BLE

Image: Freepik.com

RF Communication in Mobile App Development

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Educational Purposes only

Overview

- Bluetooth vs Bluetooth Low Energy (BLE)
- BLE Basics
- Link Layer
- GATT
- Demo

Bluetooth
What it is?

Image: Freepik.com

Bluetooth Classic

- Before 2010
- BR/EDR/AMP
- Short distance
- Audio streaming
    - telephone connections
    - speakers
    - headphones

Bluetooth Low Energy - BLE

- 2010 - Bluetooth 4.0
- Low power consumption
- ISM Band 2.4GHz
- 40 Channels
    - 3 primary - advertisement channels
    - 37 data transfer during connection
- IoT devices, fitness monitoring equipment, battery powered accessories

Bluetooth Classic vs BLE

- Incompatibility
    - modulation & demodulation
- Data transfer patterns
    - bursty, bandwidth
- Updates

BLE

- Range
- Power Consumption
- Data Throughput

Range

- Configuration
- Environment
  - ~ meters —> 1 Km
    - Line of sight / Greenfield
  - 50m - 200m

Power Consumption

- Turn off the radio as much as possible
- Send, Receive, go to Sleep
- Peak - depends on the chipset
- Months, years

Data Throughput

- Configuration
- 2Mb/s PHY mode
- 1.4 Mb/s
- Range vs Throughput

Main Advantages

- Ubiquitous support
- Open & Free access to specs

BLE Deep Dive

Image: Freepik.com

BLE

Link Layer

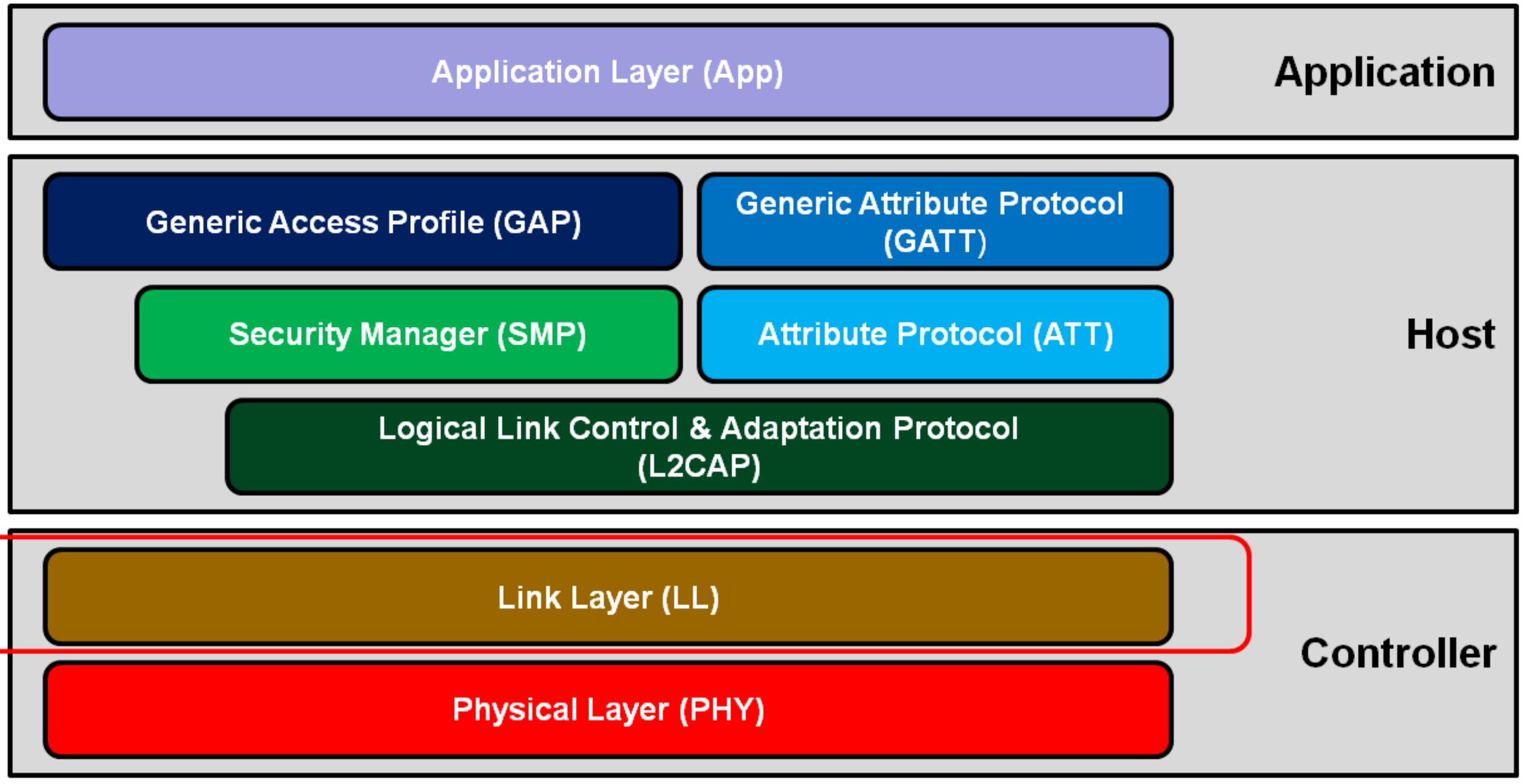


Image source: https://microchipdeveloper.com/wireless:ble-link-layer-overview

Channels

- Advertising Channels: 37, 38, 39
- Data Channels

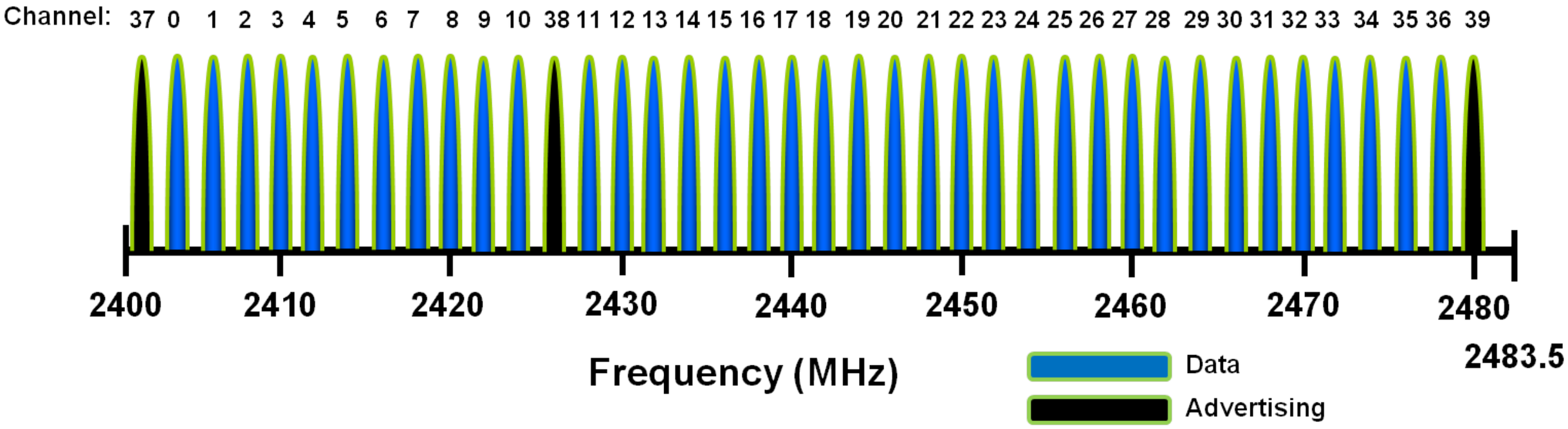


Image source: https://microchipdeveloper.com/local--files/wireless:ble-link-layer-channels/ble-phy-channel-assignment.png

Peripheral & Centrals

- Peripheral
  - Advertisement
  - Connection-oriented
    - Smartwatch
  - Connectionless
    - Beacon
- Central
  - Discover & Connect
  - Controls timing params
  - Consumes more power
- Multiple connections

BLE Device Address

- Standard IEEE 48-bit universal LAN MAC
  - IEEE assigned company ID
  - Company assigned device ID

