

## Errors in GPS Readings When Satellite Signals are Obscured

Laurent Lacroix

What happens when GPS satellite signals are obscured by buildings or tree canopy? How badly is accuracy affected? Even in cases where not all satellite signals are lost, measurement is seriously compromised. To illustrate this, I drove my Nissan through downtown Winnipeg's most famous intersection, Portage and Main, with an eTrex GPS.

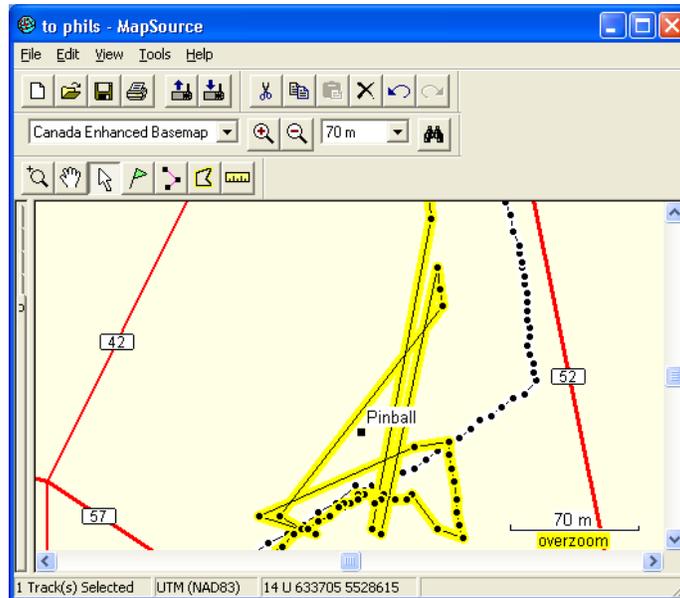
The device's track log was set to record track points at one second intervals and set on the dashboard by the windshield (this unit does not accept an external antenna). The result of a weak or lost signal is that the GPS is unable to record a definite position, even when stationary. The track log in Fig. 1 shows how the GPS records position when this is the case. Undefined positions are shown as movement, as demonstrated in track points 4 to 7. According to the GPS, my decade-old Nissan is capable of acceleration that would make NASA proud! For a 30 second period the GPS recorded 786.8 metres of displacement. A glance at the track log (in yellow) on the map (Fig. 2), dramatically illustrates how the GPS perceived its movement over the 26 seconds between 16:51:25 and 16:51:50 on November 9, 2002.

Figure 1. Track Points Recorded in Downtown Winnipeg, 2002-11-09

Index	Time	Altitude	Leg Length	Leg Time	Leg Speed	Leg Course	Position
3	11/9/2002 4:51:24 PM	222.7 m	12.0 m	00:00:01	43.4 kph	171° grid	14 U 633659 5528814
4	11/9/2002 4:51:25 PM	223.2 m	12.0 m	00:00:01	43.4 kph	171° grid	14 U 633661 5528802
5	11/9/2002 4:51:26 PM	222.7 m	172.6 m	00:00:01	622 kph	189° grid	14 U 633663 5528790
6	11/9/2002 4:51:27 PM	223.2 m	5.2 m	00:00:01	18.7 kph	116° grid	14 U 633635 5528620
7	11/9/2002 4:51:28 PM	223.2 m	148.9 m	00:00:01	536 kph	11° grid	14 U 633639 5528618
8	11/9/2002 4:51:29 PM	223.2 m	12.0 m	00:00:01	43.4 kph	171° grid	14 U 633667 5528764
9	11/9/2002 4:51:30 PM	223.2 m	9.7 m	00:00:01	34.8 kph	169° grid	14 U 633668 5528752
10	11/9/2002 4:51:31 PM	222.2 m	145.3 m	00:00:01	523 kph	216° grid	14 U 633670 5528742
11	11/9/2002 4:51:32 PM	222.2 m	14.2 m	00:00:01	51.3 kph	119° grid	14 U 633584 5528626
12	11/9/2002 4:51:33 PM	222.2 m	8.1 m	00:00:01	29.0 kph	106° grid	14 U 633596 5528619
13	11/9/2002 4:51:34 PM	223.2 m	32.2 m	00:00:01	116 kph	286° grid	14 U 633604 5528617
14	11/9/2002 4:51:35 PM	223.2 m	92.9 m	00:00:01	334 kph	64° grid	14 U 633573 5528625
15	11/9/2002 4:51:36 PM	223.2 m	18.6 m	00:00:01	67.0 kph	81° grid	14 U 633657 5528666
16	11/9/2002 4:51:37 PM	222.2 m	7.2 m	00:00:01	25.8 kph	179° grid	14 U 633675 5528669
17	11/9/2002 4:51:38 PM	222.2 m	7.3 m	00:00:01	26.4 kph	166° grid	14 U 633675 5528661
18	11/9/2002 4:51:39 PM	222.7 m	7.3 m	00:00:01	26.4 kph	166° grid	14 U 633677 5528654
19	11/9/2002 4:51:40 PM	222.7 m	9.7 m	00:00:01	34.8 kph	169° grid	14 U 633679 5528647
20	11/9/2002 4:51:41 PM	223.2 m	7.2 m	00:00:01	25.8 kph	179° grid	14 U 633681 5528638
21	11/9/2002 4:51:42 PM	223.2 m	7.3 m	00:00:01	26.4 kph	166° grid	14 U 633681 5528631
22	11/9/2002 4:51:43 PM	223.6 m	7.3 m	00:00:01	26.4 kph	166° grid	14 U 633682 5528623
23	11/9/2002 4:51:44 PM	224.1 m	14.6 m	00:00:01	52.7 kph	288° grid	14 U 633684 5528616
24	11/9/2002 4:51:45 PM	224.1 m	23.6 m	00:00:01	85.0 kph	323° grid	14 U 633670 5528621
25	11/9/2002 4:51:46 PM	224.1 m	3.9 m	00:00:01	14.0 kph	231° grid	14 U 633656 5528639
26	11/9/2002 4:51:47 PM	224.1 m	6.2 m	00:00:01	22.2 kph	269° grid	14 U 633653 5528637
27	11/9/2002 4:51:48 PM	224.1 m	6.6 m	00:00:01	23.8 kph	290° grid	14 U 633647 5528637
28	11/9/2002 4:51:49 PM	224.6 m	2.8 m	00:00:01	10.2 kph	211° grid	14 U 633640 5528639
29	11/9/2002 4:51:50 PM	225.6 m	3.9 m	00:00:01	14.0 kph	231° grid	14 U 633639 5528637
30	11/9/2002 4:51:51 PM	225.1 m	5.0 m	00:00:01	18.1 kph	341° grid	14 U 633636 5528634

