Solar 3G internet repeater
Guide

Why bother?

I myself cannot get broadband or a strong 3G signal at my house. After being stuck using satellite internet for the past four years, I've had enough. Poor speeds, poor value for money and overall poor service.

I know my neighbour can get 3G phone reception and wondered if she would get enough reception to use the internet. This led me to the idea of setting up some sort of relay station to get 3G internet that I can't and relay it to my house.

It took approx. seven months from signing up with my 3G ISP to turning off my satellite modem. Everything in the guide was done using my own research and a lot of trial and error. It would have been a lot quicker and easier if I had a guide like this to follow – you're welcome☺.

Can't I just buy one off the shelf?

Yes, but they cost as much as mine without the router, wireless link, pole, cement not to mention the cost shipping a heavy system to Australia. Plus, replacing broken parts in warranty would be a huge hassle, especially when they would have to come from the other side of the world or if you're somewhat lazy.

How much does it cost?

If you're like me and can't get another satellite subsidy, you can build one for less than the cardiac arrest inducing price of $2,750 they charge for the satellite equipment. It is well worth the money in my opinion.

Obviously spending a couple grand on an internet connection is not cheap and would seem very odd to most people. As said, I have no choice. It was going to cost the same amount to go to another satellite ISP. After 4 years of being done over really hard, the cost of building my own system was a no brainer.

This guide is really helpful

What's in its pants?

This guide will help you with everything from choosing a location to browsing the internet. Guide includes:

- Help choosing a location
- Tips on selecting parts suitable
- A complete parts list my station uses including links
- Configuration of all the hardware
- Solar power calculations
- Advice on building the station
- Links to helpful sites

My 3G internet provider is Telstra BigPond and uses Telstra BigPond Ultimate USB modem (Sierra Wireless AirCard 312U). I chose them because no other network is present at my location and the NextG network is far more superior.
Feel free to use any other 3G network or any other compatible modem you like with only a few straightforward modifications to this guide.

Any hardware setup in this guide that needs a computer is based off Windows 7. Again, you can substitute it for any OS you like.

This guide was written based off my relay station using loads of research and lots of trial and error. This may not be the most ideal setup for some or could be done differently/better but this is what I did and is perfect for my needs.

Choosing a site
Where to put the beast

Kind of obvious but...
The first thing you need to do is make sure you even get reception. If you can use a mobile phone at your house fine (lucky bastard) then you may not have any probs. To be sure, check Telstra's official [BigPond coverage maps](#) to give you a good idea if NextG is available in your area. The maps use some sort of computer wizardry to determine if reception is most likely available so they aren't pinpoint accurate.

If you have three bars or less, I strongly recommend you get yourself an external antenna and try to boost reception. I tend to find that any less than 4 bars give constant drop-outs and poor performance.

You may have more than one NextG tower in your area that may offer a more reliable connection. It is worth seeing if this is the case.

Finding NextG towers
I already knew where my nearest NextG tower was but wanted to try and find any other towers that may be closer to get better reception. [This](#) site shows tower locations for Telstra and other 3G providers but it hasn't been updated in years so I rang BigPond support. If anyone else wants to find NextG towers then whatever you do, don't call support.

After going back and forth for over a month and BigPond telling me tower locations that didn't exist on any map known to mankind or the ACMA site or giving me towers that didn't have any Telstra equipment, they admitted they don't have this information available to them. They also couldn't explain to me why they gave me said useless information.

The solution is to ring the Telstra satellite and installers number in Brisbane and ask for the locations. They were really friendly and kind enough to print out a colour map and post it to me. Their number is **1800 305 307** (option 2 for wireless).

No reception at your house? Try somebody else's!
Unfortunately, I cannot get a strong enough NextG signal at my house. Even with an external antenna on my roof, I can only connect for a few seconds before it drops out for hours at a time.

My super-nice neighbour is lucky enough to have a tall hill on her property that can get full five bar reception. Even luckier for me, she gave me permission to put a relay station on her farm to receive internet and relay it to my house.
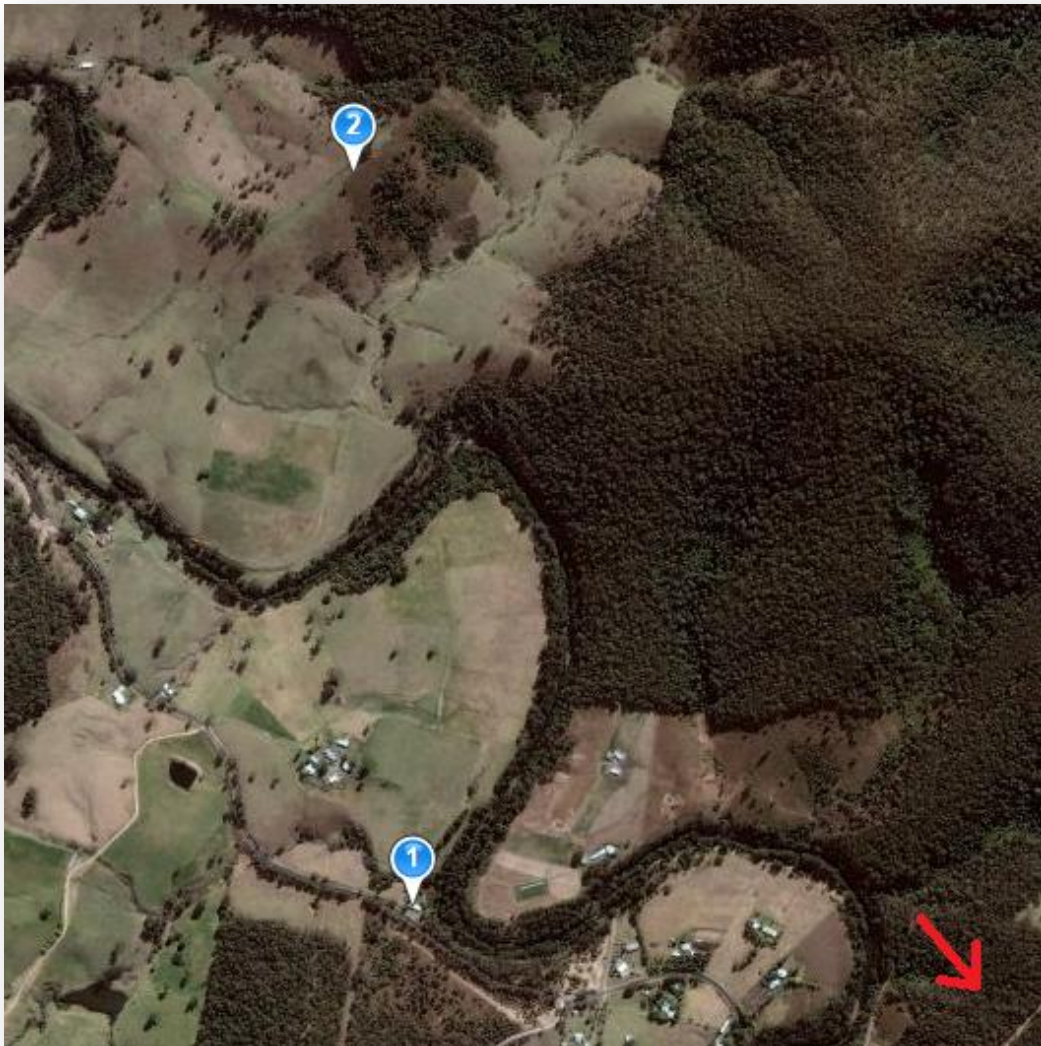
The relay station (pushpin 2) is 1.75 kilometres from my house (pushpin 1). The area was chosen after spending the weekend wandering around my neighbour's farm with a laptop, BigPond Ultimate modem and a compatible NextG antenna.

My nearest NextG tower is in the direction of the red arrow and is approx. 16km from the station as the crow flies.

Link planning

You will need line of sight to your house for good signal strength and quality when relaying the internet. Ubiquiti Networks make quality, user-friendly low cost radios and are an excellent choice to bridge the station and your house.

