Advanced Computer Networks

Exercise Session 3

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IEEE 802.15 – Personal Area Networks
The 802.15 Family

- Target deployment environment: communication of personal devices working together
  - Short range
  - Low power
  - Low cost
  - Small number of devices

- Four standards:
  - IEEE 802.15.1 – Bluetooth
  - IEEE 802.15.2 – Interoperability (e.g., Wifi)
  - IEEE 802.15.3 – High Data Rate WPAN
  - IEEE 802.15.4 – Low Data Rate WPAN (ZigBee)
Some common themes

- Master/Slave notion
  - Or 'simple' node versus coordinator

- Use of Piconets
  - Small group of devices managed by a master or coordinator
  - Scalability is not the main concern

- Support for QoS
  - Voice needs fixed bandwidth and latency
  - Data, transmitted in bursts

- But many variants how functionality is supported
Bluetooth - Overview

- Universal radio interface for ad-hoc wireless connectivity
  - Interconnecting mobile phones, handset, laptops, bar code readers, GPS receivers, printers, etc..
- Cheap, low power,
  short range (up to 100m)

- History:
  - First Bluetooth Specification 1994 by Ericsson
  - Foundation of Bluetooth Special Interest Group 1998
  - First consumer products for mass market in 2001, spec. vs. 1.1.)
  - Latest specifiction, version 4.0
Piconet

- Piconet = Collection of BT devices connected in an ad hoc fashion
- One unit acts as master and the others as slaves for the lifetime of the piconet
- Each piconet has a unique hopping pattern determined by the master
- Participation in a piconet = synchronization to hopping sequence
- Each piconet has one master and up to 7 simultaneous slaves (> 200 could be parked)

M=Master
S=Slave
P=Parked
SB=Standby
Forming a Piconet

- Any two or more device can form a piconet
- The device establishing the piconet becomes the master
- Master sends its clock and device ID to the slaves
- Hopping pattern determined by the device ID, the phase is determined by the clock of the master
- Addressing:
  - Active Member Address (AMA, 3 bit)
  - Parked Member Address (PMA, 8 bit)
Scatternets

- Scatternet = group of piconets
- Device can participate multiple piconets
  - Jumping between the hopping sequences of the different piconets
  - Before leaving a device informs the current master that it will be unavailable for a certain amount of time

M=Master
S=Slave
P=Parked
SB=Standby
Bluetooth – Exercise Questions

- Q1. Bluetooth bandwidth limitations
  - Suppose a single computer is capable of generating output data at a rate higher than Bluetooth's bandwidth. If the computer was equipped with two or more Bluetooth masters, each with its own slaves, would that work?

- Q2. Draw a Bluetooth network topology for 16 nodes to communicate with each other so that:
  - every device can communicate with each other
  - all devices operate in active mode

- Q3. How do Bluetooth devices find each other and establish connections?
  - Briefly describe the Bluetooth device states and explain the transition from one state to the other

- Q4. More Bluetooth:
  - How can QoS be provided in Bluetooth?
  - What is the parked state in Bluetooth and what does it imply?
Sensor Networks

- Wireless networks built from sensor nodes

- Example: Mica 2
  - 4KB RAM
  - 128KB Program Flash Memory
  - 16Mhz Microcontroller
  - Wireless Radio
Sensor Networks: Applications (1)

- Monitor temperature of goods in supermarket (attach sensor nodes to fridges)

- Monitor environment of plants in agriculture (solar radiation, temperature, humidity)
Sensor Networks: Applications (2)

- Earthquake detection
  - Earthquake speed ~5-10km/h,
  - Instant detection can give warning ~30 second before the shockwave hits a city 200km from the epicenter

- Structure Monitoring in buildings
  - Understand interactions between ground motions and structure foundation
Sensor nets: Exercise Questions

- Why is it not practical for each node in a sensor net to learn its location by using GPS? Describe a practical alternative.