Séminaire CAPTRONICS

Objets Connectés:

Quelle connectivité RF Choisir ?

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ALPWISE Wireless Solutions

13 Mai 2014

Bluetooth

Sommaire

- **Focus sur la technologie Bluetooth**
  - Historique et acteurs du domaine
  - Principe de la technologie BT
  - Topologie et bande ISM, comparaison
  - standard et ses évolutions : BT , BLE , BT4.1...
  - Les applications du Bluetooth : quelques exemples

- **Contraites de mise en œuvre d'une solution Radio**
  - Choix de la solution et du protocole : fonction de l'application
  - Le principe de l'interface / architecture globale
  - Problématique antenne
  - Challenge débit/consommation/autonomie
  - Qualification CEM, normes et coûts de la solution.
  - Démonstration sensor & Mobile Phone

Historique

Origine du Bluetooth

- Nom de la norme : chef Viking, Harald Bluetooth
- Il aurait réussi à unifier les différents royaumes nordiques à la fin du Moyen-Age
- Dr Japp Haartsen, le concept de hopping frequency pour by-passer les interférences, et permettre un fonctionnement worldwide (# local regulations)
- Adopté en 1998
- Première publication de la spécification v 1.0 en 1999
- Définie et maintenue par le Bluetooth SIG Special interest Group
- Plusieurs évolutions depuis
- Les ventes devraient dépasser 1.8 Milliards de devices en 2016

Spécification du Standard

Specification

- Jusqu'à BT3.0 (Bluetooth Classic), BT 4.0 (BT Low Energy)
- BT 4.1 en cours …

Core Version 1.2	05 November 2003
Core Version 2.0 + EDR	04 November 2004
Core Version 2.1 + EDR	26 July 2007
Core Version 3.0 + HS	21 April 2009
Core Version 4.0	30 June 2010

Spécification du Standard

Specification

- Conçus pour promouvoir le standard et assurer l'interopérabilité
- Organise des périodes de test d'interopérabilité entre membres (Unplug-fest).
- La spécification volumineuse, 3 volets:
  - Radio
  - Protocoles
  - Profils
  - Documents test
- Les documents sont disponibles pour les membres du BT SIG.
- Utilisation de la bande du spectre sans licence (2,45 GHz)
- bas coût de mise en place et d'utilisation
- Taille réduite & Consommation électrique faible
- Réseau Ad hoc

Intérêts du standard Bluetooth

- Le **Standard** apporte une **interopérabilité d'utilisation** au niveau international.
- l'**Adoption** par de nombreux fabriquants conforte le standard et ses évolutions.
- Assure une robustesse de fonctionnement et l'avantage d'un coût moindre par une diffusion importante.

Domaine d'application BT & BLE

	Voice	Data	Audio	Video	State
Bluetooth ACL / HS	x	Y	Y	x	x
Bluetooth SCO/eSCO	Y	x	x	x	x
Bluetooth low energy	x	x	x	x	Y
Wi-Fi	(VoIP)	Y	Y	Y	x
Wi-Fi Direct	Y	Y	Y	x	x
ZigBee	x	x	x	x	Y
ANT	x	x	x	x	Y

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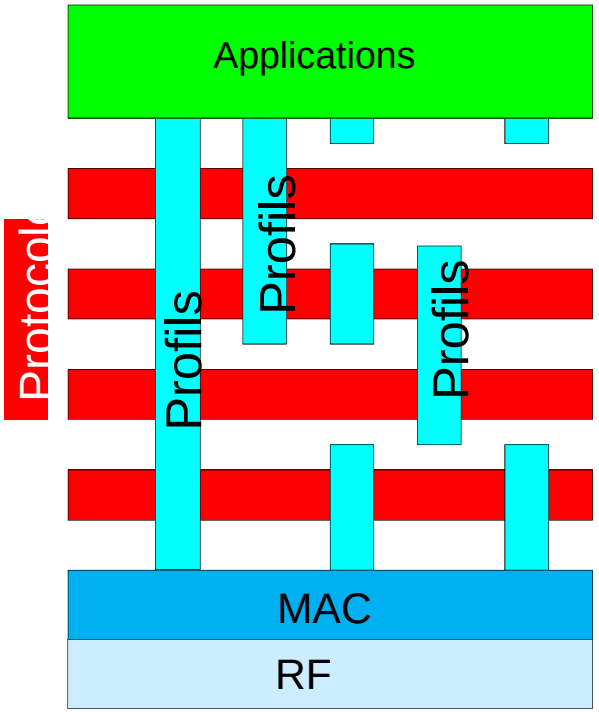
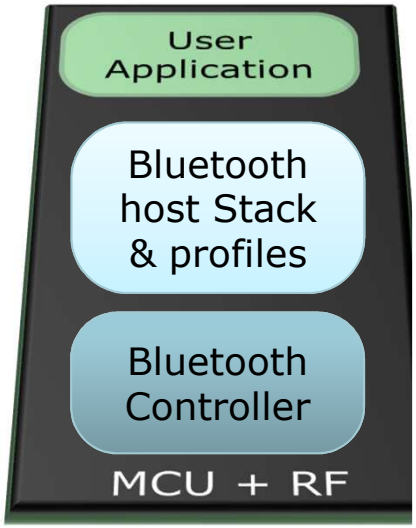
Interopérabilité & Profils d'applications

❑ Principe du Profil

- Il représente une solution pour un modèle d'utilisation
- Tranche Verticale à travers la pile de protocoles
- Chaque dispositif Bluetooth supporte un ou plusieurs profils
- Le MAC définit les protocoles pour :
  - L'économie d'énergie
  - La sécurité
  - Le routage multi-sauts
  - Service de transfert de données vers les couches supérieures

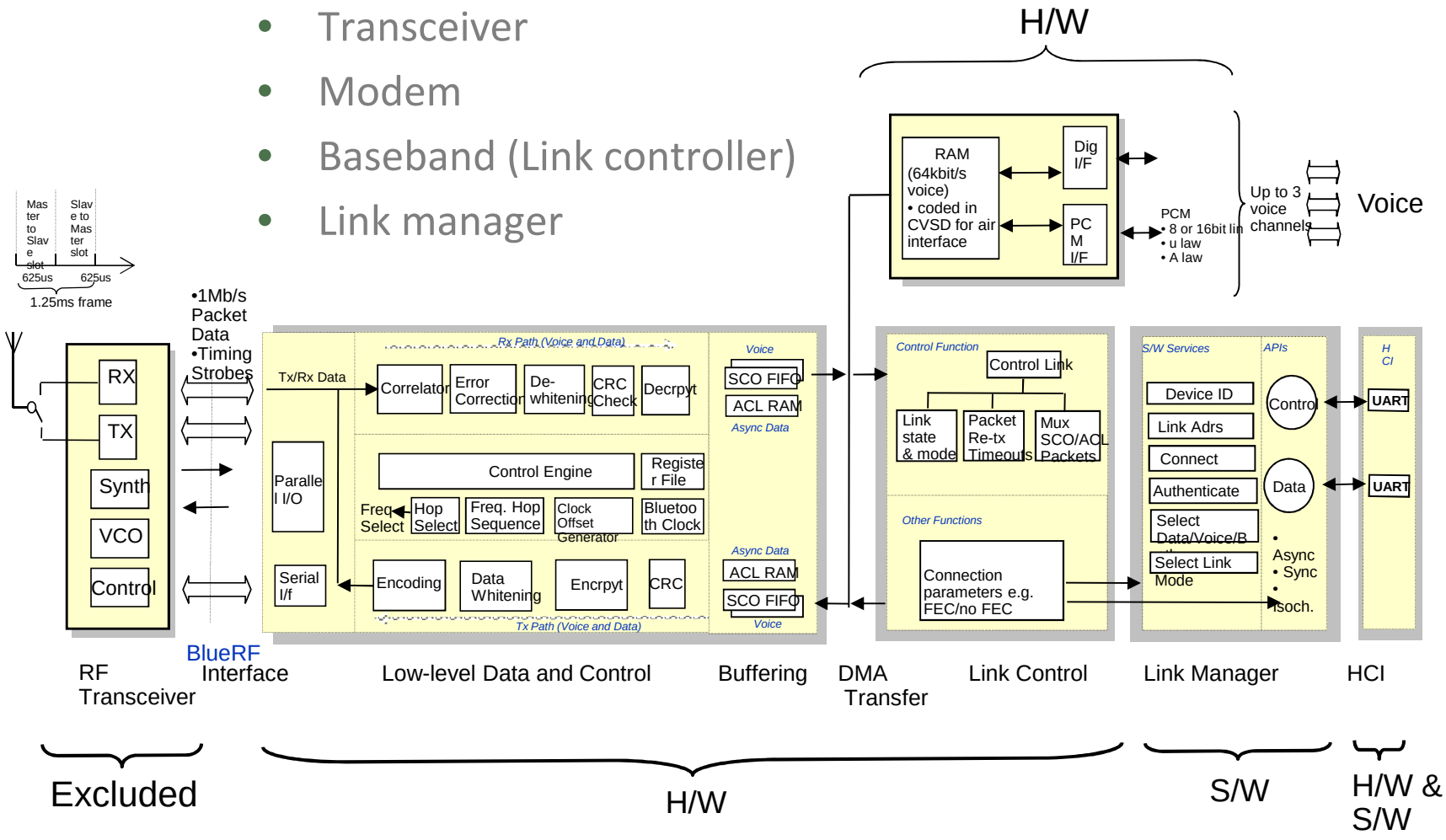




Architecture d'un composant Bluetooth

Chip function

- Transceiver
- Modem
- Baseband (Link controller)
- Link manager



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Acteurs

- **Chipmakers les plus connus**
  - BROADCOM
  - CSR
  - DIALOG
  - EM
  - FREESCALE
  - NORDIC
  - ST
  - Texas
- **La tendance (nouvelle génération de composants)**
  - Multi-standard (BT, ANT, Zigbee..)
  - Single mode très optimisé en BLE
  - Baisse radicale de la conso. (de 25mA, 15mA, 5mA..) et en mode de veille qq uA..

Market - Applications

Electronics (suppliers and integrators)

Bluetooth

Mobile & Office Accessories

Healthcare

Home & Entertainment

Sport & Fitness

Watches & Wrist wearable devices

Automotive

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Caracteristics comparison BT & BLE

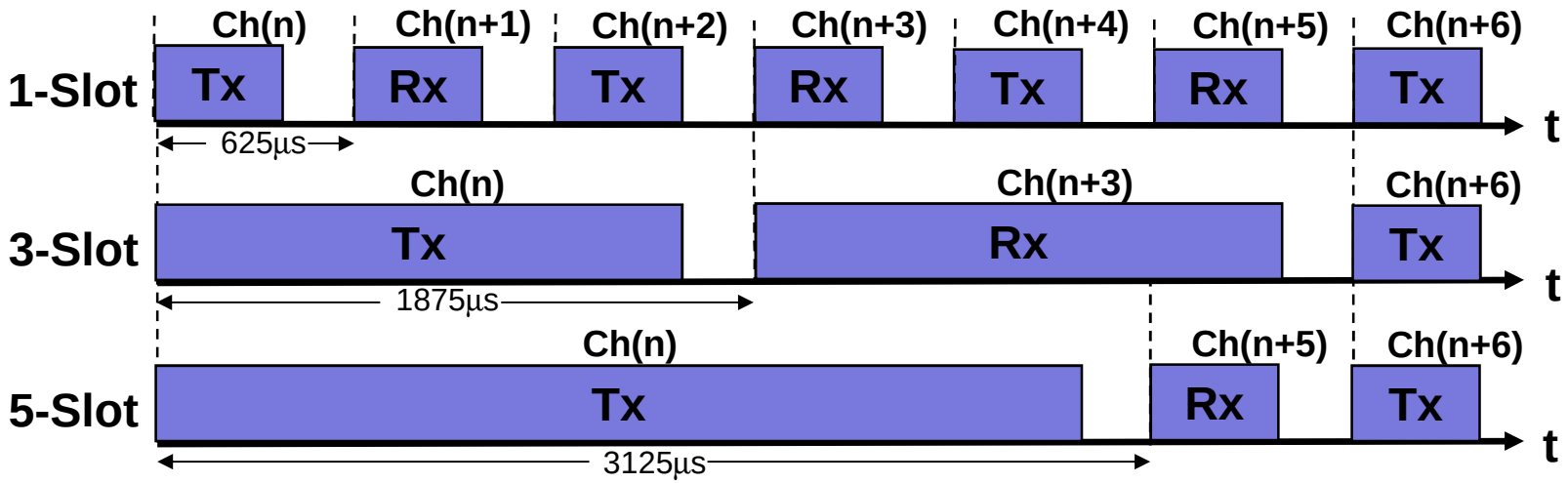
	Bluetooth LE	Bluetooth BR/EDR
IEEE Standard	IEEE802.15.1	IEEE802.15.1
Operation Frequency	2.4GHz	2.4GHz
Number of Channels	40 ch	80 ch
Max data Rate	1 Mbit/s	3 Mbit/s (Bluetooth 2.1)
Avr Range between Nodes	30m	20m class2, 100m class1
Supply voltage	1,5 V	2,0V to 3,3 V
Number of Nodes	Depend of ressources of Master	7 nodes on a piconet, more on scatternet
NetworkTopology	Point to point, star	Point to point, star, clustering
Main device types	Master or multislaves, broadcast role, scan role, initiator, advertiser role	Master and slaves, master/slave
Response/latency time	5ms	100ms
Target Applications	Mobile Phone, automation, fitness, healhtcare	Mobile Phone, Audio-Video transmission, automation, medical

Bluetooth & Bluetooth Low Energy

- Bluetooth
  - En ‘BT classic’, le lien radio est un lien orienté connexion, le communication est permanente et maintenue même sans le flot de données
  - Transmissions synchrones et asynchrones (Audio voice, transfert de fichiers ou photos)
  - Même s’il existe des modes de low power, les pics de courant (25ma en standard) pendant un transmission ne permettent pas de fonctionner sur des batteries type bouton.
- Bluetooth Low Energy
  - mécanismes différents du BT dans la transmission: synchronisation et connexion plus rapide (3ms), payload plus petit…
  - Transmissions asynchrones uniquement
  - D’autres profiles adaptés à l’internet of Things
  - Capable de fonctionner sur une simple pile ou par de l’énergie harvesting. (15mA TX/RX, 1uA en sleep, 10mw en TX
  - Tnasmission de datagram, (simple envoi de données: 1 byte à qq Bytes)

Bluetooth Packet Transmission Timing

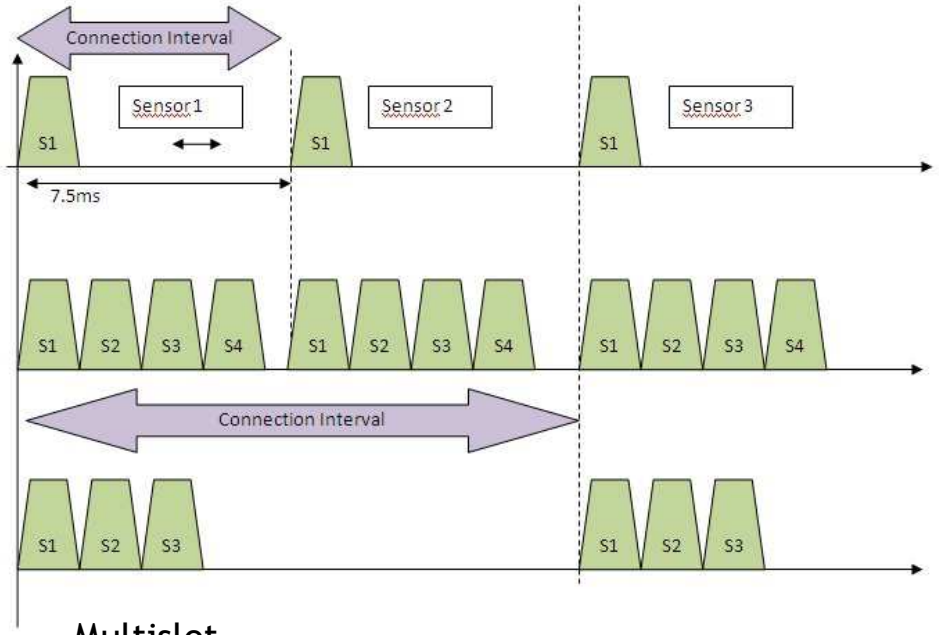
- Time Slot : 625 µs
- Time Division Duplex (TDD)
- To increase the throughput of the Bluetooth link longer packets are available. These result in less time spent re-tuning the synthesizer and therefore more time spent transferring data
- 1, 3 and 5 slot packets are available for use in a dynamic fashion (Multislot)



Bluetooth Low Energ Packet Transmission Timing

So Bluetooth Low energy is optimized for:

- Low duty cycle/ low standby time
- Low peak current



Multislot

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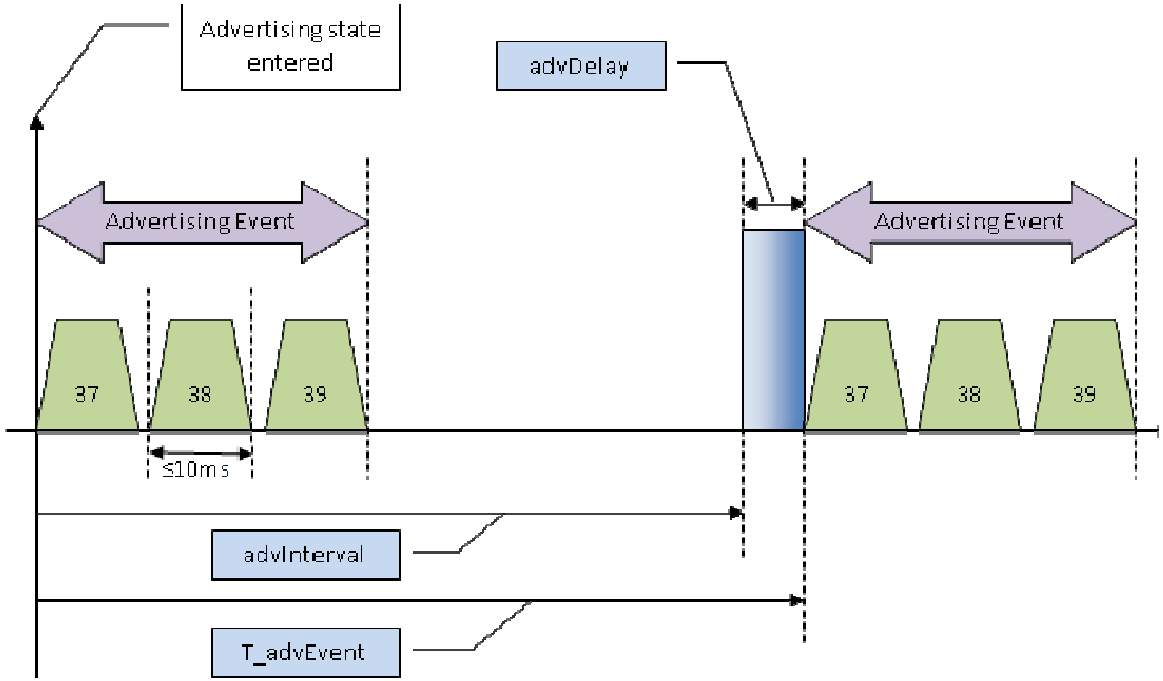
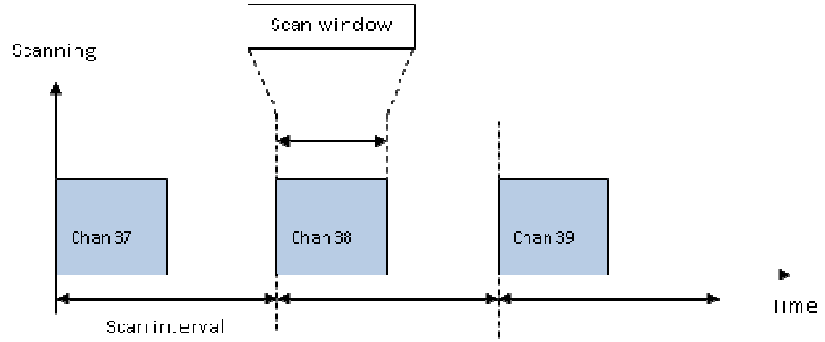
Bluetooth Low Energ Packet Transmission Timing

