Introducing NovAtel's New AdVance RTK™

NovAtel Inc.

ABSTRACT

This white paper discusses the performance of NovAtel's new AdVance RTK engine. In this paper, AdVance RTK is compared to NovAtel's old processing engine and the results of tests performed on both engines are presented. The outcomes of the tests confirm that, compared to the old engine, AdVance RTK has more reliable ambiguity solutions and a much faster narrow lane convergence on short, medium and long baselines. This paper concludes that the new AdVance RTK engine enables users to work more reliably and efficiently in a wider range of conditions.

Figure 1: OEMV-2 & OEMV-3 Cards

INTRODUCTION

Although updates have improved NovAtel's RTK (real time kinematic) engine over the years, recent analysis conducted by NovAtel has determined that a new engine is necessary to further advance the performance of its products. The need for fixed solutions on longer baselines and in obstructed sky conditions is required as GNSS users challenge the industry for faster and more accurate results in difficult environments. These results depend on many factors including improvements in TTNL (Time to Narrow Lane) as well as the availability and reliability of fixed solutions on longer baselines.

This paper compares the performance of NovAtel's AdVance RTK, available on the OEMV-2 and OEMV-3, to the engine in the older generation of NovAtel products. The performance tests include position accuracy, TTNL and reliability of the fixed solution. The results of these tests as well as the new engine's overall performance and improvements, are discussed here.

METHODOLOGY

Resources for this paper were provided by NovAtel Inc. and it includes information from the development group who worked on AdVance RTK technology.

The new engine was tested at NovAtel Inc., and at external sites, to evaluate multiple user situations and environments. Tests were conducted using short, medium and long baselines over varying periods of time. The tests were also performed in a variety of environments, including dense foliage and urban canyons, where both static and kinematic data were collected.

ADVANCE RTK OVERVIEW

The new AdVance RTK engine was developed to enhance the performance of NovAtel's OEMV product family. The new engine is customized for NovAtel's OEMV hardware and focuses on fast initialization times and position accuracy for a much greater range of usable baseline lengths.

The AdVance RTK engine has an independent quality check that is done to verify the initial solution with more stringent reliability settings. If the results of the quality check and initial solution agree, the solution is considered verified. If there is disagreement, the quality check process is restarted. This process is invisible to the user.

The new engine also includes a flag that indicates when the narrow lane ambiguity resolution has been verified. This additional verification flag provides an extra level of assurance that the ambiguity selection is correct. The new verification flag helps achieve the best reliability, particularly when operating in difficult environments such as high foliage, longer baselines or unstable atmospheric conditions.

TESTS, RESULTS AND COMPARISONS

Data was collected in parallel using both the AdVance RTK engine and NovAtel's old engine to verify improved performance.

Testing was set up using a NovAtel OEM4 base station and OEMV-2 rovers. The base station receiver was connected to a NovAtel 533 Choke Ring antenna, at a known location, while the rovers used a NovAtel 702 L1/L2 antenna. The OEM4 base station was configured to transmit corrections at a rate of 1 second. Wireless corrections were then received at the rover station using an AirCard and laptop computer.

This section discusses these results and how the new engine's performance compares to the old engine.

The following tests were conducted on short, medium and long baselines to measure the performance of the new AdVance RTK engine compared to the old engine:

- Time to Narrow Lane (TTNL)
- Position error
- Position accuracy repeatability
- Fix reliability

This paper describes these tests and discusses the results.

Time to Narrow Lane

TTNL is defined as the time, in seconds, after parity is known on 5 satellites, until narrow lane ambiguity resolution.

The TTNL performance of Advance RTK and the old engine was first compared for short (see *Figure 2* on *Page 2*), medium (see *Figure 3* on *Page 3*) and long (see *Figure 4* on *Page 3*) baselines, in open sky conditions.

Figures 2 to 4 illustrate that AdVance RTK TTNL is dramatically faster than NovAtel's old engine, with fixed solutions available at baselines which were previously not supported.

As highlighted with a triangle, *Figure 2* below shows that the AdVance RTK ambiguities are resolved in less than 4.5 s, 95% of the time.

Figure 3 on *Page 3* shows that on a 15 km baseline, AdVance RTK has a TTNL of less than 17 s, 95% of the time, and that the old engine gets an integer fix in less than 350 s, 95% of the time. In *Figure 4* on *Page 3*, with a 34 km baseline, AdVance RTK has a TTNL of only 34 s, 95% of the time. An integer fix was not possible with the old engine on the same baseline.

