# Wireless Networking in Latin America:
## Abdus Salam ICTP

# Project-oriented Advanced Training on

# Wireless Networking
## June 2006

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# Agenda

- Motivation
- Background

- Wireless Computer Networks
- Training activities

- Broadband Licensed Wireless

- Unlicensed  2.4 GHz Networks  in Mérida: RedUla and Fundacite

- Point to Point 5.8 GHz

# Background

- Very limited resources, both financial and human

- 700 km by mountain road to the capital

- Telephone communication out of Mérida by terrestrial analog microwave only

- Low teledensidity, no cell phones

- Experience with radio ham technologies for voice and packet radio

# Background

- In 1987 first trials with packet radios using a TNC (Terminal Node Controller) to connect a PC to a Ham radio at 300 Bauds in the HF bands. At VHF (2 m) the more stable propagation conditions allowed for transmission at 1200 Bauds later the same year.

- In 1988 a VHF link between Merida and Caracas was established by means of 3 repeating stations (Digipeaters), one leg was 400 km between a 4200 m amsl station in Pico del Aguila and El Junquito.

- In 1989 a gateway between the VHF and HF bands was established linking Venezuela with the outside world

# Background

- In 1991 the first Internet connection with packet radio at 1200 bit/s in the VHF band was accomplished, later increased at 9600 bit/s.

- By migrating to the UHF band, where the channel width allowed for radio ham use is 100 kH, we were able to achieve transmission speeds of 19.2 kbit/s and later 56 kbit/s

# Background

- Faced with the need to deploy a computer network, we concluded that despite our big technical hurdles the main obstacle was the lack of trained people

- Established a pilot computer network with two LANs connected by modems

- Started training a group of enthusiastic students in Unix, TCP/IP, and basic networking techniques

- Realized that we did not have the means to provide advanced training

# Wireless Computer Networks

- Packet Radio in HF, VHF and UHF
  - Low speed (up to 56 kbps),
  - Good range (up to 400 km)
- Spread Spectrum transmission in the ISM bands (915, 2400 and 5800 MHz)
  - Speed up to 54 Mbps
  - Ranges of up to 65 km

# RedUla

Meanwhile, the momentum gathered by the training activities helped securing resources for our university network that led us to:

- Establishing the first Fiber Optic links with multimode fiber in 1992

- Installing a Satellite connection to the Internet

- Building the first monomode Fiber MAN that spans our city with a 100 Mbps TDM

- Deploying the first ATM network in an academic institution in Venezuela

- Installing Gigabit Ethernet over 50 km of SM fiber

# University Network: RedULA

-50 Kilometers Gigabit Ethernet SM fiber

Hechicera

49 clients nodes 2.4 GHz
7 clients nodes 915 GHz
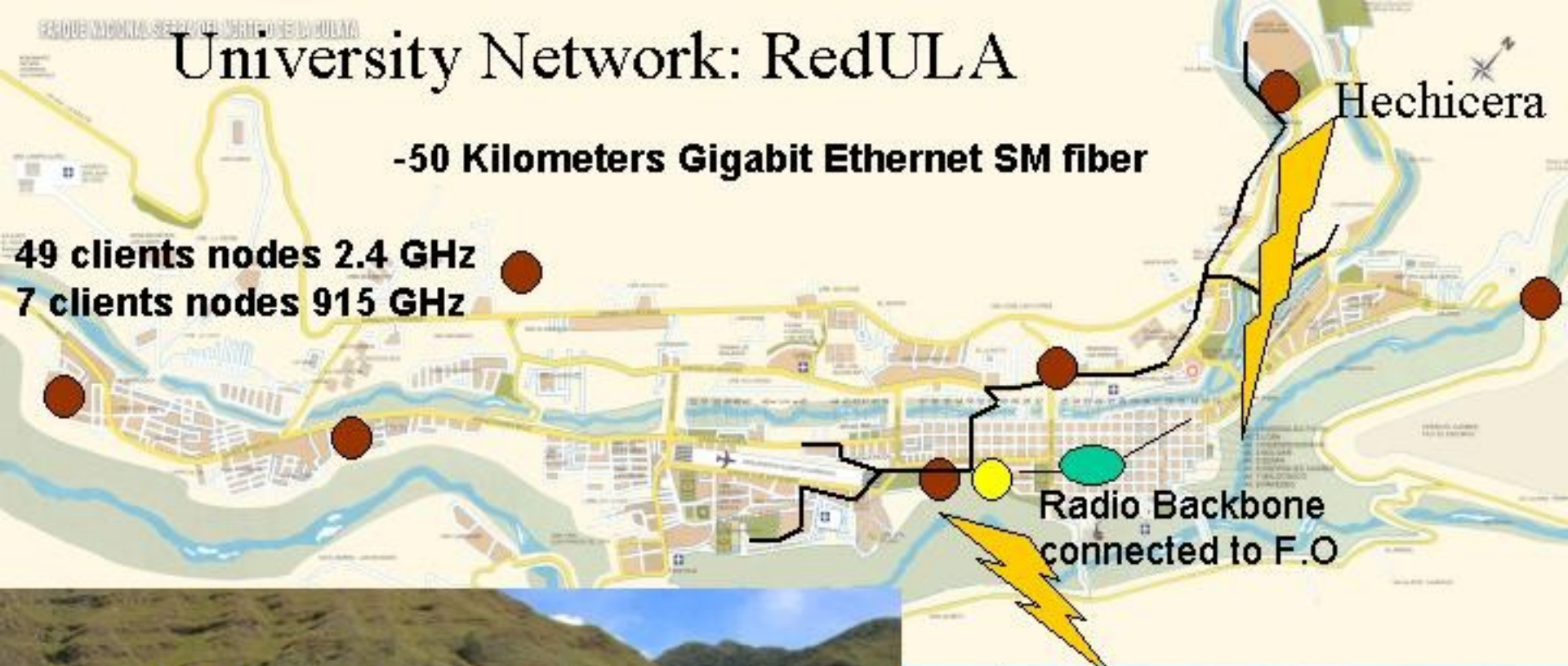
Radio Backbone connected to F.O

