

Poland Ground Based Augmentation System (GBAS) Seminar AGENDA

- 0900-0915 Welcome (PANSA)
- 0915-0930 Introductions (All)
- 0930-1030 GBAS Overview (Honeywell: Pat Reines)
- 1030-1045 Break (All)
- 1045-1115 Warsaw and Krakow Approach Concepts & Videos
(Honeywell: Pat Reines)
- 1115-1145 DFS GBAS Operational Implementation
(DFS: Olaf Weber)
- 1145-1245 Lunch Break (All)
- 1245-1345 Possible Funding Sources
(Honeywell: Alex Laybros)
- 1345-1445 GBAS Approval Processes
(Honeywell: Garrett McKelvey)
- 1445-1515 Discussion and Wrap Up (All)



Pat Reines
(pat.reines@honeywell.com)

SmartPath®
Ground Based Augmentation System (GBAS)
A New Era in Precision Navigation

Honeywell

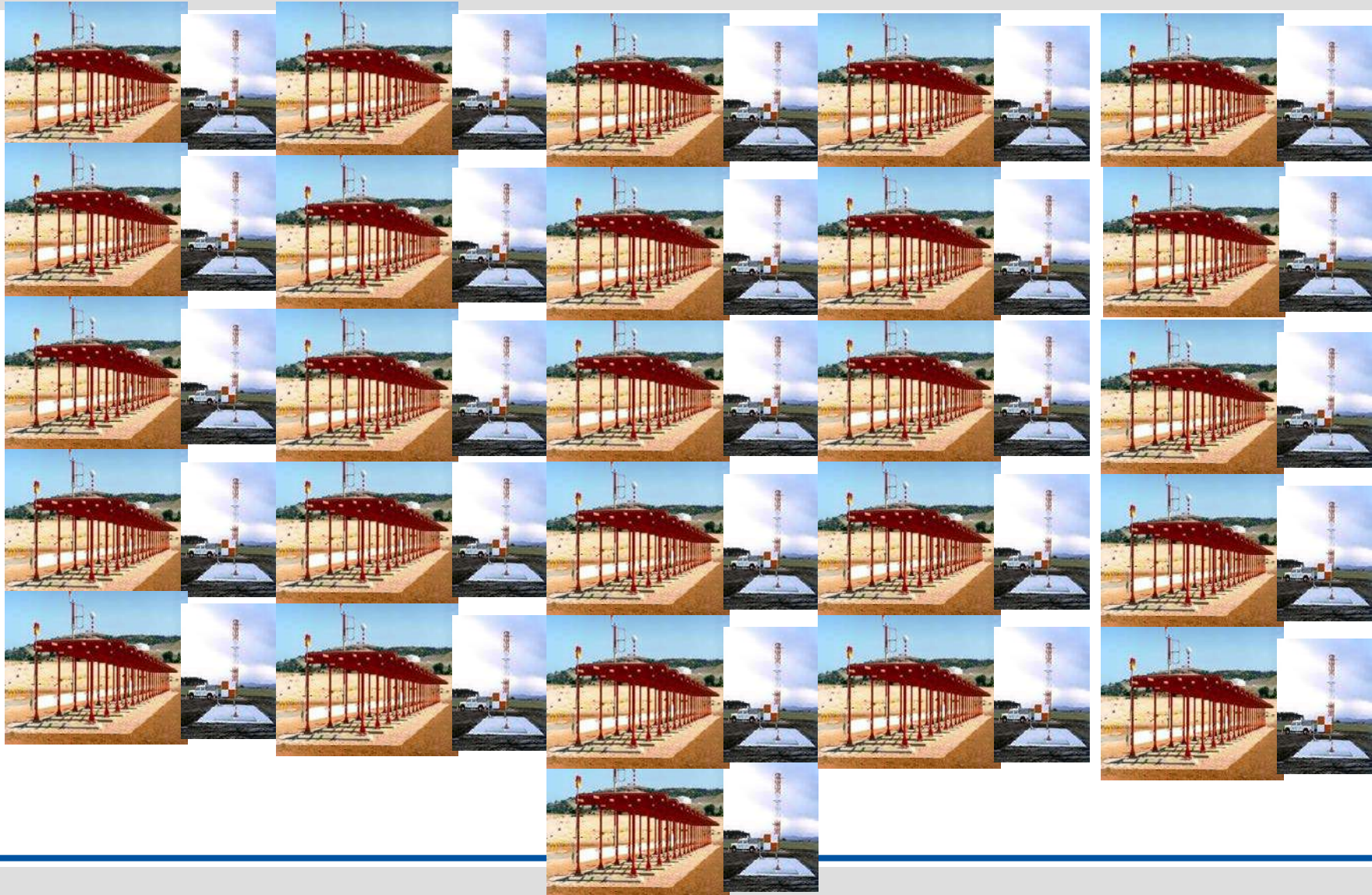
Flight Plan

- **Ground Based Augmentation System (GBAS) Overview**
- **SmartPath Enabled Air Operations Overview**
- **SmartPath Installations Update**
- **SmartPath Status and Growth**
- **SmartPath Value Summary**

Flight Plan

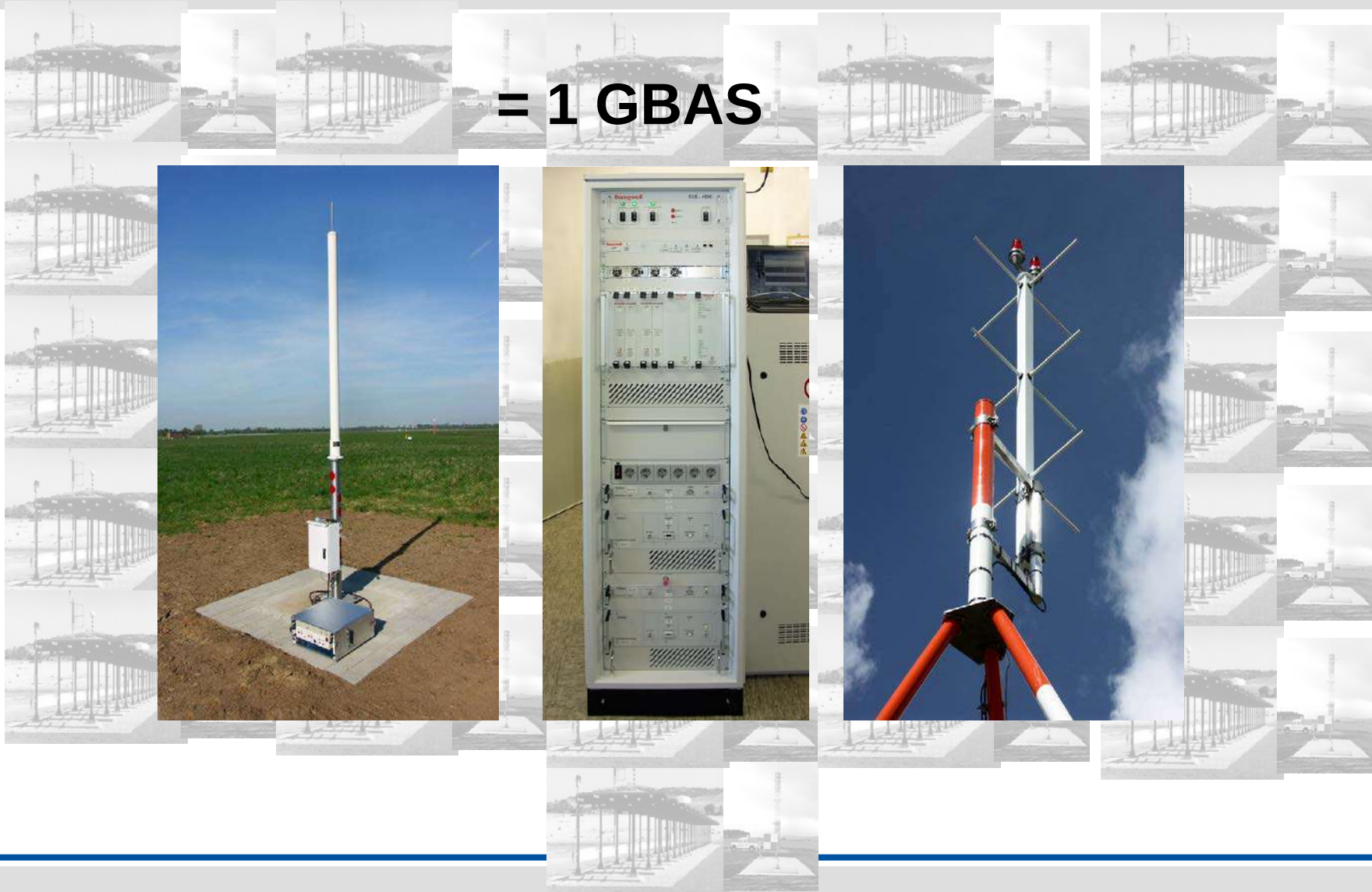
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26 ILS Approaches = 26 Localizers and Glide Slopes



