System Development - KASS

KASS: Korea Augmentation Satellite System

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Expected Signal in Space Area of KASS
I. OVERVIEW
KASS Program

[Period] 5 Phases in 8 Years (2014 - 2022)

• Phase C (May 2017-Sept. 2019): Critical Design
• Phase E (Jul. 2020-Oct. 2022): Initial Operation and Approval Process

[Program Participants]
• Supervising Agency(MOLIT, KAIA), KASS Program Office, KARI, ETRI, TASF, KT, KTsat
Ⅱ. DEVELOPMENT STATUS
KASS Development Process

System Kick-Off → System Requirement Analysis → System Preliminary Design → Sub System Specification → System SDR → System IPKP (CDR #1) → System CDR #2 → System IVQ Preparation → System On-site Integration → System Qualification → System Deployment

Sub System Kick-Off → Sub System Preliminary Design → Sub System PDR → Sub System Integration → Sub System Qualification → Component Development → Component Specification → Component Qualification

For each subsystem / KFI

<Legend>
□ : Main Activity  ● : Milestone
KASS System Architecture

<table>
<thead>
<tr>
<th>S/S (Sub System)</th>
<th>Qty. (Baseline)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KRS (KASS Reference Station)</td>
<td>7</td>
</tr>
<tr>
<td>GEOs</td>
<td>2</td>
</tr>
<tr>
<td>KUS (KASS Uplink Station)</td>
<td>3</td>
</tr>
<tr>
<td>KCS (KASS Control Station)</td>
<td>2</td>
</tr>
<tr>
<td>KPS (KASS Processing Station)</td>
<td>2</td>
</tr>
</tbody>
</table>

GPS satellites

KRS Channel 1(A)
KRS Channel 2(B)
7 KRS Sites

KUS 1 (Master)
KUS 2 (Backup)
KUS 3 (Master)

KCS (Master)
KCS (Backup)

KPS 1
KPS 2

GEO 1
GEO 2

SBAS Message
GEO

L1 / L5
L1 / L2
C1 / C5
C1 / C5
L1 / L5
L1 / L5
L1 / L5
L1 / L5
Sites for KASS system

- KRSs
- KCSs & KPSs
- KUSs
- GEO satellites

Legend:
- : KRSs
- : KCSs & KPSs
- : KUSs
- : GEO satellites
KRS Overview

- The **KRS (KASS Reference Stations)** are the ranging and integrity monitoring stations of the KASS system used for data collection of the GPS and GEO measurement.

- KASS acquires GPS and GEO measurement from 7 KRS and transmits the data to the KPS and KCS.

- **Each KRS consists of 1 Cabinet** *
  - KRS Cabinet: 2 KRS Channel*, 1 Frequency Standard, 2 FEE, RPMU, Sensors
  * KRS channel: mainly composed by a GNSS antenna, a receiver and a core computer.
KRS Sites

- The survey was conducted for about 2 years in order to select the best KRS sites candidate. (KRS site candidates: 60 locations → 7 locations)

- 7 KRS sites were selected considering sufficient space for installation (the distance between the antennas), No obstacle (Clear horizon) and Good EMI (GPS band interference minimum).

(Initial: 60 sites) (Final: 7 sites)
KPS Overview

- **Main Roles of KPS**
  - **Generate SBAS Message** (Correction & Integrity Information)
  - **Ensure the Integrity** of Provided SBAS Message

- **Main Features of KPS**
  - Unmanned System
  - Redundancy
    - There are two KPSs in KASS baseline architecture
    - Two KPSs are located at two MCC sites respectively
  - Constitution
    - KPS-PS (Processing Set) : Generate SBAS Message
    - KPS-CS (Check Set) : Monitor SBAS Message
  - Interface with All KASS Subsystems
  - SW Development: DO-178B DAL-B

*DAL (Development Assurance Level)
KCS Overview

- **KCS (KASS Control Station)** is in charge of the centralized supervision of the KASS System and Services
  - Monitoring & Control (M&C) of KASS subsystem status
  - First level KASS Mission Monitoring (MiMo)

- **KCS is deployed in 2 distinct Mission Control Centers (MCCs)**
  - KCS has Master and Backup mode, and both KCSs are synchronized for the handover
  - Full control capability will be only possible through Master MCC
KCS Architecture

- KCS consists of 3 main components: Central Control Function (CCF), Support Function (SF), and NOTAM information Function.
KUS Overview

- **KUS (KASS Uplink Station) is in charge of transmitting SBAS RF Signal to GEO Satellite**
  - Receive the Augmentation Message from KPS.
  - Generate the PRN code, BPSK Modulation, Signal Amplify and then transmit the GEO satellite.