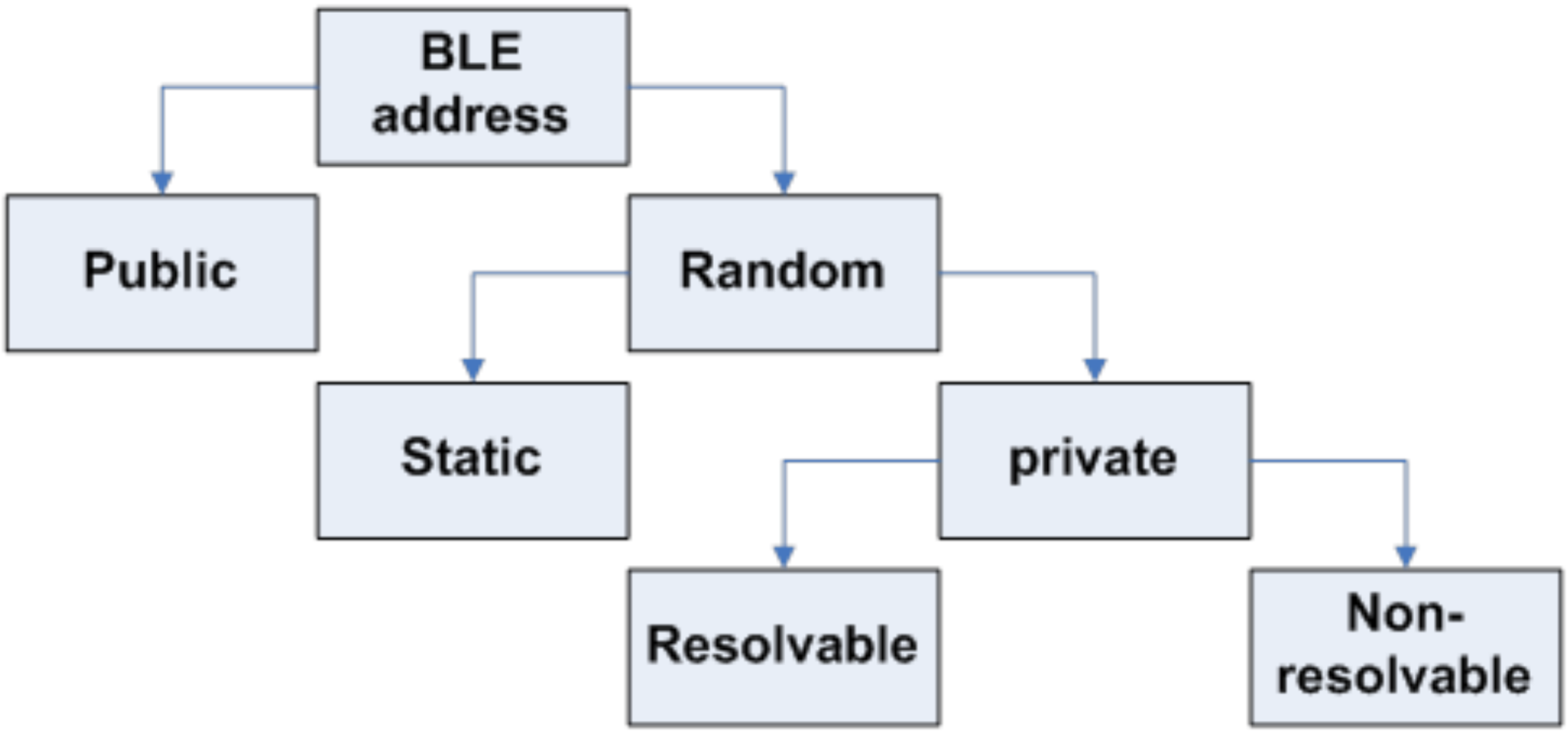


Image source: https://microchipdeveloper.com/wireless:ble-link-layer-address

Advertising & Scanning

- Peripheral
  - Advertising packet
    - Device name
    - Tx Power level
    - Services
    - Appearance ID
    - Connectable flag
- Central
  - Scanning (3 channels)
    - Controls timing params
  - Scan Window
  - Scan Interval

