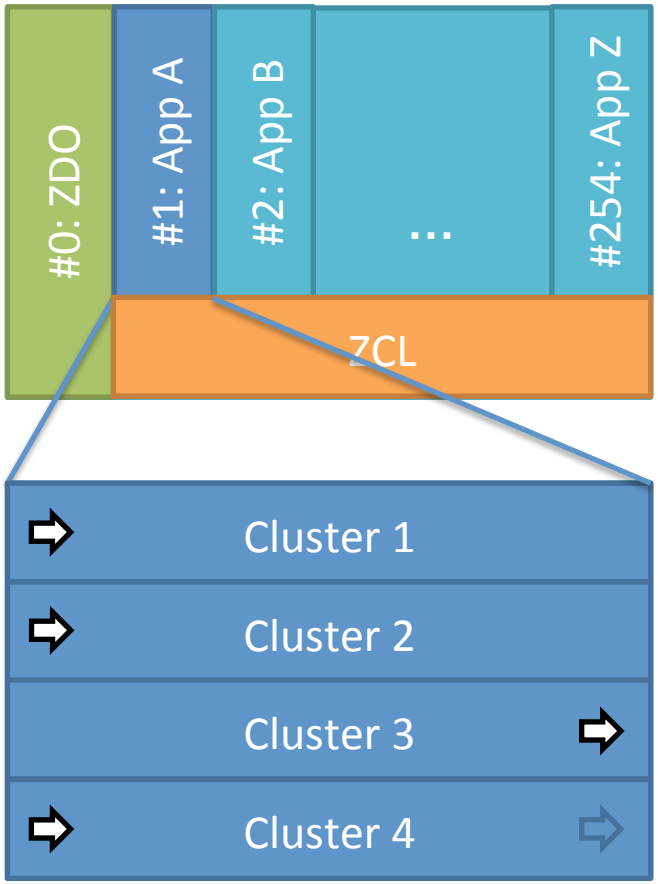
- Based on IEEE 802.15.4 MAC and PHY
- ZigBee Network and Application Support Layers
- ZigBee Device Object
- ZigBee Cluster Library
- A few device-specific Application Endpoints



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Endpoints explained

- Functional Unit (“Device”)
- Can be source and destination of ZCL frames
- Individually addressable
- Can be member of a multi-cast group
- Can be bound to mating target devices
- Hosts Clusters

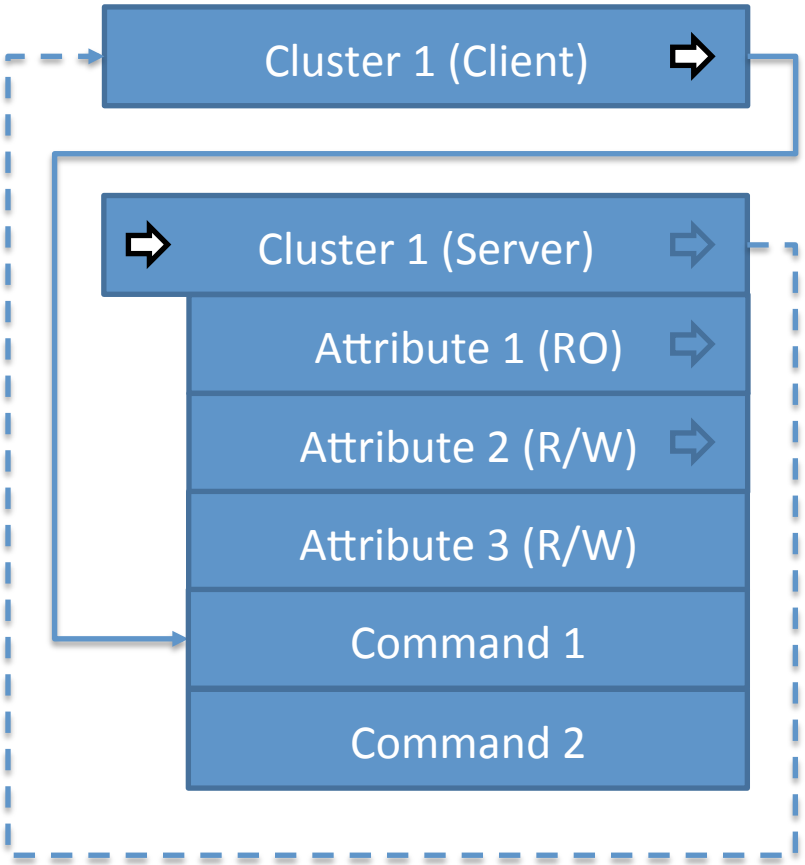


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Clusters explained

- Clusters are interfaces for features or domains (“contracts”)
- They are directional (inbound = “server”, outbound = “client”)
- Smallest interoperable units in ZigBee
- Framework for commands & attributes



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What's the ZigBee Cluster Library?

- A framework for making clusters with attributes, commands, reporting, discovery, versioning, etc.
- A collection of standard clusters, a toolbox with building blocks for complex applications
- Client/server cluster instances are interoperable right "out-of-the-box"
- Samples: On/off, level control, color control, groups, scenes, window covering, occupancy sensing, thermostat, etc.

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Sample Device: Connected Bulb

- Endpoint #0: ZDO
- Endpoint #1: Connected Bulb
  - Basic Cluster (Server)
  - Identify Cluster (Server)
  - Groups Cluster (Server)
  - Scenes Cluster (Server)
  - On/off Cluster (Server)
  - Level Control Cluster (Server)
  - Color Control Cluster (Server)
  - Over-the-Air Firmware Upgrade Cluster (Client)

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Sample Device: Smart Bulb

- Endpoint #0: ZDO
- Endpoint #1: Smart Bulb
  - Basic Cluster (Server)
  - Identify Cluster (Server)
  - Groups Cluster (Server)
  - Scenes Cluster (Server)
  - On/off Cluster (Server)
  - Level Control Cluster (Server)
  - Color Control Cluster (Server)
  - Over-the-Air Firmware Upgrade Cluster (Client)
  - Occupancy Sensing Cluster (Server) new!
  - Illuminance Measurement Cluster (Server) new!