Synchronisation sur 3 canaux:

- Fast connection





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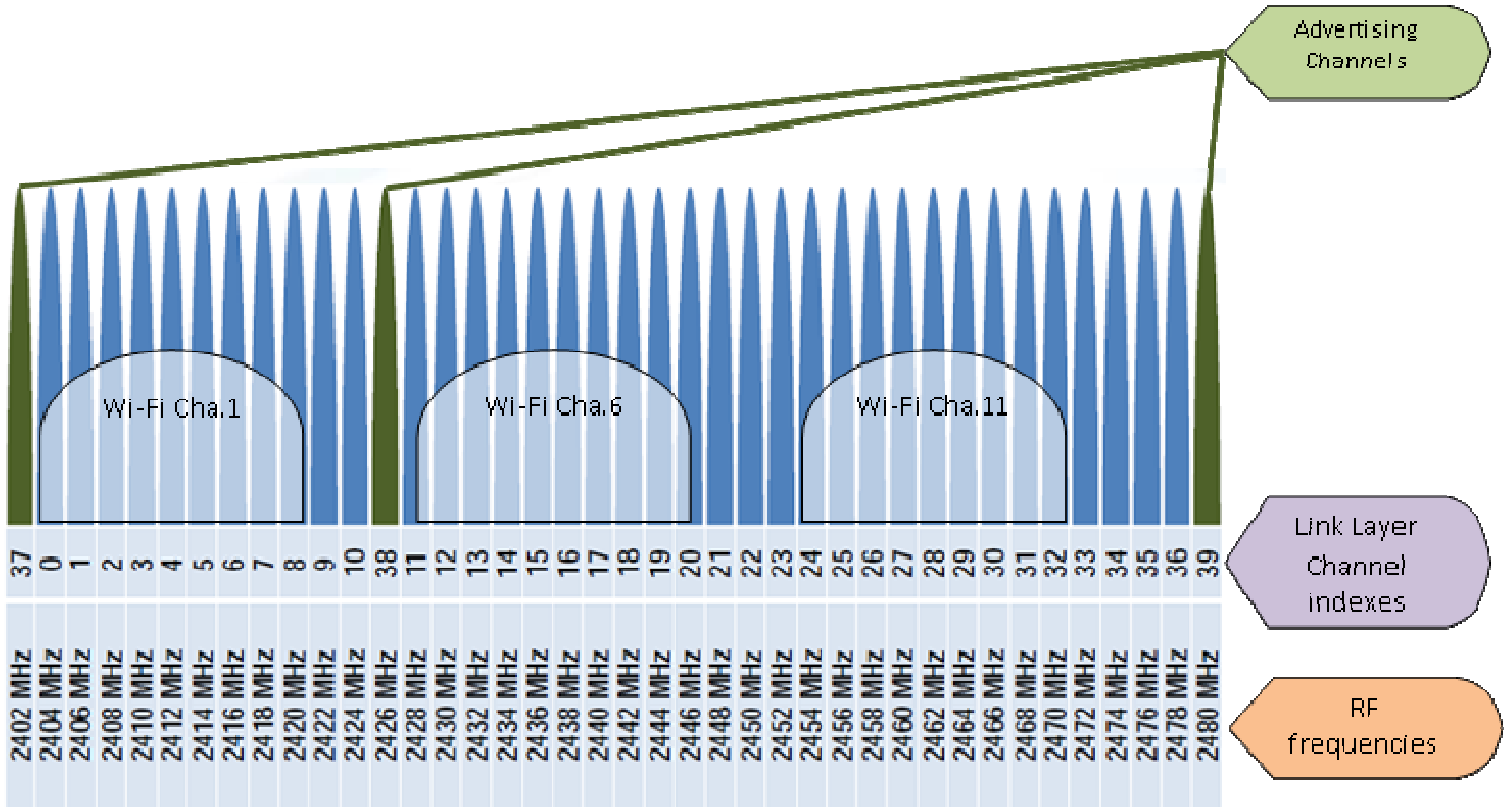
Bande de fréquence 2.4Ghz

- Hopping Frequency



Dual and Single mode

Single-mode *Bluetooth* low energy

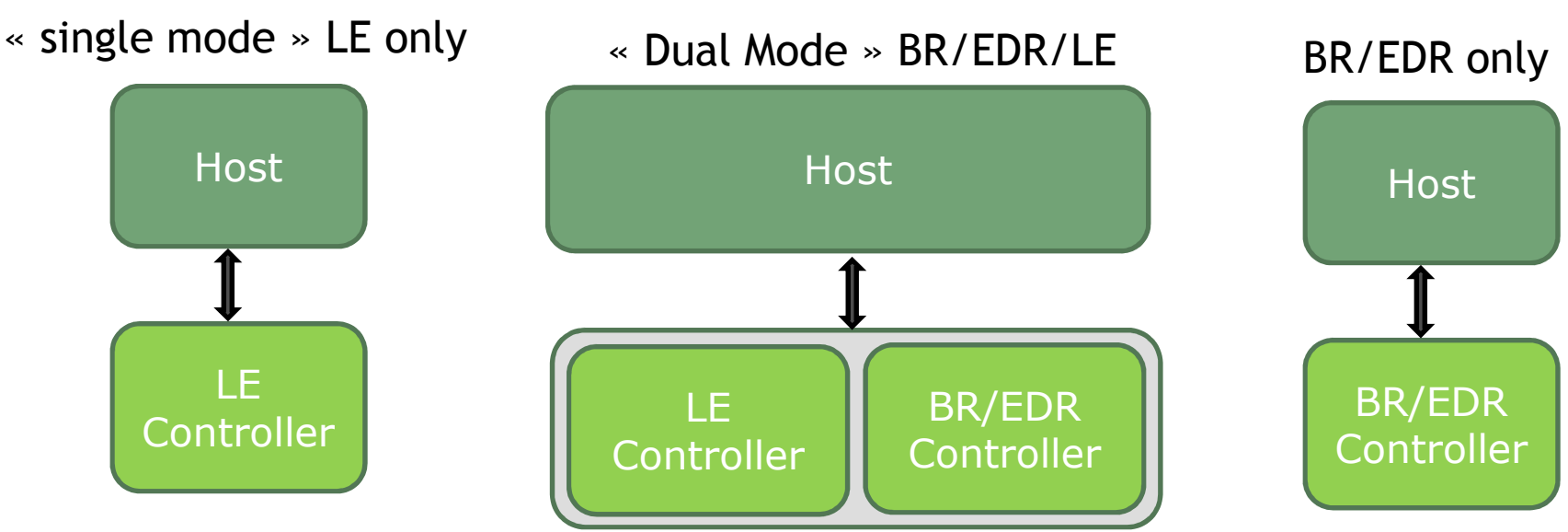
- Low consumption devices like sensors & terminals
- Health & Fitness Sensors, Watches, Remote Controls, small remote display…

Dual-mode *Bluetooth* + BLE

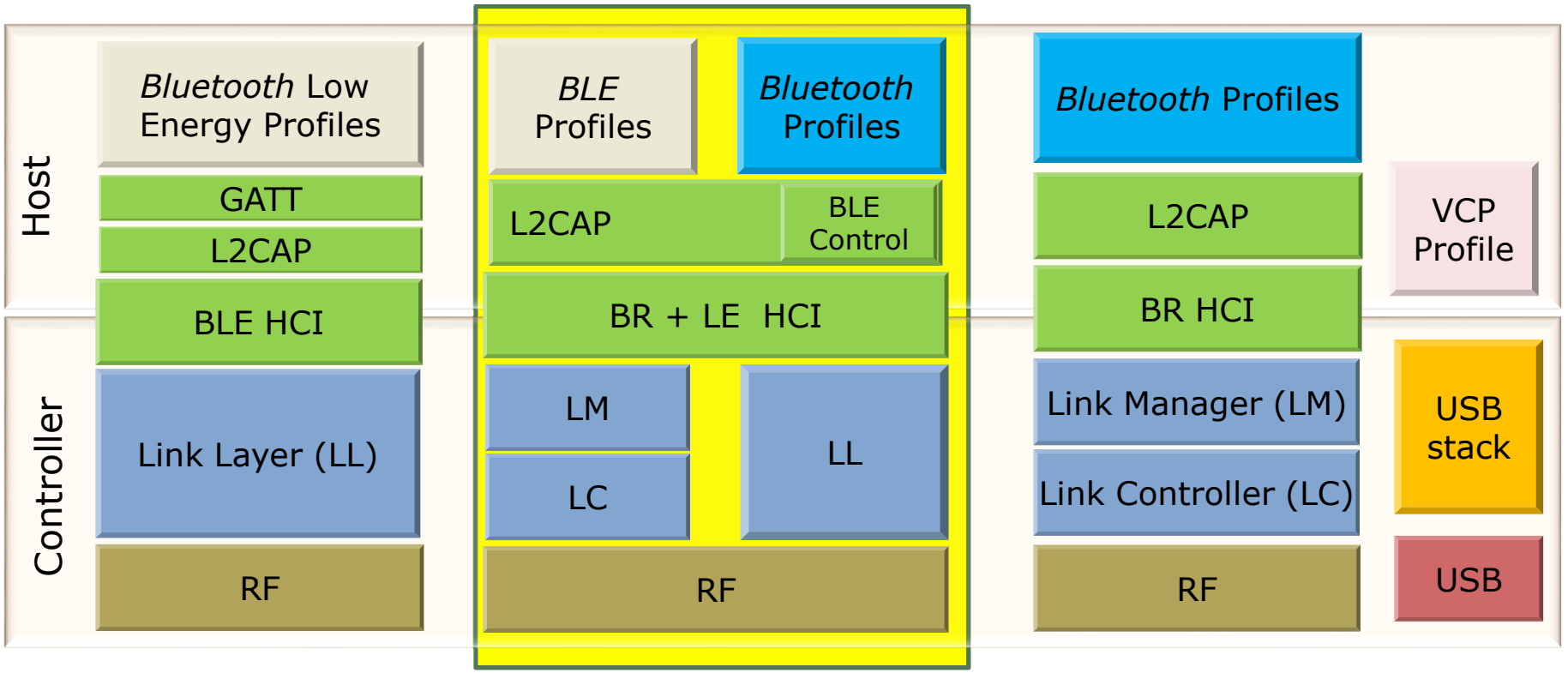
- Data collector devices acting as gateway
- Cell Phones, PCs…

Bluetooth 4.0

- Bluetooth Basic Rate / Enhanced Data Rate
- Bluetooth Low Energy



BT/BLE protocol



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Bluetooth Profiles

- Bluetooth BR/EDR
  - Overview
  - Host Protocol Stack
- Bluetooth LE
  - Overview
  - Host Protocol Stack
- Bluetooth BR/EDR Profiles Examples
  - (Audio): HFP, A2DP, AVRCP
  - (Data): SPP, PAN (networking), OBEX (photo, file)
- Bluetooth LE Profiles Examples
  - Time, proximity, cycling, oxymeter, health thermomer, heart-rate,

Bluetooth

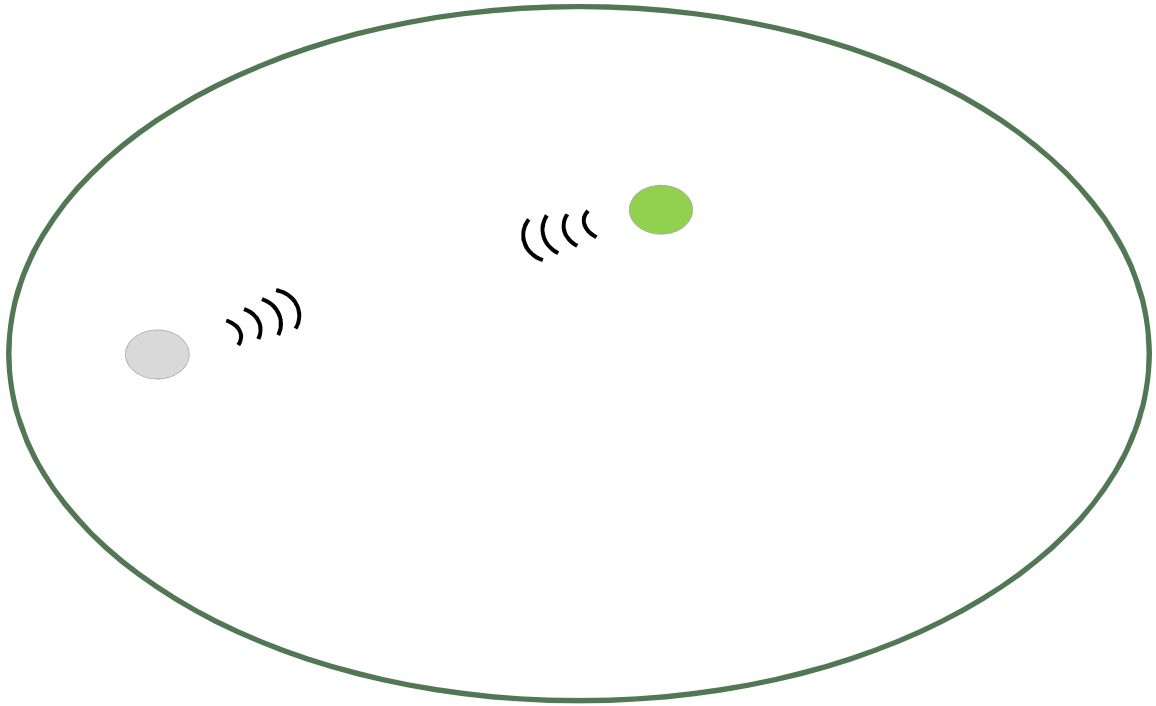
BLUETOOTH Description

Bluetooth functionnalities

- Provides point-to-point connections
- Provides ad-hoc networking capabilities
- Bluetooth specification details how the technology works
- Bluetooth Profiles detail how specific applications work to ensure interoperability

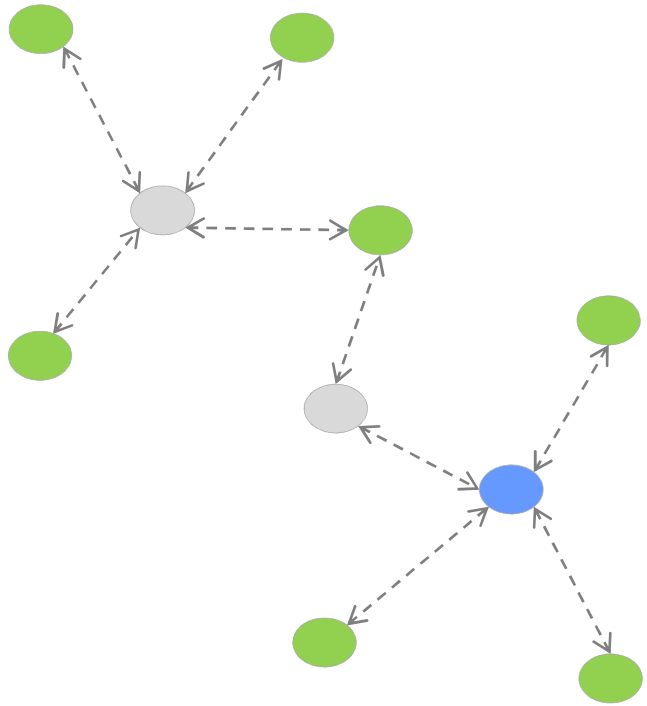
Bluetooth - Point-to-point

- Two devices locate each other
- Form a connection and transfer data
- The device that initiates the connection is called the Master
- Any other devices the Master is connected to are referred to as Slaves



Bluetooth Network (Point-to-Multipoint)

- Piconet Structure
- 1 Master and up to 7 Slaves
- One Physical Channel per Piconet with a common clock and hopping sequence.
- Master/Slave role
- Scatternet : interconnected piconets



Bluetooth Channels

- A master can create two types of logical channel with a slave device:
  - Synchronous Connection Oriented (SCO): Circuit Switched System provides real time unreliable connection with a guaranteed bandwidth; usually used for voice based applications
  - Asynchronous Connection Less (ACL): Packet Switched System provides a reliable data connection with a best effort bandwidth; depends on radio performance and number of devices in the piconet

- The Bluetooth connections are limited to 1Mbps across the air with BR and 3 Mbps with EDR.

Packet types

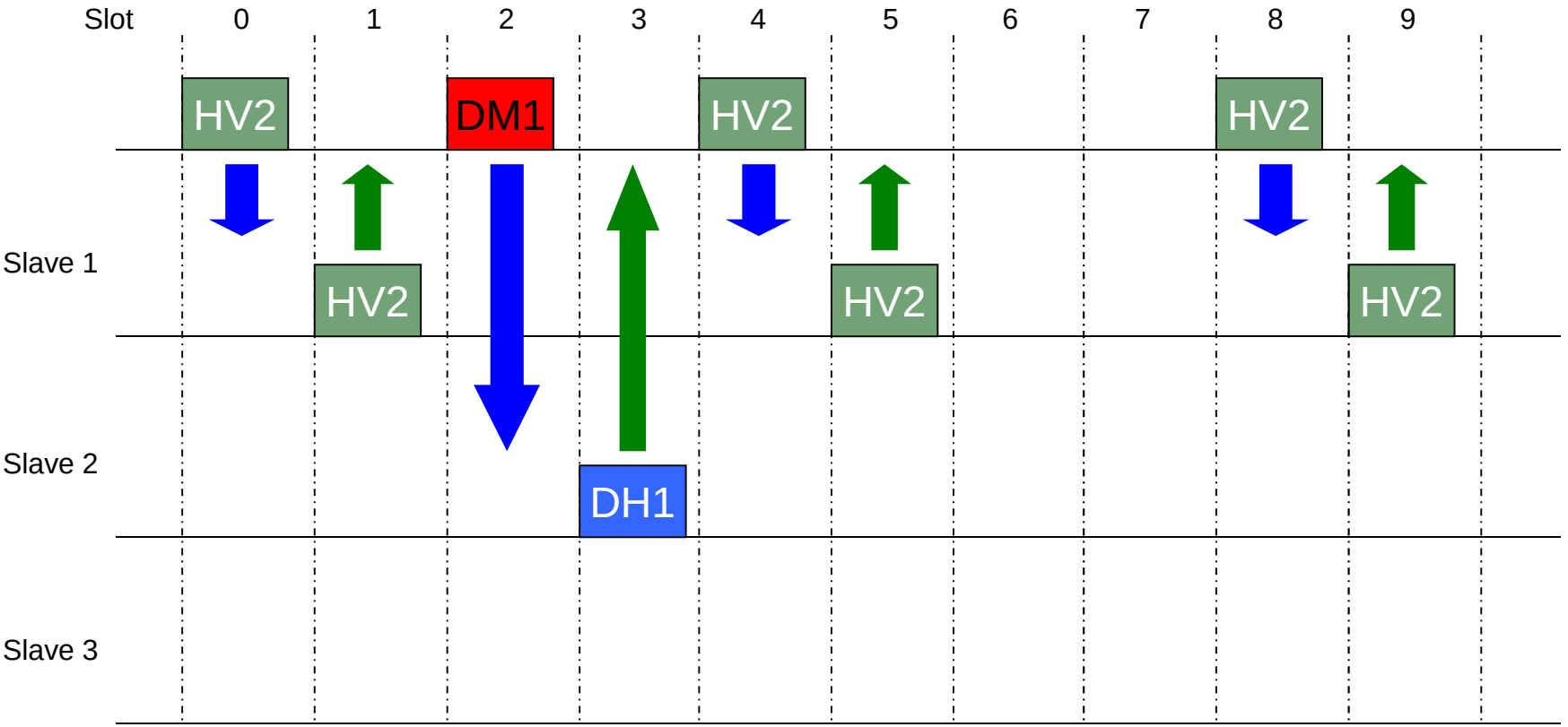
- There are 28 packet types defined, split into 4 segments:
  - 4 Common Packets (both ACL & SCO) (Control type)
    POLL, NULL, ID, FHS
  - Single slot packets
    - DM1, DH1, 2-DH1,3-DH1, AUX1 for ACL packets
    - HV1, HV2, HV3, DV for SCO packets
    - EV3, 2-EV3, 3-EV3 for eSCO packets
  - 3 slot packets
    - DM3, DH3, 2-DH3,3-DH3 for ACL packets
    - EV4, EV5, 2-EV5, 3-EV5 for eSCO packets
  - 5 slot packets
    - DM5, DH5, 2-DH5,3-DH5 for ACL packets