Advertising & Scanning

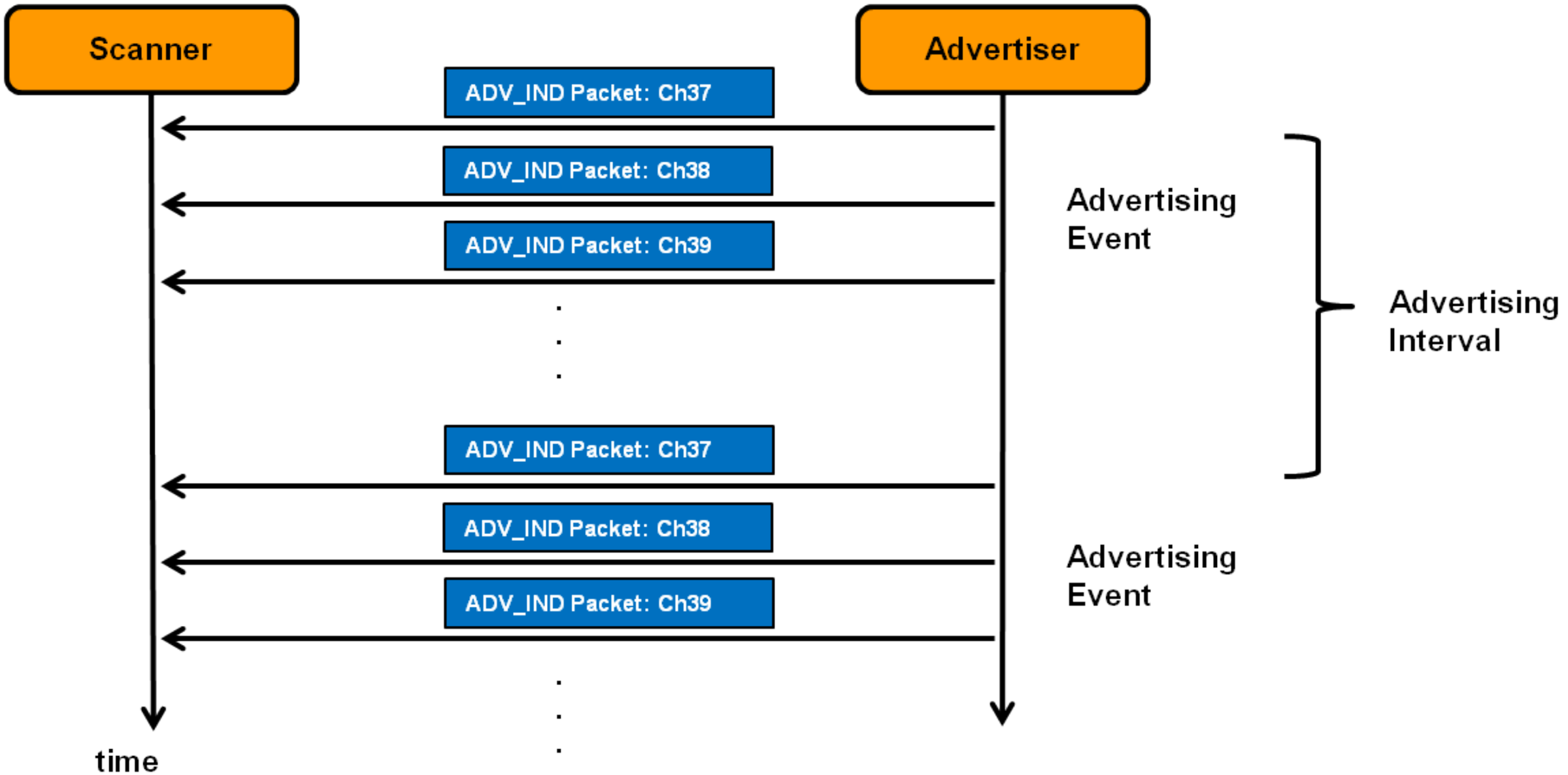


Image source: https://microchipdeveloper.com/wireless:ble-link-layer-discovery

Advertising & Scanning

Parameters

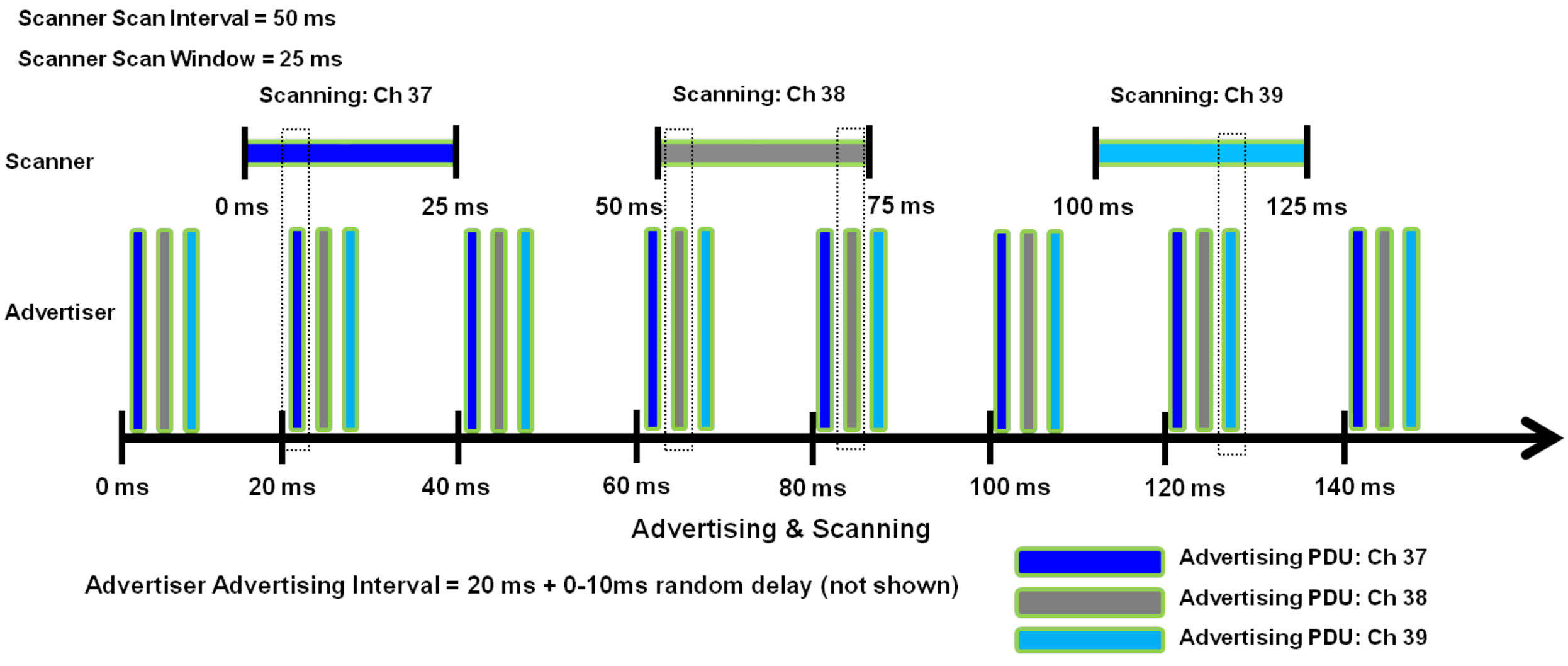


