PS-08: Emitter Location Enhancement

1. General Description

The Problem Statement pertains to finding precise geographic location of a signal source or emitter. An emitter usually transmits radio frequency (RF) waves having fixed or multiple set of parameters based on technology. By capturing these parameters from a RF receiver, signal characteristic can be extracted and location of signal emitter can be estimated. This is achieved by the following:

- Collecting RF (Radio Frequency) signals from various geographic positions
- Estimating direction of the received RF signal by RF receiver along with other parameters
- Applying Triangulation method, to check convergence of received signal direction to a common point.

The captured RF signals are processed by the RF receiver and their basic RF parameters are estimated. Based on RF parameters, classification and segregation of RF signals of similar characteristics are carried out and triangulation method is applied to estimate the signal source location.

Normally, triangulation of collected RF signal gives a rough idea of signal source location and an area (**Probable Area**) is defined where the probability of locating the signal source is highest. This area could be large/ small which depends upon the accuracy of signal collected by the RF receiving system.

The accuracy of the receiving system requires constant calibration of the hardware, also it depends on stability of platform where the system is installed and RF interference. With these unavoidable circumstances, the location area estimated by the system are larger due to poor estimation of direction by the RF receiver and accuracy of signal location suffers. Improvement can be made in terms of post processing of collected data by applying different estimation algorithm/ model which could enhance the accuracy of signal location **in absence of good quality RF signal w.r.t to direction.**

2. Problem Statement

a. Identification and Classification of emitters along with their respective parameters.

b. Define and display the Probable Area on GIS platform where the probability of locating the signal source is highest.

c. Estimate the geographical coordinates of emitters based on Probable Area. Centre point of probable area will be considered as estimated geographical coordinates of emitter.

d. Enhance the accuracy of emitter location by defining smaller Probable Area.

3. Expected Outcomes

a. Stage-1: As mentioned in Problem Statement (expected Probable Area of Max **(20 X 20) Km** showcasing the convergence of direction of received signals. Probable area must contain actual emitter location during evaluation.)

b. Stage-2: As mentioned in Problem Statement (expected Probable Area of Max **(15 X 15) Km** showcasing the convergence of direction of received signals. Probable area must contain actual emitter location during evaluation.)

c. Stage-3: As mentioned in Problem Statement (expected Probable Area of Max **(10 X 10) Km** showcasing the convergence of direction of received signals. Probable area must contain actual emitter location during evaluation.)

4. Datasets. Datasets will be made available to participants as per below:

Stage	**Type of Dataset**	**Format**	**Datasets & Dates**	**Remarks**
Stage-1	Synthetic RF data with parameters	*.csv/ *.xlsx	Training T0 Mock T0 + 45 days onwards Shortlisting datasets on 30 Oct 2025 (one at 1000h and second at1400h) Holdout* T0 + 90 days onwards	01 Training set 04 Mock set (Testing) 02 Shortlisting set 01 Holdout set (evaluation)
Stage-2	RF Receiver data with parameters	*.csv/ *.xlsx	Training T0 Mock T0 + 60 days onwards Holdout* T0 + 120 days onwards	01 Training set 04 Mock set (Testing) 02 Holdout set (evaluation)

Stage-3 (Org Premises)	Real World RF data with parameters	*.csv/ *.xlsx	Training T0 Mock T0 + 75 days onwards Holdout* T0 + 150 days onwards	01 Training set 04 Mock set (Testing) 02 Holdout set (evaluation)

* Evaluation set will not be made available to participants.

a. In Training dataset, number of emitters and their parameter will be provided alongwith geographic locations. Participants to use this dataset to build their solution/ model accordingly.

b. Mock dataset will be made available half way from the start of each Stage during challenge. Participants to use mock dataset for self-learning and evaluation. 01 mock dataset will be made available every week to participants for 4 weeks starting from T0 + 45 days (Stage I) as mentioned in above table.

c. Participants to submit their results based on their solution within 24 hrs of release of each mock dataset. Submission must contain the followings:

- GIS layer depicting Probable Area (*.Geojson, *.kml, *.shp).
- Size of Probable Area.
- Estimated Geographical Coordinates.
- Number of emitters identified and their respective parameters.

d. Locations of emitter and their parameters will be declared. A leader-board will be announced and updated after each round of release of the mock dataset.

e. Shortlisting dataset will be used during last week of the stage where top 15-20 participants will be shortlisted based on evaluation criteria and will be called for final evaluation. **The results are required to be submitted within 4 hours from release of the shortlisting datasets**. The number may vary based on overall performance at the discretion of Jury of this Problem Statement. The shortlisted participants will be published alongwith the cutoff score as per the evaluation criteria. Participants individual scores will be shared over the email.

5. <u>Selection of 15-20 participants for offline-evalution in Stage-1:</u>

a. Results generated on the Shortlisting Dataset will be evaluated for final selection of 15-20 participants. Submissions found Incomplete in any manner will not be considered for further processing.

b. The results submitted against Shortlisting Dataset will be evaluated as per the metric given in the table below: -

Stage	Accuracy (50%)	Error Distance (30%)	Classification of Parameters (20%)
Evaluation	Would be graded when Probable area contains actual emitter location.	Distance between estimated geographic coordinates and actual coordinates (would be graded if accuracy criteria is achieved).	Segregation of emitters based on parameters.

c. **Best results out of the two shortlisting datasets will be considered for selection of 15-20 participants ..**

6. Evaluation at of Shortlisted Participants at the end of Stage-1.

a. The **on prem offline evaluation** of shortlisted 15-20 participants will be carried out on **holdout dataset** which will be given to the participants for demonstration of their solutions. The dates for this would be communicated to the participants.

b. **All participants will bring and deploy** an executable file (plug and play) or docker based solution on the on prem **Testing/ Evaluation Infrastructure** as under: -

- Work-Station class computer system having 01 GPU (40GB).
- Open source GIS platform (preferably free version of ArcGIS, QGIS) for visualization of dataset and output results.

c. The evaluation criteria with weightages as given in the table below, will be considered for selection of maximum 6 participants for Stage-2.

Stage	Accuracy	Error Distance	Classification of Parameters	Tech Approach	Solution Approach
Evaluation	Would be graded when Probable area contains actual emitter location.	Distance between estimated geographic coordinates and actual coordinates (would be graded if accuracy	Segregation of emitters based on parameters.	Technical approach towards solution.	To be based on the module/ mathematical approach.

		criteria is achieved).			
Stage1	40	30	15	10	5

7. **Evaluation Criteria for Stage-II and Stage-III** would be similar as above. Details would be released before the beginning of these stages. The participants will develop their solution based on datasets given at end of all stages and submit an executable file (plug and play) or docker based solution.

Input Output Format

Input format: *.csv/ *.xlsx

Output format:

1. A detailed write up covering Technical and Solution Approach along with team capabilities and resource utilisation in <Startup_name>.pdf file format.

2. GIS Layer depicting Probable Area in *.Geojson/ *.kml/ *.shp. Tabular data in *.xlsx format showcasing:

SNo	Target	Parameter 1	Parameter 2	Parameter 3	Coordinates (in degrees)	Size of Probable Area
1	Tgt 1	P1	P2	P3	Latitude, Longitude	(10 X 10) Km