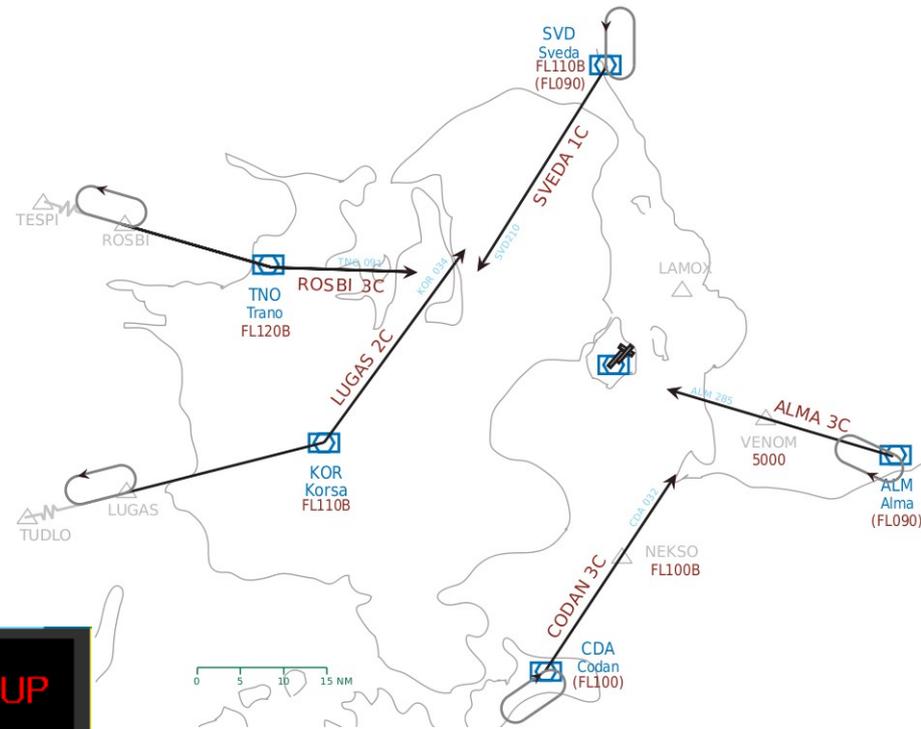


Measured (almost) does Air Traffic Control

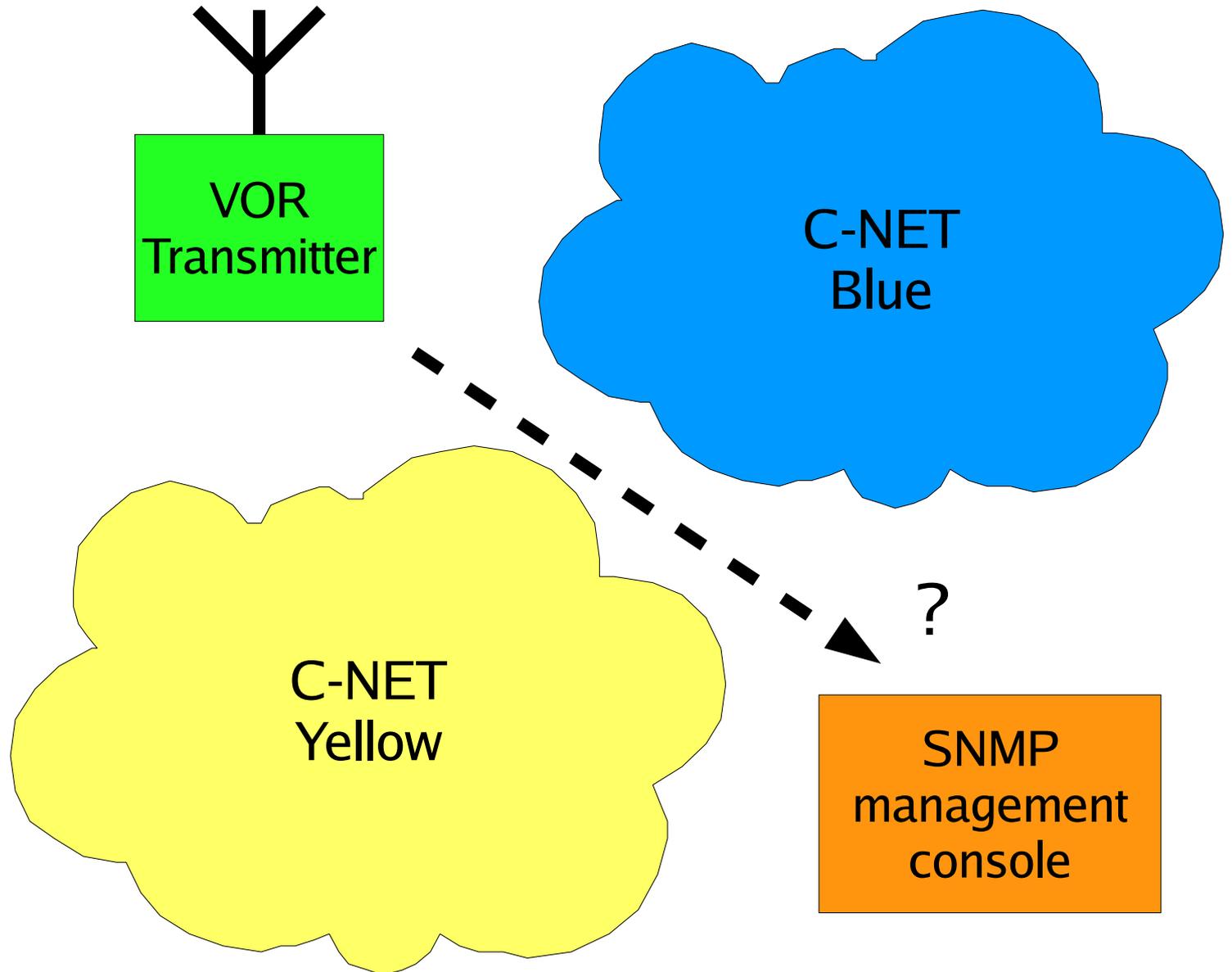


22R	04L	22L	Take-of 04R	12	30	SETUP
Wind 110	Velocity 3	X 2	QNH 1012			
Variable			Change			
150	060	+1				
9 Continue Approach	5 Cleared to Land	3 Break Off	VEHICLE on runway			

Poul-Henning Kamp

phk@FreeBSD.org

”Slagelse, we have a problem...”





