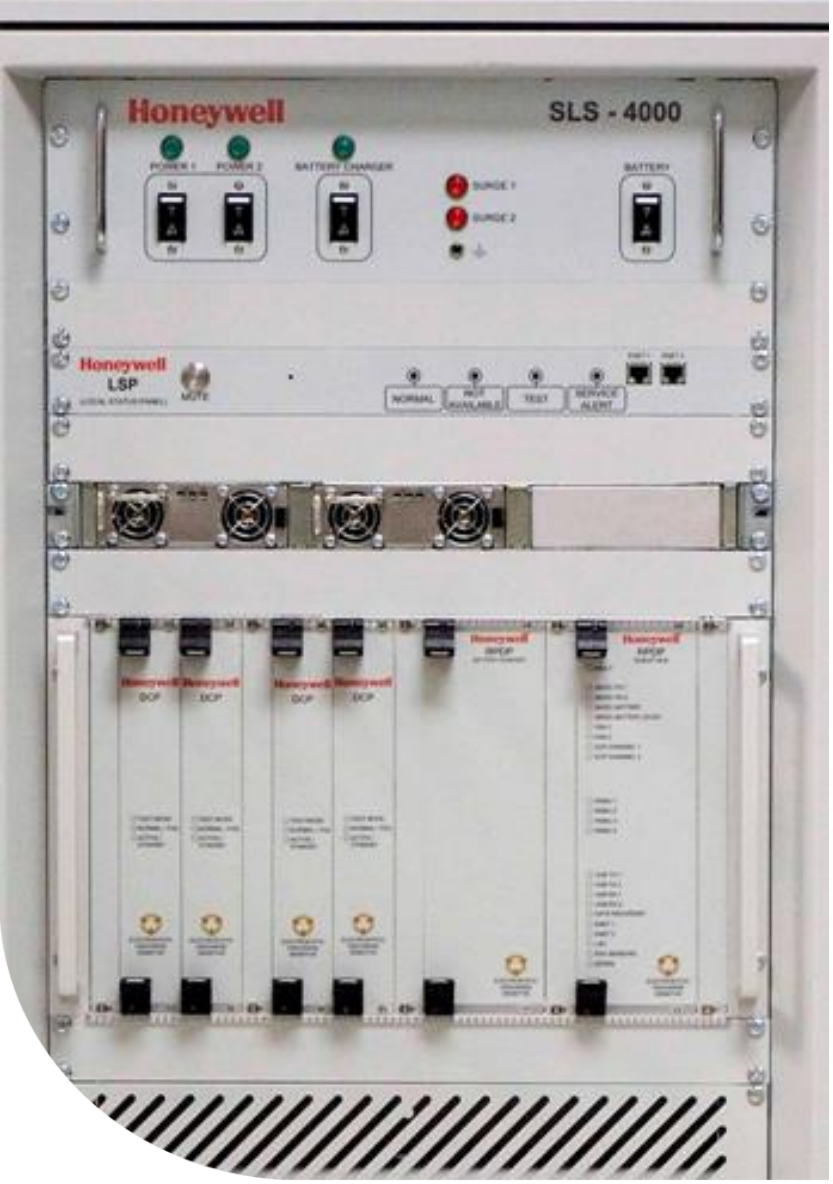
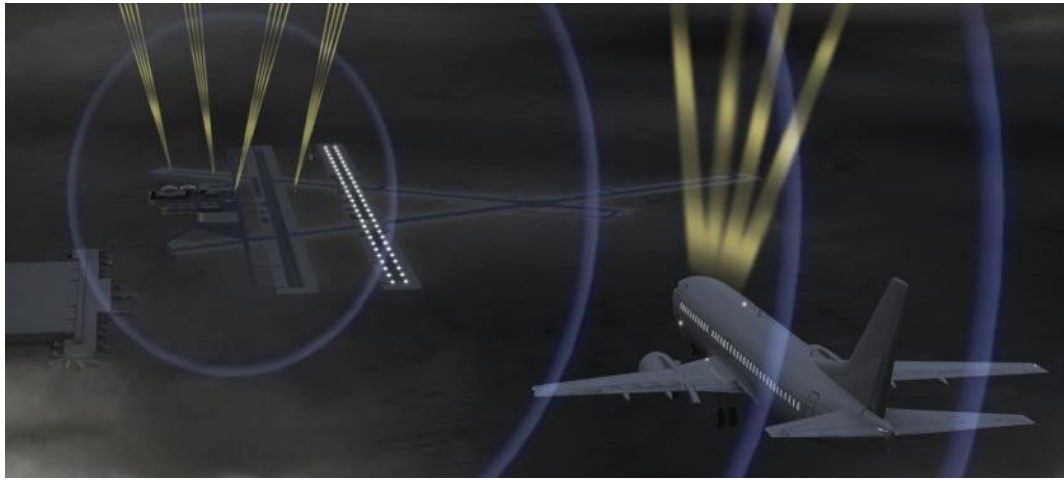


