

A Report On
Industrial Visit
National Atmospheric Research Laboratory (NARL),
Gadanki, Pakala, Andhra Pradesh 517112
Organized by
Department of Artificial Intelligence and Data Science
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Submitted by : Mr. K Durga Charan, Assistant Professor of AI&DS.

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Attended Students and Faculty: Participants including students, and faculty.

Faculty From AI & DS : 2 (Female + Male) Mrs. Manjula Prabakaran, Asst. Professor & Mr. K.Durga Charan, Asst. Professor

Artificial Intelligence Students: 12 (3-Female + 9-Male)

Data Science Students: 58 (30-Female + 28-Male)

Overview of NARL:

NARL is an autonomous research laboratory fully funded by the Department of Space, Government of India and involved in carrying out fundamental and applied research in Atmospheric and Space Sciences. It had its humble beginning in 1992 as the National Mesosphere-Stratosphere-Troposphere (MST) Radar Facility. Over the years several complementary techniques such as Rayleigh/Mie lidars, wind profilers have been added. NARL is administered by a Governing Council with Secretary, DOS as the Chairman and Director, NARL as member secretary. The Governing Council sets broad policy guidelines for NARL. A Scientific Advisory Committee consisting of eminent scientists in the field of atmospheric science, monitors the research activities and progress of NARL and provides future directions.

NARL has now become one of the prime centers for atmospheric research in the country and operates a state-of-the-art MST radar, Rayleigh/ Mie Lidar, Boundary Layer Lidar, Sodium Lidar, Lower Atmospheric Wind Profiler, Sodar, Disdrometer, Optical Rain Gauge, GNSS-NavIC receiver, Automatic Weather Station apart from regular launching of the GPS Radiosonde. Being relatively young, NARL's research activities are spearheaded by a team of young and vibrant full-time research scientists and students. This web site provides some salient features of the activities and experimental facilities available for national and international collaborative research work.

Scientific Facilities visited:
Facilities available in NARL



ICON	 A tall, multi-story concrete tower structure, likely the ICON facility, standing on a hillside.
GPS RadioSonde	 A large, multi-story building with a white dome on the roof, likely the facility for GPS RadioSonde launches, with a white balloon being launched into the sky.
Disdrometer	 A cylindrical instrument with a yellow top, mounted on a metal base, likely a Disdrometer used for precipitation measurement.

Scientific Facilities visited MST Radar:

The MST radar located at Gadanki is an excellent system used for atmospheric probing in the regions of Mesosphere, Stratosphere and Troposphere (MST) covering up to a height of 100 Km. It is also used for coherent backscatter study of the ionospheric irregularities above 90 km. MST radar is a state-of-the-art instrument capable of providing estimates of atmospheric parameters with very high resolution on a continuous basis, which is essential for the study of different dynamical process in the atmosphere. Radar operates at 53 MHz with a peak power of 2.5 MW. The phased antenna array

consists of two orthogonal sets, one for each polarization of 1024 three element Yagi-Uda antennas arranged in a 32 x 32 matrix over an area of 130 m x 130 m. The two sets are co-located with pairs of crossed Yagis mounted on the same set of poles. The array is aligned along the geomagnetic axes to enable the radar beam to be transverse to the Earth's magnetic field for ionospheric backscatter application. The array of either of the polarizations is illuminated using 32 transmitters of varying power, each feeding a linear sub-array of 32 antennas. The power distribution across the array follows an approximation to modified Taylor weighting in both principal directions. The radar beam can, in principle, be positioned electronically at any look angle within ± 200 off-zenith in the East-West and North-South planes. It is possible to transmit both coded and un-coded pulses with pulse repetition frequency in the range of 62.5 Hz to 8 KHz, with a maximum duty of 2.5 %. Coded and un-coded pulse can be varied from 1 to 32 μ s with a baud length of 1 μ s providing a range resolution of 150 m. The radar operates under instruction from a PC based radar controller that executes an experiment according to the experimental specification set by the scientists. Both time series and power spectrum data can be recorded on-line. The recorded data can be processed offline to derive various atmospheric parameters



