WAAS Technical Memorandum
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Pomona, New Jersey
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DR #90 Extended SIS Outage on CRW (PRN 135)
GPS Week/Day: Week 1569 Day 6 (2/6/2010)

Discussion:

On February 6, 2010 there were no correction messages or ranging capability available from the WAAS GEO CRW (PRN 135) during a portion of the day. CRW stopped transmitting due to a known error condition that is being fixed in the next WAAS software update. The condition is a timing error when the primary GUS goes to backup status and the backup GUS does not get commanded to primary, resulting in a condition in which both GUS's are in backup mode. However, in this case, after maintenance activities it appeared that the CRW GEO was not transmitting, pointing to a problem with the GEO itself. By the end of the investigation, it was a maintenance action, not the GEO, which was the reason for the extended outage.

The two GUSs for the CRW GEO are Littleton and Napa. At the beginning of this event Napa was primary and commanded to backup by the C&V because the C&V had not received a message from CRW for a certain amount of time. When the C&V does not get a message for 4 seconds from a GEO the C&V assumes a problem with the GUS, so the C&V commanded a switch in primary from Napa to Littleton. However, due to the timing error, both GUSs had a state of 'backup'. The WAAS Operations Specialist (WOS) restarted both Napa and Littleton and tried to make Littleton the primary GUS. Due to an issue at Littleton, it was not able to get into primary mode. The WOS then designated Napa as the primary GUS and Littleton was commanded to be the backup GUS, and it appeared that the situation was resolved. After over one hour the WOS did not receive an indication of 'full loop lock'. Therefore the WOS commanded the Napa GUS to backup state and the Littleton GUS to primary. This action did fix the problem.

On February 4, 2010 the site technicians at Littleton switched to a new Klystron Power Amplifier (KPA). During this maintenance a switch control cable was not installed properly. This means that as soon as Littleton became primary it was not transmitting to the GEO, though there was no indication to the WOS that the GUS was not transmitting. Since it appeared that the Littleton GUS was transmitting the suspicion was that there was a problem with the GEO. Because the GEO was suspected to be the problem, the master oscillator and receiver on the GEO were switched to the backups. After this action did not fix the problem, further troubleshooting found the problem with the cable at the Littleton GUS.

The loss of the CRW SIS causes a loss of service in the area where the CRE GEO and the CRW GEO do not overlap. The location where there is no overlap includes northwestern Alaska and the western part of the Pacific Ocean, beyond the WAAS service volume. Figure 1 shows the footprints for the CRW and CRE GEOs.

