iWRAP⁴ *Bluetooth* stack firmware

Bluegiga Technologies

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Agenda

- iWRAP4 Overview

- Technical Features

- Supported *Bluetooth*® Profiles

- Bluetooth 2.1 + EDR support

- Other New Features

iWRAP4 Overview

iWRAP4 Overview

- **iWRAP4 firmware is an embedded software that runs in the internal RISC processor of WT32, WT12 and WT11 and WT41 modules**

- **iWRAP4 implements the full *Bluetooth* protocol stack and a set of *Bluetooth* profiles**

  - Serial Port Profile (SPP)
  - Hands Free Profile (HFP)
  - Headset Profile (HSP)
  - Object Push Profile (OPP)
  - File Transfer Profile (FTP)
  - Dial-up Networking Profile (DUN)
  - Human Interface Device (HID)
  - Advanced Audio Distrubution Profile (A2DP)
  - A/V Remote Control Profile (AVRCP)
  - Device Identification Profile (DI)
  - Health Device Profile (HDP)
  - Phone Book Access Profile (PBAP)

- **iWRAP4 also implements two Bluegiga proprietary profiles**
  - Bluegiga IO profile (BGIO)
  - Over-the-Air Configuration Profile (OTA)

- **iWRAP4 firmware can be configured to operate autonomously or is controlled by a host processor via ASCII commands (modem like operation)**
  - Supported host communications interfaces: UART, GPIO
  - Other supported interfaces: Analog audio, Digital audio, AIO

- **Bluegiga can easily customize iWRAP4 for specific application needs**
  - Entire applications can be run on the RISC processor of the modules