- **KUS is deployed in 2 Site**
  - KUS site consists of Primary and Backup Site.
  - Primary site has a two(2) uplink station and Backup site has a one(1) uplink station.
To select the properly KUS sites, site survey was conducted during the 2 years. (KUS site candidates : 14 locations → 2 locations)

KUS sites were selected by considering Clear horizon, Multipath and lower EMI for GPS L1, L2 and L5 band.
WAN Overview

- **Wide Area Network**
  - KASS ground segment is deployed on sub-system sites in Korea
  - WAN is a system that provides telecommunication service between sub-systems
  - WAN is aimed at ensuring the performance and quality of telecommunication

- **Site Types**
  - 2 MCCs (KPS, KCS)
  - 3 KUSs
  - 7 KRSs

- **Types of equipment per site types**

<table>
<thead>
<tr>
<th></th>
<th>MCC</th>
<th>KRS</th>
<th>KUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPMU</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>FEE</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>RPM Maintenance Tool</td>
<td>○</td>
<td></td>
<td></td>
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<tr>
<td>WNM</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- RPMU: Remote Power Management Unit
- FEE: Front End Equipment
- WNM: WAN Monitoring

*The WAN users*
WAN Architecture

- **WAN is divided into**
  - Access network (NTE, Access line)
  - Core network

- **The Access network connects the on-site TE to the Core network**

- **The Core network provides connectivity with the PoP assigned to reach the destination site**

- NTE: Network Terminal Equipment, the WAN part installed in a KASS site
- Access line: one or two terrestrial access lines used for the connection to one or two different PoP’s
- TE: Terminal Equipment, the set of subsystems using the WAN service
- PoP: Points of Presence
# GEO and SBAS payload Acquisition Plan

<table>
<thead>
<tr>
<th>Original Schedule for leasing GEO</th>
<th>For Test and Open Service</th>
<th>For SoL Service</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>('18)</td>
<td>('23)</td>
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<tr>
<td></td>
<td>('19)</td>
<td>('24)</td>
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<tr>
<td></td>
<td>('20)</td>
<td>('25)</td>
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<td></td>
<td>('21)</td>
<td>('26)</td>
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<tr>
<td></td>
<td>('22)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acquisition (lease) Plan</th>
<th>1(^{st}) GEO</th>
<th>New Satellite</th>
<th>2(^{nd}) GEO</th>
<th>New Satellite</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(^{st}) GEO</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2(^{nd}) GEO</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

- \(18.12\) GEO for Test and Open Service
- Open Service ('20.7)
- SoL ('22.10)
- '21 3Q Ktsat-Airbus
- TBD

※ The plan may be changed after making contract of the 2\(^{nd}\) GEO satellite
III. PERFORMANCE
Assessed availability performance is more than 99%

<table>
<thead>
<tr>
<th>Performance</th>
<th>Best on LM*</th>
<th>Mean on LM*</th>
<th>Worst on LM*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessed availability performance</td>
<td>99.763 %</td>
<td>99.743 %</td>
<td>99.703 %</td>
</tr>
<tr>
<td>Assessed HNSE (95%)</td>
<td>0.87 m</td>
<td>0.92 m</td>
<td>0.97 m</td>
</tr>
<tr>
<td>Assessed VNSE (95%)</td>
<td>1.64 m</td>
<td>1.61 m</td>
<td>1.57 m</td>
</tr>
</tbody>
</table>

※ LM : South Korea Peninsula + Jeju Island
※ HNSE (95%)
Assessed availability performance is more than 99%

- South Korea peninsula + Jeju Island are covered by the 99% compliance area.

<table>
<thead>
<tr>
<th>Assessed availability performance (%)</th>
<th>Best on LM*</th>
<th>Mean on LM*</th>
<th>Worst on LM*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fault Free</td>
<td>100</td>
<td>99.98</td>
<td>99.95</td>
</tr>
<tr>
<td>Including GPS failures</td>
<td>99.91</td>
<td>99.89</td>
<td>99.87</td>
</tr>
<tr>
<td>TOTAL including GPS + GEO + G/S** failures</td>
<td>99.763</td>
<td>99.743</td>
<td>99.703</td>
</tr>
</tbody>
</table>

※ LM : South Korea Peninsula + Jeju Island  
G/S : Ground Segment
**Assessed accuracy**

<table>
<thead>
<tr>
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<th>Mean</th>
<th>Worst</th>
</tr>
</thead>
<tbody>
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<td>0.92</td>
<td>0.97</td>
</tr>
</tbody>
</table>

- **HNSE (95%) target < 20m**

<table>
<thead>
<tr>
<th>Performance on LM* (m)</th>
<th>Best</th>
<th>Mean</th>
<th>Worst</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessed VNSE (95%)</td>
<td>1.64</td>
<td>1.61</td>
<td>1.57</td>
</tr>
</tbody>
</table>

- **VNSE (95%) target < 16m**
IV. FUTURE PLAN
## Future Plan

<table>
<thead>
<tr>
<th>Development</th>
<th>System Design</th>
<th>System IVQ</th>
<th>Operation Support</th>
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</thead>
<tbody>
<tr>
<td>2014</td>
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<td>2015</td>
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<td>2016</td>
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<td>2020</td>
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<tr>
<td>2021</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2022</td>
<td>Open Service ('20.4Q)</td>
<td>1st GEO launch</td>
<td>SoL ('22.4Q)</td>
</tr>
<tr>
<td>2023</td>
<td></td>
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<tr>
<td>2024</td>
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</tbody>
</table>

**Certification**
- System Certification
- Operation Certification

**Operation**
- Establishment of GNSS Center & KSP
- OS
- SoL Service
Thank You!