Request for Proposal:
Numerical Weather Prediction (NWP) System for incorporating weather radar data

ISRO TELEMETRY TRACKING AND COMMAND NETWORK

INDIAN SPACE RESEARCH ORGANISATION

DEPARTMENT OF SPACE, GOVT. OF INDIA

BANGALORE -560058

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1 INTRODUCTION & OBJECTIVE

1.1. The ISRO Telemetry Tracking and Command Network (ISTRAC), the “Purchaser”, has issued this Tender Enquiry document for purchase of goods/stores/articles and related services as mentioned in "Request for Proposal (TENDER DOCUMENT)" which also indicates, inter alia, the required stores, delivery period, terms and conditions and place of delivery etc.

1.2. The proposed system shall ensemble several studies to be taken up at the regional level such enable based on high resolution weather forecasting. Acceptance shall be unconditional and vendors shall have no claim and right in future on their terms, if any.

1.3. The objective of this document is to solicit tender response from the interested vendors in India for “Numerical weather prediction (NWP) system for incorporating weather radar data” of ISTRAC/ISRO. The detailed Technical Specifications are provided in Section 3.

2 INSTRUCTIONS TO VENDORS

2.1 **Vendor Eligibility criteria**: Vendors who fulfill the following eligibility only will be considered for Technical Evaluation of bids.

a) Vendor shall be an Application Developer for Radar Data Processing / Data Visualization System & shall have good expertise in Software Development. Documentary proof shall be submitted along with the tender. OR

b) Vendor shall have installed Weather data Forecasting system / Weather Radar Data assimilation with model / Weather Radar Data Products system. Documentary proof shall be submitted along with the tender.

2.2 Pre-bid Meeting: The vendors are invited to attend Pre-bid meeting conducted ISTRAC on the date given in the tender noting.

2.3 All software and firmware source codes and installation kit containing actual deliverable software shall be provided.

2.4 Vendor is required to quote for 3 years warranty and application support.

2.5 Vendors are required to furnish clause by clause compliance of specifications bringing out clearly the deviations from specifications, if any. Otherwise their bid will not be accepted.

2.6 Delivery Period: 18 months from the date of release of purchase order.

2.7 The bidders shall send their clarifications/questions through email only. The vendor shall indicate their email ID clearly to enable ISTRAC to clarify their doubts/questions, if any. The clarifications questions shall be send to the following email:

Email: purchase@istrac.gov.in

2.8 **Documents comprising Tender:** The tender is to be submitted in Two Bid System. The "***Techno - Commercial Bid***" and "***Price Bid***" prepared by the vendor.

2.9 **Price Bid:** Price Bid shall be preferred as per price schedule format online.

2.10 Technical Evaluation:

2.11.1 Vendor is required to submit the detailed technical proposal except price. If any price information is disclosed anywhere in the techno-commercial bid, bid will be disqualified

2.11.2 Tenders shall be evaluated to assess the technical suitability of the bid with respect to the terms and conditions of the RFP by ISTRAC.

2.11.3 If during the preliminary examination, ISTRAC finds any minor deviations/irregularity and/or non-conformity regarding technical evaluation in a tender, ISTRAC has the right to accept or reject may waive the same provided it does not constitute any material deviation, system performance and has no financial impact and, also, does not prejudice or affect the ranking order of the vendors.

2.11.4 Wherever necessary, ISTRAC will convey its observation on such 'minor' issues to the vendor seeking vendor's response by a specified date. If the vendor does not respond by the specified date or provides evasive/incomplete reply without clarifying the exact point in clear terms, that tender will be liable to be ignored for further processing.

2.11.5 During technical evaluation, ISTRAC committee reserves the right to visit the vendor premises for assessing the technical capability.

2.11.6 Technical presentation in the presence of the committee shall be held in ISTRAC, Bangalore, if required. The ISTRAC will seek proof of capabilities claimed in the compliance matrix provided by the respective vendor. ISTRAC will seek clarifications on the design, performance and other technical points during the presentation. All points will be recorded.