Map **Satellite** Terrain

Show labels



200 mi
200 km

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Map **Satellite** Terrain

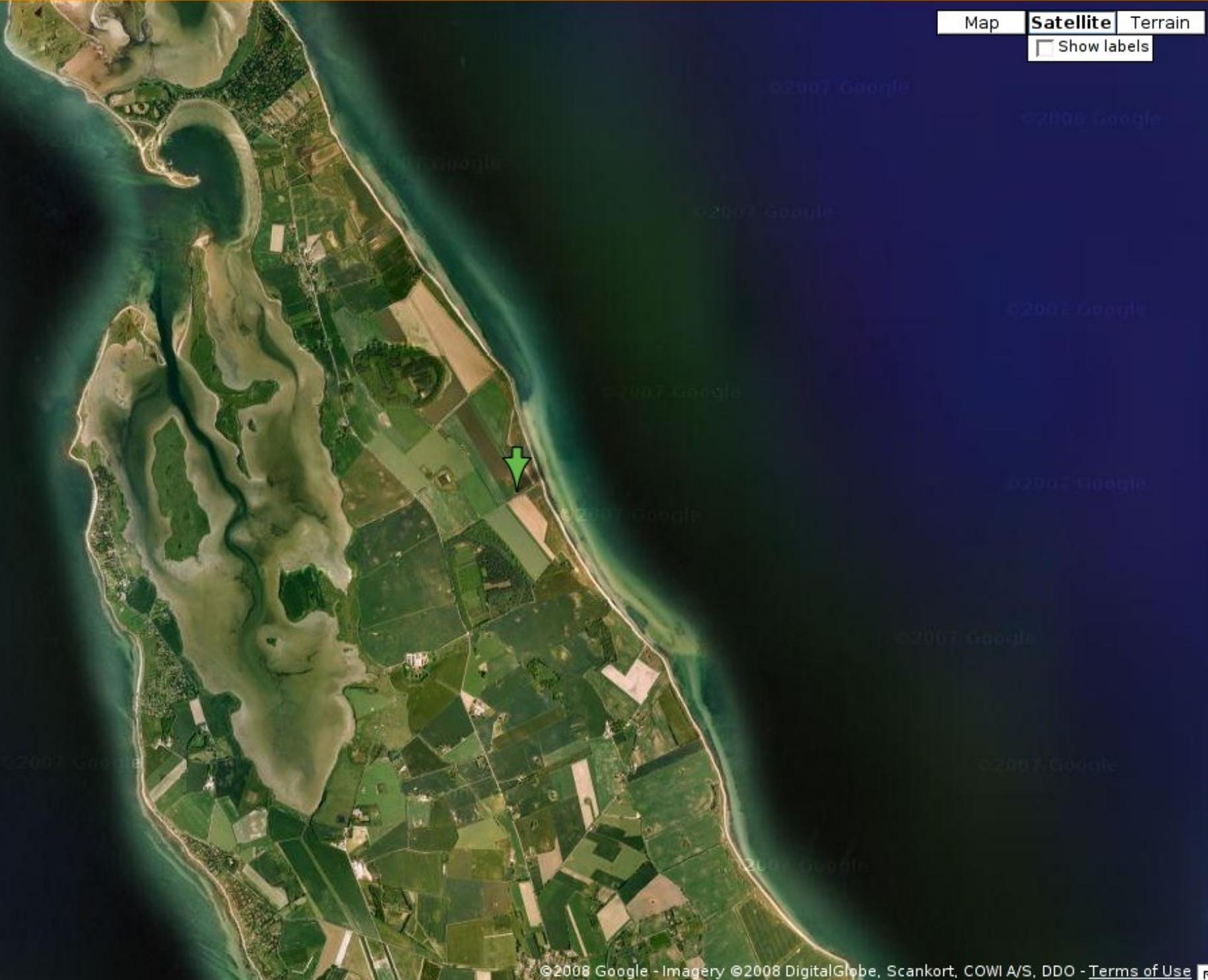
Show labels

10 mi
20 km

©2008 Google - Imagery ©2008 TerraMetrics - Terms of Use

Map **Satellite** Terrain

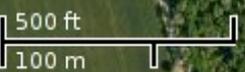
Show labels



2000 ft
1 km

Map **Satellite** Terrain

Show labels



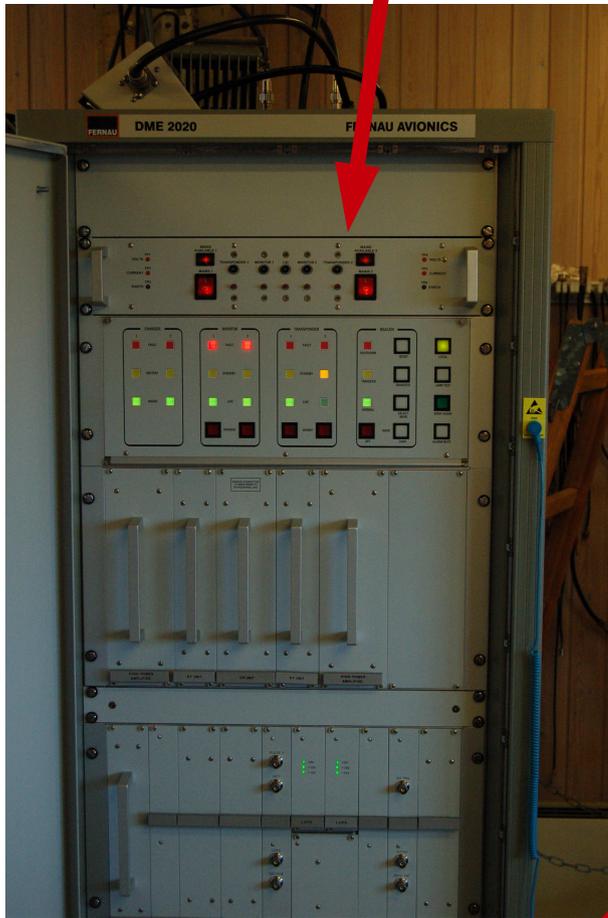
Map **Satellite** Terrain

Show labels





"Brand New" DME (1998)



μ P control

Serial interface
ad-hoc protocols

"New" VOR (1980)

"Old" VOR (1970)

No μ P control

Analog outputs

Digital outputs

Relay inputs



(Sorry, picture not released.)

Terms of Reference

Transmitters must be monitored or declared unusable.

No transmitters -> Visual Flight Rules ("VFR").

VFR ~ = All planes below the clouds in daylight

"monitored" = Known good signal or ability to shut signal down.

Overlapping service areas

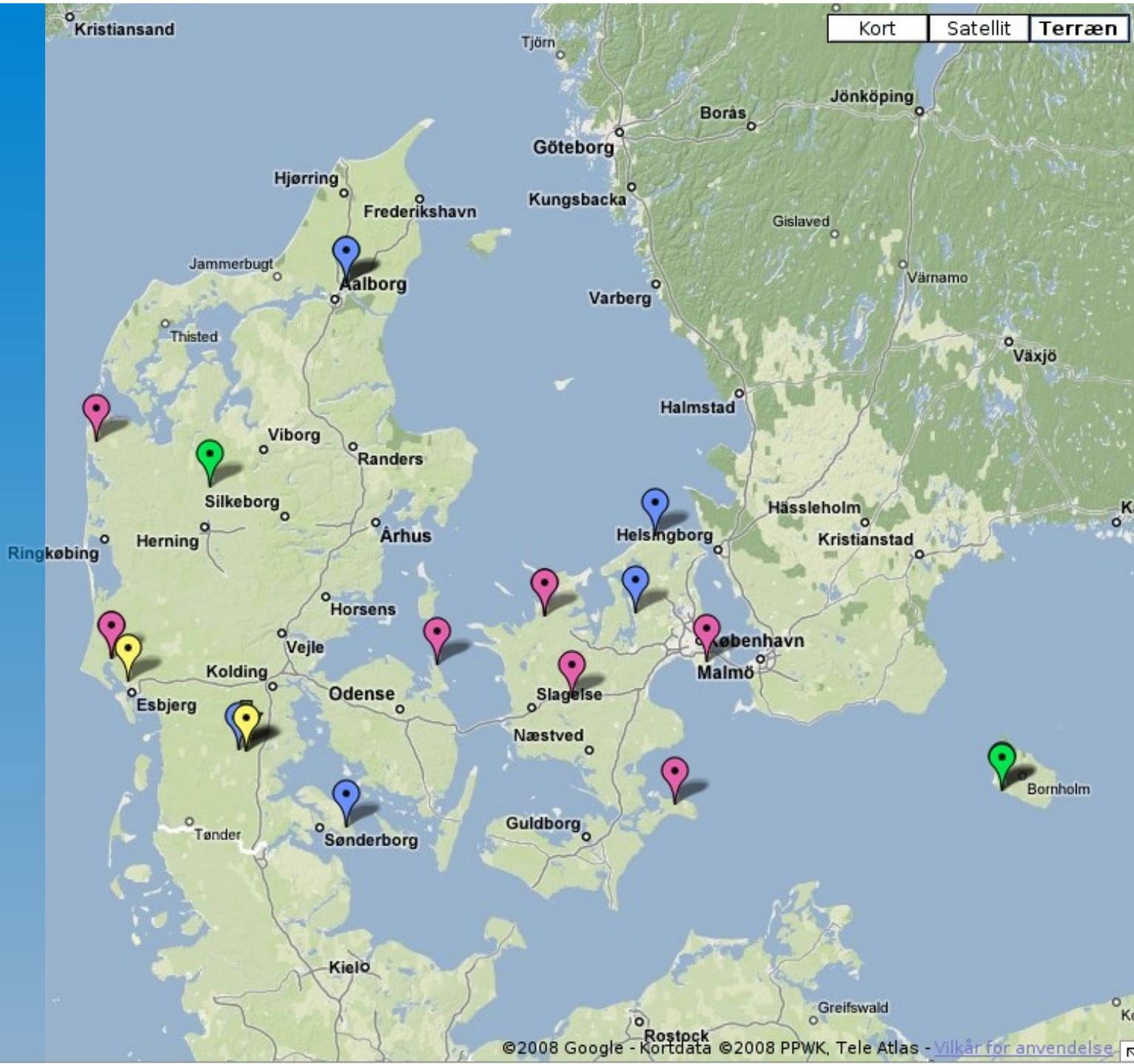
1+1 Transmitters

Integral monitor receivers

Backup power (Bat/Diesel)

