



**ZigBee™ Alliance**  
*Wireless Control That Simply Works*

**Wireless Sensors and Control Networks:  
Enabling New Opportunities  
with ZigBee**

**Bob Heile**  
Chairman, ZigBee Alliance

December, 2006



ZigBee™  
Alliance

# From Popular Science Magazine

## SIX WAYS ZIGBEE WILL CHANGE YOUR HOME



**MEET AND GREET**

**SENSIBLE SENSORS**

**CLIMATE CONTROL**

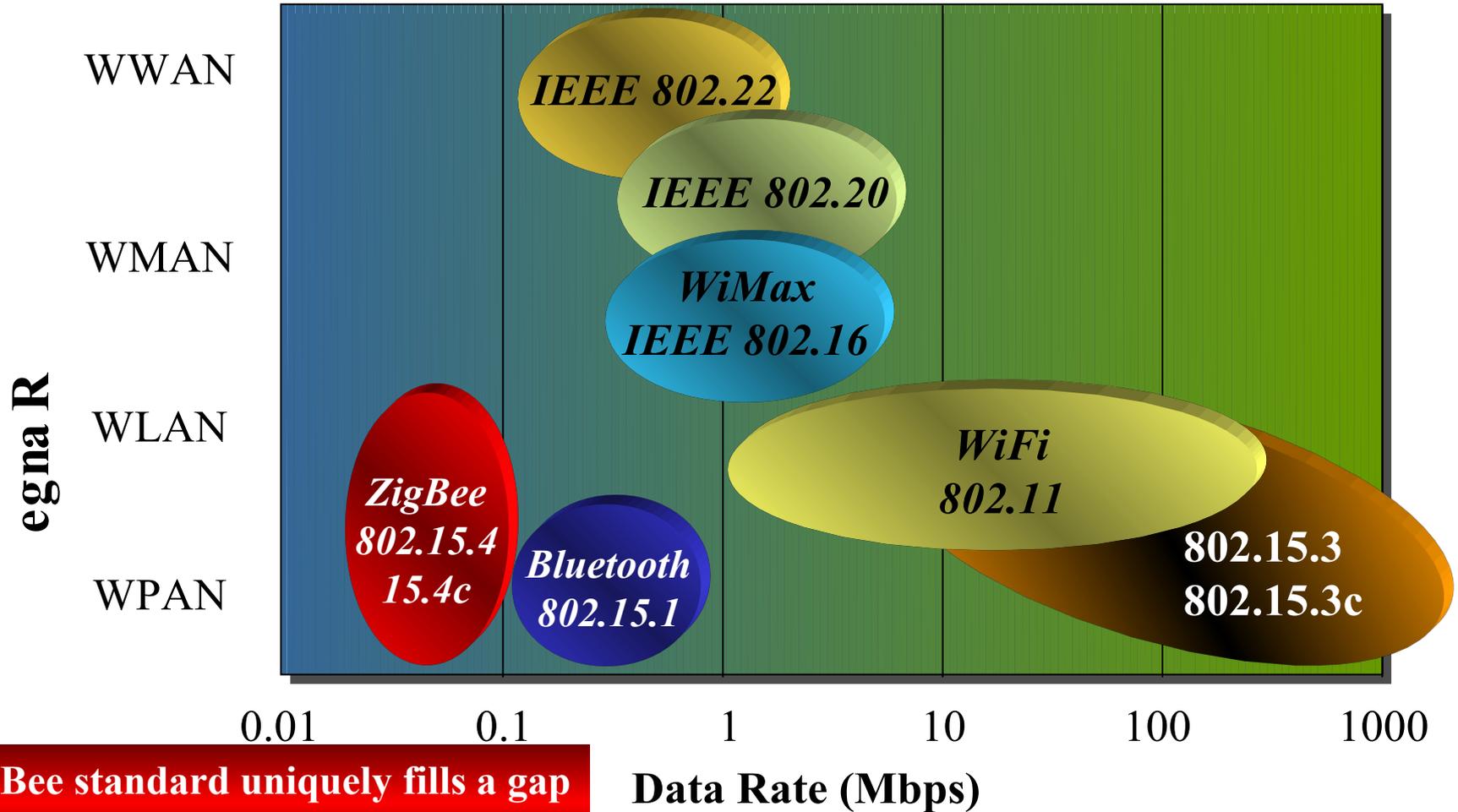
**SAFER SPACE**

**NO-HASSLE LIGHT**

**SMART SPRINKLER**



# The IEEE 802 Wireless Space



**ZigBee standard uniquely fills a gap for low data rate applications**



# Sensor/Control Network Requirements

- Networks form by themselves, scale to large sizes and operate for years without manual intervention
- Extremely long battery life (years on AA cell),
  - low infrastructure cost (low device & setup costs)
  - low complexity and small size
- Low device data rate and QoS
- Standardized protocols allow multiple vendors to interoperate



# ZigBee Alliance Overview-

- Organized as an independent, neutral, nonprofit corporation in 2002
- Open and global
  - Anyone can join and participate
  - Membership is global
- Activity includes
  - Specification creation
  - Certification and compliance programs
  - Branding, market development, and user education



ZigBee™  
Alliance

# The ZigBee Promoters



**MOTOROLA**



**PHILIPS**



**SIEMENS**



STMicroelectronics

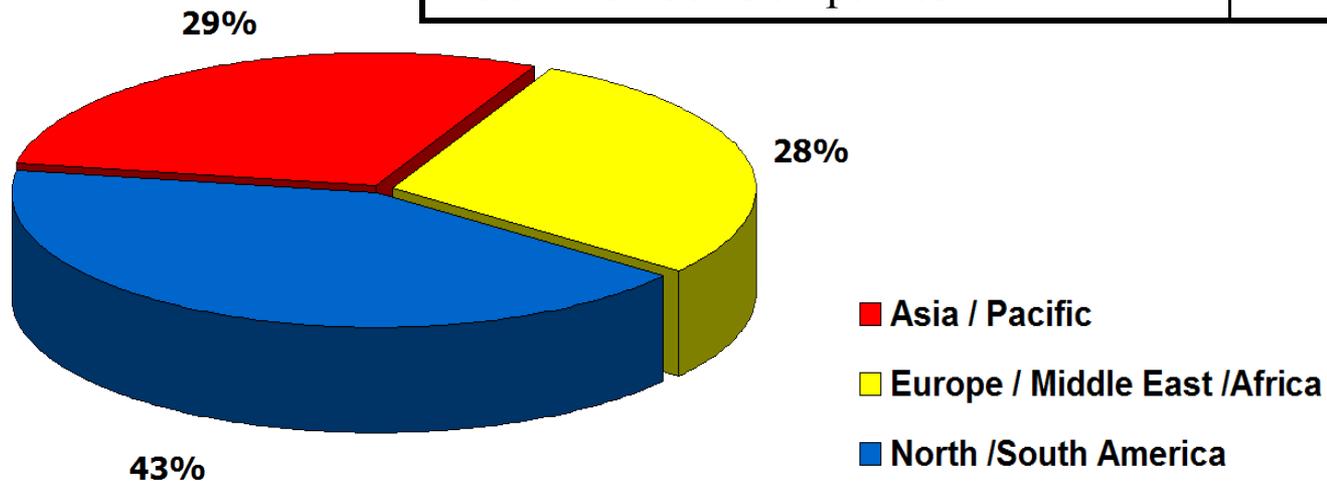


TE<sub>N</sub>DRIL



# ZigBee Member Geographic Distribution

Region	November 2006
Asia / Pacific	60 (29%)
Europe / Middle East/Africa	58 (28%)
North/South America	86 (43%)
Total Member Companies	204





# The ZigBee Alliance --

- Is a growing community of companies
  - ~200 members vs. 35 Dec. 2002 (5+X Growth)
  - Includes major names in the Semiconductor, Software Developer, End Product Manufacturer, and Service Provider Industries including major Telecom Carriers
- Has made its specification publicly available
  - ZigBee is open to all-ZigBee 2006 now available
  - 38,000+ downloads to date
- Has over 30 compliant platforms
  - Many certified vendors make choosing ZigBee a safe choice
  - No dominating elements or companies



# ZigBee Applications

security  
HVAC  
AMR  
lighting control  
access control



**BUILDING  
AUTOMATION**



TV  
VCR  
DVD/CD  
remote

**CONSUMER  
ELECTRONICS**

**ZigBee**  
*Wireless Control that  
Simply Works*

patient  
monitoring  
fitness  
monitoring



**PERSONAL  
HEALTH CARE**



**TELECOM  
SERVICES**



mouse  
keyboard  
joystick

**PC &  
PERIPHERALS**

asset mgt  
process  
control  
environmental  
energy mgt



**INDUSTRIAL  
CONTROL**

m-commerce  
info services  
object interaction  
(Internet of Things)