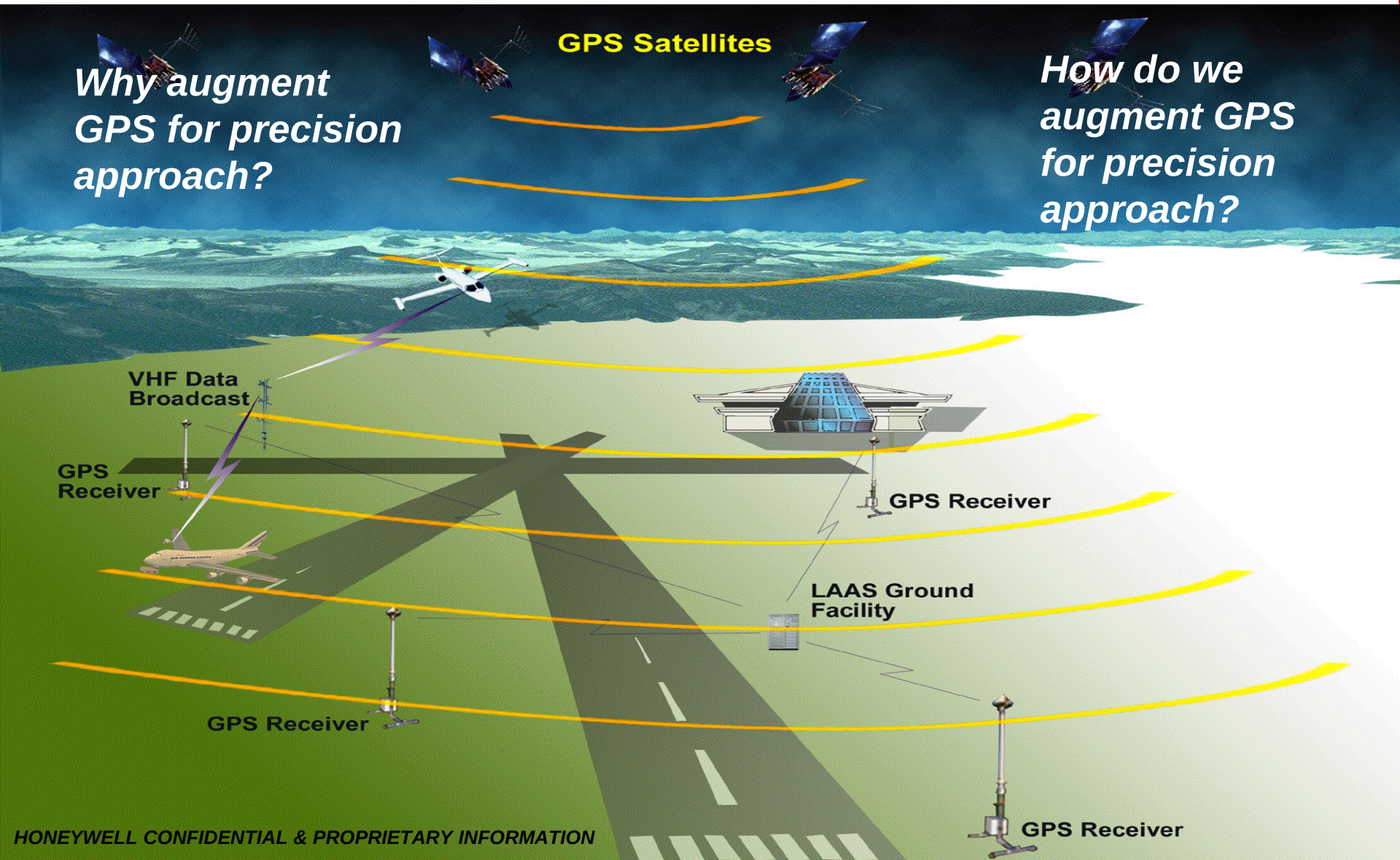


Michael Underwood

HONEYWELL GBAS PRESENTATION

9 April 2018

Ground Based Augmentation System (GBAS)