iWRAP4 Overview
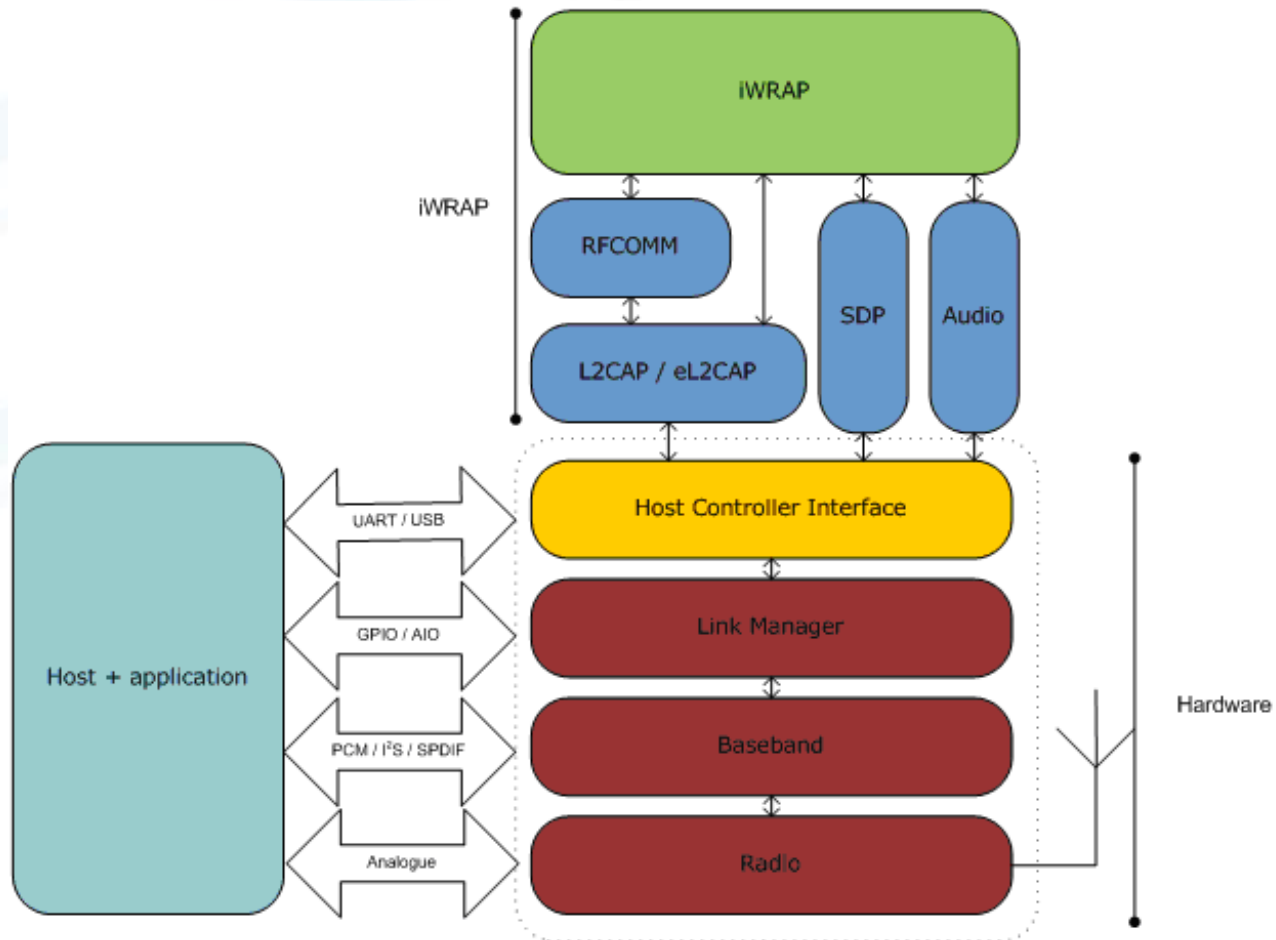
Technical Features

Technical Features

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| Feature	Value
MAX simultaneous ACL connections	7
MAX simultaneous SCO connections	1 (2 with WT32)
MAX data rate	600 kbps (WTxx to BT2.0 USB dongle) 500 kbps (WTxx to WTxx) 450 kbps (WTxx to BT1.1-BT1.2 device) N/A (MUX data rate) 50 kbps (OBEX transfer)
Typical data transmission delay	10-15ms
Minimum data transmission delay	5-10ms
Typical SCO delay	30-40ms
Typical A2DP delay (*	150-200ms
A2DP coding/encoding methods	SBC, APT-x**, FastStream**, MP3** and AAC**
PIN code length	Configurable from 0 to 16 characters.
Encryption length	From 0 to 128** bits
MAX simultaneous pairings	16
MAX Friendly name length	Configurable up to 248 characters
RFCOMM Packet size	Configurable from 21 to 1008
Supported power saving modes	Sniff and deep sleep
Bluetooth QD ID	iWRAP4 4.0: B016540 iWRAP4 3.0: B014328 iWRAP4 2.2.0: B012647
Secure Simple Pairing	Just works mode Man-in-the-middle protection (MITM) Out-of-Band (OOB) pairing

Supported *Bluetooth*® Profiles

Supported *Bluetooth* Profiles

- Serial Port Profile (SPP)   - DevA and DevB

- Hands Free Profile (HFP) v.1.5   - HPF and HFP-AG modes

- Headset profile (HSP) v.1.2   - HSP and HSP-AG modes

- Object Push Profile (OPP)   - OPP server and client

- File Transfer Profile (FTP)   - FTP client

- Dial-up Networking Profile (DUN)   - Terminal emulation

- Human Interface Device (HID)   - HID device (mouse and keyboard)

- Advanced Audio Distrubution Profile (A2DP)   - Sink and source modes

- A/V Remote Control Profile (AVRCP)   - AVRCP controller and target

- Health Device Profile (HDP)   - HDP sink and source

- Phone Book Access Profile (PBAP)   - PBAP client

- Device Identification Profile (DI)

Serial Port Profile

- **SPP defines how to set up virtual serial ports and connect two *Bluetooth* enabled devices**

  - **Device A** – This is the device that takes initiative to form a connection to another device (initiator).
  - **Device B** – This is the device that waits for another device to take initiative to connect (acceptor).

- **RFCOMM is the *Bluetooth* adaptation of GSM TS 07.10, providing a transport protocol for serial port emulation.**

Serial Port Profile

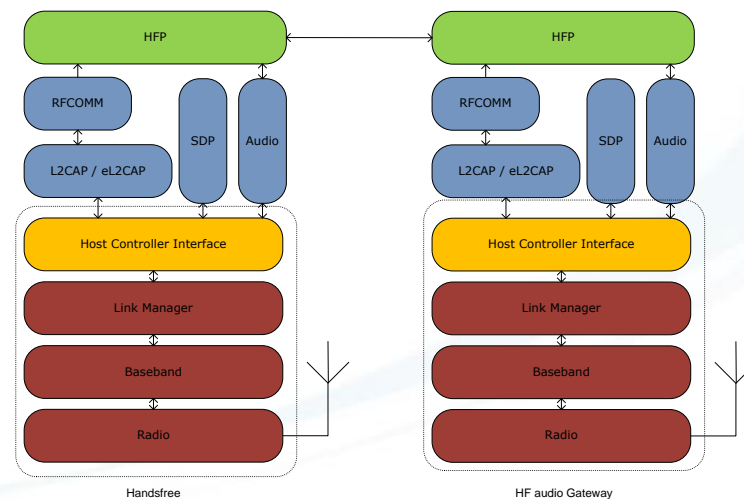Dev A   Dev B
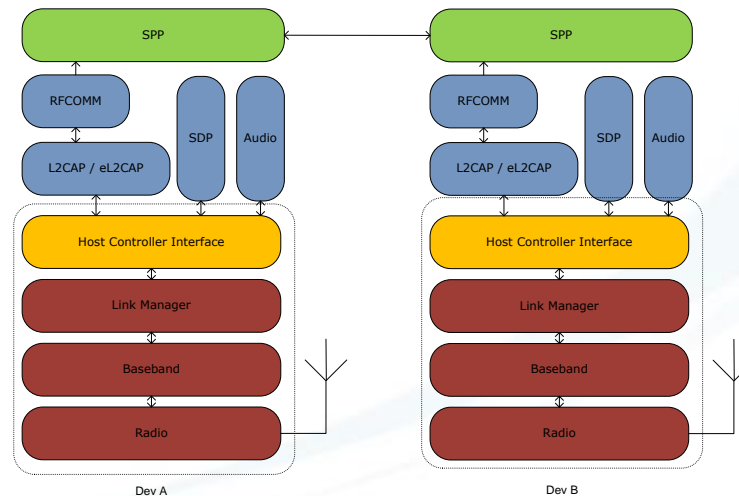
Summary:

- 7 simultaneous SPP connections can be achieved
- Data rate split among the connections
- MUX mode can be used to send/receive data "simultaneously" from several connections

Hands Free Profile

- **HFP describes how a gateway device can be used to place and receive calls for a hand-free device.**

  - **Audio Gateway (AG)** – This is the device that is the gateway of the audio, both for input and output, typically a mobile phone.