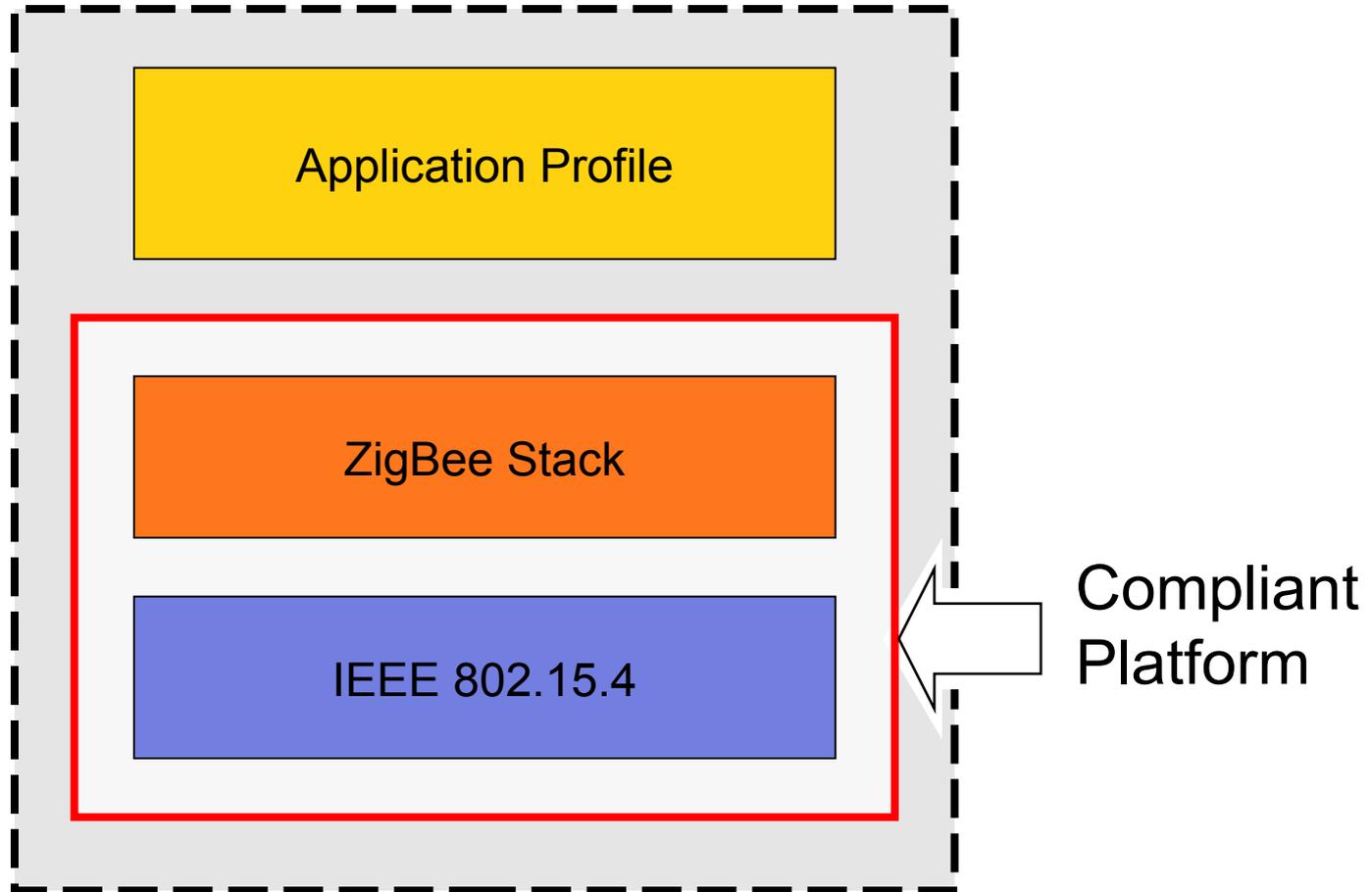


**HOME  
CONTROL**

security  
HVAC  
lighting control  
access control  
irrigation

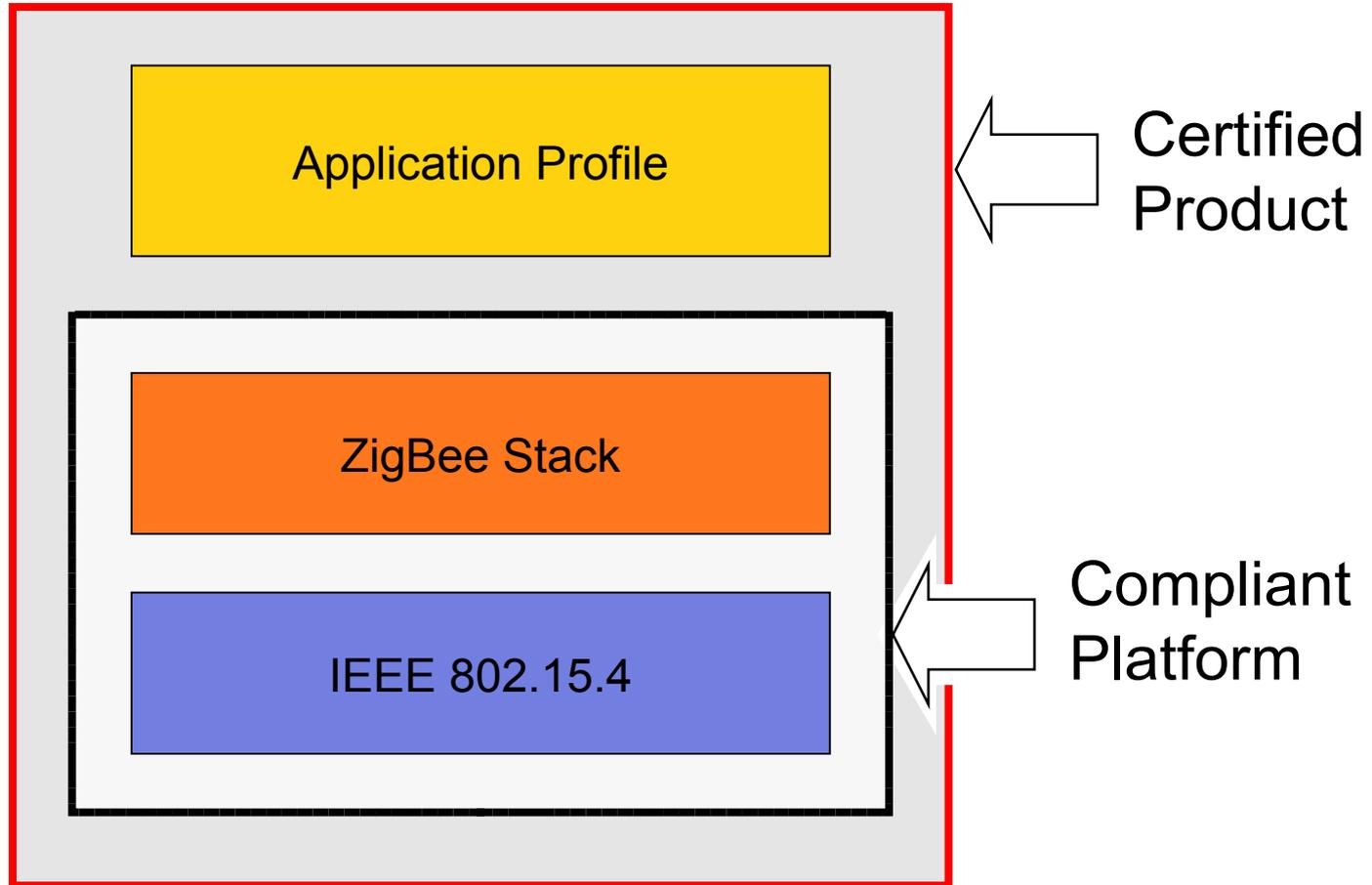


# The ZigBee *Platform*



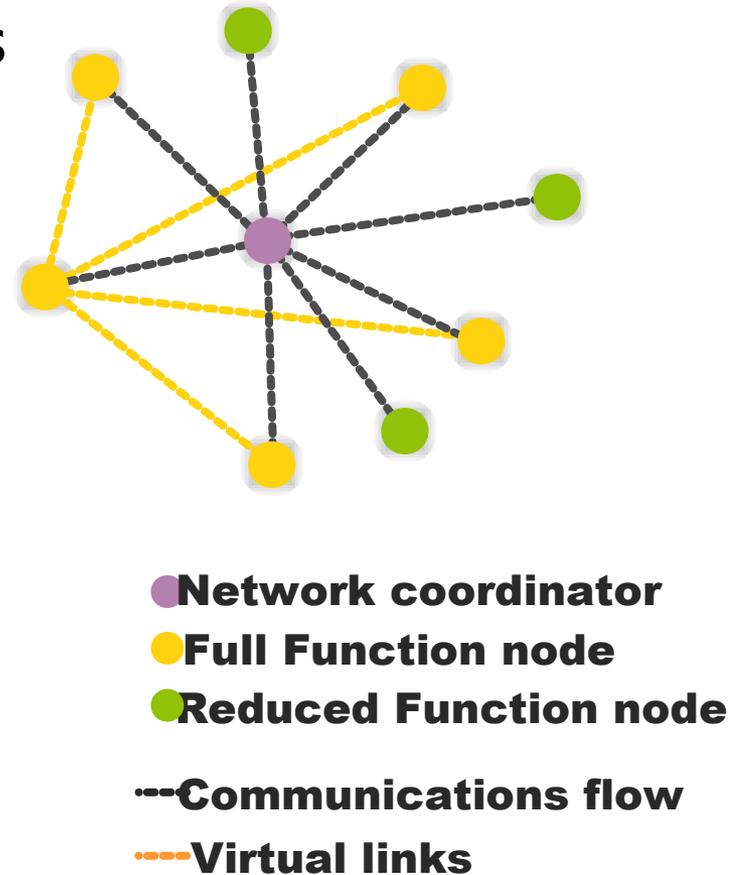


# The ZigBee *Product*



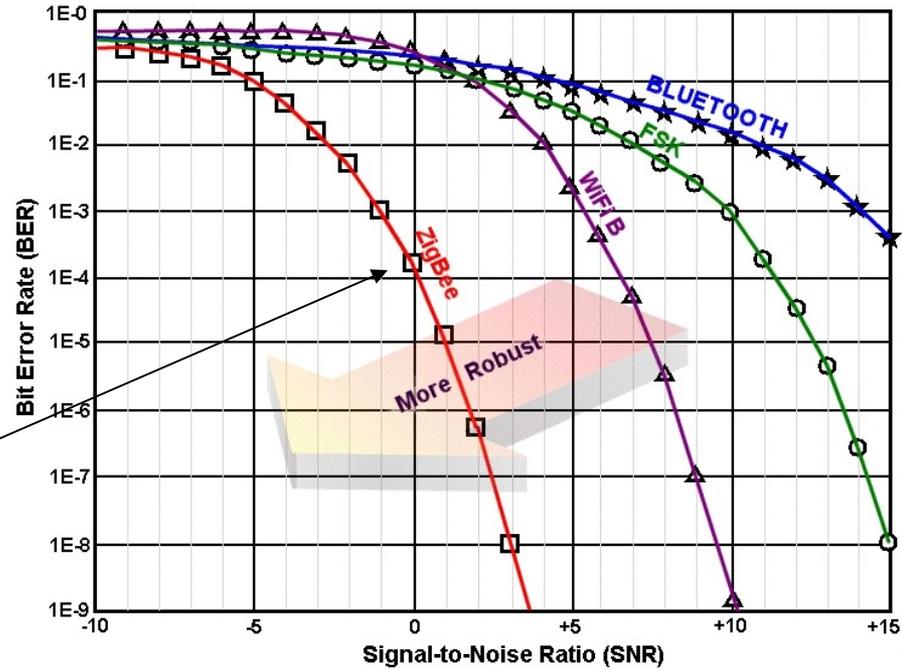
# Basic Network Characteristics

- 65,536 network (client) nodes
- 27 channels over 2 bands
- 250Kbps data rate
- Optimized for timing-critical applications and power management
- Full Mesh Networking Support





