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ENRNG3076 : Oral presentation

BEng Computer and Communications Engineering

Origin

- Purpose :
  - Create a cable replacement standard for personal area network
  - Handle simultaneously both data and voice between a wide range of devices
- Key features :
  - Robustness
  - Low complexity of use
  - Low power
  - Low cost

History

- Harald Bluetooth : 10th century Danish King, managed to unite Denmark and Norway

- Bluetooth SIG (Special Interest Group) :
  – Founded in 1998 by : Ericsson, Intel, IBM, Toshiba and Nokia
  – Currently more than 2500 adopter companies
  – Created in order to promote, shape an define the specification and position Bluetooth in the market place
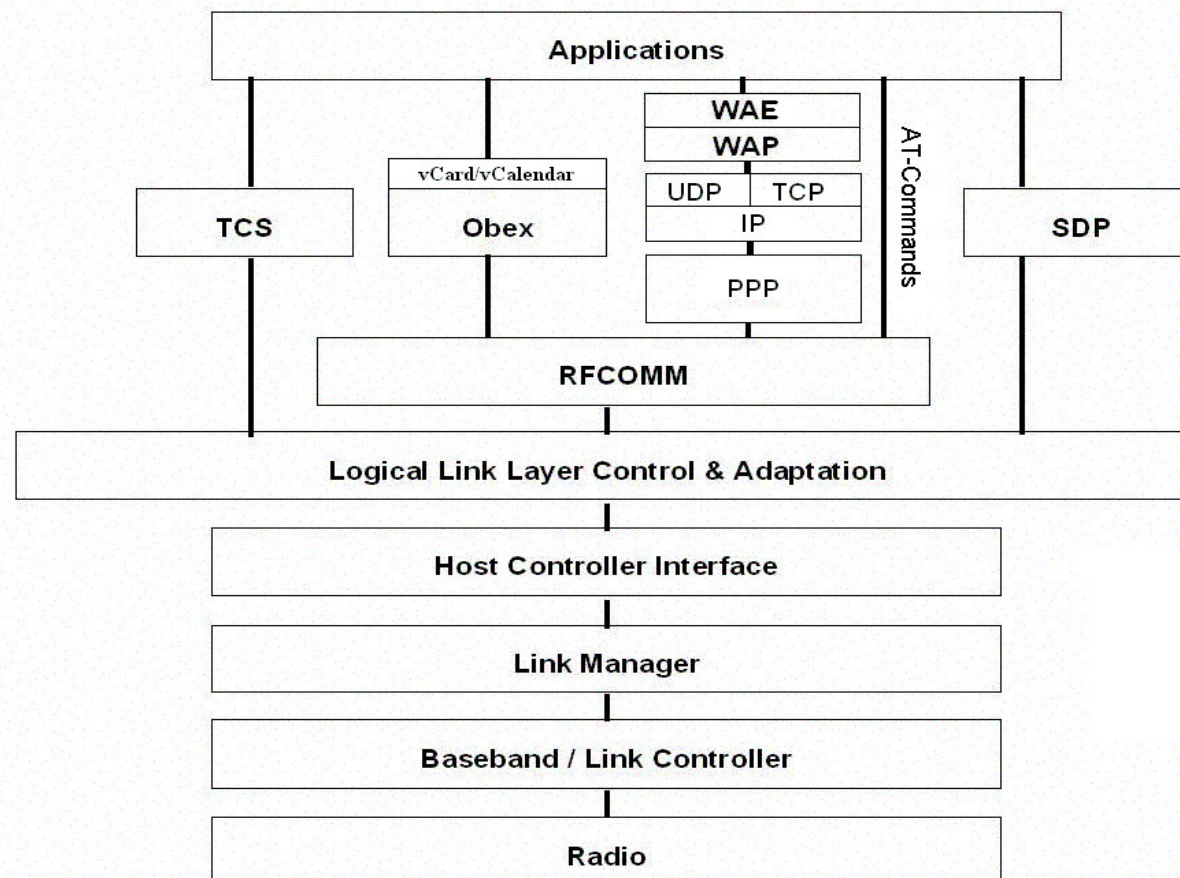 – Current specification : Bluetooth 1.2

