

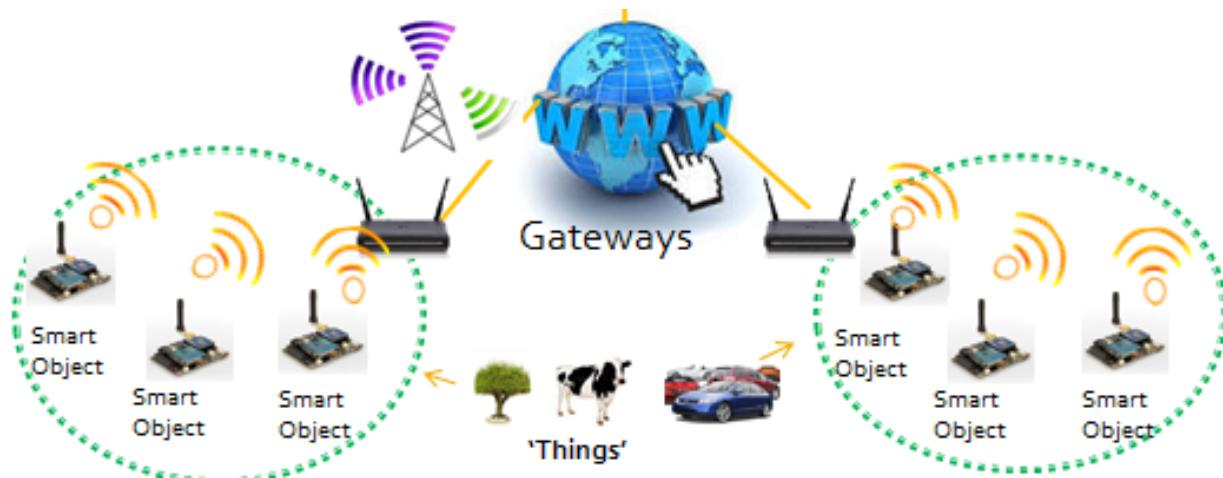
Communications Technology (Part 2)

IT3779 Smart Object Technologies

Outline

- Smart Objects Wireless Networks
- Smart Object Networks & Zigbee
- Emerging Standards for Smart Objects communication
 - 6LowPan
 - CoaP

What are Smart Objects Wireless Networks?

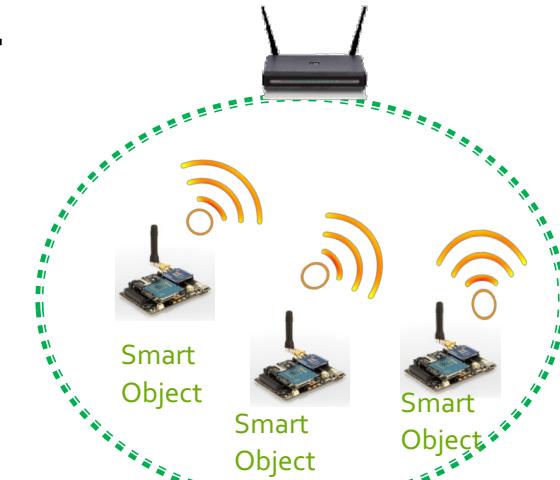


- A collection of small randomly dispersed smart objects that providing following functions:
 - Efficient & reliable communication
 - Monitoring of environmental conditions such as temperature etc
 - At times, ability to operate devices such as switches that control those condition

Characteristics of Smart Objects Wireless Networks

- Designed for low traffic monitor and control applications
 - Low data rates throughput
 - Operate with lower power consumption
 - Large distance coverage

- Typically self-organizing and self-healing
 - Allow new nodes to automatically join the network without manual intervention
 - Reconfigure link associations and find alternative pathways around failed or powered-down nodes



