



community metering

- MSc. Electrical Engineering
- Alcatel-Lucent Antwerp '99 - '07
- ADSL R&D '99 - '04
- Bell Labs ReNA '04 - '07
- Co-founder Jokamajo Institute '07 - present
- Founder Flukso '07 - present



micromecánica S.A.

kWh

1 4 9 3 0



INDUSTRIA URUGUAYA.

1 FASE

2 HILOS

1kWh.

450

220 V

10 A

50 Hz I max.

6



IPO M6S1z AÑO 1988 CLASE

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**FLUKSO**<sup>alpha</sup>

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electricity

hour | day | month | year | night

**HELP PEOPLE IN REDUCING RESOURCE CONSUMPTION:**

- \* VISUALIZE ENERGY STREAMS
- \* CLOSE FEEDBACK LOOP
- \* BENCHMARK AGAINST PEERS

icarus75	min: 241	max: 2820	avg: 1654	last: 497
mackenzie	min: 1080	max: 1380	avg: 1216	last: 1200
jan	min: 117	max: 2250	avg: 432	last: 136
Ludo	min: 87	max: 2130	avg: 503	last: 290

icarus75

- Invite another Fluksonian
- My account
- My relationships
- Create content
- Administer
- Log out

Subscriptions

- [x] mackenzie
- [x] jan
- [x] Ludo

Fluksonians

- [+] jan
- [+] Ludo
- [+] mackenzie

Unit

watt

kWh/year

euro/year

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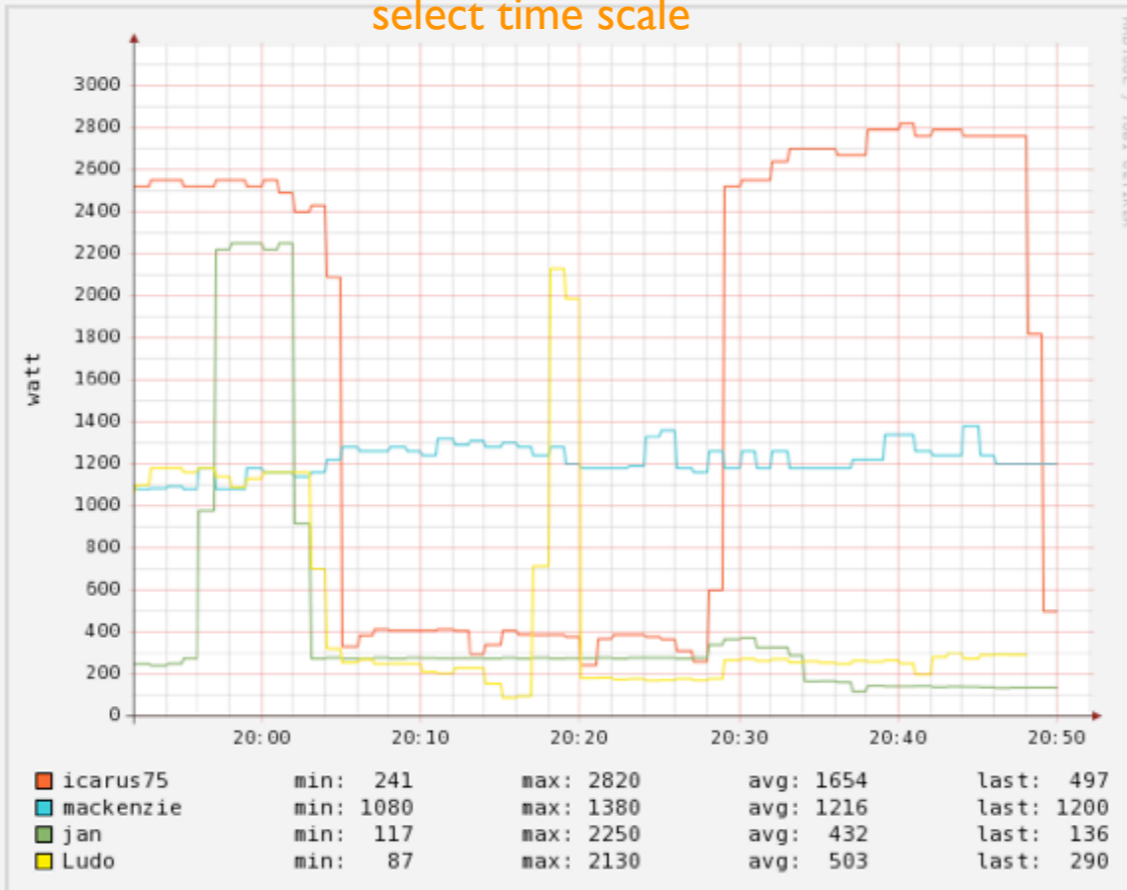
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electricity

hour | day | month | year | night

select time scale



icarus75

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- ▶ My relationships
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dynamically (un)subscribe to other Fluksonians' data streams

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**Fluksonians**

- jan
- Ludo
- mackenzie

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PROTOCOL / TOBI OETIKER

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Fluksonians

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- [+] Ludo
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Unit

