With the Australian callsign VK4ION

Welcome to my pages

Building a NextG Yagi Antenna for Wireless Internet

It's a small antenna - widest aluminium element is 168mm

Length is 700mm

The one pictured has an elbow on the end so it can be used Vertically or Horizontally

Background: No Broadband
We relocated to regional Queensland but found we couldn't get Cable or ADSL Broadband Internet. We're in a gap area with no spare copper lines and it isn't commercially viable for Telstra to close the gap.
We tried Satellite and endured 2 years with Telstra with terrible download speeds then changed to Reachnet/Orion Satellite for 3 years. Speeds were pretty ordinary and although calls to tech support gained a boost for a while it would soon decline to about dial-up speed.
People in town were getting respectable download speeds on Wireless Internet without external antennas but I'm a realist and knew that being 25km North of Bundaberg may put us out of high speed wireless range so rather than whine about ISP's not bringing Broadband to my door I should be doing something positive about it.
As an amateur radio operator I understand propagation and could see the possibilities of an external antenna. I also have the means to build anything I need.

The next step was research

There is some vague material floating about on the Web and some of it is actually wrong but it's not difficult..... just concentrate on what Wireless frequencies you need to capture with your antenna.
My focus was Telstra/Bigpond Next G only... so be prepared to use your common sense as you research this stuff, ok?
Navigating this Site

This document will provide some basic antenna theory, materials, antenna dimension and a step by step photo diary of how to build a simple Yagi antenna.

There is also a section answering Frequently Asked Questions and a photo gallery of other people's antennas. You will be amazed at how ingenious some folks are!

Who taught me?

A fellow club member working in the bush had written about his attempts at improving signals and this got me thinking about to make it better.
After trialling a borrowed modem with a crude antenna we got a good signal so figured that building an 850MHz antenna would have to work from our location.

There is some modelling information at VK7JJ NextG Yagi and Phil's work inspired my Yagi project.

There are commercial antennas which cost at least $200 but I found they were trying to be one-size-fits-all and besides, making your own is so much fun.

This DIY Yagi costs less than $20 so if you'd like to make one, read on.

What's the Frequency?

This antenna is for Telstra Bigpond Next G Wireless Internet which uses two frequencies: uplink 839.8MHz and downlink 884.8MHz. [Commonly referred to Telstra 3G 850MHz]

Don't be confused with 2G or CDMA - this is NextG wireless we're chasing - keep these frequencies in mind as you troll for Telstra Transmission tower information in your area.

Materials and making a start:

First the Boom - it should be non-metal so I was looking for rigid but light.

Best starting place, a large hardware store - for me that's Bunnings - from the gardening section pick up a 'riser' - a thick walled (sturdy) black plastic pipe. They're sold for attaching taps ... hence the name Riser and why it's threaded both ends. Your final antenna will be around 700mm so the 900mm Riser will allow some leftover for bracing and your desired end attachments - cost is about $6.

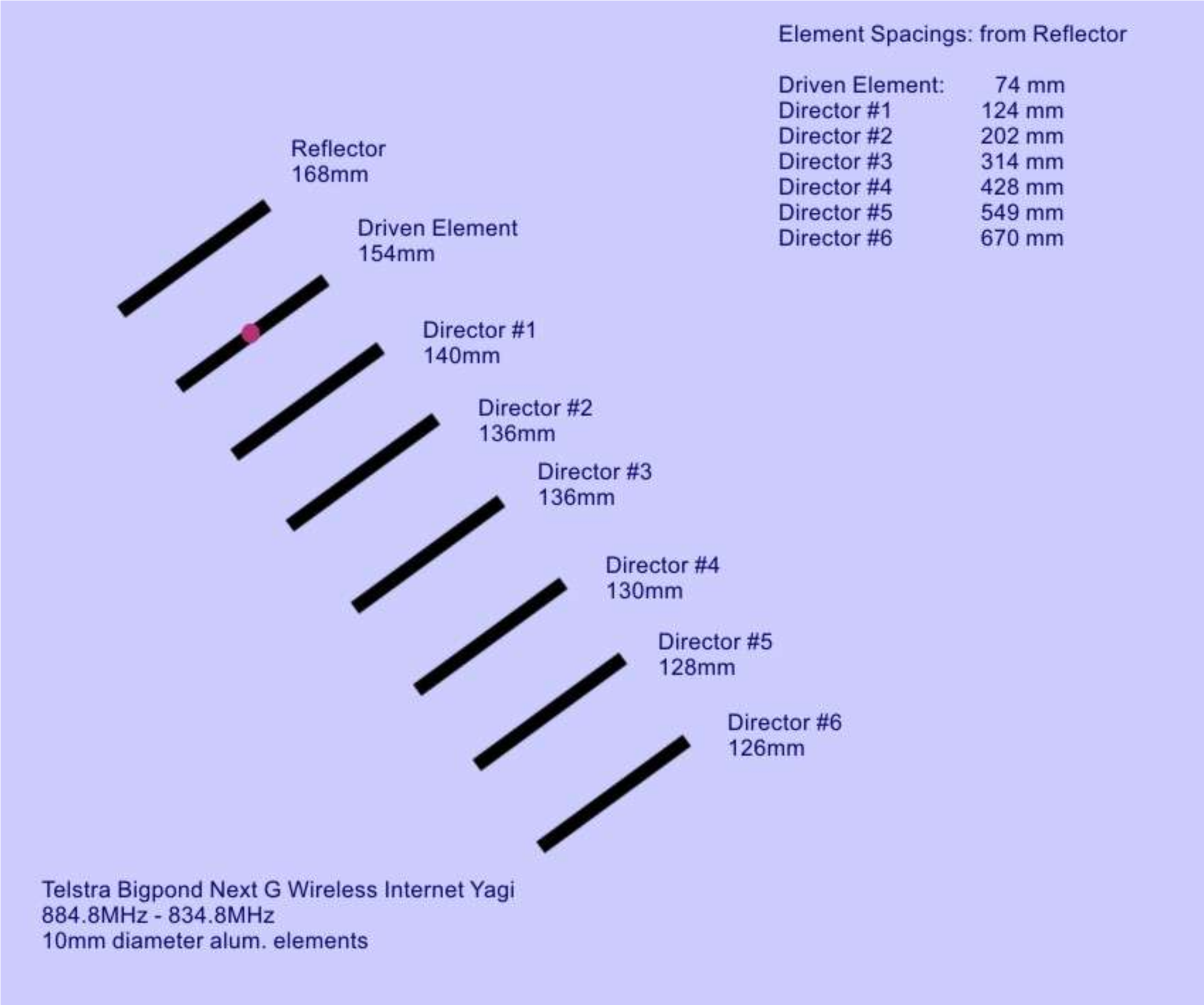
Take the riser over to the Plumbing section and buy a straight PVC joiner which will fit over the riser - costs about $2.

