



FUNDACION ESCUELA LATINOAMERICANA DE REDES

# Long Distance WiFi Trial

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Venezuela

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Pico del Aguila

# Motivation

- For rural area, Wireless is the only economically feasible solution for achieving digital inclusion
- WiFi is by far the less expensive technology available, and can provide voice and data
- Interference is less severe in sparsely populated areas



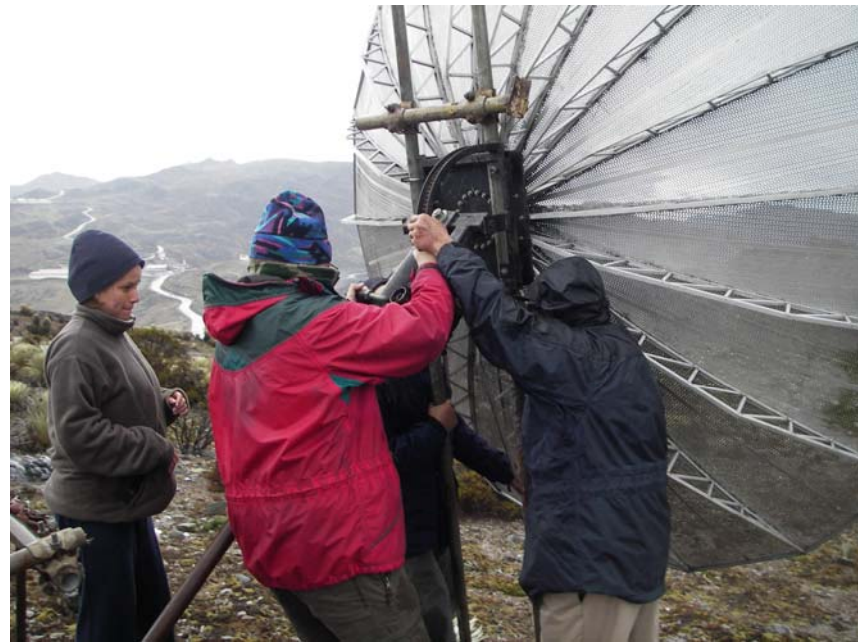
# WiFi LD Background

- 70 km link operational in Merida since 2001
- Swedish space agency 300 km transmission towards a stratospheric balloon
- Defcon contest in 2004 achieved 125 miles w/o amplifiers



