WAAS Technical Memorandum

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DR#110: PRN4 Carrier Phase Anomalies Cause WAAS SV Alerts

GPS Week/Day: W16954 (5-Jul-12) through W1701D5 (17-Aug-12)

Discussion:

On twelve separate days, beginning July 5, 2012 extending through August 17, 2012, PRN 4 experienced repeated carrier phase anomalies on the L1 frequency. In response to these anomalies, WAAS issued SV alerts on the satellite, appropriately increasing the UDREi values. The satellite was set to "Not Monitored" (UDREi=14) by WAAS in response to the detected events. The dates, times, event lengths and UDREi values of all the events are documented in Table 1 below.

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Table 1: PRN4 Carrier Phase Event Summary

GPS Week/Day (Calendar Date)	Start Time (GMT)	Stop Time (GMT)	Event Duration (seconds)	UDREi Change (before – after)
W1695D4 (5-Jul)	22:52:04	22:52:14	10	6 - 14
	22:52:25	22:53:55	90	11 - 14
	22:53:16	22:53:55	39	12 - 14
W1695D5 (6-Jul)	0:27:44	0:27:53	10	5 - 14
W1696D1 (9-Jul)	14:11:28	14:17:07	339	7 - 14
	23:44:40	23:44:49	9	5 - 14
W1696D3 (11-Jul)	3:07:34	3:07:43	9	11 - 12
	3:08:10	3:08:19	9	11 - 14
	3:34:18	3:36:45	147	7 - 14
	3:44:35	3:50:31	356	11 - 14
W1696D4 (12-Jul)	23:09:34	23:09:43	9	5 - 14
W1698D3 (25-Jul)	20:59:15	21:02:06	171	12 - 14
W1699D0 (29-Jul)	23:44:04	23:44:13	9	5 - 14
W1699D2 (31-Jul)	22:09:04	22:09:13	10	6 - 14
W1699D6 (4-Aug)	11:26:51	11:33:48	417	9 - 14
W1700D4 (9-Aug)	22:42:02	22:42:11	9	5 - 14
W1701D3 (15-Aug)	10:33:15	10:40:42	447	11 - 14
W1701D5 (17-Aug)	22:28:34	22:28:43	9	5 - 14

Figures 1 through 6 below show the range error's rate of change for PRN4 during several times WAAS issued SV alerts. The red traces show the difference between L1 code-based pseudorange and the estimated true range. The green trace displays the difference between the L1 carrier-based pseudorange and the estimated true range. The plots show the carrier phase anomaly as a bump in the green curve (high rate of change) at the times WAAS issued SV alerts. This "bumping" effect was apparent for every instance documented in Table 1.

Every event in table 1 resulted in a loss of LPV200 coverage in CONUS. The August 17th event was slightly different because of the prominent location of PRN4 over North America during the event. That particular event resulted in a LPV200 coverage loss in CONUS, Alaska and Mexico. Figures 7 through 10 show the LPV200 coverage over North America for July 5th, 9th, 11th and 17th respectively. On September 24th, satellite maintenance was performed on PRN4 per NANU's 2012056 & 2012058. Since the maintenance action, no carrier phase anomalies have been detected by the WAAS system on PRN4.

Conclusion:

PRN4 experienced multiple carrier phase anomalies over the course of two months. The WAAS system reaction was to issue SV alerts based on the severity of the anomaly. As a result of the SV alerts issued by WAAS, LPV200 coverage was diminished in every instance.

