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Internet Users Society - Niue | .NU Domain

Solarfi

Niue's WiFi Nation Goes Green

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It's about 18:00 hours on April 25th, 2005 and the red sun is setting over the Pacific Ocean on the tiny Island nation of Niue. Emani Lui and I finish loading up the truck and van for tomorrow's new experiment: a completely solar powered WiFi station at a location off the power grid in an outer village.

This past week, Young Vivian, the Premier of Niue, has given the Internet Users Society — Niue (IUS-N) permission to use an abandoned one hundred twenty foot tower that was once used for some kind of Government Department of Agriculture, Forestry and Fisheries project. It's been standing unused for almost two lustrum*, and since Niue's second largest village sits next to it, we can make good use of it as a WiFi tower for distributing WiFi Internet services across the island.

The people of Hakupu (Niue's second largest village-second only to the Capital, Alofi) have requested local WiFi mainly because of their telephone systems being very unreliable for dial up Internet connections. They are on ancient analog cell phone systems that at best can handle 4800 baud over dial up. Not good enough for today's modern Internet user. So they want WiFi.

Ed. Note: Five years, from the ancient Roman word for the five-year census.

No power and no phone lines, but Niue's most isolated places have WiFi hotspots. This is a hands-on manual on how .NU Domain built a solar WiFi system for the world's tiniest nation

Hakupu being seven miles from the nearest WiFi access point makes it difficult for individual users to access it. The signal is up there above their heads, but to connect from that distance they would have to have a mast or tower roughly sixty feet high to get into the signal stream. They simply don't have the resources to do that as individuals. We need to solve that problem so that it will be easier and cheaper for them to connect. The only answer [for them] is for us to bridge link from our Earth station at Kaimiti (seven miles away) to the abandoned tower of Hakupu, and then distribute WiFi locally.

The entire population of Hakupu can see the top of the abandoned tower via pure line of site. And that's what we're after: to get the WiFi Internet connection to the top of that tower.

Niue's terrain is mainly a flat average of rolling coral diversity, covered in rain forest with a canopy of fifty to seventy five feet. No high elevations, mountains, volcanoes, etc, to build radio stations or repeaters on. Nothing of any significant elevation to hang antennas on. Just pure ground-to-ground using only man-made towers or masts.

Punching through the rain forest

With the characteristics of WiFi in the 2.4ghz range, penetrating the jungle is next to impossible for distances of more than just a few hundred feet unless you can get above the tree line or somehow be lucky enough to do pure line of site through the foliage. We've had some success punching through the rain forest using sixty-foot towers with fifteen-foot masts at the top, and pointing beams of up to 24db with up to two watts of power amplification behind it. But living rain forest just doesn't cooperate with those kinds of microwave frequencies - and even a long distance bridge of that nature is on the expensive side, and certainly out of the question for individual users.

Trango Broadband (www.trangobroadband.com) saved the day for those of us in the jungle environment when they recently released 900Mhz point-to-point AP/Client units operating multi channel in the 900 band. They are fully self contained units, running POE (Power over Ethernet) with built in Web Interface Management, telnet, console, integrated panel antenna with an excellent front to back ratio, and built to withstand the elements in either extreme heat or extreme cold (they carry built in heaters). Our trials in the past year with these units prove they will not only penetrate the rain forest for at least the length and width of Niue (roughly eight miles by ten miles) but for short distances they will also bounce over coral as well.

Richard St. Clair assembles WiFi networking equipment for the solar-powered base station in Hakupu.

This is important since Niue is a raised coral atoll and with no high elevations on Niue to choose from other than man made towers, it seems a signal over any distance more than a few miles has to penetrate at least a few coral obstacles depending on where you are.

Now in Hakupu's case, and from a purely RF (radio frequency signal) point of view, we're pretty certain the 900mhz will make it to the tower location from our earth station at Kaimiti. Our Earth station is ready, with the recent upgrade to a four-meter commercial dish, five megabit receive link from California with the 256K uplink on the back side on the New Skies Satellite networks.

