Introduction to BLE Technology

BLE = Bluetooth® Low Energy

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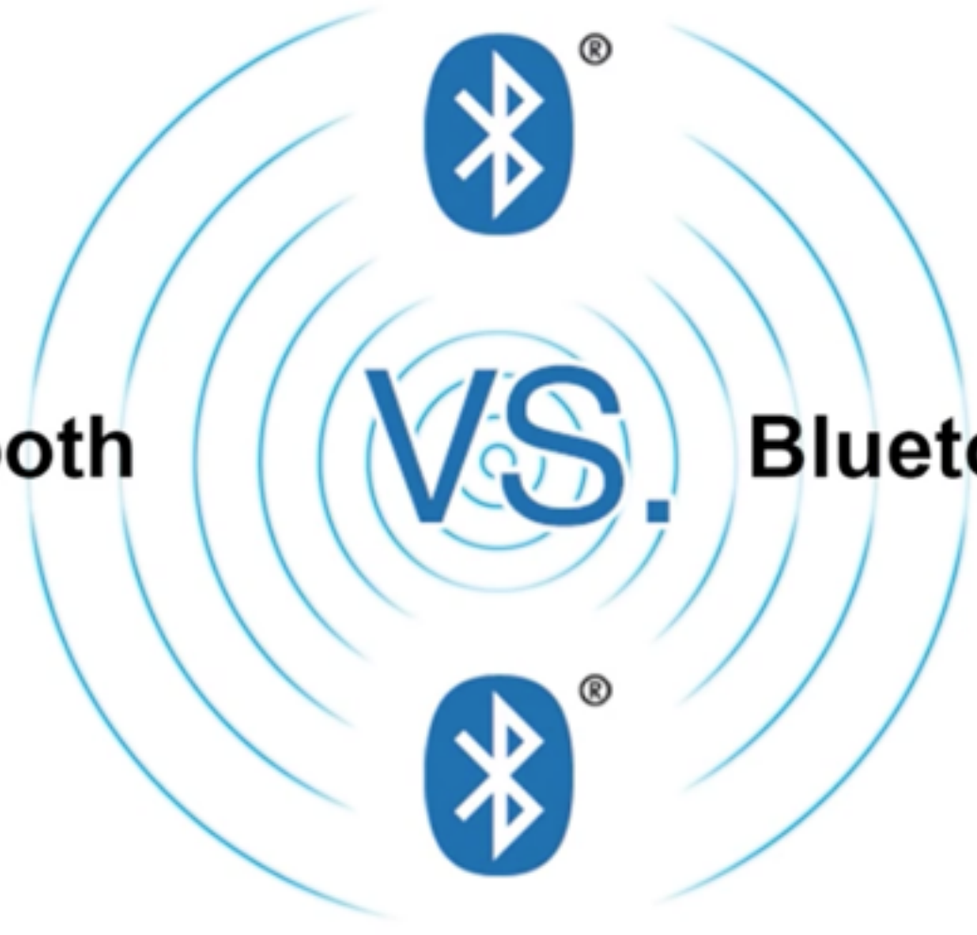
Summary

1 - Bluetooth Difference
2 - Bluetooth terms
3 - BLE Pioneer Kit Overview
4 - IoT Sensor-Based Systems
5 - PSoC 4 BLE and PRoC BLE
6 - GAP and GATT notions
7 - Demo
8 - My project

What is the bluetooth difference ?



Classic Bluetooth **Bluetooth low energy**

What is the bluetooth difference ?

Classic Bluetooth

- v2.1+EDR / v4.0
- Streaming data
- High data transfer rates
- Standard Bluetooth profiles (SPP, DUN, PAN)
- Up to 7 slaves

VS.

Bluetooth low energy

- v4.0
- Low data transfer rates
- Ultra low power consumption
- Connection times: few ms
- Profiles based on the Generic Attribute Profile (GATT)
- Large no of slaves
- Advertising functionality

What is the bluetooth difference ?

