Energy Consumption Project - Process Documentation

Original Documentation & Setup

2012/08

[zip] FlipDot_OriginalCode includes:

- pushersign Documentation
- displayTest.ino
  - *code for receiving energy data and controlling dot display - nanodeRf*
  - *External Serial Monitor printout - for reference purposes.*
- emonTest.ino
  - *code for reading and sending energy data - emonTx*
- mobitech - Communication Protocols

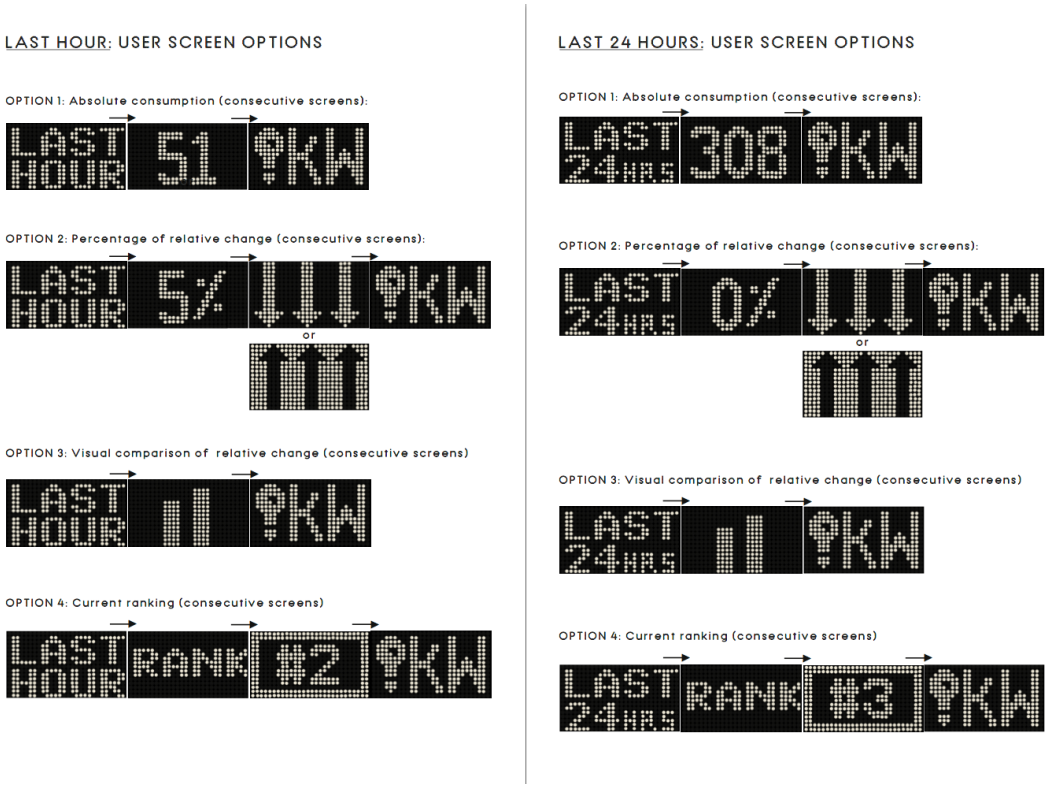
This setup involved:

- emonTx
  - sending energy data
  - code: emonTest.ino
  - Links:
    - http://openenergymonitor.org/emon/emontx
    - http://openenergymonitor.org/emon/emontx/make/assemble/buildguide22
- NanodeRf / emonBase
  - location: situated ~10m away from the emonTx
  - receiving energy data
  - code: displayTest.ino
  - Links:
    - http://openenergymonitor.org/emon/node/227
    - http://openenergymonitor.org/emon/emonBase/NanodeRF

        - Alternatives: http://openenergymonitor.org/emon/emonbase
- DFRduino Shield
    - Attached to the NanodeRf
    - Controlled the dot display's content.

