Wireless Network Management

SANOG16

Matt Peterson

Matt … who?

- Career of dial-up ISP, enterprise IT, 24/7 NOC, non-profit helpdesk, WiFi hotspot, video streaming, ccTLD/gTLD DNS root server deployment, start-ups
- Pro bono WiFi network deployments: Burning Man, Farallon Islands, ToorCamp, BARWN/BAWUG
- Speaker at NANOG49, SANOG6, APRICOT, …
  - http://matt.peterson.org/presentations/
  - This talk file name “SANOG16_Wireless_NetMgmt”

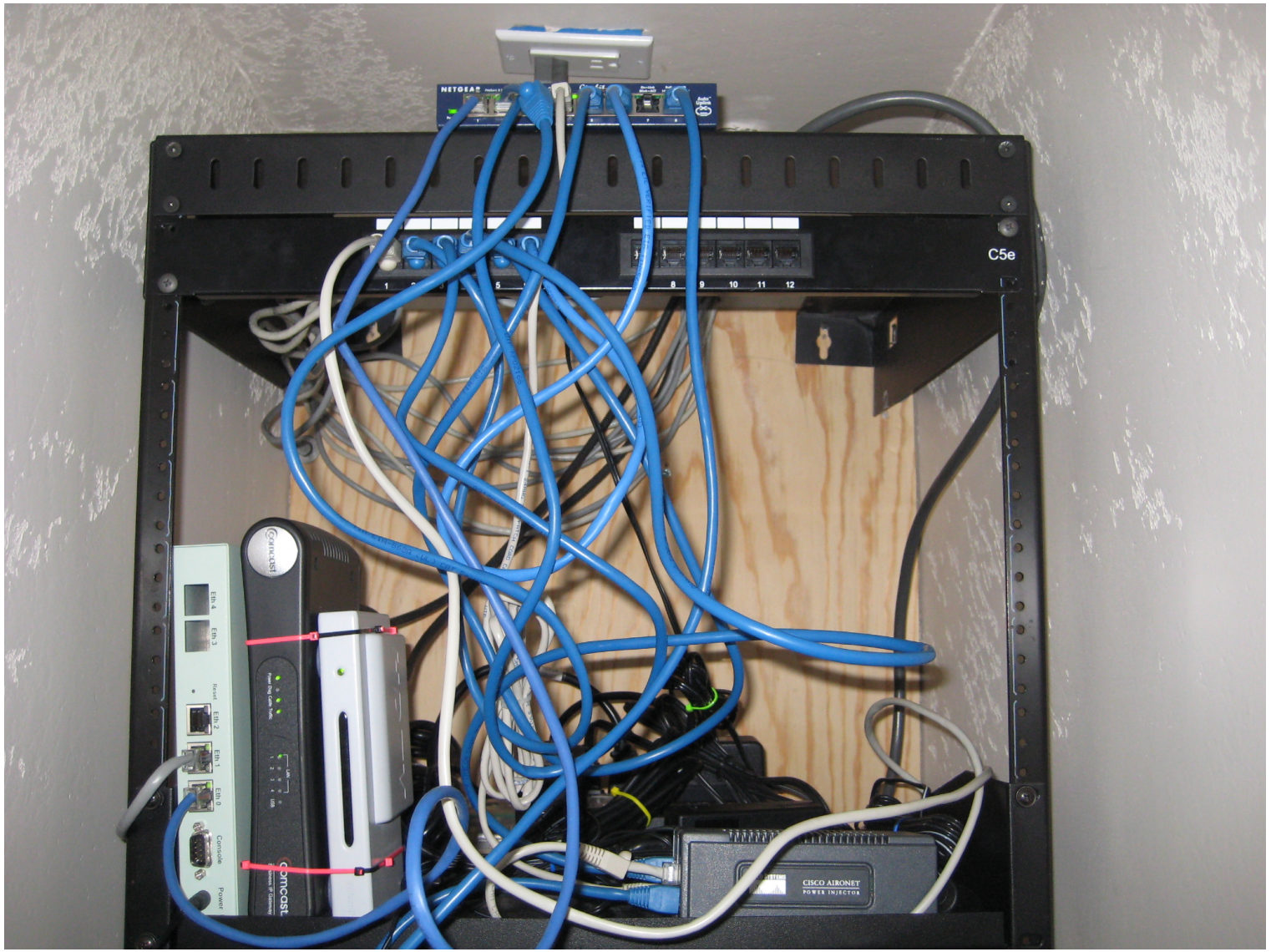
Matt random facts

- Enjoys Traveling

  .ae .at .be .bt .bz .ca .ch .de .dk .hk .ie .it .kh .jp .my .nl .ru .se .sg .th .uk

- "Right tool, for right job" guy
  - Linux = work servers
  - FreeBSD = personal server
  - OSx = personal laptop
  - Networks built by me, powered by: Cisco, Juniper, Linux, BSD
- Not representing my day job
  - Site-Ops & NetEng at Square, Inc. (AS15211)
  - This week is personal vacation time with girlfriend
- Extremely honored to be in Bhutan!
  - Thanks - Norbu, Jichen, Gaurab

Matt geek cred



Talk Overview

- **Please** be interactive – interrupt me!
  - Q&A highly encouraged

Effective network monitoring encompasses: planning, deployment strategy, documentation – a shared culture