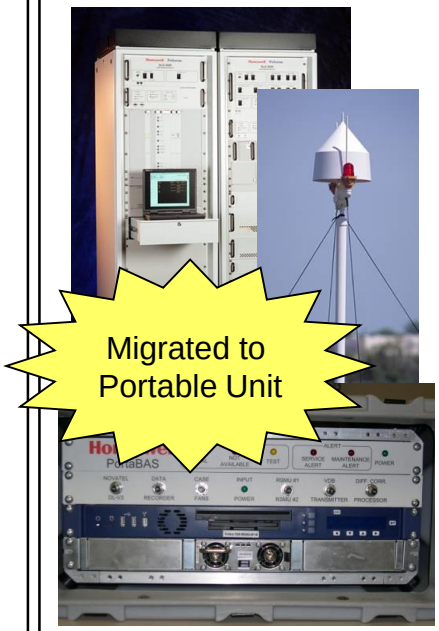
Honeywell's SmartPath® Ground-Based Augmentation System (GBAS)

SCAT I

World's First DGPS Cert

SLS-1000/2000

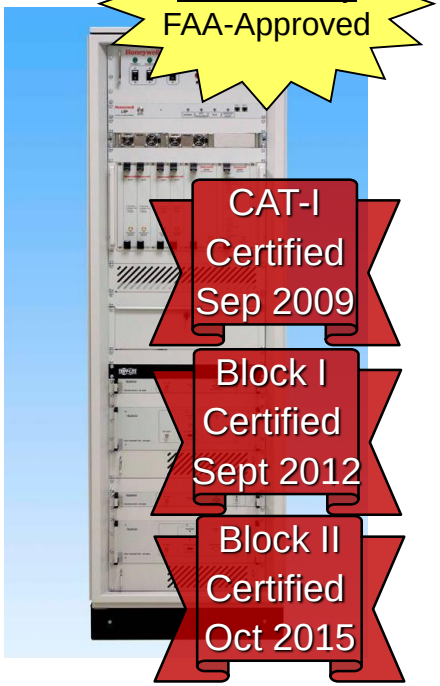
Portable



SLS-3000

CAT I

World's Only FAA-Approved



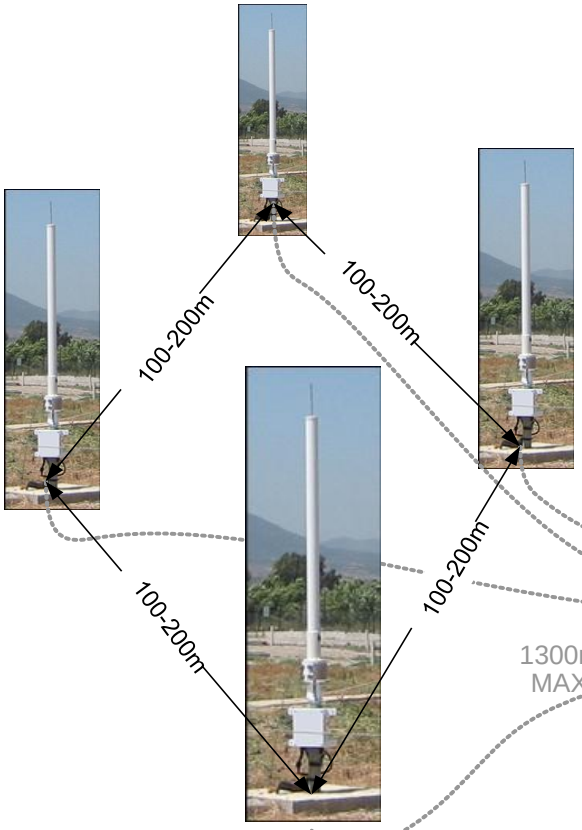
SLS-4000

CAT II/III

SLS-5000

Leading the Industry in Satellite Landings Systems for > 20 Years

Honeywell SmartPath GBAS

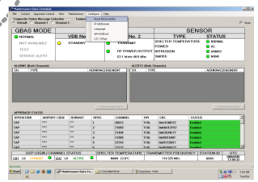


Reference Receivers

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

Dual Processor Channels

- Differential Corrections
- Overall System Integrity
- Approach Database
- Redundant Channel



Maintenance Data Terminal

- System Status, Mode, Control
- System Alerts, Alarms
- Approach Control

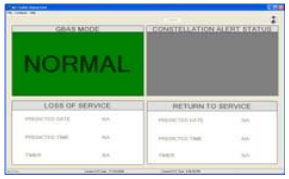
TDMA – Time Division Multiple Access
Hz – Hertz
LAN – Local Area Network (typ. Ethernet)