Bluetooth technology

- Short-range (theoretically 10 – 100m)
- Wireless (ISM frequency band – 2.4GHz)
- Point-to-point or point-to-multipoint
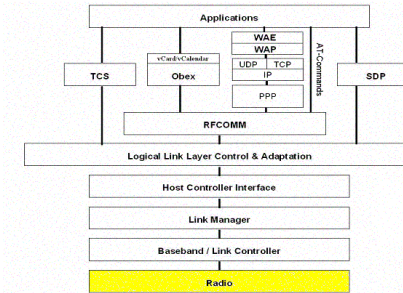- Voice and data transfer (up to 1Mb/s)

Bluetooth enabled devices

- Laptops
- Cellular phones
- Personal Digital Assistants
- Headsets
- Printers
- Keyboards/mice
- GPS, etc…

Protocol stack

RF : physical layer (1)

- Utilises the license free 2.4GHz ISM radio band
- Pseudo-random frequency-hopping scheme with 1600 frequency hops per second (FHSS)
- 79 carriers (f=2402+k MHz, k=0,…,78)
- Gross data rate up to 1Mb/s
- Coding techniques (Forward Error Correction)
- Gaussian Frequency Shift Keying modulation
- Automatic power control

RF : physical layer (2)
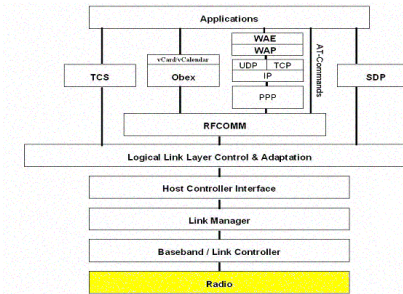
- Power classes :
  - I : max output power : 100mW (20dBm) => 100m
  - II : max output power : 2.5mW (4dBm) => 20m
  - III : max output power : 1mW(0dBm) => 10m
- Low transmission power :
  - About 1/1000 of a mobile phone
 - Limits the range of Bluetooth

Baseband
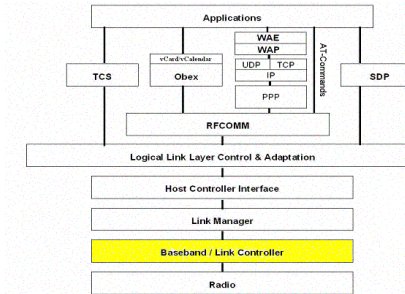
- Enables RF to form a piconet (physical channel shared among several devices)
  - Up to 7 slaves can be connected to 1 master
- Provides 2 different kind of physical links, with their corresponding packets
  - Synchronous Connection-Oriented (SCO)
  - Asynchronous Connection-Oriented (ACL)

Link Manager Protocol (LMP)
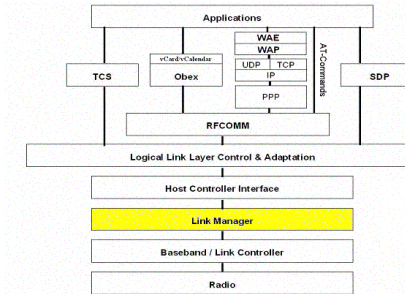
- Responsible for link set-up between devices, including security functions :
  - Authentication
  - Encryption
- Controls and negociates baseband packet size
- Controls power modes and connection states

Host Controller Interface (HCI)
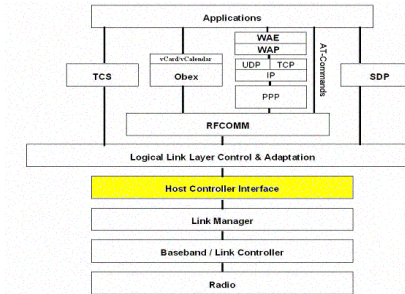
- Uniform interface method of accessing the Bluetooth controller capabilities
- Alows the software stack on the host processor to communicate with Bluetooth hardware
- Not used for communicating among devices

# Logical Link Control and Adaptation Protocol (L2CAP)
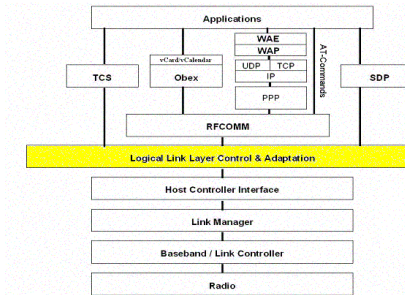
- Its role is to adapt upper protocols over the Baseband :
  - Multiplexing capability
  - Segmentation and reassembly operations
- Permits to transmit and receive upper layer data packets up to 64kB in length
- Also permits per-channel flow control and retransmission

