Inet'99
San Jose, June 1999

Wireless Data Transmission in the Andes: Networking Merida State

Ermanno Pietrosemoli
Escuela Latinoamericana de Redes
Mérida - Venezuela
LabCom ULA
ermanno@ula.ve

Contents

- Introduction
- Packet Radio
- Spread Spectrum
- Broadband Delivery System
- Training
- References

Sierra Nevada

Introduction

The city of Merida, in the northern Andes, is at 1600 m altitude (5000 feet) and lays below some mountains that reach 5000 m (16400 feet). It has a two centuries old university, ULA that is spreaded all over and makes good use of its optical fiber data network, TDM and ATM

The city of Merida from Aguada (3600 m)

Introduction

- Challenges:
  - Difficult terrain
  - Limited reach of telephone network
  - Lack of technology oriented culture

Introduction

- Solution: Wireless Network
  - Packet Radio, VHF, UHF
  - Microwaves
- Training

Packet Radio

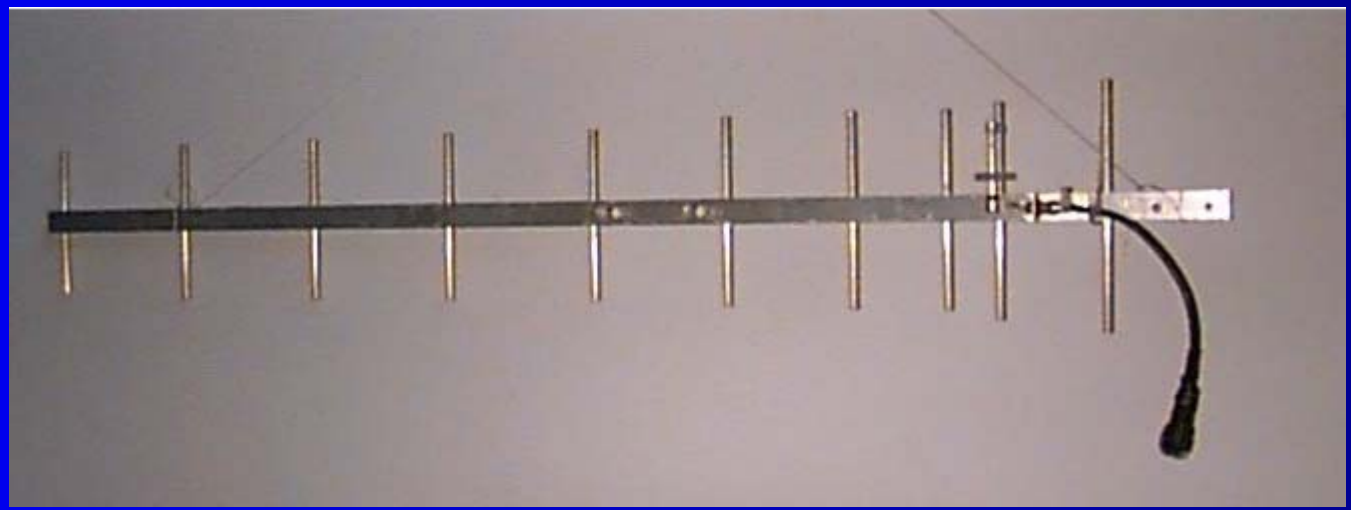
- 300 bit/s in HF, for long distance ionospheric bouncing
- 1200 bit/s in VHF, later 9600 bit/s
- 19200 bit/s in UHF, then 56 kbit/s

AX.25 protocol, ka9q TCP/IP package

Inexpensive but slow!