Figure 1: Code & Carrier Pseudorange at Kansas City, KS – July 5, 2012

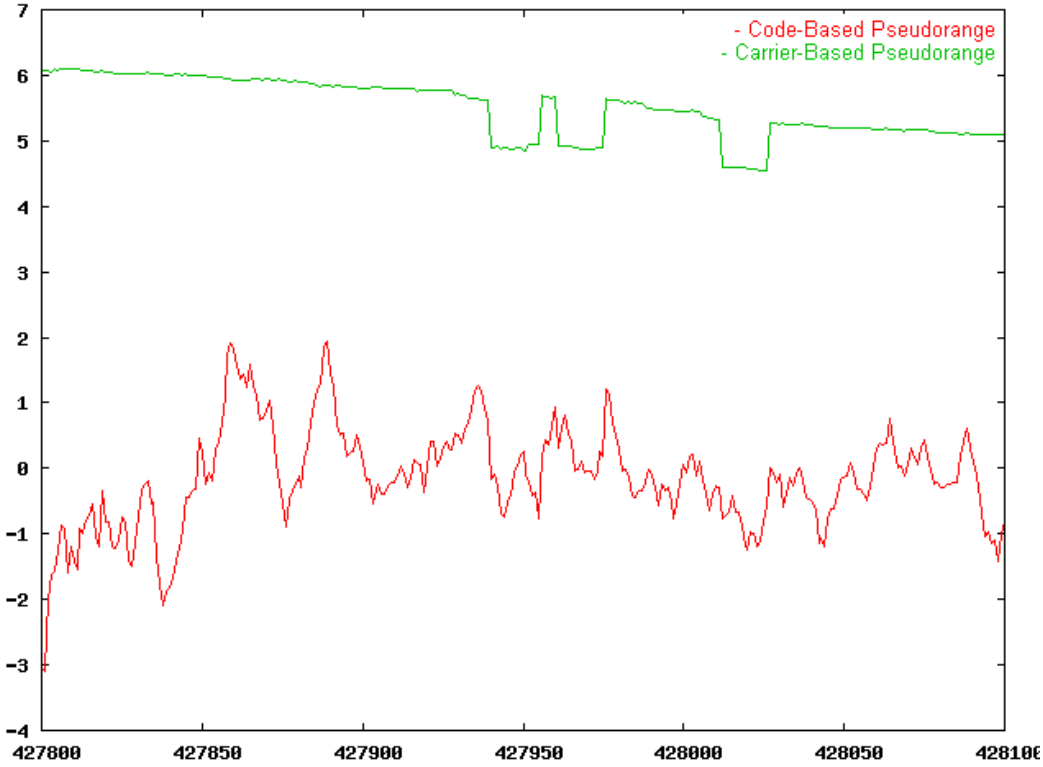

Figure 2: Code & Carrier Pseudorange at Kansas City, KS – July 6, 2012