Image source: https://microchipdeveloper.com/local--files/wireless:ble-link-layer-discovery/advertising-and-scanning.png

Connection

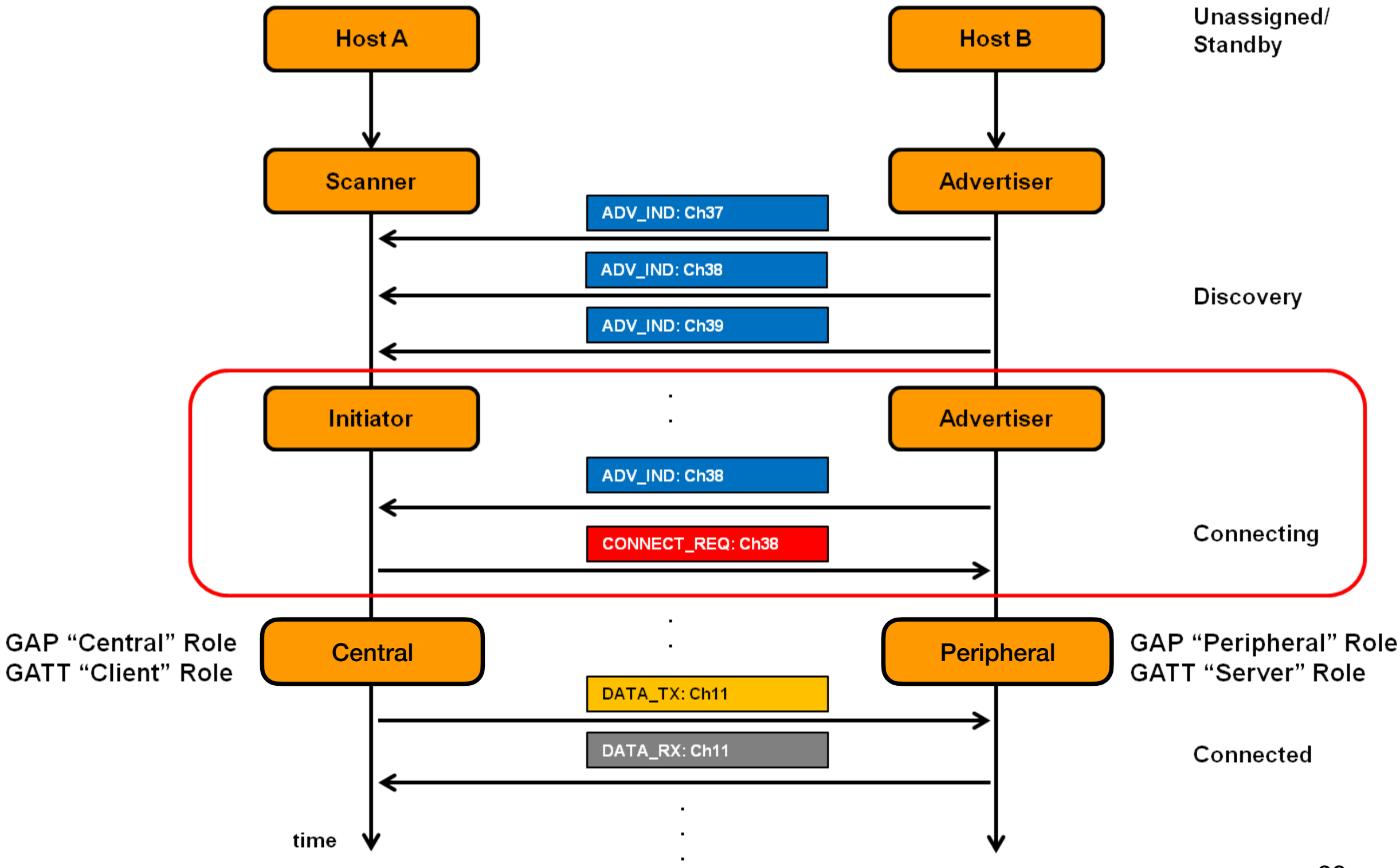
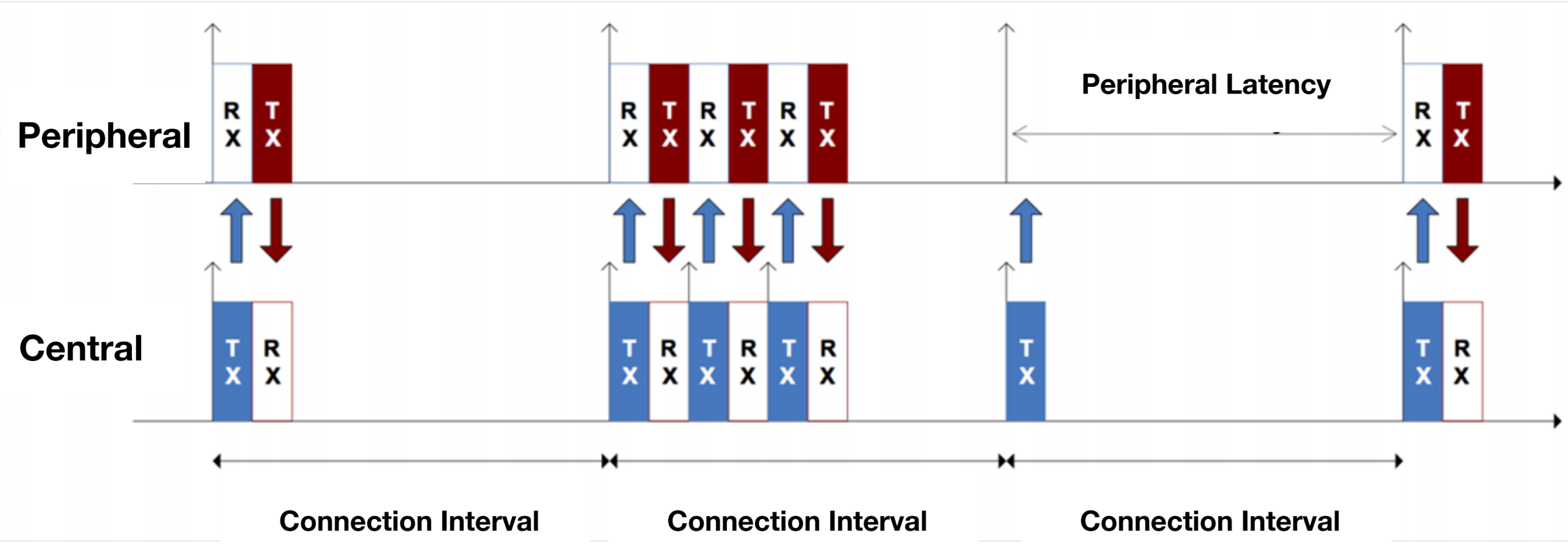