2.11.7 Vendor must attach detailed data sheet of quoted Model/product along with relevant information brochures, wherever applicable in the technical bid

2.12 ISTRAC shall evaluate the price bids of technically qualified vendors for deciding lower vendor (L-1) on the basis of ultimate landing cost including all the deliverables, software and warranty as per tender. L-1 will be computed based on the total landing cost with 3 years warranty

2.13 This contract shall be governed in all respects by Indian Laws.

3 SPECIFICATIONS OF NUMERICAL WEATHER PREDICTION (NWP) SYSTEM FOR INCORPORATING WEATHER RADAR DATA

3.1. The scope includes weather data assimilation and generating forecasting products using weather radars & other sensors in the specified computing system as given in Table 3 using WRF modeling framework and ICON modeling framework. The top level requirements are provided in Table 1 and Table 2 for WRF modeling framework and ICON modeling framework respectively, which shall be implemented by the vendor in the computing system.

Table 1 Top level requirements for WRF modeling framework

Sl. No	Requirements
1.	Supply and install Weather Research and Forecasting (WRF) framework in computing system as given in Table 4.
2.	48 hrs forecast of a 9 km × 9 km (183 × 183 grid points) resolution nested WRF simulation Forecasts shall be generated for South West Indian region comprising Kerala and Arabian Sea and South East Indian region comprising Tamil Nadu, AP and Bay of Bengal.
3.	50-member ensemble simulation at 3 km x 3 km (183x183 grid points) resolution for 2days (48hrs) simulation. Forecasts shall be generated for South West Indian region comprising Kerala and Arabian Sea and South East Indian region comprising Tamil Nadu, AP and Bay of Bengal. Simulation runs to be completed in less than 200 minutes for a range of 550kms.
4.	Configure computing system to meet all the models performance requirements
5.	Demonstrate all the features of WRF with sample data sets
6.	Develop the following assimilation methods: Three-dimensional variational methods (3D-Var); Four-dimensional variational methods (4D-Var); Ensemble Kalman filter (EnKF) and Hybrid method (3D/4D-Var + EnKF).
7.	ISTRAC shall provide 5 weather radars data and 3 satellites data as the input

	source. Vendor shall assimilate weather radars, satellites and model data for forecast lead time of 12hrs to 120hrs.
8.	Use digital filters and Newtonian nudging techniques to assimilate radar observations without considering the physical processes involved
9.	Create the initial conditions for an NWP model (state of the atmosphere) and lateral boundary conditions
10.	Carry out pre-processing steps which include the generation of grids and external parameters as well as the remapping of initial conditions.
11.	To carry out horizontal remapping of the prognostic output onto regularly spaced ("longitude-latitude") grids and vertical interpolation
12.	To carry out interpolation of model data from the mesh onto a regular longitude-latitude grid
13.	Use diabatic digital filter initialization which adjusts latent heating based on radar reflectivity
14.	Integrate the below major programs for the WRF Modeling System : The WRF Pre-processing System (WPS); WRFDA for radar data assimilation (3D-Var and 4D-Var); ARW solver & Post-processing graphics tools
15.	Convert the weather radar data files into the required file format for the above applications / models.
16.	Ingest the weather observations in the model as per the model required formats
17.	As our radar is giving volume scan data at every 5 mins step, output from WRF like Temperature and all will be utilized for producing effective QPE, VIL, Hail products and radar quality control algorithm.
18.	Carry out performance logging for different parts (setup, physics, dynamics, I/O) of the code.
19.	Carry out performance evaluation and validation of forecast output from these two applications vs Real time DWR output and generate comparison report
20.	To test the correctness of particular aspects of the model, by comparison with real data, comparison with analytic reference solutions or by comparison with results from other models.

