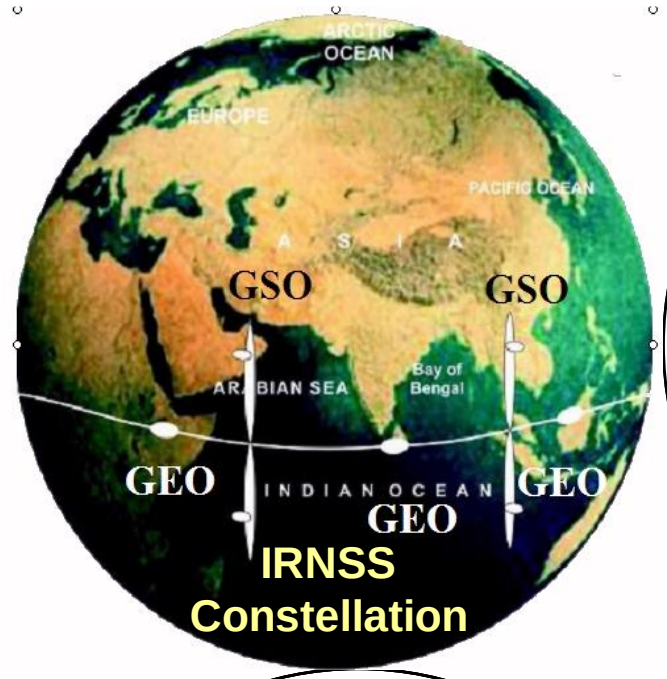
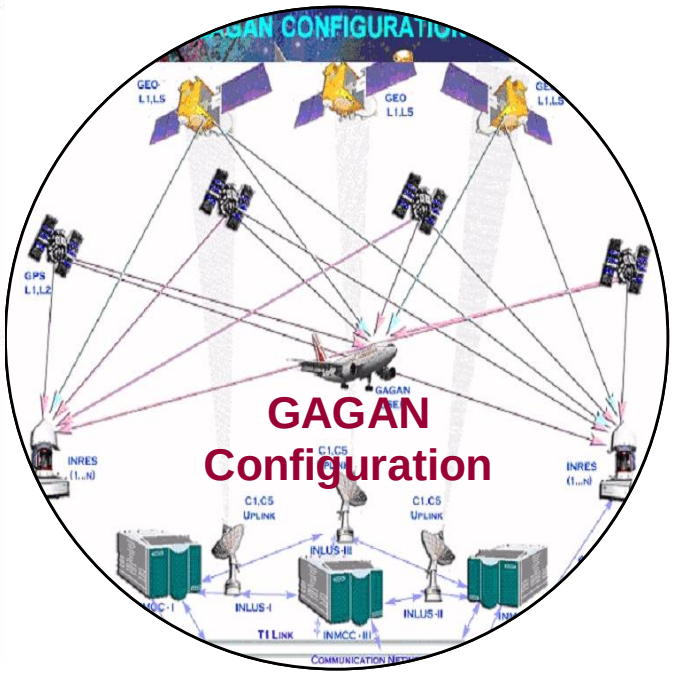
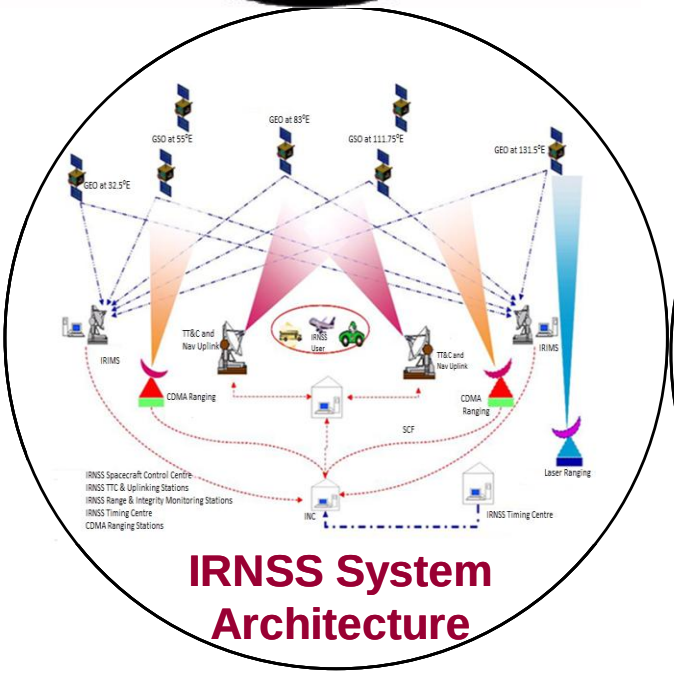
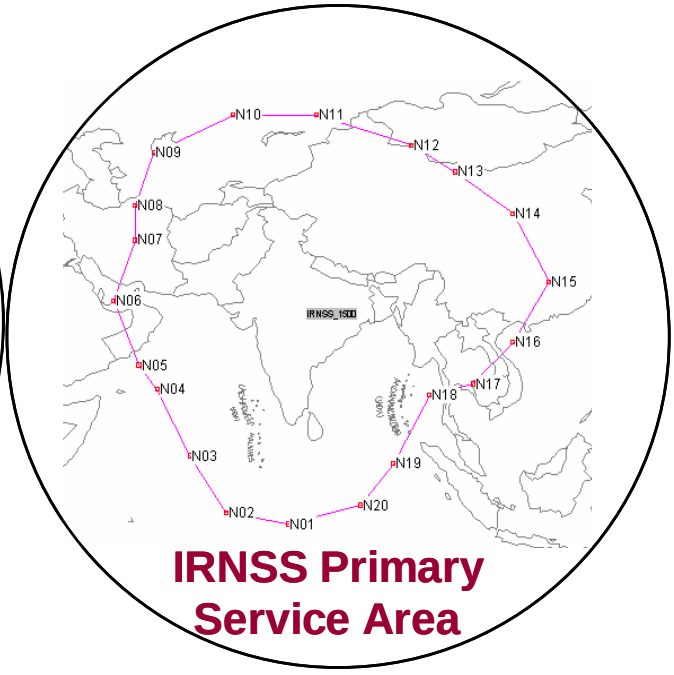
Announcement of Opportunity for IRNSS/GAGAN Navigation Data Utilization Program









