



SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution



Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECT312 – EMBEDDED SYSTEM DESIGN

III YEAR/ VI SEMESTER
1

UNIT 2 :DEVICES AND EMERGING BUS STANDARDS

TOPIC 2.8 & 9 - Bluetooth & Zigbee



BLUETOOTH



- Radio band: 2.4-2.48 GHz
- Average 1 Mbps - Up to 3 Mbps
- Supports point-to-point and point-to-multipoint
 - Creates personal area networks (PANs/Piconets)
 - Connects up to 8 devices simultaneously
- Minimal interference between devices
 - **Devices alter frequencies arbitrarily after packet exchanges -up to 1600 times/second - frequency hopping**
- 3 classes of Bluetooth transmit power

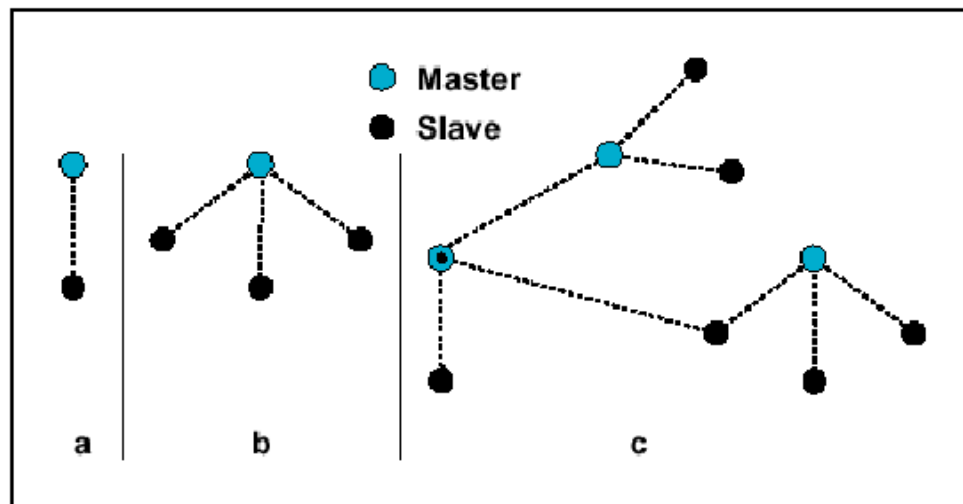


Figure 1.2: Piconets with a single slave operation (a), a multi-slave operation (b) and a scatternet operation (c).

Class	Maximum Power	Operating Range
Class 1	100mW (20dBm)	100 meters
Class 2	2.5mW (4dBm)	10 meters
Class 3	1mW (0dBm)	1 meter



BLUETOOTH



- Alternatives to cables
- IEEE 802.15.1 standard (2002)
- “Short range” and “Mobile products”
- POS of 10m radius, with mobility
- Ad-hoc connections between devices

- Network topology
- # of devices
- Scalability / Extendibility
- Flexibility
- Resilience / Reliability



BLUETOOTH



- Wireless communication between devices
 - Mobile phones, laptops, cameras, gaming controllers, computer peripherals, etc
- Short range sensor transmission
- Share multimedia - pictures, video, music
- A2DP - Advanced Audio Distribution Profile
 - Stream audio wirelessly