  - **Hands-Free Unit (HF)** – This is the device acting as the Audio Gateway's remote audio input and output mechanism. It also provides some remote control means.

- **iWRAP4 will act as Hands-Free control entity responsible for Hands-Free unit specific control signaling; this signaling is AT command based.**

| Handsfree | HF audio Gateway |

Hands Free Profile

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Hands-Free Unit (HF)

HFP

HFP

Audio Gateway (AG)

GSM

GSM / PSTN network

Hands-Free Unit (HF)

Summary:

- HFP allows sending AT commands between HF and HF Audio gateway (RFCOMM)
- Bi-directional audio can be transmitted over eSCO/SCO connection
- Audio quality: full-duplex, mono, 8kHz, 8bits -> 64kbps

Headset Profile

- **The HSP describes how a Bluetooth enabled headset should communicate with a computer or other Bluetooth enabled device such as a mobile phone.**
- **HSP defines two roles:**

  - Audio Gateway (AG) – This is the device that is the gateway of the audio, both for input and output, typically a mobile phone or PC.

  - Headset (HS) – This is the device acting as the Audio Gateway's remote audio input and output mechanism.

- **Headset Control is the entity responsible for headset-specific control signalling; this signalling is AT command based.**

Headset Profile

Headset (HS)

HSP

HSP

Headset Audio Gateway (AG)

**GSM**

GSM / PSTN network
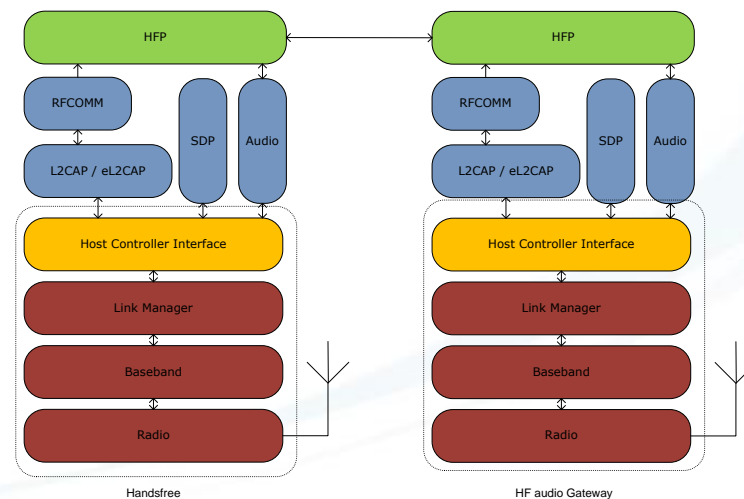
Headset (HS)

Summary:

- Bi-directional audio can be transmitted over eSCO/SCO connection
- AT command set is VERY limited -> HFP recommended
- Audio quality: full-duplex, mono, 8kHz, 8bits -> 64kbps

Object Push Profile

- OPP defines the roles of push server and push client. These roles are analogous to and must interoperate with the server and client device roles that GOEP defines.

  - **Push Server** – This is the device that provides an object exchange server.
  - **Push Client** – This is the device that pushes and pulls objects to and from the Push Server.

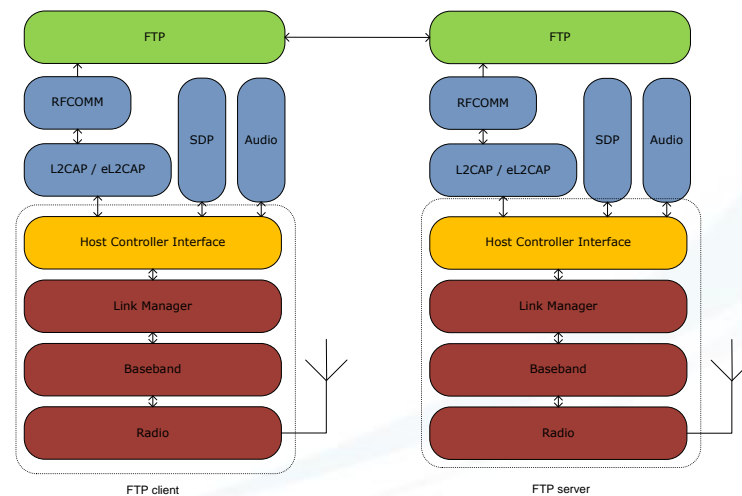- OBEX is the *Bluetooth* adaptation of IrOBEX.

