Oxford Flood Network

Building a citizen-led flood detection network with the Internet of Things & TV Whitespace *- Love Hz, MLL Telecom & Oxford Hackspace*
http://oxfloodnet.co.uk

Why?

Oxford is prone to flooding. Although the Environment Agency provide blanket warnings they have a limited number of expensive, professional sensors and aren't keen to share this data. Even with access to this data, the lack of detail wouldn't really help understand the streams, groundwater rising and complex basin of the Thames & Cherwell to a degree that can identify flooding at a street level. What we need is higher resolution data.

Figure 1 - Typical Flooding

Figure 2 –An Installed OxFloodNet Sensor

The Smart City Built by Citizens

In the floodplain of Oxford members of the local community are installing their own water-level monitoring sensors. Inspired by the crowdsourced Japan Radiation Map they are sharing local knowledge about rivers, streams and groundwater to build a better, hyper-local picture of the situation on the ground.

A variety of locations and methods can monitor water levels. Some properties have boreholes which can be used to determine current groundwater levels. Some have water sloshing about under their living room in their floor void. And those who live by swollen streams have intimate knowledge of the conditions that lead to floods. These are all great indicators of imminent flooding but are often passed by word of mouth in a local community.

This project aims to produce a working example and reference design showing how to monitor water levels in your own community. This forms the basis of a blueprint for communities to build their own sensor networks to highlight their own issues – air quality, radiation, noise, whatever they can find a sensor for.

The Internet of Things

With low-cost sensors feeding data to the Internet citizens who have local knowledge of the areas likely to flood can install monitors in their own area and contribute to a community map. Crowdsourced environmental sensor data can be collected inform communities of conditions - even down to which streets are currently flooded.

Tweet My Flood

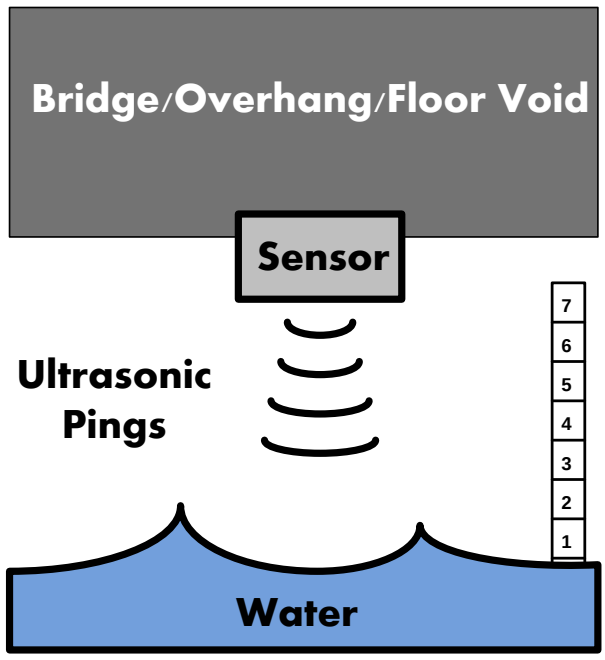
The data will be published with an open licence so it can be turned into an application by anyone. For example, while the basic output is a heatmap of flooding around Oxford, an app could be written to tweet when water levels threaten your particular property, or to warn of heavy rainfall in the catchment area.

TV Whitespace

To enable the Oxford Flood Network a local company Love Hz (http://love-hz.com) and telecoms operator MLL Telecom (http://mlltelecom.com) are running a pilot of a cutting-edge technology called TV Whitespace (TVWS).

Ofcom, the UK telecoms regulator, is opening the airwaves for this experiment. TVWS is a technology which uses gaps between TV channels for wireless communication and is particularly suited to machine-to-machine (M2M) communication and the Internet of Things whilst also having applications in rural broadband and disaster communications.

How it Works



Ultrasonic rangefinders periodically ping the surface of the water, calculating the height to the sensor. This data is sent to the gateway where it is uploaded to the Internet.

The small, battery powered, wireless devices can be attached to bridges or overhangs at participating locations, or even under floor voids.

The data is analysed by a central system which has been told about typical levels and flooding thresholds. Based on these values a map can be produced with warnings of abnormally high levels or sudden changes in depth.

Funding

The Flood Network side of the project is currently self-funded by Love Hz. The TV Whitespace pilot consists of a donation of Whitespace equipment by Adaptrum and network build effort by MLL Telecom.

The project is seeking further funding to improve sensor technology beyond initial prototypes and also to develop a blueprint to reproduce this in other communities whilst covering infrastructure costs.

Making it open-source doesn't mean we're no longer needed. There is potential for business to be made from consultancy, training and provision of network services to communities, even creating kits to make deployment simpler.

