WAAS Technical Report
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DR#6: Localized Loss of Availability due to SV 27 Being Set 'Do Not Use'
GPS Week/Day: Week 1321 Day 4 (5/5/2005)

Discussion:

On Day 0 of GPS Week 1323 (5/15/2005), 99% and 100% LPV availability levels were lost over a localized area in the vicinity of the Great Lakes. Receivers that were specifically affected included the Chicago WAAS reference station as well as the Cleveland WAAS reference station. Although ionospheric activity that occurred that day was considered as a potential reason for this loss of service, problems with SV 27 turned out to be the cause.

At GPS time of week 4559, SV 27's UDREi was changed from 14 to 15, or from 'Not Monitored' to "Do Not Use' rendering it unusable as a ranging source. Table 1 is an excerpt from an output file created by daily processing that is performed post-time on the GEO WAAS message stream. Note satellite 27's UDREi change.

Table 1 – SV UDREi changes

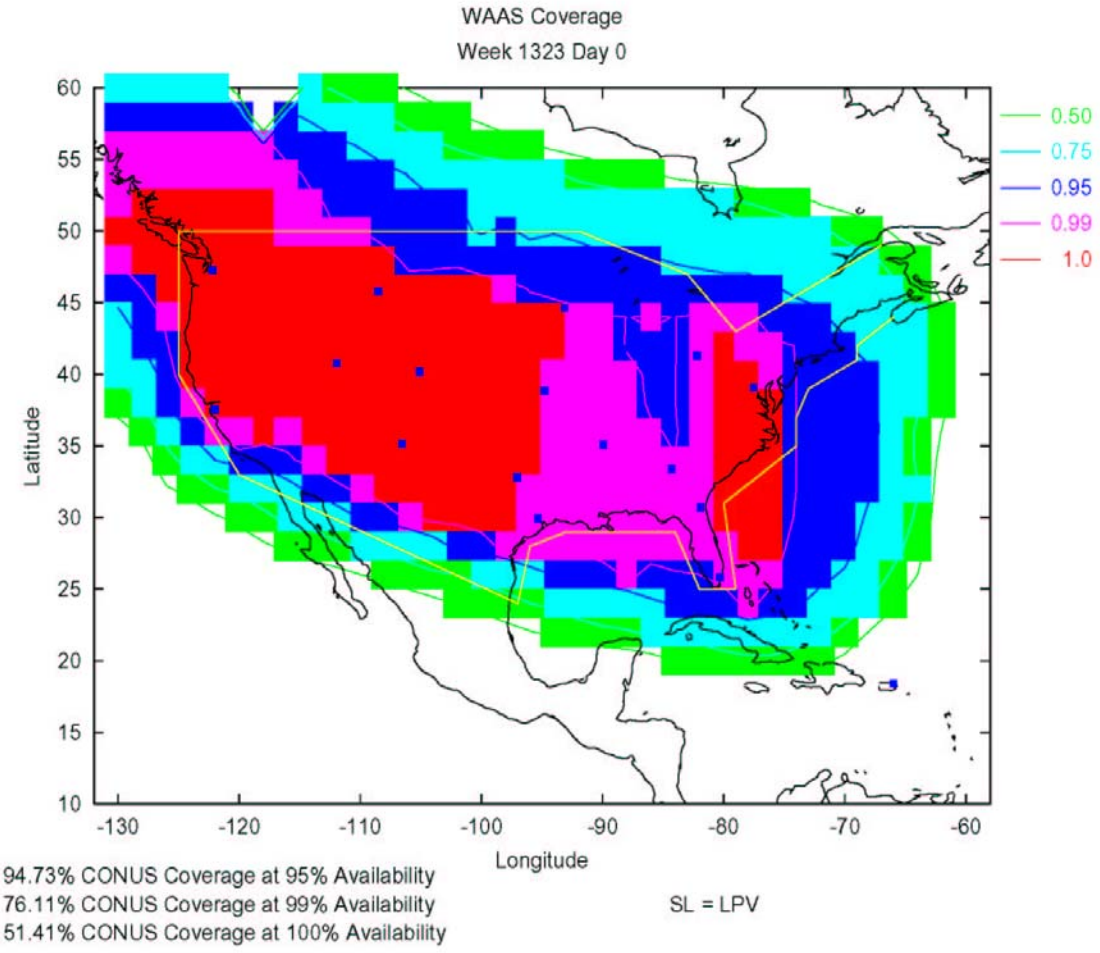
Message Type	SV	Prev UDREi	Current UDREi	Prev Time	Current Time	Delta	Status
T 3	S 24	7	6	4214	4220	6	PA -> PA
T 2	S 11	6	7	4392	4398	6	PA -> PA
T 2	S 2	14	12	4536	4542	6	NM -> NPA
T 3	**S 27**	**14**	**15**	**4556**	**4559**	**3**	**NM -> NU**
T 24	S 30	7	8	4684	4690	6	PA -> PA
T 3	S 16	6	5	4712	4718	6	PA -> PA
T 24	S 30	8	9	4750	4756	6	PA -> PA