- Each packet type has a different level of error correction and protection and different size payloads

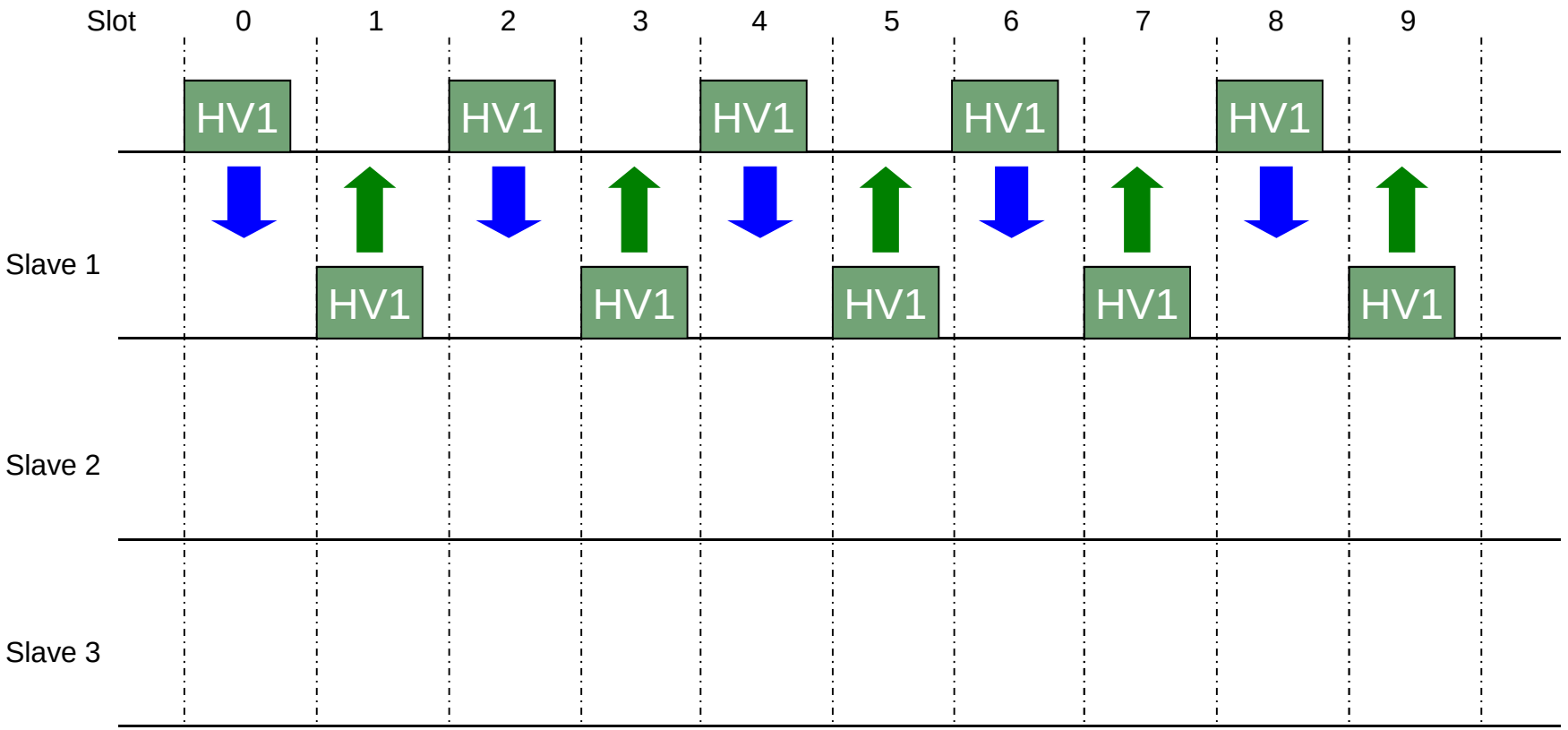
Forward Error Control

- Bluetooth defines three levels of forward error correction
- No Error Correction
  - There is no error correction!
  - Data is just put in the payload and sent
- 1/3 FEC :
  - Each bit is repeated 3 times
  - Majority voting decides bit value
- 2/3 FEC:
  - The data is encoded using a (15,10) shortened hamming code
  - Every 10 bits of data are encoded into 15 bits of data
  - Can correct single bit errors and detect double bit errors
- ARQ schemes:
  - Automatic Repeat reQuest
  - Packets are transmitted and retransmitted until an acknowledgment is returned.

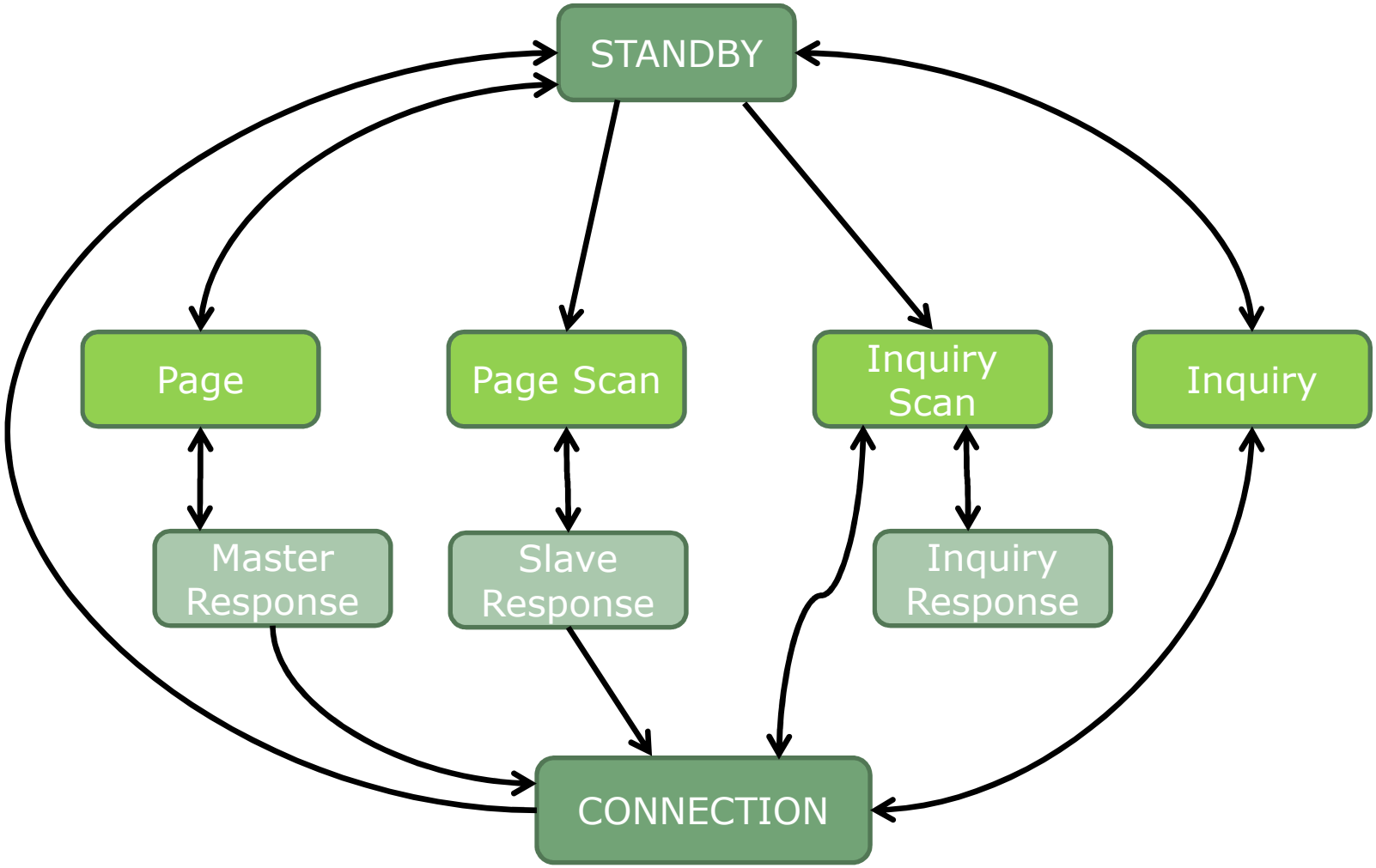
Mixing ACL and HV2 SCO packets



Mixing ACL and HV1 SCO packets



Bluetooth States



Low Power Modes

- To help reduce power consumption, there are three Bluetooth low power modes
  - Sniff Mode (The most used)
  - Hold Mode
  - Park Mode
- Slaves can request to be placed in any of these modes
- Masters can ask a slave to enter one of these modes
- Masters can also force a slave into one of these modes if it has previously accepted the mode

Secure Simple Pairing (SSP)

- Feature of Bluetooth 2.1
- Enable easier connectivity between devices and better use of security features

SSP – Association Models

- Numeric Comparaison

  Both devices are capable of displaying a six digit number and both are of capable having the user enter “yes” or “no”.

- Just Works

  One of the devices does not have a display capable of displaying a six digit number and nor does it have keyboard capable of entering “yes”or “no”.

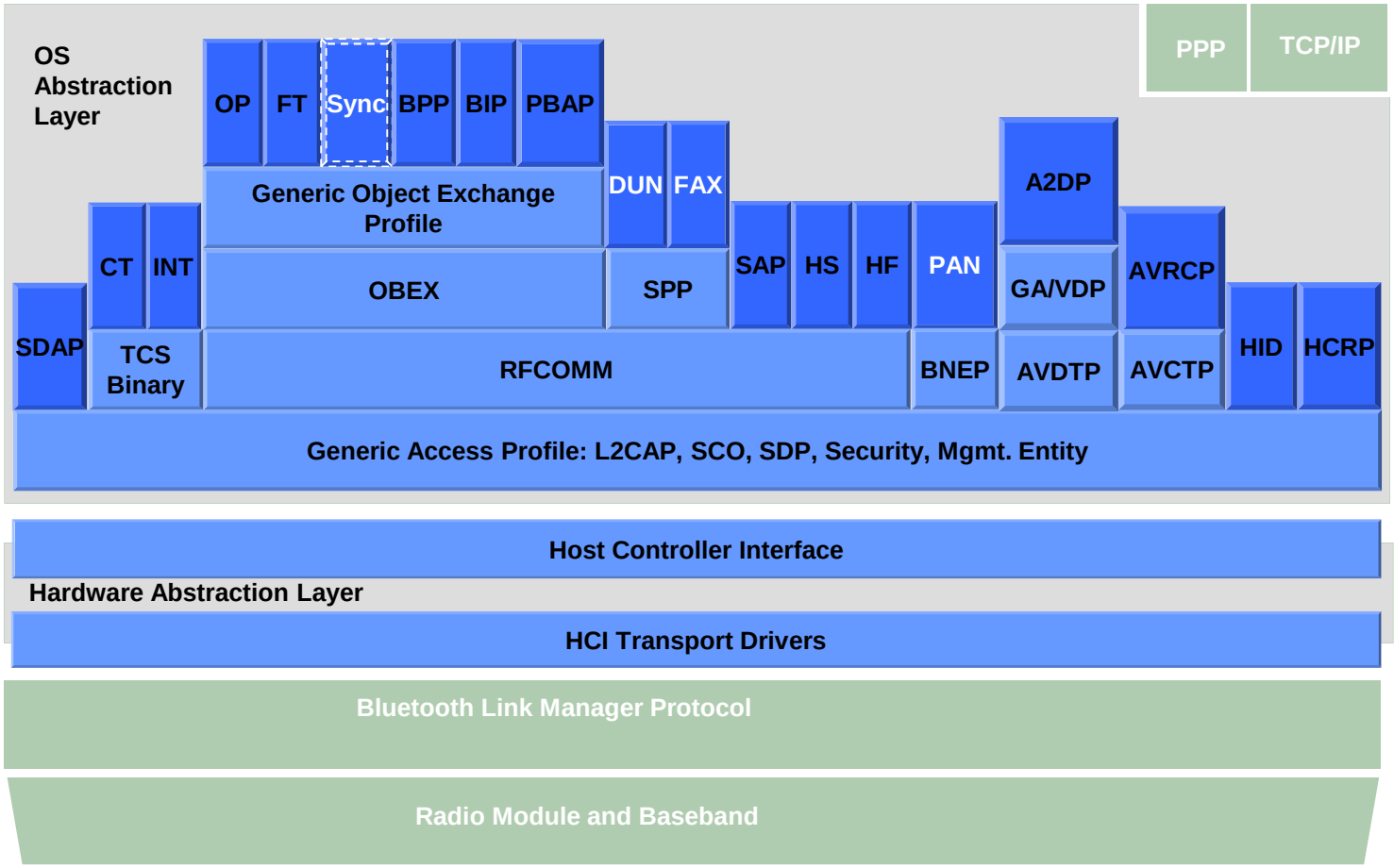
- Out Of Band

  Out of Band mechanism is used to both discover the devices as well as to exchange or transfer cryptographic numbers used in the pairing process.

- Passkey Entry

  One device has input capability but does not have the capability to display six digits and the other device has output capabilities.

Bluetooth Protocol Stack

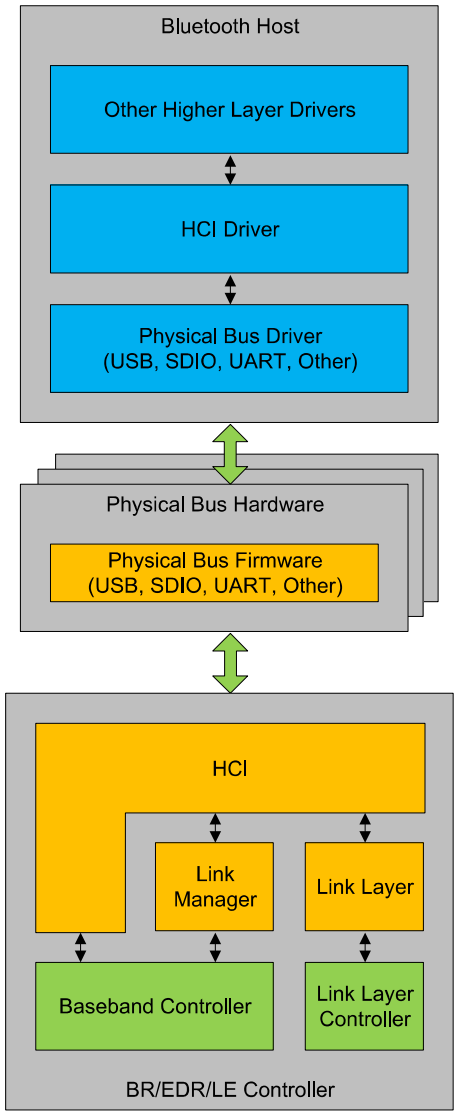


Link Manager (LM)

- Manages link set-up
- Manages security
- Manages piconet connections
- Provides test modes for simplified testing
- Link manager messages have higher priority than user data

Host Controller Interface

- The HCI interface defines a physical connection between a host (e.g. PC) and a host controller (e.g. Bluetooth module)
- 4 Types of HCI packet types:
  - HCI Command Packet
  - HCI ACL Data Packet
  - HCI SCO Data Packet
  - HCI Event Packet



Logical Link Control and Adaptation Protocol

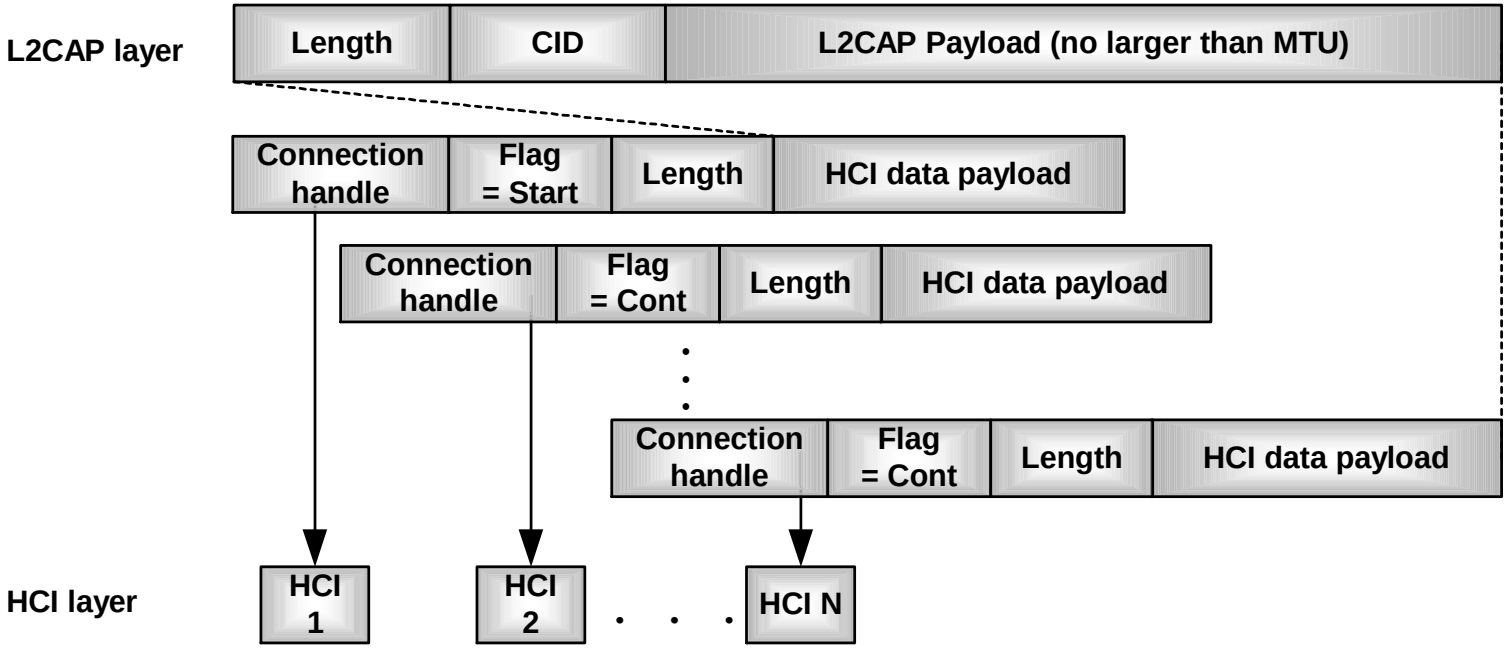
- Logical Link Control
  - Multiplexing: many logical links onto one physical link
- Adaptation
  - Segmentation & reassembly: adapts large packets to baseband size
- Protocol
  - A well defined set of signaling rules understood by all devices

L2CAP Multiplexing

- During channel setup, protocol multiplexing capability is used to route the connection to the correct upper layer protocol.
- For data transfer, logical channel multiplexing is needed to distinguish between multiple upper layer entities.

- L2CAP adds a Destination Channel ID to every packet
- The DCID is used to identify and direct packets to the appropriate handler (Protocol).

