Wireless for Mobile Robots

Followed by Bluetooth LE

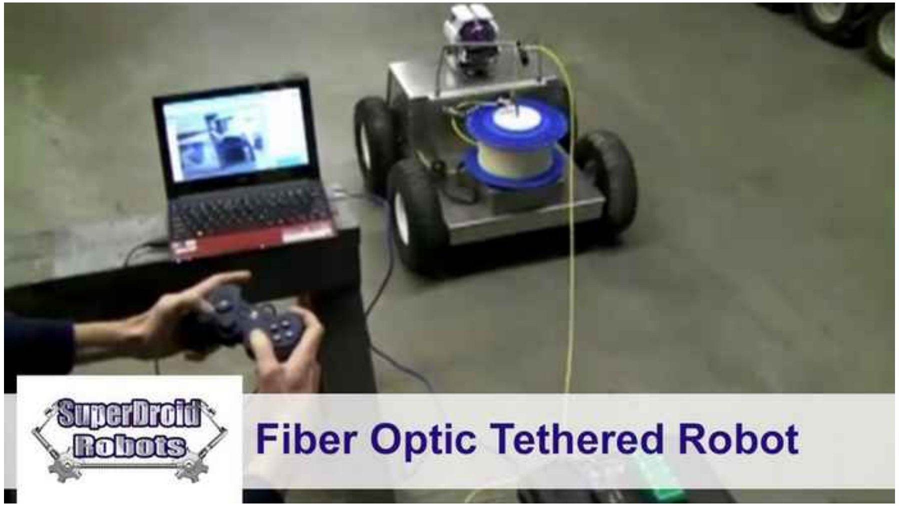
Rob Probin, May 2022

Serial – Wired, Fibre or USB

- **Advantages: Simple, reliable, fast speeds, low power**
- **Disadvantage: The wire!**

- However - thin 2 / 3-wire to target
  - Limited movement…
  - Or fibre optic?

- GND + RX (logging only)
  - Or logging to local memory?
- GND + RX + TX (control)

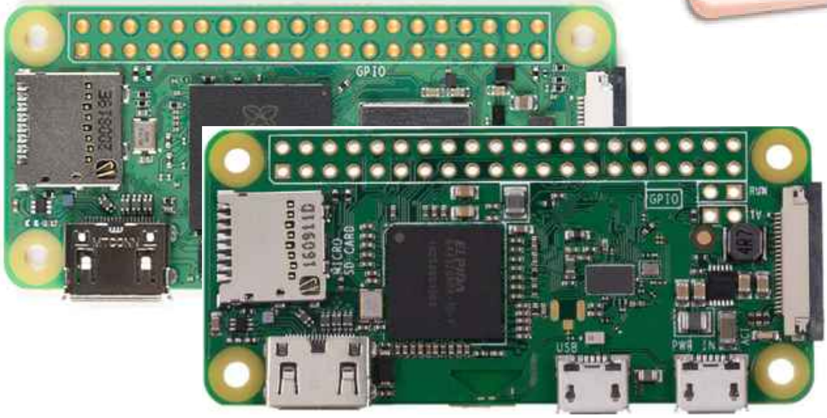


Wi-Fi

- Advantage: High speed, potentially multiple connections, Flexible
- Disadvantages: Complex, cost, size, power

- ESP8266 and ESP32 – as a co-processor
  - Alternatively: even ESP8266 has a Forth
- Excellent on Linux, e.g. Raspberry Pi
  - Easier than BT/BLE for setup

- Access point mode
- Connect to laptop shared internet
- Connect to AP/router/existing network(s)