Dot Display User Screen Options

2012/09



Document

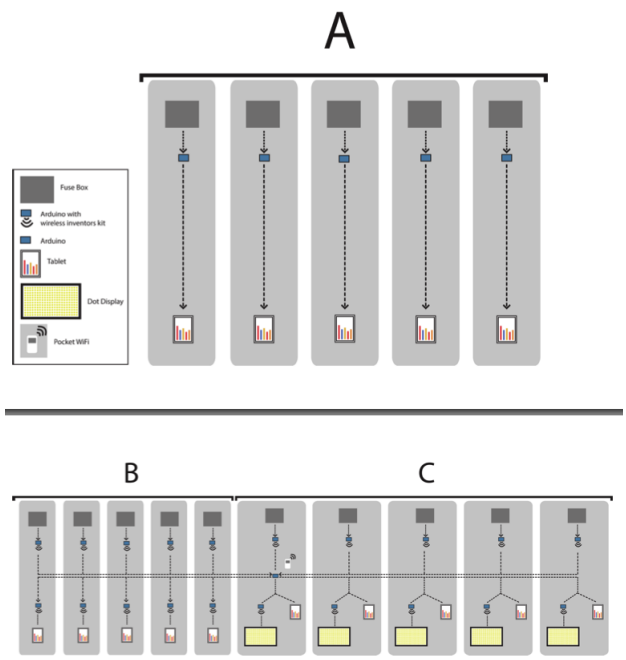
Initial Network Setup

2012/10

As altered by changes in potential hardware introductions or constraints.
Ongoing Notes:

- No use of resident's internet permitted.
- Preferred update rate varies. Currently stands at every house having a data point every 1 minute, and an hourly aggregated ranking pushed to all participants.

a.



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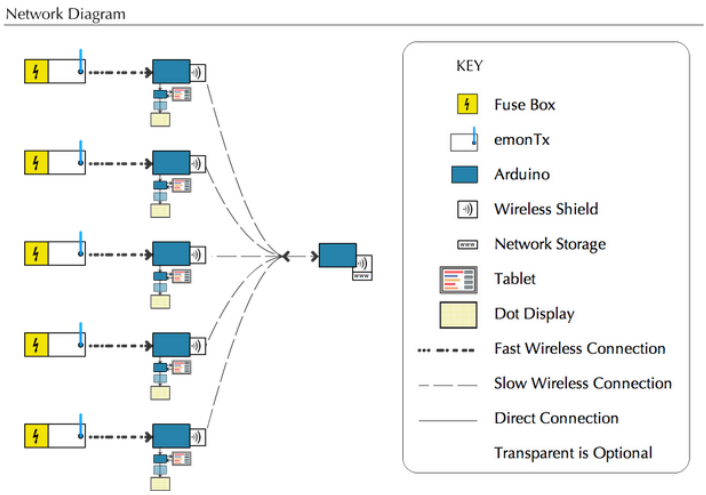
b.



Full Documentation

Network Component Research:

All the following scenarios require the use of an Arduino and a power pack to generate an ad hoc network.

XBee 1mW Chip Antenna
This setup would be ideal for simple point to multipoint network communication between close points of contact. Consists of a single parent node that polls the child nodes for data regarding electricity usage, it would have to keep track of the node id and the values, order the nodes and send the order value to the correct node id's. This requires the parent node to do a lot of on board processing.

Pro:
Can be bought locally/existing access to some locally
Heavily documented
Easy to setup
We already have access to some within the faculty

Cons:
Would need to purchase the xbee and then an explorer shield if we need more.
Range is heavily affected by the environment.
Quite a short line of sight range - 300ft (100m)

Price per unit:
$32.50 + $18-$26 for expansion shield

Xbee Pro 60mW:
Very similar to the 1mW setup.

Pro:
Longer range than the 1mW Antenna (1500m) range
Heavily Documented
Easy to setup
Can support point to point and multipoint networks

Cons:
We would need to buy all the modules
Would need to purchase the xbee and then an explorer shield for each
Range can reach one or two houses max.
More expensive
Requires more power to run than the 1mW

Price per unit:
$52 + $18-$26 for expansion shield

Xbee with Zigbee 50mW
Utilises the zigbee protocol. Zigbee enables Mesh networking. All points can access all other nodes to share and relay information. This would ensure that data could be sent to the control node even if the direct connection was broken between the control node and the individual node. Much more complex in terms of the network and ability to relay data over nodes to controller node.

Pro:
Better support for expanding node structure.
Reliable data relay as it can bypass bad connections to relay information through other nodes.
1600m line of sight range

Cons:
Needs extensive setup.
Not plug and play
Expensive

Price per unit:
$46 + $18-$26 for expansion shield

Wireless Inventors Shield scenario:
These would be ideal for a multi point network covering large distances

Pro:
- It's Long Range - distances up to 500 feet.
- It's Error Free - built-in forward error correction and data recovery, you only ever receive cleaned and CRC verified data.
- It's Simple To Use - anything you input, is wirelessly transmitted, then cleanly outputted for you on the other end.
- It's Immune To Noise - your data inside the wireless pipe is protected from the elements outside such as interferences like WiFi, Bluetooth, Zigbee, cordless phones, cellular phones, all types of servo and motor noise, etc.

