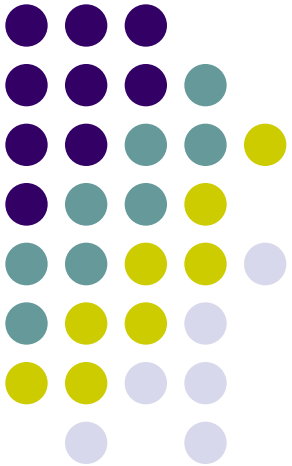
Chapter 12: Zigbee

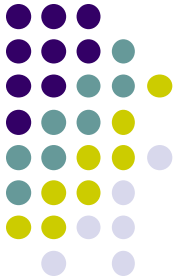
EE2405

嵌入式系統與實驗

Embedded System Lab

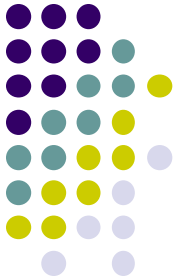


Content



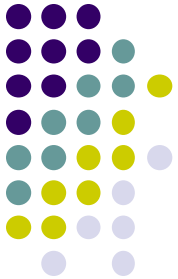
- Introduction
- ZigBee/IEEE 802.15.4
  - Physical Layer
  - MAC Layer
- ZigBee Network Topologies
- ZigBee Application Profiles
- ZigBee and Bluetooth Comparison
- Technology Trends

Sensor Network Challenges



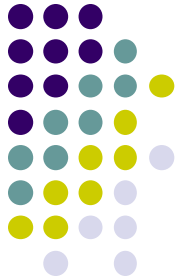
- Low computational power
  - Less than 10 MIPS
  - Low memory budget: a few KB~MB
- Limited energy budget
  - AA batteries provide ~2850 mAh
  - LiIon and NiMH batteries provide 800-2500 mAh
    - iPhone ~ 3000 mAh
  - Solar cells: around 5 mA/cm^2 in direct sunlight
- Communication?

Wireless Communication for WSN



- Wireless communication standards:
  - IEEE 802.11 a/b/g/n/ac/ax
  - Bluetooth
  - GSM/3G/5G
- What makes them unattractive for WSN:
  - Power hungry (need big batteries)
  - Complexity (need lots of clock cycles and memory)
- New protocol for WSN:
  - 802.15.4 and Zigbee (ratified in Dec 14, 2004)
  - Bluetooth Low Energy 4.0
  - LoRa
    - License-free sub-gigahertz radio frequency bands
    - LoRa enables long-range transmissions (>10 km in rural areas) with low power consumption.

Basic ZigBee overview



- ZigBee is a specification for a high level protocol stack using small, low-power and low-cost radios.
- Based on IEEE 802.15.4 standard for Personal Area Network.
- Maintained by ZigBee Alliance (www.zigbee.org)
- ZigBee data transmission rate varies from 20 to 900kbits.

