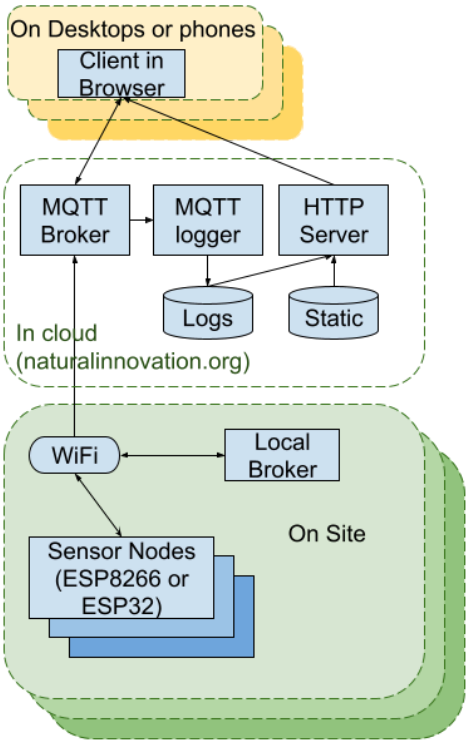
Frugal IoT - March 2025 update

Here is my second regular update on the Frugal IoT project.

For those who missed the December update, you can find it here and it covers the development of an architecture and each of its basic open-source components.



Quarters highlights --- since December.

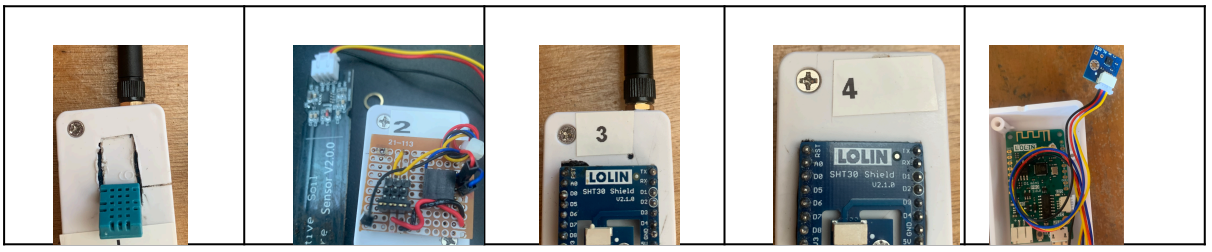
- The UI's graphing capabilities were made usable
- It works on mobiles
- Ported to Sonoff and Lilygo devices
- Successfully integrated into Kopernik's in-house device.
- A set of physical prototypes were built and tested at Magi Farm in Indonesia.
- Over-The-Air updates now supported.

Port to Sonoff switch

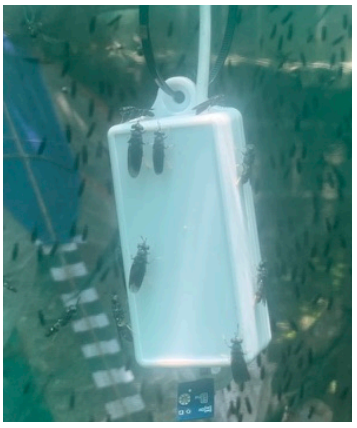
A volunteer - Jonathan Semple - got the platform working on the Sonoff family of switches. This required a total of 10 lines in the configuration file, and I'm super pleased that it was this easy.

This is a big deal. The Sonoff switch can be inserted into a power-line, of a fan or a pump or something. Technically that is easy to do, but since its handling 240V it is hard to safely cut corners. The Sonoff's are ~USD4.50 and once reprogrammed to sit in the Frugal-IoT platform enable simple automated control, at around USD10, for example for a fan that comes on at high temperatures, or can be controlled remotely.

Prototypes and tests at Magi Farm.



I developed five prototypes, with a combination of different processor cards; sensors; aerials; batteries. In the end, the most useful was the simplest - using an external powerbank ($10 from a local warung), and shown here suspended in the fly-mating cage, where we immediately saw the temperature was significantly above optimum.



The unfortunate finding was that the cheap soil-probes won't work in the coarser medium consisting of waste food and black-soldier-fly larva.

The most important learning, was a reminder that what matters - and where the money gets spent is on: power; enclosure; and communications; rather than the device & sensors. I'm happy with the small ABS boxes as enclosures but communications and power need work over the next few months, as there is neither accessible power, nor WiFi at their remote bioconversion sites.

Port to LilyGo Higrow

The Lilygo Higrow is a compact device incorporating temp/humidty, soil moisture, light, and some other options. It was a little harder to convert than the Sonoff, but still successful. At ~USD17 ($10 without the case) there are some situations where it might be the right solution.