- watt
- kWh/year
- euro/year

change the chart's y-axis unit

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Done

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Unit

watt

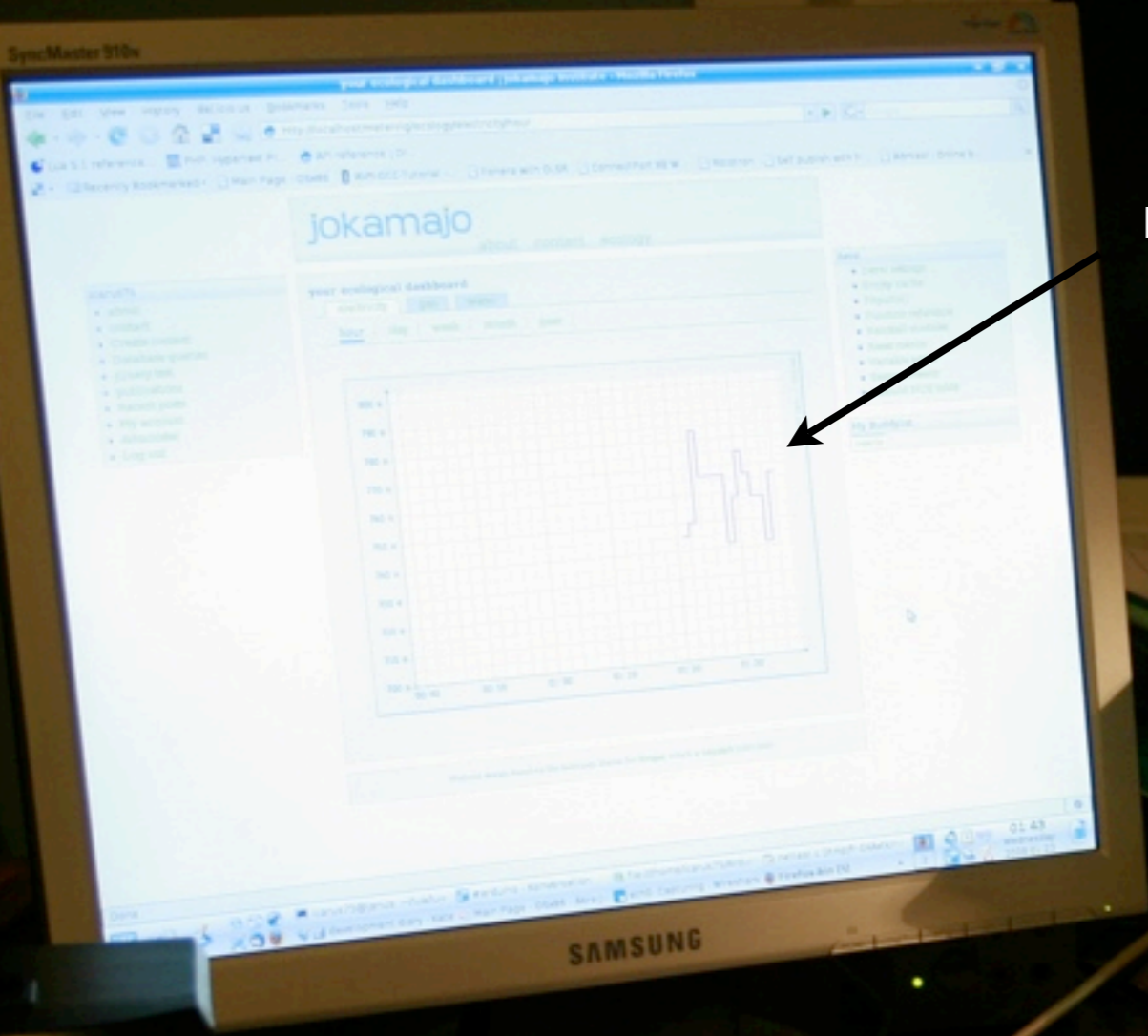
kWh/year

euro/year

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min/max/avg/last  
statistics





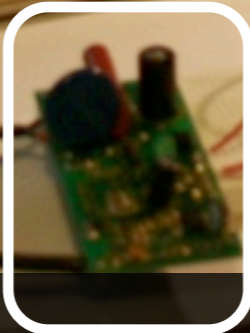
Flukso's first steps!



