iBEACON application

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...personal
...portable
...connected

What is iBeacon?

It’s just a device which says:

“Hi, I am here and I have that number set”

iBeacon is an exciting technology introduced by Apple. A Beacon has to use the same format as the iBeacon to be able to communication with Iphones and Android SmartPhones.

A Beacon might use Tx slots only to save energy. For a connectable beacon also Rx slots are needed.

Agenda

- What is iBeacon and how to use it?
- iBeacons in more details
- **Software:** How to dynamically change the advertising data?
- **Software:** How to switch roles?

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What is iBeacon and how to use it?

iBeacon broadcasts a very small packet of data which includes:

UUID:
A 128-bit value that uniquely identifies one or more beacons as a certain type or from a certain organization.

MAJOR value:
An optional 16-bit unsigned integer that can group related beacons that have the same UUID.

MINOR value:
An optional 16-bit unsigned integer that differentiates beacons with the same UUID and major value.

Measured power at 1 meter (RSSI):
The RSSI is determined **by measuring** the beacon's **signal strength** at a **fixed distance of 1 meter**.

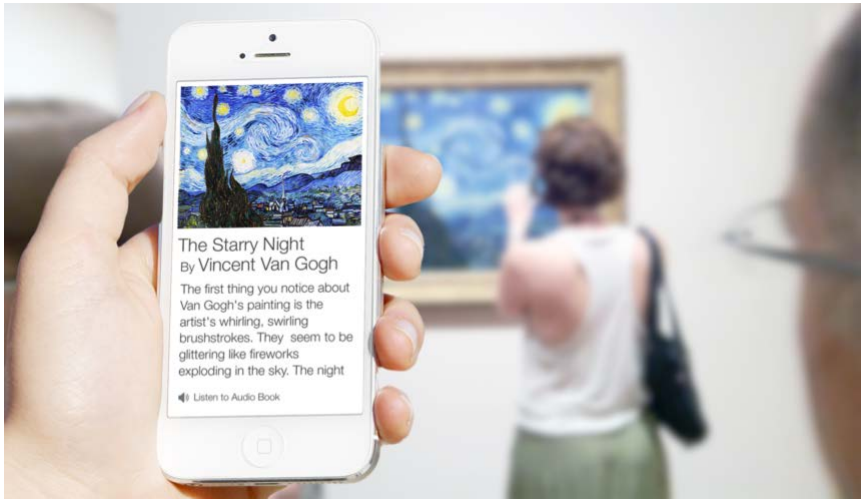
This is a signed 8-bit **fixed** and **programmed** into the beacon **during manufacturing**.

The iBeacon app compares the measured RSSI to the expected value of the RSSI at 1 meter broadcast in the advertising packet by the beacon to estimate the distance between the beacon and iOS device.

What is iBeacon and how to use it?

Requirements for the Central device side (e.g SmartPhone)

1. User needs the application to detect beacon
2. User must have app-on (does not need to be “open”)
3. User needs Bluetooth Low Energy compatible device
4. User needs Bluetooth ON
5. User must allow you to push messages



Picture taken from: http://www.google.nl/imgres?imgurl=http%3A%2F%2Fitechcraft.com%2Fwp-content%2Fuploads%2F2014%2F07%2Fgame-changing-beacons-museum.png&imgrefurl=http%3A%2F%2Fitechcraft.com%2Fibeacon-museum%2F&h=499&w=864&tbnid=5kR2GTe9szQV1M%3A&zoom=1&docid=YRL7-u0yJEFSmM&ei=vdy_U7K6CqeI7AbBgoC4Dg&tbm=isch&client=firefox-a&ved=0CGIQMyg4MDg&iact=rc&uact=3&dur=554&page=2&start=36&ndsp=43

Agenda

- iBeacons in more details
- **Software:** How to dynamically change the advertising data?
- **Software:** How to switch roles?

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iBeacons in more details

iBeacon is a new class of low-powered and low-cost transmitters that can notify nearby iOS 7 devices of their presence.

Devices running the Android operating system can receive iBeacon advertisements but cannot emit iBeacon advertisements (Central role only).

The customer needs to obtain a license from Apple before building ibeacons devices. Thanks to this license, the iBeacon logo can be used.