Hechicera

Redula, Base Station La Aguada

# RETIEM

- Our efforts to wire the city where joined by Fundacite Mérida, a government organization that provided support for a wireless network to span the state of Mérida

- The first links used packet radio techniques at 19.2 kbps, but the advent of the web made mandatory the quest for faster technologies

- We thus deployed a spread spectrum network at 2.4 GHz, installing a base station in a 3450 m mountain overlooking the city and surrounding

# RETIEM

While looking at the alternatives for building a robust wireless backbone, in July 1997 I visited a small startup, Spike Technologies, that had an experimental broadband network in Nashua, New Hampshire. By using MMDS frequencies, they were able to provide full duplex 10 Mps on a pair of 6 MHz wide channels. But the real innovation was a special patented base station multisector antenna that allows for up to 24 sectors with only 3 frequencies pairs. A deal was arranged to install a base station in Mérida and a 90 km broadband backbone to reach the town of Tovar

# Broadband Delivery System

- Sectored antenna

- Frequency Reusability

- Long Range, 50 km

- High Throughput, 10 Mbit/s, Full Duplex

- Upgradable

- Standards based

# Broadband Delivery System

## THE SECTORED APPROACH
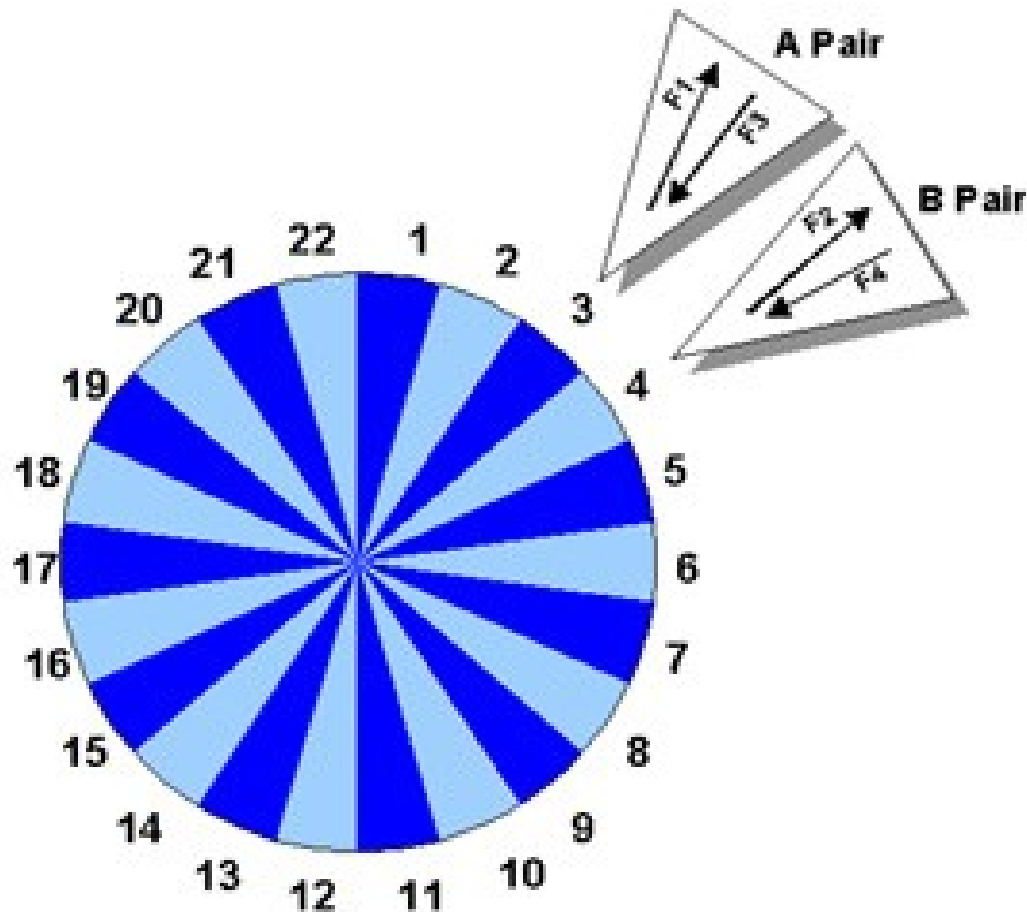
- PRIZM BDS utilizes a patented, sectored single aperture that allows spectral reuse of two channel pairs