Personel on call

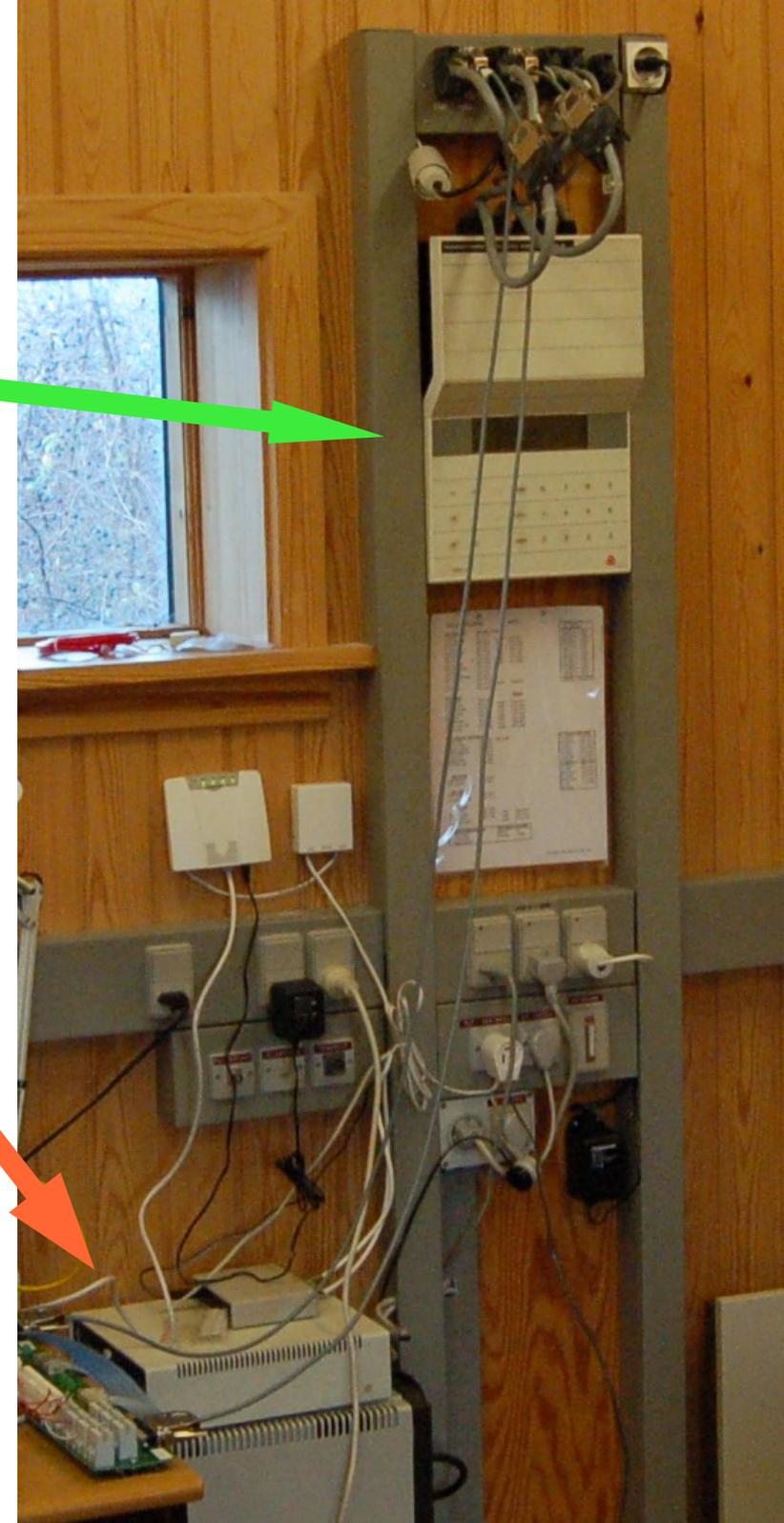
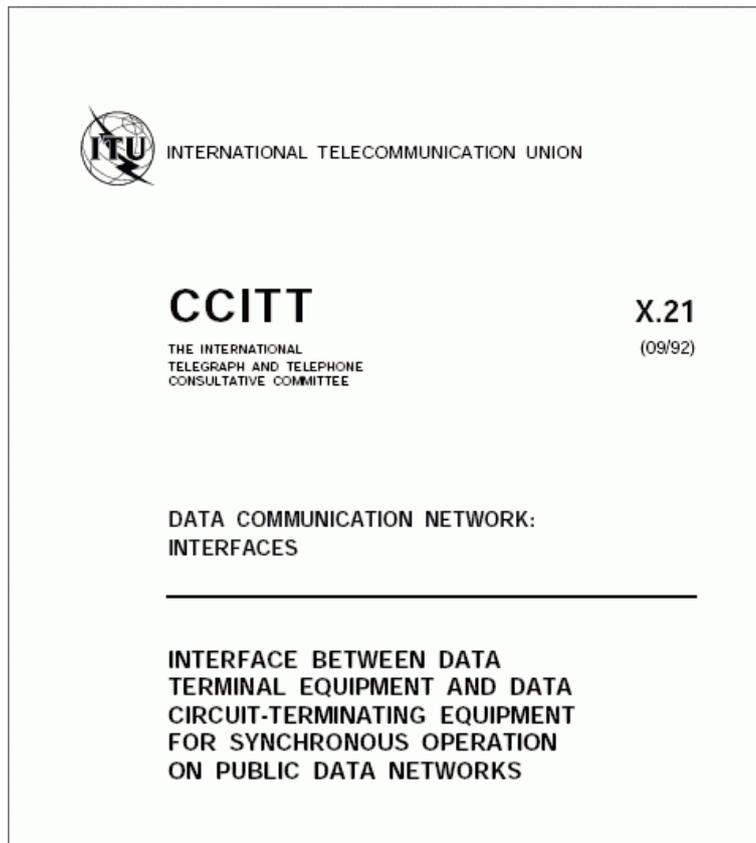
On-site spares



Existing monitoring system

Custom hardware at site:
Z80, ADC, LCD,EEPROMS

Communication:
PSDN/X.21/Datex-L



Central monitoring station

IBM PC-AT

MSDOS 3.30a

Combined station-poller + GUI program

TurboPascal

Real-Time logging to matrix printer

"Issues"

Source code for existing system on file

-> but does not compile to running version

Spare part issues

X.21 PSDN closes 2008-07-01

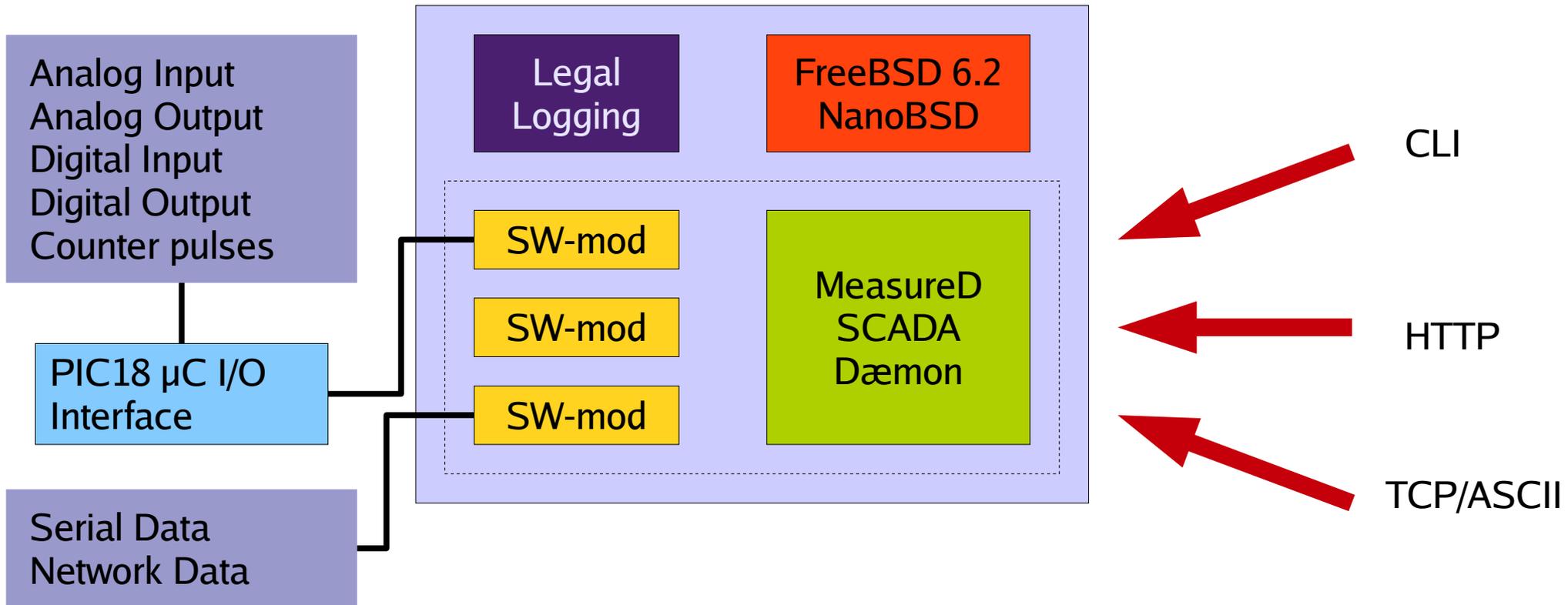
"Brand New" DME transmitters for R-NAV.

R-NAV:

New spec. that allows planes to be packed 3 times closer in XYZ+Hz



The MeasureD solution



All of this is open source (BSD or Beerware)

Not in ports, I lack the time+fu+bit, volunteers welcome

Command line interface

Mostly for configuration

"ConfigKit" tool writes most of the booooring code, based on a specification

"show" hook presently unused.

```
pic18m 98 point 4 unit V
pic18m 98 point 4 offset 8.192 # "8.192"
pic18m 98 point 4 scale 2.000 # "2.0"
pic18m 98 point 5 format %.3f
pic18m 98 point 5 unit V
pic18m 98 point 5 scale 4.000 # "4.0"
pic18m 98 point 8 format %.3f
```

```
NODE point {
    name      cfg_point
    desc      "per point stuff"

    WORD label WORD {
        desc   "Alphanumeric label"
        func   cfg_point_label
    }
    WORD format WORD {
        desc   "Format string"
        func   cfg_point_format
    }
    WORD unit WORD {
        desc   "Measurement units"
        func   cfg_point_unit
    }
    WORD offset WORD {
        desc   "Offset value"
```

Built in WEB-server

Quick/Ad-hoc access to status and changes to outputs.