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ZigBee Device Object

- Provides Management Functions
  - Address resolution (hardware ↔ network)
  - Browse neighbor table (explore mesh network)
  - Add/remove/browse bindings
  - Explore endpoints (which clusters are available?)
  - Find matching endpoints
    (e.g. “Which are color controllable devices?”)
  - Remove devices from the network

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Commands

- Well-defined “over-the-air” frame format
- Agreed-upon behavior
- Might be as simple as a command identifier, e.g. “on”, “off”, “toggle”
- Might also convey a payload (arguments), e.g. “move to level 32 within 4 seconds”
- Can be unicast, multicast, broadcast
- Similar to a “method” in C++

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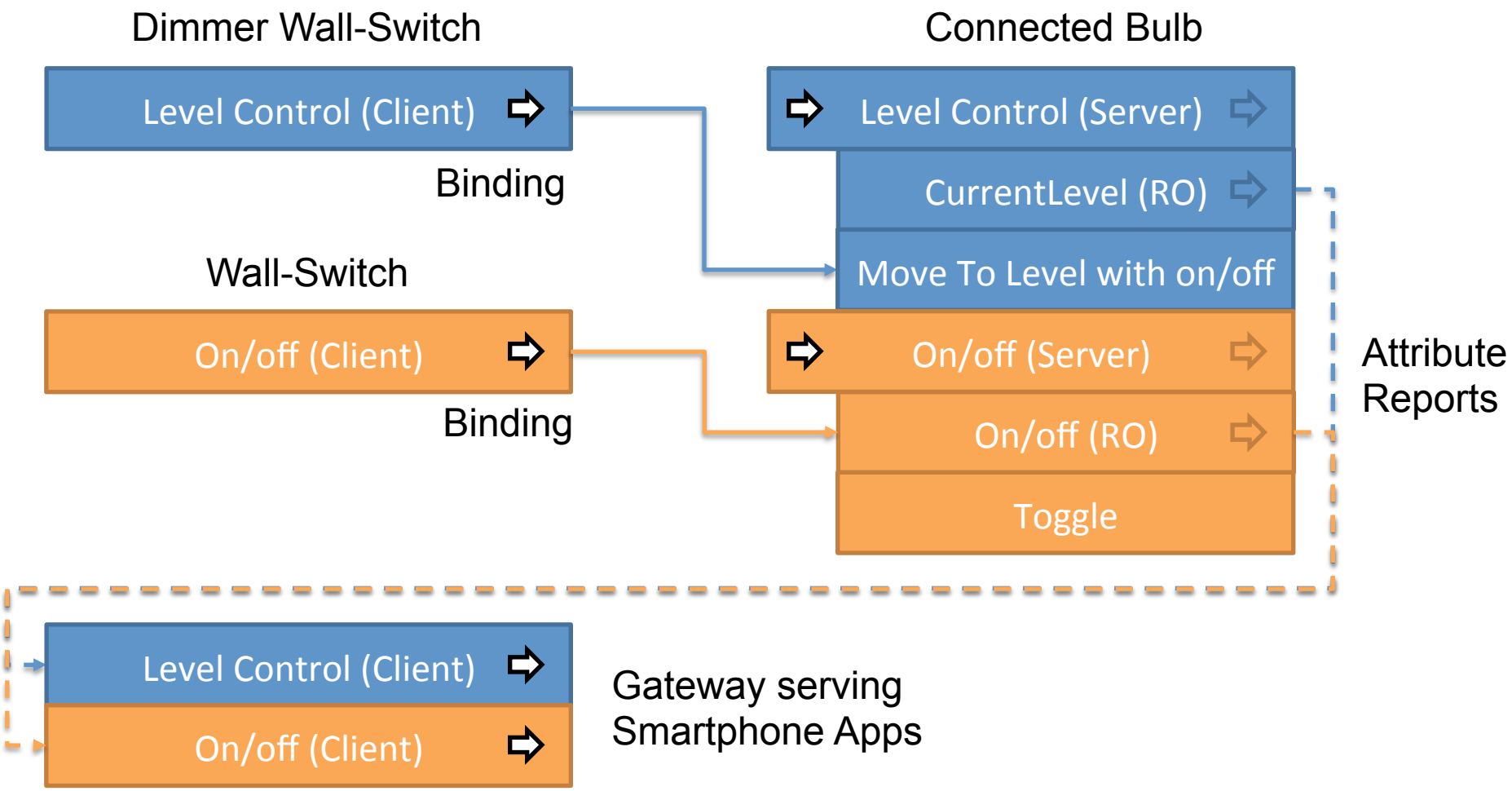
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Attributes

- Binary encoded; data types include
  - Integer (signed & unsigned, 8…64 bit)
  - Floating point (semi, full, double precision)
  - String (variable length)
  - Raw data (variable length, BLOB)
  - Array, set, bag
  - Structure
- Read/write, read-only, one-time-programmable, persistent, access rights, …
- Reportable (significant change, intervals)

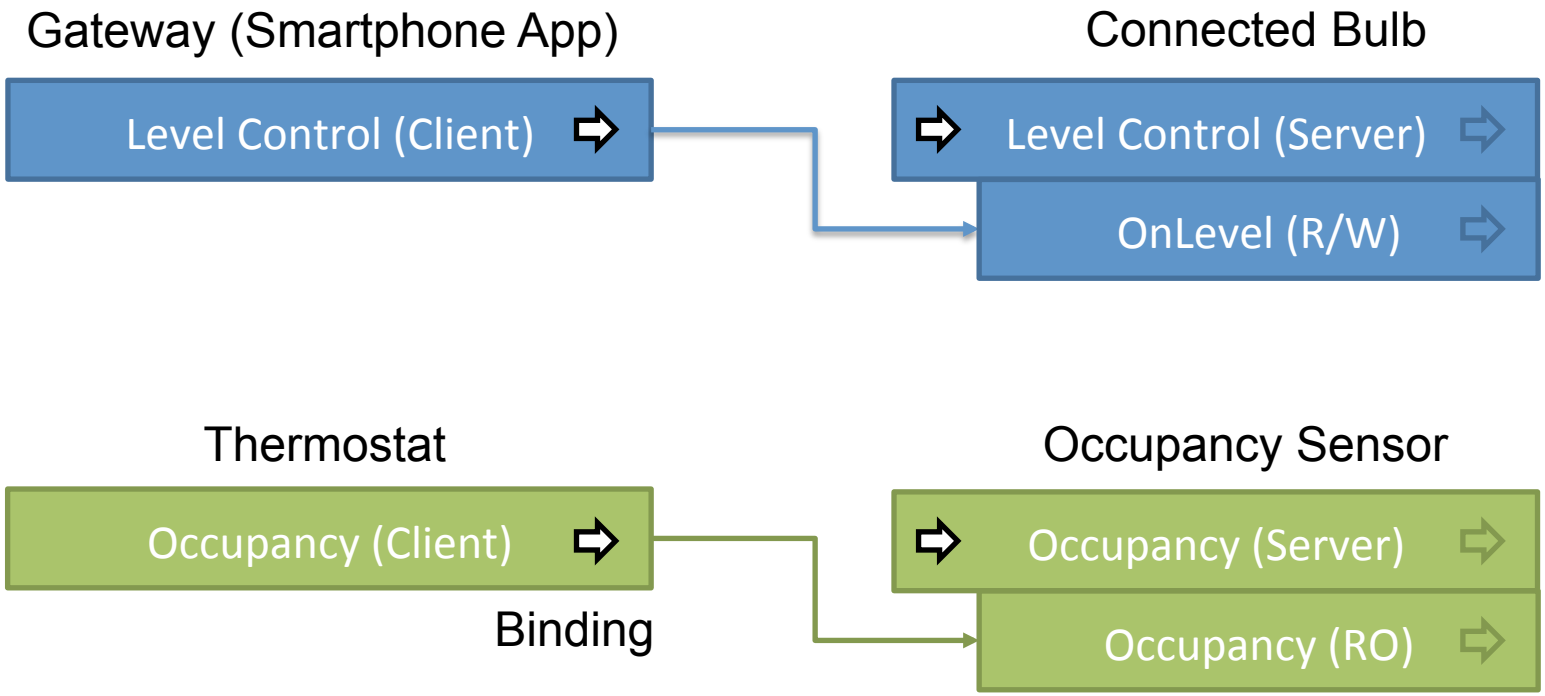
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Examples of executing commands



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Examples of reading/writing attributes



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ZigBee and the Internet of Things

Ryan Maley
Director of Strategic Marketing
ZigBee Alliance

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What is the Internet of Things?



