



Accuracy when positioning with VRS-corrections (Virtual Reference Station)

Abstract

This short report describes a comparison between position accuracy when using differential corrections from a VRS-server and traditional corrections calculated in RS-receiver hardware.

The result from the test setup shows an age of the VRS-correction of ~18sec. when received at the IM-receiver. This shall be compared with an age of ~7 sec. for corrections calculated by the RS-receiver.

Position accuracy is ~0.6m (mv) for 99% of the positions using VRS-corrections as differential source, and ~1.1m (mv) for 99% of the positions using traditional corrections, thus a great improvement in absolute positioning.

However, the distribution of the positions is the largest benefit of using the VRS-corrections. The maximum positioning error over 24h is ~0.7m when using VRS corrections and ~2.4m when using traditional corrections.

The change in positioning (speed) was not possible to record using 1 decimal digit (0.1m/s = resolution in output from receiver) when using VRS-corrections, and the maximum speed was 0.3m/s when using traditional corrections.

The result clearly shows benefits of using VRS-corrections calculated with rawdata from many RS-receivers instead of traditional corrections calculated within one RS-receiver.

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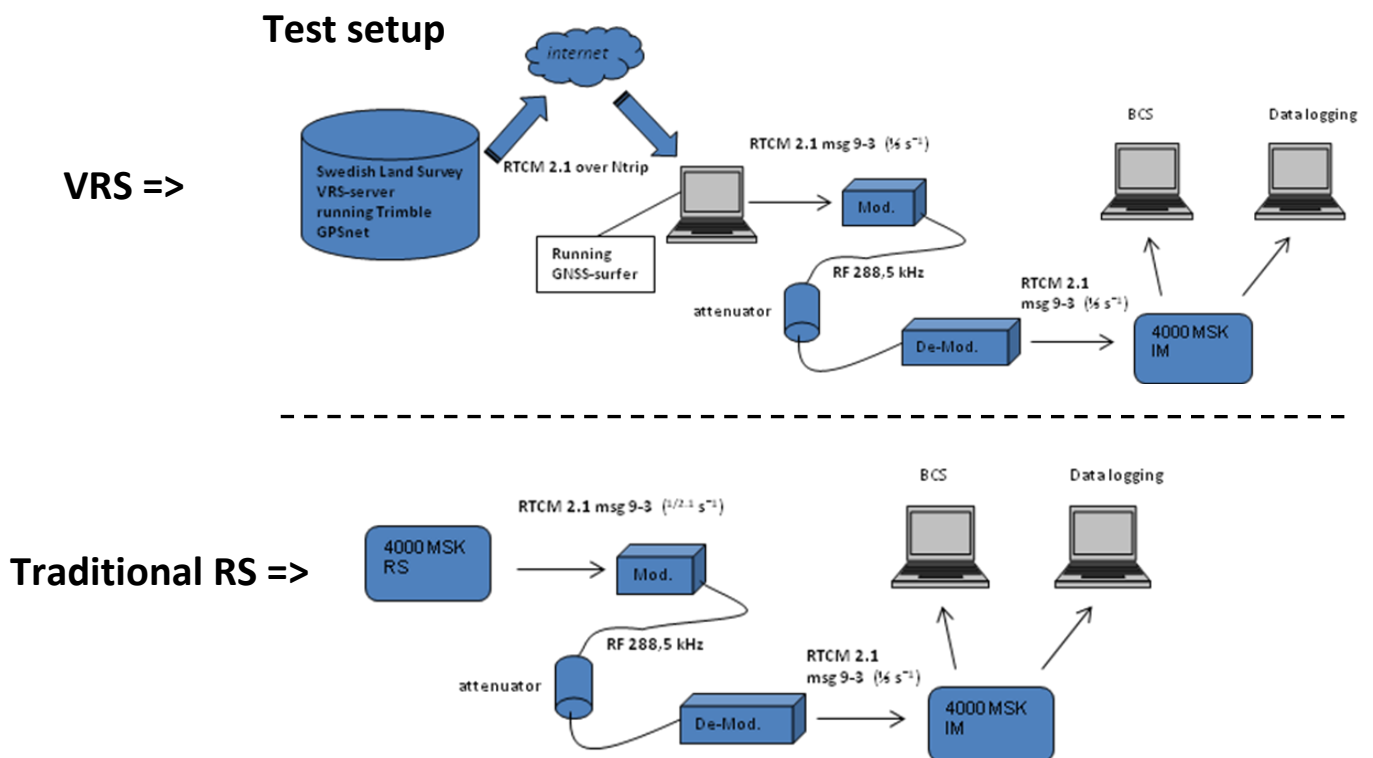
Introduction