Smart Object Networks & Review of Zigbee

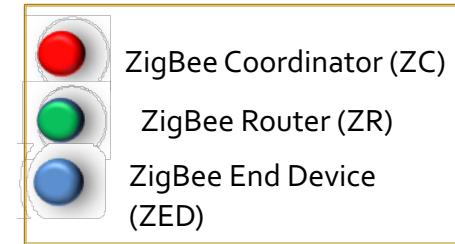
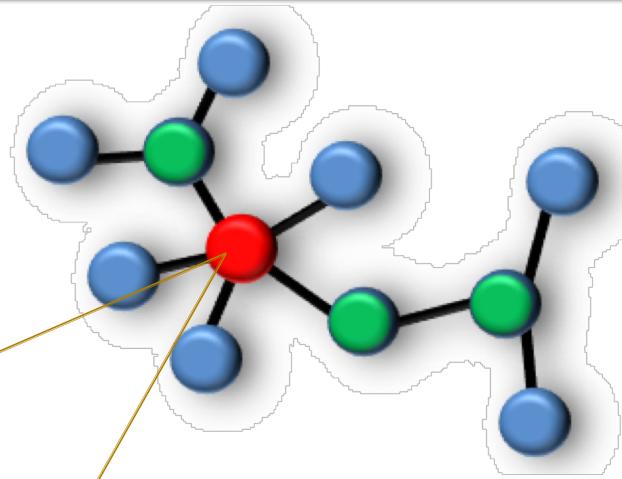
Requirements of SO Networks

- Low data rates throughput
- Operate with much lower power consumption
- Large distance coverage
- Typically self-organizing and self-healing

Zigbee Features

- Low data rate, typically 20 – 250kps, usually in burst
- Very low power; Nodes can sleep most of the time, lasting years
- Distance about 75 m, extended using routers
- Supports Mesh & other topologies. See later slides

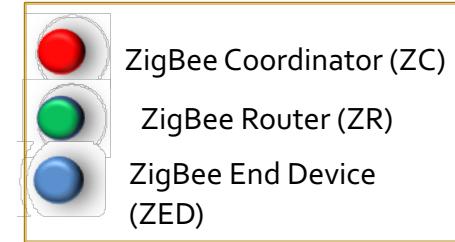
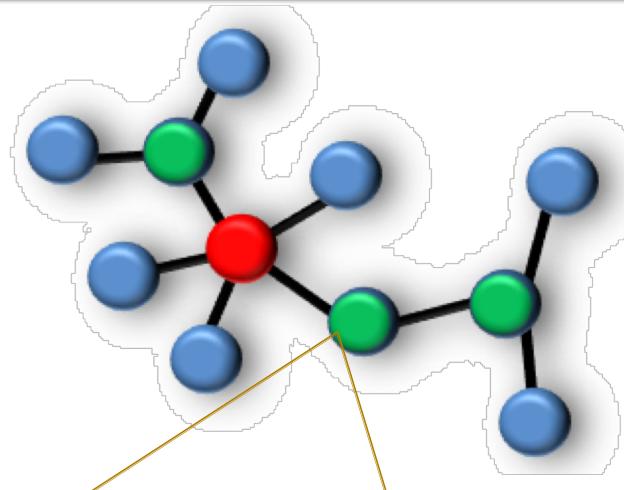
Zigbee Devices



ZigBee Coordinator (ZC)

- Responsible for creating the network
- Assign network addresses
- Adds other nodes to the network
- Can communicate with either ZR or ED

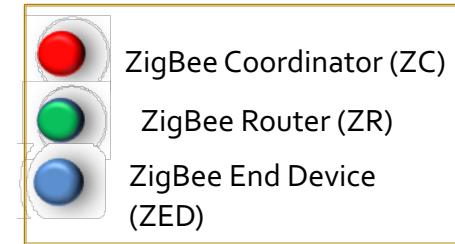
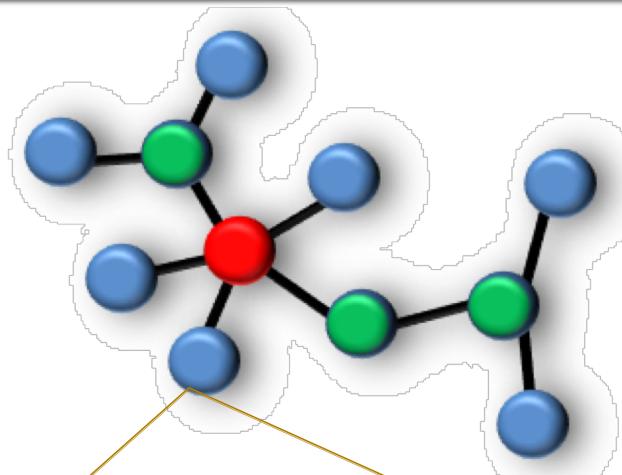
Zigbee Devices



ZigBee Router (ZR)

- Buffers data packets and route data between nodes
- Increase number of nodes allowed in network
- Extend the range of the network

