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SYSTEM OUTREACH OF INDIGIS - AN INDIGENOUS TECHNOLOGY FOR MIL APPLICATIONS

Technology Focus focuses on the technological achievements in the organization covering the products, processes and technologies.

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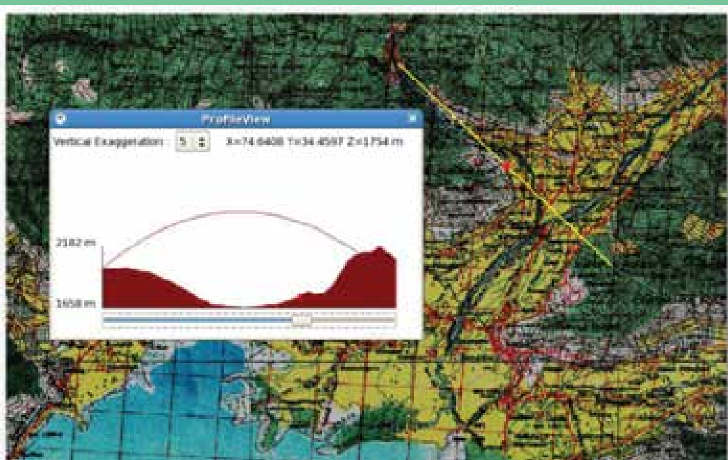

Crest Clearance

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Local Correspondents

From the Desk of Guest Editor

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A Geographic Information System (GIS) is capable of visualising digital maps, electronic navigation charts, and air navigation charts. GIS has now become the front-end system for net-centric operations, providing the much-sought terrain information and visualisation of different Order of Battle (ORBAT). The visualisation of the deployment of forces in the form of own ORBAT, enemy ORBAT, weapon ORBAT, and electronic ORBAT gives the commander an overview of the battle. It helps in operation planning, execution, post-execution analysis, and helping in reducing the battle attrition. In effect, GIS has become a collaboration tool, integrating information exchanges between platforms, sensors, and weapon systems on one hand and multiple decision-makers on the other hand.

Often this technology is proving to be a key decision support aid in spatial and temporal analysis of the battle. It can visualise the current state by depicting the real-time tracks and the sphere of influence of any weapon or sensor system. It has also emerged as the platform for many simulations involving moving entities that are constrained by terrain features. Therefore, the ability of a GIS to be customisable for integrating sensor-generated data or for enabling customisation of its computation modules is important.

For these reasons, the INDIGIS developed by Centre for Artificial Intelligence and Robotic (CAIR) has proved to be a preferred choice of many sensor development projects of various DRDO laboratories. INDIGIS has been integrated with many indigenously developed sensors, e.g., Radar, SONAR, LiDAR, MSS, CAMOP, etc. To scale up the adoption and proliferation of INDIGIS, CAIR has had to leverage industry partners via the ToT mechanism. This edition of the *Technology Focus* brings out how INDIGIS as a technology has been (and continues to be) transferred to the Indian industry for building capacity and capability for its proliferation. The software ToT process has been discussed to put forward to the reader the salient nuances of software technology transfer and bring out an analogy with the usual technology of transfer. INDIGIS has been transitioned to the industry as a 'capital good' to be leveraged for downstream product development, rather than as a specific product that has to be productionised as-is. It is expected that this will lead to more varied utilisation.

Dr Subrata Rakshit

OS & Director, CAIR

SYSTEM OUTREACH OF INDIGIS - AN INDIGENOUS TECHNOLOGY FOR MIL APPLICATIONS

INDIGIS Technology

Centre for Artificial Intelligence and Robotic (CAIR) has developed many Command and Control (C2) Systems, Command Control and Communication (C3) Systems and Tactical Command Control Communication and Intelligence (Tac C3I) Systems for various Armed Force users. To name a few, Artillery Command Control and Communication System (ACCCS), Battle Field Management System (BMS) and Command Information and Decision Support System (CIDSS). A common factor of all these Operation Information System (OIS) is terrain information which is available in digital form as spatial information through a Geographic Information System (GIS).

A GIS is a collaborative information system which helps in visualisation, analysis and measurement of spatio-temporal data associated with land, sea and space. Most of the GIS systems used in Tac C3I systems were Commercial Off-The-Shelve System (COTS) originating from foreign Original Equipment Manufactures (OEMs.) The COTS GIS available in market are licensed and hence have significant license cost and license-based usage restriction. Also most of the COTS GIS are non-interoperable in the sense that while they may import spatial data from many sources and formats, but export in only their own native formats preserving full functionality. Also most of the COTS GIS are not able to display the Indian military grid reference. Another aspect of COTS GIS are that they are Windows OS and Intel CPU (WINTEL) compatible and are not available in many other platforms as may be required for security or reliability considerations. In addition to these, the COTS GIS were not so flexible to customise to accommodate the user specific workflow and are often subjected to the risk of technology denial. After many successful customisations of COTS GIS and their delivery to users, it was felt that most of these customisation efforts and intellectual wealth generated by the scientists in customising the COTS GIS were going futile as the core of the GIS was undergoing change or because of merger and accusation of the COTS GIS by other OEMs.

Therefore, to overcome the above pitfalls, CAIR undertook a technology demonstration project named 'Development of Indigenous Geographical Information System for Military Applications'. The resulting outcome of this project is the Indigenous Geographic Information System (INDIGIS) technology which is a platform for customisation and integration of various military applications. This technology is available in the form of a Software Development Kit (SDK) making it available to the application developers through 500+ Application Programmer Interface (API) and is available in LINUX, Windows and Android OS. This indigenous GIS is available in desktop and client/server platforms.

INDIGIS project was sanctioned in 2007 which resulted in development of indigenous GIS kernel named as 'INDIGIS' which is available to the DRDO community and user community in the form of a SDK. Both as a validation and as a concrete guide, an application called INDIGIS having 136 different end user military functions was also developed as part of the TD project itself.

The SDK has roughly 500 APIs, user manual, installation manual and programmer's manual. After the successful completion of the project, INDIGIS was installed in Indian Army and Indian Navy formations for couple of years and users' feedback was taken for its operational utility. Some of the unique functions which were developed during 2012 to 2015 were found very useful in field exercises of Indian Army and Indian Navy. Some of the unique functions of INDIGIS was so useful that many DRDO projects came forward to

Projects using Indigenous GIS Technology

make use of the indigenous GIS in different context integrating to different systems. The list of such projects using the indigenous GIS is depicted in Figure. Looking at its usefulness and utility in various projects, Bharat Electronic Limited (BEL), Bangalore, took the first ToT of INDIGIS technology in 2018. BEL successfully integrated this technology in 15 different systems under production and deployed as many as 100+ field licenses in user sites based on the unique capabilities of INDIGIS in visualisation and rendering of large volume spatial data in the form of digital maps, bathymetric charts and long distance navigation charts.

Besides these, INDIGIS has been designed to have many unique relevant capabilities.

- Seamless visualisation of land and sea maps (Topo-bathymetry surface unified datum, projection and co-ordinate system) for amphibious operation planning
- Measurements of location, distance, direction, height, slope aspect, curvature of terrain surfaces in different datum and units
- Simulation of 3D perspective view, fly-thru view and orthographic view of terrain
- Creation and manipulation of operation overlay using (customisable) Indian military symbols and the subsequent transmission of the encoded operation overlays between nodes
- Spatio-temporal query in the form of spatial query, temporal query, buffer zone analysis and iterative and cascaded query of both terrain data and operation data
- Large scale visualisation of sensor data and its real-time updating
    - Integration with GPS, INS, RADAR, LiDAR, SONAR and UAV
    - Depiction of UAV video overlaid of satellite image and digital maps for surveillance
    - Support for enabling manually assisted auto geo-coding for UAV videos that are lacking in inherent digital geo-coding telemetry data is currently being added
- Support for various military maps in use by Indian Armed Forces

INDIGIS – Advanced Features and Capabilities

INDIGIS is a suite of GIS components, developed indigenously by CAIR, Bengaluru. INDIGIS component suite is a set of GIS libraries, which are customisable, scalable and data centric, and cater to the specific GIS requirements of a collaborative defence environment. The features and capabilities of the library are depicted in the Figure.

