



GPS Ireland talks about VRS Network RTK Surveying In Ireland

Network RTK in Ireland

Katarina Bazelides - GPS Consultant - GPS Ireland Consultants Ltd

March 2012

To get high accuracy (cm level) with GPS to support its use for surveying, GPS must be corrected from an external source. Traditional Real Time Kinematic (RTK) surveying has been used for this purpose where a static GPS base station corrects a roving GPS station.

As with other techniques, traditional RTK has its disadvantages, mostly in relation to radio communication limitations.

The advent of Network RTK, a GPS/GNSS survey solution providing real-time corrections over large areas, normally over a whole country or state allowing surveyors use only rover equipment without setting up their own base station, has been very important.

Real-time corrections generated by the network are normally of survey level accuracy. Additionally sub 1 metre accuracy level corrections are also very often available as part of the solution; mostly used for GIS data capture.

Network RTK is also very often called VRS RTK (Virtual Reference Station RTK).

The reason comes from the correction process involved. VRS RTK uses a network of active stations, in Ireland giving National coverage (permanently established GNSS stations receiving and logging data 24/7).

All stations feed data to the main server where data is stored, processed in various ways and distributed as needed. Generated corrections are calculated for where the roving survey unit is; - hence reference to a "Virtual" station. Different providers have different ways of handling data, modelling errors, algorithms, data access and options and payment methods for the end users in place.

Once you have a license that allows access to correction data of the chosen provider;- you need to setup your equipment to be able to receive it. Corrections are available online, kind of like information that you can read on the webpage. Your license, in simple terms, is your username and password given to you by the provider on the receipt of your payment. And the username and password is then used like a login to the webpage which allows the realtime download of correction data while surveying. Online access is achieved using a GPRS connection (General Packet Radio Service) on a mobile phone network. Those familiar with RTK surveying, will understand that in principle you can just imagine that instead of using the UHF radio communication link, you are instead using a different communication method to receive corrections for the area you are working in. Therefore, a mobile phone becomes an essential part of the Rover unit when surveying in the Network RTK mode.

Once your rover unit is setup to survey in Network RTK style as you start the survey, a GPRS connection is created, then it goes to the place online where the correction streams are available (given by the provider) and then using the allocated login details (given by the provider) accesses the data.

As a connection is made, the rover "informs" the server about its geographic location. Based on this location the reference station observations are virtually shifted to the rover site;- a Virtual Reference Station is created and corrections are modelled for the VRS station position. Normally, the whole permanent station network contributes to the modelling but of course the nearest station(s) are given more weight in the correction modelling process.

This is not a necessity though. Different providers use different approaches. Instead of a VRS based solution, the surveying rover can be receiving corrections based on the so-called "Master-Auxiliary Concept" (MAC). In this case modeling of corrections is based on using one Master Reference Station and its raw data stream and reduced information from other Auxiliary Reference Stations in the vicinity where the rover is operating.

I am sure everyone can appreciate the advantages of the Network RTK solution;- mainly there is no need for a base station resulting in equipment requirements, surveying time, personnel and all related costs are reduced.

There are no restrictions on what equipment manufacturer can be used. Once it is manufactured with the network RTK capability then you can use it no matter whose service is to be used. The correction data stream format is an open format

GPS House, Church Bay Road, Crosshaven, Co. Cork, [W8L-84-4YK](tel:+353214832990)

2

Tel: +353 21 4832990 Fax: + 353 21 4833665 Tel: International +353.21.4832990

Email: info@gpsireland.ie

Website: www.gpsireland.ie

called RTCM used internationally as a standard for Differential Global Navigation Satellite Systems.

Using the same RTK network service in all survey work guarantees consistency in data collected from a single network solution infrastructure. On the other hand, when you set up your own base station, the related survey precision depends on the experience of the surveyor and the precision of the reference station coordinates used, and these can vary.

However, using your own base station is still the most accurate GPS/GNSS survey technique as a locally established base generates locally measured (not modelled) actual corrections for the vicinity with accuracy in the order of 15mm horizontal and 20mm vertical vector measurements with respect to the base station. These accuracies can normally be maintained if the location of the survey is no more than 20km away from the established base. Using a UHF radio for communication between base and rover guarantees this somewhat as normally UHF is restricted to line of sight ranges which can be in the order of 6-8km under standard conditions. This applies to Ireland and most other developed countries where there are radio licensing and broadcast power restrictions. The maximum power allowed in Ireland is 0.5 watt or 1 watt under certain conditions. Of course, there are territories with no restrictions whatsoever and with a very powerful radio you could cover a very large area (larger than 20km perhaps). However, as UHF radio is restricted by line of sight requirements, the maximum coverage range will also be limited by the landscape or the built environment.