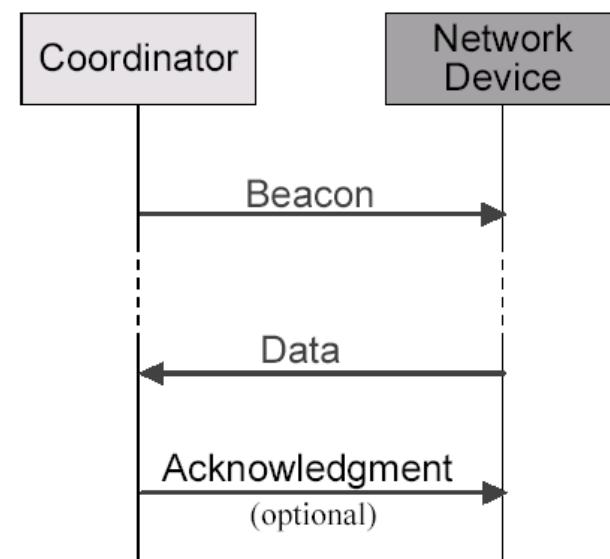


DATA TRANSFER MODEL

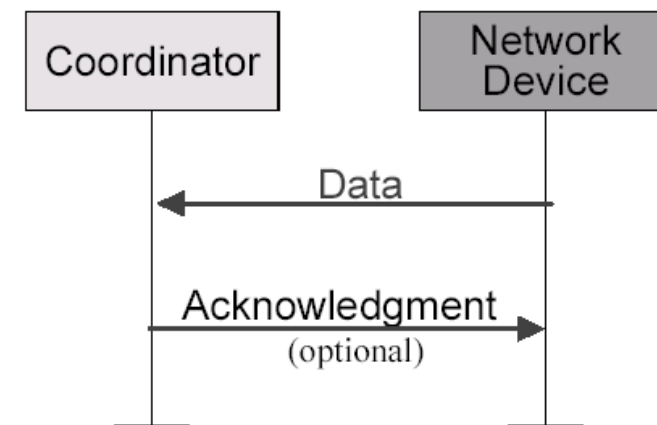


Data transferred from device to coordinator

- In a beacon-enabled network, device finds the beacon to synchronize to the super-frame structure. Then using slotted CSMA/CA to transmit its data.
- In a non beacon-enabled network, device simply transmits its data using un-slotted CSMA/CA



Communication to a coordinator
In a **beacon-enabled** network



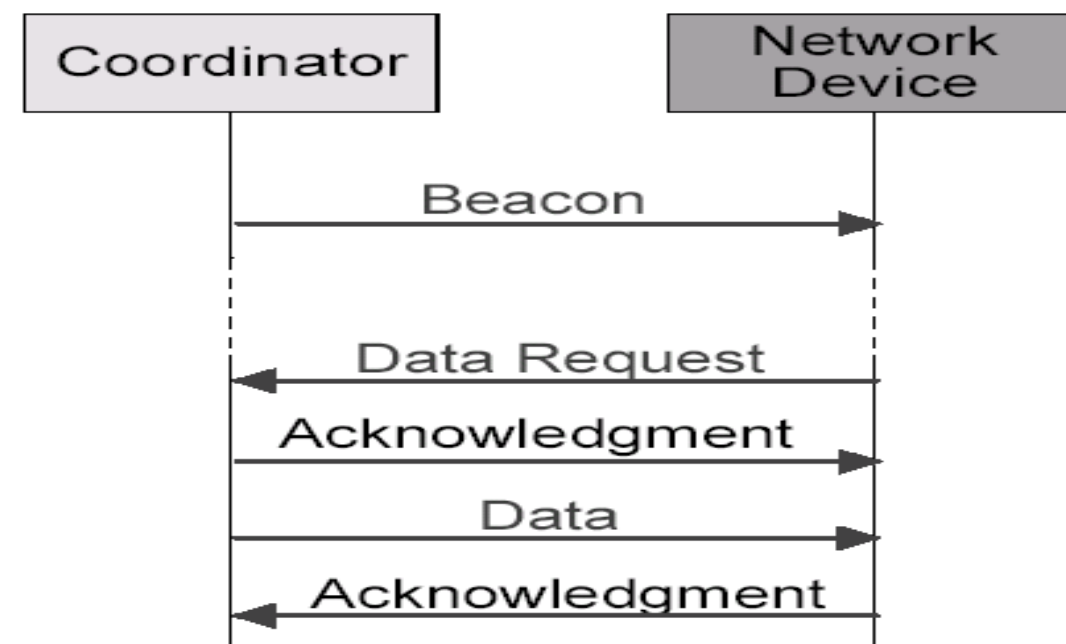
Communication to a coordinator
In a **non beacon-enabled** network



DATA TRANSFER MODEL



- Data transferred from coordinator to device
 - In a beacon-enabled network, the coordinator indicates in the beacon that “**data is pending.**”
 - Device periodically listens to the beacon and transmits a **MAC command request** using slotted CSMA/CA if necessary.