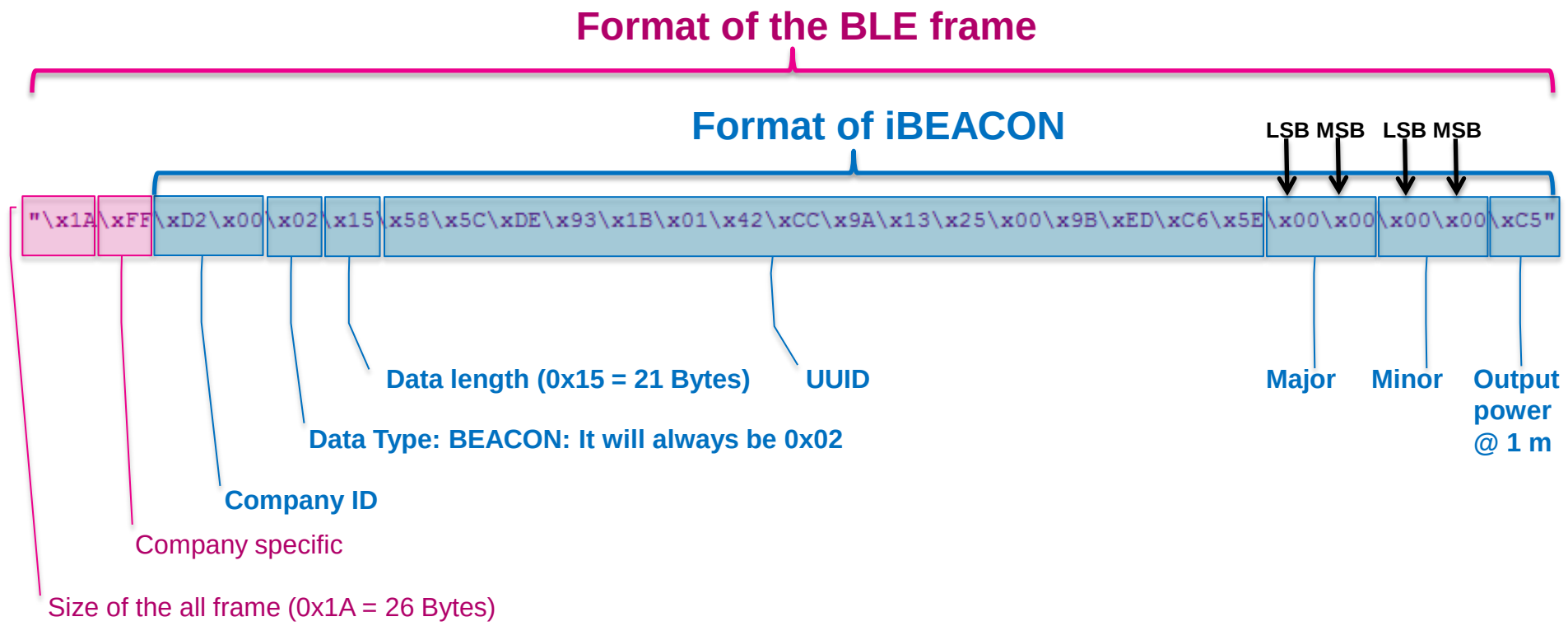
For more information:
https://developer.apple.com/ibeacon/Getting-Started-with-iBeacon.pdf
https://mfi.apple.com/MFiWeb/getFAQ.action#4-2

iBeacons in more details

Format of an iBeacon (25 Bytes)

DATA	Number of bytes
Company ID	2 Bytes
Data type	1 Byte
Data length	1 Byte
UUID	16 Bytes
Major	2 Bytes
Minor	2 Bytes
Measured power at 1 meter	1 Byte

Format of the overall BLE frame (27 Bytes)



The structure of advertising data is called: **NVDS_APP_BLE_ADV_DATA.**
This can be found in the ***nvds.c*** file of each applications from the following path:
(DA14580_SDK_3.0.2.1\dk_apps\src\modules\nvds\src)

Agenda

Software: How to dynamically change the advertising data?

Software: How to switch roles?

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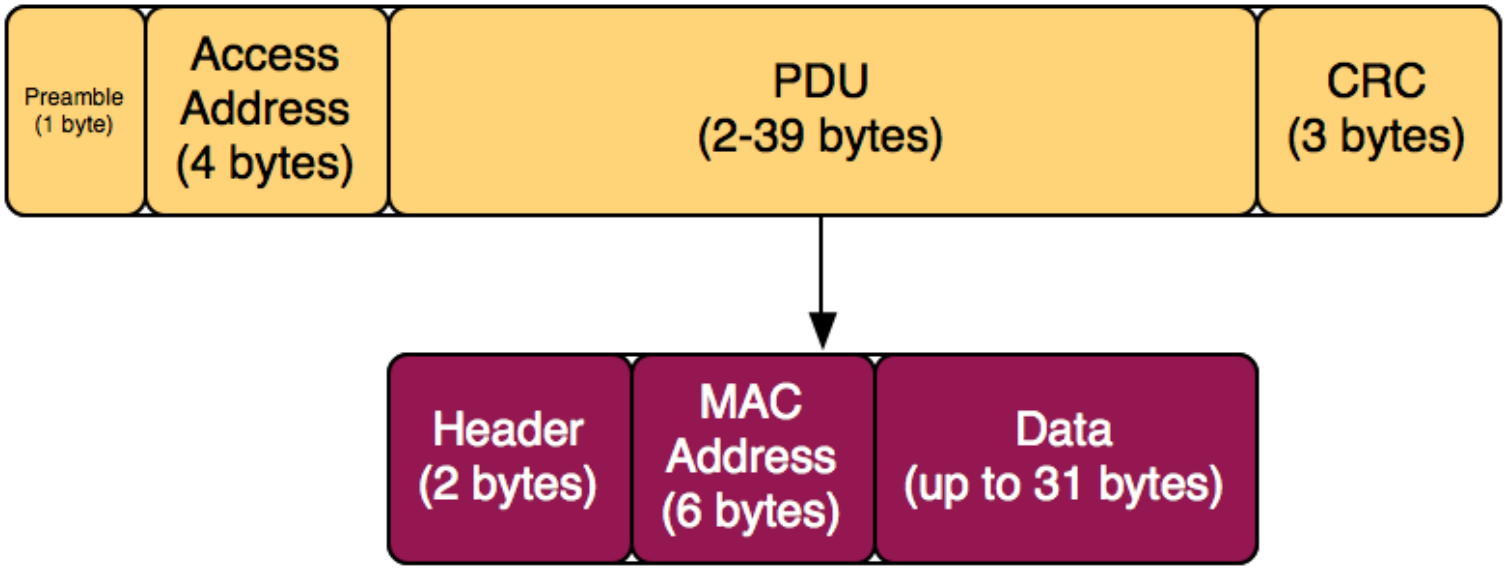
...connected

Software: How to dynamically change the advertising data?

In Bluetooth Low Energy, there are two types of packets:
Advertising and Data packets. The packet structure is shown here

Devices use advertising packets to find and connect to other devices.
Data packets are used once a connection has been made.
The only different is that a data packet in understandable by only two devices, known as the master and slave devices.

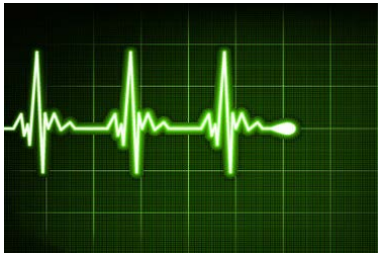


Software: How to dynamically change the advertising data?