In a time when the Smart City is a buzz-word in technology companies and local authorities, it's important that the citizens themselves are empowered by the technology. Asymmetric infrastructure projects lead to mistrust. Instead, communities can take control of their destinies and provide their own evidence for their own issues.

Contact

The project is led by Ben Ward, founder of Love Hz. Contributions have been made by members of Oxford Hackspace and makers from further afield.

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About Love Hz – Love Hz is an Oxford-based startup specialising in the Internet of Things and wireless sensor networks. They are one of a handful of networks in the UK's TV Whitespace pilot, organised by Ofcom to explore the technology, and are using it to deploy sensor networks in remote locations.

Design

Overview

We connect small, battery-powered sensors to a nearby gateway (with mains power), then backhaul the traffic over TV Whitespace to a base station and onto the Internet.

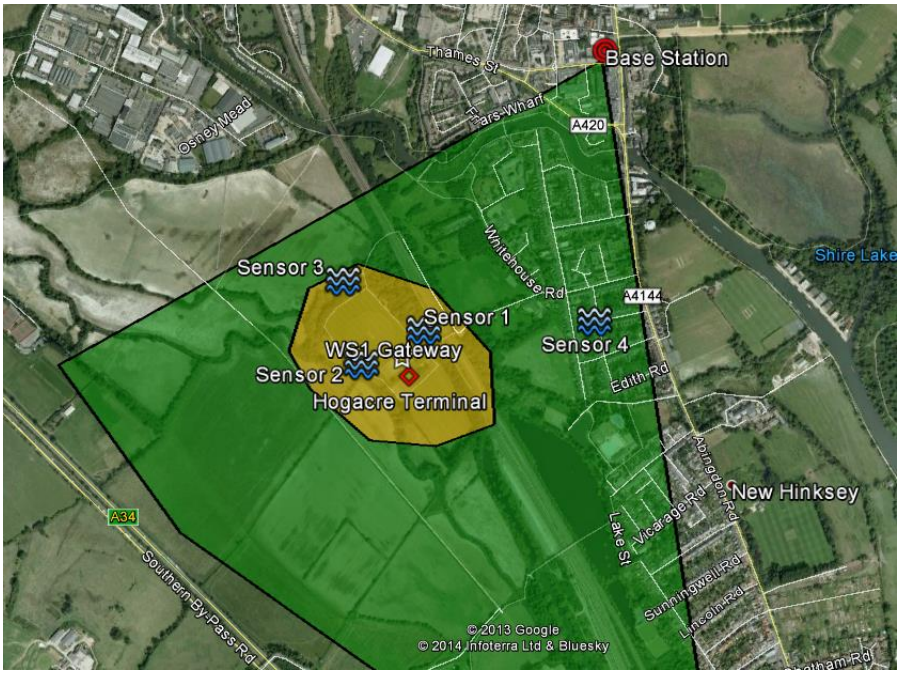

Figure 3 - Example Site at Hogacre Common

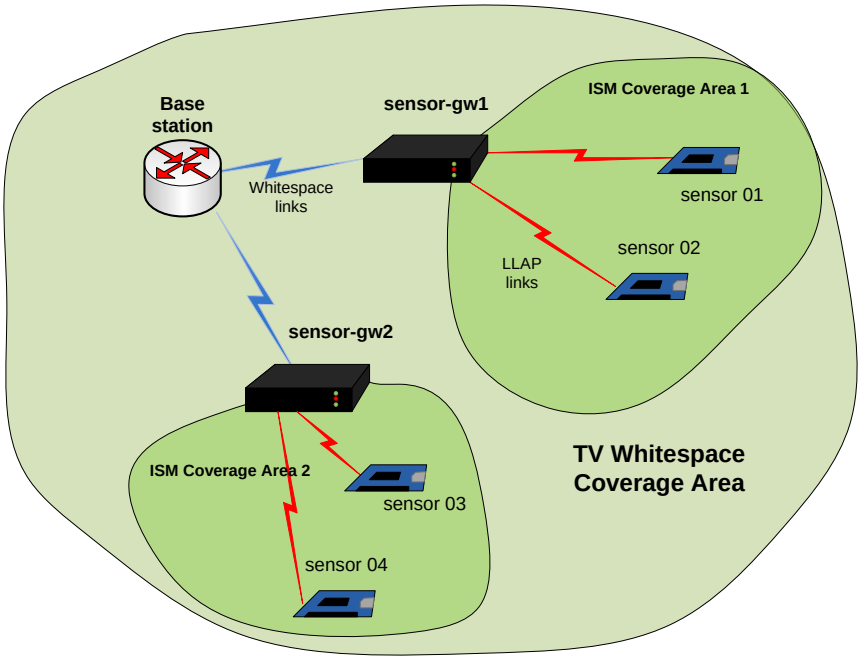

Figure 4 - Network Overview

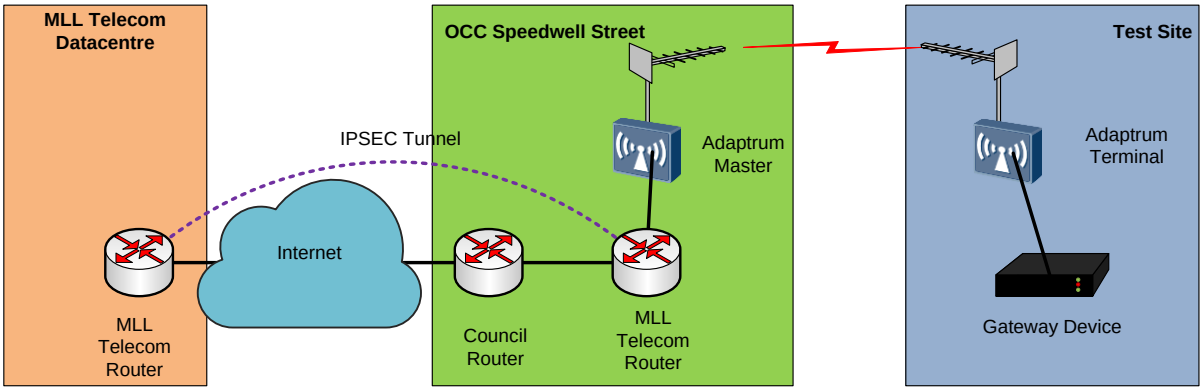

Figure 5 - Whitespace Backhaul

Radio Hardware