Ubiquity has an online tool to plan wireless links called [AirLink](). It uses Google Earth plugin (unfortunately) to put markers on the map where the stations are. You can use the tool to see which radio will give a better quality signal.

Radios are available in both 2.4GHz and 5.8GHz frequencies.

Results from my survey

The site was actually the 3rd best spot regarding signal speed and quality but was chosen for the following reasons:

- The site is blocked from view of my neighbour's farm house by a large Banksia tree. Since she is letting me put it on her farm and allow me to walk across her property whenever I like free of charge, the least I could do is put it somewhere she wouldn't have to look at it.
- The site is in the open, a nice distance from any tree that will cast a shadow or drop branches on the station
- The site is in full sun from the sun peaking over the mountains at around 8am 'till disappearing at around 4.30pm.
- It has direct line of sight to my house with no trees obstructing the path
- No tree will be large enough to block my house for at least a few more decades so the location will be future proof

With the Ultimate modem and **no** external antenna, the site gets the full five bars of reception, an average ping of 59 – 75 milliseconds and -70 to -80dBi reception. With the modem lying on the ground, it drops to 3-4 bars of reception.

When an external antenna is connected to the modem, in my case a 10dBi Yagi, the modem gets full five bars and the signal improves to -69 to -75dBi whilst the ping stays the same. The speed of the connection varies from 5-7 Mbps which is a massive improvement over the 512Kbps (supposedly) I use to get.

If you may notice that there isn't a super-duper amount of difference with or without an antenna, but the drop in signal strength with the modem lying on ground level is the same as you'll experience (at least for me) when the modem is locked up tightly in a weatherproof enclosure.

Required parts

Router with BigPond Ultimate USB modem

Since the BigPond Ultimate (aka Sierra Wireless AirCard 312U) modem is a USB modem, it will need to be plugged into a router. I use the RouterBOARD 411U made by MikroTik.

Finding a router that works 100% with this modem is a little tricky. Some work, some don't. If you search the [Whirlpool](#) forums you'll find this out.

I chose the MikroTik router for the following reasons:

- It has a 3 watt power consumption compared to the 15 watts plus that most other 3G routers consume
- Designed to run between -35°C and +70°C so it won't overheat in summer or cook it self like the BigPond Elite Gateway (3G21WB)
- Designed for remote installations and has no issues being run off solar
- Don't have to worry about the modem firmware or any software issues

Wireless link

Unless you want to run a huge whack of cable or use carrier pigeons to get the internet from the station to your home, you will need a pair of wireless radios.

For my wireless link, I use the AirGrid M2 16dBi 2.4GHz by Ubiquity Networks, primarily due to its maximum 3 watt power consumption and that it can be mounted to a pole without needing to purchase any extra mounting hardware.

Due to the design of the AirGrids, they are not MIMO like most other Ubiquiti radios. This isn't a problem for me as NextG maxes out at around 7 Mbps so 100 Mbps capacity is plenty for my needs. MIMO radios are available from Ubiquity so feel free to switch to any other radio you like and use AirLink to see which will work best for your particular location.

The radios are powered via POE (power over Ethernet). The radios come with a POE injector. Since the station side is solar powered and is a 12 volt DC system, the POE for this side is not needed. A basic passive POE injector can be used or a DC-DC POE injector.

FYI: the maximum diameter of a pole that the AirGrids can be mounted to is 50mm. For some strange reason, you won't find it in the manual, on the Wiki or on the forums.

Solar power components

The location I chose for my station has no mains power available so it needed to be solar powered. If the station goes down for any reason, I won't have any internet access so the system needs to be reliable enough to run 24x7x365 with little or no interaction from me.

When designing something to run off solar, there are a few key things to consider: how much sunlight the site gets and how much power the station will need.

Sunlight

You need to consider how much sunlight your proposed site will get (insolation). During winter, sunlight is not as intense and the days are shorter. You need to keep this in mind. My figures are based off winter values to ensure there is always enough power during the colder months. You can get the figures for your area in Australia [here](#).

Power consumption

I based my figures off the maximum values listed in product manuals for the various parts I chose. It is better to go off the maximum values so you aren't short with power – it is better to have it and not need it than to need it and not have it.

- Router = 3 watts
- AirGrid = 3 watts
- DC-DC POE injector = 1 watt
- BigPond Ultimate USB modem = 4 watts (according to Sierra Wireless, when connected to a HSPA/WCDMA network, an average call uses 700-800mA. I have no idea what 'call' refers to)

My total power consumption is 11 watts per hour. Again, this is based off the maximum figures. Actual power consumption is a lot less than this.

Calculating the size of the battery

A deep-cycle battery is a type of battery that is designed to be regularly deeply discharged using most of its capacity where car batteries are designed to provide small amounts of power before being recharged. You need a deep-cycle battery for the station.

1. Determine how many amp hours per day is used
   a. 11 watts per hour = 264 watts per day / 12 volt system = 22 amps
2. Determine the battery storage required for 3-4 days of reserve
   a. 22 amp hours per day multiplied by 3.5 = 77 amps
   b. 77 / 0.8 (AGM batteries can discharge to 80%) = ~97 amp battery required

3. Round to the nearest battery size available, in my case 100aH

I've gone for an AGM (Absorbent Glass Mat) battery. They are sealed lead acid battery that can be safely discharged to 80% of their capacity without causing any problems, don't require any maintenance and have a long service life.

Other types are Gel and flooded/wet cells.

Calculate the size of the solar panel required
Use the following calculation to work out what size solar panel is required. Batteries don't store 100% so the calculation needs to reflect this.

1. 22 amp hours / 0.8 battery efficiency factor / 3 hours of sun in winter = 9.2
2. 9.2 multiplied by 12 volt system = 111 watts

I use two 60 watt panels mainly because I had not much of an idea of what I was doing when I first started planning and was trying to skimp – I didn't have this very handy guide to go off☺. If you have more than one panel, you will need to wire the solar panels in parallel or buy a branch adaptor to save the hassle.

Calculate the size of the solar regulator
The solar regulator is responsible for charging the battery from the solar panels. It also prevents overcharging. If you've chosen to use an AGM or Gel battery, make sure your chosen regulator supports charging these battery types otherwise charging can damage the battery.

You need to select a solar regulator that can handle more than the short circuit current (Isc) of your solar panel. An extra 25% is added as a safe measure.
1. 7.7 amps (solar panel Isc value) multiplied by 1.25 = ~9.7 amps
2. Round this up to the nearest size regulator. I chose 15 amps just to be sure.

The regulator I've chosen is a little larger than I need in case I decide to add more solar panels down the track if I need to.

Summary
We now know from the above calculations that we need:
• 100+ amp hour battery
• 120 watts of solar panel
• 15 amp solar regulator

If it is cloudy and rainy often at your location then you might want to use a larger battery to store a few more days power and larger panels to recharge the battery quicker.

Metal pole selection

You don't have to use a metal pole; use a timber power pole, a building or whatever will work for your location. Since the location I selected for my solar station is in the middle of nowhere, I wanted a metal pole that would last.

Make sure you get a pole with an outer diameter the correct size for the gear that will be mounted to it. If you are using the same stuff as I did, then a pole with an outer diameter of 48.3mm is the perfect pole diameter you will need.

Things to ask yourself when selecting a pole diameter:
- What does my enclosure pole mount require?
- What does my solar panel pole mount require?
- What does my wireless radio pole mount require?

I knew the answer to the above questions **_before_** I went shopping for a pole. I used the Yellow Pages online to search for **_metal merchants_** and phoned a couple telling them my requirements. They all recommended a galvanised pole with a wall thickness of 3.3mm and bury around 50cm into the ground with concrete if possible.

Depending on where you get your pole, you'll find that poles come in certain outer diameters and wall thicknesses. You'll save time and money if you can just get one of the shelf. The price for my pole listed in the parts list included cutting, delivery and a galvanised top cap to stop water filling up the inside of the pole.

My pole is 3.5 metres tall with half a metre buried in the ground with three bags of rapid set cement mix with sand and gravel picked up from my local hardware store.

My pole is also galvanised to protect it from the elements.

