### Suitable systems

Below are several chips and developments boards considered for the project plus a short description of their pro’s and con’s and suitability for the task at hand.

Note prices are taken from <https://uk.farnell.com> on the 23/2/2019 unless otherwise specified.

### CC2640R2F

This is an ultra-low power microcontroller (cortex m3) and RF system on a single chip, it is designed specifically to be capable of running on a coin cell battery or via an energy harvesting device (Texas Instruments, 2019). The wireless capabilities include Bluetooth 4.3 and Bluetooth 5le connected to an ultra-low power sensor controller (based on a cortex m0) this is designed to run independently of the main cortex m3 processor allowing for extremely low power consumption while the main processor is in sleep states.  
The cost of this chip is approximately £4.07 per chip and the development kit (Launchpad) is £23.55 and is available immediately.

* Wide Supply Voltage Range
  + Normal Operation: 1.8 to 3.8 V
  + External Regulator Mode: 1.7 to 1.95 V
* Active-Mode RX: 5.9 mA
* Active-Mode TX at 0 dBm: 6.1 mA
* Active-Mode TX at +5 dBm: 9.1 mA
* Active-Mode MCU: 61 µA/MHz
* Active-Mode MCU: 48.5 CoreMark/mA
* Active-Mode Sensor Controller: 0.4mA + 8.2 µA/MHz
* Standby: 1.1 µA (RTC Running and RAM/CPU Retention)
* Shutdown: 100 nA (Wake Up on External Events)

### NXP-QN908X

QN908x is an ultra-low-power, high-performance and highly integrated Bluetooth Low Energy solution for Bluetooth® Smart applications such as sports and fitness, human interface devices, and app-enabled smart accessories. It is specially designed for wearable electronics with a small capacity battery.(NXP products, 2019). This chip is based around the Cortex®-M4F microcontroller and is capable of providing floating point operations as denoted by the ‘F’ postfix and provides Bluetooth Low Energy support.   
This chip is based on a single CPU design and as such requires its main CPU to be active in order to use its Bluetooth functionality.  
The cost of this chip is approximately £4.52 and the development platform (QN9080-DK) is £88.93 but is currently out of stock.

* Single 1.8 V ~ 3.6 V power supply
* 1 µA deep sleep mode
* 2 µA sleep mode (32-kHz OSC/RTC on)
* 3.5 mA RX current with DC-DC at 3 V supply
* 3.5 mA TX current @0dBm Tx power with DC-DC at 3 V supply

### NXP-QN902X

QN902x is an ultra-low power, high-performance and highly integrated Bluetooth LE solution. It is used in Bluetooth Smart applications such as sports and fitness, human interface devices, and app-enabled smart accessories. It is specially designed for wearable electronics and can run on a small capacity battery such as a coin cell battery(NXP products, 2019).   
This MCU is designed around Cortex® M0 design and also provides Bluetooth Low Energy support.   
The cost of this chip is approximately £3.95 and the development platform (QN9020DKUL) is £37.40 but is again unavailable at the time of research.

* Single power supply of 2.4 V to 3.6 V for QN9020/1
* Single power supply of 1.8 V to 3.6 V for QN9022
* Integrated DC-to-DC converter and LDO
* 2 μA deep sleep mode
* 3 μA sleep mode (32 kHz RC oscillator on)
* 9.25 mA RX current with DC-to-DC converter
* 8.8 mA TX current @0 dBm TX power with DC-to-DC converter

### Comparison

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Chip | Architecture | Power Consumption | RF support | Cost for chip | Cost for development |
| CC2640R2F | Cortex® M3 + Cortex® M0 components |  | Bluetooth 4.3, Bluetooth 5 low energy | £4.07 | £23.55 |
| NXP-QN908X | Cortex®-M4F |  | Bluetooth 5 low energy | £4.52 | £88.93 |
| NXP-QN902X | Cortex®-M0 |  | Bluetooth 5 low energy | £3.95 | £37.40 |

### Hardware decision

The decision for what MCU to use was almost made for us due to time/availability constraints, with the only device both available and at a reasonable cost being the TI CC2640R2F. In actuality the NXP-QN902X may have been the better choice as its simpler design based on a Cortex M0 is likely to yield minor power efficiency advantages however the larger costs of the development kit and at the time of research being unavailable made the CC2640R2F the better choice. The NXP-QN908X was largely ruled out due to its very high development cost, also being based on a Cortex M4 means its computational power is fay beyond what is required – its inclusion of a floating-point math coprocessor as denoted by the ‘F’ part of Cortex M4F is also an addition that would be unused in this project.  
An advantage of using the TI CC2640R2F allows for usage of Texas Instruments own Eclipse based ‘Code Composer Studio’ development environment which we already have some experience with.

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