Everyday objects communicating with each other and with people.

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The More Objects Connected, The More Interesting the Applications

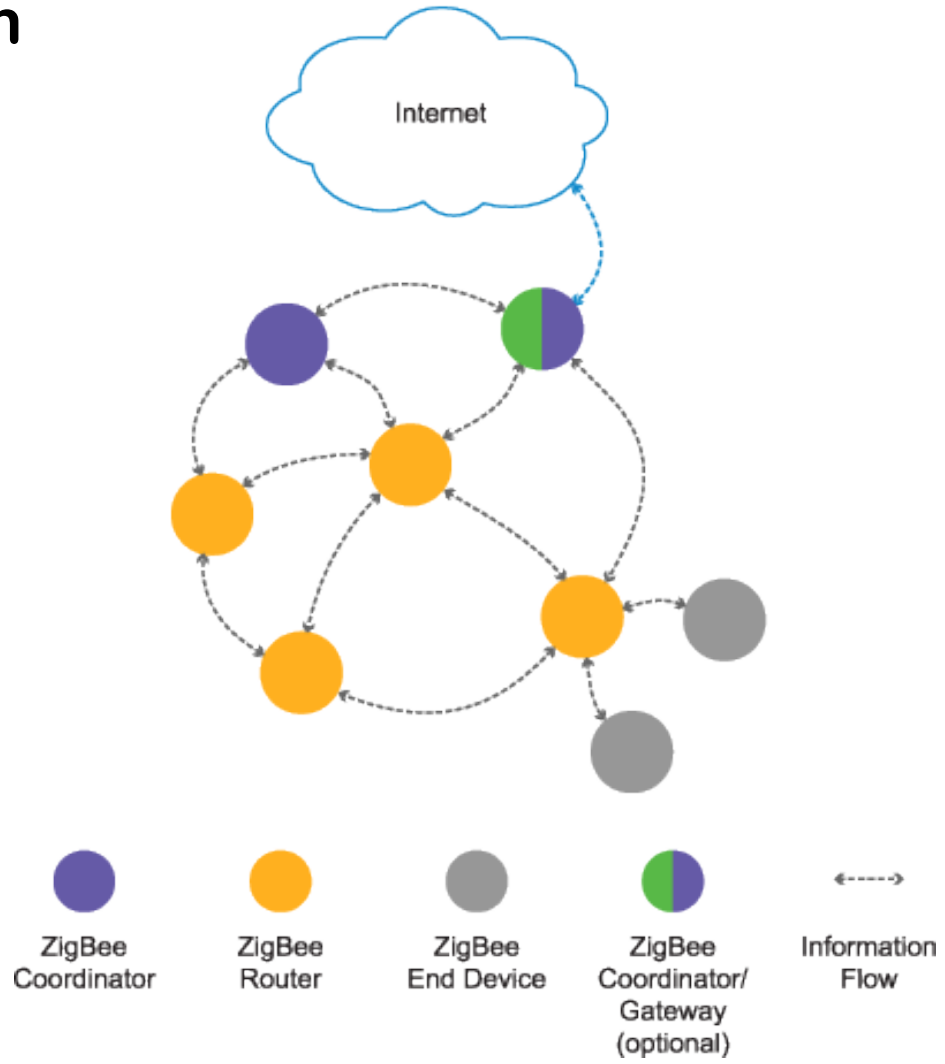


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Key IoT Network Attributes

- Easy to install and maintain (mesh, self organizing, self healing)
- Reliable (mesh, multiple channels, demonstrated interference tolerance)
- Scalable to thousands of nodes
- No new wires
- Low Cost (many suppliers, open standard)
- Long battery life (years on an AA battery)
- Secure (AES 128)



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The ZigBee Difference

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Standardized at all Layers



OSI Model

- Application Layer
- Presentation Layer
- Session Layer
- Transport Layer
- Network Layer
- Data Link Layer: MAC
- Physical Layer

What is a light bulb?
What is on?
What is off?
What is dim?

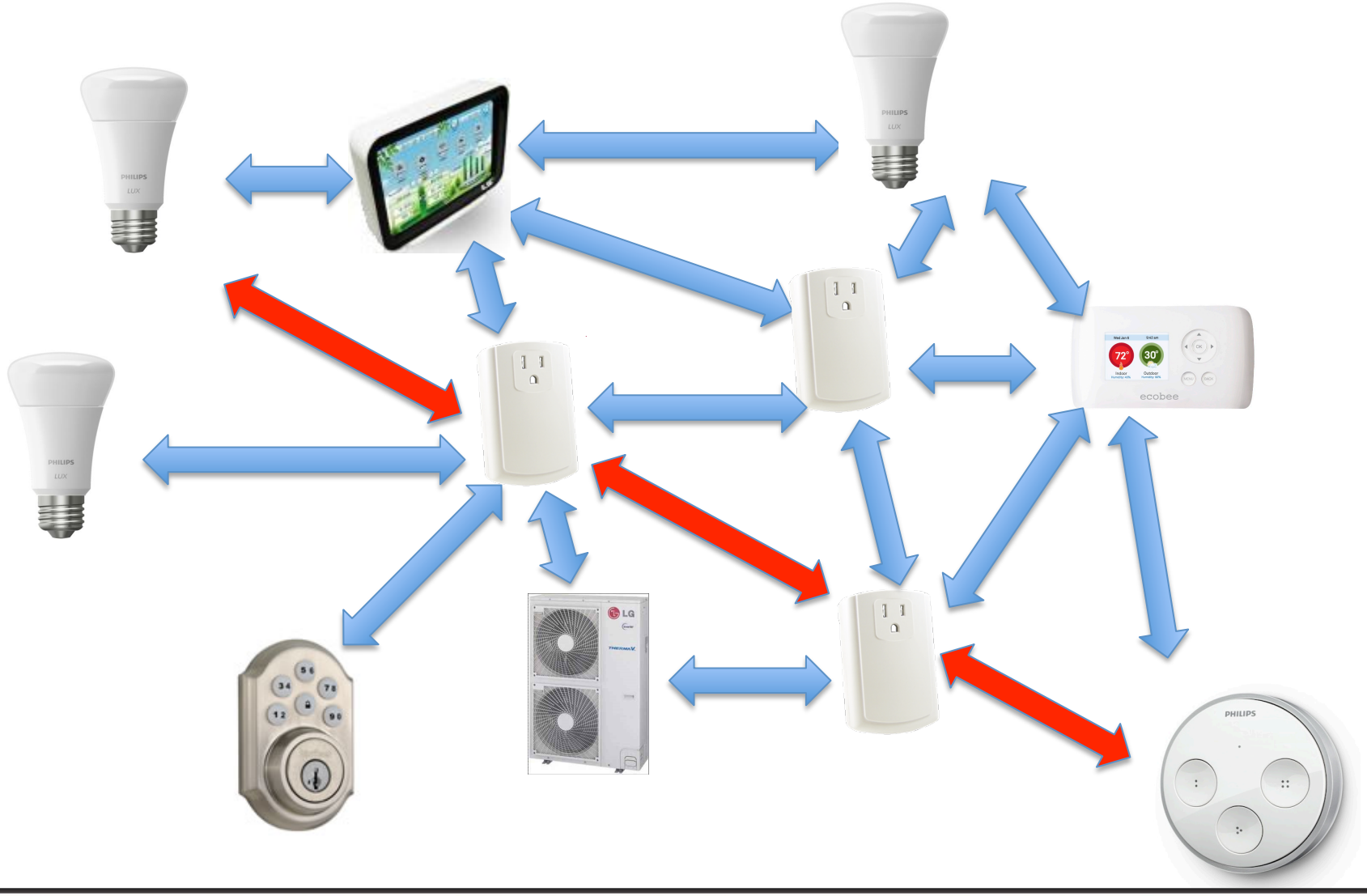
How does the network form?
What is the network size?
How do devices join?
How are messages encrypted?