Enclosure selection

You need an enclosure to house all the parts in and keep it safe from the weather. The enclosure I bought has plenty of space for a large battery, router and solar regulator. Knowing the size of your battery and parts that go into the enclosure _before_ buying is a must – you don't want to end up with an enclosure that is simply far too small.

Solar panel mount selection

Solar panels don't come with any pole mounts (or any mounts for that matter). Iron Ridge is one of several manufacturers of solar mounts for rooftops, ground arrays and poles. They make pole mounts for both the top and side of poles supporting one or more panels.

An online sizing calculator is available to tell you what mount you need by entering a solar panel model and the quantity of panels. Iron Ridge doesn't sell panels directly but [Bing](#) can help you or look at their [distributors](#) list.

Antenna selection

If you're using a 3G ISP and need an external antenna, make sure the antenna you choose is compatible with the 3G service you need and that it connects to your modem correctly.

[RF Shop](#), [City Technology](#) and [Telco Antennas](#) are a few sites that sell NextG antennas (850MHz) or you could try your luck if you know what you're doing and [make your own](#) for a bargain basement price. [Here](#) is a very long and meaty forum post about making your own.

I originally bought this [22dBi antenna](#) to use on my roof and continued to use it at my station. The antenna does look a little cheap and shoddy, and is kind of large so I decided to replace it with a 10dBi antenna as it is perfect for the area my station is in.

Someone said once on the [WhirlPool](#) forums that the 22dBi NextG antenna is only ever 22dBi on the marketing material. For me, the 10dBi antenna gives an extra 5dBi odd over the 22dBi. If I were you, I wouldn't bother spending the extra dollars on the 22dBi and go for something less.

The 10dBi antenna I have comes with 10 metres of low loss cable. I spent a few dollars extra to have it cut down to 2 metres so I didn't have metres and metres of cable coiled up in my enclosure.

Home router selection

If the router you already have at home supports Bridge mode, then you won't need to buy another one. My old D-Link router didn't so I needed a new one.

There are plenty of routers on the market with loads of different features. I chose the PowerAP from Ubiquiti as it has 100+ metres of range with 300Mbps+ speeds and 5 Ethernet ports.

The operating system on the router is AirOS, the same operating system that runs on the AirGrids. AirOS's UI is clean, simple and intuitive.

Parts list

All the parts I use in my station are listed below. It took months to find all the parts and research them thoroughly, so I'm making it easy for you by listing them. To make it even easier, the part itself links to the manufacturer's website and the country to the website where I purchased from.

All prices are in the country of origin for each part and the cost of postage is not included in any of the items.

Part	Country	Price
Ubiquiti AirGrid M2 2.4GHz 16dBi x2	NZ	$290
Ubiquiti ToughCable – 2+5 metre lengths	NZ	$14
Ubiquiti PowerAP N (router)	AU	$150
MikroTik RouterBOARD 411U	AU	$95
Enclosure for 411U	AU	$23.50
10dB NextG antenna with 2m cable	AU	$78.95
Tight-fitting patch lead for 312U	AU	$15
SunTech 60 watt solar panel x2	AU	$682
12V 100aH AGM battery	AU	$248.40
1.5m of solar cable + connectors	AU	$24.20
MC4 branch connector set	AU	42.90
3.5m galvanised pole (48.3mm diameter)	AU	$60
Quickset sand + cement + gravel (3 bags)	AU	$23.85
DC barrel jack adaptor	AU	$2.95
15A, 2-core wire – 1 metre	AU	$2.60
Alligator clips	AU	$2.45
DC-DC Power over Ethernet injector	AU	$69
Morningstar 15A regulator	AU	$149
Outdoor vented enclosure	USA	$229.99
Enclosure hole plugs	USA	$6.99
Pole mount for enclosure	USA	$37.99
Cat5e 30cm patch lead	USA	$2.99
Pole mount for two panels	USA	$188.95
Total (accounting for exchange rates)		**~$2,400**

Shipping all the individual items from America to me would have cost a fortune. I used Shipito to have all the items from the various suppliers sent to them to be consolidated before being forwarded on to me.

The cost of shipping all the items via DHL Express (with insurance) was the same as just shipping the enclosure to me by itself.

How it will go together

Station

The station end of the network is not as complex as you might think.
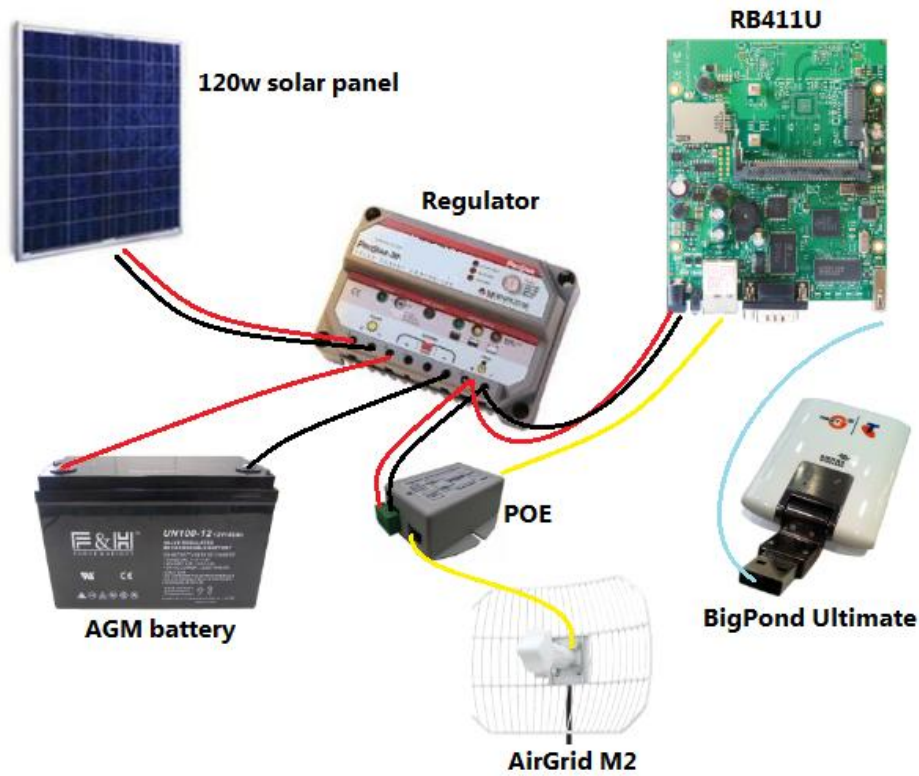
Home

The home end is pretty straight-forward.

Setting up wireless link

Getting Windows to work with AirGrids

To set the AirGrids up to act as a wireless bridge between the station and your house, you need to follow the steps below:

1. Plug the POE injector into a power point
2. Connect a shielded Ethernet cable to the AirGrid and the other end to the jack marked **POE** on the injector
3. Connect an Ethernet cable to the jack marked **LAN** on the POE injector and the other end to a PC.
4. **Right+Click** on your network icon in the Notification area and click **Open Network and Sharing Center**
5. Click on **Change adapter settings**
6. **Right+Click** on the network adapter the AirGrid is plugged into and click **Properties**
7. Click on **Internet Protocol Version 4 (TCP/IPv4)** then click the **Properties**
8. Enter the details as below, and then click **Ok**. The AirGrids are now ready to configure.

Configuring the station AirGrid

To start, open a web browser and go to **192.168.0.20**. By default, **ubnt** is both the username and password.

Click the **Wireless** tab and use the following details:

1. Select **Access Point WDS** from the list
2. Enter a SSID. This can be whatever you like.
3. Choose a security method and a preshared key
4. Press **Change** but do **not** click **Apply** just yet

Click on the **Network** tab and apply the following changes:

1. Select **Bridge** from the list
2. Make sure **DHCP** is checked
3. Press **Change**
4. Press the **Apply** button

Feel free to change any other items you want whilst you're connected to the AirGrid such as the country, antenna type, time, device name, etc.

The AirGrid will restart once you click apply and after it starts back up, this radio will be ready to use. You can unplug it from your PC and move onto configuring the other AirGrid.