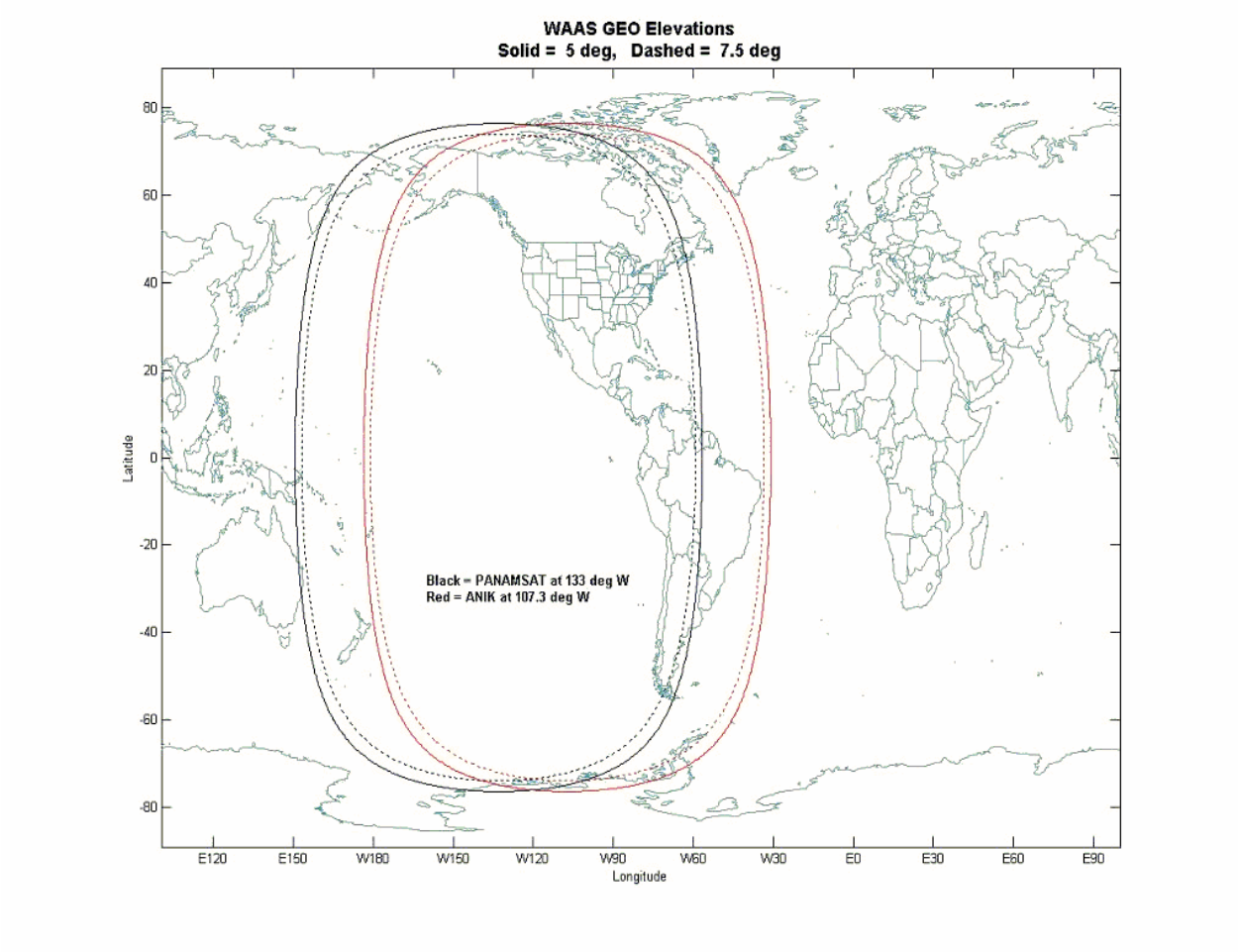

Figure 1. CRW and CRE GEO Footprints

The CRW GEO stopped transmitting at 3:11 GMT. At this time the C&V commanded Napa to be the backup GUS and both GUSs had a state of backup GUS. At 4:03 GMT the WAAS Operations Specialist (WOS) restored the SIS for CRW. Figure 2 shows a basket of coverage plots for North America before, during, and after the first CRW SIS event. Following clockwise and starting with the upper left plot the times for each of the plots are 3:11, 3:14, 4:05, and 4:08 GMT.