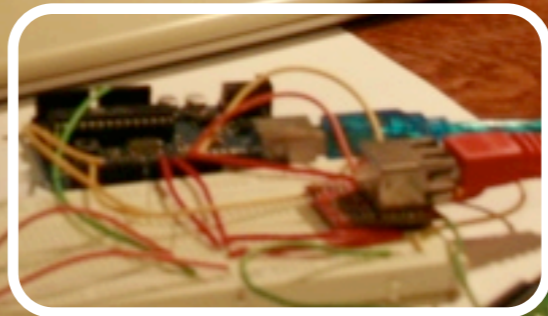
hacked commercial energy meter

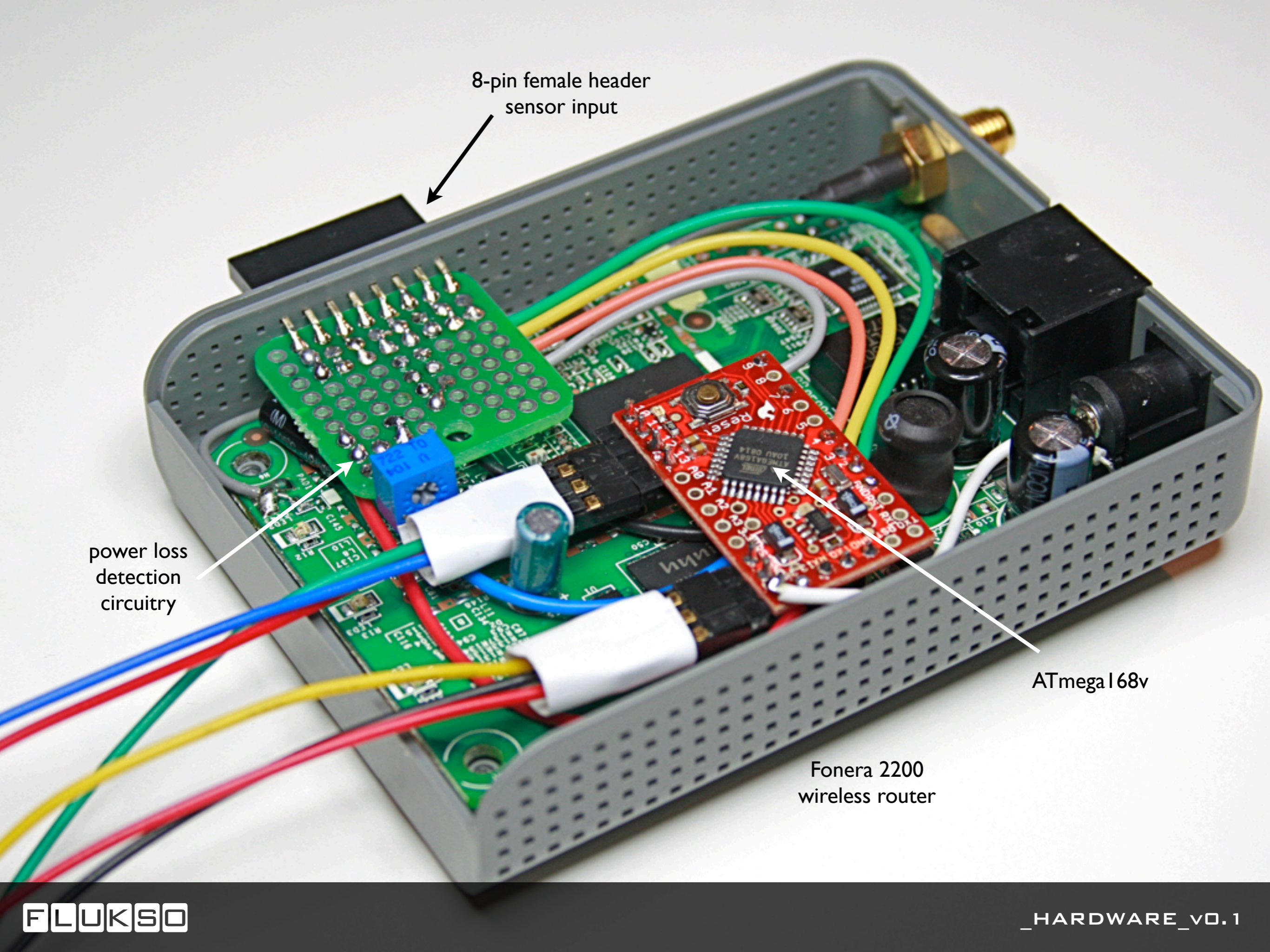


energy meter dev board



ethernet-enabled Arduino





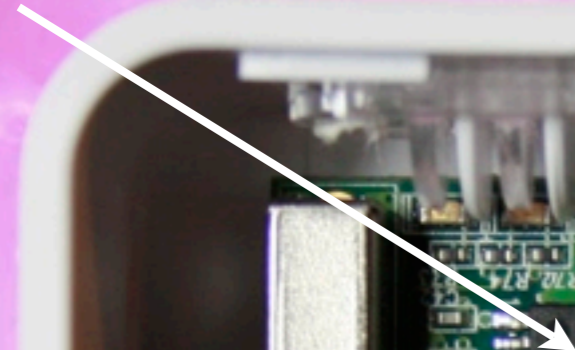
8-pin female header  
sensor input

power loss  
detection  
circuitry

ATmega168v