# Service Discovery Protocol (SDP)
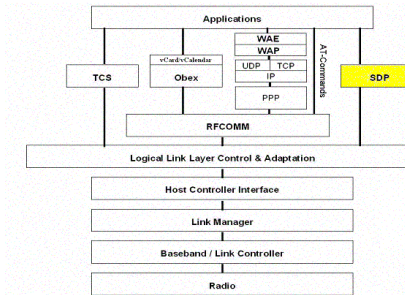
- Provides a means for a Bluetooth device to discover what services of another device are available and determine the characteristics of those available services
- Client-Server interaction
- Service records (database) provide a list of services and associated attributes

Cable replacement and telephony
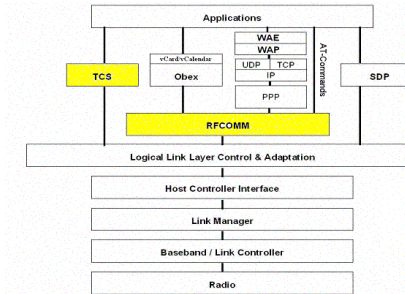
- RFCOMM : cable replacement protocol
  - Emulates an RS-232 control and data signals over Bluetooth Baseband
  - Provides transport capabilities for upper level services (e.g. OBEX)
- TCS : Telephony Control protocol – Binary
  - Defines the call control signaling for the establishment of speech and data calls between Bluetooth devices

Adopted protocols
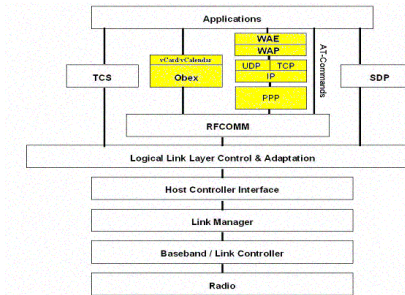
- Point-to-Point Protocol (runs over RFCOMM)
- TCP/UDP/IP : allows communication with any other device connected to the Internet/WAP
- OBEX : allows to exchange objects in a simple and spontaneous manner (developed by the IrDA)
- WAP : allows to build application gateways (functions like remote control and data fetching from a PC to handset)
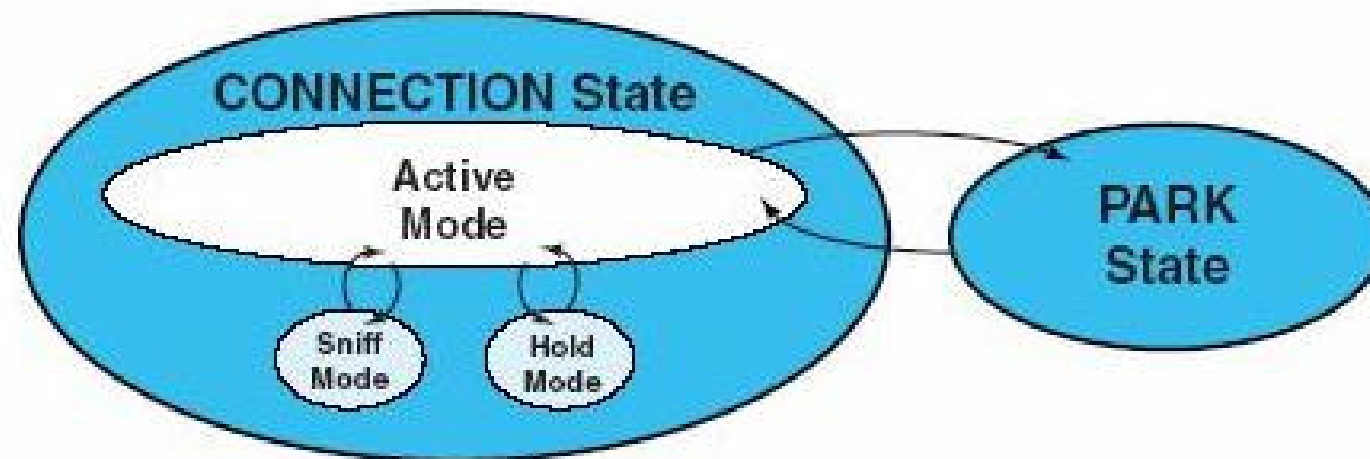
States/Substates/Modes (1)

- 3 states : STANDBY, CONNECTION, PARK

- 7 substates : page, page scan, inquiry, inquiry scan, master response, slave response, inquiry response