# Basic Radio Characteristics



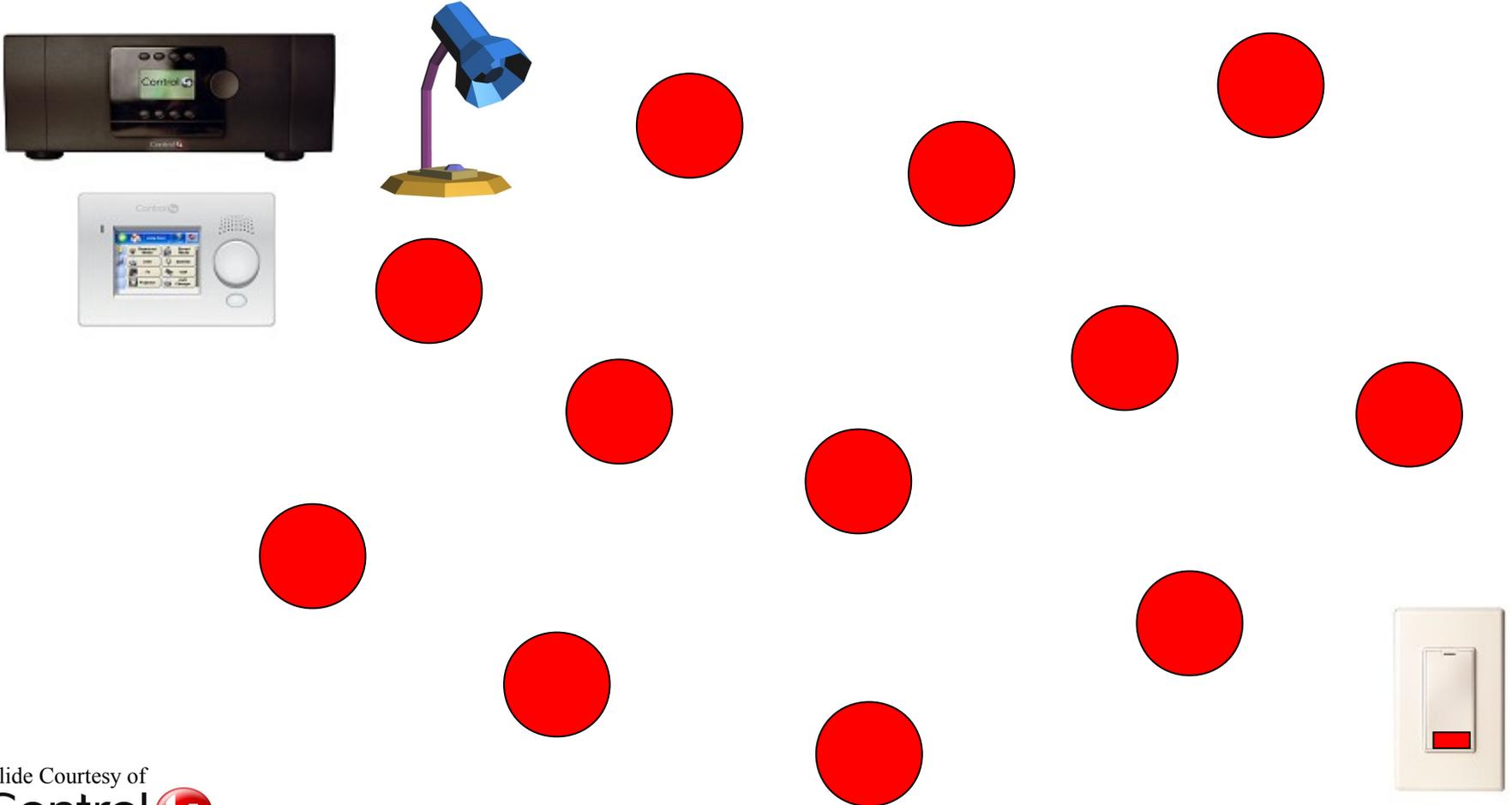
ZigBee technology relies upon IEEE 802.15.4, which has excellent performance in low SNR environments

Frequency Band	License Required?	Geographic Region	Data Rate	Channel Number(s)
868.3 MHz	No	Europe	20kbps	0
902-928 MHz	No	Americas	40kbps	1-10
2405-2480 MHz	No	Worldwide	250kbps	11-26