We use a combination of types of **radio devices** with different power requirements.

Radio	Band	TX Power	Bandwidth	Size	Notes
Adaptrum ACRS2.0	TV Whitespace (470-790MHz)	100 mW	30Mbps	22 x 20 x 4 cm Antenna: Yagi	Medium-range, high-power
Ciseco SRF	ISM (898MHz)	10 mW	500Kbps	2.2 x 2.7 x 0.2 cm Antenna: 8cm Whip	Short-range, low-power

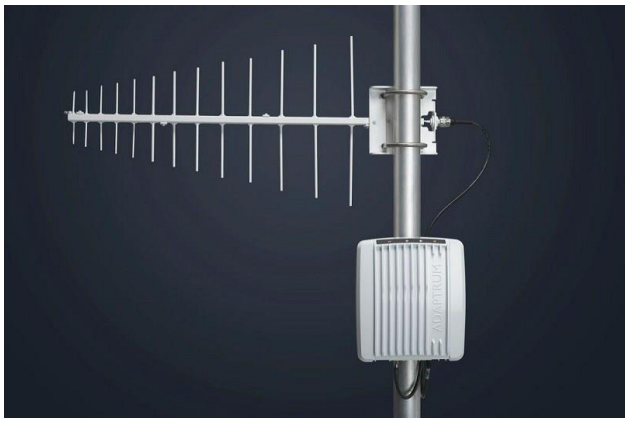

Figure 6 - Adaptrum ACRS2

Figure 7 – Ciseco RFu (SRF)

Adaptrum's ACRS2.0 was recently approved for use in the UK's TV Whitespace by Ofcom (Q1 2014). Because ACRS2.0 operates at 12v and is still a considerable size compared with the sensors it would be impractical to put them at each sensor. Instead we're using the whitespace network as a backhaul for sensor gateways.

Ciseco's SRF radios provide a short-range low-power radio solution which integrates well with microcontrollers and other off-the-shelf hardware. This reduces time to create a prototype.

Sensor Hardware

Sensor Devices

The sensor devices consist of a Ciseco RFu328 (an SRF radio with integrated ATMega328 microcontroller) and are compatible with the Arduino development environment. They are equipped with an ultrasonic rangefinder which is suspended above the surface of the water and reports the distance.

