Linux Home Automation

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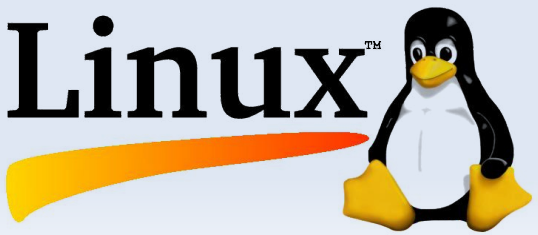


Motivation

- Major house renovation planned
- Had been acquiring/building a range of Linux based devices
- Interest in home automation
- Something fun to do ☺

Project Objectives

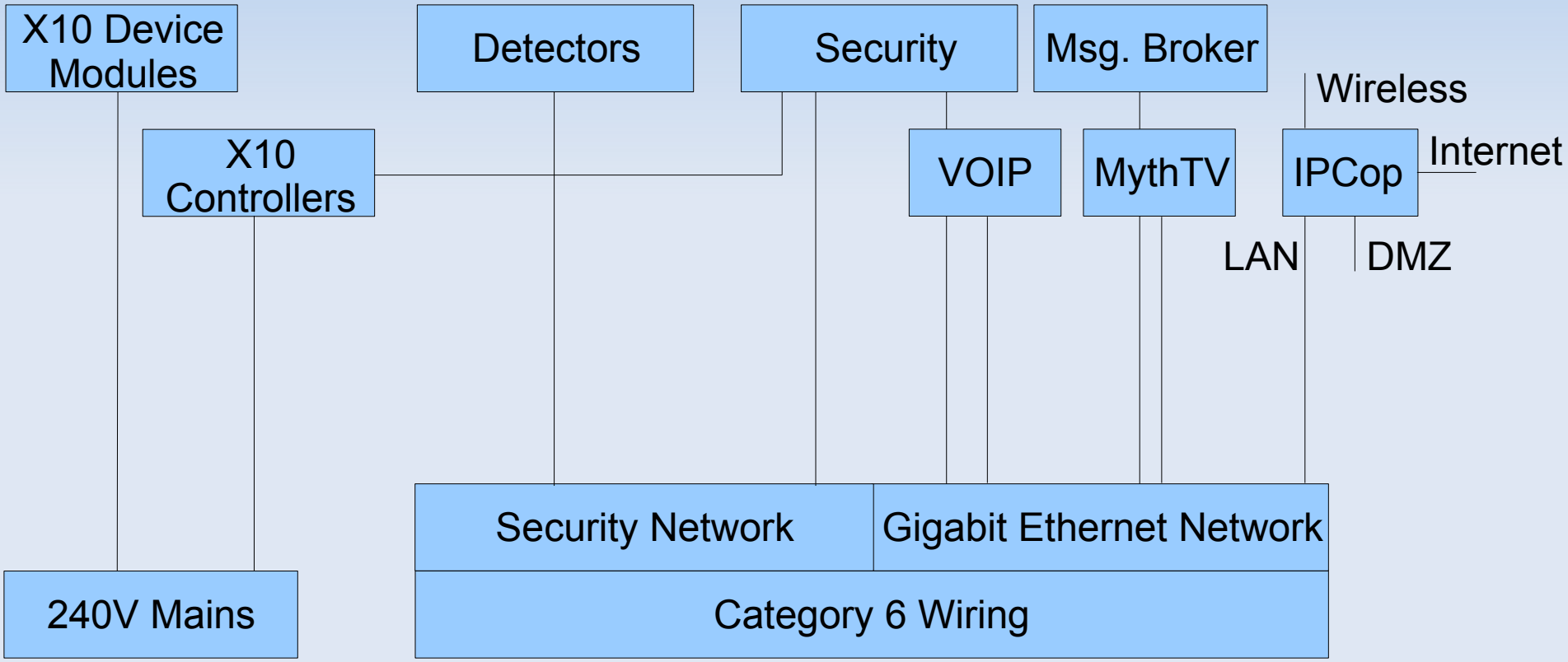
Establish an infrastructure that was:

- Low cost
- Robust
- Exploited open standards
- Extensible
- Secure
- Loosely coupled
- Energy efficient
- Exploited Linux
- Not dependent on Windows
- High SAF
- Integrated with security system

Functional Requirements

- VOIP telephony
- PVR
- Utility metering
- Media streaming
- Lighting and device automation
- Security system