- Spectral efficiency of this model results in a ratio of 11:1
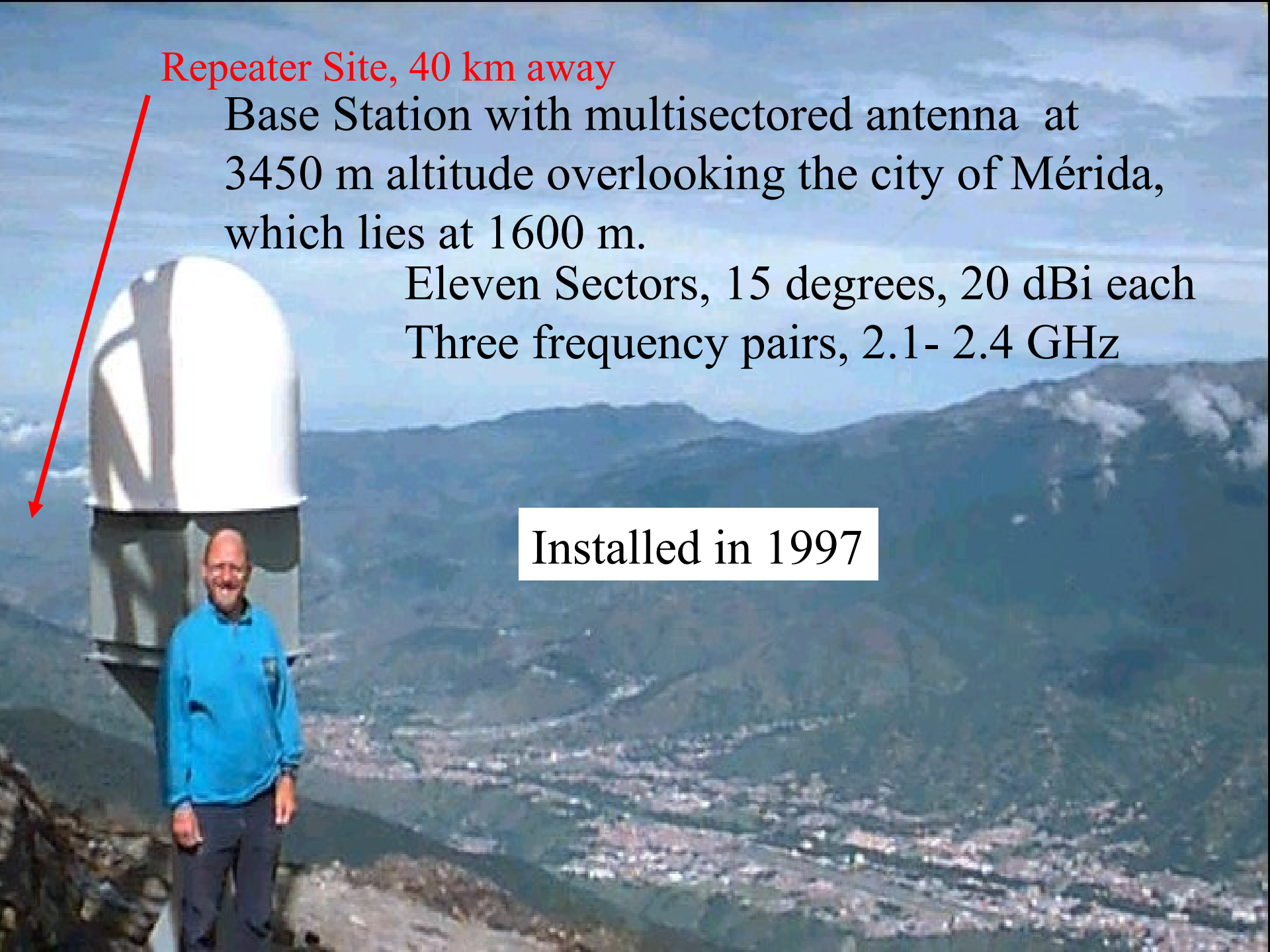
Repeater Site, 40 km away

Base Station with multisectored antenna at 3450 m altitude overlooking the city of Mérida, which lies at 1600 m.