# WiFi LD Background

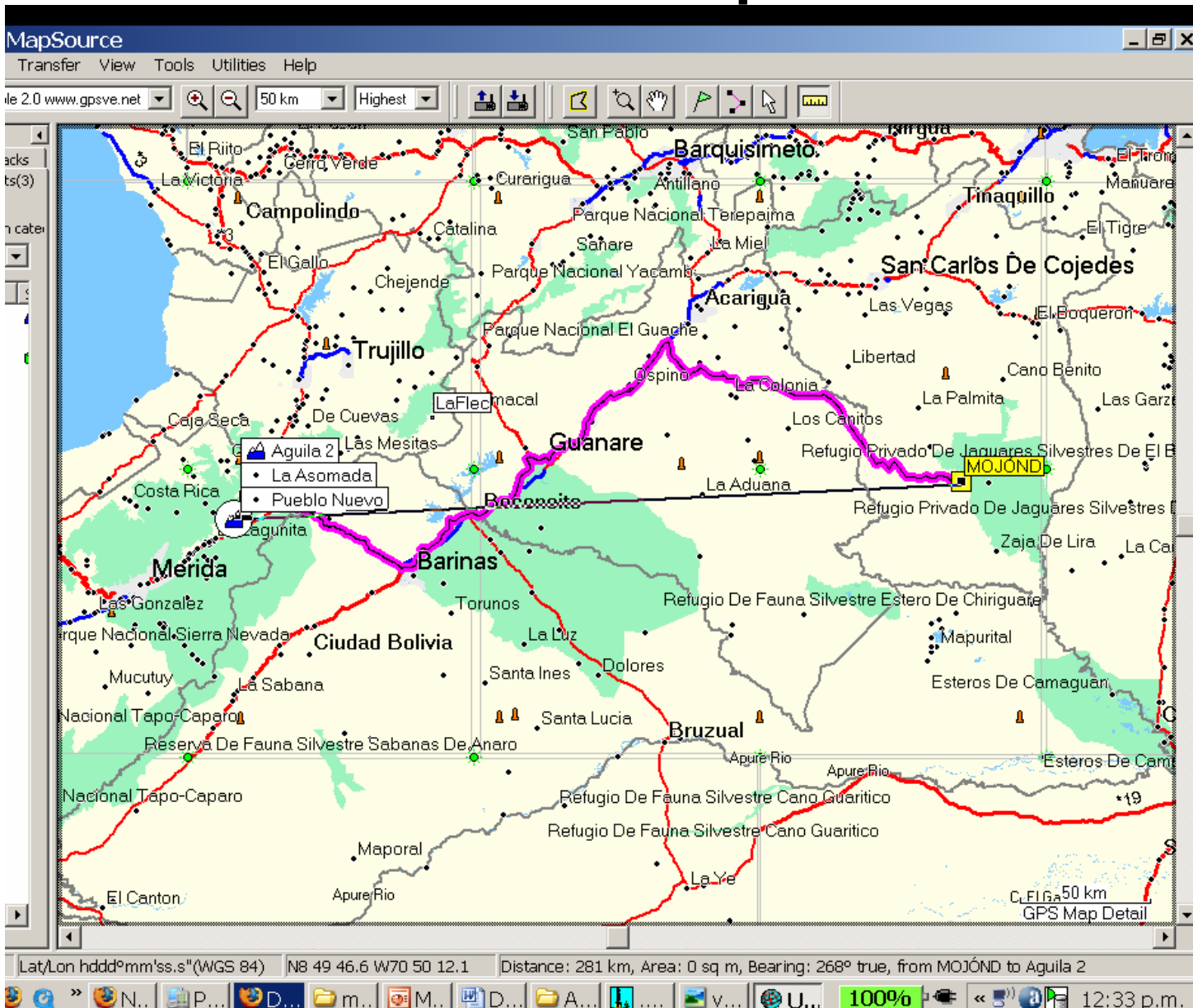
- EHAS program for health maintenance support in rural areas
- Berkeley's TIER group activities in several countries
- EsLaRed 279 km link with 100 mW transmitters and repurposed antennas in 2006



