ROK's perspective on GBAS/SBAS implementation

Mr. K.J JANG, Air Navigation Facilities Division
Office of Aviation Policy, MOLIT
Republic of Korea

Contents

I. Introduction

◆ Issues and Needs in Korea

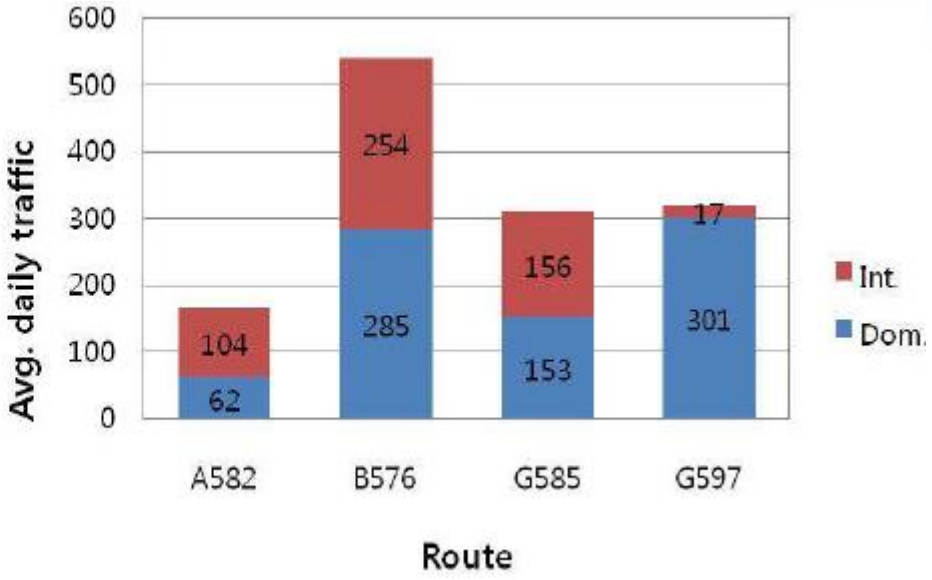
- **Increasing air traffic volume** (5% / Year)
- **Over 70% area is mountainous** & much airspase is restricted
- **Some runways do not have an ILS**
- **Demands of green technology** (echo-friendly aircraft operation)

Gimhae Int. Airport (2004)

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

GBAS Test-Bed I
(1998~2000)

GBAS Test-Bed II
(2003~2007)

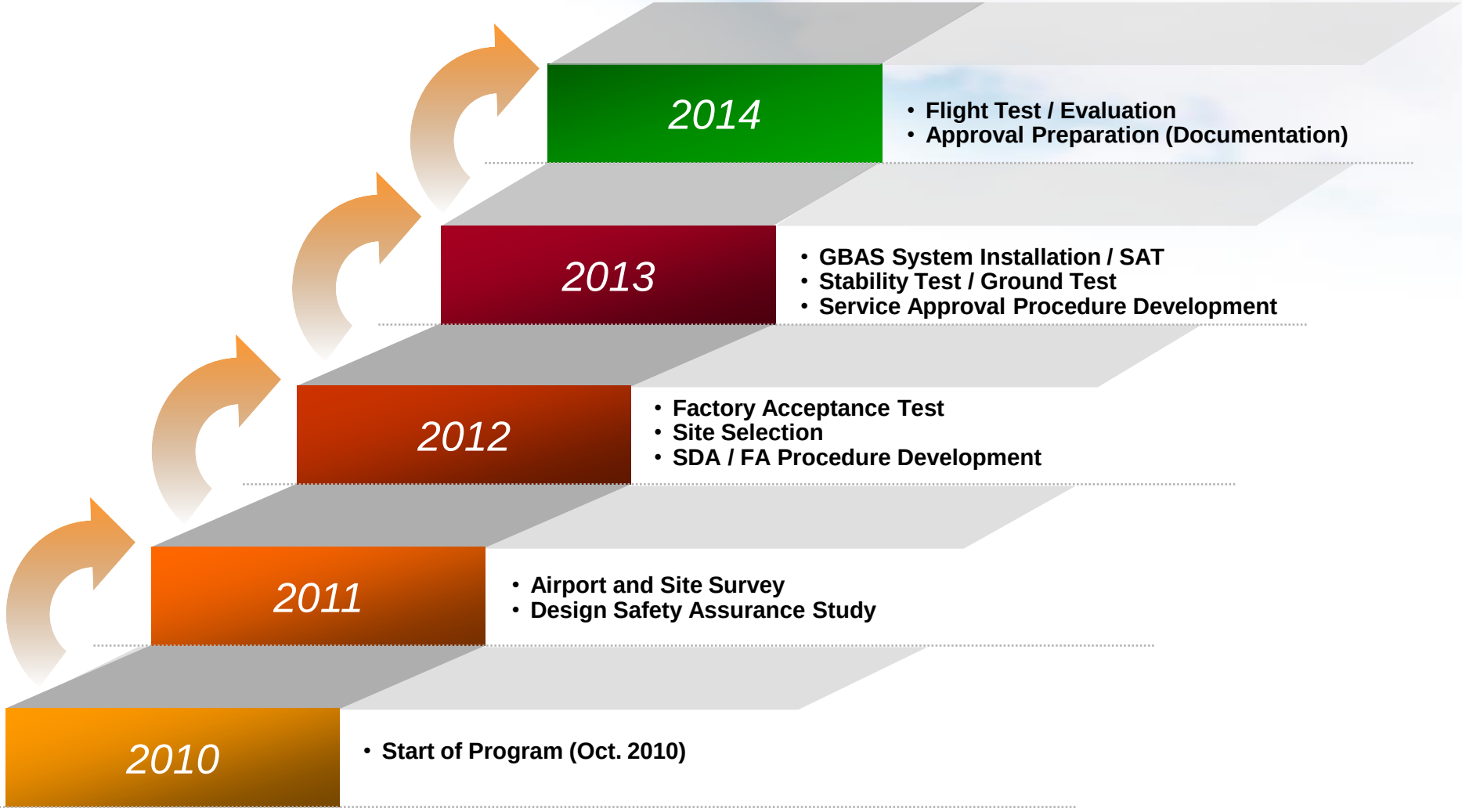
GBAS Test-Bed II in Jeju Airport
(2008~)

DGPS Receiver
(2001~2004)

'98 '99 '00 '02 '04 '05 '06 '07 '08 '09 ' 10

II. Perspective on GBAS Implementation

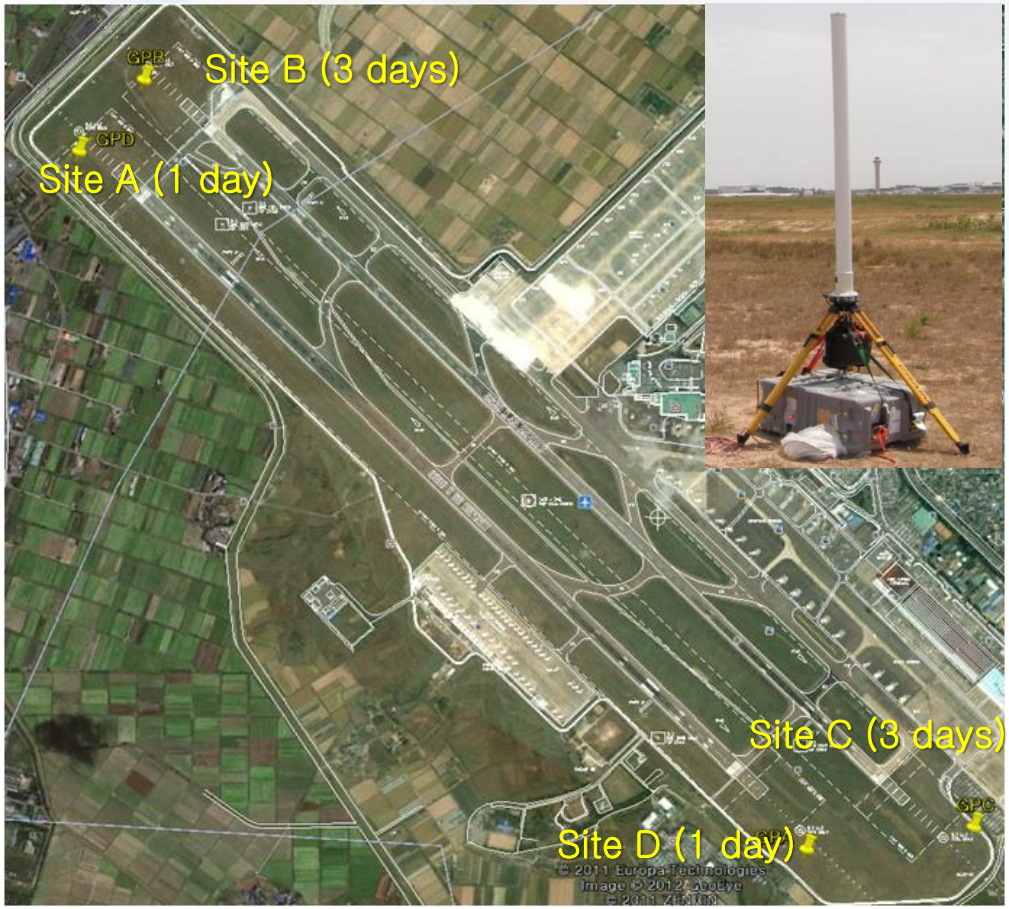
◆ CAT-I Operational Technology Development Program