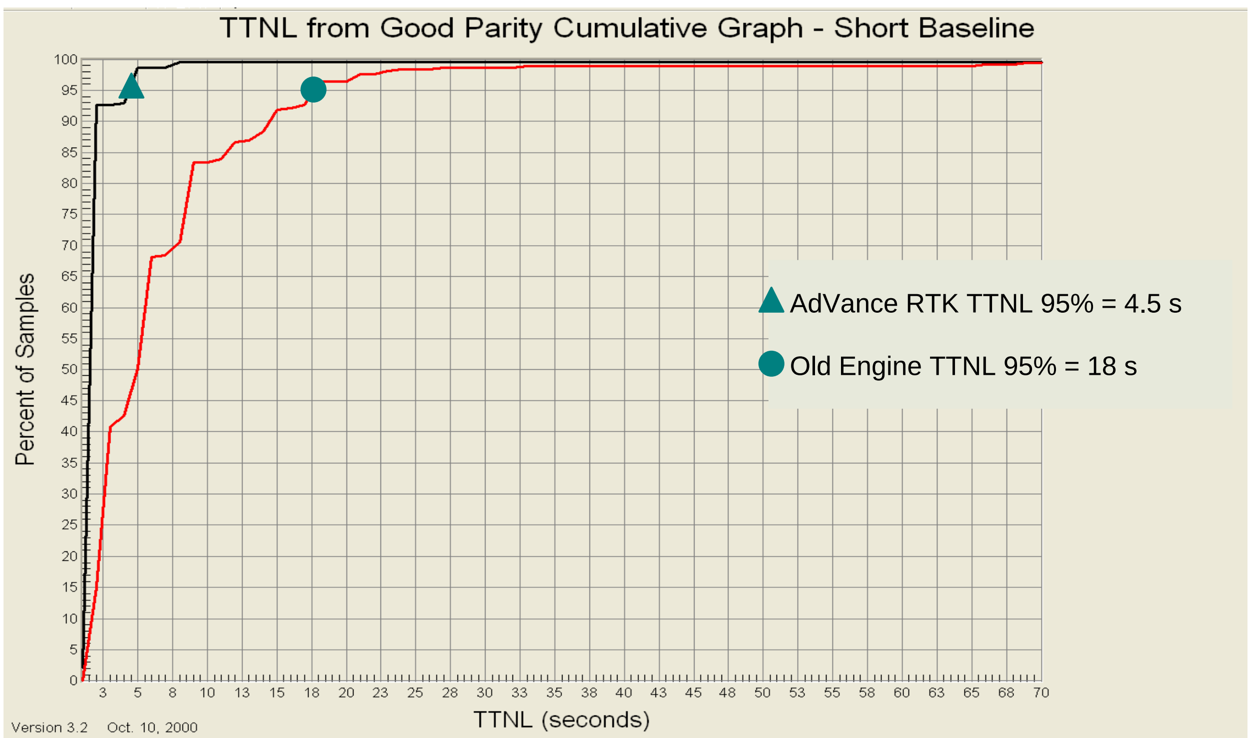

Figure 2: TTNL on a 4 m Baseline Under Open Sky

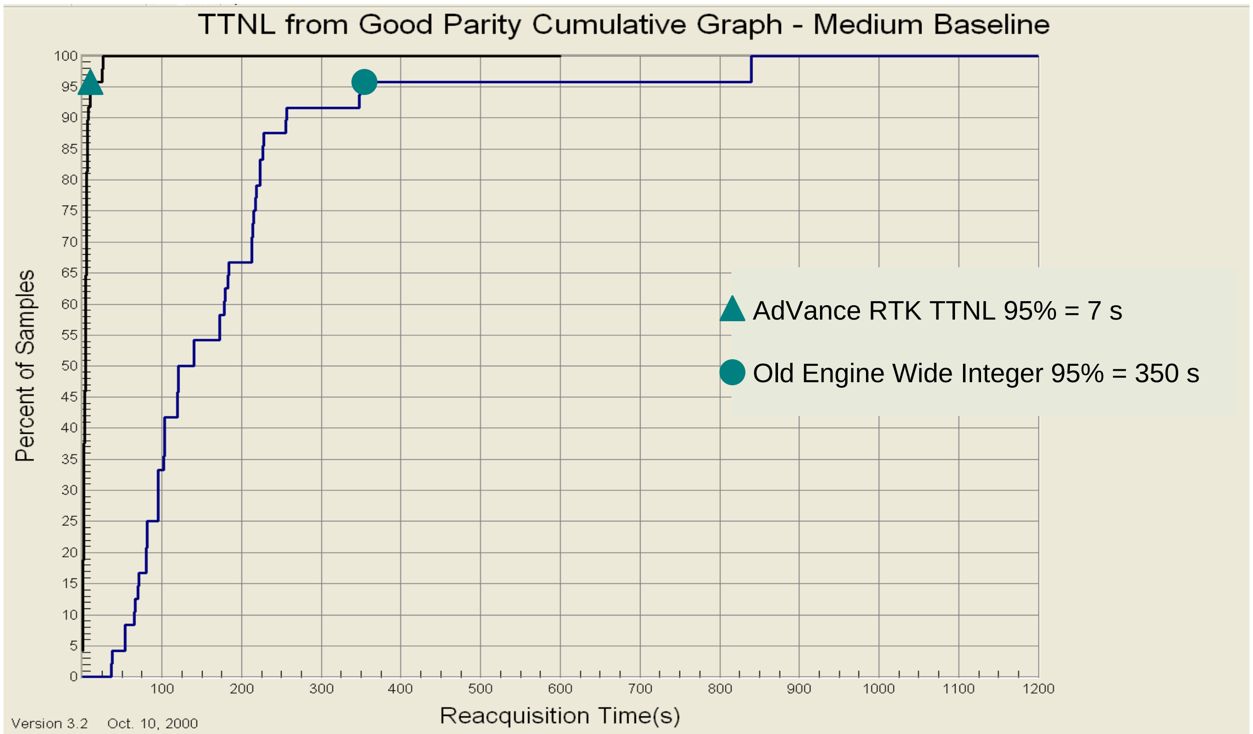

Figure 3: TTNL on a 15 km Baseline Under Open Sky

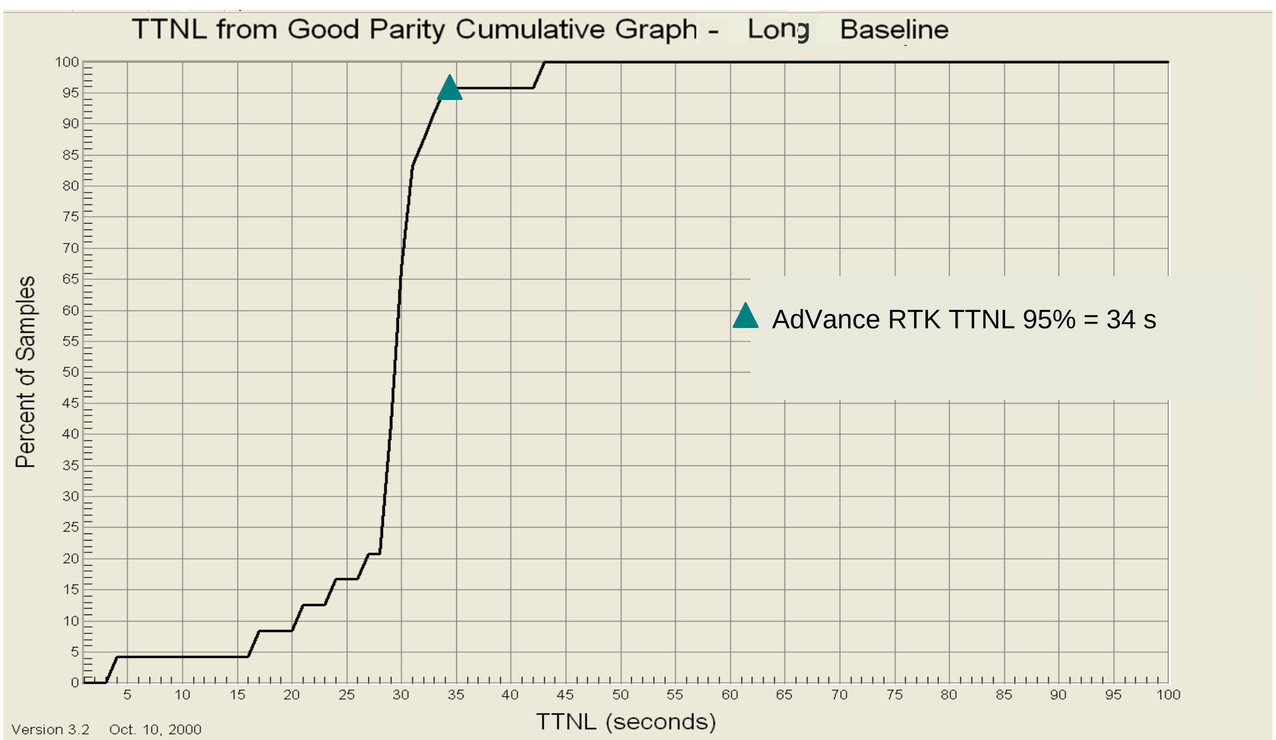

Figure 4: TTNL on a 34 km Baseline Under Open Sky

After testing performance in benign conditions, AdVance RTK was tested on a 4.8 km baseline (see *Table 1* on this page and *Figure 5* on *Page 4*), with moderate foliage canopy and some obstructions at elevations up to 30 degrees.