Configuring the home AirGrid

As per the previous AirGrid, open a web browser and go to ***192.168.0.20***. By default, ***ubnt*** is both the username and password.

1. Select ***Station WDS*** from the list
2. Enter a SSID – this ***must*** be the same as the one you selected for the previous AirGrid
3. Choose a security method and a preshared key – this ***must*** be the same as the one you selected for the previous AirGrid
4. Press ***Change*** but do **not** click ***Apply*** just yet

Click on the **Network** tab and apply the following changes:

1. Select **Bridge** from the list
2. Make sure **DHCP** is checked
3. Press **Change**
4. Press the **Apply** button

Feel free to change any other items you want whilst you're connected to the AirGrid such as the country, antenna type, time, device name, etc.

The AirGrid will restart once you click apply and after it starts back up, this radio will be ready to use. You can unplug it from your PC.

Both AirGrids have now been configured and are ready to use. Remember to remove the IP you changed on the network adapter.

Router & modem setup

Registering the BigPond Ultimate modem

If you haven't already registered the modem, you will need to do this first. Just plug your modem into a PC and follow the instructions when the software kicks-in.

After the modem is registered, feel free to remove the BigPond Connection Manager from your PC as you won't need it.

Connecting to the RB411U

After registering the modem, plug it into the USB port on the router, connect the power and use an Ethernet cable to connect the router to your PC.

After powering on the router, use WinBox to connect to the router from your PC. It does not need to be installed which is nice.

Upgrading RouterOS

The first thing you need to do after connecting to the router is to upgrade the RouterOS (the operating system on the router) to a newer version. From my experience, the Ultimate USB modem will **not work at all** on any version below 5.2. To see what version you have, look at the title strip on WinBox.
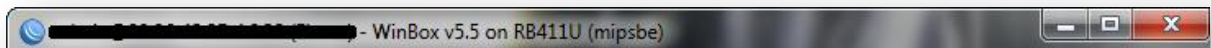
If you already have a version 5.2 or higher, you can skip the next step. If you don't, you will need to download the combined package for the RB400 series from the MikroTik download page.

After downloading the combined package, click **Files** on the menu in WinBox. Drag the downloaded file to the title strip in the files list – this will ensure it will be in the root menu and not any other folders present.

Reboot the router and it will automatically upgrade RouterOS. Check the title strip to confirm it went okay.
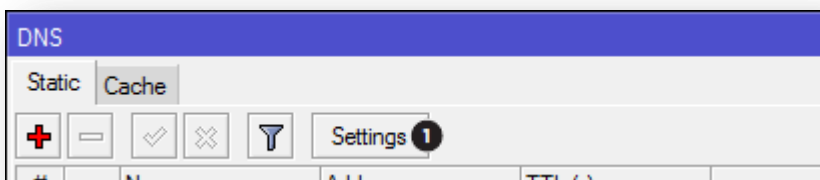
Configuring DNS servers

I set up a free account with OpenDNS so I don't have to rely on BigPond's DNS servers for the following reasons:

- You don't know what the DNS server IP is until after you've connected to BigPond
- They aren't always the greatest and are a little slow
- You need to specify DNS servers when creating DHCP server
- Amazon Kindle and some other devices need a DNS server when using a static IP address

After you sign-up for the free account, they give you a primary and secondary IP address.

To set up DNS, click **IP->DNS** then click the **Settings** button:
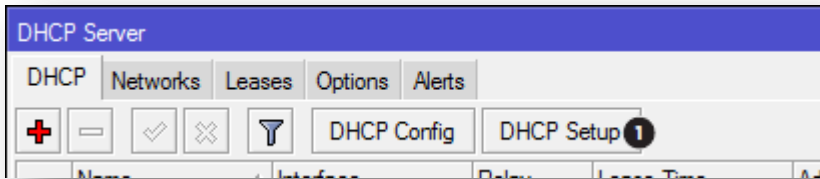

Use the following instructions to finish setting up DNS servers:
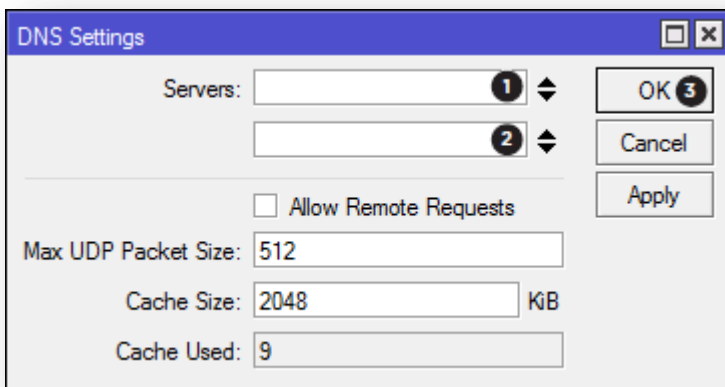
1. Enter the primary DNS IP address you received from OpenDNS
2. Enter the secondary DNS IP address you received from OpenDNS
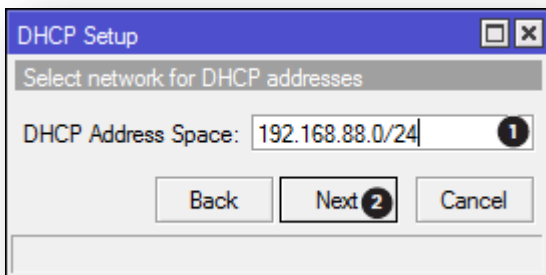3. Click **Ok**

Configuring DHCP server

To set the RB411U as the DHCP server on the network, go to **IP->DHCP Server** then click **DHCP Setup**:

Use the following instructions to finish configuring DHCP:
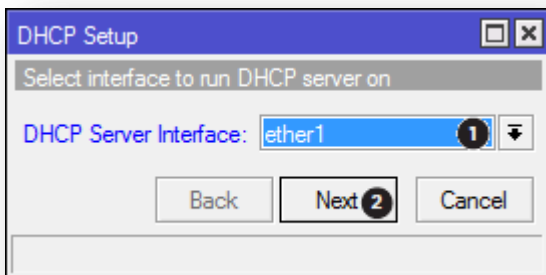
1. Select **ether1** from the list
2. Click **Next**

1. Enter the IP address range
2. Click **Next**
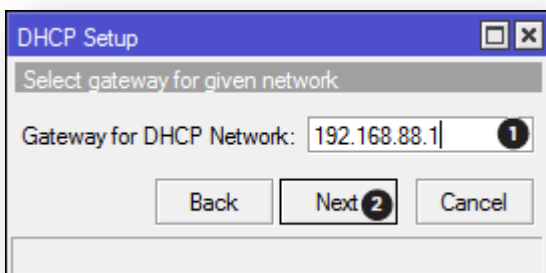
1. Enter the IP address for the gateway

2. Click **Next**
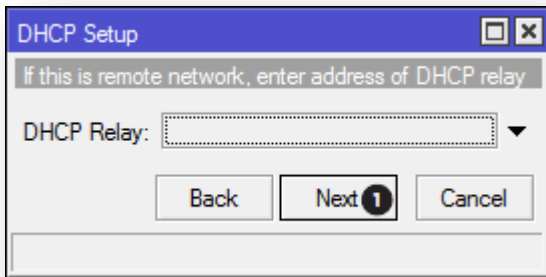
1. DHCP relay is not needed for this setup so just click **Next**

1. Enter an IP address range to hand out to clients. I chose **192.168.88.5** to **192.168.88.254**
2. Click **Next**
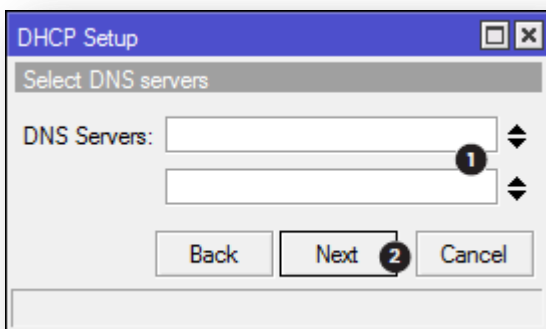
1. Enter the DNS servers from OpenDNS.
2. Click **Next**
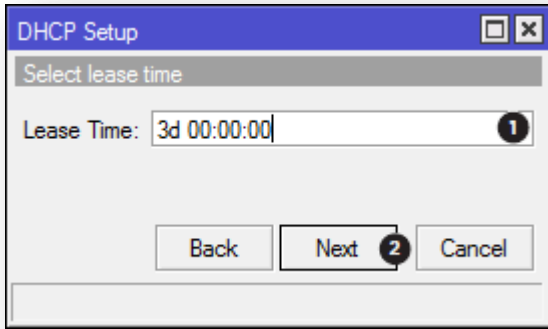
1. Choose a lease time
2. Click **Next**

You've now set the RB411U as the DHCP server for your network.