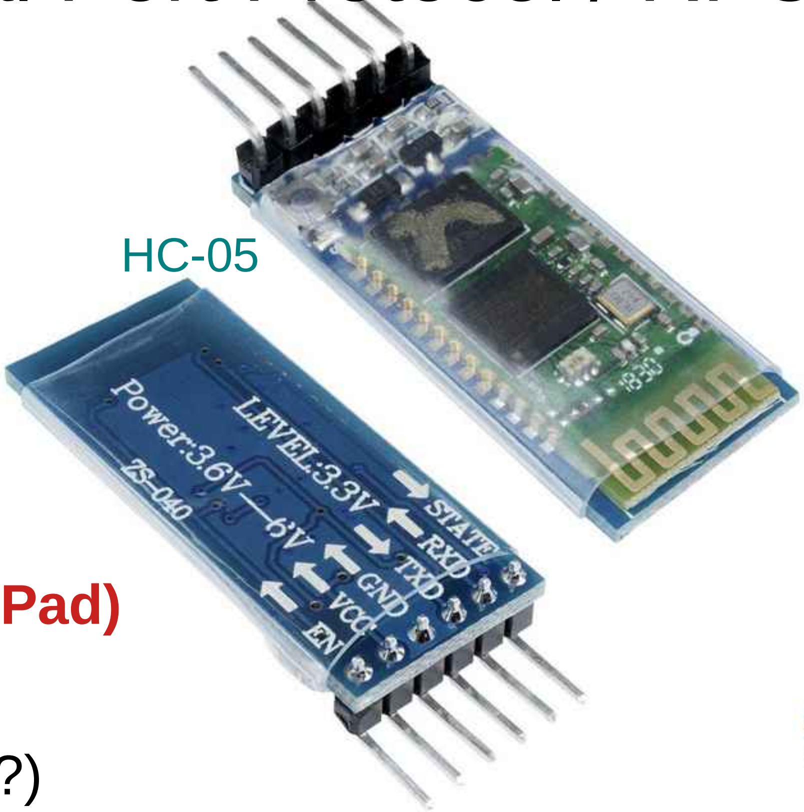
Pi Zero W & 2 - camera i/f + Wi-Fi / BT

ESP-03 17.3 × 12.1 mm

Bluetooth Classic
Serial Port Protocol / RFCOMM

- Advantages
  - Reliable
  - Good speeds
  - widely supported
  - reasonable speed
  - works REALLY well
- Disadvantages
  - **No iOS (no iPhone/iPad)**
  - Power (~?)
  - Considered old tech(?)

HC-05



Waveshare
Pico
Dual-Mode BT

Bluetooth LE

- Advantages: iOS, device-to-device, all new low-end MCUs, lower power, lower latency
- Disadvantage: Not a serial protocol, more complex, speed can be variable
    - *Theoretically* 50KBytes/s
    - More realistically < 10KBytes/s with BLE 4.2+ (using DLE)
    - Some items don’t have DLE which means some devices have trouble managing 9600 baud!
    - Not designed for speed, but small RF transmissions