200m
MAX

VHF Broadcast

- Corrections, Integrity, Approaches
- Horizontally Polarized, Omni-Directional
- 108-118 MHz
- 2 TDMA Time Slots (typ.)
- 2 Hz Corrections
- Redundant Radio

Airport LAN



Air Traffic Status Unit

- System Mode
- System Availability

Honeywell

Next Generation Landing System- Available Now

- **Today's presentation focuses on the next generation of landing system (GBAS) that provides:**
  - **Enhanced Safety:**
    - Multiple ANSP Certification Pedigree
    - Signal Stability (immune to signal bends inherent in ILS)
    - Wake Vortex Mitigation – Customizable Glide Paths/Approaches
  - **Increased Airport Capacity:**
    - Offers precision approach where ILS cannot due to geography
    - Enables flexible approaches (48), improved accuracy versus ILS
    - Airport benefits from increased revenue (landings fees, concessions, etc.) and cost avoidance (capacity increase without adding runways
  - **Lower Life-cycle Costs:**
    - One SmartPath GBAS Station serves all runways/runway ends at any airport
    - Lower maintenance costs/lower flight inspection costs
  - **Environmental Friendliness:**
    - Variable Glide Slopes, RNAV/RNP to GLS Finals
    - Airline fuel & emission savings, increased schedule flexibility, avoid noise violations
    - Airports increased capacity and schedule flexibility, improved community relations

Honeywell

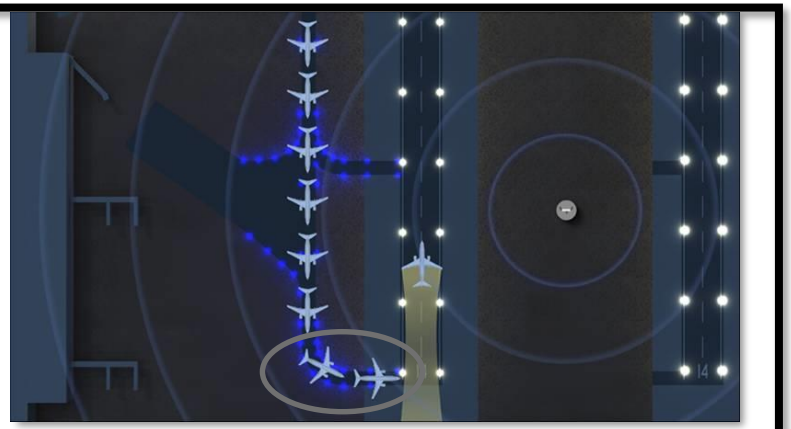
Key GBAS Benefits Over Legacy ILS

Flexible, Digital Approach Paths

- ILS: Single defined slope, same touchdown point on runway
- SmartPath GBAS: Multiple touchdown points and glide slope combinations

Create Spacing; Mitigate Noise; Avoid Runway Construction

Requires No "Clear Zones"