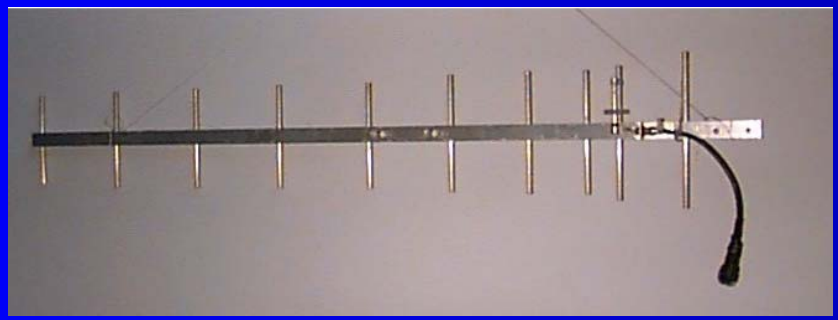
Packet Radio

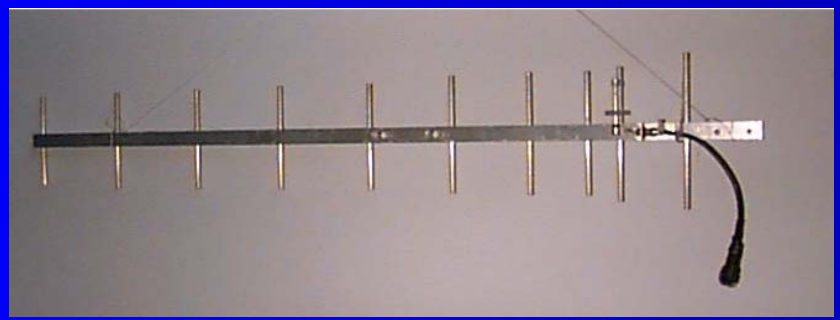
- Home built antennas:



Packet Radio

- Passive Repeaters:





Spread Spectrum

- Direct Sequence
- Frequency Hopping

400~512 MHz

806~960 MHz

2.4~2.4835 GHz

5.725~5.850 GHz

maximum EIRP of 36 dBm

Spread Spectrum

- Direct Sequence

  nominal speed 2 Mbit/s, corner reflector antenna at Aguada with a 90 degree bandwidth illuminated most of the city
- Bilateral Amplifiers to overcome cable losses

Spread Spectrum

- Computer Network Project

  Abdus Salam International Centrer for Theoretical Physics, Trieste, Italy

  August 1995

  University of Ile-Ife, Nigeria

Spread Spectrum

- Computer Network Project
  Computer Center
  Physical Sciences
  Technology Building

Funding from United Nations University

Spread Spectrum

- 2.4 GHz band to combat interference and increase available bandwidth
- Lower span
- Limitations of protocols
- Hidden station problems

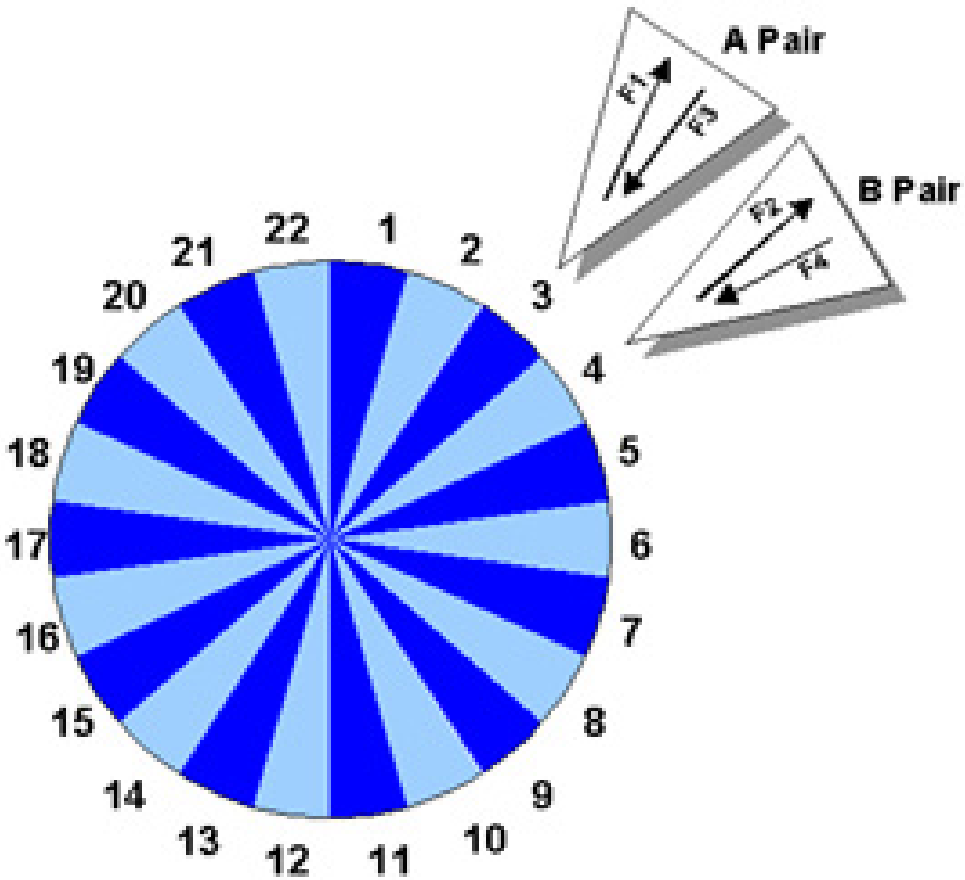
Look for alternatives!

