Head-To-Head Comparison of Four SiRF-Based GPS Receivers

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Disclaimer - Results reported here are not the products of comprehensive or rigorous evaluation. They are simply what happened when four SiRF-based GPS receivers were arranged around a survey control position, and allowed to simultaneously record GPS positions for 2 hours 46 minutes.

Background - The SiRF Star 3 GPS chipset started appearing in commercially available GPS receivers around 2005. Its primary advantages are:

1. Fast fix times;
2. High sensitivity improves satellite lock in difficult GPS environments, like heavy tree canopy or steep terrain; and
3. Low power drain prolongs battery life.

The trade-off necessary to gain that extra sensitivity, however, is that SiRF receivers will accept very weak, low-quality signals. For instance, Trimble's SiRF implementation (includes the Nomad series, Juno series, and Pathfinder XB and XC receivers) is hard-wired to a maximum PDOP of 99, minimum SNR of 12, and an elevation mask of 5°. As such, SiRF receivers are likely to surrender some position quality in exchange for high productivity in difficult GPS environments.

Post-Processing SiRF Data - Post-processing SiRF-derived data can occasionally produce poorer positions than the original autonomous positions. Here's why.

SiRF receivers are hyper-sensitive, making them more susceptible to multi-path error, especially in heavy tree canopy or steep terrain. Multi-path errors cannot be corrected by post-processing.

Furthermore, SiRF receivers have a 5° elevation mask, while most base stations have a 10° elevation mask. This creates a situation where SiRF receivers may include satellites in their working constellation that base stations are ignoring. The post-processing engine can only use satellites common to both the base and rover, which has the effect of recalculating each rover position based on only the mutually-seen satellites. The result is a series of re-calculated rover positions having poorer DOP (lower resolution) than the original autonomous positions, which are then post-processed.

The bottom line is that post-processing SiRF-based data cannot always be relied upon to provide an improved result.

Procedures – General procedures are described below, and parameters are described in **Table 1**.

- Establish a survey control position at the center of a 26-inch diameter manhole cover near the Coconino National Forest Supervisor's Office in Flagstaff, AZ.
- Place a Trimble ProXRS on the survey control position, and arrange four SiRF-based receivers around its periphery, as illustrated in **Figure 1**.
- Record GPS positions during a single occupation from 1110 through 1355 on 7 March 2009. GPS satellites make a horizon-to-horizon transit in roughly two hours, so this timeframe insures complete observation of at least one full cycle of a working constellation.
- Maintain all data in WGS84 to prevent transformation issues.
- Use the CEP utility in DNRGarmin 5.4.1 to assess radial departure of GPS positions from the survey control position (approximates accuracy), and from each receiver's mean position (approximates precision).
- **Figures 2**, **3**, **4**, and **5** illustrate sky obstructions and multi-path surfaces around the test location.

