KAUAI: ADVENTURE IN PARADISE

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ABSTRACT

The paper will describe the evolution of Garden Isle Cablevision from acquisition to present day. Special attention will be paid to the use of fiber optics and the innovative use of UHF transmission to solve a difficult off-air problem on the western-most of the Hawaiian islands.

HISTORY

In the late 1960's, a Los Angeles auto parts manufacturer named Ray Derby Sr. owned a vacation home in Kauai on the eastern side of the island. Mr. Derby was unable to receive television at his location due to terrain obstruction and the 90+ mile distance from Honolulu. Many tests were made by a wide variety of people in attempts to receive Honolulu television stations. All tests results indicated only one small accessible area in Kalaheo was suitable. Mr. Derby decided to build a headend on the site in Kalaheo and run a cable to his home. Thus, a cable system was formed.

Apparently Mr. Derby had some dispute with the local utilities and decided to install all cables and equipment underground in ducts and vaults. Originally the vaults were on the side of the road, but due to road widening, some of the vaults now sit in the middle of one of the main roads, which circles approximately 75% of the island. Kaiser Phoenician single ended amplifiers spaced at 220 MHz (approximately 2,000' with 1st generation GIP cable) were installed from Kalaheo and eventually reached Kapaa. This required 60 amplifiers in cascade. By the mid 1980's, the system was carrying 12 channels consisting of 5 Honolulu broadcast stations, 3 pay services, 3 satellite basic services and a bulletin board channel.

PROBLEMS

In 1983, Rifkin and Associates, Inc. became aware that Derby Cable was for sale. We made an offer which was accepted in 1984. Approximately two years later we were able to get the franchise transferred and in April, 1986, the name was changed to Garden Isle Cablevision.

During the time interval required to purchase the system and transfer the franchise, we discovered a few problems with the operation that needed attention:

- Satellite reception in Hawaii is difficult due to low power levels. The Galaxy satellites feed Hawaii with a side beam which is about 6 to 8 db lower than normal in level. Some channels are not available as Satcom FIIIR only sends 12 of 24 channels on the Hawaii beam. Some eastern satellites are not visible due to blockage by the earth.

- Off-air reception is only available at one point on the island. The Honolulu broadcast stations operate in the downtown area and ghosting from buildings is a problem. The path to Kauai requires the signal to pass over a mountain ridge and about 90 miles of water. This results in low signal levels which are more subject to electrical interference which is more prevalent in coastal environments due to salt spray corrosion. This corrosion covers insulators allowing paths for arcing and it degrades connectors, causing them to loosen and arc.

- Underground plant in vaults is not necessarily a problem, but Kauai is the wettest spot on earth, with some areas of the island receiving over 400 inches of rain per year. Some vaults literally have rivers running through them after a rain shower. We opened a splitter once in the trunk and found the inside completely encrusted with salt corrosion. Amazingly, even though the cables were pointed up and submerged in water much of time, the water had not penetrated the cable more than an inch or so. No waterproofing had been used.

- A 60 amp cascade of single ended amplifiers was installed to reach the furthest subscribers. No standby power was used and much of the system was still at 30 volts, requiring many power supplies. This was compounded by a small local power company that experiences frequent outages. Invariably, upon restoration of power after an outage, a large surge would flow through the cable plant, causing fuses and equipment to blow. Finding an outage in a 60 amplifier cascade is very time consuming. System channel capacity was limited to 12 channels.

Along with this were a variety of other technical and operational problems, such as:

- A one-of-a-kind billing system.

- Newest vehicle was 10 years old with well over 100,000 miles and held together with wire and tape.
- A very small office located at one end of the system.

- A program of daily tape playback requiring at least a 3 hour long round trip to the headend.

- Existing manager left two months after purchase.

- Only an unreliable mobile phone system for communication. There were many dead areas where there was no communication possible.

- All Hawaii systems are State regulated by a professional staff that oversees most areas of operation. This system could not meet State minimum technical standards.

- The staff had little formal training due to the distance from most of the industry. Fortunately, this was positively offset by good attitudes and a willingness to work hard.

- Everything costs 20% to 100% more due to shipping and tax, and it sometimes takes 4 to 8 weeks to receive equipment after it is shipped.

