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University of Waikato
WAND Network Research Group

- New Zealand's largest network research group
  - 4 academics
  - 5 technical staff
  - 12 students
  - Associates at Auckland and in Industry

- Two Govt funded projects
  - CRC Net
  - Measurement and Simulation

- Practical Focus (we build stuff)
CRCnet Project

• Project started 3 years ago
• Rural communities were frustrated by low speed unreliable Internet access
• Develop a new platform suitable to deploy future generation (>>10Mbps) wireless networks in rural and remote areas
  • Based around a tree/mesh architecture
Subscriber Unit Prototype

• Contains Soekris Biscuit PC with miniPCI wireless card and running custom Linux distribution
• 15.5 dB Antenna (no loss in antenna cable)
• Single power over Ethernet cable
• True Linux PC allows full firewalling and other Linux services
• Control and administration can be a provider or subscriber responsibility
Murupara Network

- connecting 4 schools plus 10 houses back to Murupara township
  - Regarded as 3 of the most remote schools in NZ
- Technology based on trial network
  - With all issues pushed much further
- Community input
  - Planning and building
Solar sites
Solar Sites
Rotorua Network

• Connects 5 Schools back to ICT centre
• Very flat landscape with LOTS of trees
• Build as a ring network
  • Small distances between nodes
  • Used high gain antenna despite short distances
  • Uses OSPF so any single link can fail
African Network

• Asked to build a wireless network to run a Tele-medicine application on
Network Management in CRCnet

- Manual maintenance of 40+ machines is not feasible
  - Mixed systems (Debian Woody/Embedded Linux)
  - Configuration typos / consistency of nameservers / ntp servers etc
- Nice easy interface is also desirable
- Ensure consistency of configuration across network
  - DNS / NTP / syslog servers
Host Configuration - Edit Host

Please enter the new details for this host below.

<table>
<thead>
<tr>
<th>Field</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hostname</td>
<td>mph</td>
</tr>
<tr>
<td>Current Location</td>
<td>Murray Pearson's House, Ngahinapou [change location]</td>
</tr>
<tr>
<td>Asset</td>
<td>[100] Soekris net4521 [change hardware]</td>
</tr>
<tr>
<td>Distribution</td>
<td>CRCnet Biscuit PC</td>
</tr>
<tr>
<td>Kernel</td>
<td>2.4.28-pmp-elan</td>
</tr>
<tr>
<td>Act as an Internet Gateway?</td>
<td>[ ]</td>
</tr>
<tr>
<td>Configure Automatically?</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

### Interfaces

<table>
<thead>
<tr>
<th>Interface Name</th>
<th>Status</th>
<th>IP Address</th>
<th>Subnet</th>
<th>Link</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>gw</td>
<td>OK</td>
<td>10.1.248.1/24</td>
<td>eth0</td>
<td>[100] Soekris net4521</td>
<td>[configure]</td>
</tr>
<tr>
<td>map</td>
<td>OK</td>
<td>10.1.255.1/24</td>
<td>eth0</td>
<td>[100] Soekris net4521</td>
<td>[configure]</td>
</tr>
<tr>
<td>hen</td>
<td>Degraded</td>
<td>10.1.224.1/24</td>
<td>eth0</td>
<td>[116] Omnio Gold PCMCIA Card 11MBits</td>
<td>[configure]</td>
</tr>
<tr>
<td>mph</td>
<td>Peer Down</td>
<td>10.1.232.1/24</td>
<td>eth0</td>
<td>[115] Atheos a/b/g PCMCIA Card</td>
<td>[configure]</td>
</tr>
</tbody>
</table>

### Services

<table>
<thead>
<tr>
<th>Service Name</th>
<th>Status</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Routing (Quagga)</td>
<td>OK</td>
<td>[configure]</td>
</tr>
<tr>
<td>AMP</td>
<td>OK</td>
<td>[configure]</td>
</tr>
<tr>
<td>Darpwatch</td>
<td>WARNING - Unknown MAC address observed</td>
<td>[configure]</td>
</tr>
<tr>
<td>CRCnetDaemon</td>
<td>OK</td>
<td>[configure]</td>
</tr>
<tr>
<td>DHCP</td>
<td>OK</td>
<td>[configure]</td>
</tr>
<tr>
<td>Firewall</td>
<td>CRITICAL - Firewall not running</td>
<td>[configure]</td>
</tr>
</tbody>
</table>

