Category: National Science Foundation Project (1993-2000)
Published: Thursday, 24 November 2011 14:24
Written by dave
Hits: 4480

The San Luis Valley Project

As I had told Mitchel and Goldstein from the NSF, that I wanted first to try to link up very rural schools to the Internet, with the new Spread Spectrum wireless technologies.

So when the final approval came for my NSF 'Wireless for Education' grant, I had already selected the public school in the very small Hispanic town of San Luis, Colorado, the second oldest town in all Colorado.

San Luis is on the western edge of the 100 mile long, 50 mile wide, flat San Luis Valley, which was an ancient lake bed. The Sand Dunes national Monument is in that valley 20 miles north of San Luis, which has 30 small towns all spread out north to south and east to west of that valley, with the largest town in the center Alamosa, which had Western State College in it.

The only place in the San Luis Valley that was connected up to the Internet was Alamosa, the College and businesses there. The town - its school - in San Luis wanted to be connected to the Internet that its educators knew about.

But US West, which provided rural telephone service throughout the valley wanted $2,000 per month to extend a T-1 (1.5mb) line the 40 road miles between the school in (San Luis north to Fort Garland, then west to Alamosa) to an Internet provider. Completely unaffordable to the school.

Thirty Mile 'Free Wave' Radio Connections

So I did two things: First I went to Boulder, Colorado to look over a set of Spread Spectrum, Frequency Hopping, 902-928Mhz radios from Free Wave Technologies. They produced 4 watts 'EIRP' of radiated power and were quite configurable. And quite low cost in comparison with the list price of the Cylinks I had been using - in the range as I recall of $250 each. I would have to attach a pair of directional antennas I was sure to each radio. I ordered 4.

I then did my obligatory 'Site Survey' both at the Alamosa and San Luis ends. In Alamosa the situation was perfect. A tall radio tower - at least 30 feet -was on the roof of a downtown building that served a number of short range, in town, radios, which were connected to the Internet. I affixed the base radio well up on the tower and by compass direction only, aimed a rod antenna in the general direction of the town of San Luis.

The San Luis end was much more problematic. For the town, and its school, are down in a 'hole' behind a tall ridge that blocks any view of far away Alamosa. The ridge contains the famous 'Stations of the Cross' sculptures by famous Humberto Maestas that many a pilgrim ascends, to reach the Church, La Capilla de Todos Los Santos on top. There was a long winding very rough roadway to the top of the ridge, and I could see at least three large towers on top and on the shoulder of the ridge. One belonged to the Sheriffs Office in San Luis, but I learned it also served as a radio relay tower for the School - so school bus drivers who took and picked up kids radiating out from San Luis where there was always a danger of severe winter blizzards stranding buses filled with kids, could communicate by radio from and to the buses.

If the school was able to also use the Sheriff's tower, I figured it could be permitted to be a relay point for school supporting wireless radios.

So I drove up the muddy rutted road to the vicinity of the Sheriff's tower and found a hut that contained electronics for both the school and the sheriffs equipment. Good, for there was 110 volt wall power inside.

I was then able with my binoculars to scan westward until, voila!, I spotted the tower just peeping up over the dunes between where I was standing, 30 miles away, in Alamosa. i.e. we had partial 'line of sight' which radios would require. Excited, I even plugged into my cigarette lighter in my car, to a transformer, then to a small Free Wave Radio, attached a smaller directional antenna to the radio with about 4 feet of cable, and pointed it toward Alamosa and again, voila, I got a 'connected' light on the Free Wave!

We could connect 30 miles away!

But then there was a problem I had to overcome with some clever engineering.

I really needed to get that antenna at or near the top of the Sheriff's tower, in order to both (1) clear the ridge I was standing on enough so that the reflection of the bottom half of the oval shaped signal (Fresnel Zone) would not hit the close by ridge, and thus diminish the strength of the signal. (2) I couldn't put it where I had been standing on the ridge when I got the good connection - because there would not be any wall power to power the radio.

But by eyeball looking up at the 50 foot high or so Sheriff's tower, whose base was down on the shoulder of the ridge, I could not tell whether an antenna on top the tower would give a clear line of sight the 30 miles to the tower in Alamosa.

So I had to hire a surveyor in Alamosa to come out with his theodolite so we could measure just how much clearance the antenna beam would have - without me trying - at 53 - to climb that tower myself! I would have to hire a pole climber later to drag a heavy antenna cable to the top and fasten it every 10 feet or so.

So I got the surveyor to put his instrument right on the ridge which was online between the tower and the Alamosa tower 30 miles away. And then had him sight in on the Alamosa tower, note the precise angle, which was less than a degree from perfectly level with our ridge, then flip the theodolite 180 degrees, factor in the partial degree and see where it intersected the Sheriff's tower.

It cut the tower 7 feet below its top! So we had 7 feet clearance over the top of the ridge toward the Almosa tower 30 miles away!

Now the only question was whether the elliptical envelope of the radio beam aimed at Alamosa would be chopped too much by the ridge and reflect away too much power of the sparse 4 watts of energy to maintain a connection? To calculate that I had to get, from Free Wave the exact angle of the bottom edge of the ellipse of a spread spectrum 902mhz 4 watt power 'envelope) at 125 feet from the antenna which is how far back the Sheriff tower was

Category: National Science Foundation Project (1993-2000)
Published: Thursday, 24 November 2011 14:24
Written by dave
Hits: 4480

from the ridge highest point on line to Alamosa.

I did the calculations and less than 10% of the bottom portion of the radio beam in the envelope would intersect the top of the ridge, and bounce away to be reflected into space, losing that much energy in the beam, which is not like a laser, but as a long envelope, which at its mid point at 30 miles would be as much as 50 feet thick.

10% seemed acceptable loss, which would only mean the strength, thus dataate of the signal would be perhaps 10% slower.

Whew! So it would work. I hired the tower climber who climbed the Sheriff's tower to the top, affixed the directional rod antenna (about 5 feet long) to the top, aimed at Alamosa, had the copper-core (less loss) rubber cable connected to the back of the antenna and weather sealed, then fastened the cable every ten feet to about 7 feet off the ground, then was connected at the roof level of the radio shack, and inside connected with the Free Wave radio itself, whose signal then went via RJ45 into a server that passed the data signal out to a second radio, whose antenna was on the roof of the shack aimed at the roof of the school about a half mile away, where the final antenna was affixed aimed back at the second radio antenna, and its data signal then went from the roof of the school, down into a classroom where it was connected to the school computer.

Everything worked. All the calculations were good enough. And the students and teacher in the Small school in San Luis was fully connected to the world wide Internet.

A major achievement, and proof of what such radios could do for education. The only cost to the school was about $50 a month to be connected to the Internet service in Alamosa.

Many Progress Reports and Case Studies

That first San Luis to Alamosa Success, became the bedrock of a whole series of other wireless projects. If you go to the URL below that will take you to all of them.

http://wireless.oldcolo.com/course/reports.htm

Category: National Science Foundation Project (1993-2000)
Published: Thursday, 24 November 2011 14:24
Written by dave
Hits: 4480