L2CAP Segmentation and Reassembly



L2CAP Error Control and Retransmission

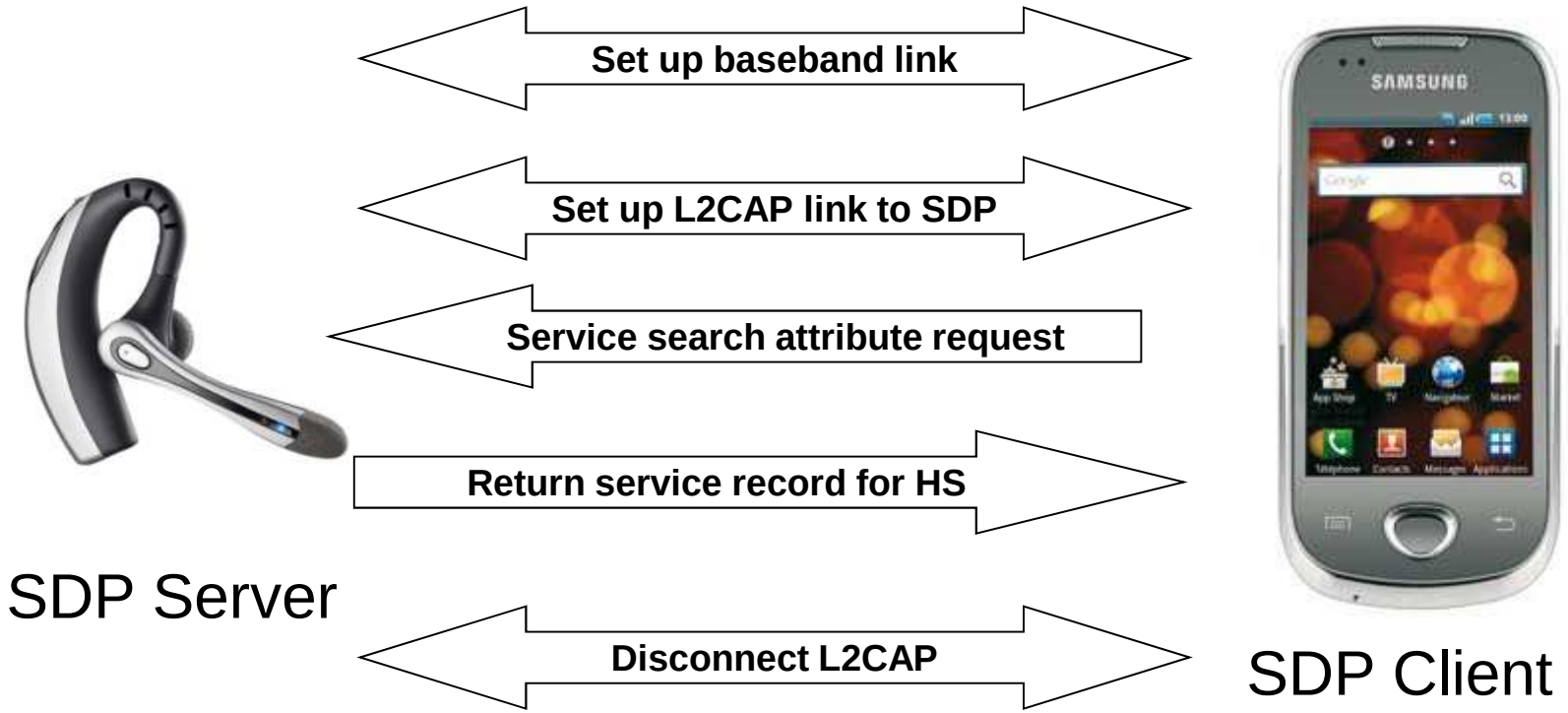
- The error checking in L2CAP protects against errors due to Controllers falsely accepting packets that contain errors but pass Controller-based integrity checks.

- L2CAP error checking and retransmission also protect against loss of packets due to flushing by the Controller.

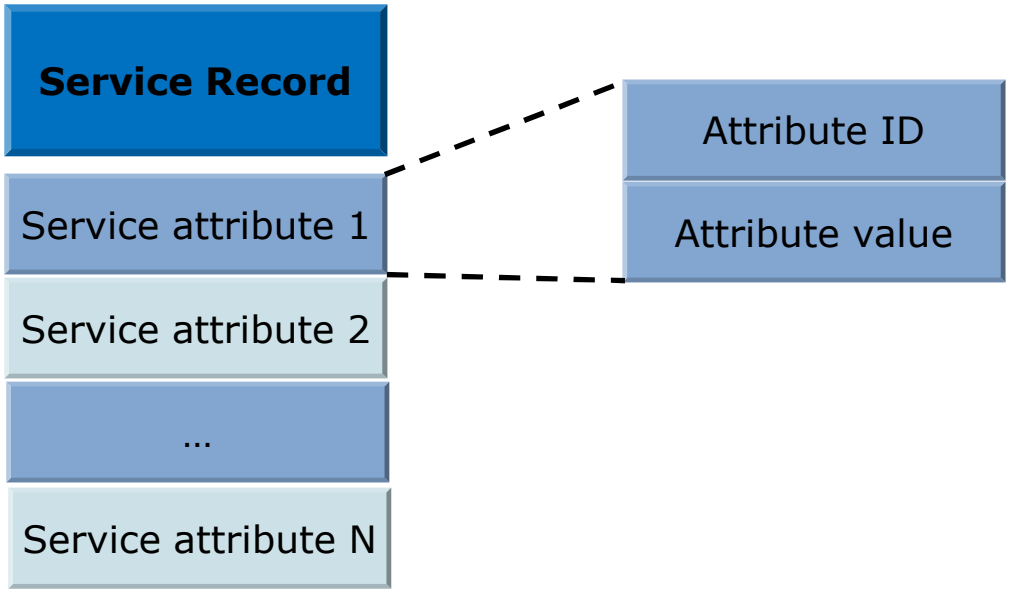
Service Discovery Protocol (SDP)

- SDP servers maintain a database on services offered
  - Made up of service records.
- SDP allows clients to search for services of all Bluetooth devices in range.
  - based on attributes and service classes.
- SDP uses connections set up via the usual Inquiry and Paging operations.

SDP Client-Server Functioning



SDP - Service Record



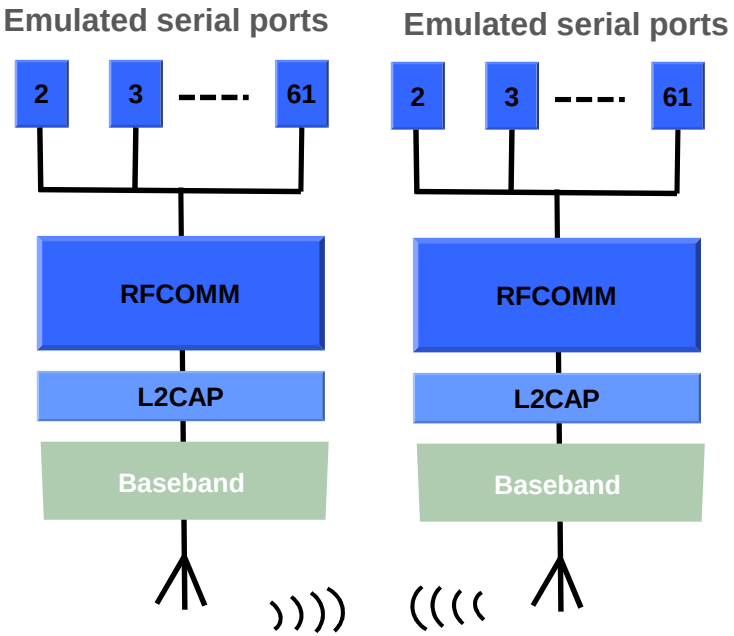
RFCOMM

- Emulation and multiplexing of serial port over L2CAP
  - Up to 60 emulated serial port connections per RFCOMM session.
  - Depending on implementation, multiple RFCOMM sessions are possible.

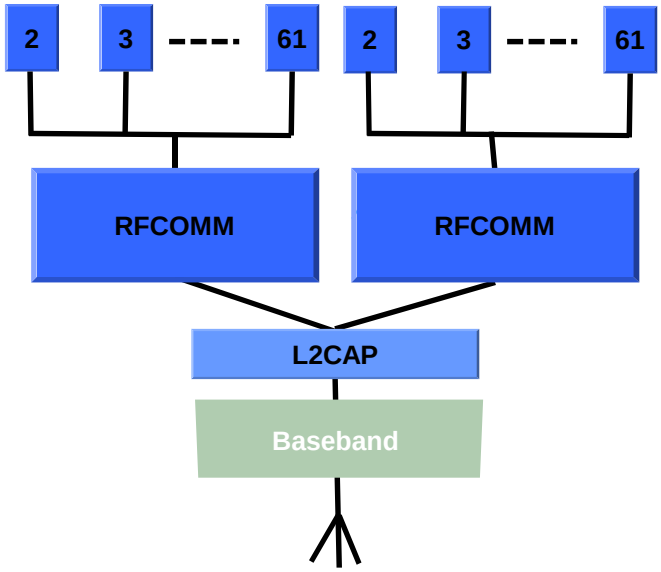
- RFCOMM intends to cover applications based on serial ports usage.

- Credit Based Flow Control
  - Negotiated credit tokens determine data flow
- RS-232 control signal emulation
- RS-232 flow control emulation
  - Software (Xon/Xoff)
  - Hardware (CTS/RTS)

RFCOMM Session



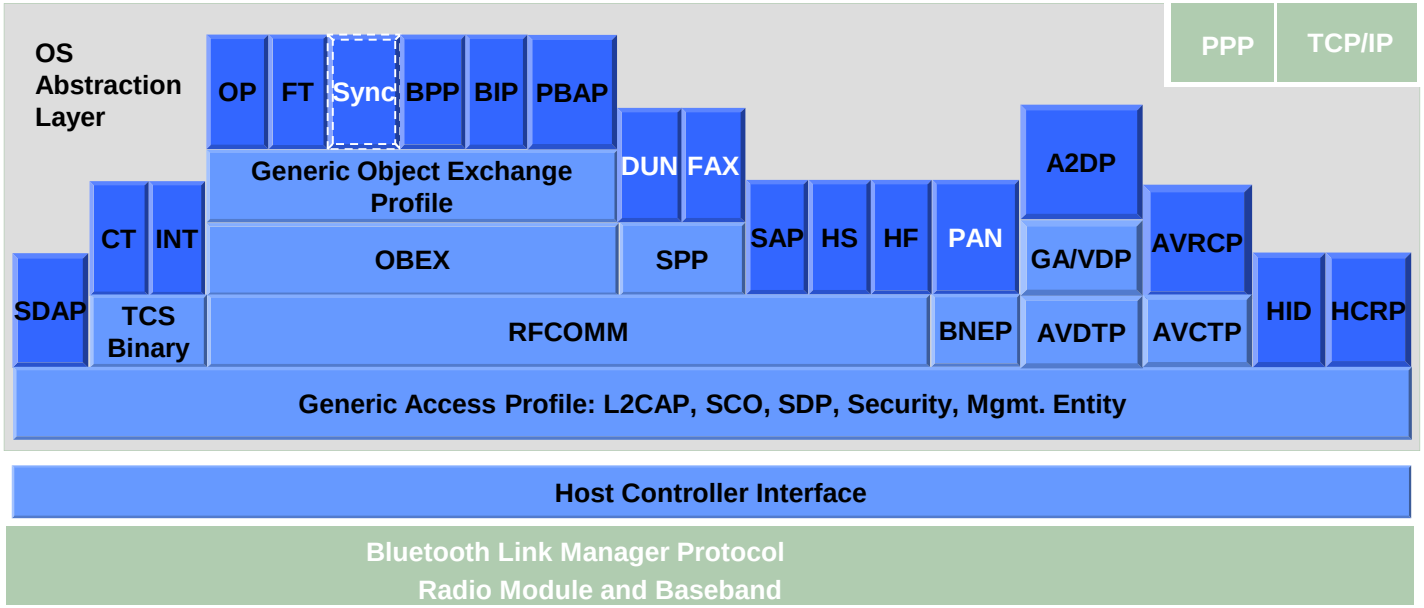
Multiple Emulated Serial Ports between two Devices



Multiple Emulated Serial Ports and Multiple Bluetooth Devices

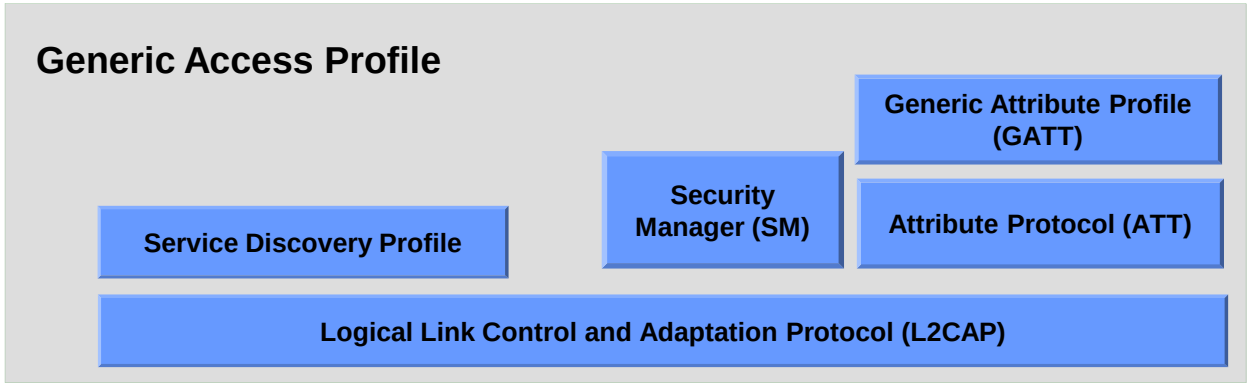
- **DLCI** (Data Link Connection Identifier) : identifies an ongoing connection between a client and a server application (usable value range is 2…61)

Bluetooth Profiles



- Ensures interoperability
  - Radio Level – ensures devices can contact each other.
  - Protocol Level – ensures devices can communicate.
  - User/usage Level:
    - Ensures application can interoperate.
    - Ensures user can interact with the device.

Generic Access Profile



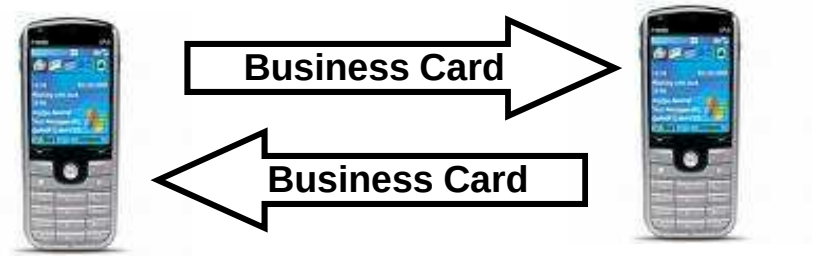
- Profile roles
  - Paging device / Paged device
  - Initiator / Acceptor
- Discovery modes and procedures
  - Discoverable mode
  - Inquiry
- Connection modes and procedures
  - Connectable mode
  - Create/Accept connection
- Security modes and procedures
  - bondable mode
  - Pairing, Authentication, Encryption

Generic Object Exchange Profile (GOEP)

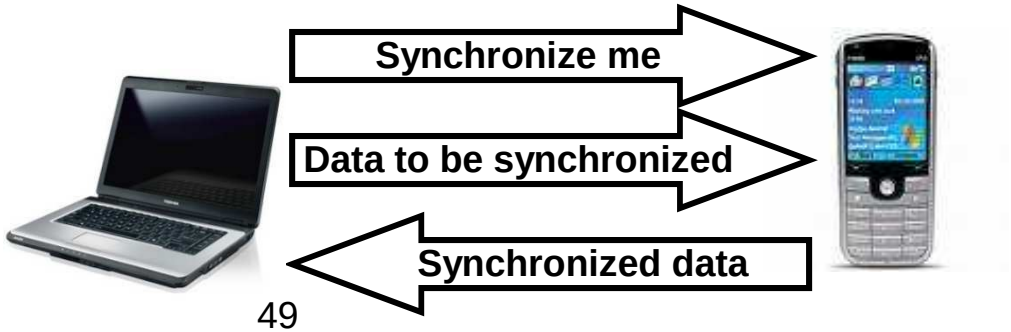
- **Application handling object exchange**
- **Procedures for pushing/pulling data**

- File Transfer

- Object Push

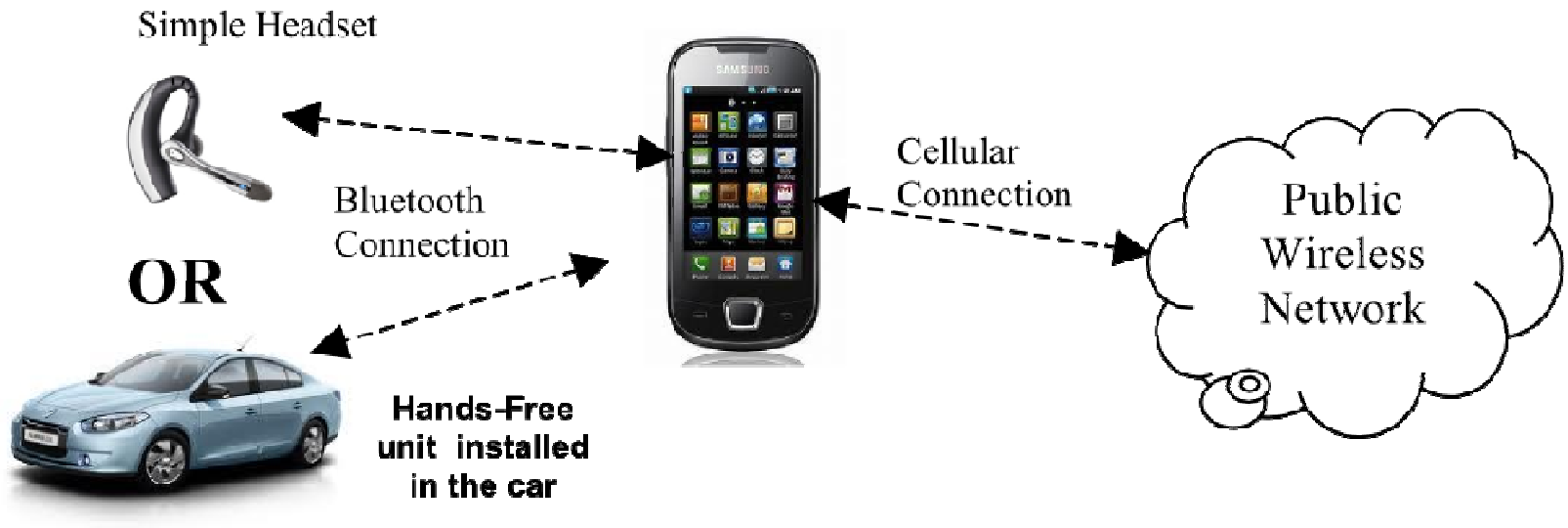


- Synchronisation



Handsfree Profile - Configuration and roles

- **Audio Gateway (AG)**
  - gateway for the audio input/output
  - typically a cell phone
- **Hands-Free Unit (HF)**
  - AG's remote audio input/output
  - means of remote control (AT command based)



Handsfree Profile - Call Control

- Audio connection setup
- Audio connection release
- Answer incoming call from AG
- Change in-band ring tone setting
- Reject incoming call from HF
- Reject incoming call from AG
- Audio connection transfer toward HF
- Audio connection transfer toward AG
- Place call with phone number supplied by HF
- Memory dialing from HF
- Last number re-dial from HF
- Call waiting notification activation
- Three way calling – third party called from HF
- Calling line identification notification
- Disabling EC/NR
- Voice recognition activation
- Remote volume control