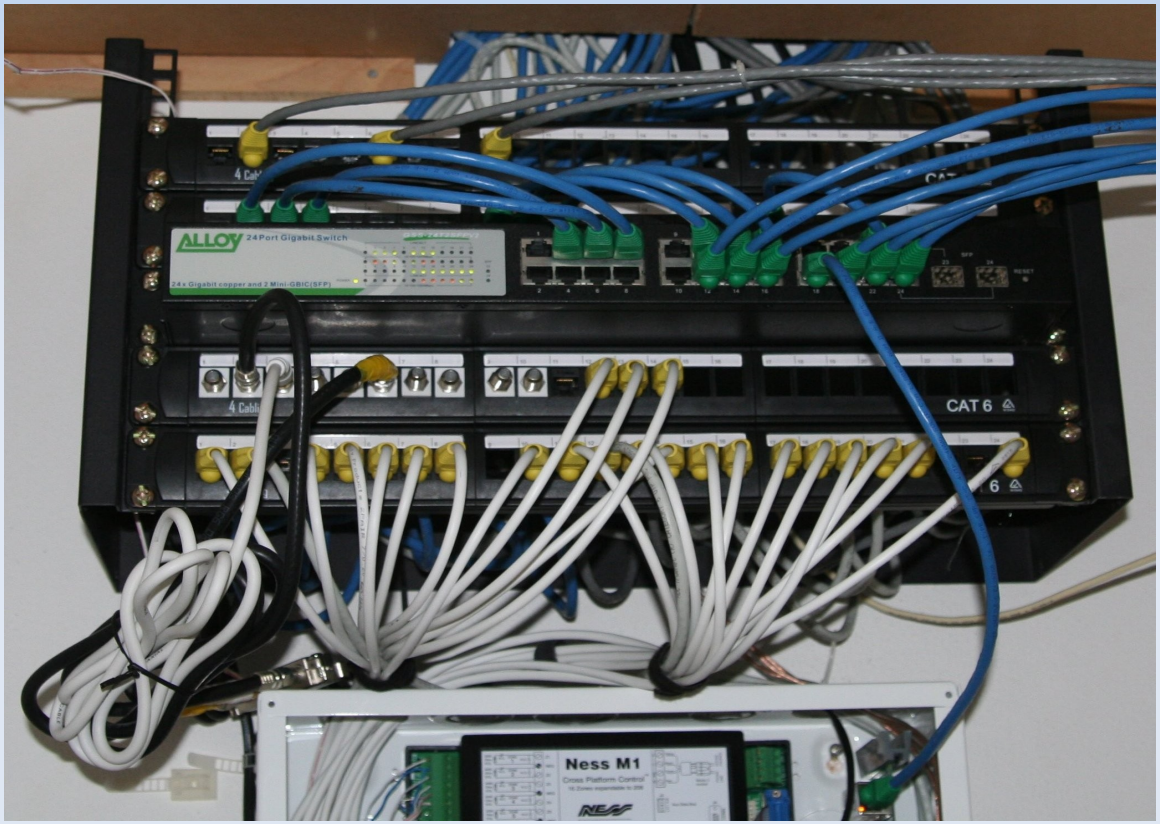
Architecture



Wiring

- Category 6 cable
- 8P8C modular connectors
- TIA/EIA-568-A cable termination (T568A scheme)
- Coloured boots:
  - Green
  - Red
  - Blue
  - Orange