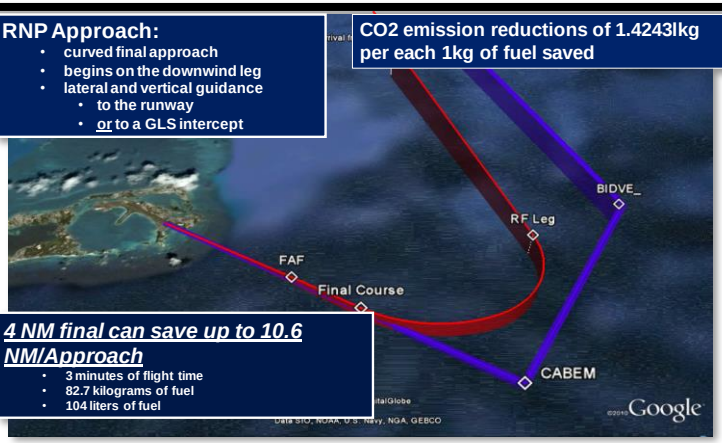


Increases Capacity; Reduces Delays

Enables Efficient Flight Path

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

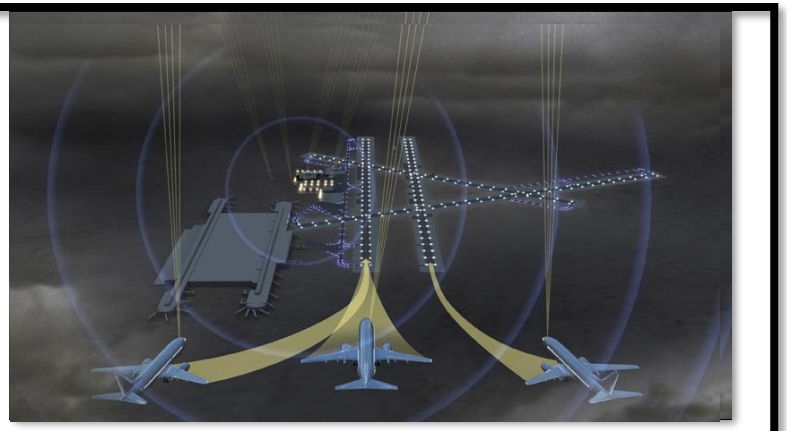
CO2 emission reductions of 1.4243lkg per each 1kg of fuel saved



4 NM final can save up to 10.6 NM/Approach
- 3 minutes of flight time
- 82.7 kilograms of fuel
- 104 liters of fuel

Reduce Fuel Consumption; Minimize Emissions; Avoid Terrain

Serves All Runway Ends



Reduce Maintenance Costs; Increase Precision Approaches

Increasing Runway Capacity, Reducing Noise, Reducing Track Miles, Reducing Operating Costs
Flexibility to Address Multitude of Operational Challenges at the Airports You Fly To

