IoT Deep Dive #3

Advanced BLE - Custom GAP/GATT

Grab Food ‘n Drink

- Connect to WiFi
- Download Evothings Workbench (evothings.com/download)
- Download smartphone apps

iOS	ANDROID
• LightBlue • Evothings Client	• nRF Master Control panel • Evothings Client

Schedule

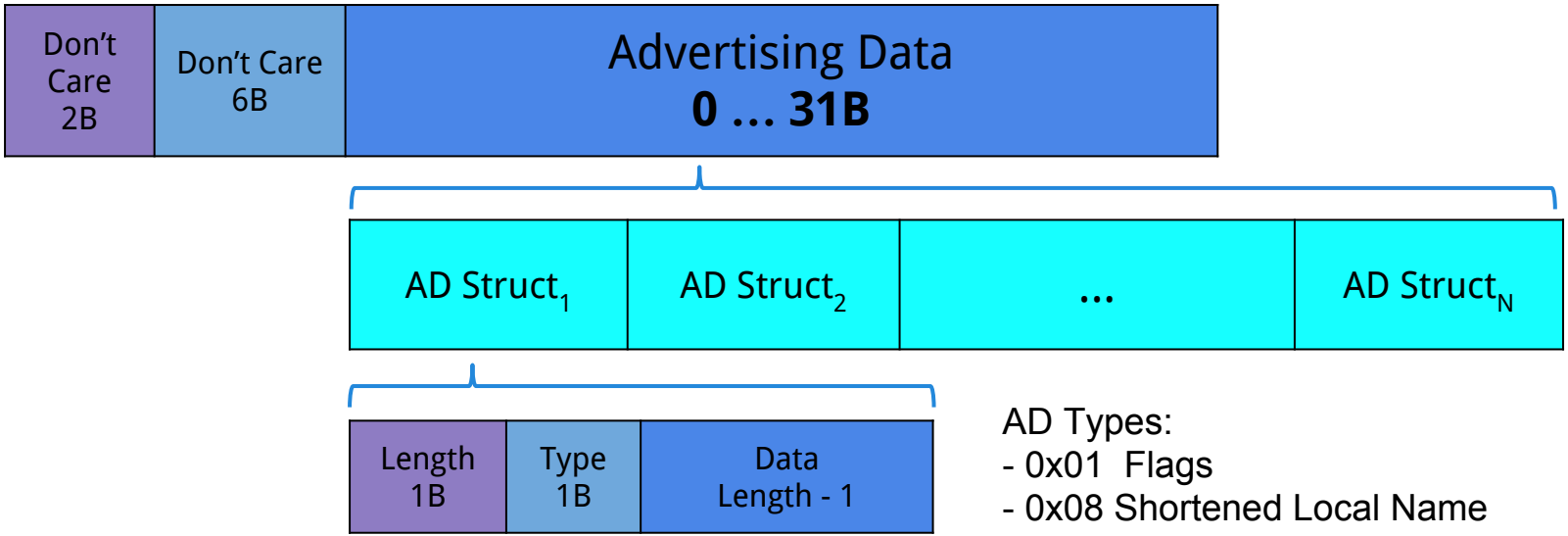
- BLE overview ~1hr
  - Custom GAP/GATT - mbed
  - Evothings - smartphone
- BLE workshop ~1hr
  - create custom protocol
  - send data back and forth

Custom GAP

Use those 26B!

GAP : A review

Advertising data : 2B overhead for every type of information



AD Types:
- 0x01 Flags
- 0x08 Shortened Local Name
- 0xFF Manufacturer Data
- ...

GAP: A Review

31B Advertising Data Space

-3B to Flags

-2B to Header per field

= **26B** Max of space

http://goo.gl/QqmePE

```
// Headers necessary for mbed and BLE device mode
#include "mbed.h"
#include "BLEDevice.h"

// BLE object
BLEDevice ble;

const static uint8_t AdvData[] = {"ChangeThisData"};          // example of character data
const static uint8_t AdvData[] = {0x01,0x02,0x03,0x04,0x05};  // example of hex data

int main(void){
        // Initial                                ways do this first!
        ble.init();

        // Sacrifice 3B of 31B to Advertising Flags
        ble.accumulateAdvertisingPayload(GapAdvertisingData::BREDR_NOT_SUPPORTED | GapAdvertisingData::LE_GENERAL_DISCOVERABLE );
        ble.setAdvertisingType(GapAdvertisingParams::ADV_CONNECTABLE_UNDIRECTED);

        // Sacrifice 2B of 31B to AdvType overhead, rest goes to AdvData array you define
        ble.accumulateAdvertisingPayload(GapAdvertisingData::MANUFACTURER_SPECIFIC_DATA, AdvData, sizeof(AdvData));

        // Set advertising int                                l = longer battery life
        ble.setAdvertisingInte                             in multiples of 0.625ms.
        ble.startAdvertising();

        // Infinite loop waiting for BLE events
        for (;;) {
        ble.waitForEvent(); // this saves battery
        }
}
```