.. not just alert emails & pretty graphs

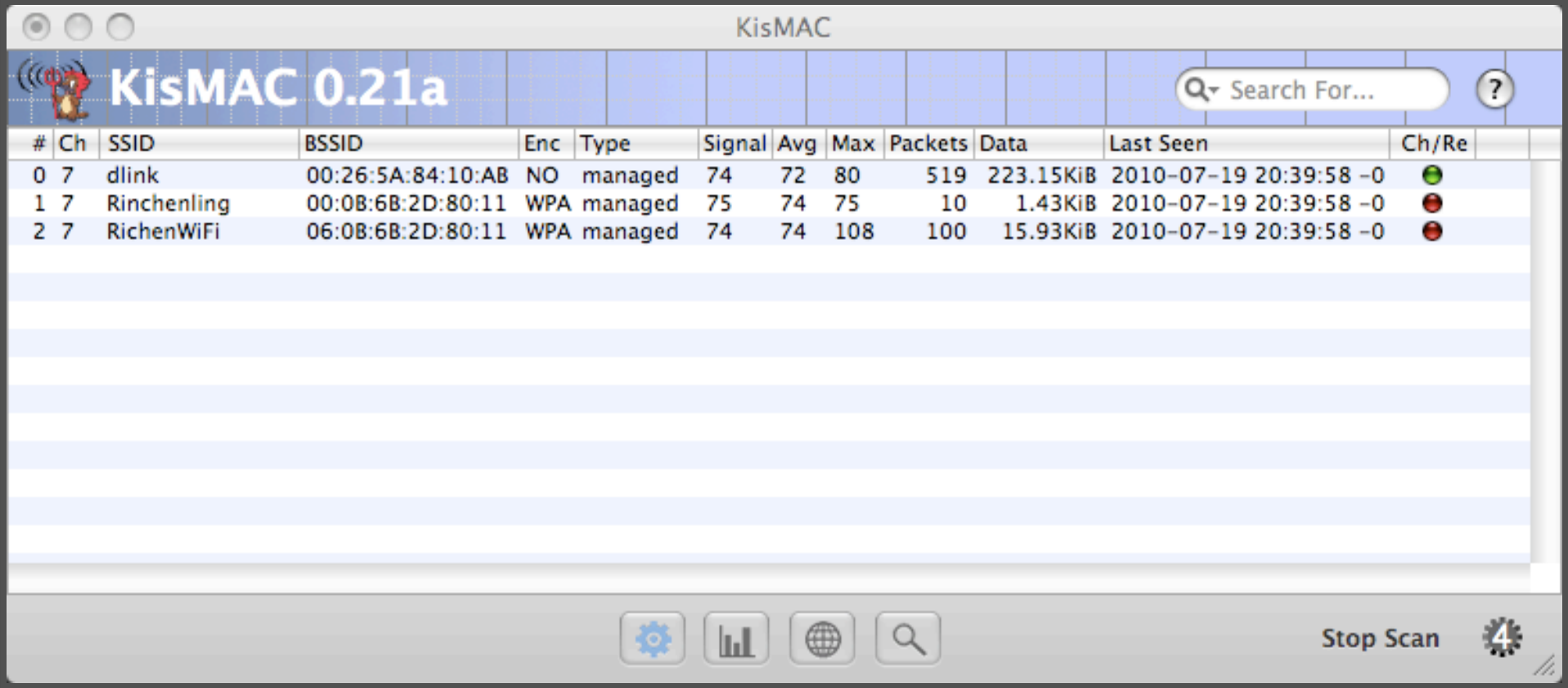
Agenda

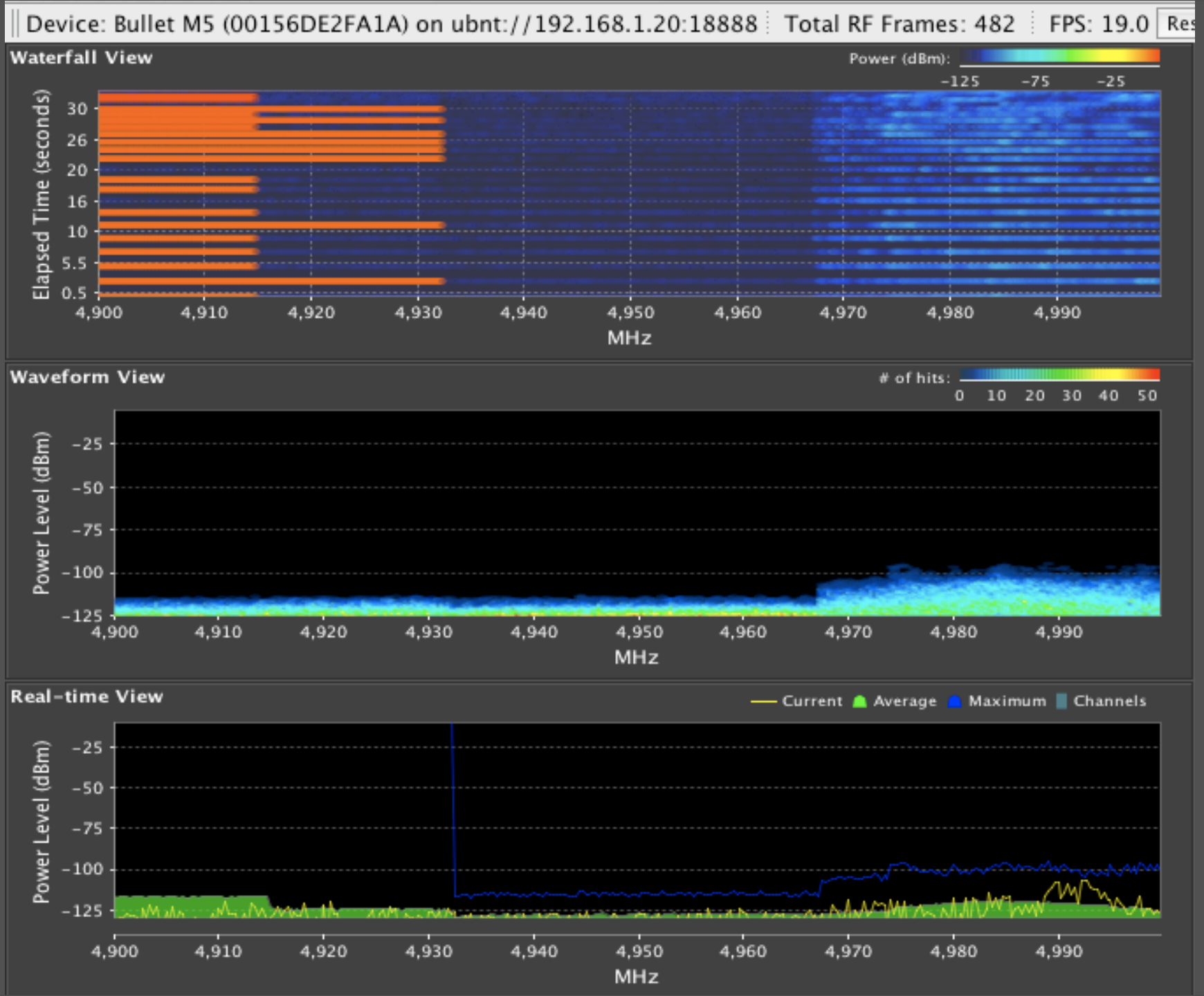
- **Planning**
  - Design
  - Equipment
- **Deployment**
  - IP Allocation
- **Documentation**
- **Monitoring**
  - Real-time Status
  - Historical Trending
- **Examples**
  - Nagios
  - Cacti
  - PHP Weathermap

Initial Planning

- Patch clearance
  - Obstructions (buildings, trees)
  - Earth curvature
- Link budget
  - Calculate radio output, coax/connector loss, antenna gain
- Site Survey
  - Physical Security – Hours to access equipment, theft
  - Supporting Infrastructure – Power, OOB network
  - Catalog RF environment
    - Simple channel scanning – KisMAC, Netstumbler
    - Spectrum Analyzer'like - AirView, EaKiu, Wi-Spy
  - Work with your competitors (if possible)
    - Coordinate frequencies, channel width, antenna polarizations, shared UPS, towers

      Consider this peering at layer 1, it's in all parties best interest


KisMAC
KisMAC 0.21a
Search For...
Ch SSID BSSID Enc Type Signal Avg Max Packets Data Last Seen Ch/Re
0 7 dlink 00:26:5A:84:10:AB NO managed 74 72 80 519 223.15KiB 2010-07-19 20:39:58 -0
1 7 Rinchenling 00:0B:6B:2D:80:11 WPA managed 75 74 75 10 1.43KiB 2010-07-19 20:39:58 -0
2 7 RichenWiFi 06:0B:6B:2D:80:11 WPA managed 74 74 108 100 15.93KiB 2010-07-19 20:39:58 -0
Stop Scan


Device: Bullet M5 (00156DE2FA1A) on ubnt://192.168.1.20:18888
Total RF Frames: 482
FPS: 19.0
Waterfall View
Power (dBm):
-125
-75
-25
Elapsed Time (seconds)
30
26
20
16
10
5.5
0.5
4,900
4,910
4,920
4,930
4,940
4,950
4,960
4,970
4,980
4,990
MHz
Waveform View
# of hits:
0
10
20
30
40
50
Power Level (dBm)
-25
-50
-75
-100
-125
4,900
4,910
4,920
4,930
4,940
4,950
4,960
4,970
4,980
4,990
MHz
Real-time View
Current
Average
Maximum
Channels
Power Level (dBm)
-25
-50
-75
-100
-125
4,900
4,910
4,920
4,930
4,940
4,950
4,960
4,970
4,980
4,990
MHz

Popular WISP Platforms

	UBiQUiTi	MikroTik	OpenWrt Wireless Freedom
Total Cost	$$	$$$	$
Official HW	Yes	Yes	No
Architectures	ARM, MIPS	ARM, MIPS	ARM, MIPS, x86, …
Admin	SSH, HTTP	SSH, Winbox	SSH, HTTP
SNMP MIB's	IEEE802dot11 MIKROTIK	MIKROTIK	Net-SNMP
Open Source	SDK available	None	Completely
Support	Forum, email	Forum, email	Forum, listserv
Conferences	Minimal	Many	None

WiFi Equipment Guidelines

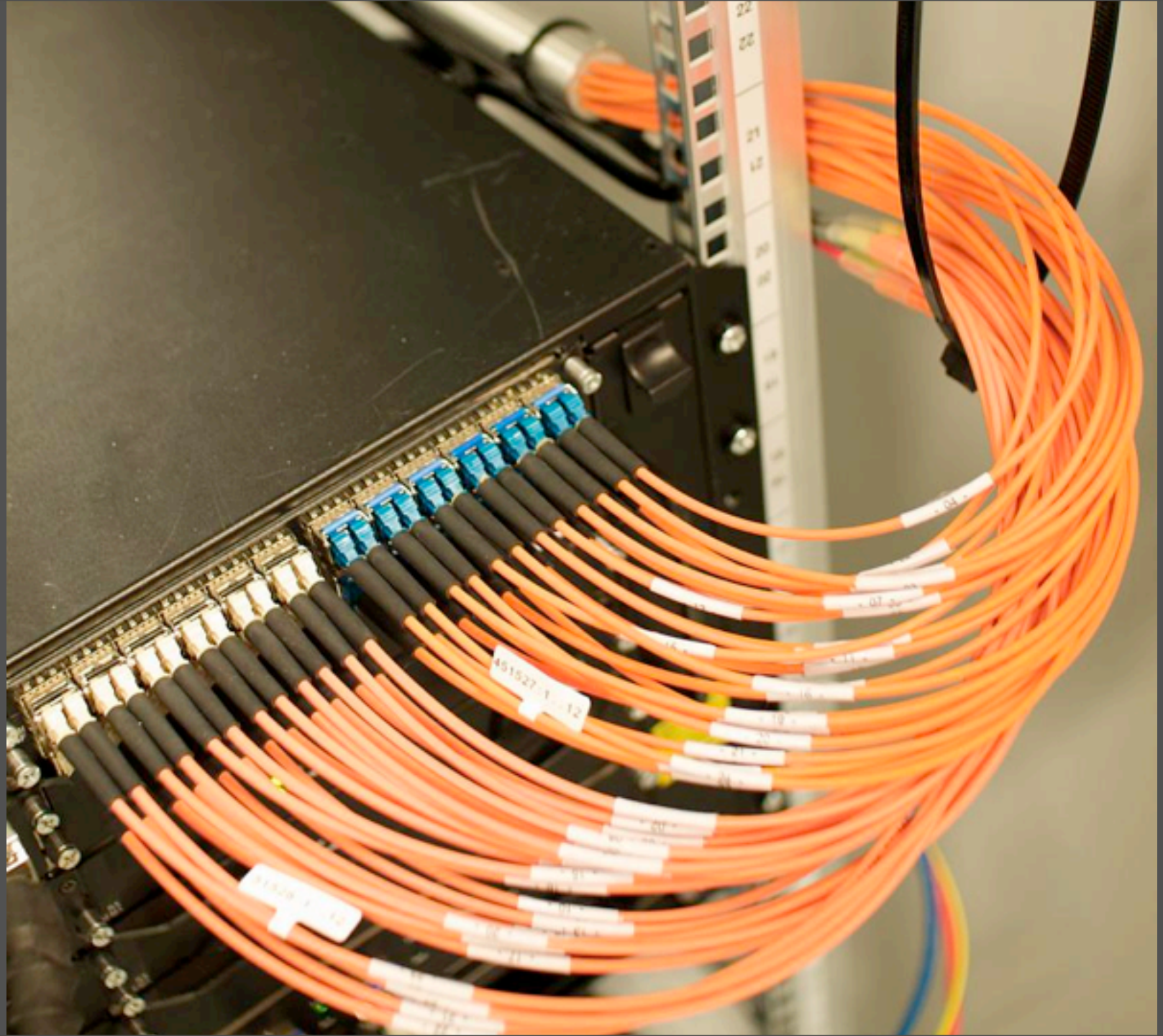
- Handoff should ALWAYS be wired ethernet
  - Dedicated hardware router/node, not USB or PCI card
  - DSL PCI cards aren't popular for a reason
- PoE – Power over Ethernet
  - Less signal loss from coax
  - Cat5 easier to crimp, cheaper copper
  - Not all standards-based, check voltage & polarity!
- Enable NTP
  - Accurate logging timestamps for debugging