Communication from a coordinator
In a **beacon-enabled** network



COMPARISON WITH PEER TECHNOLOGIES!

Feature(s)	IEEE 802.11b	Bluetooth	ZigBee
Power Profile	Hours	Days	Years
Complexity	Very Complex	Complex	Simple
Nodes/Master	32	7	64000
Latency	Enumeration upto 3 seconds	Enumeration upto 10 seconds	Enumeration 30ms
Range	100 m	10m	70m-300m
Extendability	Roaming possible	No	YES
Data Rate	11Mbps	1Mbps	250Kbps
Security	Authentication Service Set ID (SSID)	64 bit, 128 bit	128 bit AES and Application Layer user defined



Bluetooth is Best | But ZigBee is Better

For :

- Ad-hoc networks between capable devices
- Handsfree audio
- Screen graphics, pictures...
- File transfer

If :

- The Network is static
- Lots of devices
- Infrequently used
- Small Data Packets





AIR INTERFACE



ZigBee

DSSS

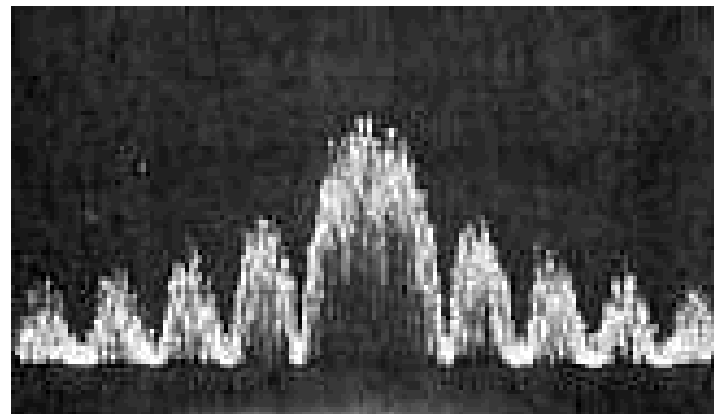
11 chips/ symbol

62.5 K symbols/s

4 Bits/ symbol

Peak Information Rate

~128 Kbit/second



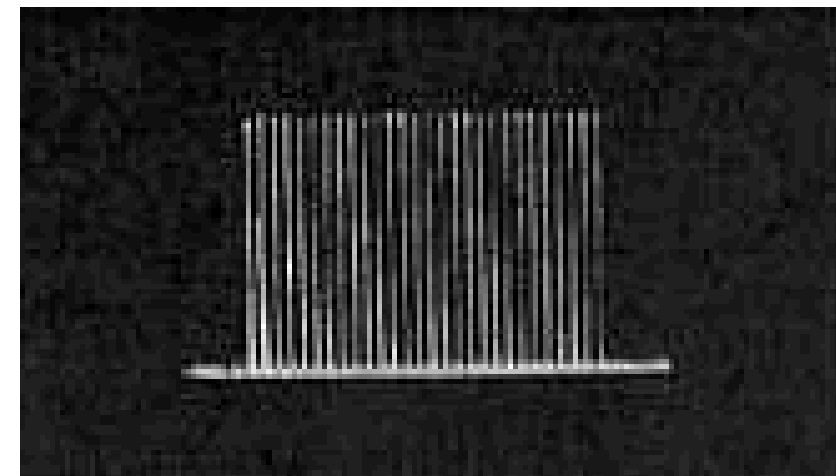
Bluetooth

FHSS

1 M Symbol / second

Peak Information Rate

~720 Kbit/second





TIMING CONSIDERATIONS



ZigBee:

