GLS/LPV procedure Design & Validation

3-5 June 2019, GBAS/SBAS Implementation Workshop, Seoul

SBAS-Satellite based Augmentation System

Advantages of SBAS

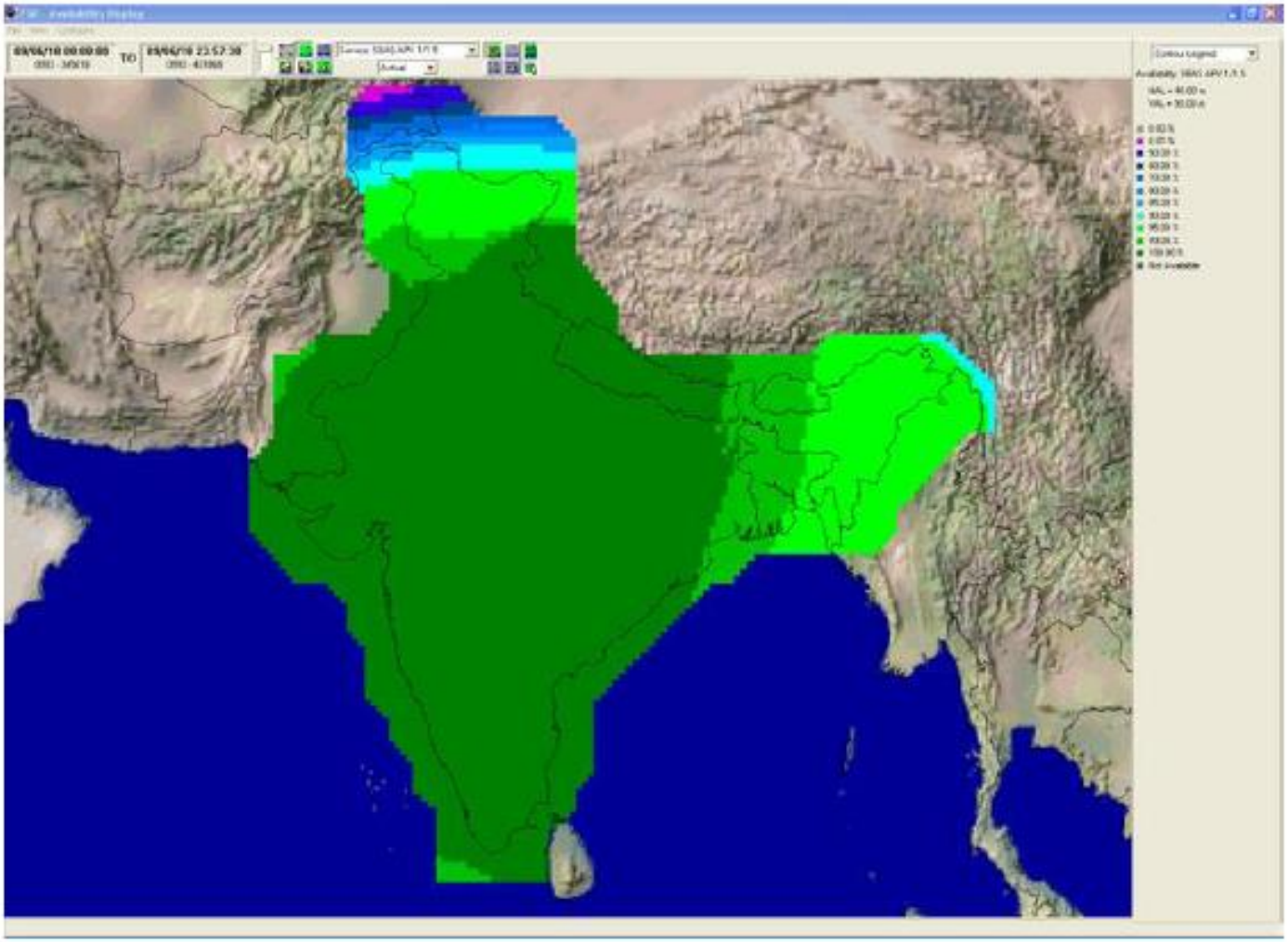
- SBAS supplements Global Navigation Satellite Systems (GNSS) to provide a more accurate and reliable navigation.
- SBAS includes integrity as a part of its service and eliminates the need for GPS Receiver Autonomous Integrity Monitoring (RAIM) checks.
- SBAS is not sensitive to temperature fluctuations and has no barometric / temperature limitations.
- SBAS enables Localizer Performance with Vertical guidance (LPV) approaches(cat I).