What frequency is used?
How does transmission work?

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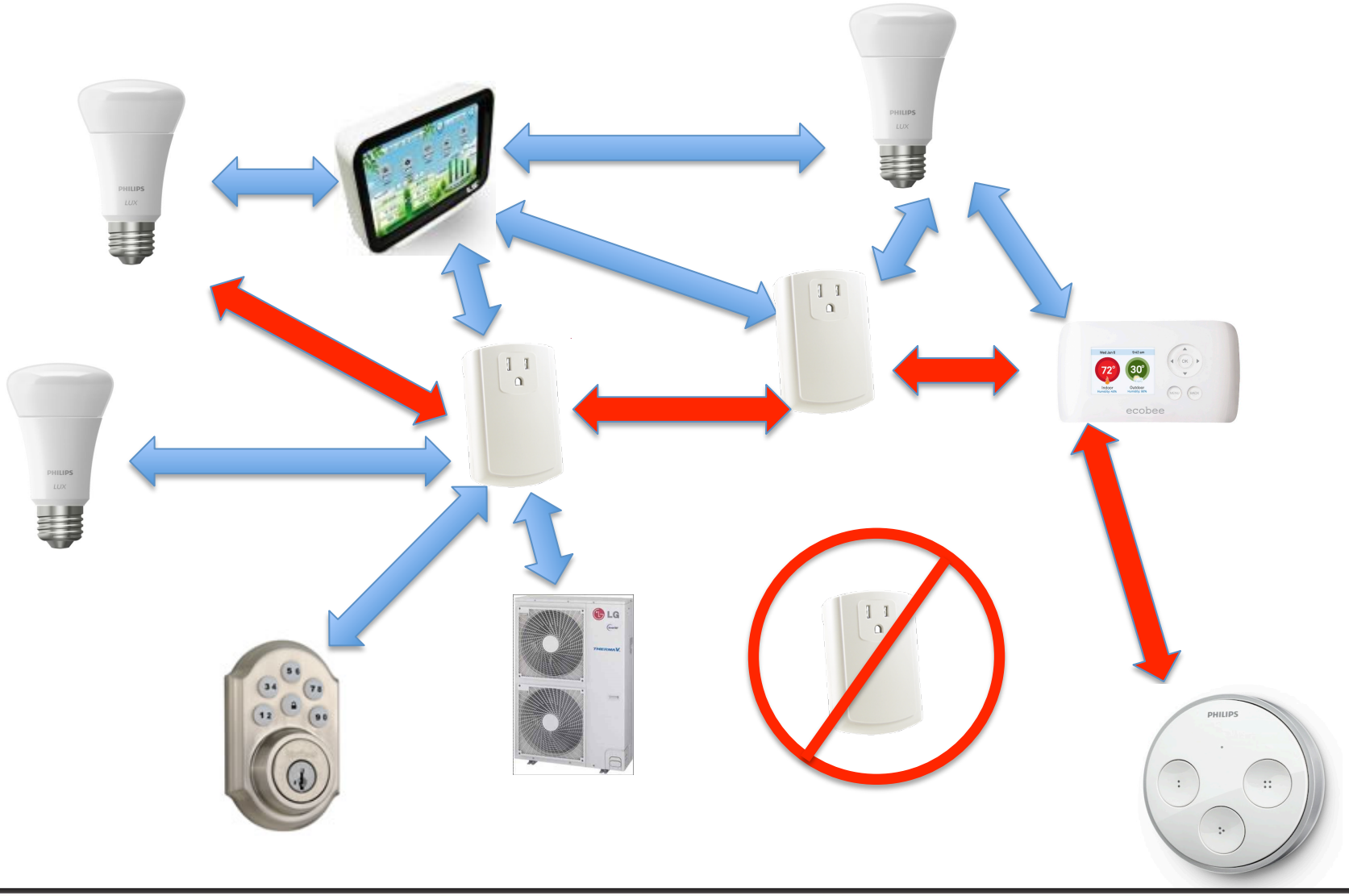
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The Power of the Mesh