The national Land Survey of Sweden (NLSS) runs a network of ~160 Reference Stations for GPS and GLONASS. The rawdata from the stations makes it possible to calculate corrections for Virtual Reference Stations for the Swedish DGPS system.

The Swedish Maritime Administration finds this technology very interesting and has done some preliminary tests of positioning utilizing the VRS corrections and compared the result with corrections calculated in RS-receiver hardware.

Test setup

The test setup used for VRS and RS corrections can be seen in the figure below:



A VRS using rawdata from six NLSS Reference Stations was setup and calculated in the VRS server running Trimble GPSnet at NLSS.

The RTCM 2.1 stream was transferred over internet using the Ntrip-protocol. A PC running a slightly modified version of GNSS-Surfer (by Jürgen Siebert) read the RTCM-stream and output it to a modulator (the

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same as in Trimble 4000MSK RS-receiver). The modulated RF-signal was attenuated and then de-modulated before sending the RTCM-stream to the DGPS IM-receiver (Trimble 4000MSK-IM). By this, delay of the corrections in the whole transmitter-receiver chain, as well as the position accuracy could be studied. The results were analyzed using BCS and logged data from the receiver.

The test was repeated using the Trimble 4000MSK RS-receiver as differential source and a comparison was done

Results

Correction age:

The age of the corrections using the VRS solution are ~18 sec for 12 satellites, and from the RS-receiver ~7 sec for 9 satellites.

On the 100bps MSK data link it takes 2.1sec to transfer one RTCM message. When corrections for 3 satellites are sent at every RTCM message type 9-3, four messages have to be sent for 12 satellites before the corrections are repeated (three messages for 9 satellites).

$4 \times 2.1 \text{ sec} = 8.4 \text{ sec}$ and $3 \times 2.1 \text{ sec} = 6.3 \text{ sec}$.

The VRS server output rate can be set in increments of 1sec. Since 2sec. is too fast it had to be set for 3sec, leaving the data link on "idle" for 0.9 sec. With an idle time of 0.9sec for every message the age of the corrections are set back 3.6sec for four messages.

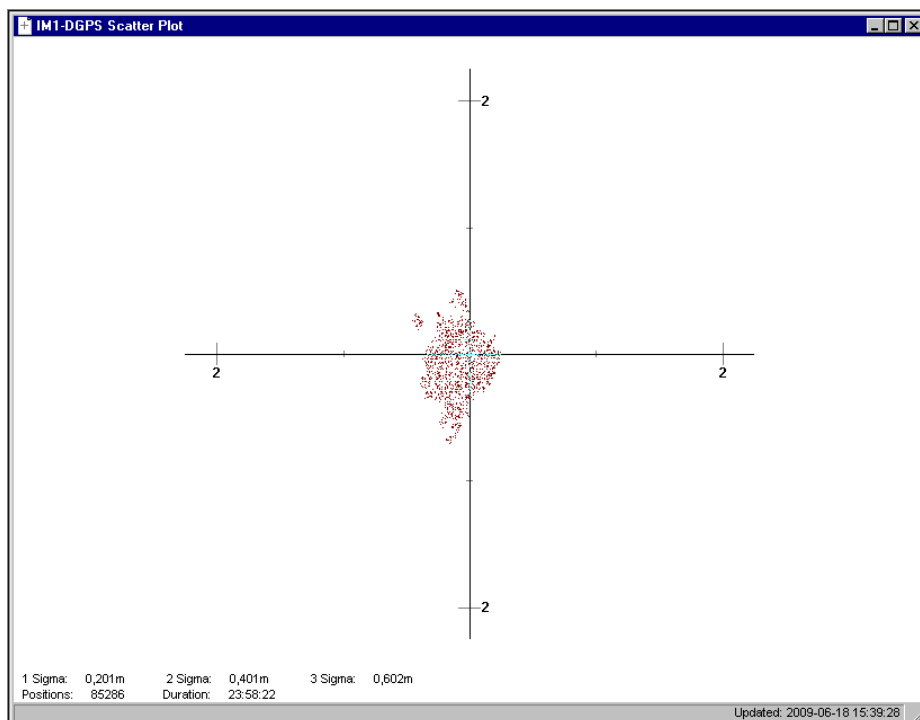
$8.4 \text{ sec} + 3.6 \text{ sec} = 12 \text{ sec}$.

