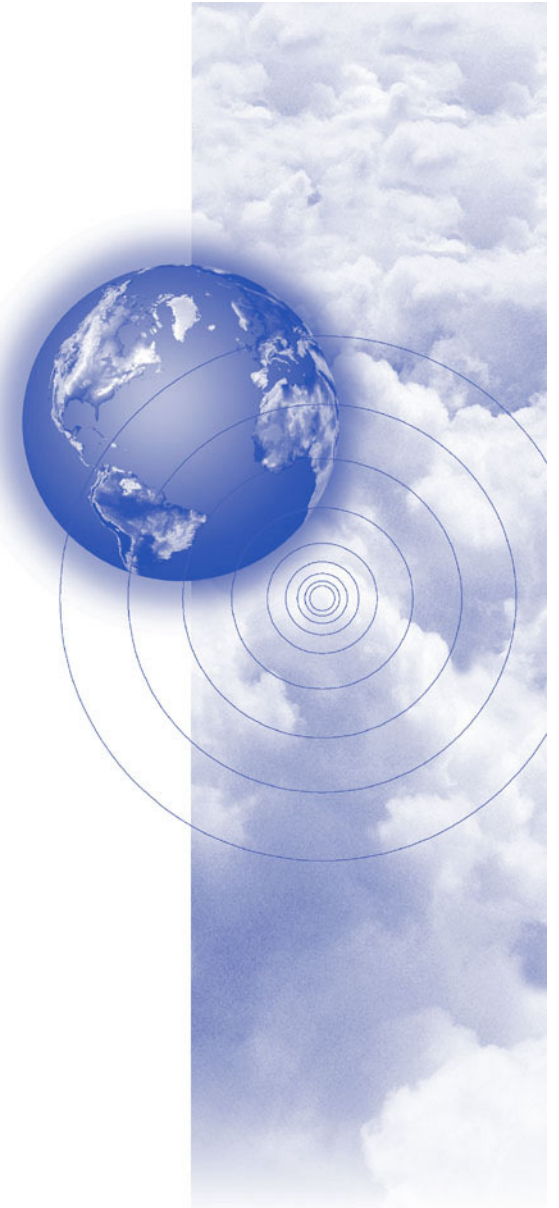




Commercial Aviation

Modernizing ARINC 743 To DO-229D/253B/310 and ADS-B

Presented to
AEEC SAI Subcommittee
16 April 2008



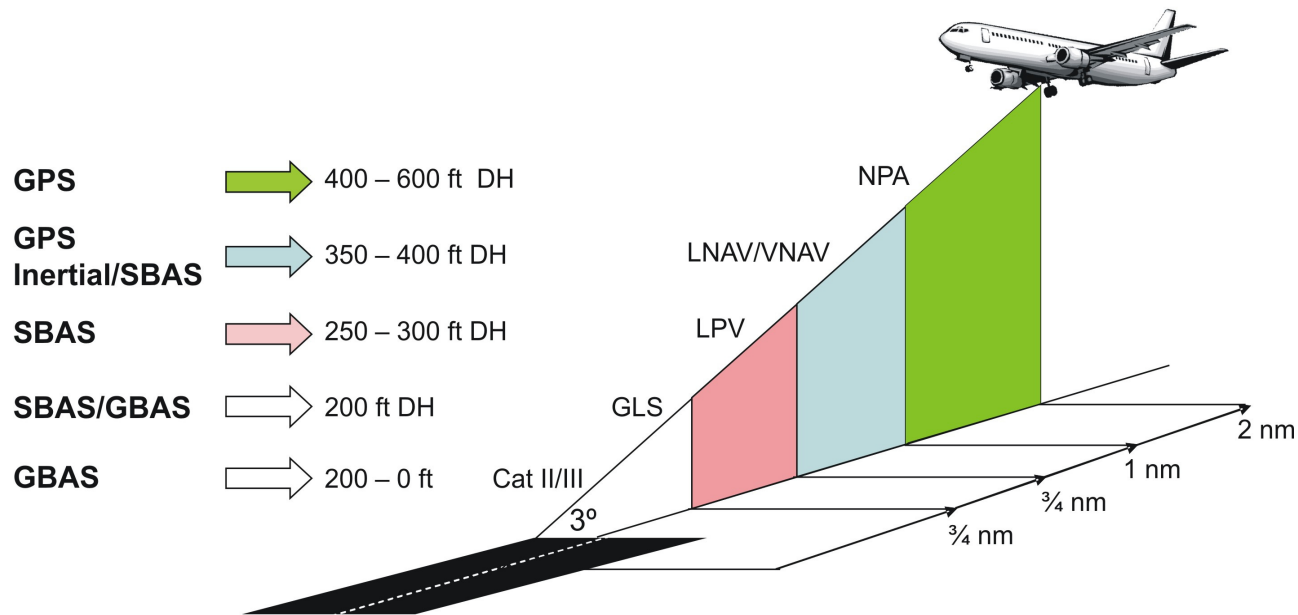
Navigation Evolution Overview

- **Transition to performance-based navigation infrastructure:**
 - *Shift from ground-based to satellite-based services*
 - *Eventually nav aids like VOR and NDB will be “divested”*
 - *NAS-wide services for enroute, terminal and approach, including backup for approach and landing, are all GNSS based*
 - *ADS-B will depend on GNSS for accurate position, velocity, time*
- **Advantages of GNSS:**
 - *Enhances RNAV, RNP navigation*
 - *RNP SAAAR*
 - *New capabilities such as LPV and GLS, CAT-I today, CAT-II/III in future*
- **Aircraft equipage assumptions:**
 - *GNSS with or without inertial navigation*
 - *Minimal or NO FMS modifications*
 - *Address retrofit – “bolt-on” solution, not a gut and re-equip*

GNSS Infrastructure Evolution

- **SBAS:**
 - *2007: DO-229D released, Delta class equipment redefined*
 - *2008: on track with 300 LPV approaches/year*
 - *2009 – 2013: deploy 200 foot LPV (CAT-I ILS equivalent)*
 - *2013 – 2028: dual frequency GPS/SBAS satellite upgrades consistent with GNSS modernization*
- **GBAS**
 - *DO-253B MOPS released, CAT-I today, CAT-II/III being addressed*
 - *No Federal program to deploy GBAS at this time*
- **GRAS**
 - *New concept, DO-310 MOPS released*
- **Modernized GPS and Dual Frequency**
 - *2013 onwards, for applications to safety of life 2018?*
- **Galileo**
 - *Being defined, in very preliminary stages*
- **Other Items of Interest: ADS-B**

Approach Procedures – NPA to LPV to GLS



- Existing Procedures:
 - *Almost 1000 LPVs*
- Procedure production:
 - *300 LPV procedures/year commitment*

Motivation to Update ARINC 743

- Proposal to modernize ARINC 743A-4 to 743A-5

- **GNSS Navigation only characteristic**
 - *Account for DO-229D, SBAS Navigation*
 - *Account for DO-253B, GBAS Navigation*