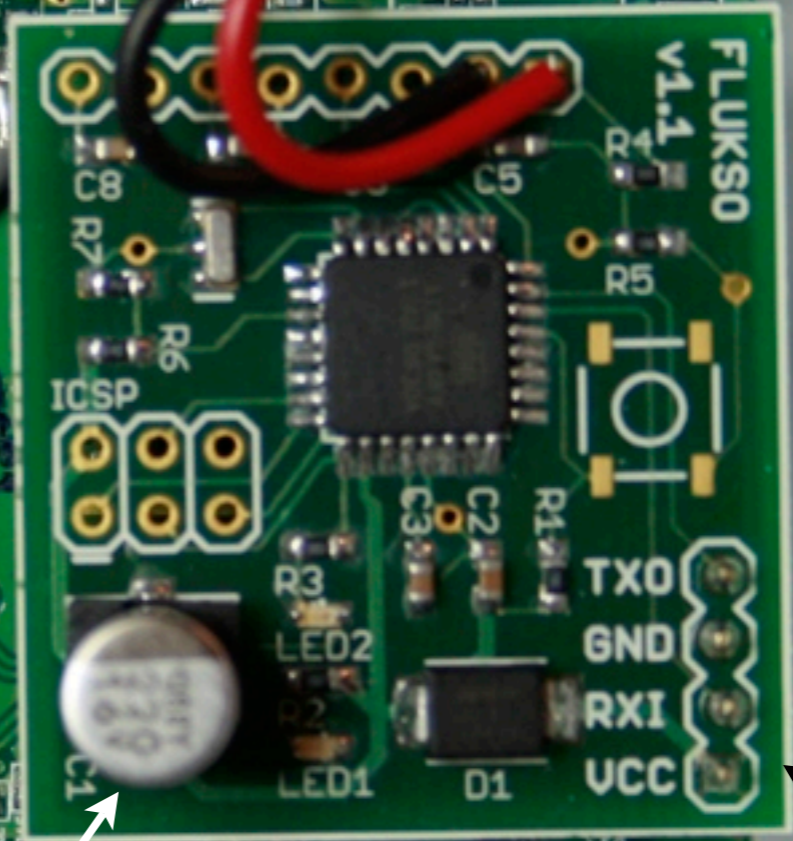
Fonera 2200  
wireless router

4MB Flash/16MB RAM

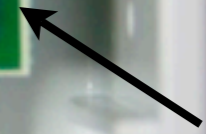


*to connect*

Flukso sensor board



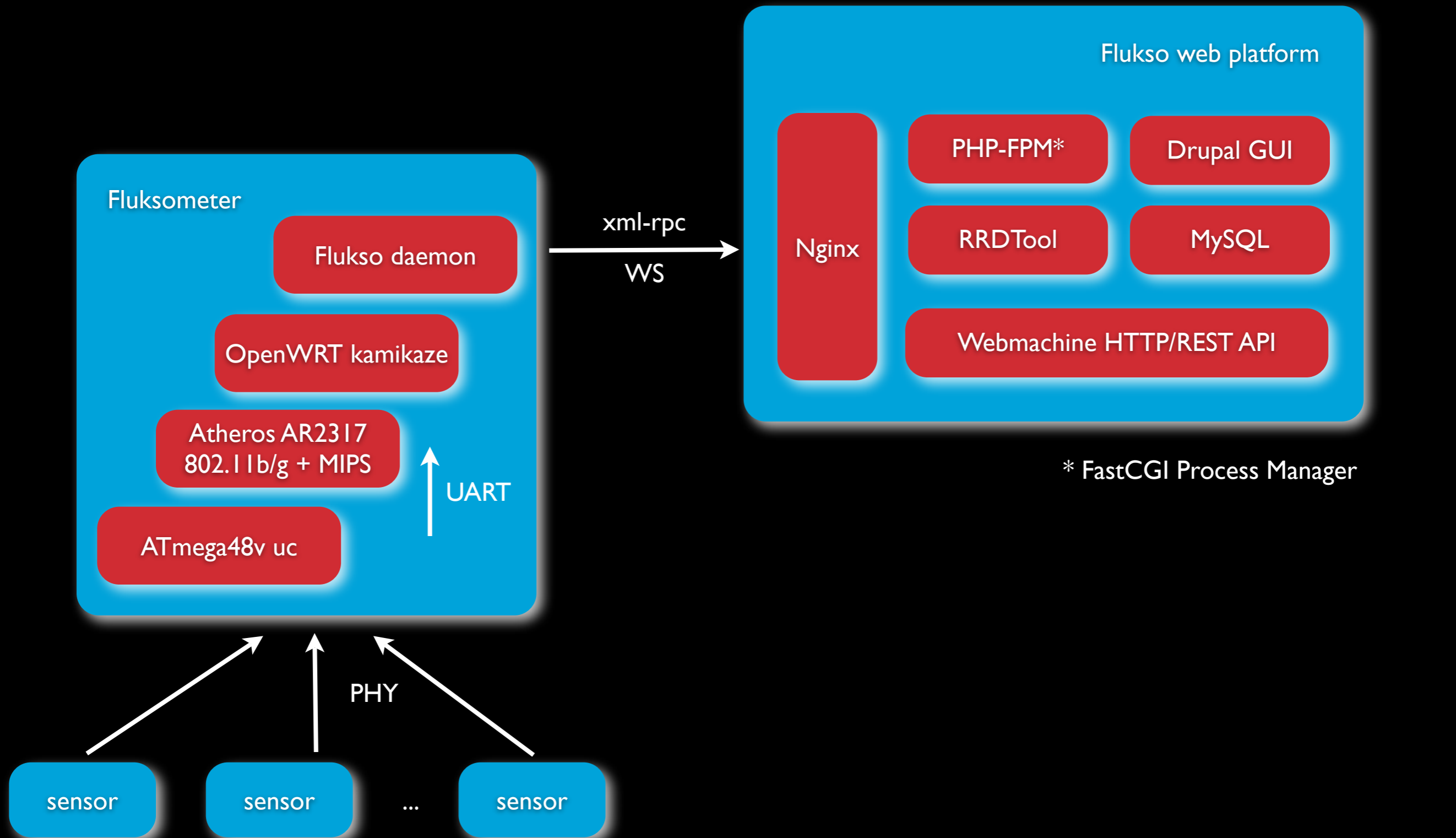
UART and power to main board



current clamp

Fluksometer

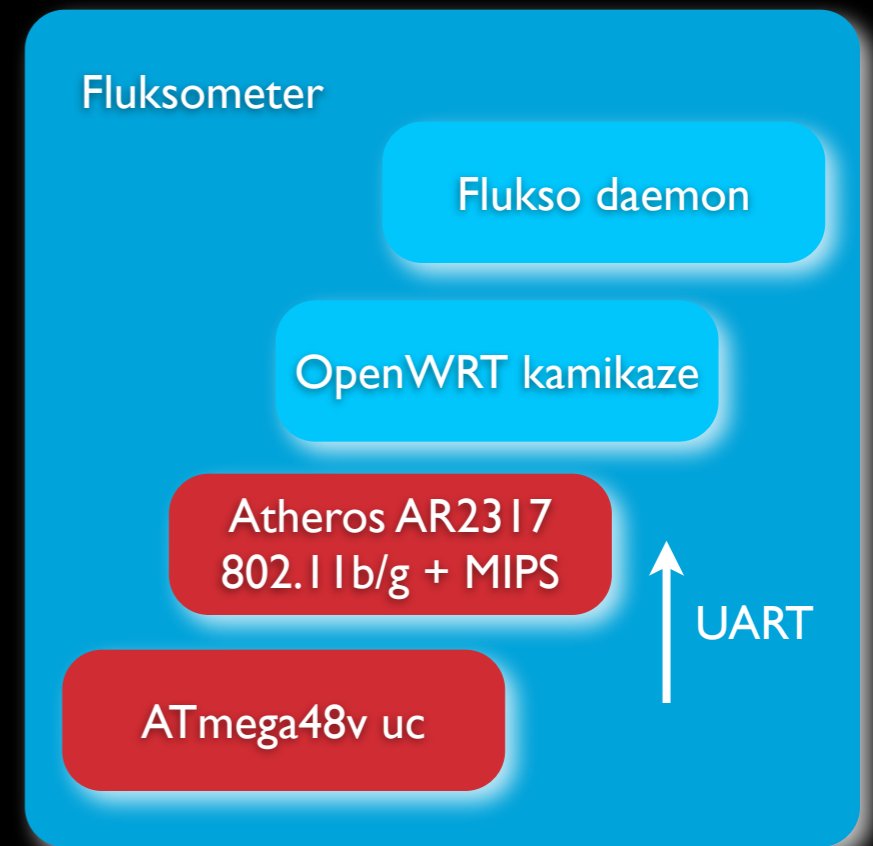




