المركز الوطني لعلوم وتكنولوجيا الفضاء

UAEU The National Space Science & Technology Center

جامعة الإمارات العربية المتحدة
United Arab Emirates University

GNSS Augmenting system Program Overview

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ICG-16

WASC Senior College and University Commission

"جامعة المستقبل"
"The University of the Future"

Outline

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- Program vision
- Interests of LEO PNT
- Potential capacity building
- Where is the other in LEO PNT
- Project Design Consideration
- Project approach

Program Vision

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UAE GNSS vision :

- Involved in GNSS technology with associated educational and technical development.
- Building capability and capacity in the GNSS sector in UAE.

Technical vision :

- Answering to the current market needs in terms of quick precise positioning.
- Provide a very quick and very accurate positioning , anytime in the area of interest.
- Support the Autonomous Transportation Strategy.

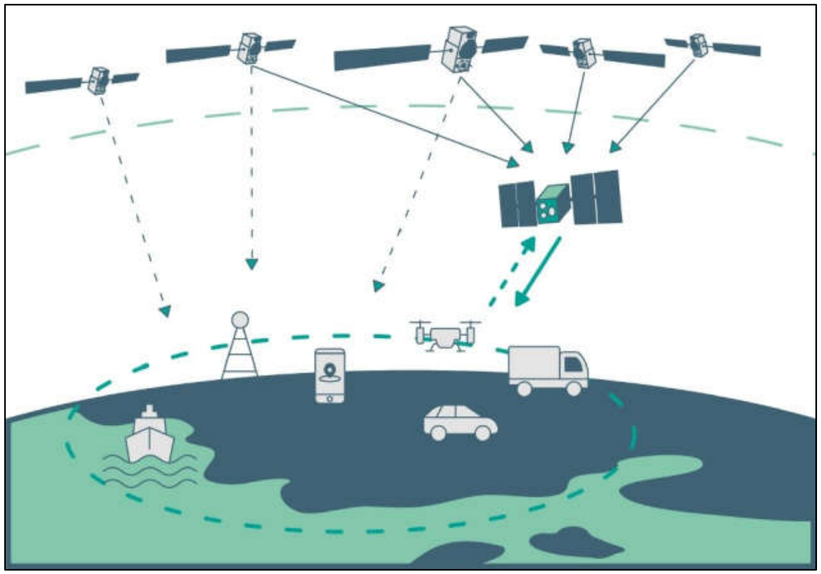
Cost

Accuracy / Time

Robustness

Why LEO PNT ?

- Quick accurate positioning (Doppler dynamic accelerating carrier phase ambiguity resolution)
- Low cost compared to MEO/GEO/IGSO constellations solutions.
- Multipaths filtering thanks to high Doppler.
- More accurate result from Doppler measurement (than MEO and GEO).
- Geometric improvement provided with LEO+MEO increase the positioning accuracy.----
- Receiver Autonomous Integrity Monitoring (RAIM) is improved (more satellites, visibility, dynamic, better geometry: MEO+LEO).
- Better protection against radiation, impacting surface charges and/or component.



Potential Capacity Building

GNSS Sector

- Full GNSS system components starting with the signal generation IP to the full navigation message generation(HW + SW)
- Industrialized GNSS signal processing systems (SDR, antenna, …etc)

Space Sector

- Attitude determination and control system.
- Orbit Determination and Time Synchronization (OTDS) software
- Command and data handling subsystem
- Mechanical structure platform

Where are the Others in LEO PNT

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	Operation Region	L-Band	S-Band	Coverage	Date of Full Operational Capability
Galileo G1	EU	Yes	No	Worldwide	2022
Galileo G2	EU	Yes	No	Worldwide	2034
GPS	USA	Yes	No	Worldwide	1995
Glonass	Russia	Yes	No	Worldwide	1996
Beidou-3	China	Yes	Yes	Worldwide	2020
NAViC/IRNSS	India	Yes	Yes	Worldwide	2030
QZSS	Japan	Yes	No	Regional	2024
QZSS-2	Japan	Yes	NO(TBC)	Regional	2030
KPS	South Korea	Yes	Yes	Reginal	2030
Xona-Space	USA	YES	NO(TBC)	Worldwide	2026
GEESAT and Centispace	China	Yes	No	Worldwide	2028

Project Design Consideration

Space segment

- System studies for defining a GNSSaS constellation architecture that does not rely on a ground network of reference station.
- Achieving high precision (aiming for centimetric accuracies)
- Achieving high resilience (availability, resilience to jamming, resilience to spoofing)
- Optimize GNSSaS constellation configuration (number of satellites and orbit)

Ground Segment

- Compatible with multi GNSSaS frequencies and signals
- Capable of receiving existing multi-frequency, multi-constellation GNSS signals and perform position determination
- Capable of performing ionospheric correction using dual frequency measurements
- Shall track Doppler effects of GNSSaS signals transmitted from LEO

Project Approach

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Three Stages approach

GNSSaS Stage-1 (Technology demonstration)

1. To transmit GNSSaS signals in at least two ITU approved frequency bands.
2. Implementation with reprogrammable software radio technology.
3. To transmit signals to the ground without interference with other GNSS signals.
4. To Incorporate Pseudo Random Codes for unique identities.
5. To validate the transmitted signals using ground based GNSS signal analyzer.
6. Demonstrate a ODTS Technology in single frequency dual constellation mode.

