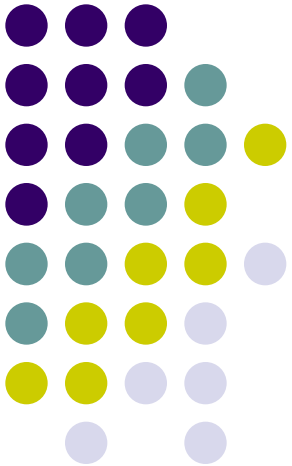
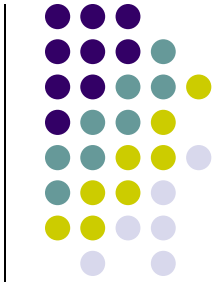
Introduction to Bluetooth

Bluetooth簡介

清華大學電機系 劉靖家

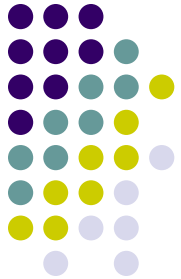


Introduction

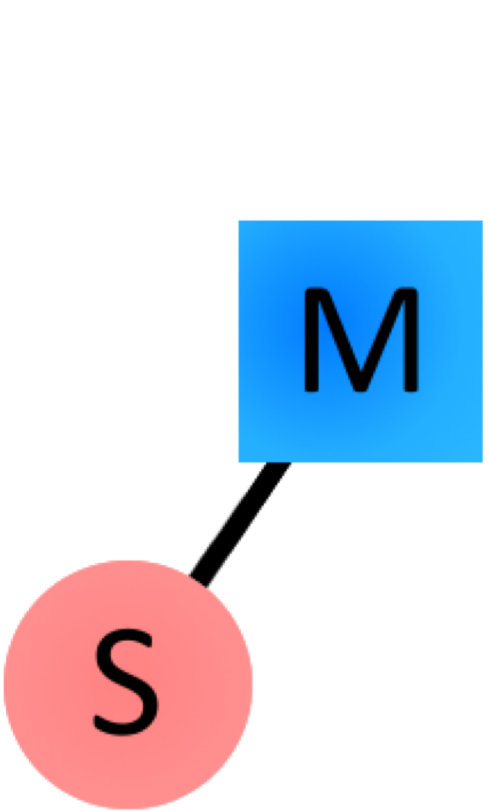


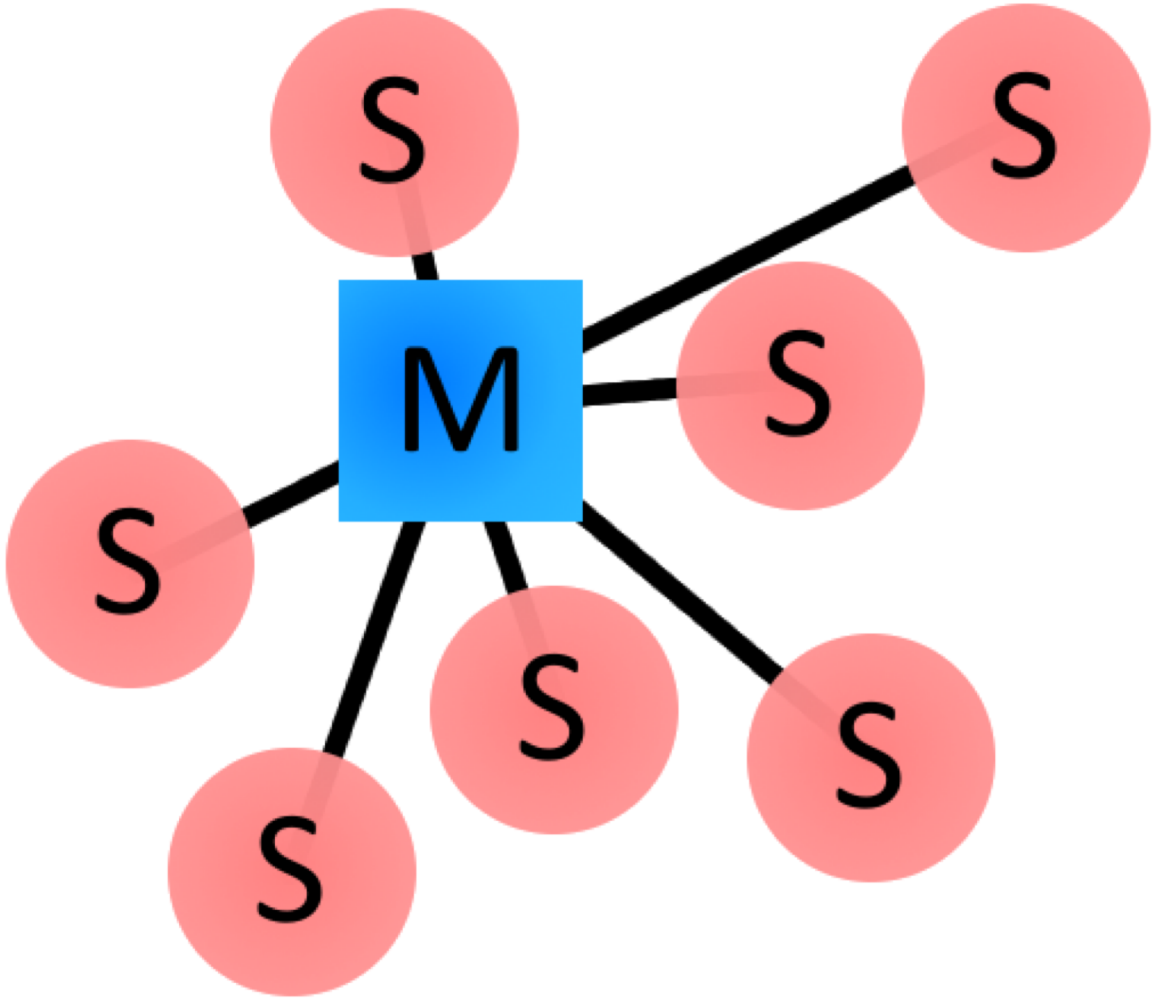
- A short range wireless standard for exchange data
- Use ISM band from 2.4 to 2.485 GHz
- Originally to replace RS-232 (UART).