Broadband Delivery System

- Sectored antenna
- Frequency Reusabilty
- High Range, 50 km
- High Throughput, 10 Mbit/s, Full Duplex
- Upgradable
- Standards based

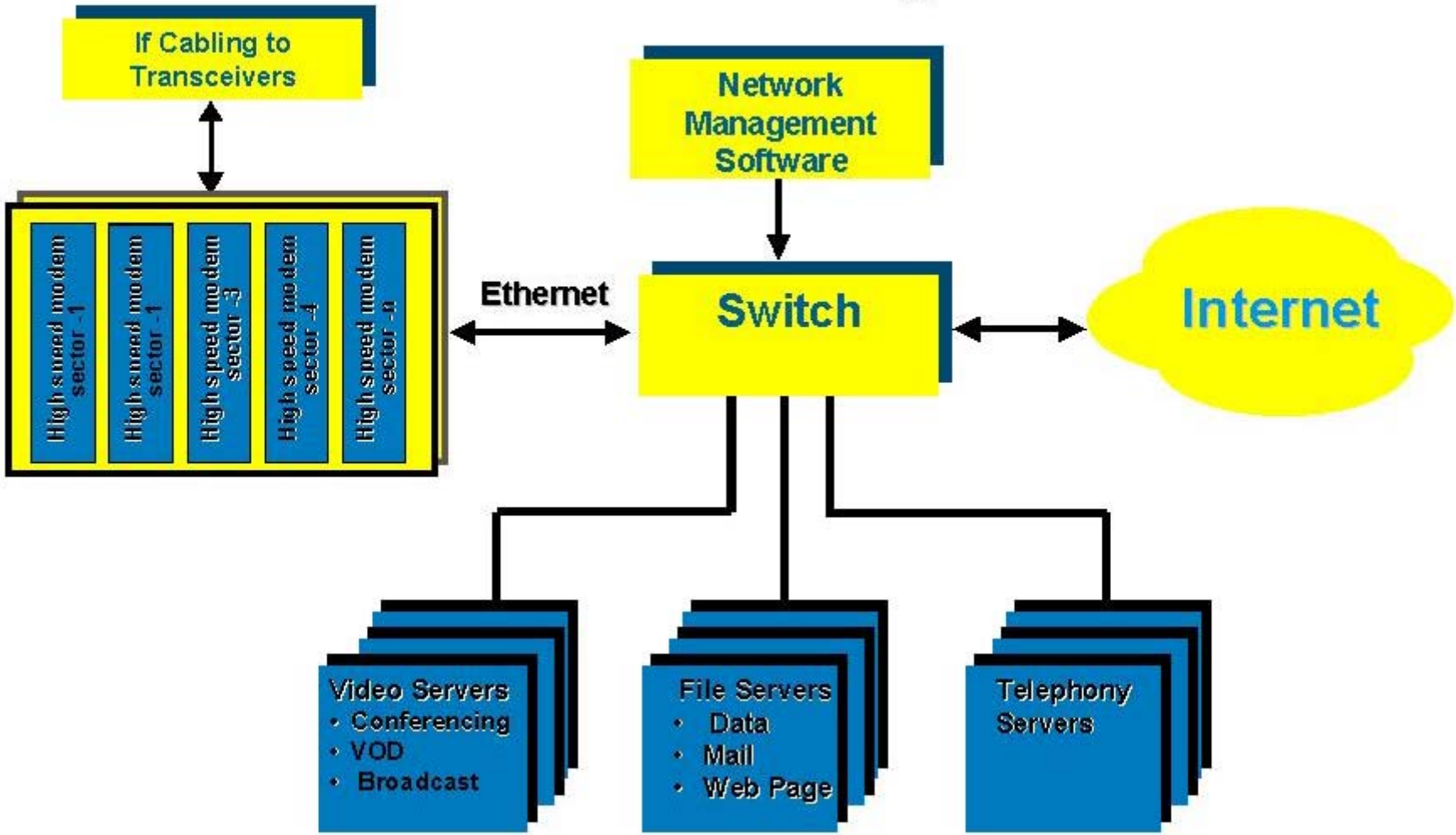
Broadband Delivery System

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

Network Diagram



Broadband Delivery System Spike Technologies

- Up to 22 sector
- 6 MHz video channel can a provide up to 30 Mbit/s
- Symmetrical
- Spectrally efficient