II. Perspective on GBAS Implementation

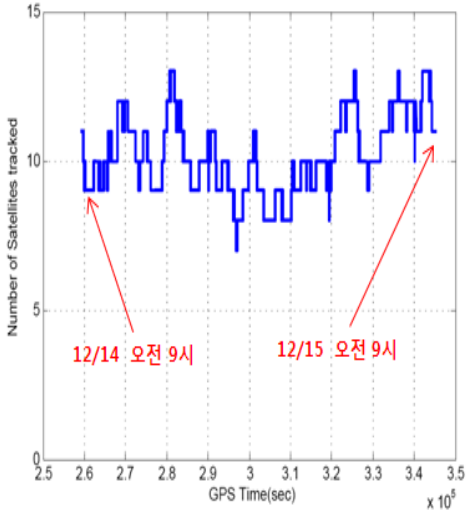
◆ Ground System Site Survey

- 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

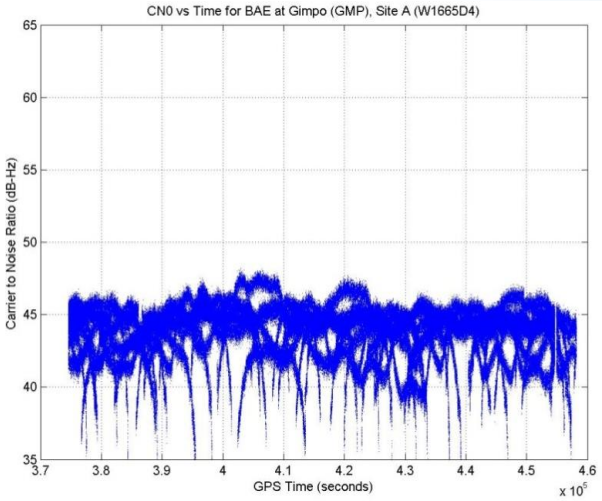


II. Perspective on GBAS Implementation

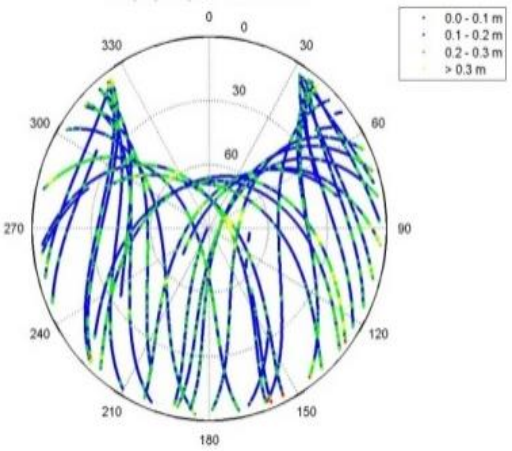
- GPS data collection and analysis



SAT Constellation



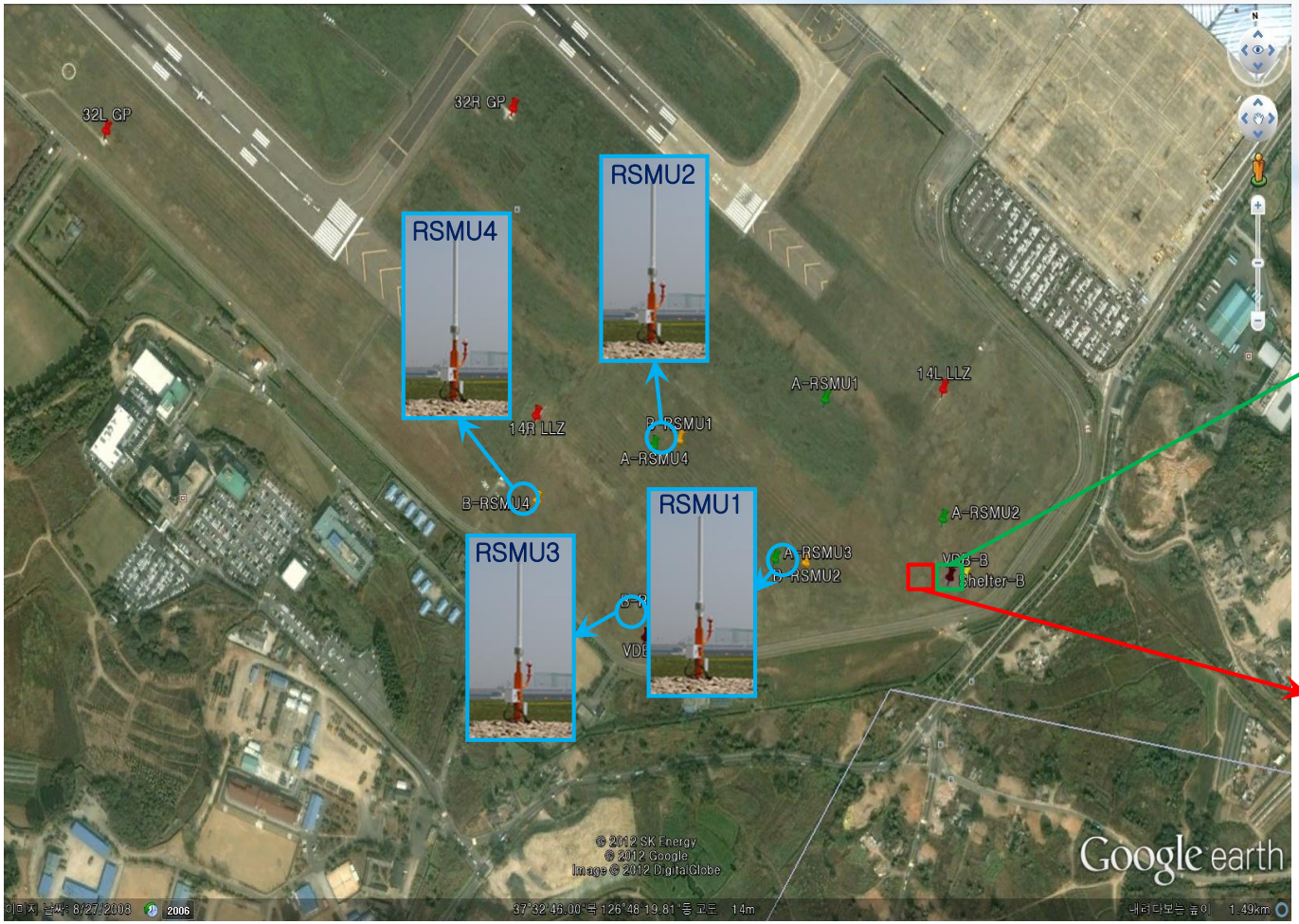
Signal Interference(RFI)

