Deploying an Island-Wide Wireless Network

A case study on providing broadband internet service in American Samoa

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Blue Sky

- ~400 Wireless subscribers
- Coverage available in 90% of the populated areas
Overview

- Last mile connectivity options for Broadband Service Providers
- Reasons for choosing a fixed wireless solution
- Deployment
The Last Mile

Cable

DSL

Wireless
Wireless Advantages

- Requires relatively less infrastructure
- Lack of outside plant maintenance
- Comparatively quick rollout
- Modular equipment
- Simple installation
- Layer-2 everywhere
Wireless Disadvantages

- Use of the unlicensed band presents issues
- Radio frequency interference is always a concern
- Line-of-sight is almost always required
- Layer-2 everywhere
Wireless Wins

• We have cell site towers for PCS that can be utilized for Wireless Access Points
• We don’t have to build out physical connections for the last-mile
• Customer installations are easy to rollout
• The equipment is relatively inexpensive
  • $800USD per Subscriber Module;
Motorola Canopy

- Operates on the 5.7Ghz and 900Mhz band
- SNMP v2c capable
- Access points have 7Mbps of total bandwidth
  - Usually configured for 3.5Mbps up/down
- Backhauls are either 10Mbps or 20Mbps
- VLAN support
Frequency

- The ISM Unlicensed Band (Industrial, Scientific and Medical)
  - 902 to 928 MHz
  - Spread spectrum: 1 W
  - Microwave ovens: 750 W
  - Industrial heaters: up to 100 kW
  - Military radar: up to 1000 kW
- 2.4 to 2.4835 GHz
  - Spread spectrum: 1 W
  - Microwave ovens: 900 W
- 5.725 to 5.850 GHz
  - Spread spectrum: 1 W
Modules

- Backhaul Unit
- Point-to-point connection
- Access Point
- Point-to-multipoint connection
- Subscriber Module
- Receiver
Deployment

- Terrain concerns
- Deployment strategies
- Using wireless backhauls
- Customer premises installation
- Solving line-of-sight issues
- Upgrading service
American Samoa Terrain
Population Density
Access Point Deployment
American Samoa Terrain
Olotele Backhaul ~3mi.
Aunu’u Backhaul ~12.5mi
Installation

Device Information

<table>
<thead>
<tr>
<th>Device type</th>
<th>5.7GHz - Multipoint - Subscriber Modem - 0a-00-3e-f1-fd-5d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software Version</td>
<td>CANOPY 7.3.6 Oct 24 2005 12:06:56 SM-DES</td>
</tr>
<tr>
<td>Software Boot Version</td>
<td>CANOPYBOOT 3.0</td>
</tr>
<tr>
<td>FPGA Version</td>
<td>070605 (DES Sched)</td>
</tr>
<tr>
<td>Uptime</td>
<td>4d, 06:44:32</td>
</tr>
<tr>
<td>System Time</td>
<td>07:14:57 06/13/2007</td>
</tr>
<tr>
<td>Ethernet Interface</td>
<td>100Base-TX Full Duplex</td>
</tr>
</tbody>
</table>

Subscriber Modem Stats

<table>
<thead>
<tr>
<th>Session Status</th>
<th>REGISTERED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registered AP</td>
<td>0a-00-3e-f6-de-f6</td>
</tr>
<tr>
<td>RSSI</td>
<td>828 (-67 dBm)</td>
</tr>
<tr>
<td>Jitter</td>
<td>7</td>
</tr>
<tr>
<td>Air Delay</td>
<td>349 (approximately 3.24 miles (17101 feet))</td>
</tr>
<tr>
<td>VPL Depth</td>
<td>348 (seawater) 3.54 miles (11101 feet)</td>
</tr>
<tr>
<td></td>
<td>828 (sea) 828 (01 dBm)</td>
</tr>
<tr>
<td></td>
<td>644 (sea) 644 (00 dBm)</td>
</tr>
</tbody>
</table>
Monitoring

Canopy - Satala API - Traffic - 1

Canopy - Satala API - Registered SM Count

Canopy - Satala API - Temperature

From 2007/06/12 14:14:31 To 2007/06/13 14:14:31

Current: 120.00 Average: 120.43 Max: 127.00 Min: 117.00
Layer-2 VLANs

- VLANs are used extensively to segregate broadcast domains.
- Each site is allocated a /26 subnet on a distinct VLAN.
- Each Access Point has a trunk port to carry multiple VLANs.
- Canopy equipment is addressed from a protected VLAN.
Service Upgrades

- Canopy Advantage
- 900Mhz Access Points
- Private VLAN Point-to-point connections
Canopy Advantage

- 2x Multiplier allows for up to 14Mbps shared bandwidth
- Hardware scheduling reduces latency
  - Usual wireless latency on a long hop (>3Mi) is reduced from ~80ms to ~8ms
- Slight drop in signal strength
- Must be 10Mhz above the noise floor
900Mhz Access Points

- 5.7Ghz modules are heavily reliant on line-of-sight
- 900Mhz modules operate on near line-of-sight
- Better foliage penetration
- Operates in conjunction with 5.7Ghz
- 900Mhz band is the same one used by
Private VLAN Point-to-point

- Private VLAN segregation
- Allows customers to connect satellite offices
- Ideal replacement for T1/Frame Relay links
- For bandwidth intensive applications, Backhaul units are used in place of SMs
Private VLAN Setup

Managed Switch needed to tag multiple VLANs

Managed Switch

Public VLAN Internet Access

Private VLAN

Local LAN

dot1q Trunk

Public VLAN Out to Internet

Private VLAN

SMs only do default ingress tag

Local LAN
Notes about bandwidth

- There is a hard limit to upstream bandwidth on a subscriber module.
- 5.7Ghz SM only reaches about 1Mbps upstream in real-world conditions.
- Asynchronous links are normally utilized.
- Wireless bandwidth far exceeds satellite bandwidth.
Frequency Map

- Work out the frequency map with any other service providers using the same frequency range
- 10-15Mhz separation is ideal
- Update each other regularly
Final Impressions

- Performs well
- Relatively stable
- Highly configurable
- Cross-training in RF technologies needed
- Cooperation is necessary
Module Placement

- The higher the better
- Take terrain into consideration
- Keep expansion in mind
Best Current Practices

• What’s important is what works
Tools

- Google Earth
- Google Sketchup
- Microsoft Visio or Omnigraffle
- Nagios
- Cacti