Table 2 Top level requirements for ICON modeling framework

S. No	Requirements
1.	To supply and install ICON (ICOsahedral Nonhydrostatic) modeling framework, which is a unified next-generation global numerical weather prediction (NWP) and climate modeling system.
2.	Main forecasts shall be performed 4 times a day at 0, 6, 12, 18 UTC, covering a forecast time span of 180h for the 0 und 12 UTC runs and 120h for the 6 und 18 UTC runs upto a range of 500kms
3.	Additional short-range forecasts are performed at 3, 9, 15 and 21 UTC upto a range of 500kms
4.	To execute simulations with horizontal grid spacing of 13km and 90 vertical levels
5.	To download model forecast data sets publicly available from Online Data Services
6.	To convert and ingest the ISRO weather radar data files into the required file format for the above model (GRIB and NetCDF).
7.	To carry out pre-processing steps for ICON (without limited area mode) which include the generation of grids and external parameters as well as the remapping of initial conditions.
8.	To carry out lateral boundary conditions, when running ICON in limited area mode (LAM)
9.	To test the correctness of particular aspects of the model, by comparison with real data, comparison with analytic reference solutions or by comparison with results from other models.
10.	To carry out horizontal remapping of the prognostic output onto regularly spaced (“longitude-latitude”) grids and vertical interpolation
11.	To carry out check pointing feature which allows to restart the execution from a pre-defined point using the data stored in a file
12.	To carry out interpolation of model data from the triangular mesh onto a regular longitude-latitude grid
13.	To carry out parallel execution of the ICON model. This is important for performance scalability when increasing the model resolution and core counts.

14.	To carry out performance logging for different parts (setup, physics, dynamics, I/O) of the code.
15.	To carry out performance evaluation and validation of forecast output from these two applications vs Real time DWR output and generate comparison report

3.2 The following Table 3 provides the minimum computing system configuration to run above simulations, however, vendor shall suggest the required computing system configuration to achieve peak computing power of 18 teraflops or better computations and Vendor shall procure the suggested computing system.

Table 3 Specifications of computing system

Sl No	Parameter	Specifications
1.	Processor	The Vendor shall quote for 8 Nos of Intel Xeon / AMD latest processor with minimum 32 physical cores and 2.1GHz base clock frequency or Better
2.	Memory Slots	The server should be provided with 96 DIMM slots or better.
3.	Memory Configuration	Server should be configured with 6 TB DDR5 RAM or better (48 Nos of 128 GB DIMM) and Minimum 48 slots should be free for future scalability.
4.	Raid Controller	The server should be provided with Raid controller, 12Gb SAS connectivity with Support for hardware all RAID configurations. Raid support for RAID 0/1/5/6
5.	Internal disks	OS disks 2 X 960GB NVME Drive in RAID-1 Minimum 4x 7.68 TB NVME or higher internal drives should be provided in RAID 5.
6.	GPU	Vendor shall quote 2 Nos of GPU cards for computational accelerations with all required GPU enablement kit with minimum 48 GB Memory or better.
7.	OS Support	The hardware platform shall support the following OS: AlmaLinux OS, RHEL, SLES, Oracle Linux/UEK, VMware, Windows Virtualization technologies: VMware vSphere,

		RHEV, KVM and Microsoft Hyper-V."
8.	Compilers & Libraries	Intel latest Edition for Linux (free edition)
9.	Ethernet	i. The server should be configured with the below Network Ports. • 4x 10Gb Copper Ports • 2x 10/25G SFP28 and MM fiber cables All network ports should be distributed across redundant PCI cards. ii. All required transceivers should be provided.
10.	Management	i. The server should provide built-in tools to manage hardware and provide mission-critical system availability (inventory, monitor, diagnose, configure, maintain, and self-healing) ii. The server management architecture should make it easier for users and applications to manage the system (inventory, start, stop, connect console, and so on)
11.	Server RAS	i. The server should provide Predictive fault handling feature that monitors server resources continuously and predict hardware faults, and initiate self-repair without operator assistance. ii. System should provide error containment at the firmware level, including memory, CPU, or I/O channel errors, before any interruption can occur at the operating system layer.
12.	Server	Mission Critical Enterprise Class server to be Quoted with high level of Reliability, availability and serviceability features
13.	Certifications	The offered server shall be certified for Latest version of RHEL, Windows Server. The URL for OS certifications by respective OS OEM for the supported hardware- list shall be provided for each platform along with the offer.
14.	PCIe support& direct IO	The server must support PCIe 5.0 and Direct IO implementation from all CPUs for unblocking, best performance and low latencies
15.	Operating System	One Red Hat Enterprise Linux (latest version) server license with Kernel Virtual Manager, one Windows server latest

		version.
16.	Power	Vendor shall quote for suitable power supply in N+1 configuration to support full load condition with 2nos of GPU enabled.
17.	Support services	Comprehensive 5 years NBD Replacement support

