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Bluetooth

- What is bluetooth?
- Introduction
- Overview
- Specifications & Layers
- Profiles
- Ad-hoc networking
- Qualification
- Products & Future Usage

What is bluetooth?

- Bluetooth wireless technology is an **open** specification for a **low-cost**, **low-power**, short-range radio technology for **ad-hoc** wireless communication of **voice and data anywhere** in the world.

Intoduction

- 1994 Ericsson gets interested in wireless connections from mobile telephones to other devices like PDAs and accessories like Headsets
- Forming the SIG (SpecialInterestGroup) with 4 other members (IBM, Intel, Nokia, Toshiba) in order to develop a wireless standard for communication between mobile devices

Introdution

- Today over 2000 members
- 2 main priorities:
  - Cheap
  - Lower energy consumption
- IEEE 802.15 committee standardizes the physical and link layer
- SIG still enhances Bluetooth
  - two versions in future possible (SIG vs IEEE)

Overview

- Originally conceived as a cable replacement technology
- Other usage models began to develop:
  - Personal Area Network (PAN)
  - Ad-hoc networks
  - Data/voice access points
  - Wireless telematics

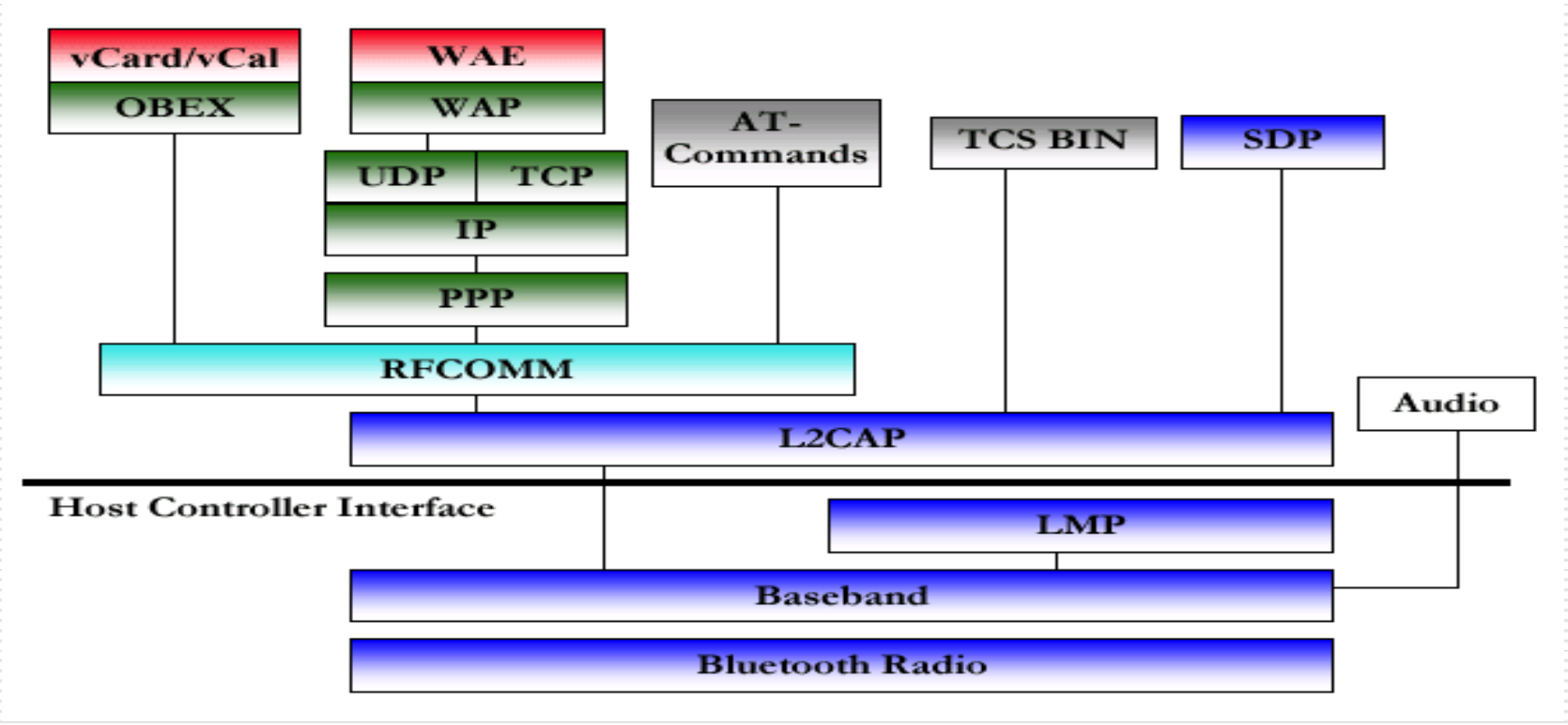
Overview

- Advantages
  - Bluetooth: interoperable
  - IrDA: line of sight needed, point-to-point
  - WLAN: higher power consumption
- Disadvantages
  - Bluetooth: only up to 1 Mbps
  - IrDA: much cheaper, faster (up to 16 Mbps)
  - WLAN: faster (up to 11 Mbps)

  WLAN and Bluetooth interfere each other (both are using the ISM band)

Specifications & Layers

- specification protocol stack



Layers

- Bluetooth Radio
- Baseband
- LMP (Link Manager Protocol)
- HCI (Host Controller Interface)
- L2CAP (Logical Link Control and Adaptation Protocol)
- RFCOMM (Radio Frequency Communication)
- SDP (Service Discovery Protocol)

Bluetooth Radio

- the lowest defined layer of the Bluetooth specification
- operating in the 2,4 GHz ISM Band
- accomplishes spectrum spreading by frequency hopping (FHSS) from 2.402 GHz to 2.480 GHz

Bluetooth Radio

- 3 different power classes
  - Power Class1: long range (100m,100mW)
  - Power Class2: mid range (10m,1-2,5mW)
  - Power Class3: short range (0.1-10m,1mW)
- signal strength adjustment

Baseband