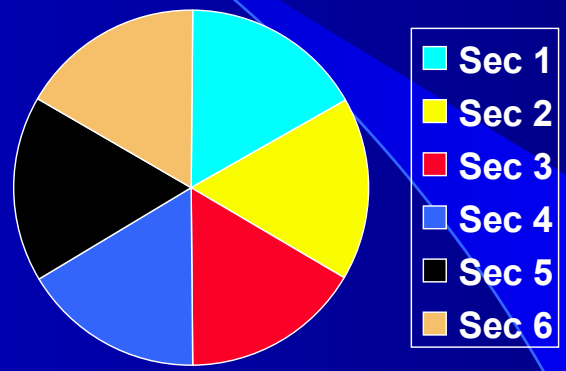
Prizm BDS
Spike Technologies

Base station configuration:

- Multisector Antenna (up to 22 sectors)
- Transceivers bank
- Modems bank
- Switch
- UPS

Prizm BDS
Spike Technologies

- Sectorizacion
  - 22 sec * 500 usrs./sec
    = 11,000 users
- Small Size
- Equivalent to 22 antennas

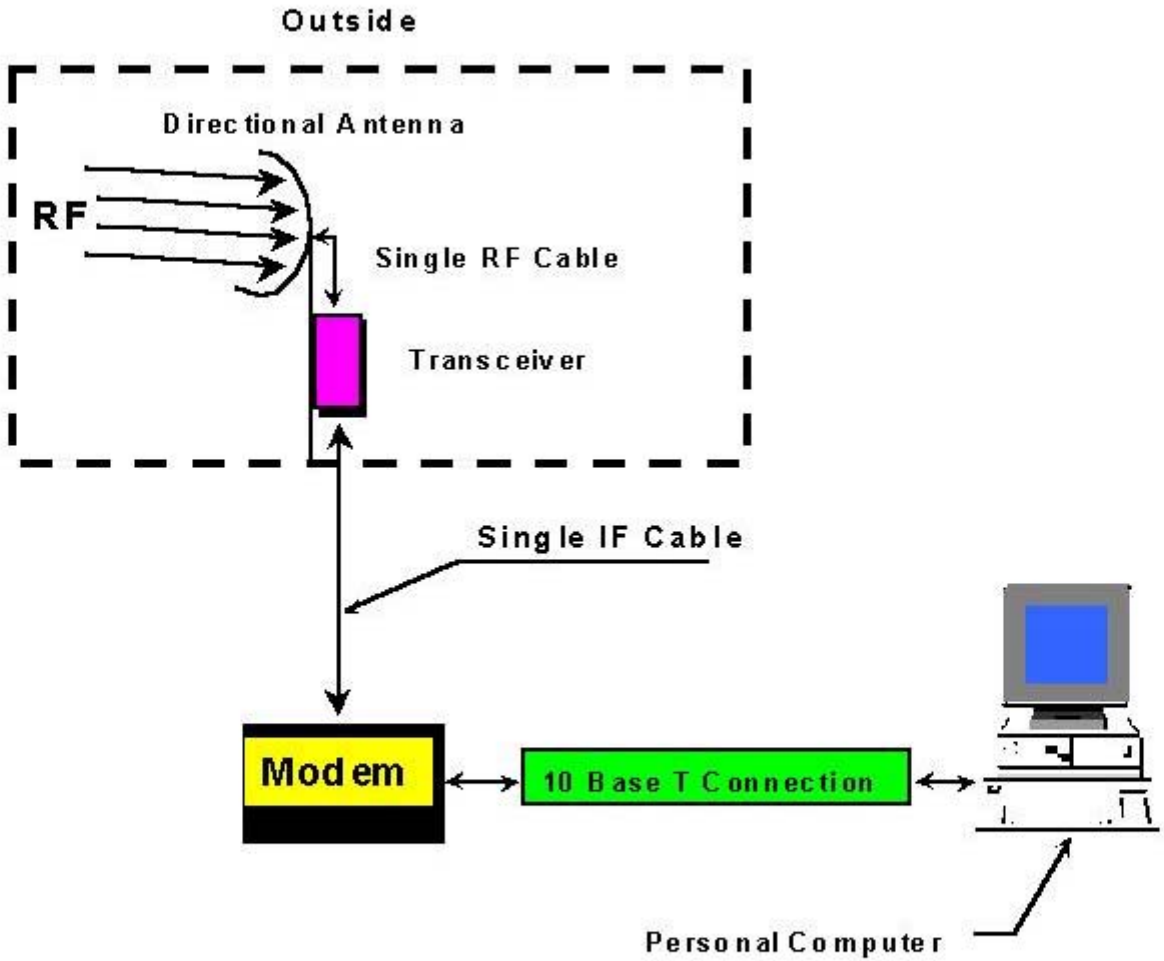


Prizm BDS
Spike Technologies

Advantages:

- Multipath interference resistance thanks to high gain antennas
- High throughput

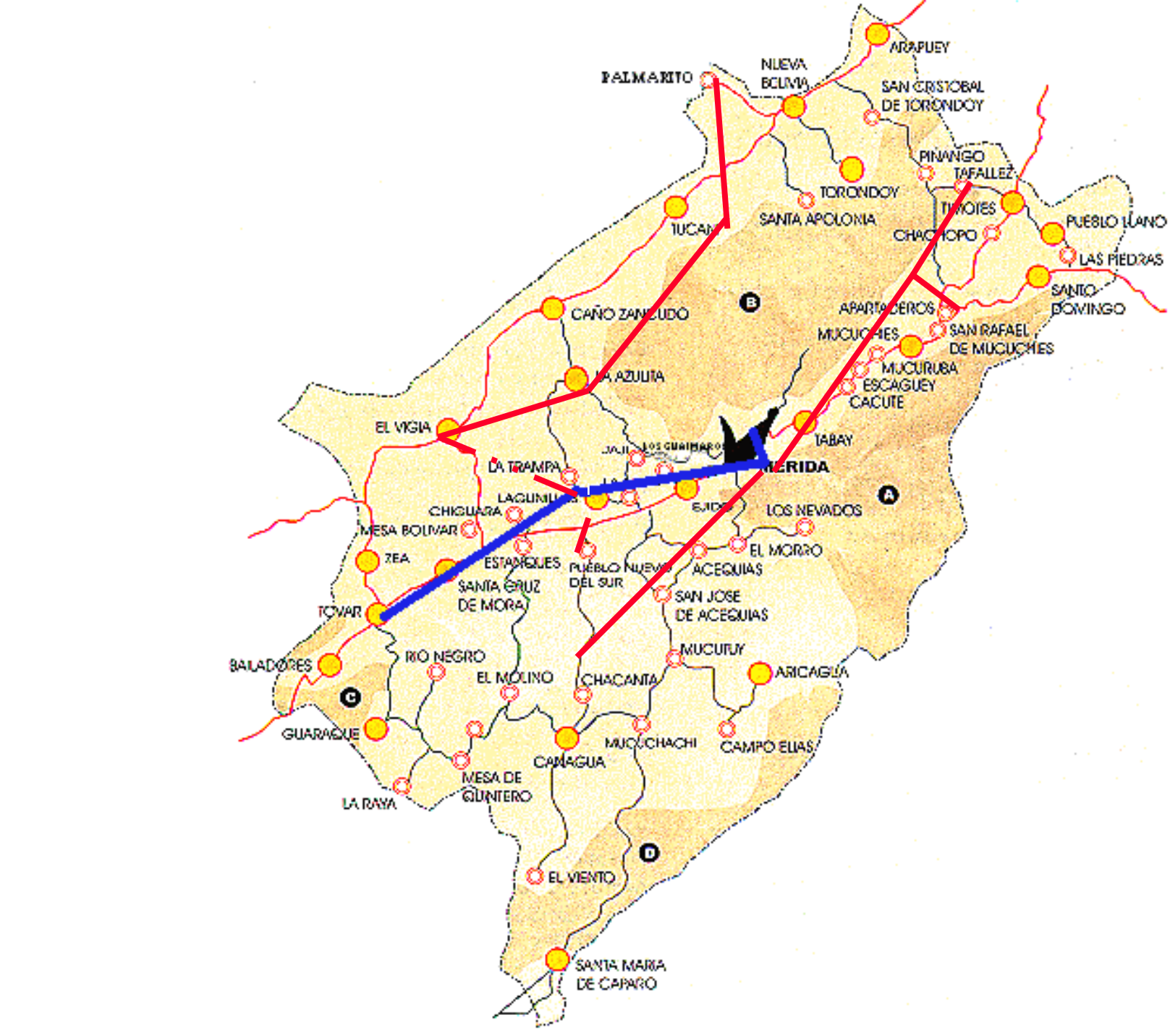
Subscriber Configuration



10 Mbit/s Backbone

Fundacite Mérida decides to build a backbone between Merida and Tovar by means of a repeater station at a small village