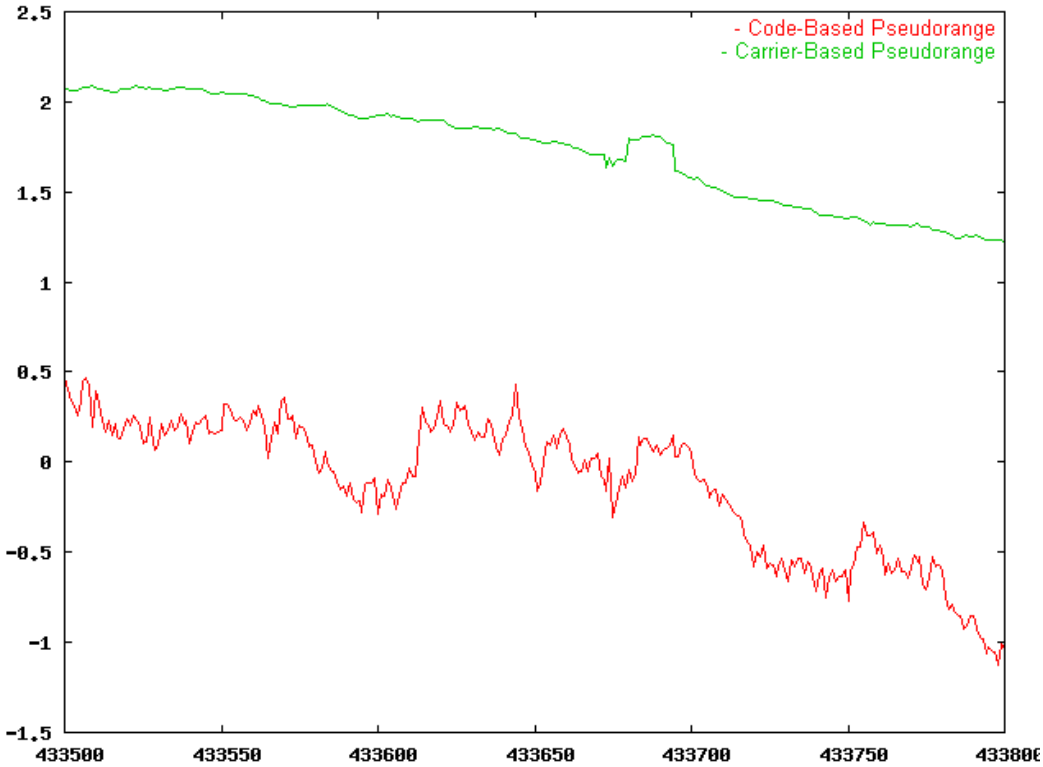

Figure 3: Code & Carrier Pseudorange at Barrow, AK – July 9, 2012

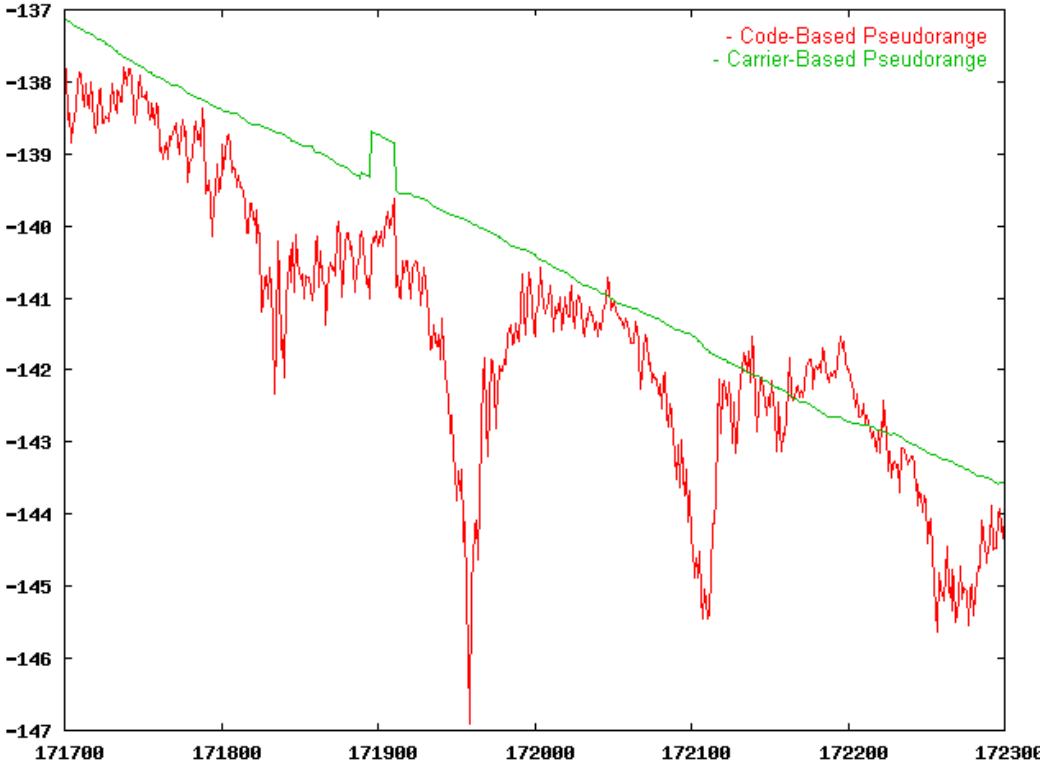

Figure 4: Code & Carrier Pseudorange at Barrow, AK – July 9, 2012