Figure 1 – Arrangement of GPS receivers

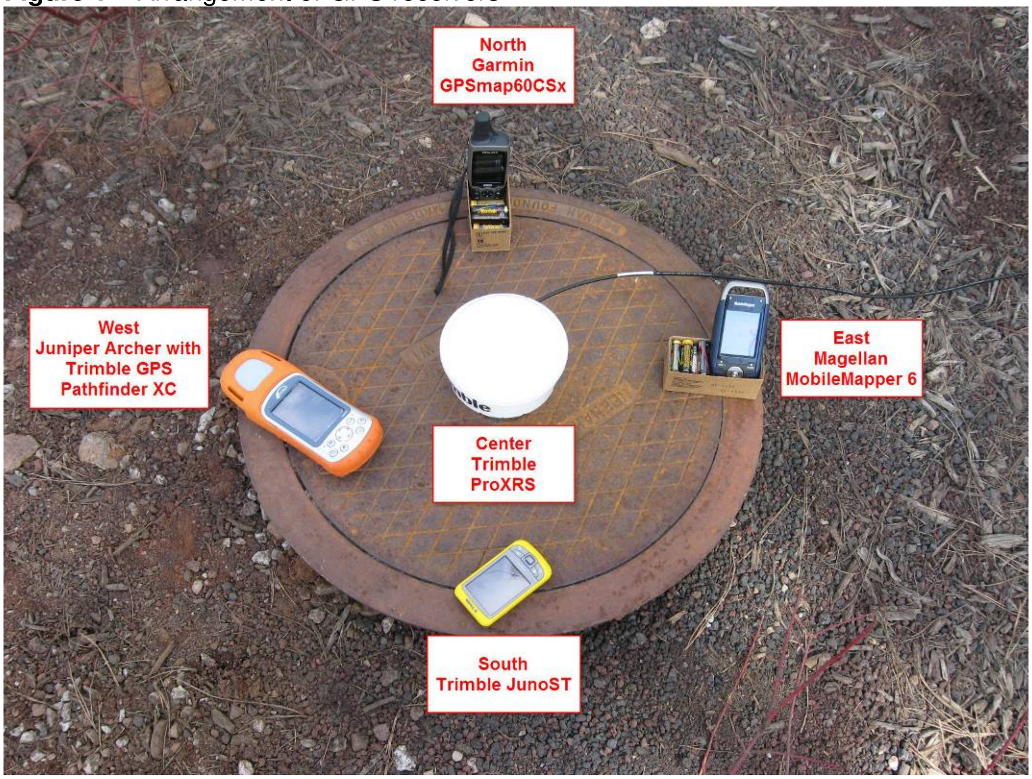

Table 1 – Data collection parameters

Item	Garmin GPSmap60CSx	Magellan MobileMapper6	Trimble GPS Pathfinder XC	Trimble JunoST	Trimble ProXRS
PDOP mask	None	None	99	99	6
SNR mask	None	None	12	12	39
Elevation mask	None	None	5°	5°	15°
Logging interval	10 seconds	11 seconds[1]	10 seconds	5 seconds[2]	10 seconds
Capture method	Garmin active tracklog	ArcPad tracklog	TerraSync line feature	TerraSync line feature	Asset Surveyor line feature
Receiver position[3]	Vertical	Inclined at 45°	Horizontal	Horizontal	Horizontal
Capture mode	Autonomous	WAAS[4]	Autonomous	Autonomous	Autonomous
Post-processed[5]	No	No	Yes	Yes	Yes
Positions in 166 minutes	996/996 100.0%	894/905 98.8%	996/996 100%	1992/1992 100%	982/996 98.6%

[1] ArcPad's tracklog interval was set to 10 seconds, but it actually recorded positions every 11 seconds.

[2] The Juno's logging interval was supposed to be 10 seconds, but user error intervened.

[3] As per the manufacturer's recommendation.

[4] So far as I know, WAAS can't be disabled in ArcPad when NMEA is the selected GPS input protocol.

[5] The correction source was Ashler Hills CORS, 158 km distant, with an Integrity Index of 92.39.

GPS Position Quality - GPS position quality is influenced by:

- Receiver settings like PDOP, SNR, elevation mask, and so on;
- Antenna design and shielding;
- Sophistication of signal processing firmware; and
- The proximity of sky obstructions and multi-path surfaces.

Tables 2 – 5 summarize the departure of corrected and uncorrected positions from the survey control position (an approximation of accuracy), and from the receiver's mean position (an approximation of precision). In **Table 2**, for instance, a value of 5.28 meters at the 95% level indicates that 95% of the receiver's sample positions were within 5.28 meters of the survey control position.

Figures 6 – 9 illustrate the distribution of each receiver's positions about the survey control position.

Figures 10 and **11** illustrate estimated PDOP and satellites in view during the test period.

Table 2 - Radial departure (meters) of uncorrected positions from survey control (~ accuracy)

Percent of Positions	Garmin GPSmap60CSx	Magellan MobileMapper6	Trimble GPS Pathfinder XC	Trimble JunoST	Trimble ProXRS
50%	2.46	-	3.02	4.32	1.35
90%	4.31	-	5.11	9.47	2.89
95%	5.28	-	6.79	11.22	3.17
98%	6.89	-	8.05	12.53	3.52

Table 3 - Radial departure (meters) of corrected positions from survey control (~ accuracy)

Percent of Positions	Garmin GPSmap60CSx	Magellan MobileMapper6	Trimble GPS Pathfinder XC	Trimble JunoST	Trimble ProXRS
50%	-	2.26	2.56	3.65	1.33
90%	-	4.36	5.02	8.38	1.82
95%	-	4.86	6.65	9.77	2.06
98%	-	5.46	7.85	11.33	2.41

Table 4 - Radial departure (meters) of uncorrected positions from mean position (~ precision)

Percent of Positions	Garmin GPSmap60CSx	Magellan MobileMapper6	Trimble GPS Pathfinder XC	Trimble JunoST	Trimble ProXRS
50%	2.33	-	2.32	3.87	1.12
90%	4.20	-	4.08	8.26	1.93
95%	5.10	-	5.35	9.89	2.13
98%	7.35	-	6.95	11.59	2.53

