International Civil Aviation Organization

ALLPIRG/5-IP/13
17/03/06

INFORMATION PAPER

FIFTH MEETING OF THE ALLPIRG/ADVISORY GROUP

(Montreal, 23 – 24 March 2006)

Agenda Item 5.2: Global harmonization of RNP/area navigation (RNAV) implementation

FAA WIDE AREA AUGMENTATION SYSTEM (WAAS) PERFORMANCE

(Presented by the United States of America)

SUMMARY

The FAA commissioned the US Space-Based Augmentation System (SBAS) almost three years ago. This paper summarizes the performance of WAAS.

Action by ALLPIRG/5 is in paragraph 3.

1. BACKGROUND

1.1 Since 1999 the WAAS Group at the William J. Hughes Technical Center has reported GPS performance as measured against the GPS Standard Positioning Service (SPS) Performance Standard. These quarterly reports are known as the PAN (Performance Analysis Network) Report. In addition to that report, the WAAS/NSTB Team has reported on the performance of the Wide-Area Augmentation System (WAAS) since July of 2001. The performance analysis uses data from independent monitoring stations of the National Satellite Testbed as well as raw data from WAAS reference receivers. Each day, approximately 5 GB of data are archived and processed to monitor system performance. This paper summarizes the cumulative performance since commissioning, from 6 July 2003 to present.

2. WAAS PERFORMANCE

2.1 Performance of WAAS has exceeded expectations. The system accuracy is better than 1 m (horizontal) and 2 m (vertical). Figures 1 and 2 show the horizontal and vertical accuracy at several of the monitor stations within the conterminous U.S., representing some sites well within the service area (Kansas City, Salt Lake City) and some on the edge of the current service area (Los Angeles, New York). Each data point on these figures represents the 95% of accuracy throughout that day.

2.2 A more compelling indication of system performance is the maximum error, rather than the 95%. The maximum position error for any point where LPV (APV-1 performance defined in Annex 10) was available is shown in Table 1. The worst-case errors are generally caused by residual ionospheric errors.

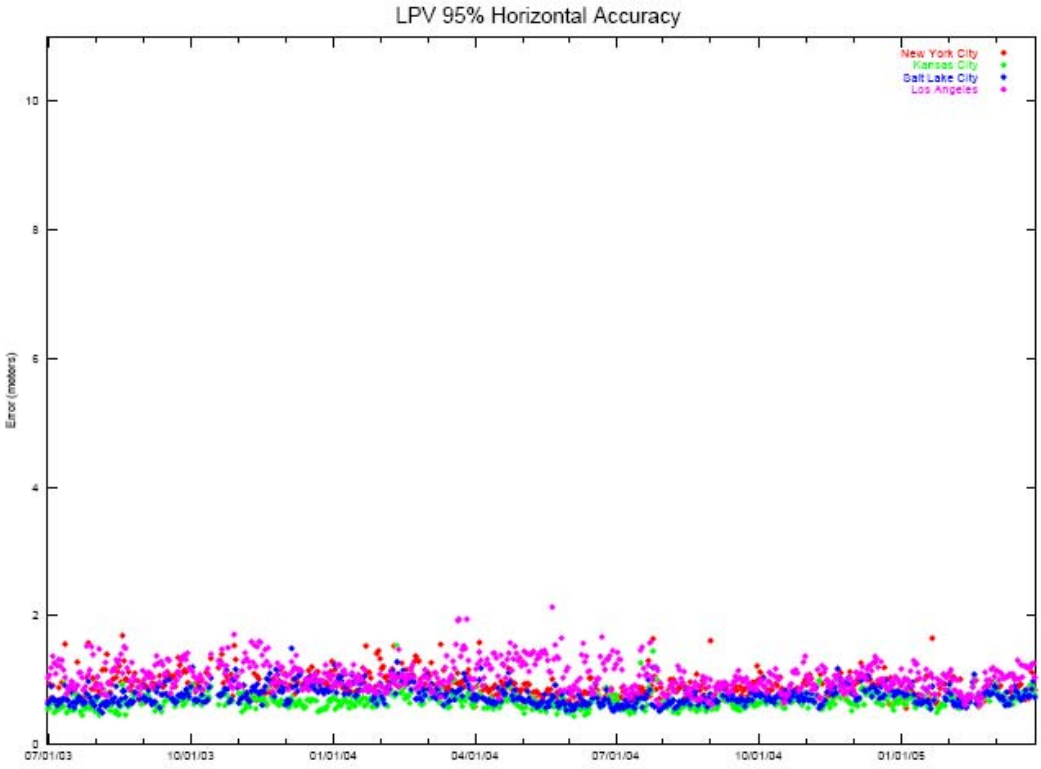
Table 1. Maximum WAAS Position Errors (LPV), 1 April 2004 to present