 - *Account for DO-310, GRAS Navigation*
 - *Account for DO-235B interference environment*
 - *Address ADS-B, velocity outputs*
 - *Remain 100% compatible with other characteristics (e.g. 755 MMR) that refer to it.*
 - *Navigation solution not guaranteed to support approach operations; refer to 743B for additional approach characteristics.*

Motivation to Update ARINC 743

- Proposal to modernize ARINC 743A to 743B

- Complete GNSS based Navigation & Approach characteristic
 - Account for DO-229D, SBAS Navigation and LPV
 - Account for DO-253B, GBAS Navigation and GLS
 - Account for DO-310, GRAS Navigation and GLS
 - Account for DO-235B interference environment
 - Address ADS-B, velocity outputs
 - Address retrofit aircraft
 - New receiver provides SBAS navigation, SBAS LPV, and GBAS/GRAS GLS, minimal retrofit impact

- Both Form Factors addressed:
 - Introduction of new GNSS Landing System Sensor Unit (GLSSU)
 - Navigation data bus with standard ARINC 743A-5 interface
 - New Approach data bus defined, include 10 Hz navigation for approach operation
 - ILS/DME Look-Alike data busses

- Alternate Form Factor addressed:
 - Introduction of new Approach connector
 - Active antenna

Work Schedule to Update ARINC 743

APIM approval April 15th 2008

- *Draft 743B available now, Draft 743A-5 April 28th*
 - *Monthly meetings May of August (hard deadline)*
 - *Draft 743A-5 and 743B available at least one week prior to meetings*
 - *Comments submitted within one week of meeting*
 - ✓ *Two weeks to prepare for next draft*
 - *Final document September 20th for October 2008 approval*
-
- **First introductory Webex meeting April 29th 2008**
 - **Second Webex meeting May 14th 2008**
 - **Third meeting June 11th & 12th 2008**
 - *In person, hosted at CMC Electronics (Montreal)*
 - **Fourth WebEx meeting July 9th 2008**
 - **Fifth meeting August 20th and 21st 2008**
 - *In person*
 - ✓ *Hosted by CMC Electronics or other participant*
 - **Approval at October 20th to 23rd 2008 General Session**