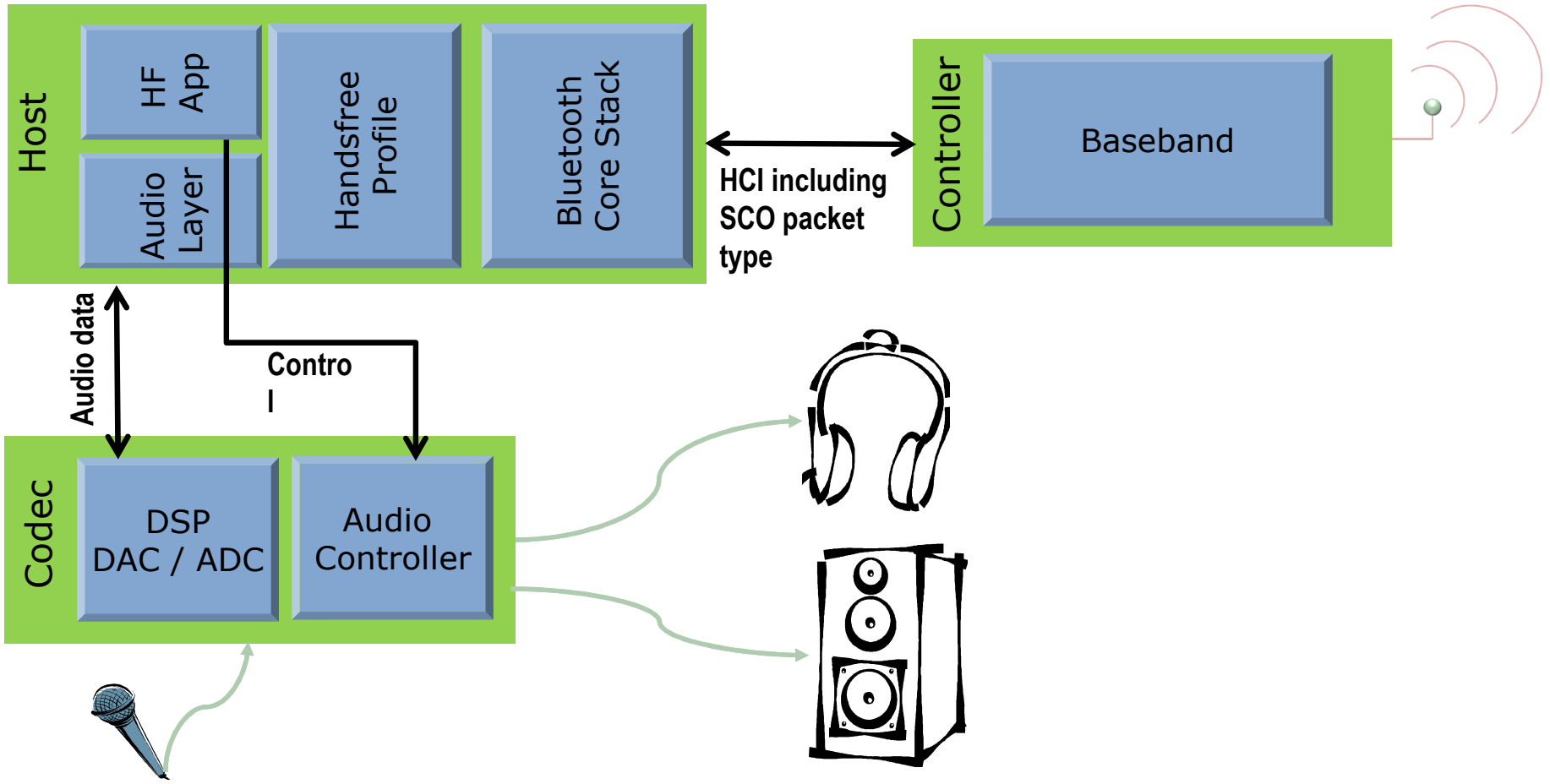
Handsfree Profile – Synchronous Connection

- Realized by a SCO or eSCO logical transport link establishment
- Narrow Band (HFP 1.5) or Wide Band Speech (HFP 1.6)
- Voice Settings Format

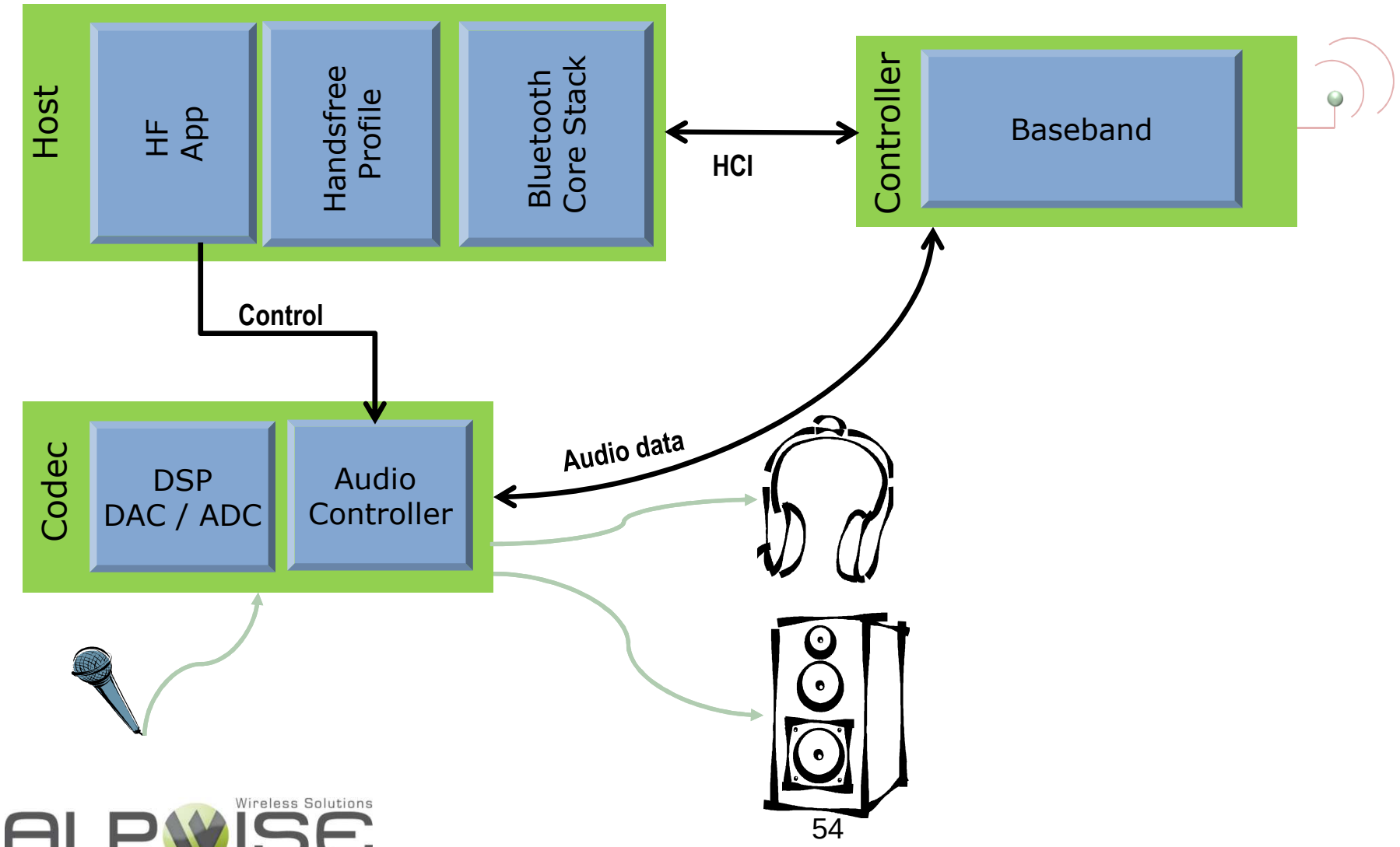
Air Coding	Input Coding
CVSD	Linear
µ-Law	µ-Law
A-Law	A-Law
Transparent Data	

- Voice Path : SCO over HCI / SCO over PCM

Handsfree Unit Solutions (SCO over HCI)



Handsfree Unit Solutions (SCO over PCM)



Advanced Audio Distribution Profile (A2DP)

- Source (SRC)
  - Source of digital audio stream that is delivered to the sink of the piconet
  - Media player, phone, PC
- Sink (SNK)
  - Acts as a sink of the digital audio stream that is delivered by the source
  - Stereo headset, wireless speakers, car audio system

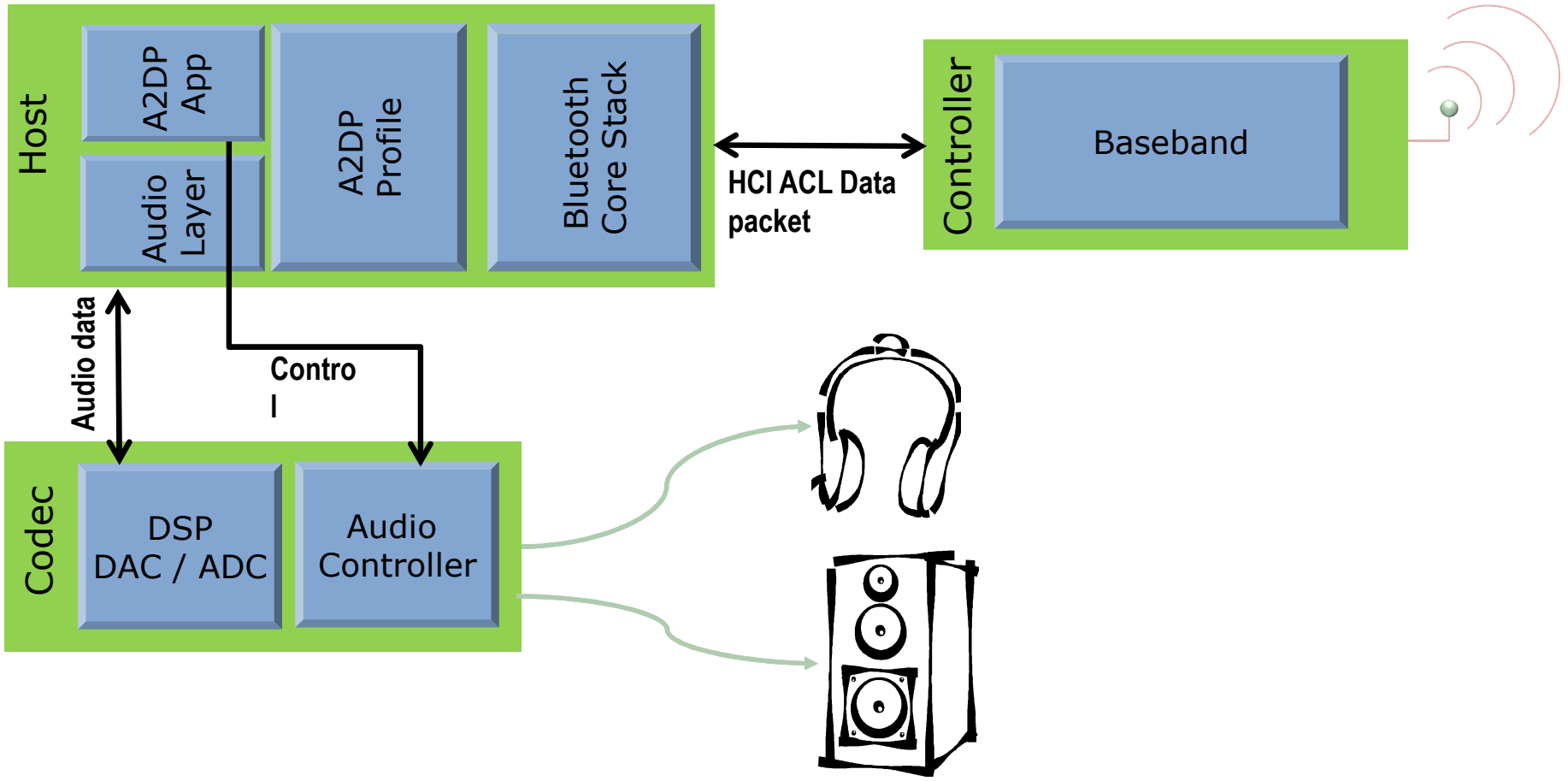
A2DP – Audio Codec Interoperability Requirements

- Must support SBC
- Optional support for MP3, AAC, ATRAC
- Support can be extended to non-A2DP codecs

A2DP -Codec Specific Information Elements

- AVDTP signaling procedure negotiates codec parameters
- Parameters part of Codec Specific Information Elements
  - Sampling frequencies (16 kHz, 32 kHz, 44.1 kHz, 48 kHz)
  - Channel modes (mono, dual channel, stereo, joint stereo)
  - Bit rates
  - Other information specific to selected codecs (blocks, Subbands…)

A2DP Sink Solutions



Audio/Video Remote Control (AVRCP)

- Controller (CT)
  - Initiates transaction by sending command to target
  - Headsets, remote controls
- Target (TG)
  - Receives command and generates a response frame
  - Media player, TV, tuner

AVRCP - Categories

- Categorie 1 : Player / Recorder

  Basic operations of a player or a recorder are defined, regardless of the type of media (tape, disc, solid state, etc.) or the type of contents (audio or video, etc.).

- Category 2 : Monitor/Amplifier

  Basic operations of a video monitor or an audio amplifier

- Category 3 : Tuner

  Basic operation of a video tuner or an audio tuner.

- Category 4 : Menu

  May be a display panel of the device itself, or on-screen display (OSD) on an external monitor

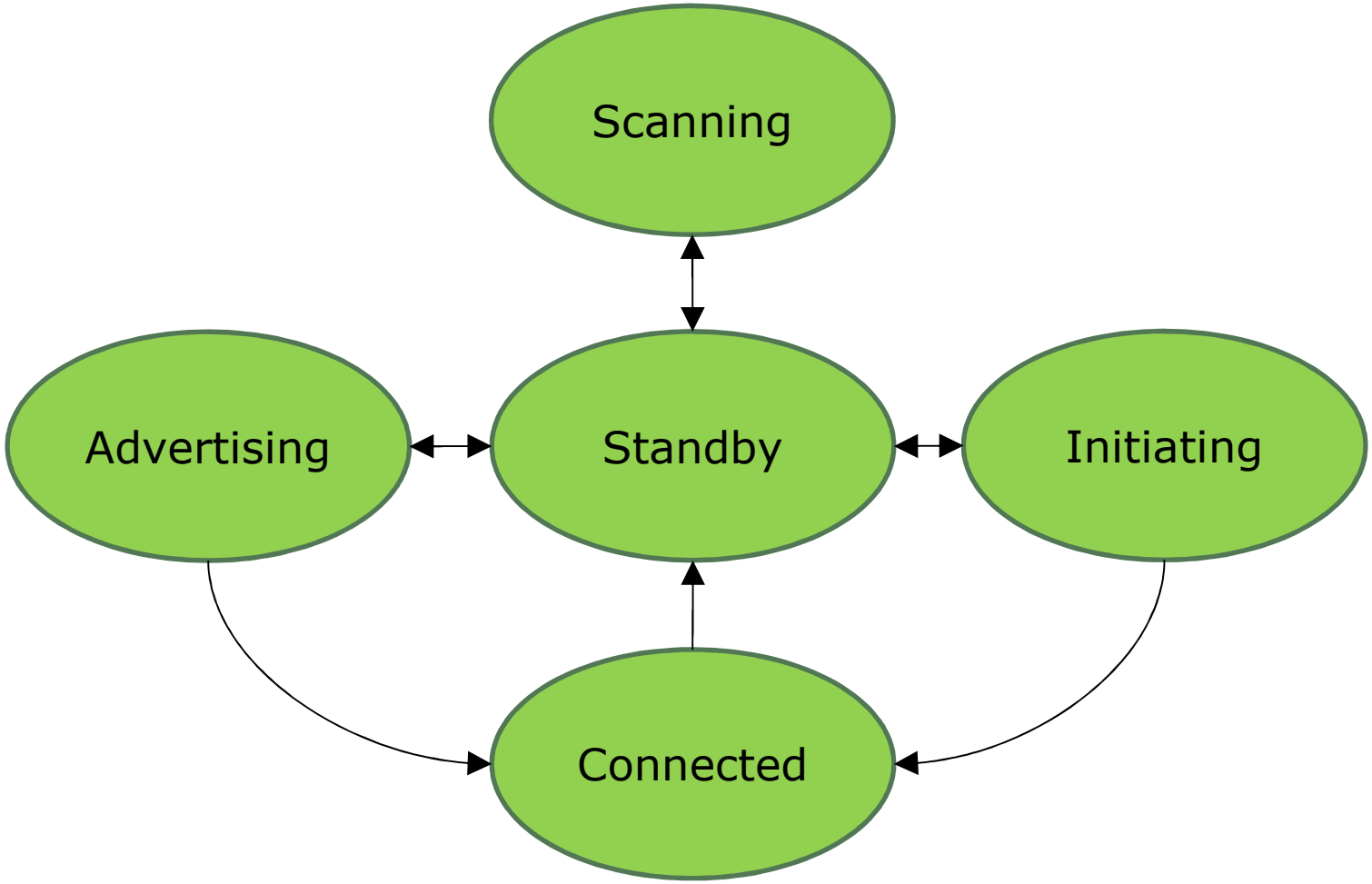
AVRCP - Versions

- AVRCP 1.3 - adds support for metadata
  - **Query capabilities** (List of Company IDs or Events IDs supported by TG)
  - **Query Target player application settings** (Equalizer, Repeat Mode, Shuffle, Scan…)
  - **Attributes for currently selected media track** (Title, Artist, Album…)
  - **Event notifications** (Play status, Track change, Volume change…)
  - **Continuation** (i.e. segmentation/re-assembly packets over AV/C)
  - **Group navigation** (ability for CT to logically view TG media storage as a flat structure (play lists, folders)).
- AVRCP 1.4
  - **Media player selection** (music players, video players, streaming players, FM radios, mobile TV tuners).
  - **Browsing** (allows a CT device to navigate and view media content on the TG).
  - **Searching** (allows a CT to locate specific media elements on the TG).
  - **Advanced volume control** (allows the CT to show a volume level slider).

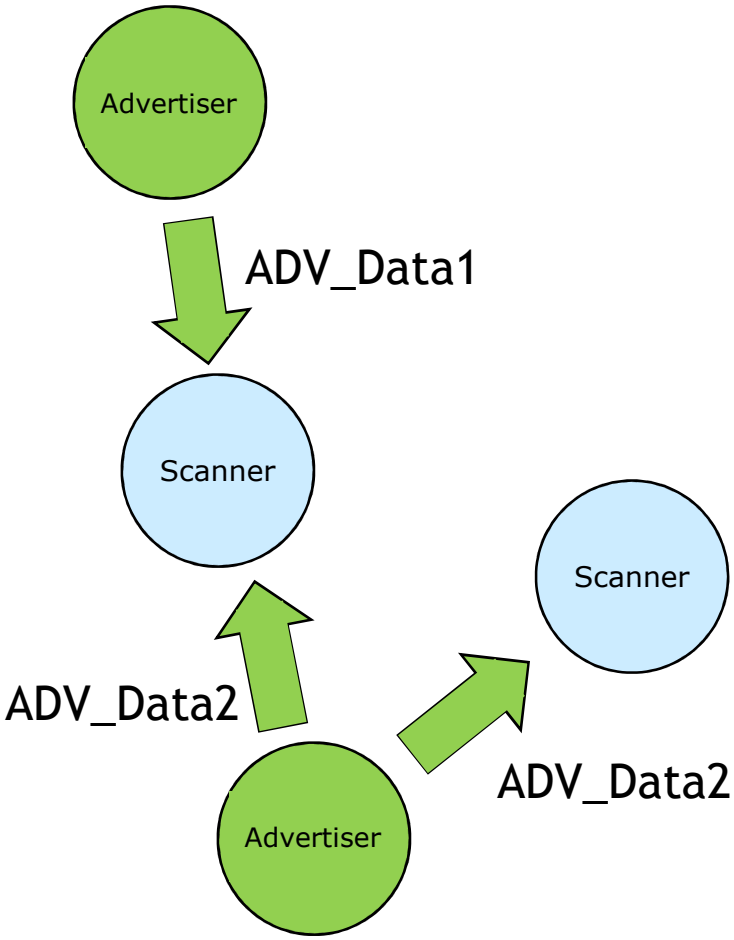
BLUETOOTH LOW ENERGY

Description

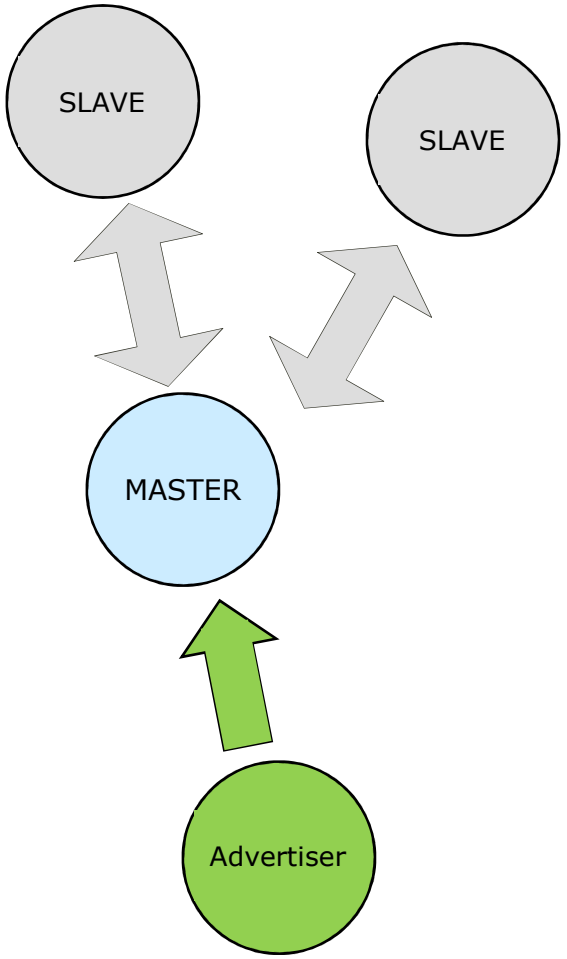
Bluetooth Low Energy - Link Layer Modes



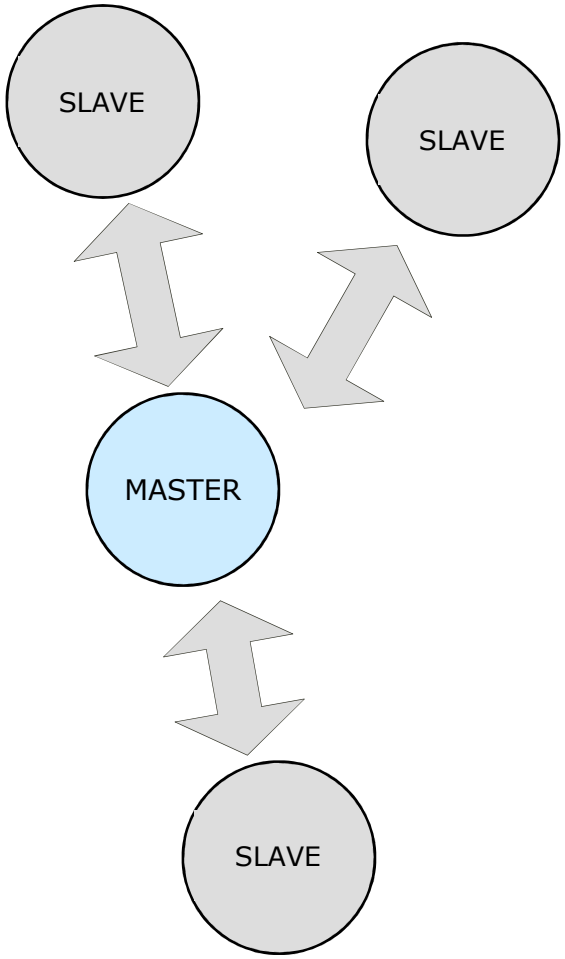
Bluetooth Low Energy - Connection-less topology