But that's only potential Internet bandwidth for an isolated village like Hakupu. There's no electricity at the tower site itself-and that's where the signal has to go. So here we have an excellent opportunity to point a signal to something that can be seen from an RF point of view, above the canopy, and no power source on the ground to run it. Naturally this is the perfect equation for a solar powered WiFi station.

Let's talk power.

The station configuration we want to use will be low current draw. Everything that goes up on the tower runs POE (power over Ethernet). So we have no coaxes going up. That means more signal to and from the antennas, and less losses. Good stuff. We need 24 volts DC for the Trango 900mhz SU (subscriber unit), 7.5 VDC for the switch in the control room at the base of the tower, 48 Volts DC for the Value Point WiFi Access Point (www.valuepointnet.com) and 5 VDC for the security camera. If we were any place else in the world, we would run a few solar panels in parallel charging some sealed gel cells, run down to pure dc of 48 volts and then build DC to DC converters for whatever voltages we need to run the actual

Richard St. Clair (right front), Steve Jefferson (left rear) and Niuean Member of Parliament Michael Jackson (right rear) take a breather after clearing the jungle away from the tower in Hakupu.

St. Clair with the Trango Access Point and antenna units used for WiFi systems serving Niue's outer villages.

components up on the tower. But we're in Niue. On a tiny rock in the middle of the Pacific Ocean there's no Radio Shack for hundreds (if not thousands) of miles from here. So we have to use what is easy to get in this part of the world. Since we're also in the cyclone belt, and have already been through a disaster-rated category 5 cyclone (Heta in January 2004), we also have to think about what can be replaced almost immediately as well as what can be kept on the shelves locally in case of failure. Niue gets just one supply boat a month so freight is hard to import, and we have to be self sufficient on what we have within an arm's reach.

Graeme Ebbett of Ebbett Manufacturing (www.acourt.co.nz/home/H0014.htm) in the Wellington New Zealand area makes a fantastically designed DC to AC inverter. They come in both 12 and 24 VDC inputs. They are small, built in a ruggedly constructed housing, put out 240 VAC at pure sine wave, are rated for continuous run, and the overhead current draw is almost not worth mentioning. They have to be the most efficient inverter I've ever seen. That being the case, we're going to think outside the box, use the solar panel to charge a pair of ordinary gel cell deep cycle batteries (in parallel for capacity), run the DC to the inverter to get the 240VAC we need and use the factory power bricks and power chords for each device needed at the station.

Using this method of design, all the components are stockable, available in New Zealand or the US, only a boat or plane shipment away, and simple design that can easily be repaired in the event of any failure. As an added bonus, by doing it that way, we also get the advantage of being able to run our power tools while we're building [installing] the site.

Solar power also means we could do it anywhere on the island where it might be needed. It might not seem important in some parts of the world, but most of Niue is still not developed. No running water, no electricity, no roads, and no houses. So if we wanted to install a repeater site anywhere other than the outer [developed] ring of the island, solar is the only way to do it. This particular installation in Hakupu will be the test run that we will use to see how well it goes with such a configuration.

We arrive at the site just past 07:30 Saturday morning. It's hot already, but we're glad it's not pouring down rain. We have a few thousand square miles of clear skies up there according to the latest NOAA pictures, and the perfect day to build a site. It's going to get hotter though. We park the two trucks and the mini-mini-van on the narrow jungle overgrown road next to the tower. It's a quiet morning.

Hacking in the jungle

The first thing we notice is that the jungle has grown over the tower site to the point where the tower is sticking up of course, but the concrete equipment building at the base is almost invisible, the blocks for the guy wires are hidden and there's no trail to any of it. No problem, within seconds of arrival, a local Niuean businessman who lives nearby is already on the scene (appearing out of nowhere) with his bush knife (known as a machete in some parts of the world) and begins hacking away at the jungle to make a trail to the base of the tower (there's more than one kind of hacker on Niue). The three of us (adding our own bush knives to

the party) manage to cut a trail to the equipment room and clear the base of the tower in short order. Of course I'm tired already, but nothing a Jolt Cola can't fix, "All the Sugar and Twice the Caffeine".