Image source: https://microchipdeveloper.com/local--files/wireless:ble-link-layer-connections/connecting-phase.png

Connection

Parameters



- Supervision Timeout - Maximum time between two received valid data packets before a connection is considered “lost”

Image source: https://microchipdeveloper.com/local--files/wireless:ble-link-layer-connections/connected-phase.png

Broadcast Connection

Connection(less)

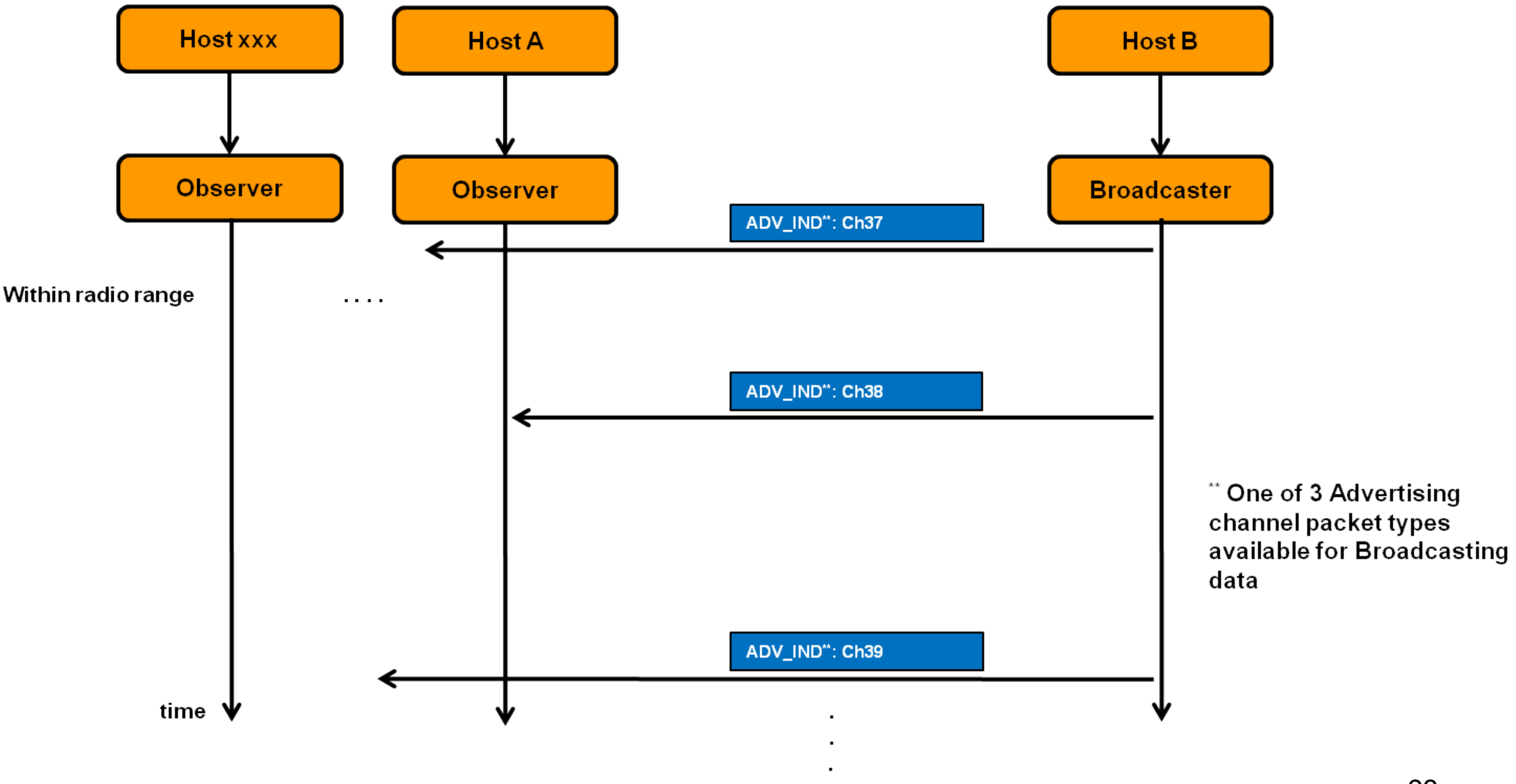


Image source: https://microchipdeveloper.com/wireless:ble-link-layer-roles-states