Advertising dynamically data can be used to:

- **Update the advertising data to represent different items (i.e pant & shirt): This is what it is going to be shown in the next slides.**

- **update ADC measurements**



- **Send the time**

Software: How to dynamically change the advertising data?

To dynamically change the advertising data, the 3 steps must be achieved:

1. **Active the BLE timer to update the advertising string after a certain amount of time**
   ➔ Example of BLE timer function: app_timer_set(APP_ADV_TIMER, TASK_APP, 300);
   ➔ function which has to be called at the end of the *app_adv_func ()*.

2. **Once the time has been elapsed, a GAPM_CANCEL message has to be sent to the KERNEL**. This is going to cancel the ongoing activities before advertising the new parameters.
   ➔ This is done by calling *the app_adv_stop ()* in the BLE timer handler.

3. **Advertising can start again**
   ➔ In the gapm_cmp_evt_handler (), case GAPM_ADV_NON_CONN, the function *app_adv_start()* must be called.

The last slide of this chapter show how those steps have to be implemented.

Software: How to dynamically change the advertising data?

In the ***app_dialog_beacon_proj.c*** file (DA14580_DIALOG_BEACONS_3.40.2\dk_apps\src\modules\app\src\app_project\dialog_beacon_fh), the following variables must be added:

```
struct ibeacon
{
    uint16_t comp_id;
    uint8_t data_type;
    uint8_t length;
    uint8_t uuid[16];
    uint16_t major;
    uint16_t minor;
    uint8_t power;
};

struct ibeacon *pbeacon;
```

A temporary structure must be created in order to dynamically change the data.

Major & **Minor** data use **Big Endian** form:
The 1st Byte is **LSB** (**L**east **S**ignificant **B**yte)
The 2nd Byte is **MSB** (**M**ost **S**ignificant **B**yte)

```
#define SWAP(num) ((num>>8) | (num<<8))
```

As Major and Minor use Big Endian form, this **#define** can be used in order to send the right value of e.g. ADC

Example:

	MSB	LSB
num = Value of ADC = 0x4B03 =	1001 0110	0000 0011
(num >> 8) =	0000 0000	1001 0110
(num << 8) =	0000 0011	0000 0000
((num >> 8) | (num << 8)) =	0000 0011	1001 0110
	LSB	MSB

Software: How to dynamically change the advertising data?

In the ***app_dialog_beacon_proj.c*** file, the following function must be modified as:

```
void app_adv_func(struct gapm_start_advertise_cmd *cmd)
{
   //  Device Name Length
  uint8_t device_name_length;
  int8_t device_name_avail_space;
  uint8_t device_name_temp_buf[64];

  uint8_t adv_string[32] = {0x1A, 0xFF, 0xD2, 0x00, 0x02, 0x15, 0x58, 0xEE,
                            0xDE, 0x93, 0x1B, 0x01, 0x42, 0xCC, 0x9A, 0x13,
                            0x25, 0x00, 0x9B, 0xED, 0xC6, 0x5E, 0xFF, 0xFF,
                            0xFF, 0xFF, 0xC5}

  /*--------------------------------------------------------------------------------
   * Set the Advertising Data and the Scan Response Data
   *-------------------------------------------------------------------------------*/
  cmd->op.code      = GAPM_ADV_NON_CONN;
  cmd->info.host.mode = GAP_BROADCASTER_MODE;
  cmd->op.addr_src = GAPM_PUBLIC_ADDR;
  cmd->intv_min     = 1600;                          //APP_ADV_INT_MIN;
  cmd->intv_max     = 1600;                          //APP_ADV_INT_MAX;
  cmd->channel_map = APP_ADV_CHMAP;
  cmd->info.host.adv_data_len       = APP_ADV_DATA_MAX_SIZE;
  cmd->info.host.scan_rsp_data_len  = APP_SCAN_RESP_DATA_MAX_SIZE;

  // Advertising Data
  pbeacon = (struct ibeacon *)&adv_string[2];
  // It is a pointer of an iBeacon structure pointing at the start of ibeacon info in advertising string.
  // Bytes 0 and 1 are used for BLE advertise packet info and the beacon info starts from byte 2.

  pbeacon->major = SWAP(100);                    // MAJOR is LSB first and MSB second
  pbeacon->minor = SWAP(200);                    // MINOR is LSB first and MSB second
  cmd->info.host.adv_data_len = 27;              // APP_ADV_DATA_LEN;
  memcpy(&cmd->info.host.adv_data[0], adv_string, 27);
```

New buffer which is going to be sent over the air.

Fill GAPM_START_ADVERTISE_CMD message

Start advertising the content of adv_string: 27 Bytes including 25 Bytes for iBeacon format

Software: How to dynamically change the advertising data?

In the ***app_dialog_beacon_proj.c*** file, the following function must be added at the end of the app_adv_func:

```
    app_timer_set(APP_ADV_TIMER, TASK_APP, 100); // 100 means 1sec; 350 means 3.5seconds
    // With this function I setup a timer (APP_ADV_TIMER) with a specific timeout (100)
    // and give the task id that have the timeout handler (TASK_APP)
    // When the APP_ADV_TIMER expires the app_adv_timer_handler is called
    // TASK_APP is the task that handles the timer timeout
    // TASK_APP has the app_adv_timer_handler
    return;
}
```

The BLE timer is counting up to 1sec

In the ***app_task.c*** file, the following handler must be added:

```
int app_adv_timer_handler(ke_msg_id_t const msgid,
                          void const *param,
                          ke_task_id_t const dest_id,
                          ke_task_id_t const src_id)
{
  app_adv_stop(); //Stop Advertising and so we cancel all the ongoing activities.
  return(KE_MSG_CONSUMED);
}
```

Once the BLE timer has reached 1 sec, we have to stop advertising in order to update the new data which have to be sent.