Table 5 - Radial departure (meters) of corrected positions from mean position (~ precision)

Percent of Positions	Garmin GPSmap60CSx	Magellan MobileMapper6	Trimble GPS Pathfinder XC	Trimble JunoST	Trimble ProXRS
50%	-	1.88	2.15	3.33	0.49
90%	-	3.70	4.10	7.33	0.96
95%	-	4.26	5.12	9.18	1.28
98%	-	5.16	6.42	11.20	1.76

General Conclusions - The results of this non-rigorous assessment seem to indicate that the MobileMapper6 may provide slightly better position quality than the GPSmap60CSX and GPS Pathfinder XC, which are roughly equivalent. The JunoST appears to be the under-performer in this instance.

Figures 2 and 3 - Sky obstructions and multi-path surfaces to the north and east of the test location

Figures 4 and 5 - Sky obstructions and multi-path surfaces to the south and west of the test location

Figure 6 - Arrangement of GPSmap60CSx positions (purple) around the survey control position

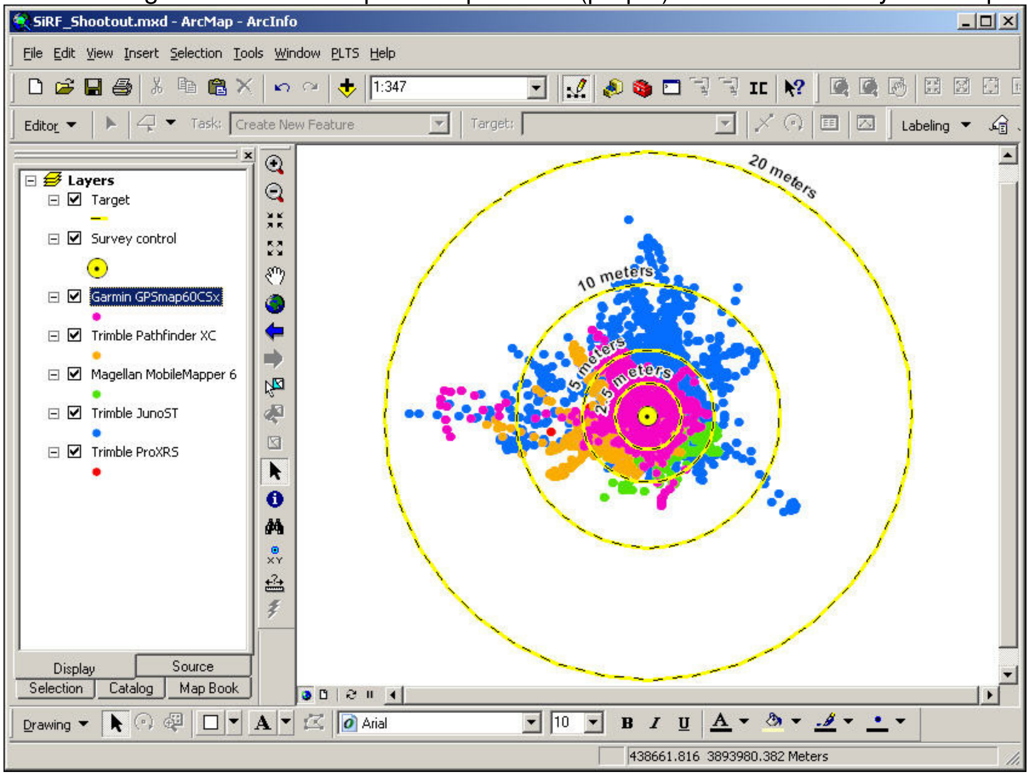

Figure 7 - Arrangement of MobileMapper6 positions (green) around the survey control position