INDIGIS libraries can be customised to build Military GIS applications to facilitate planning, executing and supporting of operations.

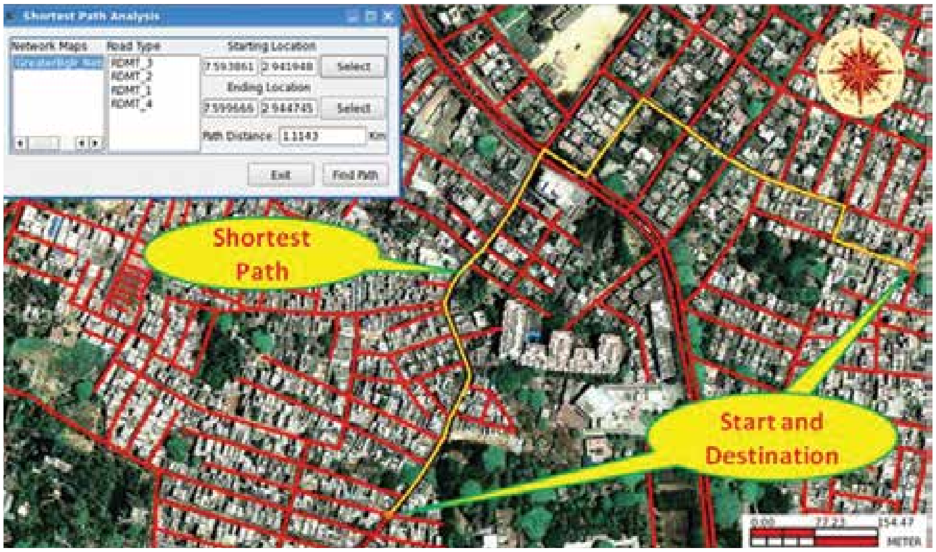
Advanced Features and Capabilities of INDIGIS

Decision Support Aids

INDIGIS supports set of functionalities which provides advanced spatial decision support to the users. Functionalities under this category are mainly composite functions which involve terrain analysis, spatial and attribute query analysis, buffer generation and spatial computations. User can perform shortest path analysis, site suitability analysis, radio line of sight analysis, crest clearance analysis and cross country path analysis.

Computing Shortest Path between Two Locations

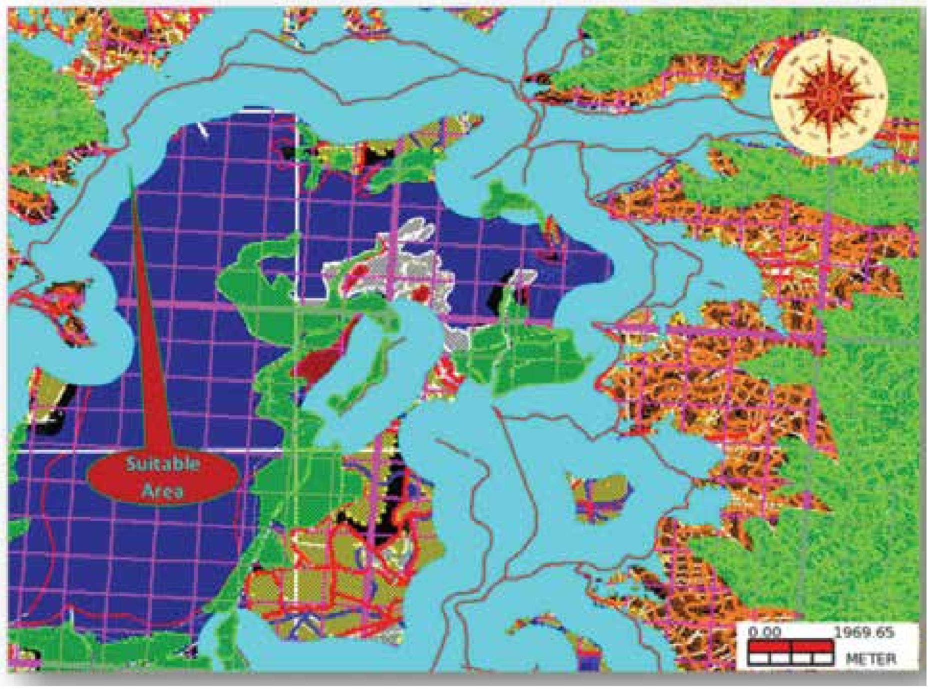
Shortest path analysis can be used for computing the shortest path and distance between two user-selected locations on the map as shown. A network map (generated with build topology tool) covering the area of interest should be opened in the map window prior to perform this analysis. User can open a network map of the area of interest using open map file menu. Once the network is loaded in the map window, the nodes and edges will be displayed in the view. User can switch off these layers to avoid the cluttering. However, node and edge layers should be loaded in the map window to perform any network analysis operation.



Shortest Path

Finding Suitable Sites

Site suitability analysis enables the User to identify suitable area based on the input criteria. This functionality can effectively be used for locating suitable areas for a helipad construction, staging, weapon/sensor deployments, etc. INDIGIS supports area suitability functionality on cross-tile surfaces and multiple vector maps having different coordinate systems seamlessly. That means, data sources – elevation images (DTED/DEM/IEF/HGT, etc.) and vector layers (DGN/DVD/SHP/IVF, etc.) can have heterogeneous projections and formats. There is no need for transforming the data to a common projection or mosaicing/merging the data explicitly; it works transparent to the User.



