Wireless LAN and Personal Area Network

Lesson 07

ZigBee, WiFi and Bluetooth

ZigBee– a suite of high-level communication protocols

- ZigBee devices for personal area network of embedded sensors, industrial controllers, or medical data systems

ZigBee– a suite of high-level communication protocols

- ZigBee 1.0 specification released in December 2004
- ZigBee devices conform to the IEEE 802.15.4-2003 Wireless Personal Area Network (WPAN) standards

ZigBee IEEE 802.15.4

- Lower stack size (28 KB) in the protocol than Bluetooth
- Lower network-joining latency when compared to Bluetooth (250 KB)
- Lower carrier frequencies (915 MHz band or 868 MHz) in place of 2.4 GHz Bluetooth, requiring lesser transmission energy. Needs low transmitting power systems

ZigBee IEEE 802.15.4

- Interoperable standard based on RF wireless communication

ZigBee

- Provides large-scale automation and the remote controls up to a range of 70 m
- Data rates of 250 kbps, 40 kbps, and 20 kbps at the spectra of 2.4 GHz, 902 MHz to 928 MHz, and 868 MHz to 870 MHz, respectively
- Uses DSSS

ZigBee

- Designed for robotic control
- Industrial
- Home
- Monitoring applications

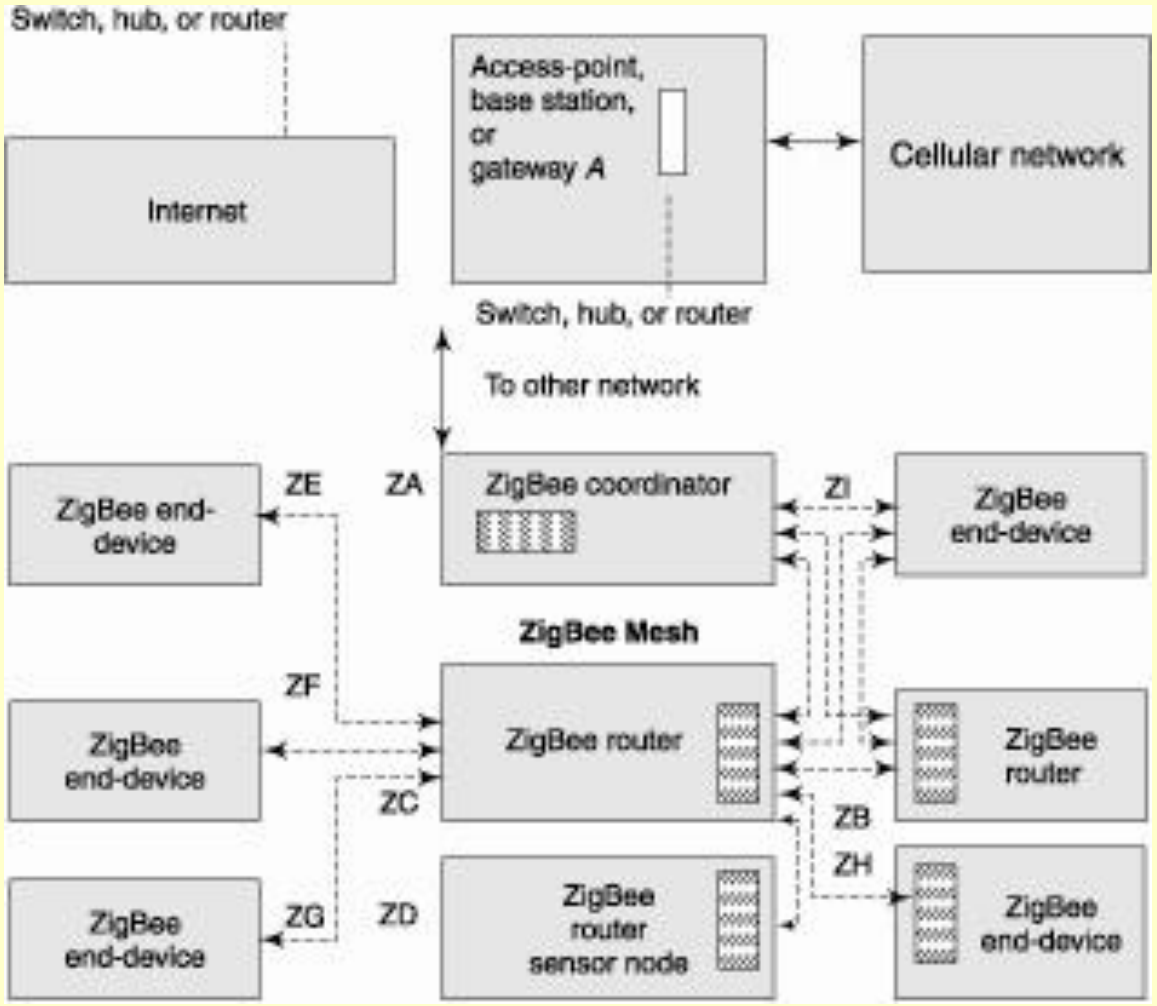
ZigBee Applications

- ZigBee enabled electric meter communicates electricity consumption data to the mobile meter reader
- A ZigBee enabled home security system alerts the mobile user of any security breach at the home

Three type of ZigBee devices in networks

- ZigBee Coordinator
- End-devices
- ZigBee router-devices

Three type of ZigBee devices in networks



ZigBee coordinator

- Root node at each ZigBee network tree
- It can connect to other networks and has full network information along with a store of the security keys for the ZigBee network nodes [ZA]

ZigBee router node

- Responsible for transfer of packets from the neighboring source to nearby node in the path to destination [ZB, ZC, and ZD]

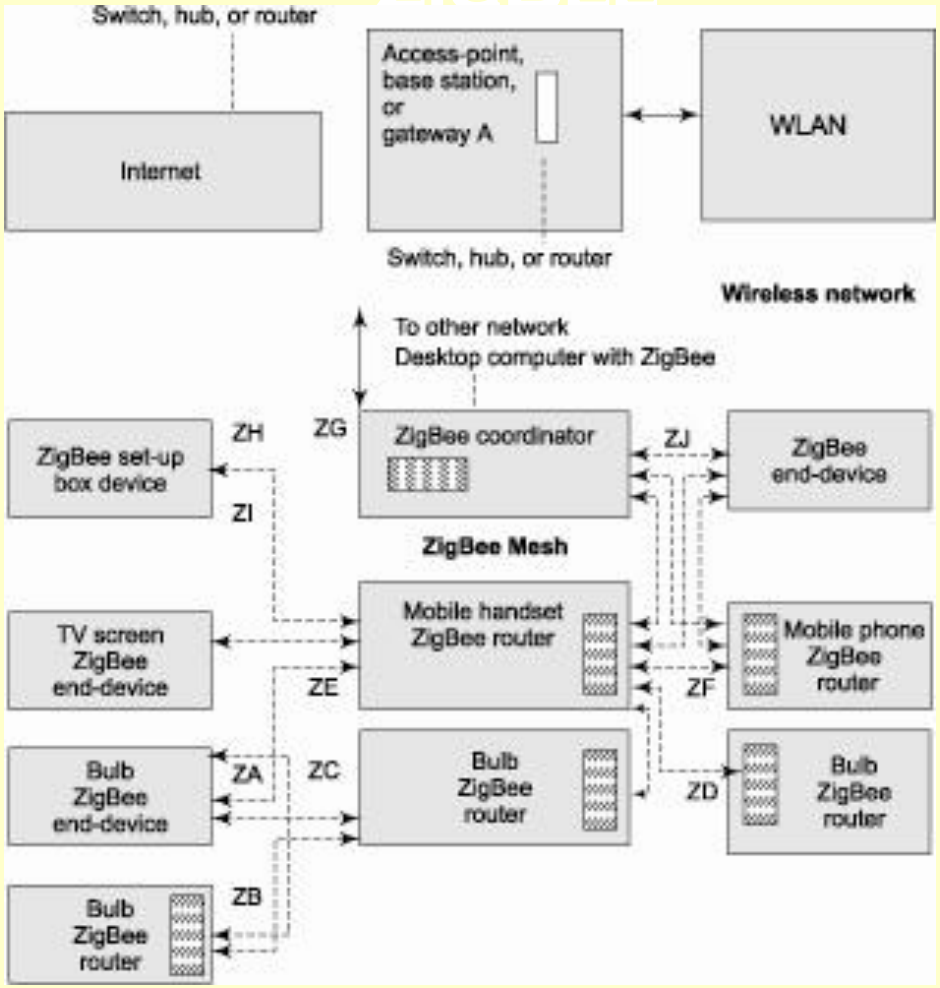
ZigBee end-device

- Receives packet from a nearby node in the path from a source

ZigBee networks of two types

- Peer-to-peer—For example, ZC—ZD—ZH network in which each node has a single path to neighbouring node only
- Mesh—For example, ZA— ZB— ZC network in Fig. 12.17 in which each node has a path to every other node

