WAAS Technical Report
William J. Hughes Technical Center
Pomona, New Jersey
July 12, 2005

Author(s): Nathan Vary

DR#12: UPM trip at Juneau causes NPA outage in the POR service area.
GPS Week/Day: Week 1330 Day6 (7/9/2005)

Discussion:

On Week 1330 Day 6 at approximately 11:33 AM UTC, three messages were broadcast on POR that affected the availability of 9 satellites, setting them all to "Not Monitored." The satellites returned to a monitored state approximately 6 seconds later. The loss of NPA availability at the 7 affected POR sites lasted approximately 12 seconds. The seven affected POR sites were Seattle, Cold Bay, Juneau, Anchorage, Honolulu, Mauna Loa and Kotzebue.

At the time of the event, AORW broadcast the same message types as POR, but they did not affect satellite UDRE values in the same manner. In other words, the message content differed between the two GEO streams. This is expected since the C&V processes data for each GEO separately. Table 1 below provides detail on the aforementioned POR messages' affect on satellite UDRE values. ZDC was the selected source for both AORW & POR for the entire day of the event. As stated above, there were no corresponding UDRE changes to list for AORW in the table below.

TABLE 1 – Summary of POR Messages and their effect on Satellite UDRE

Message Type	Time	Affected PRN	UDRE Change
T2	560016	2	11 → 14
T2	560016	6	10 → 14
T2	560016	10	11 → 14
T2	560016	13	12 → 14
T3	560017	16	10 → 14
T3	560017	21	11 → 14
T3	560017	25	07 → 14
T24	560018	30	09 → 14
T24	560018	134	13 → 14
T2	560022	2	14 → 05
T2	560022	6	14 → 05
T2	560022	10	14 → 05
T2	560022	13	14 → 12
T3	560023	16	14 → 10
T3	560023	21	14 → 06
T3	560023	25	14 → 07
T24	560024	30	14 → 05
T24	560024	134	14 → 13

Data taken from Raytheon's system monitoring website showed that there was a UPM (User Position Monitor) trip in Juneau at the time of the event. Further investigation showed that this is what caused the satellites listed above to go to "Not Monitored." In the thirty seconds before the event, the vertical error at all three Juneau receivers jumped over three meters, while the ionospheric delay on PRN6 jumped almost two meters (See Figure 2). By design, a UPM trip sets all satellites tracked at that location to "Not Monitored" and all ionospheric grid points used at the particular site to "Not Monitored". All nine satellites tracked at Juneau at the time of the trip

matched the nine satellites affected by POR. There was no PA availability of AORW at Juneau, hence no satellites were affected on the AORW data stream. Table 2 below lists the affected Juneau grid points from AORW. UPM does not alarm when changing the UDRE or GIVE to 'Not Monitored'. Instead if the condition persists at the time the message is to be broadcast then the values of the UDRE or GIVE are set to 'Not Monitored'. In this case, the POR did not broadcast 'Not Monitored' for the affected grid points since their GIVE was scheduled to be broadcast after the UPM trip condition cleared.

**Table 2 – Summary of Affected Juneau Grid Points from AORW**

Latitude	Longitude	Previous GIVEi	Current GIVEi	Time
50	-135	11	15	560019
55	-135	11	15	560019
55	-140	11	15	560019
65	-140	12	15	560019
75	-140	12	15	560019
50	-135	15	11	560027
55	-135	15	11	560027
55	-140	15	11	560027
65	-140	15	12	560027
75	-140	15	12	560027

Investigation into the solar activity in the area at the time of the event showed some possible causes for the UPM trip. Figure 1 shows two Alaskan magnetometer charts, one from the day before the event and one from the day of the event. A magnetometer is an instrument that measures the strength of a magnetic field. The figure shows a significant amount of ionospheric activity compared to the previous day. Gakona is approximately five hundred miles northwest of Juneau. It is the closest magnetometer in Alaska.

Concerning Figure 1 below, the horizontal scale is always a full 24 hours. The vertical grid is 250 nano-Tesla/grid lines. The mean value (in nano-Tesla) printed off the right hand edge of the plot is the average magnetic field strength for that day for each component. The magnetic deviation displayed is computed from that value. The H-component (deviations down indicate the local field has dipped southward) has the greatest deviations in that direction and so is plotted on top. The D-component dips are magnetic west deviations as the magnetometer head is oriented in magnetic coordinates not geographic. The Z component is vertical component.

Note: Each component is offset by 2 vertical grid boxes (500 nT) where the component letter indicator off the left and the mean value on the right indicate the zero reference point for each curve. This was done so each component could be identified separately and does not reflect the absolute magnitude of the magnetic field of the component.