Zigbee Devices

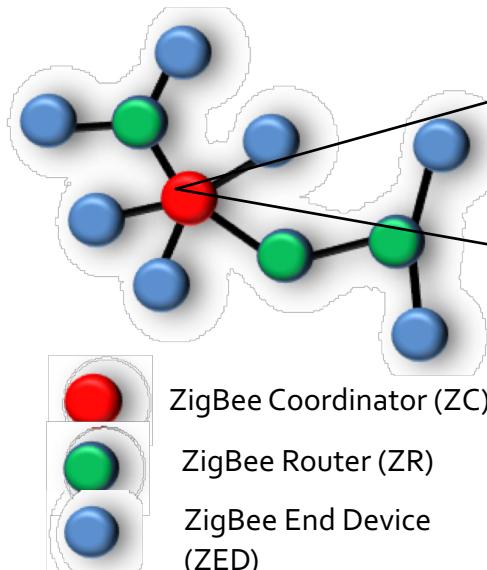


ZigBee End Device (ZED)

- Usually placed on devices like sensors
- Cannot relay data from other device
- Sleep significant amount of time to save power

Zigbee Network Fundamentals

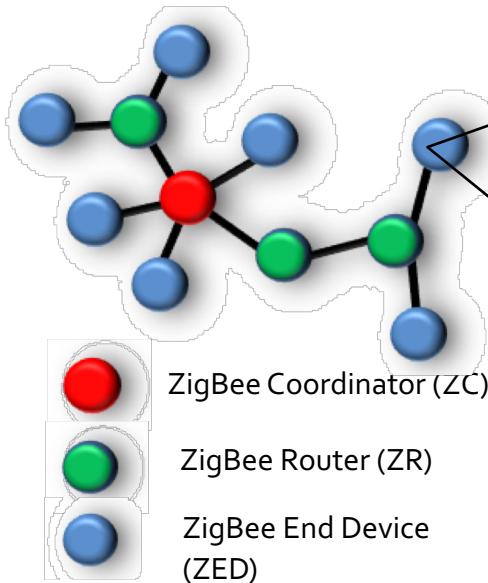
□ How is a Zigbee Network formed?



1. Coordinator starts network by searching for a radio channel
2. Once channel is found, Coordinator assign a PAN ID to network after detecting ID is not in conflict with other nearby networks
3. Coordinator also assigns a network address to itself
4. Coordinator starts network & ready to respond to queries from other devices that wish to join the network

Zigbee Fundamentals

How do new nodes join a Zigbee Network?

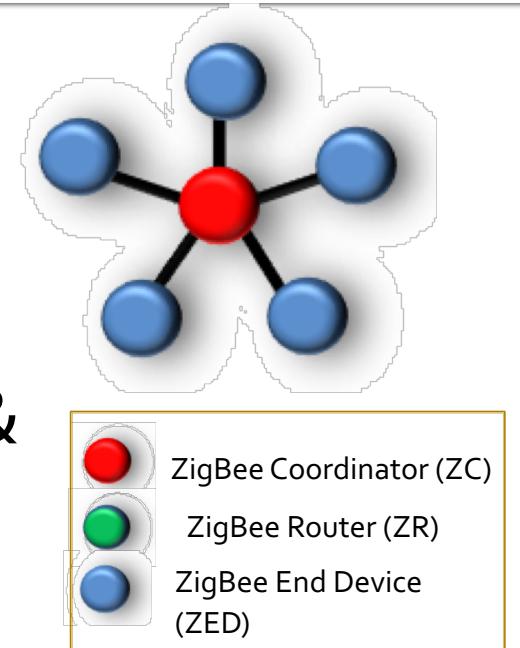


1. New node searches for network
2. New node selects a Parent which can be a Router and Coordinator, usually, one with the strongest signal
3. New node sends a Join Request to relevant Router or Coordinator to request permission
4. Router or Coordinator Accept or Reject Join Request
5. Accept or reject depends on whether request within same address space or if currently allowed to join