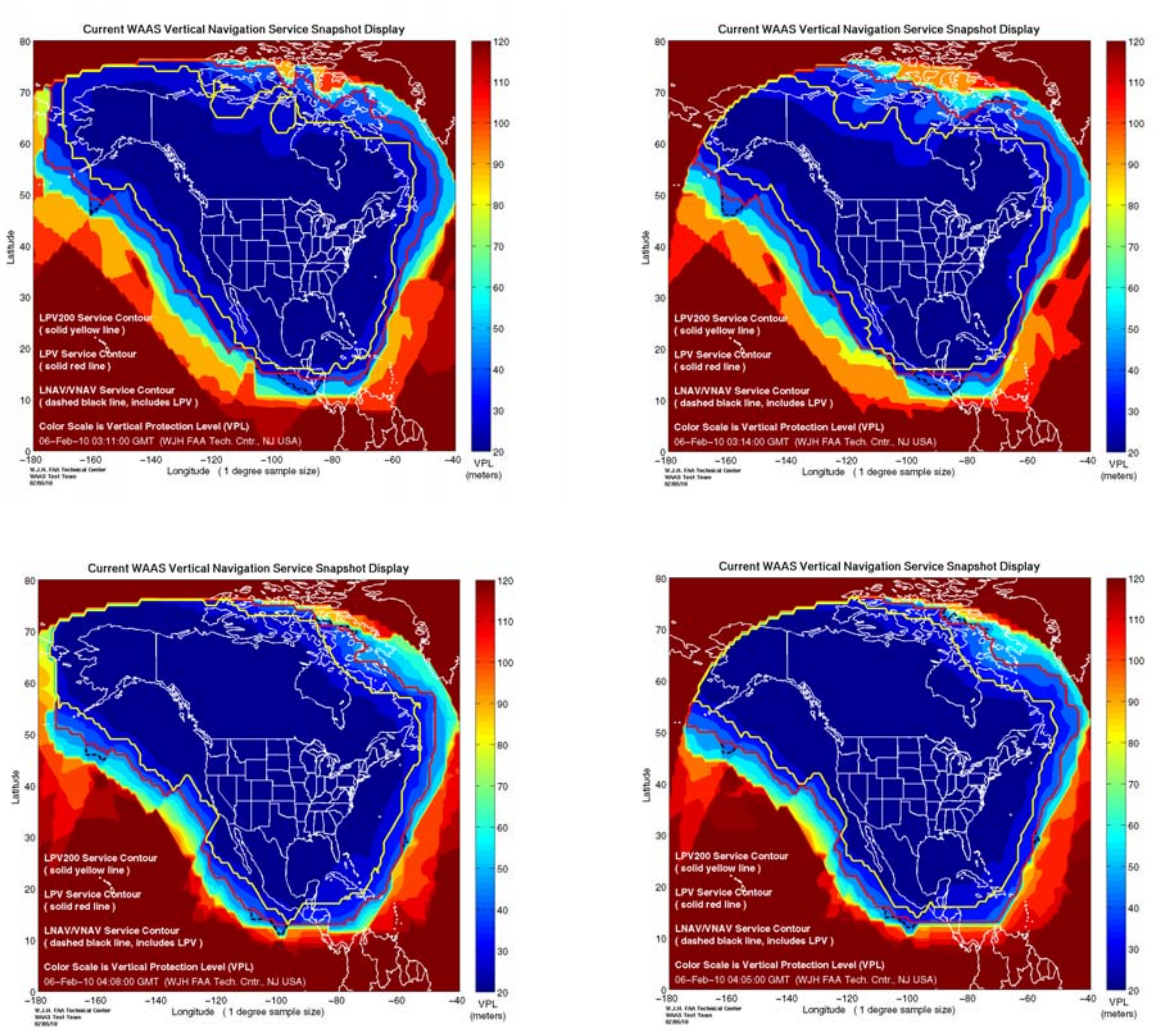

Figure 2. North America Coverage Plots during First CRW SIS Loss

Figure 3 shows plots of the entire WAAS service volume and the effect of losing the CRW SIS. The SIS loss follows closely with the GEO footprints shown in Figure 1. Similar to Figure 2, four plots are shown in Figure 3. Following clockwise and starting with the upper left plot the times for each of the plots are 3:11, 3:14, 4:02, and 4:05 GMT.