ZigBee™  
Alliance

# ZigBee Mesh Networking

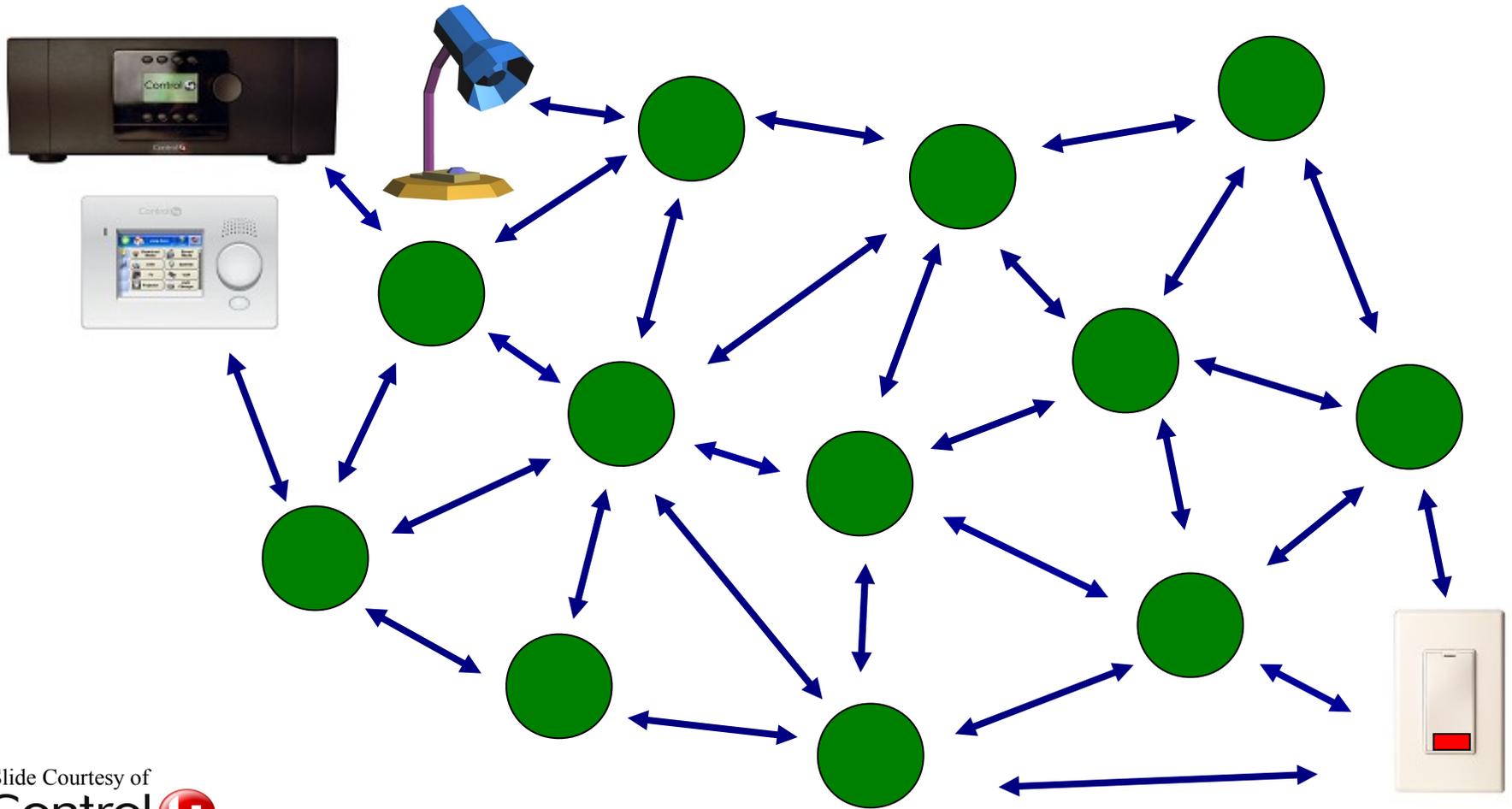


Slide Courtesy of  
**Control4**



ZigBee™  
Alliance

# ZigBee Mesh Networking

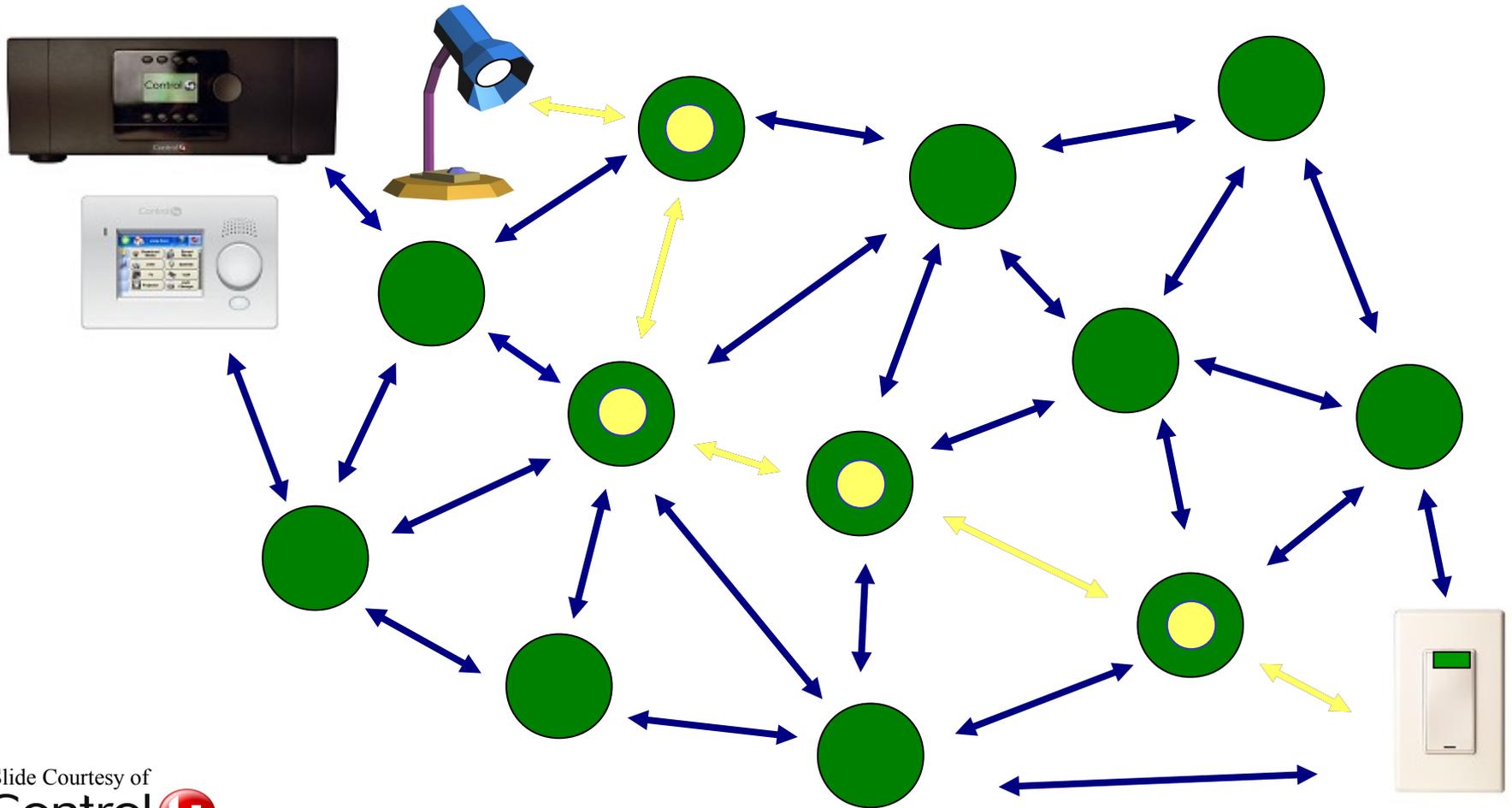


Slide Courtesy of  
**Control4**



ZigBee™  
Alliance

# ZigBee Mesh Networking

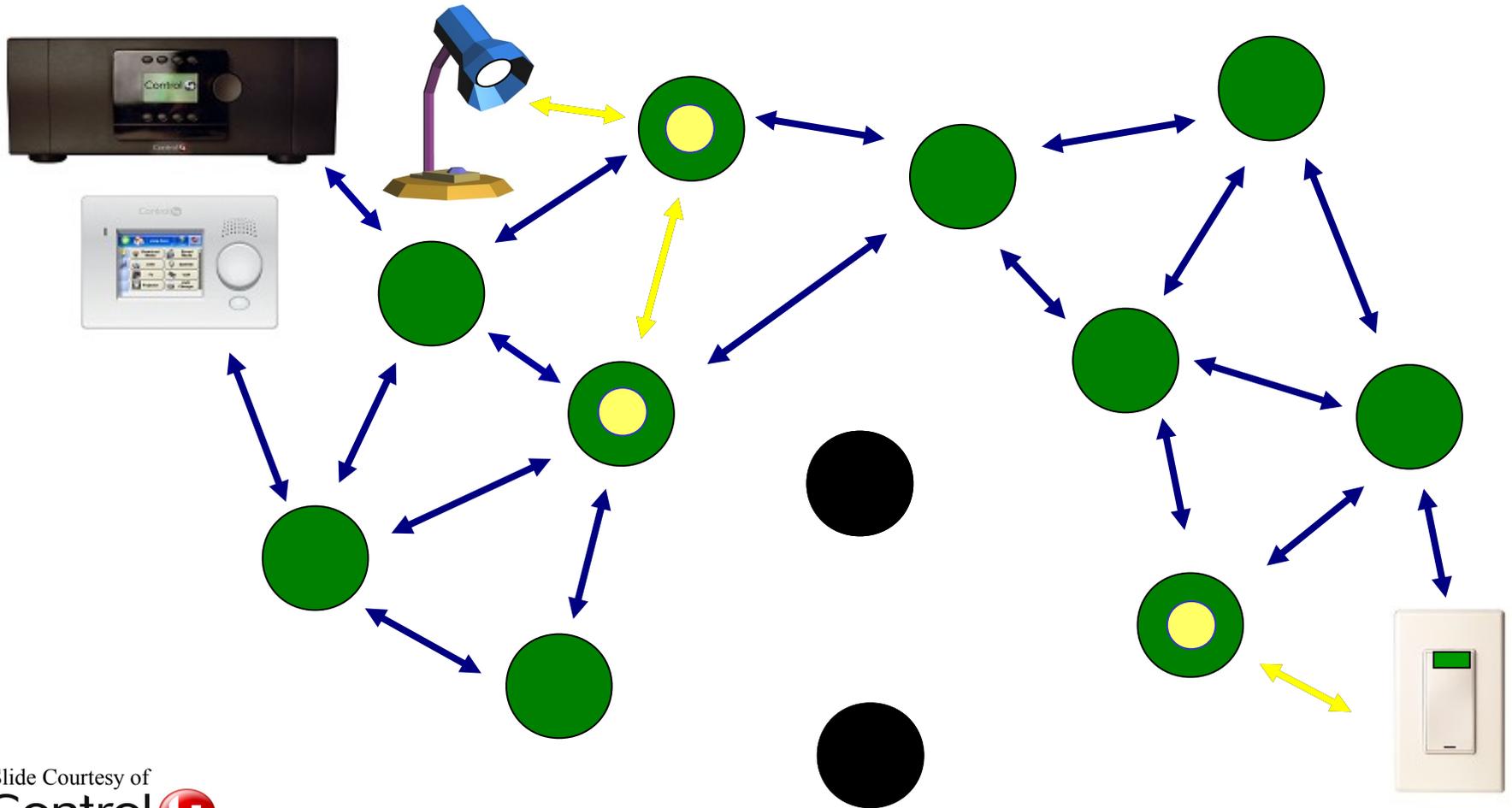


Slide Courtesy of  
**Control4**



ZigBee™  
Alliance

# ZigBee Mesh Networking

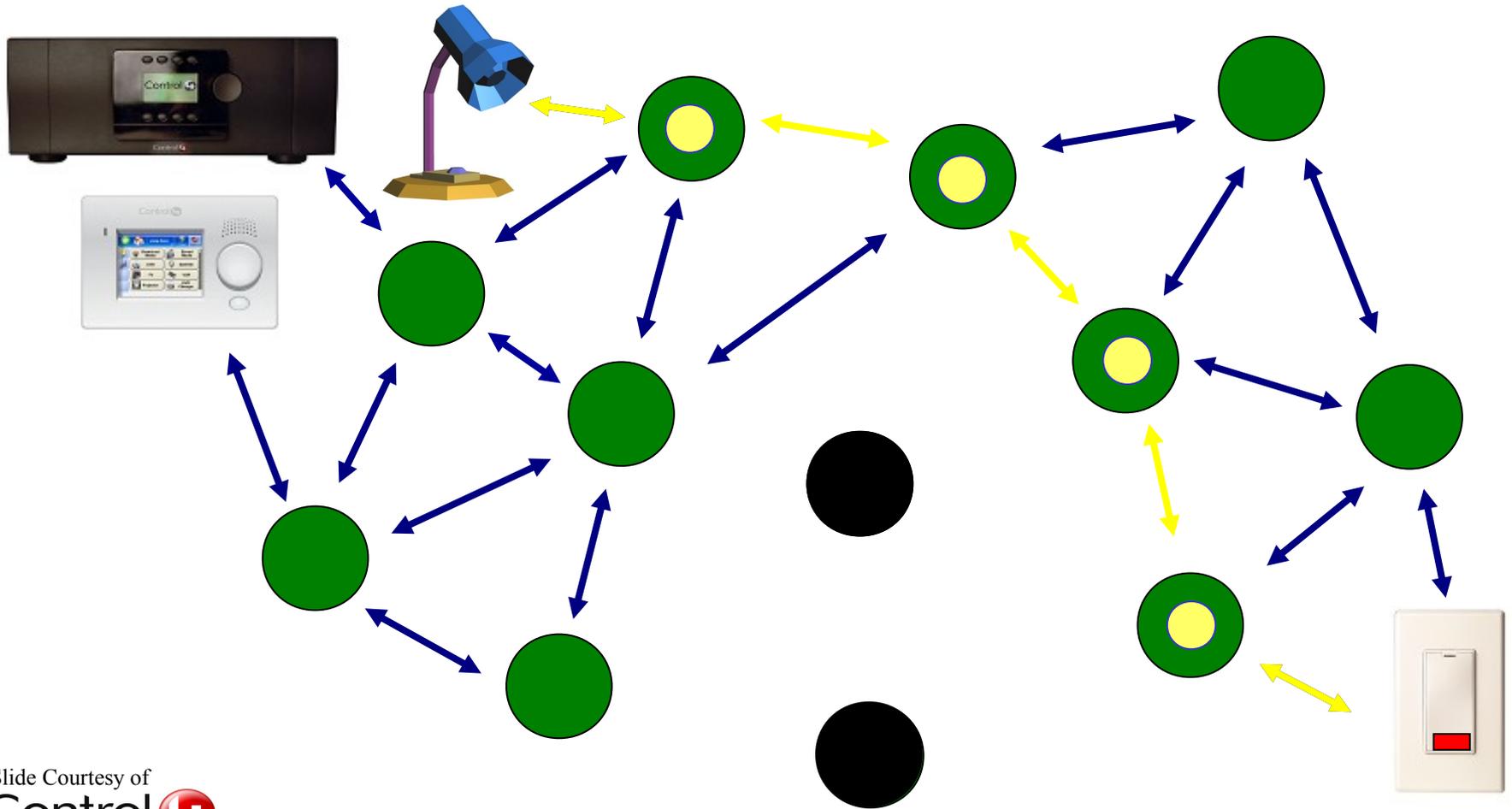


Slide Courtesy of  
Control



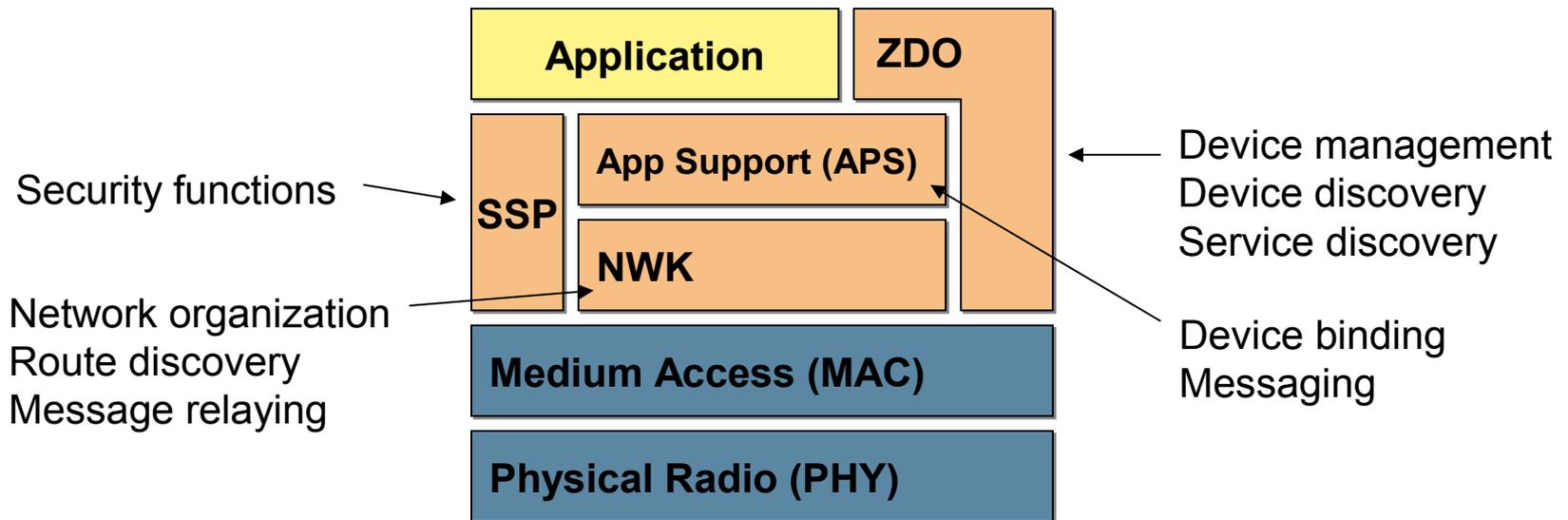
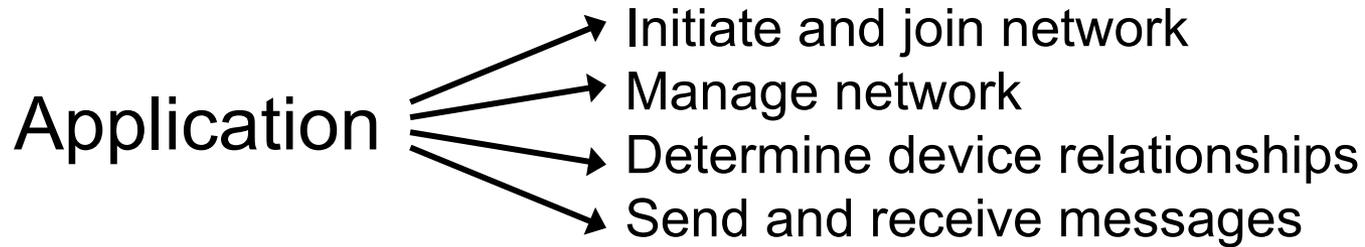
ZigBee™  
Alliance

# ZigBee Mesh Networking



Slide Courtesy of  
Control

# ZigBee Stack Architecture



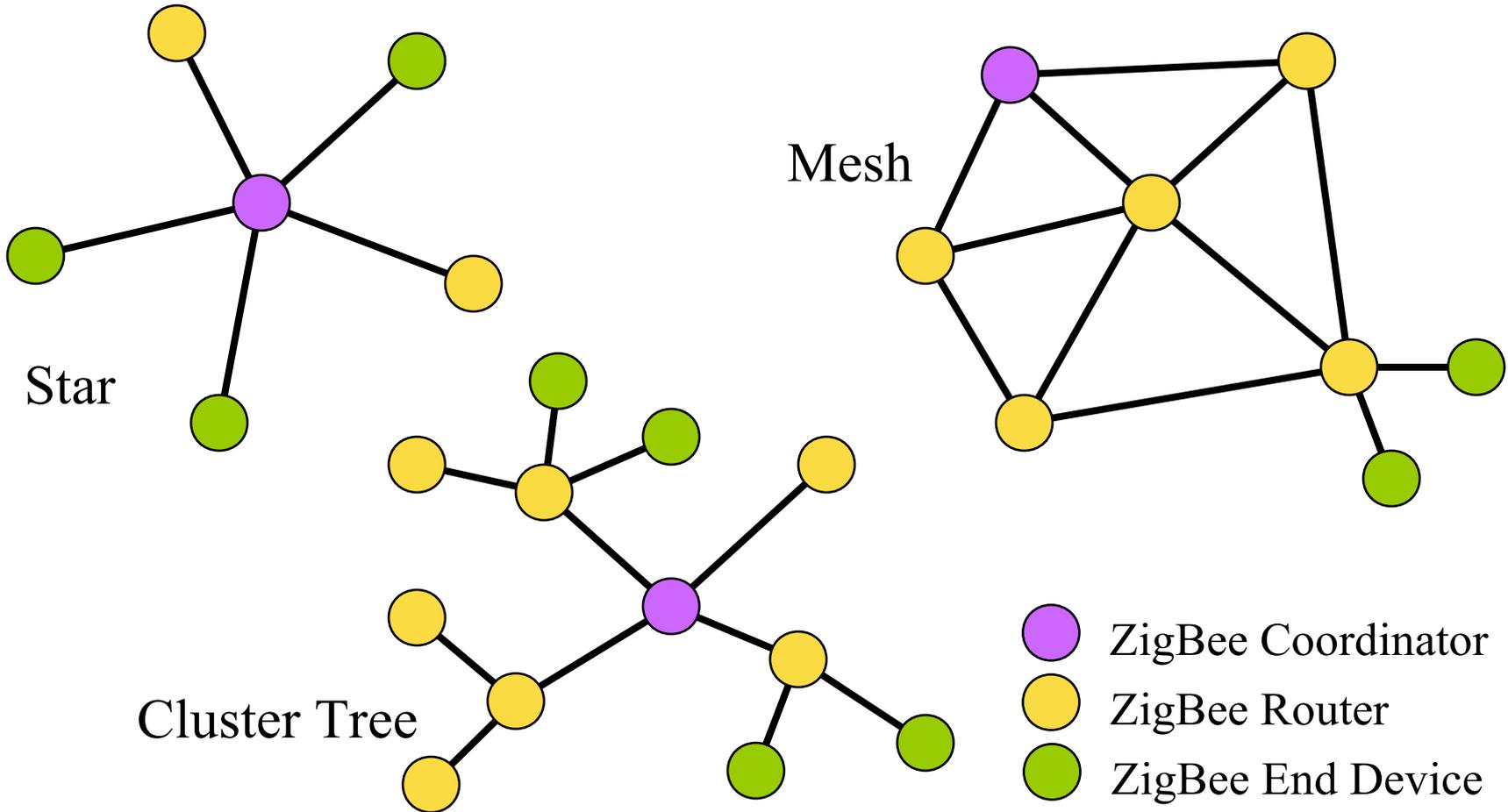


# ZigBee Device Types

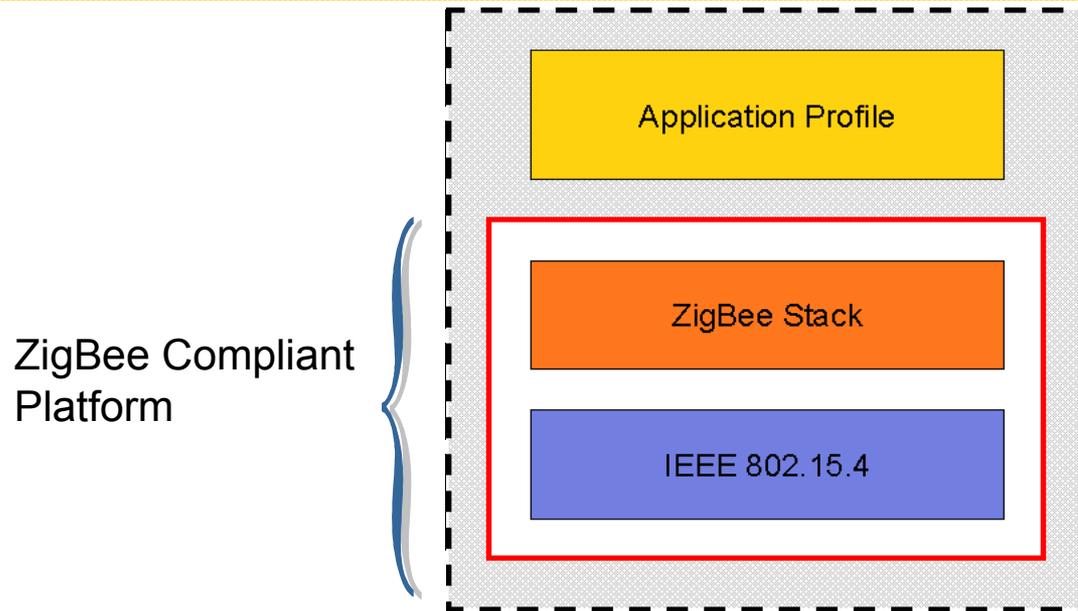
- ZigBee Coordinator (ZC)