BACKUP MATERIAL



SBAS/GBAS/GRAS Approach Receiver

- **GBAS, GRAS, and SBAS combined in one receiver**
- **Supports all GNSS based functions: Navigation and Approach**
 - **Glide Slope and Localizer look-alike guidance, identical to ILS provided on ILS look-alike bus**
 - **Distance to Threshold, identical to DME (but not slant range) provided on DME look-alike bus**
 - **Retain existing ILS, displays, FMS, add “bolt-on” GNSS approach solution**
 - **Has built-in digital High Integrity Switch to intercept ILS and DME busses**
 - **Approach data bus provides 10 Hz navigation data and both rectilinear and ILS/Look alike guidance**

Comparison between SBAS/WAAS and GBAS/LAAS

• Approach Selection

- *Pilot selects 5-digit ICAO tuning number*
 - ✓ 20000 to 39999 reserved for GBAS
 - ✓ 40000 to 99999 reserved for SBAS
 - ✓ 00000 to 19999 reserved for ILS and MLS
- *Same cockpit procedure for ILS, SBAS, and GBAS*

• Differential Data

- SBAS differential and integrity data from SBAS satellite – no need for any additional hardware, use same GPS receiver
- GBAS differential and integrity data from GBAS ground station – need VDB receiver and VHF antenna
- Will need TSO C-190 Active antenna for LPV or GLS

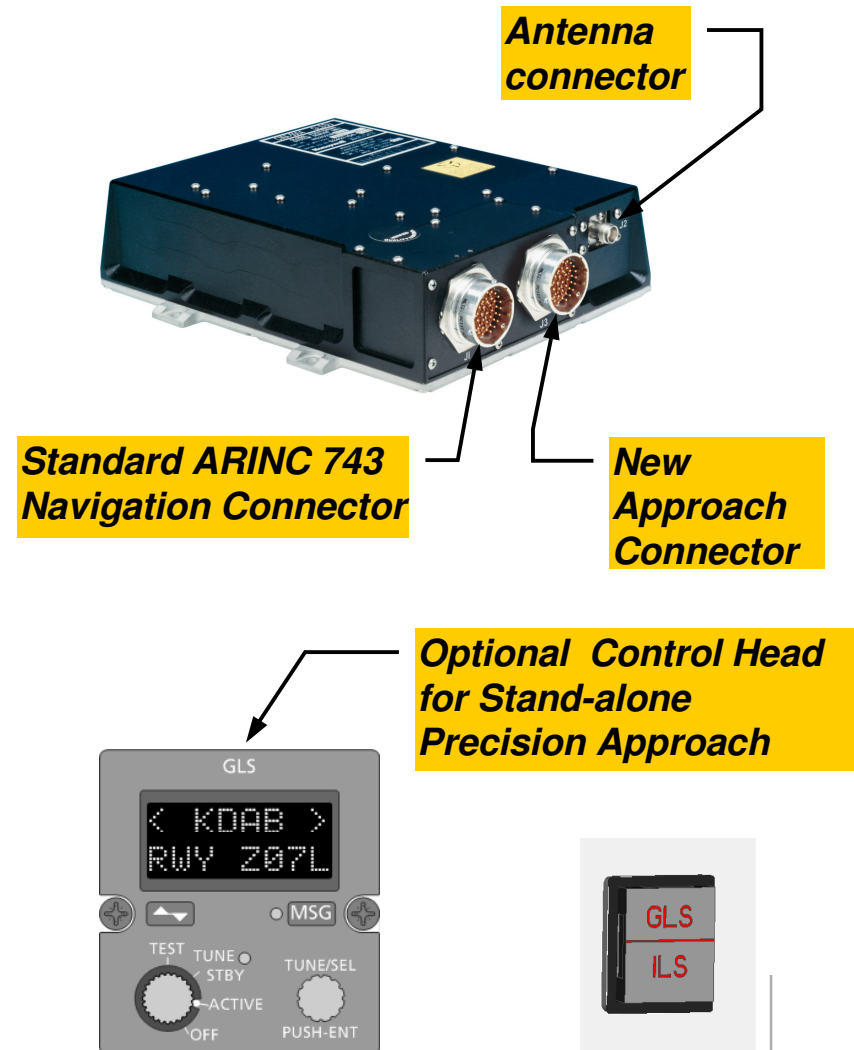
• Approach Capability

- WAAS/SBAS will provide LPV to 200ft minimum (depends on TERPS and current GPS and SBAS satellite capability)
- LAAS/GBAS will provide GLS CAT-I (depends on TERPS and GPS satellite capability)
- Neither can currently be certified to support CAT-II or CAT-III.