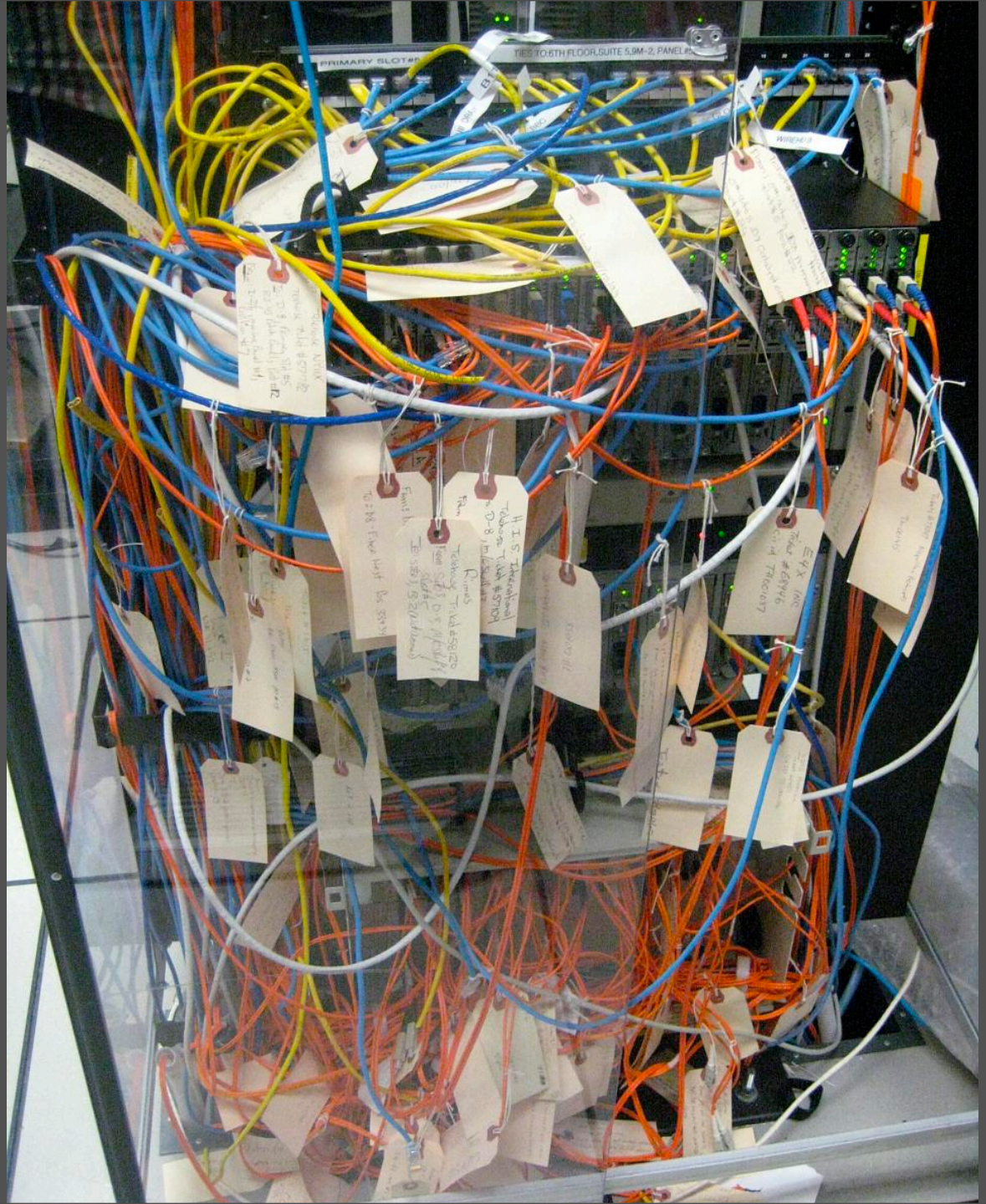
Security

- Link Level
  - WPA2-AES current best practice (however, does your wired-line ISP encrypt DSL or DOCCIS?)
  - Can make debugging difficult
- Administration
  - Enable HTTPS; avoid HTTP
    - Pro-tip: Change to locally managed CA authority, prevent MITM
  - SSH; avoid telnet, all modern gear supports SSH
    - Pro-tip: Use ssh user public key authentication (UBiQUiTi)
  - SNMP
    - Different then root pw, mixed characters, non-dictionary

Deployment

- Take installation pictures
  - Easier to debug on the phone
- Labeling & organization as a future investment
  - Interfaces (ie: ath0), power supplies (ie: PoE AP #2)
  - Color cables as standard (ie: red = WAN, blue = LAN)
- IP should avoid RFC1918 / RFC5735 space
  - Your customers use this already
  - IPv6 for network mgmt. is a great lesson
- Typical IP protocols not suited for wireless
  - Remember that OSPF, BGP, etc doesn't factor in RF flaps
  - Mesh protocols are standards & HW mess





Documentation

- Self-serve docs will be adopted well before “policies”
  - Wiki of best practices, checklists, procedures
  - Comments in configuration files
    - Answers next available VLAN id, IP allocation, naming schema
  - Anyone can edit and revise diagrams
    - Exported as PDF isn’t helpful if the native file isn’t available
  - Check into source control system – Git, SVN, RCS
- Plan for failure
  - Backup configuration of all devices (including CPE’s)
    - Rancid, SCP cron job, SNMP TFTP push – your choice
  - Follow stable firmware train
    - Review changelog & test (especially major version numbers) in

Example named comments

```
; Bastion       74.122.184.0/29
; VLAN10 "VLAN-BASTION"
network-v10                 IN      A       74.122.184.0
gw-v10                      IN      A       74.122.184.1
gw-v10.core1                IN      A       74.122.184.2
gw-v10.core2                IN      A       74.122.184.3
bastion                     IN      A       74.122.184.4
$GENERATE 5-6 unallocated-$.v10 A       74.122.184.$
broadcast-v10               IN      A       74.122.184.7
```

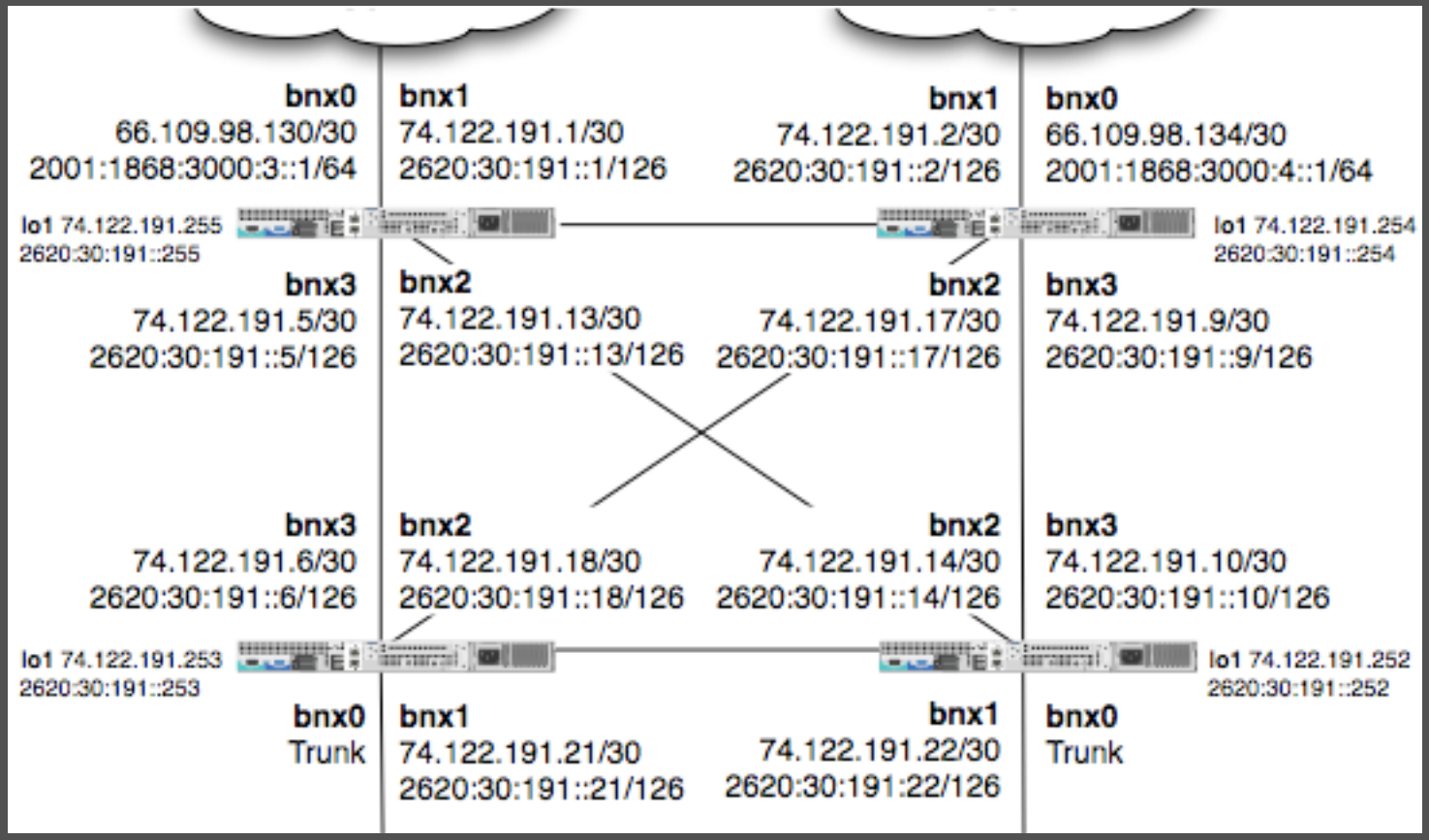

10 51p 09:08:14 Dial 1 then # SIP
NOC (702) 448-2935
Taz Cell
Your current options
Redial NewCall CFwdALL


BULLET


5.8
2.4
Bullet
1 - Rocket - 0


Tim Poza 15) 637–8512
Matt Peterson (5 315–1948
Twin Peaks
UCSF/SONIC.NET
Local Island LAN
Eth 4
Eth 3
Reset
Eth 2
Eth 1
Eth 0
Console
Power
USB

Example Network Diagram



Monitoring

- Tactical, real-time status

  Interface Gi0/22: Rx power high warning; current operating value: 0.3 dBm, Threshold value: -1.0 dBm

- Trending, analysis

  Graphing of disk usage

Monitoring

- Pull (collector fetches data on intervals)
  - SNMP agent
  - TCP-based agent (Nagios NRPE, collectd, etc)
- Push (collector receives data as needed)
  - SNMP trap
  - Syslog

NMS Software

- Ideal Network Monitoring Software combines both real-time alerting & trending, such as:
  - Nagios (forks: Nagios XI, Opsview, Icinga)
  - OpenNMS
  - Zenoss
  - Intermapper
  - What's Up
  - PRTG
  - The Dude (Mikrotik/WiFi specific)

