ROK’s perspective on GBAS/SBAS implementation

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Contents

I Introduction

II Perspective on GBAS Implementation

III Perspective on SBAS Implementation
I. Introduction
I. Introduction – Background

◆ Issues and Needs in Korea

▪ Increasing air traffic volume (5% / Year)
▪ Over 70% area is mountainous & much airspace is restricted
▪ Some runways do not have an ILS
▪ Demands of green technology (echo-friendly aircraft operation)
I. Introduction - Background

◆ New technology is needed for safe & efficient operation
  - New navigation systems beyond ILS, VOR and DME
  - New methods to reduce aircraft separation
  - Reduction of cost, emission & noise

* Source : ICAO APAC RASMAG/15 IP(2018)
I. Introduction – GBAS & SBAS

◆ GBAS implementation in Korea (October 2010-2014)
  ▪ Establish a GBAS approval process
  ▪ Build a national research infrastructure and install a test system
  ▪ Develop a research capability for GBAS technology

◆ SBAS Implementation in Korea (October 2014 – October 2022)
  ▪ Implement certified SBAS APV-I system in korean Peninsula
  ▪ Test and evaluate SBAS operations
  ▪ Establish an SBAS approval and safety assessment process for Korea
II. Perspective on GBAS Implementation
II. Perspective on GBAS Implementation

◆ 1990s : Feasibility Study on GNSS Based Air Navigation
  ▪ Follow up from decision of 10th ICAO ANC in 1991
  ▪ Prepared GNSS implementation for future air traffic demand

◆ 2000s : Integrity Monitoring Test-bed for GBAS
  ▪ Investigated ionospheric behavior over Korean peninsular
  ▪ Developed algorithms for accuracy enhancement, integrity monitoring
  ▪ Developed GBAS test-bed and installed at the airport, etc.

◆ 2010s : GBAS CAT-I operational technology development
  ▪ GBAS ground system Installation and accomplished Initial performance test
  ▪ Develop GBAS approval process for Korea
II. Perspective on GBAS Implementation
II. Perspective on GBAS Implementation

◆ CAT–I Operational Technology Development Program

- **2010**
  - Start of Program (Oct. 2010)

- **2011**
  - Airport and Site Survey
  - Design Safety Assurance Study

- **2012**
  - Factory Acceptance Test
  - Site Selection
  - SDA / FA Procedure Development

- **2013**
  - GBAS System Installation / SAT
  - Stability Test / Ground Test
  - Service Approval Procedure Development

- **2014**
  - Flight Test / Evaluation
  - Approval Preparation (Documentation)

- **2015**
  - Flight Test / Evaluation
  - Approval Preparation (Documentation)
II. Perspective on GBAS Implementation

◆ Ground System Site Survey

● GPS Data Collection
  ▪ Location : Gimpo Int. Airport
  ▪ Period : 2011.12.08 ~ 12.28
  ▪ Receiver : Honeywell PortaSAT

● Sites and Duration
  – Site A (1 day)
  – Site B (3 days)
  – Site C (3 days)
  – Site D (1 day)

● Analysis : 2012. 6. 5 ~ 6.7
II. Perspective on GBAS Implementation

◆ GPS data collection and analysis

SAT Constellation

Signal Interference (RFI)

Multipath Environment
II. Perspective on GBAS Implementation

◆ GPS Ground System Installation

* 4 Remote Satellite Monitoring Units    1 VHF Ground-Air Data Broadcast system
II. Perspective on GBAS Implementation

- Ground & flight test items were identified based on ICAO Doc. 8071
- GBAS test system was developed for ground monitoring and flight test

![Diagram of GBAS test system components]

- MMR (GLU-925)
- Controller (PC)
- Power Supply

Landing inform., VDB messages, GBAS Navigation inform, etc Display
II. Perspective on GBAS Implementation

- GLS procedures design (ILS-like approach) for testing
- Flight procedure simulation for pilot and controller
II. Perspective on GBAS Implementation