Points: 26    Length: 786.8 m    Elapsed Time: 00:00:26    Avg Speed: 109 kph    Show On Map

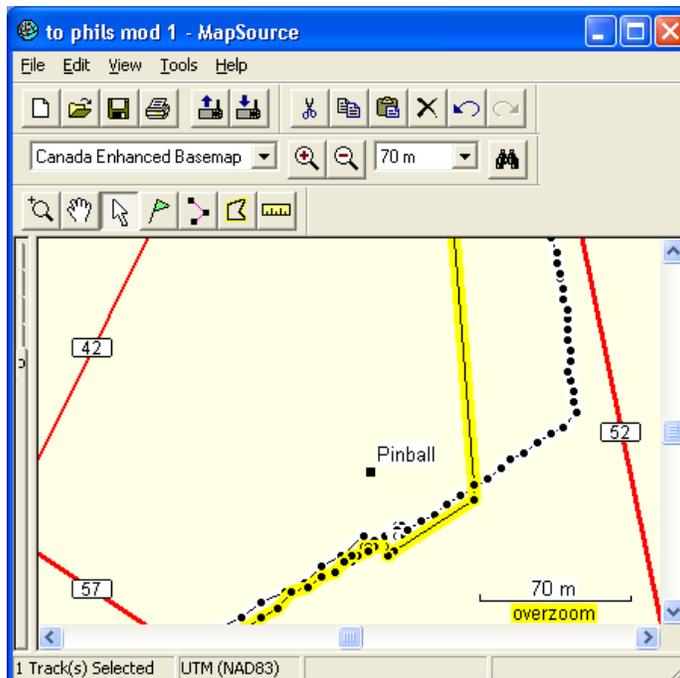
**Figure 2. Track Log Recorded in Downtown Winnipeg, 2002-11-09**



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An estimate of the actual displacement is possible by deleting the track points that show the most inconsistencies with the known path. The map in Fig. 3 shows a closer estimate of the actual trajectory, though the GPS still puts me puts me and my trusty Nissan on the wrong side of the road for a while according to an earlier track log (the one that's not highlighted in yellow).

**Figure 3. Track Log With Deleted Track Points**



With the offending track points deleted, the measured course is now 189.2 metres, a difference of 597.6 metres. My average speed for that 26 second interval drops from 109 km/h to respectable 26.2 km/h, which is what you'd expect with Winnipeg's poorly coordinated traffic signals.

**Figure 4. Track Points With Deletions Between 16:51:25 and 16:51:50**

Index	Time	Altitude	Leg Length	Leg Time	Leg Speed	Leg Course	Position
1	11/9/2002 4:51:22 PM	222.2 m	12.0 m	00:00:01	43.4 kph	171° grid	14 U 633656 5528838
2	11/9/2002 4:51:23 PM	223.2 m	12.0 m	00:00:01	43.4 kph	171° grid	14 U 633657 5528826
3	11/9/2002 4:51:24 PM	222.7 m	12.0 m	00:00:01	43.4 kph	171° grid	14 U 633659 5528814
4	11/9/2002 4:51:25 PM	223.2 m	134.2 m	00:00:12	40.3 kph	174° grid	14 U 633661 5528802
5	11/9/2002 4:51:37 PM	222.2 m	7.2 m	00:00:01	25.8 kph	179° grid	14 U 633675 5528669
6	11/9/2002 4:51:38 PM	222.2 m	44.0 m	00:00:12	13.2 kph	236° grid	14 U 633675 5528661
7	11/9/2002 4:51:50 PM	225.6 m	3.9 m	00:00:01	14.0 kph	231° grid	14 U 633639 5528637
8	11/9/2002 4:51:51 PM	225.1 m	5.0 m	00:00:01	18.1 kph	341° grid	14 U 633636 5528634
9	11/9/2002 4:51:52 PM	225.1 m	1.5 m	00:00:01	5.5 kph	269° grid	14 U 633634 5528639
10	11/9/2002 4:51:53 PM	225.6 m	1.5 m	00:00:01	5.5 kph	269° grid	14 U 633633 5528639

Points: 4    Length: 189.2 m    Elapsed Time: 00:00:26    Avg Speed: 26.2 kph

My conclusion is that Paul Oerth is going to be in the counter manufacturing in business for a few more years.