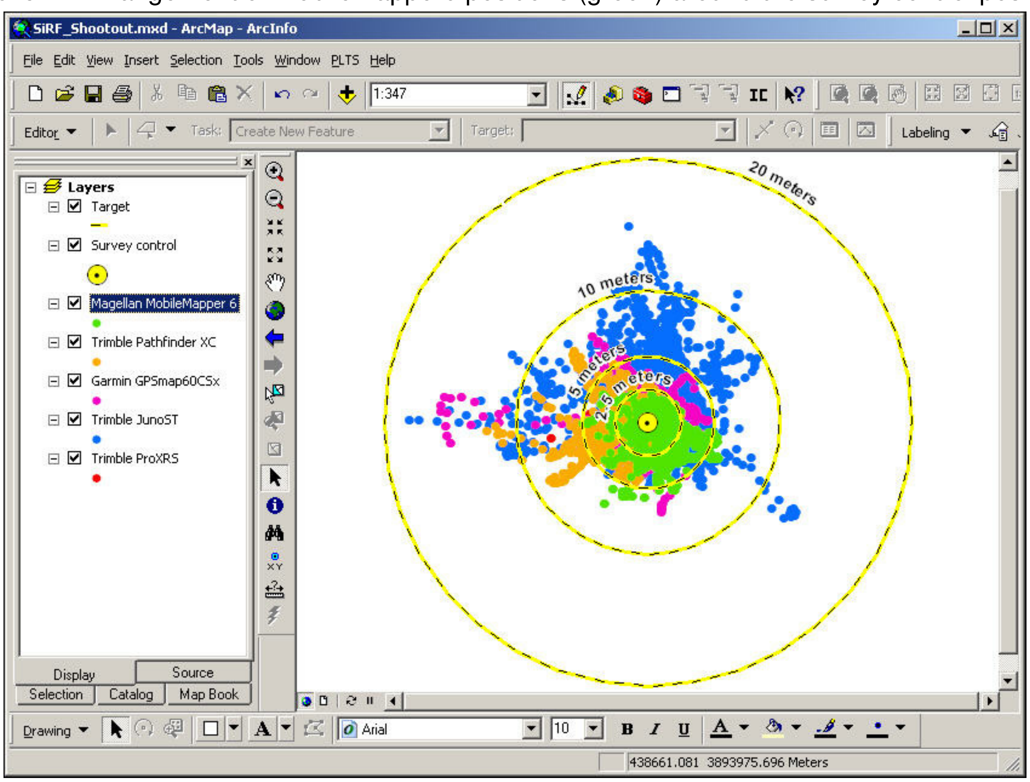

Figure 8 - Arrangement of GPS Pathfinder XC positions (orange) around the survey control position

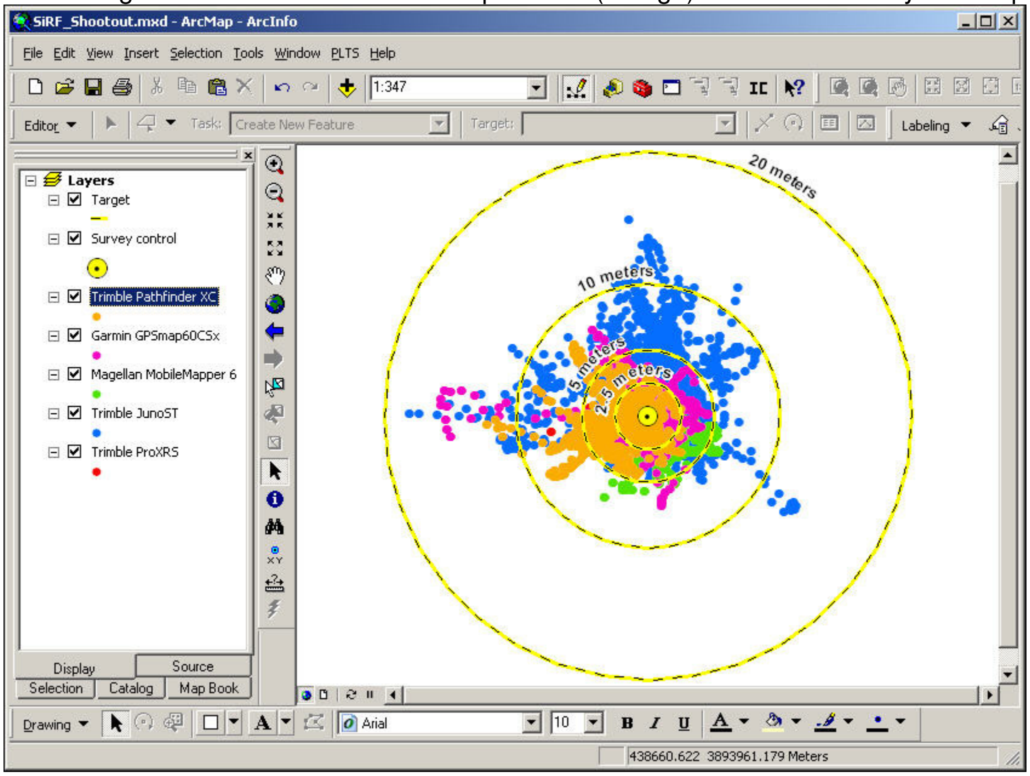

Figure 9 - Arrangement of Trimble JunoST positions (blue) around the survey control position