\* FastCGI Process Manager

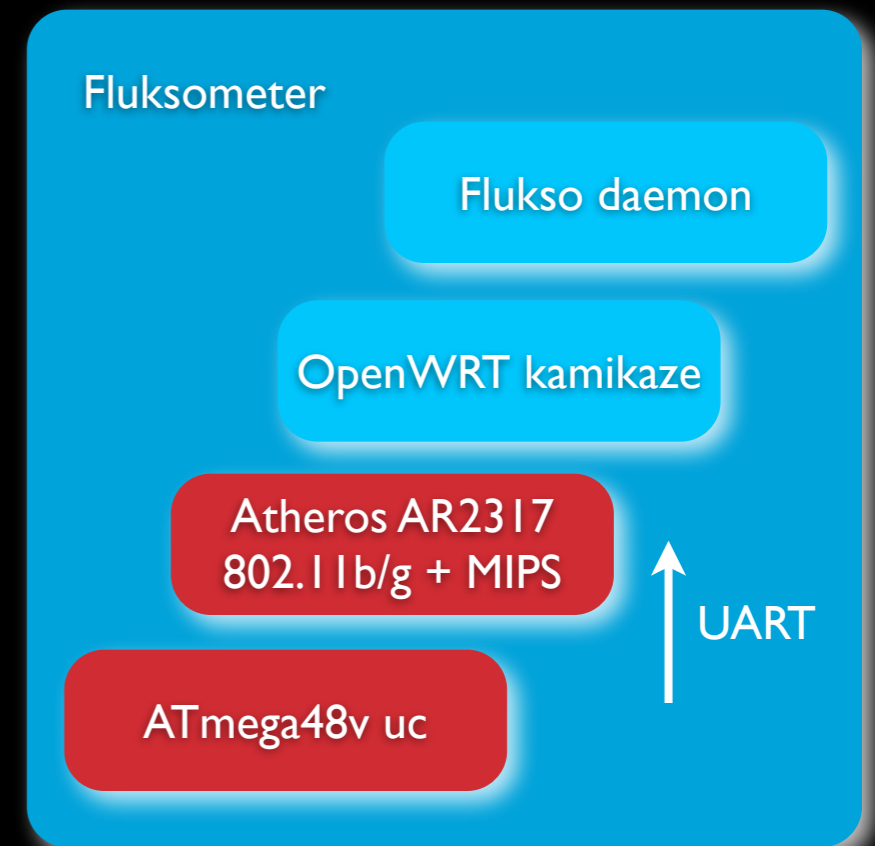
# Why two platforms?

- ATmega48v is an 8 bit AVR uc
- Loads of GPIOs
- 10 bit ADC / analog comparator
- U(S)ART / SPI / 2-wire
- Multiple timers / PWM
- A great platform for hooking up any sensor or actuator!
- BUT: Limited network connectivity