- 3 modes in CONNECTION state : Active, Sniff, Hold

States/Substates/Modes (2)
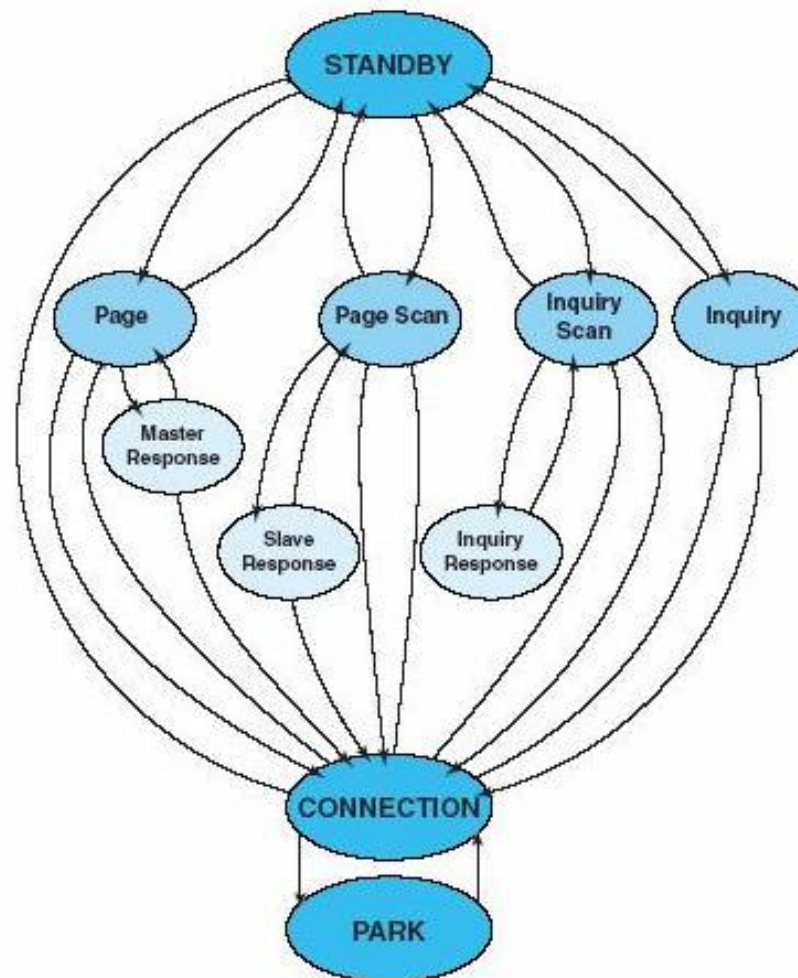
States/Substates/Modes (3)

Profiles (1) : Definition

- Set of instructions specifying how to implement a service
- Defines the functionality that a device must be able to support in a given application
- 4 generic profiles :
  - Generic Access Profile (GAP)
  - Service Discovery Application Profile (DSAP)
  - Serial Port Profile (SPP)
  - Generic Object Exchange Profile (OBEX)

Profiles (2) : examples

● Cordless Telephony	● File transfer
● Intercom	● Synchronisation
● Headset	● Basic Printing
● Fax	● A/V remote control
● Dial-up networking	● Hands-free
● LAN access	● Common ISDN Access
● Object push	● SIM Access

Usage models

- Describe the main applications and the intended devices

- For each model there is one or more corresponding profiles defining protocol layers and functions to be used

- E.g. : Internet bridge, 3-in-1 phone, Ultimate headset, LAN access, File transfer, Synchronization

Establishing connections

- Inquiry
- Paging
- Link establishment
- Service Discovery
- L2CAP channel
- RFCOMM channel
- Security
- PPP/TCP/IP

Competting technologies

- Infrared IrDA (WPAN) : synchronization, link between a phone and a laptop…
  - Less flexible than Bluetooth, need of a line of site
  - Comparable data rate
- Wi-Fi (WLAN) : Wireless LAN access
  - Far higher bandwidth and data rate than Bluetooth
  - Higher power consumption than Bluetooth
  - Requires infrastructure investment

Interferences / Frequency usage conflicts / Fading

- Unlicensed ISM band : any number of devices can use it (e.g. 802.11b LANs, Cordeless telephones, microwave ovens…)
- Consequences : collisions, slowdown, loss of data
- Combats interference and fading thanks to frequency hopping at 1600hps (faster than other systems => more robust)
- Uses Forward Error Correction (limits impact of random noise)

References

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