Eleven Sectors, 15 degrees, 20 dBi each
Three frequency pairs, 2.1- 2.4 GHz

Installed in 1997

# Radiation Pattern:

File # 1139 8/25/99

ref = 22.2306 dBi

TX=H RX=H EC

2.6 GHz

## Single Sector

## Complete Antenna

3 dB bw = 11 deg

...sgh00135

10 dB bw = 22 deg

Ave sll = -37.4237

Gain dB

Azimuth
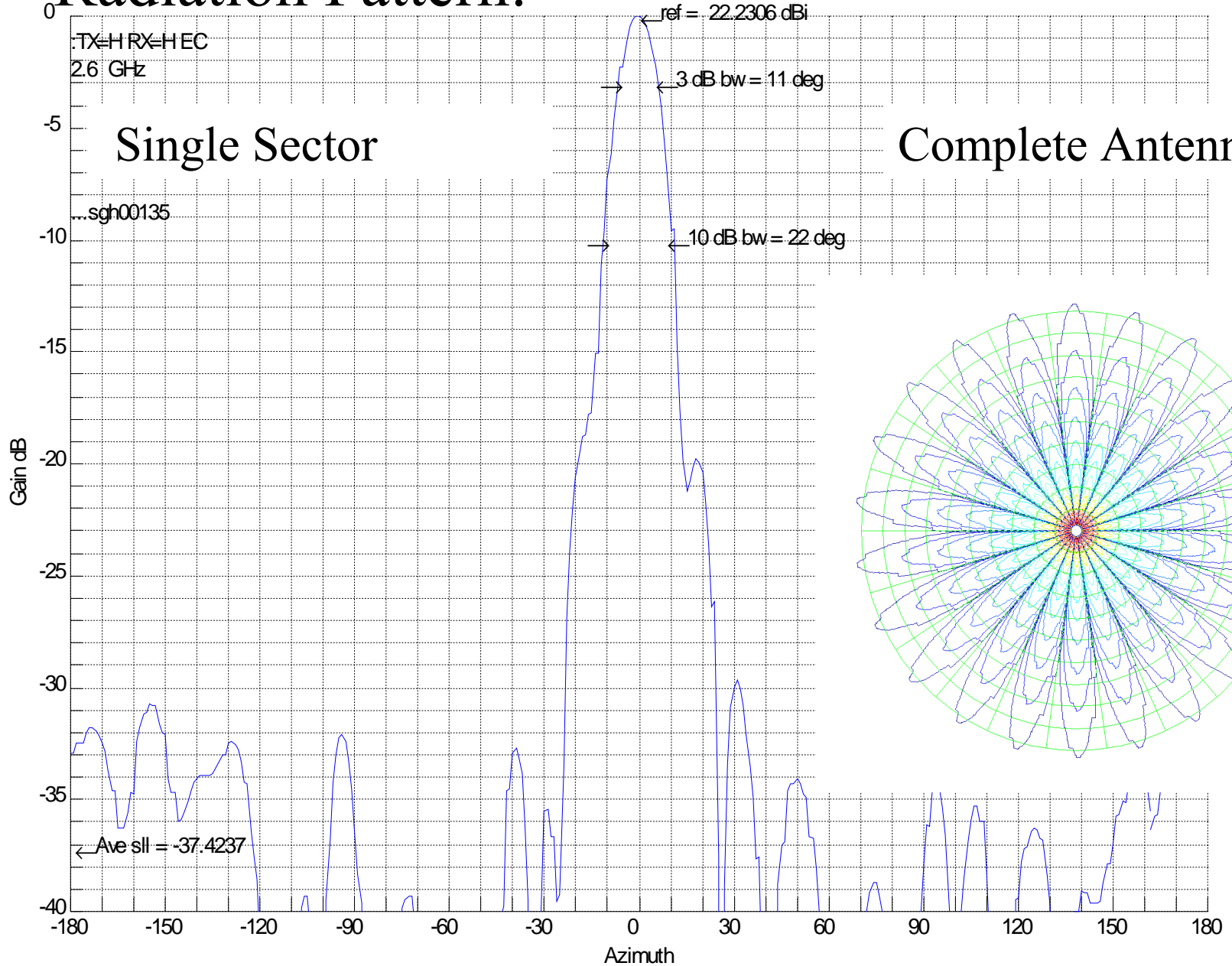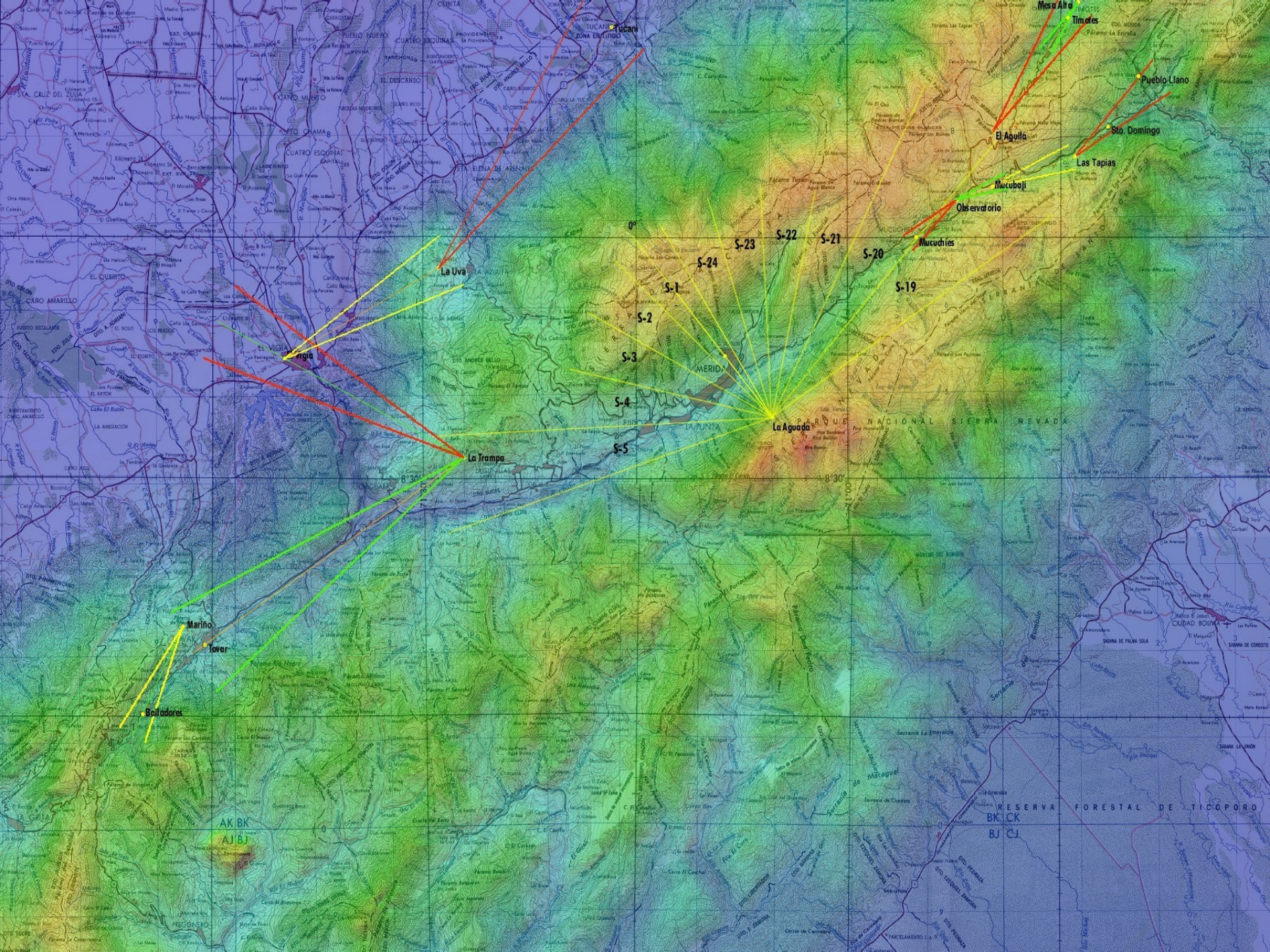
Spike Sub with 2 antennas
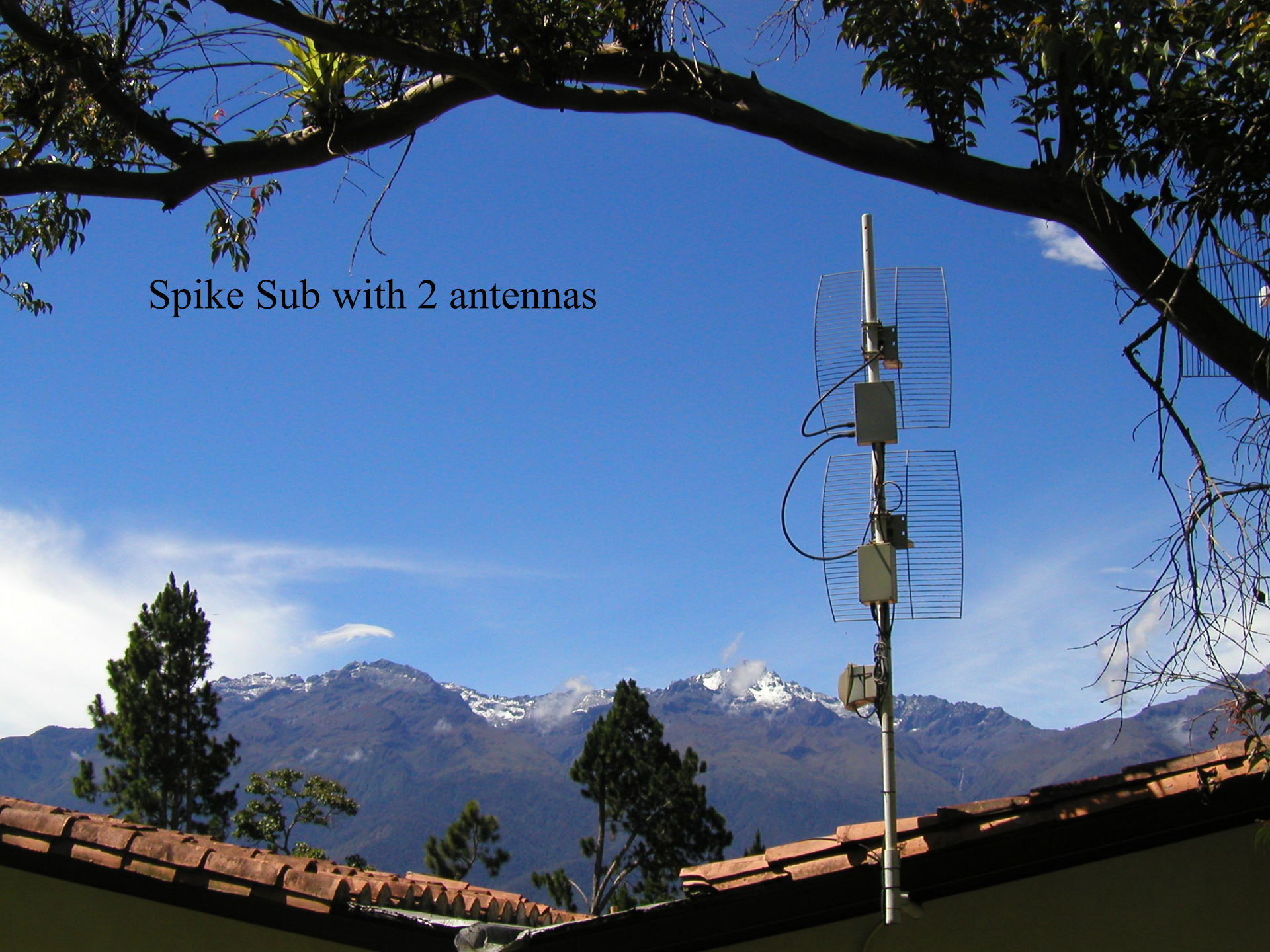
# Active REPEATER