  - One required for each ZB network.
  - Initiates network formation.
- ZigBee Router (ZR)
  - Participates in multihop routing of messages.
- ZigBee End Device (ZED)
  - Does not allow association or routing.
  - Enables very low cost solutions



# ZigBee Network Topologies



# ZigBee Compliant Platform [ZCP]



- Platform certification - ensures all parts of the stack other than the application are compliant with the ZigBee Standard
- Allows Network interoperability but does not imply interoperability at the application layer
- There are currently 30 Compliant Platforms to choose from

# Application Profiles

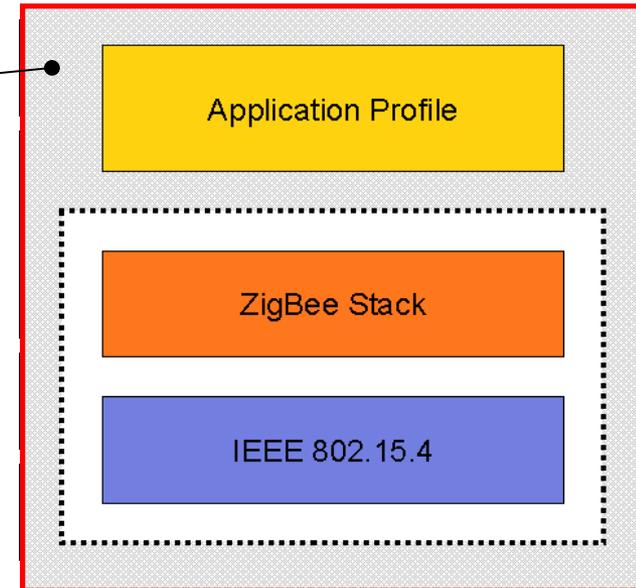


## Clusters

```
0: off
1: on
2: scene 1
3: scene 2
```

## Clusters

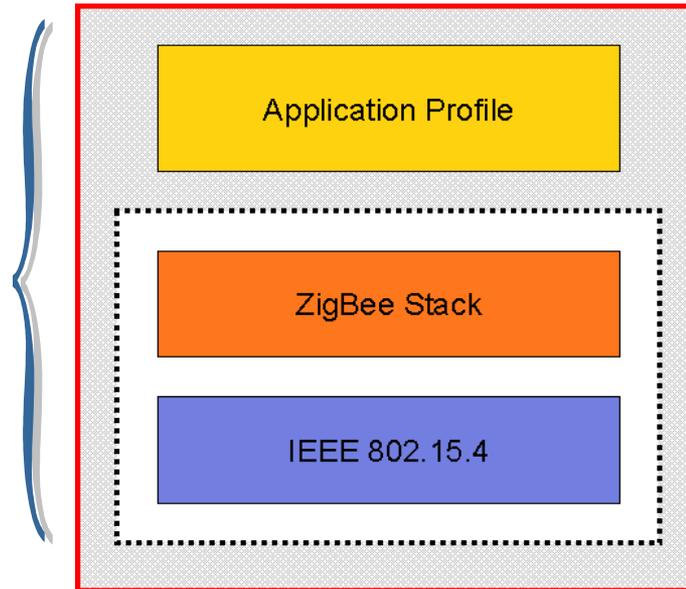
```
0: fan off
1: fan on
2: temp set
3: time set
```