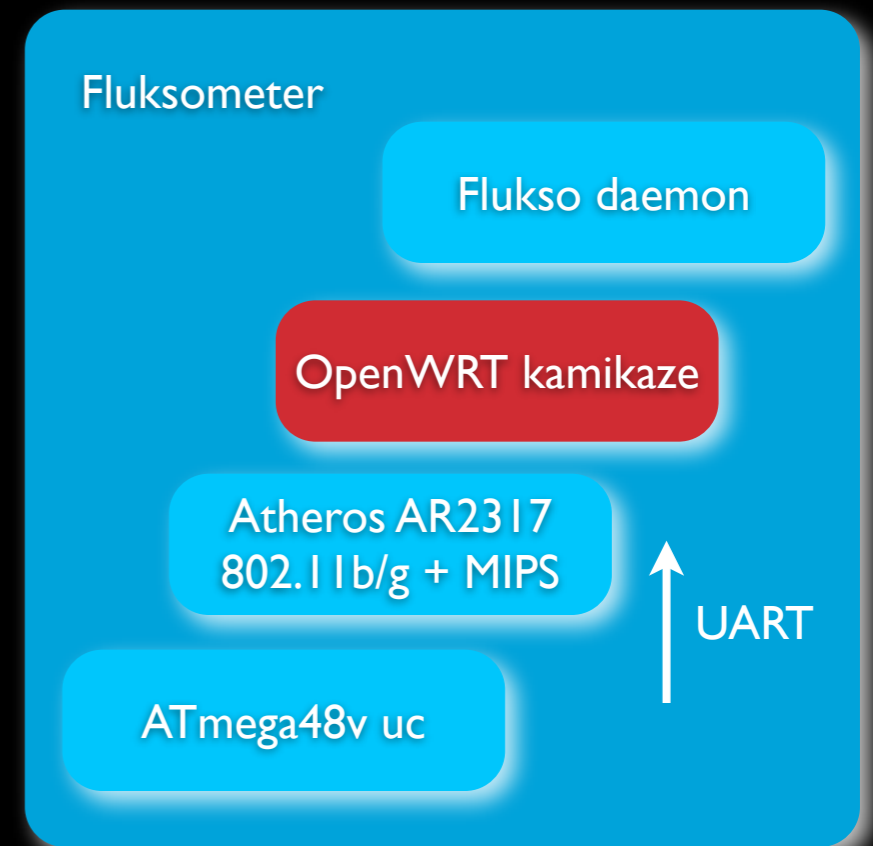
## Why two platforms? cont.

- Atheros AR2317 is an 802.11b/g SoC
- Integrated 32 bit MIPS R4Kc proc
- Flash with OpenWRT and you get an embedded Linux box
- Eth, Wifi, DHCP, NTP, PPP, PPTP, PPPoE, SSL, [your favorite acronym here]
- BUT: Only 8 GPIO pins. Poor physical computing platform.



# OpenWRT Buildroot

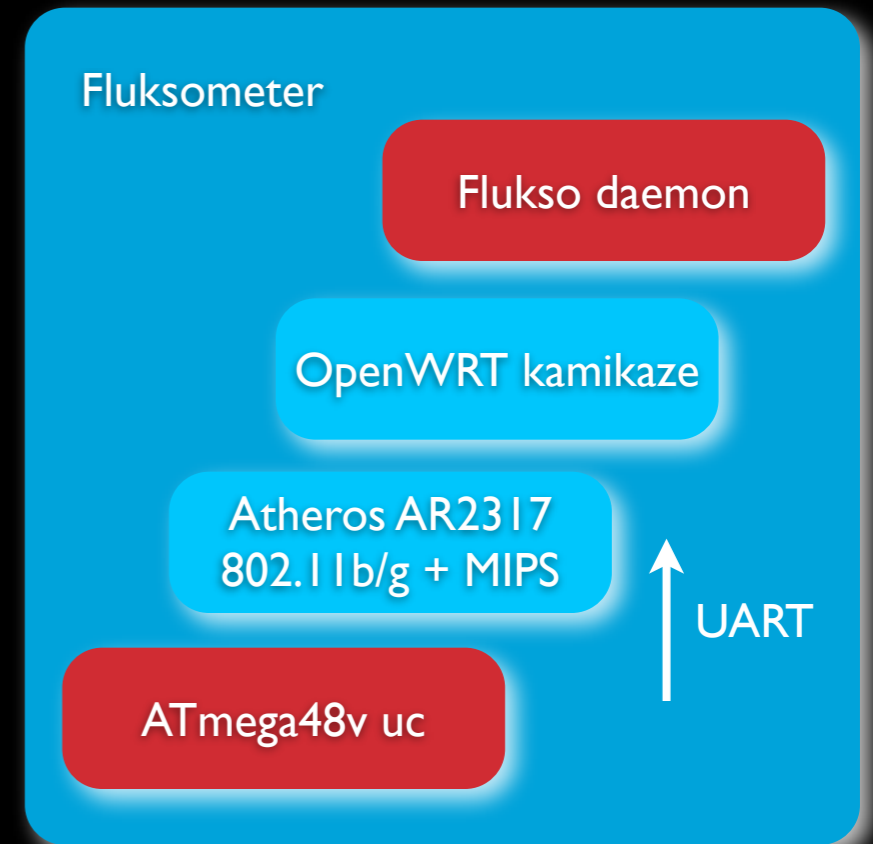
- set of Makefiles and patches
- x-compilation toolchain based on Linux kernel / uClibc and Busybox
- generates target firmware images and additional selected packages
- includes opkg package manager on target