Object Push Profile

File push/reception

OPP

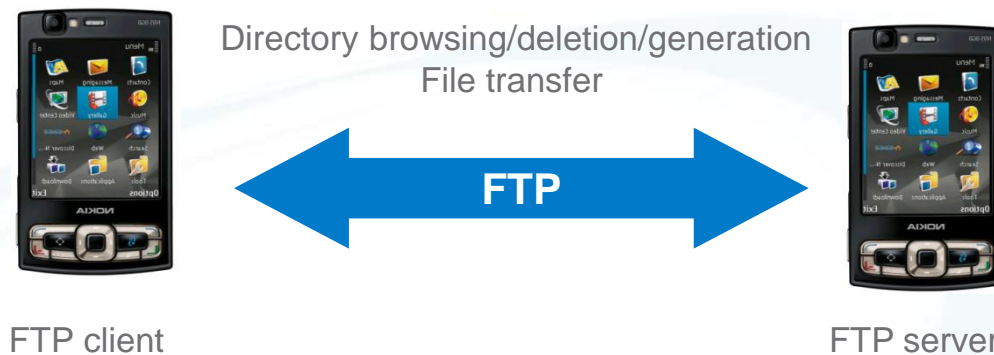OPP server   OPP client
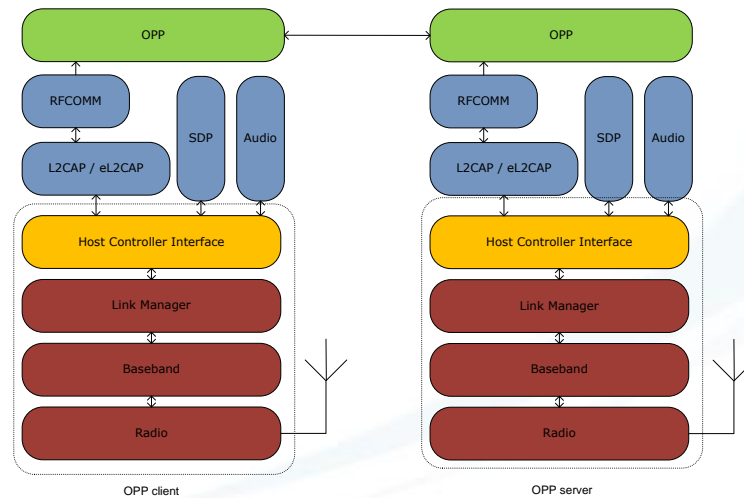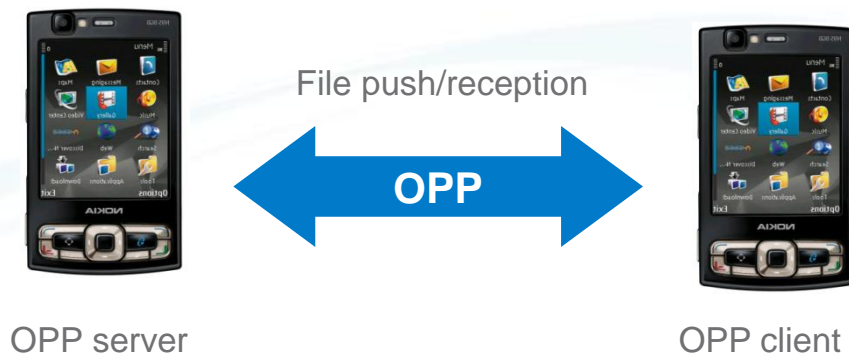
Summary:

· OPP allows sending/reciption of files over Bluetooth
· OPP requires the use of iWRAP's MUX mode because the data needs to be packetized

File Transfer Profile

- **FTP defines how folders and files on a server device can be browsed by a client device. Once a file or location is found by the client, a file can be pulled from the server to the client, or pushed from the client to the server using GOEP.**

- **The FTP defines two roles, that of a Client and a Server:**
  - Client – The Client device initiates the operation, which pushes and pulls objects to and from the Server.
  - Server – The Server device is the target remote Bluetooth device that provides an object exchange server and folder browsing capability using the OBEX Folder Listing format.

- **iWRAP only implements FTP client**

FTP client   FTP server

File Transfer Profile

Directory browsing/deletion/generation
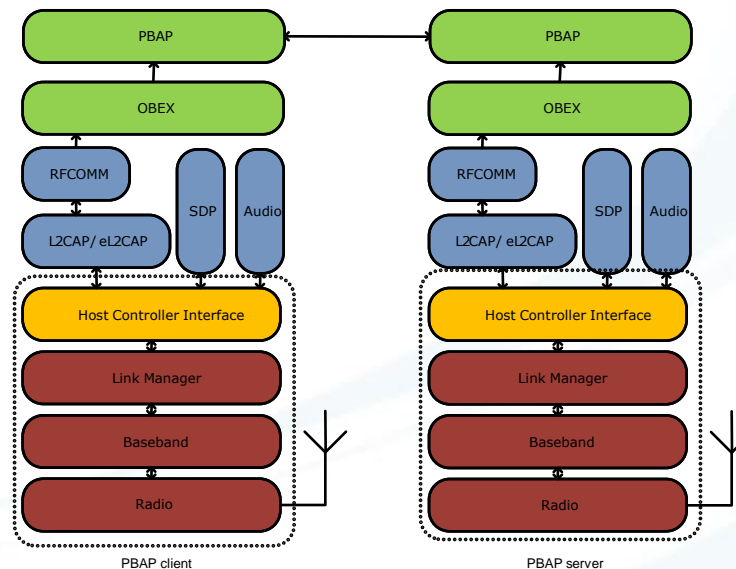File transfer

FTP

FTP client

FTP server

Summary:

- FTP allows sending/reception of files over Bluetooth
- User can also browse/create/delete directories or files
- FTP requires the use of iWRAP's MUX mode because the data needs to be packetized

Phone Book Access Profile

- **Phone Book Access Profile (PBAP) is a profile that allows exchange of Phone Book Objects between devices. It can be used for example between a car kit and a mobile phone to:**
  1. Allow the car kit to display the name of the incoming caller;
  2. Allow the car kit to download the phone book so the user can initiate a call from the car display

- **The PBAP defines two roles:**
  - Phone Book Server Equipment (PSE): this role is for the device that contains the source phone-book objects; for example, a mobile phone.
  - Phone Book Client Equipment (PCE) role: this role is for the device that retrieves phone-book objects from the PSE device; for example, a portable navigation device (PND).

