

**HARDWARE
ACADEMY**

**Selecting the Right Wireless
Technology for Your
New Electronic Product**

Course Overview

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Lesson 2 – Bluetooth

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Lesson 1 – Wireless Introduction

- Larger range and higher bandwidth = Higher power
- Higher power = Bigger battery or lower battery life
- Select wireless technology with minimum required range and bandwidth
- Use pre-certified modules ideally with built-in antenna
- FCC certification requirements
- Mesh versus Peer-to-peer

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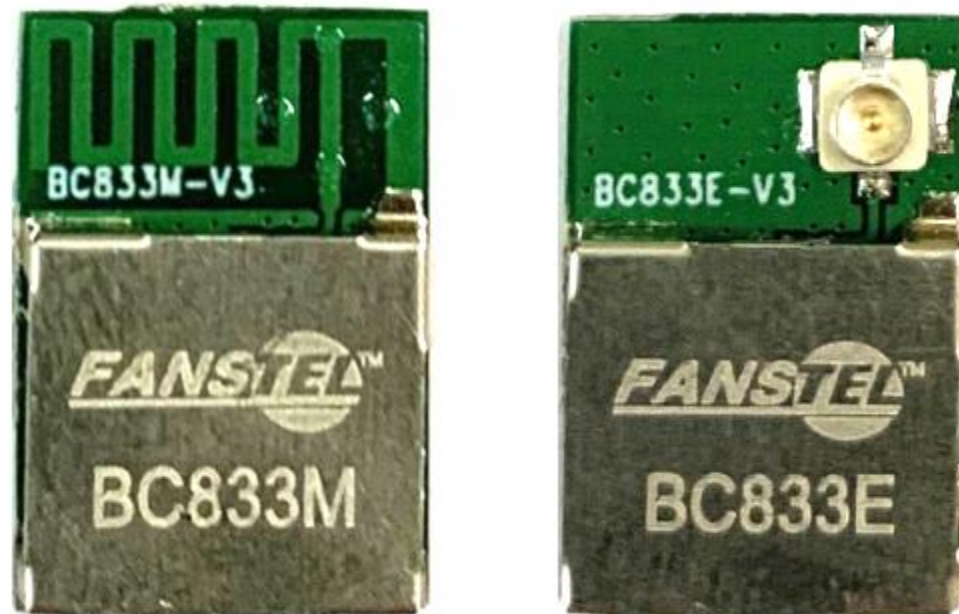
MODULE #1

Short/medium range wireless solutions

Lesson 2 – Bluetooth

- **Bluetooth Classic:** Peer-to-peer mainly used for streaming audio, wireless mice, etc. Moderate power consumption. 2-3 Mbps
- **Bluetooth Low-Energy (BLE 4.2):** Mesh used mainly used for IoT devices requiring very low power. 1 Mbps
- **Bluetooth 5.X:** Merges these two together into low-power solution with streaming audio over BLE. Twice the bandwidth of BLE @ 2Mbps.
- Range: 50m up to 1km line of sight

Lesson 2 – Bluetooth



Fanstel BC833M/E Bluetooth 5 / ZigBee modules based on Nordic nRF52833 SoC

Lesson 3 – WiFi

- **WiFi:** Local Area Network (LAN). 100-250 Mbps. 100m+ range
- **WiFi Direct:** Peer-to-peer version with same specs
- **WiFi Mesh:** Mesh network. Greater coverage area.
- **WiFi Now:** Proprietary ESP32 network similar to mesh for < 20 devices
- Power consumption: Moderately high
- Popular implementation solution: ESP32

Lesson 3 – WiFi



Espressif ESP32-WROOM-32 WiFi/Bluetooth module based on ESP32 SoC

Lesson 4 –NFC

- NFC = Near-Field Communication. Peer-to-peer communication.
- Uses electromagnetic fields shared between two coils
- Operating range is only about 1-2 inches. Frequency = 13.56MHz
- Subset of RFID technology used for identifying items
- Most common use for NFC is in contactless payment systems
- Extra secure because of short operating range
- Allows the use of passive NFC tags