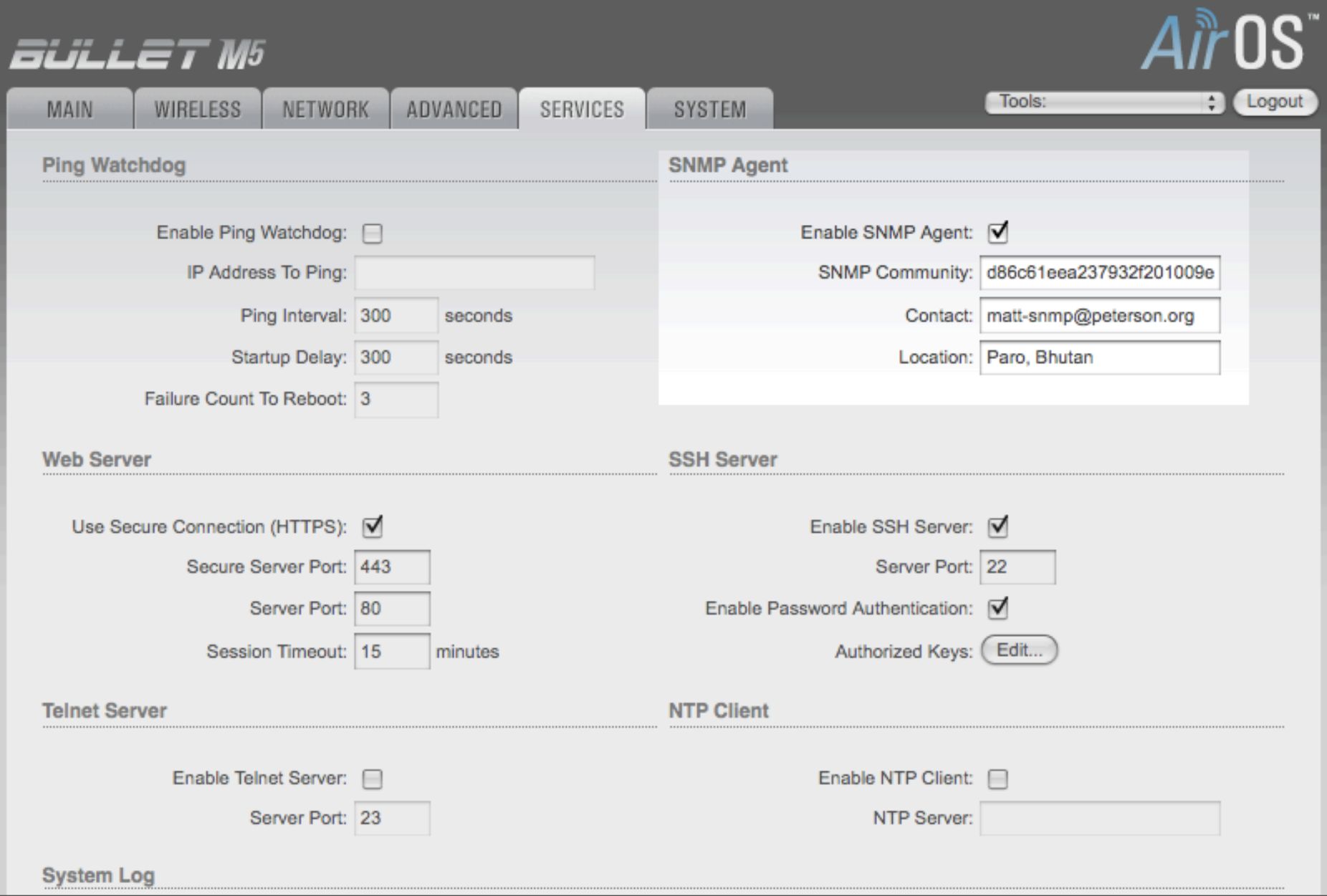
http://en.wikipedia.org/wiki/Comparison_of_network_monitoring_systems

SNMP Quick Refresher

- **S**imple **N**etwork **M**anagement **P**rotocol
  - Stateless UDP (port 161) protocol (optional TCP)
  - Version 1 & 2 plain text auth
  - Version 3 auth HMAC protection & optional encryption
  - Structured key – value pairs
  - Keys are “OID” Object ID’s, OID’s are hierarchical
- **MIB** “Management Information Base” translate numeric OID’s into textual descriptions
- **Agent** is the host or device offering data
- **Manager** requests data from agents or receives traps

http://www.ciscozine.com/2008/09/17/an-introduction-to-snmp/

Ubiquiti Configure SNMP Agent



Net-SNMP snmpwalk

```
snmpwalk -v1 -c {COMM} {IP} IF-MIB

IF-MIB::ifIndex.3 = INTEGER: 3
IF-MIB::ifDescr.3 = STRING: eth0_real
IF-MIB::ifType.3 = INTEGER: ethernetCsmacd(6)
IF-MIB::ifMtu.3 = INTEGER: 1500
IF-MIB::ifSpeed.3 = Gauge32: 4294967295
IF-MIB::ifPhysAddress.3 = STRING: 0:15:6d:e3:fa:1a
IF-MIB::ifAdminStatus.3 = INTEGER: up(1)
IF-MIB::ifOperStatus.3 = INTEGER: up(1)
IF-MIB::ifLastChange.3 = Timeticks: (0) 0:00:00.00
IF-MIB::ifInOctets.3 = Counter32: 299154
IF-MIB::ifInUcastPkts.3 = Counter32: 1660
IF-MIB::ifInNUcastPkts.3 = Counter32: 595
IF-MIB::ifInDiscards.3 = Counter32: 0
IF-MIB::ifInErrors.3 = Counter32: 0
```

Find Supported SNMP MIB's

```
snmptable -Cw 50 -Ci -v1 -c {COMM} {IP} SNMPv2-MIB::sysORTable

Index sysORID
     1 SNMPv2-MIB::snmpMIB
     2 iso.2.840.10036
     3 IF-MIB::ifMIB
     4 SNMPv2-SMI::enterprises.14988
     5 SNMPv2-SMI::enterprises.10002.1.1.1.31

SNMP table SNMPv2-MIB::sysORTable, part 2

 index
   sysORDescr
     1 The MIB module for SNMP entities
     2 The MIB module for IEEE 802.11 entities.
     3 The MIB module to describe … network interface sub-layers
     4 The Mikrotik experimental wireless MIB module
```

Load additional vendor MIB's

- snmpwalk –v1 –c **{COMM} {IP}** enterprises.14988

```
enterprises.14988.1.1.1.1.1.3.7 = Gauge32: 13000000
enterprises.14988.1.1.1.1.1.4.7 = INTEGER: -64
enterprises.14988.1.1.1.1.1.5.7 = STRING: "farallon"
```

- curl http://www.mikrotik.com/Documentation/manual_2.9/Mikrotik.mib \
  --output /usr/share/snmp/mibs/contrib/Mikrotik.mib
- grep "DEFINITIONS ::= BEGIN" Mikrotik.mib | awk '{print $1}'

```
MIKROTIK-EXPERIMENTAL-MIB
```

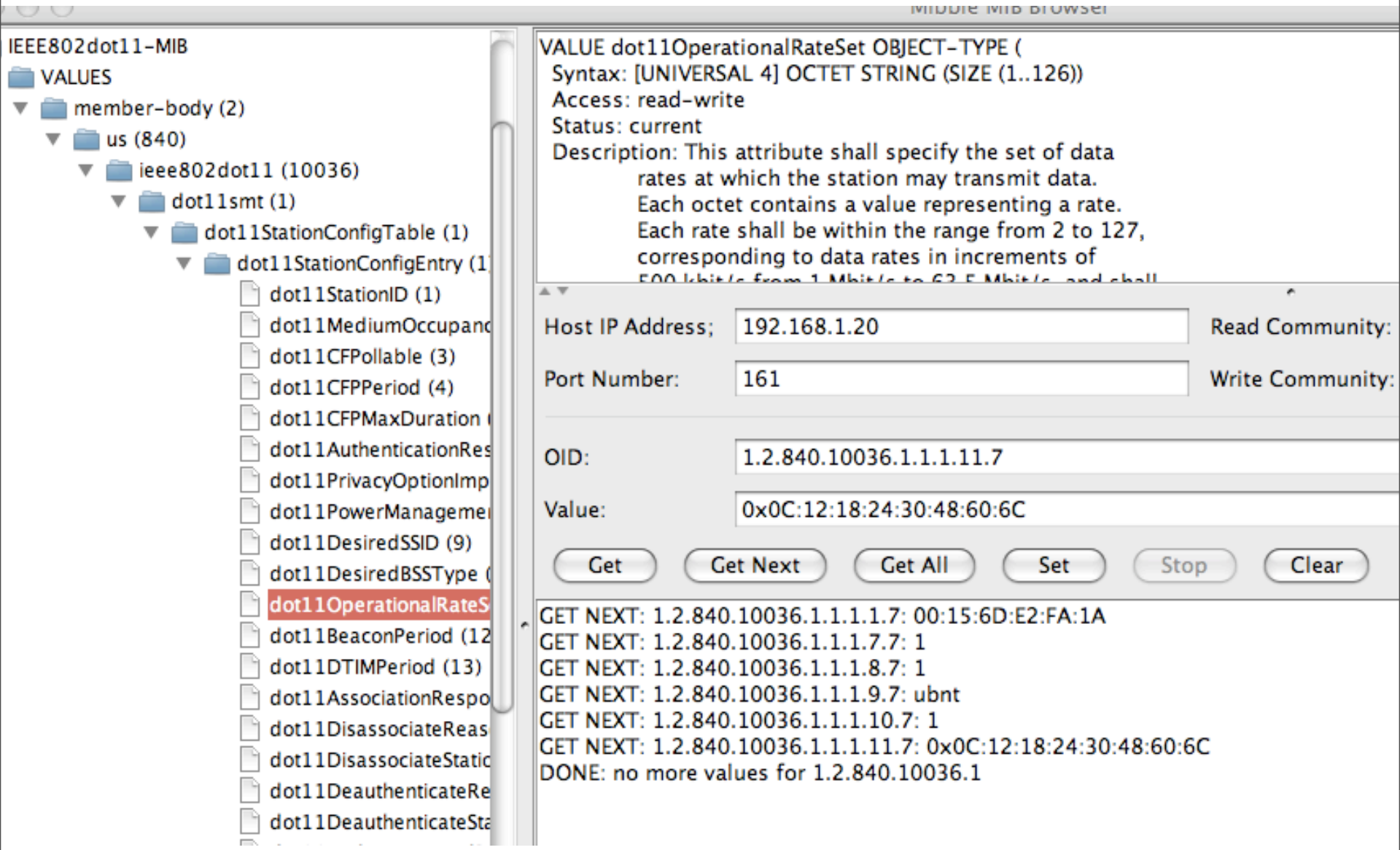
- vi /etc/snmp.conf

```
mibdirs /usr/share/snmp/mibs
mibs +MIKROTIK-EXPERIMENTAL-MIB
```

- snmpwalk –v1 –c **{COMM} {IP}** enterprises.14988

```
MIKROTIK-EXPERIMENTAL-MIB::mtxrWlStatRxRate.7 = Gauge32: 13000000
MIKROTIK-EXPERIMENTAL-MIB::mtxrWlStatStrength.7 = INTEGER: -65
MIKROTIK-EXPERIMENTAL-MIB::mtxrWlStatSsid.7 = STRING: farallon
```

