GNSS is a Key Enabler for NextGen

Arrivals and Departures At High Density Airports
Collaborative Air Traffic Management
Weather Impact
Safety, Security and Environmental Performance
Facilities
Flexibility In To Terminal Environment
Trajectory Based Operations
## RNP and ADS-B (RAD) Enabled with GNSS PNT

<table>
<thead>
<tr>
<th></th>
<th>Navigation (≥ 99.0% Availability)</th>
<th>Surveillance (≥99.9% Availability)</th>
<th>Positioning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Accuracy (95%)</td>
<td>Containment (10^{-7})</td>
<td>Separation</td>
</tr>
<tr>
<td>En Route</td>
<td>*10 nm</td>
<td>20 nm</td>
<td>5 nm</td>
</tr>
<tr>
<td></td>
<td>*4 nm</td>
<td>8 nm</td>
<td>0.1 nm (7)</td>
</tr>
<tr>
<td></td>
<td>*2 nm</td>
<td>4 nm</td>
<td>1 nm (5)</td>
</tr>
<tr>
<td>Terminal</td>
<td>*1 nm</td>
<td>2 nm</td>
<td>3 nm</td>
</tr>
<tr>
<td>LNAV</td>
<td>*0.3 nm</td>
<td>0.6 nm</td>
<td>0.05 nm (8)</td>
</tr>
<tr>
<td>RNP (AR)</td>
<td>*0.1 nm</td>
<td>**0.1 nm</td>
<td>0.05 nm (8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DPA</td>
<td>0.2 nm (7)</td>
</tr>
<tr>
<td>LPV</td>
<td>16m/4m</td>
<td>40m/50m</td>
<td>2.5 nm DPA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.05 nm (8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.2 nm (7)</td>
</tr>
<tr>
<td>LPV-200</td>
<td>16m/4m</td>
<td>40m/35m</td>
<td>2.5 nm DPA</td>
</tr>
<tr>
<td>GLS Cat-I</td>
<td>16m/4m</td>
<td>40m/10m</td>
<td>2.0 nm IPA</td>
</tr>
<tr>
<td>GLS Cat-III</td>
<td>16m/2m</td>
<td>40m/10m</td>
<td>121 m (8)</td>
</tr>
</tbody>
</table>

*Operational requirements are defined for total system accuracy, which is dominated by fight technical error. Position accuracy for these operations is negligible.

** Containment for RNP AR is specified as a total system requirement; value representative of current approvals.

Dependent Parallel Approach (DPA)  Surveillance Integrity Level (SIL)  Navigation Accuracy Category
Independent Parallel Approach (IPA)  Navigation Integrity Category (NIC)  for Position (NACp)
Wide Area Augmentation System (WAAS)

- 38 Reference Stations
- 3 Master Stations
- 4 Ground Earth Stations
- 2 Geostationary Satellite Links
- 2 Operational Control Centers
Pacific Ocean Region (POR) 
Inmarsat GEO
Current WAAS LPV Coverage

Current WAAS Vertical Navigation Service Snapshot Display

- LPV200 Service Contour (solid yellow line)
- LPV Service Contour (solid red line)
- LNAV/VNAV Service Contour (dashed black line, includes LPV)

Color Scale is Vertical Protection Level (VPL)
09-Sep-10 15:14:11 GMT (WJH FAA Tech. Cntr., NJ USA)

International Committee on GNSS (ICG-5)
October 2010
Current WAAS RNP 0.3 Performance
WAAS Approach Procedures Today

As of Aug 26th, 2010
2,209 LPVs serving 1174 Airports
- 1,350 LPVs to non-ILS Runways
- 859 LPVs to ILS Runways
- LPVs at 553 Non-ILS Airports
- 246 LPV-200
Universal Navigation Systems (UNS)

Completed Aircraft Approvals

- Astra 1125*
- Beech 400*,
- Boeing B-737-200, B-727-200, B-737
- Bombardier Q-series, Q-300, Q-400
- Bombardier CL-600/60
- Bombardier DHC-8-400 series ‘Q-400’
- Citation 550 Bravo Series,
- Citation V 560 Series, & XL, , 525*, Fleet
- DeHaviland ‘Dash-8’
- Falcon 10, 20D, 50, 50*
- Gulfstream G-II*
- KingAir 200*, 350
- LEAR 31A, 35, 35A,
- LEAR 40, 40XR, 45, 45XR, 60
- MD-87
- S-76, S-76B, S-76C++
- Sabre 65