Project Approach

Three Stages approach :

GNSSaS Stage-2 (Prototype)

1. Optimize GNSS signls transmitted power for optimized received power density on the ground.
2. Demonstrate an accurate ODTS Technology in dual frequency dual constellation mode.
3. Position determination using Stage-2 and other existing GNSS constellations.
4. Synchronization with existing GNSS constellations, Augmentation systems or/and existing GNSS ground networks.
5. Shall be representative of the intended satellites of the GNSSaS constellation.
6. Finalize the design of the constellation.

Project Approach

Three Stages approach :

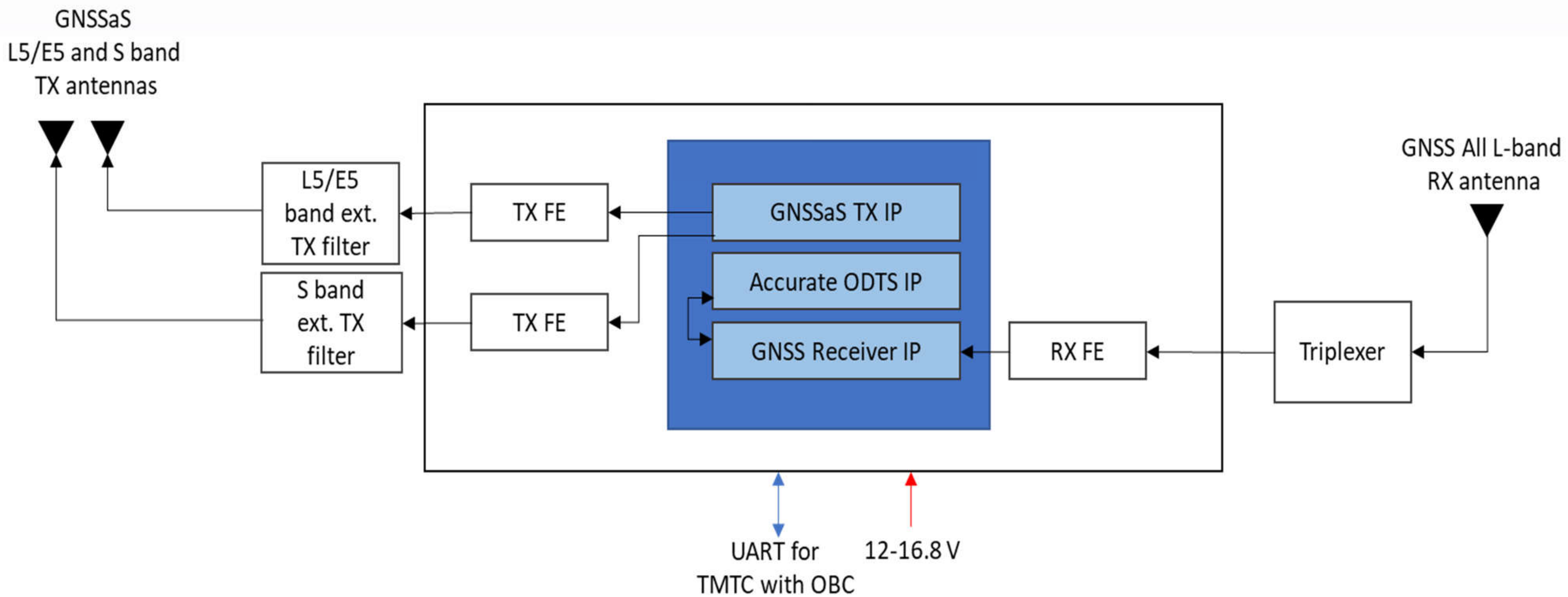
GNSSaS Stage-3 (Constellation Demonstration Satellites)

1. To build, launch and validate at least 4 satellites.
2. Demonstrate technology resilience for GNSSaS satellites.
3. Demonstrate the GNSSaS user receiver technology.
4. Demonstrate position determination using GNSSaS satellites only.
5. Demonstrate positioning accuracy using GNSSaS satellites only.

Stage-1 payload targeted Frequencies

Item	Freq. Band	Description	Value	Compatible Constellation
Transmitter	L5	Freq. Range	1168.20 – 1184.70 MHz	GPS, IRNSS, QZSS, BEIDOU-3, GALILEO
		Center freq.	1176.45 MHz	
		Baseline Modulation	BOC(2,2)	
		Data rate	25 bps (50 sps)	
		Transmission Bandwidth	16.5 MHz	
	L5/E5	Freq. Range	1168.20 – 1200.23 MHz	
		Center freq.	1184.1225 MHz	
		Baseline Modulation	AltBOC(7.5,BOC(2,2))	
		Data rate	25 bps (50 sps)	
		Transmission Bandwidth	32.03 MHz	
	S	Freq. Range	2483.50-2500 MHz	IRNSS, BEIDOU-3,KPS, GLOBALSTAR
		Center freq.	2491.75 MHz	
		Baseline Modulation	BOC (2,2)	
		Data rate	25 bps (50 sps)	
		Transmission Bandwidth	16.5 MHz	
Receiver	L1	Center frequency	1575.42 MHz	GPS + GALILEO

Stage-1 Payload Architecture



THANK YOU