GPS Newsletter – Sensor

A Newsletter On System 500 GPS, Vol. 01, No. 06.

RTK – Did You Know?

The RTK performance on System 500 is so good that most people use it without even considering what is going on "behind the scenes".

This newsletter explains what is happening inside the sensor and why System 500 is simply the best GPS RTK system available today. But first a little history....

It All Began....

Until RTK became available, GPS was mainly used to measure static baselines for networks or control purposes. Kinematic GPS was also possible using techniques such as **Stop and Go** or **Kinematic GPS** and then the user would have to post process this data. Obviously the main problem with post processing any survey is "Have I collected enough good data to get the results I need?"

Leica RTK first became available with System 300 which, as today, allows users to survey points and ensure that they have cm (centimetre) accurate positions. Overnight, surveying with GPS became much more productive - the number of points that could be collected in one day increased enormously. Staking out with GPS also became possible – quite simply, GPS surveying was revolutionised.

So How Does It Work?

The RTK rover and reference both simultaneously observe the same satellites. The satellite observation data from the reference is then sent to the rover over the data link.

Using both the reference and rover observations and knowing the co-ordinates of the reference, the rover must now find the correct solution – that is, compute the correct co-ordinates of the rover. The key to this is to search for the **correct ambiguities** using the most efficient RTK algorithms possible.

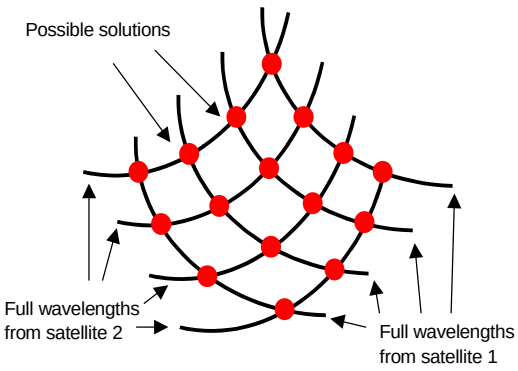
Unfortunately, this newsletter does not have the space to discuss the **ambiguity search** in detail, or even explain what an **ambiguity** is. However, it can be considered in the following way.

The RTK algorithms are trying to determine the number of full wavelengths between each satellite and the rover antenna. Once this number of full wavelengths is known for each satellite then it is possible to compute the rover co-ordinates to cm accuracy.

Unfortunately, there are many possible number of whole wavelengths that could be between the satellites and the rover. Because of this there are always many possible "**sets**" of ambiguity solutions.

The diagram below tries to show this – it is very much simplified for only two satellites – in reality this could be an 8 or 9 dimensional intersection problem.

Thus, a search routine is



needed to determine which of these possible solutions is correct – this is known as an **ambiguity search routine**.

Many, many papers have been written about ambiguity search routines - all with the same goal, to find the correct ambiguities (and hence the correct co-ordinates of the rover) as quickly as possible. Leica uses a search routine, that, as you know, is fast, but even more importantly is reliable.

If the sensor were to use one "correct" set of ambiguities then this would give one set of co-ordinates. If it were to use the next "correct" set of ambiguities this would give another and different set of co-ordinates. If the system chose the wrong set of ambiguities then this would be clearly unacceptable for the surveyor – basically you would be measuring points with the wrong co-ordinates!

So how does the rover know which "correct" solution to use? Rigorous **statistical techniques** are used to determine the "most probably correct" solution and the "second most probably correct" solution. These two "most probable" solutions are then compared and if the probability that the first solution is much more likely to be correct than the second solution then the first solution is taken as the correct answer.

And Then Do It Again

So now we found ambiguities that are considered to be "most likely correct". But we have already said that if we did have the wrong ambiguities – even after applying the statistical analysis to determine the most likely correct solution – we would get the wrong co-ordinates for the rover.

How can we be even more certain of having found the correct ambiguities?

To be Continued in Newsletter Vol 01, No. 06.

Leica Geosystems