GLSSU: SBAS Navigation + LPV and GBAS GLS Solution

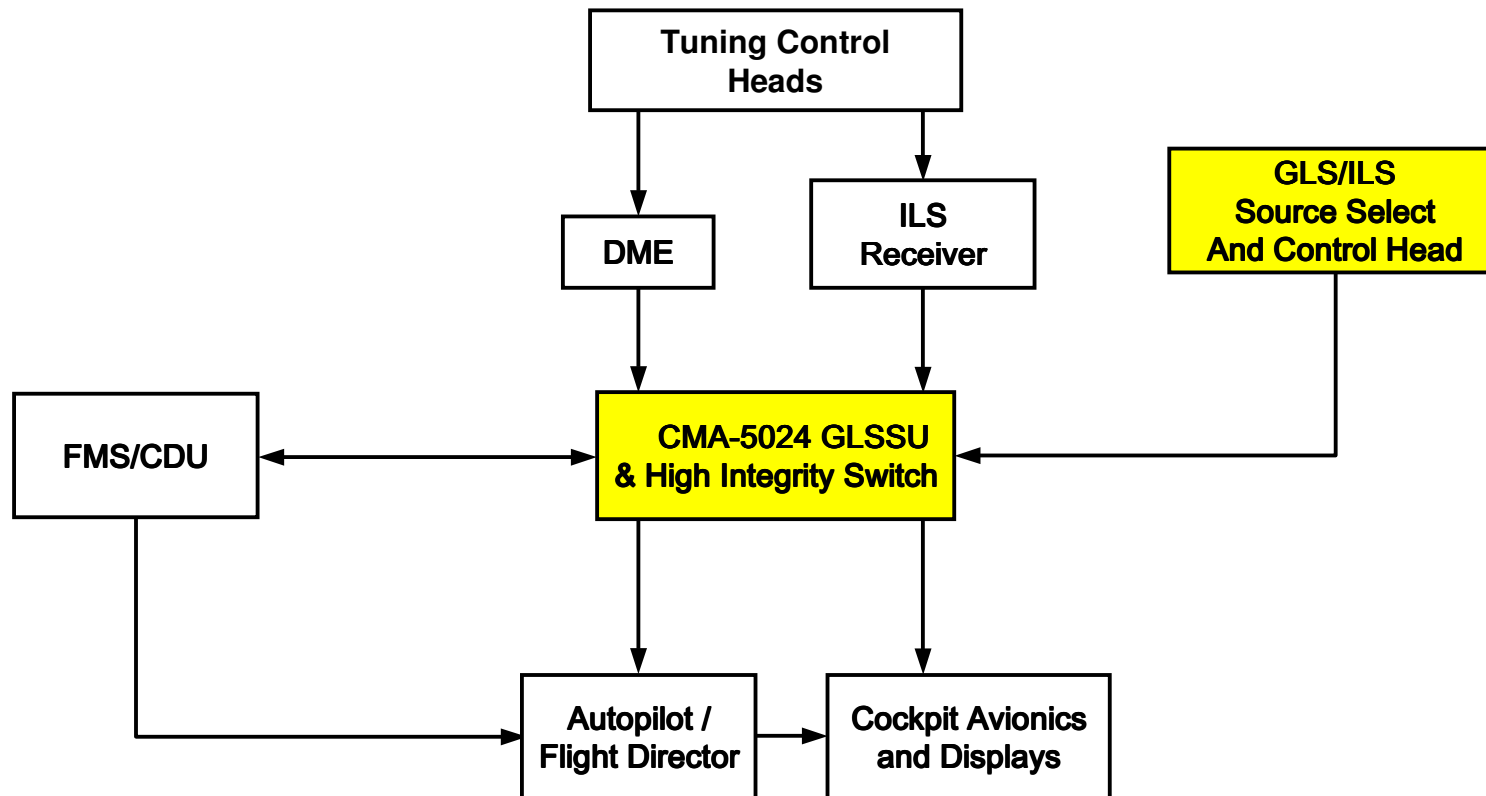
- **GLSSU dual purpose:**
 - *Improved RNP navigation*
 - *SBAS LPV + GBAS/GRAS GLS*