Mibble SNMP MIB Browser



http://www.intermapper.com/custom-probes-a-snmp/683-mibble

Nagios

- **N**agios **A**in't **G**onna **I**nsist **O**n **S**ainthood
  - Rewrite of original NetSaint program
  - Open Source NMS, GPL licensed
  - Runs under Linux, BSD, Solaris, OS X
  - Core framework with contributed add-on's (graphing, recourse checking, configuration
  - Web CGI interface
- **Check** scripts
  - Executable (shell, Perl, C) programs with standardized output formatting & exit codes

  0 = Ok, **1** = Warning, **2** = Critical, **4** = Unknown

Nagios Configuration Files

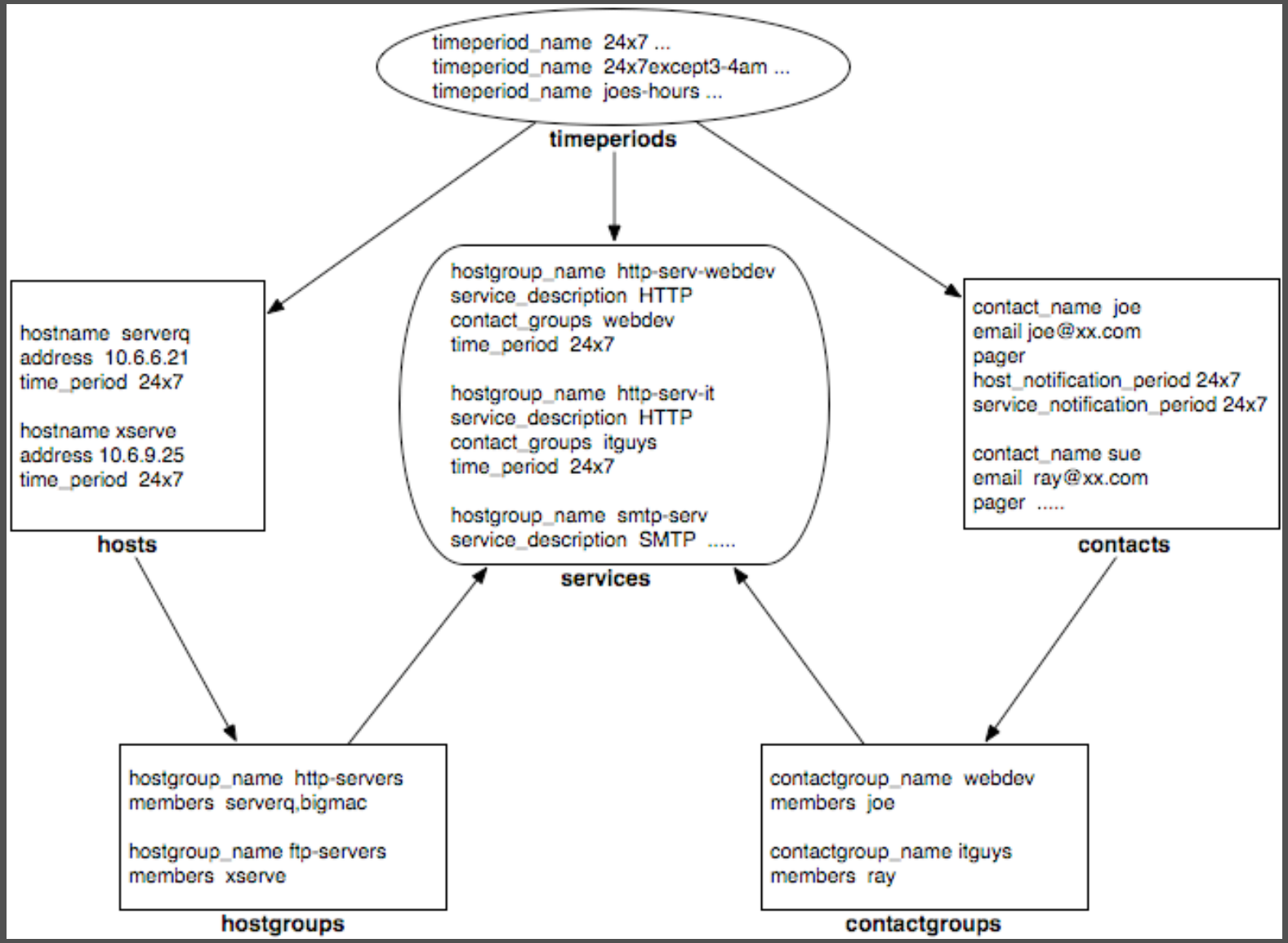


Diagram c/o http://homepage.mac.com/duling/halfdozen/Nagios-Howto-p1.html

Monitoring Concepts

- Determine Availability
  - Bad simple ICMP ping
  - Good SSH or other interactive/2-way expected response
- Alerting should be relevant, concisely detailed
  - Bad *Backup has failed*
  - Good *db_backup.tgz is 2 hrs old & 82Mb in size*
- Logical grouping
  - By operations group, customers, geographical – your choice
- Dependencies
  - If switch it down, then assume hosts are down

Metrics to Monitor

- Generic
  - Load average, memory utilization
  - Interfaces (up/down status, bandwidth min/max)
  - Disk storage {hard drive, compact flash} size
  - Environmental (fan, temperature, power supply)
  - NTP drift
- Network
  - Routes (OSPF neighbors, BGP peers, prefix thresholds)
  - Interface meta-data (95^{th} percentile, dBm for optical or RF)
- System

Advanced Monitoring

- Step though entire user/customer dependencies
  - *What does it take for customer to use service, call us, email*
  - Power UPS/PDU (check_ups)
  - Switch port/access point (check_snmp_int)
  - DHCP lease offer (check_dhcp)
  - DNS (check_dns)
  - VoIP call center (check_sip)
  - etc
- Use acknowledgements
  - Nagios CGI and/or email reply to entire team

Advanced Monitoring

- From “outside” your network, very important
  - WebSitePulse, Pingdom, Circonus
  - Nagios instance on VPS server
- Retain monitoring data indefinitely
  - Reporting for SLA analysis, growth predictions

Monitoring Notifications

- Define clear escalation time periods
  - Costly to wake up senior personal for non-critical issues
  - Define SLA per each host and/or service, know when to call
- Mechanisms
  - Email – Only read during business hours, possibly filtered
  - SMS via SMTP – Limited msg length, unreliable delivery
  - SMS via SNPP, WCTP, TAP – Limited carrier availability, paid service, delivery receipts/two-way confirmation
  - SMS via GSM – Cheap, slightly better delivery then SMTP

Recommended check scripts

- check_ssh, check_dns, check_http

  http://nagiosplugins.org/

- IF-MIB: Interface up/down, thresholds in/out traffic

  http://nagios.manubulon.com/snmp_int.html

- Environmental: fan, temperature, power supply states

  http://nagios.manubulon.com/snmp_env.html

- Storage

  http://nagios.manubulon.com/snmp_storage.html

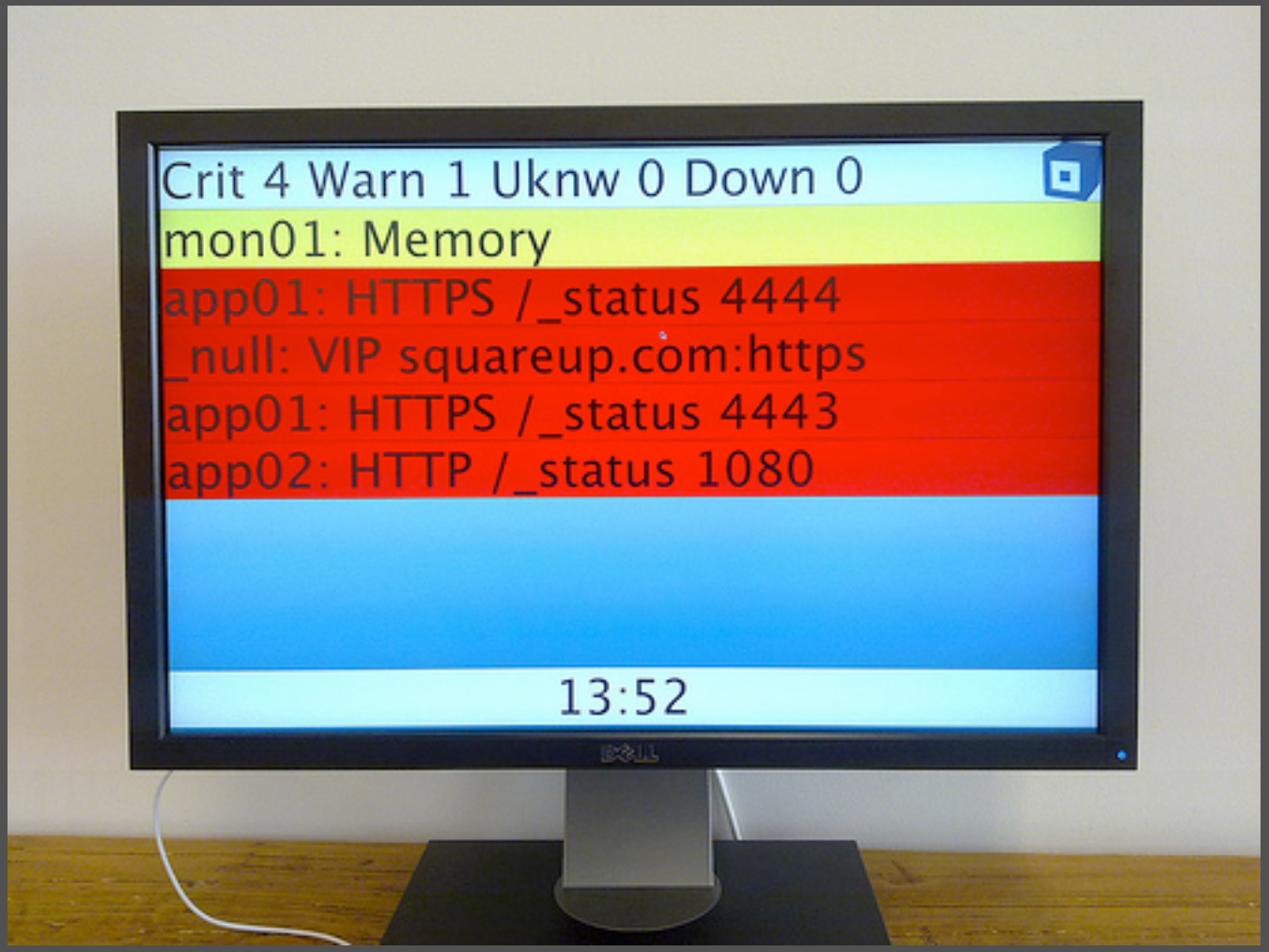
- IEEE-802dot11 (Ubiquiti)

