# Wireless WAN

ICE Networks

San Juan, PR


- Founded in 1996
  - Third operational ISP in Puerto Rico
    - No ISPs running when forming
    - No AOL until summer of 2001
  - First to provide T1 internet access
- Today still a small/medium sized ISP:
  - 15,000 dial up accounts
  - 80 businesses and institutions via T1, ISDN or wireless
  - Consumer broadband via satellite
  - CLEC status

# Puerto Rico and PRTC background

- Puerto Rico population:
  - 3.8 million island wide
  - 500,000 in San Juan
  - 1.6 million in greater metro area
- Puerto Rico is part of the US – FCC regulations apply

- PRTC = Puerto Rico Telephone Company
- 1974: State assumes ownership of PRTC from ITT
  - Only 200,000 lines operational at that time
- 1998: GTE buys majority interest in PRTC (40%) for $2.2 billion
  - 1.6 million lines in operation then
- 1999: PRTC had no internet offering, purchased coqui.net
- June 2000: GTE & Bell Atlantic merge into Verizon
- PRTC identity preserved until 2002, Verizon brand is only now being promoted; GTE brand was never promoted.
- 25+ years with a governmental monopolistic bureaucratic mindset
- PRTC dialup accounts estimated at 200,000 in 2001, pre-AOL

# Why Wireless?

- Initial motivation in 1999:
  - No broadband availability
- Excellent local line of sight
  - Located in 20 story Citibank tower
- Successful pilot offering to a local college
- Today's motivation:
  - Telco Bypass
  - Very limited broadband availability:
    - Telco DSL sole offering: 256k down 128k up: $60/mo
    - Single cable provider offering @home

# Why Wireless?

- It's about money
  - PRTC monthly charges

| Speed | Point to Point | With Internet |
|---|---|---|
| T1 metro | $400 | $700 |
| T1 long haul | $1,800 | $2,100 |
| DS3 metro | $5,800 | $11,000 |
| DS3 long haul | $25,000 | $31,000 |