26 ILS Approaches = 26 Localizers and Glide Slope

= 1 GBAS

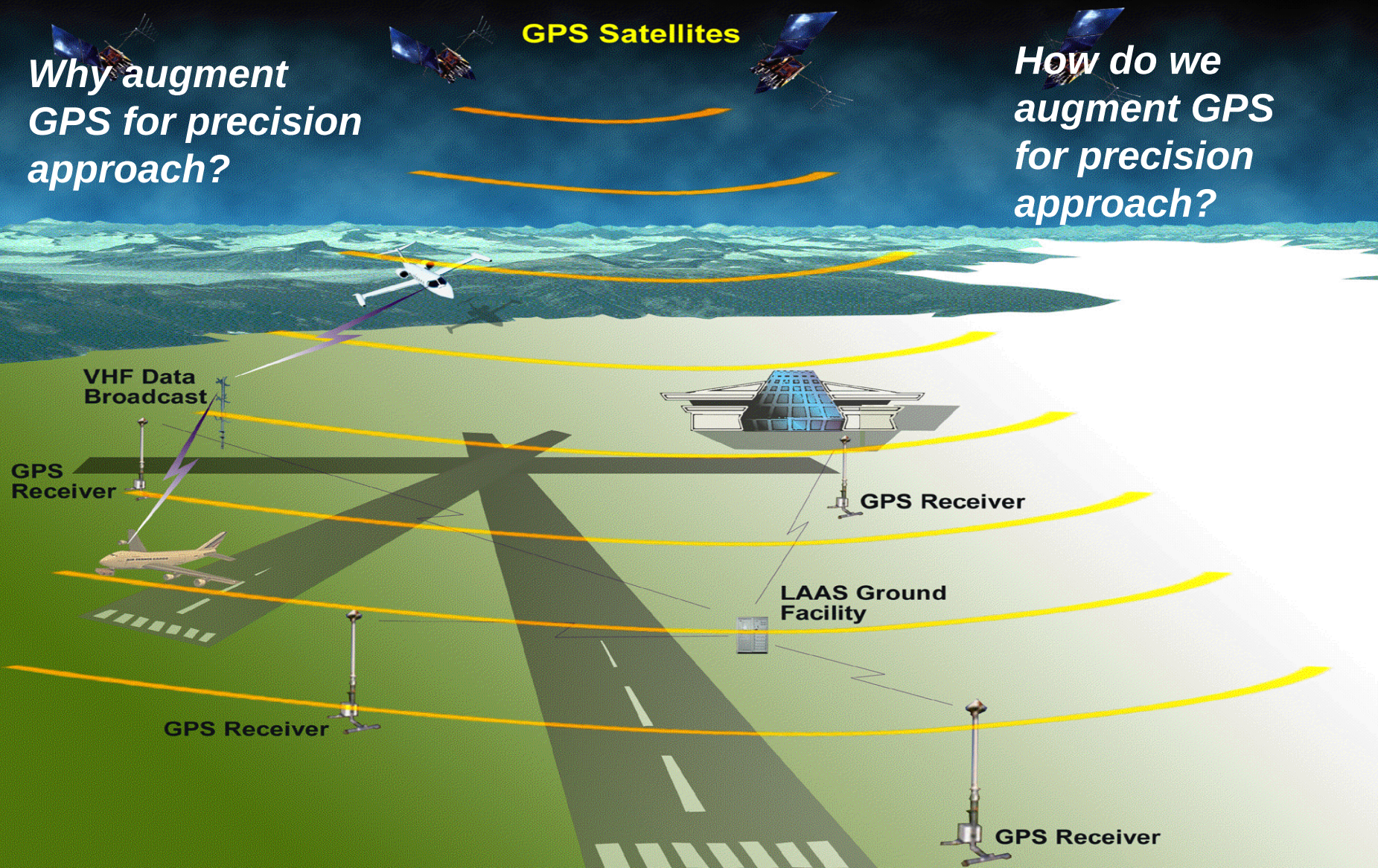


Ground Based Augmentation System (GBAS)

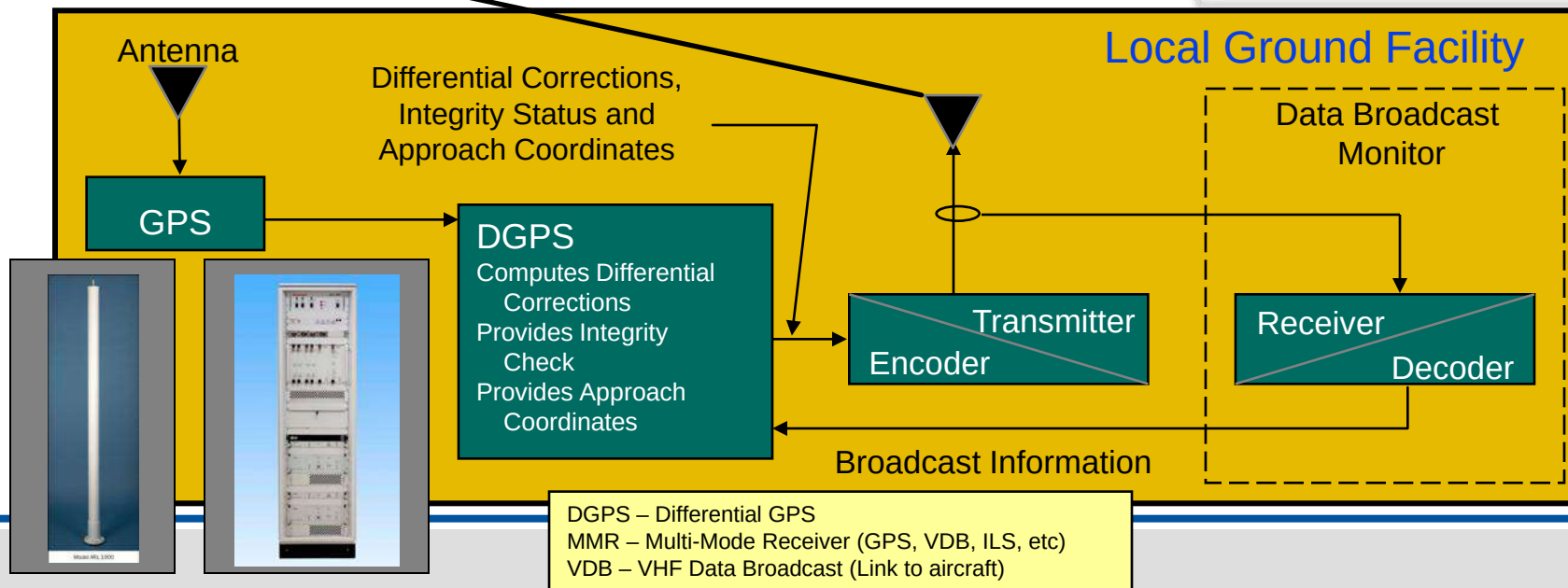
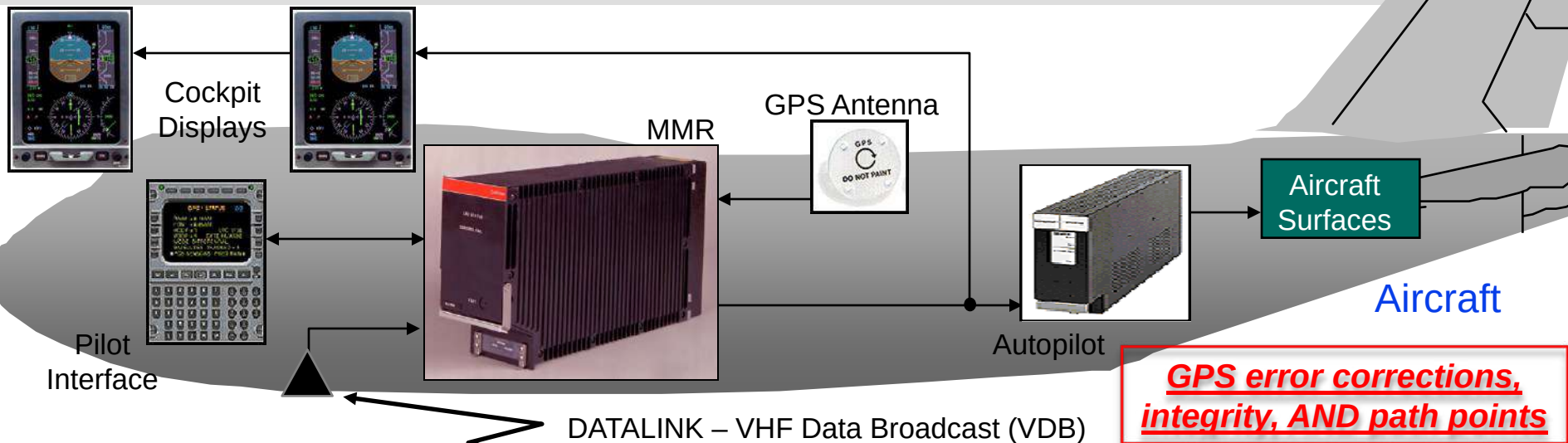
*Why augment
GPS for precision
approach?*