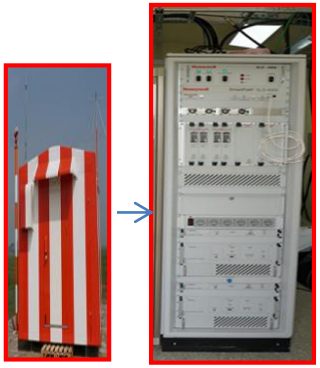


Multipath Environment

II. Perspective on GBAS Implementation

◆ GPS Ground System Installation



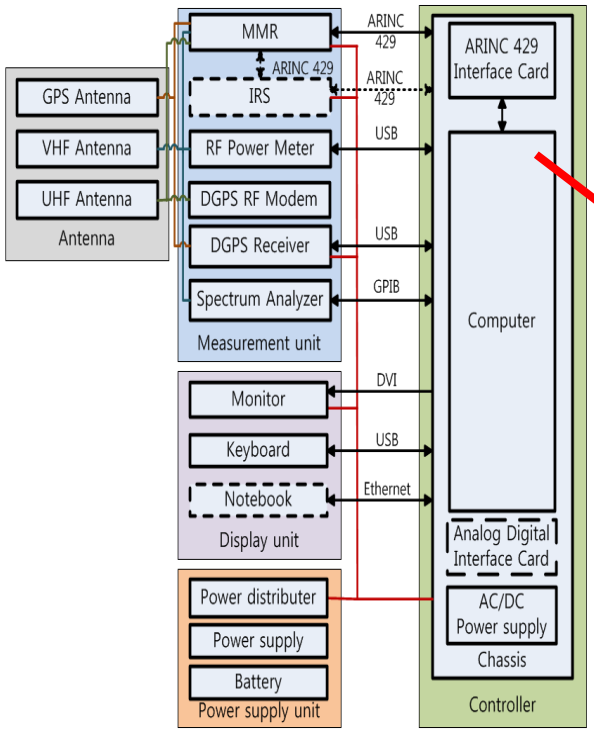


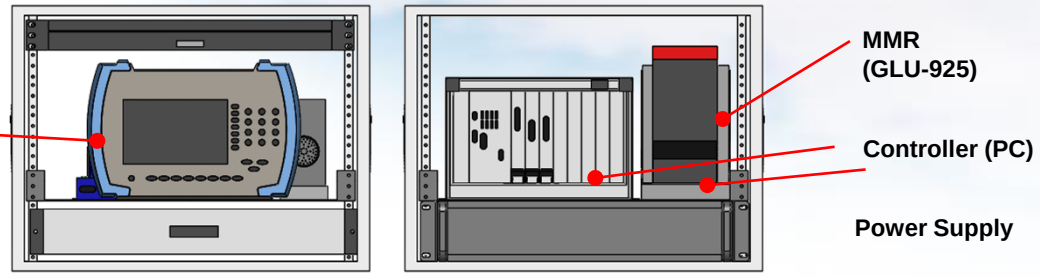
(Tower)

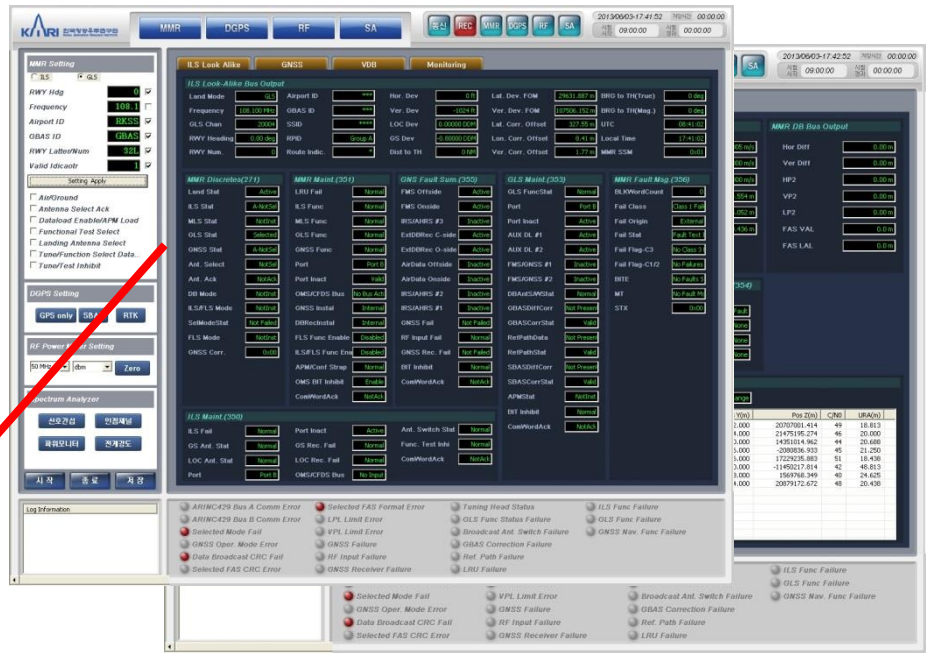
* 4 Remote Satellite Monitoring Units 1 VHF Ground-Air Data Broadcast system

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



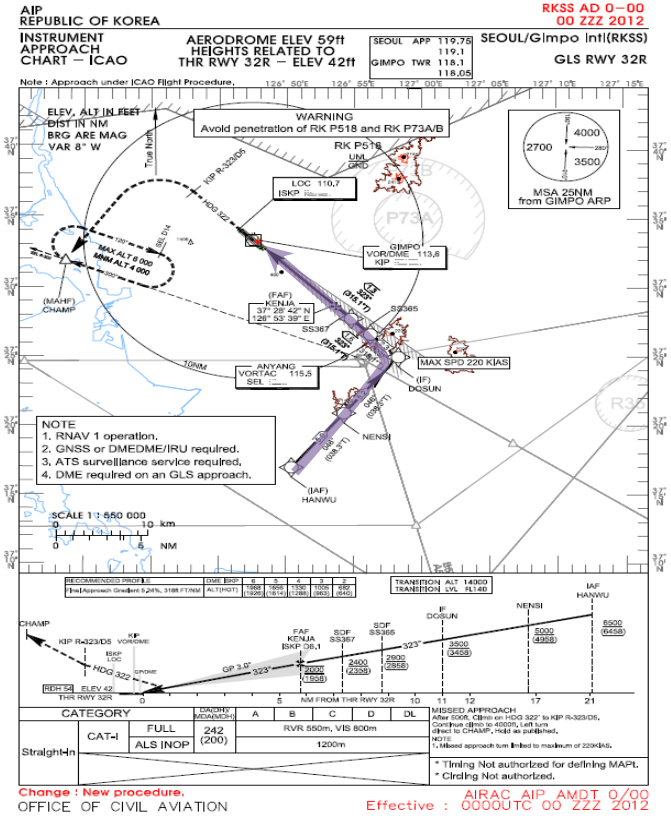




Landing inform., VDB messages,
GBAS Navigation inform, etc Display

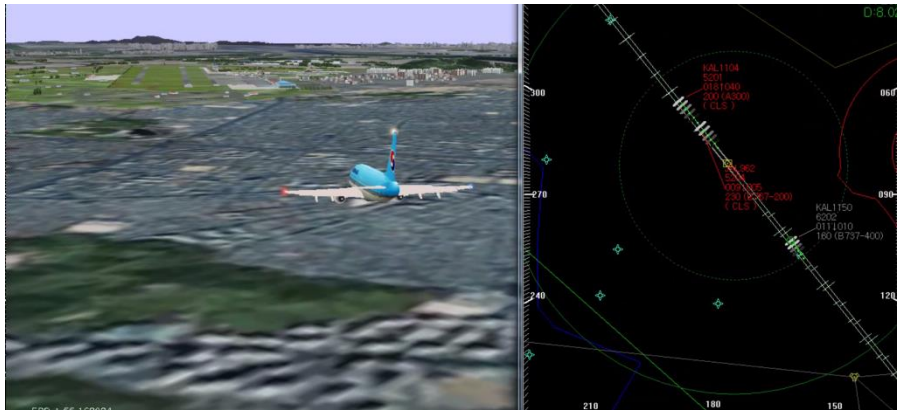
II. Perspective on GBAS Implementation

- GLS procedures design (ILS-like approach) for testing
- Flight procedure simulation for pilot and controller