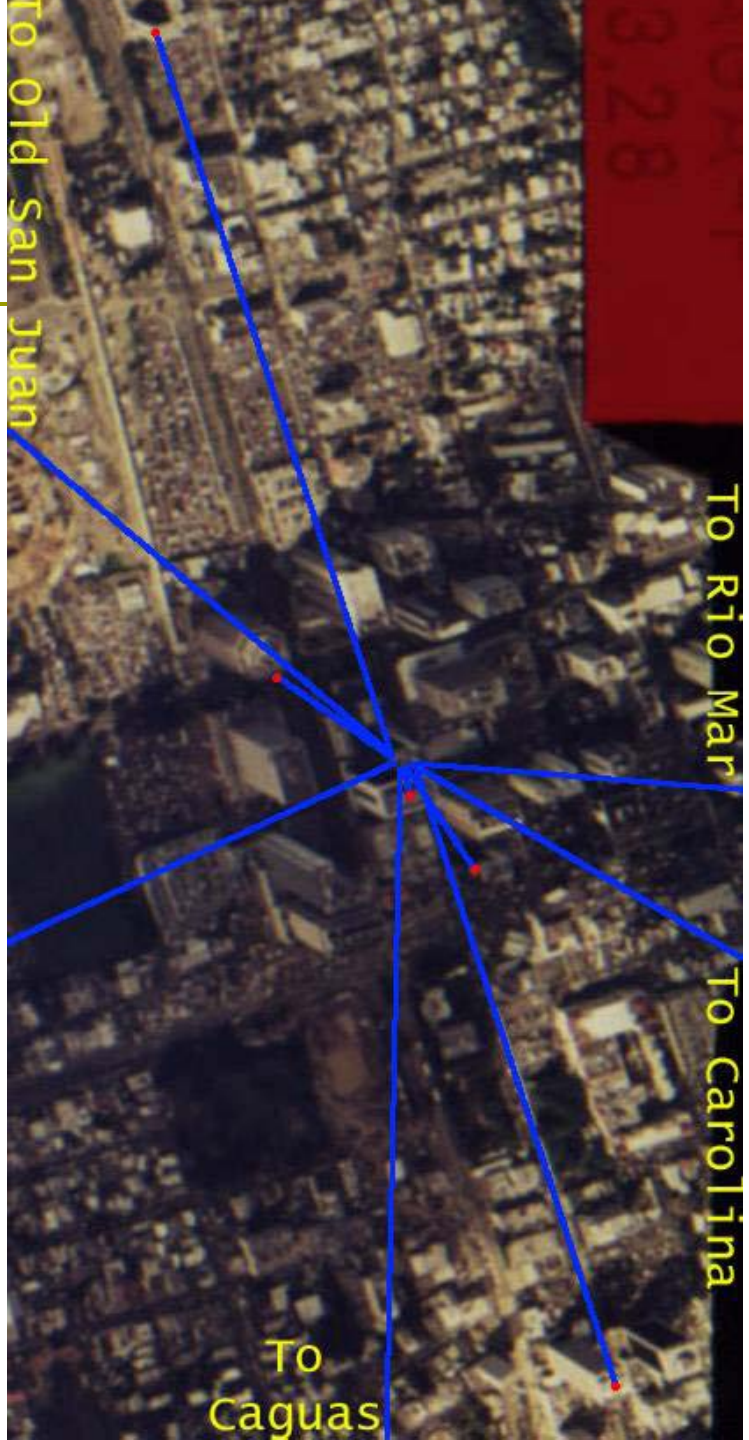
  - Wireless Costs

| | |
|---|---|
| Access points | $200 - $1,000 |
| 24 dBi parabolic grid | $120 |
| 14 dBi 30° yagi | $150 |
| 14 dBi 120° sector | $200 |
| 35 dBi parabolic solid | $1,000 |
| 500mW amp (27 dBm) | $300 |
| 1000mW amp (30 dBm) | $450 |
| 5.8GHz complete DS3 link | $30,000 |