GATT

Generic Attribute Profile

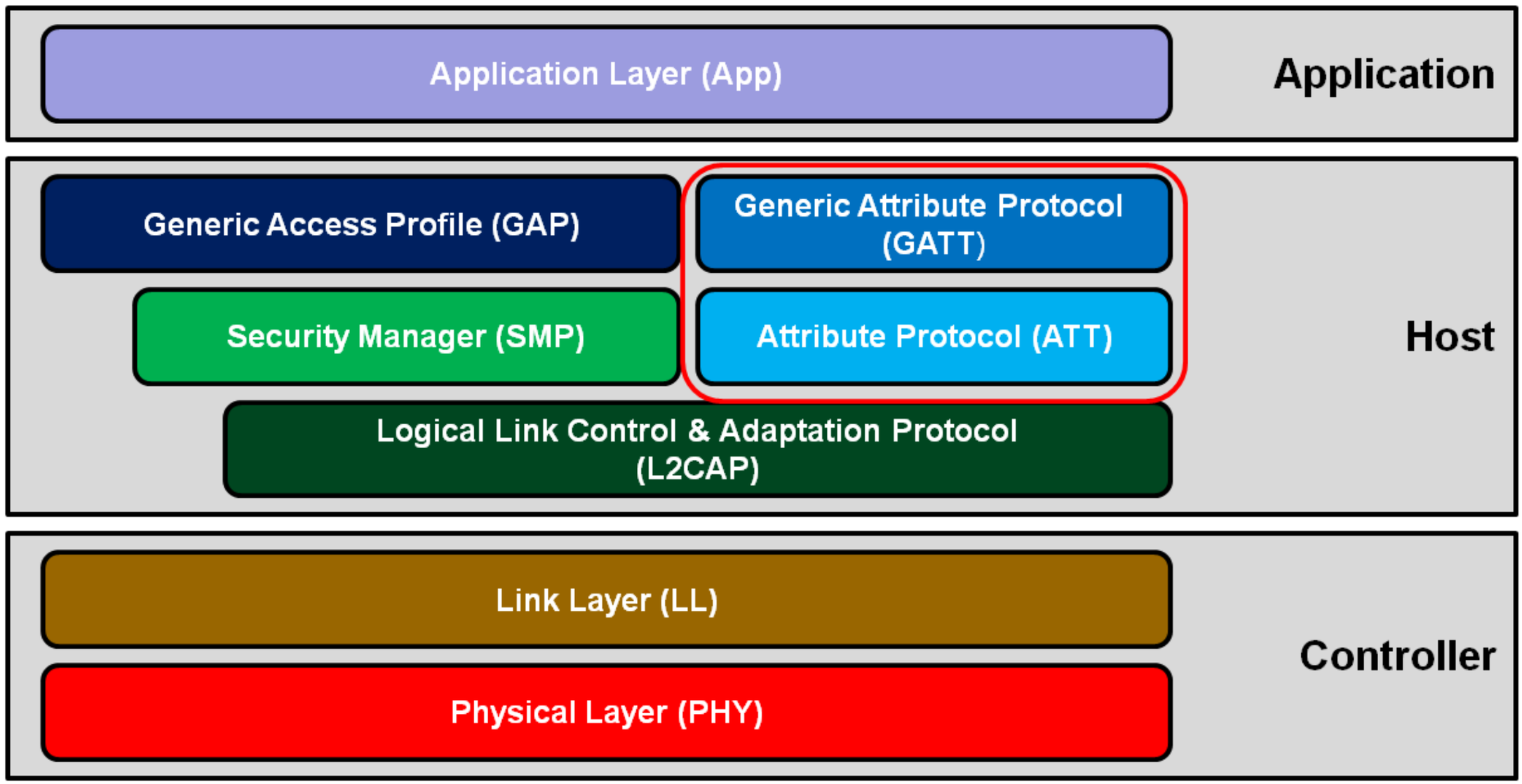


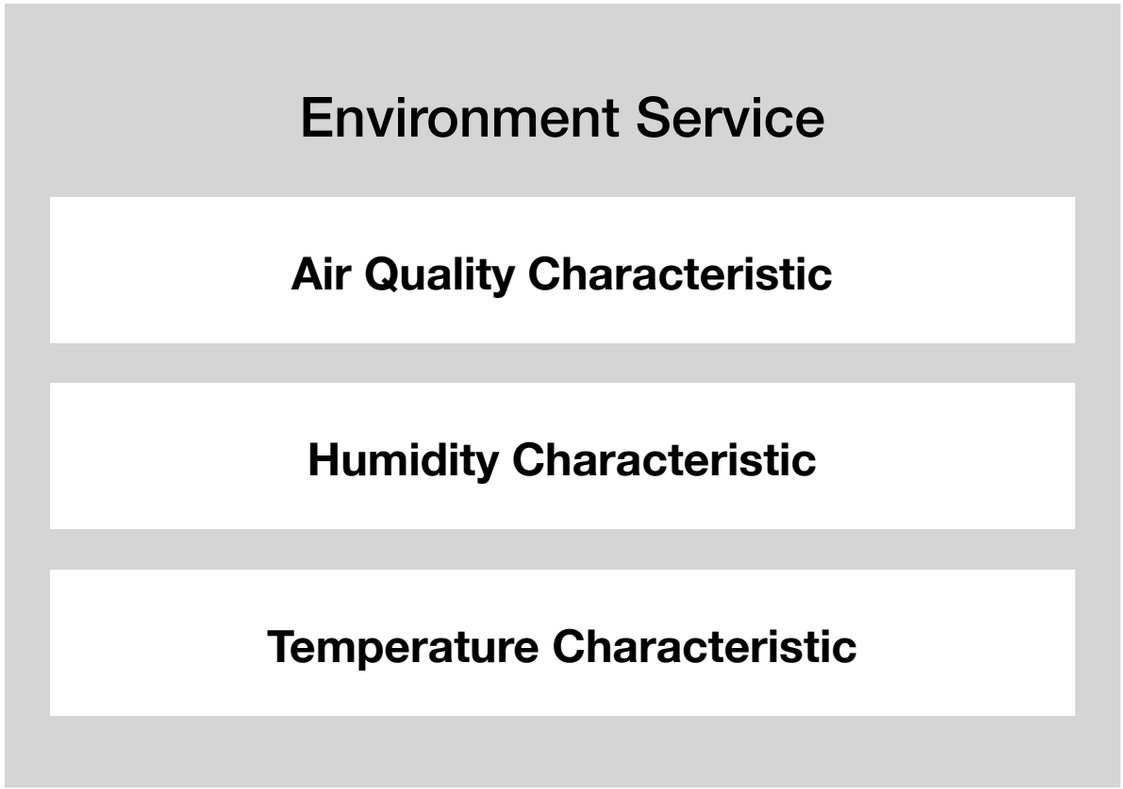
Image source: https://microchipdeveloper.com/wireless:ble-gatt-overview

GATT

Characteristics & Services

- Characteristic
    - Sensor readings, Control
- Service
    - Logical grouping
- UUIDs
    - 128b or 16b (short format)
    - uuidgenerator.net

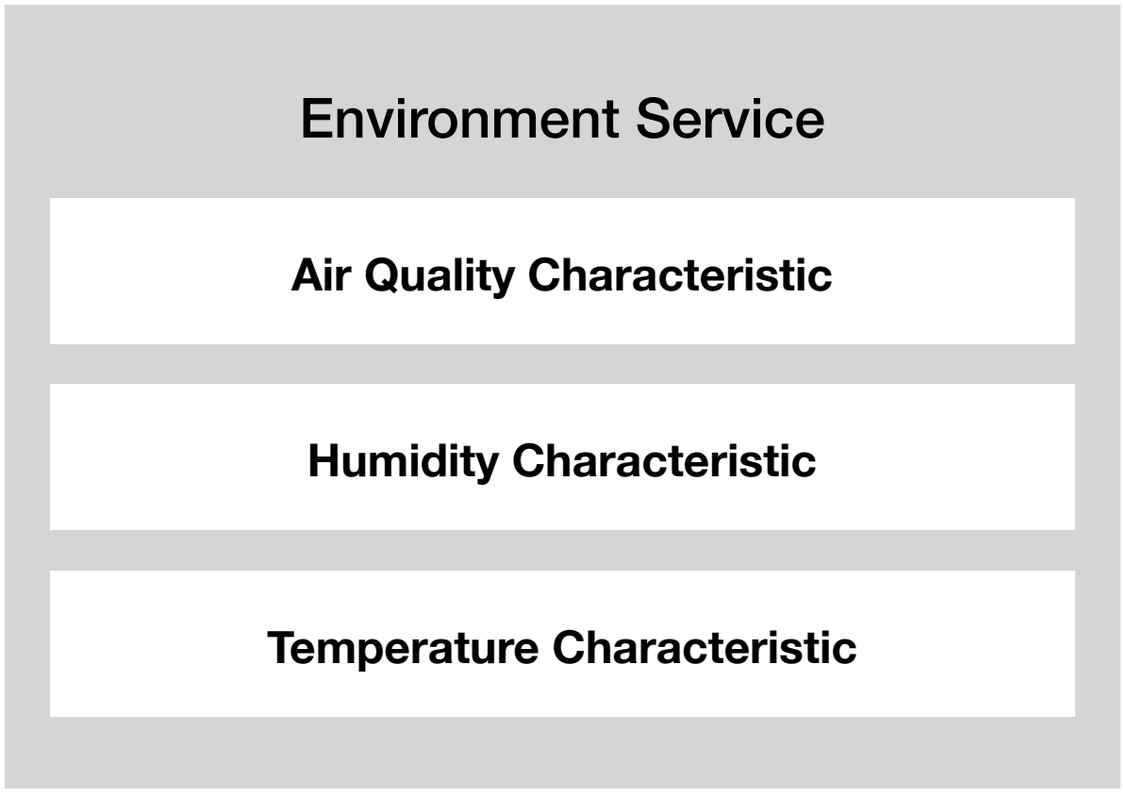
      45ae6ec4-396d-4991-8ae2-2d41ebe3afba



GATT

Roles

- **Client**
  - Discovers data
  - Sends requests
  - Central
- **Server**
  - Hosts data
  - Handles requests
  - Peripheral