GPS Radiosonde

NARL launches GPS radiosonde (RD-11G, Meisei make) every day around 1730 LT (12 UTC). It provided profiles of Pressure, Temperature, Relative humidity, Wind Speed and Wind Direction up to the balloon burst altitude typically 30-35 km. These are being launched regularly since April 2006. The RD-11G ground station is designed for the Upper Air Observing System using the D- GPS (Differential Global Positioning System). The GPS receiving device in a Radiosonde tremendously improves observation accuracy, thus allowing the GPS ground station simplified and compact. The RD-11G Upper Air Observing System consists of a radiosonde receiving antenna system, GPS receiving antenna, GPS Sonde Receiver, and the data processor, PC computer which is connected to a networking subsystem via a TCP/IP. The system is also provided with the Base Line Checker (BLC) used for ground check before launching a radiosonde. The GPS receiving device in a radiosonde obtains information on the direction and the velocity of the GPS satellite with the frequency deviation of radio signals from the satellite due to the Doppler shift and transmits the positioning information of the radiosonde to the RD-11G ground station. Upon receiving radio signals from the radiosonde, the RD-11G ground stations processes the data obtained by the radiosonde and GPS satellites to observe wind direction and wind speed in the upper air



HPC Facilities:

We visited the High-Performance Computing (HPC) Lab Facility in NARL, high performance computing cluster facility for accelerating analysis of genomics and transcriptomics data is available.

This facility comprises with the following Configurations

- 96 Parallel processing
- 200TB of RAM
- 200GBPS Connectivity
- 2 petabytes of Data Storage
- 32GPU's

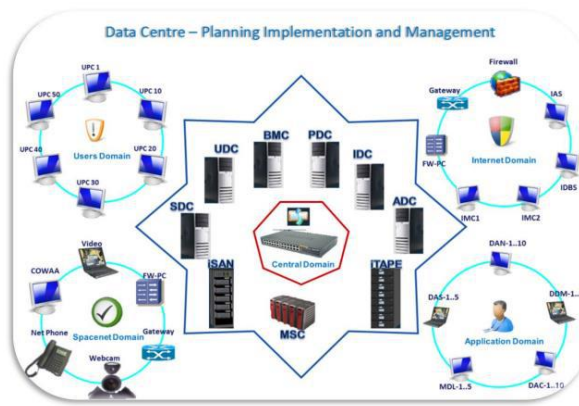


NARL data center:



Domain creation

The data flow and management would be centrally controlled by a server known as Primary Domain Controller (PDC). The PDC would ideally control other servers like User Domain Controller (UDC), Backup Management Controller(BMC), Internet Domain Controller(IDC), Spacenet Domain Controller(SDC), and Application Domain Controller(ADC). The central domain contains these aforementioned servers along with low-cost supercomputer for modeling, iSAN as secondary data storage and iTAPE as tertiary storage. The iSAN would contain 150TB of data storage capacity. The BMC will be assigned to take auto backup from the iSAN to the iTAPE periodically with a predefined policy



Central Domain: It comprises of 250TB Storage system, configured in 3-Tier D2D2T architecture with Raid5, LTO4.

Users domain: User Domain is being maintained by UDC of central domain. UDC in turn manages 50 user PCs viz UPC 1..50. UDC will have the policies for individual users to access the iSAN server with security privileges. Users sitting in any of the UPC 1..50 would request data electronically . Upon approval from UDC, data would be shared immediately from the iSAN for which no copy need to be done to the UDCs.

Application domain: Application Domain will be maintained by ADC of central domain. The ADC will contain all the required policies regarding Data Analysis, Data Archival, Data Assimilation, Data Modelling and Data Dissemination.

For L1 data analysis data center will use DAN1..10 PCs and generate L2 and L3 processed data. These data will be stored with a quality control stamp to the iSAN and L3 will be allowed to be published by IDC to the internet.

L1 data product will be generated and temporarily stored in the primary storage viz DAC1..5. Data center will pick up these data thus collected everyday periodically and does the quality check on the data.