≤26B data

First thing

-3B of Flags

-2B of Header overhead

Last thing

Do This http://goo.gl/QqmePE

- Add Name by uncommenting

```
//const static char     DEVICE_NAME[]        = "ChangeMe!!"; // change this
...
//ble.accumulateAdvertisingPayload(GapAdvertisingData::COMPLETE_LOCAL_NAME, (uint8_t *)DEVICE_NAME,  sizeof
    (DEVICE_NAME));
```

- compile & load onto board
- 

use 

, 

use 
  - Find your device
  - view Advertising Data
  - Change advertising data

Play with it!

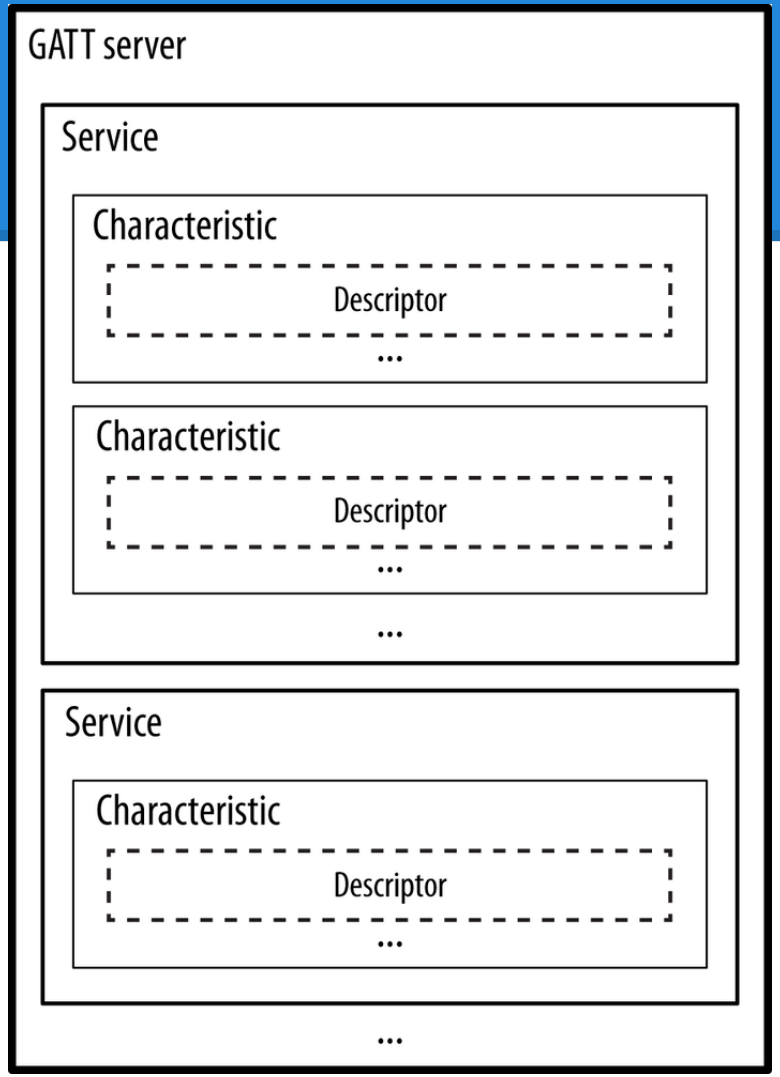
change the data!

