Korean Satellite Based Augmentation System

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ABSTRACT

A K-SBAS (Korean Satellite Based Augmentation System) is proposed as one of the space infrastructure. The proposed system considers the existed elements to the utmost for the most economical SBAS construction. As reference system the current DGPS (differential global positioning system) network is investigated. Space segment is investigated based on the COMS-1 (Communications, Oceanographic, and Meteorological Satellite-1). While bus system of COMS-1 can be kept to minimum change, the communication payload of COMS-1 needs to be experienced in major change. Even though new facility for master control center is needed, crucial parts such as softwares, man power can be easily secured through the DGPS network operation heritage.

Key Words : GNSS, SBAS, Augmentation

요 약

지상의 인프라 못지않게 중요시 되고 있는 GNSS (global navigation satellite system) 를 위한 한국형 위성기반 보강시스템을 제안하였다. 제안된 시스템은 가장 경제적인 위성기반 보강시스템 구축을 위하여 시스템 요소로서 현재 존재하는 시스템의 사용을 적극 고려하였다. 기준시스템은 현재 운용되고 있는 DGPS (differential global positioning system) 네트워크를 최대한 활용하는 것으로 하였고, 위성은 통신해양기상위성 1호(COMS-1)을 근간으로 조사하였다. 버스 시스템은 최소한의 변경이 예상되는 반면 통신탑재체는 주요한 변화를 겪게 될 것으로 분석되었다. 지상의 주제어 센터는 새롭게 건설되어야 하지만 소프트웨어, 인력 등 센터의 필수적인 요소는 DGPS 네트워크의 운용 경험을 통하여 쉽게 확보될 수 있으리라 판단된다.

I. Introduction

Since the C/A (coarse/aquisition) code signal of GPS (global positioning system) was formally accessible on 1984, civilian applications of GPS have showed the explosive increase. GNSS (global navigation satellite system), so called the space infrastructure, become the one of the most important infrastructure which is as fundamental as ground infrastructure.

Recognizing its importance and effect, Europe is making the Gallieo and China is investing to the Gallieo Project which is another global navigation system. Some countries are developing the regional navigation system and/or the SBAS (satellite based augmentation

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system) in order to escape from any dependencies.

Even SBAS requires considerable amount of money. Fortunately we have many applicable resources for SBAS. So we propose how to develop our own SBAS with minimum cost by using the existed facilities, heritage including man-power. In this paper we will name this system as Korean SBAS or K-SBAS.

Ⅱ. Existed and Planned SBAS

At the present, three SBAS are operating[1][2] and one SBAS is planning in the world[3]. We summarize their characteristics of space and ground segments in Table 1.

Table 1. Characteristics of Existed or Planned SBAS

	WAAS	EGNOS	MSAS	GAGAN	Remarks
Target	GPS	GPS/GLONASS		GPS/GLONASS	
Operator	FAA/DoT	ESA/EC	MOT/JMA	AAI/ISRO	
Space Segment	POR & AOR-W (Inmarsat)	IOR & AOR-E (Inmarsat)	MTSAT	INSAT	
Frequency	- C-band uplink/down link - L1, L5 downlink (in case of Inmarsat 4)	- C-band uplink/down link - L1, L5 downlink (in case of Inmarsat 4)	- S-band , Ku-band - Ka-band - L-band - UHF	- C-band uplink /down link - L1, L5 downlink	
Expected Accuracy	1~2m(horizont) 2~3m(vertical)	~ 5m			ICAO requirement 16m(horizont) 6m(vertical)
Location	174E	64E &	140E		
Ground System	2 Master station 25 Reference Station Data link Station	4 Master Station 34 Reference Station (RIMS) 7 Link Station (NLES)	2 Master Station (MCS) 4 Reference Station (GMS) 2 Link Station (MRS)	1 Master Station (INMCC) 8 Reference Station (INRES) 1 Link Station (INLUS)	

* FAA : Federal Aviation Administration, DoT: Department of Transportation
* MOT : Ministry of Transportation, JMA : Japanese Meteorological Agency, AAI: Airports Authority of India

Ⅲ. System Architecture of K-SBAS

Overall system architecture of K-SBAS is proposed as depicted in Figure 1. As reference station, K-SBAS can use the existed ordinary GPS measurement network which is shown Figure 2[4]. However it needs to complement with additional channels for COMS navigation and Galileo. Reference

stations will collect measurement data and broadcast messages from all the GPS, Galileo and COMS satellite in view and forward it to the MCC (mission control center).

