Trial of Dial-in GPS 'Virtual Reference System'

A Major Initiative by Trimble, Ultimate Positioning, and the Queensland Department of Natural Resources

Let's start by keeping this simple, before we get to the complicated part.

Imagine, if you will, a triangular area bounded by Brisbane, Ipswich, and Bundall on the Gold Coast. (As it happens, that triangle covers the fastest growing urban area in Australia.)

You have to dig a two-kilometre trench for a sewer main in the middle of the bush out past Beenleigh.

It starts at point A, does a couple of dog-legs at points B and C, and finishes at point D. And you have no reference points to establish any of those positions.

You call up two surveyors, to get quotes. The first one prices the job on the basis of two men for a day and a half, traversing in by conventional means from the nearest fixed survey station twenty five kilometres away.

The second bloke quotes you on the basis of three hours work. He comes out with a GPS rover, and navigates himself to within twenty metres of point A.

He then presses a button, and his dedicated mobile phone attachment (costing about $4,000) phones through to a computer in Brisbane.

Within two minutes he receives data over the phone that permits him to refine his position, to an accuracy of one inch.

He belts a peg in the ground and repeats the procedure for points B, C, and D.

In less than an hour, he gets back in his car, and goes off to play golf.

Time Saved Equals Money Saved

Clearly, he has saved himself a lot of time, and you have hopefully benefited by saving a lot of money. The whole job has turned out to be much cheaper.

So what exactly are the processes involved here?

With apologies to those who already know a good deal about it, we will try to give a simple explanation.

For those surveyors who want the real nitty gritty, give Alan Archbold a call at Ultimate Positioning on 3852 1245.

As we all know, GPS receivers tune in to the twenty-four U. S. military satellites orbiting 18,000 kilometres above the earth.

They read the data being transmitted by four or more satellites that are 'in sight' in our part of the sky at any particular time, and to put it crudely, use a triangulation procedure to figure out the present position of the receiver.

An unaided GPS receiver will do it to an accuracy of about twenty metres.

The inaccuracy in the result can be caused by a number of factors, including interference in the ionosphere, interference by weather in the lower atmosphere, wobbling of the satellites in their orbit, and so on.

Those factors vary, every minute of the day.

Differential GPS Refines Accuracy

Differential GPS is a refinement of the system, producing far more accurate results.

How it works is that a reference station is established in the area where accurate results are required.

This reference station is simply another GPS receiver, but the position of its antenna has been established with great precision by conventional survey methods.

It might, for instance, be located on the roof of a site office on a particular subdivision.

A communication link is established between this reference station and say, a GPS receiver operating on a bulldozer.

If the link is by VHF radio, it will typically have an operating radius of about 10 kilometres.

GPS Receivers 'Talk' to Each Other

What essentially happens is that the reference station—let's call it a base station—continuously 'talks' to its on-board cousin, and says something like this:

"I am receiving signals from the same satellites as you are, and they tell me that I am at such and such a location.

"However, I know that my exact position is slightly different, because mine has been established by conventional survey.

"The error is 1.285 metres to the north, and 1.795 metres downwards in the vertical axis.

"If you correct the data you are receiving by those figures, you'll be spot on the money."

Accuracy of About 25mm

That's fine, and it works very well. The reference station is in fact 'correcting' the data, so that the rover can establish its position to a high degree of accuracy—typically about 25mm.

It needs to keep doing this constantly, since conditions in the ionosphere (for example) might be gradually altering.

But the bloke who came out to establish your points A to D didn't need a surveyed reference station.

He did it via a mobile phone. How?

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Matt Higgins, Senior Surveyor, headed up the DNR team collaborating with Trimble and Ultimate Positioning on the trial.

Virtual System Replaces Fixed Reference Station

Now we come to the complicated bit. The technical term is a Virtual Reference System Network (VRS).

The network being trialled, which is the first in the southern hemisphere, has been set up by the Queensland Department of Natural Resources, in partnership with Trimble Navigation Ltd., and their Brisbane-based distributors, Ultimate Positioning.

Early results have been highly satisfactory.

Make No Mistake—It's Coming!

DNR are talking about it as a trial, which it is. Trimble are talking about it as the prelude to things that are definitely going to happen—and soon. Not just in South East Queensland, but extending in due course to other areas of the state, and presumably, the rest of the country.

Indeed, as Paul Bright of Ultimate Positioning observes, in a matter of a few years we will wonder what all the fuss was about, and take for granted the ability to fix a point quickly and accurately to within millimetres, anywhere we wish, without present-day survey techniques.

DNR Facilities Form Basis of 'Triangle'

The VRS trial uses GPS receivers established on the roof of QDNR offices at Brisbane, Ipswich and Bundall—there is a fourth one at Beenleigh to help in assessing accuracy, but that's another story.

The GPS receivers are constantly feeding data in to a central computer in Brisbane—it performs a lot of complex tasks, but in essence it 'averages' the data.

At the same time it does a good job of sifting it, to negate the inaccuracies caused by ionospheric interference, etc.

When a rover 'phones in', it tells the computer where it is located within the triangle.

The computer then says (more or less!) "OK, I read you, that you are eighteen kilometres from my nearest fixed station.

"I am going to use all the information I'm getting from my three fixed GPS receivers to create for your exclusive use an imaginary (or 'virtual') reference station, very near to where you are.

"This virtual reference station will then provide you with the information that a real one would have provided, to update your data and obtain the required degree of accuracy.

"Here we go!"

System Will Serve Earthmoving Operations

During this first trial, operations are limited to rovers phoning in.

But in a permanent system, clearly the next step would be to provide for distribution of the information by other means, so that (for example) real-time guidance control of earthmoving equipment can be facilitated.

The accuracy achieved by this 'virtual' system, going on early figures, is proving very comparable to what can be expected from a physical reference station.

That is, something in the order of 30mm—and many of the test readings that made up this average figure were taken outside the triangle.

Additional Benefits

But better yet, the VRS contains a number of inherent advantages:

- reliability—if a physical reference station breaks down, operations stop. But if one station in a network goes down, the others can compensate.
- as we noted before, a network has a greater capacity to negate interference factors than a single station has,
- physical survey is undertaken only once, when the network is established, not every time you move a base station,
- the possibility of making a simple surveying error in locating a mobile base station, which would throw error into all subsequent operations, is eliminated,
- problems of accidental or malicious damage to an unattended base station, or theft or other loss, are eliminated (some contractors with these expensive stations are dismantling them and taking them off sites at night)

Switzerland is Already Entirely Covered

Such networks have already been established in various places in the northern hemisphere.

Trimble has, for instance, peppered the whole of Switzerland with a national network of about twenty stations feeding data in to one central computer.

The Queensland trial will conclude around the end of May, and we look forward to reporting in detail on its results, soon after that. PK