GATT

Operations

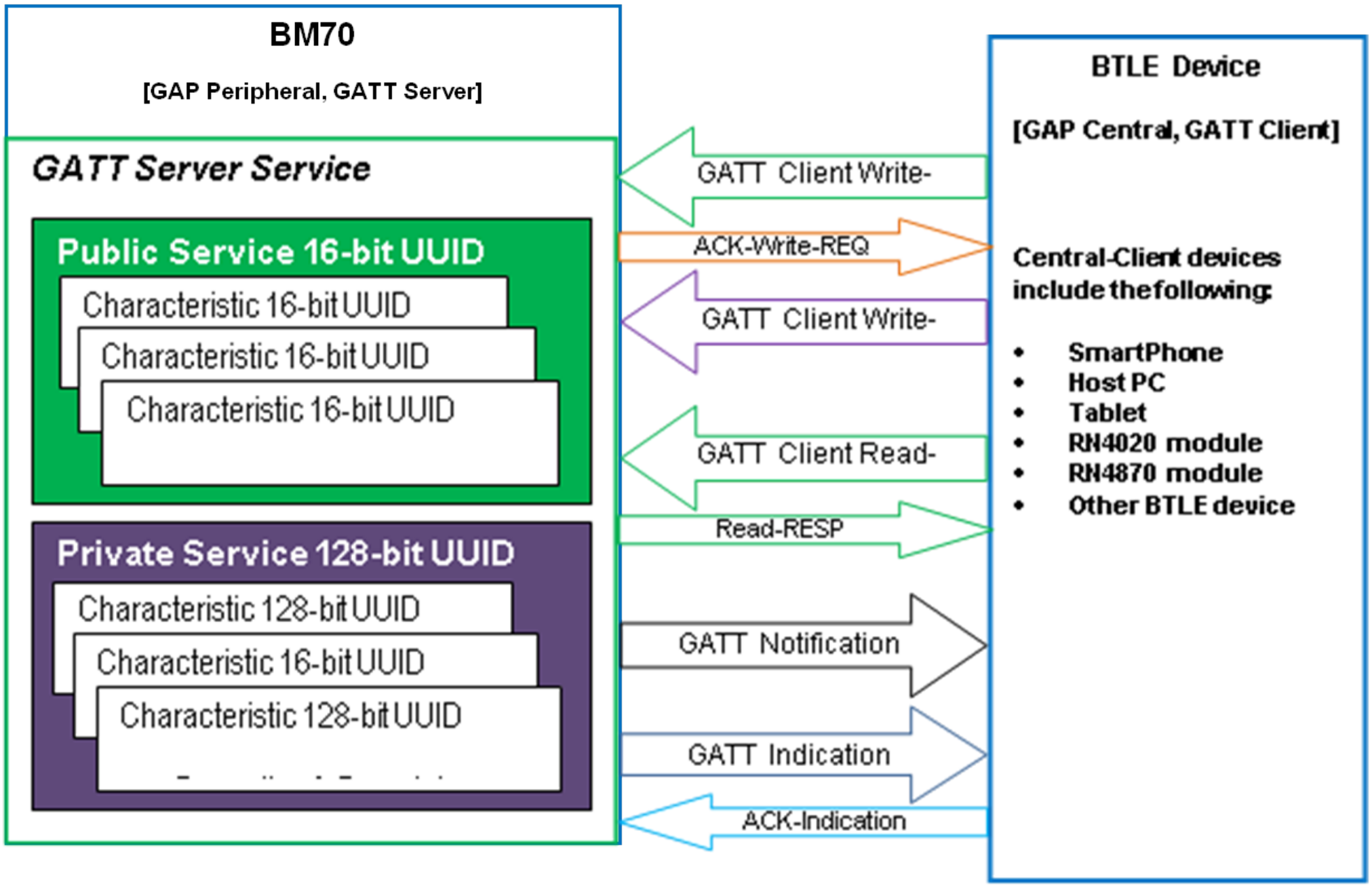


Image source: https://microchipdeveloper.com/wireless:ble-gatt-overview

Quiz

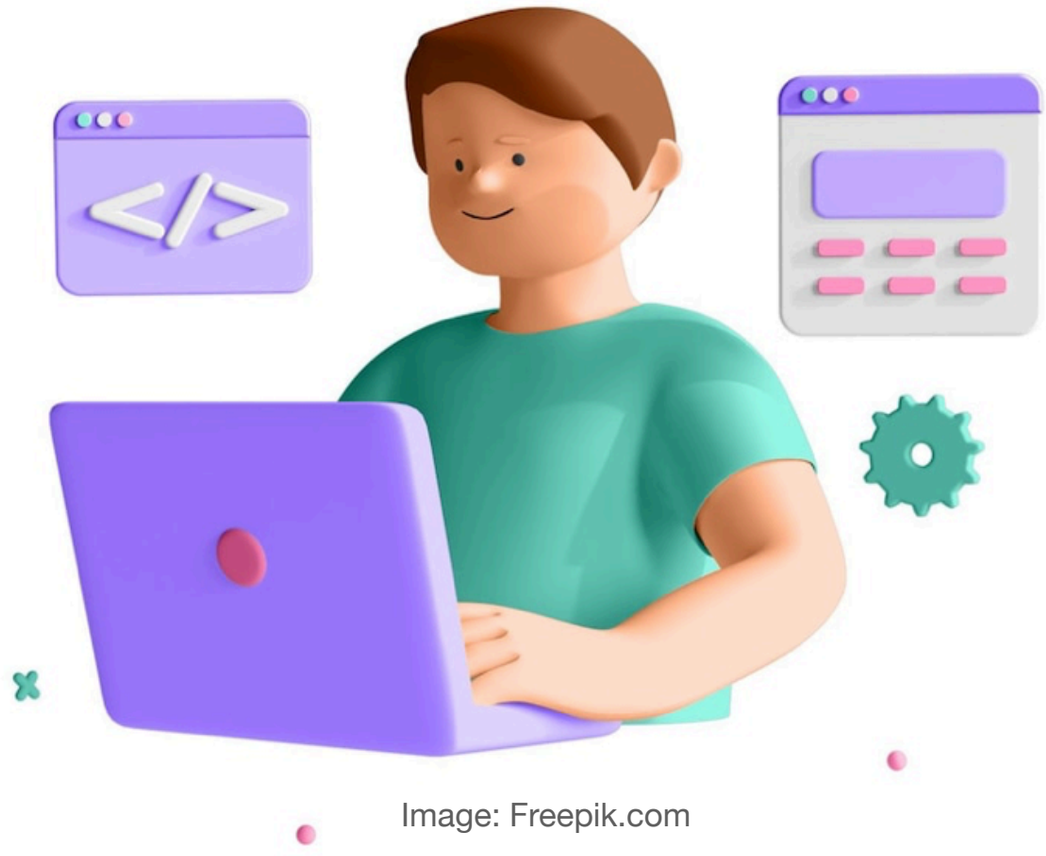
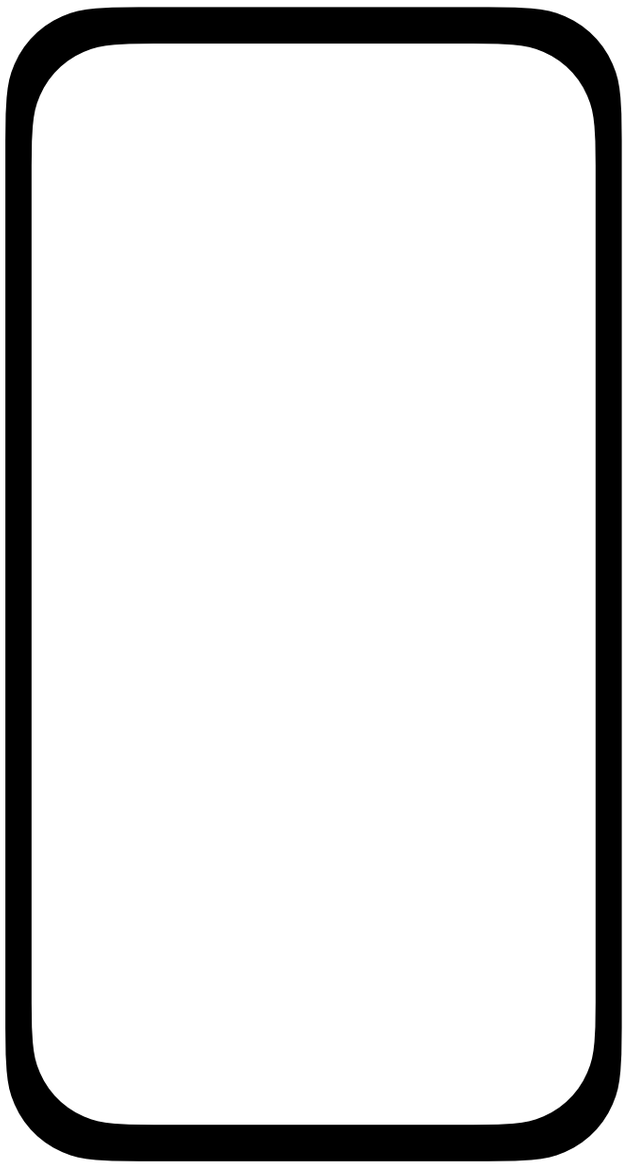
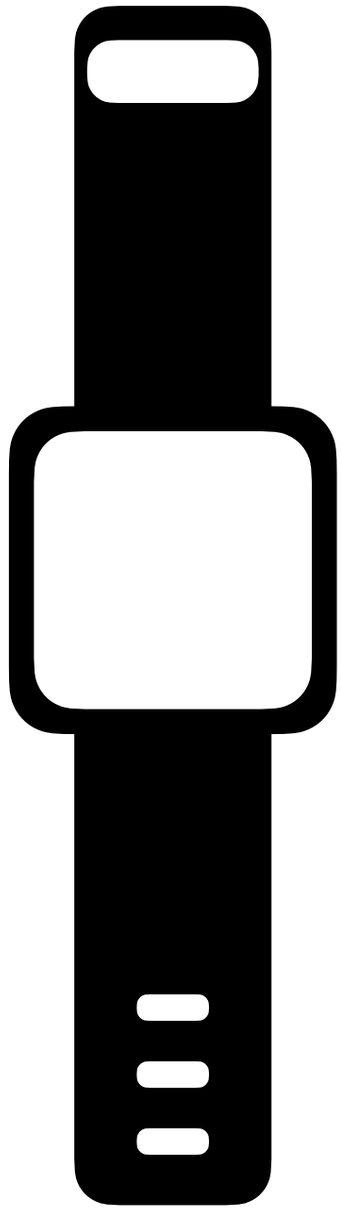
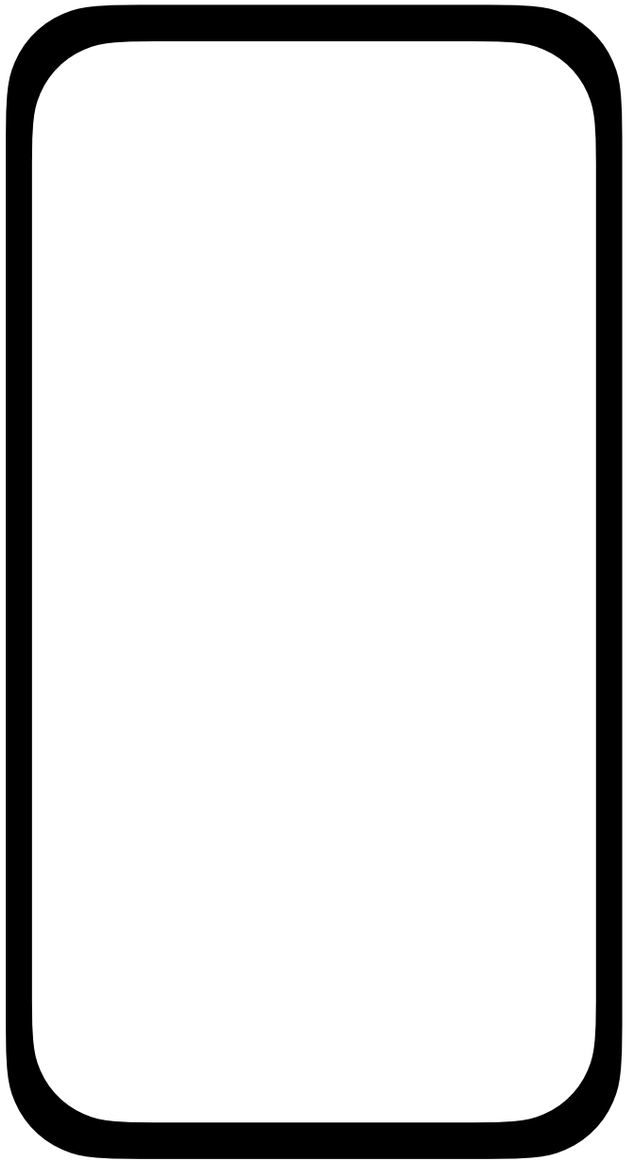