Configuring PPP-Client

To create a connection to BigPond, go to *Interfaces* then choose *PPP-Client* from the drop-down list:

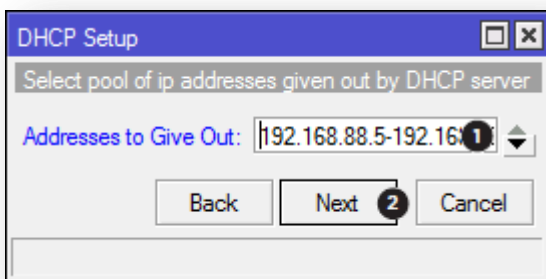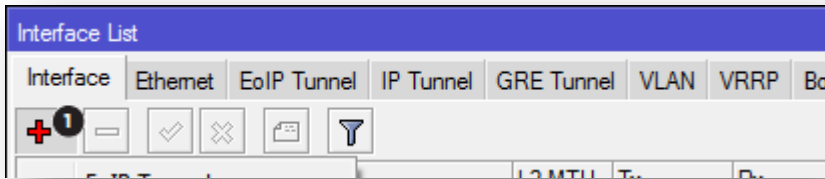Use the following instructions to finish creating the interface:
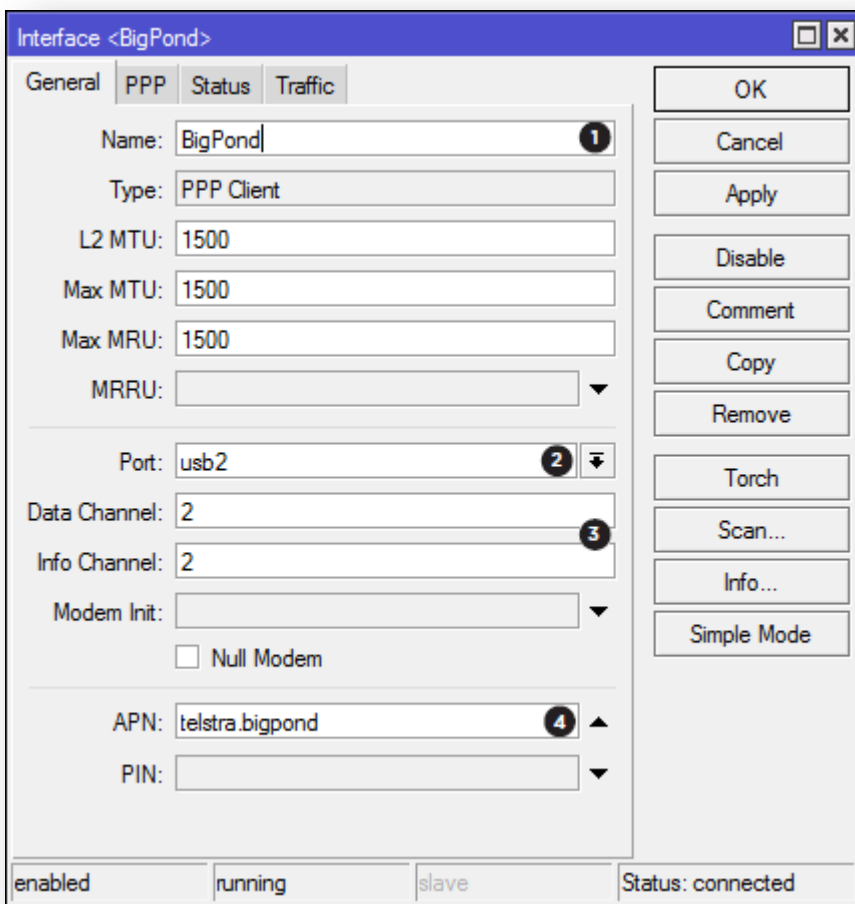
1. Give your PPP-Client a nice and meaningful name
2. Select the USB port from the list
3. Set both the info and data channels to 2 for the BigPond Ultimate USB modem
4. Use BigPond's APN
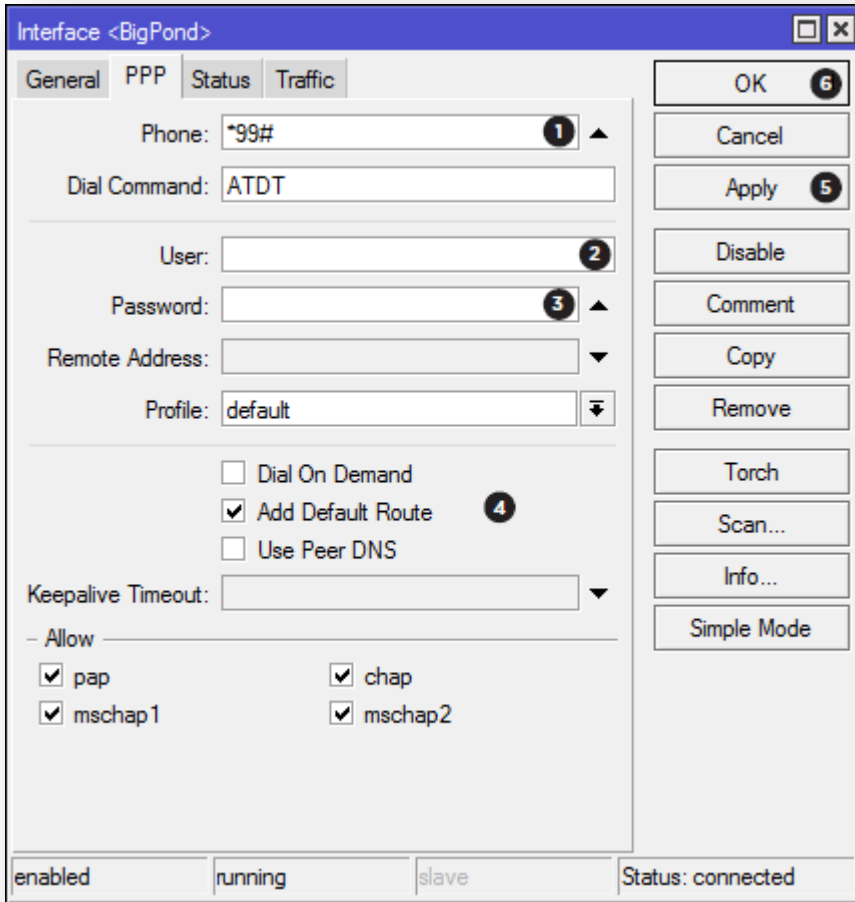
1. The phone number to dial is ***99#***
2. Your username is your full BigPond email associated with your BigPond account
3. Your BigPond password
4. Make sure ***Dial On Demand*** (disabled will allow BigPond to automatically connect without having to manually dial) and ***Use Peer DNS*** (disabled means you don't want to use BigPond's DNS servers) are both disabled
5. Click ***Apply***
6. Click ***OK***

The connection to BigPond is now complete.