	Classic Bluetooth technology	Bluetooth low energy technology
Data payload throughput (net)	2 Mbps	~100 kbps
Robustness	Strong	Strong
Range	Up to 1000m	Up to 250m
Local system density	Strong	Strong
Large scale network	Weak	Good
Low latency	Strong	Strong
Connection set-up speed	Weak	Strong
Power consumption	Good	Very strong
Cost	Good	Strong

Bluetooth Terms

BLE Profile (Profile)

A Bluetooth specification that describes a set of operations and behaviors that devices use to communicate with one another

Ensures interoperability when two or more devices use a common Profile

For example, keyboards use the HID Profile and Heart Rate Monitors (HRMs) use the HRM Profile

Internet of Things (IoT)

An expansion of the Internet to include everyday physical objects such as thermostats

BLE Pioneer Kit Overview

The $49 BLE Pioneer Kit (CY8CKIT-042-BLE) contains:

BLE Pioneer Kit baseboard
Is compatible with Arduino™ and Digilent® Pmod™ hardware ecosystems Features onboard CapSense slider, RGB LED, push buttons and Cypress F-RAM Includes PSoC 5 for program and debug Supports 1.9 V, 3.3 V, 5 V and coin cell battery operation

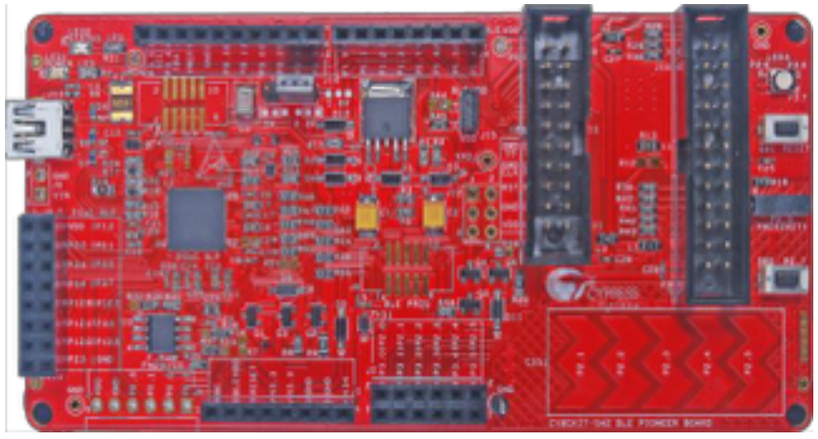
Modules[1]
Two FCC-certified[2] BLE modules that plug into the BLE Pioneer Kit Baseboard Feature an onboard antenna and provide access to all GPIOs
Support BLE-UART bridge via an onboard four-pin header

BLE-USB bridge with PRoC BLE
Enables the use of a PC to develop and debug BLE peripherals
Features an onboard LED, push button and PSoC 5 for program and debug

Mobile apps[3]
Include CySmart mobile apps[3] for both iOS and Android mobile operating systems to test and debug BLE systems

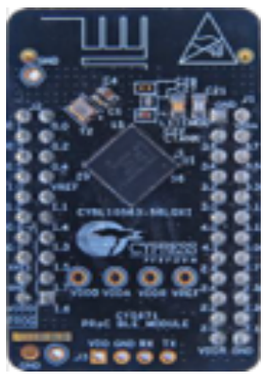
[1] Additional BLE modules are available, refer to the wrap-up section for more details
[2] Designation for products manufactured or sold in the U.S. that meet the electromagnetic interference standards of the Federal Communications Commission
[3] Mobile apps are software programs that run on a mobile device