Zigbee Network Topology : Star

□ Star Topology

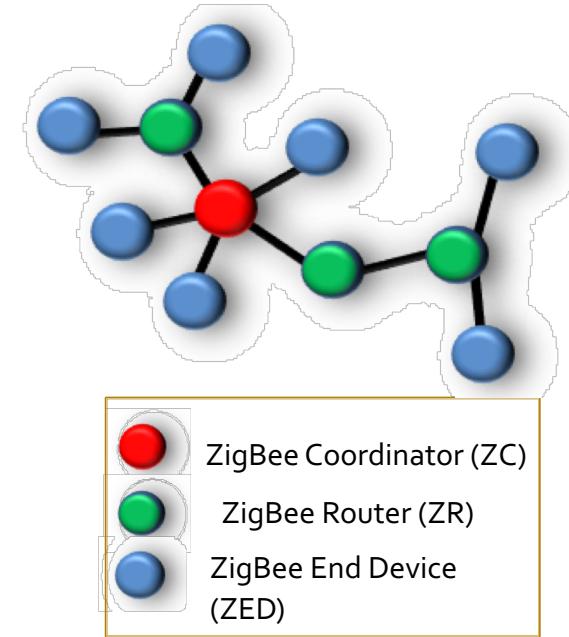
- Aggregation of ZR End devices linked to ZC Coordinator
- **ZC** Coordinator controls network & responsible for maintaining network devices
- All other devices, known as end devices, directly communicate with coordinator
- Drawback : master node is a single point of failure; if a master node fails, the entire sub-network fails



Zigbee Network Topology

Tree Topology

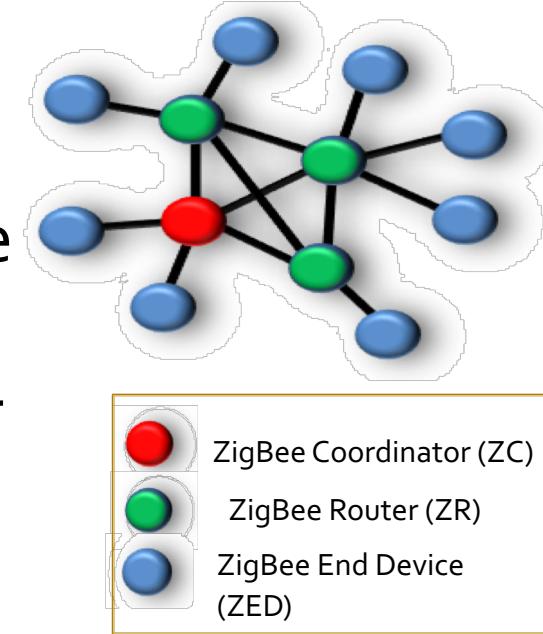
- ZC Coordinator also responsible for starting network
- Network may be extended using of routers ZR
- Routers move messages through the network using a hierarchical routing strategy
- If ZC is down, communication still possible



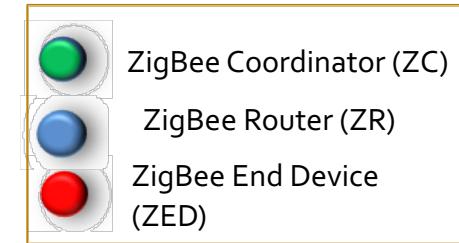
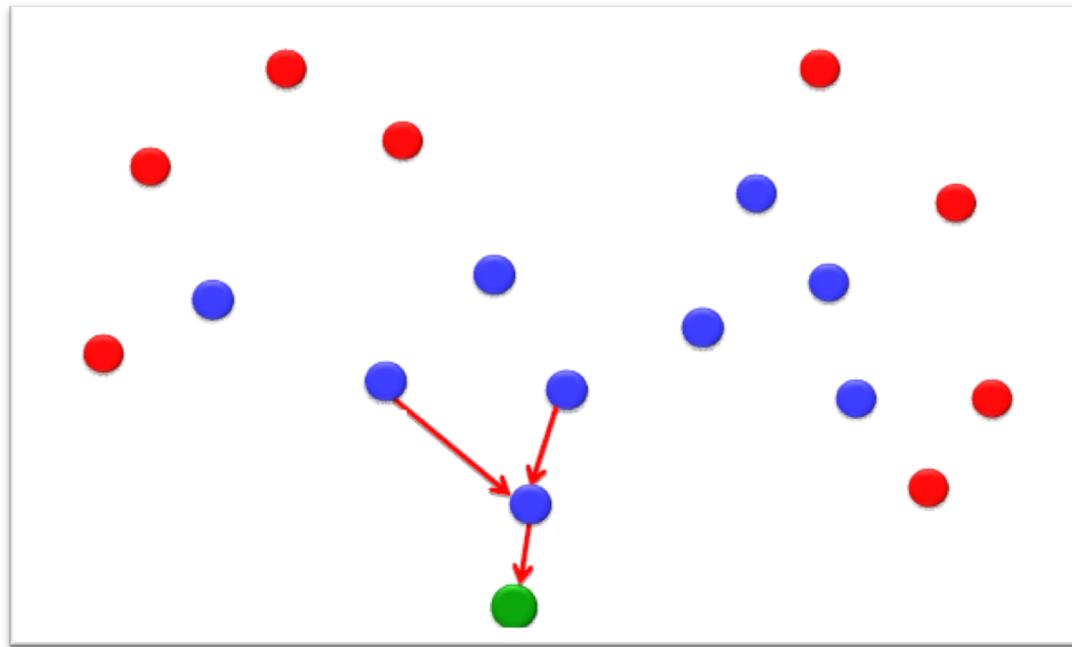
Zigbee Network Topology