4 GUIDELINES AND OTHER TERMS & CONDITIONS

4.1. Place of Delivery: ISTRAC Bangalore

4.2. An undertaking (self-certificate) is to be submitted that, the vendor hasn't been blacklisted by any central/state government department and is not under any illegal expression of Govt. of India.

4.3. The scope of the work involves radar data assimilation, processing, formatting and weather forecasting by the vendor. The vendor is tasked with conducting all aforementioned activities at ISTRAC, utilizing Radar and satellite data provided by ISTRAC under non-disclosure agreement. It will be the responsibility of the vendor to install, commission, and integrate the whole system and demonstrate it at ISTRAC Bangalore

4.4. Complete technical details, design document, software, third party device drivers and other blueprints about the system/subsystem shall be handed over to ISTRAC/ISRO.

4.5. ISTRAC shall retain the absolute rights and intellectual property rights (IPR) of all the outcomes (including source code, documents and reports, etc) during the work tenure.

4.6. The activities need to be completed in a time bound manner and the progress of the same will be monitored by ISTRAC periodically and the status report shall be submitted.

5 LIST OF DELIVERABLES

The List of deliverables is as per Table 3.

Table 4: List of Deliverables

S.No	List of Deliverables:
5.1.	Numerical weather prediction (nwp) system for incorporating weather radar data as per Technical specifications in Section 3 including all the computing system (Table -3) and related software's.
5.2.	Software and firm wares, GUI Project Files and executable, etc
5.3.	User Manual, ATP, Test Reports, Technical Manual, Programming Manual, SRS, SDD, Software/Firmware Design Document including algorithm and flowchart, Troubleshooting Documents
5.4.	Detailed documentation of all the proprietary data formats, bit-by-bit information on the header and data patterns should be provided.
5.5.	All software should be developed by the vendor and executable/source code to be provided

6 SOFTWARE PROCESS

The source code of application software/firmware should be supplied and follow ISRO Software Development Process (ISPD) or equivalent and should be supplied with ISRO standard documentation. Any upgrade in software during the warranty period should be supplied free of charge.

7 PRLIMINARY DESIGN REVIEW

The preliminary design reviews will be held at ISTRAC Bangalore after the release of purchase order where in the design of hardware & software to be delivered as part of the system will be discussed.

8 ACCEPTANCE TESTS

The deliverables will be accepted only after obtaining successful technical performance as per the specifications. ISTRAC shall appoint Committee/Engineers to carry out Acceptance Tests. The test plan shall require approval by the ISRO. Site Acceptance Tests (SAT) shall be

undertaken by ISTRAC based on mutually acceptable terms and condition. SAT documents shall be submitted to ISTRAC two weeks before SAT test.

9 WARRANTY/GUARANTEE

Thirty six months warranty from the date of acceptance at ISTRAC shall be provided. In case of any modifications/ tuning of model as required in software/firmware and documents delivered by the vendor, the vendor shall rectify the same at ISTRAC premises at vendor's expense.

10 COMPLIANCE STATEMENT

The vendor shall submit detail point-by-point compliance statement of these tender mentioning full details with reference Para, Clause and page no. for each parameter along with reasons for compliance/ non-compliance, if any. Silence on any paragraph or simply making a statement 'complied' without proper justification or reference will not be considered. All the claims with respect to any specification shall be supported by document along with bid document otherwise same may be treated as non- compliance. Compliance matrix should be filled in at all points of tender document individually.

11 PAYMENT

11.1	70% payment against the hardware delivery and installation
11.2	30% payment against SAT clearance of application and hardware by ISTRAC

In case of any different payment terms proposed by vendor, the same will be discussed during tender evaluation process.