Suitable Site Analysis

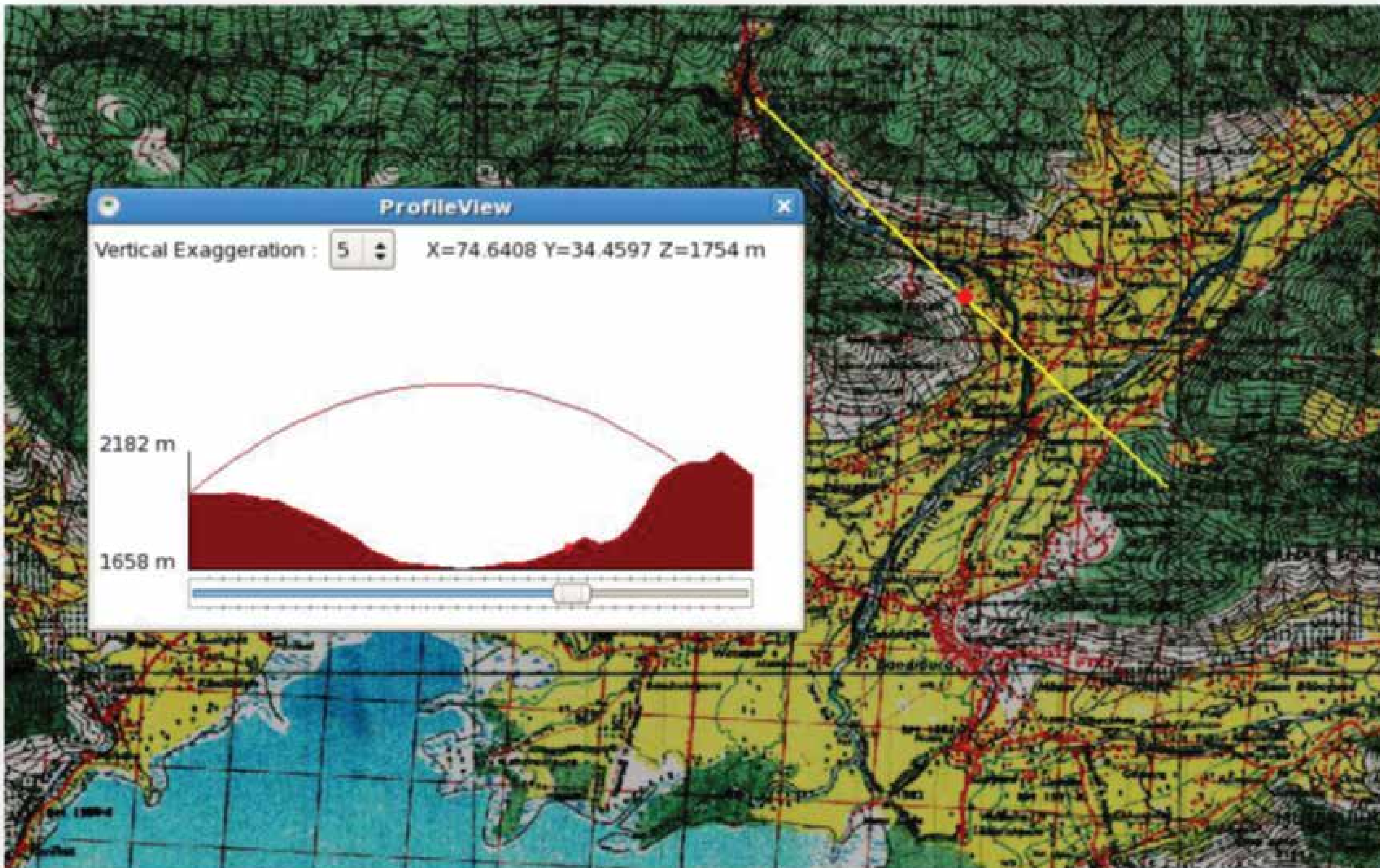
Computing Radio LOS Between Two Points

Radio LOS functionality allows the user to compute the radio line of sight between transmitter and receiver located at two points. The algorithm considers the characteristics of the transmitter and receiver like gain, power, sensitivity and signal frequency, cable loss, etc. K factor value corresponding to the earth curvature and atmospheric conditions is also required. It computes the RLOS based on these inputs and the actual terrain elevations along the line between Tx and Rx.

Radio Analysis

Computing Crest Clearance

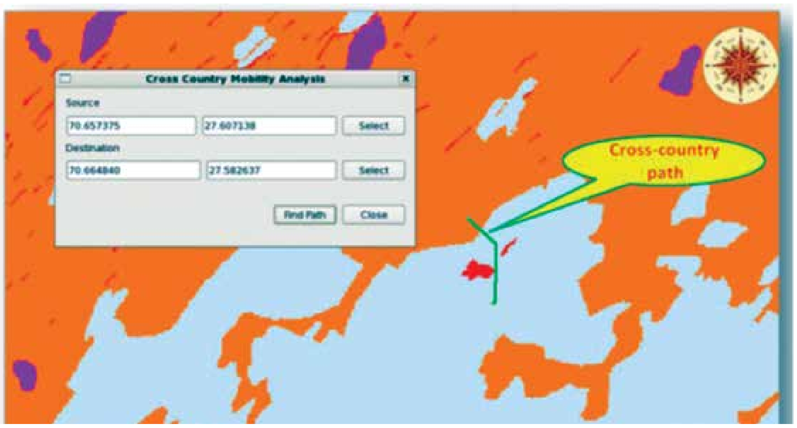
This functionality allows the user to view the path of a projectile for given firing angle and speed along with elevation profile of the terrain. The user can interactively modify the parameters and view the changes in the path profile of the projectile.



Crest Clearance

Computing Cross Country Mobility

This functionality enables the user to compute the cross country path for a Type A or Type B vehicle between two selected points. Cross country mobility analysis is based on path computation algorithm executed on a Going Map (Generated Using Going Map Updation Tool). Going map corresponding to the AOI shall be loaded in the map window to perform this functionality.



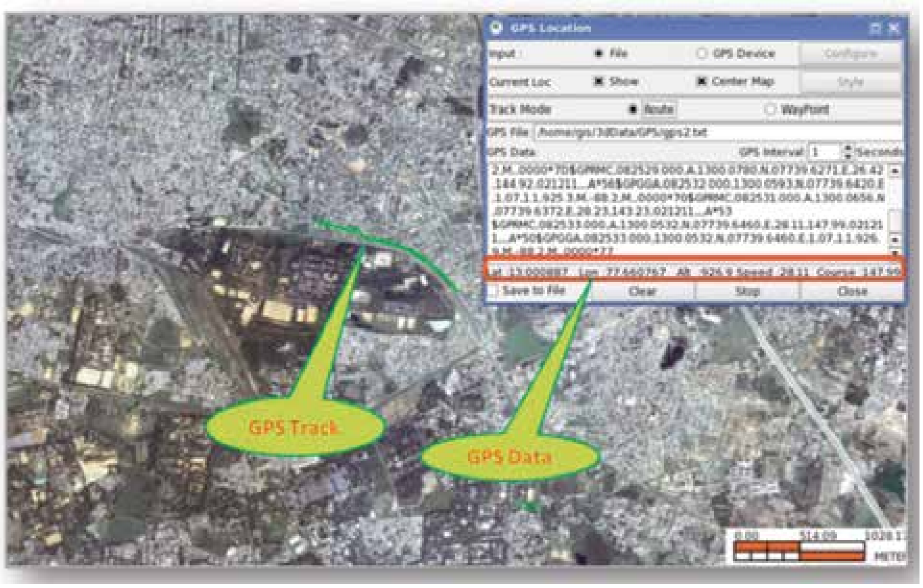
Cross Country Mobility

Sensor Data Analysis

INDIGIS can act as a platform for sensor data fusion/integration. INDIGIS can be used as GIS platform for display and analysis of integrated/fused data from various sensors (INDIGIS does not implement any sensor data fusion algorithm). INDIGIS application is integrated with sensors like GPS, digital compass, BFSR, etc. It supports real-time viewing and analysis of the sensor data in combination with other types of spatial data.

GPS Data

INDIGIS application allows the User to read and display the data from a GPS receiver connected to the system. The data can be read in two modes: online mode, which allows reading of data directly from the GPS and tracks will be displayed in real time while navigating and offline mode, which supports reading and displaying of data from a file containing the GPS data. It also supports saving of data read from a GPS receiver into a file. Once the GPS tracks/way points have been captured in INDIGIS, they can be converted to data layers like road, temple, etc.