❑ Mesh Topology

- Consists of 1 ZC Coordinator, Multiple ZR Routers and ZED End Devices
- Routers can send data to Coordinator or other Routers
- Multiple routes providing resiliency to network
- Uses algorithm to optimize for lowest latency or lowest power
- If ZC down, communication still possible

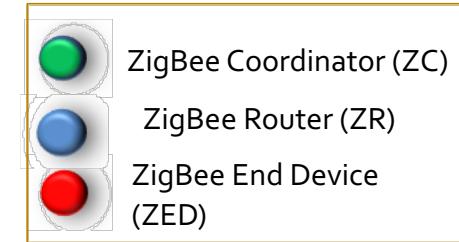
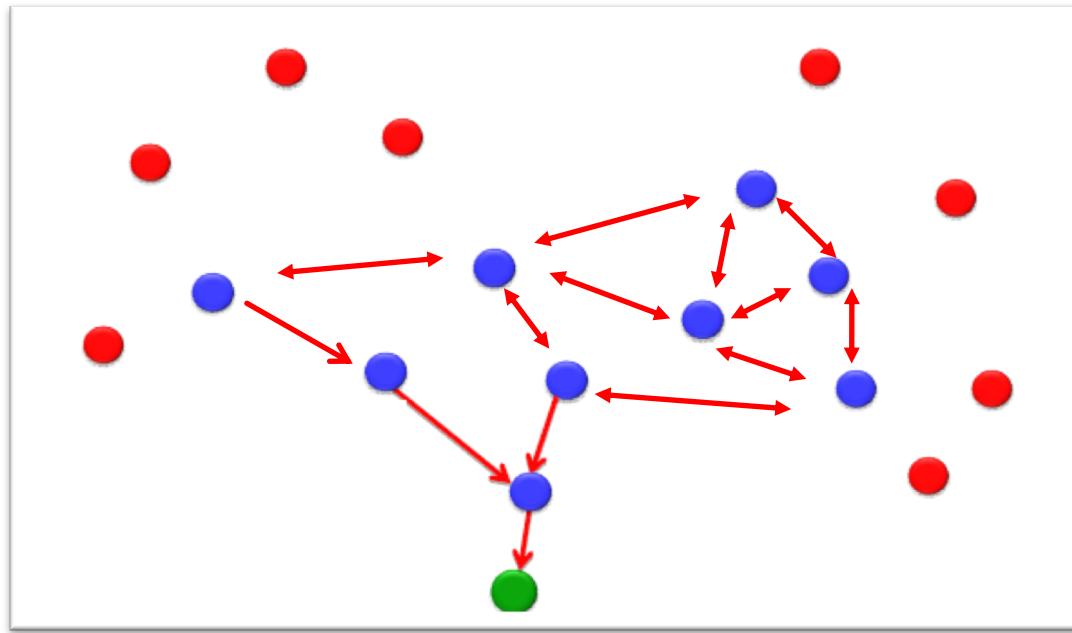


How does Zigbee Mesh Network work?