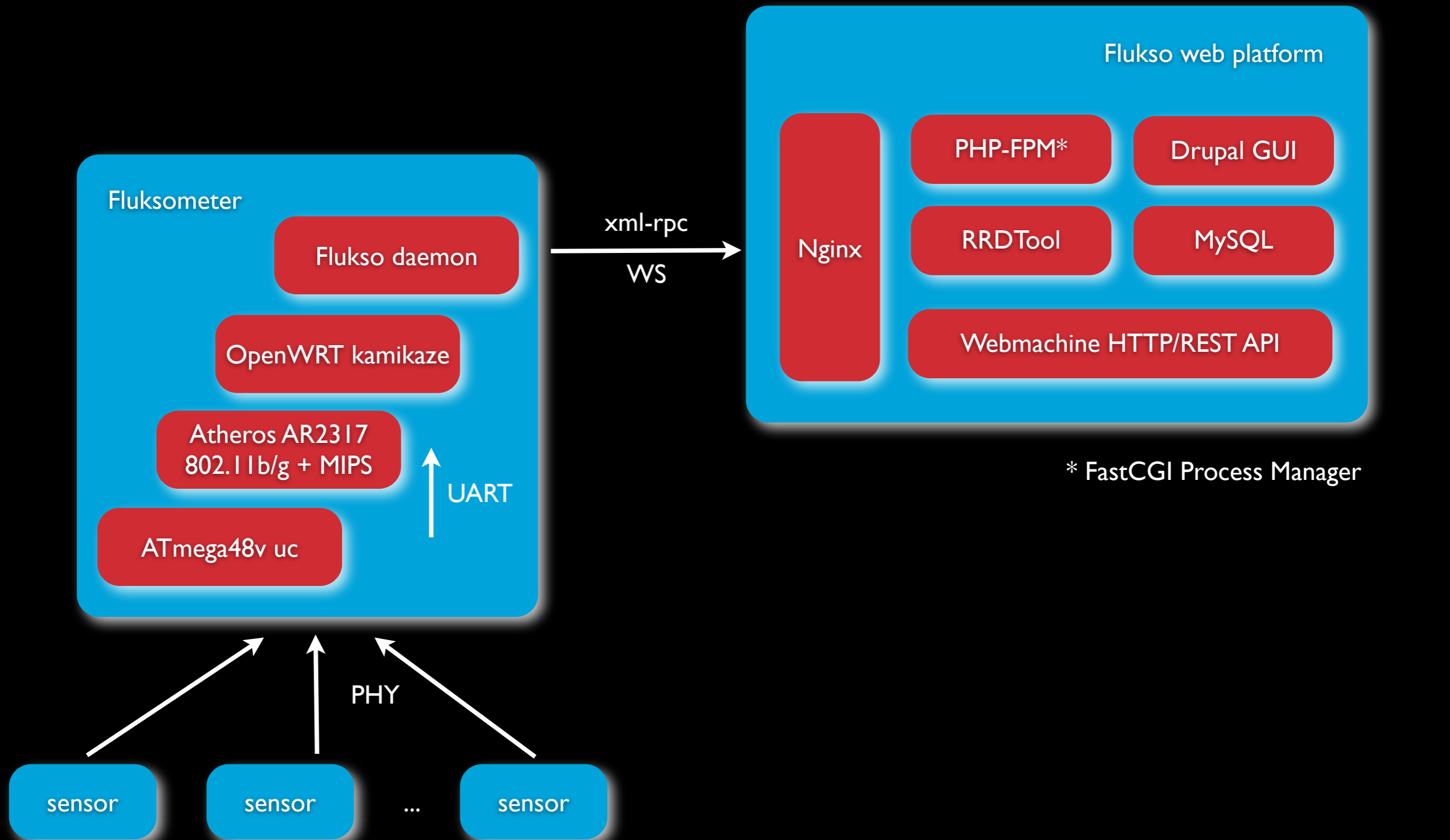
# What if the connection drops?

- Log {Timestamp, Counter} tuples
- Allows for 'gaps' in logging
- Never lose track of Counter! Use power loss detection circuitry in uc to trigger EEPROM write of Counter
- Buffer tuples in Fluksometer RAM
- Age tuples in the daemon so that RAM increases logarithmically in time