GPS Aided Geostationary Earth Orbit (GEO) Augmented Navigation (GAGAN)

- Conceived in 2002 to provide navigation system for all phases of flight over the Indian airspace and in the adjoining area.
- Consists of 15 Reference stations, 3 navigation land uplink stations, 3 mission control centers.
- Technology Demonstration of the System was successfully completed during 2007 by installing eight Indian Reference Stations (INRESs) at eight Indian airports and linked to the Master Control Center (MCC) located near Bangalore.
- Certified for en-route use of up to RNP0.1 in 2013.
- Certified in 2015 for APV1 (vertical guidance up to 250 ft DH).

GAGAN Coverage

APV I



LPV Procedure Design criteria

Type of SBAS procedure

- APV 1 – Type A 3D operation, Minima >= 250 ft.
- Cat I - Type B 3D operation, Minima < 250 ft.

Both procedures will be represented by LPV minima on chart.

OAS(Obstacle Assessment Surface)

- SBAS APV1 OAS – 7 sloping Surfaces, W, W', X,Y & Z – No CRM
- SBAS Cat I OAS – 6 sloping Surfaces, W, X,Y & Z – ILS Cat I surfaces – ILS Cat I CRM

- **LLZ-THR replaced by GARP-THR**

- **FAS Data Block**

Requirements for SBAS (LPV)Procedures

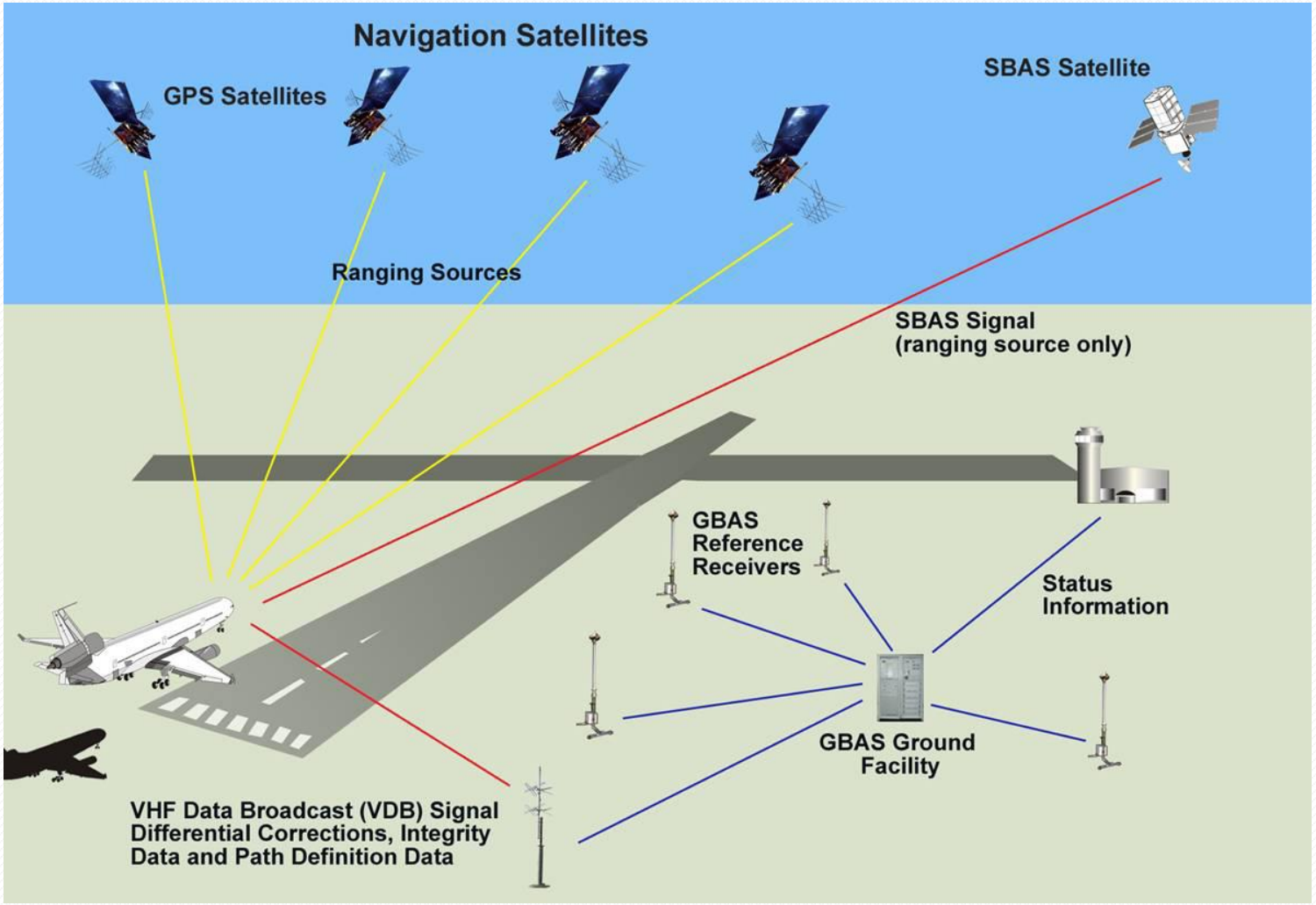
Actions for Stakeholders

- **Regulator**
- Rules for SBAS operations and airworthiness approval
- **ANSP/Airports**
- WGS 84 surveyed aeronautical & obstacles data
- Runway to be suitably certified as instrument runway
- Development & validation of IFPs
- Publication of IFPs
- **Airspace Users**
- Avionics available & certified
- Flight Crew training and approval

Ground Based Augmentation System (GBAS)

- The current GPS/GNSS constellation is unable to provide accuracy, availability, continuity and integrity to achieve precision approach. GBAS uses the concept of differential corrections to augment satellites signal in order to meet these requirements.
- GBAS provides augmentation to the core constellations to enable precision approach up to Category III.
- In Annex 10, volume 1, to date, there are SARPs for GBAS operating over single frequency and single constellation to CAT I operations.

GBAS works on three segments: satellites constellation, ground station and aircraft receiver



GBAS CAT-I situation: ground equipment implementation