Once the DAC1..5 data is validated, DAN1..10 would work on them to store and publish them on internet.

Similarly data assimilation for the modeling will be done through DAS1..5. These servers will work on the numerical algorithms and parameterization for several models. Then they will request the MSC of data center to use these parameters.

MDL1..5 will ask the MSC to run a particular model with the corresponding parameters from DAS1..5. In turn MSC will take the stored data in the iSAN, act upon them and the result thus produced will be given back to the MDL 1..5.

DDM1..5 will be used to parallel access user requested either L1, L2, L3 data and backup them in either tape or DVD as requested by the user.

Internet domain: Internet Domain will be maintained by IDC of the central domain. IMC1 and IMC2 known as internet management console will define the policies for the data in the iSAN. Internet Database Server (IDB) will maintain database for the internet user access and other downloading / uploading related issues.

Internet Application Server (IAS) will contain the application logic for the data uploading and FTP related issues. Firewall PC and Firewall Hardware will be used for Traffic policy control, HDCP, DNS, SSL-VPN configurations, web rule policies, antivirus and anti-spam policies, Secured Client access to the LAN . Router Gateway will provide access to a high speed 2Mbits line to the internet.

Space-net domain: Space-net domain will be maintained by Space-net Domain Controller (SDC) of the central domain. SDC will route to ISRO server. SDC will further cater the policies of separation for the INET domain. The IP Phone and Webcam will be facilitated to have proper audio-video link to the head quarters and other DOS centers. At present COWAA server management can be done by SHAR through SDC. In future SDC will also aid towards paperless office management of DOS and their central data management feature. Data Center handles

Data retention & dissemination policies

Data Pre-Processing Module: Facilitate users to procedurally Clean, Integrate, Select and Transform data

Data Upload Module: Facilitate users to Buffer, View and Registering files and folders

Meta-data Search Module: Facilitate users to search based on Atmospheric condition, Filename, Time

Data Analysis & Quality tagging Module: Process and generate L2 & L3 data, tag Data quality information

Data View & Download Module: Facilitates Data Visualization at Cycle to Frame level

Management Modules: User Management, Type Management, Complaint & Rights Management

20GB metadata for Search Performance Optimization: It handles 50TB of data from 21 different instruments with file size from KB to GB with at varying Transparencies.

Database Design: It includes SQL performance Tuning, Normalization, Relationships, Views, Keys, Stored Procedures, UDF, Cursors, Triggers and Indices 30 servers realize total IT Setup by Data Centre

Data Access over Intranet: Any user scientist either internal or external is being provided with the computational facility at the DPR (data processing room). NARL is well connected with fiber optics network and WiFi. Every user-scientist is provided with a Data-center login on <http://datacenter.narl.res.in> over intranet only, due to security and bandwidth reasons. Each user has conditional access to the data center, which is based on predefined policies. These policies are defined and recommended by the data[1]approval-committee.

Data products: NARL datacentre provides an easy web-based user interface to retrieve any or all data from datacentre. User can access all the three levels of data viz. L0 (Raw data), L1 (Level1 processed data), L2 (Level2 Processed data). L0, L1, L2 data is archived in the raw (.bin) format. After logging in, user need to search, preview & select the required files. Files can be individually downloaded over http or group downloaded by ftp. The data is availed directly to the intended memory-drive or hard-drive of the user. This download can be done either in binary format or in Ascii/Text/NetCDF format.

Online access to Virtual Data center over internet: <https://www.narl.gov.in> Here user can collect the daily wind derived from MST radar observations in either Binary(.bin) or ASCII format. MST Radar L2 product known as MST Moments is also available at this site. This is a virtual server which is mapped to an actual data centre server over intranet, providing a secured data access mechanism. Online access to Virtual

Students Visited status in NARL website:



College/Institution/University Name	Number of Persons	Date Visited on
Madanapalle Institute of Technology & Science	72	16 December 2022
Easwari Engineering College	52	09 December 2022
Annamacharya Institute of Technology and Sciences, Autonomous (AITS)	54	02 December 2022
Madanapalle Institute of Technology & Science	60	02 December 2022