Configuring NAT

Go to *IP->Firewall* then click on the *NAT* tab:

1. Click the red plus icon to add a new rule
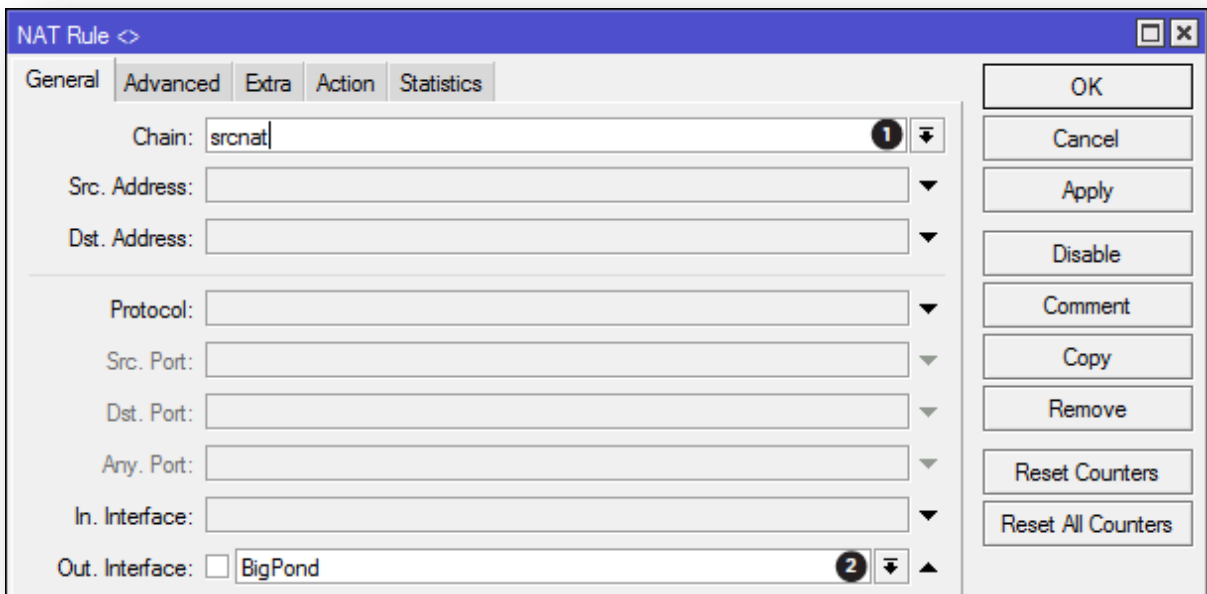
1. Set the Chain option to *srcnat*
2. Select the BigPond interface from the list
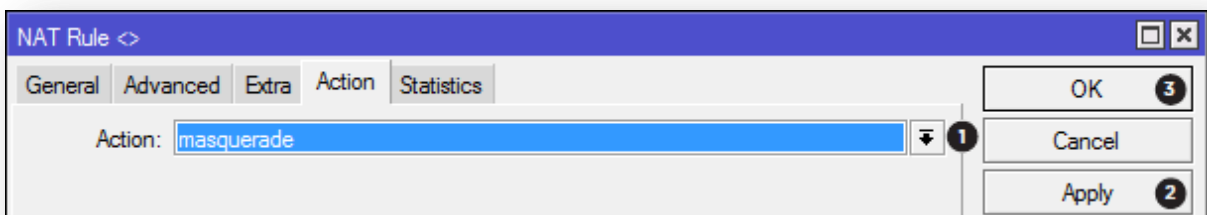
1. Choose *masquerade* from the list
2. Click *Apply*
3. Click *OK*

Setting up the home router

Getting Windows to work with PowerAP

Use the following to setup the router:

1. Plug the router into a power point
2. Connect an Ethernet cable to the router and the other end to a PC
3. *Right+Click* on your network icon in the Notification area and click *Open Network and Sharing Center*
4. Click on *Change adapter settings*
5. *Right+Click* on the network adapter the AirGrid is plugged into and click *Properties*
6. Click on *Internet Protocol Version 4 (TCP/IPv4)* then click the *Properties*
7. Make sure you network adaptor is set to get an IP address automatically, and then click *Ok*. The router is now ready to configure.
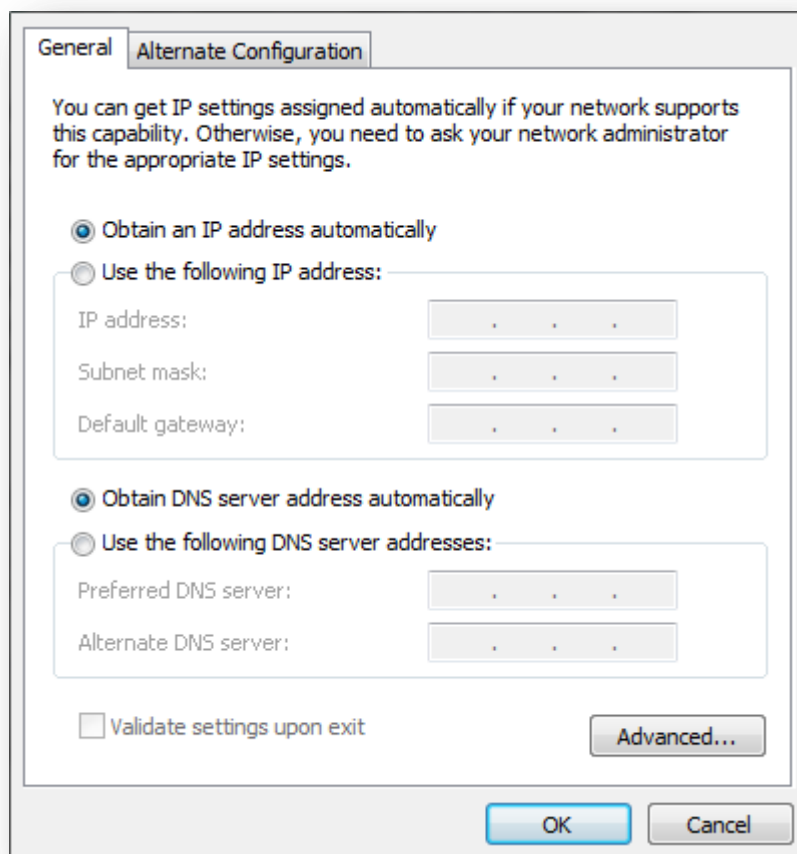
Configuring the station PowerAP

To start, open a web browser and go to **192.168.1.1.** By default, **ubnt** is both the username and password.

Click the **Wireless** tab and use the following details:

1. Select **Access Point** from the list
2. Enter a SSID. This can be whatever you like.
3. Choose a security method and a preshared key
4. Press **Change** but do **not** click **Apply** just yet

Click on the **Network** tab and apply the following changes:

1. Select **Bridge** from the list
2. Select **Static** and enter the above information
3. Enter your DNS addresses
4. Press **Change**
5. Press the **Apply** button

Feel free to change any other items you want whilst you're connected to the router such as the country, time, device name, etc.

The router will restart once you click apply and after it starts back up, the router will now be configured to work with the station.

Testing the hardware

Save yourself a lot of bother...
The router and the AirGrids have now been configured and can be tested. You don't want to be putting it all together before testing only to have to go back your station and bring parts home to see why it all doesn't work.

Testing the AirGrids
I mounted my home AirGrid on the roof pointing in the location of where my station was going to be and connected it to a PC inside my house.

Instead lugging the station AirGrid and a laptop into the garden and testing outside, I decided to be lazy and connect it to another PC whilst resting the AirGrid on an ironing board and point it at the ceiling in the direction the other AirGrid.

The AirGrids worked fine and the two computers where networked together so I knew that they worked fine. Leave the AirGrids on and running so you can go and test the router.

Testing the router and modem
I unplugged one AirGrid from a PC and connected it to the RB411U with the modem connected. My Windows 7 PC automatically connected to the router and got an IP address.

With my NextG antenna connected to my modem I can get pretty much get next to useless reception inside my house, but enough (-103dBi) to be able to connect to the NextG network (before it disconnecting).

Once connected, fire up Internet Explorer or any other browser and see if you can use the internet. If you have bugger-squat reception like I did, then it pretty much won't work but confirming with WinBox that the connection to BigPond is transferring small amounts of data and the router says it is connected to the Telstra 3G network then you know it works.