In the ***app_task.c*** file, the following case must be added in the int gapm_cmp_evt_handler:

```
case GAPM_ADV_NON_CONN:
{
    // We receive a completion event for the operation canceled
    // We start advertising again with the updated data
    app_adv_start();
}
break;
```

Once the app_adv_stop() function is called, it is going to generate a GAPM_ADV_NON_CONN case in the GAPM_CMP_EVT handler. From this case, we have to start advertising again.

Agenda

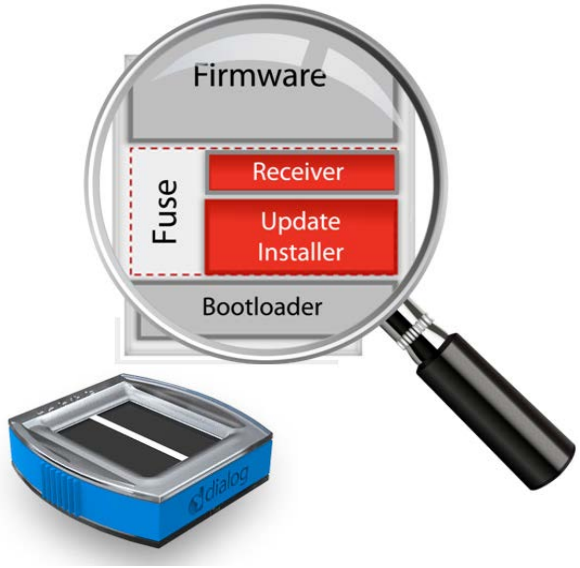
Software: How to switch roles?

...personal
...portable
...connected

Software: How to switch roles?

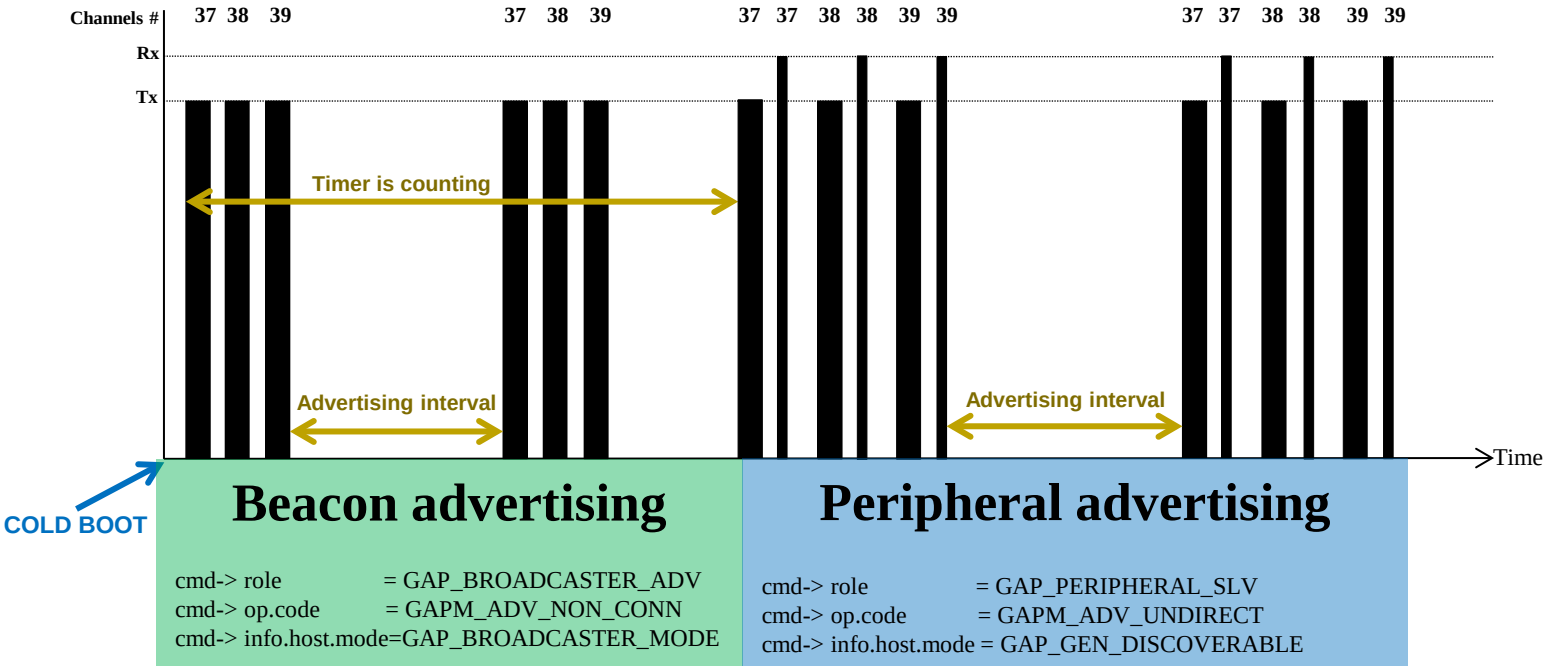
Why roles may be switched in a iBeacon application?

By default, an iBeacon sends non connectable advertising.
It can send connectable to have the possibility to run OTA (Over The Air) feature.



Software: How to switch roles?