* Return to host list
Community Networks

- Previous examples are “Community Networks”

Problem with all of them is how they connect to the Internet
WAND NIC Card

- The group has been developing its own Wireless NIC card
  - Current version MiniPCI

- Applications:
  - Mac Layer Development
    - 802.11 with fast handoff
    - Rural networks
  - Location measurement
  - Wireless Measurement
    - Can synchronised with GPS time pulse
Rapid Deploy Networks

• Based on experience with CRCnet we believe technology well suited to networks that can be deployed quickly

• Currently looking working on the design of a number of different nodes:
  • Minimise time and expertise to do installation

• Proposed Node Types
  • Trailer/Helicopter deployable
  • Vehicle Based
  • Balloon Based??
Trailer/Helicopter Deployment

• Currently Designing a trailable version
• Completely standalone unit
  • 1 – 2 week battery life
  • 5 – 7 metre high mast
  • Up to 6 radio links
  • Trailer fitted with generator?
Prototype Node

• Fully Self Contained

• Current prototype uses 802.11b
  • going to add a 5.8GHz technology in next month

• Prototype:
  • Simple interface to configure links
  • Automatically sets up IP addressing and routing
Measurement and Simulation

• Simulation is only accessible to very large network operators and users
• AIM: Make simulation available to medium sized enterprises
• Integrate measurement and simulation
• FRST funded
Project Overview

- Topology Discovery
- Measurement
- Workload Model
- Network Model
- Validation
- Simulator
- Visualisation
Projects

• Automated Input
  • Topology discovery
  • Extraction of simulation parameters from traces
• Improved Simulation
  • Traffic Models
  • TCP/IP Stack Models
• Getting It Right
  • Continuous validation
  • Emulation
• Improved Output
  • Visualization
Passive Measurement

- Traffic model development and parameter extraction require long traces of real traffic.
- Previous work developed high performance passive capture devices (known as Dag cards)
- Speeds from Ethernet to OC48 (2.5Gbps WAN)
- Spun off a startup
  - Endace ([www.endace.com](http://www.endace.com))
  - now OC192
  - better support
Dag Cards

• Capture IP headers or full packet
• Add accurate timestamp
  • GPS or CDMA for external time
• Originally header trace focused
  • real-time flow based
  • security applications
• Optical splitter, electrical card relay or electrical tap
Traffic Capture

- WITS – Trace Archive
  - Long traces from Auckland University and NZIX
  - traces up to 45 days (3.2 billion packets - 65GB)
- New Waikato Trace Set
  - 100M packets/day (gzip 2-3GB)
  - Approaching 18 months continuous capture (~1TB)
- Have arrangements for capture of commercial traffic in NZ and Internationally
  - Much higher rates
  - Different traffic mixes
  - Real IP addresses
Traffic Modelling

• Need to:

• Classify traffic automatically
  • Requires categories to classify into.
  • Automatic generation of categories.
  • Work with Machine Learning group

• Model traffic sources accurately
  • Separation of User/application behaviour from Network behaviour.
  • Use a state machine approach to track application.
  • Requires extraction of data transfer boundaries
Improved TCP/IP Stack Models

- Many simulators have TCP/IP models
- Differences often due to implementation
  - Choices, timers, bugs
- Most accurate option to use OS source code.
  - Has been done before for specific OS
- Need an automated solution to extract source quickly for any OS stack
Visualisation

• Important for data interpretation by non-experts
• Useful for interpreting very large data sets
Futures

• Application Measurement
  • Use object detection and state machines to separate network performance from server performance.

• Event Detection
  • Automatic detection of anomalies
  • Passive and Active measurement sources

• Large Scale Simulation

• Autonomous Network Management
  • Measure – Detect problems – Simulate solution - Implement
Sensor Networks

• Small low cost devices
• Automatic network forming
• Ideal is “Smart Dust”
• Environment monitoring
• “Hot” research topic