This UDREi change was also independently verified with real-time processing that sends out e-mail alerts when a satellite's UDREi is set to 15, i.e. 'Do Not Use.' The content of this e-mail notification is as follows.

```
Satellite : 27
Time(GMT) : 01:15:46
GPS Week  : 1323
GPS Day   : 0
GPS TOW   : 4559
Old UDREI : 14
New UDREI : 15
```

The loss of SV 27 appears to have affected a very specific portion of the CONUS service volume. Figure 1 is a plot of LPV coverage for Day 0 of Week 1323. The loss of 99% and 100% availability of LPV occurred primarily from longitude 82W to 90W and latitude 35N to 45N.

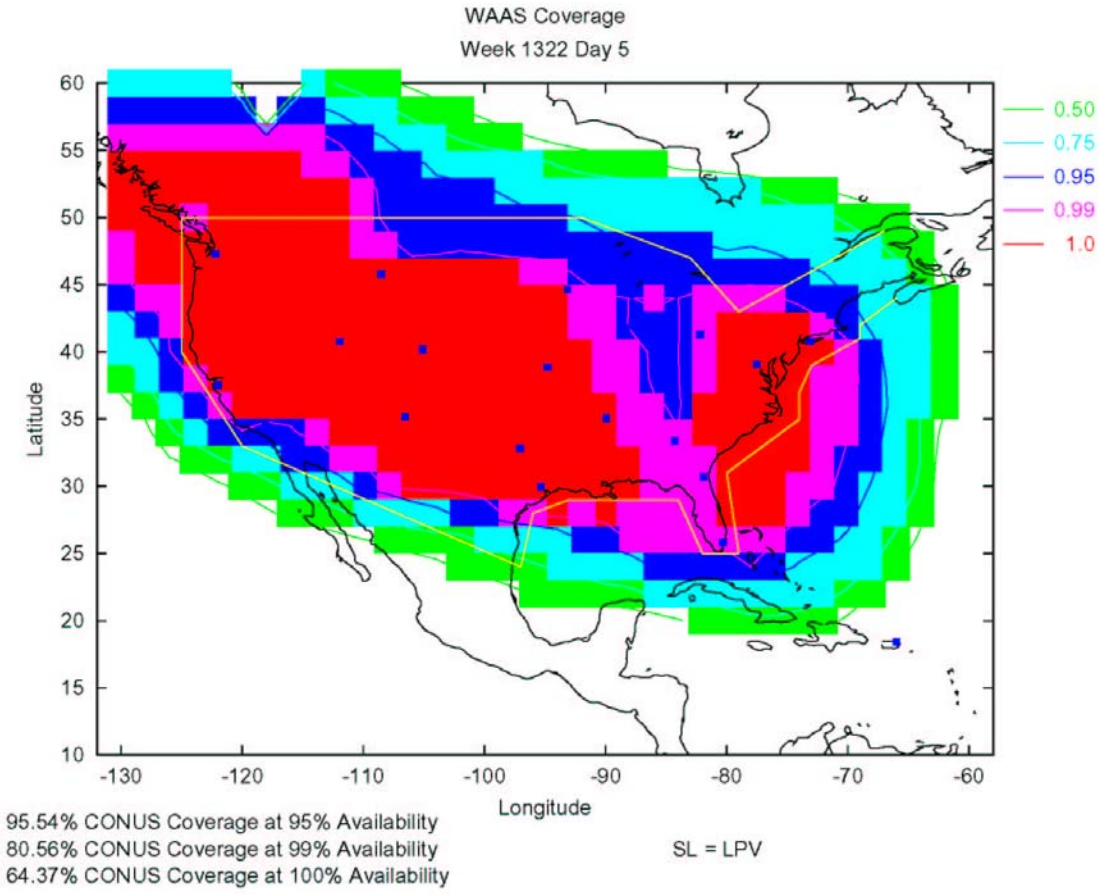
Figure 1 – LPV Coverage plot for Week 1323 Day 0