- the physical layer of the Bluetooth that provides
  - Error correction
  - Flow control
  - Hopping sequence
  - Security
- hopping through 79 channels
- data is divided in packets
  - access code: e.g. timing synchronization
  - header: e.g. packet numbering, flow control, slave address
  - payload: voice, data or both

Baseband

- Connection Modes

  describes the set of rules by which all bluetooth devices must abide in order to establish a link a communicate with one another

  - STANDBY : not connected in a piconet
  - ACTIVE : active participation on the channel
  - Power Saving Modes
    - SNIFF : slave listens to the channel at a reduced rate (decreasing of duty cycle) least power efficient
    - HOLD : data transfer is held for a specific time period, medium power efficient
    - PARK : synchronized to the piconet but does not participate in traffic

Baseband

- Security Modes
  - non-secure
  - encryption enforced by application layer
  - encryption enforced by link layer

  - For devices
    - trusted device
    - untrusted device
  - For services
    - require authorization and authentication
    - require authentication
    - open to all devices

Audio

- two codecs: PCM and CVSD
- both at 64kbit/s
- synchronous connection oriented(SCO) links
- time-critical
- no retransmission
- errors appear as background noise

LMP (Link Manager Protocol)

- provides authentication, link setup and link configuration including power surveillance
- takes place as a service provider
- communication with LM PDUs (protocol data units)

HCI (Host Controller Interface)

- provides a command interface to baseband controller and link manager
- also to hardware status, control and event register
- Bluetooth defined Host Controller Transport Layers:
  - UART (HCI over serial interface)
  - RS232(HCI over serial interface)
  - USB(HCI over USB interface e.g. USB dongle)

L2CAP (Logical Link Control and Adaptation Protocol)

- provides a connection-oriented and connectionless service to upper layer
- protocols with quality-of-service functions using multiplexing, segmentation and reassembly
- two link types defined in Baseband layer:
  - 1. SCO (synchronous connection-oriented)
  - 2. ACL (asynchronous connection-less)

  BUT ONLY ACL is supported by L2CAP (SCO not planned)