Bluetooth Low Energy - Connected topology



Bluetooth Low Energy - Connected topology



Bluetooth Low Energy - Host Stack

- Host Protocol Stack

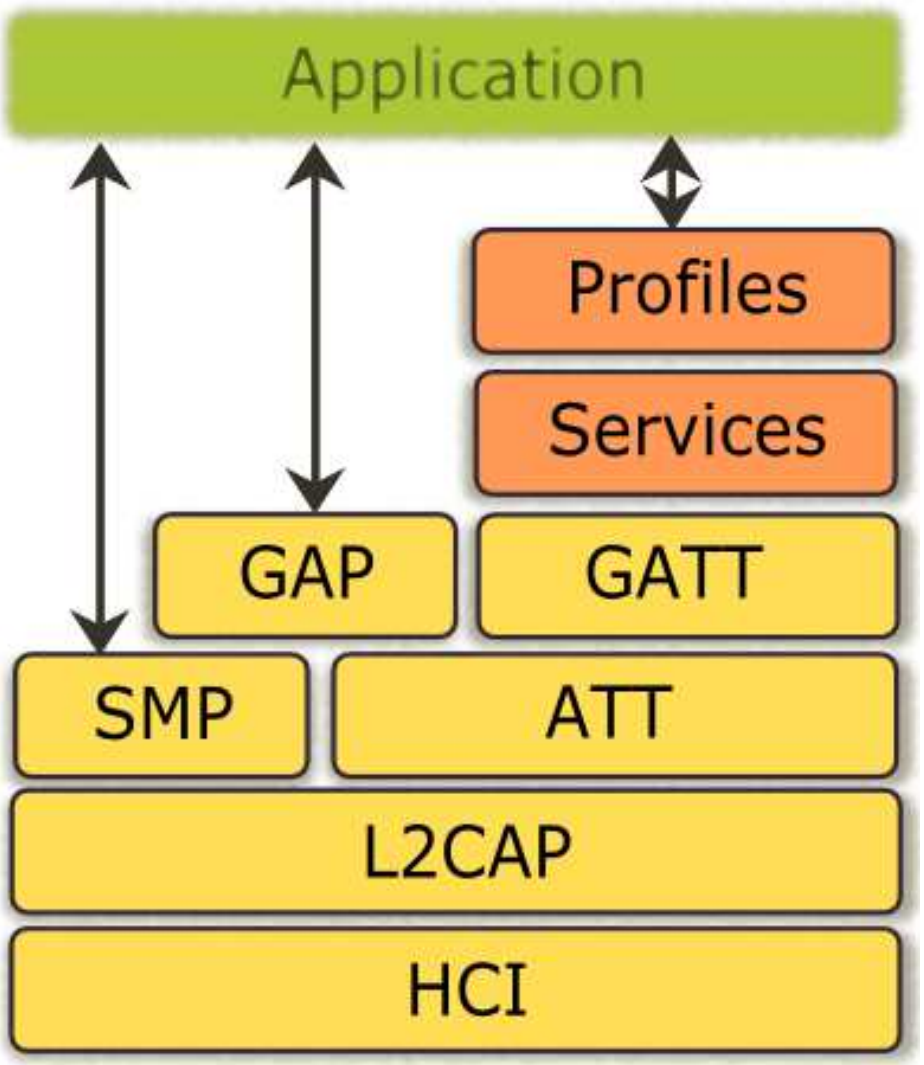
Again it is simple

HCI and L2CAP are reused from the Bluetooth Protocol Stack

The Security is managed by a protocol named SMP for Security Manager Protocol

The topology is managed by the GAP

The Data Exchange from Profiles are Managed by a single protocol named ATTribute Protocol and formatted by the GATT (Attribute Profile)



Bluetooth Low Energy - Attribute Protocol

- The ATTribute Protocol is used to exchange the data between two remote profiles.

The ATTribute Protocol defines two roles

- A SERVER: it host the value

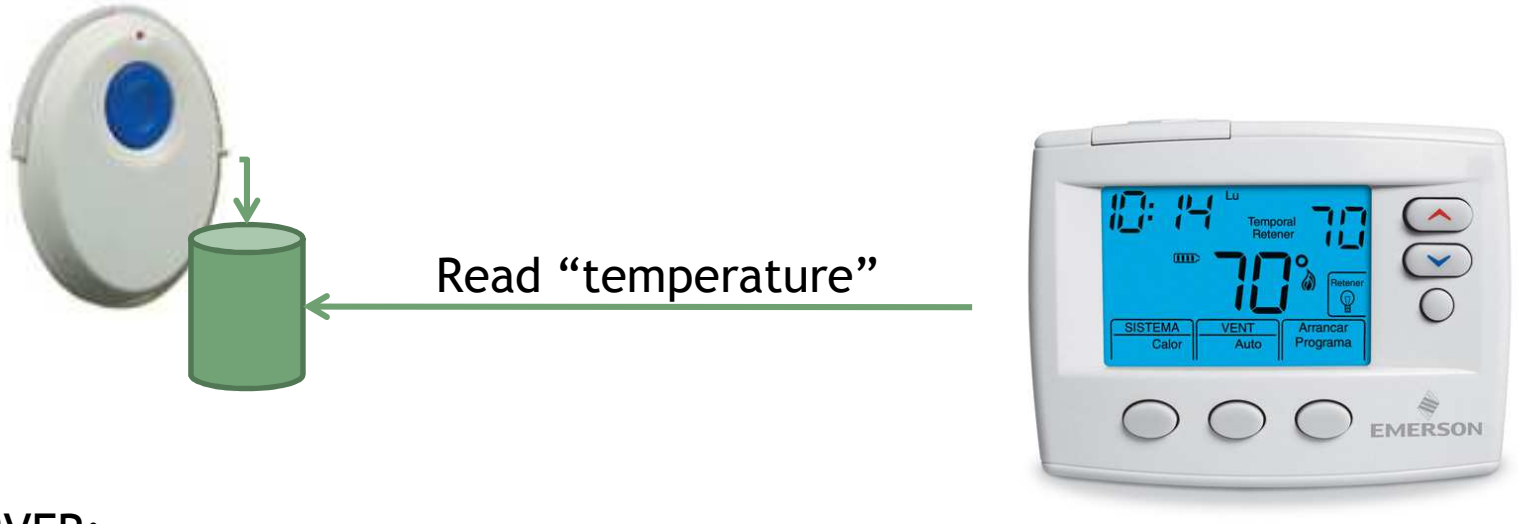
  It store attributes into the ATTRIBUTE database,

  Attributes means something, a temperature characteristic inside the Health Thermometer Service or A report characteristic inside the HID Service.

- A CLIENT: it access to the remote device's ATTRIBUTE SERVER database.

  it read/write or configure the remote characteristic

Bluetooth Low Energy - Attribute Protocol



The SERVER:

It stores the temperature Inside its ATTRIBUTE database

The CLIENT:

It reads the temperature from the remote ATTRIBUTE database

Bluetooth Low Energy - Generic Attribute Profile

- The GATT is used on server side to pack the attributes into Characteristics and services.

  Characteristic are used to describe the exported value (unit, format, permission, properties…)

  Service are used to pack characteristic to form a specific use case.

  As example: the Heath Thermometer Service define two characteristics:

  - The temperature (with the units in Celsius or Fahrenheit)
  - The temperature location (ear, mouth…)

Bluetooth Low Energy - Generic Attribute Profile

- The GATT is used on Client Side to defines procedures

  Procedures are used to:
  - discover remote services available in the remote database
  - Discover the characteristic within a service
  - read the remote characteristics
  - write the remote characteristics
  - Configure the remote characteristics

- The GATT client should also be able to save the remote SERVER database structures (handle) in order to speed up the Attribute access upon reconnection (Attribute caching)

Bluetooth Low Energy - Attribute Protocol

The SERVER has store the “temperature value” in its ATTRIBUTE database

Inside the “room temperature” characteristic

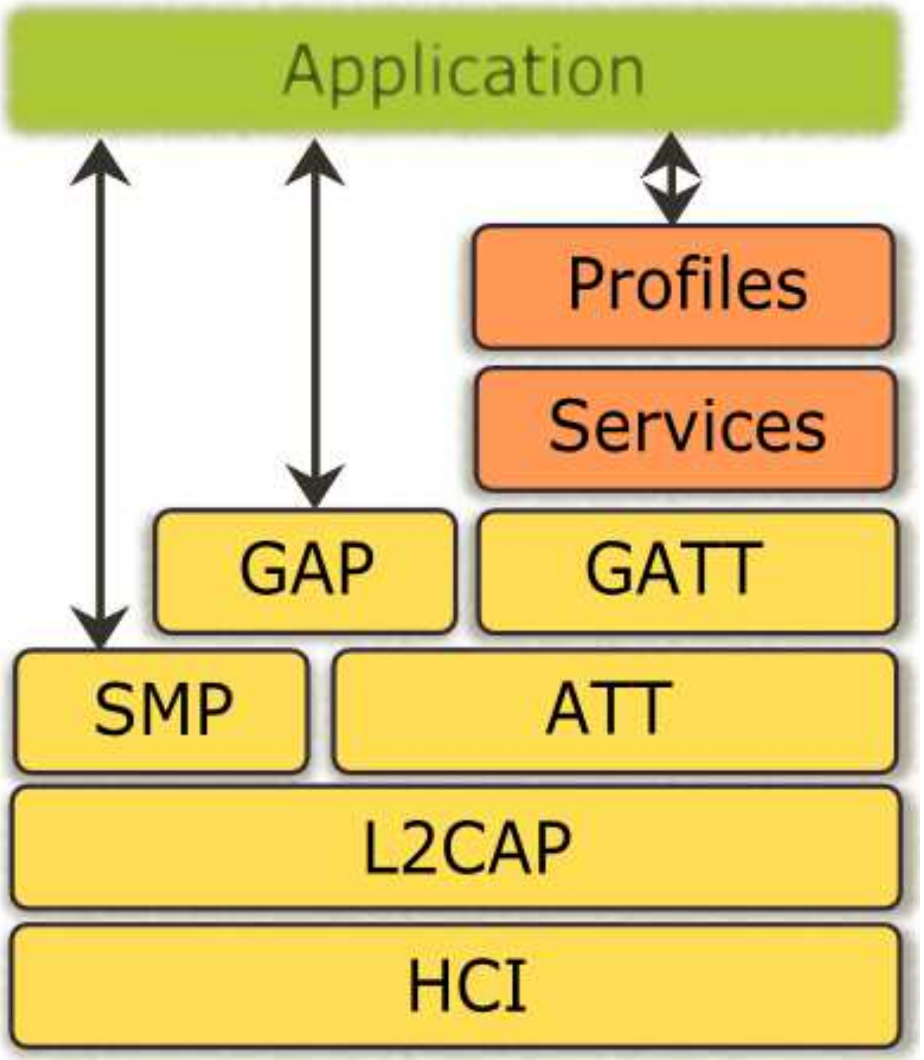
Inside the “automation temperature” service

In the first connection from CLIENT to SERVER:
-The client will try to find the “automation temperature” service
-If found, the client will try to find the “room temperature” characteristic
-If found, it should save the handle of the “temperature value” attribute
-Then it will read the “temperature value”

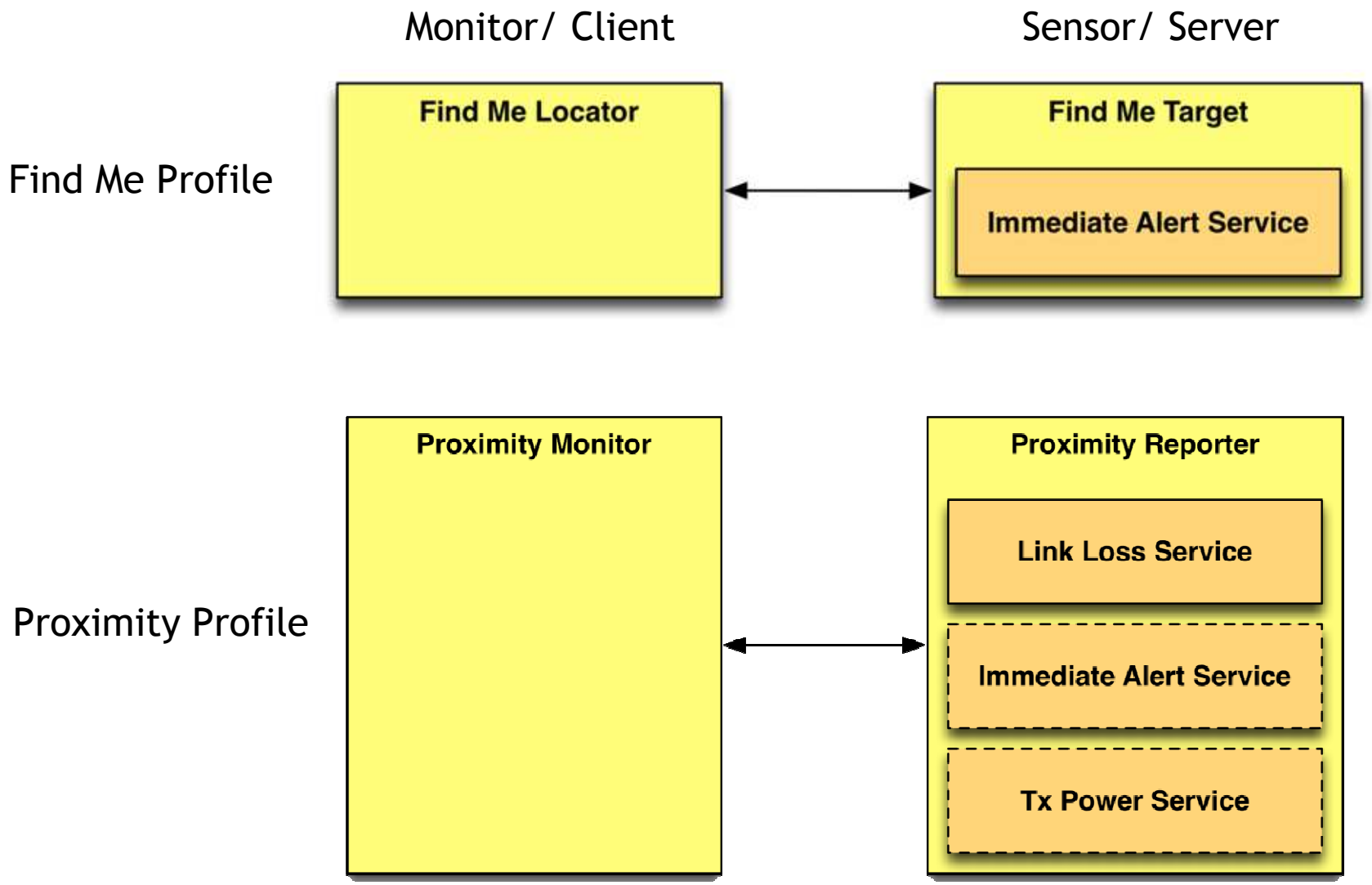
In the next connections from CLIENT to SERVER:
- it will read the “temperature value” directly

Bluetooth Low Energy - Profiles and Services

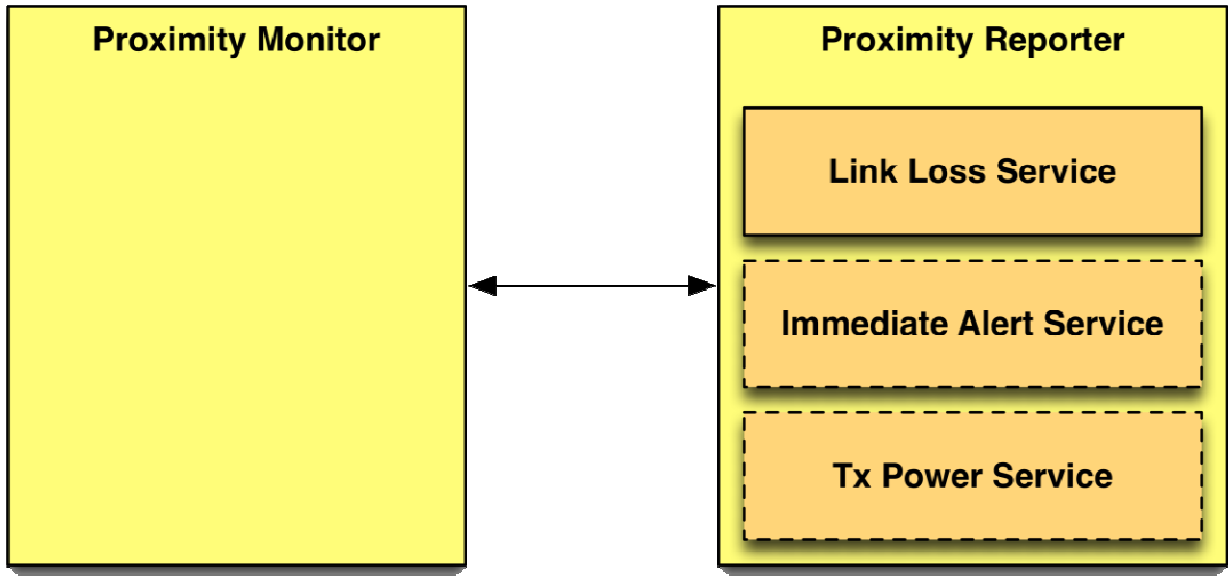
- Bluetooth Low Energy Profiles and Services
  - The BLE Profile are all based on Services
  - Profiles have their proper specification
  - Services have as well their proper specification
  - A single Profile may embeds several services
  - Services may be shared between profiles
- Profiles have two roles, one for the sensor/server side, one for the monitor/client side



Bluetooth Low Energy - Profiles and Services



Bluetooth Low Energy - Proximity Profiles



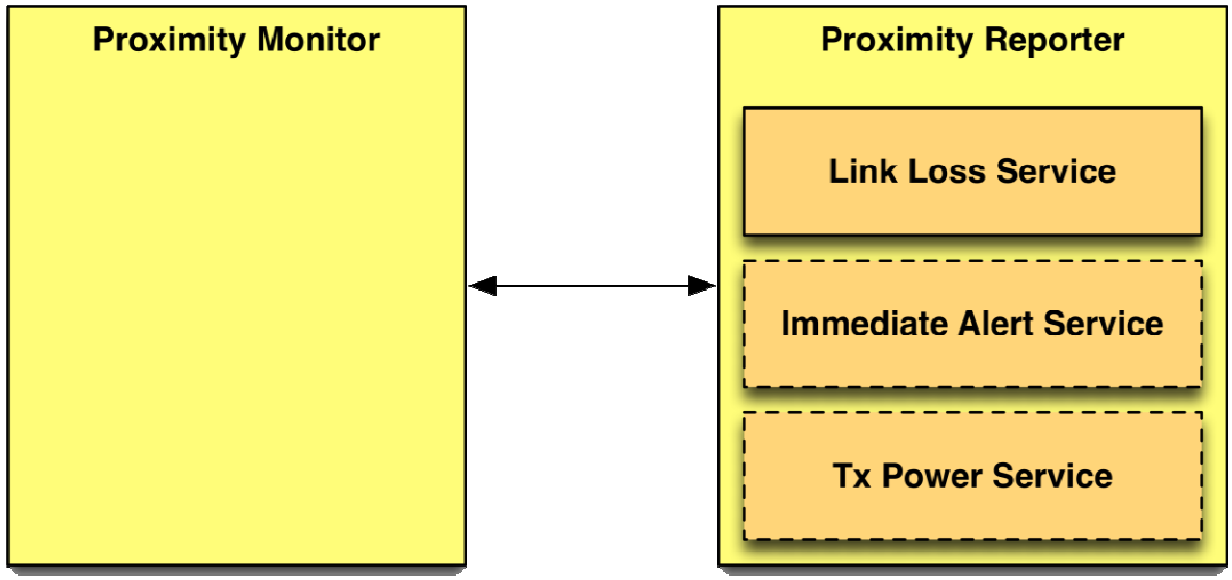
- The Proximity Profile use case:

  - The monitor wants to monitor its link with the reporter

  - The Reporter Raise an Alert (Ring, LEDs, flash) when the connection is dropped

  - The monitor may also raise an Alert when a path loss (RSSI) threshold is raised.