Regulator

Airlines

Lowers operational cost, and increases schedule reliability

ANSP

Enhances safety, environmental impacts, ATM modernization

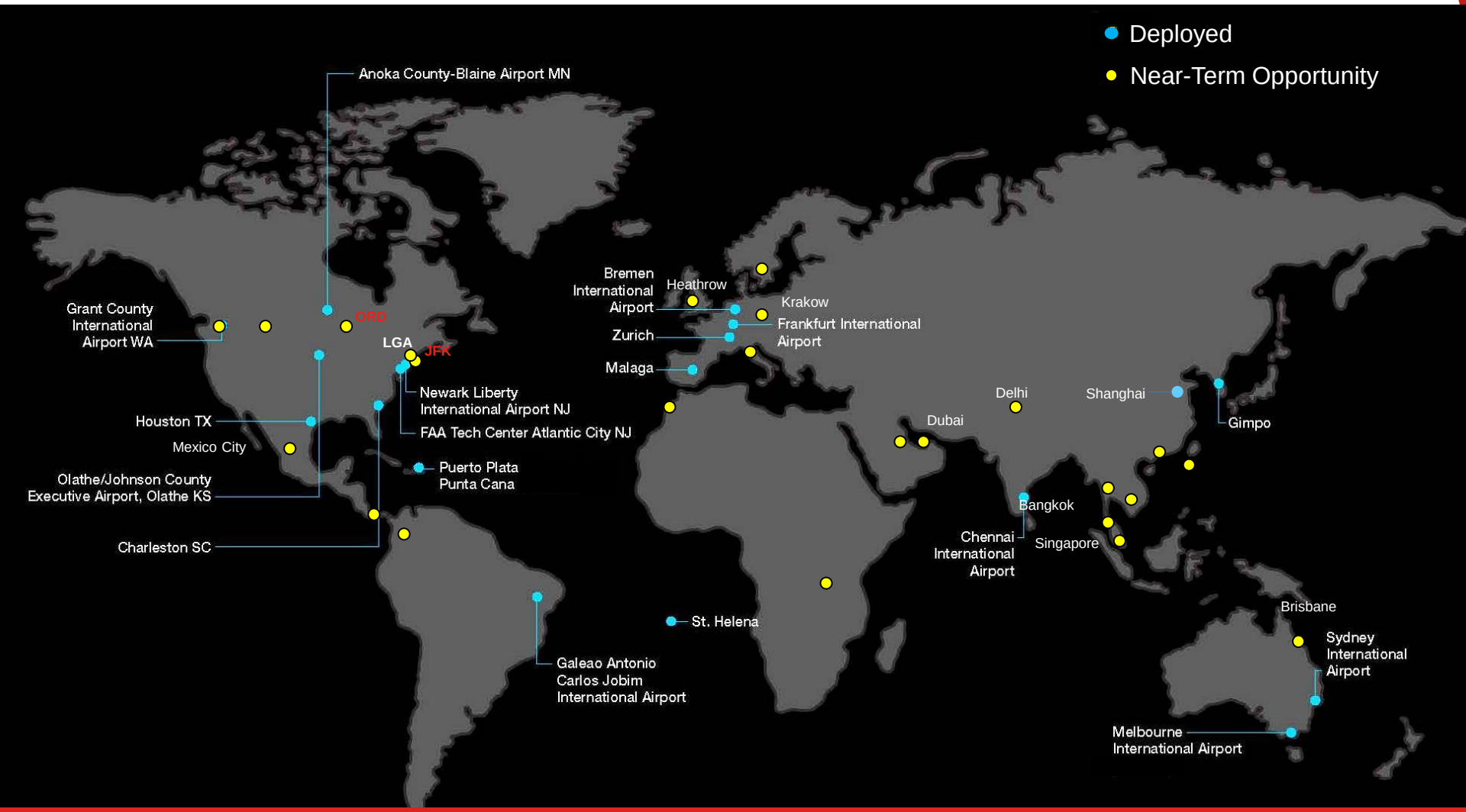
Airports

Improves capacity, lowers cost, future proof to CAT III

Value is shared across all stakeholders

Stakeholder Involvement Throughout the Whole Project = Successful Implementation

SmartPath® GBAS Deployment Expanding Globally



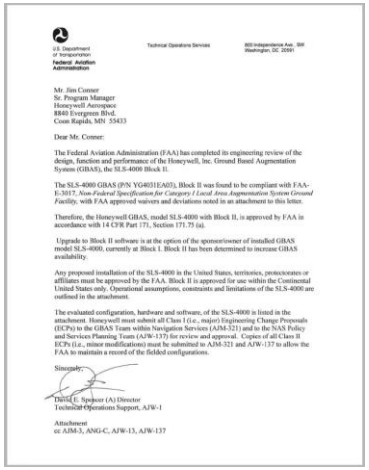
Numerous Near-Term Opportunities for Network Expansion

Honeywell

SLS-4000 Block II SW – What Improves?

- Honeywell Achieved System Design Approval for our 3rd Generation Block II GBAS Software in October 2015

FAA System Design Approval



U.S. Department of Transportation
Federal Aviation Administration

Technical Operations Services

800 Independence Ave., SW
Washington, DC 20591

Mr. Jim Conner
Sr. Program Manager
Honeywell Aerospace
8840 Evergreen Blvd.
Coon Rapids, MN 55433

Dear Mr. Conner:

The Federal Aviation Administration (FAA) has completed its engineering review of the design, function and performance of the Honeywell, Inc. Ground Based Augmentation System (GBAS), the SLS-4000 Block II.

The SLS-4000 GBAS (P/N YG4031EA03), Block II was found to be compliant with FAA-E-3017, *Non-Federal Specification for Category I Local Area Augmentation System Ground Facility*, with FAA approved waivers and deviations noted in an attachment to this letter.

Therefore, the Honeywell GBAS, model SLS-4000 with Block II, is approved by FAA in accordance with 14 CFR Part 171, Section 171.75 (a).

Upgrade to Block II software is at the option of the sponsor/owner of installed GBAS model SLS-4000, currently at Block I. Block II has been determined to increase GBAS availability.

Any proposed installation of the SLS-4000 in the United States, territories, protectorates or affiliates must be approved by the FAA. Block II is approved for use within the Continental United States only. Operational assumptions, constraints and limitations of the SLS-4000 are outlined in the attachment.

The evaluated configuration, hardware and software, of the SLS-4000 is listed in the attachment. Honeywell must submit all Class I (i.e., major) Engineering Change Proposals (ECPs) to the GBAS Team within Navigation Services (AJM-321) and to the NAS Policy and Services Planning Team (AJW-137) for review and approval. Copies of all Class II ECPs (i.e., minor modifications) must be submitted to AJM-321 and AJW-137 to allow the FAA to maintain a record of the fielded configurations.

