SmartPath®
Ground Based Augmentation System (GBAS) & Performance Based Based Navigation (PBN)
A New Era in Precision Navigation
Overview

• Ground Based Augmentation System (GBAS)

• Honeywell SmartPath GBAS overview

• SmartPath enabled air operations

• SmartPath Value Summary
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ICAO Global Air Navigation Plan for ATM

Which technologies when? Aviation System Block Upgrades

- B0-30 - Information Management based on AIXM
- B0-60 - Common Time Reference
- B0-40 - Initial Data Link En-Route
- B0-10 - Improved En-route Profiles
- B0-20 - Improved Flight Departure Profiles
- B0-85 - Early ASAS Applications (ITP)
- B0-5 - Improved Flight Descent Profiles
- B0-15 - Runway Sequencing
- B0-25 - Ground Integration through AIDC
- B0-75 - Runway Safety - Airport surface surveillance for ANSP
- B0-5 - Ground Communications using IPv6
- B0-70 - Wake Vortex Separation, refined
GBAS is an ICAO Block “0” 2013 Recommendation
ICAO Global Air Navigation Plan for ATM

GBAS is an enabling technology for NextGEN and SESAR
Ground Based Augmentation System (GBAS)

Why augment GPS for precision approach?

How do we augment GPS for precision approach?
GLS: GBAS Airborne Implementation

- Cockpit Displays
- GPS Antenna
- MMR
- Aircraft Surfaces
- Pilot Interface
- Autopilot
- DATA LINK – VHF Data Broadcast (VDB)

- GPS
- DGPS
- MMR – Multi-Mode Receiver (GPS, VDB, ILS, etc)
- VDB – VHF Data Broadcast (Link to aircraft)

- Antenna
- Differential Corrections, Integrity Status and Approach Coordinates
- DGPS – Differential GPS
- Computes Differential Corrections
- Provides Integrity Check
- Provides Approach Coordinates

- Local Ground Facility
- Data Broadcast Monitor
- Transmitter
- Encoder
- Receiver
- Decoder

- GPS error corrections, integrity, AND path points
GLS Uses Existing Aircraft Architecture

- ILS look alike
  - Glideslope
  - Localizer
GLS: GBAS Airborne Implementation

737NG – GLS forward fit, retrofit
787 – GLS basic
747-8 – GLS basic

A-380 – GLS activation option
A-320 – GLS option
A-340 – GLS option
A-330 – GLS option
A-350 – GLS activation option
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Honeywell SmartPath GBAS

Dual Processor Channels
- Differential Corrections
- Overall System Integrity
- Approach Database
- Redundant Channel

VHF Broadcast
- Corrections, Integrity, Approaches
- Horizontally Polarized, Omni-Directional
- 108-118 MHz
- 2 TDMA Time Slots
- 2 Hz Corrections
- Redundant Radio

Reference Receivers
- Multipath Limiting Antenna (MLA)
- Narrow Correlator GPS Receiver
- 2 Hz Measurements
- 4 GPS Receivers

Maintenance Data Terminal
- System Status, Mode, Control
- System Alerts, Alarms
- Approach Control

Air Traffic Status Unit
- System Mode
- System Availability

Honeywell SmartPath GBAS

1200m MAX
200m MAX

TDMA – Time Division Multiple Access
Hz – Hertz
LAN – Local Area Network (typ. Ethernet)
SmartPath Certification Baseline, Growth

**SmartPath Cat I System Design Approval**
- FAA: September 2009
- BAF (Germany): December 2011
- CASA (Australia): March 2013
- Spain, Brazil, Korea: Q2-4 2013
- Primary certification criteria
  - FAA Non-Fed Spec, FAA-E-AJW44-2937A
  - ICAO SARPS compliant

**Cat II performance from Cat I system**
- Aircraft and flight operations requirements
- Available 2013-2014

**Cat III development and validation underway**
- Minimal or no ground station hardware changes
- FAA Cat III ground station/avionics contracts to Honeywell 2010
- Prototype ground station/avionics: 2011
- Flight testing and additional development: 2012-2015
- Operationally available ~2016-2017
Bremen First Flight

• The first unrestricted GLS landing occurred at Bremen, Germany 9 Feb 2012.