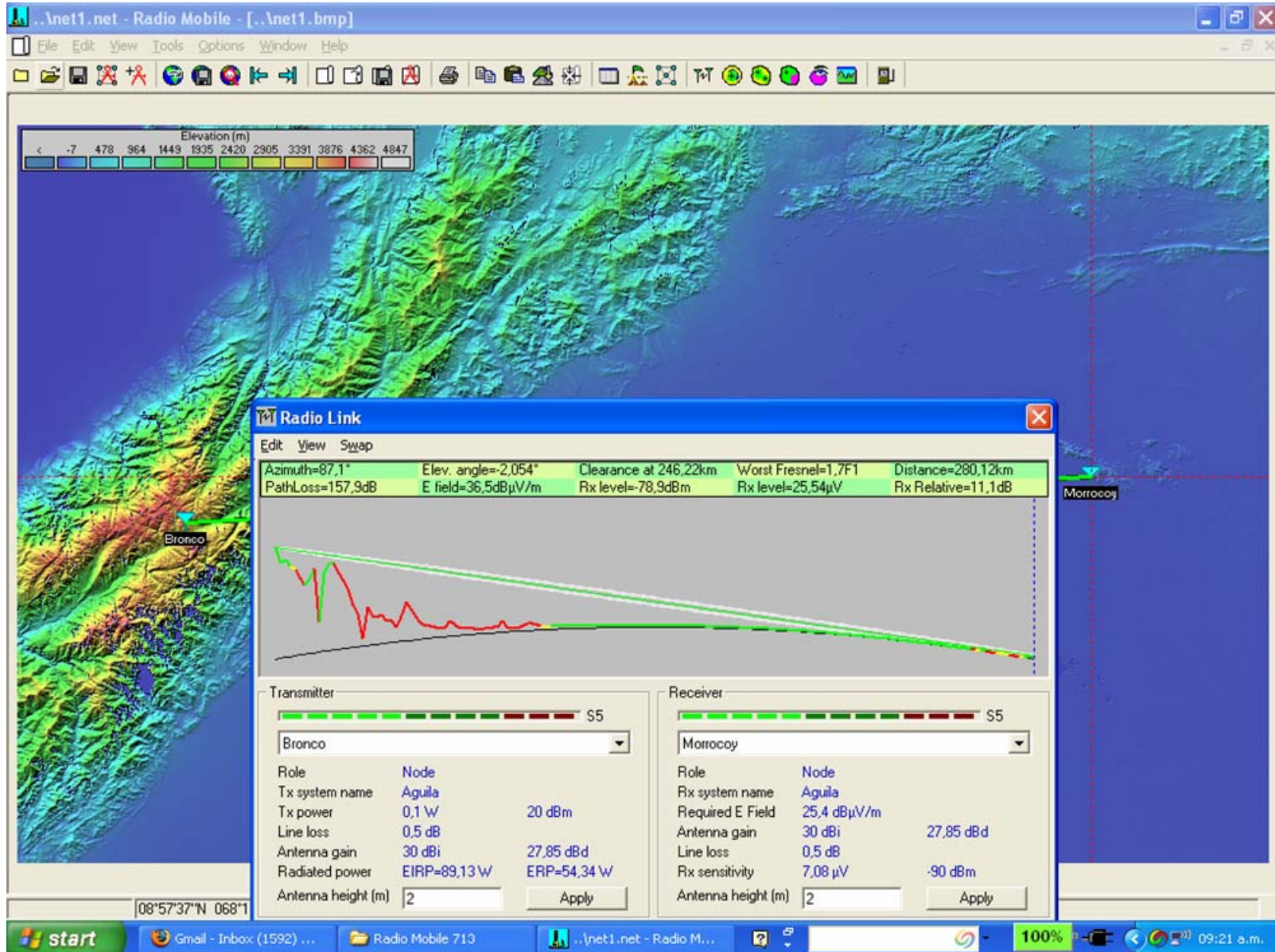
# Issues

- MAC of WiFi designed for up to 100 m, extending the range two orders of magnitude requires modifications
- CSMA/CA not well suited for Pt-Pt links
- Established Telecom operators vested interests

# 279 km path



# 279 km path



# Aerial view of El Aguila site





# View from El Aguila site



# El Baul Site



Accounting for the declination, we aimed the antenna to a bearing of 277 degrees

# TIER Wireless routers at Baul



We were able to establish a video and audio communication over the 279 km path:

The screenshot displays a Windows desktop environment. In the foreground, a 'NetPerSec' window shows network performance metrics. The 'Received' section indicates 311.0 Mbits total, with a current rate of 411.4 kbits/s, an average of 505.2 kbits/s, and a maximum of 601.3 kbits/s. The 'Sent' section shows 58.5 Mbits total, with a current rate of 21.6 kbits/s, an average of 22.1 kbits/s, and a maximum of 28.9 kbits/s. The 'Display' options are set to 'Current' and 'Average' using 'bits per second (bps)' and 'Line graph' respectively. In the background, a command prompt window shows the results of a ping test to 10.0.2.56, with four successful replies and a total of 12 packets sent. To the right, a 'NetMeeting' window shows a video call in progress with a participant named 'Alejandro Gonzalez' and another named 'javier trivino' listed in the name box.

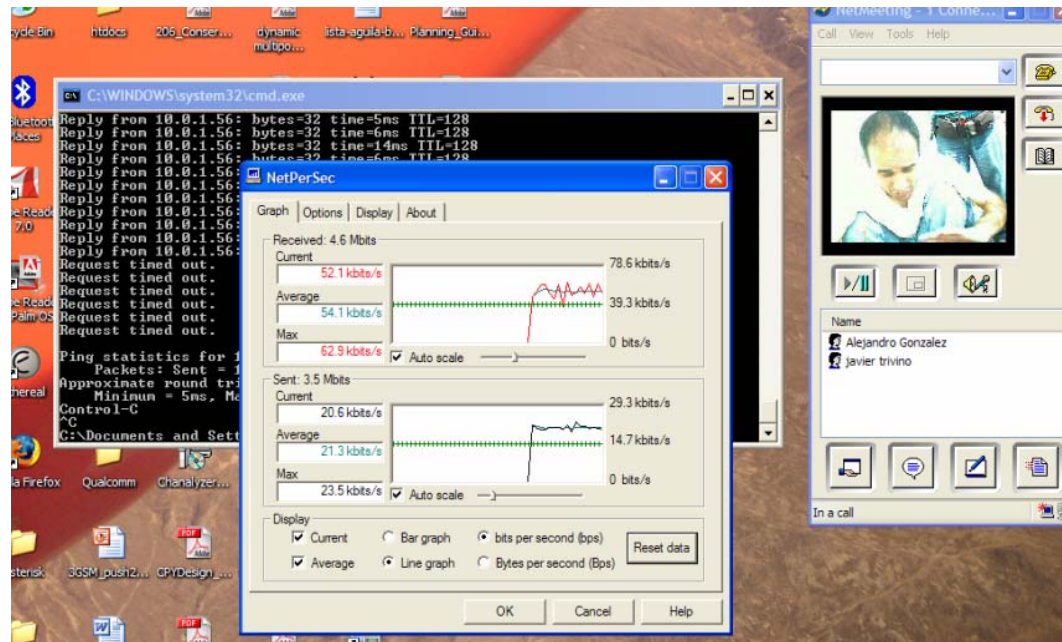
lperf showed a solid throughput greater than 3 Mbps in both directions