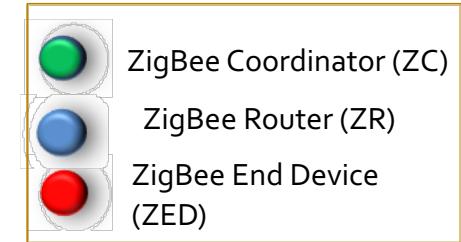
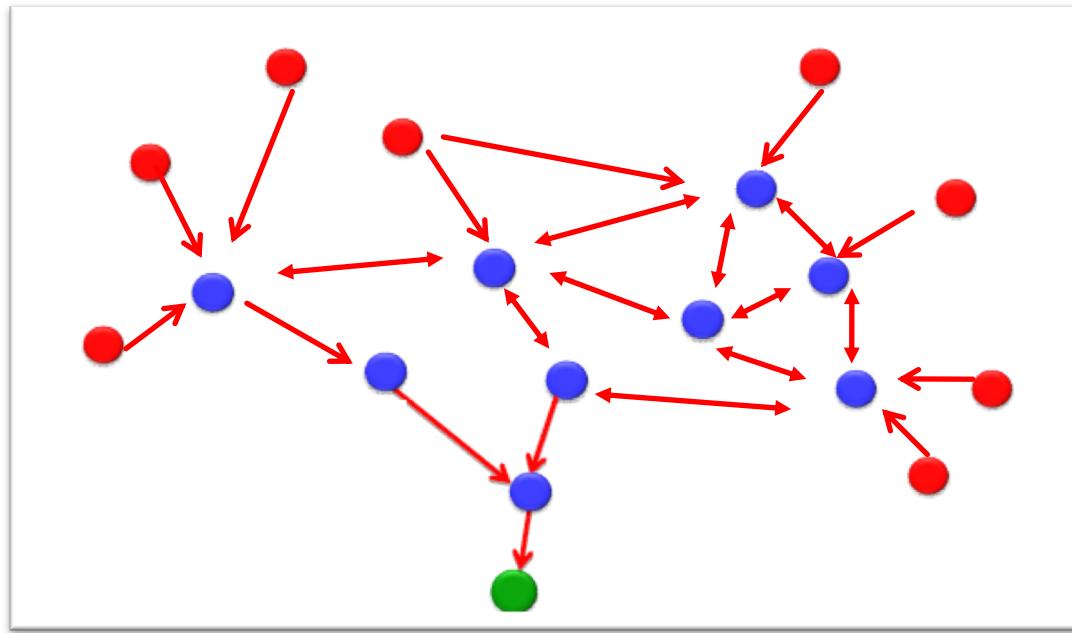
- ZC Coordinator establishes a PAN ID and nodes within range effect joining

How does Zigbee Mesh Network work?



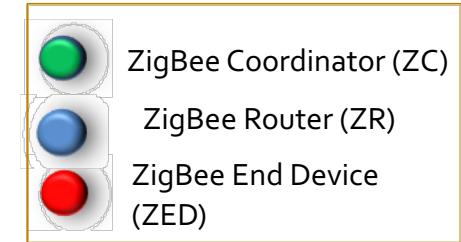
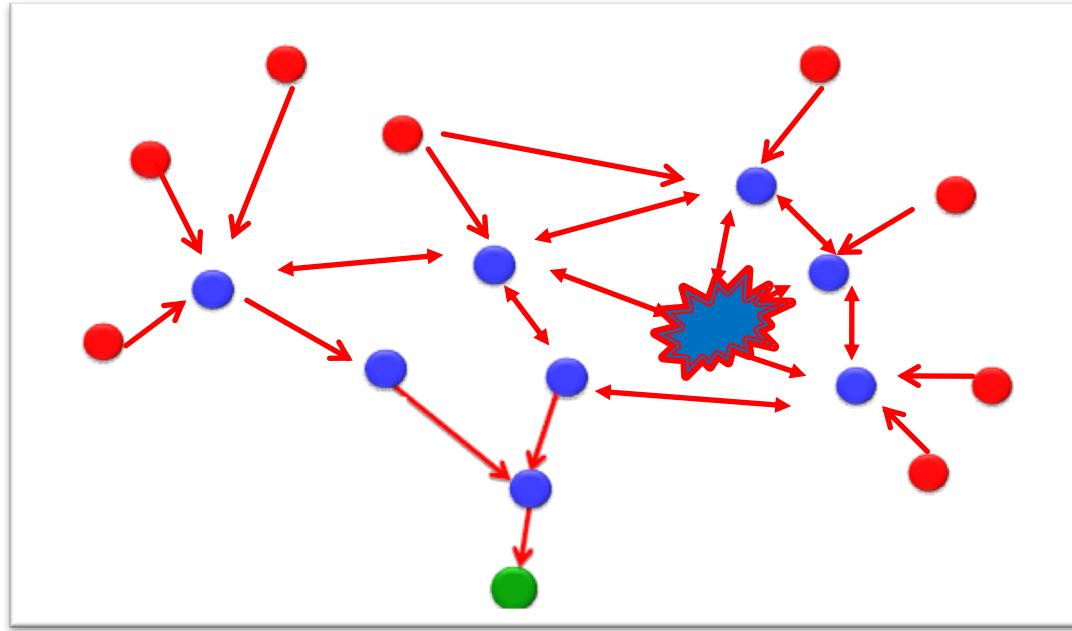
- As ZR routers join a network they mesh with each other
- The resulting network is very robust and reliable

How does Zigbee Mesh Network work?