April, 2016

Space Applications Centre (ISRO)
Ahmedabad-380015

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1.0 Description of the Opportunity

Space Applications Centre (SAC), Indian Space Research Organization (ISRO), Department of Space (DOS), Government of India, declares an **"Announcement of Opportunity (AO)"** to carry out scientific research under "IRNSS/GAGAN Data Utilization Program".

1.1 Overview of IRNSS/GAGAN

India has its own satellite navigation program, consisting of the GNSS augmentation system, called GAGAN in addition to its own primary navigation system "Indian Regional Navigation Satellite System (IRNSS)". These systems offer navigation services which caters both the civilian and strategic needs. However, apart from the navigation uses, the signals issued by these systems may also be used for several other purposes. The utilization of the system depends upon nature and the quality of data that we get from it.

1.1.1 IRNSS

The IRNSS is an ISRO's initiative to provide independent satellite navigation services including position, velocity and time to users over the Indian region. It is supposed to provide two kinds of services viz., standard positioning service (SPS) for civilians and restricted service (RS) service for strategic users. The transmission is done using L5 band and S band to provide required coverage in right hand circular polarization (RHCP). The intended service area for IRNSS has been assumed to be primarily the Indian land mass, and a region extending to about 1500 km around it. The design specifications of the IRNSS offer to provide about 20 m of position accuracy for SPS and a time accuracy of about 50 ns. The features of the different types of services in different frequencies and over the different regions are shown in the Table-1.

Table 1: Specification of IRNSS Signals

	Centre Frequency	**Bandwidth**	**SPS Modulation**
S- Band	2492.028 MHz	16.5 MHz	BPSK
L5- Band	1176.45 MHz	24 MHz	BPSK

The IRNSS system mainly consists of space segment, ground segment and user Segment. Space segment consists of seven satellites. Three of these satellites are in GEO at locations 32.5º E, 83º E and 131.5º E and four satellites in GSO with inclination of 29° to the equatorial plane. These satellites have their longitude crossings 55º E and 111.75º E (two in each plane). All the satellites will be visible in service region for 24 hrs and will transmit navigation signals in both L5 and S bands. Spacecrafts are designed to have 7 to 10 years' life however will be replaced suitably to have a sustained mission operation.

The ground Segment is responsible for the maintenance and operation of the IRNSS constellation. It provides the monitoring of the constellation status, correction to the orbital parameters and navigation data uploading. The ground segment consisting of the Master Control Centre, providing the monitoring of the constellation status, correction to the orbital parameters and navigation data uploading. Other units of the Ground segment comprise of TTC & navigation data up linking Stations, Spacecraft Control Centre, IRNSS Network Timing Centre, IRNSS Range and Integrity Monitoring Stations, CDMA Ranging Stations, Laser Ranging Stations, Navigation Control Centre and Data Communication Links.

The user segment mainly consists of the user receivers. There may be different genres of receivers which are used by the user community depending upon the price and the purpose of their usage.