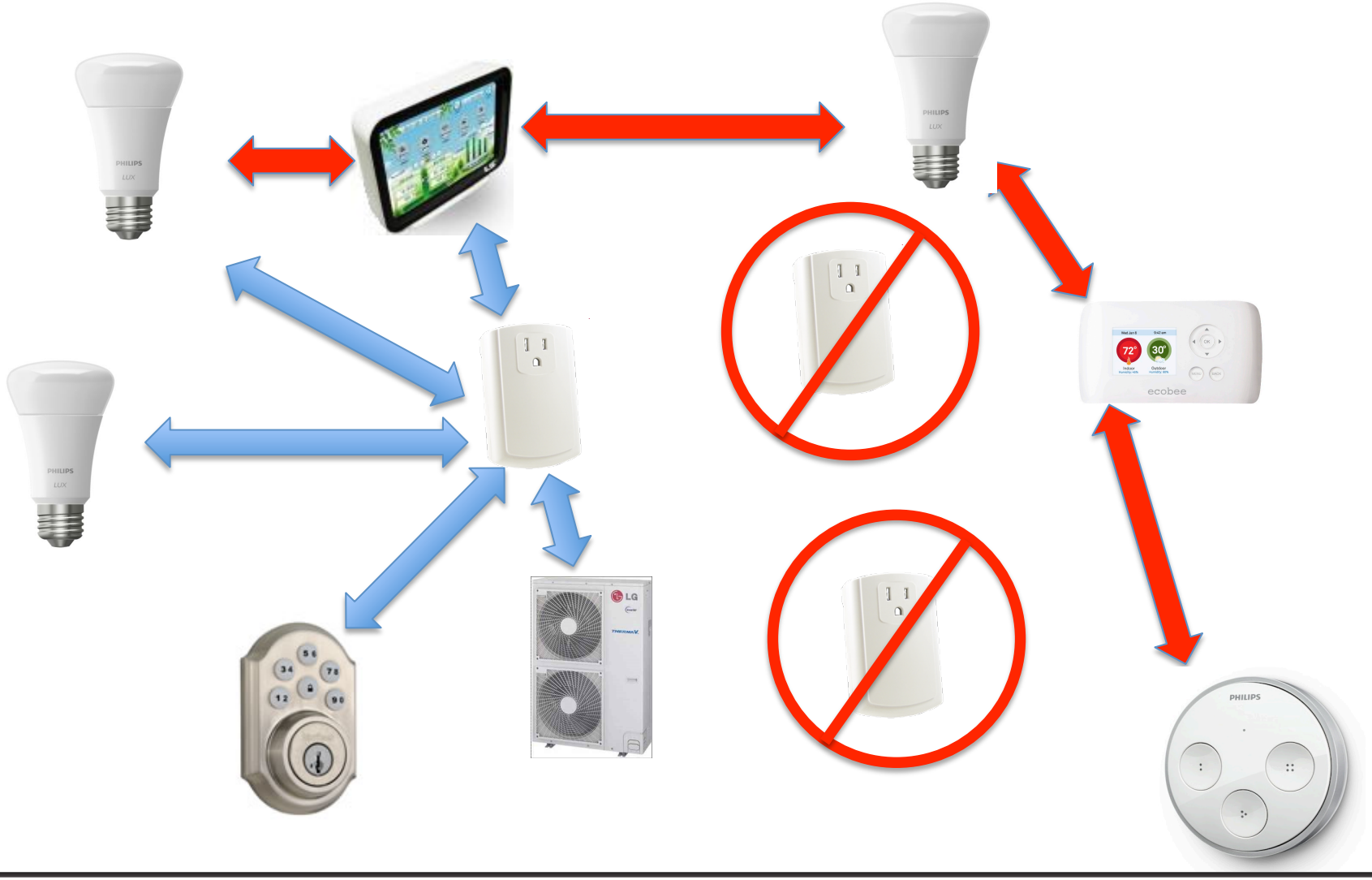
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The Power of the Mesh: Self Healing



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The Power of the Mesh: Self Healing

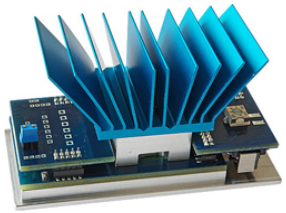


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Lowest Power: Green Power Feature of ZigBee

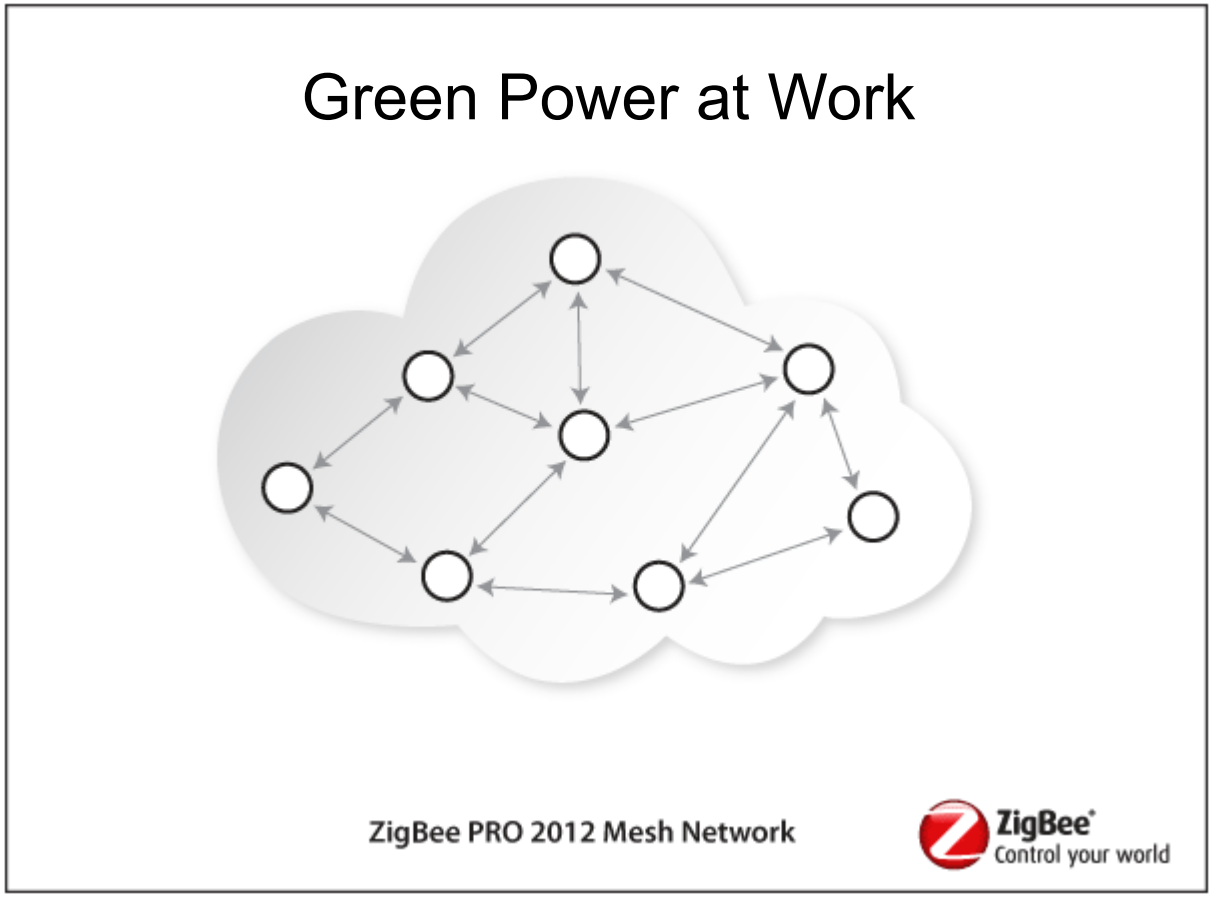
Connect devices when batteries or mains AC power is not practical or available.