Masters, Slaves, and Piconets

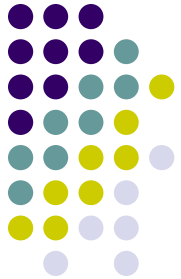


- Bluetooth networks (**piconets**)
  - Master/slave model
  - A master device can be connected to up to 7 different slaves
  - Any slave device in the piconet can only be connected to a single master
  - The master coordinates communication throughout the piconet
    - Only master to slave, no slave to slave


M
S

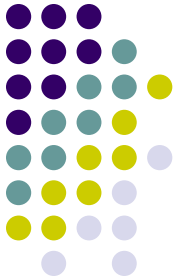

S
S
M
S
S
S
S
S
S

Bluetooth Addresses and Names



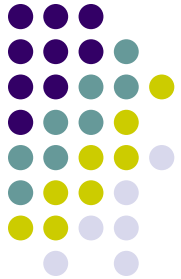
- Every Bluetooth device has a unique 48-bit address (**BD_ADDR**)
  - MSB 24 bits are organization unique identifier (OUI)
  - LSB 24 bits are unique device ID
- Names are identification strings (248 bytes)

Connection Process



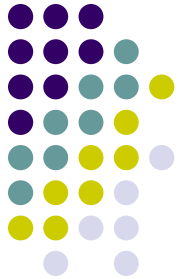
- Inquiry
  - When initially two Bluetooth devices know absolutely nothing about each other
  - One device sends out the inquiry request, and any device listening for such a request will respond with its address, and possibly its name and other information.
- Paging (Connecting)
  - Paging is the process of forming a connection between two Bluetooth devices using known addresses.
- Connection
  - After a device has completed the paging process, it enters the connection state.
  - While connected, a device can either be actively participating or it can be put into a low power sleep mode.

Connection Modes



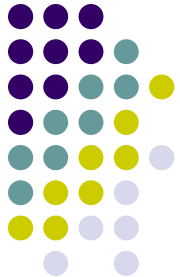
- **Active Mode** – This is the regular connected mode, where the device is actively transmitting or receiving data.
- **Sniff Mode** – This is a power-saving mode, where the device is less active. It'll sleep and only listen for transmissions at a set interval (e.g. every 100ms).
- **Hold Mode** – Hold mode is a temporary, power-saving mode where a device sleeps for a defined period and then returns back to active mode when that interval has passed. The master can command a slave device to hold.
- **Park Mode** – Park is the deepest of sleep modes. A master can command a slave to "park", and that slave will become inactive until the master tells it to wake back up.

Bonding and Pairing



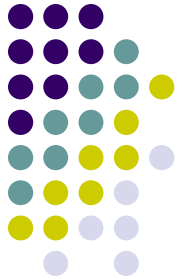
- Bonded devices automatically establish a connection whenever they're close enough.
- Bonds are created through one-time a process called **pairing**.
  - Both sides share address, name, profiles and a secret key.
- Pairing usually requires an **authentication process** where a user must validate the connection between devices.
  - Eg. 6-digit codes.