  http://blog.jasonantman.com/tags/ubiquiti/

Standard Nagios CGI view

	MySQL Backup S3	OK	07-18-2010 22:46:27	1d 10h 1m 30s	1/2	is 122431 seconds old and 83310368 bytes
	MySQL Replication	OK	07-18-2010 22:45:59	2d 6h 7m 6s	1/2	OK - Slave is 0 seconds behind
	NTP Drift	OK	07-18-2010 22:46:08	5d 4h 46m 25s	1/2	NTP OK: Offset 0.001248717308 secs
	Puppet	OK	07-18-2010 22:46:25	5d 4h 52m 37s	1/2	PUPPET OK - state file is 2 minutes old: process running
	Redis Replication	OK	07-18-2010 22:46:42	1d 10h 17m 15s	1/2	OK
	Storage	OK	07-18-2010 22:46:00	5d 4h 46m 25s	1/2	/boot: 9%used(0GB/0GB) /: 1%used(2GB/131GB) /data: 0%used(1GB/670GB) (<70%) : OK
	Syslog-ng	OK	07-18-2010 22:46:23	5d 4h 46m 25s	1/2	OK: syslog-ng
log01	Dell Chassis	OK	07-18-2010 22:46:49	4d 10h 48m 8s	1/2	Processors:Ok, Intrusion:Ok, Voltages:Ok, Fans:Ok, Temperatures:Ok, Memory:Ok, Batteries:Ok, HardwareLog:Ok - [8:Success, 0:Warning, 0:Critical]
	Dell Storage	OK	07-18-2010 22:46:06	4d 10h 47m 51s	1/2	VirtualDisk0: Ok, DATA: Ok, PhysicalDisk0:0:0: Ok, PhysicalDisk0:0:1: Ok, PhysicalDisk0:0:2: Ok, PhysicalDisk0:0:3: Ok, PhysicalDisk0:0:4: Ok, PhysicalDisk0:0:5: Ok, PhysicalDisk0:0:6: Ok, PhysicalDisk0:0:7: Ok, PhysicalDisk0:0:8: Ok, PhysicalDisk0:0:9: Ok, PhysicalDisk0:0:10: Ok, PhysicalDisk0:0:11: Ok, PhysicalDisk0:0:12: Ok, PhysicalDisk0:0:13: Ok, Battery0: Ok - [17:Success, 0:Warning, 0:Critical]
mon01	CPU Load	OK	07-18-2010 22:46:23	5d 4h 52m 37s	1/2	8 CPU, average load 1.1% < 60% : OK
	Dell Chassis	OK	07-18-2010 22:46:40	5d 4h 13m 17s	1/2	Processors:Ok, Intrusion:Ok, Voltages:Ok, Fans:Ok, Temperatures:Ok, Memory:Ok, Batteries:Ok, HardwareLog:Ok - [8:Success, 0:Warning, 0:Critical]
	Dell Storage	OK	07-18-2010 22:46:17	5d 4h 30m 41s	1/2	VirtualDisk0: Ok, PhysicalDisk0:0:0: Ok, PhysicalDisk0:0:1: Ok, Battery0: Ok - [4:Success, 0:Warning, 0:Critical]
	Mail queue	OK	07-18-2010 22:00:43	5d 4h 46m 14s	1/2	OK: mailq reports queue is empty
	Memory	OK	07-18-2010 22:46:38	5d 4h 46m 14s	1/2	Ram : 9%, Swap : 0% : : OK
	NTP Drift	OK	07-18-2010 22:46:36	5d 4h 46m 14s	1/2	NTP OK: Offset 0.001308202744 secs
	Puppet	OK	07-18-2010 22:46:04	5d 4h 46m 14s	1/2	PUPPET OK - state file is 23 minutes old: process running
	Storage	OK	07-18-2010 22:46:23	5d 4h 46m 14s	1/2	/boot: 9%used(0GB/0GB) /: 1%used(2GB/131GB) (<70%) : OK
	Syslog-ng	OK	07-18-2010 22:45:53	5d 4h 46m 14s	1/2	OK: syslog-ng
office-pbx	Asterisk: Bandwidth.com	OK	07-18-2010 22:45:56	2d 11h 42m 1s	1/2	OK: BW-PRI-SJC 216.82.225.202 5060 OK (16 ms)
	Asterisk: VoicePulse	OK	07-18-2010 22:46:35	1d 21h 3m 22s	1/2	OK: VP-PRI-SJC/rwV83GWq49 209.31.18.12 5060 OK (28 ms)
	CPU Load	OK	07-18-2010 22:46:36	1d 18h 42m 21s	1/2	2 CPU, average load 1.0% < 60% : OK
	NTP Drift	OK	07-18-2010 22:46:47	5d 4h 52m 37s	1/2	NTP OK: Offset -0.007276646968 secs
	md RAID	OK	07-18-2010 18:00:55	5d 4h 46m 2s	1/2	OK md0 status=[UU]. md1 status=[UU]. md2 status=[UU].
office-router	CPU Load	OK	07-18-2010 22:45:56	5d 4h 45m 51s	1/2	1 CPU, load 1.0% < 60% : OK
	Flash Storage	OK	07-18-2010 18:01:06	5d 4h 45m 51s	1/2	/sbin: 44%used(0GB/0GB) /bin: 45%used(0GB/0GB) /tmp: 0%used(0GB/0GB) /etc: 5%used(0GB/0GB) /flash: 66%used(1GB/1GB) /usr: 95%used(0GB/0GB) /var: 92%used(0GB/0GB) /: 80%used(0GB/0GB) (<96%) : OK
	NTP Drift	OK	07-18-2010 22:45:56	0d 1h 57m 1s	1/2	NTP OK: Offset -0.008107628324 secs
stage01	CPU Load	OK	07-18-2010 22:46:36	5d 4h 45m 42s	1/2	8 CPU, average load 1.0% < 60% : OK
	Dell Chassis	OK	07-18-2010 22:46:36	4d 10h 48m 26s	1/2	Processors:Ok, Intrusion:Ok, Voltages:Ok, Fans:Ok, Temperatures:Ok, Memory:Ok, Batteries:Ok, HardwareLog:Ok - [8:Success, 0:Warning, 0:Critical]
	Dell Storage	OK	07-18-2010 22:46:36	4d 10h 48m 26s	1/2	VirtualDisk0: Ok, PhysicalDisk0:0:0: Ok, PhysicalDisk0:0:1: Ok, Battery0: Ok - [4:Success, 0:Warning, 0:Critical]
	HTTP / status 1080	OK	07-18-2010 22:46:36	5d 4h 32m 26s	1/2	HTTP OK: HTTP/1.1 200 OK - 435 bytes in 0.004 second response time
	HTTPS / status 4443	OK	07-18-2010 22:46:36	5d 4h 32m 26s	1/2	HTTP OK: HTTP/1.1 200 OK - 475 bytes in 0.028 second response time
	HTTPS / status 4444	OK	07-18-2010 22:46:36	5d 4h 32m 26s	1/2	HTTP OK: HTTP/1.1 200 OK - 475 bytes in 0.022 second response time
	Mail queue	OK	07-18-2010 22:14:31	5d 4h 45m 42s	1/2	OK: mailq reports queue is empty
	Memory	OK	07-18-2010 22:46:36	5d 4h 45m 42s	1/2	Ram : 17%, Swap : 0% : : OK
	NTP Drift	OK	07-18-2010 22:46:36	5d 4h 32m 26s	1/2	NTP OK: Offset 0.001468896866 secs
	Puppet	OK	07-18-2010 22:46:36	5d 4h 52m 37s	1/2	PUPPET OK - state file is 26 minutes old: process running
	Storage	OK	07-18-2010 22:46:36	5d 4h 45m 42s	1/2	/boot: 9%used(0GB/0GB) /: 6%used(8GB/131GB) /home/square: 6%used(8GB/131GB) (<70%) : OK
	Syslog-ng	OK	07-18-2010 22:46:36	5d 4h 32m 26s	1/2	OK: syslog-ng