Bluetooth LE

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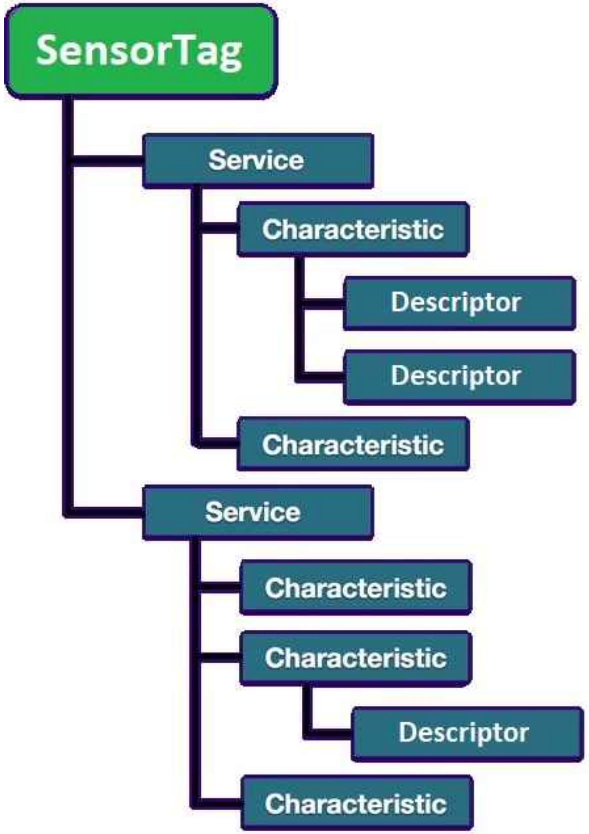
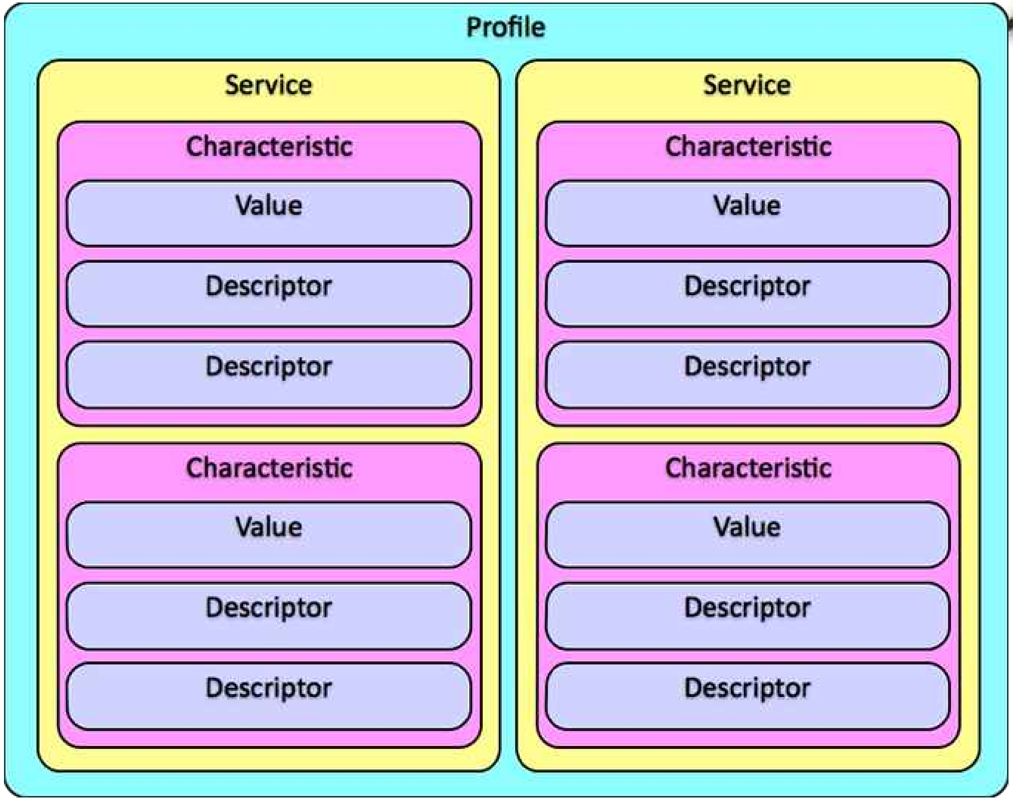
What is Bluetooth Low Energy



- **NOT** A SERIAL PROTOCOL – at all
- Each characteristic is like a shared variable
  - Read
  - Write
  - Notify (on change)
  - Indication (ACK)

What is Bluetooth Low Energy



Profile

Service

Characteristic

Value

Descriptor

Descriptor

Characteristic

Value

Descriptor

Descriptor

Service

Characteristic

Value

Descriptor

Descriptor

Characteristic

Value

Descriptor

Descriptor

Using BLE

- Programming Options
  - BLE as serial adapter
  - Use characteristics to define device ‘variables’
  - Mixture of two ← this is interesting