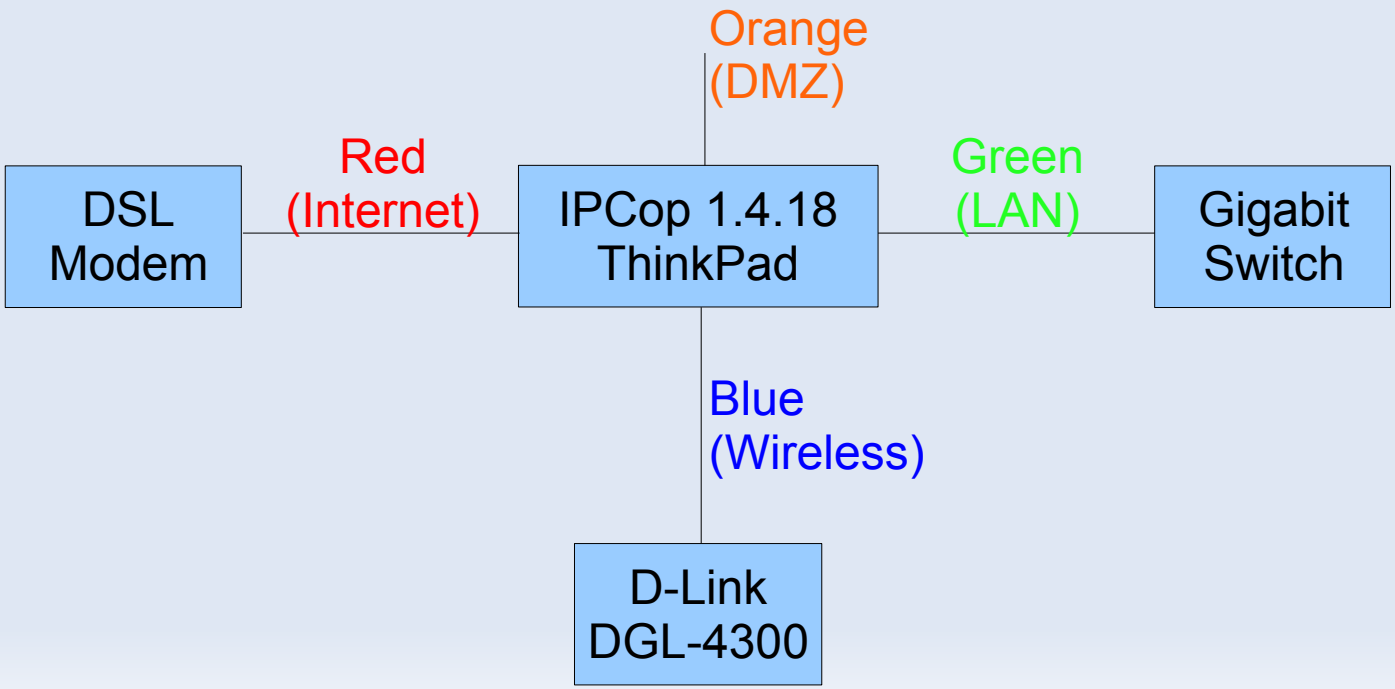
  → IPCop
  - Yellow → Security



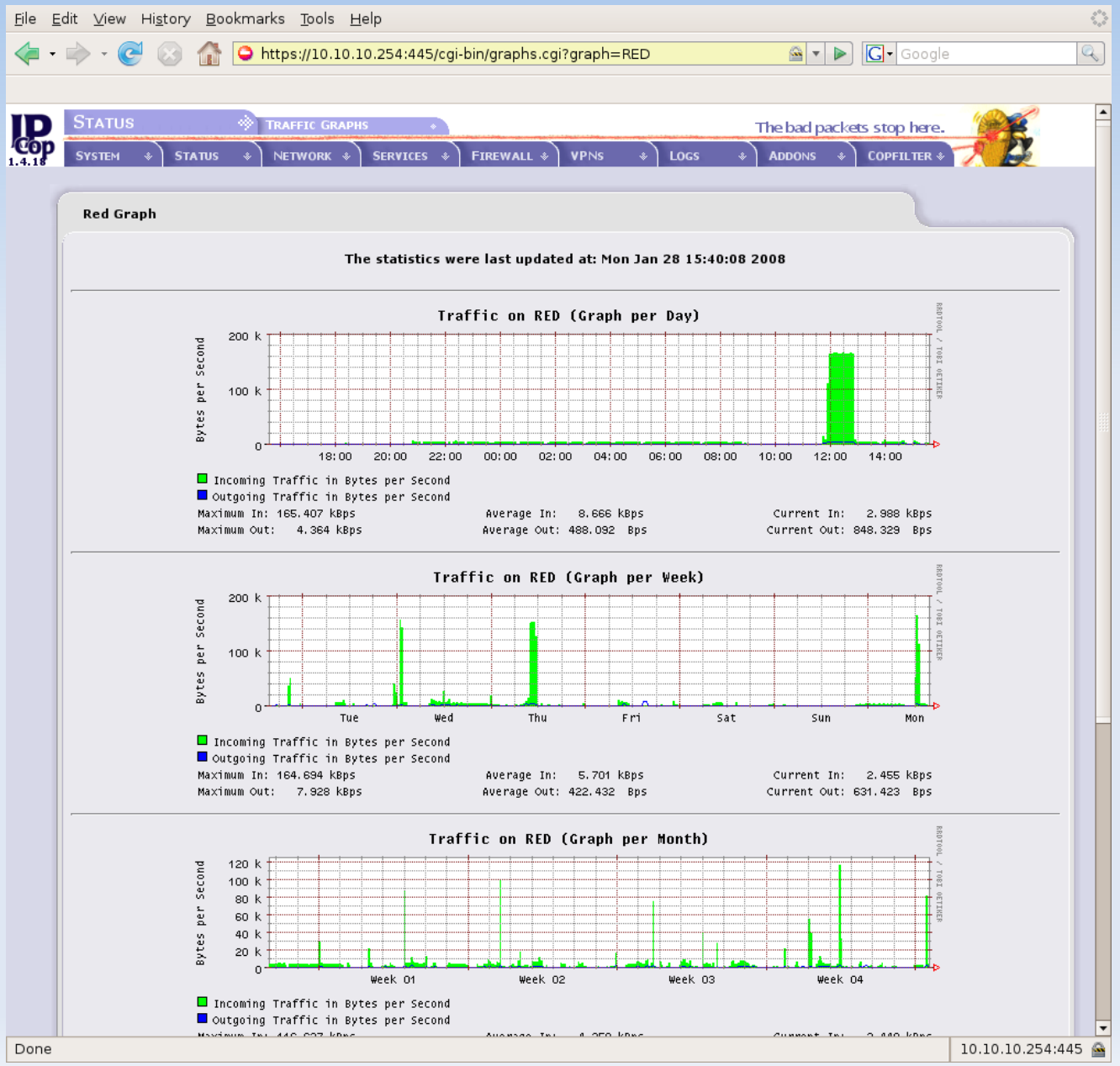
LAN Cupboard

TCP/IP

- www.ipcop.org
  - Stable Linux firewall distribution
  - DNS, DHCP, NTP
  - Addons
    - OpenVPN, Copfilter



TCP/IP


File Edit View History Bookmarks Tools Help
https://10.10.10.254:445/cgi-bin/graphs.cgi?graph=RED
Google
IP Cop 1.4.18
STATUS
TRAFFIC GRAPHS
The bad packets stop here.
SYSTEM STATUS NETWORK SERVICES FIREWALL VPNS LOGS ADDONS COPFILTER
Red Graph
The statistics were last updated at: Mon Jan 28 15:40:08 2008
Traffic on RED (Graph per Day)
Bytes per Second
200 k
100 k
0
18:00 20:00 22:00 00:00 02:00 04:00 06:00 08:00 10:00 12:00 14:00
Incoming Traffic in Bytes per Second
Outgoing Traffic in Bytes per Second
Maximum In: 165.407 kBps
Maximum Out: 4.364 kBps
Average In: 8.666 kBps
Average Out: 488.092 Bps
Current In: 2.988 kBps
Current Out: 848.329 Bps
Traffic on RED (Graph per Week)
Bytes per Second
200 k
100 k
0
Tue Wed Thu Fri Sat Sun Mon
Incoming Traffic in Bytes per Second
Outgoing Traffic in Bytes per Second
Maximum In: 164.694 kBps
Maximum Out: 7.928 kBps
Average In: 5.701 kBps
Average Out: 422.432 Bps
Current In: 2.455 kBps
Current Out: 631.423 Bps
Traffic on RED (Graph per Month)
Bytes per Second
120 k
100 k
80 k
60 k
40 k
20 k
0
Week 01 Week 02 Week 03 Week 04