Gimpo international airport
GLS RWY 32R
Experimental Purpose

Procedure Simulation
prototype



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

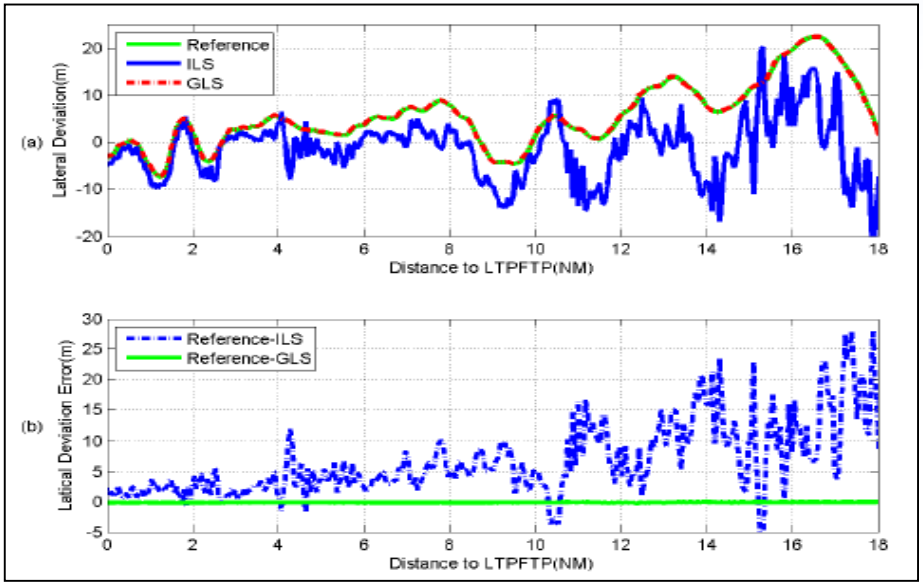
< Hardware>

< Software >

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

GBAS Ground test & Flight test



Comparison between ILS and GLS horizontal deviation and accuracy

II. Perspective on GBAS Implementation

- After R&D Program
  - GBAS Ground test-bed is used by KARI
  - Aircraft avionics equipage rate is monitored

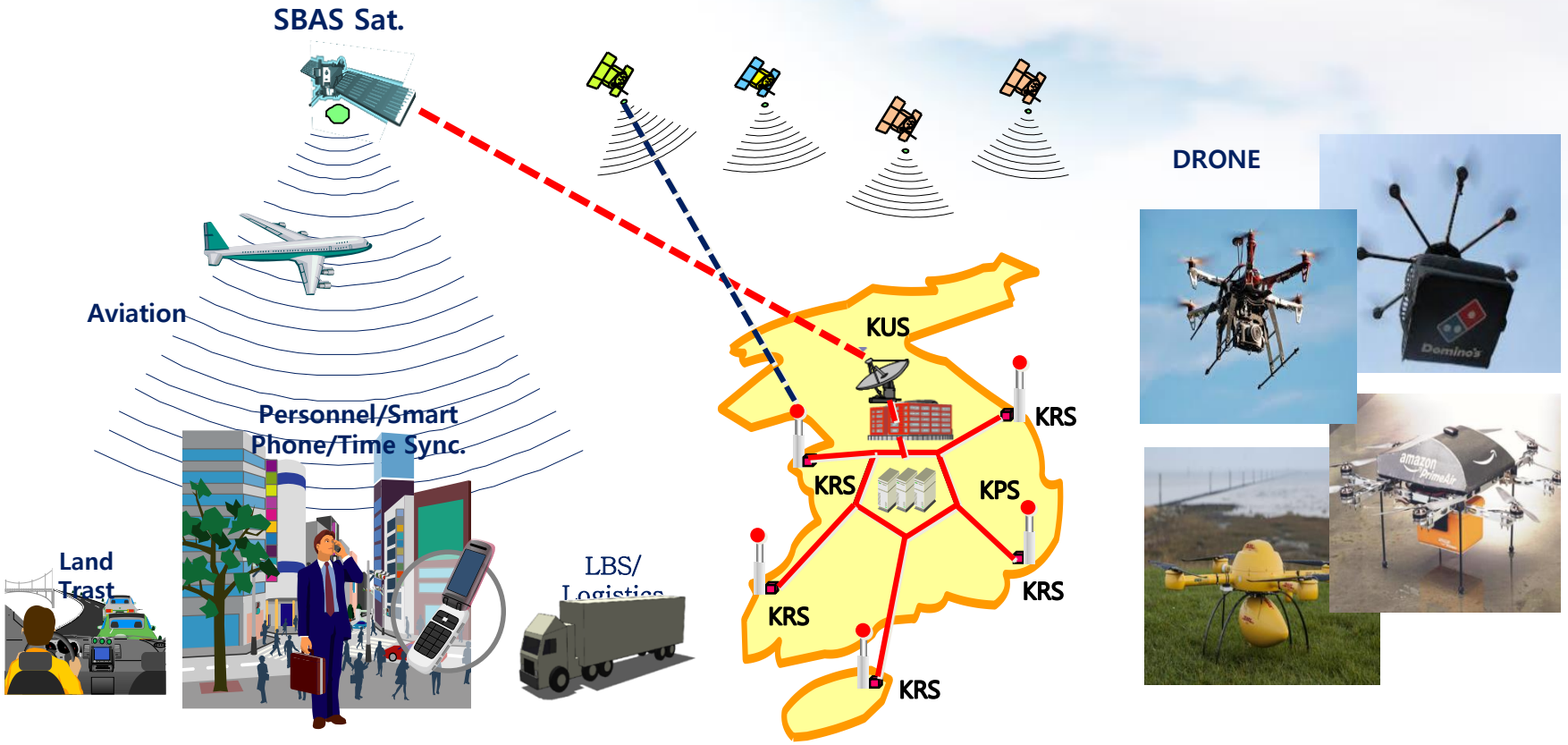
  * GBAS equipage is still very low

- Future Plans
  - Will continue Primary reasearch for GBAS till 2020
  - As the result of research for GBAS implementation, will extend the GBAS program until 2030