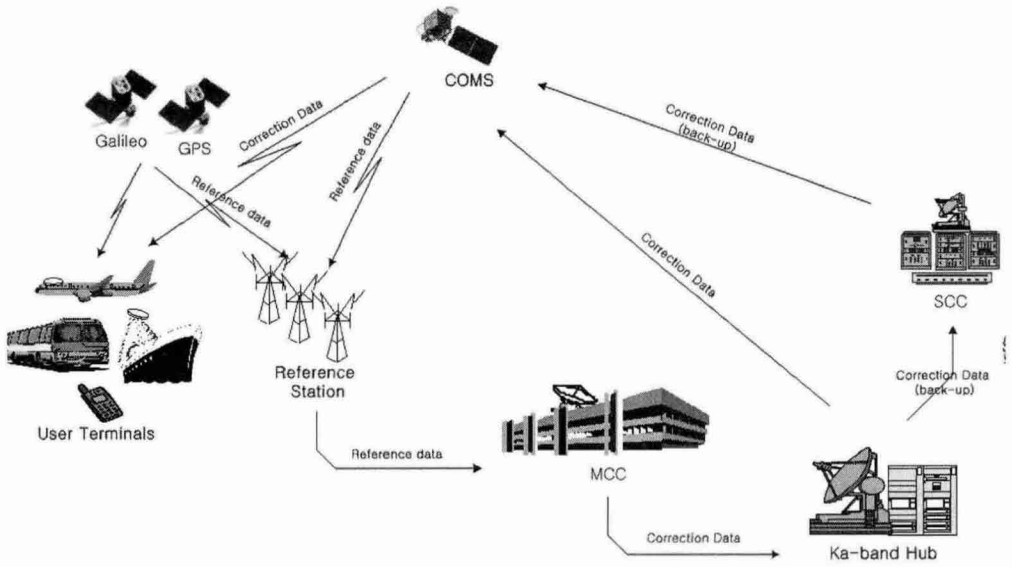

Figure 1. The Proposed K-SBAS architecture

MCC will be a new facility. It will function as followings;

- Network management
- Integrity monitoring
- Delay estimation by Iono-tropo modelling
- Orbit determination
- Command generation

MCC should generate the correction data and integrity data. The current techniques and manpower for post processing DGPS (differential global positioning system) can be re-used for the MCC.

One of the special characteristics is to use the Ka-band for the uplink of the correction data and S-band for the backup uplink. The occasion enables uplink station to re-use the Ka-band earth station which was applied in the previous COMS system. When the severe rainfall is happened, Ka-band uplink station can no longer perform its function. The transmission function for correction data uplink will be switched to SCC (satellite control center). In order to maintain the backup line using S-band, more elaborate mission planning is needed not to interrupt the satellite control.

Receiving the correction data from uplink station, spacecraft will transform Ka-band signal or S-band signal to L-band signal and distribute them to user terminals including Reference Station. COMS platform can be re-used with a little modification. Expected change will be described in section IV. Communication payload will experience huge modifications. But as the current services have to be maintained, Ka-band channel should be included. Section V shows the detailed configuration.

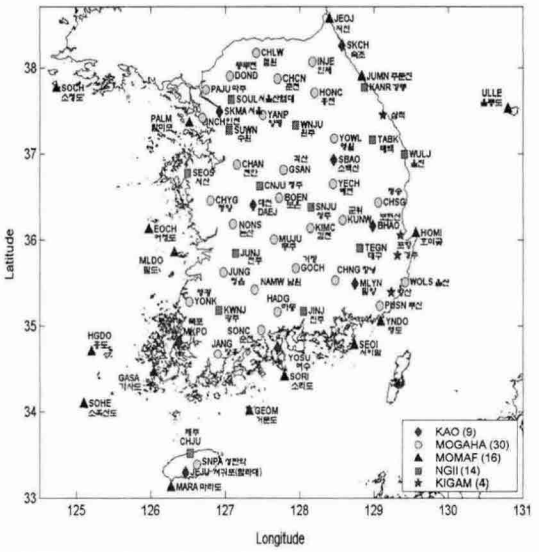

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Figure 2. Domestic Ordinary GPS Measurement Network

Ⅳ. Spacecraft

COMS-1 has three different missions; Communication, Ocean and Meteorological monitoring. In case of COMS-2, it assumes that Communication mission of COMS-1 might be replaced by Navigation mission, while the other missions do not change. As the navigation payload will consist of three channels, the mass of spacecraft will be similar to COMS-1. In terms of power consumption it will be less than COMS-1 because of less high power channels like Ka-band. And the antenna pointing requirement of COMS-1 needs to be kept due to Ka-band spot coverage. Under condition of no change in meteorology and oceanic mission COMS-2 will be similar to COMS-1.

Ⅴ. Navigation Payload

Navigation payload in general plays two roles. One is the transmission of timing and ranging signal on one or two L-band frequencies. The other is to relay in near real time the data originated on the ground to user receiver to improve performance in terms of reliability and accuracy with GPS and Galileo signals.