Assembling the hardware

Battery box

The bottom of the enclosure has a grounding lug and a cable conduit that protrudes into the enclosure so the battery can't sit level.

I made a little box out of 42mm x 19mm treated pine that battery can sit on top of to fix the above issue. Also, as you can see, I've cut little notches into the box that allows all the cables entering the cable conduit to get out the box and tuck neatly behind the mounting plate.

This is the second box – my first one originally had holes the cables were fed through but getting the cables out to make adjustments was a real pain in the arse. Also, it started to grow unfriendly looking mould – the newer model has been painted so any mould can easily be wiped off.

The battery sits on the box and squashes all the cables down.

Mounting the gear

I originally purchased the metal mounting plate to go with the enclosure but after trying to drill a simple hole and having the drill bit snap and get stuck in the plate, it became rapidly apparent that the metal sheet was going to become a huge hassle.

After this, I went to Bunnings and got a sheet of Perspex. Again, the wheels fell off pretty quick. Cutting the sheet with a saw chewed the edges, I couldn't keep the hack saw from going wonky, a Stanley knife was just as useless as the fibro cutter I tried next and finally, my circular saw chipped it and made it look like a high school project.

Save yourself a lot of bother and get yourself a sheet of 1cm thick plywood. I've gone for the thicker ply so I can just use screws to attach stuff to without fiddling around with tiny nuts and bolts. I painted mine an orange switchboard colour with a can of spray paint. You can get the measurements from the L-Com site.

Attach the mounting plate to the enclosure, place the battery in and layout the solar regular and router and make some pencil markings and once you happy with how things a laid out, you can attach these parts to the board. Attaching at your house surrounded by all the tools you need is a lot simpler than doing it on a side of a hill.

As you can see above, I've also drilled a couple of holes to reduce clutter by hiding the antenna, battery and solar cables. The mounting plate is 15mm odd off the back of the enclosure which is enough room for the cables to fit behind.

Router
The router case is attached to the mounting plate with two screws through the enclosure. Also, the two screws on the case at the top are not used, otherwise to get access to the router you will need to remove the mounting plate which is a real hassle.

Since the enclosure has vents, I've opted for a case to protect the router.

DC-DC POE injector

The injector is mounted to the ceiling of the enclosure using high quality double-sided adhesive pads. Having the injector mounted on the ceiling saves space and helps to keep things neat, tidy and accessible without having spaghetti style wires every which way.

Building the station

What to do
Putting it all together is pretty straight forward and logical. Here is how I did mine:

1) Metal pole
The first thing I did when all the equipment was on site was on site was to dig the hole for the metal pole. I buried 50cm of the 3.5 metre pole and cemented it into place with three bags of quickset cement, sand and gravel mix.

2) Mounting the solar panels
Assembling the solar panel mount is pretty straight forward. All the nuts and bolts where provided with the mount + a useful manual. All the bolts come in separate bags with part numbers to make things easier.

Attaching the mount to the pole is a two-man job. I reused a couple of U-bolts I had left over from the previous mount when I only had one panel. The mount does come with four hose clamps but I prefer something a little more solid.

3) Antennas
The NextG antenna and the Ubiquiti AirGrid mount to the pole.

4) Enclosure
Attach the enclosure to the pole.

4) Cable conduit
Now that all the gear is on the pole, you can feed the Ethernet, solar and battery cables through the cable conduit. There is enough room in the enclosure to hide the excess cable as long as you don't have kilometres of it.

Once the cables have been fed into the enclosure, go ahead and cable-tie everything to the pole to make it look neat and tidy.

Inside the enclosure
Now that everything has been mounted to the pole and the cables are in place, you can now finish the inside of the enclosure.

Cables
Start by feeding the cables behind the mounting plate (you may need to loosen or remove the plate for this) and connect to the various devices. All the cables will end

up being neat and tidy hidden behind the mounting plate out of view. The battery box sits on the floor of the enclosure to finish it off.

Easy disconnect

Since the router and POE injector power wires are screwed into the regulator, they aren't that easy to disconnect in a hurry + you have to fiddle around putting them back again.

I've gone for alligator clips attaching to the battery wires so I can easily disconnect the power.

Finished!

Once everything is done and you've double-checked all the wiring, you can now connect the battery and fire it all up! Check the regulator is working correctly and all the lights are as they should be.

The internet should now just connect and work. Congrats! You now have your own high-speed internet relay.

Useful stuff

Issuing AT commands to the modem

I haven't had any luck getting the modem to communicate on any other data channel apart from 2 and changing the info channel doesn't seem to do anything, so if you want to use any of the following AT commands, you will need to disable the BigPond interface first.

To send AT commands to the modem, go to **New Terminal** and type the following:

```
Terminal                                                                    □ ✕

MMMM    MMMM      KKK                              TTTTTTTTTTT      KKK
MMM MMMM MMM  III  KKK  KKK  RRRRRR      OOOOOO        TTT      III  KKK  KKK
MMM  MM  MMM  III  KKKKK      RRR RRR  OOO  OOO        TTT      III  KKKKK
MMM       MMM  III  KKK KKK    RRRRRR  OOO  OOO        TTT      III  KKK KKK
MMM       MMM  III  KKK  KKK  RRR RRR  OOOOOO         TTT      III  KKK  KKK

MikroTik RouterOS 5.5 (c) 1999-2011        http://www.mikrotik.com/



[admin@Flame] > /system serial-terminal usb2 channel=2

[Ctrl-A is the prefix key]


at!pctemp?
Temp state: Normal
Temperature: 31 degC


OK
```

Here is a list of useful commands to display bits and bobs of info:

- Reset the modem: **at!reset**
- Reception details: **at+rscp?**
- Power details: **at!pcvolt?**
- Modem temperature: **at!pctemp?**
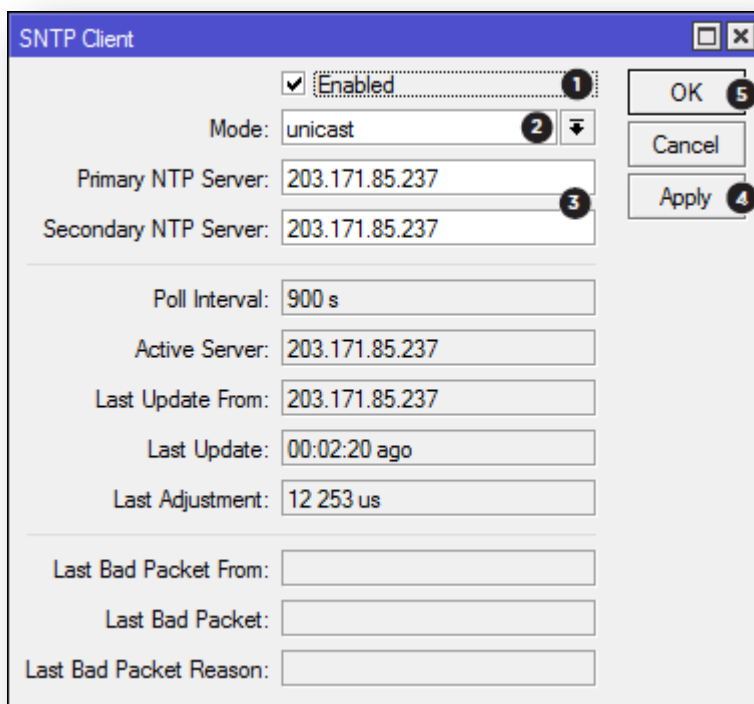
To exit the terminal, press the prefix key (Ctrl+A), then press Q. Remember to enable the BigPond connection again to get internet access.

A full list of supported AT commands can be grabbed here in PDF form from Sierra Wireless.

Updating the clock

The RB411U router does not have a real-time clock. Every time the router is shutdown or rebooted, the clock will revert to its favourite date in the '70s. This is fine if you don't care about the time, but having the correct time is useful when running scripts or viewing events in the log.