Logfile (fixed size buffer)
Alarms (fixed size buffer)

Data from one of the battery chargers in my 12/24V UPS

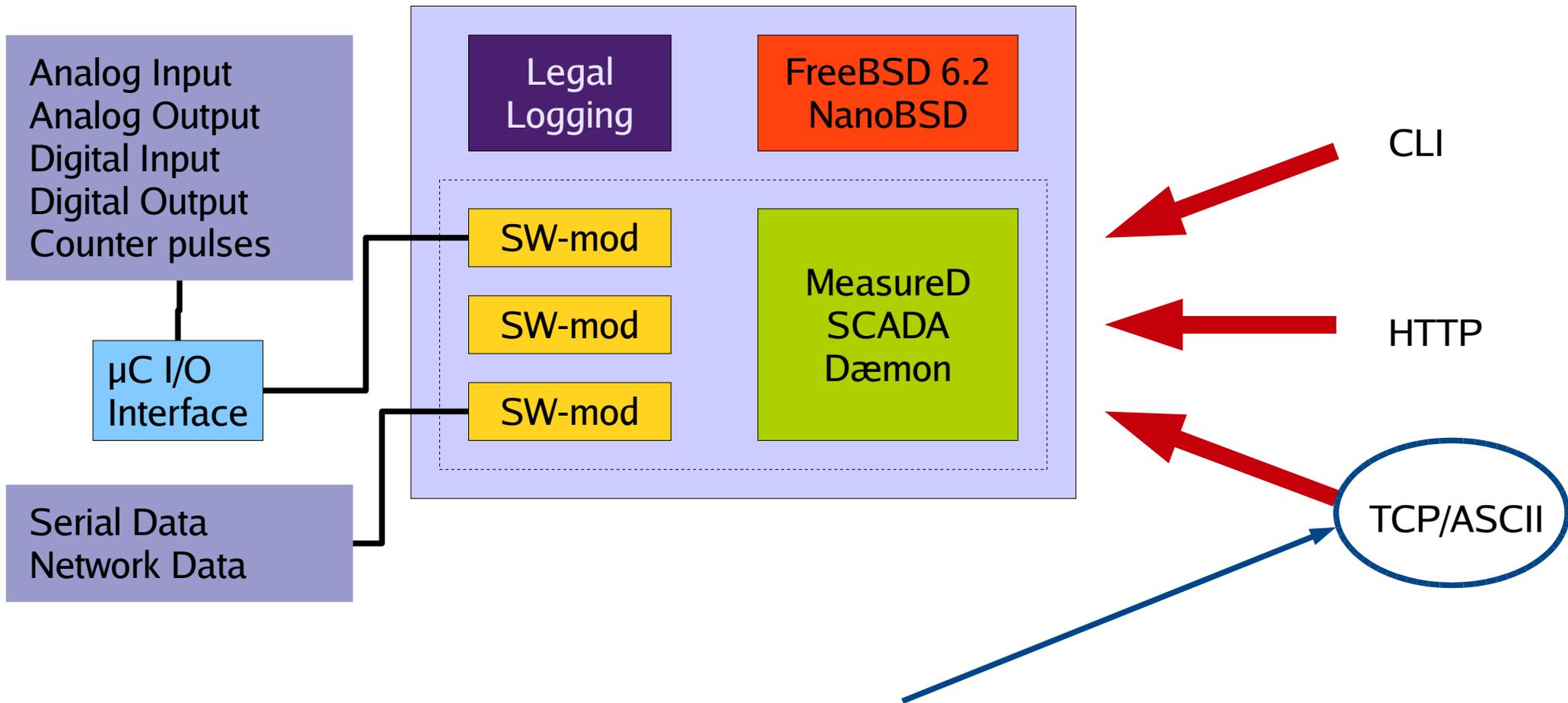


[Data](#) [Logfile\(old->new\)](#) [Logfile\(new->old\)](#) [Configuration](#) [Alarm-State](#) [Alarm-Log\(old->new\)](#) [Alarm-Log\(new->old\)](#)

site 000

group 000.098 pic18m

Index	Type	Label	Value	Action	Units	Low	Sag	Raise	High	Trap
000.098.001	ain	IREF	-0.000							
000.098.002	ain	IBAT	0.003		A					
000.098.003	ain	IMON	0.053		A					
000.098.004	ain	VBAT	11.549		V					
000.098.005	ain	VCHG	13.836		V					
000.098.006	aout	VTRIM	39321	39321						
000.098.007	aout	ITRIM	32	32						
000.098.008	ain	TBAT	18.625		°Celcius					
000.098.009	aout	AUTO	1	1						
000.098.010	ain	L	1							
000.098.011	ain	ERR	6							
000.098.012	aout	ERR1	1	1						
000.098.013	aout	ERRVAL1	39928	39928						
000.098.014	aout	ERRVAL2	39750	39750						
000.098.015	din	ILIM	0							
000.098.016	aout	TMAX	20	20						
000.098.017	aout	ICC	3	3						
000.098.018	aout	IFLT	0.3	0.3						
000.098.019	ain	VTFL	13.8251							
000.098.020	ain	VTCV	14.2967							



This is the important bit:

Measured offers subscription to data in real-time
Allows real-time control of outputs

```
$ telnet h55 2040
```

```
Connected to h55.freebsd.dk.
```

```
Escape character is '^]'.  
GET /master HTTP/1.1
```

```
HTTP/1.1 200 OK
```

```
Content-Type: text/html; charset=iso-8859-1
```

```
Cache-control: no-cache; no-store;
```

```
Pragma: no-cache
```

```
PATTERN 0.98.4
```

```
EVENTS value
```

```
E 000.098.004 P VALUE 11.549 1209905866.434603376
```

```
E 000.098.004 P VALUE 11.550 1209905867.584414041
```

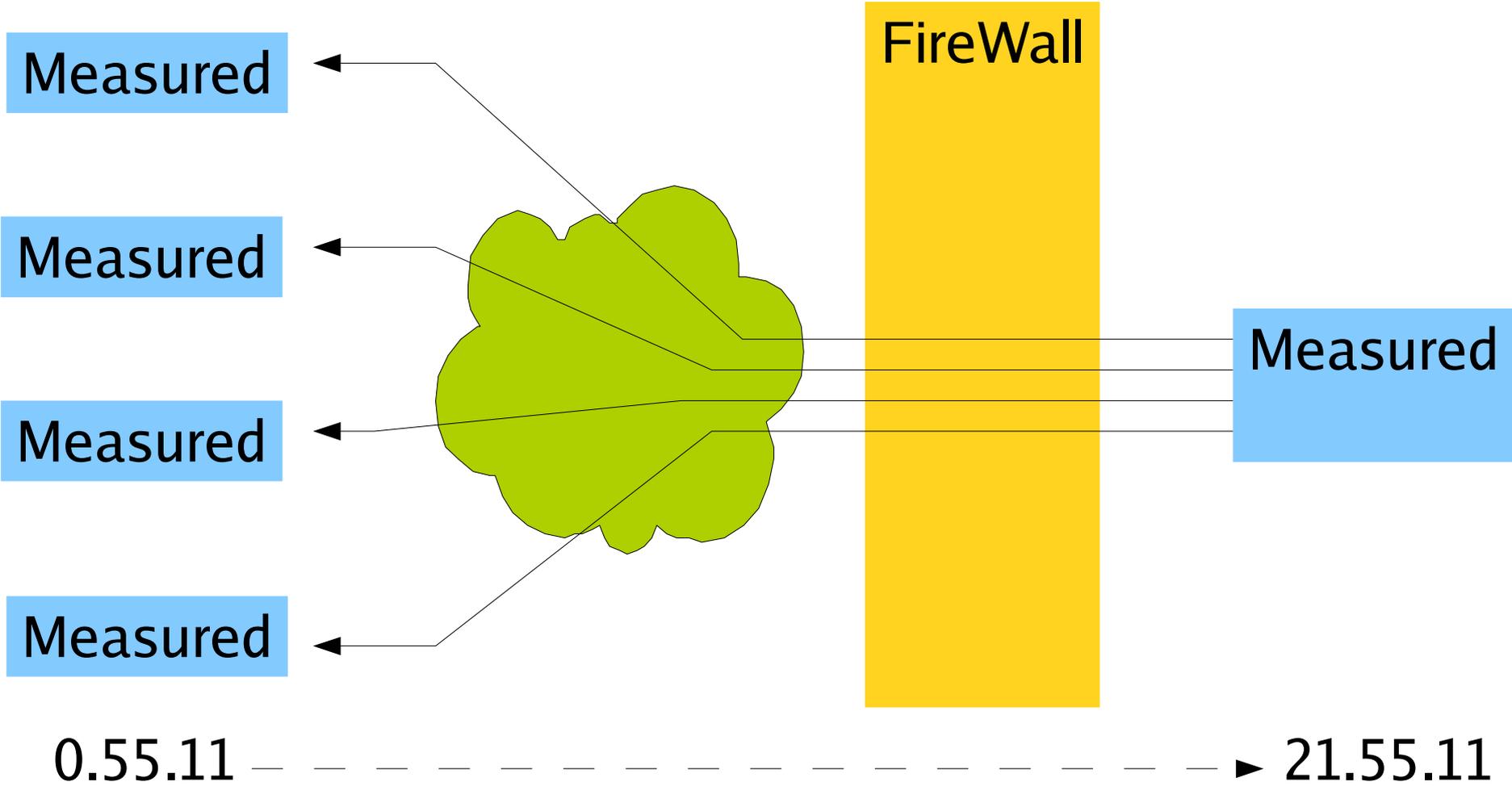
```
E 000.098.004 P VALUE 11.549 1209905868.734283199
```

```
E 000.098.004 P VALUE 11.551 1209905869.884083691
```

```
E 000.098.004 P VALUE 11.550 1209905871.033900573
```

```
...
```