- Application profiles define what messages are sent over the air for a given application
- Devices with the same application profiles interoperate end to end
- ZigBee publishes a set of public profiles, but vendors may create manufacturer specific ones as well

# Manufacturer Specific Profiles

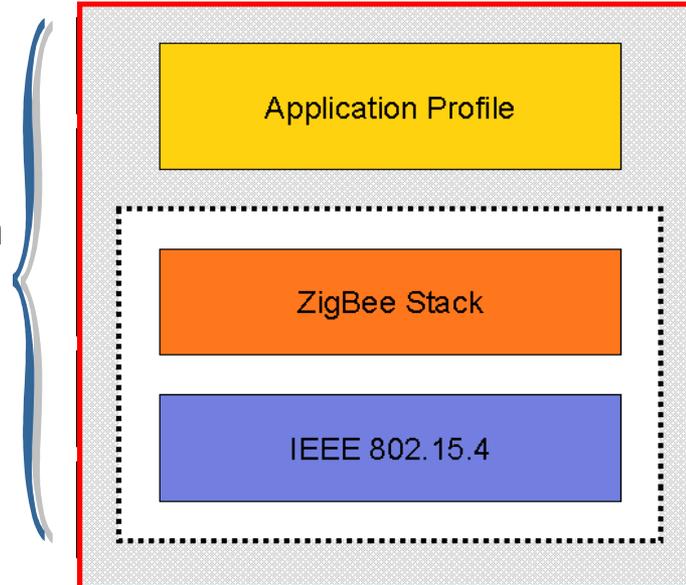
Certification testing ensures application does not interfere with other ZigBee networks



- Allows a vendor to build specialized products with a ZigBee Compliant Platform
- Certification testing ensures their product does not harm other ZigBee networks
- Manufacturer specific applications are not intended to interoperate at the application layer
- Allows product vendor to use ZigBee language and logos on their product

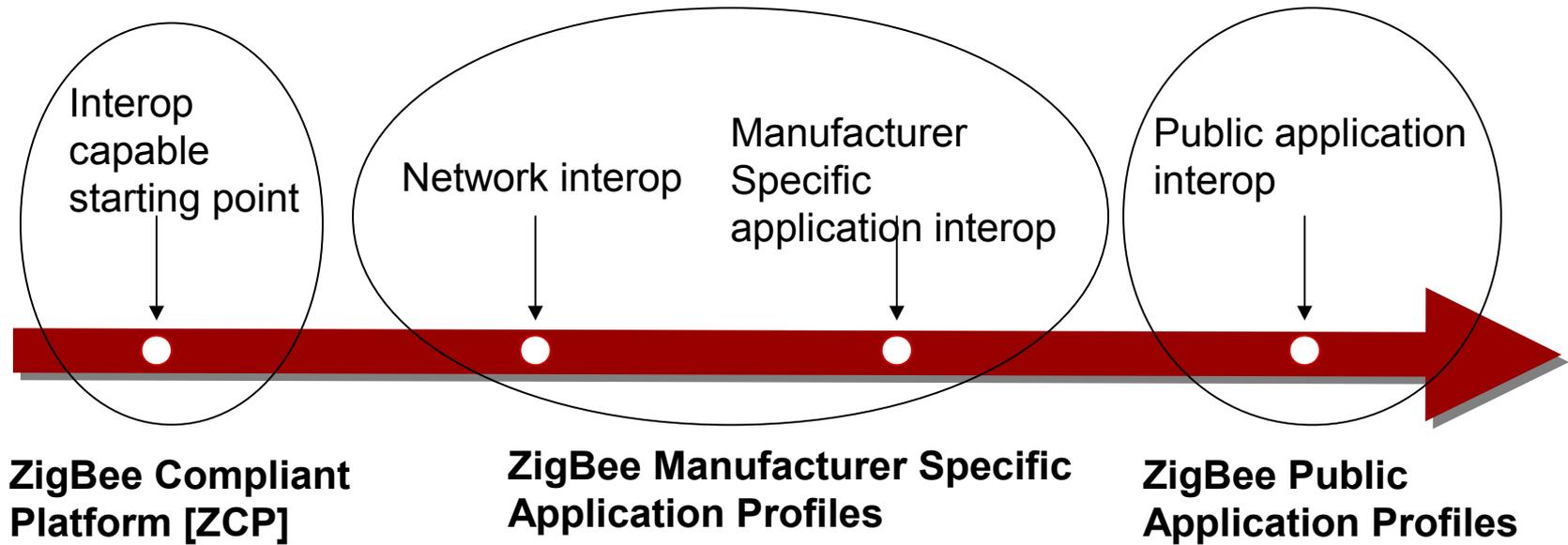
# ZigBee Public Profiles

Ensures application conforms to a specific public application profile



- Guarantees interoperability between products all running the same public application profile
- Product vendors may add additional features to the public profiles
- Allows product vendor to use ZigBee language and logos on their product

# Interoperability Summary



- Devices built on ZigBee interoperate on different levels
- Wide spectrum of interoperability choices
- It's a designer choice on level of vendor interoperability to support

# Some Application Profiles



- Home Automation [HA]
  - Defines set of devices used in home automation
    - Light switches
    - Thermostats
    - Window shade
    - Heating unit
    - etc.

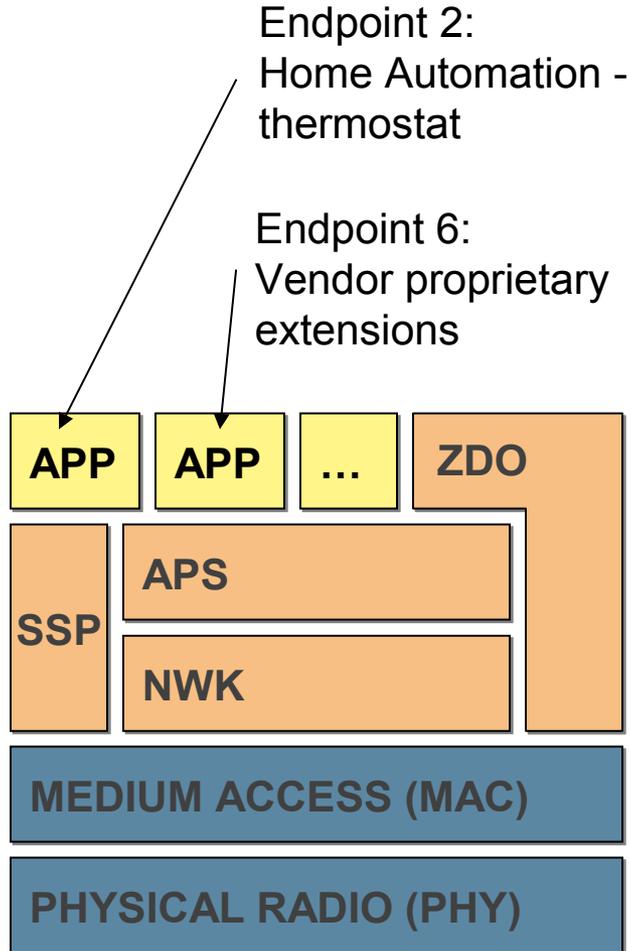


- Industrial Plant Monitoring
  - Consists of device definitions for sensors used in industrial control
    - Temperature
    - Pressure sensors
    - Infrared
    - etc.

# More Application Profiles

- Multiple profiles at various stages of completion
  - Commercial Building Automation
    - Building control, management, and monitoring
  - Telecom Services/M-commerce
  - Automated Meter Reading
    - Addresses utility meter reading
  - Wireless Sensor Networks
    - Very low power unattended networks
- Vendors may form new profile groups within ZigBee and/or propose private profiles for consideration
- 400+ private profile IDs issued

# Multi-Profile Devices



- Vendor devices may implement multiple profiles
- Additional application profiles live on different endpoints within the device
- Allows creation of vendor specific extensions

# ZigBee – Highly Reliable

- Mesh networking protocol provides redundant paths
- Automatic retries and acknowledgements
- Parents keep track of messages for sleeping children
- High intrinsic interference tolerance
  - Multiple channels
  - Supports Frequency agility
  - Robust modulation



# ZigBee – Highly Secure

- Utilizes AES 128-bit encryption
- Concept of a “trust center”
- Link and network keys
- Authentication and encryption
- Security can be customized for the application
- Keys can be “hard-wired” into application