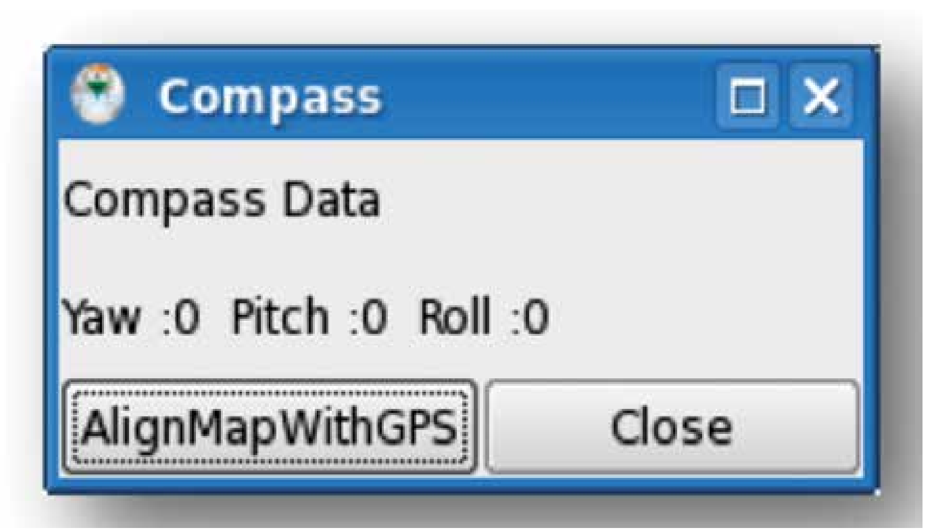


GPS Data Analysis

Digital Compass

INDIGIS application enables the user to read data from a digital compass.

Digital compass gives Yaw, Roll and Pitch directions and accelerations along these directions of the platform on which the compass is fixed. System connected with both GPS and compass will enable the user to align the map displayed in the map window with true ground direction. This is active by centering the map with respect to the GPS current location and rotating the map with respect to the yaw angle. The yaw angle will give the angular difference from the magnetic north; which will be added with the magnetic declination at that location to get the actual angular deviation (aspect) from the true north.



Digital Compass

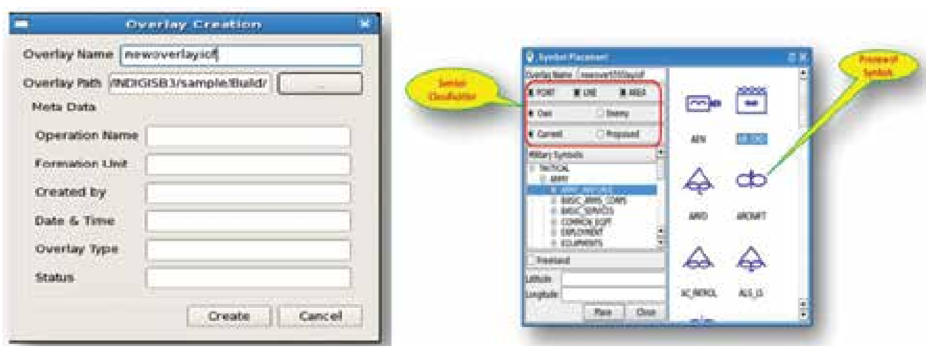
UAV Video

The video data obtained from an UAV can be viewed in INDIGIS. UAV video playing functionality enables the user to view the video along with the foot print (instantaneous field of view) of the UAV on the map window. This functionality has been implemented in INDIGIS as a prototype model for playing video data of Nishant UAV. UAV data consists of two parts: A video file and a coordinate file. Video file contains the frames captured by the UAV in any of the standard formats like mpeg or avi. The coordinate file is a text file, contacting the geo-referencing information (geographic extents) for the frames. The video and the coordinates should be synchronised and the frequencies of the video frames and coordinates should be known.

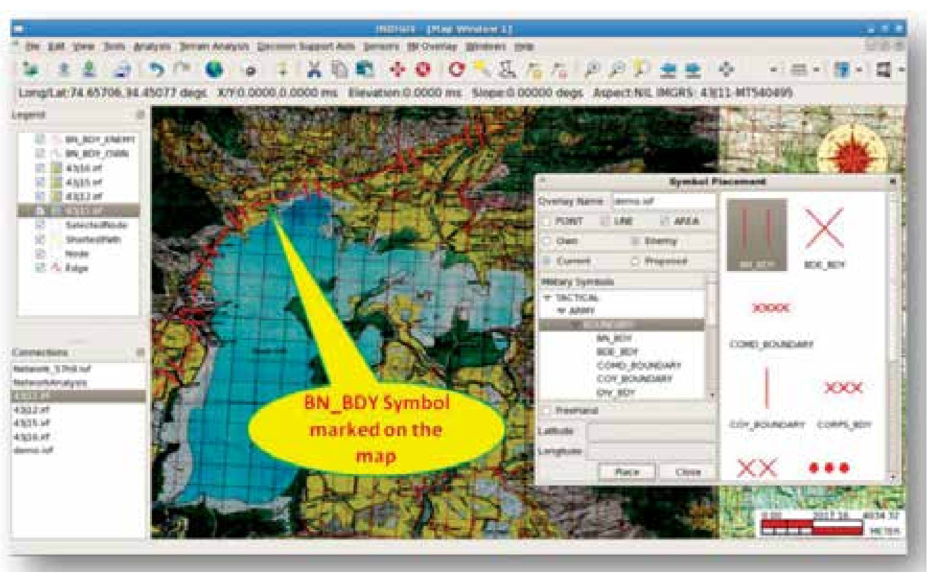
UAV Video

Military Overlays

INDIGIS supports creation of user defined layers by providing interactive drawing tools and rich set of military symbols. This functionality enables the user to depict the tactical scenarios during planning and execution of operations with digital map background by interactively marking the symbols on the map. Military symbols are categorised based on the context of usage. INDIGIS supports symbols in SVG as well as in various raster formats (PNG, JPG, BMP, etc.). INDIGIS has a built-in symbol maker utility which supports creation of military symbols in SVG format. INDIGIS allows the user to create, open, edit, save and merge military overlays. Overlays are stored in INDIGIS Overlay Format (IoF) which is similar to the IVF format.



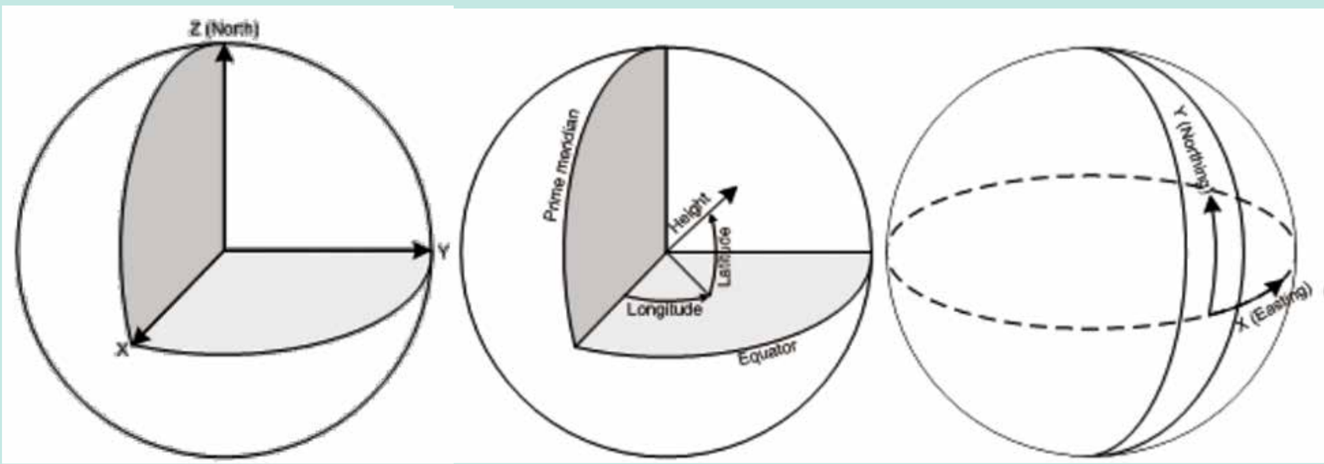
Overlay Creation and Symbol Placement



Symbol Marking and Placement

Map Projections

A spatial coordinate system provides the mathematical basis for relating the features in the map to their real-world positions. INDIGIS supports the following types of coordinate systems and methods for coordinate system transformations among these. Spatial data which can be operated with INDIGIS should be associated with a valid coordinate system.