ZigBee Applications

ZigBee

Wireless Control that Simply Works

BUILDING AUTOMATION

security
HVAC
AMR
lighting control
access control

CONSUMER ELECTRONICS

TV
VCR
DVD/CD
remote

PERSONAL HEALTH CARE

patient monitoring
fitness monitoring

PC & PERIPHERALS

mouse
keyboard
joystick

TELECOM SERVICES

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

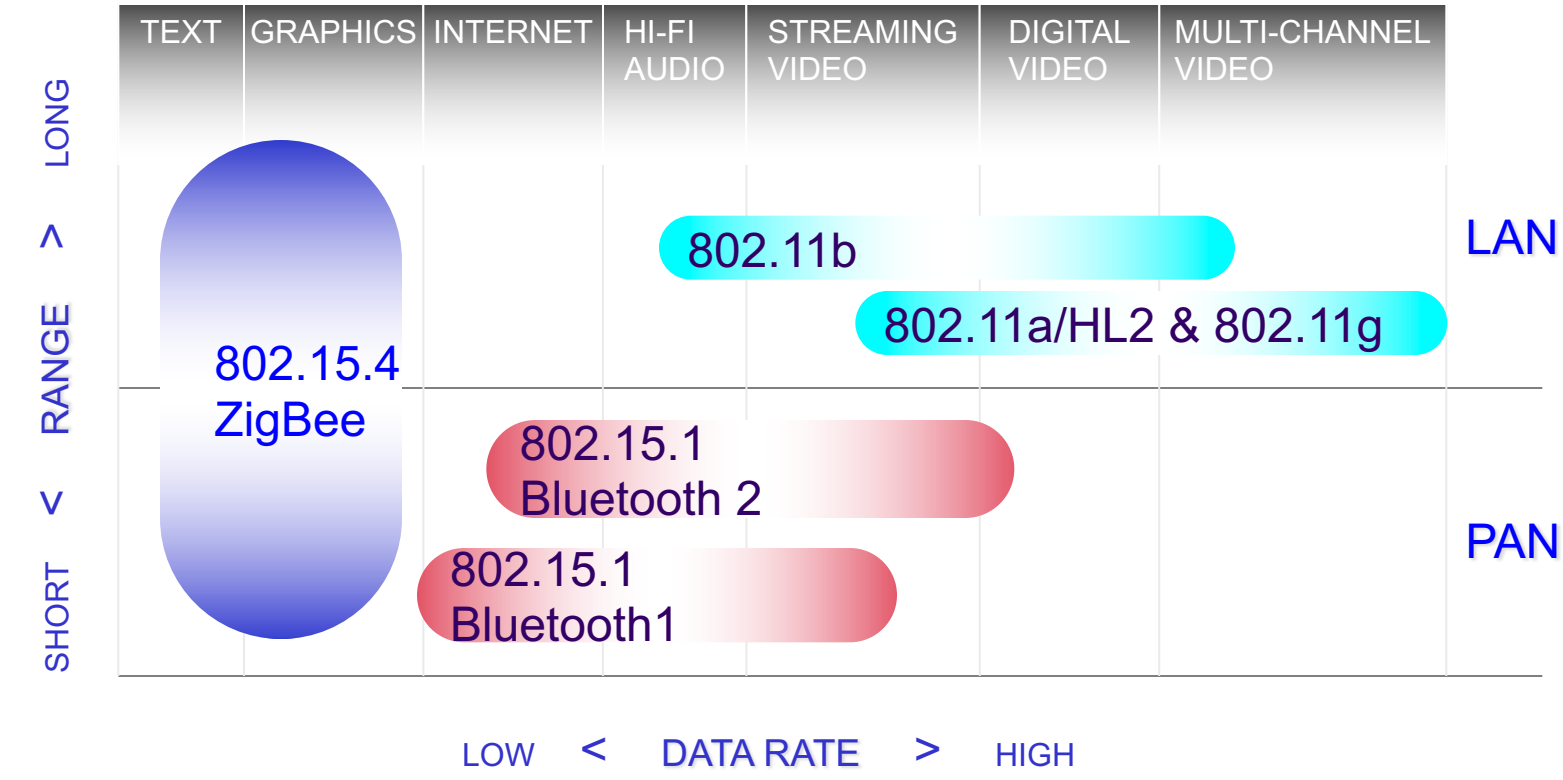
INDUSTRIAL CONTROL

asset mgt
process control
environmental
energy mgt

HOME CONTROL

security
HVAC
lighting control
access control
irrigation

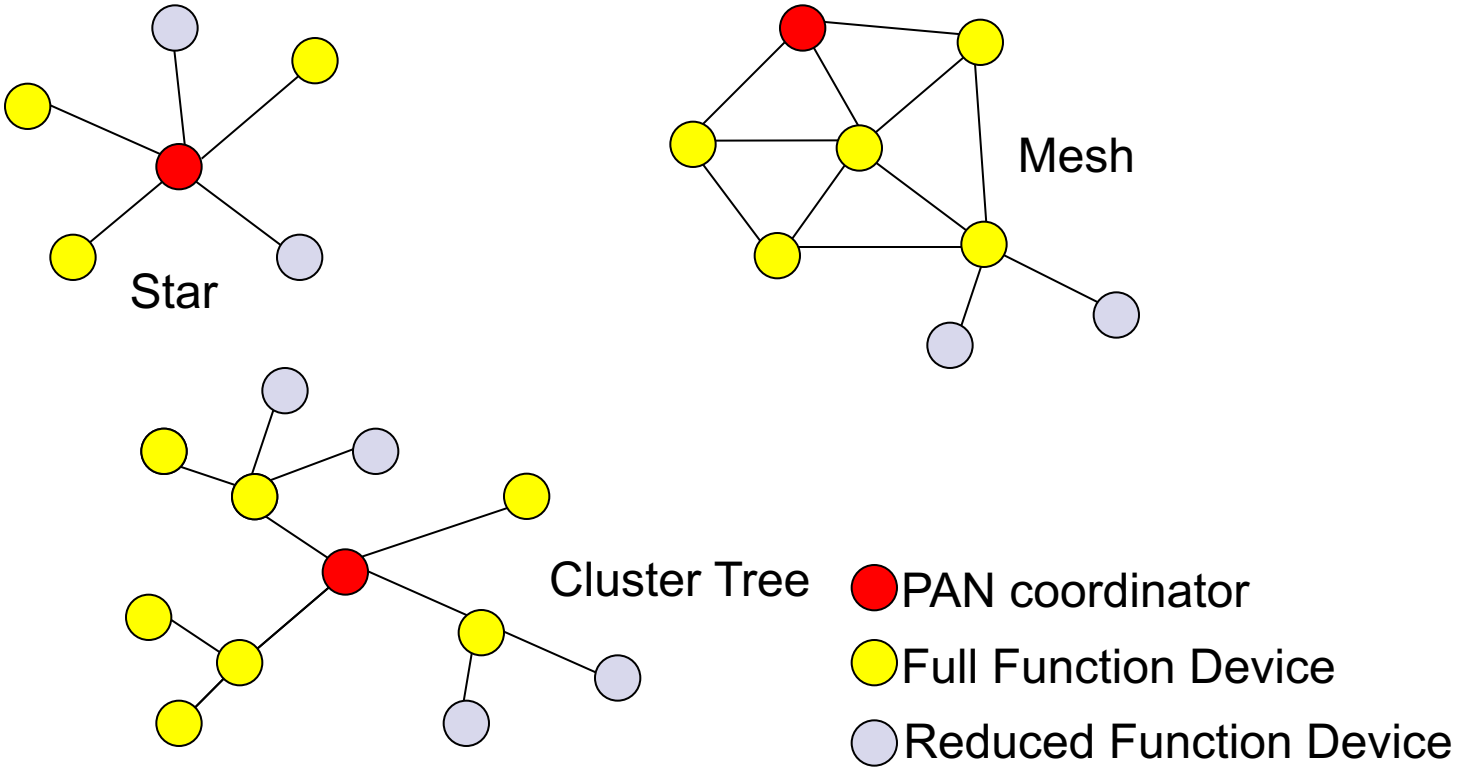
ZigBee and Bluetooth Comparison



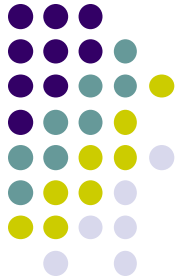
ZigBee and Bluetooth Comparison

Feature(s)	Bluetooth	Bluetooth Low Energy 4.0	ZigBee	WiFi
Complexity	complex	simple	simple	high
Nodes/Master	7	undefined	65535	255 subnet
Latency	100 ms	<3 ms	<10 ms	<100ms
Range	10 -100m	10-100m	10m-200m	10-100m
Power	1 as ref.	0.01-0.5	0.1-2	10
Data Rate	1-3 Mbps	1 Mbps	250 Kbps	11M-Gbps
Network	scatter	star	star or mesh	flexible
Security	64bit, 128bit	128bit AES and Application Layer	128bit AES and Application Layer	flexible

ZigBee Network Topologies



ZigBee AT Commands



- "**+++**" to enter the AT Command mode.
- **ATRE** to reset the XBee.
- ATCH to search the channel.
- ATDL to find the default DL value.
- ATMY to find the default MY value.
- ATCT 500 to increase the timeout value to 0.5s.
- ATWR to store your setting.
- ATCN to exit the AT Command mode.

https://www.digi.com/resources/documentation/digidocs/pdfs/90002002.pdf

Example of DL and MY