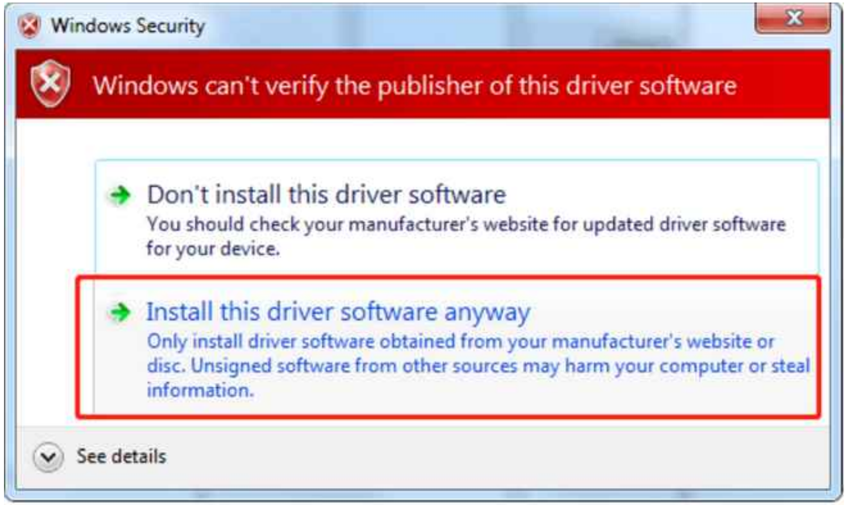
BLE Serial 'adapter'

- Use one or two characteristics for send and receive

- Two options:

  1) Install 'driver'

     - Long term support?
     - Crashes?
     - All operating systems?



Windows Security

Windows can't verify the publisher of this driver software

Don't install this driver software
You should check your manufacturer's website for updated driver software for your device.

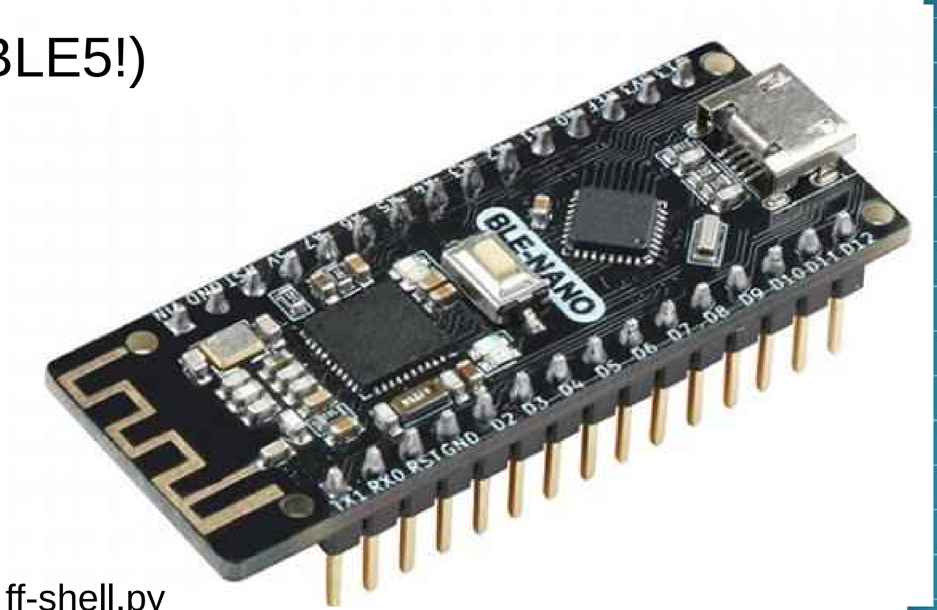
Install this driver software anyway
Only install driver software obtained from your manufacturer's website or disc. Unsigned software from other sources may harm your computer or steal information.