Table 1: Convergence to Narrow Lane Solution Statistics on a 4.8 km Baseline

	New Engine	Old Engine
# RTK Resets	189	116
Min	1.0 s	1.0 s
Max	23.0 s	92.0 s
50%	3.0 s	26.0 s
68%	4.0 s	30.0 s
75%	4.0 s	32.0 s
80%	4.0 s	33.0 s
95%	5.0 s	48.0 s

As illustrated in *Figure 5*, these results on a 4.8 km baseline, under more challenging conditions, indicate that AdVance RTK has a reacquisition time that is over forty seconds faster than the old engine, 95% of the time.

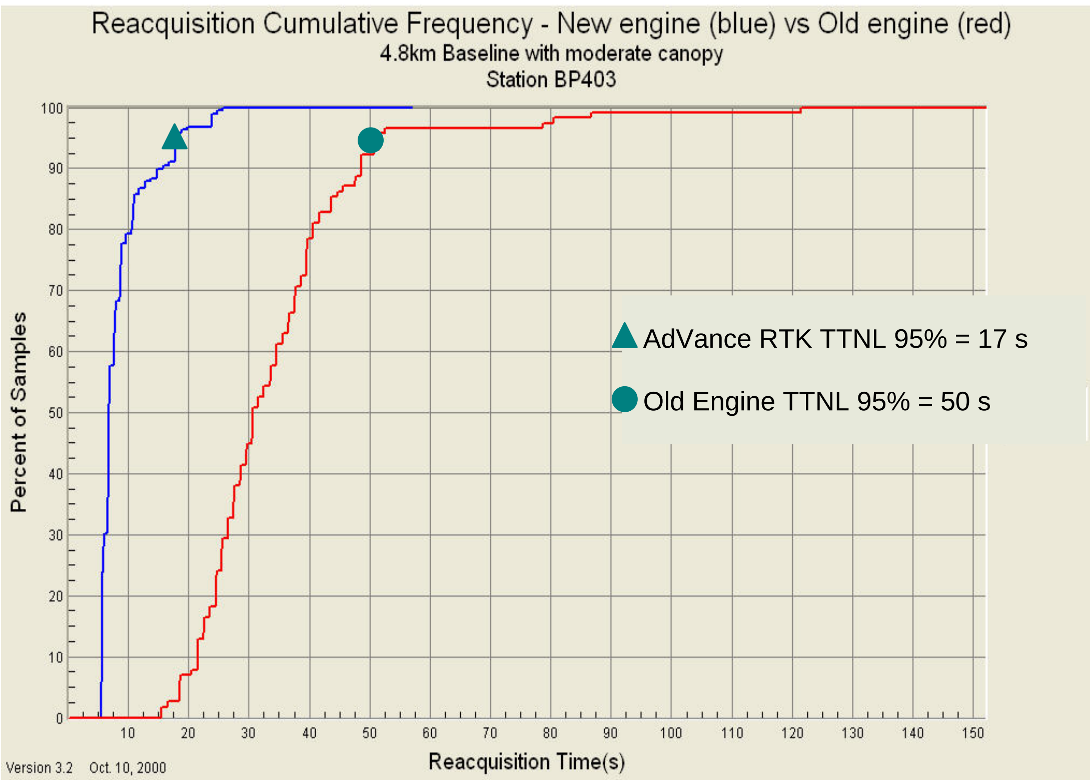

Figure 5: Reacqusition Time Under Moderate Canopy

Position Error on a Known Point

This test measured the position difference over a period of time. The plots are from a 7.8 km baseline under open sky (see *Figure 6* and *Figure 7* on *Page 5*). The test included test sections of RTCM1819, RTCM2021, RTCMV3, CMR+, CMR, and RTCA. All signals were blocked on the receiver for 2 seconds every 3600 seconds. The RTKDYNAMICS command was set to DYNAMIC.