Geocentric **Spherical** **Cartesian**

Projection Systems

INDIGIS supports coordinate systems at following three levels:

Storage Coordinate System

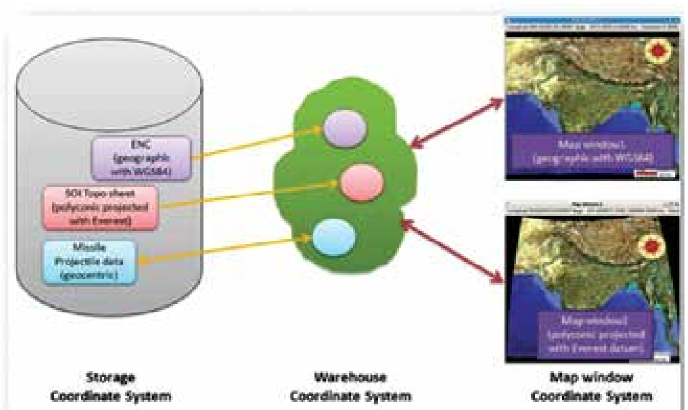
This is the coordinate system in which the map data is stored in data source as described above. INDIGIS supports reading of map data in various standard coordinate systems.

Warehouse Coordinate System

This is the coordinate system in which the map data is loaded in the warehouse. That means, the data can be transformed (re-projected) into a different coordinate system while loading into warehouse. By default, the storage and warehouse coordinate systems for a data source are same in INDIGIS application. Hence, the warehouse might contain map data with different projections.

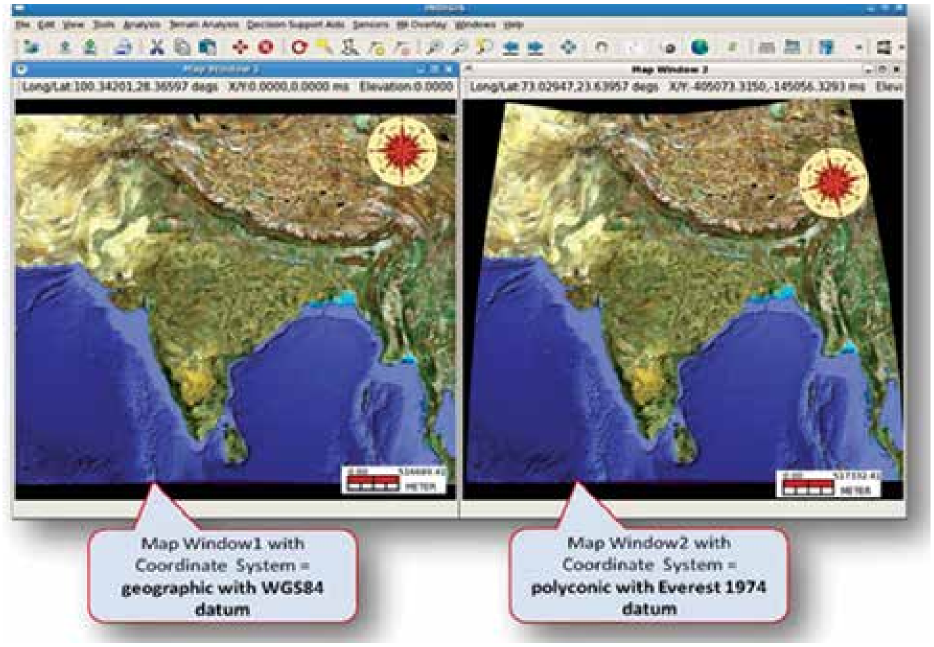
Map Window Coordinate System

This is the coordinate system in which the map data is displayed in the map window. As the warehouse might contain data with different projections, they need to be transformed into the view coordinate system before being displayed in map window. User can modify the coordinate system of the map window at any time. This is called on the fly projection of maps, which allows the user to view the data (both raster and vector) with different projections in a selected projection. Since, INDIGIS supports multiple map windows, the same data can be viewed in different projections (in different windows).



Coordinate System Transformation

INDIGIS supports the following projections and datum. However, the projection module can be extended by adding more projections and datum in the configuration files of INDIGIS. The user can view and/or change the coordinate system of the active map window. On changing the projection of the map window, the map will get displayed in the selected projection system in the window as shown in Figure.



Data using Different Projection Systems

Transfer-of-Technology

Transfer-of-Technology (ToT) is a very important issue among the S&T fraternity because ToT holds a key to participation, creation of capacity and capability in industry and market thus generating revenue and utilisation of the technology among masses. The ToT for a generic technology encompassing mechanical, electrical or combination of the engineering discipline is well-laid down. But ToT of software is a bit tricky issue, in the sense as software has both tangible and intangible aspects. Tangible parts of a software are KLOC for source code, number of pages of documentation, cardinality of input domains, number of functions it performed, size of data (KB, MB, GB, TB), UI/MMI/GUI, while intangible part of the software technology are ways software designer and developer metamorphose algorithms to a source code thus achieving the functional goal of a software. Therefore, ToT should address both tangible and intangible parts of the software technology. Often, computing and fixing a price for tangible part of software technology is well-laid down and easy but ToT and costing of non-tangible part holds a key to successful ToT of software technology.

Therefore software ToT must look into both tangible and non-tangible part of software while performing ToT. The first part is quantifiable and industry must have ways and means to quantify and put a number and cost to a tangible part of software ToT. The ToT of a software technology will not be successful if appropriate absorption of non-tangible part of a software is not taken care. This is often known as domain knowledge. Significant steps involved in ToT of a software technology are:

- Technology nomination
- Finding the right industry partner
- Accessing its capacity and capability
- Formulating License Agreement (LAToT)
- Passing tangible part of technology through human resources training
- Passing non-tangible part of technology through appropriate example programme
- Hand holding of technology partner till sufficient insertion of technology in different systems

There is growing requirement of an indigenous GIS technology across different DRDO laboratories to realise their project objectives. Many DRDO laboratories have evaluated and experimented the capability and features of the INDIGIS technology for their domain usage. On realising the immense potential of INDIGIS, the laboratories have approached

CAIR for support in developing GIS work flows for their projects. Also, INDIGIS was evaluated from different independent private and govt. agencies for its export potential to different countries.

To build capacity and capability building in Indian industry to meet such rising demands and further proliferate and export this technology, a nonexclusive ToT of INDIGIS was imparted to Bharat Electronic Limited (BEL), Bengaluru. BEL has inducted this technology to 17 existing Indian military systems and exported to Armenian military (as part of WLR system). To further proliferate this technology in military and civil applications a dual use version of this technology has been offered for ToT to Indian industry and multiple vendors have expressed their interest to take up this technology.