All of these items add up to dissatisfied customers. The rate for eight basic channels was $11.95 or $1.50 per channel. In a classic market with no other choices, this is less of a problem, but because Mr. Derby was unwilling to serve the entire island, a second franchise was granted and the other operator offered more channels for the same rate. There is also an overbuild area of about 300 homes.

SOLUTIONS

During the franchise transfer, Garden Isle Cablevision made commitments to the State to fix many of the problems and bring the system into technical compliance. We wanted to add channels to reduce the cost per channel

We were also aware of the customer complaints and, like most operators, we intended to run a quality operation. Therefore, we were committed to solving the problems and only two other items were necessary; money and creativity. This is a stand alone operation that is separately financed, so creativity became the focus.

Satellite Reception

The satellite pictures at time of purchase typically had some impulse noise due to the use of a dual feed 7 meter earth station with 120 ° LNA's. The earth station was realigned along with a realignment of the dual feeds. New LNA's of 50 - 60 ° were installed and impulse noise is now rare. When Galaxy 3 channels were added, a new 7 meter was purchased. The dish cost about $20,000, but it cost $20,000 to ship it and another $10,000 to install it. The look angle to Galaxy 3 is 13.9° elevation, so site planning was very critical.

Channel Capacity

While we wrestled with ways to cut the cascade, we also knew that the single ended amplifiers would have to be replaced. The vaults were custom built and are difficult to work in, so we wanted to find a drop-in upgrade. With some experimenting we discovered that Kaiser Phoenician II modules would fit the old housings and the Phoenician II's could be retrofit with modern chips. These use a single slope compensated pilot AGC system and were not considered a long term solution but did allow the addition of some mid-band channels.

After substantial research and testing we found one amplifier that would fit the vaults, although it was tight. The main trunks have been replaced with dual pilot AGC high gain power double amplifiers. All old line extenders have also been replaced with power doubled units. The main trunk is now capable of 300 MHz operation and the feeder lines are now capable of about 250 MHz. The system is now carrying 5 broadcast, 5 pay, 11 satellite basic channels and an access channel. The basic rate is $16.95 or $1.05 per channel, for a 33% reduction from purchase.

During these upgrades the system was converted to 60 volt to reduce power supply connections. Strategic locations also employ standby power. Much attention has been paid to surge suppression. Outages presently are at about 10% of their previous level. Subscribers can now turn on their television at night with reasonable confidence that they will get pictures.

60 Amp Cascade

The off-air reception had to stay on the south end of the island and we had to continue to provide service to the Kapaa area, so our only choice was to relay the signals with high quality to the middle of the system. We considered several alternatives.

Microwave was difficult because the mountainous terrain required two hops as there is no line of sight from the headend to any portion of the east side of the island. Use of microwave also would involve use of at least one site with difficult access and difficulty in obtaining power. While AML would be less expensive, it is subject to fades because of rain and this is the wettest spot on earth. A repeatered low power AML system did not seem to be the answer. FM microwave was considered but was deemed too expensive.

Consideration was given to adding the off airs to the existing coaxial system using FM to improve quality. The earth stations would be moved to a new site. This option was rejected because of the cost and the continued reliance on a long amplifier cascade with potential outages. We would also have long term capacity problems as we continue to serve subscribers directly from the headend. FM requires at least 12 MHz per channel and the original cable only has about 300 MHz of capacity. This would limit normal capacity to about 240 MHz. A separate coaxial system was rejected because of reliability and cost concerns.

We finally settled on fiber optics using FM because it offered the reliability we desired due to no repeaters and cost was equivalent or less than other options. Our major concern was introducing a relatively new technology into an area far removed from normal support systems. We selected Synchronous FM equipment because of cost, experience, and the reputation the equipment has for being very reliable.