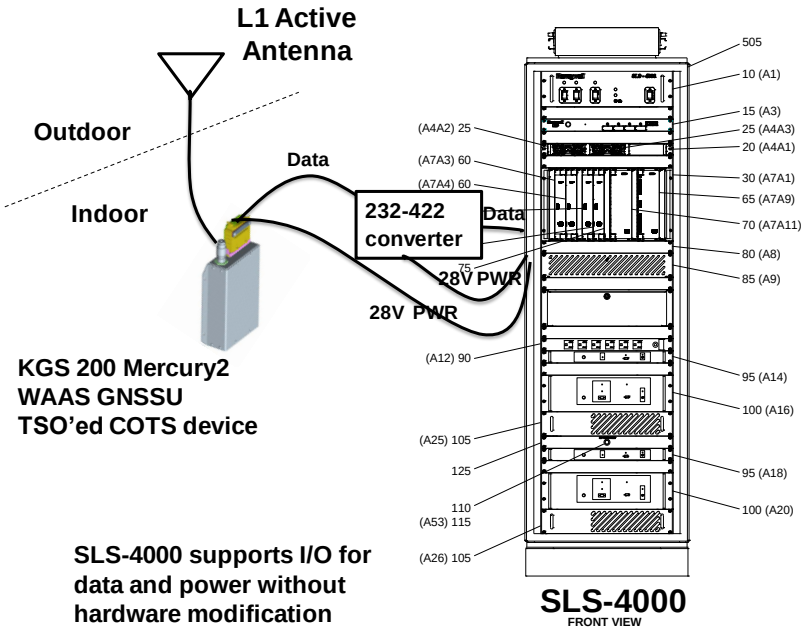
Sincerely,

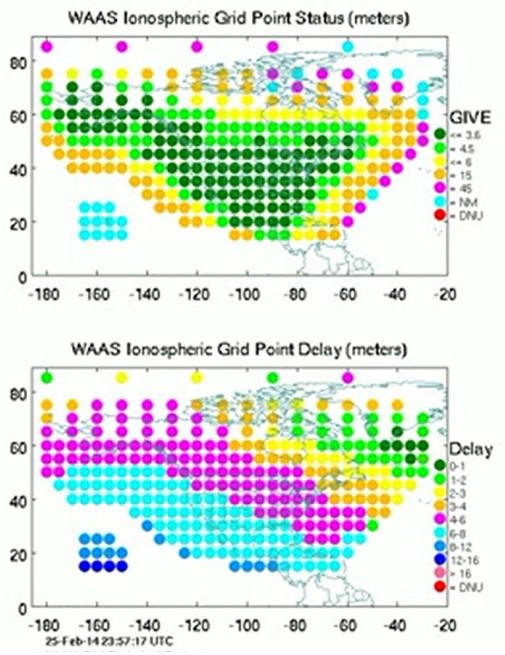
David E. Spencer (A) Director
Technical Operations Support, AJW-1

Attachment
cc: AJM-3, ANG-C, AJW-13, AJW-137

- Enhances Availability
  - Include satellites that are currently omitted in Block I
  - Change fault reactions to re-admit faulty satellites sooner
  - Operate on two receivers for common masking
    - Block I requires three receivers to broadcast corrections
- Provides Configurability Options
  - Allows for a user-defined iono threat model
    - Enables improved availability in all geographies
  - Allows for automatic user-defined GLS approach procedures for a specific time period
    - Motivated by low latitudes – Set up to broadcast only during specific time periods
- Maintenance Improvements
  - Enable or disable VHF broadcast without going into test mode
  - Display enhancements for usability
- Enables 48 FAS Data Blocks (from 26)

Block II-S – SBAS Integration Supports CAT II on CAT I





No change to existing SLS-4000 Hardware

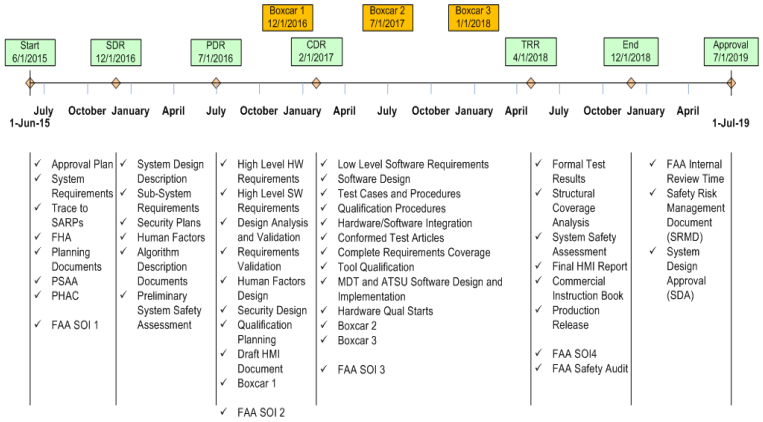
- SBAS Integration option included in Block II System Design Approval
- Performance Enhancement of Ground System Supports:
  - CAT II on CAT I with no change to existing GAST C avionics
  - CAT I Autoland
  - 100% Availability
  - Extend Service Volumes
  - Turn on Differentially Corrected Positioning System

Concept Valid for all ICAO Compliant SBAS Systems

SLS-5000 CAT III SmartPath® GBAS

- Road to CAT III is Paved…
  - SDA Approval Plan submitted and acknowledged by FAA
  - FAA CAT III validation project completed
    - Substantially de-risked CAT III development
  - FAA formally supporting CAT III development
  - Heavy Re-use of Block II baseline
    - 100% re-use of 13 integrity monitors from Block II
    - Adding 2 new monitors; Updating 2 others
  - Minimal HW changes from CAT I (ex: Copper Cables to Fiber)
  - SDA … Market Driven Delivery