# With the Linksys WRT54



# With the Linksys WRT54

The measured throughput was above 65 kbps, enough to sustain an audio and video session:



# Can we do better?

The screenshot displays the Radio Mobile software interface. The main window shows a topographic map with a green line representing a radio link between two points: 'Aguilas 2' and 'Platillon'. A red dashed line indicates the path of the link. The 'Radio Link' dialog box is open, providing detailed technical specifications for the link.

**Radio Link**

Parameter	Value
Azimuth	72,3°
Elev. angle	-2,122°
Clearance at 260,14km	Worst Fresnel=2,6F1
Distance	381,69km
PathLoss	156,2dB
E field	44,3dBμV/m
Rx level	-71,2dBm
Rx level	61,98μV
Rx Relative	17,8dB

**Transmitter**

Parameter	Value
Role	Node
Tx system name	TierTest
Tx power	0,4 W 26,02 dBm
Line loss	0,5 dB
Antenna gain	30 dBi 27,85 dBd
Radiated power	EIRP=356,5 W ERP=217,38 W
Antenna height (m)	2

**Receiver**

Parameter	Value
Role	Node
Rx system name	TierTest
Required E Field	26,54 dBμV/m
Antenna gain	30 dBi 27,85 dBd
Line loss	0,5 dB
Rx sensitivity	8 μV -88,94 dBm
Antenna height (m)	3

**Net**

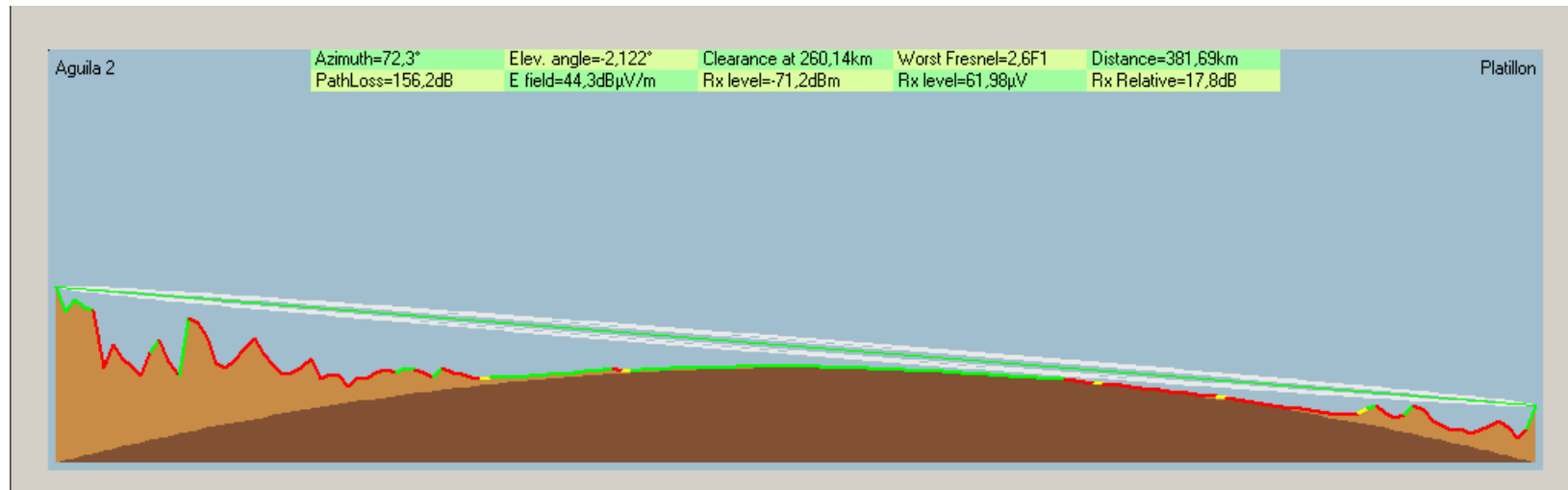
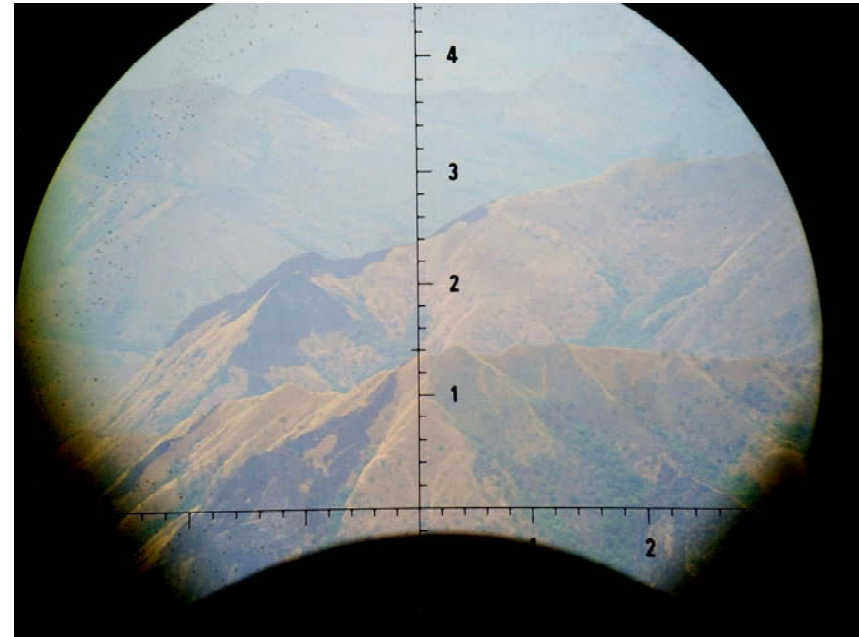
Parameter	Value
Amazonas	

