Case study

MONITORING NOXIOUS GASES WITH A SMARTPHONE

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Measure

Lone working can often be dangerous, especially in an environment where there are noxious gases. We created a wearable device to keep these workers safe from unseen threats – with the help of their smartphone.

The challenge

Many jobs take lone workers to dangerous places, but the risks are often invisible. A drayman going down into a cellar to change barrels is just as at risk of coming into contact with CO_2 as a swimming pool technician is of chlorine in an enclosed back room. Both CO_2 and Chlorine are heavier than air and tend to flow downhill and pool in lower areas. So, if there's ever a leak, an unsuspecting worker could step into a deadly situation.

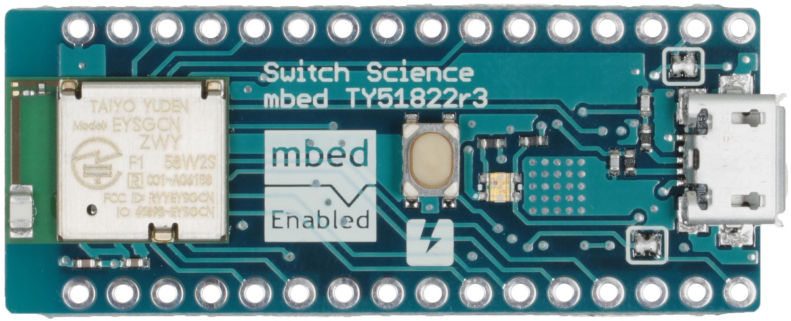
While our client's workers were already wearing sensors to warn them to 'get out' when gas was detected, the data was stored on the device and couldn't be gathered remotely. This made the system clumsy and inefficient.

The brief

Our client wanted a system that could send data about gas in the environment from a worker's sensor badge to a web server, via their smartphone. This would not only monitor the person's health and log the data onto a central database, but it would also detect whether they were wearing and using the badge correctly.

Our response

We decided to build a system for ourselves as a proof of concept. We chose a temperature sensor, just for simplicity. We hooked this up to a Bluetooth Low Energy device and programmed it to query the temperature sensor at regular intervals. We also built an app running on iOS, which queries the BLE device and uploads the data to a web server – and a server to store the data and display a simple graph.



We began with a TY51822R3 BLE development board (see image) from Switch Science with a RF51822 chip from NORDIC. It has 256kB of RAM and 32kB of flash memory, is powered from the USB-B connector and has SPI, UART, I2C and GPIO ports. Then we hooked up a TMP102 temperature sensor, which communicates over the I^2C port.

The TY51822R3 can be programmed in C using the online compiler at mbed.org. This is an attractive working environment and ideal for producing quick prototypes. The compiled code is downloaded and dropped onto the

TY51822R3, which appears as a USB drive on the computer. A reboot then runs the new software.

BLE relies on a fixed set of protocols to allow communication with a smartphone. The quickest and most reliable way to communicate with an app is to use the existing protocols because this is well tested and proven. We used the Health Thermometer protocol as it fitted our temperature sensor.

The software on the TY51822R3 sends data every 30 seconds.

The next step was to write software for an iPhone. Purely out of interest, we chose to write the app in Swift – Apple's new software language for Apple Mac and iPhone. It's an easier language to work with than Objective C, which was Apple's previous offering.

The first element of the Swift app is connecting up to the BLE device. This is a step-by-step process to work through the hierarchy. Basically, the TY51822R3 says what parts of the BLE system it offers and the Swift app steps through each one to find the temperature service. Once it's done that, it gets data every time the TY51822R3 updates its value.

The Swift app then posts the data to the web server, along with a timestamp to identify when the data was captured. This is an important element of the Internet of Things (IoT) – that most measured data needs to record the time it was captured. The Swift app uses the simple HTML *'put'* command. Normally, when you view a web page, the HTML *'get'* command is used to pull the page from the web server. The *'put'* command works in reverse.

The result

We built our own IoT server, so you can see the system working for yourself at http://www.xors.com/ble/index.html (please let us know before you look as it's not always on). It can be set up quickly and simply without our help, and responds to incoming data by storing it onto a table. Data uploaded using the correct API key will be written to a table that is unique for every device.

You can view the temperature data on a graph by the last hour, the last day and the last week – at the click of a button.

This, of course, shows the system in action for the temperature of our office. But our client is using it in 'real life' with a gas sensor instead of a temperature sensor to track the safety of all its workers. The worker's phone is constantly pulling data off the sensor and sending it back to the web server as soon as it has a WiFi, 3G or 4G connection, along with the GPS location. Over the longer term, the client can plot the data and discover trends – and breaches. The great thing about this system is that it has the capability to measure anything, and record the data in exactly the same way via a smartphone.

Final words

This whole approach is based on the same technique used in the Fitbit (for example). It's an interesting reflection on the way we work. Sometimes, a project will demand a radically new approach, and we'll have to come up with that – innovate and find a way forward. Sometimes, like this example, the client approaches us and postulates an approach: "Just how does the Fitbit work? Can you do that for us?"

So many times this is just what the client wants; they understand enough of technology and then they see the introduction of new technology - like Bluetooth for instance - and ask us: "How can we use this in our product?" It's what Xor specialises in – helping businesses leverage the latest technology for their products.

The other fascinating thing about this particular project is that there are two distinct benefits to the solution. One is in the accumulation of data; we can collect readings on gas levels in pub cellars on a weekly visit, and this builds up an interesting and useful set of data. The other benefit is that it provides another sort of data - it shows that the staff are using the safety equipment - vital information for the employer.

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