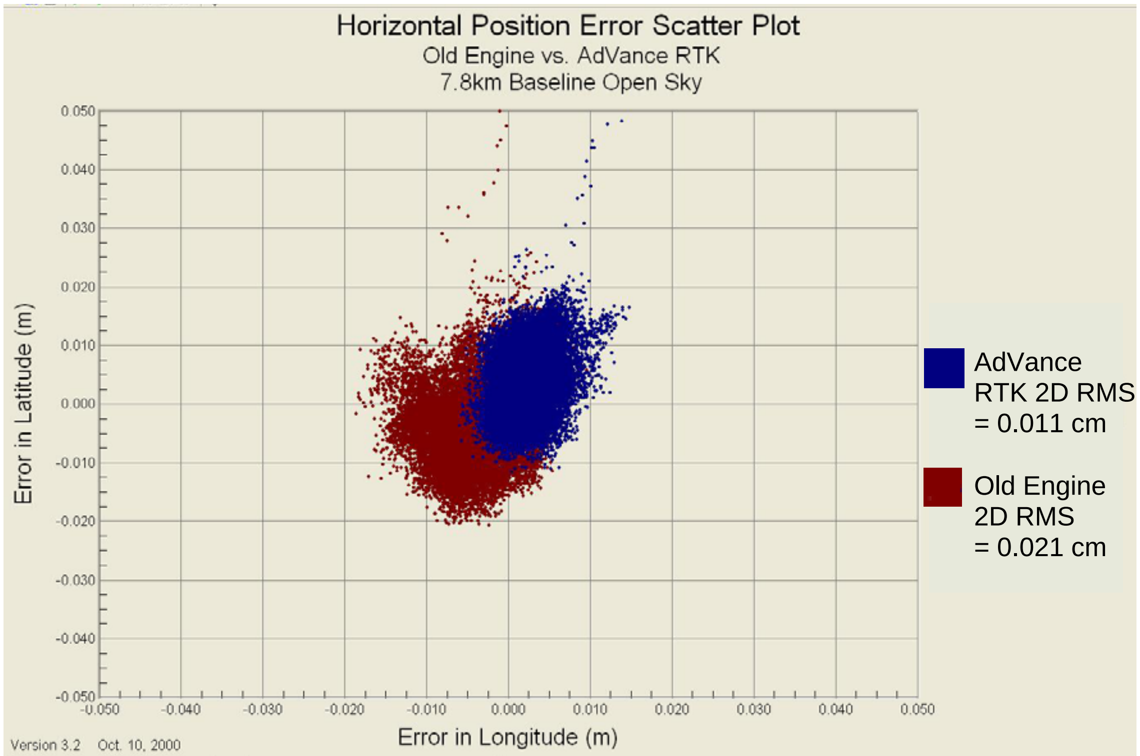

Figure 6: Old Engine vs AdVance RTK Horizonatal Position Error

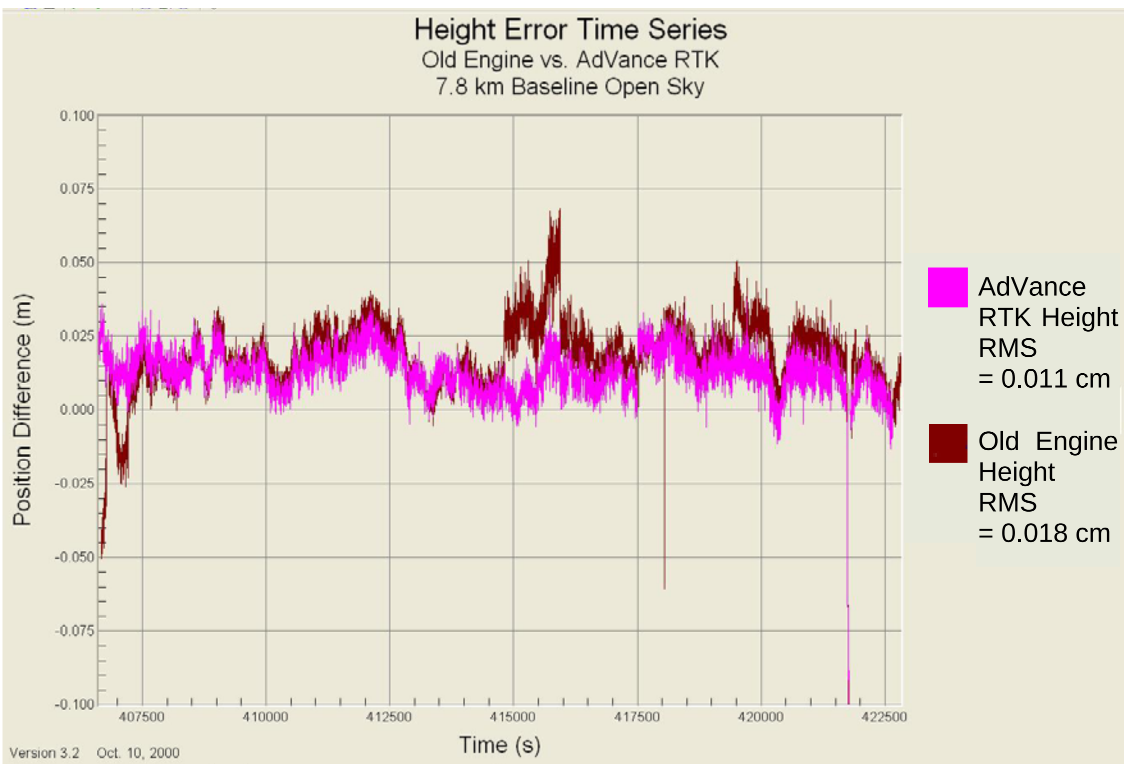

Figure 7: Old Engine vs AdVance RTK Height Error

The results of the position and height error tests for the old engine versus the AdVance RTK engine demonstrate that both the AdVance RTK 2D Root Mean Square (RMS) horizontal position and height errors are smaller than those for the old engine (see *Figure 6* and *Figure 7* on *Page 5*).