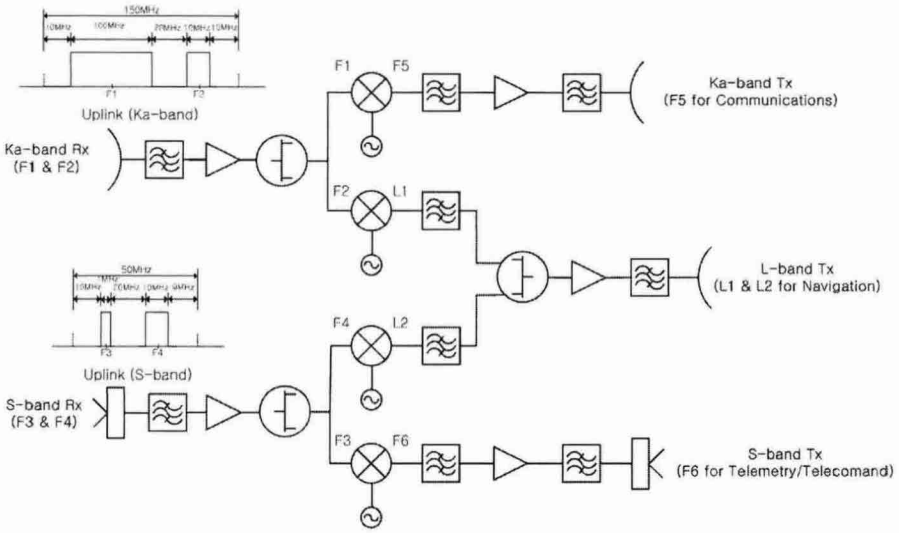

Figure 3. The Proposed Navigation Payload for K-SBAS

The transponder subsystem is a four-channel bent-pipe repeater that converts Ka-band and S-band uplink signals from ground earth station to four downlink signals in Ka-band (F5), S-band (F6), and L-band (L1 and L2) as shown in Figure 3. Ka-band uplink signal consists of 2 channels which are to be used for communication (F1) and navigational use (F2), S-band uplink signal also includes 2 channels which are for TM/TC (telemetry /telecommand) (F3) and other navigational use (F4).

The antenna subsystem employs three antennas, as shown in Figure 4 excluding the antennas for Oceanographic and Meteorological mission. The west deployed offset single reflector generates the Ka-band transmit and receive spot beams for South Korea region based on current heritage. The east deployed reflector generates the L-band transmit global beam for the desired region. The current two S-band antennas are for the TC&R (telemetry, telecommand, and ranging) subsystem at the transfer and on-station phase. One S-band omni antenna for on-station purpose located at the earth-deck can be re-designed for the both TM/TC and backup navigation purpose.

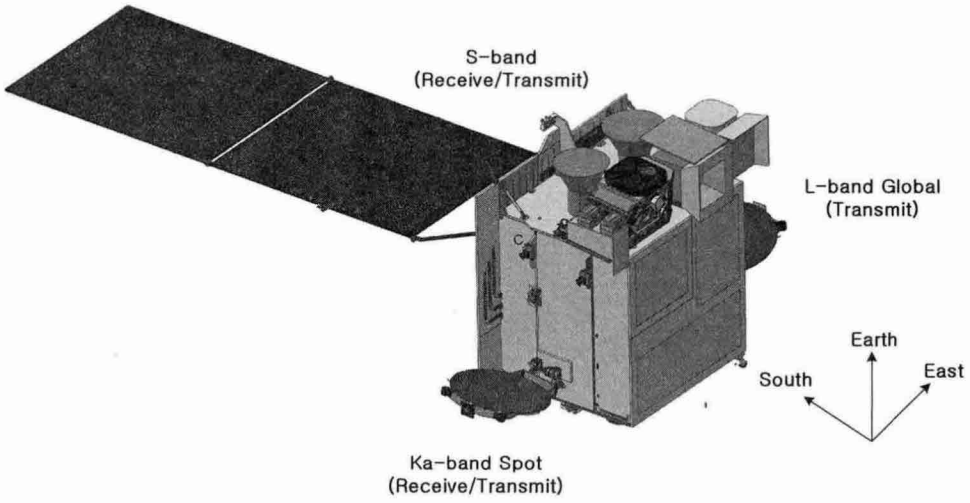

Figure 4. The Proposed Spacecraft for K-SBAS

Ⅵ. Summay

The concept of K-SBAS have proposed in this paper. The proposed K-SBAS system is summarized as Table 2.

Ⅶ. Conclusion

The K-SBAS in this paper is properly proposed as one of the most efficient augmentation system for the first SBAS in Korea. It can certainly be the start of development for the economic and efficient system by adopting a way aimed at COMS-2 program. Especially the utilization of the existed heritage in major modified payload and newly constructed MCC has the key to the successful opening of K-SBAS.

Table 2. Summary of K-SBAS

Segment	Element	K-SBAS	Existed	Modification
Space	Spacecraft	COMS	Existed	Minor
	Navigation Payload	Communication Payload & TCR transponder	Existed	Major
Ground	MCC	New facility	New	-
	Reference Station	GPS Measurement Network	Existed	Minor
	Uplink Station	Ka-band Hub & COMS SCC	Existed	Minor

Reference

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