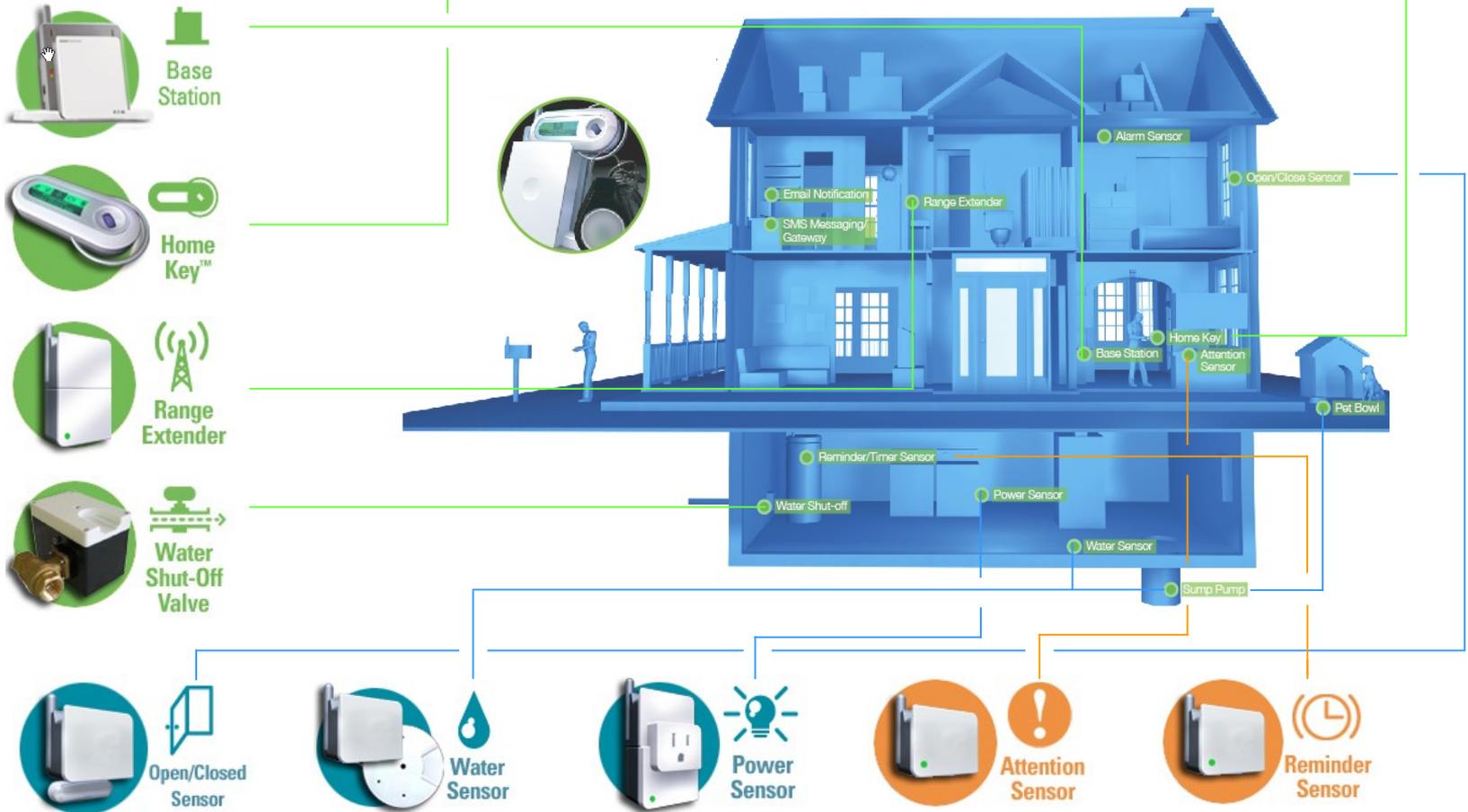




# Home Awareness

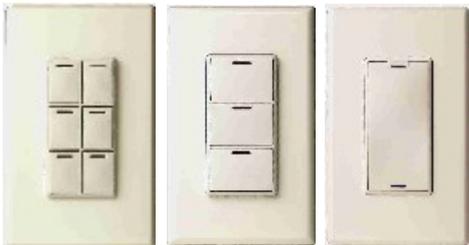


## Home Heartbeat



# Home Entertainment & Control

## Control





# In-Home Patient Monitoring

- Patients receive better care at reduced cost with more freedom and comfort---
  - Patients can remain in their own home
    - Monitors vital statistics and sends via internet
    - Doctors can adjust medication levels
  - Allows monitoring of elderly family member
    - Sense movement or usage patterns in a home
    - Turns lights on when they get out of bed
    - Notify via mobile phone when anomalies occur
    - Wireless panic buttons for falls or other problems
  - Can also be used in hospital care
    - Patients are allowed greater movement
    - Reduced staff to patient ratio



# Commercial Lighting Control

- Wireless lighting control
  - Dimmable intelligent ballasts
  - Light switches/sensors anywhere
  - Customizable lighting schemes
  - Quantifiable energy savings
  - Opportunities in residential, light commercial and commercial
- Extendable networks
  - Lighting network can be integrated with and/or be used by other building control solutions





# Wireless Lighting Control-key value drivers



**Simplify Lighting Control System design in both new construction and retrofit applications**

**Reduced cost and complexity of system installation**



**Simplicity of Commissioning**



# Wireless Lighting Control-key value drivers



**Easy and intuitive to use facilitating improved worker productivity**

**Operating cost and complexity reductions**



**Improved energy management and control**

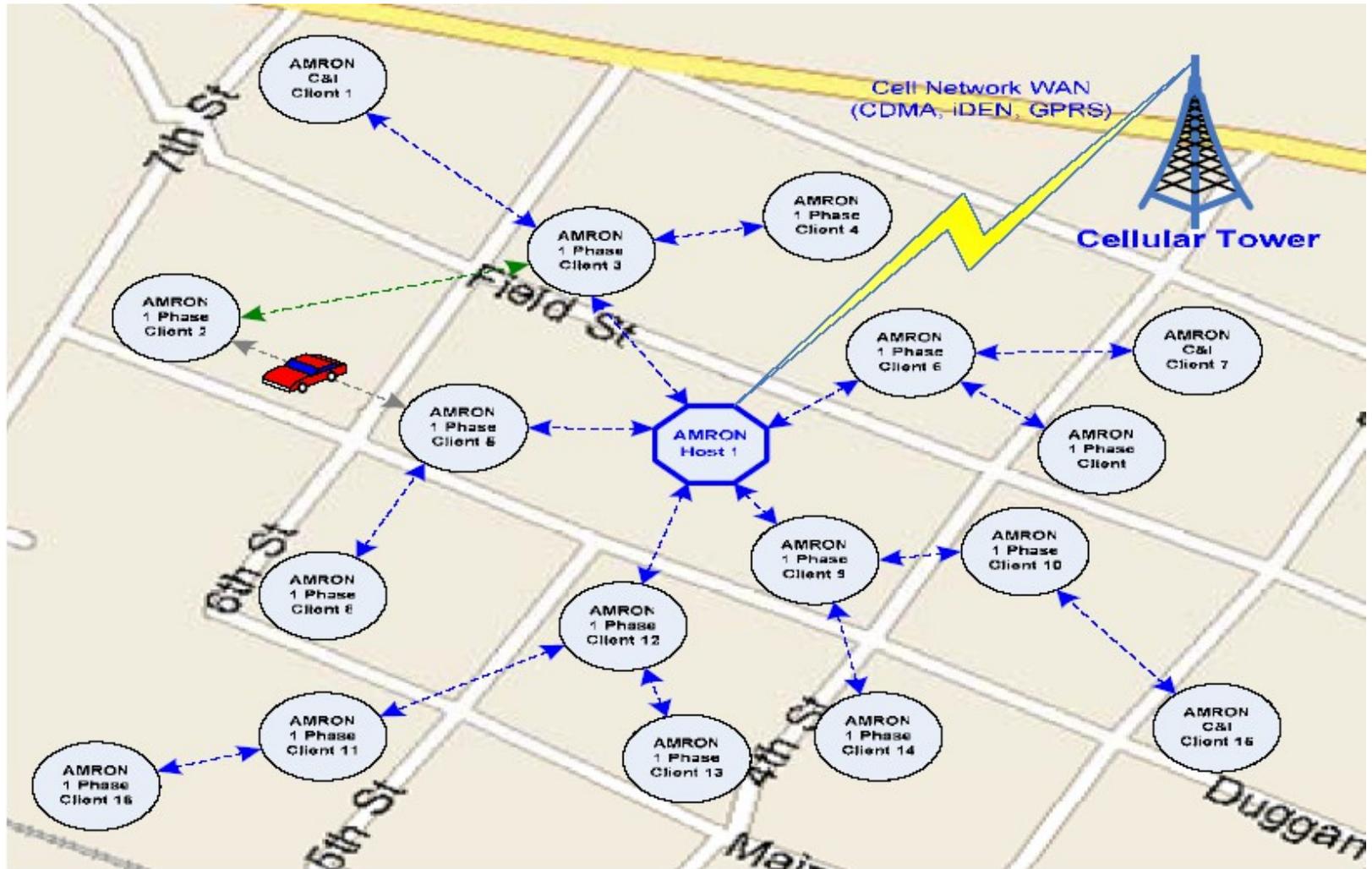
# HVAC Energy Management

- Hotel energy management
  - Centralized HVAC management allow hotel operator to ensure empty rooms are not cooled
  - Easy to retrofit
  - Battery operated thermostats, occupancy detectors, humidistats can be placed for convenience
  - Personalized room settings at check-in





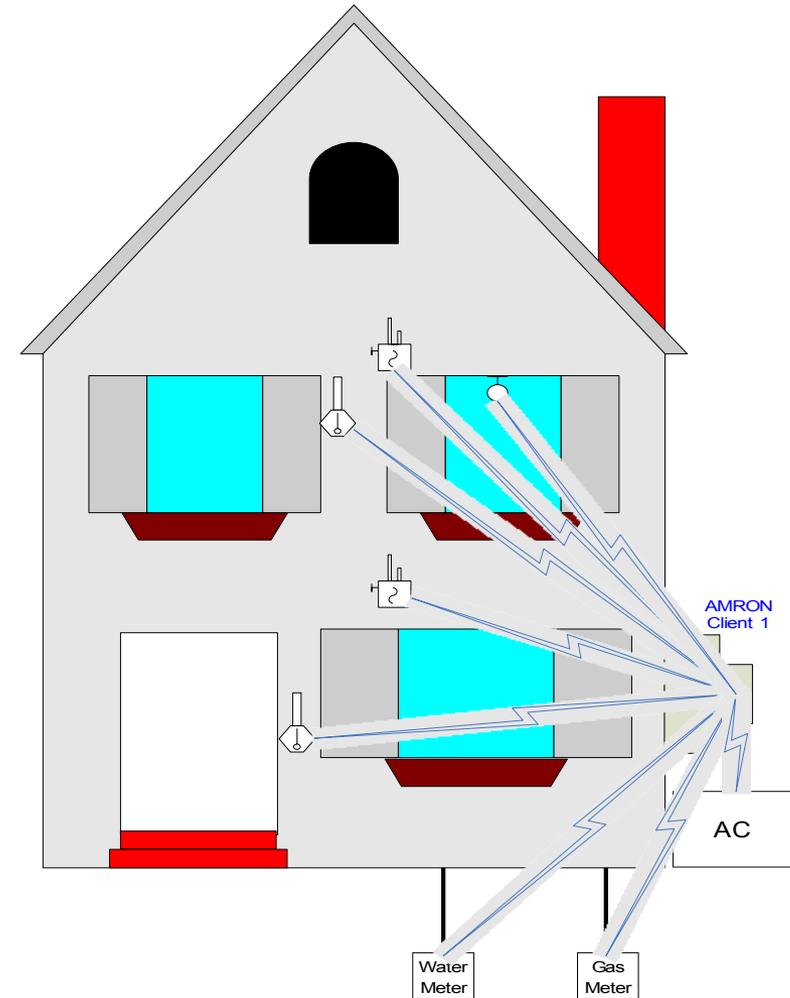
# AMR network example





# Advanced Metering Platform with ZigBee

- Rapid method to help manage global electric generation shortage and meet existing and pending legislation for energy control
- Can network with other ZigBee devices in the home for load control – e.g. Heating/AC, Security, Lighting, White Goods
- Worldwide standard ZigBee allows communications between various meter types from different manufacturers.