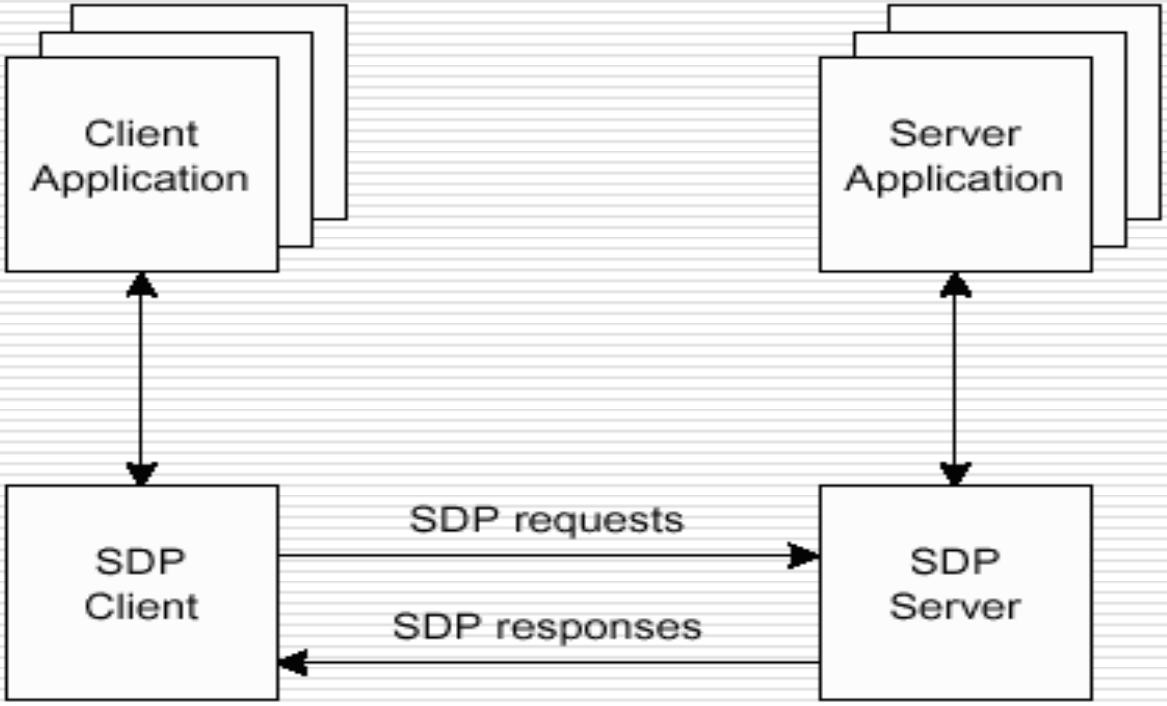
RFCOMM (Radio Frequency Communication)

- Provides emulation of serial ports
- Supports up to 60 simultaneous connections
- Differentiates between two device types:
  - Type 1: communication end points (e.g. printer or headsets)
  - Type 2: devices which are part of communication (e.g. modems)
- But in the protocol itself no distinction is made, some information is for type 1 other for type 2

SDP (Service Discovery Protocol)

- discovers which services are available
- identifies the characteristics of the services
- uses a request/response model where each transaction consists of one request protocol data unit (PDU) and one response PDU
- SDP is used with L2CAP
- is optimized for the dynamic nature of bluetooth
- SDP does not define methods for accessing services