Bluetooth Low Energy - Proximity Profiles

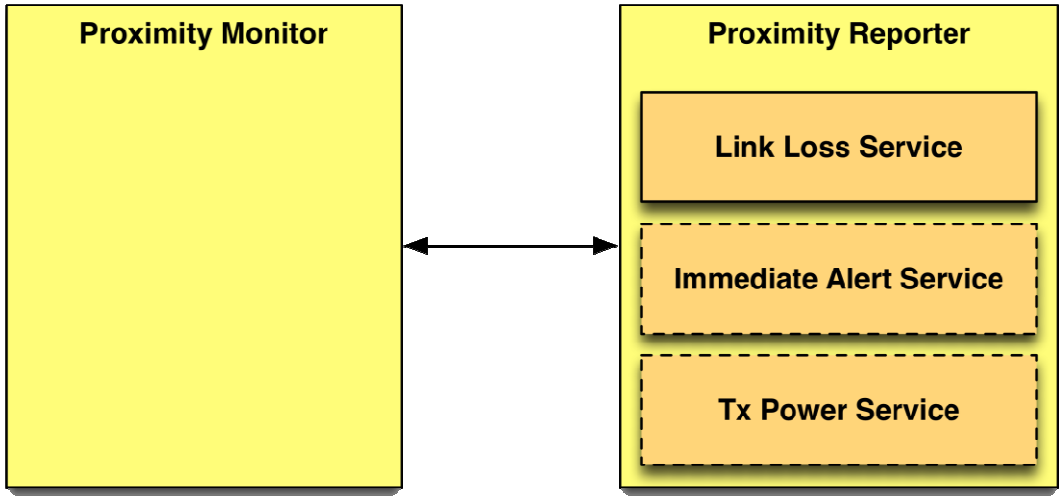


- How to achieve the Out of Range use cases

  The link Loss service specifies an Alert characteristic, the Alert Value defines the Alert level (NO_ALERT, MEDIUM_ALERT, HIGH_ALERT) to be raised when the connection is dropped by out of range.

  If the monitor wants to raise an alert when out of range, it just have to write the characteristic with the desired alert level

Bluetooth Low Energy - Proximity Profiles



- How to achieve the Path Loss use cases

The proximity monitor Profile specifies that the monitor may monitor the Path Loss.

In order to do that the Monitor

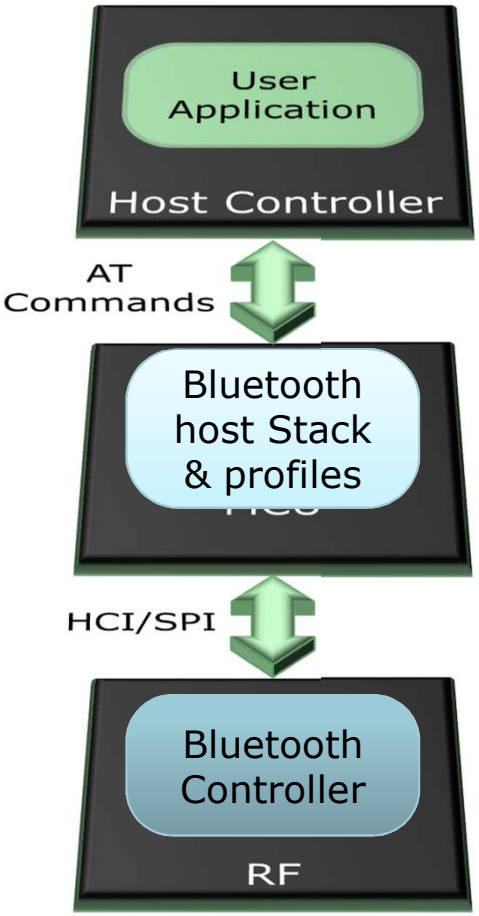
- shall read the value of the “Tx Power level” characteristic value hosted in the “Tx Power Service”.

- compute the path loss (RSSI minus Remote TX Power level)

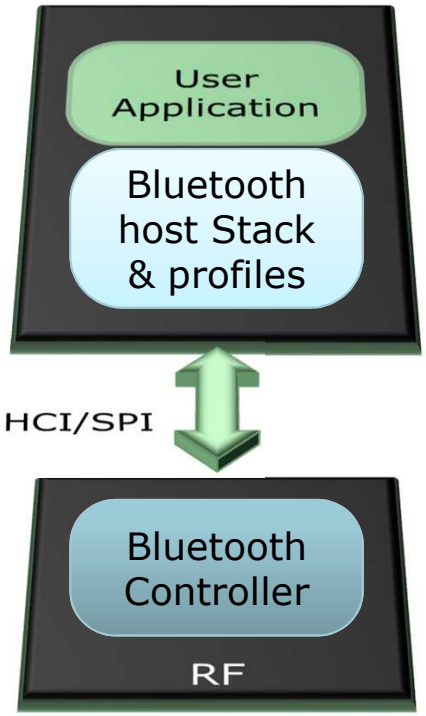
- raise an alarm by writing the immediate Alert characteristic when path loss exceeds a user defined value.

Interface & configurations

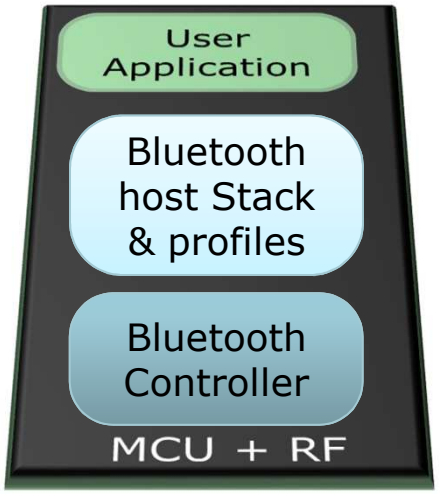
- Host Configuration



- Half-Embedded Configuration



- Full-Embedded Configuration



Choix du Module ou d'un chip

- Selon l'application et sa complexité

  - Selon coût du noeud Radio, mais dépend des quantités et du niveau d'integration.
  - Interface logiciel en général facile à implémenter avec l'application existante (commandes AT, sur lien série)
  - inconvénient majeur ne permet pas d'accéder à des fonctions profondes ou paramètrage fin.
  - L'avantage d'un module déjà certifié et homologié, Pas de test de qualification RF de votre côté.
  - Le choix de développer sur un chip directement, depend du niveau de competence.

Technologies to products

Bluetooth **chip radio**

Host µController

Bluetooth **protocol stack**

SW Development Kit

Modules

Evaluation board

Services

- Support
- Maintenance
- Engineering
- SW & HW design

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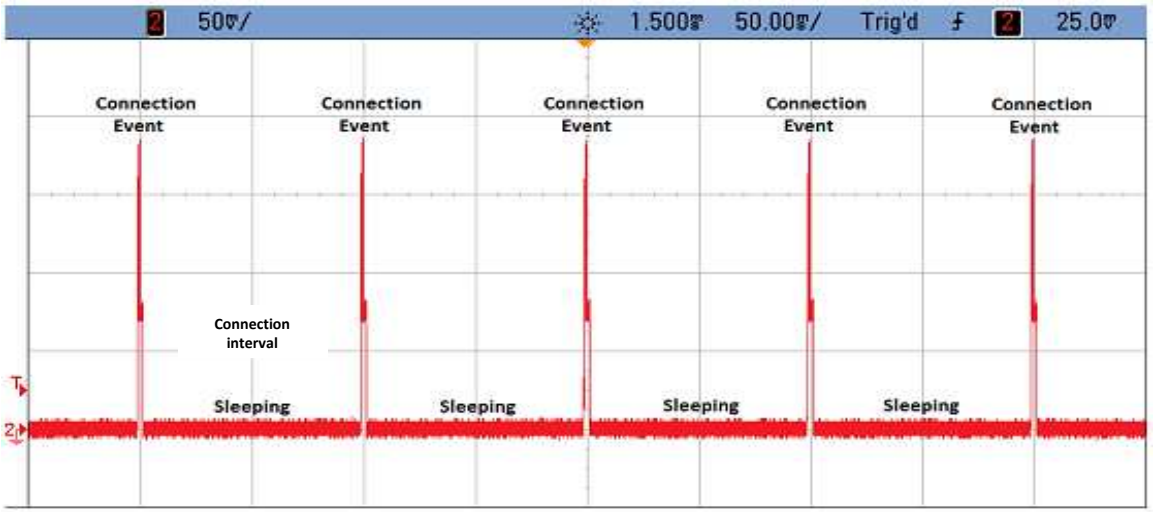
Consommation

Low Power

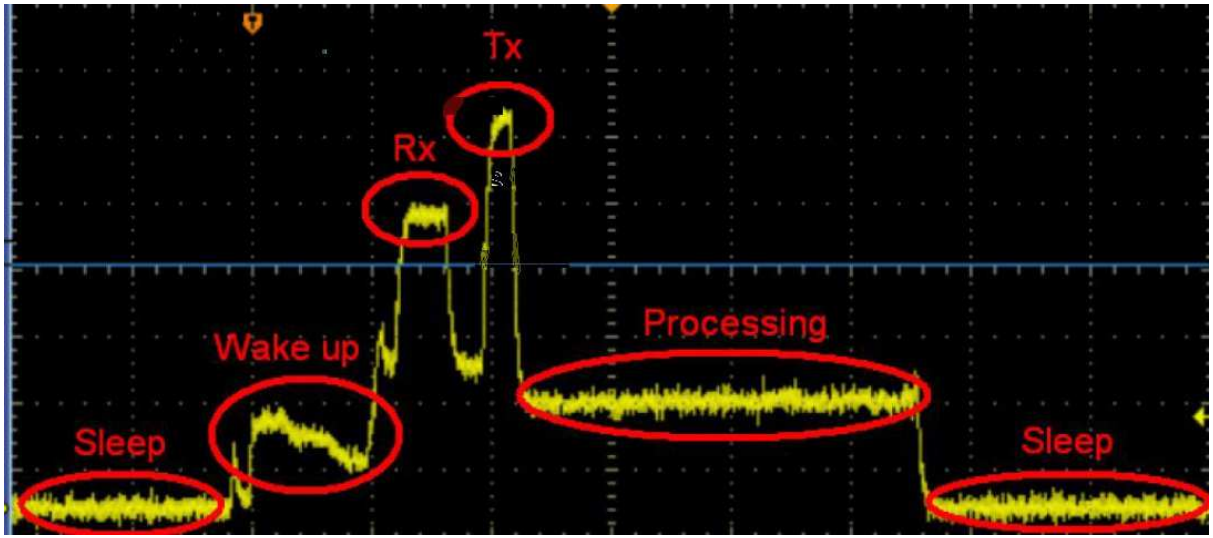
- La problématique de la consommation est essentiellement sur les capteurs autonomes (sensor)
- Les systèmes sont la plupart du temps en attente d'un évenement ou d'une mesure cyclique.
- Peu de data à envoyer mais garder la synchronization, le système oscille entre le mode sleep et la radio active.
- Si un évênement survient la réponse doit être immediate (#ms)
- Exploiter les modes low power pour baisser la consommation.
- Selon les modes la RF est On et en RX, et le uP est en general en clock réduite F= 32khz (réveil par IT)



Consommation

Low Power

- Les aspects consommation sont directement liés aux contraintes et besoins de l'application
- le duty cycle est à adapter à l'application dans le cas de systèmes autonomes
- Les différents états des composants et des modes d'utilisation est determinant dans les calculs de consommation.

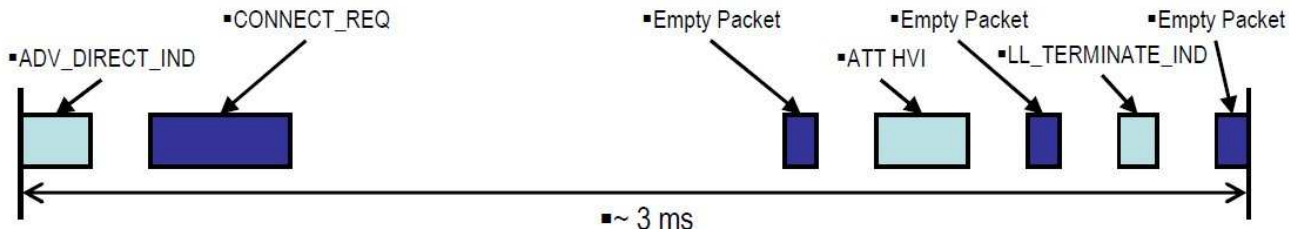


Consommation

Calcul de consommation

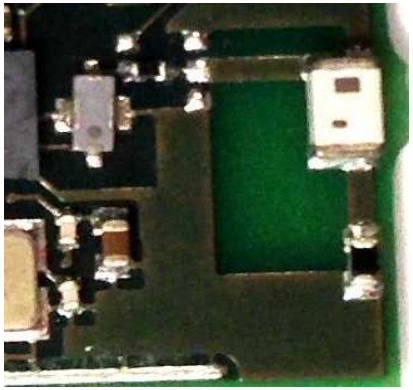
- Si 3ms par transaction , si 15mw pour un TX ou RX , tension de 1.5 v, 10mA de TX ou 15mwx 3ms = 45uJ (utile si harvesting)
- Avec une pile de 180mAh, 1,55V
- 180/10= 18h = 64800 s soit 21.6 transactions
- Data envoyé toute les minutes > 1440 par jour
- On tient 15000 jours,

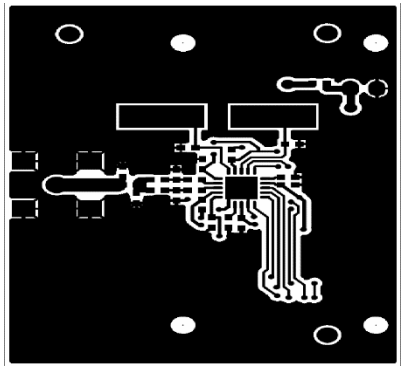
Time (us)	Master Tx	Radio Active (us)	Slave Tx
0		176	ADV_DIRECT_IND
326	CONNECT_REQ	352	
1928	Empty Packet	80	
2158		144	Attribute Protocol Handle Value Indication
2452	Empty Packet (Acknowledgement)	80	
2682		96	LL_TERMINATE_IND
2928	Empty Packet (Acknowledgement)	80	

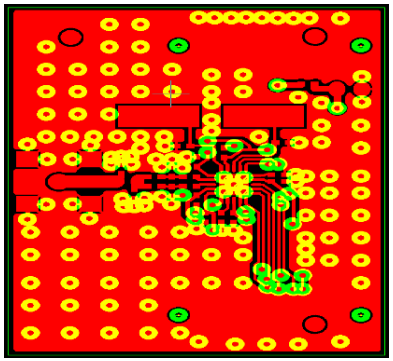


Front-end RF et Antenne

- Les meilleurs performance sont atteintes en travaillant sur l'optimisation du front-end et de bonnes connaissances techniques, et de la pratique.
- Balun, Matching d'antenne et découplage doivent être implémentés correctement.
- Le layout doivent être adapté au stacking du PCB.
- Le choix de l'antenne est crucial, Antennes céramique, planar ou sur le PCB.
- Test TX & RX avant test complet
- Output power TX et sensibilité RX







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Test Radio

- **Puissance de sortie TX**
  - Génération de la porteuse (CW) à travers un cable coaxial our le matching d'antenne, Mesure avec l'analyseur de spectre
- **Sensibilité de la réception RX**
  - Injecter un signal avec un generateur RF
  - Visualiser les datas recues sur un BER/PER testeur
- **Bilan de liaison**
  - Faire l'addition de tous les gains ou pertes dans la puissance du signal entre chaque extrémité. Puis évaluer ce qui reste entre le départ et l'arrivée.

Bilan de liaison

Bilan de liaison

- Il faut en pratique 12dB, sinon risque de coupure.. 10 dB c'est SNR de 10 pour 1; 13 20x, et 7dB 5x .