Bluetooth scheme of the switching roles

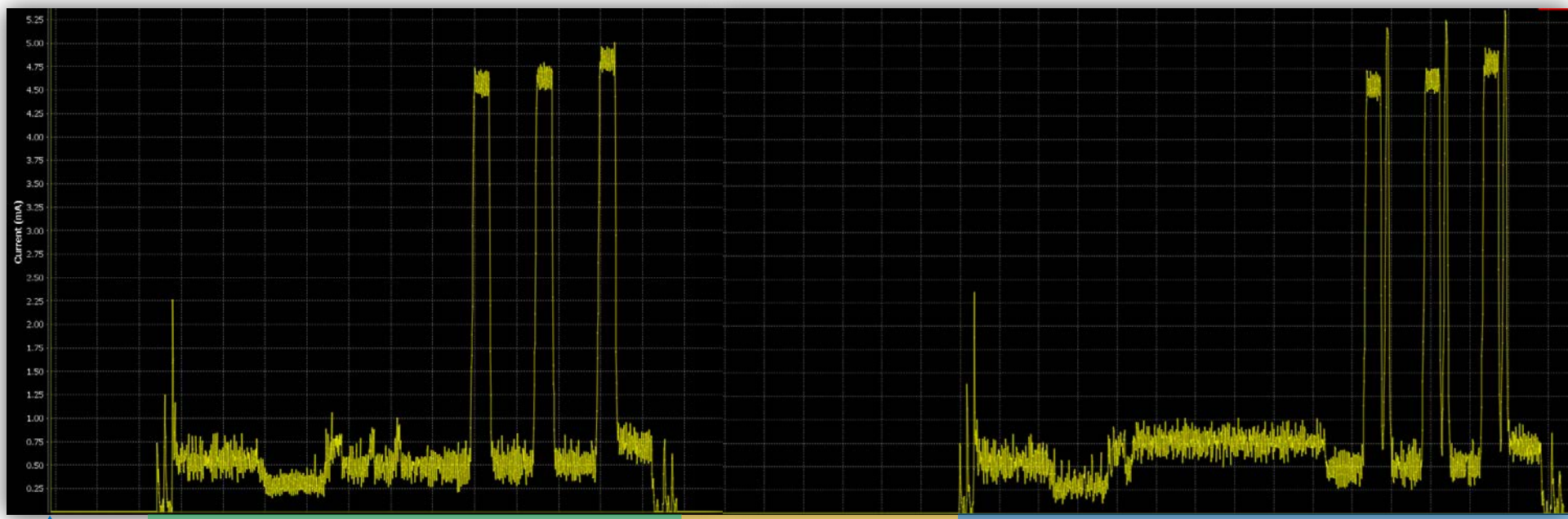


BLE timer can count up to **5 minutes**. This time can be extended using iterations.

Advertising interval can be set **from 20 ms until 10.24 seconds** (Bluetooth spec).

When the iBeacon is connected to a Master device (Peripheral advertising mode), the **connection interval** can be set **from 7.5 ms until 4 seconds** (Bluetooth spec).

Bluetooth scheme of the switching roles in PRACTISE



COLD BOOT

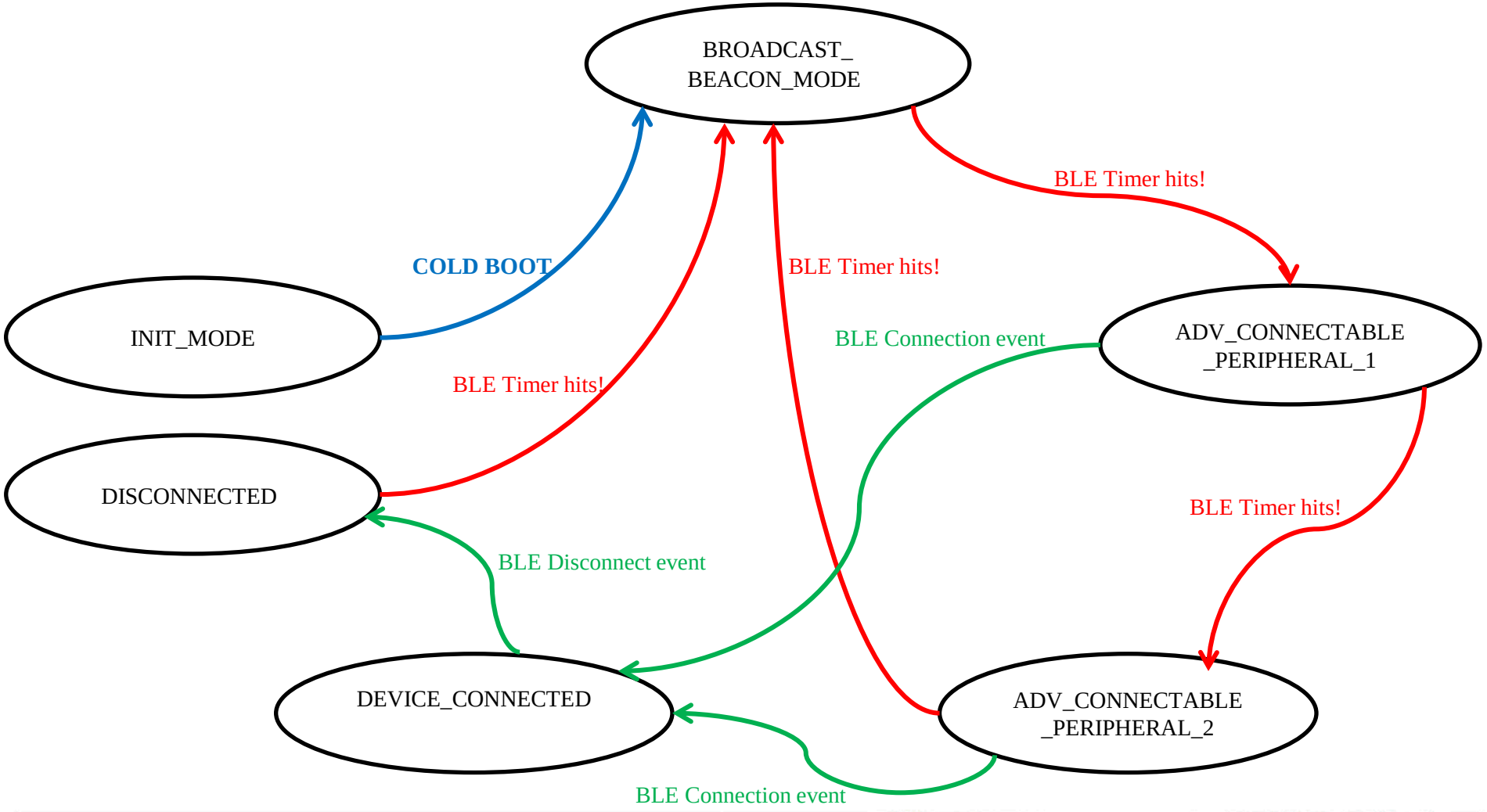
Beacon advertising

Advertising interval

Peripheral advertising

Software: How to switch roles?