- ICAO GBAS CAT-I SARPs published in 2001
- Honeywell SmartPath GBAS station certified (System Design Approval) by the FAA in 2009
- First GBAS CAT-I operational approval at Bremen airport (Germany) in 2012
- GBAS CAT-I is now operational at several airports

  -Frankfurt, Zurich, Malaga, Newark, Houston, Sydney, Melbourne
- Planned GBAS CAT-I implementation in

  -Brisbane, Perth, Tokyo Haneda, Shanghaï, Tianjin, Singapore, Hong Kong, Chennai, Krakow, Oslo

GBAS CAT-II/III situation

- ICAO GBAS SARPs to support CAT-III operations are under development.
- Solution based on Single-Constellation Single-Frequency technology (GPS L1 only) Concept called GAST-D. GAST-D SARPs Approved by ICAO NSP.
- GBAS CAT III capable Ground Station is under development.
- ICAO GBAS CAT-III procedure design criteria under development by IFPP.

Navigation information in GBAS

The navigation data transmitted by GBAS includes the following information:

a) pseudo-range corrections, reference time and integrity data;

b) GBAS-related data;

c) final approach segment data when supporting precision approach; and

d) predicted ranging source availability data.

GLS Procedure Design Criteria

- GLS criteria - ILS criteria
- ILS CRM.
- *Final approach segment (FAS) data*. Final approach segment defined by FAS data block in electronic form with a cyclic redundancy check (CRC).
- Initial approach segment – RNAV-1 or RNP-1 or better.
- FAP mandatory as Descent Fix and GP verification check.

GBAS/GLS FAS Data Block

- FAS Data Block contains the safety critical information for a precision approach
- FAS Path is a line in space defined by:
  - Landing threshold point/fictitious threshold point (LTP/FP)
  - Flight path alignment point (FPAP)
  - Threshold crossing height (TCH)
  - Glide path angle (GPA)
- FAS data block is protected by CRC
- Transfer of FAS DB to the GBAS ground station should be electronically via media or via network.

Benefits of GBAS

- Reduction of critical and sensitive areas;
- Curved approach – *No standards for procedure design so far*
- Positioning service;
- Provision of service in several runways in the same airport;
- Provision of several approach glide angles and displaced threshold;
- Guided missed approach; and
- Adjacent airports use.

Thank You