A positioning error test was also completed on a 2.6 km baseline, under moderate foliage, see *Figure 9* at the bottom of this page. In *Figure 8*, the plot below, the AdVance RTK 2D RMS is < 3cm through the entire data set while the old engine makes ambiguity errors.

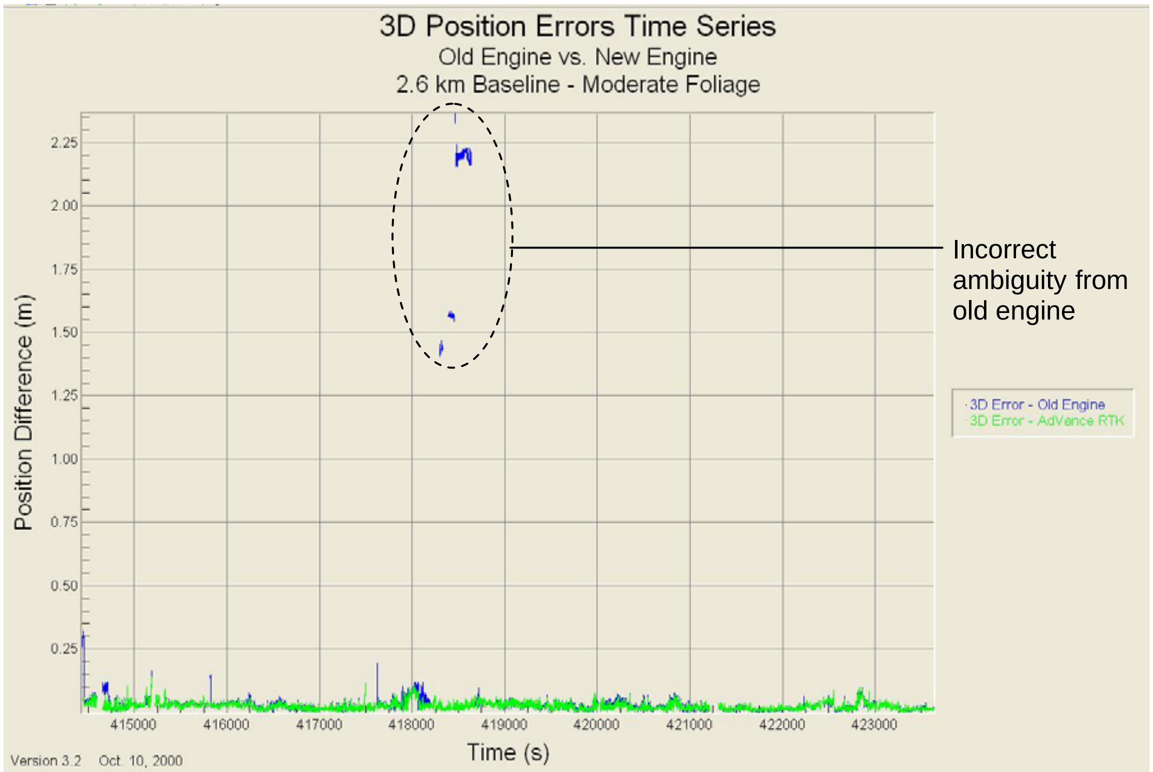

Figure 8: Old Engine vs AdVance RTK Horizonatal Position Error

Figure 9: Moderate Foliage

Position Accuracy Repeatability

This test measures how reliably the same result is achieved.

For a test at 1.7 km (see *Figure 10* below), there were ~250,000 data points over four separate days in open sky conditions and included 4292 RTK resolutions with 0% ambiguity selection errors.