**Frequency (MHz)**

Parameter	Value
Minimum	2412
Maximum	2480

The interface also shows a Windows taskbar at the bottom with the Start button, several open applications, and the system clock displaying 12:47 a.m. on 09°51'33"N 067°31'19"W x=785 y=78.

# From Platillon:





# Aguila-Platillon (382 km)

- We tried at different power settings and there was a considerable variation on the results,
- So we concluded that although communication over this path is feasible, further testing are required to ascertain the stability of this kind of links.
- The Iperf results for the 382 km link with TIER routers and TDMA:merida2:~# ping  
10.0.200.12PING 10.0.200.12  
(10.0.200.12) from 10.0.200.12 :  
56(84) bytes of data.64 bytes from  
10.0.200.12: icmp\_seq=1 ttl=64  
time=0.745 ms64 bytes from  
10.0.200.12: icmp\_seq=2 ttl=64  
time=0.399 ms64 bytes from  
10.0.200.12: icmp\_seq=3 ttl=64  
time=0.399 ms--- 10.0.200.12  
ping statistics ---3 packets  
transmitted, 3 received, 0% loss,  
time 2003msrtt min/avg/max/mdev  
= 0.399/0.514/0.745/0.164

we then repeated the experiment over the 382 km path using two Linksys boxes, obtaining the following results:

- --10.0.1.1 ping statistics ---58 packets transmitted, 57 received, 1% packet loss, time 57569 ms rtt
- min/avg/max/mdev = 6.165/11.990/40.591/8.011 ms

# Acknowledgements

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- Roger Coudé, author of the free Radio Mobile Software, which has been so useful to the international wireless community

# Members of the Team

## El Aguila

- Javier Triviño, EsLaRed
- José Torres M., CPTM-ULA
- Francisco Torres N., RedULA



## Baúl and Platillón sites

- Leonardo González V., Dirección de Servicios – ULA
- Alejandro González, RedULA
- Leonardo González G., EsLaRed
- Ermanno Pietrosevoli, EsLaRed

# Conclusions

- WiFi is a viable and economic means for wireless links at distances of hundreds of kilometers when a good LOS is available.
- TDMA over WiFi as implemented by the TIER group of UC Berkeley has shown a remarkable throughput greater than 3 Mbps over a 300 km on a Pt- to- Pt link.