A primary concern with fiber is the mean time to repair. Few people question that it will fail less often, but if it takes many hours to repair, then overall reliability may be equivalent to coaxial systems. The key to quick repair is technical training and reducing the inherent fear of the new technology. For that reason, we selected AT&T LXE cable with six fibers. Using 16 FM channels per fiber, the ultimate capability is 96 channels using the 1300 nanometer band. Use of the 1550 nanometer band could potentially double this. AT&T was selected primarily due to the availability of rotary mechanical splices. We wanted our technicians to install the splices to reduce their fear of the technology. The link distance was 24 kilometers and had 12db of loss upon completion. If we figure .4db per kilometer of loss for the fiber, then 12 splices averaged about 0.2 db each. They were not yet optimized with a TDR or other devices but <u>were</u> installed by our technicians. When the transmitter was turned on, we had excellent pictures at the receive end.

Admittedly, we did have experts from AT&T and Anixter on hand for training and supervision during the initial splicing. However, about 9 months later the fiber had to be cut for rerouting around a new bridge. All the splicing was again done by our technicians and the link loss is still in good shape. The point is that fiber is not to be feared and the same technicians that maintain your coaxial system can maintain your fiber system. With proper prior preparation, a cut fiber can be restored in less than two hours.

The fiber hub was installed at the 38th amplifier location and by reversing the middle amplifiers, the longest cascade was cut from 60 to 22. End of line signal to noise improved by an average of 6db. Obviously, this is part of the overall reliability improvement. We have had no outages on the fiber to date.

Now that the fiber is in and amplifiers have been replaced, we have a clean transportation system. Unfortunately, we have poor off air signals and we fall into the "garbage in-garbage out" syndrome.

<u>Off-Air Problem</u>

Over the years, many sites have been used for off-air reception on Kauai. While certain sites yielded slightly higher signal levels, none of the sites could provide a picture free of ghosts and electrical interference. The ghosts are a problem even in Honolulu and Oceanic Cable, which serves Honolulu, takes a direct feed from the stations to avoid the problem. They also relay these feeds via FM microwave to Mauna Kapu which is a mountain on the west side of Oahu. From there, they use AML to feed to various hub sites. The off-airs exist in excellent shape on the mountain due to the very high quality transmission paths.

Near Oceanic's facility is a Hawaiian Telephone microwave site that relays signal to Kauai. We asked them for a bid to transport two channels and the price was near $10 per subscriber per month. However, we believed that if they could do microwave, we could also do it. We discovered, however, that they have two separate paths, both with frequency and space diversity. They also back it up with an underwater cable. The problem with microwave over a long water path is reflections from the water arriving at the receive antenna out of phase with the main signal and causing fades. A microwave signal has a short wavelength and ocean water can at times look like a mirror to these wave lengths.

Other solutions such as a satellite or underwater were much too expensive. It occurred to us, however, that if high frequencies and low frequencies have problems, that maybe middle frequencies might be suitable. UHF is far enough away from power line frequencies to avoid electrical interference and yet has a long enough wavelength so as not to be as subject to reflections. UHF also has the ability to be focused well to allow an antenna to project a reasonably narrow beam with fairly high gain. Unfortunately, these frequencies are licensed only to broadcasters and there were no previous cases of cable usage of those frequencies (at least legally).

We ran the calculations and it appeared that a 100 watt UHF transmitter with a 12' transmit and an 8' receive dish would offer a good signal to noise. Calculations are shown in Exhibit A. We were unsure however, about reflections and fades. Therefore, we decided to ask the FCC for an STA (Station Temporary Authority). We paid a visit to the FCC and presented our case and were very favorably received, based on our desire to improve customer service.

About a month later we were able to clear channel 38 for use and we began our test two months later. Our input was a video feed from Oceanic and we installed our transmitter in an old building of theirs and the antenna was placed on their tower. From the inception and alignment there have been no multi path problems. The signal has been rock steady since turn on. There are no ghosts, no electrical interference, and no fades. After the tests were complete, we presented evidence of our success to the FCC and were subsequently granted a full license. The license is secondary to any other full power user and, of course, is subject to restrictions concerning harmful interference.

It should be emphasized that this license is unusual because the circumstances were unusual. There was no other economically feasible method and there is not a high probability of interference as this is a remote place without high UHF usage. There are certainly other parts of the US where this method would apply, but UHF congestion would prevent finding a clear channel. Generally, rules preventing adjacent channel and seventh adjacent channel operation due to local oscillator interference will not allow additional channels in many cases. It is very possible that, even with the aforementioned restrictions, there are other places where this technology would apply.