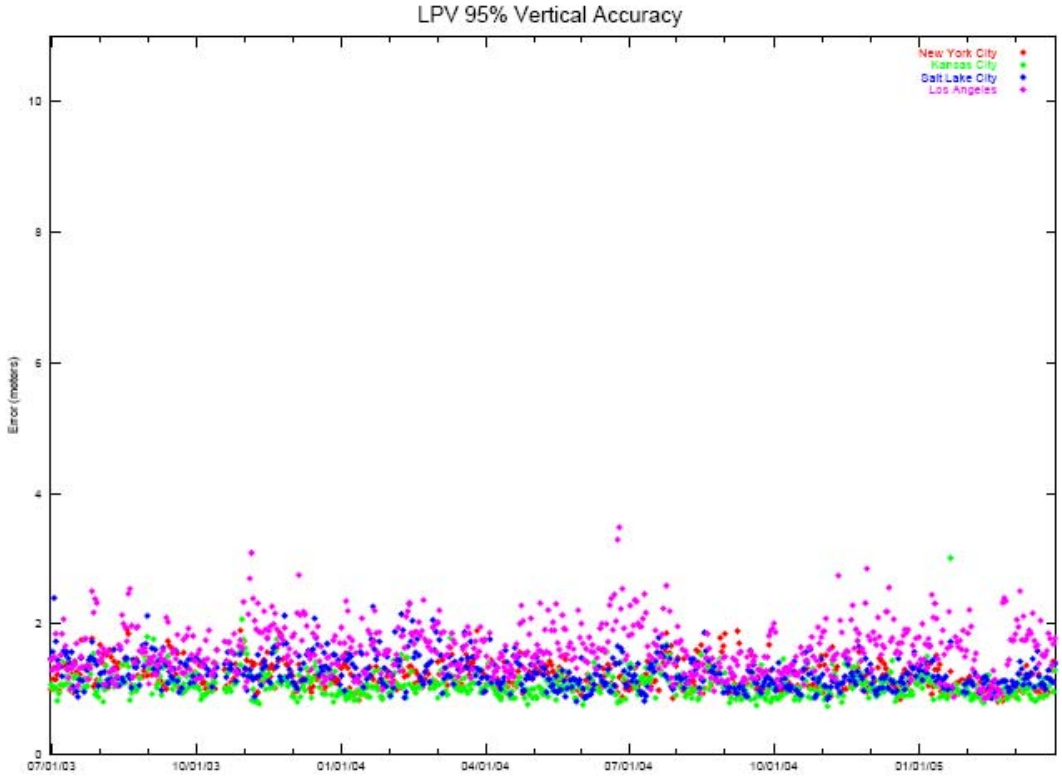
	Horizontal Error	**Vertical Error**
Worst Location	7.9 m (Minneapolis)	8.6 m (Salt Lake City)
Best Location	3.5 m (Anderson)	5.5 (Houston)

2.3 Another performance metric is to compare the maximum position error to the corresponding protection level. This metric provides more insight into the integrity of the system, which has been designed to ensure that the likelihood of a position error larger than the protection level is less than 10^{-7}. This ratio is typcially between 0.2 and 0.3 with the maximum values seen as 0.322 (Dallas) in the Horizontal and 0.313 (Chicago) in vertical.

2.4 The system availability of LPV service from 6 July 2003 to 26 March 2005 is shown in Figure 3 and 4. Figure 3 shows the availability throughout the U.S., showing the degradation around the edge of the country. Around the edges, the availability drops off due to limitations in ionospheric observability. This performance will improve when the new stations in Canada and Mexico become operational. Inside that region the unavailability has been caused by two effects: ionospheric storms and ground uplink switchovers (switching between one uplink station and another causes a brief disruption of service), with the ionospheric storms making the most significant impact. Figure 4 shows the availability at the airports that have published vertical approach procedures. As of 12 May 2005 there are 94 published LPV approaches, which increased to over 300 by September 2005. In addition, there are over 700 published LNAV/VNAV approaches.

2.5 Additional information on the performance of WAAS is available in the complete Performance Analysis Reports, available at http://www.nstb.tc.faa.gov.


LPV 95% Horizontal Accuracy
New York City
Kansas City
Salt Lake City
Los Angeles
Error (meters)
0
2
4
6
8
10
07/01/03
10/01/03
01/01/04
04/01/04
07/01/04
10/01/04
01/01/05