Other factors which increase the age can be explained by the VRS server calculation process, the decoding process in GNSS-surfer, and transfer times.

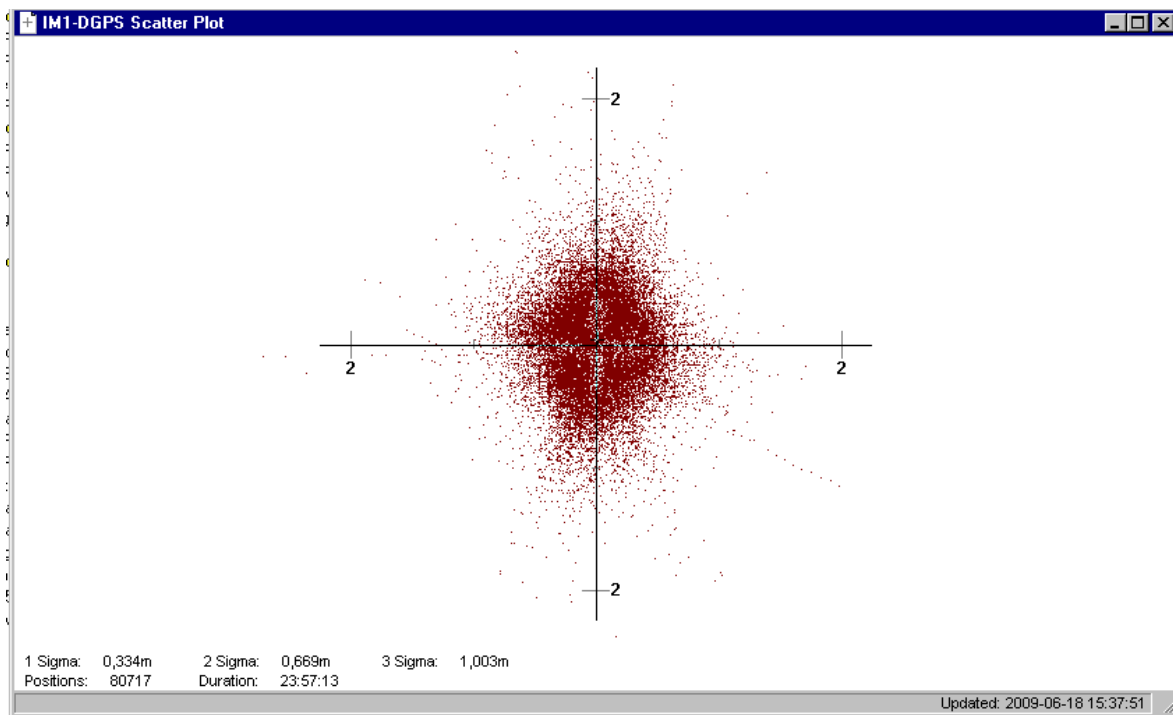
Accuracy:

The average error for the positions using the VRS-corrections as differential source is ~0.6m, whilst the error for positions using traditional corrections are ~1m See scatter plots below.

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Scatter plot VRS-corrections as differential source



Scatter plot, traditional RS-receiver corrections as differential source

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Change in position (speed)

The largest benefit of the VRS-corrections can be found in the stability of the position. The rapid change in positioning is eliminated and can not be measured with a receiver resolution of 0.1m/s. With the traditional RS-calculated positions as differential source the change in position can be as high as $>0.3\text{m/s}$.

Conclusion

There is a clear advantage of using VRS-corrections as differential source when navigating. The largest benefit is the increased stability of the position, which is of use for a mariner trying to determine the movement of the vessel without visual references.

The increased age of the corrections is a minor problem and can be mitigated by better software and faster data connections.