Incoming Traffic in Bytes per Second
Outgoing Traffic in Bytes per Second
Done
10.10.10.254:445

Security

- Elk-M1G (www.ness.com.au)
  - Modular expansion
  - Published protocol
  - Ethernet/RS-232 interfaces
  - X10 control
  - Rules engine
  - Affordable
- Detectors
  - 17 PIR, 5 temperature sensors, 3 smoke alarms, front door bell, tamper switches

VOIP

- Asterisk (1.2.13) PBX:
  - Slug (Linksys NSLU2) with Debian
  - Linksys SPA-3000 ATA
  - Snom handsets
- Fairly complex to set up but very reliable
- Fun with extensions
  - Weather forecasts
    - wget Sydney forecast from BoM
    - flite to convert from text to speech
    - ffmpeg to convert to 8 kHz .wav format

X10

- Communication protocol over power lines
  - 4-bit house code, 4-bit unit code, 4-bit command
  - Variety of device modules
  - Variety of controllers
  - Transmitted at AC zero-crossing
  - Quite slow (20 bit/sec)

Messaging

- Publish/Subscribe Model
  - Topic tree defines subjects of interest
  - Publisher creates message, associates it with a topic and sends message to broker
  - Subscriber registers request to receive messages published on particular topics
  - Can create many topologies
  - Nicely decouples/abstracts stuff
- Microbroker (IBM product)
  - Open protocol (mqtt.org)
  - Various QoS parameters for messages