Master/Slave



Control Agents

Measured ↔ Tcl Script

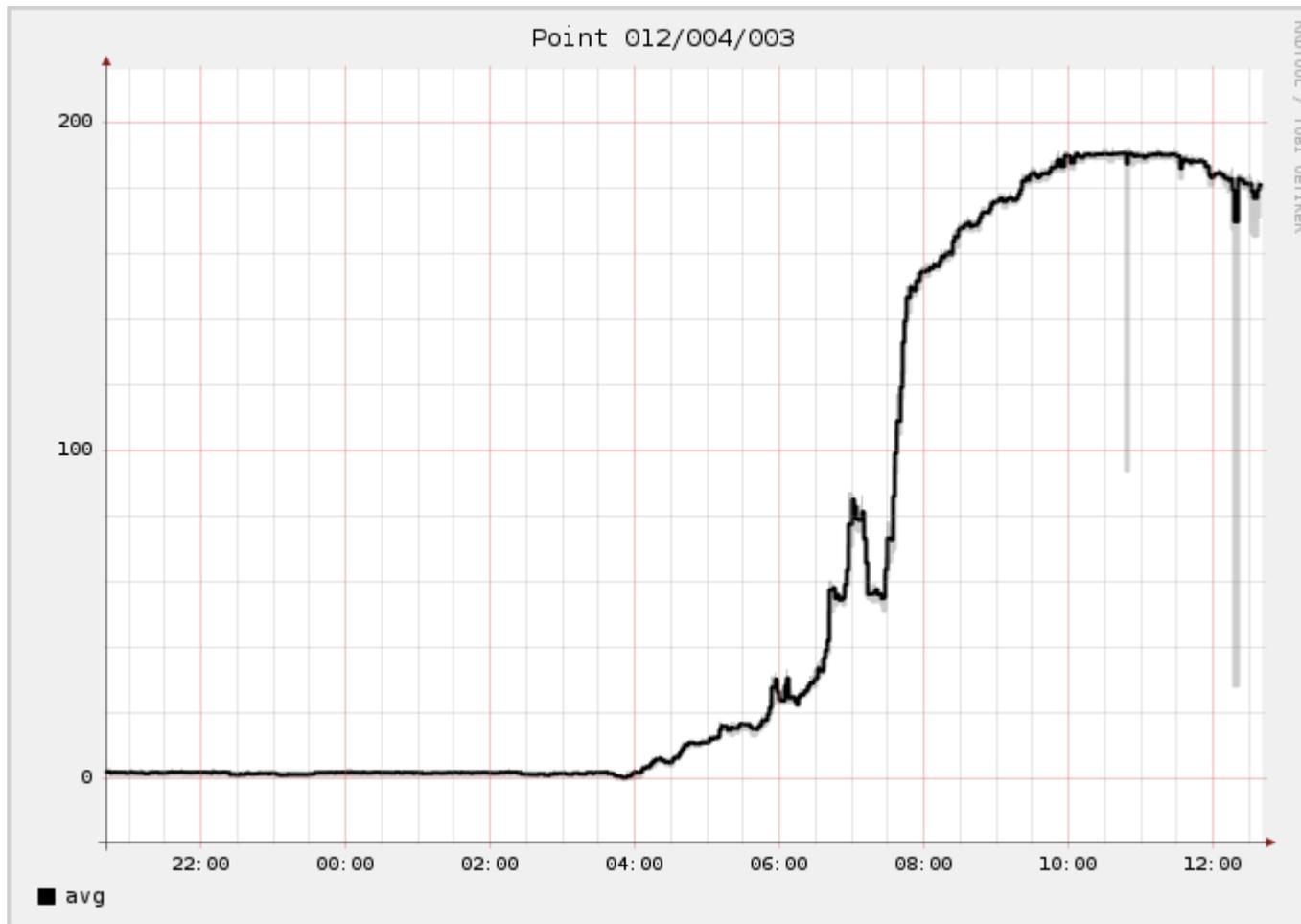
```
Subscribe to input points
while read measurements {
  if (condition becomes true) {
    send "CONTROL 12.43.1 2"
  } else if (condition becomes false) {
    send "CONTROL 12.43.1 5"
  }
}
```

Plotting trends

Measured

Tcl Script

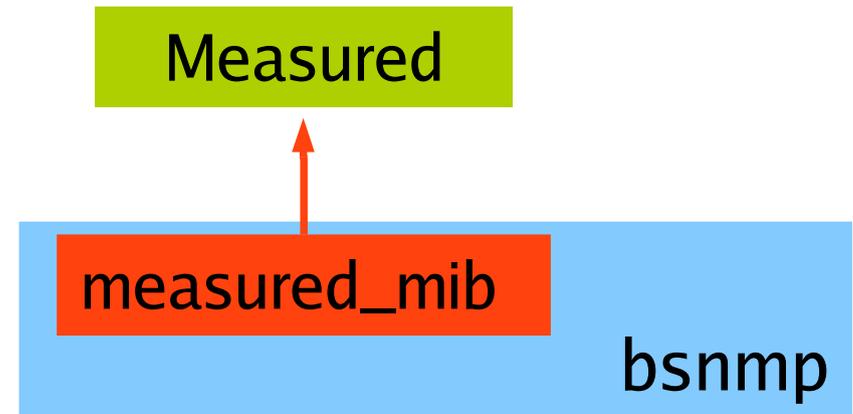
RRDtool



Data from a Soekris in my beach-house, which talks RS-485 + MODBUS to a power-meter on my PV-system.

SNMP gateway

bsnmp module



Connects to measured via TCP/"master" protocol

GET support for all measurement points

GET support for "virtual alarm lights"

TRAPs for limits & lights

Real-Time View

The screenshot shows a monitoring interface with the following components:

- Header:** A speaker icon, the title "FERN - VOR / DME Overvågning", and the time "19:27:36".
- Transmitter Status:** Two columns of buttons representing transmitters. The left column is labeled "Vest" and includes "ODN", "RAM", "dme (29)", and "dme (30)". The right column is labeled "Øst" and includes "ROE", "KAS", "NOA", "TNO", "KOR", "BEL", "CDA", "SUP", "hut (1)", "hut (2)", "hut (3)", "hut (4)", "hut (5)", "hut (26)", "hut (7)", "vor (1)", "vor (2)", "vor (3)", "vor (4)", "vor (5)", "vor (7)", "dme (22)", "dme (24)", "dme (25)", "dme (26)", "dme (27)", and "dme (39)".
- Alarm Logs:** Two scrollable lists. The left list, titled "Alarm Vest OTBI/OTYT", contains two red entries: "19:26:42 ran dme No measurement" and "19:26:42 ran dme Beacon Shutdown". The right list, titled "Alarm Øst OTN", is currently empty.
- Controls:** "Clear" and "Silence" buttons are located below each alarm list.

Overview of all xmitters

Gateway to other apps

Alarm-view
(two silenced alarms)

Written in Tk, 3000 lines



From: asm@... (Dept. of minor systems)

Subject: We have a problem: "TAMI"

The MET data, RWY-in-USE and 9-5-3 are still outstanding, we propose to combine them into one "TAMI" system, since we only have room for a 6" touch-panel in most of the workstations.

[...]

Deadline: Beatles, HELP, side B, track 6 ("Yesterday")

Data from two separate systems:

”Vindpanel” - RS-485 active multidrop

”We sort of have the protocol doc”

Measured-module: 294 lines of C

AIS – RS-232 passive multidrop

”We have no docs on the protocol”

Measured-module: 278 lines of C

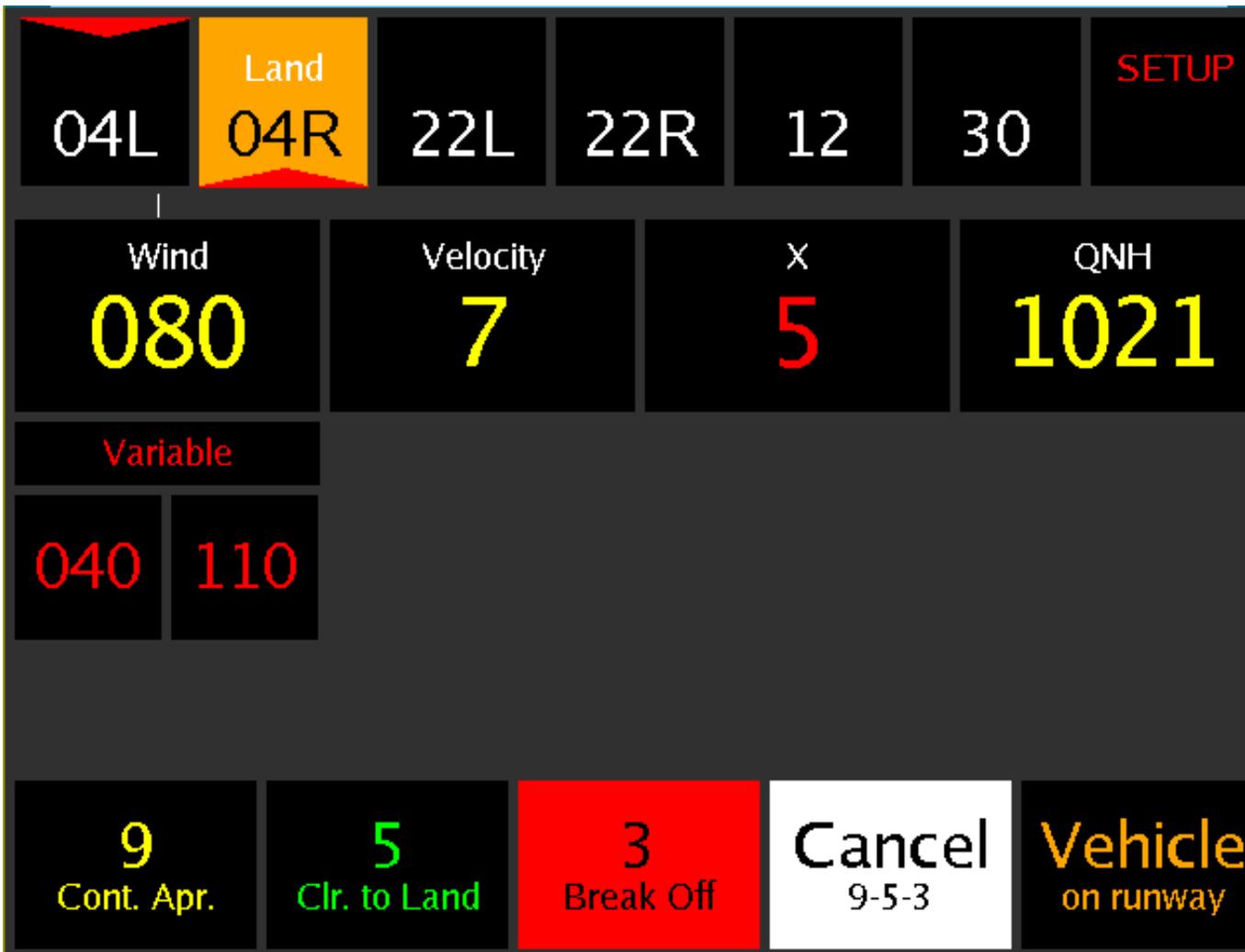
HW:

2 redundant Soekris ”proxies”

Yellow/Blue network

Prototype running in 2 weeks.

User-interface <3k lines Tk
Touch panel support in C
.wav file support in C
"9-5-3" voting protocol in C



HW:

Via EPIA-N
6" LCD + Touch
Custom Casing
picoPSU
4GB ATA-Flash



Current Measured Modules

<i>Name</i>	<i>LOC</i>	<i>Description</i>
Circutor	- 217	Circutor Electricity meter (RS-485)
Fifolog	- 258	Log module
Hmr2300	- 129	Honeywell magnetometer
Pc87366	- 320	Soekris GPIO chip
Pic18m	- 666	PIC18F based I/O expander
Prs10	- 273	SRS Rubidium Frequency Standard
Serspy	- 90	Serial Data Spy (just logs all data)
Soekris	- 195	Soekris Environmental (temp + voltages)
Test	- 98	Pseudo-Module for testing stuff
Vaillant	- 304	Vaillant EcoTech Natural Gas Furnace

(+ 8 weird ATC specific modules)

The PIC18 I/O expander

Needs PIC18F1320 or larger chip

Serial interface to FreeBSD computer

Wires directly to Soekris GPIO port, no level converter.

Firmware updates (ICSP) via Soekris GPIO port.

Pins configurable to:

Analog input

Digital input

Digital output

PWM output

Counter input

1-Wire TEMP-sensor (on PIC's with enough flash)

The PIC18 I/O expander

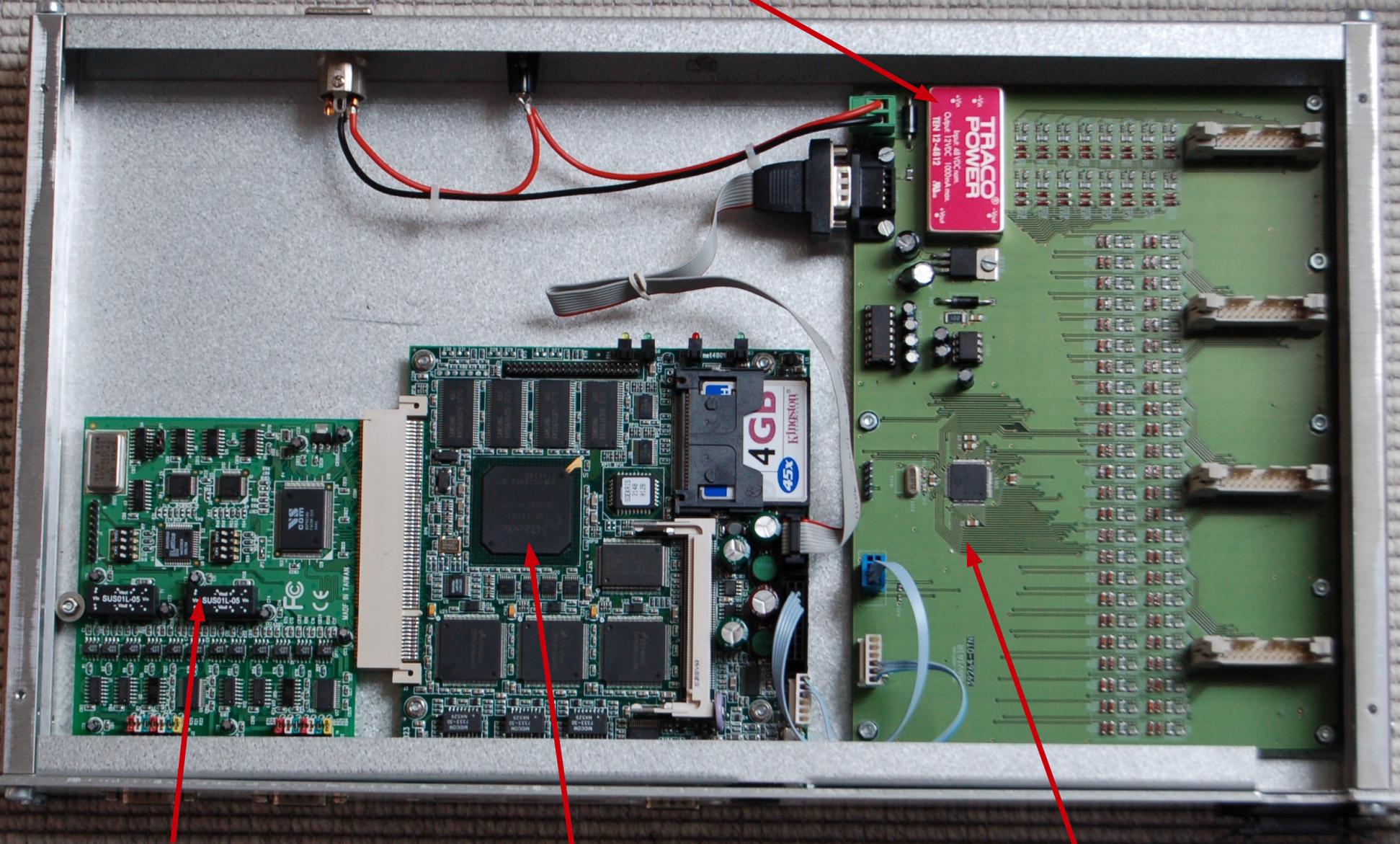
Firmware written in C (ports/lang/sdcc)