GPS Satellites

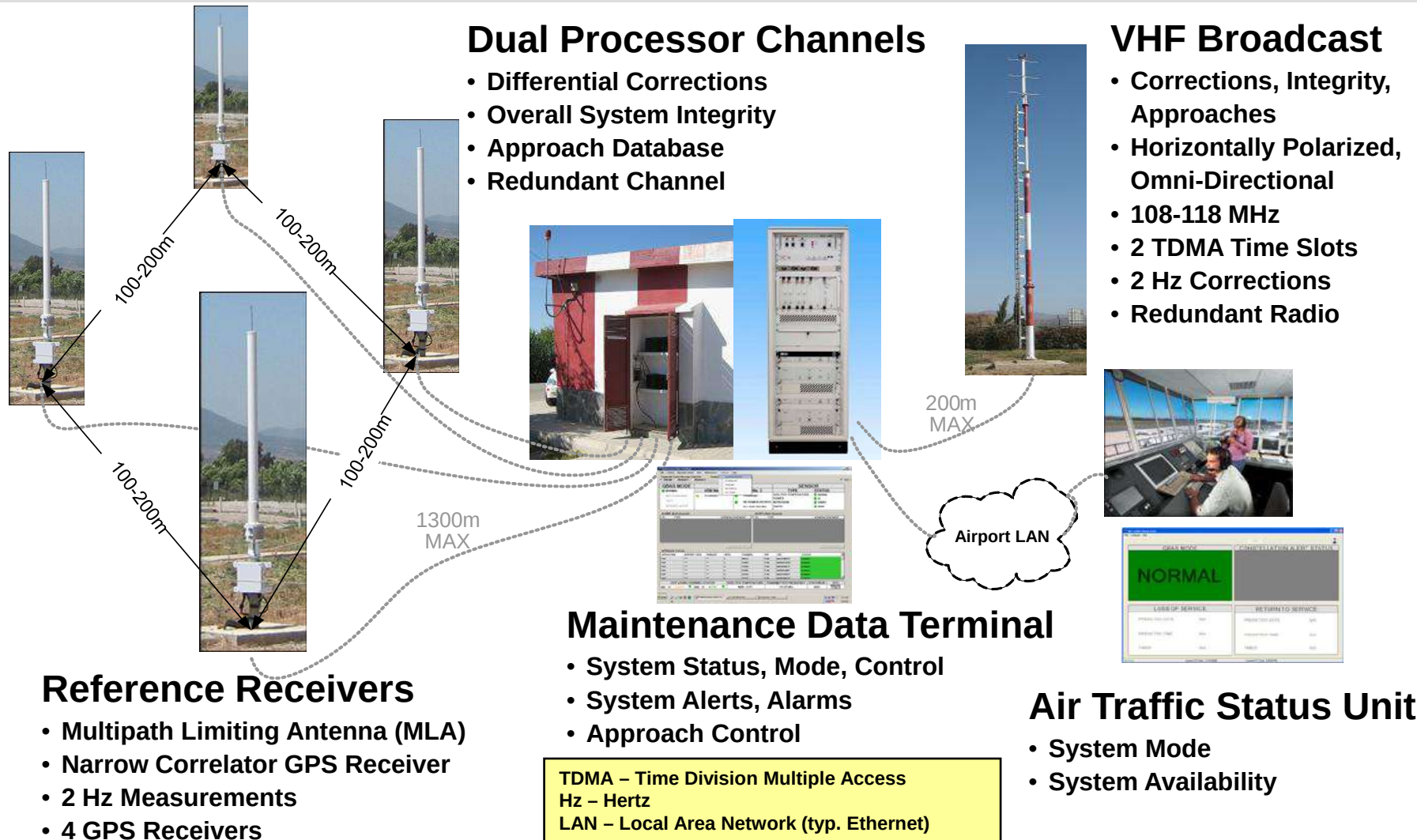
*How do we
augment GPS
for precision
approach?*



GLS: GBAS Airborne Implementation



Honeywell SmartPath® GBAS



GLS Uses Existing Aircraft Architecture



GLS – GNSS Landing System
ILS – Instrument Landing System

- ILS look alike
 - Glideslope
 - Localizer

737-07-XX

July XX, 2007

GLOBAL POSITIONING LANDING SYSTEM (GLS) PROCEDURES

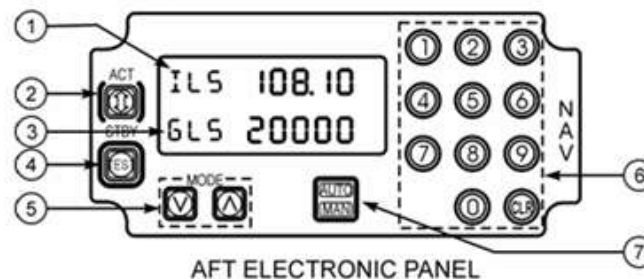
This bulletin describes aircraft systems and procedures for GLS approaches.

The initial aircraft to obtain this system will be the Continental Micronesia 737-800's. Installation will commence at the end of June, with flight procedures to begin in the fall timeframe.

The aircraft will have the following physical differences on the flight deck:

1. Multi-Mode Navigation Control Panel. This is visually identical to the panel currently installed in the 500's. The difference is the ability to select GLS frequencies.

Multi – Mode Navigation Control (If Installed)



AFT ELECTRONIC PANEL

7376-11005

- Active (ACT) Mode and Frequency Indicator
Indicates the active mode and frequency.
- Transfer Switch

Flight Plan

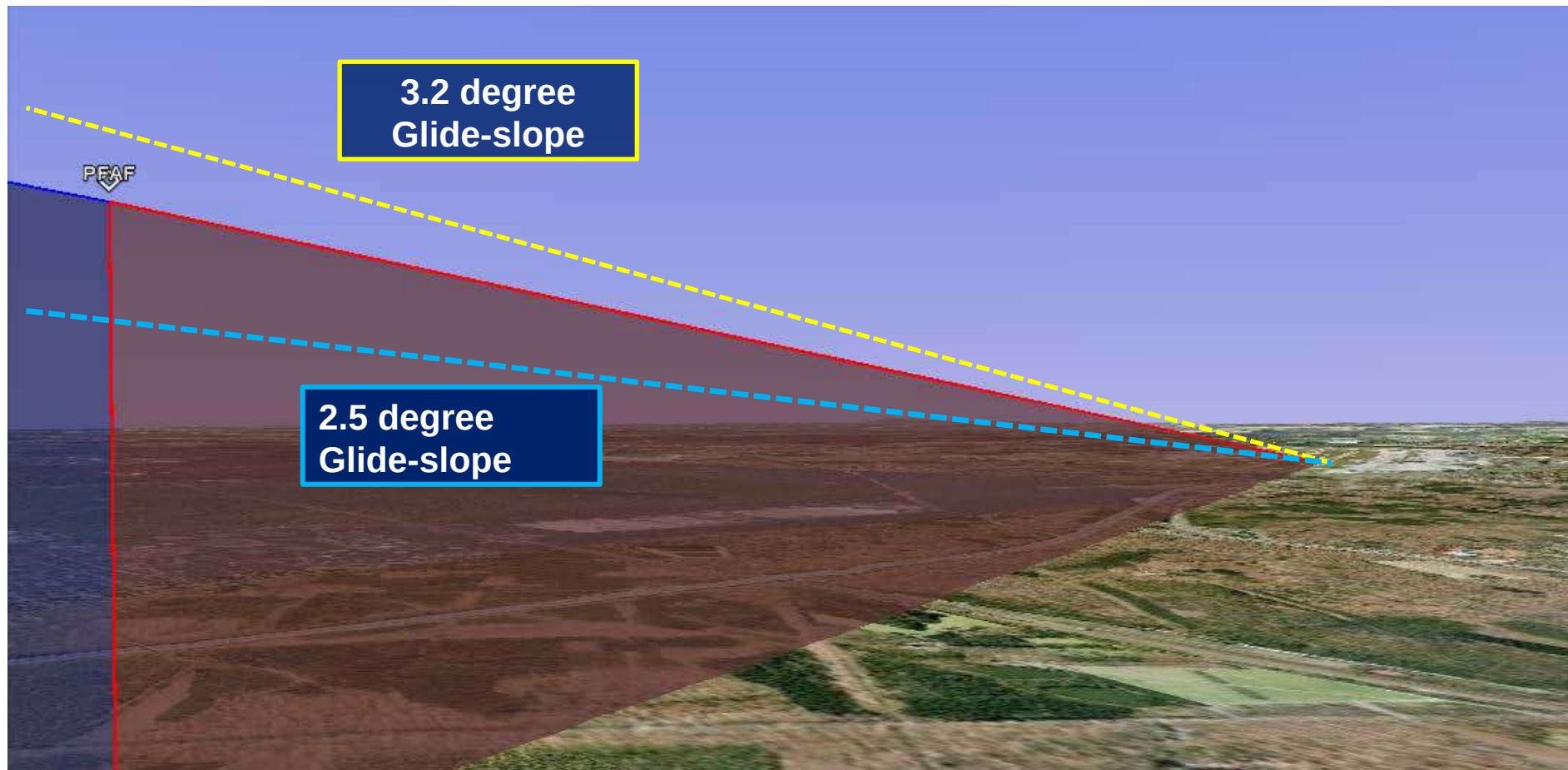
- Ground Based Augmentation System (GBAS) Overview
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GBAS: Programmable Touchdown Points and Path