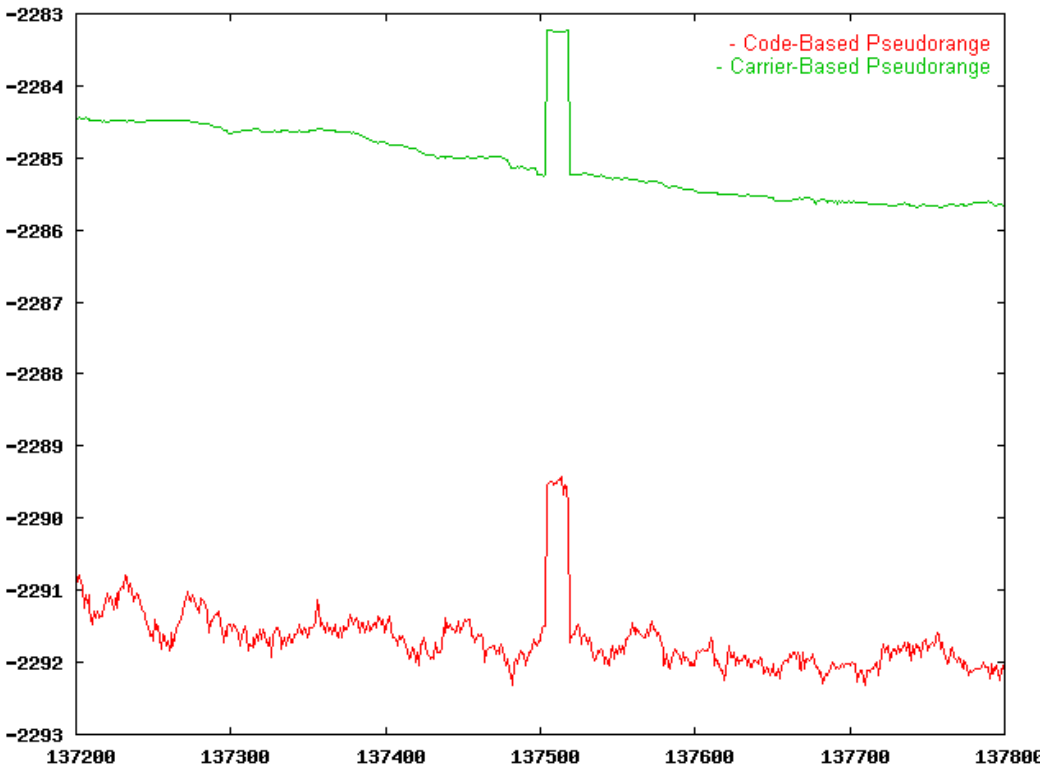

Figure 5: Code & Carrier Pseudorange at Boston, MA – July 11, 2012

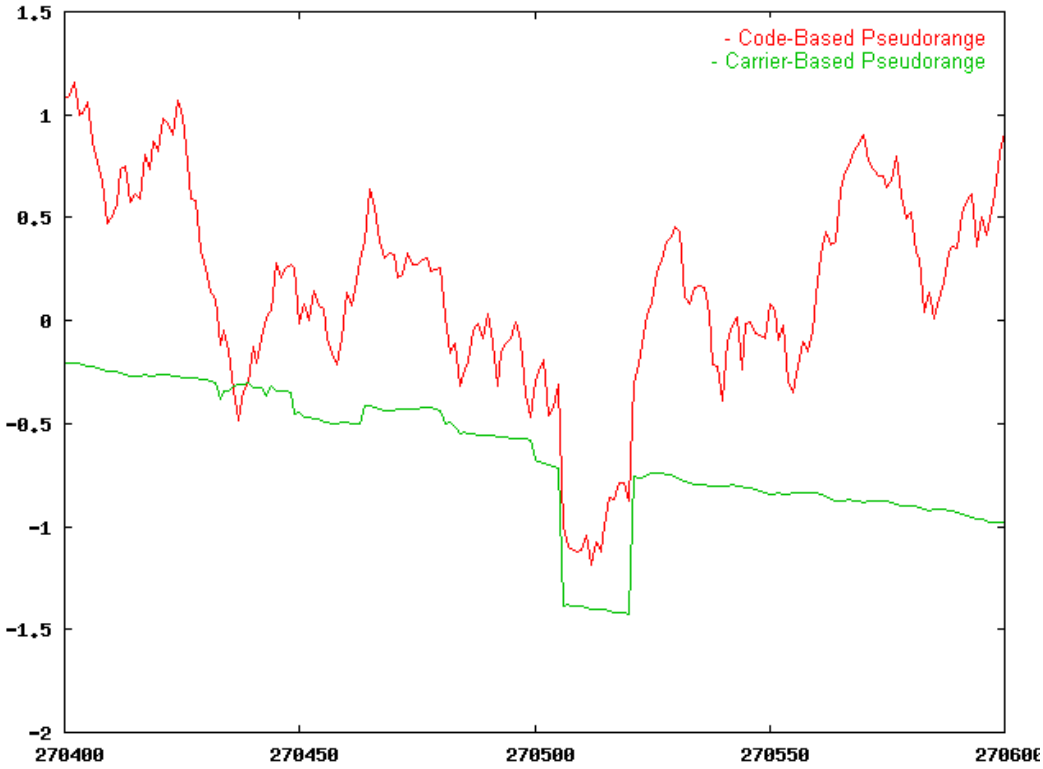

Figure 6: Code & Carrier