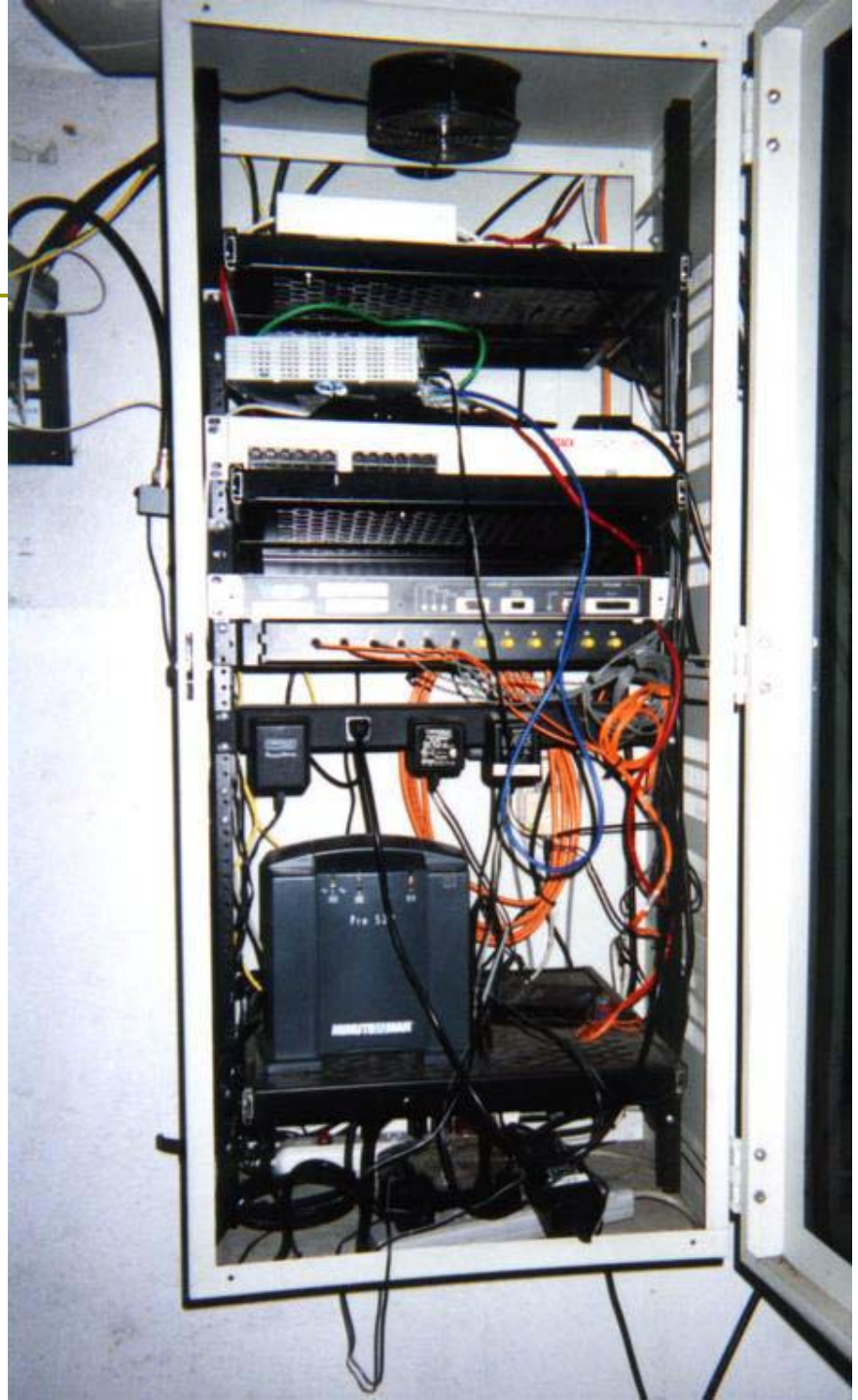
# Long Haul Nodes


Old
San Juan
High resolution at http://pr.cuzuco.com/aerial-l.jpg
To Rio Mar
To Carolina
To
Caguas