BLE Pioneer Kit Baseboard



PSoC 4 BLE Module

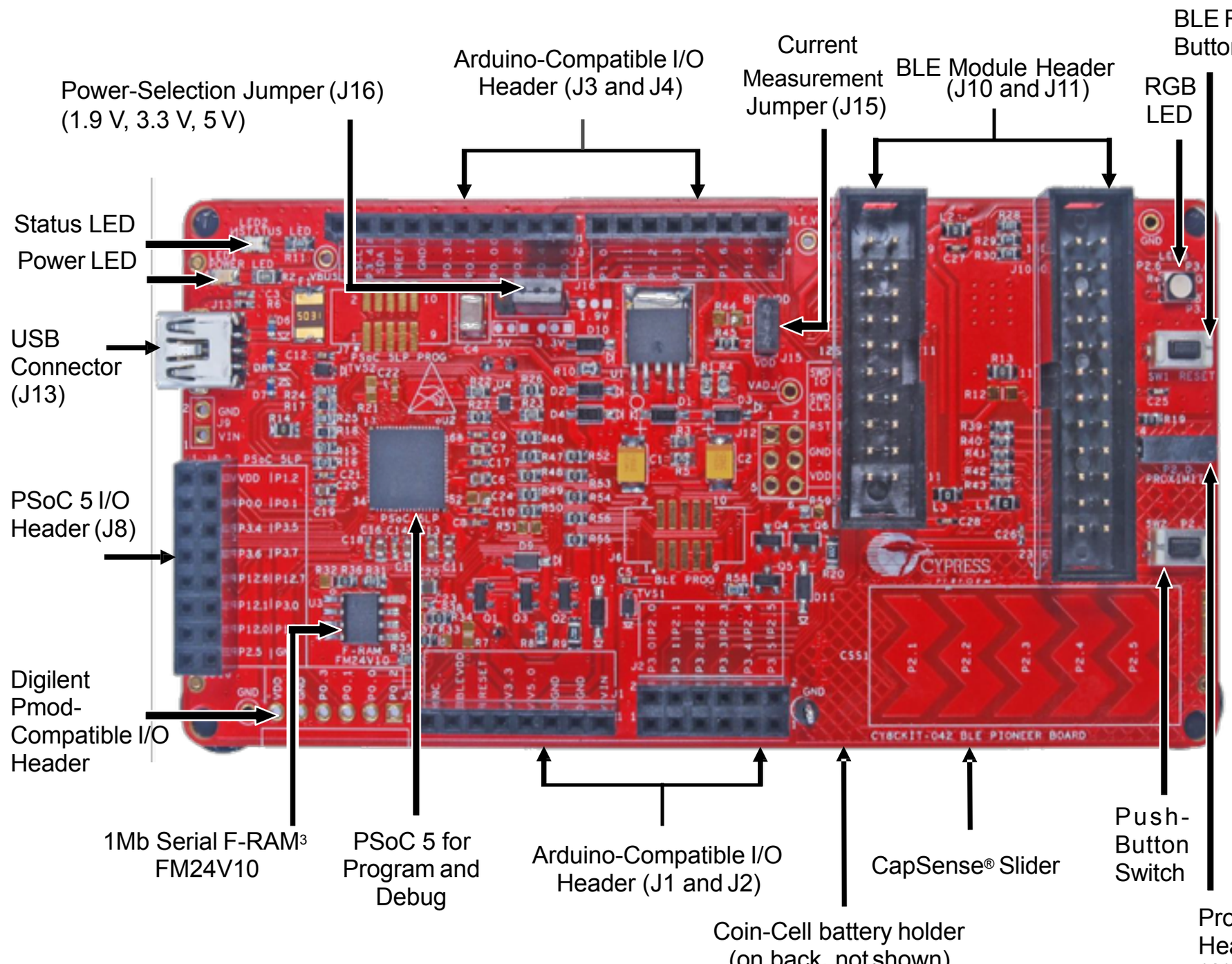
PRoC BLE Module



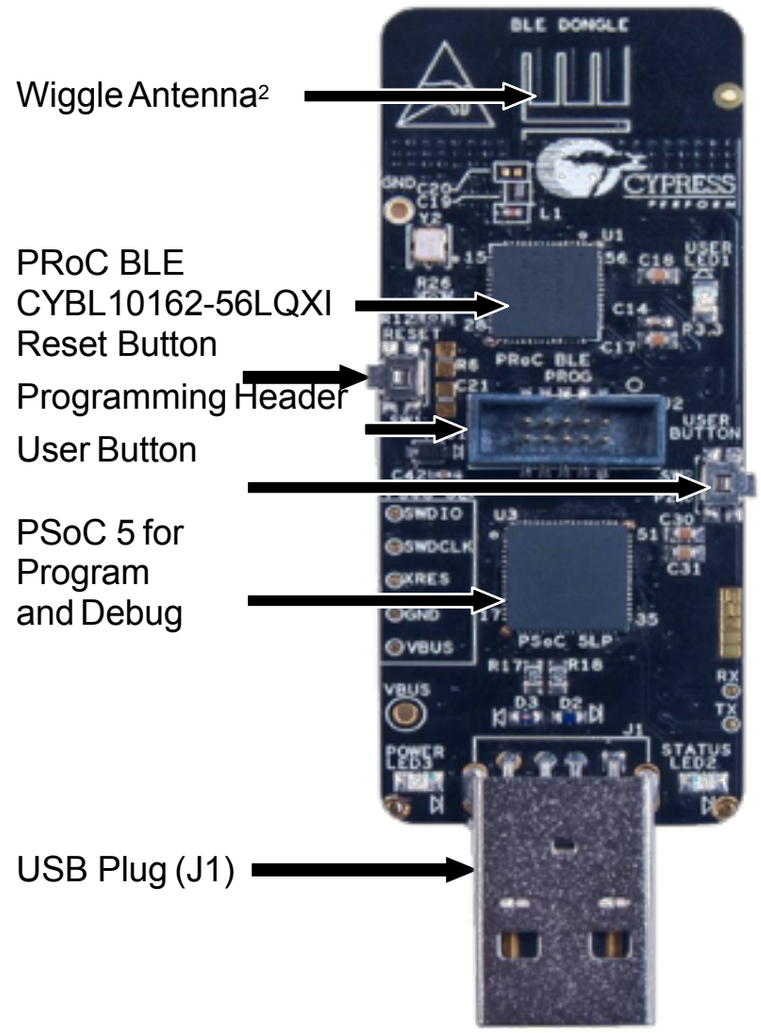
BLE-USB Bridge with PRoC BLE

BLE Pioneer Kit Baseboard and BLE-USB Bridge

BLE Pioneer Kit Baseboard to Develop a "GAP Peripheral[1]"