Lesson 4 –NFC

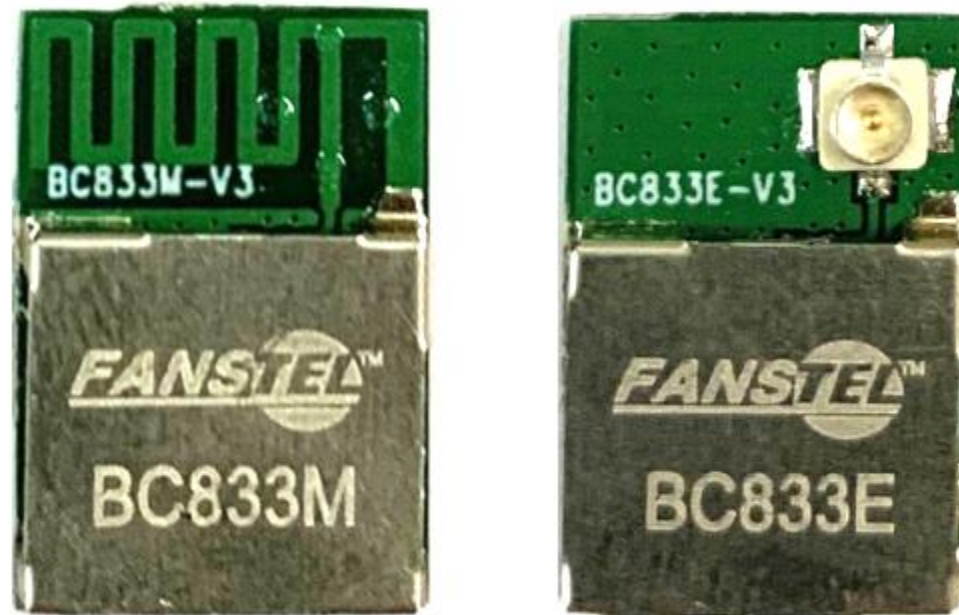


NFC module

Lesson 5 – ZigBee / Z-Wave / 6LoWPAN

- Low-power, low data-rate mesh technologies similar to Bluetooth 5
- ZigBee and Z-Wave especially popular for home automation
- ZigBee uses same 2.4GHz carrier frequency as Bluetooth
- Z-Wave uses a sub-1GHz carrier that varies for different countries. Also slower than Bluetooth or ZigBee.
- 6LoWPAN is a competitor to ZigBee but uses an IP-based network similar to WiFi
- In most cases go with Bluetooth 5

Lesson 5 – ZigBee / Z-Wave / 6LoWLAN



Fanstel BC833M/E Bluetooth 5 / ZigBee modules based on Nordic nRF52833 SoC

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MODULE #2

Long range wireless solutions

Lesson 6 – GSM / GPRS

- In the past the most common cellular technology
- Low cost modules available
- Low cost and low power made this a popular choice for low speed applications
- Being phased out so not viable for new products

Lesson 6 – GSM / GPRS

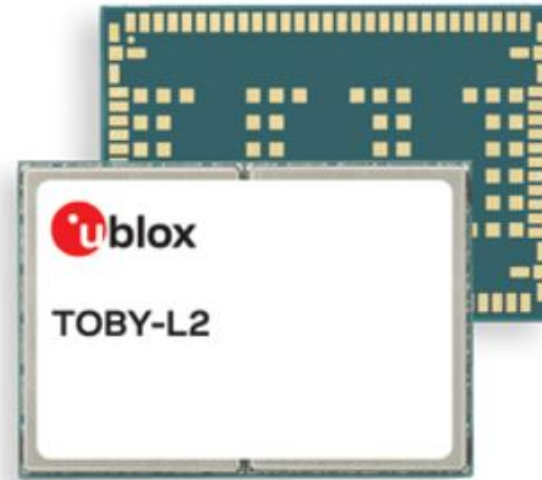


SimCom SIM800 GPS/GRPS module

Lesson 7 – LTE

- 4G cellular technology
- Much more expensive than GSM (~5x)
- LTE data rate: 10 Mbps (LTE Cat 1)
- LTE data rate: 150 Mbps (LTE Cat 4)
- LTE is too expensive for many applications
- Most applications don't require high LTE data rate

Lesson 7 – LTE

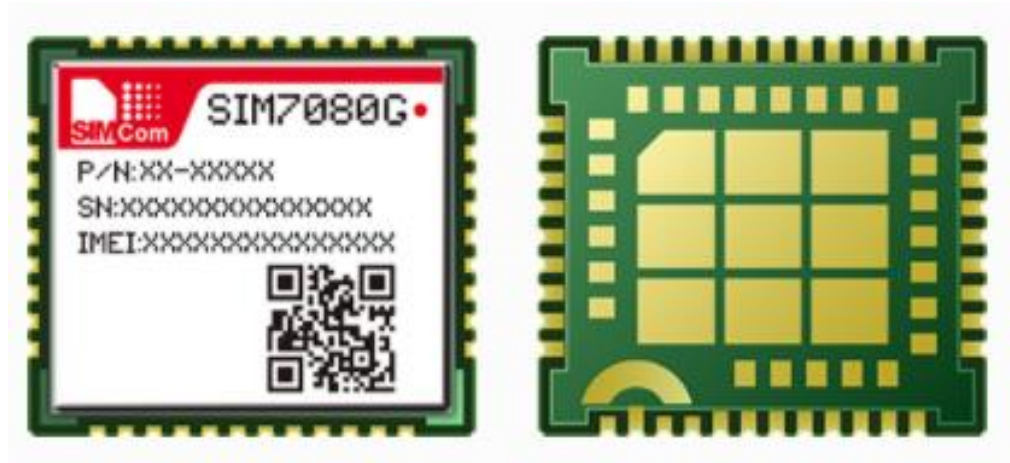


ublox TOBY-L2 LTE Cat4 module

Lesson 8 – LTE-M

- For lower power and/or lower cost products with lower data rates use LTE-M (LTE Cat-M)
- LTE-M requires less complex hardware = significantly lower cost than LTE
- LTE-M1 data rate: 1 Mbps
- LTE-M2 data rate: 4 Mbps
- Power consumption: Medium

