Keeping track of things with MeasureD

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Things I do for a living...

• “Can you make our 20 year old VOR transmitter talk SNMP?”
NAVAIDS

- ILS
  - Multisector beam guides plane to strip
- VOR
  - Phase difference gives compas angle
- DME
  - Ping-pong tells difference to DME
- RNAV = Improved VOR+DME
  - Backup for GPS/Galileo
There's also some other kit...

- Diesel Generator
- Diesel Tank
- Diesel engine starter battery
- Main batteries
- Air Condition
- &c
...and another thing...

- “This is part of the CAT3 landing system...”

CAT3 landing (fog), as seen from cockpit of 747
...and...

- ...a few other details, such as:
  - Must be low power (battery backup)
  - High Reliability (no rotating parts)
  - Secure

- ...the usual stuff:
  - User friendly, Windows Compatible, Standards Compliant, Configurable, General purpose, Maintainable, Open Source, Extensible, ...
Bad serial Protocols

16          frame header 1
130         frame header 2
n + 5       number of bytes in frame – 1
destination - 1 or 2- Cpu.
             - 0 Local/Remote PC
source       as for destination
message type D = normal dialogue. A = alarm
data char 1   
data char n   
checksum byte 1
checksum byte 2
13           end of frame 1 ) carriage-return
10           end of frame 2 ) line-feed
Things I do for fun...

- Monitor my old house
  - Electricity
  - Natural Gas
  - Water
  - Solar water heating
  - Temperatures
  - Humidity
The MeasureD concept

- VOR
- PIC
- CF-card
- SNMP agent
- RRD agent
- CGI-script
- Logfile
- Browser
- KAS
- RAMME
- NORA
Hardware

- Soekris NET4801 (with NanoBSD)
- Industrial 4GB CF card
- Opto-isolated dual serial PCI card
- DC/DC converter psu
- Home built 1U rack boxes
- Custom design PIC card
General Purpose I/O

- Digital/Analog inputs/outputs
- Use PIC18F8722 microcontroller
  - Serial interface to computer
  - 64 I/O pins, 16 with A/D converter
  - Eeprom for state storage
  - Fast power-on
  - Electrically Robust
PIC firmware

• Written in small C
  – Using SDCC compiler

• Functionality
  – Define pin function
    • (ain,din,dout,counter,temp)
  – 1-wire temp sensor protocol
  – Self- / mfg- test routines
Make interfaces simple

- External constraints:
  - Real-Time requirements
  - Odd-ball protocols
- There will be many off them
  - 9 so far, typically 200-500 lines of code
- Where future extension will happen
Threads or events?

- I generally prefer event-driven
- Writing to FIFO log (raw device, CF card) will sleep.
  - Bad for high-speed protocols
- Writing web-pages to TCP sockets in eventsized bits is nasty programming
- Threads are more convenient
ConfigKit

• Compiler and library for implementing cisco style CLI/config-file
• Saves tons of trivial code
  - Does argument syntax checking
• Supports multiple input sources
  - TELNET/SSH server
  - Files
  - Internally generated
INSTANCE prs10 UINT {
    name   cfg_prs10
    new    cfg_prs10_new
    destroy cfg_prs10_destroy
    desc   "SRS PRS10 Rubidium Frequency Standard"
}

WORD serial WORD {
    desc   "serial port device name"
    func   cfg_prs10_serial
}

WORD point WORD ... {
    desc   "point configuration"
    func   cfg_prs10_point
}

WORD debug UINT {
    desc   "Debug configuration"
How it works...

• MeasureD's core contains:
  - Data-point management
  - Configuration parser
  - Event dispatcher
  - HTTP server
Extensions

- FIFO record/log buffer
  - Zlib compressed with timeout
- MASTER protocol server
  - And SLAVE “interface”
- ALARM facility
  - For service/off-line/fall-back &c.
Interfaces

• Talks via some interface to $real_world
  - Creates points
  - Updates points
  - Controls (output) points
  - Destroys points
  - Configuration functions
Addressing points

- Points have three part addresses:
  - Site (###.----.----)
  - Group (----.###.----)
  - Point (----.----.###)

- 21.4.34
  - Site NORA, SEL4000 VOR, Battery OK
Data point types

- Analog Input ("Battery voltage")
- Analog Output ("Transmitter power")
- Digital Input ("Diesel running")
- Digital Output ("Start Diesel")
- Counter ("Door opens")
Data point attributes

- Label -- “Battery Voltage 48V”
- Format -- “%.2f”
- Units -- “Volt”
- Limits (high, raise, sag, low)
  - Hysteresis & limitdelay
- Timeout, Change
- SNMP trap number
Events

- Create/Destroy site, group, point
- Attribute changes to points
- Limit/Alarm changes to points
- New measurements on points
**Built in Web-server**

**site 000**

**group 000.022 prs10**

<table>
<thead>
<tr>
<th>Index</th>
<th>Type</th>
<th>Label</th>
<th>Value</th>
<th>Units</th>
<th>Low</th>
<th>Sag</th>
<th>Raise</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>000.022.001</td>
<td>ain</td>
<td>Serial Number</td>
<td>nan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>000.022.002</td>
<td>aout</td>
<td>Lock mode</td>
<td>nan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>000.022.003</td>
<td>dout</td>
<td>Lock Loop status</td>
<td>nan</td>
<td></td>
<td></td>
<td></td>
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<td>000.022.004</td>
<td>ain</td>
<td>Frequency Control</td>
<td>nan</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>000.022.005</td>
<td>ain</td>
<td>Power Cycles</td>
<td>nan</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>000.022.006</td>
<td>ain</td>
<td>FC Saves</td>
<td>nan</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Macros for web-pages

.macro col 3
.if value($2) > .5
   <td bgcolor="$3">$1</td>
.else
   <td bgcolor="#000000">
      <font color="#888888">$1</font>
   </td>
.endif
.endmacro
Custom pages

Measured
MASTER/SLAVE protocol

- ASCII based
  - Easy interface from scripts
- Subscribe to events for some set of points
- Send “CONTROL” events back
- Built on top of HTTP server functionality
Master/Slave station

- Master subscribes to points from slave
  - NORA:0.4.* -> MASTER:7.4.*
  - KAS:0.4.* -> MASTER:8.4.*
- Only local points (site==0)
Project Status

- KAS DME goes live in a few weeks
  - CAT3 landing in Copenhagen Airport
- Roll-out throughout autumn/winter
  - 7 DME
  - 8 VOR
  - My house :-}