Output pins come up in last saved state on power-up

Hooks for custom algorithms

- Lead-Acid battery-charger

24-48V Isolated DC/DC supply



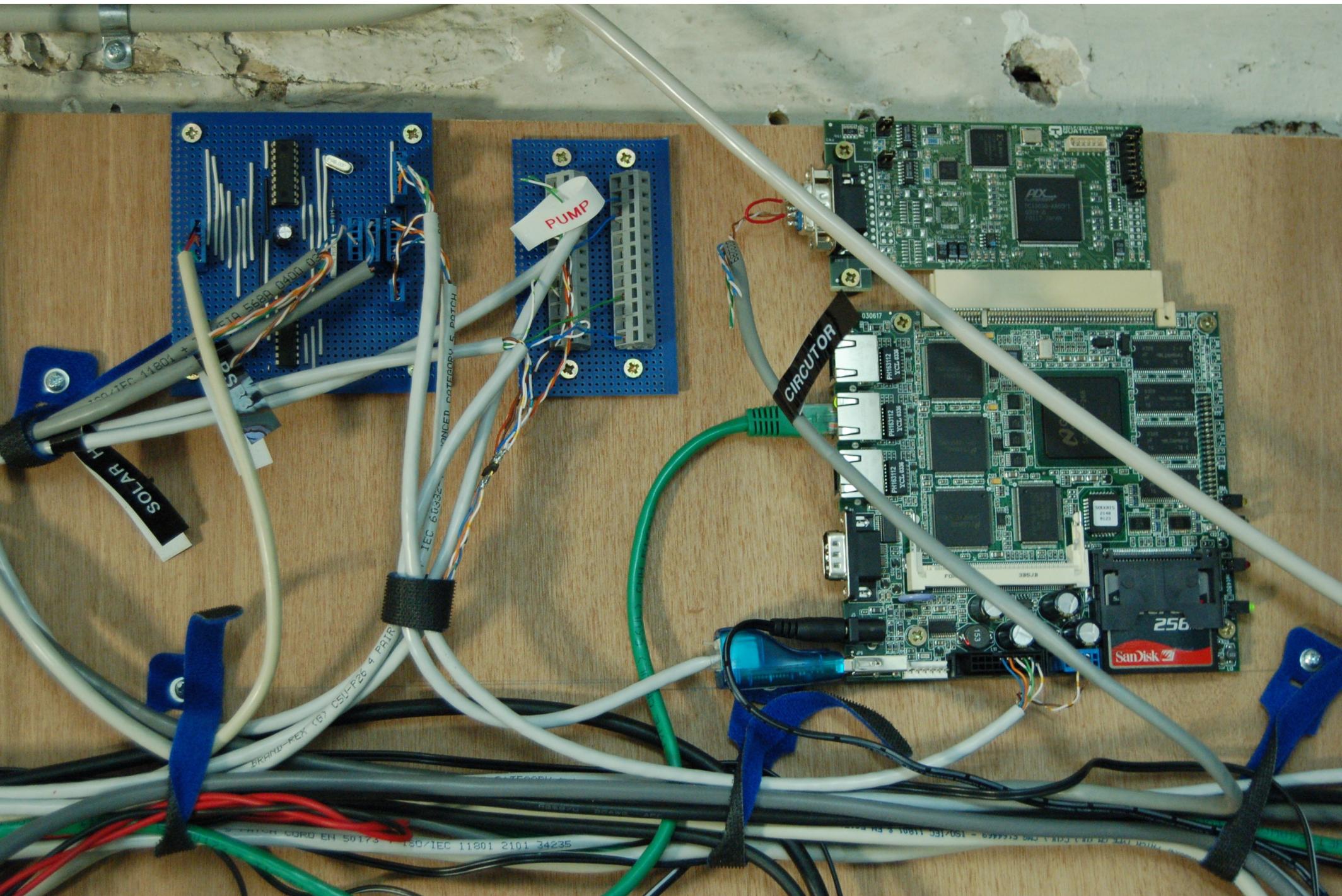
Isolated Serial
RS232/422/485

NET4801

PIC18F8722

Wiring it up to the station





SOLAR H...

PUMP

CIRCUITOR

FRAND-REX (C) CSU-P26 4 PPR

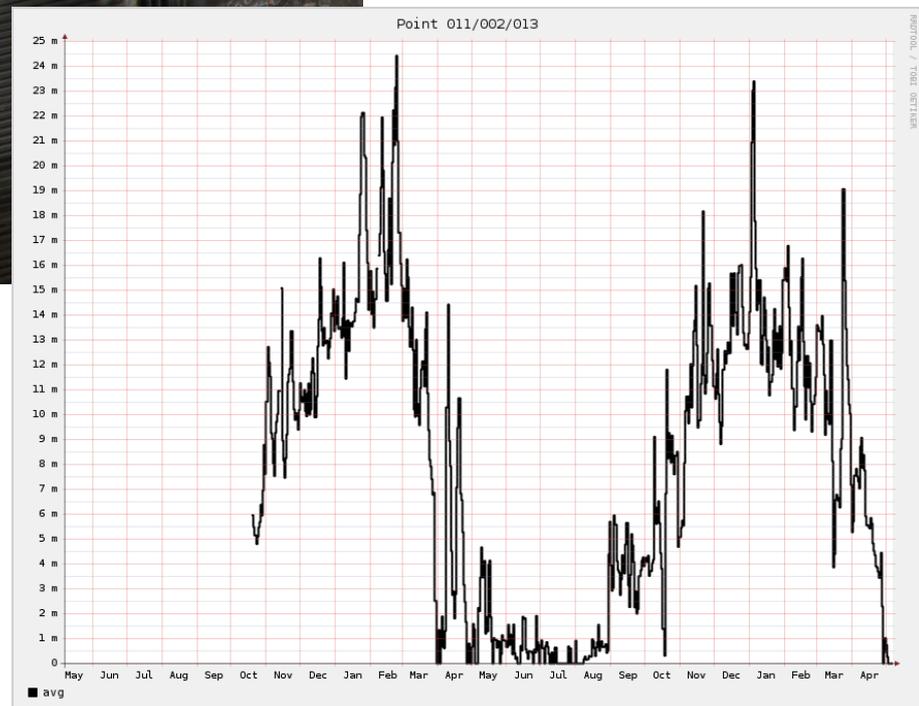
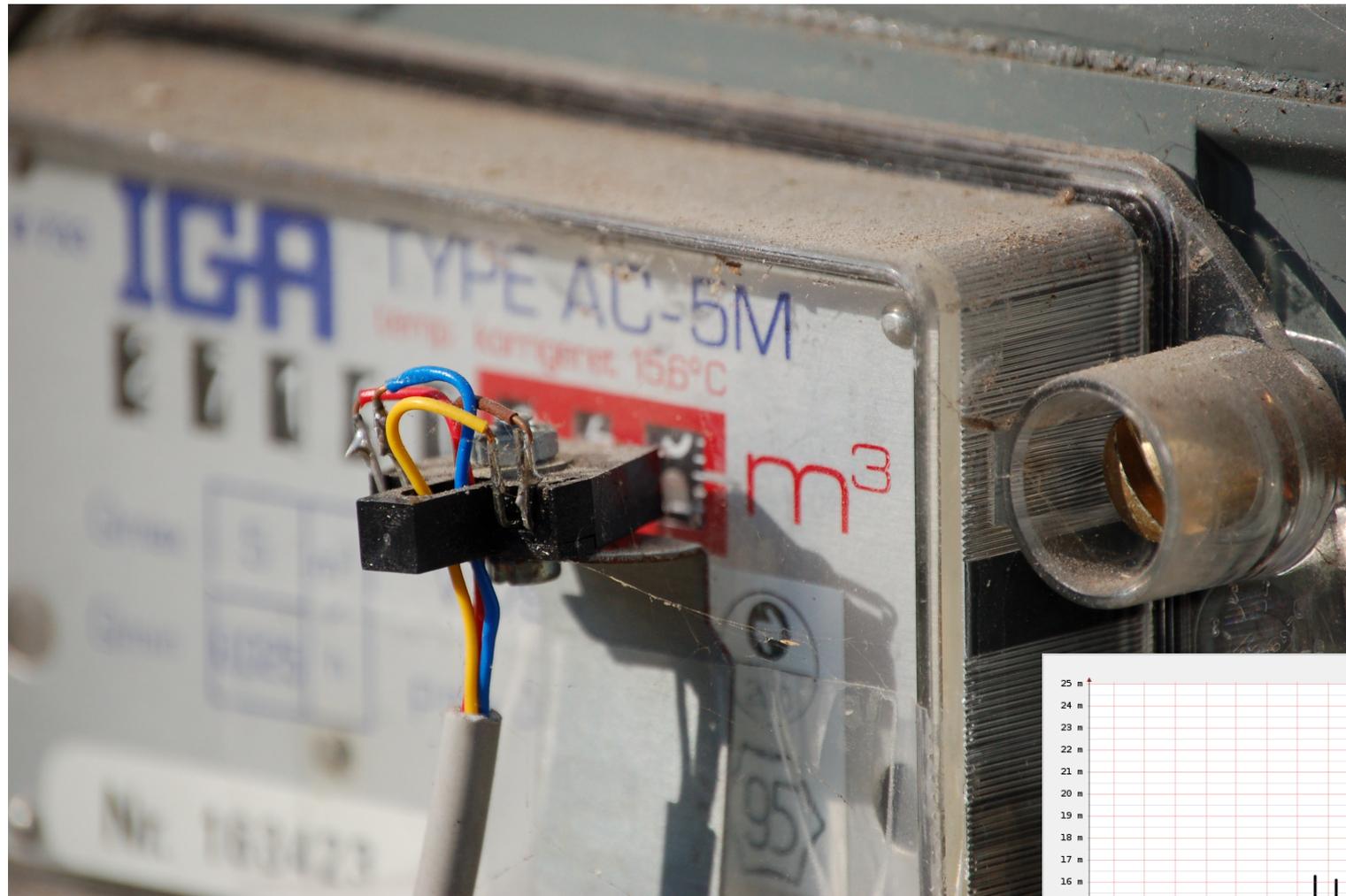
IEC 60332-1-1801 2101 34235