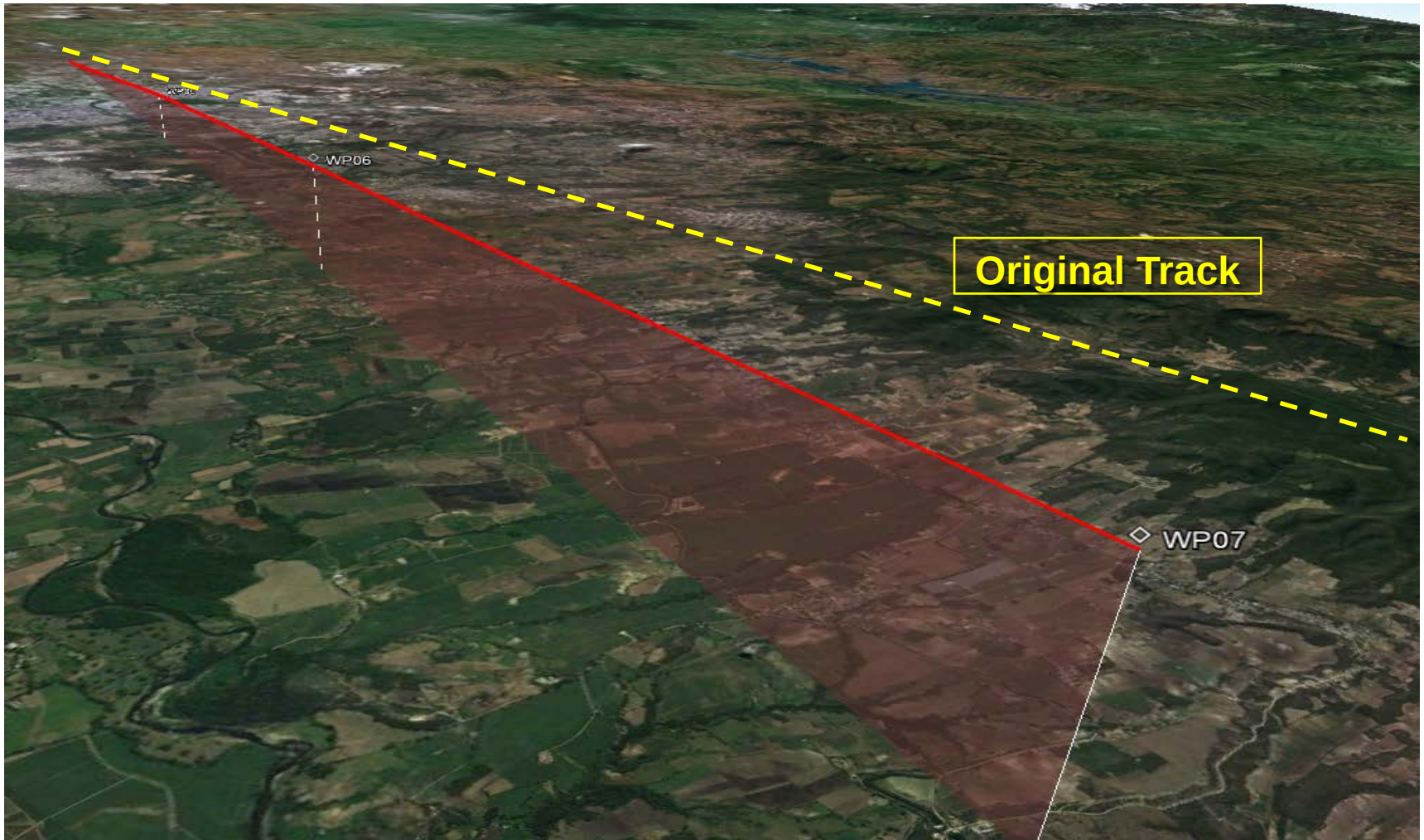
- ILS: single defined vertical path, same touchdown point on runway
- SmartPath GBAS: multiple touchdown points and glide slope combinations



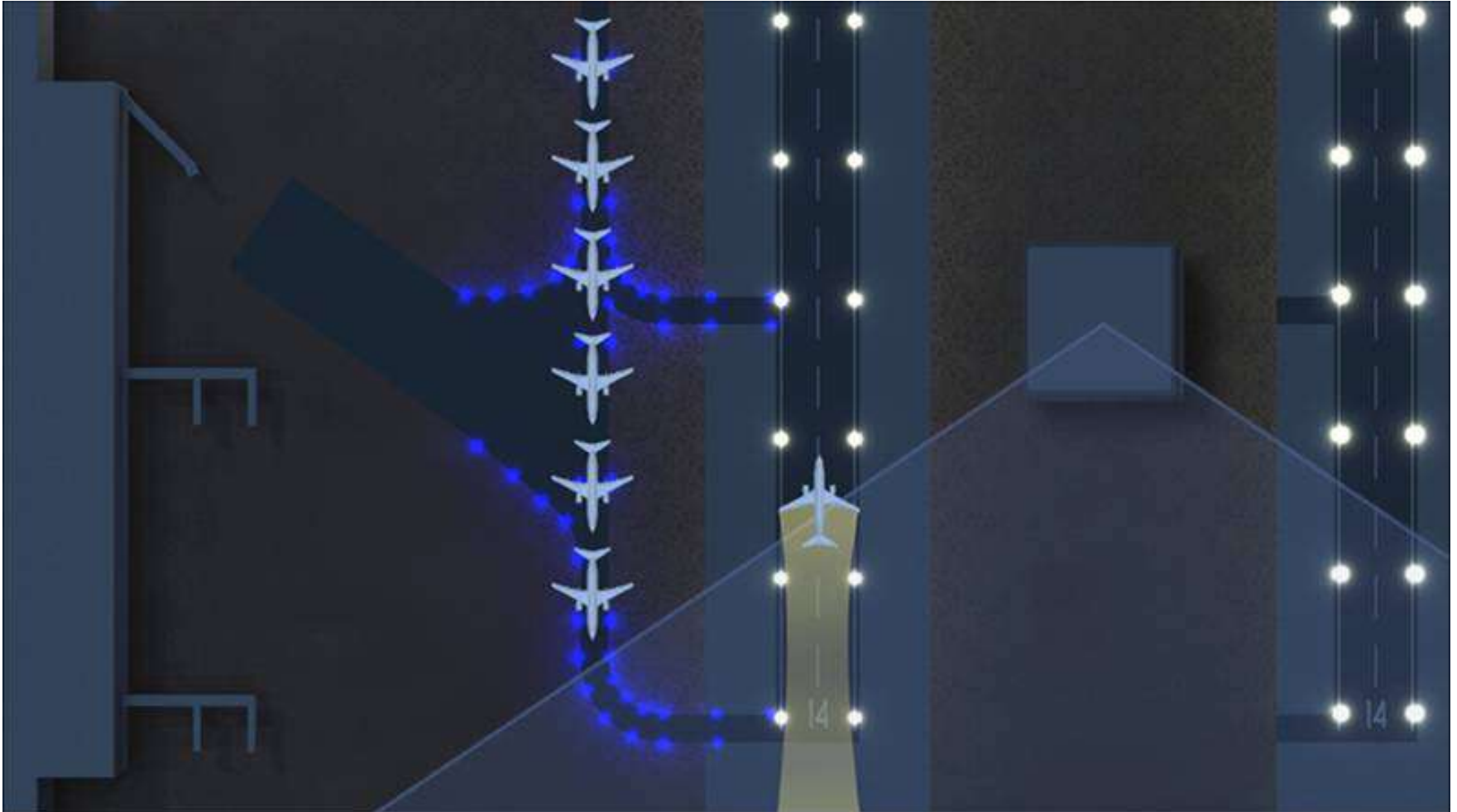
GBAS: Programmable Touchdown Points and Path