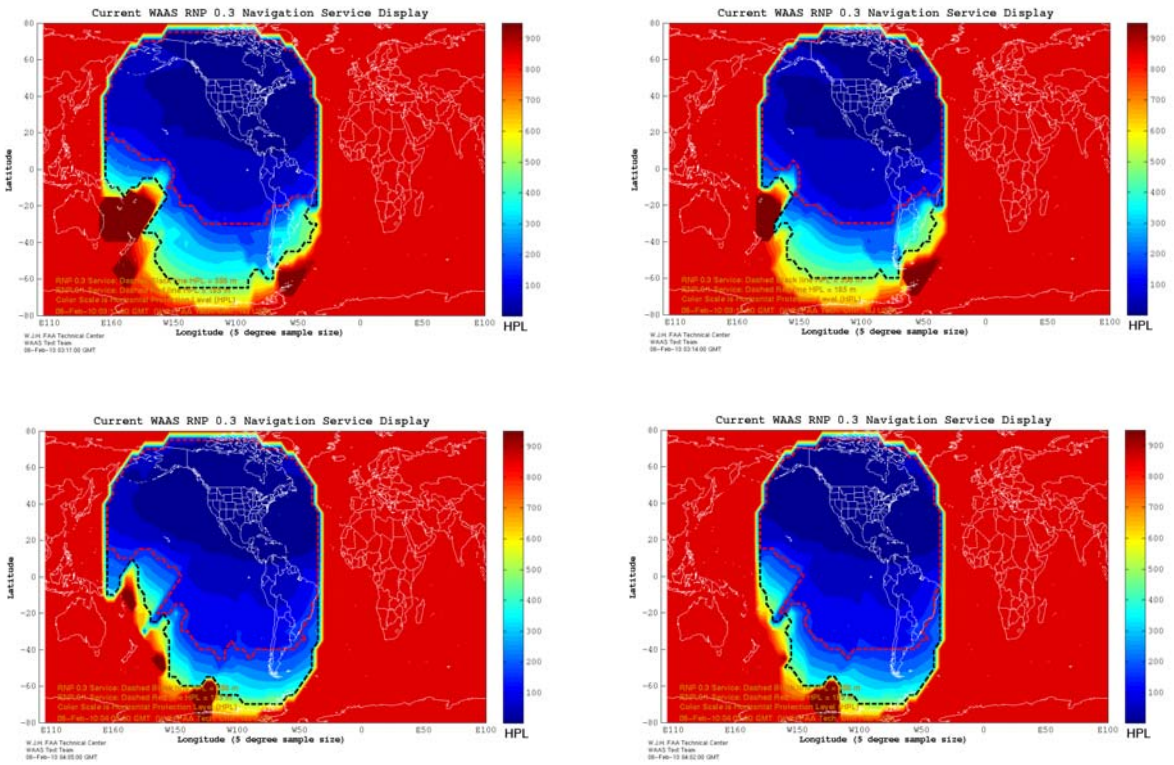

Figure 3. WAAS Service Volume during First CRW SIS Loss

The SIS returned but this event was not yet over. The SIS returned at approximately 4:03 GMT with Napa as primary and Littleton in backup. However, by 5:25 GMT no loop lock was observed for the Napa GUS. At 5:25 GMT the WOS commanded a GUS switch to make Littleton the primary GUS and Napa the backup. Littleton was not transmitting as expected, but the WOS did not receive this indication. At 5:49 GMT the Littleton GUS faulted and Napa was placed into maintenance mode to focus on the problem at Littleton.

At this point a problem with the GEO satellite was suspected. Littleton was again placed into the primary GUS state at 6:16 GMT. This would allow Intelsat engineers to troubleshoot the CRW GEO. By 11:45 GMT it was discovered that a waveguide switch control cable was hooked up incorrectly. This occurred during a maintenance action to replace the KPA on February 4. This cable controlled whether the WAAS signal is transmitted to the satellite or not. The configuration of the cable connection caused no signal to be transmitted to the satellite when the Littleton GUS was in primary state. The SIS returned for good at 11:45 GMT when Littleton became the primary GUS.

Figure 4 shows the WAAS LPV coverage just before the end of the outage and after the outage was over. Figure 5 shows the entire WAAS service volume just before the end of the outage and after the outage was over.