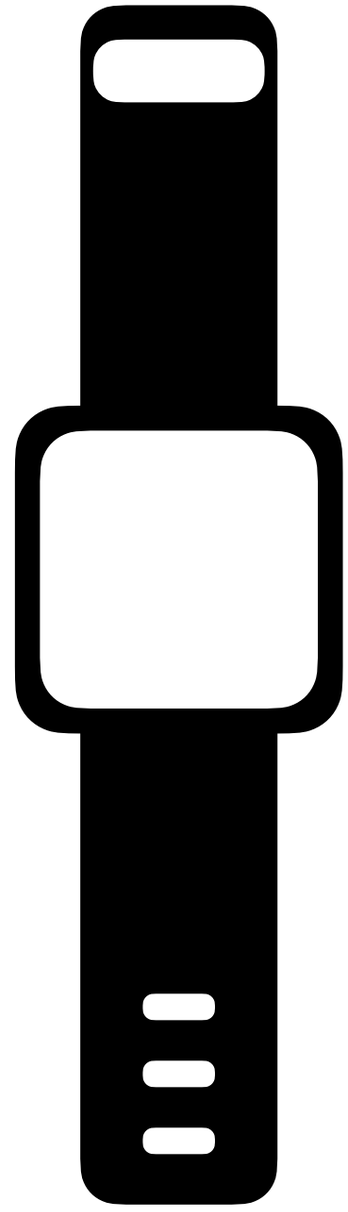
Image: Freepik.com



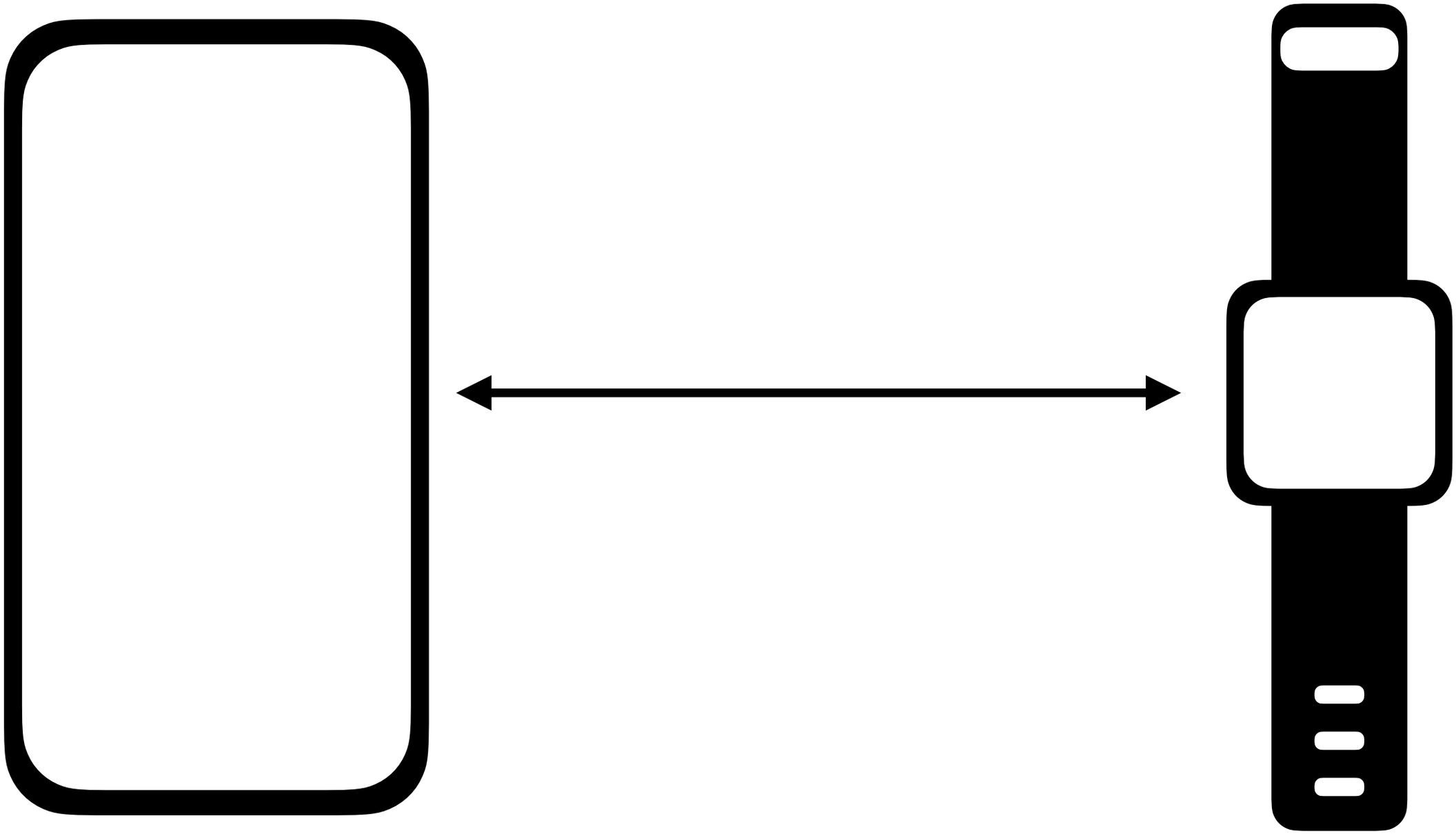




Central
GATT Client

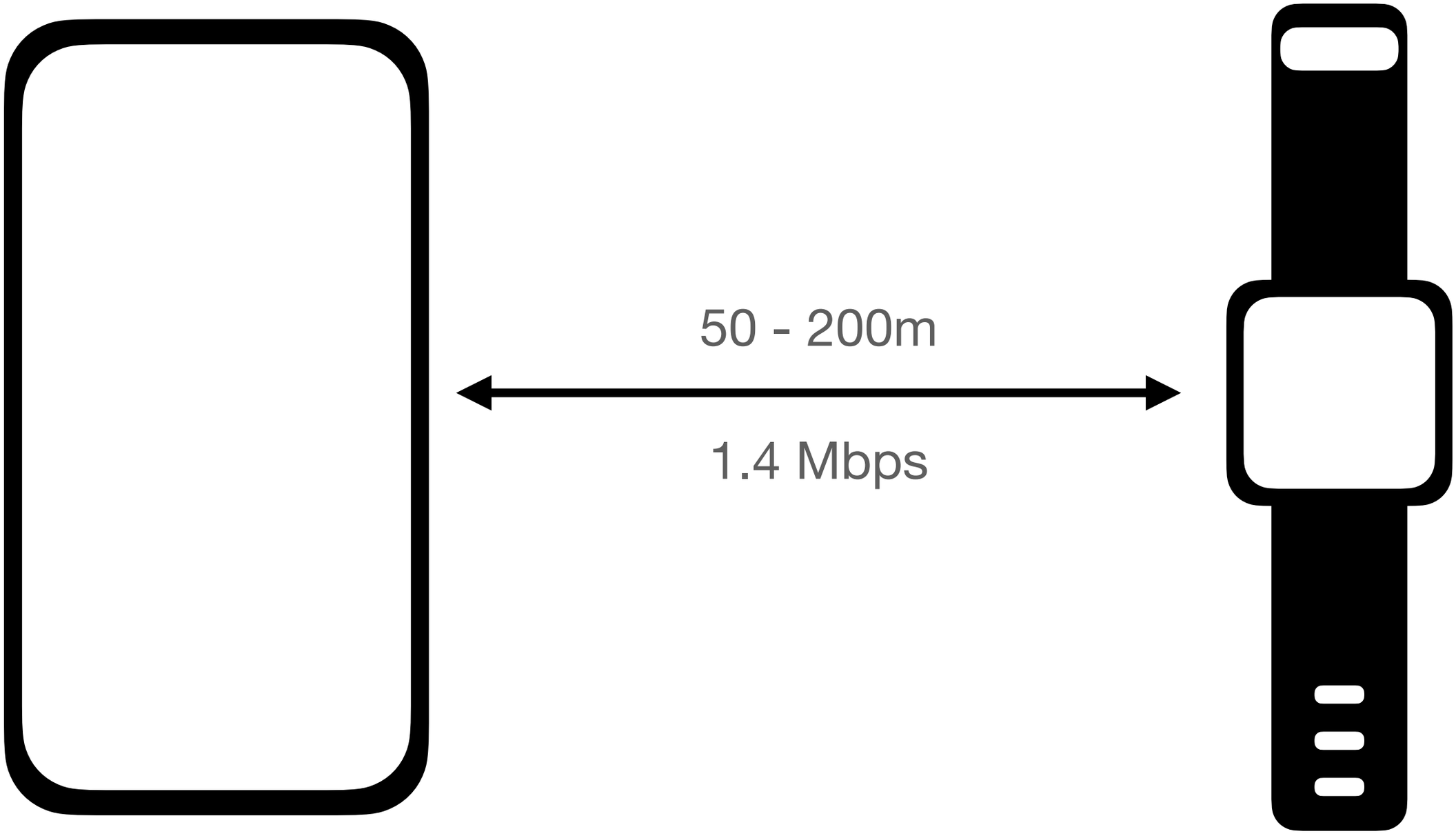


Peripheral
GATT Server



Central
GATT Client

Peripheral
GATT Server



Central
GATT Client

Peripheral
GATT Server

Demo

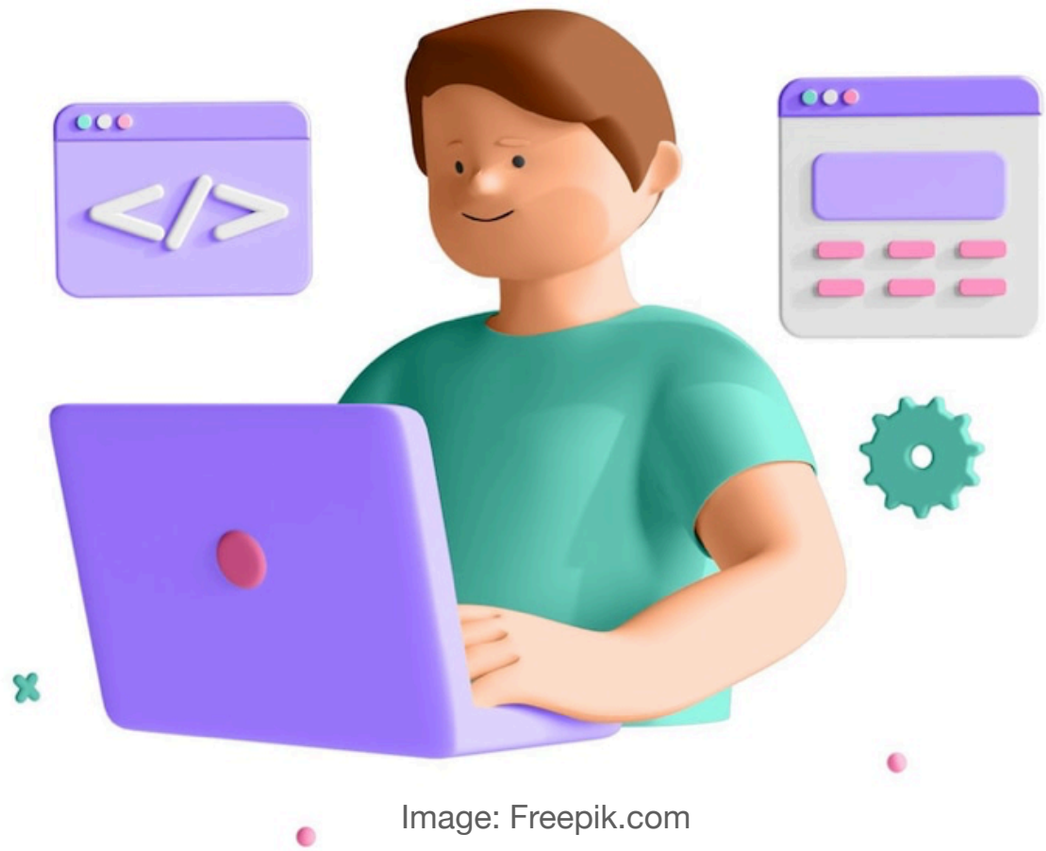


Image: Freepik.com

Temperature sensor

- Xiaomi LYWSD03MMC ~5-6 euros
    - Temperature & Humidity
- nRF Connect - mobile application

Peripheral

General flow

1. Declares and registers the structure of Generic Attribute Profile
2. Starts advertising
3. Accept connection(s)
4. a. Handle ATTRequests (read and writes)

   b. Sends notifications

https://github.com/vladcorneci/IoT-BLE-17-May

Central

General flow

1. Scans for peripherals
2. Establish connection
3. Discover Services and Characteristics (GATT profile)
4. a. Send ATTRequests (read and writes)

   b. Receive notifications

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