Tracking In the Footsteps of Marconi

The Benefits of Height for UHF Communications

The environment, what is between transmitter and receiver has a very significant effect on UHF communication. In an urban area the buildings between the transmitter and receiver will severely attenuate the UHF signals. It's much the same for wooded areas such as forests; trees severely attenuate signals. Assume the limit of reception between transmitter and receiver at ground level in an urban area is 1km. With good line of sight between transmitter and receiver, such as from the ground to a high altitude balloon or a satellite then the range could be up to 1000km. The difference between and obstructed view and good line of sight really can be as much as 1000:1 for UHF communication.

At ground level, in an urban area or forest, then your not going to get good line of sight (LOS). However, if your receiver were directly above the transmitter, there would be good LOS and thus reception range is dramatically increased.

So for a transmitter on the ground, the higher we can get the receiver then the better will be the LOS view, and thus the longer the range.

For a transmitter in an urban area its easy enough to demonstrate the effect with a long pole. I carry a 10M extensible pole in my car, its useful for persuading model aeroplanes out of trees, its fairly small when packed, only 67cm long, see picture.

With the LoRa transmitter on a table in my garden I wandered around the locality with the receiver on the end of the pole. I had set up the software to report the received signal strength and measured the difference between reception at shoulder height versus on the top of the pole. With the receiver on top of the pole, signal strength improved by at least 6dB, and by 12dB if the pole allowed the receiver to be above obstructing trees or buildings.

These signal improvements represent a distance improvement of 2 and 4 respectively. Thus a simple pole could increase the search range by at least 2, possibly more.

With practical fixed installations the effect of height is well known, UHF antennas are often placed on masts or the roof of buildings in order to improve range.

Whilst higher is better in the context of using LoRa for hearing (and locating) a lost tracker transmitter, there is a limit as to the height of mast we can carry around with

us. Spiderbeam make an 18M fibreglass collapsible mast, that is about the limit of what can be easily erected.

On way to get height above the transmitter is to use geography. For instance 4.5km to the North of my garden is a hill overlooking the city, from here the transmitter in my garden can easily be picked up with a hand held receiver.

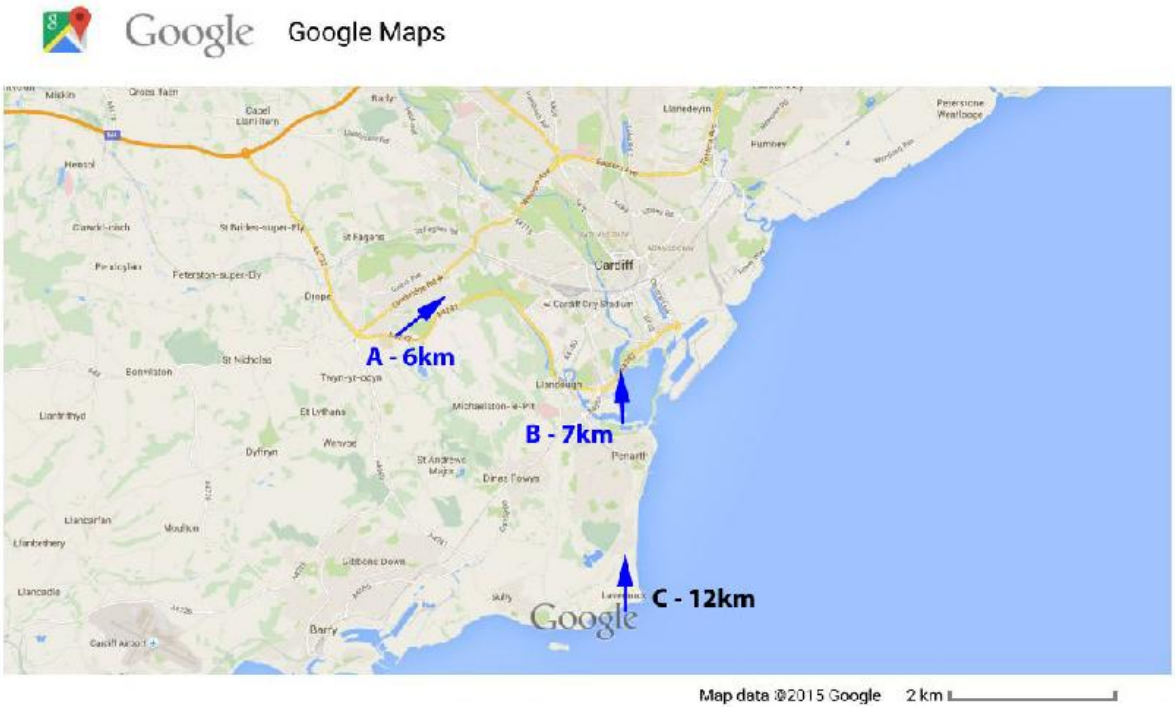
However, there wont always be a convenient hill overlooking the search area.

One day I placed a test transmitter on a pole in my garden.

Fitted a UHF magnetic mount antenna to the roof of my car and went for a drive.

The range I get when walking around on foot in the City with a hand held receiver is around 1-1.5km, a magnetic mount antenna on a car should be considerably more efficient.

Point A on the map below is where I picked up the LoRa from the transmitter in my garden using the car mounted antenna. This was on the link road between the M4 and Cardiff docks, the transmitter was 6km away across the City



At point B, the edge of Cardiff Bay and 7km away from the transmitter, I could pick up the signals with the car magnetic mount antenna on the road bridge in front of the block of flats (see below) but not with the hand held receiver and its small antenna on the banks of the river. However with a 7 element portable yagi, I was able to pick up the signals on foot even though the view back to the transmitter was significantly obstructed by buildings, see picture below;

A lot of tracking systems use a fairly bulky receiver, either a portable UHF transceiver or a custom made (and expensive) receiver, the wildlife trackers are examples. Apart from using a handy nearby mountain, one way with these types of tracker to give the receiver a good line of sight above a tracker ‘lost’ on the ground is to hire a person carrying aeroplane or helicopter, perhaps not too practical.

The Arduino Pro Mini LoRa tracker I built is small and light and by its nature is specifically designed to be carried in small model aeroplanes or copters. The tracker transmitter is a receiver as well and you can write code for it to act as a telemetry relay. In this mode the tracker on the plane or copter listens for incoming telemetry and then re-transmits the packets down to the ground. Range from the plane to the ground is no issue, since the plane is not that far away and you have good line of sight to it.

So I taped my relay tracker to the wing of a small easy build and low cost Radio Controlled model plane, an AXN Floater, see below.

In 1897 Marconi used the height of the cliffs at Lavernock point near Cardiff to demonstrate the first radio communications over water.

Over a hundred years later I went to the same spot, C on the map above and the picture below, it was 12km from the tracker transmitter in my garden.

Would I be able to pick up the transmitter from this spot?

I launched and flew the plane up to altitude. In a few seconds and at around 300ft up the relay had picked up the telemetry from the transmitter 12km away and relayed it back down to my receiver, success!

The potential here is clear, with a simple Radio Controlled plane or copter and the right software you can dramatically increase the search range. Flying higher and fitting a better antenna on the search plane should increase the range even further.

The LoRa devices used in the tests above were Hope RFM98s, running at 10mW. The device is capable of 50mW, which if used should double the range.

Stuart Robinson

GW7HPW

August 2015