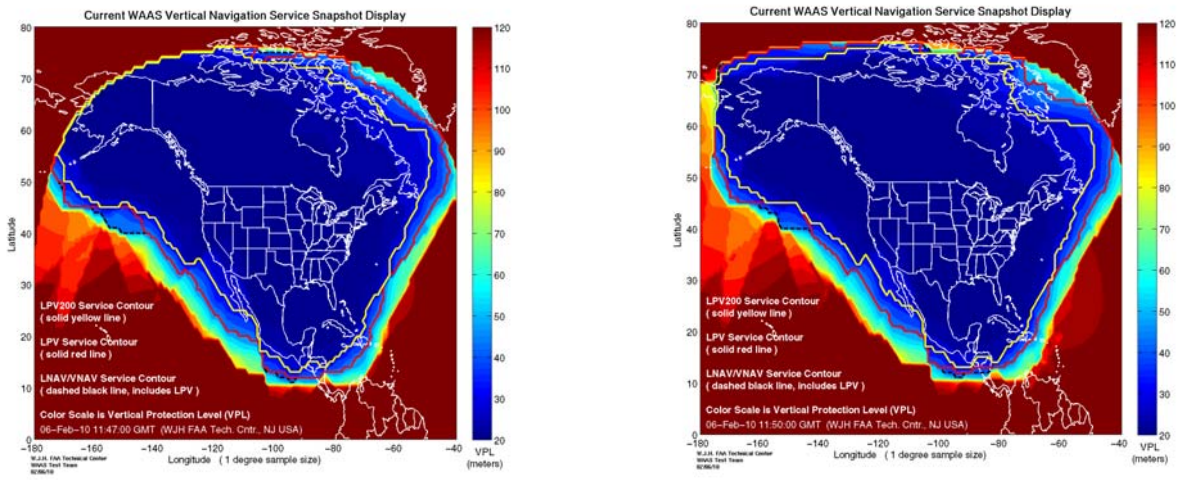

Figure 4. North America Coverage Plots during Second CRW SIS Loss

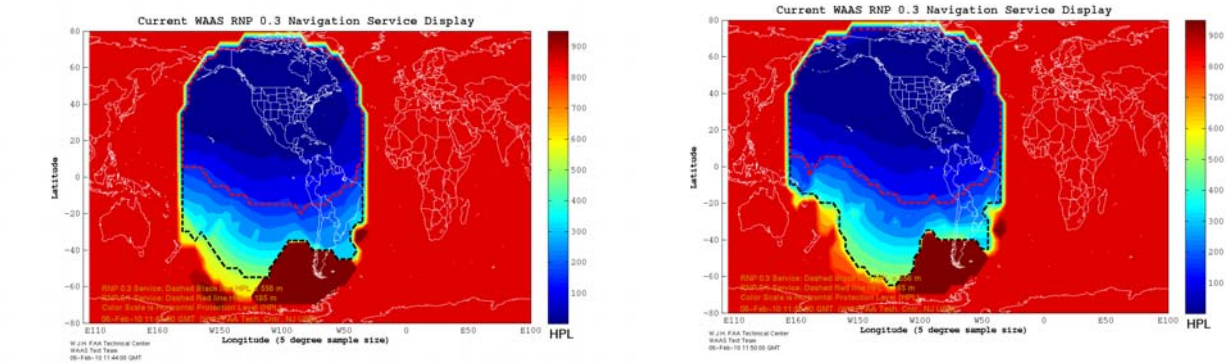

Figure 5. WAAS Service Volume during Second CRW SIS Loss

Figure 6 shows the coverage over the WAAS service volume for February 5, the day before this event. Figure 7 shows the coverage over the WAAS service volume for February 6, the data of this event. The comparison shows where the loss of coverage occurred during the CRW outage.