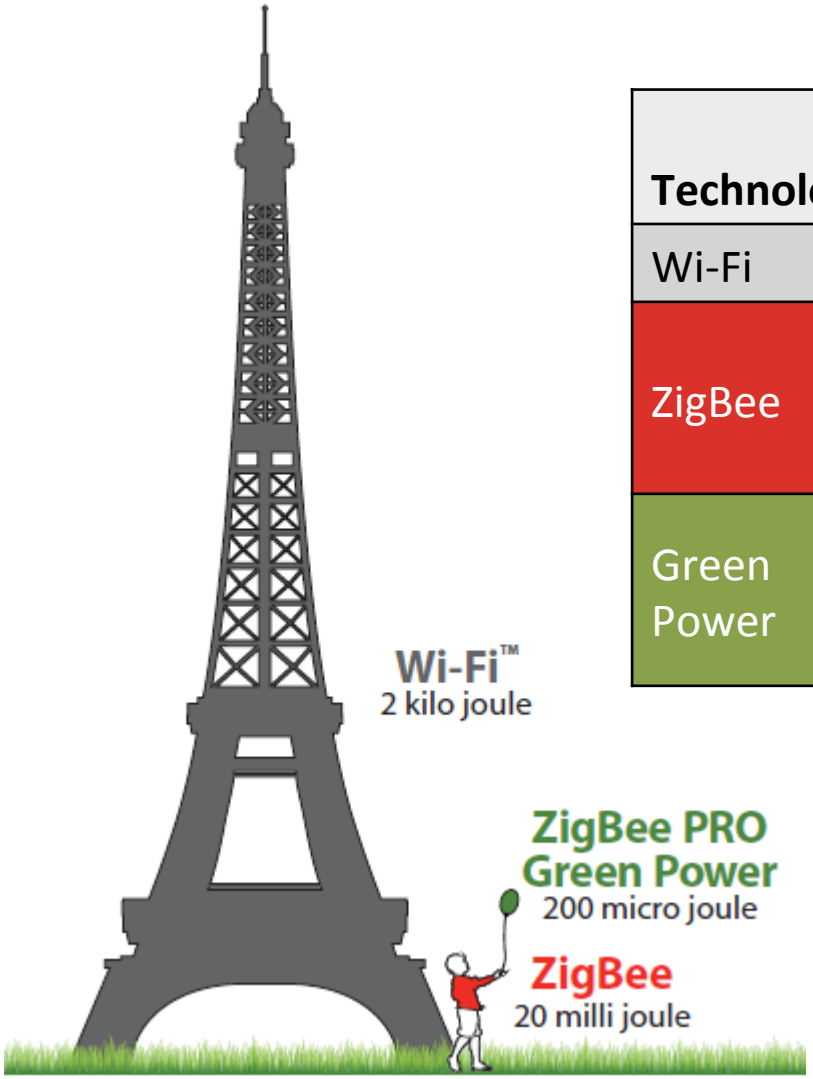






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Differences in Energy Consumption



Technology	Power use per hour	Device	Comparison
Wi-Fi	2 kilo Joule	Laptop	
ZigBee	20 milli Joule	Set top box	1/100,000 compared to Wi-Fi
Green Power	200 micro Joule	Light switch	1/100 compared to ZigBee

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Scalable for IoT



Aria Hotel City Center, Las Vegas
+ 100,000 ZigBee devices



GM Spring Hill Plant: 28,773 connected lights, 20 million square feet



Hampshire City Council, Hampshire UK: 90,000 connected street lights

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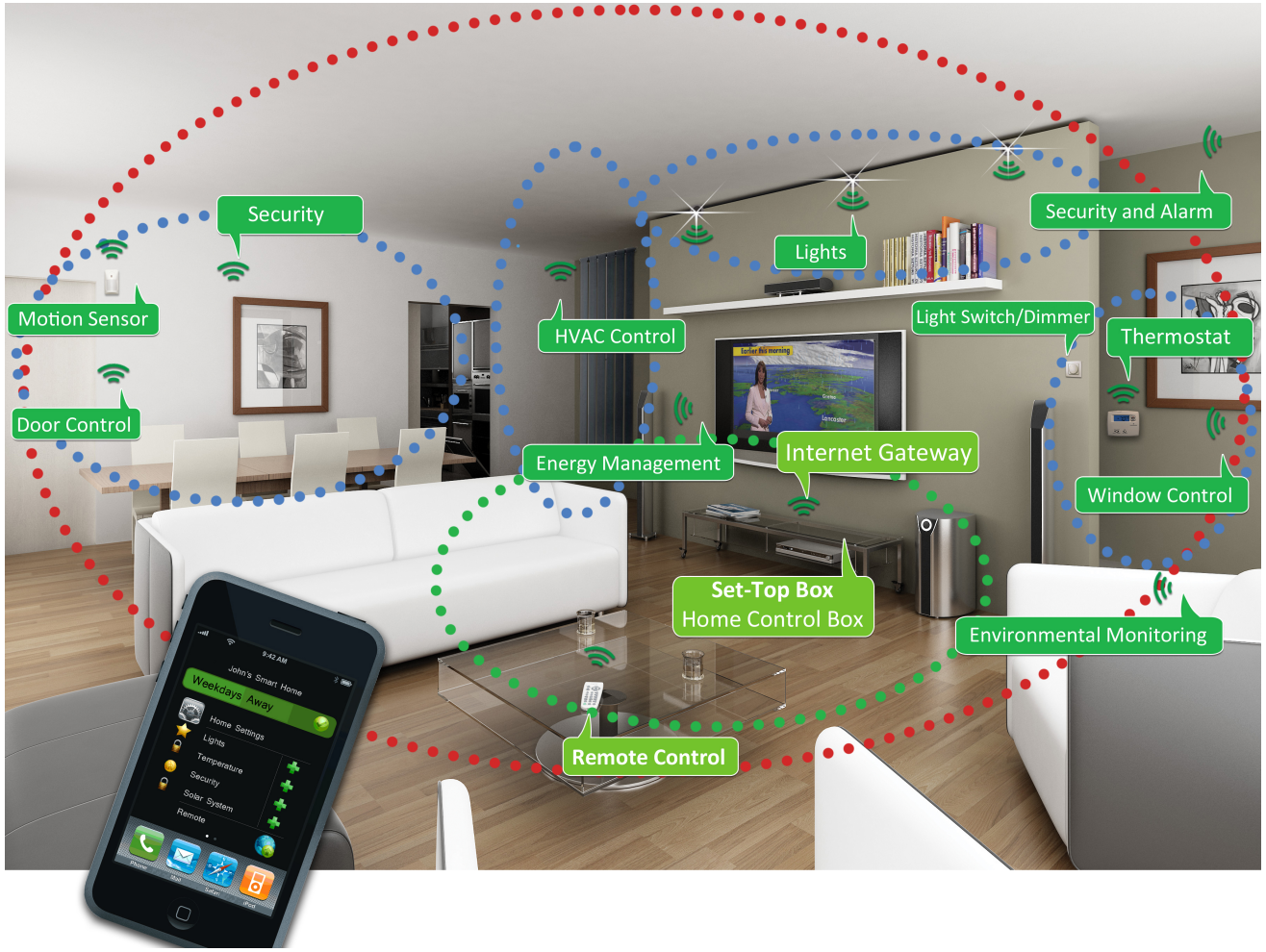
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IoT Applications