State machine



Software: How to switch roles?

Flow chart (part 1/4)

COLD BOOT

1

gapm_device_ready_ind_handler()
target_mode=BROADCAST_BEACON_MODE
cmd-> operation = GAPM_RESET

app_configuration_func()
cmd-> role = GAP_BROADCASTER_ADV
cmd->operation = GAPM_SET_DEV_CONFIG

app_adv_func()
cmd-> op.code=GAPM_ADV_NON_CONN
cmd->info.host.mode=GAP_BROADCASTER_MODE
TIMER STARTS COUNTING

BLE Timer hits!

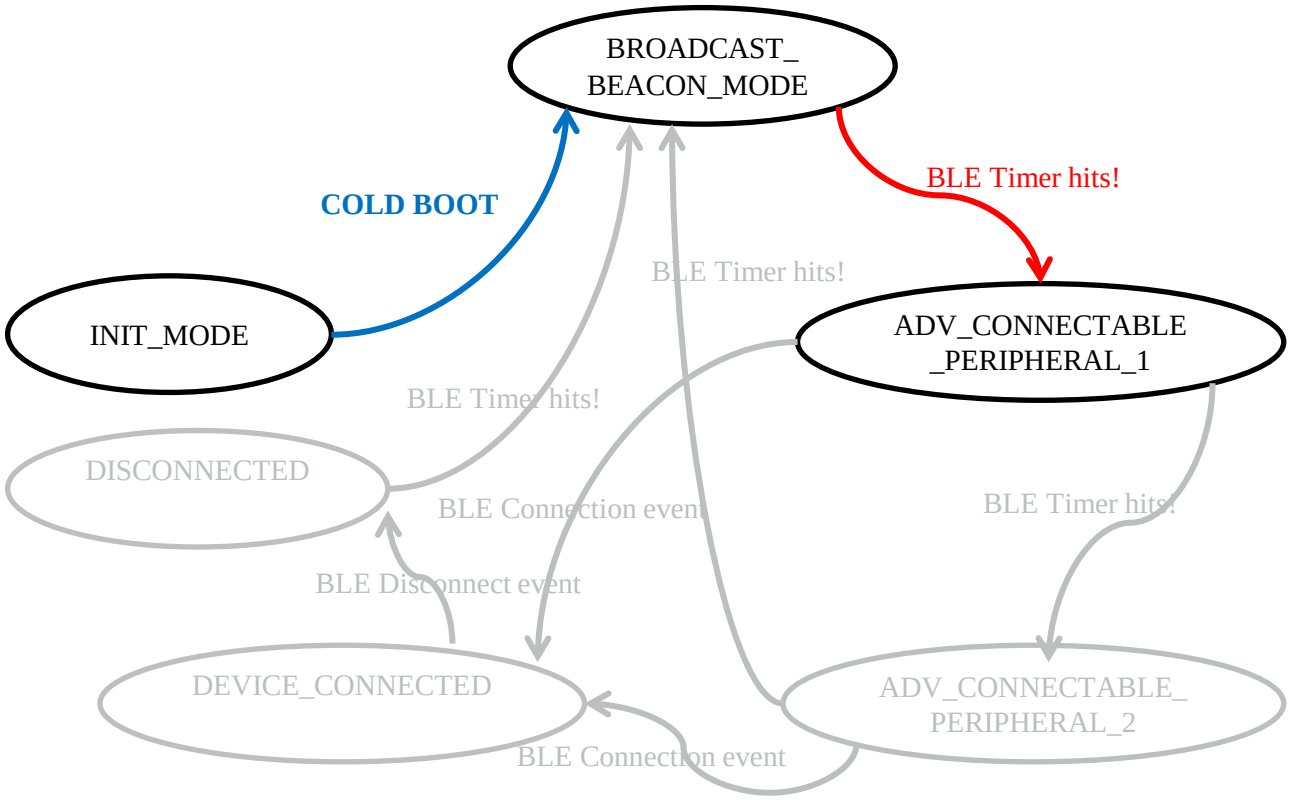
app_adv_timer_handler()
⇨ App_adv_stop()
⇨ Cmd-> operation = GAPM_CANCEL

2

gapm_cmp_evt_handler()
Case GAPM_ADV_NON_CONN
target_mode=ADV_CONNECTABLE_PERIPHERAL_1
cmd->operation = GAPM_RESET

app_configuration_func()
cmd-> role = GAP_PERIPHERAL_SLV
cmd->operation = GAPM_SET_DEV_CONFIG

app_adv_func()
cmd->op.code = GAPM_ADV_UNDIRECT
cmd->info.host.mode = GAP_GEN_DISCOVERABLE
TIMER STARTS COUNTING



Software: How to switch roles?