Power Classes



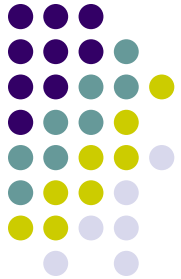
	Max Output Power	Max Output Power	Max Range
Class 1	20 dBm	100mW	100m
Class 2	4 dBm	2.5mW	10m
Class 3	0 dBm	1mW	1m
Class 4	-3 dBm	0.5mW	50cm

Bluetooth Profiles



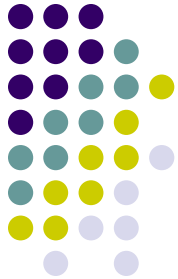
- Profiles define what kind of data a Bluetooth module is transmitting
  - Serial Port Profile (SPP)
    - To replace UART
  - Human Interface Device (HID)
    - Mice, keyboards, and joysticks
  - Headset Profile
  - Advanced Audio Distribution Profile (A2DP)
  - A/V Remote Control Profile (AVRCP)

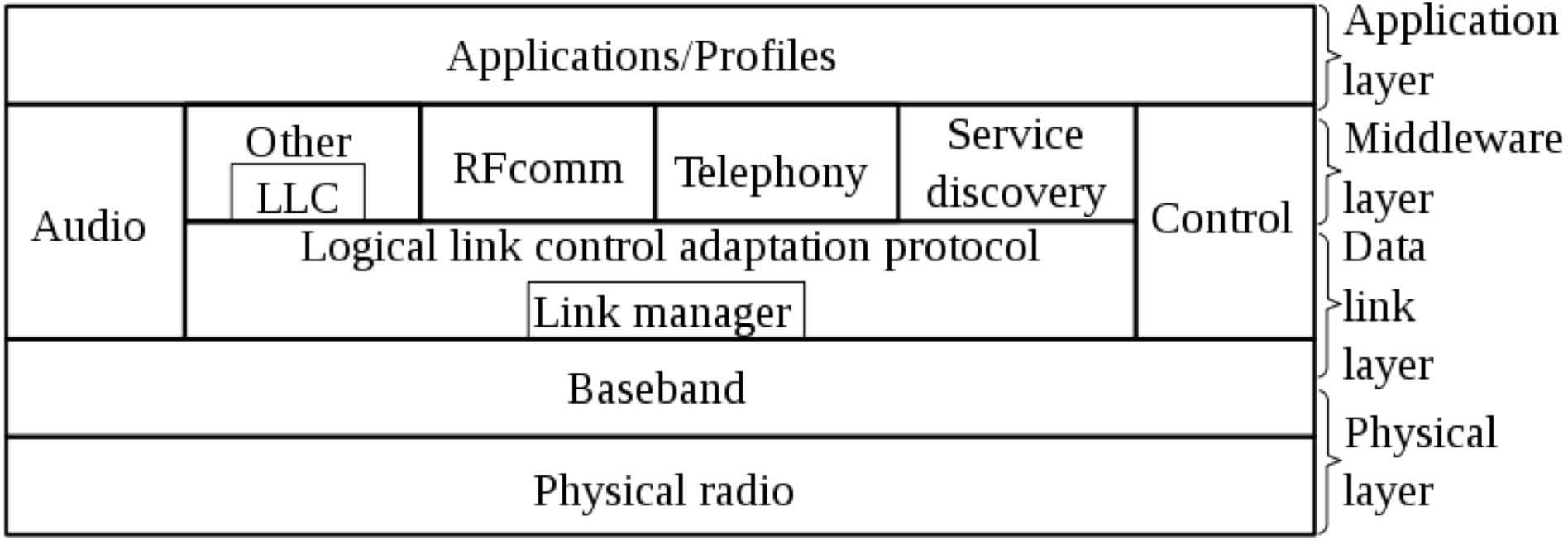
Bluetooth Versions



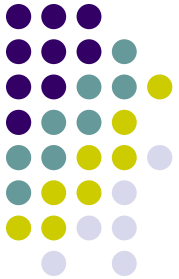
- Bluetooth v1.2
  - 1.0Mbps (0.7) 10m range
- Bluetooth v2.1 + EDR
  - 3Mbps (2.1)
- Bluetooth v3.0 + HS
  - Ability to use wifi.
- Bluetooth v4.0 and Bluetooth Low Energy
  - BLE: 0.27Mbps
- Bluetooth v5.0
  - BLE: tradeoff speed (up to 2M bps) and range (up to 4X)

Bluetooth Protocol Stack



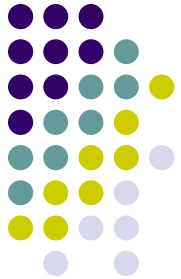


Protocol Stacks



- Link Management Protocol (LMP)
  - Set up and control of the radio link between two devices
- Logical Link Control and Adaptation Protocol (L2CAP)
  - Multiplex multiple logical connections between two devices using different higher level protocols.
- Service Discovery Protocol (SDP)
  - Discover services offered by other devices, and their associated parameters
- Radio Frequency Communications (RFCOMM)
  - Serial port emulation

Reference



- https://learn.sparkfun.com/tutorials/bluetooth-basics
- https://en.wikipedia.org/wiki/Bluetooth
- http://www.althos.com/tutorial/Bluetooth-tutorial-title-slide.html