Messaging – Topic Tree

utility/	electricity/	watts				
	water/	mains				
		tank/	depth			
			volume			
	gas/	<???>				
device/	sensor/	pir/	[level]/	[area]/	[location]	
		smoke/	[level]/	[area]/	[location]	
		reed/	[level]/	[area]/	[location]	
		temperature/	[level]/	[area]/	[location]/	[temperature]
		camera/	[level]/	[area]/	[location]	
	X10/	transmitter/	XM10E			
		receiver/	[house_code]/	[device_code]/	[status]	
	light/	[level]/	[area]/	[location]		
	tv/	[level]/	[area]/	[location]/	status/	(on | off)
					input/	
					channel/	
					volume/	
	voip/	pbx/				
		phone/	[level]/	[area]/	[location]	
	elk-m1g/	zones/	[zone]/	[zone_status]		
		area/	[status]			
environment/	temperature/	[level]/	[area]/	[location]		
	humidity/	[level]/	[area]/	[location]		
	pressure/	[level]/	[area]/	[location]		
	wind/	direction/	[level]/	[area]/	[location]	
		speed/	[level]/	[area]/	[location]	

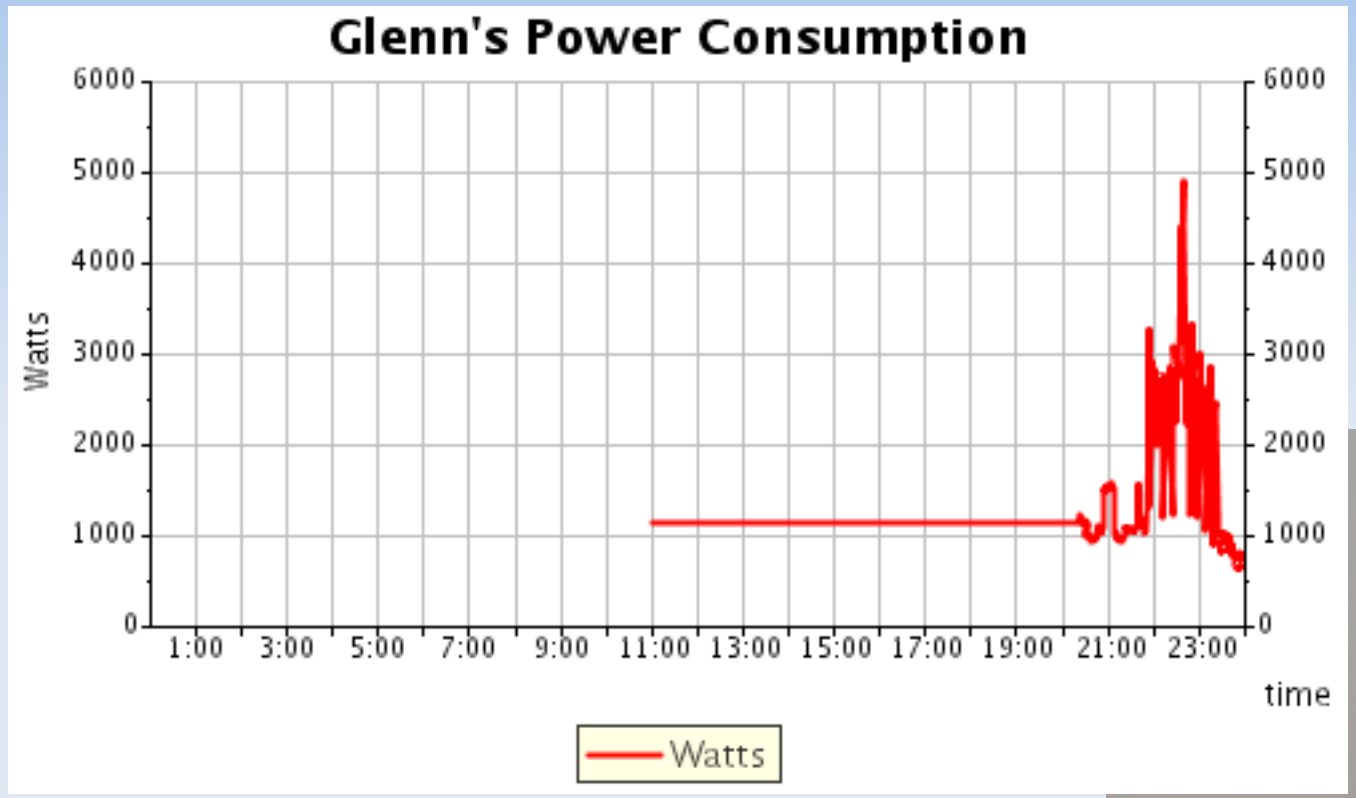
Device Management

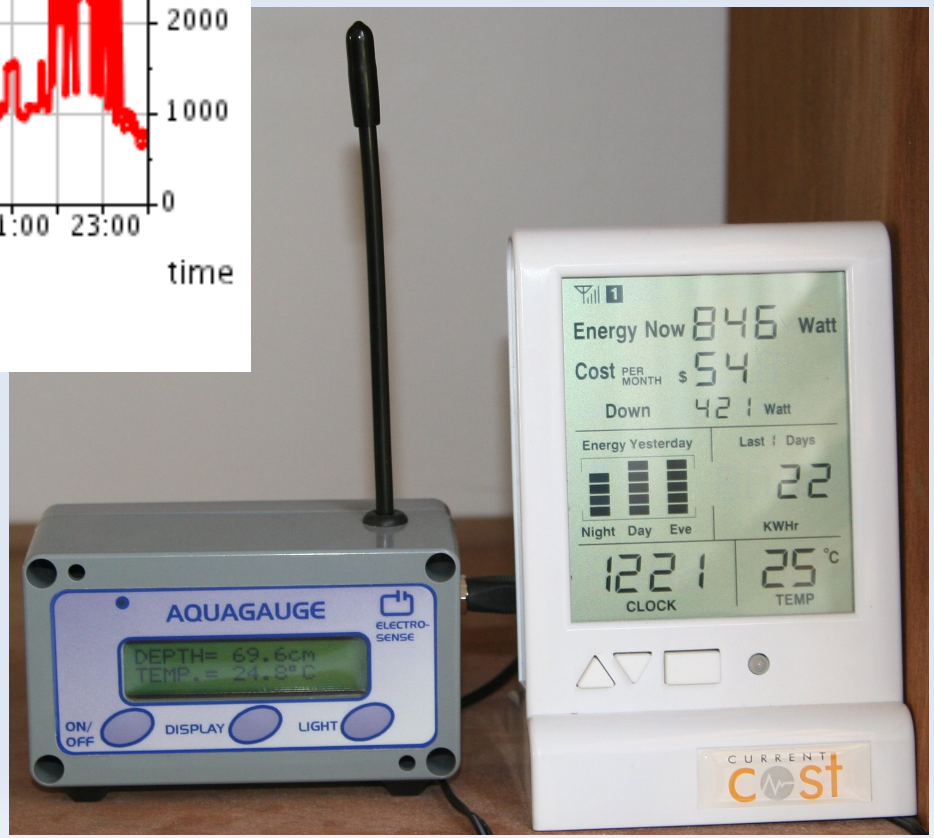
- Various devices (e.g. TV and AVR) support external control via RS-232 and publish command protocol
  - Slug (Linksys NSLU2) with Debian connected to devices via USB serial adapter
  - Perl script implements device protocol