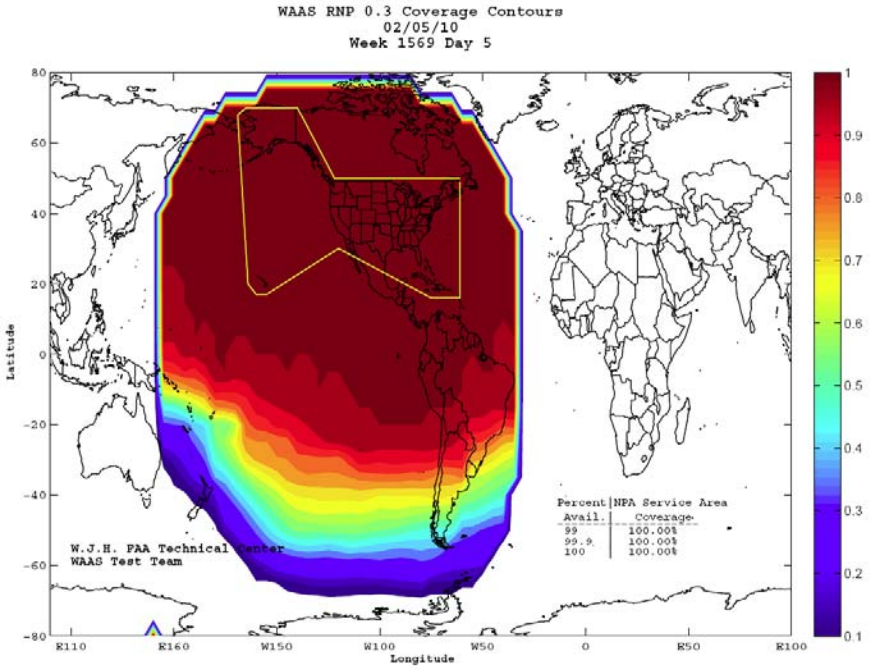

Figure 5. WAAS Service February 5, 2010

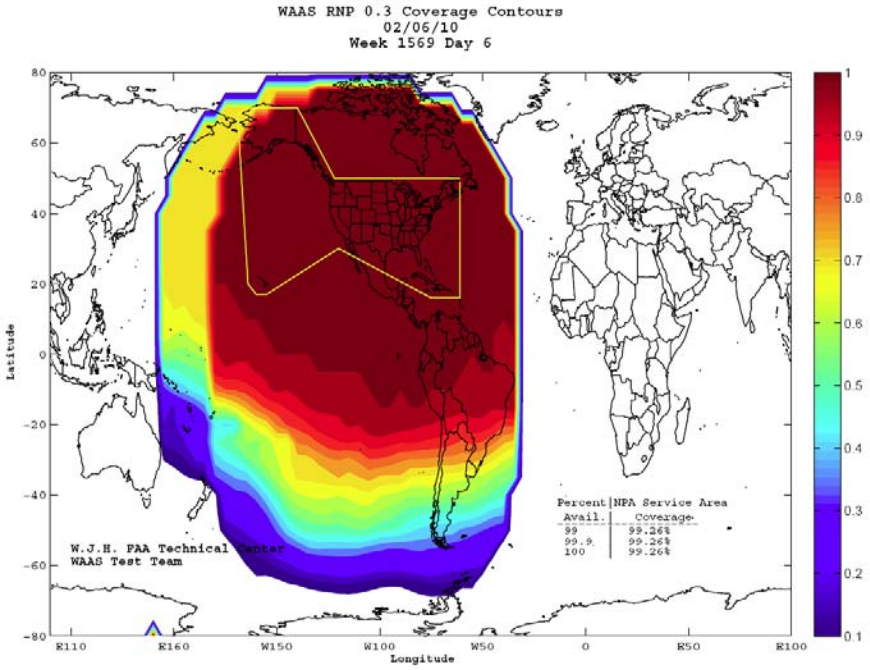

Figure 6. WAAS Service February 6, 2010

Conclusion

Due to a known WAAS issue and an error made during maintenance at the Littleton GUS, there was an extended outage of the CRW SIS on February 6, 2010. The known WAAS issue, both GUSs being in the backup state at the same time, is being fixed in the next WAAS software upgrade. A WAAS user in extreme northwest and western Alaska lost WAAS service because of the outage of the CRW SIS.