Summary

All of the other aforementioned problems with billing systems, vehicles, etc. have been solved though replacement. All of these actions have reduced service call rates to about 50% of their previous levels. All of the improvements in Garden Isle Cablevision have resulted in much more satisfied subscribers. While money and manpower have certainly played their part, we believe the major improvements have come through creativity and training. Improved customer service is not gained by simply spending more money and hiring more people. It is gained by listening to your subscribers and through training and creativity finding solutions to their concerns.

<u>EXHIBIT A</u>

OAHU TO KAUAI UHF PATH ANALYSIS

1. DETERMINE IF THERE IS LINE OF SIGHT

IF DISTANCE IN MILES IS LESS THAN OR EQUAL TO THE SUM OF THE SQUARE ROOTS OF TWICE THE ANTENNA HEIGHTS IN FEET, THERE IS LINE OF SIGHT.

TRANSMIT ANTENNA HEIGHT	2700 FEET	MAUNA KAPU, OAHU
RECEIVE ANTENNA HEIGHT	459 FEET	KALAHEO, KAUAI
SUM OF SQUARE ROOTS	103.8 MILES	
TRANSMIT COORDINATES	21D 24M 13S NORTH 158D 06M 06S WEST	
RECEIVE COORDINATES	21D 55M 01S NORTH 159D 22M 21S WEST	

USING GREAT CIRCLE CALCULATIONS DISTANCE IS 88.98 MILES (D)

SINCE D IS LESS THAN THE SUM OF TWICE THE SQUARE ROOTS, THERE IS LINE OF SIGHT.

2. CALCULATE PATH LOSS USING LINE OF SIGHT

FORMULA IS	A = 37 + 20LOG(D) + 20LOG(F)	
	A IS ATTENUATION IN DECIBELS	
	D IS DISTANCE IN MILES	88.98 MILES
	F IS FREQUENCY IN MHZ (CH 38)	615.25 MHZ

CHANNEL 38 AT 88.98 MILES

FREE SPACE ATTENUATION	131.8 DB
MULTIPATH ATTENUATION	<u>20.0 DB</u>
TOTAL ATTENUATION	151.8 DB

3. CALCULATE RECEIVE SIGNAL STRENGTH

	WITH MULTIPATH	WITHOUT MULTIPATH
TRANSMIT POWER 100 WATTS	+ 50.0	50.0 DBM
TRANSMIT ANTENNA GAIN 12' MARK	+ 24.7	24.7 DB
FEEDLINE LOSS	- 1.2	- 1.2 DB
PATH LOSS	- 151.8	- 131.8 DB
RECEIVE ANTENNA GAIN 8' MARK	+ 21.2	21.2 DB
RECEIVE ANTENNA OUTPUT	- 57.1	- 37.1 DBM
CONVERSION TO DBMV	+ 48.8	48.8
	- 8.3	11.7 DBMV

4. CALCULATE SIGNAL TO NOISE

USING PREAMPLIFIER WITH 4 DB NOISE FIGURE

RECEIVE LEVEL	- 8.3	11.7 DBMV
THERMAL NOISE, 75 OHM, 4 MHZ	- 59.3	- 59.3 DBMV
PREAMP NOISE FIGURE	- 4.0	4.0 DB
SIGNAL TO NOISE	47.0	67.0 DB