• Air Berlin flight 6573 landed at 21:52 using Honeywell’s SmartPath system.
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GBAS Standard Glide Slope
Any Glide Slope, Displaced Threshold
GBAS: Programmable Touchdown Points and Path

- ILS: single defined vertical path, same touchdown point on runway
- SmartPath GBAS: multiple touchdown points and glide slope combinations
GBAS: Programmable Touchdown Points and Path

3.2 degree Glide-slope

2.5 degree Glide-slope
GBAS Offset Approaches
GBAS Offset Approaches

Original Track

Image © 2013 GeoEye
ILS Clear Zones
GBAS Requires No Clear Zones
GBAS Multiple Concurrent Operations
RNP + GBAS GLS: Enabling Maximum Efficiency

- 4nm GLS Final Approach
- 8nm ILS Final Approach
- Efficient Approach
- Inefficient Approach
RNP + GBAS GLS: Efficiency Quantified

RNP Approach:
- curved final approach
- begins on the downwind leg
- lateral and vertical guidance
  - to the runway
  - or to a GLS intercept

CO2 emission reductions of 1.4243 kg per each 1 kg of fuel saved

4 NM final saves 10.6 NM/Approach
- An average aircraft saves
  - 3 minutes of flight time
  - 82.7 kilograms of fuel
  - 104 liters of fuel
RNP & GLS Fusion Maximizes Operational Benefits

- Course guidance
  - RNAV/RNP curved segments
  - GLS for final segment

- Final approach segments
  - ILS: 10 NM or more
  - GLS: 4NM

- Approach Minimums
  - RNP ≥ 250’ (non-precision)
  - GLS minimums 200’ Cat I
  - Cat II/III 2012-2016
  - GLS is precision approach

- Requirements
  - RNP ≤ .3NM: RNP/AR
  - GLS final: no RNP/AR
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SmartPath Value for Multiple Stakeholders

Capacity
- Reduced delays
- Fuel savings
- Reduced emissions

Airport
- Safety & Efficiency
- Throughput
- O&M savings
- Reduced noise

Airline
- Safety & Efficiency
- Capacity
- Reduce flight inspection
- $ Savings

ANSP
SmartPath Summary

• *Increased airport efficiency:*
  – Eliminates ILS critical zones
  – Enables flexible approaches; synergistic with RNAV/RNP
  – Offers precision approach where ILS cannot due to geography

• *Lower life-cycle cost:*
  – 26 different precision approaches from a single ground station
  – One SmartPath GBAS serves all runways, initial acquisition cost is lower
  – Lower maintenance cost
  – Lower flight inspection cost
  – Growth to Cat II/III

• *Increases level of safety:*
  – Signal stability (immune to signal bends inherent in ILS)
  – Precision lateral and vertical guidance

• *Reduced noise/ shorter routes:*
  – GBAS final approach segment optimizes curved path approaches
  – Lower approach minimums
  – Autoland capability
The Honeywell - Hughes Team: PBN Planning & Deployment Experts

**Aircraft & Airside Equipage**
- Honeywell Equipment
  - GBAS Systems
  - FMS software upgrades to bring low RNP capability to most Honeywell equipped aircraft
  - Inertial Reference Units
  - WAAS GPS Receivers
  - Display Systems
  - EGPWS
  - MMR/INR Units

**Operational Approval**
- Consultancy Services
  - Operational approval preparation and submittal package for AC90-101 or AMC 20-26
  - Crew/ATC Training Services
  - PBN/ATC Training Services
  - Obstacle Surveys
  - Environmental Impact Surveys
  - Efficiency / Fuel Saving Programs

**RNP Operations**
- Procedure Development and Database Validation
  - RNAV, RNP, RNP AR, WAAS LPV, GBAS GLS Procedure Design
  - Validation of all public RNP AR procedures & validation every 28 day cycle. 540 day procedure revalidations.
  - Flight, Obstacle and Simulator Validation for Air Carrier, Business and Helicopter Flight Operations.
The Honeywell - Hughes Team: PBN Planning & Deployment Experts

Aircraft & Airside Equipage
- Enhanced Ground Proximity Warning System (EGPWS)
- Flight Management System (FMS)
- Inertial Reference System (IRS)
- Global Positioning System (GPS)

Operational Approval
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RNP Operations
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- Operational approval preparation and submittal package for AC90-101 or AMC 20-26
- Crew/ATC Training Services
- PBN Roadmap Development
- Obstacle Surveys
- Environmental Impact Surveys
- Efficiency / Fuel Saving Programs

Flexible, Low-risk SmartPath Implementation Programs Available Now
- GBAS Systems
- FMS software upgrades to bring low RNP capability to most Honeywell equipped aircraft
- Inertial Reference Units
- WAAS GPS Receivers
- Display Systems
- EGPWS
- MMR/INR Units

Database Validation
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Questions?