Enterprise Tri-services GIS

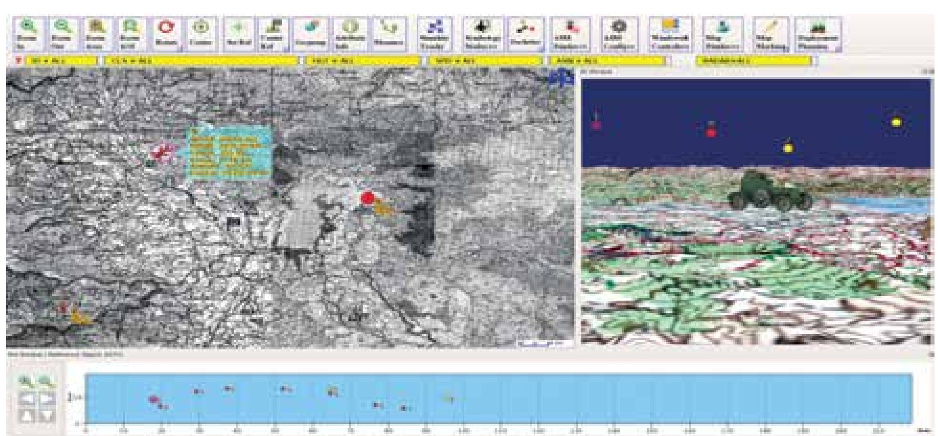
Based on the success of INDIGIS, the Users of this service evaluated its potential and has decided to make use of the INDIGIS kernel to develop a "Indigenous GIS for Tri-Services", through a mission-mode project sanctioned as per DPP 2016. This project aims at making use of the INDIGIS kernel to build a state-of-the-art enterprise GIS which will make the visualisation, analysis, measurement and simulation functions of the IGIST available to 1500 Users across pan India through DCN.

The unique challenge of this project is to make available the state-of-the-art GIS functions available to users across DCN in a varying and very low bandwidth. Also the challenge is to fuse the spatial data in different radiometric and spatial resolution obtained from various sources and agencies and process and extract operation information useful for the 1500 user simultaneously.

Defence Applications of INDIGIS Technology

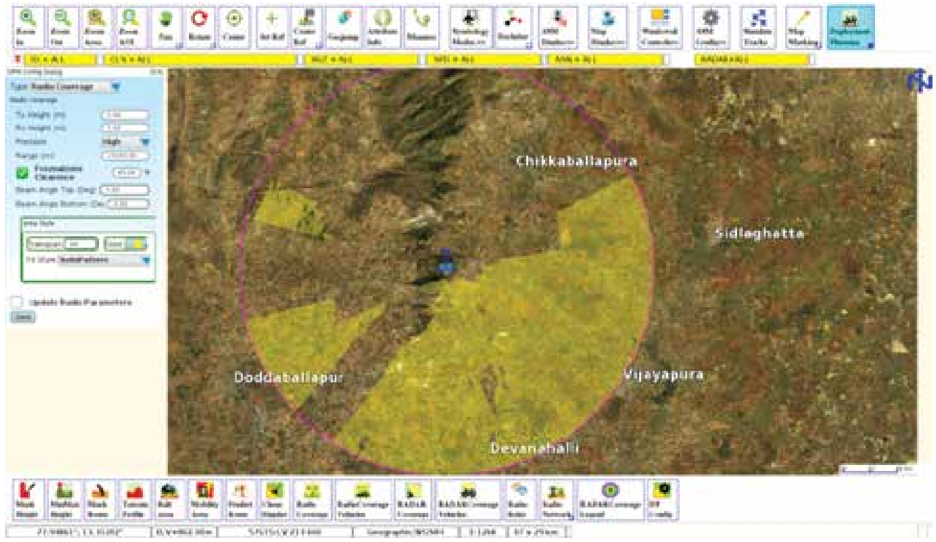
Quick Reaction Surface-to-Air Missile

The Quick Reaction Surface-to-Air Missile (QRSAM) is a mobile, ground-based air defence system capable of providing defence against a wide variety of air threats in the combat zone. The objective of QRSAM weapon system is to provide protection to mechanised assets of army on the move with a capability to fire on short halts. The QRSAM weapon system consists of a higher echelon and Regimental Command Post (RCP) controlling three guided weapon batteries (Bty). The heart of the Bty system is the Battery Command Post (BCP) which is capable of commanding up to six Combat Groups (CG). Each CG, in its two vehicle configuration, consists of one Battery Multi-Functional Radar Vehicle (BMFRV) with the capability to track 64 targets simultaneously at distance of up to 80 Km and Mobile Launcher Vehicle (MLV). BCP also receives target data from Battery Surveillance Radar Vehicle (BSRV) with a tracking range of 120 Km The CG in its single vehicle configuration shall house the BMFR and mobile launchers in the same vehicle which is termed as Combat Vehicle (CV).



Air and Ground Situation Monitor Display of QRSAM

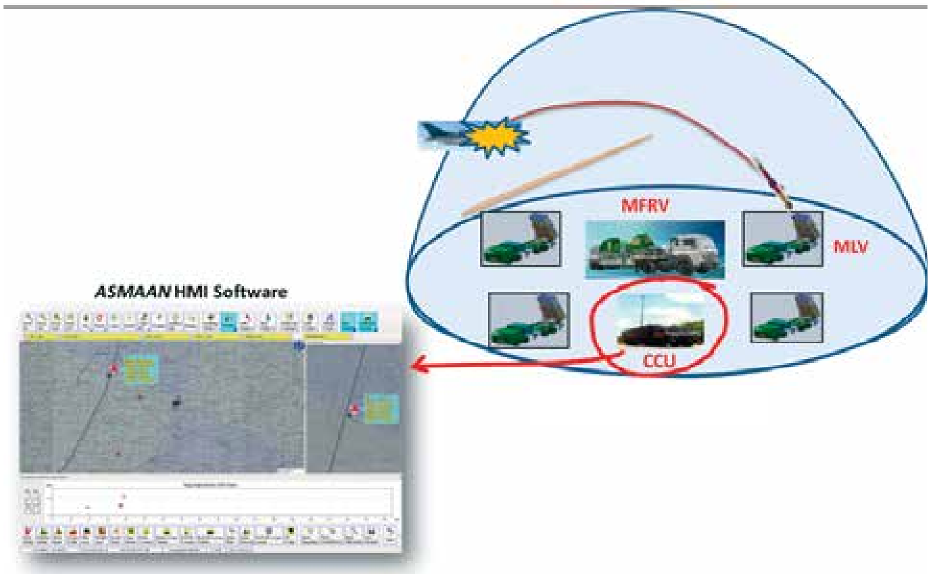
- The Battery Command Post Vehicle (BCPV) of QRSAM system is an automated command post co-located with surveillance radar BSRV. The BCPV coordinates and controls up to four CGs. Each CG consists of a fire control radar (BMFRV), Electro-Optical Tracking (EOT) system, target update links and an MLV mounted with six canisterised missiles. The BCPV user needs to be provided with appropriate interfaces to enable the user to carry out BCPV tasks. INDIGIS provided the solutions to the following needs of BCPV user of the QRSAM weapon system.
- Interactive graphical display of ground and air situation picture with digital map background
- Spatial decision support for deployment planning of combat vehicles



Deployment Planning Module of QRSAM

Akash-NG Surface-to-Air Missile

The Akash-New Generation (Akash-NG) is a Surface-to-Air Missile (SAM)-based Air defence system, capable of providing air defence cover to defended area. The Akash-NG firing Unit consists of Command and Control Unit (CCU), Multi-Functional Radar (MFR) and four Missile Launcher Vehicles (MLV). Each MLV contains six canisterised Akash-NG missiles. The CCU is the automated command and control centre for the Akash-NG. The CCU shall perform command and control functions for the Akash-NG weapon system. The CCU shall receive and process target data from MFR, neighboring FUs and IACCS and provide integrated air situation picture for combat operations and to the commander. CCU shall perform target classification, identification, threat evaluation, engagement and kill assessment for neutralising the threat.