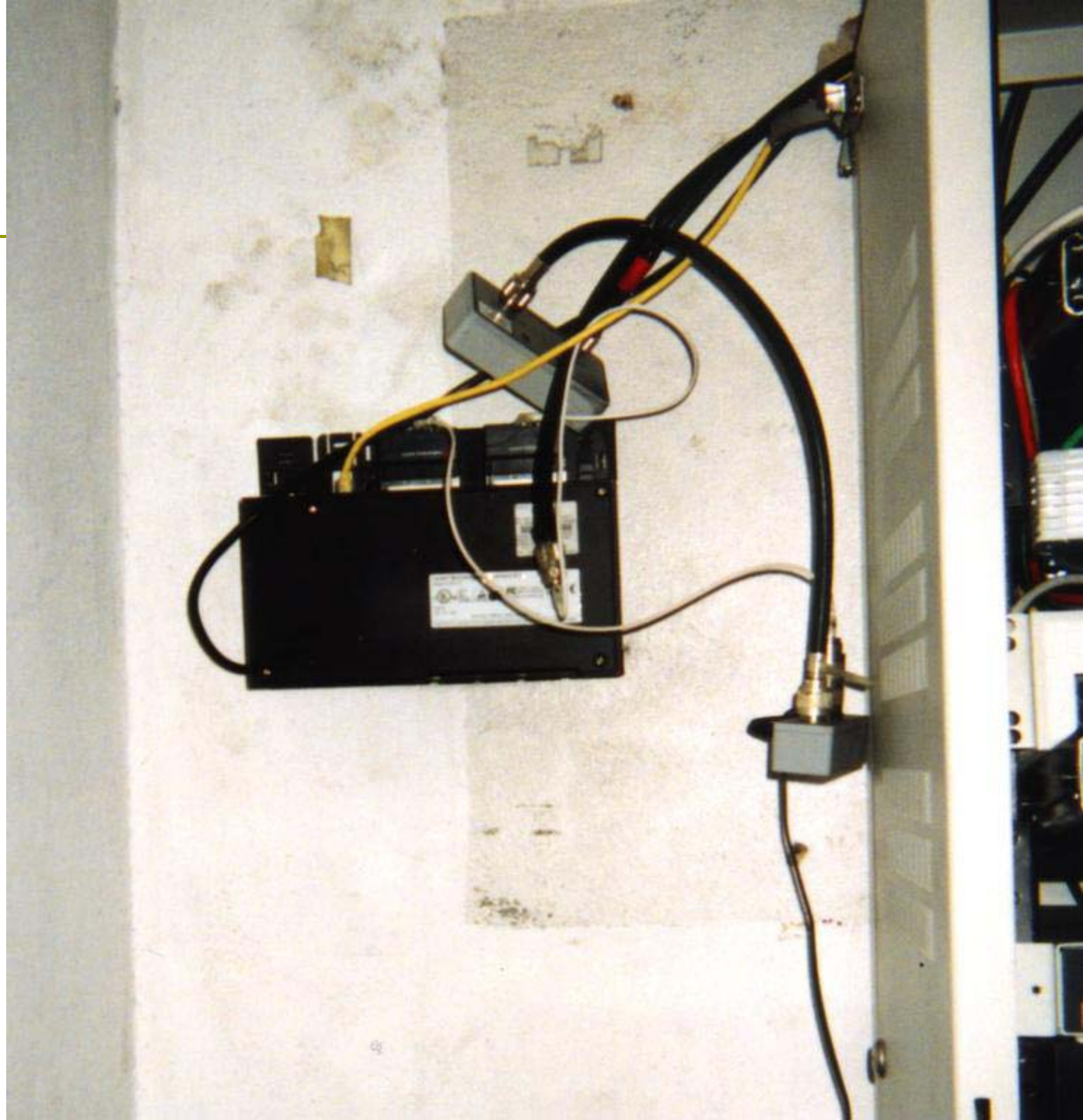
- Close up aerial view



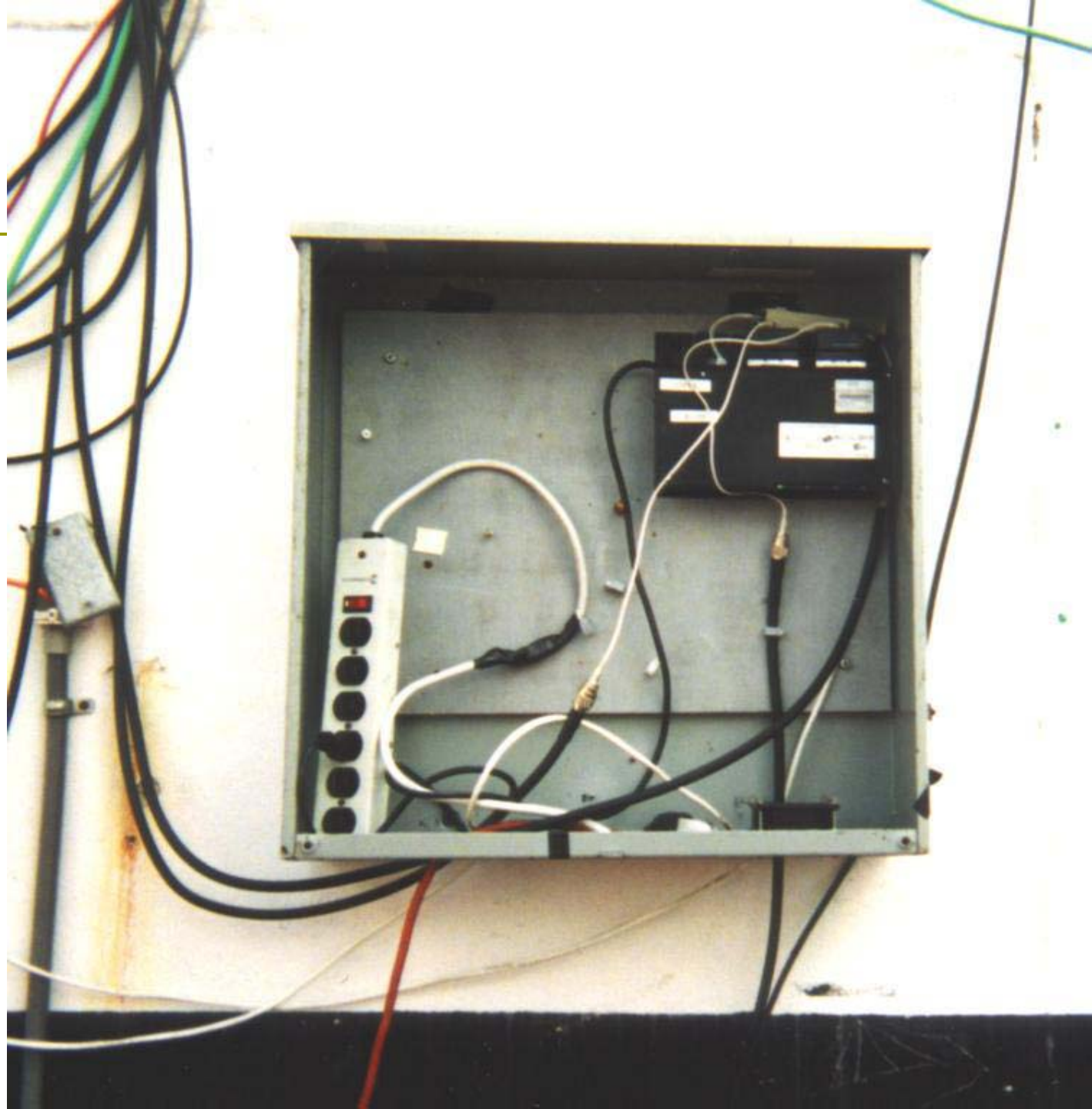
- Equipment locker in elevator room above 20th floor