III. Perspective on SBAS Implementation

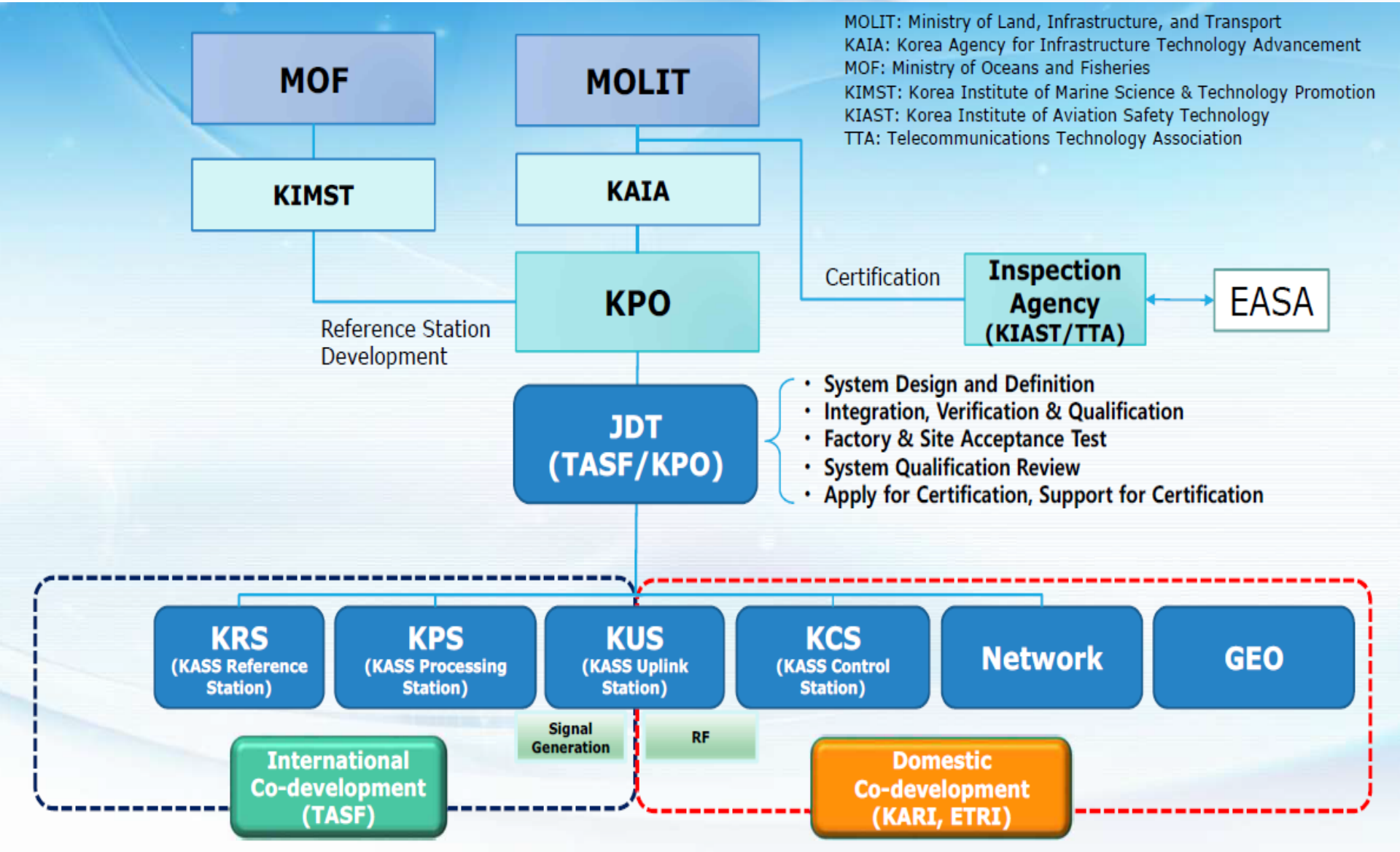
III. Perspective on SBAS Implementation

◆ Republic of Korea's SBAS Concept



III. Perspective on SBAS Implementation

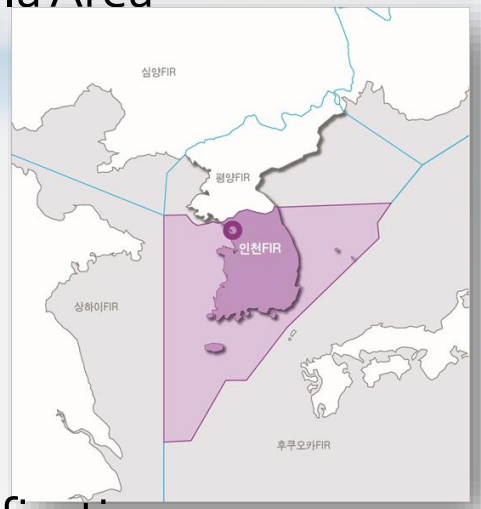
◆ Korea SBAS **Project Organization** Chart



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)



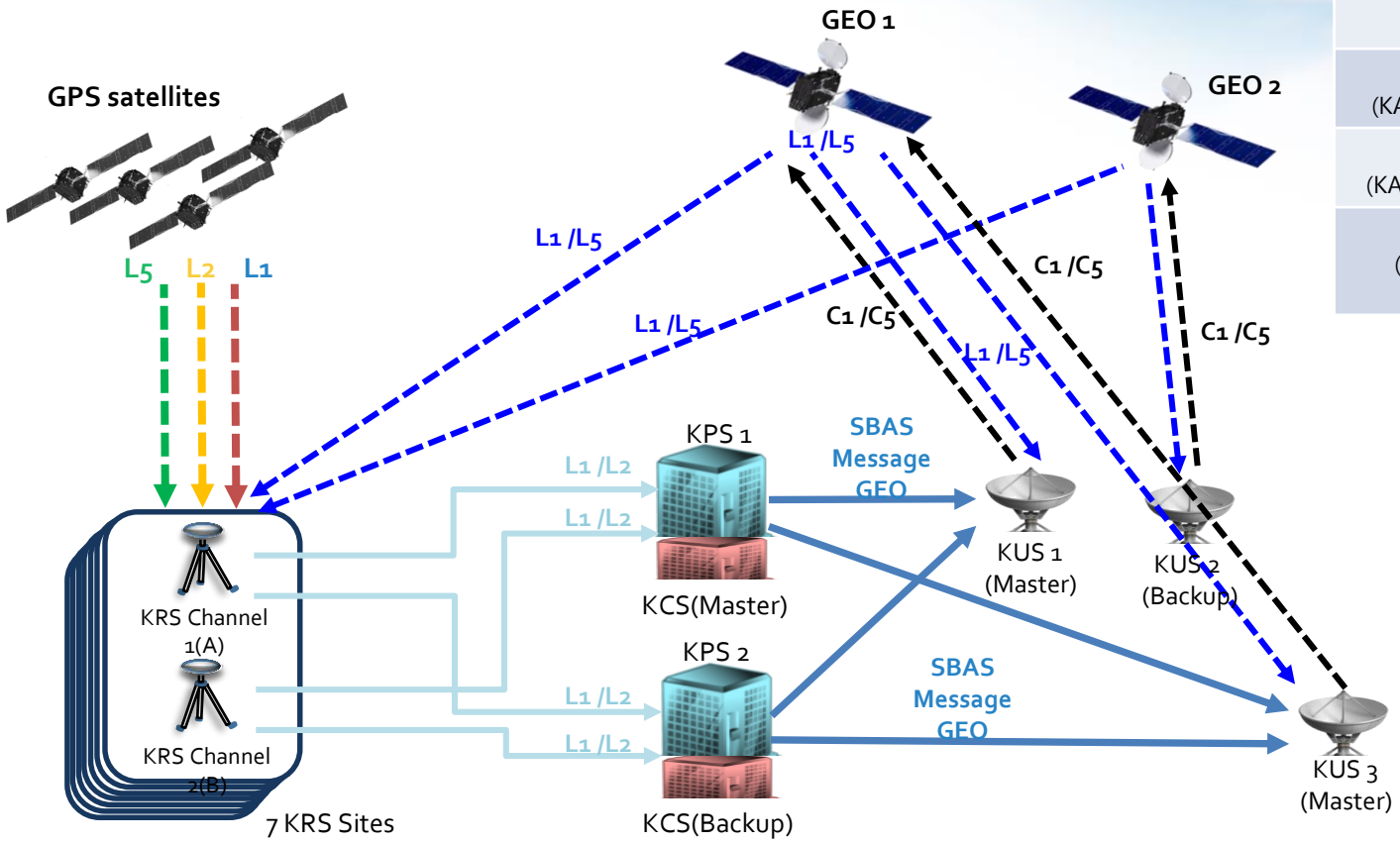
◆ **Duration: Oct 30, 2014 ~ Oct 29, 2022 (8years)**

- Phase 1 (Oct. 2014~Apr. 2017): System Definition & Specifications
- Phase 2 (Mar. 2017~Jun. 2019): Critical Design, Implement, Integration and Testing
- Phase 3 (Jul. 2020~Oct. 2022): Initial Operation and Certification

※ SoL: Safety of Life, APV : Approach Procedure with Vertical guidance

III. Perspective on SBAS Implementation

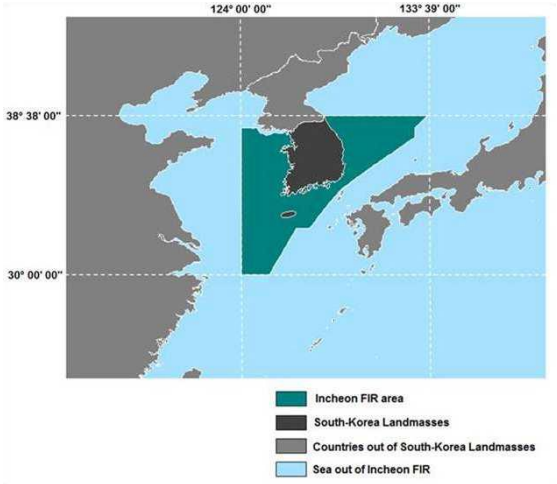
S/S (Sub System)	Qty. (Baseline)
KRS (KASS Reference Station)	7
GEOs	3
KUS (KASS Uplink Station)	3
KCS (KASS Control Station)	2
KPS (KASS Processing Station)	2



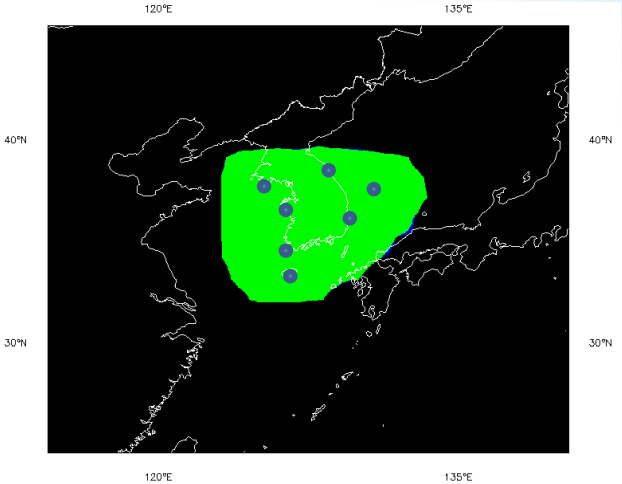
L1: 1575.42MHz
L5: 1176.45MHz
C1: TBD
C5: TBD