Pseudorange at Chicago, IL – July 29, 2012

Figure 7: North America LPV200 Coverage – July 5, 2012

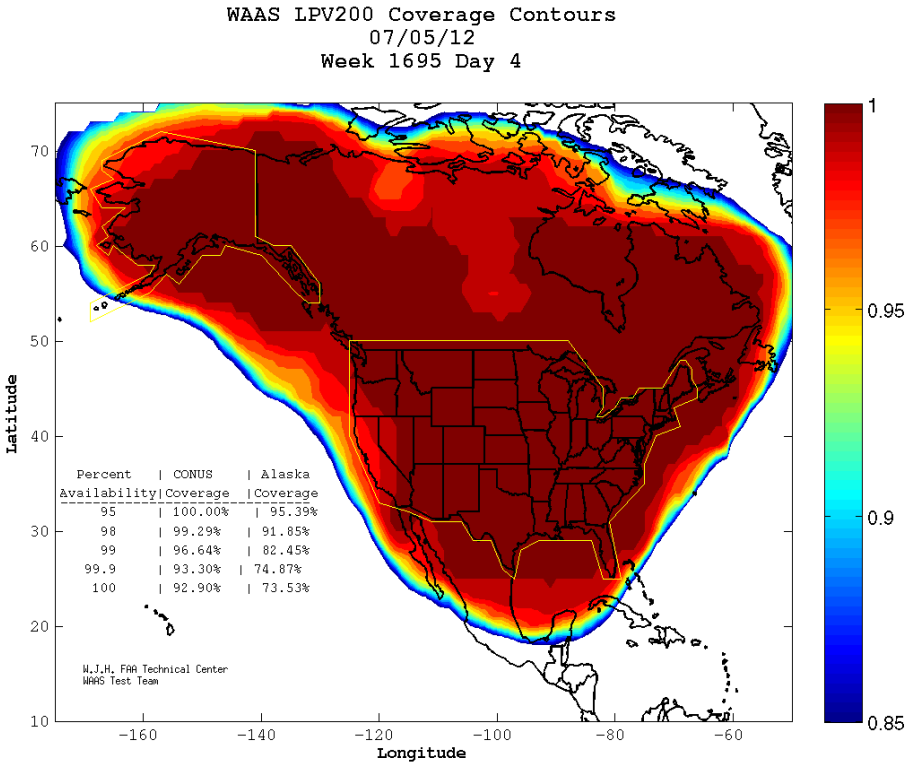

Figure 8: North America LPV200 Coverage – July 9, 2012