You'll need a couple of stainless 3mm bolts long enough to go through your 10mm alum tubing... take what you can get, excess length won't be a bother. A couple of washers to suit and a couple of small lugs to solder your tails to.

Elements are 10mm aluminium (cannibalised from a really old beam) you'll need just under 1200mm of aluminium tubing.

For ease of tool setup drill all 8 holes in the black plastic boom (including the hole for the driven element). Later we will cut the boom through the centre of the hole that was drilled for the driven element - but don't get ahead of me just yet.

The hole at the end... Director #6 was placed close to where the 'thread' section began. We left the thread on the leading edge and stuffed the end with styrene (lightweight filling) simply to keep the bugs out.



Consider printing this .jpg so you have a handy workshop reference

To clarify some points:

Measurements are Centre to Centre - You can measure left side of one element to left side of the next and still retain the C to C relationsip [be sure not to take left side of one piece to right side on another piece].

You begin at the Back element - the Reflector - and each measurement is taken from that so do note the "Element Spacings from Reflector" measurements.

10mm Aluminium Tubing was used but 12mm can be used with the same measurements.

Construction Process

So far you should have drilled 8 holes in the boom just the right size for the aluminium elements and you've pressed 7 of them in... Do not fit the Driven Element yet. [I don't need to tell you how to drill a nice tight hole and get the elements fitted in the correct order, do I?]

We pressed our elements through tight holes so we didn't have to glue or screw them so do think about precision and accuracy to make it an easy construction.

Photo shows elements in place with hole left vacant for the D.E.

The next photo will give you a clue to how we will cut the main boom (cutting through the centre of the D.E. hole) and replace it with the plumbing white PVC Joiner.... later... later...

Note the detail of the driven element. It was cut as one piece 154mm long then cut in half and has a piece of plastic cut to fit the ID of both ends, with a ridge left in the middle to stop the two ends of the driven element from touching.

However you decide to join the two halves of the driven element, (plastic, dowel, pencil... whatever) ensure your gap is only about 1mm. Remember we're dealing with high frequencies so millimetres make a difference.

We drilled and tapped two 3mm holes through the Driven Element quite close to the end. These will take the pig tail coax ends and also ensure the ends don't move and touch each other. If you can't Tap the hole, no problem but do be sure to pre-drill the holes so you can work with the coax ends in a confined space later.

Visual of where the white PVC joiner & Driven Element will fit

Drill 3 holes in the white PVC joiner

Now work separately on the PVC Joiner, drilling, turning coax into 2 'tails' and fitting the Driven Element.

Drilling the white PVC joiner:
Drill one hole through the centre of PVC joiner just large enough to take the Driven Element and drill another off-centre smaller hole to take the coax.

We used RG58 CellFoam Low Loss highly flexible coax (see coax info later).
Drill a hole sized to suit your coax... being off-centre will aid attaching the coax as it is a tight space inside the PVC.

Turning Coax into Tails:

Remove about 25mm of black coax outer insulation. Extract the outer mesh braid and twist together to make a single thick tail/wire.

Carefully remove some inner plastic dielectric to expose the centre wires. Twist them together to make a single thin tail/wire.