Cons:
- Not much documentation
- Can only be bought from the US

Price per unit:
$30 USD

Document

Hardware Component Notes & Wifi Network Notes

2012/11

notes

Resources:

- nanodeRf-master.zip - *https://github.com/openenergymonitor/NanodeRF*
  - Example sketches of communication between the NanodeRF and emonTx.
- openenergymonitor-EmonLib-7519fc8.zip - *https://github.com/openenergymonitor/EmonLib*
  - Arduino Energy Monitoring Library - for emonTx

Sketches:

- ~~*displaytest-raw-emonbasereceive*~~
- emonbase-basicreceive
  - ~~simplified~~ receiving sketch for the emonbase.

Dot Display Test Notes

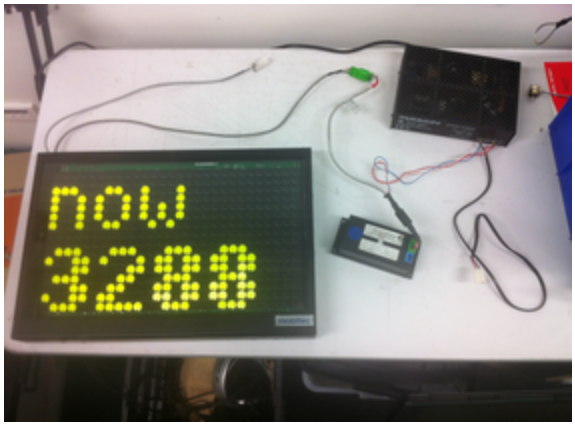
- Generating Content:
  - A processing sketch was written to convert a black and white bitmap to a string that can be read by the arduino communicating with the Dot Display.
  - [Program]

- Max FrameRate:
    - Tested by switching between screen states with different randomly activated pixels (flipdots).
    - Found a delay of 100ms is reachable but uneven - though it has shown to be proven for a sustained maximum test time of 5 minutes.
    - Found a delay of 150ms appears to be the minimum stable and safe speed for switching the display content. This was also tested for 5 minutes. It is assumed in implementation, the display will only need to perform at this speed for short bursts (e.g. few seconds) at a time e.g. for transitional animations. For longer-lasting animations, longer delays are preferable.
    - It should be noted that each change of the display draws power, hence, constant change is not energy efficient.

Dot Display - Frozen Issue

2013/02

Non-Working (unresponsive display) Setup:



Notes: Ran a multimeter through the above setup. 24V appears to be traversing throughout the entire connection - i.e. data and power connections appear to be connected properly (tested by measuring the minute resistance inbetween).
(Sidenote: A crimping tool can be used for noninsulated terminals (~22AWG)).
Most likely a loose connection in the sign, with permissions to the display, it should be a simple matter of unscrewing the back panel of the display and repositioning the wire if that's the problem.

Electric Imp - Background Information

2013/02

Electric Imp – http://electricimp.com/

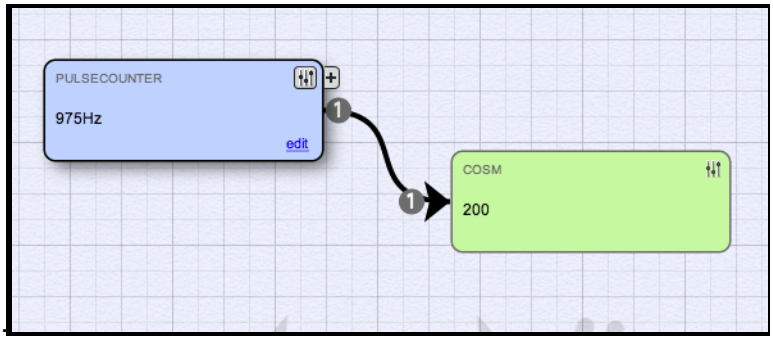
Chosen above other alternatives (wifly, xbee, etc.) for establishing a network of devices because it's more stable, scalable and can update faster (*update 2013/04: the ideal update speed has since been lowered*). However, it does require a wifi connection (currently though of as a personal hotspot) and therefore more expensive. Arduinos with sim cards and a data plan are also another alternative that may be applicable in the future setups.