Akash NG System

Air Situation Monitor (ASM) and Deployment Planning Module (DPM) software which is part of the CCU HMI software of Akash-NG is realised using INDIGIS. ASM provides an interactive display of tracks captured by various sensors on the map background, enabling situational awareness to field commanders. The DPM is used for deployment planning of Akash-NG weapon system elements such as CCU, MLV and MFR.

MBT Arjun

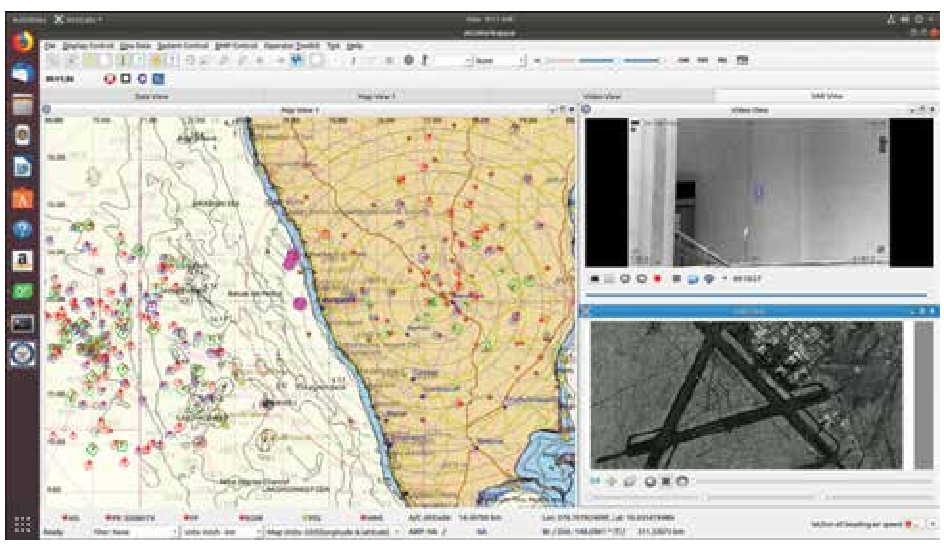
Unmanned systems are increasingly being deployed to generate and leverage tactical and strategic advantages in the modern battlefield. One critical technology that is poised to dramatically alter the dynamics of warfare is the Unmanned Ground Combat Vehicle (UGCV). The game changing role of UGCV has been acknowledged worldwide and many countries have embarked on long term UGCV development programmes on different vehicle platforms. Of particular importance is the UGCV developed on heavy tracked combat platforms, due to its decisive role in the front line of the battlefield. As a proactive effort in this critical domain and to provide technological superiority to Indian Armed Forces, Combat Vehicles Research and Development Establishment (CVRDE) has proposed the design and development of an UGCV-based on the MBT Arjun MK 1A tracked combat platform. The objective of the proposed project is the design, development and field validation of an UGCV on the MBT Arjun Mk 1A, with the 120 mm main gun as the primary weapon.

The operational context of the system is long-range navigation in sandy and dunal desert terrains of Rajasthan. One of the relevant challenges in the development of the system is route planning over long distances (far beyond the perceptual ranges of the on-board sensors). Another relevant challenge is the provision of a user-interface for the unmanned vehicle at a remotely placed control station, to provide contextual information to the operator. INDIGIS is proposed to be employed to meet the above challenges. It will be used to provide the operator with a visual perspective of the operational terrain and the location of the vehicle in the terrain. Further, INDIGIS will be used to generate a feasible route for the vehicle to follow to reach an operator-defined target location in the terrain.

AESA-based Integrated Sensor Suite for Maritime and Pollution Surveillance

To carry out the roles of maritime and pollution surveillance critical technologies, which are different from those used in Airborne Early Warning and Control system (AEW&CS) were designed and developed in a Technology Demonstrator (TD) project titled 'AESA-based Integrated Sensor Suite (ABISS) for Maritime and Pollution Surveillance'. The mission sensors in ABISS include an Active Electronically Scanned Antenna (AESA)-based Maritime Patrol Radar (MPR), Automatic Identification System (AIS), Electro-Optical/Infra-Red (EO/IR) system and Pollution Surveillance Sensors (PSS) suite. These sensors have to be integrated using a distributed, scalable and modular Mission Management System (MMS) and the Maritime Domain Awareness (MDA) picture to be displayed to the operators on dual monitor Multifunctional Tactical Console (MTC). The integrated testing of sensors with Mission Management System (MMS) and MTC is being done in a laboratory environment with the sensors mounted on the roof top.

CARIGIS is used for the development of Multifunctional Tactical Console (MTC) HMI application for ABISS. MTC provides human-machine interface for operator to control sensors and visualise sensor output in the form of combined Real-time Maritime situation Picture (RMP). ABISS is a feeder project to the development of Multi-Mission Maritime Aircraft (MMMA) for Indian Coast Guard.



ABISS System

Indian Maritime Situation Awareness System

Indian Maritime Situation Awareness System (IMSAS) is a system developed by Centre for Artificial Intelligence and Robotic (CAIR) for Indian Navy to provide common operating Picture and situation awareness to naval commanders. The geospatial visualisation and analysis functionalities for the system is developed using INDIGIS technology. One of the major features provided by INDIGIS is the dynamic visualisation large volume of moving ships across the world.

Indian Maritime Situation Awareness System

Dharastra

INDIGIS technology is part of a geospatial visualisation software being developed by CAIR for Project Dharastra of Defence Geoinformatics Research Establishment (DGRE), Chandigarh. Dharastra is a flagship on-going project of DGRE for study and analysis of geographic data pertaining to strategic locations in Tibetan regions. The project envisages to design and develop terrain topographic database and GIS application for geo-spatial framework with special emphasis on artificial triggering of mass movement. CAIR is one of the collaborative laboratory for development of desktop and enterprise software for visualisation and analysis of large terrain datasets.

Multi-static Surveillance System,

The objective of the project is design, development and proof of concept demonstration of Multi-static Surveillance System (MSS) for detection and tracking of airborne targets. Salient features of MSS are capability of detecting low observable targets and covert, anti-ARM and anti-jamming operation.

The operator workstation of MSS requires a GIS-based application capable of analysing the deployable configurations of the stations (coverage analysis) located geographically apart. Also, radar range coverage, LoS communication between two stations are the modules that require GIS-based solution for the project.

Performance of this category of sensor system highly depends on the deployment configuration and GIS software is expected to aid in the selection of suitable locations for their receive station.

MSS System

Integrated Reconnaissance Information System

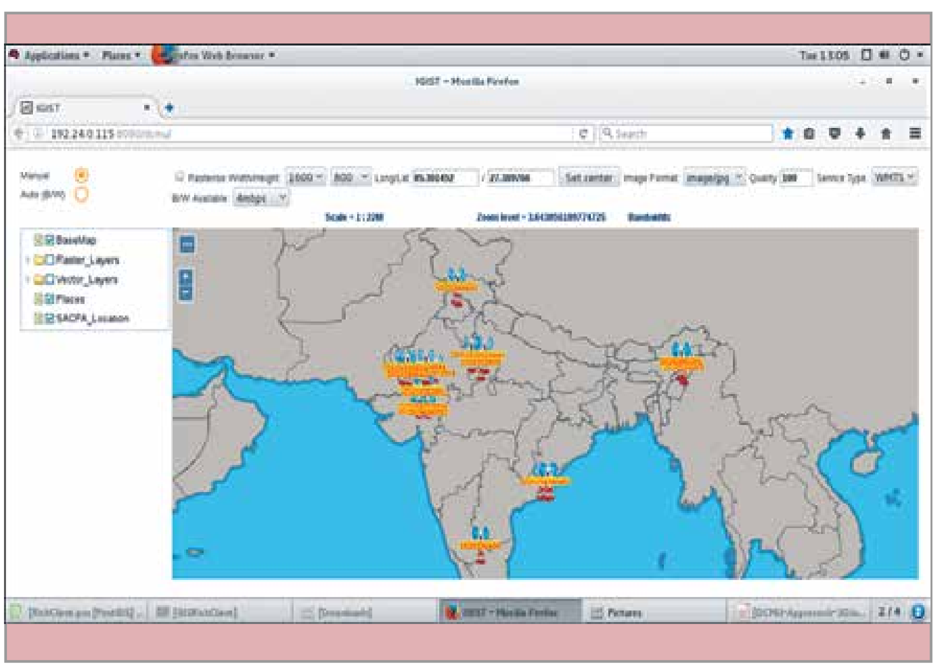
The objective of the project Integrated Reconnaissance Information System (IRIS) is to design and develop upgraded operator console for AEW&C and future projects of Centre for Air Borne Systems (CABS). Major features of this system are 2D and 3D map display, mission parameter data management, mission time processing, periodic health processing, Air Situation Picture (ASP) display and management, Command & Control, facility for management & control of AEW&C subsystems, recording and playback, dual monitor, finger print authentication, multi-touch screens and voice commands.