This backbone is 90 km long


ARAPUEY
PALMARITO
NUEVA BOLIVIA
SAN CRISTOBAL DE TORONDOY
PINANGO
TAFALLEZ
TORONDOY
SANTA APOLONIA
TUCANI
TIMOTES
CHACHOPO
PUEBLO LLANO
LAS PIEDRAS
SANTO DOMINGO
CAÑO ZANCUDO
B
APARTADEROS
MUCUCHIES
SAN RAFAEL DE MUCUCHIES
MUCURUBA
ESCAGUEY
CACUTE
LA AZULITA
EL VIGIA
TABAY
LOS GUAIMAROS
LA TRAMPA
MERIDA
LAGUNILLAS
EJIDO
A
LOS NEVADOS
CHIGUARA
MESA BOLIVAR
EL MORRO
ZEA
ESTANQUES
PUEBLO NUEVO DEL SUR
ACEQUIAS
SANTA CRUZ DE MORA
SAN JOSE DE ACEQUIAS
TOVAR
MUCUTUY
BAILADORES
RIO NEGRO
EL MOLINO
CHACANTA
ARICAGUA
C
GUARAQUE
MUCUCHACHI
CAMAGUA
CAMPO ELIAS
MESA DE QUINTERO
LA RAYA
D
EL VIENTO
SANTA MARIA DE CAPARO

Repeater Station

at 40 km from

Aguada

Red Teleinformática del estado Mérida RETIEM

- Fundacite Mérida,
- Fundem,
- Gobernación del Edo,
- Palacio de Justicia,
- Internado Judicial de Lagunillas (penitentiary)

RETIEM

Providing Service to:

- Libraries
- Cultural and ScientificCenters
- Educational Institutions
- Health Center
- Government Offices

Supercomm ‘98 Atlanta Georgia, USA

During this event, RETIEM was awarded the best network prize in the cathegory of **Remote Access, while Third Rail Technologies, a Spike Technologies subsidiary that uses the same technology got the Local Access prize.**

Training

- Training is an often neglected aspect of many initiatives, but we found that it makes the whole difference between a successful project and a “white elephant”
- Since 1991 we have devoted most of our efforts to training activities

Training

- First Latin-American Networking School, Nov. 1992 (3 weeks), 45 part., 8 countries
- Lima Workshop, April 1993
- Second Latin-American Networking School, Nov. 1995 (2 weeks), 110 part.
- ICTP Computer Networking Project
- Third Latin-American Networking School, Nov. 1997 (2 weeks), 120 part.

Training

- RNP, First Latin-American and Caribbean Workshop on Networking Technologies, Rio de Janeiro, Brasil, July 1998
- Fourth Latin-American Networking School, and Second Latin-American and Caribbean Workshop on Networking Technologies, Merida, June 14-19, 1999, 195 participants, from 18 countries and 5 tracks

Latin American Training Workshop

- ISOC sponsored WALC'98 in Rio de Janeiro, with local support provided by the Universidade Federal de Rio, a Spanish and Portuguese training organized by EsLaRed
- WALC'99 merged with EsLaRed'99 in Mérida
- WALC'2000 was held at Universidad Autónoma in Mexico City
- WALC'2001 merged with EsLaRed'2001 in Mérida

References

- 1. Karn, Phil, "The KA9Q Internet (TCP/IP) Package: A Progress Report" Sixth ARRL Computer Networking Conference, Redondo Beach, Ca, August 29, 1987
- 2. Heatherington, D., "A 56 kilobaud RF modem", Sixth ARRL Computer Networking Conference, Redondo Beach, Ca, August 29,1987

References

– 3. Conatel, Comision Nacional de Comunicaciones, Ministerio de Transporte y Comunicaciones, "NORMAS PARA LA OPERACION
DE SISTEMAS DE TELECOMUNICACIONES CON TECNOLOGIA DE BANDA ESPARCIDA (SPREAD SPECTRUM)",
Caracas,17 de noviembre de 1993.

References

- 4. International Centre For Theoretical Physics, "Programme of Training and System Development on Networking and Radiocommunications", Trieste, Italy, 1996, http://www.ictp.trieste.it
- 5. Spike Technologies, Inc. http://www.spke.com
- 6. Escuela Latinoamericana de Redes, http://ing.ula.ve/~eslared.

urls

www.wavelan.com

www.spke.com

www.ictp.trieste.it

www.isoc.org

www.eslared.org

www.ula.ve