A Low-Cost, Modular, Open Source Datalogging System

Thomas Lake*, Ian Masters, Alison J. Williams

Energy and Environment Research Group, Faculty of Science and Engineering, Swansea University

* t.lake@swansea.ac.uk

Overview

Following on from work on the SURFTEC project, this part of the Selkie project is looking at the use of a low-cost datalogger based around a single-board computer and a modular software platform.

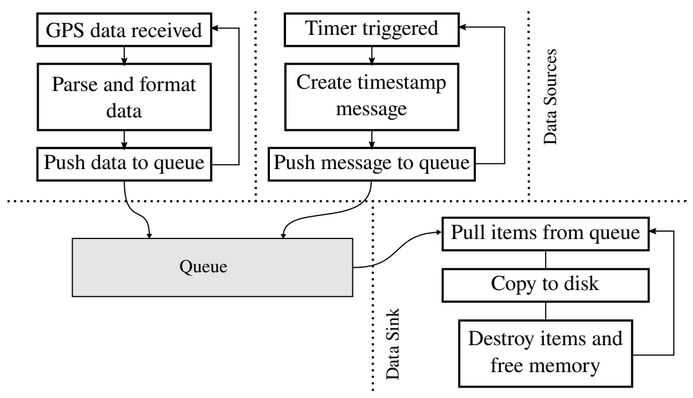
Requirements identified as part of the previous project or its review included:

- designed to operate from low voltage DC
- able to record multiple serial data streams
- able to timestamp recorded data
- flexible enough to allow use with different combinations of sensors and equipment

The system uses a Raspberry Pi 4, interfacing with other sensors using a combination of directly connected hardware, serial/USB links, and network communication.

The Pi itself has no analog inputs, so these are provided by an expansion board connected to the Pi and dedicated ADC adaptors connected to an Arduino, which provides the data to the Pi over a USB serial connection

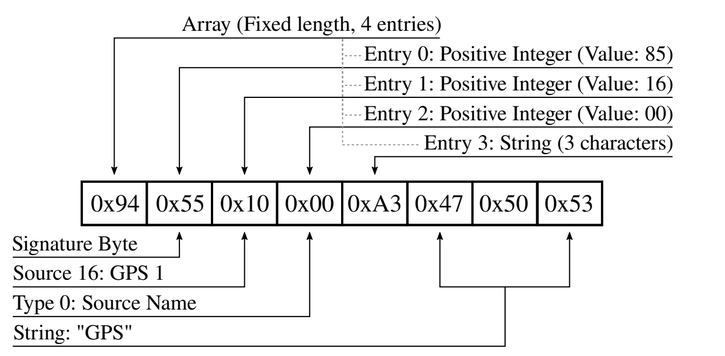
Data Flow



The core of the logging software is implemented in C. Each data handler runs in its own thread, reading in data and converting it into suitably formatted messages. These messages are then queued before another thread removes messages from the queue and writes them to disk.

The messages contain no timing information, so timestamp messages are generated at a fixed rate and added to the queue. The interval between these timestamps defines the temporal resolution of output data - a particular message (for example, representing a sensor reading) is only known to have been pushed at some point after the preceding timestamp and before the next one.

Message Structure



A common message format has been defined for the project, and all incoming data is converted or encapsulated in these messages for storage and further processing.

The msgpack standard is used to encode the data, with each logged message consisting of 4 parts as shown above:

- A signature or marker byte
- Source ID

The format allows up to 127 simultaneous data sources

- Message type

Up to 127 types can be defined, although 6 are predefined.

- Message data

This can be one or more strings or floating point values

Supported Data Sources

The software currently supports the following sources:

- u-Blox GPS receivers
- NMEA message sources
  - GPS position, velocity and time data
  - Environmental data
- I^2C devices
  - Analog to digital converters (ADCs)
  - Support is chip specific, but includes voltage and current measurements
- Datawell Waverider HXV messages
- MQTT data

Additionally, any network (TCP) or serial stream can be captured and recorded for later extraction, even if the values aren't interpreted in real time. This allows data for one day to be collected in a single file, for later extraction and analysis using standard tools.

Testing

Principal testing has been carried out in conjunction with MEECE and ORE Catapult on a measurement buoy deployed at Dale Roads, just outside Milford Haven in south west Wales.

This test deployment includes a Waverider, multiple analog sensors, an interface with the buoy's on board power management system and the GPS and marine (NMEA) instruments on board.

Related other work

A separate part of the Selkie project has been the design, development, and testing of a converging beam ADP device at the Marine Energy Test Area (META) in Milford Haven.

The core hardware is similar but lacks the internet connection present on the MEECE buoy. This allowed the testing of dedicated real time clock hardware and power reduction, which may be useful for future logging system deployments.

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