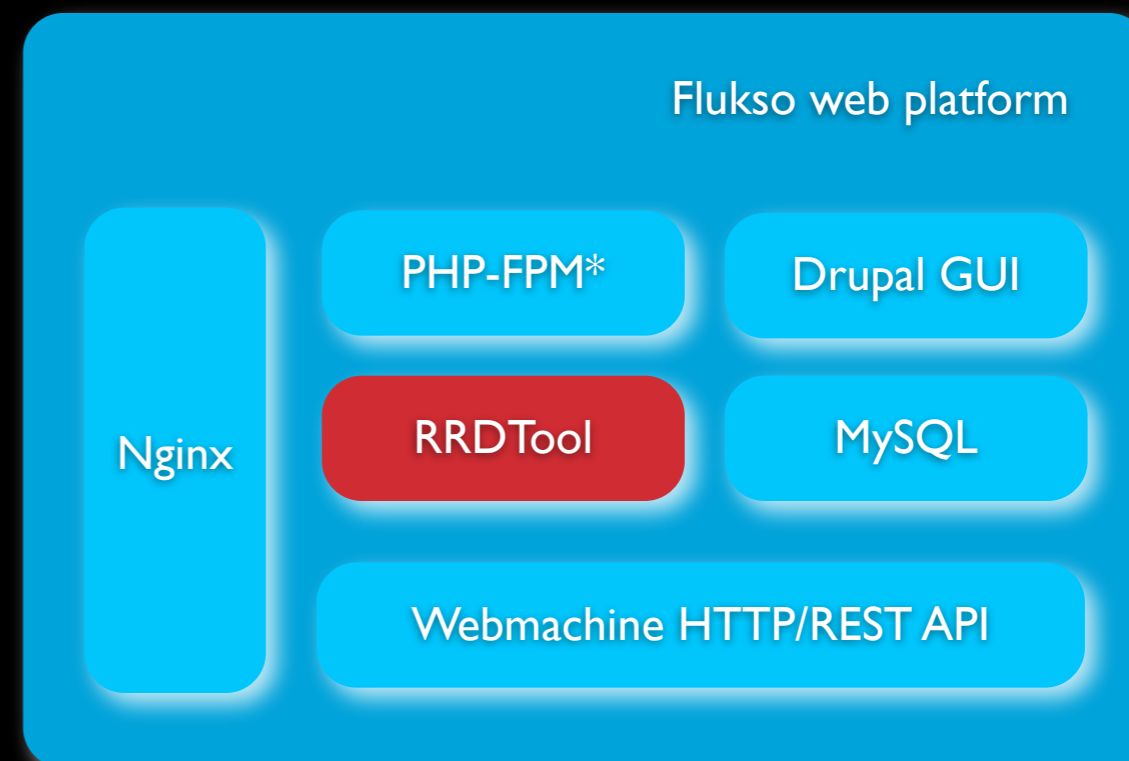


- Dynamically typed and garbage collected
- Primary and only data structuring mechanism: the ubiquitous table `{}`
- First-class functions, closures, proper tail calls
- Coroutines for non-preemptive multithreading
- Dynamic module loading
- Extensible through C API
- All these goodies on a 150KB footprint, incl luac!

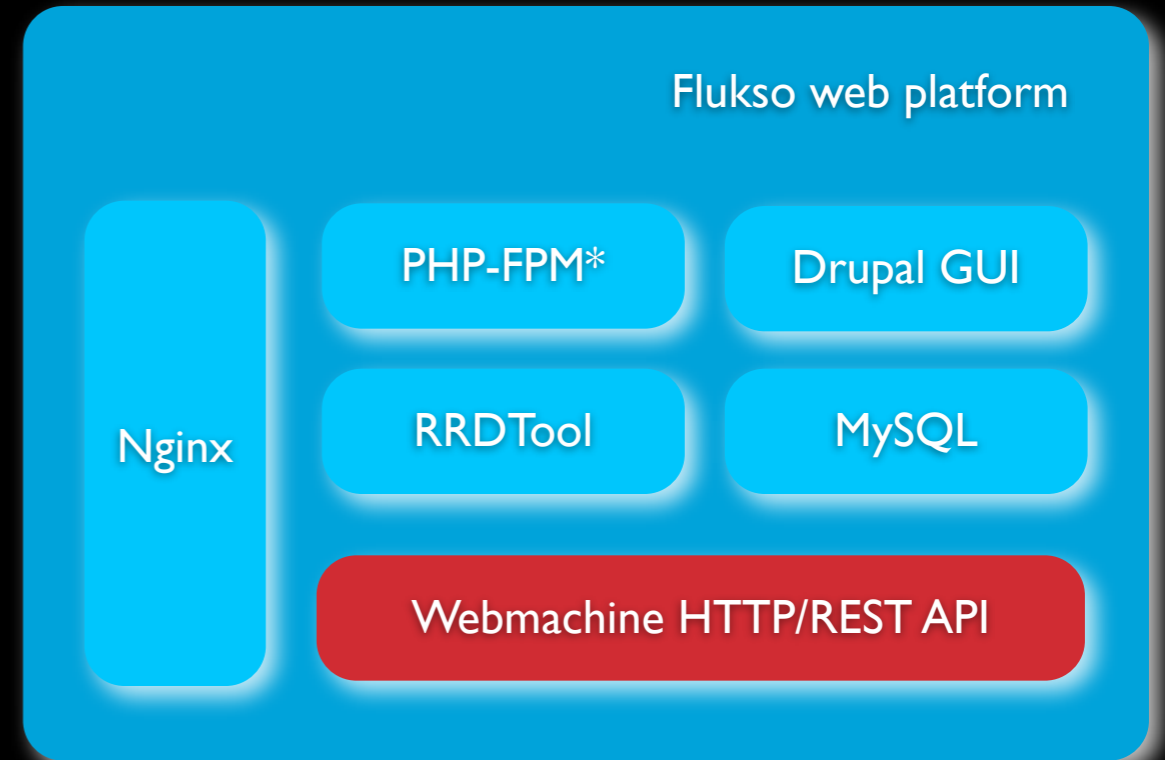


# Data storage?

- Log time series data in RRDs
- Data set will not grow in size!
- It will simply age the data, reducing resolution
- Graphing layer included
- 1.4 introduces a caching daemon for improved performance



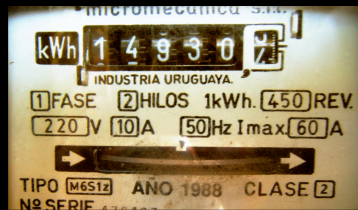
# Show me the API!



- Webmachine / Mochiweb based
- JSON HTTP/REST API
- [GET http://api.flukso.net/sensor/d8a8ab8893ea73f768b66b45234b5c3a/hour/watt](http://api.flukso.net/sensor/d8a8ab8893ea73f768b66b45234b5c3a/hour/watt)

- Introduce a broader range of current sensors [50A, 100A, 250A, 500A]
- Measure multiple electricity flows: aggregate consumption & PV or wind generation
- Monitor other resources: water, heating?
- Monitor environmental parameters: temp, humidity?
- Add RS-485 communication to the Fluksometer: mySmartGrid project





Vince Alongi, kWh

[www.flickr.com/photos/vincealongi/2927254475](http://www.flickr.com/photos/vincealongi/2927254475)



Macarena C., ?

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HW and SW repository at [dev.jokamajo.org](http://dev.jokamajo.org)