CoffeeSaint displaying Nagios

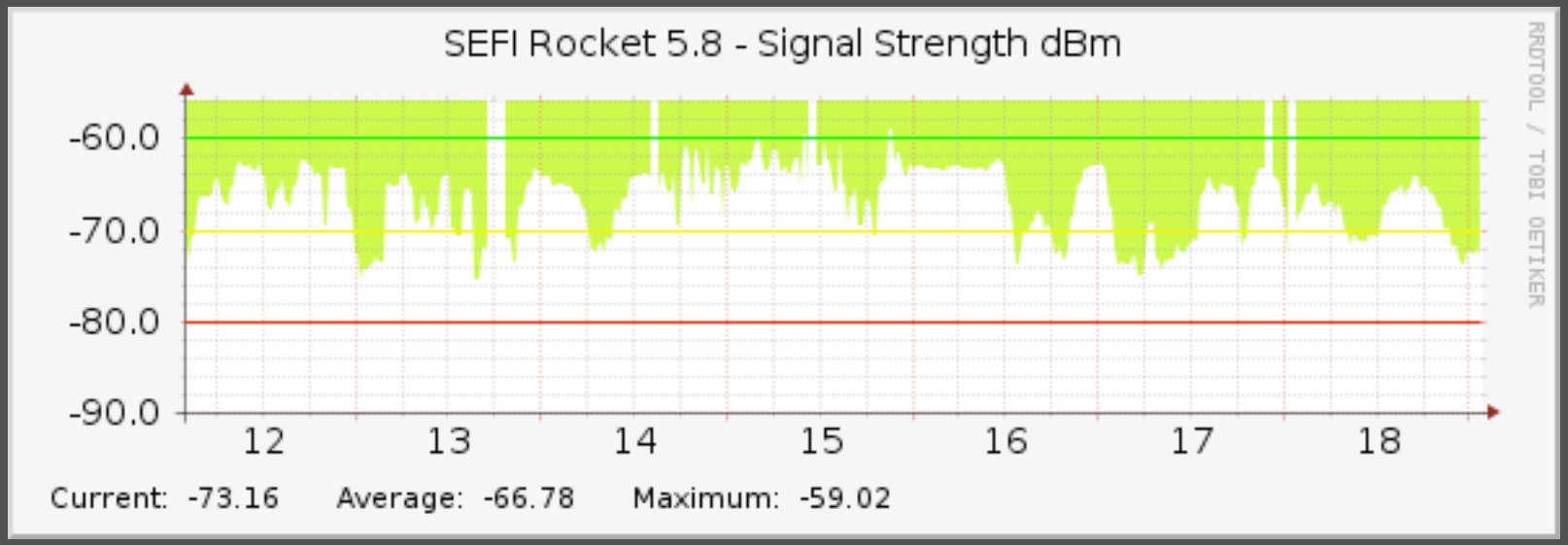


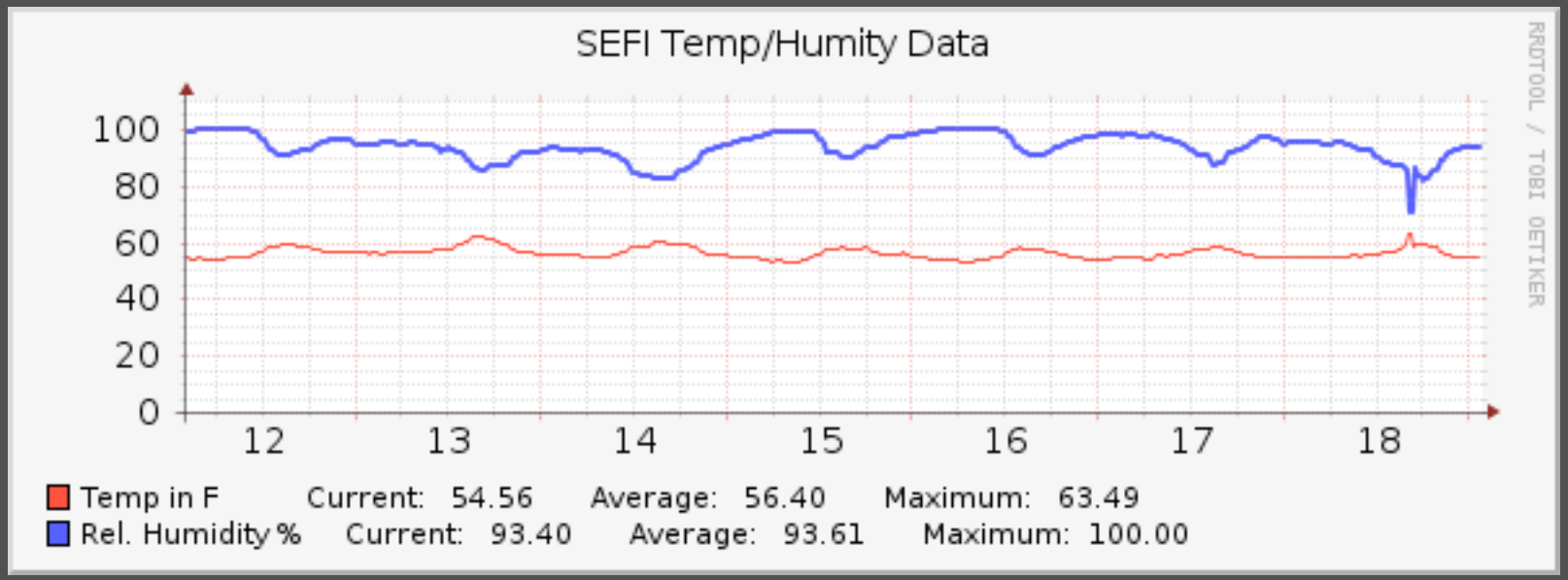
Trending

- Cacti
  - Popular for ISP's, content providers
- Munin
  - Systems focused
- Smokeping
  - Latency measurement

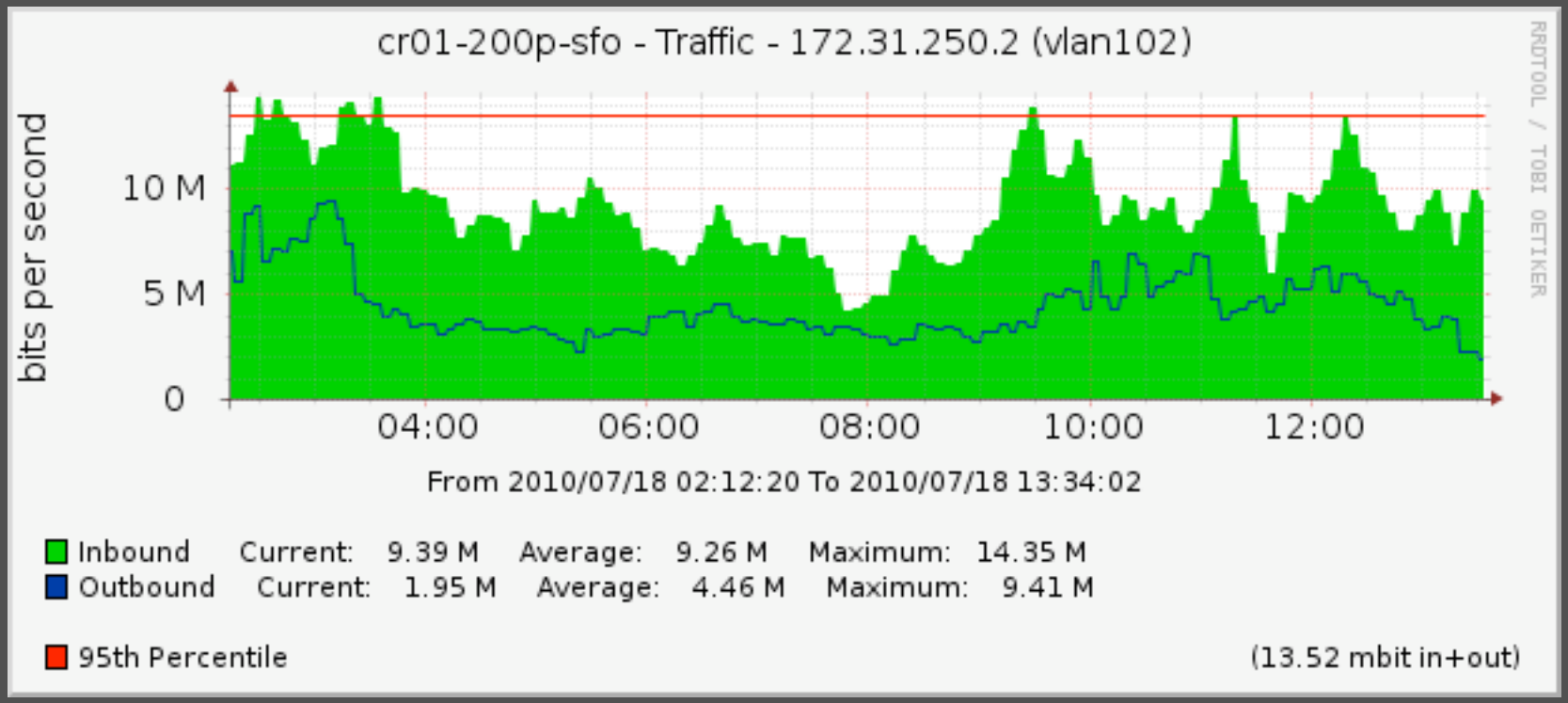
Above tools rrdtool based **round robin database**; automatically