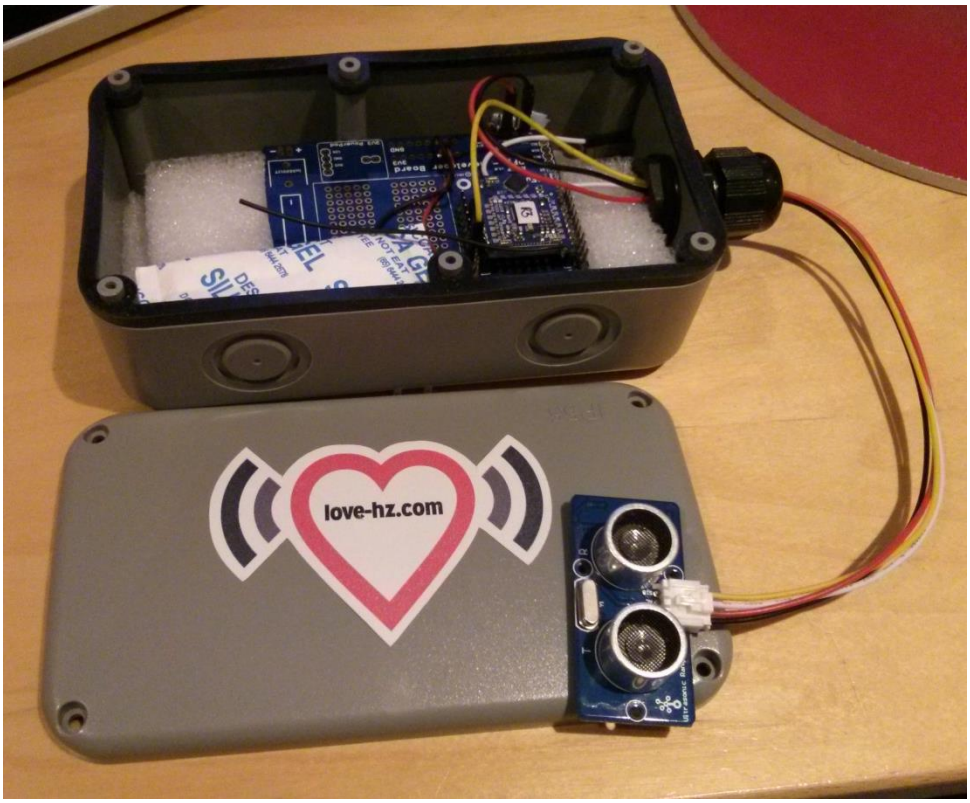

Figure 8 – Early Prototype Sensor Device

The sensors need a gateway to get onto the Internet, so they transmit their readings over a low-power radio network to the sensor gateways, usually situated where there's power (and optionally broadband).

Sensor Gateways

The gateways consist of a Raspberry Pi with a Ciseco “Slice of Radio” on the GPIO header (a USB variant can also be used) and aggregate all the sensor devices onto an ethernet connection before uplinking to the Internet via whitespace or broadband. These contain the logic to aggregate the sensors into datastreams for the database.

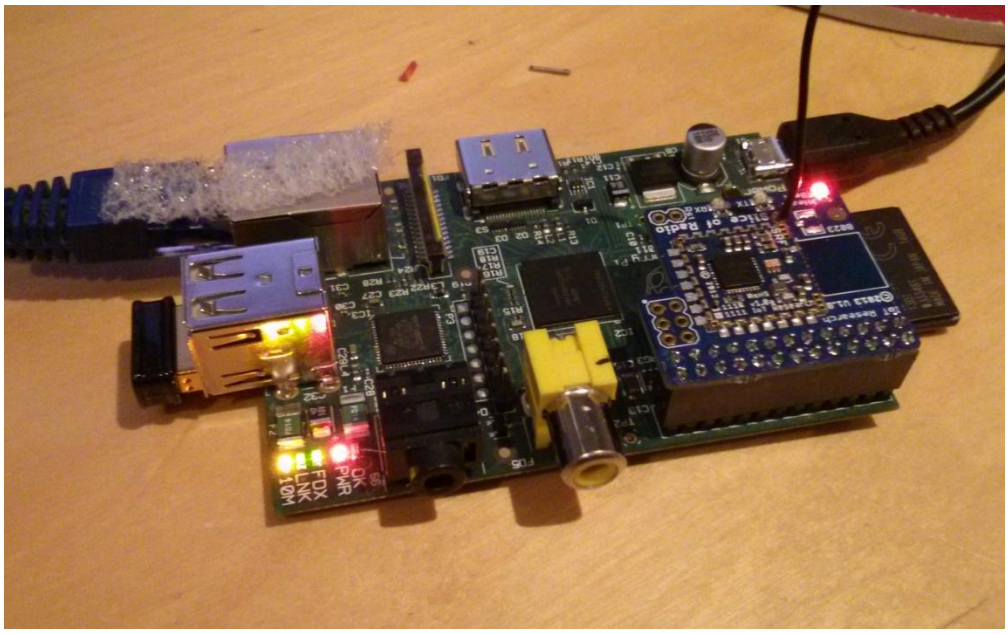

Figure 9 - Sensor Gateway (Pi)