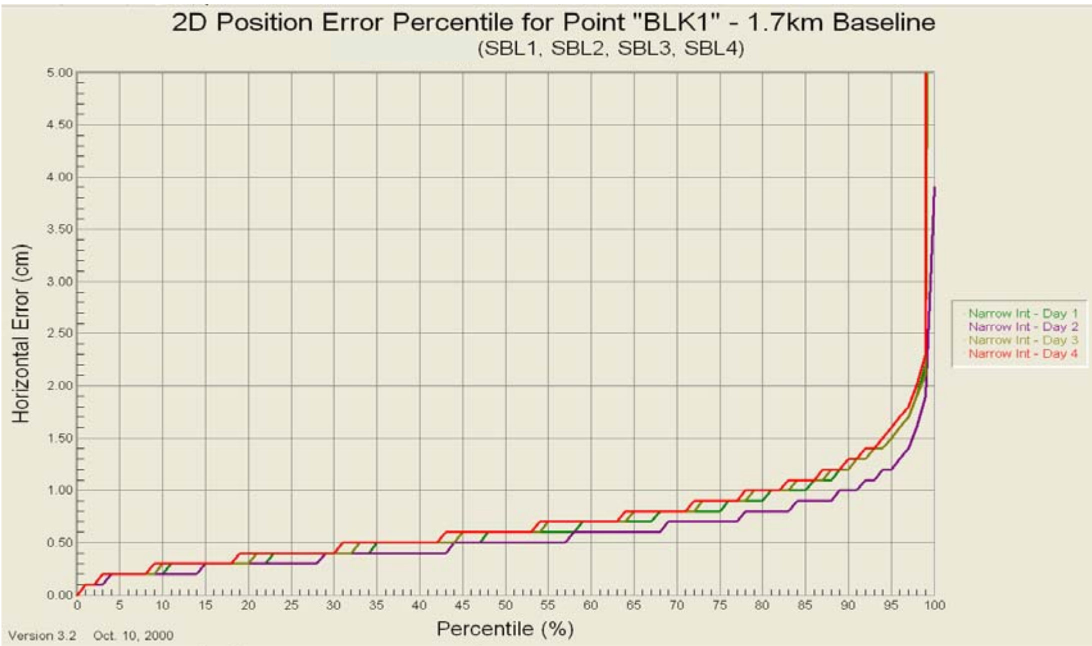

Figure 10: AdVance RTK Position Error at 1.7 km

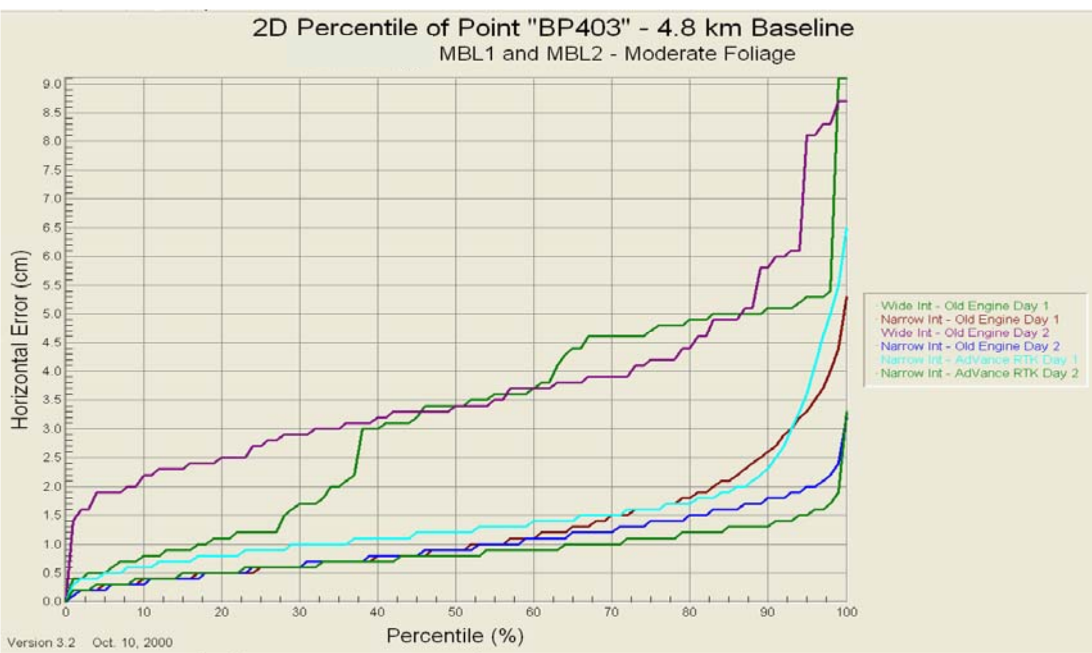

Figure 11: Both Engine's Position Error at 4.8 km Baseline

The AdVance RTK specification for position error is 1 cm +1ppm so that at 1 km, accuracy should be 1 cm. *Figure 10*, at the top of this page, for a 1.7 km baseline, shows that 1 cm accuracy is repeatable.