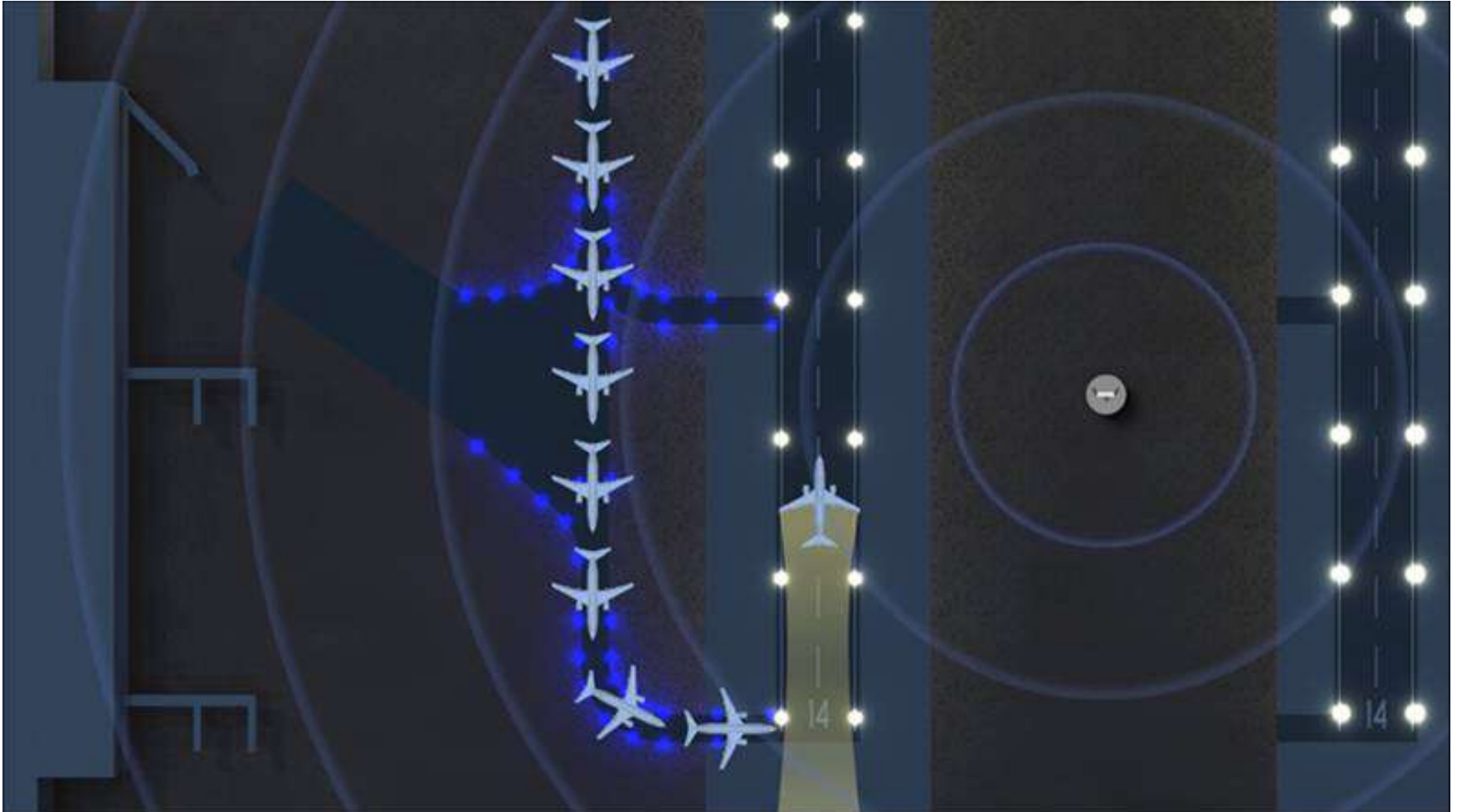
GBAS Offset Approaches



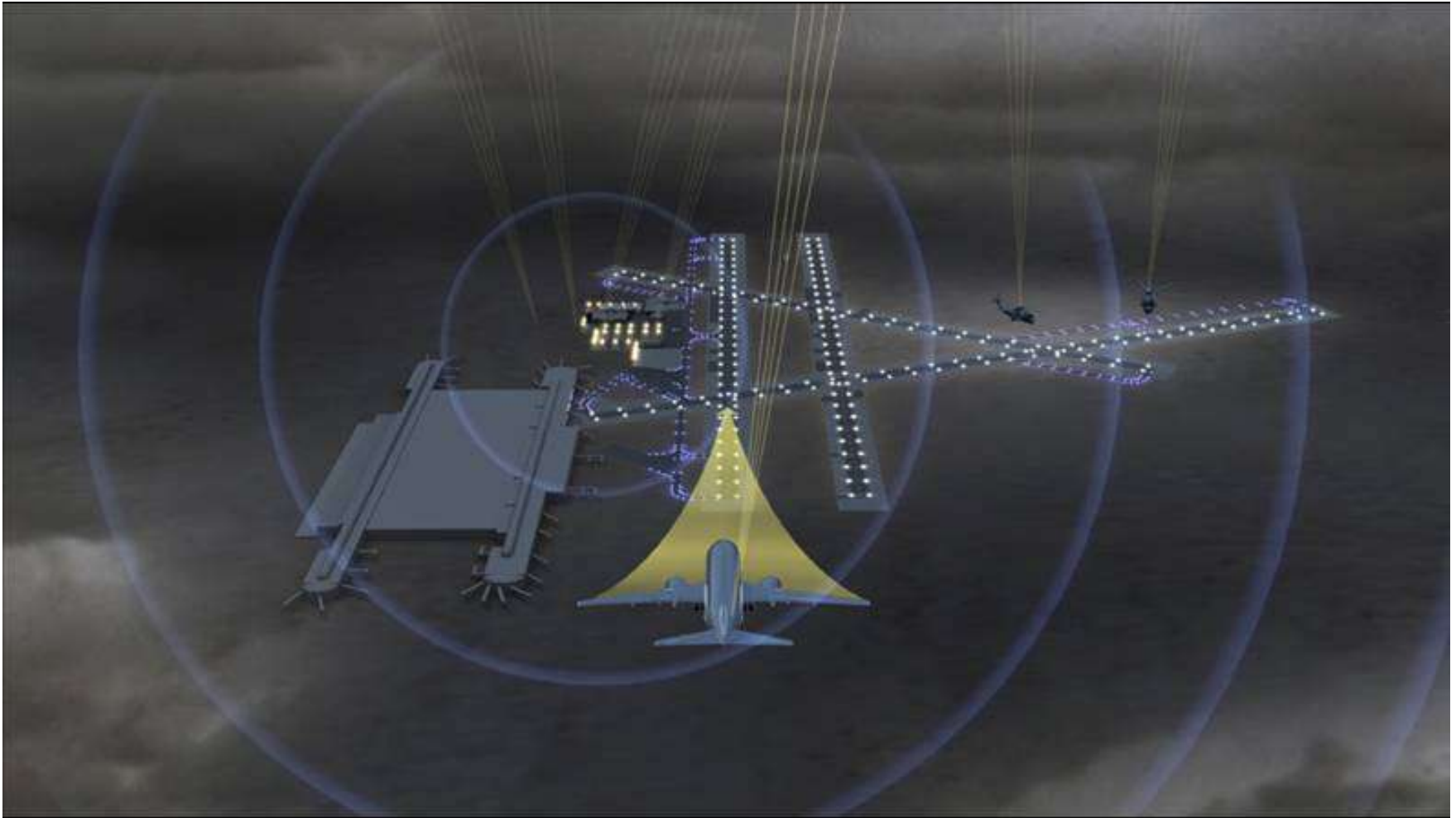
ILS Clear Zones



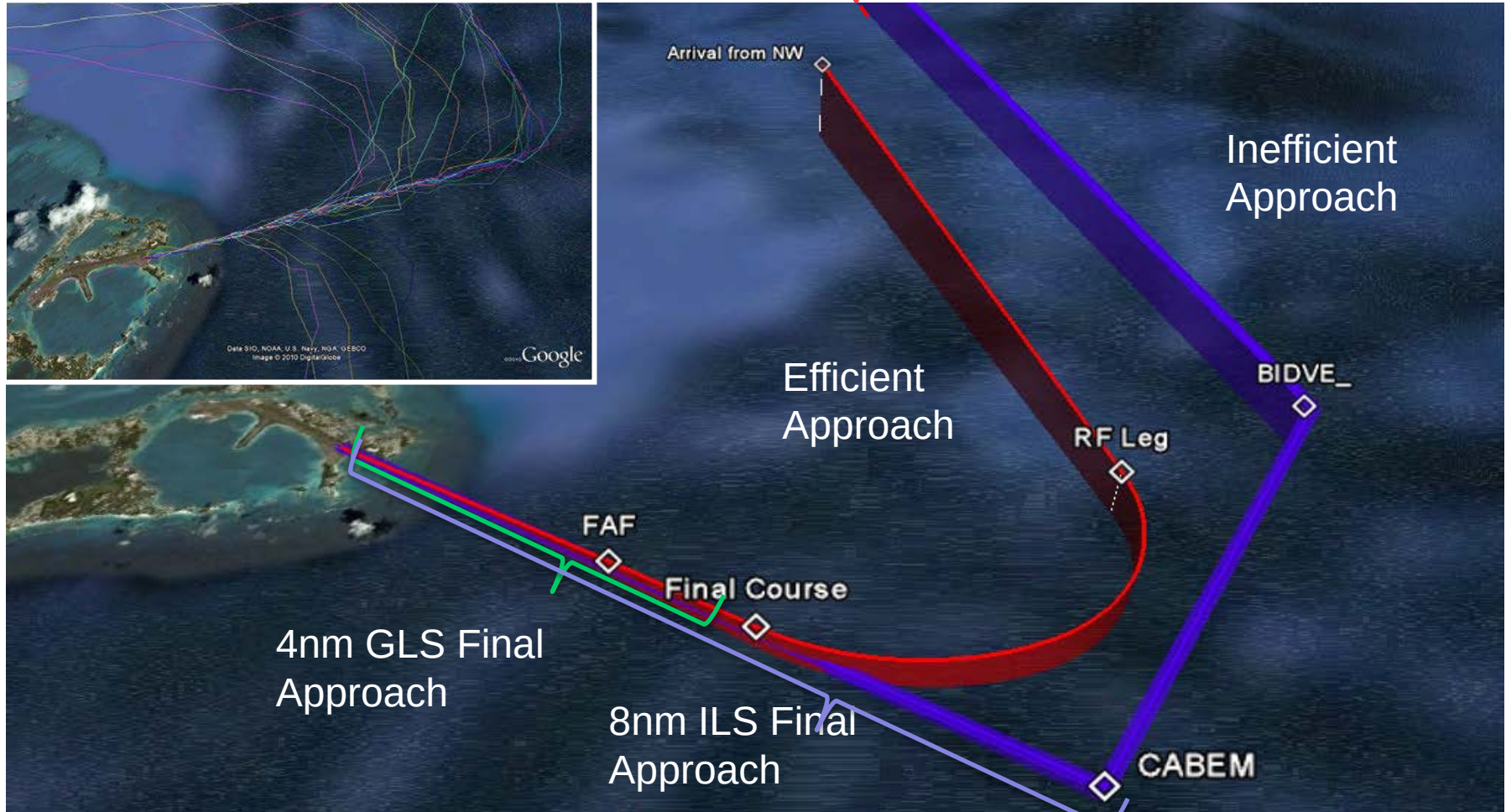
GBAS Requires No Clear Zones



GBAS Multiple Concurrent Operations



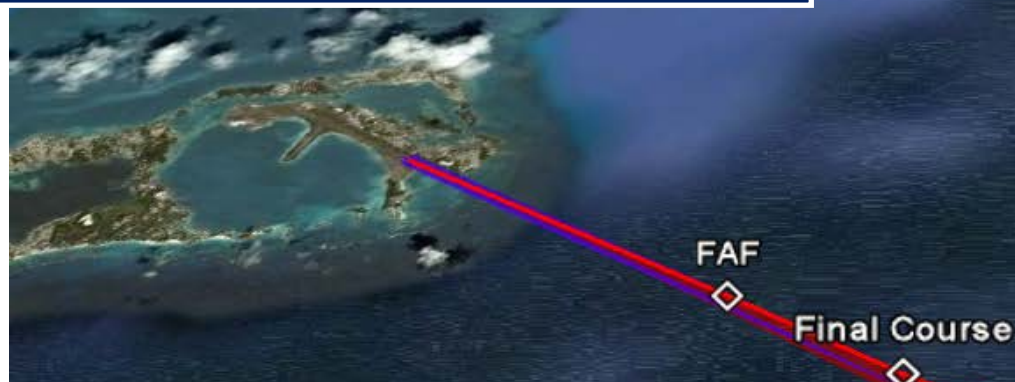
RNP + GBAS GLS: Enabling Maximum Efficiency



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



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

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