Keep these unshielded tails as short as you can and using silver solder to "Tin" both coax tails - this will make it easier to get them onto the small lugs.

The tails on my small lugs were too long so I nipped them off then soldered the coax tails onto the remaining lug-tail.

Keep checking that they'll fit and can be screwed into place without touching (shorting). Adjust as necessary and keep your eye on how you will get the lugs screwed onto your D.E. and get the excess coax back out of the off-set hole..
Use insulation tape to maintain the angles that you need to get a tight fit.

You will have noticed one tail must be longer than the other due to the angle that your coax is coming into the PVC Joiner.

Now you'll be very pleased you pre drilled the holes in the Driven Element.

A long skinny screwdriver will get the 3mm stainless bolts with washers screwed down tight to the Driven Element... while at the same time you retract the coax back out the hole so it doesn't kink.

I also test the continuity quite often during this process to ensure I haven't shorted these fiddly pieces together somewhere.
Better to find it now than when it's taped and joined back into the antenna or worse - it's up on your ROOF!

In the photo of the rear of the PVC Joiner you can see that my 3mm stainless bolts were a bit long, but it was all we had.

The Riser is going to fit around them just fine when it butts right up to the aluminium element on this side.

You're almost finished.

Take a deep breath and cut the Riser through the centre of the hole you drilled for the Driven Element.

Because there is Coax hanging out of your PVC Joiner the riser won't push all the way in and your ***C to C*** measurements will be WRONG.

Use a Stanley knife and shave a little at a time from that section of your riser until it will go in - all the way - and you have the correct measurements for distance between those elements.

You're working with the critical dimensions between your Reflector and the Driven element when it's all back together that measurement must be 74mm. (see the table of specifications above)

Choosing your Coax:

Coax used was RG58 CellFoam low loss. It has properties similar to good quality RG213 but is so much more flexible. Mine is a 20metre run from the top of the antenna into the roof cavity, through the trusses and down into the office.

Theory says the shorter the coax run the better performance, but I live in the real world and I want my Wireless Modem in the office - not up on the outside eaves. So be practical – purchase quality coax that will be a bit more forgiving in a longer run.

Buy what you can afford of course - just avoid cheap RG58 if you can - you'll get what you pay for.

The ***Balun*** is just an 'ugly balun' - 6 turns of the RG58 Cell Foam formed up and taped. You can see that the Cellfoam lends itself to this shape... imagine trying to do it with RG213 or heavier.

I put the BALUN in because of the short lengths of exposed/unshielded coax and this will mitigate any problems.

Fitting the rear portion of the Riser - the piece with the Reflector fitted

To get the rear piece of Riser to push all the way into the centre of the PVC Joiner you will have to nibble away a small section to allow the Riser to pass over/around your coax and butt neatly to the centre.
This may be trial and error as you cut a little, push it on... measure... take it out, cut a little more away... measure and so on until you get the correct spacing's of your elements from the specifications above.

Once it fits, your elements are aligned and your dimensions are correct, turn the antenna over and put a sheet metal screw into the PVC joiner - one each end of the joiner - making sure to miss the coax or anything important... this will secure the PVC Joiner to the Riser.

I don't know if glue would work as most plumbing glues set too fast to allow you to get it right and you're working with two distinct types of material... but you choose.

The final stages are for you to decide how you want to finish the rear end and make whatever attachments you need to get it in the air. You can leave the rear end behind the reflector as long as you like.

We cut off the threaded end section and only left enough to allow for some bracing as we have a glorious kookaburra family living with us who have a thing about sitting on my Yagi's.

We inserted a timber piece into the end of the Riser and pre-drilled it to take a bolt later when attaching it to the upright mast.

Polarisation:

Now that promised information on polarisation. This will take some getting your head around as all the experts will tell you that Next G technology is a vertically polarised medium and hence they say you should make vertical antennas.

What you will soon discover as you research your nearest Telstra NextG transmission towers is that some are Vertical and many are SLANT polarisation.

Research on Whirlpool will enthral you as people build and test antennas and compare results.

There is no doubt about it - if your intended transmission tower is Slant polarisation - you will get better download speed from a Horizontally polarised Yagi.

If your nearest intended Next G transmission tower is Vertical - then you stick with Vertical polarisation too.

Performance:

What about all those pretty signal-strength lights and bars?

Hate to tell you this but the number of bars is simply an indication of the noise in the air that the modem can see/hear. It is NOT a true indication of the directional gain you're achieving with your Yagi. (I could prove this to you with lots of testing equipment but that would bore you)

The results from this QTH tested on Speedtest, is a consistent download speed of 2.75mbps with only 2 bar signal strength showing - why? Because my antenna is doing a nice job of filtering out all the other noise - in effect I'm just getting the signal I went looking for.

I do not proclaim myself an expert by any means and I research propagation continually.

I can however build an antenna and achieve the results I want - at the home handyman prices and that's good enough for me.

I hope this project page has been of some help to you.

If you have any feedback or questions please email vk4ion@tigereye.net.au