BLE-USB Bridge With PRoC BLE to Simulate a "GAP Central[1]"



BLE Pioneer Kit Supports PSoC 4 BLE and PRoC BLE

Feature	PSoC 4 BLE	PRoC BLE
Applications	IoT sensor nodes, wearables, small home appliances, home automation and portable medical devices	Mice, keyboards, trackpads, game controllers, remote controls, toys and BLE bridges
CPU Core	ARM Cortex-M0	ARM Cortex-M0
CPU Speed (MHz)	48	48
Flash/SRAM Sizes (KB)	128/16-256/32	128/16-256/32
ADC	1-Msps 12-bit SAR[1]	1-Msps 12-bit SAR[1]
Opamps	4	-
Comparators	2	-
IDACs	2	-
UDBs	4	-
Timers, Counters, PWMs	4/4/8	4/4/8
CapSense (I/Os)	Yes (36)	Yes (36)
I/Os	36	36
Serial Interfaces	4 SPI, 2 I²C, 4 UART, I²S	2 SPI/I²C/UART, I²S
Packages	56-QFN, 68-CSP	56-QFN, 68-CSP

PSoC 4 BLE Module

PRoC BLE Module

IoT Sensor-Based Systems

The Internet of Things (IoT) is now a commercial reality
The IoT is how everyday physical objects are connected to the Internet Fitness monitors are examples of new IoT devices

A thing, in the Internet of Things, can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low -- or any other natural or man-made object that can be assigned an IP address and provided with the ability to transfer data over a network.

Up3 Fitness Monitor by Jawbone

The newest Jawbone Up3 Fitness Monitor features a heart rate monitor, a touch-sensing interface and connectivity to mobile devices

Microsoft Band Fitness Monitor

Fitness monitors require:

A heart rate monitor (HRM)
Activity monitoring and a step counter BLE connectivity to a mobile device
A touch-based user interface Maximum battery life

GAP: Establishing a BLE Connection

Generic Access Profile (GAP)

Defines how BLE devices discover each other, establish a connection and interact based on their roles

A BLE device can operate in the following "GAP roles":

GAP Peripheral: Role in which a device, like a fitness monitor, connects to a **GAP Central** device, like a mobile phone **GAP Central**: Role in which a device, like a mobile phone, connects to a **GAP Peripheral** device, like a fitness monitor **GAP Broadcaster**: Role in which a device only advertises or transmits data[1]

GAP Observer: Role in which a device only listens or scans for devices[1]

Establishing a BLE Connection in Three Easy Steps

Bluetooth Smart-Ready Mobile Phone

1. **GAP Central** Scans for Peripherals ← **GAP Peripheral** Transmits Availability and Capabilities
2. **GAP Central** Initiates Connection → **GAP Peripheral** Accepts Connection
3. **GAP Central** Exchanges Data ↔ **GAP Peripheral** Exchanges Data

Bluetooth Smart Fitness Monitor

[1] GAP Broadcaster and GAP Observer roles are included for completeness but not used in the this introductory workshop. Refer to the Appendix slide for examples of GAP roles.

GATT: Defining How to Communicate

Generic Attribute Profile (GATT)
Defines the way that two BLE devices exchange data

A BLE device can operate in the following "GATT roles":
GATT Server: A device that receives requests and sends data, typically a **GAP Peripheral**, like a fitness monitor
GATT Client: A device that requests and receives data, typically a **GAP Central**, like a mobile phone

GATT Database (DB)
Stores and provides data
Runs in a GAP Peripheral and responds to read and write requests from both GAP Central and the GAP Peripheral itself