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DFS: Bremen First Flight

World's 1st/Only
FAA/ICAO
Compliant

FAA CAT-I
Certified
4 Sep 2009

German BAF
Certified
28 Nov 2011

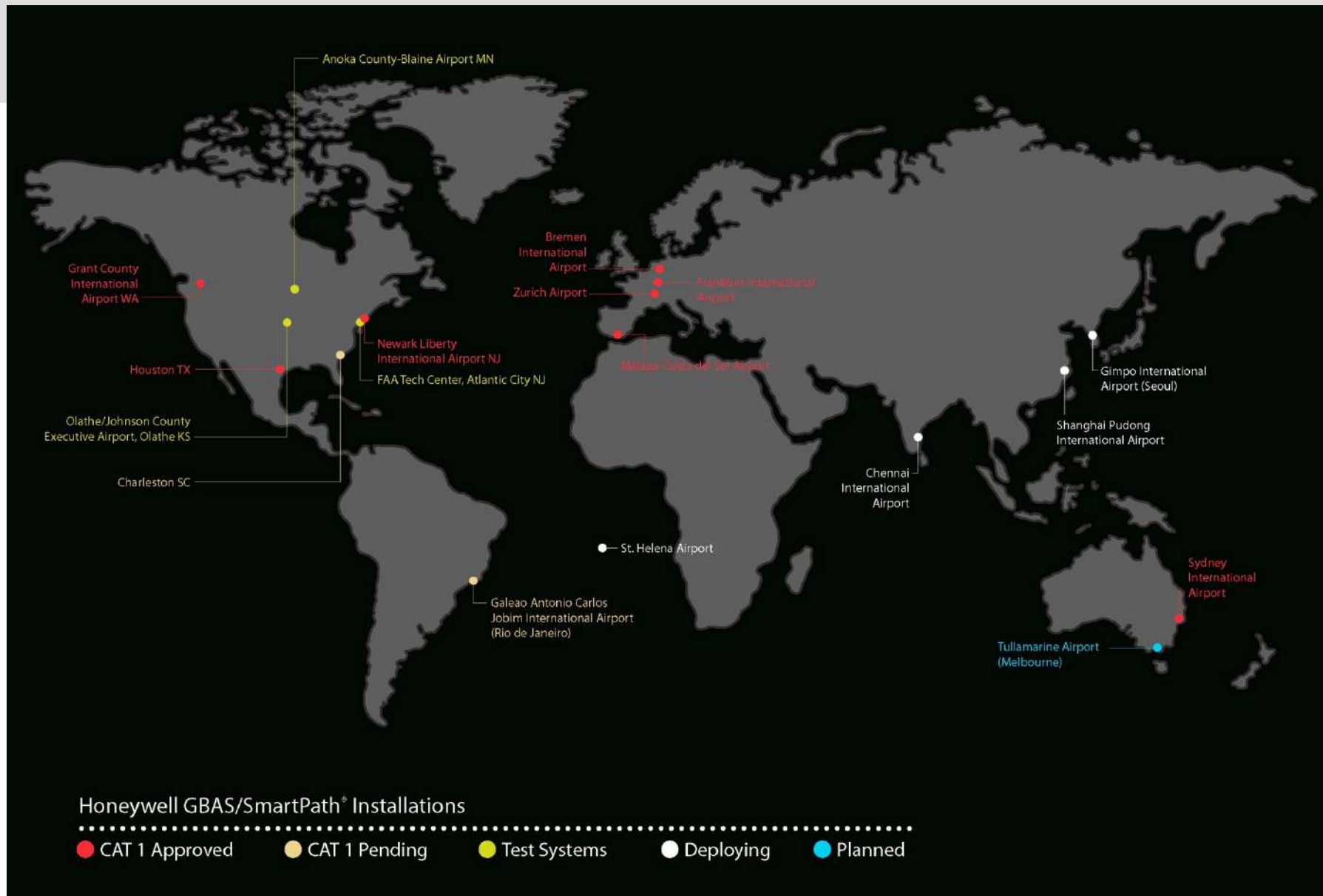
Spanish CAA
Approval
5 May 2014

Switzerland
GBAS Operational
14 October 2014

Australian CASA
Approval
29 May 2014



- The world's first unrestricted GLS landing occurred at Bremen, Germany
- 9 Feb 2012: Air Berlin 6573 landed at 21:52 using Honeywell's SmartPath GBAS