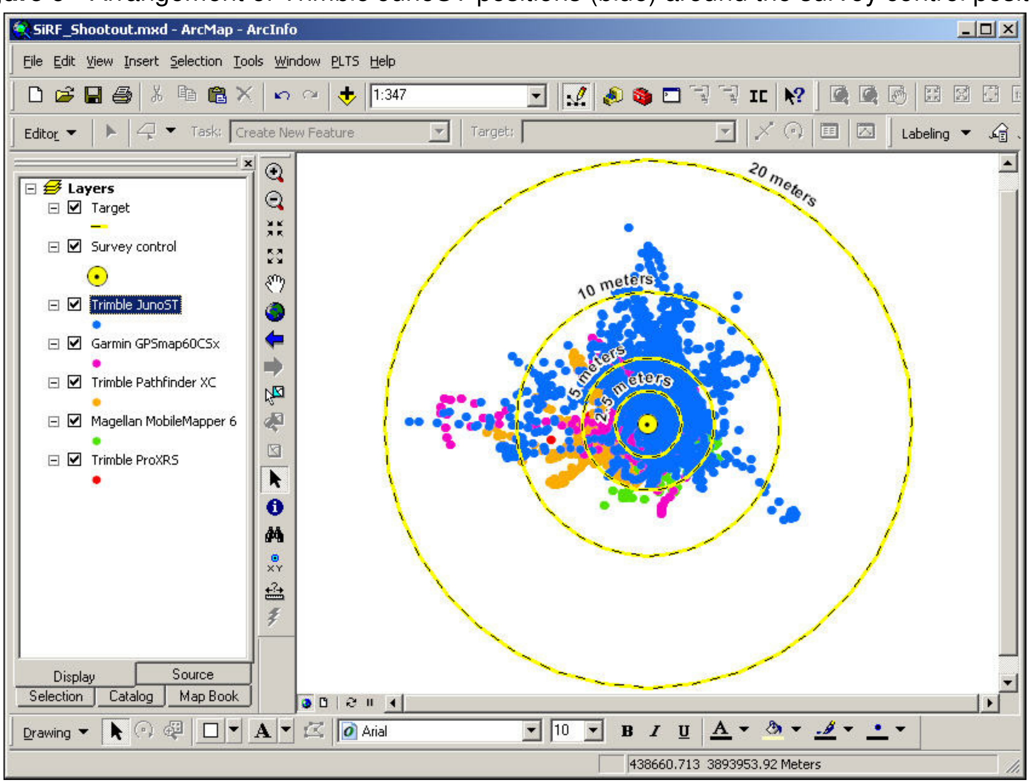

Figure 10 – Estimated PDOP (15° elevation mask) during the test period

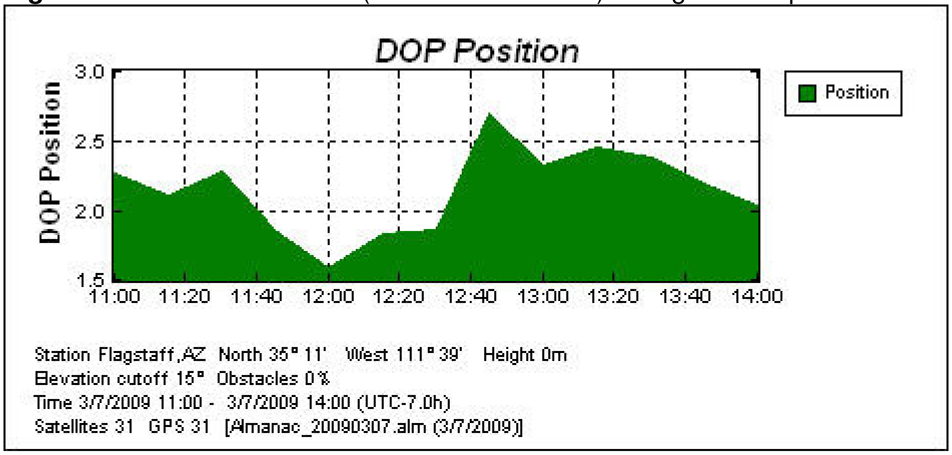

Figure 11 – Estimated number of satellites in view (15° elevation mask) during the test period