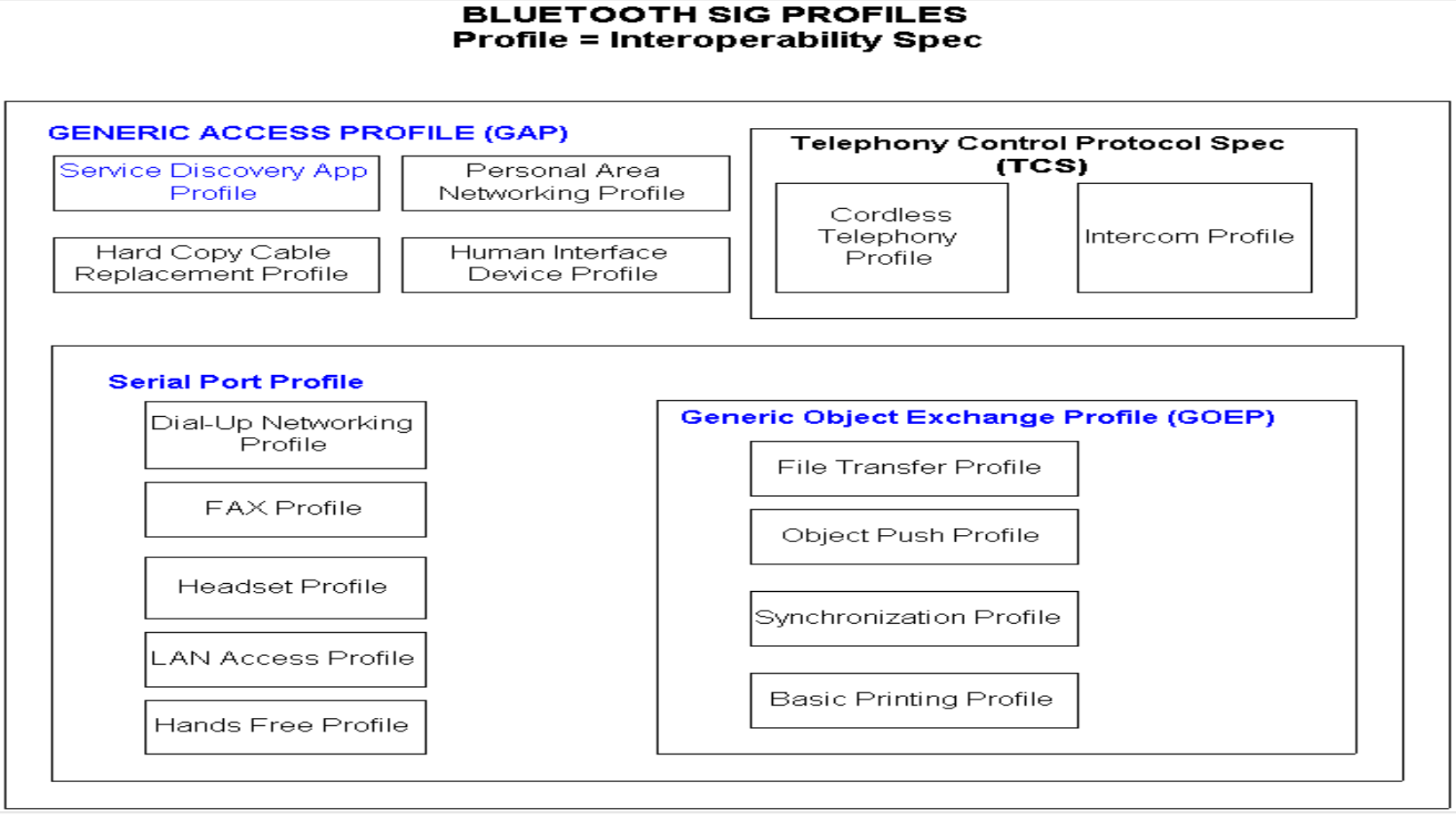
SDP (Service Discovery Protocol)



Profiles

- how bluetooth is used
- describe how implementations for a specific use must be written
- defines options in each protocol
- defines parameter ranges
- profiles are used to solve interoperability problems between different manufacturers' products