1.1.2 GAGAN

GAGAN is a satellite based augmentation system on the primary services of the GPS. It has been implemented in India jointly by ISRO and the Airport authority of India (AAI). The objective of this is to provide satellite-based navigation services with accuracy, integrity, continuity and availability required for civilian and aviation applications over Indian air space. This will lead to better air traffic management over Indian air space.

The basic architecture of the system consists of three segments, viz. the space segment, ground segment and user segment. The space segment consists of three GEO Satellites, which will transmit the systematic errors in the basic GPS services along with the

integrity values. Two operational navigation payloads are already in place onboard GSAT 8 and GSAT 10. One in orbit spare navigation payload will also be available.

The ground segment consists of the Indian Master Control Centre (INMCC), Indian Navigation Land Uplink Station (INLUS), Indian Reference Stations (INRES) distributed across the whole service area with communication links to the Master Control Centre.

GAGAN space segment transmit the error corrections and integrity values in defined standard formats in L1 (1575.42 MHz) and L5 (1176.45 MHz) band. It uses SBAS PRN codes 127 and 128 to transmit these parameters to the SBAS receivers. The signal with the code is BPSK modulated

High position accuracies with integrity (APV-1.5 or better) are expected over Indian geographical area. These position accuracies to be simultaneously made available to all airports and air fields in Indian region, enabling satellite based landing of aircraft fitted with SBAS receivers.

2.0 Who can submit a proposal?

Proposals could be submitted by individuals or a group of scientists and academicians belonging to recognized institutions, universities, government and private organizations of India. Only those having at least a minimum remaining service of four years before superannuation are eligible to lead the project as PI/Co-PI. The proposals must be forwarded through the Head of the Institution, with appropriate assurance for providing necessary facilities for carrying out the projects under this AO program.

3.0 Data availability

The data from GAGAN is continuously being collected since 2005 and can be provided however, IRNSS data will be made available by July, 2017.

4.0 Evaluation of proposals

This Announcement of Opportunity (AO) for potential Principal Investigators (PIs) is aimed towards stimulating newer research and for encouraging development of specific

techniques by utilization of IRNSS/GNSS data on a local/regional scale. Towards this, the proposals received in response to this AO will be evaluated considering primarily the scientific/technical merits. The principal elements considered in selecting the proposals, among other things, would be:

- The overall, scientific or technical merit of the proposal, uniqueness and innovative methods, approaches or concepts planned to be demonstrated.
- Potential for contributing to innovative science by making synergistic use of data sets.
- The competence and relevant experience of the PIs and/or co-investigators for achieving the proposed objectives.

5.0 Specific Areas of Interest

The major emphasis of the proposals are research studies and real-time/ near real-time applications using the data provided by IRNSS/GNSS.

The research can be addressed under the following domains but not limited to:

- Algorithm/software Development
  - Applications using IRNSS & GPS
  - Precise ephemeris and clock products generation
  - Precision agriculture
  - Surveying applications for optimum land use
  - Software Receiver Development
  - Development of Positioning algorithms
  - Development of Multipath & Interference Algorithms
- Navigation Applications
  - Land Navigation
  - Air Navigation
  - Marine Navigation
- Atmospheric Applications
  - Alerts of extreme weather conditions like heavy rain, cyclones etc.
  - Retrieval of integrated water-vapor
  - Short range weather prediction

  - Radio Occultation
- Geodetic Applications
  - Land slide prediction
  - Crustal deformation studies
  - Earthquake hazard studies
- Oceanic Applications
  - Altimetry applications
  - Tsunami alerts
- Ionospheric Applications
  - Ionospheric Model Development for Indian Region
  - Ionospheric TEC studies
  - Ionospheric scintillation studies
- Tropospheric Applications
  - Tropospheric Model Development
  - Water Vapor Tomography
- Differential positioning
  - Real Time Kinematic (RTK) positioning using carrier-phase measurements
  - Network RTK
  - Code-based differential Positioning
  - Performance Evaluation of User Receiver in Dynamic Conditions
  - Testing Performance of Terrestrial Navigation Systems

6.0 Guidelines for Proposal Preparation

The potential PI should submit the proposal in a format described in the following sections. The format for the cover page is given in Annexure - 1. The format for the detailed proposal is given in Annexure -2. The format for proposal includes a declaration to be signed by the PI and the head of the institution.