Figure 1 – Gakona, Alaska Magnetometer Charts: 8 & 9 July 2005
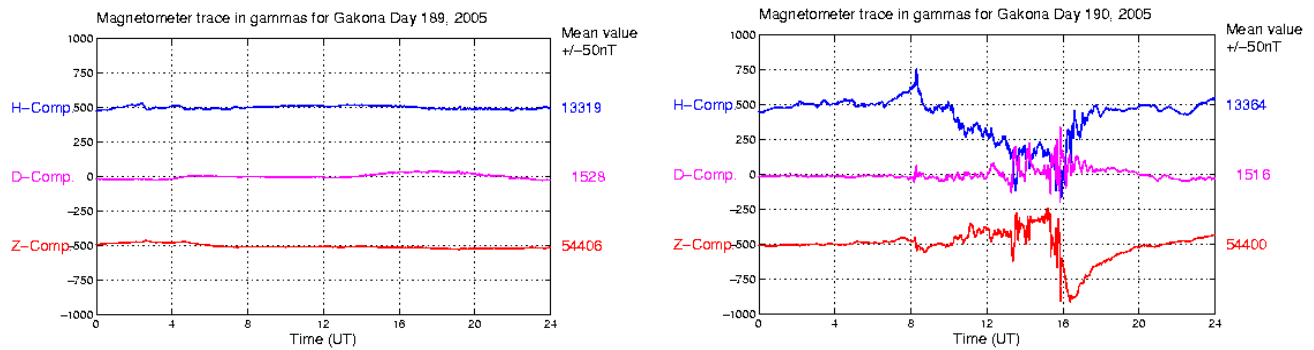
Looking deeper into the performance of the Juneau receiver at the time of the event, there was a drastic change in the vertical ionospheric error for PRN 6. This change greatly affected the vertical error at Juneau, most likely causing the UPM trip. Figure 2 shows the vertical position error at Juneau, along with the vertical ionospheric error for several satellites tracked at Juneau. The maximum vertical error at Juneau that day was 6.9 meters. The maximum vertical protection level (VPL) was 238 meters at time 560016, but reached 529 meters upon returning to NPA mode with 4 satellites used at time 560028.

Figure 2 – Vertical & Ionospheric Errors at Juneau: 9 July 2005
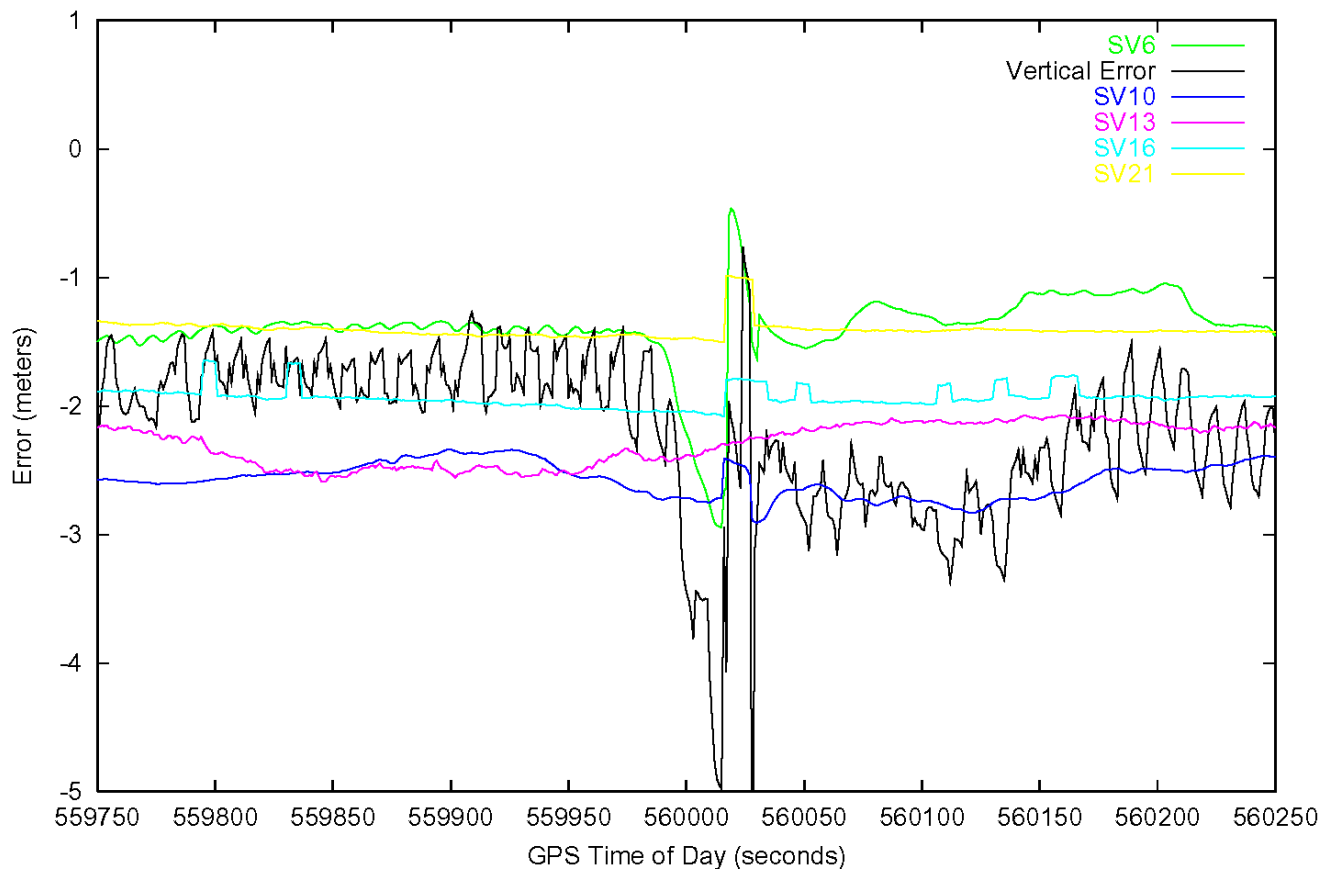
Conclusion:

A UPM trip, caused by ionospheric activity, set the nine satellites tracked at Juneau to "Not Monitored" by POR. This affected seven POR sites and created an NPA/PA outage to POR users. The UPM trip at Juneau also resulted in five ionospheric grid points being set to "Not Monitored." Further investigation

into the GEO data streams showed that the AORW data stream set the ionospheric grid points to "Not Monitored," but did not affect the UDRE's of the nine satellites tracked at Juneau. POR on the other hand, changed the UDRE's of the nine satellites, but did not have any effect on the grid points set to "Not Monitored" by AOR. This behavior is expected based on the design of the UPM.