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IoT and the Smart Home

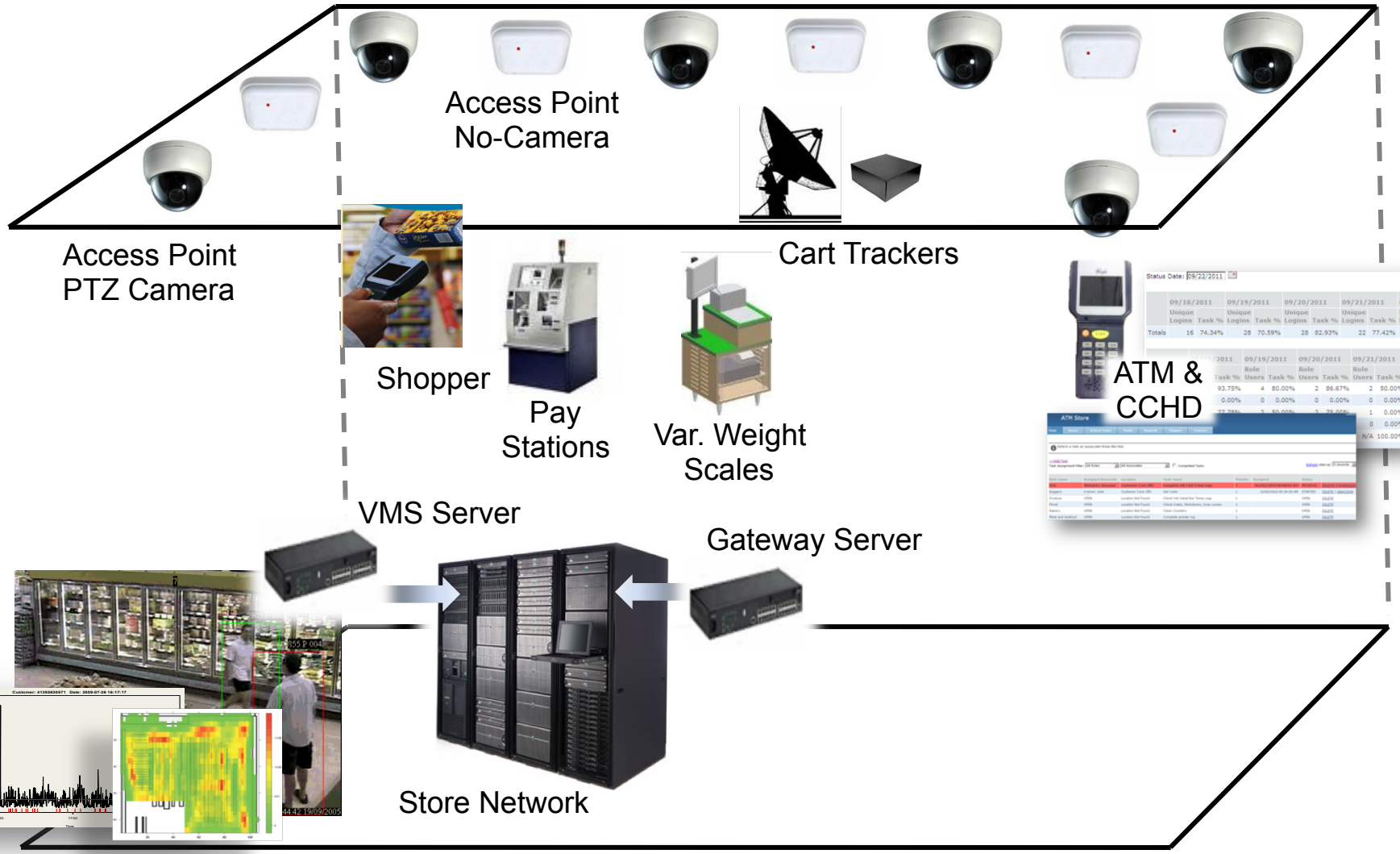


ZigBee is the only global, standards-based wireless solution that can conveniently and affordably control the widest range of devices

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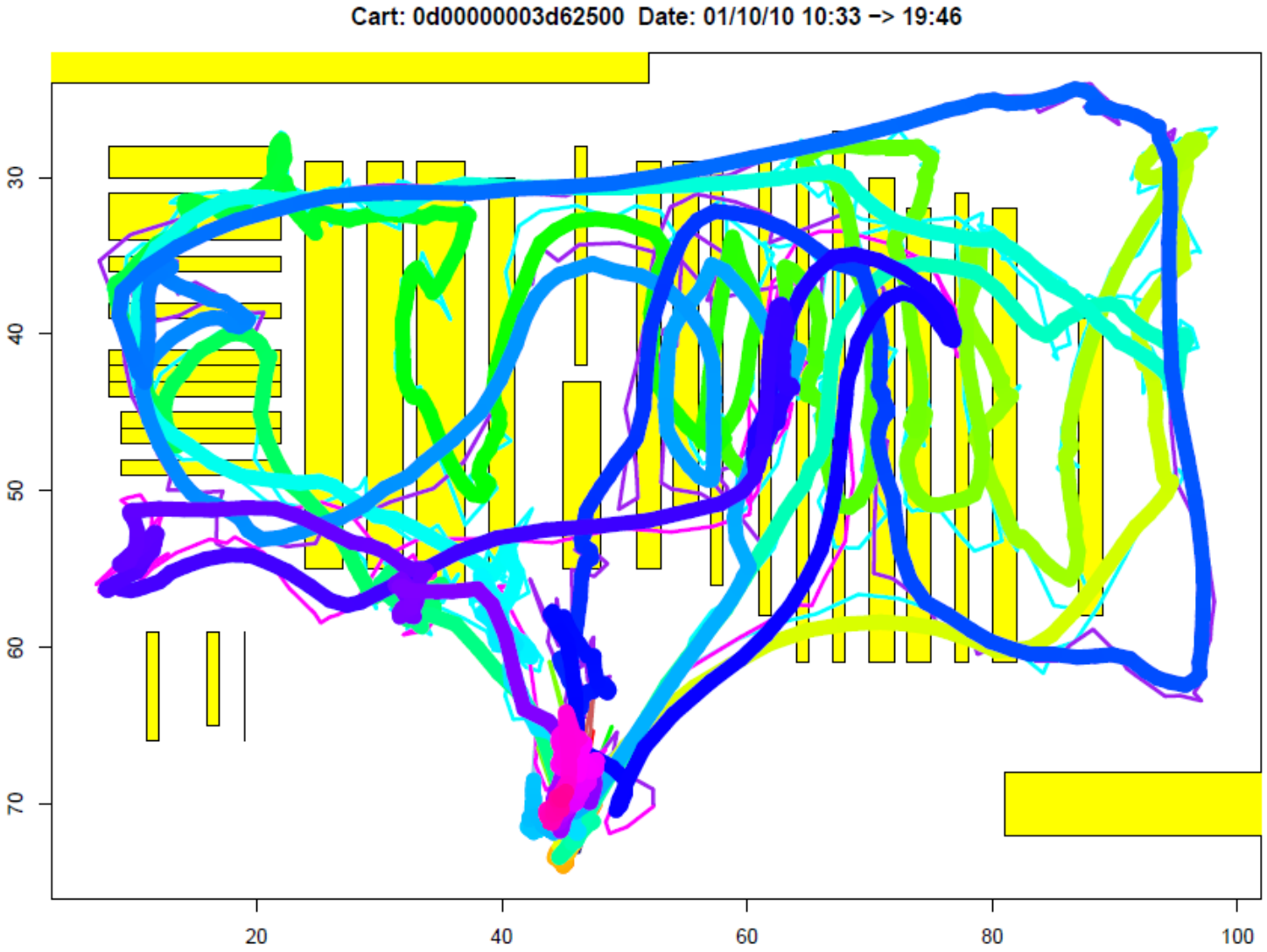
IoT in Retail Stores