A significant improvement in horizontal error can clearly be seen in *Figure 11* above, for a 4.8 km baseline under moderate foliage. The lines for AdVance RTK are much lower, < 1.5 cm, than the old RTK engine, < 5 cm. The test for both engines included ~420 AdVance RTK resolutions with 0% ambiguity selection errors.

Fix Reliability

The position difference of the new engine was tested in foliage on 2 km baselines, see the image in *Figure 9* on *Page 6*. The result plots (see *Figures 12* and *13* below) illustrate the old engine attempting to fix with limited success, and the new engine, while fixing slower, is more likely to be correct.

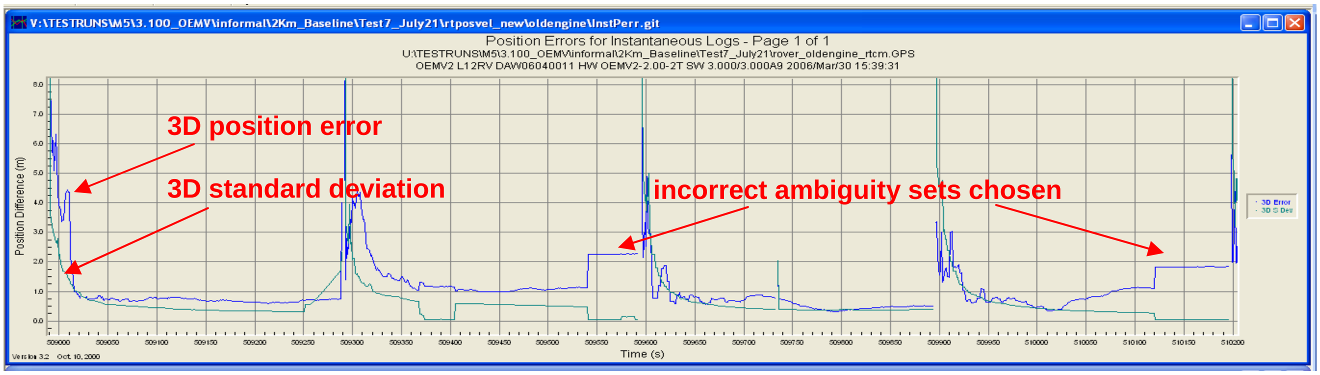

Figure 12: Old Engine's Position Difference in Foliage

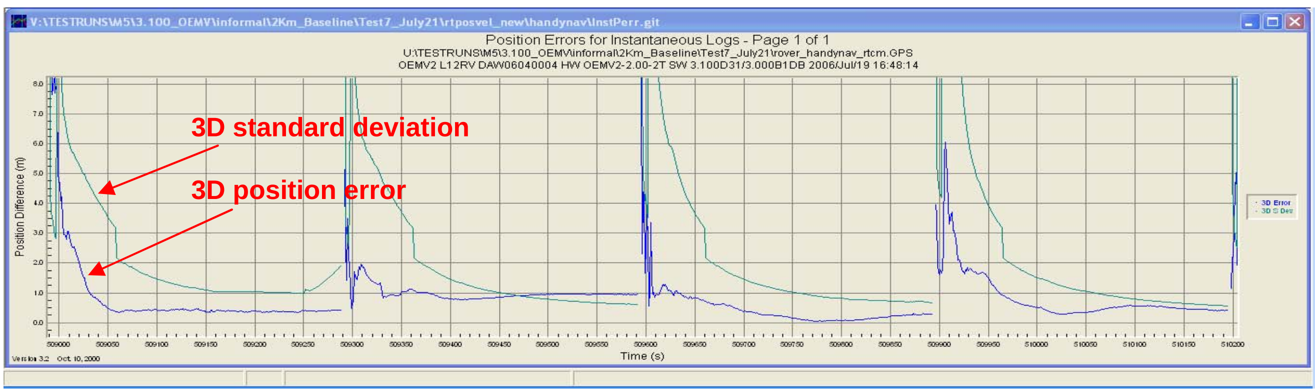

Figure 13: AdVance RTK Engine's Position Difference in Foliage

CONCLUSION

Test results measuring NovAtel's new AdVance RTK engine have been presented in this paper. When these results are compared to Novatel's old engine performance, it is evident that AdVance RTK allows for dramatically faster fix times on different lengths of baselines in a variety of areas, including dense foliage. In addition, AdVance RTK produces more reliable solutions resulting in improved accuracy in all situations. These comparisons conclude that NovAtel's OEMV family with AdVance RTK is better suited to meet GNSS users' needs in a broader range of conditions.

NovAtel's Advance RTK will continue to evolve and be enhanced as the ability to track more GNSS satellites, including L5 and Galileo, are further developed.