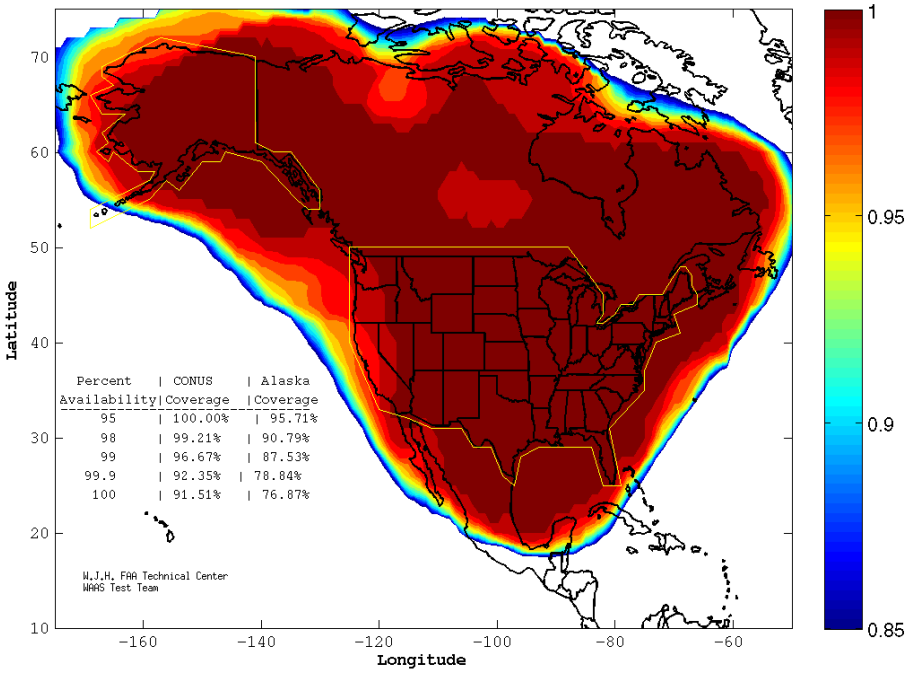

Figure 9: North America LPV200 Coverage – July 11, 2012

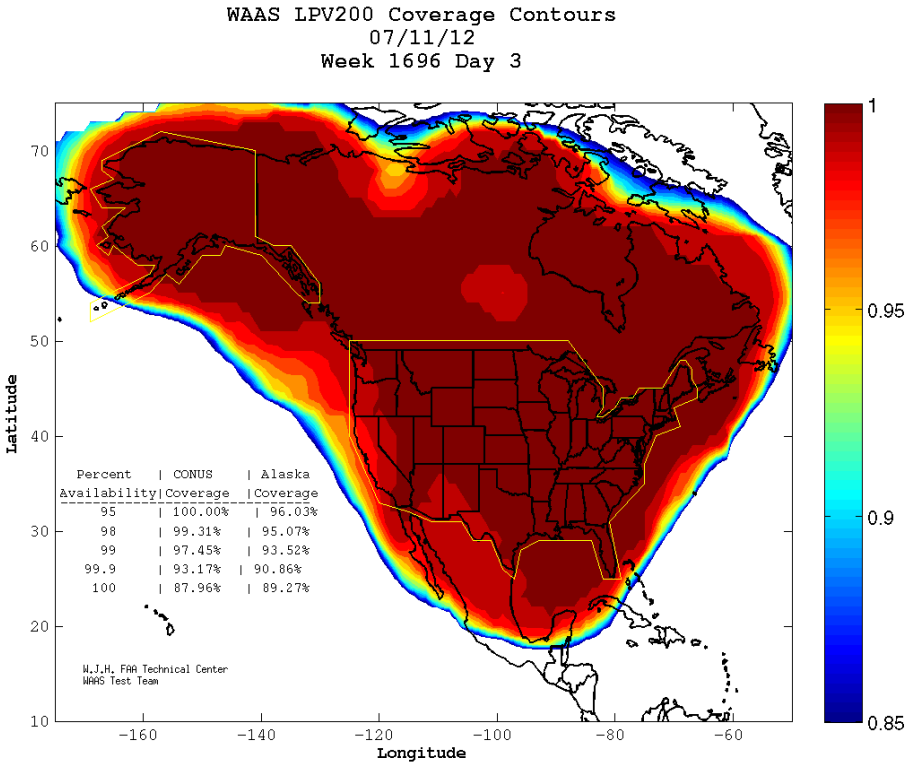

Figure 10: North America LPV200 Coverage – July 17, 2012