- Due to the rugged topography, repetitions points where required to serve neighboring villages

- We found a suitable repetition point at 40 km from the base station, that allowed the extension of the coverage to further 41 km

# Frequency Plan

**Bartolo**
d= 17.2 mi
219°

Sector
Ch A

CIDA

S24
Ch C

S23
Ch B

S22
Ch A

S21
Ch D

S20
Ch C

**Mucuchies**

d= 1.0 mile
311°

S1
Ch D

S2
Ch A

S19
Ch B

118°

**El Vigia**

d=15.5 mile

El Vigia Sector
Ch C

83°

139°

**Fundacite**

S3
Ch B

S4
Ch C

d=5.5 mile

61°

d=29 mile

4°

S5 Ch D

**Mariño**

Tovar Sector
Ch B

**La Trampa**

d=25 mile

**PRIZM La Aguada**

d=4.2 mile

Pto-Pto
Ch A

57°

d=24.9 mile

Sector 5: Ch-D:
Tx: 2503 MHz.
Rx: 2665 MHz.

6°

**Tovar**

**Bailadores**

Legend of Map.

Site

Repeater

# RETIEM

- Currently 150 remote stations provide broadband connectivity to schools, health centers, libraries, community centers and government institutions

CMP                                                    June 5, 1998
Ermanno Pietrosemoli
Director of Engineering
FUNDEM      Universidad de los Andes Merida, Venezuela

Dear SUPERQuest Award Winner:

 Congratulations !

 I am pleased and honored to inform you that your company has been cited as a SUPERQuest Winner in the first annual SUPERQuest awards program.

The panel of judges has chosen <u>FUNDEM</u> in Category 8 ⬜ Remote Access as the best in that particular field of nominees.

I  speak for the entire panel of judges when I say that your company has made a real contribution to the advancement of communications technology.

# Supercomm '98 Atlanta Georgia, USA
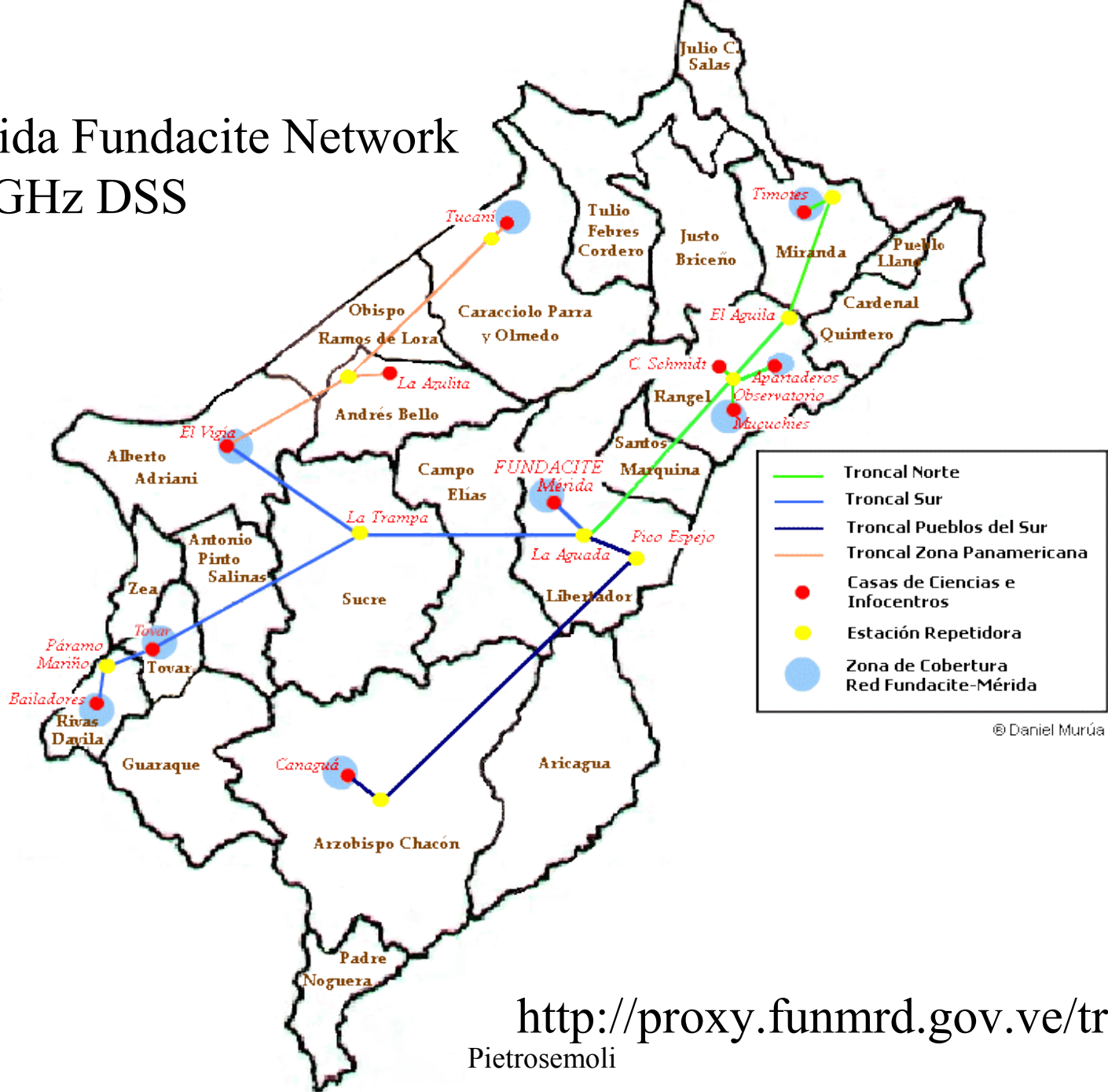
During this event, RETIEM was awarded the  best network prize in the category of **Remote Access, while Third Rail Technologies, a Spike Technologies subsidiary that uses the same technology got the Local Access prize.**