III. Perspective on SBAS Implementation

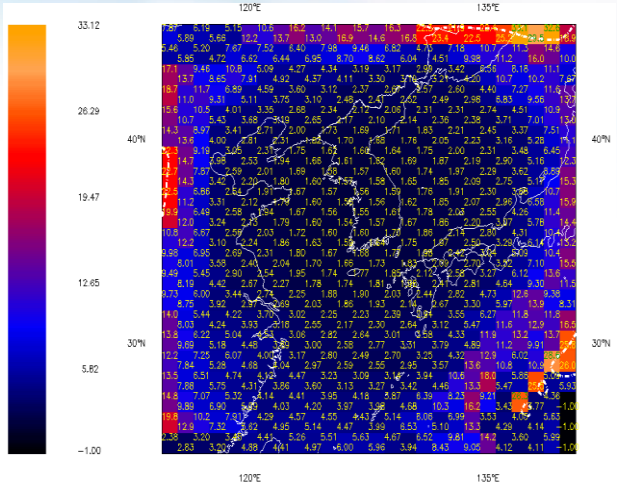
- **Landmass area meets the APV-I availability (XPL<XAL) more than 99%**
- **Green area in the middle figure presents the coverage of APV-I availability more than 99%)**



KASS Service Area



Estimated APV-I Availability Performance

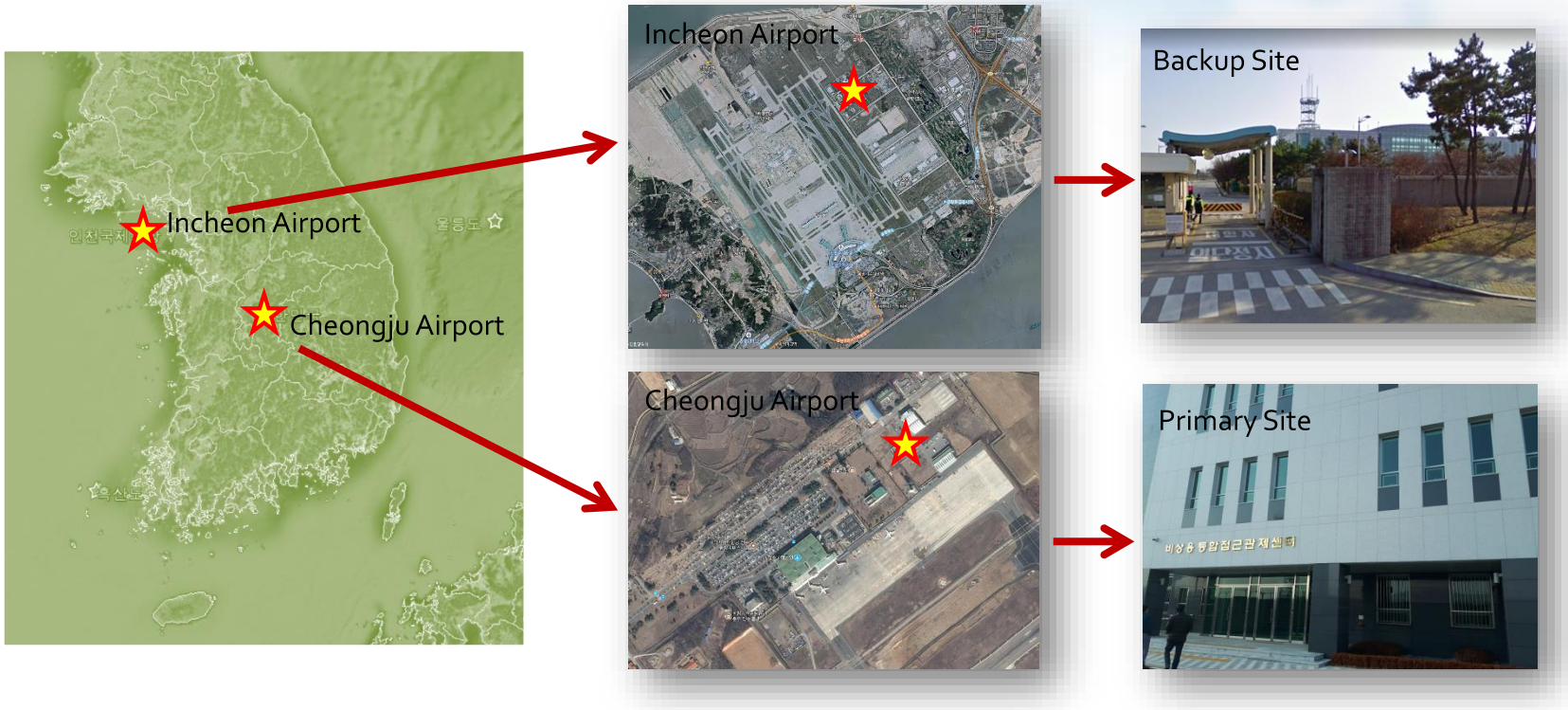


95% VNSE for the APVI service level

*** 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)**

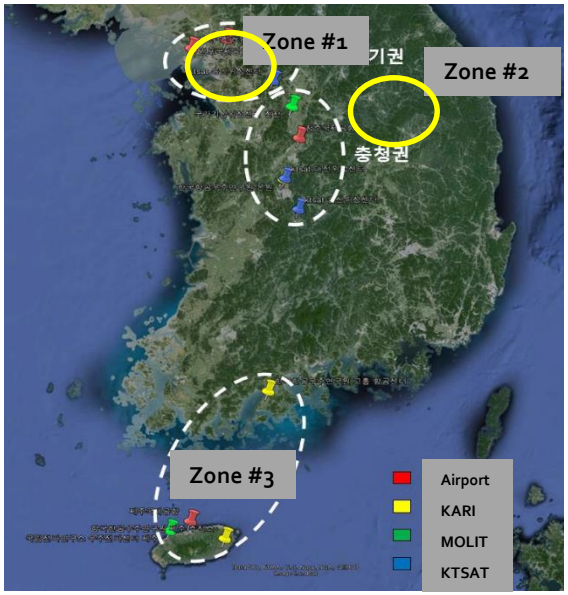


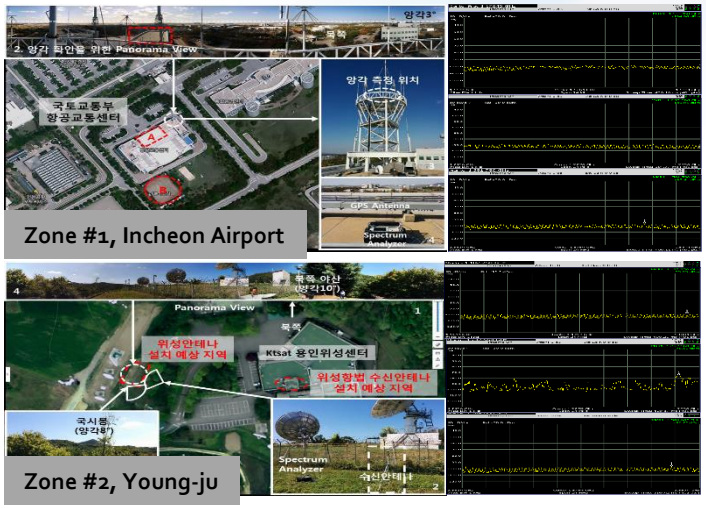
* KPS : KASS Processing Station, KCS : KASS Control Station

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

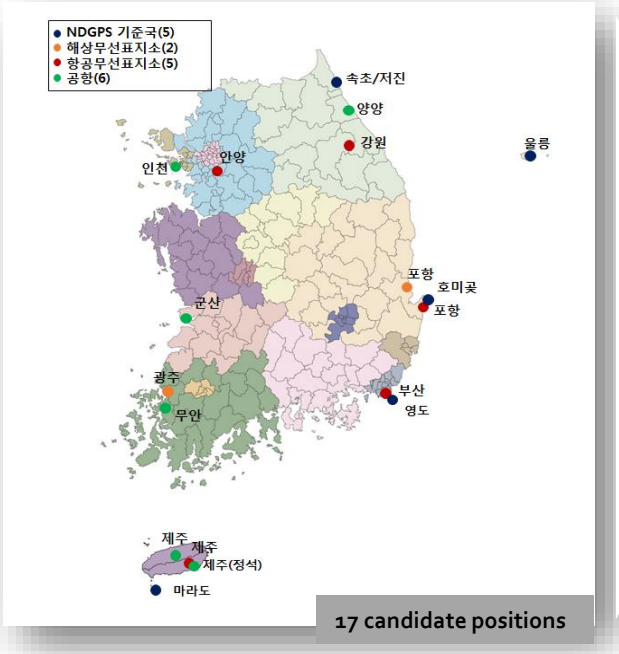
(1H 2019)