- **iWRAP firmware supports PCE role.**

Phone Book Access Profile

Phone book transfer
Call log transfer
SMS transfer

PBAP

PBAP server

PBAP client

Summary:

· iWRAP can be used to download phone book/call log/SMS messages from the PBAP server

Dial-Up Networking Profile

- **DUN provides a standard to access the Internet and other dial-up services over *Bluetooth* technology.**

  - **Gateway (GW)** – This is the device that provides access to the public network. (NOT supported by iWRAP4)

  - **Data Terminal (DT)** – This is the device that uses the dial-up services of the gateway.

- **The most common scenario is accessing the Internet from a laptop by using your mobile phone as a wireless dial-up modem.**

Dial-Up Networking

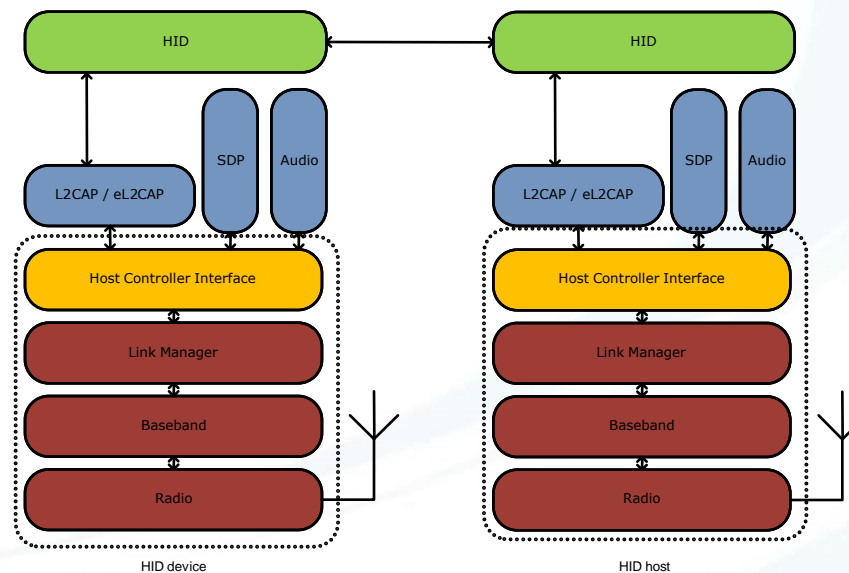GSM / GPRS / 3G network

Cellular

DUN
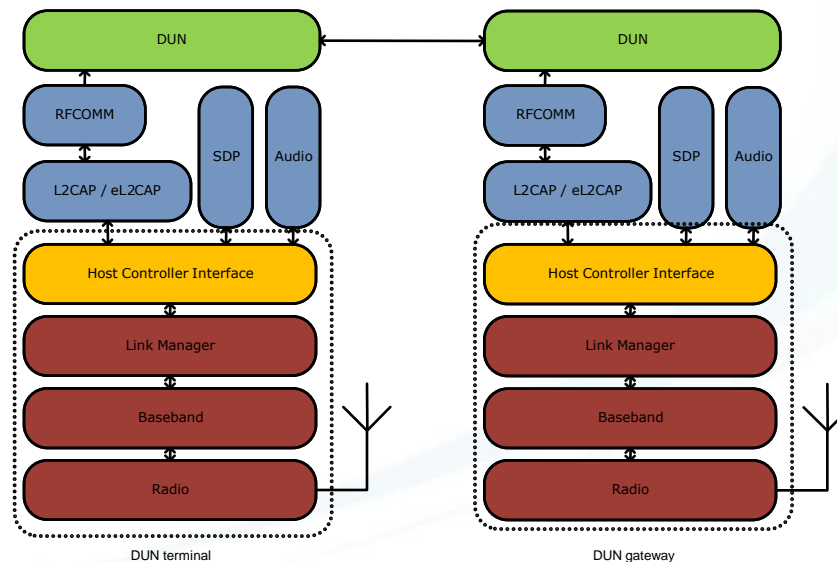
DUN Gateway

DUN Terminal

Summary:

- DUN profile allows you to control the modem hardware (SMS, Phone calls, TCP/IP)
- Control is done with AT commands
- iWRAP4 only suppports DUN terminal mode
(DUN gateway requires modem hardware)
- iWRAP4 does not run PPP not TCP/IP stacks, so host must implement one of them
  (free implementations exists)

Human Interface Device Profile

- The HID profile defines the protocols, procedures and features to be used by *Bluetooth* HID such as keyboards, pointing devices, gaming devices and remote monitoring devices.