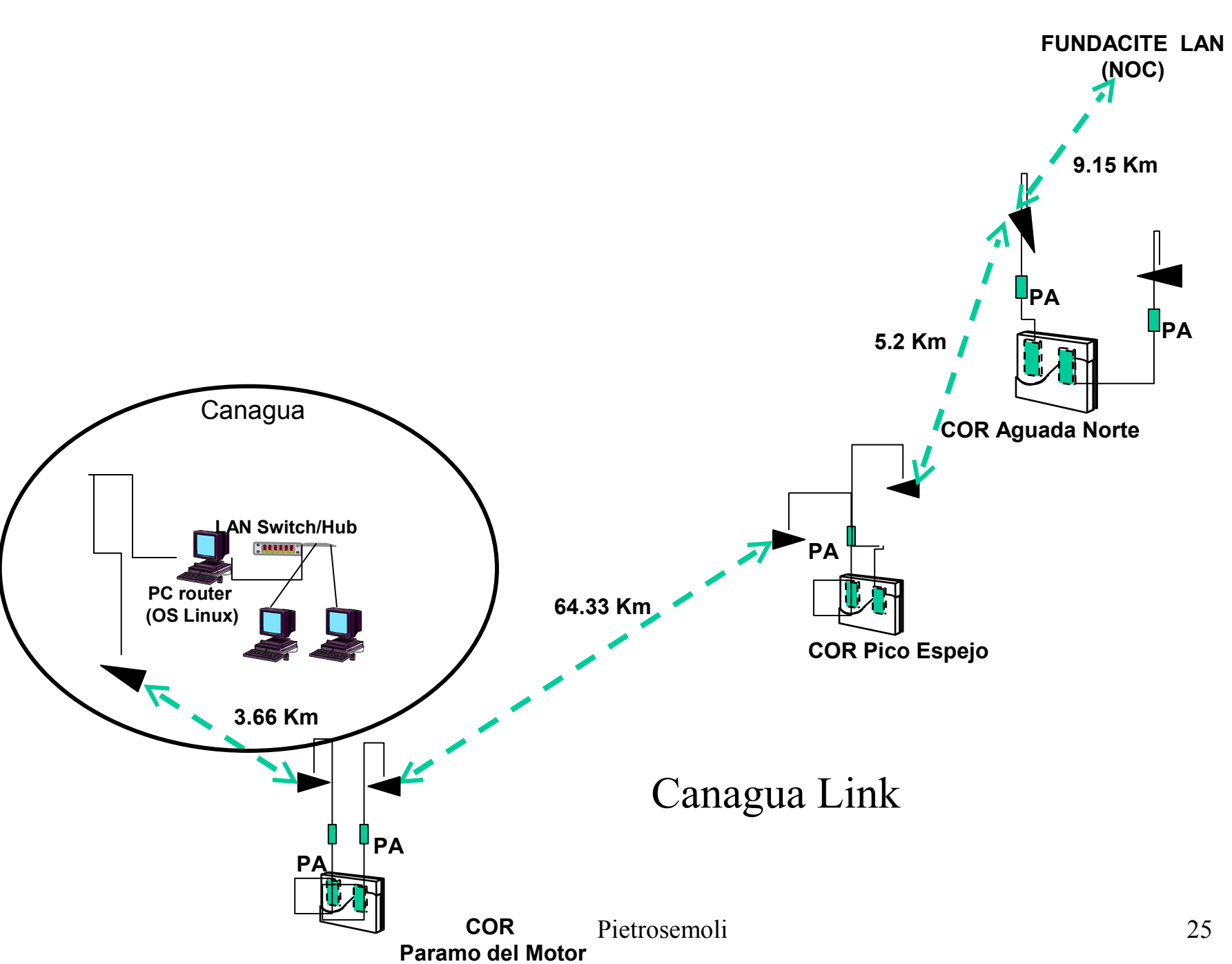# Other installs of licensed systems

- 1999 Caracas, Venezuela
- 2000 Argentina (9 cities), Mexico, Peru (Lima), Trinidad and Nicaragua (Managua)
- 2001 Maracaibo, Venezuela