Flow chart (part 2/4)

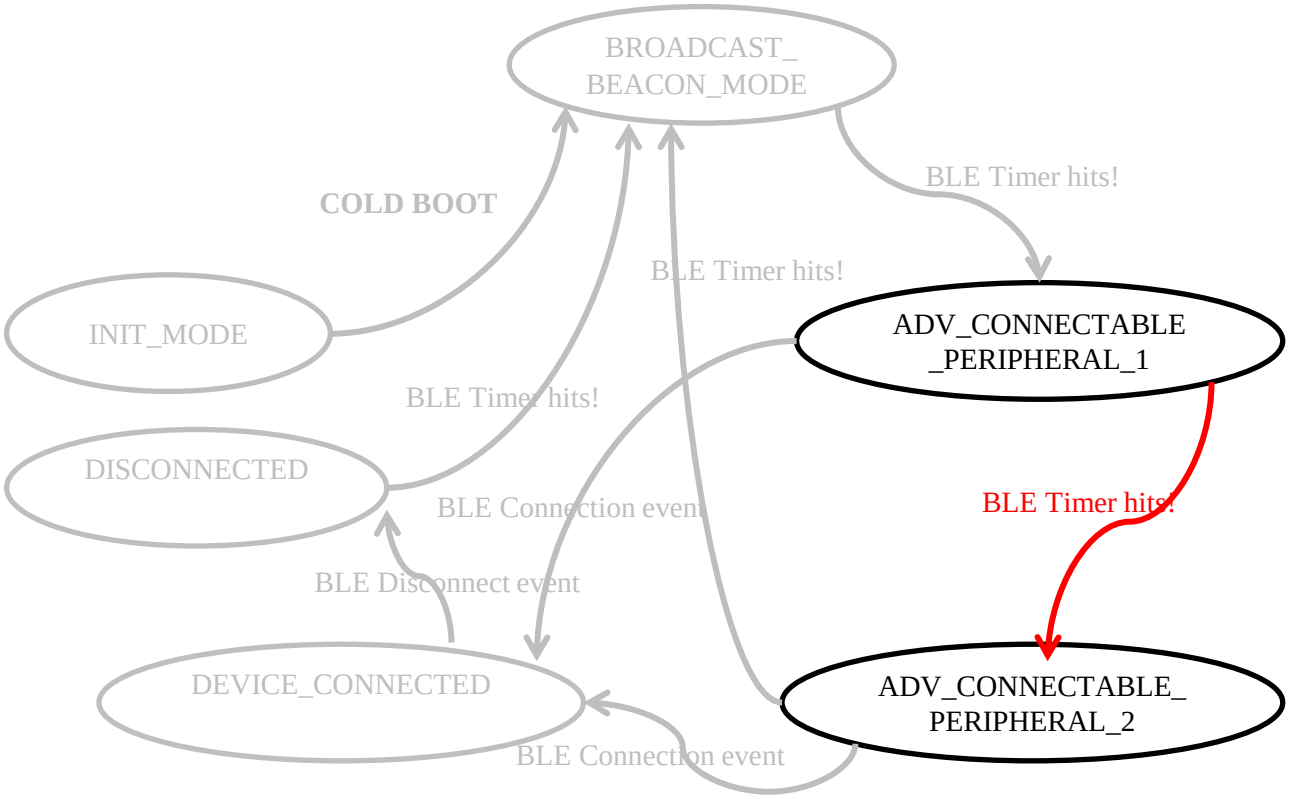
BLE Timer hits!

app_adv_timer_handler()
App_adv_stop()
Cmd-> operation = GAPM_CANCEL

3

gapm_cmp_evt_handler() Case
GAPM_ADV_UNDIRECT
target_mode=ADV_CONNECTABLE_PERIPHERAL_2

app_adv_func()
cmd->op.code = GAPM_ADV_UNDIRECT
cmd->info.host.mode = GAP_GEN_DISCOVERABLE
TIMER STARTS COUNTING



Software: How to switch roles?

Flow chart (part 3/4)

BLE Timer hits!

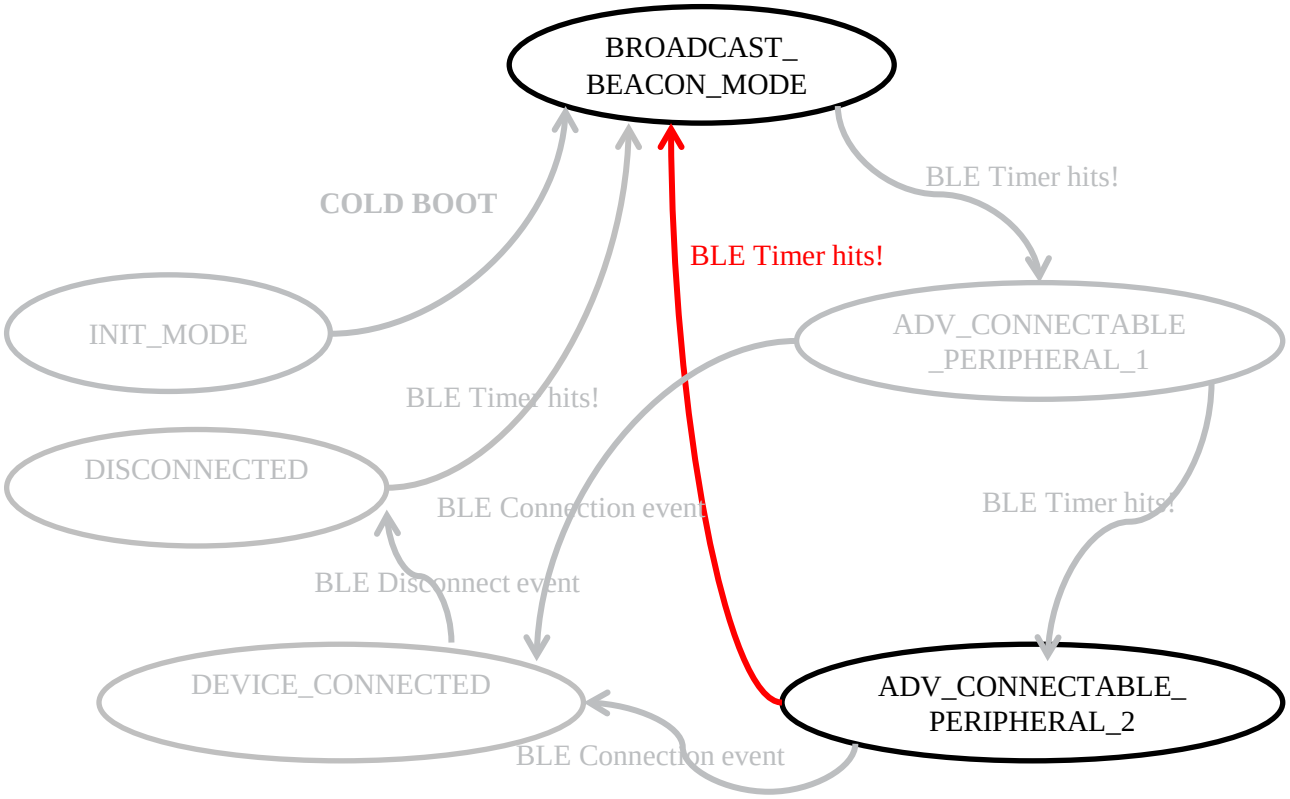
app_adv_timer_handler()
⇨ App_adv_stop()
⇨ Cmd-> operation = GAPM_CANCEL