Wireless personal area network of each sensor, device, or node using ZigBee



ZigBee devices

- ZA– ZigBee end-device
- ZB, ZC, and ZD – a set of electric bulbs associates with the ZigBee routers
- Each router in parallel
- The set forms a peer-to-peer connection network (ZE—ZD —ZC—ZB — ZA) with last one being ZigBee end-device (ZA)

ZigBee coordinator (ZG)

- Connect this network with other ZigBee networks (for example, of mobile hand-held devices ZE and ZF)
- The coordinator ZG also connects the access-point for WLAN and provides Internet connectivity to router ZJ for security system, to cellular phone network and set-up box device ZH, and screen ZI

ZigBee network router nodes

- ZE, ZF, and ZG use mesh network connections

Basic Features of ZigBee

- Radio frequency bands and modulation methods— ISM bands— 2.4 GHz orthogonal QPSK , 915 MHz (USA) BPSK, and 868 MHz (USA) BPSK
- ZigBee device channels— For 2.4 GHz, there are 16 ZigBee channels
- Each channel has freuency band (2400 + 5× n) ± 1.5 MHz, where n = 1, 2, ..., 15, or 16

Basic Features of ZigBee

- ZigBee data transfer rates– 2.4 GHz at 250 kbits/s per channel, 915 MHz bands at 40 kbit/s per channel, and 868 MHz bands at 40 kbit/s per channel
- Radio interface– DSSS

Basic Features of ZigBee

- ZigBee protocol layers— Physical and a DLL (data link layer) part, called MAC (media access control)
- Device types— Coordinator, router, and end-device types
- Routing protocol— AODV

Protocol layers

- Physical layer as provided in IEEE 802.15
- MAC layer as provided in IEEE 802.15
- Security and application software layers as specified by the ZigBee Alliance

Network Characteristics

- Self organization
- Peer-to-peer
- Mesh networks
- Mesh networking for big scale automation and remote controls at short ranges at small data rates

Comparison of ZigBee and WiFi

- Protocol 802.11z for WiFi; ZigBee 802.15.4
- WiFi Carrier Two 2.4 GHz physical layers
- ZigBee 2.4 GHz for high data transfer rate and 915 MHz and 868 MHz bands for low transfer rates
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Similarity of WiFi and ZigBee

- Both conform to IEEE 802.15 set of standards
- Use of spread spectrum modulation results in spectrum efficiency in both
- Use of 2.4 GHz (in USA) in both

Comparison of WiFi and ZigBee

- WiFi 6 MHz to 54 MHz (Data rate of each carrier 5.5 Mbps by QPSK to map 4 bits and 11 Mbps 8-QPSK to map 8 bits simultaneously) [OFDM supports multi-carrier communication.]
- Using 2.4 GHz at 250 kbps per channel, using 915 MHz bands at 40 kbps per channel, and using 868 MHz bands at 40 kbps per channel

WiFi and ZigBee Applications

- WiFi: a wireless LAN interconnecting a set of computers. Networking is such that all units in the set can address and communicate with each other
- ZigBee: A wireless-based low-power, short-range WPAN generally for routing of messages, forming a mesh network, and using reactive and proactive protocols for routing.

Dissimilarity with Bluetooth

- Bluetooth for wireless short range exchanges in mobile environment
- ZigBee for big scale mesh-network-based automation and remote control

Comparison of Bluetooth and ZigBee

- Network connection latency—3 s for Bluetooth and 20 ms for ZigBee
- Bit rate—1 Mbps for Bluetooth and 250 kbps for ZigBee
- Protocol stack—250KB for Bluetooth and 28 kB for ZigBee

Comparison of Bluetooth and ZigBee

- Code Size—50% down to 2% as compared to a Bluetooth device
- FHSS used for Bluetooth and DSSS for ZigBee

Similarity of Bluetooth and ZigBee

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Similarity of Bluetooth and ZigBee

- Used for low power short range transmission
- Both have small form factors radiation pattern

Summary

- ZigBee for automation and the remote controls up to a range of 70 m
- For Data rates of 250 kbps, 40 kbps, and 20 kbps at the spectra of 2.4 GHz, 902 MHz to 928 MHz, and 868 MHz to 870 MHz, respectively
- DSSS

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...Summary

- Three types of devices: Coordinator, end-device and router
- Two type of networks- peer to peer and mesh
- Low stack size of protocol header

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End of Lesson 07

ZigBee, WiFi and Bluetooth