To have the time automatically synchronized so you don't have to manually set it after every reboot, you can set up the SNTP Client. Go to **System->SNTP Client** and set up the client as follows:

1. Check this box to enable the SNTP client
2. Change the mode to **unicast**
3. Enter a primary and secondary NTP server
4. Click **Apply**
5. Click **OK**

Where do I find the NTP server addresses?
You can get NTP servers from the NTP Pool Project for your country.
Copy and paste the address e.g. oceania.pool.ntp.org. The IP will automatically be resolved and filled in.

Viewing network info

To check the network info such as the operator and signal strength, go to **Interfaces** then double-click on the *BigPond* interface (or whatever you called yours).

As per issuing AT commands, you can only use one channel at once so you will have to disable the interface first.

Electronics from New Zealand

The Ubiquiti radios and the outdoor shielded Ethernet cable came from New Zealand – the price of the radios here in Australia is almost double for the AirGrid. I couldn't find anyone that would do custom lengths of Ubiquiti ToughCable with jacks so they came from NZ too.

If you don't know already, Australia and New Zealand share the same power standards and power sockets so you don't have to bother with adapters of any kind.

Useful websites

Some interesting stuff on power calculations
A guide to run MikroTik router from solar
Basic info on solar panels, regulators and batteries
MikroTik Wiki
MikroTik forums
A list of 3G modems and other devices that are supported by MikroTik RouterBOARD*
Ubiquiti Networks Wiki –info on configuring AirGrids is an updated version of this
Ubiquiti Networks forums
Ubiquiti Networks AirLink – free online tool to calculate wireless links
Shipito – mail forwarding from USA to Australia (cheap shipping)
VLRA battery – Wikipedia article all about AGM and Gel batteries
AT commands – full list of commands supported by most Sierra Wireless modems

* If your modem is not listed, there is no need to work yourself up into a near catatonic state. Nearly all the modems listed on the Wiki have been added by users themselves. You may need to upgrade the RouterOS version before you have any luck.

The BigPond Ultimate (Sierra Wireless AirCard 312U) wasn't on the list until I added it.

Troubleshooting

Modem/internet related

Why won't the modem connect to BigPond?
Check the blinking lights on the 312U modem. If it is blinking yellow, try unplugging the modem and reconnecting it so the lights blink blue.

The connection is stuck authenticating or resetting the link?
From time to time, either the Ultimate modem or NextG likes playing silly buggers. Try the following:
1. Try disabling and enabling the BigPond interface
2. If the modem is responsive, try sending the reset command
3. If the above doesn't work, you will need to unplug the modem and plug it back in again.

Power related

The charge light on the solar regulator never says the battery is charging?
Try the following:
- Make sure everything is connected properly
- Make sure you haven't got the polarity wrong on the wiring
- Use an amp meter to check if the solar panel is actually generating power
- Check to make sure the metal socket thingy inside the solar connectors on the cable from the regulator haven't detached inside

Everything is powered on but the AirGrid has no power?
Make sure you don't have the patch lead and the AirGrid Ethernet around the wrong way on the POE injector.

NAQ
Never asked questions

Do I need to use shielded Ethernet cables?
Ubiquiti warranty is useless if you don't use shielded cables + the UBNT POE injector doesn't work without them.

Also, the cable will be outdoors and most Ethernet cable won't last long unprotected out in the wild.

Do I need the DC-DC POE injector?
No. I started off with a basic passive POE injector but it caught fire and melted. Not sure why, there was no short circuits in the wiring or anything else I could find wrong.

The DC-DC injector stabilises the voltage that fluctuations up and down a few volts each day and provides over voltage, over current and short circuit protection.

Where do you have the AirGrid on your house mounted?
I have mine mounted to my antenna pole with my free-to-air TV antennas. The Ethernet cables goes into the ceiling and down the wall cavity and out the same hole where the satellite cables use to live.

Does bad weather affect the station at all?
No. Heavy rain that lasted for a week straight resulted in:
- NextG signal strength dropped to -85dBi from -69dBi (this would have happened regardless of where the station was)
- Signal quality drop from 98% to 88% for the wireless link
- The battery level was not affected – the battery status indicator remained on full charge.

My link is only 1.75km line of sight with zero obstructions or any interference. Don't expect the same from your station.

Why not wait for the NBN to be built?
The Government has deemed my house not worthy of laying fibre cable – instead they'd much prefer to spend $50 billion odd to give fast internet to people who already have it.

The NBN satellite will be just as crap as what is available now and since I can only get enough NextG reception at my house to receive a SMS (not send), the chances of the NBN wireless working at my house is slim to none.

Telstra may not be brilliant but at least they update their network and plans from time to time.

Why don't you use the profiles in the modem?
Because they are totally useless and because the info needed to connect is manually put into the PPP interface.

Why do I get the message saying 'Couldn't start – can't reuse channel while ppp-client is running! (6)'?
Think of it like a TV, you can't watch two channels at once. It is the same with the modem. The BigPond Ultimate USB modem does have four channels (0 to 3) but only channel 2 seems to be responsive and able to communicate.

I haven't had any luck getting any other channel to work so you need to disable the BigPond PPP-Client whilst you get any other info from the modem and re-enable it when you're done.

I've contact Sierra Wireless about this and they said to contact Telstra. I haven't yet.

Summary

Problems with the station

For me, the relay station is five billion times more reliable and better value than my old satellite provider. However, no system is perfect and my station does have some quirks:

- The RB411U has a design flaw – rebooting doesn't cut power to the USB port. If the Ultimate modem locks up completely, you need to trek to the station, unplug it and plug it back in.
- Amazon Kindle is clueless. I have two in my house and for a few weeks they connected to the network without a problem. Then, for no reason they started saying they couldn't connect. The router logs show they were offered an IP but they rejected it. The solution is to set the Kindles up to use a static IP.

Just a guide...

There is little information on the internet about making one of these babies – this guide is to give you step by step instructions from finding a site, to finding the parts to configuring it all.

You might have some of the parts lying around or can get them a lot cheaper than what I did. I tried to source the best and affordable parts and looking back, I'm happy with what I chose.

Remember, this guide is based on my station which is perfect for my needs. Every part that went into it was chosen to suit these needs.

Feel free to swap parts with others so that your station works perfectly for you.

Back breaking work

My solar station does not have a road near it and is located on the other side of a river. Not wanting to use my neighbour as a mule, I opted to lug the equipment to the site 2.2km by foot.

The weight of all the gear including bottled water to mix with the cement was 160kg. This took multiple trips over multiple days.

Tip: tying a 30 kilogram battery to a skateboard and pulling it on a rope doesn't work. My advice would be not to bother and suck it up like a man. The skateboard's wheels tilt slightly and the battery falls off at the slightest movement. One of those

cute little red carts with a handle that Christopher Robin pulls Winnie the Pooh and gang around in would have worked a treat.

Telstra NextG tower congestion

You read all the time on the WhirlPool forums about tower congestion - I personally don't notice and difference. My connection speed varies between 3-7 Mbps during the week. I'm putting that down to my NextG tower being in a country town and there is hardly any passing traffic or droves of people commuting for work that my tower has to service.

I'm guessing the tower probably services the same amount of people every day. I haven't really noticed and difference during school holidays either.

Nutritional info

Here are some statistics and fun (if you're a geek) facts:
- My station is 1.75km with perfect line of sight from my house
- It is 4.4km return trip following the river
- My nearest Telstra NextG tower is 16km away with near line of sight
- The Telstra NextG tower is 333m above sea level
- My station is 150 metres above sea level
- My house is 60 metres above sea level
- Over 30 trips went into assembling the station alone
- I carted 25 litres of water with 8 litres only needed to mix the cement
- It took seven months from start to finish

Comments welcome!

If you've got any comments, questions or suggestions, feel free to email them to me. I've spent a lot of time making my station and would appreciate any feedback.

xanderguerin@gmail.com

Photos

Photo taken at the site of my station before construction started.

The red cross on the map marks my house.

I've added a smaller enclosure to keep all the tools I used to assemble the station, cable ties, amp meter and the manual for the regulator. Having these items on site is very handy when you have to walk 2.2km back home to fetch what you've forgotten.

The enclosure is mounted upside down so the doors open the same way.