LPV 95% Vertical Accuracy
New York City
Kansas City
Salt Lake City
Los Angeles
Error (meters)
0
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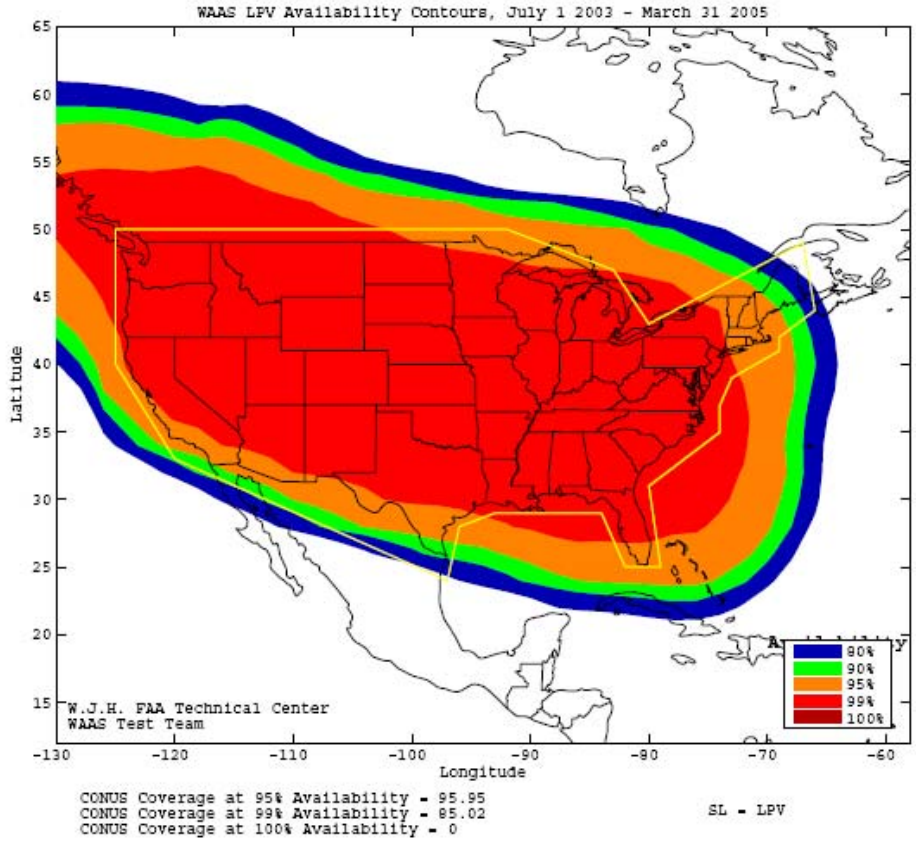
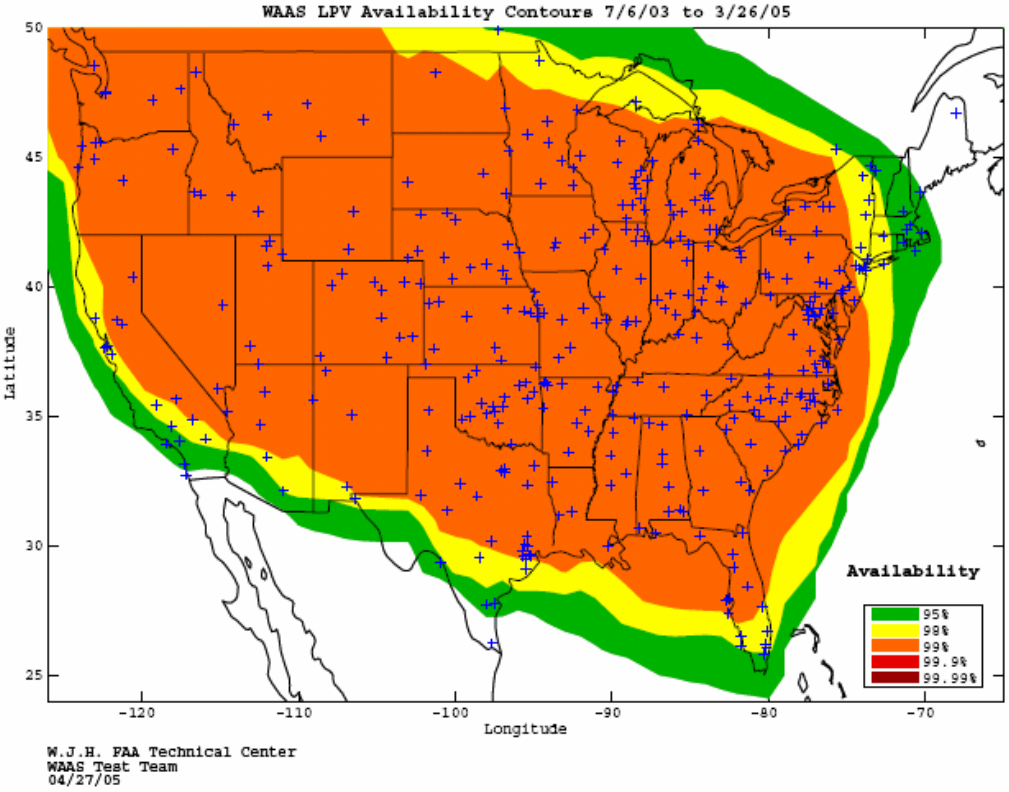
07/01/03
10/01/03
01/01/04
04/01/04
07/01/04
10/01/04
01/01/05


WAAS LPV Availability Contours, July 1 2003 - March 31 2005
Latitude
Longitude
80%
90%
95%
99%
100%
W.J.H. FAA Technical Center
WAAS Test Team
CONUS Coverage at 95% Availability = 95.95
CONUS Coverage at 99% Availability = 85.02
CONUS Coverage at 100% Availability = 0
SL - LPV


WAAS LPV Availability Contours 7/6/03 to 3/26/05
Latitude
Longitude
Availability
95%
98%
99%
99.9%
99.99%
W.J.H. FAA Technical Center
WAAS Test Team
04/27/05

3. ACTION BY ALLPIRG

3.1 The ALLPIRG/5 Meeting is invited to review the information contained in this information paper on GPS policy.

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