Electric Imp - Integration Process

2013/03

Notes:

- Voltage for Electric Imp is 3.3V - it is preferable for it to have its own stable power. (*as of 2013/04, this is not the case in the current setup).*
- Setting up Imp: http://devwiki.electricimp.com/doku.php?id=commissioning
- Basic Tutorials: http://devwiki.electricimp.com/doku.php?id=blinkomatic, http://devwiki.electricimp.com/doku.php?id=example:start
- As input, the imp can read, a boolean signal (button press), a pulse-count-over-time (pwm - convenient for the arduino) or a voltage. [link]
    - Note, with the NanodeRF, only the analog pins appear to be free for use, however that's fine since they can also send digital signals and emulate a pwm.
    - Note2, in Arduino code implementation regarding communication, asynchronous delays should be avoided if possible (Delay, DelayMicroseconds), in favour of their synchronous equivalents (Millis, Micros).
- For output. The data was originally intended to be sent to somewhere like Google App Engine, however, the Electric Imp web interface conveniently has a COSM module.



Cosm Feed: https://cosm.com/feeds/119427
The cosm data is also exportable. [link]

- *Some basic tests also showed that the imp can also be used to receive signals from the web e.g. in order to control the contents of a display.*

Electric Imp Code.

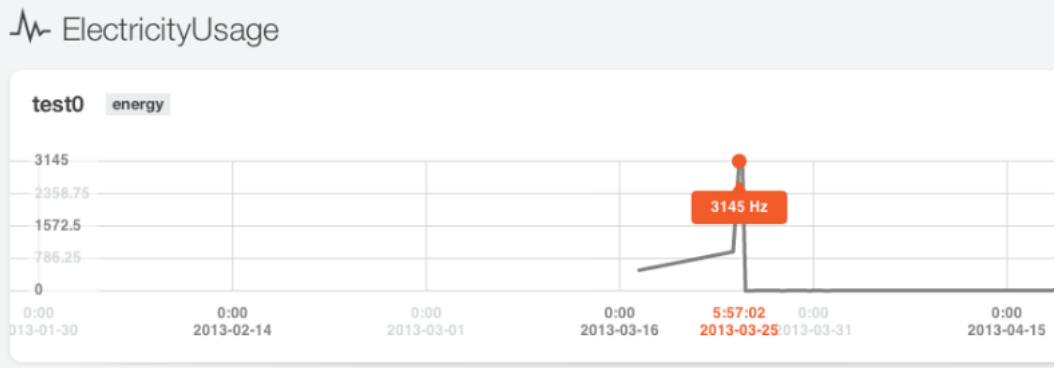
- Blink_forImp.ino - Example sketch
    - Simple sketch to send a signal from an arduino board, through an imp, to the net.
- emonBase_basicReceive_AndImp.ino - Running on EmonBase (with Imp attached)
    - Sketch that combines emonBase_basicReceive, and Blink_forImp .
    - 'Sets an emonBase to listen for incoming signals from an emonTx and forward that value to an imp'.
- [IMP] Pulse Counter Module - Running on Imp Planner
    - Simple pulse counter that counts pulses for 0.2s and multiplies by 5 to get Hz.
- Accuracy note.
    - With the current code. There is increasing inaccuracy with the number of pulses being sent from the emonBase, and the pulses received by the electric imp. This is noticable when values rise above 500. [link] . Possible modifications/solutions could be:
        - scaling the received value
        - prolonging the sample time of the pulse counter
        - ensuring there are no interrupts from any other tasks on either device
        - only sending a new value when there is significant change.

Setup as of 2013/04

2013/04

The setup is currently:

- a wifi network established by a Personal Hotspot (that will support multiple devices and is not WPA2e - currently using 'Telstra Elite Mobile Wi-Fi').
- an emonTx measuring voltage and wirelessly sending outing energy data.
- an emonBase (nanodeRf) receiving the signal from the emonTx.
- the emonBase emulates the received value as a PWM that is read by an attached electric imp.
- the emonBase and imp are powered independently.
- the imp sends the value online, via the personal hotspot, which is then recorded to COSM.



The current setup does not include the display. With a display; another arduino, with a dfrduino-shield (to control the display), and an imp (to receive dot-display-control-signals from the web - values that are a result of the cosm data above) in a compatible wifi network (theoretically within range of the same personal hotspot supporting the current setup) will be sufficient.

Additional note: The emonTx appears to drop in voltage levels it sends after some use, this is probably due to a loose connection, probably power. The miniusb that is used to power the emonTx appears to be loose and this may be the cause.