Projected Aircraft Approvals

- ATR-42
- Beech Be-200, -300
- Boeing B-727-200 C&F, B-737
- Bell 412
- Cessna Citation II
- Cessna Citation 560XL/XLS, 650
- Cessna Citation VII, Encore
- C-9
- Northrop Grumman T-38
- Gulfstream G-II, G-III
- Falcon 20, 2000
- Hawker 125-700B
- King Air 300, RC-12, US Army
- PC-12
- Embraer NB-145

International Committee on GNSS (ICG-5)
October 2010
Completed Aircraft LPV STCs:

- Bombardier Challenger CL-604
- Bombardier CRJ-200
- Cessna Citation Jet CJ-1+, 2+, 3
- King Air-300
- Hawker 800XP
- Cessna Citation Encore+

Aircraft LPV STCs in work:

**Estimate completion w/in 6 months:**
- Bombardier CRJ-700/900
- Beechcraft Premier 1 & 1A
- Beechcraft King Air 200, 200GT, 300, 350, C90GTi
- Hawker 400XP, 750, 850/XP, 900XP
- Beechjet 400A (est. 30 Sep for STC)

**Estimate completion w/in 12 months:**
- Dassault Falcon 20, 50/EX, 2000/EX
- Piaggio P-180
- Gulfstream G-150, G-200
- Bombardier Lear 60XR

**Estimate Completion w/in 18 months:**
- Bombardier Challenger CL-300, CL-605
<table>
<thead>
<tr>
<th>Approved Avionics LPV TSOs:</th>
<th>Approved Aircraft LPV STCs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Primus Epic FMS</td>
<td>• Gulfstream G-450 &amp; -550</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Pending Avionics LPV TSOs:</th>
<th>Pending LPV STC Approvals:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Primus 2000 (NZ-2000)</td>
<td>• Gulfstream G-IV, G-V</td>
</tr>
<tr>
<td>• APEX</td>
<td>• F-900B,-900EXC</td>
</tr>
<tr>
<td>• EPIC (in other airframes)</td>
<td>• Challenger CL-601</td>
</tr>
<tr>
<td>• KSN 770 (for GA aircraft)</td>
<td>• Hawker 800</td>
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<tr>
<td></td>
<td>• Citation X</td>
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<td>• PC-12</td>
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<td>• Viking</td>
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<td>• Dassault EASy</td>
</tr>
<tr>
<td></td>
<td>• Cessna Sovereign</td>
</tr>
</tbody>
</table>
Local Area Augmentation System (LAAS)

- Precision Approach For CAT- I, II, III
- Multiple Runway Coverage At An Airport
- 3D RNP Procedures (RTA), CDAs
- Navigation for Closely Spaced Parallels
- Super Density Operations
GBAS Pathway Forward

- Cat-I System Design Approval at Memphis – Complete
- Cat-III Validation by - 2010
- Cat-III Final Investment Decision by - 2012

International Committee on GNSS (ICG-5)
October 2010
GBAS Facilities

- Current airlines GBAS equipped
  - Continental
  - Delta Airlines
  - Qantas
  - Air Berlin
  - TuiFly
  - Sonair
  - Air Vanatu
  - Emirates

- Over 15 countries have active GBAS programs
LAAS/GBAS International Efforts

Rio De Janeiro, Brazil

Agana, Guam

Malaga, Spain

Sydney, Australia

Frankfurt, Germany

Bremen, Germany

International Committee on GNSS (ICG-5)
October 2010
Commercially Available GPS Jammer
(so called “Personal Privacy Device”)
Zeta “SnapShot” System Data

- Baseline/Nominal L1 RF
- Broadband RFI straddling L1
... and a few more “Personal Privacy Devices”

$110 Ebay
$335 Ebay
$92 Ebay
$40 GPS&GSM
www.chinavasion.com
$55 Ebay
$83 GPS&GSM
www.Tayx.co.uk
$152 Ebay

International Committee on GNSS (ICG-5)
October 2010
Summary

- WAAS implementation progressing on track
- Geostationary satellite procurement activities underway to mitigate recent failures
- LAAS program activities underway for Cat-III
- RFI challenges being investigated
Recommendations

• States and service providers should establish controls to mitigate impacts of privacy jammers

• Augmentation service providers should investigate establishing a cooperative global network of multi-constellation monitoring stations to support ARAIM
Questions