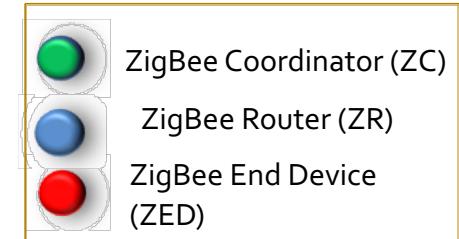
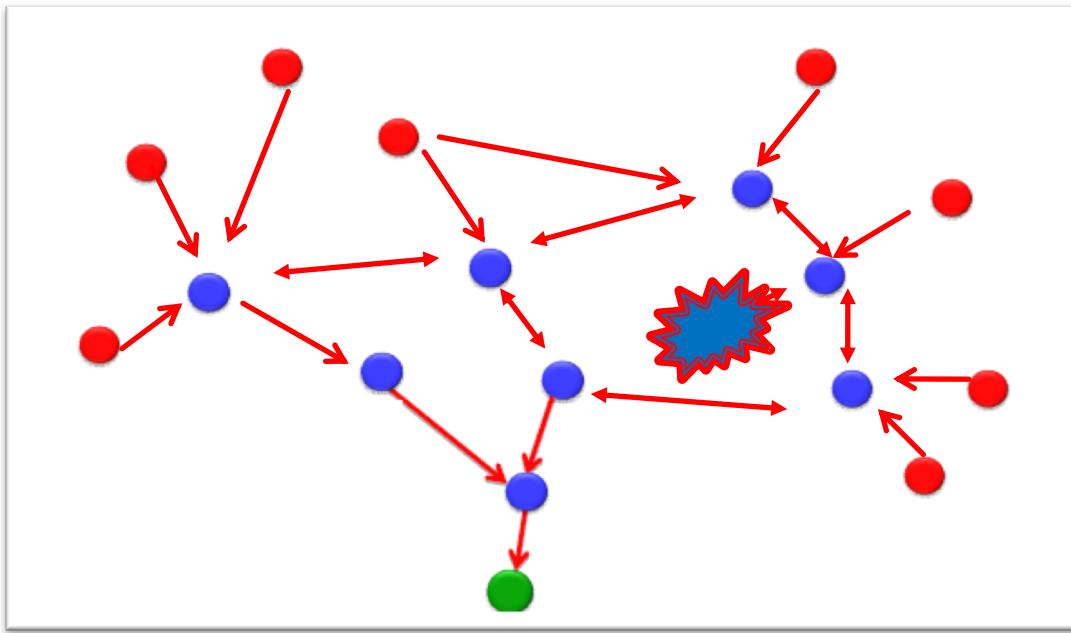
- End devices (ZED) do not have routing responsibilities in networks –being asleep most of the time

How does Zigbee Mesh Network work?



- The loss of a node is not catastrophic in networks
- Nodes will seek alternative data paths back to the coordinator (ZC)

How does Zigbee Mesh Network work?



- ❑ The loss of a node is not catastrophic in networks
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Emerging Standards for Smart Objects communication

- ❑ Existing lower power wireless communication technologies are proprietary & are not compatible with each other
- ❑ The emerging trend is to IP-enabled every Smart Object using IPv6
 - IP-based devices can be connected easily to other IP networks without using gateways
 - IP networks allow the use of existing network infrastructure
 - IP-based technologies have existed for decades, are very well known, and have been proven to work and scale



Emerging Standards for Smart Objects communication

- However, IP based protocols are too complex & demanding on low power smart objects



- Security : IPv6* support for IP Security (IPsec) which are too complex
- Web services: Internet services rely on web-services, using TCP, HTTP and XML with complex transaction patterns
- Frame size: IP Internet protocols require minimum frame length of 1280 bytes for IPv6

*IPv4 is not used as it is running out of addresses

6LowPAN

- Solution to IP based protocol for Smart Objects :
6LowPan* *Acronym of IPv6 over Low-Power wireless Area Networks
- 6LowPan: A protocol for Smart Objects to carry
IPv6 over *Low power* Wireless Area Networks

6LowPAN

□ Main characteristics

- Small packet size: maximum physical layer packet of 127 bytes
- Low bandwidth: Data rates of 250 kbps maximum
- Topologies include star and mesh operation
- Low power & low cost: devices are battery operated
- Large number of devices expected to be deployed during the lifetime of the technology