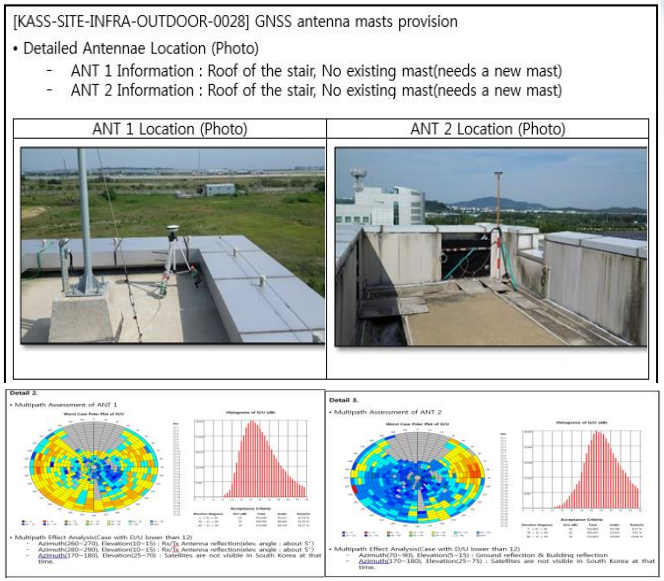
12 sites → Preliminary Survey, Elementary Analysis → 8 candidates → Intermediate Survey, Observation Analysis → 4 candidates → Detailed Survey, Observation & Analysis → 2 sites

III. Perspective on SBAS Implementation

◆ Surveying for KASS Reference Sites(KRS)

- **Seven sites were selected for KASS Reference Stations (KRS) in 2018**





7 sites

(2H 2018)

60 Sites → Elementary Analysis → 17 Sites → Detailed Site Survey & Observation Analysis → 7 sites

III. Perspective on SBAS Implementation

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

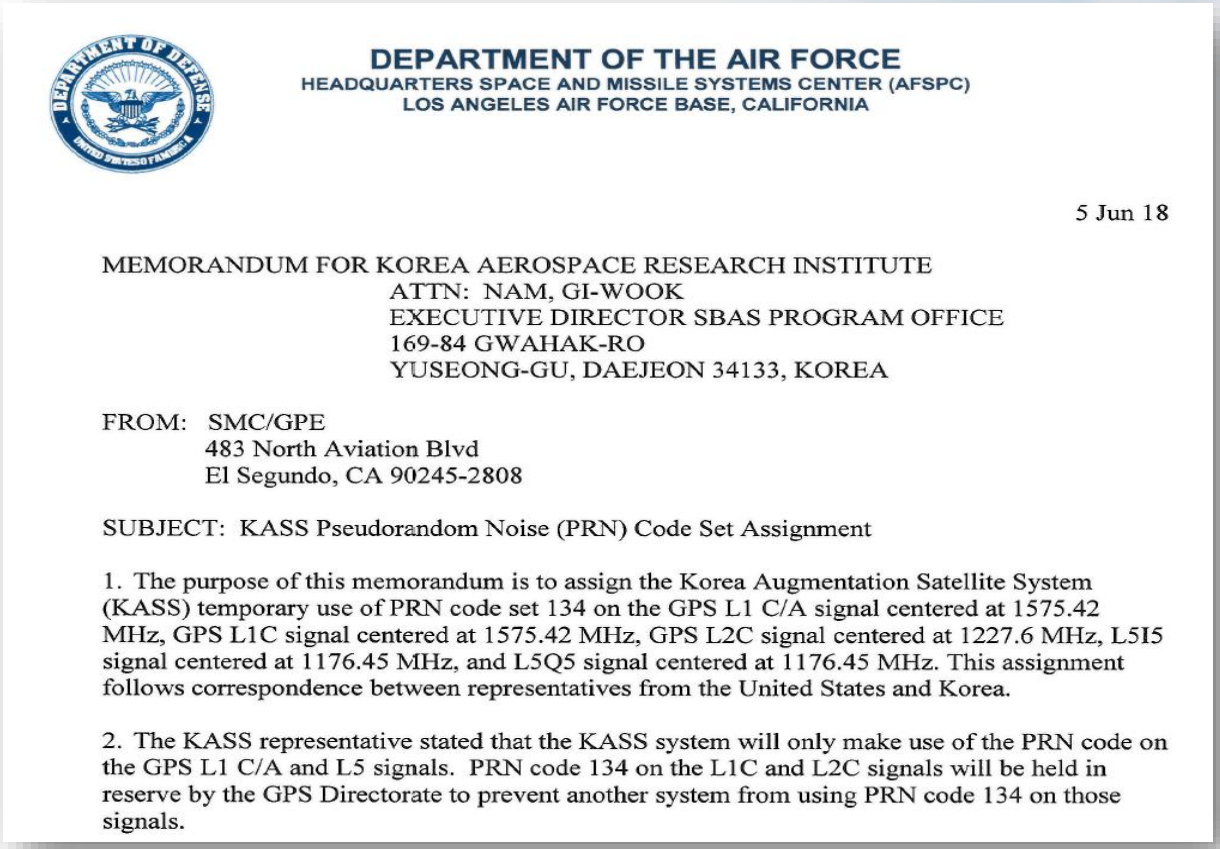
Changes to Annex 10, Volume 1, Appendix B

Table B-27. SBAS service provider identifiers

Identifier	Service provider
0	WAAS
1	EGNOS
2	MSAS
3	GAGAN
4	SDCM
5	BDSBAS
6	KASS
7 to 13	Spare
14, 15	Reserved

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.**



DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SPACE AND MISSILE SYSTEMS CENTER (AFSPC)
LOS ANGELES AIR FORCE BASE, CALIFORNIA

5 Jun 18

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

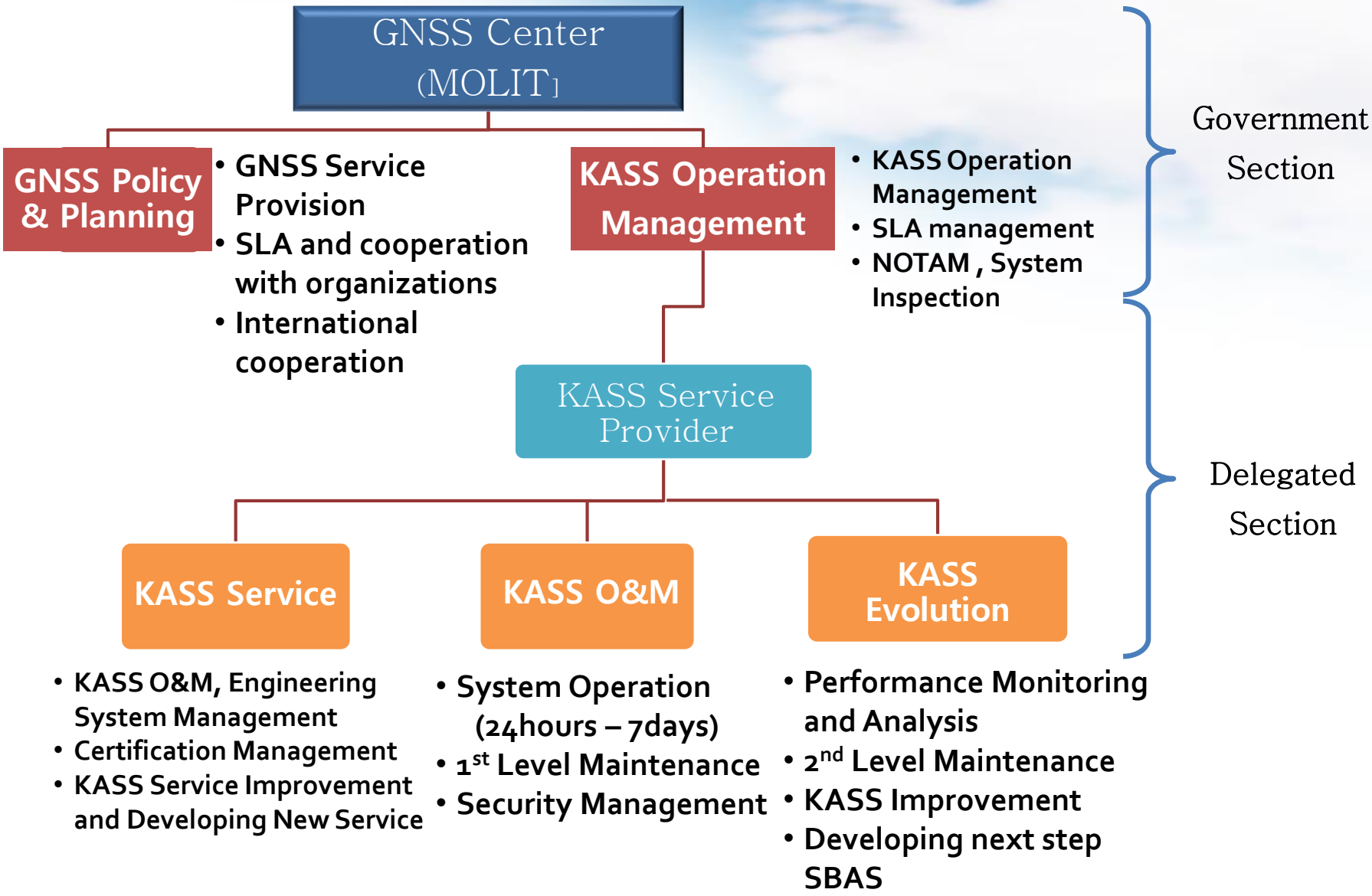
FROM: SMC/GPE
483 North Aviation Blvd
El Segundo, CA 90245-2808