BLE Communicates via GATT DB Reads and Writes

GATT Client in a GAP Central
Like a Mobile App[2] on a Mobile Phone

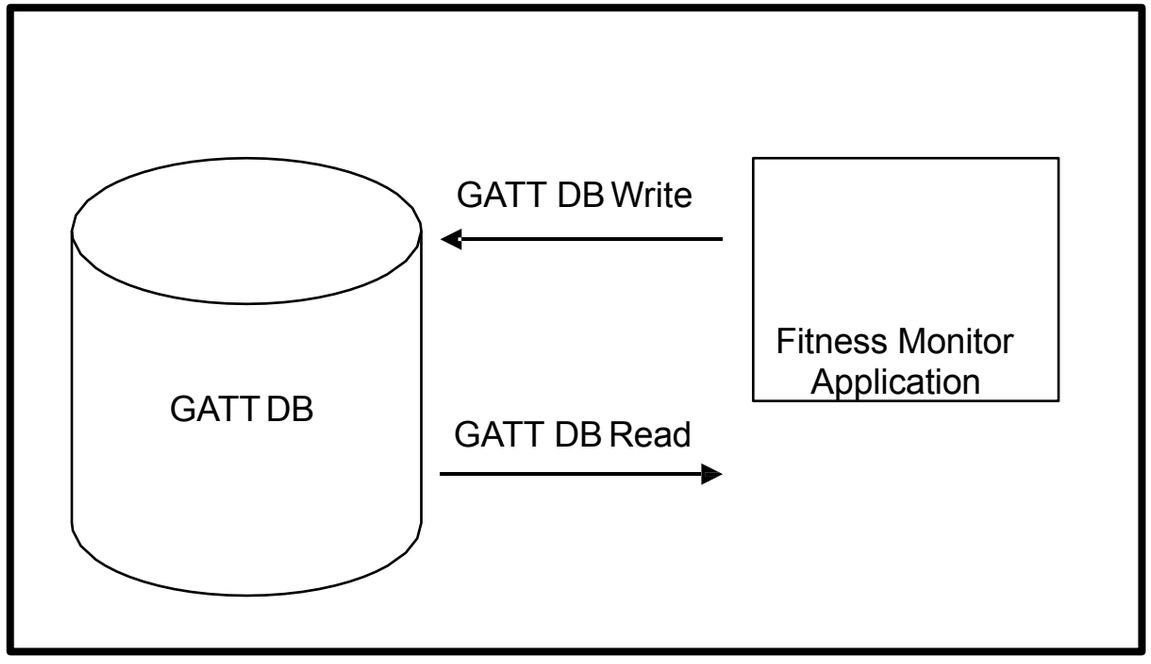
Bluetooth Smart-Ready mobile phone

GAP Peripheral

GATT DB Write →

← GATT DB Read

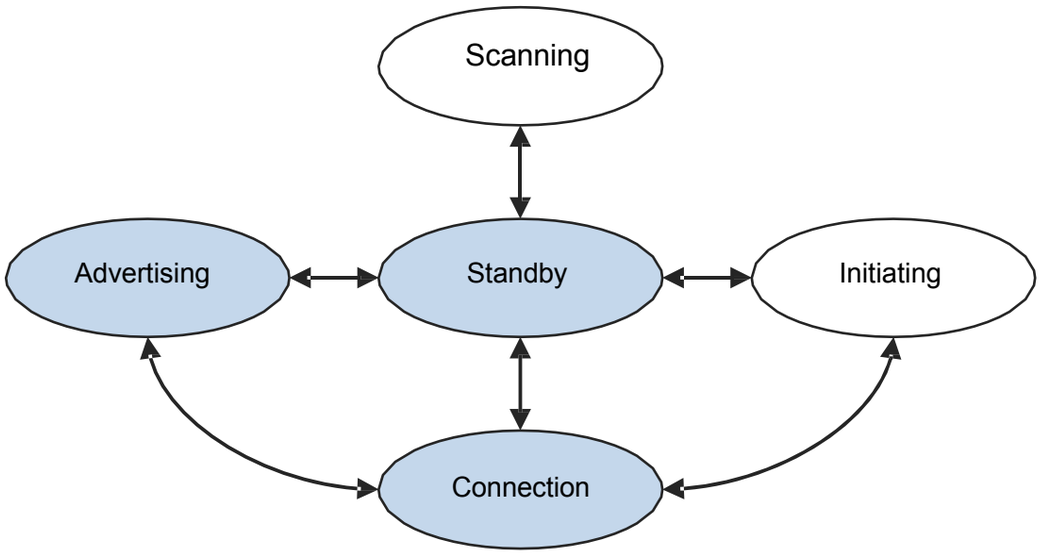
GATT Server in a GAP Peripheral
Like a Fitness Monitor Application



[1] Data that describes other data for the purposes of categorization
[2] Mobile apps are software programs that run on a mobile device