The system provides visualisation of plots and tracks of air/surface targets from the on-board sensors and provide composite ASP to the operator along with geographical information. The IRIS console will display with background map. All the detection and tracks from sensors will be plotted on the map. The map can be in 2D and 3D (Terrain).

IRIS System

Mobile Tower Allocation for IAF

It is an INDIGIS-based web application for IAF to be used as a decision aid for sanctioning of mobile towers in India. It will be used across IAF (from Air HQ to Lodger Unit), over AFNET. It will provide visualisation of existing mobile towers, various operational installations and locations of new requests for mobile towers over map/satellite background.

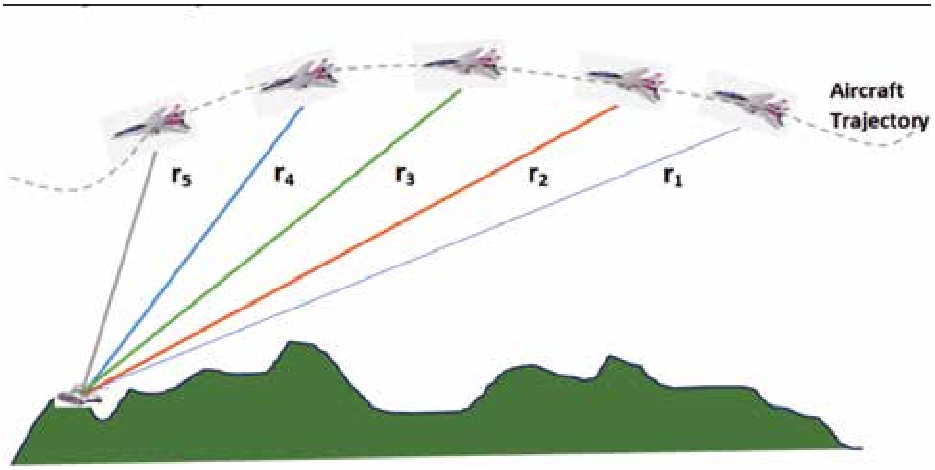


Mobile Tower Allocation (IAF)

Geo-Pointing and Geo-location, IRDE

An aerial gyro-stabilised system provides the reconnaissance, surveillance, target detection and automatic target tracking from the airborne platforms. Imaging sensors are fitted in the belly of the airborne platform to provide the video to compute system fitted inside the aircraft.

The aerial platform is flown over a pre-planned sortie, loaded with the associated gimbal and sensors. Pre-planned sorties are flown on the airborne platform to gather video and aerial imagery around Areas of Interest (AOI) identified by the operator. During the flight the pilot/ operator would like to point to a particular AOI or geo-locate the current video frame. This location awareness enables operator to communicate to ground personnel who can determine direction and distance to the AOI, eliminating



Operational Scenario

guess work and speeding up strategic decisions. The actuating parameters of the gimbal have to be computed to look at the targets of interest for Geo-Pointing (GP). In the Geo-Location (GL) scenario, the problem is to compute the location of a target that is being currently pointed/tracked by the sensors.

The GP and GL functions required in a search and rescue operation have been enabled by CAIR's indigenously developed GIS. The geo spatial data as computed and displayed by INDIGIS is used for decision making and surveillance. This encumbrance free solution from CAIR will be integrated and deployed with the Compact Airborne Multi-Optronics Payload (CAMOP) system of Instruments Research and Development Establishment, Dehradun.

Screenshot of Software for Geo-Pointing and Geo-Location

Advanced Light Towed Array SONAR

INDIGIS technology has been ported onto IBM Power PC platform and integrated with HMI utility of SONAR applications, which provide an interactive display of tracks captured by SONAR with Electronic Navigation Chart (ENC) background for usage in Advanced Light Towed Array SONAR (ALTAS).

ALTAS System

Future Roadmap of INDIGIS Technology

Battle Field Visualisation

The visualisation of battlefield through GIS is an emerging topic. INDIGIS gives various options to the battle commander to visualise the battle elements through thematic maps. At present the battle commander can see the troop deployment as an overlay with themes like own ORBAT, enemy ORBAT, sensor deployment, terrain appreciation, deployment in 3D terrain, etc. In future the technology will have sensor coverage analysis in 3D with analysis of sensor shadow zone for deployment planning. Also, a spatio-temporal appreciation of intelligence events in the battle zone is important to appreciate the intelligence correlation by the battle manager. Therefore INDIGIS is poised to develop battle visualisation and appreciation from the prospective of Ops, Int and Logistic in land, sea and space dimension.

Geo-Spatial Intelligence

The corner stone of any military GIS is analysis and prediction of geo-spatial intelligence in association with terrain intelligence. INDIGIS, because of its inherent nature of element level spatial data handling capability and intelligence data handling capability will be helpful in forecasting spatio-temporal intelligence. In the future scope, the laboratory are augmenting the INDIGIS with a library of spatial statistics which will analyse the correlation between geo-events and extract spatio-temporal intelligence.

Spatio-Temporal Artificial Intelligence

The future scope of artificial intelligence in general and GIS technology in particular will be to make use of AI techniques to analyse and extract patterns from spatio-temporal data. There are various examples of ANN in the form of CNN and deep neural network to process spatio-temporal data for object extraction, change detection and image registration. The GIS of future will make use suitable AI techniques to process satellite images for registration, de-noising, for extraction of terrain features and detect terrain change so as to extract geo-intelligence which will be useful to the society for prediction of disaster, monitoring of misuse of land use and land cover resources and effective management of terrain resources for the human kind in a more sustainable manner.

The laboratory is in process of augmenting the indigenously developed GIS with a state-of-the-art AI library for analysis of spatio-temporal data.

Digital Mapping of Celestial Objects

The future GIS will be not only exploit the spatio-temporal data generated from land, sea, and air in the form of digital terrain maps, navigation charts but the space data in the form of location and ephemeris data produced by celestial objects such as planets, satellites, debris in space. These celestial data will be used in different space datum and co-ordinate systems to visualise and analyse the spatio-temporal events exhibited by natural and man-made space constellations. GIS will be able to predict the launching time of satellites and space vehicles, the time for starting of countdown. Also GIS will be capable of mapping the surface of celestial objects like moon, mars or other celestial planets for exploration. The GIS, capable of computing the location and trajectory of PMG and other space vehicles, will be increasingly used for future space-based missions such as air-defence missions, ICBM missions and air-offence missions of future.

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