# Merida Fundacite Network
# 2.4 GHz DSS

Julio C. Salas

Timotes

Tucani

Tulio Febres Cordero

Justo Briceño

Miranda

Pueblo Llano

Obispo

Ramos de Lora

Caracciolo Parra y Olmedo

Cardenal

El Aguila

Quintero

La Azulita

C. Schmidt

Apartaderos Observatorio

Andrés Bello

Rangel

Mucuchies

El Vigía

Santos

Alberto Adriani

Campo Elias

FUNDACITE Mérida

Marquina

La Trampa

Pico Espejo

Antonio Pinto Salinas

Zea

Sucre

La Aguada

Libertador

Páramo Mariño

Tovar

Tovar

Rivas Davila

Bailadores

Guaraque

Canaguá

Aricagua

Arzobispo Chacón

Padre Noguera

**Troncal Norte**
**Troncal Sur**
**Troncal Pueblos del Sur**
**Troncal Zona Panamericana**

● **Casas de Ciencias e Infocentros**

● **Estación Repetidora**

● **Zona de Cobertura Red Fundacite-Mérida**

© Daniel Murúa

http://proxy.funmrd.gov.ve/trafico/

Pietrosemoli

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Canagua

FUNDACITE LAN (NOC)

9.15 Km

PA

PA

5.2 Km

COR Aguada Norte

LAN Switch/Hub

PC router (OS Linux)

64.33 Km

PA

COR Pico Espejo

3.66 Km

Canagua Link

PA

PA

COR Paramo del Motor

Pietrosemoli

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# Wireless Roof

Spike

Fdcte DSSS

RedUla

Packet Radio

**Radio Link**

Edit    View

Distance:15.29km  Clearance:5.00m  PathLoss:133.1dB  Rx:18.48dB  ( S 7 )

Transmitter

Pico Espejo

Receiver

Hechicera
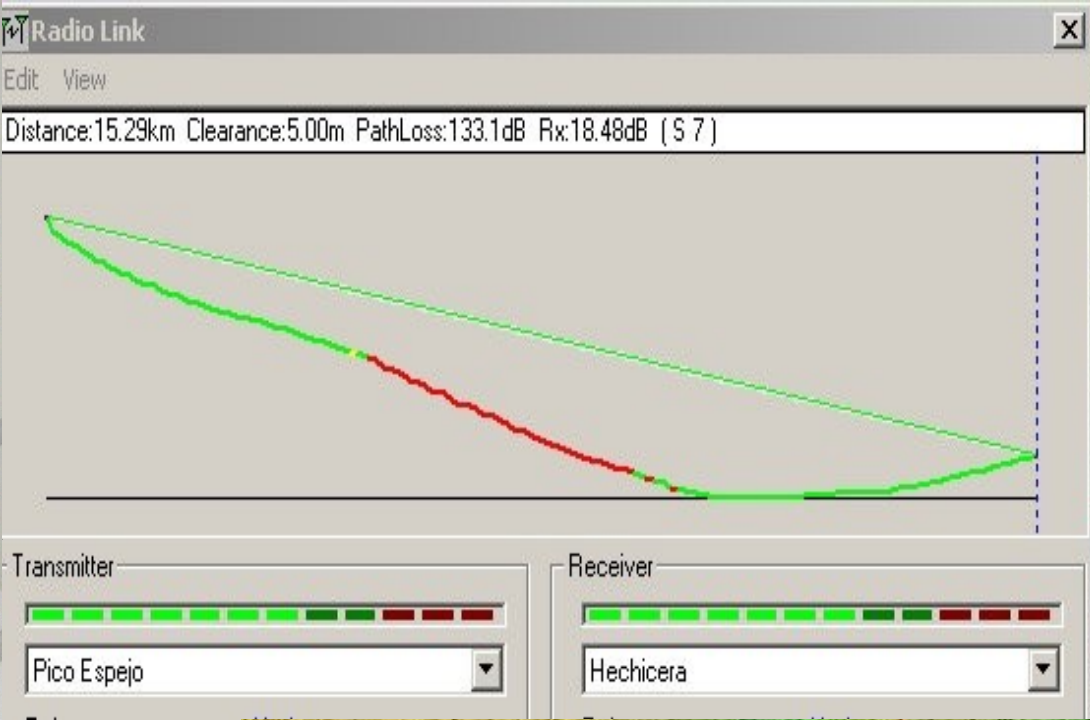
**Mérida Atmospheric Research Station (MARS)**
Joint Venezuelan-German project:
5.8 GHz, 16 km link
Pico Espejo. 4765 m
to Hechicera 1800 m

A webcam is at Pico Espejo pointed towards Pico Bolivar (5000 m altitude) and can be seen at:

http://www-imk.fzk.de/imk2/mira/home.html

with the details of this research project

# Conclusions

- We succeeded in turning the region lack of trained personnel into an opportunity

- By focusing on manageable projects within the framework of a long term plan we were able to overcome budget limitations

- Team work was essential to accomplish our goals, and helped securing international support

# urls

www-imk.fzk.de/imk2/mira/home.html

www.third-rail.net

wireless.ictp.trieste.it

www.isoc.org

www.eslared.org.ve

www.ula.ve

Earth at Night
More information available at:
http://antwrp.gsfc.nasa.gov/apod/ap001127.html

Pietrosemoli

Astronomy Picture of the Day
2000 November 27
http://antwrp.gsfc.nasa.gov/apod/astropix.html

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