4

gapm_cmp_evt_handler()
Case GAPM_ADV_UNDIRECT
target_mode= BROADCAST_BEACON_MODE
cmd->operation = GAPM_RESET

app_configuration_func()
cmd-> role = GAP_BROADCASTER_ADV
cmd->operation = GAPM_SET_DEV_CONFIG

app_adv_func()
cmd-> op.code=GAPM_ADV_NON_CONN
cmd->info.host.mode=GAP_BROADCASTER_MODE
TIMER STARTS COUNTING



Software: How to switch roles?

Flow chart (part 4/4)

BLE Connection event

gapc_connection_req_ind_handler()
target_mode=DEVICE_CONNECTED
TIMER IS STOPPED

BLE Disconnect event

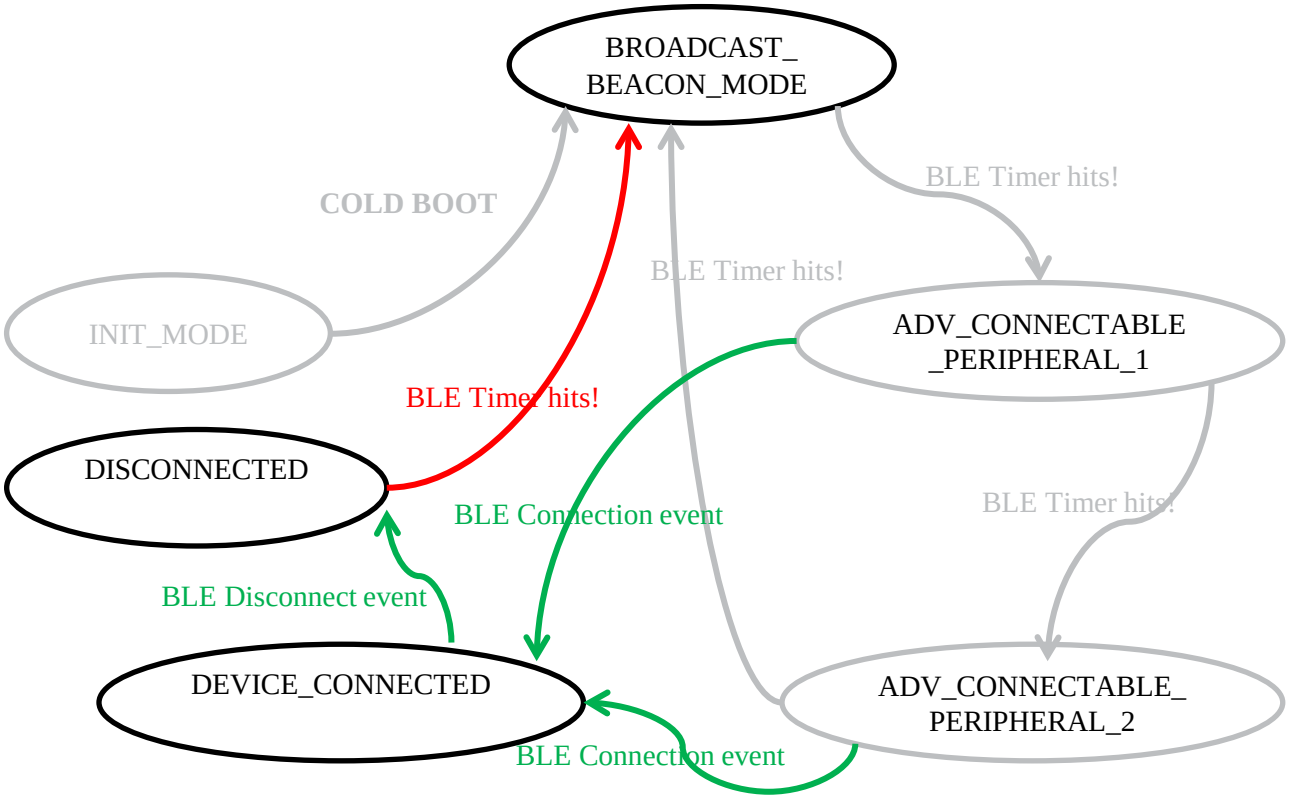
gapc_disconnect_ind_handler ()
target_mode= BROADCAST_BEACON_MODE

app_configuration_func()
cmd-> role = GAP_BROADCASTER_ADV
cmd->operation = GAPM_SET_DEV_CONFIG

app_adv_func()
cmd-> op.code=GAPM_ADV_NON_CONN
cmd->info.host.mode=GAP_BROADCASTER_MODE
TIMER STARTS COUNTING

BLE Timer hits!

app_adv_timer_handler()
⇨ App_adv_stop()
⇨ Cmd-> operation = GAPM_CANCEL



dialog SEMICONDUCTOR

The power to be...

...personal
...portable
...connected