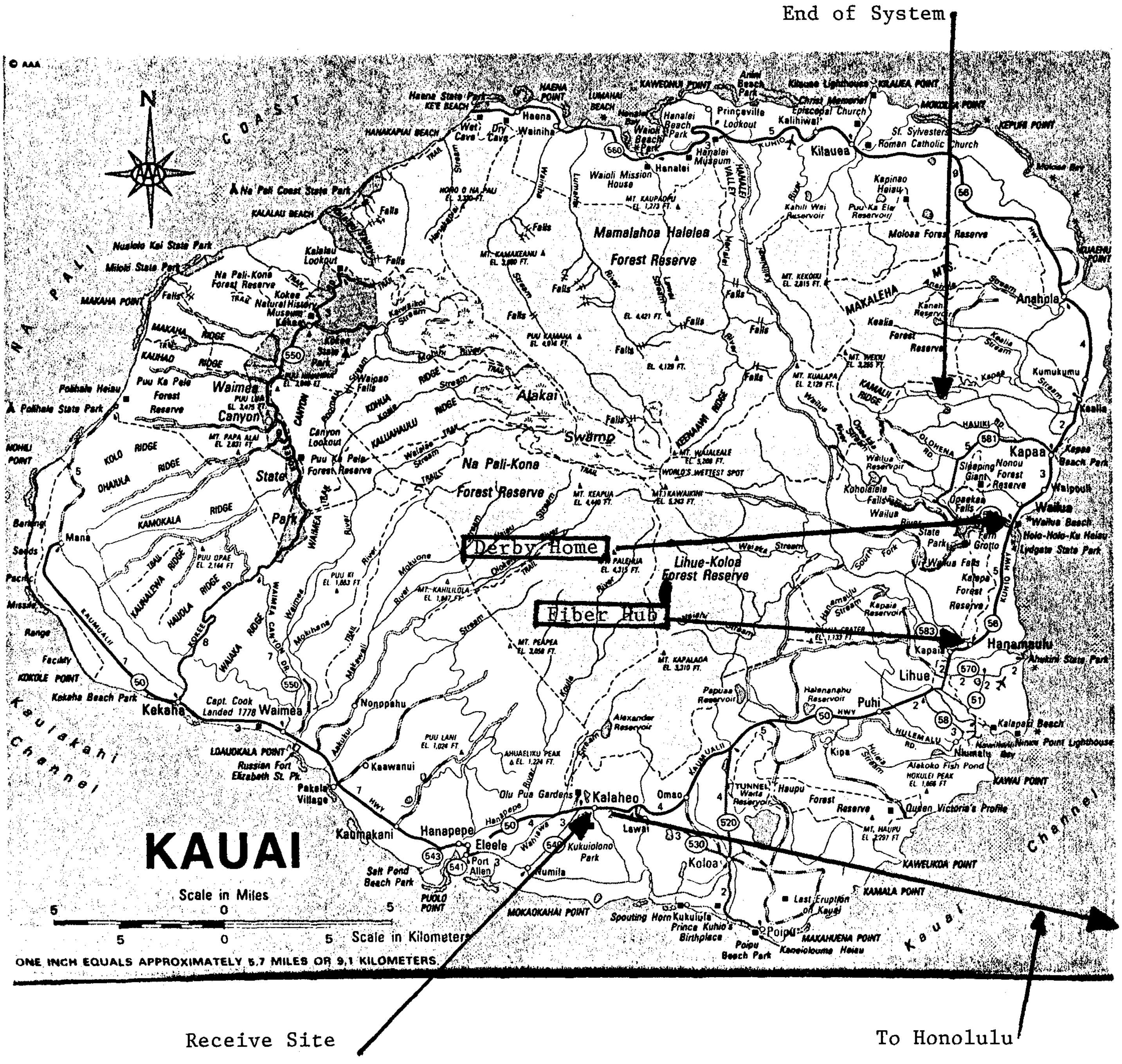
5. SIGNAL TO NOISE AT VARIOUS TRANSMIT POWERS HOLDING ALL OTHER FACTORS CONSTANT.

TRANSMIT WATTS	DBM	WORST S/N(DB)	BEST S/N(DB)
1.0	30.0	27.0	47.0
5.0	37.0	34.0	54.0
10.0	40.0	37.0	57.0
20.0	43.0	40.0	60.0
50.0	47.0	44.0	64.0
100.0	50.0	47.0	67.0
1000.0	60.0	57.0	77.0
10000.0	70.0	67.0	87.0

6. ACTUAL RESULTS

		S/N	
LOWEST LEVEL	-10 DBMV	45.3	VERY RARE
HIGHEST LEVEL	10 DBMV	65.3	
NORMAL LEVEL	6 DBMV	61.3	GREATER THAN 99% OF THE TIME

EXHIBIT B


End of System
Derby Home
Fiber Hub
Receive Site
To Honolulu
KAUAI
Scale in Miles
Scale in Kilometers
ONE INCH EQUALS APPROXIMATELY 5.7 MILES OR 9.1 KILOMETERS.
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