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Cart Tracking to Enhance Merchandising & Marketing



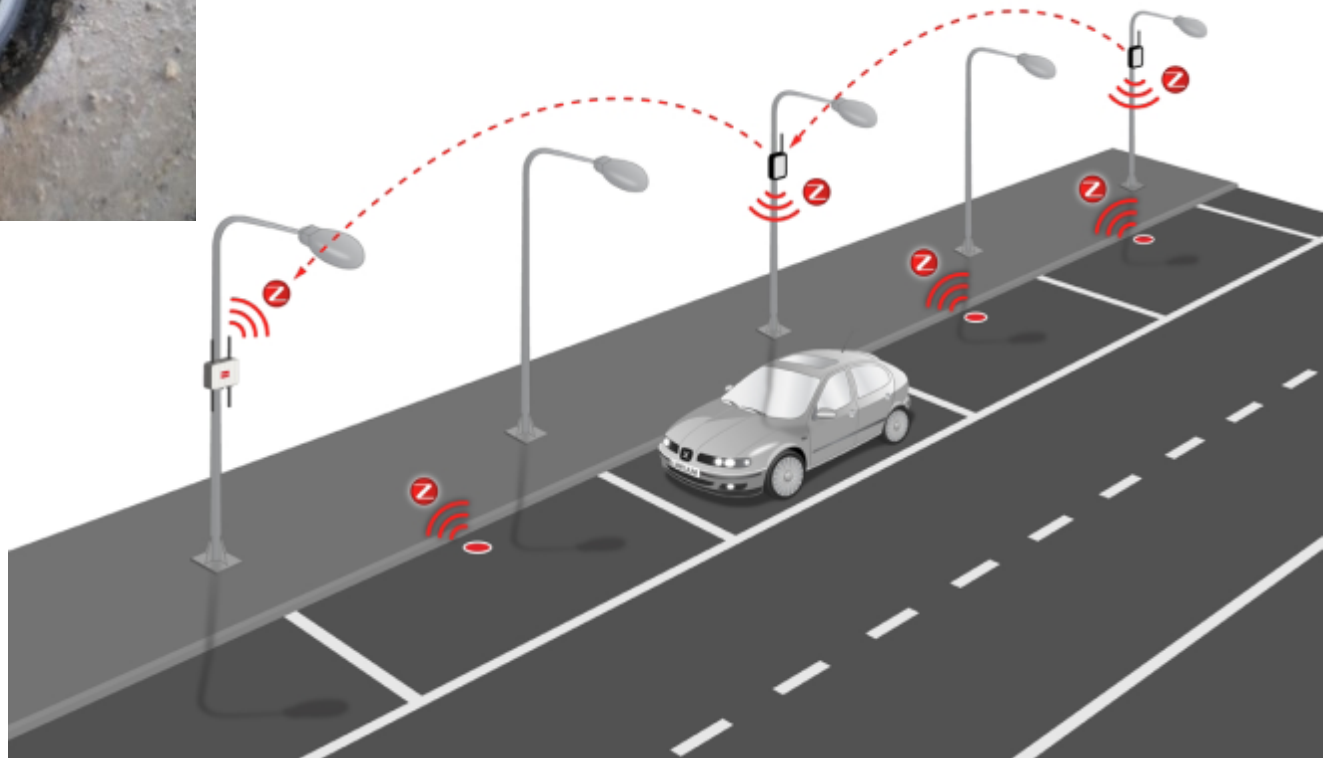
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IoT for Smart Parking





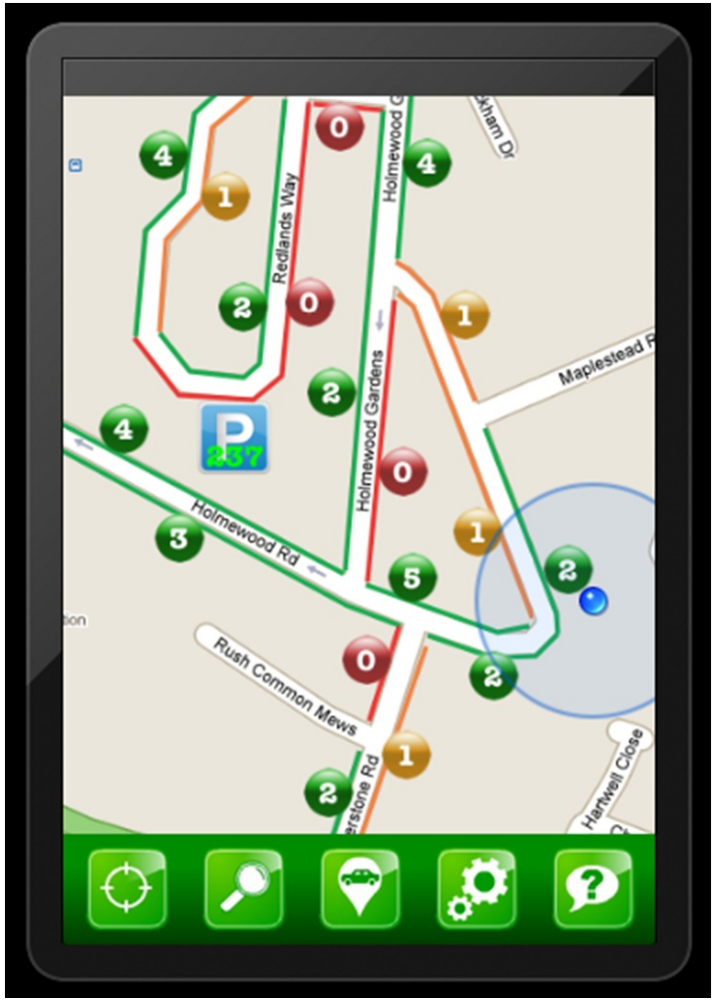


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IoT for Smart Parking





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Question & Answers

Submit your questions using the Chat Function

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Reminders

- Webinar will be available for on-demand viewing
- Email with link to presentation slides will be sent to everyone viewing the live presentation once materials are ready

- To participate in the standards development process and shape the future of the IoT , join the ZigBee Alliance
- Learn more at www.ZigBee.org

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THANK YOU FOR ATTENDING THE WEBINAR!

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