In order to distinguish the effects of losing satellite 27 as a ranging source from the effects (if any) of the ionospheric activity that was also observed on this day, a simulation

was run using data from a day that exhibited more robust coverage. Coverage was reprocessed using the WAAS message content from Day 5 of Week 1322 with satellite 27 manually edited from the almanac. This produced the following output plot (Figure 2), which illustrates that the localized loss of coverage observed on Day 0 of Week 1323 (5/15/2005) was a direct result of satellite 27 being set to 'Do Not Use.'

Figure 2 – LPV coverage plot from Week 1322 Day 5, loss of SV 27 simulated



Figures 1 and 2 show that both the actual loss of satellite 27 and the simulated loss of satellite 27 produced a similar and very specific pattern of availability loss within the CONUS service volume.

A trend of the instantaneous LPV coverage level (Figure 3) shows that availability losses occurred early in the day (~GPS Time 15,000 seconds). The change of SV 27's status to 'Do Not Use' also occurred early in the day (GPS Time 4559), however this time should not necessarily coincide directly with the availability losses, as the satellite was already set to 'Not Monitored.' What is more relevant is the fact that it remained 'Do Not Use' throughout the day and was ultimately unavailable during a period of time during which it is typically critical as a PA ranging source (~15,000 seconds into the GPS day). This

means that losses of availability would be experienced wherever it is most important to that region's satellite geometry during that time. In this case, that region was eastern/central CONUS. (SV 27's status was still 'Do Not Use' at the time this report was written.)