# Mobile Handset as ZigBee Gateway

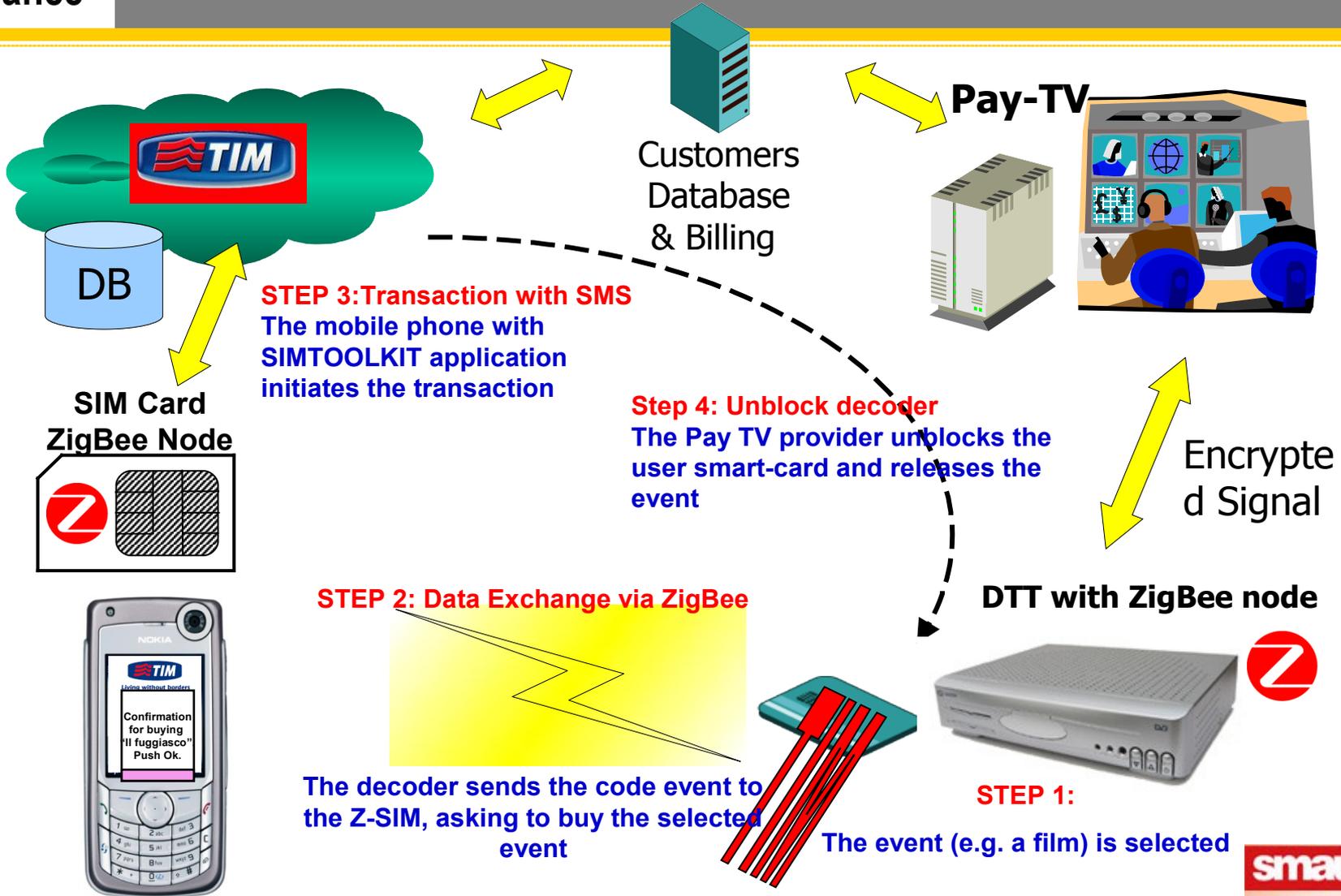
- Use mobile handset as a gateway to collect and display information
- In a mobile phone a **ZigBee** enabled SIM, the personal token, can play the **Gateway** role



- The Telecom operator does more than transport data:
- **Trust-Center**: security, user authentication, reliability
  - **Service Provider of new value-added services**
  - **Service management, configuration and personalization**



# Use Case (1) : DTT STB

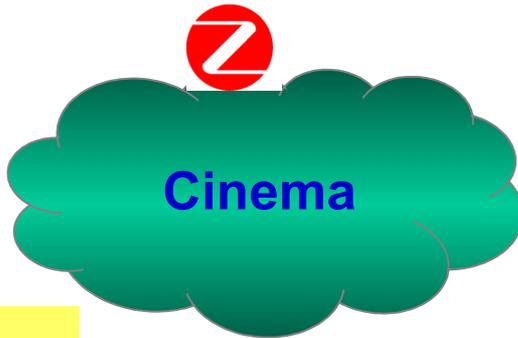




# Use Case (2): Cinema Example

## STEP 1:

Environment with ZigBee node



## Step 3:

The users with SIMTOOLKIT application buy the content. The operator manages the bill transaction and downloads the token to the SIM for enabling the access to the cinema



## STEP 2:

User having Z-SIM is recognized by the environment and is invited to buy a cinema ticket



Encrypted SMS



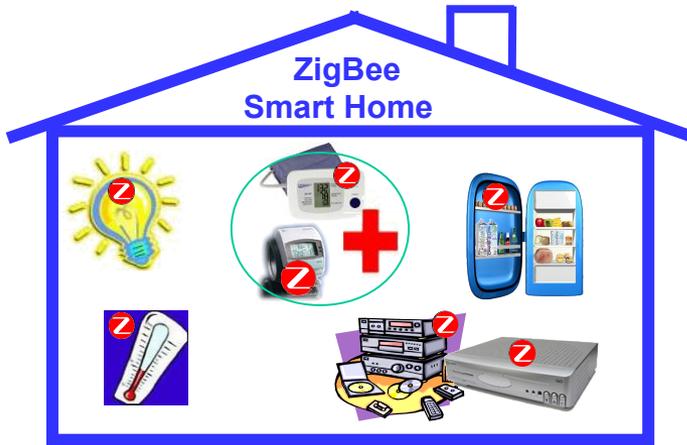
## Step 4:

The token is received and sent to the printer via ZigBee

The ticket is automatically printed

# Z-SIM: M-commerce and Beyond

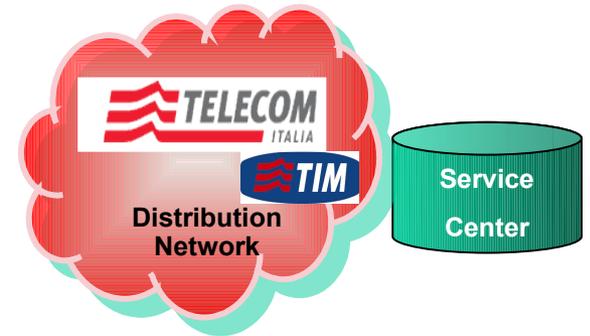
**Z-SIM is the hub of the interaction between user and objects**



## Home Automation & Control

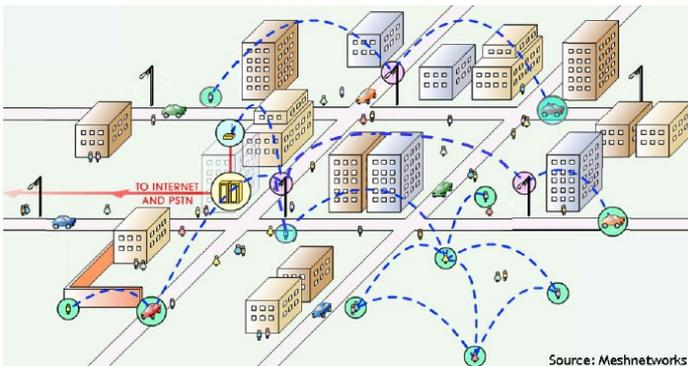
- Lights, HVAC, Domestic appliances
- Entertainment (e.g. DTT)
- Healthcare, Tele-assistance
- Monitoring & Security (e.g. temperature, gas)

Mobile Terminal



## M-Commerce Services

- m-payments (bar, shops, supermarkets)
- m-ticketing (cinema, train, bus)



## Digital Smart City

- Access Control
- Parking payment system
- Infomobility services (e.g. traffic control)
- Environmental Monitoring
- Localization

# ZigBee Enables Enhanced Value

Location



Safety



Maintenance



Security





# Why ZigBee?

- Standards based
  - Low cost
  - Can be used globally
  - Reliable and self healing
  - Supports large number of nodes
  - Easy to deploy
  - Very long battery life
  - Secure
- 
- Open Standards Enable Markets



# Open Standards vs. Proprietary Solutions?

- Product interoperability
- Vendor independence
- Increased product innovation as a result of industry standardization
- A common platform is more cost effective than creating a new proprietary solution from scratch every time
- Companies can focus their energies on finding and serving customers



# Benefits of joining the alliance

- Access to
  - Specifications
  - Member IP pool
  - Event lists
  - Media and analysts
  - VCs
- Network with
  - Members
  - Customers
  - Vendors
  - Partners





# Benefits of joining the alliance

- World class PR
  - Be associated with a hot technology
  - Leverage Alliance event and PR activities
- Your competitors are here, chance to strengthen your leadership position
- Get access to marketing ideas, get a sense of the market direction and optimize your product/company plans
- Equivalent info from other sources would cost many multiples of the annual membership fee
- Result is you get to market quicker with a better solution

# ZigBee Alliance Tradeshows and Events First Half 2007

- Jan 8-11 CES Las Vegas, NV
- Jan 29-31 AHR Expo Dallas, TX
- April 1-5, 2007 ESC San Jose, CA
- April 2-5, 2007 ZigBee Dev Con co-located with ESC
- April 16-20, 2007 Hannover Messe Hannover, Germany
- April 26, 2007 ZigBee Open House & Expo Europe
- May 8-10, 2007 Lightfair New York, NY
- June 11-13, 2007 Sensors Expo Chicago, IL
- June 10-21, 2007 ZigBee DevCon Europe Munich, Germany
- July 17-19, 2007 Wireless Japan Tokyo, JP



“Just as the personal computer was a symbol of the '80s, and the symbol of the '90s is the World Wide Web, the next nonlinear shift, is going to be the advent of cheap sensors.”

*-Paul Saffo*

*Institute for the Future*





# More Information

*Be a part of the future-Join the ZigBee Alliance*

ZigBee Alliance Web Site

<http://www.ZigBee.org>

Bob Heile

ZigBee Alliance Chairman, [bheile@ieee.org](mailto:bheile@ieee.org)