- Lucent outdoor router. It is two PCMCIA cards.
- 500mW amps added



- Another Lucent Outdoor Router
- No amps



# 35 dBi 2.4GHz antenna. End point in Rio Mar about 21 miles.

Two 24dBi 8° parabolic grids, two 14dBi 30° yagis, 34.5dBi 3° 5.8GHz 4 foot parabolic solid.

**End point of 5.8GHz parabolic: Caguas, 16 miles. This a DS3 (45Mb/s) from**

**Western Multiplexer, see** http://www.wmux.com/products/datasheets/LynxDS-3licexempt.pdf

**end point of one of the yagis is on the tower in front of the helipad**

- 2 more 24dBi 8° parabolic grids. One end point is on the 20 story building directly behind the one.

end point of another grid is on the hill that has the yellowish stripe, Carolina about 6 miles.

# 2 more parabolic grids and a 14dBi 120° sector panel.

# parabolic grid servicing Old San Juan: 4 miles

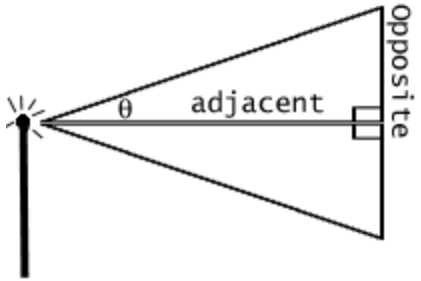
**end point in Old San Juan is atop the light green building, however the antenna is washed out by the bright sky.**

# Antenna Alignment

- Do it yourself
  - Binoculars
  - Laptop
  - GPS receiver
  - Electronic compass
  - Cell phone
  - Calculation tools such as those found at http://www.ydi.com/calc.php
- Hire professionals from the Telco

# Beam Width  Footprint and Adjustment

- Basic right angle trigonometry
  - $\tan\theta =$ opposite / adjacent
  - $\theta =$ Beam Width in degrees/2
  - adjacent = distance
  - end beam width = 2 * opposite




- Calculations
  - A 3° beam width sent 21 miles
    - End Width (footprint) = 2 * (21 * tan(3/2)) = 1.1 miles
    - 1° antenna movement moves center by (21*tan(1/2)) = 967 feet
  - A 8° beam width sent 4 miles
    - End Width (footprint) = 2 * (4 * tan(8/2)) = 0.5 miles
    - 1° antenna movement moves center by (4*tan(1/2)) = 184 feet