  - Publish status to message broker
  - Execute commands (on/off/volume/channel etc.) through message broker subscriptions

Utility Monitoring

- Current Cost Monitor (www.currentcost.com)
  - Current clamp/transmitter
  - Display unit
  - Serial port ouputs XML content
- Slug (Linksys NSLU2) with Debian
  - Simple Perl scripts to parse XML and publish via message broker

Utility Monitoring





Utility Monitoring

- AquaGauge (www.electrosense.com)
  - Differential pressure sensor/transmitter
  - Display unit
  - Serial port ouputs character content
- Slug (Linksys NSLU2) with Debian
  - Simple Perl scripts to parse content and publish via message broker

Automation

- Via Elk-M1G rules

  WHENEVER Bathroom 2 (Zn 12) BECOMES NOT SECURE

  AND IT IS DARK OUTSIDE

  THEN TURN Bathroom 2 Light [7 (J7)] ON FOR 5 MINS

- Via simple Perl code
  - Subscribe to relevant topics
  - Execute appropriate logic
  - Send X10 commands via CM12 to control devices etc.

Automation Scenarios

- Sub-floor fan
- TV control
  - Automatically turn off
  - Integration with AVR
- Lighting
  - Simple on/off control triggered by detectors
  - Timed lighting

Future Directions/Enhancements

- Voice control
- MythTV
- Weather monitoring
- Event correlation