- New slave enumeration = 30ms typically
- Sleeping slave changing to active = 15ms typically
- Active slave channel access time = 15ms typically

Bluetooth:

- New slave enumeration = >3s
- Sleeping slave changing to active = 3s typically
- Active slave channel access time = 2ms typically

ZigBee protocol is optimized for timing critical applications



INITIAL ENUMERATION

ZigBee

Coordinator



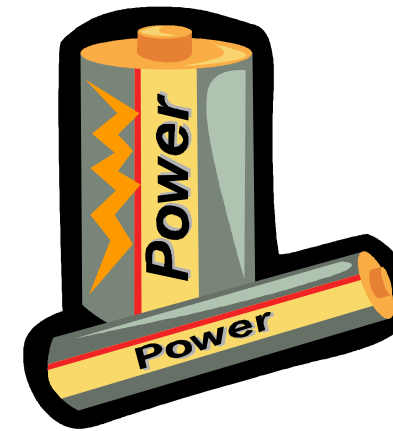
Bluetooth

Coordinator





POWER CONSIDERATIONS



ZigBee

- 2+ years from 'normal' batteries
- Designed to optimise slave power requirements

Application example of a light switch with respect to latency and power consumption

Bluetooth

- **Power model as a mobile phone (regular charging)**
- **Designed to maximise ad-hoc functionality**



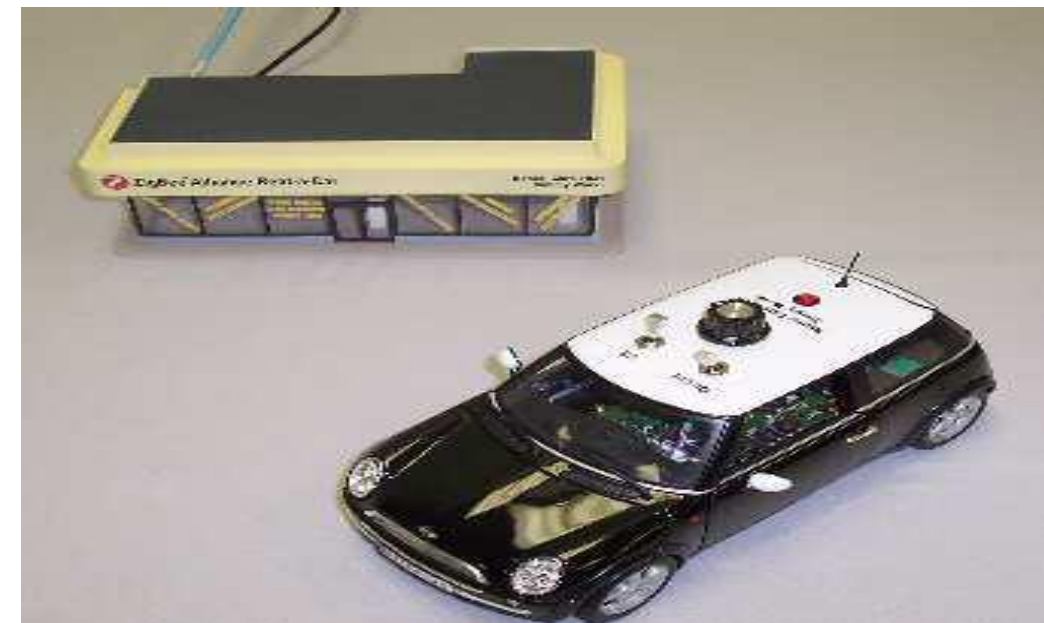
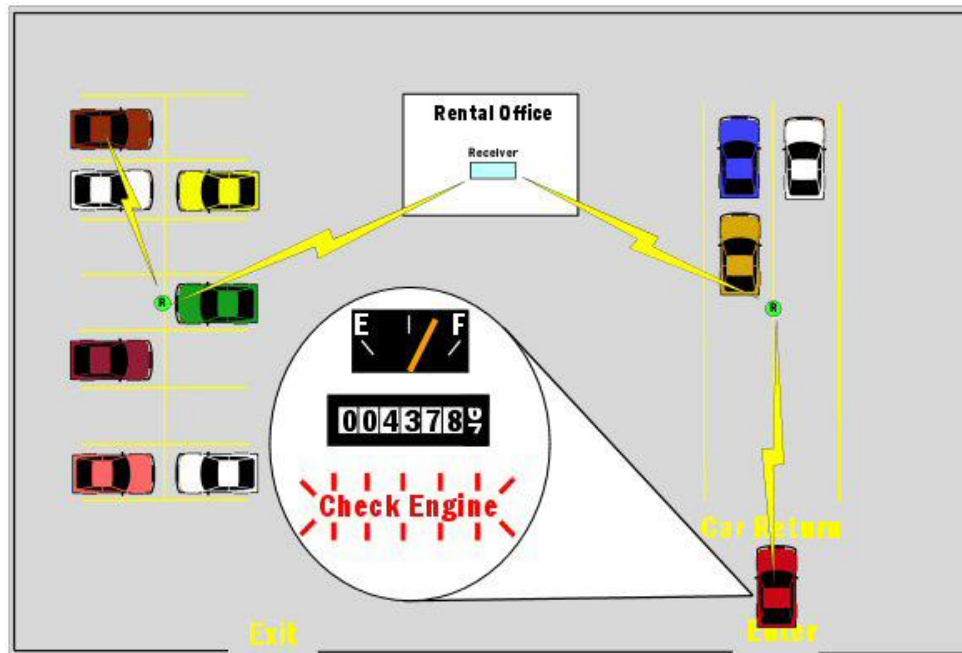
AUTOMATED RENTAL CAR RETURN*