• Transmit output	+ 015 dBm
• Cable + Connectors	- 003 dB
• Antenna TX	+ 024 dBi
• FSL (50 km - 31 miles at 2.4 Ghz)	- 134 dB
• Antenna RX	+ 024 dBi
• Cable + Connectors	- 003 dB
• Receive Sensitivity	- 090 dBm (soustraire!)
• **TOTAL**	**+ 013 dB margin (OK !!)**

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Qualification RF & CE

Essais dans un labo agrée

- **Sécurité** EN60950-1 ed 2006+A1 ed 2010 +A11 de 2009 + A12 de 2011
- **CEM**
  - ETSI EN 301 489 -1 v1.9.2
  - ETSI EN 301 489-17 V2.2.1
  - EN 55022
  - EN 55024
- **Radio EU**
  - ETSI EN 300 328V 1.7.1
  - EMF EN62311 (2008) et recommandations 1999/519/CE
- **Radio US**

  CEM: FCC part 15 subpart B

  Radio: FCC part 15 subpart C
- **Canada**

  RS210 and RSS-GEN

Qualification RF & CE

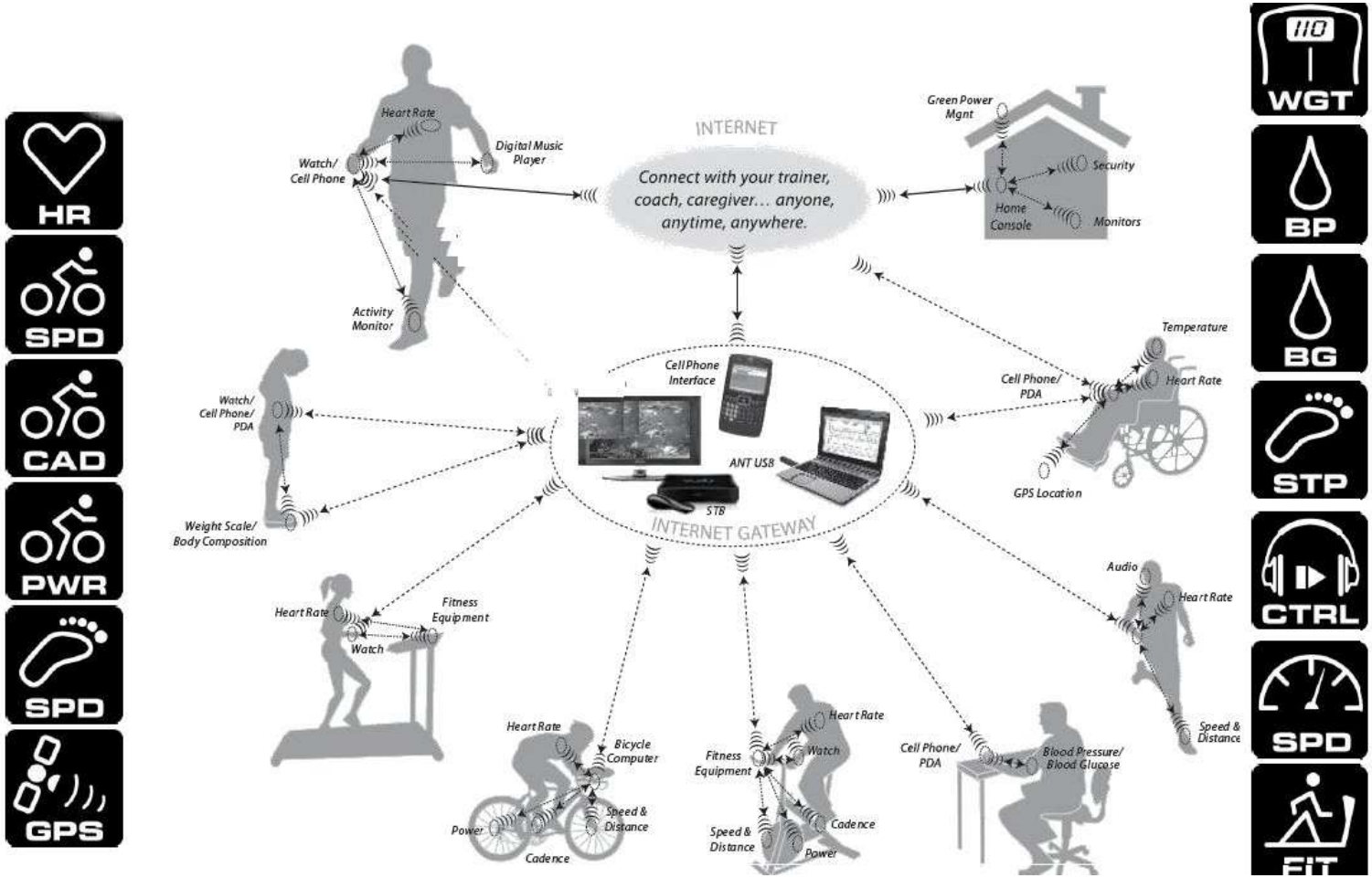
❑ Estimations des coûts d'homologations

PAYS	TEST	Labo
Europe	Safety 2000€ CEM/Radio 5000€	Essais en France
USA/ Canada	Safety 2000€ CEM/Radio 5500€	Essais en France
Corée	10 000€	Essais sur place
Japon	Safety 2000€ CEM/Radio 7000€	Essais en France
Taiwan	9000€	Essais sur place
Chine	22000€	Essais sur place

Objets Connectés

- **Fusion des technologies**
  - Intelligence ambiance, TAGS actifs, IOT , tablettes, smartphones… 3G, 4G… (Fusion des technologies)
  - Nouveaux objets pour des nouveaux espaces de services
  - Impact sur la vie sociétale, nouveaux modes de vie.
  - Amélioration de la qualité de vie
  - Amélioration de l'efficacité énergétique (maison & batiment intelligent)
- **Perspectives des Applications RF**
  - l'intelligence ambiante est aussi une niche d'innovation et de croissance économique.
  - Nouvelles perspectives d'applications, Création de valeur
  - relever les défis de la complexité à grande échelle.
  - Quelle autonomie des systèmes pour quel contrôle ?
  - Sécurisation…

Santé, sport, fitness



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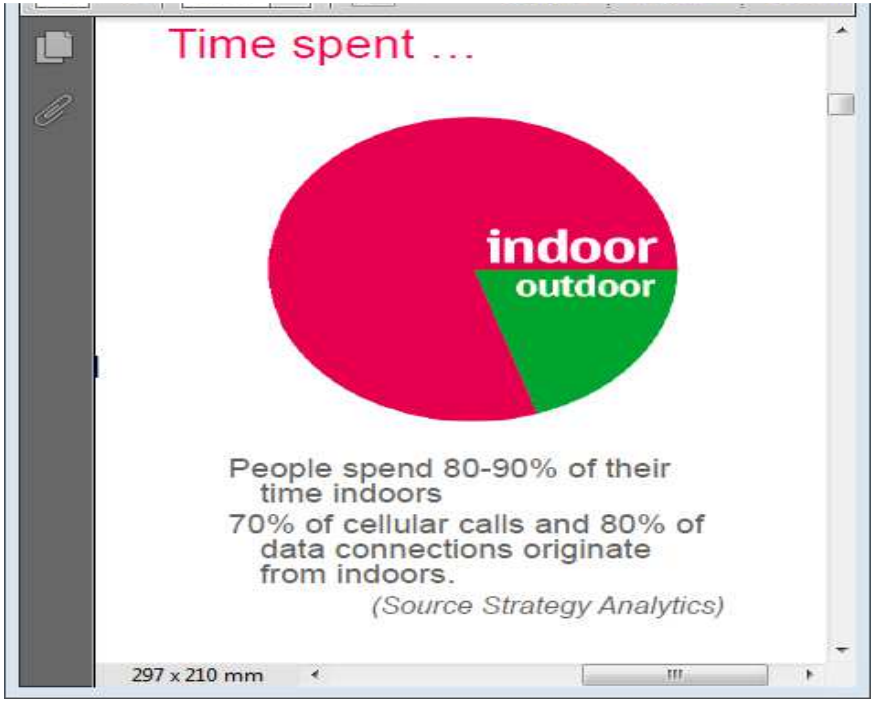
Localisation

Location based services

- Naviguation, guidage
- Indoor 3D positioning
- Cognitive positioning, agrégation de données, pression (altitude), GPS, movement (trajectoire)



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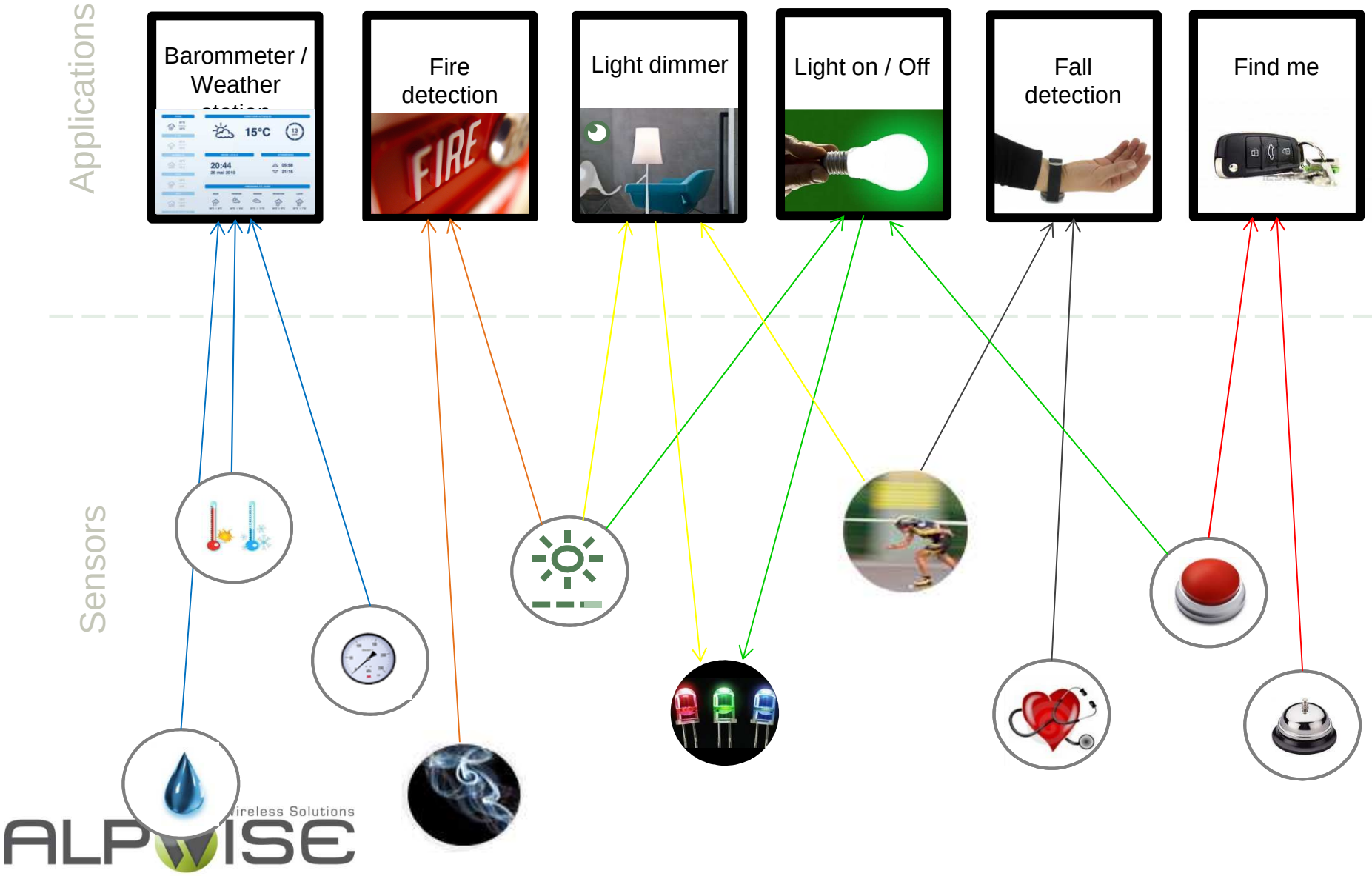
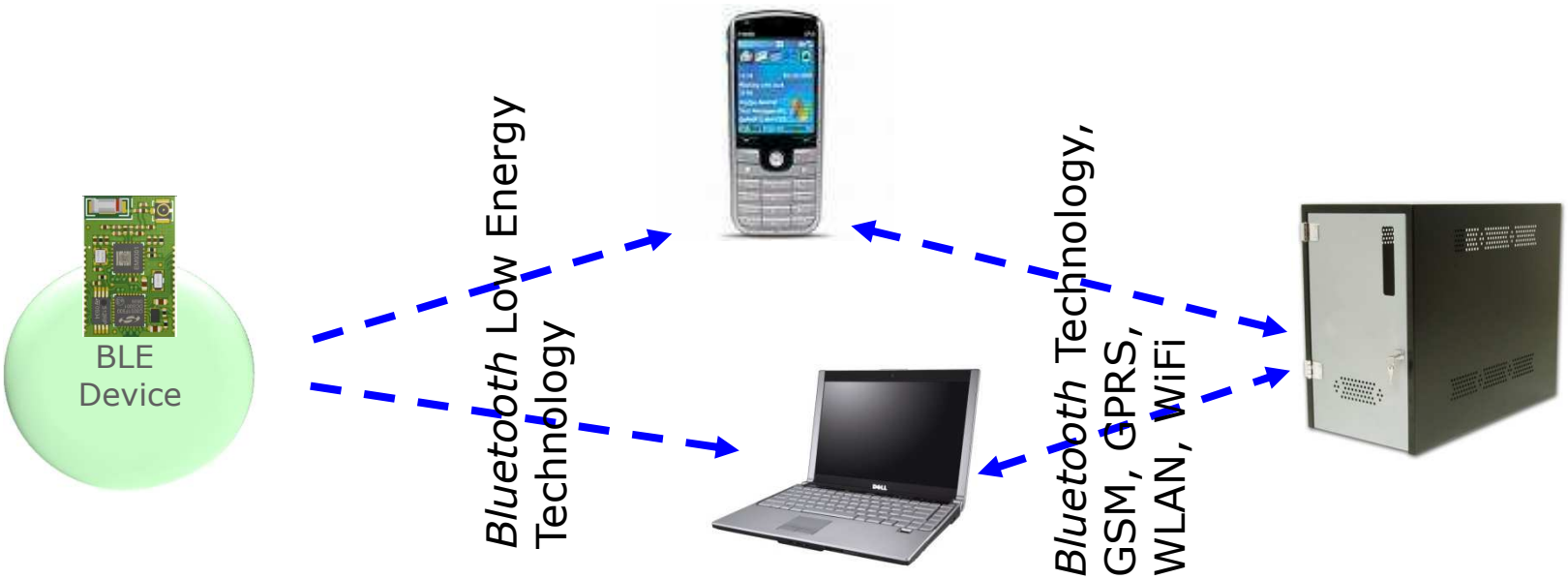

Applications
Barommeter / Weather
Fire detection
Light dimmer
Light on / Off
Fall detection
Find me
Sensors
ALPWISE
Wireless Solutions

BLE New services enabler

- Connectivity between small devices, cell phones, or PC, up to Servers & Web Services, enables enhanced remote applications



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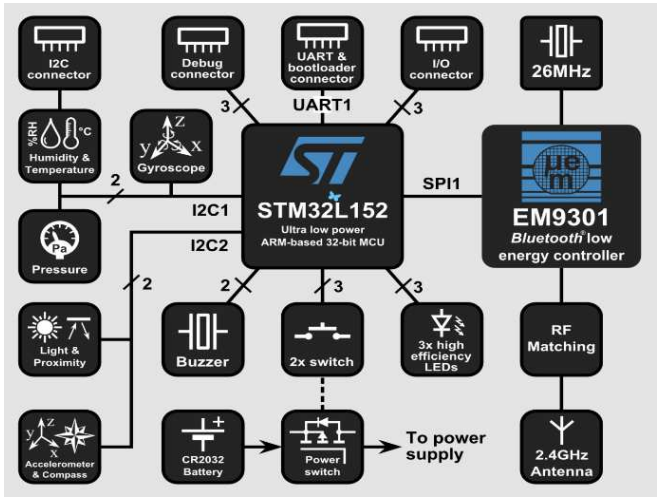
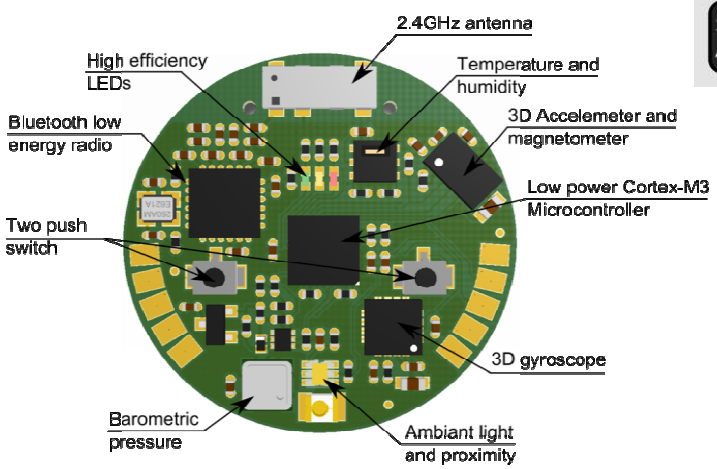
Motion Tag – BLE & Sensors

- The ALPW-BLETAG001 TAG combines UltraLow Power components:
  - EM9301 2.4 Ghz *Bluetooth*® low energy controller
  - Ultralow power ARM® Cortex™-M3 core, the STM32L152 MCU, Freq=32Mhz

- Sensors:
  - LSM303DLHC (3 axis accelerometer & Magnetometer)
  - L3G4200D (3 axis gyroscope)
  - BMP180 (pressure sensor)
  - Others:
    - Temperature / Humidity
    - Barometric Pressure
    - Light (IR and visible)
    - Optical proximity





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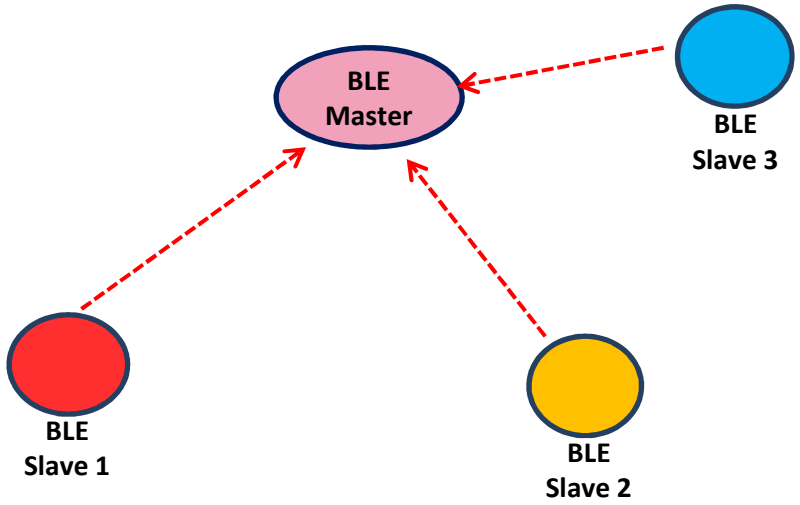
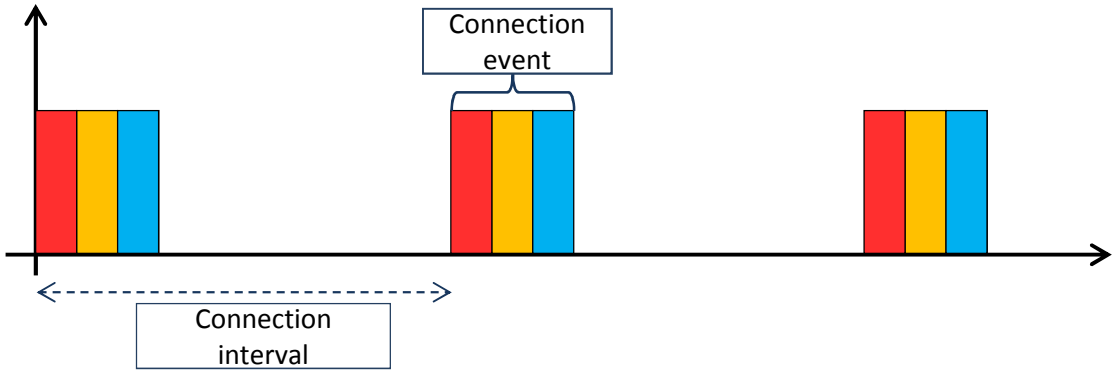
Connection Multipoint



Connection interval in multipoint:

- 20 ms of connection interval (2 Noeuds)
- mandatory to extend Connection interval when more nodes.



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Software

1. Profile data-exchange server client sur CM3 (equivalent port série)
2. Data-exchange Client developpé sur iOS

3. IOS connectivite Firmware, Application framework dediées sensors, Profiles and Services activés sur la stack BLE Native IOS

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Thank you for your attention!

Follow us on

Please contact **me**

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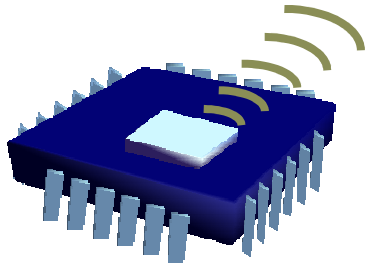

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