    - **Human Interface Device (HID)** – The device providing the service of human data input and output to and from the host.
    - **HID Host** – The device using or requesting the services of a Human Interface Device. (NOT supported by iWRAP4)

- The HID profile uses the universal serial bus (USB) definition of a HID device in order to leverage the existing class drivers for USB HID devices.

HID device   HID host

Human Interface Device Profile

HID device (mouse emulation)

**HID**

HID

HID host

HID device (keyboard emulation)

Summary:

- iWRAP4 supports HID mouse and keyboard simultaneously
- Keyboard data sent as ASCII commands (ASCII codes 32-126) + special keys
- 3 button, 2-axis mouse
- Raw mode for sending any HID reports
- HID host mode is not supported

Advanced Audio Distribution Profile

- **A2DP describes how stereo-quality audio can be streamed from a media source to a sink.**

  - **Source (SRC)** – A device is the SRC when it acts as a source of a digital audio stream that is delivered to the SNK of the piconet.

  - **Sink (SNK)** – A device is the SNK when it acts as a sink of a digital audio stream delivered from the SRC on the same piconet.

- **A2DP defines the protocols and procedures that realize distribution of audio content of high-quality in mono or stereo on ACL channels. The term "advanced audio," therefore, should be distinguished from "*Bluetooth* audio," which indicates distribution of narrow band voice on SCO channels as defined in the baseband specification.**

A2DP source   A2DP sink
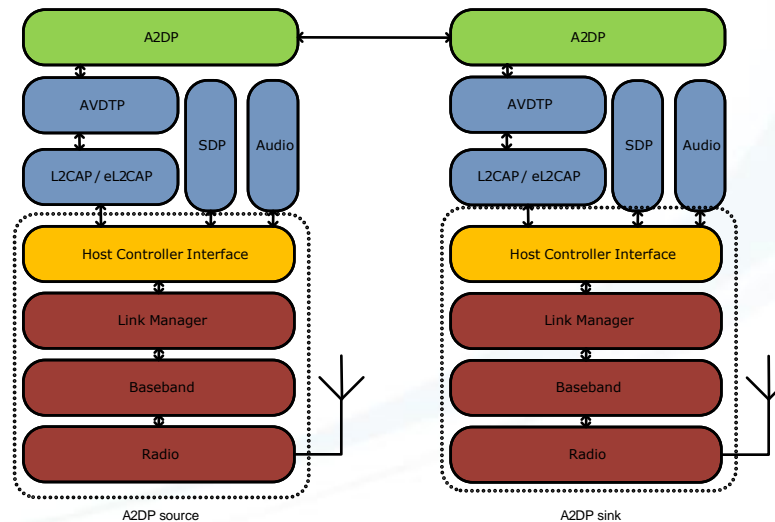
Advanced Audio Distribution Profile

A2DP source

A2DP sink

Summary:

· A2DP includes mandatory support for low complexity subband codec (SBC) and supports optionally MPEG-1,2 Audio, MPEG-2,4 AAC and ATRAC.
· A2DP is only half-duplex
· Surround sound distribution is not included in the scope of A2DP
· iWRAP4 can also support APT-x audio codec, which provides significantly better audio quality then SBC
· iWRAP4 also supports FastStream audio codec which reduces A2DP latency to 40ms

Audio/Video Remote Control Profile

- VRCP is designed to provide a standard interface to control TVs, hi-fi equipment, or others to allow a single remote control (or other device) to control all the A/V equipment to which a user has access. It may be used in concert with A2DP or VDP.

  - Controller – The controller is typically considered the remote control device.
  - Target – The target device is the one whose characteristics are being altered.
    - In a "walkman" type media player scenario, the **control** device may be a headset that allows tracks to be skipped and the **target** device would be the actual medial player.

- This protocol specifies the scope of the AV/C Digital Interface Command Set to be applied, realizing simple implementation and easy operability. This protocol adopts the AV/C device model and command format for control messages and those messages are transported by the Audio/Video Control Transport Protocol (AVCTP).
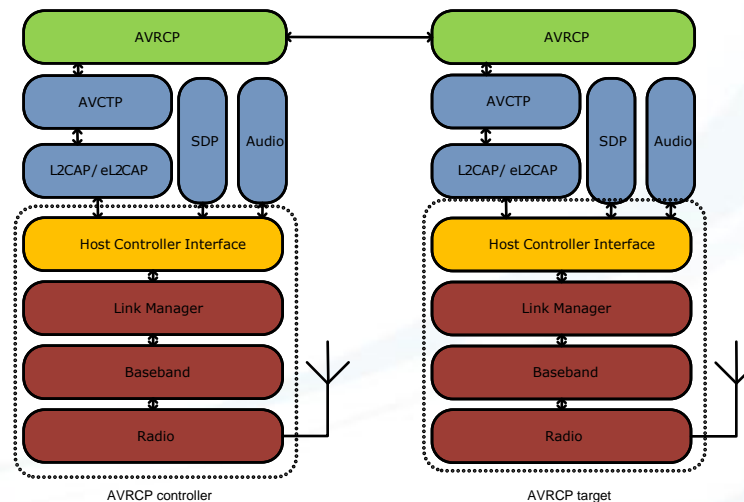
Audio/Video Remote Control Profile

AVRCP

AVRCP controller

AVRCP target

Summary:

- iWRAP4 implements both ACRVP controller and target
- AV commands are sent as simple ASCII strings, like "AV PLAY" and "AV PAUSE"

Device Identification Profile

- Device ID profile can be used to identify the manufacturer and model of Bluetpooth devices by transmitting the Device ID Service Record or so called *PNPInformation* over Bluetooth link.