- Developed tools for testing ground and flight systems
  - Test equipment was available on vehicles and aircraft avionics
  - Software included testing and real-time monitoring
II. Perspective on GBAS Implementation

- Developed GBAS Approval Criteria
  - Design, manufacture, facilities & operation
- Implemented algorithms for integrity monitor of GBAS CAT-I system
- Developed detection techniques for major threat factors
- Produced GBAS CAT-I System Specifications

Comparison between ILS and GLS horizontal deviation and accuracy

GBAS Ground test & Flight test
After R&D Program
- GBAS Ground test-bed is used by KARI
- Aircraft avionics equipage rate is monitored
  * GBAS equipage is still very low

Future Plans
- Will continue Primary research for GBAS till 2020
- As the result of research for GBAS implementation, will extend the GBAS program until 2030
III. Perspective on SBAS Implementation
III. Perspective on SBAS Implementation

◆ Republic of Korea’s SBAS Concept
III. Perspective on SBAS Implementation

**Korea SBAS Project Organization Chart**

- **MOF**
- **MOLIT**
- **KIMST**
- **KAIA**
- **KPO**
- **JDT (TASF/KPO)**
- **Inspection Agency (KIAST/TTA)**
- **EASA**

**MOF**: Ministry of Oceans and Fisheries

**MOLIT**: Ministry of Land, Infrastructure, and Transport

**KIMST**: Korea Institute of Marine Science & Technology Promotion

**KAIA**: Korea Agency for Infrastructure Technology Advancement

**KPO**: Korea Project Office

**JDT (TASF/KPO)**: Joint Design Team

**Inspection Agency (KIAST/TTA)**: KIAST (Korea Institute of Aviation Safety Technology) and TTA (Telecommunications Technology Association)

**EASA**: European Aviation Safety Agency

- **KRS (KASS Reference Station)**
- **KPS (KASS Processing Station)**
- **KUS (KASS Uplink Station)**
- **KCS (KASS Control Station)**
- **Network**
- **GEO**

**International Co-development (TASF)**

**Domestic Co-development (KARI, ETRI)**

- **Certification**
- **System Design and Definition**
- **Integration, Verification & Qualification**
- **Factory & Site Acceptance Test**
- **System Qualification Review**
- **Apply for Certification, Support for Certification**
III. Perspective on SBAS Implementation

◆ **Goal**: To develop and establish APV-I SBAS

- Provide APV-I SoL Service in Airports of Korean Peninsula Area
  - Start Open Service (Jul. 2020)
  - And APV-I SoL Service (Oct. 2022)

◆ **Duration**: Oct 30, 2014 ~ Oct 29, 2022 (8 years)


※ SoL: Safety of Life, APV: Approach Procedure with Vertical guidance
III. Perspective on SBAS Implementation

- KRS (KASS Reference Station): 7
- GEOs: 3
- KUS (KASS Uplink Station): 3
- KCS (KASS Control Station): 2
- KPS (KASS Processing Station): 2

Specifications:
- L1: 1575.42MHz
- L5: 1176.45MHz
- C1: TBD
- C5: TBD
Landmass area meets the APV-I availability (XPL<XAL) more than 99%
Green area in the middle figure presents the coverage of APV-I availability more than 99%

III. Perspective on SBAS Implementation

KASS Service Area

Estimated APV-I Availability Performance

95% VNSE for the APVI service level

* PL : Protection Level
AL : Alert Limit
VNSE : Vertical Navigation System Error
III. Perspective on SBAS Implementation

The buildings are prepared for KPS, KCS at Cheongju airport (Primary) and Incheon airport (Backup)

* KPS : KASS Processing Station, KCS : KASS Control Station
III. Perspective on SBAS Implementation

◆ Surveying a KAS Uplink Site (KUS): Two Sites were selected for a KAS Uplink Site (KUS) - Frequency environment, Obstacles, Site environment, etc. were evaluate

Two Sites (1H 2019)