Custom GATT

Services and Characteristics

GATT: Generic Attribute

- GATT organizes data
  - Service
    - Characteristic
      - Properties (R/W,notify…)
      - 1 value (<=512B)
      - 0+ descriptors



Custom GATT Service

Custom Service hooked up to LED / terminal

Service: S1 (0xA000)

Char: - C1 (0xA001), Read

- C2 (0xA002), Write

Service & Characteristic UUID's

```
uint16_t customServiceUUID      = 0xA000;
uint16_t reachCharUUID          = 0xA001;
uint16_t writeCharUUID          = 0xA002;
```

Device Name & Device UUID

```
const static char DEVICE_NAME[]         = "ChangeMe!!"; // change this
static const uint16_t uuid16_list[]     = {0xFFFF};     // Custom UUID, FFFF is reserved for development
```

C1, readable

```
// Set Up custom Characteristics
static uint8_t readValue[10] = {0};
GattCharacteristic readChar(reachCharUUID, readValue, sizeof(readValue), sizeof(readValue),
                        GattCharacteristic::BLE_GATT_CHAR_PROPERTIES_READ | GattCharacteristic::BLE_GATT_CHAR_PROPERTIES_NOTIFY);
```

C2, writable

```
static uint8_t writeValue[10] = {0};
GattCharacteristic writeChar(writeCharUUID, writeValue, sizeof(writeValue), sizeof(writeValue),
                        GattCharacteristic::BLE_GATT_CHAR_PROPERTIES_WRITE | GattCharacteristic::BLE_GATT_CHAR_PROPERTIES_NOTIFY);

// Set up custom service
GattCharacteristic *characteristics[] = {&readChar, &writeChar};
GattService       customService(customServiceUUID, characteristics, sizeof(characteristics) / sizeof(GattCharacteristic *));
```

assemble Characteristics together into a service

```
int main(void){
        ...
        ble.onDataWritten(writeCharCallback);
        ...
}

//  handle writes to writeCharacteristic
void writeCharCallback(const GattCharacteristicWriteCBParams *params)
{
        // check to see what characteristic was written, by handle
        if(params->charHandle == writeChar.getValueHandle()) {
                // toggle LED if only 1 byte is written
                if(params->len == 1) {
                        led = params->data[0];
                        (params->data[0] == 0x00) ? printf("\n\rled on ") : printf("\n\rled off " );
                }
        // print the data if more than 1 byte is written
        else {
                printf("\n\r Data received: length = %d, data = 0x",params->len);
                for(int x=0; x < params->len; x++) {
                        printf("%x",params->data[x]);
                }
        }
        // update the readChar with the value of writeChar
        ble.updateCharacteristicValue(readChar.getValueHandle(), params->data, params->len);
        }
}
```

Initialize write callback

This function handles all writes to the device

Check to see what characteristic we are responding to (could be multiple that are writable)

If 1B, toggle LED,
If >1B, print to console

copy value to readChar characteristic

Grab the custom GATT code

http://developer.mbed.org/users/mbedAustin/code/BLE_EvothingsExample_GATT

or

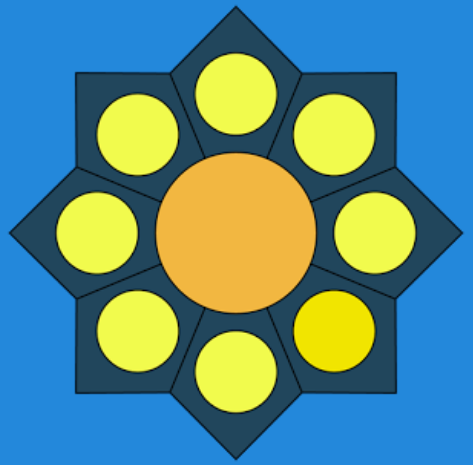
http://goo.gl/urWUTv

Do This http://goo.gl/urWUTv

- Change `const static char DEVICE_NAME[] = "ChangeMe!!"; // change this`
- compile & load onto board
-  use  ,  use 
  - Connect to your device
  - Write 0 or 1 to write characteristic to see LED flash

Play with it!

see what you can do!



Smartphone Apps in Javascript

Grab the Evothings Custom Apps

- GAP: http://goo.gl/tJP5EY
- GATT: http://goo.gl/F9YmEO

- Drag index.html into evothings workbench
- run Evothings program with mbed code from earlier
- See notes for Evothings API references

Evothings Custom GAP

The Custom GAP program will print out advertising data of all GAP devices it can find.

Make sure to check Tools window for console.log() output.

Evothings Custom GATT

- In app.js change “ChangeMe!!” to your device name
- When connected use toggle button to change LED status.
- Inspect the code and play with it!