Our crew today consists of myself, Emani Lui, the local technical consultant for IUS-N and the co-owner and operator of our local downstream provider, "RockET Systems", and Steve Jefferson, jack-of-all-trades and Internet enthusiast. A few words to initiate the plan of attack, now that we have a trail to where we want to go, and the project is off to a good start.

Next we remove the boards from the concrete equipment room. It's been boarded up for years. Nobody we've spoken to so far can remember exactly when the tower was put there, or when it was abandoned. Out back there's a 46U rack laying on it's side. Rusted to virtually nothing. The only thing left that is recognizable is an aluminum identification tag that says "Japan Radio Corporation, 1976". Whatever equipment that was, must have been in the concrete equipment room, but the tower probably hasn't been there since 1976.

Insects, lizards and spiders

Still, it's been a long time. The inside of the equipment room is full of vines, old chunks of wood, all kinds of living creatures, insects, lizards, spiders. But it's a small building about 5 feet square inside, and it doesn't take long to clean it out. Fortunately it is made of thick cinder blocks, and has a cement roof. Not only has it withstood the elements of time, but it's going to remain nice and cool inside, even on the hottest tropical days.

A few more hacks at the base of the tower and we can clearly see the giant block of concrete that supports it. Single bolt hinge base type with multiple sections guyed to the outer concrete blocks on three sides. The guy wires are in good shape, are all there, and have just proved themselves by standing up to the forces of Cyclone Heta, the cat 5 that recently swept over Niue in January 2004. So we're confident the tower is solid. It's galvanized, it's painted on top of that, the step bolts all look good. And we think we're ready to do it.

Emani Lui, IUS-N director of development, as well as owner of RockET Systems on Niue (www.rocketsystems.nu) is our "tower monkey." He assembles his climbing gear, harness, tool bags and safety glasses for the long trip up. It's over a hundred feet to the top, and he'll be up there a few hours today.

He loads the Trango 900 unit in his backpack, ties the nylon rope to his harness tail, and begins his ascent. We all wait on the ground with apprehension since this tower hasn't been climbed in who knows how long. But after he gets past the first three sections it is obviously solid, and we all go back to our ground duties.

We're using all POE (Power Over Ethernet) for the components on the tower, so we need outdoor cat 5 cable fully shielded and strong enough for the tower hang. We also have to mount our big control box inside the concrete equipment room at the base of the tower. Whatever was on the tower before it was abandoned, used Heliax of the finest grade and it's laying all over the grounds (useless now of course) around the tower as well as some of it hanging from the guy wires where it was apparently ripped from the tower by the cyclone. That all has to be cleaned up and stored away. The door of the concrete building is wooden, and needs some minor repairs. The ground crew starts on all these little jobs while Emani is on his way to the top of the tower.

Now Emani is at the top, and reports clear visibility to just about anything on Niue that sticks up above the canopy. He begins work on the mounting of the Trango 900 unit at the top. We've used the handheld GPS to take coordinates and bearings to point the integrated antenna back to our machine room at Kaimiti. A few hand signals, and he's got it all lined up.

At this point the ground crew has to confine themselves to working inside the concrete building. Emani's fingers are generally pretty reliable when it comes to being able to hang on to a wrench or a screwdriver, but if he should happen to drop something [anything at all] from that height, it will turn into a bullet by the time it gets to the ground. So in we go.

It's a pretty calm day so we can communicate with

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Emani using voice only (sometimes we have to use FM walkie talkies and headphones). It's going to be a pleasant operation all the way today.