As importantly it confirmed what was learned with the Sonoff, i.e. that we can take off-the-shelf consumer products and reprogram them to work in a deployable platform.

Kopernik

I met with Kopernik again on this recent trip. Kopernik is a design lab that have already identified a set of needs for affordable sensors in a variety of scenarios from solar dryers; automated irrigation; seaweed processing; ocean salinity & PH measurements. They had also put together a team with a couple of local engineers, who are skilled, but new to IoT and started work on an automated irrigation device consisting of a soil sensor, and a relay attached to a Wvroom development board (which was new to me).

As an exercise we set aside a morning to see if we could take the system, that had taken them a few months to build, and provide all the functionality on the Frugal-IoT platform. The process took about two hours in total !

For Kopernik one benefit is having the data easy to handle for analysis - like many NGOs and startups they were using the “Free” level of a Freemium platform, which didn’t allow them to export data. Frugal-IoT, being open-source, has no such restriction.

OTA - Over The Air updates.

Devices can now be remotely updated, i.e. a developer can fix a bug, post it to the site and the device will remotely update itself. This is not yet live, as uploads have to be appropriately permission controlled, and that will take some server work.

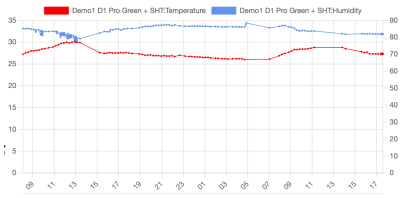
Other node progress

Key progress on the node side

- Much more solid WiFi and MQTT handling, and can now be pre-programmed with a number of known WiFi networks.
- Configuration portal - that pops up when the device does not connect to a network - translated into Indonesian
- Support for batteries, in a variety of combinations (for example using a battery shield, or plugged into a board like the Lolin D1-pro of Lolin C3)
- Added analog sensors - especially the Soil Sensors.

Graphing

The graphing looks quite good now and can automatically add data saved by the Logger by simply clicking an arrow. Multiple channels, from different devices can be shown on the same graph, and things with different scales shown simultaneously.



Other Platform developments

Some key steps have improved the platform (how the user monitors their devices) from “Proof of Concept” to something that is usable, but still has limitations. In particular since the last update.

- Switched from HTTP to HTTPS as a first step towards adding security and user controls.
- There are now programmable controls - that can for example control a relay based on humidity level, adding hysteresis so that the pump doesn’t cycle on and off around the set-point.
- Lots of small usability changes, for example the data you rarely want (battery, etc) is hidden behind a dropdown, and nodes that are offline are greyed out.
- It works - though not perfectly yet - on most mobiles.
- Controls can be embedded in third party web pages - this means that an organization could for example embed a graph, with live data, onto one of their pages.

Demonstrations and Participation

The site is live at https://frugaliot.naturalinnovation.org if you point a browser at that page you should see whatever devices I’m working on - for example at the moment it shows a temperature/humidity device in my home office.

Code is regularly updated, and is now split across 4 repositories for the Device; Logger; Server and Client; and I'm starting to migrate documentation to GitHub's Wiki.

Next Focus - Power

All sensors need an affordable power solution appropriate to their requirements. A key focus of the next couple of months should be finding a set of good choices. Input is very welcome, but at the moment I am seeing a range of solutions.

- Reducing power consumption of the device, with diligence we should be able to extend battery life 10x.
- An architecture of pluggable solutions - probably based on mass produced 5V sub-circuits, and including.
- Solar panel to 5V
- 5V powerbank architecture that can be incorporated directly - i.e. USB charge/discharge circuits attached to whatever batteries are appropriate.
- Good mix and match between a variety of components - so for example a USB transformer with solar backup.

Communications

Looking for a solution to the expensive backhaul problem. WiFi ($15) devices are reputably unreliable. LoRa gateways are ridiculously expensive ($200-600), and GSM on the board limits board choice and is power-hungry.

It is not yet clear what the right solution is yet, but I hope by the next update we've learned some more.

An appeal for help …..

If this is what one person can do in 9 months, imagine what a small funded team could achieve !

We need: **volunteer developers** to help add features, fix bugs, and all the other parts of a dynamic open-source ecosystem.

We need: some **funding** - to help tackle some of the long-list of things left to do, ideally enough to have a couple of full-time engineers/project managers.

We need **partners -** who want to try this in different situations.

I'd also love to talk to anyone who has an interest - or a different take on this - for example funders struggling to support IoT in their grantees, or support organizations with a number of projects that need Frugal IoT.