See details

  2) Talk directly to BLE characteristics – **not hard**

Example 1: BLE Serial on BLE-Nano

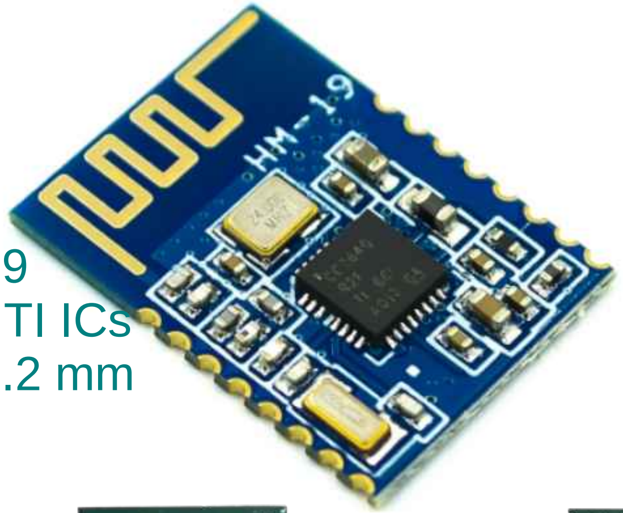
- ATMEGA328P + TI cc2540
- TI cc2540 acts as BLE Serial ‘adapter
- “Ble-Nano is bluetooth4.0”
  - (But actually cc2540 can support BLE5!)
- AT directive to configure BLE
- 20 bytes / packet
- Trouble keeping up
  - e.g. FlashForth ‘words’



WIP: https://github.com/robzed/FFControlPanel, like e4thcom, ff-shell.py

Example 2: BLE Serial Modules

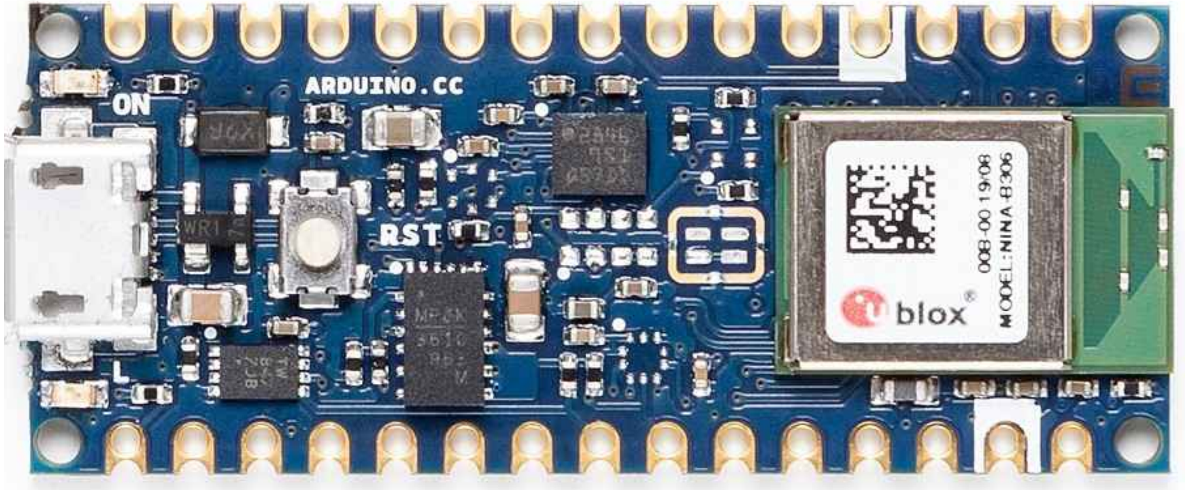
- Small Form factor BLE
  - acting as a serial interface
- Nordic devices
  - Tend to use ‘NUS’
    - = Nordic UART service
- TI devices
  - Use arbitrary characteristics
  - Not hard to reverse engineer
  - Mostly published



HM-19
based on TI ICs
18 * 13 * 2.2 mm

Fanstel BT832
based on Nordic ICs

Example: Arduino Nano 33 BLE



Ublox Nina B306
available separately
15 x 10 x 2.23 mm

- Based on the uBlox Nina B306
  - Module containing a Nordic chip
- Available in standard and Sense version
- Underlying Arduino is mbedTLS … so C-based Forth to leverage stack

BLE Characteristics on Arduino Nano 33 BLE

C Programming

https://github.com/robzed/LED_Display2/blob/master/led_display2/led_display2.ino

Forth Programming

- pForth with patched through BLE setup
- https://github.com/robzed/Nano_33_BLE_Forth

Questions?