Throughout the morning, passers by stop in to see what's happening at the old abandoned tower site. The Anapala sea track trail is out front of the tower (it's almost a road) and local fishermen on their way to their canoes are coming by. Some village residents have pigpens on the same road, and some of them farm taro, Tapioca, and other Niuean foods in their bush plots out in the same general area. Mid morning a Niue government Cabinet minister from Hakupu shows up with food and pleasant conversation. And a few others happen by with cold drinks, bananas, avocados, and other tropical delights. You see by now the word has spread through the village that the WiFi is going in. And everybody wants to help it along in any way they can (we're glad they want to help out by feeding the crew).

By this time Emani is finished with the installation of the 900mhz unit at the top of the tower. The POE network cable has been hoisted up on the rope and plugged in. It's time to try the link and see if the project can continue. Getting that initial link to our Earth station back at Kaimiti seven miles away is crucial at this point. What we've learned about radio signals on flat ground is that the calculations don't always work. You never know what's going to work and what will not, until you plug it in and watch it go hot. So the top man at the tower gives a "ready" yell, and on the ground we plug in the Inverter to the car battery, plug in the POE supply for the Trango and wait for it to boot.

We've preconfigured the Trango unit to lock on to our 900mhz Access point at IUS-N's Kaimiti Earth Station at the top of our own seventy-foot tower/mast combination which we built last year. Bench tested and ready to go - so if the signal is there, it's going to lock. It has seven miles of rain forest, coral, and who knows what else in between to go through. And we all hold our breaths while the Trango boots up. We have a nine-foot long stainless steel 22db beam that we can use if we have to. But the Trango units come with an integrated antenna that has been performing brilliantly in all the installations so far. So we would rather not use the beams if we don't have to.

Emani Lui climbs to the top of the 120 foot high tower overlooking the village of Hakupu to install the WiFi Access Point.

Ready for 150 Mph winds

Using the beams would be more difficulty in getting it up the tower of course, but the main reason we don't like to use them is because of the increased wind resistance during cyclones. The Trango units with their compact shape, size and weight, will easily withstand a 150mph wind and that means we don't have to take them down when a cyclone threatens the area. These units also have a built in LED inspection plate at the base which shows booting activity, connect lock, signal strength, and network traffic.

After what seems like a very long thirty seconds or so, Emani's voice rings out from the top of the tower that he sees a solid green light with two yellows. In Trango talk, that means we not only have a lock with the Access Point at Kaimiti [through all that rain forest] seven miles away, but it's also a very strong lock.

We therefore have a solid Internet connection to Hakupu, and it's terminating at an RJ45 socket in the concrete building at the base of the tower — with no connection to a power grid.

A sigh of relief, gestures of thumbs up, smiles and a big "atta boy" to Emani at the top, and we're ready to move on to phase two.

By this time Emani has been up the tower for an hour or more — and he's got about four hours more to go before it's all over. It's time for him to come down for a break, eat some of this food that the locals have brought to us, and have something cold to drink. We'll plan what's next, and finish the installation after we regroup and formulate a plan - now that we know we have a solid link.

Next on the list is the installation of the actual WiFi access point that we will use to distribute the 802.11b Internet connection to the village, and the 90-degree flat panel antenna. The Value Point Access Point is a fully outdoor certified, POE, 802.11bg access point with a build in 500mw (1/2 watt) amplifier all built in to a solid, water tight, UV proof box, for about the same price as what an amplifier all by itself would normally cost. It's light, and easy to carry up the tower, and since it's POE, the coax need only run a foot or two, to the 90-degree panel antenna that we'll face toward the village.

This is a much more efficient way to run RF power to the top of a tower than using 100 plus feet of coax. Even extremely low loss coax can loose enough signal strength over a distance like that at 2.4ghz to show noticeable performance deterioration. Because they are all POE components, the Trango and VP units make the perfect companions for each other in a tower installation.

While we all take a banana break, gobble down a few cookies, and drink coconuts and more Jolt Cola, I take the time to connect a laptop with a crossover cable direct to the Trango unit and run a few tests. The signal to Kaimiti is good, the Internet is very fast, we have a zero percent packet loss, and even with only one solar panel, the voltage on the battery bank is gaining. All good.