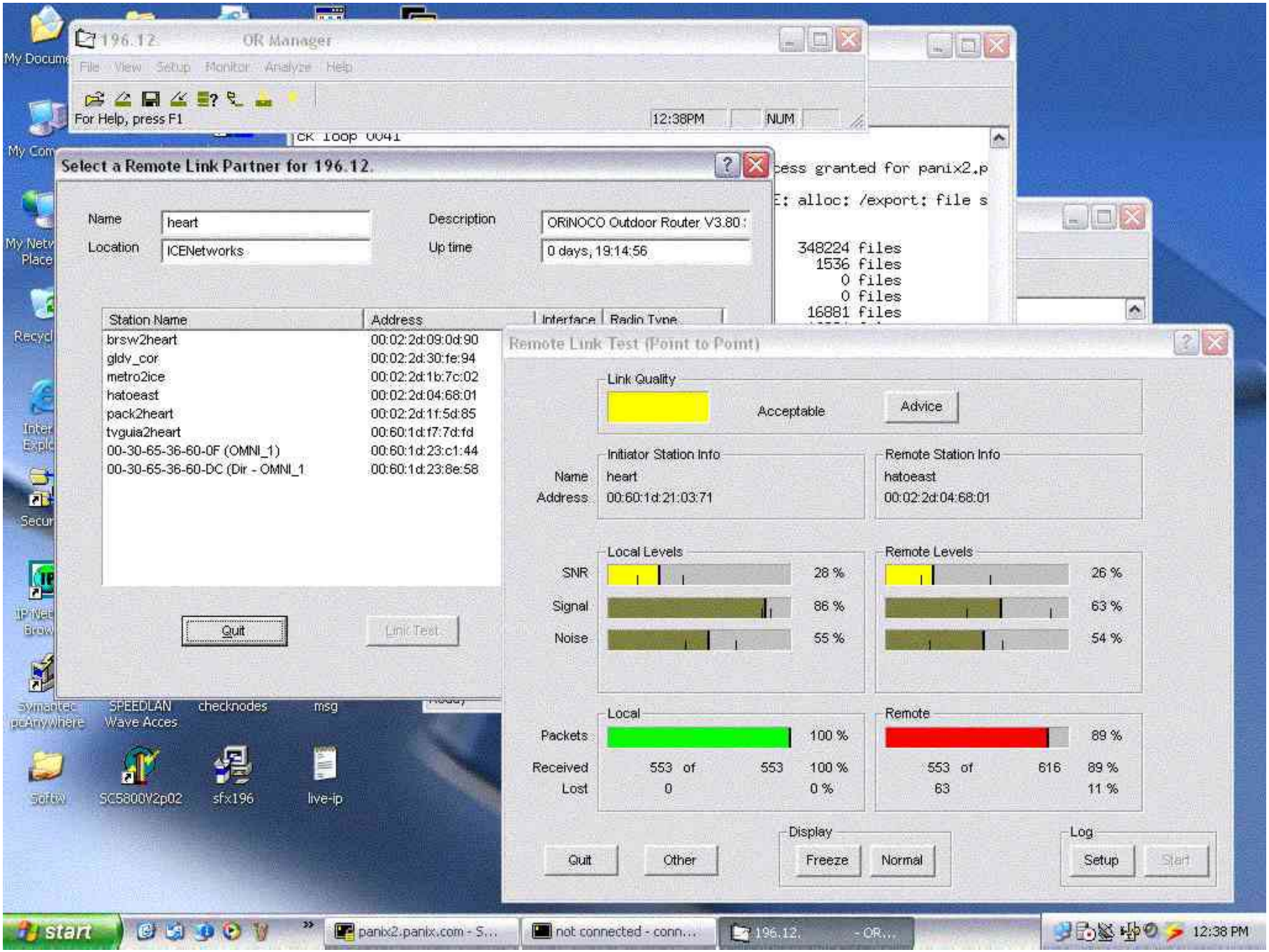
# Security & Management

- Access to the spectrum is limited
  - Easier to eavesdrop than to access the network
    - Narrow beam width
    - Antenna polarization
- Use of proprietary protocols
- Use of WEP
- Use of VPN

- Management of many nodes becomes problematic
  - Orinoco management software consolidates