Profiles

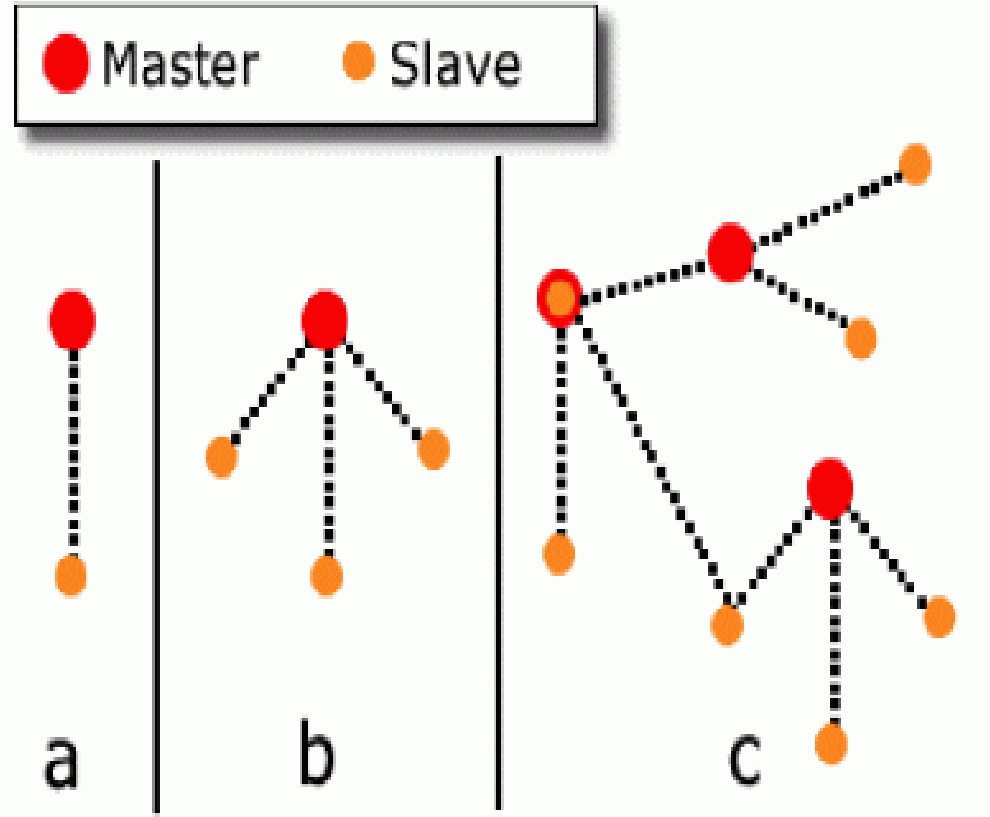

BLUETOOTH SIG PROFILES
Profile = Interoperability Spec
GENERIC ACCESS PROFILE (GAP)
Service Discovery App Profile
Personal Area Networking Profile
Hard Copy Cable Replacement Profile
Human Interface Device Profile
Telephony Control Protocol Spec (TCS)
Cordless Telephony Profile
Intercom Profile
Serial Port Profile
Dial-Up Networking Profile
FAX Profile
Headset Profile
LAN Access Profile
Hands Free Profile
Generic Object Exchange Profile (GOEP)
File Transfer Profile
Object Push Profile
Synchronization Profile
Basic Printing Profile

Ad-hoc-networking

- piconet
  - decentral, one master up to 7 slaves
  - up to 255 parked slaves
  - point to point or point to multipoint conn
  - unique bluetooth device address
- scatternet
  - overlapping of two piconets, up to 10
  - different hopping sequences
  - peer to peer (P2P) network

Ad-hoc-networking

- a: piconet with a single slave
- b: piconet with a multi slave
- c: scatternet



Qualification

- aims interoperability between all bletooth devices
- no license fees
- bluetooth devices must support same profiles
- bluetooth logo guarantees interoperability

Qualification

- no line of sight required
- you can use it everywhere
- bluetooth chip
  - integrated
  - power management
  - not really cheap
- Automatic ad-hoc networking (invisible)

  e.g.automaticdata synchronisation

Products

- Notebook PCs & desktop computers
- Printers
- PDAs
- Other handheld devices
- Cell phones
- Wireless periperals:
  - Headsets
  - Cameras
- Access Points
- CD Player
- TV/VCR/DVD
- Telephone Answering Devices
- Cordless Phones
- Cars

Products

- 2004 Toyota Prius – hands free calls
- Toshiba Washer & Dryer – downloads the washer/dryer software for new clothes!
- Nokia N-gage
- Digital Pulse Oximetry System

Future Usage

- Home Automation
- Home Entertainment/Games
- Electronic Commerce/M-Commerce
- Industrial Control
- Surveillance
- Access Control
- Location Based Services
- Current Trials: Shopping Malls, Train Stations

Thats All !

Thanks for listening...