Figure 3 - % of CONUS Service Volume Available for LPV, 30 second sampling

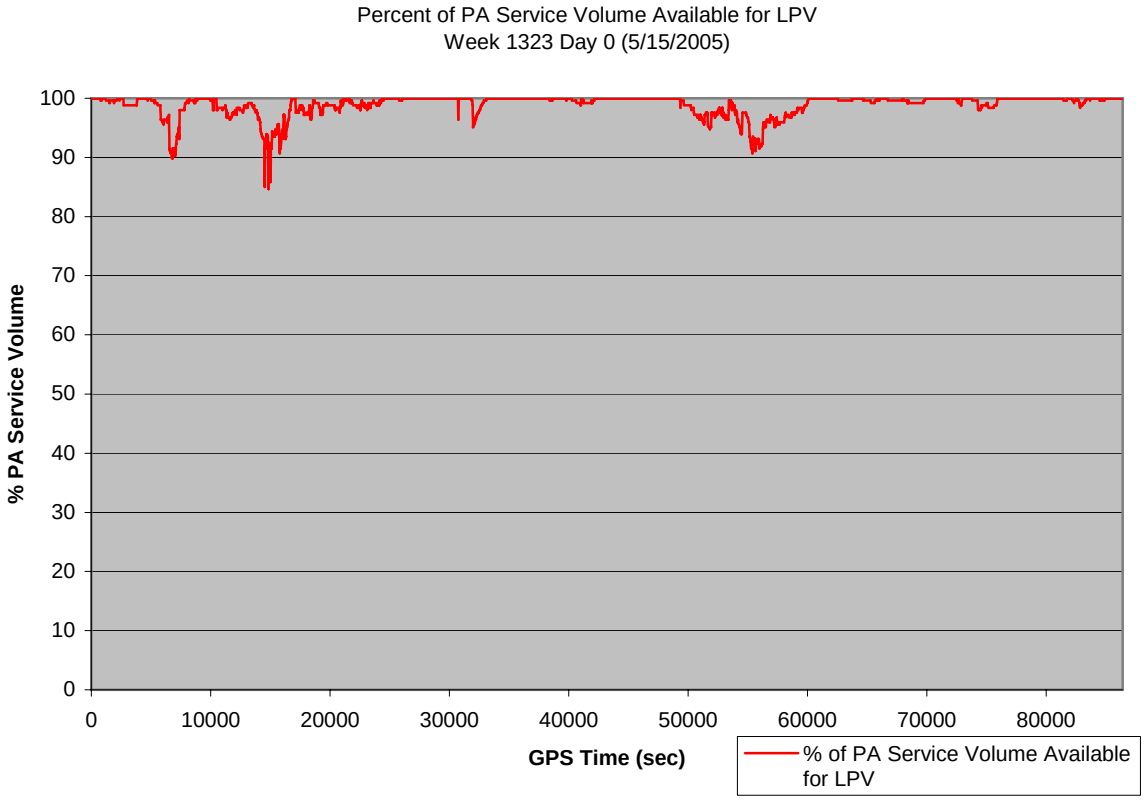
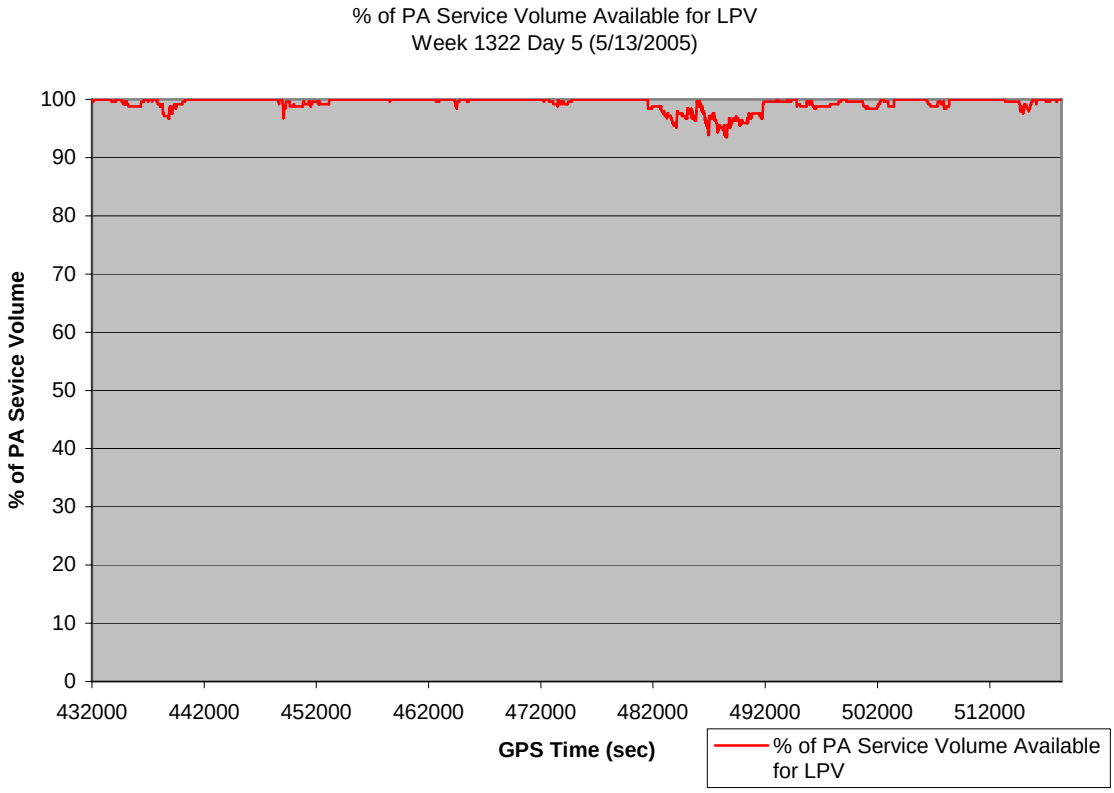


Figure 3 is otherwise representative of LPV coverage on a normal day, as can be seen when compared to the plot below (Figure 4), which is of LPV coverage for Week 1322 Day 5 (actual…not simulated to emulate the loss of SV 27). The only inconsistency is the second dip in the percentage of the PA service volume that is available, occurring around 15,000 seconds into Day 0. (It should be noted that the substantial loss occurring around 55,000 seconds into the day is a daily phenomena and is the result of performance currently delivered by the GPS/WAAS constellation.)