GLS: GBAS Airborne Implementation

**737NG: GLS certified,
650 GLS activated = 20% of operators
900 GLS provisioned = 40% of operators
787: GLS certified, basic = 886 aircraft
747-8: GLS certified, basic**



**A-380: GLS certified, 8 airlines
A-320 family: GLS certified, 8 airlines
A-330/340: GLS certified 2013
A-350: GLS certified at entry into service, 4 airlines**

GLS: GBAS Airborne Implementation

**737NG: GLS certified,
650 GLS activated = 20% of operators
900 GLS provisioned = 40% of operators
787: GLS certified, basic = 886 aircraft
747-8: GLS certified, basic**

GLS Equipped Aircraft by 2016: 4000+

**A-380: GLS certified, 8 airlines
A-320 family: GLS certified, 8 airlines
A-330/340: GLS certified 2014
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Airbus GLS Customers

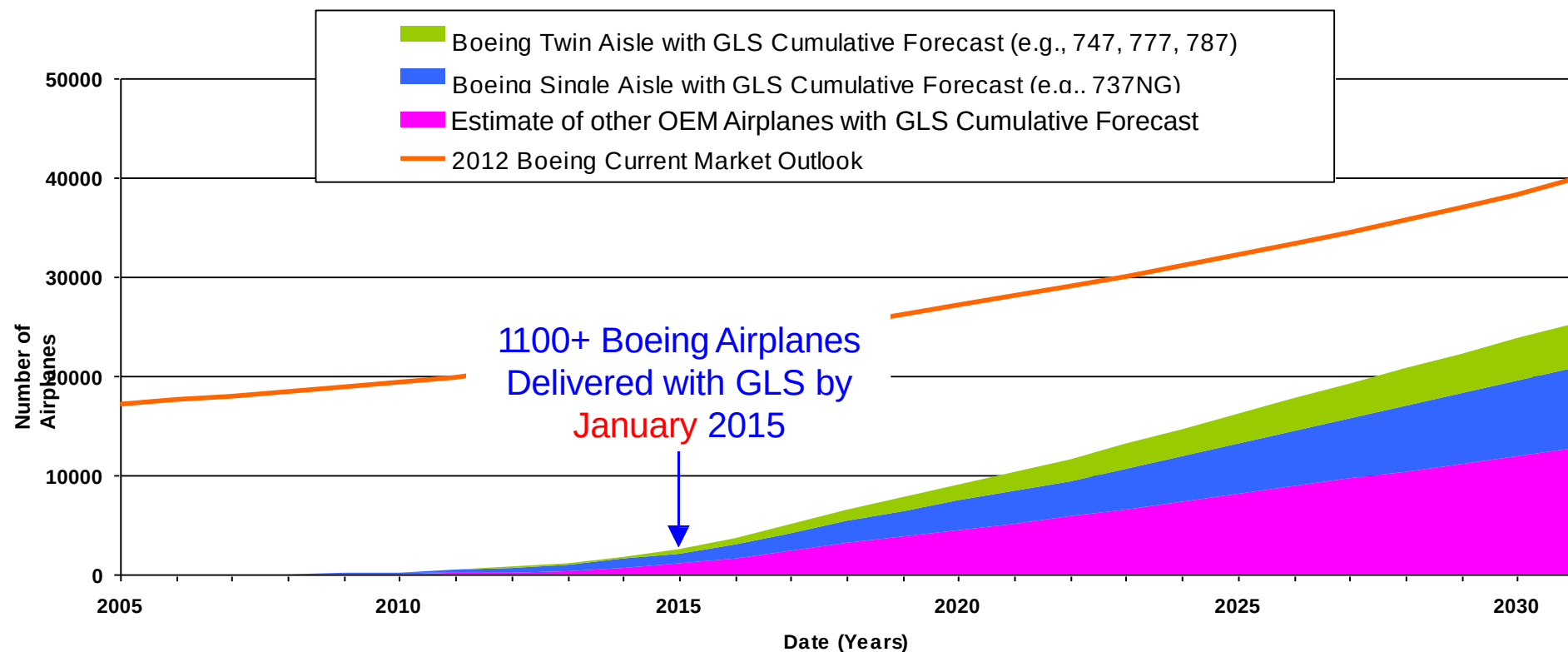


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Boeing GLS Program | Equipage Forecast Update

Boeing Airplane Programs GLS Equipage Forecast

(based on publically released production rates)



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SmartPath Certification Baseline, Growth

- **SmartPath Cat I System Design and Operational Approvals**
 - FAA (US): September 2009
 - BAF (Germany): November 2011
 - Other approvals: Spain, Australia, Switzerland
 - **In revenue passenger service**
- **Cat II performance from Cat I system**
 - 2 methods
 - Aircraft and flight operations requirements
 - Cat I with SBAS
 - SBAS network provides iono status: benign iono enables GBAS parameter changes
 - No new avionics needed
 - **Available 2015**