- **Complete GLSSU system:**
 - *Built-in High integrity switch for ILS-GLS signal source selection*
 - *External VDB receiver for GBAS and GRAS*
 - *Optional control head*
 - *Addition of guidance mode ILS-GLS/LPV selector*
 - *Active antenna TSO C-190 required for LPV or GLS*



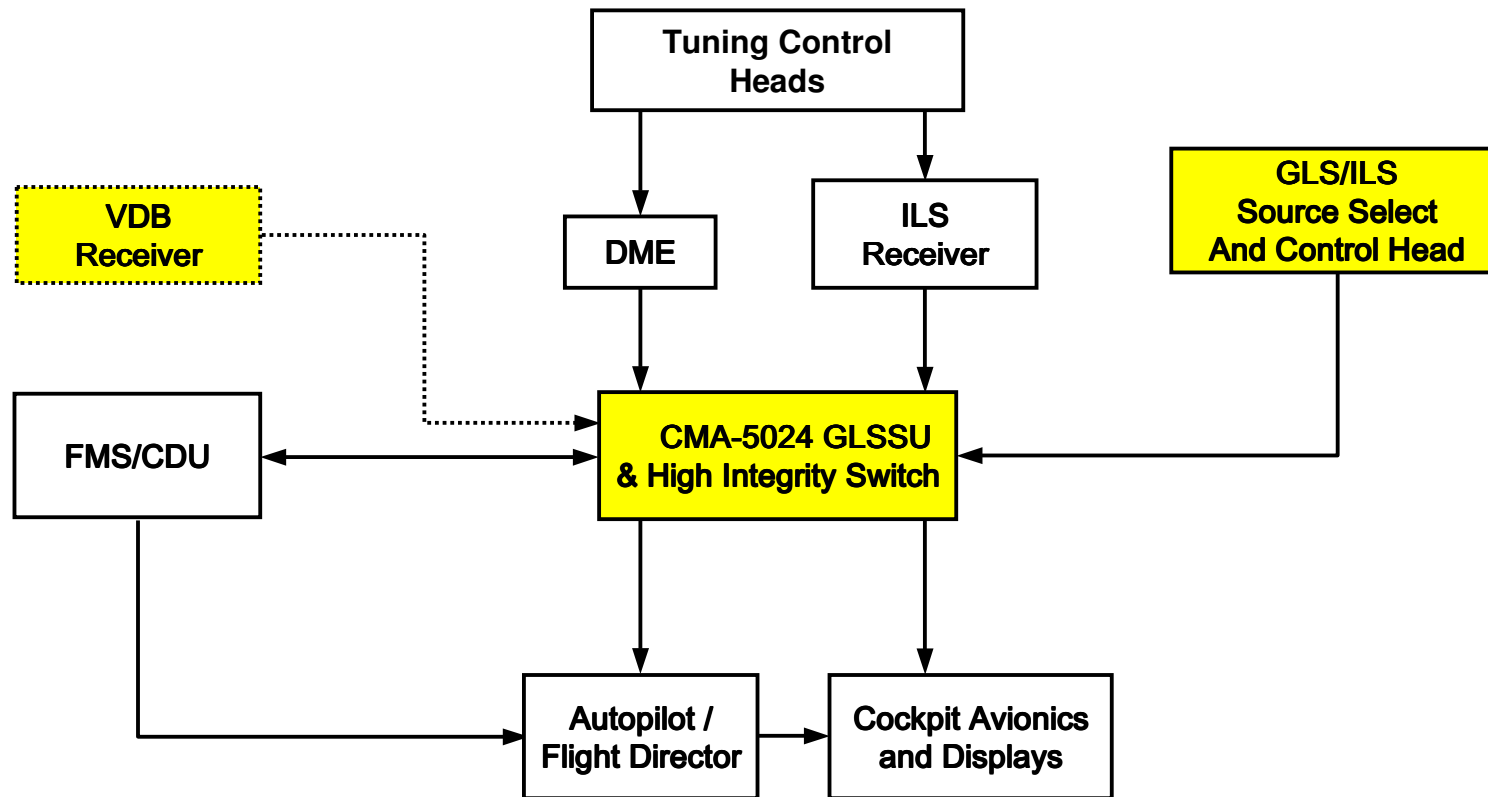
Architecture - WAAS/LPV

- SBAS LPV Simplified Block Diagram – digital architecture



Architecture – LAAS/GLS

- LAAS GLS Simplified Block Diagram – digital architecture



GNSS Landing System Architecture

GLS/LPV Top-Level Block Diagram