6.1 Instructions for Submitting a Proposal

Proposals should be limited to around 10 pages in length on standard A4 size paper, typed double-spaced and in the prescribed format. Two copies of the proposal prepared in the formats given in **Annexure - 1** and **Annexure - 2** should be mailed to:

Shri Atul P. Shukla
Space Applications Centre (ISRO)
Ahmedabad - 380015, India
Telephone : +91-79-26912493
E-mail : atulshukla@sac.isro.gov.in

6.2 Description of the Proposal

The main part of the proposal should contain a summary (briefing the objectives, methodology, deliverables of the project and the time schedule), followed by a detailed description of the objectives and the scientific rationale being addressed. The data requirement and the analysis methods should be highlighted. The methodology or approach to be followed, the expected results of the project must be presented. Targeted schedule for various stages of the project must be indicated including the completion date.

6.3 Project Duration

It is expected that the project will be completed within 3 years. Projects will be evaluated and shortlisted by July, 2016. PIs are expected to present the results in a IRNSS user workshop to be conducted around as and when announced. PIs are also expected to publish the results from these studies in national/international peer reviewed journals and present their results in national/international conferences/symposia.

6.4 Personnel

The project may involve joint efforts involving many individuals from the concerned institution(s). However, only one PI will be recognized. Other participants could be designated as "Co-Investigators". PI/Co-Investigator shall provide Curriculum Vitae referring to educational qualifications, the work carried out in the related areas and list of

recent publications. The PI is responsible for ensuring timely completion of the project. The assurance of necessary administrative and fund utilization certificate to PI and Co-Investigators from Head of the Institution(s) is a must.

6.5 Facilities and Equipment

Describe available computer facilities and software packages in the home institution or in sister concerns that are accessible for the project.

6.6 Project Evaluation

It is proposed that a workshop will be conducted once in a year for the purpose of reviewing the progress of the AO projects and sharing the results with GNSS community. PIs of each project are expected to attend these workshops and brief about the progress of the respective project.

7.0 Terms and Conditions

SAC/ISRO reserves the right to revoke in part or in whole its support for a project at any time without assigning any reason.

- The data sets provided must be used only for the purpose specified in the proposal. The project personnel do not have the right to copy, lease or loan the satellite data without the prior permission of ISRO/DOS. Ownership and copyright of the data lies with ISRO. Also, this data is supplied free of cost purely for scientific research and it should not be used for any commercial purposes. Commercial use is defined as that involving the sale or resale of data, as well as data derived there from, for more than the cost of reproduction.
- The user will make available to the scientific community the salient results of the AO projects through publication in appropriate journals or other established channels. Acknowledgement of SAC/ISRO support must be made in all reports and publications arising out of the AO projects. Copies of all publications resulting from these research projects must be submitted to SAC/ISRO.

SAC/ISRO reserves the right to use the published results in its reports and publications with due reference to the publication.

- The PI is required to submit progress report every six months during the duration of the project. A detailed report is to be submitted during the mid-term and final reviews in soft copy form.
- The PI must maintain an inventory of data products received/ obtained under the AO project(s) and the data products must be deposited with the home institution after the end of the project.
- The declaration contained in the proposal format must be signed by the PI and Head of the Institution (Annexure 6). Otherwise the proposal will not be considered valid and is liable to be rejected.

8.0 SCHEDULE

Deadline for submission of proposals: **May 31, 2016**

Notification of evaluation results to Principal Investigators (PIs): **July, 2016**

Cover Page of the Proposal

Title of the Proposal

Name and Designation of PI

Telephone, Fax and E-mail Address

Name of Institution with full Address

Signature of PI with Date

Signature of Head of Institution

Announcement of Opportunity (AO) proposal

Submitted to Space Applications Centre (ISRO) on

Format of the Proposal

1. Title of the Proposal:
2. Name of the Principal Investigator:

   Institution:

   Telephone:

   Fax:

   E-mail:

   Mailing Address:
3. Summary of the proposed work
4. Details on the preliminary work done/background experience, if any
5. List of Publications in the related field
6. Description of the project

   - Title
   - Objective(s)
   - Scope
   - Brief Description of the Methodology
   - Schedule
   - Expected results and Applications
   - Deliverables (Algorithm/Software etc.)
   - Budget Required

7. Name of Co-investigator(s) in the AO project
   (Please include bio-data of all Investigators)
8. Available facilities and equipment at your institution

Format of Declaration

We have carefully read the terms and conditions of Announcement of Opportunity (AO) program for utilization of data of IRNSS/GAGAN and agree to abide by them.

It is certified that if the AO proposal is accepted and supported by the Space Applications Centre (ISRO), Ahmedabad, the facilities as identified in the proposal and administrative support available at our institution and needed to execute the project will be extended to the Principal Investigator and other Co-investigators.

We certify that the data products provided would be used only for the intended AO project. It is agreed that data products will be returned to ISRO in case the AO project does not progress / completed as scheduled.

Signature of PI with Name and Designation

Signature of Head of Institution with Name and Designation

Date:

Seal of Head of Institution