Cacti – dBm Signal vs. Weather

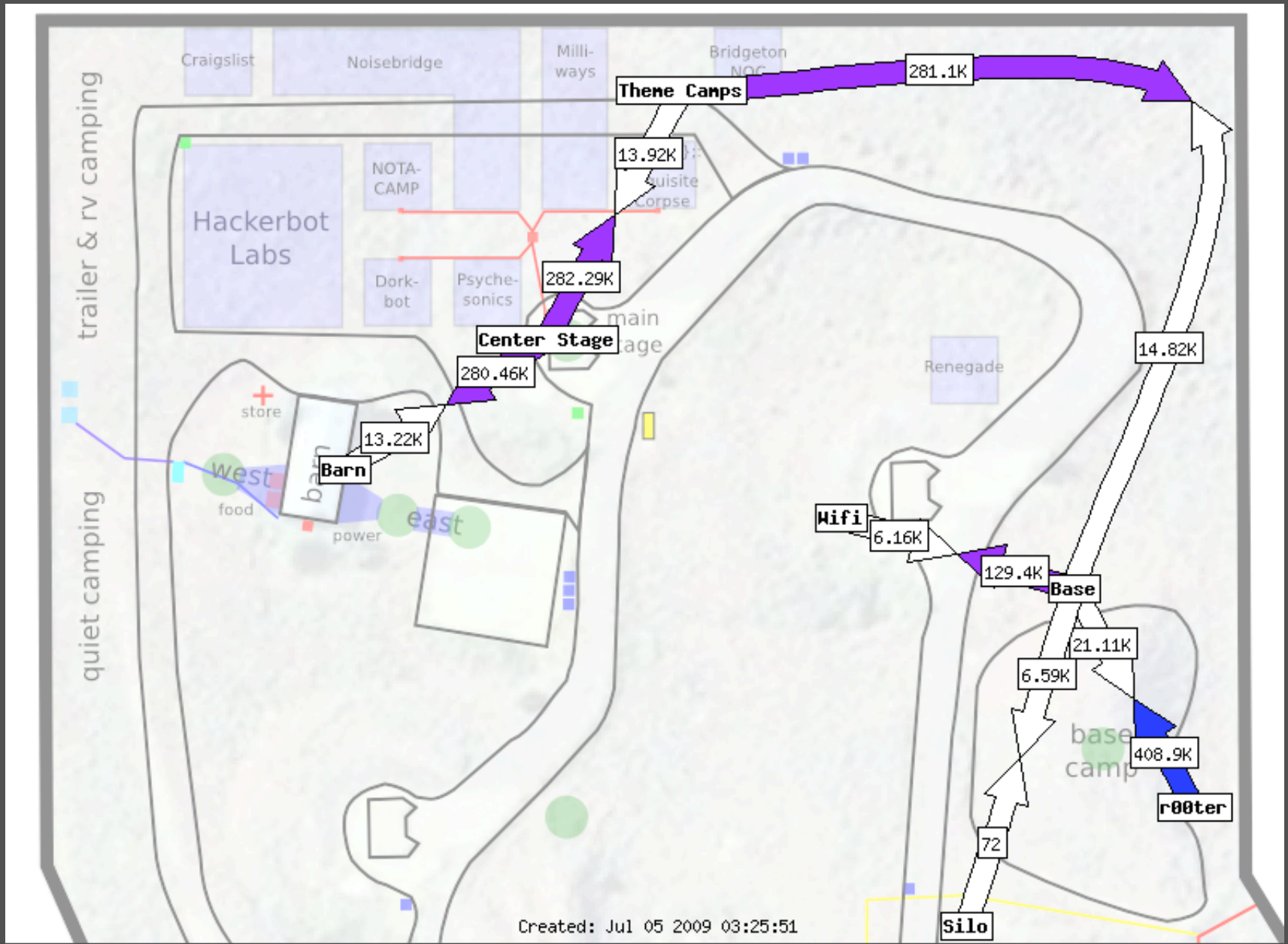




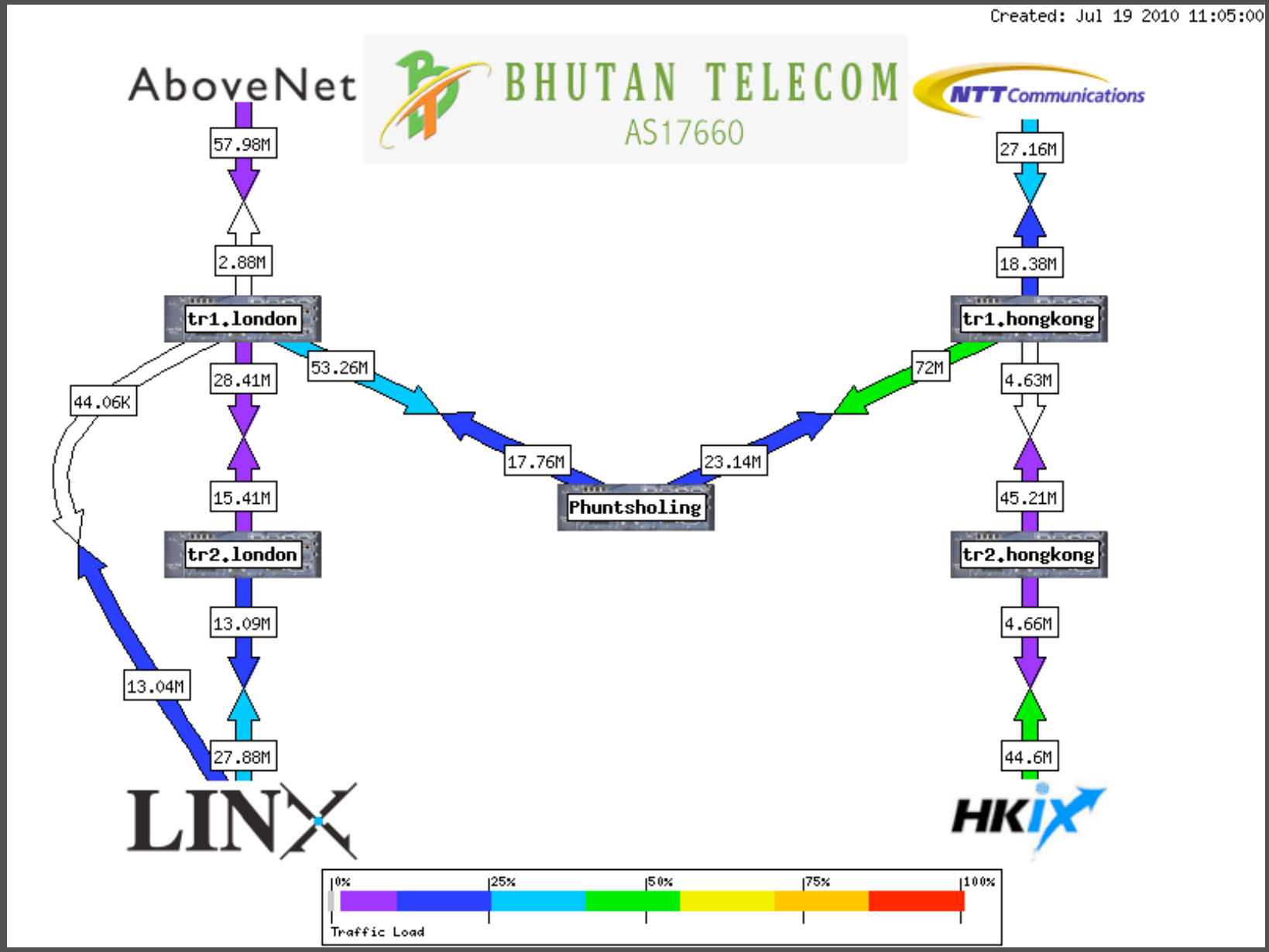
Cacti – Interface In/OutOctets



PHP Weathermap



PHP Weathermap



Grab File Edit Capture Window Help

Rx: 346 KB/s

matt@Bofhs-MacBook-37 | ssh root@206.158.7.9:~ — ssh

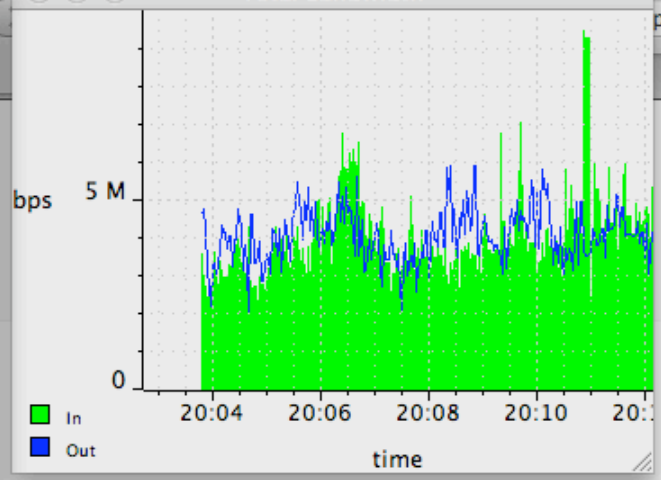
```
bwm-ng v0.6 (probing every 0.100s), press 'h' for help
 input: getifaddrs type: avg (30s)
\         iface                 Rx                 Tx              Total
==============================================================================
          vr0:          441.33 KB/s        201.61 KB/s        642.94 KB/s
          vr1:            0.28 KB/s         44.78 KB/s         45.06 KB/s
          vr2:          203.79 KB/s        400.23 KB/s        604.03 KB/s
          vr3:            0.05 KB/s          0.02 KB/s          0.07 KB/s
      vlan100:           10.99 KB/s         18.56 KB/s         29.56 KB/s
      vlan102:            5.32 KB/s         77.66 KB/s         82.98 KB/s
      vlan103:           15.67 KB/s        129.12 KB/s        144.79 KB/s
      vlan104:           98.69 KB/s          3.66 KB/s        102.36 KB/s
      vlan107:            0.04 KB/s          0.02 KB/s          0.07 KB/s
      vlan111:           43.86 KB/s        115.68 KB/s        159.53 KB/s
      vlan112:           22.76 KB/s         49.95 KB/s         72.71 KB/s
------------------------------------------------------------------------------
        total:          842.62 KB/s       1041.18 KB/s       1883.80 KB/s
```

matt@Bofhs-MacBook-37 | ssh root@206.158.7.9:~ — ssh

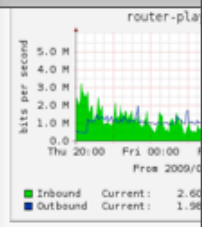
```
  2 users    Load 0.12 0.23 0.16                  Sun Aug  2 09:42:40 2009

UEUE                 BW SCH  PR  PKTS BYTES DROP_P DROP_B QLEN BORR SUSP P/S  B/S
oot_vr0            9000K cbq   0 67027   33M      0      0    0    0    0 476 174K
q_noc_nat          1000K cbq   7  7424 1908K      0      0    0   13    0  45  29K
q_wired_guests      560K cbq   5     0     0      0      0    0 9174    0   0    0
 q_artery           78400 cbq         0     0      0      0    0    0    0   0    0
 q_westwing         78400 cbq   3     0     0      0      0    0    0    0   0    0
 q_mansonian        78400 cbq        32 10164      0      0    0    0    0   0    0
 q_firstcamp        78400 cbq   3     8  6094      0      0    0    0    0   0    0
 q_geeklandia       78400 cbq   6     0     0      0      0    0    0    0   0    0
 q_mediamecca       78400 cbq         3   270      0      0    0    0    0   0    0
 q_webcam           78400 cbq   3 12626   13M      0      0    0  12K    0  50  41K
q_esd_n_box         1120K cbq   6  6207  487K      0      0    0    0    0  61 4571
q_brcprivate        1400K cbq   3     0     0      0      0    0    0    0   0    0
 q_dmvrangers        224K cbq         1325 88105      0      0    0    0    0   9  539
 q_bmirplayainf      224K cbq   3  2561  143K      0      0    0    0    0  17  957
 q_accounting        224K cbq   7  3267  265K      0      0    0    0    0   0    0
 q_heavymachine      224K cbq        4865  347K      0      0    0    0    0  34 2299
 q_depot             224K cbq           0     0      0      0    0    0    0   0    0
 q_airport           224K cbq   6     0     0      0      0    0    0    0   0    0
q_gateperimeter      560K cbq   6  1177  273K      0      0    0   23    0   2 1184
q_publicwifi        4360K cbq       27532   15M      0      0    0    0   71 255  94K
```

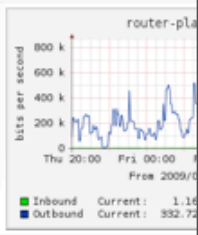
Done

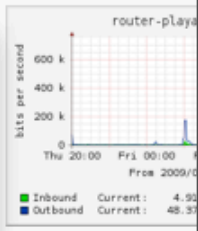
Total Bandwidth

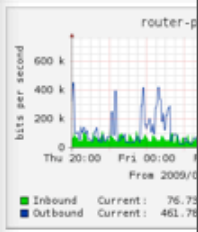


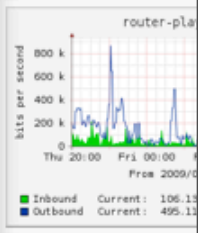
p?action=tree&tree_id











burningman LIVE – ustream.tv

http://www.ustream.tv/channel-popup/burningm

1895 Viewers / Broadcasting Live Menu

Proxy: None

Conclusion

- Successful WiFi deployment isn't difficult
  - Do the prep work; don't assume anything!
- Documentation matters
  - Reward personnel for sharing knowledge
- Monitoring isn't proprietary
  - Share & visualize availability within your organization

Thank you!

matt@peterson.org