- DI profile is part of Bluetooth SDP profile.
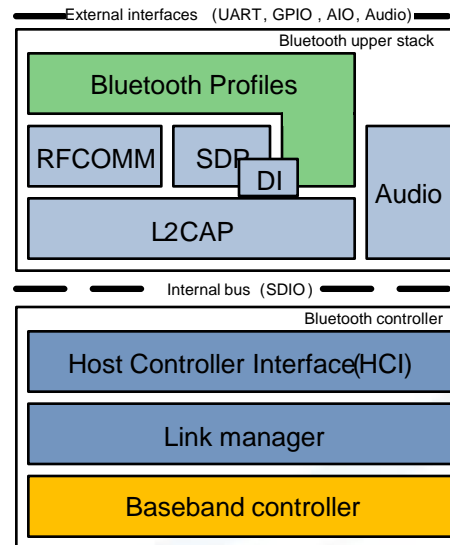
Health Device Profile

- **The Bluetooth Health Device Profile (HDP) allows the transmission of health and medical related data between Bluetooth devices. The typical uses cases are wireless blood pressure monitors, weight scales, blood glucose meters and ECG transmitters.**

- **The HDP profile offers unique features and extra reliability not included in the other Bluetooth profiles.**

- **A key feature in the HDP profile is also the application level interoperability defined by a set of IEEE 11073-xxxxx standards.**

- **The HDP defines two roles:**
  - HDP sink: this role is for the device that receives the data from one or several medical sensors and processes it or relays it to other services like Personal Health Records.

  - HDP source: this role is for the device that is used to make the measurements and transmit them over Bluetooth connection for future processing, for example a blood pressure meter.
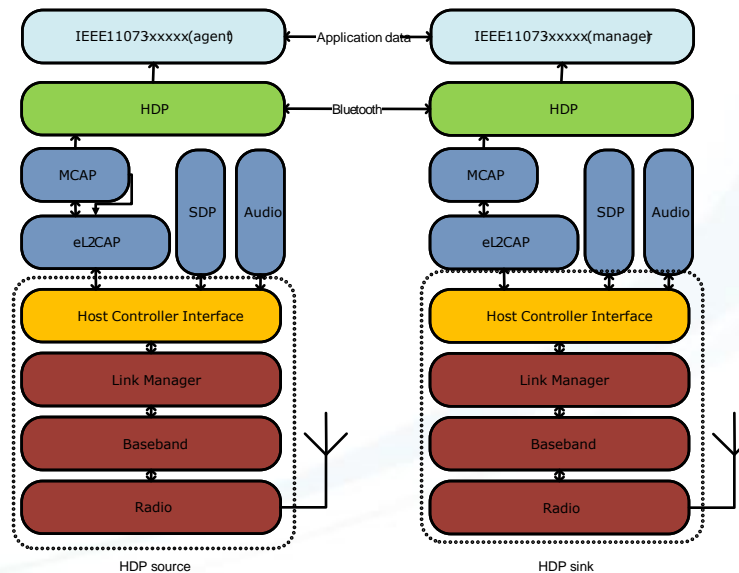
Health Device Profile

HDP source

HDP source

HDP sink

Summary:

- iWRAP4 supports both HDP source and sink (raw HDP gateway)
- iWRAP4 has dedicated versions for IEEE agents:
    - Blood Pressure Meter
    - Weight Scale
    - Blood glugoce level meter

Bluegiga Proprietary Profiles

BGIO Profile

- **Has unique UUID**

- **Uses simple and light weight binary protocol for communication**

- **Remote device can configure which PIOs are measured and how often**

- **Allows creation of sensors without need for host processor**

Bluetooth SPP

External interfaces (UART, GPIO , AIO, Audio)

Bluetooth upper stack

BGIO profile

RFCOMM	SDP

L2CAP

Internal bus (SDIO)

Bluetooth controller

Host Controller Interface (HCI)

Link manager

Baseband controller
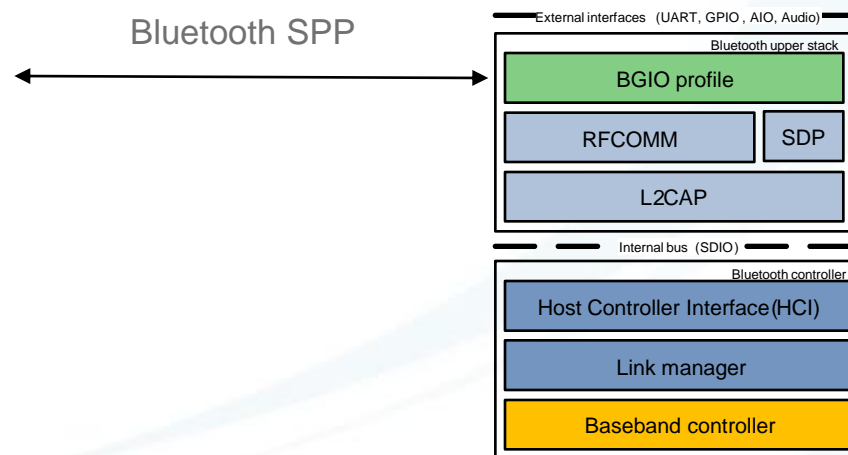
Over-the-Air configuration