CAT III Schedule



CAT I and CAT III Integrity Monitors

SCAT I	GAST-C	GAST-D	
SCAT I Operations (1998)	CAT I Operations	CAT I Operations	CAT II/III Operations
Broadcast Msg Type 1, 2 & 4	Broadcast Msg Type 1, 2 & 4	Broadcast Msg Type 1, 2 & 4	Broadcast Message Type 11
	Sigma PR Ground	Sigma PR Ground	
	Phase Center Non-Zero Mean	Phase Center Non-Zero Mean	
	Ground System Sigma Monitor	Ground System Sigma Monitor	
	Ionosphere Anomaly Monitor	Ionosphere Anomaly Monitor	
	Troposphere Anomaly Monitor	Troposphere Anomaly Monitor	
	Ephemeris Monitor	Ephemeris Monitor	
	Signal Deformation Monitor	Signal Deformation Monitor	
	Low Satellite Signal Power Monitor	Low Satellite Signal Power Monitor	
	Code Carrier Divergence Monitor	Code Carrier Divergence Monitor	
	Excessive Acceleration Monitor	Excessive Acceleration Monitor	Excessive Acceleration Monitor
	Executive Monitor	Executive Monitor	Executive Monitor
	RFI Above the Mask	RFI Above the Mask	
	Iono Screening Real Time Inflation	Iono Screening Real Time Inflation	
	Constellation Alerts	Constellation Alerts	
	Broadband RFI Monitor	Broadband RFI Monitor	
			Cross Correlation Monitor
			Iono Gradient Monitor

Clear Path to CAT III Based on Certified Block II Baseline

Demonstrating the Value of GBAS

2014

eco Demonstrator PROGRAM

BOEING

Honeywell

SESAR JOINT UNDERTAKING

SESAR 9.12
GBAS CAT II/III – 150 Trials

AIRBUS Honeywell

2015

Shanghai Pudong GBAS Trials

中国民航 CAAC

中國東方航空 CHINA EASTERN

Honeywell

2015 - 2016

Large Scale Demonstrations (2016)

SESAR JOINT UNDERTAKING

Honeywell

Air Navigation Services of the Czech Republic

AIRBUS

NETJETS

DFS Deutsche Flugsicherung

Elbit Systems

DASSAULT AVIATION

skyguide

DLR

dgac

DSNA

ZURICH AIRPORT

Fraport

SWISS

Lufthansa

EBAA

- RNP to GLS with 1.4 nm short final approach
- 3.5 – 4.0 deg Glideslope approaches with up to 1000 ft displaced threshold
- CAT III “hands-off” Autoland by an airline crew
- GBAS landing in Asia Pacific (Australia excluded)
- Published RNP to GLS approaches (2016)

Customer Testimonial – DFS, Germany

CUSTOMER SUCCESS STORY

Honeywell

DFS embraces new precision approach technology

Honeywell SmartPath® GBAS increases airspace efficiency and capacity with the prospect to lower airport costs

Overview

With global air travel continuing to rise, airports need to find new ways to handle additional aircraft movements without incurring the costs of building more runways. GBAS has been identified by ICAO, the U.S. Federal Aviation Administration (FAA), and Eurocontrol as an enabler for improving air traffic and Honeywell's solution, the SmartPath Precision Landing System, is the world's only certified system. Bremen Airport in Germany was the first airport in the world to adopt the technology.

DFS Deutsche Flugsicherung

AT A GLANCE

Customer

Names: DFS Deutsche Flugsicherung GmbH

Location: Bremen, Germany

Industry: Air navigation service provider

Website: www.dfs.de

Honeywell solution

SmartPath Ground-Based Augmentation System (GBAS)

Why DFS chose Honeywell

- GBAS identified by ICAO, FAA and Eurocontrol as an enabler for improving air traffic capacity
- Honeywell SmartPath is world's first and only certified GBAS system
- DFS wanted to familiarise itself with GBAS as the organisation sees it as an eventual successor to ILS technology

Customer results

- Reduced the chances of taxi time delay and much less impact from weather or significant sitting obstacles on the airfield, unlike ILS critical areas
- Significanly reduced maintenance effort as GBAS requires fewer checks by flight inspection than ILS systems
- Used by airlines under IMC down to CAT I decision altitudes

Honeywell