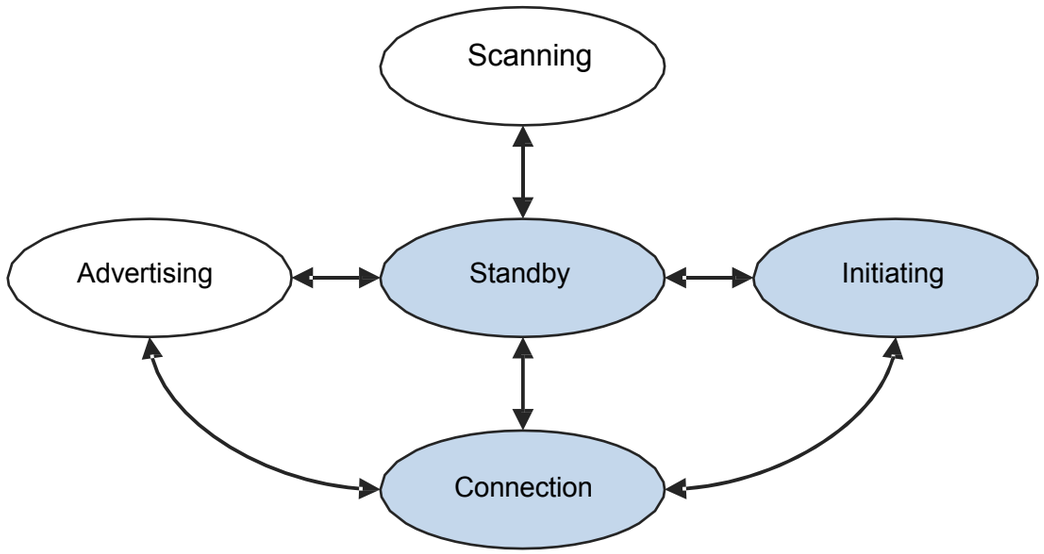
GAP: Example of GAP Roles

GAP Peripheral



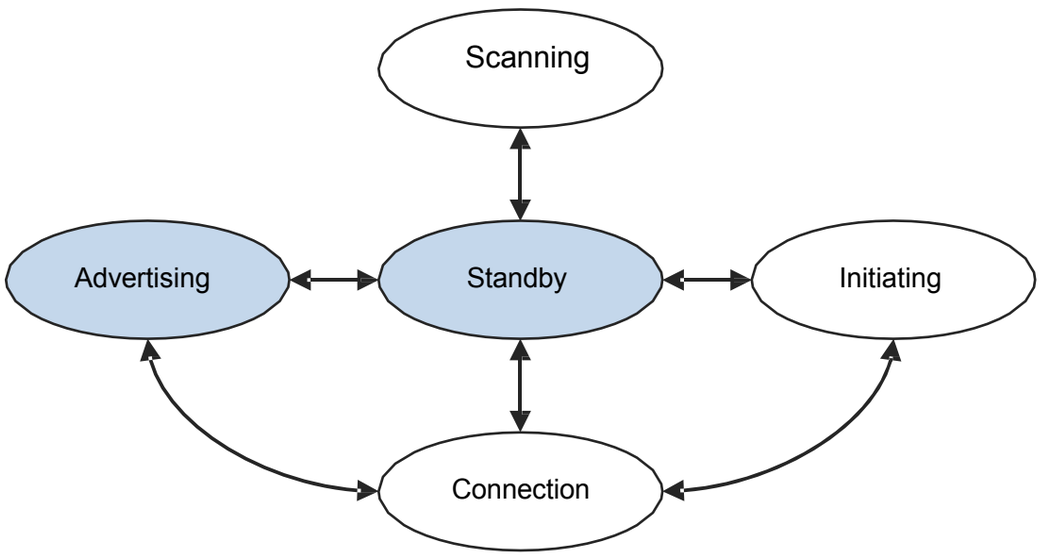
Advertises its capabilities and establishes connections