6LoWPAN

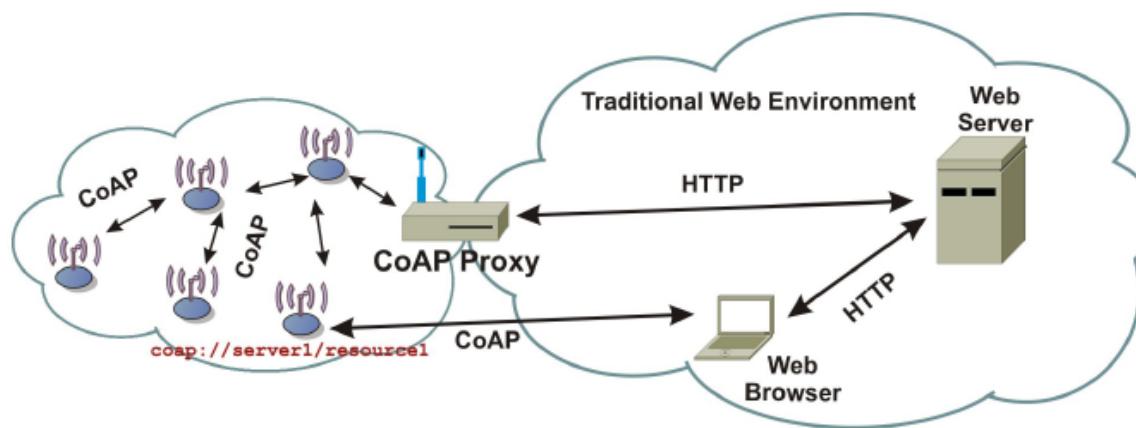
**IP-Based Wireless
Connectivity for the
Internet of Things**



[Click here for 6LowPan Video Intro](#)

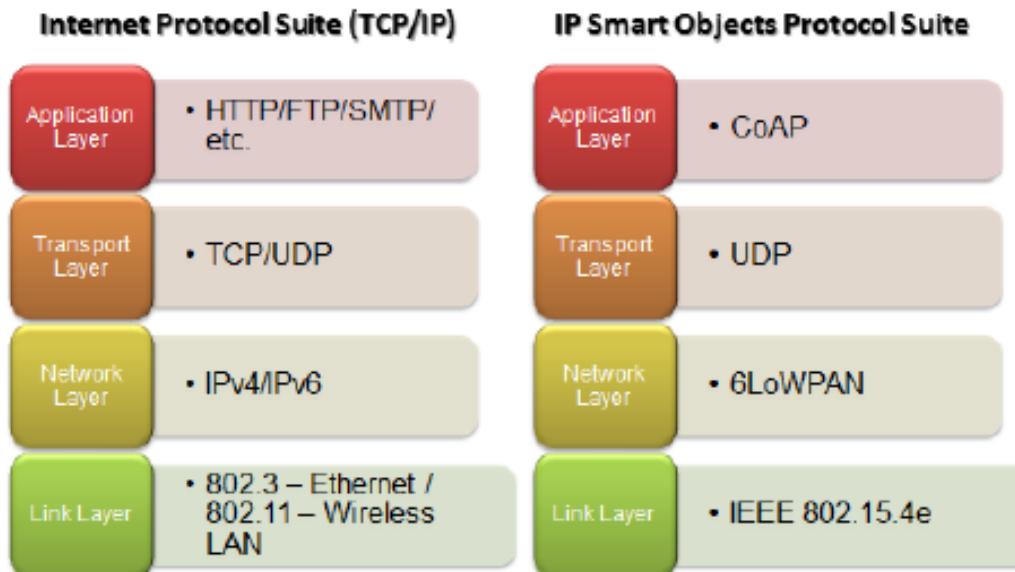
CoAP

- Internet services using TCP, HTTP and XML require complex transactions; Hence, not suited for Smart Objects
- Constraint Application Protocol (CoAP)
 - HTTP based functionality designed for low power Smart Objects
 - Like HTTP, access resources using GET, PUT, POST, DELETE



CoAP

- Comparison between Internet Protocol & Smart Object Protocol



CoAP

- Comparison between Internet Protocol & Smart Object Protocol

	HTTP Transaction	CoAP Transaction
Data size for same request	1451 bytes	154 bytes
Power consumption for same request	1.333 mW	0.744 mW

- CoAP is more efficient than HTTP in terms of data transmission & power consumption

End