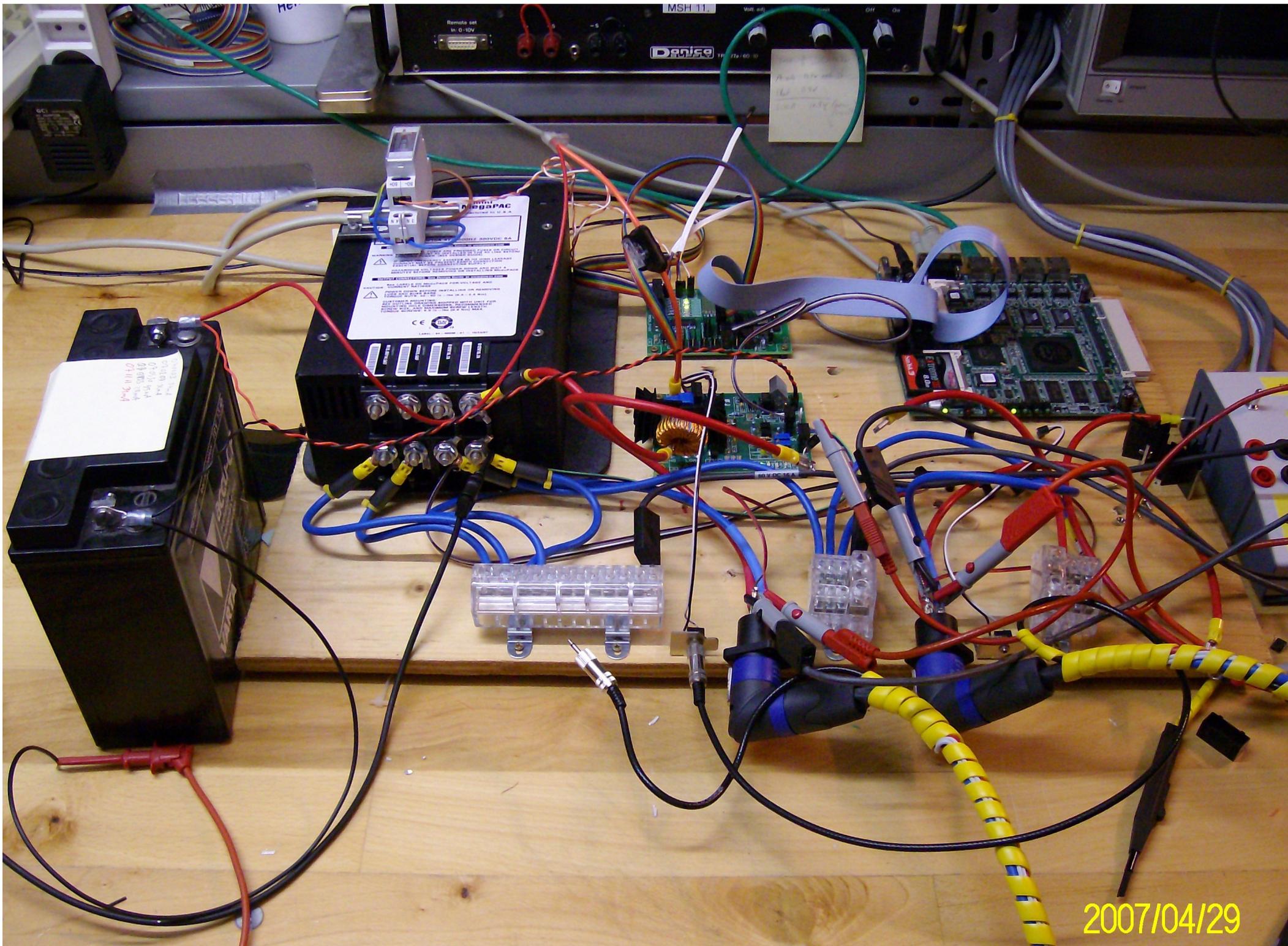
Left breadboard containing a black integrated circuit, several resistors, and jumper wires. A white label with the number '11801' is attached to the board.

Right breadboard containing a grey multi-pin connector with several colored wires plugged into it.

Small green printed circuit board (PCB) with various electronic components, including a large black chip labeled 'ADXL'.

Main green PCB assembly featuring a SanDisk 256MB memory card, several capacitors, and other electronic components. A blue USB cable is plugged into a port on the board.





2007/04/29

Logging, the legal side:

Relatively short retention time requirement

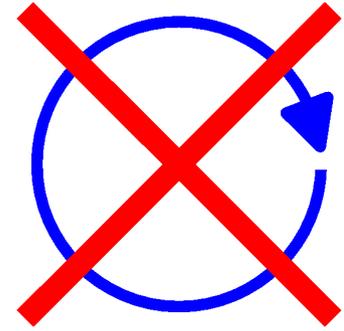
”We generally know it pretty soon if something fell down”

No (clearly) specified level of detail requirement

”You never know what they might ask about anyway”

”We're the ones who are supposed to know about this”

Logging, the practical side



No maintenance

CF card based (Write wear-out concerns)

High data capacity (compression)

How to sensibly locate data in 3.5GB of compressed log ?

FifoLog:

Circular log

Finite size

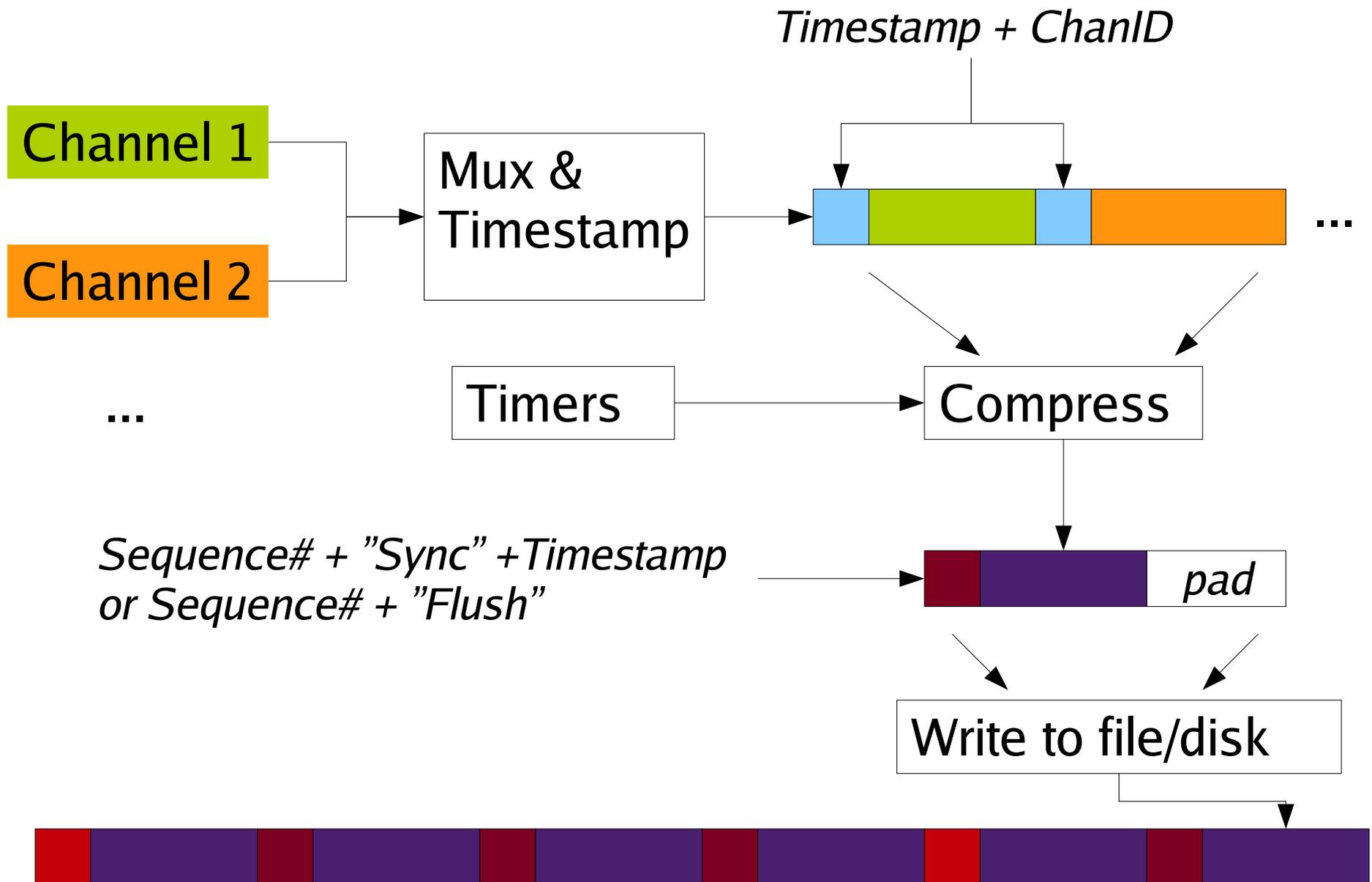
Compressed

Seekable timestamps

Multi-channel

Now in FreeBSD-8-Current

Fifolog, writing:



Fifolog, reading:

Establish current end of log

Binary search of uncompressed seq#

Find start of desired time-interval

Binary search of uncompressed timestamps

Uncompress, demux, select & present



Fifolog, multiple channels

1. [bin] Transmitted serial bytes to VOR
2. [bin] Received and accepted serial bytes from VOR
3. [bin] Rejected serial bytes from VOR
4. [txt] Measured "master" protocol output
5. [txt] Log messages
6. [txt] Debug messages
- ...

KAS-VOR# /etc/fiforead \

-B "24 hour ago" \

-E "22 hour ago" \

-t -r /dev/ad1s4

From 1210019274 Mon May 5 20:27:54 2008

To 1210026474 Mon May 5 22:27:54 2008

Data selected

Record selected

Read from 10662800

20080505202754 000.010.002 r 08 00 80 00 22 00 00 00 00

20080505202754 000.010.003 P VALUE 0

20080505202754 000.010.004 P VALUE 1

20080505202754 000.010.005 P VALUE 0

20080505202754 000.010.006 P VALUE 1

20080505202754 000.010.007 P VALUE 0

20080505202754 000.010.008 P VALUE 0

20080505202754 000.010.009 P VALUE 1

20080505202754 000.010.010 P VALUE 0

20080505202754 000.010.011 P VALUE 0

Fifolog, /var/log/* replacement ?

Advantages:

Fixed allocation for /var/log

No heavy /etc/periodic compression job

Less file-system churn (Flash devices)

One place to look as opposed to

```
critter phk> ls /var/log | wc -l  
46
```

Very fast search for time interval

Fifolog, /var/log/* replacement ?

Disadvantages:

Fixed allocation for /var/log

Grep'ing through log as slow as always

Probably not POSIX compliant