GAP Central



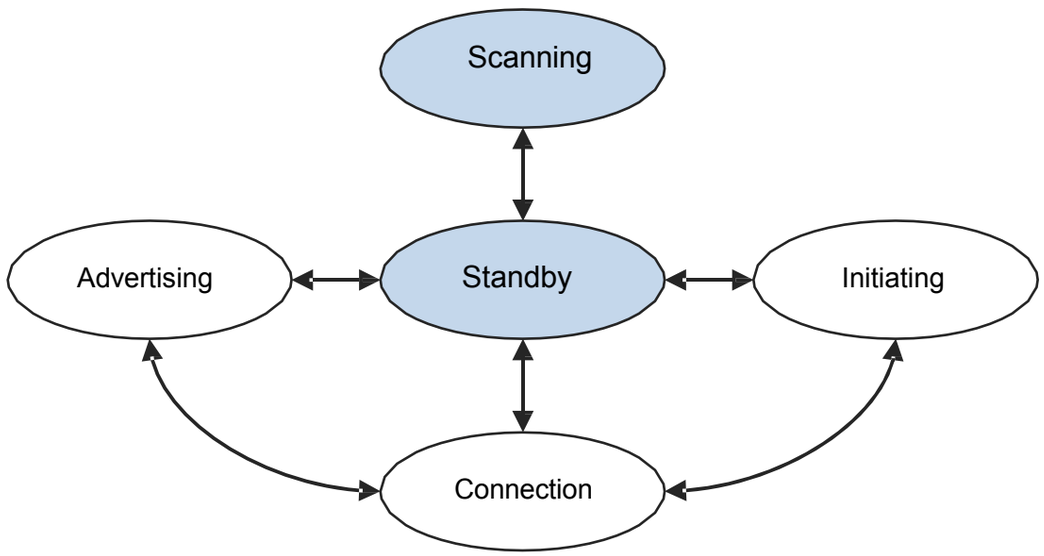
Scans for advertising devices and initiates connections

GAP Broadcaster



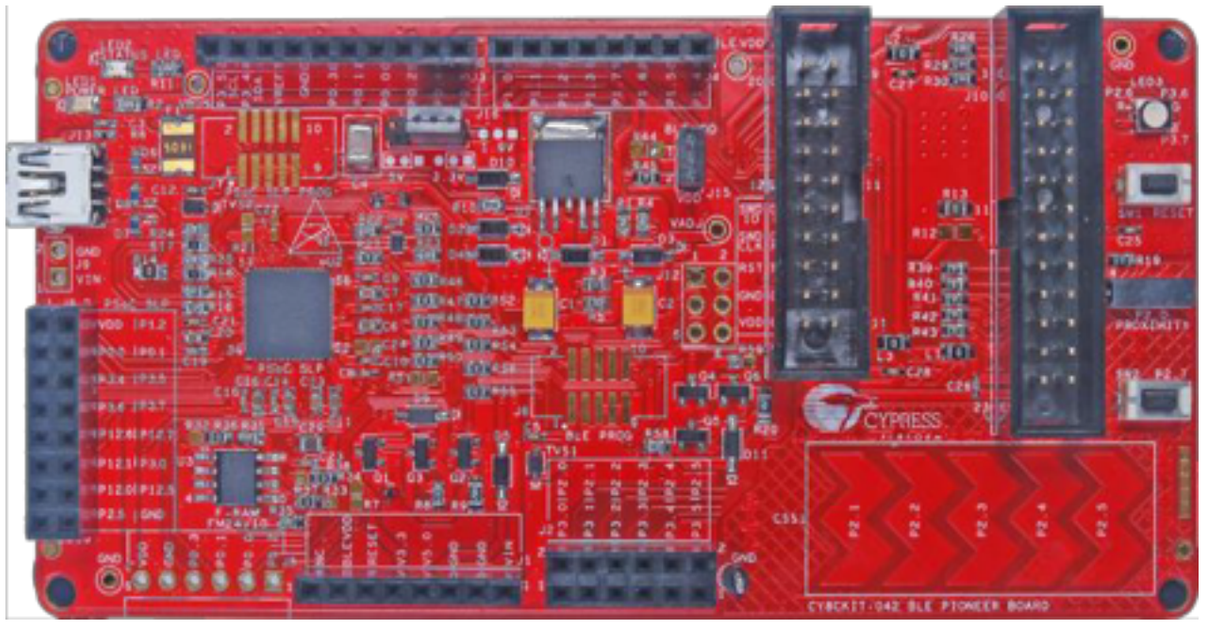
Advertises its capabilities only, does not establish connections