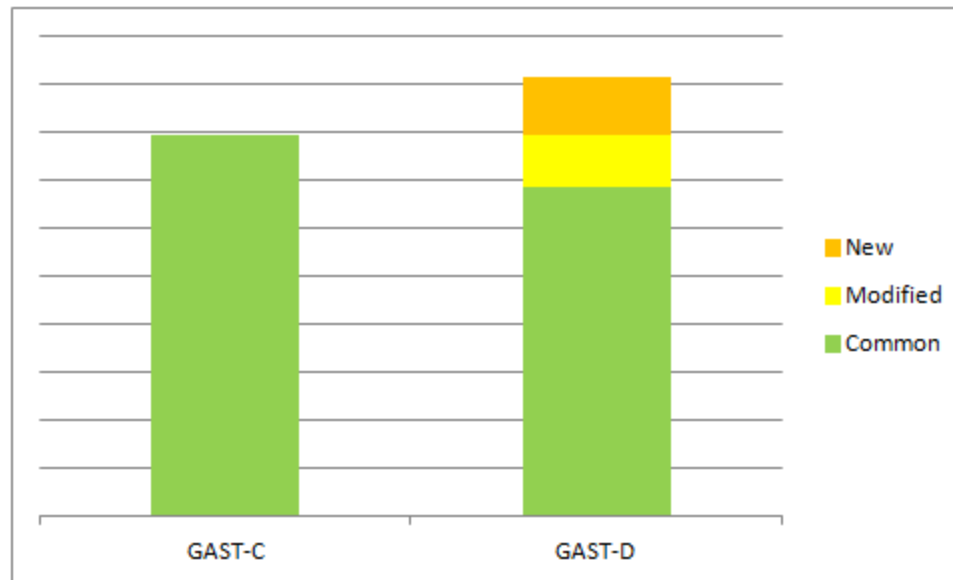


SmartPath Certification Baseline, Growth

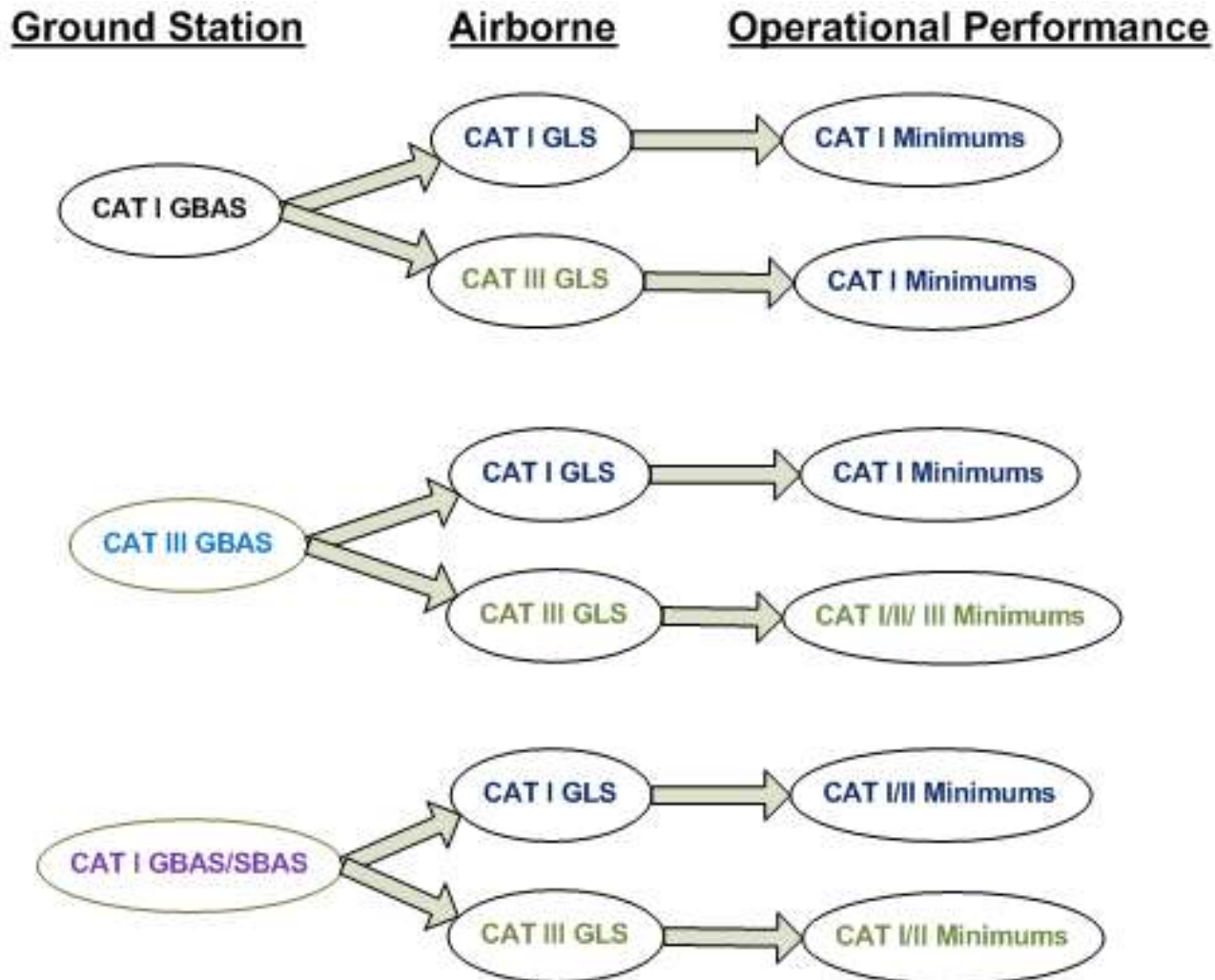
- **Cat III development and validation underway**
 - **Cat I station is upgradeable to Cat III**
 - **Cat III GBAS works with Cat I and Cat II/III GLS avionics**
 - FAA Cat III ground station/avionics contracts to Honeywell: 2010
 - Prototype ground station/avionics based on SLS-4000 and INR
 - Flight testing and additional development: 2012-2016
 - FAA testing 2012
 - SESAR flight tests October 2013
 - Boeing ecoDemonstrator 2014
 - Certifications: 2017-2018
 - FAA/Honeywell approval project underway
 - **Forecasted to be operationally available: 2019**

GAST-D (CAT II/III)

- Honeywell has initiated an FAA approval plan for a GAST-D system
- Core architecture unchanged from GAST-C SLS-4000 system
- Two new monitors for GAST-D
- Requirements prototyped and validated by the FAA



SmartPath Certification Baseline, Growth

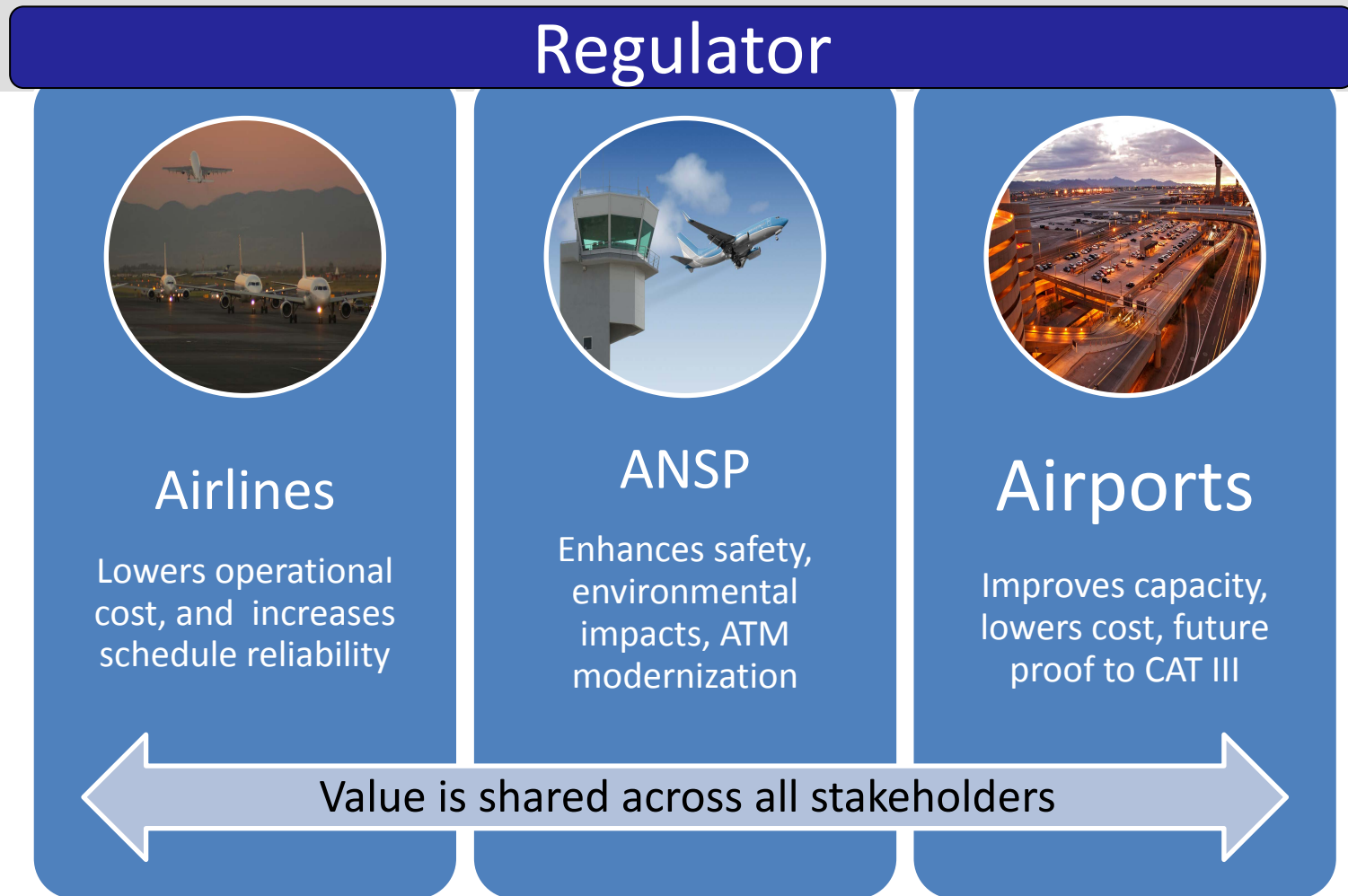


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SmartPath Summary

- **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



***Stakeholder Involvement Throughout the Whole Project =
Successful Implementation***



Thank You!

Honeywell

Approach technology Comparison

Feature	GBAS	SBAS	ILS
Coverage	All runways at the installed airport	Continental (based on number of installed reference stations)	One runway end
Equipment and installation Cost (capital)	~\$3,300K <u>per airport</u>	TBC - \$1,000M+ per country	\$1,500K <u>per runway end</u>
O&M Annual cost	\$85K - \$135K <u>per station</u> , parts and labor; annual flight inspection not req.	\$50M-\$100M per country	>\$140K <u>per ILS</u> Flight test/calibrate once per year
Users per approach	Unlimited	Unlimited	1
Number of approaches	26 (48 w/Cat III) approaches from 1 ground station (approaches broadcast from ground station)	Unlimited non-precision approaches (airborne database contains approaches)	1
Aircraft equipage	GLS avionics	SBAS capable GPS receiver, approach data base	ILS receiver
Capabilities	Flexible approaches: multiple glide slopes, thresholds, offsets; No ILS critical area; Cat I, growth to Cat II/III	Flexible non-precision approaches including LPV	1 approach per ILS; Cat I, II, and III