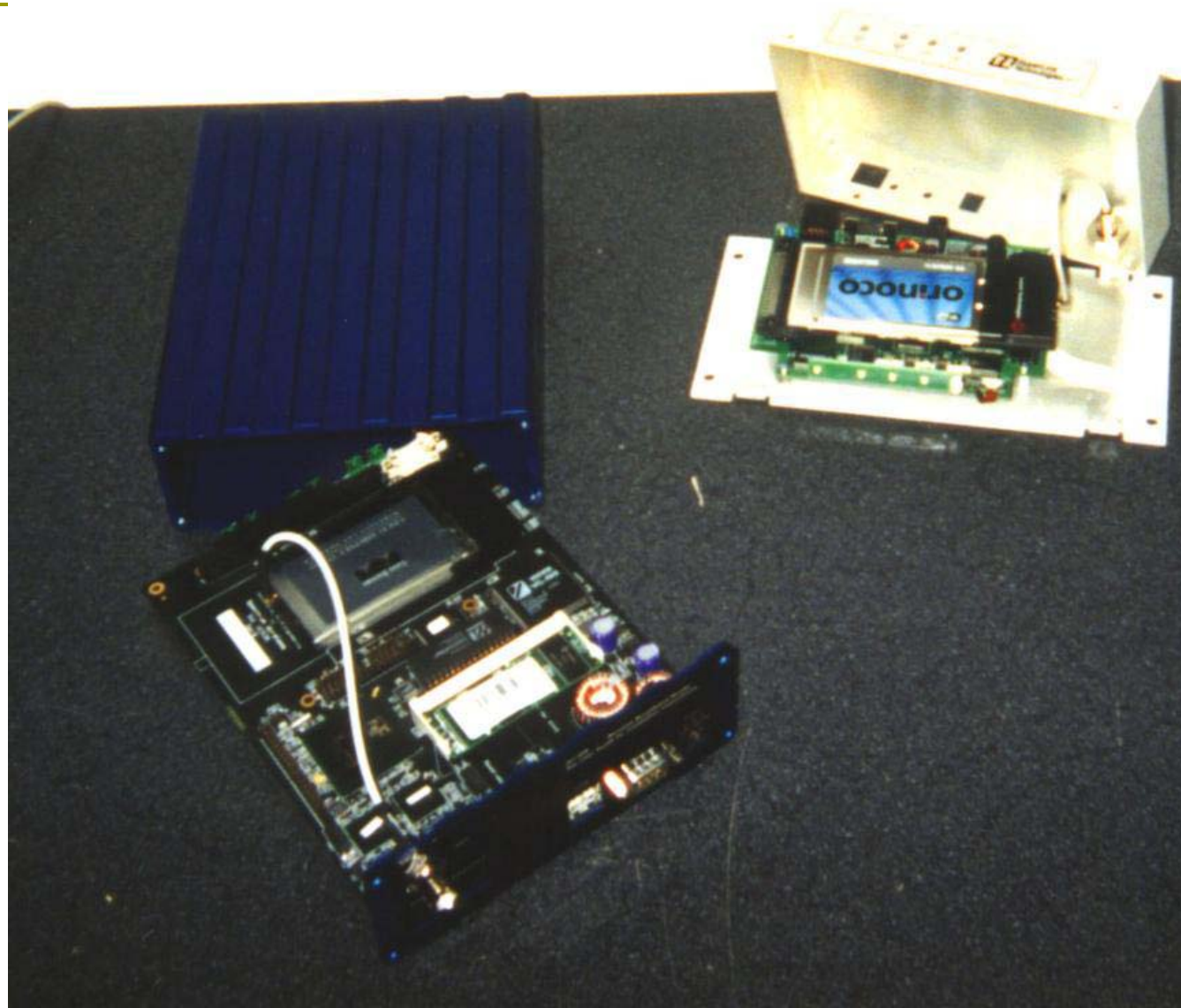
- 2.4GHz is all ready crowded
  - 2.4GHz to 5.8GHz converters (requires antenna change)

# screen shot of outdoor router management software



**Purchased whichever AP was cheapest at the time, causing node management headaches. But here's the contents of some access points.**

- Spectrum Wireless 2011DSr (blue): Cisco based
- Hyperlink Technologies H-SR2400-32 (beige): RG-1000 sans modem



# Other wireless initiatives

- Satellite
  - Dedicated 8Mb/s downlink
  - Residential offering: shared 2Mb/s
    - Provide upstream via dialup
    - 36 inch dish, Ku-band
- Ricochet
  - Aerie Networks now owns rights

# 3.8 meter satellite downlink, dedicated 8Mbit/s

- **Reference for size of the 3.8M dish**

# 36 inch satellite downlink, shared 2Mbit/s