It is important to realise and keep in mind the pros and cons of a network RTK solution in comparison to single base RTK using a UHF radio. There are significant and easily experienced benefits even after the first time using the technique. However, there are also issues;- some of which might not be obvious and some may not be experienced right away...

Firstly, remember the point I have made above;- establishing and using your own GPS/GNSS base station will always give you the most accurate results for your survey location. This is most significant in vertical measurements and therefore if vertical accuracy is critical, then Network RTK should never be your first choice.

In Ireland height errors even greater than 80mm can be experienced when using the Network RTK solution. One contributing factor for such errors can be large height differences between the nearest Network RTK reference station and the

rover. This has been noted in practice and reported by ourselves in GPS Ireland and also identified in research work being carried out in the UK.

Working with a VRS Network solution, your rover can easily be more than 20km away from the nearest active station feeding the network. Generally, at 20km distance from a reference station ionospheric conditions at the survey location (these greatly influence the accuracy of satellite positioning technologies) can be markedly different to those at the nearest reference station. In addition, some related algorithms are modelled in these solutions and no model can keep up with very sudden changes created by unpredictable solar activity which influences ionospheric errors. This is something that is notable at the time of writing this article in March 2012 when large solar storms are being experienced.

These facts cannot take away from the robustness and usability of the network solution. They do, however, contribute to the other fact that the accuracy cannot be expected to be the same as we know from the traditional base/rover/radio RTK survey technique.

If using or planning to use a Network RTK solution, at some stage you may also experience problems with mobile phone communications. Unlike PCs, mobile phones do not use fixed IP addresses, and so when getting to the internet via a mobile phone, an IP address is allocated to the mobile phone if it is available. Every mobile phone mast has only a certain number of IP addresses available at each time, therefore there is a higher probability of having to wait for the IP address in rush hours (early morning, midday, evening) when more people are on the move and getting online checking their emails etc. Also, when moving from the coverage of one mast to another you may well be disconnected and may end up in a queue before getting reconnected again.

If working abroad, in countries where a Network RTK solution is available, normally you would find one established network spread over the whole state territory, possibly run by one provider. In Ireland, however, we have three providers offering Network RTK services;- Leica, Trimble and Topcon. Network RTK correction services can be found under the following commercial names:

Smartnet - offered by Leica

VRSnow - offered by Trimble

TopNet - offered by Topcon

GPS House, Church Bay Road, Crosshaven, Co. Cork, [W8L-84-4YK](tel:+353214832990)

4

Tel: +353 21 4832990 Fax: + 353 21 4833665 Tel: International +353.21.4832990

Email: info@gpsireland.ie

Website: www.gpsireland.ie

It may sound good, but this phenomenon actually creates an additional issue for surveyors and potential errors as a result of surveying from multiple networks in the same vicinity could result in different coordinates for the same point. Combining or comparing survey results from projects surveyed using corrections from different providers can introduce new problems due to different infrastructures, different software, different model calculations etc etc.

In Ireland, we have two completely different active station network infrastructures. One established by OSi as part of an IRENET95 program and another by Trimble specifically built for the purpose a couple of years ago.

Both Leica and Topcon use the OSi active station infrastructure.

In addition to two completely different Network RTK infrastructures in Ireland, we are now also facing the slow disappearance of the ground control network which is not being maintained anymore. This is causing quite a concern for surveyors and can cause a situation where they are trying to establish a new on the site control point which is too far from any of the network stations to give the necessary resulting accuracy. In such cases, normally a passive ground station established and published by the OSI would serve as a reference to start a shorter baseline from. However, even though most passive stations may still physically exist on the ground, significant mismatches in height measurements when compared to the active Network have been noticed. Also, as this control is not actively maintained and the alternative Network GPS/GNSS control cannot be occupied (as it exists only in the centre of a GPS/GNSS antenna on the roofs of buildings) therefore it is the case that the ability to independently check survey work and or control stations is becoming less and less possible.

In conclusion, Network RTK VRS solutions are time and money saving when compared to traditional RTK, but they do not have the same accuracy guarantees and should not be used where vertical accuracies are critical. In Ireland, potential inaccuracies are exacerbated by the presence of 2 distinct network infrastructures which may not necessarily agree with each other and using both in the same survey may cause problems.

You can of course set up your own VRS Network over a small area and get the same accuracy as traditional RTK;- delivering corrections via the internet and GPRS without UHF limitations and perhaps I will discuss this in one of our later monthly articles.

Finally, the success of using a VRS RTK Network in any area will be totally dependent on good mobile phone and GPRS coverage and this is not a given and must be checked out first in the survey area. This is not just about having enough bars on the phone, it is more about data speed and quality.

If you have any questions on this or any other GPS/GNSS subject please feel free to contact us at GPS Ireland + 353 21 4832990 or info@gpsireland.ie ,
www.gpsireland.ie