Car Rental

File Settings

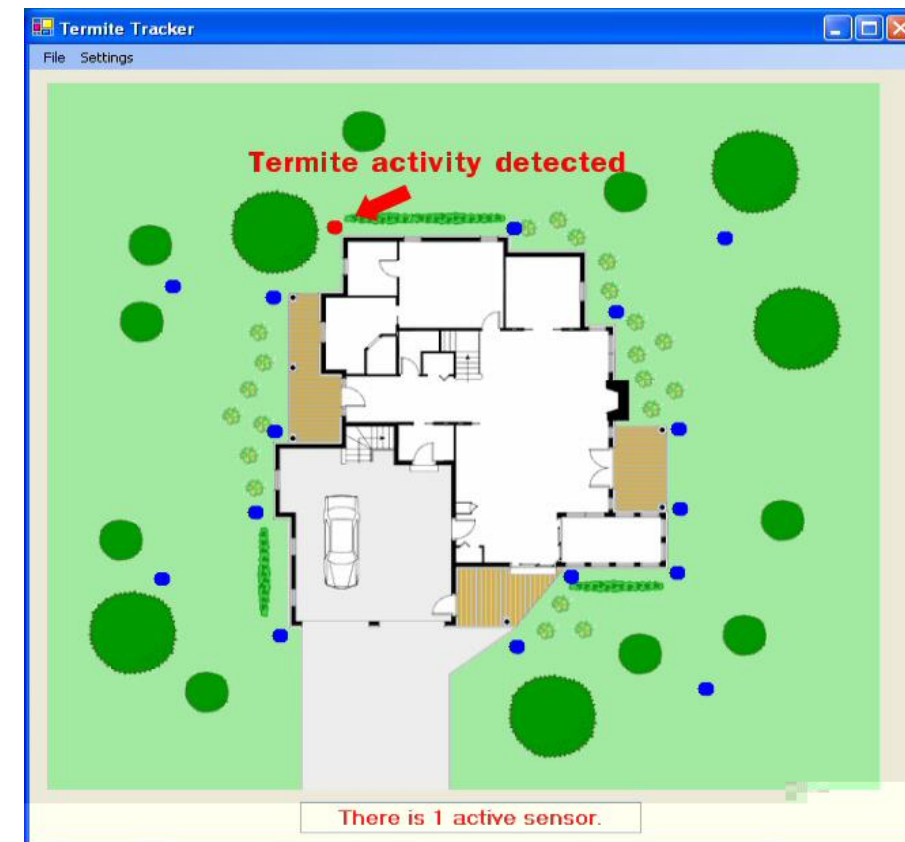
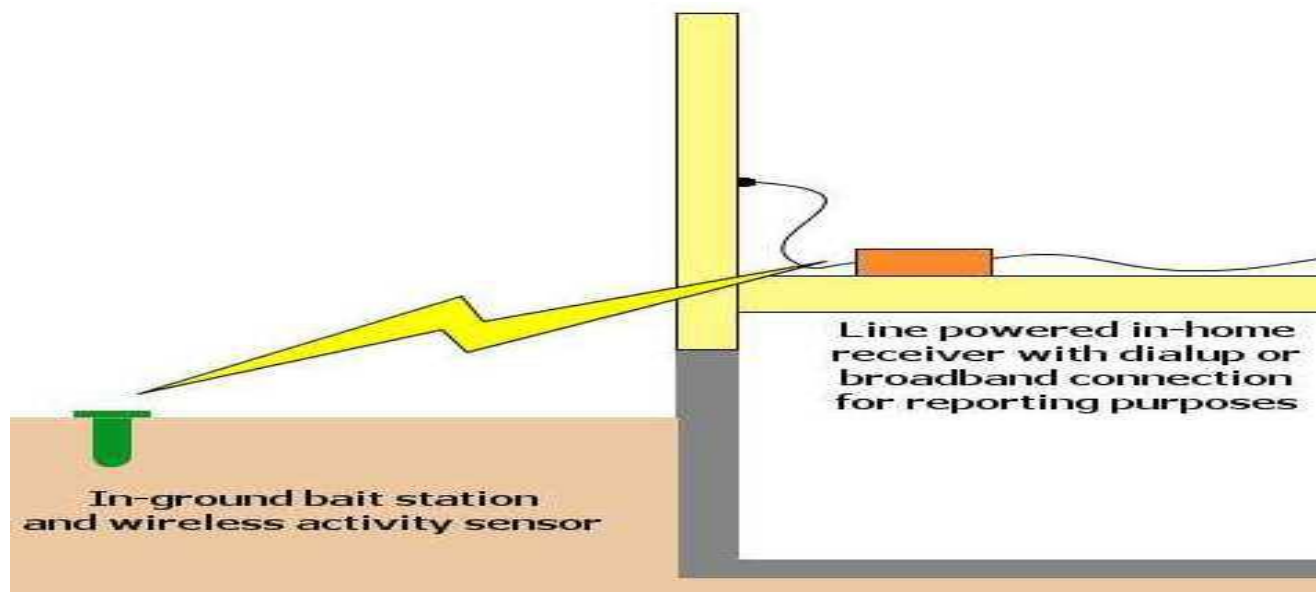
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WMWRC33412TC34910	MINI 723	2004 Mini Cooper, Black	57829	3/4	Check	Ok
WBAEH73455B191834	7Z 2715	2005 BMW 645Ci, Metallic Blue	87410	Empty	Ok	Check
WP0ZZZ99Z2S630474	SAB 1973	2003 Porsche 911, Silver	38579	1/2	Ok	Ok



**FROM SOFTWARE TECHNOLOGIES GROUP*



TERMITE DETECTION*



**From Software Technologies Group*



THANK YOU