Emani loads up his pack with coax sealer, more tools, and the rest of what he needs to mount the Value Point unit along side the Trango at the top. We'll send the unit up on the rope when he gets there, and send up the panel antenna as well.

Up he goes, and we get back to work mounting the rest of the gear inside the control box inside the concrete equipment room. The Inverter is mounted at the bottom of the inside of the control box, above that goes the POE unit for the Trango, a small five port switch, and the POE unit for the Value Point Access Point. A power strip goes along side to power the factory power bricks. The rest of the cables are cut and crimped, and laid in. And a chunk of old Heliax is used for a stress relief for both cables to get them from the tower to the top of the concrete equipment room to be guides into the control box.

Hakupu hotspot lights up

The details are time consuming, and before we know it, the afternoon sun is overhead, and it's getting pretty warm out here in the tropical humidity. There's a cool breeze blowing up where our tower monkey is, and the temperature inside the concrete equipment room is staying pretty low, so overall, we're OK.

Emani announces from the top that he's got the Access Point wired and the panel antenna is pointed at the village. We power it all up for a test before he leaves the top of the tower…just to be on the safe side. We can see by the lights on the switch (now mounted inside the control box) that everything has gone well during boot. So we stroll out to the jungle in front of the tower with the palmtop to see "google.com" for the first time using WiFi from Hakupu. It's there. It's all good and everything is working just the way we wanted it to.

We give a yell up to Emani and he starts the job of tying the wires to the tower and buttoning up the loose ends with tie wraps on the way down. On the ground we start mounting the solar panels to the roof of the concrete equipment building.

Emani Lui at the top of the 120 foot tower in Hakupu points the way for the "line of sight" WiFi bridge connection to IUS-N's earth station in Kaimiti.

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We have three fifteen-watt solar panels, more than enough current to run this station, and they go side-by-side flat against the roof. We're lucky enough that the equipment room is square with north south east west, and there are no huge trees blocking the east west trek of the sun during the day. That means major sun all day long for the solar panels.

The cables from the tower are run into the control box, tidy and nice, all the components are mounted inside. The twelve-volt car batteries are temporarily placed on the floor side by side. Later when the boat arrives from New Zealand, the deep cycle sealed batteries we ordered a few weeks ago will replace them.

Tools back to the car, eat some more bananas. Drink another coconut, and fire up the palm top again to make sure we didn't break anything by tidying it up. It's all working brilliantly - and all running off of the sun's energy.

And I say to Steve, "I'm going to be the good kind of tired tonight". He wipes the sweat off his face and says, "Ya me too". The two of us watch Emani slowly but surely descend from the top of the tower as he ties the cables on the way down, and puts the final touches on his handy work.

By the time he gets back on the ground, more food has arrived. Roasted chicken, Uga (Niue's coconut crab), some Umu roasted Taro. We load up, lock up the equipment room, admire our handy work for a bit, and then drive over to the village green in "downtown" Hakupu. From there we wander around with the palmtops, checking the coverage. It's good, and it's strong, and its solid.

Eventually we're satisfied that it's going to be what we wanted it to be, and head back for the shade tree the trucks are parked under. Late lunch or maybe by this time early dinner, whatever it is, it tastes pretty good after a long day. It was time well spent and we're walking away from an isolated South Pacific village now with full Internet WiFi services, running off of the sun. In the coming weeks we will try and do the same with several of the other outer villages who have requested the services. They're all in the same situation. And solar units like this could be the answer.

One last look with the palmtop into the web interface for monitoring the Valuepoint access point before we leave for home. There are already users from the village online surfing the web. Word travels fast in this part of the jungle. Ones and zeros travel even faster.

Overlooking the village of Hakupu from 120 feet up, IUS-N's solar powered WiFi Access Point has excellent coverage.

No Power for WiFi? Not a Problem in Niue.

Basic Wiring Diagram for Solar Powered WiFi Repeater Stations and Access Points in Niue Island in the South Pacific