Lesson 8 – LTE-M



SimCom SIM7080G LTE-M Module (also supports NB-IOT)

Lesson 9 – NB-IOT

- NB-IOT (LTE Cat-NB) is a cellular technology
- Much lower data rate than LTE-M
- Less power consumption than LTE-M
- Data rate: ~25 kbps (Cat-NB1)
- Data rate: ~125 kbps (Cat-NB2)
- Not for voice/audio streaming

Lesson 9 – NB-IOT

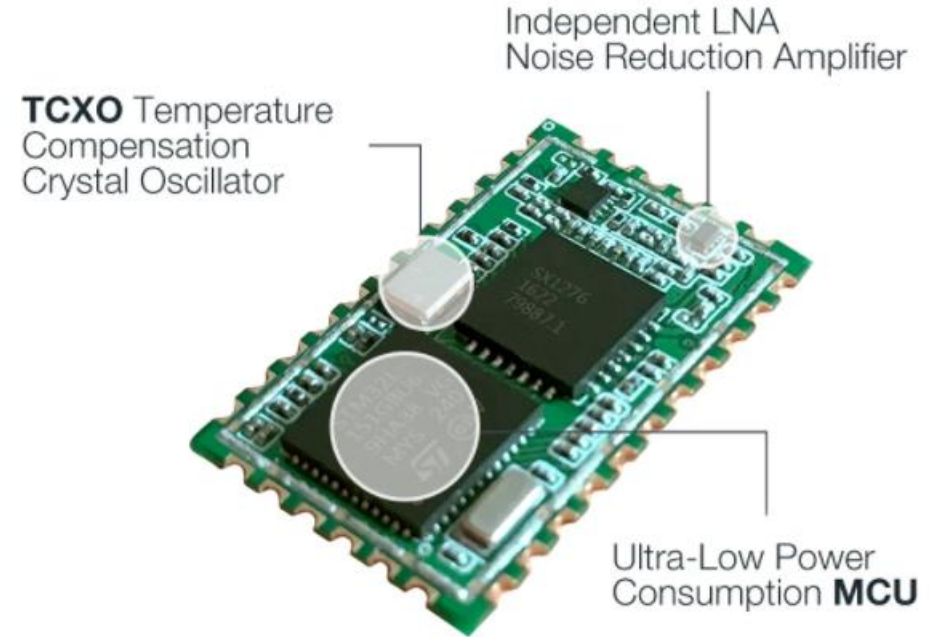


SimCom SIM7060R NB-IOT module

Lesson 10 – LoRa/LoRaWAN

- LoRa is short for Long-Range and can operate over a few miles
- Not a cellular technology like LTE-M or NB-IOT
- High range, low data rate (~27 kbps), and low power consumption
- LoRa is the lower level technology. Peer-to-peer communication.
- LoRaWAN is the upper layer networking protocol
- LoRa modules are cheaper, LoRaWAN modules are more expensive.
- Different carrier frequencies depending on region: 915 MHz for North America, 868 MHz for Europe, 923 MHz for Asia.

Lesson 10 – LoRa/LoRaWAN



RAK811 LoRaWAN module

Lesson 11 – Final Advice & Suggestions

- Most products will use Bluetooth 5 or WiFi
- Products requiring cellular connectivity will use LTE-M or NB-IOT
- Special applications may need LoRa/LoRaWAN or NFC
- Home automation products may use ZigBee, Z-Wave, or 6LoWAN, but most will still use Bluetooth 5.
- GSM is outdated and not recommended. Instead look at LTE-M or NB-IOT
- 2.4GHz carrier frequency is for worldwide use. Other carrier frequencies vary by region.

Lesson 11 – Final Advice & Suggestions

	Bluetooth 5	WiFi	LTE	LTE-M	NB-IOT	LoRa(WAN)
Range	50m to 1km	100m+	Cellular	Cellular	Cellular	~10km
Speed	2 Mbps	100-250 Mbps	10-150 Mbps	1-4 Mbps	25-125 kbps	Up to 27 kbps
Power	Ultra-low	Moderate	High	Moderate	Lower	Low
Cost	Ultra-low	Ultra-low	High	Moderate	Lower	Low

Lesson 11 – Final Advice & Suggestions

- Low power, short range, moderate speed, peer-to-peer/mesh = Bluetooth 5
- High power, medium range, high speed, gateway/peer-to-peer/mesh = WiFi
- High power, long range, high speed, higher cost, cellular = LTE
- Medium power, long range (cellular), moderate speed, lower cost = LTE-M
- Low power, long range (cellular), low speed, lower cost = NB-IOT
- Lower power, long range (non-cellular), low speed, lowest cost = LoRa/LoRaWAN