12 sites

Preliminary Survey, Elementary Analysis

8 candidates

Intermediate Survey, Observation Analysis

4 candidates

Detailed Survey, Observation & Analysis

2 sites
III. Perspective on SBAS Implementation

◆ Surveying for KASS Reference Sites (KRS)
  ▪ Seven sites were selected for KASS Reference Stations (KRS) in 2018

17 candidate positions

60 Sites → Elementary Analysis → 17 Sites → Detailed Site Survey & Observation Analysis → 7 sites
III. Perspective on SBAS Implementation

- Participated 4\textsuperscript{th} ICAO NSP meeting('17.10)
  - Presented the KASS and requested to put KASS ID in Annex 10

### Changes to Annex 10, Volume 1, Appendix B

#### Table B-27. SBAS service provider identifiers

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III. Perspective on SBAS Implementation

◆ Submitted PRN assignment documents to the SMC and KASS filing documents to ITU in 2016.

  ▪ Acquired the PRN from SMC with related activities in June of 2018.

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MEMORANDUM FOR KOREA AEROSPACE RESEARCH INSTITUTE

ATTN: NAM, GI-WOOK
EXECUTIVE DIRECTOR SBAS PROGRAM OFFICE
169-84 GWAHAK-RO
YUSEONG-GU, DAEJEON 34133, KOREA

FROM: SMC/GPE
483 North Aviation Blvd
El Segundo, CA 90245-2808

SUBJECT: KASS Pseudorandom Noise (PRN) Code Set Assignment

1. The purpose of this memorandum is to assign the Korea Augmentation Satellite System (KASS) temporary use of PRN code set 134 on the GPS L1 C/A signal centered at 1575.42 MHz, GPS L1C signal centered at 1575.42 MHz, GPS L2C signal centered at 1227.6 MHz, L5I5 signal centered at 1176.45 MHz, and L5Q5 signal centered at 1176.45 MHz. This assignment follows correspondence between representatives from the United States and Korea.

2. The KASS representative stated that the KASS system will only make use of the PRN code on the GPS L1 C/A and L5 signals. PRN code 134 on the L1C and L2C signals will be held in reserve by the GPS Directorate to prevent another system from using PRN code 134 on those signals.
III. Perspective on SBAS Implementation

- **GNSS Center (MOLIT)**
  - GNSS Policy & Planning
    - GNSS Service Provision
    - SLA and cooperation with organizations
    - International cooperation
  - KASS Operation Management
    - KASS Operation Management
    - SLA management
    - NOTAM, System Inspection
  - KASS Service Provider
  - KASS Service
    - KASS O&M, Engineering System Management
    - Certification Management
    - KASS Service Improvement and Developing New Service
  - KASS O&M
    - System Operation (24 hours – 7 days)
      - 1st Level Maintenance
      - Security Management
  - KASS Evolution
    - Performance Monitoring and Analysis
      - 2nd Level Maintenance
      - KASS Improvement
      - Developing next step SBAS
III. Perspective on SBAS Implementation

- The system & operation organization will be certified in 2022
- The KASS service provider (KSP) will be established in 2020
  - will operate the KASS system after taking over it from the KPO

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- The system & operation organization will be certified in 2022
- The KASS service provider (KSP) will be established in 2020
  - will operate the KASS system after taking over it from the KPO
III. Perspective on SBAS Implementation

**KASS Operation Approval (Designating Operation Company) - Draft**

- System (Design) Certification
- KPO
  - Complete Safety Case A
- Inspection Agency
  - Performance Inspection (ICAO ANNEX 10, DO-178B)
  - MOLIT
    - Safety Case A Take Over
- Operation Approval
  - Applicant (company) for KASS Operation
    - Complete Safety Case B
  - KSP (MOLIT)
    - Designate of Operation Company
      - By Inspecting Safety Case B (EC Regulation 1035, 552, 482, etc)
        - Inspection Result
          - Safety Case A Handover
            - Safety Case A Take Over
            - Safety Case B Take Over
Thank you!