- **A 2nd Serial Port Service (SPP) that gives access to the iWRAP4 command interface**

- **2 level protection:**
  - Bluetooth pin code
  - Password protection

- **Can be used for production line or "on the field" configuration.**

Bluetooth SPP

iWRAP cmd interface

External interfaces (UART, GPIO , AIO, Audio)

Bluetooth upper stack

Serial Port Profile

RFCOMM | SDP

L2CAP

Internal bus (SDIO)

Bluetooth controller

Host Controller Interface (HCI)

Link manager

Baseband controller
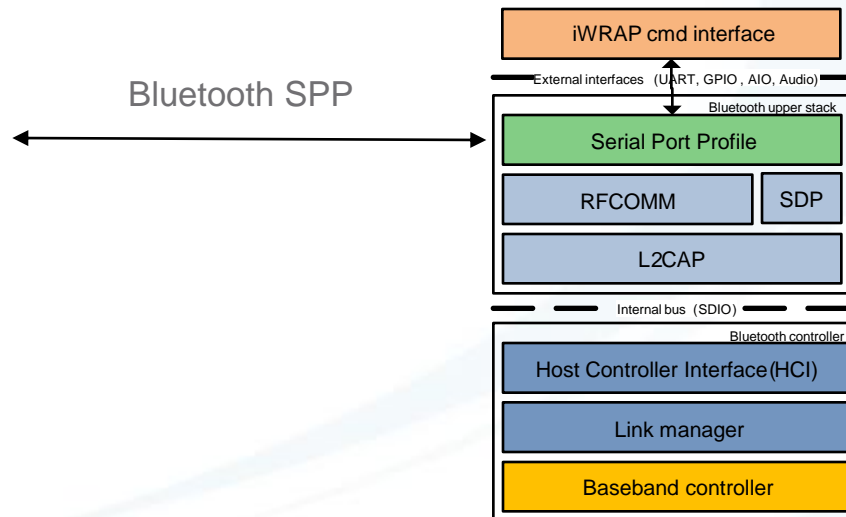
Bluetooth® 2.1 + EDR support

iWRAP4 Overview

- **iWRAP4 full supports** *Bluetooth* **2.1 + EDR specification**

- **Secure Simple Pairing (SSP) support : More secure and simplified pairing process**
  - Just works mode
  - Man-in-the-middle protection
  - Out-of-band pairing

- **Extended Inquiry Response**
  - Inquiry responses can carry data

- **Sniff subrating**
  - Improved current consumption in certain scenarios

Other new features

Audio Configuration

Several new commands hor handling audio configuration and audio hardware.

- **SET CONTROL GAIN**   - Controls ADC and DAC gain

- **SET CONTROL PCM**   - Configures PCM codec and data format

- **SET CONTROL MICBIAS**   - Configures MIC bias voltage and current

- **SET CONTROL PREAMP**   - Enables/Disables the 20dB preamplifier

- **SET CONTROL AUDIO**   - Selects the audio interfaces (I2S, SPDIF, PCM)

- **SET CONTROL CODEC**   - Configures the audio codecs (SBC, APT-x etc.)

- **VOLUME**   - Increases or decreases volume level

GPIO Handling

iWRAP4 has commands to read and write the direction and status of GPIO pins:

- **"PIO GETDIR"**   **-** Reads the contents of the PIO data direction register

- **"PIO GET"**   - Reads the contents of the PIO data input register

- **"PIO SET {mask} {bits}"**   - Sets the contents of the PIO data output register

- **"PIO SETDIR {mask} {bits}"**   - Sets the contents of the PIO data direction register

- **"PIO GETBIAS"**   - Reads the contents of the bias register

- **"PIO SETBIAS {mask} {bits}"**   - Sets the contents of the bias register

- **"PIO RESET"**   - Restores iWRAP4 default PIO registers

Adaptive Sniff mode

iWRAP4 can automatically change the power saving state of Bluetooth connections.

- **"SET BT SNIFF {mode} {min} {max} {attempt} {timeout} {duration}"**

Example:

"SET BT SNIFF 1 40 20 1 8 60"

iWRAP4 will use ACTIVE mode until link has been 60 seconds idle and then moves then to sniff equivalent to SET BT SNIFF 40 20 1 8.

L2CAP connections

iWRAP4 supports setting up raw L2CAP connectinos.
Is useful if one wants to implement L2CAP based profiles over iWRAP4.

- **L2CAP {psm}**   - Registers L2CAP psm

- **CALL {bd_addr} {psm} L2CAP**   - Opens L2CAP connection

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Bluetooth Clock

- **Clock command and event can be used to read Bluetooth piconet clock value.**

- **This is useful in sensoring applications where one needs to time synchronize slaves**

- **CLOCK {link_id}**   - Reads Bluetooth piconet clock value
                                    - Resolution 625us
                                    - Synchronization between slaves in same
                                          piconet possible in microsecond scale

Connection Repeater

iWRAP4 can act as a repeter / range extender for RFCOMM connections

- **CONNECT {link_id} {link_id}**   - Connects two {link_id}:s together as a transparent connection

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Thank you!

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