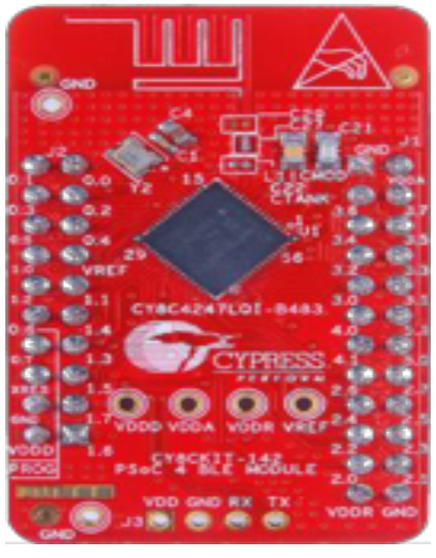
GAP Observer



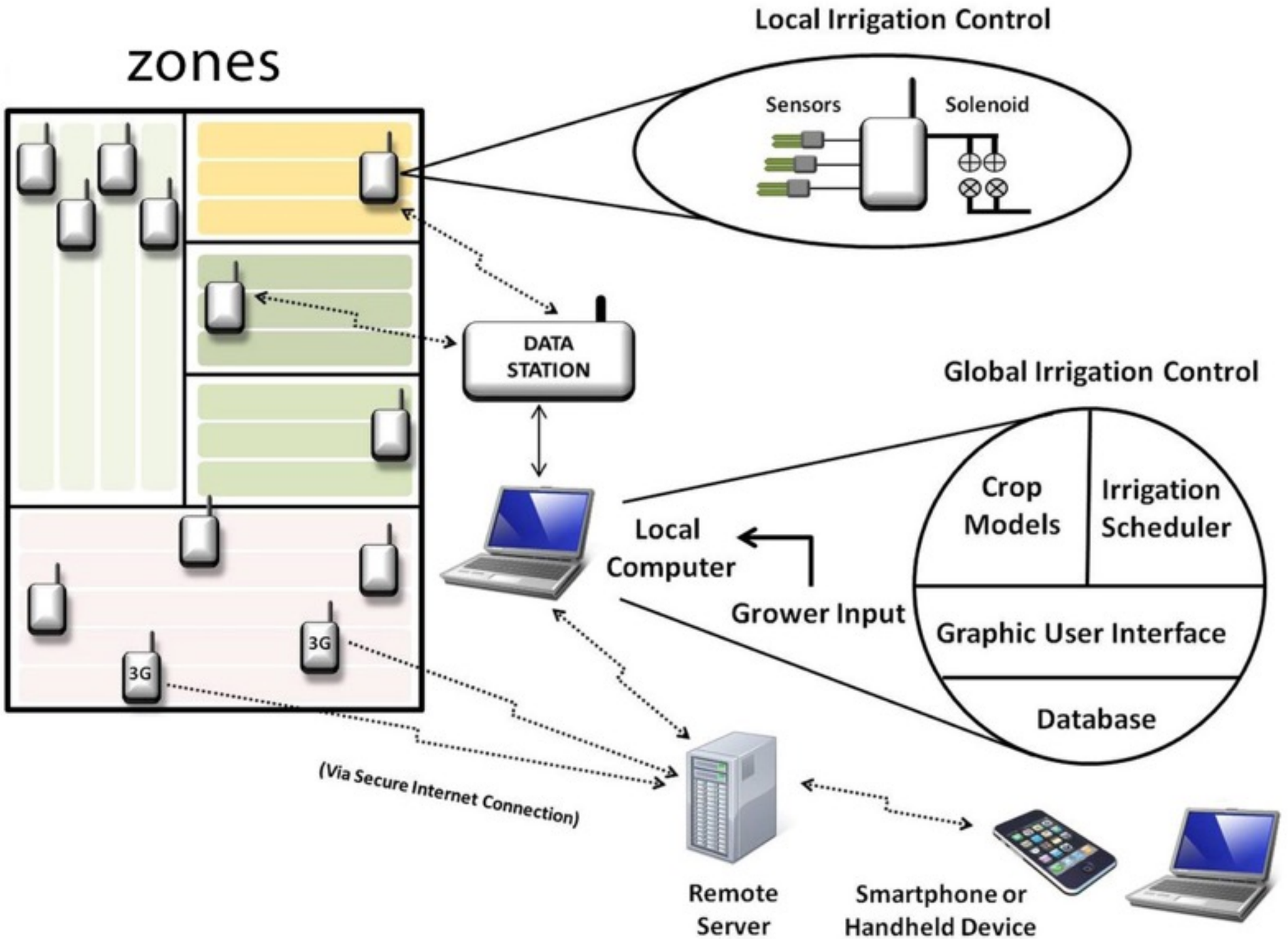
Scans for advertising devices only, does not establish connections

DEMO


CYPRESS
CY8CKIT-042 BLE PIONEER BOARD


CY8C4247LQI-BB83
CYPRESS
VDDD VDDA VDDR VREF
CY8CKIT-142
PSoC 4 BLE MODULE
VDD GND RX TX
VDDR GND

My Project


Local Irrigation Control
zones
Sensors
Solenoid
DATA STATION
Global Irrigation Control
Crop Models
Irrigation Scheduler
Local Computer
Grower Input
Graphic User Interface
Database
3G
3G
(Via Secure Internet Connection)
Remote Server
Smartphone or Handheld Device

Thank you for your attention

Introduction to BLE System Design

BLE = Bluetooth® Low Energy

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