Figure 4 - % of CONUS Service Volume Available for LPV, 30 second sampling, Week 1322 Day 5



When the trend of instantaneous LPV coverage for Week 1323 Day 0 (Figure 3) is compared to a more typical day, Week 1322 Day 5 (Figure 4), the loss of availability occurring ~15,000 seconds into the day is clearly anomalous. A trend of instantaneous LPV coverage from data simulating the loss of SV 27 on Week 1322 Day 5 recreates this anomaly. See Figure 5.

Figure 5 - % of CONUS Service Volume Available for LPV, 30 second sampling, Week 1322 Day 5, loss of SV 27 simulated

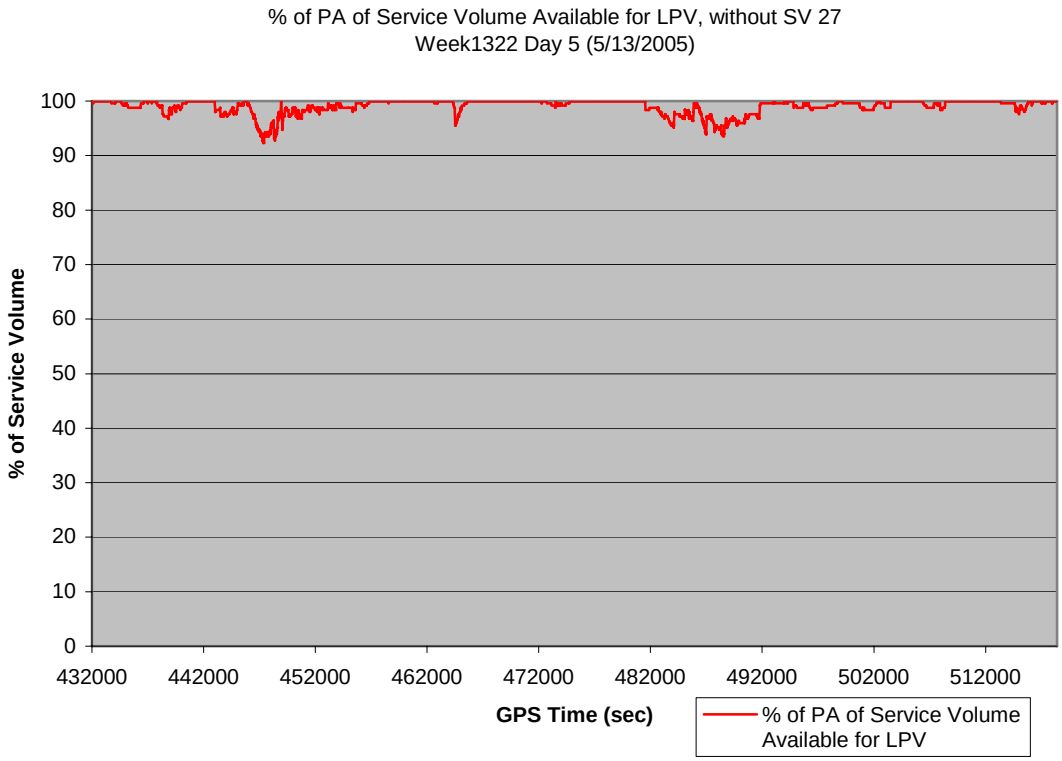


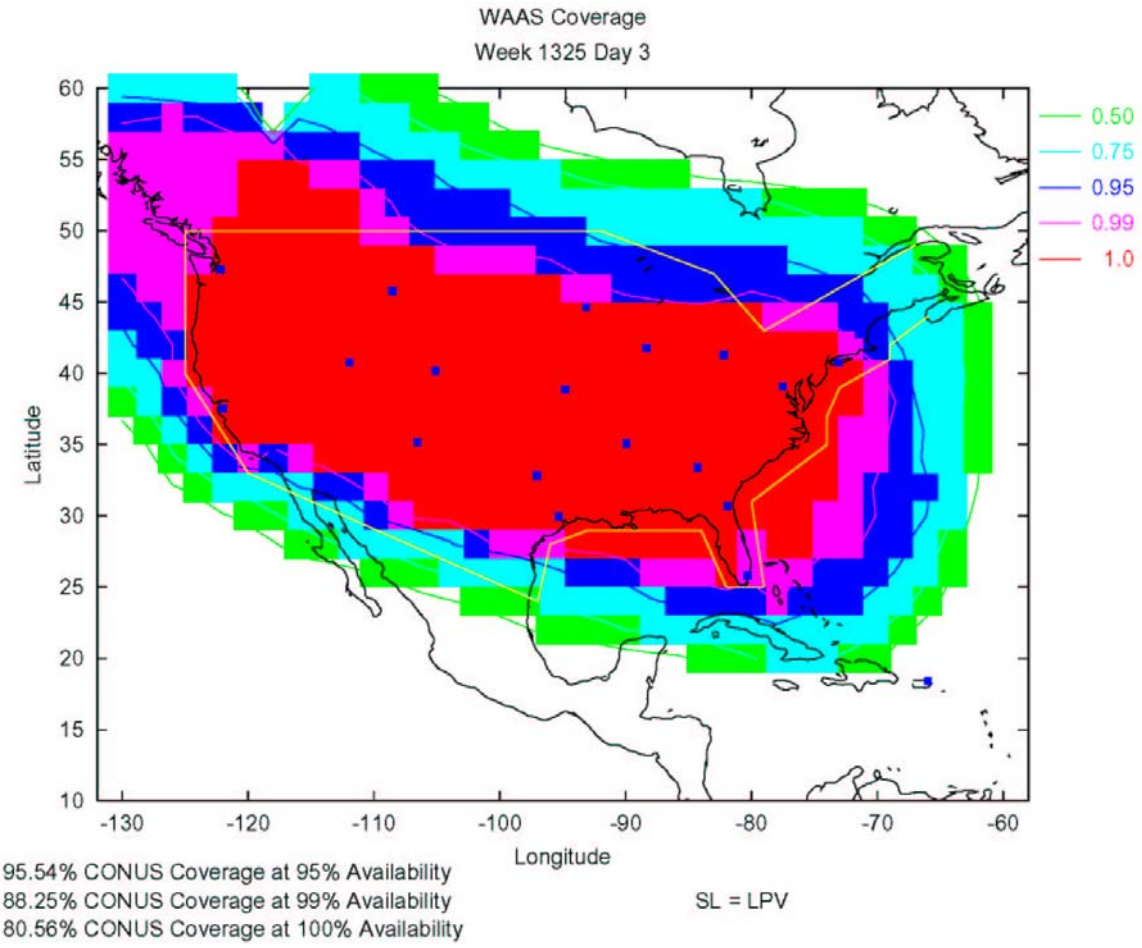
Figure 5 shows that a simulated loss of SV 27 creates a drop in coverage that is remarkably similar to the one resulting from the actual loss of SV 27, roughly 15,000 seconds into the day. Figure 2 shows that this loss occurred over a similar area.

On Week 1325 Day 3, SV 27 became available once again as a ranging source. Below are the contents of a real-time based e-mail alert containing the time and UDREi change for satellite 27.

```
Satellite : 27
Time(GMT) : 00:50:49
GPS Week  : 1325
GPS Day   : 3
GPS TOW   : 262262
Old UDREI : 15
New UDREI : 14
```

WAAS coverage improved significantly as a result of SV 27's return. Figure 6 is a contour plot of LPV coverage for Week 1325 Day 3, the day of satellite 27's return from Do Not Use status.

Figure 6 - LPV coverage plot from Week 1322 Day 3



Conclusion:

Analysis strongly supports the conclusion that the absence of satellite 27 as a ranging source is the direct cause of the recently observed availability loss in eastern/central CONUS and reduction in overall coverage values. The day that satellite 27 became available for PA ranging, coverage was restored to levels consistent with previous system performance.