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.

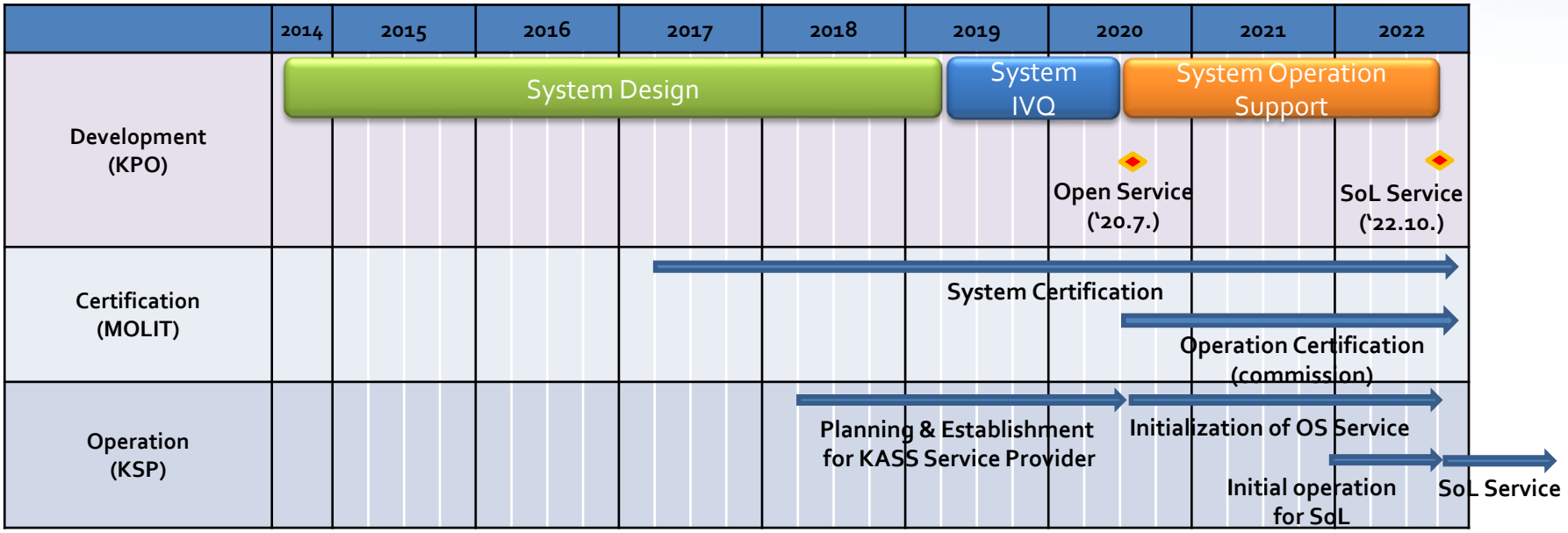
2. The KASS representative stated that the KASS system will only make use of the PRN code on the GPS L1 C/A and L5 signals. PRN code 134 on the L1C and L2C signals will be held in reserve by the GPS Directorate to prevent another system from using PRN code 134 on those signals.

III. Perspective on SBAS Implementation



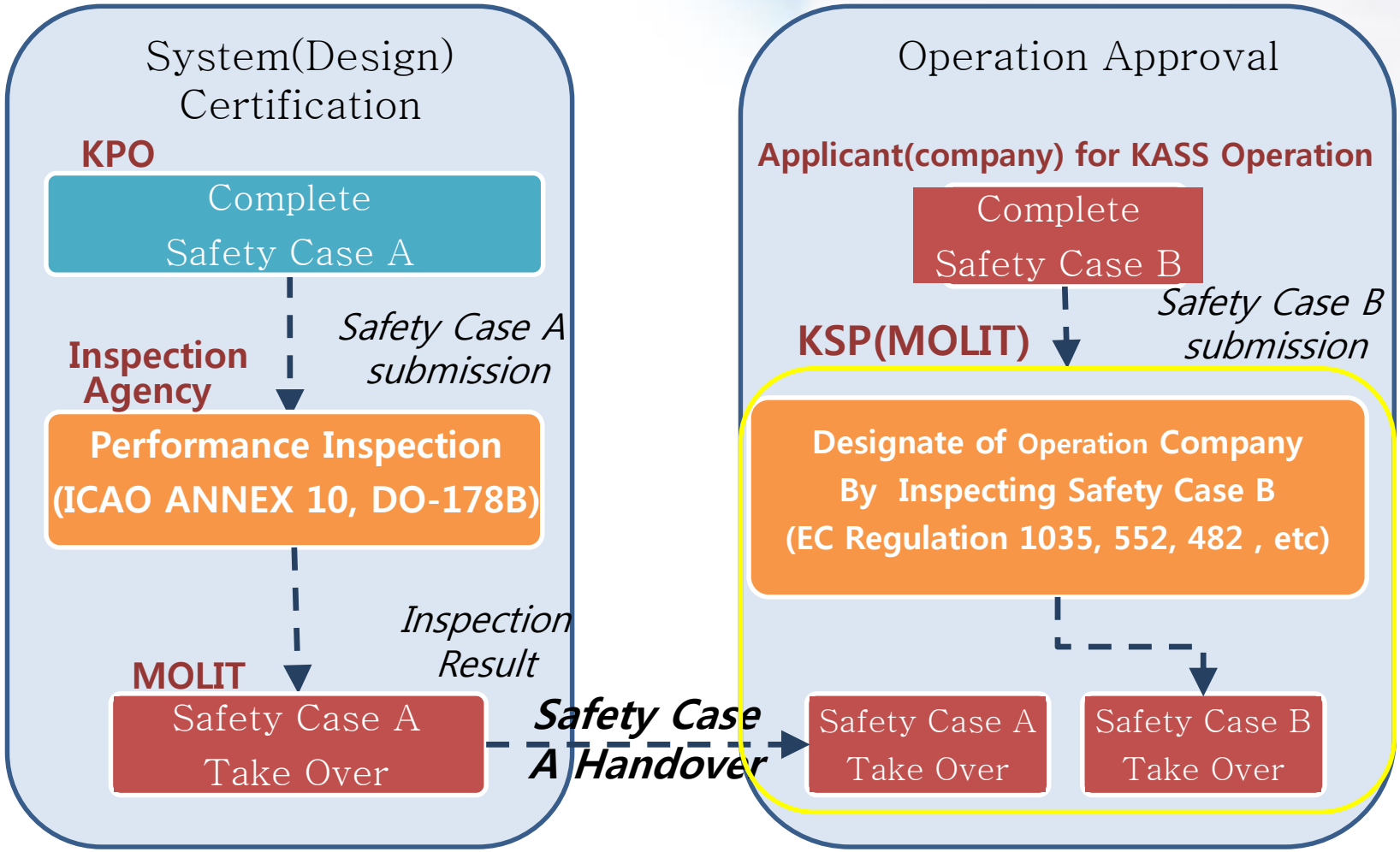
III. Perspective on SBAS Implementation

- 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



III. Perspective on SBAS Implementation

❖ KASS Operation Approval(Designating Operation Company) - Draft



ROK's perspective on GBAS/SBAS implementation

Thank you!